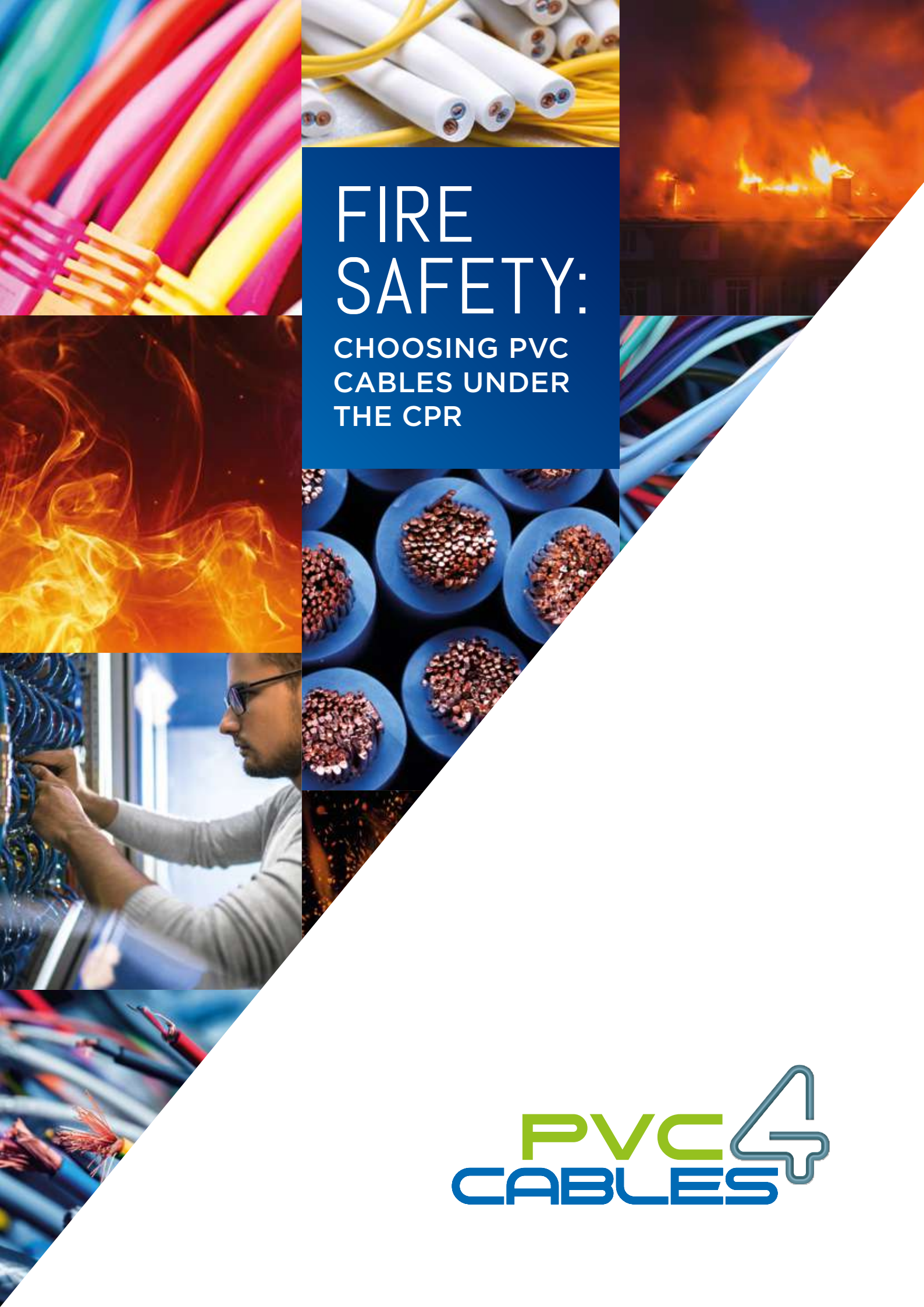
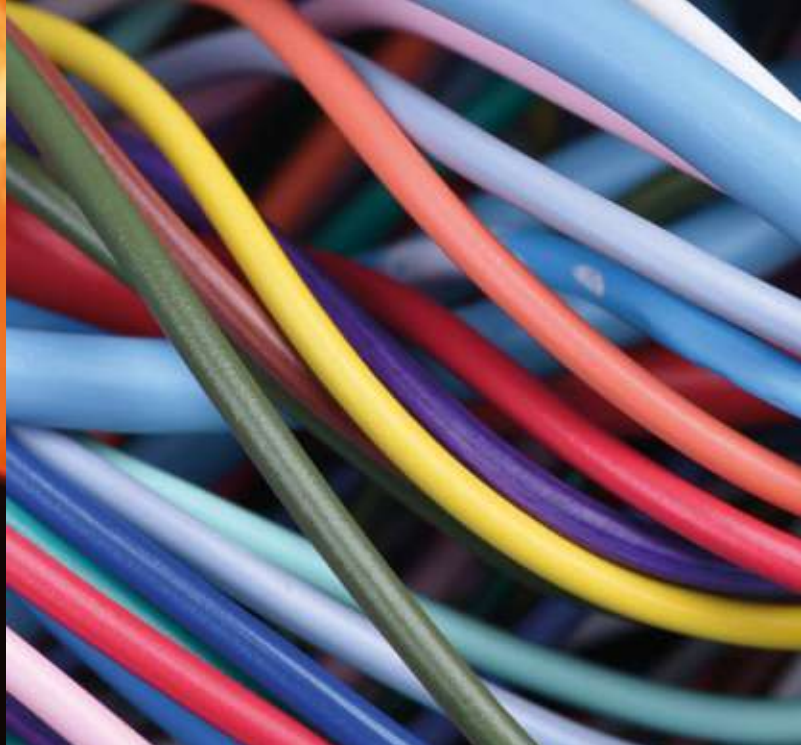




