

Arc Fault Containment

Low Voltage Systems

Agenda

- Electric Arc Hazards Awareness
- Arc Fault – Behaviour
- Internal Arc Fault Type Testing
- MNS – Arc Safety

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Electric Arc Hazards Awareness
Introduction

Electric Hazards

- Shock
- Arc
- Blast

Arc Flash is a dangerous radiant electrical explosion.

- Electric Arc Temp = 20,000 °C v.s. Surface temp of sun= 5,600 °C
- Pressure wave. 10KA, 415V arcing fault = 8 sticks of TNT



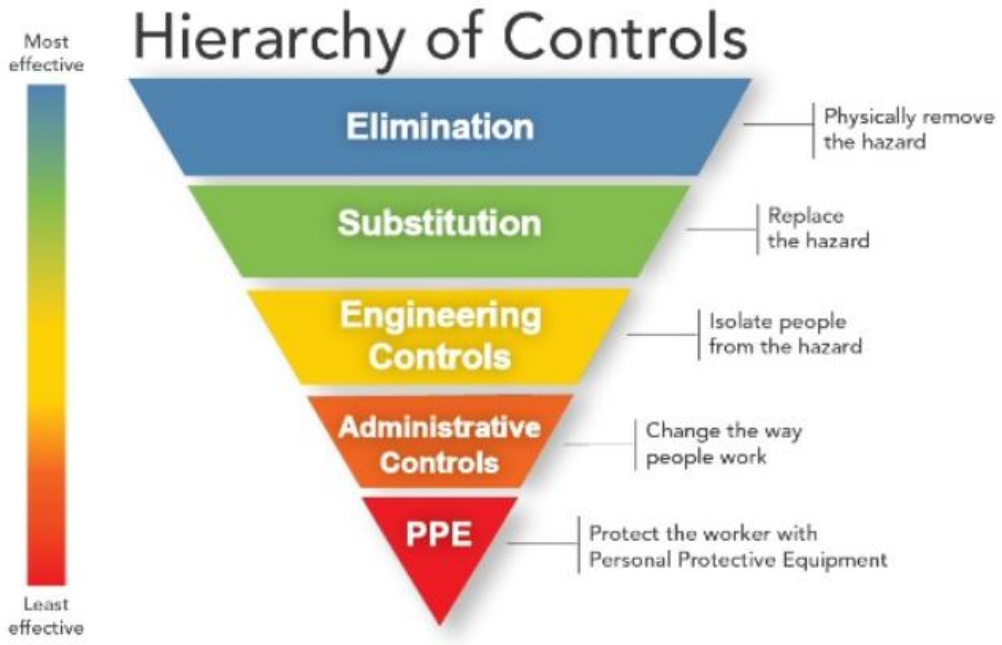




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Electric Arc Hazards Awareness

Mitigation activities



Electric Arc Hazards Awareness

Safety measures applied in Switchgear

Actions taken to improve safety

- Installing IR windows in compartment doors
- Installing Temperature Monitoring System
- Use of Long handle tools
- Remote racking and closing of circuit breakers
- Installing Current limiting fuses
- Installing Arc detection equipment
- Installing Earth fault protection
- De - energise before entry to the switchgear
- Enforcing PPE

Progressing to :

- Replacing the switchgear with “ Arc fault contained switchgear “



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Arc Fault – Behaviour

Arc Fault

Not all arcing faults are an instantaneous electrical explosion.

There are a number factors:

- The fault level
- The gap distance
- The voltage
- The switchgear materials and construction
- The protection equipment
- How the arc was created



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Arc Fault – Behaviour

Types of Arcs

Switching Arc

The prime function of switchgear is to switch on & off electrical circuits. Interrupting a current results in arcing between the contacts. There are many types of interrupters with many ways of arc extinction . The interrupters *control* the arc.

Switching arc video:
https://www.youtube.com/watch?v=MAlyEMQxTN0

Travelling Arc

Experiments in the 1950's showed that if an arc was initiated on a 3 phase bus system by a fuse wire the arc and the resultant Ionised gas would travel along the bus at speeds greater than 100m/sec – There is little damage until the arc is impeded. Then there is an arc explosion.

