

UL Validated Testing of Arc-Resistant Motor Control Centers

**Ensure Protective Features
Perform as Designed**

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SUMMARY

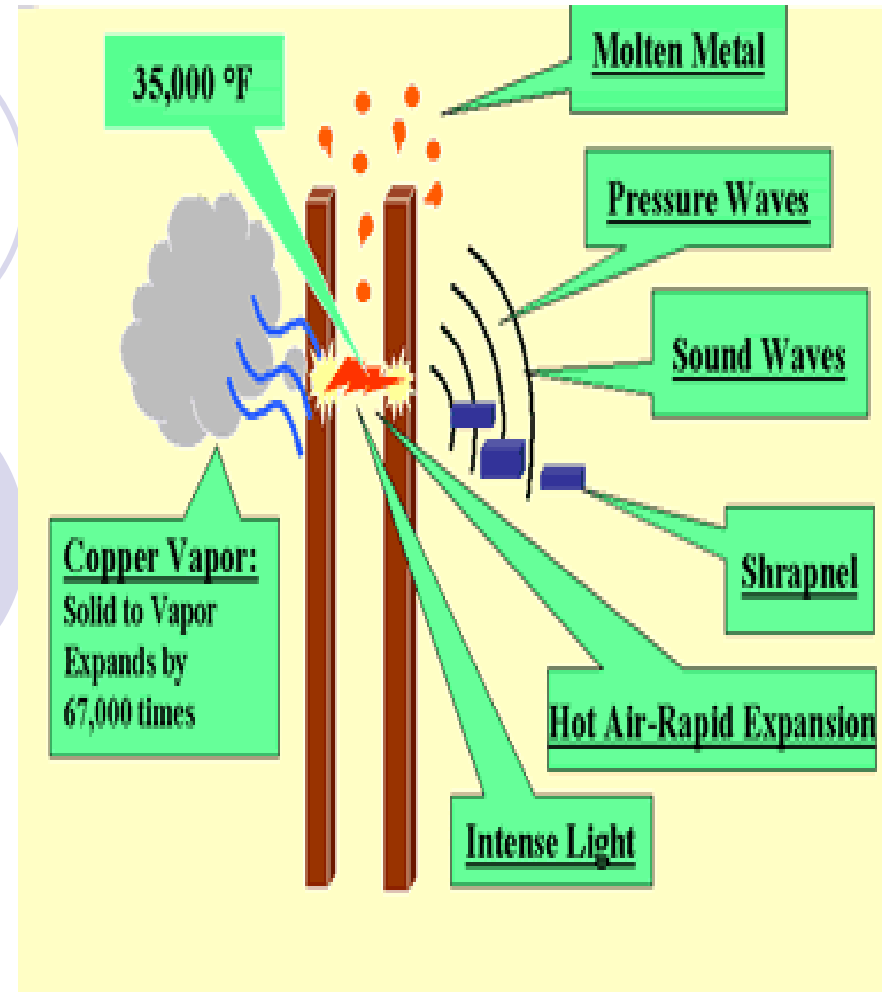
- Arc flashes are responsible for about 80 percent of electrical accidents in the U.S. each year.
- Personal Protective Equipment (PPE) can help avoid or reduce the severity of injuries, and its widespread use should be seen as a top priority for industrial users.
- Electrical equipment manufacturers have applied strengthened structural design to improve the safety potential of its Switchgears.
- Standards for performance-testing arc-resistant features have so far only been defined for switchgear, but manufacturers are using those standards for testing arc-resistant MCCs.

SUMMARY

- Siemens is the first manufacturer in the industry to have Underwriters Laboratories (UL) observe and validate the testing of its arc-resistant tiastar™ MCC model.
- The tiastar arc-resistant MCC successfully met the testing criteria required by the standards, and a qualified, independent third-party has confirmed this satisfactory performance.

Introduction

- Arc flashes happen when an electric current passes through the air between two conducting metals.
- The arc can superheat the air around it to a temperature about four times the sun's surface temperature.
- This extreme heat ionizes all nearby materials creating explosive gaseous plasma.
- Under these conditions, for example, each cubic inch of copper converts to almost 39 cubic feet of copper vapor.



