

**INSTALLATION & SERVICE MANUAL**  
**1500 Induction Control Relays**



**Principle of Operation**

A B/W floatless liquid level control system consists of a relay of the proper type, a holder designed to support one or more electrodes or probes in the liquid container, and the corrosion resistant electrodes themselves. In as much as all B/W induction relays are quite similar differing only in contact arrangement, the following description of how a 1500-C Relay functions on a pump down control application will serve to explain the design, construction, and operating principles for the entire line.

As shown in diagrams below, the laminated core of the relay is **H** shaped. The primary coil is assembled to the upper bar of the core, and the secondary coil for the electrode is placed on the lower bar. An armature located below the legs of the **H** core is connected to an insulated arm carrying the movable contacts. When the armature is raised, these contacts close or open the motor and electrode circuits, depending upon whether the contacts are normally open or closed. (Contacts shown normally open in this example).

When a source of alternating current is connected to the primary coil at terminals 3 and 4, the primary coil sets up a magnetic flux which circulates through the shortest path following the lines of least resistance. As shown in Figure 1, this is through the lower bar of the laminated core on which the secondary coil is mounted. This magnetic flux induces a voltage in the secondary or electrode circuit coil. No current can flow in this coil, however, until the circuit is completed between the electrodes. Thus, the electrode circuit voltage being generated within the relay has no connection with the power line.

The B/W 1500 induction relay utilizes the liquid as an electrical conductor to complete the secondary circuit between the upper and lower electrodes. Thus, when the liquid contacts the upper electrode, the resulting flow of current in this circuit sets up a bucking action in the lower bar of the core. This action tends to divert lines of magnetic force to the core legs and sets up an attraction that pulls the armature in to contact with the legs, as shown in Figure 2. This armature movement closes the electrode and load contacts.

The lower contacts on 1500-C Relays (terminals 9 and 10) connect the secondary circuit to ground when liquid contacts the upper electrode and act as a holding circuit to maintain the relay in its closed position until the liquid falls below the lower electrode. This holding circuit provides control of the relay over any desired range in the liquid level, depending on the distance between the upper and lower electrodes.

The flow of current through the low energy secondary circuit is very small and varies with the voltage of the secondary coil. The secondary coil is selected to operate over the resistance of the liquid being controlled. Accordingly, since there is a wide range of secondary coils from which to choose, it is important that complete information regarding the nature of the liquid be furnished when ordering B/W induction relays.

**1500C Relay Used for Pump Down Control**

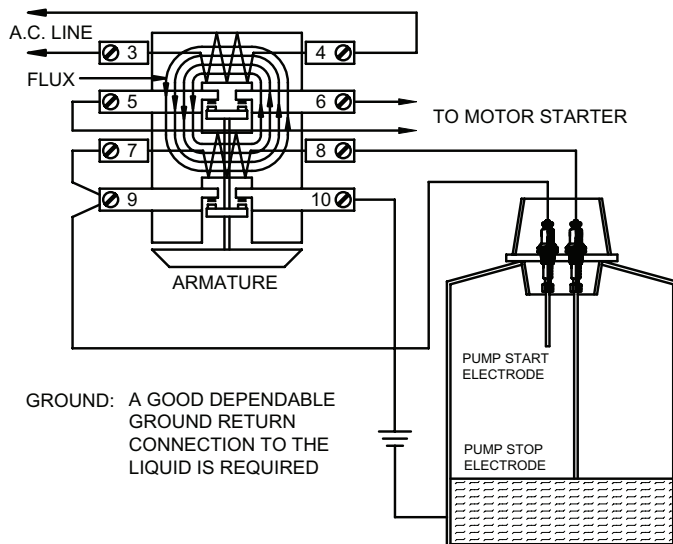


Figure 1 - Secondary coil circuit open; armature down.

