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REACTION TO FIRE PERFORMANCE OF CABLING INSIDE BUILDINGS

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EXECUTIVE SUMMARY

There is currently a substantial focus on the behaviour of various products under fire conditions. This document provides a detailed understanding of the background to this topic related to telecommunications and power cables.

The telecommunications cabling community have long recognised that their cables are commonly routed in substantial volumes and over significant distances within buildings. That routing would potentially pass through spaces with many functions and indeed many of those spaces would be regarded as evacuation routes.

Since telecommunications cables cannot be repeatedly jointed without unacceptable performance degradation, it became obvious that guidance was needed and BSI Technical Committee TCT/7 initiated activity in this area ten years ago leading to the publication in 2009 of BS 8492 which acted as a Code of Practice for the fire performance and protection of telecommunications equipment and telecommunications cabling.

BS 8492:2009 focussed on the need for compartmentalisation of spaces inside buildings together with effective fire detection and suppression systems rather than adopt cables of a particular performance when subject to fire conditions. The reason for considering the “reaction to fire” performance as a secondary approach was that:

a) the existing fire performance tests were considered inadequate;
b) the Technical Committee were aware of the forthcoming extension of the Construction Products Regulation to these cables - and there was little point in attempting to pre-empt the impact of the CPR;
c) many products associated with cables such as cable management systems were not well specified in terms of “reaction to fire”.

However, BS 8492 did focus attention on the key aspects of reaction to fire which are flame spread and the evolution of smoke and acid gases and did differentiate general spaces from those where the critical issues were either evacuation of personnel or protection of equipment.

BS 8492 was revised in 2016 to take account of the extension of the Construction Products Regulation to cover “power, control and communication cables”. Now in 2017, an amendment has been issued to reflect the full implementation of Construction Products Regulation to telecommunication cables from 1st July 2017.

There is no equivalent to BS 8492 for power cables and requirements and recommendations for fire performance of those cables were left to BS 7671, commonly referred to as the Wiring Regulations.

However, BS 8492 and the Construction Products Regulation DO NOT define where cables of a given reaction to fire performance shall be used. This is the role of BS 7671 for power cables and BS 6701 for telecommunications (communications and control) cables - subject to any future implementation of requirements within Building Regulations.

BS 6701:2016 has been amended in 2017 to specify requirements for cables in relation to their EuroClass under the Construction Products Regulation. The 18th Edition of BS 7671 (published 1st July 2018) was initially expected to address this issue for power cables – but has failed to do so, preferring to deferring this to a subsequent amendment.

Initially, there was confusion both over the actual requirements of the CPR about its scope i.e. what "things" were covered by the regulation. This document opens by dealing with those aspects.

Subsequently, customers, consultants and installers have been subjected a number of different, sometimes conflicting, messages about which cables can be used where - this has nothing to do with the CPR itself but with the contents of standards, national and local regulations that specify the planning and installation of power, control and communication cabling. This document explains what is happening in the United Kingdom in this regard.

Finally, there is considerable confusion over apparent contradictions between the fire performance specification of cables (as dictated by the CPR) and that of cable management systems (containment). This document provides some advice on how we may marry the two to obtain consistent objectives for reaction to fire insider buildings.

The FIA make no apology for the length of this document. There is no short version if a full understanding of this matter is to be gained.

THE CONSTRUCTION PRODUCTS REGULATION

There is both a substantial degree of ignorance and a great deal of confusion in relation to the impact of the EU Construction Products Regulation with regard to the general topic of cabling within buildings and other structures.

In July 2016, the Construction Products Regulation (referred to hereafter as CPR) was extended to cover "power, control and communication cables" and all relevant cables placed on the market after 1st July 2017 are required to conform to the CPR.

The EU Construction Products Regulation 305/2011 has replaced the earlier Construction Products Directive (CPD). It covers many building products including doors, ceiling tiles and now power, control and communication cables which are produced and placed on the market for incorporation in a permanent manner in construction works. The term "permanent" is a typically legal statement and this is discussed further below.

Any products within scope of the CPR are defined within a "harmonised standard" which provides a technical basis to assess the performance of that type of product. For "power, control and communication cables" the relevant harmonised standard in all European Economic Area (EEA) countries is EN 50575. In the UK this is published as BS EN 50575.

EN 50575 - ITS IMPORTANCE

EN 50575 addresses the "reaction to fire" of cables when subject to fire conditions by using a range of tests and associated limits which are specified in EN 13501-6. Products other than cables are addressed by other standards in the EN 13501 series.