Introduction

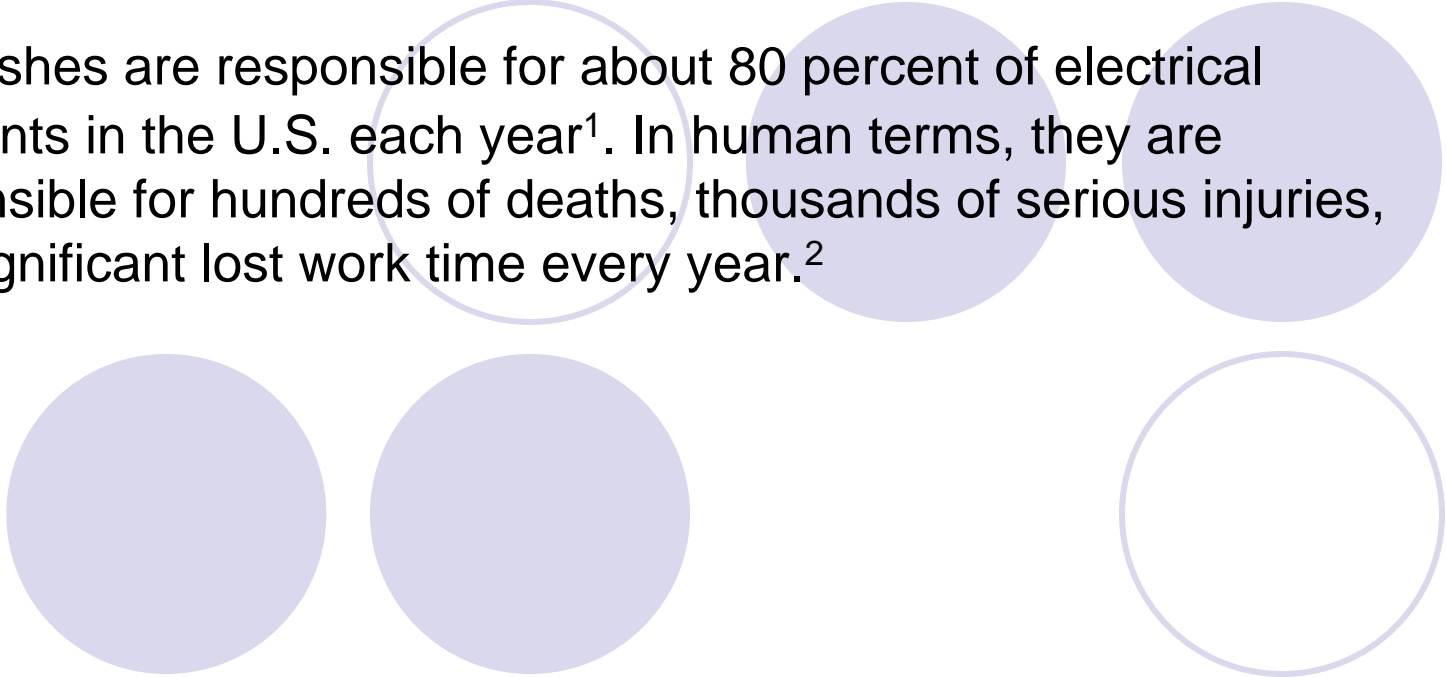
- Arc faults are different from the bolted faults that happen on the load terminals of standard electrical equipment.
- Electrical distribution and control gear is designed to withstand bolted fault currents until circuit breakers or fuses interrupt the current flow.
- When a bolted fault occurs, the voltage at the point of the fault is virtually zero and the total fault energy gets dissipated into the entire power system, while any arcs are contained and cooled within the circuit breaker's interrupters or the fuses.

Introduction

- The incident energy of an arcing fault is much more difficult to contain and is concentrated almost entirely at the fault location.
- Its flash can spread hot, ionized plasma over a distance of 20 feet or more with significant accompanying sound and shock waves.
- This explosive force can cause significant injury to individuals in the immediate vicinity, including death.

Introduction

Arc flashes are responsible for about 80 percent of electrical accidents in the U.S. each year¹. In human terms, they are responsible for hundreds of deaths, thousands of serious injuries, and significant lost work time every year.²



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1. Bureau of Labor Statistics
 2. Census of Fatal Occupational Injuries

Evolving safety standards

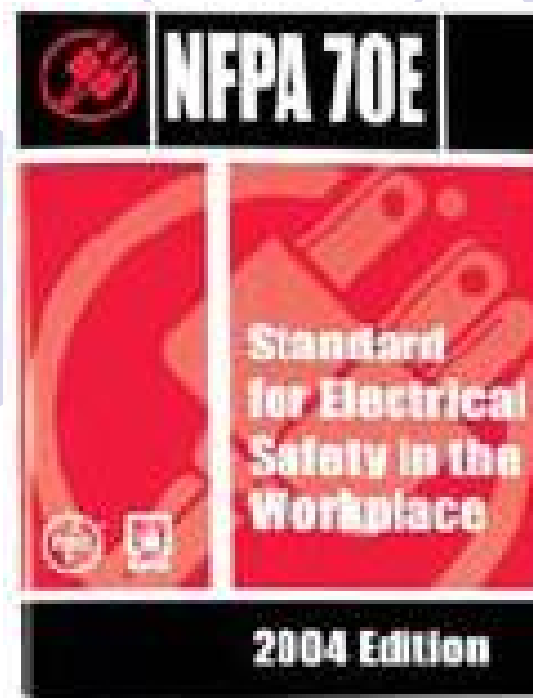
Arc faults have numerous causes that fall into two categories

- Intrusive environmental factors such as cabinet moisture, insulation failures, over-voltage, corroded terminals, dust, dirt and animals, including rodents and snakes.
- The second category is human error such as improper work procedures, misplaced tools, loose connections, and inadvertent contact with energized components.

Inadequate maintenance practices are often contributor to both categories. As the number of arc flash incidents suggest, they are a paramount electrical safety concern, for which a range of industry safety standards have evolved.

Evolving safety standards

In North America, the main safety standard for working with electrical equipment is the National Fire Protection Association (NFPA) 70E: Standard for Electrical Safety in the Workplace.



Evolving safety standards

- Under NPFA 70E, employees whose work may potentially expose them to arc flashes are required to wear arc-rated protective clothing.
- This clothing is made of fabric that provides thermal insulation and is also self-extinguishing to minimize burns, as prescribed by ASTM F 1506-08 Standard Performance Specification for Wearing Apparel for use by Electrical Workers to Momentary Electric Arc and Related Thermal Hazards.

Evolving safety standards

- The Occupational Safety & Health Administration (OSHA) has said that clothing conforming to ASTM 1506 complies with OSHA 29 CFR 1910.269 Electrical Power Generation, Transmission and Distribution directive regarding the wearing of protective clothing that will not contribute to severity of burns.
- Protective clothing is a primary part of an arc flash injury mitigation known as Personal Protective Equipment (PPE), which can also include other equipment such as a helmet or headgear, face shield, gloves, and ear protection.

