White Paper

ATS Selection Basics

ASCO Power Technologies®

Low-voltage (<600 volt) automatic transfer switches (ATSs) are available in a wide range of ampacities and features. This document surveys common ATS configuration options and the types of information needed to select an ATS for a specific application.

BASIC PARAMETERS

The ampacity rating of an automatic transfer switch must meet or exceed the ampacity of the loads it will serve. In addition, the voltage rating of the ATS must match the nominal voltage of the power distribution system. For example, ASCO offers 16 nominal voltages between 115 and 600 Volts at ampacities ranging from 30 to 4000 Amps. This document assumes that the nominal ampacity and voltage requirements for an application are known.

To determine the number of poles that will be required, specifiers must know whether the ATS will be serving a single-phase or three-phase system, as shown in Figure 1 and Figure 2, and whether a neutral connection is needed. They must also know the configuration of the grounding system that serves the building's power distribution and backup power systems. The following sections explain specific aspects of ATS design and describe additional information needed to make appropriate selections.

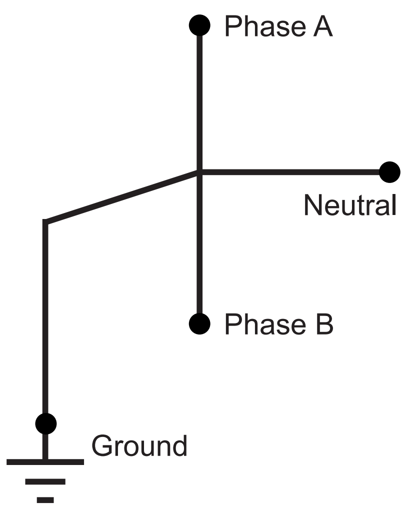

Figure 1: Single-phase circuits typically require a two-pole ATS

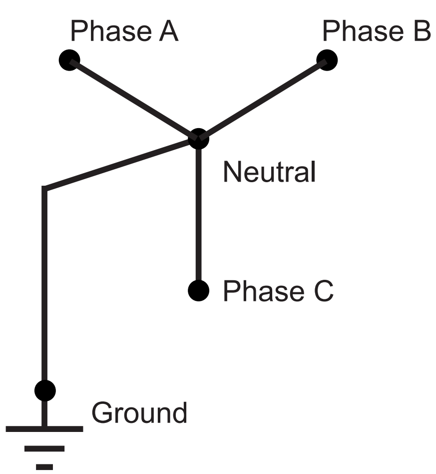

Figure 2: Three-phase circuits typically require a three-pole ATS

FRAME TYPE

Manufacturers design ATS frames that can be provisioned to provide a range of ampacities and features. For instance, ASCO's G-frame ATSs are available in models ranging from 1000 to 4000 amps, and can serve systems up to 600V. A manufacturer's catalog may show that a particular ampacity can be provided by multiple models that utilize different-sized frames. ASCO's own catalog shows H, G, Q, and S-frame models that can each handle nominal loads of 1000 Amps. What considerations should be applied to select an appropriate frame type?

The primary factor affecting frame type selection is the maximum continuous current rating of the connected load. However, the short circuit current that an ATS will need to withstand and the duration for which the ATS will need to withstand it are also significant factors, which are functions of the overcurrent protection (OCP) devices upstream of the ATS. Consequently, ATS selection is dependent not only on the nominal ampacity of loads, but also on the Withstand and Close-On Ratings (WCRs) and Short Time Ratings that result from the short circuit testing required for qualification to *UL 1008*, the ANSI *Standard for Transfer Switches.*

Before evaluating WCR and Short Time Ratings, it is important to distinguish the purpose of the ATS from the purpose of the OCP devices. Unlike a fuse or a circuit breaker, an ATS is relied on to remain connected to an available power source, even when a fault occurs. OCP devices are designed to protect power conductors and equipment by disconnecting loads from power sources when faults occur.

