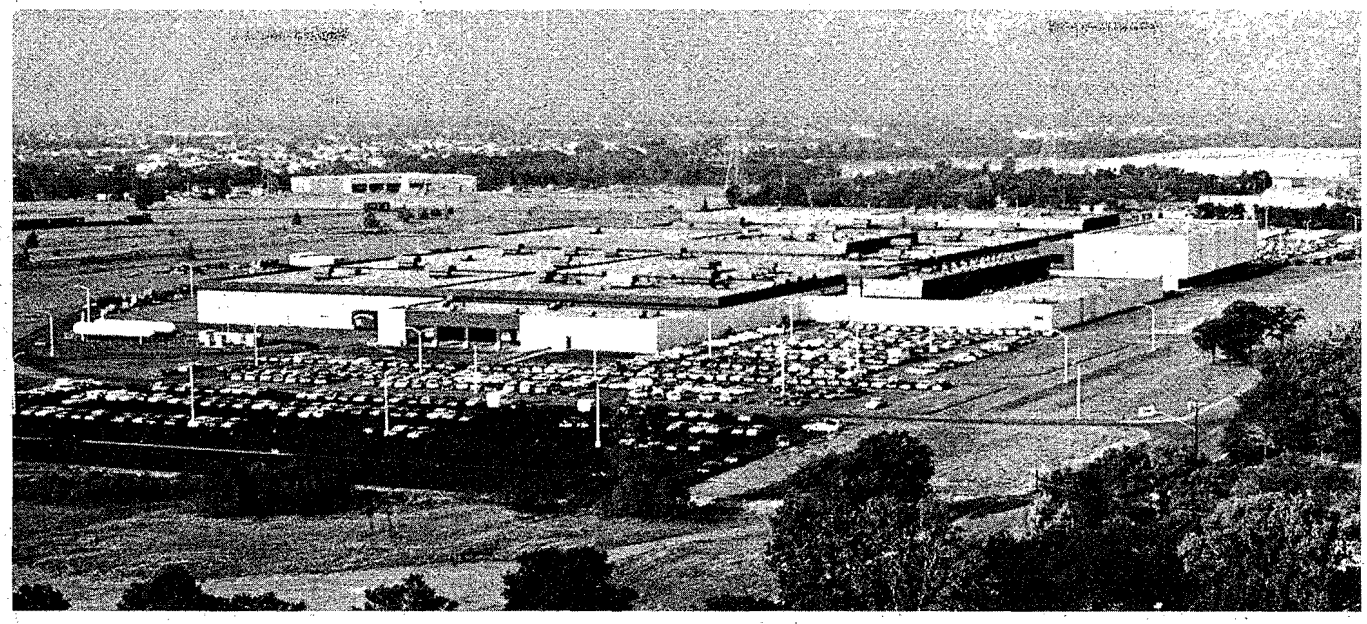
T-011

technical bulletin

"LT" SERIES AUTOMATIC TRANSFER SWITCHES

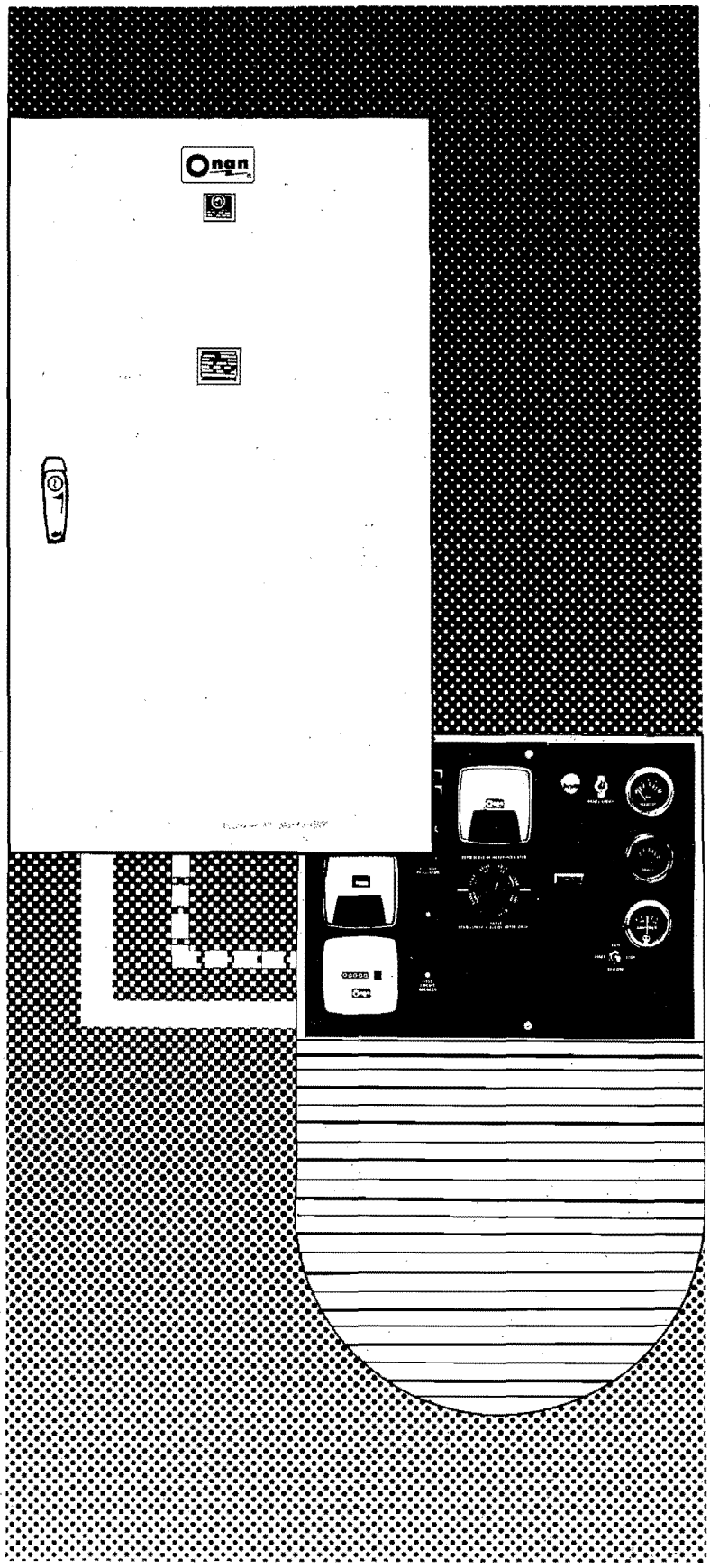


ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF ONAN CORPORATION

Printed in U.S.A.

MAY 1978

INTRODUCTION



The standby system-

Onan's business . . . . .

When automatic operation of transferring the electric load to an emergency power source is required, specify an Onan automatic transfer switch. It switches the load to the emergency power source during a power outage of normal line power and returns the load to normal power after power returns.

Onan produces a wide variety of equipment for standby applications. Because Onan automatic transfer switches are used for many applications, special modifications and options are available to fit most requirements.

Use this bulletin to help select the model and options for your particular standby needs. The application check list at the end of the bulletin can aid in your selection.

TABLE OF CONTENTS

THE TRANSFER SWITCH

The transfer switch is the heart of the automatic transfer switch. It connects commercial power to your load, and when power fails, connects emergency power to the load. The transfer switch must handle full line power, break the currents it passes, and pass peak current many times its rated value without damage.

Onan transfer switches are two-coil, double-break contact type. Each set of contacts is operated by its own coil, the power supplied by the source to be connected to the load. Therefore, to connect line and load, the line side coil closes the line contacts. To connect the generator and load, the generator coil closes the generator contacts.

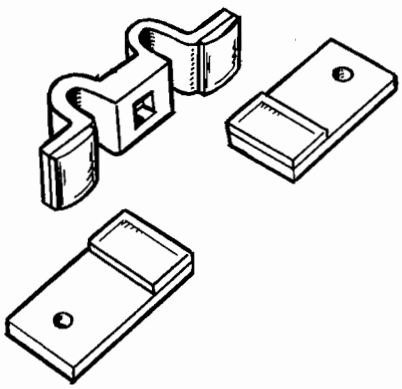


FIGURE 1. TRANSFER SWITCH CONTACT SET

Both sets of contacts are mechanically and electrically interlocked to give double protection against both closing simultaneously. The mechanical interlock operates whenever one set of contacts closes, to lock the other open. When the line contacts start to close, the electrical interlock disconnects power from the generator coil, and vice versa.