Evolving safety standards

From NFPA70E-2000 Table 3-3.9.3 Protective Clothing Characteristics

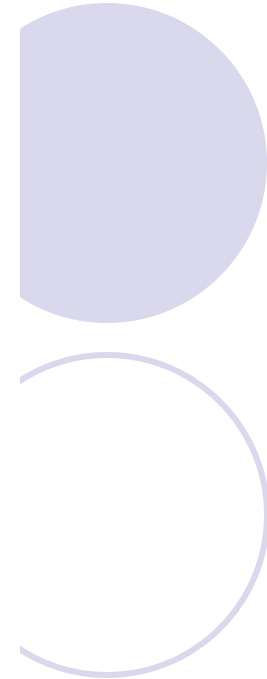
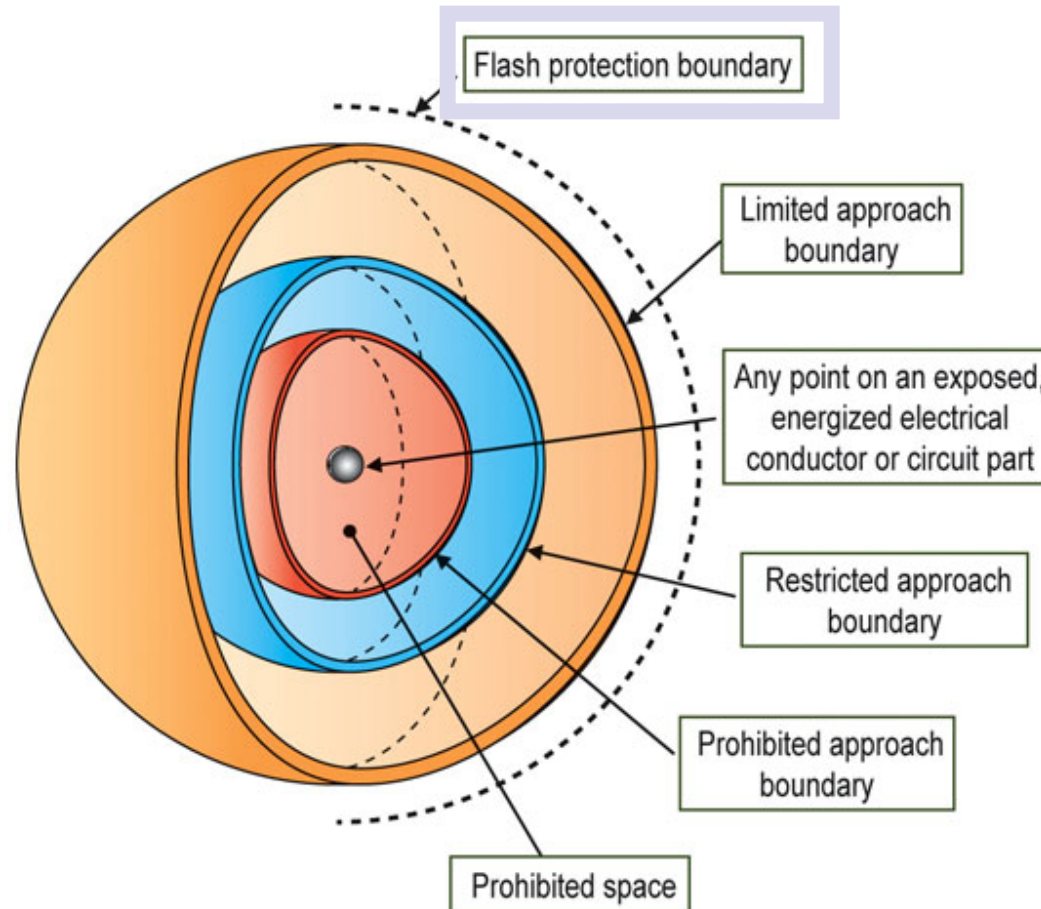
Category	Energy Level	Typical PPE Examples
0	N/A (>1.2)	Non-melting flammable materials (e.g. untreated cotton, wool, rayon, etc.)
1	4 cal/cm ²	FR shirt and FR pants
2	8 cal/cm ²	Cotton underwear plus FR shirt & pants
3	25 cal/cm ²	Cotton underwear plus FR shirt & pants plus FR coverall
4	40 cal/cm ²	Cotton underwear plus FR shirt & pants plus double layer switching coats and pants

Note: Voltage rated gloves also be required for Cat 1 & 2.

Change to NFPA70E-2004 Category 1 is 4 cal/cm².

*Face protective face shield and hearing protection may also be required.

Evolving safety standards



Safer equipment, safer environments

- The simplest and most effective measure to prevent an arc flash is to shut off all power to the equipment to be worked on.
- Siemens advises that individuals should only work on MCCs or other electrical equipment after all power to the equipment has been turned off.
- Arc flash prevention, safety training and PPE can only go so far in keeping workers out of harm's way should an arc fault occur.
- **Although PPE can provide protection from an arc flash, it still cannot protect an operator from being struck by enclosure doors blown off or open from an arc flash – or from fragments ejected from a disintegrating enclosure.**

Safer equipment, safer environments

Arc flash hazard mitigation and arc-resistant features. Designed to complement each other.

