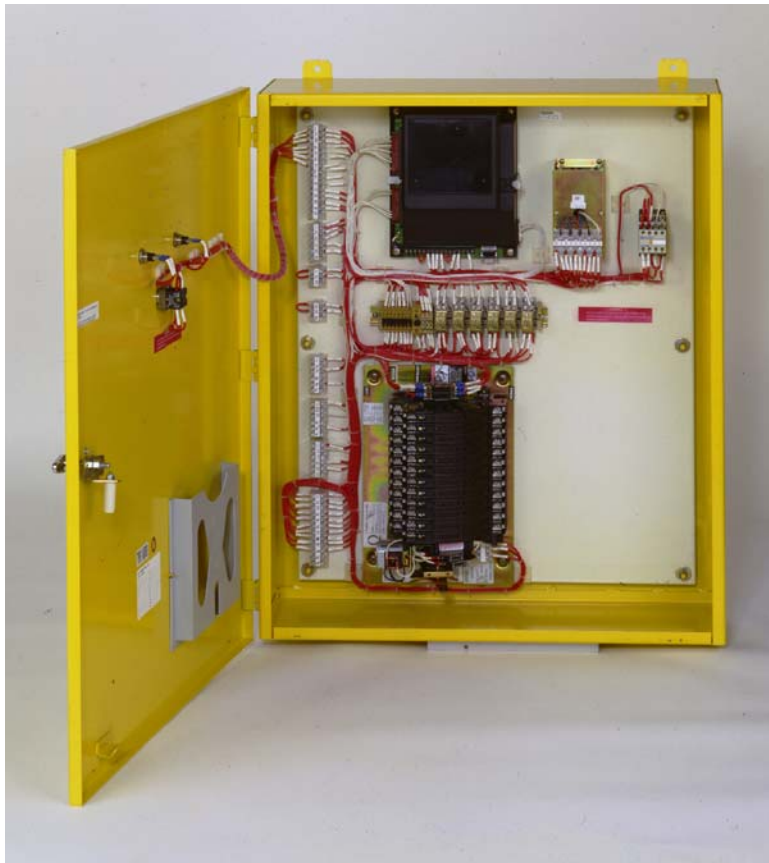


EMERGENCY TRANSFER EQUIPMENT IN THEATRES AND PLACES OF ASSEMBLY



Scope and Intent of Document

The intention of this monograph is to provide specifying professionals and facility owners with current regulatory and design requirements for Emergency Transfer Systems that are to be used in Places of Assembly. This document contains public information that can be used to make informed decisions when evaluating transfer equipment for use in this type of space. This information is considered to be the minimum required to make such a decision. This document is not intended to be a design manual or handbook for construction. The information concerning legal issues is not to be used as legal advice, but to raise the issue for discussion when evaluating these systems.

The scope of the document concerns Automatic Emergency Transfer Systems that are considered necessary for life-safety requirements in Places of Assembly. The sources referred to in this document are national in scope, but may be superseded by local jurisdictions and authorities. The standards and regulatory information presented here is the latest available material at the time of publication. The reader is encouraged to check with local and national sources (a partial list is provided) for the latest information when final evaluations are being made prior to purchase.

Union Connector is an original equipment manufacturer of power distribution equipment, not a testing laboratory or regulatory agency. However, with over 75 years of experience in this field, we feel an obligation to present our customers and industry professionals with non-biased information so they can make informed decisions concerning these types of products. The UC700 Automatic Emergency Transfer System was the first of its type to be designed specifically for the entertainment and controlled lighting industry. This equipment is intended for use in situations where power transfer is critical to life safety evacuation of an audience or public assembly. Care should be taken in the evaluation and purchase of such equipment. It could be a matter of life or death.

Emergency Transfer System Definition

The definition of the equipment described here is paraphrased from Article 700 of the National Electric Code.

Emergency transfer systems are those systems legally required by and classed as Emergency by municipal, state federal or other codes having jurisdiction. These systems are intended to automatically transfer supply power for Emergency illumination in the event of failure to the Normal supply, or in the event of accident to elements of a system intended to supply, distribute and control power and illumination essential for safety to human life. This discussion will be limited to the elements of the system that transfers power, and not with the lighting or other ancillary systems involved.

