Custom Automatic Transfer Switches for Critical Uptime

Engineering the transfer switch around the facility - not the catalog

A technical white paper

Apex Power Distribution (APD)

Executive Summary

When a facility loses utility power, one device decides what happens next. The automatic transfer switch (ATS) senses the outage, starts the transfer, and carries every downstream load until normal power returns. For a data center, a hospital, or an industrial plant, that makes the ATS one of the most consequential components in the electrical system - and one of the most casually specified.

Transfer switches are often bought the way breakers are bought: by amperage, from a catalog, at the last minute. That works for simple buildings. It works less well for critical facilities, where the loads, the sources, and the maintenance realities vary enough that transition type, withstand rating, bypass isolation, and control behavior deserve real engineering attention.

This paper explains how transfer switches work in the standby power chain, what the transition types actually do, why bypass isolation matters in facilities that can never go dark, and how ratings and controls should be coordinated with the rest of the system. It compares standard catalog units with application-engineered switches honestly - standard units are the right answer more often than not - and walks through a realistic facility example showing how load types drive selection. It closes with the most common selection mistakes and a checklist of questions to answer before a switch is specified.

The central argument is simple: a transfer switch should be selected around how the facility must detect an outage, transfer, ride through, and return to normal - not simply picked from a catalog by amperage.

Why Transfer Switches Are Critical to Uptime

Most components in a power system carry load all the time, so problems announce themselves. A transfer switch is different. It may sit for months doing nothing except monitoring voltage, and then it is asked to perform its entire function in a fraction of a second, under stress, exactly when the facility can least afford a failure.

A generator that starts perfectly is useless if the switch never transfers. A UPS rides through only as long as its batteries allow; if the transfer fails, the ride-through simply delays the outage. In practice, the ATS is the hinge of the whole standby power investment. Facilities routinely spend heavily on generation and UPS capacity, then treat the hinge as a commodity.

Uptime statistics in critical facilities bear this out: transfer equipment and its controls are a recurring root cause in outage post-mortems - not because the technology is weak, but because the selection, testing, and maintenance never matched the criticality of the role.

How Transfer Switches Work in the Standby Power Chain

The standby power chain is a sequence: a normal source (usually the utility), an emergency source (usually an engine generator), a transfer switch that selects between them, and the distribution that carries the selected source to the loads.

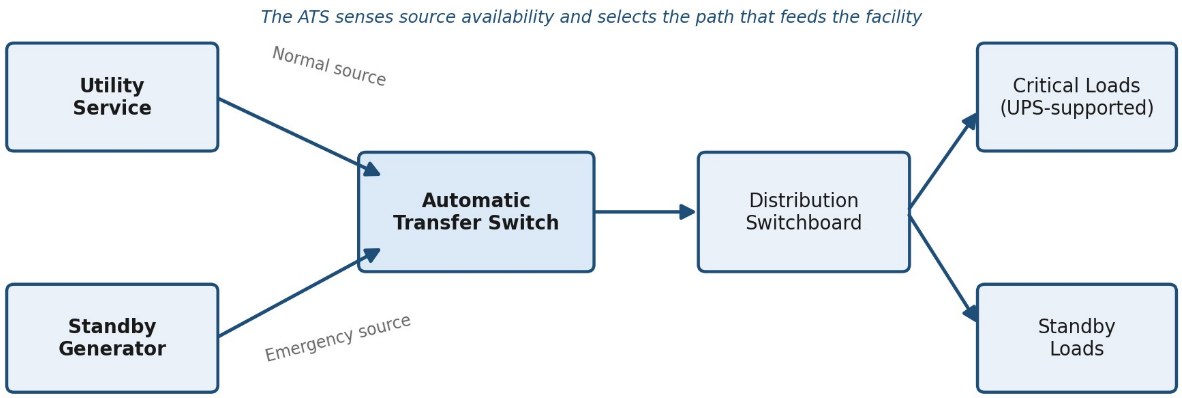

Figure 1. The ATS sits between the sources and the distribution it feeds.

