

2018 AUGUST

What is AFDD?

S-ARC1 _ AFDD integrated with MCB

Raymond Koh

Agenda

- Introduction to AFDD concept (fire statistics, arcs description, AFDD applications)
- S-ARC1: Product at a glance

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IEC 62606

- Excerpt from IEC 62606, “Residual Current Devices (RCDs) are recognised as efficient to reduce the risk of fire by detection of leakage current and arcing to ground as a consequence of tracking currents within an electrical installation.”

- However, RCDs as fuses or circuit-breakers are not able to reduce the risk of electrical fire due to series or parallel arcing between live conductor.

IEC 62606

- Excerpt from IEC 62606, “During a series arc fault, there is no leakage to ground therefore RCDs cannot detect such a fault. “
- In the case of a parallel arc between phase and neutral conductor, the current is only limited by the impedance of the installation.
- MCB is not designed to trip under arc fault condition.

Arc Protection Solution

Ø In the final distribution.

installed AFCI or AFDD.

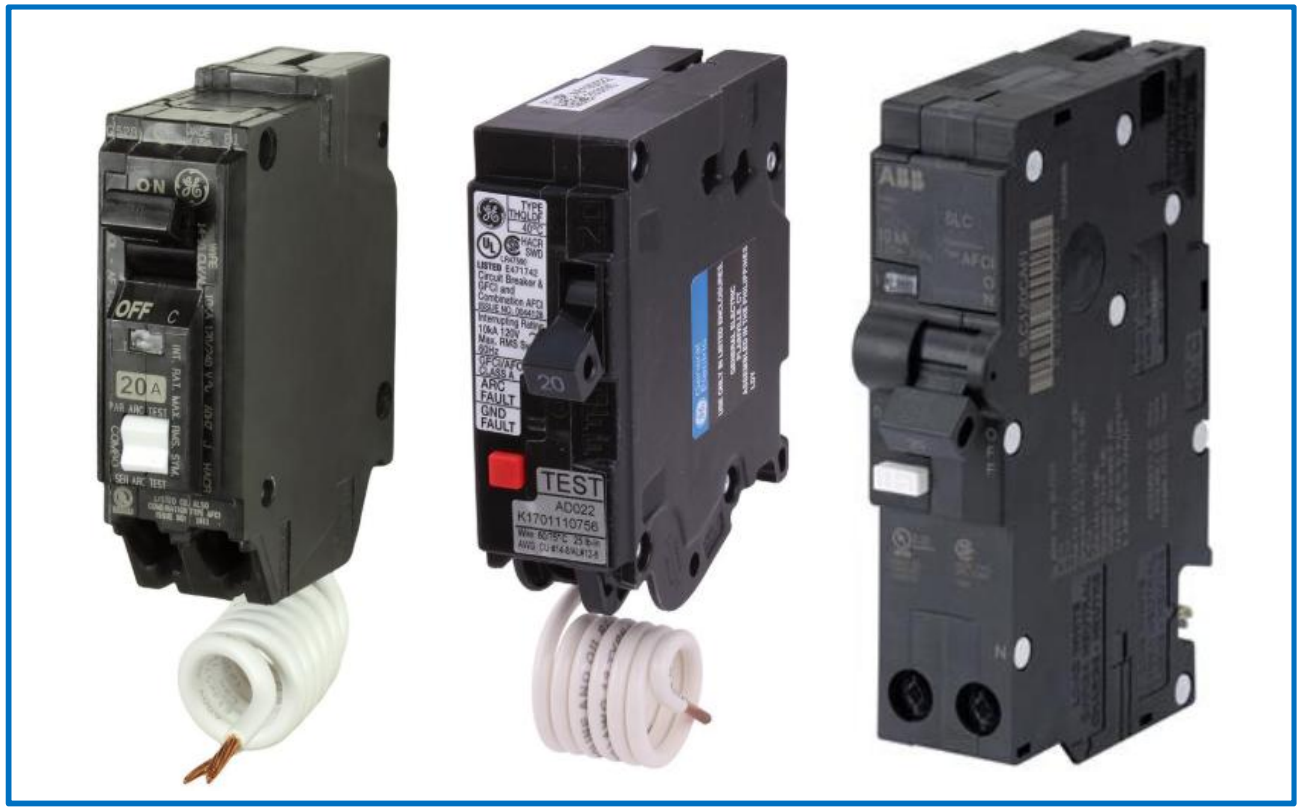
Ø In the DB/ SDB, installed

Arc fault detection relay

Arc Containment measure.

Arc Protector Device

AFCI



AFDD



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Arc Protector Detection Relay

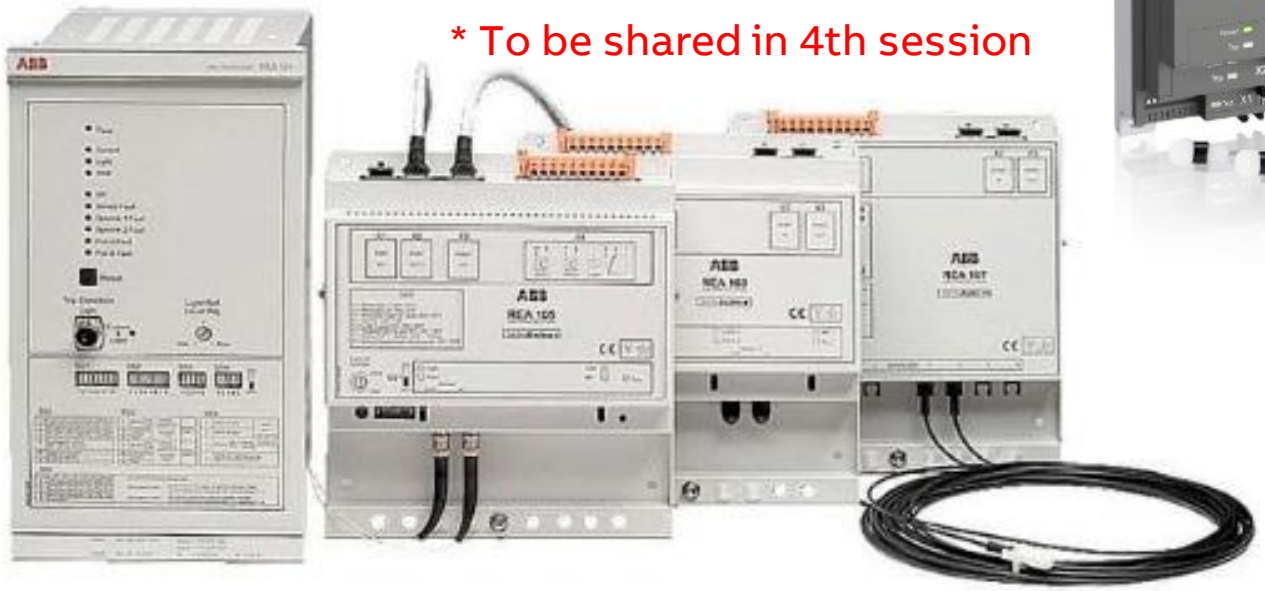
Arc Detection Relay TVOC2

* To be shared in 2nd session



Protection Relay integrated with Arc detection

* To be shared in 4th session



IEC 62606

1 Scope

This International Standard applies to arc fault detection devices (AFDDs) for household and similar uses, intended to be used in a.c. circuits, for rated voltages not exceeding 440 V a.c, with rated frequencies of 50 Hz, 60 Hz or 50/60 Hz and rated currents not exceeding 63 A.

NOTE 1 In the USA, Arc Fault Circuit Interrupters (AFCI) are considered similar to AFDDs.

An AFDD is designed by the manufacturer:

- either as a single device having opening means able to open the protected circuit in specified conditions; or
- as a single device integrating a protective device; or
- as a separate unit, according to Annex D assembled on site with a declared protective device.

The integrated protection device is either a circuit-breaker in accordance with IEC 60898-1 or an RCD in accordance with IEC 61008-1, IEC 61009-1 or IEC 62423.

These devices are intended to mitigate the risk of fire in a final circuits of a fixed installation due to the effect of arc fault currents that pose a risk of fire ignition under certain conditions if the arcing persists.