EN 50575 covers cables that are intended to be used for the supply of electricity and communications in buildings and other civil engineering works with the objective of limiting the generation and spread of fire and smoke. It excludes circuit integrity cables which are required to function in the event of fire (e.g. fire alarm cables).

EN 50575 deals with the "system aspects" of the CPR when applied to power, control and communication cables. It defines the test regimes (in terms of audit control), the marking and labelling of cables and the application of the all-important CE mark.

The actual "reaction to fire" tests are specified in EN 13501-6 and the results of those tests allow the products to be allocated a Class (commonly referred to as a EuroClass). EN 13501-6 defines seven basic EuroClasses A_{ca}, $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca}, E_{ca} and F_{ca}.

Definitions of EN 50575

electric cable

all power, control and communication cables, including optical fibre cables and hybrid cables which are a combination of two or more of these cable types

power cable

assembly comprising one or more insulated conductor(s), together with any coverings and protective layers, used for the transmission or supply of electrical energy

control cable

assembly comprising insulated conductors, together with any coverings and protective layers, used for the transmission of control, measuring and indication signals in electric installations

communication cable

assembly of suitably insulated coaxial conductors or twisted pairs of insulated conductors fabricated to meet transmission, mechanical and environmental requirements, and sufficient to allow conveyance of information between two points with the minimum of radiation

optical fibre cable

assembly comprising one or more optical fibres or fibre bundles inside a common covering designed to protect them against mechanical stresses and other environmental influences while retaining the transmission quality of the fibres

From this definition, an optical fibre cable is required to provide mechanical and environmental protection to the optical fibre(s) - i.e. it has to be installable without any further protection.

For products other than EuroClass F_{ca}, the tests have to be undertaken by a Notified Body (from the appropriate NANDO list) who will issue a Certificate of Conformance (CoC) enabling the supplier to issue a Declaration of Performance (DoP) to indicate the relevant EuroClass. EN 50575 specifies the requirements for the contents of the CoC and DoP. Combining this concept of cable with that of "permanent" installation, it is clear that **any cable** that **may be installed within building**s falls under the scope of the CPR and **has to be specified in terms of EuroClass**. The only exceptions would be cables that are specifically intended for the production of short cable assemblies (cables terminated with connectors known as cords) and jumpers, which are obviously non-permanent.

It is therefore wise to assume that all cables placed on the market have to be underpinned by a DoP from the supplier indicating their EuroClass.

Cable suppliers and their routes to market (i.e. wholesalers and distributors) are required to apply this philosophy to all cables within scope of the CPR - applying marking, labelling and making available, upon request, a DoP in accordance with EN 50575 and applying the CE mark to indicate its compliance with CPR and with a particular EuroClass designation.

EXCLUSIONS

There has somewhat of a "head in the sand" attitude on behalf of some elements of the cabling industry as to what is covered by the CPR. There are very few exclusions - so to be clear from the communications side:

- coaxial cables **<u>are in scope</u>** of the CPR;
- UK "de-facto standard" cables such as CW1308 telephony cables **<u>are in scope</u>** of the CPR;

However, it is important to identify the exclusions that do exist and these are detailed below.

SEVEN IMPORTANT FACTS

- Œ CPR requires certain cables to be certified in terms of their "reaction to fire" - it DOES NOT specify where cables can be used
- • These cables are designated in terms of Class (or EuroClass), supported by a DoP traceable to a CoC and marked or labelled with the CE mark
- Ž Optical fibres and bundles of optical fibres that are not installable without additional mechanical and environmental protection are NOT within scope of CPR
- • CPR as defined by EN 50575 does not apply to "circuit integrity" cables which are required to function when subjected to fire e.g. fire alarm cables - it is anticipated that a future extension of the CPR will deal with these cables also but the timeframes are unclear
- • Cords are NOT within scope of CPR - but the cables they are constructed from may be
- ‘ Cable management systems are NOT within scope of CPR - this includes conduit (and blown fibre microduct), trunking, ducting and tray
- ’ Cables and cable management system may be CE marked to show their conformance with the Low Voltage Directive - documentation should indicate which Directive of Regulation is applicable

Cords of any length and for any purpose are not subject to the CPR, cannot be issued with a DoP and cannot be CE marked. However, the cable used to create them can be. Only cable specifically designated with an intended use of non-permanent installation can avoid CPR compliance.

Optical fibres and optical fibre bundles that are placed on the market in that form for installation by blowing or pulling into tubes (often called microducts) are not considered to be cables in accordance with the definition detailed above if they do not have a structure to protect them against mechanical stresses and other environmental influences without accommodation within that tube. For this reason, they do not fall under the scope of the CPR and cannot, legally, be subject to the marking, labelling, DoP and the CE designation in accordance with EN 50575. However, if they are placed on the market within a tube then the combination of tube and optical fibres/bundles are acting as a cable and are within scope of the CPR (as would be a conventional loose tube optical fibre cable).