The transfer of power from Normal to Emergency may be required for a number of facility power applications, including lighting, HVAC, elevators, communication, etc. The part of the system that most often concerns theatrical applications is illumination of the audience, aisles, hallways, lobby and other areas necessary for evacuation. In addition to traditional theatre spaces, it is now commonplace to use theatrical lighting control technology in other places of assembly, such as lobbies, boardrooms, ballrooms and convention/arena spaces. The requirements for Emergency transfer equipment are the same for both applications.

One method for providing Emergency lighting in these spaces is to dedicate a number of houselights to this function. These houselights are controlled by dimmers, but there is also some mechanism available to transfer control and power source from the dimmers to an Emergency power supply. This mechanism is an Emergency Transfer System. Figure 1 shows a typical one-line diagram of this method.

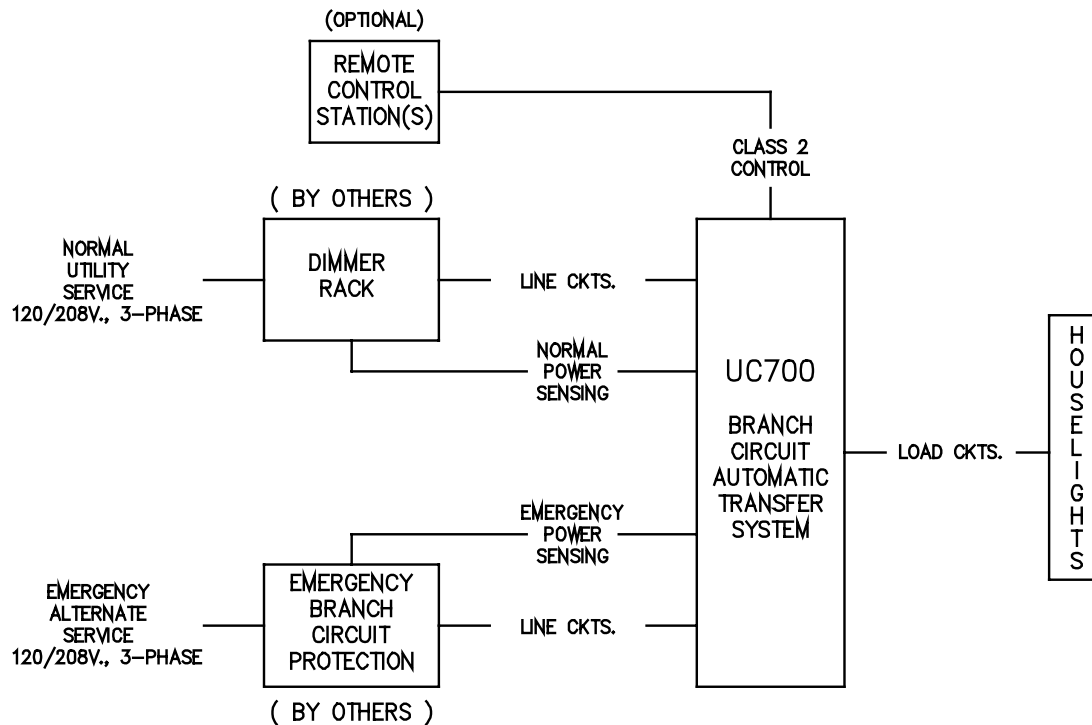


figure 1

A common practice is to place industrial grade relays inside a dimmer rack or cabinet, and use various types of line monitoring sensors to transfer to Emergency power should the Normal power source fail, or if the Emergency system is activated. As will be seen in the following excerpts from various standards and codes, this does not follow national, and in many cases local, standards for Emergency systems. It is also a dangerous practice, as it places a critical part of the Emergency system inside an enclosure that is not easily accessible for manual control of the Emergency system, should that be required. Industrial grade relays are not tested to the same standards as Emergency relays, and are not as reliable. Remember, lives are at stake here.

