White Paper

Application and Design Factors for Automatic Transfer and Bypass-Isolation Switches
Part 2 of 2

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This document is the second of a two-part series about automatic transfer and bypass-isolation switch operation and design. Part 1 describes reasons for implementing a comprehensive transfer switch maintenance program, the role of testing in such programs, and the how bypass-isolation transfer switches support effective maintenance and testing. Part 2 describes the features of automatic transfer and bypass-isolation switches that provide effective performance and serviceability.

DESIGN CRITERIA FOR AUTOMATIC TRANSFER AND BYPASS-ISOLATION SWITCHES

Specific design criteria must be considered for automatic transfer switches that include bypass-isolation features (Figure 1). The following narrative describes those features and how they work together with the automatic transfer switch to provide comprehensive protection of emergency system loads.

Construction

The bypass-isolation switch must carry the entire system load. Consequently, it must be designed to meet the same criteria that apply to the transfer switch. The bypass-isolation switch must possess the same load carrying, interruption, and short-circuit capabilities as the transfer switch.

The bypass and isolation contacts must be able to withstand the same levels of short-circuit current as the transfer switch. Bypass switch contacts replace those of the transfer switch when the transfer switch is disconnected from service, and require the same short-circuit rating as the transfer switch. Because the isolation contacts are arranged in series with the transfer switch contacts, they also require the same short-circuit rating. Additionally, isolation contacts that are not required to interrupt current are not subject to contact wear, thus supporting the "zero maintenance" goal described later in this paper.

Figure 1 - A transfer switch equipped with bypass-isolation features

Draw-Out Transfer Switch

A simple means of bypassing and isolating the transfer switch is necessary to facilitate its service and testing. The draw-out transfer switch utilizes primary disconnects in its power circuits and secondary disconnects in its control circuits to provide positive connection and disconnection from all sources of power. A draw-out transfer switch arrangement provides a safe and convenient means of testing and isolating the transfer switch after the load has been bypassed to an available source of power (Figure 2).

Figure 2 – A transfer switch draw-out design

Accessible Contacts

A draw-out transfer switch provides the ability to thoroughly inspect its contacts. Inspection of contacts should be a regular part of the preventive maintenance program.

Interlocks

Positive interlocks must be provided between the transfer switch, bypass switch, and isolation contacts to allow only the intended positions of operation. The interlocks must prevent:

- Simultaneous connection of the two power sources
- Interruption of the load by non-load-breaking primary disconnects that provide the transfer switch isolating function
- Unequivocal indication of the transfer switch position in relation to its isolating means, including the connected, test, and isolated positions

These interlocks assure a proper sequence of operation under all conditions.

All solenoid interlocks should be fail-safe to prevent unsafe operation. They should be continuous duty, even if they are subject only to intermittent duty during normal operation. This reduces the risk of solenoid failure that could result in the unavailability of transfer, bypass, and isolation functions when required.

Zero Maintenance Design

The bypass switch and isolation assemblies should incorporate a “zero maintenance” design philosophy that precludes the need for system shut down for maintenance or repair. To achieve a “zero-maintenance” design, bypass switch contacts must be engaged in the power circuit only during bypass operation, and not during operation in automatic mode. A design including bypass switch contacts that carry current continuously is less desirable. Such designs are typically included in bypass-isolation arrangements that require load interruption as part of the transfer switch isolation sequence. Retaining the bypass switch contacts in the circuit during normal operation will subject them to damage should a short-circuit fault occur. While the transfer switch can be repaired without disrupting service, the bypass switch cannot. In addition, bypass-isolation arrangements that require load interruption as part of the transfer switch isolation sequence create a short power interruption, a situation that should be avoided in emergency systems. The design of the bypass switch should be such that it requires no maintenance over the life of the equipment.

Physically Isolated

The bypass-isolation switch must be physically isolated from the automatic transfer switch when the transfer switch is in its isolated position. To avoid safety hazards, there must not be any live power present on the transfer switch when it has been placed in the isolated position. This is accomplished with the primary disconnects in the power circuit of the transfer switch and secondary disconnects in its control circuits (Figures 3 and 4). When mounted in a common enclosure, additional safety should be achieved through compartmentalization using metal and/or insulating barriers between the transfer switch and the bypass switch.