CE

It is illegal to apply a CE designation to any product that is not subject to a harmonised standard under a European Union Directive or Regulation - irrelevant of whether tests have been carried out which indicate adequate performance.

Cables that are required to **only provide function in the event of fire** (i.e. fire alarm cables) are excluded from EN 50575 but if they are placed on the market with a combination function (i.e. act also a telecommunications cables) then they are within scope .

Cable management systems (CMS) are not within scope of the CPR and cannot be designated with a EuroClass in terms of reaction to fire. CMS are not covered by any harmonised standard under the CPR and are therefore cannot be designated with a EuroClass. Within the standards for CMS, reaction to fire performance is simply differentiated by the terms "flame propagating" or "non-flame propagating". It should be highlighted that "non-flame propagating" does not mean "does not propagate flame". For example, for a conduit to be "non-flame propagating" it is required to be tested in accordance with IEC 60695-2-11 and IEC 60695-11-2 - and these tests allow for a level of flame propagation of the same order as that for a cable of EuroClass E_{ca}. There are no tests specified in the CMS standards for evolution of smoke or acid gases. We return to the topic of cable management systems later in this document.

THE EUROCLASS SYSTEM

As detailed in Annex A, the EuroClass system indicates the performance of a telecommunications cable in relation to a number of "essential characteristics" as follows:

- for EuroClass E_{ca}
  - flame spread;
- and for D_{ca} to $B1_{ca}$
  - flame spread;
  - heat release;
  - smoke production (relevant for evacuation and fire-fighting activities) - designated with a sub-classification "s";
  - flaming droplets (which may be establish fire in adjacent materials) - designated with a sub-classification "d";
  - acid gas generation (relevant for equipment survival) - designated with a sub-classification "a".

NOTE: we ignore EuroClass A_{ca} here since it is virtually impossible to produce telecommunications cables that do not burn.

The result of this is that telecommunications cables may be designated as either E_{ca} or as a rather more complex designation such as C_{ca}-s1b, d2, a2.

What the CPR does not do is state where cables of a given EuroClass should or shall be used.

IMPLEMENTATION LEGISLATION, REGULATIONS, STANDARDS ETC.

National regulations may be legislative in nature and can be:

- truly national such as the Electricity at Work Act which addresses electrical safety within the UK and The Building Regulations that addresses most aspects of the construction of new buildings;
- a national implementation of a European Union Directive such as the EMC Directive;
- a European Union Regulation such as the CPR.

A local regulation may simply be the rules that apply to a particular location (e.g. an oil refinery) or an infrastructure (e.g. the London Underground).

HISTORY OF BS 7671

1882	1st edition: published as "Rules and Regulations for the Prevention of **Fire Risks** arising from Electric Lighting
1897	3rd edition: published as "General Rules recommended for Wiring for the Supply of Electrical Energy"
1907	5th edition: published as "Wiring Rules"
1924	8th edition: published as "Regulations for the Electrical Equipment of Buildings"
1992	BS 7671: "Requirements for Electrical Installations - IET Wiring Regulations"

Standards can be referenced by a national (or local) regulation. For example, The Part P of the Building Regulations for England states that BS 7671 gives guidance for compliance those regulations in relation to electrical works. This linkage contributes to a very important source of confusion between standards and regulation.

The current edition of BS 7671, the 17th, and its revision in 2018 (18th edition) contains hundreds of what are termed "regulations" but they are not legal regulations - they are requirements of the standard. So under the Building Regulations, BS 7671 gives guidance to compliance with true regulations. Also since 1992, BS 7671 has become the standard which is essentially the default reference during any prosecutions under The Electricity at Work Act and other health and safety legislation concerning low voltage installations. So in certain circumstances, standards can become a tool of national legislation or regulation.

It is also important to note that BS 7671 refers to supplementary standards which are essentially integral to their application - for telecommunications cabling, the standard referenced is BS 6701.

Finally and importantly, in cases of contractual dispute, legal decisions may be made on the basis of applicable standards - even if those standards have not been mentioned in the supply contracts.

UK STANDARDS FOR IMPLEMENTATION OF CABLE FIRE PERFORMANCE

The CPR is not intended to create new national legislation, regulation or standards in relation to fire safety.

Instead the CPR requires existing legislation, regulation or standards to reference the EuroClass system instead of any other measures of the "essential characteristics".