FIRE SAFETY:

CHOOSING PVC
CABLES UNDER
THE CPR

PVC4
CABLES



ABOUT PVC4CABLES

PVC4Cables is the European Council of Vinyl Manufacturers' (ECVM) platform dedicated to the PVC cables value chain. It brings together the producers of PVC resins, stabilisers and plasticisers, and PVC compounders. It is open for participation by PVC cables producers, recyclers and value chain's associations.

PVC4Cables intends to act as a driver for environmentally responsible innovations in the PVC cables sector and as a focal point for dialogue and communications with all stakeholders: cable producers, regulators, specifiers, installers, electricians, media and the general public.





INTRODUCTION

Without wires and cables, our society, as we know it, would not exist. Electricity, electronics, transports, IT, home automation depend on cables, especially in our interconnected and digitalised society.

Therefore, the choice of the ideal cable for the various applications assumes a fundamental importance to ensure maximum functionality and durability.

In building and construction, in particular, choosing the right cable means combining technical performance, fire safety, environmental performance, as well as

economic aspects in the most efficient way.

Fire safety and prevention are the fundamental basis for a correct building design. It must be supported by the adequate knowledge of the performance of the components to be used. Fire safety planning is a complex issue that takes a number of parameters, causes and effects into account.

This document aims to provide necessary information to make the right choice for the cable to be used in different building context, demonstrating the ability of PVC cables

to adapt to the individual specifications of intended-use/fire-risk with competitive costs.

In many cases, PVC cables continue to represent the best choice in terms of cost-efficiency and fire performance, in full compliance with the CPR (Construction Products Regulation) and related standards.

The PVC cable value chain will continue working to further enhance the technical and fire performance of its products, and to make PVC the material of choice for all applications.

