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(NASA-CR-161484) SOLAR HEATING AND COOLING
SYSTEM INSTALLED AT LEAVENWORTH, KANSAS
Final Report (Citizens Mutual Savings and
Loan Association) 318 p HC A14/MF A01

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DOE/NASA CONTRACTOR
REPORT

DOE/NASA CR-161484

SOLAR HEATING AND COOLING SYSTEM INSTALLED AT
LEAVENWORTH, KANSAS - FINAL REPORT

Prepared from documents furnished by

Citizens Mutual Savings & Loan Association
5151 South Fourth Street Trafficway
Leavenworth, Kansas 66048

Under DOE Contract EM-78-F-01-5193

Monitored by

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



U.S. Department of Energy



Solar Energy

NOTICE

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16. ABSTRACT <p>This report describes in detail, the solar heating and cooling system installed at the headquarters of Citizens Mutual Savings Association in Leavenworth, Kansas. The project is part of the U.S. Department of Energy's solar demonstration program and became operational in March, 1979. The designer was TEC, Inc. Consulting Engineers, Kansas City, Missouri and contractor was Norris Brothers, Inc., Lawrence, Kansas.</p> <p>The solar system is expected to furnish 90 percent of the overall heating load, 70 percent of the cooling load and 100 percent of the domestic hot water load. The building has two floors with a total of 12,000 square feet gross area. The system has 120 flat-plate liquid solar panels with a net area of 2,200 square feet. Five, 3-ton Arkla solar assisted absorption units provide the cooling, in conjunction with a 3,000 gallon chilled water storage tank. Two, 3,000 gallon storage tanks are provided with one designated for summer use, whereas both tanks are utilized during winter.</p>			
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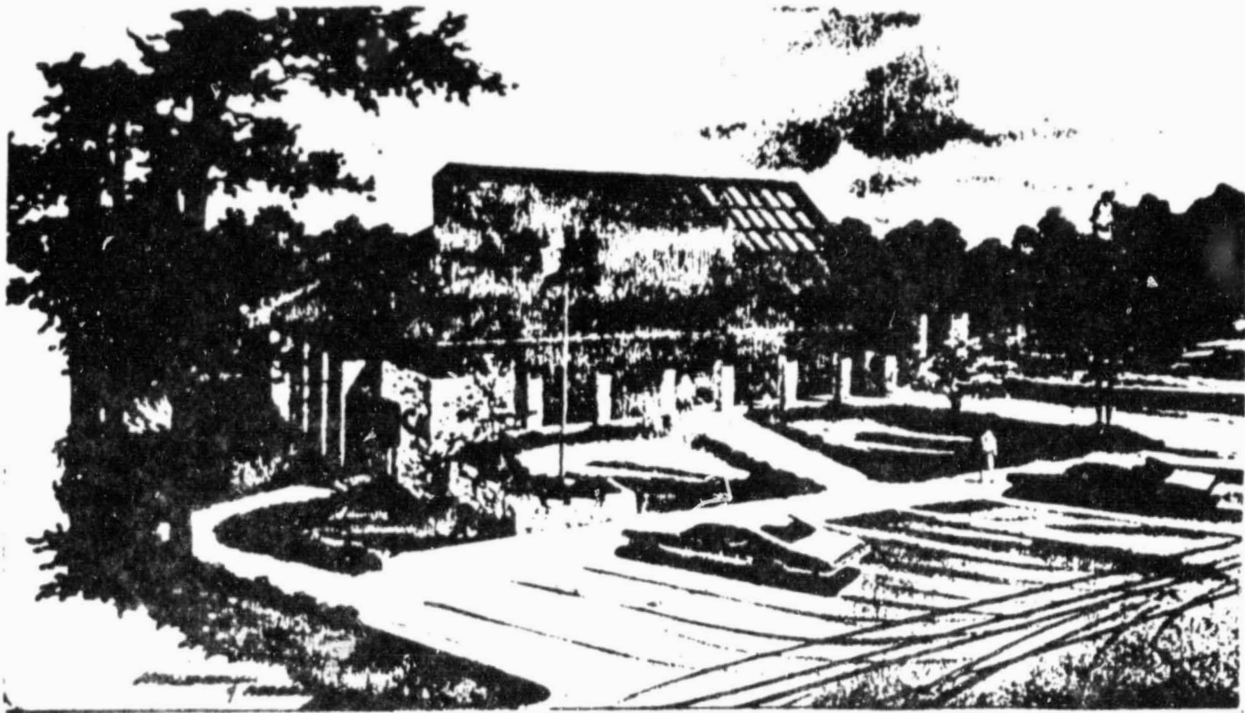
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1. SUMMARY



90% Solar Heating & 70% Solar Cooling

Citizens Mutual Savings Association

Ray M. Perkins, P.E.

Citizens Mutual Savings Association is headquartered in Leavenworth, Kansas, some 40 miles west of Kansas City. The association was founded in 1884 and, after numerous growth expansions, had finally outgrown the urban facilities and decided to move to the suburbs. The Board of Directors decided that their new facility should set a precedent for the entire community; that they should be a leader rather than a follower, and therefore, made a decision to incorporate solar heating and cooling into their growth plans.

The design intent, then, was to develop a system that would save energy, utilize solar energy to its utmost, that would be economically feasible and virtually maintenance free. The Owner, in one of the many review sessions, stated that his business was that of saving and the lending of money, and not the operation of mechanical systems. He, therefore, directed the design team to produce a system that would be completely automatic and would not require his attention and service.

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The building site is unobstructed by trees and other structures that could cause shadow casting on the solar collectors. Surface parking is provided on the south and east side of the building, thus adding to the potential for diffuse radiation collection. A major thoroughfare passes the site on the west side.

Building orientation is such that the collector panels have a heading of due south and are sloped approximately 40° to the horizontal. Leavenworth is located slightly above the fortieth latitude. There are 120 flat plate panels connected in a series/parallel arrangement with three panels in series and in parallel with all other groups of three. The collectors are Sunworks "Solector" with single glazing and their special coating.

There are two floors in the building, each having 6,000 square feet of area, or a total of 12,000 square feet gross area. Approximately 9,000 square foot is heated and cooled by the solar system, 6,000 on the first floor and 3,000 on the lower level. The upper floor, or first floor, contains all the normal banking facilities, including teller spaces, bookkeeping, vault, and private and general office spaces.

The Energy Code in the State of Kansas requires that new buildings cannot have a heat loss greater than 19 BTU's per square foot of floor area. The Citizens Mutual Building, since it is so well insulated, has a heat loss of 13 BTU's per square foot, considerably below the state code requirement. The roof has a "U" factor of .04 or a resistance of 25, whereas the composite "U" factor of the wall/window is .1526 or 6.55 resistance. The windows, which are double glazed, equal 12% of the total exterior wall area. Resistance of the wall area without glass is 11.54.

Interestingly enough, the air conditioning load of a similar building designed prior to the energy crunch would have been one ton for every 300 square feet of floor area. The Citizens Mutual building has a requirement of one ton air conditioning load for every 666 square feet of conditioned space, or one ton for every 888 square feet of gross area. In other words, Citizens' has a heating load equal to 70% the state maximum and a cooling load requirement less than 50% of the previously accepted values.

In an effort to establish the solar design approval, a review was made of the heating degree days and the expected full load cooling hours for the Leavenworth Building. In TABLE 1, degree days and annual full load cooling hours are tabulated for various locations.

TABLE 1

	Heating Degree Days	Cooling Full Load Hours
Leavenworth, Ks.	5200	1000
Dallas, Tx.	2400	1200
New Orleans, La.	1400	1400
Tampa, Fl.	700	1500

It became apparent after reviewing the data in TABLE 1 that the design approach had to consider heating as the most important aspect of the solar design. The annual cooling requirement of Leavenworth is 67% of Tampa, yet the heating is almost six (6) times greater.

With the design approach established, nine computer runs were made to determine the ideal choice of collector type and array size. The computer runs included tracking concentrating and flat plate type of various sizes. Life Cycle Costing was completed on each of various combinations. Table 2 lists three of the computer runs, all of flat plate collector type, giving the pertinent data.

TABLE II

	Alt. #1	Alt. #2	Alt. #3
Collector Area	2220	1665	1332
Number of Panels	120	90	72
Cost/Sq. Ft. of Panel	\$54.30	\$66.16	\$75.41
Heating % of Annual Load	91%	69%	55%
Cooling % of Annual Load	70%	56%	48%
Cost/Earning Ratio	100	125	162

Alternate No. 1 was chosen for implementation due to the lowest cost/earning ratio. The other computer runs were for tracking collectors, heating only and cooling only. None were as cost effective as the chosen Alternate No. 1. Since heating was the major concern, the largest volume of solar heated water was the goal. Studies indicated that 100° water would meet the peak heating requirement, whereas cooling required 190°. This data led to the selection of the flat plate collector and its ability to collect more diffuse radiation over the tracking collector.

The building orientation and arrangement indicated a need for five zones of temperature control. System design was five water to air heat pumps with an outdoor cooling tower, and five solar heated absorption units for cooling. Following is a tabulation of space temperatures and the corresponding system mode of operation:

Space Temp.	Mode of Operation
78°	Auxiliary Heat Pump Cooling
76°	Solar Absorption Cooling
74°	Economizer Cooling
72°	Solar Direct Heating
70°	Solar Assisted Heat Pump
68°	Auxiliary With Heat Pump

Solar absorption cooling will handle the entire cooling load as long as sufficient quantities of 190° water are available. A chilled water pump and piping system transfer the absorption cooling to the air stream with a coil in each zone duct. The absorption units are all in parallel on the chilled water loop and are staged on as required to maintain the chilled water supply temperature at 45° F. Variable flow through the collector was provided to assist in delivering the highest water temperature possible. The solar water storage tank capacity of 6,000 gallons was divided into two (2) three thousand gallon tanks, one for summer (higher temperature) use and both for winter (highest volume) use.

Solar direct heating, accomplished with a coil in the air stream of each zone, will provide total heating as long as the solar heated water is 90° or higher. If solar heated water is below 90° and above 68°, the solar assisted heat pump will provide the necessary heating at a coefficient of performance of approximately 2.85. Between the need for direct solar heating and absorption cooling, the outdoor and return air dampers will modulate to provide cooling by natural means from cool outdoor air.

The system, then, included a water to air heat pump for each of five (5) zones in series with a chilled water coil and hot water (solar water) heating coil. The additional fan resistance necessitated the addition of a booster fan in series with all five (5) zone heat pumps and connected to the common return air and outdoor air duct. Air filtration was accomplished at the booster fan and deleted from the individual zone heat pump.

The main banking area has a vaulted ceiling, following the pitch of roof and offering an ideal opportunity to pick up the stratified hotter air at the roof peak in the winter. High return air was provided for winter operation and a low return for summer. Supply air to the individual spaces was through floor grilles, thus permitting the circulation of lower

temperature air for heating, a situation well suited for direct solar heating.

The solar system, as stated earlier, will provide 91% of the heating and 70% of the cooling, and is completely automatic. The Owner had instructed the designers to "keep the system simple"; that their business was "savings and loan and not mechanical system operation". With these instructions in mind, the designers set out to provide the automatic system. Approximately 20% of the system cost was for temperature control, or almost \$11.00 per square foot of collector panel. The control system is pneumatic, because of cost advantages, and includes step controllers for sequential control of absorption units.

Six months of operating experience has been gained with the completed system. Only minor problems have been encountered to date. Power failure, with the sun shining, was the first problem. A rapid increase in collector temperature and pressure occurred and the safety relief valve functioned as intended, with the resulting loss of antifreeze solution. The relief valve didn't operate until the collector circulation pump was restarted on power restoration. A check of the system piping found that the Contractor had installed the relief valve at the pump discharge rather than at the expansion tank connection (point of no pressure change) as called for on the design drawings. A relocation of the relief valve has eliminated this problem.

Project Paper
Citizens Mutual Savings Association
Leavenworth, Kansas

Ray M. Perkins, P.E.

2. KEY WORK ABSTRACT

Application-----	Heating, Cooling and Hot Water
System Type-----	Heat Pump and Absorption
Collector Type-----	Flat Plate Liquid
Collector Manufacturer-----	Sunwork "Solelector"
Collector Area-----	2220 Sq. Ft. Net, 2520 Sq. Ft. Gross
Storage Capacity-----	3,000 Gal. Hot - 3,000 Gal. Cold
Building Load-----	366.1 x 60 ⁶ (Solar Conditioned)
Btu's Produced-----	363.6 x 10 ⁶
Building Owner-----	Citizens Mutual Savings Association Leavenworth, Kansas
Designer-----	TEC, Inc. Consulting Engineers Kansas City, Missouri
Contractor-----	Norris Brothers, Inc. Lawrence, Kansas

3. INTRODUCTION

Citizens Mutual Savings Association, Owner of the installation was founded in 1884 and has its headquarters in Leavenworth, Kansas, some 40 miles west of Kansas City. The Owner, after numerous growth expansions, had finally outgrown his facilities and decided to move to the suburbs. He, the Owner, had decided that their new facility should set a precedent for the entire community, that they should be a leader rather than a follower and, therefore, made a decision to incorporate solar heating and cooling into their growth plan.

Siting

The site for the new facility is unobstructed by trees and/or other structures that could cause shadow casting on the contemplated solar collectors. Parking is provided on the south and east side of the structure, this increasing the potential for additional diffuse radiation. A major throughfare passes the site on the west side.

Building Description

The building has two floors and is constructed of native stone veneer with a reinforced concrete foundation and first floor framing system. The upper or first floor contains all the normal banking facilities including tellers, book-keeping, vault, private and general office space. The lower floor includes the mechanical space, storage space and a finished meeting room and other functional spaces. The lower level is totally exposed on one side and partially exposed on two sides; windows and entrance door occupy the exposed side. The building has a gross area of 12,000 square feet, 6,000 square feet per floor, with 9,000 square feet of conditioned space.

Heat Loss and Gain

The building, with a design heat loss of 13 BTU per square foot is considerably less than the State Code maximum of 35 BTU per square foot. All wall insulation is outside the structure mass to provide the greatest heat sink effect possible, thus reducing internal temperature variations that would result from external temperature changes. The wall has an overall winter "U" factor of .1526 BTU per square foot per degree, which includes the total glass area. Glass occupies less than 12% of the total exterior wall area and is of the insulating type with 1" thickness. Jacketed wooden window sashes were utilized to minimize heat loss and maintenance. The roof has an overall "U" factor of .04 BTU per square foot and includes 8" batt fiberglass insulation.

The building is considered very efficient in terms of heat loss and heat gain and would qualify as an "Energy Conserving Design".

Solar Goals

Passive solar control is gained thru the shading of the exterior glass to preclude the direct entrance of sunlight until after October twenty-first. The active solar system, hydronic, was designed to provide 100% of the domestic water heating, 91% of the space heating and 70% of the space cooling.

4. DESIGN PHILOSOPHY

Zoning

Building partitioning, exterior exposure, and space function all dictated a need for five zones of temperature control, each separate and independent. Heat pumps were selected to provide the heating and cooling on this multizone application.

System Basics

The building base design included five air to air heat pumps without solar. Three alternate bid packages were prepared for bidding by the Contractor, each with solar collectors and solar assisted heating, cooling, and domestic water heating. Alternate bid relationships are given in Table 1.

Table 1

	Alternate 1	Alternate 2	Alternate 3
Collector Area	2220	1665	1332
Number of Panels	120	90	72
Cost-Square Foot of Panel	\$54.30	\$66.16	\$75.41
Heating % of Annual Load	91%	69%	55%
Cooling % of Annual Load	70%	56%	48%
Cost/Earnings Ratio	100	125	162

Alternate 1 was chosen for implementation due to the lowest cost/earnings ratio.

Five "water to air" heat pumps are included, all connected to a common return air, outdoor air and relief air duct system. A booster fan is installed in the mixed air (return and outdoor air) plenum to offset the additional pressure losses caused by the supplementary chilled water and hot water coils. The buildings main banking area has a high vaulted ceiling, permitting the installation of dual return air dampers, one high near the roof peak for winter operation to recover the stratified "hot" air for heating purposes and one damper low, near the floor, for summer operation. All supply air, for the upper floor is through floor grilles, whereas the lower floor has ceiling air diffusers. The floor grilles permitted higher volume air circulation at a lower temperature for heating, thus complementing the solar heating design approach.

Solar Collectors

Nine computer run comparisons were made to determine the optimum collector type and area. Table 1 shows the relationship of area and system performance. Other computer runs compared concentrating tracking collectors to fixed flat plate collectors. The need for the highest volume of energy rather than the highest quality (temperature) led to the decision to use the flat plate collector. Flat plate collectors are more sensitive to diffuse radiation than are concentrating collectors. Computer runs were made to compare natural gas to total electric as the basic source of energy. Operating cost was very nearly the same at the present rate relationship, but total electric was favored because the energy source for electric generation was coal and would probably have a more stable future cost.

Solar Heating

The direct use of solar heated water to provide heating is the most economical use of solar energy on an input to output energy comparison. For this reason, we choose to include hot water coils in the air duct for each of the five zones. Solar heated water, when warmer than 90° F., will provide the full building heating requirement thru the use of the aforementioned hot water coils. With solar heated water below 90° and above 68°, the building will be heated by use of the solar assisted heat pump operation. When the solar heated water drops below 68° F., an auxiliary electric booster heater becomes operative to maintain the water at 68° F. Heat again is provided by the heat pump but this time with the booster heated 68° F. hot water.

Solar Cooling

As the outdoor temperature modulates to where cooling would be required, the fan system changes to the economizer control cycle, thus utilizing the cool outdoor air to provide the cooling. Zones not needing full cooling by natural means will have the solar heated water coil to temper the air. A continued increase in outdoor temperature to where cooling by natural means cannot be accomplished will automatically cause the cooling tower to start and solar pump to deliver solar heated water to the absorption chiller units. A chilled water sensor will cause the five, three ton absorption chillers to cycle off and on to maintain the 45° F. chilled water set point. Solar heated water at 170° will produce 30% of the cooling design requirement, whereas water at 190° will produce 100%.

Solar Storage

Three different rates of flow are possible thru the collector panels. The lowest, .5 gpm per panel, was established to produce the hottest water for summer cooling with the absorption chillers. The intermediate flow, 1 gpm per panel, was selected for winter or heating use, and will collect the largest quantity of energy rather than the highest quality that is needed for summer operation. Two storage tanks are provided, each 3000 gallon in capacity, with one designated as hot for summer use to reduce dilution, whereas both tanks are utilized during winter, thus storing the maximum energy for summer and winter.

5. SYSTEM OPERATION

As mentioned earlier, the solar system will provide 100% of the domestic water heating, 91% of the space heating and 70% of the space cooling needs. The Savings and Loan facility operates six days a week and, therefore, offers an ideal usage schedule. Weekend storage of solar energy is reduced because of the actual hours of facility usage.

One of the original instructions by the Owner was to keep the systems as simple as possible and to make the system as nearly automatic as possible. He reminded us that his business purpose was "Savings and Loan" and not mechanical system operation. With these instructions in mind, we set out to design a system that was completely automated. The results were that approximately 20% of the system cost was for temperature control, or almost \$11.00 per square foot of collector panel. This cost includes all the normal zone space control for summer and winter and all the automatic change over from heating to cooling.

Economizer cycle cooling, as mentioned, is included to provide space cooling by natural means when the outdoor air is sufficiently low. During this mode of control, the outdoor air and return air dampers modulate to provide the 60° mixed air temperature needed for cooling. Cooling then can be provided by natural means at any temperature below 60° outside air temperature.

If heating is needed below 60° outside, the direct heating hot water coil for each zone with its thermostatically controlled valve will operate. Heating can be provided as long as the solar heated water is 90° F. or above. When the solar heated water is between 90° F. and 68° F., the heat pumps will operate and extract the heat from the water. During this mode of operation, the water heating coil valves are closed. If the solar heated water continues to drop below 68° F., then the aforementioned electric resistance water heater will become operational to provide the supplementary energy to the heat pump.

The cooling or air conditioning cycle begins, of course, with the economizer cycle described earlier. So called "free cooling" from atmospheric conditions will permit storing of solar heated water and extend the usage of energy stored. At the point when outside temperatures preclude the use of "free cooling" and the space temperatures reach 78°, the solar assisted absorption units will become operative to provide the air conditioning. The absorption units will continue to operate from the solar heated water until water temperature drops below the required temperature for absorber operation.

(160°). At this point, the heat pump cooling cycle becomes operative to produce the required cooling. During heat pump operation, the solar water storage system is accumulating solar energy to reduce the heat pump operating period.

6. PROBLEMS AND SOLUTIONS

The Savings and Loan structure has a sloping roof at 39.8° from the horizontal. The initial architectural decision was to apply the solar panels directly to the roof surface. Problems in flashing and waterproofing have proven this to be a bad decision. Every effort has been made to assure a water tight installation, but yet, if the roof had been flat or the collectors had been ground mounted, these problems would not have arisen.

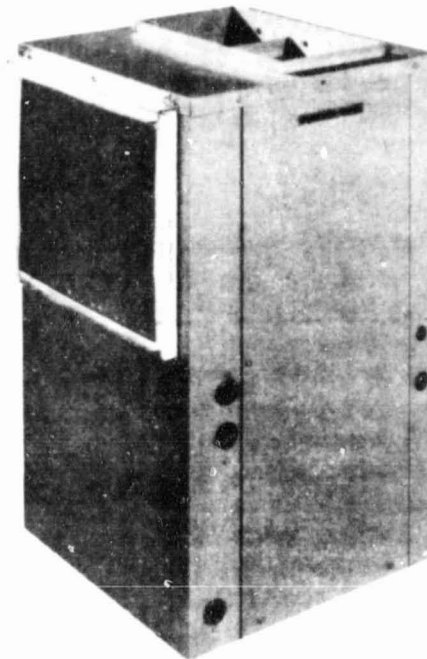
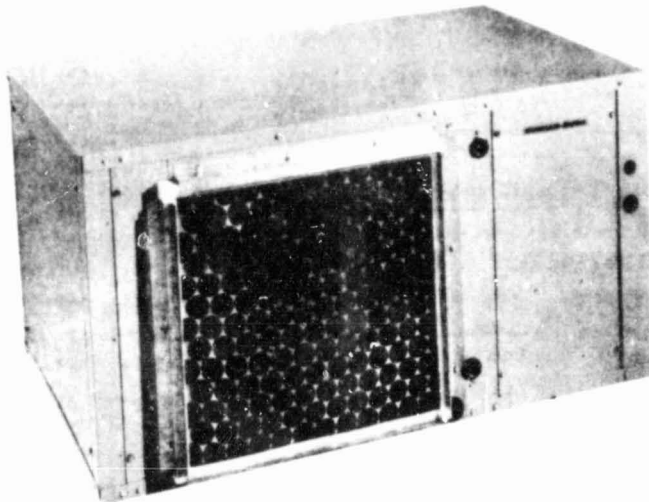
Storage tank location was another major concern. Consideration was given to an underground, insulated steel tank; basement located, insulated steel tank; underground, reinforced concrete insulated tank; and above ground (basement), reinforced concrete insulated tank. The potential of sub-grade water, damaging tank insulation, tank corrosion and accessibility led to the decision to have the tank in the basement above the floor. The reinforced concrete tank offered the advantage of having mass to reduce heat loss and provide additional energy storage. Thus, the option of using a concrete tank was accepted.

Temperature control logic, without the use of software, required many design hours and considerable control hardware. The control system is pneumatic because of the cost advantage as compared to an electric control system. Pneumatic step controllers were utilized for the sequential control required for the absorption units. Each of the five absorption chillers will operate to provide the quantity of chilled water required to meet the air conditioning demand. Sequential control then was a must to achieve this partial loading requirement to match solar energy consumption to air conditioning demand.

7. ITEMS OF INTEREST

Solar energy dissipation, after maximum energy collection and storage became a major concern. Inasmuch as our system was closed and contained freeze protection, there was not a need to drain the system when not in use. In fact, quite the opposite; our research indicated that less problems would be encountered if we did not drain the system. Dirt, etc., entering the system each time it is drained can cause a rapid reduction in solar collector efficiency as well as cause corrosion in the piping system. Energy collection, then, is continuous, regardless of the need or load. Our storage tank system can absorb only a certain quantity of energy and the surplus must be dissipated back to the atmosphere. Control and piping circuitry permitted us to use our cooling tower for this energy dissipation and, through a heat exchanger, we are able to lower the water temperature entering the cooling tower to an acceptable level. The approach appears to solve our heat dissipation problem.

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DUNHAM-BUSH

AQUA-MATIC HEAT PUMP

**SERIES AQM
INSTALLATION
OPERATING &
MAINTENANCE
INSTRUCTIONS**

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Instructions and data in this form, describe the products as manufactured at time of publication.
Dunham-Bush reserves the right to make changes in specifications and design without notice.

GENERAL

All models of the "Aqua-Matic" Heat Pump are designed and manufactured to give you conditioned air during both the heating and cooling seasons. This unit when installed in accordance with these instructions will be virtually trouble-free and give you years of comfort.

The Aqua-Matic heat pump is factory assembled, requiring only electrical power of the proper voltage, and an adequate supply of water in the range of 60°F to 95°F. In addition, a condensate drain is necessary to remove the excessive moisture extracted from the air during the cooling cycle. Duct work to supply return air to the unit and to discharge conditioned air is to be provided by the installer.

INSPECTION

When the unit is delivered an inspection should be made, in the presence of the carrier's representative, for visible and concealed shipping damages. If any are found a notation should be made on the delivery receipt before signing. A claim should be filed immediately against the delivering carrier as it is his responsibility to pay for any shipping damages.

INSTALLATION

A. Water Supply

If water for the heat pump is to be supplied from a well, a water pump should be electrically interlocked to operate with the compressor. If it is not practicable to do this, or a pressure tank or city water is used, a normally closed water solenoid valve should be installed ahead of the unit. The purpose of the valve is to open on demand, thereby using water only when the unit is in complete operation, either on the heating or cooling cycle.

B. Location

For economical operation of the Aqua-Matic heat pump, it is advisable to prevent heat transmission from ambient (outdoors) to the conditioned space.

This unit may be located in carport, garage or utility room, when roof construction has adequate space for running required ducts.

When it is necessary to install the unit inside the conditioned space, precautions should be taken to avoid transmission of noise to the structure of the building. The unit must be level to insure the proper functioning of controls. In closet installations, install the unit with the access panel facing the door to aid in servicing, such as changing air filters, etc.

After unit is set in place, remove all tape, blocks and supports which are marked. The compressor is suction cooled and internally sprung. **Do not loosen mounting bolts.** Double check all component parts in unit to make sure they are properly bolted and secure before installing the unit. If parts are broken loose from their securing, it is considered damage. File a claim against the delivering carrier.

C. Vibration Isolation

To avoid transmission of sound throughout the structure all points of support between the unit and the supporting structure should be provided with some good resilient material which is equal in resiliency to Neoprene ribbed padding, known as "Shear Flex". It can be supplied by Vibration Mountings, Inc.

A four-inch collar of canvas or similar resilient material should be used between the unit and the duct system. All water and drain pipes, electrical conduits, and air ducts must be provided with flexible connections between the unit and the building structure, and all pipes must be isolated at the supports where they pass through the walls. The use of flexible connections also applies to pipes to and from water pumps to prevent noise transmission to building.

D. Plumbing Connections

Since the "Aqua-Matic" heat pump is a true heat pump which uses water as its source of heat exchange, pipe size and water flow are considered vitally important. By following the very simple rules as itemized below, assurance is given that an adequate supply of at least 20 pounds water pressure is available for efficient operation of these units.

Item 1 — The recommended pipe sizes from water source, such as pump, pressure tank, city water, etc., are 3/4" nominal galvanized pipe or equal up to the 3 ton heat pump, and 1" pipe for the 4 and 5 ton models. The diameter of this pipe should be constant not only from the source of supply to the unit, but the same sizes are also to be used from unit to source of disposal.

Item 2 — Because varying pressure above 20 pounds create varying volume, it is recommended that a globe valve be inserted in the discharge line. This is needed to regulate the flow so that the disposal water during the cooling cycle is in the proper range. This range will automatically set the proper flow for the heating cycle also. The only difference is that during the heating cycle the disposal water will be going out colder than the entering water.

Item 3 — The condensate disposal line (separate from the condenser disposal) should be not less than 3/4" diameter; 1" is preferred and should be set at a downward pitch from the unit to create a natural flow. In sandy ground the condensate can often be disposed into a 2" diameter pipe embedded three to four feet in the ground at or near the unit location. This can be done only where the ground condition of sand is capable of absorbing the trickle of condensate moisture.

Item 4 — If rigid pipe is used between the water source and the unit, and from the unit to point of disposal, 12" to 16" flexible connections should be made immediately outside the unit location to absorb pump or water source vibration and pulsation. This recommendation is made for the purpose of quieting the entire unit operation. If longer flexible connections such as hoses are to be used, the minimum diameter should be 5/8 of an inch for longer runs. On 4 and 5 ton models 1" I.D. is preferred.

E. Electrical Connections

The Aqua-Matic heat pump has been completely wired at the factory. When the unit is received control wiring should be checked against the wiring diagram to assure there was no damage incurred in transit.

A fused disconnect switch should be provided by the customer to protect the system against short circuits and overloads. It should be sized and installed in accordance with local, state and national

electrical codes. Fuses and wiring should also be sized and installed accordingly. Minimum circuit ampacity should consist not only of the compressor amps, but should include the blower motor and pump motor if the pump is connected to the unit. (Refer to Unit Specifications.)

F. Duct Connections

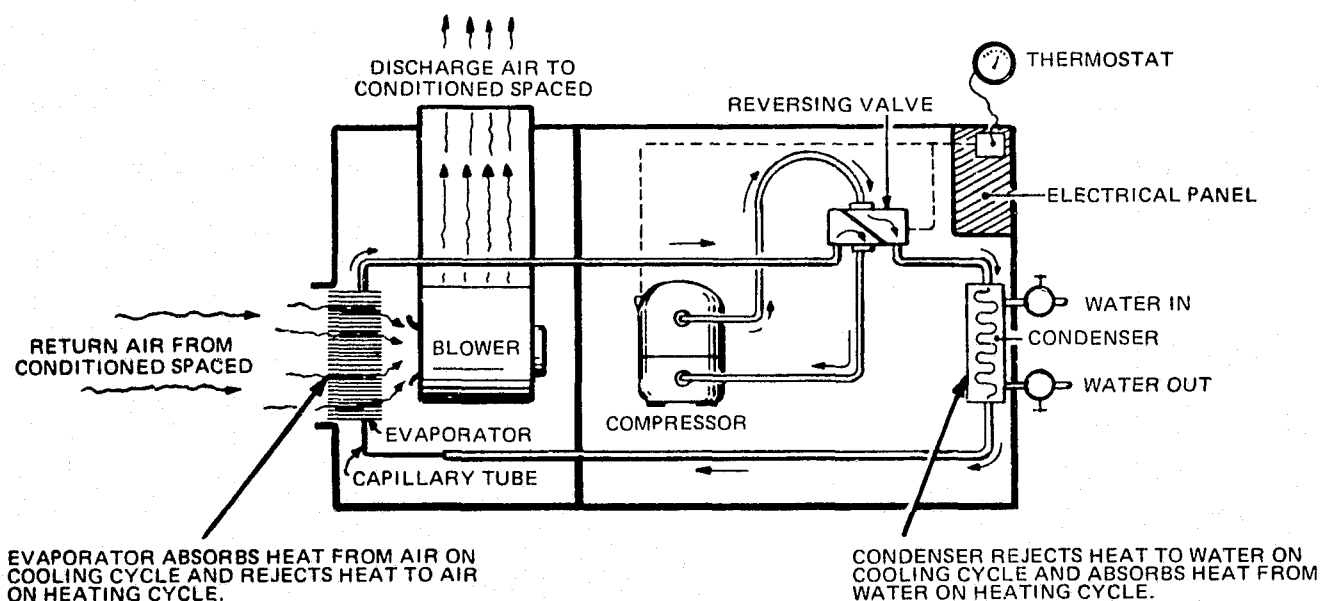
The supply and return air ducts, and grilles, should be of adequate size to allow an air flow equivalent to a minimum of 400 CFM PER TON OF REFRIGERATION.

The Aqua-Matic Heat Pump has been factory wired to supply the design air flow when operating against static pressure listed below:

MODEL	EXTERNAL STATIC PRESSURE (IN W.C.)
AQM-13V, 13H	0.10
AQM-22V, 22H	0.10
AQM-26V, 26H	0.10
AQM-33V, 33H	0.15
AQM-42V, 42H	0.15
AQM-53V, 53H	0.20
AQM-61V, 61H	0.20

When connecting duct work to the heat pump be sure to use a canvas collar or other resilient material to prevent sound transmission.

FIGURE 1. HEAT PUMP SHOWING COOLING CYCLE



OPERATION

The principle of operation of the Aqua-Matic heat pump is to remove excessive room heat from the air being conditioned during the cooling cycle, and during the heating cycle adding heat to the air being conditioned. Dehumidification is also achieved during the cooling cycle.

The basic components of an Aqua-Matic heat pump are a compressor, water cooled condenser, direct expansion evaporator, reversing valve and blower.

During the cooling cycle the heat pump acts like an air conditioner. When the compressor operates, the hot gas is passed through the reversing valve to the condenser, where heat is rejected to the water. The condensed refrigerant flows to the evaporator where it is expanded and it picks up heat and moisture from the air being conditioned (the blower will operate continually, drawing air to be conditioned over the evaporator). The expanded refrigerant with its added heat is then drawn back to the compressor, through the reversing valve, for re-compression (see figure 1).

During the heating cycle the flow of refrigerant is reversed and the heat of compression is used to warm the air being conditioned. When the compressor operates, hot gas passes through the reversing valve to the evaporator where the heat of compression is expended to the air being conditioned. The cooler refrigerant then travels to the water cooled condenser, for additional removal of heat, and is drawn through the reversing valve to the compressor for re-compression.

The heat pump is controlled by a remote thermostat which signals the unit to operate on either the cooling or heating cycle. When the comfort level is achieved the unit will automatically cycle off.

A. Controls

All "Aqua-Matic" models are equipped with a low voltage control panel and a remote manual change-over low voltage thermostat (automatic change-over is optional). Included in the control circuit are high pressure and low temperature cut-out.

1. Heating Cycle

When the heating contacts of the thermostat close, low voltage power is fed to the panel box which will start the compressor. A fan switch is located on the thermostat with its positions marked "on" and "auto". If the switch is set to "on" position, the blower will operate continuously. If the switch is set on "auto" position, the blower will start and stop with the

compressor. When heating is demanded the thermostat energizes the reversing valve.

2. Cooling Cycle

A popular but erroneous concept is that if the thermostat is set at extremely low or high temperatures, the environment will cool or heat faster. It is good practice to set the thermostat at the desired level of comfort and not try to achieve comfort levels by constantly changing the thermostat from cooling to heating to cycling the unit.

B. Initial Start Up

Prior to starting the heat pump the following items should be checked.

1. With the disconnect switch on "OFF" position, check the electric power supply to make certain the voltage corresponds with the nominal voltage of the heat pump, and check wire, disconnect switch and fuses for proper size.
2. Be sure there are no water leaks.
3. With the disconnect switch still off, go to the thermostat and set the fan switch to "AUTO" position and the system switch to "ON" position, if the thermostat is of the automatic change-over type. If the thermostat is of the manual change-over type, set the "COOL-OFF-HEAT" switch to the desired operation for the initial test run of the system.
4. Assuming the room is relatively warm it would be logical to test the cooling cycle. Set the change-over switch to the "COOL" position. If the cooling contacts are not closed, then the temperature setting of the adjustment should be lowered sufficiently to the "demand" point of the thermostat so the system will operate.

Note: Should the room temperature be below 55°F on initial start up of the unit, it may be necessary to cycle the unit several times in the heating position before unit will operate continuously.

Under extreme low ambient temperature conditions, it may be necessary to operate the unit for a short period on the cooling cycle and then switch to the heating cycle at which time the unit should operate continuously.

5. Throw the disconnect switch. The compressor and blower should operate. The water should flow through the condenser.
6. After a few minutes operation, switch the thermostat to heating position and adjust it to demand heating. Both the compressor and the blower should operate and water should flow through the condenser. **NOTE:** The reversing valve is energized during the heating cycle.

MAINTENANCE

THERE IS NO SUBSTITUTE FOR THE "KNOW HOW" AND EXPERIENCE OF A COMPETENT REFRIGERATION AND/OR AIR CONDITIONING SERVICEMAN.

Like any other type of mechanical equipment, the Aqua-Matic unit performs best when it is well maintained. Regular service will greatly improve the operating efficiency, reliability and longevity of the Aqua-Matic unit.

A preventive maintenance schedule is simple to set up and the items listed should be checked periodically.

1. Air Filters — The Aqua-Matic heat pump is furnished with a fiberglass throw away type air filter. The unit should not be operated without this filter in place. (A filter back grille may be used in lieu of unit filter in some applications.)

Filters should be inspected every three months and replaced when it is evident they are dirty. Unit operation becomes very inefficient with dirty filters. Three or four filter replacements may be necessary per year depending on the unit application and location.

2. Condensate Drains — Condensate drains can pick up lint and dirt, especially with dirty filters. The condensate pan and drain should be cleaned and inspected twice a year to avoid the possibility of overflow.

3. Condenser Water — For units that are on city water or well water, check the cleanliness of the condenser. Should the condenser become contaminated with dirt and scaling, they will have to be back flushed and cleaned with a chemical that will remove the scale. Your Aqua-Matic dealer or maintenance man can determine the exact procedure for this problem.

Cooling towers must be maintained and kept free of algae and contaminants. An adequate water treatment should be provided.

4. Electrical — Check all contactors and relays within the control panel at least once a year. Spray with a non-conductive silicone spray to remove and prevent dust and dirt from accumulating.

It is good practice to check the tightness of the wire connections within the control panel (especially when power wiring to the machine is aluminum).

5. Blower Motors — The blower motor is permanently lubricated.

Some units are employed on closed circuit water systems where there is auxiliary equipment, such as cooling towers, boilers, pumps, etc. Preventive Maintenance of the system and its components is just as important as Preventive Maintenance of the Aqua-Matic units.

OPERATING PRESSURES AND TEMPERATURES

1. General

There are many variables (airflow, air temperatures, water flow and temperatures) in an air-conditioning system that will affect operating refrigerant pressures and temperatures. The chart below shows approximate conditions and is based on airflow at the rated CFM.

2. COOLING CYCLE – RANGE OF APPROXIMATE OPERATING PRESSURES (PSIG)*

AIR ON (°F)	LEAVING WATER TEMPERATURE (°F)					
	85°F		95°F		105°F	
	SUCTION	DISCHARGE	SUCTION	DISCHARGE	SUCTION	DISCHARGE
75	66 – 70	190 – 210	68 – 74	220 – 240	70 – 76	240 – 260
80	68 – 72	195 – 215	70 – 76	220 – 240	72 – 78	245 – 265
85	70 – 76	200 – 225	74 – 78	220 – 250	76 – 80	250 – 275

3. HEATING CYCLE – RANGE OF APPROXIMATE OPERATING PRESSURES (PSIG)*

AIR ON °F	WATER TEMPERATURES		DISCHARGE PRESSURE (PSIG)
	°F ENTERING	°F LEAVING	
70°	60°	53°	210 – 230
	70°	63°	240 – 260
	80°	73°	280 – 300
75°	60°	53°	230 – 250
	70°	63°	250 – 270
	80°	73°	290 – 320

*Variances from these operating pressures will occur from machine to machine and model to model, therefore the above chart serves as a guide only.

For abnormal pressures see the trouble shooting charts.

A machine that is normally operating well on cooling cycle will have a warm (to touch) compressor dome and cool crankcase at the suction port. If the crankcase and dome are very hot (to touch) it is an indication of insufficient charge. On the contrary, if the crankcase and dome are very cold or frosting, the unit is likely to be overcharged.

VII. TROUBLE SHOOTING CHART

SYMPTOM	POSSIBLE CAUSE	CHECKS AND CORRECTION
A. Entire unit does not run.	1. Blown fuse	1. Replace fuse or reset circuit breaker.
	2. Broken or loose wires	2. Replace or tighten the wires.
	3. Voltage supply low	3. If voltage is below minimum voltage specified on dataplate, contact local power company.
	4. Control center	4. Check 24 volt transformer for burnout or voltage less than 18 volts.
	5. Thermostat improperly set	5. Set thermostat on "COOL" and lower temperature setting, unit should run. Set thermostat on "HEAT" and highest temperature setting, unit should run. Set fan on "RUN", fan should run.
	6. Thermostat improperly wired or faulty	6. To ensure faulty or miswired thermostat disconnect thermostat wire at unit and jumper between "R", "Y", "G", and "W" terminals and unit should run.
B. Blower operates but compressor does not.	1. Voltage supply low	1. If voltage is below minimum voltage specified on dataplate, contact local power company.
	2. Thermostat	2. Check setting, calibration and wiring.
	3. Wiring	3. Check for loose or broken wires at compressor, capacitor or contactor.
	4. High pressure controls	4. a. The unit could be off on the high pressure cut out control. Reset the thermostat to "Off". After a few minutes turn to "Cool". If the compressor runs, unit was off on high pressure. (See complaints for possible causes.) b. Check for faulty pressure switch by jumpering out the high and low pressure controls individually.
	5. Defective capacitor	5. Check capacitor, if defective remove, replace and revise correctly.
	6. Seized compressor	6. Wire an auxiliary capacitor in parallel with the run capacitor momentarily. If the compressor starts but the problem reoccurs on starting install an auxiliary start kit. The hard start kit is comprised of a recommended start relay and correctly sized capacitor. If the compressor still does not start, replace the compressor.

SYMPTOM	POSSIBLE CAUSE	CHECKS AND CORRECTION
B. Blower operates but compressor does not. (continued)	7. Compressor overload open	7. In all cases an 'external' or 'internal' temperature sensitive compressor overload is used. If the compressor dome is too hot to touch the overload will not reset until the compressor cools down. If the compressor is cool and the overload does not reset, there may be a defective or open overload. If the overload is external replace the overload, otherwise replace the compressor.
	8. Compressor motor grounded	8. Internal winding grounded to the compressor shell. Replace the compressor.
	9. Compressor windings open	9. Check continuity of the compressor windings with an ohmmeter. If the windings are open, replace the compressor.
C. Unit off on high pressure cut-out control.	1. Discharge pressure too high	1. On COOLING Cycle: a. Lack of or inadequate water flow. b. Entering air too warm. c. Scaled or plugged condenser. On HEATING Cycle: a. Lack of or inadequate air flow. b. Entering air too hot. c. Blower inoperative, clogged filter or coil, restrictions in duct work.
	2. Refrigerant charge	2. The unit is overcharged with refrigerant. Bleed off some charge or evacuate and recharge with specified amount of R-22.
	3. High pressure switch	3. Check for defective or improperly calibrated high pressure switch.
D. Unit off on low temperature cut-out control.	1. Suction pressure too low.	1. On COOLING Cycle: a. Lack of or inadequate air flow. b. Entering air too cold. c. Blower inoperative, clogged filter or coil, restrictions in duct work. On HEATING Cycle: a. Lack of or inadequate water flow. b. Entering water too cold. c. Scaled or plugged condenser.
	2. Refrigerant charge	2. The unit is low in charge of refrigerant. Locate leaks, repair, evacuate and recharge with specified amount of R-22.
	3. Low temperature switch.	3. Check for defective or improperly calibrated low pressure switch.
E. Unit short cycles.	1. Thermostat	1. The differential is set too close in the thermostat. Readjust setting.
	2. Wiring and controls	2. Loose connections in the wiring or the control contactors defective.
	3. Compressor overload	3. Defective compressor overload, check and replace if necessary. If the compressor runs too hot, it may be due to the deficient refrigerant charge.

SYMPTOM	POSSIBLE CAUSE	CHECKS AND CORRECTION
F. Insufficient cooling or heating.	1. Unit undersized	1. Recalculate heat gains or losses for space to be conditioned. If excessive rectify by adding insulation, shading, etc.
	2. Loss of conditioned air by leaks	2. Check for leaks in duct work or introduction of ambient air through doors and windows.
	3. Thermostat	3. Improperly located thermostat (eg. near kitchen sensing inaccurately the comfort level in living areas).
	4. Airflow	4. Lack of adequate airflow or improper distribution of air.
	5. Refrigerant charge	5. Low on refrigerant charge causing inefficient operation.
	6. Compressor	6. Check for defective compressor. If discharge pressure is too low and suction pressure too high, compressor is not pumping properly. Replace compressor.
	7. Reversing valve	7. Defective reversing valve creating bypass of refrigerant from discharge to suction side of compressor.
	8. Operating pressure	8. Incorrect operating pressure (see chart).
	9. Refrigerant system	9. Check capillary tubes for possible restrictions to flow of refrigerant. The refrigerant system may be contaminated with moisture, noncondensables and particles. Dehydrate, evacuate and recharge the system.
G. Noisy operation.	1. Compressor	1. a. Make sure the compressor is not in direct contact with the base or sides of the cabinet. b. Loosen hold down bolts used for shipping so that the compressor is floating free on its isolator mounts. c. Excessive noise will occur if the compressor has a broken valve or loose discharge tube. Replace the compressor.
	2. Blower and blower motor	2. a. Blower wheel hitting the casing. Adjust for clearance and alignment. Bent blower, check and replace if damaged. b. Loose blower wheel on shaft. Check and tighten. c. Defective bearings. Check and replace.

SYMPTOM	POSSIBLE CAUSE	CHECKS AND CORRECTION
G. Noisy Operation	3. Contactors	3. A 'clattering' or 'humming' noise in the contactor could be due to control voltage less than 18 volts. Check for low supply voltage, low transformer output or extra long runs of thermostat wires. If the contactor contacts or coil is defective, repair or replace.
	4. Rattles and vibrations	4. a. Check for loose screws, panels or internal components. Tighten and secure. b. Copper piping could be hitting the metal surfaces. Carefully readjust by bending slightly.
	5. Airborne noises and other sounds	5. Undersized duct work will cause high airflow velocities and noisy operation. Excessive water through the water-cooled heat exchange will cause a rattling sound. Throttle back on the water flow ensuring adequate flow for good operation but eliminating the noise.

9 ABSORPTION CHILLER

3-ton Absorption Chiller for Solar Air Conditioning

SPECIFICATIONS

MODEL WF 36

DESIGN DELIVERED CAPACITY, Btu/h..... 36,000¹
DESIGN DELIVERED CAPACITY, Tons I.M.E..... 3.0¹

ENERGY REQUIREMENTS

Design Hot Water Input, Btu/h..... 50,000
 Design Hot Water Inlet Temperature, °F..... 195
 Design Hot Water Outlet Temperature, °F..... 185.9
 Permissible Range of Inlet Temp..... 170 to 205
 Design Hot Water Flow, gpm..... 11.0
 Pressure Drop, Feet of Water, at 11 gpm..... 9.8
 Permissible Range of Flow, gpm..... 5 to 22
 Pressure Drop, Feet of Water, at 22 gpm..... 29.9
 Maximum Working Pressure, psig..... 100
 Unit Water Volume, Gallons, Approx..... 3.0
 Electrical Voltage, 60 Hz, 1 Phase..... 115²
 Maximum Wattage Draw..... 250

CHILLED WATER DATA

Design Inlet Temperature, °F..... 55
 Design Outlet Temperature, °F..... 45
 Design Flow, gpm..... 7.2
 Pressure Drop, Feet of Water, at 7.2 gpm..... 4.6
 Permissible Range of Flow, gpm..... 4 to 13
 Pressure Drop, Feet of Water, at 13 gpm..... 12.5
 Maximum Working Pressure, psig..... 100
 Unit Water Volume, Gallons, Approx..... 1.5

CONDENSING WATER DATA

Design Heat Rejection, Btu/h..... 86,000
 Design Inlet Temperature, °F..... 85
 Design Outlet Temperature, °F..... 99.3
 Permissible Range of Inlet Temp..... 75 to 90
 Design Flow, gpm..... 12.0
 Pressure Drop, Feet of Water, at 12 gpm..... 9.6
 Permissible Range of Flow, gpm..... 9 to 25
 Pressure Drop, Feet of Water, at 25 gpm..... 33.9
 Maximum Working Pressure, psig..... 100
 Unit Water Volume, Gallons, Approx..... 3.0

FOR COOLING TOWER SELECTION

Maximum Heat Rejection, Btu/h..... 106,000
 Range, °F..... 14 to 17
 Minimum Permissible Sump Temperature, °F..... 75³

SERVICE CONNECTIONS

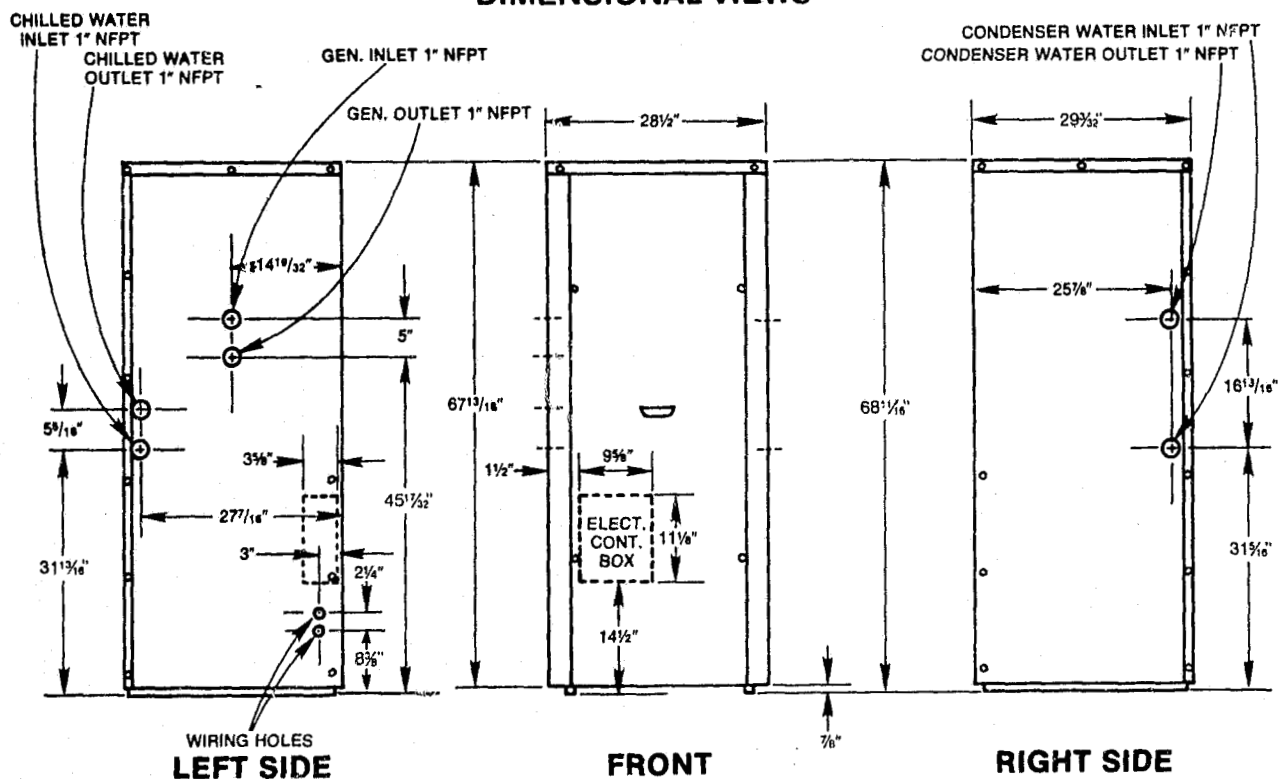
Hot Water Inlet and Outlet..... 1" FPT
 Chilled Water Inlet and Outlet..... 1" FPT
 Condensing Water Inlet and Outlet..... 1" FPT

PHYSICAL DATA, APPROXIMATES

Operating Weight, Pounds..... 675⁴
 Shipping Weight, Pounds..... 680⁵
 Crated Size, Inches..... 36W, 34D, 75H

- NOTES:** 1. Capacity at design conditions. For capacities at other conditions, see Page 4.
 2. Units equipped for operation on 230V-50Hz-1Ph available on special order.
 3. Thermostatic switch to control tower fan MUST be used. Set to "cut out" at 75°F.
 4. Includes circulating water weights.
 5. Units as shipped contain Lithium Bromide charge.

DIMENSIONAL VIEWS



MODEL WF 36

Hot Water Flow..... 11.0 GPM
 Condensing Water Flow..... 12.0 GPM
 Chilled Water Flow..... 7.2 GPM
 Chilled Water Leaving Temperature..... 45° F

HOT WATER		ENERGY INPUT BTU/H	INLET COND. WATER TEMP	DELIVERED CAPACITY		REJECTED HEAT BTU/H
INLET TEMP	OUTLET TEMP			BTU/H	TONS	
170° F	187.0	16,400	80° F	9,700	0.81	28,100
	187.4	14,500	85° F	6,400	0.53	20,900
	*	*	90° F	*	*	*
175° F	170.7	23,800	80° F	17,300	1.44	41,100
	171.1	21,600	85° F	13,100	1.09	34,700
	*	*	90° F	*	*	*
180° F	174.3	31,200	80° F	24,400	2.03	55,600
	174.8	28,800	85° F	19,400	1.62	48,200
	175.7	23,800	90° F	14,200	1.18	38,000
185° F	178.0	38,400	80° F	31,100	2.59	69,500
	178.5	35,900	85° F	25,600	2.13	61,500
	179.4	30,600	90° F	19,300	1.61	49,900
190° F	181.7	45,800	80° F	36,800	3.07	82,600
	182.2	42,900	85° F	31,300	2.61	74,200
	183.2	37,500	90° F	23,800	1.98	61,300
195° F**	185.3	53,100	80° F	40,600	3.38	93,700
	185.9	50,000	85° F	36,000	3.00	86,000
	186.9	44,300	90° F	27,600	2.30	71,900
200° F	189.3	58,800	80° F	41,800	3.48	100,600
	189.8	56,000	85° F	40,200	3.35	96,200
	190.7	51,000	90° F	30,500	2.54	80,500
205° F	193.4	63,800	80° F	42,000	3.50	105,800
	193.9	60,800	85° F	42,000	3.50	102,800
	194.8	56,200	90° F	32,500	2.71	88,700

*Unit operation unstable in these areas. **Lighter area represents conditions for rated capacity.

MODEL WF 36 Pressure Drops vs Water Flows For Pump Sizing

FLOW, GPM	PRESSURE DROP, FEET OF WATER		
	CHILLED WATER	HOT WATER	CONDENSING WATER
4	1.7 Min.		
5	2.5	2.8 Min.	
6	3.4	3.7	
7	4.4	4.7	
7.2	4.6		
8	5.5	5.9	
9	6.8	7.1	5.8 Min.
10	8.1	8.4	7.0
11	9.4	9.8	8.3
12	10.9	11.3	9.6
13	12.5 Max.	12.8	11.0
14		14.4	12.5
15		16.1	14.2
16		17.8	15.8
22		29.9 Max.	27.4
25			33.9 Max.

Where Progress Is Built On Quality

Arkla Industries Inc.
 P.O. Box 534
 Evansville, IN 47704

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FORM NO. SP 611T-1. NOV. 1976

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9.1 Installation

RECOMMENDED WAY TO USE INSTALLATION SECTION

This section of the manual pertains to specifications, details, recommendations and information necessary to the proper installation of ARKLA SOLAIRE AIR CONDITIONERS and related items.

The "key" to quickly finding the information desired is the proper use of the INDEX for the INSTALLATION section of the manual. The section is divided into sub-sections to group related items:

III- 1 through 9	-	Miscellaneous
III-10 through 14	-	Leveling
III-15 through 19	-	Chilled Water Piping
III-20 through 29		
III-30 through 49	-	Condensing Water Piping
III-50 through 59	-	Hot Water Piping
III-60 through 69	-	Electrical
III-70 through 89		
III-90 through 99	-	Check Lists

Each page has an INDEX number at the top. Under the INDEX number there is a DATE showing when the page was originally published. If the page has been rewritten to include later information, the word REVISED will replace the word DATE and show when that page was rewritten. Under the word MODELS will be shown a list of models to which the information on that page pertains. Be sure to select the page which shows the model for which you want the information. Also under a model number, there may be a break-down by serial numbers.

When sub-contracting parts of the installation, pages may be reproduced and given to the sub-contractor as guides for him on his part of the installation.

AGAIN, the "KEY" to quickly finding the information desired is the proper use of the INDEX.

INDEX		
INDEX NO.	REV.	SUBJECT
		Specification Sheet
III-1-1	4/77	Recommended way to use Installation Section
III-1-3	4/77	INDEX
III-2-3		General Installation Information
III-3-4		Handling and Uncrating
III-4-6		Checking Unit for Possible Shipping Damage
III-6-4		Cooling Tower Location
III-6-7		Unit Minimum Clearance
III-6-8		Thermostat - Location and Mounting
III-11-5	4/77	Leveling - Preliminary
III-20-1		General Information - Water Pipe Sizing
III-21-5		Chilled Water Piping
III-30-2	4/77	Condensing Water
III-33-3		Condensing Water Piping - At Unit
III-52-4	4/77(B)	Solar Hot Water Piping Connections
III-60-2		Electrical Wiring - Line Voltage to Unit
III-62-1		Electrical Wiring - External Low Voltage to Control Circuits.
III-65-2		Electrical Wiring - Low Voltage to Control System
III-92-3		Installation Check List

WF-36

GENERAL

It is recommended that trained air conditioning service personnel be employed to properly install, perform maintenance and service this equipment.

This equipment shall be installed in accordance with standards of the American Standards Association and with all applicable National, State and Local codes. Authorities having jurisdiction should be consulted before installation is made. In addition, all piping shall be installed in accordance with good practices and such as to facilitate removal of the air conditioner or any component for service.

Good installation is necessary for the customer to receive full benefits from the air conditioning system. Good installation is also necessary so that the system can be properly adjusted, maintained and serviced with the least amount of time, effort and expense.

Any additional information needed may be obtained from ARKLA INDUSTRIES INC., P. O. Box 534, Evansville, Indiana 47704.

WF-36

HANDLING AND UNCRATING

The WF-36 may either be hoisted or trucked with an ordinary appliance dolly. If the unit is to be trucked it should be done with the shipping carton intact. It should be trucked from the back side. If the unit is to be lifted by a hoisting device, it must first be uncrated and the unit top panel removed. The unit can then be lifted by the lifting plates which are welded to each side of the sealed unit. (See Figure 1) The unit weight is approximately 680 lbs. and the hoisting device should be capable of safely lifting in excess of this amount.

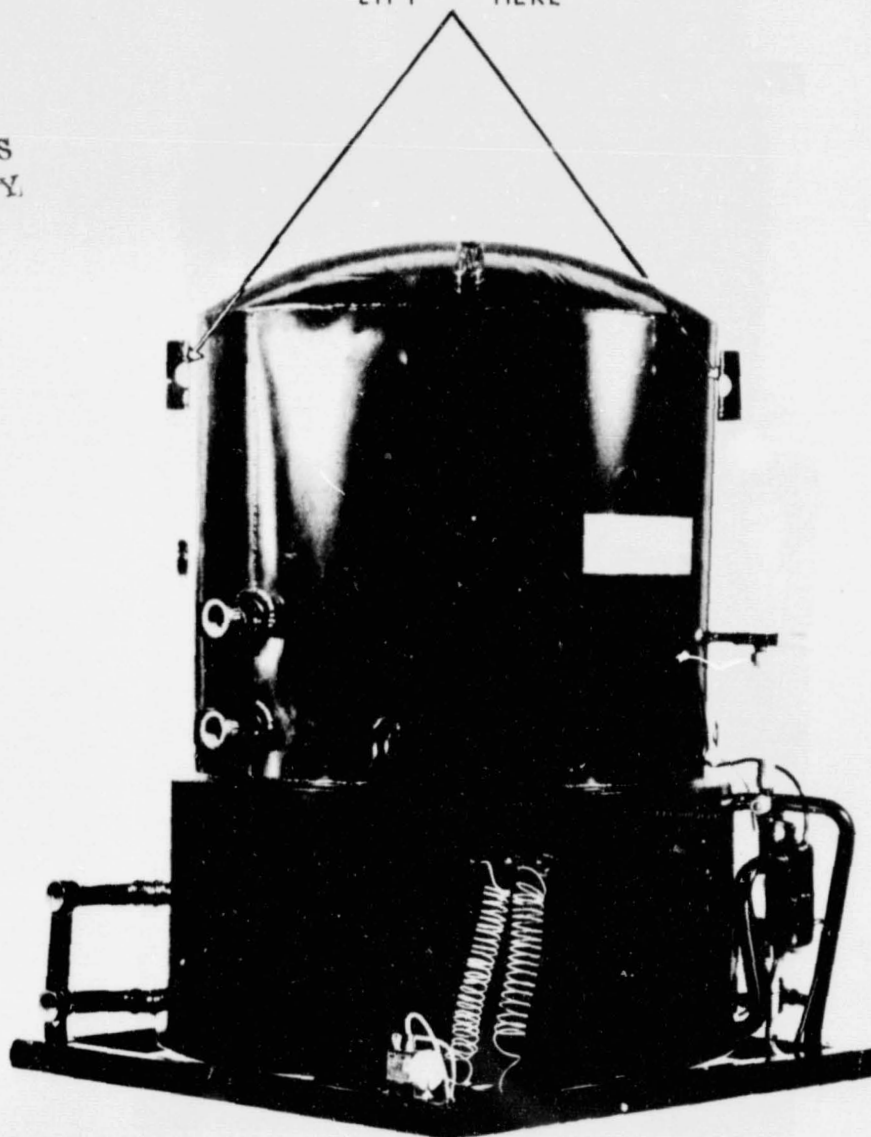
WF-36

Note: The four hex head machine bolts holding the crate base to the unit are to be used later for leveling legs. DO NOT THROW AWAY.

CAUTION: THIS EQUIPMENT HAS A RELATIVELY HIGH CENTER OF GRAVITY. SUFFICIENT PERSONNEL SHOULD BE AVAILABLE TO ASSURE SAFE HANDLING.

LIFT HERE

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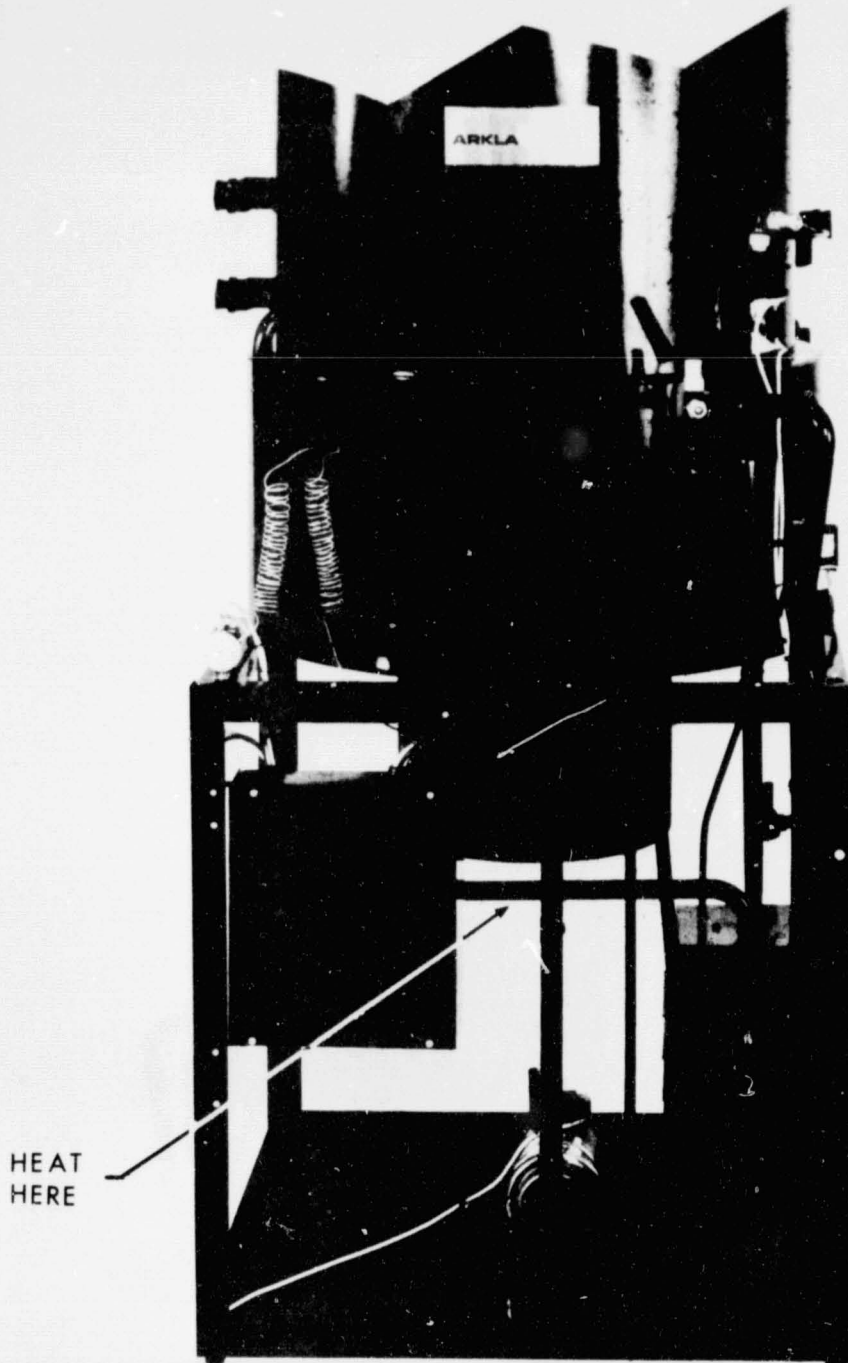
CHECKING UNIT FOR POSSIBLE SHIPPING DAMAGE

The unit should be checked for concealed damage when it is received. If a unit is received damaged, it should be noted on the carrier's Freight bill.

If damage is suspected, when the unit is received the unit should be uncrated and the front panel removed.

Use a small propane torch to apply heat to the strong solution tube. (See Figure 1) A popping and crackling sound should be heard within two minutes. This indicates that the sealed refrigeration unit is still under a vacuum.

WF-36



COOLING TOWER LOCATION

It is recommended that the cooling tower be installed outside if at all possible (Check manufacturer's recommendation on inside installation). Locate so that outlet air does not blow across a walk or passageway. Locate as remote from trees as possible or provide for protection to prevent entry of leaves or other foreign materials. Locate so that humid discharge air is not recirculated.

Consideration must be given to whether the cooling tower location is such that the normal operating sound level is not objectionable to occupants of the building.

If on a roof, install the cooling tower so that it is in a safe location for service and maintenance personnel.

It is always necessary to provide a solid base under the cooling tower. The base should be constructed of either concrete block or a poured concrete slab. The dimensions of the surface area of the slab should be slightly larger than the cooling tower. Make certain that the surface of the slab is level.

WF-36

UNIT MINIMUM CLEARANCES

The unit shall be installed with minimum clearances of 18" on each side, 12" from the back side and 24" from the front. A minimum of 12" must be maintained from the top (See Figure 1).

In no case shall clearances be such as to interfere with accessibility for servicing. Additional clearances should be provided where possible to permit adequate accessibility for cleaning, removal of motors, controls and for adjustment of parts requiring such attention.

WF-36

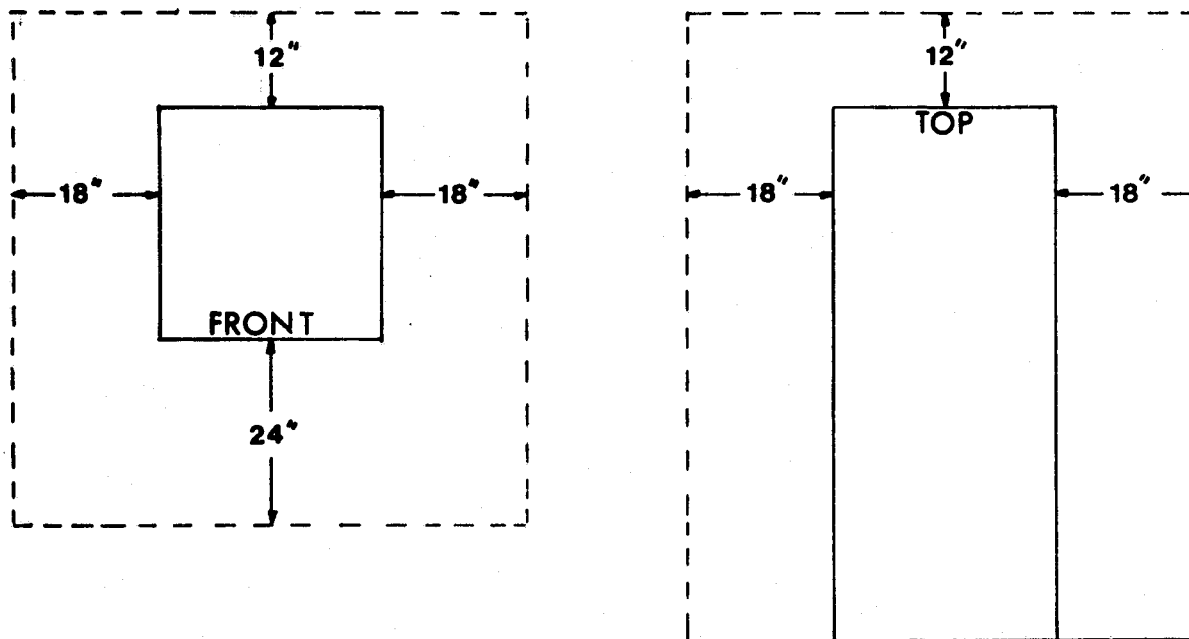


FIGURE 1

MODELS

THERMOSTAT-LOCATION AND MOUNTING

The thermostat should be located on an inside wall about 54" above the floor. It should be located so that it will not be affected by any of the following items:

- (a) Discharge air from a supply grill
- (b) Drafts
- (c) Direct sunlight through a window or glass door.

The thermostat should be located so that it senses the average temperature of the conditioned space.

The thermostat should be mounted according to the manufacturer's instructions (packaged with the thermostat). THERMOSTATS USING A MERCURY BULB SWITCH MUST BE LEVEL.

See 111-65-2 for thermostat electrical connections.

WF-36

PRELIMINARY LEVELING

It is extremely important for proper operation that the unit be level.

Preliminary leveling should be done after the unit is placed in its final location and prior to attaching any water piping or electrical wiring.

Insert leveling bolts (four hex head machine bolts which held unit to crate base) from the bottom with heads down to rest in recesses of leveling plates. Leveling plates are shipped in a separate cloth bag which is located just inside the front access panel. When the chiller is to be installed in a location where access to the rear is almost impossible, insert the rear leveling bolts from the inside with the heads up and end resting in recess of the leveling plate.

The unit may now be leveled by adjusting the four bolts.

The leveling bar is located on the solution reservoir shell. (See Figure 1) Front to back leveling should be checked by placing a 6" spirit level vertically against the front of the leveling bar. (See Figure 1). Scrape paint from the front and side of the leveling bar before setting the level in place. Side to side leveling should be checked by placing a 6" level against the right edge of the leveling bar. (See Figure 2).

THIS IS ONLY THE INITIAL LEVELING. FINAL LEVELING IS NOT DONE UNTIL THE START-UP.

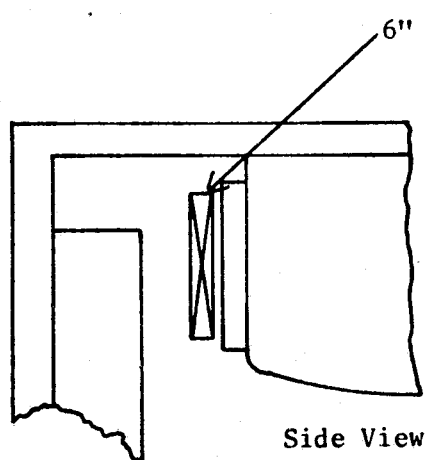


Figure 1

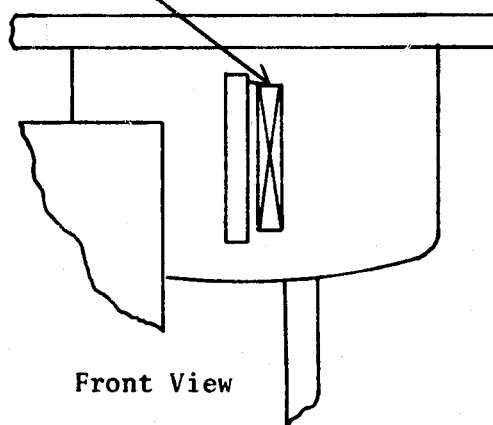


Figure 2

WATER PIPE SIZING - GENERAL

The size of the pipe connections on the Arkla Solaire unit does not determine the size of the piping to be used between the chiller and the air handler, cooling tower or hot water source.

Determining the correct size of pipe to be used depends on a number of different factors and should be calculated on each individual installation.

Some of the factors which must be taken into consideration are:

- (a) Rated flow of water required.
- (b) Capacities of the water pump.
- (c) Type of pipe to be installed.
- (d) Length of pipe needed.
- (e) Number and kinds of fittings.
- (f) Pressure drop through the Arkla unit.

Check the specification sheets on the equipment being installed for detailed information. Study the pages in this manual referring to water connections at the chiller which pertain to the particular installation being made. Be sure to arrange the fittings as recommended.

For more information on how to calculate pipe sizing and the tables needed to make these calculations, a booklet is available from Arkla Industries Inc. "General Applications Data - Pipe Sizing," Form No. HT65T-7R-2.

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CHILLED WATER PIPING

The chilled water connections are located on the left side near the rear and just below the center of the unit. The inlet connection is the bottom pipe and is a 1" FPT fitting. The outlet connection is the top pipe and is a 1" FPT fitting.

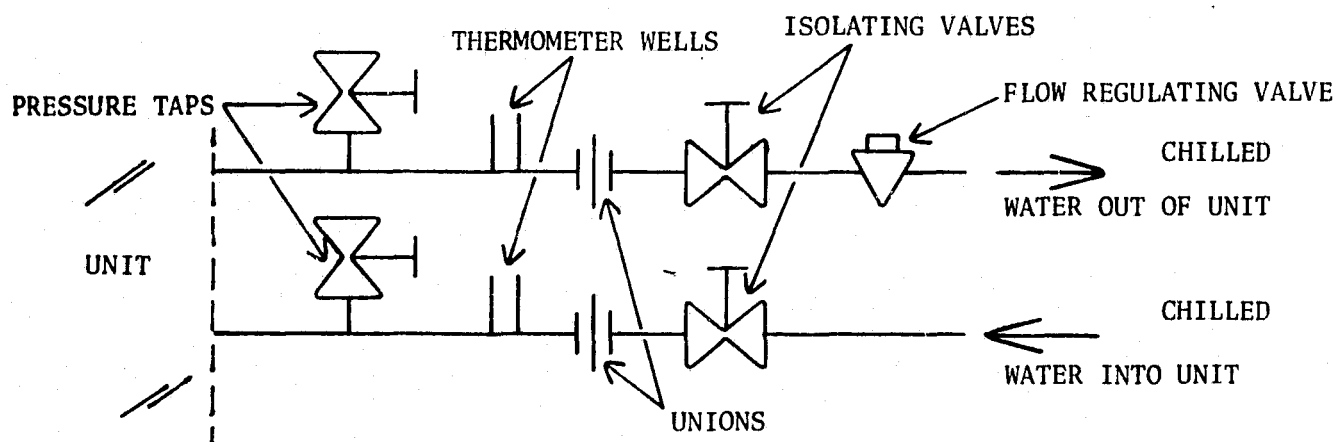
Any vertical piping to these connections should be far enough away from the panel to permit easy removal of this panel if necessary.

Certain fittings should be installed in the chilled water piping as shown in Figure on 111-21-5, for the reasons mentioned below.

- A 1/4" pet cock should be installed in the inlet and outlet connection next to the unit. These are needed to take pressures when adjusting the water flow.
- A union and an isolating valve (Gate valve) should be installed in each line so the piping can be disconnected from the unit without making it necessary to drain the water from the rest of the system.
- A flow regulating valve (plug cock) should be located in the water line leaving the unit and down stream of the isolating valve for the purpose of balancing and regulating chilled water flow.
- "Blow down" valves should be installed at end of dirt legs to make it convenient for draining off sediment or draining the unit, if necessary.

One of the six thermometer well fittings shipped (in a carton behind the front panel) with each unit is to be installed in each the inlet and outlet chilled water lines. For the most accurate temperature readings, these should be located as close to the unit as possible. They must be installed in horizontal lines with the well part of the fittings in the vertical up position.

