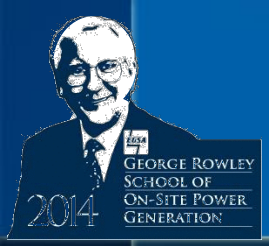

Bob Birdsong

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EGSA Instructor since the beginning

BSNE from USNA, BSEE from Univ of NY
35 Years Experience

VP of Industry Relations, GenServe, Inc.

EGSA Basic Power School
Automatic Transfer Switches

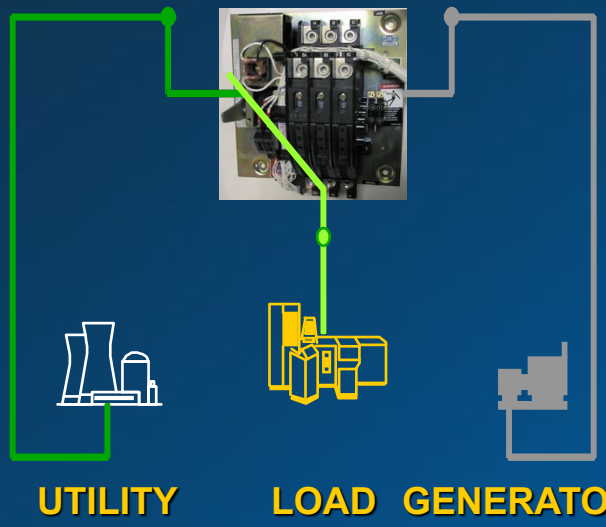
- Transfer Switch Ratings
  - Poles
  - Voltage
  - Current
- Power Switching Methods & Solutions
  - Non-Selective Automatic Transfer Switches
  - Delayed Transition Transfer Switches
  - Closed Transition Transfer Switches
  - Automatic Transfer / Bypass Isolation Switches

Why Are Transfer Switches Needed?

- To assure continuity of vital electrical power for essential loads:
  - Help prevent accidents, panic and possibly loss of life
  - Help avoid or mitigate loss of revenue or material goods
  - Comply with codes & standards
  - Comply with Government regulations
- Whenever two or more sources of power are utilized for essential electrical loads

Transfer Switch Definition & Purpose

- Definition: A device which transfers electrical loads between two dissimilar sources of power by using either manual or automatic controls.



Importance: Even with the most reliable power sources, the entire system is only as reliable as the ATS which is the heart of the power system

Transfer Switch Definition & Purpose

UL 1008 Safety Standard for Transfer Switch Equipment

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

A "Non-automatic transfer switch" as covered by these requirements is a device, operated manually by a physical action, or electrically by remote control, for transferring a common load between a normal and alternate supply.

Transfer Switch Definition & Purpose

UL 1008 Non-Automatic Transfer Switches

- Two Types
  - Electrically Operated
    - Uses simple control panel
    - Limited accessories and voltage / frequency sensing
  - Manually Operated
    - No electronic controller
    - Limited features & options
    - No controls or voltage sensing

Transfer Switch Definition & Purpose

UL 1008 Non-Automatic Transfer Switches

- Two Types
  - Electrically Operated
    - Uses simple control panel
    - Limited accessories and voltage / frequency sensing
  - Manually Operated
    - No electronic controller
    - Limited featues & options
    - No controls or voltage sensing

Transfer Switch Codes & Standards

Manual Transfer Switches

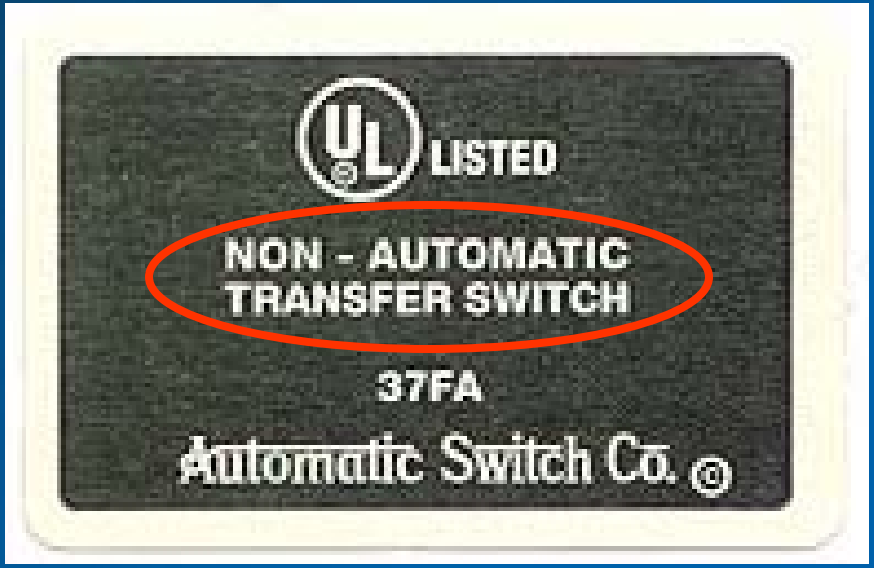
- Double Throw Safety Switch
- Rated 30 to 200 amps
- Listed to UL98 (Standard for Enclosed & Dead Front Switches)
- Popular for Use in Light Commercial Applications with Roll-Up Portable Gensets (Especially in Florida)

Comparison of UL 1008 / UL98 / UL67

Requirement	UL1008	UL98	UL67
Overload	6 x Rating	1.5 x Rating	Not Req'd
Post O.L. Temp Rise	Yes	Not Req'd	Not Req'd
Endurance	6000 w/ Load	6000 w/ Load	No Load
Dielectric	Yes	Yes	Not Req'd
Withstand	10Ka > 100A	5Ka Minimum	Calculated
Close-on	Same Test Sample	Untested Sample	Not Req'd

Comparison of UL 1008 / UL98 / UL67

Electrical Inspectors (AHJ) follow the NEC stating a device must be listed and approved for its intended purpose. This requires a label on the product which contains the words "Transfer Switch". In order to VERIFY a UL labeled device has been listed in accordance with UL1008 the UL label must state "Transfer Switch"



Typical Installations

Non-Automatic / Manual* Transfer Switches are *typically used for portable gensets requiring manual starting in installations like these:

- Residential installations
- Convenience stores
- Gas stations
- Some WWTPs
- Small office buildings & businesses & tunnels
- Some wireless cell sites

Typical Installations

Where are Automatic Transfer Switches used?

- Hospitals & other health care facilities
- Telecommunications & other utilities
- Banks & computer facilities
- Industrial buildings
- Large office buildings
- Airports & ARTCC
- Government & military installations
- Police & security systems
- Fire Pump Controllers – NFPA 20

Automatic Transfer Switches

Transfer Switch - Physical Elements

Transfer Switch (TS)

Controller (CP)

Over 90% of ATSs are supplied in enclosures by manufacturer, also mounted in switchboards & motor control centers.

Secure Type Enclosures
Outdoor Locations

EGSA Electrical Generating Systems Association

Outer Door Open

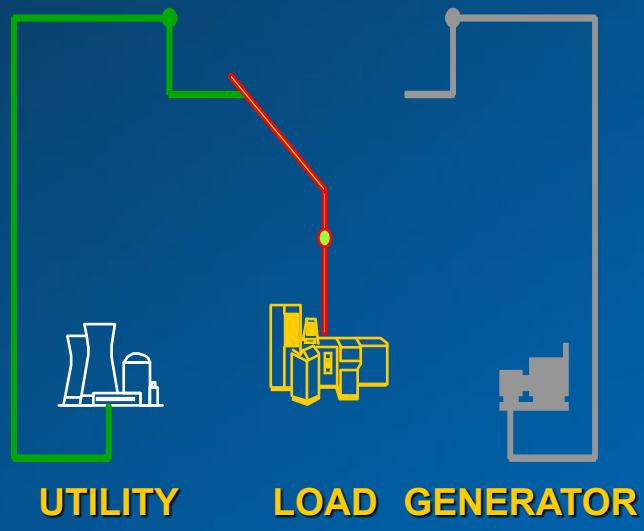
Inner Door Open

Automatic Transfer Switch Operation

Automatic Transfer Switch Operation

Seven Major Functions

- Carry Current Continuously-TS
- Detect Power Failures-CP
- Initiate Alternate Source & Transfer Operation-CP
- Transfer Connected Load-TS
- Sense Normal Source Restoration-CP
- Re-Transfer Load to Normal-TS
- Withstand & Close-On Fault Currents-TS



Automatic Transfer Switches

Transfer Switch - Physical Elements

Transfer Switch (TS)