1 / PVC FOR CABLES

Wires and cables are the largest application sector for flexible PVC in Europe, absorbing 7% of PVC resins production. PVC wires and cables account for around 41% of the European cables market, thanks to their advantages in terms of best cost/performance, sustainability and recyclability, which translate into technical, functional and safety benefits for end-users and consumers.



PVC is used for the production of electric and data transmission cables as well as insulation and sheathing in various fields: classic electric cables for power transmission at low and medium voltage for homes and offices; telephone cables; coaxial cable TV/computer/hi-fi; cables for cars; battery cables and robotics; data transmission cables, LAN and IT.

**PVC WIRES AND CABLES
ACCOUNT FOR AROUND 41%
OF THE EUROPEAN CABLES
MARKET**

PVC cables are recyclable and successfully recycled. Cables recycling might follow two different streams:

- 1 /** cables subject to one or both the relevant European directives: WEEE (Waste from Electrical and Electronic Equipment) or ELV (End of Life Vehicles).

WEEE
WASTE FROM ELECTRICAL AND
ELECTRONIC EQUIPMENT

ELV
END OF LIFE VEHICLES

In these cases, there is a general obligation to recover and recycle end-of-life electrical and electronic equipment and vehicles sent to demolition, although without a direct, explicit obligation for cables;

- 2 /** cables not subject to the WEE and ELV directives, such as electric cables for power transmission and data transmission cables.

vinyl ^{plus}
COMMITTED TO
SUSTAINABLE DEVELOPMENT

This kind of end-of-life PVC cables is recycled within the framework of VinylPlus®, the European PVC industry's sustainability programme.

In 2018, more than 151,000 tonnes of PVC cable waste were recycled within the VinylPlus framework, representing 20% of the total recycled PVC volumes, and saving more than 300,000 tonnes of CO₂ emissions.

In the B&C sector, from private housing to public and crowded environments, PVC cables have been for decades, and still are, amongst the best choices in terms of fire safety, as they do not facilitate the generation and spread of fire.



PVC WOULD PRODUCE
VERY LITTLE SMOKE
IN A REAL FIRE SITUATION

2 / PVC CABLES PERFORMANCE IN CASE OF FIRE

Fire prevention pursues well-defined objectives, according to the principles of fire control and assessments covering social, policy, economic and psychological aspects.

OBJECTIVES HAVE ESSENTIALLY THE DUAL PURPOSE OF:

- / PROTECTION OF PEOPLE SAFETY;**
- / CONSERVATION OF MATERIAL GOODS.**

Fire performance of construction products is an essential element to be taken into account in the context of fire safety for building design.

PVC cables represent an excellent choice when considering their fire performance.

Studies and tests show that, due to its intrinsically self-extinguishing characteristics, PVC is difficult to ignite and does not sustain combustion.

The presence of chlorine in the polymer structure

makes PVC ignitability rather difficult, even in absence of any flame retardant.

This explains why, contrary to many other materials, there is no sustained lateral flame spread. Furthermore, thanks to the charring properties of PVC, there are no flaming droplets with PVC products.

Under standardised test conditions, in which the sample is forced to burn, PVC typically generates a dense smoke. However, in a real fire situation, when PVC products do not completely burn or represent a small

part of burnt materials, the smoke contribution from PVC is generally not so relevant.

Unlike odourless toxic gases, such as carbon monoxide that is by far the most hazardous element in a fire, the presence of hydrogen chloride generated by PVC combustion can be detected at totally harmless trace levels, due to its distinctive smell.

As such, the emission of HCl (hydrogen chloride) gas at an early stage of fire acts as a 'warning' signal to people to evacuate the area immediately.