In a typical utility failure the sequence looks like this. The ATS controller continuously monitors the normal source for undervoltage, overvoltage, frequency deviation, and phase loss. When the source falls outside its settings and stays there past a short time delay - a delay that prevents nuisance starts on momentary dips - the controller signals the generator to start. When the generator reaches acceptable voltage and frequency, the switch transfers the load. When the utility returns and holds stable through a longer retransfer delay, the switch returns the load and runs the engine unloaded for a cool-down period before shutdown.

Every step in that sequence is a setting, and every setting is a decision. How much voltage sag is too much? How long should the switch wait before starting the engine? Should retransfer happen automatically, or should an operator confirm it during business hours? These decisions belong to the facility, and a switch whose controls cannot express them forces the facility to live with someone else's assumptions.

Transition Types and Where Each Fits

The transition type defines what the load experiences during transfer. There are three basic behaviors.

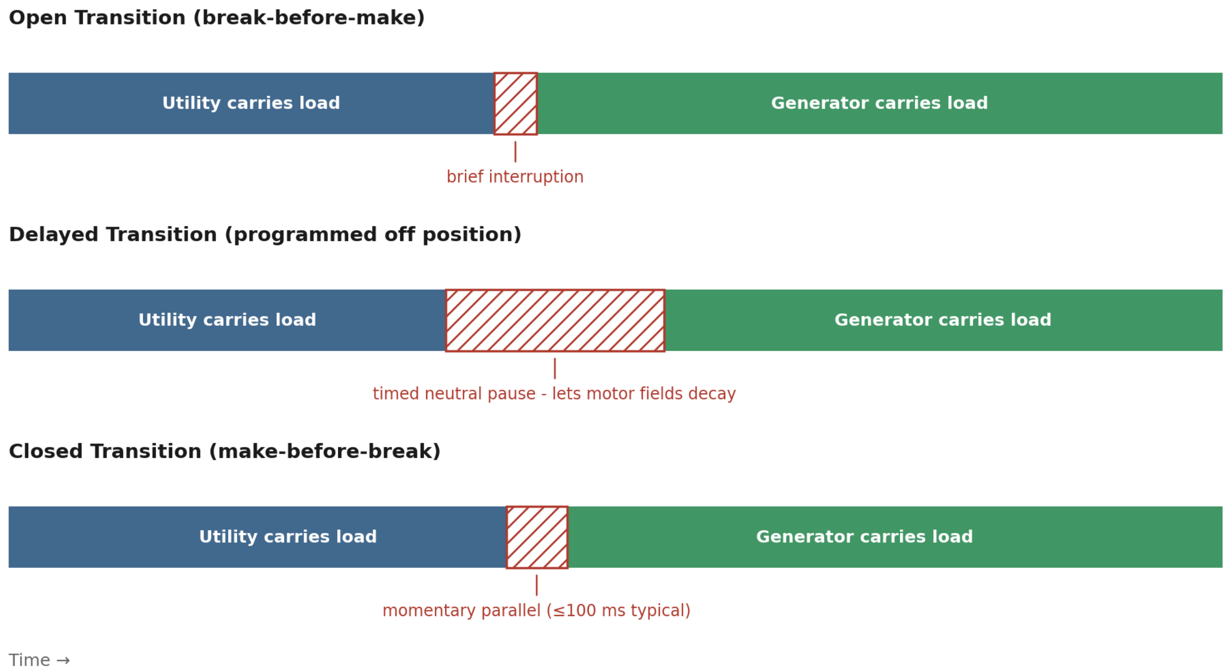

Figure 2. What the load sees: open, delayed, and closed transition compared.

Open transition (break-before-make). The switch disconnects from one source before connecting to the other. The load sees a brief interruption - typically a few cycles to a few seconds. This is the simplest, most economical, and most common arrangement, and for lighting, receptacles, and UPS-protected loads it is usually all that is needed: the UPS bridges the gap, and everything else tolerates it.

Delayed transition (programmed neutral). The switch opens, pauses in a center-off position for an adjustable time, then closes to the other source. The pause lets residual voltage on motor windings decay before re-energization. Without it, transferring a large spinning motor out of phase can produce torque transients and inrush that trip breakers or damage couplings. Facilities with significant motor load - chillers, air handlers, pumps - are the natural home for delayed transition.