Protection against fire ignition due to overvoltage due to a broken neutral within a three phase installation to be included in this type of equipment as an additional option is under consideration in 9.22.

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IEC 62606

- Excerpt from IEC 62606, “AFDDs provide isolation, they are intended to be operated by uninstructed persons and do not require maintenance. “

- Particular requirements may be necessary for:
- – AFDDs incorporated in or intended only for association with plugs and socket-outlets or

- - with appliance couplers for household or similar general purposes;

What is Arc Fault?

Ø What is Arc fault?

Clause 3.1 Arc … Arcing

Luminous discharge of electricity across an insulating medium, usually accompanied by the partial volatilization of electrodes

Clause 3.1 Arc fault … Arcing fault

Dangerous unintentional arc

What is Arc Fault?

To mitigate the risk of fire, an AFDD shall ensure detection for:
– earth arc fault, parallel arc fault , and series arc fault.

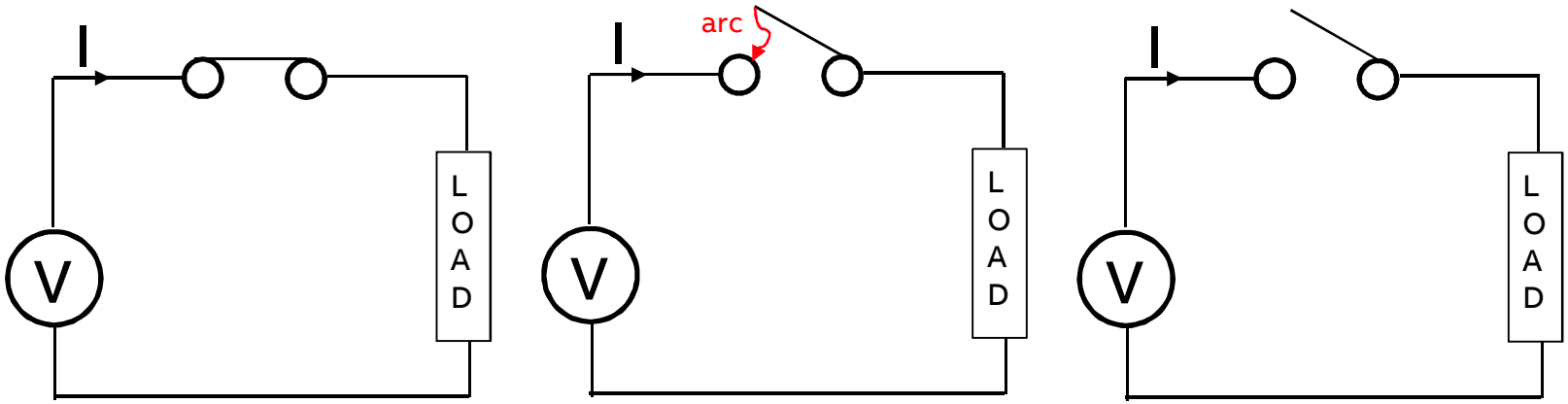
3.7
earth arc fault
arc fault where the current is flowing from active conductor to the earth

3.8
parallel arc fault
arc fault where the arc current is flowing between active conductors in parallel with the load of the circuit.

3.9
series arc fault
arc fault where the current is flowing through the load(s) of the final circuit protected by an AFDD

What is Arc Fault?

- Ø Arcing Phenomena
- Ø When you turn off a switch, two contacts will separate



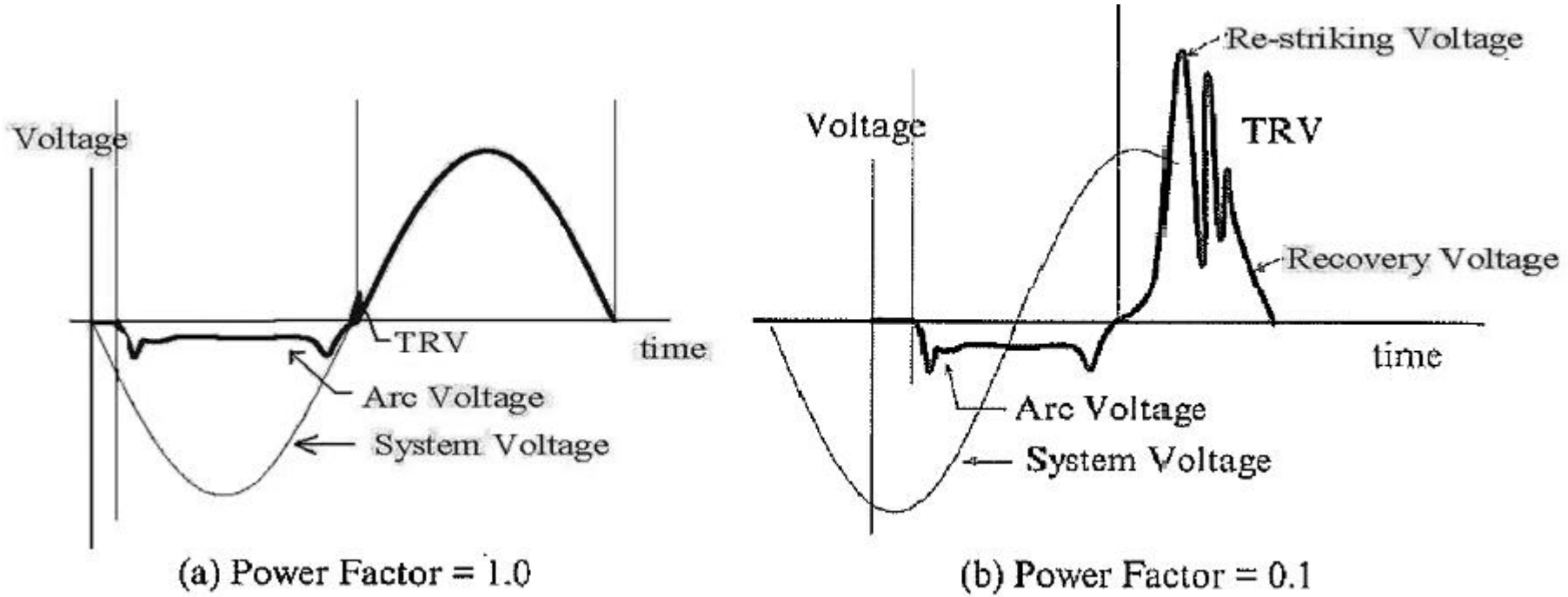
Switch closed

Switch opening

Switch fully opened

What is Arc Fault?

- Ø Arcing Phenomena
- Ø When you turn off a switch, two contacts will separate



Fire statistics

Statistics about fire accidents in Europe

Fires in Europe

- 2.000.000 fires are reported in Europe each year
- 90% of fire happen in buildings on average, where we spend 90% of our time

People killed and injured

- 4.000 people are killed by fire in Europe every year. This is 11 deaths per day
- 70.000 people are hospitalized in Europe each year due to severe injures caused by fire

Damages due to fire

- 3 minutes is all it takes for fire to involve an entire room, because we use more flammable materials than before
- 126 billion € property burnt up in fire each year

Fire prevention is very important to avoid death, injuries and damages

Fire statistics

Statistics about fire accidents in Germany

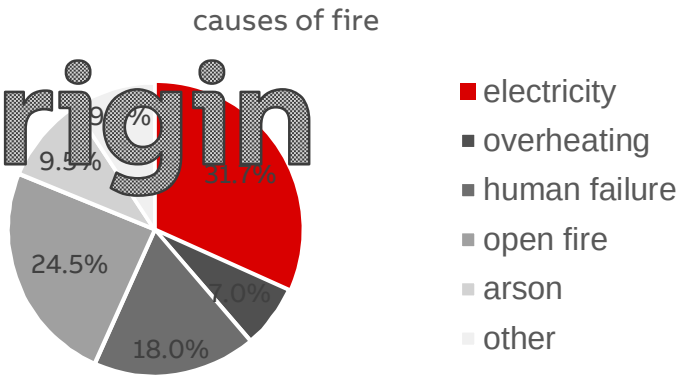
Germany 2015 statistics

- 230.00 damages due to fire in 2015
- 343 deaths due to exposure to smoke, fire and flames
- 77 deaths caused by electricity

