

**PROFESSIONAL
DEVELOPMENT
SEMINAR
SERIES**

Welcome to GPS 110

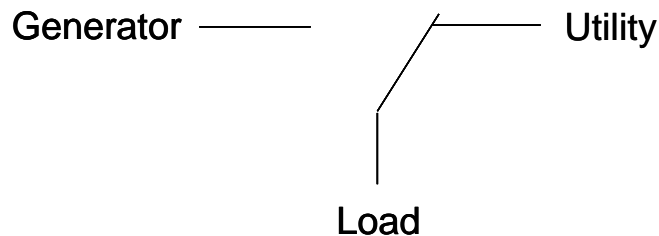
Generator Switching



Generator Switching

AUTOMATIC TRANSFER SWITCHES (ATS)

- An Automatic Transfer Switch transfers the connected load from one source of power to another.
- Generally, the two power sources are:
 - Utility
 - Generator



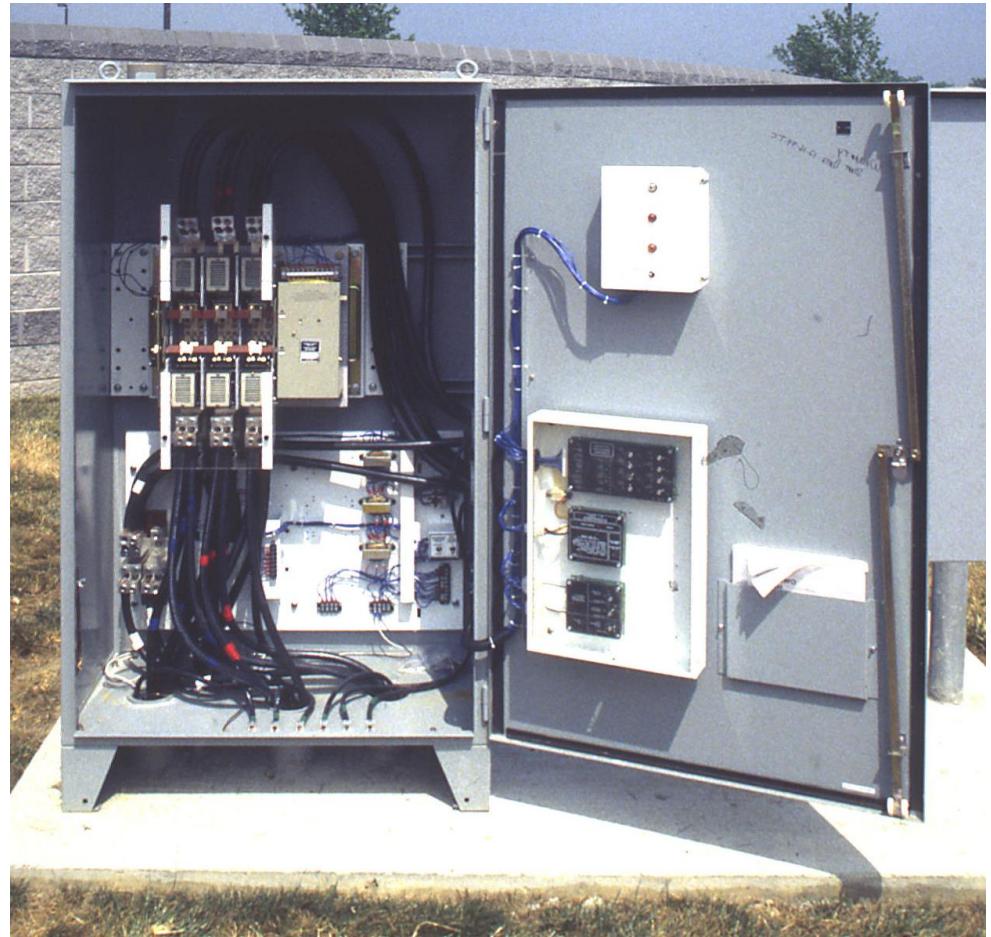
WHAT DOES AN ATS LOOK LIKE?

- **ATS Enclosures**
 - Indoor (NEMA 1 & 12)
 - Outdoor (NEMA 3R)
 - Non-corrosive (NEMA 4x)



WHAT DOES AN ATS LOOK LIKE?

- **Controller**
- **Indicating lights**
- **Test switch**
- **Transformers**
- **Contactor**
- **UL 1008 Sticker**



Generac TX Transfer Switch



Generac TX Transfer Switch

BEST IN CLASS TX SERIES TRANSFER SWITCHES

As a single source supplier, Generac offers a full line of Industrial Transfer Switches to meet varying needs from light industrial applications all the way to the most demanding critical installations. New to the Industrial Transfer Switch line is the TX Series. The TX Series switches are both Generac designed and built in house with exceptional features that meet, and exceed, any application needs.

CERTIFICATIONS & RATINGS

- Rated for use in any of the following applications:
 - Optional standby systems (702)
 - Legally required systems (701)
 - Emergency systems (700)
 - Critical operation power systems (708)
- UL 1008 certified through ETL
- Meets all relevant NEC codes

ADDITIONAL PERFORMANCE FEATURES

- Front accessible customer connections
 - Voltage agnostic
 - Controller Access
 - Battery Replacement
 - Terminal Board for I/Os
- Front accessible standard USB port for firmware updates
- Programmable heater for temperature control, standard on NEMA 3R enclosures

SAFETY & RELIABILITY

- No PPE required for controller use, firmware updates, or data downloads when the enclosure door is installed
- High withstand and closing ratings (WCF) with optional 3 cycle ratings available

ACCESSORIES

- Integrated metering with optional current transformers
- NEMA 3R Pad-lockable Cover for Controller (Standard on 3R Enclosure)
- Emergency inhibit
- Manual generator retransfer
- Time delay in neutral transition (TDN), or in-phase with a default to time delay in neutral transfer
- Expandable input/output board module includes 4 relay outputs and 4 optically isolated inputs

All of our transfer switches are available in contactor type, which are double-throw and interlocked with an over-center design to ensure safe, positive transfer between power sources.

CONTROLLER

- Built in battery backup increases switch reliability and reduces switch transition time to alternate source, with the battery backup able to provide power to the controller for 60 minutes in the event of no source availability

100% RATED ON SERVICE ENTRANCE MODELS

- Readily accessible service entrance breaker meets code requirements and prevents the need to upsize to a larger switch for full rated coverage

MODULAR DESIGN

- Removable mounting brackets for single person install
- Removable top bracket for easy mounting
- Top and bottom plates can be removed and used as gland plates



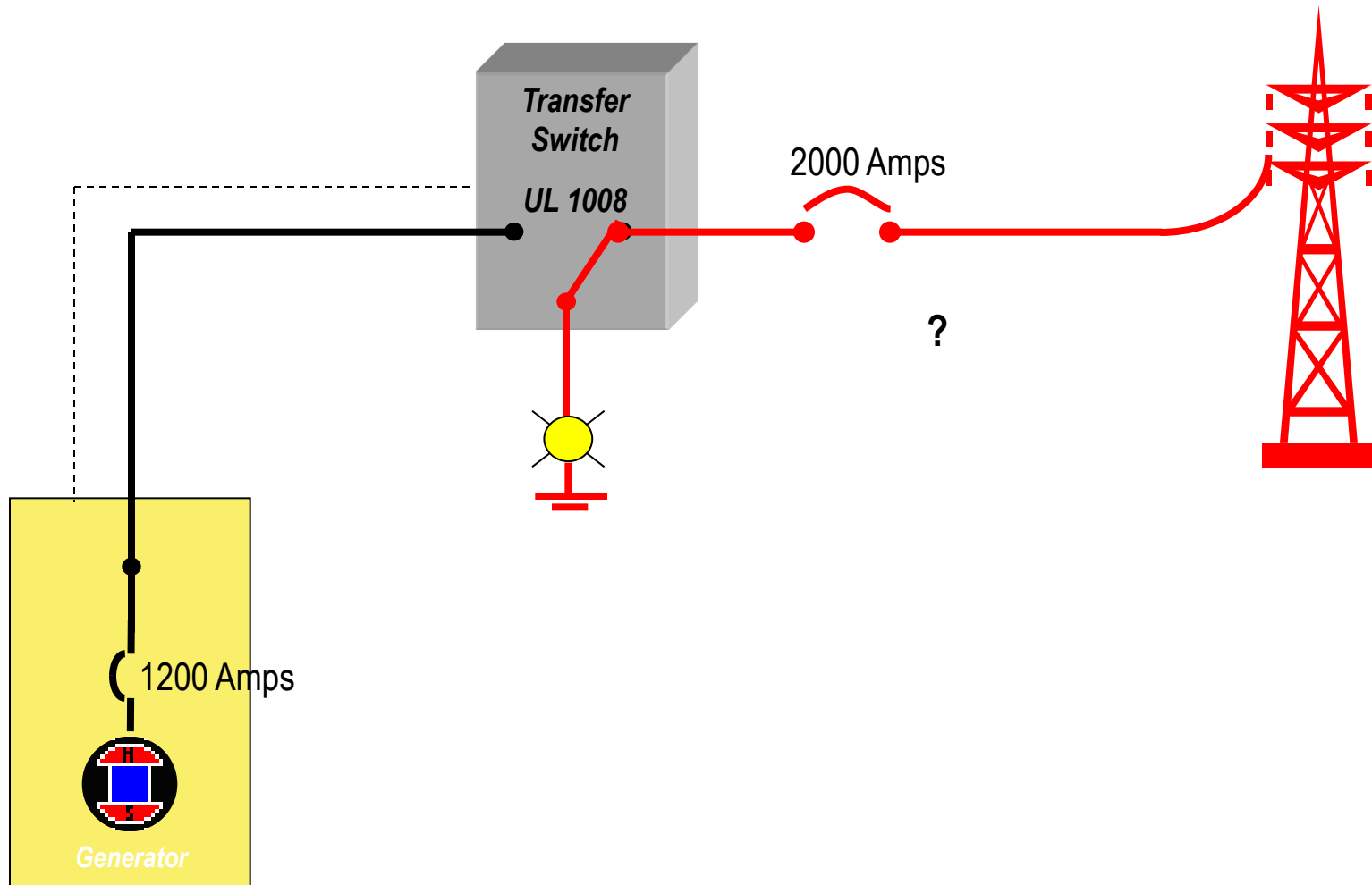
ENCLOSURE OPTIONS

- NEMA 1 or NEMA 3R enclosures available
- Field convertible from NEMA 1 to NEMA 3R
- Optional controller and breaker covers available for NEMA 1 (Standard with 3R enclosures)
- Programmable heater standard on NEMA 3R enclosures (Settable Range -10 to 50° C [14 to 122°F])

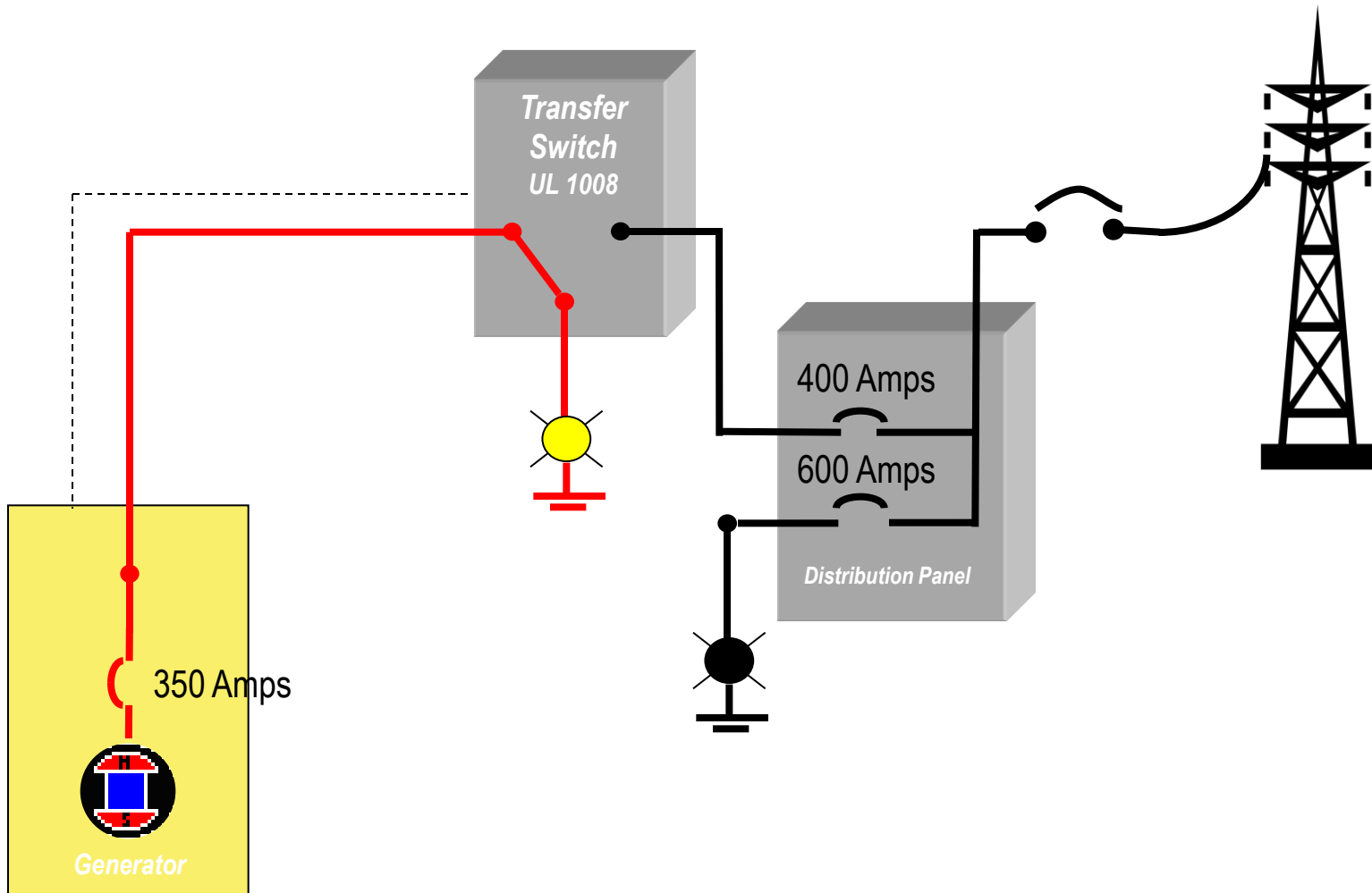
TX SERIES CONTROL SYSTEM

- 3 wire start circuit compliant per NEC 2017 Article 700.10(D)(3) built in as standard
- Voltage agnostic (120/208, 120/240, & 277/480V) programmable control without the need of additional parts, modules, or re-wiring
- Front programmable control
- Programmable engine exerciser - daily, weekly, bi-weekly, or monthly
- Time and date stamped event history log (records 200 events)
- Standard UL2054 listed lithium ion battery pack backup energizes for one hour and input for redundant generator battery backup
- Update controller firmware without personal protective equipment (PPE)
- Modbus RTU communications protocol