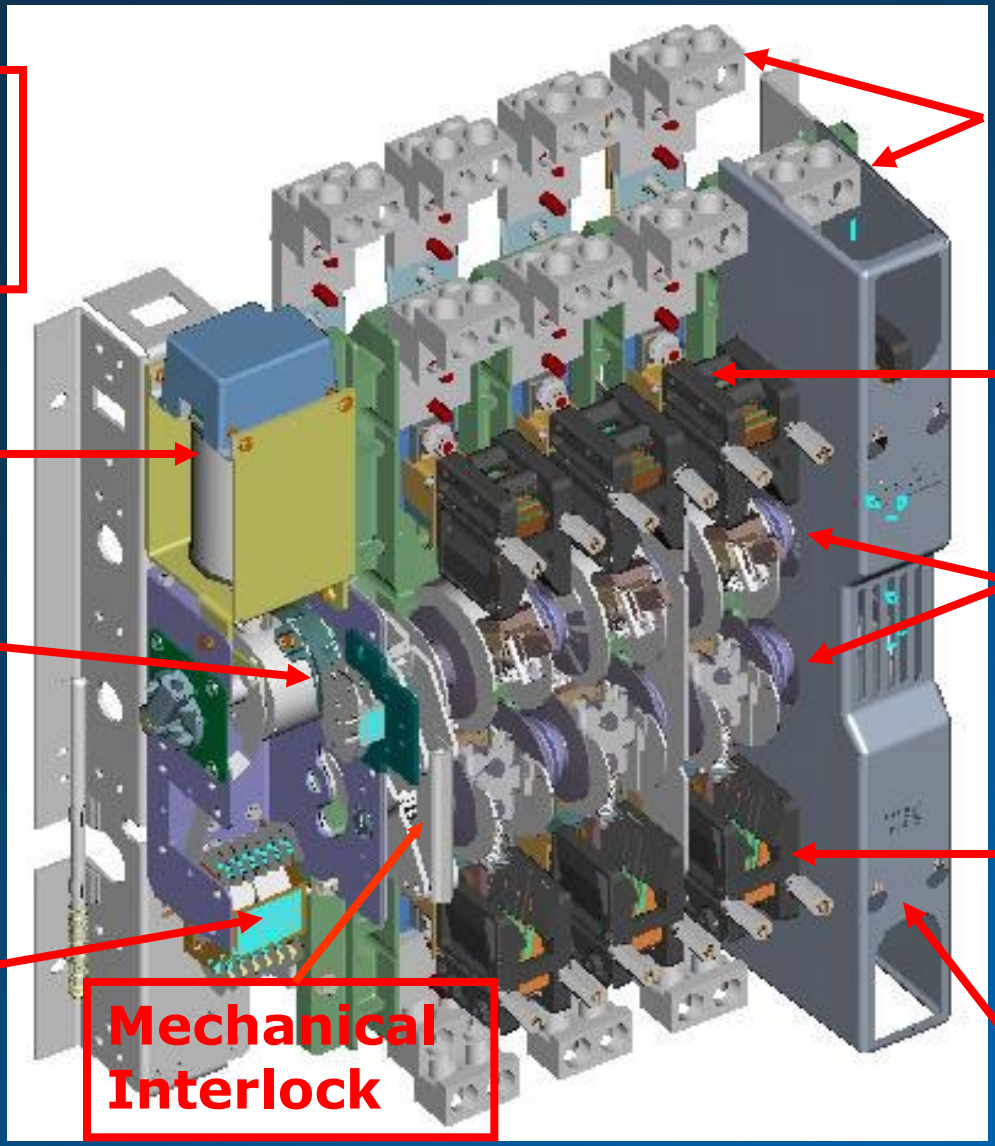
- TS Panel / Contactor
  - Solenoid Operator
  - Motor Mechanism(s)
- Main & Arcing Contacts
- Control and Auxiliary Contacts
- Power Connections
  - Mechanical Lugs
  - Bus Stab/ Bar

Controller (CP)

- Power Source Monitoring
- Time Delays
- Annunciation & Controls
- Transfer Control

Over 90% of ATSs are supplied in enclosures by manufacturer, also mounted in switchboards & motor control centers.

Transfer Panel Major Components



Transfer Switch Operator

TS Power Connection Terminals

Main Contact Assembly

Main Contact Shafts

Operator Drive Linkage

Arc Chutes

Auxiliary Contact Ass'y

Mechanical Interlock

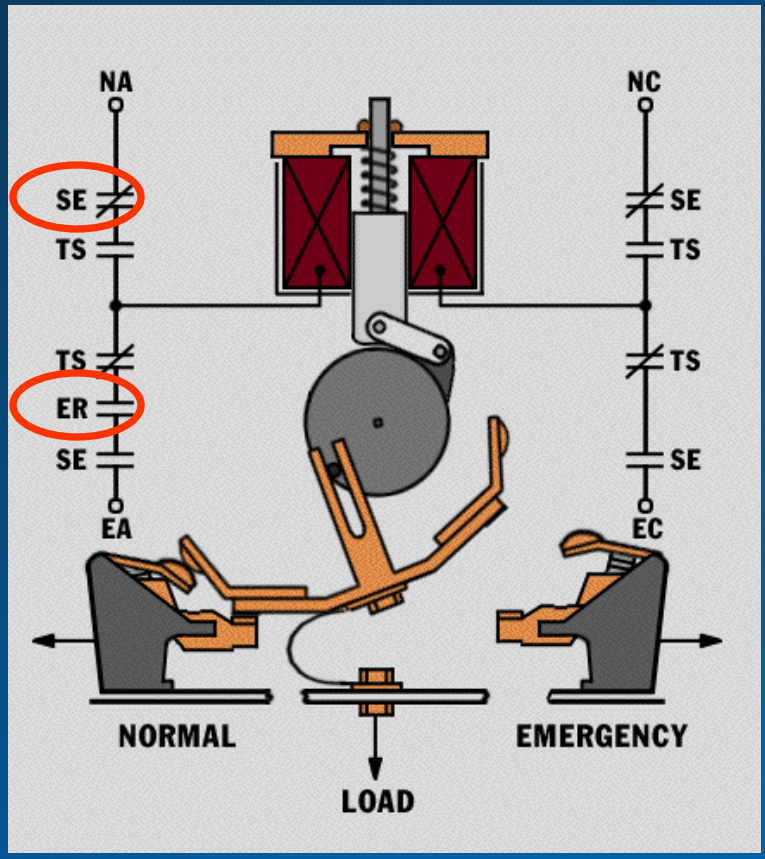
Pole Covers

Daniel Barrios

Automatic Transfer Switch Operation

Transfer Switch Controls

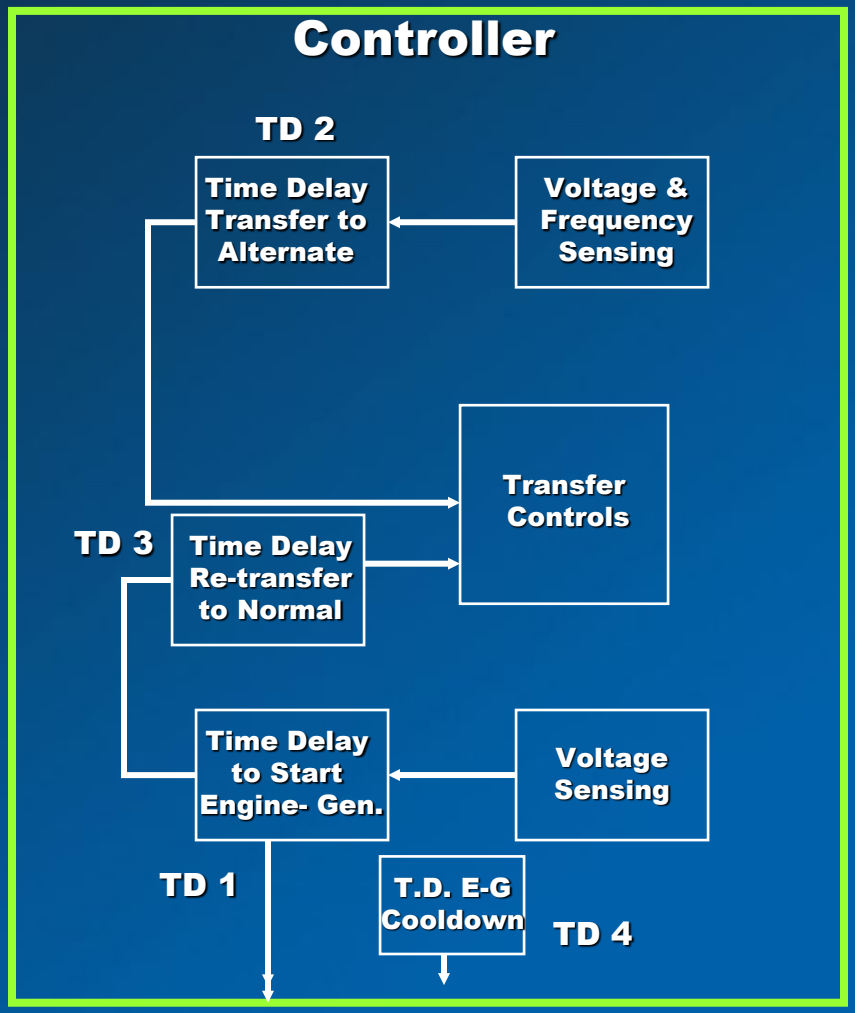
- The operator of the ATS is powered by relays in the controller
- The controller initiates transfer of the load by energizing the SE (normal) relay for emergency to normal transfers or the ER (emergency) relay for normal to emergency transfers.
- The switch operator is always powered from the source to which the load is being transferred



Automatic Transfer Switch Operation

ATS Control Circuit Design

- Transfer Switch Controls
  - Microprocessor
- Source Monitoring
- Time Delays
- Annunciation & Control
  - Pilot Lights & Test Switch
  - Auxiliary Contacts
  - Control Signals



Automatic Transfer Switch Operation

Methods for Initiating Transfer

- Automatic Operation
  - Complete power source failure or deviations outside preset limits
  - Programmable exercise timer in ATS controller
- Manual Operation
  - Local test switch
  - External customer commands
    - Dry contact
    - Remote test switch

Automatic Transfer Switch Operation
Source Monitoring

- **Automatic Power Sensing Parameters**
  - Source voltage
    - UV/OV on all three phases of normal source
    - Single phase UV & under frequency on emergency source
    - Voltage unbalance detection
    - Phase sequence monitoring for phase sensitive loads
  - Most ATS controllers typically do not monitor load current , but metering is offered as an optional accessory

Automatic Transfer Switch Operation

Typical Sequence of Operation

Time Delays

- Momentary Normal Source Failure Override
  - Delays all transfer signals to override voltage transients on the normal source or allow OC devices to clear short circuit faults - set at 1 second
- Normal to Emergency Transfer Time Delay
  - Allows emergency source V & F to stabilize and enables sequential load transfer to emergency on multiple ATS installations - set at 5 minutes

Automatic Transfer Switch Operation

Time Delays

- **Momentary Normal Source Failure Override**
  - Delays all transfer signals to override voltage transients on the normal source or allow OC devices to clear short circuit faults - set at 1 second
- **Normal to Emergency Transfer Time Delay**
  - Allows emergency source V & F to stabilize and enables sequential load transfer to emergency on multiple ATS installations - set at 0 for life safety switches and TD settings to sequence transfer

