

# Arc Fault Management Testing and Arc Flash Calculations

# Agenda

- AS/NZS 61439-1 Appendix ZC – ZD Internal Arc Fault Management Testing
- IEC TR 61641 Internal Arc Fault Management Testing
- IEC TS 63107 Arc Fault Mitigation Systems

Refreshment break

- IEEE 1584 Performing Arc Flash Calculations
- Conclusion

*\*Excerpts of source material from publications such as Standards is required to study technical points completely and in full context. The direct copying of excerpts from standards publications for educational purposes is protected under moral rights by the Copyright Act of 2000.*

# Introduction



## Switchboard Standards

- There are several available standards for switchboard testing
  - IEC and AS/NZS standards provide guidance on passive measures to reduce the effects of Arc Faults.
  - IEC standard provide guidance on active measures to reduce the effects of Arc Faults.
- The final section will look at IEEE 1584 Arc Flash calculations.
- Do the results from IEC and AS/NZS standards change the outcome for IEEE 1584.

# AS/NZS 61439.1: 2016

# AS/NZS 61439-1 Review of compliance



AS/NZS 61439-1 Compliance. **No Arc Fault Management Testing included**

Failed IP rating after test

Module Passed IP after test



# AS/NZS 61439.1: 2016

Appendix ZC and ZD – Internal Arc Fault Management Testing

# AS/NZS 61439-1 Annex ZC - ZD



GUIDELINES FOR ASSEMBLIES INTEND TO PROVIDE INCREASED SECURITY AGAINST THE OCCURRENCE OR THE EFFECTS OF INTERNAL ARCING FAULTS

Annex ZC – ZD is an Informative section of the 61439 Standard “BY AGREEMENT”

- ZC1-6 sets out the introduction & objectives
  - To provide means to reduce the probability of internal arcing faults
  - To protect personnel from injury in the event of arcing fault in **normal operating conditions**
  - Limit as far as possible the extent of damage to equipment from an arcing fault
- ZD sets out the guidelines for the test
  - Instructs on the initiation of the arc fault
  - Instructs on the assessment of the test
  - Specifies the report content

# AS/NZS 61439-1 Annex ZC 3



This Annex has had only one minor revision since 1980

In the standard it lists possible causes for failure of the assembly Annex ZC 3

*Note: Times have changed and responsibility for infrastructure maintenance has changed*

## **Construction Issues**

- Omission of barriers
- Incorrect install of devices
- Loose connections
- Presence of foreign objects

## **Now - Maintenance Issues**

- Omission of barriers after maintenance
- Corrosion
- Loose connections
- Incorrect repair or replacement of devices
- Ingress of vermin
- Ingress of particulates
- Aging of insulation
- Ventilation

# AS/NZS 61439-1 Annex ZC 4 – 5



## ZC 4 Arcing Fault Conditions

*Note: The Annex currently reflects the conventions at the time it was developed.*

- Arc fault currents are determined by Voltage and Source impedance
- Arc events are of a dynamic nature and difficult to predict and is affected by thermal and magnetic forces
- Arcs generally will continue until they become unstable and self-extinguish
- Arcs should not be relied on to become unstable and self-extinguish

## ZC 5 Minimisation of arcing

- ZC 5 directs you to ZC 6

# AS/NZS 61439-1 Annex ZC 6



## ZC 6 Means of achievement

- Arrange compartments with venting via roof or back (If not accessible)
- Use fuse and breakers to limit duration
- Use radiation detection devices to activate protective devices
- Or all of the above



# AS/NZS 61439-1 Annex ZD



## ZD 1 Introduction

The requirements for internal arc fault testing are subject to agreement to either Annex ZD or IEC TR 61641

- This appendix specifies tests for increased security against the effects while in service with ALL DOORS AND COVERS IN PLACE.
- It is impossible to simulate all condition that may causes an arc fault the methods contained are designed for a repeatable manor of instigating an arc the test has been designed in such away to allow reasonable assessment of the measures taken.
- These tests are standard arc fault test carried out on the load side terminals of the protective device.

# AS/NZS 61439-1 Annex ZD



## Test requirements

- The initiation of the arc is to be on the load side of the protective device inside the module
- To facilitate this any terminal covers or insulation should be removed in the module
- Fuse wire is then wrapped around the terminals of the protective device load side

## Arc Fault Test



## Effects on the enclosure

- An Arc in free air exposes the enclosure to direct heat
- Reduce reaction time of the MCCB due to higher impedance

# AS/NZS 61439-1 Annex ZD



## ZD 2 Relevance of Tests

The arcing fault test is carried out to assess the ability of the ASSEMBLY to limit the risk of personal injury and the extent of equipment damage resulting from an arcing fault. As a representation of an arc this test may not cover all arcing events.

- The tests described herein are generally applicable only on outgoing functional units.
- Main Busbar compartments are not generally required due to the low likelihood of an arcing fault occurring.
- By agreement tests on main bus and incoming units falls under “special test requirements”
- Any changes to the tested arrangement that may impact on the performance will require re-testing:-
  - Change in protective device include setting of device during test
  - Modification to venting
  - Constructional changes

# AS/NZS 61439-1 Annex ZD



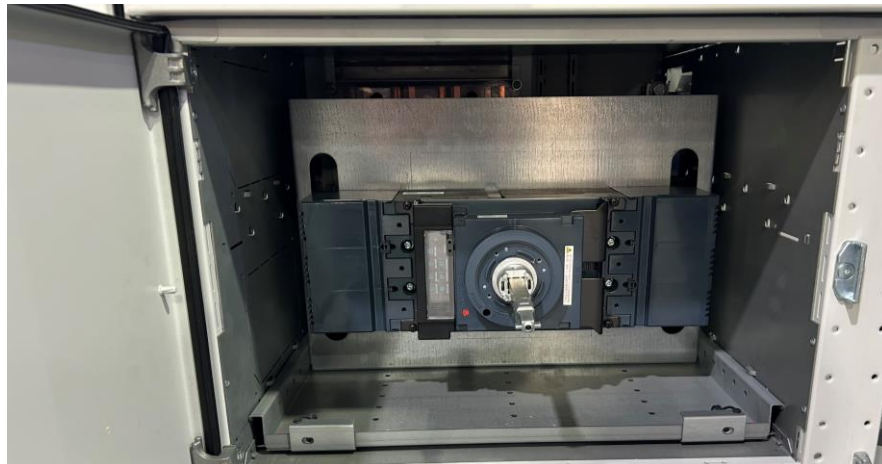
## ZD 4 - 5

### Preparation for Arcing fault test

- All compartments within the board shall be as for their normal service condition.
- Compartment under test shall contain all components as intended during operation Wood blocks can be used to substitute active equipment during test.

### Conditions to repeat test

- An arc had not established
- The protective device had operated
- The arc transferred to line side of device