TYPICAL TOPOLOGIES



TYPICAL TOPOLOGIES



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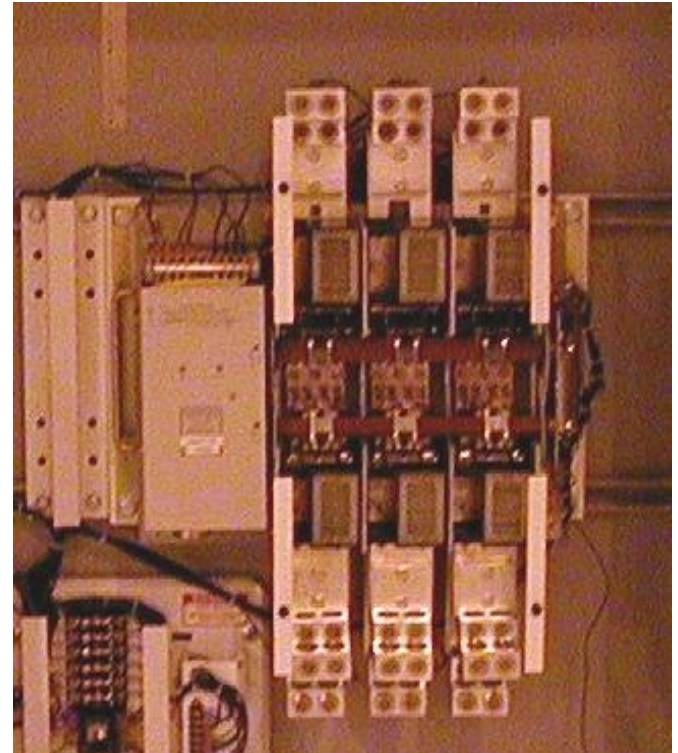
OPEN TRANSITION

**Standard Switches
Operating Sequence**

Generator Switching

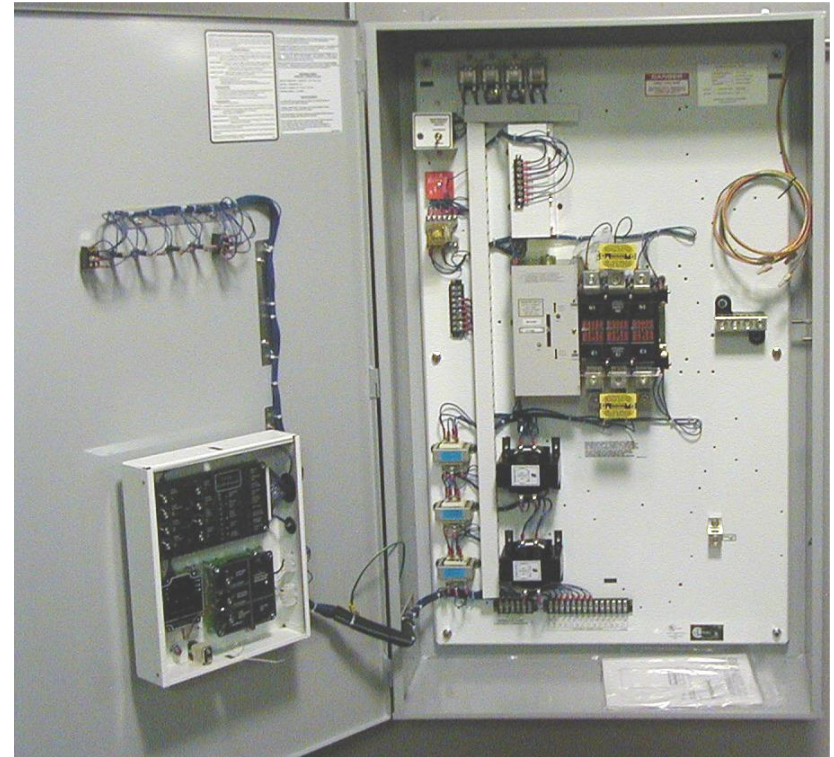
OPEN TRANSITION

- **Open Transition ATS**
 - “Break” before “Make”
 - Interrupts power to the load
 - ◆ During all transfers



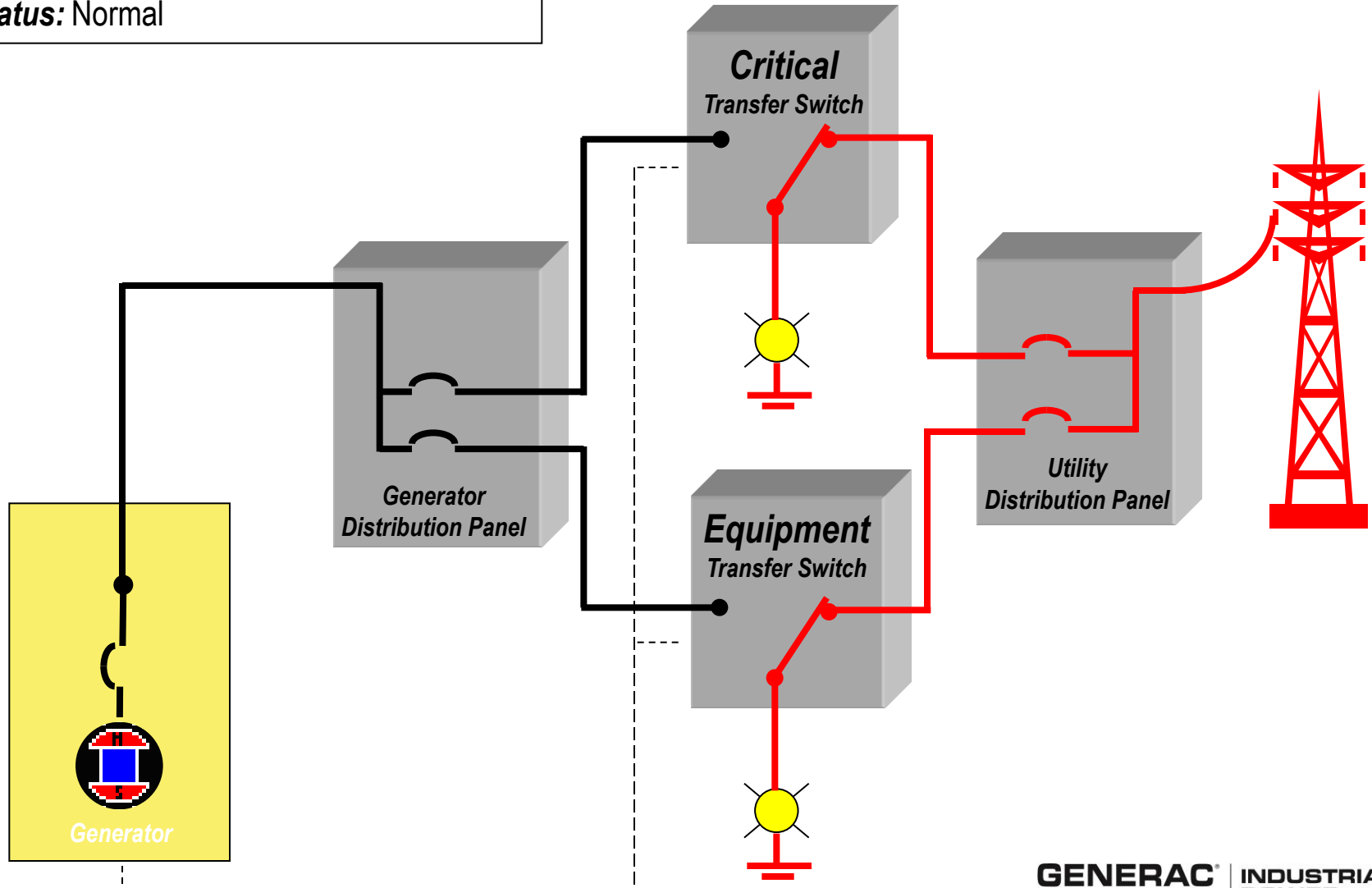
OPEN TRANSITION

- **Open Transition Switches**
 - Cost-effective
 - Most commonly used
 - Momentary outage on retransfer
 - Outage to maintain switch contacts



