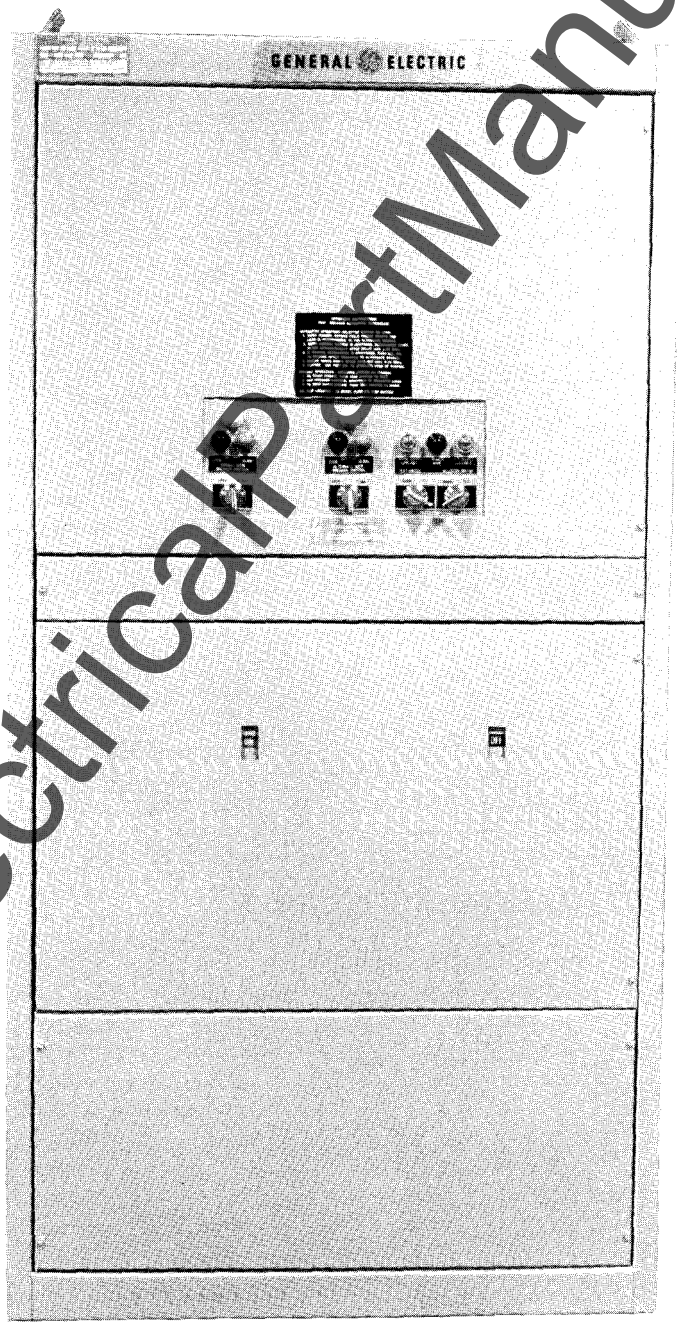
Automatic Throwover Equipment

For GE AV-Line® and Power Break® Switchboards



Although all electrical load can be served with only one power source, many modern installations have two or more power sources feeding loads on a common bus to provide improved reliability and continuity of service. Means must be provided to switch additional power sources in and out of the power system in response to abnormal outages of the normal sources. Alternate power sources are automatically turned on while the normal power source may be returned either automatically or manually when the source of trouble is cleared.

Standard automatic throwover equipments in switchboards have the functions, features, and devices described and listed here. There are several functions that must be considered to completely specify equipment for any particular application.

RADIAL SYSTEM

Figure 1 shows a *normal* source feeding a load through circuit breaker 52-1. This source is generally provided by the electric utility. The emergency source feeds the load through 52-2, with 52-1 open when the *normal* source is out of service. The *emergency* source may be provided from another electric utility supply or a local *in-house* emergency generator.