All chilled water lines and fittings should have insulation applied according to the ambient temperatures involved. At least 1/2" of good grade insulation with a vapor barrier would be considered as minimum. If the lines pass through a damp area, very high or very low temperature area or underground, the insulation should be at least 3/4" thick and be a moisture proof, non-deteriorating type.



CONDENSING WATER

WF-36

The "Cooling" efficiency of an Arkla Solaire unit is dependent upon having good condensing water flowing through the unit at the right flow rate and at the right temperature. Using a cooling tower with properly sized piping between the chiller and cooling tower will assure proper flow rate and temperature. Normally the water taken from city mains or wells is excellent water and can be used for condensing water through the water-cooled Arkla Solaire Chiller, but certain conditions must be avoided.

1. The use of sulphur water, salt water, acid water or water containing solids in excess of 700 ppm.
2. Providing less than the specified bleed-off from the cooling tower water. (See 111-30-2 (B & C).
3. Condensing water flow rates greater than the maximum specified.
4. Neglecting to clean excessively scaled tubing.

COOLING TOWER BLEED-OFF: As water evaporates from the cooling tower, any solids which may have been in the water will remain within the recirculating water or in the sump. In a short time, concentration of these solids (dissolved or undissolved) will build up to a point which will cause a service problem in the form of reduced efficiency and possible ultimate unit failure. It is recommended that provision be made to bleed-off at all times the cooling tower is in operation. The bleed-off rate must be at least equal to the amount evaporated, approximately 3.5 GPH/ton of refrigeration minimum.

IT MAY BE NECESSARY TO PROVIDE WATER TREATMENT IN SOME AREAS. (See 111-30-2 (B & C).

ARKLA COOLING TOWER MAKE-UP WATER INDEX

Arkla is frequently asked to analyze samples of condensing water sent in from the field, to report the condition of the water and, if treatment is necessary, to recommend a type or method of treatment. We would like to provide this service, realizing its importance, but we do not have the facilities to run complete analysis on water samples sent in to us.

The purpose of this information is to provide the field with a method of determining the fitness of water for use as recirculated condensing water in Arkla air conditioners, and an indication of whether or not the water requires treatment for such use.

To use the method outlined, first obtain from a competent water chemist a Report on Analysis on the cooling tower MAKE-UP water in question. This report should contain the following information.

1. Total dissolved solids, ppm (Parts Per Million).
2. Calcium hardness, reported as ppm calcium carbonate (CaCO_3).
3. Bicarbonates, reported as ppm calcium carbonate (CaCO_3).
4. Sulphates, ppm.
5. Magnesium, ppm.

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6. The pH of the water.)
7. Sulphide, ppm.)
8. Chloride, ppm.)
9. Silica, ppm.)

NOTE: See the Caution on
111-30-2(C) about
items 6 through 9.

The information in the report on the FIRST THREE ITEMS above is then used to find three "Factors", which Factors will then in turn be used in calculating the Cooling Tower Make-up Water INDEX. These Factors are Factor "S" (for the total dissolved solids), Factor "H" (For the calcium hardness), and Factor "B" (for the bicarbonates).

Factor S (Solids): If the parts per million reported in Item 1 do not exceed 200, use .1 for Factor S; if above 200 ppm, use .2.

Factor H (Hardness): Use the ppm reported in Item 2 to find in the Table below.

Factor B (Bicarbonates): Use the ppm reported in Item 3 to find in Table below.

ppm	Hardness Factor H	Bicarb's Factor B
5	.6	8.6
6	.7	8.8
7-8	.8	9.0
9-11	.9	9.2
12-13	1.0	9.4
14-17	1.1	9.6
18-22	1.2	9.8
23-27	1.3	10.0
28-34	1.4	10.2
35-44	1.5	10.4
45-55	1.6	10.6

=

ppm	Hardness Factor H	Bicarb's Factor B
56-69	1.7	10.8
70-88	1.8	11.0
89-112	1.9	11.2
113-137	2.0	11.4
138-177	2.1	11.6
178-222	2.2	11.8
223-277	2.3	12.0
278-347	2.4	12.2
348-442	2.5	12.4
443-500	2.6	12.6

Now, use Factors S, H, and B in the equation below to find the Cooling Tower Make-up Water INDEX:

$$\text{INDEX} = H \text{ plus } B \text{ minus } 11.0 \text{ minus } S$$

For example, suppose the make-up water analysis shows 230 ppm Total Dissolved solids, 90 ppm Calcium Hardness (as CaCO_3), and 18 ppm Bicarbonates (as CaCO_3).

Total Dissolved Solids ppm of 230 = Factor S of .2
 Calcium Hardness ppm of 90 = Factor H of 1.9
 Bicarbonates ppm of 18 = Factor B of 9.8

H plus B minus 11.0 minus S = INDEX

$$1.9 + 9.8 - 11.0 - .2 = \text{INDEX OF PLUS } .5$$

APPLYING THE INDEX

THE CONCLUSIONS FOLLOWING ARE BASED ON THE USE OF BLEED-OFF, OR BLOW-DOWN, AT LEAST EQUAL TO THE MAXIMUM RATE OF EVAPORATION OF WATER FROM THE COOLING TOWER.

MODELS

WF-36

When a tower supplies the cooling water to an Arkla air conditioner, a certain portion of the water being circulated MUST be bled off, and every effort should be made to assure that the bleed-off is maintained at the MINIMUM rate of 8 ounces per minute per rated air conditioner ton. If, for example, a 3.0 ton Arkla unit is used, bleed-off MUST be maintained at a MINIMUM rate of 24 (3.0 x 8) ounces per minute. No practical form or method of water treatment eliminates or even reduces this requirement.

1. If the INDEX is from 0 to PLUS .7, there will probably be some scaling, requiring periodic acidizing.
2. If the INDEX is above PLUS .7, there will be some scaling. Some other form of water treatment may be desirable.
3. If the INDEX is a MINUS VALUE, some form of chemical treatment MUST be used since the water will probably be corrosive.

If further information is needed after following this procedure, send the INDEX along with water analysis report to the Service Department, Arkla Industries Inc. P.O. Box 534, Evansville, Indiana 47704.

CAUTION - CAUTION - CAUTION

See Items 6 through 9 in the first paragraph, 111-30-2 (B). These properties of water have a somewhat special importance in the determination of its fitness for use. It is true that very few natural waters, when these properties are considered, can be classified as undesirable. Nevertheless, if these properties are marginal in value or if there is some other area of doubt, the utmost care must be exercised in using that water in ANY water-cooled equipment. It is probably good, general practice to AVOID MAKING INSTALLATIONS where the make-up water analysis shows:

- a. A pH below 7 due to mineral acid(s). Acids are corrosive.
- b. Any TRACE of sulphide. Sulphide is corrosive.
- c. Chloride exceeding 100 ppm. Chloride is corrosive.
- d. Silica exceeding 50 ppm. Silica causes hard-to-remove scale.

LEAKS IN THE CONDENSING WATER CIRCUIT DUE TO WATER SIDE CORROSION OR EROSION ARE NOT COVERED BY WARRANTY.

CONDENSING WATER PIPING - AT UNIT

MODELS

WF-36

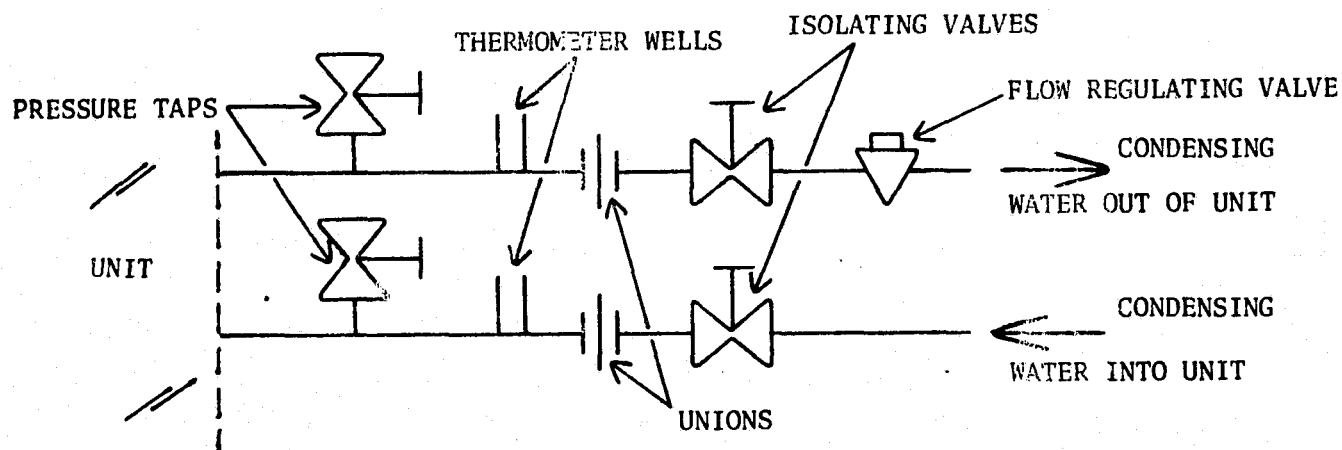
Both inlet and outlet condensing water connections are located on the right side near the rear. The inlet connection is the bottom pipe and is a 1" FPT fitting. The outlet connection is the top pipe and is a 1" FPT fitting.

Any vertical piping to these connections should be far enough away from the panel to permit easy removal of this panel if necessary.

Certain fittings should be installed in the condensing water piping as shown in Figure below, for the reasons mentioned below.

- A 1/4" pet cock should be installed in the inlet and outlet connection next to the unit. These are needed to take pressures when adjusting the water flow.
- A union and an isolating valve (Gate valve) should be installed in each line so the piping can be disconnected from the unit without making it necessary to drain the water from the rest of the system.
- A flow regulating valve (plug cock) should be located in the water line leaving the unit and down stream of the isolating valve for the purpose of balancing and regulating condensing water flow.
- "Blow down" valves should be installed at end of dirt legs to make it convenient for draining off sediment or draining the unit, if necessary.

One of the six thermometer well fittings shipped (in a carton behind the front panel) with each unit is to be installed in each the inlet and outlet condensing water lines. For the most accurate temperature readings, these should be located as close to the unit as possible. They must be installed in horizontal lines with the well part of the fittings in the vertical up position.



MODELS

HOT WATER PIPING

The WF-36 requires a hot water supply of 11 G.P.M. at 170°F to 195°F. The unit produces 36,000 BTU's of cooling at 195°F hot water and 85°F condensing water.

WF-36

Only clean, hot water, free from oil and other foreign materials should be used. If any other hot liquid or mixture is going to be used, check with Arkla Industries Inc. P.O. Box 534, Evansville, Indiana 47704, for particulars. All hot water piping, including return piping should be installed in accordance with good hot water piping practice (See III-20-1).

See Figure on III-52-4(B), for the proper hot water piping connections to the unit.

Any vertical piping to these connections should be far enough away from the panel to permit easy removal of this panel if necessary.

Certain fittings should be installed in the hot water piping as shown in Figure on III-52-4(B) for the reasons mentioned below.

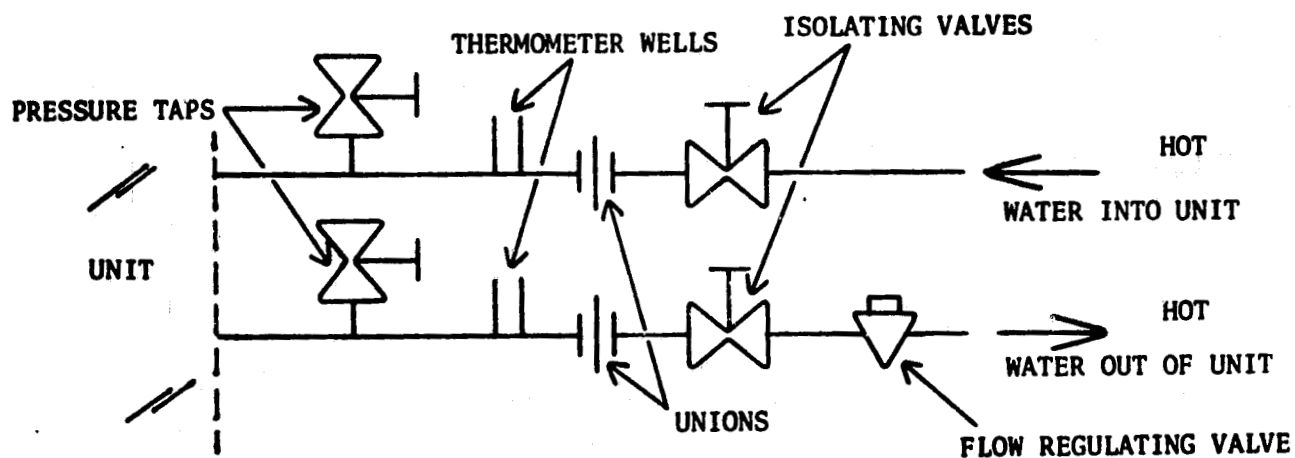
- a. A 1/4" pet cock should be installed in the inlet and outlet connection next to the unit. These are needed to take pressures when adjusting the water flow.
- b. A union and an isolating valve (Gate valve) should be installed in each line so the piping can be disconnected from the unit without making it necessary to drain the water from the rest of the system.
- c. A flow regulating valve (plug cock) should be located in the water line leaving the unit and down stream of the isolating valve for the purpose of balancing and regulating hot water flow.
- d. "Blow down" valves should be installed at end of dirt legs to make it convenient for draining off sediment or draining the unit, if necessary.

One of the six thermometer well fittings shipped (in a carton behind the front panel) with each unit is to be installed in each the inlet and outlet hot water lines. For the most accurate temperature readings, these should be located as close to the unit as possible. They must be installed in horizontal lines with the well part of the fittings in the vertical up position.

The hot water supply and return lines should be insulated at least up to the point of connection on the unit to reduce heat loss and to avoid injury to personnel.

Low water flow will reduce effective cooling and waste energy. It is recommended that a flow switch be a part of the control system to cut off the unit at a minimum flow rate of 5 G.P.M.

It is recommended that some type of minimum and maximum input control system be installed. This must be field fabricated and installed. Minimum input is 170°F hot water. Maximum input is 205°F hot water. Water temperatures below 170°F produce no effective cooling and wastes energy. At water temperatures above 205°F the unit again wastes energy.



ELECTRICAL CONNECTIONS - TO UNIT

The Arkla Solaire unit is wired for operation on 115 volts, 1 phase, 60 cycle current.

The unit control box contains a 115/24 volt, 50 VA transformer to supply low voltage current to the control system.

The main switches, disconnect switches, fuse holders and fuses are not furnished by Arkla. The fused disconnect should be installed within sight of and not more than 50 feet from the unit.

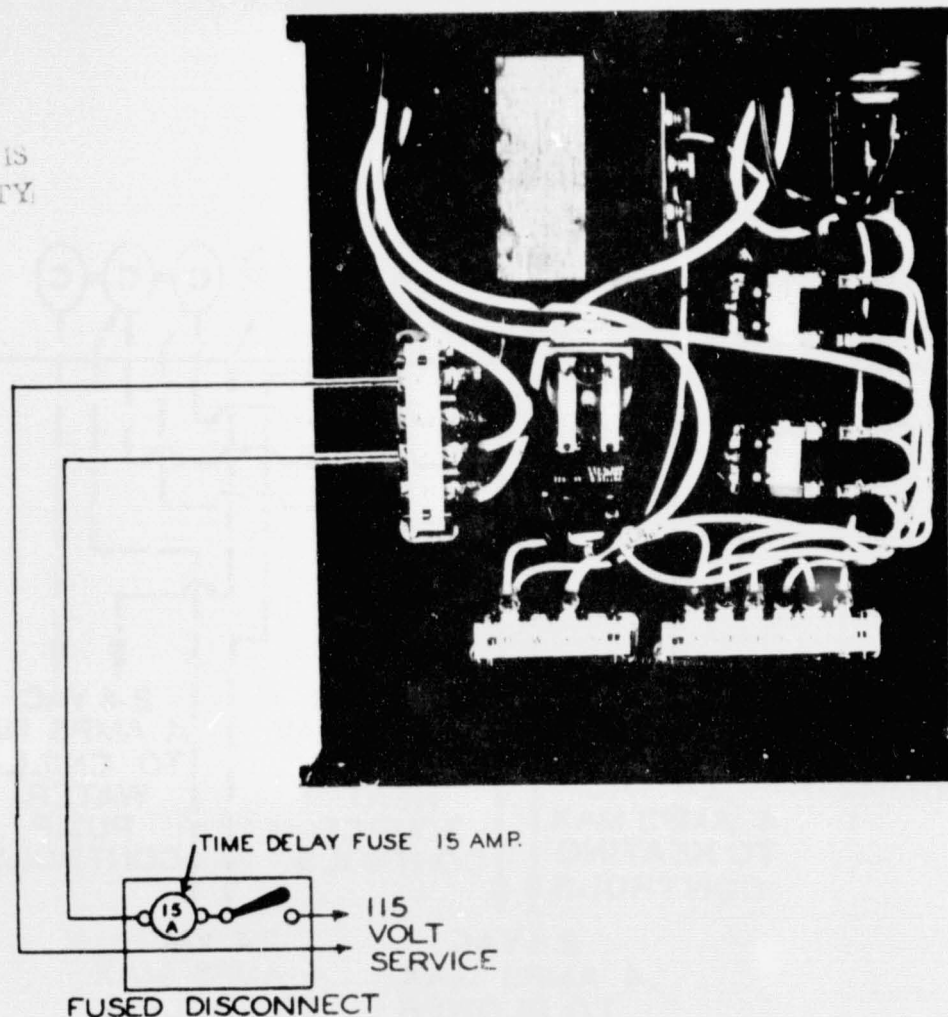
The recommended line voltage wiring to the unit can be found on 111-60-2.

GROUNDING

If type UF underground cable is used, the unit should be grounded by running wiring from an approved electrical ground to a convenient point on the unit's frame. Grounding wire should be attached to the frame in a manner approved by national and/or local Electrical Codes. If conduit is used, it will serve as an adequate ground, providing that the conduit is connected to the building's electrical grounding system.

WF-36

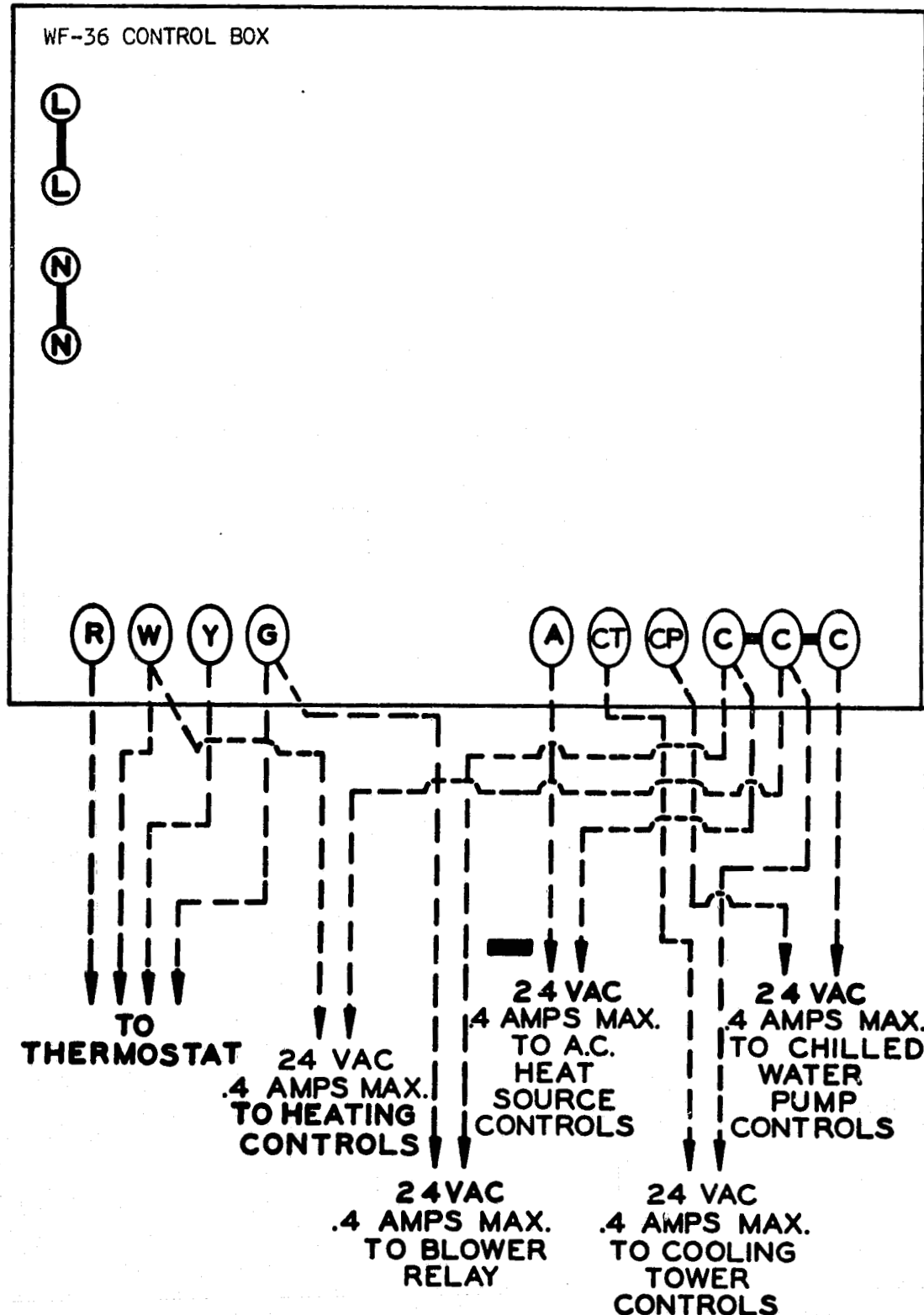
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ELECTRICAL WIRING - LOW VOLTAGE TO CONTROL SYSTEM

The Arkla Solaire unit is wired such as to provide 24 VAC to external relays to control the various pumps and air handler(s) in the heating and air conditioning system. The relays selected should not exceed .4 amp. draw maximum. Wiring from the unit to the relays should be a minimum of 18 gauge.

WF-36

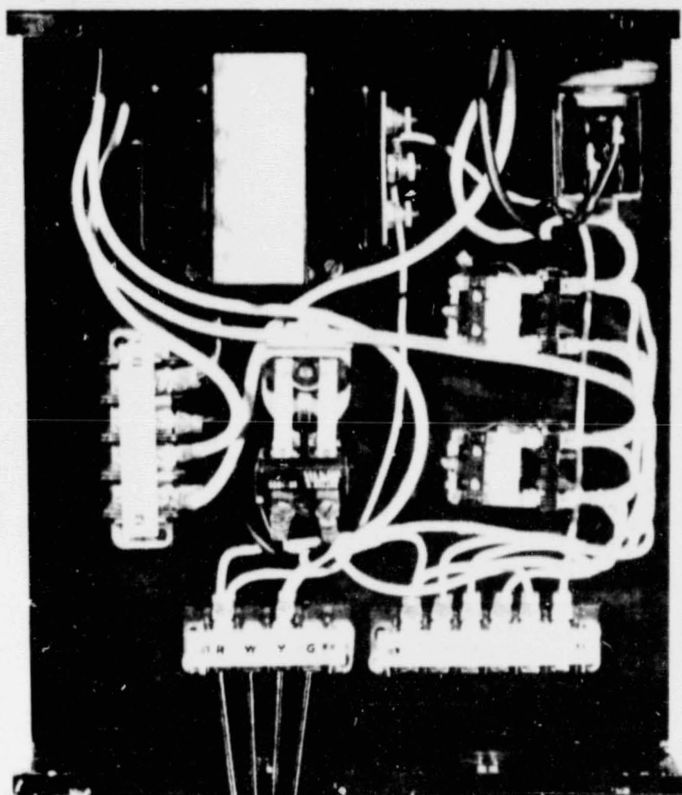


ELECTRICAL WIRING - UNIT TO THERMOSTAT

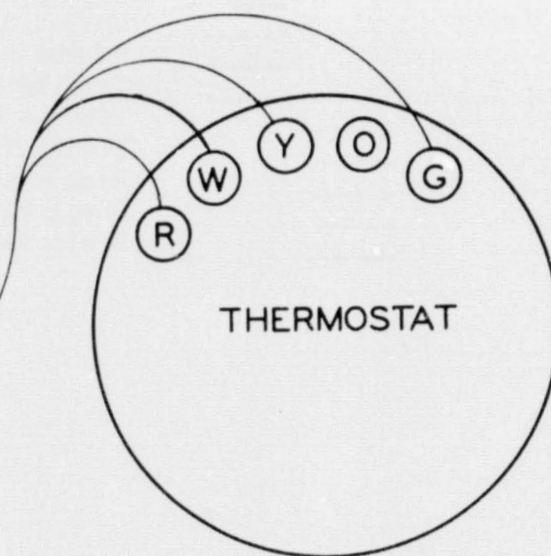
The wiring from the unit to the thermostat carries 24 volt current. The wires should be a minimum of 18 gauge. Color coded cables carrying the necessary number of wires should be used.

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OF POOR QUALITY

WF-36



4 WIRE #18
THERMOSTAT CABLE



DATE: Nov., 1976

MODELS

INSTALLATION CHECK LIST

WF-36

CUSTOMER NAME: _____ DATE: _____

ADDRESS: _____

CITY: _____ STATE: _____

SOLAIRE CHILLER: MODEL: _____ CODE: _____ SERIAL #: _____

COOLING TOWER: MAKE: _____ MODEL: _____ SERIAL #: _____

HOT WATER PUMP: MAKE: _____ MODEL: _____ SERIAL #: _____

CHILLED WATER PUMP: MAKE: _____ MODEL: _____ SERIAL #: _____

CONDENSING WATER PUMP: MAKE: _____ MODEL: _____ SERIAL #: _____

AIR HANDLER: MAKE: _____ MODEL: _____ SERIAL #: _____

AIR HANDLER TOWER UNIT

PROPER CLEARANCES AND SUPPORT

Clearances (111-6-7)

Support (111-6-7)

Clearances (111-6-4)

Support (111-6-4).

Thermostat - Location and Installation (111-6-8).

Clearances

Support

LEVELING (111-7-5)

Side-to-side

Front-to-back

CHILLER WATER PIPING (111-20-1) (111-21-5)

Pet Cocks correctly located

Thermometer wells correctly located

Unions and valves suitably located

Pipes for correct flow

Insulation

CONDENSING WATER PIPING (111-20-1) (111-33-3)

Pet Cocks correctly located

Thermometer wells correctly located

Unions correctly located

Valves - right kind and correctly located

City Water Valve Kit properly installed (if used)

Make-up water line has union, valve and means of draining

Bleed-off arrangements

Plug cock (or globe valve) correctly located

Check valve correctly located (if needed)

Drain valve(s) at low point(s) in piping

INDEX: 111-92-3 (B)

ARKLA INDUSTRIES INC.

P. O. Box 534

Evansville, Indiana 47704

DATE: Nov., 1976

AIR HANDLER TOWER UNIT

ELECTRICAL (111-60-2) (111-62-1) (111-65-2)

Switch and fusing arrangement in power supply wiring

_____ Chilled Water Pump

_____ Hot Water Pump

Power Supply on Correct Terminals

_____ Chilled Water Pump

_____ Hot Water Pump

Low Voltage Wiring on Correct Terminals

_____ Chilled Water Pump Relay

_____ Hot Water Pump Relay

HOT WATER PIPING (111-20-1) (111-54-2)

Pet Cocks correctly located

Thermometer Wells correctly Located

Unions and Valves Suitably Located

Piped for correct flow

Insulation

9.2 - Adjustments

RECOMMENDED WAY TO USE START-UP AND ADJUSTMENTS

This section of the manual pertains to the recommended routine for starting up a new installation, checking adjustments on a service call and the technical data needed for making correct adjustments.

Correct adjustments are "simple and easy" to make, if the equipment has been properly installed, instructions are followed and the proper tools are used. The tools and instruments needed, other than normal hand tools, are listed on IV-2-2.

The "key" to quickly finding the information desired is the proper use of the INDEX for the START-UP AND ADJUSTMENTS section of the manual. The section is divided into sub-sections in order to group related subjects.

IV - 1 through 9	-	Miscellaneous
IV - 10 through 19	-	Level
IV - 20 through 29	-	Chilled Water
IV - 30 through 39		
IV - 40 through 49	-	Cond. Water
IV - 50 through 59	-	Hot Water
IV - 60 through 69		
IV - 70 through 79		
IV - 80 through 89		
IV - 90 through 99	-	Check Lists

Each page has an INDEX number at the top. Under the INDEX number there is a DATE showing when that page was originally published. If the page has been rewritten to include later information, the word REVISED will replace the word DATE and show when the page was rewritten. Under the word MODELS will be shown a list of models to which the information on that page pertains. Be sure to select the page which shows the model for which you want the information. Also Under a model number, there may be a breakdown by serial numbers.

AGAIN, the "KEY" to quickly finding the information desired is the proper use of the INDEX.

INDEX			MODELS
INDEX NO.	REV.	SUBJECT	
IV-1-1		Recommended way to use Start-Up and Adjustments	WF-36
IV-1-3	4/77	Index	
IV-2-2		Suggested Tool List	
IV-2-3		Suggested Hose and Gauge Arrangement	
IV-11-2		Leveling	
IV-21-4		General Information on Filling and all water piping.	
IV-22-3		Addition of Antifreeze to the chilled water system	
IV-25-3		Adjustment of chilled water flow rate	
IV-38-2	NEW	Condensing water temp. control external of unit	
IV-45-2		Adjustment of condensing water flow rate	
IV-47-2	4/77	Condensing water bleed-off	
IV-53-9		Adjustment of hot water input	
IV-92-3	4/77(A)(B)(C)	Start-up and adjustment check list	

MODELS

SUGGESTED TOOL LIST

The following tools are necessary along with normal hand tools for the proper adjustment of a newly installed Arkla Solaire WF-36 unit. Tools may be obtained locally or ordered from Arkla Industries Inc., Evansville, Indiana 47704.

WF-36

QUANTITY	PART #	ITEM NAME
2	3469-7	6" Pocket Thermometer -40° to +120°F
4	14267-18	12" Thermometer 0° to 300°F
7	4569-4	12" Thermometer 0° to 120°F
1	14267-6	Gauge: 0 to 30 p.s.i.g.
1	14267-7	Gauge: 0 to 100 p.s.i.g.

The following items are also necessary but will have to be purchased locally:

1	N/A	Volt - Amp Meter
2	N/A	30" High Pressure Hose (Refrigerant Charging hose is suitable)
1	N/A	Spirit Level

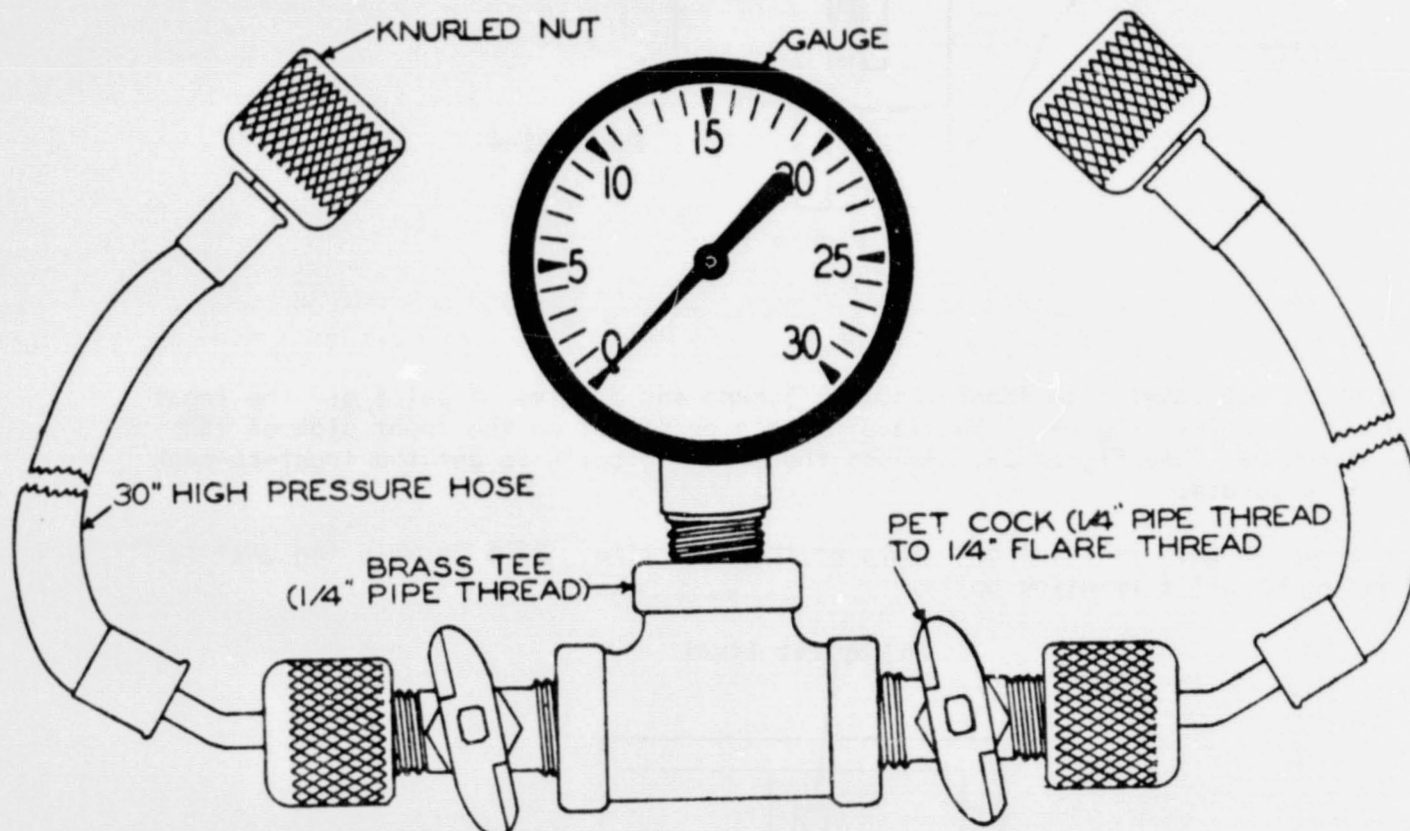
SUGGESTED HOSE AND GAUGE ARRANGEMENT

The flow rate of the chilled water, condensing water, and hot water circuits are checked by the pressure drop method. Using this method calls for both the inlet and outlet pressure to be checked with the same gauge.

WF-36

Shown below is a convenient hose and gauge arrangement. It is suggested that this arrangement be made up and carried as a service tool. It has many uses.

Be certain the gauge has sufficient range to withstand the hydrostatic pressures present in the system being checked.

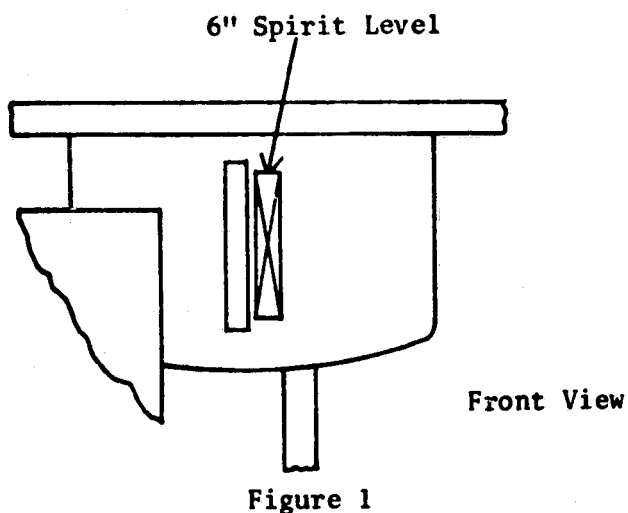


LEVEL

The unit must be level from front-to-back and side-to-side, so that liquids will flow properly inside the unit.

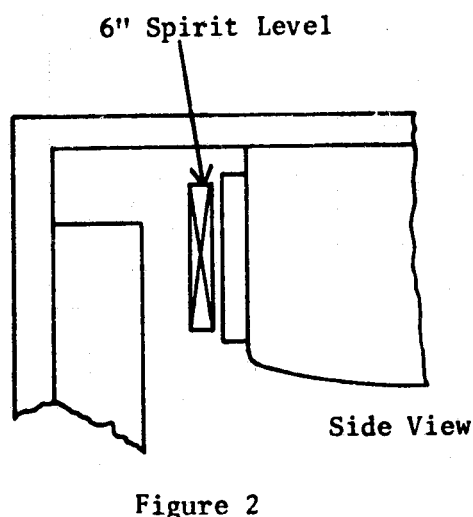
To check the level from side-to-side: Remove the front access door from the unit. The unit leveling bar is located on the solution reservoir shell (See Figure 1). Scrape any bubbles of paint off the right side of the leveling bar. Place a good 6" spirit level on the right side of the leveling bar (See figure 1). Adjust the leveling bolts on the bottom of the unit to get the side-to-side level accurate.

WF-36



To check the level from front-to-back: Scrape any bubbles of paint off the front side of the leveling bar. The level should be placed on the front side of the leveling bar (See Figure 2). Adjust the leveling bolts to get the front-to-back level accurate.

Be sure the unit is level both ways at the same time. Make certain the unit is resting on all 4 leveling bolts.



GENERAL INFORMATION ON FILLING AND TESTING ALL WATER PIPING.

All water piping should be leak tested before installing insulation or adding antifreeze.

If the water piping is to be pressure tested, DO NOT EXCEED 100 P.S.I.G.

System pumps should not be operated until the system is filled with water.

For the addition of antifreeze See IV-22-3.

WF-36

MODELS

ADDITION OF ANTIFREEZE TO THE CHILLED WATER CIRCUIT.

Once it has been determined that there are no leaks in the system, freeze protection must be considered. The chilled water system must be protected against freezing, particularly when air handling coils are subjected to large percentages of outside air.

IT IS RECOMMENDED THAT AT LEAST 10% ANTIFREEZE SOLUTION BE MAINTAINED AT ALL TIMES TO PROTECT AGAINST DAMAGE FROM FREEZING IN CASE OF A LOW TEMPERATURE SAFETY SWITCH FAILURE. A higher percentage of antifreeze should be considered for the winter season to protect against freeze damage in case the unit is not in operation during extremely low ambient temperatures. Freeze damage to a unit is not covered by the Limited Warranty.

Only ethylene glycol base antifreeze solution should be used for such protection. Listed below are recommendations concerning antifreezes to be used:

- (a) Inhibited permanent - type antifreeze.
- (b) No sealants in the mixture.
- (c) A reliable brand.

The liquid capacity of the chilled water system must be calculated. The capacity of the evaporator coil is found in Table 1.

MODEL	GALLONS IN EVAPORATOR
WF-36	1.5

To this must be added the capacity of the air handling unit(s) and can be obtained from the manufacturer. If not available, approximate capacity of air handlers can be obtained by multiplying face area of coil in square feet by number of rows of coils by .15.

The water capacity of the expansion tank must be added.

The quantity of water in pipes must also be added to arrive at the system capacity. Table 2 below will permit water line capacity to be figured.

PIPE SIZE INCHES	LINEAL FEET OF PIPE CONTAINING 1 GALLON	GALLONS PER 100 LINEAL FEET OF PIPE
1/2	65	1.6
3/4	35	2.8
1	25	4.1
1-1/4	13	7.7
1-1/2	10	10
2	7	16.7
2-1/2	4	25
3	2.6	38.5
4	1.5	66.7
5	1	100
6	67	150

INDEX: IV-22-3 (B)

DATE: Nov., 1976

ARKLA INDUSTRIES INC.

P. O. Box 534

Evansville, Indiana 47704

Table 3 below will show the percentage (by volume) of antifreeze needed to maintain protection down to a given temperature.

PERCENT BY VOLUME ETHYLENE GLYCOL ANTI-FREEZE	FREEZING POINT OF MIXTURE
10	25°F
20	15°F
30	3°F
40	-13°F

ADJUSTMENT OF CHILLED WATER FLOW RATE

It is extremely important that the chilled water flow (G.P.M.) be adjusted correctly. While checking and adjusting the chilled water flow rate, the hot water flow to the generator should be turned off. Start the chilled water pump and establish chilled water flow.

Attach a gauge to the pet cocks on the chilled water lines.

NOTE: The same gauge must be used for both readings. See IV-2-3 for suggested gauge make-up. Open both the pet cocks to fill the hoses and gauge with water. Close the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Close the pet cock on the inlet line and open the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Subtract the outlet pressure from the inlet pressure to determine the pressure drop through the unit chilled water circuit.

Using Table adjust the regulating valve in the leaving chilled water line until the pressure drop indicates the "Rated" G.P.M. through the unit.

WF-36

MODEL	CHILLED WATER G.P.M.	PRESSURE DROP P.S.I.
WF-36	6.0	1.27
	7.0	1.65
"Rated"	7.2	1.73
	8.0	2.08
	9.0	2.55
	10.0	3.03
	11.0	3.55
	12.0	4.11
	13.0 MAX.	4.72

MODELS

CONDENSING WATER TEMPERATURE CONTROL - EXTERNAL OF UNIT

The inlet condensing water to these units must be maintained at approximately 75°F or above. The adjustment of the tower fan sump switch and/or condensing water blending valve should be checked on every new start-up and every spring start-up. The temperature check should be made at the factory installed thermometer well - inlet condensing water to absorber.

WF-36

Cooling tower fan switch is shipped with the unit. It can be found behind the front panel.

CONDENSING WATER ADJUSTMENT - USING A COOLING TOWER

The cooling tower that is being used with the Arkla Solaire chiller must have the capacity, range and approach to meet the condensing water needs of the Arkla chiller. The tower manufacturer's recommendations should be followed with regards to sump water level, water distribution, etc. The actual flow rate should be adjusted at the Arkla chiller.

WF-36

ADJUSTMENTS:

For maximum efficiency and proper unit performance it is important that the condensing water flow (G.P.M.) be adjusted correctly. While checking and adjusting the condensing water flow rate, the Solaire unit itself should be turned off.

Start the condensing water pump and establish condensing water flow. Attach a gauge to the pet cocks on the condensing water lines.

NOTE: The same gauge must be used for both readings. See IV-2-3 for suggested gauge make-up. Open both the pet cocks to fill the hoses and gauge with water. Close the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Close the pet cock on the inlet line and open the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Subtract the outlet pressure from the inlet pressure to determine the pressure drop through the unit condensing water circuit. Using Table 1 adjust the regulating valve in the outlet condensing water line until the pressure drop indicates the "Rated" G.P.M. through the unit.

TABLE 1

MODEL	CONDENSING WATER FLOW G.P.M.	PRESSURE DROP THROUGH UNIT P.S.I.
WF-36	9.0	2.20
	10.0	2.63
	11.0	3.11
"Rated"	12.0	3.62
	13.0	4.16
	14.0	4.72
	15.0	5.33
	16.0	5.93
	22.0	10.31
	25.0 MAX.	12.77

NOTE: The pressure drop method and Table 1 is correct only when the unit condensing water circuit is clean and free of dirt, trash and scale.

DATE: Nov., 1976

USING WELL WATER - ONCE THROUGH

When well water is the source of condensing water for the Arkla Solaire chiller, the water flow should be adjusted so the leaving water temperature will correspond to the inlet water temperature as shown in Table 2.

TABLE 2

INLET WATER TEMPERATURE °F	ADJUST LEAVING WATER TEMPERATURE TO °F
75° Minimum	95°
80°	95°
85°	100°
90° Maximum	105°

MODELS

CONDENSING WATER BLEED-OFF

GENERAL

On III-30-1, there is a discussion concerning water treatment for condensing water from a cooling tower. The MINIMUM BLEED-OFF RATE OF 3.5 GALLONS PER TON PER OPERATING HOUR MUST BE MAINTAINED regardless of whether or not additional water treatment (chemical treatment) is used. If the water contains a large quantity of solids, the bleed-off rate should be increased above the minimum. The above formula is another way of saying "bleed-off one gallon of water for every gallon evaporated at the tower."

The rate of bleed-off should be checked on every new start-up and on every spring start-up.

ADJUSTMENT:

Start the unit on cooling operation.

Use a measuring vessel and catch the bleed-off water for three(3)"one minute" tests. Average these three tests and check the average ounces per minute against the chart below.

BLEED-OFF RATE

MODEL	3.5 G.P.H. Per ton	4.0 G.P.H. Per ton	4.5 G.P.H. Per ton	5.0 G.P.H. Per ton
	Minimum			
WF-36	oz. Per Min. 24	oz. Per Min. 26	oz. Per Min. 29	oz. Per Min. 33

WF-36

ADJUSTMENT OF HOT WATER INPUT

For maximum efficiency it is important that the hot water flow (G.P.M.) be adjusted correctly. While checking and adjusting the hot water flow rate, the Solaire unit itself should be turned off.

Start the hot water pump and establish hot water flow.

Attach a gauge to the pet cocks on the hot water input lines.

NOTE: The same gauge must be used for both readings. See IV-2-3 for suggested gauge make-up. Open both the pet cocks to fill the hoses and gauge with water. Close the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Close the pet cock on the inlet line and open the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Subtract the outlet pressure from the inlet pressure to determine the pressure drop through the unit generator hot water circuit.

Using Table adjust the regulating valve in the outlet hot water line until the pressure drop indicates the "Rated" G.P.M. through the unit.

MODEL	HOT WATER FLOW TO UNIT G.P.M.	PRESSURE DROP THROUGH UNIT P.S.I.
WF-36	5.0	1.04
	6.0	1.39
	7.0	1.78
	8.0	2.21
	9.0	2.68
	10.0	3.16
"Rated"	11.0	3.68
	12.0	4.24
	13.0	4.81
	14.0	5.41
	15.0	6.06
	16.0	6.71
	22.0 MAX.	11.26

WF-36

REV: Apr., 1977

START-UP AND ADJUSTMENT CHECK LIST

MODELS

CUSTOMER: _____ DATE: _____

ADDRESS: _____ CITY: _____ STATE: _____

UNIT: MAKE _____ MODEL _____ SERIAL NO. _____

TOWER: MAKE _____ MODEL _____ SERIAL NO. _____

AIR HANDLER: MAKE _____ MODEL _____ SERIAL NO. _____

CONDENSING WATER PUMP: MAKE _____ MODEL _____
H.P. _____ GPM _____ FT. HEAD _____HOT WATER PUMP: MAKE _____ MODEL _____
H.P. _____ GPM _____ FT. HEAD _____CHILLED WATER PUMP: MAKE _____ MODEL _____
H.P. _____ GPM _____ FT. HEAD _____

WF-36

PRE-START-UP INSPECTION

AIR
HANDLER

TOWER

CHILLER

Air conditioning system is properly
installed and has been inspected using
Installation Check List (III-92-3)LUBRICATION (Follow Motor Manufacturers
Instructions)NOTE: Motors should be oiled with electric
motor oil or oil recommended by
motor manufacturer

Air Handler(s) blower motor

Tower blower motor

Tower pump motor

LEVEL (IV-11-2)

Side-to-side

Front-to-back

CHILLED WATER PIPING (III-21-5) (IV-25-3)

Check for leaks before insulation is applied

Proper amount of insulation applied

Piped for correct flow through coil

Proper amount of antifreeze added (IV-22-3)

Inlet water pressure to unit

Outlet water pressure from unit

Pressure drop through unit

Chilled water G.P.M.

AIR
HANDLER

TOWER

CHILLER

 _____ in.
 _____ cfm

AIR HANDLER(S)

Lubricate according to manufacturer's
instructions

Coil clean and dry

Filters clean

Pulleys aligned

Proper belt tension

Draft gauge reading

Air flow across coil

Clearances (III-6-7) (III-6-4)

Front

Back

Overhead

Left end

Right end

Thermostat properly located (III-6-8)

CONDENSING WATER

Using Tower (IV-45-2)

Tower adjustments made according to manu-
facturer's instructions

Inlet Water pressure to unit

Outlet water pressure from unit

Pressure drop through unit

Condensing water G.P.M.

Bleed-off rate (IV-47-2)

HOT WATER INPUT

Hot water temperature drop through generator

Inlet hot water pressure to unit

Outlet hot water pressure from unit

Pressure drop through unit

Hot water G.P.M.

CHECK ALL AUTOMATIC SAFETY CONTROLS - OTHER
ADJUSTMENTS

Adjustment of external condensing water
temperature controller (V-36-2)

MODELS

TEMPERATURES

Place unit in operation. After one hour of continuous operation, measure and record the following temperatures. For thermometer well locations, See Index: VI-15-5.

WF-36

	INITIAL	SUBSEQUENT AS NECESSARY		
Condensing water - absorber inlet	_____	_____	_____	_____
Condensing water - condenser inlet	_____	_____	_____	_____
Condensing water - condenser outlet	_____	_____	_____	_____
Condenser Surface	_____	_____	_____	_____
Weak Solution	_____	_____	_____	_____
Strong Solution	_____	_____	_____	_____
Generator return	_____	_____	_____	_____
Generator	_____	_____	_____	_____
Hot Water Generator IN	_____	_____	_____	_____
How Water Generator Out	_____	_____	_____	_____
Chilled water Inlet	_____	_____	_____	_____
Chilled Water Outlet	_____	_____	_____	_____
Coil	_____	_____	_____	_____

2.3 Controls

MODELS

RECOMMENDED WAY TO USE CONTROL SECTION

This section of the manual pertains to the electrical controls, safety switches and equipment and the hot water controls used on Arkla Solaire Air Conditioning equipment. The information on each item pertains to what is being used on current production or the current replacement for previously used items at the time of the writing. Each item is identified as to its location on the equipment, purpose and other pertinent information.

WF-36

Quite often it will be necessary to use information from the Adjustments Section and the Service Section along with the Controls Section to perform the necessary service on an air conditioning system.

The "key" to quickly finding the information desired is the proper use of the INDEX for the CONTROLS Section of the manual. The section is divided into sub-sections in order to group related subjects.

V - 1 through 4	-	General
V - 5 through 9	-	Figures showing physical location of controls switches etc.
V - 10 through 29	-	Safety Switches
V - 30 through 49	-	Controls
V - 50 through 59		
V - 60 through 69		
V - 70 through 79		
V - 80 through 89	-	Control circuits
V - 90 through 99	-	Wiring Diagrams

Each page has an INDEX number at the top. Under the INDEX number there is a DATE showing when that page was originally published. If the page has been rewritten to include later information, the word REVISED will replace the word DATE and show when the page was rewritten. Under the word MODELS will be shown a list of models to which the information on that page pertains. Be sure to select the page which shows the model for which you want the information. Also under a model number, there may be a breakdown by serial numbers.

AGAIN, the "KEY" to quickly finding the information desired is the proper use of the INDEX.

ARKLA INDUSTRIES INC.

P. O. Box 534

Evansville, Indiana 47704

INDEX: V-1-3

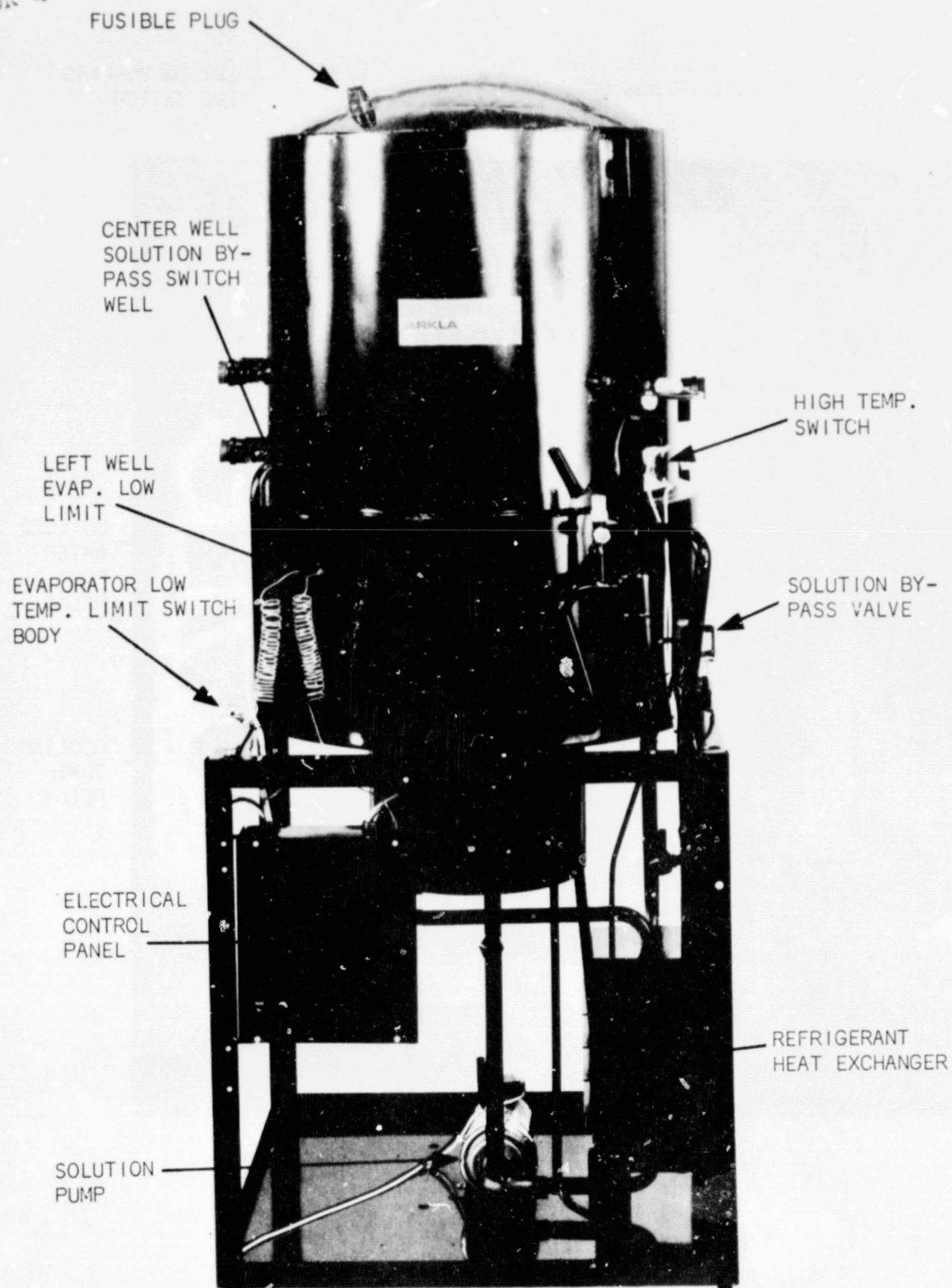
REV: Apr., 1977

MODELS

		INDEX	
INDEX NO.	REV.	SUBJECT	
V-1-1		Recommended way to use Control Section	
V-1-3	4/77	INDEX	WF-36
V-5-8		Pictures Showing Location of Switches and Controls.	
V-10-4		High Temperature Limit Switch	
V-11-5		Evaporator Low Temperature Limit Switch	
V-11-6	4/77	Solution By-Pass Valve Switch	
V-27-2		Fusible Plug	
V-36-2		Tower Sump Switch	
V-45-2		Control Voltage Transformer	
V-75-5		Solution By-Pass Valve	
V-85-1		Control Data	
V-90-2		Wiring Diagram	

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PICTURE SHOWING LOCATION OF SWITCHES AND CONTROLS



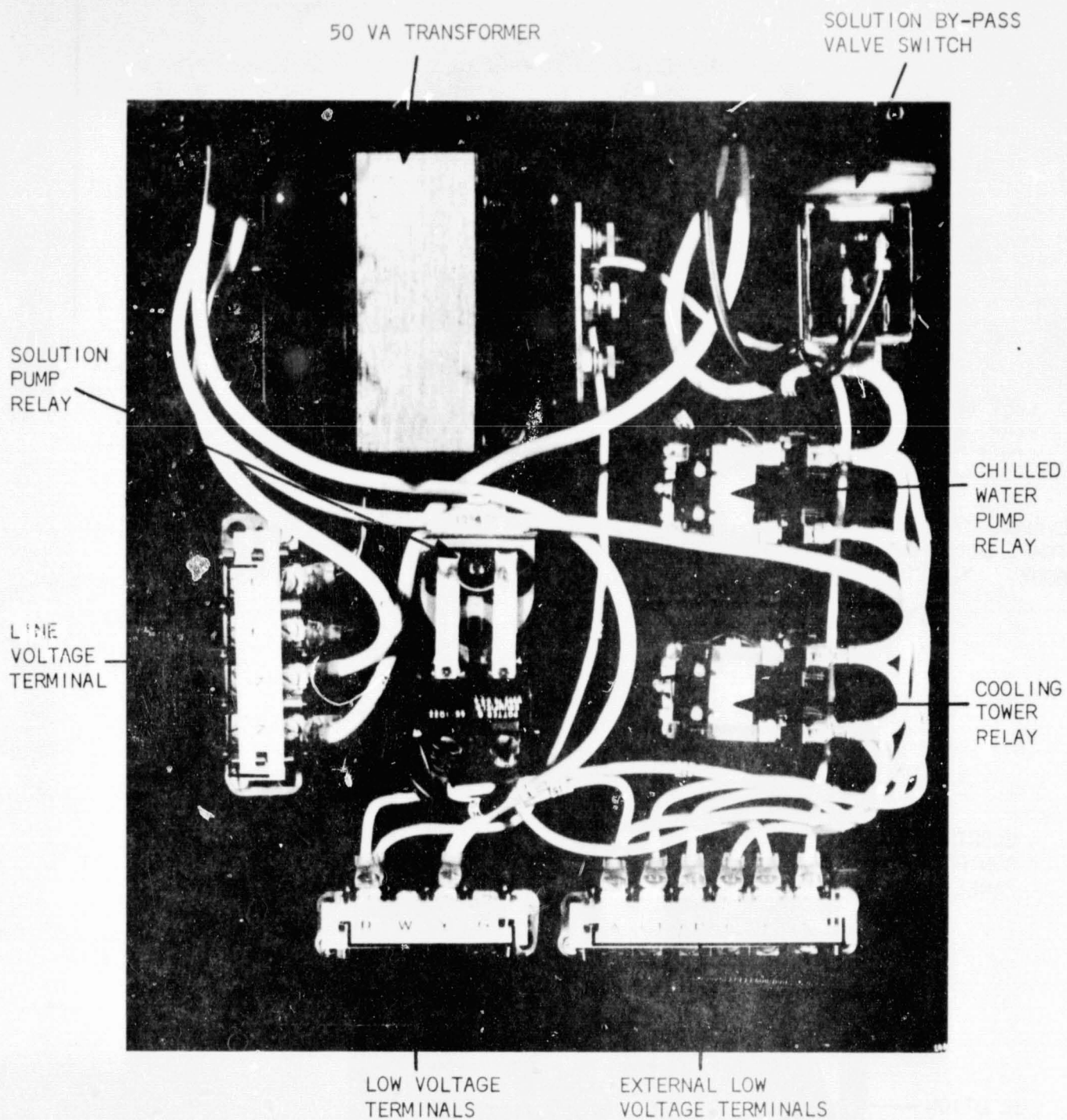
INDEX: V-5-8 (B)

DATE: Nov., 1976

ARKLA INDUSTRIES INC.

P.O. BOX 534

EVANSVILLE, INDIANA 47704



HIGH TEMPERATURE LIMIT SWITCH

This switch is mounted on the right front area of the condenser shell close to the condenser surface thermometer well. (See Index V-5-8(A)).

WF-36

The function of this switch is to stop the flow of hot water to the generator, shut off the chilled water circulating pump, and shut off the unit's solution pump when the unit overheats.

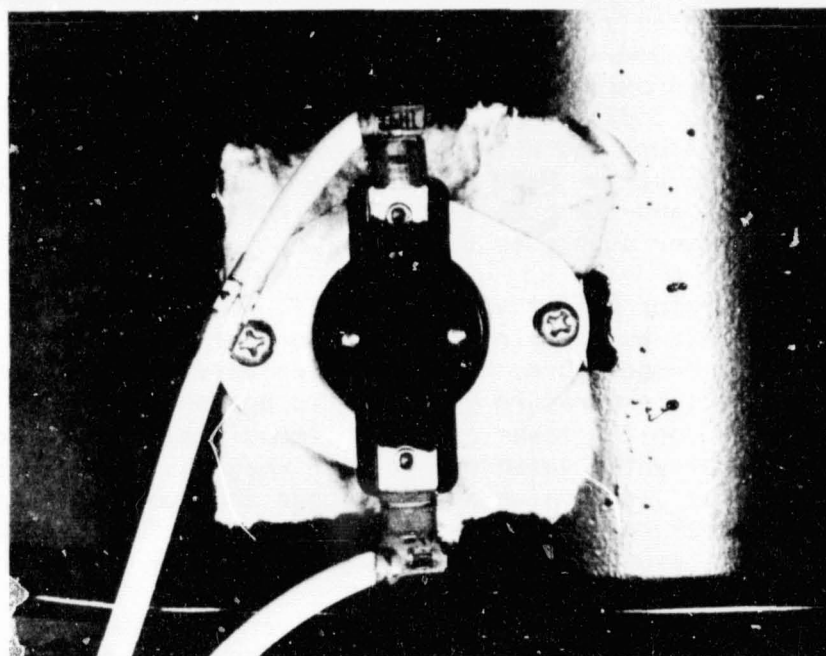
The switch is in the low voltage circuit controlling the chilled water pump relay. For detailed information see the Schematic Wiring Diagram on V-90-2.

The switch is calibrated at the factory to open when the condenser surface temperature rises to $120 \pm 6^\circ\text{F}$ and automatically reset when the temperature goes down to $110 \pm 6^\circ\text{F}$. The switch cannot be recalibrated in the field.

A trained service man should be called to determine the cause if the unit is cycling on this switch.

UNDER NO CONDITIONS SHOULD THE UNIT BE OPERATED WITH WITH SWITCH JUMPERED ELECTRICALLY, LOOSE FROM ITS MOUNTED POSITION, OR DEFECTIVE.

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EVAPORATOR LOW TEMPERATURE LIMIT SWITCH

WF-36

The body of this switch is mounted left front corner of unit frame. (See Figure on V-5-8 (A)). Its capillary bulb must be placed in the left well on the side of the evaporator. (See Figure on V-5-8 (A)).

The primary purpose of this switch is to interrupt hot water flow and condensing water flow through the unit if the coil temperature goes down to approximately $33\pm 1^{\circ}\text{F}$. The switch will automatically reset when the coil temperature rises approximately 4°F .

This switch is in the control wiring circuits for the external hot water valve and cooling tower. For detailed information, see the Schematic Wiring Diagram at rear of this section.

The calibration of this switch has been set at the factory, but its calibration should be checked on initial start-up and every cooling season start-up. IF THIS SWITCH IS DEFECTIVE, REPLACE IT. UNDER NO CIRCUMSTANCES OPERATE THE UNIT WITH THIS SWITCH ELECTRICALLY JUMPERED OR WITH ITS BULB OUT OF ITS WELL OF IF THE SWITCH IS DEFECTIVE.

This switch can be adjusted in the field, BUT EXTREME CARE SHOULD BE TAKEN TO ADJUST IT ACCURATELY. The calibration should be checked several times before making any change.

Information on two different ways to check the calibration is given below. The safest method is the use of ice and water.

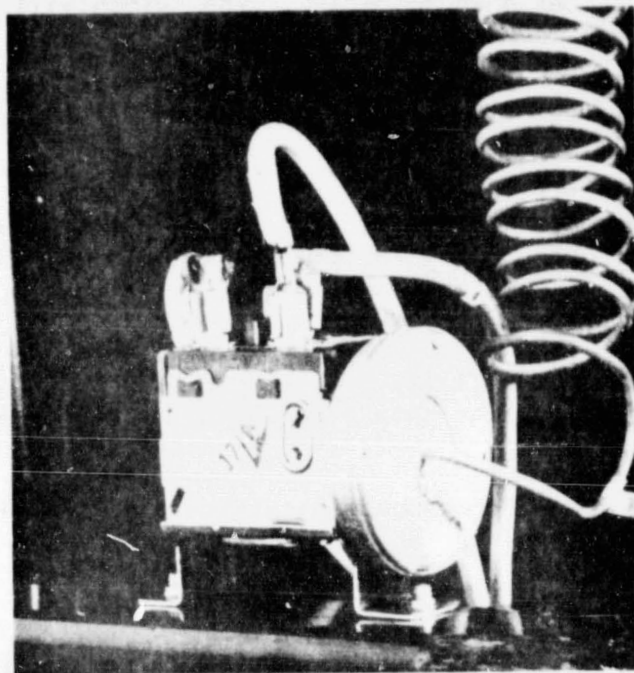
1. Turn off the power supply to the unit. Remove the bulb from its well. Place the bulb and a thermometer in a container with enough water in it to completely immerse the bulb. Add ice slowly and stir constantly with the thermometer. Listen closely at the switch body for an audible "click." Read the thermometer. The switch should open at approximately $33\pm 1^{\circ}\text{F}$. Slowly warm the water in the container and listen for the audible "click" when the switch closes. It should close when the water temperature has risen about 4°F . When calibration is correct, replace the bulb in well. Make sure the well is full of aluminum heat transfer paste or glycerine and the bulb is properly held in the well with the rubber stopper. Turn on power supply to unit.
2. Place thermometer in evaporator coil thermometer well. Operate unit on "cooling." Gradually reduce load on unit by covering more and more of the return air grill(s). Continually watch the coil temperature. The hot water valve should close and cooling tower cut off, when the coil temperature goes down to approximately $33\pm 1^{\circ}\text{F}$. When hot water valve closes and cooling tower cuts off, immediately remove cover from return air grill(s). The hot water valve should open when the coil temperature rises about 4°F . If the hot water valve does not open and cooling tower cut off by the time the coil temperature has gone down to 32°F , turn "OFF" hot water supply and cooling tower, uncover return air grill(s) and recalibrate the switch.

To adjust the calibration, slide out the phenolic end cover from the switch body. A screw driver adjustment slot will be seen as well as an indicating arrow for raising or lowering of control point. Approximately $1/3$ of a turn will change the control point one degree. Check for correct calibration several times after making any change in adjustment.

DATE: Nov., 1976

UNDER NO CIRCUMSTANCES SHOULD THIS UNIT BE OPERATED WITH THIS SWITCH ELECTRICALLY JUMPERED, BULB OUT OF ITS WELL, OR DEFECTIVE.

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MODELS

SOLUTION BY-PASS VALVE SWITCH

WF-36

The body of this switch is mounted in the control panel. (See Figure on V-5-8(B)). Its capillary bulb must be placed in the center well on the left side of the evaporator coil. (See Figure on V-5-8 (A)).

The primary purpose of this switch is to energize the solenoid coil on the solution by-pass valve (See Figure on V-5-8 (A)) to open valve when the evaporator coil temperature goes down to $36 \pm 1^\circ\text{F}$. The switch will automatically open when the evaporator rises approximately 4°F .

The switch is in the 115 volt control circuit for the solution by-pass valve. For detailed information see the Schematic Wiring Diagram on V-90-2.

The calibration of this switch has been set at the factory, but its calibration should be checked on initial start-up and every cooling season start-up. IF THIS SWITCH IS DEFECTIVE. REPLACE IT. UNDER NO CIRCUMSTANCES OPERATE THE UNIT WITH THIS SWITCH ELECTRICALLY JUMPERED, WITH ITS BULB OUT OF ITS WELL OR DEFECTIVE.

This switch can be adjusted in the field, BUT EXTREME CARE SHOULD BE TAKEN TO ADJUST IT ACCURATELY. The calibration should be checked several times before making any change.

Information on two different ways to check the calibration is given below:
The preferred method is the use of ice and water.

1. Turn "off" the power supply to the unit. Remove the bulb from its well. Place the bulb and a thermometer in a container with enough water in it to completely immerse the bulb. Add ice slowly and stir constantly with the thermometer. Listen closely at the switch body for an audible "click." Read the thermometer. The switch should close at approximately $36 \pm 1^\circ\text{F}$. Slowly warm the water in the container and listen for the audible "click" when the switch opens. It should open when the water temperature has risen about 4°F . When calibration is correct, replace the bulb in well. Make sure the well is full of aluminum heat transfer paste or glycerine and the bulb is properly held in the well with the rubber stopper. Turn "on" power supply to unit.
2. Place thermometer in evaporator coil thermometer well. Operate unit on "cooling." Gradually reduce load on unit by covering more and more of the return air grill(s). Continually watch the coil temperature. To determine when the solution by-pass valve opens and closes, place fingertips on the solenoid coil casing. The valve should make an audible "click" when it opens or closes and a vibration should be felt at the same time. The solution by-pass valve should open when the coil temperature goes down to approximately $36 \pm 1^\circ$. When the solution by-pass valve opens, immediately remove cover(s) from return air grill(s). The solution by-pass valve should close when the coil temperature rises about 4°F . If the solution by-pass valve does not open by the time the coil temperature has gone down to 35°F , turn "OFF" hot water supply and cooling tower uncover return air grill(s) and re-calibrate the switch.

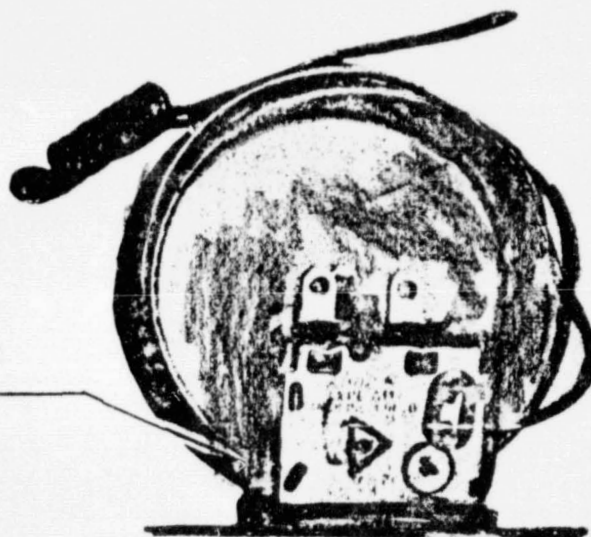
DATE: Nov., 1976

To adjust the calibration, slide out the phenolic end cover from the switch body. A screw driver adjustment slot will be seen as well as an indicating arrow for raising or lowering of control point. Approximately 1/3 of a turn will change the control point one degree. Check for correct calibration several times after making any change in adjustment.

UNDER NO CIRCUMSTANCES SHOULD THIS UNIT BE OPERATED WITH THIS SWITCH ELECTRICALLY JUMPERED, BULB OUT OF ITS WELL, OR DEFECTIVE.

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ADJUSTING SCREW
UNDER COVER



MODELS

FUSIBLE PLUG

This safety device is located on the top of the unit. (See Index V-5-8(A)).

The function of this safety plug is to melt in case of an excessive build up of heat in the unit.

The fusible plug is designed to melt at a temperature of 255°F.

In the event the fusible plug ever melts, a trained serviceman should be called to determine the cause.

UNDER NO CIRCUMSTANCES OPERATE THE UNIT WITH THIS SAFETY DEVICE DEFECTIVE.

WF-36



TOWER SUMP SWITCH

WF-36

This switch is shipped in a package with the Solaire unit. It should be installed in the cooling tower if there is not already a fan aquastat with the tower. The bulb of this sump switch should be located such that the water dripping from the packing sheets will splash on it.

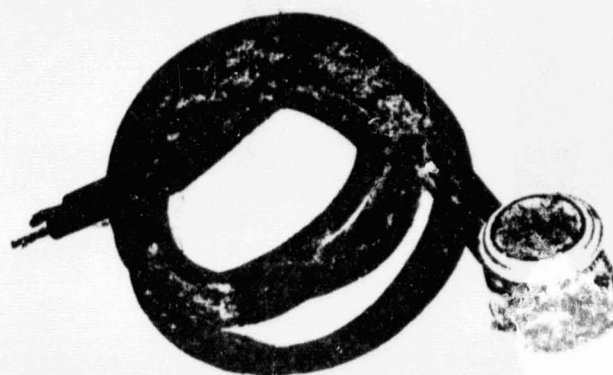
The purpose of this switch is to maintain the inlet condensing water temperature to the unit at 75°F or above.

This switch should be wired in high voltage wiring to the tower blower motor.

This is a sealed bi-metallic disc type of switch and is single pole, single throw. It is calibrated to close at 85°F and open at 75°F.

To check the calibration of this switch set the thermostat switch and dial to call for "cooling." Place a thermometer with its bulb in the water beside pump's strainer screen. Read thermometer when the blower motor starts. Turn off the hot water supply to the unit. When the tower blower motor stops, read the thermometer. If the sump switch is out of calibration or defective, it must be replaced. After checking the calibration, return all controls to their normal operating position.

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SUMP SWITCH

MODELS

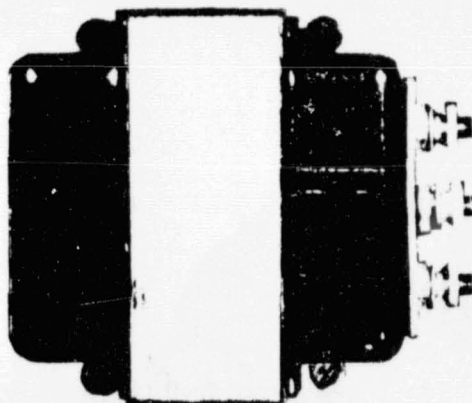
CONTROL VOLTAGE TRANSFORMER

The 115 volt primary, 24 volt secondary, 50 VA transformer is located in the units electrical control box. (See Figure 1 on V-5-8 (C)).

The purpose of this transformer is to supply 24 volts to operate the units control system and also to supply 24 volts to operate external relays which control system operation. See the wiring diagram on V-90-2.

A defective transformer must be replaced with one of correct voltage and adequate VA capacity.

WF-36



DATE: Nov., 1976

MODELS

SOLUTION BY-PASS VALVE

The valve body is welded into the by-pass line from the weak solution line. The valve is located at the right front corner on the evaporator coil tank. (See Index V-5-8(A)).

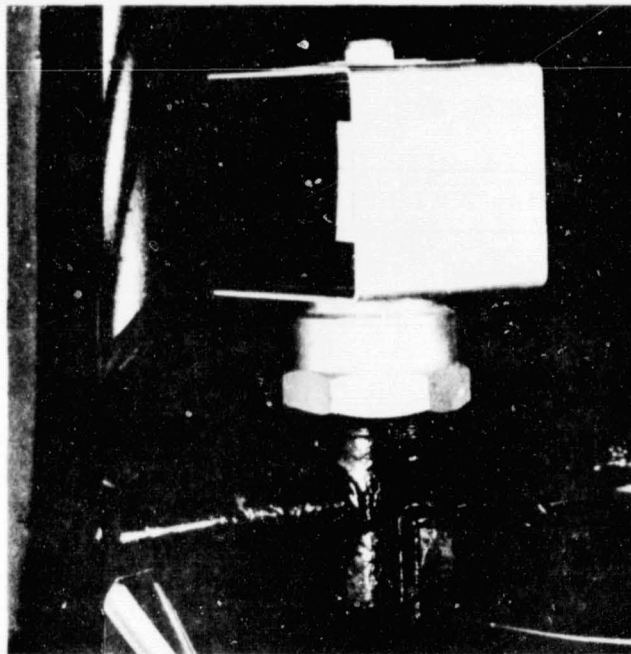
WF-36

The function of this valve is to by-pass weak solution away from the absorber coils to prevent flashing of refrigerant and possible unit cycling on the evaporator low temperature switch.

The solenoid coil for the valve is in a 115 volt circuit and is controlled by the solution by-pass valve switch. (See Index V-11-6 for checking operation of the valve.) When the valve is closed, the by-pass line from the valve to the tank will be approximately ambient temperature. When the valve is open, the by-pass line from the valve to the tank will be much warmer than ambient. Also, the evaporator coil temperature will rise when the valve is open.

IF THE SOLENOID COIL FAILS, IT MUST BE REPLACED.

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ARKLA INDUSTRIES INC.

P. O. Box 534

Evansville, Indiana 47704

INDEX: V-85-1

DATE: Nov., 1976

MODELS

CONTROL DATA

ARKLA PART #	DESCRIPTION	VENDOR NAME AND #
14537-326	High Temperature Limit Switch	Texas Instrument #2060167-245
14537-324	Evaporator Low Temperature Limit Switch	Ranco-Type A22-2267
14537-325	Solution By-Pass Valve Switch	Ranco-Type A22-2267
14537-106	Tower Sump Switch	Texas Instrument #20420F3-79-89
14512-99	Transformer - 50 V.A. N.E.C. Approved for Class 2 Service U.S. Approved	Basler Electric #BE84451CD47
14214-53	Solenoid Coil For Solution By-Pass Valve	Sporlan #KC-12-40-BK48
14537-174	Solution Pump Relay SPST-N.O.	Potter Brumfield AK-1022
14537-234	Chilled Water Pump Relay DPST-N.O.	Potter Brumfield - KU7A15
14537-234	Cooling Tower Relay DPST-N.O.	Potter Brumfield - KU7A15
14509-7	Capacitor For Solution Pump Motor 370VAC-12.5 MFD	P.R. MALLORY CO. 37BE37125

WF-36

WF-36
Code 1**NOTES:**

1. HEAVY LINES INDICATE CONNECTIONS TO BE MADE AT TIME OF INSTALLATION. MAIN SWITCH AND T.D. FUSE TO BE SUPPLIED LOCALLY.
2. POSITION OF ALL SWITCHES SHOWN WITH POWER OFF.
3. IF ORIGINAL WIRE SUPPLIED IS REPLACED, USE U.L. APPROVED TYPE WIRE FOR 105°C.