PVC ADVANTAGES IN CASE OF FIRE



- ✓ **PVC CABLES CAN REACH THE EUROCLASS B-s1-d0**
- ✓ **PVC IS DIFFICULT TO IGNITE AND DOES NOT SUSTAIN COMBUSTION**
- ✓ **PVC IS SELF-EXTINGUISHING**
- ✓ **PVC DOES NOT CONTRIBUTE TO FLAME PROPAGATION**

- ✓ **PVC DOES NOT GENERATE SPARKS OR FLAMING DROPLETS**
- ✓ **PVC IRRADIATES ONLY A MINIMUM AMOUNT OF HEAT**
- ✓ **PVC WOULD GENERATE VERY LITTLE SMOKE IN A REAL FIRE SITUATION**

- ✓ **PVC EXPANDS BY UP TO 800% AND CARBONISES IN THE EXTERNAL LAYER (LIKE A MERINGUE) WHEN IT IS BURNED, THUS MAKING A SIGNIFICANT CONTRIBUTION TO SLOWING DOWN FIRE PROPAGATION**



- ✓ **THE SMOKE RELEASED FROM PVC COMBUSTION IS NOT MORE TOXIC THAN THE ONE RELEASED FROM ANY OTHER CARBON-BASED MATERIAL, INCLUDING NATURAL MATERIALS SUCH AS WOOD**
- ✓ **HYDROGEN CHLORIDE CONTAINED IN THE SMOKE IS IRRITATING AND PROVIDES AN IMMEDIATE SIGNAL OF THE DEVELOPMENT OF THE FIRE, ACTING AS AN ESCAPE ALARM**

3 / THE REGULATORY FRAMEWORK

To be considered safe, electric cables installed in any type of construction or engineering work, need to comply with essential safety requirements.

All cables must be placed on the European market as CE marked with an available Declaration of Performance. Safety requirements are listed in two EU regulatory documents:

**ALL CABLES MUST
COMPULSORILY BE
PLACED ON THE
EUROPEAN MARKET
AS CE MARKED**

THE LOW VOLTAGE DIRECTIVE

(Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits), often referred to as the LVC;

THE CONSTRUCTION PRODUCTS REGULATION

(Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, as amended), often referred to as the CPR.

The Construction Products Regulation sets the harmonised technical conditions for free circulation of products within the European Union and identifies a number of essential requirements to respect, including reaction-to-fire performance of products in the event of an outbreak of fire.

Following the publication of the products standards and of all the necessary supporting standards related to test methods and classification, the CPR basic requirements related to safety in case of fire for construction works came fully into force for cables on 1st July 2017.



PRODUCT STANDARD

EN 50575

Power, control and communication cables – Cables for general applications in construction works subject to reaction to fire requirements

TEST METHODS

EN 50399

Common test methods for cables under fire conditions – Heat release and smoke production measurement on cables during flame spread test – Test apparatus, procedures, results

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

EN 61034-2

Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements

EN 60754-1

Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content

EN 60754-2

Test on gases evolved during combustion of materials from cables – Part 2: Determination of acidity (by pH measurement) and conductivity

SUPPORTING STANDARD

CLC/TS 50576

Electric cables – Extended application of test results for reaction to fire

4 / CABLE CLASSIFICATION

The European standard EN 13501-6 classifies electric cables in 7 reaction-to-fire classes from A to F, identified by the subscript 'ca' (cable), according to their heat release and flame spread performance:

A_{ca}

**HIGHEST PERFORMANCE;
PRACTICALLY
FOR INCOMBUSTIBLE
MATERIALS ONLY.**

This indication is accompanied with additional classifications that define performances such as: smoke production (s), flaming droplets and/or particles (d) and acidity (a), in turn accompanied by an index relative to the level of performance (the higher the index, the lower the performance).

B1_{ca}

**HIGHEST PERFORMANCE
FOR COMBUSTIBLE
MATERIALS, WHICH DO NOT
OR HARDLY BURN.**

Each Member State refers to this classification scheme in its own legislative instruments addressing fire safety in buildings and constructions. As a consequence, the use of a given cable category can change depending on the final application for which each Member State independently prescribes class requirements in terms of primary class (A to F) and additional classification (s, d and a).