# AS/NZS 61439-1 Annex ZD

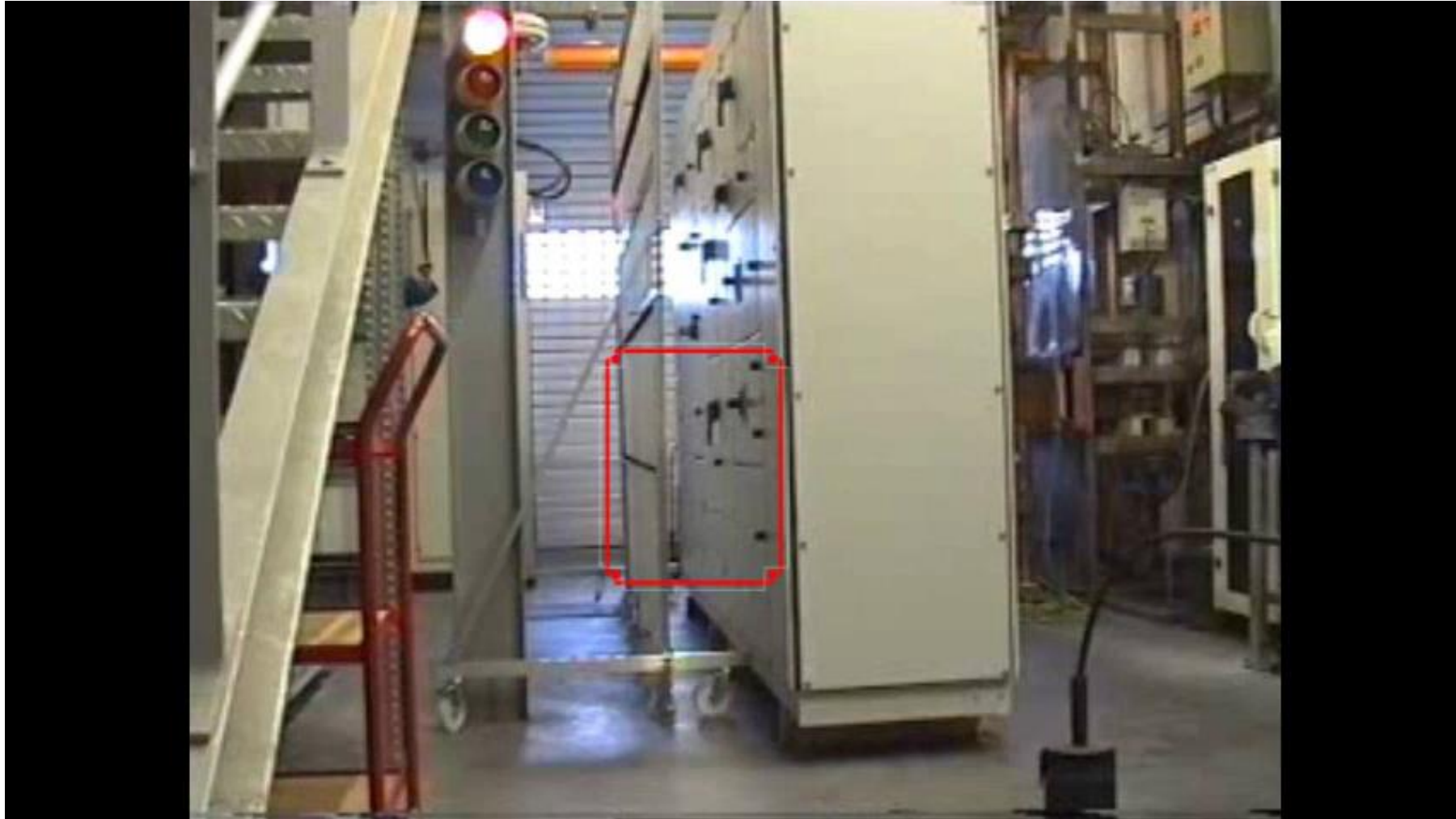


## ZD 7 Assessment of Test Results

The assembly is assessed on the likelihood of operator injury and extent of damage to the assembly shall be assessed as follows.

- For assessment of operator protection in vicinity of the assembly
- All covers, doors and fastenings are intact
- No component was dislodged in a manner that may cause injury
- Cotton gauze did not ignite
- For assessment of suitability for further service of circuits and components
- Other modules are fully operational, both mechanically and electrically
- All doors and covers in place and IP rating maintained

# AS/NZS 61439-1 Annex ZD



# IEC TR 61641 : 2014

## Technical Report

Enclosed low-voltage switchgear and controlgear assemblies – Guide for testing under conditions of arcing due to internal fault

# IEC TR 61641



## IEC 61641: Guide for testing under conditions of arcing due to internal fault

- **4.0** Classification of low-voltage and controlgear assembly
- **Arcing class A** – Assembly providing personnel protection under arcing condition by arc tested zones conforming to arcing conditions in 8.7, criteria 1 to 5, and by arc ignition protected zones, if any;
- **Arcing class B** – Assembly providing personnel and ASSEMBLY protection under arcing conditions by arc tested zones conforming to arcing conditions to 8.7, criteria 1 to 6, and by arc ignition protected zones, if any;
- **Arcing class C** – Assembly providing personnel and ASSEMBLY protection under arcing conditions by arc tested zones conforming to arcing conditions with limited operation in 8.7, criteria 1 to 7, and by arc ignition protected zones, if any;
- **Arcing class I** – Assembly providing a reduced risk of arcing faults solely by means of arc ignition protected zones.

## 4.2 Classification with regard to persons who have access

Additionally, the ASSEMBLY is classified according to the kind of persons who have access to area where the ASSEMBLY is installed, as follows:

- Restricted access (Default arrangement)
- Unrestricted access (Special arrangement)

These arrangements are by agreement between the Manufacturer and the End User

**NOTE 1** Operation of ASSEMBLIES according to IEC 61439-2 by ordinary persons is not intended. Never the less they can be accessible to ordinary persons, e.g. when they are placed in a general work floor without any complementary safety measures and/or rules.

**NOTE 2** Additionally local safety regulations have to be taken into account and can impose additional and/or more stringent requirements with regard to access, personal protective equipment (PPE) to be used and working procedures to be applied.

# IEC TR 61641



| Classification Item                                         | Classifications                                                                                                                                                 | Comments                                                                                             |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Assembly which is tested according to this technical report | Arcing Class A:<br>Personal Protection. (Criteria 1 to 5)                                                                                                       | Where there is an agreement between the user and the manufacturer one of the assembly criteria apply |
|                                                             | Arcing Class B:<br>Personal Protection plus arcing restricted to a defined area within the assembly. (Criteria 1 to 6)                                          |                                                                                                      |
|                                                             | Arcing Class C:<br>Personal Protection plus arcing restricted to a defined area within the assembly limited operation after fault is possible,(Criteria 1 to 7) |                                                                                                      |
|                                                             | Arcing Class I:<br>Assembly providing protection by means of arc ignition protected zones.                                                                      |                                                                                                      |
| Access                                                      | Restricted (Default)                                                                                                                                            | Authorised persons only have access to the assembly                                                  |
|                                                             | Unrestricted                                                                                                                                                    | The assembly can be placed in a location accessible to everyone including ordinary persons           |

## 8.7 Assessment of the test

**Class A** Personnel protection is achieved when the following criteria 1 to 5 are fulfilled

1. Correctly secured doors and covers do not open and remain effectively in place and provide a minimum level of protection in accordance with the requirements of IP1X of IEC 60529. The ASSEMBLY does not need to comply with its IP code after the test
2. No parts of the ASSEMBLY are ejected which have a mass of more than 60 g except those which are dislodged and fall between the ASSEMBLY and the indicators;
3. Arcing does not cause holes to develop in the external parts of the enclosure below 2 m, at the sides declared to be accessible as a result of burning;
4. The indicators do not ignite (indicators ignited as a result of paint or stickers burning are excluded from this assessment);
5. The protective circuit for accessible part of the enclosure is still effective in accordance with IEC 61439-2.

# IEC TR 61641



**Class B** Personnel and ASSEMBLY protection is achieved when criteria 1 to 6 are fulfilled:

6. The ASSEMBLY is capable of confining the arc to the defined area where it was initiated,

No propagation of the arc to other areas within the ASSEMBLY.

No effects of hot gases in adjacent units other than the unit under test are acceptable

**Class C – I** Personnel and ASSEMBLY protection with limited operation capability is achieved when criteria 1 to 7 are fulfilled:

7. After clearing of the fault or after isolation or disassembly of the affected functional units in the defined area

Emergency operation of the remaining ASSEMBLY is possible.

Verified by a dielectric test according to IEC 61439-2:2011, 10.9.2, Damage to doors and covers of the unit under test and adjacent units is acceptable providing it can be readily restored to a minimum level of protection in accordance with IPXXB of IEC 60529. With the exception of the tested zone as declared by the manufacturer, all other units should remain fully operable both mechanically electrically

## 8.6.4.1 General Indicators (for observing the thermal effects of gases)

The indicators are made from 100 % black cotton fabric.

- a) restricted access (authorized personnel): cretonne with a mass of  $150 \text{ g/m}^2 \pm 20 \%$ ;
- b) unrestricted access (ordinary persons): interlining lawn with a mass of  $40 \text{ g/m}^2 \pm 20 \%$ .

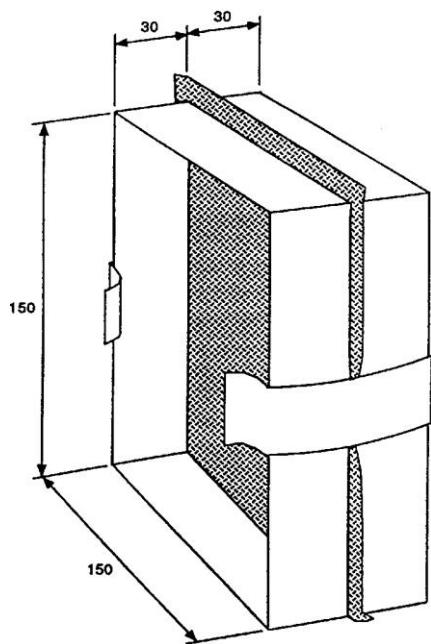
*Note: AS/NZS 61439 ZD deploys one type 40 g/m<sup>2</sup>.*

## 8.6.4.2 Fitting of the indicators

The indicators are 150mm x 150mm arranged in a checkerboard pattern covering 40 to 50% of the area under evaluation floor to maximum height of 2 m 300 mm from the face of the switchboard.