Each contact set is constructed as shown with two contacts in series. Each contact face is made of solid silver cadmium oxide. See Figure 1.

For silent operation, the line side mechanism includes a mechanical latch that locks the contacts closed once pulled in and disconnects the line pull-in coil. So, once the line contacts pull in, power is disconnected from the coil and the contacts are locked closed. If a failure occurs, power from the emergency source disengages the latch.

OPERATION OF TRANSFER SWITCH

Transfer switch in normal position connects load and line. Note in Figure 2 that the mechanical latch (9) holds the line contacts (1) closed and the coil disconnect switch (8) open, so no power is on the main coil.

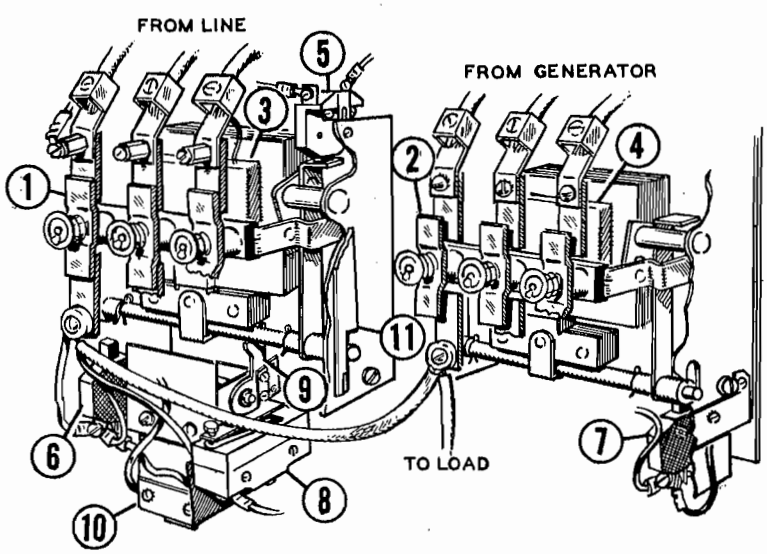


FIGURE 2. TRANSFER SWITCH IN NORMAL POSITION

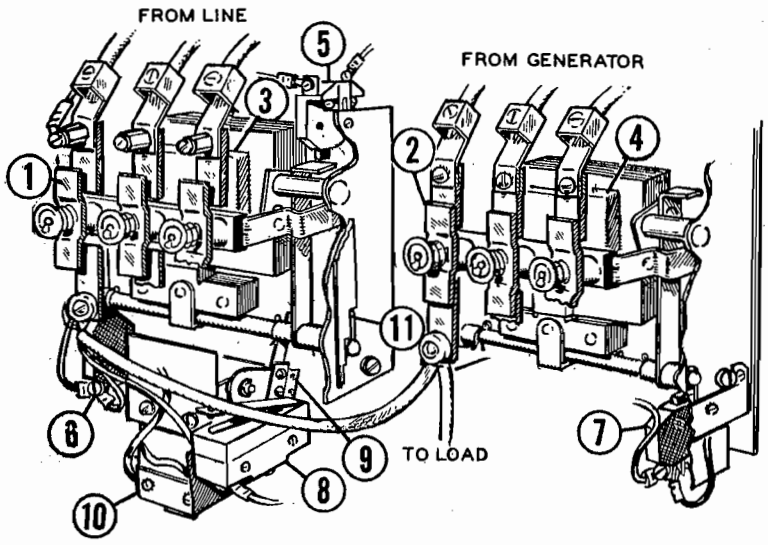


FIGURE 3. TRANSFER SWITCH DURING POWER OUTAGE

Power Outage

When a power outage occurs, the automatic transfer switch control section starts the generating set. Simultaneously, the instant-transfer relay closes. As the generating set builds up speed and voltage, current flows through the latch disconnect coil (10). See Figure 3. This disengages the latch which allows the line contacts (1) to open. When the line contacts open, they in turn open switch (5) which disconnects power from the latch coil and closes switch (6), the electrical interlock switch.

With switch (6) closed, generator output power is fed to the generator side coil (4). The generator contacts (2) pull in supplying generator power to the load.

Return Of Normal Power

When normal power returns, the control circuit initiates the transfer switch retransfer by opening the instant-transfer relay contacts. At the same time, it stops the generating set. Opening these contacts breaks the generator coil circuit (4). The main generator contacts open. When they open, they close electrical interlock switch (7) which allows line voltage to the line coil. This coil pulls in the line contacts (1) which engages the mechanical latch (9). Engaging the latch opens switch (8), disconnecting the line side main coil (3). The line contacts are now locked closed and all coil power disconnected. This operation takes less than 0.050 seconds.

LOADS AND THE TRANSFER SWITCH

The maximum current the transfer switch can carry continuously determines its rating; this rating in turn becomes the load transfer control's maximum current rating.

In addition to the maximum continuous rating, maximum inrush current and maximum break current are important transfer switch ratings. Many loads draw more current starting than running. Motors draw as much as five times running current during starting. More important, incandescent bulbs draw as high as 18 times their normal current during the first instant of operation. This current, then falls to normal value in approximately 0.3 seconds. Contacts without the thermal capacity to withstand this magnitude of inrush current would weld together.

Onan transfer switches (Figure 4) have been proven capable of passing 20 times their rated current for a full second. They have passed UL testing including tungsten lamp tests of closing on inrush current ten times normal for one second repeated six times per minute for 6000 operations.

Maximum break current is the maximum current passage under which the contacts can open. A transfer switch must be capable of interrupting not only its rated currents, but even higher inductive currents such as motor locked rotor currents.

The arc produced depends on the type of load — resistive or inductive. Inductance in the load

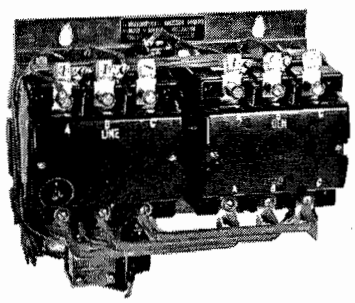


FIGURE 4. ONAN TRANSFER SWITCH (CONTRACTS COVERED)

produces an arc when its magnetic fields collapse. Contact breaking ability is determined by the arc it is capable of breaking; therefore, contacts are rated in terms of the type load with which they will be used. Some manufacturers rate switches for tungsten lamp loads or for motor load. A lamp load transfer switch is for use with tungsten lamps only, and not motor or fluorescent lamps (fluorescent lamps are inductive loads). An inductive switch is rated for motor and other inductive loads, and will suppress the arc they produce when the switch opens.

Onan transfer switches are capable of switching all classes of loads up to and including 15 times the continuous switch rating for inductive loads to 0.5 power factor — lower than normally encountered out of the laboratory. It eliminates the need for specifying a particular type for the automatic transfer switch.

FAULT CONDITIONS AND THE TRANSFER SWITCH

If a fault occurs in the load circuits, high currents will result until overcurrent protective devices operate. The transfer switch contact must be large enough to absorb the heat accumulated by fault currents without heating to the weld or damage point. Without this capacity, damage will result. The fault current that can be tolerated depends not only on the current during fault, but also on the duration of fault, for it is the total power imparted to the contacts that determines heating. Onan contacts are designed to tolerate fault currents as high as 20 times the switch rating for a full second. With the addition of low peak fuses, even higher currents can be tolerated for shorter fault periods. It should be noted that the contacts are not designed to open under these conditions; over-current protective devices will break the current.

ARC CONTROL

Correct arc control is protection both for an automatic transfer switch and other electrical equipment in the system. Correct arc control also permits the switch usage for all load types as described above. While in most switches arc control is unimportant, it is essential to a two-source transfer switch as used in Onan automatic transfer switches.

Because of differing phases in the two sources, voltages as high as twice the voltage of the sources can exist between them. So, connecting two sources, normal and emergency, together could be disastrous — high short circuit currents could destroy the transfer switch. An arc sustained across opening contacts until the opposite contacts had closed would constitute a short circuit between the two sources. For this reason, the arc must be extinguished as fast as possible and positively before the opposite contacts close.