High-current faults generate magnetic forces that oppose ATS contact closure, and heat that results from resistance across ATS contacts. Without adequate design provisions, these high-current faults would cause contacts to open, or would produce heat that could degrade contact materials and surfaces. For these reasons, the UL 1008, NFPA 99, and NFPA 110 standards require the ATS to be electrically switched and mechanically held. Based on product testing, manufacturers provide UL 1008 ratings for the amount of current that ATS contacts can close on and withstand if a short circuit fault occurs. UL 1008 testing can also be used to provide optional Short Time Ratings, indicating the amount of current that an ATS can carry for specific durations from 0.1 to 0.5 seconds. The ratings for ASCO H, Q, S, and G-frame ATSs that can support a nominal ampacity of 1000 Amps are shown in Table 1.

Table 1: Ratings for Select ASCO ATSs

Type & Ampacity			Current-Limiting Fuses				Specific Beaker			Time-Based Rating				Short Time Ratings (sec)							
														480V Max				600V Max			
Frame	Transfer Switch	Bypass Switch	480V Max	600V Max	Max Amps	Class	240V Max	480V Max	600V Max	Sec.	240V Max	480V Max	600V Max	.1	.13	.3	.5	.1	.13	.3	.5
H	800-1200	800-1200	200kA	200kA	1600	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA			--	36kA			--
G	1000-1200	1000-1200	200kA	200kA	2000	L	85kA	85kA	85kA	0.05	85kA	85kA	85kA	--				--			
Q	600-1600	600-1600	200kA	200kA	2000	L	65kA	65kA	65kA	0.05	65kA	65kA	65kA	50kA				50kA			
S	800-1200	800-1200	200kA	200kA	2000	L	100kA	100kA	65kA	0.05	100kA	100kA	65kA	65kA				65kA			

To select an appropriate frame, the available fault current and its expected duration must be known for the location where the ATS will be installed. This information is typically determined from a selective coordination study of a facility's power distribution system. By comparing the magnitude and duration of the available fault current to the published UL 1008 WCR ratings, an appropriate ATS can be selected according the upstream OCP that will be provided.

The amount of time that contacts can hold fault current is inversely proportional to the amount of current passing across ATS contacts, as shown in Figure 3. Table 1 is shows an approximation of the short circuit ATS ratings for ASCO's 7000 SERIES ATS lineup. This table lists the amount of fault current that specific ATSs can withstand and the durations for which these currents can be maintained. Typically, these values are determined by testing various types of overcurrent devices such as fuses and circuit breakers, and using an optional time-based test described in UL1008. For the H-frame models, a 1000 Amp transfer or bypass-isolation switch can carry up to 200kA if current-limiting fuses are used, which open very quickly when faults currents exceed their rating.

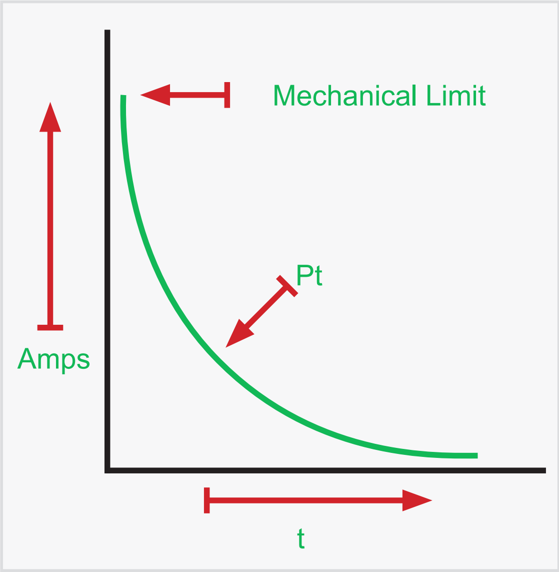

Figure 3: The time that an ATS can hold a fault is inversely proportional to the amount of fault current.

Because most applications use circuit breakers to provide OCP, the UL 1008 *Specific Breaker* and *Time-Based* ratings most often apply. When manufacturers test ATSs equipped with specific circuit breakers, they can list the manufacturer, model, and maximum ampacity of those breakers on the UL 1008 equipment label. For ASCO H-frame models, these ratings exceed the associated Time-Based ratings, which are 0.05-second ratings that apply when using breakers other than those identified on the UL equipment label. Optionally, manufacturers can also test ATSs by applying fault currents for longer periods to develop Short Time Ratings.