Article 8.3 of the CPR states

"…the CE marking shall be the only marking which attests conformity of the construction product with the declared performance in relation to the essential characteristics"

AND

" … Member States shall not introduce any references or shall withdraw any references in national measures to a marking attesting conformity with the declared performance in relation to the essential characteristics covered by a harmonised standard other than the CE marking.

The UK does not have any regulations that stipulate where cables of a given fire performance shall be used and therefore it has nothing in which to replace existing requirements with those of a EuroClass.

This is not true in other countries such as the Netherlands and Germany and national regulations in these countries are being replaced with EuroClass references.

In the UK, two standards specify where cables with a specified reaction to fire performance are to be installed. For power cables, the relevant document is BS 7671 and for telecommunications cables (of all types) the key document is BS 6701. These two standards represent a virtuous circle of cross-referencing since BS 7671 mandates BS 6701 for telecommunications cabling and BS 6701 returns the favour in relation to power supply cabling.

It should be remembered that unless specifically called up by legislation or regulations, the compliance with standards is contractual and voluntary. An installer and his customer could ignore the requirements of a standard but caution would be advisable since, if anything were to go wrong, the national standards tend to be the first port of call in any civil or criminal litigation.

THE PROBLEMS FOR POWER CABLES

Most telecommunications are specified in terms of their transmission performance rather than the materials used in their construction.
Unfortunately many UK standards for power cables are "product standards" which define their construction materials. Examples include

- BS 6004 (the base standard for twin = earth cables which is entitled "Electric cables. PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting".
- BS 7211, covering similar cables to BS 6004 but with better fire performance is entitled "Electric cables. Thermosetting insulated and thermoplastic sheathed cables for voltages up to and including 450/750 V for electric power and lighting and having low emission of smoke and corrosive gases when affected by fire".

BS 7671 has been revised (published as the 18th Edition, 1st July 2018) but it has deferred any incorporation of EuroClass implementations until an amendment (possibly in 2020). However, the 2017 amendment of BS 6701 is very clear about its requirements.

Within buildings and other structures, BS 6701 discriminates between installation cables and others where **installation cables** are defined as intended for installation into pathways which are hidden (below floors, above ceilings, behind walls) or to which access is limited and which can either be terminated in-situ or "pre-terminated". The term "**installation cable**" focuses attention on the location and accessibility of the cable should it subject to fire conditions.

Irrelevant of where the cables are installed BS 6701 states that, for new installations and the refurbishment or extension of existing installations, cables installed in the spaces bounded by the external fire barriers of buildings and other structures shall meet the following requirements:

- installation cables shall, as a minimum, meet the requirements of EuroClass C_{ca}-s1b,d2,a2;
- all other cables shall as a minimum meet either:
  - the requirements of EuroClass E_{ca} ;

  or
  - recommended requirements of BS EN 60332-1-2.

The second bullet generally requires some explanation:

- cables which are specifically designated as not suitable for the production of installation cables (e.g. jumpers) can avoid CPR conformance but are required to meet the minimum recommended requirements of BS EN 60332-1-2 - this matches the minimum requirement for cables inside buildings in accordance with BS EN 50174 series standards.
- cables which are not implemented as installation cables (i.e. they are NOT installed in pathways which are hidden and are accessible) may have been subject to CPR classification and in this circumstance they shall meet or exceed EuroClass E_{ca} (which maps to the minimum recommended requirements of BS EN 60332-1-2).

This requirement is simple and clear - and there are good reasons for this approach.

Telecommunication cables are generally routed on a point-to-point basis resulting in higher volumes of cables when compared with the power cables serving the same spaces. Telecommunications cables, whether high performance metallic or optical fibre cables, cannot be jointed as they pass from a space of one "category" to another without significant performance degradation.

Therefore, the fire performance of a telecommunications cable has to be selected to reflect the requirements of the most demanding space from the fire perspective - which is generally an "evacuation route". It is recognised that the use of a space can change during the lifetime of a building and that cables are rarely re-installed to match the nature of the space in relation to the key fire safety aspects.

The revision of EN 50174 standards in early 2018 states that within the spaces bounded by the external fire barriers of buildings or other structure, telecommunications cables shall be installed within a cable management system that is considered as a fire barrier in accordance with local fire regulations where the telecommunications cables:

- do not comply with the national or local fire regulations;
- do not meet the requirements of EuroClass E_{ca} or the minimum recommended performance requirements of EN 60332-1-2.