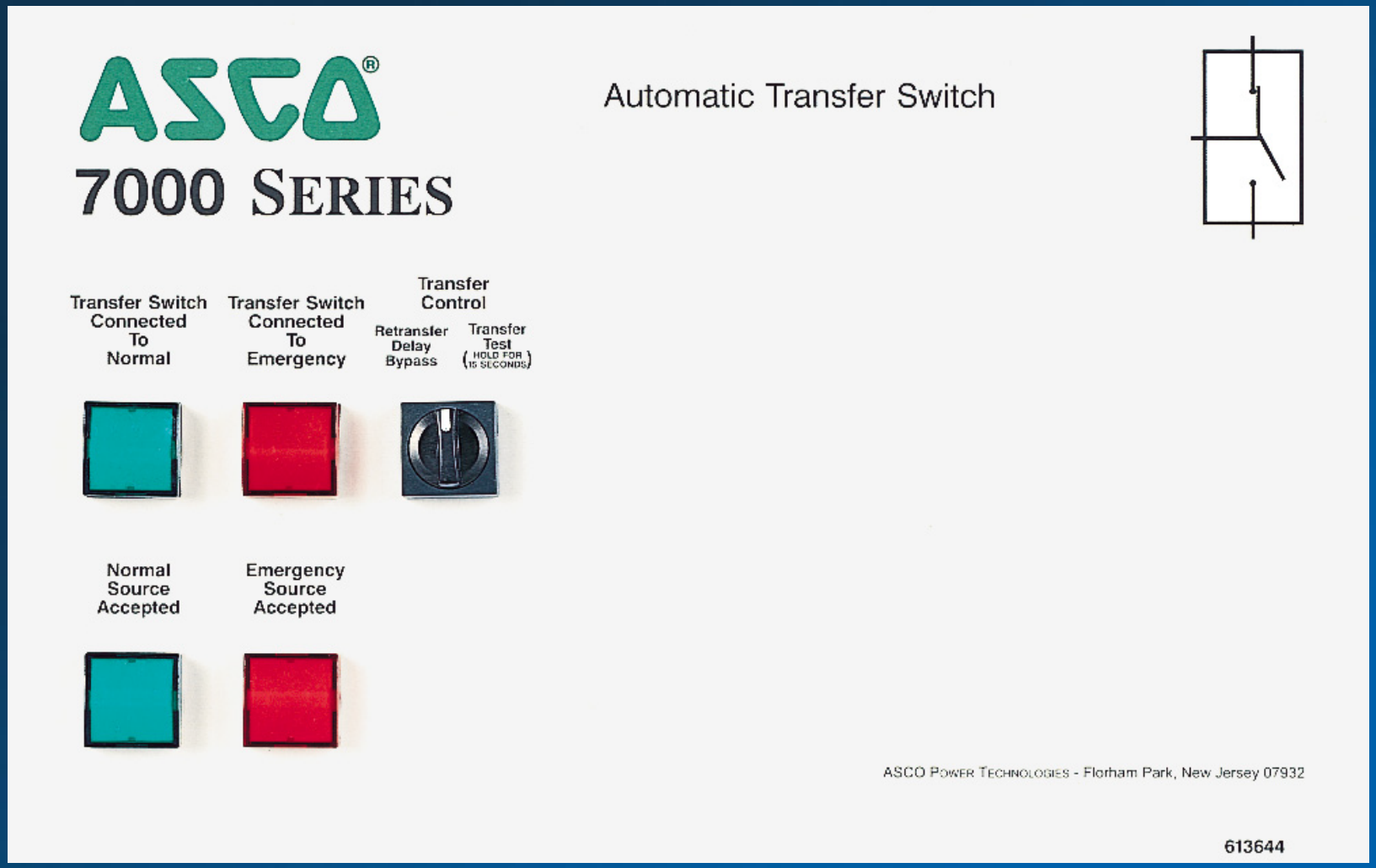
Automatic Transfer Switch Operation

Time Delays (Continued)

- Emergency to Normal Transfer Time Delay
  - Allows normal source to stabilize prior to re-transferring the load from emergency to normal - set at 30 minutes. Separate TD setting for test mode
- Engine Cool Down Time Delay
  - Allows generator run unloaded after the load has been retransferred to the normal source
- Engine Generator Stabilization Time Delay
  - Overrides momentary voltage & frequency transients during initial generator set loading

Automatic Transfer Switch Operation

User Interface Panel



Transfer Switch Ratings

Transfer Switch Ratings

- Number of Poles
- Maximum Voltage
- Current Rating

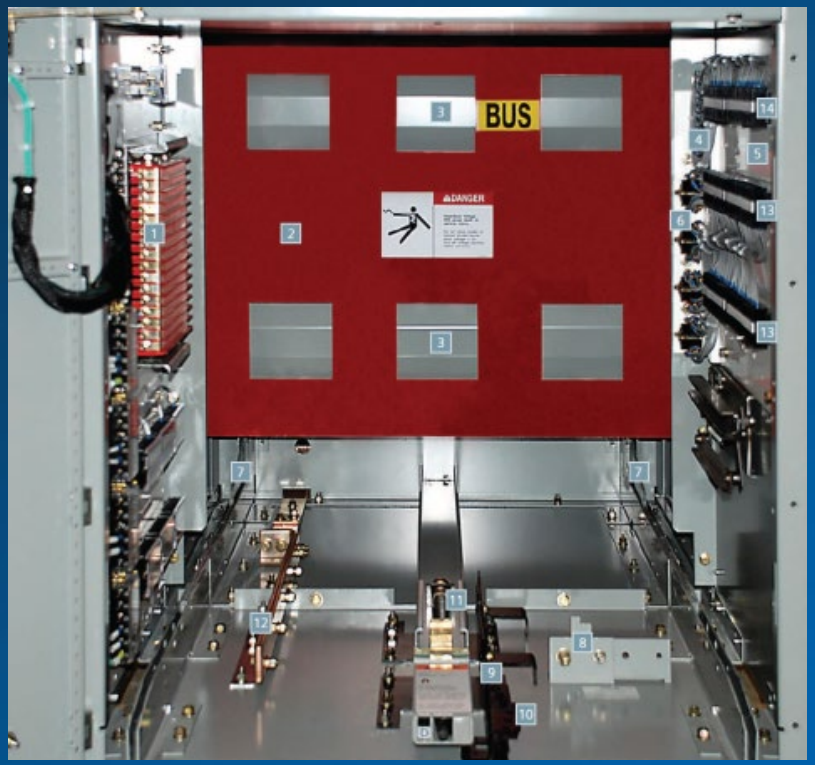
Transfer Switch Ratings

Voltage and Frequency Ratings

- Low Voltage - 120 to 600 Volts AC, 250 VDC
- 50 or 60Hz, Also DC
- Medium Voltage Transfer Switches - 5 to 15 KV

Transfer Switch Ratings

Medium Voltage Transfer Switch



- 15KV Medium Voltage Transfer Switch

Transfer Switch Ratings

Current Ratings

- Continuous
- Inrush
- Interrupt / Overload
- Withstand / Closing Rating

Transfer Switch Ratings

Continuous Current Rating

- Must Carry 100% of Rated Current 24 Hrs/Day
- In Both Normal or Emergency Positions
- 7 Days/Week for 20 to 40 Years
- No Overheating of Contacts

Transfer Switch Ratings

Interrupt Rating

UL1008 Over Load Testing

- Incandescent Lamp or Resistive - 1.5X Rated Current
- Electric-Discharge- Lamp Control - 3X Rated Current
- Motors or Total System Load - 6X Rated Current for AC
- 20 to 600% of Continuous Rating for All Classes of Load

Transfer Switch Ratings

Transfer Switches & Circuit Breakers

- An automatic transfer switch connects a critical load to an alternate power source when the normal power source is not acceptable. It must be able to withstand & close-on short circuit currents - WCR.

- A circuit breaker's function is to disconnect the circuit and the load from the power source under overcurrent conditions. It must be capable of interrupting or breaking short circuit currents - AIC

Transfer Switch Ratings

Withstand / Close-on Rating (WCR)

- Withstand Short Circuit Amps Until OCD Clears Fault
- Short Circuit Current Causes Extreme Heat and Magnetic Stresses
- ATS Contacts Must Not Weld to the Point Where It Cannot Transfer to the Alternate Source Automatically

Transfer Switch Ratings

Short Circuit/Fault Considerations

2.4-15KV

Transformer

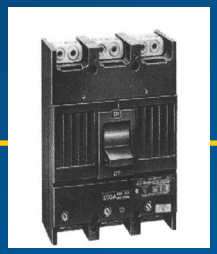
480, 208, 240

Fault Current Delivery

ATS Must Close-On And Withstand Fault Energy Levels

Engine

Gen



F_2

F_1

- Multiple EGs May Deliver More Fault Current Than Utility Service

Transfer Switch Ratings
Withstand / Close-on Rating (WCR)

- WCR Rating is inversely proportional to length of fault current time - the longer the fault time, the lower the current it can withstand or close-on
- Typical Clearing Times
  - Fuses: 4-8mS
  - MCBs: 25-33 mS
  - Power Bkrs w/Inst Trip: 50-60mS
  - Power Bkrs w/o Inst Trip: 0.1-0.5 Secs

Any Circuit Breaker or Current Limiting Fuses

ASCO Transfer Switch Product	Transfer Switch Frame Prefix	Transfer Switch Rating (amps)	Transfer Switch Short Circuit Withstand Current Ratings (I_{sc}) (kA RMS Symmetrical Amps)					
			When Protected With Any Circuit Breaker			When Protected With Current Limiting Fuses		
			I_{sc} 480 VAC max.	I_{sc} 600 VAC max.	Time Cycles @ 60Hz	I_{sc} 480 VAC max.	Fuse Size (amps)	Fuse Class
175, 300, 386, 7ATS, 7NTS, 7MTS	D	30	10	10	1.5	100	60	J
		70 100 150				200	200	
175, 300, 386, 7000 TS, 7000 BP	E	150	35	22	3	200	450	
175, 300, 386, 911 7000 TS, 7000 BP		260 400					600	
300, 386, 911 7000 TS, 7000 BP	H	600 800 1000 1200	50 65 36	50 65 36	3 1 18		1600	L
300, 386, 911 7000 TS, 7000 BP	G	1000 1200	85 65	85 65	3 30		2000	
		1600 2000	100 65	100 65	3 30		3000	
		3000					4000	
300, 386, 7000 TS, 7000 BP	E	4000					6000	

Withstand / Close-on Ratings

Critical Power Switches Have 0.05 Sec (Formerly 3 Cycle “Any Breaker”) Rating

UL Listing Valid Only if Used with the Circuit Breakers Indicated on Manufacturers Label. Listing must Include Numerous Breakers for Application Flexibility.