MODEL
WF 36

PART NO.

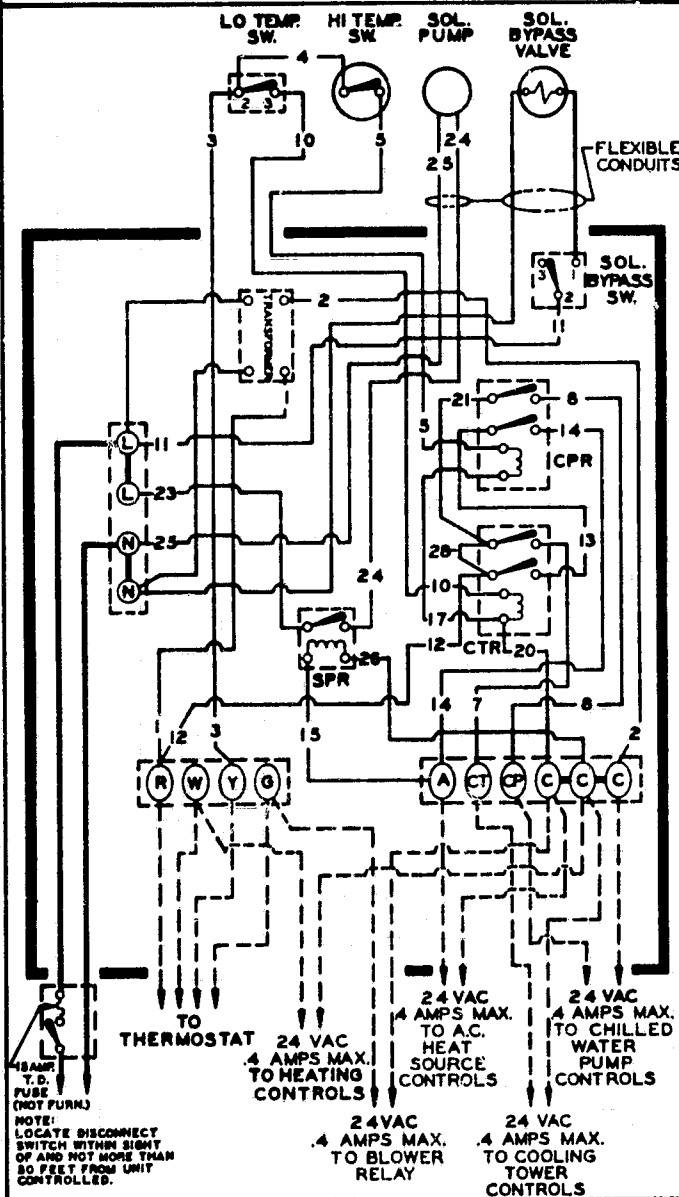
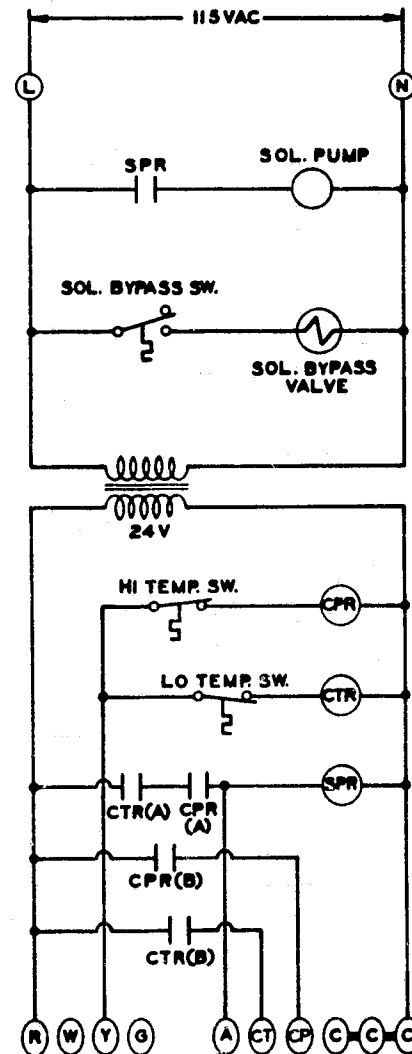
DI4004-464

REVISION

C

CAUTION

AIR COND. 115V

ARKLA INDUSTRIES INC.
EVANSVILLE, INDIANA 47704

SCHEMATIC DIAGRAM

9.4 Maintenance

MODELS

RECOMMENDED WAY TO USE MAINTENANCE
AND SERVICE SECTION

This section of the manual pertains to the maintenance and service of Arkla Solaire Air Conditioning Equipment other than routine adjustments. Information on controls and the checking or servicing of controls is in the Controls Section of the manual.

WF-36

Routine maintenance and service is not difficult provided the right tools are used and instructions are followed. Service instructions in this manual list tools needed other than normal hand tools.

The "key" to quickly finding the information desired is the proper use of the INDEX for the MAINTENANCE AND SERVICE section of the manual. The section is divided into sub-sections in order to group related subjects.

- VI - 1 through 9 - Maintenance
- VI - 10 through 14 - Unit Cycle of Operation
- VI - 15 through 19 - Thermometer Well Location Charts
- VI - 20 through 24 - Temperature Analysis
- VI - 25 through 29 - Complaint Analysis Charts
- VI - 30 through 39 - Condensing Water
- VI - 40 through 49 - Non Condensibles
- VI - 50 through 54 - Over Concentration
- VI - 55 through 59 - Under Concentration
- VI - 60 through 69 - Unit Repairs
- VI - 70 through 79 - Tower Service
- VI - 80 through 89
- VI - 90 through 94
- VI - 95 through 99 - Service Report Forms

Each page has an INDEX number at the top. Under the INDEX number there is a DATE showing when the page was originally published. If the page has been rewritten to include later information, the word REVISED will replace the word DATE and show when that page was rewritten. Under the word MODELS will be shown a list of models to which the information on that page pertains. Be sure to select the page which shows the model for which you want the information. Also under a model number, there may be a break-down by serial numbers.

AGAIN, the "KEY" to quickly finding the information desired is the proper use of the INDEX.

INDEX		
INDEX NO.	REV.	SUBJECT
VI-1-1		Recommended Way To Use Maintenance And Service Section
VI-1-3	4/77	Index
VI-4-2	4/77(A)	Maintenance
VI-5-1	4/77(B)	Checking Switches, Controls and Circuits
VI-10-2		Cycle of Operation
VI-15-5		Thermometer Well Locations
VI-20-1		Normal Operating Temperatures
VI-21-5		Temperature Analysis
VI-21-6		Special Temperature Analysis
VI-31-2		Condensing Water - Effects Of Scale, Trash or Etc. In Circuit.
VI-32-1		Scale Removal
VI-33-2		Mud or Trash In Condensing Water Circuit
VI-34-2		Cleaning Purge Pump
VI-41-2		Non-Condensable Gases In Unit
VI-43-2		Vacuum Pumping
VI-45-2		Purge Pump - Operation
VI-47-1		Inhibitor
VI-47-2		Instructions For Adding Inhibitor
VI-47-3		Instructions For Adding Inhibitor
VI-48-2		Obtaining Solution Samples
VI-50-1		Over Concentration - Effects And Causes
VI-51-3		Correction of Over Concentration
VI-53-2		Installing And Removing Charging Valve Wrench
VI-55-2		Under Concentration
VI-61-11		Air Leak - Sealed Unit
VI-61-12		Air Leak - Sealed Unit - Above Solution Level
VI-61-13		Air Leak - Sealed Unit - Below Solution Level
VI-64-5		Replacing Fusible Plug
VI-71-2		Tower Problems
VI-95-2		Service Report Form

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MODELS

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MAINTENANCE.

Proper maintenance is a necessity to insure continuous, efficient operation of the equipment. It prolongs the life of the equipment and reduces service requirements.

The maintenance requirements on Arkla's Solaire Units are relatively simple. The suggested monthly routine can be done by competent building maintenance personnel.

Spring and fall change-overs and any service should be handled by trained servicemen.

Maintenance on auxiliary equipment to the Arkla unit should be performed according to the manufacturer's recommendations.

In the suggested inspection routines, reference is made to page numbers in the Arkla Service Manual. This is to aid in finding the information needed on a particular subject.

As these inspections are made, all temperatures and adjustments should be recorded. Changes in temperature or conditions should be noted for discussion with the servicing agency.

MONTHLY INSPECTIONSCOOLING:

1. Take a complete set of temperature readings (VI-15). If a problem is indicated, call servicing agency.
2. Check cooling tower;
 - a. Cleanliness of sump.
 - b. Cleanliness of sump screen
 - c. Condition of fan belt.
 - d. Level
 - e. Check water distribution system
3. Check condensing water bleed-off flow rate (IV-47-2)
4. Check operation of condensing water chemical treatment equipment (if using).
5. Open all valves, on dirt legs and strainers, long enough to flush out any dirt or trash.
6. Visually check piping for leaks.
7. Perform maintenance on auxiliary equipment as per manufacturer's instructions.
8. Check equipment and area for cleanliness.

SPRING START-UPA. TOWER

1. Clean and flush distribution system and sump and sump strainer.

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2. Replace all drain plugs, clean strainers, and close all drain valves.
3. Start filling tower sump.
4. Perform maintenance on tower fan motor and pump motor as per manufacturer's instructions.
5. Check condition and adjustment of tower fan belt.
6. When tower sump is filled, check adjustment of water level control.
7. Check fuses, start the condensing water pump.
8. After full flow of condensing water has been established, check the bleed-off flow rate (IV-47-2).
9. Check operation of chemical treatment equipment (if using).
10. After condensing water has been flowing at least 10 minutes, shut off pump.
11. Open valves on dirt legs and strainers and flush out any mud or trash.

B. UNIT

1. Perform maintenance on water pumps as per manufacturer's recommendations.
2. Check level of unit (IV-11-2).
3. Turn off manual hot water valve and then put unit into operation electrically.
4. Open valves on dirt legs just long enough to drain out any dirt or trash.
5. Clean filters.
6. Purge all air from chilled water system.
7. Check water piping for leaks.
8. Check chilled water flow rate (IV-25-3).
9. Check anti-freeze concentration (IV-22-3).
10. Check condensing water flow rate through unit (IV-45-2).
11. Check hot water flow rate through unit (IV-53-9).

C. CONTROLS

1. Check operation of weak solution by-pass valve and switch. See (V-75-5, (V-11-6).
2. Check operation of tower fan sump switch. (V-36-2)

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3. Check operation of low temp switch. (Index V-11-5).

4. Check all external controls in the system.

D. OPERATIONAL CHECK

1. Place thermometers in all thermometer wells (VI-15).

2. Operate unit on cooling for at least 30 minutes or until all temperatures have stabilized.

3. Record temperatures.

SHUT DOWN

A. TOWER

NOTE: If the condensing water system could be subjected to sub-freezing temperatures it is recommended that the system be flushed with a mixture of anti-freeze and water after performing the shut down procedure given below. This mixture should be capable of withstanding the lowest expected ambient temperature.

1. Close valve in tower make-up water line.

2. Open all drain valves and remove all plugs in condensing water system.

3. Clean and flush tower's distribution system.

4. Clean and flush tower sump.

5. Clean all strainers in condensing water system.

6. Circulate anti-freeze through condensing water circuit.

7. Remove fuses so that condensing water pump or tower fan cannot accidentally be operated without water.

B. UNIT

1. Turn off unit.

2. Open all valves to drain the condensing water circuit.

3. Turn off manual hot water supply valve to the unit. Open drain valves.

4. Check anti-freeze concentration (IV-22-3) and close chilled water valves at unit.

MODELS

CHECKING SWITCHES, CONTROLS AND CIRCUITS

Checking of switches, controls and control circuits can be simple, provided the right tools are used and a careful analysis is made. The tools necessary are a low voltage test light, a high voltage test light, a volt-ammeter and normal hand tools.

Suggested below are some step-by-step routines that can be followed for checking various conditions. Many steps can be bypassed provided a careful analysis is made before starting your checking routine.

ON ANY SERVICE CALL--FIRST CHECK THE THERMOSTAT TO MAKE SURE THE SWITCHES AND DIAL ARE SET CORRECTLY FOR THE TYPE OF OPERATION DESIRED.

COOLING

Generally the customer complaint will be "Not Cooling." After checking the settings of the dial and switches on the thermostat, observe the operation of the major components (Hot Water Valve, Air Handler, Chilled Water Pump, Cooling Tower and Solution Pump).

A. If none of the major components are operating, make checks in this suggested order:

1. Main electrical switch and fuses.
2. Voltage to units high voltage terminal block with high voltage test light and/or volt meter.
3. Voltage at T1 and T2 terminals of transformer with low voltage test light and/or volt meter.
4. Turn off main switch. Remove thermostat wires from R and Y post on unit's terminal block. Fasten jumper between R and Y on unit's terminal block. Turn on main switch.
 - a. If unit operates, turn off power supply. Remove jumper and replace wires. Remove wires from R and Y terminals on thermostat and twist wires together. Turn on power supply. If unit operates, the problem is in the thermostat. If unit does not operate, the trouble is in wiring between unit and thermostat.
 - b. If unit does not operate, turn off power supply. Check wiring on control panel for loose connections, bad wires or incorrect wiring.

B. If all components are "short cycling" together, trouble is in the thermostat, wiring or incorrect voltage. Follow the same checking routine as listed in A.

C. If a particular major component (Hot Water Valve, Air Handler, Chilled Water Pump, Cooling Tower or Solution Pump) is "short cycling," follow the checking routine listed below.

1. Study the schematic wiring diagram for the unit to determine the switches and controls in the circuit for the particular component that is "short cycling".

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2. Check each switch and control in the low voltage circuit with low voltage test light. Place the prongs of the test light on the terminals of the switch or control. If the test light does not light, the switch is closed. If the test light lights, the switch is open.
3. Check write-up on the switch or control that shows open to determine whether switch or control is operating properly.
 - a. If it needs to be calibrated, recalibrate it. If it is defective, replace the switch.
 - b. If a motor is "short cycling" on its thermal over load switch, check wiring to motor, voltage at motor with volt meter, amperage draw with ammeter, and motor load to determine cause.

For quick reference, see the Table below for operation of major components when certain switches are not in their normal position. If hot water is flowing through unit and all motors are running, refer to Unit Analysis (VI-21-5) in Arkla Service Manual Form #611S-258

	Lo Temp Sw. OPEN See V-11-5	Hi Temp Sw. OPEN See V-10-4	Sol. By-Pass Valve Switch CLOSED See V-11-6
HOT WATER VALVE	Closed	Closed	Open
CHILLED WATER PUMP	Running	Off	Running
COOLING TOWER	Off	On	Running
AIR HANDLER BLOWER	Running	Running	Running
SOLUTION PUMP	Off	Off	Running

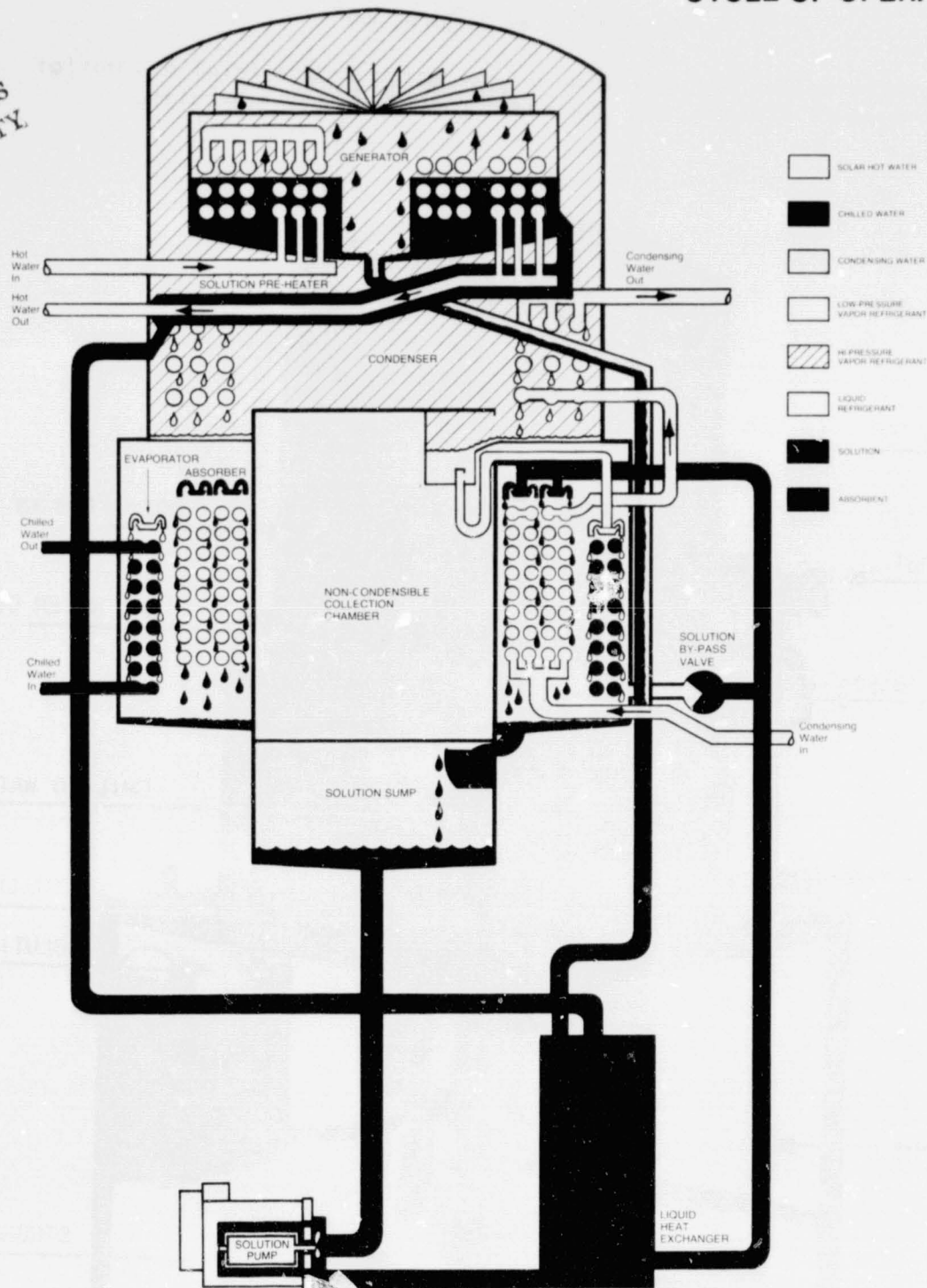
See Unit
Analysis (VI-21-5)

ARKLA **solaire**[®] SOLAIRE 36

SUN POWERED AIR CONDITIONING

CYCLE OF OPERATION

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The Arkla SOLAIRE[®] unit operates on the absorption principle, utilizing solar heated water as the energy source, with lithium bromide and water as the absorbent-refrigerant solution. Its refrigeration tonnage is delivered by chilled water which circulates in a closed loop between the unit's evaporator coil and a standard fan-coil assembly(s) located inside the conditioned space. In another loop, condensing water is circulated through the unit's absorber and condenser coils to remove waste heat from the cycle.

The explanation of the cycle illustrated above begins with the solution in the solution sump. The hermetically sealed stainless steel solution pump moves solution through the liquid heat exchanger to the generator. Inside the generator, heat (from solar heated water) separates the refrigerant (water) from the absorbent (lithium bromide solution). At this point the absorbent flows by gravity back through the liquid heat exchanger to the absorber. The vaporized refrigerant passes to the condenser, where it gives up its latent heat to the condensing water and is liquefied. It then flows through a metering device to the evaporator. There, the heat from the chilled water circuit is absorbed by the evaporating refrigerant. The refrigerant vapor and absorbent are reunited by the absorption process. The lithium bromide solution flows into the solution sump to begin the cycle again.

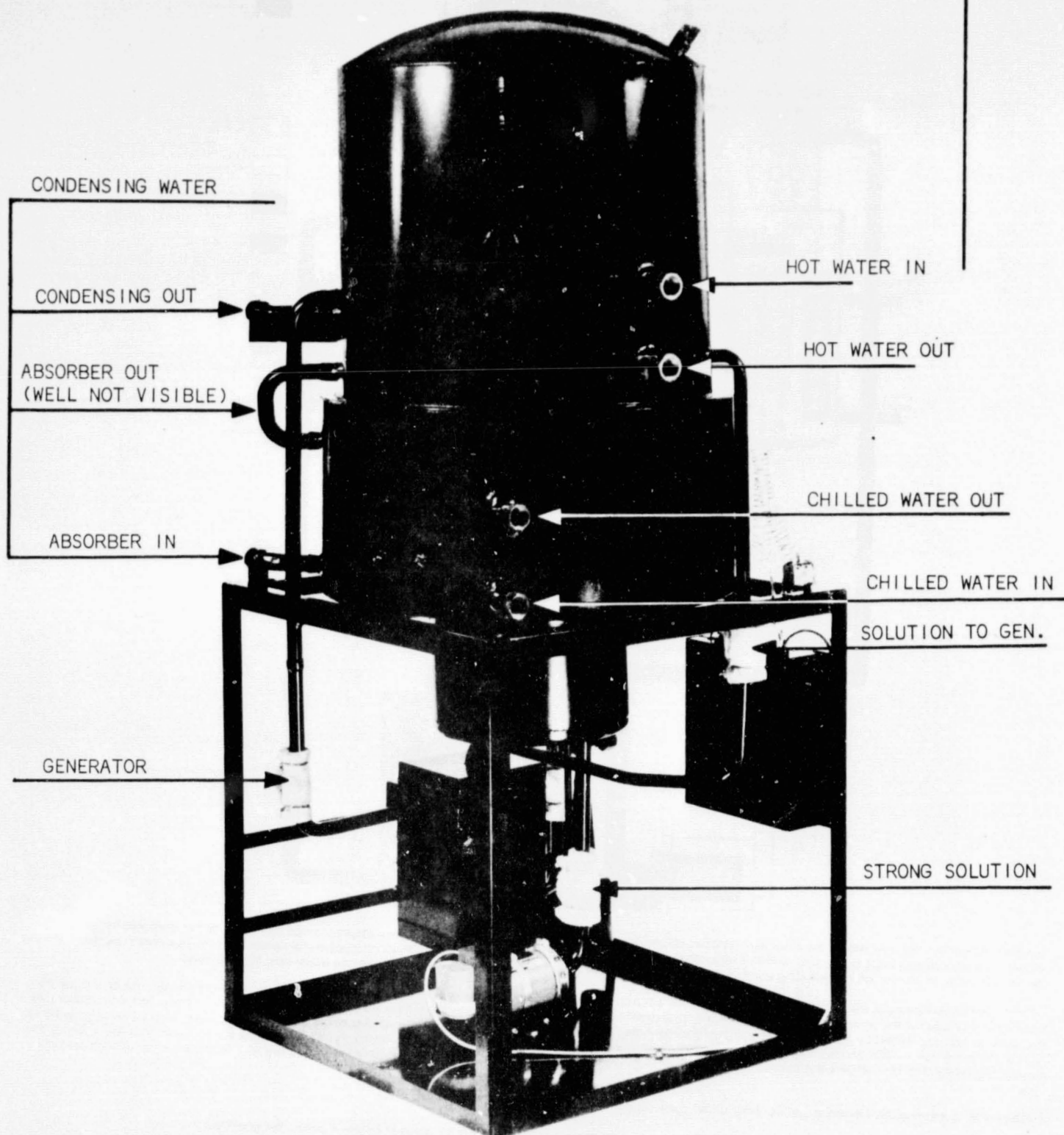
Refinements to improve the efficiency and flexibility of the cycle include:

- The liquid heat exchanger which conserves heat by using the hot absorbent liquid to preheat the solution before it enters the generator.
- The solution by-pass valve. This valve is opened by a thermostatic switch which senses refrigerant temperature in the evaporator. The valve by-passes solution from the absorber coil allowing the unit to maintain maximum efficiency.

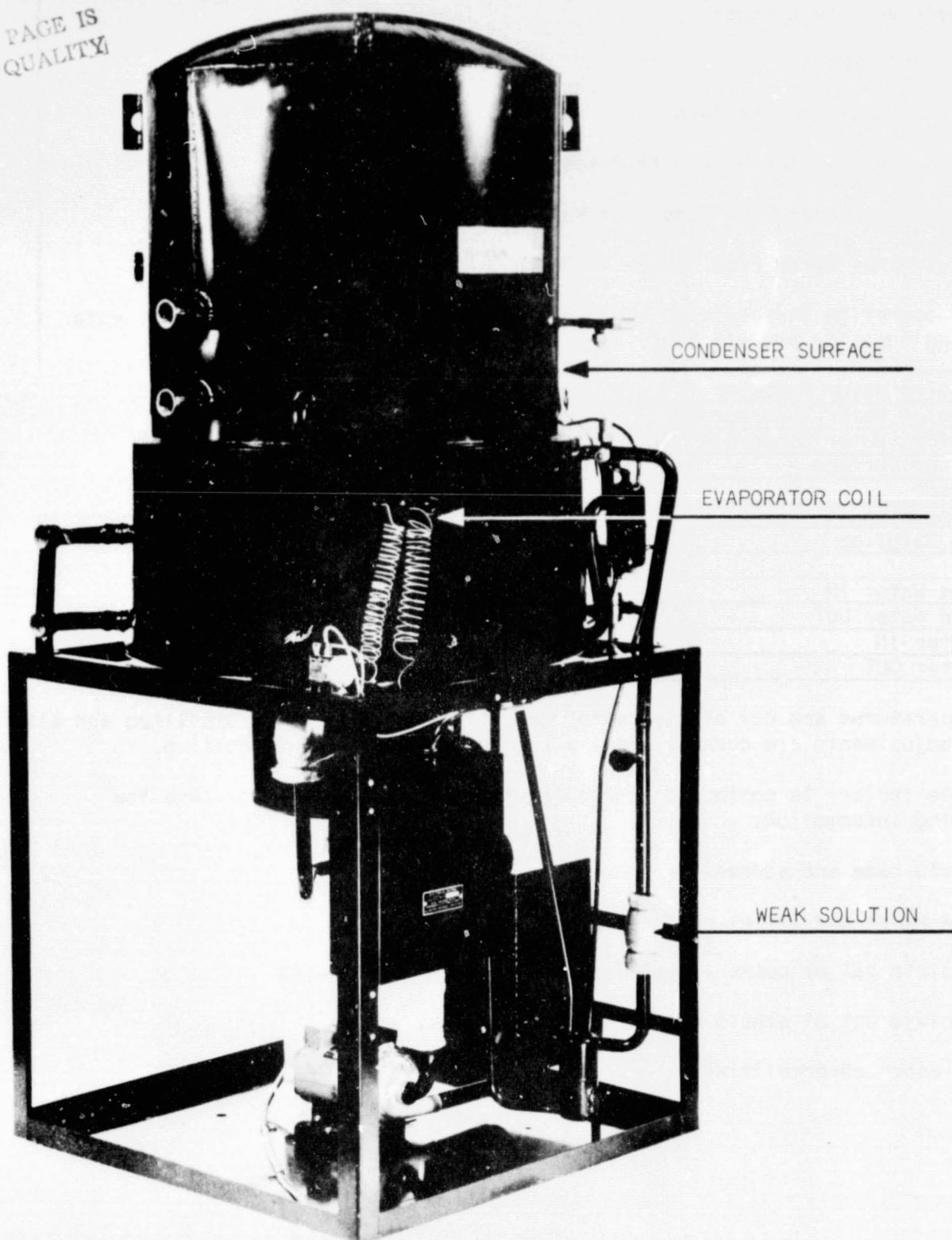
THERMOMETER WELL LOCATION

NOTE: Thermometer wells furnished should be located in the Inlet and Outlet connections of the hot, chilled and condensing water circuits.

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OPERATING TEMPERATURES

Operating temperatures of the unit should stabilize after one hour of steady operation. Normal reading can be expected; only, if all basic adjustments were made and are correct.

BASIC ADJUSTMENTS:

1. Level - Unit Must be Level
2. Chilled Water Flow Rate - At Rated G.P.M.
3. Condensing Water Flow Rate - At Rated G.P.M.
4. Input - Hot Water Flow Rate - At Rated G.P.M.

SEE
ADJUSTMENTS
SECTION

Normal operating temperatures when 85°F condensing water and 195°F hot water is being supplied and all basic adjustments are correct.

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Condensing Water Absorber IN	85°F	to	88°F
Condensing Water Absorber OUT	93°F	to	98°F
Condensing Water Condenser OUT	100°F	to	103°F
Condenser Surface	102°F	to	105°F
Generator	170°F	to	175°F
Weak Solution	112°F	to	115°F
Strong Solution	93°F	to	95°F
Coil	40°F	to	43°F
Chilled Water IN	55°F	to	57°F
Chilled Water OUT	43°F	to	46°F
Hot Water IN	195°F		
Hot Water OUT	185°F		

If temperatures are out of line after operating long enough to stabilize and all basic adjustments are correct; call a knowledgeable service technician.

When the factory is contacted concerning the unit; be certain to have the following information.

1. User's name and address.
2. Unit Model and Serial number.
3. Complete set of current readings on all basic adjustments.
4. Complete set of stable operating temperatures.
5. Any other abnormalities.

TEMPERATURE ANALYSIS -- "COOLING"

Temperatures and temperature relations are used for analysis of unit operation and unit problems. Those shown in the table on the next page will generally apply where cooling tower water is used and a normal load is presented to the air conditioner and it has run long enough for the temperatures to stabilize.

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BUT the basic adjustments:

1. Level
2. Chilled Water Flow Rate (Rated)
3. Condensing Water Flow Rate (Rated)
4. Input Hot Water Flow Rate (Rated)

SEE
ADJUSTMENTS
SECTION
OF
MANUAL

MUST BE CORRECT before temperatures can be used for analysis. Incorrect adjustments can cause false temperatures.

Temperatures and temperature relations vary according to inlet condensing water temperature from the cooling tower. On the following pages are Tables for 80° to 85° and 75° to 80° inlet condensing water. Use the applicable Table.

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COOLING TOWER WATER INLET TO UNIT 80° to 85° 75° to 80°						
TEMPERATURES AND TEMPERATURE RELATIONS	NORMAL	NORMAL	CHANGES DUE TO			
	WF-36	WF-36	SCALE IN COND. WATER CIRCUIT	NON CONDENSI- BLES IN UNIT	OVER CONCENTRA- TION	UNDER CONCENTRA- TION
			SEE VI-31-2	SEE VI-41-2	SEE VI-50-2	SEE VI-55-2
CONDENSING WATER OUT ABOVE CONDENSING WATER IN	14° to 18°	14° to 18°			LOW	LOW
CONDENSING WATER TEMPERATURE RISE THROUGH ABSORBER	50% to 60% of TOTAL RISE	50% to 60% of TOTAL RISE	LESS THAN 50%	LESS THAN 50%		
CONDENSER SURFACE ABOVE CONDENSING WATER OUT	2° to 5°	2° to 5°	HIGHER THAN 5°			
STRONG SOLUTION ABOVE CONDENSING WATER IN	8° to 10°	11° to 13°		HIGHER		
WEAK SOLUTION ABOVE STRONG SOLUTION	20° to 25°	20° to 25°			BOTH TEMP. ABOUT SAME	LOW
GENERATOR	170° to 180°	160° to 170°	HIGH	HIGH	ABOUT SAME AS WEAK SOLUTION	LOW
COIL	40° to 45°	40° to 43°	HIGH	HIGH	HIGH	HIGH
CHILLED WATER OUT ABOVE COIL	3° to 5°	3° to 5°				
HOT WATER TEMPERATURE LOSS THROUGH GENERATOR	9° to 10°	9° to 10°		LESS	VERY LOW	
NOTES			UNIT MAY CYCLE ON HI-TEMP SWITCH	UNIT MAY CYCLE ON HI-TEMP SWITCH	SOLUTION PUMP CUTS OFF ON OVERLOAD	RUNS CONSTANTLY
					UNIT RUNS CONSTANTLY	

MODELS

SPECIAL TEMPERATURE ANALYSIS

A. Occasionally the following temperatures may be encountered.

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Generator Temperature - Normal

Evaporator Temperature - High

Weak Solution Temperature - High

Strong Solution Temperature - High

Temperature rise of condensing water through the absorber will be very low.

These temperatures could indicate that the weak solution by-pass valve (V-5-8 (B)) is remaining open. This could be caused by (a) the solenoid being constantly energized or (b) for some mechanical reason The valve is not properly seating. A check can be made by feeling the connection from the rear of the valve body to the absorber shell. When valve is not by-passing, this connection will be ambient temperature. When solution is by-passing this connection will be approximate same temperature as weak solution.

Follow the procedure given below to correct:

1. Check the solution by-pass switch operation. (See V-11-6). If switch is defective, replace it.
2. Check wiring for possible short or mis-wiring that is causing solenoid coil to stay energized. Correct any wiring problems.
3. Tap the side of the valve to try to shake the valve loose in case it is being held open by lithium bromide salt or other matter. Hold wood block against valve body and hit wood block with light snapping blows.
4. With the aid of external power source (115 volt extension cord) energize and de-energize solenoid coil rapidly to try to shake the valve loose in the event that lithium bromide salt is causing the valve to stick open.

Valve will have to be replaced if step 3 or 4 does not correct the problem.

B. On other occasions the following temperatures may be encountered:

Generator Temperature - Very Low

Evaporator Temperature - High

Weak Solution Temperature - Very Low

Strong Solution Temperature - Low

Solution to Generator Temperature - Low

Temperature rise of condensing water through the absorber will be very low.

These temperatures could indicate that the solution pump is not moving solution due to one of the following conditions.

1. No electrical power to the solution pump motor.
2. Worn bearings can cause high amperage draw thus causing the motor to cycle on overload.
3. Defective solution pump motor. Windings burnt - out or grounded.

INDEX: VI-21-6 (B)

ARKLA INDUSTRIES INC. P.O. BOX 534 EVANSVILLE, INDIANA 47704

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4. Low suction head. Unit short on solution or solution not returning to the reservoir properly.
5. Discharge head too high. Restriction in the discharge screen, orifice or liquid heat exchanger.
6. Impeller clogged or damaged.

If problem is found to be the solution pump or motor. See VII-54-5 for procedures.

SCALE, TRASH OR ETC. IN CONDENSING WATER CIRCUIT

Scale, trash, dirt, algae or etc. in the condensing water circuit reduces the flow of condensing water flow and the heat pick-up reduces the capacity of the unit and causes abnormal temperatures and temperature relations.

To clearly identify this condition in the condensing water circuit, all of the basic adjustments:

1. Level
2. Chilled Water Flow Rate (Rated)
3. Condensing Water Flow Rate (Rated)
4. Input Hot Water Flow Rate (Rated)

SEE
ADJUSTMENTS
SECTION
OF
MANUAL

MUST BE CORRECT

Then four temperatures (1. Inlet condensing water, 2. Absorber outlet, 3. Condenser outlet and 4. Condenser surface) and their relations will show if the condition exists.

	WF-36	
RELATIONS	NORMAL WITH 75° - 85° INLET COND	SCALE TRASH OR ETC.
CONDENSER OUTLET OVER ABSORBER INLET	14° -- 18°	
ABSORBER OUTLET OVER ABSORBER INLET	50% - 60% TOTAL RISE	LESS THAN 50%
CONDENSER SURFACE OVER CONDENSER OUTLET	2° - 5°	MORE THAN 5°

NOTE: Generally, when this condition exists, all temperatures will be high. The unit may be short cycled by the HI-TEMP. SWITCH.

If just back flushing is needed; this can be accomplished by connecting high pressure (Up to 100 psig) water to the condenser outlet. Be sure that all valves are wide open. After flushing make sure the condensing water line through the purge pump is clear. See VI-34-2.

If the obstruction is algae, use a reliable brand of algicide and carefully follow the manufacturer's instructions on how to use.

If the problem is mud, follow the instructions in VI-33-2.

If the condensing water circuit is scaled, refer to VI-32-1.

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SCALE REMOVAL

To remove scale from the condensing circuit of the unit requires the use of an inhibited acid-water solution. Two types of acid are normally used, either inhibited muriatic (hydrochloric) or sulfamic.

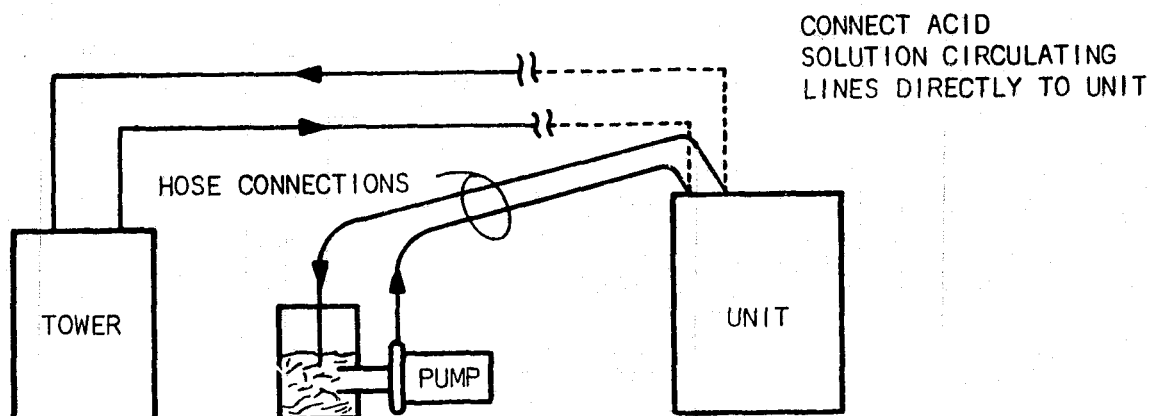
INHIBITED MURIATIC ACID

A good inexpensive, general purpose descaler is commercial grade, INHIBITED muriatic (20% hydrochloric) acid. This may be obtained in bulk from chemical manufacturers or supply houses (be sure to specify that it be INHIBITED acid). It should be mixed with water in proportions of one (1) part acid to nine (9) parts water to prepare a solution of approximately 3% acid concentration by volume.

There are also a large number of reliable brands of well-inhibited muriatic base descalers on the market. These are available from most refrigeration supply houses. These should be mixed with water in accordance with their manufacturer's instructions.

Muriatic or any other mineral acid base descaler requires the use of special equipment: a container, circulating pump, circulating lines, etc. It is recommended that the acid solution circulating lines be connected as closely to the unit as possible, preferably directly to the unit. BE SURE TO CAREFULLY FOLLOW THE DESCALER MANUFACTURER'S INSTRUCTIONS. Additionally, outlined below are some general instructions.

1. Obtain the scale remover, instructions and testing materials from the supplier.
2. Use an acid resistant container which has about twice the volume capacity of the condensing water capacity of the unit. The volume capacity of the unit is 3 gallons.
3. Use a circulating pump that will not be damaged by the scale remover. Special pumps for this purpose are available.
4. Locate the pump and container on the job site so that any leakage, splash or over-flow from the container will not damage the customer's property. Wherever possible, the pump and container should be located outdoors.
5. Arrange and connect the scale removing equipment to the unit as shown in the figure below.



ARRANGEMENT OF SCALE REMOVING EQUIPMENT

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6. Fill the container about 1/2 full of water and start the circulating pump. Add more water, if necessary, to maintain the container about half full while the water is circulating. Check for leaks.
7. Start adding the scale remover in the container as per manufacturer's instructions. Add acid to water - NEVER WATER TO ACID. AVOID INHALING THE FUMES FROM THE SCALE REMOVER. Quite often there is a large volume of foam in the container when the scale remover reacts on the scale. Be prepared to scoop out this foam and dispose of it so that it will not damage the customer's property. Maintain tight connections and keep hose ends in acid solution in container, while circulating to prevent aeration of acid solution.
8. Proceed with adding scale remover and testing of the solution with indicators, as per manufacturer's instructions, until the scale is removed.
9. Drain scale removing solution. Thoroughly flush unit with water.
10. Remove condenser cap (if there is one) and examine condition of condenser tubes.
11. Check for full water flow through purge pump condensing water tubing. VI-34-1 or 2.
12. Fill condensing water system and put unit in operation on cooling. Take a full set of temperatures to determine if all scale, trash and etc. has been cleared from the unit's condensing water circuit.
13. Adjust Bleed-off.

SULFAMIC ACID

As with the muriatic, there are a large number of reliable brands of well-inhibited sulfamic acid descalers available from refrigeration supply houses and they do not work as fast, but they are decidedly safer to use, both from the standpoint of handling and of harm to the equipment.

Sulfamic acids may be dumped into the tower sump and circulated by the tower pump and the regular condensing water connecting lines to the unit. PRIOR to dumping in the acid, the tower should be thoroughly cleaned and flushed, the sump filled with fresh water and full water circulation established. Arrange to stop the tower fan operation while the acidizing is under way. DO NOT ATTEMPT TO OPERATE THE UNIT WHILE ACIDIZING. Be sure to carefully follow the manufacturer's instructions.

Sulfamic acids may also be used with the special acidizing equipment as described previously.

GENERAL

If normal scale removing acids do not remove the scale from the unit, a sample of the scale should be given to a company specializing in this field for analysis and recommendations.

Sometimes, normal acidizing loosens dirt and silt in the condensing water circuit of the unit, but does not wash it out. Then it is necessary to clean the condensing water circuit as described in VI-33-1 or 2 for the different types of units.

MODELS

SOLAIRE

Always check for proper water flow through the purge pump. The condensing water tubing for this pump is small. Occasionally the scale is not removed from this tubing during a normal acidizing, or debris which is freed by acidizing lodges in this small tubing. Special cleaning instructions for the condensing water tubing of purge pump will be found on VI-34-2.

After any acidizing operation thoroughly back flush the entire condensing water system. If the unit will be used for cooling immediately after the acidizing, it is only necessary to flush with clear water. However, if it will not be used immediately for cooling, the clear water flush should be followed by flushing with a solution of one (1) pound of baking soda (sodium bicarbonate) per five (5) gallons of water for approximately ten (10) minutes, then flushing again with clear water.

MODELS

MUD OR TRASH IN CONDENSING WATER CIRCUIT

If it is determined that the obstruction in the condensing water circuit is mud or trash, this can sometimes be removed without acidizing the unit.

Add a "non-sudsing" detergent to the condensing water and circulate the condensing water. When it is believed the mud has been washed out of the unit, the unit should be carefully back-flushed. Use high pressure (up to 100 psig) water, if necessary.

Protect the rest of the unit, insulation and anything else in the equipment room from water damage while doing this type of cleaning operation.

Before putting the unit into operation, check for water flow through the purge pump. For additional instructions on cleaning the purge pump condensing water circuit, See VI-34-2.

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CLEANING OF PURGE PUMP'S CONDENSING WATER TUBING

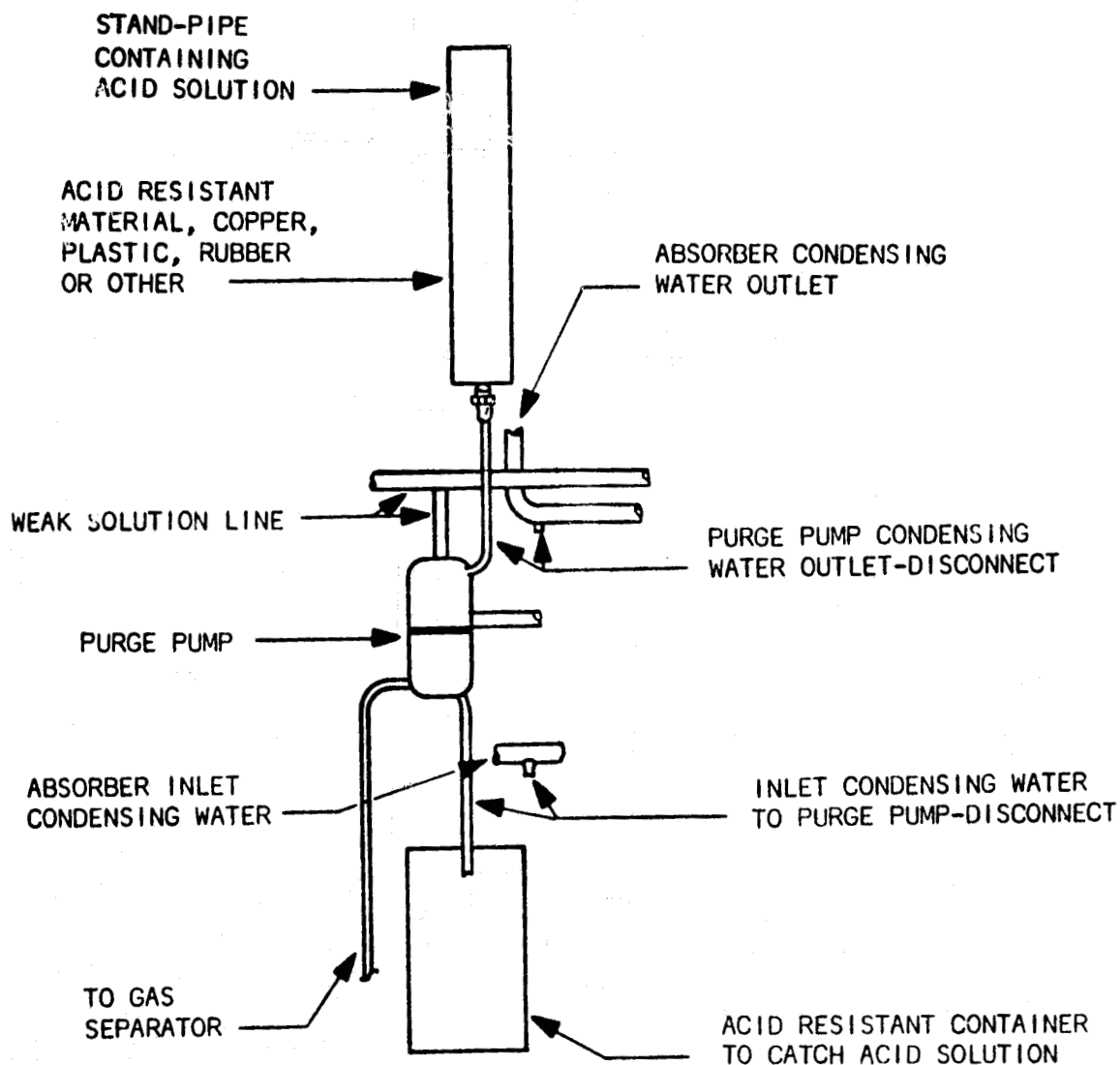
The efficiency of the purge pump (See VI-45-2) is dependent on the flow of condensing water through this assembly. It is suggested to check the operation of this pump on every service call. The methods of checking are shown on VI-45-2.

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Whenever the unit's condensing water circuit is cleaned, one of the last checks to be made before putting the unit into operation is to disconnect the outlet water line from the purge pump and check for water flow through this line. Also, make sure the fitting on the unit's condensing water line is open. If the purge pump line is clogged, listed below are suggestions for cleaning it.

1. Cut the inlet water line to the purge pump at a point where it will be convenient to reconnect it with a union and compression nuts (or flare nuts). Check for flow through the tube soldered to the unit's inlet condensing water line; the blockage might be at this point. If the blockage is in the tubing through the pump, connect high pressure water (up to 100 psig) to the outlet tube and try to flush it out. If the tubing shows scale, circulate scale removing solution through this tubing until it is clean.
2. Use the "stand-pipe" method when the tubing cannot be cleared by the back flushing method. Attach a "stand-pipe" to the outlet tube of the purge pump. Fill the "stand-pipe" with a scale removing solution (of the same strength that is normally circulated through the unit). Sometimes it takes several hours for the solution to work its way through the blockage in the tubing. In such cases, the fittings on the unit's condensing water line should be capped so that the unit can be put into operation. Place a container underneath the inlet tube to the purge pump so as to catch the solution when it does work its way through the tubing. When there is an opening through the tubing circulate scale removing solution through this tubing until it is clean. Reconnect the purge pump tubing to the unit's condensing water lines. See illustration on back of this page.
3. If the purge pump line cannot be cleared by the 2 methods previously outlined, it may be necessary to use a small hand operated hydraulic pump of the type commonly used by plumbers. Attach the pump to the fitting on the outlet line of the purge pump. Pump the pressure up to 300 psig to try to clear the blockage. If this much pressure does not clear the blockage install a "stand-pipe" as outlined in #2 with scale removing solution in it and pressurize the "stand-pipe." Again, it may take several hours for the combination of scale removing solution and pressure to clear the blockage. Place a container under the inlet tube to the purge pump to catch the solution when it works its way through the blockage. When the opening through the tubing is large enough, circulate scale removing solution through the tubing until it is clean. Reconnect the tubing to the unit's condensing water lines.

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ACIDIZING PURGE PUMP CONDENSING WATER CIRCUIT

MODELS

NON-CONDENSIBLE GASES IN UNIT--"COOLING"

Gases which cannot be absorbed by lithium bromide solution are considered "non-condensable" gases in the Arkla unit. When the unit is operating on cooling, these gases will collect in the lowest pressure area of the unit, which is the absorber. The presence of non-condensable gases in the absorber restricts the absorption of refrigerant vapor by the lithium bromide solution and causes a rise of pressure in the absorber. Since there is a direct relation between absorber pressure and coil temperature, the coil temperature, will rise, other temperatures will be affected and there will be a loss of capacity by the unit.

Because incorrect adjustments may cause temperature which will falsely indicate the presence of non-condensable gases in the unit, it is necessary to make sure that all basic adjustments are correct before taking temperature for analysis:

The basic adjustments are:

1. Level
2. Chilled Water Flow Rate (Rated)
3. Condensing Water Flow Rate (Rated)
4. Input--Hot Water Flow Rate (Rated)

SEE
ADJUSTMENTS
SECTION
OF
MANUAL

After making sure that all these adjustments are correct, allow the unit to operate long enough for the temperatures to stabilize. The Table on back of this page shows the temperatures and temperature relations which will be affected when there are non-condensable gases in the unit.

Non-condensable gases can be removed from the unit with a vacuum pump. See VI-43-2, "Vacuum Pumping".

More information concerning non-condensable gases may be found on VI-45-2 "Purge Pump".

WF-36

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TEMPERATURES AND TEMPERATURE RELATIONS	NORMAL WITH 80° to 85° INLET CONDENSING WATER MODEL WF-36	NORMAL WITH 75° to 80° INLET CONDENSING WATER MODEL WF-36	CHANGES IN TEMPERATURES AND TEMPERATURES RELATIONS WITH NON-CONDENSIBLE GASES IN UNIT
CONDENSING WATER TEMPERATURES RISE THROUGH ABSORBER	50% to 60% OF TOTAL RISE		LOWER THAN 50%
STRONG SOLUTION ABOVE CONDENSING WATER IN	8° to 13°	11° to 16°	GENERALLY A WIDER RELATION
GENERATOR	170° to 180°	160° to 170°	GENERALLY HIGHER
COIL	SEE TEMPERATURE ANALYSIS TABLES		HIGHER
CAPACITY			LOW

MODELS

WF-36

VACUUM PUMPING

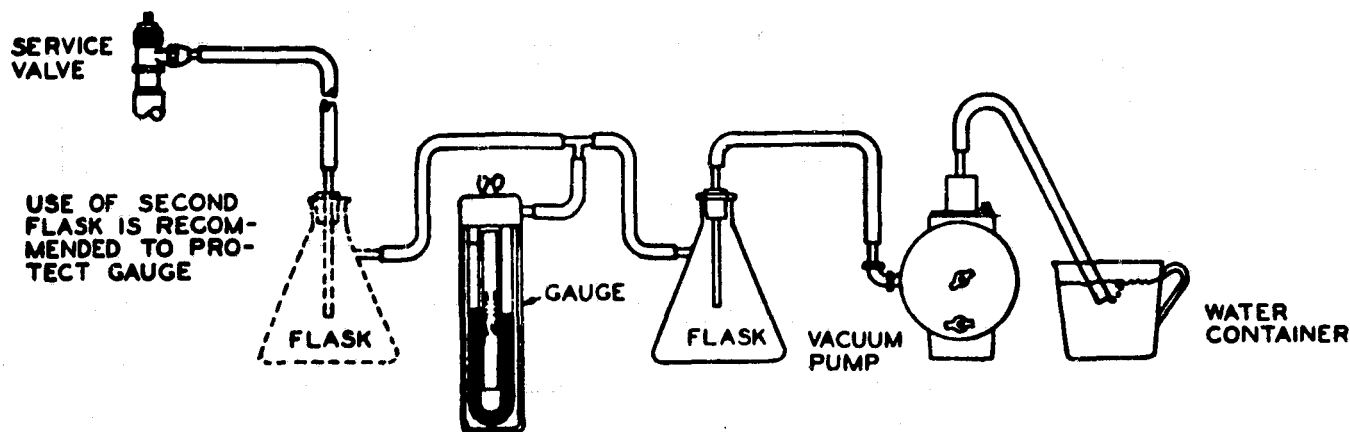
The objective or purpose of vacuum pumping is to remove non-condensable gases from the unit.

Pumping a unit is simple, BUT A STANDARD PROCEDURE MUST BE FOLLOWED, SAFETY MEASURES MUST BE OBSERVED AND GOOD CLEAN EQUIPMENT MUST BE USED.

PUMPING EQUIPMENT

The equipment that is necessary is listed below. The Figure shows the correct arrangement of each item.

QUANTITY	ARKLA PART NO.	ITEM
1	67-1	Vacuum Gauge
2	4253-61	Rubber Stopper
1	4267-22	Purge Valve Wrench
2	4276-2	Flask
1	5304-3	Vacuum Hose
1	14267-12	Tee
1 pt.	Z-2661	Black Japan Paint
1		Vacuum Pump



ARRANGEMENT OF PUMPING EQUIPMENT

The vacuum pump used should have the ability to pull down to 2mm (Hg-Absolute pressure) and the capacity of 1 cu. ft./min.

The mercury vacuum gauge (Arkla Part #67-1) is a "must". A compound spring gauge is not suitable due to the probability of inaccuracy at low absolute pressures. The use of a mercury gauge is one of the safety measures necessary in the pumping procedure. It is necessary to prove that the pump has the ability to pull down to a lower pressure than the pressure in the unit, to prevent sucking oil out of the pump towards the flask, the mercury gauge and the unit.

The vacuum flask is also a necessary safety device. Its purpose is to try to prevent oil from being pulled into the mercury gauge or unit in case of a pump failure or stoppage.

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The vacuum hose available from Arkla is a 12 foot length of medical vacuum hose. When assembling the pumping equipment, cut the hose to convenient lengths. The piece used between the 3/8" flare connection (to be attached to purge valve) and the tee should be as long as possible, but be sure the other pieces are long enough to be conveniently crimped when necessary. The hose from the discharge of the pump does not have to be vacuum hose. All of the equipment should be kept clean and in good condition. If oil vapor is allowed to get inside of the sealed unit, it cannot be removed and is detrimental to the efficiency of the unit.

The arrangement of the equipment (See Figure) is important to provide maximum safety.

WARNING

WF-36 MODEL

ALWAYS PUMP FROM THE GAS STORAGE CHAMBER PURGE VALVE FIRST

Gas storage chamber pressure must be 20 M.M. or lower before vacuum pumping from the absorber purge valve.

PUMPING PROCEDURE - COOLING

If the coil temperature and solution temperatures in absorber are excessively high, the unit should be cooled before pumping. Cooling of the unit may be accelerated by circulating condensing water through the unit and/or air across the evaporator coil (chilled water through the evaporator coil on chiller models) with the heat source turned off. The coil temperature should be below 85° before pumping to prevent the possibility of pulling refrigerant vapor from the unit.

Generally, the unit can be pumped to a lower pressure and more of the non-condensable gases removed, if unit is operating on "cooling" while it is being pumped.

Listed below is a recommended step-by-step routine for pumping.

1. Check the condition of the oil in the pump. Open the drain valve on the pump. A few drops of water may drain out ahead of the oil. Observe the condition of the oil. If a large amount of water is in the pump or the oil is murky (indicating water vapor mixed in the oil), the oil should be changed. Vacuum pump oil or a good grade of S.A.E. #20 non-detergent motor oil should be used in the pump. Make sure the oil level in the pump is correct.

2. Arrange and connect the equipment as per Figure.

3. Start the unit on "Cooling" operation.

ALWAYS PUMP FROM THE GAS STORAGE CHAMBER PURGE VALVE FIRST

4. Remove the cap covering the gas storage chamber purge valve stem. Use valve wrench to make sure valve is closed. Check packing gland nut for tightness.
5. Remove cap from valve opening and attach 3/8" flare nut on end of vacuum hose to valve.

6. Start the vacuum pump and run for several minutes.

7. Observe pump discharge hose in the water container. The end of the hose should be at least 1" below the water level in the container. When the pump is first started, there will be a large amount of bubbling. As the pump evacuates the air from the pumping equipment, the bubbles will decrease in size and number until there are not any bubbles coming out of the discharge hose. If bubbles continue to come out of the hose, it indicates there is an air leak in the pumping equipment.

A leak may be located by crimping the hose, starting with the section between the valve connection and the gauge. When the hose is crimped between the leak and the pump, the bubbles will cease. If the leak is at the threaded connection, tighten it. If the leak is a hose connection, it can usually be stopped by applying water around the edge of the hose. It is not advisable to put a sealing compound (such as black japan paint) as it may deteriorate the rubber and it will make it difficult to remove the hoses when it is necessary to clean the pumping equipment.

If it is necessary to disassemble a connection to clean it or to correct a leak, follow later instructions on how to disconnect vacuum pumping equipment before separating the connection.

8. After it is determined there is not a leak in the pumping equipment (no bubbles from the discharge hose), then check the ability of the pump by reading the mercury vacuum gauge. The reading must be below the absolute pressure of 4mm mercury. The reading is the distance between the two mercury levels in the "U" tube.

If the reading is not low enough, it may be improved by changing oil. If the reading is still not low enough, have the pump repaired before using it to pump units.

9. Open the gas storage chamber purge valve wide open. IMMEDIATELY SET RACHET ON VALVE WRENCH FOR CLOSING.

DO NOT LEAVE THE PUMPING EQUIPMENT UNATTENDED WHILE PURGE VALVE IS OPEN.

Always stay within reach of the hose attached to the purge valve. In case of a power failure, pump failure or other unexpected occurrence, IMMEDIATELY crimp the hose to the purge valve and close the purge valve with the ratchet wrench. Prevent the oil from the pump from getting into the mercury gauge by crimping. Do not allow oil from the pump to be sucked into the unit. If any oil does get inside the sealed unit the failure is not covered by warranty.

10. While pumping non-condensable gases from the unit, test to find out if the gas is hydrogen. Use a straight walled, open mouth pyrex test tube. Fill the test tube with water. Cover the mouth of the test tube with your thumb and invert the tube. Lower the tube into the water container until the open end of the tube is just below the surface of the water, then remove thumb. Position the tube over the end of the tube from the discharge hose, so that the bubbles from the hose will rise up into the tube and displace the water. When all the water has been displaced from the tube, light a match, remove the tube from the water (keep tube inverted) and hold it over the flame. If the gas is hydrogen, a "popping" or "whoosing" sound should be heard.

11. Continue pumping unit until the gas storage pressure is 20 M.M. or lower before vacuum pumping from the absorber purge valve.
12. When you are ready to stop pumping, close the purge valve. Seat the valve snugly, but AVOID EXCESSIVE TIGHTENING, AS IT WILL DAMAGE THE VALVE SEAT.
13. Remove the pump discharge hose from the water container.
14. Crimp the hose close to the flare fitting attached to the purge valve.
15. While holding the hose crimped, remove the flare nut from the valve. Then put a film of saliva over the opening of the valve. If the saliva is pulled into the valve, it is an indication the valve is leaking and should be tightened.
16. Watch the mercury gauge, while slowly releasing the crimp on the hose to full open. Releasing crimp too quickly might allow mercury to bounce in glass tube and crack the glass.
17. Disconnect electrical power to pump.
18. After the gas storage chamber has been pumped, pump from the absorber purge valve.
19. Remove cap covering valve stem on absorber purge valve. Make sure valve is closed snugly and packing gland nut is snug.
20. Remove cap covering valve opening and attach a 3/8" flare nut fitting on end of vacuum hose to absorber purge valve.
21. Repeat steps #7 and #8.
22. Open absorber purge valve wide open. IMMEDIATELY SET RACHET ON VALVE WRENCH FOR CLOSING. Heed warning in Step #9. Repeat step #10.
23. Continue pumping unit until the rate of bubble discharge from the hose is approximately one bubble every two seconds. If pumping from the absorber purge valve while the unit is operating on "cooling" under "no-load" conditions, pump until the coil temperature is 40° or the rate of bubbles is one every two seconds.
24. Repeat steps #12 through #17.
25. Replace caps on both purge valves and paint with black japan paint to seal against possible leakage.
26. Record pumping on service report and identity of gas removed.

MODELS

SOLAIRE

PURGE PUMP

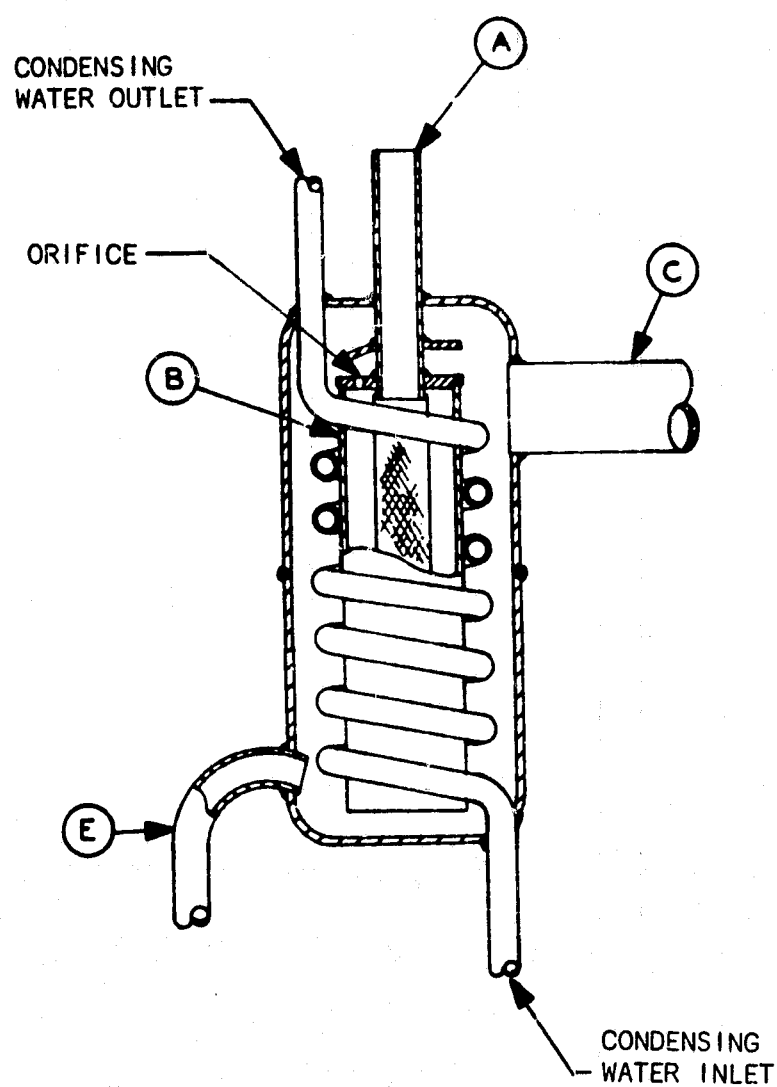
Every Solaire unit has a "built-in" purge pump for the purpose of removing non-condensable gases from the absorber.

The purge pump is a small, but very powerful, absorber coil. Its principle of operation is the same as the absorber. A cross-section of a purge pump is shown on next page. Weak solution is introduced through tube (A) into the inside of tube (B) where it is pre-cooled. Weak solution comes out of the orifice at the top of tube (B) and trickles along the spiral coil of copper tube which is wrapped around and soldered to tube (B). This further cooling of the weak solution makes it very "thirsty" for water vapor. A special tube (C) from the purge pump to the center of the unit absorber coil allows the weak solution in the purge pump to pull water vapor from the center area of the absorber coil. Any non-condensable gases in that area are entrained in the water vapor flow and pulled into the purge pump. Inside of the purge pump, the water vapor is absorbed by the weak solution and the non-condensable gases are freed. Non-condensable gases will be caught by the trap (E) and carried with the strong solution draining out of the bottom of the purge pump down to the separator pot. In the separator pot the bubbles of non-condensable gases can be freed from the flow of strong solution and will rise up a tube to the purge receiver tank. The gases collected in this tank are stored and cannot get back into the rest of the unit.

The purge pump requires a flow of water to cool the weak solution and cause the absorbing action. There are several ways to determine whether the purge pump is working. (A) Feel the top and bottom of the purge pump; the top should be warmer than the bottom. (B) Feel the condensing water tubes entering and leaving the purge pump; the outlet tube should be warmer than the inlet tube. (C) A sure way is to disconnect the outlet condensing water line for the unit. Make sure a full stream of water is coming out of the tube and fitting on the absorber outlet water line.

Any time that a unit is acidized, check for a full stream of water through condensing water tube for the purge pump before considering that the acidizing operation is completed. This is a small tube and can be easily clogged by scale and trash freed by the acidizing of the unit.

PURGE PUMP



MODELS

SOLAIRE

INHIBITOR

A small amount of hydrogen (non-condensable gas) is produced inside of the unit while the unit is both in and out of operation. To reduce hydrogen production in the unit, an inhibitor is put into the unit along with the solution. The inhibitor has a characteristic which causes it to adhere to the metal on the inside of the unit. This puts a coating on the metal surfaces of the unit. This coating reduces the hydrogen production to a minimum.

If excessive heat is applied to the unit, some of the inhibitor coating may be destroyed. This will be indicated by the necessity of having to pump the unit frequently to remove non-condensable gases (hydrogen) to maintain unit performance.

If a unit has to be pumped as often as once a month, to remove excessive hydrogen, to maintain performance, it is an indication that additional inhibitor may be needed.

Inhibitor can be added to the unit in the field. To get the inhibitor for a unit, the following information must be supplied to Arkla Industries Inc.

1. Customer's name and address.
2. Air Conditioner model and serial number.
3. Unit model and serial number.
4. Pumping record of the unit (dates pumped, whether or not the gas removed was hydrogen, temperatures and any other pertinent information).

Whenever inhibitor is to be put into a unit, it should be pumped just before adding the inhibitor. See instructions on how to add inhibitor VI-47-2. It requires operation of the unit to circulate solution and recoat the areas where the coating has been "broken down". It will probably be necessary to pump the unit at least once and possibly a second time before the "recoating" process is completed.

Sometimes a second minimum charge of inhibitor is needed. The information listed above is again needed, plus the information as to when the first charge of inhibitor was added.

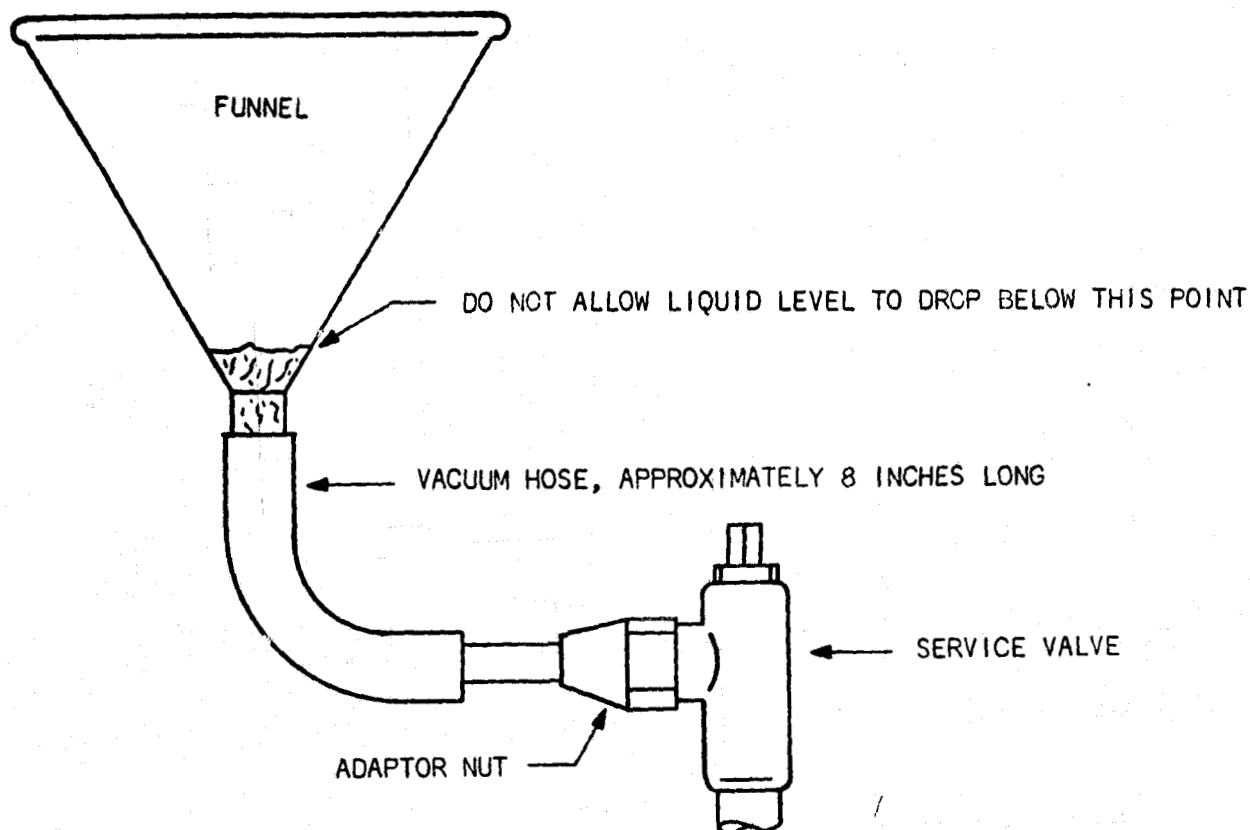
If two minimum charges of inhibitor have been added to a unit and the unit still has to be pumped frequently to remove hydrogen, Arkla Industries Inc. should be advised. Arkla will review information supplied and advise as to action to be taken.

INSTRUCTIONS FOR ADDING INHIBITOR

CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

A transparent funnel is desirable, but any type funnel may be used so long as it is clean. The inhibitor must be added through the absorber service valve.

1. Connect funnel, hose and adaptor to the service valve as shown in the sketch, leaving the adaptor nut loose. THESE ITEMS MUST BE CLEAN AND FREE OF OIL.
2. Purge hose and adaptor of air by pouring distilled water into funnel and allowing this water to leak out the loose adaptor nut. Wrench tighten adaptor nut while water level is still visible in the funnel as shown in the sketch.
3. Pour inhibitor into the funnel, then open the service valve and allow the inhibitor to be drawn into the unit. KEEP THE LIQUID LEVEL IN SIGHT IN THE FUNNEL, closing the service valve whenever the level drops to the point shown in the drawing.
4. After all of the inhibitor has been used, add approximately 3 oz. of distilled water and allow this to be drawn into the unit. KEEP THE LIQUID LEVEL IN SIGHT.
5. Close the service valve. Remove adaptor and flush the service valve port with distilled water, using a syringe.



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6. Replace seal caps after first checking the condition of the copper gaskets these caps must contain. If these gaskets are worn install new ones. Tighten seal caps, then paint joints with air-dry black japan. (Arkla Part #Z-2661).

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.

INSTRUCTIONS FOR ADDING INHIBITOR

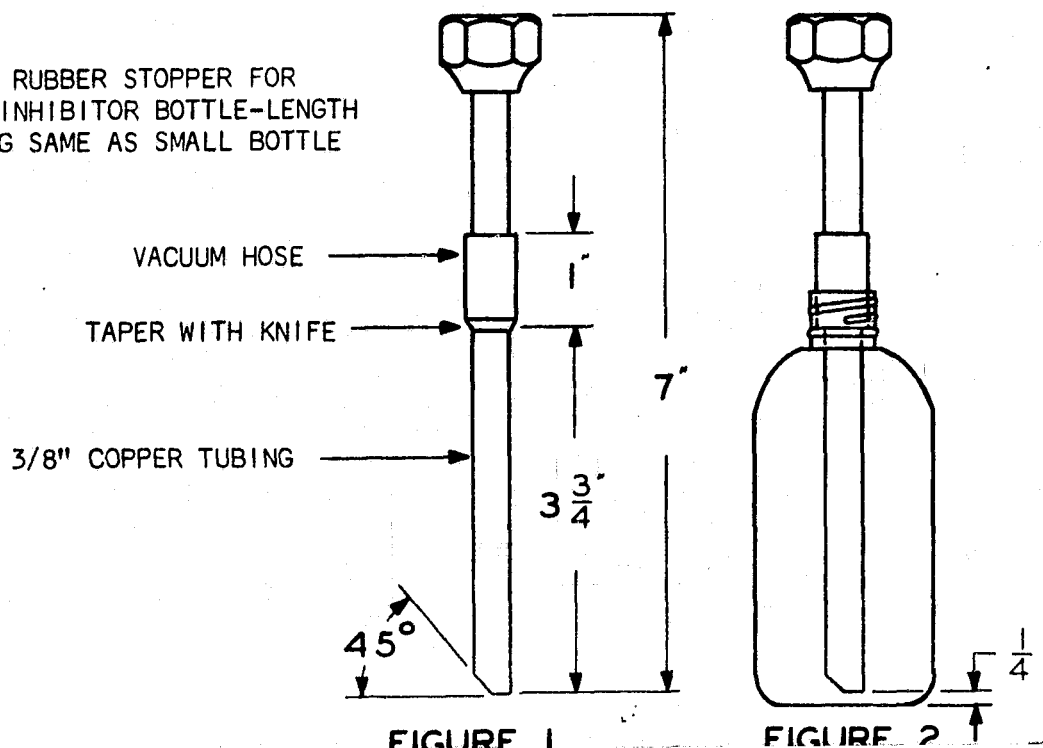
CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

CAUTION: ALL ITEMS MUST BE CLEAN AND FREE OF OIL.

NOTE: Inhibitor must be added through the absorber purge valve only.

1. Remove cap from plastic bottle of inhibitor and insert adaptor, shown in Figure 1 using a twisting motion until stopper adaptor is firmly in place. See Figure 2.
2. Fill copper tube with distilled water.
3. Connect flare nut to purge valve.
4. Using the positive end of the purge wrench, open the purge valve until inhibitor is drawn into unit. When the liquid level approaches the level portion of the copper tube close the valve.
5. Remove flare nut from purge valve and put about two inches of distilled water into bottle.
6. Repeat steps 1 and 2. This will flush the purge valve seat.
7. Remove copper tubing from the purge valve and flush the service valve port with distilled water, using a syringe.
8. Check condition of flare seal bonnet (Y-8509) in flare nut. If bonnet is in bad condition, replace. Screw flare nut in place, tighten and seal with black japan paint (Arkla Part #Z-2661).

USE A #2 RUBBER STOPPER FOR
A LARGE INHIBITOR BOTTLE-LENGTH
OF TUBING SAME AS SMALL BOTTLE



INDEX: VI-47-3 (B)

DATE: Nov., 1976

ARKLA INDUSTRIES INC.

P. O. Box 534

Evansville, Indiana 47704

NOTE: This same piece of copper tubing may be used when adding inhibitor to one of the large tonnage units. Use a #2 rubber stopper instead of vacuum hose as a gasket for the larger bottle.

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.

OBTAINING SOLUTION SAMPLES

Due to certain operating conditions it may be necessary to draw a solution sample from the unit and send it to Arkla Industries Inc. for an analysis check.

CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

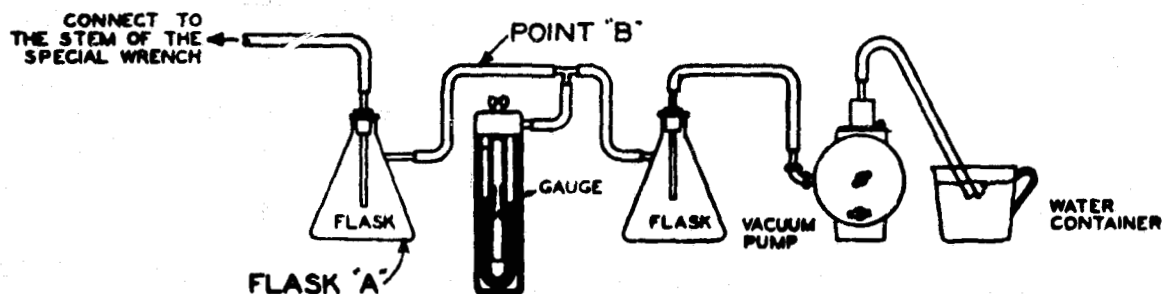
Drawing samples of solution from the unit will require the use of a special wrench. Please See Index: VI-53-2 for information about the use of this special wrench.

