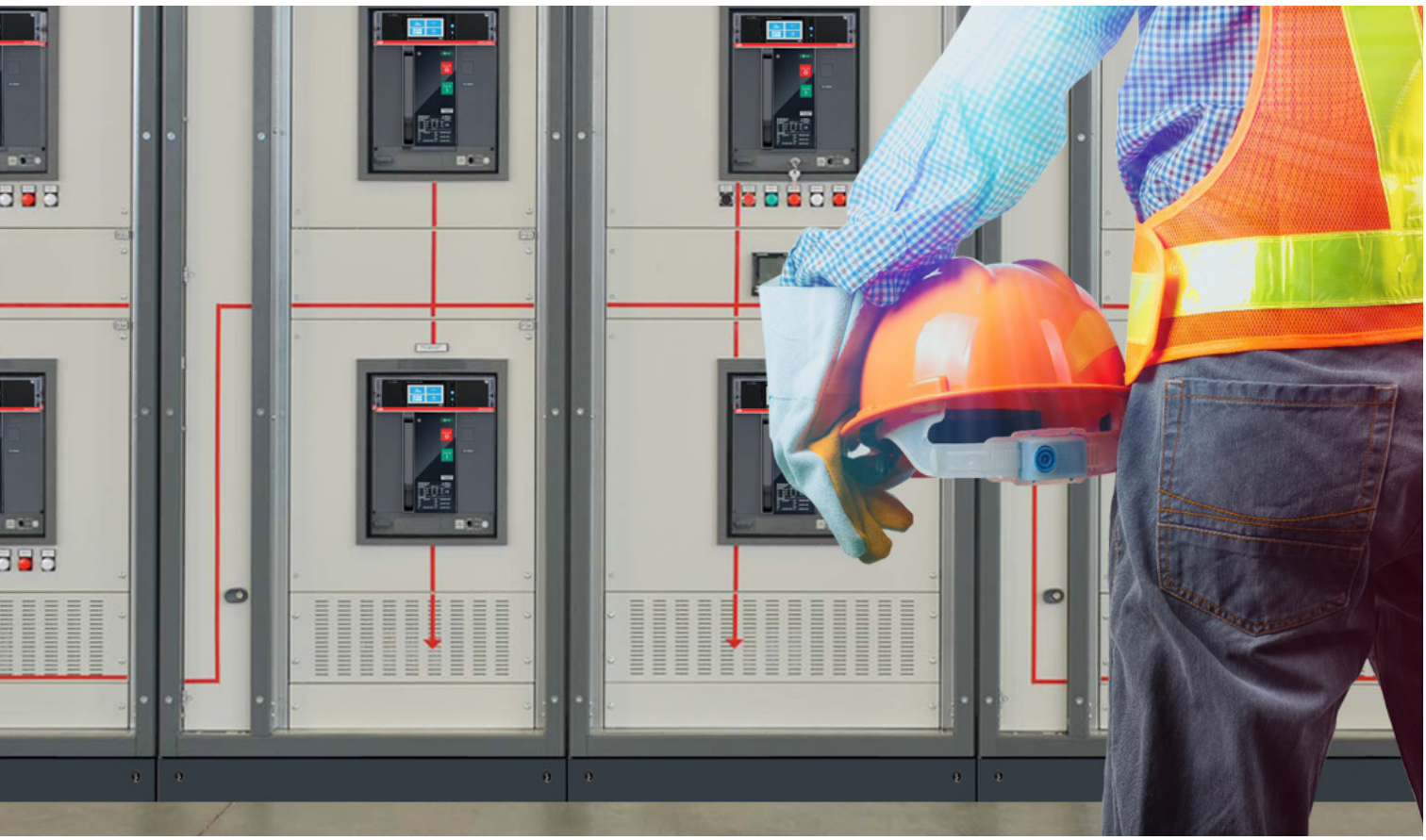
WHITE PAPER

Protection against electric arc
TVOC-2 integration in SpEp TBBS



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1. Introduction

The subject of electric arcs is becoming increasingly important in the context of electrical switchgear equipment and personnel safety

It is crucial to mitigate this phenomenon in order to enhance the safety of both personnel and electrical equipment.

Electric arcs result in internal overpressures and local overheating, which can lead to high mechanical and thermal stresses in the equipment, as well as potential health consequences for personnel in the proximity of switchgear, including hearing problems, inhalation of toxic gases, and ejection of materials.

Arc accidents can occur due to various factors, such as human error, faulty connections, or the presence of animals. These accidents most commonly happen when individuals are performing maintenance or installation work in the switchgear with an open cabinet door, significantly reducing the protection provided by arc-proof switchgear design. While such accidents are relatively uncommon, their consequences can be severe, often resulting in serious injuries or fatalities, as well as extended downtimes and equipment damage.