Standards for telecommunication cables generally focus on their transmission properties rather than the materials that they are made from. Therefore, cables of a given transmission performance (e.g. Category 5) can be produced using different materials and methods allowing a number of different EuroClasses to be achieved. Naturally higher EuroClasses may cost more but they can be produced.

By comparison, many standards for power cables dictate their materials which essentially define the EuroClass for the cables and restrict their capability to achieve better reaction to fire performance than allowed by those materials.

CABLE MANAGEMENT SYSTEMS

CMS will always be subject to fire conditions at the same time, or even in advance of, the cable(s) that it contains. Many lay readers will therefore wonder why cables are being specified across a range of essential characteristics of reaction to fire when the products we install them in, or on, are not subject to the CPR and avoid the same level of scrutiny.

NOTE: CMS products are subject to the Low Voltage Directive and may carry a CE mark based upon that Directive - not on the basis of the CPR.

This paper cannot explain why this situation pertains but this is clearly a topic worthy of consideration - and to determine if there are any measures that could be applied to regularise the situation.

We can firstly identify what the standards for CMS currently state and then will address any improvements in their procurement to match the performance of the cables they contain.

CABLE MANAGEMENT STANDARDS

BS EN	
50085	**TRUNKING AND DUCTING**
-1	General requirements
-2-1	Walls and ceilings
-2-2	Floor
-2-3	Cabinets
-2-4	Service poles
61386	**CONDUIT**
-1	General requirements
-21	Rigid
-22	Pliable … can be bent by hand with reasonable force, and which is not intended for frequent flexing
-23	Flexible … can be bent by hand with reasonable force, and which is intended to flex frequently throughout its life
-24	Underground
61537	**CABLE TRAY AND LADDER**

CONDUIT

Flame propagating material shall be “self coloured” orange..

Non-flame propagating material may be of any colour except yellow, orange or red, unless clearly marked on the product to be of non-flame propagating material.

The relevant products standards covering CMS and products are EN 61386 series (for conduit), EN 50085 series (for trunking and ducting) and EN 61537 (for tray and ladder). As mentioned above, within these standards the reaction to fire performance is simply differentiated by the terms “flame propagating” or “non-flame propagating”. It should be highlighted that “non-flame propagating” does not mean “does not propagate flame”. Obviously manufacturers of cable management systems do not know what cables will be installed within them so they have an argument for keeping things simple. Therefore, we have to delve a little deeper into the world of CMS.

It is a reasonable assumption to make that CMS constructed of metal are considered “non-flame propagating” and it would also be reasonable to expect that they therefore meet the most demanding requirements for smoke, droplets and acid gas evolution.

The more problematic areas are the CMS solutions constructed of non-metallic materials. These include a range of plastic materials used for conduit, trunking, ducting, tray and ladder. Many of these meet the “non-flame propagating” requirements when tested according to the relevant standards.

However as indicated above, a CMS is “non-flame propagating” if it meets requirements of the same order as that for a cable of EuroClass E_{ca}. Therefore, if the cables to be contained within or on the CMS:

- have an implied flame spread performance of D_{ca} or better then there is no automatic mechanism for matching the performance of CMS to these requirements;
- have an implied smoke performance of s2 (or better) and/or an acid gas performance of a2 (or better) then there is no automatic mechanism for matching the performance of CMS to these requirements.

An even more complex situation exists for the tubes used for blown (or similar) optical fibre installations. These tubes should conform to BS EN 61386-22 or BS EN 61386-23 and are not just CMS (as specified in BS EN 50174 standards) but they could also be installed alongside conventional cables and accommodated in or on other CMS. In this latter situation they act as de-facto cables.

It is obvious that we should not wish to degrade the reaction to fire performance of the cables by installing them in or with other products with lower levels of performance.

Even the most cursory Google™ search will identify that CMS products are available which are quoted as being low smoke and fume (LFS), low fire hazard (LSF) and low smoke zero halogen (LSZH and LSOH) and many other reaction to fire epithets. However these are very terms which the CPR system was established to avoid for the world of cables - but as we know CPR does not apply to CMS. Moreover, many of the detailed specifications for these CMS solutions refer to the material specifications of the CMS components rather than the actual components in any form of fire test - which is a little like defining the reaction to fire of a piece of paper by measuring the burning characteristics of a piece of wood.

So it is clear that the situation for non-flame propagating CMS of materials other than metal is unclear - the only clarity that could be applied would apply to small conduits such as those used for blown optical fibre.

WHAT COULD BE STATED ABOUT THE "REACTION TO FIRE" CHARACTERISTICS OF SMALL CONDUITS?