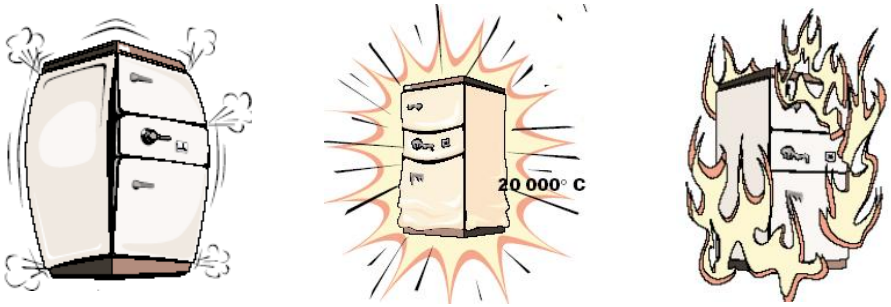
Travelling Arc Video:
C:\Users\SGFEYIN\Documents\ABB\5. Presentations\EPES\Arc Containment\Travelling Arc

Arc Fault – Behaviour

Internal Arc Fault

4 phases of arc fault

- Compression Phase: Pressure increases inside the switchgear, exerting forces onto the enclosure lasting 5 – 10ms
- Expansion Phase: Creates a wave like movement lasting 5 – 10ms.
- Emission Phase: At this point the ionised gasses from the arcing fault reach the outside of the switchgear and will continue to flow until pressure equilibrium is achieved between the inside and the outside of the enclosure.
- Thermal Phase: This ends only when all viable fuel has been expended, or the fault interrupted, with the heat energy acting on the equipment vaporising and melting metal and insulating parts.



We believe the only way to verify Arc Fault protection is by conducting *Internal arc fault containment type tests* on the particular switchboard for the actually operational conditions. Not only by :

- Arc flash calculations or
- Wearing PPE or
- relying on the Short Circuit Protection Relays

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Internal Arc Fault Type Testing

IEC / TR 61641 – Arcing Classes

4.1 Classification with regard to the protection characteristic

According to their characteristics under arcing conditions ASSEMBLIES can be classified by the manufacturer into:

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.

Internal Arc Fault Type Testing

IEC/TR 61641 – Testing Criteria

Personnel Protection – Criteria 1 to 5

1. Correctly secured doors, covers, etc., do not open.
2. Parts (of the assembly), which may cause a hazard, do not fly off.
3. Arcing does not cause holes to develop in the freely accessible external parts of the enclosure as a result of paint or stickers burning or other effects.
4. The indicators arranged vertically do not ignite (indicators ignited a result of paint or stickers burning are excluded from this assessment.
5. The earth bonding arrangement for accessible parts of the enclosure is still effective.

Plant & Equipment Protection – Criteria 6-7

6. The arc must be limited to the defined area and must not re-ignite in the adjacent compartments.
7. An emergency operation of the switchgear and control gear assembly must be possible when the fault has been repaired and/or the functional units of the defined area have been isolated or removed. This requirement must be evidenced by an insulation test carried out at 1.5 times the rated operating voltage for 1 min.

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Internal Arc Fault Type Testing

LV/MV Type Test Set Up



Test arrangement, MNS with cotton indicators at critical places

Horizontal indicators are only required in medium voltage

Vertical cotton indicators up to 2m height

Cotton indicator

Switchgear front

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MNS – Arc Safety

Safety Plus

The MNS solution meet and exceed the IEC 61439 -1/-2 and IEC/TR 61641 safety standards for arc flash protection.

Priority 1

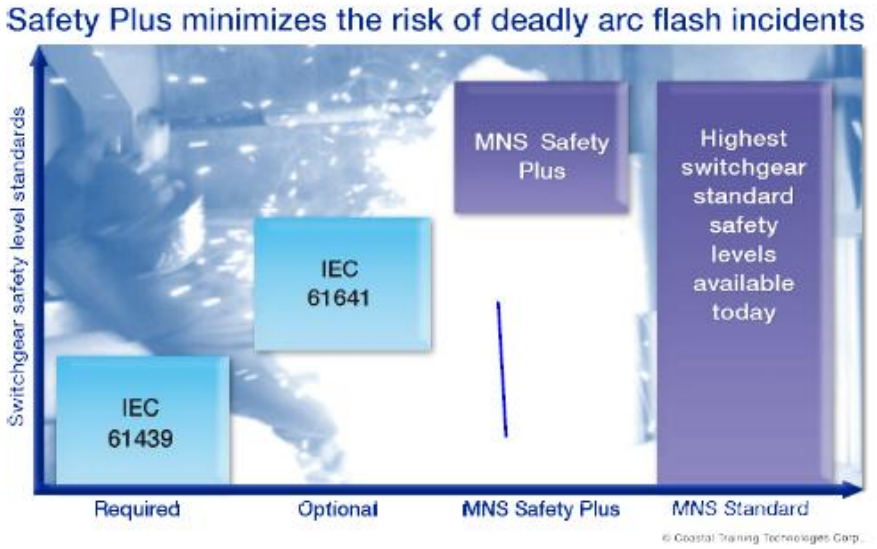
Active Protection in MNS

The basic ABB MNS principle is that an arc fault should be prevented from occurring in the first place by designing and dimensioning the equipment absolute reliable.