B2_{ca}

**GOOD PERFORMANCE;
LIMITED CONTRIBUTION
TO HEAT PRODUCTION AND
FLAME SPREAD.**

The EU classification assumes a level of performance of cables in the event of a fire and when they are subject to a naked flame¹:

C_{ca}

**AVERAGE
PERFORMANCE;
MODERATE CONTRIBUTION
TO HEAT PRODUCTION AND
FLAME SPREAD.**

how much the cable contributes to the development and the propagation of the flames;

how much and how quickly heat is released; and

which emissions it produces.

D_{ca}

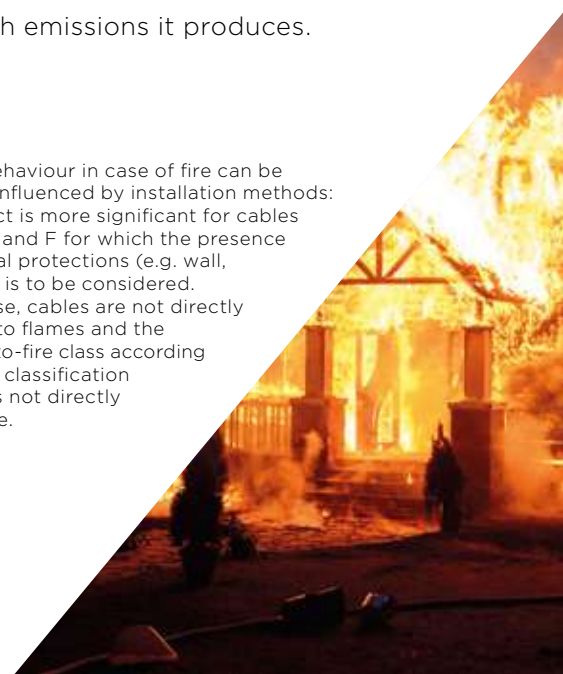
**ACCEPTABLE
PERFORMANCE;
LIMITED CONTRIBUTION TO
FLAME SPREAD IN CASE OF
SMALL FLAME ATTACK.**

¹Cables behaviour in case of fire can be strongly influenced by installation methods: this aspect is more significant for cables in class E and F for which the presence of physical protections (e.g. wall, conduits) is to be considered. In this case, cables are not directly exposed to flames and the reaction-to-fire class according to the EU classification scheme is not directly applicable.

E_{ca}

F_{ca}

**FLAMMABLE MATERIALS;
NOT REACHING ANY OF THE
ABOVE LISTED CLASSES.**



In reality, a particular class of cables can be suitable in different situations and inversely.

The choice can be defined as 'optimal' only after considering the combination of a series of parameters as a whole and after a risk assessment, which is a necessary complement to the assessment of the fire hazard:

- /// **BUILDING OR CONSTRUCTION DESTINATION;**
- /// **TYPE OF CABLE USAGE;**
- /// **REACTION TO FIRE CLASS, ASSESSED IN SPECIFIED CONDITIONS**
(I.E. EU CLASSIFICATION);
- /// **FIRE SCENARIO;**
- /// **INSTALLATION PARAMETERS**
(I.E. END-USE CONDITIONS);
- /// **HUMAN PARAMETERS**
(I.E. OCCUPANTS' DENSITY AND CHARACTERISTICS, PEOPLE'S ABILITY TO ESCAPE);
- /// **OTHER SAFETY MEASURES.**

Based on this comprehensive approach, buildings can be sorted by usage groups, for which the associated fire risks are the basis for product selection, also considering other provisions put in place.

The following table lists the risk utilised in the examples of applicability graphs of p. 12-13, being the most frequently associated to the type of buildings or constructions in various national descriptions. These tables are only given as examples and are **neither exhaustive nor prescriptive**.

The sound and general principle is that the higher the occupants' density; the difficulty

of escape routes and of the intervention of fire fighters or rescue teams; the vulnerability of the population; the relevance of heritage preservation; thus, the higher should the required or recommended product's fire performance be.