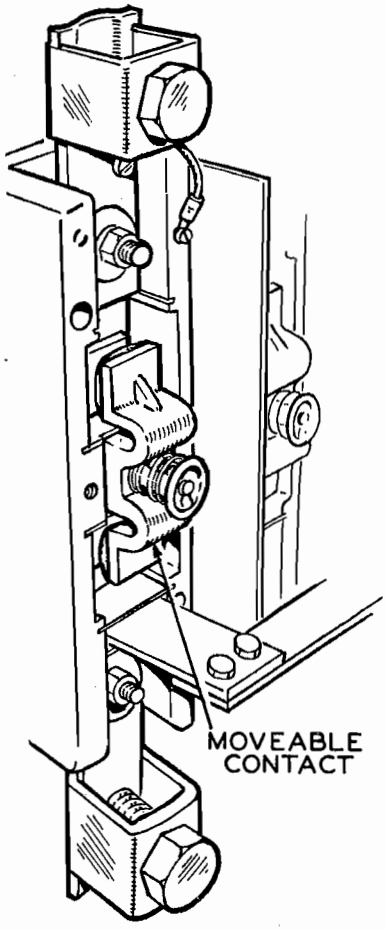


FIGURE 5. DOUBLE-BREAK CONTACTS

Onan assures rapid and positive arc control by:

1. Using double break contacts. See Figure 5. An arc is produced by the power in an inductive load; the power dissipates as a voltage and current across the contacts. The faster the contacts open the higher the voltage and faster the arc goes out. Fast separation of opening contacts means fast arc suppression. By using two contacts in series, the transfer switch forces the circuit to open twice as fast as each contact moves cutting arc time to half of what it would normally be.
2. Using a mechanical interlock mechanism so that the second set of contacts cannot close until the first has opened completely. By proper contact design it is assured that the arc will be suppressed by the time the contacts are fully open. By using a mechanical interlock that permits the generator contacts to close only when the line contacts are completely opened and vice versa, you are assured that they will not close until the arc is suppressed.

SPEED OF OPERATION

Operating speed is considered at the time the power to the load is broken while the automatic transfer switch transfers from one source to the other. When transferring to emergency power, transfer time of the automatic transfer switch is unimportant — insignificant as compared to the time required to start the generating set (5 to 10 seconds). But during the retransfer to normal power transfer time can be important. It determines the power break your equipment will see.

Transfer time depends on the transfer switch's switching speed. Time for the 30 and 60 ampere switches is under 50 milliseconds. The power break with an Onan transfer switch is small enough that to the average observer, it appears only as a slight flicker in lights.

TRANSFER SWITCH WIRE CAPACITIES

Table 1 gives the number of wires and maximum-minimum wire sizes the transfer switches will accept.

TABLE 1. TRANSFER SWITCH WIRE CAPACITIES

AUTOMATIC TRANSFER SWITCH (AMPERES)		30	60
Number of Conductors and Size per Pole	Switch Pole*	One 14-6	One 14-1/0
	Neutral Bar*	One 14-2	One 14-2

* - Connectors will accept copper or aluminum conductors.

AVAILABLE AUTOMATIC TRANSFER SWITCHES AND FEATURES

COMPATIBILITY WITH THE GENERATING SET — STANDBY CONCEPT

Your automatic transfer switch will be only one part of the complete standby system providing automatic emergency power. It is important that all components of the system be compatible. The automatic transfer switch must be able to satisfactorily start and stop the unit. Equipment such as a cranking limiter or cycle cranking must be included in either the unit's control or automatic transfer switch depending on the type of control used. Provision must be made for check and test of the system, especially the generating set.

The best way to maintain compatibility between unit and automatic transfer switch or throughout the system is to specify components designed for use together. Onan automatic transfer switches and units are designed for integrated use. Each automatic transfer switch is designed and built with certain Onan generating sets in mind.

Often, mixing generating sets and automatic transfer switches of different manufacture requires design modification on the part of the installer. Components such as cranking limiters neglected in both the unit and automatic transfer switch must be installed and wired by the installer. The automatic transfer switch must be re-engineered to fit the unit or vice versa.

When an Onan automatic transfer switch is used with an Onan unit to provide a complete Onan standby system, the equipment is engineered at the factory and requires only installation at the site.

AUTOMATIC TRANSFER SWITCH CONTROL SECTION

In order for the automatic transfer switch to have automatic operation, it includes a control or supervisory section. The control section performs the following functions (also see Figures 6 and 7).

1. It senses commercial line voltage and detects a power outage.
2. Upon power outage, it signals the generating set to start by closing the remote start circuit.
3. When the unit starts, the control circuit disconnects the starting circuit.

   On some Onan automatic transfer switches, the unit's control circuit disconnects starting.
4. When generator voltage builds up, the control section detects this and allows the transfer switch to switch the generator output to the load.