Arc flash mitigation features:

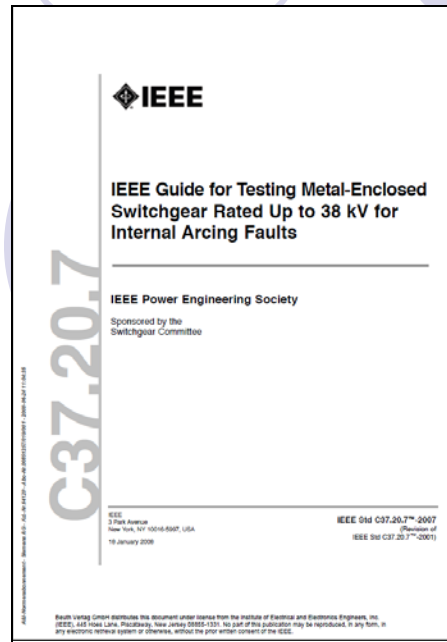
- To keep the workers beyond the Arc Flash Boundary
- To shorten the arc flash duration

Arc resistant equipment:

To make sure that, in the event of an arc flash when the MCC's doors are closed and latched, the equipment will contain the explosion, directing the arc blast, including its heat, plasma and pressure, away from workers.

Safer equipment, safer environments

In addition, the industry has codified the performance testing of arc-resistant features according to the rigorous requirements set forth in the IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults (ANSI/IEEE C37.20.7 - 2007).