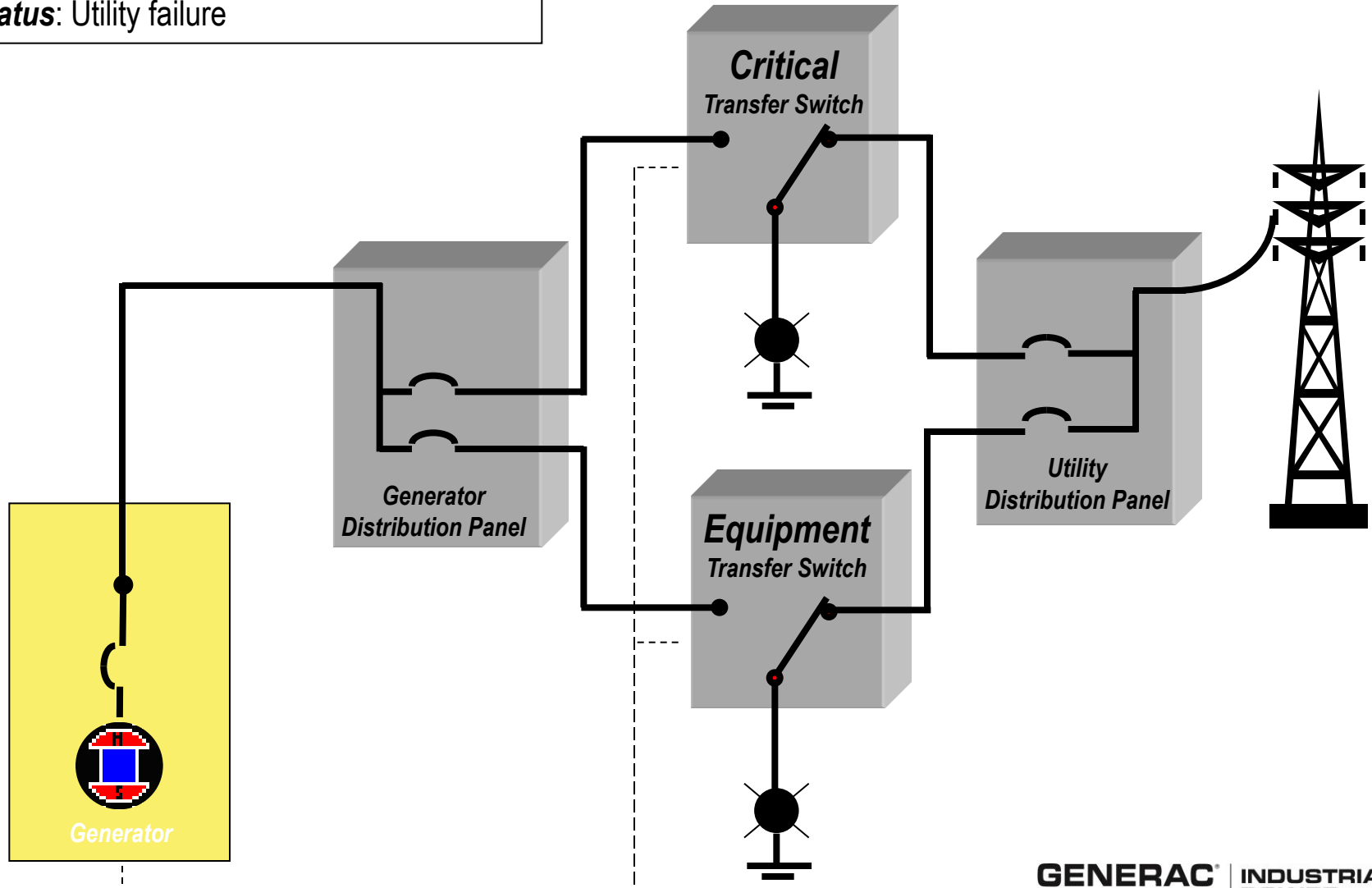
SEQUENCE OF OPERATION

Status: Normal



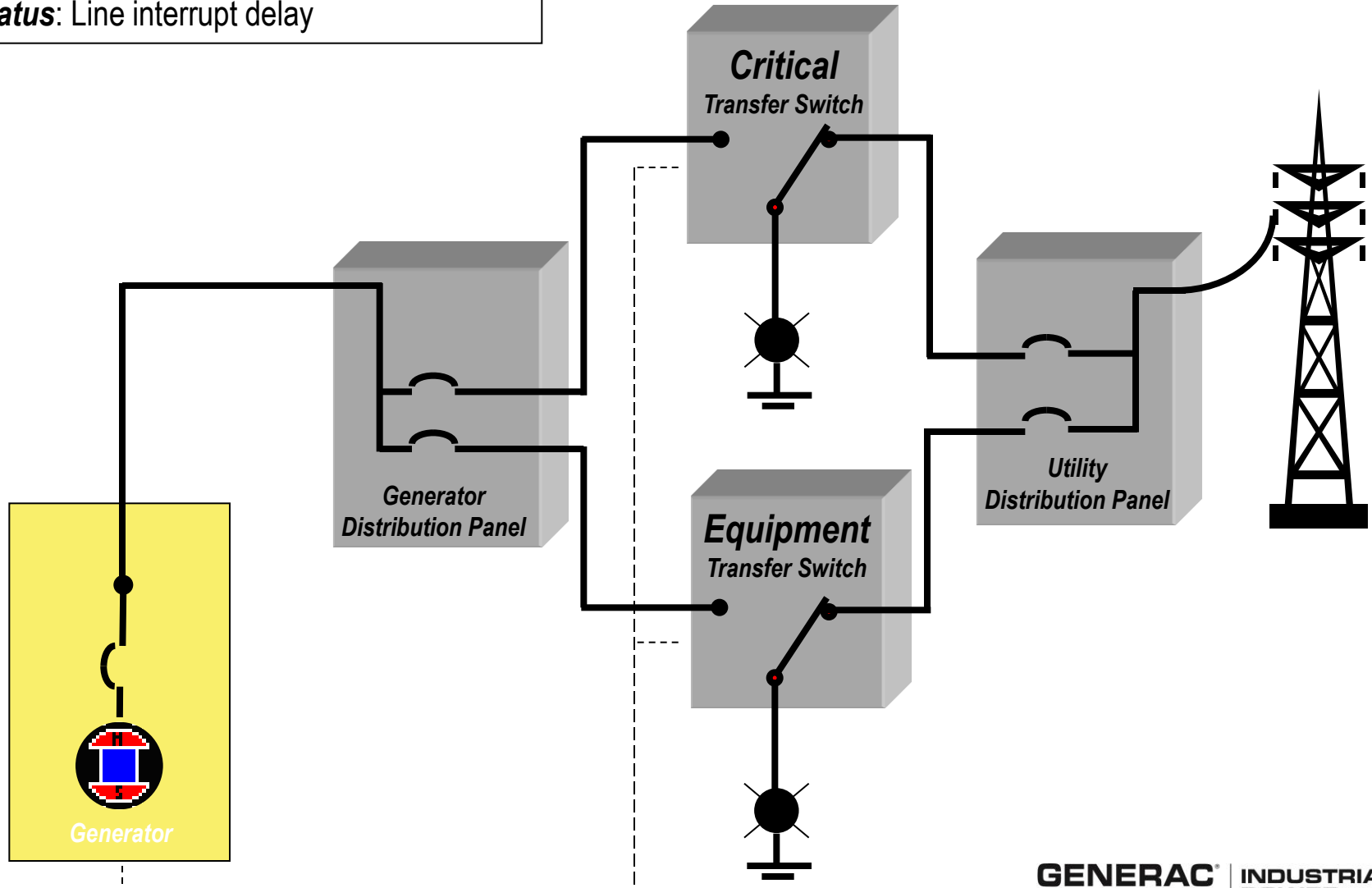
SEQUENCE OF OPERATION

Status: Utility failure



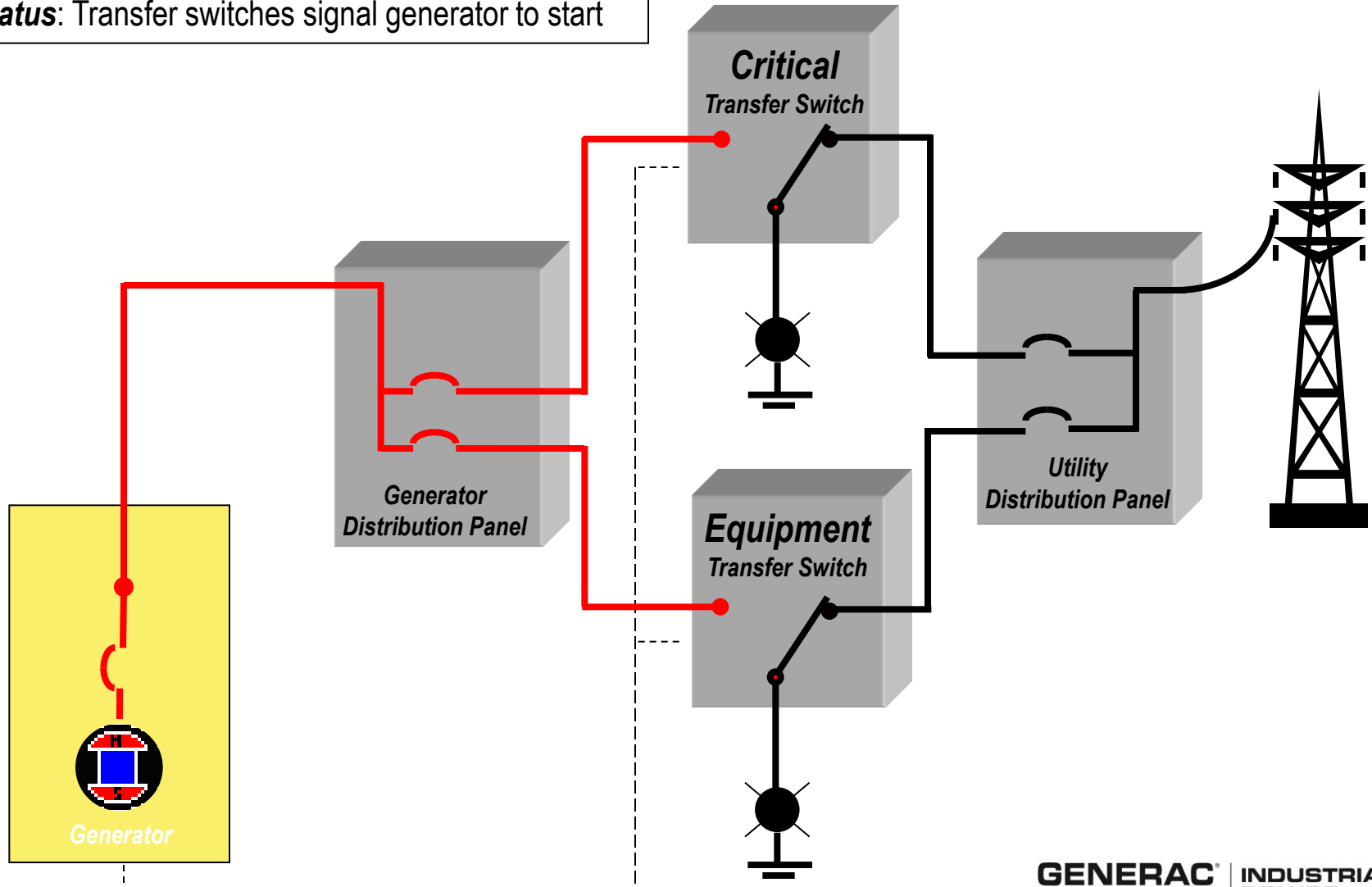
SEQUENCE OF OPERATION

Status: Line interrupt delay



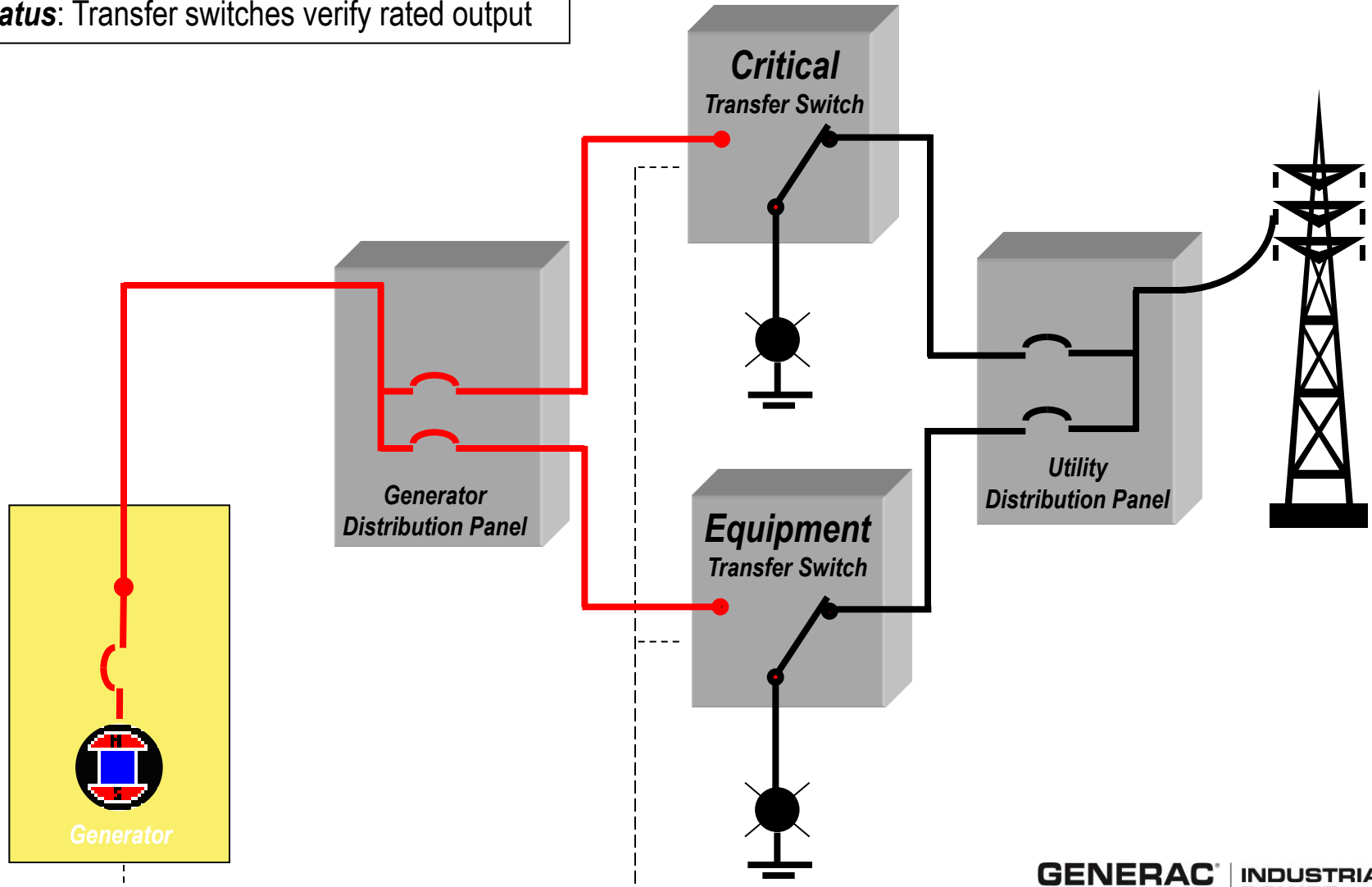
SEQUENCE OF OPERATION

Status: Transfer switches signal generator to start



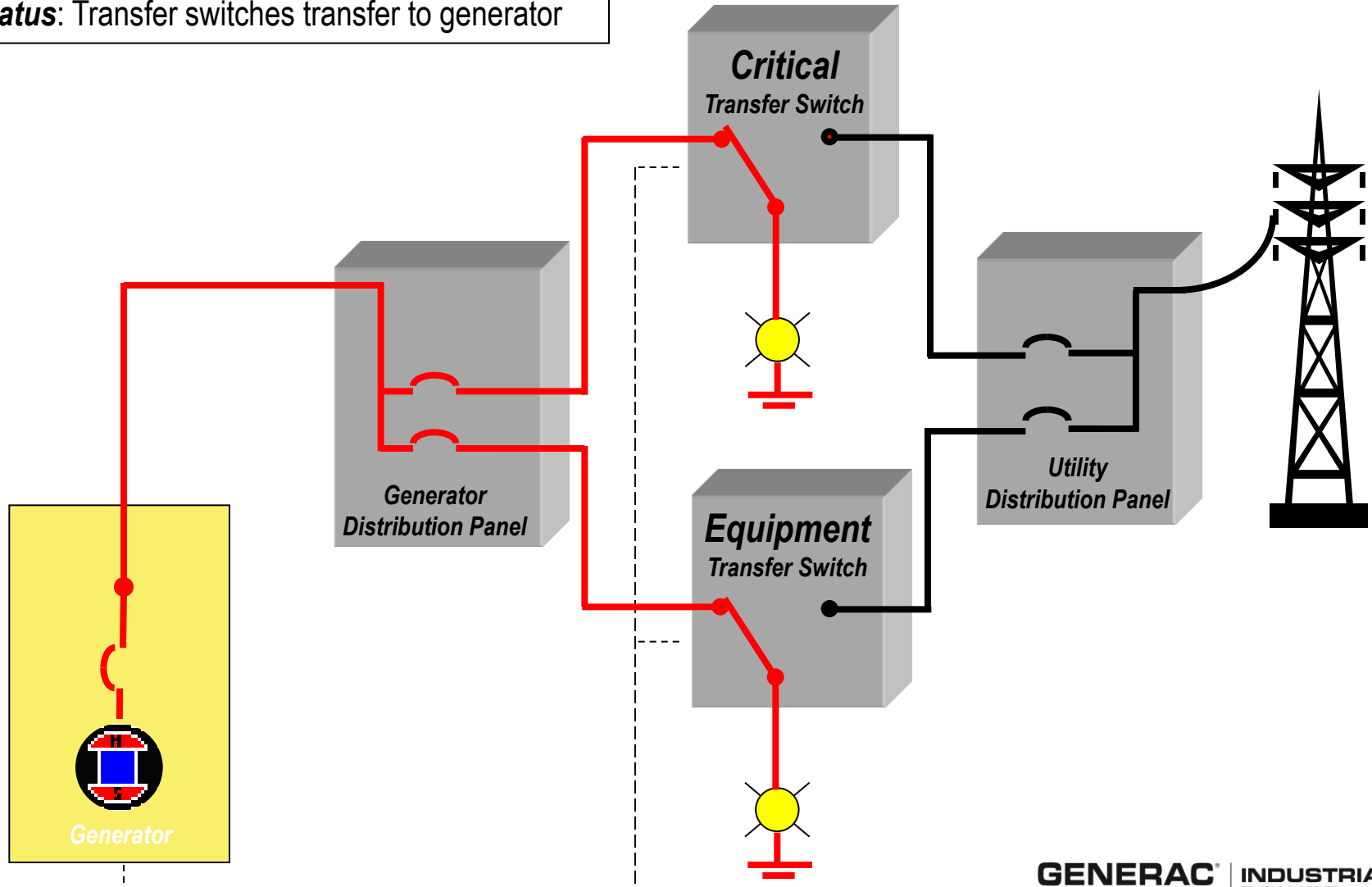
SEQUENCE OF OPERATION

Status: Transfer switches verify rated output



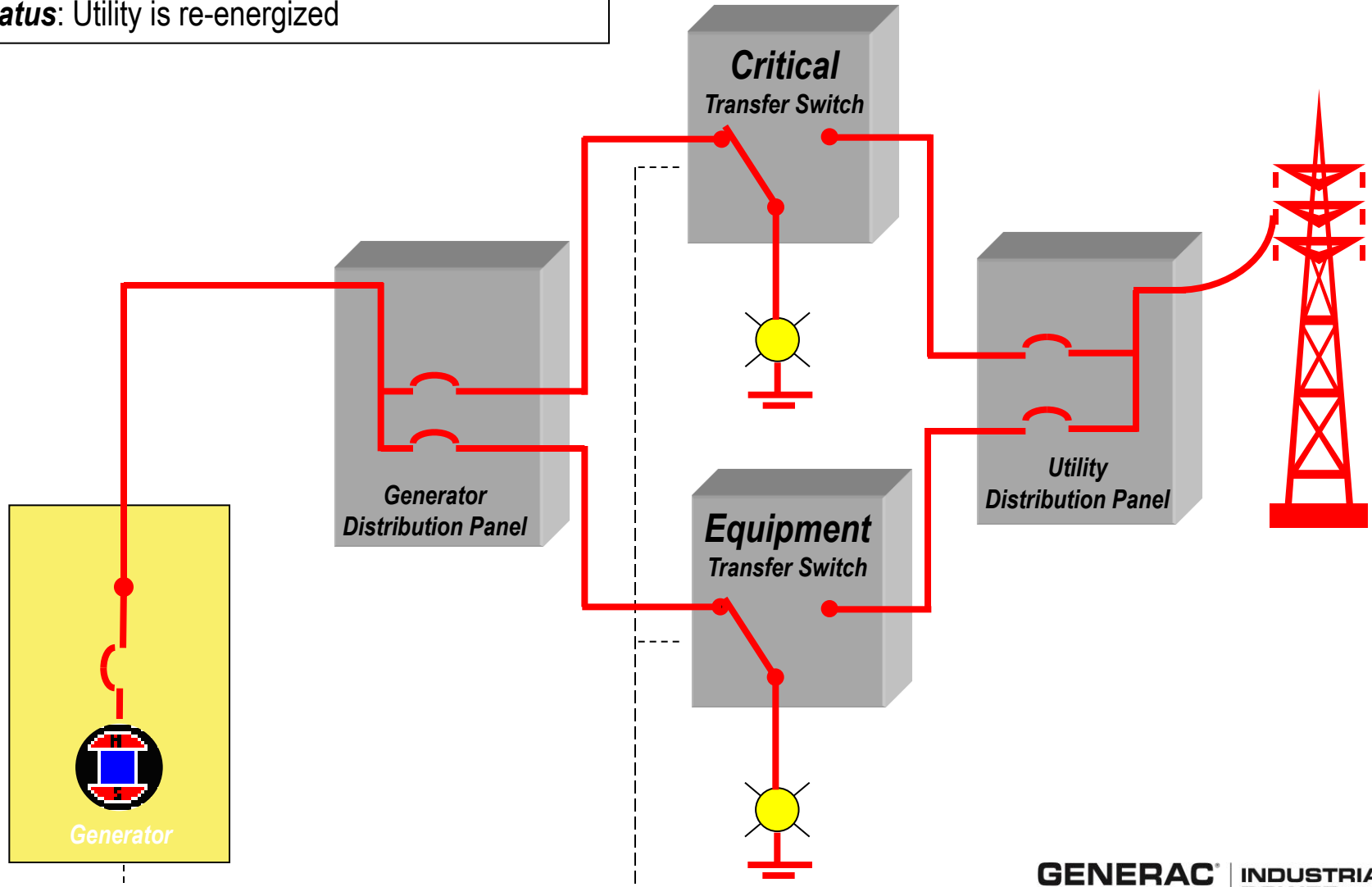
SEQUENCE OF OPERATION

Status: Transfer switches transfer to generator



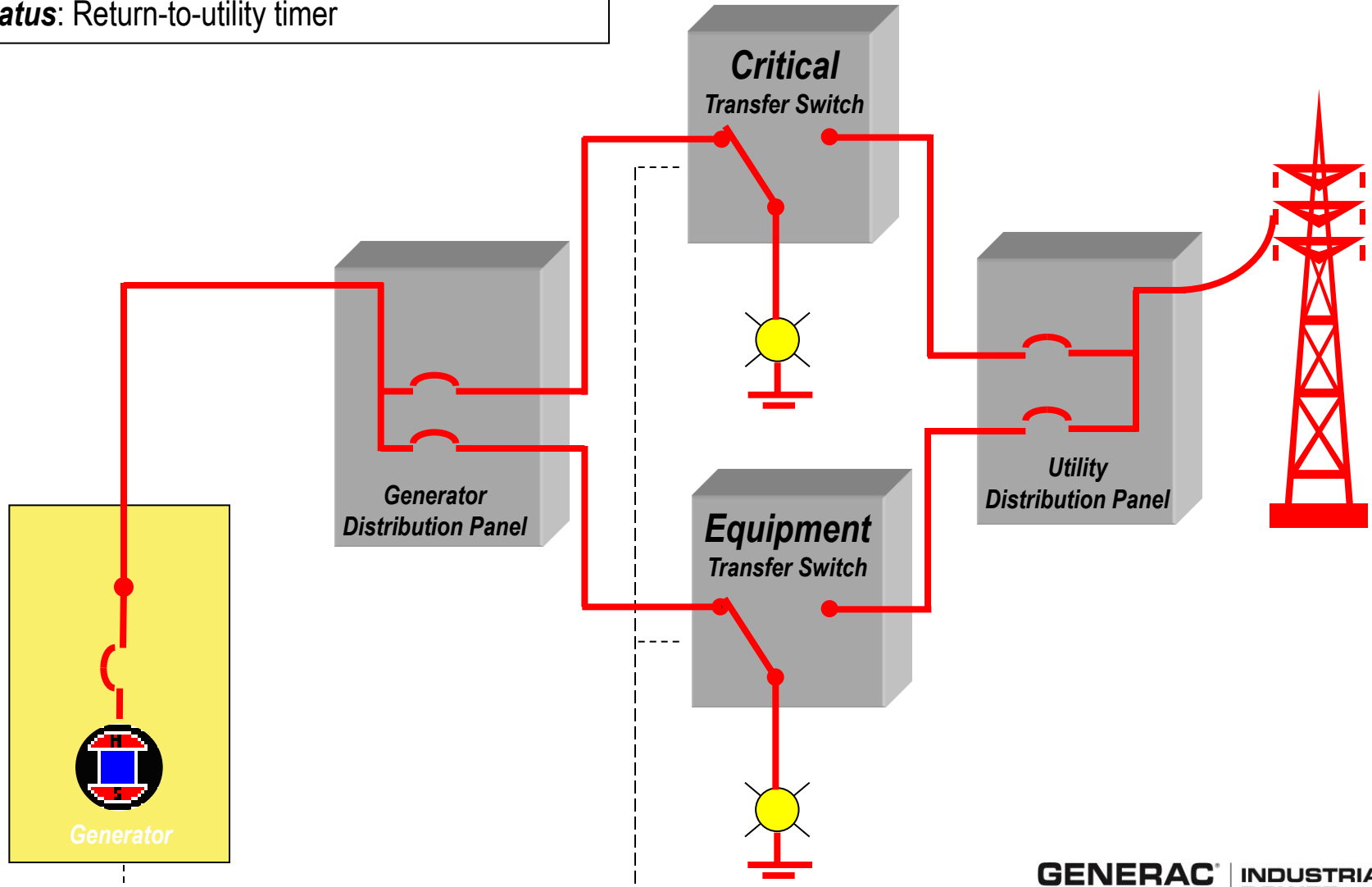
SEQUENCE OF OPERATION

Status: Utility is re-energized



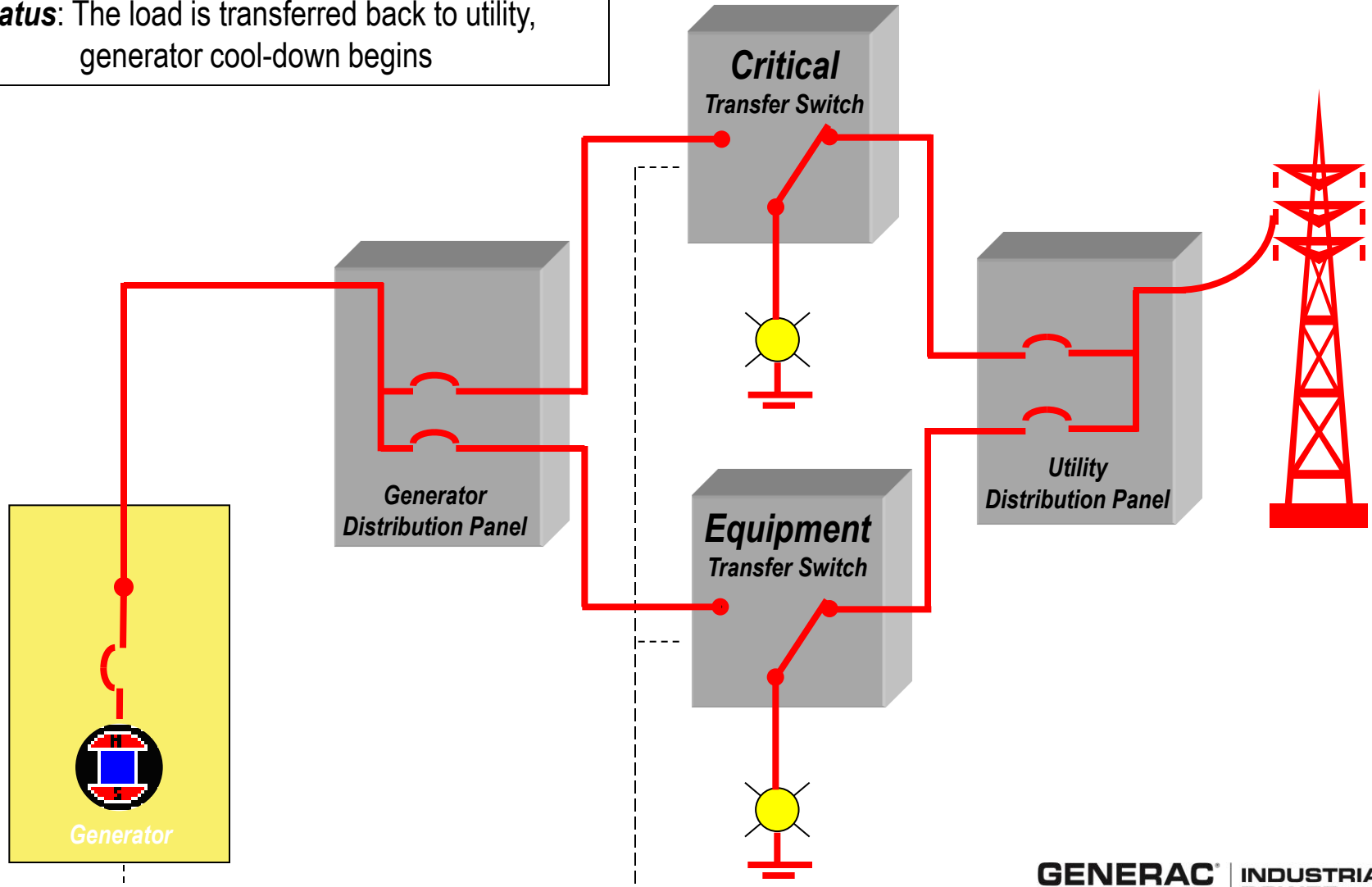
SEQUENCE OF OPERATION

Status: Return-to-utility timer



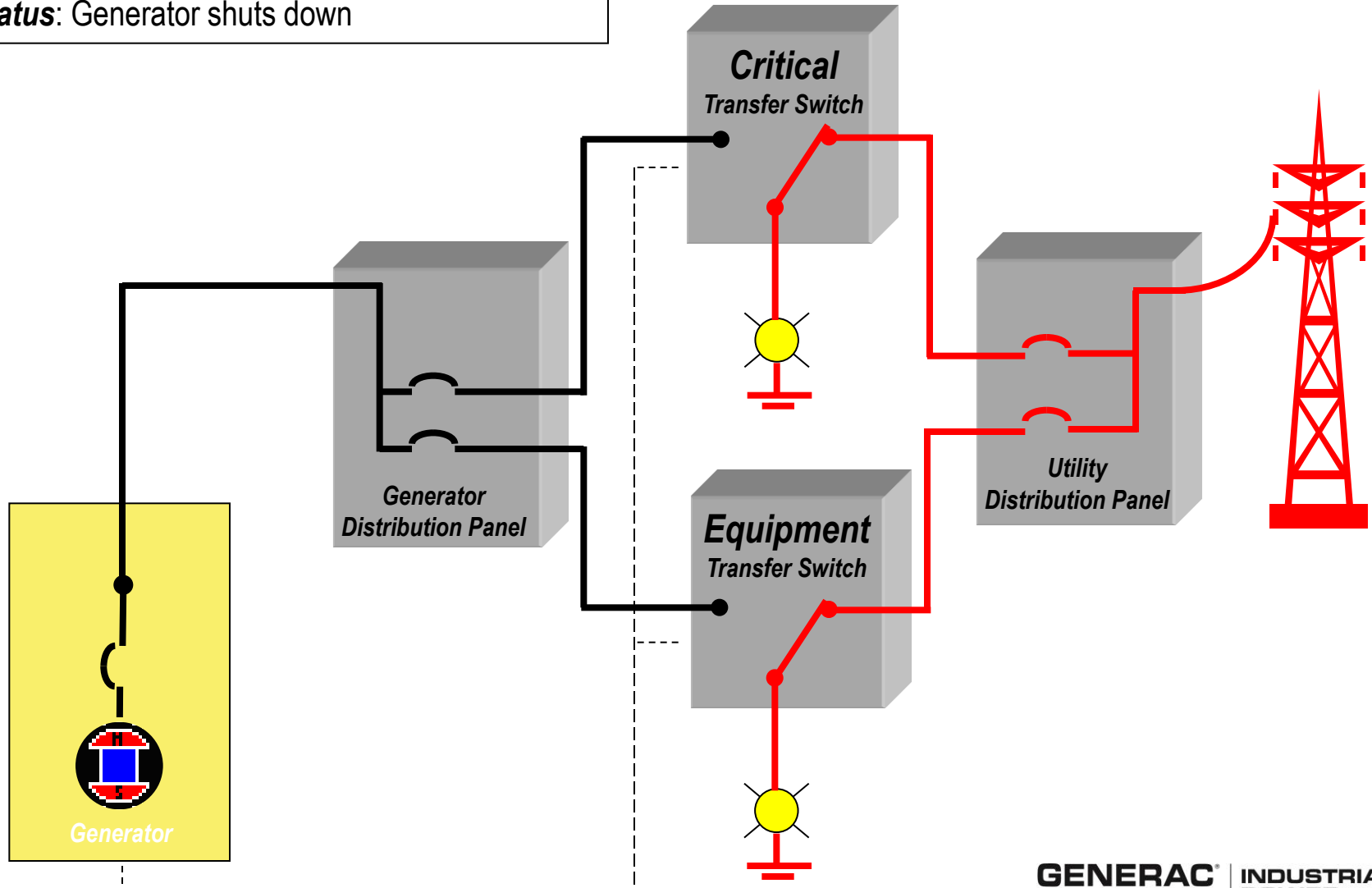