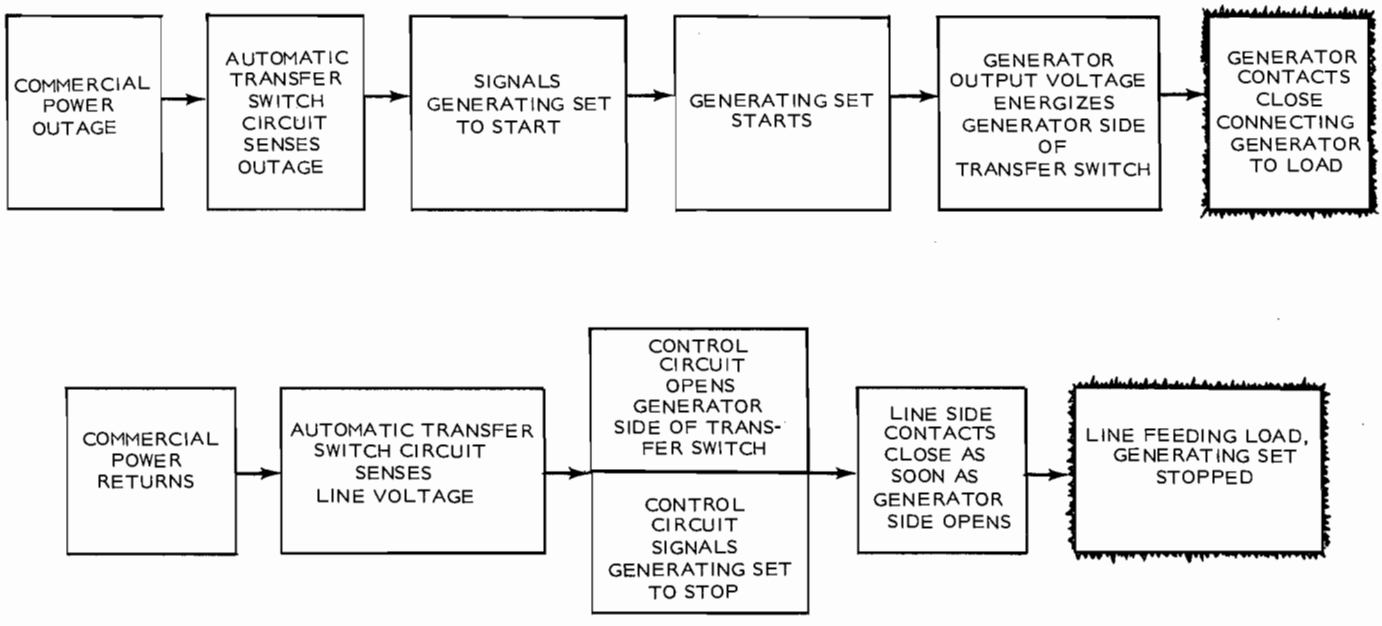


FIGURE 6. OPERATION SEQUENCE OF ELECTRICALLY-HELD TRANSFER SWITCH

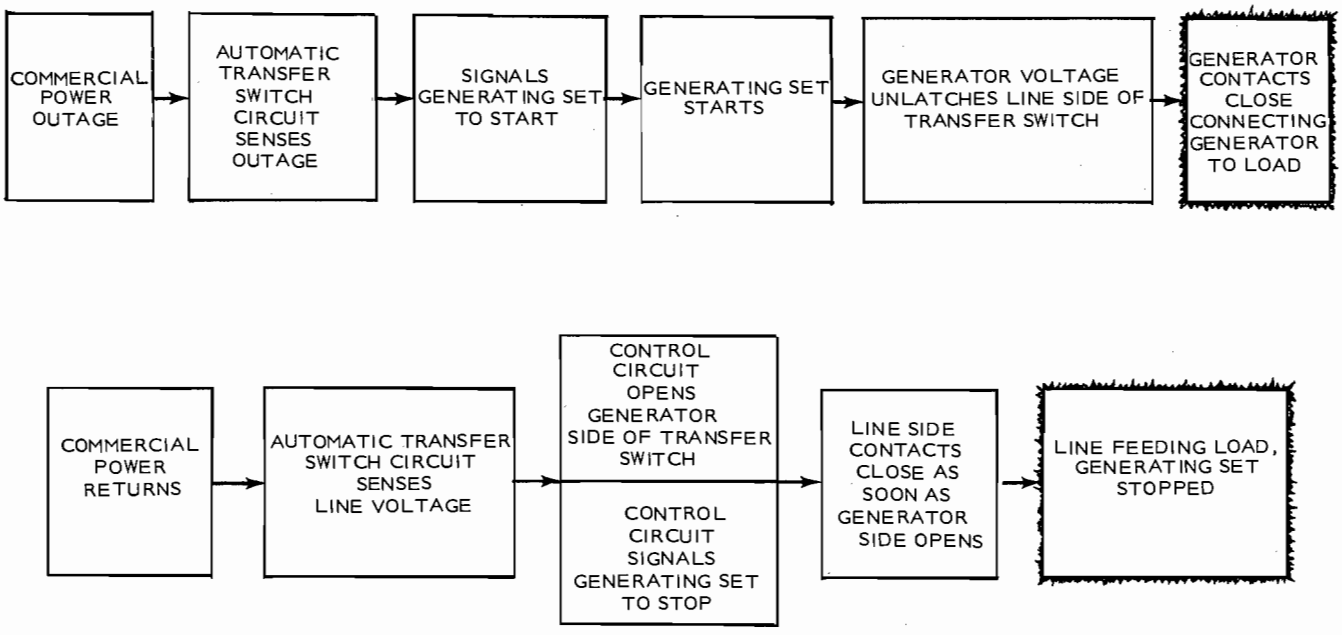


FIGURE 7. OPERATION SEQUENCE OF MECHANICALLY-LATCHED TRANSFER SWITCH

5. If the generating set fails to start, the control's cranking limiter stops cranking after about 45 seconds.

   On some automatic transfer switch systems, a cranking limiter is included in the generating set control rather than the automatic transfer switch.

2- OR 3-WIRE STARTING

To control the generating set, the automatic transfer switch is connected by remote wires. Onan uses 2- and 3-wire starting depending on the model of the generating set (Figures 8 and 9). To insure compatibility, the 3-wire generating set must be matched with a 3-wire automatic transfer switch, a 2-wire unit must be matched with a 2-wire automatic transfer switch. Also, the battery voltage of both the generating set and automatic transfer switch must be the same.

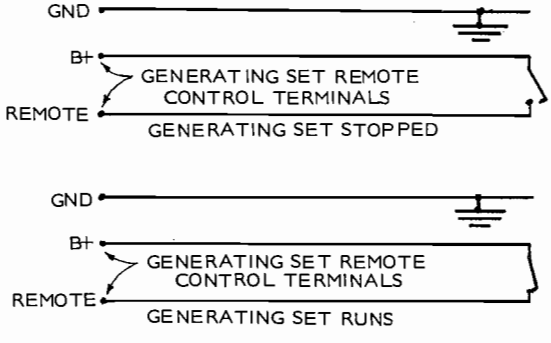


FIGURE 8. TWO-WIRE STARTING

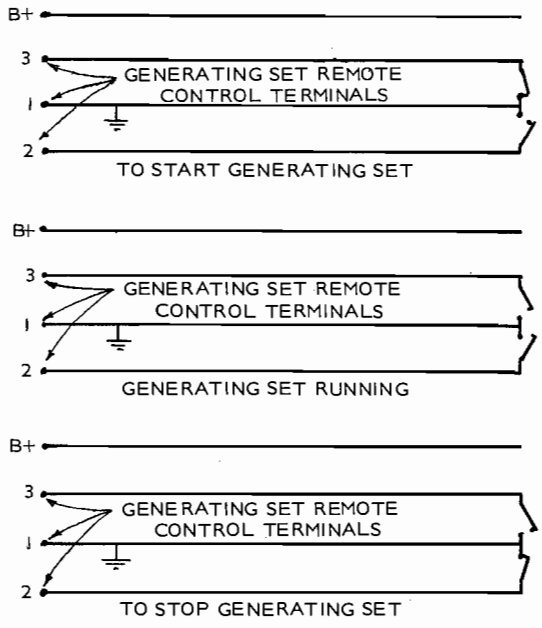


FIGURE 9. THREE-WIRE STARTING

Choose the Onan automatic transfer switch suitable to your needs by following this example:

1. Establish the type of control on your unit (see Table 2). (For example: AJ, 3-wire start control, 12-volt battery). Then, choose the compatible Onan automatic transfer switch. The LTE or LTEU automatic transfer switch would be used with the AJ generating set.

   Letter "U" designates UL listed automatic transfer switch.

TABLE 2. GENERATING SET CHARACTERISTICS AND COMPATIBLE AUTOMATIC TRANSFER SWITCH

GENERATING SET NO. WIRES/BATTERY VOLTAGE	ONAN AUTOMATIC TRANSFER SWITCH
3-Wire Start Control 12-Volt Battery	LTE, LTEU
2-Wire Start Control 12-Volt Battery	LTD, LTDU

2. Choose size and desired voltage from Table 3. For example: 60 amp, 120/240 volt: This would require an LTEU 60 automatic transfer switch.

CABINETS

The standard cabinet of Onan automatic transfer switches is a NEMA type 1 cabinet designed for installation indoors in dry areas. These cabinets are suitable for general purpose applications with normal atmospheric conditions (oil, dust or water are not a problem).

LOW VOLTAGE PROTECTION

The basic Onan automatic transfer switch switches to emergency power when its transfer switch or supervisory relays drop out at about 50% normal line voltage and retransfers to normal power when voltage returns to about 70% of normal line voltage. Many applications require more exact voltage sensing, transfer at a higher voltage or protection for equipment from low voltages. Some communications equipment cannot tolerate low voltage from any source.

To provide for these instances, Onan has available voltage sensors that pick up and drop out at a specified voltage, initiating the transfer to emergency power and the return to normal power. You can specify exactly the value of low voltage emergency power source will start and take over the load, and the voltage of returning commercial power before it will be reconnected to the load.

Low voltage problems usually exist not with rapidly falling voltages but when voltage falls slowly or drops to a steady low value. Under rapidly falling voltage conditions, there is no time for the unit to start before power is completely out. But when voltage falls slowly, it is often desired to switch the load at a specified low voltage. Voltage sensors are also important upon power return, allowing the transfer only when voltage has reached a specified point.

The use of voltage sensors and selection of their pick-up and drop-out voltages will depend on the type of load being protected. In the case of special equipment, the manufacturers' recommendations concerning low voltage should be followed. The following suggestions can be used on general equipment.

Low voltage protection is used either because equipment operation deteriorates under low voltage or because low voltage is actually harmful to equipment.

For example, incandescent lights are highly voltage sensitive (Figure 10). At 96 volts, a 120-volt lamp produces only about 50% of normal light and at 80 volts, only about 1/4 of its normal light.

Fluorescent lights, according to manufacturer's recommendations, are designed to withstand voltages 10% higher or lower than normal. Below that value, light output drops off rapidly. About 70% of normal voltage, the lights go out and can't be restarted. Starting is often difficult or impossible even at 80% of normal voltage, and it takes only 1/2 cycle of low voltage to put the lamp out.

A steady low voltage can cause a running motor to overheat in minutes. It is important that motor circuits be protected against low and harmful voltages.