Power Switching Methods & Solutions

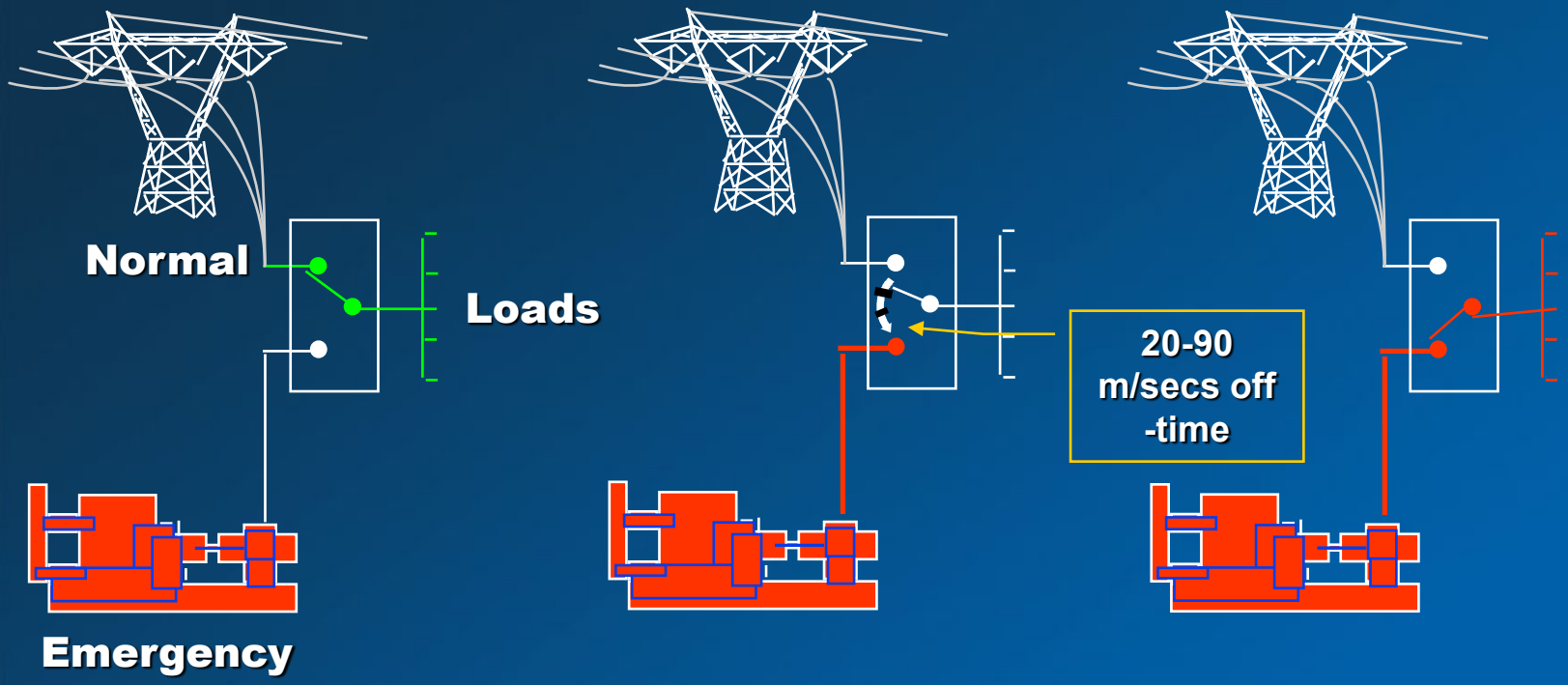
Power Switching Methods & Solutions

- Standard Normal seeking ATS
- Non-selective (Normal) ATS
- Delayed Transition Switches
- Closed Transition Switches
- Automatic Transfer Bypass-Isolation Switches

Power Switching Methods

Most Automatic Transfer Switches Are "Normal Seeking"

Load stays connected to the normal source until the source fails or is unacceptable. It will transfer the load back to normal source when it is restored or becomes acceptable.



Power Switching Methods

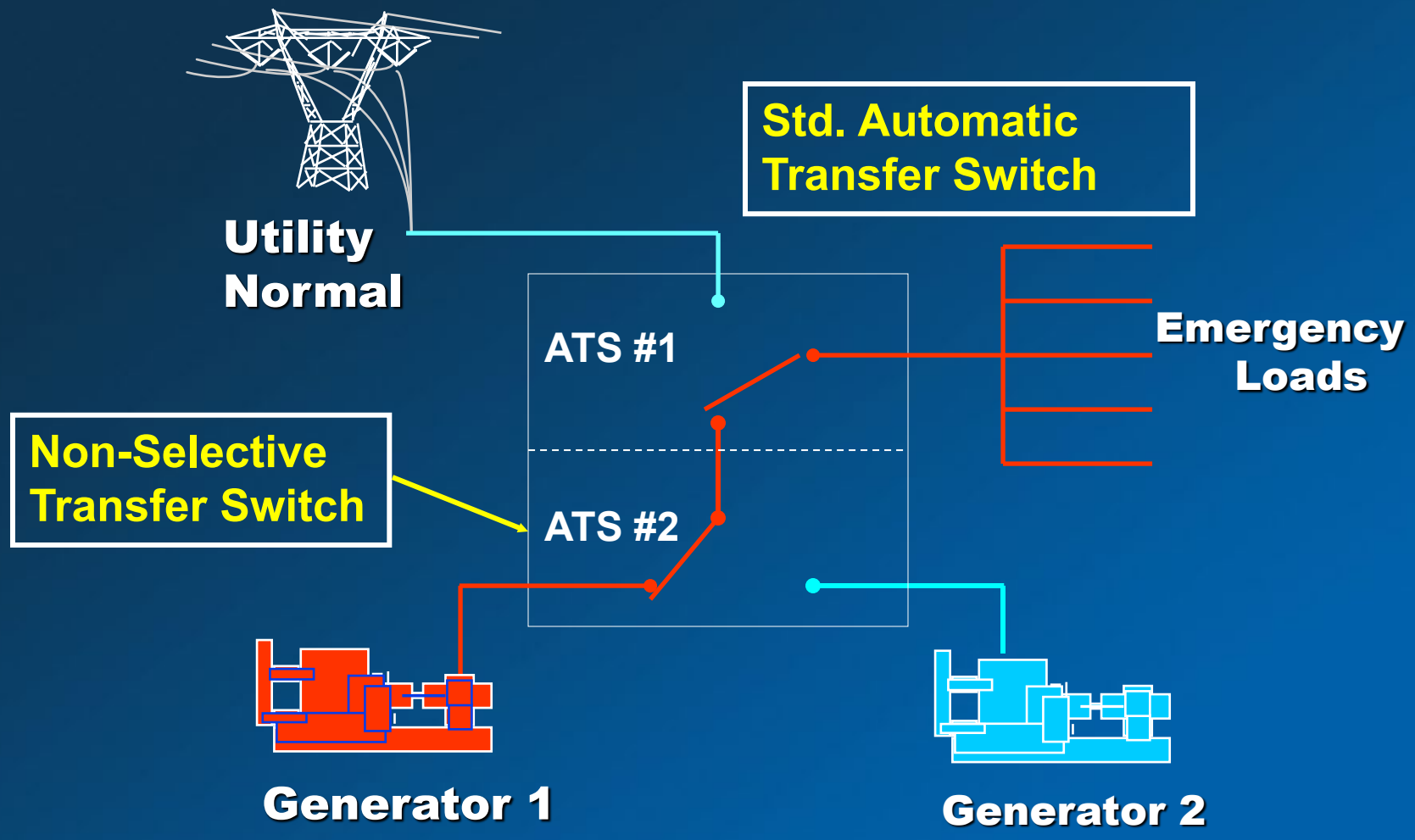
Non - Selective Automatic Transfer Switch

An automatic transfer switch whose control circuitry is configured so it has **no preference as to which source is connected to the load.** In other words, it is a **power seeking device.**

- Sequence of Operation
  - The transfer switch is configured to transfer the load to an alternate source upon failure of the connected source.
  - The transfer switch does not retransfer upon restoration of the original power source.
  - The transfer switch only re-transfers to the original source if the alternate source fails, or the test switch is activated.