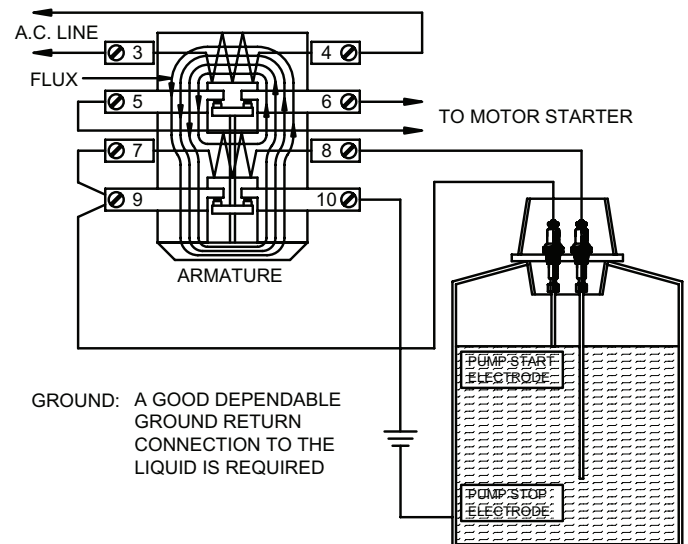


Figure 2 - Secondary coil circuit closed; armature up.

## Installation Instructions

**Relay:** Install relay in level upright position. Connect wires from AC supply to terminals #3 and #4 on relay. Make sure power is of same rated voltage and frequency as shown for connection to primary coil on relay data plate. Relays draw 9 volt amperes.

**Electrodes:** Install electrodes in tank or well by suspending them vertically from an electrode holder or some other suspending means. One electrode should be set at desired start level and one at desired stop level. For sewage or surface drainage sumps, make sure electrodes are hung far enough apart so that foreign matter floating on water cannot foul electrodes. Size 18 or larger Type TW or THW wire is recommended for connection to the relay.

**CAUTION - Although the electrodes are connected to a low energy secondary coil output which has inherently low current, there may be up to 800 volts between the electrodes or from an electrode to ground. (See Secondary Coil Table.) Thus wiring and electrodes should be installed to protect personnel from accidental contact.**

**Ground:** A system ground return circuit is required from the indicated relay terminal to the liquid in order to complete the secondary circuit of relay. **Conduit should not be used.** Instead, connection should be made directly to uninsulated metal tank, or to metal pipe connected to tank below normal low liquid level. In wells, connect ground to pump or metallic water pipe. For concrete, wood, or insulated tanks, use an extra common electrode extending slightly below the longest operating electrode.

**Secondary Coil:** Because the secondary voltage on all B/W relays is an induced voltage generated within the relay itself, the secondary coil should never be connected to any source of power. Voltage of the secondary coil installed on a given relay is determined by conductivity of liquid to be controlled.

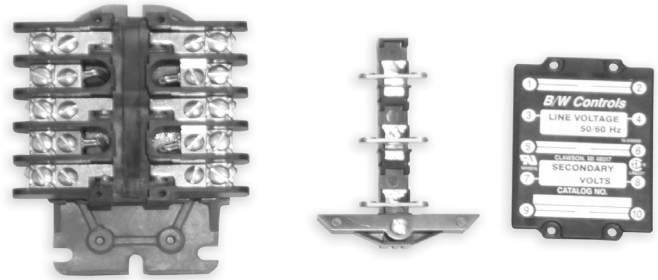
**Load Connections:** B/W relays are two-wire control devices having load contacts rated at 1 hp., single-phase, 115 or 230 volts AC or standard duty pilot rating up to 600 volts AC. In operation, load contacts act as a switch to open or close a circuit. Connecting them to an external load does not introduce a source of alternating current into the circuit.

Accordingly, in making connections for direct operation of single-phase loads within rated capacity of relay, power connections must be made as shown in relay wiring diagram.

To operate higher rated single-phase loads or three-phase loads, a magnetic starter must be used. In making connections to motor starter, follow directions given on the starter wiring diagram for connecting two-wire control devices.

