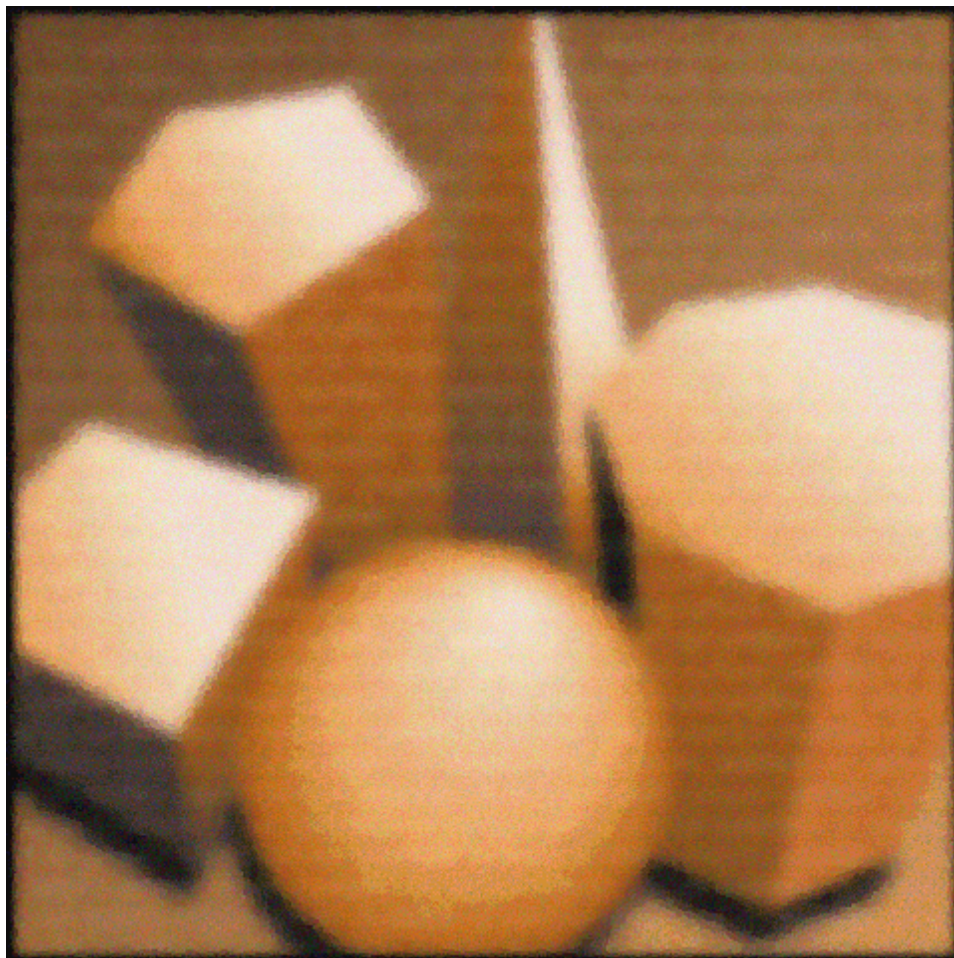


# 101 Basic Series

**Learning Module 29:**

## **Transfer Switch Equipment**



**EAT•N**

**Electrical**

# Transfer Switch Equipment

**What You Will Learn** We'll step through each of these topics in detail:

<b>Introduction</b>	<b>4</b>
<b>What Is A Transfer Switch?</b>	<b>6</b>
Non-Automatic (Manual) Transfer Switch	7
Automatic Transfer Switch (ATS)	7
<b>What Makes Up a Transfer Switch</b>	<b>8</b>
Switching Device	9
Transfer Mechanism	12
Transformer Panel	15
Logic Panel	16
Summary	18
<b>Review 1</b>	<b>20</b>
<b>Standards and Testing</b>	<b>21</b>
National Electrical Code (NEC)	21
National Fire Protection Association (NFPA)	22
Underwriter's Laboratories, Inc. (UL)	22
Other Standards and Codes	22
Summary	22
<b>Features and Accessories</b>	<b>27</b>
<b>Switch Configurations</b>	<b>39</b>
Open Transition	39
Closed Transition	40
Drawout	41
Service Entrance	41
Bypass Isolation	42
Maintenance Bypass	46
<b>Review 2</b>	<b>47</b>
<b>Selection Factors and Process</b>	<b>48</b>
Withstand, Closing and Interrupting Ratings	48
Integral Overcurrent Protection	48
Manual Transfer Under Load	49
Catalog Numbering System	50
<b>Review 3</b>	<b>51</b>
<b>Glossary</b>	<b>52</b>
<b>Review 1 Answers</b>	<b>55</b>
<b>Review 2 Answers</b>	<b>55</b>
<b>Review 3 Answers</b>	<b>55</b>

# Transfer Switch Equipment

## Welcome

Welcome to Module 29. This module covers *Transfer Switch* equipment. It was prepared for individuals who want a better understanding of what transfer switch equipment is and what it does. This module provides information on basic equipment concepts as well as state-of-the-art details. It may be used by new students as an introductory course or by individuals with an advanced understanding as a refresher or reference document.

Like the other modules in this series, this one presents small, manageable sections of new material followed by a series of questions about that material. Study the material carefully, and then answer the questions without referring back to what you've just read.

You are the best judge of how well you grasp the material. Review the material as often as you think necessary. The most important thing is establishing a solid foundation to build on as you move from topic to topic and module to module.

## A Note on Font Styles

**Key points are in bold.**

*Glossary terms are underlined and italicized the first time they appear.*

## Viewing the Glossary

Printed versions have the glossary at the end of the module. You may also browse the Glossary by clicking on the Glossary bookmark in the left-hand margin.

# Transfer Switch Equipment

## Introduction

All of us have experienced the loss of electricity from time to time. In most instances, we just grin and bear it. There are, however, numerous manufacturing, commercial and institutional facilities that cannot tolerate the loss of electricity. In a hospital, for example, power failures can be fatal to patients who depend on electricity to operate life-sustaining equipment in places like the operating room (Figure 1). Although the loss of power to a manufacturing facility might not be a life-threatening, the cost of lost production time can be tremendous. As a matter of fact, one sustained power outage can cost far more than the installation of an entire backup system. Think about other places where the loss of power could create big problems. How about an airport's control tower? In general, a backup source should be a part of any facility that depends on electricity to:

- Preserve life
- Prevent accidents
- Prevent theft or panic
- Prevent the loss of goodwill

Figure 1. Typical Hospital Operating Room



You will notice that we said backup power source. The National Electric Code (NEC) defines the terms “Emergency Systems,” “Legally Required Standby Systems,” and “Optional Standby Systems” Other words such as alternate, standby, backup and critical are often used in the industry to describe dual source power systems. In this module, the words “backup power” will be used most of the time as a general term to cover all cases. “Normal Power” will most often be used in this module as the general term covering the primary power or power source typically used every day. “Emergency Power” will most often be used in this module as the general term for the secondary power source.

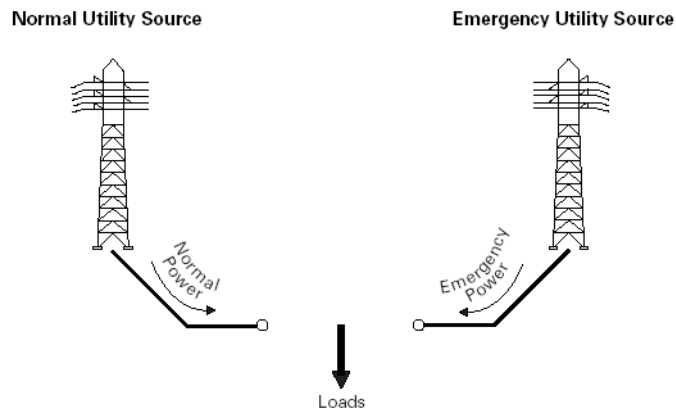
If there is a normal power source failure, emergency power can be supplied in two ways:

- An additional service from the utility supplying the normal power
- On-site Generation of emergency power

An additional emergency service from the utility would have to come from a source separate from the utility's normal supply (Figure 2). This requires additional equipment and lines from the utility. In addition, the normal and emergency lines would probably come from different supply locations to reduce the possibility of losing both power supplies at the same time due to the same condition, like a thunder and lightning storm.

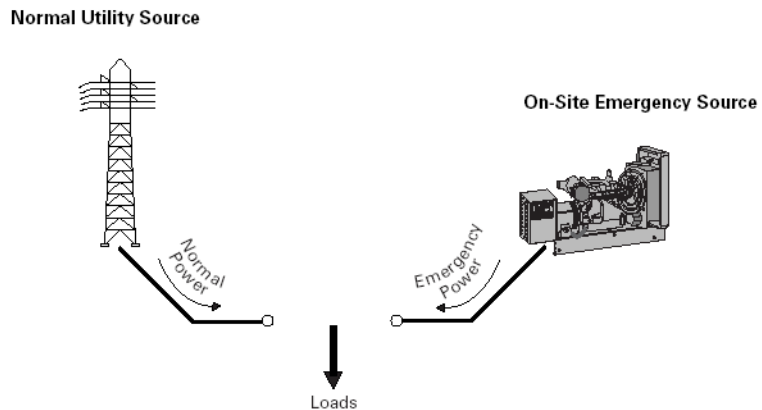
# Transfer Switch Equipment

Figure 2. Normal And Emergency Power Provided By Utility



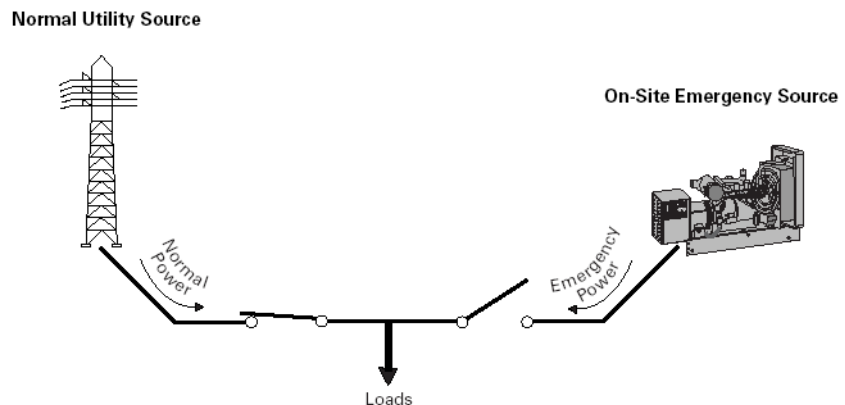
Generation of emergency power using gasoline or diesel engine-generator sets on-site is the most common method utilized for standby power systems (Figure 3).

Figure 3. Normal Power Provided By Utility And Emergency Power Generated On-Site



Whether the utility provides both power sources or emergency power is generated on-site, a means must be provided to transfer the load circuits to the available source (Figure 4). Transfer switch equipment provides a means to quickly and safely transfer the critical load circuits, and is the primary topic of discussion of this module.

Figure 4. Typical Emergency System With Transfer Switch Equipment



Standby power systems are defined by one of the three following application categories:

# Transfer Switch Equipment

1. Emergency System
2. Legally Required Standby System
3. Optional Standby System

**1. Emergency System** - An emergency system is a system legally required and classified as emergency by municipal, state, federal or other governmental agencies having jurisdiction. This type of system is intended to **automatically supply** power to designated areas and equipment if the primary supply source is interrupted. The emergency system designation usually applies when the loss of illumination or power would be a hazard to safety or human life. **Transfer from the normal source to the emergency source cannot exceed 10 seconds.**

Some typical instances where emergency systems are required include: facilities occupied by large numbers of people (hotels, sports arenas, health care).

**2. Legally Required Standby System** - Legally required systems are those that are so classified by municipal, state, federal or other governmental agencies having jurisdiction. These systems are intended to **automatically supply** power to selected loads, other than those already classified as emergency. **Transfer from the normal source to the emergency source cannot exceed 60 seconds.**

These types of systems are typically installed to serve loads such as heating, refrigeration, communications, smoke removal, sewage disposal and industrial processes.

**3. Optional Standby System** - This type of system is intended to protect public or private property or facilities, where life and safety do not depend on the system's performance. Generally, on-site generated power is **supplied to selected loads either automatically or manually. There is no time limit associated with the transfer.**

This type of system is typically installed as an alternate source of electric power for facilities such as commercial buildings, farms and even residences. Typical loads served include heating, data processing, and industrial processes that when stopped could interrupt or damage the product or process.

A type of optional system that is increasingly popular is a load sharing system. On-site power generation assets are being installed as a backup to the normal source, or as a way to reduce utility bills. It is even possible for these on-site assets to have surplus generating capacity. This allows for power to be supplied back to the utility grid (cogenerate). For cogeneration to take place, the on-site asset must run in parallel with the utility source.

Especially in certain areas, there is a strong interest in customers providing prime power with on-site generation. This is especially true when demand utility rates are extremely high or reliable utility power for peak demand windows is not readily available.

## What Is A Transfer Switch?

A **transfer switch** is a critical component of any standby power system. When the normal (preferred) source of power is lost, the transfer switch transfers from the normal source of power to the emergency (alternate) source of power. This permits critical loads to continue running or begin running again, once the transfer is made. After the normal source of power is once again available, the transfer switch transfers back to the normal source from the emergency source.

Operation of the transfer switch from normal to emergency and back to normal can be a manual type operation or an automatic type operation. It depends on the type or configuration of the transfer switch equipment. If loads are very critical, an

## Transfer Switch Equipment

Automatic Transfer Switch (ATS) would probably be used to insure the fastest possible transfer. An airport's control tower is an example of a very critical need. An automatic transfer switch might also be used if there are no operators conveniently in residence who could make a manual transfer. If loads are not quite as critical, but still cannot go for any extended period of time without power, a Manual Transfer Switch could be used.

The operation of a transfer switch is more involved than just described. There are a number of questions that could be asked that are not addressed by this simple explanation. For example: Even if transfer switch is an automatic type, isn't there a brief loss of power as the transfer is being made? The answer is yes, unless a special design configuration is used. Different types of design configurations will be discussed later in this module.

### Non-Automatic (Manual) Transfer Switch

As just mentioned, transferring can be done with a Manually Operated device, also referred to as a Non-automatic Transfer Switch. In such applications, operating personnel are readily available and the load is not of a critical nature requiring immediate restoration of power. A refrigeration plant is an example of a less critical need. Obviously, the refrigeration plant could not live with any extended power outage, but might be able to tolerate a brief down time while a manual transfer is made. Other typical applications would be many industrial plants and normal telephone facilities.

From a very simplistic standpoint, double-throw knife switches and safety switches have been used as manual transfer switches. Because these devices are marginal adaptations, lack a high degree of reliability, and the restricted operation requirements can be abused, personnel are reluctant to operate them. For these reasons, only switches specifically designed for manual transfer applications will be considered in this module.