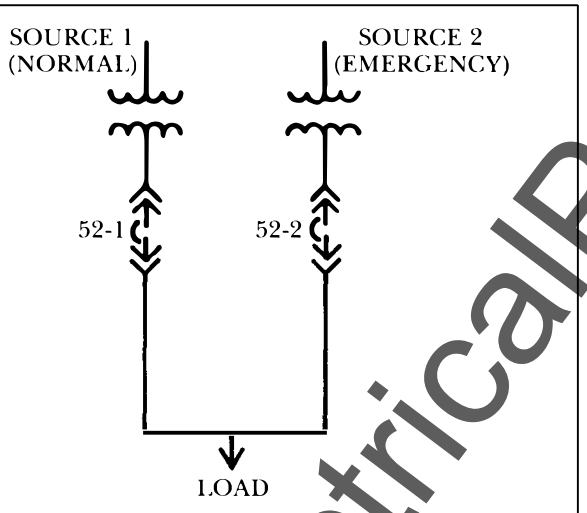


Figure 1. Radial System with Single Bus

SECONDARY SELECTIVE SYSTEM

Figure 2 shows two normal sources feeding their respective loads. Tie breaker 52-BT is normally open. The tie breaker closes only when either source 1 or 2 is out of service. Thus, one source feeds its own load as usual and feeds the other load through the tie breaker in the event of a power outage on that source.

Either power source, of course, must be of sufficient magnitude to carry the combined loads of 1 and 2.

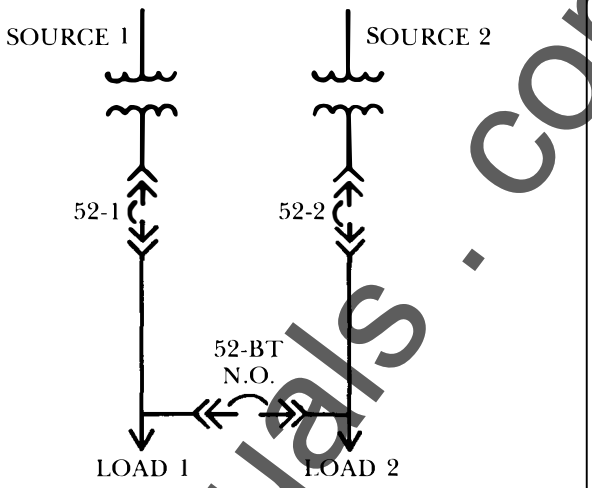


Figure 2. Secondary Selective System with Sectionalized Bus

POWER SOURCE SYNCHRONISM

The sequence of circuit breaker switching during return to normal is dependent upon whether or not the two sources are in synchronism:

- Non-synchronous sources come from different power systems or generators which are never interconnected. Control circuits must ensure that circuit breakers do not overlap; one of the two must always be open.
- Synchronous sources cannot be out of synchronism. Sources come from the same distribution system or generator. To provide uninterrupted service on return, the control circuits should close the normal circuit breaker before opening the emergency circuit breaker.
- Synchronous sources can be out of synchronism. Sources come from two interconnected power systems or generators normally operated together but may be out of synchronism if a tie is open. This is similar to the previous case except that a synchronism check device is required.

THROWOVER

Because the throwover sequence is automatically responsive to normal power status, throwover timing is an important point. Instantaneous throwover is *never* recommended because transient voltage dips on the normal supply could begin the throwover sequence. Delayed throwover allows a definite time interval to pass after normal outage before the throwover sequence begins. A short delay of one to two seconds is provided in most schemes to ride through voltage transients while providing relatively fast response to complete outages. This is accomplished using a pneumatic time-delay with instantaneous undervoltage relays. An adjustable delay allows setting for longer time intervals when needed.

AUTOMATIC RETURN

Instantaneous and Immediate. Fast return is generally not recommended because power system interruptions on the normal source may be sporadic. This could cause unnecessary cycling of the throwover equipment. In addition, the loads are usually being supplied by an adequate power source and there is little need to return until the source of trouble on the normal supply has been cleared.

Delayed—If automatic return is required, then it generally should be delayed for a definite time after the normal source has been re-energized for the reasons last stated.

Manual Return—Frequently employed, it allows verification that trouble on the normal source has been cleared before return to normal.