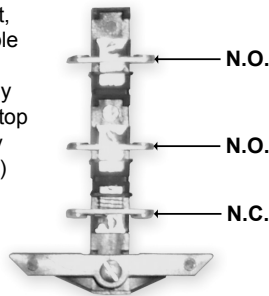
## Field Replaceable and Convertible Contacts

The Series 1500 Induction Relay provides circuit versatility by offering a contact kit that allows field conversions from N.O. to N.C. or N.C. to N.O. contact arrangements. This option also allows you to add or replace contacts (up to 3 per relay) as required for expansion of your liquid level control needs.



### Remove cover plate and armature

For a N.O. contact, install the moveable contact in the armature assembly facing toward the top of the relay. (away from the armature)



For a N.C. contact, install the moveable contact in the armature assembly facing toward the bottom of the relay. (toward the armature).

### Contact Kit Part No. 15-000001

#### N.O. Contact

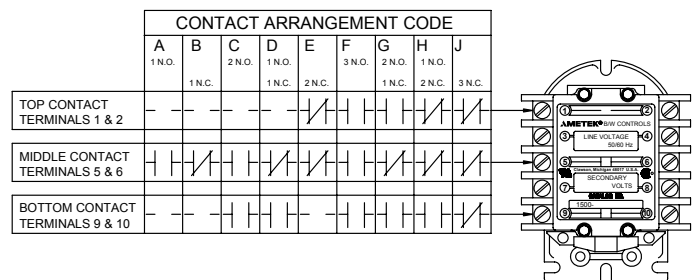
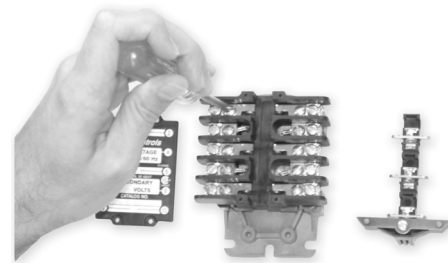


For a N.O. contact, install the stationary contacts facing toward the bottom of the relay (toward the armature).

#### N.C. Contact



For a N.C. contact, install the stationary contacts facing in toward the top of the relay (away from the armature).



INDUCTION RELAY CONTACT ARRANGEMENT	WIRING DIAGRAM AND OPERATION		TYPICAL APPLICATIONS
	DIRECT OPERATION	PILOT OPERATION	
<b>1500-A Relay</b> <b>Single Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit <hr/> 1                    0                    0			High Level Signal Control. Low Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Remote, long distance and low voltage manual control applications, etc.
<b>1500-B Relay</b> <b>Single Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit <hr/> 0                    1                    0			Low Level Signal Control. High Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Remote, long distance and low voltage manual control applications, etc.
<b>1500-C Relay</b> <b>Single Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit <hr/> 2                    0                    0			Same as 1500-A Relay above except that an additional Normally Open contact is provided to permit simultaneous operation of different types of secondary signal devices in remote locations.
<b>1500-D Relay</b> <b>Single Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit <hr/> 1                    1                    0			High or Low Level Signal Control. High or Low Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Can also be used to interlock various types of signal devices.
<b>1500-E Relay</b> <b>Single Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit <hr/> 0                    2                    0			Same as 1500-B Relay above except that an additional Normally Closed contact is provided to permit simultaneous operation of different types of secondary signal devices in remote locations.
<b>1500-C Relay</b> <b>Two Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit <hr/> 1                    0                    1			Pump Down Control for sewage and sump pumps, condensate return system, etc. Low Level Cutoff for submersible pumps. Normally closed Solenoid Valve Control for discharging liquids from tanks, etc.
<b>1500-D Relay</b> <b>Two Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit <hr/> 0                    1                    1			Pump Up Control for supply pumps on elevated tanks and towers, carbonators, etc. High Level Cutoff for pumps and valves. Normally closed Solenoid Valve Control for plating tank and boiler make-up, etc.