There are two types of non-automatic transfer switches:

- Manually operated
- Manually initiated, Electrically Operated

Manually Operated Non-automatic Transfer switches provide all the mechanics to effect the transfer from source to source. The actual transfer of power, however, is accomplished by true hand operation of the transfer switch mechanism.

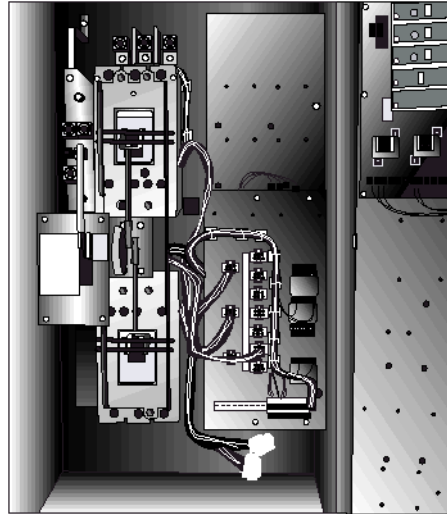
Manually initiated, Electrically Operated Non-automatic Transfer Switches are similar to the manually operated version just described except that an electrical operation feature is added to the switch. The switch electrically transfers power when a pushbutton, usually mounted on the switch's enclosure, is pushed. If necessary, the switch can also be manually operated.

### Automatic Transfer Switch (ATS)

The most convenient and reliable method to transfer power is with an automatic transfer switch (Figure 5). In general, the automatic transfer switch includes controls (logic) to detect when a power failure occurs, and triggers other controls (logic) to start the engine when the emergency power source is an engine generator. When the generator reaches the proper voltage and frequency, the switch transfers load circuits from the normal source to the emergency source.

# Transfer Switch Equipment

Figure 5. Closeup Of Automatic Transfer Switch Mounted In Enclosure Using Molded Case Switches



When the normal source is once again ready to supply power, the switch retransfers the load circuits to the normal source. It also triggers controls (logic) to shut down the engine generator. The standard complete operation handled by the automatic transfer switch each time there is a power failure and power restoration is:

- Engine starting
- Transfer to generator
- Retransfer to normal
- Engine shutdown

## What Makes Up a Transfer Switch

In the previous section, several basic types of transfer switches were discussed as an initial introduction. In general, there are four types of transfer switches:

- Automatic Transfer Switch (ATS)
- Non-Automatic Transfer Switch (Manual)
- Bypass Isolation
- Basic Transfer Switch

There are also specialty designs dedicated to performing unique functions for specialized applications. These special designs will be discussed later in this module. For now, we will concentrate on the four general types just outlined.

Transfer switches are comprised of certain basic components, each intended to perform a well defined function. All transfer switch designs, however, do not necessarily perform these basic functions in the same manner. In this section, you will be introduced to the common basic components, with special attention given to the different design approaches used by different manufacturers to provide the same component functionality.

An **automatic transfer switch** consist of three basic components:

1. Power switching device to shift the load circuits to and from the source of power.



## Transfer Switch Equipment

2. Transfer logic controller to constantly monitor the condition of the power sources and provide the control signals to the power switching device.
3. Control power source to supply operational power.

A **non-automatic transfer switch (manually operated)** consists of item 1 and a manual operating handle.

A **non-automatic transfer switch (electrically operated)** has components similar to the automatic transfer switch except that power source monitoring and automatic transfer control are not included.

A **basic transfer switch** is designed for use with customer furnished controls. It is similar in design to the automatic transfer switch except intelligence and supervisory circuits are omitted. This type of switch is not necessarily available from all manufacturers. It is intended for use by customers with the expertise to complete the design, and with a desire for additional value added.

The discussion of the different types of components used in the industry to make up an automatic transfer switch will be broken down into an individual discussion of four different topics followed by a brief summary. The three basic components are:

1. Switching device
2. Transfer logic controller
3. Transformer Panel

### Switching Device

The switching device transfers the loads from one power source to another. Many engineers believe there are two basic types of transfer switch designs centering around the type of switching device used. The common phrases used to describe the types of switches are "the circuit breaker type" and "the contactor type." There are indeed a number of design concepts, but the terminology just used is misleading. Contactor Type Transfer Switches do not use motor starting/lighting contactors, and circuit breaker type transfer switches do not use circuit breakers. Actually, there are four basic types of switching devices used:

1. Molded case switch
2. Insulated case switch
3. Contactor
4. SCR (silicon controlled rectifier)

Although our concentration in this manual will be on the first three types of switching devices, all four will be covered to some degree.

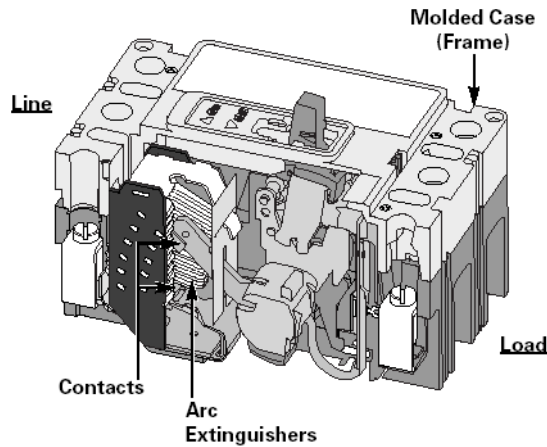
**1. Molded Case Switch** - A molded case switch is a molded case circuit breaker without a thermal trip element. Molded case switches are often used when a circuit requires a compact, high capacity disconnect device.

Transfer switches known as the circuit breaker type use specially designed switching devices that are typically molded case switches. Circuit breakers are, however, an option. The contacts and arc chutes are completely enclosed in an insulated housing, as they were originally designed to be (Figure 6). The switching devices are required to meet a number of UL requirements for molded case circuit breakers, molded case switches and automatic transfer switches. The exact standards will be discussed later in detail. Considering the wide range of standards the circuit breaker type transfer switch must meet, it is fair to say that the circuit

## Transfer Switch Equipment

breaker type transfer switch is held to a more rigorous testing standard than the contactor type.

Figure 6. Cut-away View Of Typical Eaton's Cutler-Hammer Molded Case Switch



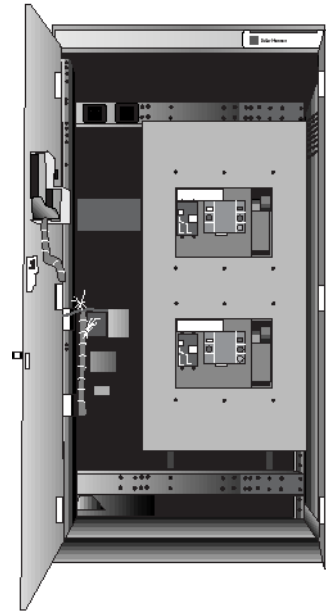
Typically, molded case switching devices are oversized for the ampacity of the transfer switch. For example, an 800 ampere molded case switch type transfer switch uses 1200 ampere switching devices. Thus the contacts are likely to be larger in the molded case switch design than the contacts used in a contactor type of equal rating.

The molded case switch type switching device is normally used with smaller ampacity transfer switches. It provides for self protection with a fixed instantaneous trip setting feature. It will interrupt a fault current at or above its preset level. In most cases, a Cutler-Hammer automatic transfer switch of this type would utilize the Series C molded case switch design.

**2. Insulated Case Switch** - Transfer switches also use insulated case type switching devices (Figure 7). They fall into the circuit breaker type transfer switch category. Testing is rigorous and covers a broad scope just like the molded case type switch. Unlike the molded case type device, the insulated case type switching device can be provided without any type of Trip Unit. This is true because the insulated case type device has very high withstand and endurance ratings, often greater than those of comparable contactor type switches. In addition, the insulated case type switch is available in a true Drawout configuration which lends itself to certain specialty transfer switch configurations.

# Transfer Switch Equipment

Figure 7. Eaton's Cutler-Hammer Fixed SPB Type Transfer Switch In Its Enclosure



**3. Contactor Switch** - Transfer switches known as the contactor type do not use motor starting/lighting type contactors. In fact, contactor type transfer switches use circuit breaker design contacts, arc chutes and arcing horns. Moreover, most contactor type transfer switch manufacturers get these parts from circuit breaker manufacturers. Thus contactor type transfer switches actually owe their design more to circuit breaker technology than contactor technology.

**4. SCR Switch** - Where the emergency (standby) system is required to supply solid-state equipment, electromechanical transfer switches cannot accomplish the high-speed switching. In addition, arcing during transfer is a source of intense radiated and conducted noise.

Solid-state silicon controlled rectifiers (SCRs) are used for these AC switching applications. Normally, SCR junctions are switched on when control input is applied and turned off at the first current zero after control input is removed. The switch-on time is a few microseconds. By design, transfer between voltage sources always takes place between voltage sources that are in phase.

High switching speed combined with no contact bounce seems to offer an ideal way to accomplish high-speed transfer switching. This type of switching is typically used when both sources are utilities or one source is an uninterruptable power supply (UPS).

**5. Summary** - The SCR type switch is designed and almost exclusively used for a very specific application. It will not be included in this summary.

Because contactor and circuit breaker type transfer switches both use circuit breaker parts, what is the difference in performance? Under most downstream fault conditions, both designs perform the same. This means that the upstream circuit breaker will trip and the automatic transfer switch intelligence (logic) will initiate the transfer sequence to the alternate source.

Contactor type transfer switches and circuit breaker type transfer switches using insulated case type switches without trip units perform identically under all circumstances. It should be noted, however, that these circuit breaker type transfer switch designs normally have much higher withstand and endurance ratings than

## Transfer Switch Equipment

contactor type transfer switches. This could be very valuable if the upstream circuit breaker is a power circuit breaker without an instantaneous trip. If the power circuit breaker's short time delay setting is set high, fault current might flow in excess of the limited time and current withstand ratings of the contactor type switch. The insulated case type transfer switch could possibly be selected to withstand the short time delay.

Contactor type transfer switches and circuit breaker type transfer switches using molded case switches with a fixed instantaneous trip setting perform identically when applied in systems with molded case circuit breakers.

### Transfer Mechanism

The switching device was just discussed. Now it is time to discuss the mechanism, of which there are a number of different designs, used to effect the transfer of the main contacts from source to source. In other words, there has to be a mechanism that will operate the switching devices.

From a very simplistic standpoint, a double-throw knife switch could be considered the switching device. If an individual took hold of the switch's handle and operated it, the hand and arm could be considered the transfer mechanism.

The mechanism used with a transfer switch can be put in motion in two ways:

- Manually
- Electrically

**Manually operated** mechanisms require operating personnel to perform a function by hand, such as directly operating a manual handle. Operation of the handle results in the switching devices effecting the transfer from source to source.

**Electrically operated** mechanisms are powered by motors or solenoids. The electrical operator may be initiated manually (pushbutton) or automatically.

Automatically Operated mechanisms do not require the intervention of operating personnel. Through the use of an intelligence package and pre-programmed operating conditions, the mechanism is automatically set in motion when the programmed operating conditions are met.

There are four primary types of transfer mechanisms used with transfer switches:

- Unidirectional gear motor
- Twin Stored Energy
- Single solenoid
- Linear motor

**1. Unidirectional Gear Motor** - This type of mechanism transfers between power sources through the use of a unidirectional motor driven mechanical device. Rigid shafts or arms are linked to the motor through a ratchet type device or gears. The rotary motion created by the motor is in turn converted to linear motion. The linear motion moves the rigid shafts or arms to operate the switching devices, such as the operating handles on molded case switches. The unidirectional motor is energized from the source to which the load is to be transferred. It operates at a standard 120 Vac, independent of the line voltage.

This type of transfer mechanism can also be operated manually, often through the use of an integrally mounted operating handle. The operating handle, whether it is ratcheted or rotated, produces the linear motion required to operate the switching devices.

# Transfer Switch Equipment

Eaton Electrical uses this type of mechanism on its 1000 ampere and below transfer switches:

**1. 150 ampere to 1000 ampere switches** - The Eaton Electrical mechanism is a vertically mounted design using a ratchet type approach to produce the necessary linear operating motion required to operate the switching devices (Figure 8).

**2. Switches below 150 amperes** - The Eaton Electrical mechanism is a horizontally mounted design using gears and rotational motion to produce the required linear motion (Figure 9).

Figure 8. Eaton Electrical Vertical Design With Protective Cover Removed For Clarity  
(150-1000 Amperes)

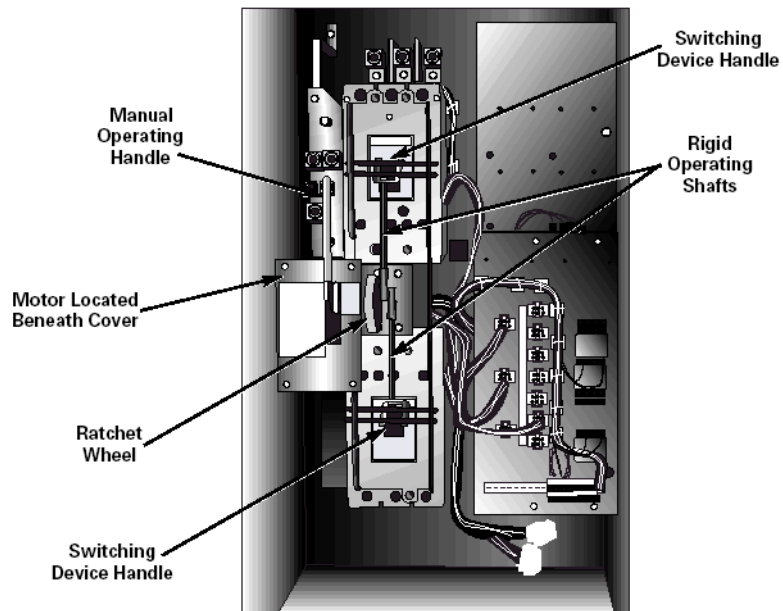
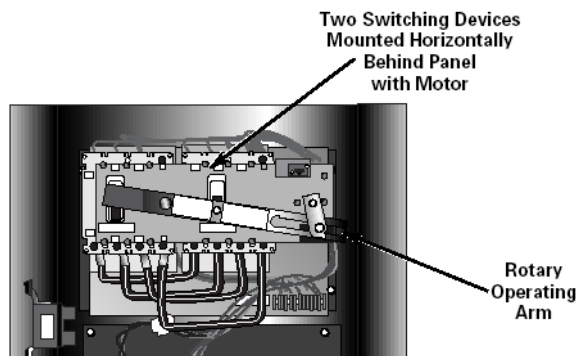


Figure 9. Eaton Electrical Horizontal Design With Protective Cover Removed For Clarity  
(Below 150 Amperes)

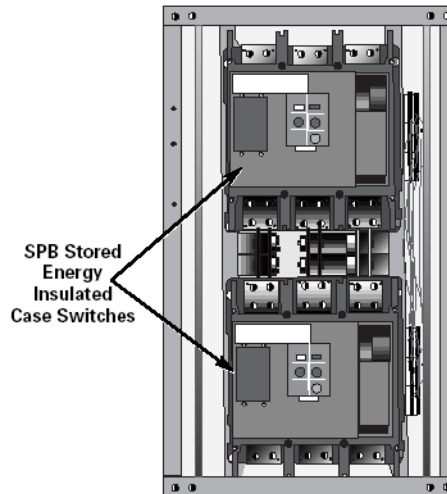


**2. Twin Stored Energy** - This type of mechanism uses insulated case switches with true two-step stored energy mechanisms as the switching devices (Figure 10). The stored energy mechanism provides the required mechanical motion to open and close the two sets of main contacts. A rigid mechanical interlock between the main contacts of the two switching devices prevents both sets of main contacts from being closed simultaneously. Except for the mechanical inter-

## Transfer Switch Equipment

lock, the switching device and the transfer mechanism are automatically provided in the form of the one device, the insulated case switch.

