Optimizing safety and reliability

Maintaining transfer switches within the essential electrical system of a healthcare facility

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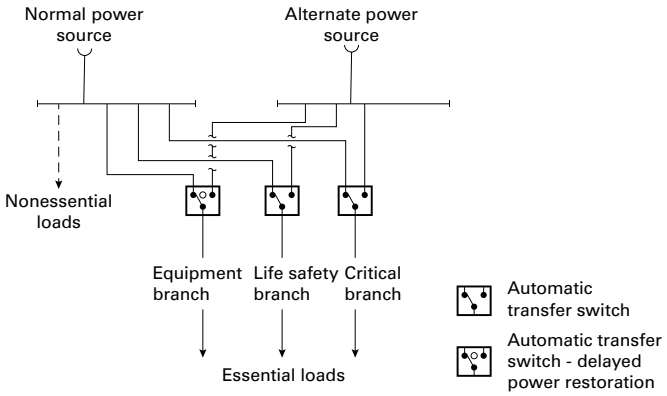
Essential electrical system

The essential electrical system (EES) plays a vital role in healthcare facilities such as hospitals and is designed to ensure continuity of power to essential electrical loads. A system or equipment load is considered essential when its failure is likely to cause injury or death to a patient, staff member or visitor. The EES distributes power originating from a normal power source (typically a public utility service) or alternate power source (typically a diesel generator, battery energy storage system or fuel cell system) to essential loads via three distinct branch circuits within the electrical infrastructure: a life safety branch, critical branch and equipment branch. Division of the EES into individual branch circuits occurs at the automatic transfer switch equipment when more than one transfer switch is required.



Essential Electrical System (Type 1)

The **life safety branch** is limited to loads related to a facility's fire alarm systems, egress lighting, exit signs, electrically powered doors, elevator lighting and emergency communication systems. The **critical branch** provides power for the direct care and well-being of patients to include task illumination, nurse call systems, tissue banks and select receptacles in spaces such as treatment rooms and recovery areas. Lastly, the **equipment branch** services medical gas equipment and other mechanical systems such as pumps, ventilation, compressed air and heating to support clinical activities significant to patient care.

The Healthcare Facilities Code (NFPA 99® 2021) specifies that all activities, systems and equipment that occur or reside within a healthcare facility are grouped into one of four risk categories during an assessment conducted by the facility's governing body. Category 1 patient care spaces are critical in nature and must be served by a Type 1 EES. Category 2 spaces are less critical and shall be served by a Type 1 or Type 2 EES. Where a Type 2 EES is provided, it is divided into only two branches: a life safety branch and equipment branch. Category 3 and Category 4 spaces are not required to be served by an EES.

Category	Patient space	EES Type	Risk to patient, staff or visitor upon system or equipment failure
1	critical care	1	major injury or death likely
2	general care	1 or 2	minor injury likely
3	basic care	not applicable	injury not likely but may cause patient discomfort
4	support	not applicable	physical impact on patient care not likely

When a disruption or failure of the normal power source is detected, maintaining power to essential loads is mandatory due to their significant role in safeguarding human life, and the code specifies that the EES shall automatically restore operation to all functions of the associated life safety and critical branches within 10 seconds. Equipment branch loads are not required to be restored within 10 seconds for a Type 1 EES but are required to do so for a Type 2 EES.

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Loads served by the equipment branch are predominantly mechanical and draw significant inrush current when energized, therefore time delays can be programmed into the restoration sequence to help reduce the instantaneous demand placed on the alternate power source (e.g. standby generator). Meeting these performance requirements is achieved with listed automatic transfer switch equipment.

Automatic transfer switches

An automatic transfer switch (ATS) is a self-acting device that seamlessly transfers connected electrical loads between normal and alternate power sources. In its rudimentary form, a conventional ATS consists of a set of main power contacts that are operated (opened and closed) by intelligent microprocessor logic. Although this action may sound mundane, an ATS deployed in an EES must be vigilant by constantly monitoring system voltage and frequency while remaining at the ready to operate with a high degree of reliability.

UL® 1008 is the industry product standard for transfer switches, which must be specified by consulting engineers when constructing or renovating healthcare facilities. Only UL 1008 listed transfer switches are suitable for emergency electrical service. UL 1008 ensures the highest levels of equipment reliability through rigorous performance testing and compliance to a robust set of construction and safety criteria.

However, specifying transfer switch equipment that is UL 1008 listed and marked is not enough. For an ATS to continue performing reliably after installation, it is imperative that the facility manager establish and implement a maintenance program based on the directives and best practices prescribed in NFPA 70 (articles 517 and 700), NFPA 99 (chapter 6), NFPA 110 (chapter 8), NFPA 111 (chapter 8) and to a lesser degree NFPA 101, which predominantly cites codes and standards previously listed.

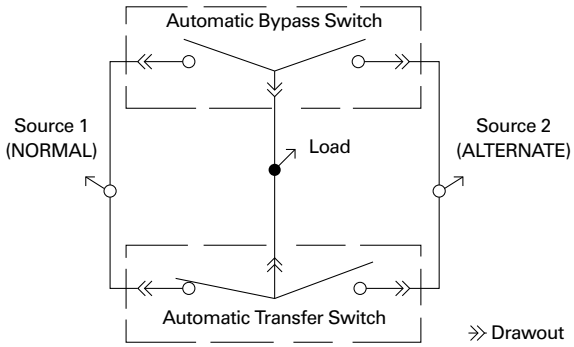
Maintenance, inspection and testing

Prior to performing maintenance, a conventional ATS must often be de-energized to eliminate the inherent dangers associated with working on live equipment. In this instance, if electrical power cannot be rerouted through an alternative distribution path, the essential load will likely experience a prolonged outage until maintenance activities are completed.