31.7% fire is electrical origin

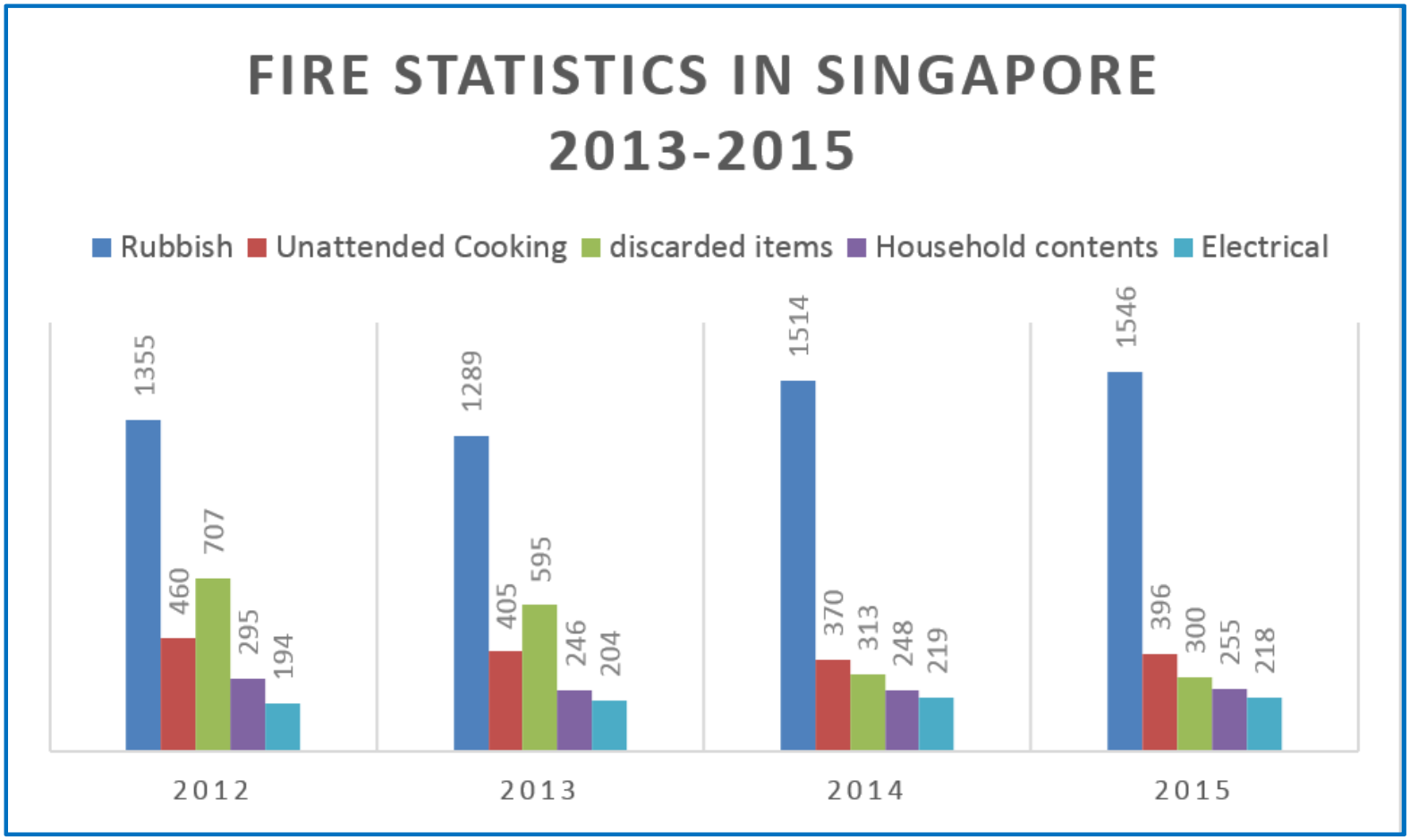
Fire due to electricity

31.7 % of fires in Germany in 2015 had their origin in electricity and can be traced back to defects in the electrical installation due to damage wires, loose connections and/or defect devices



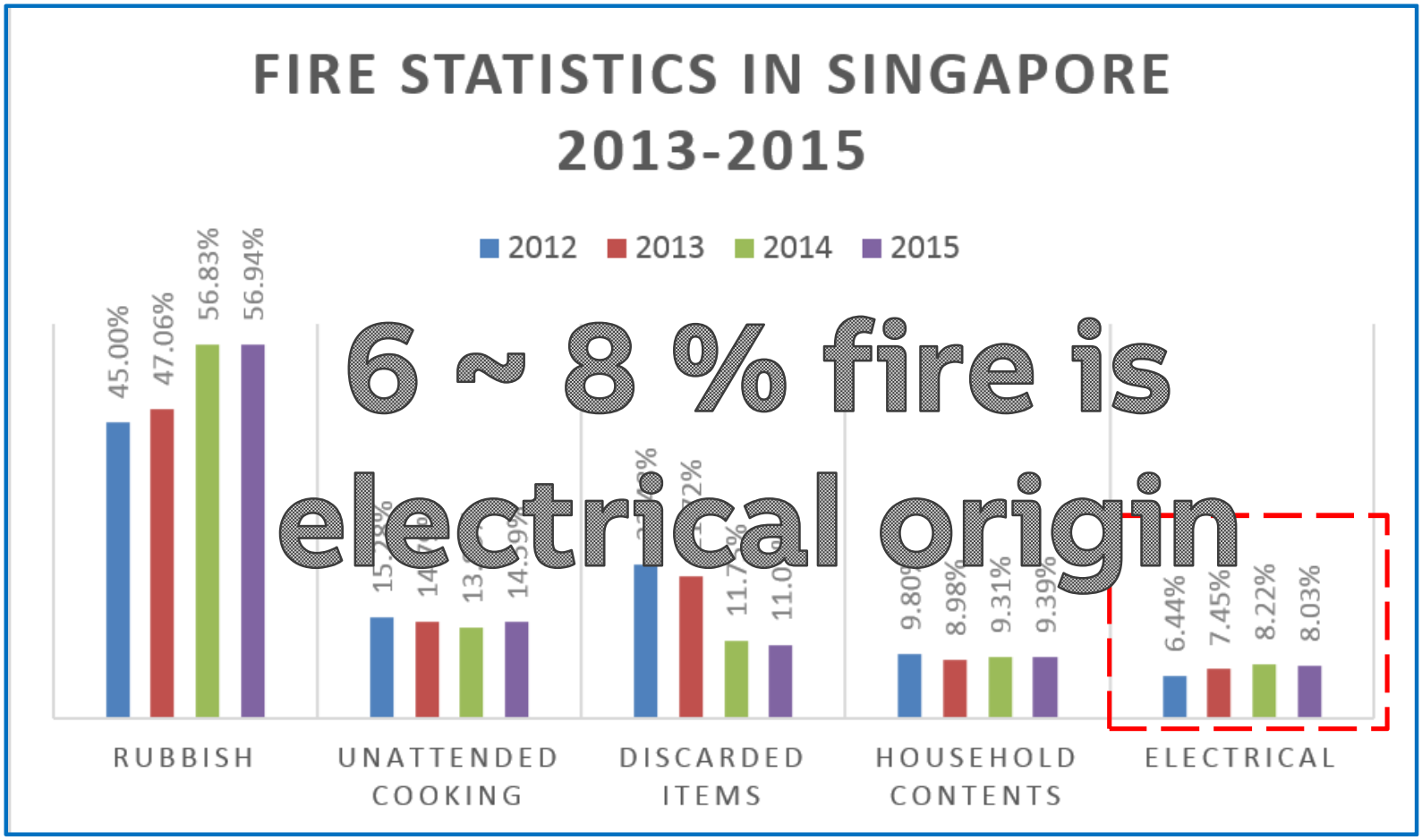
Germany is the first country in Europe that prescribes as mandatory fire prevention in electrical installations

Fire Statistics for Singapore



Data available on National Fire and Civil Emergency Preparedness Council website

Fire Statistics for Singapore



Data available on National Fire and Civil Emergency Preparedness Council website

Fire in Singapore (Clementi West Street 2)

“ cause of the fire is currently under investigation ”

Fire due to electricity

Fire due to Arc culprit

What is an arc fault

A very common cause of fire due to electricity can be found in the arc faults.

