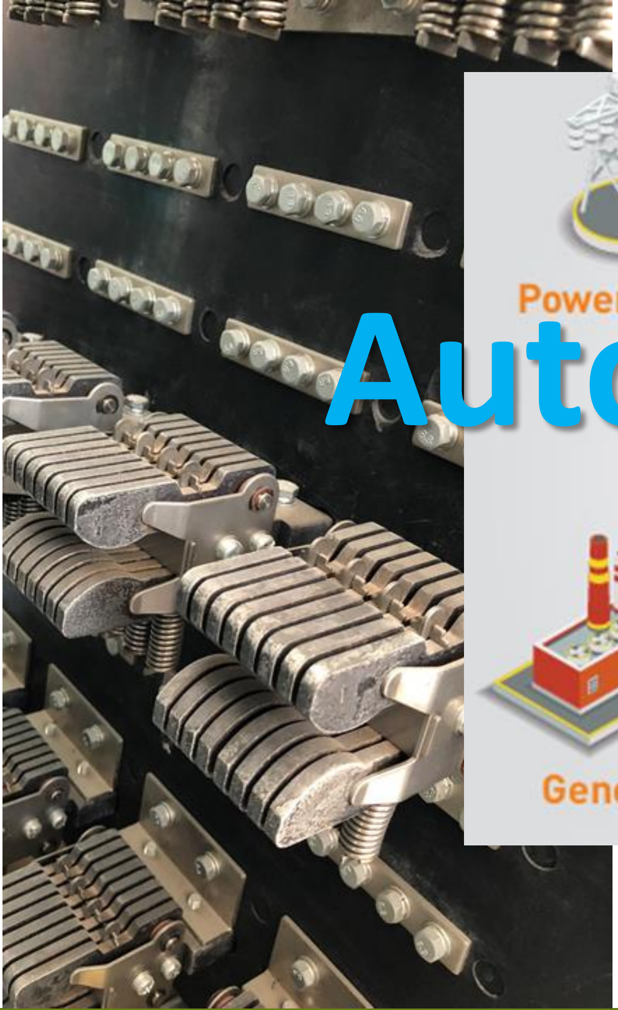
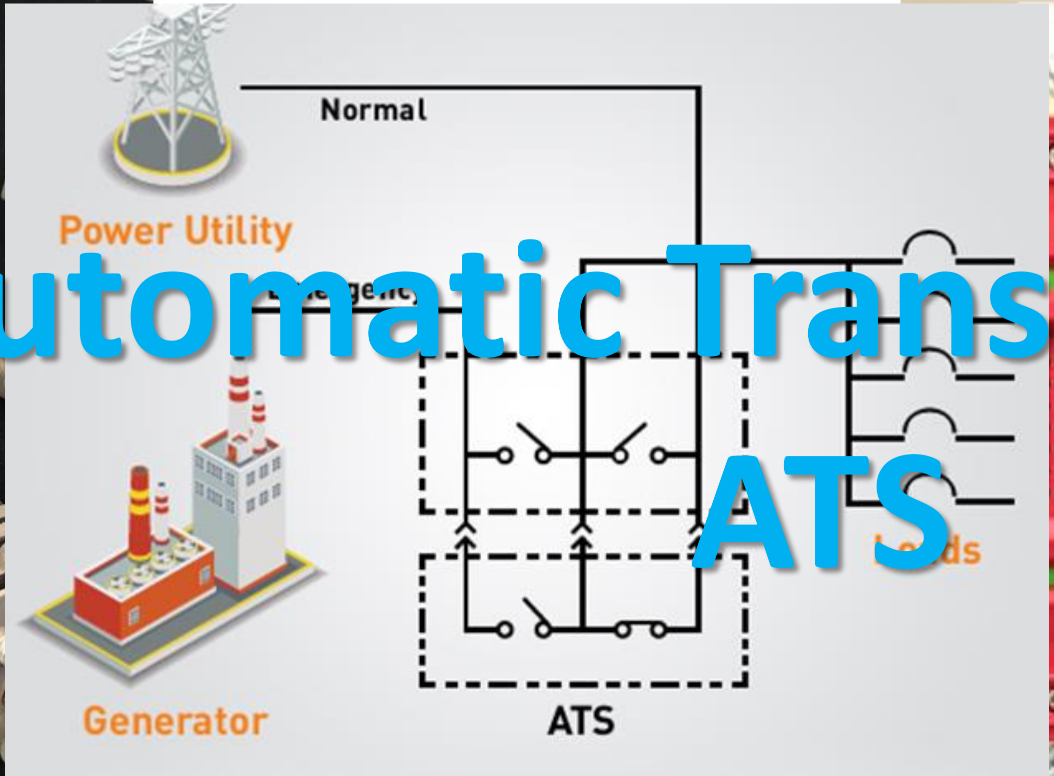
Automatic Transfer Switch
ATS





ธัมรัต พรหมเพ็ญรังษี วฟก.818/ACPE 01242/TH
เลขาธิการสมาคมเครื่องกำเนิดไฟฟ้าไทย
อุปนายก สมาคมผู้ตรวจสอบอาคาร
กรรมการผู้จัดการ บริษัท นอร์ธพลัส จำกัด
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GEN THAI
สมาคมเครื่องกำเนิดไฟฟ้าไทย
THAI GENERATOR ASSOCIATION

AGENDAS

- Why do we need ATS?
- Codes and Standard
- Architecture Arrangement
- Open transition (OTTS) and Close Transition Transfer Switch (CTTS)
- 3 Poles vs. 4 Poles ATS
- By Pass Switch
- Application

WHY DO WE NEED ATS?

WHY DO TRANSFER SWITCH NEEDED?

- **To assure continuity of vital electrical power for essential loads:**
  - Life Safety purpose
  - Prevent accidents, theft, panic, loss of revenue
  - Maintain your business-critical continuity
  - Comply with codes & standards
  - Comply with government regulations

- **Whenever two or more sources of power are utilized for essential electrical loads.**

CODES & STANDARDS

Codes & Standards for equipment applied as ATSE

- ❖ What are the Internationally recognized codes?
- ❖ What is the Performance difference of devices tested to these codes?

ELECTRICAL CODE AND STANDARD

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IEC Low-Voltage Switchgear and Control gear or UL Standards

- IEC 947-1: General Rules
- IEC 947-2 / UL1066 UL 489 : Circuit Breakers
- IEC 947-3 / UL 363: Switches, Disconnectors, Switch Disconnectors and Fuse Combination Units
- IEC 947-4 / UL 508 : Contactors and Motor Starters
- IEC 947-5: Control Circuit Devices
- **IEC 947-6-1 / UL 1008: Automatic Transfer Switching Equipment**

IEC

Underwriters Laboratories Inc.

TRANSFER SWITCH LEGAL DEFINITION

- **IEC 60947-6-1**: A device for transferring of one or more load circuits from one supply to another. A self acting equipment containing the transfer switching device & other necessary devices for monitoring supply circuits and for transferring one or more load circuits from one supply to another.

  "อุปกรณ์สำหรับการถ่ายโอนโหลดหนึ่งวงจรหรือมากกว่า จากแหล่งไฟหนึ่งไปอีกแหล่งจ่ายไฟหนึ่ง อุปกรณ์ทำงานได้เอง ดังกล่าวจะต้องประกอบด้วยอุปกรณ์สับเปลี่ยนแหล่งจ่ายไฟและอุปกรณ์อื่น ๆ ที่จำเป็นสำหรับการตรวจสอบแหล่งจ่ายไฟและเพื่อการสับเปลี่ยนโหลดหนึ่งวงจรหรือมากกว่าจากแหล่งไฟหนึ่งไปอีกแหล่งจ่ายไฟหนึ่ง"

- **UL-1008**: A transfer switch as covered by these requirements is a device that automatically transfers a common load from a normal supply to an alternate supply in the event of failure of the normal supply and automatically returns the load to the normal supply when the normal supply is restored.

  "สวิตช์สับเปลี่ยนแหล่งจ่ายไฟที่ครอบคลุมตามข้อกำหนดเหล่านี้เป็นอุปกรณ์โอนถ่ายโหลดร่วมจากแหล่งจ่ายไฟปกติไปยังแหล่งจ่ายสำรองโดยอัตโนมัติเมื่อเกิดความล้มเหลวของแหล่งจ่ายไฟปกติและจะโอนถ่ายโหลดกลับคืนให้กับแหล่งจ่ายไฟปกติโดยอัตโนมัติเมื่อแหล่งจ่ายไฟนั้นกลับคืนสู่สภาวะปกติสามารถจ่ายไฟได้"

TRANSFER SWITCH LEGAL CLASSIFICATIONS

Transfer switching equipment is classified according to:

a) their short-circuit capability:

- class PC: TSE that is capable of making and withstanding, but is not intended for breaking short-circuit currents;

  NOTE Contactors can be used in class PC if they fulfil the test requirements of class PC.

- class CB: TSE provided with over-current releases and the main contacts of which are capable of making and are intended for breaking short-circuit currents;
- class CC: TSE that is capable of making and withstanding, but is not intended for breaking short-circuit currents. TSE based on devices fulfilling the requirements of IEC 60947-4-1;

b) the method of controlling the transfer:

- manually operated switching equipment (MTSE);
- remote operated switching equipment (RTSE);
- automatic transfer switching equipment (ATSE).

IEC 60947-6-1

ELECTRICAL CODE AND STANDARD

GEN THAI

Standards Establish The Criteria For The Suitability of a device for the

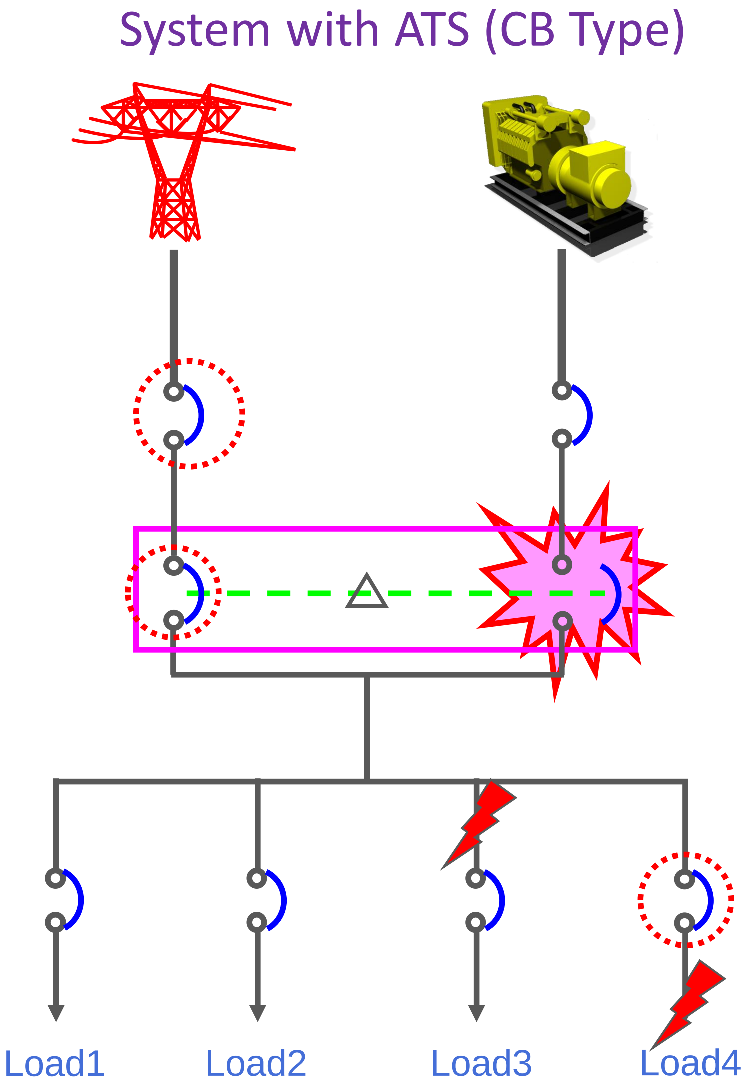
Intended Use

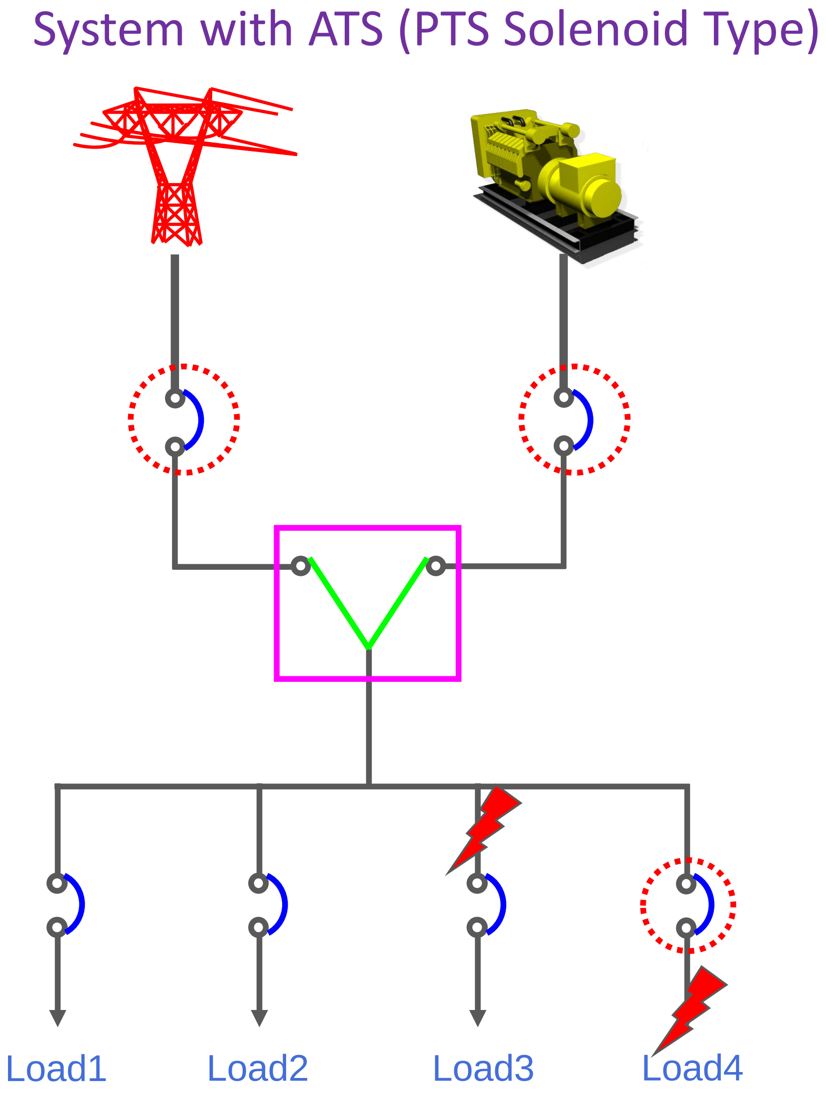
- **Class CB :** Circuit Breakers interrupt overload and fault currents. They were not intended to be used as a repetitive switching device.
- **Class CC :** Contactors were not intended to remain closed under high fault conditions or to make on faults.
- Switch Disconnector were not intended to transfer loads from Live to Live.
- **Class PC :** ATS are designed to perform repetitive switching from Live to Live and closed on high fault currents!

EN/IEC 60947-6-1: WCR v.s. kAIC

- **PC-type ATS are tested to:**
  - Withstand fault currents (remain closed), for a set period of time, permitting downstream devices to trip and isolate the fault.
  - Close into faults, to permit the Backup supply fault current necessary to clear the fault.
  - **For this reason, PC-type ATS have Withstand and Close on Ratings (WCR) vs. Traditional kAIC Fault rating (as in a CB).**

WITHSTAND & CLOSED-IN ON FAULT





EN/IEC 60947-6-1: SHORT CIRCUIT WITHSTAND

Table 4 – Value of the test current for the verification of the ability to operate under short-circuit conditions

Rated operational current I_e (r.m.s.) V	Test current (r.m.s.) A
$I_e \leq 100$	5 000
$100 < I_e \leq 500$	10 000
$500 < I_e \leq 1\,000$	20 I_e
$1\,000 < I_e$	20 I_e or 50 kA whichever is the lower
The power factors and time constants shall be as given in Table 16 of IEC 60947-1.	

EN/IEC 60947-1:
SHORT CIRCUIT WITHSTAND

Table 16 – Values of power-factors and time-constants corresponding to test currents, and ratio *n* between peak and r.m.s. values of current (see 8.3.4.3, item a))

Test current A	Power-factor	Time-constant ms	*n*
$I \leq$ 1 500	0,95	5	1,41
1 500 < $I \leq$ 3 000	0,9	5	1,42
3 000 < $I \leq$ 4 500	0,8	5	1,47
4 500 < $I \leq$ 6 000	0,7	5	1,53
6 000 < $I \leq$ 10 000	0,5	5	1,7
10 000 < $I \leq$ 20 000	0,3	10	2,0
20 000 < $I \leq$ 50 000	0,25	15	2,1
50 000 < I	0,2	15	2,2

STANDARDS IEC 60947-6-1
UTILISATION CATEGORIES

Nature of current	Utilization category		Typical applications
	Operation A	Operation B	
Alternating current	AC-31A	AC-31B	Non-inductive or slightly inductive loads
	AC-32A	AC-32B	Switching of mixed resistive and inductive loads, including moderate overloads
	AC-33A	AC-33B	Motor loads or mixed loads including motors, resistive loads and up to 30 % incandescent lamp loads

- **TSE assigned any utilization category shall comply with the rated making and breaking capacity (Table 2) … corresponding to the assigned utilization category.**
- **The designation of utilization categories is completed by the suffix A or B, according to the number of operations required by the application.**

  (see tables 8, 9 et 10)

Automatic Transfer Switch,ATS : Thammarat Promphenrangsi : ธัมรัต พรหมเพ็ญรังษี

STANDARDS IEC 60947-6-1

VERIFICATION OF MAKING AND BREAKING CAPACITY

	Utilization category	Make and break conditions					
		I/I_e	U_r/U_e	cos φ [a]	On-time [b] s	Cycle time min	Number of operating cycles
AC	AC-31A AC-31B	1,5	1,05	0,80	0,05	c	c
	AC-32A AC-32B	3,0	1,05	0,65	0,05	c	c
	AC-33A AC-33B	10	1,05	h	0,05	c	c
	AC-35A AC-35B	3,0	1,05	0,50	0,05	c	c
	AC-36A AC-36B	1,5 [d]	1,05	d	0,05	c	c

a Tolerance for cos φ is ±0,05.

b Time may be less than 0,05 s provided that the contacts are allowed to become properly seated before re-opening.

c See Table 8.

d Tests shall be carried out with an incandescent light load in accordance with the general test conditions as specified in 9.3.3.5.1.

e Tolerance for L/R is ±15 %.

f If the polarity is not marked, half the number of operating cycles is effected with one polarity and half with reverse polarity.

g No intentional time constant.

h Cos φ = 0,45 for $I_e \leq 100$ A and cos φ = 0,35 for $I_e > 100$ A.

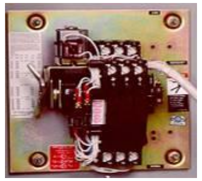
STANDARDS IEC 60947-6-1

NUMBER AND DURATION OF OPERATING CYCLES FOR MAKING AND BREAKING CAPACITY TEST

Rated operational current I_e A	Number of operating cycles			Duration of operating cycle min [a]
	Operation A	Operation B		
	AC-31A, AC-32A, AC-33A, AC-35A, AC-36A DC-31A, DC-33A, DC-36A	AC-31B, AC-35B, AC-36B DC-31B, DC-36B	AC-32B, AC-33B DC-33B	
$0 < I_e \leq 300$	50	12	5	1
$300 < I_e \leq 400$	50	12	5	2
$400 < I_e \leq 630$	50	12	5	3
$630 < I_e \leq 800$	50	12	5	4
$800 < I_e \leq 1\,600$	50	12	5	5
$1\,600 < I_e \leq 2\,500$	25	6	5	5
$2\,500 < I_e$	3	3	3	5

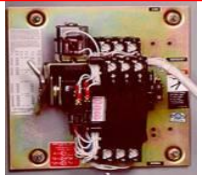
[a] The duration of operating cycle may be reduced with the consent of the manufacturer.

PERFORMANCE COMPARISON : OPERATIONAL PERFORMANCE

I_e	 Circuit Breaker UL 489, 1066 IEC 947-2			 Load Break Switch UL 363 IEC 947-3			 Contactor UL 508 IEC 947-4			 Transfer Switch Equipment UL 1008 IEC 947-6-1		
	Load categories A			Load categories AC-23A			Load categories AC-3			Load categories AC-33A		
	I/I_e	Cos θ	Cycles	I/I_e	Cos θ	Cycles	I/I_e	Cos θ	Cycles	I/I_e	Cos θ	Cycles
100	1	0.8	1500	1	0.65	1500	2	0.45	6000	2	0.8	6000
300	1	0.8	1000	1	0.65	1000	2	0.35	6000	2	0.8	6000
400	1	0.8	1000	1	0.65	1000	2	0.35	6000	2	0.8	4000
630	1	0.8	1000	1	0.65	1000	2	0.35	6000	2	0.8	2000
800	1	0.8	500	1	0.65	500	2	0.35	6000	2	0.8	2000
1600	1	0.8	500	1	0.65	500	2	0.35	6000	2	0.8	1500
2500	1	0.8	500	1	0.65	500	2	0.35	6000	2	0.8	1000
> 2500	1	0.8	500	1	0.65	500	2	0.35	6000	2	0.8	1000

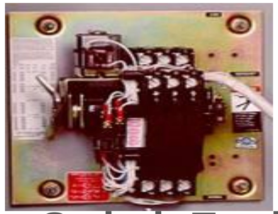
- Operating cycle for contactors is 5000 without current and 1000 with current

PERFORMANCE COMPARISON : MAKING AND BREAKING PERFORMANCE

I_e	 Circuit Breaker UL 489, 1066 IEC 947-2			 Load Break Switch UL363 IEC 947-3			 Contactor UL 508 IEC 947-4			 Transfer Switch Equipment UL 1008 IEC 947-6-1		
	Load categories A			AC-23A			AC-3			AC-33A		
	I/I_e	Cos θ	Cycles	I/I_e	Cos θ	Cycles	I/I_e	Cos θ	Cycles	I/I_e	Cos θ	Cycles
100	6	0.5	12	8	0.45	5	8	0.45	50	10	0.45	50
300	6	0.5	12	8	0.35	3	8	0.35	50	10	0.35	50
400	6	0.5	12	8	0.35	3	8	0.35	50	10	0.35	50
630	6	0.5	12	8	0.35	3	8	0.35	50	10	0.35	50
800	N/A	N/A	N/A	8	0.35	3	8	0.35	50	10	0.35	50
1600	N/A	N/A	N/A	8	0.35	3	8	0.35	50	10	0.35	50
2500	N/A	N/A	N/A	8	0.35	3	8	0.35	50	10	0.35	25
> 2500	N/A	N/A	N/A	8	0.35	3	8	0.35	50	10	0.35	3

Note : Contactors have make time of 0.05 sec and off time range from 10 to 240 sec depend on rating.

PERFORMANCE COMPARISON : SHORT CIRCUIT PERFORMANCE

 Circuit Breaker UL 489, 1066 IEC 947-2	 Load Break Switch UL363 IEC 947-3	 Contactor UL 508 IEC 947-4	 Transfer Switch Equipment UL 1008 IEC 947-6-1
Test current declared by manufacturer	Withstand $I_{test} \le 12 \times I_{rated}$ Making I_{test} declared by manufacturer	**Amp** — **Test Current** $I_r \le 16$ — 1 kA $16 \le I_r \le 63$ — 3 kA $63 \le I_r \le 125$ — 5 kA $125 \le I_r \le 315$ — 10 kA $315 \le I_r \le 630$ — 18 kA $630 \le I_r \le 1000$ — 30 kA $1000 \le I_r \le 1600$ — 42 kA $1600 \le I_r$ — declared	**Amp** — **Test Current** ≤ 100 — 5 kA 101 – 500 — 10 kA 501 – 1000 — $20 \times I_{rated}$ > 1000 — $20 \times I_{rated}$ or 50kA
Test apply to both service (I_{cs}) and ultimate (I_{cu}) short circuit breaking capacity. Fully normal operation then pass temp rise and dielectric test after S/C test.	After S/C withstand test, the test unit must be carried on S/C making immediately without maintenance. Fully normal operation then pass temp rise and dielectric test after S/C test.		The test current is the minimum value. Manufacturer can declare higher S/C currrent. Fully normal operation both close and open. Including pass temp rise and dielectric test immediately without maintenance after S/C test.

ELECTRICAL STANDARD TYPE TEST

UL Requirements

- Must Capable of withstanding The Dielectric Tests
- Must Be Able To Carry The Rated Operational Current
- Must Pass Operational and Performance Tests
- Must Carry Short Circuit Current for 3 to 25 Cycles
- The Main Contact Must Not be Change Due To Over Heating (After Short Circuit)

IEC Requires the Above Plus

- Must Pass Temperature Rise After Close On And Withstand Tests

ARCHITECTURE ARRANGEMENT

TYPICAL ARCHITECTURE

FROM THE MOST BASIC TO VARIOUS HIGHER LEVELS OF ARCHITECTURE FOR IMPROVED AVAILABILITY

Single source

Single cable

Single cabinet

Any problem, loss of power

But not enough… any loss of utility supply means loss of power

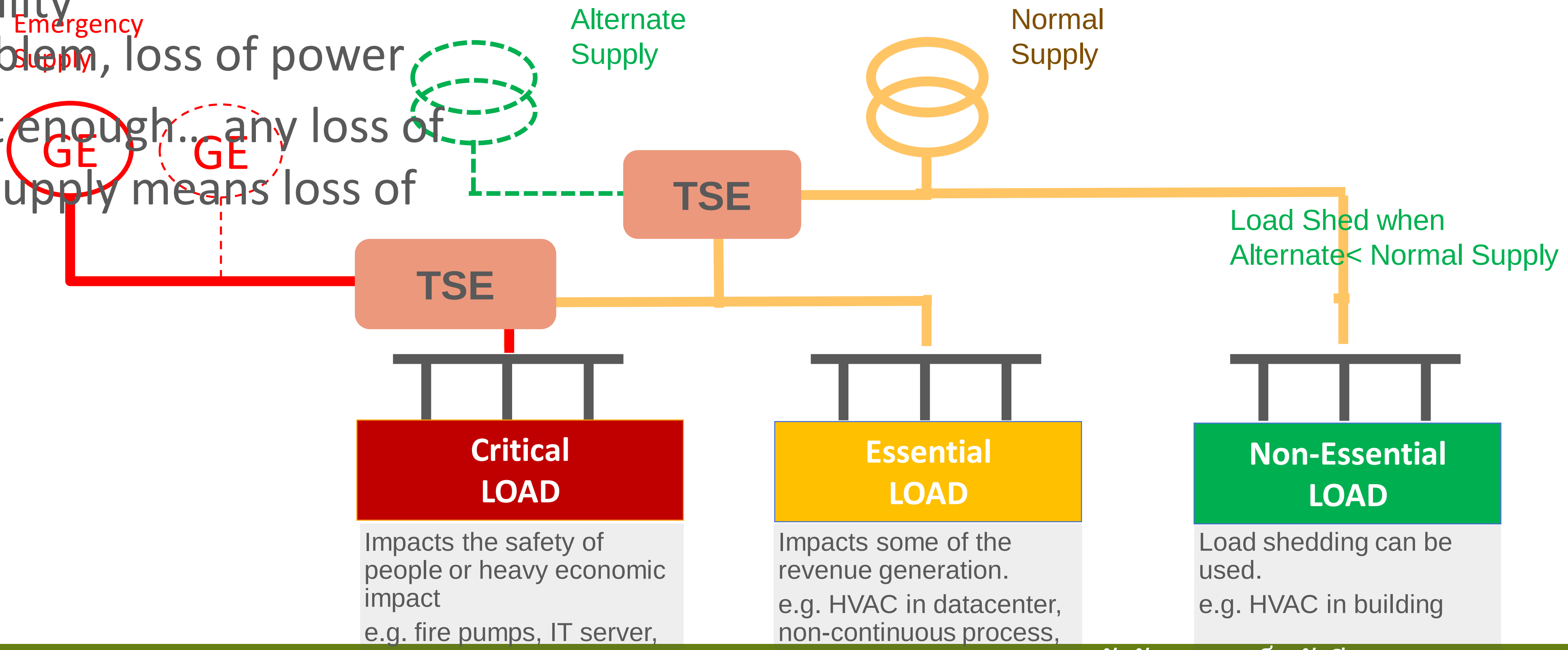
Split between Critical / Essential / Non-essential