Power Switching Methods & Solutions

Three Source Power System

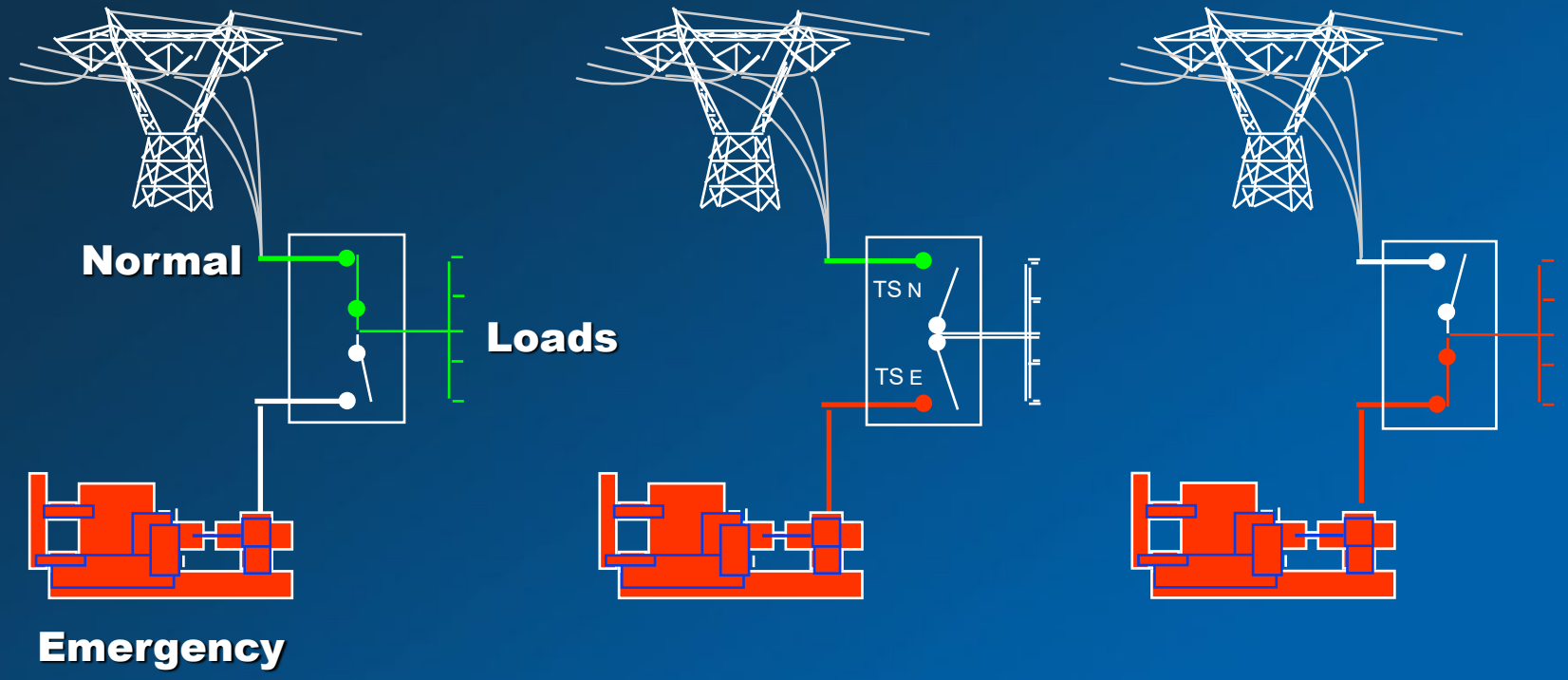


Power Switching Methods & Solutions

- Standard Normal seeking ATS
- Selective Normal ATS
- Delayed Transition Switches
- Closed Transition Switches
- Automatic Transfer Bypass-Isolation Switches

Power Switching Methods & Solutions

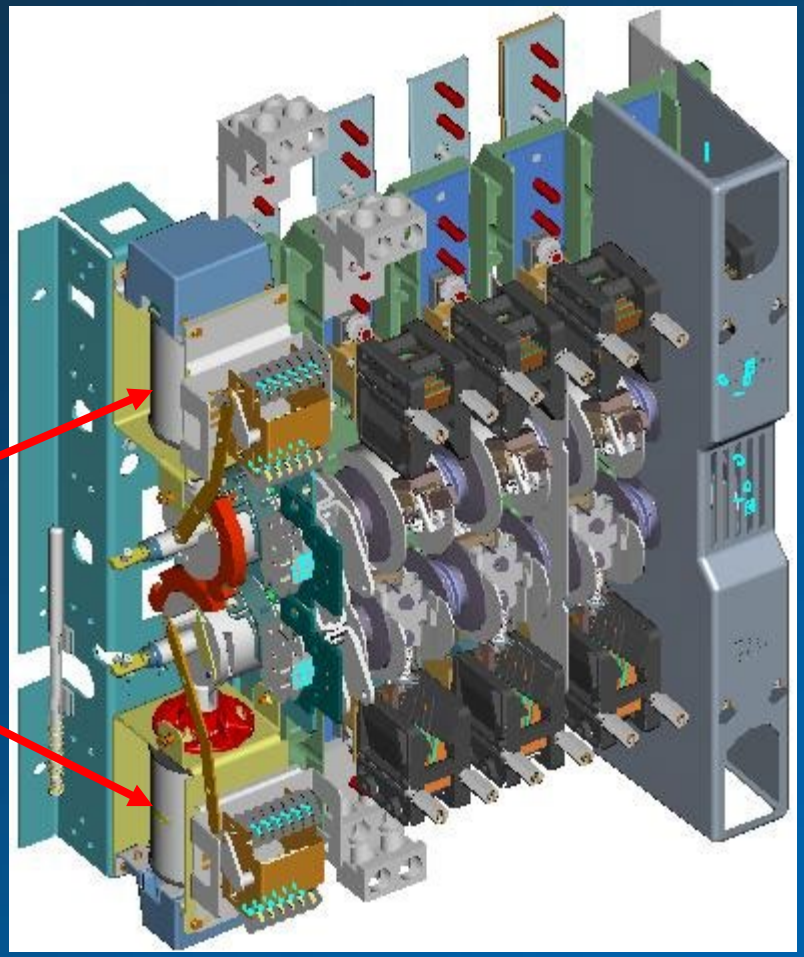
- Break Both Sides - Delayed Transition
  - One set of contacts opens before the other set closes
  - The other sets of contacts delays in closing
  - Load is disconnected from power during all transfers



Power Switching Methods & Solutions

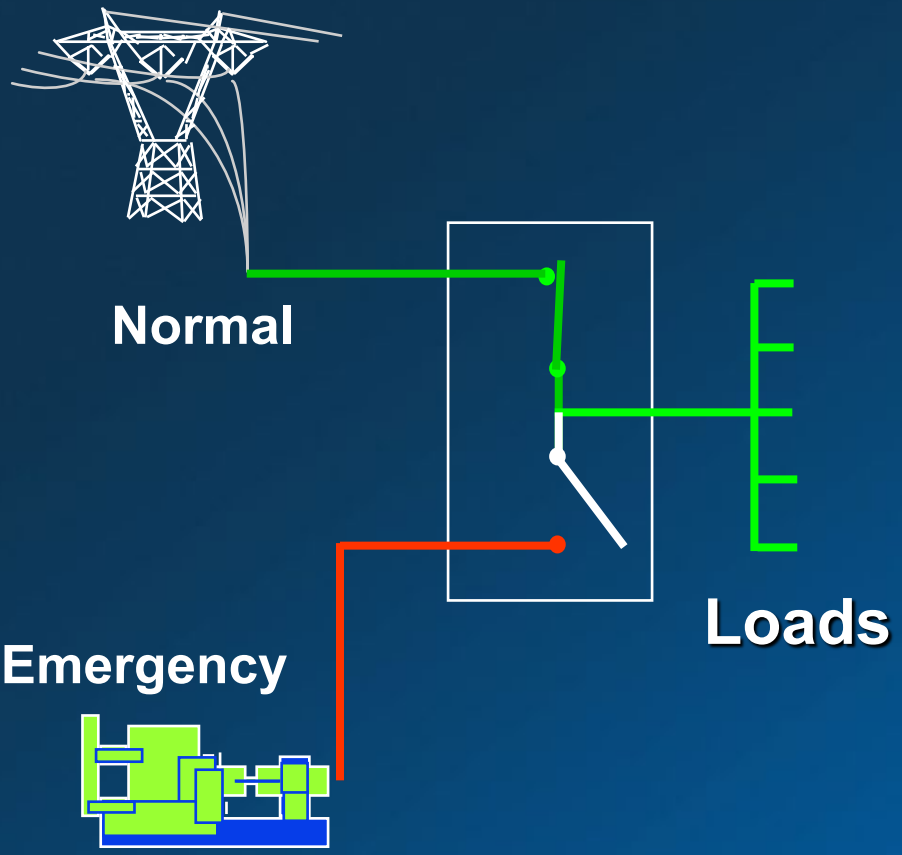
Transfer Panel Major Components

DUAL SOLENOID ASSEMBLY



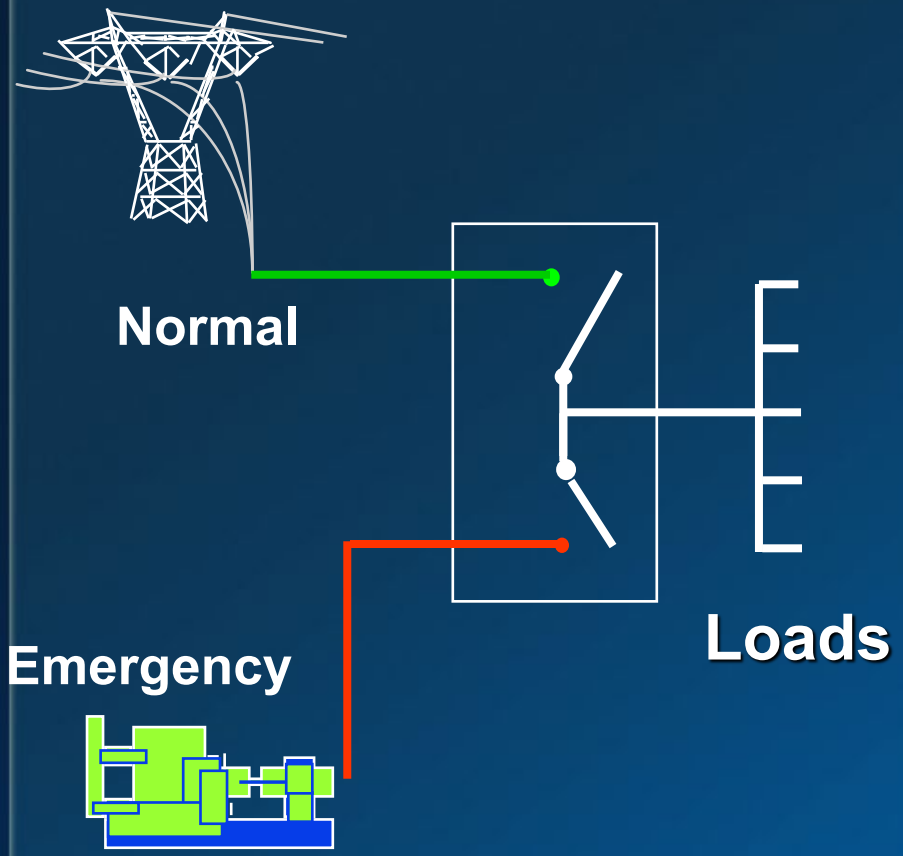
Power Switching Methods & Solutions

Delayed Transition Transfer Switch



- Time Delayed Neutral Position to Allow Motor Voltage to Decay
- Mechanical Interlock for Inadvertent Manual Operation
- Off Position Time Delay Can be Adjusted as Long as Necessary to Minimize Any Load Transients from Motors, Large Xfmrs, Old Design VFDs