The "contact arcs" are generally related to two conductive parts at different voltage placed in direct or indirect contact through low conductive paths.

For example a damaged conductor could enable the creation of electric arcs between the initial merged contacts.

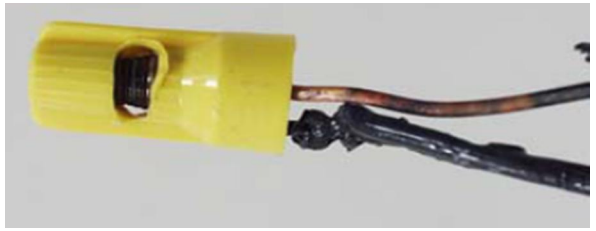
This arc current flows through the damaged section, and eventually intensify. Resulting in a heat increase in the affected area for Joule effect, thus in a overheating process of the insulation. The copper at this point, oxidizes and subsequently merges, starting to carbonize the insulation. Thus, an air gap condition between the two conductors exists, and then small arcs appear in the insulation.

Different causes of the arc faults

Fire due to Arc culprit

Ageing, lack of maintenance, damaged wires (defect isolation)





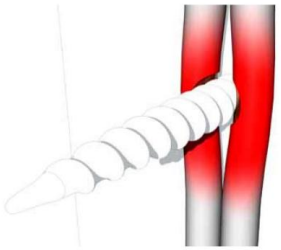
Aggressive environment, vibrations, rodents, defect devices





Multiple sockets, trapped cables in doors, incorrect installation with screw, nails and clips






Different types of arc faults

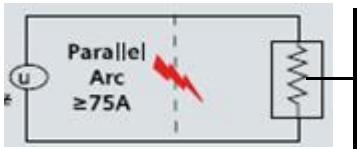
Introduction to arc the arc fault concept

3 different types of arc fault



1 **Earth arc fault**

– current is flowing from active conductor to the earth



2 **Parallel arc fault**

– current is flowing between active conductors in parallel with the load of the circuit.



3 **Series arc fault**

– current is flowing within one conductor of the final circuit

An AFDD (Arc Fault Detection Device) according to the product standard "**IEC 62606** - General requirements for Arc Fault Detection Devices" is a device intended to mitigate the effects of arcing faults by disconnecting the circuit when an arc fault is detected: this product standard is partially derived from the **UL 1699** standard.

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What Arc condition?

Table 1 – Limit values of break time for U_n = 230 V and 400 V AFDDs

Test arc current (r.m.s. values)	2,5 A	5 A	10 A	16 A	32 A	63 A
Maximum break time	1 s	0,5 s	0,25 s	0,15 s	0,12s	0,12 s

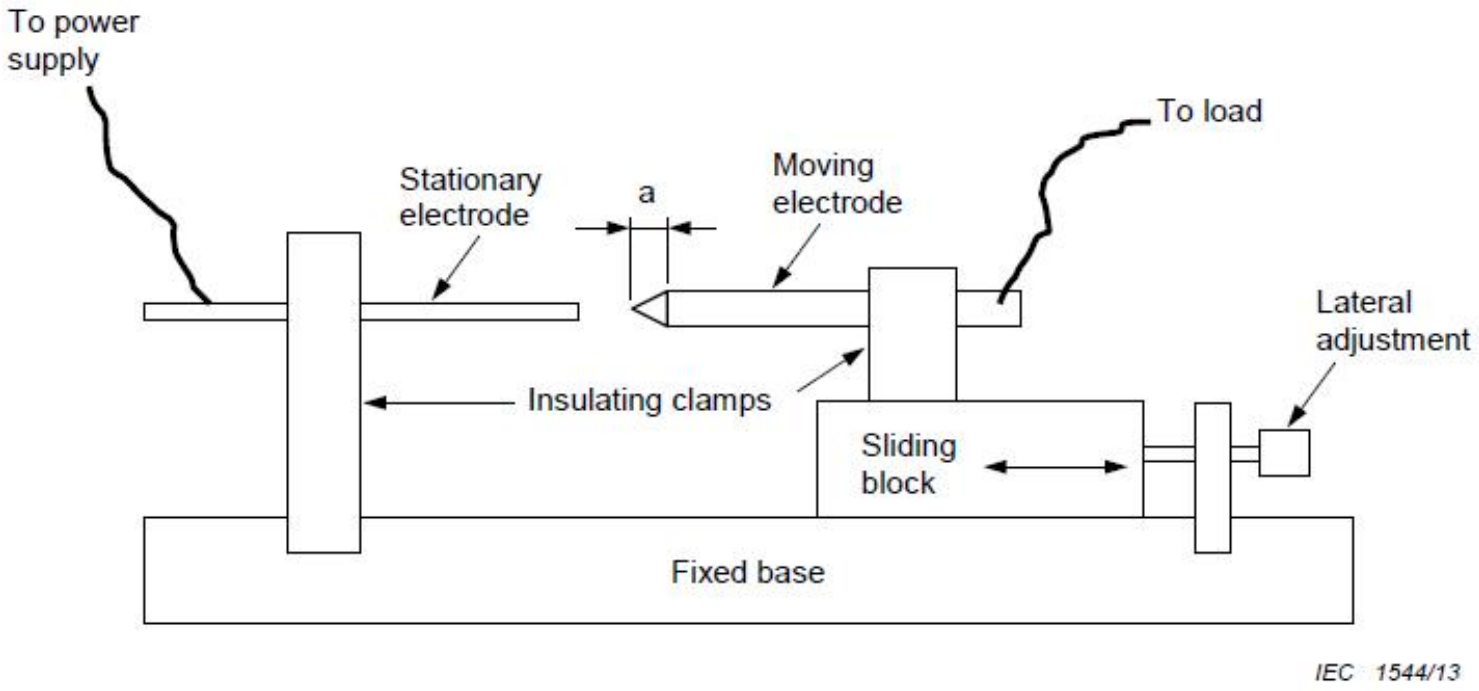
Table 3 – Maximum allowed number of arcing half-cycles within 0,5 s

Test arc current [a] (r.m.s. values)	75 A	100 A	150 A	200 A	300 A	500 A
N [b]	12	10	8	8	8	8

[a] This test current is the prospective current before arcing in the testing circuit.

[b] N is the number of half cycles at the rated frequency.

Arc Fault DD testing?



What Arc condition?