Better selectivity, so better availability

Add a second source, possibly load shedding for secondary loads

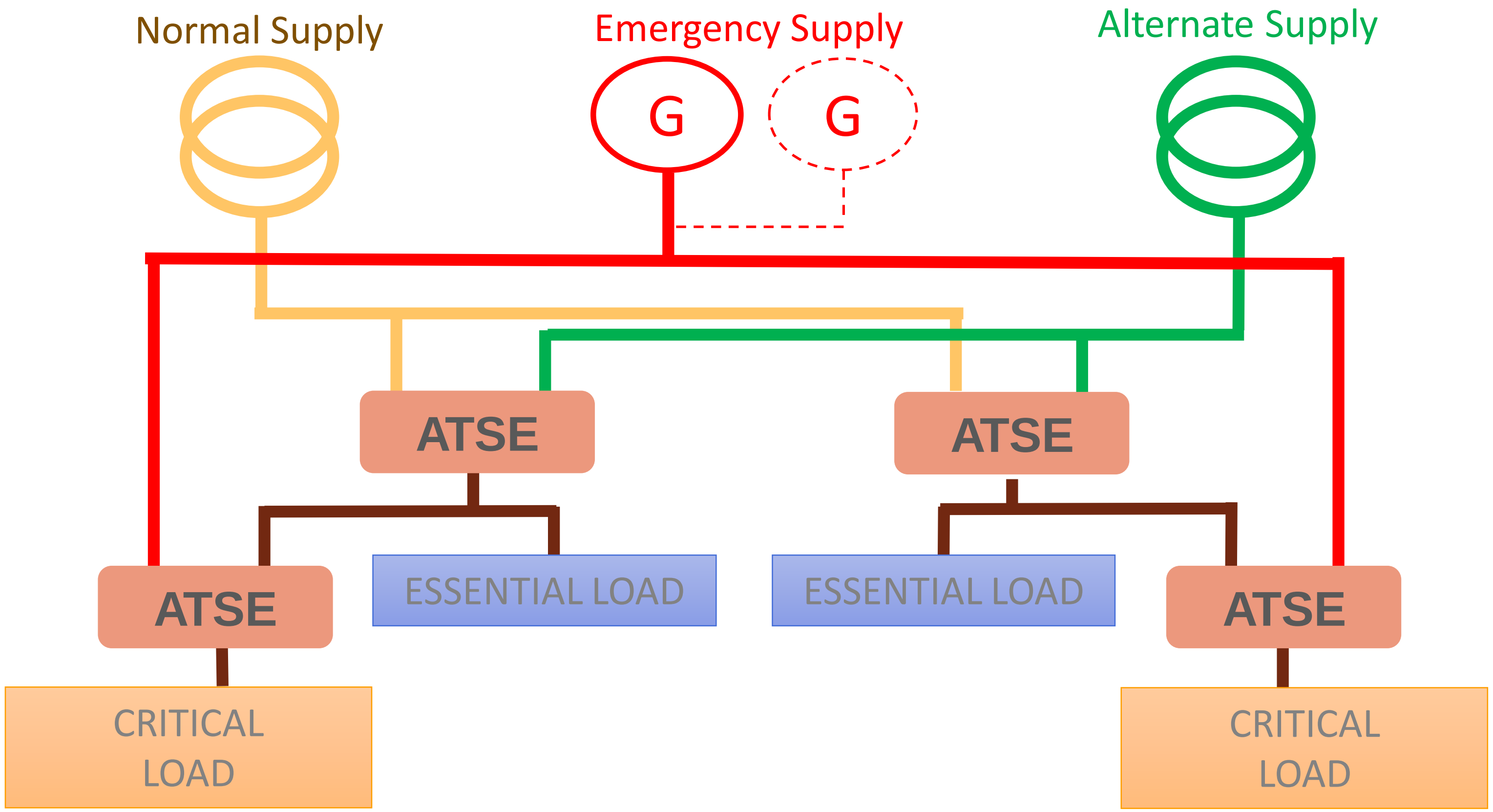
Get rid of loss of utility, but still risks, even if low probability of occurrence:

>problem with cables / Switchboard / …



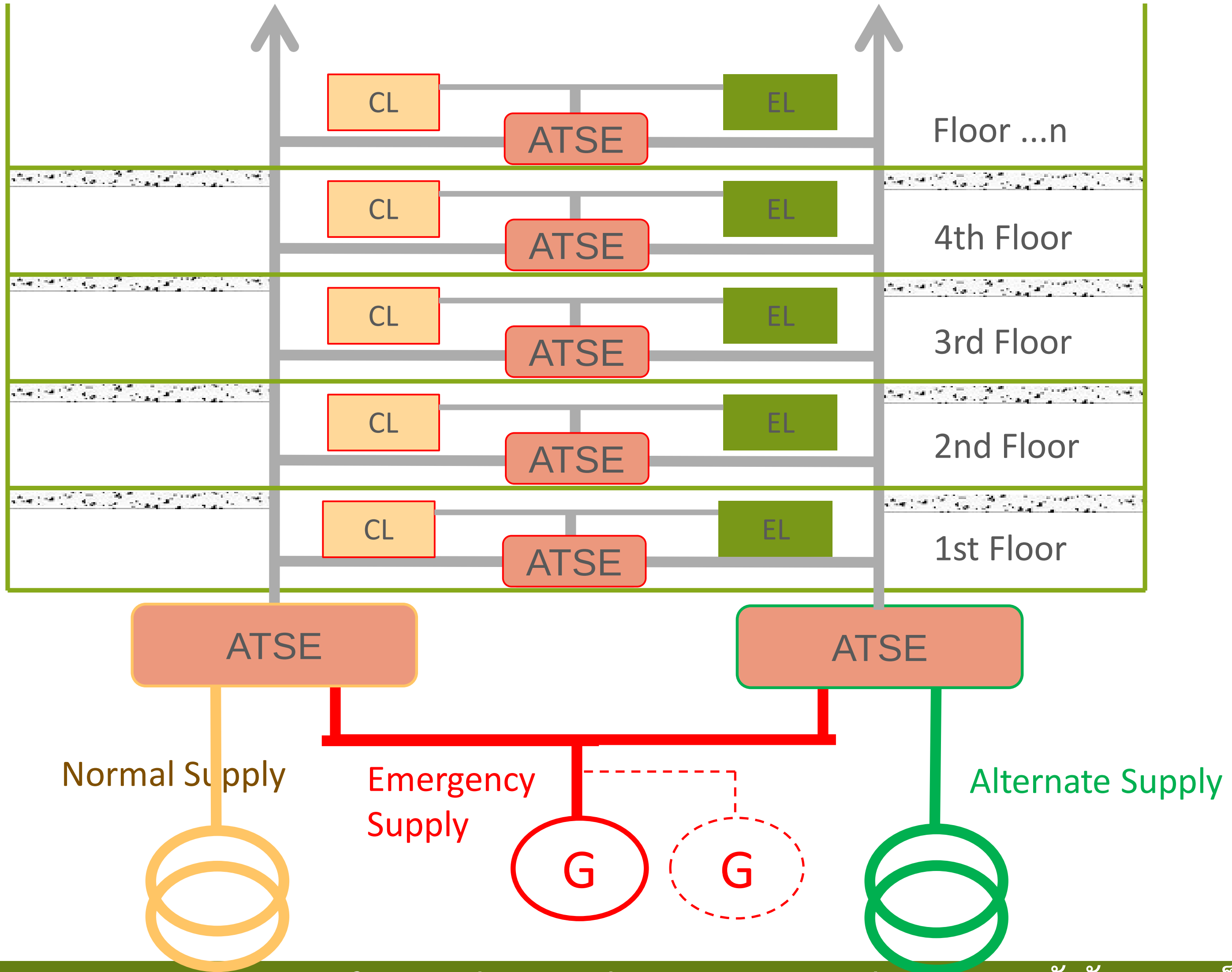
TYPICAL ARCHITECTURE

FROM THE MOST BASIC TO VARIOUS HIGHER LEVELS OF ARCHITECTURE FOR IMPROVED AVAILABILITY



TYPICAL ARCHITECTURE

FROM THE MOST BASIC TO VARIOUS HIGHER LEVELS OF ARCHITECTURE FOR IMPROVED AVAILABILITY



OPEN TRANSITION TRANSFER SWITCH (OTTS)

VS

CLOSE TRANSITION TRANSFER SWITCH (CTTS)

DIFFERENT TYPE OF POWER SWITCHING SOLUTION

Open Transition

Open/Closed Transition with Bypass Switch

Closed Transition

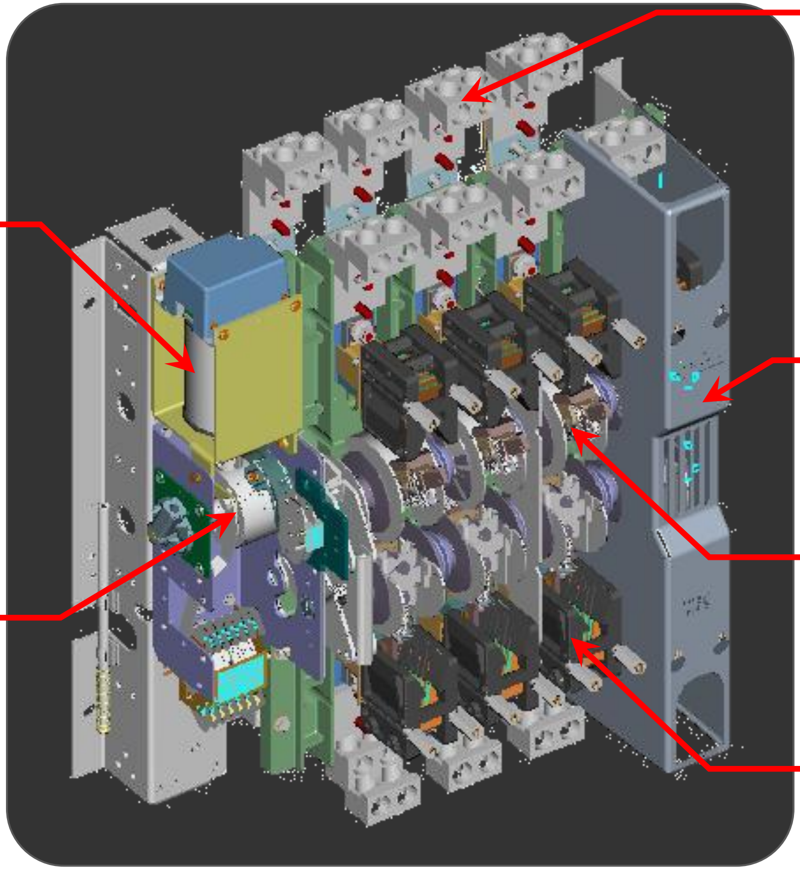
OPEN TRANSITION TRANSFER SWITCH (OTTS)

POWER SWITCHING SOLUTION

OPEN TRANSITION

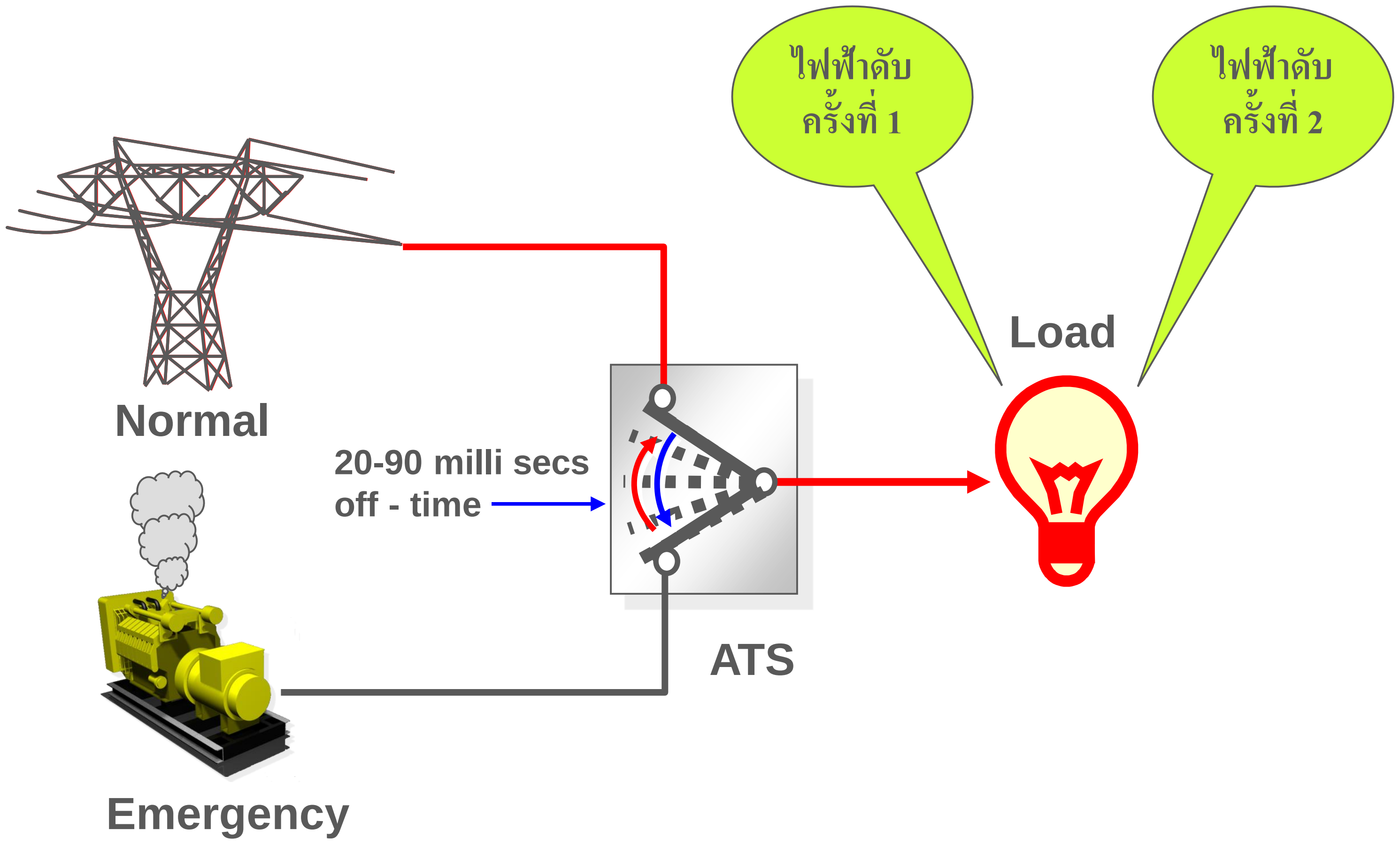
Open Transition Transfer
(Break Before Make)

- One set of contacts open before the other set close
- Load is disconnected from power during all transfers



POWER SWITCHING SOLUTION

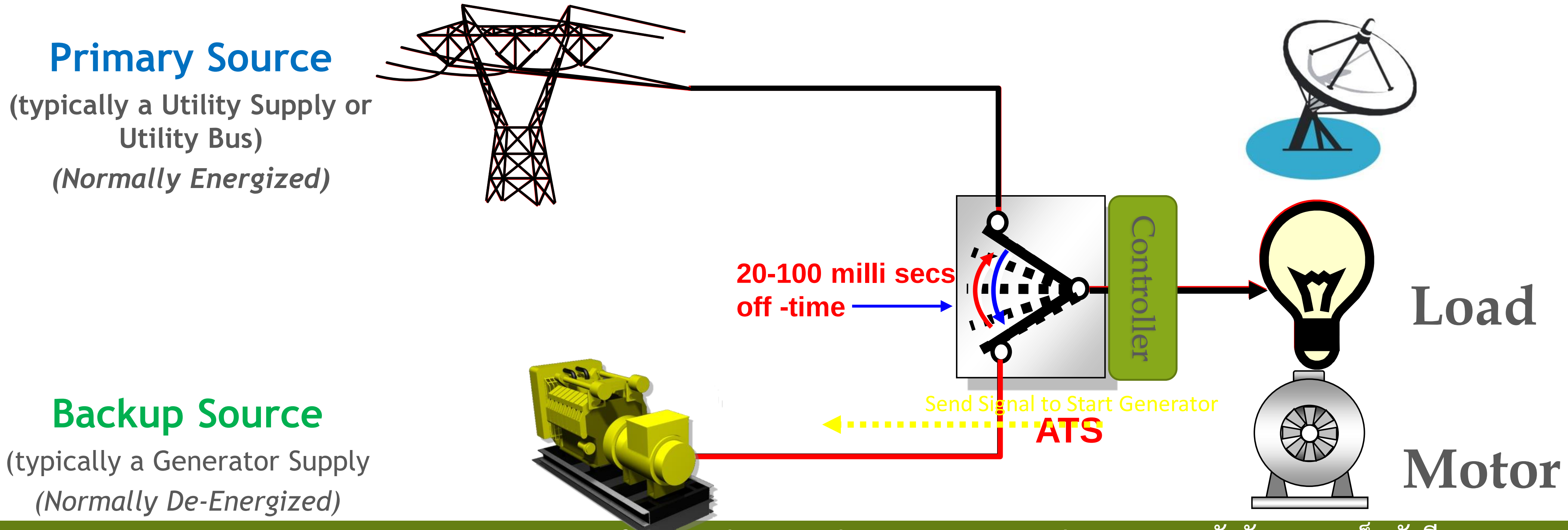
OPEN TRANSITION



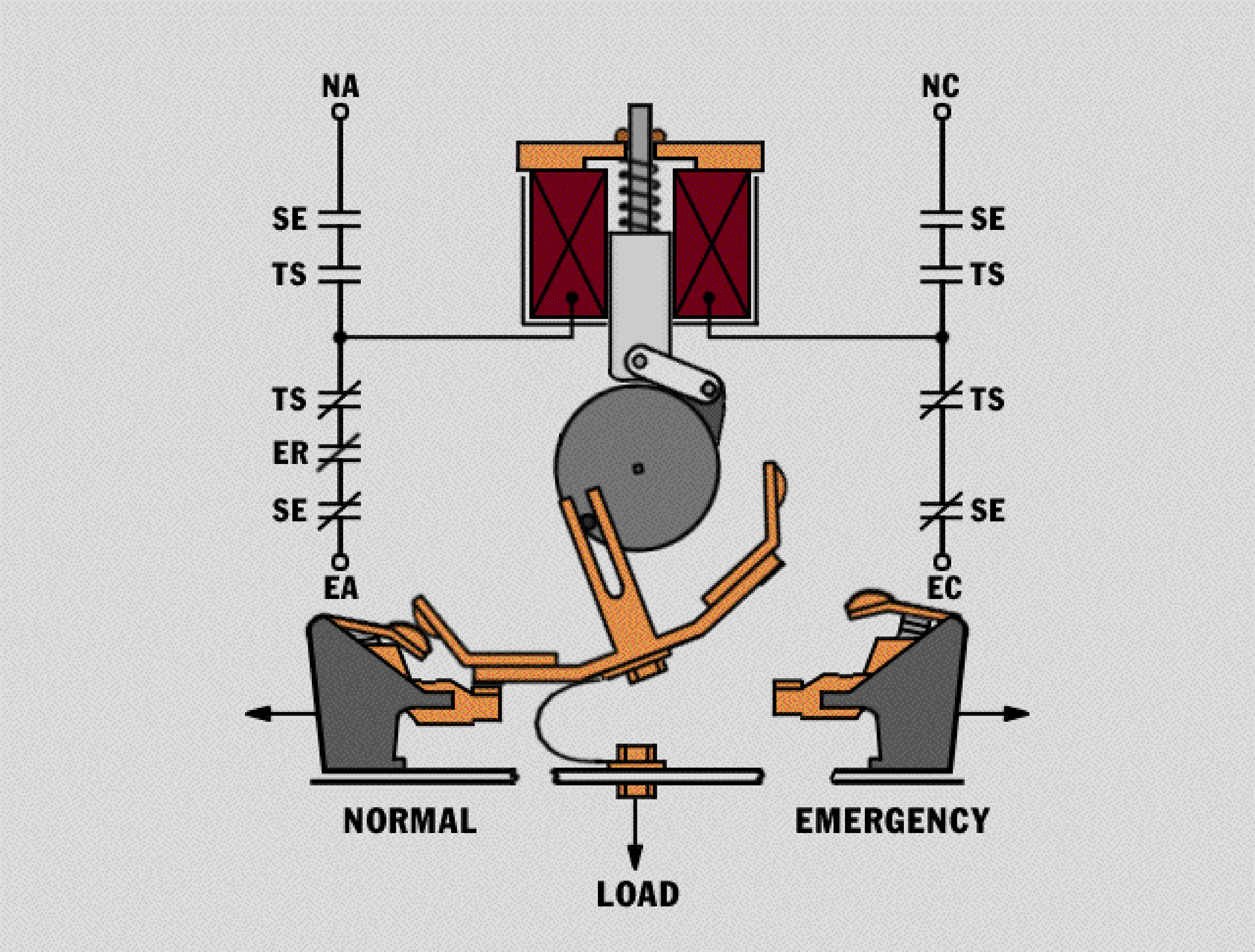
POWER SWITCHING SOLUTIONS

BREAK BEFORE MAKE (OTTS) – 20~100 MILLISECONDS

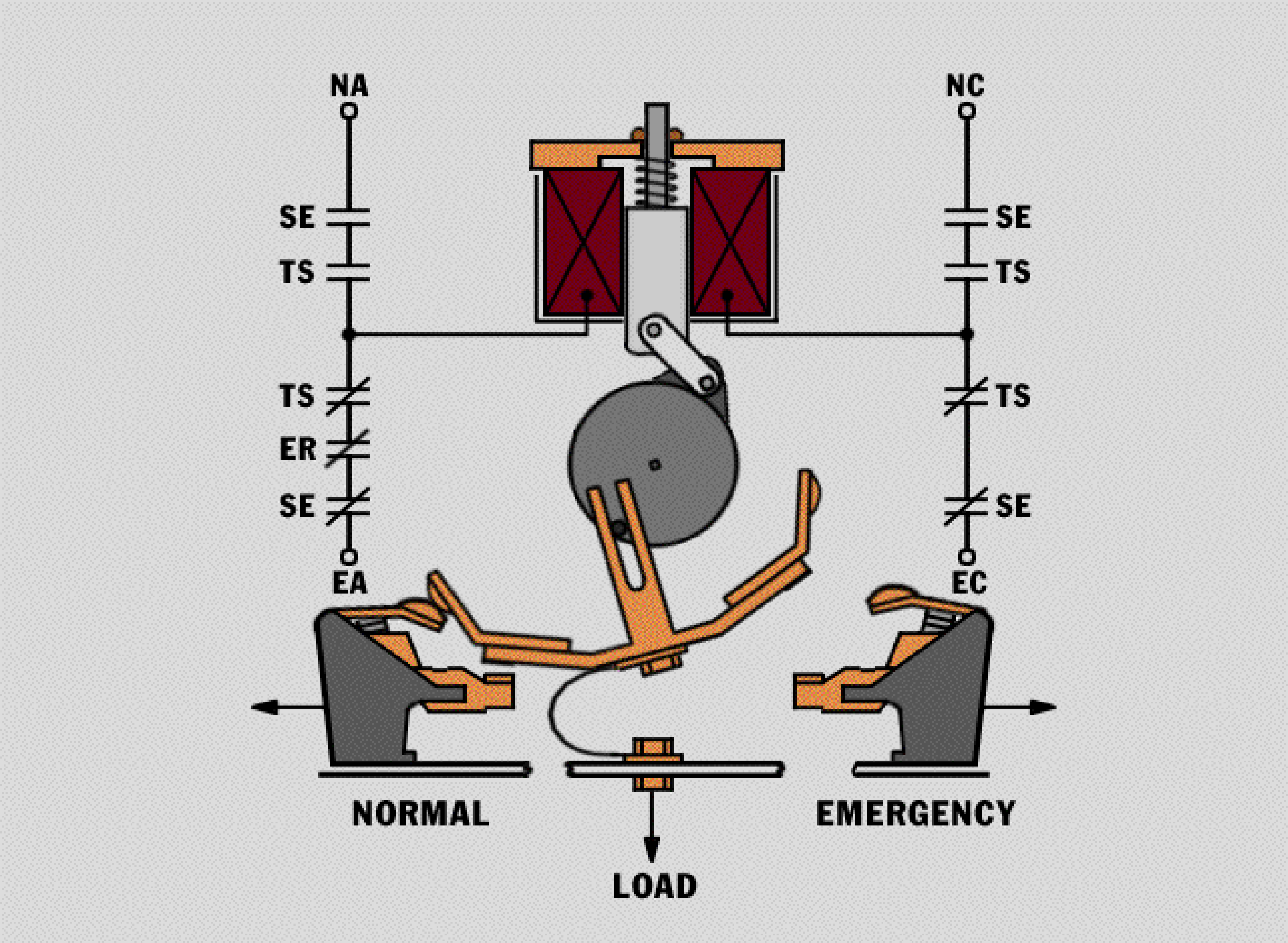
- One set of contacts open before the other set close
- Load is disconnected from power during all transfers
- Fast Break Fast Make



Single Operators 20~100millsecs



Single Operators 20~100millsecs



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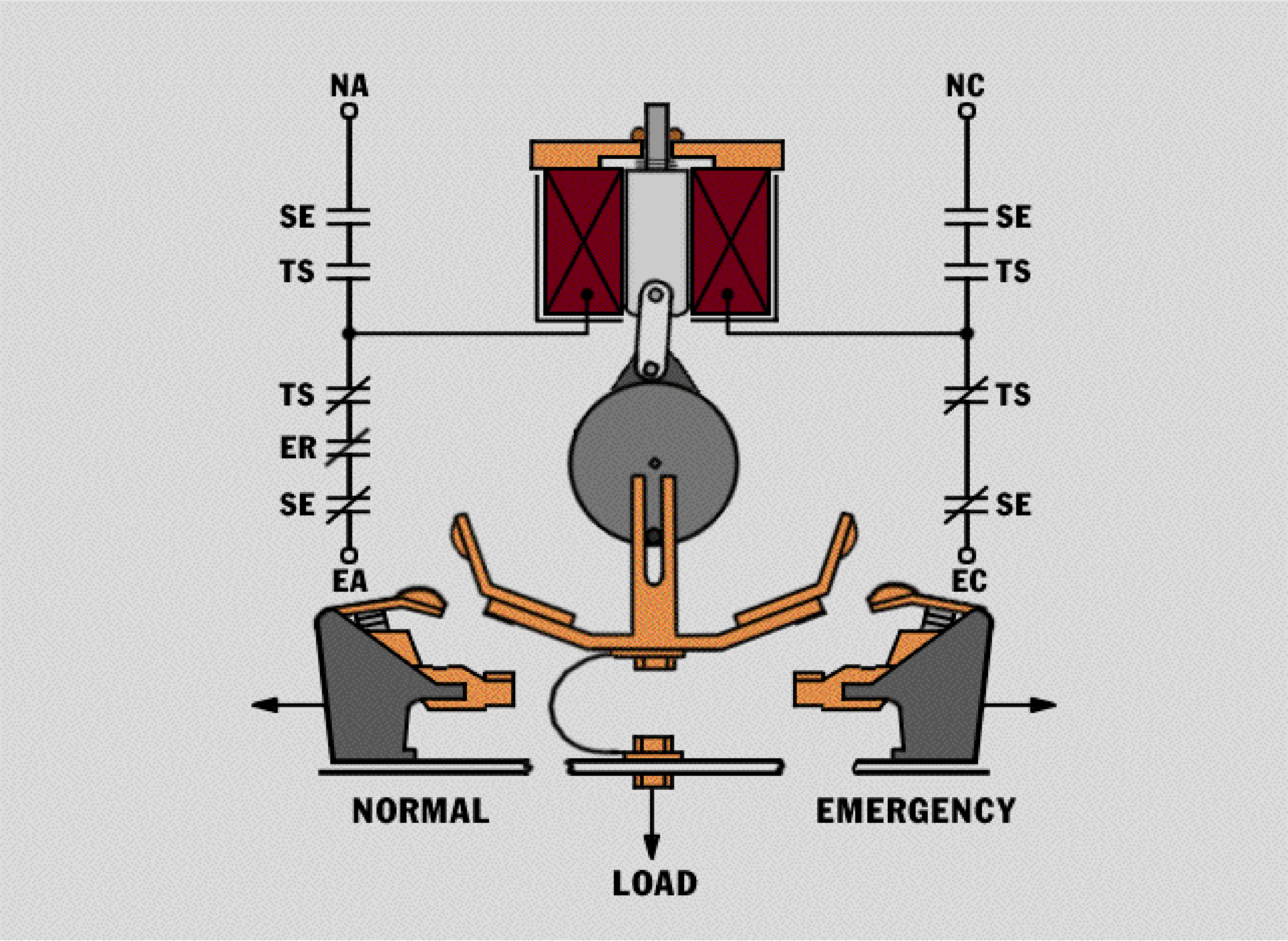
Single Operators 20~100millsecs