Delayed Transition Transfer



Disadvantages of DTTS:

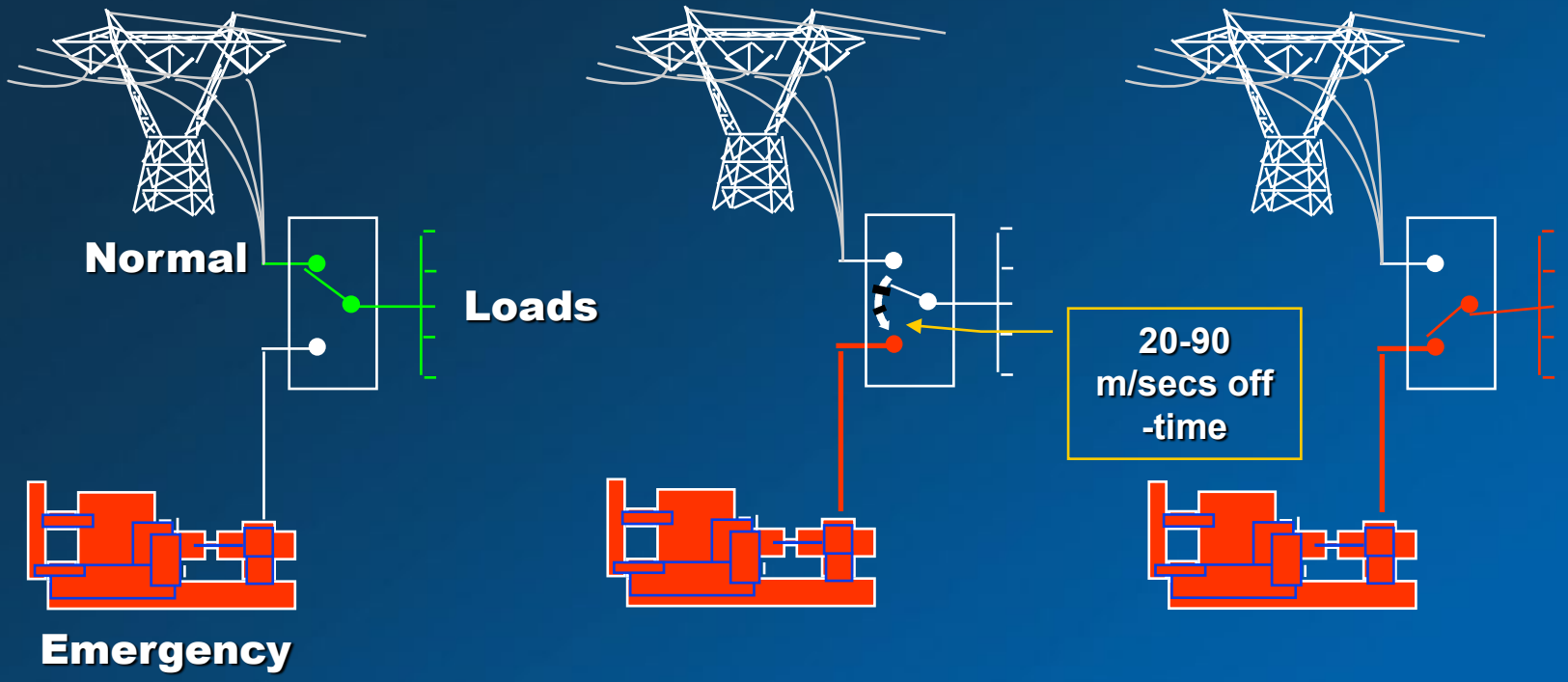
1. Off Position on ATS
2. Other Loads Without Power
3. Need to Know Motor Time Constant
4. Other Switching Solutions for Motor Load Transfer Will be Discussed in the Advanced Power School Class

Power Switching Methods & Solutions

- Standard Normal seeking ATS
- Selective Normal ATS
- Non-selective (Normal) ATS
- Delayed Transition Switches
- Closed Transition Switches
- Automatic Transfer Bypass-Isolation Switches

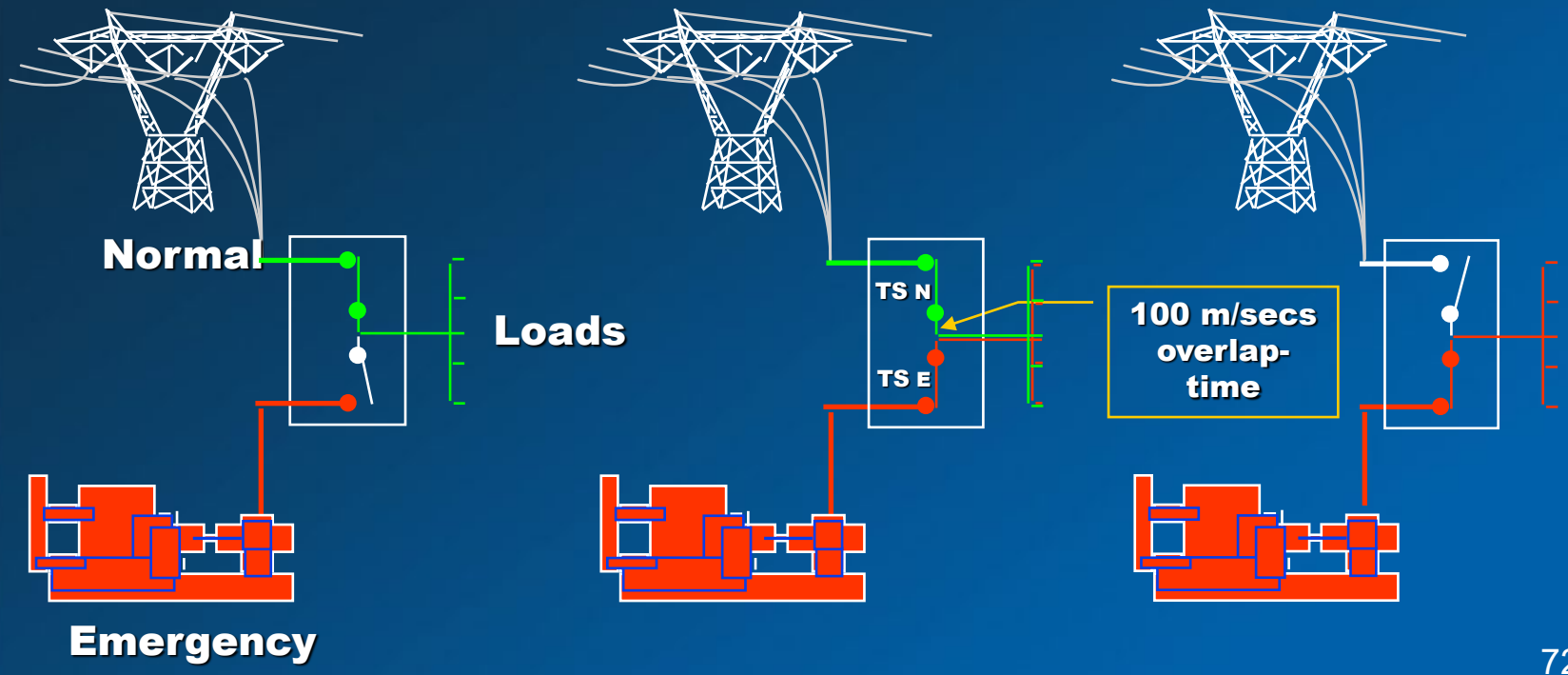
Power Switching Methods & Solutions

- **Break Before Make - Open Transition**
  - One set of contacts opens before the other set closes
  - Load is momentarily disconnected from power during all transfers



Power Switching Methods & Solutions

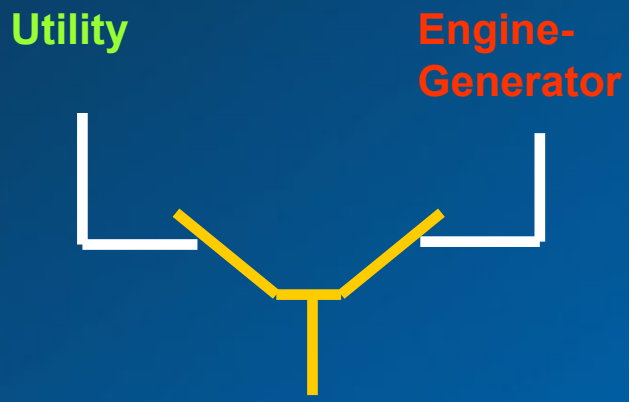
- Make Before Break - Closed Transition
  - Contacts overlap with hot-hot & acceptable sources
  - Load is not disconnected from power during transfers



Power Switching Methods & Solutions

Closed Transition Transfer Requirements

- Both Sources Must Be Present
  - +/- 5% Voltage Differential
  - +/- 0.2 Hz. Frequency Differential
    - Isochronous Governor Required
  - +/- 5 Electrical Degrees Phase Angle Difference
    - Operates in the Open Transition Mode w/Source Failure

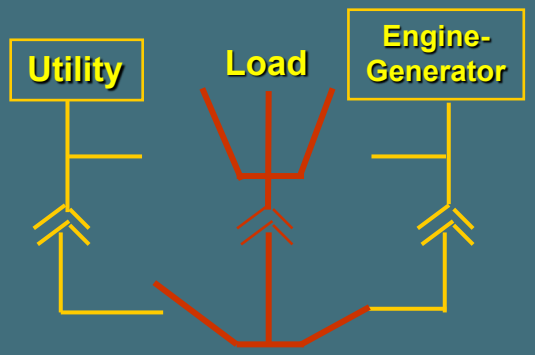


Power Switching Methods & Solutions

- Standard Normal seeking ATS
- Selective Normal ATS
- Non-selective (Normal) ATS
- Delayed Transition Switches
- Closed Transition Switches
- **Automatic Transfer Bypass-Isolation Switches**