It is preferred that solution samples be drawn from the "weak solution" valve. This valve is located on the weak solution line between the liquid heat exchanger and the absorber liquid inlet.

GENERAL INSTRUCTIONS

WITH THE UNIT OPERATING, and after it has operated continuously for at least 15 minutes:

1. Connect the special wrench to the proper charging valve on the unit in accordance with the instructions in Index: VI-53-2.
2. Connect CLEAN vacuum pumping equipment to the wrench as shown in the diagram below.



ARRANGEMENT OF PUMPING EQUIPMENT

3. Start the pump and evacuate the air from the pumping equipment. Check the special wrench and the pumping equipment for leaks. When leak free:
4. Clamp or crimp the vacuum hose at Point "B", then open the charging valve. Solution will begin to flow into Flask "A". When the desired amount of solution has been withdrawn, or about 1" depth in the flask, close the charging valve.
5. Disconnect the hose from the stem of the wrench and allow any solution in the hose to drain into the flask.

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6. Disconnect the hose from the side-outlet of Flask "A". Remove the vacuum pump's discharge hose from the water container, then release the clamp at Point "B" slowly so as to collapse the vacuum gradually. When the vacuum is fully collapsed, stop the pump.
7. Remove the stopper from Flask "A", then pour the solution into a CLEAN plastic shipping container. The small plastic bottles in which ARKLA ships inhibitor, well-rinsed and dried, are ideal for this purpose. FOUR (4) FLUID OUNCES ARE REQUIRED FOR ANALYSIS.
8. Thoroughly rinse and clean Flask "A" and the hose and standpipe through which solution was drawn.
9. Label the bottle with the USER'S NAME and ADDRESS, the MODEL and SERIAL NUMBERS of the unit, and the sender's return address including ZIP CODE. Carefully pack it in a shipping carton and send it by FIRST CLASS MAIL to the address below.

The Service Manager
ARKLA INDUSTRIES INC.
Post Office Box 534
Evansville, Indiana 47704

DO NOT SEND BY PARCEL POST. If speed is essential the sample should be sent by AIR MAIL. Any samples so received will be given special handling and any required inhibitor will be returned by Air Mail.

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.

OVER CONCENTRATION

WF-36

"Over Concentration" is a description of the condition in the unit which occurs when excessive water has been stored somewhere in the unit away from the rest of the solution. With too high a concentration of Lithium Bromide salt in the solution, it becomes too heavy or thick for the unit's solution pump and gravity to cause it to flow. The WF-36 is highly resistant to this problem.

Over concentration is a possibility during shut down periods when the unit is subjected to low ambient temperatures. The known fact that super-cooled solution in the Liquid Heat Exchanger results in the first stage of over concentration explains this problem. Solution in the unit should be 45°F or above before attempting to put this unit into operation.

SYMPTOMS:

1. Generator, weak solution and strong solution temperatures are all about the same and low. See Index: VI-20-1.
2. Coil temperature will be high.
3. Solution pump motor may be cycling on thermal overload.

CAUSES

Over concentration is generally caused by incorrect adjustments, over heating of the solution, rapid and continuous short cycling of the unit by a safety switch, external control or defective electrical control or other unusual circumstances. It is usually a combination of circumstances, which cause a unit to over concentrate. Whenever a unit over concentrates, the cause should be determined and corrected. Listed below are some of the possible causes and why they can cause over concentration.

POSSIBLE CAUSE	COOLING
1. Unit not level	This will unbalance the flow of solutions and vapors through the unit.
2. Very low volume of chilled water	Short-cycling of unit on evaporator low temperature switch
3. Low temperature condensing water	Suddenly introduced into a hot unit.
4. High temperature or low volume of condensing water	Short-cycling on high temperature switch
5. High input	Short-cycling on high temperature switch
6. Excessive non-condensable gases in unit	Simmering instead of boiling solution in unit.

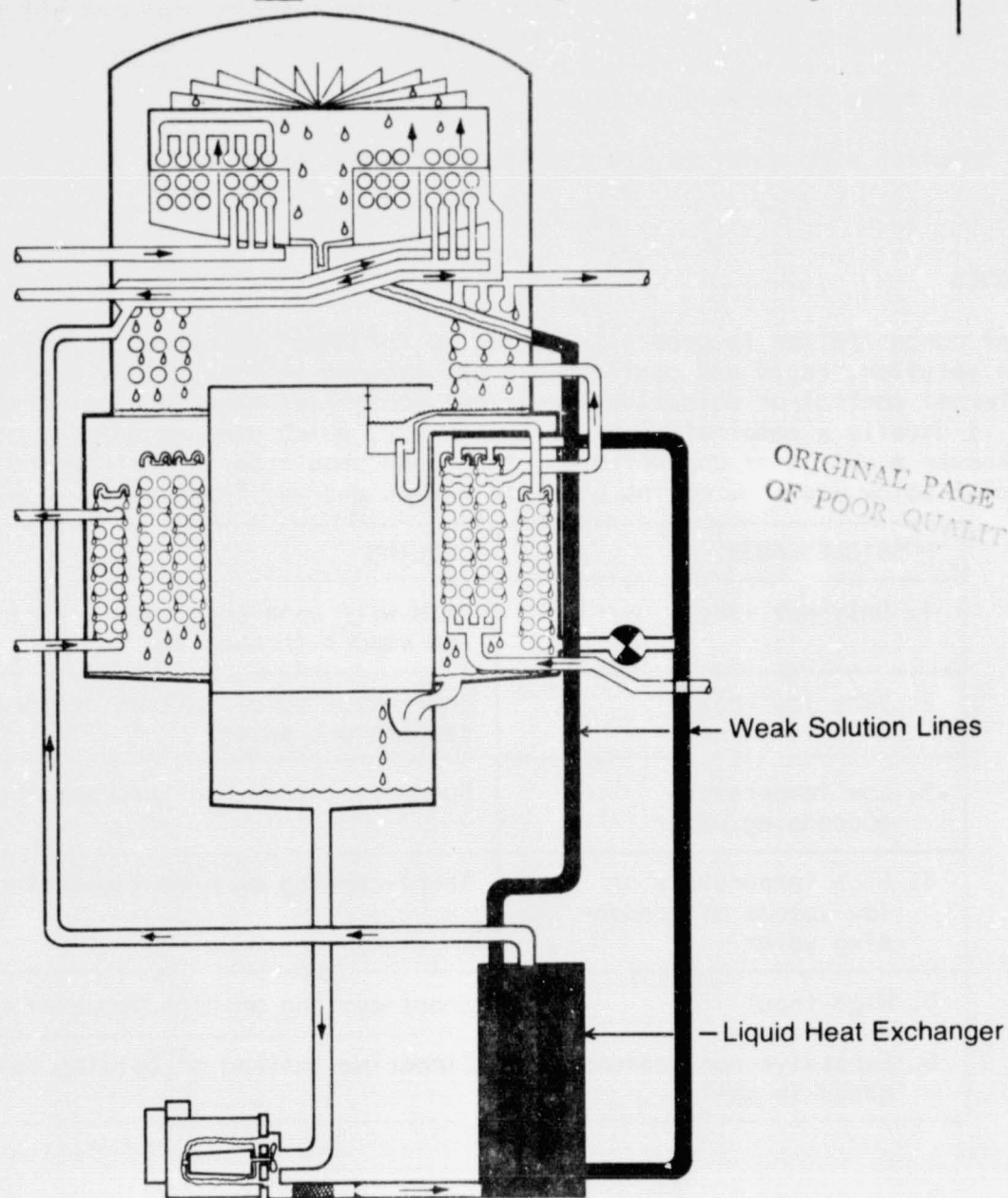
CORRECTION OF OVER CONCENTRATION

The equipment needed:

1. Tools and instruments to check all adjustments.
2. Vacuum pumping equipment.
3. Heating torch (Prest-o-lite, blow torch, propane or etc.)

The following is the recommended general routine to be followed in sequence given below:

1. Follow the recommended routine for Vacuum pumping a unit, (See VI-43-2).
2. Turn off unit and set thermostat to "OFF" position. Condensing water, hot water and chilled water should NOT be flowing through the unit during this process.



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OF POOR QUALITY

3. Start heating liquid heat exchanger with torch. Start at bottom and work upward. Do not use too hot a flame that will burn the paint. Heat all of the way up the sides of liquid heat exchanger. It usually requires 30 to 45 minutes of slow heating. The sides of the liquid heat exchanger should feel very warm to the touch.
4. Remove insulation from generator and weak solution thermometer wells. Start heating the weak solution line at the bottom of the liquid heat exchanger. Place your free hand on this line about 9" to 12" above where you are heating. When you feel the hot solution move through the line under your hand, move your hand and the torch up. Continue this routine all the way to where the weak solution line is attached to the absorber.
5. Perform the same operation outlined in (4) on line with generator thermometer well welded to it. Start at liquid heat exchanger and go up to the point where tube enters the shell.
6. Heat solution line between liquid heat exchanger and generator.
7. Set thermostat switch to "ON" and do not allow condensing water to flow. Place jumper wire across high temperature switch.
8. Place thermometers in generator thermometer well and condenser surface thermometer well. Place wet rag on fusible plug.
9. Turn unit on. Watch condenser surface temperature and generator temperature. IF CONDENSER SURFACE TEMPERATURE GOES TO 210°F, TURN UNIT OFF. The generator temperature should start rising within 3 to 5 minutes. If it does not, turn unit off and repeat steps (3) through (9).
10. If steps (3) through (9) have been tried 2 or 3 times without clearing the over concentration, it is suggested the unit be allowed to cool for several hours (preferably overnight) before trying the routine again. The unit should be turned "off" and no hot water or condensing water flow permitted during the cooling period. Then repeat steps (1) through (9).
11. Operate unit with throttled condensing water flow for at least 15 minutes after solution starts flowing. Maintain an approximate 105°F outlet condensing water temperature.
12. REMOVE JUMPER WIRE ON HIGH TEMPERATURE SWITCH.
13. Gradually adjust condensing water flow back to normal
14. Check for cause of over concentration and correct.
15. The unit will probably have to be vacuum pumped again at later date to remove non-condensable gases created by the heating of the unit.

MODELS

SOLAIRE

PROCEDURE FOR INSTALLING AND REMOVING CHARGING VALVE WRENCH
(Arkla Part #14267-39)INSTALLING

1. Remove cap from charging valve. Clean threads on charging valve.
2. Place finger over hole in end of needle valve. Using adjustable wrench, loosen needle. Then screw needle valve closed, snug, but not tight.

NOTE: WASH ALL OIL OFF OF WRENCH.
3. Position wrench stem in nylon holding nut such that slotted end of stem is flush with end of nylon holding nut. (See Figure VI-53-2(B))
4. Fit slotted end of wrench stem onto needle valve.
5. Push nylon holding nut down until it contacts threads on charging valve. Screw nylon holding nut onto charging valve until neoprene "O" ring gasket seats tightly against charging valve.
6. Attach vacuum pumping rig to charging valve wrench and make sure there are not any air leaks at charging valve wrench.
7. When turning wrench stem to open needle valve, always hold nylon holding nut to prevent losing seal between charging valve and "O" ring gasket in holding nut.

REMOVING

1. Use a wrench to turn the stem to make sure the needle valve is closed tight.
2. Leave wrench on the stem to hold needle valve closed. Screw nylon holding nut loose from charging valve.
3. Use a wrench to further tighten the needle valve.
4. Wash needle valve and valve body thoroughly to remove any bromide.
5. Replace the cap on the valve.
6. Paint the charging valve with Black Japan paint.
7. THOROUGHLY WASH THE CHARGING VALVE WRENCH WITH LOTS OF WATER.

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.

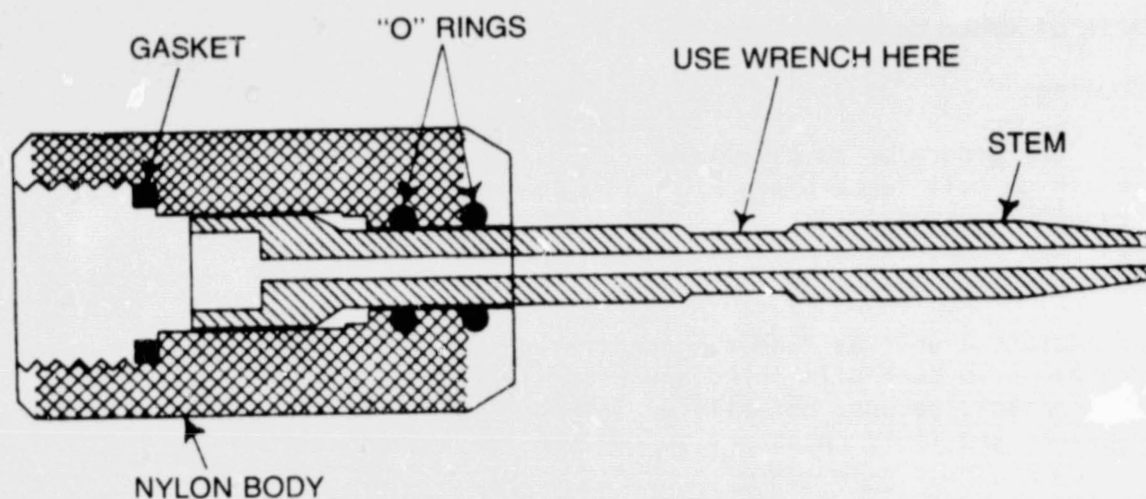
INDEX: VI-53-2 (B)

ARKLA INDUSTRIES INC.

P. O. Box 534

Evansville, Indiana 47704

DATE: Nov., 1976



CHARGING VALVE WRENCH

PART NO. 14267-39

UNDER CONCENTRATION

"Under Concentration" is a description of the condition of the solution in a unit, when the percentage of water in lithium bromide solution is too high. This can only occur when there is a leak in the condensing water circuit, hot water circuit, chilled water circuit inside of the unit or when water has been mistakenly added to the charge through the purge valves or charging valves.

WF-36

Effects of under concentration

Cooling:

- (a) Low generator temperature
- (b) High coil temperature
- (c) Low capacity
- (d) Low temperature rise of condensing water through unit.
- (e) Constant operation

Never declare a unit as "under concentrated" until all other possible causes of trouble have been eliminated and a positive check has been made. This is very important, because normally an internal water leak in a Solaire unit cannot be repaired and it is necessary to replace the sealed unit.

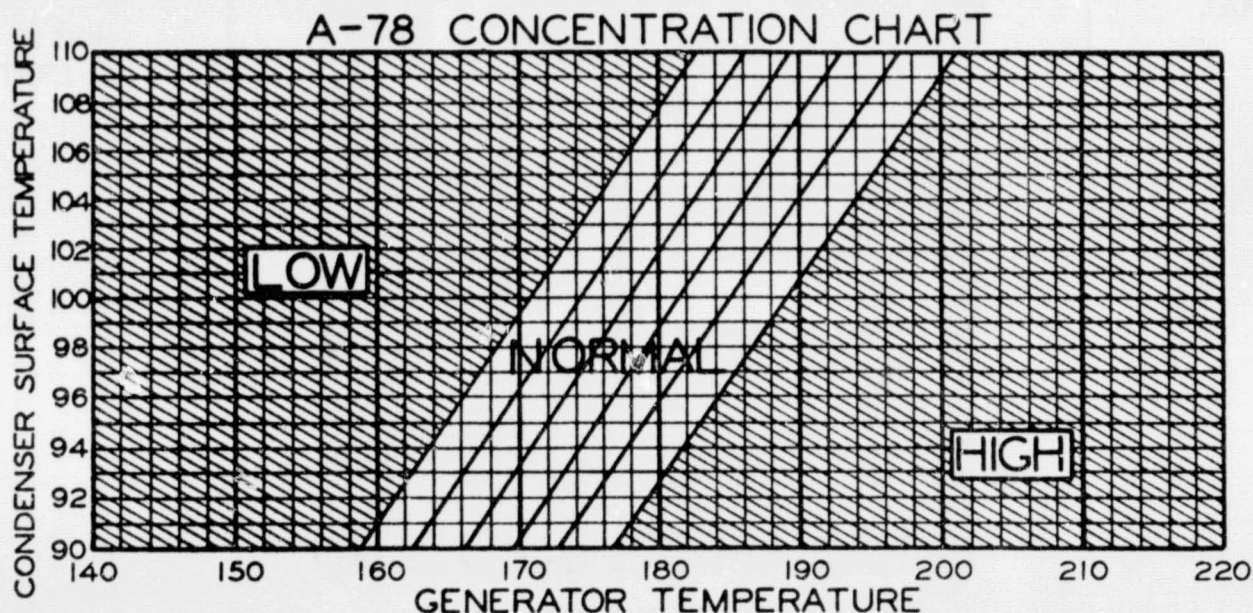
There are several ways to determine under concentration. Use two or more of these checks to positively prove an internal water leak in the unit.

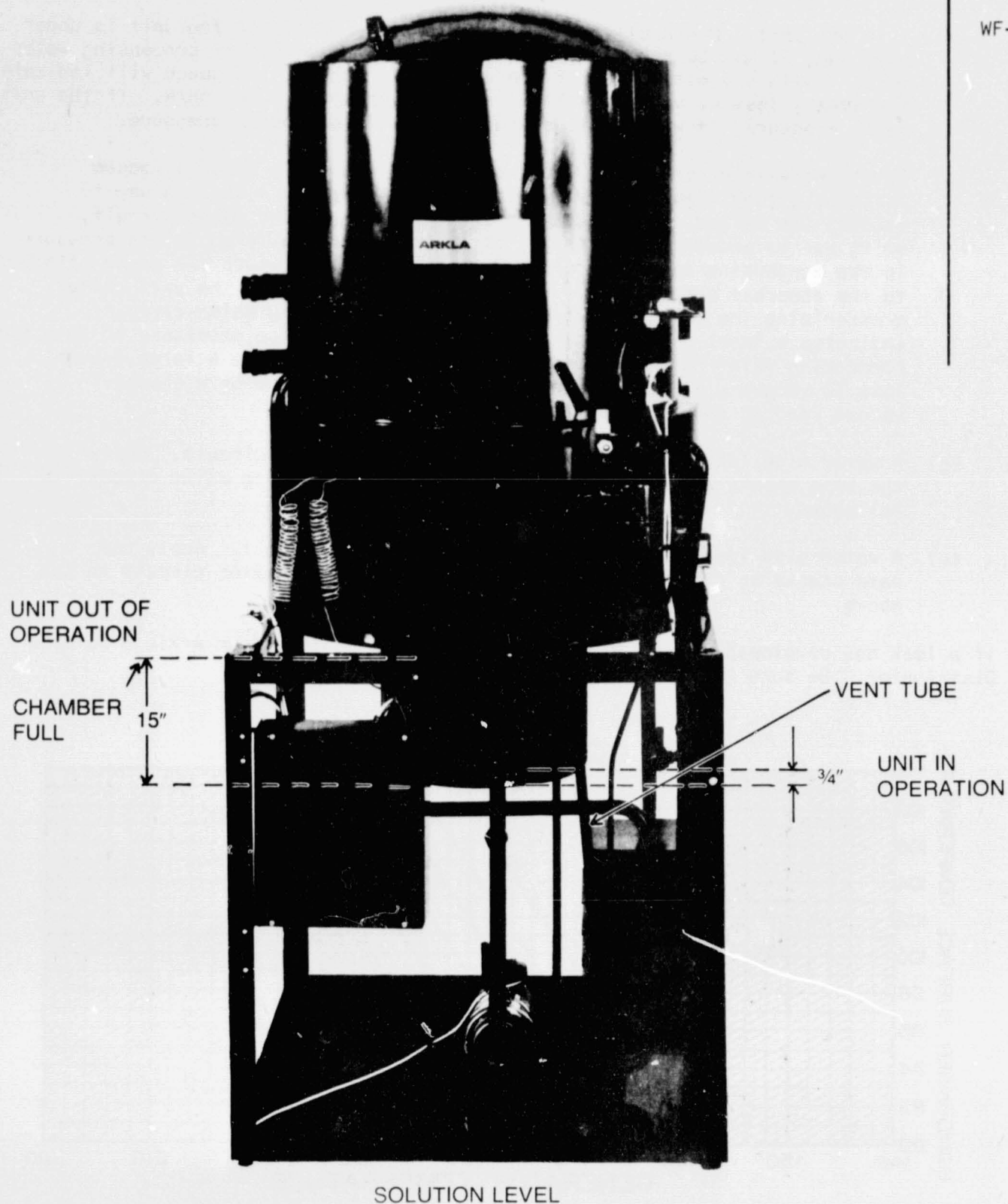
1. Temperatures and operation indicating under concentration.
2. Observe the operation of the unit for several⁴ days. Each day make a record of the temperatures. Use the generator and condenser surface temperatures and the chart on the back of this page to determine the concentration each day. If the concentration progressively goes lower, it is an indication of an internal water leak.
3. Excess water in the unit increases the total volume of solution in the unit and raises the solution level above normal. This can be checked when the unit is "in" operation or "out" of operation.
 - (a) "In" operation, the solution level will be between the measurements shown on the drawing on VI-55-2 (C). Using finger tips to sense the difference in temperature, the temperature will be lower above the solution level than below the solution level. Sometimes this is hard to correctly determine by this method. Method (b) is more positive.
 - (b) Turn off hot water supply to the unit. Allow unit to cool for several hours. Continued flow of condensing water and chilled water will shorten cooling time. Allow time for unit to cool and all solution to settle to bottom of unit. Then heat vent tube in area of solution level and above with small torch. By this method the metal will be hotter above solution level than below. A solution level higher than limits shown below can indicate excessive solution in unit. Correct solution level shown in drawing on VI-55-2 (C).
4. This method requires extra equipment, but usually gives definite indications and can save time.

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- (a) Attach compound gauge (30" vacuum to 30 p.s.i.g.) to absorber purge valve. Open valve. Observe vacuum or pressure reading.
- (b) Turn off unit. Drain all condensing water from unit. If the unit is under a vacuum, it may be necessary to blow residual water out of condensing water circuit with dry nitrogen. If the unit has a vacuum, the gauge will indicate the steady loss of vacuum until it reaches atmospheric pressure. If the unit has a pressure, it will lose pressure down to atmospheric pressure.
- (c) Sometimes with a very small leak, and when the unit is under a vacuum it takes a long time to show a change on the gauge by 4 (b). A way to quicken the method, is to seal off the units condensing water circuit, so it can be pressurized with dry nitrogen. Start building up the pressure in the condensing water circuit and at the same time watch the gauge attached to the absorber purge valve. A steady loss of vacuum in the unit while pressurizing (no more than 25 p.s.i.g.) the condensing water circuit indicates a leak. If the leak is very small, it may be necessary to have the condensing water circuit pressurized for some time before a large enough loss in vacuum will indicate a leak. Do not be misled by a change in vacuum reading due to temperature change.
- (d) A water side leak may have developed in the Hot Water circuit. Apply the same checks as described for checking the condensing water circuit in (c) above.
- (e) A water side leak may occur in the Chilled Water Circuit. Apply the same checks as described for the checking condensing water circuit in (c) above.

If a leak has developed in one of the water circuits; contact your Arkla - Solaire Distributor. Be sure to give model and serial number.





AIR LEAK - SEALED UNIT

An air leak into the unit is indicated when it is necessary to vacuum pump the unit frequently to remove non-condensable gases (not hydrogen) to maintain unit performance. An accurate check should be made on each pumping to make sure the non-condensable gas is not hydrogen.

If it is believed there is an air leak, certain actions should be taken before ordering a replacement service unit.

- A. Always paint both caps (black japan, Arkla part no. Z-2661) on the absorber purge valve and purge receiver tank valve when they are replaced after pumping. This is to prevent air getting into unit in case there is a leak by the valve.
- B. Paint the following items with black japan:
 1. Fusible plug (see figure 1).
 2. Easy Flo joint at base of absorber purge valve (see figure 2).
 3. Easy Flo joint at base of purge receiver tank valve (see figure 2).
- C. If an air leak is still indicated after steps A and B have been taken, the unit should be pressurized to locate the leak (See Indexes VI-61-12, VI-61-13 and VI-55-2).

FUSIBLE PLUG
(WELL FOR BLACK JAPAN
MADE OF ELECTRIC TAPE)

FIGURE 1

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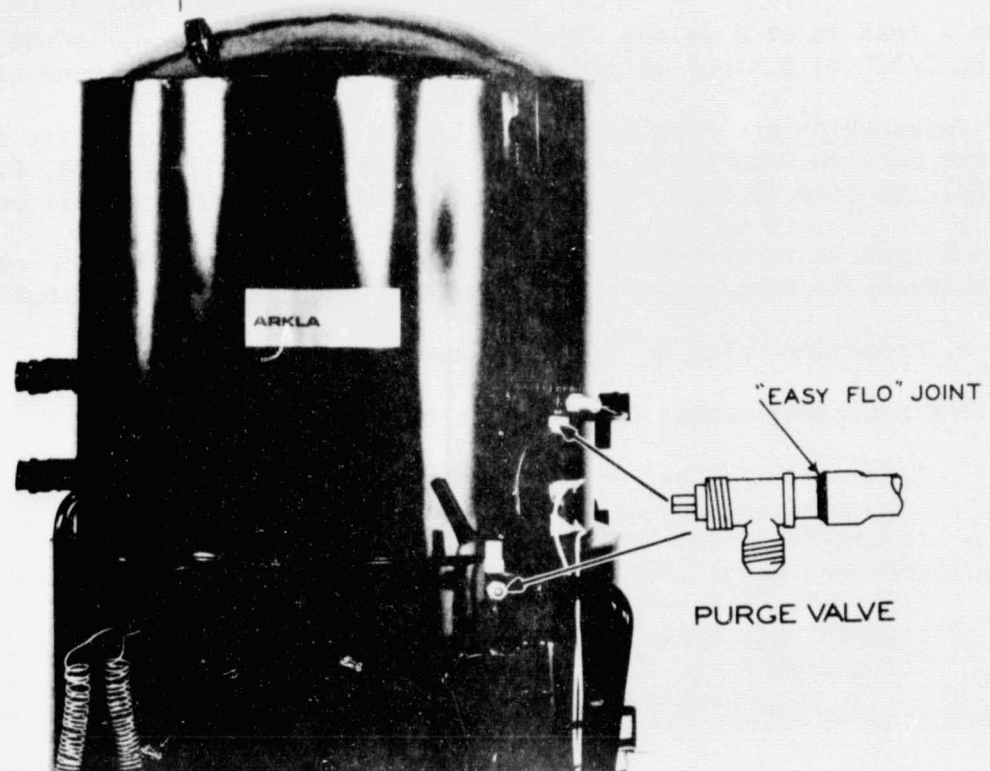


FIGURE 2

AIR LEAK--SEALED UNIT--ABOVE SOLUTION LEVEL

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CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

Small leaks that cannot be found with nitrogen and Liquid Leak Detector can sometimes be found by using Helium and Nitrogen with the liquid leak detector. See Method "B" below.

If instructions in VI-61-11 have been followed and the air leak still persists, the unit should be pressurized to locate the leak.

Follow instructions on how to pressurize and locate leaks above solution level (See VI-55-2 for information on solution levels) by one or more of the procedures listed below.

- A. Procedure Using Dry Nitrogen, and Liquid Leak Detector.
- B. Procedure Using Dry Nitrogen, Helium and Bacharach or Gow-Mac Leak Detector.

If air leak is not located above the solution, then follow instructions on how to locate a leak below the solution level as given in VI-61-13.

When the leak is at the fusible plug, it should be corrected in the field.

Follow the instructions on VI-64-5 for sealing or replacing the fusible plug.

When a leak is at an "Easy Flo" joint above the solution, it can be repaired by using "Easy Flo" #35 or equivalent.

When a leak is at a welded steel joint above the solution, it can be repaired by using 3/32" mild steel welding rod and acetylene welding equipment.

Any leaks which are repaired in the field on "in warranty" units should be reported to the Service Department, Arkla Industries Inc., P.O. Box 534, Evansville, Indiana 47704. Be sure to show the model and serial number of the unit on the report.

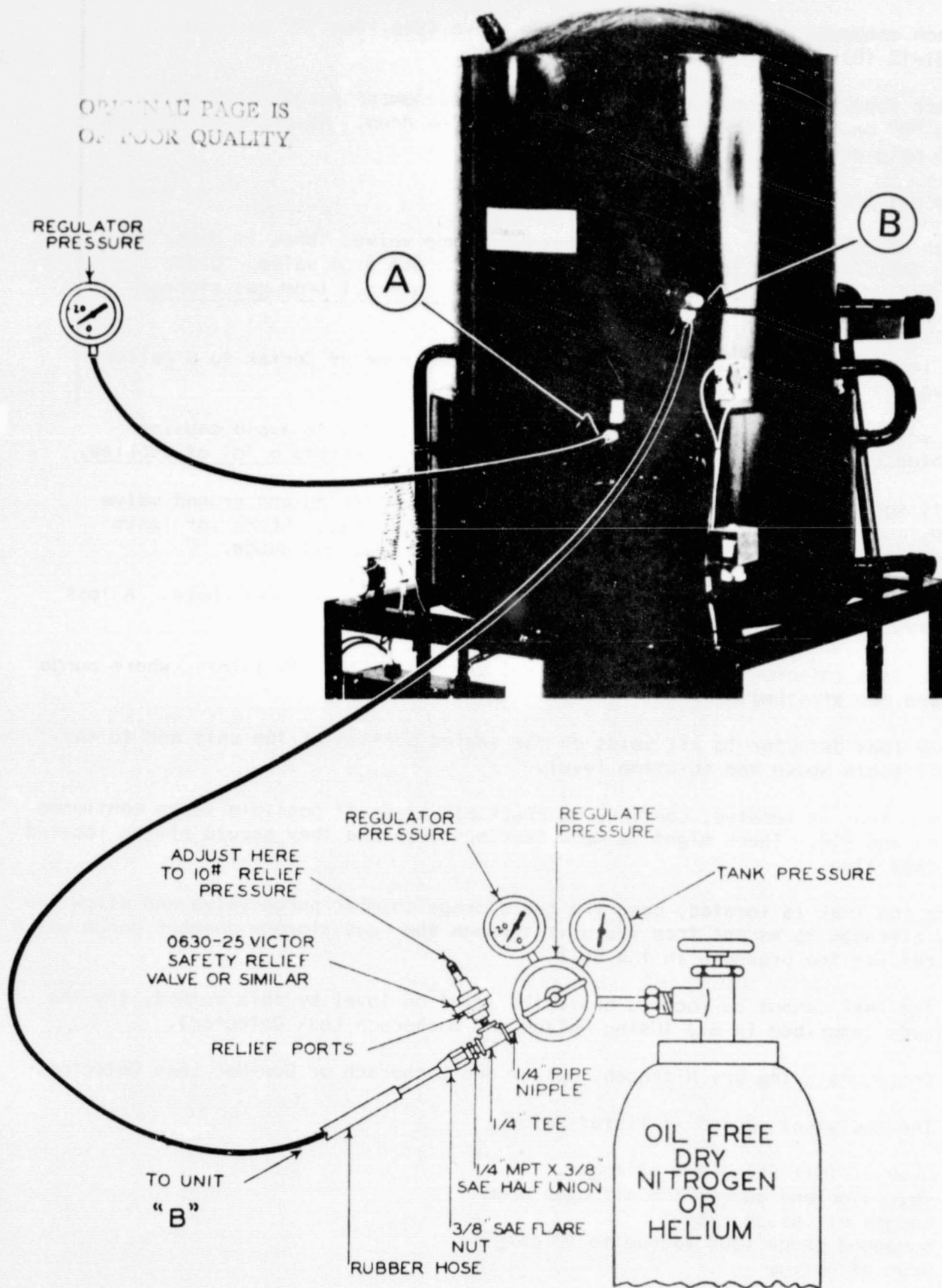
When a leak is located that is at a difficult spot to repair or requires a part or assembly to repair, immediately contact your Solaire Distributor.

- A. Procedure Using Dry Nitrogen and Liquid Leak Detector.

The equipment needed is listed below.

- Drum of (Oil Free) dry nitrogen
- Regulator and gauges for nitrogen drum
- Length of vacuum hose
- Compound gauge (30" vacuum to 30 psig)
- Leak detection solution (Cerfak-Arkla Part #16009-223)
- Squeeze bulb syringe (for applying Cerfak)
- Valve wrench

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MODELS

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The general steps to follow are:

1. Attach compound gauge to absorber purge valve (See Item "A" on Figure VI-61-12 (B) and open valve.
2. Attach hose from nitrogen drum to gas storage chamber purge valve (See item "B" on Figure VI-61-12 (B). Open valve on drum. Adjust drum regulator to 8 psig as shown on drum regulator gauge.
3. Open gas storage chamber purge valve.
4. Watch compound gauge attached to absorber purge valve. When it reads 8 psig (NEVER PRESSURIZE A UNIT OVER 10 psig), close drum valve. Close the gas storage chamber purge valve. Remove flare nut from gas storage chamber purge valve.
5. Mix leak detector solution with water (1 tablespoon of Cerfak to a gallon of water) in a clean bucket.
6. Use squeeze bulb to apply leak detector solution. Try to avoid causing bubbles when applying. Do not use brush as it will create a lot of bubbles.
7. Apply solution to gas storage chamber purge valve opening and around valve stem. Continuous formation of bubbles indicates a leak. Check for leaks around absorber purge valve stem and fittings to compound gauge.
8. Accurately read gauge and check reading frequently during leak check. A loss of pressure indicates a leak.
9. Apply leak detector to fusible plug, and all "Easy Flo" #35 joints (where purge valves are attached to steel tubing).
10. Apply leak detector to all welds on the sealed portion of the unit and to any rusty spots above the solution level.
11. When a leak is located, continue to check all areas of possible leaks mentioned in #9 and #10. There might be more than one leak and they should all be located at this time.
12. When the leak is located, open the gas storage chamber purge valve and allow the dry nitrogen to escape from the unit through the gas storage chamber purge valve to relieve the pressure in the unit.
13. If the leak cannot be located above the solution level by this method, try the methods described in B., (Using Helium and Bacharach Leak Detector).

B. Procedure Using Dry Nitrogen, Helium and Bacharach or Gow-Mac Leak Detector.

The equipment needed is listed below.

Drum of (Oil Free) dry nitrogen.
Regulator and gauges for nitrogen drum
Length of vacuum hose
Compound gauge (30" vacuum to 30 psig)
Drum of Helium

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Equipment needed cont.

Regulator and gauges for Helium drum and adapter so that regulator and gauges for nitrogen drum can be used on Helium drum.

Valve wrench

The general steps to follow are:

1. Attach compound gauge to absorber purge valve (See Item "A" on Figure VI-61-12-B). Open valve.
2. Attach hose from nitrogen drum to gas storage chamber purge valve. (See item "B" on Figure VI-61-12-B). Open valve on drum. Adjust drum regulator to 8 psig as shown on drum regulator gauge.
3. Open gas storage chamber purge valve.
4. Watch the compound gauge attached to the absorber purge valve. When this gauge reads 1 psig, close the drum valve. Close gas storage chamber valve.
5. Remove hose from nitrogen drum regulator and attach to regulator on Helium drum.
6. Open Helium drum valve and adjust regulator to 8 psig. Open gas storage chamber purge valve. Never put over 10 psig in vacuum side of unit.
7. Watch compound gauge attached to absorber purge valve. When it reads 8 psig (NEVER PRESSURIZE A UNIT OVER 10 PSIG). Close drum valve. Close gas storage chamber purge valve. Remove flare nut from gas storage chamber purge valve.
8. Carefully study Instruction Booklet with Bacharach or Gow-Mac Leak Detector on how to detect leaks.
9. Check for leaks around the gas storage chamber purge valve and the absorber purge valve, the compound gauge and the fittings between the valve and gauge.
10. Accurately read gauge and check reading frequently during leak check. A loss of pressure indicates a leak.
11. Apply leak detector probe to fusible plug, and all Easy Flo joints (where purge valves are attached to steel tubing).
12. Apply leak detector probe to all welds on the sealed portion of the unit and to any rusty spots above the solution level.
13. When a leak is located, continue to check all areas of possible leaks mentioned in #11 and #12. There might be more than one leak and they should all be located at this time.
14. When the leak is located, open the gas storage chamber purge valve and allow the dry nitrogen to escape from the unit through the gas storage chamber purge valve to relieve the pressure in the unit.

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Evansville, Indiana 47704

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NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed always wash and paint all rusty or bare metal surfaces.

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AIR LEAK -- SEALED UNIT
BELOW SOLUTION LEVEL

WF-36

CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

If instructions in VI-61-11 and VI-61-12 have been followed and the air leak has not been found, it is possible the leak is below the solution level. See VI-55-2 for information on liquid levels. The methods for checking air leaks below the solution level are given below.

A. Procedure Using Dry Nitrogen and Torch

The equipment needed is as follows:

Drum of (Oil Free) Dry Nitrogen
Regulator and gauges for nitrogen drum
Length of vacuum hose
Compound gauge (30" vacuum to 30 psig)
Prest-O-Lite torch or acetylene torch
Valve wrench

The general steps to follow are:

1. If the unit is not already pressurized, pressurize it as described in VI-60-12, Procedure A., steps 1 through 8.

If there is a leak below the solution, the pressure will push the liquid lithium bromide through the hole. Lithium bromide is a very "thick" solution. If the hole is very small, it may take a long time to push a noticeable amount of it out through the hole. Lithium bromide absorbs water vapor from the air at a rapid rate. So, when it is forced out through the hole, a "wet" spot will be formed.

2. Carefully examine all welds and metal areas below the solution level for wet spots. Also check around the "V" band which secures the motor to the pump casing.
3. (a) When a spot is noted, get a very small amount of it on your finger. It will feel "sticky". Just barely touch it to your tongue, it will taste very salty.

(b) Another method of checking is with a torch. When lithium bromide is heated, it causes the torch flame to turn a "reddish purple" color. The torch method will sometimes show a leak that has not yet formed a wet spot.
4. When a leak (or leaks) is (or are) located, check by both the "taste" and "torch" method to positively identify the leak(s).
5. When the leak (or leaks) has (or have) been located, immediately relieve the pressure from the unit by opening the gas storage chamber purge valve. Allow the nitrogen to escape from the unit through the gas storage chamber purge valve only.

6. Make a temporary patch on the hole to prevent any more solution from draining out of the unit.
7. Immediately contact your ARKLA SOLAIRE DISTRIBUTOR. Be sure to give the model and serial number of the unit and the exact location of the leak.

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally, it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.

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MODELS

SOLAIRE

REPLACING FUSIBLE PLUGS

In the event a fusible plug requires replacement the following procedure must be followed:

The unit must be brought to atmospheric pressure with water pumped, oil-free nitrogen as described in VI-61-2 or -12. Loosen the old plug with a 7/8" 6 point socket wrench. Using a wire brush, remove the black japan paint and any accumulation of dirt from the area around the fusible plug. Remove the fusible plug. Clean the threads in the spud and inspect for damage.

Apply "Leak Lock" joint sealer sparingly to the first four threads of the fusible plug. CAUTION: AVOID GETTING ANY SEALER ON THE BOTTOM OF THE PLUG. It is necessary that the sealer be brushed into the threads of the plug. "Leak Lock" joint sealer must be applied to first four threads of the spud in the same manner. Install plug and torque to 90 or 95 ft. lbs.

Pressurize unit and leak test the fusible plug and the weld around the spud as described in VI-61-2 or 12. If no leak is found, tape around the fusible plug until the tape is at the shoulder of the fusible plug and pour this area full of black japan.

Pump the unit as described in VI-43-1.

The use of the correct plug is necessary to insure safe operation:

PART NUMBER

STAMPED

MODEL

14253-22

255

SOLAIRE

The use of "Leak Lock" joint sealer is necessary. "Leak Lock" is a common refrigeration sealer which may be purchased locally or ordered from Arkla under Part Number Z-1194 for all models.

TOWER PROBLEMS

POSSIBLE CAUSES	High Temperature Water From Tower	Low Temperature Water From Tower	Low Water Volume	High Water Volume	Low Sump Level	Pump Motor - Noisy	Pump Motor - Short Cycling	Blower Motor - Will Not Run	Blower Motor - Short Cycling	Blower Motor - Will Not Run	INDEX
Cond.. Water Flow Rate Adj.	x		x	x							IV-45-2
Sump Level Adj.	x		x		x						
Blower Belt Adj.	x										
Dirty Sump Screen	x		x								
Low Sump Level	x		x								
Obstructed Air Flow	x										III-6-4
Recirculation of Air	x										
High Ambient Wet Bulb Temperature	x										
Low Ambient Wet Bulb Temperature		x									
Restrictions in Piping or Unit	x		x								VI-33-2
Dirty, Scaled or Defective Packing Sheets	x										
Blower Bearings	x							x			
Blower Motor - Short Cycling	x										
Blower Motor - Defective	x										
Defective Pump Seal	x		x		x	x	x				
Defective Pump	x		x			x	x	x			
Defective Pump Motor Bearings	x		x			x	x	x			
Pump Motor - Short Cycling	x										
Pump Motor - Defective	x					x	x	x			
Fuses								x		x	
Incorrect Voltage	x						x	x	x	x	
Defective Make-Up Water Valve	x		x		x						
Sump Switch - Location or Defective	x	x						x	x		V-36-2
Tower Level	x		x		x						III-6-4

ARKLA INDUSTRIES INC.

P. O. Box 534

Evansville, Indiana 47704

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DATE: Nov., 1976

MODELS

CUSTOMER _____ DATE _____

ADDRESS _____

CITY & STATE _____

AIR CONDITIONER MODEL NO. _____ CODE _____ SERIAL NO. _____

UNIT MODEL NO. _____ CODE _____ SERIAL NO. _____

TOWER MODEL NO. _____ CODE _____ SERIAL NO. _____

AIR HANDLER MODEL NO. _____ CODE _____ SERIAL NO. _____

CONDENSING WATER PUMP: MAKE _____ MODEL _____ H.P. _____ GPM _____ FT. HEAD _____

CHILLED WATER PUMP: MAKE _____ MODEL _____ H.P. _____ GPM _____ FT. HEAD _____

HOT WATER PUMP: MAKE _____ MODEL _____ H.P. _____ GPM _____ FT. HEAD _____

COMPLAINT:

REMARKS:

SERVICEMAN

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LEVEL	FOUND		
Front-to-back			
Side-to-Side			
AIR VOLUME			
Filters			
Draft Gauge Reading			
Volume-C.F.M.			
CHILLED WATER			
Evap. In-PSIG			
Evap. Out-PSIG			
Pressure Drop			
Flow Rate-GPM			
TOWER			
Sump-Condition			
Sump Screen-Condition			
Sump Water Level			
Packing Sheets-Condition			
Blower Belt Adjustment			
Pump Pressure			
Bleed-Off Oz./Min.			
CONDENSING WATER			
Absorber In-PSIG			
Condenser Out-PSIG			
Pressure Drop			
Flow Rate-GPM			
INPUT-HOT WATER			
Gen. In-PSIG			
Gen. Out-PSIG			
Pressure Drop			
Flow Rate-GPM			
TEMPERATURES OF			
Condensing Water-Absorber In			
Condensing Water-Absorber Out			
Condensing Water-Condenser Out			
Condenser Surface			
Weak Solution			
Strong Solution			
Generator			
Generator Return			
Hot Water In			
Hot Water Out			
Evaporator			
Chilled Water In			
Chilled Water Out			
Air Supply			
Air Return			
PUMPING			
Absorber-From MM of Hg.			
Absorber-To MM of Hg.			
Receiver-From MM of Hg.			
Receiver-To MM of Hg.			

9.5 Repairs

RECOMMENDED WAY TO USE UNIT REPAIR SECTION

This section of the manual pertains to the actual replacement of sealed unit component parts on the ARKLA SOLAIRE AIR CONDITIONING EQUIPMENT.

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The repair sheets in this manual will be the same sheets that provide instructions for making a given repair found with each kit and have the kit part number and repair instruction part number printed on these instructions.

Each page has an INDEX number at the top. Under the INDEX number there is a DATE showing when the page was originally published. If the page has been rewritten to include later information, the word REVISED will replace the word DATE and show when the page was rewritten. Under the word MODELS will be shown a list of models to which the information on that page pertains. Be sure to select the page which shows the model for which you want the information. Also under a model number, there may be a breakdown by serial numbers.

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MODELS

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INDEX NO.	REV.	SUBJECT
VII-1-1		Recommended Way To Use Unit Repair Section
VII-1-3		Index
VII-2-2		Suggested Repair and Service Tool List
VII-2-5		Welding Hints and Tips
VII-12-1		Removing Solution
VII-12-2		Putting In Complete Solution Charge
VII-54-5		Replacing Solution Pump Parts
VII-54-6		Replacing Body Assembly - Pump Casing
VII-64-6		Replacing Purge Valve
VII-64-7		Replacing Solution By-Pass Valve
VII-65-10		Replacing Liquid Heat Exchanger
VII-65-11		Replacing Purge Pump

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MODELS

SUGGESTED SERVICE TOOL LIST

The following tools are necessary along with normal hand tools for the proper adjustment and completion of a repaired Arkla Solaire WF-36 unit. Tools may be obtained locally or ordered from Arkla Industries Inc., Evansville Indiana 47704.

WF-36

QUANTITY	PART NO.	ITEM NAME
2	3469-7	6" Pocket Thermometer -40° to +120°F
4	14267-18	12" Thermometer 0° to 300°F
7	4569-4	12" Thermometer 0° to 120°F
1	14267-6	Gauge: 0 to 30 p.s.i.g.
1	14267-7	Gauge: 0 to 100 p.s.i.g.
1 pt.	16009-223	Cerfak (Leak Testing Solution)

The following items are also necessary but will have to be purchased locally:

1	N/A	Volt - Amp Meter
2	N/A	30" High Pressure Hose (Refrigerant Charging hose is suitable)
1	N/A	Spirit Level (6")
	N/A	Emery Cloth
1	N/A	Hand File (8" Half-Round)
1	N/A	Ruler
1	N/A	Magnet
1	N/A	Hack Saw
	N/A	Oxy-Acetylene Welding Equipment (if welding or soldering)
	N/A	Normal Hand Tools
	N/A	Glass or Heavy Plastic Container To Store Solution
1	N/A	7/8" Six Point Socket (Fuse Plug)
1	N/A	Vacuum Pump

The tool kit listed below is very convenient and helpful if the quantity of Arkla units installed warrants its purchase. It contains all of the special tools, needed to satisfactorily maintain and service Water Cooled Specified Products Model Air Conditioners, not listed above.

TOOL KIT (Part No. 02-146)

QUANTITY	PART NO.	ITEM NAME
1	67-1	Meriam Vacuum Gauge
2	4253-61	1 Hole #7 Rubber Stopper
1	4267-22	Purge Valve Wrench 1/4" Ratchet
1	4267-24	Shaft Speed Indicator
2	4276-2	Vacuum Flask - 500 cc.
1	5304-3	Vacuum Hose - 12 ft.
1	14267-6	Pressure Gauge - 0 to 30 PSI
1	14267-7	Pressure Gauge - 0 to 100 PSI
1	14267-12	Vacuum Hose Tee
7	4569-4	12" Thermometer - 0° to 120°F
4	14267-18	12" Thermometer - 0° to 300°F
2	3469-7	6" Thermometer - minus 40°F to 120°F
1	14267-39	Charging Valve Wrench
1	5301-12	Water Manometer
1	4256-11	Draft Gauge 0 to 1.0" with case

WELDING HINTS AND TIPS

Thorough preparations; the use of proper materials and good operating welding equipment are essential in obtaining successful welds and repairs.

SAFETY: This subject should be first and foremost in our mind and actions. Practicing safety and good common sense can prevent many unnecessary accidents.

1. The work area should be cleared of any unnecessary flammable materials.
2. Personnel not involved in the actual repair should be kept at a safe distance.

COMPONENT CHANGE OUT: Exact instructions for component removal and replacement will be found in this section. The instructions should be followed in the step-by-step procedure in which they are written.

1. Thoroughly clean the inside of tubes at the weld joint to remove any copper oxides.
2. Tubes should have perfect alignment. (No offset joints.)
3. Always have the unit vented during the welding operation; open both purge valves.
4. Use a magnet to determine the type of metal before hacksawing any tubing. Stainless steel tubing used in Arkla units is non-magnetic.

WELDING EQUIPMENT:

1. Do not use a welding tip size which has a flame port opening larger than a #56 (.0465) drill.
2. Use tip cleaners to clean the welding tip. Do not scrub tip against metal to clean.
3. Never use brazing to make repairs on lithium bromide units.
4. Always weld vertically up with an oxy-acetylene torch, never vertically down.
5. Acetylene regulator working pressure should be 8 to 10 psig.
6. Oxygen regulator working pressure should be 15 to 20 psig.
7. Use a neutral flame on oxy-acetylene torch when welding mild steel. (Never oxidizing.)
8. Use a slightly carburizing flame on oxy-acetylene torch when welding stainless steel.

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FLUX:

1. Stainless steel welding flux must be used when oxy-acetylene welding stainless steel. AIRCO Formula #34 and N.C.G. #8 are two brands of stainless steel welding flux that can be used. Flux of these equivalents or better should be used.
2. Brazing flux used along with the oxy-acetylene welding rod can be very helpful in stopping the cracking and splitting of completed mild steel welds.
3. Silver solder flux must be used when making a silver solder joint. CLEAN flux will prove most beneficial.

WELDING ROD:

1. Mild steel welding rod should be uncoated and never larger than 3/32" in diameter.
2. Stainless steel welding rod should be for the welding of type 304, 308 or 347 stainless and never larger than 3/32" in diameter.
3. Silver Solder (35%) 1/16" diameter.
4. Silfos (15%) 1/16" diameter.

The chart below is intended as a guide. The left column indicating the types of metal to be joined and the right column indicating the method and material to use:

Mild Steel to Mild Steel	Oxy-acetylene Torch and <u>Uncoated Welding Rod</u> Heliarc Torch and Heliarc Welding Rod
Stainless to Stainless or Mild Steel	Oxy-acetylene Torch, Stain- less Steel welding Rod and Flux <u>Heliarc Torch and Stainless Steel Welding Rod</u> Oxy-acetylene Torch, Silver Solder and Flux
<u>Mild Steel to Copper</u> Copper to Brass	Oxy-acetylene Torch, Silver Solder and Flux
Copper to Copper	Oxy-acetylene Torch and Silfos

HOW TO REMOVE ALL THE SOLUTION FROM UNIT

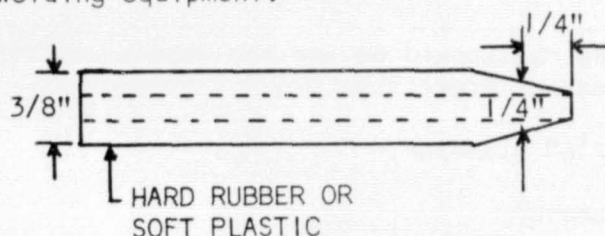
MODELS

CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

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EQUIPMENT NEEDED:

- Container(s) for storing solution. Container(s) must be clean and oil free. (GLASS OR STRONG HEAVY PLASTIC)
- Charging valve wrench. (See Service Bulletin #106 Rev. or VI-53-2)
- Pressurizing Equipment (See VI-61-12).
- Hand Tools.
- Clean length of vacuum hose (5' to 6')
- Clean rags.
- Drill motor and 1/4" bit
- Special nozzle (See sketch below). Make from end of ball point pen.
- Acetylene welding equipment.



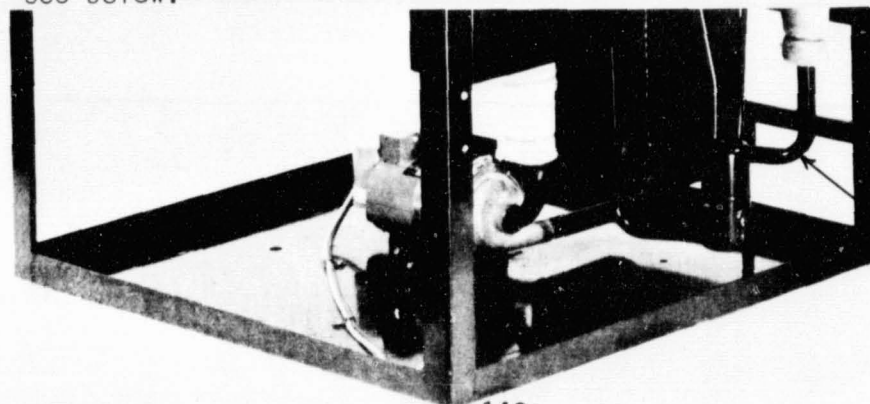
Total Solution Volume Is 85 lbs. Approximately 7 gallons.

INSTRUCTION:

- Make sure the container(s) for storing solution are CLEAN, OIL FREE AND DO NOT LEAK.
- Turn off electrical and hot water supply to the unit.
- Remove front, top, rear and right side panels.

REMOVING SOLUTION FROM WEAK SOLUTION CIRCUIT:

- Pressurize unit, following procedures in Index: VI-61-12. When compound gauge, attached to the absorber purge valve (A) reads 2" vacuum; close valve on nitrogen cylinder.
- Use center punch to mark the location for drilling of 1/4" hole in the weak solution line. See below.



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DRILL HOLE

6. Place clean rag under the weak solution line where hole will be drilled.
7. Put an end of the vacuum hose into the solution storage container. Place special nozzle in other end of vacuum hose. Be sure that tapered end of nozzle is not inside the vacuum hose. Pinch the vacuum hose so as to close it approximately 12" to 14" from the nozzle. Lay nozzled end of hose on rag directly beneath where hole will be drilled.
8. Arrange some type of shield on drill bit such as a plastic coffee can lid or cardboard to protect drill chuck from bromide.
9. Drill hole. As soon as drill goes through the tube wall and made a clean hole, remove drill. Quickly insert tapered end of nozzle into hole and while exerting pressure turn the nozzle clockwise, this should form a seal.
10. Open valve on nitrogen cylinder and continue to pressurize unit to 3 psig. Close valve on nitrogen cylinder.
11. Release pinch on vacuum hose so that solution can flow into the container. When all the solution has been removed from this weak solution circuit, pinch the vacuum hose again so as to shut off the flow of nitrogen from the unit.

REMOVING SOLUTION FROM STRONG SOLUTION CIRCUIT:

12. Remove cap from charging valve on left; rear bottom of liquid heat exchanger. Connect charging valve wrench. See VI-53-2 for proper procedure.
13. Attach a vacuum hose between charging valve wrench and clean, oil free container, open charging valve to drain the solution from the strong solution side of liquid heat exchanger and solution storage chamber. Close the charging valve after all the solution has been removed.
14. Release remainder of unit pressure by opening pinched vacuum hose. Remove nozzle from hole, in weak solution line.
15. Use clean rag and an abundance of clean water to wash away any bromide that may have dripped into the unit base pan. Remove charging valve wrench and also wash the charging valve housing on the liquid heat exchanger.
16. Use acetylene torch to weld shut the hole in the weak solution line.
17. Pressurize unit and leak test this repair weld. See VI-61-12 for procedure. Release unit pressure through the absorber purge valve when unit is leak free.
18. Do not seal glass storage containers air tight.
19. Wash all equipment using clean water to remove any bromide.

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.

HOW TO PUT COMPLETE BROMIDE CHARGE INTO THE UNIT

MODELS

CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

WF-36

EQUIPMENT NEEDED:

- (a) Vacuum pumping equipment
- (b) Hand tools
- (c) 3/8" copper tube (42") CLEAN, OIL FREE
- (d) Charging valve wrench
- (e) Vacuum hose - 6'
- (f) Distilled water - 1 gallon

INSTRUCTIONS:

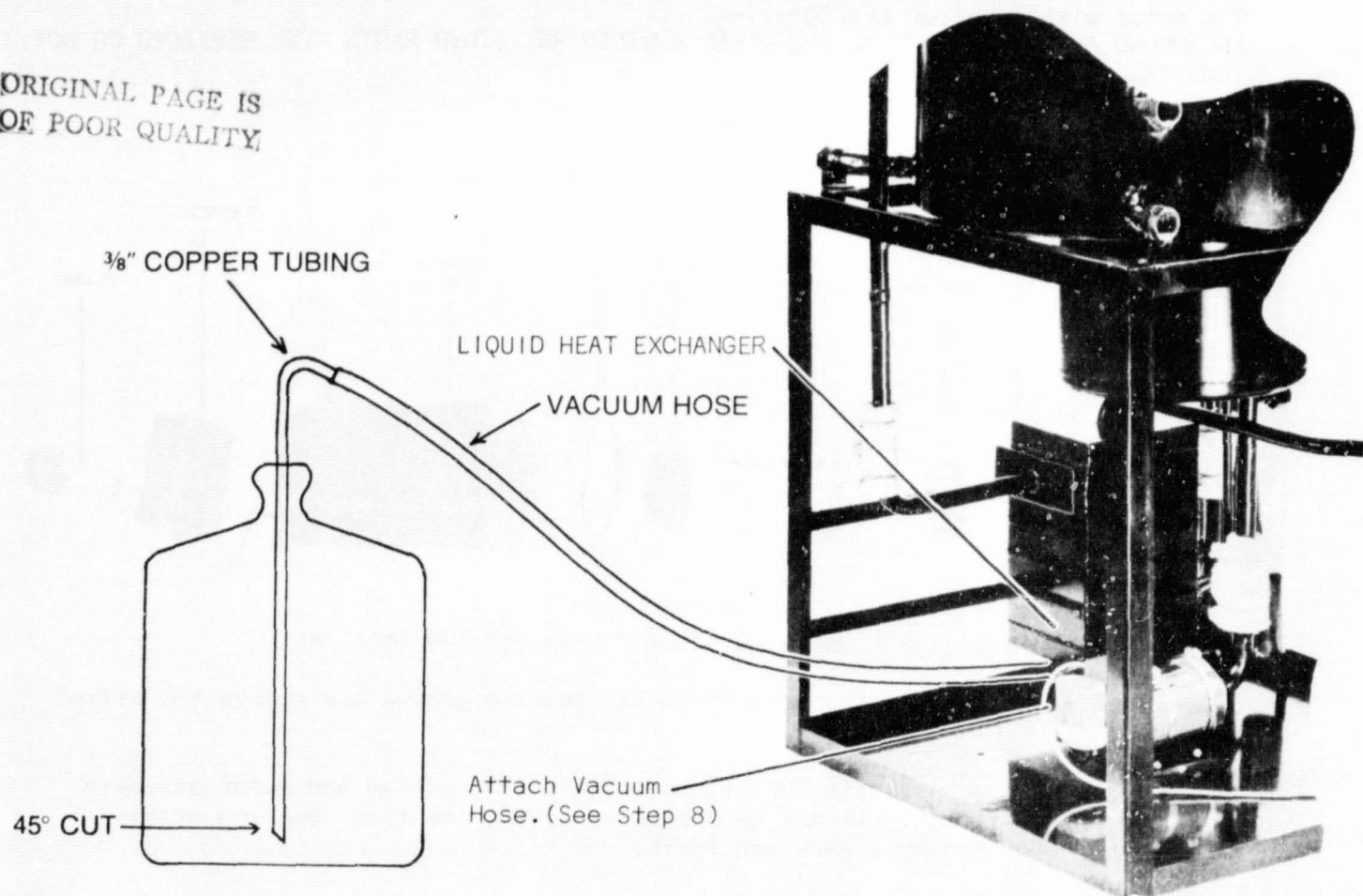
1. Vacuum pump unit to approximately 20 mm Hg absolute pressure (See VI-43-2).
2. Close gas storage chamber purge valve. Disconnect pumping equipment from unit.
3. Remove top panel and right side panel.
4. Install charging valve wrench (See VI-53-2) on charging valve located at lower left rear corner of liquid heat exchanger.
5. Insert 3/8" diameter copper tubing (42" long onto one end of 6' vacuum hose. (See VII-12-2(B)).
6. Fill hose and tube with distilled water.
7. Pinch vacuum hose approximately 2" from loose end, keep tubing pointing up to keep from draining.
8. Attach loose end of vacuum hose onto charging valve wrench.
9. Release pinch on vacuum hose and refill tubing with distilled water.
10. Pinch hose next to long copper tubing with tubing pointing up and full of distilled water.
11. OPEN CHARGING VALVE on Liquid Heat Exchanger.
12. Place finger over 45° end of tube. Plunge tube into solution. Release pinch on hose. Vacuum will pull solution into unit.
13. Pull all solution possible out of container without pulling air. Pinch hose next to long tube after all charge has been put into unit.
14. Withdraw tube from solution container and put end of tube into distilled water.
15. Release pinch on hose. Draw enough distilled water to clean hose and charging valve wrench of bromide. Pinch hose. CLOSE CHARGING VALVE.

16. Disconnect hose from charging valve wrench. Remove charging valve wrench. (See VI-53-2) wash charging valve housing, flush with an abundance of clean water.
17. Attach pumping equipment. Pump from Gas Storage Chamber purge valve on WF-36 and absorber purge valve on other models. See (VI-43-2).
18. Put right side and top panels back on unit.
19. CAUTION: LET UNIT SET 30 minutes for solution to level out before operating after having put in a complete bromide charge.
20. Solution will have to have been circulating long enough to fill the weak solution side of Liquid Heat Exchanger before being able to get an accurate solution level check. (Refer to Index: VI-55-2(C))

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.

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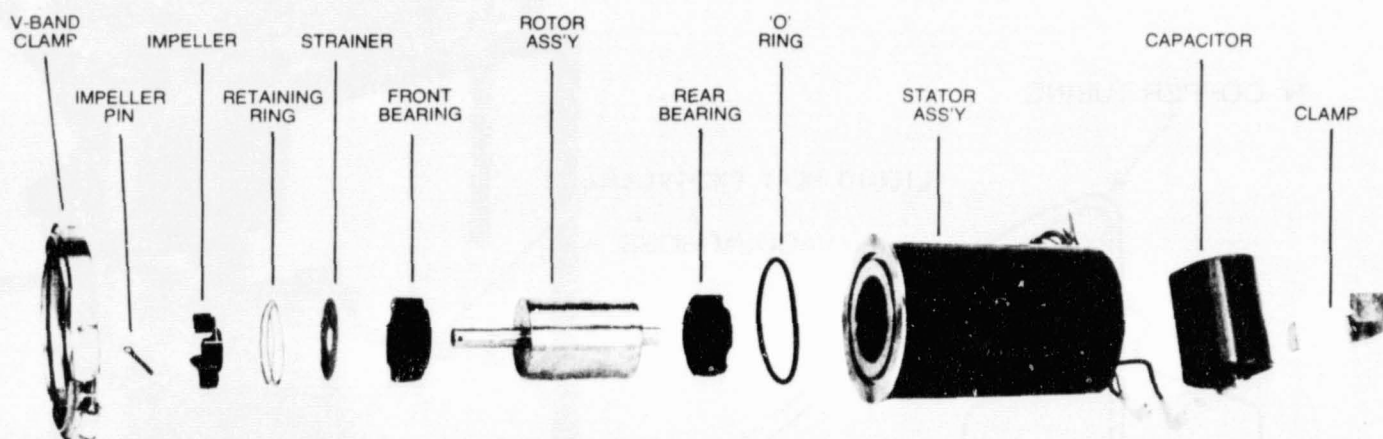
REPLACING SOLUTION PUMP PARTS

CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

WF-36

Replace solution pump parts in the following manner:

1. Turn "OFF" power supply to unit.
2. Remove all the solution from the strong solution side of the Liquid Heat Exchanger. (See VII-12-1). DO NOT REMOVE SOLUTION FROM WEAK SOLUTION SIDE OF LIQUID HEAT EXCHANGER.
3. Disconnect the electrical supply at the connection box on top of the motor.
4. Remove the clamp securing the motor to the mounting base.
5. Remove one screw on each side securing motor support to the unit base pan. Slide motor support out from beneath the motor.
6. Spread clean plastic garbage bag or liner beneath the pump and motor assembly as there will be approximately 1 pint of solution that will drain out when the V-band clamp is removed.
7. Remove the V-band clamp holding the front end bell to the pump casing. Remove the motor with impeller and "O" ring.
RECOMMEND A NEW "O" RING BE INSTALLED WHETHER ANY OTHER PARTS WERE REPLACED OR NOT.
(See the exploded view below)



8. Remove the impeller pin from the shaft and slip off the impeller.
9. Remove the spiralox retaining ring from its seating groove and remove the filter screen.
10. Pull on the protruding shaft and slip out the front bearing and rotor assembly from the motor section. It may be necessary to tap the front bearing out by moving the rotor assembly back and forth.

INDEX: VII-54-5 (B)

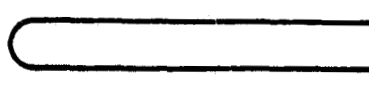
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11. To remove the rear bearing from inside the motor section slip a "U" shape wire curled outward at both ends inside the bearing shaft hole. Once the curled ends are engaged on the back side of the bearing, pull the bearing out. See sketch.



Reassembly

To reassemble, reverse the disassembly procedure, add the new parts to replace the old and carefully note the following;

1. When replacing the rear bearing (with stepped end toward you), make sure the bearing seats against the bottom end of the motor section and that one of the key slots in the back of the bearing seats over the retaining dimple. (The front and rear bearings are identical).
2. The front bearing is replaced with the stepped end away from you.

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.

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MODELS

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REPLACING BODY ASSEMBLY PUMP CASING

INFORMATION BEING RESEARCHED

INSTRUCTIONS WILL BE WITH KIT

INSTRUCTIONS FOR REPLACING PURGE VALVE

CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

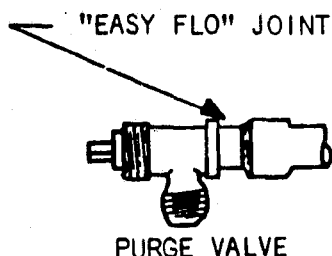
WF-36

Equipment needed:

Valve (Arkla Part #15691-236 or Mueller Brass B32636)
Welding equipment - Acetylene
Easy Flo #35 Handy Harmon
Flux - Handy Harmon
Pressurizing equipment - See VI-61-2 or VI-61-12 Procedure "A".
Pumping equipment - See VI-43-1
Arkla Service Manual
Hand tools

GENERAL INSTRUCTIONS:

1. Cut off electrical and hot water supply to unit.
2. (a) If unit has been pressurized with dry nitrogen, relieve pressure to atmosphere by opening gas storage chamber tank purge valve.
(b) If unit has vacuum, pressurize unit by following Procedure "A" on VI-61-12. Only pressurize the unit to 1/4 psig, then shut off drum valve. Close gas storage chamber tank purge valve and remove hose fitting from this valve and relieve pressure to atmosphere.
(c) Remove gauge from absorber purge valve.
3. After pressure in unit is down to atmospheric, open absorber purge valve.
4. Heat "Easy Flo" joint at base of valve to be changed until valve body can be pulled out with pliers. Flux "Easy Flo" joint before applying heat. Refrain from oxidizing steel connection.



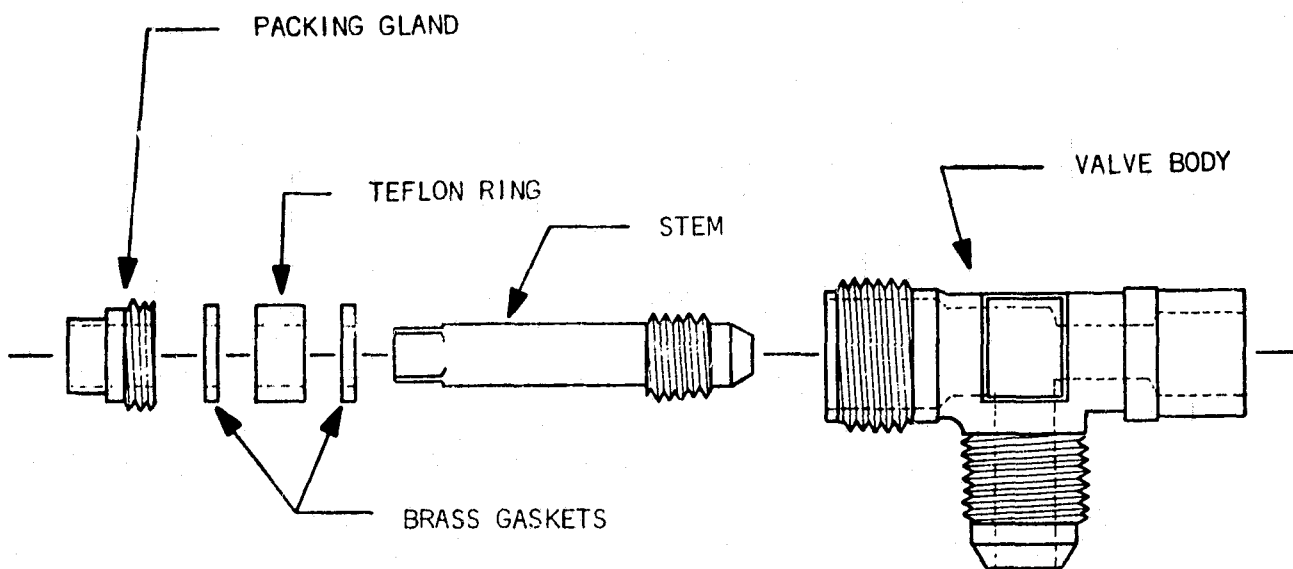
5. Disassemble new valve. Screw out packing gland nut. Screw out valve stem assembly.
6. Clean tube and valve using emery cloth. Apply flux. Put valve body in place.
7. Use Easy-Flo #35 (Handy Harmon) to make joint on new valve body.
8. After Easy Flo joint has cooled, wash off all flux.
9. Replace valve stem and packing gland nut.

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10. Leak test "Easy Flo" joint and valve using Procedure "A" on VI-61-2 or VI-61-12.
11. Pump unit according to instructions on VI-43-1. If the unit is to be operated on "cooling". Do not turn the unit "On" until the unit has been pumped down to approximately 20 mm Hg. absolute pressure.
12. After the unit has been pumped, a service specialist should check all adjustments and operation of the air conditioner. The unit will have to be pumped once or twice more to remove the remainder of the nitrogen.
13. Clean repair area and paint with black japan.

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.



PURGE VALVE

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MODELS

REPLACING SOLUTION BY-PASS VALVE

Replacement of the coil does not require breaking the units vacuum. Any other inspection or repair of the solution by-pass valve will require the following equipment and following of the listed procedures.

WF-36

CAUTION: Lithium bromide solution is not poisonous, but it has a drying effect on skin. If any gets on the skin, it should be washed off immediately. If it gets in the eyes, wash with clean water immediately and go to the doctor.

EQUIPMENT NEEDED:

Pressurizing Equipment See VI-61-12
Solution Removal Equipment See VII-12-1
Hack saw and normal hand tools
Service tools - for suggested list See IV-2-1
Acetylene Welding Equipment
Vacuum Pumping Equipment See VI-43-1.
Equipment to put solution into unit. See VII-12-2

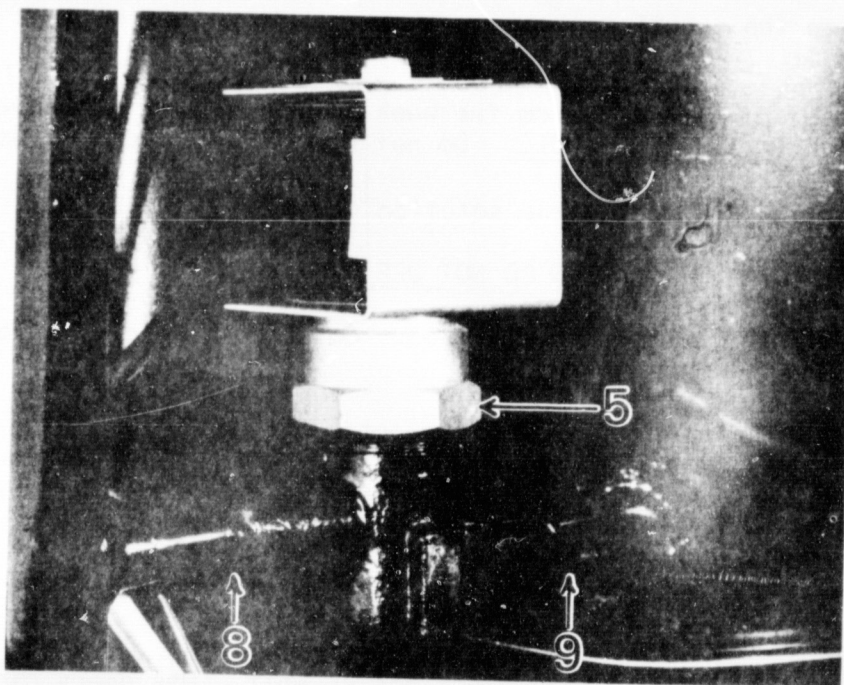
GENERAL INSTRUCTIONS:

1. Unpack the solution by-pass valve; check to be certain that correct part was received.
2. Manually energize the solution by-pass valve coil to allow the weak solution to drain down.
3. Remove only 1 pint of solution from the weak solution charging valve. See VII-12-1(D): DO NOT DRILL HOLE. Do not remove any strong solution.
4. Remove the coil from the top of the solution valve.
5. Loosen hex nut (1 7/16"). CAUTION DO NOT USE PIPE WRENCH.
6. Nut and upper half of valve can be removed. Core and seat can now be lifted out for inspection.
7. If valve body is not to be replaced; reassembly can be made by reversing the disassembly procedure. Recommend a new "O" ring be installed whether any other parts were replaced or not. Tighten hex nut to 15 ft/lbs. Proceed to Step 13.
8. Measure new valve body to determine where the connections will have to be sawed to remove the old valve.
9. Use file to remove burrs on tube connections on unit. Use emery cloth to polish the inside ends of tubes on unit.
10. Remove nut, upper half and core from new valve.
11. Position new valve body and tack weld, avoiding any offset joints. Complete welds. Allow welds and valve body to cool normally.

12. Reassemble valve as outlined previously in step 7.
13. Pressurize unit and leak test. See VI-61-12.
14. When free of leaks; install coil on valve.
15. Vacuum pump unit as per Index: VI-43-1.
16. Put drained solution in unit. This can be done by using same method used for adding inhibitor. See VI-47-2.
17. Put unit into operation. Unit may have to be vacuum pumped once or twice at later date to remove more noncondensibles (nitrogen).

NOTE:

Lithium Bromide solution is very corrosive when exposed to the atmosphere. If any solution should leak out, be spilled or splashed on the unit externally; it should be washed off and thoroughly rinsed with an abundance of clean water. This is also true of floor or surrounding objects on which bromide is spilled. If stepped in, it tracks very badly. Any bromide left will absorb humidity and remain damp constantly. After a repair or service work has been completed, always wash and paint all rusty or bare metal surfaces.



