ASCO Power Technologies™

Protecting Transfer Switches from Water-Related Damages

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Life Is On Schneider Electric

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Adequate Protection Involves More than Specifying the Correct Enclosure

Water ingress into transfer switches and other critical power equipment can impact operability, reliability and service life. This document summarizes measures for mitigating water-related risks throughout the equipment lifecycle.

EXAMPLES OF WATER-RELATED IMPACTS TO TRANSFER SWITCHES

Transfer switches provide important functions by transferring loads to alternate sources when power outages occur. Both the functions they provide and the energy they manage require their safe operation. Because contact with water can degrade transfer switch condition and performance, it is important to understand how water-damaged equipment can impact facilities. Consider the following examples:

- In a hospital, a water supply pipe is damaged by contractors. Water ejected from the pipe sprays onto a nearby 1200 Amp bypass-isolation automatic transfer switch in a Type 1 cabinet, causing its controller to malfunction. This leaves the associated life-safety and critical loads without reliable access to a standby power source.

- In a wastewater treatment facility, an overdue service inspection identifies corrosion in a 400 Amp, open transition, automatic transfer switch. Housed in a Type 3R cabinet, the equipment is located near chemical handling equipment. Airborne moisture and corrosive substances are suspected to have contributed to the corrosion.

- A high-rise building houses telecom switching and transmission equipment. An ATS in one of the basement levels is inundated with water that discharged from open conduit connected to a manhole that flooded.

- An electrical equipment distributor stores an automatic transfer switch in its warehouse prior to sale. During a rain event, water floods the facility and inundates the bottom portion of the switch. Mud and water residues are found on cables, terminal boards and connectors.

Figure 1 ASCO G-Frame 4000 Amp isolation Bypass Automatic Transfer Switch

Sound far-fetched? These hypothetical examples resemble situations that ASCO staff have encountered. Events like these underscore the need to mitigate water-related risks for transfer switches and other critical power equipment.

ASSESSING WATER IMPACTS

When water enters power equipment, it can corrode or otherwise degrade mechanisms and components. For instance, the metallic surfaces of mechanical assemblies and linkages could corrode and waterborne soils could contaminate lubricants, affecting their ability move or operate smoothly. Water and waterborne substances such as debris and salt-containing soils can cause arcing in powered switches and contaminate the surfaces of electrical contacts, changing their electrical properties. In addition, water can bridge circuit traces on printed circuit boards, resulting in shorts, shunts, arcing and corrosion that damage control systems and impair their function. The resulting damages could ruin control boards and render a switch inoperable.

One difficulty with assessing water-exposed equipment is an inability to precisely qualify or quantify damages and predict their impact on future equipment performance, reliability and longevity. Equipment users, providers and insurers have grappled with these issues. A document from the National Equipment Manufacturers Association (NEMA) entitled *Evaluating Water-Damaged Electrical Equipment* describes the concerns that attend water-impacted electrical equipment.[1] It prescribes which types of equipment may be reconditioned in consult with manufacturers. It also describes which types should be replaced outright and specifically identifies switches for replacement, not reconditioning. It provides no option for continued use of water-exposed transfer switches.

Transfer switches typically serve life-safety or critical loads and often power high-revenue operations. As a result, switch manufacturers and service teams usually will be unwilling to represent that water-impacted equipment remains fit for service. The possibility of even small risks of failure may require replacement of entire units. For these reasons, manufacturers are unlikely to warrant claims regarding water-exposed equipment.

ADDRESSING ALL WATER SOURCES

To properly protect equipment, users must assess risks from all forms of water from all potential sources throughout the lifecycle of the product. Most commonly, users address potential ingress of liquid water. Nevertheless, water can occur as solid ice or as vapor. The occurrence and mitigation of moisture in these states varies by application. Table 1 provides an overview of protections offered by UL50 enclosure types.[2] Enclosure types specified by NEMA are similarly defined.[3,4]

[1] National Electrical Manufacturers Association. Evaluating Water-Damaged Electrical Equipment. 2016.
[2] Underwriters Laboratories. UL50 - Enclosures for Electrical Equipment, Non-Environmental Considerations, 1st Edition, 2015.
[3] National Electrical Manufacturers Association. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum). 2014.
[4] While UL 50 and NEMA 250 provide similar definitions, users should carefully discern the differences between the standards before specifying enclosures.