Closed transition (make-before-break). The switch parallels the two sources for a moment - typically 100 milliseconds or less - so the load never sees an interruption during planned transfers such as monthly tests or peak-shave operations. The cost is real complexity: synchronizing controls, protective relaying to abort a failed parallel, and utility interconnection approval, since the generator briefly operates in parallel with the grid. Closed transition is valuable where even test transfers must be seamless; it is unnecessary complexity where they need not be.

None of these is the best transition type. Each is the right answer for a particular set of loads and operating expectations, which is exactly why the choice deserves more attention than it usually gets.

What an Application-Engineered Transfer Switch Really Means

The phrase custom transfer switch invites skepticism, and some of it is deserved - a different paint color is not engineering. Real application engineering means the switch is configured around the facility's sources, loads, and maintenance strategy rather than around a catalog page. Customization is much more than amperage and pole count:

- Transition type matched to the loads actually served - open for UPS-bridged loads, delayed for motor-heavy branches, closed where seamless test transfers matter.
- Withstand and closing ratings coordinated with the actual available fault current and the specific upstream overcurrent devices, not assumed from a table.
- Bypass isolation where the facility can never schedule an outage to service the switch.
- Control logic that expresses the facility's operating decisions: engine-start delays, retransfer behavior, load shed and priority schemes, elevator pre-transfer signals.
- Metering, monitoring, and communications that report into the building or plant systems the operators actually watch.
- Enclosure and construction matched to the environment - service entrance rating, NEMA rating, seismic certification, cable entry and gutter space that fit the installation.

On a simple project, every one of those dimensions collapses to a default, and a standard unit is genuinely the right purchase. On a critical project, two or three of them usually matter enough to change the specification. The engineering is in knowing which.

Standard vs. Engineered Transfer Switches

Standard catalog switches have real advantages, and it is worth stating them plainly. They are less expensive. They ship faster. They are built in volume with well-proven mechanisms. Spare parts and service knowledge are widely available. For offices, retail, schools, light industry, and any application where the loads are ordinary and a brief transfer interruption is acceptable, a standard open-transition switch sized correctly is not a compromise - it is good engineering.

Application-engineered switches earn their cost where the facility's requirements exceed the catalog's assumptions:

- Loads that cannot tolerate the default transition behavior - large motors, sensitive process equipment, or facilities where even test transfers must be invisible.
- Fault currents or coordination requirements that demand specific withstand ratings or fully rated construction.
- Maintenance realities that require bypass isolation because the switch can never be de-energized.
- Operating schemes - load priority, peak shaving, multi-source arrangements, generator paralleling - that standard controls cannot express.
- Integration needs: annunciation to a 24/7 operations center, communications into SCADA or BMS platforms, coordination with UPS and generator controls.

The honest summary: most transfer switches in the world should be standard units, and the critical minority should not. The expensive mistakes happen in both directions - buying engineered features a simple building will never use, and buying a commodity switch for a facility whose loads and maintenance strategy quietly required more.

Ratings, Sizing, and Coordination

Three rating conversations matter more than the amperage on the nameplate.

Continuous and inrush sizing. The switch must carry the continuous load, but it must also close into and carry the inrush the loads actually draw. Motor-heavy branches can demand six times running current at starting; transformer energization draws its own inrush. A switch sized to the running load alone may transfer successfully into a dead bus and then be asked to survive every motor on the branch restarting at once. Generator capacity belongs in the same conversation - the sizing of switch, generator, and load steps is one coordinated decision, not three separate ones.

Withstand and closing ratings. Transfer switches listed to UL 1008 carry withstand and closing ratings (WCR): the fault current the switch can endure and close into while a specific upstream overcurrent device clears the fault. These ratings are established with particular device types and clearing times, which means the switch and its upstream protection must be verified as a pair against the available fault current at the installation. A switch that is perfectly rated on paper can be misapplied simply because the upstream breaker is not the type or setting the rating assumed. This verification is project-specific and must be performed for the actual application.

Service entrance applications. Where the transfer switch is the service disconnect, it must be service entrance rated - with the disconnecting, overcurrent, and grounding provisions the NEC requires at the service. This is a listing and construction question, not a field modification, and it should be settled early because it changes the equipment.