Safer equipment, safer environments

Siemens WL Arc Resistant Switchgear features

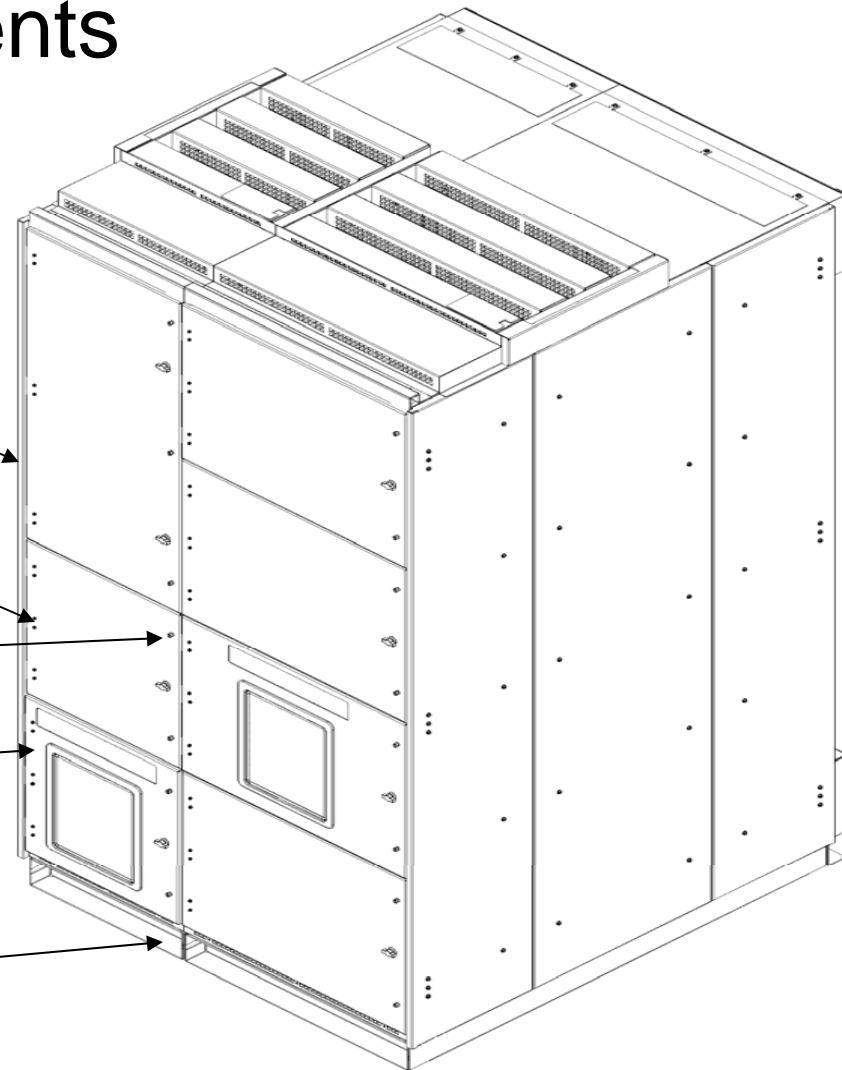
Door Gaskets and Sealing Trims

Extra Hinges

Thumb Screw latches added

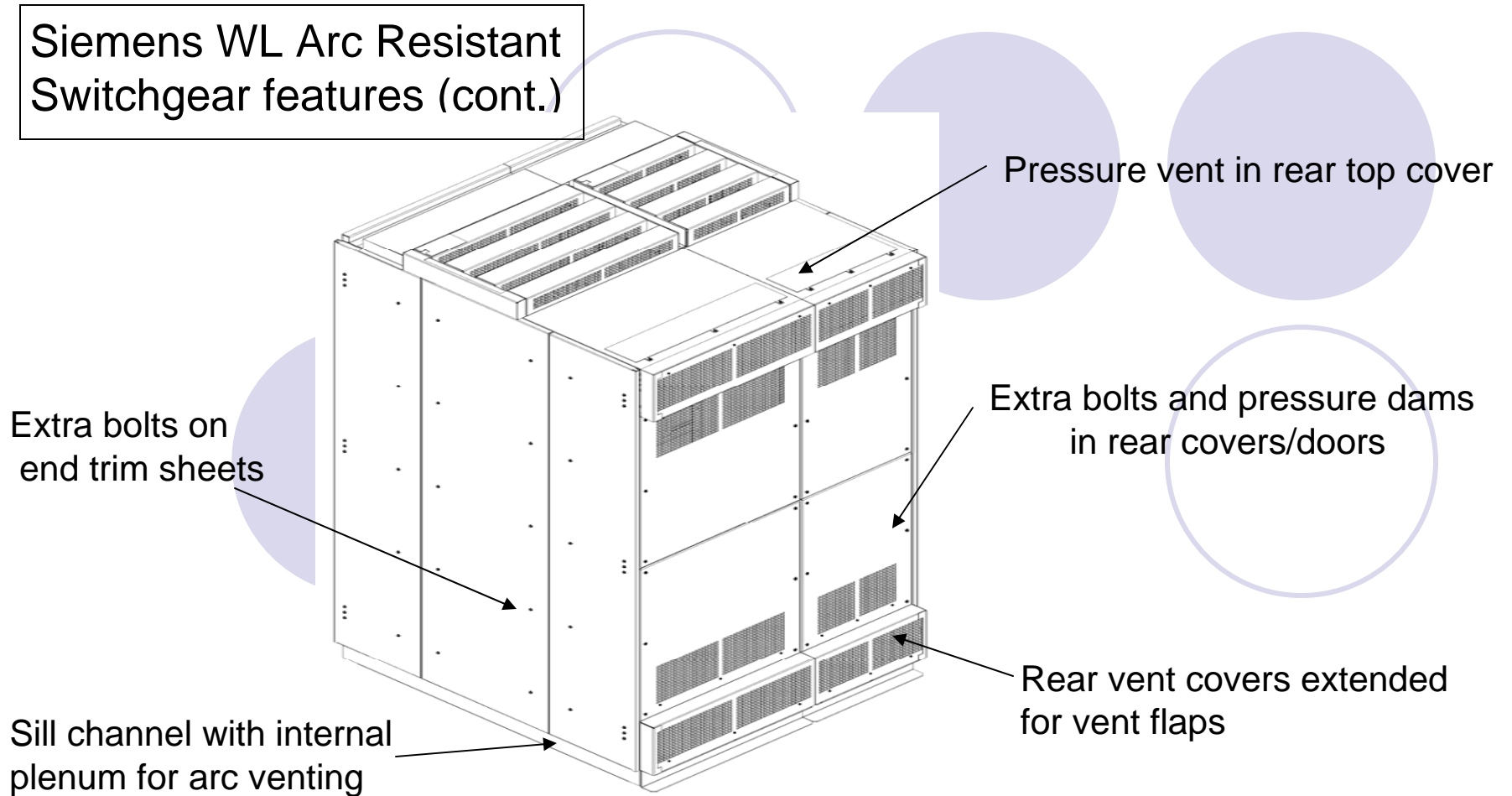
One Piece Breaker Door

Enhanced Sill-Channel



Safer equipment, safer environments

Siemens WL Arc Resistant Switchgear features (cont.)



Siemens arc-resistant tiastar: the first UL test-validated MCC

Soon the ANSI/IEEE C37.20.7 standard is expected to evolve further and to include specifications for performance-testing arc resistance of specially designed MCCs.

Like arc-resistant switchgear, arc-resistant MCCs incorporate many of the features above to minimize the duration of an arc fault and, with doors closed, redirect its flash away from personnel.

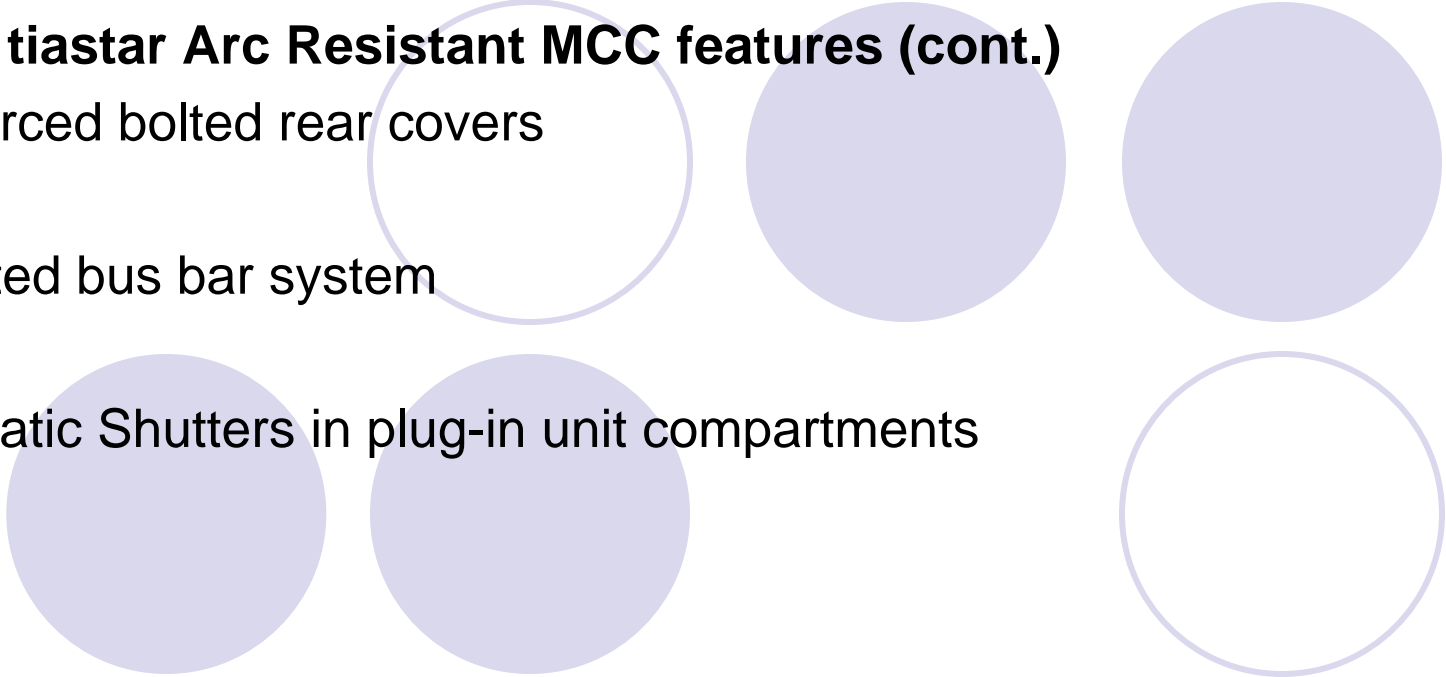
Siemens arc-resistant tiastar: the first UL test-validated MCC