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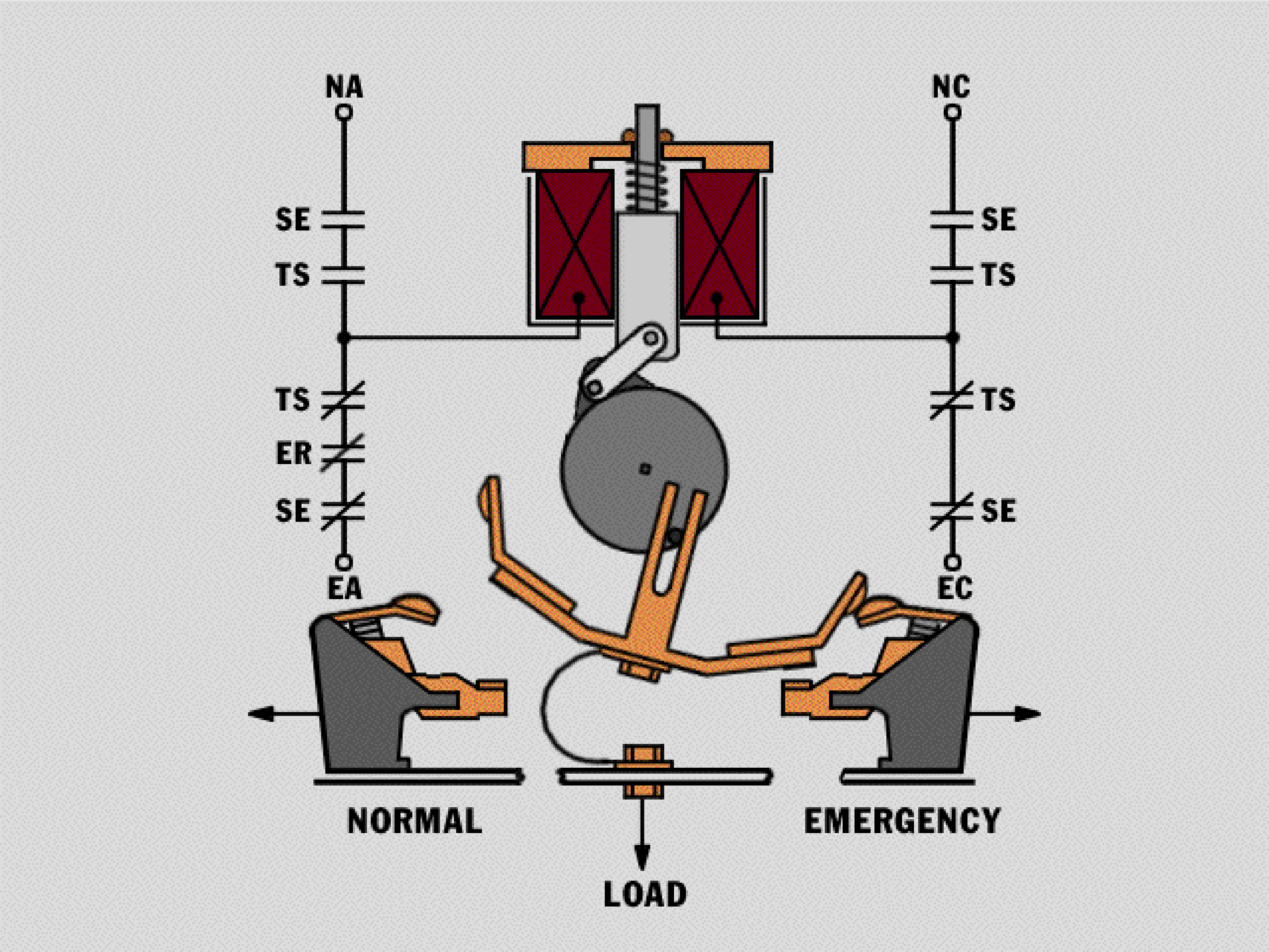
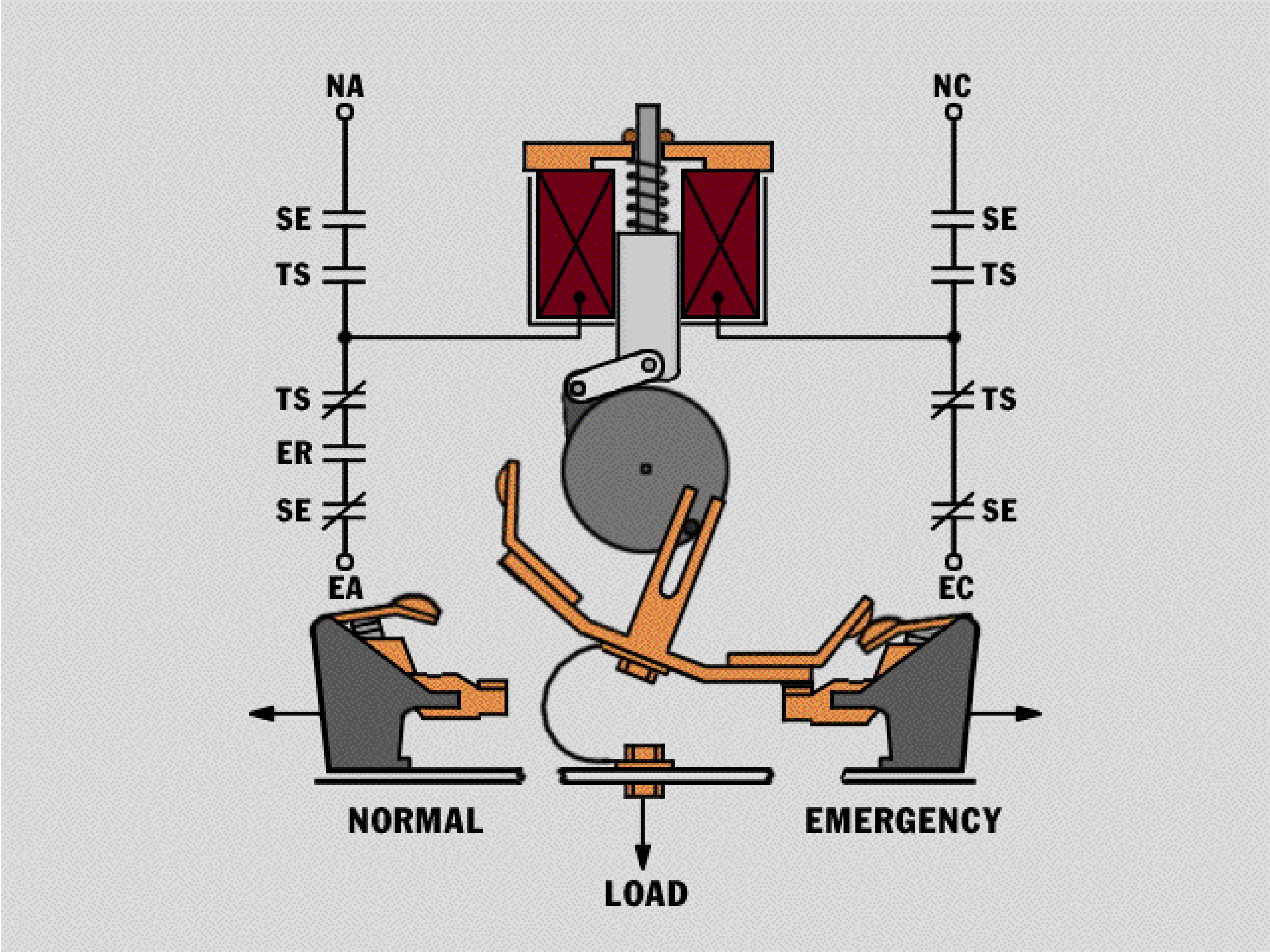
Single Operators 20~100millsecs



Single Operators 20~100millsecs



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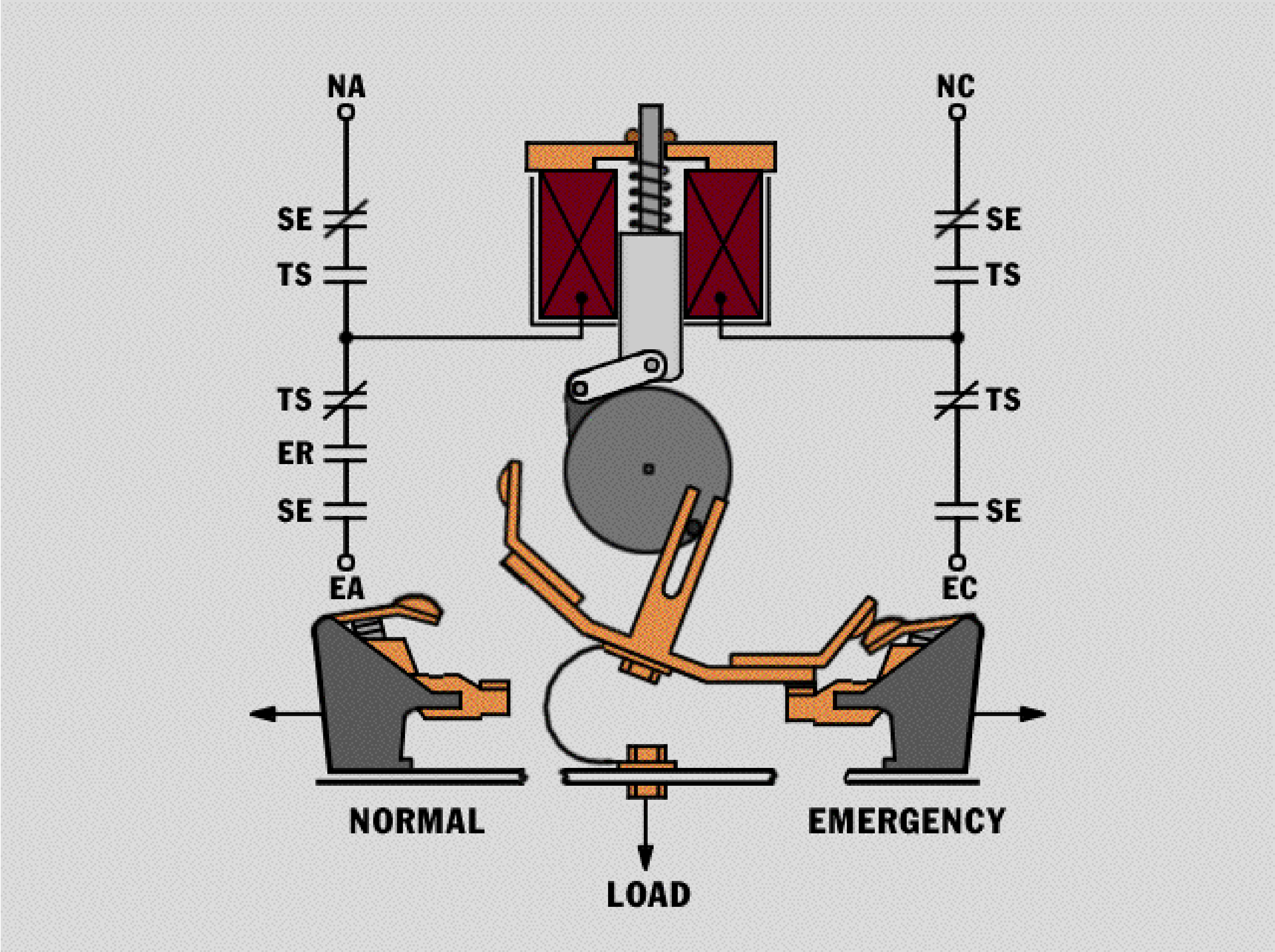
Single Operators 20~100millsecs



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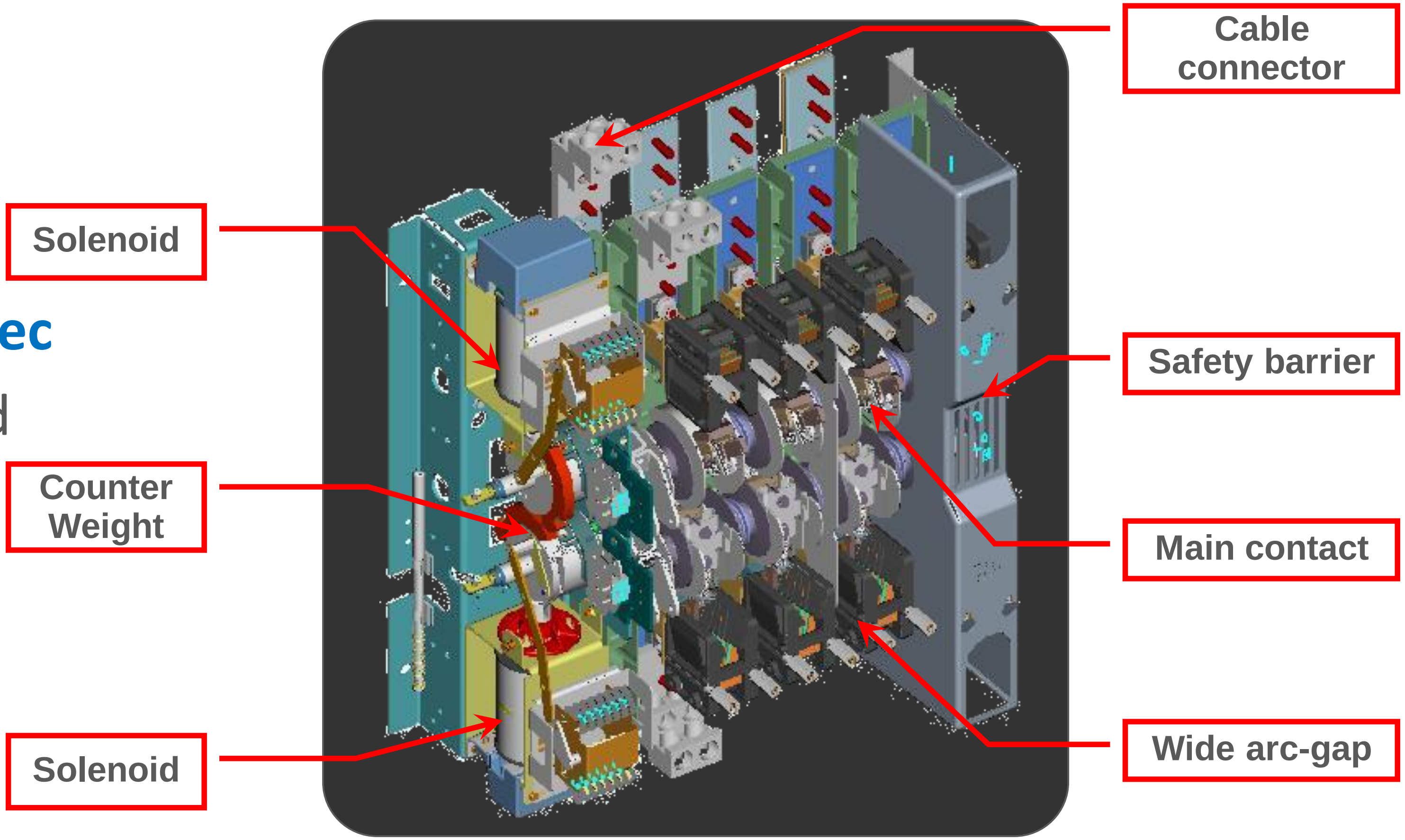
CLOSE TRANSITION TRANSFER SWITCH (CTTS)

POWER SWITCHING SOLUTION CLOSED TRANSITION

Closed Transition Transfer
(Make Before Break)

- Two sets of contact are in parallel **not more than 100 msec**
- Maintain power supply to load during re-transfer



POWER SWITCHING SOLUTION
CLOSED TRANSITION

Closed Transition Transfer Requirement

- Both Sources Must Be Present
- Passive Type Synchronizer
- Sources Must In Synchronism
  - ✓+/- 5% Voltage Differential
  - ✓+/- 0.2 Hz. Frequency Differential
  - ✓+/- 5 Electrical Degrees Phase Angle Difference

  If these three requirements are not met, closed transition transfer will be inhibited (2mins)
- Electronic Governor For Gen-set
- Overlap Time Shall **Not Exceed 100 m sec.**

POWER SWITCHING SOLUTION CLOSED TRANSITION

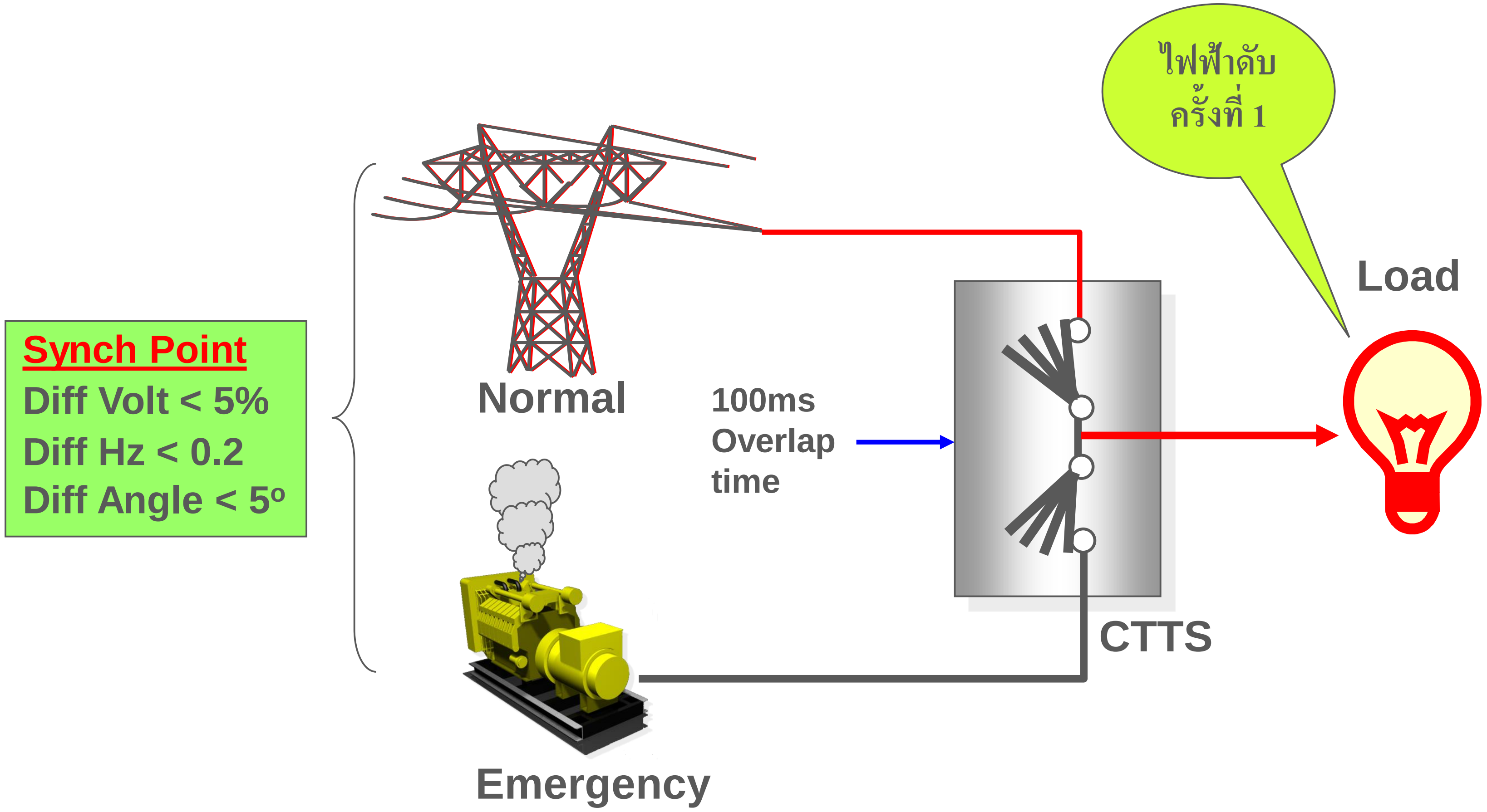
Closed Transition Transfer Benefits

- *Only one time power interruption*
- *Maintains Power to the Loads*
- Minimizes Inrush Currents
- *Reduces Stress on UPS – Longer life time of battery*
- *Peak load shaving when advanced to* ***Soft Load Transfer***
- *Better Periodic Testing and Avoid Reluctance to Test*
- *Anticipated Power Failure*

ATSE SAFETY FEATURES IN CTTS

- Two separate controllers, one for normal and one for emergency.
- A passive type of synchronizer to give transfer signal to the controllers.
- Computerized sensing and logic for voltage, frequency and phase angle.
- System lock out if the two sources unable to reach synchronism after pre-set time.

POWER SWITCHING SOLUTION CLOSED TRANSITION

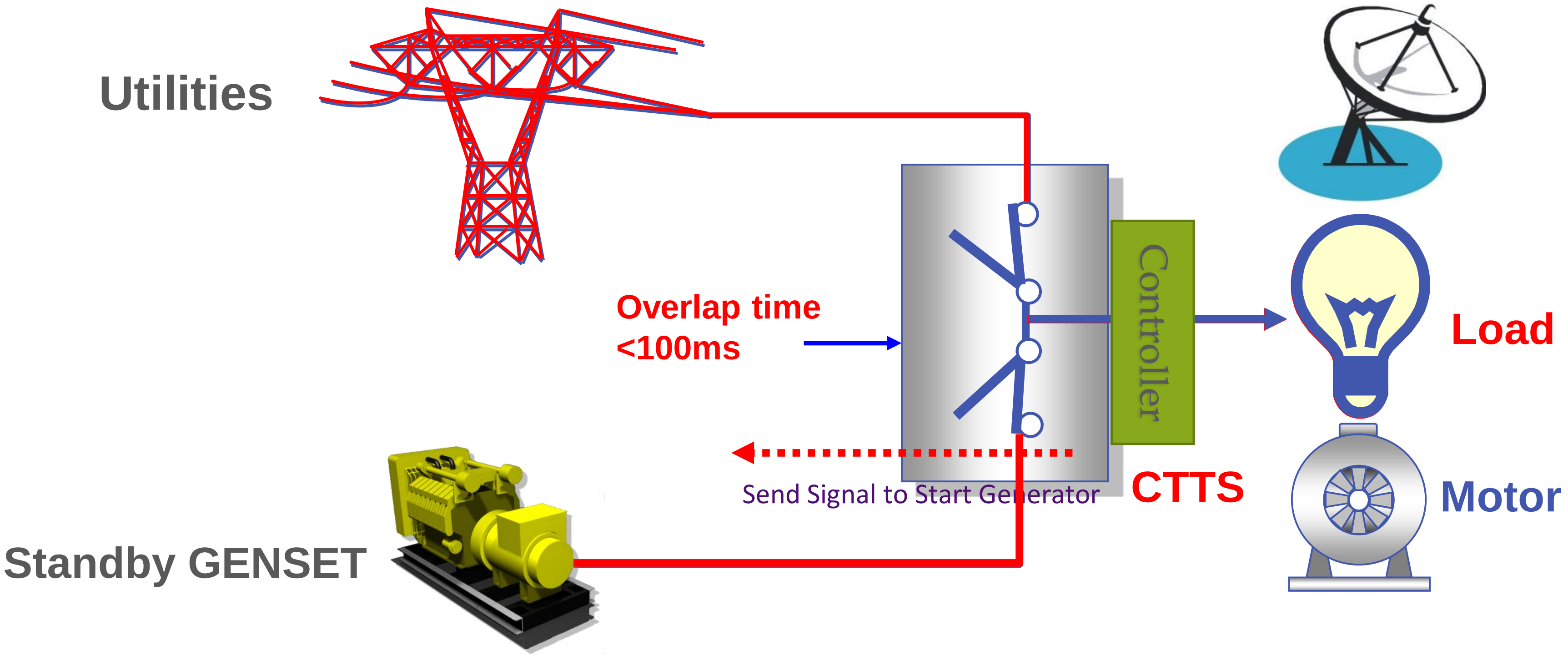


CLOSED TRANSITION OPERATION

MAKE BEFORE BRAKE (<100 MILLISECONDS)

MAKE BEFORE BREAK (Closed Transition Transfer)

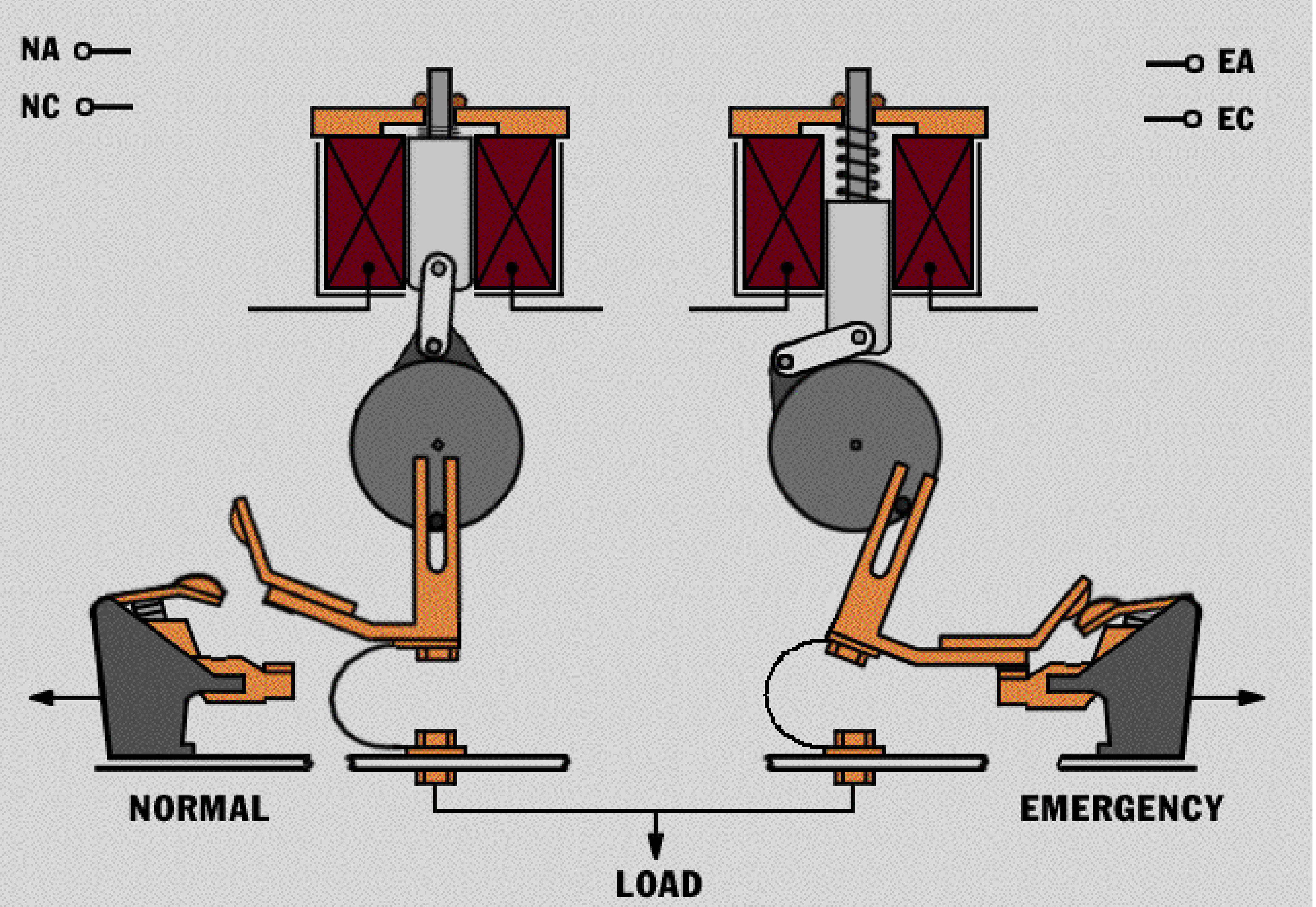
- Two (2) set of contacts are in parallel not more that 100 mSec.
- Maintain power supply to load during re-transfer
- Fast Make Fast Break



Automatic Mode

Electrically Manually Mode

Automatic to Emergency, Manual Mode for retransfer



Both Operators Momentarily <100millsecs

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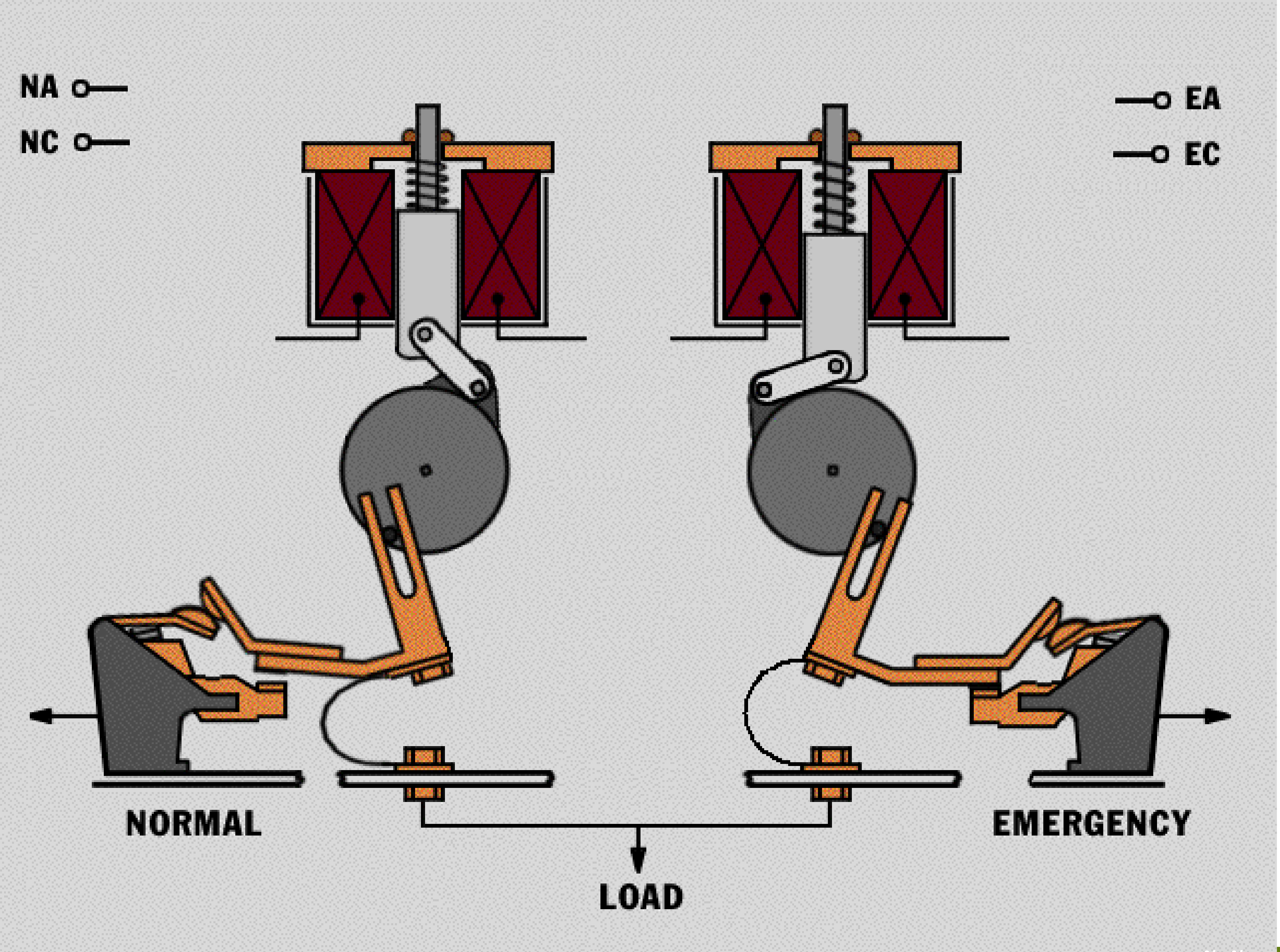
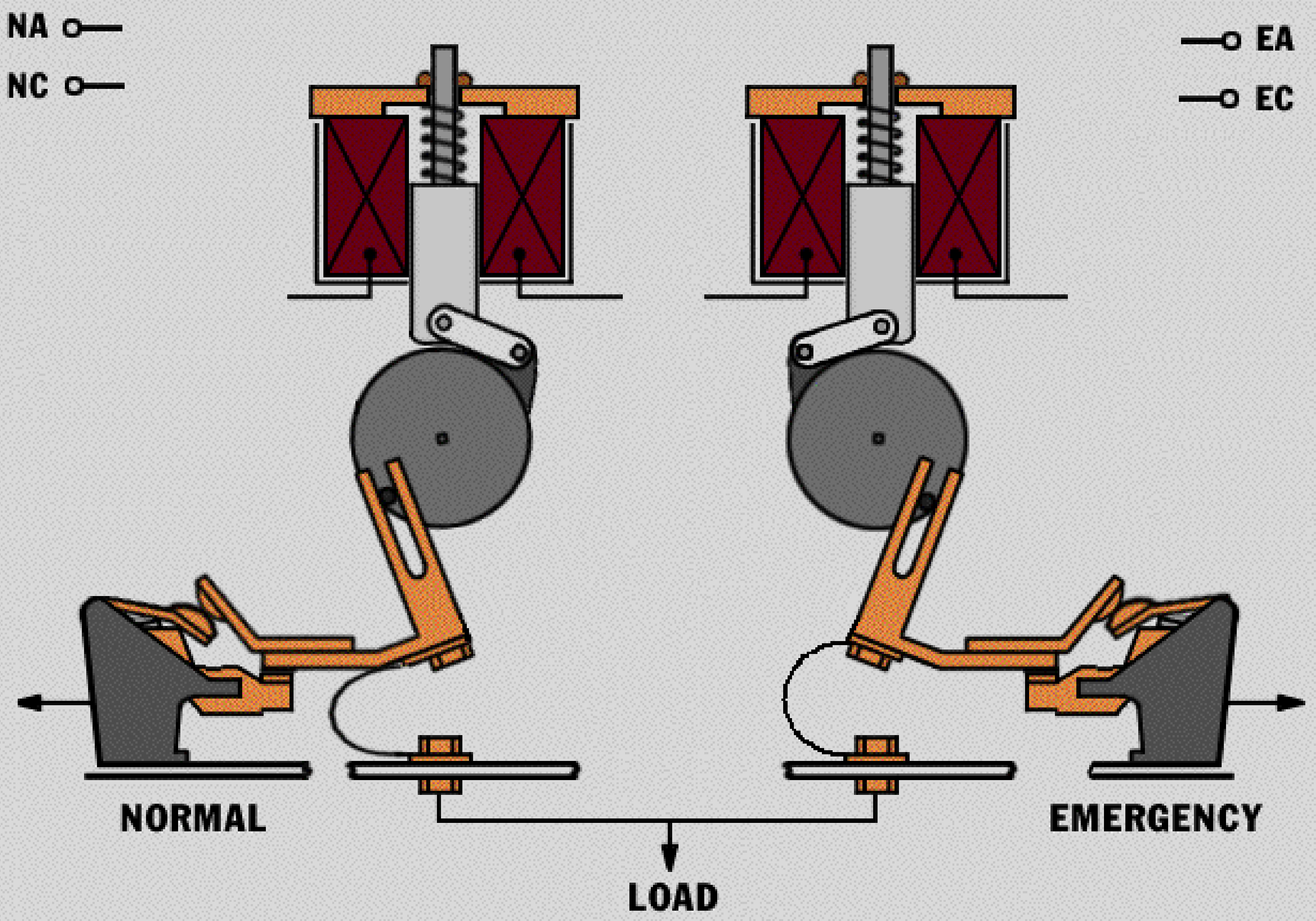
Both Operators Momentarily <100millsecs