CONTROL CLOSE AND TRIP POWER

Either ac or dc control power may be used. Most automatic throwover schemes in switchboards are provided with ac close and trip control power.

VOLTAGE LOSS DETECTION

Single-phase voltage loss detection may be used if there are no single-phase interrupters upstream, such as fuses. Three-phase voltage loss indication is recommended if power fuses are used in this upstream position. Three-phase voltage detection is provided on normal sources in most switchboards. Alternate or emergency sources are provided with single-phase voltage sensing plus frequency-sensing. This ensures that a generator is up to rated speed and delivering rated voltage before a load is transferred to it.

OVERCURRENT LOCK-OUT

Short circuits can cause a sustained drop in voltage which could initiate throwover. To prevent throwover under these conditions, an overcurrent lockout contact is required in the throwover circuit. An amber light indicates that a breaker has tripped on overcurrent.

RADIAL SYSTEM—SOURCE PREFERENCE

If the alternate source on a radial system is of the temporary type such as an *in-house* generator, then normal operation would mean a return to the normal source after restoration of an outage.

Conversely, if both sources are equally capable of continuously feeding the load, then normal operation can be either to return to the normal source, or to remain on the alternate source. In the first case, control is called *fixed-preferential*, and, in the second case, control is called *non-preferential*. If both sources are equally capable of feeding the load, some customers require a selector switch which can set up the circuits for preferential control of either source. This is sometimes called *selective-preferential* control and has the advantage of equalizing equipment service.

MANUAL-AUTOMATIC MODES

Even though the throwover equipment can be provided for automatic throwover and automatic return, either immediately or with time-delay, a selector switch with *manual-automatic* modes is required. This allows the equipment to be operated manually by overriding the automatic control circuits.

DELAYED ENGINE STARTING

Delayed closing of engine-start contacts is provided by a pneumatic time delay relay to avoid unnecessary startups every time there is a momentary outage. A delay of two or three seconds is generally used.

DELAYED ENGINE-SHUTDOWN

The drive engine for the alternate power source is allowed to cool off by running it unloaded for five minutes after the load has been transferred back to the normal source. If an engine is shut down immediately after the generator load is removed, it tends to overheat with resultant actuation of high temperature cutouts. If this happens, and if these cut-outs are of the manual-reset type, it is quite possible that the next time it is called for, the engine will not start.

OPERATION

The most common automatic throwover equipment furnished in switchboards for a power bus arrangement of the type shown in Figure 1 is termed a "two-breaker automatic throwover." It has non-synchronous sources, delayed throwover, delayed automatic return, ac control power, three-phase voltage sensing on the normal source, and single-phase voltage and frequency sensing on the alternate, or emergency generator, source.

Assume that the load is normally connected to source 1, which means that 52-1 is closed and 52-2 is open.

Step 1. When source 1 fails, engine-start contacts signal the engine to start, and when the generator voltage and frequency are up to 90 percent of rated values, 52-1 is tripped by control power.

Step 2. Then 52-2 is closed by interlocking auxiliary contacts. The load is connected to source 2.

Step 3. When source 1 returns, the delayed-return timer starts timing and at the end of the preset delay period, 52-2 is tripped.

Step 4. Then 52-1 is closed by interlocking auxiliary contacts, and, following a five-minute engine cool-off period, the engine is shut down.

Note that the load must be interrupted for a finite time during retransfer because the sources are nonsynchronous.

Sectionalized Bus: The automatic throwover control for the double ended bus arrangement in switchboards is termed a "three-breaker automatic throwover" Figure 2. In this case there are two loads, each connected to its own normal source. Transfer is made by tripping the breaker of the source that failed and then closing the bus-tie breaker. The sequences are the same as for the single bus except substitute 52BT wherever 52-2 appears, and omit references to engine-start and shutdown. This scheme has three-phase voltage sensing on both normal sources.

SOURCE PREFEREENCES

A two-breaker automatic throwover scheme may have two normal utility sources, each with three-phase voltage sensing. A source preference switch is included by which either source may be made the preferred source, or these can be either fixed-preference or non-preference. In the latter case, the sequence will stop after step 2. The load will remain connected to source 2 indefinitely. However, if source 2 fails, the load will be transferred to source 1.