**Figure 10. Closeup Of Eaton's Cutler-Hammer SPB Insulated Case Design Utilizing A Twin Stored Energy Mechanism With Protective Cover Removed For Clarity (Above 1000 Amperes)**



When insulated case switches are used as the switching devices, each device can be manually opened and closed through the use of manual buttons located on the front of the device. If required, the switching devices can also be configured to be electrically closed and opened. The closing springs can be manually charged using a front mounted manual charging handle.

If it is not desirable to perform the functions just described manually or the transfer switch is to be fully automatic, electrically operated switching devices are available. This means that the closing springs are automatically charged, as required, through the use of a small integrally mounted electric motor. The motor is energized from the source to which the load is transferred. In addition, the closing and opening functions can be electrically and automatically performed.

Eaton Electrical uses this type of mechanism on its transfer switches above 1000 amperes.

**3. Single Solenoid** - A single solenoid type mechanism uses an electrical solenoid with an integrally mounted operating shaft. When the solenoid is energized, the shaft protrudes causing the main contacts to operate. With shaft extended, the contacts are in one position and in another position with the solenoid de-energized. The solenoid is directly connected to the line voltage which makes it somewhat susceptible to voltage spikes, which could short out its windings.

It is possible to make a manual transfer with this type of mechanism. It can only be accomplished, however, after all power is disconnected. The manual transfer is made using a short metal rod, which is usually not permanently attached to the switch.

**4. Linear Motor** - The linear motor mechanism is basically a coil with an operating shaft running through the coil. The operating shaft which causes the main contacts to operate is not an integral part of the coil. Because the linear motor electric operator is connected directly to the full line voltage, the circuit requires the use of capacitors. This creates difficulties when voltage rating changes are required.

## Transfer Switch Equipment

This type of switch cannot be operated manually and cannot be manually switched under full load. In fact, the motor drive circuit must be disconnected prior to manual operation. The motor drive circuit must also be reconnected before the switch will function. The manual operating handle is a separate loose tool.

### Transformer Panel

Voltage must be available to a transfer switch to power anything that requires power, such as motors, coils and logic. This power is usually provided by a small internally mounted transformer to match the application voltage. This is not a problem unless there is a required application voltage change in the field.

A common approach used to provide control power is to install a Step-Down Transformer which provides the currently required voltage level. Eaton Electrical uses a multi-tap enclosed transformer mounted in the enclosure (Figure 11). The transformer is provided with a voltage selection panel permitting a simple field change from one voltage to another. Seven front accessible voltage taps from 208 to 600 Vac satisfy any required application voltage. A change from one voltage to another is quick through the use of a small disconnect plug (Figure 12).

Figure 11. Voltage Selection Panel Shown Mounted In Eaton's Cutler-Hammer Vertical Design Transfer Switch (Protective Cover Removed For Clarity)

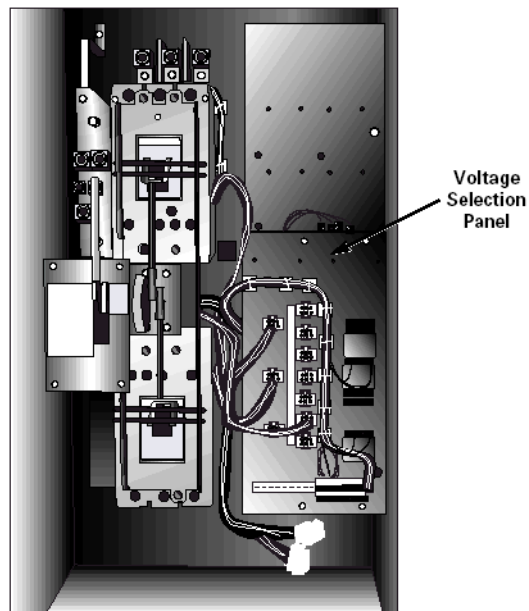
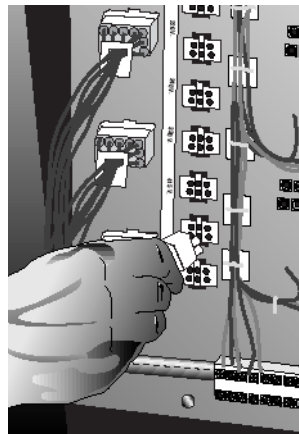


Figure 12. Vertical Design Voltage Selection Panel With Voltage Being Selected



# Transfer Switch Equipment

## Logic Panel

In this module, the automatic transfer switch (ATS) was discussed. The ATS contains something unique to the ATS. **Logic!** The logic controller tells the power switching device when and where to transfer.

The logic panel included as part of a transfer switch provides intelligence/supervisory circuits to constantly monitor the condition of the power sources and thus provide the intelligence necessary for the switch and related circuit operation.

**Microprocessor-Based Logic** - Microprocessor-based logic provides a far more comprehensive list of capabilities to the ATS world than previously available with relay logic or solid state logic. Normally, microprocessor-based logic comes in the form of a self-contained unit that can be mounted on the enclosure door (Figure 13). The biggest differences between microprocessor logic from one manufacturer to another are the features available and ease of use. Eaton Electrical offers industry leading microprocessor-based ATC-600 transfer controller (Figure 14). Because this is a state-of-the-art device and performs almost every conceivable function, it will be discussed here in some detail.

Figure 13. ATC-600 Microprocessor-based Logic Device Mounted On Enclosure Door

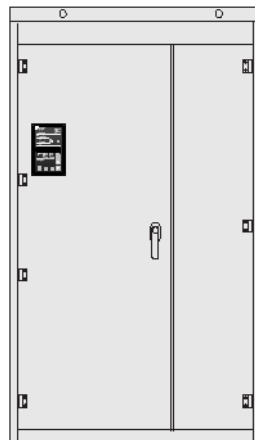
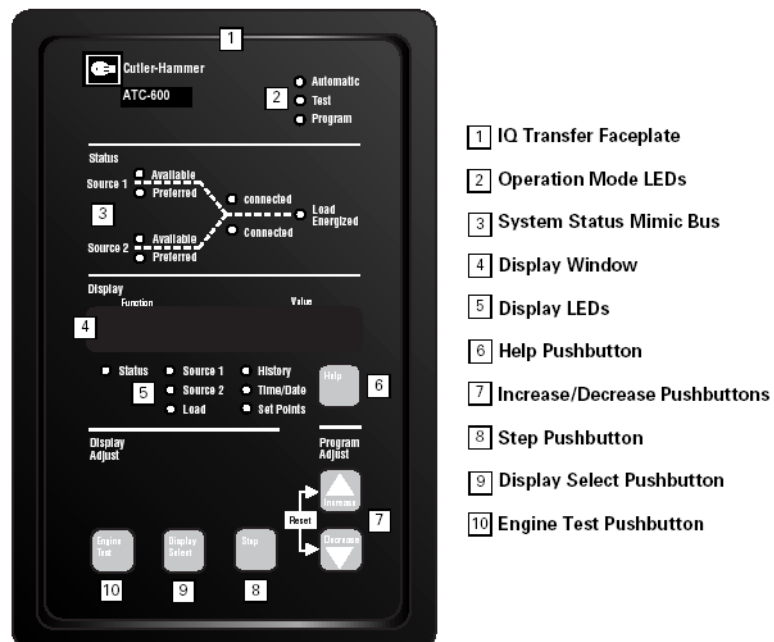


Figure 14. Closeup Of ATC-600 Operator Panel With Callouts





# Transfer Switch Equipment

## ATC-600

The primary functions of the ATC-600 are to accurately monitor power sources and provide the necessary intelligence to operate a transfer switch in an appropriate and timely manner. However, it goes far beyond these primary functions.

The ATC-600 is a programmable, microprocessor based monitoring device designed specifically to use with transfer switches. It has a user-friendly front panel interface for simple routine operations, programming, data presentation and settings adjustments. It is suitable for either new or existing Eaton's Cutler-Hammer ATS applications.

Data access and programming operations are performed using touch sensitive buttons in conjunctions with an illuminated, alphanumeric LED display window. Both the function buttons and display window are on the device's front panel. A built-in Help button even provides user assistance in the form of message displays.

The ATC-600 provides reliable two-way communications and is compatible with other Eaton Electrical communicating devices. It permits the monitoring and control of several transfer switches locally or remotely from a single point. In conclusion, a summary of standard and optional features here provides a broad view of the ATC-600's tremendous capabilities.

### IQ Transfer Standard And Optional Features Summary

Standard Features	Optional Features
Voltmeter for Source 1	Overvoltage Sensing on Source 1 Pickup Voltage - 95% of nominal to (Dropout - 2%)
Voltmeter for Source 2	Overvoltage Sensing on Source 2 Pickup Voltage - 95% of nominal to (Dropout - 2%)
Voltmeter for Load	Underfrequency Sensing of Source 1
Frequency Meter for Source 1	Overfrequency Sensing of Source 1
Frequency Meter for Source 2	Underfrequency Sensing of Source 2
Undervoltage Sensing on Source 1	Overfrequency Sensing of Source 2 (Also includes Overvoltage Sensing on Source 2)
Undervoltage Sensing on Source 2	Time Delay Bypass Pushbutton
Underfrequency Sensing on Source 2	Manual Return to Source 1
Time Delay Normal to Emergency	Delayed Transition
Time Delay Emergency to Normal	Delayed Transition - Time Delay
Time Delay Engine Start	Delayed Transition - Low Voltage Decay
Time Delay Engine Cooldown	<u>Preferred Source</u> Selection
System Selection	Plant Exerciser W/Real Time Clock
Position Indicators	Interruptible Rate (Area Protection)
Source Availability Indicators	Inhibit to Emergency
Preferred Source Indicator	Load Sequencing
Load Energized Indication	Pre-transfer Signal

## Transfer Switch Equipment

Standard Features	Optional Features
History <ul style="list-style-type: none"> <li>• Source Availability Time</li> <li>• Source Run Time</li> <li>• Source Connected Time</li> <li>• Load Energized Time</li> <li>• Number of Transfers</li> <li>• Date, Time, and Reason for last 16 Transfers</li> </ul>	Phase Rotation (Contact Factory for availability)
Viewable Setpoints	
IMPACC Capacity	
Real Time Clock	
Programmable Engine Test	
Remote Alarm Contact	
Auxiliary Relay Contacts	

### Summary

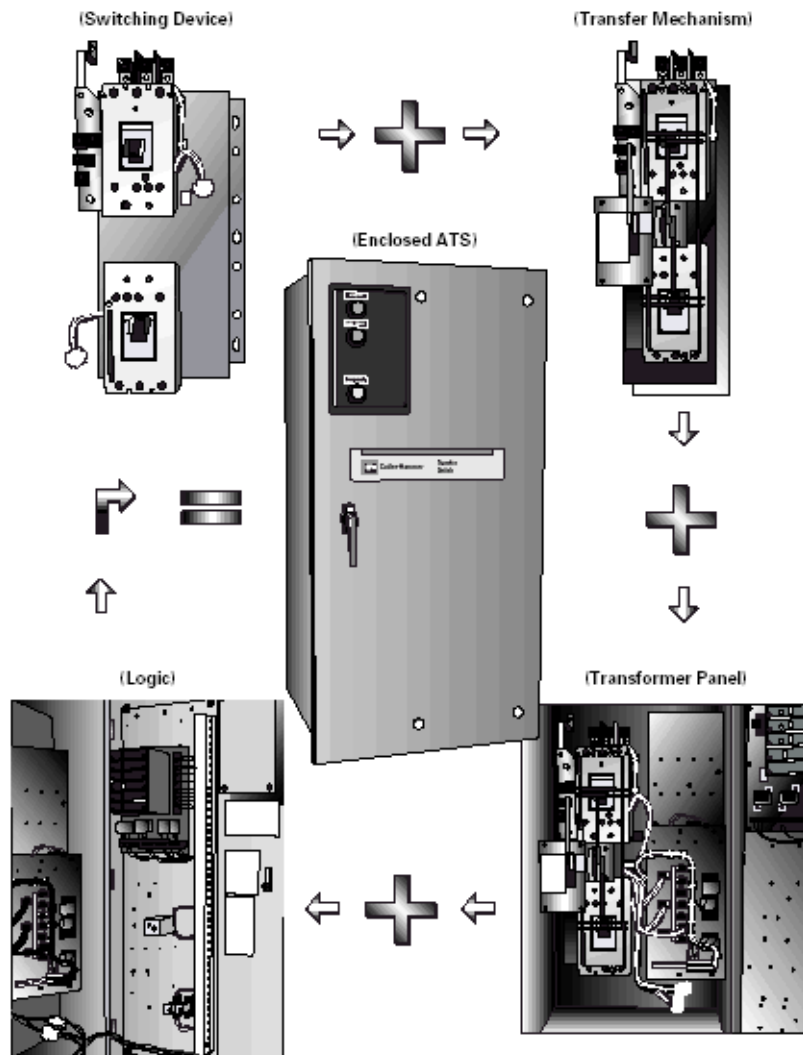
As a summary of the major components discussed in this section, let's take a final look at those components. The Eaton Electrical vertical design switch covering 150 through 1000 amperes will be used for the illustrations. You already know that all components do not look the same and do not perform exactly the same way, but all automatic transfer switches need these components in some form to perform the function (Figure 15).

An automatic transfer switch has four major components:

- Switching device
- Transfer mechanism
- Transformer panel
- Logic panel

# Transfer Switch Equipment

Figure 15. Eaton's Cutler-Hammer Vertical Design ATS (150-1000 Amperes) Makeup Summary



## Transfer Switch Equipment

### Review 1

Answer the following questions without referring to the material just presented. Begin the next section when you are confident that you understand what you've already read.