Both Operators Momentarily <100millsecs

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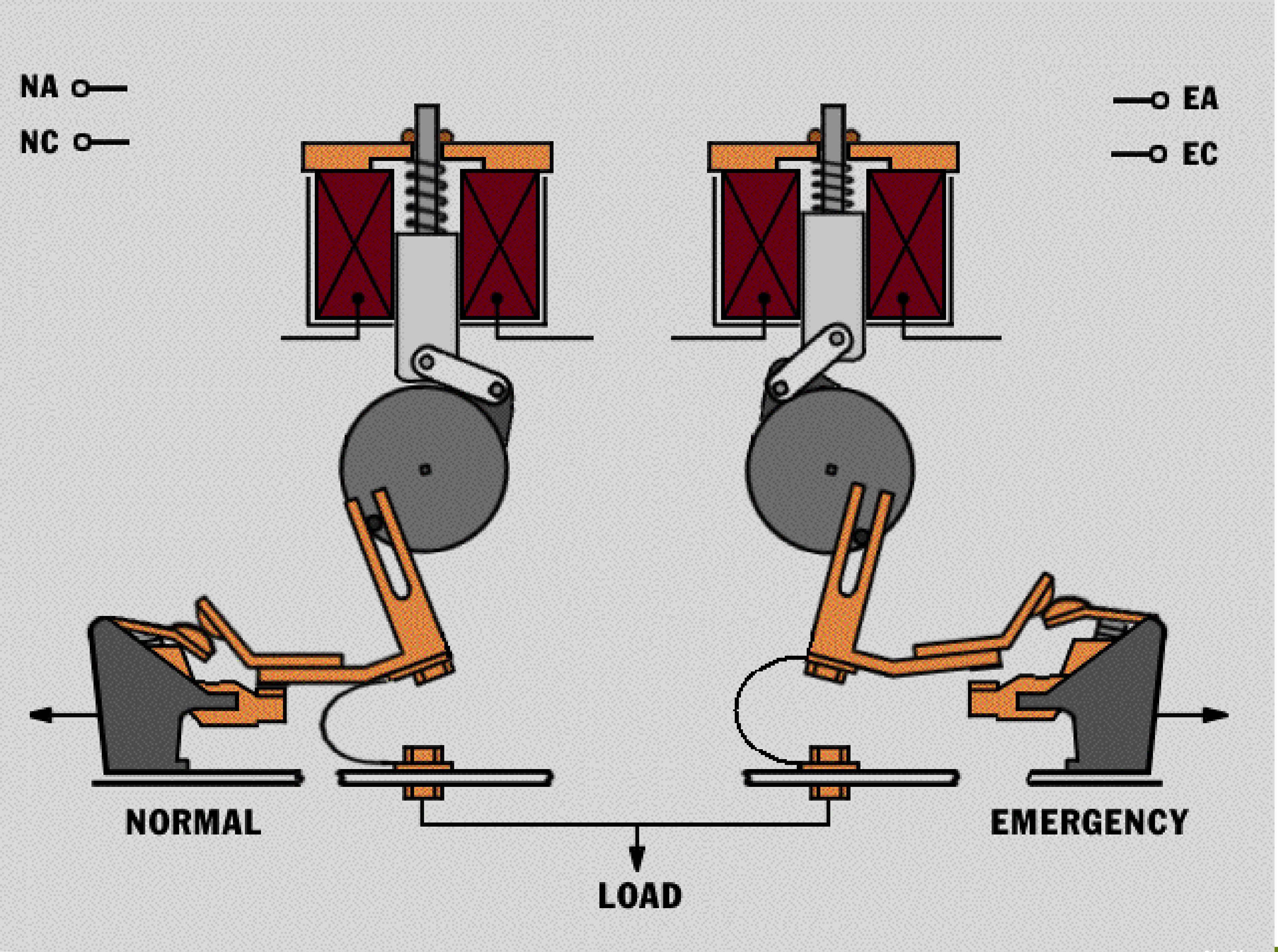
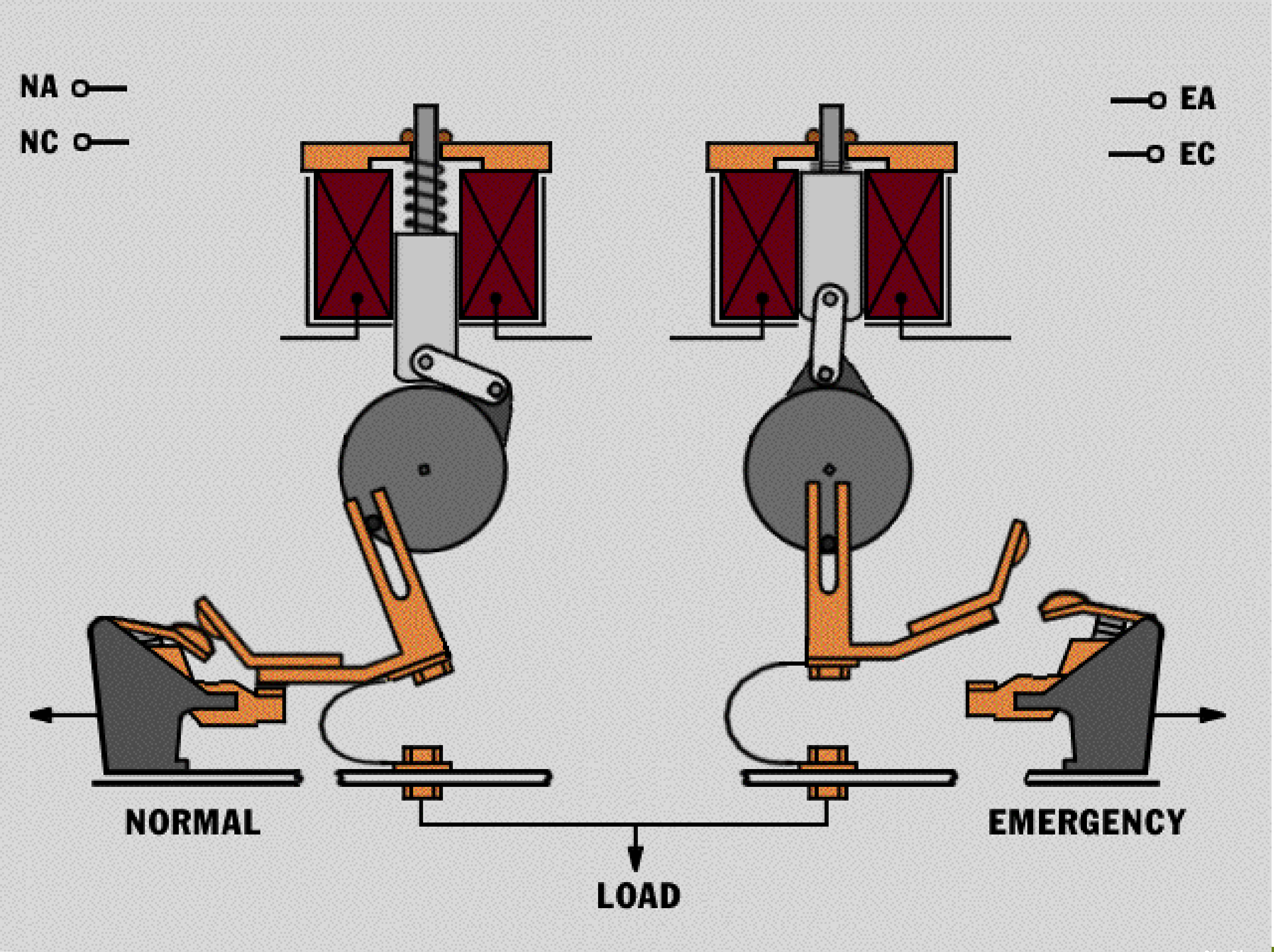
Both Operators Momentarily <100millsecs





Both Operators Momentarily <100millsecs

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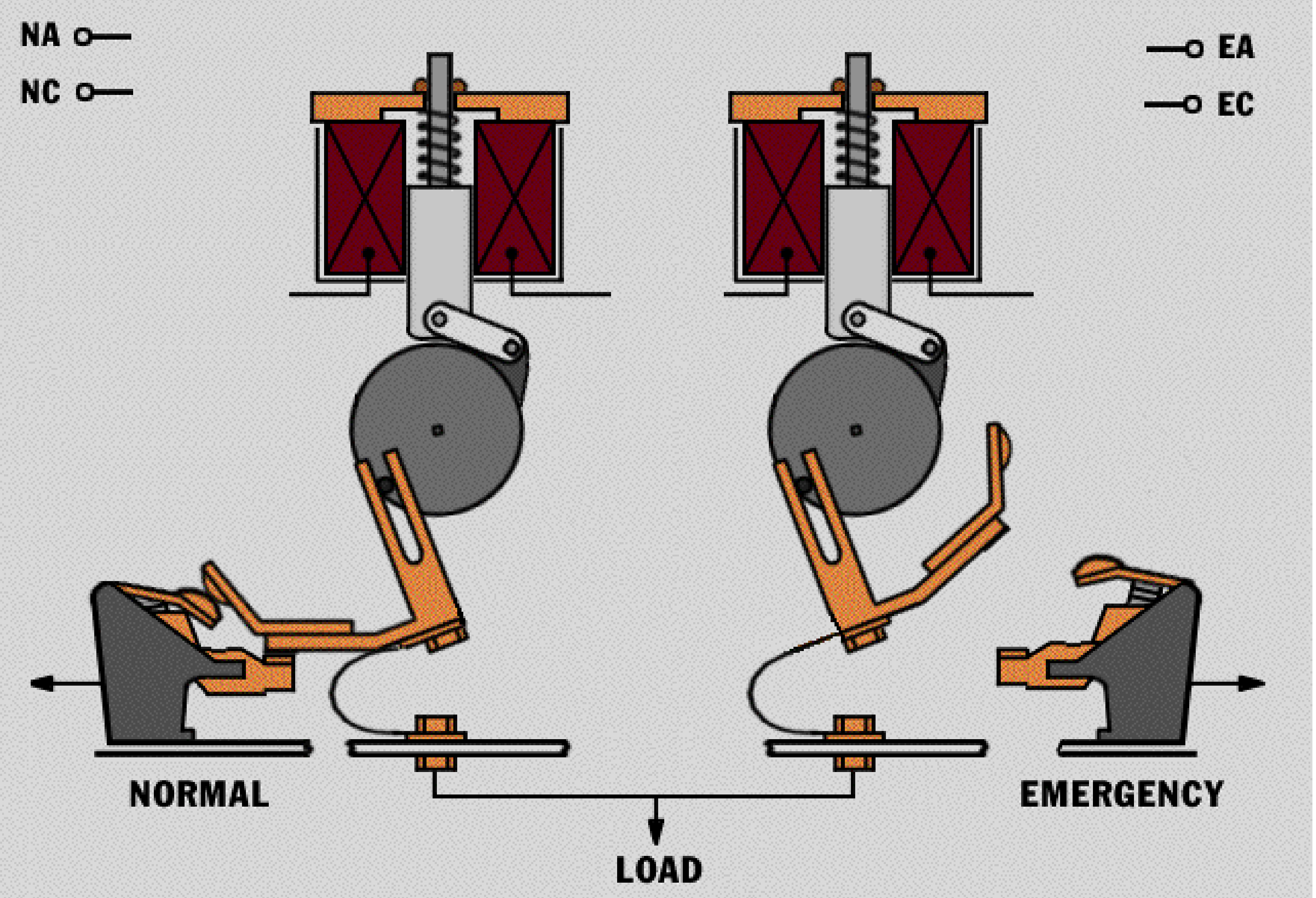
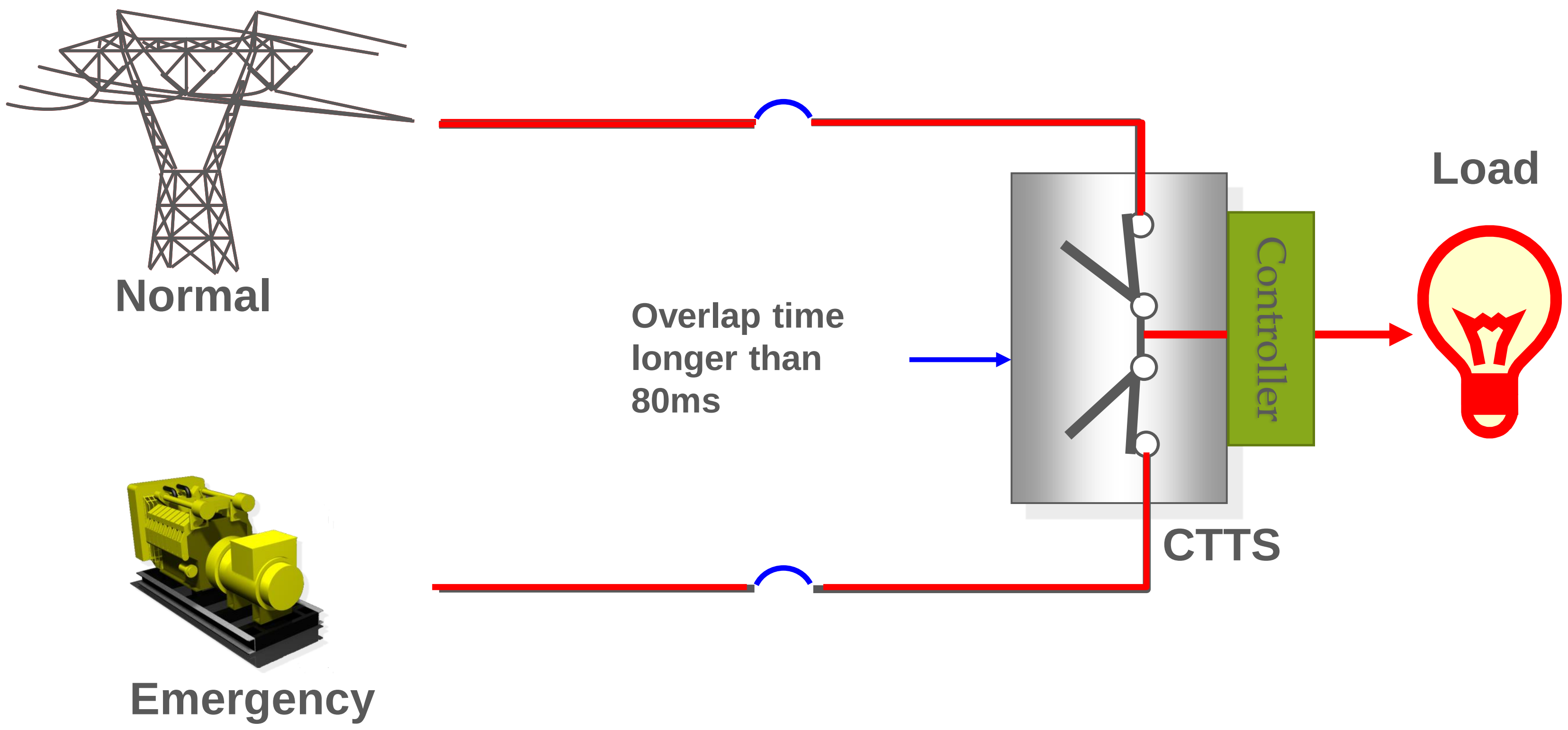
Both Operators Momentarily
<100millsecs



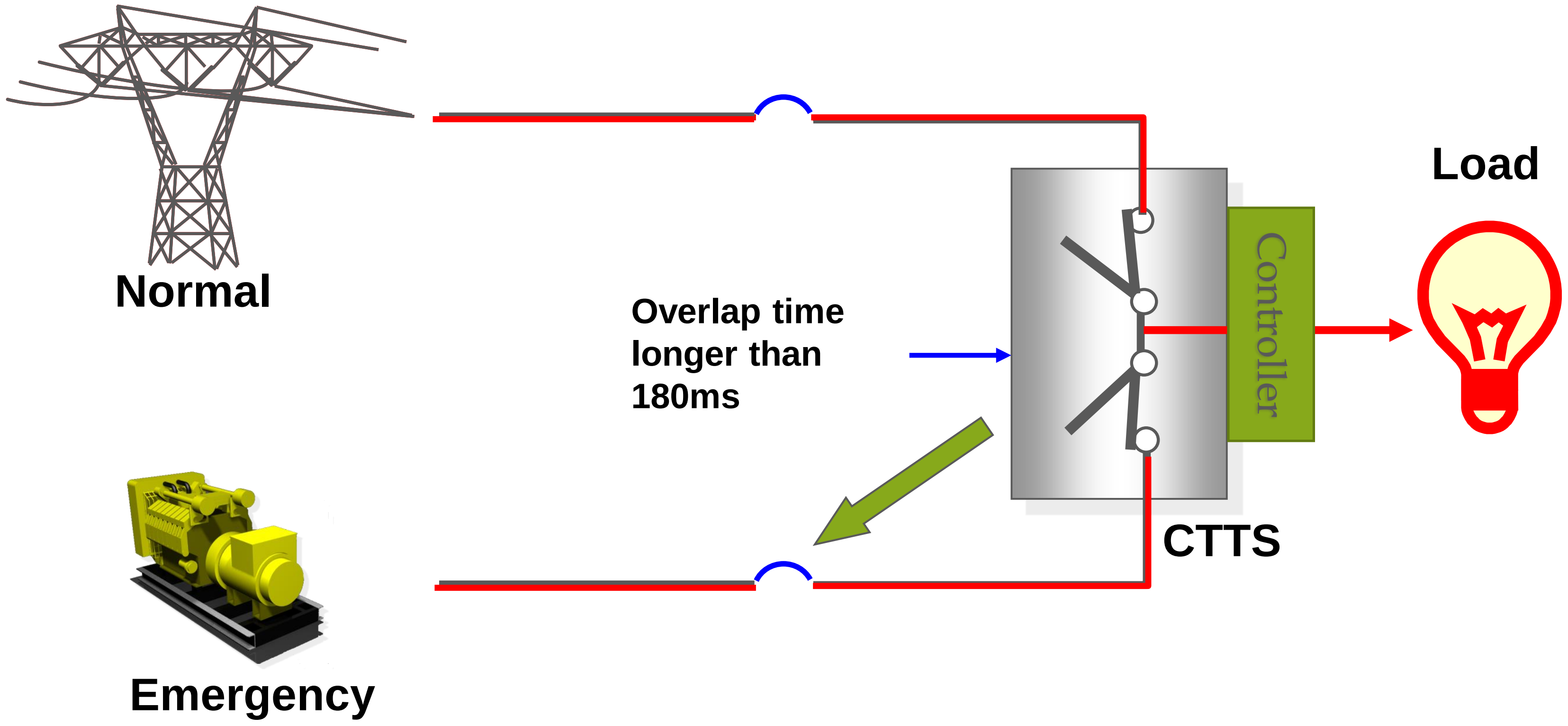
ATSE SAFETY FEATURES BUILD IN CTTS

- Last operator to close will automatically open and system will locks itself in case one of the operator fail or if the paralleling time is more than 100msec (manual reset).
- Dry contact to trip upstream Circuit Breaker in case both operators fail simultaneously.
- The operators each draw their power from the source to which they are going. If one source is not available, it will prevent the switch from transferring in close transition mode.

CTTS LAST CONTACT TO CLOSE AUTOMATICALLY OPEN



CTTS TRIP UPSTREAM BREAKER WHEN BOTH OPERATORS FAILED



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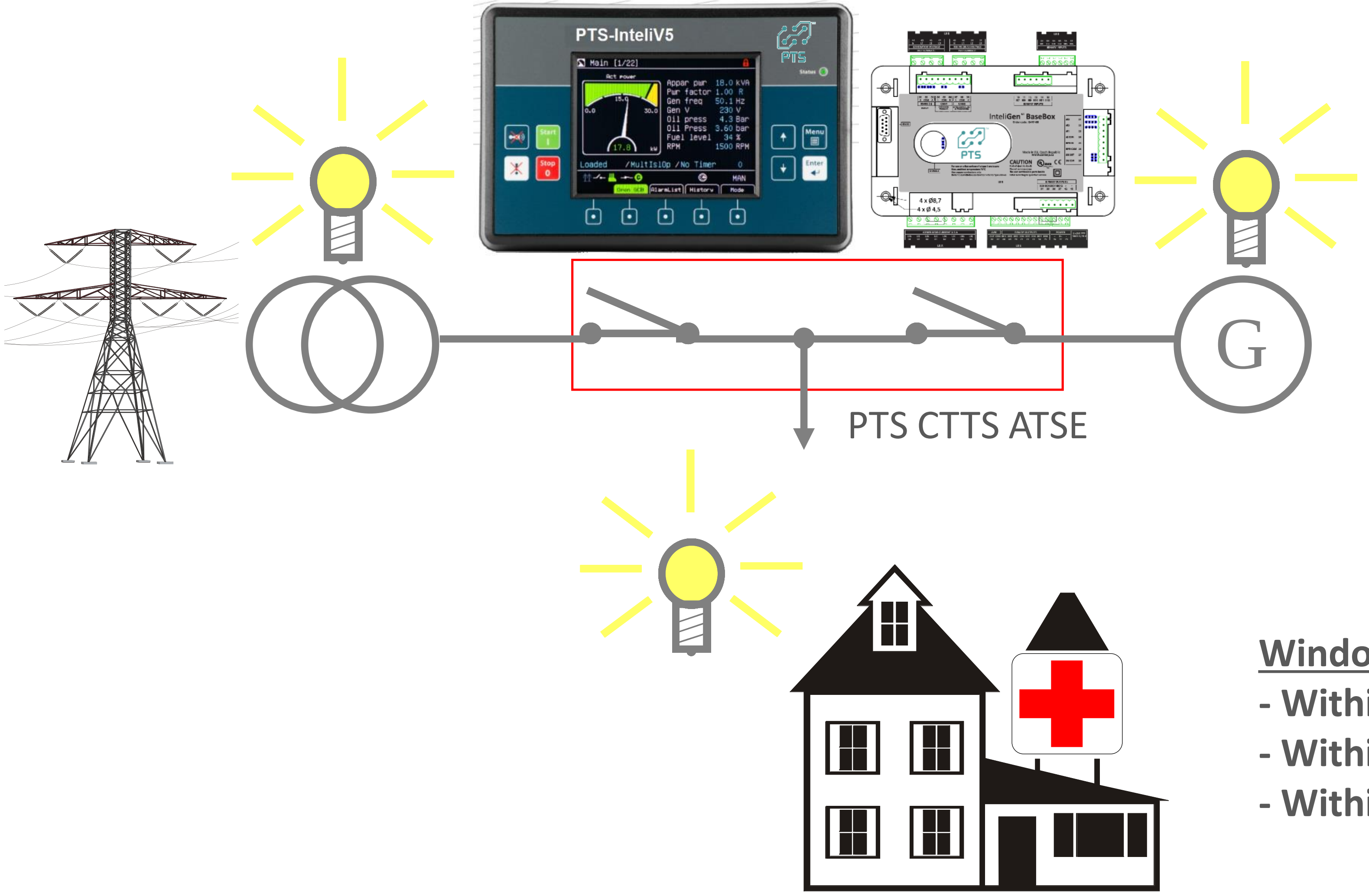
Single Parallel To Mains



- ✓ **Closed/Opened Transition**
- ✓ **Unloading/Soft Transfer**
- ✓ **Parallel with Mains (Load Test)**
- ✓ **Run-Up Synchornization (supply while voltage/speed build up)**

Windows of Parallel to Mains (adjustabel)

- Within 4% voltage

- Within 0.2 Hz difference

- Within Phase angle of 5 degree

Auto mode Parallel Transfer Video

Manual mode Parallel Transfer Video

PROBLEMS ARISING FROM OPEN TRANSITION LIVE TO LIVE TRANSFER

PROBLEMS ARISING FROM OPEN TRANSITION

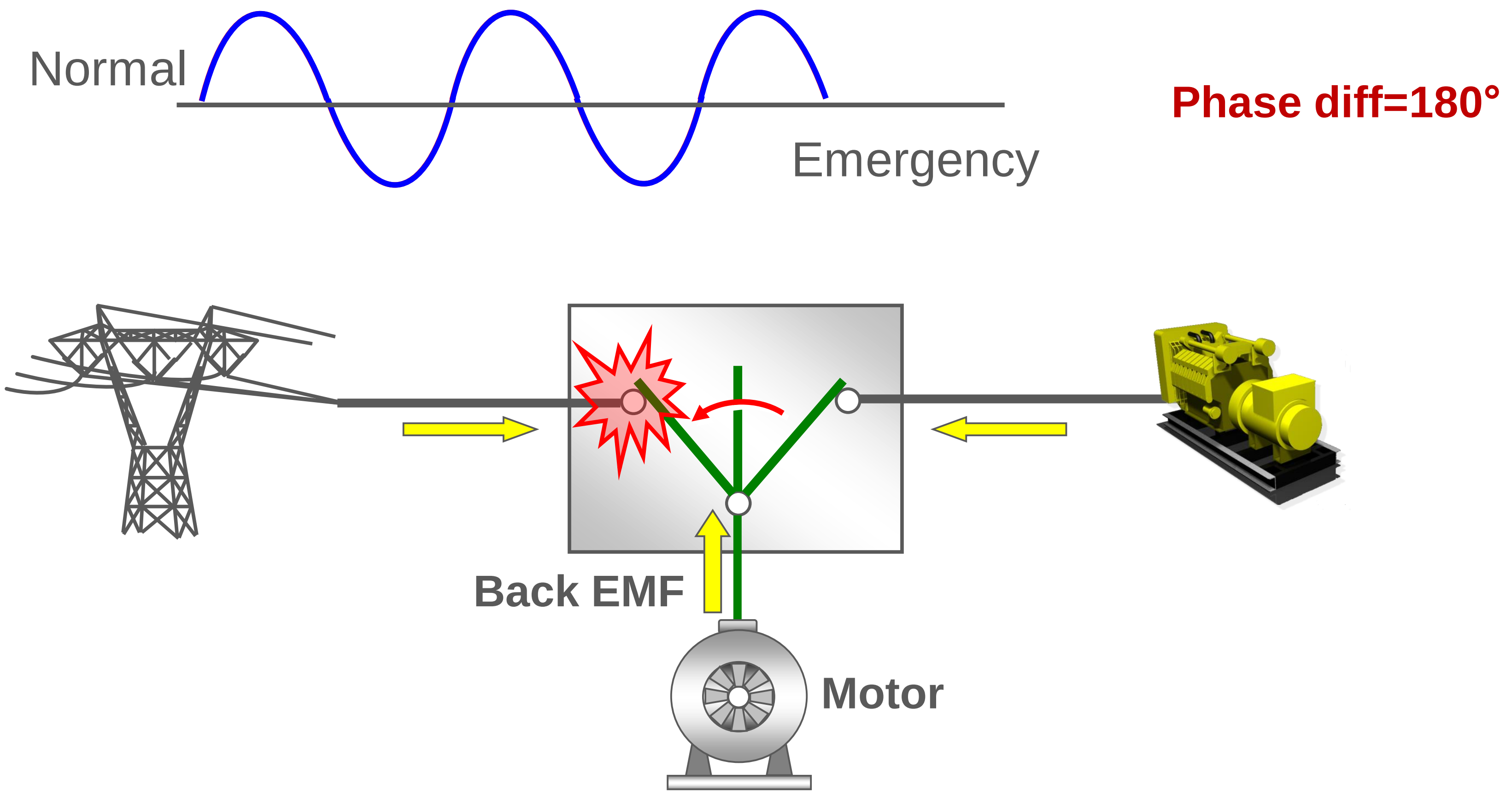
LIVE TO LIVE TRANSFER

- High making current….*no in phase monitor*
- Generate Voltage Spikes….*4 P w/o neutral overlapping or high speed transfer*