MANUAL RETURN

If the control is arranged for manual return only, the sequence will go no further than step 2. After normal power has been restored, the attendant must turn the selector switch from AUTO to MAN and operate the breakers by their control switches. It should be noted that even though the control scheme includes automatic retransfer, the attendant has the option of switching from AUTO to MAN any time after the transfer to the alternate source.

INTERLOCKS TO PREVENT PARALLELING SERVICES

In all of the throwover schemes, the closing circuits of the electrically operated breakers are interlocked. Additional interlocking to prevent manual closing is also supplied.

Power Break● insulated case circuit breakers—a manual hidden "ON" button is included on each circuit breaker.

AK/AKR low voltage power circuit breakers—the electrical lockout device (under-voltage lockout) is supplied, interlocked with auxiliary contacts of the other breaker, rendering the breaker mechanically trip-free when it should not be closed.

Molded case circuit breakers—a mechanical interlock (walking-beam type) is supplied.

EQUIPMENT

The automatic throwover control unit in GE AV-Line● and Power Break● Switchboards includes a relay panel and a control panel as shown in Figure 3. All of the relays, timers, control fuses and control power transformers are located on the relay panel. A terminal board is provided for the interconnecting wiring to each breaker. The control panel is attached by brackets to the relay panel (see Figure 4), and is located behind a cutout in the front door. The opening in the door exposes the control panel, which contains all of the indicating lights and selector switches. (See Figure 5).

For each breaker there is a control switch for manual closing and tripping. Above the switch are three lights, indicating open, closed, and tripped-on-overcurrent positions in green, red, and amber, respectively.

Also included are a test switch and a manual-automatic mode selector switch. Above these switches are located two source available lights (clear) and a manual mode light (blue). The latter is a reminder that the system is NOT set on AUTO.

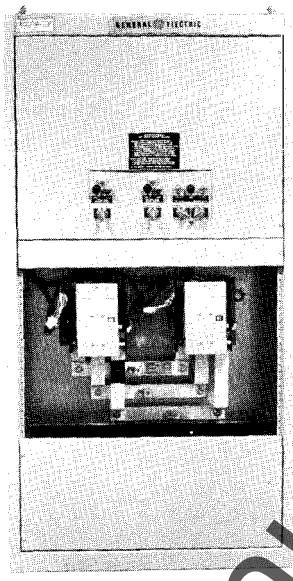


Figure 3. The automatic throwover control unit in GE AV-Line® and POWER BREAK® Switchboards include a relay panel and control panel.

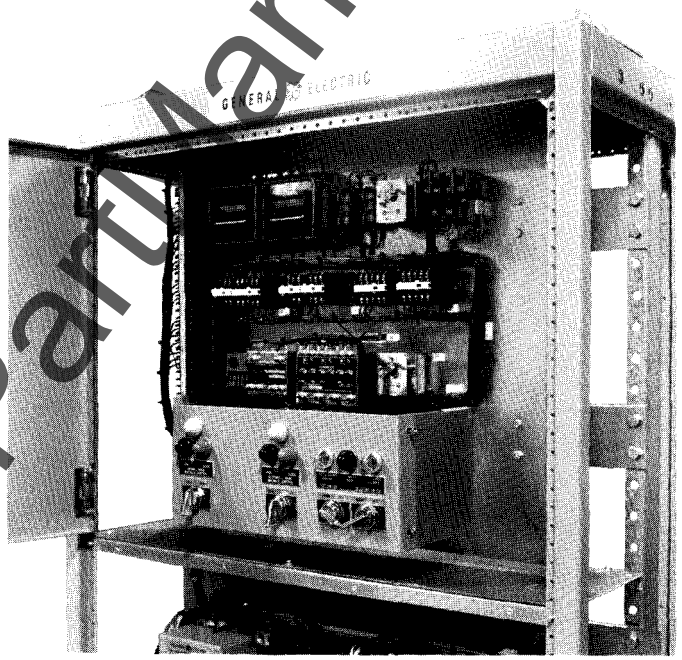


Figure 4. The control panel is attached by brackets to the relay panel.