The tubes used for blown (or similar) optical fibre installations are deserving of a little additional study because they are CMS that are installed as de-facto cables. Because of the lack of a full "reaction to fire" characterisation of conduits within BS EN 61386 standards, there is a great temptation to try to use test methods associated with cable - particularly since cable now falls under the CPR.

There are a number of cable test methods that could be applied including those referenced by EN 13501-6 and others such as EN 60332-3 series standards (which are to some degree discredited due to their replacement by EN 50399 in EN 13501-6).

These tests could not be generally applied to all CMS solutions since the test methods applied to cables are designed for circular products mounted on a frame to which a flame is applied - they would not be easily applicable to tray, ladder, trunking or ducting.

If we focus on EN 13501-6, and this is the only standard in the EN 13501 series for which any logic exists, it is certainly possible to test small conduits which have similar diameters to many of our telecommunications and power cables - even though the standard itself applies to cables.

If we do apply the test methods referenced by of EN 13501-6 to a conduit then we could say it meets, for example:

- the flame spread requirements of Class X_{ca} according to EN 13501-6 when measured in accordance with EN 50399 and EN 60332-1-2 (the limits are shown in Figure B.1);
- the heat release requirements of Class X_{ca} according to EN 13501-6 when measured in accordance with EN 50399 (the limits are shown in Figure B.2);
- the smoke production requirements of Class s_m according to EN 13501-6 when measured in accordance with EN 50399 and EN 61034-2 (the limits are shown in Figure B.3);
- the flaming droplet requirements of Class d_n according to EN 13501-6 when measured in accordance with EN 50399 (the limits are shown in Figure B.3);
- the acidity requirements of Class a_p according to EN 13501-6 when measured in accordance with EN 60754-2 (the limits are shown in Figure B.3).

However, these tests are intended to be applied to cable - not conduit - and therefore there is no automatic correlation in performance and the results would be considered indicative.

What could be stated is that **such conduit has limited levels of heat release, smoke and acid gas evolution** and that its reaction to fire performance should allow its installation in combination with cables of EuroClass X_{ca}-$s1_m,d_n,a_p$ in accordance with EN 13501-6 without degrading the overall reaction to fire performance of the overall infrastructure.

What **cannot be stated is that it has a performance of X_{ca}-s_m,d_n,a_p in accordance with EN 13501-6**. A Notified Body cannot provide a CoC, a supplier cannot provide a DoP and it is illegal to allocate a CE mark to it in relation to CPR.

ANNEX A: HOW DO THE EUROCLASSES WORK FOR CABLE

This document refers to EuroClasses for the specification of the "reaction to fire" performance of cables in accordance with EN 13501-6. EN 13501-6 defines the tests to be undertaken by reference to other standards and, most importantly, specifies the limits for the measured test results that define appropriate classifications (both as basic and sub-classifications).

Basic classifications

EN 13501-6 defines seven basic EuroClasses A_{ca}, $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca}, E_{ca} and F_{ca} which are hierarchical by reference to the measured results when cables are subject to a range of fire performance tests. These "base standard" tests are specifically EN 60332-1-2, EN 50399 and EN ISO 1716.

EuroClass A_{ca} comprises cables that "do not burn" - characterised by a low gross heat of combustion when tested in accordance with EN ISO 1716. Cable meeting this requirement (such as those comprising uncovered mineral-insulated conductors) should not be confused with those that maintain some level of performance when subject to fire conditions. This latter is termed "resistance to fire" and not "reaction to fire".

Of the remainder of cables, EuroClasses $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca} are assessed against progressively lower requirements when tested in accordance with EN 50399. EuroClass E_{ca} cables meet the minimum recommended requirement of EN 60332-1-2. EuroClass F_{ca} applies to cables that fail to meet the requirements of EuroClass E_{ca}.

Sub-classifications

EuroClasses A_{ca}, E_{ca} and F_a have no sub-classifications leading to a EuroClass format of X_{ca} where X is the EuroClass A, E or F as detailed above.

EuroClasses $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca} require the inclusion of sub-classifications relating to the generation of smoke (s), flaming droplets (d) and acid gases (a) which are based on the results other tests according to EN 61034-2, EN 50399 and EN 60754-2 respectively. This leads to a EuroClass format of X_{ca}-s_m,d_n,a_p where X is the EuroClass ranging from B1 to D as detailed above, s relates to smoke generation (where m = 1, 2 or 3), d is for droplets (where n = 0, 1 or 2) and a is acid gas release (where p = 1, 2 or 3). In all cases a lower number/designation for s, d and a represents a better performance. This is summarised in Table A.1.