**CAUTION:** Electrodes are terminals of live electrical circuits and must be installed to prevent accidental contact by personnel. Control power must be disconnected before servicing.

≡ A GOOD DEPENDABLE GROUND RETURN CONNECTION TO THE LIQUID IS REQUIRED. ≡

INDUCTION RELAY CONTACT ARRANGEMENT	WIRING DIAGRAM AND OPERATION		TYPICAL APPLICATIONS
	DIRECT OPERATION	PILOT OPERATION	
<b>1500-F Relay</b> <b>Two Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit  2                    0                    1			Same as 1500-C Relay above except that additional Normally Open contact is provided to permit simultaneous operation of second pump. Extra contact can also be used for signal purposes if desired.
<b>1500-G Relay</b> <b>Two Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit  1                    1                    1			Pump Up or Pump Down Control for same applications listed above for B/W 1500-C and 1500-D Relays. It is also suitable for use in controlling hydropneumatic tanks and motorized valve installations.
<b>1500-H Relay</b> <b>Two Electrode Wiring</b> Contact Arrangement  Normally Open    Normally Closed    Holding Circuit  0                    2                    1			Same as 1500-D Relay above except that additional Normally Closed contact is provided to permit simultaneous operation of second pump. Extra contact can also be used for signal purposes if desired.

**CAUTION:** Electrodes are terminals of live electrical circuits and must be installed to prevent accidental contact by personnel. Control power must be disconnected before servicing.  
**≡ A GOOD DEPENDABLE GROUND RETURN CONNECTION TO THE LIQUID IS REQUIRED. ≡**

### Catalog Numbering System

Catalog Section	A		L1	S7	OC	X	
	Contact Arrangements					Enclosure Type	
	Normally		Line Voltage	Secondary Coil Voltage	Typical Liquids		
	Open	Closed	L1 110-120 Volts 50/60 HZ	S1 12 Volts A.C.	Metallic circuits		X None
	A	1 0	L2 208-240 Volts 50/60 HZ	S2 24 Volts A.C.	Metallic circuits		M Manual Push Button
	B	0 1	L3 440-480 Volts 50/60 HZ	S3 40 Volts A.C.	Acid or caustic solutions: Milk; Brine and salt solutions; Plating solutions; Buttermilk; Soups		
	C	2 0	L4 550-600 Volts 50/60 HZ	S4 90 Volts A.C.	Weak acid or caustic solutions: Beer; Baby foods; Fruit juices		
	D	1 1	L5 Dual Voltage 120/240 Volts 50/60 HZ	S7 220 Volts A.C.	Sewage; Most water-except very soft; Pottery slip; Water soluble oil solutions; Starch solutions		
	E	0 2		S8 360 Volts A.C.	Very soft water; Sugar syrup		
	F	3 0		S9 480 Volts A.C.	Steam condensate; Strong alcohol solutions		
	G	2 1		S11 800 Volts A.C.	Demineralized or distilled water		
	H	1 2					
	J	0 3					

All contacts rated at:  
 25 Amp Resistive at 120, 240, or 480 VAC  
 1 HP Single Phase at 120 or 240 VAC  
 Heavy Duty Pilot 120 to 600 VAC  
 2 Amp Resistive at 120 VDC  
 10 Amp Resistive at 48 VDC

## Service Instructions

**CAUTION**  
**Be sure to disconnect relay control power before servicing electrodes or electrode holders.**

B/W relays are designed and built to require a minimum of service in the field. Each one is tested and adjusted at the factory to insure positive operation and should not be altered or tampered with prior to installation. If a relay does not operate properly after it has been installed, the following information will be helpful in determining the probable cause.

### A. Relay Will Not Pull In

If relay will not pull in when liquid contacts upper electrode, failure to operate is probably caused by one of the following conditions:

**1. Power Failure** - A power failure to relay can be caused by broken wire, blown fuse, an open switch, loose screw, corroded connection, etc. Check for power failure with voltmeter or test light directly on relay line terminals (No.3 and 4 on all B/W relays). Also check voltage at motor starter line terminals and overload heaters on motor starter to be sure they have not tripped.