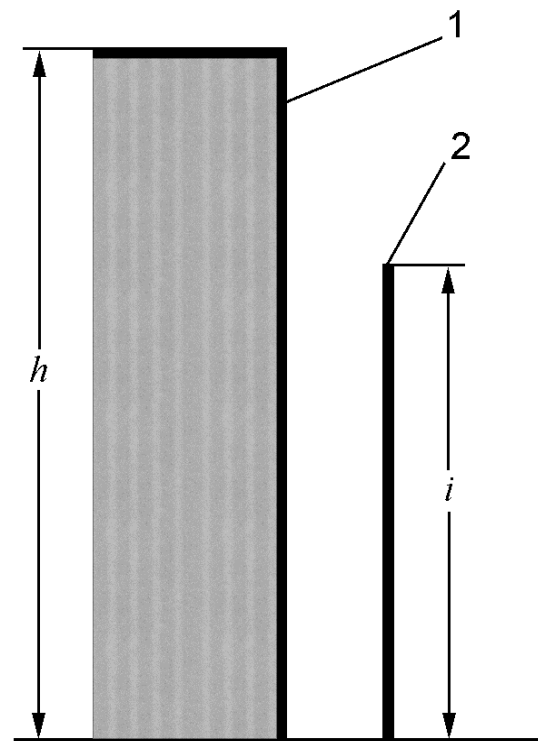
*Note: AS/NZS 61439 ZD places the indicator 250 mm from the face and must extend past the switchboard in all directions.*

# IEC TR 61641 Indicator setup

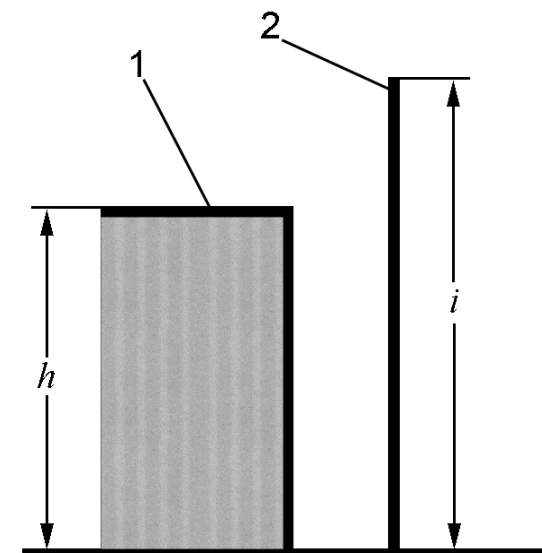


Restricted access (authorized personnel): cretonne with a mass of  $150 \text{ g/m}^2 \pm 20 \%$ ;

Unrestricted access (ordinary persons): interlining lawn with a mass of  $40 \text{ g/m}^2 \pm 20 \%$ .

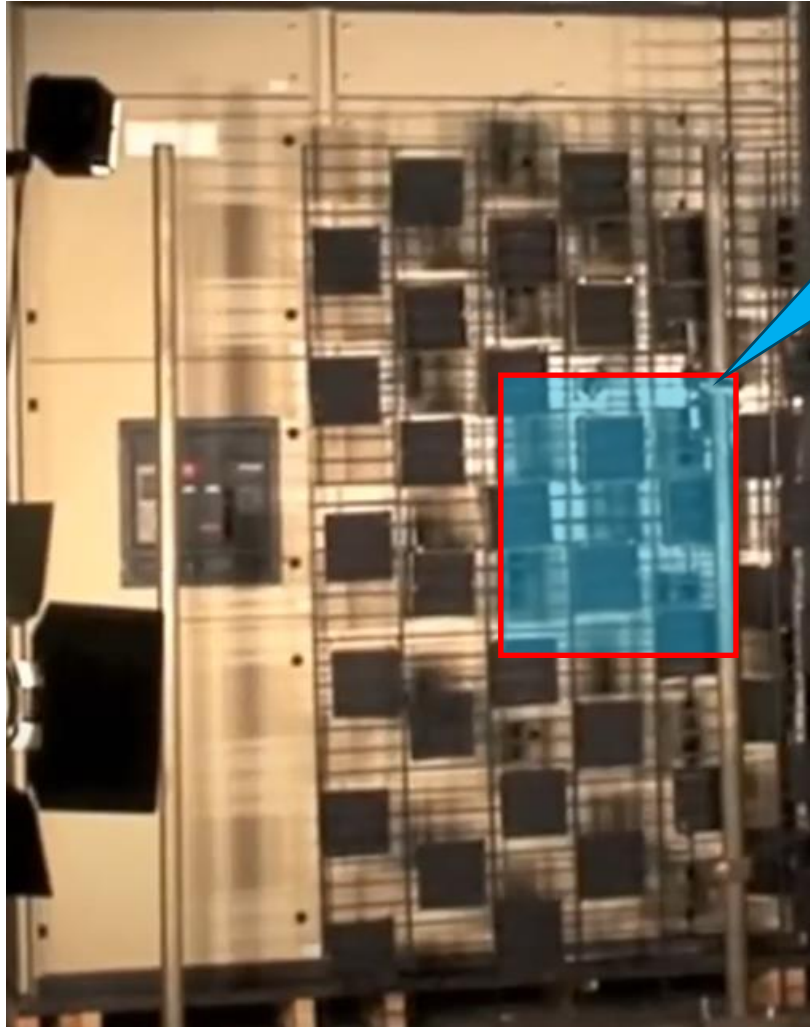


Position of the indicator for  $h > 2 \text{ m}$



Position of the indicator for  $h \leq 2 \text{ m}$

# IEC TR 61641

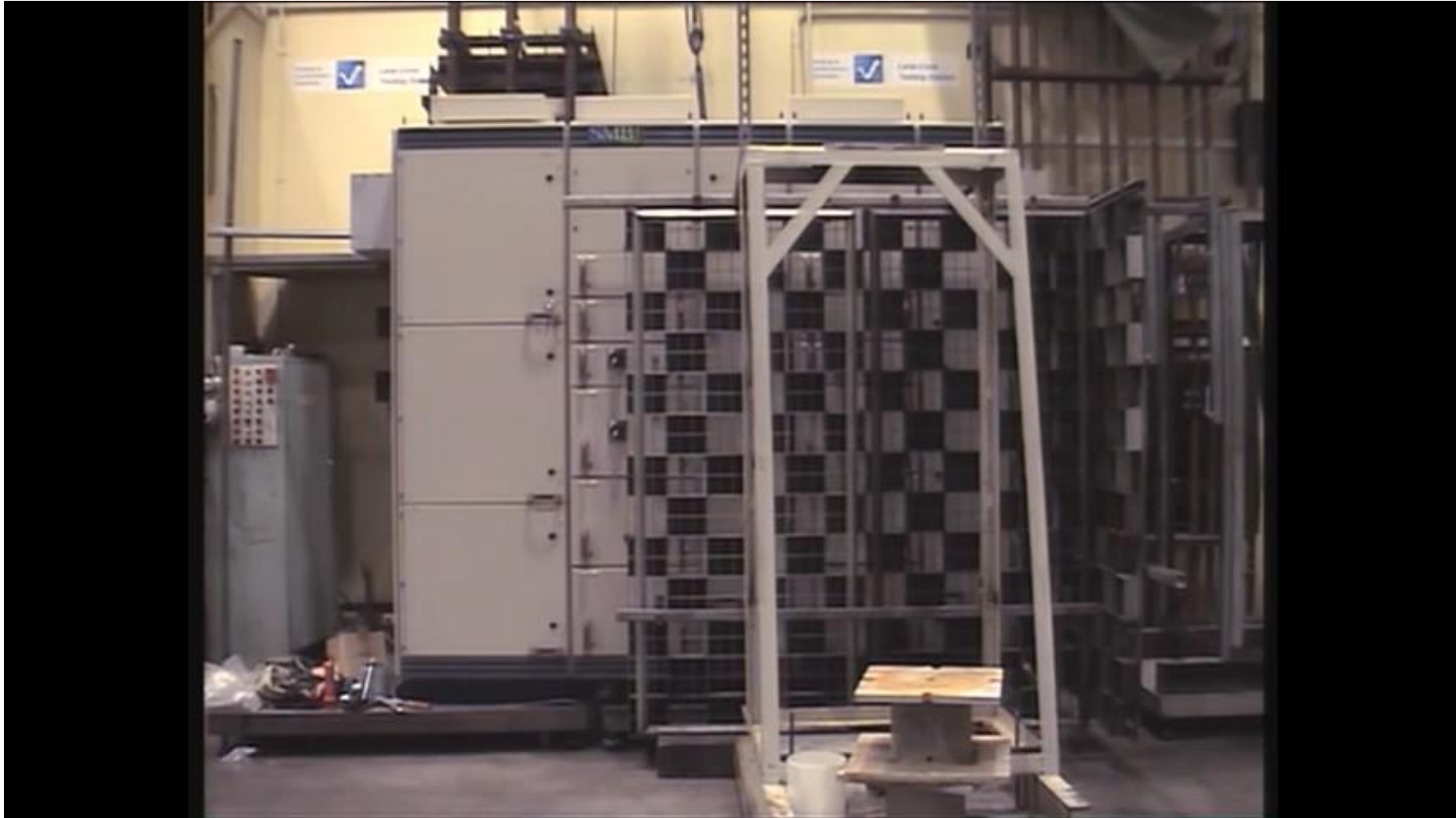


Module  
Under  
test

# AS/NZS 61439 ZD



# IEC TR 61641



# IEC TR 61641



## 9 Test Report

Operation of any arc mitigation device fitted and made operational for any of the tests

