GENERAC'S EXPERT CORNER

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Automatic Transfer Switches – Poles, Position, Rating

Poles

For three phase systems, the automatic transfer switches (ATS) can be configured for switching only the phase conductors (3-pole) or switching the phase conductors and the neutral (4-pole). This is also referenced by the National Electric Code (NEC®) as non-separately derived and separately derived respectively. The question often arises on when to use a 3-pole and when to use 4-pole. The basic answer is always use 3-pole unless there is a specific application reason. Three pole switches are less expensive, provide a simpler grounding system (single point of bond at the service), and may provide for a more securely bonded system (neutral isn't switched and only single bond at the service – normally indoors). There are five reasons to provide a 4-pole transfer switch:

1. **Engineer specified 4-pole**
   Specifying 4-pole is at the discretion of the designing engineer and is always a valid system design choice. That being said, switching to 3-pole may be a value engineering (VE) option to create competitive differentiation or free up funds to be directed elsewhere. Always verify that one of the required 4-pole applications listed below aren't relevant in the application.

2. **Backing up multiple services on a single generator system (each service has its own bond)**
   If 3-pole transfer switches are used, the system will have multiple points of bond creating a code issue (they will all be connected together via the generator neutral).

3. **Healthcare with 480V, 1000 amps or larger service and multiple ATS**
   NEC® 517 requires these applications to have ground fault protection (GFP) on the utility feeders beneath the service. When two or more of these circuits are backed up with 3-pole transfer switches, the generator's normal neutral current has the potential to create false / nuisance tripping of the utility feeder GFP while on generator power.

4. **Highly sensitive generator GFP/GFI (weak reason – code doesn't require high sensitivity)**
   When using a 3-pole ATS, the generators GFP/GFI can't differentiate between normal neutral current and ground fault current. This requires the GFP/GFI to be set higher than the systems neutral current. This normally isn't a problem because systems are relatively balanced (low levels of neutral current) and the NEC® allows for this to be set as high as 1200 amps. Basically the NEC® does not require GFP/GFI to be highly sensitive.

5. **Data Center mentality (not relying a single point failure)**
   When using a 3-pole ATS, the utility and the generator systems both rely upon the single point of bond within the utility service. A fire in the utility service or potentially maintenance of the service bond would impact both power sources.

Two Position vs. Three Position Switch

Historically, Generac distribution partners have provided pricing feedback comparing competitor's two position switching technology against Generac's three position technology. Though we appreciate the desire to always have the best market price, two position transfer technology does not always provide the application flexibility that may be needed.

Two position transfer switches are designed to maintain final position in only the generator or utility positions. They transfer through a disconnected position but are fighting against a strong spring while disconnected from both sources, making this disconnected position unsustainable. As a result of this operational limitation, two position switches are often only available with in-phase (only) transfer functionality nor are they capable of load shedding to a disconnected position. On the positive side, two position switches are often optimized for in-phase operation due to faster switching times. Generac currently offers two position (in-phase) only options in the PSTS and TX series (100 – 400 amp). Think of the two position switch option as your price leader with less flexibility.

Three position transfer switches are designed to maintain final position in three different positions – generator, utility, and a disconnected position. This switch technology is capable of sustaining the third disconnected position supporting time delay in neutral transfers and load shedding. Generac's three position contactor switches (TX & PSTS) also have the flexibility of supporting in-phase transfers through a simple controller setting. Note this dual option isn't available in PSTS molded case break switches (price leader for service entrance rated, 100 – 1000 amps) due to their slower switching time.

In-phase transfers are often favored within the market due to the minimized outages that occur during retransfer provided this fast transfer doesn't cause issues. It has long been know that in-phase transfers are potentially vulnerable to large surges of current that can cause breakers to trip. The two most prevalent causes are a concentration of motor loads or large capacitors integral to harmonic filters.

Concentrated motor loads may be a problem for in-phase transition due to the motors regenerator voltage effect and the fact that the motor slows down while the ATS is transferring. In this scenario, the ATS aligns the sinewave between the generator and utility and begins to transfer. The motors are now disconnect from the generator source and begin to slow down (pull out of phase), but they are still regenerating voltage. When the motor load is a significant percentage of the facility load, this regenerative voltage is not dissipated by other building loads. When the ATS closes into the utility source, the motor voltage and utility voltage are out of phase, causing a current spike which can trip breakers. To minimize this current surge, two position switches need to operate quickly.