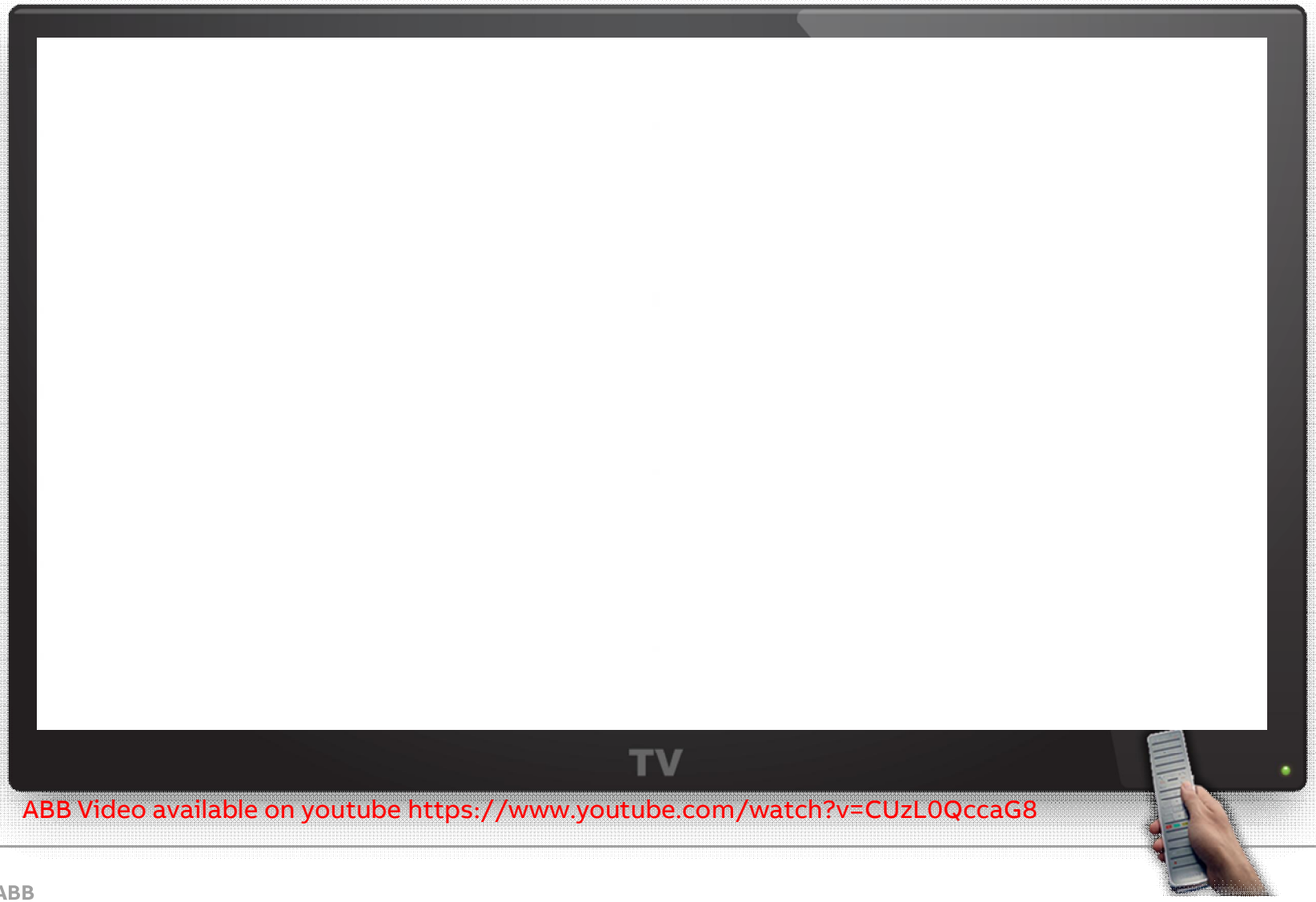


ABB Video available on youtube https://www.youtube.com/watch?v=CUzL0QccaG8

AFDD Product standard IEC 62606

Three different type of products

AFDD in series with protection device

AFDD as one single device, comprising an AFD unit and opening means and intended to be connected in series with a suitable short circuit protective device declared by the manufacturer complying with one or more of the following standards IEC 60898-1, IEC 61009- 1 or IEC 60269 series.

Integrated solution

AFDD as one single device, comprising an AFD unit integrated in a protective device complying with one or more of the following standards IEC 60898-1, IEC 61008-1, IEC 61009- 1 or IEC 62423.

AFDD + protection device assembled on site

AFDD according to Annex D, comprised of an AFD unit and a declared protective device, intended to be assembled on site.

3 different solutions to be compliant to IEC 62606 standard

Protection against arc fault

Introduction to the Arc Fault Detection Device (AFDD)

- RCDs are recognized efficient to reduce the risk of fire by detection of leakage current and arcing to ground as a consequence of tracking currents within an electrical installation. RCDs can detect only earth arc fault
- During a series and parallel arc fault, there is no leakage to ground therefore RCDs can't detect such a fault.
- RCDs as fuses or circuit-breakers are not able to reduce the risk of electrical fire due to series or parallel arcing between live conductors.



To ensure a complete protection against arc faults, it is required the installation of an AFDD

Current protection devices do not provide a complete protection against arc faults.

Protection against arc fault

Can we do without this protection?

Arc faults arise from a number of situations, including:

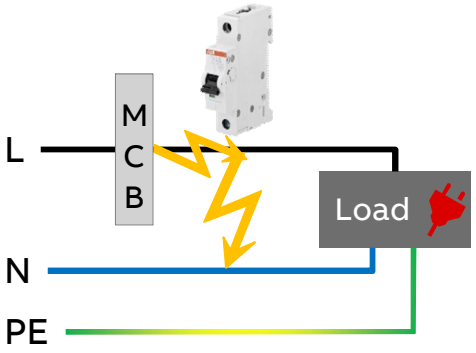
1. Damaged /Aged wires
2. Receptacle leakage
3. Neutral leads pinched to grounded metal box
4. Worn electrical insulation
5. Loose electrical connections
6. Shorted wires
7. Wires or cords in contact with vibrating metal
8. Overheated or stressed electrical cords and wires
9. Misapplied/damaged appliances

We need inspect domestic installation diligently & periodically.

Protection against arc faults

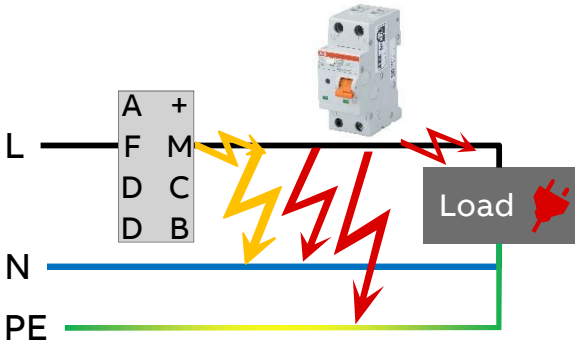
Introduction to the Arc Fault Detection Device (AFDD)

Level of protection



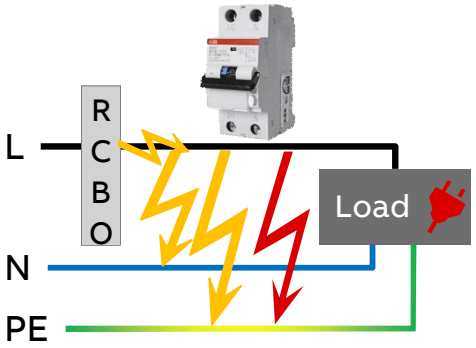
MCB:

- Overcurrent



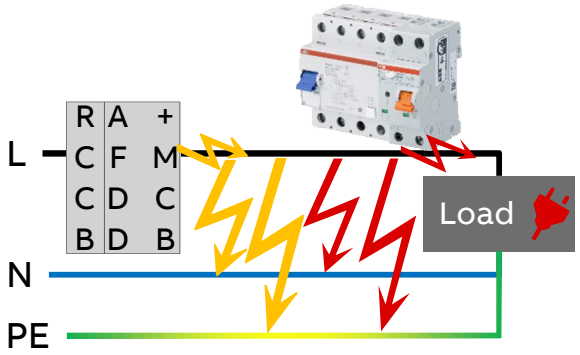
AFDD integrated with MCB

- Overcurrent
- Series Arc fault
- Earth arc fault
- Parallel arc fault



RCBO:

- Overcurrent
- Earth fault current
- Earth arc fault



RCCB + AFDD integrated with MCB

- Overcurrent
- Earth fault current
- Series Arc fault
- Earth arc fault
- Parallel arc fault

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Why do we need this product

Standard, countries

- Germany is the first country in Europe that has prescribed the AFDD installation as mandatory (starting from 18th December 2017) in the applications described in the DIN VDE 0100-420.
- The IEC 60364 standard at the moment prescribes the AFDD only as recommended, thus it is difficult to foreseen which will be the use of AFDD in other European countries.

Application of the AFDD

IEC and VDE standard comparison

IEC 60364-4-42
Recommended application

The installation in final circuit **is recommended** in:

- Rooms with sleeping accommodation
- Locations with risks of fire due to
  - Processed or stored materials
  - combustible constructional materials
  - fire propagating structures
- Locations that contain irreplaceable goods

DIN VDE 0100-420
Mandatory application

The installation in final circuits in single phase AC system with less than 16 A **is mandatory** in locations such as:

- Rooms with sleeping and living accommodation in:
  - homes and day care centers (for children, disabled and elderly)
  - barrier-free apartments
- Locations with risk of fire due to
  - the processed or stored of materials
  - combustible constructional materials
- Locations that contain irreplaceable goods

It is generally **recommended** for locations such as

- Rooms with sleeping accommodation
- Locations with fire propagating structures
- Final circuits, that supply sockets used for appliances which need high loads

What Arc condition?