1. In general, an emergency or standby power source should be a part of any facility that depends on electricity to:
  - a) Preserve life
  - b) Prevent accidents
  - c) Minimize lost production time
  - d) Prevent the loss of goodwill
  - e) All of the above
2. If there is a normal power source failure, emergency power can be supplied in two ways. What are they?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. In an optional system, on-site generated power is supplied to select loads either \_\_\_\_\_ or \_\_\_\_\_.
4. When the normal (preferred) source of power is lost, the \_\_\_\_\_ transfers from the normal source of power to the emergency (alternative) power source.
5. The two types of non-automatic transfer switches are \_\_\_\_\_ operated and \_\_\_\_\_ operated.
6. An automatic transfer switch will retransfer (return) the load circuits to the normal source when it is once again ready to supply power.  
TRUE FALSE
7. What are the three components of an automatic transfer switch (ATS)?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
8. Circuit breaker type transfer switch designs normally have much higher with-stand and endurance ratings than contactor type transfer switches.  
TRUE FALSE
9. Eaton Electrical uses a multi-tap enclosed transformer with front accessible voltage taps from 208 to 600 VAC. A change from one voltage to another is quick through the use of \_\_\_\_\_.

# Transfer Switch Equipment

## Standards and Testing

The standards and associated testing applicable to transfer switch equipment go right to the heart of the matter. This is true from a number of very important standpoints:

1. This is the industry's determination as to whether or not a particular transfer switch design is capable of meeting a wide range of published operational and physical requirements.
2. The proven and stated compliance to specific standards tells potential users that the equipment under consideration meets certain basic standards, thus helping to simplify the evaluation process. Once the basic determination is made that the manufacturers involved meet all the basic requirements, a particular manufacturer can still gain an evaluated advantage by offering additional unique features and/or an operational design approach preferred or judged superior by the potential user.
3. It is a solid way of defining what is required for specific application systems, such as:
  - Emergency systems
  - Stand-by systems
  - Legally required standby systems

A great number of components are involved in the installation of an auxiliary power system. The transfer switch equipment is a critical player. The system selected and components involved depend on the type of occupancy, type of process or activity, and specific needs of the facility.

You will hear a number of familiar codes and organizations from other types of equipment referred to, such as:

- National Electrical Code:
- National Fire Protection Association (NFPA)
- Underwriter's Laboratories, Inc. (UL)
- American National Standards Institute (ANSI)
- Institute of Electrical and Electronic Engineers (IEEE)
- National Electrical Manufacturers Association (NEMA)
- Specific local codes

Keep in mind that a standard exists for almost everything. Compliance with exacting standards ensures customers of the very best possible product selection with a high degree of comfort. **There is no room for compromise when performance, quality and safety are involved.**

The rest of this section will be devoted to the specific organizations and standards applicable to all transfer switch equipment, no matter the manufacturer. Also, additional standards that components within Cutler-Hammer transfer switch equipment are subjected to will be discussed. These additional steps taken by Eaton Electrical add to the customer's comfort level that they can expect the best in performance and safety.

## National Electrical Code (NEC)

The NEC provides guidance for safe and proper installation of equipment required for emergency and legally required standby power systems. It also contains rules for those standby systems that are installed for the convenience of operations in a facility (optional standby systems). Finally, it also deals with those systems oper-

## Transfer Switch Equipment

ated in parallel with the electric utility and are capable of delivering energy back to the utility source.

### National Fire Protection Association (NFPA)

The NFPA provides a number of very important and applicable standards:

- **NFPA 99** - Requirements for emergency systems in health care facilities
- **NFPA 101** - Guidelines to where emergency lighting is essential
- **NFPA 110** - Performance requirements for emergency and standby equipment

### Underwriter's Laboratories, Inc. (UL)

UL has developed a comprehensive test standard for automatic transfer switches designated UL 1008. In order to list an ATS under UL 1008, an ATS manufacturer must subject a sample unit of each rating and configuration to a battery of sequential performance tests. As is the case with any product standard, UL 1008 defines only minimum performance requirements.

Because Eaton Electrical uses specially designed molded and insulated case switches or circuit breakers as the main power switching contacts, these devices are also listed under two additional standards:

- **UL 1087** - Standard for molded case switches
- **UL 489** - Standard for circuit breakers

It is important to know that UL uses two basic types of listing programs:

- Re-examination
- Label service

**Re-examination** only requires a continual physical re-examination of the components used in the end product to ensure consistency with the originally submitted device. There is no required follow-up testing. UL 1008 which applies to all automatic transfer switches list product under this type of program.

**Label service** requires an extensive follow-up testing program for listed devices. UL 1087 and UL 489 apply to the devices used by Eaton Electrical as the main power switching devices, namely the molded or insulated case switches and circuit breakers. Representative production samples used by Eaton Electrical are subjected to a complete test program identical to the originally submitted devices per UL 1087 and UL 489 requirements. The frequency of such a re-submittal can be as often as every quarter for a 100 ampere device. Any failure during one of these re-submittals could result in a loss of the valued UL listing mark. Remember, Eaton's Cutler-Hammer ATS main power switching contacts must still comply with UL 1008. This triple compliance for Cutler-Hammer main power switching contacts ensures a continuing high level of performance that a customer can expect over and above any stated or implied quality commitment by a manufacturer.

For the sake of comparison, review the UL requirements for each of the three UL standards presented in the UL Summary.

### Other Standards and Codes

Other applicable standards and codes as outlined by American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA) and specific local codes must be considered and complied with supplying automatic transfer switch equipment.

### Summary

Even though all manufacturers' transfer switches meet UL 1008, there are **several methods and designs used to accomplish the basic transfer switch**

## Transfer Switch Equipment

**function.** That is one reason why the specification intensity for this product is high.

A second reason is **reliability**. The transfer switch is a key element of the emergency power system and must work every time when called upon to operate.

For these two reasons, a consultant and user are very much interested when the quality, reliability and performance of the transfer switching equipment exceeds minimum standards, especially when it is proven through testing.

# Transfer Switch Equipment

## Molded Case Circuit Breakers (UL-489)

### UNDERWRITERS LABORATORIES TEST REQUIREMENTS

#### Standard Tests

1. The tripping mechanism shall be enclosed to prevent tampering.
2. The mechanism shall trip free of the handle on overload.
3. All breakers shall be calibrated to carry their continuous rating in an ambient temperature of 40°C.
4. 200% calibration check.
5. 135% calibration check.
6. Overload test at 600% normal current at rated voltage. Up to 6000 amps 50 operations. 1601-2500 amps 25 operations. 2501-6000 amps 25 operations (ds).
7. Temperature rise check at 100% rated load continuously without exceeding specified temperature limits.
8. Endurance test:

Ampere Rating	Operations		
	With Current	Without Current	Per Minute
0-100	6000	4000	6
101-225	4000	4000	5
226-600	1000	5000	4
601-800	500	3000	1
801-2500	500	2000	1
2501-6000	400	1100	1

9. After endurance test, the breaker must again pass a calibration test at the 200% and 135% ratings.
10. It must next pass short circuit tests at the value shown in the following chart:

Breaker Rating		Test Circuit		
Volts	Amps	Common Pole Amps	Ind. Pole Amps	No. of Tests
250 & Below	100 & Below	4330	5000	7
above 250	100 & Below	8660	10000	7
Any	101-800	8660	10000	7
Any	801-1200	12120	14000	7
Any	1201-1600	14000	20000	8
Any	1601-2000	14000	25000	8
Any	2001-2500	20000	30000	8
Any	2501-3000	25000	35000	8
Any	3001-4000	30000	45000	8
Any	4001-5000	40000	60000	
Any	5001-6000	50000	70000	

11. After the short circuit test, the breaker must again pass a calibration test at 2000% of its rating.
12. Insulation test consisting of 1,000 volt plus twice the rated voltage between live parts and ground; between poles with the breaker closed and between line and load terminals with the breaker open and in tripped position.



# Transfer Switch Equipment

## Molded Case Circuit Breakers (UL-1087)

### UNDERWRITERS LABORATORIES TEST REQUIREMENTS

#### Standard Tests

1. The instantaneous response release mechanism shall be enclosed to prevent tampering.
2. The instantaneous response release mechanism shall automatically open free of the handle on short circuit.
3. All switches shall be calibrated to carry their continuous rating in an ambient temperature of 40°C.
4. N/A
5. N/A
6. Overload test at 600% normal current at rated voltage. Up to 1600 amps 50 operations. 2000-2500 amps 25 operations. 2501-6000 amps 28 operations (\*).
7. Temperature rise check at 100% rated load continuously without exceeding specified temperature limits.
8. Endurance test:

Ampere Rating	Operations		
	With Current	Without Current	Per Minute
0-100	6000	4000	6
101-225	4000	4000	5
226-600	1000	5000	4
601-800	500	3000	1
801-2500	500	2000	1
2501-6000	400	1100	1

9. N/A
10. It must next pass short circuit current withstand tests at the value shown in the following chart:

Breaker Rating		Test Circuit		
Volts	Amps	Common Pole Amps	Ind. Pole Amps	No. of Tests
250 & Below	100 & Below	4330	5000	7
above 250	100 & Below	8660	10000	7
Any	101-800	8660	10000	7
Any	801-1200	12120	14000	7
Any	1201-1600	14000	20000	8
Any	1601-2000	14000	25000	8
Any	2001-2500	20000	30000	8
Any	2501-3000	25000	35000	8
Any	3001-4000	30000	45000	8
Any	4001-5000	40000	60000	
Any	5001-6000	50000	70000	

11. N/A
12. Insulation test consisting of 1000 volts plus twice the rated voltage between live parts and ground; between poles with the breaker closed; and between line and load terminals with the breaker open and in tripped position.  
\* Three operations at 600 percent of rating at the rate of 1 cycle per minute followed by 25 operations at 200 percent of rating at the rate of 1 cycle per minute (may be conducted in groups of 5 with 15 minutes maximum between groups).

# Transfer Switch Equipment

## Transfer Switches (UL-1008)

### UNDERWRITERS LABORATORIES TEST REQUIREMENTS (IN ADDITION TO UL-489 OR UL-1087)

#### Standard Tests

1. N/A
2. N/A
- 3.
4. N/A
5. N/A
6. Overload test at 600% normal current at rated voltage. Up to 1600 amps 50 operations. 1601-2500 amps 25 operations. 2501 above 30 operations.
7. Temperature rise check at 100% rated load continuously without exceeding specified temperature limits.
8. Endurance test:

Ampere Rating	Operations			
	With Current		Without Current	Per Minute
	100%	200%		
0-300	3000	3000		1
301-400	2000	2000		1
401-800	1000	1000	1000	1
801-1600	750	750	1500	1/2
1601/above	500	500	2000	1/4

9. N/A
10. Withstand and closing test:

Switch Rating	Test Current Amps	No. of Tests
100 amps or less	5000	2
101-400 amps	10000	2
401 & greater	20 times rating but no less than 10000 amperes	2

11. N/A
12. Insulation test consisting of 1000 volt plus twice the rated voltage between live parts and ground; between poles with the breaker closed; and between line and load terminals with the breaker open and in tripped position.

# Transfer Switch Equipment

## Features and Accessories

Transfer switch options and accessories are available to meet a wide variety of application requirements. A Cutler-Hammer transfer switch can be customized, in most cases in the field, to a very specific set of requirements. Where applicable, accessories are UL listed unless specifically noted otherwise.

Because options and accessories are normally very specific relative to a particular manufacturer, no attempt will be made to discuss any items other than those supplied by Eaton Electrical. Manufacturers have uniquely different ways of identifying different accessories and options, which, on occasion, adds to the confusion. Eaton Electrical, for example, uses a numbering and lettering system to identify most items. Eaton Electrical uses a number as the first line of identification. If that item needs a more specific identification, a letter is added to the number. Take a look at the following two examples:

**Example 1:** Option 1 is Time Delay Normal to Emergency (TDNE). This option provides a time delay when transferring from the Normal Power Source to the Emergency Power Source and is supplied as part of the logic package. This is the only selection to make which means there is no letter associated with identifying the option.

**Example 2:** Option 33 is a shunt trip. This option could be supplied in the Normal Breaker and is identified with the letter "A" or the letter "B" is supplied in the Emergency Breaker. There are two choices for this option, "33A" or "33B."

The option identification numbers will be used here, although there will be no further attempt to explain the reasoning behind the numbering system. The concentration should be on the item itself and what its function is relative to transfer switch equipment. In time, the actual numbering system will become second nature. Keep in mind that all the options outlined here are not necessarily available for all transfer switch configurations.

Options and accessories fall into one of two categories:

- Non-logic
- Logic

As the names imply, non-logic items are more closely associated with the transfer switch itself, and logic items are considered part of the specific type of logic selected.

### 1. Time Delay Normal to Emergency (TDNE)

Provides a time delay when transferring from the Normal Source to the Emergency Source. Timing begins when the Emergency Source becomes available. Permits controlled transfer of the load circuit to the Emergency Source. Adjustable 0 – 1800 seconds.

### 2. Time Delay Engine Start (TDES)

Provides a time delay of the signal to initiate the engine/generator start cycle in order to override momentary power outages or voltage fluctuations of the Normal Source. Adjustable 0 – 120 seconds.

### 3. Time Delay Emergency to Normal (TDEN)

Provides a time delay of the re-transfer operation to permit stabilization of the Normal Source. Timing begins when the Normal Source becomes available. If the Emergency Source fails during timing, then re-transfer is immediate overriding the time delay. Adjustable 0 – 1800 seconds.

### 4. Time Delay Engine Cooldown (TDEC)

Provides a time delay of the signal to initiate the engine/generator stop cycle after the re-transfer operation. This allows the engine/generator to cooldown by running unloaded. Timing begins on completion of the re-transfer cycle. Adjustable 0 – 1800 seconds.

## Transfer Switch Equipment

### 5. Source 2/Emergency Source Monitoring and Protection

Provides monitoring and protection based on the Source 2 voltage and/or frequency set points. All Feature 5 functions are failsafe operations.

#### **5B. Single-Phase Undervoltage and Underfrequency Protection**

Adjustable Undervoltage:

Dropout: 50 – 97% of nominal.

Pickup: Dropout +2% – 99% of nominal.

Adjustable Underfrequency:

Dropout: 90 – 97% of nominal.

Pickup: Dropout +1 Hz – 99% of nominal.

#### **5C. Single-Phase Overvoltage and Overfrequency Protection**

Adjustable Overvoltage:

Dropout: 105 – 120% of nominal.

Pickup: Dropout -2% – 103% of nominal.

Adjustable Overfrequency:

Dropout: 103 – 110% of nominal.

Pickup: Dropout -1 Hz – 101% of nominal.

#### **5D. Single-Phase Undervoltage Protection**

Adjustable Undervoltage:

Dropout: 50 – 97% of nominal.

Pickup: Dropout +2% – 99% of nominal.

#### **5E. Single-Phase Overvoltage Protection**

Adjustable Overvoltage:

Dropout: 105 – 120% of nominal.

Pickup: Dropout -2% – 103% of nominal.

#### **5F. Three-Phase Undervoltage Protection**

Adjustable Undervoltage:

Dropout: 50 – 97% of nominal.

Pickup: Dropout +2% – 99% of nominal.

#### **5G. Three-Phase Overvoltage Protection**

Adjustable Overvoltage:

Dropout: 105 – 120% of nominal.

Pickup: Dropout -2% – 103% of nominal.

#### **5H. Phase Reversal Protection**

Provides phase reversal protection.