The UPS industry also tends to recommend not using in-phase transfers for some of the same reasons. UPS's and other non-linear load devices like VFD's may use harmonic filters. These filters contain large capacitors that charge and discharge with each cycle. When the ATS transfers, the sinewave may be on a peak and it may reclose on a trough resulting in a surge of current that could trip the input breaker to the UPS.

Generac also positions the Modular Power System (MPS) generator solution very prevalently for larger kW projects. This solution creates greater redundancy for many of our mission critical customers. This redundancy is often gained from the applications typical load factors and some load shedding as necessary. The flexibility of three position contactor technology to support load shedding is an integral feature to position the MPS solution. Correspondingly, the only option for two position switches is to load shed back to a “bad” utility and be exposed to undesirable voltage anomalies.

For the reasons identified above, Generac believes that most applications 600 amps and larger would benefit from a premium three position switch with time delay in neutral functionality. With that said, we understand that in the bid spec market, price competition may leave the market open to larger 2 position transfer switches as a price leader option. As Generac continues our ATS development effort, we will ensure we have cost effective choices to meet your market needs.

Ratings (Short Circuit WCR Rating)

Transfer switches are rated for normal running amps and short circuit amps. The short circuit rating is based upon the ability to close into and withstand a downstream short circuit (WCR rating). Transfer switches are not required to interrupt false current so the rating is expressed in thousands of amps (kA) not interrupting amp capacity (kIAC). As a result of this limitation, transfer switches must always be fed from an over current protection device providing the short circuit interruption capacity. The only exception to that is service entrance rated (SER) transfer switches which integrated the over current protection into the ATS.

When it comes to matching an ATS to its application, the transfer switch must have enough kA capacity to meet the maximum available fault current for the clearing time of the upstream over current protective device. The maximum available fault current is determined by the size of the utility transformer and location of the transfer switch within the system. The maximum fault current at the terminals of the transformer is its rated amps divided by its sub-transient reactance. Assuming 5% reactance, it is fair to estimate the maximum fault current at 20 times the service size. If you discover the ATS kA capacity is being specified significantly greater than the 20 x service amps and it is also greater than the typical market kA capacity for that size ATS, it opens up the potential for a value engineering discussion.

When establishing the ATS kA rating, the duration of time the ATS must carry the amps dramatically impact its kA rating. This leads us to three very distinctive kA ratings: fuse, coordinated breaker, and 3-cycle/any breaker. Fuses open extremely quickly (.5 cycle), typical coordinated breakers open slower (1.5 to 2.5 cycles), and any breaker rating is slower yet opening within 3 cycles. As a result of fuses high speed operation, transfer switches typically have a very high 200 kA rating when paired with a fuse. The disadvantage is that most customers don’t want to use fuses.

Breakers provide the most common type of over current protection so they represent two of the ATS kA ratings: coordinated breaker and 3-cycle/any breaker. Some breakers open faster than others. By grouping these typical high performing, current technology breakers together on a list (list of coordinated breakers), we are able to rate the ATS at a higher kA rating then some old slow breaker. The advantage of this is approach is higher kA ratings. The disadvantage of this approach is that the engineer at submittal or the authority having jurisdiction (AHJ) may want to validate that the supplied breaker is actually on the ATS suppliers list of coordinated breakers. To improve the probability of match-up, Generac has included Eaton, Siemens, ABB/GE, and Schneider (Square D) on our list of coordinated breaker for the TX series. The list of coordinated breaker for the PSTS series tends to be more Eaton based, though all the PSTS switches include a back-up 3-cycle rating.

UL recognize that all the breakers seemed to open within 3-cycles, so they created an ATS rating to be used with any breaker. This rating is referenced at the 3-cycle or any breaker rating. The advantage of this rating is the upstream breaker doesn't need to be known. Often times in new construction, everything is being bid at the same time, so it isn't real feasible to validate if the breaker is on the ATS coordinated breaker list until later in the process. This rating also provides a backup in case the breaker used isn't on the list. Currently Generac has positioned the TX series to be a dual listed and labeled product (coordinated breaker & 3-cycle). We are coordinating updating our systems to support that business choice, so in the interim always select the TX 3-cycle option (they are the same price).

In Summary:

1) Use 3-pole switches unless you have an application need for 4-pole.
2) Use 3-position switches unless up against bid spec price pressures.
3) Use the coordinated breaker rating in the sales process (3-cycle is your back-up).

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