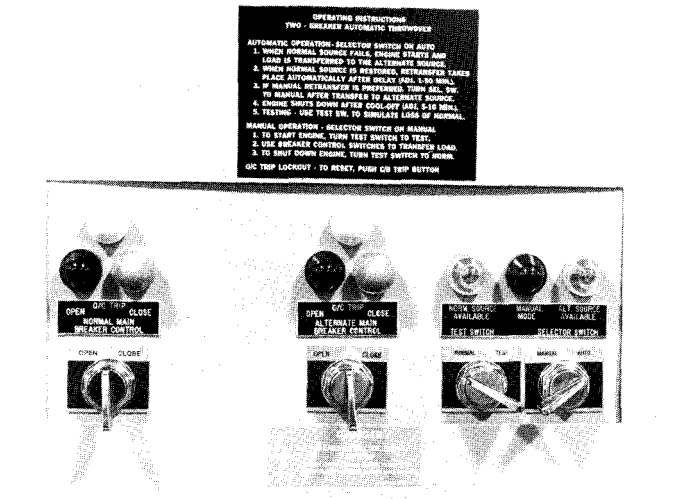


Figure 5. The control panel contains all of the indicating lights and selector switches.

STANDARD FEATURES

Table 1 lists the standard features of the basic throwover system available with GE switchboards. Optional features are available to meet requirements of other applications, such as dc control, load shedding of feeder breakers, sequence-closing of feeders, and intentional time delay between tripping and closing of the main breakers.

OPERATING INSTRUCTIONS

An operating instruction label is located on the front door just above the control panel. This provides the user a permanent copy of this essential information, located where it is needed, rather than only on the drawings in the plant engineer's files. (See Figure 5)

CIRCUIT BREAKERS

The automatic throwover unit is for use with electrically-operated circuit breakers:

- ☐ Power Break Line—stationary or draw-out
- ☐ Type AK/AKR—stationary or draw-out
- ☐ Molded case with motor-operator—stationary only (and 2-breaker throwover only)

Accessories required:

Breaker interlock—
- —Hidden "ON" Button Power Break● breakers
- —Electric lock-out (UV lock-out)—AK breakers
- —Mechanical interlock (walking beam)—molded case circuit breakers

Shunt trip device
Bell alarm/overcurrent lock-out device
Auxiliary switches

Standard Features	Automatic Throwover	
	2-Breaker	3-Breaker
1. Three-phase voltage sensing on normal sources	x	x
2. Single-phase voltage and frequency sensing on generator source	x	
3. Delayed throwover	x	x
4. Delayed engine—starting	x	
5. Delayed engine—shutdown (cool-off)	x	
6. Delayed return, automatic	x	x
7. Manual—automatic mode selector switch	x	x
8. Test switch—simulates loss of normal	x	x
9. Breaker control switches for manual operation	x	x
10. Indicating lights		
—Breakers open (green) or closed (red)	x	x
—Breakers tripped by overcurrent (amber)	x	x
—Source power available (clear)	x	x
—Operating in manual mode (blue)	x	x
11. Overcurrent trip lockout-electrical and mechanical	x	x
12. Breakers interlocked to prevent paralleling the sources:		
By closing circuits electrically interlocked	x	x
Plus additional lockouts on:		
Power break circuit breakers—Hidden "ON" button	x	x
AK Breakers—electrially-operated Electric lock-out device	x	x
Molded case breakers—mechanical-interlock	x	
13. Position switches in draw-out breaker housing provide bypass and disconnect functions	x	x
14. Control power transformers included	x	x
15. Control power transfer relay included	x	x
Optional Features		
16. Plant exerciser time switch—once-a-week operation of automatic throwover or engine only	x	

Table 1 Features of the basic throwover system available with General Electric switchboards

BLOCK DIAGRAMS

The circuitry needed to perform the automatic throwover function with electrically-operated circuit breakers is necessarily quite detailed and somewhat complex. For simplicity, the circuits are shown in the form of block diagrams in Figures 6 and 7.