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REPLACING LIQUID HEAT EXCHANGER

**INFORMATION
BEING
RESEARCHED**

**INSTRUCTIONS WILL BE
WITH KIT**

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MODELS

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REPLACING PURGE PUMP

INFORMATION BEING RESEARCHED

INSTRUCTIONS WILL BE WITH KIT

ARKLA

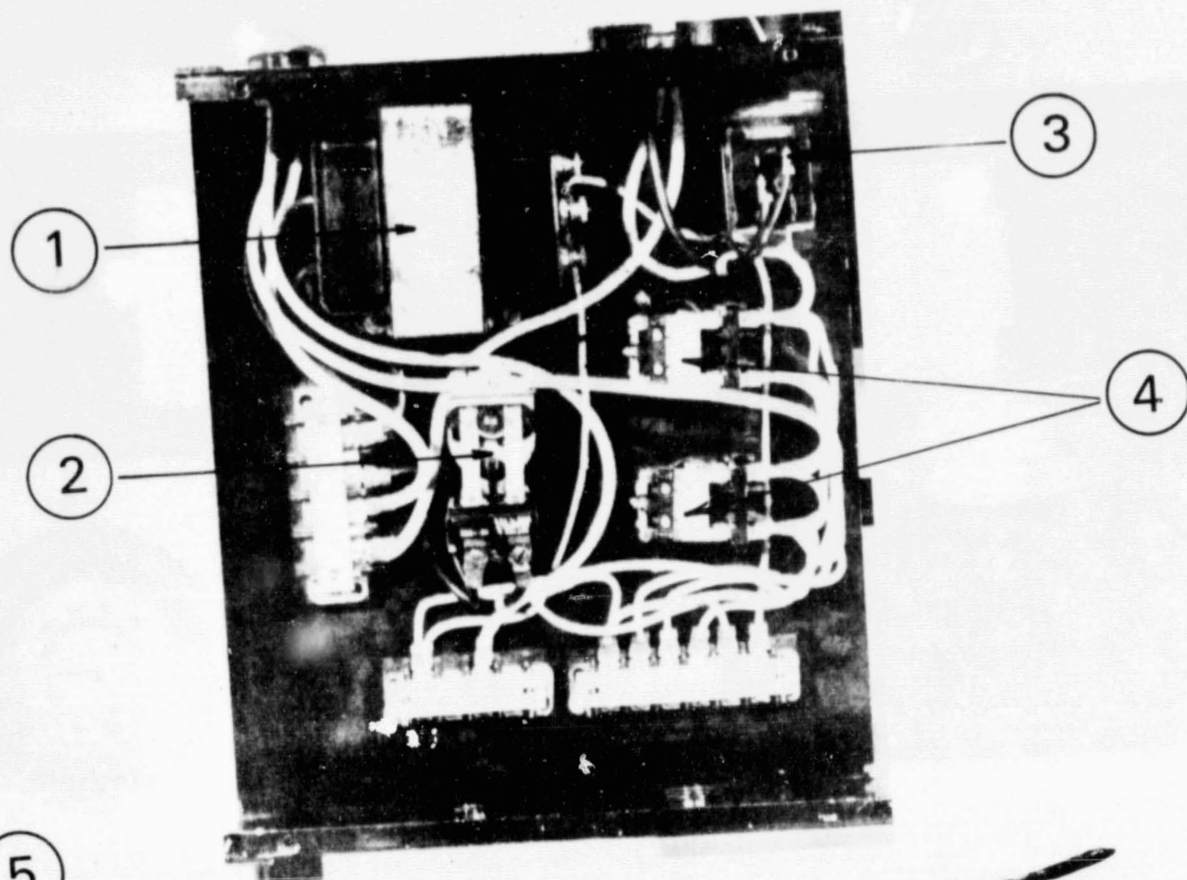
SERVICE PARTS LIST



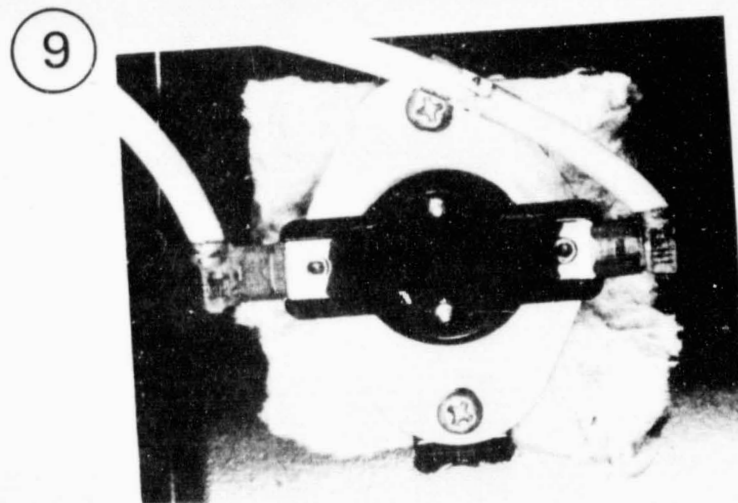
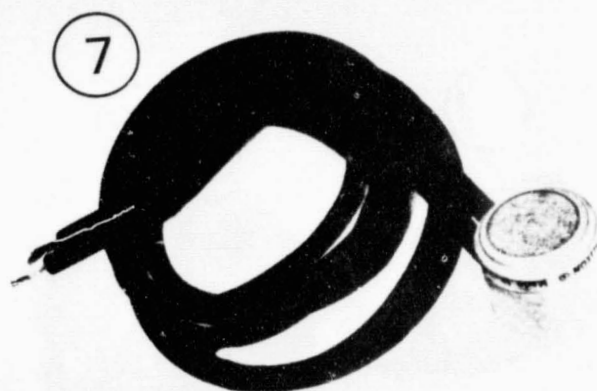
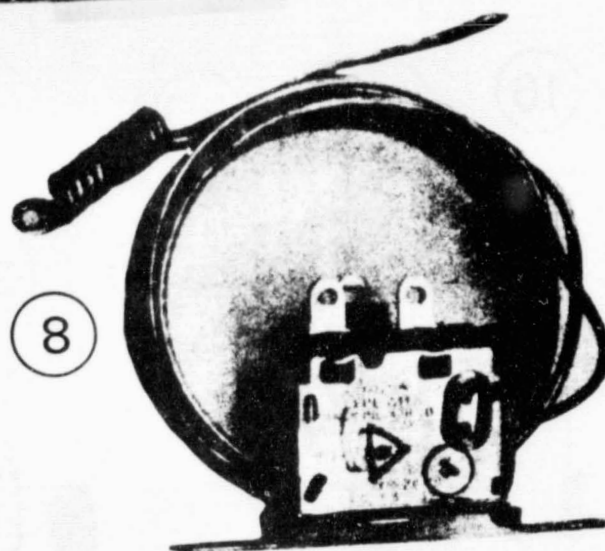
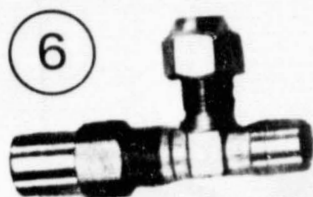
WF-36

ITEM	PART NO.	DESCRIPTION	QTY.
1	14512-99	Transformer - 50 VA - Basler #BE84451CD47	1
2	14537-174	Relay - SPST - Potter Brumfield AK-1022	1
3	14537-325	Switch - Solution By-pass Valve - Ranco - Type A22-2267	1
4	14537-234	Relay - DPST - Potter Brunfield - KU7A15	2
5	14253-22	Fusible Plug - 255°F.	1
6	15691-236	Purge Valve	2
7	14537-106	Switch-Cooling Tower Sump-Texas Instrument #2042DF3-79-89	1
8	14537-324	Switch-Evaporator Low Temperature Limit Ranco Type A22-2267	1
9	14537-326	Switch-High Temperature Limit-Texas Instrument #2060167-245	1
10	15691-446	Valve-Solution By-pass-Sporlan-Type XOM	1
11	14214-53	Coil-Solution By-pass Valve-Sporlan, #K6-12-40-BK48	1
12	14247-458	"O" Ring-Solution By-pass Valve-Sporlan #621-22	1
13	15471-71	Thermostat	1
14	14243-288	V-Band Clamp	1
15	14236-19	Pin-Impeller	1
16	15861-59	Impeller-Solution Pump	1
17	15401-85	Retaining Ring	1
18	14631-30	Filter Screen	1
19	15859-54	Bearing-Solution Pump	2
20	14503-1	Rotor Assembly	1
21	15884-12	"O" Ring-Solution Pump	1
22	14504-1	Stator Assembly	1
23	14509-7	Capacitor - Motor - Solution Pump	1
24	14354-18	Clamp - Capacitor	1
25	15874-25	Casing Assembly - Solution Pump	1
26	Z-2166	Silicon High Vacuum Grease	
27	14834-968	Insulation Boot	1
28	14546-395	Box - Connection-Solution Pump Motor	1
29	15229-805	Panel - Top	1
30	15229-802	Panel - Left Side	1
31	15247-228	Door Assembly - Access - Front	1
32	15229-803	Panel - Right Side	1
33	15229-804	Panel - Rear	1

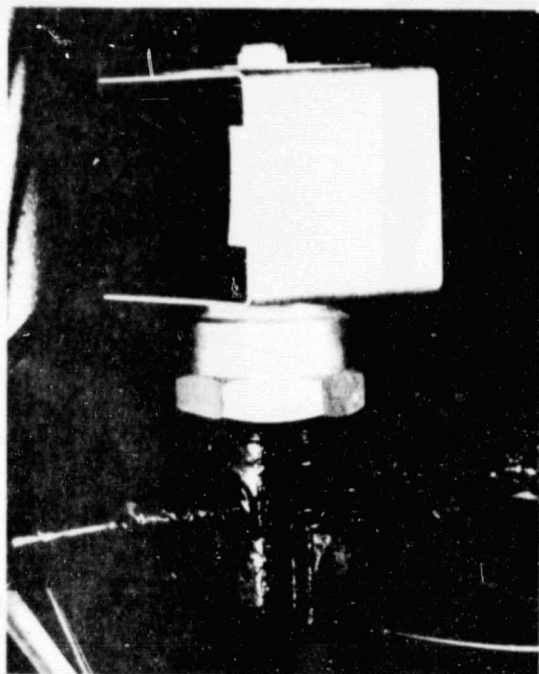
WHEN ORDERING PARTS, ORDER BY
PART NUMBER NOT ITEM NUMBER



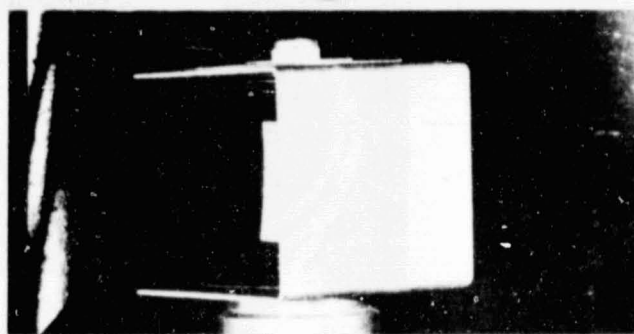
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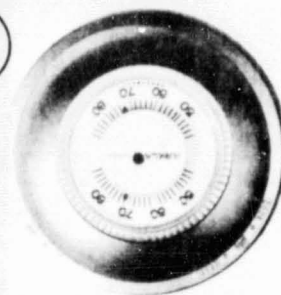


11



12

13



14

V-BAND
CLAMP

16

IMPELLER

18

STRAINER

20

ROTOR
ASSY

22

STATOR
ASSY

23

CAPACITOR

24

CLAMP

15

IMPELLER
PIN

17

RETAINING
RING

19

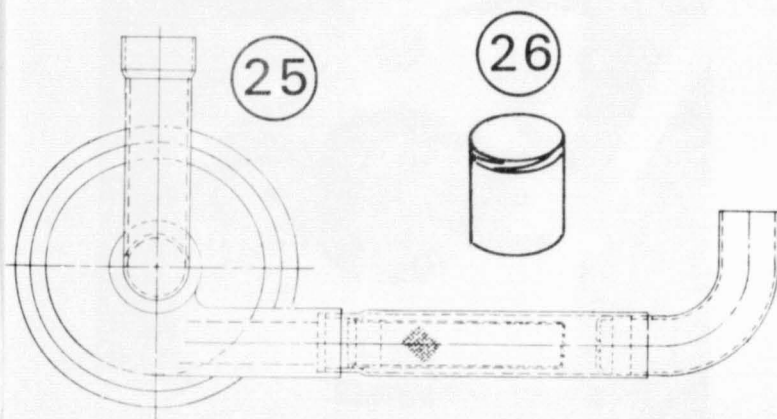
FRONT
BEARING

19

REAR
BEARING

21

'O'
RING

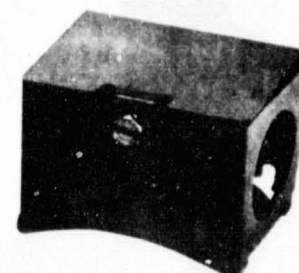


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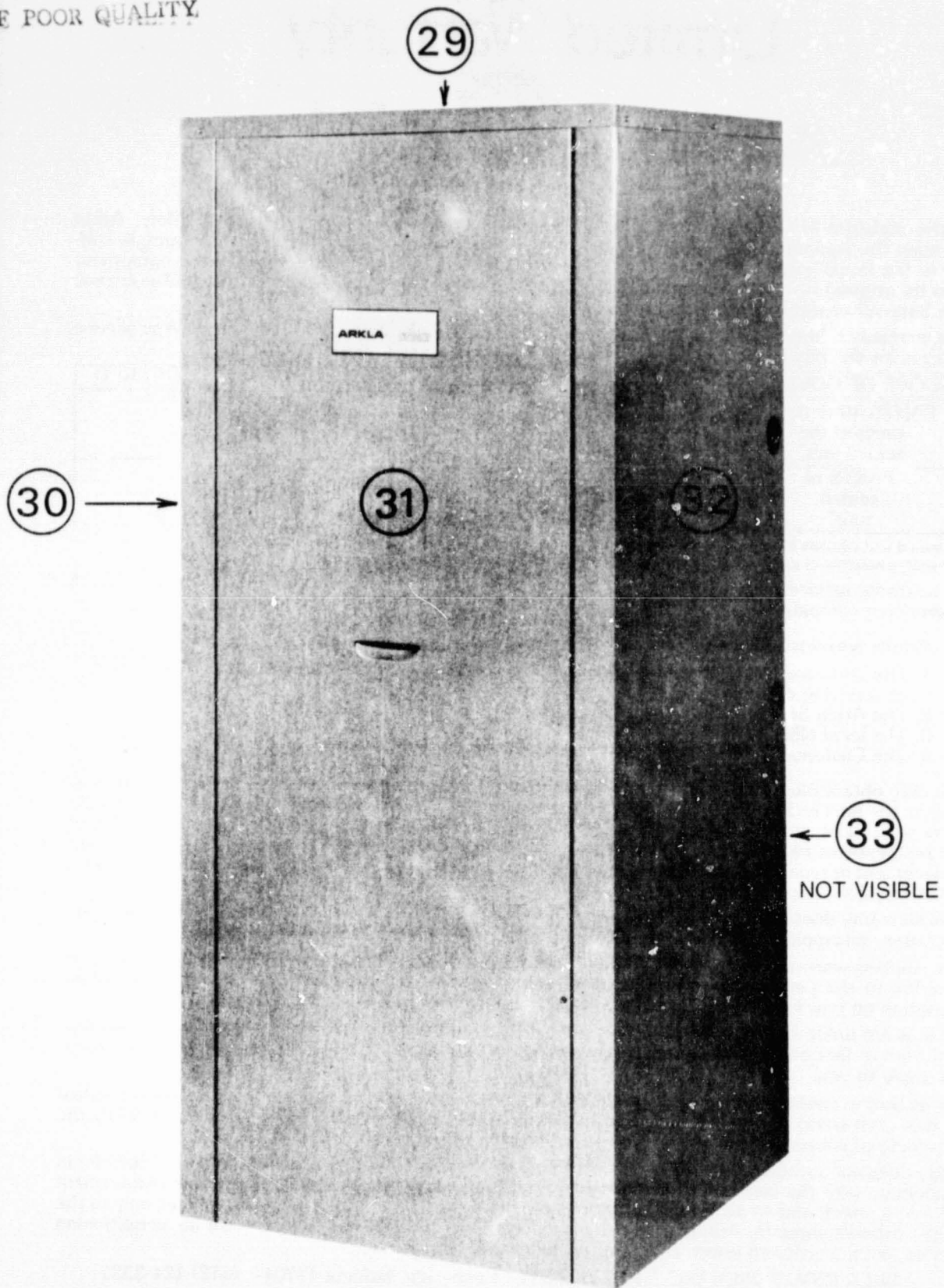
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Limited Warranty



UNITARY SOLAR AIR CONDITIONER

To the owner(s) of the equipment during the period of warranty coverage stated below, Arkla warrants the equipment to be free of defects in materials and workmanship. This warranty is subject to the terms specified below and is immediately terminated by the removal of the equipment from its original installation address. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

This warranty is limited to parts replacement and does not include any labor allowance. Any service charges for the repair or replacement of parts are your responsibility.

SCOPE OF COVERAGE	PERIOD OF COVERAGE	TYPE OF FAILURE COVERED
PARTS other than parts of the sealed unit*	ONE YEAR from date of installation	Defective materials or workmanship
PARTS of sealed unit*	FIVE YEARS from date of installation	Defective materials or workmanship

*The sealed unit consists of the solution pump, generator, absorber tank, condenser, liquid heat exchanger and various heat-exchanging assemblies and the connecting tubes through which the refrigerant (lithium bromide solution) flows.

All warranty service and repair or replacement of parts should be performed for you by an individual or servicing company which has been qualified by Arkla or its Solaire distributor.

To obtain warranty service, you should contact:

1. The company from which the equipment was purchased or another qualified Arkla dealer or servicing company;
2. The Arkla Solaire distributor for the area;
3. The local office of Arkla Industries, if present; or
4. The Customer Service Department of Arkla Industries Inc. at the address shown below.

You may obtain the benefits of warranty coverage on a failed part by having the servicing company replace the part and return it to Arkla's factory for inspection. If the failure is covered by warranty, there will not be any charge for the replacement part. Transportation charges for the shipment of the replacement part and the return of the failed part is your responsibility. Any such warranty replacement or repair shall be subject to the terms and conditions of this warranty for the remainder of the original period of coverage.

This warranty does not cover any failures or operating difficulties due to accident, abuse, misuse, alteration, misapplication, improper installation, or improper maintenance or service.

Any implied warranties of merchantability and fitness applicable to the equipment are limited in duration to the period of coverage of this express written warranty. Some states do not allow limitation on how long an implied warranty lasts, so this limitation may not apply to you.

Arkla is not liable for any special, indirect or consequential damages. Some states do not allow the exclusion or limitation of incidental or consequential damages, so this limitation or exclusion may not apply to you.

A registration card is packaged with each chiller. The effective date of warranty coverage is dependent on this card being completed and sent to Arkla. If this registration card is not sent to Arkla, the beginning of warranty coverage will be based on shipping date.

Arkla does not authorize any person or company to assume for it any other obligation or liability in connection with the sale, application engineering, installation, use, removal, return, or replacement of its equipment; and no such representations are binding on Arkla. This warranty applies only to the chiller manufactured by Arkla, and does not cover other components of your total air conditioning system, such as cooling tower, coils, piping, external controls, etc.

ARKLA INDUSTRIES INC. P.O. Box 534 Evansville, Indiana 47704 (812) 424-3331

Part No. 14084-603-R1
October, 1977

This warranty has been drafted to comply with the new Federal law applicable to products manufactured after July 4, 1975. It replaces any warranty that may be included elsewhere in this package. This warranty in no manner reduces the coverage provided to you under the warranty it replaces.

Printed in U.S.A.

DATE: Nov., 1976

MODELS

WF-36

CONDENSING WATER ADJUSTMENT - USING A COOLING TOWER

The cooling tower that is being used with the Arkla Solaire chiller must have the capacity, range and approach to meet the condensing water needs of the Arkla chiller. The tower manufacturer's recommendations should be followed with regards to sump water level, water distribution, etc. The actual flow rate should be adjusted at the Arkla chiller.

ADJUSTMENTS:

For maximum efficiency and proper unit performance it is important that the condensing water flow (G.P.M.) be adjusted correctly. While checking and adjusting the condensing water flow rate, the Solaire unit itself should be turned off.

Start the condensing water pump and establish condensing water flow. Attach a gauge to the pet cocks on the condensing water lines.

NOTE: The same gauge must be used for both readings. See IV-2-3 for suggested gauge make-up. Open both the pet cocks to fill the hoses and gauge with water. Close the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Close the pet cock on the inlet line and open the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Subtract the outlet pressure from the inlet pressure to determine the pressure drop through the unit condensing water circuit. Using Table 1 adjust the regulating valve in the outlet condensing water line until the pressure drop indicates the "Rated" G.P.M. through the unit.

TABLE 1

MODEL	CONDENSING WATER FLOW G.P.M.	PRESSURE DROP THROUGH UNIT P.S.I.
WF-36	9.0	2.20
	10.0	2.63
	11.0	3.11
"Rated"	12.0	3.62
	13.0	4.16
	14.0	4.72
	15.0	5.33
	16.0	5.93
	22.0	10.31
	25.0	12.77
	MAX.	

NOTE: The pressure drop method and Table 1 is correct only when the unit condensing water circuit is clean and free of dirt, trash and scale.

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ARKLA INDUSTRIES INC.

P. O. Box 534

Evansville, Indiana 47704

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USING WELL WATER - ONCE THROUGH

When well water is the source of condensing water for the Arkla Solaire chiller, the water flow should be adjusted so the leaving water temperature will correspond to the inlet water temperature as shown in Table 2.

TABLE 2

INLET WATER TEMPERATURE °F	ADJUST LEAVING WATER TEMPERATURE TO °F
75° Minimum	95°
80°	95°
85°	100°
90° Maximum	105°

DATE: Nov., 1976

MODELS

CONDENSING WATER BLEED-OFF

GENERAL

On III-30-1, there is a discussion concerning water treatment for condensing water from a cooling tower. The MINIMUM BLEED-OFF RATE OF 3.5 GALLONS PER TON PER OPERATING HOUR MUST BE MAINTAINED regardless of whether or not additional water treatment (chemical treatment) is used. If the water contains a large quantity of solids, the bleed-off rate should be increased above the minimum. The above formula is another way of saying "bleed-off one gallon of water for every gallon evaporated at the tower."

The rate of bleed-off should be checked on every new start-up and on every spring start-up.

ADJUSTMENT:

Start the unit on cooling operation.

Use a measuring vessel and catch the bleed-off water for three(3)"one minute" tests. Average these three tests and check the average ounces per minute against the chart below.

BLEED-OFF RATE

MODEL	3.5 G.P.H. Per ton	4.0 G.P.H. Per ton	4.5 G.P.H. Per ton	5.0 G.P.H. Per ton
	Minimum			
WF-36	oz. Per Min. 23	oz. Per Min. 26	oz. Per Min. 29	oz. Per Min. 33

WF-36

MODELS

ADJUSTMENT OF HOT WATER INPUT

For maximum efficiency it is important that the hot water flow (G.P.M.) be adjusted correctly. While checking and adjusting the hot water flow rate, the Solaire unit itself should be turned off.

WF-36

Start the hot water pump and establish hot water flow.

Attach a gauge to the pet cocks on the hot water input lines.

NOTE: The same gauge must be used for both readings. See IV-2-3 for suggested gauge make-up. Open both the pet cocks to fill the hoses and gauge with water. Close the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Close the pet cock on the inlet line and open the pet cock on the outlet line. When the pressure is steady, read and record the pressure. Subtract the outlet pressure from the inlet pressure to determine the pressure drop through the unit generator hot water circuit.

Using Table adjust the regulating valve in the outlet hot water line until the pressure drop indicates the "Rated" G.P.M. through the unit.

MODEL	HOT WATER FLOW TO UNIT G.P.M.	PRESSURE DROP THROUGH UNIT P.S.I.
WF-36	5.0	1.04
	6.0	1.39
	7.0	1.78
	8.0	2.21
	9.0	2.68
	10.0	3.16
"Rated"	11.0	3.68
	12.0	4.24
	13.0	4.81
	14.0	5.41
	15.0	6.06
	16.0	6.71
	22.0 MAX.	11.26

DATE: Nov., 1976

START-UP AND ADJUSTMENT CHECK LIST

MODELS

CUSTOMER: _____ DATE: _____

ADDRESS: _____ CITY: _____ STATE: _____

TOWER: MAKE _____ MODEL _____ SERIAL NO. _____

AIR HANDLER: MAKE _____ MODEL _____ SERIAL NO. _____

CONDENSING WATER PUMP: MAKE _____ MODEL _____
H.P. _____ GPM _____ FT. HEAD _____

HOT WATER PUMP: MAKE _____ MODEL _____
H.P. _____ GPM _____ FT. HEAD _____

CHILLED WATER PUMP: MAKE _____ MODEL _____
H.P. _____ GPM _____ FT. HEAD _____

WF-36

PRE-START-UP INSPECTION

AIR
HANDLER TOWER CHILLER

Air conditioning system is properly installed and has been inspected using Installation Check List (III-92-3)
LUBRICATION (Follow Motor Manufacturers Instructions)

NOTE: Motors should be oiled with electric motor oil or oil recommended by motor manufacturer

Air Handler(s) blower motor
Tower blower motor
Tower pump motor

LEVEL (IV-11-2)

Side-to-side
Front-to-back

CHILLED WATER PIPING (III-21-5) (IV-25-3)
Check for leaks before insulation is applied
Proper amount of insulation applied
Piped for correct flow through coil
Proper amount of antifreeze added (IV-22-3)
Inlet water pressure to unit
Outlet water pressure from unit
Pressure drop through unit
Chilled water G.P.M.

ORIGINAL PAGE IS
OF POOR QUALITY

DATE: Nov. 1976

ARKLA INDUSTRIES INC.

P.O. BOX 634

EVANSVILLE, INDIANA 47704

AIR HANDLER

TOWER

CHILLER

AIR HANDLER(S)

Lubricate according to manufacturer's instructions

Coil clean and dry

Filters clean

Putleys aligned

Proper belt tension

Draft gauge reading

Air flow across coil

Clearances (111-6-7) (111-6-4)

Front

Back

Overhead

Left end

Right end

Thermostat properly located (111-6-8)

CONDENSING WATER

Using Tower (IV-45-2)

Tower adjustments made according to manufacturer's instructions.

Inlet Water pressure to unit

Outlet water pressure from unit

Pressure drop through unit

Condensing water G.P.M.

Bleed-off rate (IV-47-2)

HOT WATER INPUT

Hot water generator temperature in

Hot water generator temperature out

Hot water temperature drop through generator

Inlet hot water pressure to unit

Outlet hot water pressure from unit

Pressure drop through unit

Hot water G.P.M.

CHECK ALL AUTOMATIC SAFETY CONTROLS - OTHER ADJUSTMENTS

Adjustment of external condensing water temperature controller

**P-KD INSTANTANEOUS
ELECTRIC WATER HEATER
OPERATING AND MAINTENANCE
INSTRUCTIONS**

P-K REFERENCE # 249085

LOCATION: Citizens Mutual Savings

Leavenworth, KS

CONTRACTOR

Norris Brothers, Inc.

SPECIFICATIONS: 25.6 GPM - FROM 67 °F to 75 °F

VOLTAGE 208 PHASE 3 CYCLE 60

WARNING: TURNING ON POWER BEFORE SYSTEM IS FILLED
WITH WATER AND RECIRCULATION PUMPS ARE STARTED MAY
RESULT IN DAMAGE TO THE ELECTRIC IMMERSION ELEMENTS
(VOIDING ALL GUARANTEE).

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P-KD INSTANTANEOUS ELECTRIC WATER HEATERS

OPERATING INSTRUCTIONS AND MAINTENANCE MANUAL

ELECTRIC POWER SERVICE

This will vary according to heater needs, size of heating element, etc. Measure line voltage to make sure specified line voltage is being supplied to operate heater (refer to drawing supplied in panel box).

WARNING:

TURNING ON POWER BEFORE FILLING SYSTEM COMPLETELY WITH WATER WILL DAMAGE ELECTRIC IMMERSION ELEMENTS. (VOIDING ALL GUARANTEE)

After start-up, check amperage and voltage drawn under operating load. Be sure amperage load does not exceed rating of contactors, etc., (refer to drawing).

WATER HEATER INSTALLATION

Local codes will probably dictate the specifications of the installation of the water heaters. However, in the absence of codes, our recommended clearance between heaters is not less than 24 inches and allowing ample room to pull heater elements (refer to element length on specs of individual heater).

Allow ample ventilation of boiler room to keep ambient temperature below 120°F to prevent breakers from opening under false conditions.

PLUMBING

Water connections—Connect a full size water inlet service without check valves to the water inlet and provide a suitable gate valve. The hot water outlet should be run through a circulation loop, depending upon the type of installation, a bypass line might be desirable. Include a gate valve in the water outlet.

BLOW-OFF

This tapping should never be plugged, but should be provided with a gate valve to permit periodic drainage of shell for cleanout and inspection. Connect the blow-off to the sewer without reduction in pipe size.

RELIEF VALVES

Relief valves of the correct size are furnished on the unit and should be piped to the sewer, without valve and without reduction in pipe size. Install relief valve in connections as shown on drawing. Do not install in connection near heater element end of shell.

Avoid use of temperature and pressure relief valves, which may bleed because of stratification.

THERMOSTAT

The thermostats used are of quality design and tested by Patterson-Kelley Engineering Staff.

The Robertshaw, Model EA3 (KL) thermostat is a single pole, single throw thermostat used with P-KD where one control step is desired.

Where a multiple number of control steps are desired the United Electric Model #E-75A-5030 step controller is used, unless otherwise specified.

Refer to thermostat bulletin for calibration and adjustment.

HIGH LIMIT SWITCH

The high limit switch is a manual reset type and is UL approved. Limit should be set at 10° to 15° above set point of control thermostat.

WATER TREATMENT

Water treatment can be harmful as well as good in many cases. Some types of water treatment intended to form a protective film on metals can be very harmful to electric immersion elements. One of the most common types of treatment used in a closed system is Sodium Chromate which forms a protective film, however, on electric immersion elements this film flakes off due to expansion and contraction. These flakes lodge in the baffles or center of the element restricting the heat transfer. When heat transfer is restricted the element or blades heat up and burst thus shorting to ground.

Water treatment in closed systems where little or no make up water is used is not really a necessity. Once the water has been heated the chemical elements in the water are destroyed, thus corrosion is stopped.

If treatment is to be used, consult your water treatment people and inform them of the possible damage to the immersion element.

GPM FLOW

The P-KD is designed to heat a specified amount of gallons of water per minute. It is important that balancing or flow cocks be installed in the outlet line of the circulating pump so proper GPM may be obtained.

Actual GPM flow may be obtained by simply installing a pressure gauge on each side of the pump and reading the inlet pressure and outlet pressure, multiplying the difference by 2.3, you can determine the foot head. Once you know the foot head, by using the pump curve for the circulator pump, you can determine the GPM flow (exceeding the designed flow of heater can damage the heating elements).

CIRCUIT BREAKERS

The circuit breakers normally used are either ITE or General Electric, rated at 40°C and sized by Patterson-Kelley Design Engineers to give safe satisfactory operation. (refer to breaker bulletin for replacement or service).

IMMERSON ELEMENTS

The P-K Immersion Element is another "FIRST" in the advanced design of the quality P-K equipment.

The electric immersion elements incorporating the replaceable blades developed by the Patterson-Kelley Engineering Staff, makes it possible to make field replacement with a minimum of down time and a minimum of expense.

BLADE REPLACEMENT PROCEDURE

To replace the defective blade, use the following procedure:

1. Turn off all power.
2. Drain heater down (open relief valve to permit air to enter and speed up draining).
3. Remove cover from heating element and disconnect wires on defective blade. (Fig. 1, Page 2-A)
4. Remove bus bars and compression nut "C".
5. Slide blade "F" through sleeve "E" far enough to cut blade off behind ferule "D".
6. Pull defective blade back through sleeve and out of copper tube support "G".

You are now ready to install a new blade in the heating element.

7. Make certain you have the correct size blade. Check voltage and kilowatt rating stamped on the blade.
8. Slide the new blade through support "G". Insert through sleeve "E".
9. Slip new ferule "D" supplied with the new blade over Blade "F".
10. Measure extended end to same length as other blade end and fasten compression nut "C" securely.
11. Make certain porcelain insulators are in place affixing 10-32 flat steel washer and first 10-32 flat steel washer and first 10-32 nut "A".
12. Remount copper bus bars "B" affix star washer and 10-32 nut "A".
13. Fill system with water. Purge air out of system.

CONTACTORS

Contactors are special purpose manufactured for Patterson-Kelley by General Electric. Periodic inspection and cleaning of contacts should be made. Pitted contacts should be replaced, as well as badly burnt contacts. (Maintain a supply of spare contacts, for the contactors used on your unit. Order contacts by contactor number on nameplate of contactor)

VENTING

The P-KD Instantaneous Electric Water Heater should be provided with an air valve in the line to prevent air pockets from forming in the shell which could cause failure of the electric element. The electric element must be flooded at all times.

CLOSED SYSTEM APPLICATION

The use of the P-KD as a heater in a closed system, such as heat pump make-up heaters, etc. where circulator pumps are used to circulate water through the system should be fully filled with water and allowed to purge air out of the system by running the pumps.

NOTE: Pumps must be running before heaters are energized, as capacity of P-KD shell is usually small in comparison to the heating element, thus boiling in the shell may occur causing a rapid pressure rise, tripping the relief valve and also tripping the high limit switch.

FLOW SWITCH

It is recommended that a flow switch be installed in the outlet line to insure water flow at all times. The flow switch should be wired in series with the control circuit thermostat.

CONDUIT CONN.

TERMINAL
COVER PLATE

TERMINAL
COVER

COVER
MFG. BOLT.

PORCELAIN INSULATORS

FLAT STL WASHER 10-32

STAR WASHER 10-32

TUBESHEET

- A = 10-32 STL NUT
- B = BUSS BAR
- C = COMPRESSION NUT
P.K 61 F 1/2"
- D = FERRULE P.K 60 F 1/2"
- E = SLEEVE
- F = ELEMENT BLADE
- G = COPPER TUBE SUPT.

THE PATTERSON-KELLEY CO., INC.
EAST STROUDSBURG, PA.

REFERENCE NO.

DRAWN BY: H.A.

FILE-A

CHECKED-

REVISED-

DATE-

SERVICE TIPS

WITH SERVICE RETURN

1. Check for correct return.
2. Check for correct return information. If correct, return 40% 15% and 20% 20%.

RETURNING SERVICE

1. Return to the correct return information. If correct, return 40% 15% and 20% 20%.
2. Return to the correct return information. If correct, return 40% 15% and 20% 20%.

WITH SERVICE RETURN

Return to the correct return information. If correct, return 40% 15% and 20% 20%.

WITH SERVICE RETURN

Return to the correct return information. If correct, return 40% 15% and 20% 20%.

WITH SERVICE RETURN

Return to the correct return information. If correct, return 40% 15% and 20% 20%.

Return to the correct return information. If correct, return 40% 15% and 20% 20%.

Guarantee

We guarantee all materials and workmanship used in the construction of Patterson-Kelley P-KD Electric Heaters to be first class in every respect. If any part proves defective within one year from date of shipment, a new part will be supplied without charge f.o.b. East Stroudsburg, Pennsylvania. We guarantee each heater to heat its rated capacity of water.

McDONNELL No. FS4-3 AND No. FS4-3-20 FLOW SWITCHES

***Make or Break an Electrical Circuit
When Flow in a Pipe Starts or Stops***

These McDonnell Flow Switches offer an economical and positive way to start or stop almost anything electrically operated. They serve as automatic controls or safety devices in air conditioning, heating and water systems, and in processing work. Design and operation of the two switches are the same, except No. FS4-3-20 includes a 20-second time delay to eliminate false starts from temporary surges or fluctuations. Here are a few specific applications of McDonnell Flow Switches:



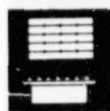
Actuate a signal light—signal an attendant to make the right moves in operating valves, pumps and the like—signal him when flow stops in a water cooled compressor, water cooled bearings and so on.



Sound an alarm—when flow stops in a process system or in any water cooled device.



Start or stop motors—start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling system when flow stops.



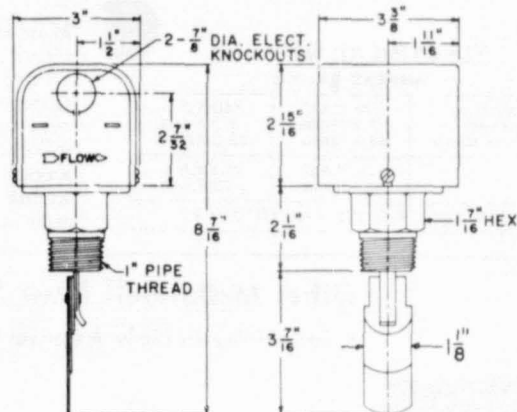
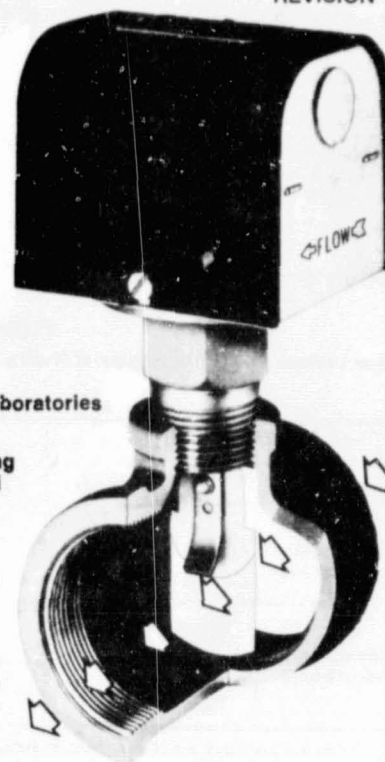
Start or stop automatic burners—start a booster heater when water draw occurs; stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.



Actuate metering device—open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

- Underwriters' Laboratories Listed
- Maximum working pressure, 150 psi
- Maximum temperature, 300°F.
- Packed shipping weight, 2½ lbs.

No. FS4-3 Flow Switch shown mounted in a 2-inch tee



McDonnell Quality Throughout

Easy Wiring—Cover completely removable. No cramped quarters, no danger of kinked wires interfering with operation.

Two Knockouts—Connect conduit at either side of housing.

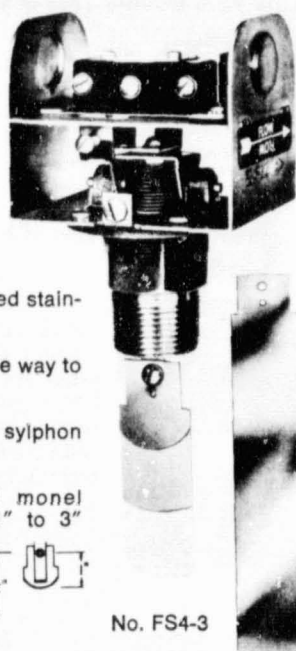
Switch—single pole, double throw. Compact in size. Powerful snap action assures dependable operation.

Knife-Edged Bearings of hardened stainless steel minimize friction.

Adjusting Screw—Provides simple way to adjust sensitivity to flow.

Packless—Heavy duty monel sylphon seals switch assembly from line.

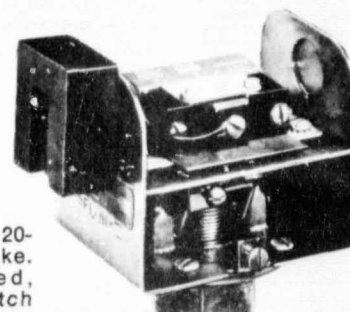
3-in-one Paddle—Segmented monel paddle quickly adaptable for 1" to 3" pipe. Extended monel paddle illustrated also included for larger pipe sizes.



No. FS4-3

No. FS4-3-20 Includes Solid State Time Delay

Provides factory-fixed 20-second delay on make. 100% encapsulated, mounts right on switch housing. For use where temporary surges in flow, water hammer or minor fluctuation in system pressure might cause false starts or switch fluttering. Input—115 volt A.C.; Output—1 ampere RMS steady state maximum, 20 milliamperes minimum.



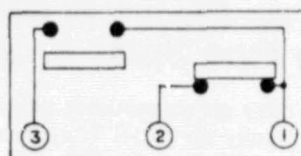
McDONNELL & MILLER **ITT**
FLUID HANDLING DIVISION

McDONNELL No. FS4-3 AND No. FS4-3-20 FLOW SWITCHES

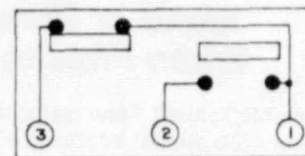
The table below shows the flow rates required to actuate the No. FS4-3 Flow Switch.

"Flow" means that the switch will close circuit 1-2, and open circuit 1-3, when the flow rate is increased to the GPM shown. (See schematic switch action "Flow" at right.)

"No Flow" means that the switch will open circuit 1-2, and close circuit 1-3, when the flow rate is decreased to the GPM shown. (See schematic switch action "No Flow" at right.)



FLOW



NO FLOW

FLOW RATES REQUIRED TO ACTUATE FLOW SWITCH

Flow rates in gallons per minute (GPM) shown in black. Velocity in feet per second (FPS) shown in color.

*Equipped with extended paddle trimmed to pipe size.

Pipe Size in Which Flow Switch Installed			1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	5"	6"
Factory or Minimum Adjustment	Flow	GPM	6.00	9.80	12.7	18.8	24.3	30.0	39.7	58.7	79.2
		FPS	2.24	2.11	2.00	1.80	1.63	1.30	1.00	0.94	0.88
	No Flow	GPM	3.60	5.60	7.00	9.40	11.6	12.0	19.8	29.3	39.6
		FPS	1.34	1.21	1.10	0.90	0.78	0.52	0.50	0.47	0.44
Maximum Adjustment	Flow	GPM	10.2	16.8	23.0	32.8	42.4	52.1	73.5	115.0	166.0
		FPS	3.91	3.62	3.62	3.14	2.74	2.26	1.86	1.85	1.84
	No Flow	GPM	9.20	15.0	19.5	24.0	37.5	46.1	64.2	92.0	123.0
		FPS	3.43	3.23	3.07	2.29	2.51	2.00	1.62	1.48	1.37

Flow rates are averages which may vary $\pm 10\%$ from tabulated values.



ELECTRICAL RATINGS

AMPERE RATING

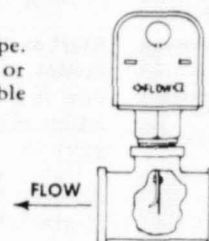
Motor Duty	120 V.A.C.	240 V.A.C.
Full Load	7.4 Amps.	3.7 Amps.
Locked Rotor	44.4 Amps.	22.2 Amps.
	120 V.A.C.	240 V.A.C.
	0.3 Amps.	0.15 Amps.

Pilot Duty: A.C. 125 V.A., 120-240 V.



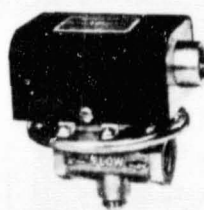
Installation

Flow switch should be mounted in a horizontal run of pipe. Avoid locations immediately adjacent to elbows, orifices or valves. Flow switch should be mounted as close as possible to pipe. Use a tee (or reducing tee) with a 1" branch, or, if welding fitting is used select a welding neck of minimum length. In position paddle should be at right angle to flow, with arrow pointing in same direction as flow. If temperature of pipeline exceeds 220° F. use wire suitable for 75° C. (167° F.).



Other McDonnell Flow Switches—All Underwriters Listed

- Sensitivity to Flow Adjustable
- Single Pole Double-Throw Switches



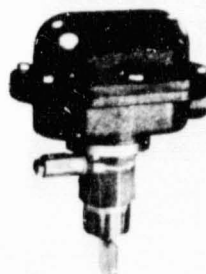
No. FS1—Actuated by low flow, with large flow-through capacity. Particularly suited for home water purification systems, as well as cooling systems for electronic tubes, bearings, compressors, etc. Has 1/2 inch inlet and outlet tappings. For pressures to 100 psi, temperatures to 225° F.



FS6 Series—Similar to No. FS1, but for hook-up to 3/4 inch and 1 inch pipe—Nos. FS6-3/4 IN. and FS6-1 IN. respectively. Applications include small and medium size water treatment systems, booster pumps to increase low city water pressure, etc.



FS4-3T Series—Similar to No. FS4-3 except furnished with a specially designed tee, threaded for 3/4 inch or 1 inch pipe. These are particularly sensitive switches, specially designed for use where flow rates are insufficient to actuate other types of flow switches.



FS7 Series—For heavier duty service or for use with process liquids. Standard, vapor-proof or explosion-proof construction, with wetted parts brass or stainless steel. Installed in a tee or welded half-coupling and fits pipe 1 1/4 inch or larger. For pressures to 1000 psi, temperatures to 300° F.

McDONNELL & MILLER

3500 N. Spaulding Ave. • Chicago, Ill. 60618

Telephone: (312) 267-1600 Telex: 25-3376

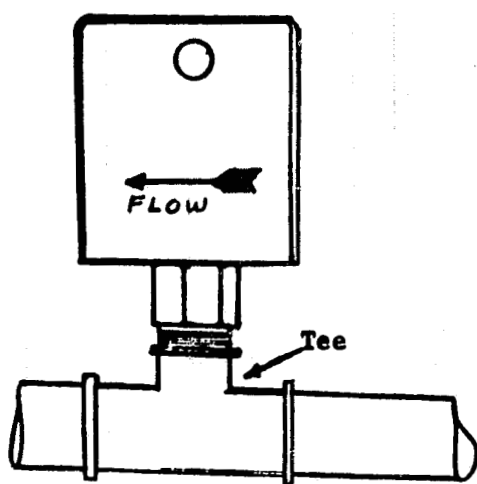
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

ITT

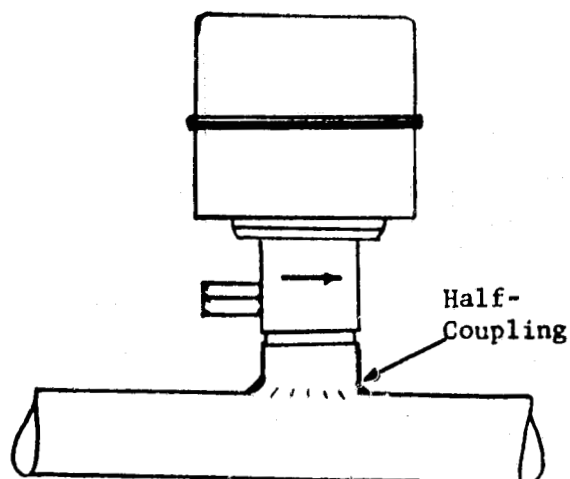
FLOW SWITCHES

Typical Installations

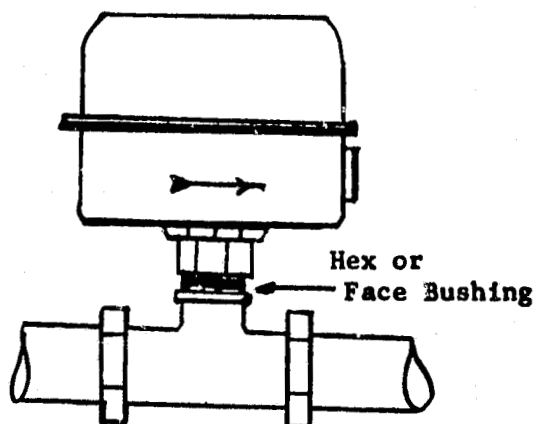
It is recommended that all models be installed upright in a horizontal run of pipe and that any valves, elbows, orifices or other restrictions be removed at least five pipe diameters from either side of the flow switch. Specific installation instructions are provided with each control.



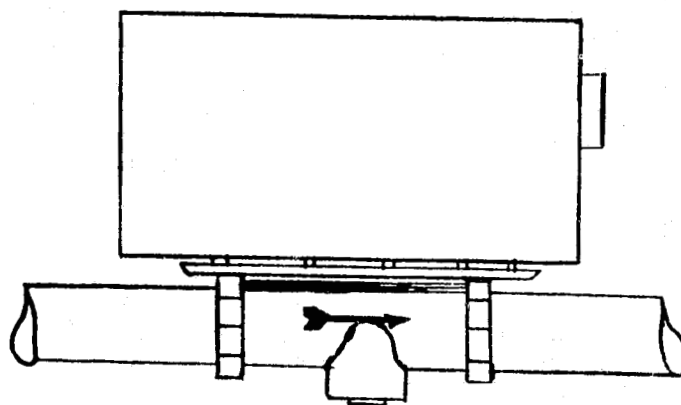
With Tee



With Welded
Half-Coupling



with Face or
Hex Bushing



With Body Tapped
For Direct Installation*

*No. FS 1, FS4-3T Series and FS6 Series.

MCDONNELL No. 150 PUMP CONTROL, LOW WATER CUT-OFF AND ALARM

For boilers of any size with pressures up to 150 psi

- **The best method of controlling an electric boiler feed pump**
- **The most thoroughly proven low water fuel cut-off and alarm**
- **Underwriters Listed**



ORIGINAL PAGE IS
OF POOR QUALITY

For manual reset on low water cut-off specify No. 150-M

The McDonnell No. 150 offers what is recognized today as the one best method of controlling a boiler feed pump. Mounted at the boiler water line, it starts and stops the pump as the boiler level itself dictates—not according to the rate at which condensate accumulated in the receiver. Consequently it holds the boiler water level between the close limits recommended by the boiler manufacturer to maintain maximum steaming efficiency.

In addition to this SPST pump control switch, the No. 150 has a SPDT switch which can provide low water fuel cut-off for automatically fired boilers. It can be utilized to interrupt a circuit to the burner should the water level drop below the minimum safe level, and also to provide low water alarm if desired.

Some of the other features of the No. 150 include:

- Two-piece fully enclosed junction box which keeps out dirt and dust, is sealed to protect switches from tampering or accidental damage, yet permits easy wiring;
- Special monel bellows, which eliminate packing, and float constructed of high tensile strength alloy for long service;
- Mercury switches specially designed for high temperature service;
- Terminal panel molded of high temperature phenolic to eliminate fracture from repeated expansion and contraction.

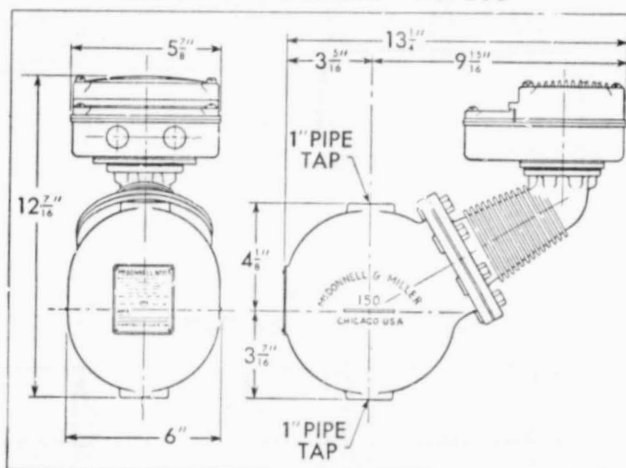
In addition to installations on boilers, the No. 150 is widely used as a general purpose liquid level controller on tanks or vessels. Some of these applications include the control of pumps, motor operated valves or alarms on open expansion tanks, compression tanks, hydro-pneumatic tanks and surge tanks.

Two variations of the No. 150 are available:

No. 158 has two SPDT switches to control a motor operated valve and provide low water cut-off and alarm;

No. 159 has two SPST switches to control two pumps at different levels.

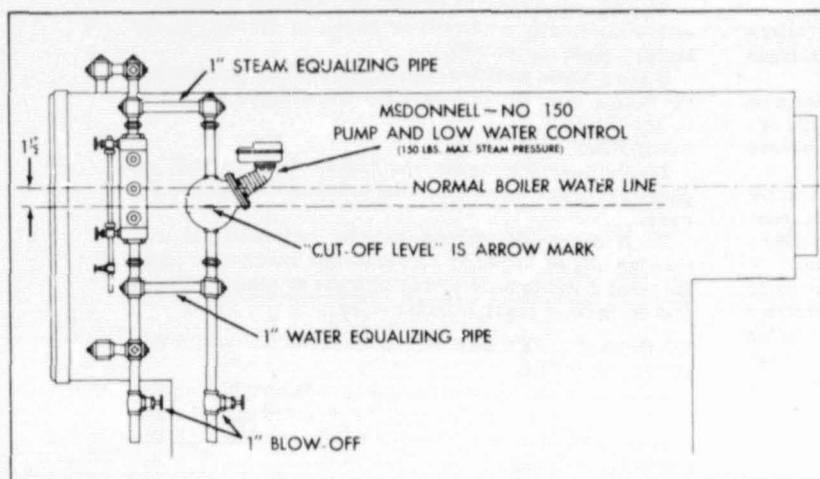
DIMENSION DETAILS—No. 150



MCDONNELL & MILLER ITT

3500 N. Spaulding Avenue, Chicago, Illinois 60618

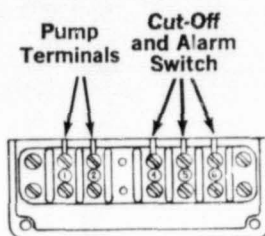
TYPICAL APPLICATION OF McDONNELL No. 150



When installed as shown in drawing the pump control switch closes when boiler water drops to a level $\frac{3}{4}$ " above the arrow mark on the body casting. Should the water level drop another $\frac{3}{4}$ " to the arrow mark on the body, the burner circuit opens and the alarm circuit, if used, closes.

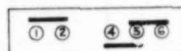
When the boiler water rises to a level $\frac{3}{4}$ " above the arrow, the burner circuit closes and the alarm circuit opens. A further rise to a level $1\frac{1}{2}$ " above the arrow mark opens the pump circuit.

JUNCTION BOX

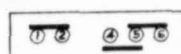


SCHEMATIC SWITCH OPERATION

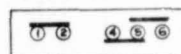
Boiler feed pump off
Burner on
Alarm off.



Boiler feed pump on
Burner on
Alarm off.



Boiler feed pump on
Burner off
Alarm on.



ELECTRICAL RATINGS

(Underwriters Listed)

Pump and Cut-off Circuits Ampere Rating

Motor Duty	115V A.C.	230V A.C.	115V D.C.	230V D.C.
Full Load	7.4	3.7	2.4	1.2
Locked Rotor	44.4	22.2	24.0	12.0

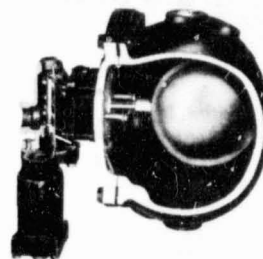
Pilot Duty Service: 345 Volt Amps., 115 and 230V A.C.

Alarm Circuit Ampere Rating

115V A.C.	230V A.C.	115V D.C.	230V D.C.
1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$

RECEIVER TANK CONTROLS

In systems utilizing a condensate receiver tank it is advisable to provide a make-up water feeder to assure an adequate supply of water to meet boiler demand, and to avoid the danger of boiler feed pump running dry. McDonnell Make-up Water Feeders are specially designed for use on condensate receiver tanks. They provide large feeding capacity and are available in models for exterior mounting with separate equalizing pipes, or for flange mounting right in the side of the receiver.



No. 25A



No. 21

McDONNELL & MILLER ITT
3500 N. Spaulding Avenue, Chicago, Illinois 60618

Bulletin No. L-95H

Printed in U.S.A.



INSTALLATION INSTRUCTIONS

L4008A, B, E REMOTE BULB AQUASTAT* CONTROLLERS

APPLICATION

These spst remote bulb immersion-type controllers operate in response to temperature changes in hydronic heating systems and other heated liquids.

ELECTRICAL RATINGS: Switch ratings are shown on the inside cover of each device. The electrical requirements on controlled equipment must not exceed this rating.

L4008A—breaks the burner circuit on a rise in water temperature. It is normally used as a limit controller. When used as an operating controller or low-limit, a separate high-limit control must be used.

L4008B—makes a control circuit upon a rise in water temperature. It is normally used as a circulator controller to prevent circulator operation until boiler water temperature is at or above the control setting.

L4008E—breaks the burner circuit and locks out on a rise in water temperature. It is used as a high-limit controller where manual reset is desirable.

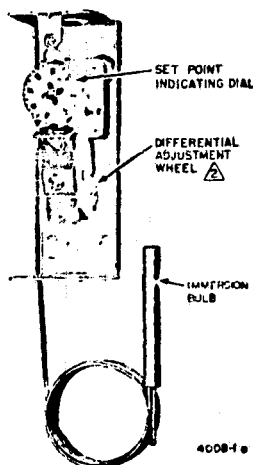


Fig. 1—Internal view.

2 Included on models with adjustable differential.

INSTALLATION

Installation should be made by a qualified serviceman.

Depending on model and installation requirements, the temperature sensing bulb is either installed in an immersion well (Fig. 2) that extends into the boiler or tank, or the bulb is directly immersed in the liquid. For installations not using a well, secure the bulb with a compression fitting (Fig. 3), or a boiler fitting (Fig. 4). Well, compression fitting, or boiler fitting must be ordered separately.

The boiler manufacturer generally provides a tapping for the insertion of the Aquastat Controller's sensing element. This tapping is located in a representative point where typical water temperature can be measured. The bulb or protecting immersion well must never be located close to a hot or cold water inlet or steam coil. The bulb can also be installed in the supply line of an indirect water heater, in the indirect water heater itself, or in the feed riser about 6 inches above the boiler. If the riser is valved, the bulb can be installed between the boiler and the valve.

*Trademark
Rev. 5-66
L. J. /D. S.

The Aquastat controller may be remotely mounted—either vertically on a wall or panel, or directly on the boiler, tank, or vessel.

If the system is filled, drain system to a point below the boiler tapping, or wherever the sensing bulb is to be installed.

TO MOUNT THE CASE

1. Remove the cover and fasten case to wall or panel using the three mounting holes in the back of the case.

2. If desirable, tubing can be re-routed to run through any of the other three corner notches in case. Be careful not to bend tubing sharply or kink it. Bends should have at least 1-inch radius.

TO INSTALL REMOTE BULB MOUNTING WITH IMMERSION WELL

Well, if used, must fit sensing bulb snugly for good thermal response. Bulb should be inserted until it rests against bottom of well, then hold it there while tightening the tubing clamp.

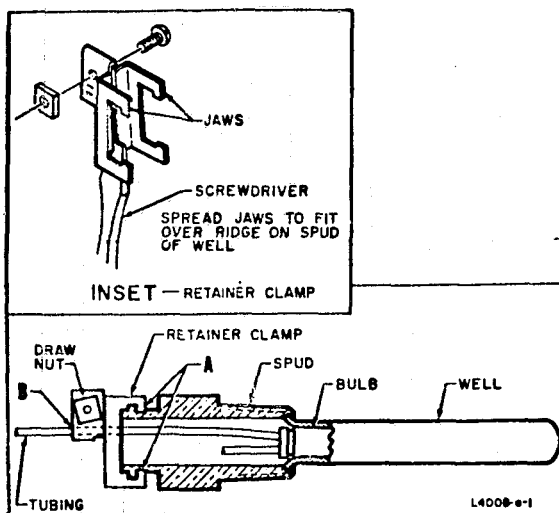


Fig. 2—Immersion well fitting.

121371A—1/2-in. N.C.S. spud, 1 1/2-in. insulation depth;

121371B—3/4-in. N.C.S. spud, 1 1/2-in. insulation depth.

1. Screw the well into the boiler, tank, or pipe tapping.

2. Insert bulb in well, pushing tubing until bulb bottoms in well.

3. Attach Retainer clamp to end of well spud. Loosen draw nut and spread jaws of clamp with screwdriver if necessary.

4. With Retainer clamp attached to well spud (be sure jaws of clamp hook over ridge at end of spud, as shown at points "A"), adjust tubing to fit through Retainer clamp groove, as shown at point "B".

5. Tighten draw nut so that Retainer clamp is firmly attached to well spud and tubing is held by clamp. CAUTION: Do not secure draw nut so tightly that Retainer clamp could cut or collapse tubing.

Form Number 95-5971
Residential Div.

MOUNTING WITH COMPRESSION FITTING

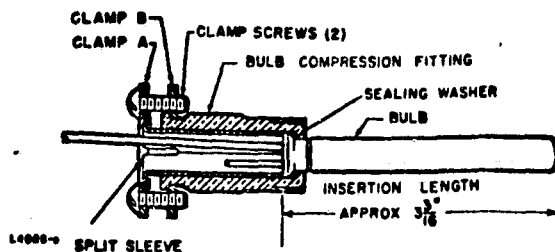


Fig. 3—#104486B bulb compression fitting.

1. Screw the fitting into boiler or pipe tapping.
2. Slide sealing washer onto bulb.
3. Insert bulb into boiler fitting until bulb bottoms.
4. Slide split sleeve into fitting.
5. Place clamps A and B on assembly so that sleeve is drawn into fitting when screws are tightened. Note: Make sure that nub on clamp A engages space between sleeve and clamp.
6. Tighten clamp screws evenly.

MOUNTING WITH BOILER FITTING

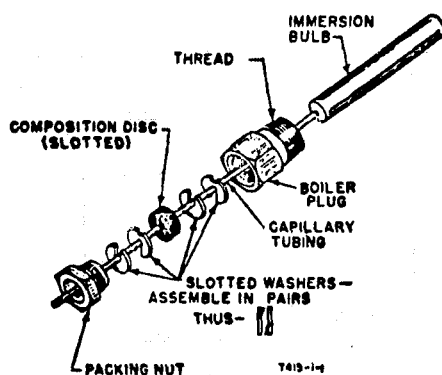


Fig. 4—#104484A boiler fitting.

1. Screw fitting into boiler or pipe tapping.
2. Place packing nut on tubing.
3. Slide bulb completely through fitting.
4. Place composition disc and 4 slotted brass washers on tubing in the order shown in Fig. 4. Turn brass washers so that slots are 180 degrees to each other.
5. Slide seal assembly into fitting and tighten packing nut.

WIRING

All wiring must agree with applicable codes, ordinances and regulations in such matters as wire size, type of insulation, and enclosure. The controllers are provided with conduit knockouts in the top and bottom of case.

Refer to Fig. 5 for a typical connection diagram.

24V 2-WIRE
THERMOSTAT

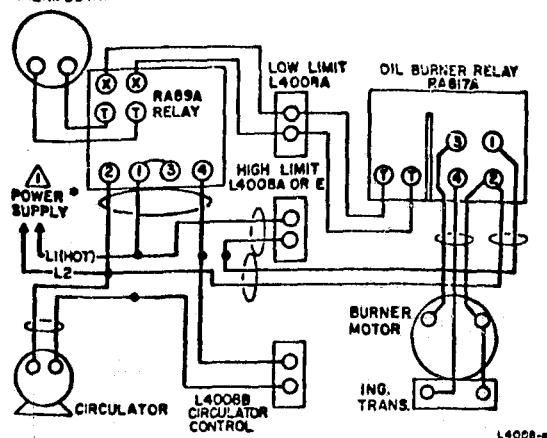


Fig. 5—Typical connection diagram for an oil-fired hydronic heating system that provides year 'round domestic hot water. The L4008A serves as the burner low-limit control, L4008A or E as high-limit control, and L4008B as the circulator controller.

⚠ Add disconnect means and overcurrent protection as required.

SETTING

CONTROL POINT: Insert a screwdriver in the slotted head visible through the cover, and turn the indicating dial to the control point. The L4008A and L4008E break contact on a temperature rise to set point. The L4008B makes contact on a temperature rise to set point. Temperature settings should be according to boiler manufacturer's recommendations.

DIFFERENTIAL (on adjustable differential models): Remove cover and move the differential adjustment wheel (Fig. 1) to a point on the scale corresponding to the desired differential. Replace cover.

MANUAL RESET (L4008E): After boiler water temperature has dropped to a point below the high-limit setting, less differential, the reset button at the front of the case must be pushed before the burner can operate.

ADJUSTING

Set the differential to correspond with the boiler manufacturer's recommendations. To adjust models with adjustable differential, rotate the wheel on the back of the snap switch until the desired reading is aligned with the "V" notch in the frame. The wheel provides an adjustment from 5 to 30 degrees (F). Replace the cover on the Aquastat controller.

Adjust the control point to correspond with the boiler manufacturer's recommendations. To adjust, insert a screwdriver in the slotted screw-type head located beneath the window in the cover. Turn the scale to the desired control point.

CHECKOUT

Check to make certain that the Aquastat controller has been installed and adjusted properly. Put the system into operation and observe the action of the device through several cycles to make certain that it provides proper low limit cut-out protection and circulator control. Further adjustments then can be made to meet more exact comfort requirements.

Form P-K 1100-B-75

INSTALLATION AND OPERATING INSTRUCTIONS FOR P-K MODEL 1100-B STEP CONTROLLER



PATTERSON-KELLEY COMPANY

Division of Taylor Wharton Co.-HARSCO Corporation
EAST STROUDSBURG, PENNSYLVANIA 18301

Manufacturer of water heaters • heat exchangers • steam generators • blenders • dryers • corrosion-resistant cements

GENERAL

The Patterson-Kelley Solid-State Step Control provides accurate control of multi-stage loads. It is U.L. listed (U.L. File #E55153).

Designed for progressive sequencing (first on-first off), it equalizes the operating time of each load.

In the event of a power interruption, all loads are dropped. Upon resumption of power, the control will re-stage the loads one at a time, beginning with stage one of the control.

L.E.D. DISPLAY

The control has visual display of energized stages indicated with light emitting diodes (LED). This feature also permits service personnel to make proper field calibration where temperature-control need is closer than 2-3°F. between stages. In domestic water heating, a setting of the normal 2° to 3°F. between steps is recommended to overcome excessive contactor wear. During the unit's normal operation, operating and service personnel can observe the sequence of operation of the solid-state controller.

SPAN

The span setting features a calibrated scale from .5° to 5°F. per step, to simplify field adjustment. Where close temperatures are required, such as in process heating, the degree differential between steps may be brought closer for close control. (This close control is not recommended for normal heating of potable water, as the contactor life will be greatly shortened.)

SENSITIVITY ADJUSTMENT

The sensitivity adjustment has been factory set to virtually eliminate the possibility of the control to hunt.

SENSOR (TEMPERATURE)

The temperature sensor is a thermistor, which is mounted in a copper probe 3/8" o.d. x 8-1/2" long. Probe resistance of standard probe is 1950 ohms at 72° ambient temperature. Connect to terminals No. 1 and 2 of the 1100-B Control.

SENSOR (PRESSURE)

On steam generators, sensing is done with a (0-135 ohm) slide wire pressure control. Connect to terminal No. 1 and 3 on the 1100-B Control and to the pressure sensor to produce a decreasing resistance for increasing pressure.

WIRING

Connect black (hot) 120 VAC lead to terminal "L".

Connect white (ground) 120 VAC lead to terminal "N".

(For controls over 10 steps, the cable between master and slave(s) must be connected, and the white (ground) connected to "N" of the slave(s).)

An isolation transformer is required to prevent false triggering. Our standard electric panel-control circuit transformer provides the necessary isolation required. (See wiring diagram in back of this manual.)

START-UP AND ADJUSTMENT PROCEDURE

1. Set span at 1° (near min. on 135 ohm) or other desired setting. (Span is the temperature differential between adding and dropping a step.)
2. Set temperature or pressure control to desired setting.
3. Switch on power. Contactors will step on at about 3 second intervals. Watch temperature rise.

As final temperature is approached, heater contactors will start dropping out. If temperature overshoots desired setting (contactors are not dropping out soon enough to allow water temperature to stabilize without going well over temperature set point), increase span slightly and check to see that temperature then stabilizes. If temperature is reached too slowly (contactors drop out too early), correct by decreasing span. When stable conditions are reached, check outlet temperature to see if it is as desired. If not, reset temperature setting.

SPECIFICATION

Input Power Requirements: 110-120 VAC./60 hertz/single phase/5 VA.

Triac Output: 120 VAC.

Ambient Temperature Range: 32° to 168°F.

Span Control: Thermistor Input: .5° to 5° F. per step

Slide Wire Input: 1.25 to 12.5 ohms per step

Controller Fusing: Power fuse 1 amp AGC type

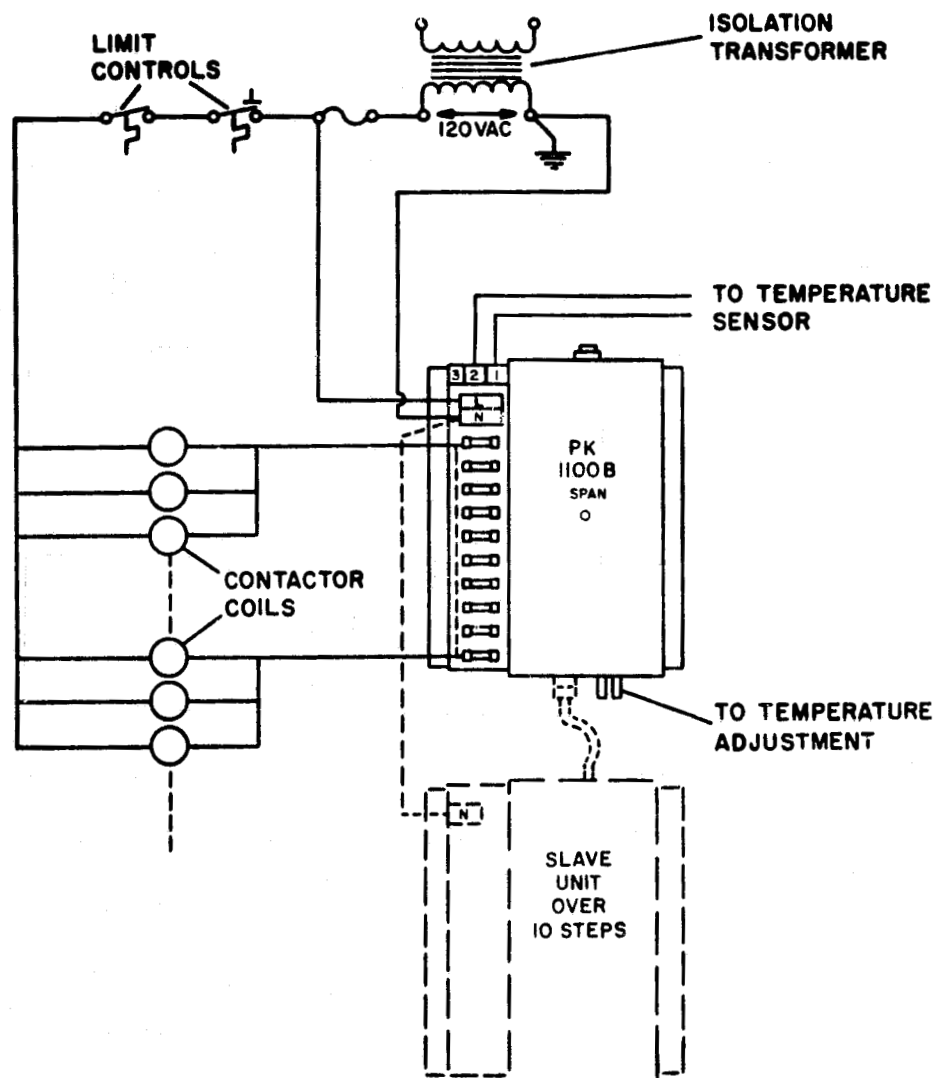
FUSE SELECTION

Fuses must be selected for each step of control based on the number of contactors per step. (See table below)

1 Contactor -- Use MDL .15 amp
2 Contactors -- Use MDL .3 amp

3 Contactors -- Use MDL .5 amp
4 Contactors -- Use MDL .6 amp
5 Contactors -- Use MDL .75 amp

POWER WIRING DIAGRAM



P-K GUARANTEE

The Patterson-Kelley Company guarantees each P-K 1100-B Solid-State Step Controller to perform as designed. We further guarantee all materials, components and workmanship used in the construction of each P-K 1100-B Controller to be of the highest quality. If any part should prove defective within one year after start-up, provided that start-up is performed within six months of date of shipment, a new part will be supplied without charge f.o.b. East Stroudsburg, Pennsylvania.



PATTERSON-KELLEY COMPANY

Division of Taylor Wharton Co.-HARSCO Corporation
EAST STROUDSBURG, PENNSYLVANIA 18301

Manufacturer of water heaters • heat exchangers • steam generators • blenders • dryers • corrosion-resistant cements

No. 174A Series

A.S.M.E. Water Pressure Relief Valves

Bronze body relief valves for pressure protection only of all types of hot water heating boiler equipment. Pressure range 30 lbs. to 160 lbs. with corresponding high BTU/HR ratings from 650,000 to 15,250,000 BTU/HR. Female inlet and outlet connections. Sizes: 3/4" to 2" inclusive.



- Seat located above drain: water can't be trapped and sediment can't foul seat
- Non-mechanical seat-to-disc alignment will not stick or freeze
- Water seal of high temperature resisting material isolates spring working parts from water during relief.

NOTE: For recommended Temperature and Pressure Protection of Domestic Hot Water Supply Systems, see S-1 sheet.

No.	Size	Model	Height	Length	Weight
174A	3/4" x 3/4"	M3	5 1/8"	2 1/2"	1 1/2 lbs.
174A	1" x 1"	M1	5 3/4"	3"	3 1/8 lbs.
174A	1 1/4" x 1 1/4"	M	8 3/8"	4 3/4"	6 1/4 lbs.
174A	1 1/2" x 1 1/2"	M	9"	4 7/8"	7 1/4 lbs.
174A	2" x 2"	M	11 5/8"	6 1/4"	13 3/4 lbs.

SETTINGS and RELIEVING CAPACITIES (National Board Certified Ratings) BTU Steam Discharge Capacities

Size	30 lbs.	100 lbs.	125 lbs.	150 lbs.
3/4"	650,000	1,695,000	2,070,000	2,445,000
1"	1,005,000	2,635,000	3,215,000	3,795,000
1 1/4"	1,865,000	4,870,000	5,945,000	7,020,000
1 1/2"	2,020,000	5,290,000	6,460,000	7,630,000
2"	3,815,000	9,970,000	12,170,000	14,370,000

NOTE: We recommend No. 740 Series as best buy for hot water space heating boiler requirements between 30 through 75 lbs.

This safety relief valve is for protection against excessive water pressure caused by thermal expansion of the water. However, the valve also has an emergency BTU steam discharge capacity if run-away firing conditions occur, but do not use for continuous steam service.

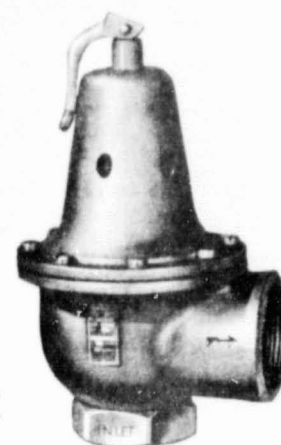
The function of the valve is to prevent excessive pressures above the valve setting, but valve will not prevent the natural build-up of temperature in the boiler because the valve works on pressure only and temperature does not affect its operation. Therefore, for domestic hot water supply systems, to prevent excessive temperature above 212°, which might result in overheating explosive dangers, combined temperature and pressure relief protection is essential.

Watts self-closing combination temperature and pressure relief valves give this protection as described on S-1 sheet.

No. 740 Series

A.S.M.E. Boiler Safety Water Relief Valves

Iron body relief valves with expanded outlets for hot water space heating boilers. Pressure range 30 lbs. to 75 lbs. with corresponding high ratings from 895,000 to 10,700,000 BTU/HR. This wide range of relieving capacities provides a much lower BTU per thousand cost because this series provides a much higher BTU rating, size for size, than other valves on the market. Female inlet and outlet connections. Sizes: 3/4" to 2" inclusive.



- Same design features as No. 174A except for difference in body construction and material

No.	Size	Model	Height	Length	Weight
740	3/4" x 1"	M1	5 5/8"	3"	1 7/8 lbs.
740	1" x 1 1/4"	M	7 1/4"	3 1/2"	3 1/8 lbs.
740	1 1/4" x 1 1/2"	M	8 3/4"	4 5/8"	6 1/8 lbs.
740	1 1/2" x 2"	M	9 1/4"	5 1/4"	7 1/2 lbs.
740	2" x 2 1/2"	M	11 5/8"	6 3/4"	16 1/2 lbs.

SETTINGS and RELIEVING CAPACITIES (National Board Certified Ratings) BTU Steam Discharge Capacities

Size	30 lbs.	45 lbs.	50 lbs.	75 lbs.
3/4" x 1"	925,000	1,245,000	1,352,000	1,886,000
1" x 1 1/4"	1,300,000	1,749,000	1,899,000	2,649,000
1 1/4" x 1 1/2"	2,105,000	2,830,000	3,075,000	4,285,000
1 1/2" x 2"	2,900,000	3,903,000	4,238,000	5,910,000
2" x 2 1/2"	5,250,000	7,050,000	7,650,000	10,700,000

NOTE: Valve settings, other than shown above, are available in 5 lb. increments between the pressure range of 30 through 75 lbs.

Nos. 2000S - 2000

Two-Way Flow Check

Assures positive gravity shut-off when circulator is not running. Quiet, no-chatter operation. Easily opened for gravity circulation when necessary. Simplified single unit service feature.

No. 2000 combines angle and horizontal checks in one stock type. Extra expansion tank connection when installed as angle check.



No. 2000S



No. 2000

No.	Size	Height	Length	Weight
2000S	3/4"	3 5/8"	3"	1 lb.
2000S	1"	3 7/8"	3 3/4"	2 lbs.
2000	3/4"	5"	4 1/8"	3 lbs.
2000	1"	5"	4 1/8"	3 lbs.
2000	1 1/4"	5 5/8"	4 3/4"	4 1/2 lbs.
2000	1 1/2"	6 3/4"	6"	7 lbs.

No. 2000S is furnished with a bronze body and sweat copper connections.