- Arrangement of the test connections and the points of initiation of the arc
- Arrangement of material of the indicators

Prospective values:

- r.m.s value of the a.c. current component
- Highest peak value of current
- Highest peak current
- Duration of the test
- Total actual burn time
- Also recording of all voltage and current levels applied and let through energies

# IEC TS 63107 : 2020

## Technical Specification

Integration of internal arc-fault mitigation systems in power switchgear and controlgear assemblies (PSC-Assemblies) according to IEC 61439-2

# IEC TS 63107 Active



Integration of internal arc-fault mitigation systems in power switchgear and controlgear assemblies

- Internal arc-fault mitigation systems (IAMS) denote systems that consist of an internal arc fault control device (IACD) and an internal arc-fault reduction device (IARD).
- This document applies only to enclosed PSC-assemblies and deals with all required verifications needed for the integration in conjunction with IEC 61439-1 and IEC 61439-2.
- The test procedure given in this document takes into consideration:
  - The correct function of the IAMS within the PSC-assembly;
  - The prevention of unintended operation of the IAMS within the PSC-assembly;
  - The functioning behavior of the system immediately after the assembly is energised.

# IEC TS 63107

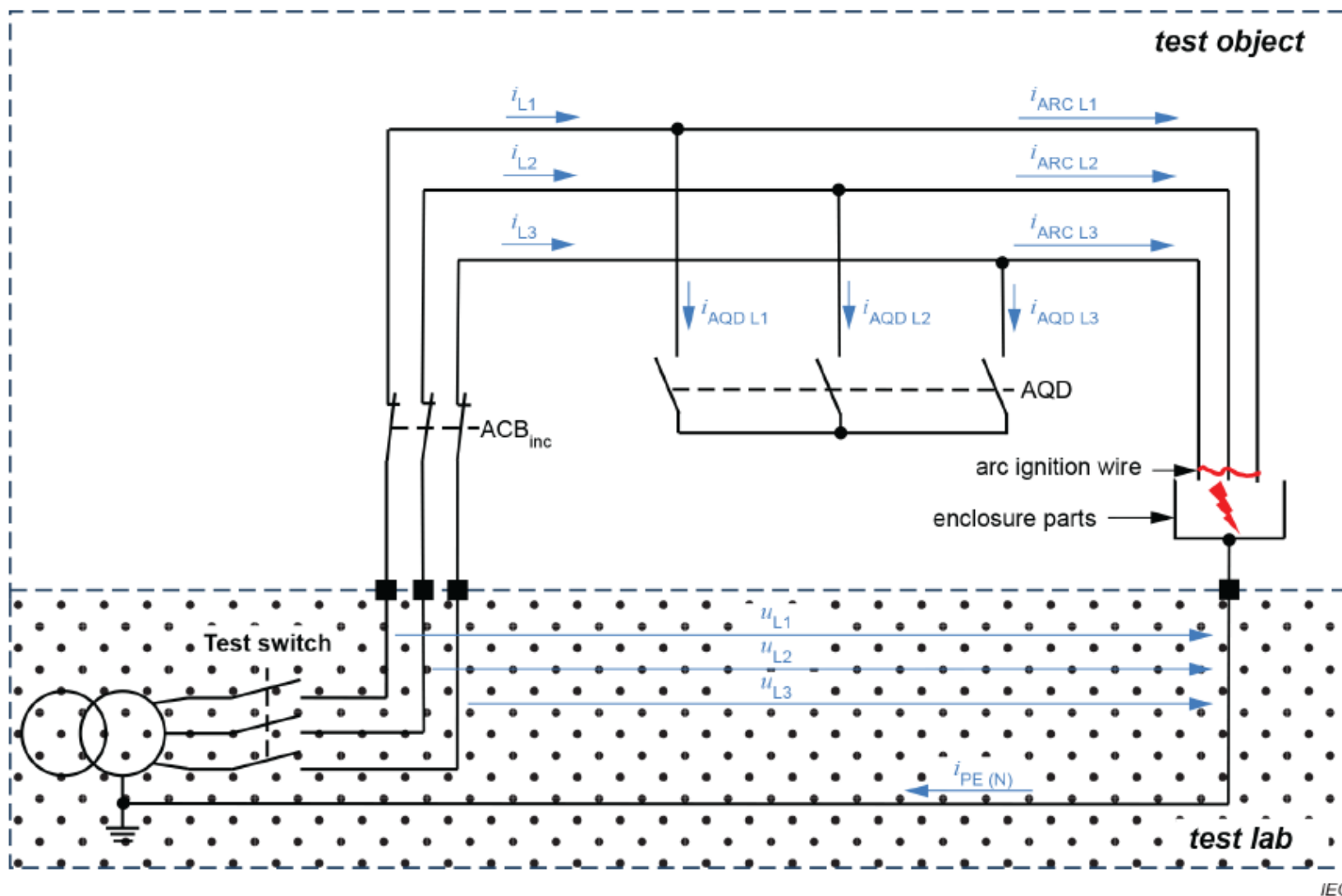


## Symbols and abbreviated terms

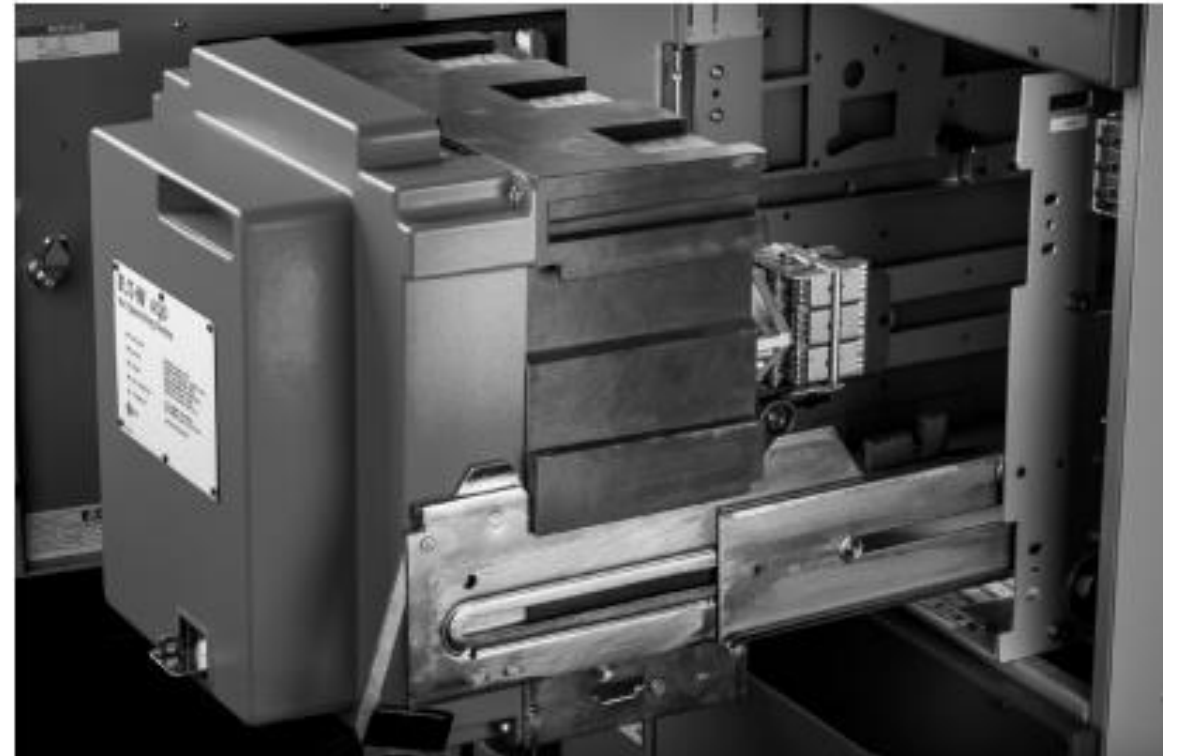
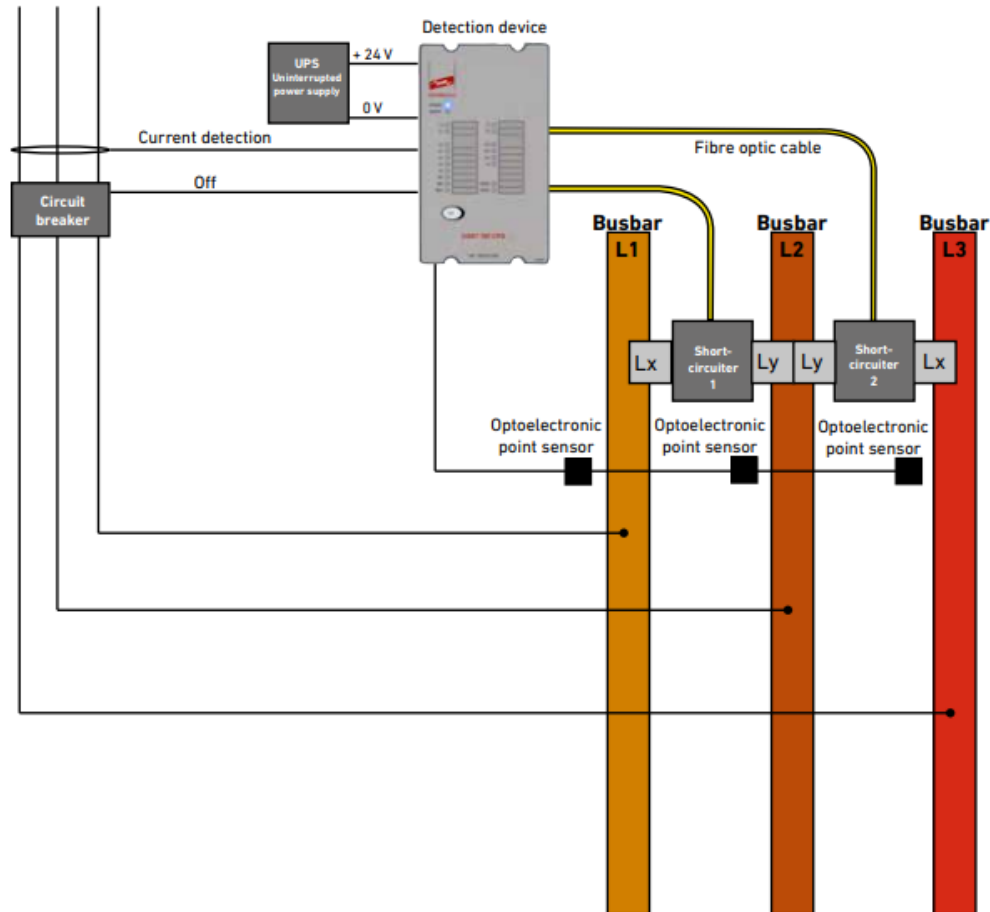
Table 1 – Symbols and abbreviated terms