#### **5J. Three-Phase Undervoltage and Underfrequency Protection**

Adjustable Undervoltage:

Dropout: 50 – 97% of nominal.

Pickup: Dropout +2% – 99% of nominal.

Adjustable Underfrequency:

Dropout: 90 – 97% of nominal.

Pickup: Dropout +1 Hz – 99% of nominal.

# Transfer Switch Equipment

## **5K. Three-Phase Overvoltage and Overfrequency Protection**

Adjustable Overvoltage:

Dropout: 105 – 120% of nominal.

Pickup: Dropout -2% – 103% of nominal.

Adjustable Overfrequency:

Dropout: 103 – 110% of nominal.

Pickup: Dropout -1 Hz – 101% of nominal.

## **6. Test Operators**

Eaton's Cutler-Hammer Automatic Transfer Switches are provided with a Test Pushbutton that simulates a loss of the Normal Power Source as standard (Feature 6B). All programmed time delays (TDNE, TDEN, etc.) will be performed as part of the Test. Engine run time of the Test is equal to the Plant Exerciser (Feature 23) programmed set point. All Tests are failsafe protected. If one of the optional Test Operators is chosen, then the standard 6B Test Pushbutton is disabled.

### **6B. Test Pushbutton**

Programmable set points include:

1. Load or No Load Testing, or Disabled.
2. Engine run time is equal to the plant exerciser (Feature 23) setting.

### **6D. 2-Position Test Selector Switch (TSS)**

Provides a 2-position, maintained contact selector switch marked "Auto" and "Test." The Test is a Load Test and will continue until the TSS is returned to the "Automatic" position. The TSS is failsafe protected.

### **6H. 4-Position Test Selector Switch (FPSS)**

Provides a 4-position, maintained contact selector switch marked "Auto," "Test," "Engine Start," and "Off." The FPSS is failsafe protected. Transfer Switch operation is determined by the switch position. Transfer Switch operations are as follows:

"Auto" — Automatic operation mode.

"Test" — A Load test is performed until the switch is moved to another position.

"Engine Start" — A No-Load test is performed until the switch is moved to another position.

"Off" — The Automatic Transfer Controller and engine start contact are disabled. A white pilot light is provided to indicate that the FPSS is in the "Off" position.

## **7. Time Delay Emergency Fail (TDEF)**

Provides a time delay that prevents a connected emergency source from being declared "Failed" in order to override momentary generator fluctuations. If the Source 2/Emergency power source remains in the failed state, then 0.5 seconds after the TDEF timer expires, the transfer switch will proceed with the programmed sequence for re-transfer. This time delay is only implemented when the emergency source is a generator. Adjustable 0 – 6 seconds.

## **8. Time Delay Bypass Pushbutton**

Provides a momentary contact pushbutton to bypass the TDNE (Feature 1) and/or TDEN (Feature 2) time delays. The Time Delay Bypass Pushbutton contact, when closed, will reduce any or all of the programmed time delay to zero.

(When both 8C and 8D are selected a single pushbutton operator is provided.)

## Transfer Switch Equipment

### **8C. Bypass TDEN**

Provides a pushbutton to bypass the TDEN time delay.

### **8D. Bypass TDNE**

Provides a pushbutton to bypass the TDNE time delay.

### **9B. Maintenance Selector Switch (MSS)**

Provides a 2-position, maintained contact selector switch marked “Off” and “On.” MSS operations are as follows:

“Off” — When the MSS is placed in the “Off” position, the control power is disconnected from the transfer motor circuit, which allows testing of the Automatic Transfer Controller without initiating a load transfer.

“On” — The MSS is placed in the “On” position for normal automatic operation.

### **10. Preferred Source Selector**

Provides a means to designate either Source 1 or Source 2 as the “Preferred” Source.

#### **10B. Preferred Source Selector**

Provides source selector for use on systems comprised of dual utility or utility and engine/generator power sources.

#### **10D. Preferred Source Selector**

Provides source selector for use on systems comprised of dual engine/generator power sources. (Dual engine starting circuits are provided.)

### **12. Indicating Pilot Lights**

Provides pilot lights to give switch position and power source availability indication.

#### **Switch Position**

Provides a pilot light to indicate switch position.

#### **12C. Source 1 — Load Connected**

Provides a green pilot light that indicates the load is connected to Source 1 when lit.

#### **12D. Source 2 — Load Connected**

Provides a red pilot light that indicates the load is connected to Source 2 when lit.

#### **Power Source Availability**

Provides a pilot light to indicate if a power source is available. Lights may be integral or separate from the controller.

#### **12G. Source 1 Available**

Provides an amber pilot light that indicates Source 1 is available when lit.

#### **12H. Source 2 Available**

Provides an amber pilot light that indicates Source 2 is available when lit.

#### **Overcurrent Trip Indication**

Available only with Integral Overcurrent Protection (Feature 16). (Shown on Automatic Transfer Controller Display.)

## Transfer Switch Equipment

### **12L. Source 1 Trip Indication**

The Automatic Transfer Controller display will read “Lockout” if the Source 1 circuit breaker is in the “tripped” position.

### **12M. Source 2 Trip Indication**

The Automatic Transfer Controller display will read “Lockout” if the Source 2 circuit breaker is in the “tripped” position.

#### **14. Relay Auxiliary Contacts**

Provides Form “C” relay auxiliary contacts.

### **14C. Source 1 Available**

Provides 4 Form “C” relay auxiliary contacts. The relay is energized when Source 1 is available.

### **14D. Source 2 Available**

Provides 4 Form “C” relay auxiliary contacts. The relay is energized when Source 2 is available.

### **14E. Source 1 Available**

Provides 1 Form “C” relay auxiliary contact. The relay is energized when Source 1 is available.

### **14F. Source 2 Available**

Provides 1 Form “C” relay auxiliary contact. The relay is energized when Source 2 is available.

#### **15. Switch Position Indication Contact**

Provides a contact that indicates if the power switching device is in the “open” or “closed” position.

### **15E. Source 1 Position Indication Contact**

Provides 1 Form “C” contact that indicates the position of the Source 1 power switching device.

### **15F. Source 2 Position Indication Contact**

Provides 1 Form “C” contact that indicates the position of the Source 2 power switching device.

#### **16. Integral Overcurrent Protection**

Provides thermal-magnetic overcurrent protection integral to the power switching device(s). All Feature 16 options include a “Lockout” function. If the power switching breaker trips on an overcurrent condition, then “Lockout” is displayed on the Automatic Transfer Controller display and automatic operation is prevented until the appropriate source is manually reset.

### **16B. Integral Overcurrent Protection on Both Power Source Switching Devices**

Provides integral overcurrent protection on both Source 1 and Source 2 power switching devices.

### **16E. Integral Overcurrent Protection on the Source 2 Power Switching Device**

Provides integral overcurrent protection on the Source 2 power switching device.

### **16N. Integral Overcurrent Protection on the Source 1 Power Switching Device**

Provides integral overcurrent protection on the Source 1 power switching device.

## Transfer Switch Equipment

### 17. High Withstand Power Switching Devices

Provides increased withstand rating of the Source 1 and Source 2 power switching devices.

#### **17C. High Withstand Power Switching Devices**

Provides power switching devices with a higher withstand rating on fixed mounted SPB type transfer switches 800A – 1200A.

### 18. Metering and Communications

The Eaton Electrical IQ family of microprocessor-based multifunction monitoring and display devices features the latest technological advances in metering and communications capabilities.

The IQ family is available with an optional communications interface for data collection, storage and printout via Eaton's Cutler-Hammer PowerNet System. (See Feature 48 — Communications for available communication modules.)

Feature 18 metering options include all required external devices (CTs etc.) for a fully functioning metering system.

#### ***IQ DP-4000***

The IQ DP-4000 is an rms sensing, multifunction microprocessor-based monitoring and display device that provides simultaneous monitoring of current, voltage, frequency, power (real, reactive and apparent), energy (real, reactive and apparent), power factor and percent THD (current and voltage).

#### ***18R. IQ DP-4000 — Source 1 Line Side Metering***

Provides an IQ DP-4000 for monitoring the Source 1 line side circuit.

#### ***18S. IQ DP-4000 — Source 2 Line Side Metering***

Provides an IQ DP-4000 for monitoring the Source 2 line side circuit.

#### ***18T. IQ DP-4000 with Selector Switch for Source 1 or Source 2 Line Side Metering***

Provides an IQ DP-4000 with a Source selector switch for monitoring the Source 1 or Source 2 line side circuit.

#### ***18U. IQ DP-4000 — Load Side Metering***

Provides an IQ DP-4000 for monitoring the load side circuit.

#### ***IQ Analyzer***

The IQ Analyzer is an rms sensing, multifunction microprocessor-based monitoring and display device with waveform capture that provides simultaneous monitoring of current, voltage, frequency, power (real, reactive and apparent), energy (real, reactive and apparent), demand (forward, reverse and net), harmonics (magnitude and phase angle), power factor and percent THD (current and voltage).

#### ***18O. IQ Analyzer — Source 1 Line Side Metering***

Provides an IQ Analyzer for monitoring the Source 1 line side circuit.

#### ***18P. IQ Analyzer — Source 2 Line Side Metering***

Provides an IQ Analyzer for monitoring the Source 2 line side circuit.

#### ***18Q. IQ Analyzer with Selector Switch for Source 1 or Source 2 Line Side Metering***

Provides an IQ Analyzer with a Source selector switch for monitoring the Source 1 or Source 2 line side circuit.



# Transfer Switch Equipment

## **18V. IQ Analyzer — Load Side Metering**

Provides an IQ Analyzer for monitoring the load side circuit.

## **20. Rear Bus Provisions**

Provides Source 1, Source 2 and Load Circuit rear accessible bus stabs with provision for bus bar connection. Cutler-Hammer Transfer Switches are provided with either front or rear (dependent on switch type) connected solderless screw-type terminals for power cable connection as standard.

### **20A. Rear Bus Provisions**

Provides Source 1, Source 2 and Load Circuit rear accessible bus stabs with provision for bus bar connection.

## **21. Optional Power Cable Connection Terminals**

Cutler-Hammer Transfer Switches are provided as standard with Source 1, Source 2 and Load Circuit solderless screw-type terminals for power cable connection. Alternate terminal wire sizes may be available dependent on transfer switch type and ampere rating.

### **21A. Optional Power Cable Connection Terminals**

Provides Alternate Power cable connection terminals. Consult Eaton Electrical sales for available optional terminal sizes.

## **23. Plant Exerciser (PE)**

Provides a means for automatic testing of the engine generator set or standby power system. All programmed time delays will be performed during plant exerciser operations.

### **23J. Plant Exerciser (PE) with Failsafe**

Provides user programmable set point for test interval. Test may be performed with or without load circuit transfer. Test may be manually cancelled during operation. Adjustable engine run time 0 – 600 minutes.

## **24. Battery Charger**

Provides an automatic battery charger for engine cranking batteries. Requires a separate 100 – 135V AC 60 Hz customer supplied power source.

### **24C. Battery Charger with 12V DC Output**

Provides an automatic battery charger with 12V DC, 5 ampere output.

### **24D. Battery Charger with 24V DC Output**

Provides an automatic battery charger with 24V DC, 5 ampere output.

## **26. Source 1 — Monitoring and Protection**

Provides Source 1 monitoring and protection functions. If the Source 1 power supply fails, then the Automatic Transfer Controller will begin the sequence of operations necessary to transfer the load circuit to the Source 2 power supply. All Feature 26 monitoring and protection functions are failsafe operations.

### **26A. All Phase Undervoltage Protection**

Provides all phase undervoltage monitoring and protection.

Adjustable Undervoltage:

Dropout: 50 – 97% of nominal.

Pickup: Dropout +2% – 99% of nominal.

### **26C. All Phase Overvoltage Protection**

Provides all phase overvoltage monitoring and protection.

## Transfer Switch Equipment

Adjustable Overvoltage:  
Dropout: 105 – 120% of nominal.  
Pickup: Dropout -2% – 103% of nominal.

### **26D. Go to Emergency (Source 2)**

Provides the capability for an external contact closure to initiate a load circuit transfer to the Source 2/Emergency power source. This includes starting the engine/generator, performing the programmed time delays and the transfer operation. Re-transfer will occur when the external contact is opened or under a failsafe condition. Includes terminal block connection point for connection of external contact.

### **26E. All Phase Underfrequency Protection**

Provides all phase underfrequency monitoring and protection.

Adjustable Underfrequency:  
Dropout: 90 – 97% of nominal.  
Pickup: Dropout +1 Hz – 99% of nominal.

### **26F. All Phase Overfrequency Protection**

Provides all phase overfrequency monitoring and protection.

Adjustable Overfrequency:  
Dropout: 103 – 110% of nominal.  
Pickup: Dropout -1 Hz – 101% of nominal.

### **26G. Phase Reversal Protection**

Provides a relay to ensure matched phase sequencing between Source 1 and Source 2.

## **29. Transfer Operation Modes**

Provides standard or optional transfer modes, mode selection devices and operational methods for Transfer switches.

### **29A. Automatic Operation**

Provides fully automatic transfer, re-transfer and engine/generator startup and shutdown operations.

### **29G. Automatic/Manual Operation With Selector Switch**

Provides 2-position selector switch (labeled Auto/Manual) that permits selection of the Automatic or Manual transfer operation mode. When in the "Auto" position, the transfer switch operates with fully automatic transfer, re-transfer and engine/generator startup and shutdown operations. When in the "Manual" position, manual pushbutton operation is required to initiate the engine/generator startup with transfer or re-transfer with engine/generator shutdown operations. The pushbuttons for manual operation are included.

**Note:** Transfer switches with Feature 29G must be labeled as Non-Automatic Transfer Switch equipment.

### **29J. Automatic Transfer or Automatic Transfer With Non-Automatic Re-transfer Operation**

Provides a field selectable programmable set point that permits the transfer switch to operate in one of the following 2 transfer modes (A or B).

A) Fully automatic operation. Same as Feature 29A.

## Transfer Switch Equipment

B) Automatic engine/generator startup and automatic transfer operation from Source 1 to Source 2. Manual pushbutton operation is required to initiate the re-transfer operation and engine/generator shutdown. The pushbutton for manual re-transfer operation is included. This is a Failsafe Feature.

### 30. Cranking Limiter

Provides an interrupt to the engine starting circuit that stops engine cranking if voltage does not become available within the selected time.

### 32. Delayed Transition Transfer Modes for Open Transition Transfer Switches

Provides delayed transition transfer modes for an Open Transition transfer switch. Often used in systems with inductive loads, a delayed transition transfer switch may prevent or reduce inrush currents due to out of phase switching of inductive loads.

#### **32A. Time Delay Neutral**

Provides a time delay in the neutral position during the transfer and re-transfer operations during which both Source 1 and Source 2 are disconnected from the load circuit.

The time delay is programmable and is the same for both transfer and re-transfer operations. Adjustable 0 – 120 seconds.