When tested with specific breakers, ratings are typically higher than time-based ratings. However, time-based ratings provide power system designers with additional flexibility in selecting circuit breaker types and manufacturers because these ratings do not depend on use of a particular breaker.

Short time ratings are sometimes required for transfer switches where power systems use multiple levels of OCP and selective coordination is desired for the application or required by code. Selective coordination is necessary to assure that the overcurrent device closest to a fault will clear first, allowing the remaining upstream loads to remain connected to the power source. Selective coordination requirements may result in removing the instantaneous trip functions or settings for upstream breakers, which requires a transfer switch to endure a short circuit current for an extended time-frame. This Short Time Rating must be developed in accordance with the corresponding requirements in UL1008. For example, the Short Time Ratings in Table 1 list fault currents that ASCO ATSs can withstand for up to 0.5 seconds at 600V, regardless of the type and rating of upstream OCP devices. For H-frame equipment, these ratings are lower than the other short circuit ratings, and are consistent the principle described by Figure 3.

To select an appropriate frame type for a 1000 Amp, 480 volt application, both the OCP and the available short circuit current for the installation must be known. If the available short circuit current is less than 36kA, than an H-frame ATS can be used for any application except those where loads must be held for 0.5 seconds. However, if the ATS must hold a 71kA fault current for 0.05 seconds, then a G or S-frame ATS must be used. For a fault current of 89kA, then an S-frame ATS must be used. If the fault current exceeds 100kA, then any of the frames in Table 1 can be used, but only with current-limiting fuses.

Frame size is the most complex aspect of ATS selection and is best accomplished in consultation with a manufacturer's qualified salesperson or application engineer. These experts can assist customers in accounting for other frame considerations such as front or rear cabling requirements, ATS dimensions, and other application details

TRANSITION MODE

Transfer switching modes differ in sequence of operation to support specific applications. The following is a brief summary of their differences.

Open Transition

In their standard configurations, ATSs transfer load from one power source to another by opening and closing contacts that serve conductors connected to utility and backup power sources. In this *Open Transition* mode, switching mechanisms operate in a “break-before-make” sequence. The switching contact positions and the resulting voltages to load are shown in Figure 4.

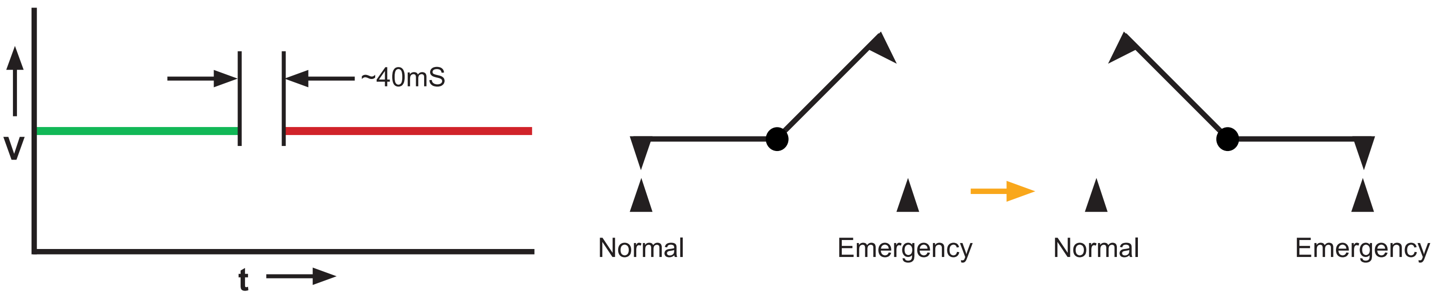

Figure 4: Open Transition Sequence

Solenoid switching mechanisms operate very quickly and power is typically interrupted for approximately 40 milliseconds (mS). Motor-operated transfer switches can take up to ¼ of a second to complete the load transfer cycle. Open transition switches are suitable for a wide range of applications where momentary power interruptions are acceptable. When necessary, open transition switches can be equipped to execute in-phase transfer between sources for large motors and other phase-sensitive loads.