Selective coordination requirements for emergency systems, where applicable, add a further layer: the overcurrent devices around the transfer switch may need to coordinate so that a downstream fault does not take out the emergency supply to unrelated loads. Whether and how this applies depends on the system type and jurisdiction, and it must be verified for the specific project.

Bypass Isolation and Maintainability

Every mechanical device eventually needs inspection, service, or replacement. The question a specifier should ask is uncomfortable and clarifying: when this switch needs work, how will the facility power the loads it feeds?

For many buildings the answer is a scheduled outage, and that is fine. For a hospital's essential branches, a data center's critical bus, or a plant that runs continuously, there is no acceptable outage window - which means an ordinary transfer switch, once installed, can never be properly maintained. Facilities discover this the hard way, years in, when a switch that cannot be de-energized starts showing its age.

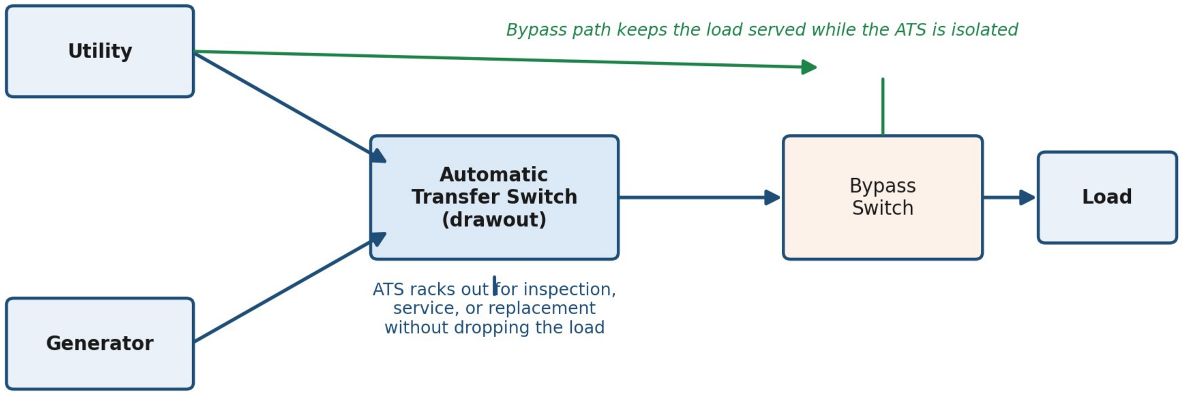

Figure 3. Bypass isolation: the load is carried on the bypass path while the ATS is racked out for service.

A bypass isolation transfer switch solves the problem structurally. A manual bypass switch carries the load directly from a selected source while the automatic switch is isolated - typically drawn out - for inspection, testing, contact replacement, or full exchange. The facility gives up automatic transfer protection only for the duration of the work, and the loads never drop.

Bypass isolation adds cost and footprint, and plenty of applications do not need it. But for switches serving loads that can never be scheduled off, it is less a feature than a maintenance strategy - and it is far cheaper specified up front than retrofitted after the first failed service window.

Integration with Generators, UPS, and Controls

A transfer switch does not act alone, and most transfer problems in the field are really coordination problems between the ATS and its neighbors.

- Generator controls: the engine-start signal, warm-up and cool-down timing, and - in multi-generator plants - the interaction between ATS transfer timing and paralleling switchgear load-add sequences.
- UPS systems: the UPS must ride through the transfer, and its input tolerance should be checked against the transition behavior; delayed transitions in particular must fit within the battery ride-through with margin.
- Load management: load shed and priority schemes, staged reconnection of large motors, and elevator pre-transfer signals that let controllers bring cars to a floor before the interruption.
- Monitoring and annunciation: switch position, source availability, and failure alarms reported where operators will actually see them - a BMS, SCADA, or remote monitoring platform - rather than a pilot light in an unvisited room.

These interfaces are exactly where application engineering pays for itself, because they cannot be resolved by any single vendor's catalog. Someone has to own the sequence of operations across the equipment, write it down, and test it end to end during commissioning.