SEQUENCE OF OPERATION

Status: The load is transferred back to utility, generator cool-down begins



SEQUENCE OF OPERATION

Status: Generator shuts down



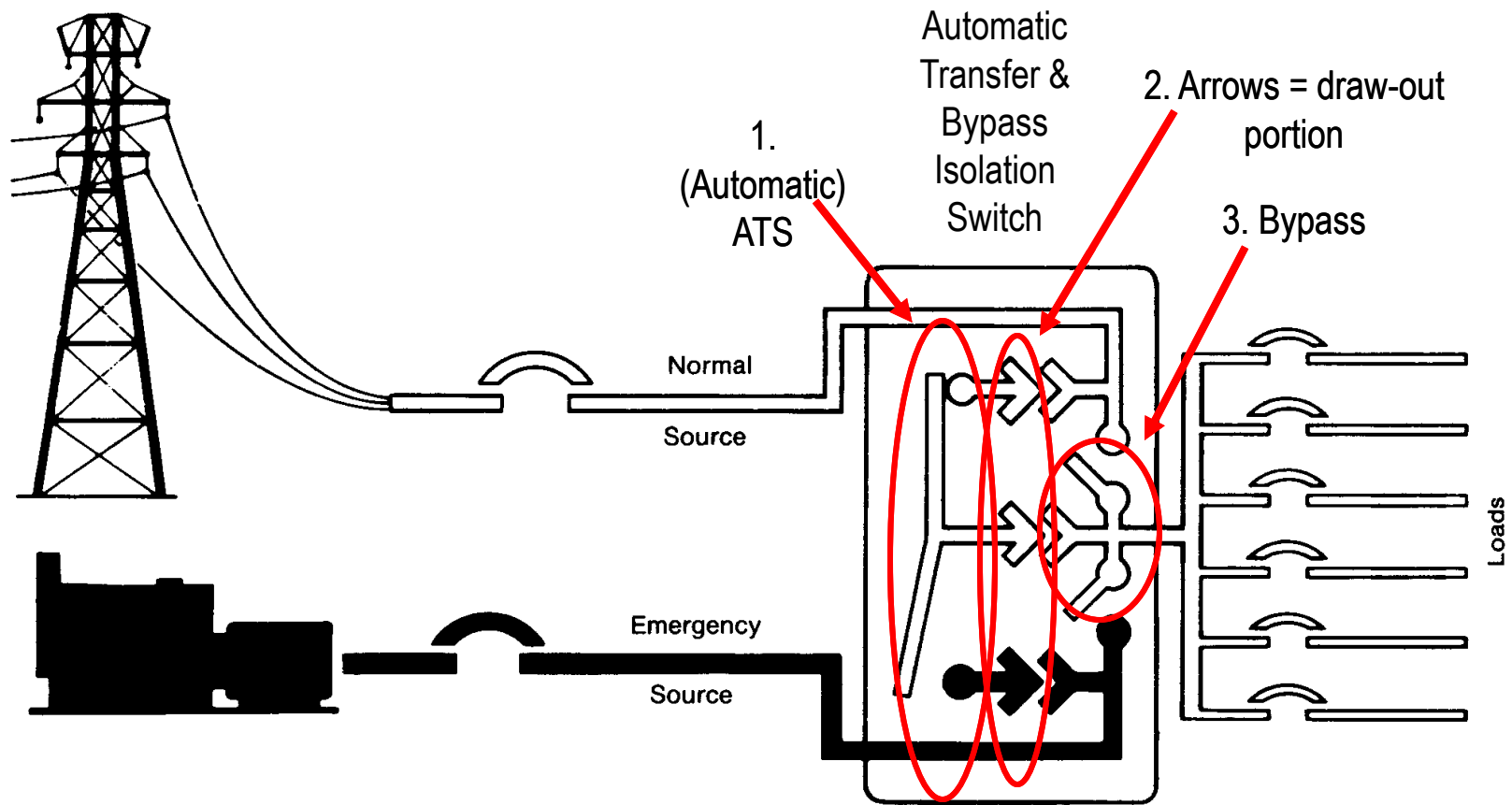
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SPECIAL FUNCTION SWITCHES

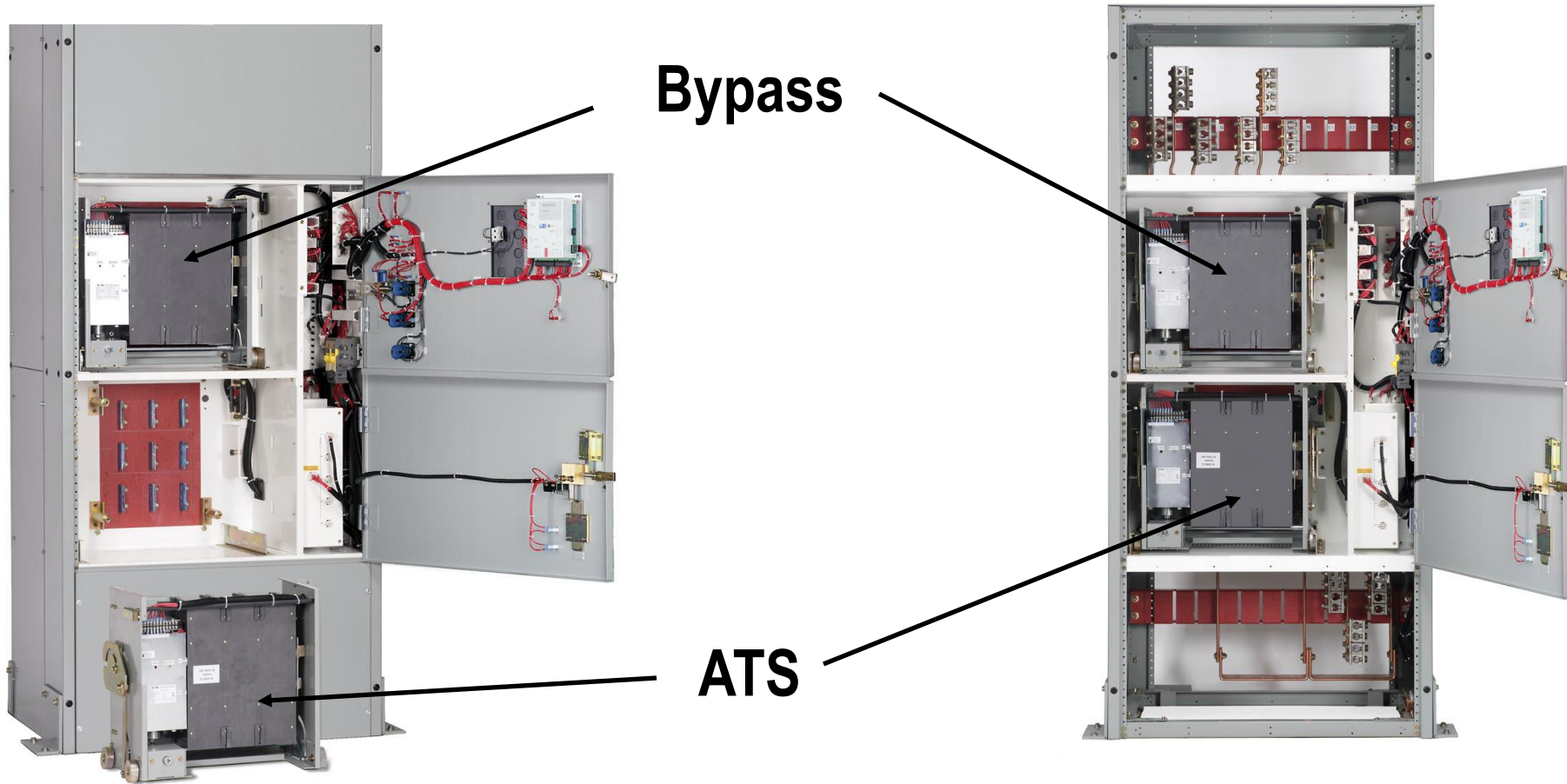
**Bypass Isolation
Service Entrance Rated**

Generator Switching

BYPASS ISOLATION ATS



BYPASS ISOLATION ATS

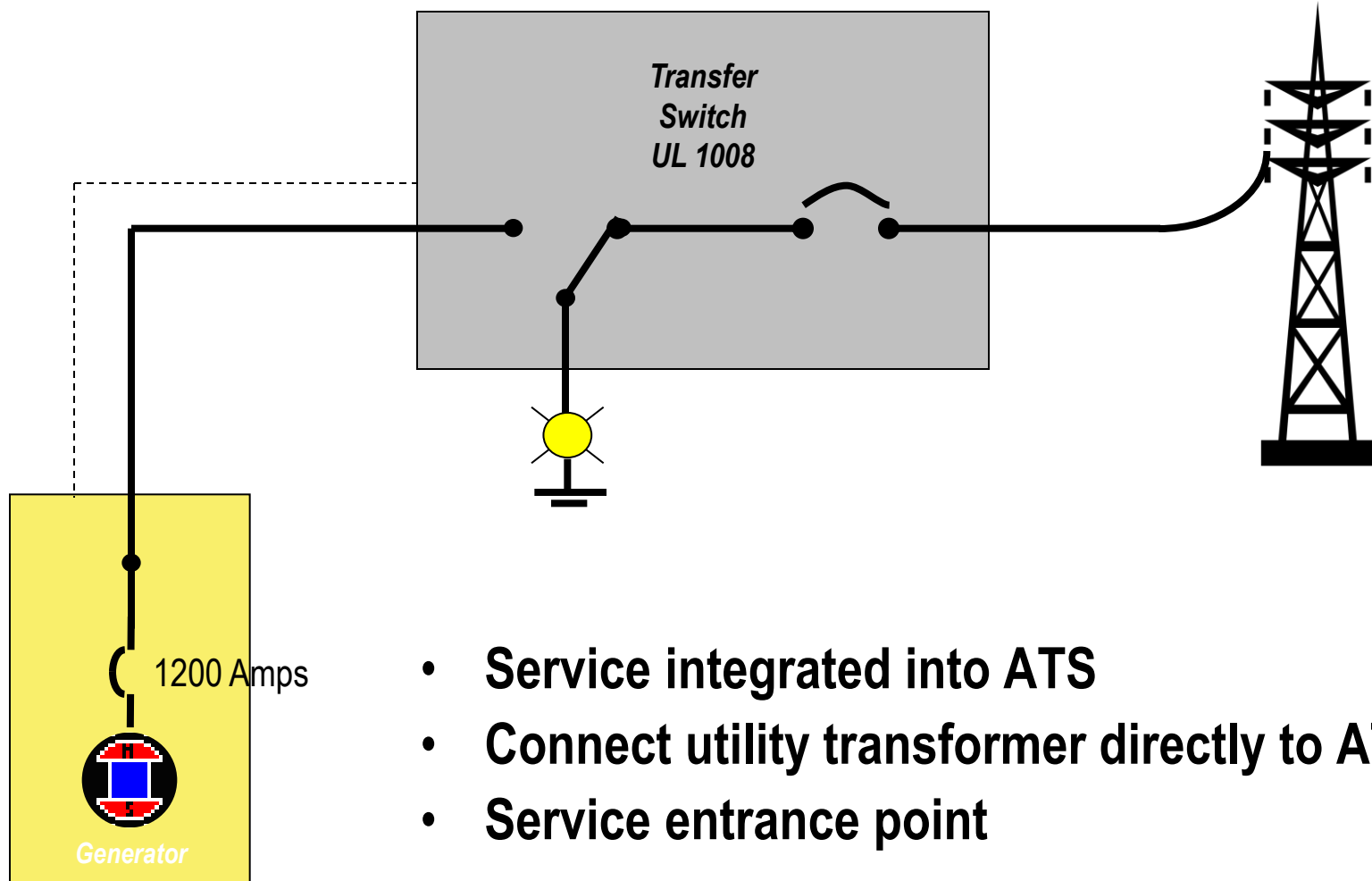


BYPASS ISOLATION ATS

- **Why Bypass Isolation?**
 - Primary markets — Healthcare and data centers
 - Service ATS w/o power outage
 - Local and application code requirements

- **Why not Bypass Isolation?**
 - Costs about 3 times normal ATS
 - Standard transfer switches are proven, reliable devices

SERVICE ENTRANCE RATED



- **Service integrated into ATS**