Delayed Transition

Delayed Transition transfer switches transfer loads between power sources using a timed load disconnect position that is held for a user-specified duration. This enables users to insert a delay that allows inertial load equipment, such as large motors, to slow or stop before transfer occurs. This type of transition is commonly used to avoid high in-rush currents that could be generated by spinning motors and other equipment such as large power transformers, uninterruptible power supplies, and some older variable frequency drives. The switching contact positions and the resulting voltages to load are shown in Figure 5.

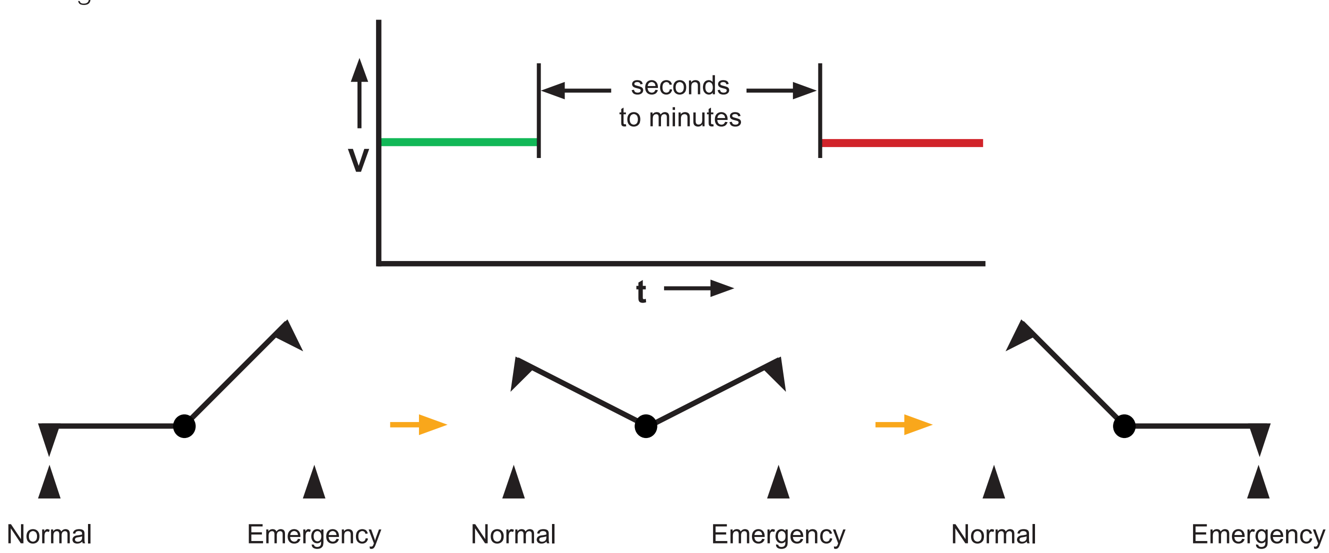

Figure 5: Delayed Transition Sequence

Closed Transition

Closed Transition transfer switches feature Normal and Emergency contacts mounted on separate solenoid operators that allow them to switch asynchronously. By closing on the alternate source just before opening on the online source, closed transition switches operate in a “make-before-break” sequence that momentarily parallels power sources under monitored source parameters, avoiding power interruptions and their potential transient effects. Importantly, the entire sequence occurs in less than 100 mS to avoid impacting utility operations. Closed transition switching avoids power interruptions during planned transfers between sources, such as those associated with routine testing.

Closed transition switching can be particularly valuable when powering digital computing equipment. Digital equipment that is not protected by an uninterruptible power supply or equipped with internal power ride-through capability is particularly susceptible to operational disruption from momentary outages. Unlike resistive loads, digital equipment often require steps to recover or restart operation when power is interrupted for even a short duration.