Enclosures, Environments, and Installation

Where the switch lives shapes what should be bought. Indoor electrical rooms suit standard enclosures; outdoor pads demand NEMA 3R or better, with attention to condensation heaters, solar heat gain, and corrosion in coastal or industrial atmospheres. Working clearances per the NEC apply wherever the switch is installed, and bypass isolation switches need the additional front access their drawout mechanisms assume. Cable entry, gutter space, and terminal sizing deserve early coordination - an otherwise correct switch that cannot accept the installed conductors is a familiar and avoidable field problem. Seismic certification, where required by the jurisdiction, is a construction and listing matter to settle at specification time, and it must be verified for the specific project.

Practical Facility Example

Consider a hypothetical regional facility - part data hall, part clinical space, part central plant - served by a 480/277 V utility service with a 750 kW standby diesel generator. Rather than one large transfer switch, the design uses three, because the loads split into three very different duties.

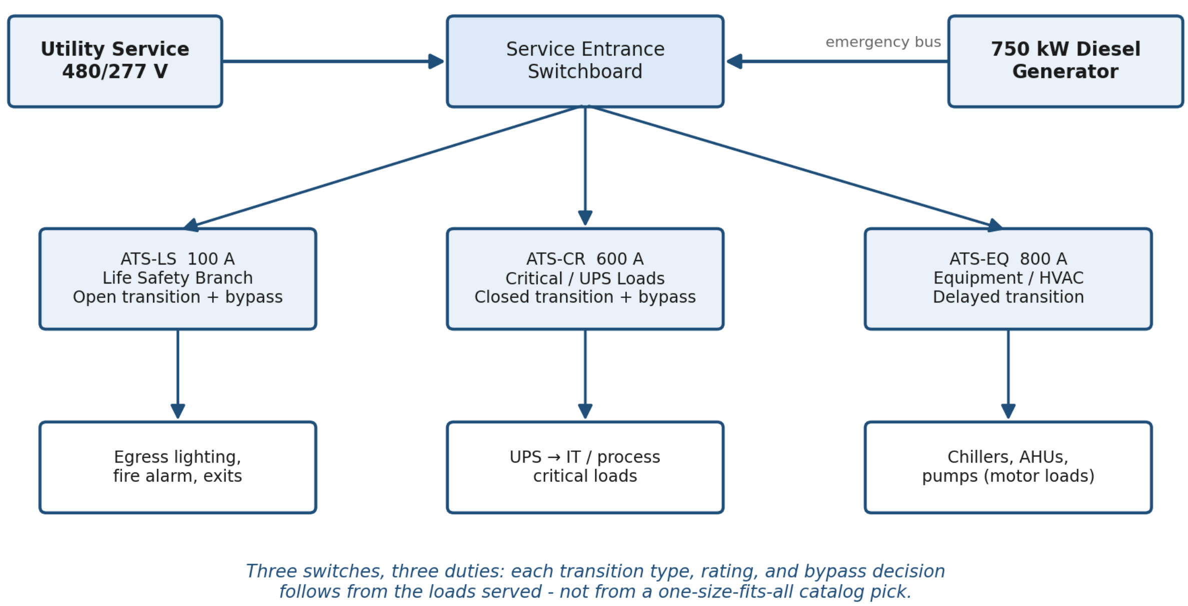

Figure 4. Example one-line: three transfer switches engineered around three different load duties.

ATS-LS - life safety branch, 100 A, open transition, bypass isolation. Egress lighting, exit signage, and fire alarm loads transfer in seconds and tolerate the interruption. Open transition keeps the switch simple and fast. Bypass isolation is included not for the loads' sake but for the code-driven reality that this branch can never be scheduled off for switch maintenance.

ATS-CR - critical branch, 600 A, closed transition, bypass isolation. This switch feeds the UPS that carries the IT and clinical-critical loads. The UPS would bridge an open transition - but this facility runs monthly generator tests under load, and closed transition makes those tests invisible to the critical bus, eliminating a dozen battery discharge events per year. Synchronizing controls and utility interconnection approval are the price; the facility judged them worth paying. Bypass isolation, again, because this bus never sleeps.

ATS-EQ - equipment branch, 800 A, delayed transition, no bypass. Chillers, air handlers, and pumps dominate this branch. Delayed transition with a programmed neutral pause lets motor fields decay before re-energization, and staged restart timers bring the large motors back in sequence so the generator sees load steps it can accept. This branch can tolerate a planned annual outage for switch maintenance, so bypass isolation was considered and deliberately omitted - engineered restraint is still engineering.