A problem that is inherent in using dimmer-controlled relays for Emergency use is the possibility of dimmer *system* failure without a Normal *power* failure. If this should occur, activation of relays built into the dimmer rack will prove useless, because the Emergency transfer system will not be activated unless the Normal power source is disrupted. The relays in the dimmer cabinet will transfer to the Emergency power source, but there will be no power available. To avoid these problems, a unit specifically designed for Emergency Systems must be used. These systems are designed to transfer power only when power is available.

Perhaps the most compelling reason for not using industrial control relays in this application is the likelihood of relay failure – sometimes catastrophically. Emergency rated systems have relays that are designed and tested for abuses of power fluctuation, arcing, mechanical wear and contact degradation. Industrial relays, even those used in other optional or standby UL1008 applications, are not mechanically or electrically adequate for the rigors of Emergency applications.

An alternative to using relays or switches is the use of a second lighting control system as the “Emergency” system. The theory is that when the primary power system fails, the secondary control system is powered by the Emergency Power System (EPS) and controls the lighting. There are two problems with this approach. First, the lighting control system is not Listed or evaluated as Emergency equipment. Second, the lighting control system is not guaranteed to bring the lights to full for egress lighting. Bringing the lights to full would require an operator to work the light board. Not exactly an automatic switch.

These Emergency Systems are much more than a mere power distribution system or system component. These are life-safety devices! Special emphasis must be placed on the proper design and installation of these systems. Failure to do so is indefensible.

Legal Considerations

Responsibility

Who is responsible for the design and specification of these systems? Good question! Because the use of dimmer controlled Emergency lighting is unique to Theatrical/Place of Assembly applications, the Theatre Consultant often is tasked with providing the solution. The fact that Emergency system design is involved, places responsibility on the Electrical Engineer of record as well. This responsibility places both parties in a position where they are directly liable for damages in the event of improper system design. The electrical inspector, being the authority having jurisdiction also shares responsibility for proper system implementation.

Small theatres and places of assembly very often do not hire outside consultants for design functions. The design may be done internally by staff members, or it may be provided by outside vendors as a service in anticipation of a sale. If that is the case, then the individuals involved, and their employers may be faced with accepting responsibility for the proper design and functioning of the system.

If the system specified does not meet standard criteria for design and operation in an Emergency system, those responsible would be open to a negligence lawsuit. If the system does not conform to standards and codes set forth by applicable statutory regulation, there is also the possibility of criminal charges, in addition to a civil lawsuit. In many cases, liability insurance policies contain a proviso that absolves the insurance company should the matter become a criminal case.

Liability

While the responsibility of the system design and specification is rather cut and dried, liability for the system can be spread to include a number of parties. With the current state of litigation in this country, it is quite reasonable to assume that the liability for an Emergency system could be placed upon the professionals involved (engineer, consultants, architect), the manufacturer of the equipment, the organization providing the equipment, the Authority Having Jurisdiction (inspector), the installing contractor, the operator of the equipment, the owner of the facility, etc.

Since the market for these devices is rather limited, and requires a certain amount of specialized knowledge not found in an average person, those who deal with the items are considered "experts". As an "expert", therefore, anyone involved with these systems is supposed to be aware of what is required to provide a safe system. This means that selling a system that is not up to applicable codes and standards makes one liable for negligence, even if a professional such as an architect, engineer or consultant specifies such a system.

The point of the preceding section is to provide a warning to those involved with specifying, selling, installing, approving or operating theatrical type lighting equipment that interfaces with Emergency lighting. You may find yourself at risk of litigation.

Standards

This is a list of organizations and their publications that define the standards for the design, installation and use of Emergency Transfer Systems.

Organization:

*National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269*

Publications:

*NFPA 70 - National Electric Code
NFPA 110 – Standard for Emergency and Standby Power Systems*

Organization:

*Underwriter's Laboratories
333 Pfingsten Rd.
Northbrook, IL 60062*

Publications:

UL 1008 - Standard for Automatic Transfer Switches

Organization:

American National Standards Institute

(NFPA 70, NFPA 110 and UL 1008 are all ANSI Standards)

1. How do the standards approach the requirements for Emergency Systems?

NFPA 70 - NATIONAL ELECTRIC CODE

ARTICLE 518 - PLACES OF ASSEMBLY

518-3 (C) - Emergency Systems. Control of emergency systems shall comply with Article 700, Emergency Systems.