#### **32B. Load Voltage Decay**

Provides load voltage measurement to sense back EMF that is generated when the transfer switch is the neutral position. It provides a delay in transfer in either direction if an unacceptable level is sensed as established by a programmed set point. Adjustable 2 – 30% of nominal voltage.

#### **32C. In-Phase Transition with Default to Load Voltage Decay**

Provides In-Phase transition, which is a feature that will permit a transfer or re-transfer between 2 available sources that have a phase angle difference near zero. The In-Phase transition feature includes permissible frequency difference and synchronization time set points. In the event Source 1 and Source 2 fail to synchronize within the permitted frequency difference and time, then the controller defaults to the Load Voltage Decay operation as described in Feature 32B. Adjustable Frequency Difference 0.0 – 3.0 Hz. Adjustable Synchronization Time Allowance 1 – 60 minutes.

#### **32D. In-Phase Transition with Default to Time Delay Neutral**

Provides In-Phase transition, which is a feature that will permit a transfer or re-transfer only between 2 available sources that have a phase angle difference near zero. The In-Phase transition feature includes permissible frequency difference and synchronization time set points. In the event Source 1 and Source 2 fail to synchronize within the permitted frequency difference and time, then the controller defaults to the Time Delay Neutral operation as described in Feature 32A. Adjustable Frequency Difference 0.0 – 3.0 Hz. Adjustable Synchronization Time Allowance 1 – 60 minutes.

### 33. Shunt Trip

Provides a means for remote tripping of a power switching device. The shunt trip is wired to a terminal block for customer connection. Shunt trip operating voltage must be specified with order entry.

#### **33A. Shunt Trip on Source 1**

Provides shunt trip operation on the Source 1 power switching device.

## Transfer Switch Equipment

### **33B. Shunt Trip on Source 2**

Provides shunt trip operation on the Source 2 power switching device.

- 34. Logic Extender Cable** Provides logic extender cables with connectors which permit remote mounting of the Automatic Transfer Controller in non-standard applications.

#### **34A. 48 Inches (1219 mm)**

Provides logic extension cable with connectors.

#### **34B. 72 Inches (1829 mm)**

Provides logic extension cable with connectors.

#### **34C. 96 Inches (2438 mm)**

Provides logic extension cable with connectors.

#### **34D. 120 Inches (3048 mm)**

Provides logic extension cable with connectors.

#### **34E. 144 Inches (3658 mm)**

Provides logic extension cable with connectors.

- 35. Pre-Transfer Signal** Provides a signal to a remote device prior to a re-transfer operation. The controller will then delay the re-transfer operation until receipt of an authorization signal. If the authorization signal is not received, then the controller will override and complete the re-transfer operation after a time delay. Adjustable 1 – 120 seconds.

#### **35A. Pre-Transfer Signal with 1 NO and 1 NC Contacts**

Provides pre-transfer signal. Includes 1 NO and 1 NC contacts.

- 36. Load Shed from Emergency** Provides the capability for an external NC contact to initiate a load circuit disconnection from the Source 2/Emergency power source. If the load circuit is connected to Source 2 and the contact is opened, then a re-transfer to Source 1 is completed if Source 1 is available. If Source 1 is not available, then the transfer switch will transfer to neutral. If the load circuit is connected to Source 1 and the contact is open, then a transfer Source 2/Emergency is prohibited. This feature is wired to a terminal block and is a wetted input that does not require an external voltage supply.

- 37. Service Equipment Rated Transfer Switch** Provides the label "Suitable for use as Service Equipment" and the features necessary to meet the requirements for the label. Includes service disconnect with visible indication and neutral assembly with removable link. Feature 16B or 16N must be selected separately.

#### **37A. Service Equipment Rated Transfer Switch without Ground Fault Protection**

Provides Service Equipment rating for an application that does not require ground fault protection.

#### **37B. Service Equipment Rated Transfer Switch with Ground Fault Protection**

Provides Service Equipment rating for an application that requires ground fault protection.

- 41. Space Heater with Thermostat** Provides a space heater and adjustable thermostat. External control power is not required.

## Transfer Switch Equipment

### **41A. Space Heater with Thermostat — 100 Watt**

Provides 100-watt space heater with an adjustable thermostat.

### **41B. Space Heater with Thermostat — 200 Watt**

Provides 200-watt space heater with an adjustable thermostat.

### **41C. Space Heater with Thermostat — 400 Watt**

Provides 400-watt space heater with an adjustable thermostat.

## **42. Seismic Certification**

Provides a Seismic certified Transfer Switch with certificate for application is Seismic Zone 4 under the California Building Code, the Uniform Building Code® and BOCA®.

## **45. Load Sequencing Capability**

Provides the capability for sequential closure of up to 10 addressable relays after a transfer. Each Addressable Relay provides (1) Form “C” contact. A single adjustable time delay between each of the relay closures is provided. Operates via a sub-network. Adjustable 1 – 120 seconds.

### **45A. Load Sequencing Contact**

Provides (1) addressable relay.

### **45B. Load Sequencing Contact**

Provides (2) addressable relays.

### **45C. Load Sequencing Contact**

Provides (3) addressable relays.

### **45D. Load Sequencing Contact**

Provides (4) addressable relays.

### **45E. Load Sequencing Contact**

Provides (5) addressable relays.

### **45F. Load Sequencing Contact**

Provides (6) addressable relays.

### **45G. Load Sequencing Contact**

Provides (7) addressable relays.

### **45H. Load Sequencing Contact**

Provides (8) addressable relays.

### **45I. Load Sequencing Contact**

Provides (9) addressable relays.

### **45J. Load Sequencing Contact**

Provides (10) addressable relays.

## **47. Transfer Modes for Closed Transition Transfer Switches**

Provides available transition transfer modes for a closed transition transfer switch. Closed Transition is a “make before break” transfer and re-transfer scheme that will parallel (100 mS maximum) Source 1 and Source 2 providing a seamless transfer when both sources are available. The closed transition feature includes permissible voltage difference, frequency difference and synchronization time

## Transfer Switch Equipment

allowance set points. The phase angle difference between the 2 Sources must be near zero for a permitted transfer.

### ***47C. Closed Transition with Default to In-Phase Transition with Default to Load Voltage Decay***

Provides a closed transition transfer as the primary transfer mode. In the event Source 1 and Source 2 fail to synchronize within the permitted voltage difference, frequency difference, phase angle difference and time, then the controller defaults to the In-Phase Transition with Default to Load Voltage Decay operations as described in Features 32C and 32B. Adjustable Frequency Difference 0.0 – 3.0 Hz. Adjustable Voltage Difference 1 – 5 percent V. Adjustable synchronization Time Allowance 1 – 60 minutes.

### ***47D. Closed Transition***

Provides a closed transition transfer as the primary transfer mode. Only under a failsafe condition (i.e. loss of the connected source) will the controller transfer to the alternate source using the Load Voltage Decay operation as described in Feature 32B. Adjustable Frequency Difference 0.0 – 3.0 Hz. Adjustable Voltage Difference 1 – 5 percent V.

### ***47E. Closed Transition with Default to In-Phase Transition with Default to Time Delay Neutral***

Provides a closed transition transfer as the primary transfer mode. In the event Source 1 and Source 2 fail to synchronize within the permitted voltage difference, frequency difference, phase angle difference and time, then the controller defaults to the In-Phase Transition with Default to Time Delay Neutral operation as described in Features 32D and 32A. Adjustable Frequency Difference 0.0 – 3.0 Hz. Adjustable Voltage Difference 1 – 5 percent V. Adjustable synchronization Time Allowance 1 – 60 minutes.

## **48. Communication Modules**

Provides Eaton Electrical communications modules for the ATC-400, ATC-600 (IQ Transfer), and ATC-800 (Closed Transition IQ Transfer) transfer switch controllers. These controllers are PowerNet compatible devices. A separately mounted communications module will enable the automatic transfer controller to be remotely monitored, controlled and programmed via the network.

### ***48A. Communications Module — IPONI***

Provides an IPONI communications module.

### ***48B. Communications Modules — IPONI and PMCOM5***

Provides IPONI and PMCOM5 communications modules.

### ***48C. Communications Module — IPONI, PMCOM5 and Null Modem Cable***

Provides IPONI, PMCOM5 communications modules and null modem cable.

### ***48D. Communications Module — EPONI***

Provides EPONI communications module (10Base-T only).

### ***48E. Communications Module — EPONI***

Provides EPONI communications module (10Base-T and 10Base-FL).

### Switch Configurations

Three basic types of transfer switches have been discussed up to this point:

- Non-automatic (manually operated)
- Non-automatic (electrically operated)
- Automatic

This section will concentrate on transfer switches with different configurations. In most instances that means the switch performs in a certain manner for a specific type application. There is a difference between a transfer switch type and its configuration.

**Example:** The **type of switch** would be one of the three types just outlined (non-automatic manual/electrical or automatic). The application could call for the switch to perform in a certain way to accomplish its function. This means the switch must be configured to do the job. The logic might be **configured** in a certain way, the switch might be physically configured in a certain way, or it could be a combination of the two. Even though the switch is configured a certain way for the application, it might be a non-automatic type or an automatic type switch. These things are dependent upon the specific design. All switch designs do not offer all the same choices.

In addition, previous discussions centered around **fixed switching devices**. Because Eaton Electrical uses SPB insulated case switches or insulated case circuit breakers as the main switching devices in some designs, **drawout switching devices** are also available. The transfer switch can, therefore, be configured as fixed or drawout.

The rest of this section will present brief explanations of a number of different switch configurations:

- Open Transition
- Closed Transition
- Drawout
- Service Entrance
- Bypass Isolation
- Maintenance Bypass

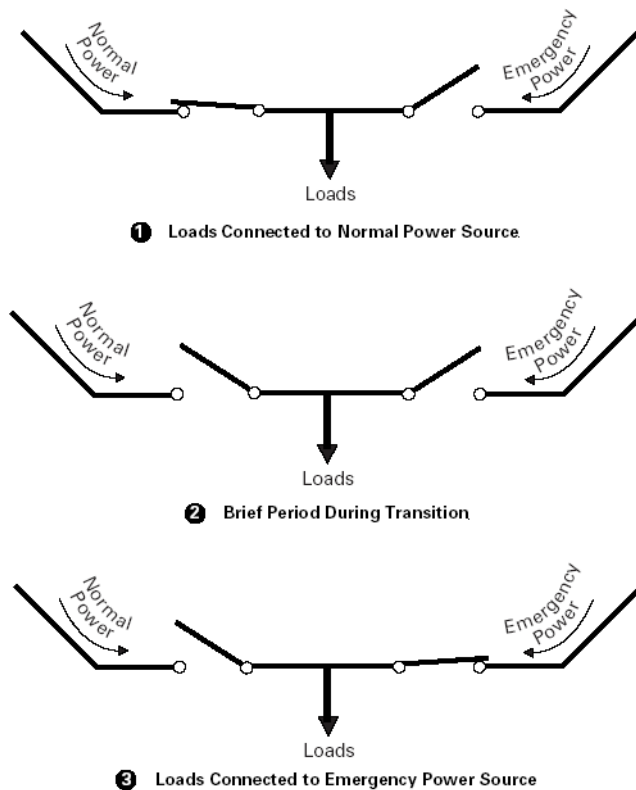
### Open Transition

An Open Transition Transfer (OTT) switch is also called a **break-before-make** switch. It is configured in such a way that the power output is broken (interrupted) before the transfer to the new source is made. There is a definite break in power as the load is taken off one source and connected to another. While this type of transfer is simple, the time delay between break and make creates an unacceptable power interruption for critical loads, such as computers. For this reason, the OTT configuration is more appropriate for less critical applications.

Typically, this type of switch uses voltage sensors and time delay circuitry to activate the operation of the switching mechanism in the desired sequence. With automatic transfer switches, the logic controls the operation. Whether the switch is transferring to the Emergency Source or retransferring to the Normal Source, it operates in the same sequence, break-before-make (Figure 16).

# Transfer Switch Equipment

Figure 16. Open Transition Operation



## Closed Transition

A Closed Transition Transfer (CTT) switch is also called a **make-before-break** switch. There is no interruption in power to a critical load during transfer operations when both power sources are available. When using this type of switch, both power sources are connected to the load before the break occurs. This is true based on several **huge assumptions**:

**Assumption 1** - The two sources have the same voltage

**Assumption 2** - The two sources have the same frequency

**Assumption 3** - The two sources are synchronized

If the conditions outlined in the three assumptions do not exist, such as the Emergency Source not even being up and running when the normal source is lost, the closed transition transfer switch would act like the open transition switch. It would wait for the Emergency Source to become available. It would then break from the Normal Source first, followed by making with the Emergency Source. When the Normal Source is once again available, it would operate as a closed transition transfer switch to retransfer to the Normal Source. It would make with the Normal Source before breaking with the Emergency Source, because both sources are the same and available. There would be no interruption in power to the critical load. For equipment that cannot tolerate even a brief loss of power as just described when the delayed transfer was made to the Emergency Source, a back-up system, such as an uninterruptable power supply (UPS), would be required in the system.

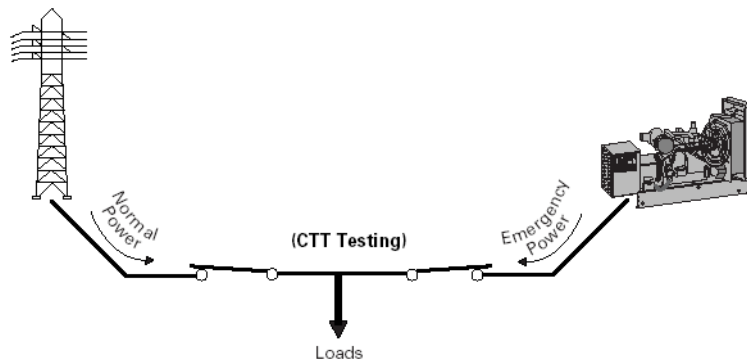
Finally, there is one additional application well suited to the Closed Transition Transfer switch, **testing of an emergency source**. It permits the periodic testing of an emergency source, such as a generator set, without interrupting power to



## Transfer Switch Equipment

the loads (Figure 17). The generator set can be brought up and when it is monitored as an acceptable source, the closed transition test can be conducted.

Figure 17. CTT Switch Used For Emergency Source Testing

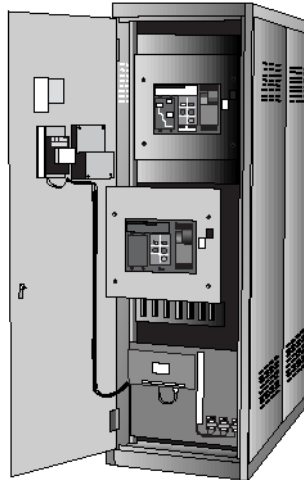


### Drawout

Cutler-Hammer drawout SPB transfer switches are intended for applications where preventative maintenance, inspection and testing must be accomplished while maintaining power continuity to the load (Figure 18). This is typically required in critical life support systems and standby power situations that require safe maintenance of the system without a power disruption. This type of configuration permits either of the two power sources to be isolated, including operational logic, while maintaining power to the load.