| Abbreviated term | Term                                     | Sub-clause |
|------------------|------------------------------------------|------------|
| ACB              | air circuit-breaker                      | JJ.1       |
| AQD              | arc quenching device                     | 3.3.1      |
| ATSE             | automatic transfer switching equipment   | 3.5        |
| E-arc            | arc-energy                               | 3.7        |
| IACD             | internal arc-fault control device        | 3.2        |
| IALD             | internal arc-fault limiting device       | 3.3.2      |
| IAMS             | internal arc-fault mitigation system     | 3.1        |
| IARD             | internal arc-fault reduction device      | 3.3        |
| T-mtA            | arc-fault mitigation time in an assembly | 3.6        |

# Arc Quenching Device - AQD



# Arc Quenching Device - AQD



## 5.101 Characteristics for each individual IAMS protected area

Declaration of IAMS protected areas shall include following parameters:

- Range of prospective short-circuit current ( $I_{cp}$ ) at the incoming terminals of the PSC assembly

Declared for each IAMS protected area for which the IAMS is effective;

- Range of rated operational voltages ( $U_e$ ) at the incoming terminals of the PSC-assembly

Declared for each IAMS protected area for which the IAMS is effective;

- Maximum arc energy during the tests ( $E_{arc}$ ) which is the highest value declared for the whole assembly defined by test(s) in 10.101.4.

The functioning behavior of the IAMS immediately after the assembly is energised shall be considered.

## 8.5.103 Quantity and location of sensors of an IAMS

The quantity, location and arrangement of the sensors to detect an internal arc-fault shall be made according to the recommendations of the IACD manufacturer (see Annex II.2) and where applicable, the knowledge gained from previous testing.

## 8.5.104 Connection of an AQD

The main connection of an AQD shall be as close as possible on the load side of the incoming / feeding device of the specific section in question. The conductors shall be as short as possible to reduce the voltage drop. These conductors shall take into account the mechanical constraints due to the magnetic forces and also the thermal stress according to the performance of the AQD.

## 8.102 Performance of an IAMS in PSC-assemblies

Areas within the PSC-Assembly which are to be protected shall be agreed between the assembly manufacturer and the user.

# IEC TS 63107

## Passive Protection

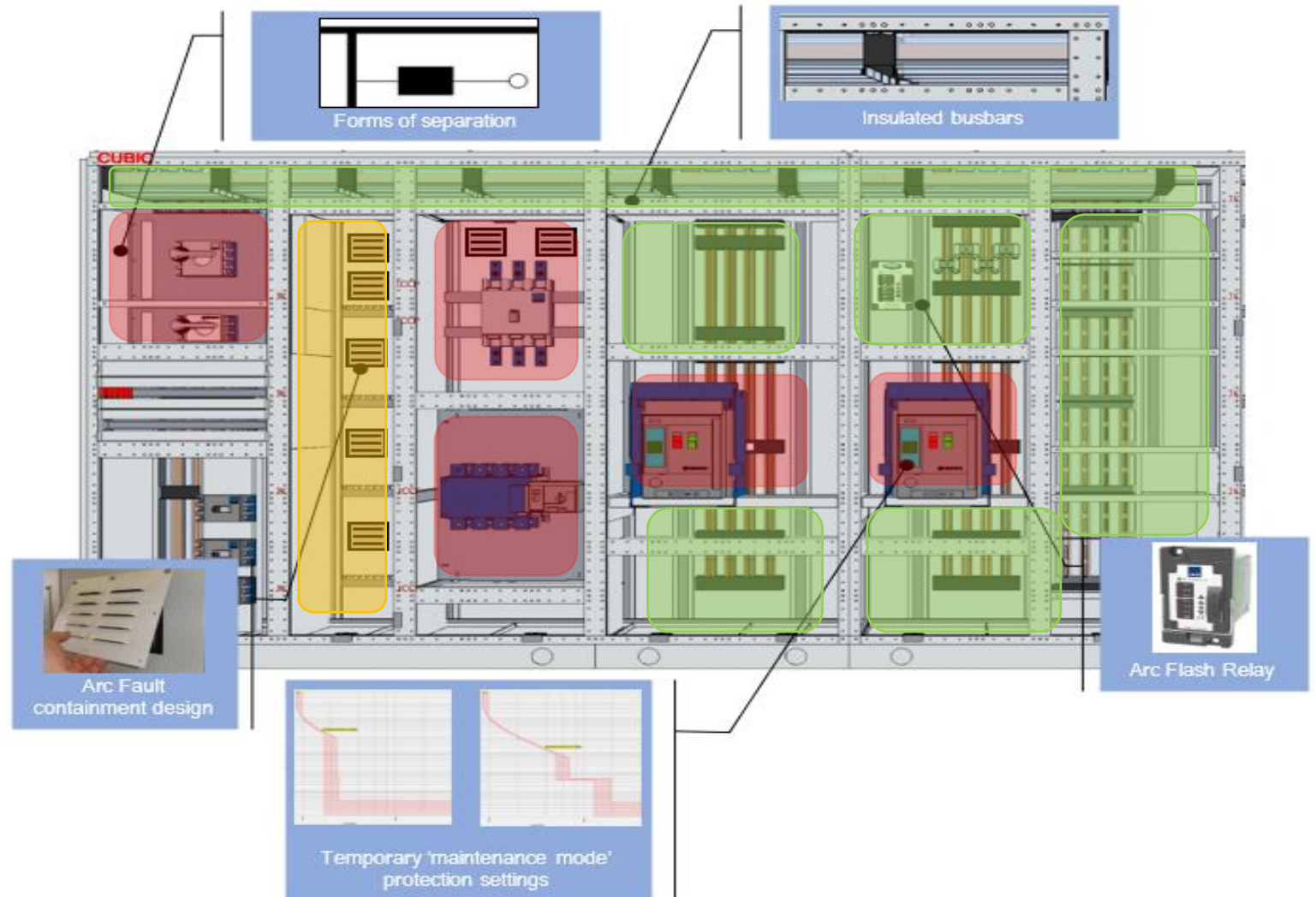
Insulation of Busbars, Forms of Separation

## Management

Specially designed, constructed and tested enclosure

## Active Suppression

IAMS (Arc Flash Relay +  
ACB's/MCCB's, AQD



Circuit Breaker

Bus Zones

Cable Zones

# IEC TS 63107



## 10.101.2 Verification of arc-fault detection by test - General

The aim of the test is to demonstrate correct detection of an arcing-fault at the most likely points where an arc could occur within the PSC assembly. Therefore, the prospective short circuit current level where an internal arc-fault can be detected with certainty within different areas shall be verified.