Normally for most equipment, the electrical industry recommends 70 to 90% protection — transfer to emergency power when line voltage drops to 70% of normal, retransfer when it returns to 90%. When specialized loads are used, the manufacturer's recommendations should be followed. For motor loads, the protection can be increased to provide 80 to 90% protection.

TABLE 3. "LT" AUTOMATIC TRANSFER SWITCHES AVAILABLE

	LTE	LTEU	LTD	LTDU	VOLTAGE	
Rated Amperes Capacity Available		30 - 60			120	Single Phase
		30 - 60		60	120/240	
	30 - 60		60		240	
		30 - 60		30 - 60	120/208	Three Phase
		30 - 60		30 - 60	120/240	
	30 - 60		30 - 60		220/380	
		30 - 60		30 - 60	277/480	
		30 - 60		30 - 60	347/600	

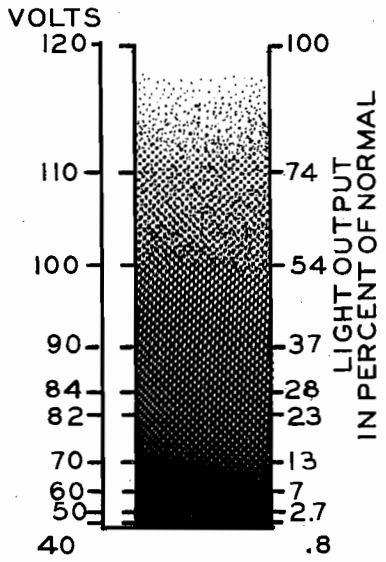


FIGURE 10. EFFECT OF LOW VOLTAGE ON INCANDESCENT BULB LIGHT OUTPUT

Increasing the transfer voltage increases the possibility of false unit starts due to momentary voltage dips. Therefore, drop-out voltage should be set only as high as is necessary to protect your equipment. Setting the voltage excessively high causes erratic operation. Only for specialized equipment is transfer at higher than 80% of normal voltage required.

For protection against low generating set voltage, a voltage sensor can be incorporated to sense generating set output voltage. The generating set will be connected to the load only if its output voltage is above a preset level and disconnected if voltage drops below the preset level. Load equipment will see a complete outage rather than damaging low voltage and will be protected against low voltage from either source.

If short duration low voltage can damage load equipment (5 to 10 seconds), the transfer switch should be opened immediately by the voltage sensor rather than after the generating set starts (as is standard on the Onan mechanically held transfer switch). To accomplish this, Onan can replace the mechanically held transfer switch with an electrically held model. By connecting the voltage sensor to disconnect the line side of the transfer switch, low line voltage is disconnected immediately. Then the load is disconnected at the instant low voltage occurs. The load will see a complete power outage for the duration of generating set starting rather than damaging low voltage. Consider the electrically held transfer switch only if load equipment is subject to damage from short duration (5 to 10 seconds), low voltages.

Large electrically held transfer switches produce hum. Use these switches if noise is not objectionable.

Voltage Sensors

The basic automatic transfer switch reacts only to complete failure (about 50% of nominal line voltage). Voltage sensors allow it to react to preset voltage drop and also higher than normal voltages.

Adjustable Voltage Sensors: Both pick-up and drop-out voltages are adjustable. In undervoltage application, voltage sensing is across the line. When line voltage falls to the drop-out point, a relay de-energizes starting the standby generating set. When line voltage returns to the preset pick-up voltage, the relay initiates the return to commercial power.

Overvoltage sensing is much the same, only that when the normal service voltage becomes excessively high, a relay opens starting the standby generating set. When the normal power source's voltage returns to normal, the relay closes and initiates retransfer of the load to the normal source.

This type of voltage sensing is also used to disconnect the generating set from the load for low voltage (which could damage load equipment).

The adjustable voltage sensing consists of a voltage sensor plug-in module in a sensor chassis with relay, Figure 11. Table 4 gives the adjustment ranges in percentages for the adjustable voltage sensing devices. The pick-up adjustment control is always set first, then the drop-out adjustment is set. Adjustments should be performed by qualified personnel only.

LOW VOLTAGE PROTECTION ON SINGLE-PHASE AND THREE-PHASE SYSTEMS

Onan automatic transfer switches for three-phase service include phase protection as standard equipment; phase protection that switches the load to emergency power if voltage on any line of the three-phase service fails. Any three-phase protection is complicated by feedback loads — loads that will maintain voltage in all three phases despite the fact one line has failed.

TABLE 4. ADJUSTABLE VOLTAGE SENSING

UNDERVOLTAGE	
UNIT STARTS (drop-out voltage)	**UNIT STOPS (pick-up voltage)**
5 to 20% below pick-up voltage setting.	75 to 100% of normal voltage.
OVERVOLTAGE	
UNIT STARTS (pick-up voltage)	**UNIT STOPS (drop-out voltage)**
101 to 116% of normal voltage.	5 to 20% below pick-up voltage.

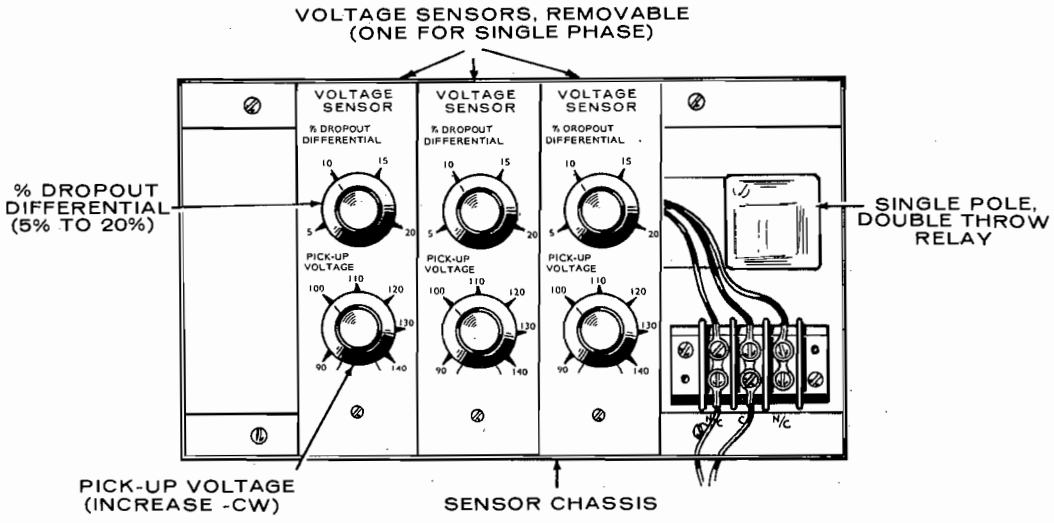


FIGURE 11. SOLID-STATE VOLTAGE SENSORS IN SENSOR CHASSIS

Feedback is normally caused either by three-phase motors or unbalanced single-phase loads on the three legs. If a single leg goes dead, a three-phase motor will (acting as an induction generator) maintain partial voltage in that leg. The phase protection relay doesn't sense an outage but simply lower voltage to which it won't react. Similarly, unbalanced single-phase loads can maintain voltage on an open line causing voltages where they normally shouldn't exist. The illustration (Figure 12) shows how voltage might exist on an open phase with unbalanced loads. If this voltage is greater than about 50 percent of normal, the phase protection relay won't react.

Single-phase, three-wire circuits with transformer or motor loads can cause similar problems. Therefore, if feedback loads exist, protection against low voltage is required, not just protection against complete outage. Onan recommends using voltage sensors, one for each phase, on automatic transfer switches that will be subject to either transformer motor loads or unbalanced single-phase loads.

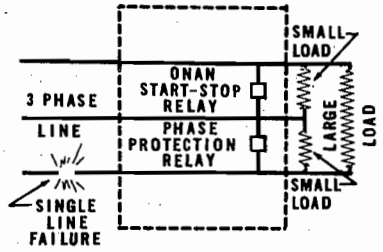


FIGURE 12. LINE FAILURE ON A THREE-PHASE SYSTEM

PROTECTION FROM HIGH VOLTAGE DAMAGE

If local commercial power is subject to high voltage peaks or steady voltages much higher than normal, Onan overvoltage sensors can be incorporated into the automatic transfer switch. These sensors, similar in construction to the adjustable undervoltage sensor, initate the transfer to emergency power if commercial voltage rises above a predetermined point. They retransfer the load to the commercial service when voltage returns to normal.