Therefore, it is essential to establish a robust safety solution that consistently provides protection. Two main design philosophies can be adopted, either individually or combined together, to provide an arc fault resistant solution. The active arc fault protection consists in installing devices to detect the arc and immediately intervene, while the passive arc fault protection aims to safely contain the arc inside the switchboard. This document mainly addresses the active protection system used to limit the effects of internal arcs by providing the necessary details for the correct use and proper integration of the Arc Guard System™ TVOC-2 a device capable of detecting electric arcs using optical sensors with the ABB System pro E power Top Busbar System switchgear.

This document provides guidelines for integrating active arc flash mitigation devices into SpEp TBBS. No configurations have been tested and certified.

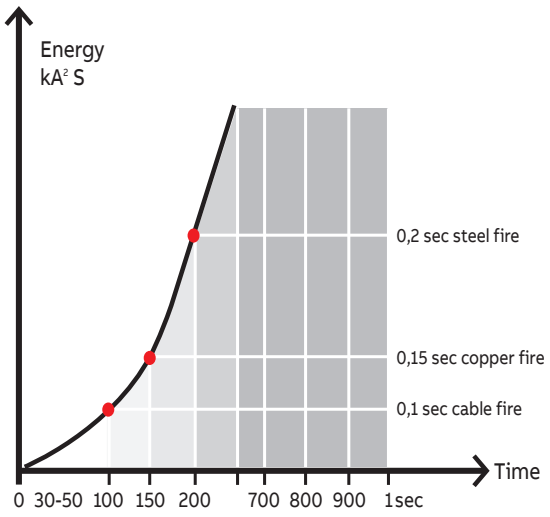
By implementing this arc guard application, it is possible to ensure that switchgear equipment remains intact and that personnel are able to return home safely by mitigating the effects of electric arcs.

2. Arc Flash overview

An arc flash is a dangerous condition associated with the release of energy caused by an electrical arc.
This occurs when there is a loss of insulation between two conductive objects at a sufficient voltage, resulting in a discharge of energy. Under certain conditions, a plasma is generated, carrying electric current until the protective device on the supply side opens. Gases, which are normally good insulators, may become conductive due to changes in their chemical and physical properties caused by temperature rise or external factors.

Additionally, arcs can also originate from short-circuits between phases, which are low impedance connections between conductors at different voltages.

The conducting element, such as a metallic tool, incorrect wiring, or the body of an animal, that leads to this low impedance connection can be subject to dangerous currents, leading to overheating and potentially causing an arc.
The resulting electric arc is characterized by intense ionization of the surrounding gas, a drop in voltage, and extremely high temperatures.
The incident energy (E) of an electrical arc is used to determine the level of Personal Protective Equipment (PPE) required, and an arc flash protection boundary (FPB) is established to define the danger to individuals working on live parts.



3. Arc Effects

In the proximity of main boards, such as those associated with large electrical machines like transformers or generators, the high short-circuit power results in significant energy associated with electric arc faults.

The extreme temperatures generated cause erosion of all insulating materials, leading to the production of hazardous gases, fumes, and molten material particles that are released into the immediate environment.
The repercussions of this phenomenon within the switchgear can lead to extensive equipment damage, resulting in downtime and lost production revenues.

Human beings can also be significantly impacted by electrical arcs, and there are various factors to consider in this regard:

Inhalation of toxic gases

During an arc event, the fumes produced by burnt insulating materials and molten or vaporized metals can be toxic.
These fumes, resulting from incomplete burning, consist of carbon particles and other solid substances suspended in the air.

Damages to hearing

The electric arc presents itself as a real explosion, generating sounds - up to 160dB - that can cause permanent injuries to hearing.

Injuries due to ejection of materials

The ejection of loose parts caused by the electric arc can lead to injuries, particularly to the most susceptible parts of the human body, such as the eyes.

The expelled materials may penetrate the cornea and cause permanent damage. The extent of the resulting injury depends on the characteristics and kinetic energy of these objects.
Additionally, gases can cause severe damage to the mucosa of the ocular region, while ultraviolet and infrared rays can injure the cornea and retina.

Burns

The high temperature levels of the gases and the expulsion of incandescent metal particles can cause severe burns of varying degrees.

An electric arc event can result in burns, including third-degree burns caused by red-hot solid bodies such as metal fragments, burns similar to those caused by hot liquids due to superheated steam, and less severe burns from radiant heat.