The following areas of arc ignition points along the main circuit shall be considered, as applicable:

- a) supply side of the incoming functional unit.
- b) load side of the incoming functional unit;
- c) along the main busbar;
- d) along the distribution busbar;
- e) supply side of any associated arc ignition protected zone;
- f) supply side of the outgoing functional unit;
- g) load side of the outgoing functional unit.

The arc shall not be initiated at an arc ignition protected zone according with 3.9 of IEC TR 61641:2014. Solid insulating material on conductors shall not to be destroyed, removed or punctured.

# IEC TS 63107

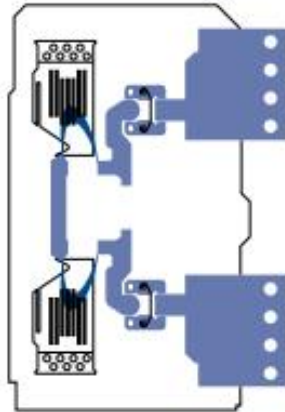


## Note

- A high current low impedance Arc Fault may reach the instantaneous region of the ACB which will result in the trip of the device with a total clearance time of the ACB.
- For all other Arc Faults keep in mind the disconnection time is the detection time of the IAMS device plus the ACB total clearance time.



Above – AR2

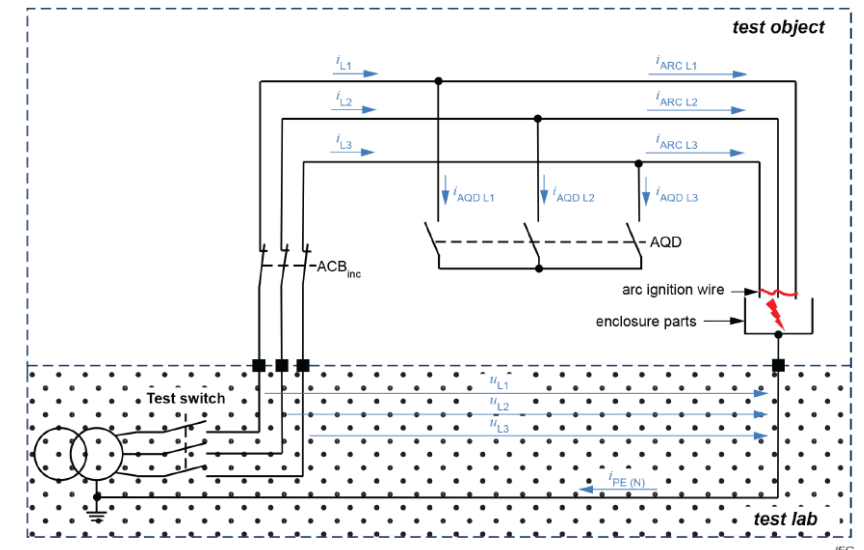


Above – AR2 – AR4 “Double Break”  
contact design

+



+



# Questions

# Refreshment Break

# IEEE 1584 - 2018

## IEEE Guide for Performing Arc-Flash Hazard Calculations

# IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations



## 1.1 Scope

This guide provides models and an analytical process to enable calculation of the predicted incident thermal energy and the arc-flash boundary. Applications include electrical equipment and conductors for three-phase alternating current (ac) voltages from 208 V to 15 kV. Calculations for single phase ac systems and direct current (dc) systems are not a part of this guide.

## 1.2 Purpose

The purpose of the guide is to enable qualified person(s) to analyze power systems for the purpose of calculating the incident energy to which employees could be exposed during operations and maintenance work. Contractors and facility owners can use this information to help provide appropriate protection for employees in accordance with the requirements of applicable electrical workplace safety standards.

## Electrical work

All electrical work could hurt someone. The biggest dangers are shock, arc flashes and arc blasts, which can reach a temperature of 19,000°C – hotter than the surface of the sun.

Since 2020 there have been more than 1,000 incidents and nearly 600 injuries recorded by SafeWork NSW. Three workers have died from electrical incidents.

Almost any job around energised equipment could end in tragedy. Don't work on energised electrical equipment. Protect your workers, don't take short cuts and never assume an electrical system is safe.