**2. Open Coils** - Coils used in B/W relays very rarely fail unless struck by lightning or subjected to some severe over-voltage condition. To check coils, disconnect electrode connections from relay terminals, apply line voltage to the primary coil, and touch both ends of secondary coil with an insulated jumper wire. Relay should pull in when the jumper is connected and fall out when the jumper is removed. Failure to do so indicates that one of the coils is open. If an open coil is found, contact dealer or the factory for a replacement relay.

**3. Poor Ground Connections** - B/W induction relays that operate from a single electrode i.e., Types 1500-A, C, B, E and D will not function unless a good dependable ground connection is made to complete the secondary circuit from one end of the secondary coil through the electrode and liquid, and back through ground to the other side of the secondary coil. If such a relay does not operate when liquid contacts the electrode, check ground connection to be sure it complies with installation instructions.

**4. Broken Wires** - A broken wire from relay to either electrode will prevent relay from operating. Broken wires can be checked by shorting the upper and lower electrode leads together at the electrode holder. If relay fails to pull in, one or both of the electrode leads is open. The individual leads can then be checked by running a temporary wire from the relay to holder outside conduit. If relay pulls in, it may be assumed that break is between the holder and the electrodes. This can be checked by shorting between the electrode tips with an insulated jumper.

**5. Low Secondary Voltage** - If the secondary coil voltage is too low for the resistance or conductivity of the liquid being controlled, the relay will not pull in - or it will buzz and chatter before pulling in. In either case, the relay should be replaced with one which has a higher voltage secondary coil. (See Table.) If in doubt about proper coil selection, furnish factory with details on liquid - or send sample for test.

**6. Fouled Electrodes** - Accumulation of dirt, grease or other deposits on the upper electrode will insulate it and prevent relay from pulling in. If this occurs, the electrodes should be inspected and cleaned at regular intervals as required to eliminate the difficulty. If unusual quantities of oil, grease, or sludge are encountered, the electrodes can be mounted inside a pipe that is flushed with clean water. A 4" pipe should be used - with the bottom located below the lowest water level, and vent holes provided at top so that the level inside and outside the pipe will be the same. A small flow of water entering the top of the pipe will cause an outward flow of water from the bottom of the pipe and prevent undesirable material from entering. Thus, the electrodes have a clear surface on which to operate and will stay clean.

**7. Electrodes Too Short** - It is possible for an installation to be completed in which the upper electrode is suspended at a point where the liquid cannot make contact. All installations should, of course, be checked to make sure that proper electrode lengths are provided.

### B. Noisy Relay Operation

If the relay functions properly but is noisy in operation, it could be caused by the following:

**1. Poor Electrode Connections** - If wire suspended electrodes are used and have either been lost or not properly connected resultant increase in resistance in secondary circuit may cause relay to buzz or chatter in

operation. This condition can be corrected by checking to see that proper electrode connections are made. Excessive accumulation of dirt, grease or other deposits on the electrodes can also result in noisy relay operation - in which case periodic cleaning will eliminate the problem.

**2. Low Secondary Voltage** - If resistance of the liquid being controlled is at the upper end of the sensitivity range of the relay secondary coil, noisy operation may result. Sensitivity may be increased slightly by interchanging the ground and lower electrode connections at the relay. If this does not correct the condition, the relay should be replaced with one having a higher voltage secondary coil.

### C. One Level Operation

If a relay operates at one level only - starting and stopping at one electrode, check the following:

**1. Electrode Wires** - If wires between relay and electrodes are interchanged, relay will not operate over range in level but from upper electrode only. To correct, simply reverse connections - either at relay or at electrodes.

**2. Ground Connection** - Poor ground connection will prevent holding circuit from functioning and cause relay to operate from the upper electrode only. This can be easily corrected by making sure that ground connections conform with Installation Instructions.