4. Arc mitigation methods

ABB offers a wide range of solutions designed to prevent and minimize the impacts of arc flash events, thereby enhancing safety, reducing damage, and minimizing downtime.

These solutions are based on two main design philosophies aimed at safeguarding operators and equipment in the event of an arc flash incident and can be adopted individually or in combination within the same switchgear.

Passive arc flash protection solutions

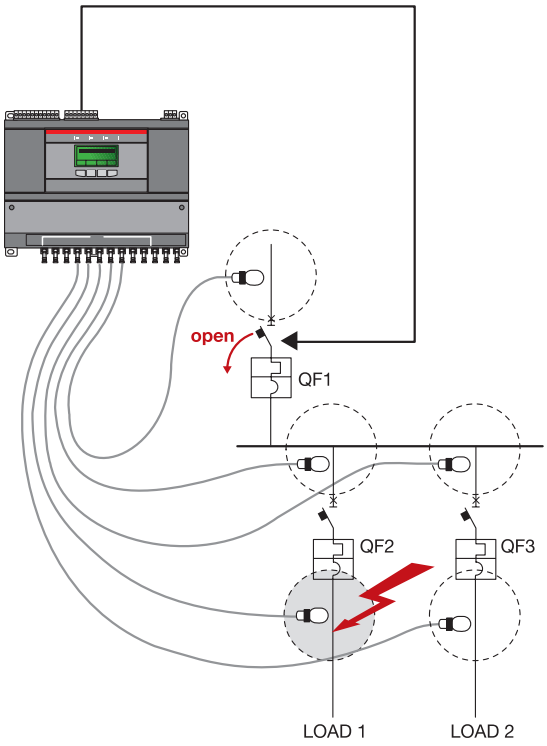
This approach involves designing and testing switchgear to withstand electric arcs mechanically as per IEC TR 61641.
Protection is provided by containing the arc within the switchgear and safely releasing gases away from areas with personnel. Following an arc event, mechanical components in the affected sections must be replaced.

The key benefit of this passive protection includes the high solution safety thanks to the internal containment of arc fault, also when devices are not functioning correctly.

Active arc flash mitigation solutions

In this approach, switchgear is equipped with devices such as the TVOC-2, which detects the arc and immediately intervenes to reduce the duration of the arc, its energy, and associated damage to switchgear components such as circuit breakers and arc protection relays.

The key benefits of this active protection include reduced downtime and minimized impact on the switchgear due to the swift device intervention.



5. Overview of solutions

The TVOC-2 is an advanced device designed to provide arc detection within switchgears. Utilizing optical fiber detectors to capture light arcs, the TVOC-2 ensures immediate breaker opening, offering a flexible and fast solution that can be integrated with external systems such as SCADA. This capability minimizes the impact of costly interruptions in various types of plants. The TVOC-2 is versatile, allowing installation in different kinds of switchgear and with various types of breakers that can receive digital input signals and/or have an opening coil. Additionally, a single TVOC-2 unit can effectively manage three selectivity zones.

The CSU-2 is an accessory designed for use with the TVOC-2 arc detection device, offering the ability to prevent unexpected flashovers in specific applications.

By interfacing with Rogowski coils, the CSU-2 promptly sends a currentincreasing signal to the TVOC-2 unit, ensuring timely tripping of the breaker to mitigate potential arc flash incidents. Furthermore, the system allows for the connection of an unlimited number of CSU-2 devices to a single TVOC-2 unit, providing scalable arc flash prevention capabilities.

System pro E power Top Busbar System is the innovative ABB's main distribution switchboard solution with rated current up to 6300A and short-circuit current up to 120kA.

Designed to easily fulfill all electrical installation requirements in terms of protection degree, segregation form and electrical characteristics, according to the latest international standards and in perfect synergy with all ABB's low voltage equipment.