WATTS TEMPERING VALVES

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OF POOR QUALITY

No. 70A, L70A

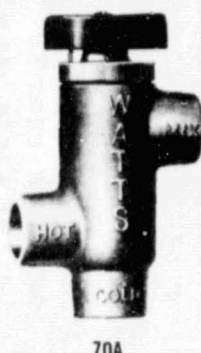
Tempering Valves for Residential and Small Commercial Installations

For domestic hot water service. Automatically mix cold water with hot water from heater. Especially recommended for automatic storage water heaters to increase draw capacity. See installation below. Equipped with convenient adjusting dial for easy "finger-tip" temperature control. Heavy stainless steel springs assure positive shut-off against higher cold water pressure differential during excessive demand for hot water, thus delivering full rated capacity. Maintenance is simple, thermostat is easily removed and replaceable as a unit.

Standard temperature range, 120-160°F.

No. L70A — Special model available for low temperature range, 100° to 130°F.

- All bronze construction
- "Perma-Fresh" finish to preserve casting appearance.
- Solid wall thermostat not vulnerable to corrosion. Powerful, supersensitive control



70A



Adjustable Feature

- Interchangeable thermostat assembly replaceable in all valves

Temperature Range		Connections	Size	Height	Length	Weight
120°-160°	100°-130°					
No.	No.					
70A	L70A	Sweat	1/2"	3 3/4"	2"	3/4 lb.
70AT	L70AT	Threaded	1/2"	3 7/8"	2 3/4"	1 lb.
70A	L70A	Sweat	3/4"	4 1/8"	2 3/4"	1 lb.
70AT	L70AT	Threaded	3/4"	4 1/8"	2 3/4"	1 1/4 lb.

No. N170, N170L

Tempering Valves for Large Commercial and Institutional Installations

Watts No. N170 series Water Tempering Valves are especially designed for use on larger hot water supply systems requiring dependable control of water temperature at fixture outlets. This new series features a unique "double thermostat design" which combines two thermostats in one to provide more sensitive control and more rapid response to changes in water temperature passing through the mixing chamber. In addition, the operating life of the element is vastly improved over contemporary designs because the load is divided evenly between the two sensing elements.

Standard adjustable range, 130-180°F. For lower tempered water requirements at or below 130°F., specify low temperature Model N170L Series below.

No. N170L—Special Model available for car wash and other low temperature range applications between 100°-130° F.

- All bronze body construction with stainless steel disc
- Solid wall hydraulic principle thermostat assures dependable control of water temperature
- Thermostat controls both hot and cold water, minimizing scalding hazard



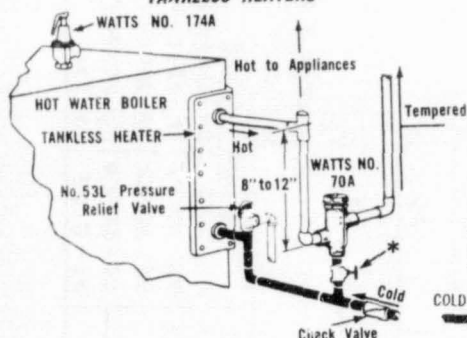
- Interchangeable thermostat assembly replaceable in all valves



Temperature Range

Temperature Range		Size	Height	Length	Weight
130°-180°	100°-130°				
No.	No.				
N170	N170L	3/4"	7 5/8"	4 1/8"	4 1/8 lbs.
N170	N170L	1"	7 5/8"	4 1/2"	4 3/8 lbs.
N170	N170L	1 1/4"	7 5/8"	5"	5 lbs.
N170	N170L	1 1/2"	8 1/8"	6"	8 lbs.
N170	N170L	2"	8 1/8"	6 3/8"	8 3/4 lbs.

TANKLESS HEATERS

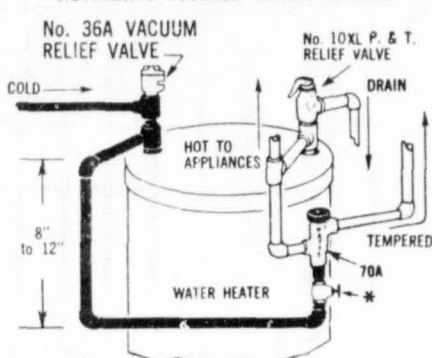


We recommend this simple, quick installation to eliminate unnecessary labor and fittings. Position of valve permits easy, visual adjustment.

- * Balancing valve should be installed, in cold water line to tempering valve, as shown to compensate for pressure drop through heater.

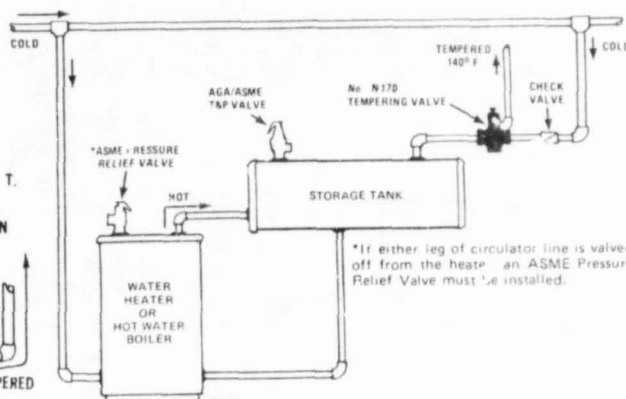
INSTALLATIONS

AUTOMATIC STORAGE WATER HEATERS



Hot Water fed direct to appliances, providing Two Temperature advantage.

LARGE SIZE INSTANTANEOUS, HEAT EXCHANGER OR CONVERTER TYPE HEATER APPLICATIONS



NOTE: A Tempering Valve cannot compensate for rapid pressure fluctuations. Therefore, where the system is subject to water pressure fluctuations, a pressure equalizing valve should be installed. Please contact your Watts Representative concerning information on pressure equalizing valves.

The Watts Tempering Valves described should not be used to provide "anti-scald" or "anti-chill" service because of system pressure and temperature variations beyond its control. Watts Tempering Valves are not designed to compensate for system pressure fluctuations and should not be used where more sophisticated pressure equalized temperature controls are required to provide anti-scald performance.

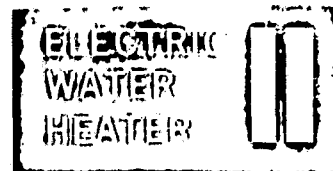
For Additional Detailed Information, send for Folder F-N170

This drawing on the Instantaneous Electric Water Heater, Horizontal has been deleted because of reproducing restrictions. For information on the electric water heater contact Patterson-Kelley Company, East Stroudsburg, PA 18301.



A. O. Smith

MODELS PEN/GED/EDTT



LIMITED WARRANTY

A. O. Smith Corporation, the warrantor, extends the following LIMITED WARRANTY to the owner of this water heater:

1. THE TANK

If the glass-lined tank in this water heater shall prove upon examination by the warrantor to have leaked due to natural corrosion from potable water therein, during the first TEN years after initial installation for residential purposes, the warrantor will supply a complete new water heater of equivalent size and current model.

- This warranty on its tank is reduced to THREE years when the water heater has been used for commercial, institutional, industrial or other non-residential purposes.
- The warranty on the replacement water heater will be limited to the unexpired term of the original warranty.

2. ALL OTHER PARTS

If within ONE year after initial installation of this water heater, any part or portion shall prove upon examination by the warrantor to be defective in material or workmanship, the warrantor will repair or replace such part or portion at its option.

3. CONDITIONS AND EXCEPTIONS

This warranty shall apply only when the water heater is installed in accordance with local plumbing and building codes, ordinances and regulations, the printed instructions provided with it and good industry practices. In addition, a temperature and pressure relief valve, certified by the American Gas Association, must have been installed.

- This warranty shall apply only when the heater is used:
 - at temperatures not exceeding the maximum setting of its thermostat;
 - at water pressure not exceeding the working pressure shown on the water heater;
 - when filled with potable water, free to circulate at all times and with the tank free of damaging scale deposits;
 - in a non-corrosive and non-contaminated atmosphere;
 - in the United States, its territories or possessions, and Canada.
- Any accident to the water heater, any misuse, abuse (including freezing) or alteration of it, any operation of it in a modified form, or any attempt to repair tank leaks will void this warranty.

4. SERVICE and REPAIR EXPENSE

Under this limited warranty the warrantor will provide only a replacement water heater or part thereof. The owner is responsible for all other costs. Such costs may include but are not limited to:

- Labor charges for service, removal, repair, or reinstallation of the water heater or any component part;
- Shipping, delivery, handling, and administrative charges for forwarding the new water heater or replacement part from the nearest distributor and returning the claimed defective heater or part to such distributor.
- All cost necessary or incidental for any materials and/or permits required for installation of the replacement heater or part.

5. LIMITATION ON IMPLIED WARRANTIES

Implied warranties, including any warranty of merchantability imposed on the sale of this heater under state law are limited to one (1) year duration for the heater or any of its parts. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

6. CLAIM PROCEDURE

Any claim under this warranty should be initiated with the dealer who sold the heater, or with any other dealer handling the warrantor's products. If this is not practicable, the owner should contact:

U.S. Customers except California

A. O. Smith Corporation
P. O. Box No. 23
Kankakee, Illinois 60901
Telephone: (815) 933-3241

California Customers ONLY

A. O. Smith Corporation
33375 Central Avenue
Union City, California 94587
Telephone: (415) 409-4374

Canadian Customers

A. O. Smith Corporation
P.O. Box 310 - 768 Erie Street
Stratford, Ontario N5A 6T3
Telephone: (519) 271-5800

- The warrantor will only honor replacement with identical or similar water heater or parts thereof which are manufactured or distributed by the warrantor.
- Dealer replacements are made subject to in-warranty validation by warrantor.

7. DISCLAIMERS

NO OTHER EXPRESS WARRANTY HAS BEEN OR WILL BE MADE IN BEHALF OF THE WARRANTOR WITH RESPECT TO THE HEATER OR THE INSTALLATION, OPERATION, REPAIR OR REPLACEMENT OF THE HEATER. THE WARRANTOR SHALL NOT BE RESPONSIBLE FOR WATER DAMAGE, LOSS OF USE OF THE UNIT, INCONVENIENCE, LOSS OR DAMAGE TO PERSONAL PROPERTY, OR OTHER CONSEQUENTIAL DAMAGE. THE WARRANTOR SHALL NOT BE LIABLE BY VIRTUE OF THIS WARRANTY OR OTHERWISE FOR DAMAGE TO ANY PERSONS OR PROPERTY, WHETHER DIRECT OR INDIRECT, AND WHETHER ARISING IN CONTRACT OR IN TORT.

- Some states do not allow the exclusion or limitation of the incidental or consequential damage, so the above limitation or exclusion may not apply to you.
- This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Fill in the following for your own reference. Keep it. Registration is not a condition of warranty. The model and serial number are found on the heater's rating plate.

Model No. _____ Serial No. _____ Date Installed _____

Dealer's Name: _____

Dealer's Address: _____ Phone No. _____

City and State: _____ Zip _____

A. O. Smith
CORPORATION

CONSUMER PRODUCTS DIVISION
KANKAKEE, ILLINOIS

KEEP THIS WARRANTY AND MANUAL POSTED ADJACENT TO THE HEATER FOR FUTURE REFERENCE WHENEVER MAINTENANCE, ADJUSTMENT OR SERVICE IS REQUIRED.

PART NO. 41858
Supersdes 41575

INSTALLATION

ORIGINAL PAGE IS
OF POOR QUALITY

The heater must be installed in accordance with local codes and utility company requirements. In the absence of local codes or utility company requirements the heater must be installed in accordance with the National Electrical Code. The heater is equipped with one of the following circuits and is identified by number on model and rating plate. The wiring diagrams show factory installed internal wiring to meet local utility requirements. The illustrations show typical installations. An approved temperature and pressure relief valve must be installed.

The heater should be located in an area where leakage of the tank or connections will not result in damage to

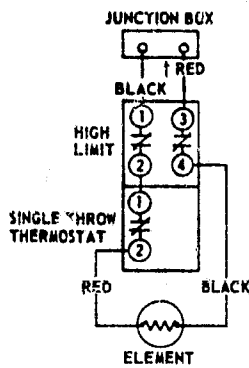
the area adjacent to the heater or to lower floors of the structure.

When such locations cannot be avoided, a suitable drain pan should be installed under the heater.

Such pans should be at least two inches deep, have a minimum length and width of at least two inches greater than the diameter of the heater and should be piped to an adequate drain.

Drain pans suitable for these heaters are available from your distributor or A. O. Smith Product Service Div., 7250 S. Cicero Ave., Chicago, Ill. 60629.

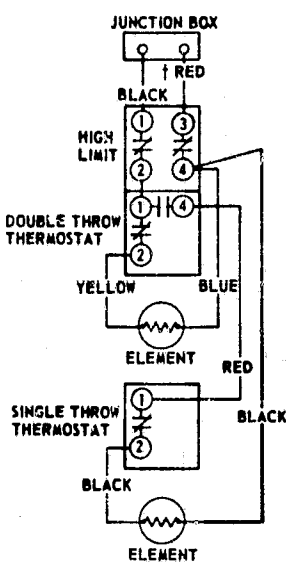
C-2
TWO WIRE CIRCUIT FOR SINGLE
ELEMENT HEATERS EQUIPPED
WITH HIGH LIMIT CONTROL



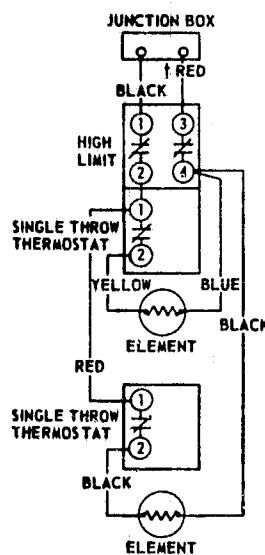
* MUST NOT BE CONVERTED
TO SIMULTANEOUS OPERATION
IF TOTAL WATTS/HR. INPUT
EXCEEDS
6240W @ 208 VOLTS
7200W @ 240 VOLTS
8300W @ 277 VOLTS

† WHITE FOR 120V AND 277V

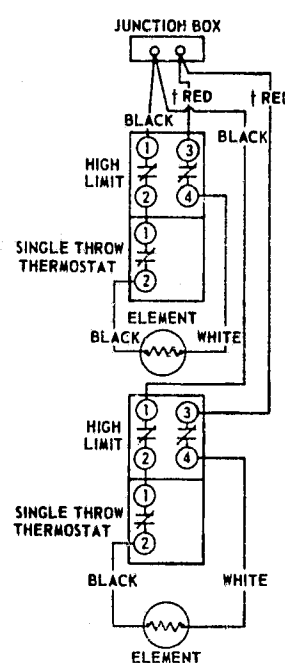
A-4
TWO WIRE CIRCUIT FOR NON-
SIMULTANEOUS OPERATION, HAS
SINGLE HIGH LIMIT CONTROL



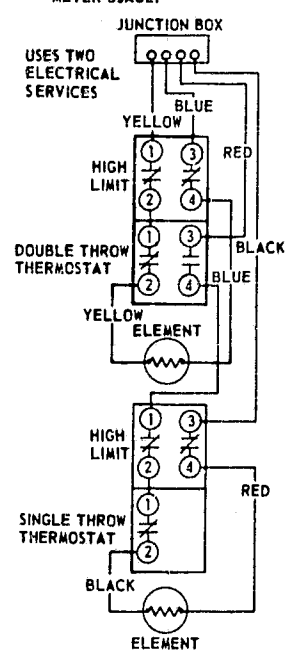
B-4
TWO WIRE CIRCUIT FOR SIMULTANEOUS
OPERATION, HAS SINGLE HIGH LIMIT
CONTROL



B-7
FOUR WIRE CIRCUIT ARE SIMULTANEOUS
OPERATION, HAS DOUBLE HIGH LIMIT
CONTROL



A-7
FOUR WIRE CIRCUIT FOR NON-
SIMULTANEOUS OPERATION, HAS
TWO HIGH LIMIT CONTROL. THIS
CIRCUIT PERMITS OFF-PEAK
METER USAGE.



VERTICAL MODELS

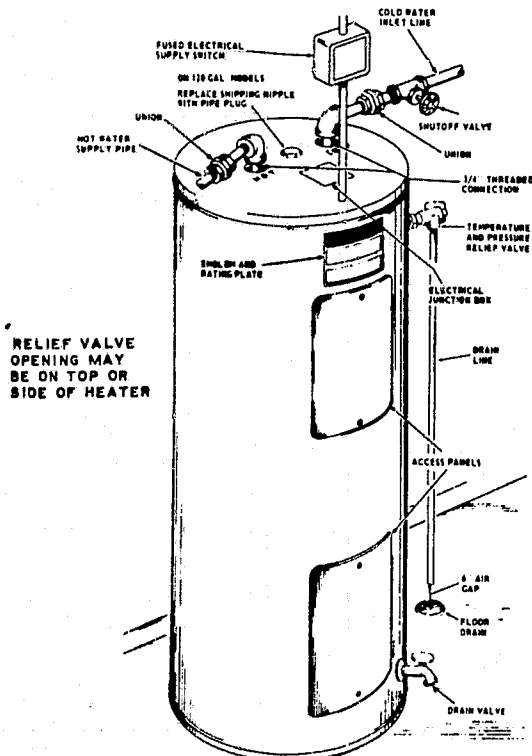


FIGURE 2

FIGURE 1

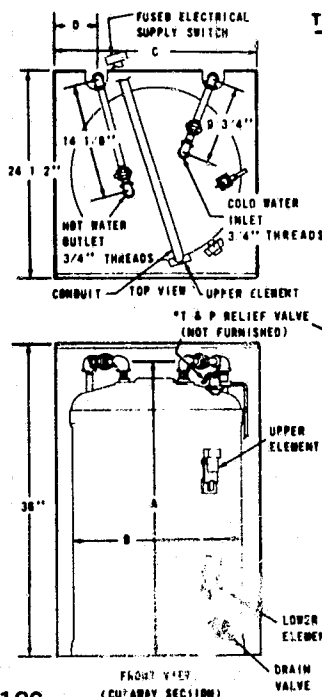


TABLE TOP MODELS

DIMENSIONS	CAPACITY		
	30 GAL.	40 GAL.	50 GAL.
A	32 1/8"	33 9/16"	33 5/8"
B	18"	20"	22 1/2"
C	22"	22"	24"
D	3"	3"	4"

ALL DIMENSIONS IN INCHES

REMOVE FRONT PANEL TO GAIN ACCESS TO
DRAIN VALVE OR CONTROLS. SEE "PANEL
REMOVAL" FOR DETAILS.

FIGURE 3

ON 120 GAL. MODELS:

Remove shipping nipple (on 120 model only), in top center of heater and install pipe plug. If this opening is to be used for temperature and pressure relief valve, install pipe plug in side opening.

PANEL REMOVAL FOR TABLE TOP MODELS

The drain valve, electrical components and wiring leads are situated behind the front panel. The following describes the method of removing the front and top panels.

1. Turn off the electrical supply to the water heater.
2. Remove screw at bottom of front panel and using the finger catch at the bottom, pull panel outward.
3. Lower front panel to clear top panel and remove. Wiring leads are now visible.
4. To expose electrical components, fold aside the insulation to uncover the components behind their electrical barriers.
5. Top panel may be removed by removing screw and hook under front edge of top panel. Slide panel toward front of heater.

RELIEF VALVE

Install temperature and pressure protective equipment required by local codes, but not less than a combination temperature-and-pressure-relief valve certified as meeting the requirements in the Listing Requirements for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22, by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials. The valve shall be installed so that discharge water from the valve will not contact any live electrical part or cause water damage. The drain line connected to this valve shall be full size and terminate near a suitable drain. The discharge opening must not be blocked or reduced in size under any circumstances. Omission or improper installation of the temperature-and-pressure relief valve voids the manufacturer's warranty and liability.

OPERATION

CAUTION

Do not operate the heater without installing an approved temperature and pressure relief valve in the relief valve opening of the heater.

Ground the heater to guard against electric shock from the heater or water system.

Never operate the heater without filling with water per the FILLING instructions. Failure to do so will damage internal parts.

FILLING

1. Close the water heater drain valve by turning hand-wheel to right (clockwise).
2. Open a nearby hot water faucet to permit the air in the system to escape.
3. Fully open the cold water inlet valve allowing the heater and piping to be filled.
4. Close the hot water faucet as water starts to flow.
5. Turn on the electrical switch to the water heater.

TEMPERATURE REGULATION

Each heating element operates under the control of a thermostat which is factory set at 150°F.

This setting has proven to be most satisfactory from the standpoint of operational costs and household needs. The thermostat(s) can be adjusted to provide a warmer or cooler water temperature, contact your dealer or utility company.

A non-adjustable high temperature limit control which is designed to shut off when excessive water temperatures are reached, has been installed. The high limit must be reset manually when it operates. Because the high limit operates only when abnormally high water temperatures are present, it is important that your dealer be contacted to determine the reason for operation.

DRAINING

If the heater is to be shut down and exposed to freezing temperatures, it must be drained. Water, if left in the tank and allowed to freeze, will expand and damage the heater.

1. Turn off the electrical switch and cold water inlet valve.
 - A hose must be connected to the drain valve to carry the water away.
2. Open a nearby hot water faucet and the heater drain valve.
 - Be careful to grasp the drain valve handle in such a way that the hand will not be exposed to hot water.
3. The drain valve must be left open during the shut-down period.
 - To restart heater, refer to the foregoing FILLING instructions.

CHEMICAL VAPOR CORROSION

Water heater corrosion and component failure can be caused by the heating and breakdown of airborne chemical vapors. Spray can propellants, cleaning solvents, refrigerator and air conditioning refrigerants, swimming pool chemicals, calcium and sodium chloride, waxes, and process chemicals are typical compounds which are potentially corrosive. These materials are corrosive at very low concentration levels with little or no odor to reveal their presence.

Products of this sort should not be stored near the heater. Also, air which is brought in contact with the water heater should not contain any of these chemicals. If necessary, uncontaminated air should be obtained from remote or outside sources.

MAINTENANCE

Electrical water heater maintenance consists of cleaning the tank and removing lime (or scale) from the heating elements in hard water areas. Your dealer should be contacted for element cleaning. In some instances a hissing sound may be heard as the scale builds up. This noise is normal.

To assure long life and efficiency, the water heater tank must have a small amount of water drained periodically.

Periodically the drain valve should be opened and the water allowed to run until it flows clean. This will help to prevent sediment buildup in the tank bottom.

Periodically the temperature and pressure relief valve should be checked to insure that it is in operating condition. Lift the lever at the top of the valve several times until the valve seats properly and operates freely.

CAUTION: The water passing out of the valve during this checking operation may be extremely hot.

CHECKLIST

Before contacting your dealer, check the water heater to see if the apparent malfunction is caused by some external fault. Consulting this checklist may eliminate the need for a repair call and restore hot water service.

NOT ENOUGH OR NO HOT WATER

1. Be certain that the water heater electrical switch is turned to ON position.
 - In some areas an additional special meter, controlled by a timer, is used to govern the periods electricity is available. If the heater operates on a timed electrical circuit, recovery will be limited to certain hours.
2. Check for loose or blown fuses in the water heater circuit.
3. If the water has been excessively hot and is now cold, the high temperature limit control may have operated. To restore service, contact your dealer or utility company.
 - Refer to TEMPERATURE REGULATION section.
4. The storage capacity of the heater may have been exceeded by large demands of hot water.
5. If the heater was installed when incoming water temperatures were warm, colder incoming temperatures will create the effect of less hot water.
6. Look for leaking or open hot water faucets.

WATER IS TOO HOT

1. Refer to TEMPERATURE REGULATION section.

WATER HEATER MAKES SOUNDS

1. Lime or scale has accumulated on the heating element(s) causing a hissing sound.
 - The noise is normal although the element(s) should be cleaned. Your dealer should be consulted for this service.

WATER LEAKAGE IS SUSPECTED

1. Check to see if the heater drain valve is tightly closed.
2. The apparent leakage may be condensation which forms on cool surfaces of the heater and piping.
3. If the outlet of the relief valve is leaking it may represent:
 - Excessive water pressure
 - Excessive water temperature
 - Faulty relief valve
 - Excessive water pressure is the most common cause of relief valve leakage. It is often caused by a "closed system". A check valve in the inlet system will not permit the expanded hot water volume to equalize pressure with the main. A relief valve must release this water or the water heater or plumbing system will be damaged.

When such a condition is encountered, local codes or inspection agency should be consulted to determine which system is acceptable in your area. These may consist of:

- Installation of a second relief valve with lower setting than the primary safety relief valve.
- An expansion tank of suitable pressure and provision to avoid water logging.
- Removal of the check valve.

IF YOU CANNOT IDENTIFY OF CORRECT THE SOURCE OF MALFUNCTION:

1. Place the water heater electrical switch in the OFF position.
2. Close the cold water inlet valve to the heater.
3. Contact your dealer.

WARNING! DO NOT ATTEMPT TO OPERATE HEATER WITH COLD WATER INLET VALVE CLOSED.

WATTS PLUMBING SPECIALTIES

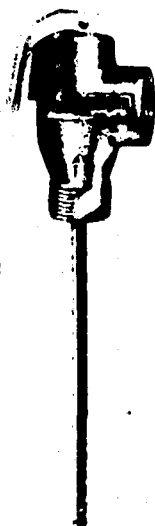
Watts ANS Z21.22 certified non-adjustable temperature and pressure relief valves are necessary to meet established water heater safety standards such as AGA, UL, FHA, Military Spec MIL V-13612C and various regional, state and local codes.

No. 1L - 1XL 1/2" Size

Self-Closing T & P Relief Valves

A compact, economical design for water heaters up to 15,000 BTU/HR. Provides both pressure and temperature relief protection. No. 1L furnished with test lever and short thermostat for installation directly in tank tapping. No. 1XL has test lever and extension thermostat for installation in hot outlet line. Male inlet and female outlet. Pressure range 75-150 lbs. Standard settings 125 and 150 lbs. Temperature relief 210°F. Also available with 8" extension thermostat at small extra cost. Specify No. 1XL-8.

ANS Z21.22 DESIGN
CERTIFIED by A.G.A.
and C.G.A. LISTED



- All bronze body
- Stainless steel spring
- Thermostat is positive, accurate and proven, exclusively designed and manufactured by Watts.

No. 10L - 10XL - Same as above except 3/4" size to meet A.S.M.E. requirements.

No.	Size	Height (Less Thermostat)	Width	Weight	A.G.A. Temp. Steam Rating BTU/HR	Model
1L	1/2"	3 1/2"	1 7/8"	5/8 lb.	15,000	M6
1XL	1/2"	3 1/2"	1 7/8"	3/4 lb.	15,000	M6
1XL-8	1/2"	3 1/2"	1 7/8"	7/8 lb.	15,000	M6
10L	3/4"	3 1/2"	1 7/8"	5/8 lb.	90,000	M4
10XL	3/4"	3 1/2"	1 7/8"	3/4 lb.	100,000	M4
10XL-8	3/4"	3 1/2"	1 7/8"	7/8 lb.	100,000	M4

No. 210 MODEL M2

Temperature Gas Shutoff

Provides protection for gas water heaters against overheating by shutting off the gas supply. Sizes: tank connection, 3/4" male; gas connection, 1/2" female. Shuts off gas supply at water temperature of 210°F.

ANS Z21.22 DESIGN
CERTIFIED by A.G.A.



- All bronze construction
- Thermostat releases snap acting spring latch to close valve at a definite controlled temperature
- Disc to metal seating assures positive seal for shutting off gas to the burner in event of high water temperature conditions
- Shuts off all fuel to the water heater, as it is entirely separate from the regular operating controls

No.	Height (Less Thermostat)	Width	Weight	Natural Gas	Liquefied Petroleum Gases
210 3	3 1/4"	2 1/2"	1 lb.	150,000	243,000
210 5	3 1/4"	2 1/2"	1 lb.	150,000	243,000

NOTE: See AGA Directory for adjustment factors when used with Mfg. Mixed and L.P. Gas-Air mixtures

BLUE RIBBON MODEL

No. 100XL 3/4" Size

Self-Closing T & P Relief Valves

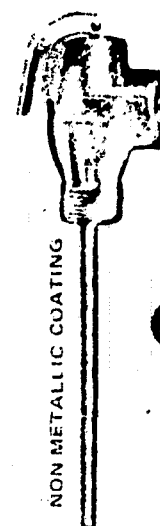
Watts Blue Ribbon Model No. 100XL is identical to No. 10XL, except it features: A UNIQUE THERMOSTAT WITH SPECIAL THERMO BONDED (NON-METALLIC) PROTECTIVE COATING.

The feature forms a highly protective dielectric barrier which isolates the copper thermostat from the heated water to prevent accumulations of mineral deposits and galvanic corrosive action. This important breakthrough dramatically extends the effective life of the valve by overcoming problems created by adverse water conditions.

No. 100XL has test lever and extension thermostat. Also available with 8" extension at small extra cost, specify No. 100XL-8. Male inlet and female outlet. Temperature Relief - 210°F.

- All bronze body
- Stainless steel spring
- Thermostat with special protective coating.

ASME RATED
ANS Z21.22 DESIGN
CERTIFIED by A.G.A.
and C.G.A. LISTED



No.	Size	Height (Less Thermostat)	Width	Weight	A.G.A. Temp. Steam Rating BTU/HR	Model
100XL	3/4"	3 1/2"	1 7/8"	3/4 lb.	100,000	M4
100XL-8	3/4"	3 1/2"	1 7/8"	7/8 lb.	100,000	M4

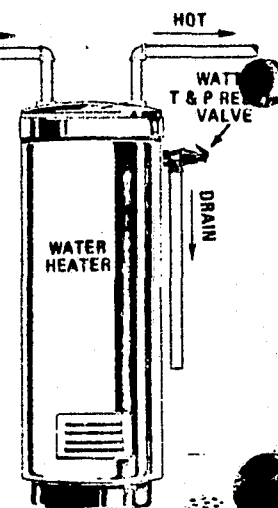
NOTE: All extension types can be specially furnished with various length extension thermostats above 8" at extra cost. Example: 10XL-11 (without coating).

IMPORTANT INFORMATION

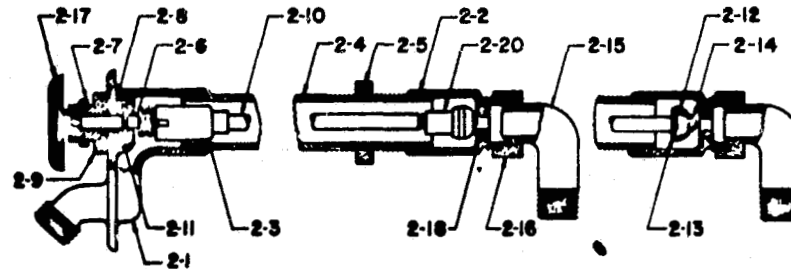
T & P RELIEF VALVES

All T & P relief valves are for protection against both excessive temperature and pressure; and if either of these conditions develop in the system, valve will open and discharge water. If valve relieves from thermal expansion pressure build-up, the valve will drip slowly. If the valve relieves from excessive temperature build-up, the valve will discharge in greater volume.

Therefore, the valve is performing its duty to keep the system safe. As a result, a drain pipe must be installed to avoid scalding and water damage; and the drain pipe should pitch downward from the valve and run to a safe place of disposal. When approved by local authorities, 150 lbs. pressure relief setting is recommended in accordance with latest allowable pressure standards for gas and electric water heaters.



PARTS LIST FOR C-132 & C-133 HYDRANTS PRIOR TO 1974

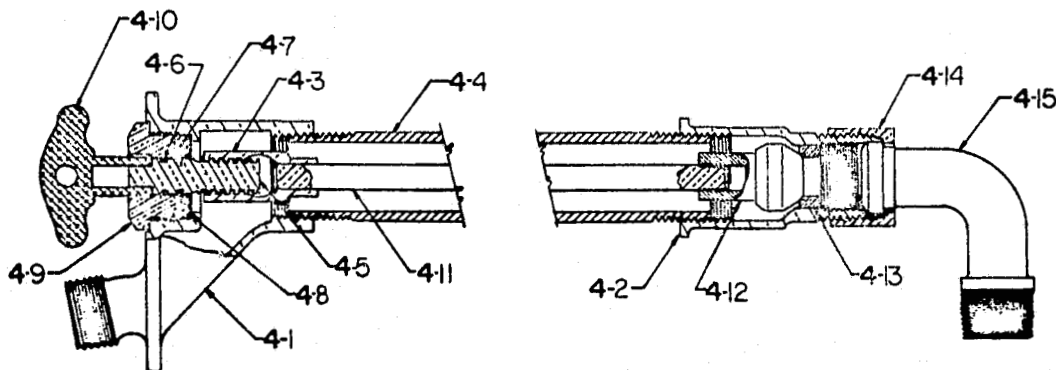


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OF POOR QUALITY

#2-1	Head Casting
#2-2	Valve Body for C-132.....
#2-2P	Valve Body for C-133.....
#2-3	Worm Casting
#2-4	1" Pipe
#2-5	1½" Hex Shoulder Nut.....
#2-6	Worm Stem
#2-7	Packing Nut
#2-8	Packing
#2-9	Worm Assembly Nut.....
#2-10	¾" Brass Rod.....

#2-11	1½ x ¾ x 1/8" Brass Washer.....
#2-12	1/8" Half Ball
#2-13	.906 x .256 x 1/8" Washer
#2-14	1/4" Washer Nut
#2-15	90 Deg. Brass Elbow.....
#2-16	1" Hex Elbow Coupling Nut.....
#2-17	Loose Key Handle
#2-18	Nylon Seat
#2-19	Cast Brass Loose Key Handle.....
#2-20	Seat Washer Assembly

PARTS LIST FOR C-132 & C-133 HYDRANT (NEW STYLE)



#4-1	HEAD CASTING.....	#4-9	BUSHING NUT
#4-2	VALVE BODY.....	#4-10	HANDLE
#4-3	WORM SLEEVE.....	#4-11	CONTROL ROD
#4-4	PIPE	#4-12	PLUNGER
#4-5	WORM STEM	#4-13	NYLON SEAT
#4-6	O-RING	#4-14	NUT
#4-7	THRUST WASHER	#4-15	ELBOW
#4-8	RETAINER SEAL		

11. CHEMICAL FEEDER

PROJECT:

CITIZEN'S MUTUAL SAVINGS & LOAN

LEAVENWORTH, KANSAS

MECHANICAL CONTRACTOR:

NORRIS BROTHERS, INC.

LAWRENCE, KANSAS

SUPPLIERS:

WESTERN CHEMICAL COMPANY

1345 TANEY

NORTH KANSAS CITY, MISSOURI 64116

OPERATION, MAINTENANCE AND PARTS LIST

ITEM:

WESTOMATIC 210

COOLING WATER CONTROL SYSTEM

CHEMICAL TREATMENT

HANDLING AND MIXING OF CHEMICALS

GENERAL

FOLLOW ALL DRUM LABELS AND CAUTIONS.

FOLLOW ALL SPECIAL INSTRUCTIONS.

1. Store chemicals in cool, dry area, particularly away from dampness and heat.
2. After treatment is taken from drums, replace drum bungs on liquids and close plastic liners on powders to prevent evaporation of liquids and caking of powders.
3. Never mix undiluted concentrated chemicals (liquids or powders) for feeding to systems. They may not be compatible in concentrated form. Follow proper mixing procedures.
 - a. To dissolve powdered chemicals-- add chemicals to water (DO NOT ADD WATER TO POWDER), while stirring or agitating. Be sure that at least as much water is used for quantity of chemical used as instructed to insure complete dissolving of powders. Stir until powder is completely dissolved.
 - b. When diluting liquid chemicals, add the liquid chemicals to water.
 - c. Where liquids and powders are fed together, dissolve powdered chemicals in water prior to adding to the feed tank. This prevents the undissolved powders from going through the pump and causing untimely and costly pump repair and general maintenance.
4. The best available water should be used for dissolving and diluting chemicals-- condensate or good soft water is preferred to hard water.
5. Frequent mixing of feed solutions of chemicals is preferred over large batch mixes to keep the chemicals stable in dilute form. This also allows for prompt adjustment of chemical quantities in the feed mixtures as is found to be necessary by regular control tests.
6. Do not attempt to mix and feed chemicals unless they are known to be compatible or instructions indicate they are to be mixed in the same solution tank.

SPECIAL PRECAUTIONS

Some of the chemical products provided in your treatment program may be alkaline or acid in character.

The particular products are identified in the Treatment section of this manual, and their containers have been marked with precautionary labels.

Always follow these special precautions in the use of these chemicals:

Handling

- Handle with care and respect.
- Avoid splashing, spilling.
- Avoid contact with eyes, skin or clothing.
- Use goggles, gloves and protective clothing.

Mixing

General

- Do not attempt to mix and feed chemicals unless they are known to be compatible or instructions indicate they are to be mixed in the same solution tank.

Alkaline Only

- Powder Form - A solution of the powder is to be made up by adding the material gradually to clean, cold water contained in an open, steel vessel, at a strength no greater than 1 lb. per gallon. Add the powder with constant stirring. Since this material contains caustic soda, proper precautions should be taken to avoid contact of the powder or the solution with the eyes, skin or clothing.

Equipment

- Be sure that the pump, solution containers and accessories (if not provided by Western) are suitable for handling alkalines.

COOLING WATER TREATMENT CONTROL
INITIAL START UP AND
INTERPRETATION AND ADJUSTMENT

6/20/78

FOR Open Tower System

Product	Estimated Daily Dosage*	Control Limits mg/l	Control Test
CWT #298	1 Pint	Blue Color (3-6)	Blue Color Comparator
Cycles of Concentration	5	5 x raw	Chloride

Solution Preparation: * Before preparing solutions read carefully all Product Information sheets and the information on Mixing and Handling of Chemicals.

Mix 10 times the above daily dosages into 50 gallons of water. Set equipment controls to feed 5 gallons per day.

Equipment Settings: * See operating instructions for component settings on WESTOMATIC Model 210 System.

Test Frequency: Recommended once every 8 hours of equipment operation (minimum of once per day).

Cycles of Concentration: Defined as cooling water chloride divided by raw water chloride (can be controlled by other tests). The control limits stated are maintained by the regular bleedoff schedule. If results are above limits increase bleedoff; if below limits decrease bleedoff. If adjustment in bleedoff is required, please consider effects on chemical dosage control.

Chemical Dosage Control: The dosages indicated above are estimations of the requirements for your system. This may have to be adjusted in actual operation to maintain the Control Limits specified. Adjustment can be controlled by varying chemical feed equipment setting or actual solution strengths.

* Where this information has not been filled in, there was insufficient data in our files to properly determine it. Please use the space provided to record your actual operational data.

PRODUCT INFORMATION

FORMULA 298-MULTIONIC COOLING WATER TREATMENT

USE:

Non-chromate scale inhibitor, corrosion inhibitor and anti-foulant. U.S.D.A. approved.

APPLICATION:

Mixing: May be fed full strength direct from shipping container, or may be diluted with water and fed from solution tank. See INITIAL START UP page.

Feeding: Continuous feed by chemical feed pump, in proportion to make up, is required.

Equipment: In concentrated form, this product is corrosive and suitable pump trim, solution tank, and chemical feed lines must be used.

CONTROL:

Use Blue Color Comparator Test, adjusting treatment feed rate so that color of the tower water is between the color of the two standards. If the tower water sample color is darker than the 3.5 mg/l standard reduce feed rate. If lighter than the 2.5 mg/l standard, increase feed rate. Filter sample first if off color.

NOTE:

This product cannot be used if chlorine or other oxidizing biocide is used, e.g., chlorine, hypochlorite, or Western 601, 602, or 603.

If system has large amounts of rust present when formula 298 is started, the iron oxide may temporarily destroy the blue color. If this happens feed treatment at estimated dosage rate (shown in Initial Start Up page) for 2 to 3 weeks. During this time, the blue color should appear in the tower water, and feed rate can then be adjusted on the basis of the Blue Color Comparator test results. DO NOT OVERFEED TREATMENT DURING THE FIRST 2 OR 3 WEEKS IN AN ATTEMPT TO GET COLOR UP TO PROPER LEVEL.

Blue stains from treatment can be removed from skin, clothing or equipment by use of a 1:10 dilution of ordinary (5-6% Sodium Hypochlorite) laundry bleach with water.

SPECIAL PRECAUTIONS:

Handle as an acid.

Avoid splashing or spilling.

Avoid contact with eyes, skin or clothing.

Wear goggles, gloves and protective clothing when handling.

Do not store at 32° F. or below.

Not for potable or internal use.

GENERAL TESTING INSTRUCTIONS

GENERAL

Instructions in this section are as brief and concise as possible to simplify testing. For this reason there are many testing procedures, aids, and policies that are too numerous to list here. The following list of General Testing Instructions are to assist you in more accurate testing and to save time. Accuracy is of the uppermost importance and with testing speed will come with accuracy.

Glassware and test equipment should be kept clean at all times to prevent errors in testing.

Reagents and solutions should be kept tightly closed except when using and care should be taken to prevent contamination or mixing of any kind.

Tests should be completed as rapidly as possible as indicators sometimes fail if excessive time is required.

INSTRUCTIONS FOR PROCURING SAMPLES

Size of Sample

Quantities used in testing should be measured carefully to prevent errors. Larger test samples normally provide more accurate answers as there is less multiplication or error. For low buffered solutions such as condensate, a full sample, 50 ml. should be used. Full samples should always be used for Cooling Water Tests, for Raw Water (city, well, etc.) Tests and on Softener and Dealkalizer Tests.

Special care should be given Automatic Burets.

- a. Stopcocks should be lubricated but not excessively.
- b. Tips should be kept clean to prevent slow flow.
- c. Silver Nitrate Buret will get stained black and be hard to read. It can be cleaned by filling reservoir with clorox (bleach) solution, pumping Buret full and letting stand overnight. Be sure to flush thoroughly with fresh water, then distilled water prior to refilling with Silver Nitrate.

Some reagents in test kit require handling with special caution. (All should be handled with care).

- a. Concentrated Sulfuric Acid, Concentrated Hydrochloric Acid, Concentrated Stannous Chloride and Buffer Solutions are all very strong acids or alkali solutions that will destroy skin tissue, clothing, etc.
- b. Silver Nitrate and Hardness Indicator produce stains very difficult to remove and Silver Nitrate stains are slow to show up -- especially if spilled or splashed on the skin.

Filter paper retention is directly related to its filtering speed. For some tests, a more retentive filter paper would be desirable than for other tests, due to fineness of suspended solids.

BOILER WATER:

(Steam Boilers or Hot Water Boilers)

The purpose of a boiler water testing is to obtain a true picture of the chemical and physical character of the boiler water itself, therefore, the sample taken for analysis must be representative of the water within the boiler. Improper sampling may lead to false or misleading results.

When to Sample

Time of sampling is of paramount importance. The best time is just before the boiler receives its bottom blow, for at this time the concentrations are highest. If treating chemicals are slug fed at intervals such as once per shift or once per day, proper sequence is:

Sample, Test, Blowdown,
Then Add Treatment

Where to Sample

Samples of boiler waters are most frequently obtained from one of three accessible outlets, these being the boiler blow-off valve, a continuous blowdown line, or the gauge glass blowdown column.

The clean sampling container should be rinsed with sample water prior to catching a sample.

Sample should be cooled until just warm to touch for in-plant tests. (Filtering helps cool sample.)

For Laboratory samples, cool sample in original container, then pour into sample bottle until it runs over. Tighten cap on container. Be sure every container is marked as to date, time and place of sampling.

- a. Bottom Boiler Blow-Off Valve. The least desirable sampling point. Aside from the safety factor involved, the boiler water at this point is lower in dissolved solids and more sludge may accumulate at this point.
- b. Continuous Blowdown Line. If an operating boiler is so equipped, this is an excellent place for sampling since the continuous blowdown is usually located a few inches under the boiling surface where the concentration of dissolved solids is greatest. It should be remembered, however, that frequently a continuous blowdown line terminates into a flash tank and therefore the sampling point should be ahead of the flash tank.
- c. Gauge Glass Blowdown Column. The most convenient point of sampling and the one most frequently employed. By taking one or two simple precautions, sampling at this point will be satisfactory and representative. Before a sample is collected here, the water column should be blown down thoroughly to get rid of condensed steam and fill the glass with boiler water. Having first blown the water column, the sample is collected by throttling the valve to a minimum to avoid excessive flashing of the water into steam.

The most accurate sampling is done in such a manner that no flashing of water into steam can possibly occur. The use of a cooling coil to avoid flashing of the boiler water during sampling is desirable for most accurate results. Where sampling is frequent, the time and effort required to install a cooling coil is worthwhile. Details will be supplied on request.

CONDENSATE:

Care should be taken in procuring condensate sample to assure that it is a true sample. Use sampling coils when available or draw sample from coolest location in system to prevent flashing.

Do not procure samples from traps unless necessary. Then, blowdown prior to sampling.

Do not take samples from makeup tank or in areas where sample may be contaminated with makeup water, chemical treatment or boiler water.

Do not obtain samples by condensing steam from top of water column since an indication of satisfactory treatment residuals here will not necessarily insure satisfactory treatment residuals further down the line in the condensate piping.

COOLING WATER:

(Circulating Water, Air Washers, Etc.)

It is preferable to take sample on discharge of circulating pump where possible. Sampling prior to addition of chemicals is preferable.

Cooling water should not be tested for control purposes too soon after an addition of Algacide or while materials such as chlorine are being used in system, due to excessive interferences experienced.

V
1948 TAMEY, P. O. BOX 7048, NORTH KANSAS CITY, MISSOURI 64110
PHONE: (816) 647-6800

CHLORIDE CONCENTRATION TEST - DROP COUNT METHOD

SAMPLING:

Blow gauge glass clean of old water and steam before sampling boiler water, or sample at bottom blowdown valve. Collect tower water sample at bleedoff or any point some distance from treatment feed point or fresh water inlet.

PROCEDURE:

1. Let the sample cool if hot and settle if cloudy. Pour clear water into test bottle up to mark (50 ml or 10 ml).
2. Add one level scoopful of Potassium Chromate Powder and mix.
3. If the sample turns red or pink, add Neutralizing Acid a drop at a time until this red color is just exactly discharged, leaving a yellow color. (Avoid using more acid than is required, as it will interfere with the test). If no red color forms, omit acid and go on to Step 4.
4. Add the Silver Nitrate Drop Test Solution dropwise, counting the number of drops, and swirling until the sample takes on a faint but permanent reddish cast. This is the end point.

CALCULATION:

If a plastic test bottle (50 ml) is used, each drop of Silver Nitrate is equal to 20 mg/l. The number of drops times 20 is the chloride content (expressed as Sodium Chloride). If a small glass test tube (10 ml) is used, each drop of Silver Nitrate is equal to 100 mg/l. The number of drops times 100 equals mg/l Chlorides (as Sodium Chloride).

NOTE: Presence of high levels of sulfites (approximately 150 mg/l) can interfere with test. To correct for this, add a small amount (capful, 1 ml, or about 20 drops) of 3% hydrogen peroxide (obtainable at any drug store) to sample after Step 3.

REPLACEMENTS:

Code 207	Neutralizing Acid
Code 102	Silver Nitrate Drop Test Solution
Code 108	Potassium Chromate Powder
Code 1020M	Plastic Test Bottle
Code 0295M	Glass Test Tube
Code 1200	Plastic Box

BLUE COLOR COMPARATOR TEST

Used to control dosage feed rate of products which have a blue color added for the specific purpose of ease in testing.

PROCEDURE:

1. Collect a sample of tower water from bleed off line or any point at a distance from fresh water inlet or chemical feed. For other systems collect sample from a point that is representative of system.
2. Fill the empty bottle with sample up to the lower ring on the neck of bottle. Replace cap.
3. Place the sample bottle between the two standards. Hold comparator so that the front opening is at eye level, with light source above and behind you. Compare colors.

INTERPRETATION:

Treatment level is correct when color of sample is inbetween two standards. If sample color is lighter than 3 mg/l standard, increase treatment feed rate. If sample color is darker than 6 mg/l standard, reduce feed rate.

NOTES:

Fluorescent light is best. Bright direct sunlight makes it very difficult to see slight color differences. Run test indoors or in shaded area.

To prevent fading of color standards, store comparator out of direct sunlight. When finished, dump sample and rinse bottle with fresh water. Be sure to discard sample, NOT STANDARD.

REPLACEMENTS:

Code No. 1034 Blue Color Comparator, Metal Rack
Code No. 1035 Blue Color Standard, 3 mg/l
Code No. 1036 Blue Color Standard, 6 mg/l
Code No. 1037 Bottle, Empty, 4 oz. plastic with cap

FOR: Citizen's Mutual Savings & Loan

Date: 6/20/78

Leavenworth, Kansas

OPERATING INSTRUCTIONS
WESTOMATIC CHEMICAL FEED SYSTEM
MODEL 100 - 210

1. The components included in your WESTOMATIC Model 210 are those indicated by check marks:

X Conductivity Controller and Probe.
X Repeat Cycle Timer, pre-wired, 5 minute interval.
X Pump Model LMI All-92.
X Conductivity Controller Assembly, including pipe strainer, solenoid valve, flow controller, pipe size 1/2", flow control 2 gpm.
 Injection Nozzle and Shut-Off Valve.

2. Consult enclosed schematic component layout and wiring diagram. Install individual components where most convenient. Refer to manufacturer's instructions for installation of Conductivity Controller and Probe.
3. The pump may be placed directly on the drum head of its chemical. However, the preferred mounting is on a horizontal shelf a few inches above the chemical drum.

Drop the suction tube of the pump directly into the chemical container. The discharge line may be directed to the tower basin or to an injection assembly installed in the tower circulating line.

If the injection and shut-off assembly is used, be sure to install it according to the accompanying diagram and after (downstream from) the bleed-off point. Before starting chemical pump, make sure the valve on the injection nozzle is wide open and that all joints are leak tight.

4. The timer is wired in series with the motor driven pump wiring.

When a timer only is furnished, the two black wires are the power supply and the red and blue wires tie into the pump.

When a pre-wired timer is furnished, it has a power cord and a convenience outlet for the pump cord.

5. Installation of Bleed-Off Assembly: Bleed-off should be taken from any convenient point in the high pressure side of the recirculating system but ahead of (upstream from) the point of treatment application. The assembly of the bleed-off components are to be made strictly in the following order:

First the pipe strainer, the solenoid next downstream, then the flow controller (use brass nipple, if provided, between solenoid and flow controller).

INITIAL SETTINGS

Pump Stroke 95 % Pump Speed 100 % Timer 50 % Conductivity 1750 Mmhos
Pump Stroke % Pump Speed % Timer % Conductivity Mmhos

NOTE: The above settings are suggested only as initial, only to give starting points. All settings are fully field adjustable and most likely will require some readjustment to obtain the desired chemical control limits. (See special instructions for chemical application and control.) Alteration of the pump stroke, speed, and/or timer setting will allow more or less chemical feed. Adjustment of the dial on the Conductivity Controller will alter the concentration level of the tower water.

PREFERRED CONDUCTIVITY CONTROLLER ADJUSTMENT

- Step 1. Disconnect power supply to Conductivity Controller so that there will be no bleed-off during the establishment of the proper number of cycles of concentration.
- Step 2. Allow the recirculating water to build up its chloride content (measured with the Chloride Test Set furnished) to 5 x raw water chlorides. This concentration of chlorides represents 5 cycles of concentration as compared to the chloride content of the raw makeup water.
- Step 3. When the proper chloride content has been reached, reconnect the power supply and turn the Conductivity Controller dial to a point where the solenoid valve on the bleed-off system just opens. Once this setting has been established, no further adjustment is required.
- Step 4. It is desirable on occasion to recheck the chloride contents both of the raw water and the tower water to determine if any changes may have occurred.

SERIES A

INSTRUCTIONS

•

MAINTENANCE

•

SERVICE



PUMP MODEL _____

LIQUID METRONICS INCORPORATED

33 JONES ROAD • WALTHAM, MA 02154 • 617-891-0690

INSTALLATION

1. Unpacking:

- (a) Chemical metering pump complete with foot valve and injection check valve and tubing are shipped in one carton. Notify delivering carrier immediately if there are any signs of shipping damage to the metering pump or parts.
- (b) Remove tubing from cardboard insert. Foot valve and injection check valve are tucked in the pump's parts pocket.

2. Location and Mounting:

- (a) Locate pump in an area that is convenient to both chemical injection point and electrical supply. Even though LMI chemical metering pumps have corrosion resistant housing, if at all possible, the pump should not be subjected to excessive temperature (over 110 deg. F or 43 deg. C), and weather.
- (b) Mount pump on a shelf directly above the chemical tank with the pump head facing left and the controls facing right. This will position the priming bulb away from the wall and make it accessible. Secure pump on the shelf by putting size 10 (3/16) or 5 mm screws through the four slots at the edge of the pump base.
- (c) The pump may also be mounted on top of molded chemical tank covers provided these covers have a recess for pump mounting so that the pump does not slide away. There is no need to secure pump with screws in this instance.

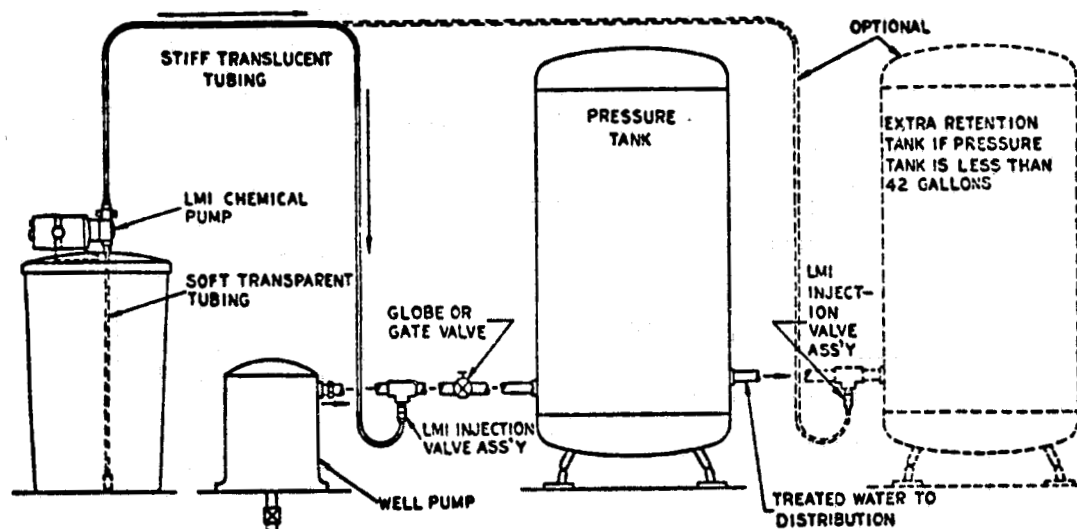


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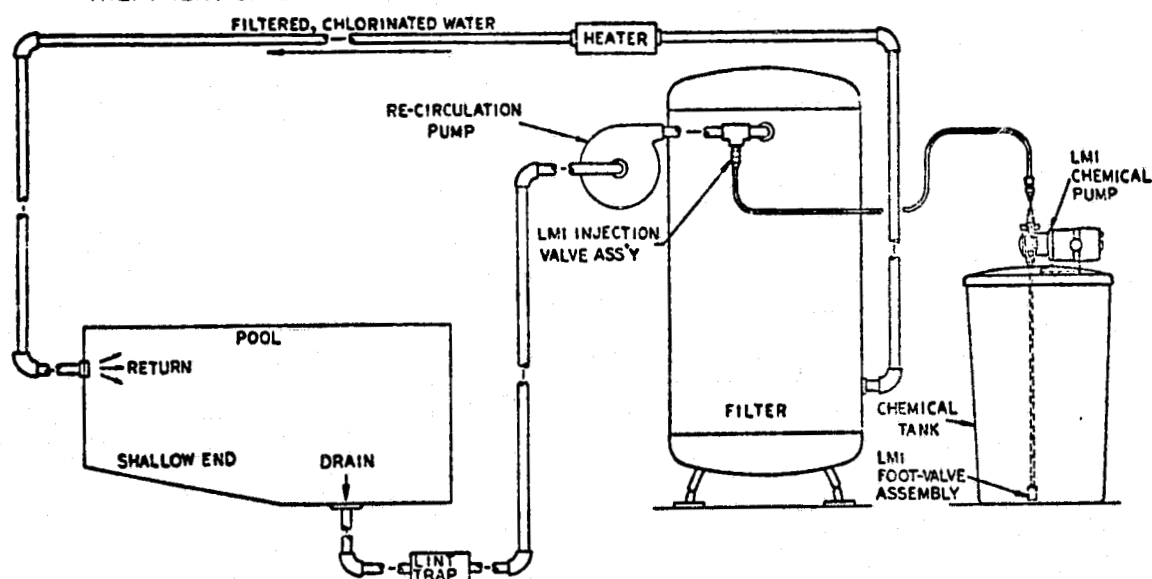
3. Injection Point:

- (a) The diagrams on this page show typical chemical pump installation methods. Note location of injection check valve which is most important. Refer to Liquid Handling Assembly Instructions section A regarding installation of Injection Check Valve.

TREATMENT OF WELL WATER



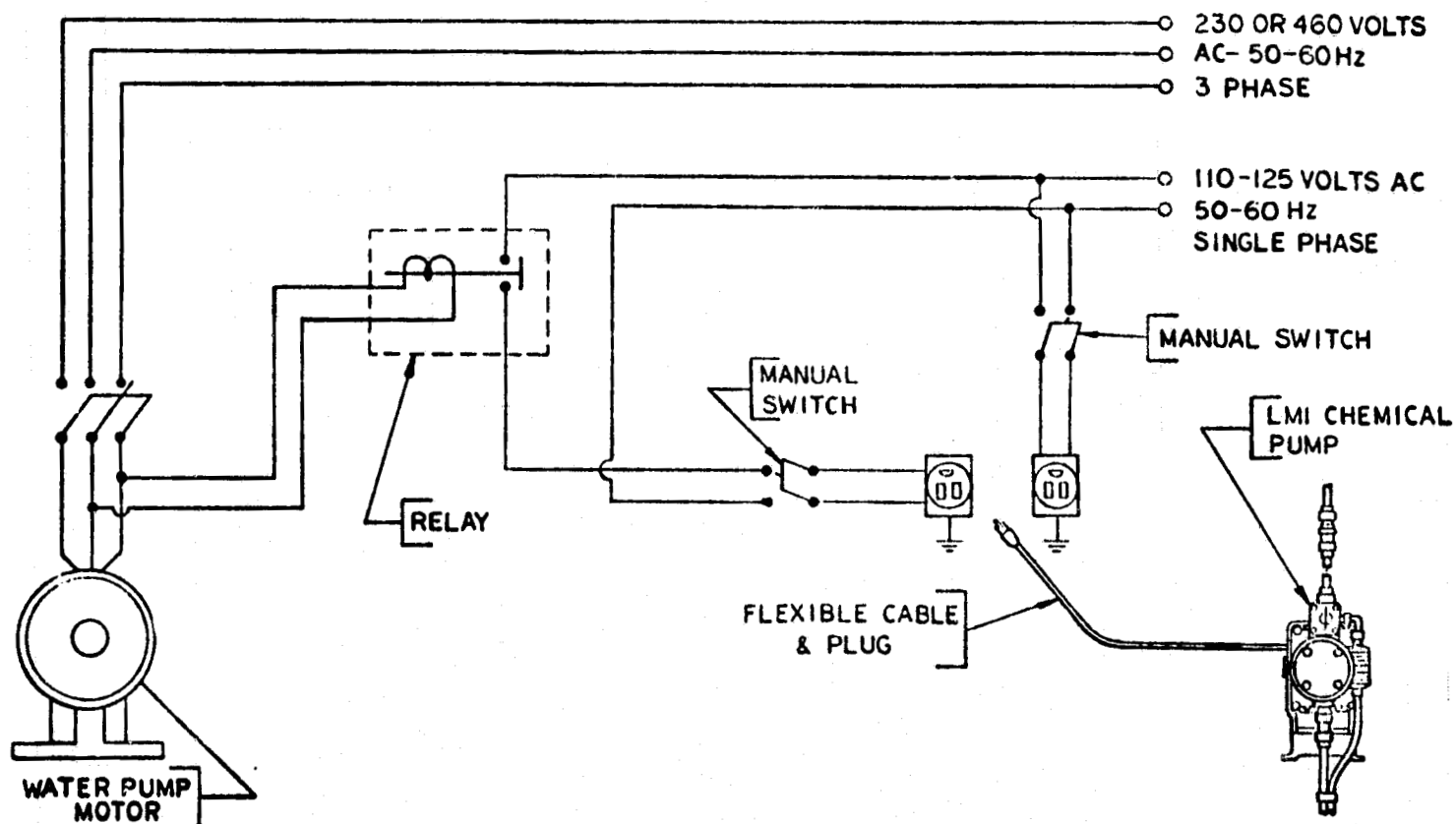
TREATMENT OF SWIMMING POOLS



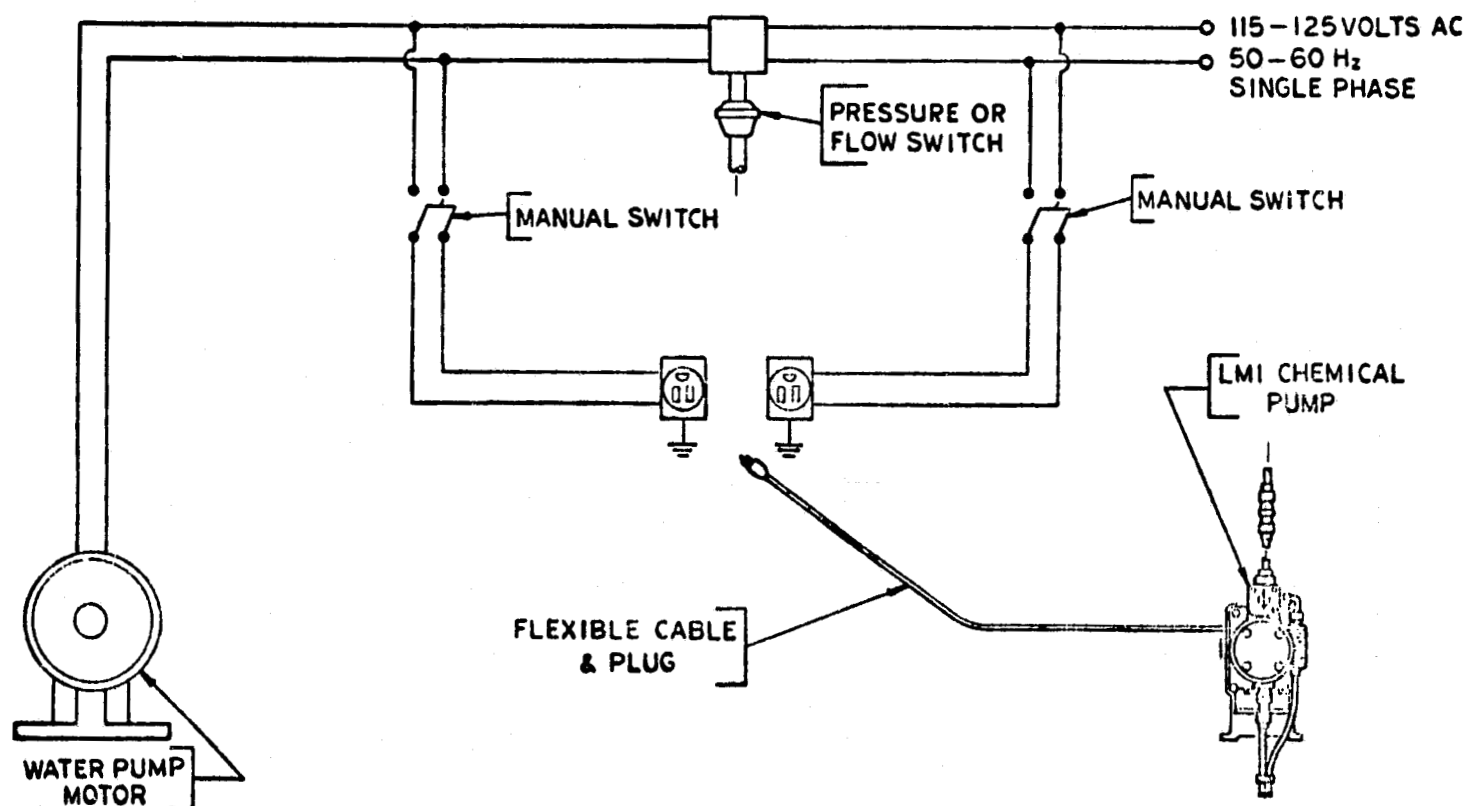
4. Electrical:

- (a) The chemical metering pump should be plugged into a 3-prong grounded electrical outlet with ratings conforming to the data on the pump control panel.
- (b) It is extremely important that the ground prong of the 3-prong plug is connected to a good ground. Do not use adapters whereby the ground lead is loose or not connected at all to a good ground.
- (c) The following diagrams are examples of wiring schemes commonly used.

WIRING DIAGRAM-CIRCULATING SYSTEM (COOLING TOWER OR SWIMMING POOL)



WIRING DIAGRAM-PRESSURE OR FLOW SWITCH SYSTEM



CONTROLS

1. On-Off Switch:

- (a) The On-Off Switch is part of the speed control potentiometer. The pump is turned on by rotating the speed control knob (smaller knob) clockwise.
- (b) AO Series has no On-Off Switch.

2. Speed or Frequency Control:

- (a) Pumping speed is adjusted by rotating the speed control knob to the desired setting. This is the smaller of the two knobs and the dial is graduated in approximate strokes per minute of the pump.
- (b) AO Series has only two fixed speeds.
Low speed - 25 strokes/min. approx.
High speed-100 strokes/min. approx.

3. Stroke Length Control:

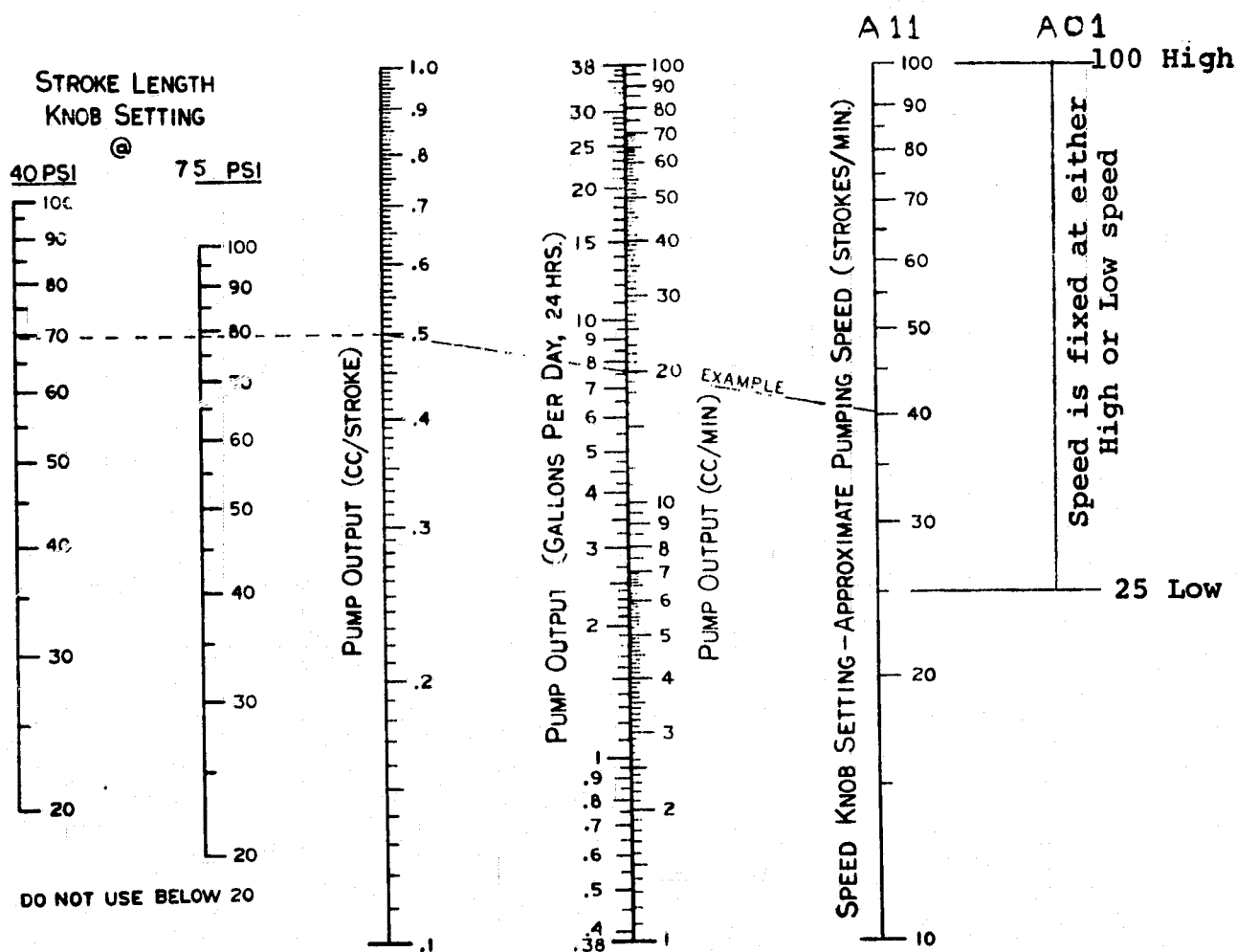
- (a) Stroke length or output per stroke is adjusted by rotating the larger of the two knobs to the desired setting while the pump is stroking. The knob is not supposed to rotate more than 360 degrees.

- (b) Always start from the zero point by turning the larger knob counter-clockwise until resistance is felt and the pumping diaphragm (Liquifram) stops moving. This is the zero point. Rotate knob clockwise to desired setting.

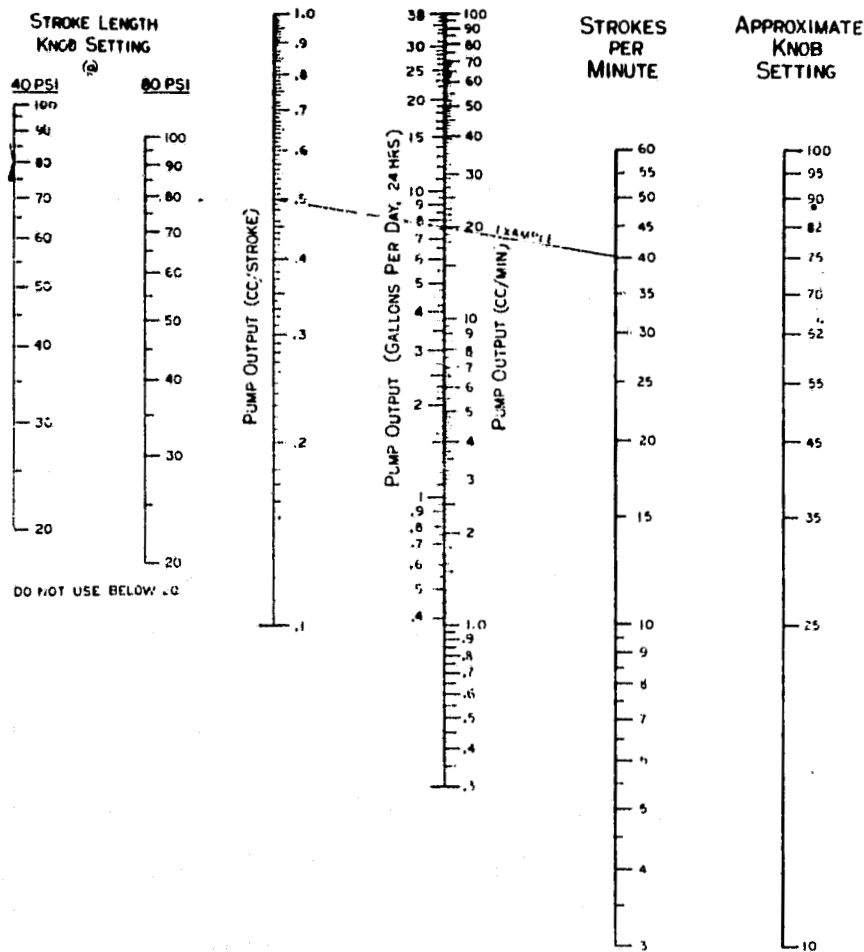
4. Output Adjustment:

- (a) Pump output is adjusted by both the speed control knob (A1 Series) or speed switch (AO Series) and the stroke length control knob.
- (b) For best results, maximize stroke length (larger knob) and minimize speed (smaller knob on A1 Series, speed switch at low on AO Series).
- (c) Use output nomograph below.

OUTPUT NOMOGRAPH, SERIES A



OUTPUT NOMOGRAPH, SERIES A10



TROUBLE SHOOTING - LIQUID END

1. Low Pump Output:

- (a) Low pump output can be caused by many things. Some of the more common ones are:

Very low stroke setting, i.e. red (A1 Series) or black (A0 Series) zone setting of knob.

Trapped air.

Air leak through valve seal rings.

Ruptured pumping diaphragm (Liquifram).

Injection into pressure in excess of 75 psi* (5.25 kg/cm²)*

Clogged Liquid End.

- (b) Very low stroke setting - check position of stroke length knob (larger knob) by rotating it counter-clockwise until pumping diaphragm (Liquifram) stops moving with the pump operating. The pumping diaphragm should not stop reciprocating (moving or clicking) until the knob points to zero. If it stops before zero, reset knob by loosening two set screws, set the knob to point to zero and retighten set screws.

Rotate knob clockwise and operate unit above the red zone (A1 Series) or black zone (A0 Series).

- (c) Trapped air - could be caused by leaks through the suction line of the pump or by dissolved air in the chemical itself.

*55 psi (3.85 kg/cm²) with anti-syphon spring in place.

For example, sodium hypochlorite has plenty of dissolved air and is very gassy. Carefully disconnect tubing at injection check valve. Set stroke knob (larger knob) at 100.

Set speed knob (smaller knob on A1 Series, speed switch at high on A0 Series).

Operate pump recirculating chemical back into chemical tank for 5 minutes to purge air.

- (d) Air leak through valve seal rings - Usually caused by deteriorated seal rings or very loose fittings. Tighten fittings by hand until they are very snug.

If there is no improvement, change both seal rings in pump head using the appropriate ones according to supplement "Liquid Handling Assembly".

- (e) Ruptured pumping diaphragm - If rupture is severe, and pump is injecting into considerable pressure, chemical leak will be obvious through the 1/8" (3mm) diameter hole at the bottom of the spacer directly behind the pump head. Replace pumping diaphragm (Liquifram).

If rupture is small such as the pin hole kind, there would most likely be oozing of the chemical through the 1/8" (3mm) diameter hole as described in previous paragraph above. Replacement of pumping diaphragm (Liquifram) will be necessary.

- (f) Clogged Liquid End - will cause low pump output. Clean liquid end by disassembling it. Reassembly after cleaning of the individual components.

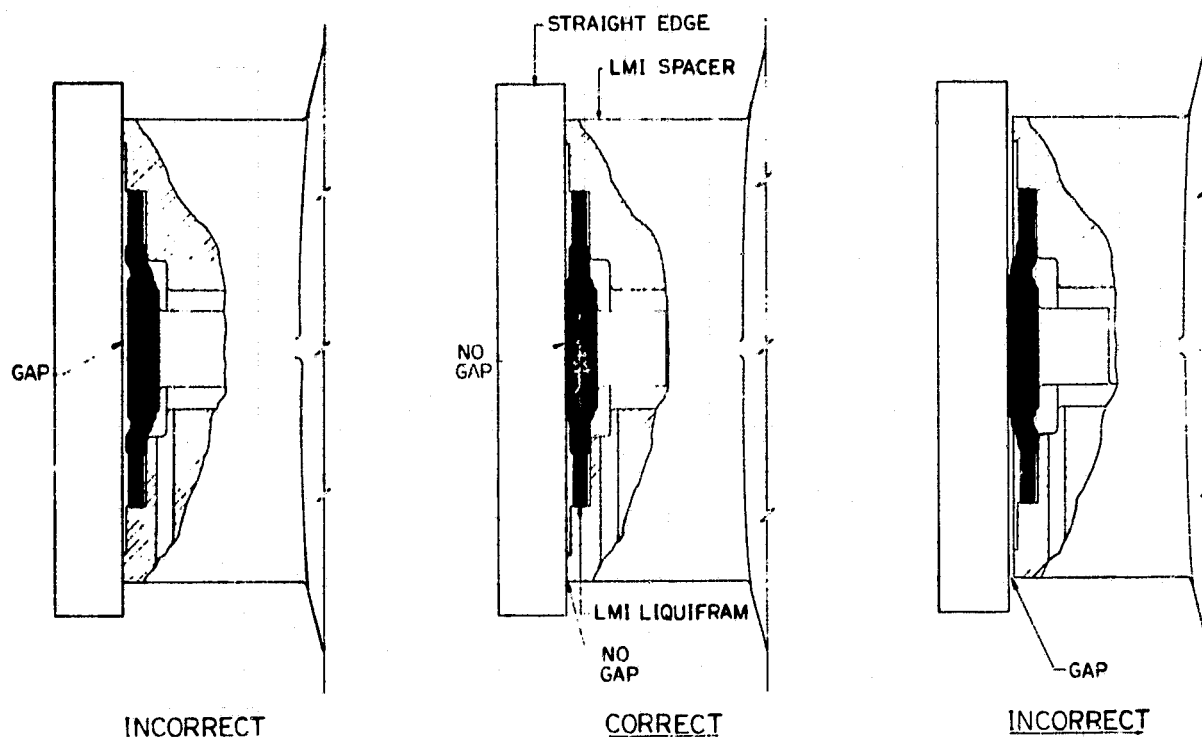
2. Changing Pumping Diaphragm (Liquifram):

- (a) Lift foot valve from chemical and let pump run pumping air for a few minutes. Then remove pump head.
- (b) Set stroke length knob (larger knob) to zero by rotating it counter-clockwise with the pump running electrically, then stop the pump by switching the speed control knob to "off" (A1) or unplug the cord (A0).
- (c) Insert one of the size 10-24 screws of the pump head into the one hole of the pumping diaphragm (Liquifram) and rotate it counter-clockwise to unscrew the diaphragm.
- (d) Before installing new pumping diaphragm (Liquifram) rotate stroke length control knob (larger knob) to 90. Start pump electrically and with pump stroking, screw on new pumping diaphragm (Liquifram) until the center part begins to buckle inwards during the latter half of the stroke. Stop pump electrically and check Liquifram position with a straight edge according to the illustration (next page).