Priority 2

Passive protection in MNS

Limiting of the arc to the compartment where it occurs. This minimizes the consequences of an arc if it should occur.



MNS – Arc Safety

Constructional Measures

Constructional measures for optimized active and passive arc fault protection

Subject	IEC	Specific solution in MNS for Personnel and System protection
Compartment for – Busbars - distribution busbars – Functional units	– Forms of internal separation – No separation between busbars and distribution bars is required	1.Common compartment for the main busbars system. 2.Multi-Functional Wall (MFW) providing single phase isolation of distribution bars. 3.Rigid arc barrier with gas-sealed connections between busbars and connection bars in ACB cubicles.
Main contact system	The IEC 61439-1 and -2 does not give requirements in terms of – Single phase encapsulation – Main contact design	Single phase isolated contacts. The contact housing provides a rigid single phase isolation prior to connection of the contacts to the distribution bar.
Arc Free Zone	IEC 61439-1 Selection and installation of non-protected active conductors (before the SCPD) to reduce the possibility of short circuits	Arc Free Zone is provided by the Multi-Functional Wall (MFW) and short-circuit protected cable with full double insulation.
– Comparative Tracking Index CTI :Material groups for Insulation purpose	IEC 61439-1 Minimum required: Material Group IIIb = CTI value 100-175	MNS Standard: Material Group II = CTI value 400-600

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MNS – Arc Safety

Constructional Measures

Constructional measures for optimized active and passive arc fault protection

Subject	IEC	Specific solution in MNS for Personnel and System protection
Clearances – between busbars – between distribution bars at Uimp= 12 KV	IEC 61439-1 Minimum required clearance: 14 mm	Minimum clearance in MNS is 20 mm
Creepage distances between busbars	IEC 61439-1 Minimum required distance: 14 mm at Ui = 1000 V	Creepage distances in MNS main busbar system are 30 mm. Creepage distances in MNS distribution bar system are 20 mm.
Busbar fastening and connections	The IEC 61439-1 and -2 does not give requirements in terms of maintenance and sealing of busbar fastening and connections.	1.Maintenance free design by thread locking bolts and conical spring washers. 2.Gas-sealed connection between: – busbars and distribution bars. – busbars and bars of other functional units – busbars and connection bars to devices such as ACBs

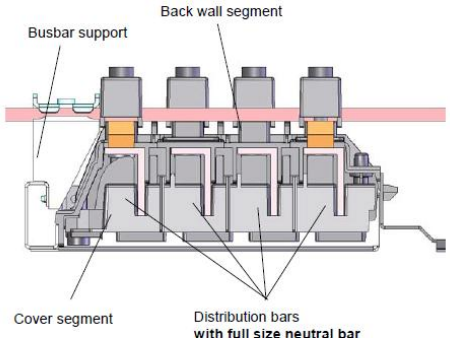
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MNS – Arc Safety

MNS 3.0 Distribution Busbars

Multi-function Wall

- A fully phase segregated encapsulated 3 or 4 pole busbars system.
- MFW constitutes a complete barrier between the main busbars and the equipment compartment.
- All the insulating components are CFC and Halogen free.



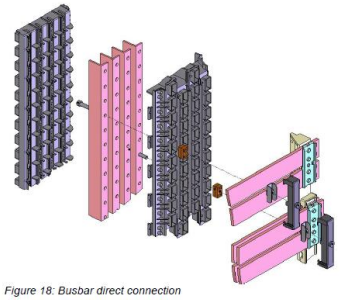


Figure 18: Busbar direct connection



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MNS – Arc Safety
Conclusion

Conclusion

- The MNS solution meet and exceed the IEC 61439 - 2 and IEC/TR 61641 safety standards for arc flash protection.

- Arc Fault Containment:
  - Ø Prospective short Circuit current: 100kA
  - Ø Duration: 300ms
  - Ø Criteria: 1-5 and 6, 7 as per IEC/TR 61641