Table 1: Attributes of Common UL 50 Enclosure Types						
Environmental Condition	**1**	**3R**	**3RX**	**4**	**4X**	**12**
Incidental Contact	X	X	X	X	X	X
Rain, Snow, Sleet	-	X	X	X	X	-
Falling Dirt	X	X	X	X	X	X
Windblown Dust	-	-	-	X	X	-
Falling Liquid, Light Splashing	-	X	X	X	X	X
Dust, Lint, Fibers, Flyings	-	-	-	X	X	X
Hose-Down	-	-	-	X	X	-
Hose-Down & Splashing Water	-	-	-	X	X	-
Oil and Coolant Seepage	-	-	-	-	-	X
Corrosive Agents	-	-	X	-	X	-

It's important to note the qualifications in the definitions of the enclosure types. For any given hazard, both UL50E and NEMA 250 use phases such as "provide a measure of protection against…" In other words, a type designation does not imply that an enclosure is waterproof. Rather the type definitions indicate that the enclosure can endure the specific conditions specified by the corresponding test procedures. Consequently, enclosures may not provide protection against extreme conditions.

For example, a Type 3R enclosure provides "a measure of protection" against snow.[5] This wording does not guarantee that the equipment inside the cabinet will not be impacted by a large snowfall event, from meltwater from a snow drift that covers the enclosure, or from a large amount of snow placed against it by snow removal equipment. In fact, windblown snow is one of the most frequent causes of failure in transfer switch equipment. A Type 3R enclosure features louvers that enable heat to escape during seasonal hot weather. While Type 3R enclosures protect equipment from falling rain or snow, they are not designed to protect against windblown rain or snow. During windy conditions, snow blows inside the enclosure, then melts and causes damage. UL 50 Type 4 enclosures should be used when these types of conditions are anticipated. Extreme conditions will warrant additional protective measures.[6] For additional information, review our document entitled Equipment Enclosure Classifications.[7]

[5] Underwriters Laboratories. UL50 - Enclosures for Electrical Equipment, Non-Environmental Considerations, 13th Edition. 2015. p. 9.
[6] In ASCO's experience, meltwater from accumulated snow is a common water-related problem. In some cases, protecting enclosures with snow fencing, shielding or shelter may be necessary to mitigate meltwater intrusion risks.
[7] ASCO Power Technologies, Inc. Equipment Enclosure Classifications. 2018. *https://www.ascopower.com/us/en/download/document/TS-WP-EQUIPENCLOSURE/*. Viewed August 16, 2019.

Choosing Suitable Enclosures

In application, the primary variables for water intrusion relate to temperatures inside and outside of equipment enclosures and methods of water entry from the environment. The following examples illustrate some common situations and remedies:

- *Type 3R cabinets are commonly used outdoors. These enclosures feature an open-bottom, with sides that mount directly to a concrete pad. Because there is no seal along the bottom edges, water that accumulates on the pad may seep across the pad surface beneath the transfer switch.*

  The need to address potential moisture entry is specified in Section 4.2 of ANSI/NEMA PB 2.1-2013 – *General Instructions for Proper Handling, Operation, and Maintenance of Deadfront Distribution Switchboards:* "Additional precautions may be necessary, during installation, to prevent moisture, water or other contaminants from entering and accumulating within the enclosures."[8] Where moisture or water could intrude into open-bottom switches, bottom-enclosed Type 4 units can be specified. To mitigate dampness, manufacturers will typically recommend providing strip heaters inside the enclosure that operate on a separate power source.

- *A facility is located along a roadway in a region that experiences pronounced winter weather. The user correctly recognizes that deicing salt residues from an adjacent parking area could present a corrosion risk.*

  A possible solution is to specify a Type 4X stainless steel enclosure, which is corrosion resistant and bottom-enclosed. However, if the site configuration allows, the transfer switch could also simply be installed in a different location that is higher, dryer and/or further from the roadway. This would reduce exposure to salt residues, reducing the risk of impact.