If Liquifram setting is not correct, restart pump then screw in or out the pumping diaphragm (Liquifram). Always stop pump electrically when checking Liquifram setting. Repeat procedure if necessary.

NOTE: Only Liquiframs with 0.9 SI embossed are for use on "A" Series chemical metering pumps.

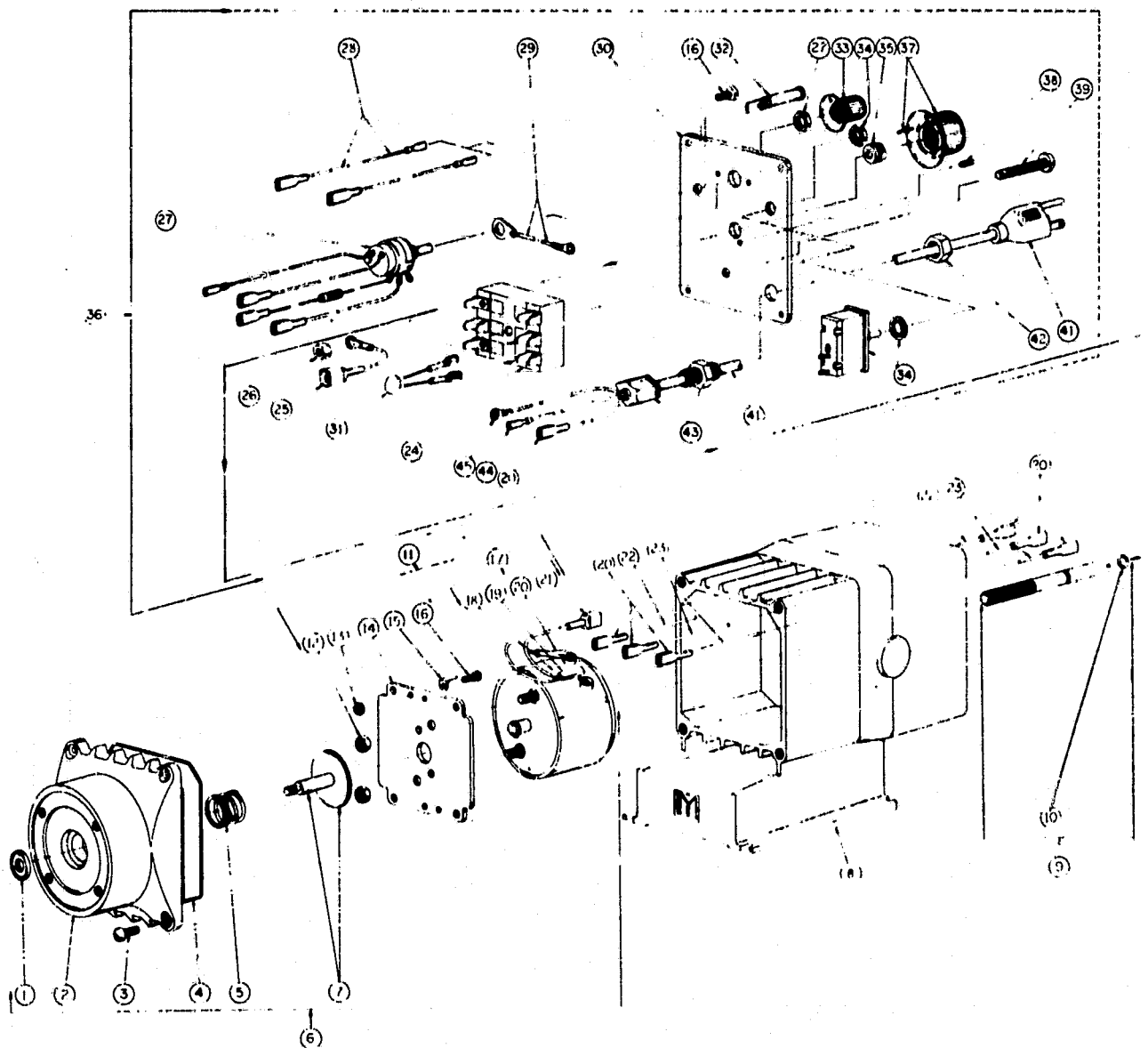
- (e) Reinstall pump head and tighten head mounting screws in criss-cross pattern.



3. Excessive Pump Output:

- Syphoning (Pumps ending in 81 thru 95) - will cause excessive pump output. Check to be sure anti-syphon spring is in place and the seal ring is in good condition. These items are inside the injection/anti-syphon valve.
- Incorrect Knob Settings - check stroke length knob (larger knob) by rotating it counter-clockwise to zero position. The pumping diaphragm should stop reciprocating. If it does not, continue counter-clockwise rotation until motion stops. Loosen knob set screws and reset knob pointing to zero. Speed control knob (smaller knob) should be checked also. Rotate counter-clockwise until the switch clicks off. Knob should point to the "O" of the word "OFF". Loosen knob set screws and reset if necessary.

INTERNAL PARTS LIST



Key No.	Model	Part No.	Description	Quantity
1	A	10552	Gasket, Sponge	1
2	A	10159	Spacer, "A" Series	1
3	A	10166	Screw, 10-24 x 7/16 PH SS	8
4	A	10166	O-Ring	1
5	A	10158	Spring	1
6	A101- A111- A102- A112- A103- A113-	10160	Solenoid & Spacer Assy, 115 V	1
6	A101- A111- A102- A112- A103- A113-	10376	Solenoid & Spacer Assy, 220-240 V	1
7	A	10161	Liquifram Shaft Assy, "A" Series	1
8	A	10201	Housing Assembly	1
9	A	10640	Adjustment Shaft w/O-ring	1
10	A	10487	O-ring	1

Key No.	Model	Part No.	Description	Quantity
11	A101- A111- A102- A112- A103- A113-	10162	Solenoid & Plate Assy, 115 V	1
11	A101- A111- A102- A112- A103- A113-	10377	Solenoid & Plate Assy, 220-240V	1
12	A	10223	Nut	2
13	A	10191	Keys Nut, 6-32	1
14	A	10130	Solenoid Plate	1
15	A	10193	Wire Terminal	1
16	A	10169	Screw, 6-32 x 3/8 PH SS	5
17	A101- A111- A102- A112- A103- A113-	10163	Solenoid w/Thermostat, 115 V	1
17	A101- A111- A102- A112- A103- A113-	10641	Solenoid w/Thermostat, 220-240V	1

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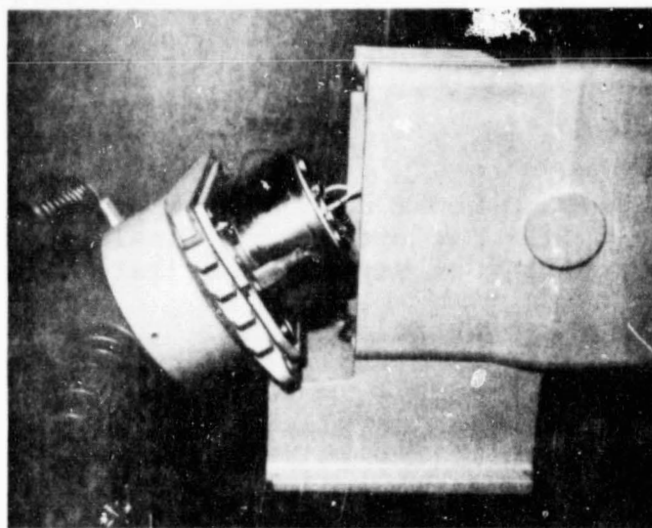
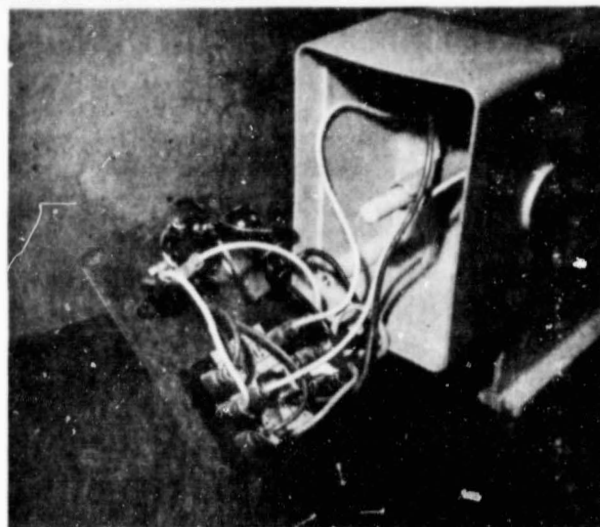
Key No.	Model	Part No.	Description	Quantity	Key No.	Model	Part No.	Description	Quantity
18	A	10239	Tape, High Temp.	A/R	32	A101-	10181	Pilot Light, 115 V	1
19	A	10176	Thermostat	1		A111-			
20	A	10182	Wire Terminal	7		A102-			
21	A	10368	Wire Terminal	1	32	A103-	10423	Pilot Light, 220-240 V	1
22	A	10588-58	Wire, 18 AWG, Green	1		A112-			
23	A	10588-48	Wire, 18 AWG, Yellow	2		A113-			
24	A111-	10150	Pulsar, 115 V, 10-100 SPM	1	33	A	10172	Knob	1
24	A101-	10235	Pulsar, 115 V, 3-60 SPM	1	34	A	10408	Circuit Breaker	1
24	A112-	10269	Pulsar, 220-240 V, 10-100 SPM	1	35	A	10486	Grommet	1
24	A113-				36*	A101-	10644	Control Panel Assy, A101	1
24	A102-	10269	Pulsar, 220-240 V, 3-60 SPM	1	36*	A111-	10221	Control Panel Assy, A111	1
25	A	10218	Wire Assembly	1	36*	A102-	10645	Control Panel Assy, A102	1
26	A	10199	Nut, 1/2-20 Nylon	1	36*	A112-	10380	Control Panel Assy, A112	1
27	A111-	10220	Potentiometer & Switch	1	36*	A103-	10646	Control Panel Assy, A103	1
27	A112-				36*	A113-	10647	Control Panel Assy, A113	1
27	A113-				37	A	10173	Knob	1
27	A101-	10642	Potentiometer & Switch, A10	1	38	A	10558	Set Screw	1
28	A	10225	Wire Assembly	2	39	A	10198	Screw, 1/2-20 Nylon	1
29	A	10347	Wire Assembly	1	41	A101-	10178	Power Cord, 115 V	1
30	A	10643	Control Panel w/Nameplate	1	41	A111-			
31	A101-	10626	MOV Assembly, 130 V	1	41	A102-	10384	Power Cord, 230 V	1
31	A111-				41	A112-			
31	A102-				41	A103-	10382	Power Cord, 220-240 V DIN	1
31	A103-	10627	MOV Assembly, 250 V	1	42	A	10363	Bulkhead Nut	1
31	A112-				43	A	10362	Fitting, Union Connector	1
31	A113-				44	A	10186	Wire Terminal	1
					45	A	10184	Wire Terminal	1

*Item 37 (Part 10173 Knob) not included in Control Panel Assy.

TROUBLE SHOOTING - ELECTRICAL - A1XX SERIES

1. Plug power cord into appropriate outlet.
 - (a) Set speed knob (smaller knob) at 100.
 - (b) Set stroke knob (larger knob) at 100.
2. Observe pilot light.
 - (a) If it blinks 95 to 110 times per minute, electronic pulser module is working correctly.
 - (b) If the pilot light stays on, go to step 3.
 - (c) If the pilot light stays off, go to step 4.
 - (d) If the pilot light blinks faster than 110 times per minute, pulser module is defective. Remove and replace.
 - (e) If the pilot light blinks slower than 95 times per minute, go to step 5.
3. Unplug unit and remove control panel from housing. The control panel is secured by a 6-32 screw in each corner. In addition the stroke length knob must be removed by loosening the two set screws with a 5/64" (2 mm) Allen wrench. Check that all connections are tight and correspond to the wiring diagram. Also check that no corrosion has formed around the connections. If the wiring is all OK proceed as follows:

- (a) Disconnect solenoid wires from terminals labeled YEL Sol + Light (3 and 5) of the pulser.
- (b) Measure the resistance across the solenoid wires. A reading of 115 to 157 Ohms for 115 V models or 418 to 572 Ohms for 220 V models indicates the solenoid coil is OK and the problem is in the pulser module. Remove and replace the pulser.
- (c) Coil resistance of other than above indicates that the solenoid is defective. The solenoid and plate assembly should be replaced as a unit. First remove four 10-24 screws securing spacer to front of housing (pump head and valves need not be removed first). Remove solenoid wires from terminals on housing wall and ground wire from terminal on solenoid plate. Remove four 10-24 screws holding plate to spacer. Install new solenoid and plate assembly in reverse order.



4. Check line voltage. 115 VAC to 120 VAC or 220 VAC to 240 VAC is normal. If OK proceed as follows:

- (a) Push circuit breaker reset button. If it was tripped you will hear a click and the pump may start operating again. If it does, observe operation of pilot light. If circuit breaker trips again after several seconds, go to step 3.
- (b) If circuit breaker was not tripped, unplug unit, remove control panel from housing, check wiring as in step 3 above.
- (c) If wiring is OK plug power cord into outlet. CAUTION 115V CAN BE LETHAL. Carefully measure voltage between terminals labeled BLK WHT (1 and 2) of pulser module. If it reads zero Volts, switch is defective. The switch is part of the speed control and the two must be replaced as a unit.

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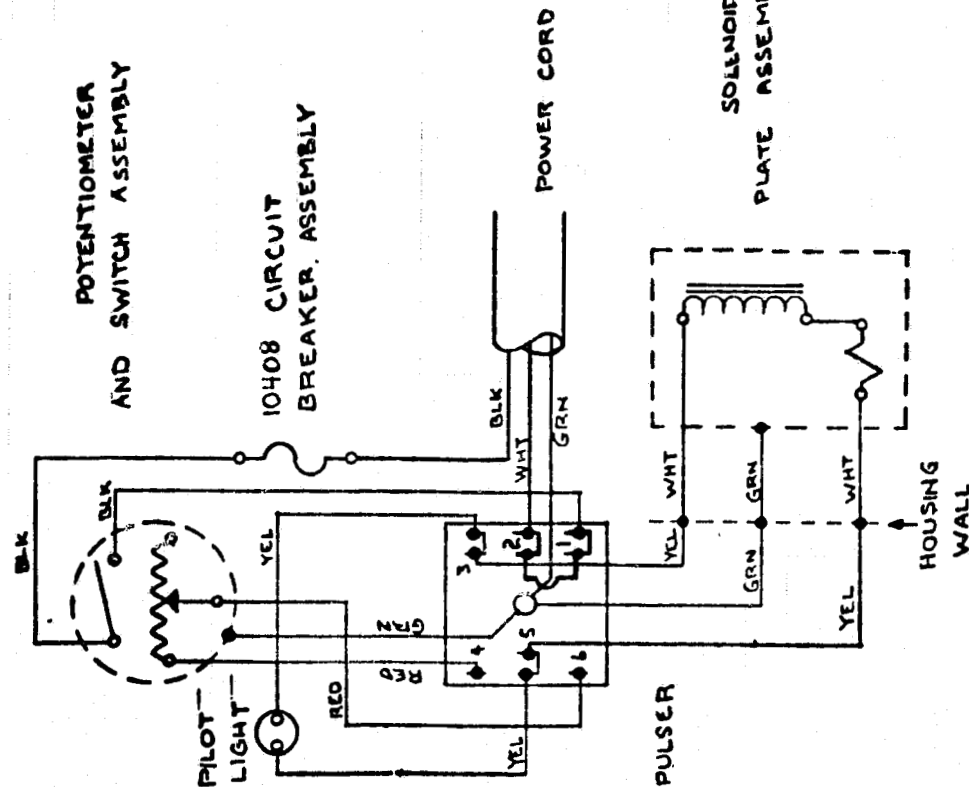
- (d) If terminals labeled BLK WHT (1 and 2) of the pulser is getting proper voltage and the solenoid is clicking, the pilot light is defective.
 - (e) If the solenoid is NOT clicking, unplug power cord. Remove red speed control wires from terminals labeled RED POT (4 and 6) of pulser. Measure resistance across these wires making sure knob is set fully clockwise. It should read zero Ohms. Turn speed knob fully counter clockwise and the resistance should read 1,000,000 Ohms (1 Meg Ohm). If the resistance is not correct, replace the potentiometer and switch assembly. If the resistance checks out OK, the pulser is defective and should be replaced.
5. (a) Unplug unit, remove control panel from housing, and check wiring as in step 3. If wiring is OK go to step 4e.
- (b) When replacing potentiometer and switch assembly or the pulser, be sure to re-connect the appropriate ground wires.

TROUBLE SHOOTING - ELECTRICAL - A0XX SERIES

1. Plug in power cord to appropriate AC outlet. Set speed switch to high. Set stroke knob to 100.
2. Listen for clicking sound from pump or watch for movement of liquifram shaft if head has been removed.
 - (a) If pump operates 95 to 100 times per minute, pulser is operating correctly. Set speed switch to low and check for 20 to 30 operations per minute.
 - (b) If no clicking sound is heard, go to step 3.
 - (c) If pump operates slower than 95 times per minute, go to step 3c.
 - (d) If pump operates faster than 110 times per minute, pulser is defective and should be replaced.
3. Unplug unit and remove control panel and check connections as in step 3 for A1XX Series.
 - (a) Disconnect yellow wires from terminals 3 and 5 of pulser. Resistance between these two wires should be 115 to 157 Ohms for a 115 V model or 418 to 572 Ohms for a 220 V model.
 - (b) If coil resistance is other than above, solenoid and plate assembly should be replaced as in step 3c for A1XX Series.
 - (c) Remove red wires from terminals 4 and 6 of pulser. Set speed switch to high. Resistance between red wires should be 0 Ohms. Set speed switch to low. Resistance should now be between 324,000 Ohms and 396,000 Ohms. If you do not get these readings, switch and resistor assembly should be replaced.
4. If above checks are OK check line voltage. 115 to 120 VAC or 220 to 240 VAC is normal. If proper voltage is getting to pump, pulser is defective and should be replaced.
5. When replacing pulser or resistor and switch assembly, be sure to re-connect appropriate ground wires.

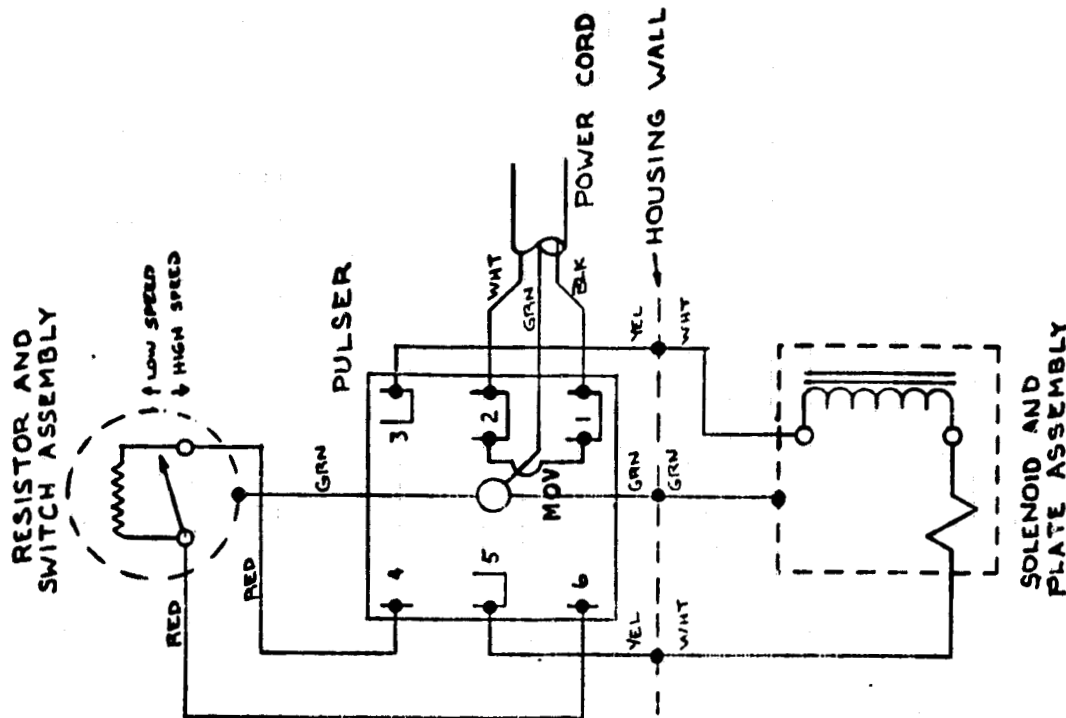
WIRING DIAGRAM

A1XX- Series



PULSER TERMINALS	
NO.	FUNCTION
1	BLK AC HOT (SWITCHED) MOV
2	WHT AC NEUTRAL MOV
3	YEL SOL + PILOT LIGHT
4	RED POT SPEED CONTROL
5	YEL SOL + PILOT LIGHT
6	RED POT SPEED CONTROL

A0XX- Series



PULSER TERMINALS	
NO.	FUNCTION
1	BLK AC HOT MOV
2	WHT AC NEUTRAL MOV
3	YEL SOL + SOLENOID
4	RED POT SPEED SWITCH
5	YEL SOL + SOLENOID
6	RED POT SPEED SWITCH

WARRANTY

Liquid Metronics Incorporated warrants equipment of its manufacture and bearing its identification to be free from defects in workmanship and material. LMI's liability under this warranty extends for a period of one year from the date of delivery from our factory or authorized distributor. It is limited to repairing or replacing any device or part which is returned, transportation prepaid, to the factory within one year of delivery to the original purchaser, and which is proven defective upon examination.

LMI disclaims all liability for damage during transportation, for consequential damage of whatever nature, for damage due to handling, installation or improper operation, and for determining suitability for the use intended by the purchaser. Replaceable elastomeric parts are expendable and are not covered by any warranty either express or implied.

LMI makes no warranties either express or implied other than those stated above. No representative has authority to change or modify this warranty in any respect.

Printed in USA
9/77

For use on LMN Series A, and B,
chemical metering pumps.

CAUTION

When pumping chemicals make certain that all tubing is securely attached to the fittings. It is recommended that tubing or pipe lines be shielded to prevent possible injury in case of rupture or accidental damage. Always wear protective clothing when working on or near chemical metering pumps.

NUMBER 92 LIQUID HANDLING ASSEMBLY

A. INSTALLING INJECTION CHECK VALVE

1. The injection check valve should always be installed as close as possible to the point of chemical injection, at the very end of the tubing run.

CAUTION

Do not operate pump using 92 Liquid Handling Assembly without injection / anti-syphon valve properly installed.

2. Purpose of injection / anti-syphon valve is to prevent backflow from treated line and to prevent syphoning or overpumping of chemical.
3. A 1/2" NPT female connection or tee will accept the injection / anti-syphon valve.
4. In order to insure correct seating of the ball inside the check valve, the injection / anti-syphon valve should be installed upwards.

B. CONNECTING DISCHARGE TUBING

Note: Cut tubing to length needed for discharge line making sure sufficient amount is left for suction line.

1. Route tubing from injection check valve to chemical metering pump making sure it does not touch hot surfaces, sharp surfaces, or is bent so sharply that it kinks.
2. Slide small end of coupling nut onto tubing.
3. Push tubing over tapered nozzle of pump head so that tubing flares out and reaches the shoulder. (If tubing is stiff from cold, dip end in hot water.)
4. Slide down the coupling nut until threads are engaged. Tighten by hand until tubing is held securely in place.

CAUTION

Excessive force will crack or distort fittings. DO NOT USE PIPE WRENCH.

5. Follow the same procedure for connecting tubing to injection valve.

C. CONNECTING SUCTION TUBING

1. Cut suction tubing to length necessary between suction valve of chemical metering pump and foot valve. Foot valve should just sit at the bottom of chemical container. Maximum recommended vertical suction lift is 5 ft. (1.5m)
2. Follow same procedure (see B) in connecting suction tubing to suction valve and foot valve.
3. If a suction tube straightener is desired, one may be fabricated from a 3 ft. (1m) piece of 1/2" Schedule SDR 13.5 (thin wall type) PVC pipe.
4. Dip end of PVC pipe in hot water for at least 1 minute.
5. Push pipe over small end of coupling nut.

D. PRIMING

1. Temporarily remove tubing from injection / anti-syphon valve and hold the end of tubing so it is above pump level.
2. Set pump at maximum speed and 100% stroke and start pump.
3. As soon as chemical is visible through translucent discharge tubing just past the discharge valve, stop the pump.
4. Pump is now primed.
5. Reconnect tubing to injection / anti-syphon valve.

Note:

- (a) Pump is normally self-priming if suction lift is no more than 5 ft. (1.5m), valves in the pump are wet with water (Pump is shipped from factory with water in pump head and therefore valves are wet) and the above steps (D1 thru D3) are followed.
- (b) If the pump does not self prime, remove discharge valve housing and ball and pour water or chemical slowly into discharge port until it is filled. Follow steps D2 through D5 thereafter.

CAUTION

Do not remove injection / anti-syphon valve spring if pressure at injection point is less than 20 psi (1.4 kg/cm²) with electronic metering pumps, otherwise over-pumping will occur.

Specifications subject to change without notice.
Printed in U.S.A.



LIQUID METRONICS INCORPORATED

3 JONES ROAD, WALTHAM, MASS. 02154 USA
(617) 891-0690 TLX 92-3478

220

1018 C
20978
replaces
1018 B

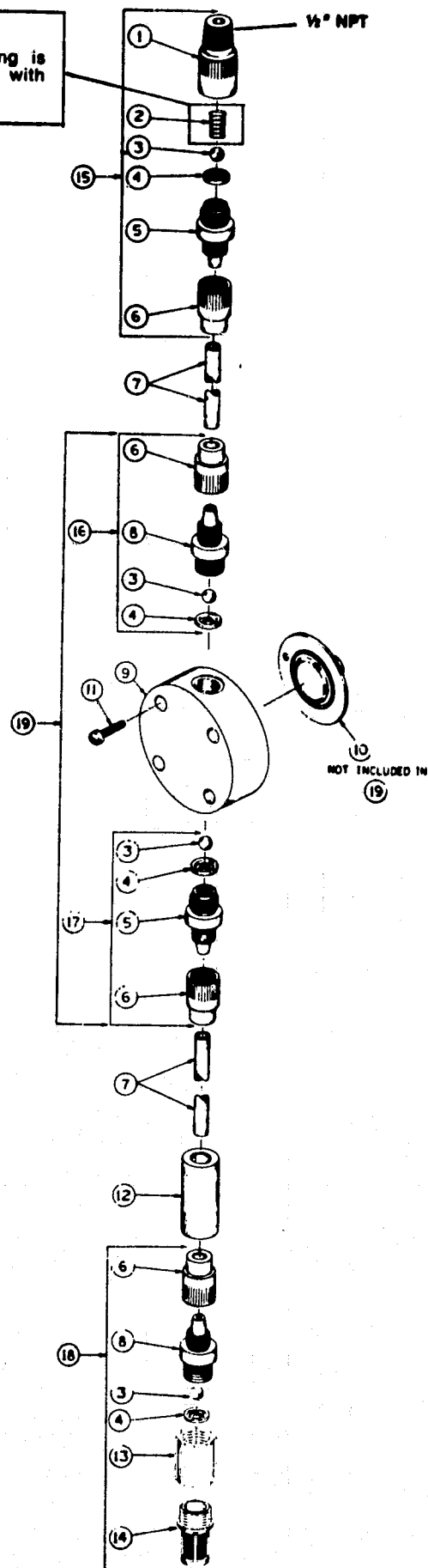
NOTE
Maximum pump pressure rating is reduced by 25 psi (1.7 bar) with anti-syphon spring installed.

PARTS LIST NO. 92 LIQUID HANDLING ASSEMBLY

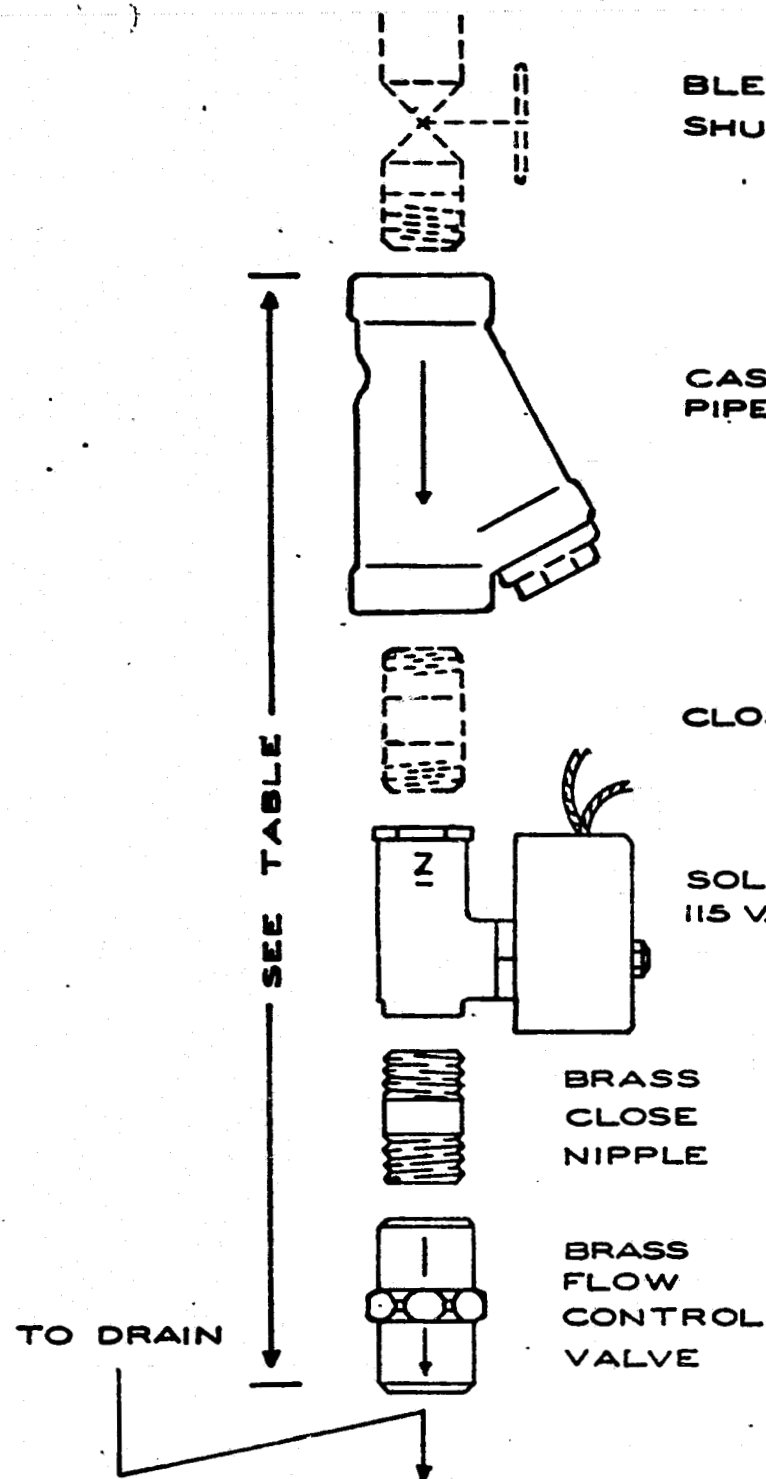
Ref. No.	Part No.	Description	Quantity
1	10297	Injector Fitting	1
2	10339*	Spring, Teflon PFA coated	1
3	10338*	Ball, Ceramic	4
4	10207*	Seal Ring, black Viton	4
5	10292	Valve Seat, gray PVC	2
6	10299	Coupling Nut, gray PVC	4
7	10342	Tubing, Polyethylene, 3/8" OD x 1/4" ID	16 ft.
8	10293	Valve Housing, gray PVC	2
9	10213	Head, gray, PVC	1
10	10302*	Liquifram, 0.9 Si Teflon Face	1
11	10340	Screw, 10-24 x 3/4 S.S.	4
12	10322	Weight, Ceramic	1
13	10978	Foot Valve Seat, black Polypropylene	1
14	10123	Strainer, white Polypropylene	1
15	10506	Injection/Anti-Syphon Valve Assy	1
16	10507	Discharge Valve Assembly	1
17	10508	Suction Valve Assembly	1
18	10509	Foot Valve Assembly	1
19	10510	Head Assembly, L.E. 92	1

*PARTS INCLUDED IN
SPARE PARTS KIT NO.

10500-92



222



BLEED LINE AND
SHUT-OFF VALVE

CAST IRON
PIPE STRAINER

CLOSE NIPPLE

SOLENOID VALVE
115 V.

BRASS
CLOSE
NIPPLE

BRASS
FLOW
CONTROL
VALVE

EQUIPMENT FURNISHED BY
WESTERN CHEMICAL CO.

1. CAST IRON PIPE STRAINER
2. SOLENOID VALVE 115 V.
3. BRASS CLOSE NIPPLE
4. BRASS FLOW CONTROL

APPROXIMATE ASSEMBLED
LENGTHS

3/8" PIPING	9"
1/2"	10"
3/4"	12"
1"	14"

ITEMS DRAWN WITH DOTTED
LINES NOT FURNISHED

BLOWDOWN CONTROL ASS'Y

SCALE: NONE

APPROVED BY:

DRAWN BY SPP

DATE: 6-11-69

REVISED

WESTERN CHEMICAL COMPANY

N.K.C., MO.

DRAWING NUMBER
BD-WOM

12. PUMPS

Information on pumps, heat exchangers, suction diffusers and airtrol systems have been deleted because of copyright. For information on these items contact Bell and Gossett 8200 N. Austin Avenue, Morton Grove, ILL 60053.

PEERLESS
ELECTRIC

FANS AND BLOWERS

Installation, Maintenance, and Operating Instructions

ORIGINAL PAGE IS
OF POOR QUALITY

MAIN OFFICE: Porter Building, Pittsburgh, Pennsylvania 15219 • Phone: (412) 391-1800

PORTER

ELECTRICAL DIVISION
H. K. PORTER COMPANY, INC.

WARREN WORKS
1401 W. Market Street
Warren, Ohio 44485
(216) 399-3651

RECEIPT AND INSPECTION

Your Peerless Unit has been carefully designed so that with proper installation and maintenance, many years of satisfactory, trouble-free service will be attained.

Upon receipt of the Peerless Unit, check the Packing List to insure all items shipped have been received.

If a shortage is noticed, immediately call this to the trucker's attention, so that it can be noted on the delivery receipt. Also call to his attention any damaged containers so that proper notation can be made and on site inspection arranged.

The above also applies to skidded units too large to package.

STORAGE

If installation of the unit is delayed the unit should be stored in a finished building or a heated warehouse. Storage in this type of facility requires no special preservation of the equipment. If stored out-of-doors special care must be taken to protect against dirt, moisture, corrosion, etc. Cover the entire unit with tarpaulin, and inspect periodically to make sure that no damage is developing.

Unless sealed for-life bearings are provided, fill the bearing completely with grease to prevent rust formation in the bearing housing and corrosion of the balls, rolls and races. Use a good grade of bearing grease and apply with a handgun opposed to a pneumatic gun to avoid bearing seal damage. Clean grease fitting and gun before lubricating to avoid forcing foreign particles into the bearings. Add grease slowly until a slight bead is noticed around the bearing seal. Avoid storage in temperature below -10°F , which could cause a breakdown of the lubricant.

Cover all bearings with water repellent, lint-free material and seal with tape. Block the wheel to prevent wheel rotation (over spin) from the wind.

If units are stored for more than 60 days, the wheel must be rotated every 30 to 45 days to prevent false brinelling of the fan bearings. False brinelling is caused by vibration of the balls or rolls between the races in a stationary bearing. This vibration may be either axial or oscillating. As the ball or rolls vibrates between the races, the lubricant is forced out of the contact area between the ball and race, causing metal-to-metal contact and localized wear of ball and races, which result in a rough and noisy bearing operation.

It is strongly recommended that records be kept on wheel rotation and inspections while in storage.

After the units are installed, follow

the bearing lubrication instruction attached to each unit.

Upon start-up of the equipment caution should be taken to run-in the bearings for a short period of time so excessive bearing temperatures are not encountered. This should be repeated until the bearings hit a normal temperature range "cool to warm" up to a point "too hot to touch for more than a few seconds;" depending on bearing size and speed and surrounding conditions.

If the fans are not put in service prior to one year after shipment, the lubricant should be changed. Grease has a tendency to become hard and deteriorate, losing its lubricating qualities.

NOTE: Storage surface must be level to prevent distortion.

INSTALLATION

CENTRIFUGAL FANS: The fan should be mounted on a rigid, flat, level foundation.

If vibration isolators are used, they should be installed in position and leveled, using large surface shims if necessary, before positioning the fan. The fan should be checked to be sure ALL bolts are tightened. The fan can then be lifted into position on the vibration base. Be sure the air flow is correct for the duct connection.

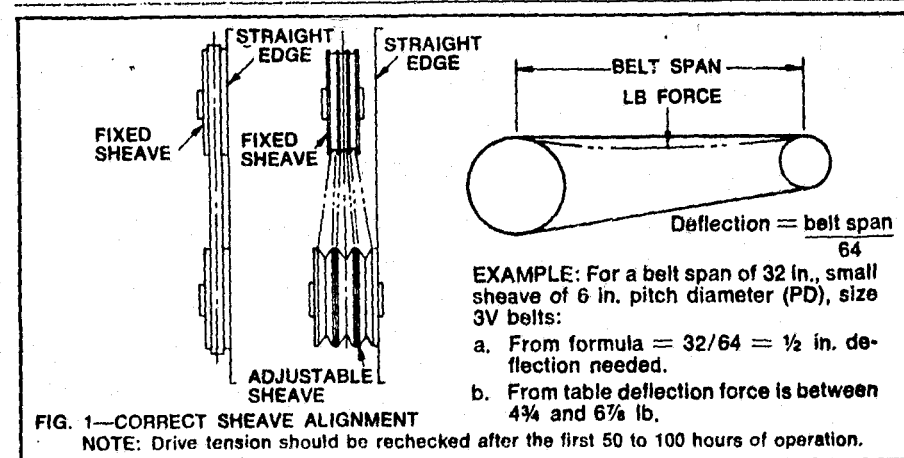
Bolt the fan securely into position. When the motor and drive are furnished separately, they should be mounted next. If the unit is mounted on an integral, structural steel base or on a reinforced concrete inertia base, adjust the base, using the leveling bolts.

Recheck the interior of the fan housing to be sure it is free of debris. Rotate the wheel to insure that it is not rubbing or binding. Check the clearance of the wheel and the inlet cone. If rubbing exists, loosen the bolts on the cone and shift the cone until clearance is obtained. If still

V-BELT DRIVE

After the wheel is determined to rotate freely, align the v-belt drive. Refer to FIG. 1 and tighten the set screws or bolts in the case of sheaves with bushings, and adjust the belt tension using the following table and deflection formula below.

BELT CROSS SECTION	SMALL PD RANGE (in.)	DEFLECTION FORCE (lb.)					
		STANDARD		SUPER		TORQUE FLEX	
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
A	3.0- 3.6	2½	3½	3	4¼	3¾	5½
	3.8- 4.8	3	4¼	3½	5	4½	6¼
	5.0- 7.0	3½	4¾	4	5½	5	6¾
B	3.4- 4.2	3¼	4¾	4	5½	5¾	8
	4.4- 5.6	4¾	6	5½	7¾	6½	9¾
	5.8- 8.6	5½	7¾	6¾	8¾	7¾	10¾
C	7.0- 9.4	9¾	12¾	11¼	14¾	13¾	17¾
	9.6-16.0	12¾	15¾	14¾	18½	15¾	20¾
D	12.0-16.0	20	25½	23¾	30¾	23¾	30½
	18.0-27.0	25¾	33¾	29¾	39½	30¾	39¾
E	20.0-32.0	34	45¾				
3V	2.65-3.65	3½	5				
	4.12-6.90	4¾	6¾				
5V	7.1-10.9	10½	15¾				
	11.8-16.0	13	19½				
8V	12.5-17.0	27	40½				
	18.0-22.4	30	45				



rubbing, loosen the set screws on the wheel and shift the wheel rearward to obtain clearance. Retighten the set screws.

VANEAXIAL-CENTRIFAN: The unit should be mounted on a rigid, flat foundation on a floor or wall. A ceiling suspended unit must be rigidly supported from rods so the fan will not shake or cause undue vibration. An isolation hanger is recommended for ceiling supported units.

Small units have pre-lubricated bearings, therefore, lubrication will not be required. ALL other units have extended lube line for regreasable bearings.

PROPELLER FANS: The fan panel should be mounted on a flat surface. For sleeve bearing units, the mounting surface should be a vertical plane; ball bearing units with cast iron housings may be mounted at any angle. If any type of superstructure is necessary, it should be rigid and well braced to prevent vibration. If sponge rubber strips are used for mounting, the rubber should be supported full length in the horizontal plane.

The panel fan is mounted by anchor bolts through the panel, secured into the mounting frame. If the unit is rigidly mounted, the anchor screws should be tightened with special attention to be sure the panel does not warp. If the panel is warped, the fan may be thrown off center and cause interference with the venturi. Propeller fans with motors in the air stream carry motor overloads up to 25 to 30 percent above nameplate ratings, a common practice in the industry. Therefore, select thermal overload elements to carry this overload factor.

BEARINGS

All bearing and wheel set screws should be checked and tightened, and rechecked after the first 50 to 100 hours of operation.

Before operating this equipment inspect and tighten the bearing set screws. After 50 to 100 hours operation reinspect and tighten if necessary.

Repeat periodically. If a torque wrench is available use the following values:

SET SCREW DIAM.	MIN. TORQUE INCH-POUNDS
1/8	73
3/16	139
1/4	251
5/16	383
3/8	554
1/2	1214

Lubricate the fan bearings while the fan is running, using a good grade ball bearing grease. Apply with a hand gun

until a slight bead of grease is noticeable around the bearing. Stop lubrication when the bead is formed. **DO NOT OVERLUBE.**

If the unit is furnished with sleeve bearings, bronze lined, fill oil reservoir with a good grade of SAE-10 lubricating oil. If bearings are ring oil type, use SAE-30 oil. Lubrication of motor bearings should also be followed as outlined for both ball and sleeve type.

It is recommended that all bearings be examined periodically for lubrication. More frequent examination should be made in case of high speed operation or heat. At the time of each examination, check alignment of the drives and tightness of the set screws and bolts.

Normally the bearing manufacturers' instructions are shipped with the unit, and should be read and used as a maintenance guide for the particular bearing installed.

Bearings of any unit that has been stored for any period of time MUST be lubricated before startup.

ELECTRICAL CONNECTIONS

Before connecting the motor to the electrical supply check the electrical characteristics as indicated on the motor nameplate.

Inspect for any damage resulting from shipment and turn the shaft by hand to insure free rotation. If the motor has been in storage or subject to adverse moisture conditions, dry it thoroughly before operating. After drying, run the motor not connected to the load for a short time for further drying and as a check on the bearings.

If a controller is furnished, the wiring diagram in the controller must be followed. Special attention should be given to see that a single phase motor is connected only to a single phase supply of proper voltage, and that a three phase motor is connected only to a three phase supply. Electric motors will burn out and fail immediately if improperly connected. It is also recommended that in every motor connection, an overload device be installed between the current supply and the motor to protect the motor from under-voltage conditions and motor overloads.

If motorized shutters are supplied, care must be taken that they are connected to the correct voltage supply or have been supplied with adequate transformers.

After electrical connections are completed, apply just enough power to start the unit. Be sure that the rotation of the motor and the unit are turning as indicated by directional arrows on the unit. Refer to Fig. 2 for

wheel type and their rotation. If the unit is turning in the wrong directions, it will not deliver the rated capacity and the motor connections must be altered to make the correct rotation.

Full electrical power can now be applied and special attention given to determine if the motor, bearings, etc. are working properly. At this time, with the air system in full operation and all ducts attached, it is well to measure current input to the motor and compare with the nameplate rating to determine if the motor is operating under safe load conditions.

If the unit is mounted outside, the drive cover should now be installed to protect the motor and drive from the elements. Fastening devices to secure this cover into position are on the frame.

AMCA Standard 400:67, Electrical Safety Code for Air Moving Devices should be followed.

FAN WHEEL BLADES ROTATION

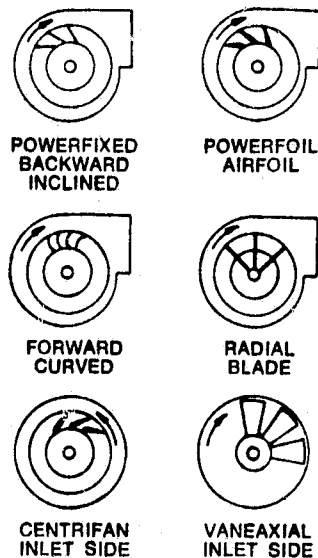
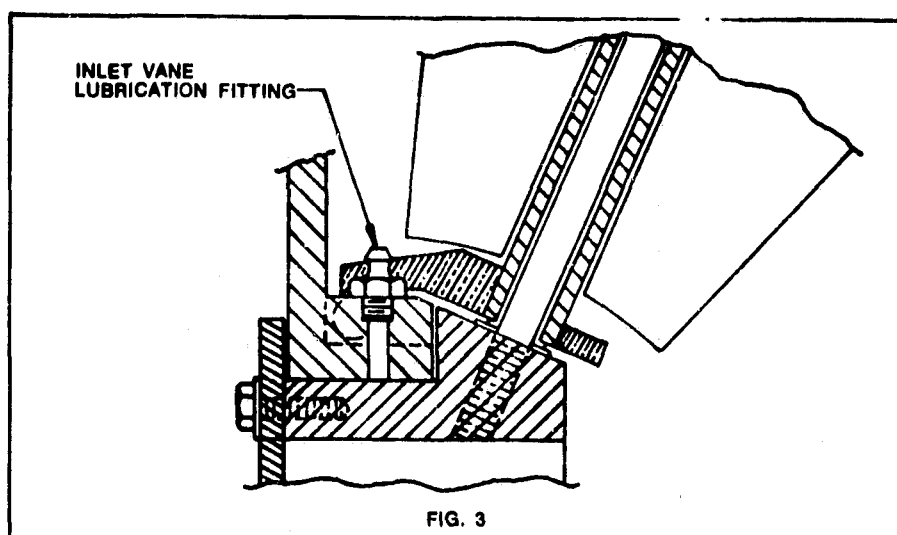


FIG. 2

ACCESSORIES

INLET VANES: Manually controlled vanes are to be adjusted to obtain the required airflow. Secure operating arm to quadrant with locking bolt.

Actuators are not furnished for automatically operated inlet vanes, whether electrically or pneumatically operated. They are normally field installed by the control manufacturer. The linkage between the actuating motor and the operating handle should be adjusted to prevent over-travel. Over-travel may cause binding or serious damage to the control ring and vane fingers. ALL nested type inlet vanes have fittings for lubrication and should be included in the periodic maintenance list. See Fig. 3.



SHUTTERS: Discharge shutters on utility blower can be furnished for either automatic or motorized operation. Be sure that the motorized shutters are wired correctly. Both types are normally maintenance free.

Shutters for other than utility blowers are furnished for either manual or motorized operation. Motor operators are not furnished by the fan manufacturer. Manual dampers are set in the same manner as manually operated inlet vanes.

Automatic and motorized wall shutters can be furnished for use with propeller fans. When installing these shutters, be sure the opening is free of any interference and the walls are plumb. Also be sure that the voltage and phase are correct for the shutter motor.

MAINTENANCE AND REPAIR

Regular inspection and lubrication is a must for trouble free operation.

Before attempting any repair work, be certain that all power to the motor and electrical accessories is turned off and, where possible, locked in the OFF position.

BEARING REPLACEMENT: Wheel and shaft must be supported before any dismantling is attempted. Remove drives, loosen and remove bearing bolts. Next loosen the retaining set screws on the bearing collars. Remove the bearings from the shaft *only after insuring that the shaft and wheel are securely supported.*

SHAFT REPLACEMENT: After following the steps listed for the removal of the bearings, loosen the set screws in the wheel hub. With the wheel securely blocked, pull the shaft from the wheel.

WHEEL REMOVAL: After following the steps above for bearing and shaft removal, remove the inlet cone by

removing eight bolts, which then permits the wheel to be lifted out through the inlet. This can also be done with the shaft in place.

To replace any of the above, reverse the procedure.

TROUBLE SHOOTING

Upon startup of your Peerless Unit, a few minor problems may be encountered due to transporting the unit from our plant to its destination. These defects can easily be corrected in the field.

Always shut off all power to the unit before attempting any repairs.

1. **NOISE IN FAN:** Shut fan down and check for foreign objects and remove.
2. **WHEEL HITTING INLET CONE:** Turn wheel by hand to determine where wheel is hitting. Loosen bolts holding inlet cone and recenter.
3. **THUMPING NOISE:** When rotating the wheel by hand, if a sound like something dropping is present check set screws in wheel hub and tighten.

4. **BEARING NOISE:** Check for alignment. Lubricate bearing. If noise persists, contact local Peerless representative.

5. **DRIVE NOISE:** Check sheaves for alignment. Check set screws to be sure that they are tight. Check belt tension. Check the adjustable pulley to be sure that all belts are properly seated.

6. **FAN VIBRATION:** NOTE: All fan wheels are statically and dynamically balanced at the factory, and runout is checked. After final assembly, the unit is checked to insure vibration level is within tolerance.

If excessive vibration is noted, check the following:

- a. Bearing and drive alignment.
- b. Mismatched belts.
- c. Wheel or sheaves loose on shaft.
- d. Loose or worn bearings.
- e. Loose mounting bolts.
- f. Motor out of balance.
- g. Sheaves eccentric or out of balance.
- h. Vibration base improperly balanced.
- i. Worn or corroded wheel (replace if bad)
- j. Accumulation of material on wheel (material accumulation should be scraped off.)

IMPORTANT

Do not attempt to increase speed on any equipment before checking the catalog or consulting the Factory for brake horsepower for the particular unit so as not to overload the motor or place the fan in another class due to tip speed of the wheel.

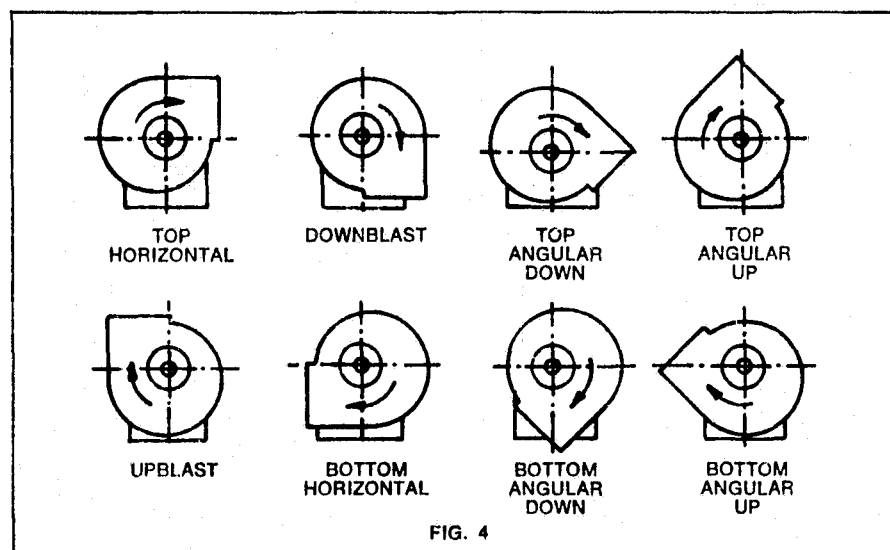


FIG. 4

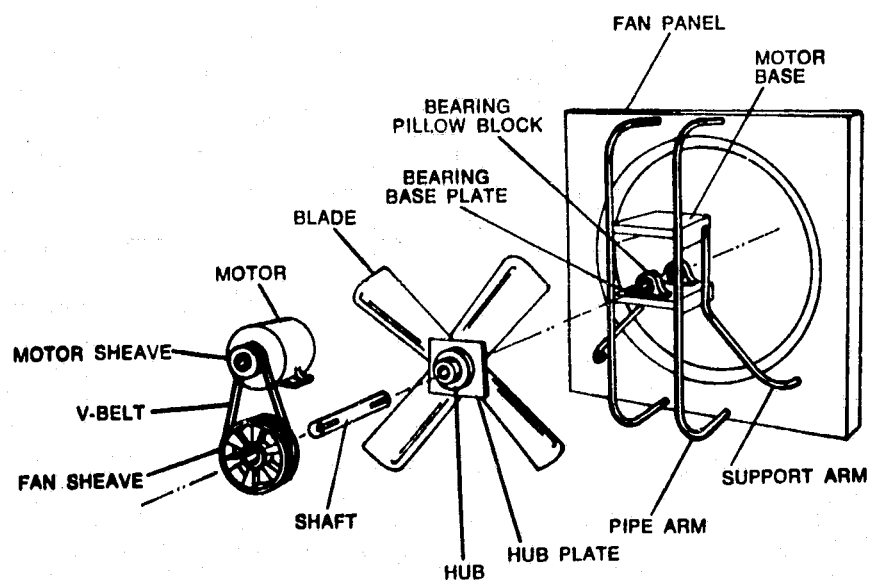
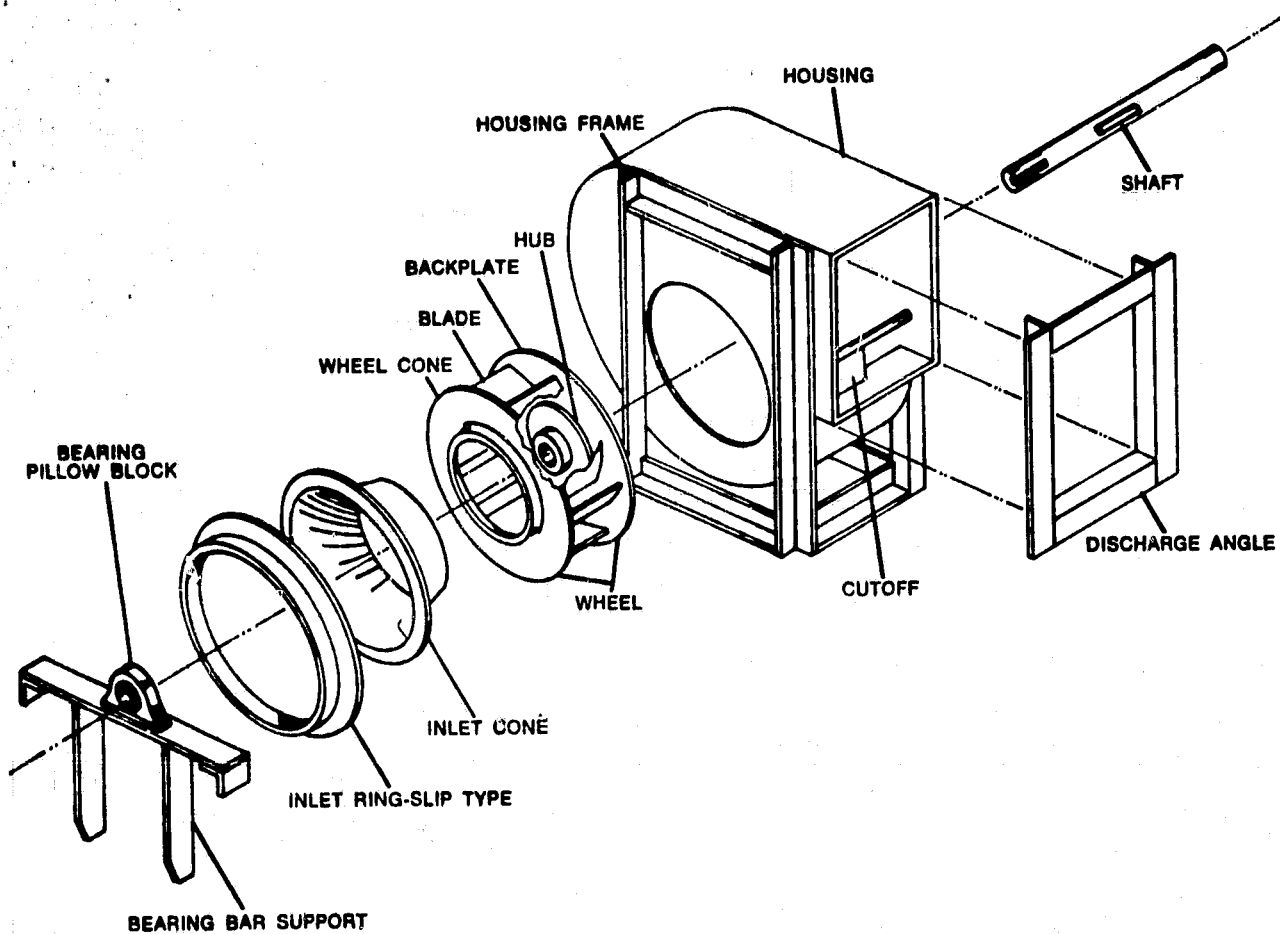


FIG. 5

14. COOLING TOWER



**COOLING TOWER
OPERATING MANUAL**

prepared for Citizens Mutual Savings & Loan
Leavenworth, Kansas

Tower Model No.	4625
Tower Serial No.	
Customer Order No.	M1673-13
Marley Order No.	KC-9-78

Please refer to Marley Order Number and Tower Serial
Number in correspondence concerning this tower.

We shall be happy to quote current parts
prices and shipment upon request.

THE MARLEY COOLING TOWER COMPANY
5800 Foxridge Drive, Mission, Kansas 66202



MANUAL

*Installation, Operation
and
Maintenance Instructions*



SERIES 4600
STEEL AQUATOWERS

APRIL, 1977

OM-4600D

5800 Foxridge Drive — P.O. Box 2912 — Mission, Kansas 66201

INSTALLATION, OPERATION, MAINTENANCE, DISASSEMBLY — STEEL AQUATOWERS

Installation, Operation and Maintenance Instructions

SERIES 4600

STEEL AQUATOWERS

TOWER LOCATION

Locate so prevailing wind will blow into the louvered face. Direct fan discharge away from building surfaces to eliminate the possibility of discoloration. Locate so there is free flow of air to and from the tower. Allow clearance on all sides for maintenance. Anchor in a level position to a stable foundation.

INDOOR INSTALLATION

A duct is required from the tower air discharge to the outside. In some cases it may also be desirable to install an inlet air duct. If ducts are used, the total draft loss should not exceed .10" water pressure. Draft losses can be minimized by:

- Using 20% oversize ducts.
- Avoiding sharp turns or abrupt changes in size.
- Keeping duct length to a minimum.
- Increasing the area of screened or louvered opening so the net free area is at least 20% greater than the tower discharge opening area.

Ducts should be attached to the tower using rubber or canvas connections. Access openings for servicing the mechanical equipment must be provided if air discharge ducts are installed. If the duct discharges into the prevailing wind, it may be necessary to install a windbreak or an elbow to serve as a deflector. Ducts installed on towers with year around usage should be water tight and insulated to prevent condensation.

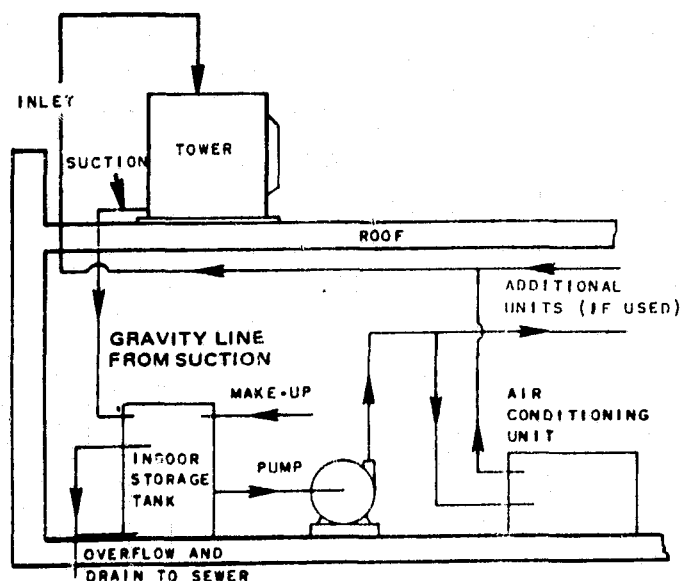


FIGURE 1. Flow Diagram for a Cooling Tower with Indoor Storage Tank. (Piping Is Arranged So That Tower Basin Will Drain When Pump Is Shut Off.)

TOWER INSTALLATION

The tower is shipped complete with the motor in a carton and miscellaneous parts package within the tower. Anchor tower by bolting a clip to the foundation and basin sides or through slots in legs using 3/8" or larger bolts.

PIPING TO TOWER (Summer Temperature Conditions)

- Use pipes of sufficient size to provide minimum friction loss.
- Connect float valve to make-up water supply.
- Install bleed-off line. Bleed-off is the continuous wasting of a small amount of water during operation which retards scale and corrosion. A bleed-off line can be installed at any point in the system, however, the best point is in the hot water line near the top of the tower so water will be removed when the pump is operating. A copper tube, pinched down or with a pet cock, can be used.

PIPING TO TOWER (Winter Freezing Conditions)

- Where operating conditions require tower use during freezing weather, it is recommended that the towers be installed for "dry basin" operation. See Figure 1.
- Provide an inside open type storage tank with a capacity of four times the cooling tower GPM.
- Connect tower suction to storage tank.
- Install make-up water, bleed-off, overflow and drain lines on tank.
- Insulate and heat water lines exposed to freezing temperatures.

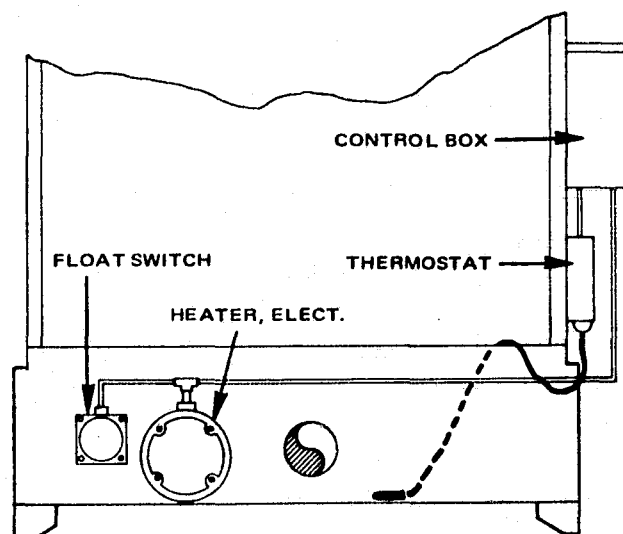
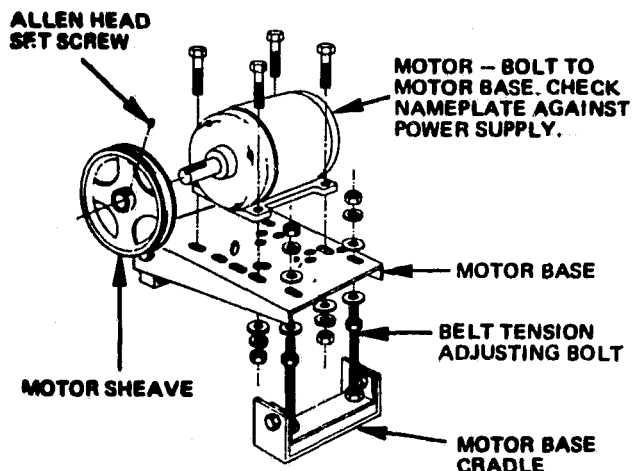


FIGURE 2. Electric heater systems are available as optional equipment to prevent freezing the cold water basin when it cannot be drained.



DETAIL "A"

MECHANICAL EQUIPMENT INSTALLATION

MOTOR, SHEAVE AND V-BELT INSTALLATION

1. Check the motor name plate to be sure its voltage, phase and frequency ratings are the same as the power supply.
2. Check to insure that fan is tightly secured to bearing housing shaft and free to rotate and that bearing housing is secured to its support.
3. Install all thread belt tension adjusting bolts in motor base cradle. See Detail "A". Install lock washers and nuts, fastening adjusting bolts to motor base cradle. Run galvanized nuts about halfway down on bolts. Insert bolts through slots in motor base, install lock washers and run top nuts down, locking base in place. Bolt motor to motor base.
4. Install motor sheave and align it with fan sheave. A

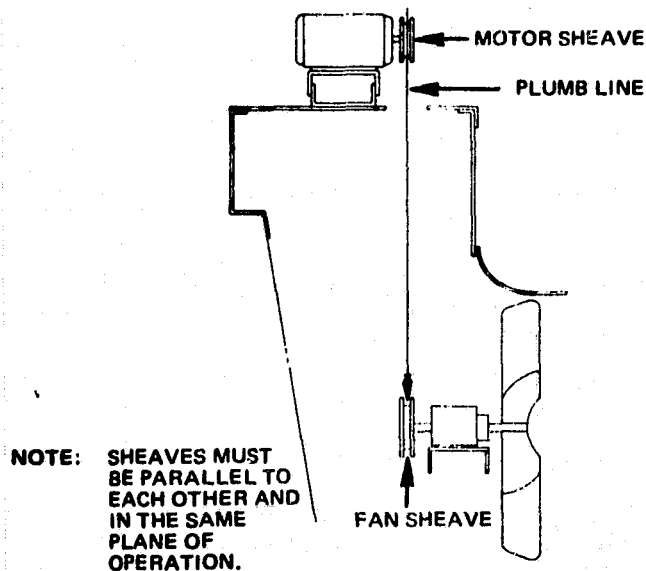
plumb line will be helpful in aligning sheaves. See Detail "B".

5. Install V-belt and adjust tension by means of belt tension adjusting bolts. A correctly tensioned belt does not slip when the fan is started; and, when running, the "tight" side is straight between sheaves. The "slack" side will have a slight bow. Correct tension can only be determined by trial runs at successively higher tensions until slipping has stopped.

A small further increase in tension should be made to account for normal belt stretch. Avoid over tensioning. Too much tension reduces bearing and belt life.

New belts must be retensioned after 8 to 12 hours operation since new belts stretch at a higher rate and "seat" into sheave grooves.

6. Connect motor to power supply using wiring, switching, short circuit protection and overload protection in accordance with the National Electric Code and local requirements. Failure to wire the motor correctly will void its warranty. The overload protection for motors must be part of the control system. See Diagram "C", page 6.
7. Sleeve bearing motors are usually shipped without oil and must be oiled before operating. Use high grade turbine type mineral oil of viscosity recommended by the motor manufacturer. Ball bearing motors are lubricated for the initial operation by the manufacturer, however, the motor bearing housing should be examined for presence of adequate grease before motor is placed in operation. Use grease recommended by the motor manufacturer. Chevron SRI-2 is recognized by many motor manufacturers as a suitable grease for ball bearing motors on cooling tower service. Refer to Marley Electric Motor service manual for lubricating procedures.
8. Install belt guard using sheet metal screws. See Figure 3.



DETAIL "B"

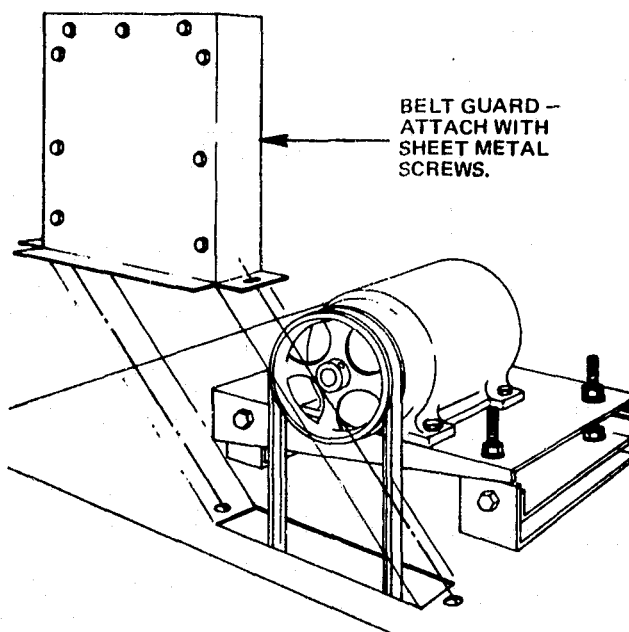
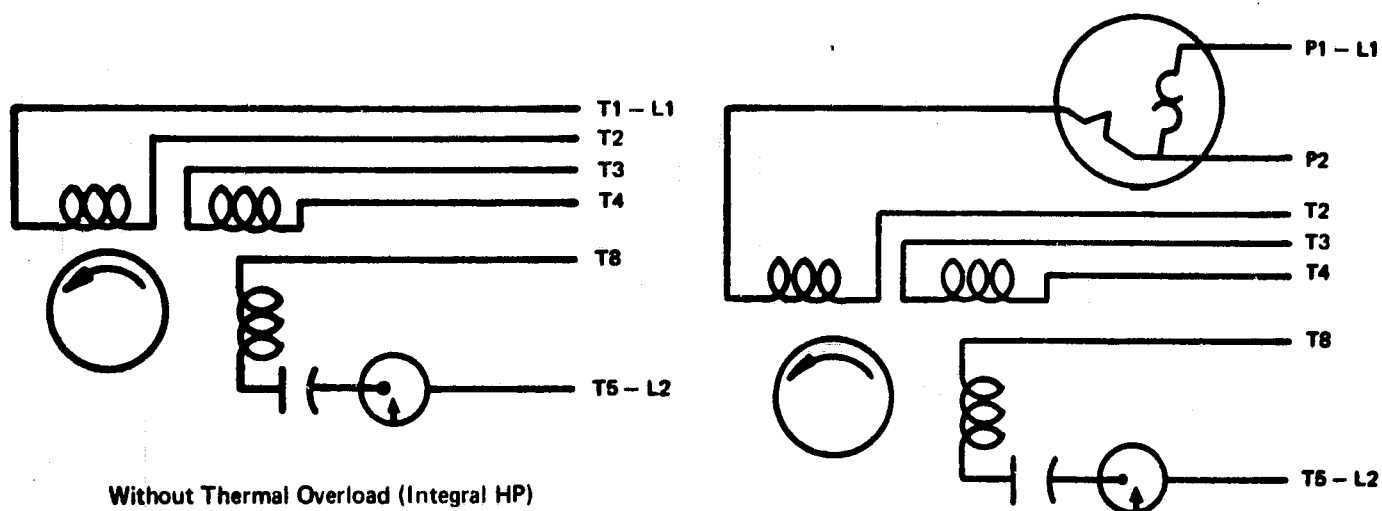


FIGURE 3. Belt Guard Installation

WIRING DIAGRAM CAPACITOR START SINGLE PHASE MOTORS, REVERSIBLE, DOUBLE VOLTAGE



Without Thermal Overload (Integral HP)

HIGH VOLTAGE

1. Connect T1 and L1 and insulate.
2. Connect T2, T3 and T8 and insulate.
3. Connect T4, T5 and L2 and insulate.

LOW VOLTAGE

1. Connect T1, T3, T8 and L1 and insulate.
2. Connect T2, T4, T5 and L2 and insulate.

GENERAL:

Colors may be substituted for numbers as follows:

T1 - Blue	T5 - Black
T2 - White	T6 - Red
T3 - Orange	P1 - No Color Assigned
T4 - Yellow	P2 - Brown

To reverse rotation, interchange leads T5 and T8.

With Thermal Overload (Fractional HP)

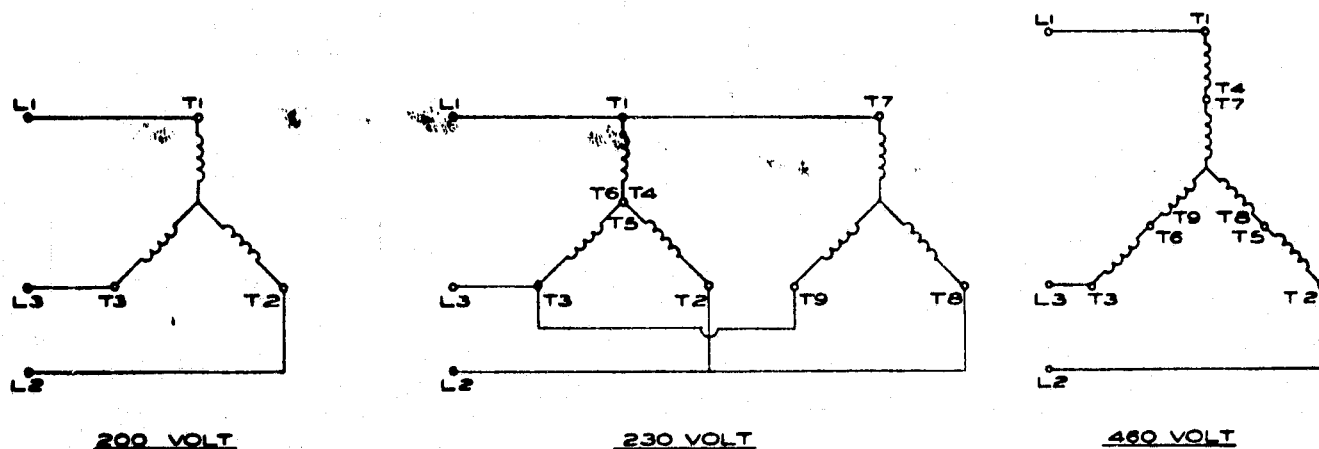
HIGH VOLTAGE

1. Insulate P2.
2. Connect T2, T3 and T8 and insulate.
3. Connect T4, T5 and L2 and insulate.
4. Connect P1 and L1 and insulate.

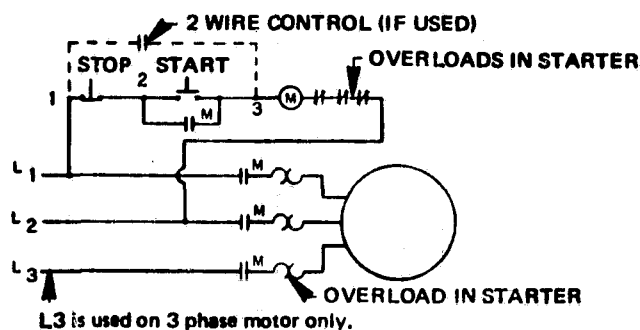
LOW VOLTAGE

1. Connect P1 and L1 and insulate.
2. Connect P2, T3 and T8 and insulate.
3. Connect T2, T4, T5 and L2 and insulate.

WIRING DIAGRAM 3 PHASE SINGLE SPEED WYE WOUND MOTORS



To reverse rotation, interchange any two of three power leads.



Showing Overload in Starter
DIAGRAM "C"

INSTALLATION OF OPTIONAL EQUIPMENT

AIR INLET SCREEN

Install hardware used to attach air inlet screen to side casing sheets. Set screen in position and install with wing nuts.

HOT WATER BASIN COVER

Install "S" strips at hot water basin sides. Remove from splash box cover those sheet metal screws indicated on installation drawing. Position basin cover segments and reinstall sheet metal screws.

OPERATION INSTRUCTIONS

1. Wash foreign matter from fill and basin.
2. Fill circulating system with water.
3. Start pump and adjust float valve to maintain 4" (5" on models 4619 thru 4625 and 8" on models 4627 thru 4633) of water in cold water basin.
4. Check bleed-off line to make sure water is being discharged during operation.
5. Check fan for free rotation and oil level in bearing housing (see maintenance instructions). Start motor and check direction of rotation. Fan must rotate clockwise when viewed from the fan discharge side. If the rotation is incorrect, change any two of the three motor leads for a three phase motor or interchange the connections of either the main or start windings for single phase capacitor start motor.
6. Depth of water in hot water basin should be uniform. If the basin overflows, reduce the flow rate. Do not pump more water than design capacity.
7. Do not cycle the motor so that the total of the starting times exceeds 30 seconds each hour.