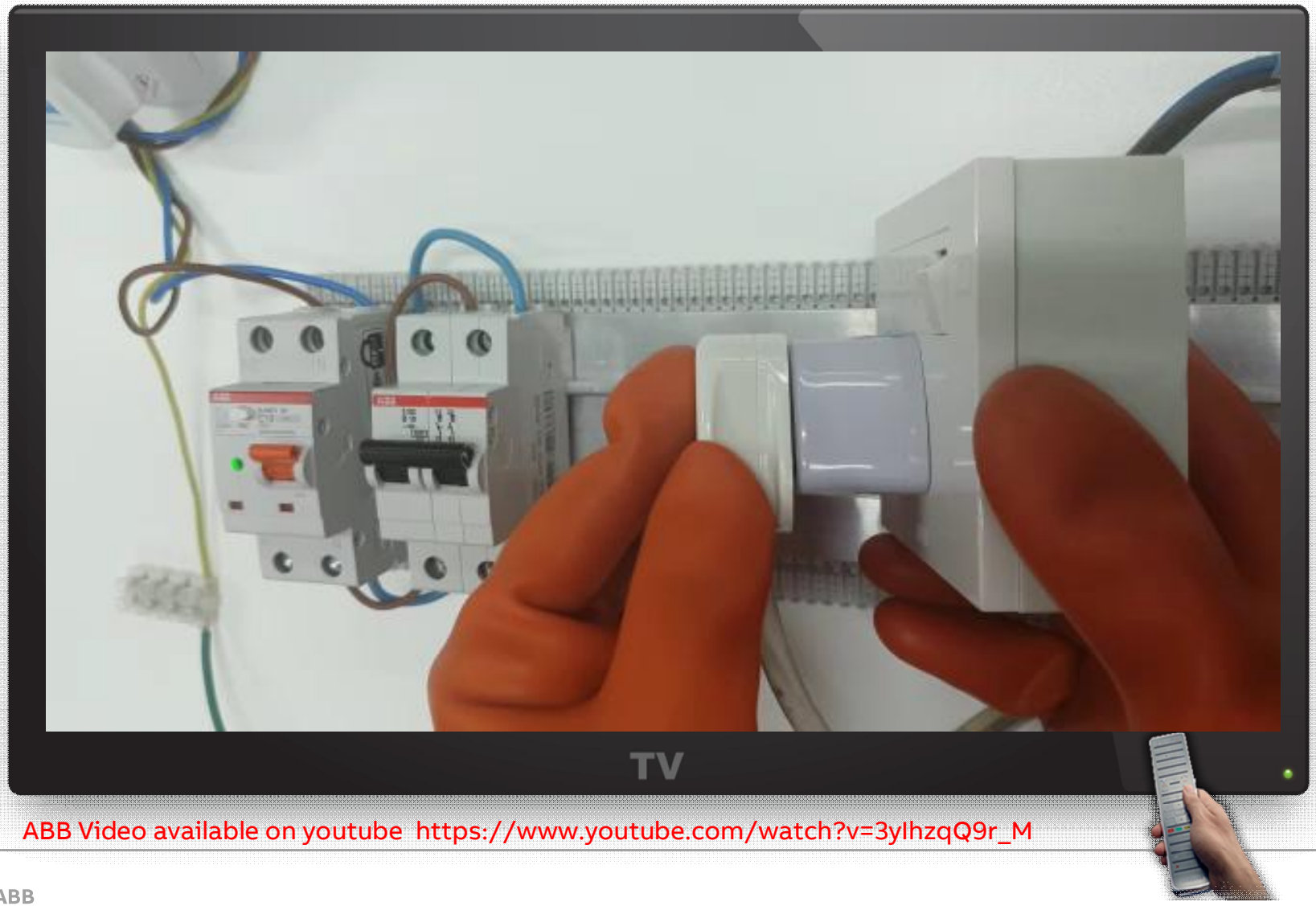


ABB Video available on youtube https://www.youtube.com/watch?v=3yIhzqQ9r_M

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Samples of application of AFDD

IEC 60364-4-42

Recommended application according to IEC 60364-4-42

Rooms with sleeping accommodation

- Home and day care centers
- Retirement home
- Asylums
- Hotels
- Hospitals

Locations with risks of fire due to combustible constructional materials

- Wooden buildings
- Carpentry
- Gas station
- Barns

Locations with risks of fire due to fire propagating structures

- Skyscrapers
- Combustible buildings
- Forced ventilation systems

Locations that contain irreplaceable goods

- Museums
- R&D centers
- Laboratory









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S-ARC1: Product at a glance

AFDD in a glance

Raymond Koh

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ABB new arc fault detection device: S-ARC1

Product overview

New

S-ARC1 and S-ARC1 M are the new 1P+N arc fault detection devices with an integrated MCB in 6 kA and 10 kA breaking capacity respectively.

Safe

They provide protection against

- Short-circuits
- Overload
- Earth arc faults
- Parallel arc faults
- Series arc faults
- Overvoltage

Compact

In only two module width, the S-ARC1 series shares the same profile as the other System pro *M* compact® devices, providing the best solution for complete protection against arc faults in the switchboard.



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Main technical parameters of the AFDD

S-ARC1: Product at a glance

	S-ARC1 and S-ARC1 M
Standards	IEC / EN 62606 IEC / EN 60898-1
Poles	1+N
Tripping characteristics	B, C
Rated current I_n	6, 10, 13, 16, 20 A
Rated short-circuit capacity I_{cn}	6 kA (10kA S-ARC1 M)
Rated frequency	50/60 Hz
Rated voltage	230-240 V
Threshold for protection against overvoltage	275 V



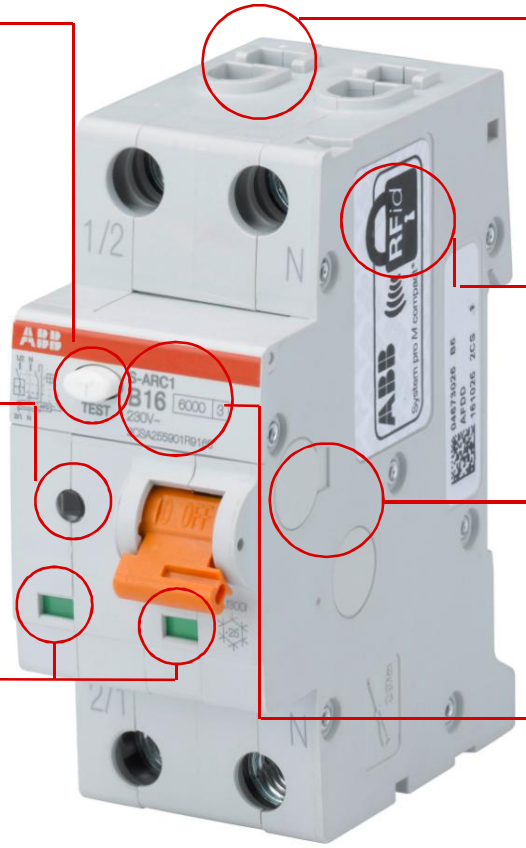
Family feeling in the System pro *M* compact® range

Product overview

Test pushbutton and self test
Test pushbutton to verify the correct functioning of the arc fault detection device.
Internal self test is also continuously running in order to check the arc detection circuit.

LED for troubleshooting
LED troubleshooting indicator to monitor the operation of the AFDD and give indication of the cause of the trip

Guaranteed security
Contact position indicator (CPI) to always know the status of the contacts(red: closed; green: open)
Independent from the toggle position



Easy to install
Twin terminals for separate feeding with busbar and cables.
Connection possible both from top and bottom side.

Anti counterfeiting
RFid tag containing a unique serial number assigned to ABB in order to authenticate the product.

Combination with auxiliary elements
Platform suitable for combination with System pro *M* compact® accessories.

Laser printed information
Information on the device are laser printed to ensure readability over time.