Note that boundaries for requirements are defined by authorities and may change from one Member State to another.

**THE CHOICE CAN BE DEFINED
AS 'OPTIMAL' ONLY AFTER
CONSIDERING THE COMBINATION
OF A SERIES OF PARAMETERS
AS A WHOLE AND AFTER
A RISK ASSESSMENT**

HIGHLY FREQUENTLY INTERCHANGE PLACES

- / Railway and maritime stations
- / Subways
- / Terminals

HIGH RISK

TRANSPORT AND COMMUNICATION

- / Railway tunnels with a length of more than 1,000 m
- / Road tunnels with a length exceeding 500 m
- / Garages

HIGH RISK

HEALTH FACILITIES

- / Hospital and nursing homes with hospitalisation
- / Assisted residences for the elderly and disabled
- / Rehabilitation facilities

MEDIUM RISK

ENTERTAINMENT, SHOW AND CULTURE

- / Cinemas, theatres, discos
- / Sports centres and gyms
- / Museums, galleries, exhibition spaces
- / Exhibition areas
- / Libraries
- / Shopping centres

MEDIUM RISK

SCHOOLS

- / School buildings of every order and degree

MEDIUM RISK

HIGH-RISE BUILDINGS

- / Buildings for civil use with fire-fighting > 24 m
- / Companies and offices with over 300 people

MEDIUM RISK

ACCOMMODATION FACILITIES

- / Hotels, motels, guesthouses
- / Tourist villages, holiday homes, campgrounds
- / Student accommodation
- / Holiday farms and bed & breakfasts

MEDIUM RISK

RESIDENTIAL BUILDINGS

- / Houses and residential buildings < 24 m
- / Small companies, professional offices < 300 people
- / Shops, bars and restaurants < 300 people

LOW RISK

RAILWAYS

GALLERIES AND PARKING LOTS

HEALTH

ENTERTAINMENT

SCHOOLS

HIGH-RISE BUILDINGS

HOTELS

RESIDENCE

The extended range of PVC compounds allows the production of electric cables in reaction-to-fire classes² F, E, D, C and B, with the following additional classification:

- ✓ flaming droplets: d0
- ✓ smoke production: s1
- ✓ acidity (of smoke): a2 / a3.

The following graphs show the applicability of the different classes of cables highlighting the best use in different building contexts, taking into account the economic parameter together with the regulatory and performance ones.

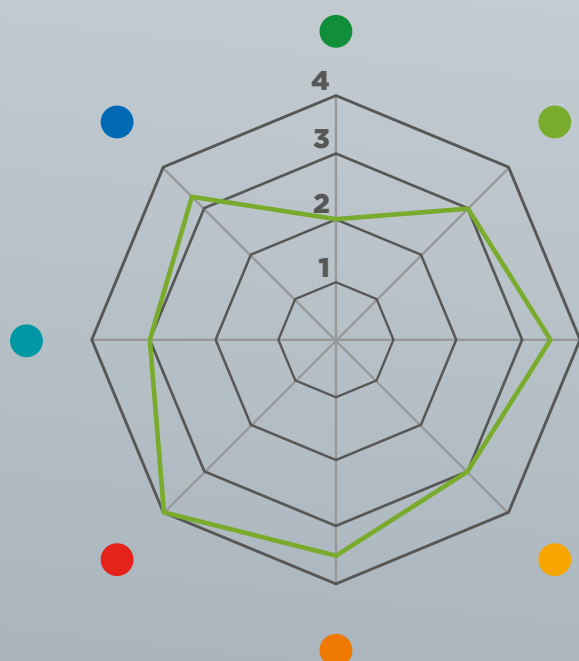
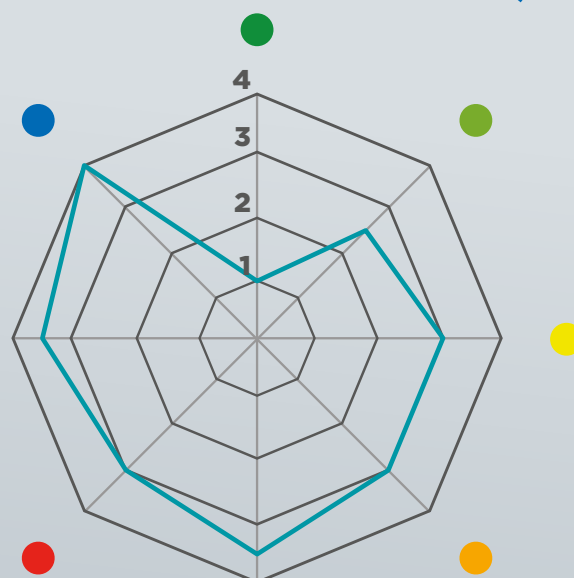
The graphs here below are meant to provide an indication of applicability. It's in any case the responsibility of the installer to ensure that the cables installed comply with all national and local regulations.