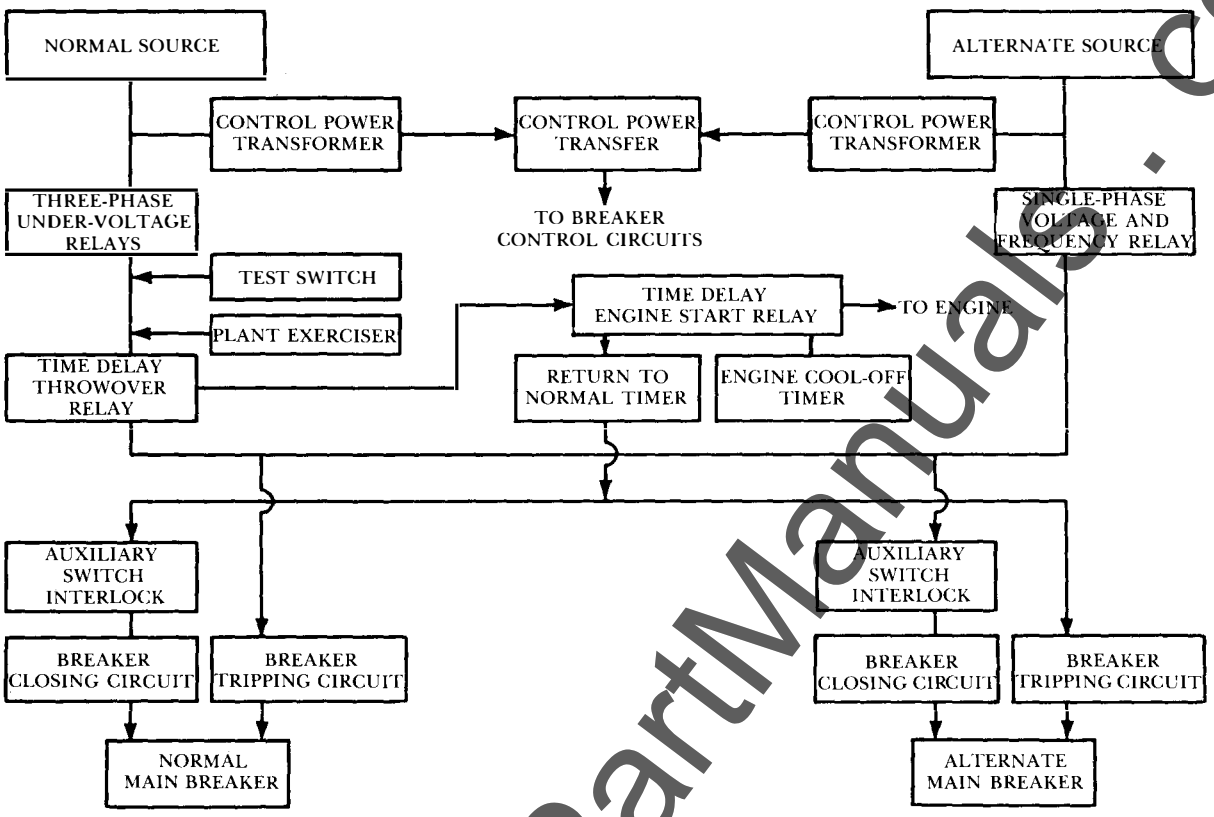


Figure 6 How the 2-breaker automatic throwover circuitry provides service from one normal source and one alternate source.