Power Switching Methods & Solutions

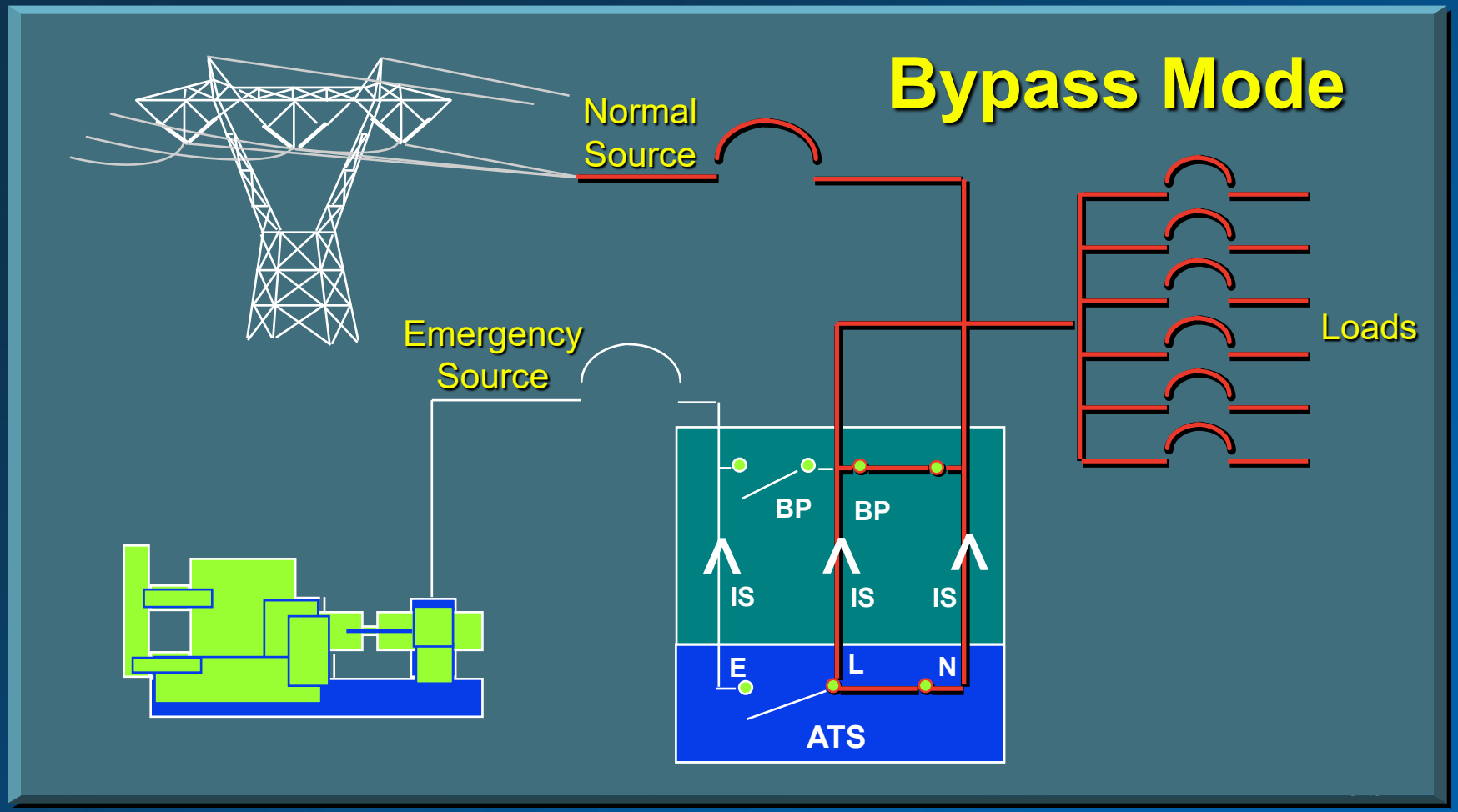
Transfer Bypass - Isolation Transfer Switch



No Load Break Type
Transfer Switch
With Bypass-Isolation

Automatic Transfer/Bypass Isolation Switch

Testing And Maintenance
No Load Interruption



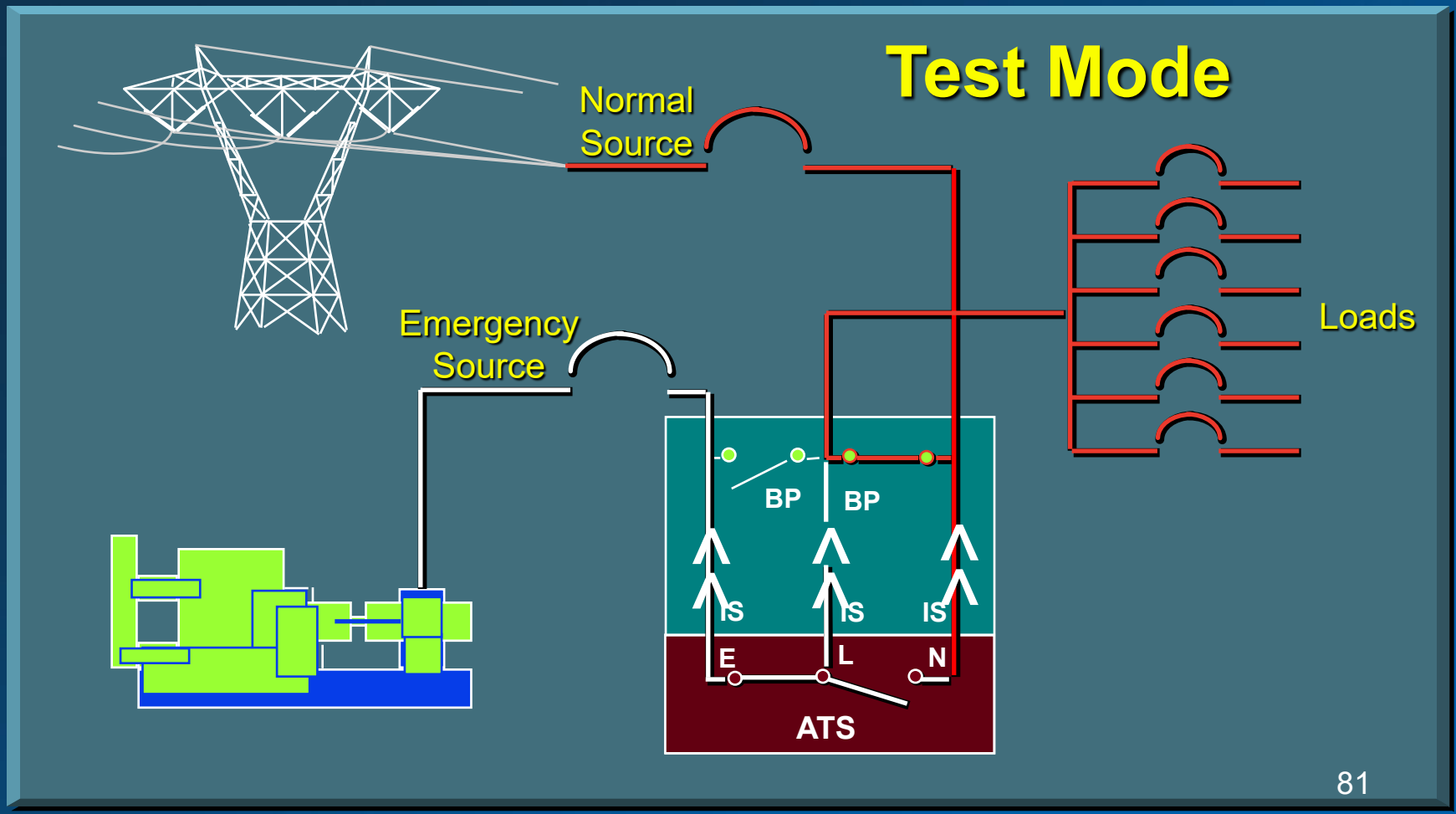
Automatic Transfer Bypass-Isolation Switch