PROBLEMS CAUSED BY RANDOM TRANSFER OF MOTOR LOADS

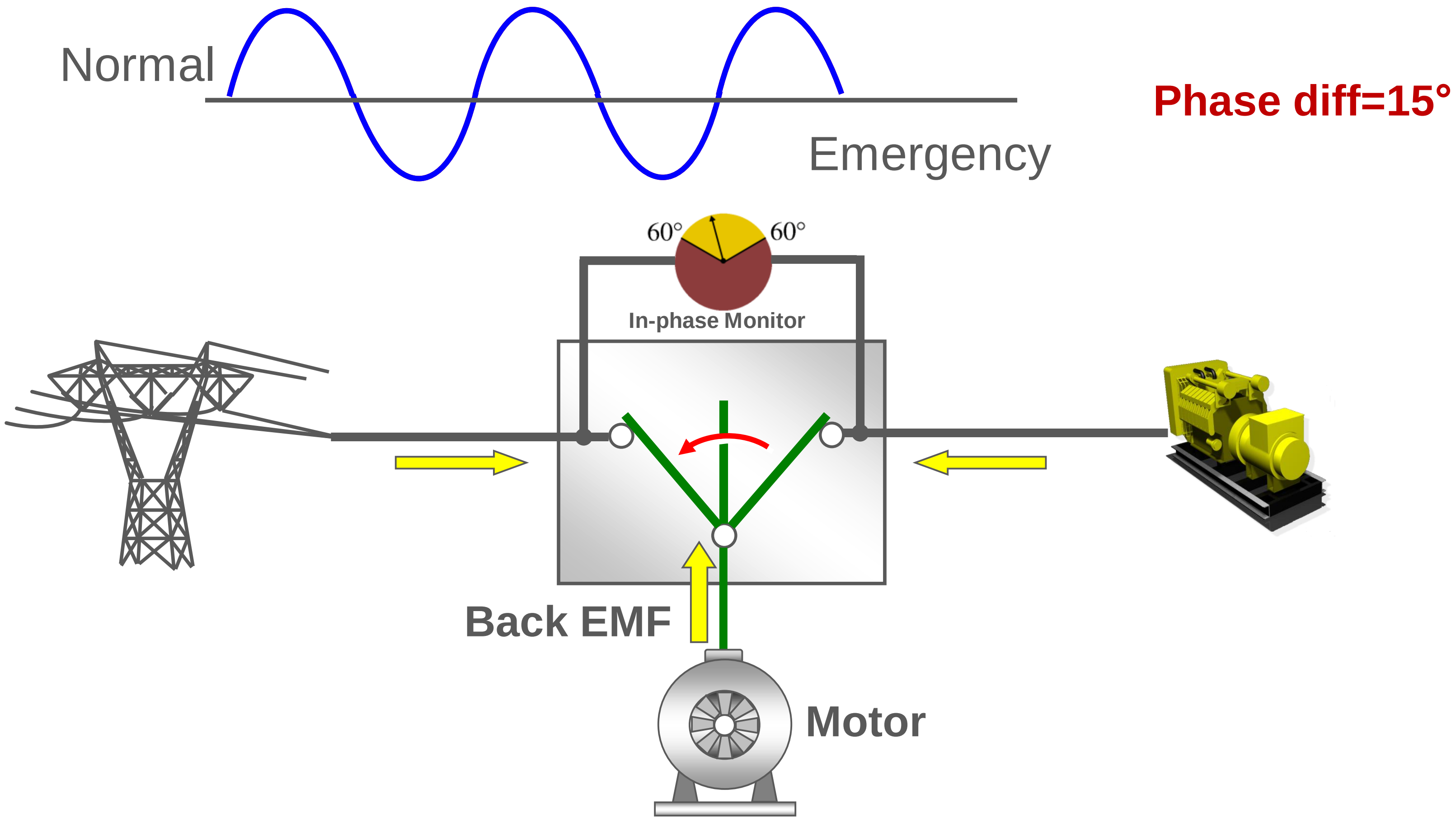
- Breaker trips due to induced high currents
- Motor insulation damage due to voltage transients
- Motor shaft and coupling damage due to mechanical stress

TRANSFERRING LARGE MOTORS OPEN TRANSITION



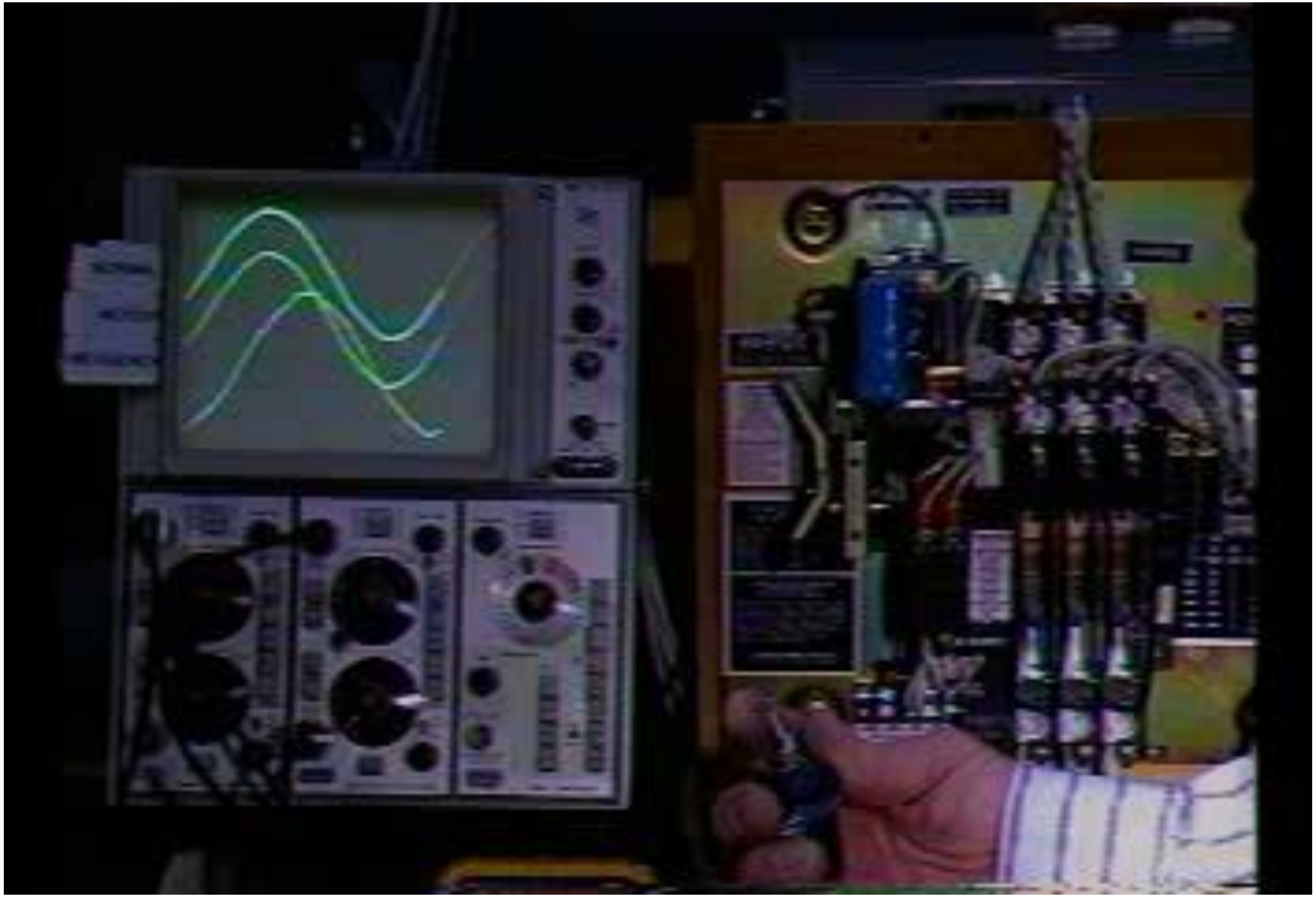
The inrush current can go up to max 18 time the running current of motor cause the CB trip

TRANSFERRING LARGE MOTORS
OPEN TRANSITION



The inrush current is limited < 6 time running current of motor by the function of *In-phase Monitor*

IN-PHASE TRANSFER VIDEO



Methods for Transferring Loads Between Two Live Sources

What does in-phase transfer require??????????

- A repeatably fast Transfer Switch (3-5 cycles)
- A consistently fast, reliable operating solenoid mechanism
- Reliable microprocessor controls complete with passive synchro scope (0-30deg)

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International Guideline

TABLE NO. I - INPHASE CONTROL OF SLOW OPERATING TRANSFER SWITCH (500 MILLISECONDS)

EX NO.	Δf HZ.	Δf DEG/SEC	Advance Angle DEG.	Synchroscope At Initiation of Transfer	Synchroscope At Completion of Transfer	Θf DEG.	REMARKS
1	2.00	720	60		①	60	(Acceptable) inrush equivalent to normal starting
2	1.50	540	60			150	Unacceptable
3	1.33	480	60		②	180	Worse than random transfer
4	1.00	360	60			120	Unacceptable
5	0.66	240	60			60	(Acceptable) inrush equivalent to normal starting
6	0.50	180	60			30	Good
7	0	0	60			60	(Acceptable) inrush equivalent to normal starting

See notes under Table II.

TABLE NO. II - INPHASE CONTROL OF FAST OPERATING TRANSFER SWITCH (166 MILLISECONDS)

EX No.	Δf HZ.	Δf DEG/SEC	Advance Angle DEG.	Synchroscope At Initiation of Transfer	Synchroscope At Completion of Transfer	Θf DEG.	REMARKS
1	2.00	720	60		③	60	(Acceptable) inrush equivalent to normal starting
2	1.50	540	60			30	Good
3	1.33	480	60		④	20	Good
4	1.00	360	60			0	Ideal
5	0.66	240	60			20	Good
6	0.50	180	60			30	Good
7	0	0	60			60	(Acceptable) inrush equivalent to normal starting

Δf = Frequency difference between sources. Θf = Phase angle at instant of motor reconnection.

① In this case, reconnection takes place 360° after initiation of transfer.

② In this case, reconnection takes place 240° after initiation of transfer.

③ In this case, reconnection takes place 120° after initiation of transfer.

IN-PHASE TRANSFER ADVANTAGES

- **Do Not Need To Re-Start Motor Starter**
- **Minimizes Inrush Currents**
- **No Mechanical Shock in Motors**
- **Increase System Reliability**
- **Neutral Position Not Required**
- **Additional Control Wiring Not Required**
- **Motor Load Time Constant Analysis Not Required**

POSSIBLE SOLUTIONS

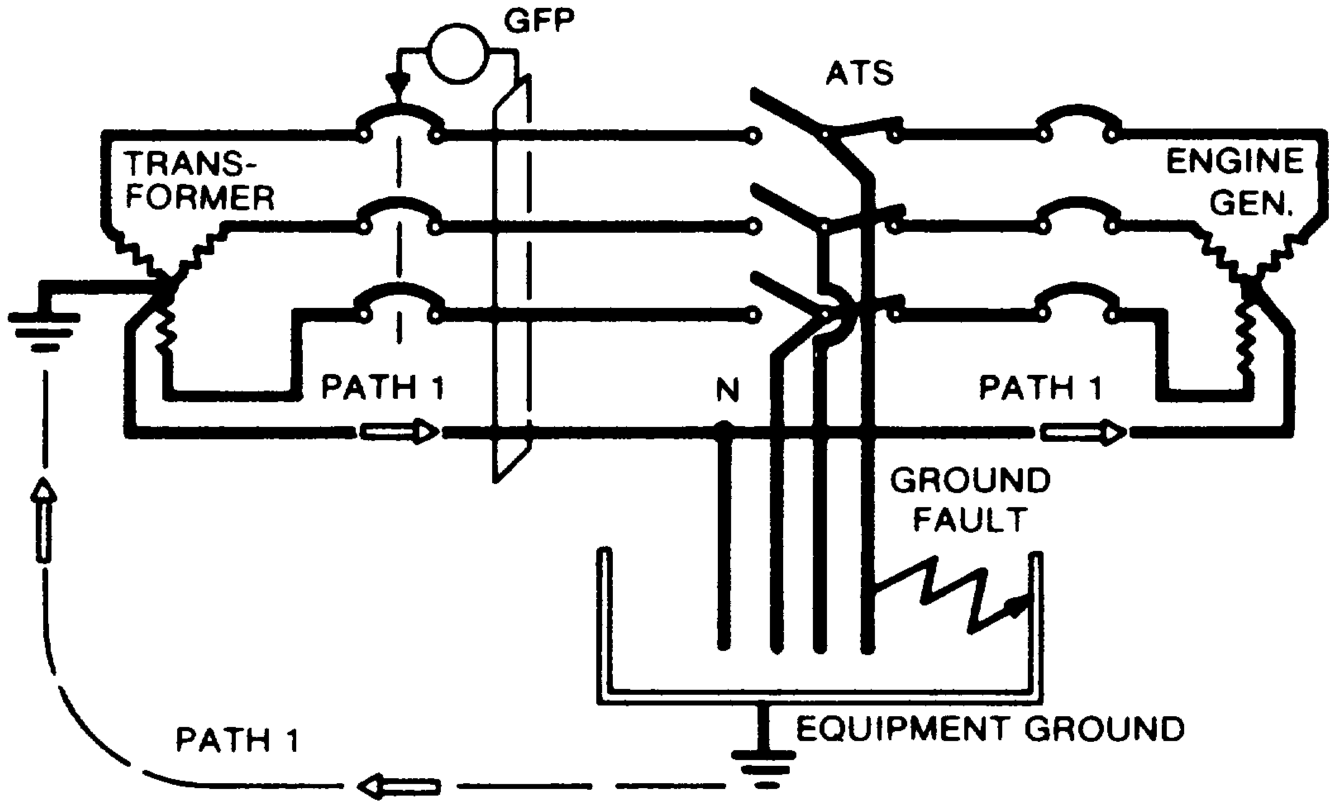
- Closed Transition Transfer (CTTS) / Make Before Break
- Over Lapping Neutral with in-phase Monitoring
- Delayed Transition Transfer
- Load Disconnector Circuit

3 POLES
VS
4 POLES ATS

SINGLE GROUND POINT CONNECTION WITH 3 POLES ATS

Problem in single ground point system

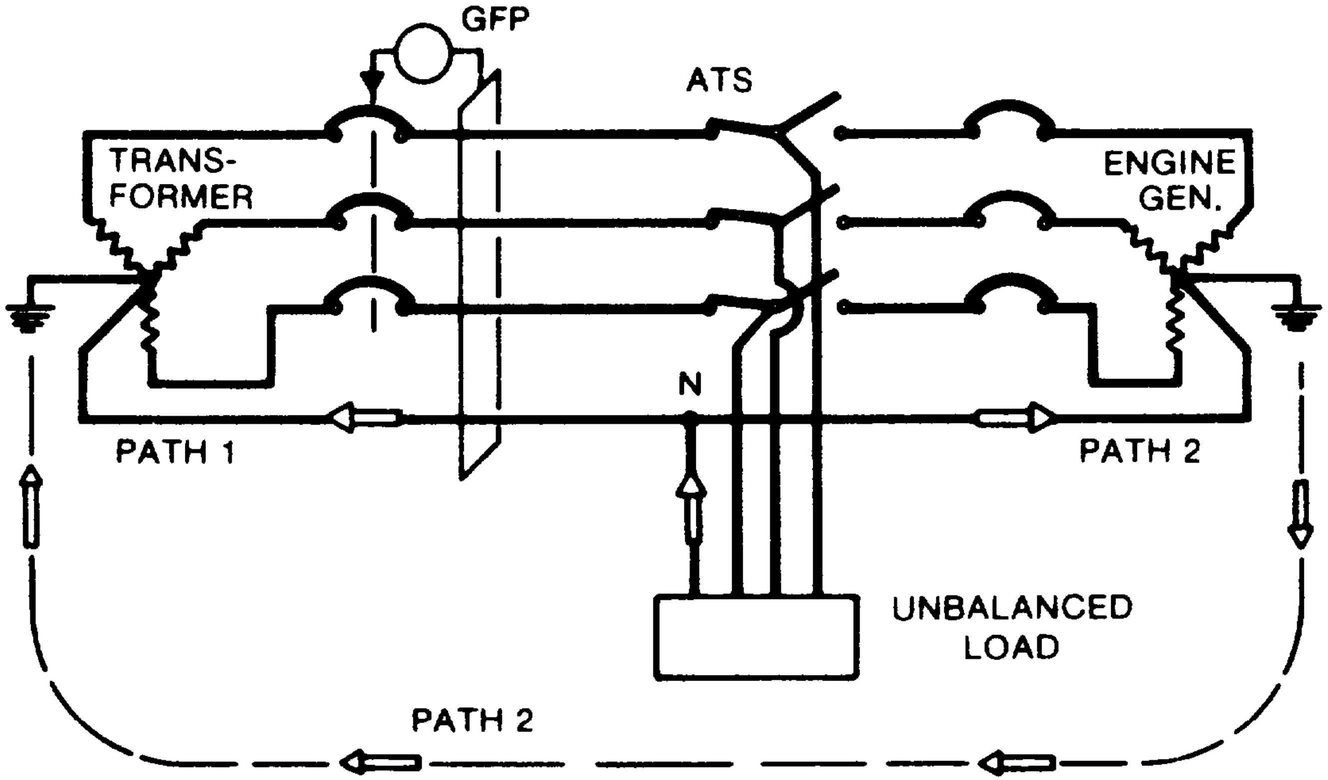
- Floating neutral when transfer to emergency incase cable failure
- Improper sensing of ground fault current cause tripping on utility circuit breaker



MULTIPLE GROUND POINTS WITH 3 POLES ATS

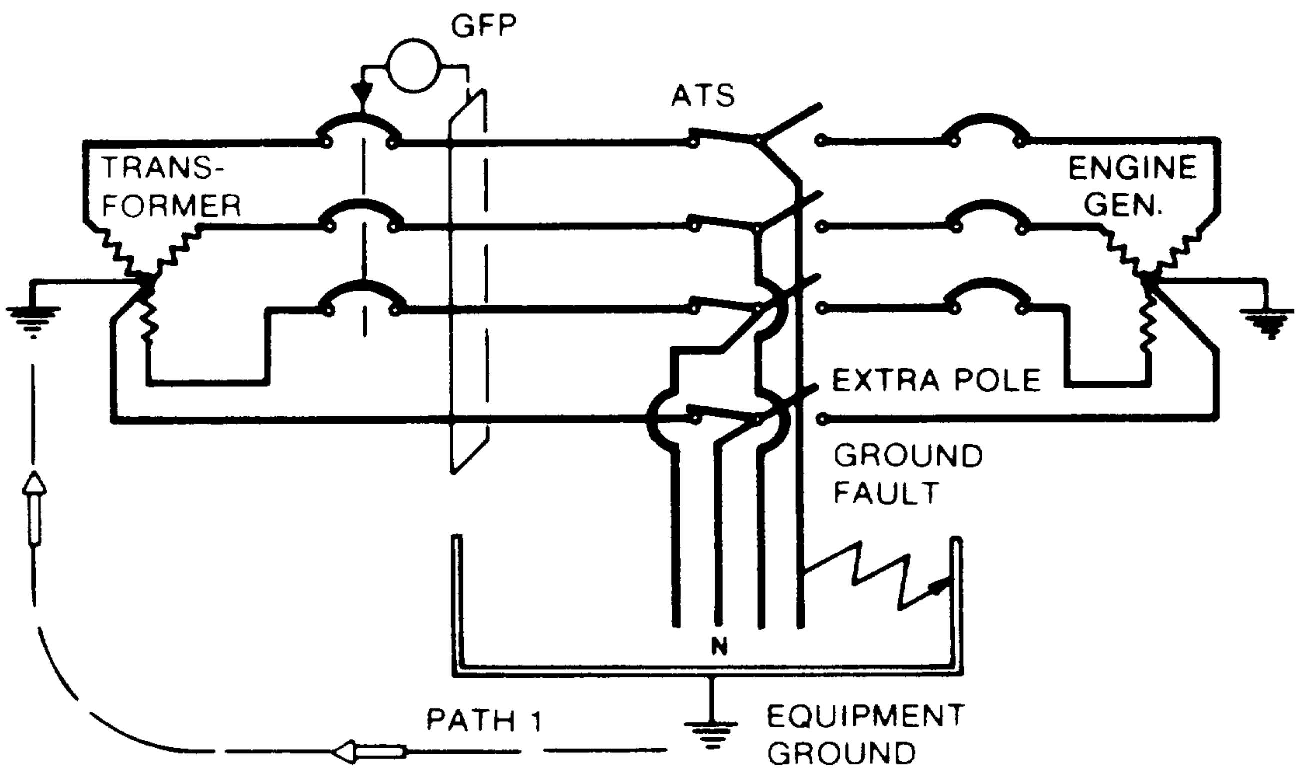
The disadvantage of 3 Poles ATS

- Improper sensing of ground fault current
- Nuisance tripping of ground fault protective equipment with unbalanced load

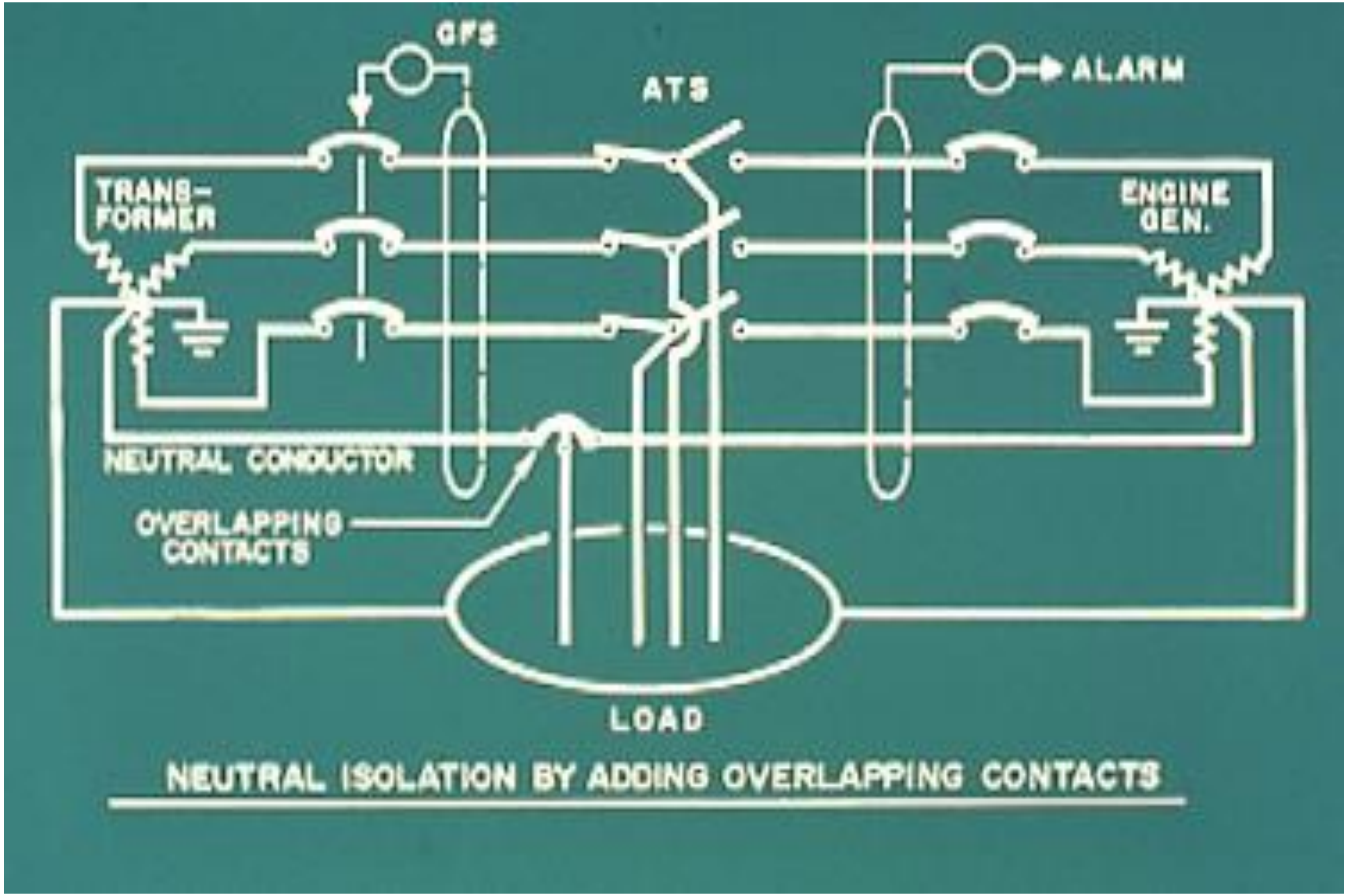


SEPARATELY DERIVED SYSTEM BY USE 4 POLES ATS

- 4 Poles ATS create only single returned path for the ground fault current to the Utility neutral.
- Improper sensing of ground fault current and Nuisance tripping of GFP are eliminated