ARTICLE 520 - THEATERS, AUDIENCE AREAS OF MOTION PICTURE AND TELEVISION STUDIOS AND SIMILAR LOCATIONS

520-8. Emergency Systems. Control of emergency systems shall comply with Article 700, Emergency Systems.

ARTICLE 700 - EMERGENCY SYSTEMS

700.1. Scope. The provisions of this article apply to the electrical safety of the design, installation, operation and maintenance of emergency systems consisting of circuits and equipment intended to supply, distribute, and control electricity for illumination or power, or both, to required facilities when the normal electrical supply or system is interrupted.

Emergency systems are those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any government agency having jurisdiction. These systems are intended to automatically supply illumination or power, or both, to designated areas and equipment in the event of failure of the normal supply, or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life.

(FPN No. 3) Emergency systems are normally installed in places of assembly where artificial illumination is required for safe exiting and for panic control in buildings subject to occupancy by large numbers of persons, such as hotels, theaters, sports arenas, health care facilities, and similar institutions....

NFPA 110 - EMERGENCY AND STANDBY POWER SYSTEMS

Origin and Development of NFPA 110

The Emergency Power Supplies Committee was organized in 1976 by the NFPA in recognition of the demand for viable guidelines for the assembly, installation, and performance of electrical power systems to supply critical and essential needs during outages of the normal power source. It was the intent of the committee to establish the necessary equipment requirements to achieve an on-site auxiliary electrical power source suitable to the needs of the applicable requirements and user criteria.

The requirements of the standard are considered necessary to obtain the minimum level of reliability and performance, particularly where life safety electrical power needs are involved.

The standard does not require the installation of emergency and standby power supply systems. Rather, it is a document that, if followed, will result in a system suitable for various situations as may be required in codes and standards.

NFPA 110 - EMERGENCY AND STANDBY POWER SYSTEMS (cont.)

1.1 Scope. This standard covers performance requirements for power systems providing an alternate source of electrical power to loads in buildings and facilities in the event that the normal power source fails.

1.1.1 Power systems covered in this standard include power sources, transfer equipment, controls, supervisory equipment and all related electrical and mechanical auxiliary and accessory equipment needed to supply electrical power to the load terminals of the transfer equipment.

1.2 Purpose

1.2.2 This standard is also intended to provide guidance for inspectors, designers, installers, manufacturers and users of EPSSs and to serve as a vehicle for communication between parties involved. It is not intended as a design manual.

1.2.3 Compliance with this standard is not intended to absolve the parties involved of their respective responsibilities of design, installation, maintenance and performance or compliance with other applicable standards and codes.

UL 1008 - STANDARD FOR AUTOMATIC TRANSFER SWITCHES

1.1 These requirements cover automatic transfer switches intended for use in ordinary locations to provide for lighting and power as follows:

A. In emergency systems in accordance with Articles 517 and 700 in the National Electric Code, ANSI/NFPA 70....

1.3 These requirements cover transfer switches together with their associated control devices including voltage sensing relays, frequency sensing relays, time delay relays, and the like.

1.4 A transfer switch as covered by these requirements is a device that automatically transfers a common load from a normal supply to an alternate supply in the event of failure of the normal supply, and automatically returns the load to the normal supply when the normal supply is restored.

Note: A word of caution is in order when evaluating Emergency Systems that are UL1008 Listed. The 1008 Listing is for Emergency, Standby and Optional Systems. Systems intended for use in Emergency systems are marked as such. Those systems intended for use in Standby or Optional transfer systems are marked as **NOT** being intended for Emergency systems.

The 1008 Listing on the UL label is not the only nomenclature that must be read. Look for the statement “Intended for use on Emergency Systems”. If that is not present, then the unit is not intended for Emergency transfer systems.