- *A transfer switch near a water collection sump or a boiler that vents steam. In this location, the transfer switch could be subjected to water-related and vapor-related risks.*

  Locating a switch in an area where industrial chemicals are used, such as at a water or wastewater plant or a facility that handles corrosive materials, could present corrosion risks. If an outdoor switch is located where storm water could accumulate on ground surfaces, an elevated concrete pad could become necessary. Wherever practicable, relocating switches to locations with reduced risk is a sensible course of action.

Notably, some enclosures may be modified to accommodate the characteristics of the devices they will contain. For instance, when a switch has a high ampacity rating, the manufacturer may provide supplemental venting in a Type 4 enclosure to facilitate cooling and ensure compliance with UL 1008 heat rise limitations. Careful evaluation will be necessary to confirm whether the enclosure will provide the intended level of protection. If it is inadequate, a different enclosure type or supplemental shielding or shelter may be needed.

Mitigating Routes of Entry

Invariably, conductors must pass into enclosures to route power to and from a transfer switch. Often overlooked are the pathways that wire and cable duct and conduit offer for water and water vapor ingress.

Given an indoor location, an enclosure type may be well-suited for an application. However, if conduit connects the transfer switch to outdoor equipment and the conduit is not sealed, vapor could enter the switch enclosure and promote condensation and corrosion.[9] If unplugged conduit connects an outdoor manhole to a basement equipment area below street level, floodwater could discharge onto or into critical power equipment located there. Attention to potential routes of entry could prevent future damages. Section 4.8 of ASI/NMA PB 2.1-2013 states, "Effectively close all unused openings in the switchboard enclosure." Adding water detection with remote annunciation can provide notice of water events, enabling users to mitigate inflows and impacts quickly.

[8] American National Standards Institute. ANSI/NEM PB 2.1-2013 - General Instructions for Proper Handling, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less. Section 4.2.
[9] National Fire Protection Agency. NFPA 70 - National Electrical Code®. 2016. p. 70-138.

Protecting Equipment Throughout Its Lifecycle

Water protection is most often considered in the context of installed equipment, and rightly so … the majority the equipment lifecycle will be spent operating in one location. Nevertheless, water damage can occur before equipment is installed or when it is temporarily decommissioned, and protection for these times must also be considered. Critical power equipment must be protected from water contact prior to installation. If water comes in contact with a switch, both its reliability and warranty status could be affected.

For the reasons above, equipment must be protected from water and other environmental conditions during shipping and storage. Special consideration should be given to keeping equipment dry. The following summarizes elements of storage guidance from Section 3 of ANSI/NEMA 2.1-2013:[10]

- Section 3.1 – A switchboard should be stored in a clean dry space having a uniform temperature to prevent condensation. It should be protected from dirt, fumes, water and physical damage.

- Section 3.2 - Switchboards should not be stored outdoors. If they must be stored outdoors, they should be covered and temporary electrical heating should be installed to prevent condensation.

- Section 3.3 - Outdoor switchboards are not weather resistant until completely and properly installed.

Likewise, equipment should remain protected during time that it may be out-of-service, such as when the building it serves is unoccupied. For instance, a commercial property may lie empty after a lease expires until a new tenant is engaged. In some cases, a property manager may shut down equipment on the premises. If critical power equipment such as transfer switches remain unpowered and unheated, condensation could result in water or ice accumulation within the equipment enclosure. The resulting damage could render a switch inoperable.

[10] National Electrical Manufacturers Association. Evaluating Water-Damaged Electrical Equipment. 2016. p. 7.

SUMMARY

Transfer switches should always be protected from water ingress and damage. This requires choosing suitable enclosures. It also requires that shipping, storage, handling and installation procedures adequately consider potential water sources in all their forms. Choosing suitable installation locations, mitigating routes of water ingress, and providing adequate protection against water intrusion throughout the equipment lifecycle will minimize the likelihood of water damages to critical power equipment.

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