### Must do's

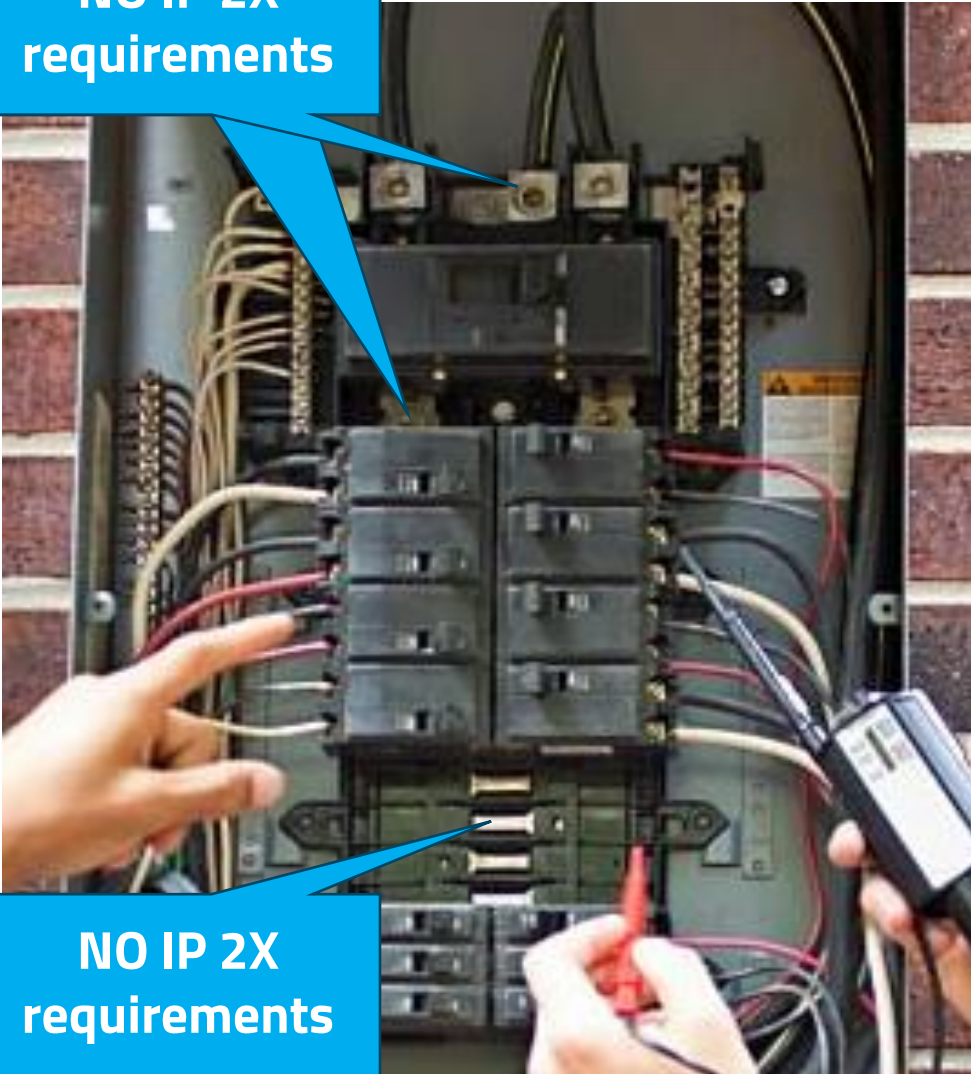


# IEEE 1584



# IEEE 1584

NO IP 2X  
requirements



# IEC-AS/NZS 61439



IP 2X

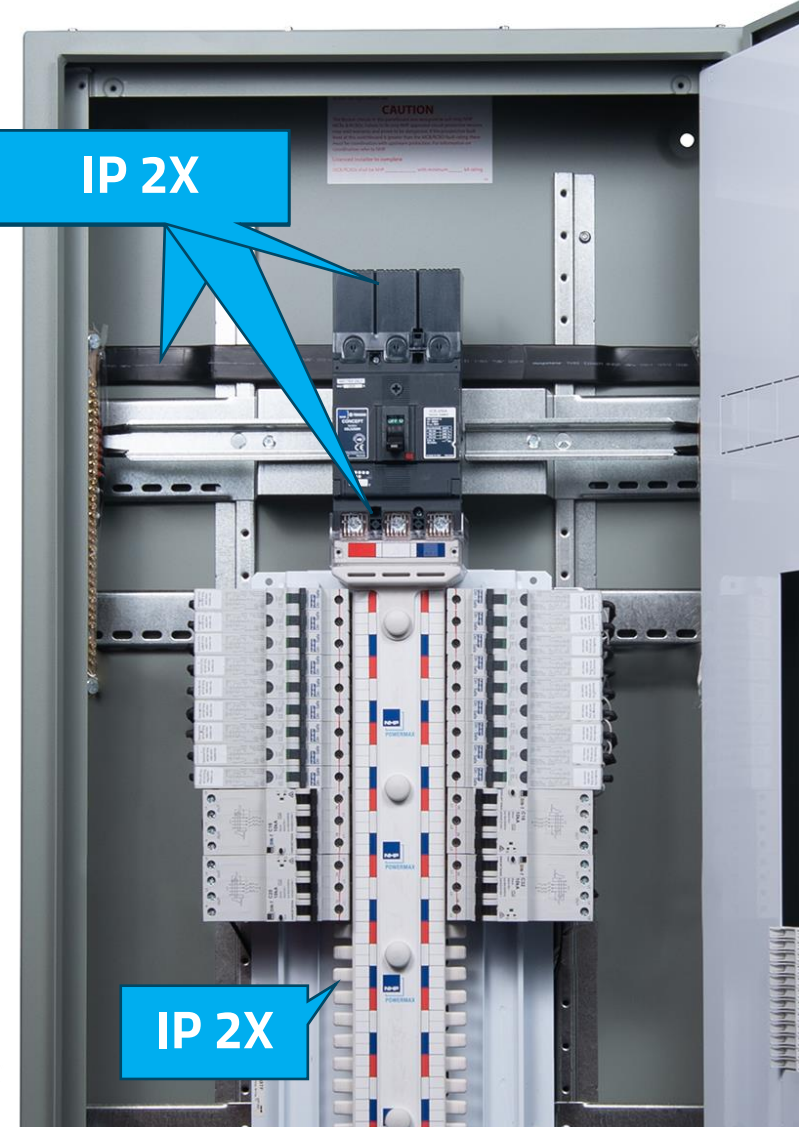
Exposed Copper  
higher risk  
NEMA



No exposed  
copper lower  
risk IEC-AS/NZS



IP 2X



# IEEE 1584



## 4.2 Range of model

The following empirically derived model, based upon statistical analysis and curve-fitting programs as well as an understanding of electrical arc physics, is applicable for systems with the following parameter range:

- Voltages in the range of 208 V to 15 000 V, three-phase (line-to-line)

Tests were performed in laboratory conditions using selected open-circuit voltages ( $V_{oc}$ ). While the model utilizes  $V_{oc}$ , pre-fault voltage (system nominal voltage, utilization voltage, etc.) can be used for application of this model.

- Frequency of 50 Hz or 60 Hz

- Bolted fault current (rms symmetrical)

- 208 V to 600 V: 500 A to 106 000 A

- 601 V to 15 000 V: 200 A to 65 000 A

- Gaps between conductors

- 208 V to 600 V: 6.35 mm to 76.2 mm (0.25 in to 3 in)

- 601 V to 15 000 V: 19.05 mm to 254 mm (0.75 in to 10 in)

# IEEE 1584



Working distances greater than or equal to 305 mm (12 in) (see [G.7.6](#) for details on the lower limit)

- Fault clearing time: No limit (see [G.7.8](#) for more details)
- Enclosures tested (with open front end) as shown in the following table:

**Table 8—Classes of equipment and typical bus gaps**

| Equipment class                          | Typical bus gaps (mm) | Enclosure Size (H × W × D)                                               |                                                      |
|------------------------------------------|-----------------------|--------------------------------------------------------------------------|------------------------------------------------------|
|                                          |                       | SI units (metric)                                                        | Imperial units                                       |
| 15 kV switchgear                         | 152                   | 1143 mm × 762 mm × 762 mm                                                | 45 in × 30 in × 30 in                                |
| 15 kV MCC                                | 152                   | 914.4 mm × 914.4 mm × 914.4 mm                                           | 36 in × 36 in × 36 in                                |
| 5 kV switchgear                          | 104                   | 914.4 mm × 914.4 mm × 914.4 mm                                           | 36 in × 36 in × 36 in                                |
| 5 kV switchgear                          | 104                   | 1143 mm × 762 mm × 762 mm                                                | 45 in × 30 in × 30 in                                |
| 5 kV MCC                                 | 104                   | 660.4 mm × 660.4 mm × 660.4 mm                                           | 26 in × 26 in × 26 in                                |
| Low-voltage switchgear                   | 32                    | 508 mm × 508 mm × 508 mm                                                 | 20 in × 20 in × 20 in                                |
| Shallow low-voltage MCCs and panelboards | 25                    | 355.6 mm × 304.8 mm × ≤203.2 mm                                          | 14 in × 12 in × ≤8 in                                |
| Deep low-voltage MCCs and panelboards    | 25                    | 355.6 mm × 304.8 mm × >203.2 mm                                          | 14 in × 12 in × >8 in                                |
| Cable junction box                       | 13                    | 355.6 mm × 304.8 mm × ≤203.2 mm<br>or<br>355.6 mm × 304.8 mm × >203.2 mm | 14 in × 12 in × ≤8 in<br>or<br>14 in × 12 in × >8 in |

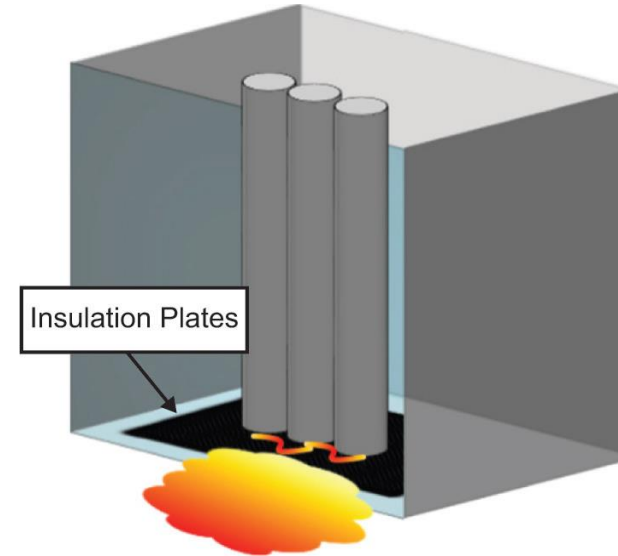
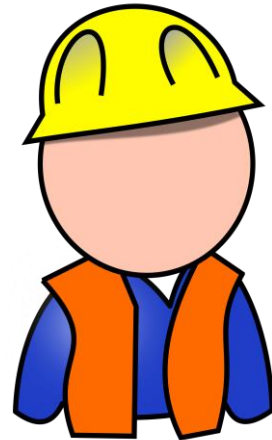
## Electrode configuration:

The orientation and arrangement of the electrodes used in the testing performed for the model development

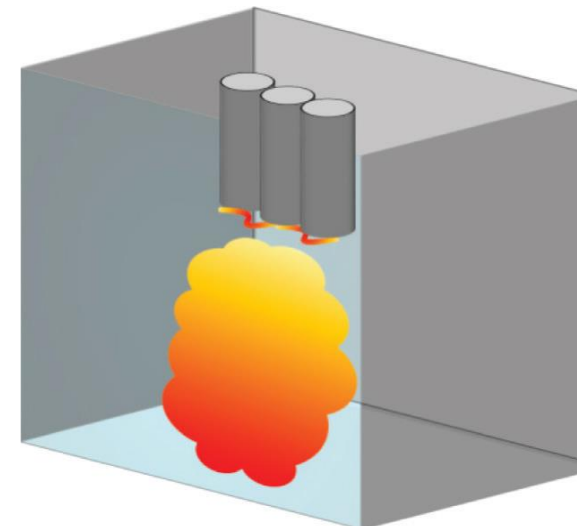
- **VCB:** Vertical conductors/electrodes inside a metal box/enclosure
- **VCBB:** Vertical conductors/electrodes terminated in an insulating barrier inside a metal box/enclosure
- **HCB:** Horizontal conductors/electrodes inside a metal box/enclosure
- **VOA:** Vertical conductors/electrodes in open air
- **HOA:** Horizontal conductors/electrodes in open air

# IEEE 1584

Doors or covers open  
working exposed to live  
equipment



VCBB - Vertical  
conductors  
inside no-  
ventilated metal  
box terminated  
on an insulating  
barrier

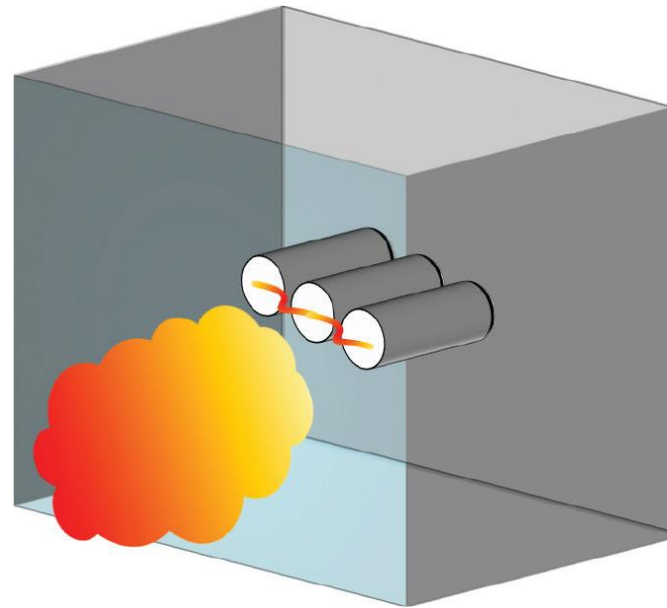
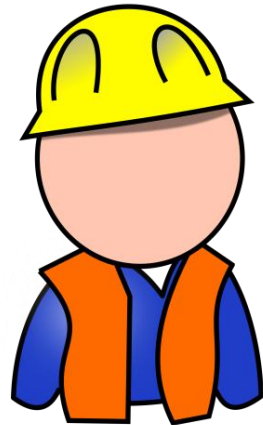