If these sensors are to be used, analyze the types of overvoltage occurring. Short peaks of a few seconds can't be protected against by a generating set and would require the use of an electrically held transfer switch to disconnect the load immediately when high voltage occurs. Even the electrically held transfer switch couldn't protect against very short peaks of 0.1 second or less. The Onan overvoltage sensor is designed primarily to protect against steady overvoltage conditions.

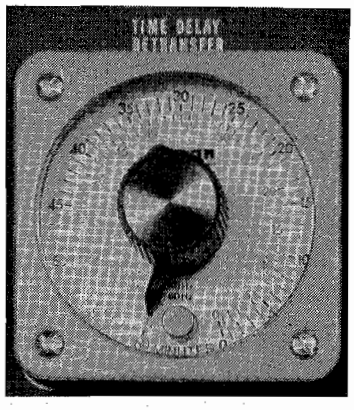
TIME DELAYS

A time delay is often required for one or more functions such as engine starting and load retransfer (from generator set to commercial power). Table 5 lists the time delays available. Figure 13 shows the adjustable time delays.

TABLE 5. TIME DELAYS

TIME DELAY TYPE	TIME DELAY	
STARTING	Adjustable	1.5 to 15 Sec. *5 to 50 Sec.
RETRANSFER	Adjustable	2 to 60 Minutes

* - Time delay for heating glow plugs on diesel engines.



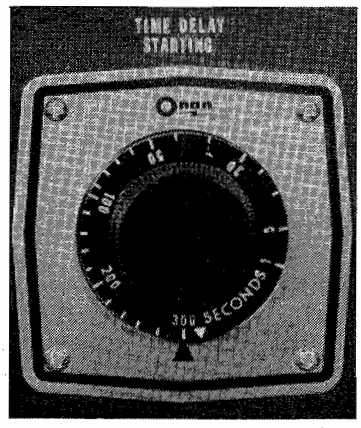


FIGURE 13. ADJUSTABLE TIME DELAYS

Time Delay on Starting

Most commercial electric service suffers from momentary outages or dips in voltage. Something as minor as motor starting will produce a momentary voltage dip usually lasting a second or less. Power company functions such as switching might produce outages lasting a second or less.

When using the basic automatic transfer switch without options, outages of this type will trigger the automatic transfer switch causing the generating set to start. The generating set however, requires several seconds to start and won't provide power during these short outages.

Even voltage dips become important when voltage sensors are used with the automatic transfer switch. Any momentary dip below the voltage sensor drop-out will trigger the automatic transfer switch starting circuit. This may happen several times a day.

To prevent the generating set from starting for each momentary dip or outage, the time delay on starting can be incorporated into the automatic transfer switch. It delays starting for several seconds after a power outage. The delay required will of course depend on the characteristics of power in your area.

When voltage sensors are used, the time delay on starting is recommended because motor starting or sudden heavy loads could trigger the automatic transfer switch.

Because cold weather starting of diesels becomes difficult whenever they are used in automatic operation, such as standby service, special precautions are recommended. These include the use of water and oil base heaters to heat the unit when it isn't running and preheat delays between a power outage and unit

TABLE 6. RECOMMENDED ADDERS FOR LOW TEMPERATURE DIESEL STARTING

SERIES	TEMPERATURE RANGE				
	ABOVE 60 F (16 C)	60 to 32 F (16 to 0 C)	32 to 10 F (0 to -12 C)	10 to 0 F (-12 to -18 C)	BELOW 0 F (-18 C)
DJA, DJB, DJC, DJE	20 second preheat delay.	1 minute preheat delay. Oil base heater on unit.		†	†
RDJC★, RDJF★	Preheat standard on unit.	Water heater on unit.		†	†
DDA, DDB, DEH, DEF, DEG, DYA, DYJ	Nothing required.	Water heater on unit.		†	†

† - Not engineered.
★ - Preheat circuit on unit.

starting. Continuous heating requires optional equipment on the unit. To incorporate a preheat delay, either the generating set or automatic transfer switch must be modified regardless of the model used. Table 6 lists some adders for low temperature starting of diesel units.

Time Delay on Retransfer

Returning commercial power often fluctuates for several minutes before settling down to its nominal voltage or returns momentarily several times. Rather than have the generating set stop and restart allowing fluctuating power to reach your load, Onan recommends incorporating a time delay on retransfer into the automatic transfer switch. This delay (adjustable) allows the unit to supply the load for a preset time after commercial power returns, the time to be determined by the maximum time of your voltage fluctuation. When the delay runs out, the automatic transfer switch reconnects line and load and shuts down the generating set.

The time delay on retransfer can also be used to assure the unit runs for at least a few minutes once started. This assures it reaches operating temperature, evaporating moisture from the oil, etc. Any engine should be run for at least a half hour once started.

Determine delay time by the characteristics of returning power in your area. If it steadies rapidly, only a short delay will be needed. If voltage fluctuates for several minutes after returning, specify a delay long enough to supply generator power throughout the fluctuation period.

TESTING AND EXERCISING

Selector Switch

Any engine, whether automobile or standby generating set, is hard to start after standing idle for weeks or months. To prevent this, every standby unit should be run regularly. Normally, a one-half hour

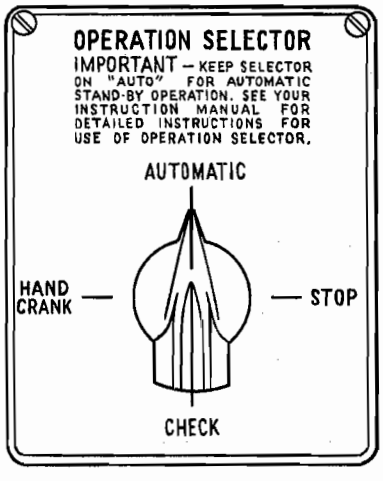


FIGURE 14. THREE-WIRE SELECTION SWITCH

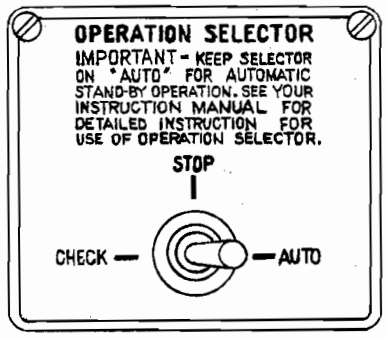


FIGURE 15. TWO-WIRE SELECTOR SWITCH

period once a week is recommended. To allow periodic exercise, all Onan LTE and LTEU automatic transfer switches are equipped with a selector switch as standard. Figure 14 shows a 3-wire selector switch, Figure 15 shows a 2-wire selector switch.

One position of the switch is CHECK. It starts and runs the unit when dialed but doesn't allow load takeover. An operator can test or exercise the unit at any time by setting the selector switch. On 2-wire start automatic transfer switches, the unit can be exercised by the operation of the selector switch on the engine control panel or the optional selector switch in the automatic transfer switch (LTD and LTDU).

Simulated Power Failure Test Switch

A test transfer switch is standard on all automatic transfer switches. This manually-operated switch starts the generating set and allows it to assume the load. The switch is normally on and will start the generating set when switched to off.

EXERCISER

Since there are many installations where a once-a-week trip to the unit is impractical or exercise is scheduled at a time inconvenient to the operator, Onan offers an optional automatic exerciser as part of the automatic transfer switch. The AC electric clock exerciser (Figure 16) starts the standby unit and allows it to run for any multiple of 15 minutes as many days of the week as you wish. Automatic exercising normally does not include load transfer, but if desired, it can be modified so the generating set serves the load during exercise.

In the event of a power outage during exercise or testing by any of the above methods, the unit immediately takes over the load.