SCALE:

- optimal / 4
- usable / 3
- or recommended
- commonly used / 2
- or acceptable
- not recommended / 1
- not suitable / 0

CLASS B

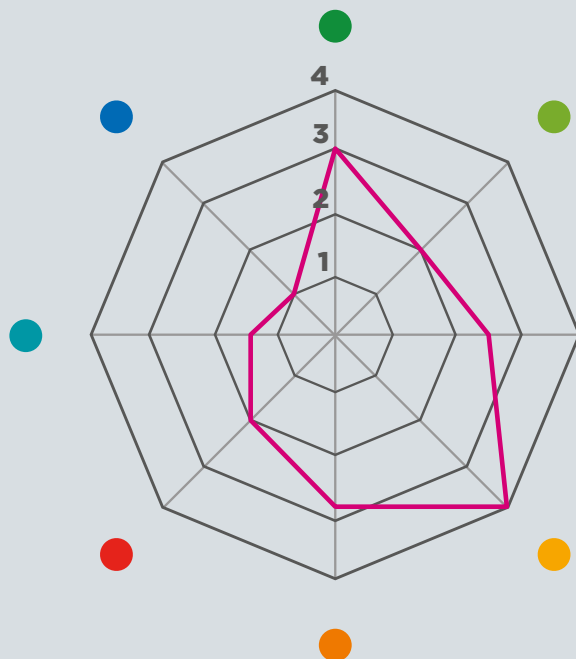
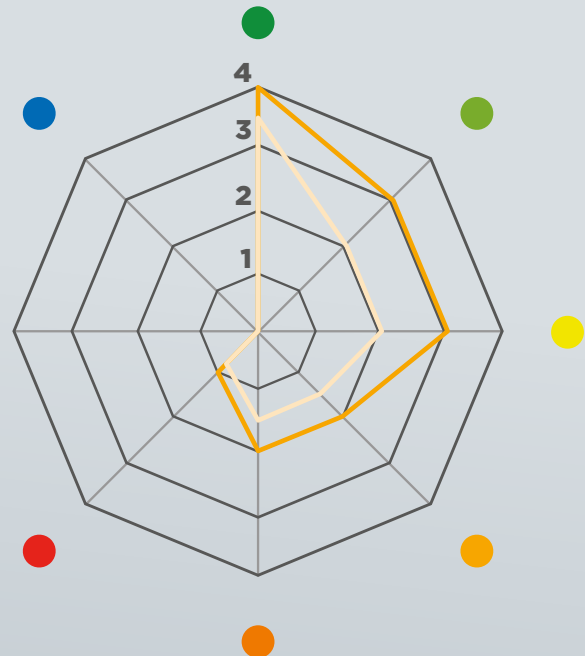
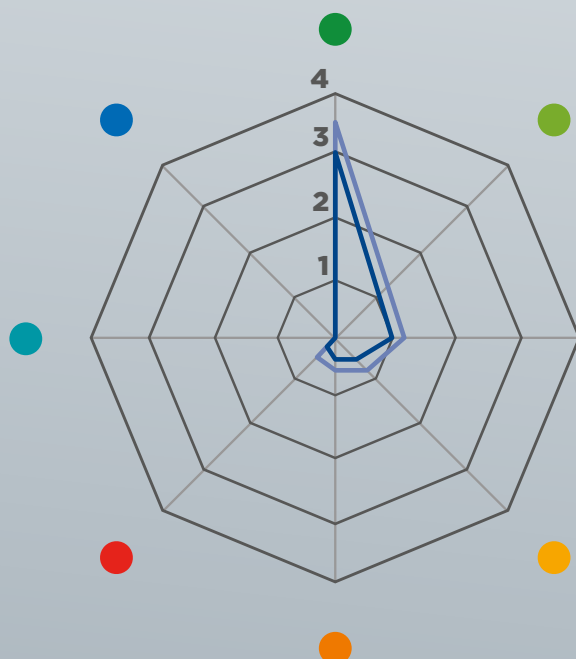
B2_{ca} / s1a / d0 / a1