Siemens tiastar Arc Resistant MCC features

- ANSI/IEEE Type 2 arc resistance to protect personnel at the front, back and sides of the equipment
- Reinforced enclosure to withstand pressure from internal arcing faults
- Internal venting system with pressure vents to channel the flow of arc fault gases and vent these gases out the top of the gear and away from personnel
- Reinforced front with doors with extra hinges and stronger latching systems

Siemens arc-resistant tiastar: the first UL test-validated MCC

Siemens tiastar Arc Resistant MCC features (cont.)

- Reinforced bolted rear covers
 - Insulated bus bar system
 - Automatic Shutters in plug-in unit compartments
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Safe Venting



Internal venting system with pressure vents to channel the flow of arc fault gases and vent these gases out the top of the gear and away from personnel

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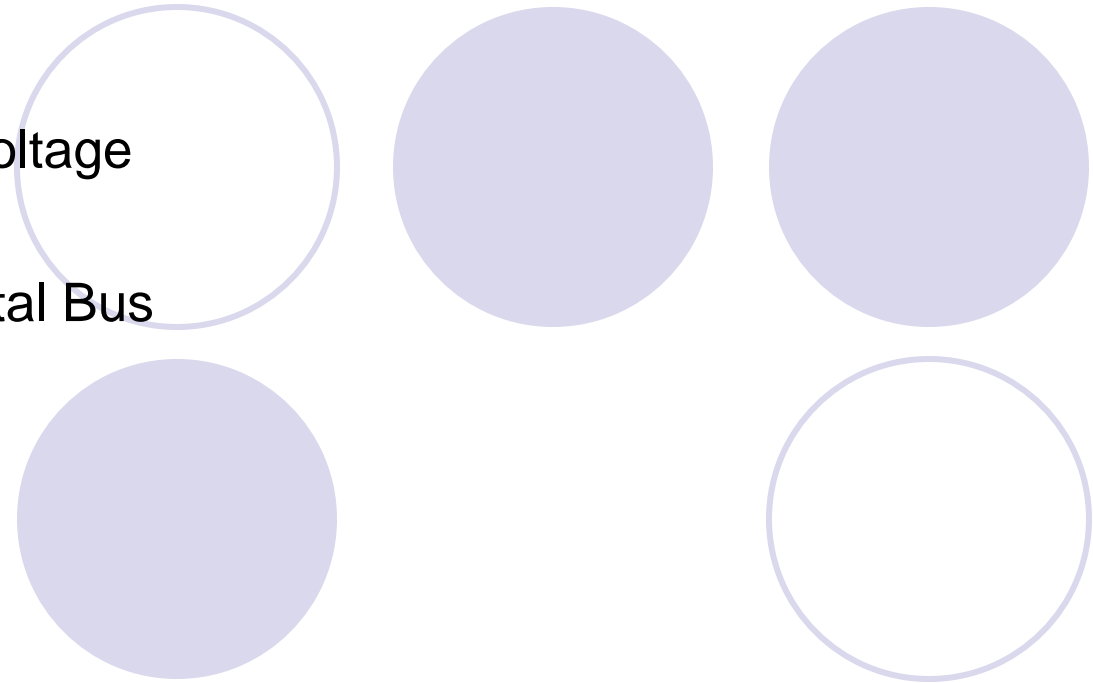
Safe Venting