DISCONNECT PLUG

The disconnect plug, standard on 60 ampere, 60-hertz automatic transfer switches (except LTP), enables the service personnel to remove the disconnect plug from the receptacle to de-energize the control panel in the cabinet. The service personnel

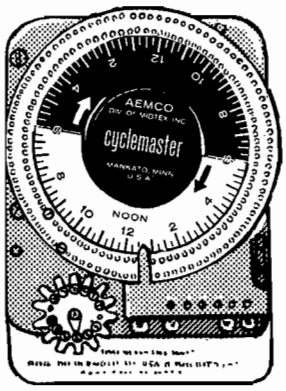


FIGURE 16. AUTOMATIC EXERCISER

can then perform maintenance, service, etc., on the control panel without interrupting normal power service.

Move the operation selector switch to "STOP" and disconnect starting batteries before removing disconnect plug. Otherwise, the generating set will start and energize the generator side of the transfer switch.

BATTERY CHARGING

Maintenance of the standby unit's batteries is essential to assure standby system reliability. In a few weeks of idleness, batteries could drain themselves. Because of this, Onan supplies as standard equipment an adjustable rate trickle charger. This trickle charger is designed to maintain the batteries fully charged, but not recharge them. The generating set should run at least 1/2 hour after each start to assure batteries are recharged by the generator charging circuit before the unit stops. The LTE, LTEU and LTD, LTDU standard battery charger has a trickle charge, adjustable from 50 to 300 milliamps (milliammeter included).

RUNNING TIME METER

This meter registers the total number of hours the generator set has run. Time is accumulative and meter cannot be reset.

SPECIAL AUTOMATIC TRANSFER SWITCH APPLICATIONS

Most of the following applications shown require modifications. Contact the factory if you want more information.

STANDBY FOR MULTIPLE POWER SERVICES

Often, two or more services (single-phase, three-wire and three-phase, four-wire delta, etc.) will enter the same building and both must be protected by standby power. Rather than supply a separate unit for each service, specially modified automatic transfer switches used with a single unit can protect all services. See Figure 17.

The generating set can then be used to supply the single phase, the three phase or both simultaneously. For this service, the unit must of course be selected with sufficient power as well as correct voltage and number of phases to supply both loads.

If you can protect multiple services with a single generating set, special multiple automatic transfer switches can be used. In this service, one automatic transfer switch contains the battery charger and engine starting equipment as well as time delay on starting and load pick-up. Add all other extras required to each automatic transfer switch. One automatic transfer switch is required for each service protected. All automatic transfer switches must be modified for this application, each selected on the basis of the electrical service it will protect.

STANDBY TO STANDBY— TWO GENERATING SETS

If the application in question requires absolute reliability of emergency power, two generating sets can be included, one to be standby to the other (Figure 18). In case of an outage, the first generating set will start and supply the load. If this unit doesn't start or stops during operation, the second unit will start and assume load.

This application requires two automatic transfer switches identical except that automatic transfer switch 2 contains a time delay on starting (or time delay on starting set longer on automatic transfer switch 2 than 1). Therefore, when a power outage occurs, the first standby unit assumes the load. If unit 1 starts, automatic transfer switch 2 senses the voltage and doesn't start generating set 2.

AUTOMATIC TRANSFER SWITCH FOR PRIME POWER GENERATING SETS

In areas where there is no commercial power, two or more generating sets can be used to supply power — functioning as prime power and as standby. The specially designed automatic transfer switch

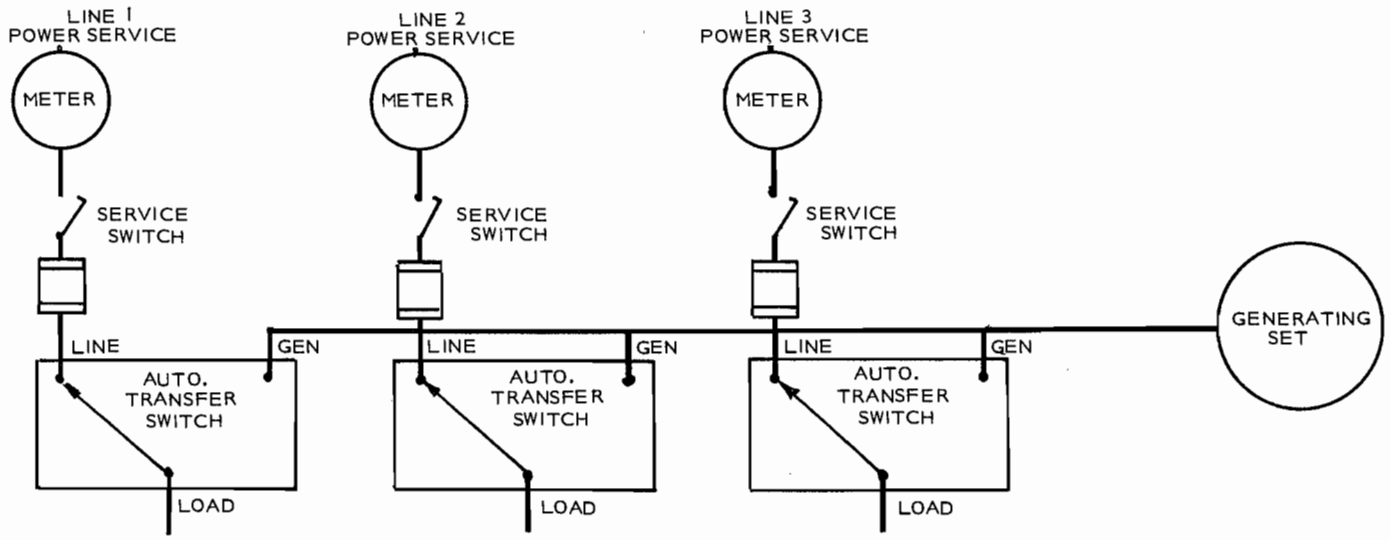


FIGURE 17. STANDBY FOR MULTIPLE POWER SERVICE

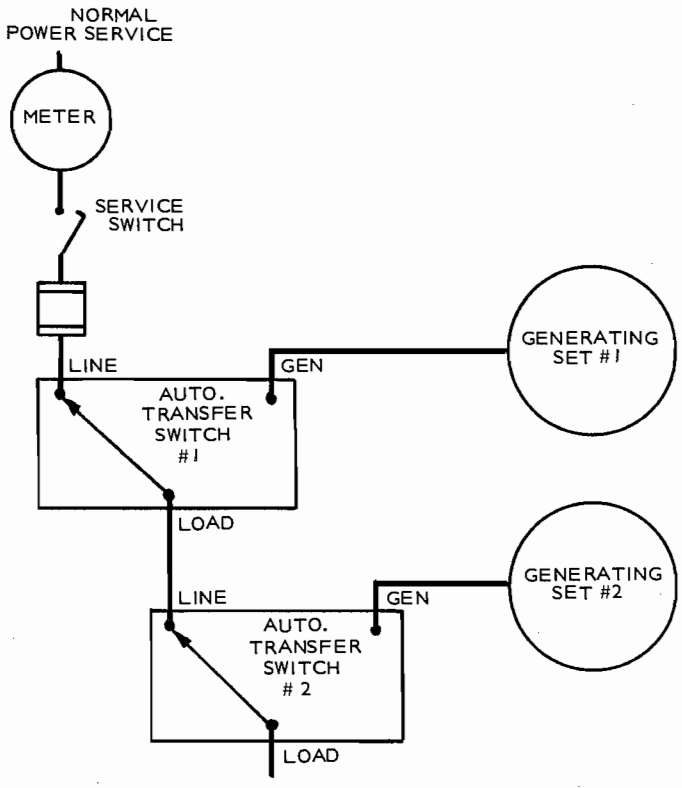


FIGURE 18. STANDBY TO STANDBY PROTECTION

(reference Spec 1142) operates one unit as standby to another generating set and allows either to be used as standby. An operator switches the unit functions at the automatic transfer switch. Switch isn't automatic—one unit will run as prime power until the operator switches to the other unit. In the event of prime power failure, the standby unit will automatically start and assume the load. See Figure 19.

Basically, this transfer switch is similar to a standard automatic transfer switch, but it has a starting circuit for two generating sets, has an electrically-held transfer switch and uses only one trickle charger (always switched to the unit on standby). This system provides a source of prime power and a standby set. By switching the units so each serves as prime power for half the time, both units will wear evenly.