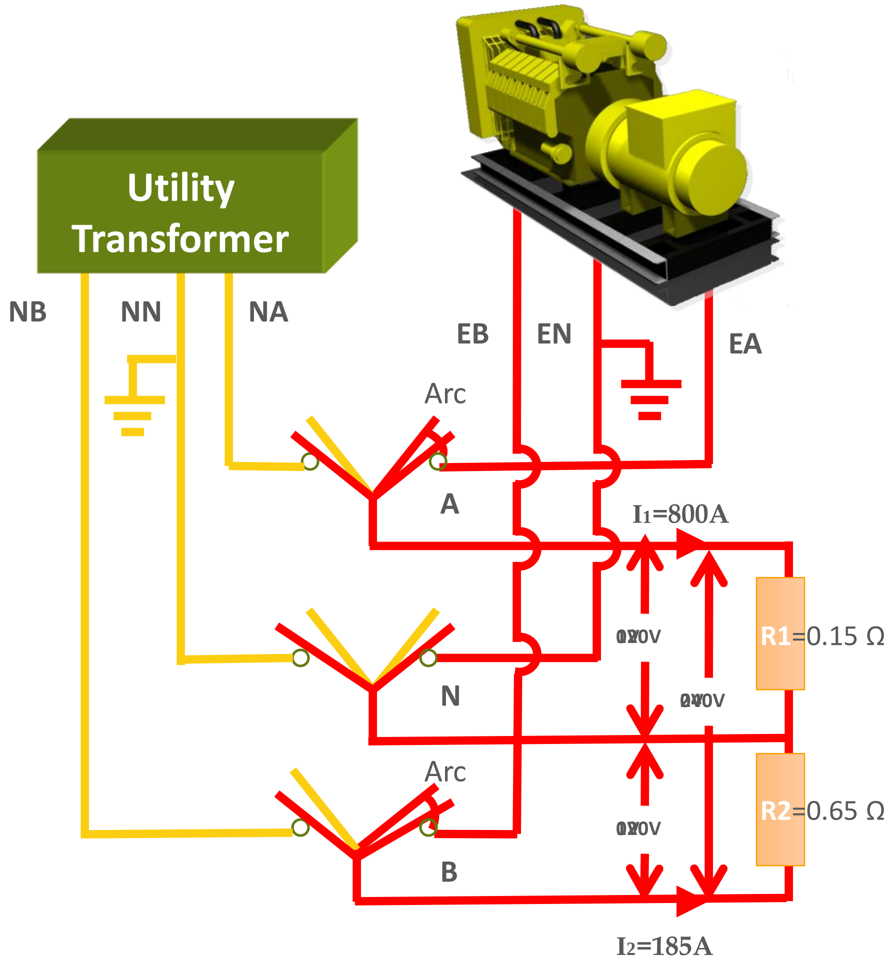


OVERLAPPING NEUTRAL CONTACTS

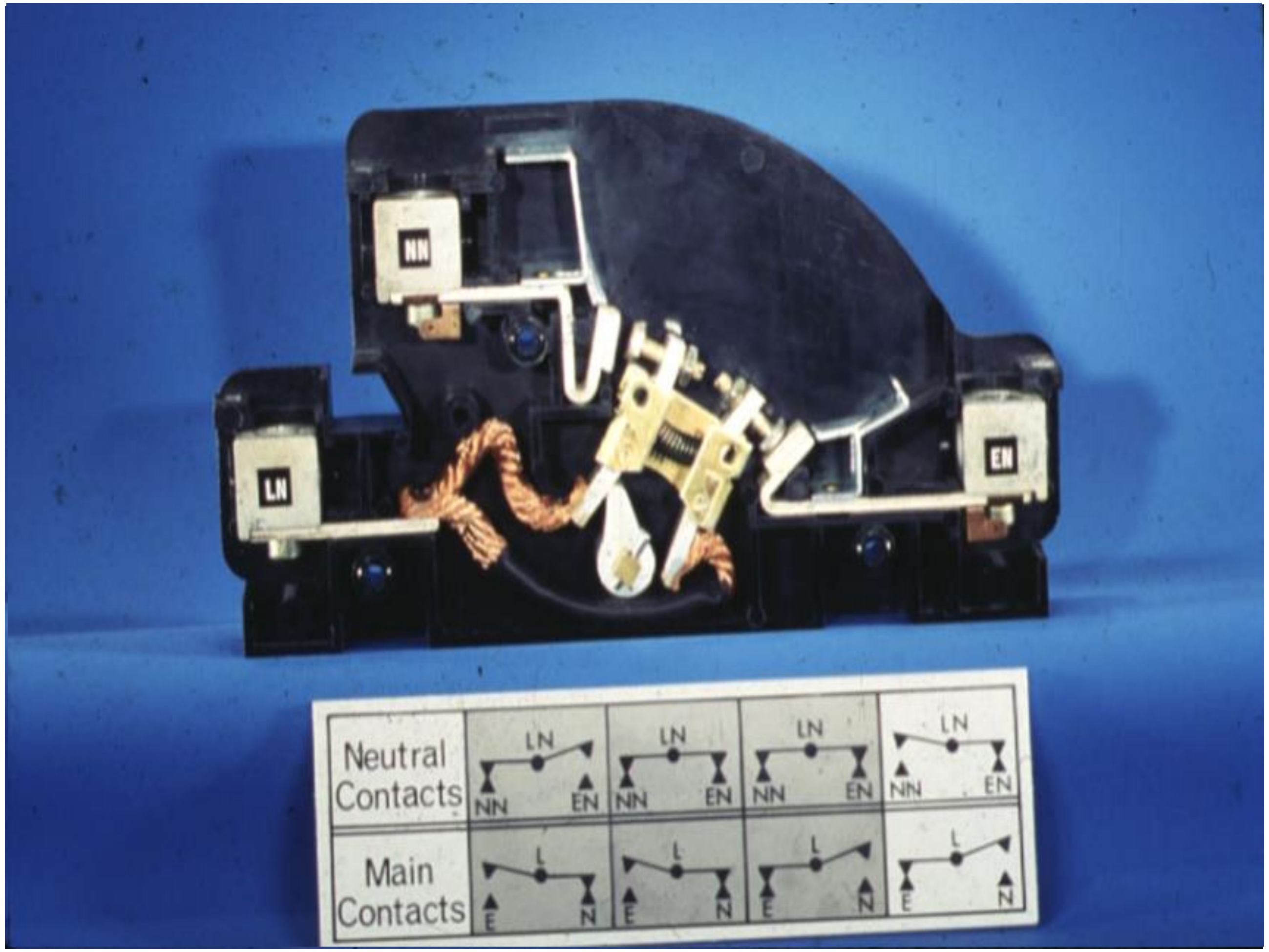


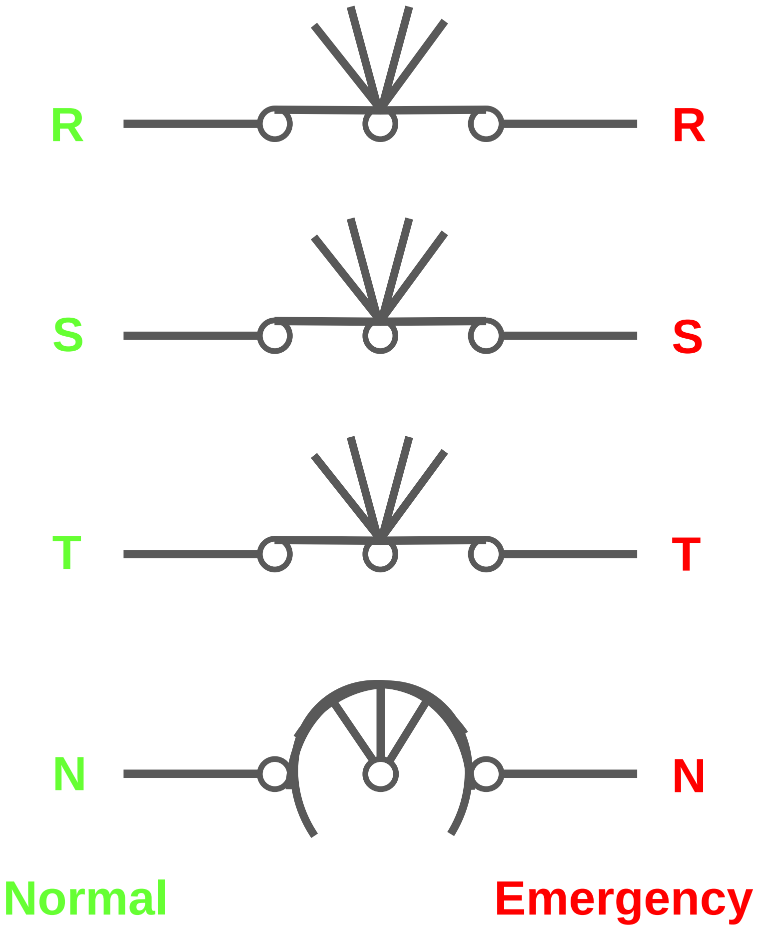
OVERLAPPING NEUTRAL TRANSFER

OVERLAPPING NEUTRAL

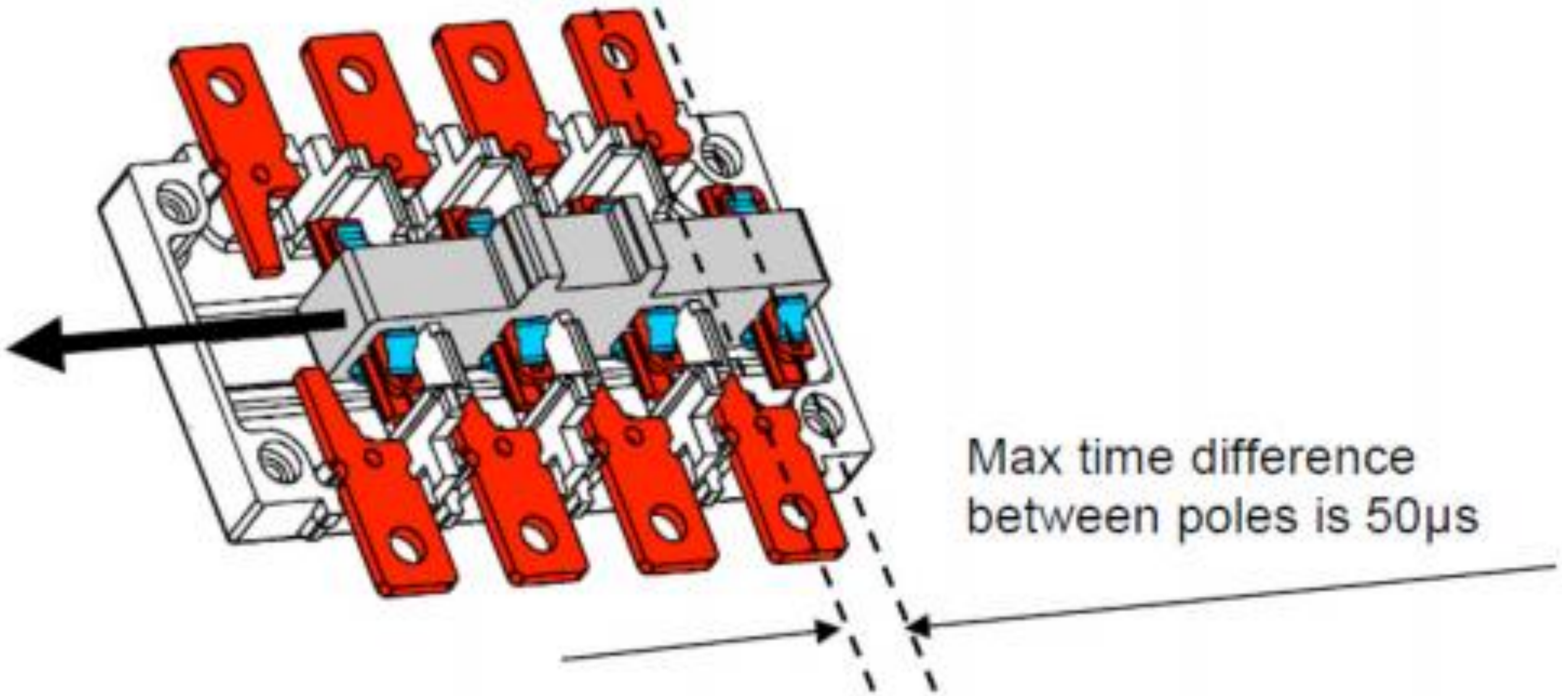


OVERLAPPING NEUTRAL OPERATION





4 POLE SIMULTANEOUS SWITCHING



COMPARISON SWITCH NEUTRAL V.S. OVERLAPPING NEUTRAL

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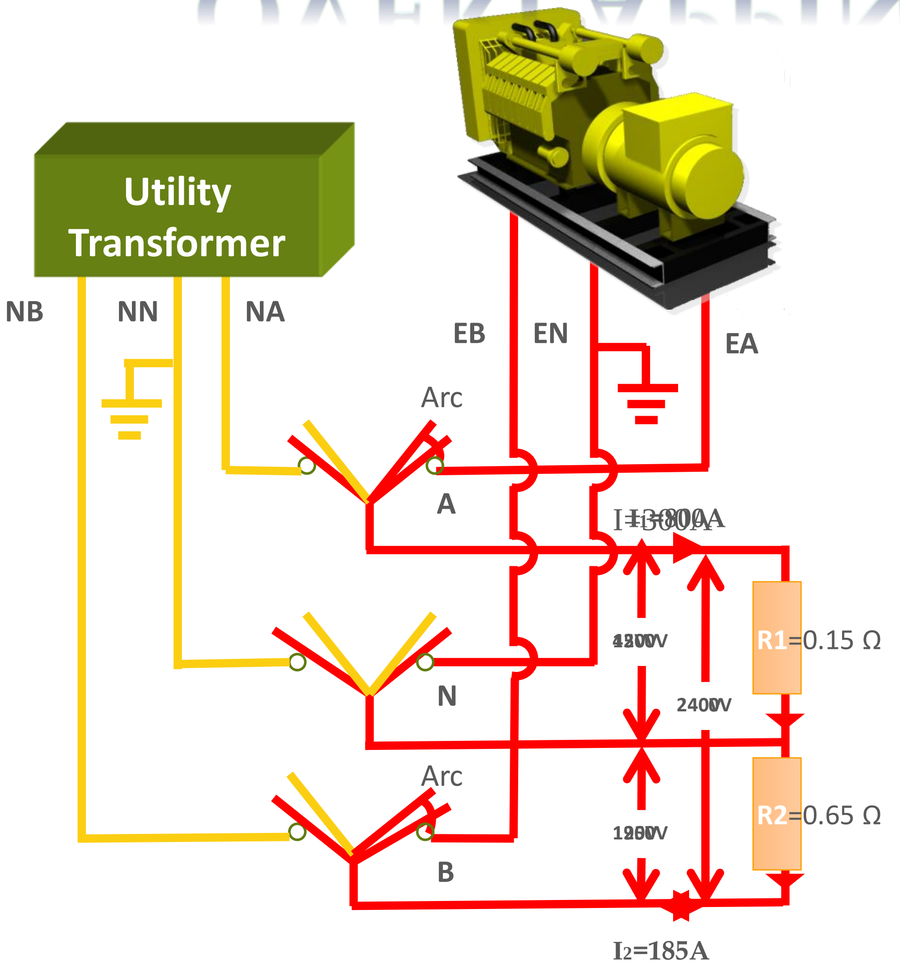
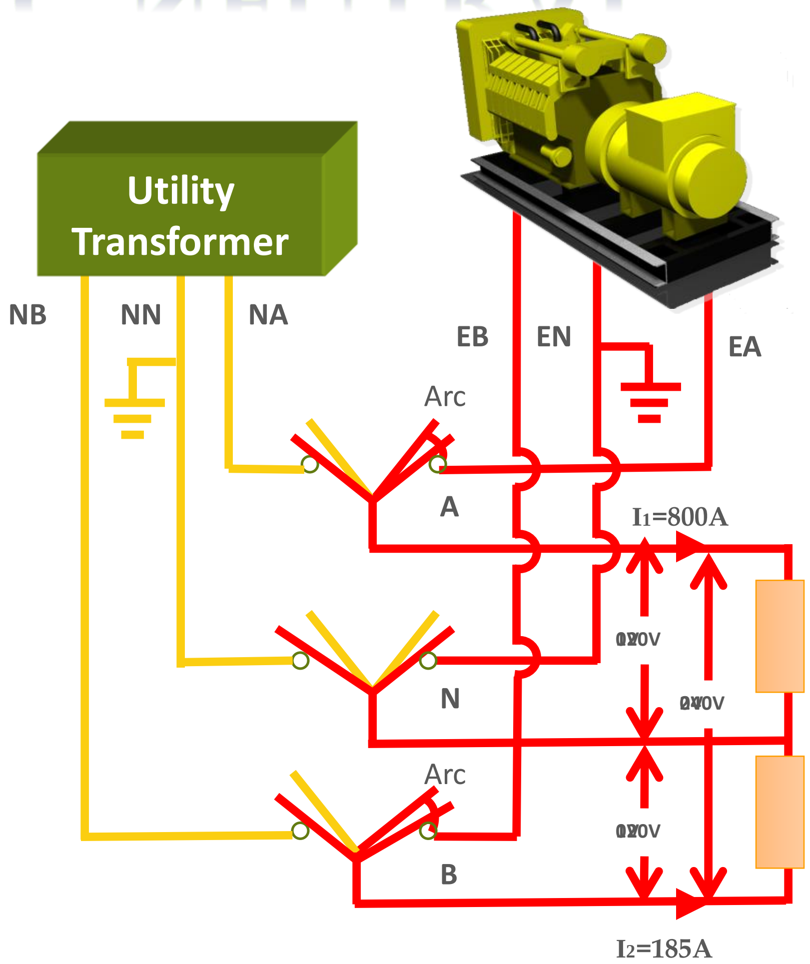


SWITCH NEUTRAL

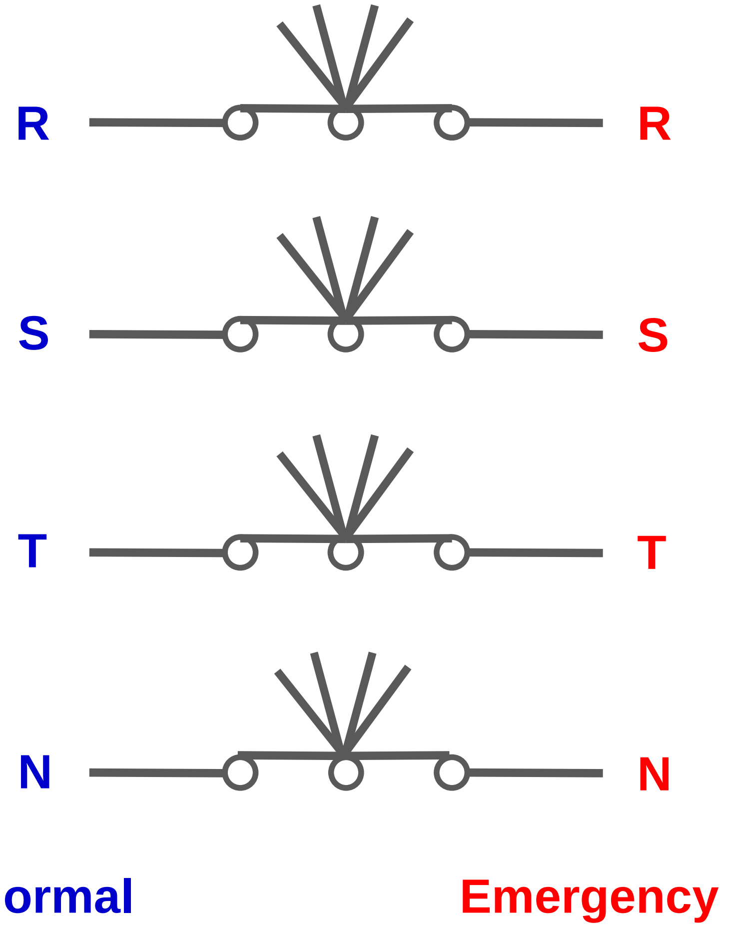


OVERLAPPING NEUTRAL

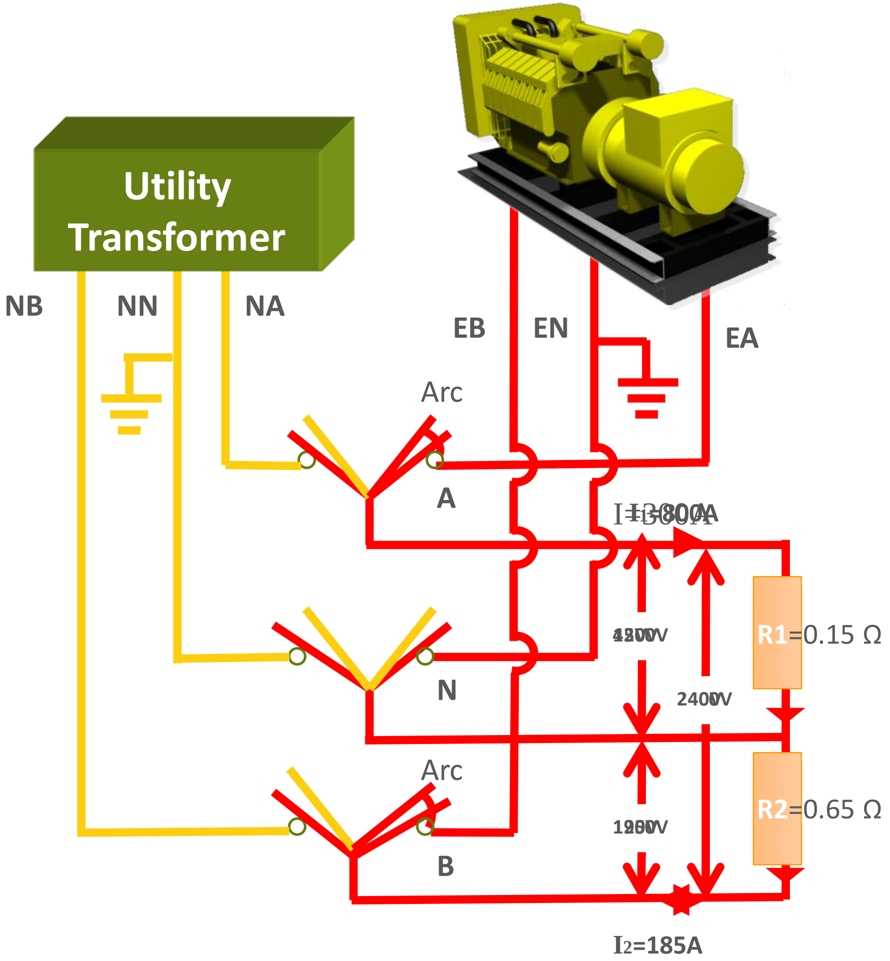
TRADITIONAL 4 POLE ATS

- **Enable Proper Detection of Ground Faults**
- **Eliminate Nuisance GFP tripping**
- **Alternate Source (EG Set) can be grounded ("Separately Derived System")**
- **Eliminate Shock Hazards**
- **Generate Voltage Spikes???**

TRADITIONAL 4 POLES OPERATION



SWITCHING NEUTRAL – UNBALANCE LOAD



CALCULATION

$$I = \frac{240V}{0.15+0.65} = 300\ Amp$$

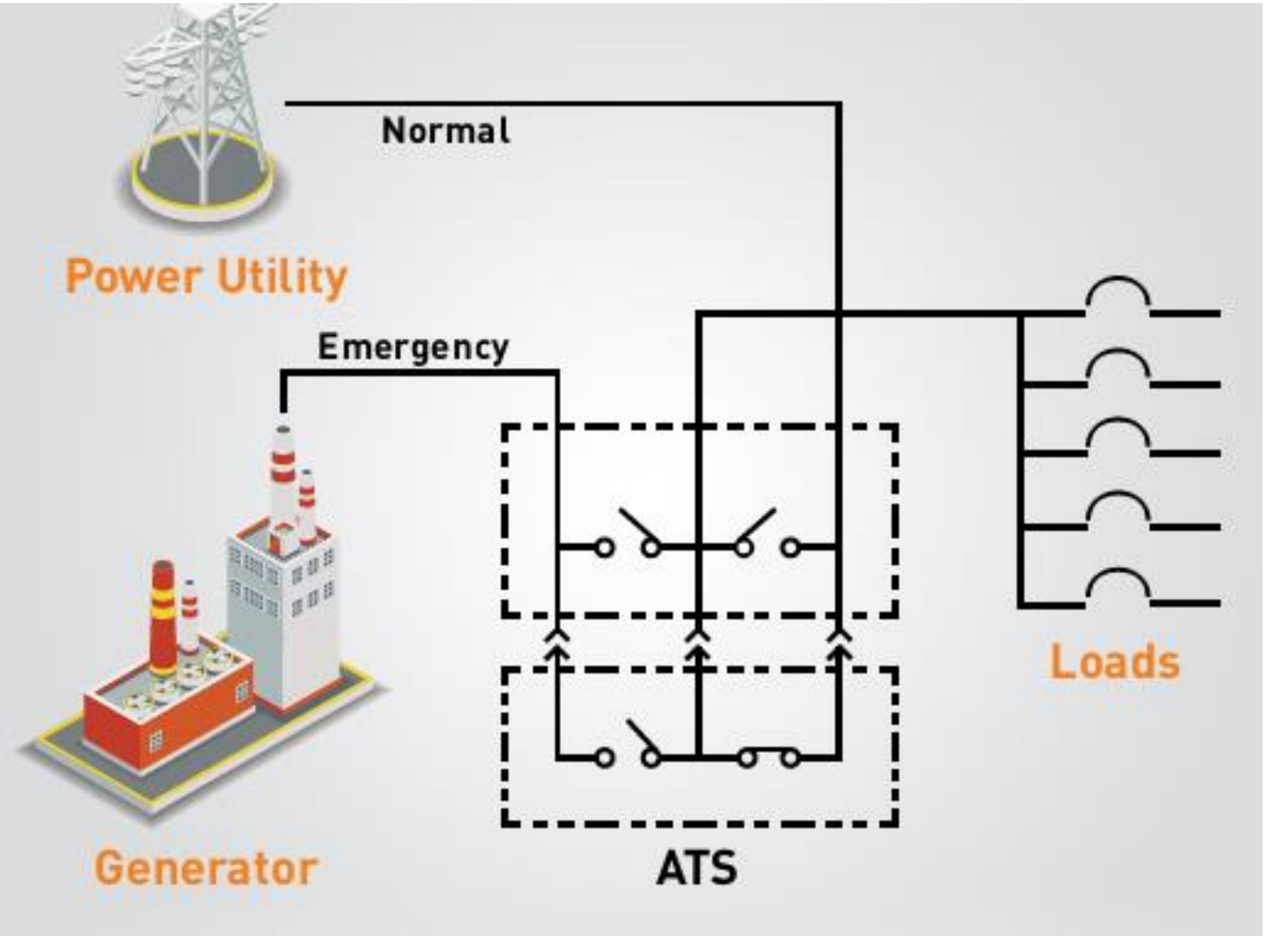
$E_1 = 0.15 \times 300 = 45$ Volts

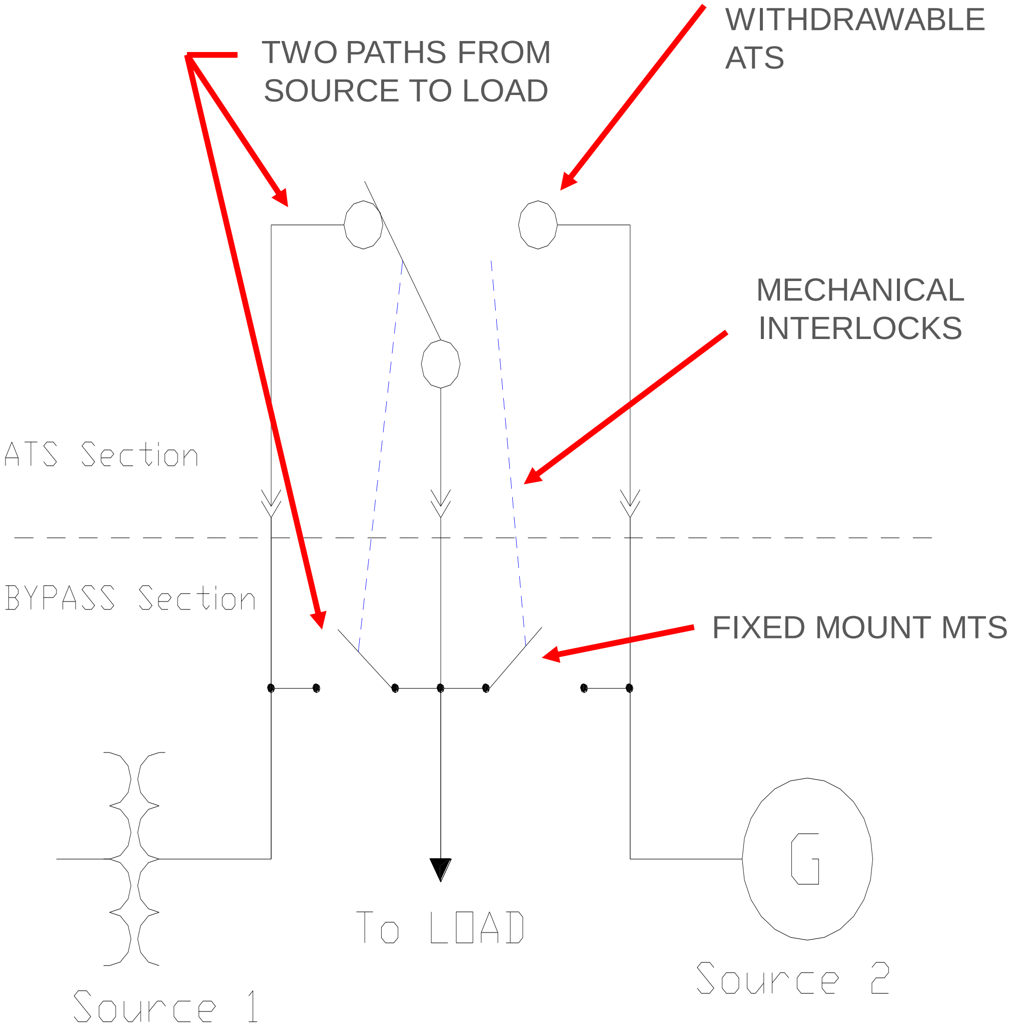
$E_2 = 0.65 \times 300 = 195$ Volts

BY PASS SWITCH

PTS WN3B – BYPASS SWITCH

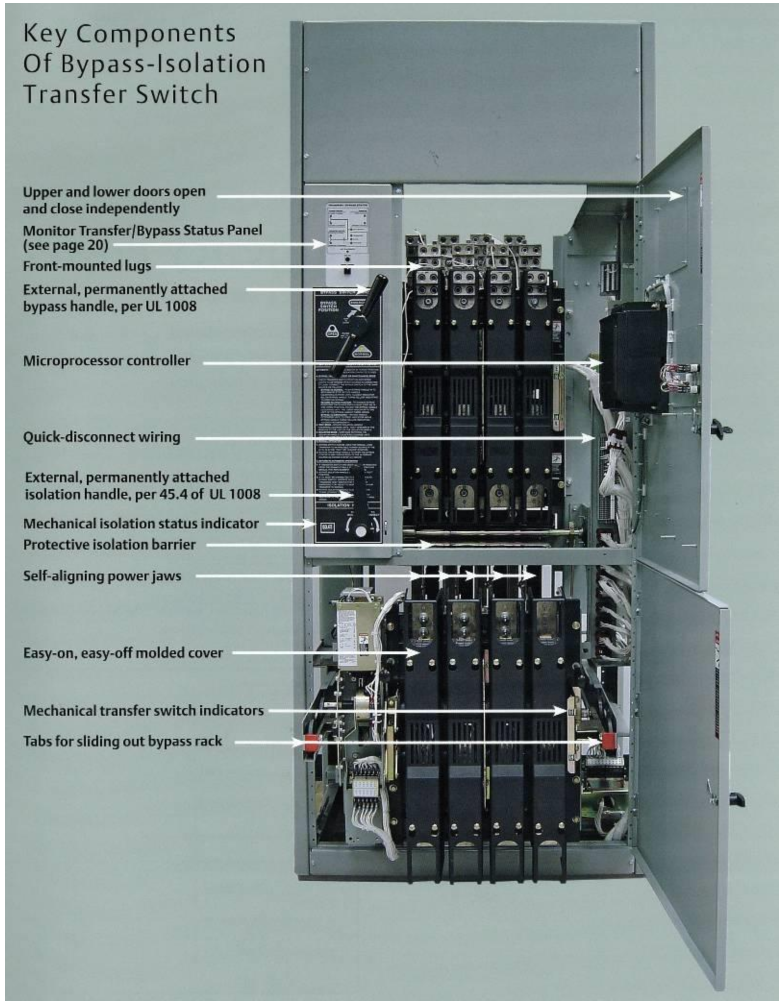
Opened Transition & Closed Transition





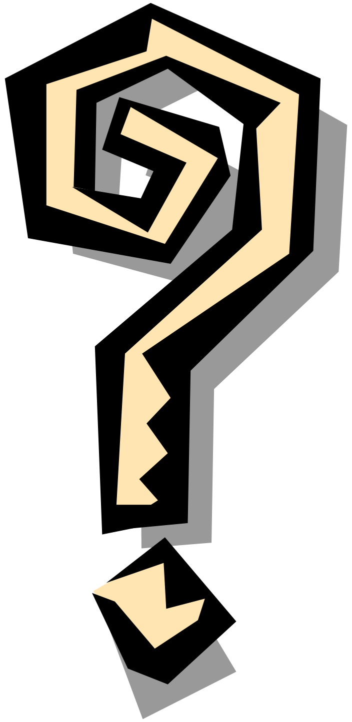
POWER SWITCHING SOLUTION

BY PASS SWITCH



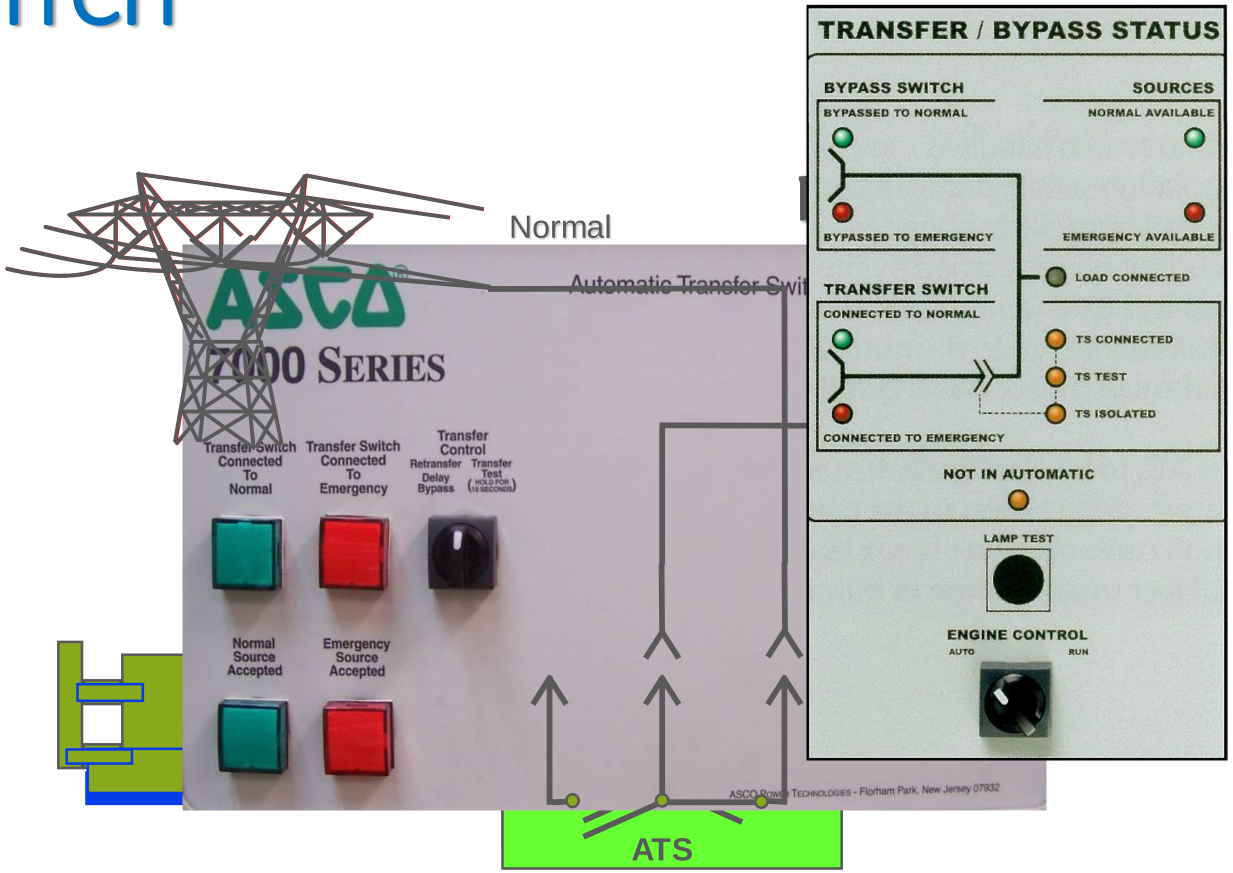
WHY USING BYPASS? QUESTION TO ASK?