The drawout configuration is also well suited for several other special configurations, such as service entrance and bypass isolation. These specialty configurations are discussed in the next few paragraphs.

Figure 18. Cutler-Hammer Drawout SPB Transfer Switch



### Service Entrance

Service entrance, as the name implies, is the point where power supplied by a utility enters a facility. Just look at the point where power enters a house from the local utility and goes directly into a load center, probably mounted on a basement wall. The incoming power line first goes to a main disconnect, probably a circuit breaker. From there it breaks down into many different circuits through any number of smaller circuit breakers to supply power throughout the house. Industrial facilities, for example, are no different, just on a larger scale.

When there is a loss of power from the utility at a house, everything electrical stops functioning. That is the way it remains until the utility takes care of the prob-

## Transfer Switch Equipment

lem and restores power. A number of facilities, such as water, waste water treatment, pumping station and many other industrial facilities cannot tolerate the loss of commercial power. An emergency power source is necessary at any of these facilities to protect against commercial power interruptions. In such a situation, it becomes necessary to have an ATS as close as possible to the point where commercial power enters the facility, the service entrance. The reason most likely is that every load at the facility is critical, and must continue functioning, even though commercial power is lost.

There are two approaches that can be used for the installation of automatic transfer switch equipment:

- Conventional ATS installation
- Cutler-Hammer ATS installation

**A conventional ATS installation** would normally be installed immediately downstream of the service disconnect devices of both the utility and standby (emergency) power supplies (Figure 19). This may not be the optimum installation location, but it is the best that can be done with conventional ATS equipment.

**An Eaton Electrical ATS installation** using circuit breaker type disconnects, such as the SPB, and a service entrance option eliminates the need for separate upstream disconnect devices and their respective power interconnections. This means the ATS is installed directly at the point of service entrance (Figure 20). It does not get any better.

Figure 19. Conventional ATS Service Entrance Installation

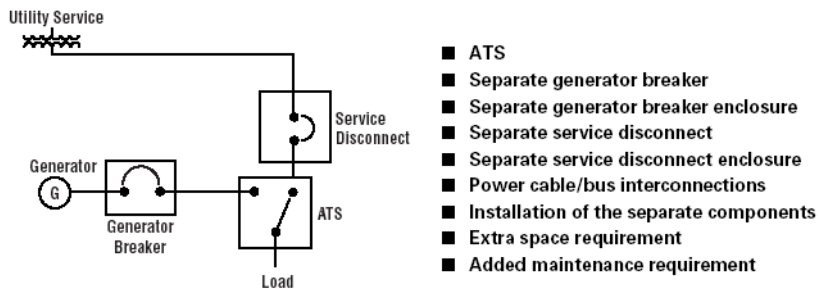
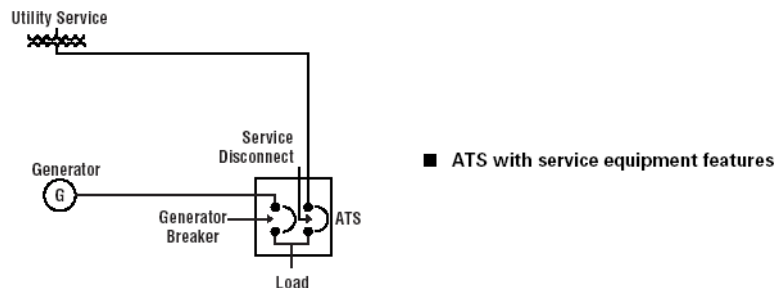


Figure 20. Eaton Electrical ATS Service Entrance Installation



### Bypass Isolation

A bypass isolation switch is actually a manually operated nonautomatic transfer switch in parallel with an electrically operated automatic transfer switch. The bypass isolation switch is also sometimes referred to as a maintenance bypass switch. In the sense that they both operate in a similar fashion to perform an isolation function, they are the same. In reality, however, they were developed to perform somewhat different functions. The maintenance bypass switch will be discussed later from an application standpoint. The concentration here will be on the bypass isolation.

## Transfer Switch Equipment

By design, the isolation of the automatic transfer switch is permitted for periodic maintenance or repair while power to the load from either power source is maintained. Because the bypass switch must carry the same load as the automatic transfer switch, they must be rated the same with the same withstand and *Interrupting ratings*.

Once again, this type of equipment is often required in critical life support systems and standby power situations requiring safe system maintenance without a power disruption.

A Cutler-Hammer SPB drawout type bypass isolation transfer switch provides a high degree of flexibility by providing a number of bypass options.

### ***Bypass Isolation Functionality***

The Cutler-Hammer Bypass Isolation Switch has two operator panels with switches, lights and key interlocks (Figures 21 and 22). This particular switch configuration provides a high degree of functionality through a number of transfer switch bypass possibilities.

Figure 21. SPB Type Bypass Isolation Switch

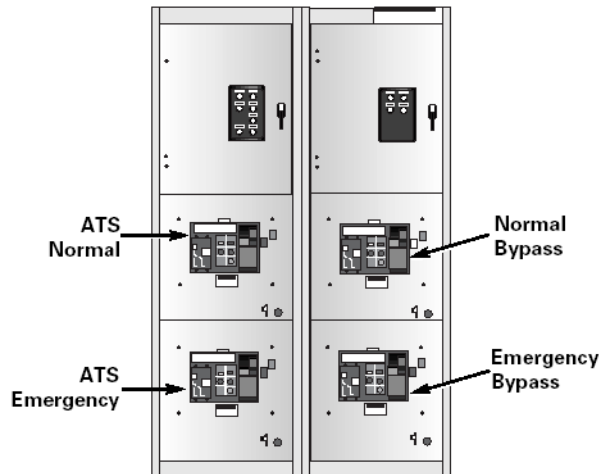
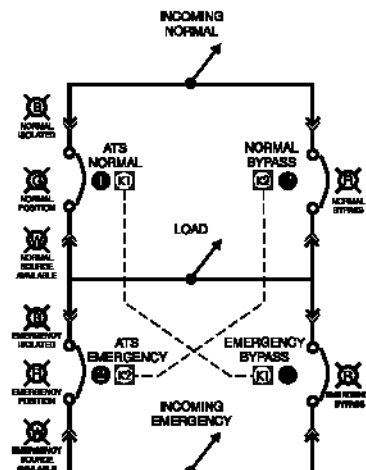


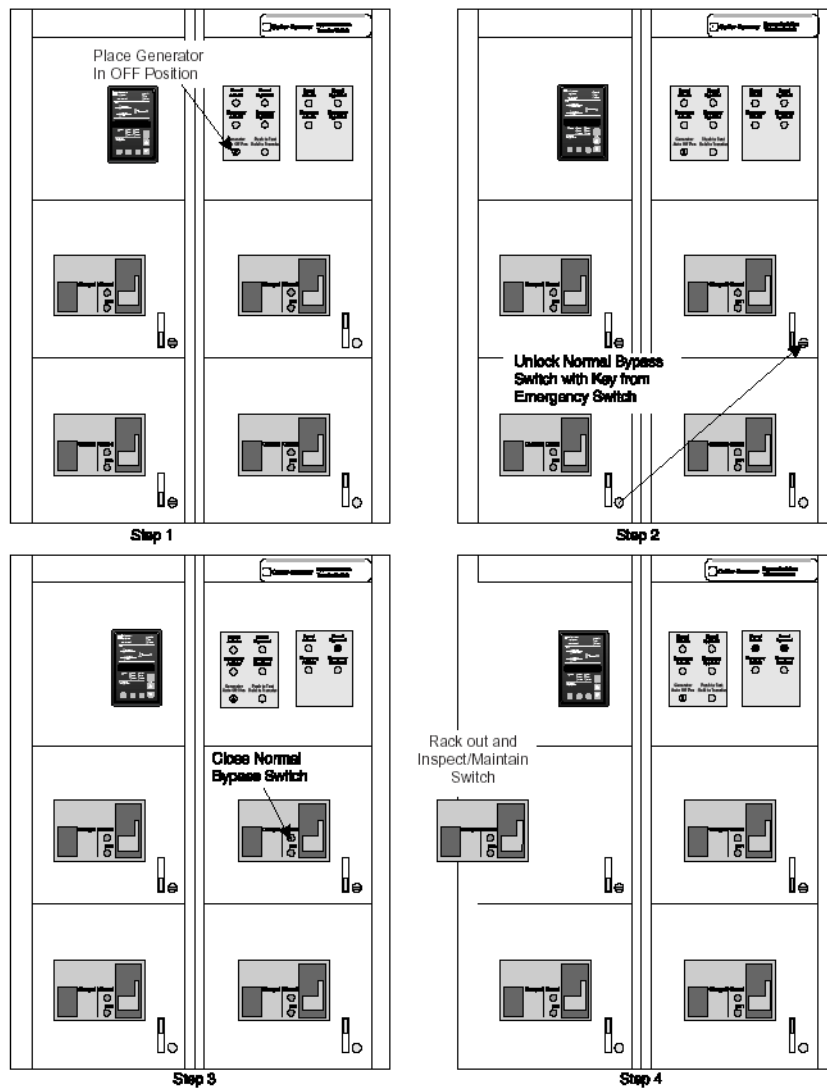
Figure 22. Bypass Isolation Switch Schematic



Consider the following possibilities and review the steps presented in Figures 23 and 24:

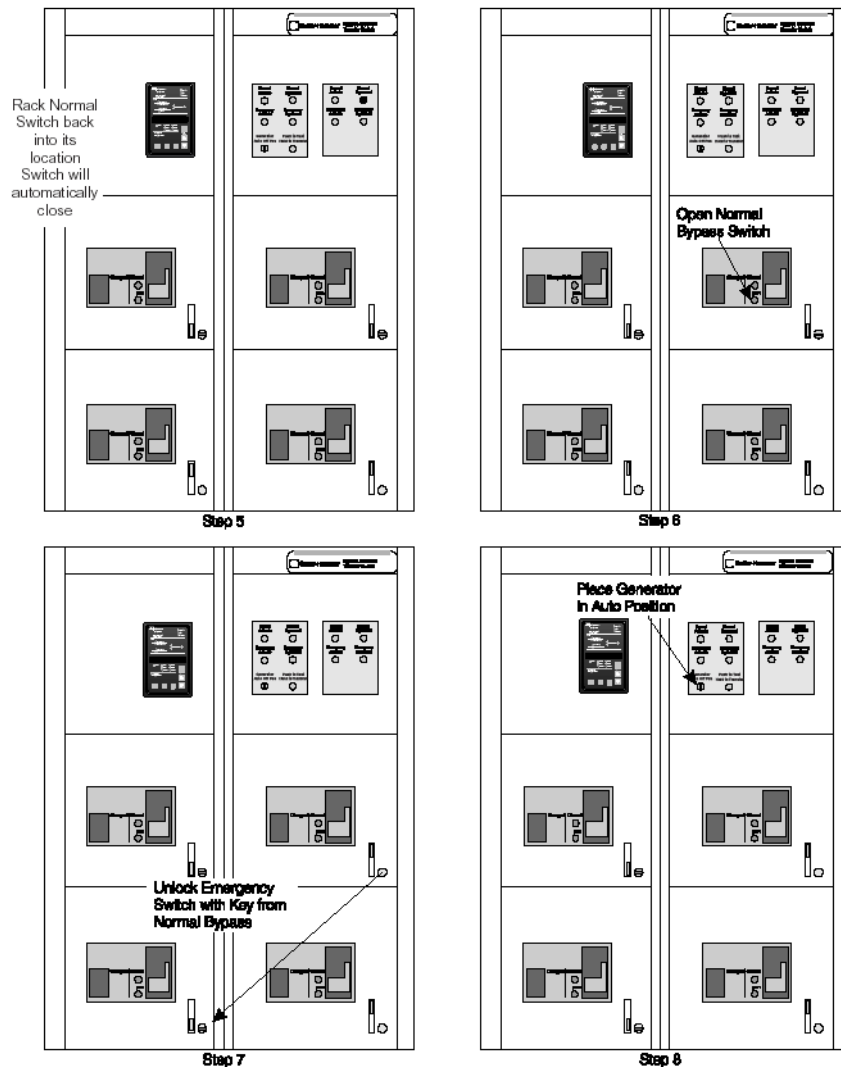
# Transfer Switch Equipment

Figure 23. Transfer From Normal Switching Device To Normal Bypass Switching Device, Steps 1-4



# Transfer Switch Equipment

Figure 24. Transfer From Normal Switching Device To Normal Bypass Switching Device, Steps 5-8



- **NORMAL TO NORMAL BYPASS** - The normal switching device is bypassed and isolated.
- **EMERGENCY TO EMERGENCY BYPASS** - The emergency switching device is bypassed and isolated.
- **NORMAL TO EMERGENCY BYPASS** - The normal switching device is bypassed and isolated.
- **EMERGENCY TO NORMAL BYPASS** - The emergency switching device is bypassed and isolated.

In addition, when the transfer switch is set to normal bypass, it can be manually operated **TO ACCOMPLISH THE FOLLOWING**:

- **NORMAL BYPASS TO EMERGENCY BYPASS** - It can be manually transferred to emergency bypass from normal bypass.
- **EMERGENCY BYPASS TO NORMAL BYPASS** - It can be manually transferred to normal bypass from emergency bypass.

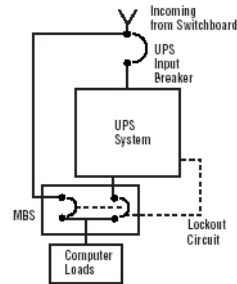
## Transfer Switch Equipment

### Maintenance Bypass

The maintenance bypass switch is similar to the just discussed bypass isolation switch in that it performs an isolation type function.

This specific configuration is less involved than the just discussed bypass isolation switch, because it is not required to perform as wide an array of bypass activities. The Cutler-Hammer maintenance bypass switch provides a simple and effective means for bypassing uninterruptible power supplies (UPS) while maintaining continuity of power to critical loads, such as computers (Figure 25). A maintenance bypass switch is required on every UPS installation in order to accommodate the maintenance and testing of the UPS system.

Figure 25. Schematic Of Maintenance Bypass With UPS System



Unauthorized bypass is prevented, because the UPS system must send the bypass an authorizing signal to proceed.

Motor generator systems also frequently require a maintenance bypass. Although a motor generator system is extremely reliable, it does require a significant amount of mechanical moving parts maintenance. Bearings and couplings need to be greased and examined to ensure proper functioning.

## Transfer Switch Equipment

### Review 2

Answer the following questions without referring to the material just presented. Begin the next section when you are confident that you understand what you've already read.