©ABB

Easy installation

Connection possible both with cables and busbars

Easy to install

- Connection possible both with cables (up to 25mm^2) and busbars (10mm2) thanks to the presence of two different slots.
- Standard System pro *M* compact® clip ensures a stable fixing on DIN rail and easy and fast mounting and dismounting operations
- **A quick installation is possible using ABB System pro M compact® busbars, without the requirements of extra cables.**
- **Supply possible both from top and bottom**

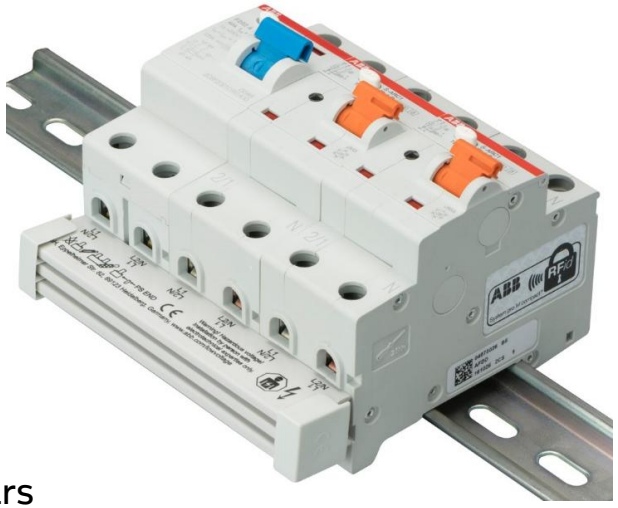


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Easy installation

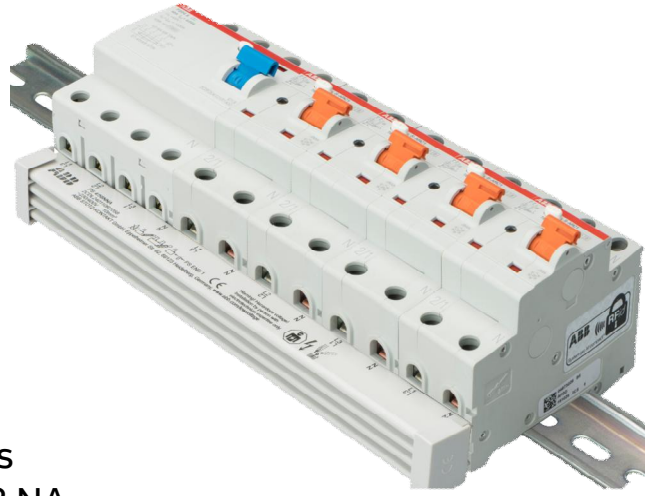
Compatibility with standard busbars and family feeling

Installation with a 2-pole RCCB



Busbars
PS 2/12, PS 2/12/16, PS 2/12 A
PS 2/58, PS 2/58/16, PS 2/58/16 A
PS 2/48 H, PS 2/48/16 H, PS 2/48/16 HA

Installation with a 4-pole RCCB



Busbars
PS 4/12 NA
PS 4/58 N, PS 4/58/16 N, PS 4/58/16 NA,
PS 4/58/16 N SP, PS 4/48/16 NH A,
PS 4/58 NN A, PS 4/58/16 NNA

Compatibility with ABB System pro *M* compact® busbars : quick installation in only one step

Reducing downtimes with easier troubleshooting

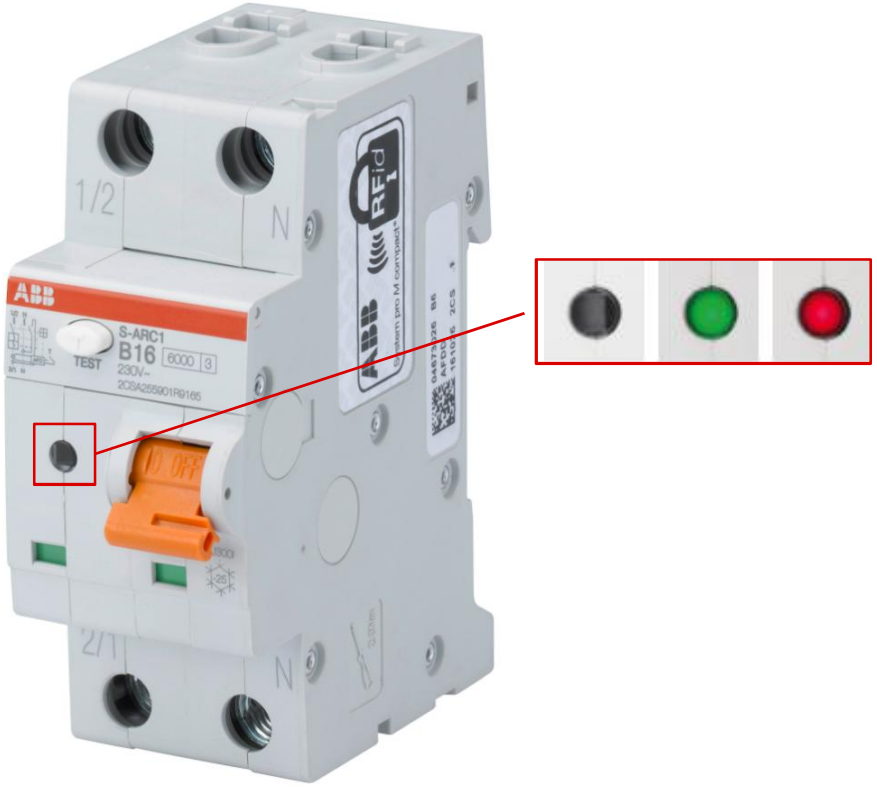
LED operation

Easy troubleshooting of the network and reduced downtime for maintenance

S-ARC1 is equipped with a LED to monitor the correct working conditions of the device and have an easier troubleshooting in case of tripping. Consequently the downtime for maintenance can be reduced.

- Standard working conditions (toggle ON): GREEN LED
- Different indications after the tripping (after reclosing the toggle):

LED color	Blink /sec	Signalling duration	Cause of trip
Green		Permanent	Manual trip, test button, overcurrent
Red blinking	1	5 sec	Series arc
Red blinking	2	5 sec	Parallel arc
Red blinking	3	5 sec	Over voltage



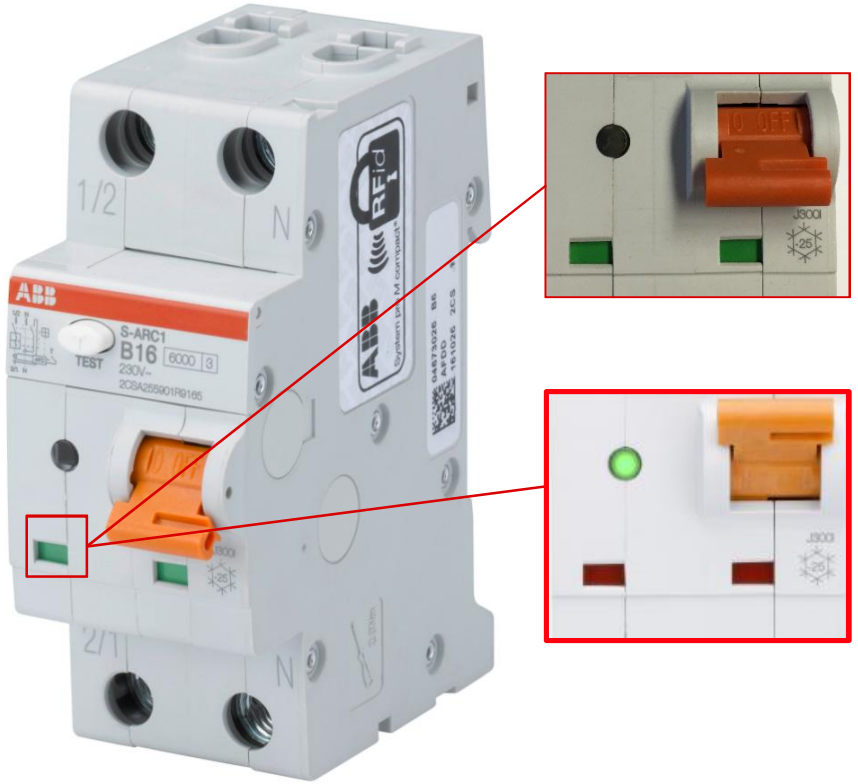
Safety conditions guaranteed for maintenance operation