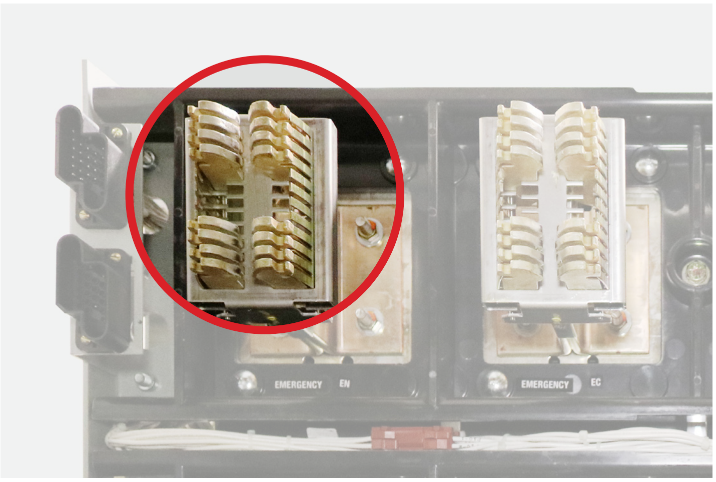

Figure 3 – Isolated primary disconnects viewed from the rear of the ATS

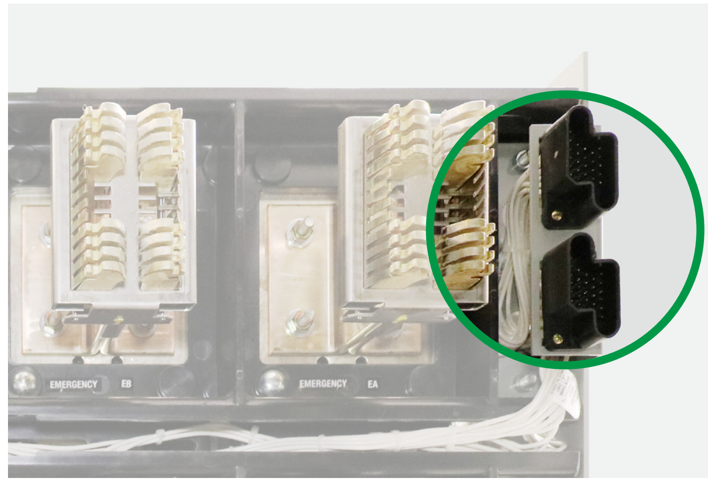

Figure 4 – Secondary disconnects isolate control circuits

Compact Size

Equipment width is usually the most important dimension affecting transfer switch placement in a facility, so compact, minimum-width designs are typically preferred. The transfer and bypass-isolation switch should be compact to allow for installation and use in typical electrical equipment areas. Consequently, the automatic transfer and bypass-isolation switch are often arranged vertically in the same enclosure. Combining the transfer switch and bypassisolation features within the same enclosure reduces installation costs and provides higher reliability.

Dual Function

The bypass switch should be able to function as a manual transfer switch, operable to either available source when the transfer switch has been removed from service through isolation. This allows transfer to an available alternate source if the source to which the load has been bypassed fails while the transfer switch is isolated. The bypass switch should be capable of transferring loads without requiring re-closing of the isolation contacts to the transfer switch. A design which requires re-closing of the isolation contacts may produce an unsafe condition should regenerative loads from spinning motors momentarily energize a transfer switch that is intended to be isolated.

Manual transfer should occur in a “quick-break, quick-make” manner, meaning that the speed with which the contacts open or close should be independent of how fast any control handle is moved. To assure operator safety, manual transfer should only occur by means of an external operating handle.

Bypass Engine-Start Circuit

The engine-start circuit should be activated whenever the switch is bypassed to the emergency source. This assures that the engine-generator remains running during the bypass of the load to the emergency source regardless of the transfer switch position in relation to its isolating means, including the connected, test, and isolated positions. This also assures that the transfer switch engine control circuits can be electrically isolated when in the test or isolated positions.

Operating Handles

Handles operated in a rotary manner are preferable to lever-style handles (Figure 5). Rotary operated handles are less susceptible to inadvertent operation and minimize protrusion of potentially dangerous obstructions into the switchgear aisle.

Figure 5 – Bypass and Isolation Handles

Internal Bus Bar Interconnection

Internal, factory-installed, bus bar interconnections are preferable to cable. Internal, factory-installed, bus bar interconnections allow for:

- A more compact design
- Higher withstand current ratings
- Increased power circuit integrity
- Elimination of the need for verifying cable tightening torques on terminals other than those required for field power connections

Cost

Utilizing an automatic transfer and bypass-isolation switch in lieu of an automatic transfer switch alone more than doubles the equipment cost. In some applications, the added cost may not be justified. However, for critical applications where disruption of service to loads during maintenance is not desired or cannot be tolerated, the added cost can be justified and full consideration should be given to the application and design characteristics described in this document.

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