- **Connect utility transformer directly to ATS**
- **Service entrance point**

SERVICE ENTRANCE RATED

- **Two implementations**
 - Package a breaker with ATS
 - ◆ Contactor type with a breaker
 - Utilize breaker style ATS
 - ◆ Molded case type
 - ◆ Isolated case “Power Breaker” type



SERVICE ENTRANCE RATED

- **Applications**
 - Retrofit whole building applications (outside installation)
 - Old distribution equipment
 - ◆ Local requirements to “bring up to code”
- ***Factors to Consider***
 - Comfort level of facility’s personnel
 - Lock-out methods implemented

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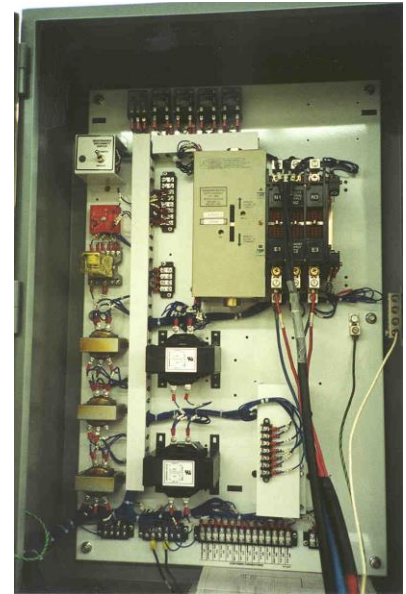
CLOSED TRANSITION

**Momentary (CTTS)
Soft-load
Grid Paralleled**

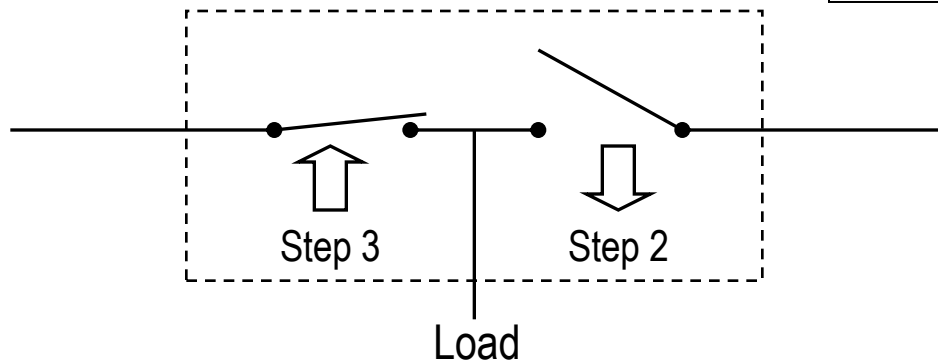
Generator Switching

CLOSED TRANSITION (CTTS)