Closed transition transfer switch controllers continuously monitor source conditions and automatically determine whether loads should be transferred using a conventional open transition sequence or a closed transition sequence. If there is a failure of one power source, an open transition transfer is automatically initiated to the opposite source. For closed transition transfers, the switching contact positions and the resulting voltages to load are shown in Figure 6.

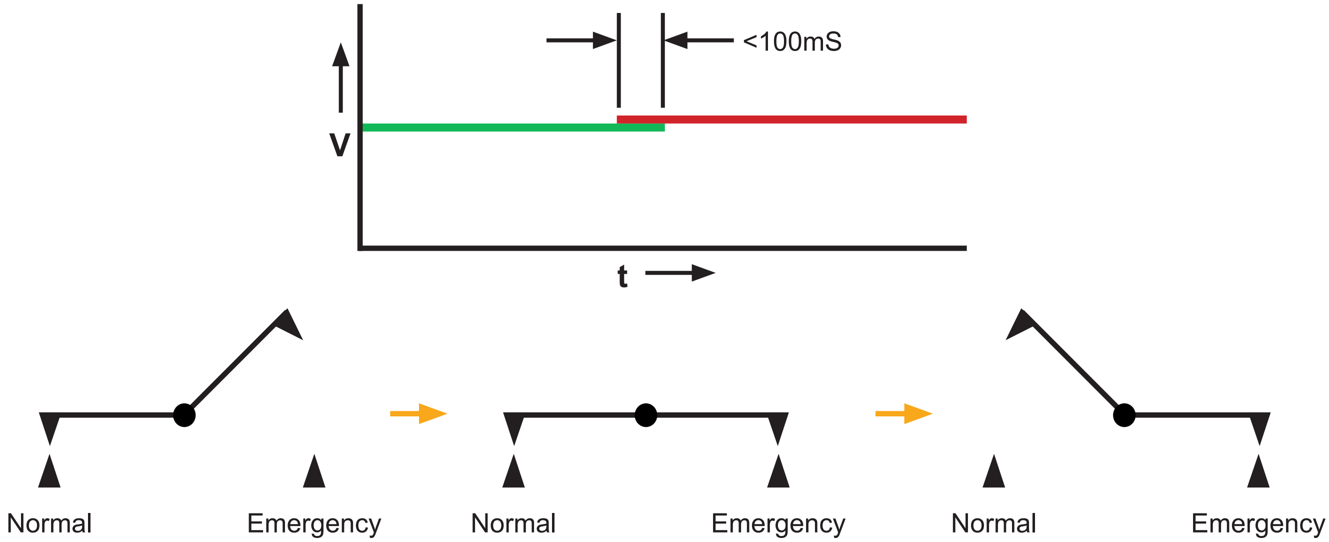

Figure 6: Closed Transition Sequence

Standard closed transition controls are passive and do not actively control a generator set. They simply wait for the generator to synchronize with the utility source before initiating transfer. With this type of control, a generator is still “block loaded” during the transfer process. Some ASCO closed transition ATSs are designed with active synchronizing controls to slowly transfer power by increasing the load on one power source while decreasing the load on the other, a process known as *Soft Load*. Using a closed transition mechanism, this technique relies on electronic controllers to modulate power during load transfer. The complexities of this method are beyond the scope of this document.

SWITCHING DEVICE

Automatic transfer switches are available in configurations that provide different modes of switch operation and/or different transfer switching capabilities. While ASCO offers additional types, ATSs and isolation-bypass switches constitute the majority of switches installed in systems supplying critical loads where extended power interruption is undesirable.

The difference between ATSs and isolation-bypass switches is the latter incorporates an integral, secondary, manually operated switch that routes current from the source to the distribution system without passing through the transfer switch. Isolation-bypass models use a draw-out design that provides access for inspecting, maintaining, or servicing the switch without interrupting power to loads. They also offer an intermediate contact position that also allows testing of the transfer switch controls without interrupting power to loads. Figures 7 and 8 show ATS and isolation-bypass switches, respectively. Figure 9 shows the operating sequence for an isolation-bypass transfer switch.