VCB - Vertical  
conductors  
inside no-  
ventilated metal  
box

# IEEE 1584



Doors or covers open working  
exposed to live equipment



HCB - Horizontal  
conductors  
inside no-  
ventilated metal  
box

# IEEE 1584



## IEEE Std 1584-2018 IEEE Guide for Performing Arc-Flash Hazard Calculations

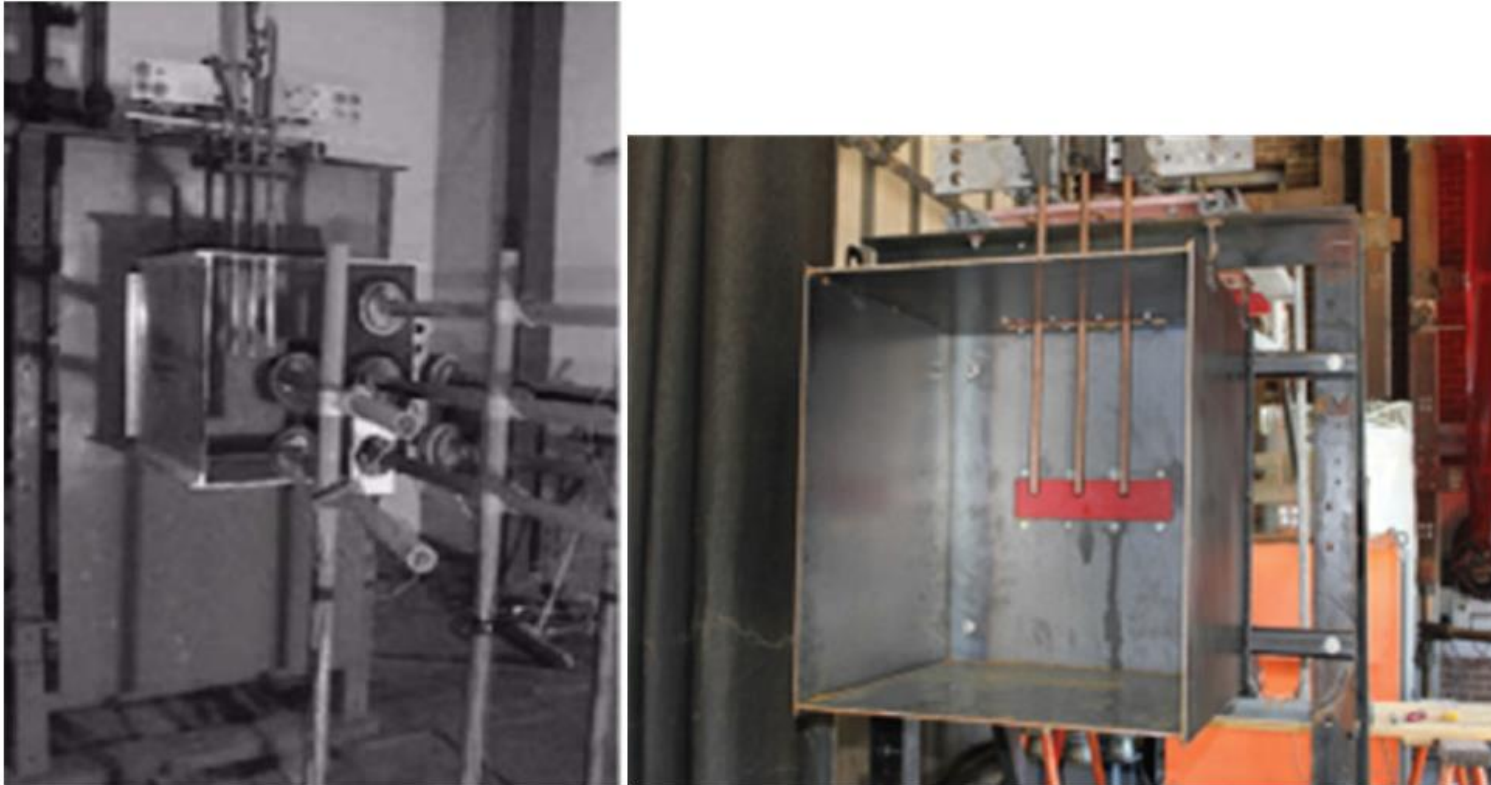


**Figure F.3—Test setup C—arc in box (VCB)**

## G.3 Summary of conclusions

Analysis of the data allowed the following conclusions:

- a) Based on the relationships among arc energy, incident energy, and arc duration, arc duration has a linear effect on the incident energy.
- b) Distance from the arc to the calorimeters has an inverse exponential affect.
- c) System X/R ratio, frequency, electrode material, and other variables that were considered were found to have little or no effect on arc current and incident energy, and so they are neglected.
- d) Arc current depends primarily on available short-circuit current, bus gap (the distance between conductors at the point of fault), electrode configurations, enclosure size, and system voltage.
- e) Incident energy depends primarily on calculated arc current, arcing duration, and working distance.

Note: Bus gap is a smaller factor.

# IEEE 1584 Summary



- This standard sets out the worst possible case for exposure
- This standard covers all configurations for connection types
- This standard is based on working in live compartments and live switchboards

## Electrical work

**All electrical work could hurt someone. The biggest dangers are shock, arc flashes and arc blasts, which can reach a temperature of 19,000°C – hotter than the surface of the sun.**

Since 2020 there have been more than 1,000 incidents and nearly 600 injuries recorded by SafeWork NSW. Three workers have died from electrical incidents.

Almost any job around energised equipment could end in tragedy. Don't work on energised electrical equipment. Protect your workers, don't take short cuts and never assume an electrical system is safe.

Must do's





# Conclusion

# Conclusion

**IEC & AS/NZS 61439-1** Passive measures afford the Authorised Personnel, using appropriate protection, a level of confidence the switchboard will operate as intended under normal conditions.



**IEC & AS/NZS 61439-1** Appendix ZC and ZD Passive measures afford both Authorised Personnel and Ordinary Persons using appropriate protection, a greater level of confidence in the operation of a switchboard in case of an internal Arc Fault event.

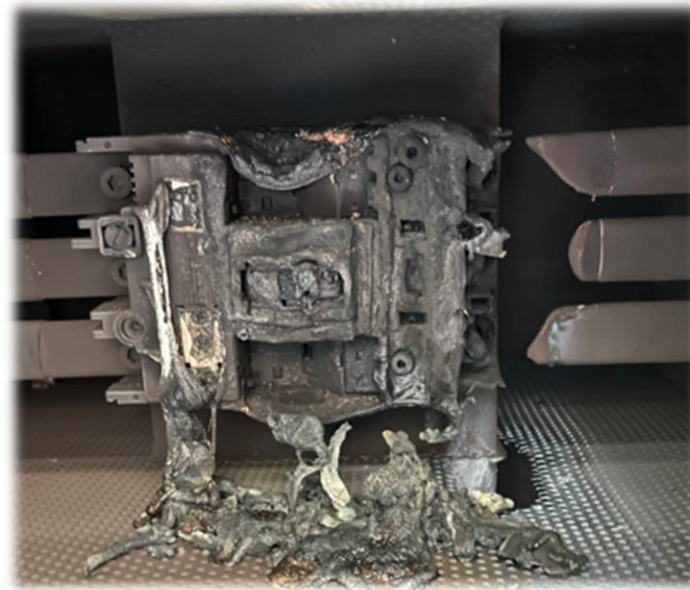
**NOTE:** A gap exists between the outcomes of testing from IEC - AS/NZS and IEEE 1584. IEC – AS/NZS do not measure the actual calories radiated from the front of a closed operating switchboard in abnormal conditions

# Conclusion continued



- **IEC 63107** Active measures for Arc Fault mitigation can minimise the level of switchboard damage during Arc Fault events. However these take time to react.

Cut off time at test station 50ms



# Conclusion continued



- **IEEE 1584** Formulas for calculating incident energy and arc-flash boundary from 208V to 15kV, as discussed throughout this guide, which uses empirically derived models based on statistical analysis and understanding of electrical arc physics.
- **Based on door open and covers removed**



# Questions



# Thank you

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