- **“Make-before-break” transfer**
 - Overlap the contacts
 - Maximum overlap is less than 100 msec
 - Load never loses power on planned transfers
- **Synchronize the generator to the utility**
 - Typically implemented with in-phase monitoring



Step 1
Utility and Generator in-phase



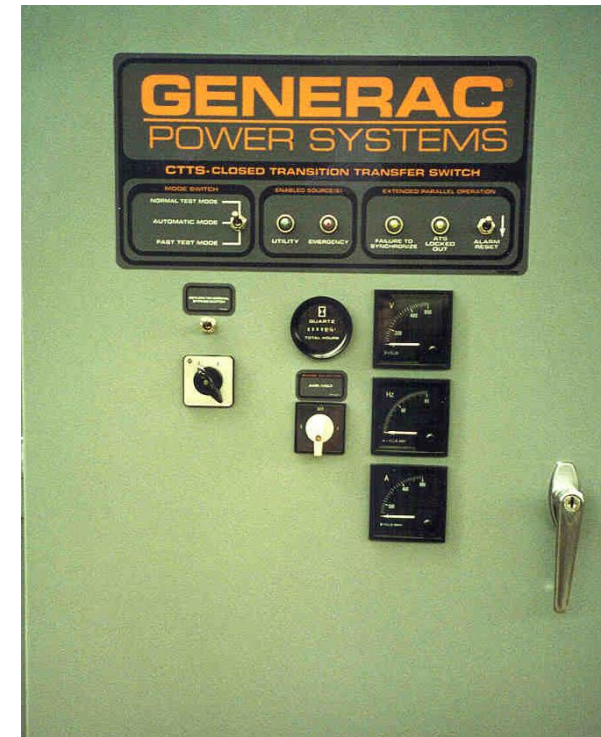
CLOSED TRANSITION (CTTS)

- **Protective considerations**
 - Check utility requirements
 - ◆ Most utilities allow 100 msec CTTS operation
 - ◆ Most utilities require a protective timer (monitors connection duration)
 - ◆ Some utilities have additional requirements
 - Protective timer (ensure grid separation during CTTS failure)
 - ◆ Common feature in most CTTSs
 - ◆ Connect timer contacts to generator's shunt trip breaker

CLOSED TRANSITION (CTTS)

- **Benefits**

- Exercise with load (more reliable generator)
- Other benefits
 - ◆ Interruptible power rate customers
 - ◆ Storm mitigation (airport philosophy)
 - ◆ Reduces power outages (retransfer)
 - ◆ Retransfer with heavily inductive loads



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APPLICATION CONSIDERATIONS

In-phase vs. Delay-in-Neutral Transfers

ATS Construction Considerations

Fault Current Ratings

Separately Derived vs. Non-separately Derived

Generator Switching

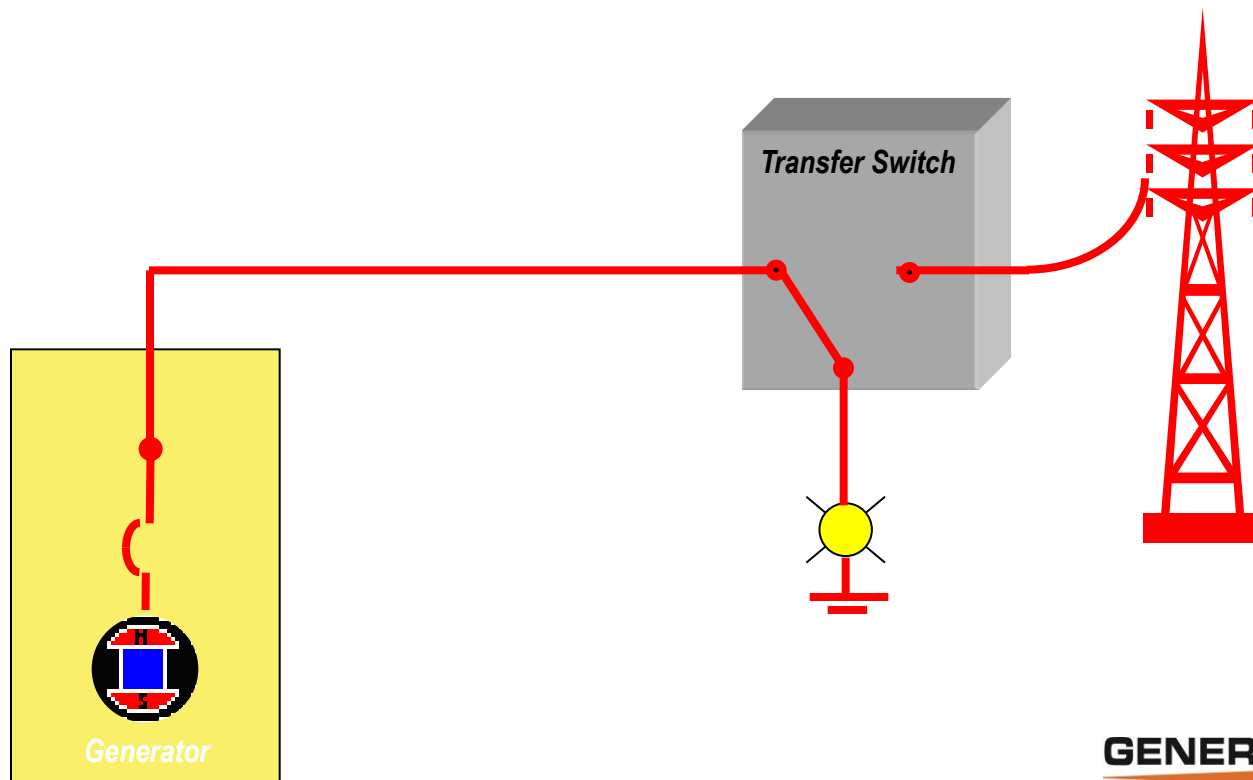
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IN-PHASE VS. DELAY-IN-NEUTRAL

Generator Switching

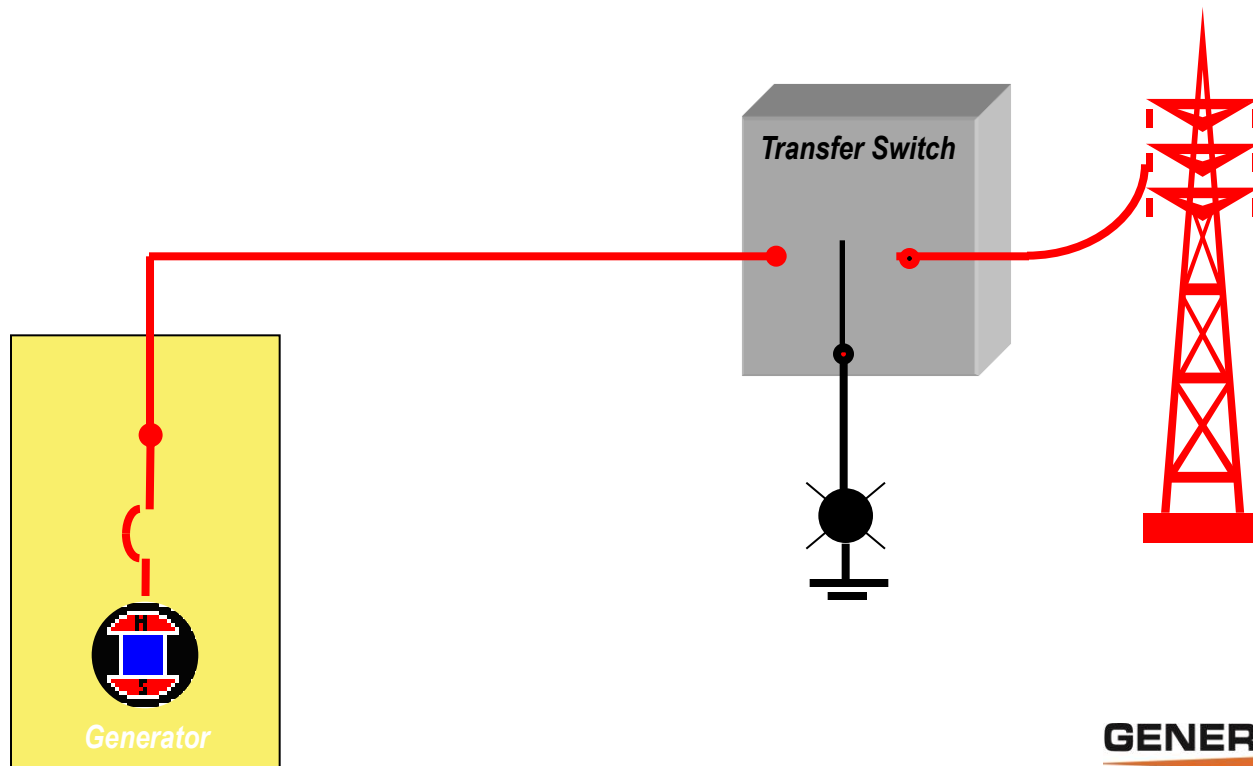
DELAY-IN-NEUTRAL TRANSFER

- **Time Delay-in-Neutral**
 - Transfers from one “live” source to another



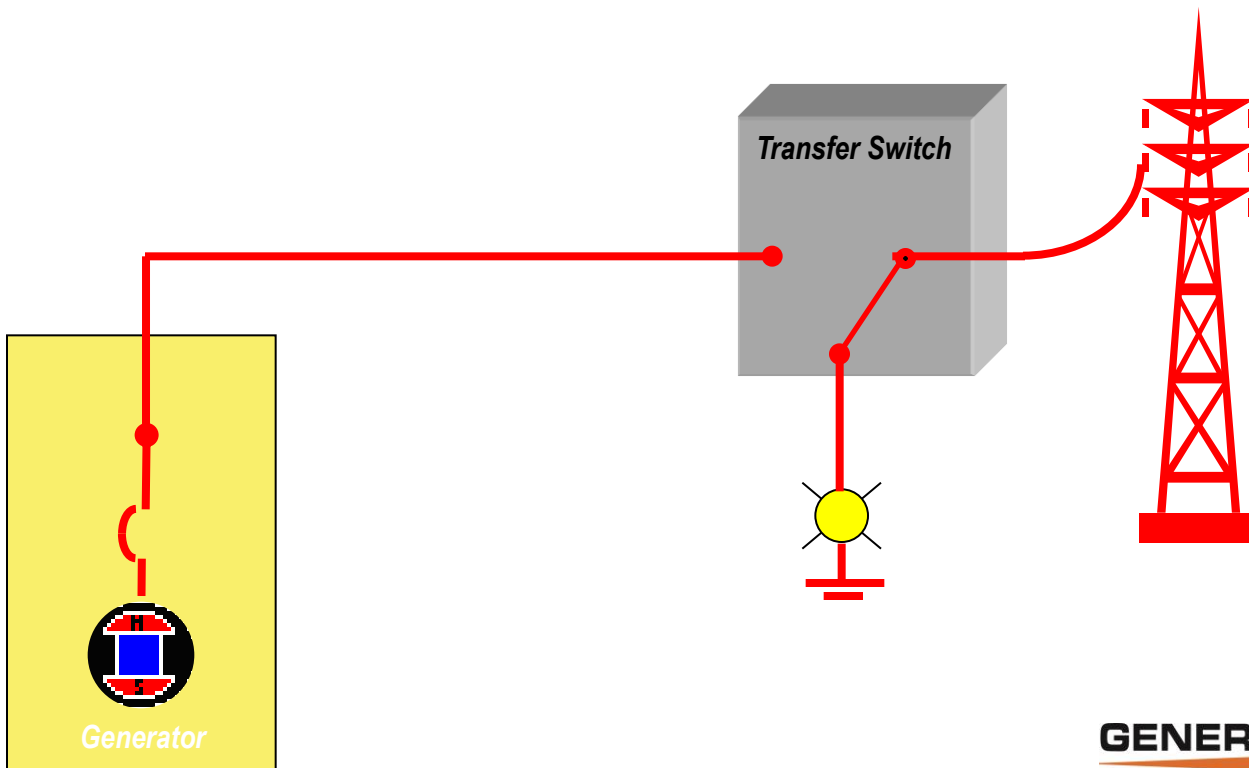
DELAY-IN-NEUTRAL TRANSFER

- **Time Delay-in-Neutral**
 - Holds in a disconnected position for several seconds
 - Allows loads (motors) to de-energize
 - Extends the outage on retransfer



DELAY-IN-NEUTRAL TRANSFER

- **Time Delay-in-Neutral**
 - Closes into other “live” source

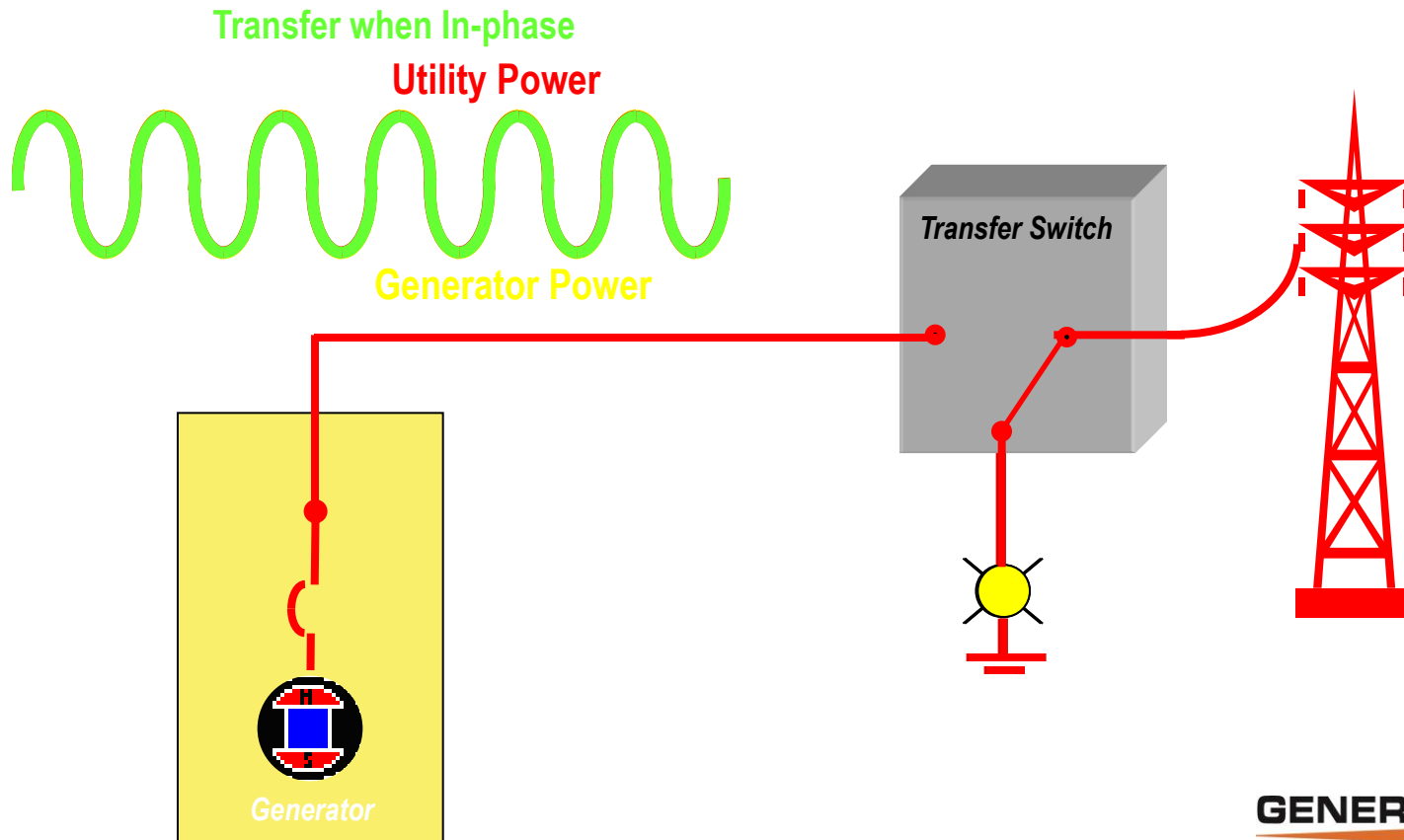


IN-PHASE TRANSFER

- **In-Phase Transfer**

- ATS monitors both sources for phase alignment
- When matched, ATS transfers
- Typical interruption of service is 120 msec