Three switches, three different specifications, one coherent logic: each selection follows from what the loads require during and after transfer, what the generator can accept, and how each branch can - or cannot - be maintained. A single catalog pick applied three times would have been simpler to buy and worse to own.

Common Transfer Switch Selection Mistakes

The same selection errors appear across projects and industries:

- Sizing only for running load and ignoring inrush and motor starting - the switch survives the transfer and struggles with the restart.
- Overlooking withstand and closing ratings relative to the actual available fault current, or pairing the switch with an upstream device type its rating never contemplated.
- Omitting bypass isolation on switches that can never be de-energized for service, guaranteeing a maintenance dead end.
- Choosing the wrong transition type for the loads served - open transition dropped onto motor-heavy branches, or closed transition complexity bought where nothing required it.
- Poor physical placement that leaves no working clearance, no drawout room, or no safe access for the maintenance the switch will eventually need.
- No plan for code-required exercising and testing - the switch is installed, energized, and never operated again until a real outage finds the problem first.
- Ignoring control power and sensing failure modes - the mechanism is robust, but the switch is only as reliable as the controls that tell it to act.
- Failing to coordinate ATS behavior with generator and UPS controls, so each device performs correctly and the system still fails.
- Treating the transfer switch as a commodity line item, value-engineered at the end of a project it was never really part of.

Questions to Answer Before Selecting a Transfer Switch

A practical checklist for owners, engineers, and contractors:

- What loads does this switch serve, and what do they experience during an open, delayed, or closed transition?
- What is the true continuous load - and the true inrush when everything on the branch restarts at once?
- What is the available fault current at the switch, and what specific upstream device will the withstand rating be coordinated with?

- Is this switch the service disconnect? Does it need a service entrance rating?
- How will this switch be inspected, serviced, and eventually replaced? Is there an outage window - and if not, where is the bypass?
- What engine-start, retransfer, and cool-down behavior does the facility actually want? Who confirmed the time delays?
- How does the transfer interact with the UPS ride-through and the generator's load-step capability?
- Do any loads need pre-transfer signals, staged restart, or load shedding?
- What monitoring, annunciation, and communications must the switch provide, and to which systems?
- What enclosure, environment, seismic, and clearance requirements apply at the installed location?
- What testing and exercising will the switch receive - at commissioning and every year after - and who owns that program?
- How much load growth should this switch accommodate before the facility would rather replace it?

Where requirements depend on system type, voltage class, or jurisdiction - selective coordination, service entrance provisions, seismic certification, healthcare branch rules - they must be verified for the specific application rather than assumed.

Testing and Maintenance Considerations

A transfer switch proves itself only under load. Commissioning should exercise the complete sequence - sensing, engine start, transfer, retransfer, cool-down - with real load on the bus, and the settings should be documented as tested, not as shipped. From then on, periodic exercising and testing keep the mechanism free and the sequence proven; where NFPA 110 applies, it establishes the testing framework for the emergency power supply system, and the switch's transfers are part of it. Contact inspection, connection torque checks, control power verification, and thermal scanning belong on the same calendar as generator service - the standby chain is only as maintained as its least-maintained link. Facilities with bypass isolation should use it: the bypass exists precisely so this work can happen without waiting for an outage that never comes.

Conclusion

The automatic transfer switch occupies a strange position in facility engineering: everything depends on it, and almost nothing about its selection is glamorous. That combination is exactly why it deserves deliberate attention. The transition types, ratings, bypass provisions, and control behaviors described here are not exotic options - they are the vocabulary of matching a switch to a facility, and most of the cost of getting them wrong arrives years after the purchase order, during an outage or a maintenance window that the specification never imagined.

Standard switches serve most buildings well. Critical facilities should expect more: a transfer switch selected around how the site must detect an outage, transfer, ride through, and return to normal - not simply picked from a catalog by amperage.

Apex Power Distribution works with owners, engineers, EPCs, and contractors to develop transfer switch and standby power solutions around actual project requirements - from transition and rating selection through bypass arrangements, controls integration, and testing. To discuss an upcoming transfer switch or standby power requirement, contact Apex Power Distribution.