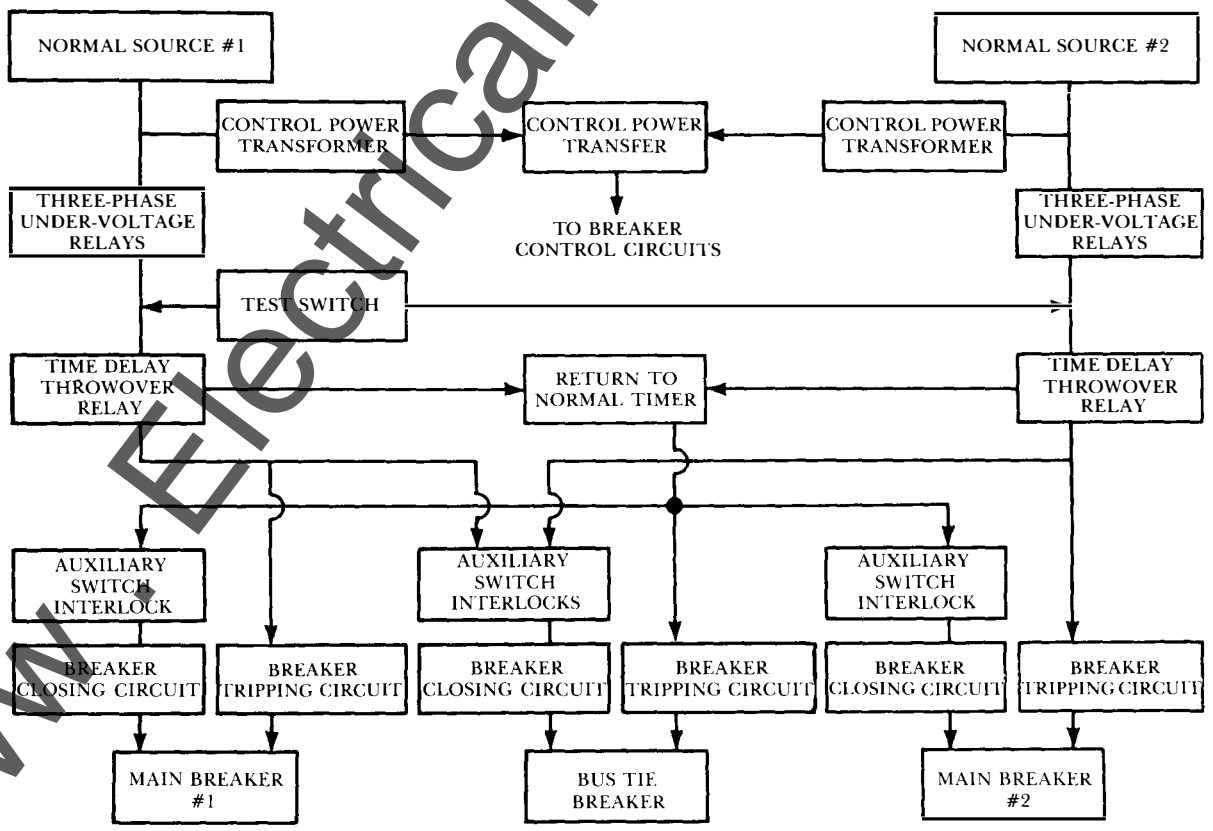


Figure 7 How the 3-breaker automatic throwover circuitry provides service from two normal sources.

DIMENSIONS

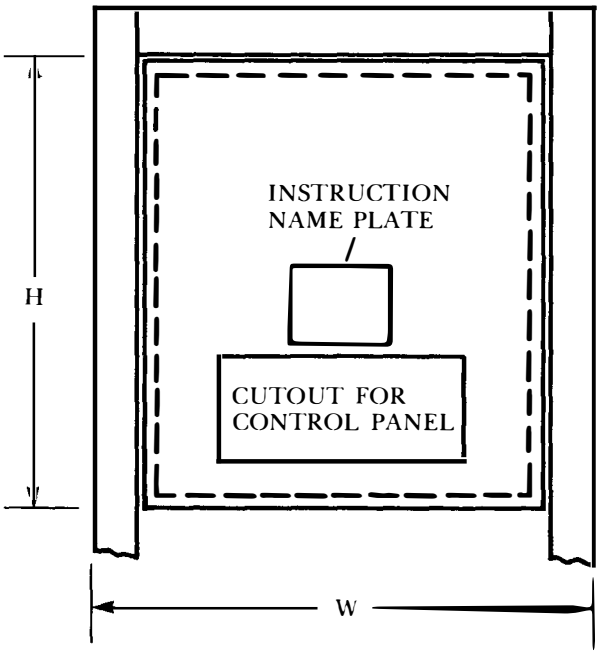


Figure 8 Front view of a typical AV-Line® switchboard automatic throwover equipment