With the doors closed and latched, the arc flash is directed away from workers

Specs

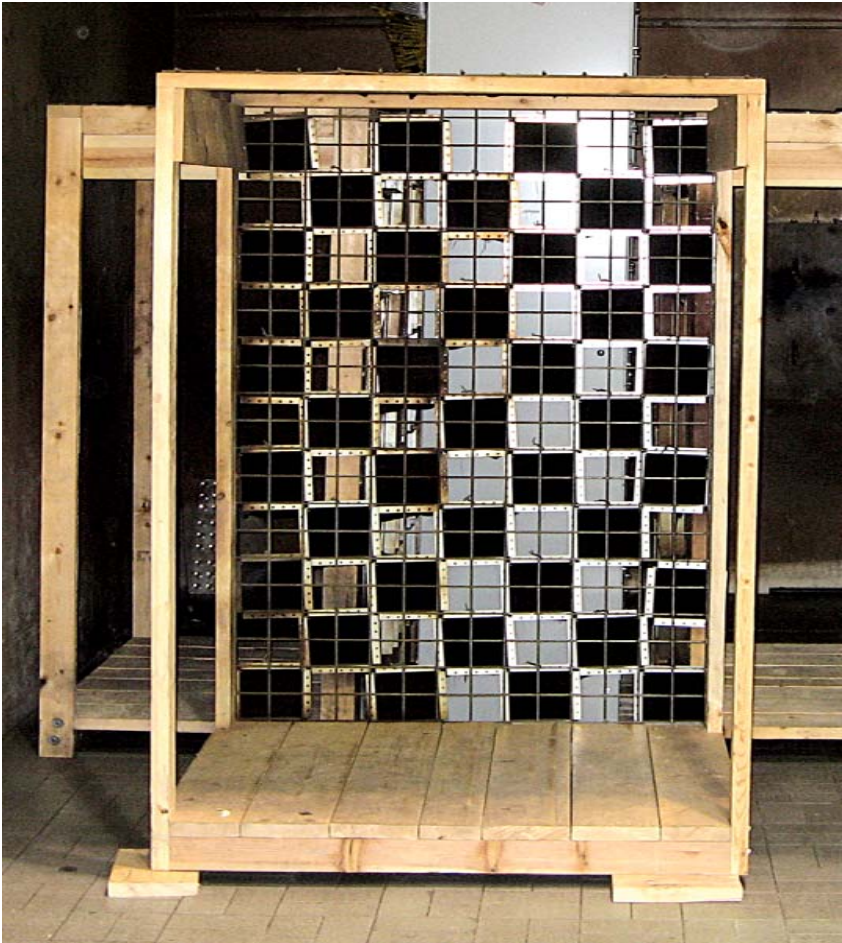
- Up to 600V system voltage
- Up to 65KAIC
- Up to 1600A Horizontal Bus
- Requires
 - 42" aisle
 - 10' ceiling
 - 12" pull box



Siemens arc-resistant tiastar: the first UL test-validated MCC

- Since 2009, Siemens has offered arc flash hazard mitigation features in its tiastar MCC.
- Since then Siemens has taken further steps to strengthen tiastar to provide an Arc Resistant MCC with Type 2 accessibility.
- The tiastar arc-resistant MCC was tested to ANSI/IEEE C37.20.7 with representatives of Underwriters Laboratories, Inc. (UL) present to observe and validate the testing procedures.
- This is important because the Siemens tiastar arc-resistant MCC is the first and currently the only manufacturer with its testing witnessed by a qualified third party.

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Picture of a UL Test setup

Cloth swatches shown 4" from the front, back and sides of the MCC

Siemens arc-resistant tiastar: the first UL test-validated MCC

ANSI/IEEE Std C37.20.7-2007 testing criteria:

- **Criterion 1:** *That properly latched or secured doors, covers, and so on, do not open. Bowing or other distortion is permitted provided no part comes as far as the position of the indicator mounting racks or walls (whichever is closest) on any assessed surface.*
To extend the acceptance criterion to an installation mounted closer to the wall than tested, two additional conditions shall be met: the permanent deformation is less than the intended distance to the wall; and exhausting gases are not directed to the wall.
- **Criterion 2:** *No fragmentation of the enclosure occurs within the time specified for the test. The ejection of small parts, up to a individual mass of 60 g, from any assessed external surface above a height of two meters and from any external surface not under assessment, is accepted. No restriction is placed on the number of parts allowed to eject.*

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- **Criterion 3:** *Assessment of burn-through: It is assumed that any openings in the switchgear caused by direct contact with an arc will also ignite an indicator mounted outside of the switchgear at that same point. Since it is not possible to cover the entire area under assessment with indicators, any opening in the area under assessment that results from direct contact with an arc is considered cause for failure. Openings above the indicator mounting rack height (two meters) that do not cause ignition of the horizontally mounted indicators are ignored.*

Accessibility Type 1: *That arcing does not cause holes in the freely accessible front of the enclosure.*

Accessibility Type 2: *That arcing does not cause holes in the freely accessible front, sides and rear of the enclosure.*

Siemens arc-resistant tiastar: the first UL test-validated MCC

- **Criterion 4:** *That no indicators ignite as a result of escaping gases. Indicators ignited as a result of the burning of paint or labels, glowing particles, and so on, are excluded from this assessment. High speed movies or video may be used to evaluate the cause of indicator ignition. Holes in horizontally mounted indicators caused by particles that do not ignite the indicator are ignored. Surface discoloration or charring that does not result in glowing or flaming of the indicator cloth is allowed. Any indicator cloth with surface discoloration or charring shall be replaced with new cloth before additional testing.*
- **Criterion 5:** *That all the grounding connections remain effective.*

Other safety-engineered innovations

Arc Flash Hazard Mitigation Features available in tiastar MCC:

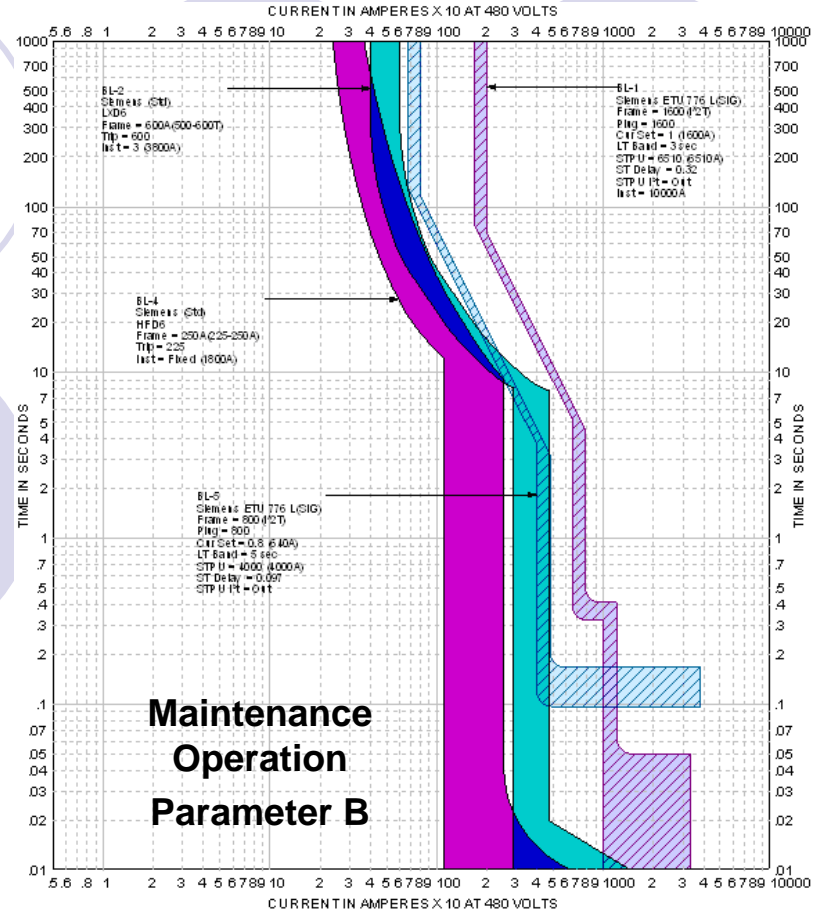
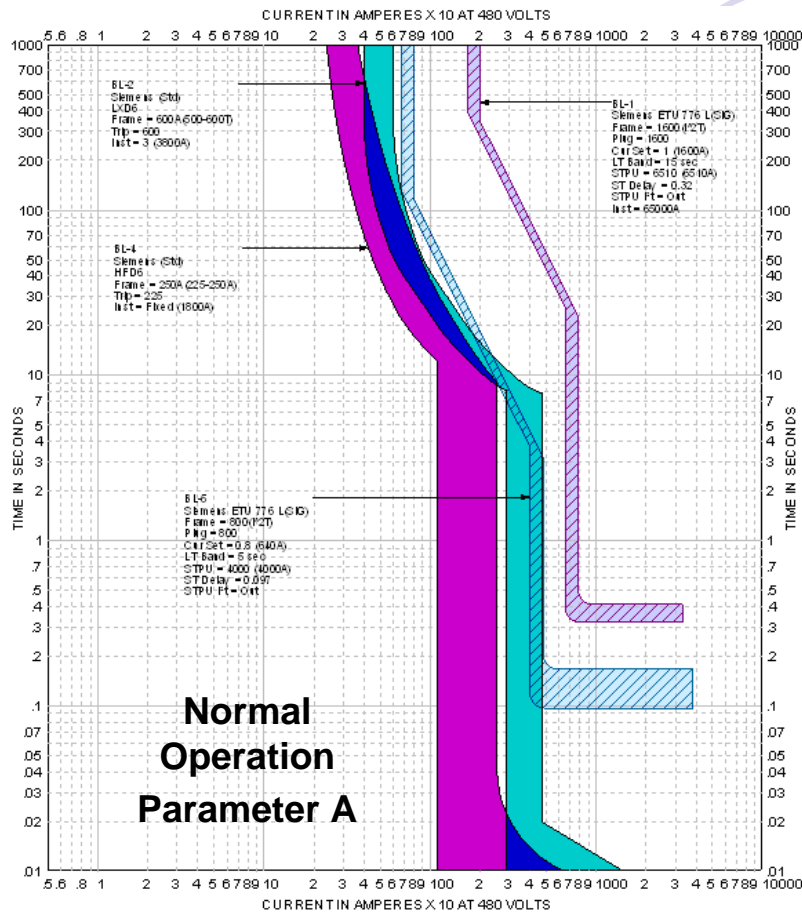
- Dynamic Arc Flash Sentry (DAS): This is a patented feature available in both Siemens MCCs and type WL Low Voltage Switchgear.

DAS (alternate parameter settings) can be activated using a variety of activation methods (keyed switch, occupancy sensors, light curtains, etc.).

Visual verification of DAS activation can be as simple as a pilot light or more elaborate such as horn and strobe light.



Other safety-engineered innovations



Other safety-engineered innovations

Smart MCC Technology with Profibus DP.

- This enables technicians to perform many functions at a safe distance
- Meter readings, resetting trip units and many other monitor and control tasks no longer require a worker to visit the electrical equipment room.
- Able to interface with the AB PLCs via a third party Prosoft interface card.

Control network for unit control and data acquisition

Smart Motor Control Centers



- Lower installation cost due to easy to install Profibus or ASI connections
- Detailed power and diagnostic data
- Easier to maintain and troubleshoot

Conclusion

- Arc flashes present a serious safety risk.
- The best protection is prevention by enforcing strict safety rules, mandate proper maintenance, and support that with regular safety training.
- Advances in technology have enabled electrical equipment the means to design and engineer much more arc flash safety features into their products and systems such as switchgear and MCCs.
- While standards continue to evolve, they inherently follow these kinds of innovations.
- It is important that the application testing of new safety features be validated by a qualified third-party like UL to ensure that the safety features work as intended and to prevent tragic accidents.