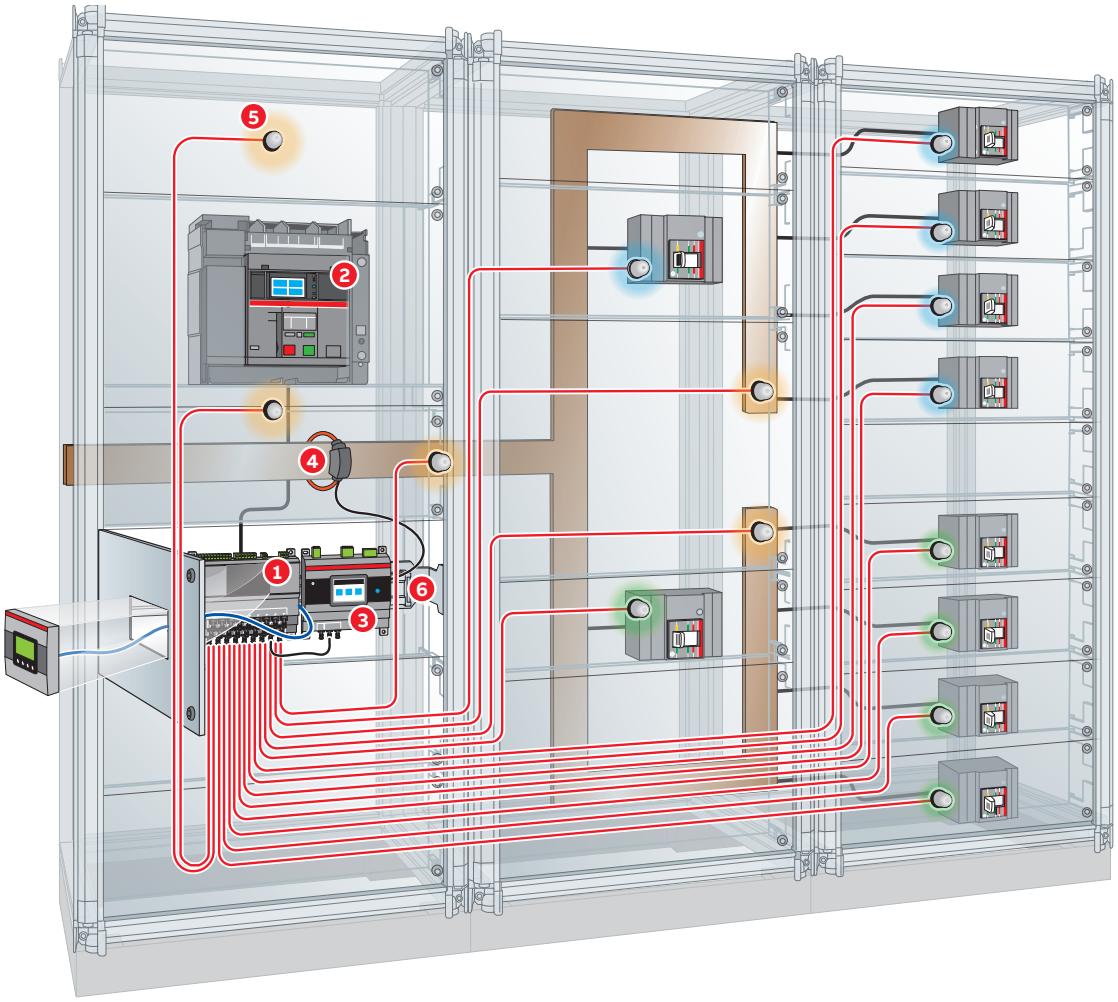
6. Integration with System pro E power

Integration of TVOC-2 Arc Guard System™ and CSU-2 devices with System pro E power TBBS main distribution board for active arc flash mitigation

In addition to its mechanical design to contain electrical arcs within the switchgear as per IEC TR 61641, the System pro E power TBBS main distribution board can be equipped with the TVOC-2 Arc Guard System ™ and CSU-2 accessory to actively mitigate arc flash incidents, minimizing damage to switchgear and assets and resulting in future cost and time savings.

The TVOC-2 can be easily incorporated into any System pro E power TBBS configuration using standard internal kits, regardless of the mechanical and electrical project features.
The arc flash mitigation apparatus can be installed within the switchgear using a mounting plate or a DIN rail kit, and then enclosed with a blind flat panel. To ensure the arc fault protection a door is also required, whether blind or glazed. To make the display visible, it may be also placed externally by creating a small hole in the front panel, and it must be connected to the TVOC-2 device through an appropriate cable. Additionally, sensors, secured with Lexan fixing points, can be strategically placed in areas at risk of arc occurrences, whether functional or segregated, to enhance the effectiveness of the arc detection and mitigation system.

TVOC-2 can effectively manage three selectivity zones, which are shown in the picture below. In this picture example, the sensors are color-coded: yellow for the main breaker and main busbars, blue for the upper circuit breakers on the columns to the right, and green for the circuit breakers positioned in the lower-right side of the configuration. In other words, if an arc is detected in a circuit breaker belonging to the blue sensors cluster, the TVOC-2 will only act on the blue cluster, allowing the yellow and green area circuit breakers to continue operating.



1. TVOC-2
2. Emax 2
3. CSU-2LV
4. Rogowski coil
5. TVOC-2 sensor
6. DIN rail kit

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