Contact position indicator (CPI)

Safety condition guaranteed

To clearly identify the real position of the contacts (open / closed) independently on the toggle position, each device is equipped with a contact position indicator (CPI):

- Green window: contacts opened
- Red window: contacts closed

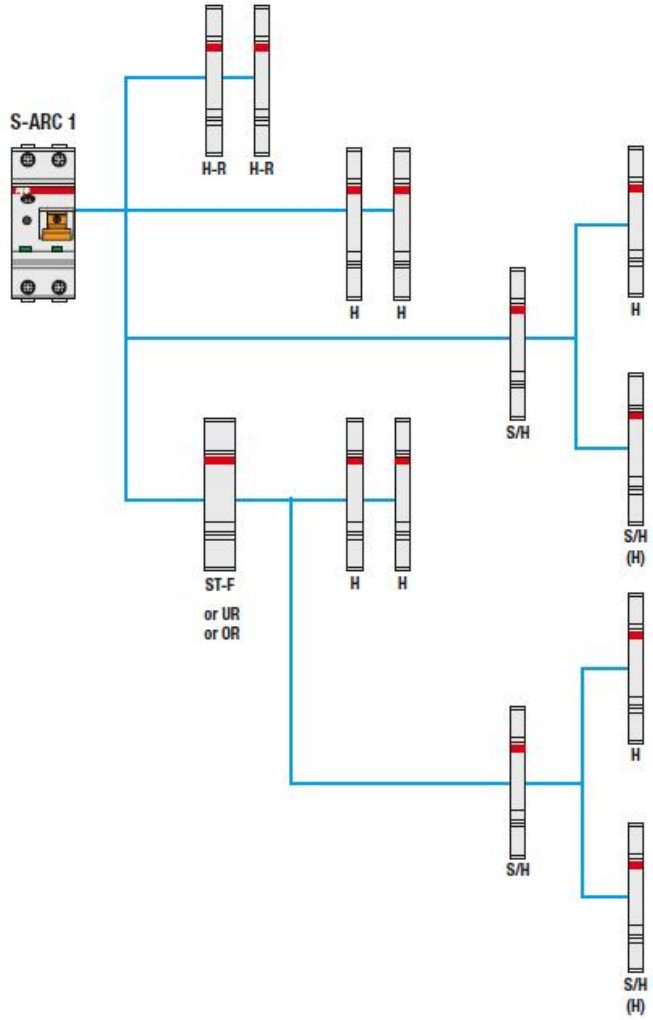


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System pro *M* compact® accessories

Combinations with accessories

		S-ARC 1
H	Auxiliary contact	S2C-H6R
H-R	Auxiliary contact	S2C-H6R / S2C-H6-xxR
S/H	Signal / auxiliary contact	S2C-S/H6R
S/H (H)	Signal / auxiliary contact used as auxiliary contact	S2C-S/H6R
ST-F	Shunt Trip	F2C-A
UR	Undervoltage release	S2C-UA
OR	Overvoltage release	S2C-OVP



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Arc – Fire Protection

CP5 : Code of practice for electrical installations - Foreword

This Singapore Standard was prepared by the Technical Committee on the Code of Practice for Electrical Installations under the direction of the Electrical Industry Practice Committee.

This edition is a revision of Singapore Standard CP 5 : 1988. The title is revised to 'Code of practice for electrical installations' as it now applies to electrical installations in general. It is aligned with the requirements and format with that of the IEE Wiring Regulations 16th Edition. However, the IEE shall not be held responsible for any errors or omissions that may occur as a result of extracting materials from the IEE publication. IEE 16th Edition is now known as BS 7671 : 1992 'Requirements for electrical installations' and is reproduced by permission of IEE and BSI, 389 Chiswick High Road, London W4 4AL, England.

This code of practice has been drawn up to ensure safety, especially from electric shock and fire in the use of electricity and relates principally to the design, selection, erection, inspection and testing of electrical installations. It is not intended to take the place of detailed specification or to instruct untrained persons or to provide for every circumstance. For installations of a special or complex character, the advice of a suitably qualified professional engineer and consultation with the supply authority will be necessary.

A section on special installations or locations has been included to highlight the more stringent requirements which are necessary for electrical safety.

Arc – Fire Protection

BS 7671 : the 18th Edition report

With the 18th Edition to the Wiring Regulations not too far off (it's due to publish 1st July 2018), Nicole Whitton looks at what is being discussed at committee level now and what changes are likely to be included in what will be BS 7671:2018.

As Leon Markwell discussed in his March 2016 blog post, four panels inform JPEL/64, the decision-making committee of BS 7671:

- Panel A – covers verification and inspection and testing (Part 6 and Appendix 6 of BS 7671) plus any work relating to Parts 1, 2 and 3 of BS 7671.
- Panel B – covers cable sizing and installation and related matters (some of Parts 4 and 5, Appendices 3 and 4 and some Part 7 items of BS 7671).
- Panel C – covers earthing installations and related matters (some of Parts 4 and 5 and some Part 7 items of BS 7671).
- Panel D – covers the remainder of Parts 4 and 5, some Part 7 items and some Appendices of BS 7671).

There are two standard setters that we work with: the IEC (International Electro-technical Committee) and CENELEC (European Committee for Electrotechnical Standardization). Mark Coles explains the working relationships with these standard setters in more detail in his October 2015 blog, and also provides instructions on how to gain access to the various topics being discussed for inclusion in the 18th Edition.

Source: http://www.optima-ect.com/news/2017/7/5/bs-7671-the-18th-edition-report

Arc – Fire Protection

BS 7671 : the 18th Edition report : Significant changes – Protection against overvoltage

Geoff Cronshaw discussed the work being undertaken on this change in the Spring 2013 issue of Wiring Matters. I summarise the likely changes here.

Clause 443 is likely to be significantly revised based on the recently published IEC and CENELEC standard. However, the exact requirements will have to be agreed by the UK national committee. Assuming BS 7671 follows the IEC and CENELEC standard the AQ criteria (conditions of external influence for lightning) for determining if protection against transient overvoltage is needed would no longer be included in BS 7671. Instead, protection against transient overvoltage would have to be provided where the consequence caused by overvoltage affects:

- human life, e.g. safety services, medical care facilities;
- public services and cultural heritage, e.g. loss of public services, IT centres, museums; and
- commercial or industrial activity, e.g. hotels, banks, industries, commercial markets, farms.

For all other cases, a risk assessment would have to be performed in order to determine if protection against transient overvoltage is required. If the risk assessment is not performed, the electrical installation would have to be provided with protection against transient overvoltage.

Source: http://www.optima-ect.com/news/2017/7/5/bs-7671-the-18th-edition-report

Arc – Fire Protection

BS 7671 : the 18th Edition report : Significant changes – Protection against overvoltage

Protection against switching overvoltages should still be considered.

Protection against fire

Protection against fire resulting from the electrical installation and the use of the electrical installation has been necessary ever since electricity was first introduced into buildings. Chapter 42 contains the requirements for the protection of persons, livestock and property against fire caused by electrical equipment, against burns and overheating and for including precautions where particular risks of fire exist.

It is recognised that RCDs can reduce the likelihood of fires associated with earth faults. However, whilst RCDs can detect earth faults they aren't able to reduce the risk of electrical fire due to series or parallel arcing between live conductors because there is no leakage current to earth. Also, it is understood that the impedance of a series arc fault reduces the load current, which will keep the current below the tripping threshold of the circuit-breaker and the circuit-breaker may therefore not operate to disconnect the circuit.

For this reason details will be included in BS 7671:2018 for the installation of arc fault detection devices (AFDDs) to mitigate the risk of fire in final circuits of a fixed installation due to the effect of arc fault currents.

Source: http://www.optima-ect.com/news/2017/7/5/bs-7671-the-18th-edition-report