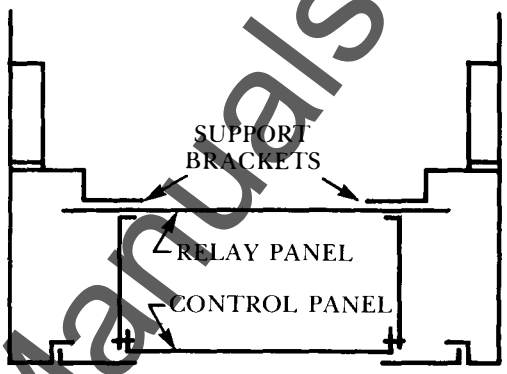


Figure 9 Top view of a typical AV-Line switchboard with automatic throwover equipment

TABLE II–DIMENSIONS

Type Switchboard	W Switchboard Section Width (Inches)	H Automatic Throwover Equipment Unit Height (Inches)
AV-Line®	35 & UP①	28
Power Break®	25-30	35
	35 and UP	28

①AV-Line switchboards require a minimum section width of 35″ for automatic thrower equipment.

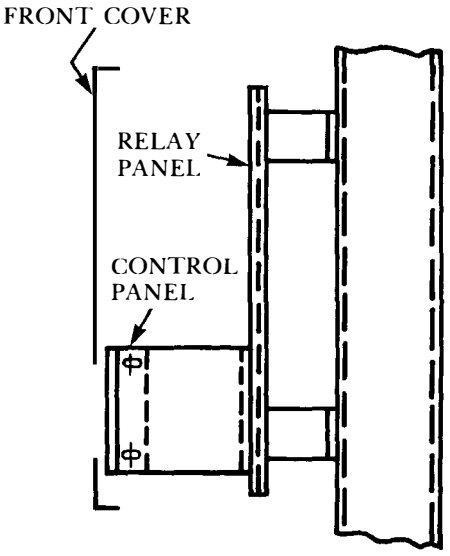


Figure 10 Side view of a typical AV-Line switchboard with automatic throwover equipment

Guide Form Specifications

GENERAL

The automatic throwover equipment shall be so arranged that in the event of interruption of the normal power source, an alternate power source shall be additionally connected to the load.

The automatic throwover equipment shall be supplied with interlocking provisions that will prevent interconnection of normal and alternate sources or any two separate sources of power during any operation of the automatic switching equipment.

The equipment shall be so connected that the load is served by the normal source of power, except when the normal source is interrupted. Controls and switching equipment shall be so arranged that interruption of the normal source automatically initiates the starting of an alternate source generator (if required), automatically disconnects the normal source of power, and connects the alternate source of power all in proper sequence.

When the normal source of power is restored, the automatic throwover equipment shall disconnect the alternate source and restore service connection to the normal source of power. An adjustable time device shall be provided delaying the return to the normal source of power to allow stabilization of the normal source and to minimize cycling between the two sources of power.

A "MANUAL-AUTO" selector switch shall provide choice of manual or automatic mode of operation. A "TEST" switch shall be provided to initiate throwover by simulating loss of the normal power source.

Individual control switches shall provide manual closing and tripping of each circuit breaker when the system is in manual mode.

Overcurrent trip lockout provisions shall prevent reclosing and transfer when a breaker has tripped because of an overcurrent condition.

OPTIONAL FEATURES THAT MAY BE SPECIFIED:

Throwover Exercise—

1. On two-breaker throwover equipment with an engine-generator alternate source, an exercise time switch shall be provided for once-a-week operation of the complete throwover equipment, or the engine only.

Manual Return to Normal—

2. Instead of the standard automatic return to normal operation, manual closing-only shall be provided.

Single-Phase Voltage Sensing—

3. Instead of providing standard three-phase voltage sensing on normal sources, single-phase voltage sensing shall be provided.

Control Circuit Interlocking Only—

4. Instead of providing electric-lockout device (electrically-operated mechanical-lockout) on AK/AKR circuit breakers, to supplement the standard closing circuit interlocking, the electric-lockout device may be omitted.

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