Turn to “TEST” Position

Isolation Handle

Automatic Transfer/Bypass Isolation Switch

Testing And Maintenance
No Load Interruption



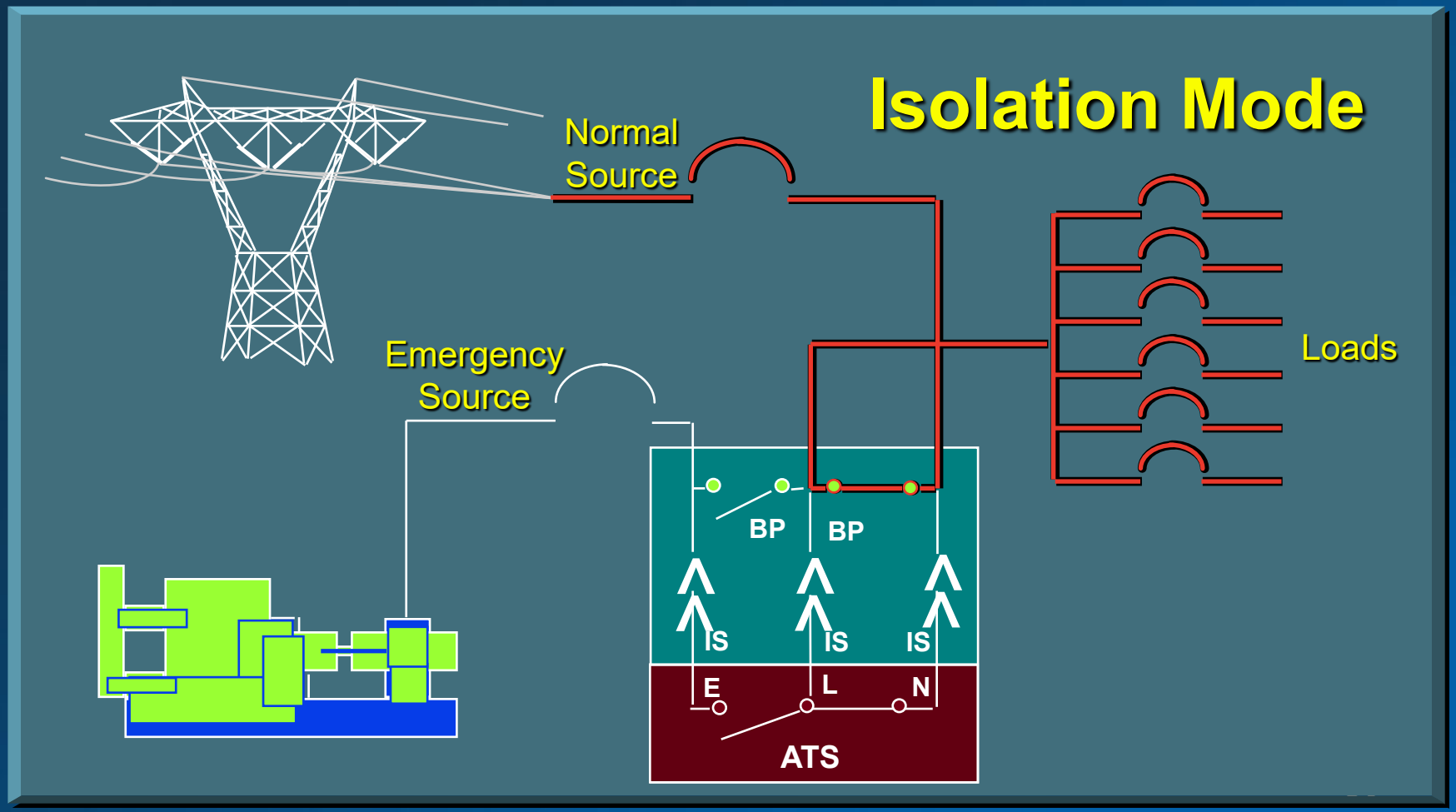
Automatic Transfer Bypass-Isolation Switch

Turn to “ISOLATE” Position

Isolation Handle

Automatic Transfer/Bypass Isolation Switch

Testing And Maintenance
No Load Interruption

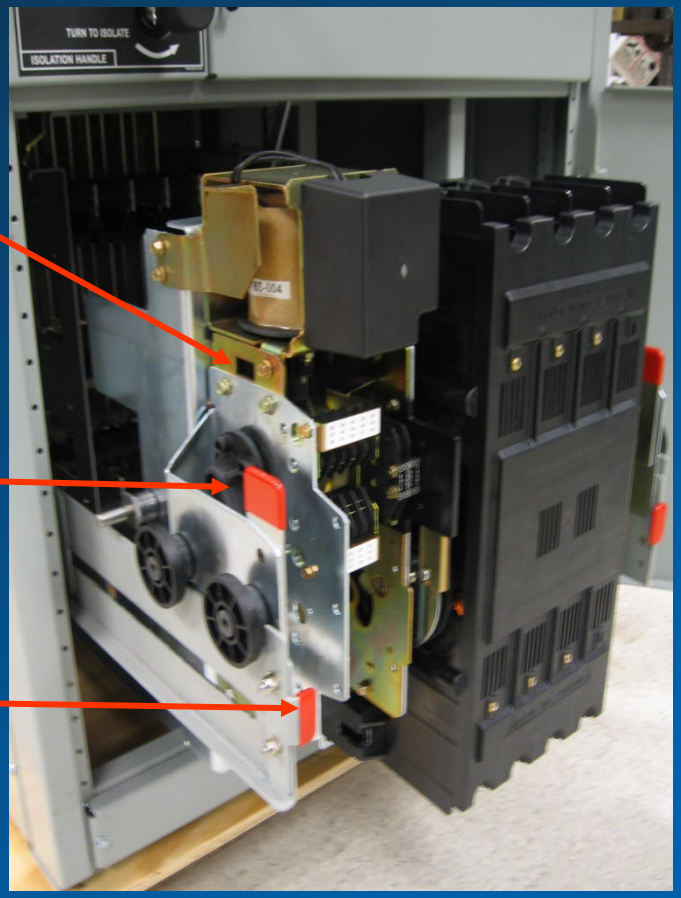


Automatic Transfer Bypass-Isolation Switch

Lifting Yoke for Transfer Switch

Tabs to Drawout Transfer Switch

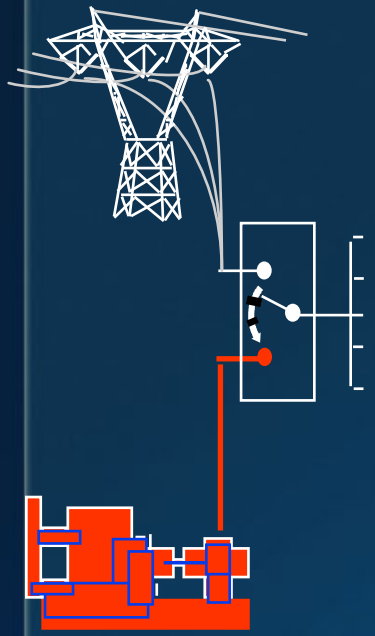
Tabs for Drawout Rails



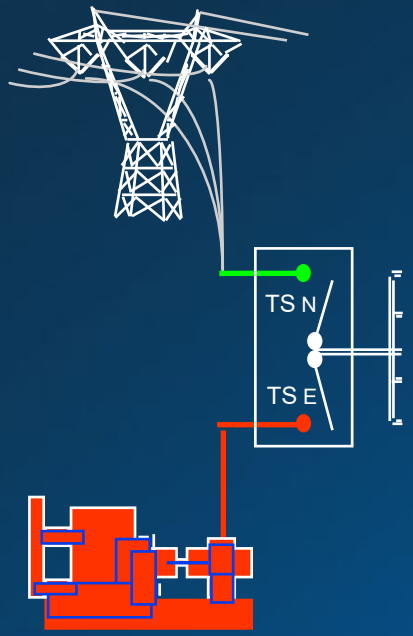
Power Switching Methods & Solutions

- Automatic Transfer Bypass-Isolation Switch Functions
  - Allows Inspection & Maintenance of ATS Without Interrupting Power to the Load
  - Allows Testing of the ATS Without Interrupting Power to the Load
  - Allows Manual Transfer of the Load if Power Fails When the ATS is Disconnected From the Load (Isolation Mode)

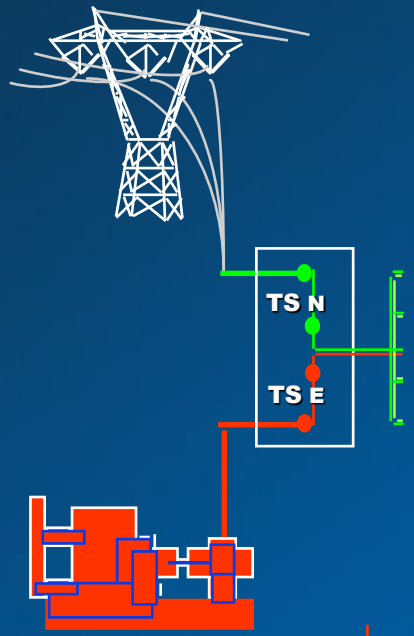
Automatic Transfer/Bypass Isolation Switch



Automatic Transfer Switch



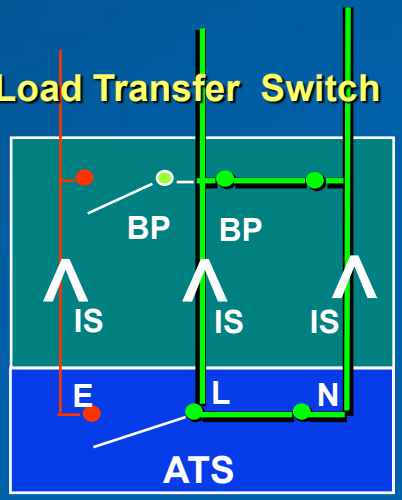
Delayed Transition Switch



Closed Transition/ Soft Load Transfer Switch

Automatic transfer switches are
normal (or utility) seeking electro-mechanical devices.

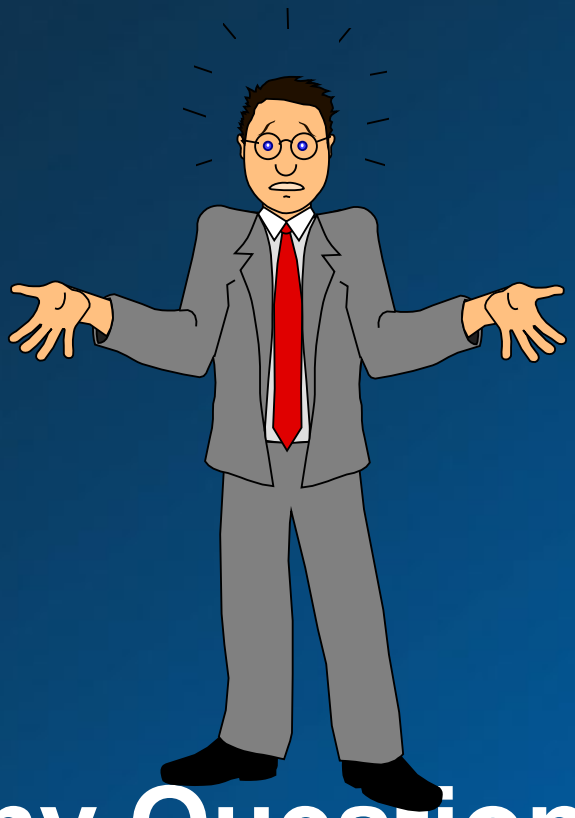
Any Transfer Switch
with Bypass - Isolation



ADVANCED TRANSFER SWITCH

- Advanced Transfer Switch Module will include:
  - Closed Transition Switches
  - Soft Load Transfer Switches
  - Static Transfer Switches
  - Service Entrance Rated Transfer Switches
  - Motor Load Transfer
  - Neutral Switching
  - Communications Networks
  - Review of Basic ATS Module

Power Switching Solutions



Any Questions?