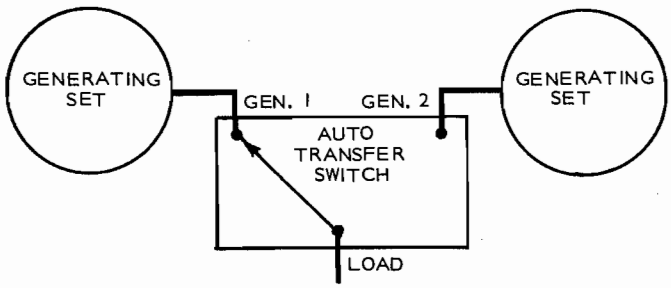


FIGURE 19. AUTOMATIC TRANSFER SWITCH FOR PRIME POWER (TWO GENERATING SETS)

STANDBY WITH ANOTHER POWER SOURCE

When more than one commercial power source is available, the Onan LTSU automatic transfer switch provides standby to the main commercial source with the second commercial source. See Figure 20. One commercial power source is used all the time unless there is a power outage or extreme voltage fluctuation of that source. Automatically, the automatic transfer switch transfers the load to the second or emergency power source. Models are available 60 through 400 amperes. Some of its features are:

1. Mechanically-held transfer switch — line 1 and line 2 sides.
2. Undervoltage sensors on line 1 side.
3. Transfer time delay to line 2 side.
4. Retransfer time delay to line 1 side.
5. Neutral bar.
6. Two disconnect plugs for control circuit (one for each line).
7. Signal lights-green for line 1 normal service operation, red for line 2 emergency power operation.
8. Test transfer switch.

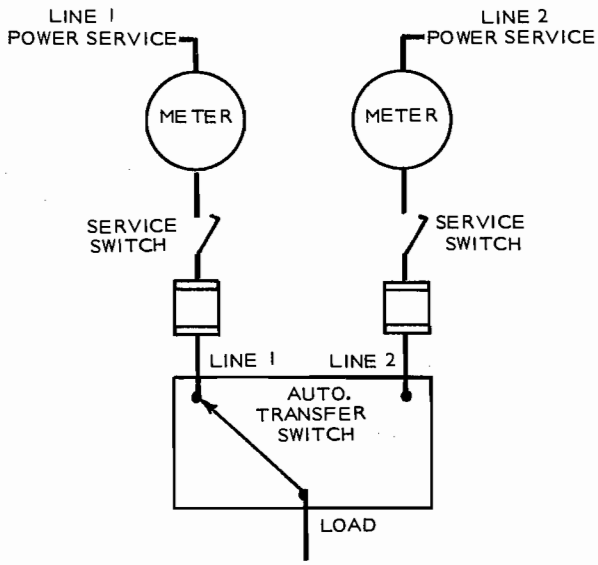


FIGURE 20. STANDBY PROTECTION WITH TWO POWER SOURCES

Application Check List

The following check list provides questions and pertinent information which will help you analyze existing power problems and select equipment which will satisfy your needs. You may then use this information as a guide when specifying Onan automatic transfer switches. Your specification gives our design facilities the information required to tailor the equipment to your needs.

Complete the following check list by filling in the information or checking the response that is applicable to you.

SUBJECT	DATA	NOTES RECOMMENDATIONS
USAGE OF AUTOMATIC TRANSFER SWITCH.	Prime Power _____ Standby Power _____	
AUTOMATIC TRANSFER SWITCH	Maximum Current Rating of commercial service to be protected. Voltage _____ Phase _____ Current _____ Current output of generator set. Voltage _____ Phase _____ Current _____	Rate the automatic transfer switch according to the maximum current handled - consider both commercial service and generator output.
YOUR NORMAL SERVICE Do momentary outages or dips occur in commercial service (these are normal in many services)? If "yes" (above), what is the duration of the output? Is commercial service subject to low voltage or outages where voltage decreases slowly? Does commercial voltage fluctuate upon its return? How long do fluctuations last?	Yes_____No_____ How Long? _____ Yes_____No_____ Yes_____No_____ How Long? _____	If momentary outages or dips occur, Onan recommends a *Time Delay on Starting.* If low voltage occurs, Onan recommends *Voltage Sensor and Time Delay on Starting.* To avoid feeding fluctuating voltage to load - use an Onan *Time Delay on Retransfer* with delay greater than maximum expected fluctuation period.

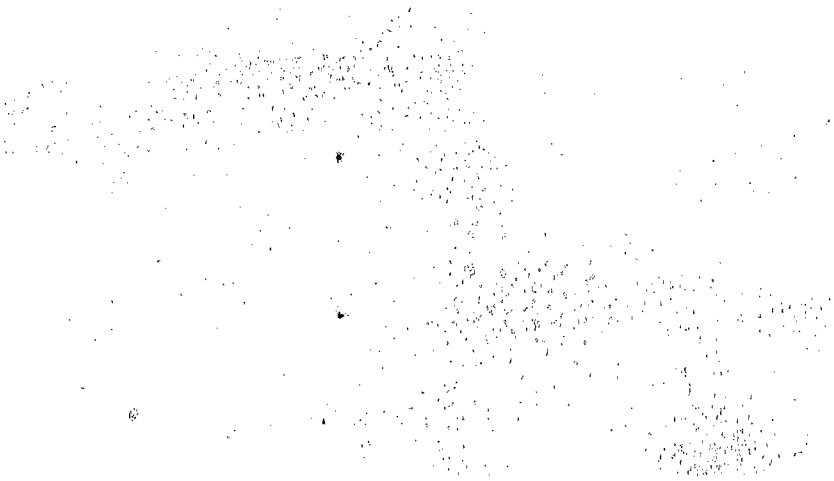
SUBJECT	DATA	NOTES AND RECOMMENDATIONS
YOUR EQUIPMENT Can your equipment tolerate low voltages? How low and for how long?	Yes_____ No_____ Min._____ Sec._____	To prevent low generator voltage from reaching your equipment, use *Voltage Sensor* on generator output.
EXERCISE AND TESTING STANDBY SYSTEM Is an operator available to test the system by starting the unit at least once a week and running for 1/2 hour. Do you want the load to transfer when the system is checked?	Yes_____ No_____ Yes_____ No_____	If not, or inconvenient, use *Exerciser Clock* for automatic exercise (specify for exercise with load or no load). Use *Test Transfer Switch* (standard).
SPECIAL MODIFICATIONS Dual or triple generating set system. Manual set selecting (operator manually selects set to act as prime power, other set acts as automatic standby). Other —	Increased reliability, etc.	

Conclusion

Make a list of the equipment you need with the Onan automatic transfer switch. If you have problems with the applications, write us including the specifications. Our design facilities and personnel are available for application problems with automatic transfer switches.

LIST OF OPTIONAL EQUIPMENT REQUIRED

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____



SUBJECT	DATA	NOTES AND RECOMMENDATIONS
YOUR EQUIPMENT Can your equipment tolerate low voltages? How low and for how long?	Yes_____ No_____ Min._____ Sec._____	To prevent low generator voltage from reaching your equipment, use *Voltage Sensor* on generator output.
EXERCISE AND TESTING STANDBY SYSTEM Is an operator available to test the system by starting the unit at least once a week and running for 1/2 hour.	Yes_____ No_____	If not, or inconvenient, use *Exerciser Clock* for automatic exercise (specify for exercise with load or no load).
Do you want the load to transfer when the system is checked?	Yes_____ No_____	Use *Test Transfer Switch* (standard).
SPECIAL MODIFICATIONS Dual or triple generating set system. Manual set selecting (operator manually selects set to act as prime power, other set acts as automatic standby). Other —	Increased reliability, etc.	

Conclusion

Make a list of the equipment you need with the Onan automatic transfer switch. If you have problems with the applications, write us including the specifications. Our design facilities and personnel are available for application problems with automatic transfer switches.

LIST OF OPTIONAL EQUIPMENT REQUIRED

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

_____

Onan manufactures a complete line of electric power systems from 1 to 750 kW (generator sets • automatic transfer switches • industrial engines), gas-, gasoline- or diesel-driven. For standby power in homes, industrial plants, commercial buildings and institutions. For auxiliary power in boats, recreational vehicles, service trucks and construction equipment.