When challenged with reconciling the need for regular maintenance, continuous operability and worker safety, a facility manager should consider a bypass isolation transfer switch. It enables power to be diverted or bypassed around the ATS (primary switching mechanism) and through a bypass switch (secondary switching mechanism). This type of construction offers numerous benefits, but most importantly it permits routine testing, inspection and maintenance to be performed on the ATS without disrupting healthcare facility operations.

After power has been bypassed, the ATS can safely be disconnected from the electrical bus of the power sources (normal and alternate) and load. Once in the isolated position, service personnel can functionally exercise and verify proper operation of the ATS main contacts, electrical operator (opens/closes main contacts) and auxiliary contacts (tracks main contact position). All action is initiated and controlled from the front of the assembly with the enclosure door(s) closed. For bench-level maintenance or repair activities, the ATS can be completely drawn out and removed from the assembly.

If the normal power source fails while the ATS is isolated for test or has been removed from the assembly, the code requirement to restore power to the essential load within 10 seconds still applies and therefore action must be taken quickly. For this situation, it is important to fully understand the bypass switch operation and specify the desired functionality. A bypass switch limited to non-automatic operation necessitates qualified personnel to actively supervise the equipment while the ATS is bypassed, constantly monitor system status, recognize the loss of normal power and manually initiate a transfer to the alternate source. In contrast, a bypass switch that can execute an automatic transfer is fast-acting and not reliant on human interaction that may be subject to delayed response. In short, a bypass switch capable of automatic operation provides true operational redundancy.

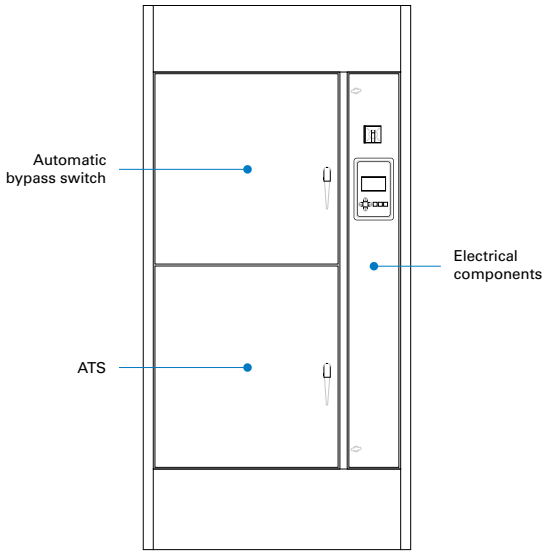


Schematic drawing of a bypass isolation transfer switch with redundant automatic operation

Accepting that the ATS should be exercised at a regular cadence in the interest of maintaining equipment reliability, consideration should be given to exercising and maintaining the bypass switch since it serves as the redundant backup and will be responsible for restoring power to the essential load when the ATS is isolated or removed. Designs that also enable the bypass switch to be isolated for test and drawn out for removal promote this best practice.

The physical construction of bypass isolation transfer switches in the marketplace varies. Some models locate the ATS and bypass switch in a single compartment accessible via a single door, while other designs provide two dedicated compartments fitted with independent doors for complete physical separation.

In addition, electric components such as logic controllers, relays, indication lights, communication modules and control power transformers can be housed in a third compartment with a means for electrically isolating this space during maintenance to mitigate shock hazard. Segmenting components by physical barrier reduces risk to the worker, enhances safety and facilitates concurrent maintenance while essential loads remain powered.



Bypass isolation transfer switch assembly enclosure with multi-compartment construction facilitates regular maintenance, continuous operability and worker safety

Conclusion

Healthcare facilities require uninterrupted, reliable power during temporary and extended outages to maintain facility operation and effective patient care. Consequently, facilities managers must determine which type of automatic transfer switch best enables the essential electrical system to reliably distribute power to these most important loads. The right choice will support reliable operation of systems and equipment, comply with performance and maintenance requirements of applicable codes, maximize operator and maintenance personnel safety and ensure continuous power to essential healthcare facility loads.

How NFPA standards pertain to transfer switches

NFPA 70®, National Electric Code®

The NEC® details requirements pertinent to the safety of installation, operation and maintenance of transfer switch equipment deemed suitable for emergency use in electrical systems, including those deployed in a healthcare facility.

NFPA 99®, Healthcare Facilities Code

This code is heavily focused on specifying the features, performance and testing criteria related to transfer switches in the healthcare environment. When the normal power source experiences an outage, automatic transfer switches must rapidly restore power to essential systems and equipment within 10 seconds.

NFPA 110®, Standard for Emergency and Standby Power Systems

The reliability and integrity of transfer switch equipment used in an EES and integral to an emergency power supply system (EPSS) is highly dependent on establishing and executing a program of routine maintenance as prescribed by the requirements and best practices found in this standard.

NFPA 111®, Standard on Stored Electrical Energy Emergency and Standby Power Systems

This standard addresses the performance requirements of a stored electrical energy system, and its use in a stored emergency power supply system (SEPSS) that provides an alternate source of electrical power in buildings and facilities. Transfer switch equipment is a critical element of either system.

NFPA 101®, Life Safety Code

The Centers for Medicare and Medicaid Services (CMS) periodically adopts new code requirements pertaining to construction, protection, occupancy and egress features that lessen danger to human life from the effects of fire. Testing and maintenance are also recognized as being essential to the proper function of life safety systems.

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