2. What are the guidelines for Emergency System design/installation?

NFPA 70 - NATIONAL ELECTRIC CODE

ARTICLE 700 - EMERGENCY SYSTEMS

700.17 Circuits for Emergency Lighting. Branch circuits that supply emergency lighting shall be installed to provide service from a source complying with Section 700-12 when the normal supply for lighting is interrupted. Such installations shall provide either one of the following:

- (1) an emergency lighting supply, independent of the general lighting supply, with provisions for automatically transferring the emergency lights upon the event of failure of the general lighting system supply, or
- (2) two or more separate and complete systems with independent power supply, each system providing sufficient current for emergency lighting purposes. Unless both systems are used for regular lighting purposes and are both kept lighted, means shall be provided for automatically energizing either system upon failure of the other. Either or both systems shall be permitted to be part of the general lighting system of the protected occupancy if circuits supplying lights for emergency illumination are installed in accordance with other sections of this article.

700.18 Circuits for Emergency Power. For branch circuits that supply equipment classed as emergency, there shall be an emergency supply source to which the load will be transferred automatically upon the failure of the normal supply.

700.20 Switch Requirements. The switch or switches installed in emergency lighting circuits shall be so arranged that only authorized persons will have control of emergency lighting.

Exception No. 2: Additional switches that act only to put emergency lights into operation but not disconnect them are permissible.

700.21 Switch Location. All manual switches for controlling emergency circuits shall be in locations convenient to authorized persons responsible for their actuation. In places of assembly, such as theaters, a switch for controlling emergency lighting systems shall be located in the lobby or at a place conveniently accessible thereto.

In no case shall a control switch for emergency lighting be in a theater, or motion-picture theater or place of assembly, be placed in a motion-picture projection booth or on a stage or platform.

Exception: Where multiple switches are provided, one such switch shall be permitted in such locations where so arranged that it can energize the circuit only, but it cannot de-energize the circuit.

2. What are the guidelines for Emergency System design/installation? (cont.)

NFPA 110 - EMERGENCY AND STANDBY POWER SYSTEMS

6.1.1 Switches shall transfer electric loads from one power source to another.

6.1.2 The electrical rating shall be sized for the total load that is designed to be connected.

6.1.3 Each switch shall be in a separate enclosure or compartment.

6.1.4 The capacity of the transfer switch, including all load current-carrying components, shall be rated to include all classes of loads to be served.

6.1.5 The switch, including all load current-carrying components, shall be designed to withstand the effects of available fault currents. (Note: see ANSI/UL 1008, Standard for Automatic Transfer Switches)

6.1.6 Where available, each switch shall be listed for emergency service as a completely factory-assembled and factory-tested apparatus.

3. What approvals are required by Emergency system standards?

NFPA 70 - NATIONAL ELECTRIC CODE

ARTICLE 700 - EMERGENCY SYSTEMS

700.3 Equipment Approval. All equipment shall be approved for use on emergency systems.

700.6 Transfer Equipment. Transfer equipment, including automatic transfer switches, shall be automatic and identified for emergency use and approved by the authority having jurisdiction. Transfer equipment shall be designed and installed to prevent the inadvertent interconnection of normal and emergency sources of supply in any operation of the transfer equipment.

NFPA 110 - EMERGENCY AND STANDBY POWER SYSTEMS

3.2.1 Approved. Acceptable to the "authority having jurisdiction".

3.2.2 Authority Having Jurisdiction. The organization, office or individual responsible for "approving" equipment, materials, an installation or a procedure.

3.2.4 Listed. Equipment or materials included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and by whose listing states either that the equipment, materials or service meets appropriate standards or has been tested and found suitable for use in a specified manner.

6.1.6 Transfer Switch Classification. When available, each transfer switch shall be listed for emergency service as a completely factory-assembled and tested apparatus. (See Section 700-3, NFPA 70, National Electric Code,...)

UL 1008 - STANDARD FOR AUTOMATIC TRANSFER SWITCHES

41.2 Transfer switches shall be plainly marked with the manufacturer's name or trademark, or other descriptive marking by which the organization responsible for the product may be identified, a distinctive catalog number or the equivalent, and the electrical rating. All markings shall be located to be visible after installation.

4. Why must the Transfer System be housed in a separate enclosure?

NFPA 70 - NATIONAL ELECTRIC CODE

ARTICLE 700 - EMERGENCY SYSTEMS

700.9 Wiring, Emergency System.

(A) Identification. All boxes, and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system.