CLASS C

C_{ca} / s1b / d0 / a2

²Class A can only be reached by incombustible materials

**CLASS D**D_{ca} / s1b / d0 / a3**CLASS E**E_{ca} / protectedE_{ca} / not protected**CLASS F**F_{ca} / protectedF_{ca} / not protected

5 / PVC CABLES INNOVATION AND PERSPECTIVES

The PVC value chain is constantly engaged in the research and development of new formulations, and seeks to continue providing the market with high-quality, high-performance products, as well as to ensure maximum safety and protection of the environment and of the health of users and consumers.

VinylPlus® commitment on the sustainable use of additives, for example, resulted in the replacement of lead-based stabilisers in PVC applications in the EU-28 by the end of 2015, whilst European plasticiser producers are committed to science and research to offer substances meeting the highest performance and the strictest regulatory standards, adapted to the evolving market demand.

New formulations for PVC cables are currently under development to further improve their performance in fires.

**NEW FORMULATIONS
FOR PVC CABLES
ARE CURRENTLY
UNDER DEVELOPMENT
TO FURTHER IMPROVE
THEIR PERFORMANCE
IN FIRES**



Nanotechnologies, too, represent an interesting perspective for the development and use of efficient functional additives in polymers. The results of an experimental work carried out by the University of Piemonte Orientale (Italy) show that positive effects at nanoscale level are evident even with a

**NANOTECHNOLOGIES,
TOO, REPRESENT
AN INTERESTING
PERSPECTIVE**

limited amount of additives in several features, combining chemical effects on thermal stability, degradation and HCl evolution with improved or unmodified physical performances.



10 REASONS TO CHOOSE PVC CABLES

1/

VERSATILITY OF FORMULATIONS

excellent flexibility, transparency and lightness; easy to colour

2/

PROCESSABILITY

easy to extrude;
excellent productivity

3/

CO-EXTRUSION

PVC can be co-extruded in multi-layer cables with excellent cost/performance ratio

4/

RESISTANCE TO TEMPERATURE

very wide range, from -40° to 125°

5/

RESISTANCE TO ATMOSPHERIC AGENTS

including UV rays

6/

RESISTANCE TO HYDROCARBONS

for example, oil and gasoline

7/

INSULATION

PVC presents an inherently high value of the insulation coefficient

8/

SELF-EXTINGUISHING

PVC is by nature a flame retardant and does not generate flaming droplets

9/

FIRE RESISTANCE

PVC is difficult to ignite, has moderate heat release and produces very little smoke

10/

RECYCLABILITY OR REUSE

most of the PVC cables are reused and recycled



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