**3. Holding Circuit** - If the holding circuit is not closing, the relay will operate from the upper electrode only. Since the holding circuit contact carries only a small current, a slight film of grease or dirt can sometimes prevent proper closure. To correct, rub contact surface with a clean paper. Do not use sand paper or emery cloth.

**4. Upper Electrode Lead** - A ground in lead wire to the upper electrode will cause relay to operate from lower electrode only. This condition can be checked out as described below.

### D. Relay Will Not Drop Out

If relay will not drop out when liquid falls below lower electrode, check the following points:

**1. Lower Electrode Lead** - A ground in the lead wire from relay to lower electrode will prevent relay from dropping out on low liquid level. If distance from holder to relay is relatively short, the best way to check for a ground is to connect a replacement wire from relay to the electrode holder outside the conduit and test the relay for operation. If it drops out properly it is safe to assume that a ground exists in the original lower electrode lead wire.

If relay is located a considerable distance from electrode holder, check for ground as follows: Disconnect power to relay. Remove wires from terminals in electrode holder and allow them to stick up to eliminate possibility of contacting a grounded part. Then turn on power to relay. If relay pulls in, a short is indicated between the electrode leads, from both electrodes to ground, or secondary coil is shorted internally. If relay does not pull in, short secondary coil with piece of insulated wire by bridging between relay terminal connections for upper and lower electrodes. Relay should pull in when this connection is made and drop out when connection is broken. If relay does not drop out, a short to ground is indicated in lower electrode lead. This ground may not be enough to pull in relay, but it can be sufficient to hold relay in once it has been closed in normal operation.

If any of these conditions exist, disconnect power to relay and replace grounded wires.

**2. Electrode Holder** - Excessive dirt or moisture over insulation at electrode holder or electrodes can cause faulty relay operation. Interior of electrode holder and its underside should be kept clean and dry. Conduit connections should be made so that no condensation can enter holder. Underside of vertically mounted holders should never come in contact with the liquid. Insulated rod electrodes should be used with horizontally mounted holders.

Electrodes should be kept relatively clean and free of dirt or grease. Check them periodically to make sure they do not become fouled with floating debris or insulating deposits.

**3. Length of Lead Wires** - On installations with excessive distance - over 900 feet - between relay and tank, relay may tend to hold in due to capacitance in electrode lines and fail to drop out when liquid leaves lower electrode. Since there are a number of ways to achieve reliable long distance control, complete information regarding such applications should be submitted to factory for recommendations.

## Conductive Liquids

With the exception of products such as oil, gasoline, animal fats and other similar products, most liquids and some moist bulk materials have sufficient conductivity to use B/W level detecting relays. The Series 1500 relay can be used on liquids with resistance up to about 90,000 ohm-cm (conductivity to 11 micromho/cm).

For liquids with higher resistance the B/W Series 52 relay described in Catalog Section 5200 must be used for applications up to 12 megohms resistance.

Liquids such as milk and beer, and some pharmaceutical products will foam during processing. The liquid phase is always a better conductor than the foam, and when the interface level is to be detected, the relay sensitivity must be carefully selected and it would be well to check the factory for our recommendation.

With nearly 50 years of experience B/W has compiled a history of applications in most major industries around the world. If you have questions regarding the proper relay selection, write us, phone us, or send a sample for test. Chances are that we have the answer for you.

## Typical Liquids

The following recommendations are satisfactory for general use, but because the conductivity of liquids varies greatly with concentration, purity, temperature and other factors, some applications may require a different selection. A number of the products listed are produced as solids such as crystals or powders, and our relay selection is based on the normally used commercial solutions of these materials.