Figure 7: An ASCO J-Frame ATS

Figure 8: An ASCO J-Frame Isolation-Bypass Transfer Switch

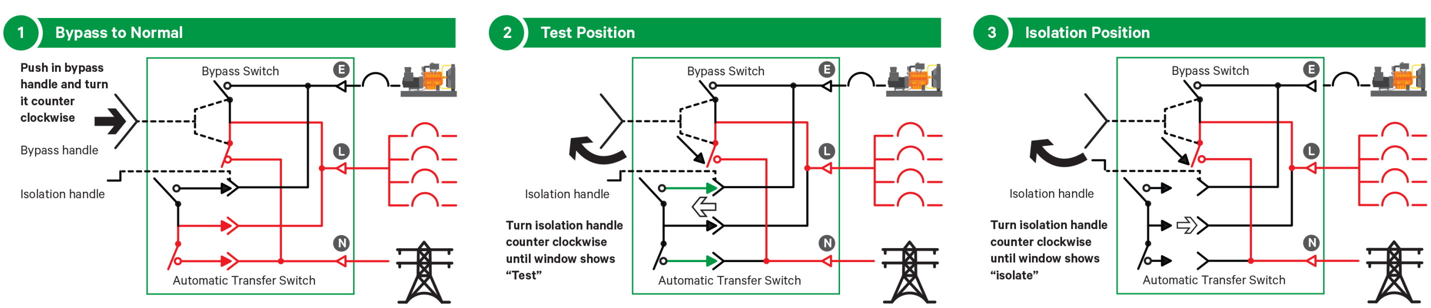

Figure 9: ASCO Bypass-Isolation Operating Sequence

Both transfer and bypass-isolation switches are available with ratings for Service Entrance applications. These models integrate a circuit breaker for the utility feed into the equipment enclosure, eliminating the need for separate service entrance disconnection equipment.

NEUTRAL TYPE

Transfer switches are available with solid and switched neutral options. In order to specify provisions for managing a neutral conductor, the configuration of a facility's grounding system must be known. For facilities with a four-wire Wye system and single ground point, an isolated terminal block is provided in the ATS to bond the neutral conductor from the emergency system to the neutral conductor of a building's power distribution system. This arrangement is referred to as *solidly grounded*.

For facilities where an emergency power system relies on a dedicated, separately derived ground point, the neutral conductor serving the live source must be isolated from the neutral conductor serving the offline source. Failing to do so could produce more than one grounding path, which could cause a ground fault to remain undetected by ground fault sensing equipment. These applications require a switched neutral pole to isolate the neutral conductor of the offline power source. An example of an electrical system with two ground points and a switched neutral is shown in Figure 10. For more information regarding switched neutral applications, read our paper entitled **Switching the Neutral Conductor**.