(B) Wiring. Wiring of two or more emergency circuits supplied from the same source shall be permitted in the same raceway, cable, box, or cabinet. Wiring from an emergency source or emergency source distribution overcurrent protection to emergency loads shall be kept entirely independent of all other wiring and equipment, unless otherwise permitted in (1) through (4):

- (1) Wiring from the normal power source located in transfer equipment enclosures.
- (2) Wiring supplied from two sources in exit or emergency luminaries (lighting fixtures).
- (3) Wiring from two sources in a common junction box, attached to exit or emergency luminaries (lighting fixtures).
- (4) Wiring within a common junction box attached to unit equipment, containing only the branch circuit supplying the unit equipment and the emergency circuit supplied by the unit equipment.

(C) Wiring Design and Location. Emergency wiring circuit(s) shall be designed and located so as to minimize the hazards that might cause failure due to flooding, fire, icing, vandalism and other adverse conditions.

NFPA 110 - EMERGENCY AND STANDBY POWER SYSTEMS

6.1.3 Each switch shall be in a separate enclosure or compartment

5. What are the operational requirements of the transfer equipment?

NFPA 110 - EMERGENCY AND STANDBY POWER SYSTEMS

6.2.1 General. Automatic transfer switches shall be electrically capable of all of the following:

- (1) Electrical operation and mechanical holding
- (2) Transfer and retransfer of the load automatically
- (3) Visual annunciation when “not-in-automatic”

6.2.2 Source Monitoring.

6.2.2.1 Undervoltage-sensing devices shall be provided to monitor all ungrounded lines of the primary source of power as follows:

- (1). When the voltage on any phase falls below the minimum operating voltage of any load to be served, the transfer switch shall automatically initiate engine start and the process of transfer to the EPS.
- (2) When the voltage on all phases of the normal returns to within specified limits for a designated period of time, the process of transfer back to primary power shall be initiated.

6.2.2.2 Both voltage- and frequency-sensing equipment shall be provided to monitor one ungrounded line of the EPS power.

6.2.2.3 Transfer of the EPS shall be inhibited until the voltage and frequency are within a specified range to handle loads to be served.

6.2.3 Interlocking. Mechanical interlocking or an approved alternate method shall prevent the inadvertent interconnection of the normal power supply and the EPS or of any two separate sources of power.

6.2.4.1 Instruction and equipment shall be provided for safe manual nonelectric transfer in the event the transfer switch malfunctions.

6.2.4.2 An automatic transfer switch shall visually annunciate when “not in automatic”.

6.2.5 Time Delay on Starting of EPS. A time delay device shall be provided to delay starting of the EPS. The timer shall prevent nuisance starting of the EPS and possible subsequent load transfer in the event of harmless momentary power dips and interruptions of the normal source.

6.2.7 Time Delay on Transfer to EPS. An adjustable time delay device shall be provided to delay transfer and sequence load transfer to the EPS to avoid excessive voltage drop when the transfer switch is installed for Level 1 use.

6.2.7.1 Time Delay Commencement. The time delay shall commence when proper EPS voltage and frequency are achieved.

6.2.8 Time Delay on Retransfer to Primary Source. An adjustable time delay device with automatic bypass shall be provided to delay retransfer from EPS to the primary source of power. The timer is intended to permit the normal source to stabilize before retransfer of the load. The time delay shall be automatically bypassed if the EPS fails.

6.2.12 Test Switch. A test means shall be provided on each automatic transfer switch (ATS) that simulates failure of the primary power source and then transfers the load to the EPS.

6.2.13 Indication of Switch Position. Two pilot lights with identification nameplates or other approved position indicators shall be provided to indicate transfer switch position.

5. What are the operational requirements of the transfer equipment? (cont.)

NFPA 70 - NATIONAL ELECTRIC CODE

ARTICLE 700 - EMERGENCY SYSTEMS

700.6 Transfer Equipment

(C) Automatic Transfer Switches. Automatic transfer switches shall be electrically operated and mechanically held.