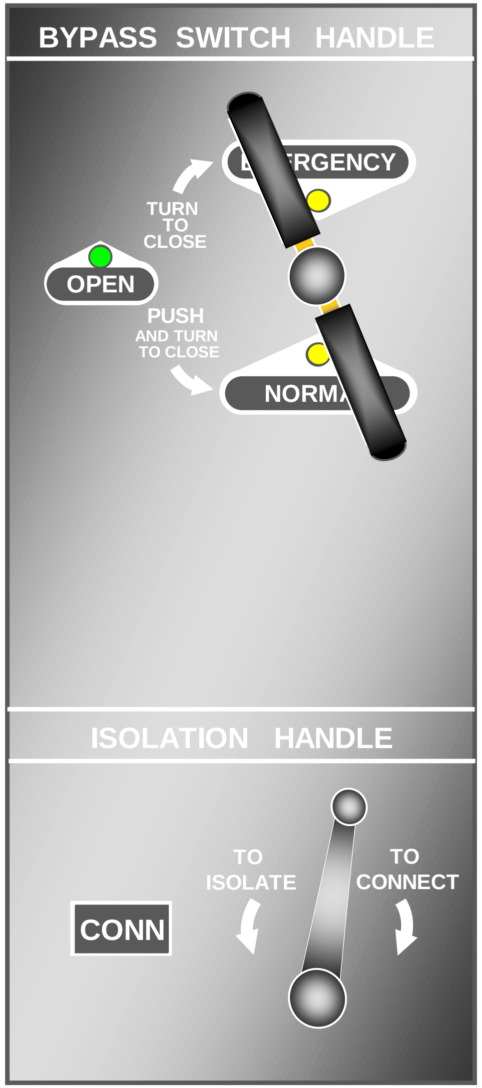
- How critical is the ATS? / Load?
- What if the ATS fails? What do you do?
- Do you need redundancy?
- Will you ever need to service the ATS?
- Can you “shutdown” to do the service?
- Can you interrupt the load for service?
- How much time do you have?
- How user friendly do you need it to be?



POWER SWITCHING SOLUTION

BY PASS SWITCH





POWER SWITCHING SOLUTION
BYPASS SWITCH

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Application for Bypass Switch

- No Interruption Maintenance of Transfer Switch For Installation Which Cannot Have Shut Down (24 Hrs X 365 Days Operation)
- For Critical Application Needs 2nd Back-up Transfer Switch
- For Testing Emergency System Without Load Interruption
- For Load that doesn't want to have Single Point of Failure
- For Load that required very high reliabilities such as Data Center, Banking, Telecommunication, Hospital and Airport

TIA 942

G.5.1.2 Standby generation

The standby generation system is the most crucial single resilience factor and should be capable of providing a supply of reasonable quality and telecommunications equipment if there is a utility failu

Generators should be designed to supply the harmo computer equipment loads. Motor starting require generator system is capable of supplying required voltage drop of 15% at the motor. Interactions be problems unless the generator is specified properly between the generator and UPS vendors. A variety requirements, including harmonic filters, line reactor motor starting, staged transfer, and generator de-ratir

Where a generator system is provided, standby pow equipment to avoid thermal overload and shutdown. overall continuity of operations if they do not support

Paralleled generators should be capable of manua automatic synchronization controls. Consideration s generator to directly feed individual loads in the even switchgear.

Lighting powered from the UPS, an emergency lighting inverter, or individual batteries should be provided around generators to provide illumination in the event of a concurrent generator and utility failure. Similarly, UPS-fed receptacles should also be provided around the generators.

Permanent load banks or accommodations to facilitate connection of portable load banks are strongly recommended for any generator system.

In addition to individual testing of components, the standby generation system, UPS systems, and automatic transfer switches should be tested together as a system. At minimum, the tests should simulate a utility failure and restoration of normal power. Failure of individual components should be tested in redundant systems designed to continue functioning during the failure of a component. The systems should be tested under load using load banks. Additionally, once the data center is in operation, the systems should be tested periodically to ensure that they will continue to function properly.

The standby generator system may be used for emergency lighting and other life-safety loads in addition to the data center loads if allowed by local authorities. The National Electrical Code (NEC) requires that a separate transfer switch and distribution system be provided to serve life-safety loads. Battery-powered emergency lighting equipment may be less expensive than a separate automatic transfer switch and distribution system.

Isolation/bypass is required by the NEC for life-safety transfer switches to facilitate maintenance. Similarly, automatic transfer switches with bypass isolation should be provided to serve data center equipment. Transfer circuit breakers can also be used to transfer loads from utility to generator however, bypass isolation of circuit breakers should be added in case of circuit breaker failure during operation.

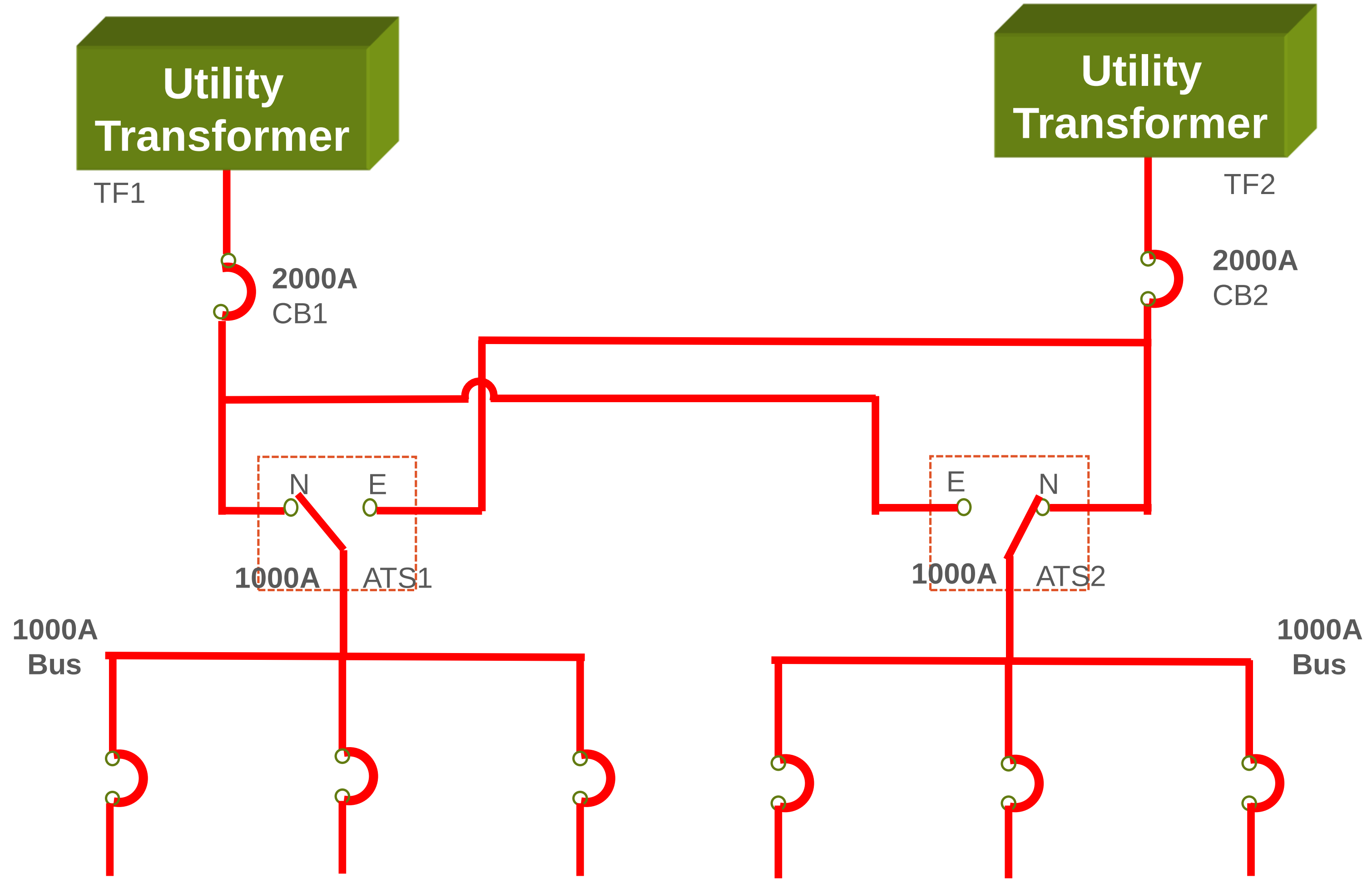
See IEEE Standard 1100 and IEEE Standard 446 for recommendations on standby generation.

CTTS is the most suitable

ATS must have the bypass switch

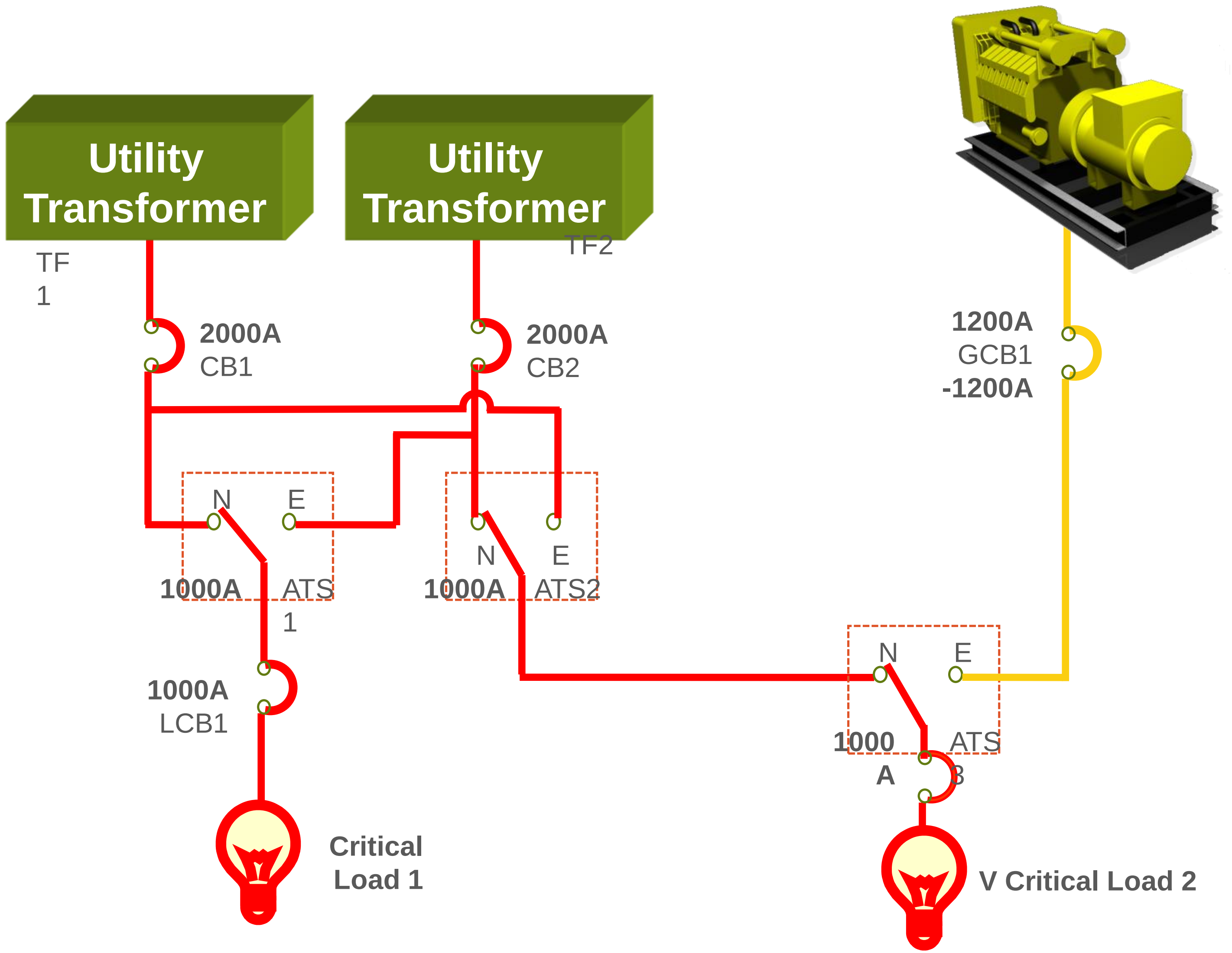
APPLICATION

APPLICATION – 2 SOURCES SYSTEM

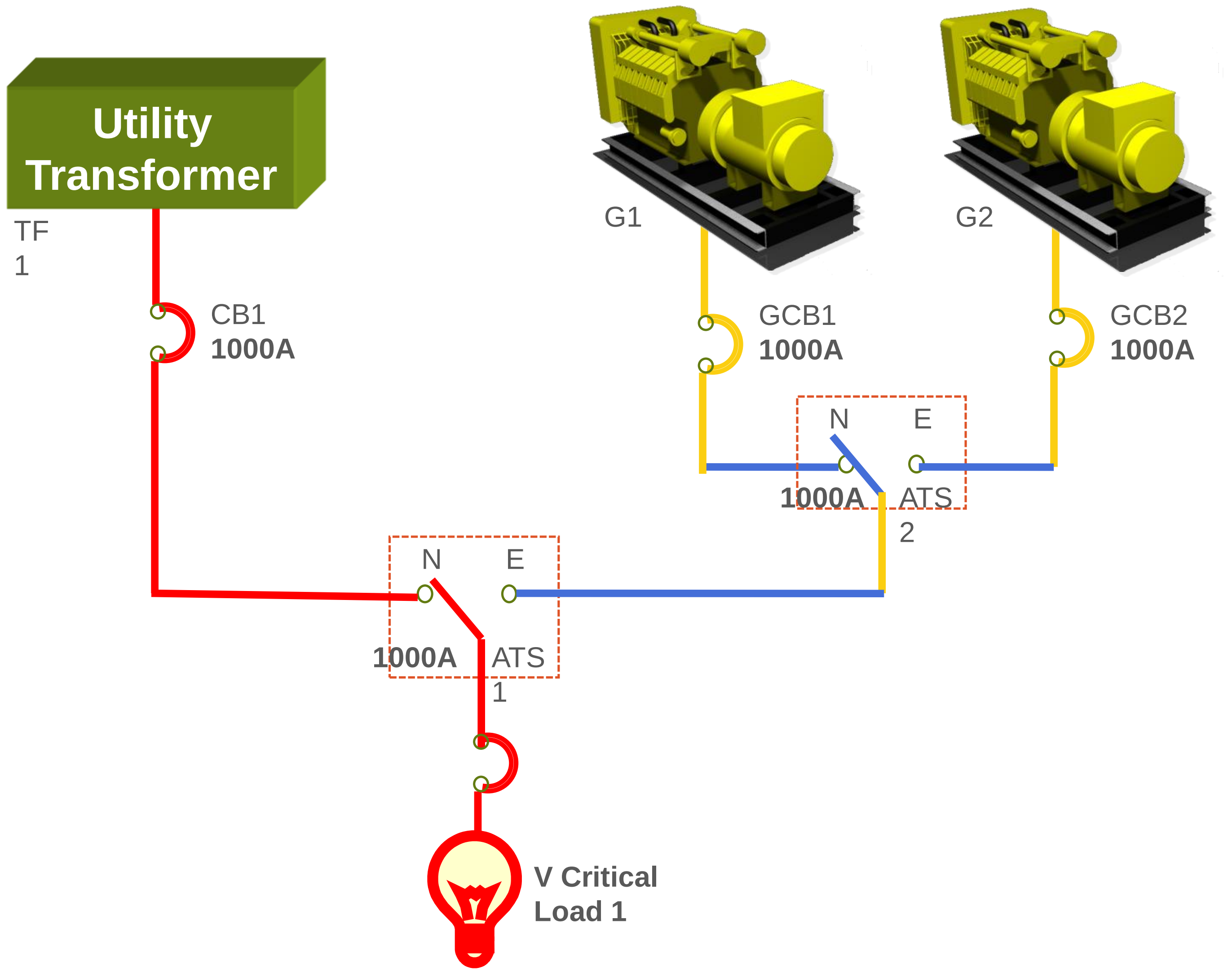


Automatic Transfer Switch,ATS : Thammarat Promphenrangsi : ธัมรัต พรหมเพ็ญรังษี

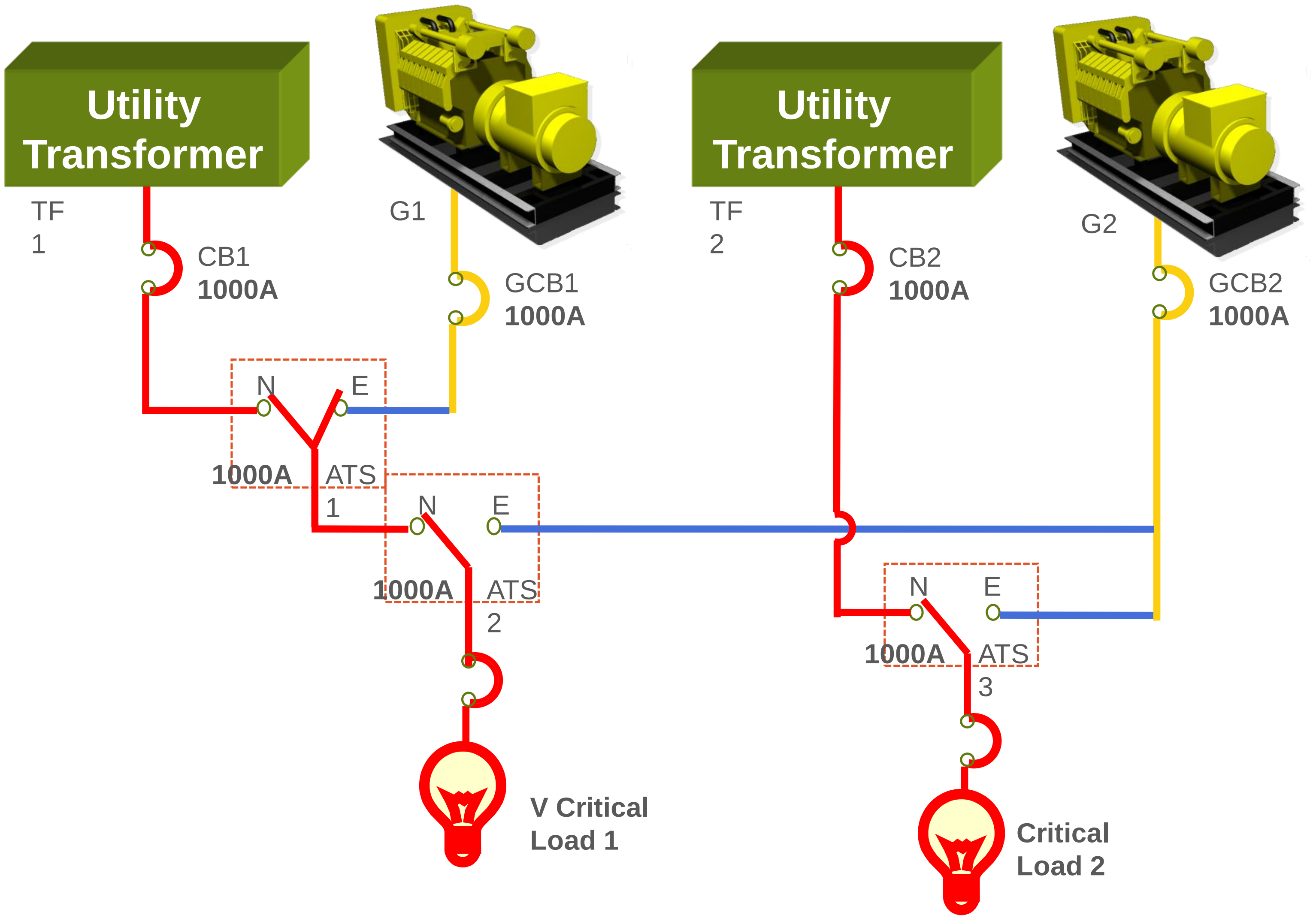
APPLICATION – 3 SOURCES SYSTEM



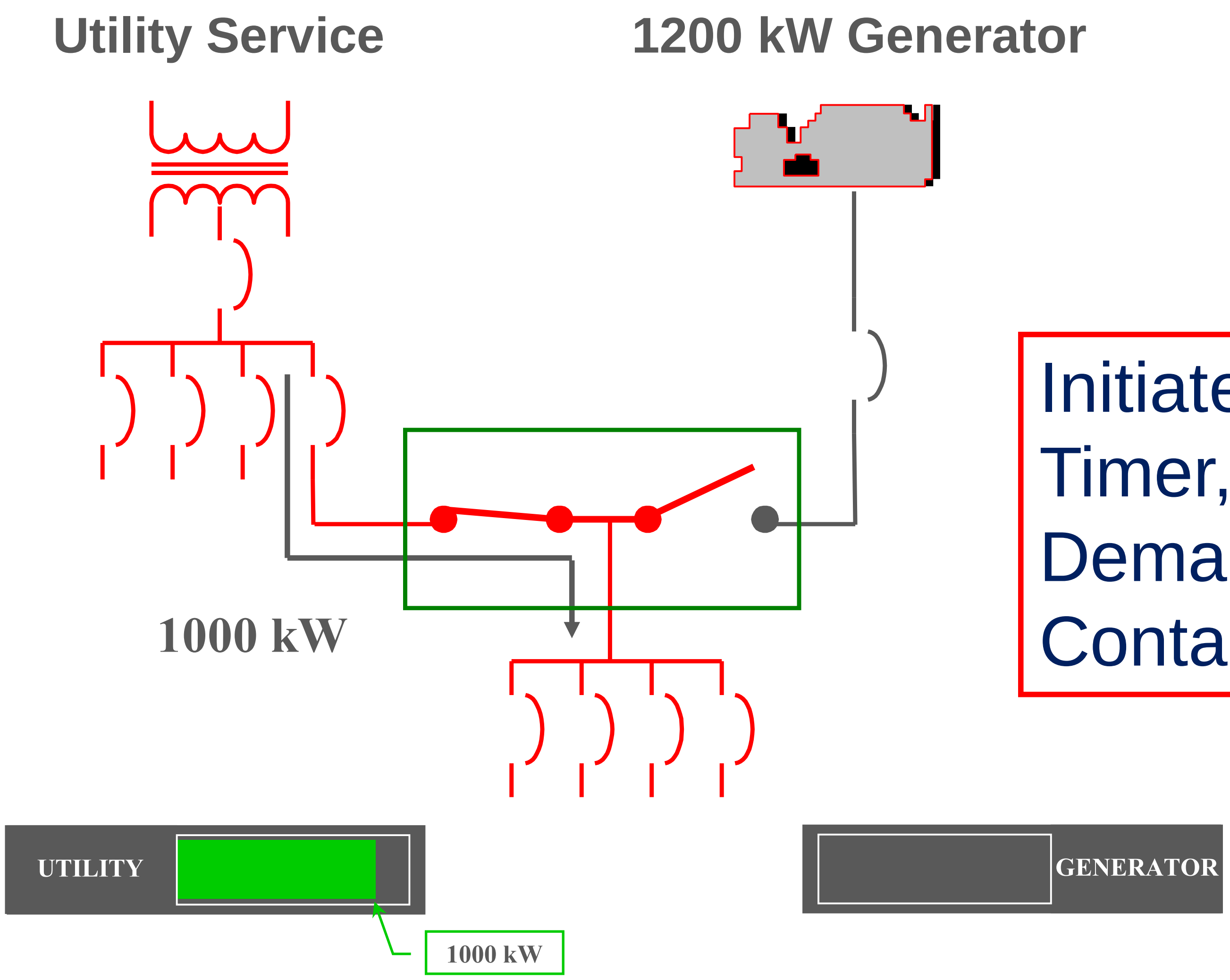
APPLICATION – 3 SOURCES SYSTEM



APPLICATION – 4 SOURCES SYSTEM



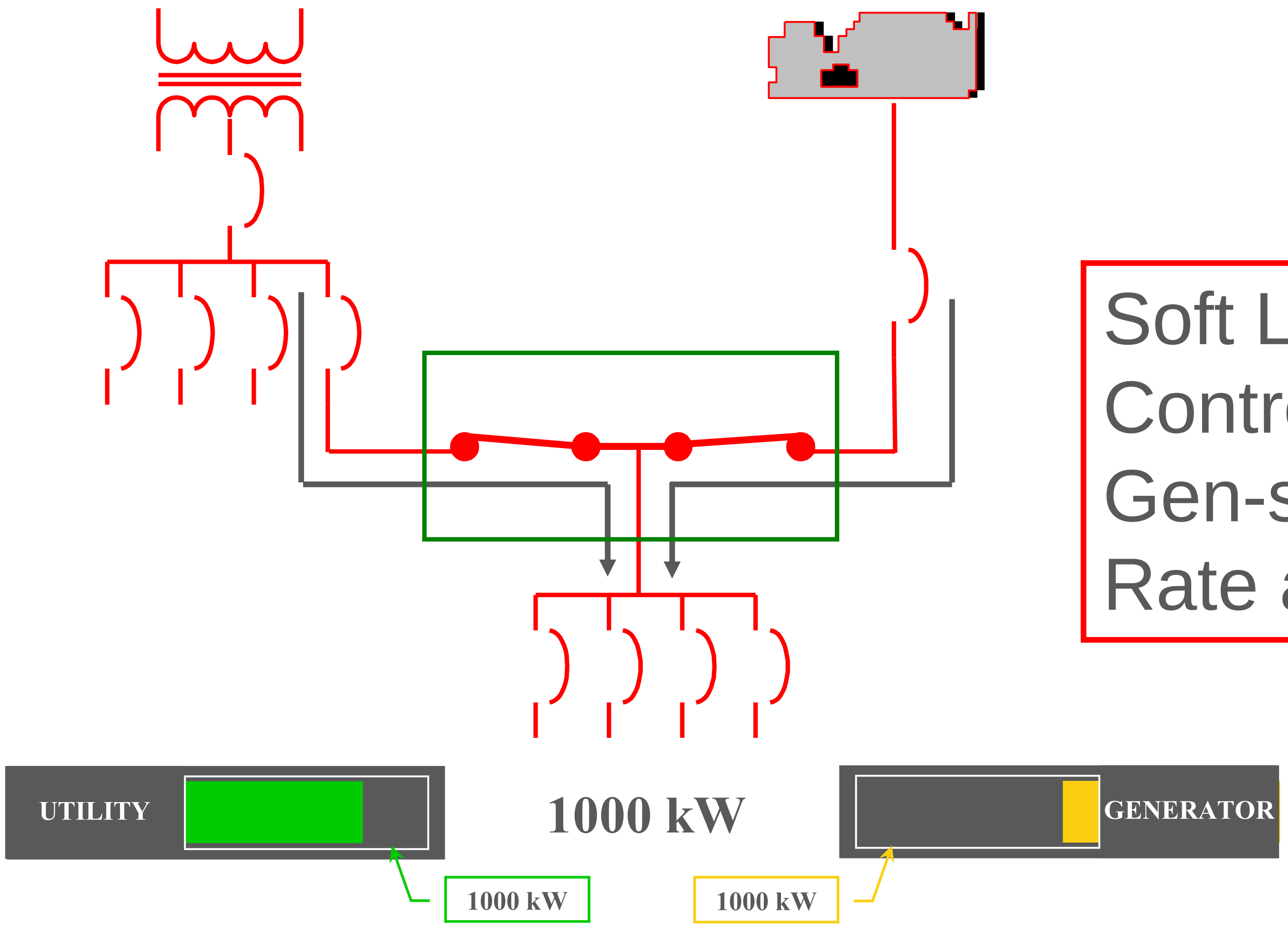
SOFT LOAD TRANSFER MODE EXAMPLE



Initiate Soft Load By Timer, Remote Command, Demand Set-point, Contact Closure

SOFT LOAD TRANSFER MODE EXAMPLE

Utility Service Sharing Load with Generator



Soft Load Controller Controls kW Loading of Gen-set at Predetermined Rate and Power Factor