Click to Animate

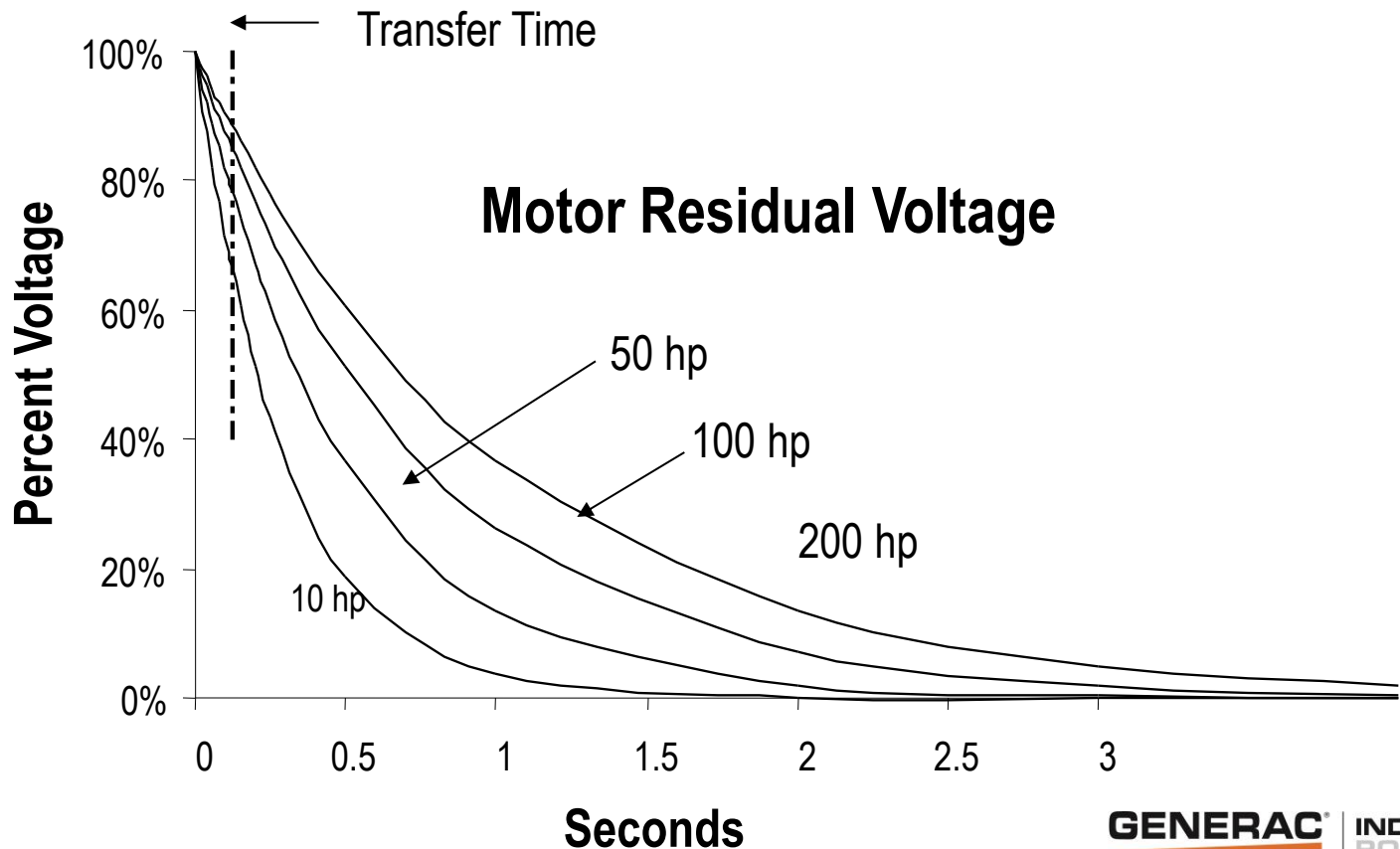


IN-PHASE vs. DELAY-IN-NEUTRAL

- **In-Phase**
 - Typical means of transfer for general applications
- **Time Delay-in-Neutral**
 - UPS with filtering capacitors
 - Applications with heavy motor loads
- **Why are motors a concern?**

IN-PHASE vs. DELAY-IN-NEUTRAL

- **Why are motors a concern?**
 - Regenerative motor voltage
 - Motor slows down and pulls out of phase



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TRANSFER SWITCH CONSTRUCTION

Controllers

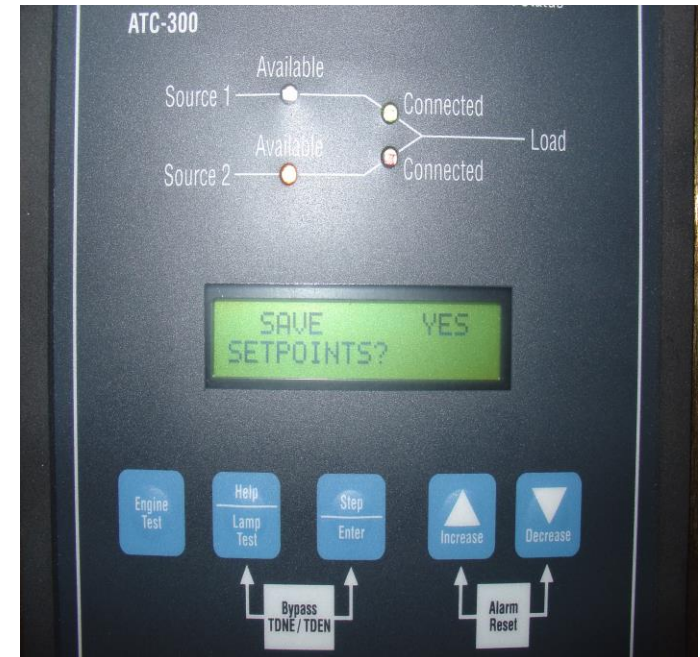
Switching Device Types

Neutral Switching: 4-pole vs. Overlapping

Generator Switching

CONTROLLER OPTIONS

- **Market offers various features**
 - Control, monitoring & protection
 - Programmable flexibility
 - Alarms & event logs
 - Communications & annunciators
- **Most application**
 - Still only require basic control
 - Over specifying features may lead to controller & cost increases



SWITCHING DEVICE

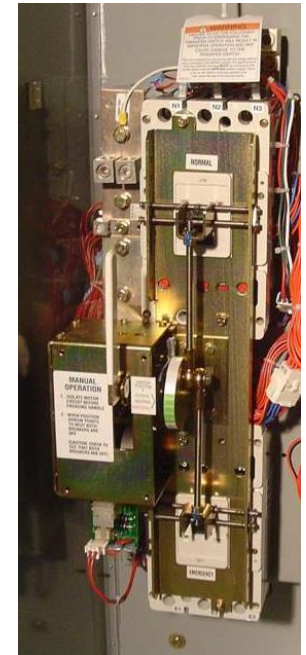
- **Contactors**

- Best cyclic mechanical operation
- Lower fault current ratings
- Good cost point



- **Molded Case**

- Good fault ratings (65 kA) & service capable
- Slower operation (Delay-in-Neutral operation)



- **Insulated Case & Power Breakers**

- Highest fault ratings (100 kA capable)
- Fast operation (in-phase & closed transition)
- Costly at smaller ratings



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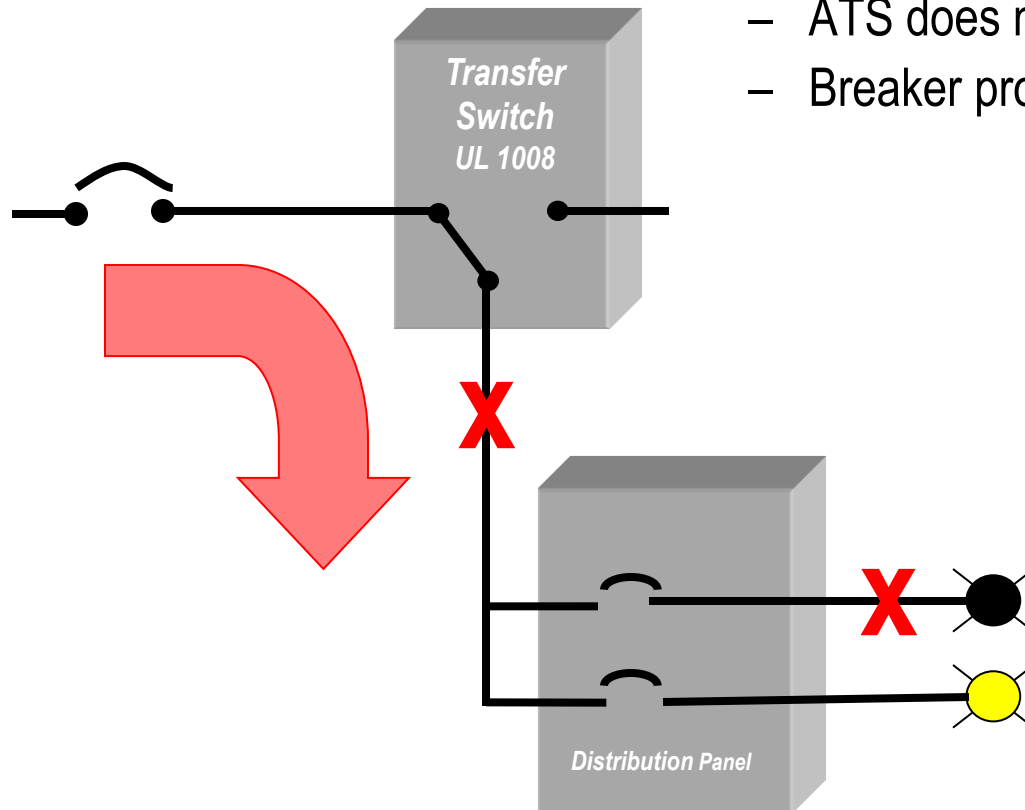
FAULT CURRENT RATINGS

Generator Switching

FAULT CURRENT RATINGS

- **Fault Current**

- ATS has a withstand and close fault rating
- ATS does not interrupt the fault current
- Breaker protection clears the fault



Generac TX Transfer Switch

UL 1008 Withstand and Closing Ratings

Ampere Rating	Specific Breaker (kA) ^{***}	3-Cycle (0.05 sec) Rating (kA)	Fuse Rating (Class J)
100	35	22	200 kA
150	42	22	200 kA
200	42	22	200 kA
300	65	35	200 kA
400	65	35	200 kA

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**SEPARATELY DERIVED
VS.
NON-SEPARATELY DERIVED**

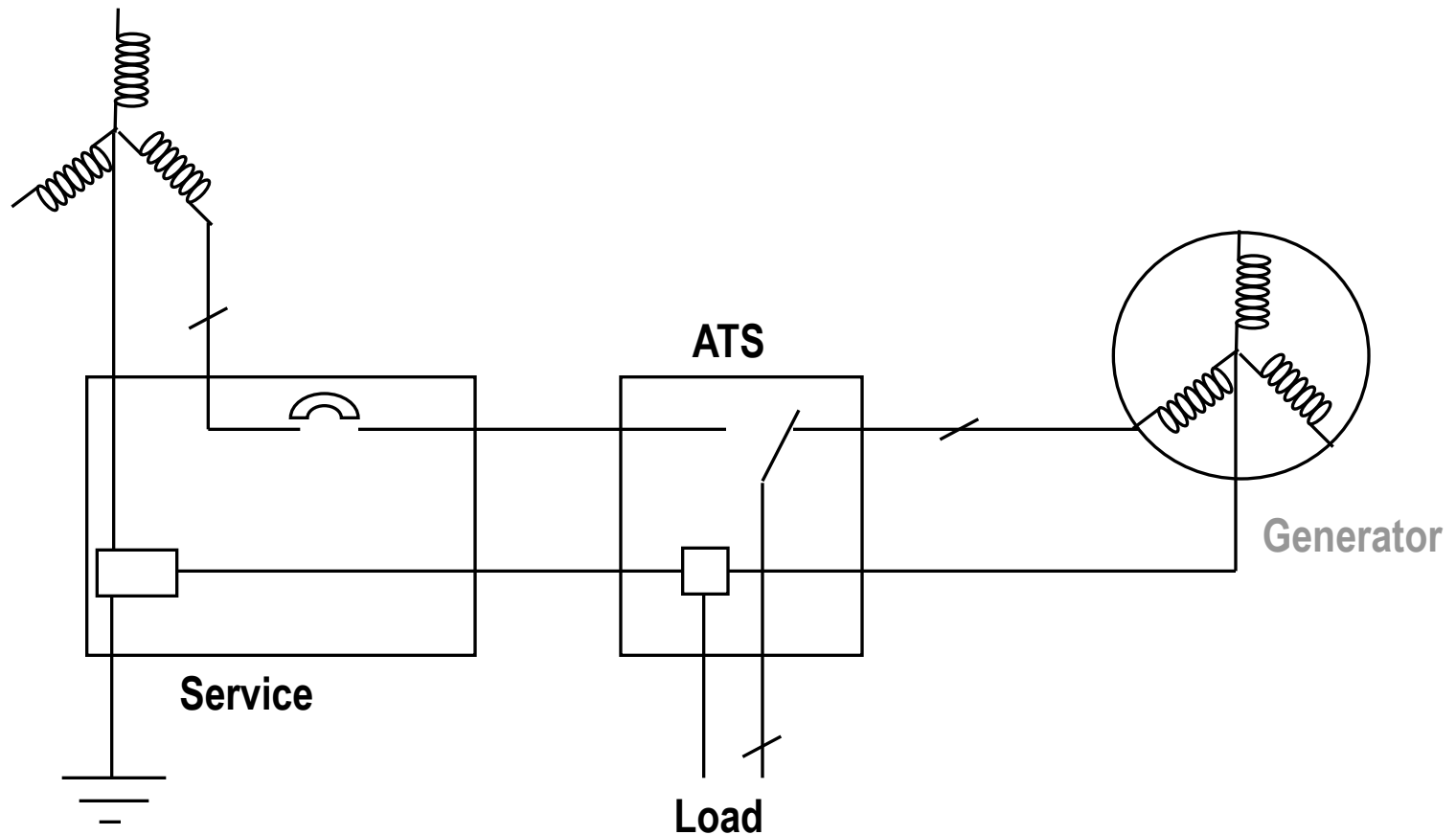
4-Pole vs. 3-Pole Switching

Generator Switching

GROUNDING

- **Grounding conductor**
 - The equipment ground (green wire)
- **Grounded “bonded” conductor**
 - The neutral conductor that is bonded to the system ground
 - The neutral conductor should be bonded at only one point
- **Generator Neutral Bonding**
 - To building ground plane (non-separately derived)
 - ◆ 3-pole ATS
 - To generator ground plane (separately derived)
 - ◆ 4-pole ATS