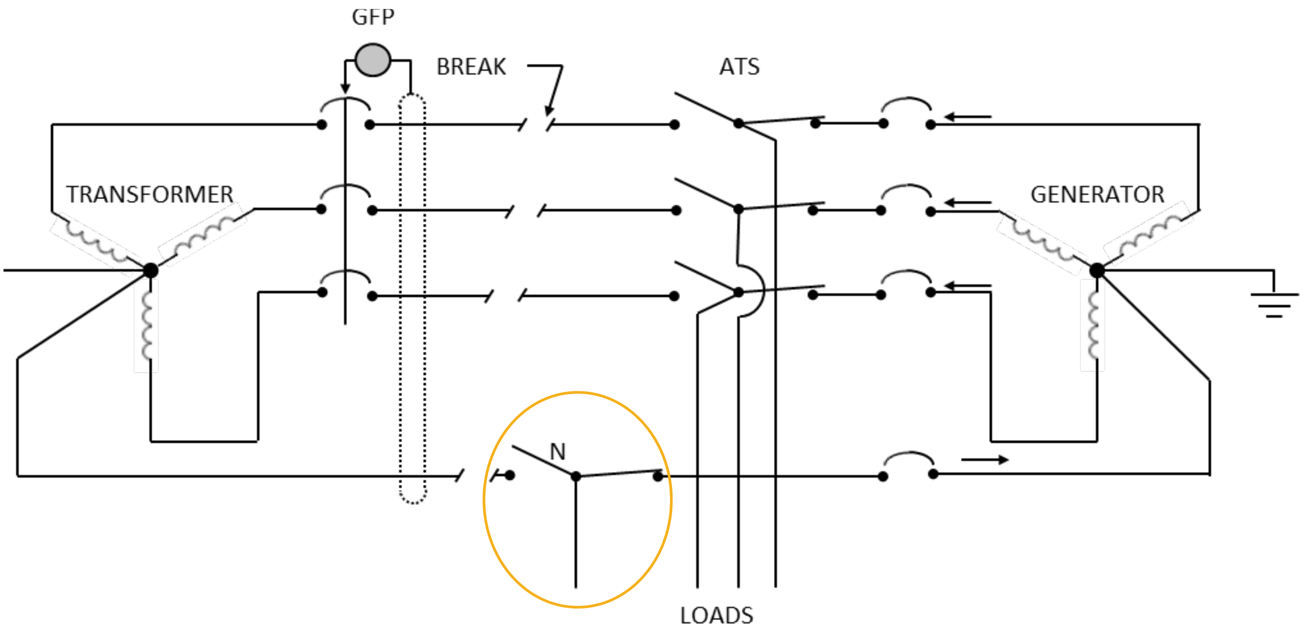

Figure 10: Both the transformer and generator have separate grounds. The extra switching pole, circled in yellow, isolates the ground of the inactive power source.

ENCLOSURES

A transfer switch should be housed in an enclosure suited to the environment where it will be installed. The majority of ATS offerings use one of the six enclosure types described in *UL 50 - Enclosures for Electrical Equipment*, *Non-Environmental Considerations*, as detailed in Table 2.

Table 2: Select UL 50 Enclosure Types

Type	Description
1	Indoor. Protects people from hazardous parts and equipment from foreign objects.
3R	Indoor or outdoor. Protects people from hazardous parts and equipment from foreign objects such as falling dirt, rain, sleet, and snow. Equipment will remain undamaged by the formation of ice on the exterior surfaces.
3RX	Type 3R characteristics plus an extra measure of protection against corrosion.
4	Indoor or outdoor applications. Protects people from hazardous parts and equipment from foreign objects such as falling dirt, windblown dust, rain, sleet, snow. Protects against splashing water and hose-directed water. Equipment will remain undamaged by the formation of ice on the exterior.
4X	Type 4 characteristics plus an extra measure of protection against corrosion.
12	Indoor, without knockouts. Protects people from hazardous parts and equipment from foreign objects such as falling dirt and circulating dust, lint, fibers, and flyings. Also protects from ingress of water due to dripping and light splashing as well as light splashing and consequent seepage of oil and noncorrosive coolants.

While the listed enclosure types address most applications, manufacturers may offer several enclosure materials. While steel is suited for noncorrosive indoor environments, Type 3RX and Type 4X enclosures are available in both Type 304 and Type 316 stainless steel. The less expensive Type 304 is suited for many outdoor applications. Because it contains molybdenum, Type 316 provides additional protection against corrosive salts and chemicals. Type 316 stainless steel enclosures can provide better protection when ATSs will be located in coastal marine environments, at sites near roadways where seasonal deicing salts are used, and at industrial facilities where corrosive chemicals are present. Further information is presented in our publication entitled **Selecting Secure Enclosures to Protect Equipment from Ultraviolet Radiation**.

SUMMARY

Selecting an ATS requires a basic understanding of their ratings, features, and options. In addition to basic amperage and voltage requirements, specifiers need to review how UL 1008 withstand and close ratings, UL 1008 Short Time Ratings, and the characteristics of upstream OCP affect transfer switch frame selection.

Transfer switching mechanisms differ in sequence of operation to support specific applications. Open, delayed, and closed transfer switching modes offer unique benefits for specific load types. In addition, ATSs can be obtained with isolation and bypass features that can avoid power interruption during ATS service and testing routines. Specifiers must also understand the grounding system and know the number of ground points to select either a solid or switched neutral ATS, and select appropriate enclosures for the installation environment.

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