SOFT LOAD TRANSFER MODE EXAMPLE

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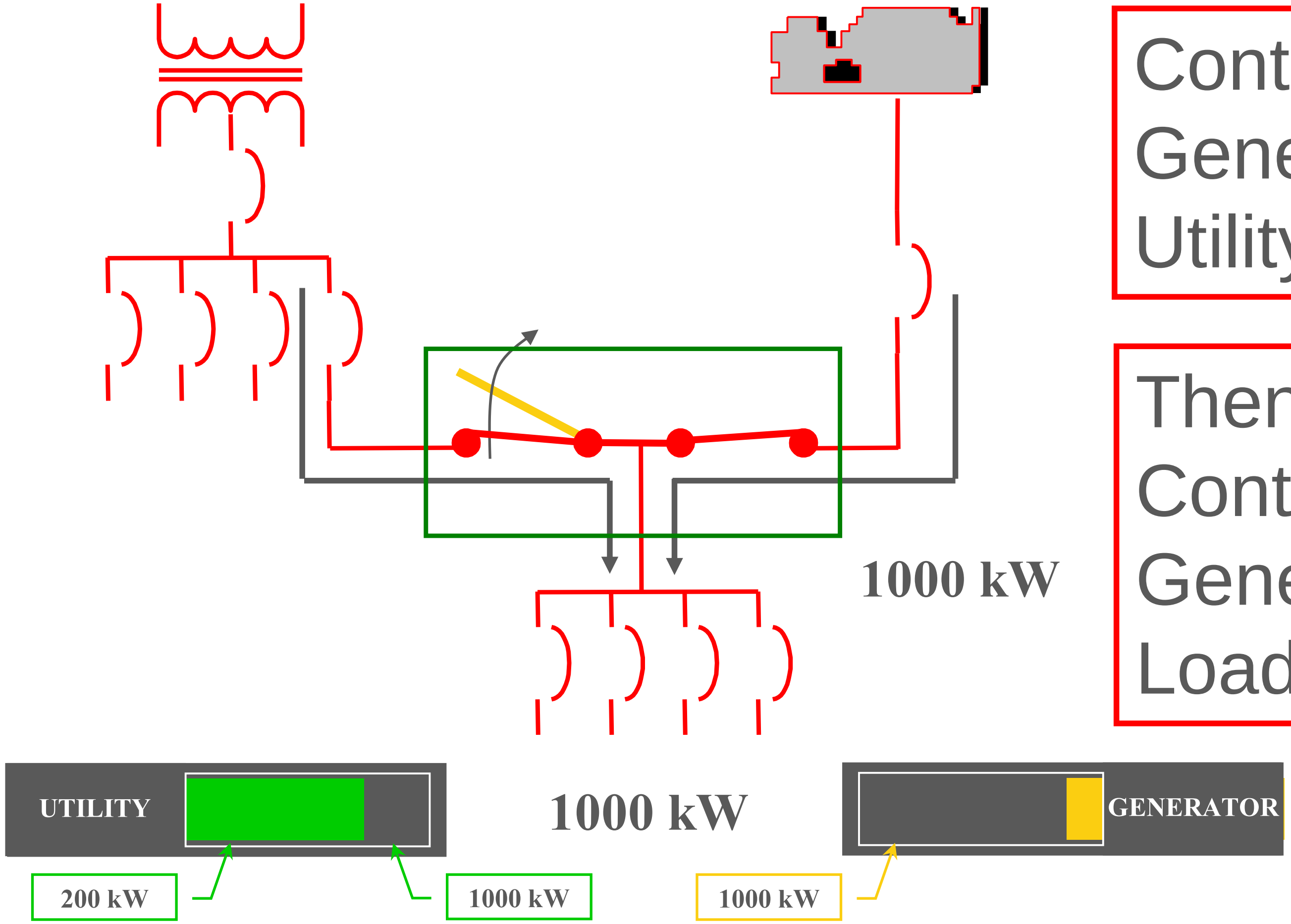
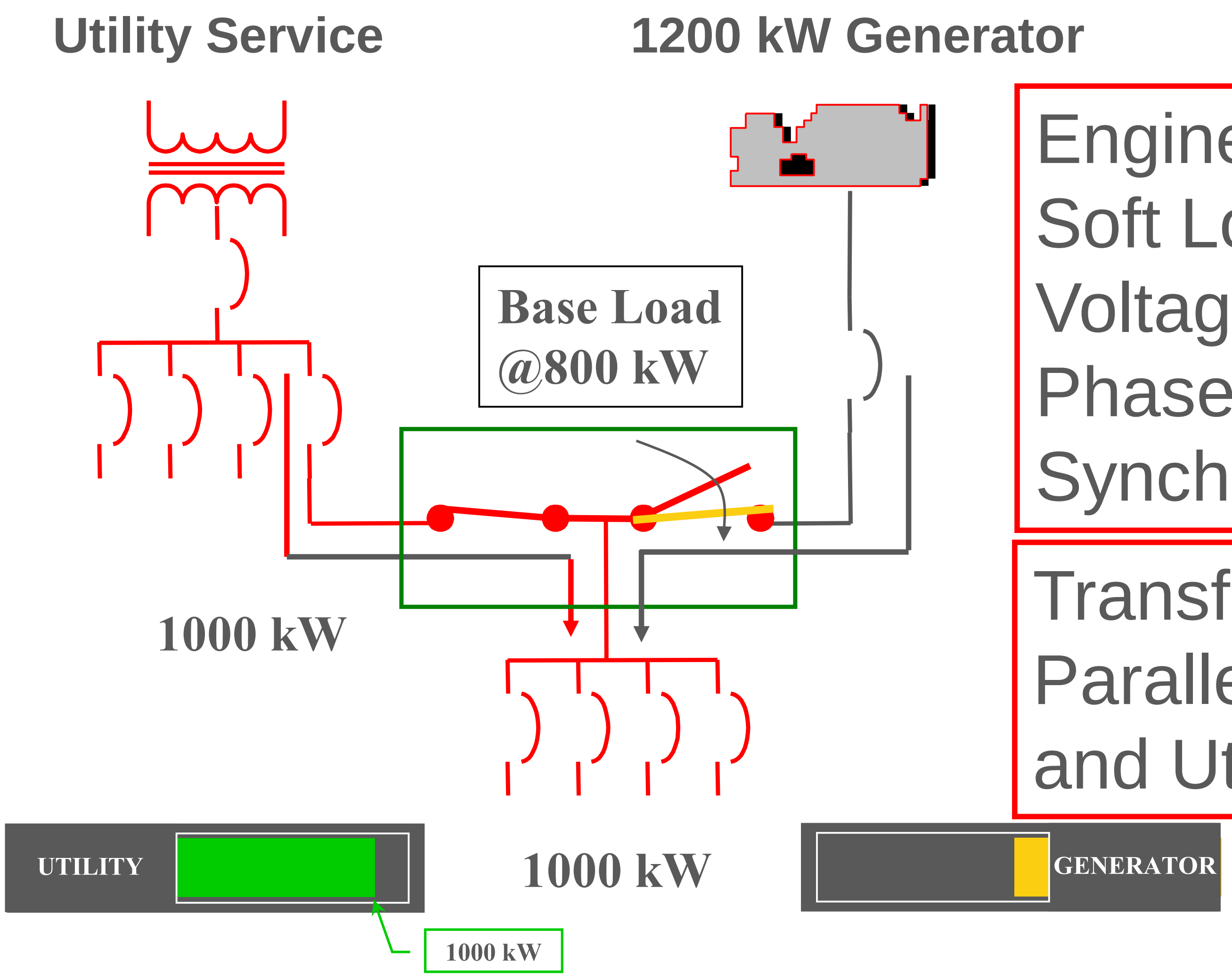
Utility Service Sharing Load with Generator



Controller Loads Generator and Unloads Utility to a Set-point

Then Opens the Utility Contacts and the Generator Supplies the Load

BASE LOAD MODE

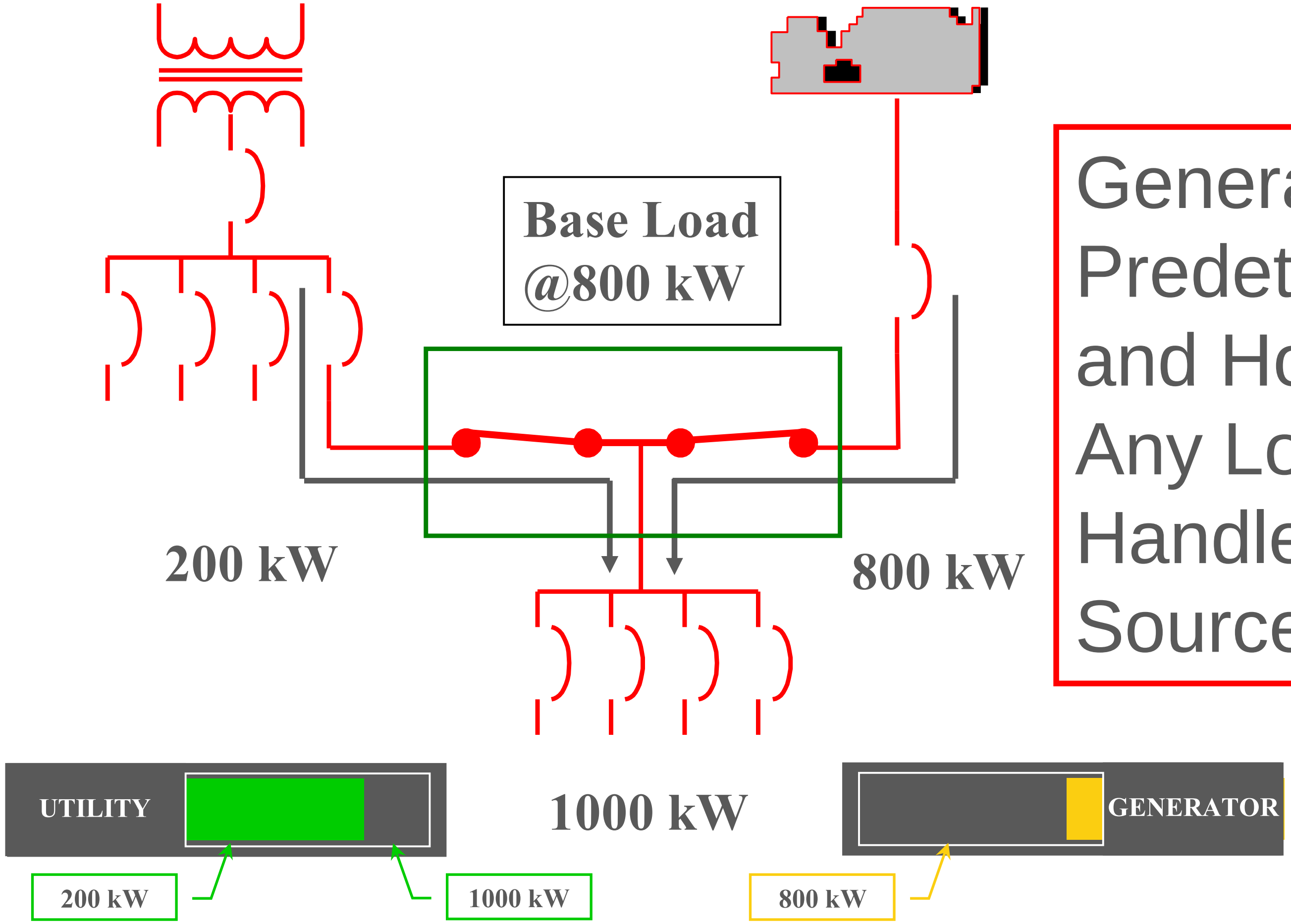


Engine is Signaled to Start. Soft Load Controls Drive Voltage, Frequency, And Phase Angle into Synchronism

Transfer Switch Closes, Paralleling the Generator and Utility

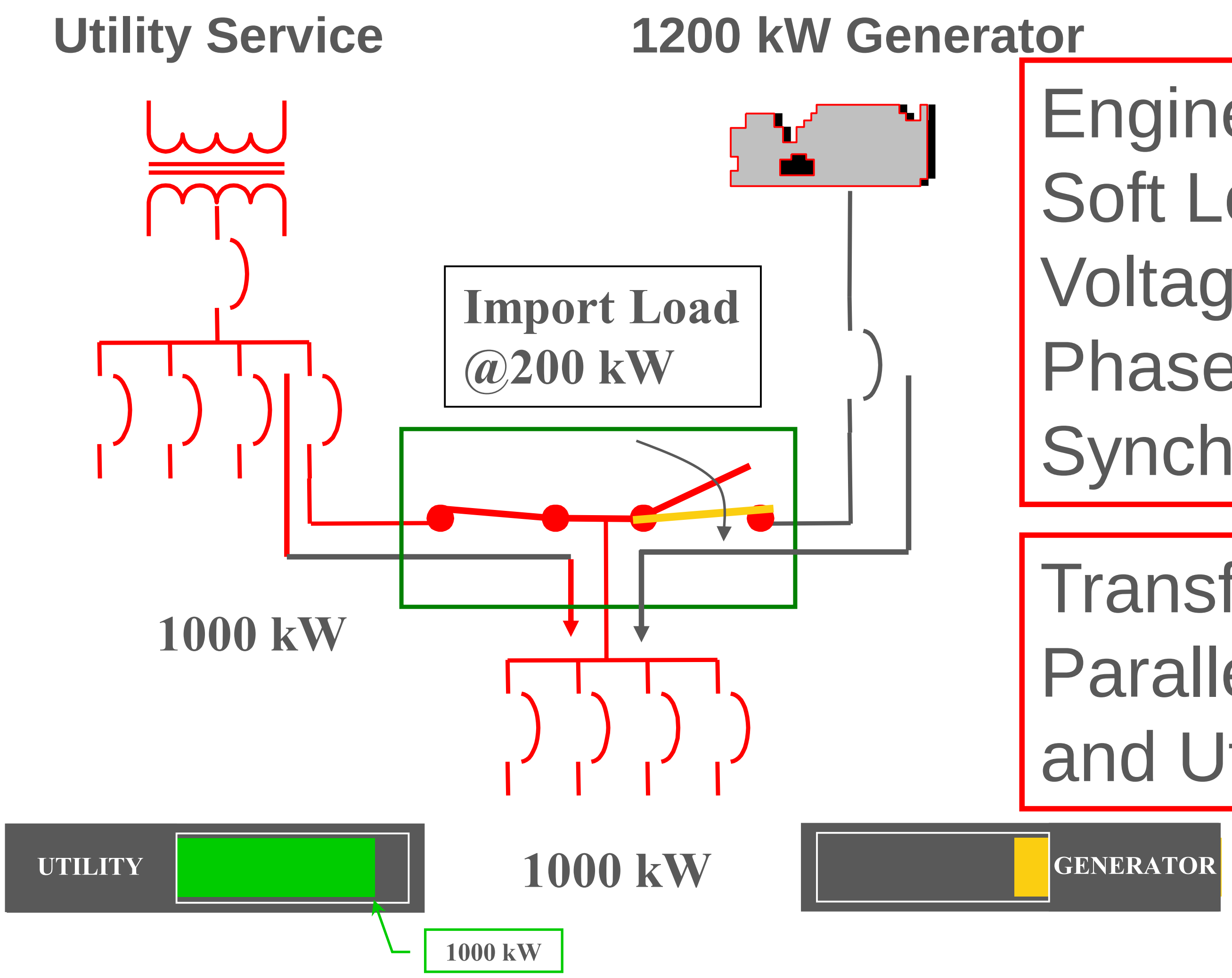
BASE LOAD MODE

Utility Service Sharing Load with Generator



Generator is Ramped to a Predetermined kW Value and Holds.
Any Load Variations are Handled by the Utility Source

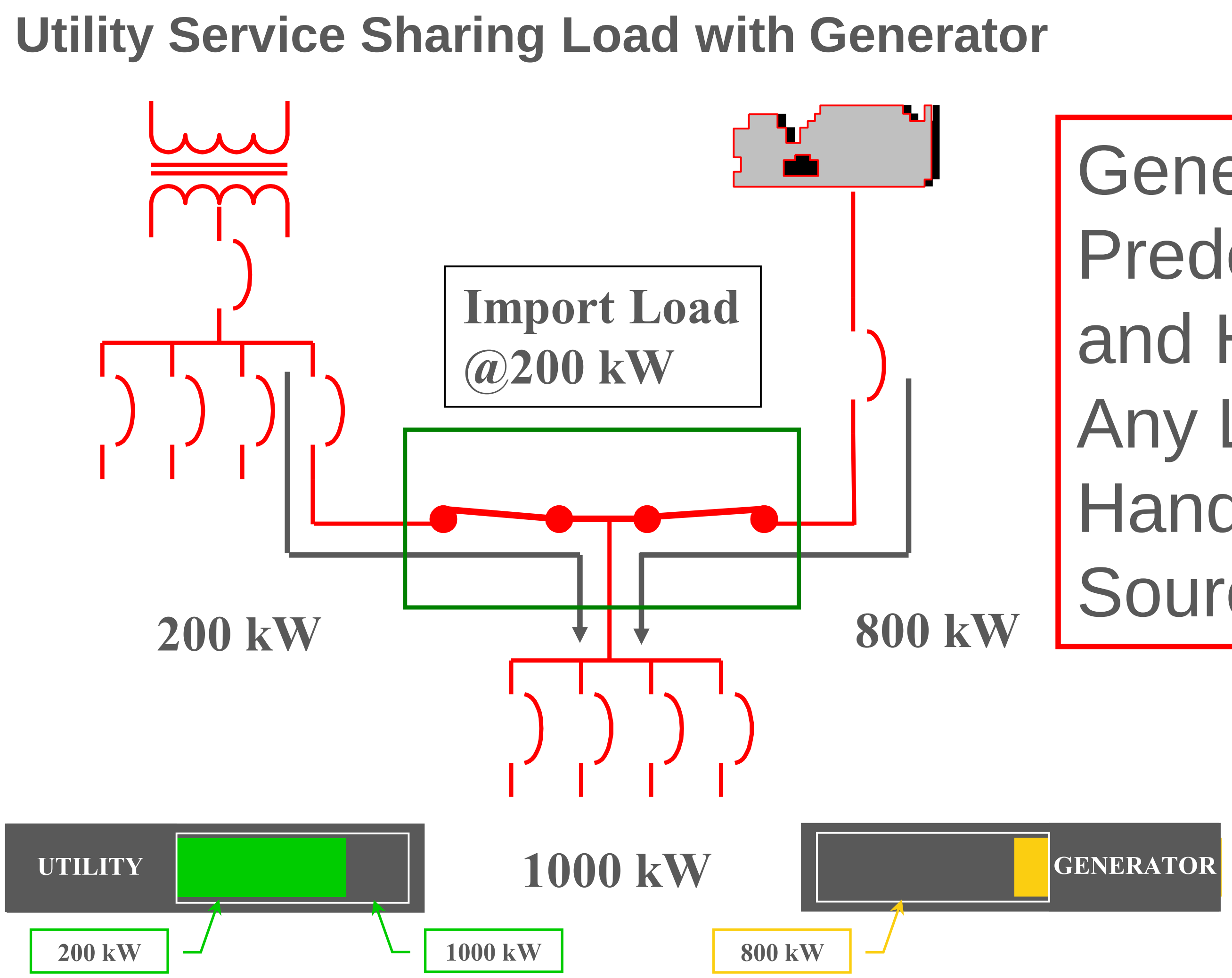
IMPORT MODE



Engine is Signaled to Start. Soft Load Controls Drive Voltage, Frequency, And Phase Angle into Synchronism

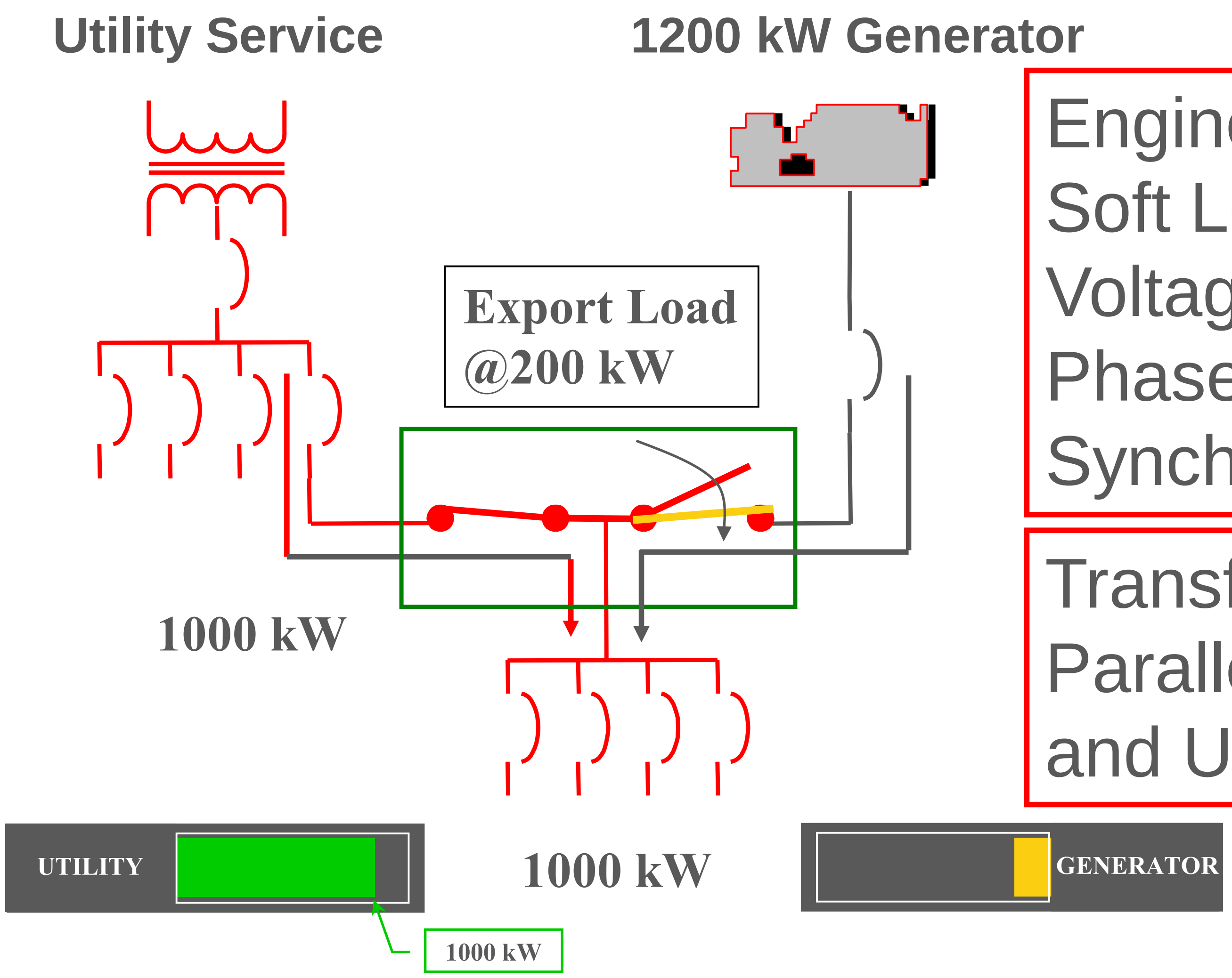
Transfer Switch Closes, Paralleling the Generator and Utility

IMPORT MODE



Generator is Ramped to a Predetermined kW Value and Holds.
Any Load Variations are Handled by the Generator Source

EXPORT MODE

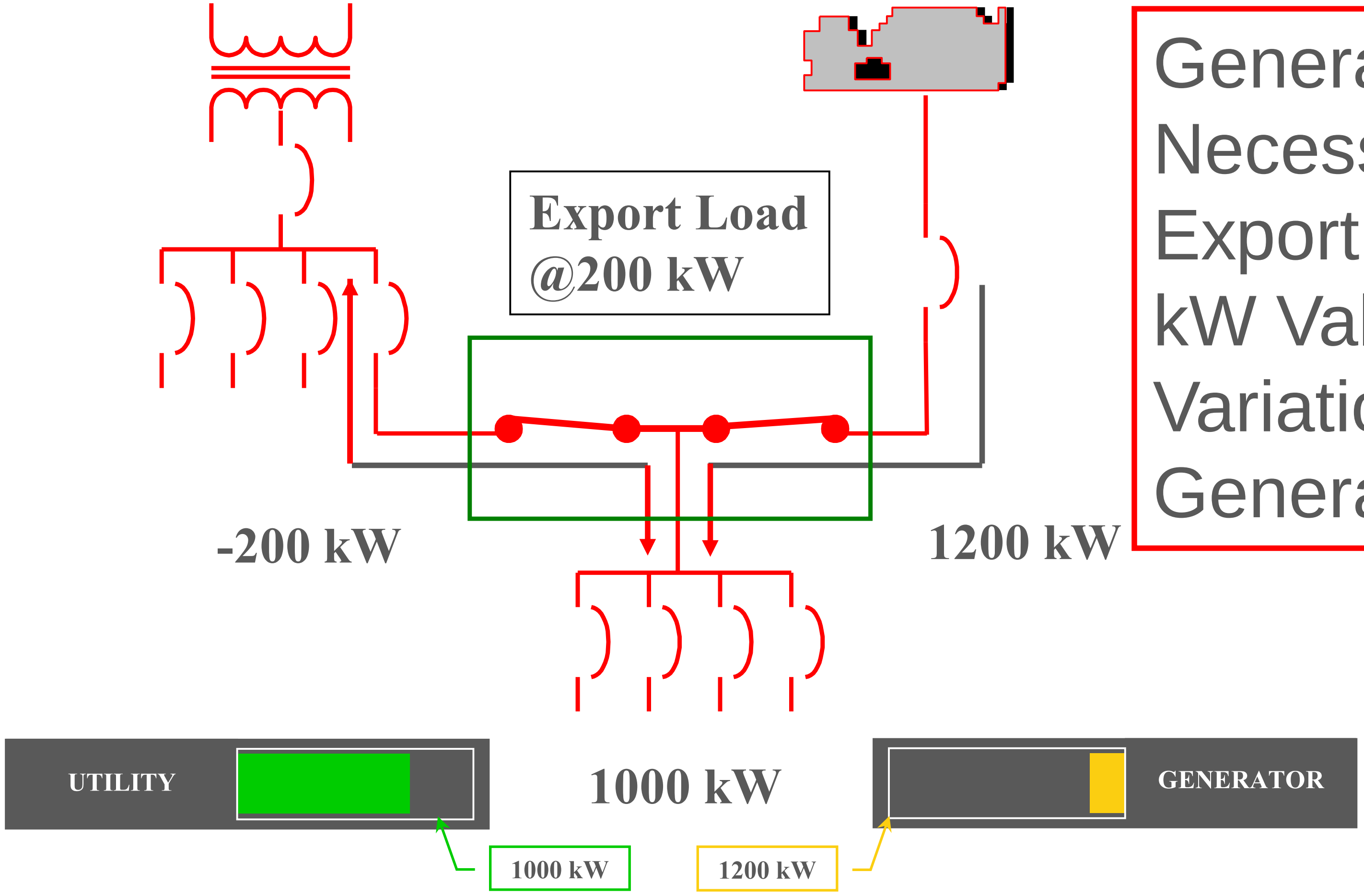


Engine is Signaled to Start. Soft Load Controls Drive Voltage, Frequency, And Phase Angle into Synchronism

Transfer Switch Closes, Paralleling the Generator and Utility

EXPORT MODE

Utility Service Sharing Load with Generator



Generator Produces the Necessary Power to Export a Predetermined kW Value. Any Load Variation Are Handled by Generator Source.

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สมาคมเครื่องกำเนิดไฟฟ้าไทย

THAI GENERATOR ASSOCIATION

END