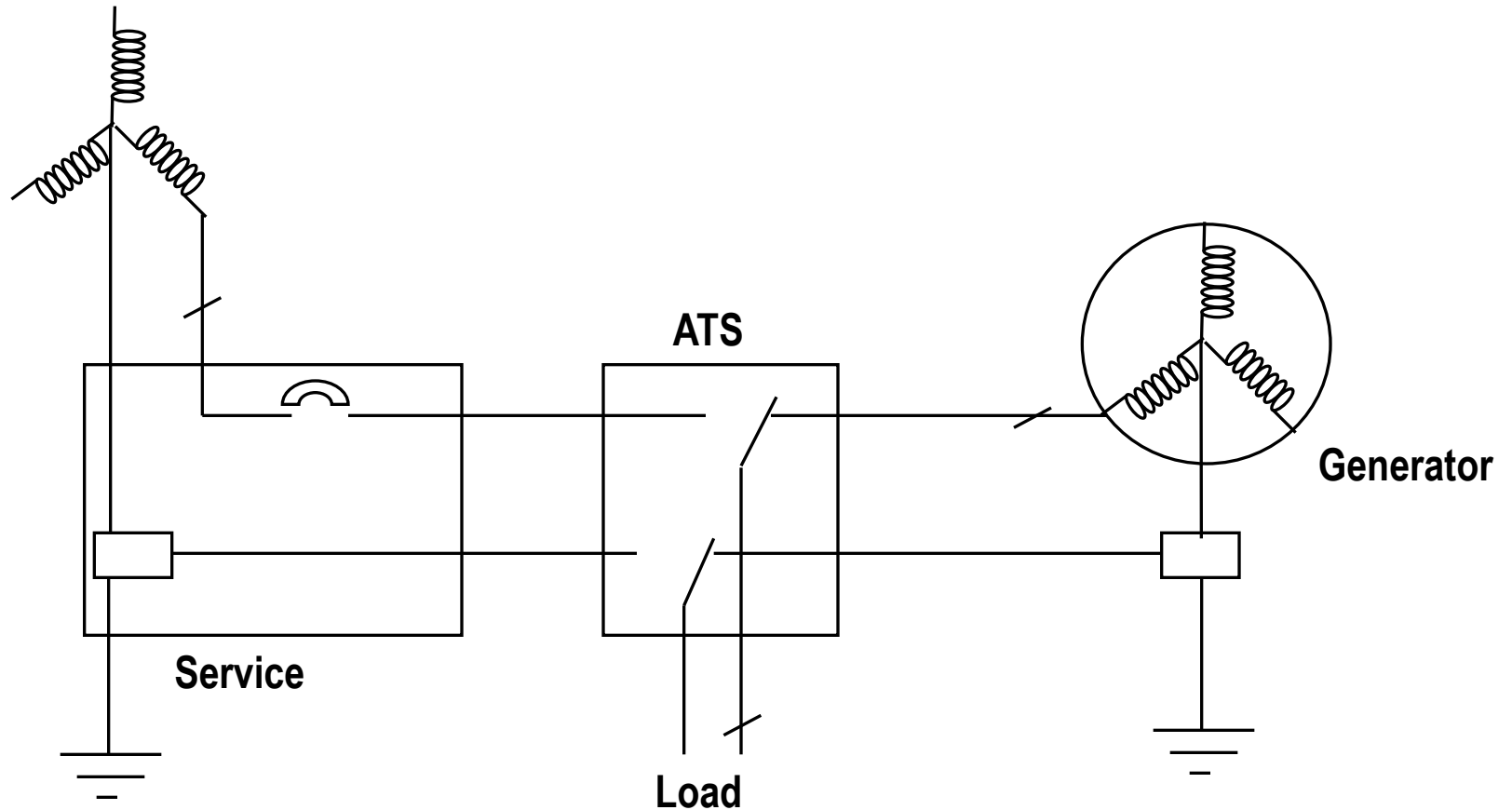
3-POLE SWITCHING



3-POLE SWITCHING

- **Three-pole transfer switches (first choice)**
 - Neutral is not switched
 - Neutral is typically bonded at the building service
 - It's known as a **non-separately derived system**
- **Advantages of 3-pole switches:**
 - Better neutral bonding (not switching the neutral)
 - No ground plane required at the generator
 - Simpler system
 - Lower cost

4-POLE SWITCHING



4-POLE SWITCHING

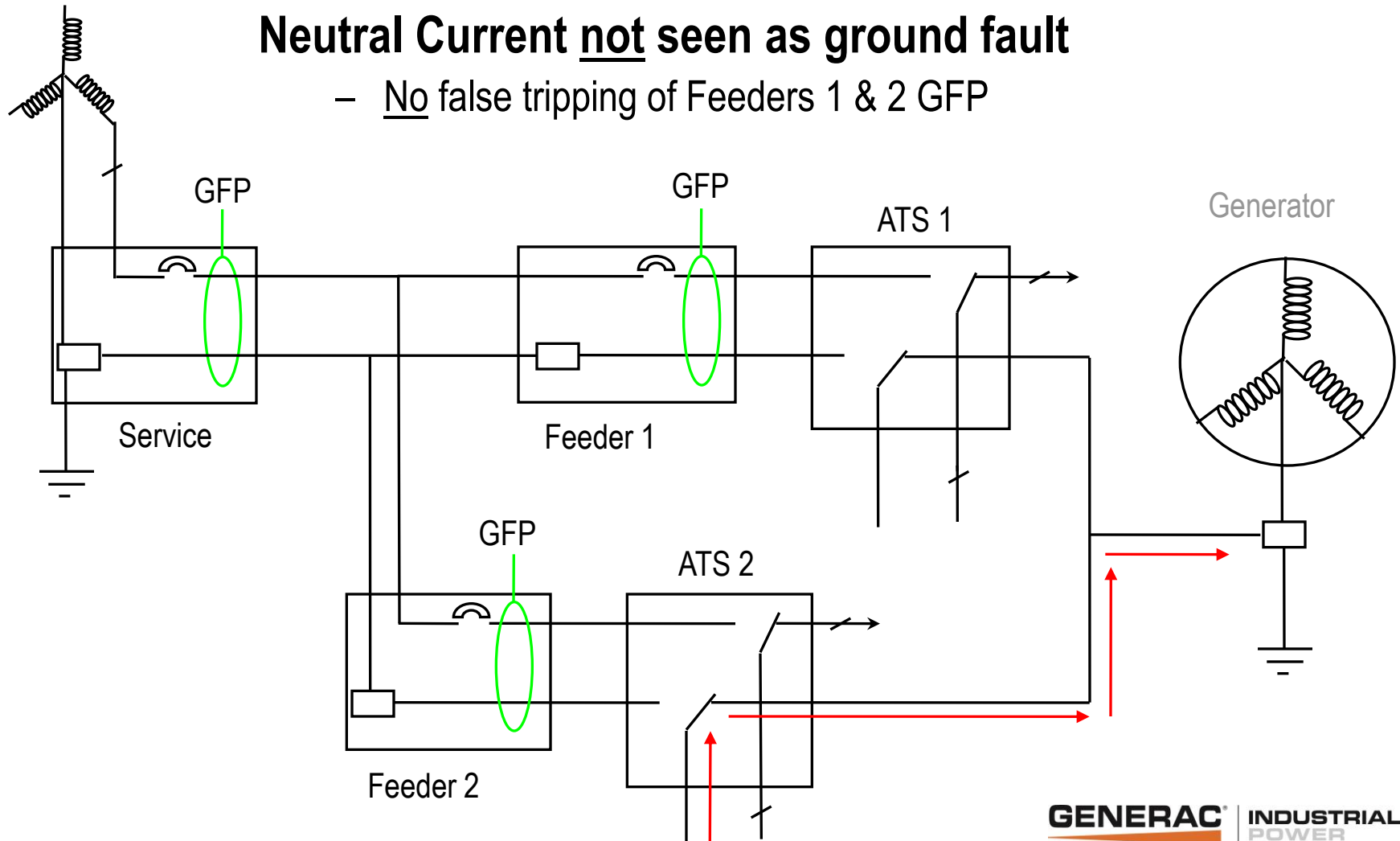
- **Four-pole transfer switches**
 - Neutral is switched
 - Neutral is bonded at the building service and the generator (switched)
 - Referred to as a **separately derived system**

- **A 4-pole switch must be used when...**
(separately derived system, switched neutral)
 - Multiple ATS application & GFP are on the utility sources
 - There is good sensitivity GFI on the generator
 - There are two buildings (separate ground planes) and one generator

MULTIPLE ATsS & GFP

Neutral Current not seen as ground fault

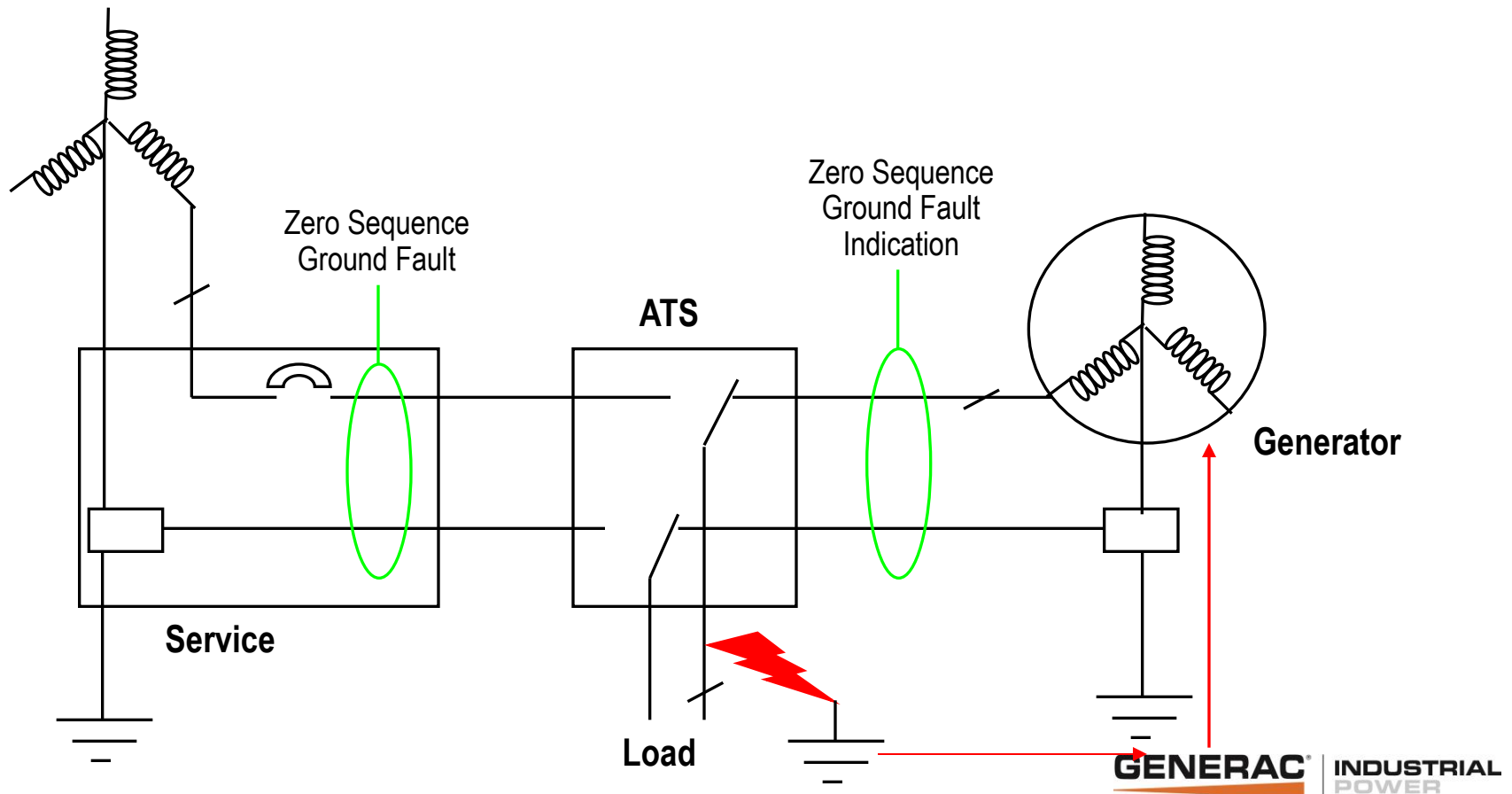
- No false tripping of Feeders 1 & 2 GFP



GOOD SENSITIVITY GFI

Generator GFI (zero sequence) works

- More sensitive than vectorial



EXERCISES

What ATS would you recommend for these applications?

- Waste water treatment plant?
- Office building?
- Data center?
- Airport?
- Hospital critical loads?
- Retrofit, whole facility application (electrical room full)?
- Base load and peak shave apply?