Liquid Description.....	Secondary Coil	Liquid Description.....	Secondary Coil
Acetic Acid		Formaldehyde	Use 5200-H Relay
- Up to 75%	90 Volt	Formic Acid	
- 75 to 90%	220 Volt	- Up to 75%	90 Volt
- Glacial	Use 5200-H Relay	- 75 to 90%	220 Volt
Acetone	Use 5200-H or 5400 Relay	Glycerine (Glycerol)	Use 5200-H Relay
Acids		Hydrochloric Acid	40 Volt
- General	40 or 90 Volt	Hydrofluoric Acid	
- Anhydrous	Use 5200-H Relay	- Up to 20%	220 Volt
Alcohols	Use 5200-H or 5400 Relay	- Above 20%	40 Volt
Alkalies		Hydrofluorsilicic Acid	90 Volt
- General	40 or 90 Volt	Hydrogen Peroxide	Use 5200-H
- Anhydrous	Use 5200-H or 5400 Relay	Jams & Jellies	360 Volt
Alum Solutions	220 Volt	Juices - Fruit & Vegetable	40 or 90 Volt
Aluminum Sulphate	90 Volt	Lemon Oil Essence	Use 5200-H Relay
Aluminum Hydroxide	90 Volt	Lignite	800 Volt
Amino Acids	90 Volt	Lithium Chloride	40 Volt
Ammonia-Anhydrous Liquid	Use 5200-H Relay	Magnesium Hydroxide	90 Volt
Ammonium Chloride	40 Volt	Mayonnaise	220 Volt
Ammonium Hydroxide (Ammonia)	220 Volt	Methanol	Use 5200-H
Ammonium Nitrate	Use 5400 Relay	Methyl Ethyl Keystone (MEK)	Use 5200-H Relay
Ammonium Sulphate	220 Volt	Milk	40 Volt
Baby Foods	90 Volt	Molasses	220 Volt
Barium Chloride	40 Volt	Muriatic Acid	40 Volt
Barium Nitrate	40 Volt	Mustard	40 Volt
Beer	90 Volt	Nitric Acid	40 or 90 Volt
Black Liquor	40 Volt	Orange Juice	90 Volt
Blood	220 Volt	Paper Stock	220 Volt
Borax		Penicillin	220 Volt
- Up to 10%	220 Volt	Phosphoric Acid	40 Volt
- Greater than 10%	90 Volt	Plating Solutions	40 or 90 Volt
Boric Acid	220 Volt	Salts - Chemical	40 or 90 Volt
Bread Dough	90 Volt	Sodium Carbonate (Soda Ash)	90 Volt
Buttermilk	24 or 40 Volt	Sodium Chloride (Table Salt)	40 Volt
Cadmium Chloride	40 Volt	Sodium Hydroxide (Caustic Soda)	40 Volt
Cake Batter	220 Volt	Sodium Hypochlorate	40 Volt
Calcium Chloride	40 Volt	Sodium Silicate (Water Glass)	90 Volt
Calcium Hydroxide	220 Volt	Soups	40 Volt
Carbolic Acid		Starch Solutions	220 Volt
- Up to 90%	220 Volt	Sugar	
- 90 to 100%	Use 5200-H or 5400 Relay	- Low Concentrations	220 Volt
Catsup	90 Volt	- High Concentrations	360 Volt
Caustic Soda (Sodium Hydroxide)	40 Volt	Sulphuric Acid	40 Volt
Cement Slurry	220 Volt	Vinegar	90 Volt
Chromic Acid	40 Volt	Water	
Citric Acid	40 or 90 Volt	- Sea	40 Volt
Coffee	90 Volt	- Ordinary Potable	220 Volt
Condensate		- Ordinary Soft	360 Volt
- Ordinary Water	480 Volt	- Ordinary Condensate	480 Volt
- D.I. Water	Use 5200-H Relay	- Purified Distilled	800 Volt or 5200-H Relay
Corn Syrup	480 Volt	- Purified Deionized	Use 5200-H Relay
Corn - Cream Style	90 Volt	Zinc Chloride	40 Volt
Ethylene Glycol	Use 5200-H or 5400 Relay		
Ferric Chloride	90 or 220 Volt		
Ferrous Sulphate	220 Volt		