1. All transfer switch manufacturers must meet UL 1008. In addition to UL 1008, Eaton Electrical meets UL \_\_\_\_\_ and UL \_\_\_\_\_. This triple compliance for Cutler-Hammer main power switching contacts ensures a high level of performance that a customer can expect over and above any stated or implied quality commitment by a manufacturer.
2. An Open Transition Transfer switch is configured in such a way as to allow the power output to be maintained to the load during transfers.  
TRUE FALSE
3. Another name for a Make-Before-Break switch is a \_\_\_\_\_ transfer switch.
4. If either source is not present, a CTT switch must operate like an OTT switch, and break from one source before making with the other source.  
TRUE FALSE
5. A draw out transfer switch has the following advantages:
  - a) Preventive maintenance can be conducted while maintaining power to the load.
  - b) Isolation of either of the power sources while maintaining power to the load.
  - c) Inspection and testing can be conducted without interruption to the load power.
  - d) Service Entrance and Bypass Isolation
  - e) All of the above
6. An Eaton Electrical ATS installation using circuit breaker type disconnects and a service entrance option eliminates the need for separate upstream disconnect devices and their respective power interconnections.  
TRUE FALSE

## Transfer Switch Equipment

### Selection Factors and Process

Automatic transfer switches may be located in the main or secondary distribution bus. Therefore, the requirements for operating characteristics of transfer switch equipment are different from those of branch circuit devices. Specifically, four major factors must be given special consideration. An automatic transfer switch must have the ability to:

- Close against high inrush currents
- Interrupt current
- Carry full rated current continuously
- Withstand fault currents

Careful attention to the transfer switch selection process is important to ensure maximum reliability and adequate capability under normal and emergency conditions. Main points to consider are:

- Types of load to be transferred
- Voltage rating
- Continuous Current rating
- Overload and fault current withstand ratings
- Type of overcurrent protective device ahead of transfer switch
- Necessary capabilities of any required logic

Fortunately, many of the critical decisions are made ahead of time by a consultant or the user. With most of the requirements outlined, making the proper selection from published literature is the required task. Although selection information provided by a manufacturer, such as Eaton Electrical, is well thought out and presented, it still requires a careful selection process to avoid unnecessary errors.

In this section, several specific selection issues will be discussed. The section will end with the presentation of an overall Eaton Electrical selection guide.

### Withstand, Closing and Interrupting Ratings

Cutler-Hammer transfer switches have the industry's highest withstand, closing and interrupting ratings. In addition, the withstand, closing and interrupting ratings are identical. This means that Cutler-Hammer transfer switches can be easily applied and coordinated within a distribution system.

With other manufacturers, interrupting ratings are lower than their stated withstand and closing ratings. This complicates coordination decisions and may necessitate oversizing switches in order to handle the application.

### Integral Overcurrent Protection

Cutler-Hammer transfer switch designs provide for the addition of integral overcurrent protection within the transfer switch main contact assembly. Integral overcurrent protection can help reduce initial equipment costs, cut installation time, and increase system reliability (Figures 26 and 27).



# Transfer Switch Equipment

Figure 26. Schematic Of Maintenance Bypass With UPS System

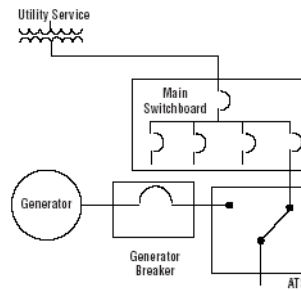
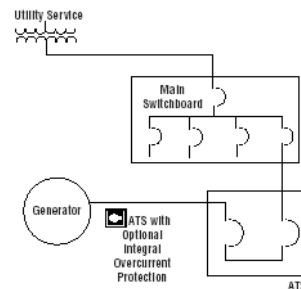


Figure 27. Schematic Of Maintenance Bypass With UPS System



A typical standby power system utilizing an engine generator as the emergency Back-up Power supply would have to use a separately mounted circuit breaker on the standby generator side to provide protection for the ATS and the interconnecting cable, if an Cutler-Hammer transfer switch is not used with integral overcurrent protection. This is similar to the situation discussed earlier under the Service Entrance topic. The use of Cutler-Hammer transfer switch equipment for that application eliminated the need for a separate upstream disconnect device.

## Manual Transfer Under Load

Cutler-Hammer transfer switch equipment has the ability to manually transfer power under full load conditions. It is desirable to be able to override the automatic controls of the transfer switch to accomplish true manual transfer under full load conditions. One example of this need is when control logic must be isolated for maintenance purposes. A number of competitive transfer switch products explicitly prohibit manual power transfer under load. Others strongly recommend that load circuits be de-energized prior to manual operation. All transfer switch designs accommodate full load transfer automatically (electrically). So what conditions change during manual operation that would preclude transfer under load? **Quick-break** has the answer.

The phrase **Quick-break** implies quick, positive and complete disconnection of the main power circuit contacts. The operation requires sufficient contact separation to insure complete arc isolation and extinction. Many transfer switch manufacturers certify their contact operation to be quick-break and quick-make contingent upon the speed of the opening force achieved by an electrical operator. During true manual operation, however, the electrical operator is disabled and opening of the main contacts is accomplished via a manual operating handle and operating personnel. Any inherent weaknesses of the transfer switch main contacts and transfer mechanism cause manufacturers to hedge their bet when it comes to manual transfers under load. Cutler-Hammer transfer switches do not need to offer any exceptions, because contact operation is **true quick-break, quick-make with no opportunity for contact teasing, regardless of the speed of manual operation.**

# Transfer Switch Equipment

## Catalog Numbering System

The Catalog Numbering System permits at-a-glance specification of custom Transfer Switch configurations to meet all applicable requirements.

The Catalog Numbering System allows the specifier to generate a 15-digit catalog number which represents ten basic style/feature categories:

- Type
- Orientation
- Logic
- Frame
- Switch
- Poles
- Ampere rating
- Voltage
- Enclosure type
- Listing

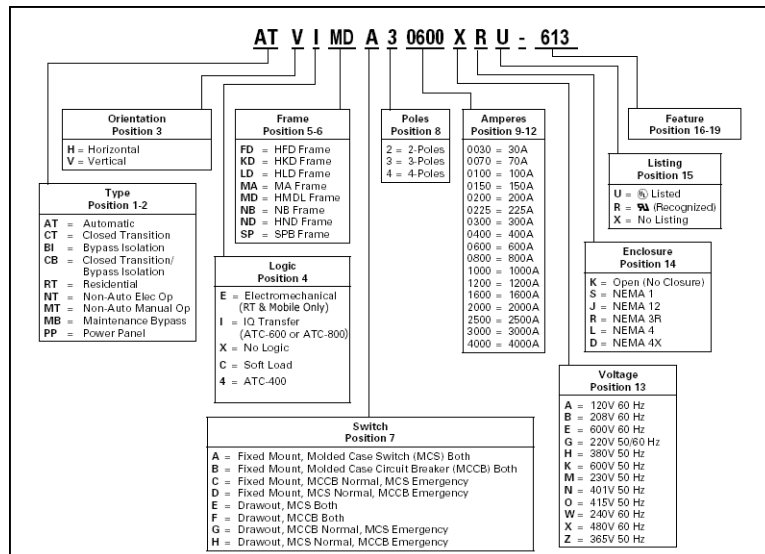
Each category is associated with a selection menu. By choosing the appropriate selection from the menu for each category in sequence and incorporating the associated selection code into the catalog number, the specifier constructs a unique catalog number which describes the desired switch configuration.

The catalog number can then be modified through the addition of appropriate code options.

### Example:

Automatic Transfer Switch, ATC-600/IQ Transfer Controller, 480/277V, 60 Hz, 3-Phase, 4-Wire, 3-Pole, 600 Ampere, UL 1008 listed, NEMA 3R enclosure with Feature 613.

Specify Number: ATVIMDA30600XRU - 613.



## Transfer Switch Equipment

### Review 3

Answer the following questions without referring to the material just presented.

1. An automatic transfer switch must have the ability to close against high inrush currents, interrupt current, carry full rated current continuously and withstand fault currents. Cutler-Hammer transfer switches have the \_\_\_\_\_ withstand, closing and interruption ratings in the industry.
2. Because other manufacturers interrupting ratings are lower than their stated withstand and closing ratings, this complicates \_\_\_\_\_ decisions and may require \_\_\_\_\_ switches to handle the application.
3. A Cutler-Hammer transfer switch with overcurrent protection can eliminate the need for a separately mounted circuit breaker on the stand by generator side to protect the ATS and interconnecting cable in a system utilizing an engine generator as the emergency back up.

TRUE FALSE

### Glossary

<b>Alternate Power</b>	Also called back-up and critical power. If there is a normal power source failure, emergency power can be supplied as an additional source from the utility or an on site generation, from an engine-generator set for example.
<b>Alternative System</b>	On-site power generation assets installed as a back-up to the normal source or as a way to reduce energy bills. Surplus generating capacity allows for power to be supplied back to the utility grid (Cogeneration). For cogeneration to take place, the on-site asset must run in parallel with the utility source.
<b>ANSI</b>	American National Standards Institute
<b>Arcing</b>	The effect generated when electrical current bridges the air gap between two contacts or conductors
<b>Automatically Operated</b>	Mechanisms that do not require the intervention of operating personnel.
<b>Automatic Transfer Switch (ATS)</b>	The ATS includes sensing circuits to detect when a power failure occurs, and triggers logic to start the engine when the emergency power source is an engine generator. When the generator reaches the proper voltage and frequency, the switch automatically transfer load circuits from the normal source to the emergency source. When the normal source is restored, the switch re-transfers the load circuits back to the normal source.
<b>Back-up Power</b>	See Emergency Power
<b>Basic Transfer Switch</b>	A design for use with customer furnished controls. Similar to an automatic transfer switch except intelligence and supervisory circuits are omitted.
<b>Circuit Breaker Type Switch</b>	Transfer switches known as the circuit breaker type use specially designed switching devices that are typically molded /insulated case switches. A molded case switch is like a molded case circuit breaker without magnetic or thermal trip elements and does not trip on overload or faults. Used when a compact, high capacity disconnect is needed, and is held to a more rigorous testing standard than the contactor type.
<b>Closed Transition</b>	Power is maintained to the load throughout the transfer process to the second power source. (Make before Break)
<b>Contactor Type Transfer Switch</b>	Transfer switches that use a contactor type design. The contactor type switches do not use motor starting/lighting type contactors. In fact, contactor type transfer switches used circuit breaker design contacts, arc chutes and arcing horns.
<b>Continuous Current</b>	The amount of current a device can carry constantly at 60 cycles without exceeding the temperature rise, according to ANSI charts.

## Transfer Switch Equipment

<b>Drawout</b>	A type of circuit breaker that can be moved into or out of its structure without unbolting, often on a racking mechanism.
<b>Electrically Operated</b>	A version of the manually operated mechanism, but is electrically operated. Operating personnel must be present to initiate the operation.
<b>Electrically Operated Non-automatic Transfer Switch</b>	Similar to the manually operated version except that an electrical operation feature is added to the switch. The switch electrically transfers power when a pushbutton, generally mounted on the enclosure, is activated. Can also be operated manually.
<b>Emergency Power</b>	Also called alternate, back-up and critical power. If there is a normal power source failure, emergency power can be supplied as an additional source from the utility or an on site generation, from an engine-generator set for example.
<b>Emergency System</b>	A system legally required and classified by government jurisdiction. Applies when loss of the normal power source would be a hazard to safety or human life. Intended to automatically supply illumination and/or power to designated areas and equipment. Characterized by a transfer time of less than 10 seconds. (Hotels, Sports Arena's, Health Care)
<b>Interrupting rating</b>	Also "Ampere Interrupting Capacity (AIC), a rating of the amount of current that a protective device can safely interrupt.
<b>IQ Transfer</b>	A programmable microprocessor based monitoring device designed specifically to use with transfer switches.
<b>Legally Required Standby System</b>	A system legally required and classified by government jurisdiction. These systems are intended to automatically supply power to selected loads, other than those already classified as emergency. Transfer time from the normal source to the emergency source cannot exceed 60 seconds. (Refrigeration, Communications, Smoke removal, Sewage disposal, Industrial processes)
<b>Logic Panels</b>	Provides the intelligence/supervisory logic circuits necessary for the switch and related circuit operations. There are three forms; Electromechanical Relay, Solid State, Microprocessor-based.
<b>Manually Operated</b>	Mechanisms requiring operating personnel to perform a function by hand.
<b>Manually Operated Non-automatic Transfer switch</b>	Provide all the mechanics to effect the transfer from source to source. The actual transfer of power, however, is accomplished by true hand operation of the transfer switch.

## Transfer Switch Equipment

<b>Manual Transfer Switch</b>	Transferring from the normal to the back-up power source is done with a manually operated device. Operating personnel are readily available and the load is not of a critical nature requiring immediate restoration. Also called a Non-Automatic transfer switch.
<b>Non-automatic Transfer Switch</b>	See Manual Transfer Switch
<b>Normal Power</b>	The power source used every day in non-emergency situations. Also called the preferred source
<b>On-site Generation</b>	Power is produced by the user, typically from an engine-generator set (genset), located in their facility.
<b>Open Transition</b>	Power is removed from the load before the transfer to the second power source. (Break before Make)
<b>Optional Standby System</b>	Intended to protect public or private property or facilities, where life and safety do not depend on the system's performance. Generally, on-site generated power is supplied to selected loads automatically or manually. There is no time limit associated with the transfer. (Commercial buildings, Farms, Residences)
<b>Preferred Source</b>	See Normal Power
<b>Service Entrance Equipment</b>	Equipment located at the point where power from the utility first enters a facility.
<b>Standby Power</b>	A power source other than that used everyday. Usually refers to a power used with optional or alternative systems.
<b>Step-Down Transformer</b>	A device used to change a voltage level to a lower voltage level.
<b>Stored Energy</b>	A mechanism used to overcome inherent forces opposed to the insulated switch (circuit breaker) closing process, which stores energy until it is needed to help open the breaker.
<b>Transfer Switch</b>	A critical component of any emergency or standby power system. When the normal (preferred) source of power is lost, the transfer switch transfers from the normal source of power to the emergency (Alternate) source of power. Operation of the transfer switch from normal to emergency and back to normal can be a manual type operation or an automatic type operation.
<b>Transformer Panel</b>	Provides operating voltage to power the switch's motors, coils, logic, etc.
<b>Trip Unit</b>	Device that trips the operating mechanism in case of a short circuit or overload condition.
<b>Twin Stored Energy</b>	This type of mechanism uses insulated case switches with true two step stored energy mechanisms as the switching devices. The stored energy provides the mechanical motion to open and close the two sets of main contacts.

## Transfer Switch Equipment

### Review 1 Answers

1. E - all of the above
2. Additional service from the Utility  
On site Generation
3. Manually or automatically operated  
Transfer Switch
4. Transfer Switch
5. Manually operated, Manually initiated electrically operated
6. True
7. Main Contacts  
Logic, intelligence or supervisory circuits  
Transfer Mechanism
8. True
9. Disconnect plug / Voltage selection plug

### Review 2 Answers

1. UL 1087, UL 489
2. False
3. Closed Transition
4. True
5. E, All of the above
6. True

### Review 3 Answers

1. Highest
2. Coordination, Oversizing
3. True