Table A.1 – EuroClass designations and their foundation standards

EuroClass	Reaction to fire	Additional classifications and parameters		
		Smoke production	Flaming droplets	Acidity
A_{ca}	Gross heat of combustion [EN ISO 1716]	None		
$B1_{ca}$	Heat release [EN 50399] Flame spread [EN 50399 and EN 60332-1-2]	s1, s2, s3 [EN 50399] Smoke transmittance s1a, s1b [EN 61034-2]	d0, d1, d2 [EN 50399]	a1, a2, a3 [EN 50399/ EN 60754-2]
$B2_{ca}$				
C_{ca}				
D_{ca}	Heat release [EN 50399] Flame spread [EN 60332-1-2]			
E_{ca}	Flame spread [EN 60332-1-2]	None		
F_{ca}	Fails to meet E_{ca}			

ANNEX B: THE EUROCLASS BOUNDARY CONDITIONS FOR ESSENTIAL CHARACTERISTICS

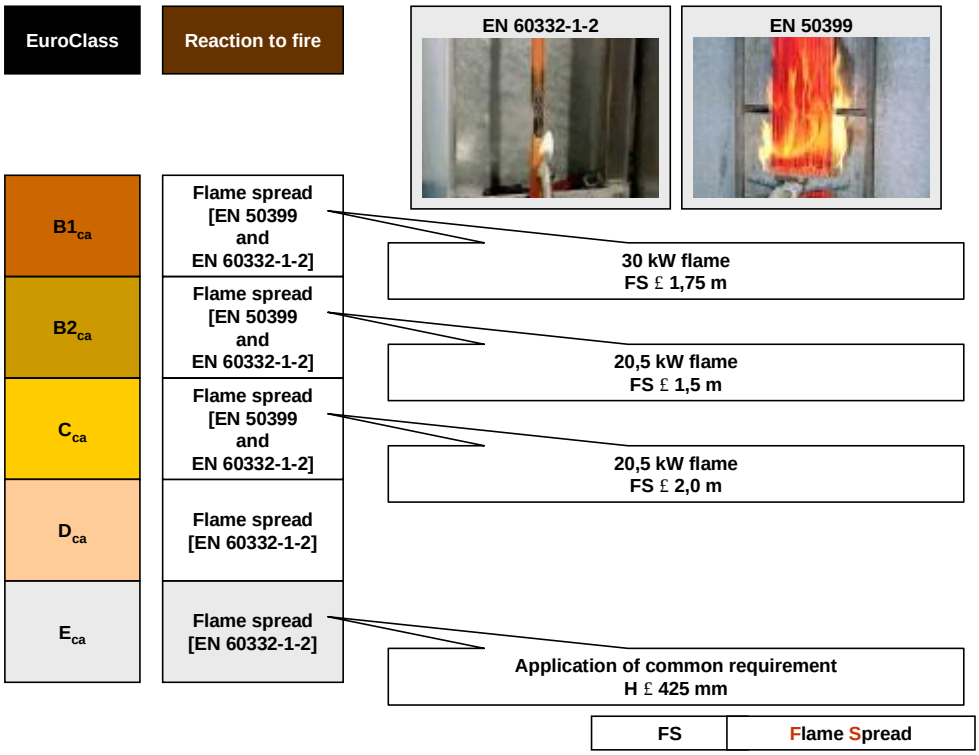


Figure B.1: Flame spread limits for Basic EuroClassification

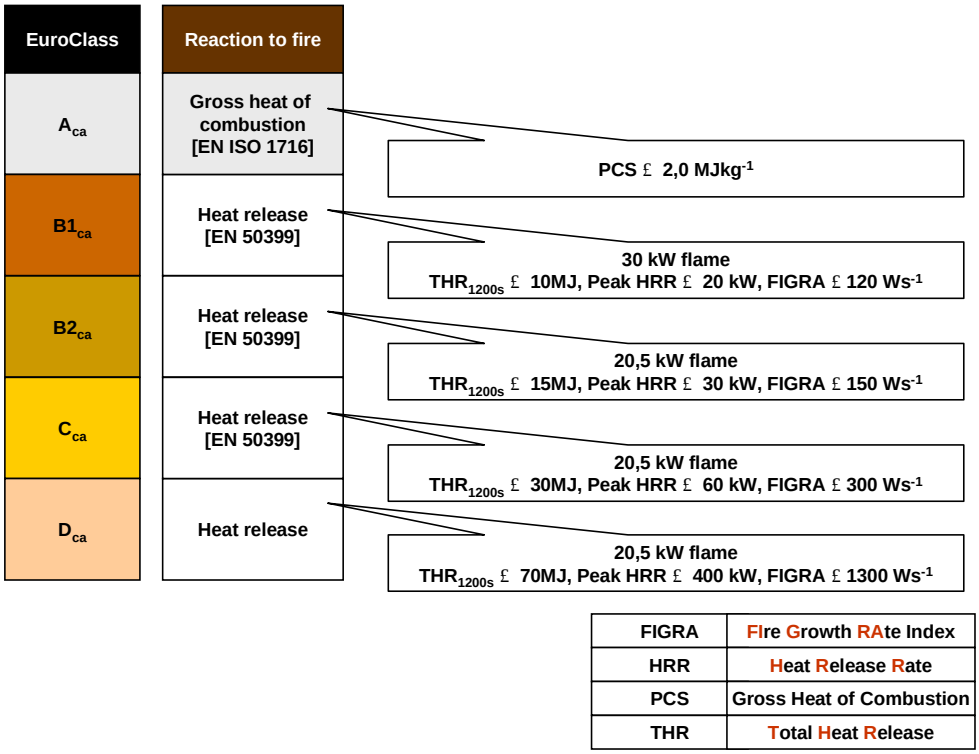
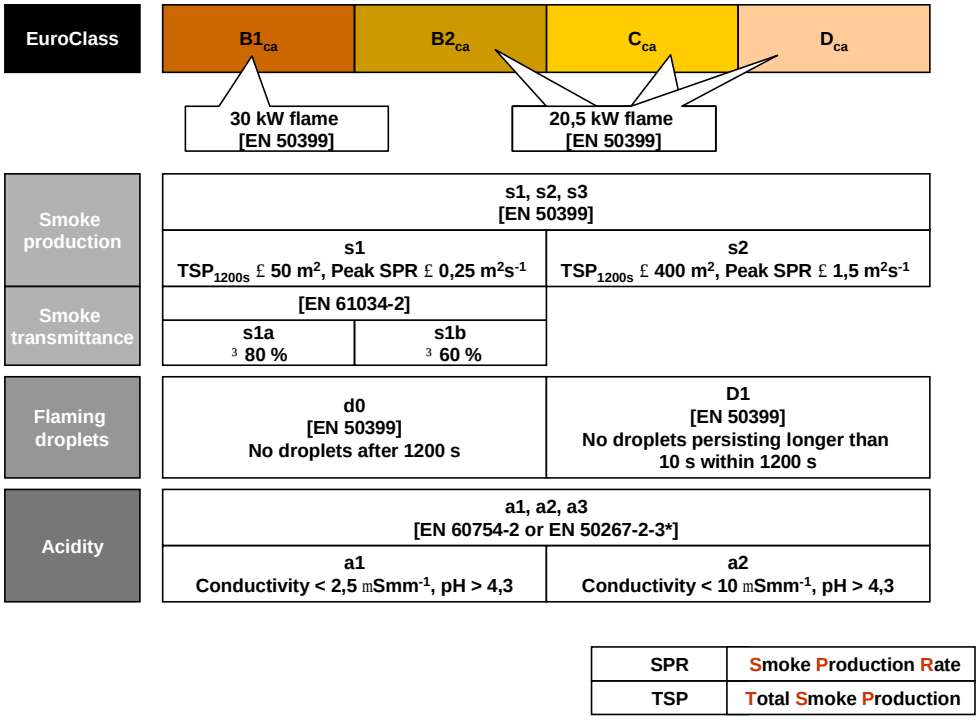


Figure B.2: Heat release limits for Basic EuroClassification



SPR	Smoke Production Rate
TSP	Total Smoke Production

* EN 50267-2-3 referenced from EN 13501-6 is superceded by EN 60754-2 (referenced in EN 50575)

Figure B.3: Sub EuroClassification limits

With regard to smoke production a classification of s1 or s2 indicates that the product meets the requirements of Figure B.3 when tested in accordance with EN 50399.

The additional classification for smoke opacity s1a and s1b applies to a product that meets s1 but has additionally been tested in accordance with EN 61034-2 and meets a transmission requirement of 80% (s1a) or 60% (s1b). A product cannot be designated s1a or s1b without meeting s1 - a product can be designated s1 without any additional opacity information.

As smoke production AND its opacity is a critical fire characteristic in evacuation situations, the UK tends to apply the joint designation of s1a or s1b.

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EN 60754-2:2014, Test on gases evolved during combustion of materials from cables. Determination of acidity (by pH measurement) and conductivity

BS EN 61034-1:2005+A1:2014, Measurement of smoke density of cables burning under defined conditions. Test apparatus

End of report

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