UL 1008 - STANDARD FOR AUTOMATIC TRANSFER SWITCHES

19.3 A transfer switch shall incorporate the necessary control equipment to initiate transfer from the normal supply to the alternate supply upon the interruption of any or all phases of the normal supply.

19.4 The transfer may be additionally controlled by equipment to provide a time delay in either or both directions of transfer. Equipment may also be provided to initiate transfer under low normal voltage conditions and by voltage-frequency measurement in the alternate supply.

19.5 The operating mechanism shall be such that the load cannot remain simultaneously disconnected from both the normal and alternative supplies when either or both supplies are available with voltage and frequency sufficient to permit proper operation...

19.7 Transfer Switches for use in Emergency systems shall be electrically operated.

19.8 Transfer Switches for use in Emergency systems shall have the normal and emergency contacts mechanically held closed.

30.1 A transfer switch shall perform acceptably when subjected to an endurance test controlling a test current as described ... and at a rate and number of cycles described in Table 30.2.

TABLE 30.2
ENDURANCE TEST CYCLES

Switch Rating	Rate of operation	Number of Cycles of Operation With Current ^c
0-300	1 per minute	6000

c ...For transfer switches rated for total system transfer, motor loads, or electric discharge lamp loads, the test shall be conducted for one half of the specified number of operations at 200 percent of rated current and for one half of the specified number of operations at 100 percent of rated current.

31.1 A transfer switch shall be capable of withstanding for 1 minute without breakdown the application of a 60-Hz sinusoidal potential of 1000 V plus twice the maximum rated voltage:

- A. Between un-insulated live parts and the enclosure with the contacts alternately closed to each supply source,
- B. Between terminals of opposite polarity with the contacts closed,
- C. Between un-insulated live parts of different circuits, and
- D. Between terminals of normal source and alternate source with switch in both normal and alternate positions.

6. What maintenance is required for Emergency transfer equipment?

NFPA 110 - EMERGENCY AND STANDBY POWER SYSTEMS

Routine Maintenance and Operational Testing

8.1.1 The routine maintenance and operational testing program shall be based on all of the following:

- (1) Manufacturer's recommendations
- (2) Instruction manuals
- (3) Minimum requirements of this chapter
- (4) The authority having jurisdiction.

8.2.1 At least two sets of an instruction manual(s) for all major components of the EPSS shall be supplied by the manufacturer(s) of the EPSS and shall contain the following:

- (1) A detailed explanation of the operation of the system.
- (2) Instructions for routine maintenance.
- (3) Detailed instructions for repair of the EPS and other major components of the EPSS.
- (4) An illustrated parts list and part numbers.
- (5) Illustrated and schematic electrical drawings of wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators.

8.3.4 A written record of the EPSS inspections, tests, exercising, operation and repairs of the EPSS shall be maintained on the premises.

8.3.4. The written record shall include the following:

- (1) The date of the maintenance report.
- (2) Identification of the servicing personnel.
- (3) Notation of any unsatisfactory condition and the corrective action taken, including parts replaced
 - (4) Testing of any repair for the time as recommended by the manufacturer.

Equipment Conforming to Standards

Acceptable Equipment

Emergency transfer equipment that is acceptable for use in theatres or other places of assembly must pass all of the following criteria:

1. be approved by local jurisdiction
2. be approved by the engineer of record
3. be Listed under UL 1008
4. be installed following proper procedures
5. be tested periodically

Equipment that meet these criteria include unit (battery) equipment, and bona fide UL 1008 Emergency Transfer Systems, such as UC700.

Non-Acceptable Equipment

Transfer equipment that is **NOT** acceptable for Emergency use in theatres or other places of assembly includes, but is not limited to:

1. industrial control relays
2. UL 1008 switches placed within dimmer cabinets
3. UL 1008 equipment intended for use with standby or optional equipment
3. dimmer `panic' switches or controls

Acknowledgments

- NFPA 70 **National Electric Code**, copyright 2005, National Fire Protection Assoc.
- NFPA 110 **Standard for Emergency and Standby Power Systems**, copyright 2002, National Fire Protection Assoc.
- UL 1008 **Standard for Automatic Transfer Switches**, copyright 1989, Underwriter's Laboratories, Inc