MAINTENANCE INSTRUCTIONS

MOTOR

Lubricate the motor according to the motor manufacturer's instructions shipped with the motor.

Remove any oil, dust or scale deposits from the motor. They can cause excessive insulation temperatures.

Refer to Marley Electric Motor service manual for maintenance and lubrication information.

BEARING HOUSING

Lubricate bearing housing with SAE 20 mineral oil.

Oil cups should be kept full to insure proper oil level in bearing housing.

BELT TENSION

Check belt tension every two to three weeks during peak operating season. Refer to page 4, item 5.

BLEED-OFF

Check the bleed-off for continuous water discharge.

BASIN AND SUCTION SCREEN

Drain and clean cold water basin and suction screen periodically.

FLOAT VALVE

Check float valve periodically for proper operation and maintenance of water level.

GENERAL

The following tables show the proper amount of bleed-off.

COOLING RANGE DEGREES F	PERCENT BLEED-OFF OF TOTAL GPM
6	.15
7-1/2	.22
10	.33
15	.54
20	.75

CHEMICAL TREATMENT

The quality of many waters is such that chemical treatment for scale prevention or removal will not normally be required if adequate bleed-off is maintained. In areas where bleed-off alone is not sufficient to prevent objectionable scale or corrosion, use a simplified phosphate treatment or contact a reputable water treatment company for aid.

Slime, a gelatinous organic growth, and algae, a green moss, may grow in the cooling tower or heat exchangers. Their presence can interfere with cooling efficiencies. Proprietary compounds are available from water treating companies for the control of slime and/or algae, however, compounds which contain copper must be used with care. Copper can accelerate corrosion of steel, iron, aluminum and galvanizing and should not be used in systems containing any of those materials. Chlorine and chlorine containing compounds are effective algicides and slimicides but excess chlorine can damage wood and other organic materials of construction. If used, chlorine should be added as intermittent (or shock) treatment only as frequently as needed to control the slime and algae, and free residual levels should not exceed one part per million parts water (1 ppm). Chlorine or chlorine containing compounds should be added

carefully since very high levels of chlorine may occur at or near the point of entry into the circulating water system.

FOAMING

Foaming occasionally becomes a problem with certain water conditions when a new tower is put into operation. The condition is not normally persistent for an extended period, and foaming can be lessened by increasing bleed-off until condition is improved. If increased bleed-off does not lessen foaming sufficiently, a foam depressant chemical should be used. These are generally available through local chemical supply companies and some water treating companies.

SEASONAL SHUTDOWN INSTRUCTIONS

BASIN AND FRAME

Drain the tower basins and all exposed piping. Leave the basin drain open. Water may be left in cold water basin if tower is located in a non-freezing area.

During shutdown, clean the tower and make any necessary repairs. Apply protective coating as required to all metal parts. Particular attention should be given to bearing housing supports.

MECHANICAL EQUIPMENT

V-BELTS AND SHEAVE

1. At shutdown, remove and store belts in a cool, dark dry room. Clean and coat sheave grooves with rust preventive, lacquer, or paint.
2. Before putting belts back on sheaves, remove rust preventive. Replace belts that show excessive wear.
3. When putting tower back into service refer to "Mechanical Equipment Installation" page 4 for belt installation and tensioning instructions.

BEARING HOUSING, Oil Lubricated Type

1. At shutdown, operate until oil is warm; drain and refill. Use Sae 20 mineral oil.
2. Each month, drain water condensate at the drain plug. Check oil level and add oil if necessary.
3. At start-up, operate until oil is warm; drain and refill.

ELECTRIC MOTOR

Clean and lubricate motor at close of each operating season. Refer to motor manufacturer's recommendations.

Do not start motor without determining that there will be no interference with free rotation of the fan drive.

The motor should be run for three hours at least once a month. This serves to dry out windings and relubricate bearing surfaces. Refer to Marley Electric Motor service manual.

At start of new operating season, make sure bearings are adequately lubricated before returning motor to service.

PROLONGED SHUTDOWN

If shutdown period is longer than seasonal, contact your Marley sales office or representative for additional information.

When writing for information or when ordering parts, always mention tower serial number shown on the nameplate.

DISASSEMBLY AND REASSEMBLY INSTRUCTIONS

(See Figure 4)

Never disassemble the Aquatower more than necessary. For example, if removal of the motor base is sufficient to get the tower to the installation site, remove only that part. When disassembling, remember how each part is screwed, bolted and set in place. Fasten screws and bolts for each part with each section. Be careful not to mar galvanized coating.

DISASSEMBLY — 4619 thru 4623 (sequence is similar for 4613 thru 4617)

1. Remove motor base.
2. Remove fan guard, fan and all hardware attaching bearing housing support channel to casing sheets.
3. Remove screws attaching top sheet, then remove sheet.
4. Remove screws attaching distribution basin, then remove basin.
5. Remove fill.
6. Remove screws from collecting basin and side casing

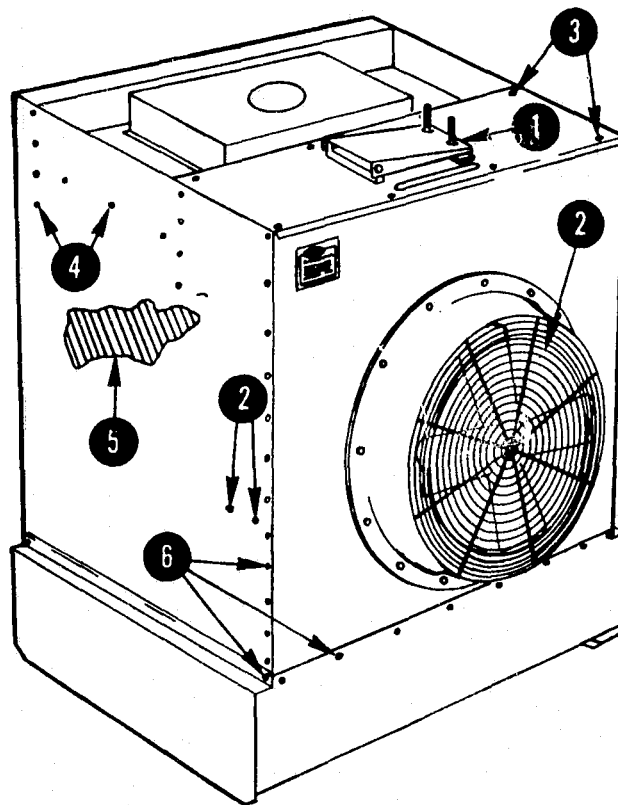


FIGURE 4

sheets at fan sheet. Remove side casing sheets and fan sheet with fan cylinder attached.

REASSEMBLY

Reassembly of the Aquatower is the reverse of the steps noted above.

The following precautions are important:

1. Fill must be installed level to assure full tower performance.
2. Bolts which use rubber sealing washers under head should be tightened securely to prevent leaks.
3. Be sure mechanical equipment is installed correctly and fan rotates freely.



MANUAL

ELECTRIC MOTORS on Cooling Towers and DriCoolers

Installation, Operation and Maintenance Instructions

NOVEMBER, 1978

SM-MOTOR-H

5800 Foxridge Drive — P.O. Box 2912 — Mission, Kansas 66201

INSTALLATION, OPERATION and MAINTENANCE — ELECTRIC MOTORS on Cooling Towers and DriCoolers



MARLEY

Installation, Operation and Maintenance of ELECTRIC MOTORS on Cooling Towers and DriCoolers

RECEIVING AND STORING MOTORS

A motor should be inspected on receipt to make sure it was not damaged during shipment. Turn the shaft by hand to see that it turns freely. Check motor nameplate for correct horsepower, voltage, phase and speed.

If a motor is stored before installation, place it in a building in which air is kept reasonably dry and with a minimum of temperature fluctuation to prevent moisture condensing in the motor. Do not store directly on the floor, always block up.

Windings should be meggered at the time the motors are put in storage.

If motors have space heaters, the heaters should be energized when the motors are placed in storage.

NOTE: Remove units from containers when heaters are energized. Reprotect if necessary.

If outdoor storage is necessary, protection should include a vapor barrier beneath the motor. The motor should be blocked up to prevent flooding. All external parts such as shafts, machined surfaces, and threaded holes should be protected with a rust inhibitor coating.

Rotate motor shaft monthly to insure that the bearing surfaces are protected with lubricant.

When a motor is removed from storage, the insulation and rotor movement should be checked. The insulation should be checked by applying the potential from a 500 volt megohmmeter between the windings and grounded frame for 10 minutes. Resistance readings should be taken at one and 10 minutes. Correct the readings to 40°C as discussed on page 6 of this manual. Calculate the winding polarization index by dividing the 10 minute reading by the one minute reading. The recommended minimum value of polarization index for alternating current machine is:

Class A insulation 1.5

Class B insulation 2.0

Class F insulation 2.0

A low polarization index indicates the insulation should be cleaned and dried before the motor is placed in operation. It is possible to operate a motor with a polarization value less than the minimum listed above but this is not considered good practice.

The rotor movement is checked by rotating the shaft by hand. If shaft is not free, contact the motor manufacturer's authorized repair shop. Grease in the motor bearings should be purged at the time of removal from storage. Refer to LUBRICATION on pages 5 and 6.

INSTALLATION

Check to see that the motor nameplate data agrees with the voltage and frequency of the power supply provided for the motor. All induction motors will operate successfully when the frequency is not more than five percent above or below the nameplate rating, the voltage is not more than ten percent above or below the nameplate rating, and the combined variation in voltage and frequency is not more than ten percent above or below the nameplate rating.

The power supply line for the motor should be of sufficient capacity to carry 125 percent of the motor's full load current with a maximum voltage drop of three percent on the line.

The power supply must conform with motor nameplate voltage. Motors rated 200 volts are for a 208 volt system. Motors rated 230/460 volts are for a 240 or 480 volt system. Do not use a 230 or 230/460 volt motor on a 208 volt system.

Unbalanced voltages in the power supply will greatly increase the internal losses of the motor, reducing the safe load the motor can carry. Have the power company correct any unbalanced voltage.

When motor power is supplied by overhead conductors, it is advisable to provide a lightning arrestor on each ungrounded line.

Wire the motor to the power supply through a disconnect switch, short-circuit protection, and suitable magnetic starter with overload protection. All wiring and fusing should be in accordance with the National Electrical Code and local requirements. All motors should be connected as shown on the nameplate diagram.

The National Electrical Code requires a motor to be in sight of the controller unless the disconnecting means can be locked open or unless there is a manually operated switch in sight of the motor which will disconnect the motor from its electrical supply.

Overload protection should be installed in all three lines. Size overload heaters in starters for nameplate service factor and amps. Overloads for 1.15 service factor motors must kick out at no more than 125% of nameplate current. Overloads for 1.0 service factor motors must kick out at no more than 115% of nameplate current.

Overloads should be at the same ambient temperature as motor. Do not use ambient compensated overloads.

If a two speed motor is used, be sure control characteristics are compatible with the motor. A two speed single winding motor requires a different starter than a two speed two winding motor. *Starters for two speed motors must include a minimum time delay of 20 seconds when switching from high to low speed.*

When disconnect switch is installed between motor and starter for two speed or part winding start single speed motor, a 6-pole or two 3-pole disconnects must be used. If two 3-pole disconnects are used, the operating handles must be mechanically locked together, because opening only one 3-pole disconnect would cause the motor to try to operate on high speed with full load but with only half the windings energized.

If reverse operation of mechanical equipment is required, provide minimum time delay of two minutes before energizing motor when changing direction of rotation.

Check the wiring system for grounds and check the resistance between all leads for open, bad or incorrect connections before operating the motor.

The conduit system should be arranged so that trapped water will collect in a sump equipped with suitable drain and will not go into the motor terminal box.

When the motor must be moved for coupling removal or belt adjustment, a short section of flexible, water-tight metallic conduit should be used in place of rigid conduit to protect the leads to the motor.

Remove all water drain plugs from Totally Enclosed motors. These plugs will be located in the lowest part of the installed motor. Because of accessibility of drain plugs

with motor installed on supports, it is necessary to remove plugs before the motor is bolted in place.

The drain plugs on Explosion Proof motors are automatic and must not be removed.

NOTE: After motor is installed, it should be run for three hours at least once a month, even if the tower is not in operation. This serves to dry out windings and relubricate bearing surfaces. If motors are purchased with space heaters, they should be energized as soon as possible. Use an auxiliary contact on the starter to turn heater off when motor is running.

OPERATION

Sleeve bearing motors are usually shipped without oil and must be oiled before operating. Ball bearing motors are lubricated for the initial operation by the motor manufacturer, however, it is recommended that the grease and relief plugs be removed and the motor bearing housing be examined for presence of adequate grease before motor is placed in operation. Add grease if necessary. See instructions on pages 5 and 6 for lubricating ball bearing or sleeve bearing motors.

Turn the rotor by hand to see that it rotates freely. Motor shaft should be parallel to driven shaft so that there are no stresses in motor frame.

INITIAL STARTING: The motor should bring the fan up to speed in less than 15 seconds. If it does not, check connections, fuses, overloads and voltage at motor terminals during start-up period. Run the motor to check the connections and direction of rotation. If the rotation is incorrect, change any two of the three motor leads for a three phase motor or interchange the connections of either the main or start windings for single phase capacitor start motor.

CAUTION: Do not cycle a motor on and off more than necessary. Too frequent cycling may cause the windings to burn out. Generally, the total of the starting times should not exceed 30 seconds each hour. For example, a motor which requires 5 seconds to come up to speed would accumulate 30 seconds total starting time in six starts.

If a two speed motor is used, *allow a time delay of a minimum of 20 seconds after de-energizing the high speed winding and before energizing the low speed winding.* Tremendous strains are placed on driven machinery and motor unless the motor is allowed to slow to low speed rpm or less before the low speed winding is energized.

When changing fan direction of rotation, allow a minimum of two minutes time delay before energizing the fan motor.

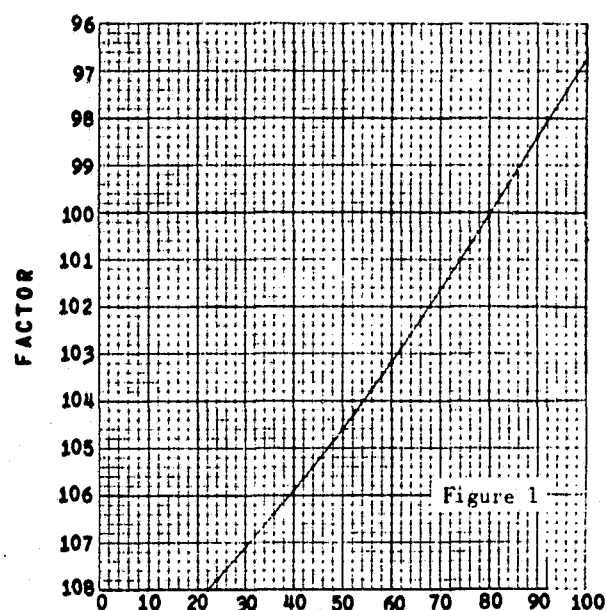
DETERMINE LOAD AT MOTOR: With design water rate and design heat load on the tower, test motor Hp as follows:

1. Run motor for 30 minutes. Record motor name plate data.
2. Measure voltage between all lines at motor terminals.
3. Measure amps in all three lines.
4. Average the measured volts and amps and calculate test horsepower using the following equation:

$$HP (test) = \frac{\text{Volts} \times \text{Amps (average)}}{\text{Volts} \times \text{Amps (name plate)}} \times HP (name plate)$$

5. For a given pitch setting and RPM, horsepower will vary directly with the air density which is a function of temperature and barometric pressure. Because fans are generally pitched for summer weather horsepower, it is expected that the motor nameplate horsepower will be exceeded during winter operation. Assuming 100% heat load, the temperature rise in the motor will be greater at the higher horsepower, but the operating temperature of the motor will actually be lower due to the drop in ambient temperature. Under these conditions, the higher horsepower should not be detrimental to the motor.

If the horsepower measurement is taken during cold weather conditions, the predicted horsepower which will result during summer operation may be determined by applying the Factors from Figure 1. For a given location, the barometric pressure will not normally vary enough to cause significant error and for this reason, has not been included in the Factors.



Induced Draft Cooling Tower – Ambient WB – °F.

Forced Draft DriCooler – Ambient DB – °F.

Example: The horsepower on an induced draft cooling tower* is 7.8 HP on a 40°F ambient wet-bulb day. What is the predicted HP on a 75°F ambient wet-bulb day?

$$HP (75°F) = HP (40°F) \times \frac{\text{Factor (75°F)}}{\text{Factor (40°F)}} = 7.8 \times \frac{100.8}{105.9} = 7.43$$

If it is desired to correct for high or low test barometric pressure, multiply the predicted horsepower by standard station barometric pressure and divide by test station barometric pressure.

*Use ambient dry-bulb temperatures if checking a forced draft DriCooler or cooling tower.

Fan motor overloads sized for summer weather will handle the higher winter horsepower without adjustment providing they are at the same ambient temperature as the motor.

NORMAL OPERATION: Class B insulated motors are rated at a maximum total operating temperature of 130°C (266°F). A thermometer in contact with the winding may indicate a temperature up to 100°C (212°F) on a protected motor or up to 115°C (239°F) on a totally enclosed motor without the motor being too hot. Therefore, if a motor feels hot to a person's hand, it is not necessarily overloaded. Check with thermometers.

MAINTENANCE

SAFETY NOTE: When working on the fan or fan drive make sure the electric motor cannot be started. See "Installation" section.

To obtain maximum motor life, establish a schedule of maintenance based on the particular application of the motor and observe the following procedures and precautions:

CLEANING: Remove any oil, dust or scale deposits from the motor. They can cause excessive insulation temperatures.

LUBRICATION:

Ball Bearing Motors: The following table may be used as a guide in determining greasing periods for motors:

DUTY	1 – 30 HP	40 – 250 HP
Intermittent	12 mo.	12 mo.
8 to 16 hours per day	12 mo.	6 mo.
Continuous	8 mo.	4 mo.

All greases will deteriorate in time depending upon bearing size, speed and temperature. The grease used should be recommended by the motor manufacturer. See instructions attached to motor for recommended lubricant. If these instructions have been lost or misplaced, obtain information on lubricant to use and local supply source from motor manufacturer's nearest authorized service facility or from the motor manufacturer. Give complete motor name plate data and the information that the motor is used on a water cooling tower. Chevron SRI-2 is recognized by many motor manufacturers as a suitable grease for ball bearing motors for cooling tower service. In general, a polyurea or lithium base grease with rust and oxidation inhibitors is recom-

mended. Use a grease of NLGI No. 2 consistency. Do not mix greases which are of different types or specifications. If a change is desired, the motor bearing housing grease reservoir should be completely cleaned of old grease before repacking with new grease.

The relief method of greasing motors tends to purge the bearing housing reservoir of used grease by forcing out old grease with new grease. Use a plunger type grease gun which will not fit the bearing grease fill hole too tightly.

Either an excess or insufficient amount of lubricant in the bearings can cause overheating. To prevent this occurrence, use the following greasing procedure:

1. Stop motor.
2. Wipe grease plugs, outside of bearing housing, and relief plug, clean.
3. Remove grease and relief plugs and free relief hole of any hardened grease. Use wire in opening.
4. Add grease with a hand operated pressure gun until new grease appears at the relief hole. Take special care when greasing the fan end bearing of TEFC motors. The long relief might be too small for the bearing to relieve properly.
5. Run the motor for approximately one hour after greasing to permit rotating parts of the bearing to expel excess grease. Take out some of the excess grease with a wire.
6. Replace plugs and wipe the outside of the bearing housing clean.

Every few years the motor end brackets should be removed and the grease reservoirs cleaned and repacked full with approved ball bearing grease. Open bearings should be cleaned and repacked.

Bearings should be checked for "roughness" by turning the outer race slowly with the fingers while holding the inner race. If the bearing feels rough or binds in spots, it should be replaced.

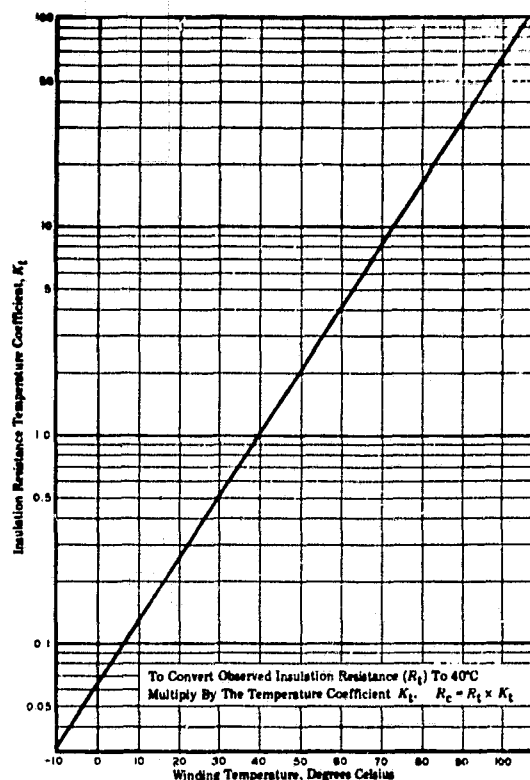
Sleeve Bearing Motors: Check oil in sleeve bearings at least every three months. When journal size is less than two inches, stop the motor to check the oil level. Old oil should be drained and replaced at least every year. Clean out oil well if there is evidence of dirt and sludge.

Motor shaft must be stopped when motor is oiled. The oil used should be a good grade of mineral oil of light or medium viscosity (such as SAE No. 10). Turbine oil rather than automotive crankcase oil is recommended.

Check bearing wear yearly by measuring the air gap with a feeler gauge. Measure gap in at least four equally spaced positions at each end of the motor with two of the places being the lowest point and the point subject to the load pull.

INSULATION: Check insulation resistance with a megohmmeter at the end of each shutdown period. Apply the megohmmeter potential to the winding for one minute be-

fore taking a reading. Correct the reading to 40°C by using the equation $R_{40^{\circ}\text{C}} = K_t \times R_t$ and the curve below.



Approximate Insulation Resistance Variation with Temperature for Rotating Machines

A record of these corrected readings will show a trend in the insulation condition. It is considered good practice to recondition a winding if the resistance, having been high on previous readings, drops to near the recommended minimum value as calculated by:

$$\text{Megohms} = \frac{1000 + \text{Rated Voltage of Machine}}{1000}$$

Motors in continuous operation will stay at a temperature sufficiently above ambient temperature to prevent condensation of moisture on and about the windings, even if the location is very humid. Idle motors, however, accumulate moisture readily which causes gradual deterioration of insulation. Where motors are idle for a long time, single-phase heating or space heaters may be required to prevent water condensation.

Check insulation resistance at least once a year with the motor at normal operating temperature. Comparison with several previous readings will give an indication of improvement or deterioration of insulating value. Readings, to have comparison value, should be taken under the same conditions (temperature, operating time since last shutdown, etc.).

Low or falling resistance readings indicate the need for

maintenance. Contact the nearest repair facility authorized by the motor manufacturer for repair service.

VIBRATION: If vibration occurs, it should be corrected without delay. Use the following procedure to determine source of trouble:

1. Check motor mounting to see that fasteners are tight.
2. Disconnect motor from load and run motor separately. If motor still vibrates, rebalance rotor.
3. If vibration is in mechanical equipment*, check:
 - a. Alignment of motor with mechanical equipment.
 - b. Tightness of Geareducer, or belt driven components, mounting bolts.
 - c. Unbalance in drive shaft or fan.

*Refer to service manuals for operating and maintenance recommendations.

SEASONAL SHUTDOWN

If a motor is used only seasonally, it should be cleaned and lubricated at the close of each season. Refer to motor manufacturer's recommendations for lubrication and maintenance instructions. At start of new season, make sure bearings are adequately lubricated before returning motor to operation. *When tower is not in operation, the motor should be run for three hours at least once a month. This serves to dry out windings and relubricate bearing surfaces.*

Do not start motor without determining that there will be no interference with free rotation of the fan drive.

MOTOR WARRANTY

Motor manufacturers' warranties run for 12 months in ser-

vice but not to exceed 18 months from date of manufacture. Motor manufacturers warrant their products to be of the type and quality described, suitable for the service for which they are supplied, and free of defects in materials and workmanship. Failures from causes external to the motor (e.g., single phasing, operation under prolonged or extensive overload, damage from handling, improper maintenance, use on other than the service for which supplied, defect in wiring to power supply, or deficiency or defect in controls) are not covered by the motor manufacturers' warranties.

If a motor failure occurs within the warranty period because of defect in material or workmanship, the motor manufacturer is liable and has the right to remedy the failure by adjustment, repair, or supplying a replacement motor F.O.B. his factory or authorized repair facility. In such event, the motor must be delivered to the nearest repair facility authorized by the motor manufacturer with notification that the motor is from a Marley Cooling Tower Company product and that warranty consideration is requested. Prompt notification of such failure should be directed to The Marley Cooling Tower Company's Field Sales Office or Representative.

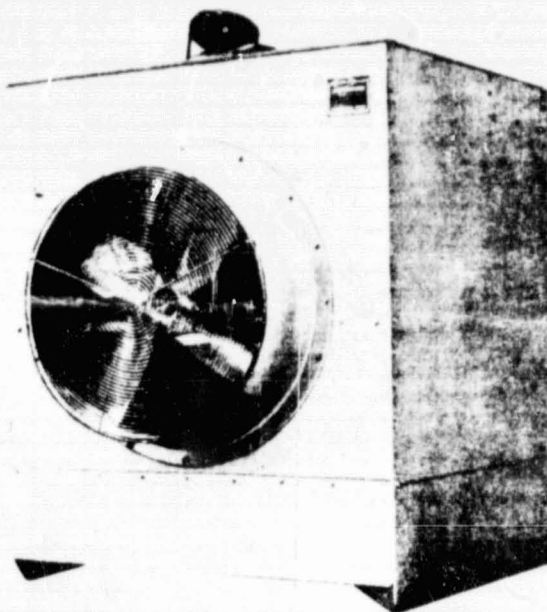
Motor manufacturers will not accept warranty obligation for repair of motors by other than their authorized repair facility nor warranty obligation for materials or workmanship employed in making repairs. Repair shops, including authorized repair facilities, generally warrant their material and workmanship for a period of 12 months.

Motor manufacturers' warranties do not cover cost of dismounting, transportation to and from repair facilities, or remounting motors.

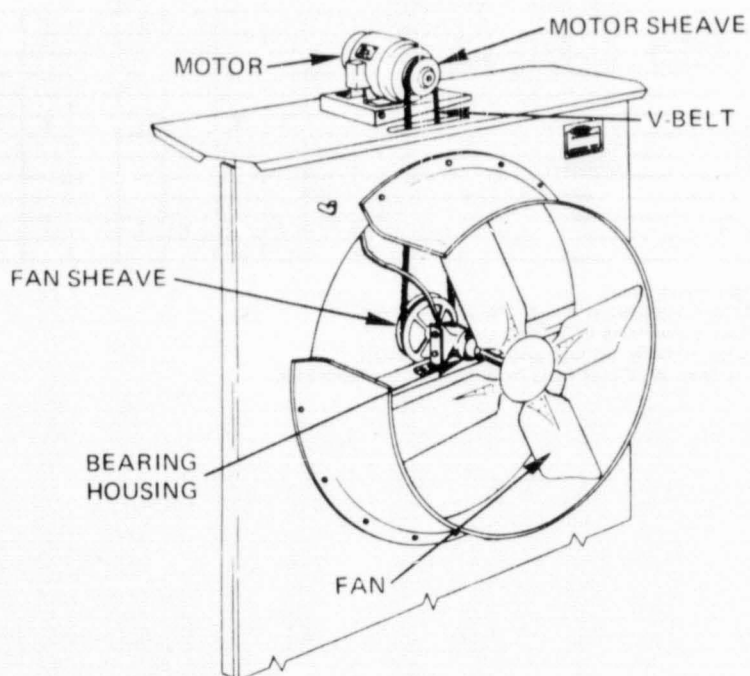
4600 SERIES AQUATOWER PARTS LIST

Models 4613, 4615, 4617, 4619, 4621, 4623, 4625, 4627, 4629, 4631 & 4633
(SEE ITEMIZED PARTS LIST ON REVERSE SIDE)

ORIGINAL PAGE IS
OF POOR QUALITY



Models
4613 through 4633



Mechanical Equipment

IMPORTANT – The serial and model numbers of tower must be provided when ordering parts.

AQUATOWER PARTS LIST

REF.	DESCRIPTION OF PARTS	MODEL QUANTITIES										
		4613	4615	4617	4619	4621	4623	4625	4627	4629	4631	4633
1	MOTOR*											
	1/3 H.P., 1750 RPM, TENV.	1	1	1								
	1/2 H.P., 1750 RPM, TEFC.				1	1						
	3/4 H.P., 1750 RPM, TEFC.						1					
	1 H.P., 1750 RPM, PROT.							1	1			
	1-1/2 H.P., 1750 RPM, PROT.									1		
	2 H.P., 1750 RPM, PROT.										1	
	3 H.P., 1750 RPM, PROT.											1
2	MOTOR SHEAVE											
	Browning, AK 49	5/8" Bore	3/16 x 3/32	1				1				
	Browning, AK 59	5/8" Bore	3/16 x 3/32		1	1						
	Browning, AK 54	5/8" Bore	3/16 x 3/32				1					
	Browning, AK 46	5/8" Bore	3/16 x 3/32					1				
	Browning, AK 59	7/8" Bore	3/16 x 3/32						1			
	Browning, AK 54	7/8" Bore	3/16 x 3/32							1		
	Browning, ITA 46, With "PI" Bushing	7/8" Bore	3/16 x 3/32								1	
	Browning, AK 56	7/8" Bore	3/16 x 3/32									1
	Browning, AK 64H, With "H" Bushing	1-1/8" Bore	1/4 x 1/8									1
3	FAN SHEAVE											
	Browning, AK 104	3/4" Bore	3/16 x 3/32	1			1					
	Browning, AK 144	3/4" Bore	3/16 x 3/32		1	1				1		
	Browning, AK 154	3/4" Bore	3/16 x 3/32				1	1				
	Browning, AK 184	3/4" Bore	3/16 x 3/32						1		1	1
4	V-BELT											
	Browning, A 68			1								
	Browning, A 90				1							
	Browning, A 105				1							
	Browning, A 110					1	1	1				
	Browning, A 112								1			
	Browning, A 128									1		1
	Browning, A 120										1	
5	FAN** TORRINGTON											
	24" Dia., N2424-4	3/4" Bore	3/16 x 3/32	1								
	24" Dia., N2436-4	3/4" Bore	3/16 x 3/32		1	1	1					
	36" Dia., R3627-4, With "H" Bushing	3/4" Bore	3/16 x 3/32					1	1	1		
	42" Dia., R4227-4, With "H" Bushing	3/4" Bore	3/16 x 3/32								1	1
	48" Dia., R4827-4, With "H" Bushing	3/4" Bore	3/16 x 3/32									
6	BEARING HOUSING											
	Including shaft and bearings	6-3494-2		1	1	1	1	1	1	1	1	1
	Bearings only (2 required)	52-155										
	Oil seals on y (2 required)	SS-5166										
7	FLOAT VALVE ASSEMBLY											
	3/4" Flipped with ball and rod			1	1	1	1	1	1	1	1	1

*1/3 H.P. Motor Available In Single Phase Only.

1/2 H.P., 3/4 H.P. and 1 H.P. Motors Available In Single Phase Or 3 Phase.

1-1/2 H.P., 2 H.P., and 3 H.P. Motors Available In 3 Phase Only.

When Ordering Replacement Motor, Specify Voltage and Phase Required.

**24" Dia. Fans Have Hub On Inlet Side. All Other Fans Have Hub On Exhaust Side.

ART WHORTON
Res. Phone 642-3843

15. SOLAR COLLECTORS

BOB WILLIAMS
Res. Phone 648-3380

WHORTON & WILLIAMS
REPRESENTING MANUFACTURERS

P.O. BOX 8128

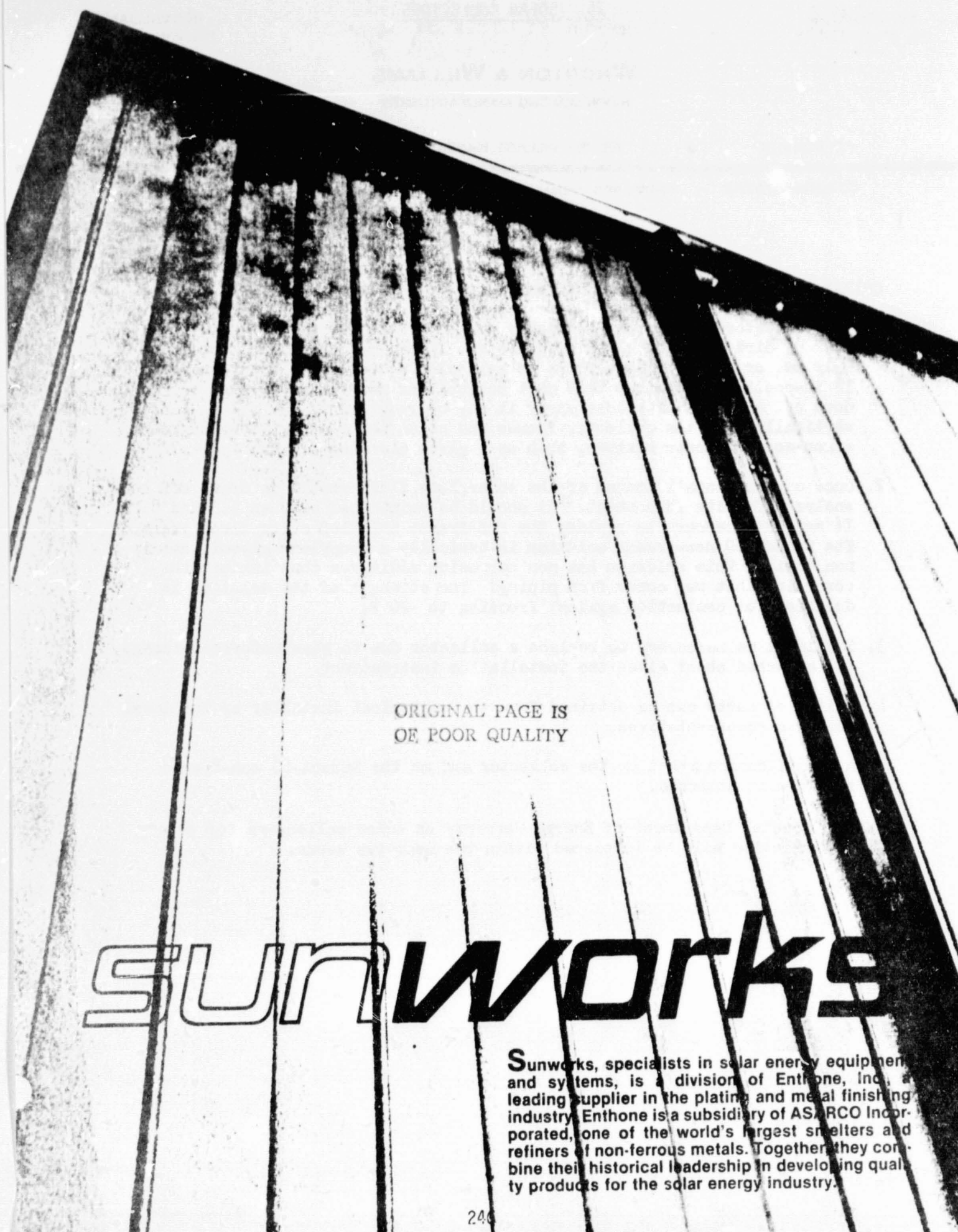
PRAIRIE VILLAGE, KANSAS 66208

(913) 432-6688

COOLING TOWERS — SUNWORKS SPECIALISTS IN SOLAR ENERGY EQUIPMENT — FIBERGLASS PIPE

OPERATION AND MAINTENANCE OF SUNWORKS SOLAR COLLECTORS

1. The collectors should be seasonally washed with water to remove any thin film of dirt from the glass coverplate. It may be necessary to do this only two or three times a year, as rain also accomplishes this purpose. If inspection determines that dirt accumulates more than expected and does not come off with hose spray it may be required to lay a long ladder vertically over the collector frames and clean the glass with water and a non-soapy ammonia mixture, such as a glass cleaning fluid.
2. Once a year a small amount of the solar loop fluid should be drawn off and analyzed for its PH content. It should be maintained between 5.5 and 8 PH. It may be necessary to replace the non-freeze solution every three years. The Sunsol 60 non-freeze solution is basically a propylene glycol that is non toxic. This solution has non corrosion additives that inhibit the corrosion that may occur from piping. The strength of the solution is designed for protection against freezing to -20 F.
3. Should it be necessary to replace a collector due to some unforeseen damage, the attached sheet gives the installation instructions.
4. A list of parts can be obtained from the mechanical installer or the local Sunworks representatives.
5. A specification sheet on the collector and on the Sunsol-60 non-freeze solution is attached.
6. The special Department of Energy Warranty on solar collectors for this installation will be furnished within the next two weeks.



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SUNWORKS

Sunworks, specialists in solar energy equipment and systems, is a division of Enthone, Inc., a leading supplier in the plating and metal finishing industry. Enthone is a subsidiary of ASARCO Incorporated, one of the world's largest smelters and refiners of non-ferrous metals. Together they combine their historical leadership in developing quality products for the solar energy industry.

SUNWORKS

internal manifold Solector®

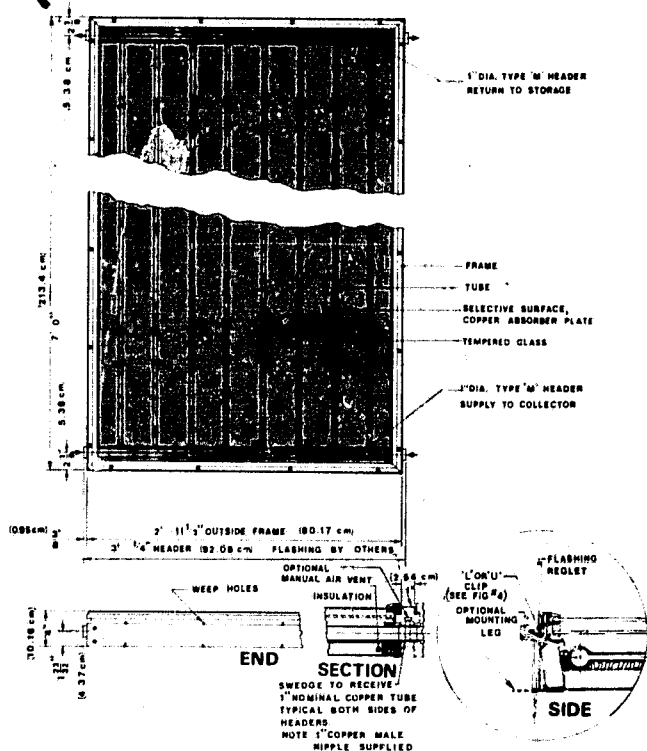


FIGURE 1

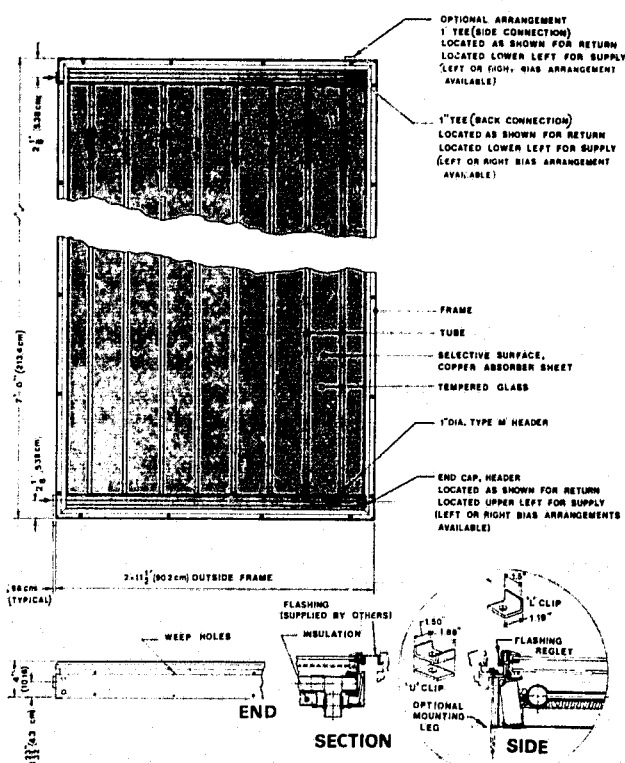


FIGURE 2

The 3' x 7' liquid cooled Solector solar energy collector, with internal manifolding and side, side/back or side/end connections allows for a multi-panel array to be coupled in parallel or parallel series before returning to the main supply or return branch. This results in fewer field connections and fewer piping accessories while retaining a high installed net to gross ratio, approximately 88 percent. The internal manifold liquid cooled Solector is available with connection locations that allow side-by-side mounting for parallel flow or end-to-end mounting for series flow. This Solector configuration responds to the specific design requirements of solar collector arrays for commercial, industrial, and institutional building types by maximizing the amount of collectors able to be placed onto the structure while minimizing the installed cost.

FEATURES AND CONSTRUCTION:

Cover: Single glazing: lo-iron (A.S.G.), 1/4 in. (.32 cm) tempered, edges swiped. Double glazing: lo-iron (A.S.G.), 2-1/4 inch (.32 cm) tempered, with weep holes. Total transmissivity: Single glazing, 89.1%; Double glazing, 79.3%. (A.S.G. 1/4" or 3/8" no iron also available.)

Absorber Container: Sides, aluminum extrusion; rear aluminum sheet .032 inches (.058 cm) thickness, pop rivet in place.

Air Space Between Cover and Absorber: Approximately 3/4 to 1 inch depending upon glazing type.

Gasketing Material: EPDM "U" gasket for glazing, closed cell elastomer, compressible high temperature silicone seal for absorber sheet.

Weatherproofing: This module can be placed out in the weather without need for further weatherproofing.

Finish on Aluminum Sides of Container: Standard mill finish, anodized clear or baked black enamel (available at extra cost).

Dimensions of Surface-Mounted Module: Outside dimensions overall: 35 1/2 inches (90.2 cm) wide x 84 inches (213.4 cm) long x 4 inches (10.2 cm) thick (add 1 1/4 inch each end for optional continuous mounting bracket). Effective absorber area = 18.50 ft² (1.72m²). Ratio of usable absorber area to total installed surface covered = 0.88. Glass area (aperture) = 18.88ft² (1.75m²).

Absorber: Copper sheet: 0.010 inches thick (.025 cm) (7 ounces). Selective black: minimum absorptivity, .85/.92; maximum emissivity, .15/.35. Manufactured by Enthone, Incorporated; guaranteed durable to 400°F (305°C). (Black chrome: absorptivity .94 emissivity .12 also available.) Copper tubes: 3/8" O.D., 4 inches (10.2 cm) on center, L-type copper. Tube pattern: grid. Bond between tube and sheet: high temperature solder, 270° wrap. Manifolds: 1 inch type M copper. Tube connections to manifold: brazing alloy. Connection to external piping: 1 inch type M copper tube. Manifold/tubes pressure tested before leaving factory to 15 atm; recommended 125 psig (8.5 atm) working pressure.

Insulation Behind Absorber: .5 in. (1.25 cm) thick glass fiber (compressed) over 1.0 inch (2.5 cm) thick foil-faced isocyanurate, R = 10.0, (glass fiber, 1.2 lbs/ft³ density).

Method of Anchoring: Keyway integral to collector frame continuous along perimeter of frame designed to accept "L" or "U" clips with predrilled 3/8" diameter hole for bolt mounting to roof or frame. Optional 1 1/4 inch (3.2 cm) mounting leg integral with top and bottom of frame; four 3/8" (.95 cm) diameter holes predrilled. Capability of through bolt anywhere along its length.

Weight Per Module: 123 pounds (55.8 kg), filled; 120 pounds (54.4 kg), empty (standard 3' x 7' unit). Add 27 pounds (12.2 kg) for double glazed unit. The liquid in the solector is equal to 0.48 gallons (1.82 liters).

Recommended Flow Rate Through Collector: 20 lbs/ft²/hr (1 gpm) (.063 l/sec) per collector.

Collector Coolant: Coolant should be Sunsol 60, made by Sunworks or equivalent. In areas where regular tap water is used as a coolant, it is important that the pH be controlled between 6.5 and 8, and the Ca. Mg. count should be below 50 ppm.

Warranty: Five year material workmanship warranty on all parts effective from date of installation. See your local Sunworks representative for further details.

specialists in solar energy equipment

air cooled Solector®

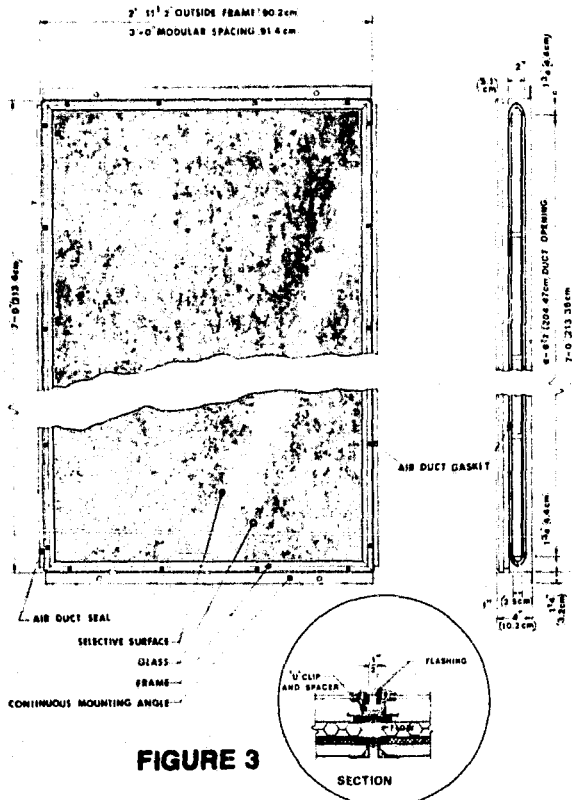


FIGURE 3

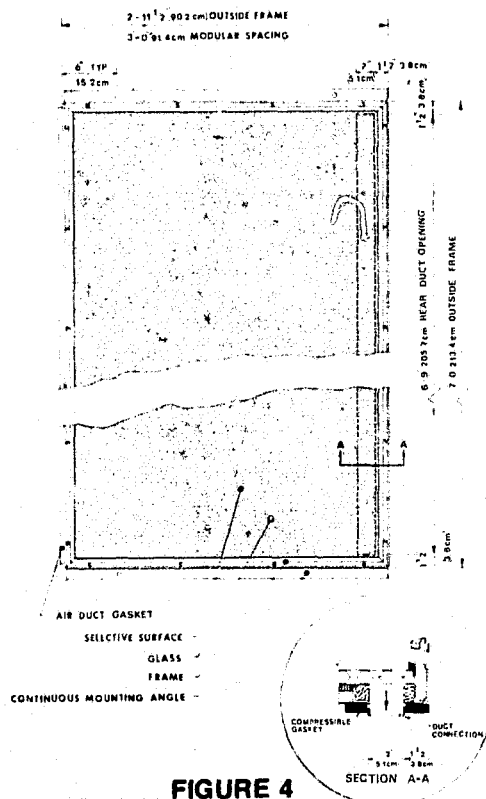


FIGURE 4

The Sunworks 3' x 7' air cooled Solector represents one of the most advanced flat plate solar energy collectors on the market today. The air cooled Solector features ductless coupling from panel to panel allowing for an array of collectors to be joined in series before returning to the main supply or return branch with no need for in field duct fabrication. This results in less field connections and ducting accessories while retaining a high installed net to gross ratio (approximately 88%). This new air cooled Solector responds to the overall design requirements of solar collector arrays for residential, commercial, industrial, and institutional building types by maximizing the amount of collectors able to be placed onto the structure while minimizing the installed cost. The optical and thermal properties as well as the physical design features of this Solector maintain the high standards of design, workmanship, and performance which set Sunworks' panels above other manufacturer's.

FEATURES AND CONSTRUCTION

Cover: Single glazing: lo-iron (A.S.G.), 1/8 in. (.32 cm) tempered, edges swiped. Double glazing: lo-iron (A.S.G.), 2-1/8 inch (.32 cm) tempered, with weep holes. Total transmissivity: Single glazing, 89.1%; Double glazing, 79.3%. (A.S.G. 1/8" or 3/16" no iron also available.)

Absorber Container: Sides, aluminum extrusion; rear aluminum sheet .032 inch (.081 cm) thickness, pop riveted in place.

Air Space Between Cover and Absorber: Approximately 3/4 to 1 inch depending upon glazing type.

Gasketing Material: EPDM "U" gasket for glazing, closed cell elastomer, compressible high temperatures silicone seal for absorber sheet. Ducting Gasket: High temperature, ultraviolet resistant, compressible closed cell silicone.

Waterproofing: This module can be placed in the weather without need for further waterproofing.

Dimensions of Surface-Mounted Module: Outside dimensions overall: 35 1/2 inches (90.2 cm) wide x 84 inches (213.4 cm) long x 4 inches (10.2 cm) thick (add 1 1/4 inch (3.2 cm) each end for continuous mounting bracket). Effective absorber area = 18.68 ft² (1.74 m²) for 3' x 7' unit. Ratio of usable absorber area to total installed surface covered = 0.88. Glass area (aperture) = 18.88 ft² (1.75 m²).

Absorber: Copper sheet: 0.016 inches (.04 cm) thick (12 ounces). Selective black: minimum absorptivity, .85, maximum emissivity, .15. Manufactured by Enthone, Incorporated; guaranteed durable to 400°F (305°C). (Black chrome: absorptivity, .94 emissivity .12 also available.) Air chamber: 1/4 inch (2.22 cm) high, thermal-conductive epoxy bond to absorber with expanded core. Connection to external duct: gasketed pressure seal.

Insulation Behind Absorber: 1/2 inch (1.27 cm) thick glass fiber over 3/4 inches (1.91 cm) thick foil faced isocyanurate, R = 9.0; glass fiber (1.2 lbs/ft³ density).

Method of Anchoring: 1 1/4 inch (3.2 cm) mounting leg integral with top and bottom of frame; four 3/8" diameter holes predrilled. Capability of through bolt anywhere along its length. Prefabricated "U" clips provided for alignment of ducting gaskets.

Weight Per Module: 125 pounds (56.7 kg) (standard 3' x 7' unit). 152 pounds (68.9 kg) for double glazed unit.

Recommended Flow Rate Through Collector: 3 to 6 cfm/ft² (15 to 30 l/sec/m²) of collector.

Warranty: Five year material workmanship warranty on all parts effective from date of installation. See your local Sunworks representative for details.

drain down Solector®

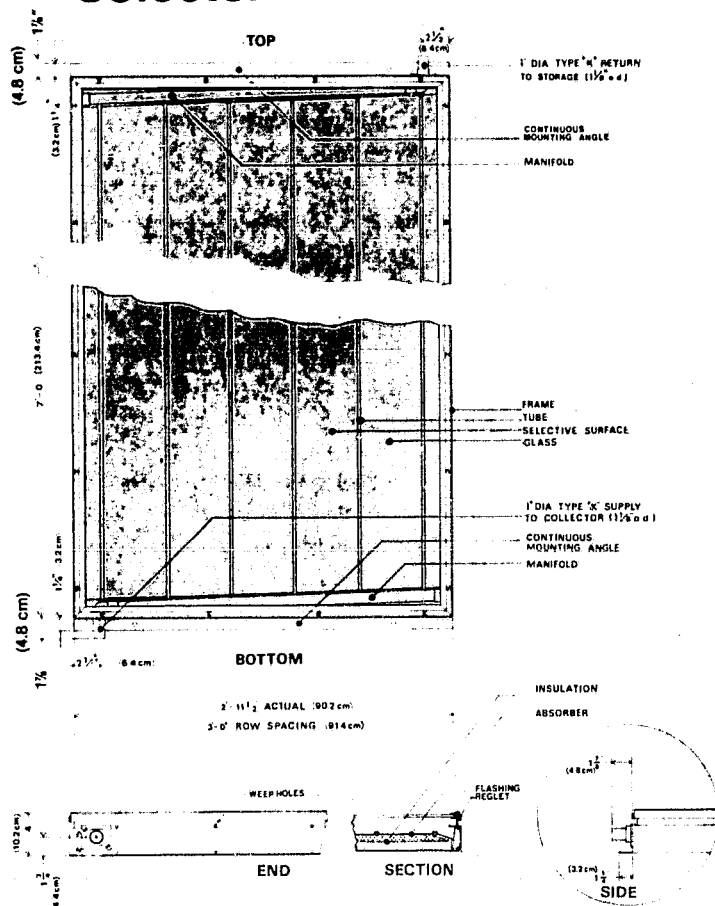


FIGURE 5

DESIGN SERVICES

To receive further information on the Sunworks Solector® solar energy collector, call the SWEETS BUYLINE 800-255-6880 for your local Sunworks representative. Your Sunworks representative will bring you further technical information on the Sunworks Solector® solar energy collector, including thermal performance in accordance with ASHRAE 93-77, pressure drop analysis, recommended piping/ducting arrangements, mounting details, etc.

The Sunworks representative will also introduce you to the professional design assistance services available to specifiers of Sunworks solar energy products. This service includes computer simulations of collector performance, system sizing, return on investment analysis and a complete engineering design manual.

The Sunworks liquid cooled drain down Solector is designed to be used in systems which require periodic draining for freeze protection. This Solector has the same high quality workmanship and is comparative in performance to the internal manifolded Solector. The drain down Solector configuration responds to the specific design requirements of a solar collector array which needs to be rapidly drained of liquid and to insure total removal of gasses on the refilling of the system. The drain down Solector is applicable to large commercial systems using external headers or smaller residential systems.

FEATURES AND CONSTRUCTION

Cover: Single glazing; lo-iron (A.S.G.) content, 1/8 in. (.32 cm) tempered, edges swiped. Double glazing; lo-iron (A.S.G.) content, 2-1/8 in. (.32 cm) tempered, edges swiped. Solar transmissivity, single glazing = 89.1% — double glazing = 79.3%. (A.S.G. 1/8" or 1/16" no iron also available.)

Absorber container: Sides, aluminum extrusion; rear aluminum sheet 0.032 in. (.081 cm) thickness, pop rivet in place. Air space between cover and absorber: approximately 3/4 to 1 in.

Gasketing material: EPDM "U" gasket.

Weatherproofing: This module can be placed out in the weather without need for further weatherproofing.

Finish: On aluminum sides of container: standard mill finish. Anodized clear or black finish (available at extra cost).

Dimensions: Of surface-mounted module: outside dimensions overall: 35 1/2 in. (90.2 cm) wide x 84 in. (213.4 cm) long x 4 in. (10.2 cm) thick (add 1 1/4 in. (3.2 cm) each end for continuous mounting bracket). Effective absorber area = 18.68 ft² (1.74 m²). Ratio of usable absorber area to total surface covered = 0.902. Glass area: 18.88 ft² (1.76 m²).

Solector solar energy collectors can be mounted end-to-end for series flow or side-by-side for parallel flow. It is recommended that no more than 3 collectors be connected in series.

Absorber: Copper sheet: 0.010 in. (.025 cm) thick (7 oz.). Selective black: minimum absorptivity .85, .92 maximum emissivity .07, .35 manufactured by Enthone, Inc., guaranteed durable to 400°F (305°C). (Black chrome: absorptivity, .94 emissivity, .12 also available.) Copper tubes: 1/4 in. (type L). Tube spacing: 6 in. (15.24 cm) on center. Tube pattern: grid. Bond between tube and sheet: 270° wrap high temperature solder. Manifolds: 1 in. (type M) copper. Tube connections to manifold: brazing alloy. Connection to external piping: 1 in. (type K) copper; extending 1 1/2 in. (4.76 cm) beyond collector ends; supply, bottom left; return, top right (when viewed from glazing side). Manifold/tubes pressure-tested to 15 atm; recommended 125 psig (8.5 atm) working pressure.

Insulation: .5 inch (1.25 cm) thk. glass fiber (compressed) over 1.0 in. (2.5 cm) thk. foil-faced isocyanurate, R = 10.0 (glass fiber density, 1.2 lbs/ft³).

Method: Of anchoring: continuous mounting bracket at each end of frame for anchoring; four predrilled holes are provided for anchor bolt or screw connections; additional holes may be drilled by installer if required.

Weight per module: 113.9 pounds (51.7 kg), filled; 111 pounds (50.3 kg), empty. Add 27 lbs. (12.2 kg) for double glazed unit.

Recommended flow rate through collector: 14.7 #/ft²/hr (0.75 gpm) (0.047 l/sec) per collector.

Collector coolant: Coolant should be Sunsol 60 made by Sunworks or equivalent. In areas where regular tap water is used as a coolant, it is important that the pH be controlled between 6.5 and 8 and the Ca, Mg count below 50 ppm.

Warranty: Five year material workmanship warranty on all parts effective from date of installation. See your local Sunworks representative for further details.

NOTE: Manufacturer reserves right to change specifications and dimensions without notice.



SUNWORKS

SUNSOL 60

P.O. BOX 1004 • NEW HAVEN, CONNECTICUT 06508 • (203) 934-6301

SUNSOL 60

Sunsol 60 is a non-toxic, non-flammable heat transfer media for solar collectors. It contains special corrosion inhibitors that will protect the life of the copper and steel components of solar heating installations.

Sunsol 60 also contains a certified non-toxic dye for easy identification of leaks that may occur in the system.

Sunsol 60 can be used as is, undiluted. It will protect the installation against freezing to a temperature of -55°Fahrenheit. For areas where the minimum winter temperature is higher, water may be added following the instructions of Table I.

TABLE I

Minimum Temperature	Sunsol 60	Water	Final Solution Volume
-55°F	5 gal		5 gal
-40°F	5 gal	0.5 gal	5.5 gal
-20°F	5 gal	1 gal	6 gal
0°F	5 gal	1.75 gal	6.75 gal
10°F	5 gal	5 gal	10 gal
20°F	5 gal	10 gal	15 gal

SPECIFICATIONS

SPECIFIC GRAVITY: 8.7 lbs/gallon

VISCOSITY:

0°C	40 cps
20°C	10 cps
40°C	4 cps

SURFACE TENSION: 25°C 42.5 dynes/cm

VAPOR PRESSURE: 20°C 12 mm Hg

SPECIFIC HEAT:

25°C808
50°C833
70°C857

BOILING POINT:

1000 mm	116°C	240°F
760 mm	109°C	228°F
300 mm	82°C	180°F

FLASH POINT: NONE

TOXICITY: Non-toxic; contains no hazardous ingredients

Our recommendations are made in good faith and are based on our skill and experience. However, since the conditions of use of these products are beyond our control, this information is given on the express condition

and agreement that Enthone, Inc., will not be liable to any person by reason thereof. Nothing herein shall be deemed to be a recommendation to use any product in violation of any existing patent rights.

Available in 5 and 55 gal. containers.
See your Sunworks Representative for pricing and shipping.
Manufactured by Enthone, Inc.

Measure "X" to the nearest 1/16"

- c) Clean 4 - 2" pieces of 1" type M Copper Tubing with emery cloth. Place a mark with tube cutter 1/4" in from the end of the tube. See Fig. 3.

1" Dia. Type "M" Tubing

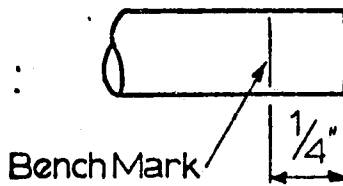


Figure 3

- d) Cut the connecting male couplings in the middle with a thin hack saw blade. Avoid Damage to the Swedges.
- e) Remove collector "B" from the array.
- f) Remove stubs from collectors "A", "B" and "C" and any solder remaining in the swedges. Emery cloth or wire brush is helpful.
- g) Apply flux to all swedges.

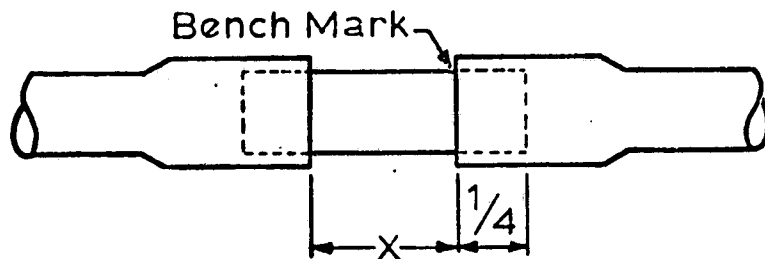


Figure 5

- 1) Use needle nose pliers or similar tool to move connector nipple into position.
- m) Repeat for all other connections
- n) Solder connections with 95/5 tin antimony.
- o) Check for leaks by pressurizing system.

NOTE:

A generous quantity of flux paste on the connecting nipple and in the swedges will permit the nipple to slide into position easily. A channel-lock plier may be used instead of needle point pliers.

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REPLACING A SELECTOR MODULE

1) Collectors at the ends of an array can be easily removed.

) Removal from the other locations can be accomplished as follows:

a) Assume Selector "B" is to be removed. See Fig. 1.

1" Dia. Nipple Typ. 4 pls.

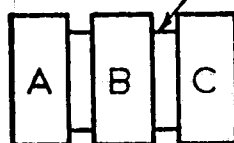


Figure 1

b) Accurately measure the distance between the swedges. (The length of the exposed connecting nipple) See Fig. 2.

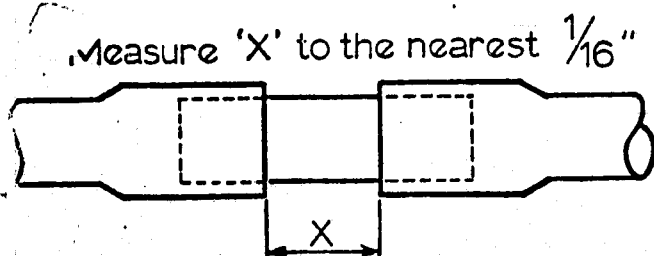


Figure 2

h) Cut the 4 pieces of Type M tubing $\frac{1}{2}$ " longer than the measurement "X". The $\frac{1}{4}$ " bench mark is included in the overall dimension ($\frac{1}{2}$ " plus "X".)

i) Insert the four (4) male coupling nipples into the swedges of collector "B" until they stop. See Fig. 4.

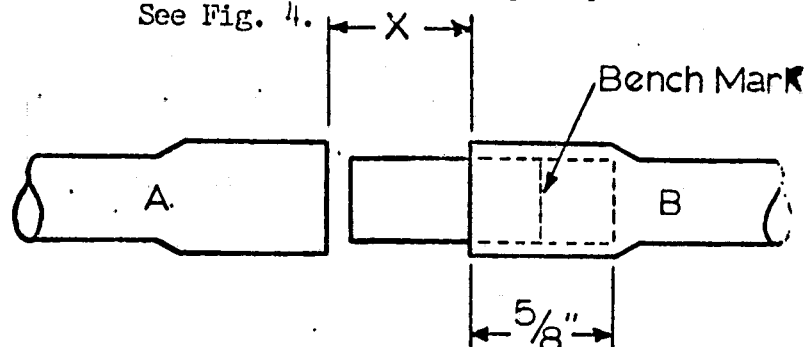


Figure 4

Example: Assume "X" = $\frac{1}{4}$ "

Add $\frac{1}{2}$ "

Nipple lg. = $\frac{3}{4}$ "

Nipple shown in stopped position.

j) Carefully place collector "B" into position. Note there is only $\frac{1}{8}$ " gap between end of header swedge and edge of nipple. See Fig. 4.

k) Align swedge of adjacent collector with coupling nipple and slide nipple into swedge until bench mark is in alignment with edge of swedge. See Fig. 5.

16. TEMPERATURE CONTROLS

Sequence of Operation

Citizens Mutual Savings & Loan

Solar Storage Summer

If ambient temperature within solar collector is less than 100° , valve V-1 is open to storage tank "W". If Solar collector temperature is above 100° then valve position is determined by Delta Temperature controller. If temperature difference between sensors is less than 20° the diverting valve V-1 is open to storage tank "W".

Solar Storage Winter

If storage tank "W" temperature is 195° or greater the diverting valve V-2 will position to allow water to go into storage tank "C". Outdoor thermostat will position diverting valve to allow water to go into storage tank "C" anytime outdoor temperature is below 60° .

Heat Dissipation

Anytime storage tank "W" temperature T-2 is 200° or greater, then diverting valve V-3 will open to allow flow through heat dissipation heat exchanger, and will start condenser water pump. Interlock will prevent operation of absorption units and water-to-air heat pumps if storage tank "W" temperature is 200° T-2 or greater.

Domestic Water Heating

Sensor in water leaving heat exchanger HE-2 will position (modulate) mixing valve V-5 to maintain set point of 120° . Set electric element thermostat in domestic electric water heater at 115° .

Solar Pumps P5, P6, P7

If ambient temperature within solar collector is 100° or greater then all solar pumps will be started through time delay relay. Time delay relay is set for 15 minutes to prevent short cycle. Delta temperature controller through sensors in solar water and hot water heating water will cause solar pumps (3) to stop if solar water is not 5° or more higher than H.W. heating water. On a call for cooling, P.E. switch will cause solar pumps P6 and P7 to stop. If solar water temperature rises to 207° then solar pump P6 will restart and a continued rise in solar water temperature to 210° will cause solar pump P7 to restart.

Hot Water Heating Pump is started by auxiliary contacts in solar pump P5 starter or by temperature controller in storage tank "W" set at 60° if the supply fan is running and there is a call for heating or cooling.

Space heating and cooling - Heating and cooling control functions for each of the 5 zones are initiated from the respective space thermostat for each zone. The control functions for each zone space thermostat shall be identical as herein described and as indicated in the diagrams. The 7-day program time clock shall provide "night" setback for nights and weekend days for selected days and selected hours as directed.

"Day" Operation

A. The main air supply fan and all 5 zone heat pump air supply fans will operate continuously when the 7-day program clock is in the "Day" cycle. Unless abnormal temperatures are sensed by the fire switches (high temperature) or the low temperature control (Freeze stat). If abnormal temperatures are sensed by the fire switches or the freeze stat, all supply fans shall stop.

B. When air supply fans are not operating the outside air dampers shall go completely closed and the return air dampers shall go fully open.

C. 9# to 10# control air pressure (set zone space thermostat for 74°F. at 9#): Control system shall provide automatic changeover from heating to cooling cycle.

D. 10# to 13# control air pressure: If all zones are in the cooling cycle (as determined by the zone space thermostats), the outside air dampers and the summer return air dampers shall modulate to maintain the main supply fan discharge temperature as set on the discharge temperature controller (set at 55°F). If the outside air temperature is above the setting of the outside air thermostat (set at 60°F.) and the fan discharge air temperature is above the setting on the discharge temperature controller, the outside air dampers shall close down to the minimum position as set on the minimum position switch (set for 10 % outside air). Any time one or more zones are operating in the mechanical cooling cycle (absorption unit or heat pump cooling is operating), the outside dampers shall close down to minimum position.

13# to 14-1/2# control air pressure: The hot water heating pump #P4 is operated as called for in note 6 above. If the solar heated water temperature is at 170°F. or higher, the absorption chiller units will be cycled on and off in sequence (through the step controller) to maintain chilled water temperature setting on chilled water temperature controller (set at 46°F.), except if heat dissipation from the solar heated water system is required the absorption chiller units will be locked-out of operation as called for in note 3. Chilled water pump, condenser water pump and cooling tower will be automatically started and stopped and condenser water control valve and hot water control valve for each chiller unit opened and closed from pilot control circuits in each absorption chiller unit and from other controls and interlocks shown on temperature control diagram. An immersion thermostat in the return water from the cooling tower shall prevent the operation of the cooling tower fan if return water temperature is at or below the thermostat setting (set at 75°F.). The control valve for each zone chilled water coil shall be opened and closed by its respective zone space thermostat to satisfy setting of the space thermostat.

14-1/2# to 17-1/2# control air pressure: Each zone heat pump (cooling cycle) shall be cycled on and off to satisfy the setting of its respective zone space thermostat. The condenser water pump and cooling tower shall be automatically started if one or more of the heat pumps are operating on the cooling cycle. If any one or more heat pumps are started on cooling cycle, all absorption chiller units shall be locked out of operation by breaking the control circuit to the step controller controlling the start-stop operation of the absorption chillers. All absorption

chiller unit condenser water control valves will also be closed thru the pilot circuits from their respective absorption chiller units. If heat dissipation from the solar heated water system is required, all heat pump units in the cooling cycle will be locked out of operation as called for in note 3. An emmersion thermostat in the return water from the cooling tower will prevent the operation of the cooling tower fan if the return water temperature is at or below the thermostat setting (set at 75°F). The control valves in the water connections to each heat pump water-to-refrigerant heat exchanger will be opened to cooling tower water and closed to heating water for each heat pump that is in the cooling cycle.

G. 6# to 9# control air pressure: Hot water heating pump #P4 is operated as called for in note 6. Hot water heating coil control valve is opened and closed by its respective zone space thermostat to satisfy the setting of the thermostat.

H. 3½# to 5# Control Air Pressure: Hot water heating pump #P4 is operated as called for in note 6. Hot water pump #P8 will automatically start. Heat pump reversing valve will change over to heating cycle and heat pump compressor will cycle on and off to satisfy the setting on its respective zone space thermostat. Heating water to the heat pumps will be supplied from the solar heated water system. Heating water temperature to heat pumps will be controlled with mixing control valve to maintain water temperature setting for emmersion sensor and controller (set for 68°F), in the supply pipe to the heat pumps. The control valves in the water connections to each heat pump water-to-refrigerant heat exchanger is normally open to the heating water and will be closed to the cooling tower water for each heat pump that is not in the cooling cycle. If outside air temperature is above the setting of the thermostat in the outside air duct (set at 70°F.), the heat pumps and water heating pump #P8 will be prevented from operating.

I. 2# to 3½# Control air pressure: Hot Water pump #P8 is operating (from "H" above). Heat pump reversing valve is in heating cycle and heat pump is operating (from "H" above). If the water temperature of the solar heated water is below the setting of the sensor and controller (set at 68°F.) in the solar heating water supply pipe connection to the heat pump heating water circuit, the auxiliary instantaneous electric water heater elements shall be energized to maintain the heater water temperature setting of the emmersion controller in the heater (set at 75°F.) and the control valves in the piping connections between the auxiliary heater water circuit and the solar heated water circuit will be closed to the solar heated water and open to the auxiliary heater water. The auxiliary heater shall not be energized if pump #P8 is not operating, or if the flow switch contacts in the auxiliary heater supply pipe is not closed, or if the safety emmersion thermostat in the heater senses 125°F. water temperature, or if the sensor and control in the solar heated water is at or above its setpoint (68°F.). Emmersion controller for heater water temperature shall provide for 2-steps of heater element control.

J. When the outside air temperature is below setting on the outside air thermostat (set at 60°F.), the winter return air dampers will fully open. The summer return air dampers will completely close

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and the outside air dampers will completely close.

Night Operation

K. When the 7-day program time clock is in the "night" setback cycle, all supply fans will be shut down. The outside dampers will be completely closed, the return air dampers will be fully open, all space cooling equipment will be shut down, and the heat pumps and auxiliary electric water heater for the heat pump heating water will be shut down. The "night" setback cycle will be by-passed by operation of the mechanical by-pass timer switch for one to six hour operation as selected. By-passing the "night" setback cycle will put all space heating and cooling systems in the "day" mode of operation. When in the "night" setback cycle the space conditioning systems will not operate for cooling requirements unless "night" setback cycle, all supply fans and heating systems as described in "G", "H" and "J" will provide heating as required to satisfy setting of the "night" thermostat (set at 62°F.) located in room #114.

L. A time-delay relay with 2 minutes to 60 minutes adjustment (set for 10 minutes) and with delay on energization will be installed in the main fan interlock circuit to prevent heat pump compressors and heating water pump #P8 from starting until fan has started and the time delay has elapsed.

**CITIZENS MUTUAL
Valve Assemblies**

Function	Control Dwg. Designation	Quantity	Part Number
Water Storage Tank	V-1 & 2	2	VK 8177-121-1-11
Solar Heat Dissipation	V-3	1	VK 8047-121-2-13
Solar Heat Dissipation	V-4	1	VK 8177-121-2-14
Absorption Chillers Solar & Cond. Water		10	VK 1515-421-1-9
Domestic Hot Water		1	VK 8045-521-1-4
Aux. Htg. Water		1	VK 8045-521-1-8
Instantaneous Electr. H.W.		2	VK 8177-121-1-10
Zone Valves			
Chilled Water Coil Valves		5	VK4*-2525-521-1-9
Hot Water Coil Valves		4	VK4*-2025-501-1-8
Hot Water Coil Valves		1	VK4*-2025-501-1-1
Ht. Pump Cond. Wtr. Valves		6	VK 3145-421-1-7
Ht. Pump Cond. Wtr. Valves		4	VK 3145-421-1-8

* VK-4 indicates valves actuator with positive positioning relay.



Product Information

Pneumatic Unitary Valves VK Series

Proportional Pneumatic Valves Using Number 11 Actuator



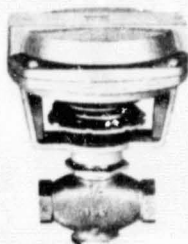
**Two Way
Single Seat, N.O.**
1/2" Thru 1 1/4"

VK-1115 ☐

For proportional control of hot and chilled water or low pressure steam. Used primarily on fan coil units, radiators and small unitary air conditioners. **Device:** Single seat bronze body with integral seat and 150 psi static pressure rating with union end on outlet and FNPT inlet. Available in angle and straightway patterns. Polished stainless steel stem with spring-loaded Teflon packing rings. Equal percentage high rangeability throttling plugs, with composition disc for tight shutoff.

Maximum Fluid Temperature (Min. +40°F)

Service	160°F Ambient	220°F Ambient
Steam	281°F	250°F
Water	281°F	250°F



**Two Way
Single Seat N.C.**
1/2" Thru 1 1/4"

VK-1515 ☐

For proportional control of the hot and chilled water or low pressure steam. Used primarily on fan coil units, radiators and small unitary air conditioners. **Device:** Single seat bronze body with integral seat and 150 psi static pressure rating. FNPT end connections. Straightway pattern. Polished stainless steel stem with spring-loaded Teflon packing rings. Equal percentage high rangeability throttling plugs, with composition disc for tight shutoff.

Maximum Fluid Temperature (Min. +40°F)

Service	160°F Ambient	220°F Ambient
Steam	281°F	250°F
Water	281°F	250°F



Three-Way Mixing
1/2" Thru 1"

VK-3145 ☐

For proportional control of water. Used primarily on small air conditioning units and similar application requiring a compact proportional three-way valve. **Device:** Compact two-way bronze body with 150 psi static pressure rating. Body has FNPT end connections. Polished stainless steel stem with spring-loaded Teflon packing rings, brass plug.

Maximum Fluid Temperature (Min. +40°F)

Service	160°F Ambient	220°F Ambient
Water	281°F	250°F



Three-Port Sequencing
1/2" SAE Flare

VK-3345 ☐

For proportional sequencing control of hot and chilled water. Used primarily on small two-pipe supply, air conditioning units with a common return. **Device:** Tight closing. Forged brass body has 250 psi static pressure rating. SAE flare fitting, threaded for standard 1/2" OD (3/8" nominal) flare nuts (not included). Polished stainless steel stem with spring-loaded Teflon packing rings and self-adjusting packing. Two tight closing discs are connected by spring-loaded sequencing mechanism. Discs have equal percentage, high turndown ratio, brass throttling plugs.

Maximum Fluid Temperature (Min. +40°F)

Service	160°F Ambient	220°F Ambient
Water	250°F	250°F

ACTUATORS FOR ALL ASSEMBLIES (MK 4600 SERIES)

A compact spring-return pneumatic power unit actuated by a tough, wear-resistant, easily-replaceable molded neoprene diaphragm, with an effective area of 11 square inches. The housing is a sturdy die-cast case incorporating a beaded diaphragm seal. Spring raises the valve stem on loss of air pressure. The actuator may be rotated on the valve to align the air connection with control piping, and can be removed from the valve without disturbing the spring setting. The air connection is 1/4" NPT female in the side of the cover. Operating range is 5 psi; 3 to 8, 5 to 10,

or 8 to 13, factory set. Start Point — field adjustable ± 2 psi. Valve position is indicated by integral pointer.

Control Requirements: Uses any Barber-Colman pneumatic proportional controller.

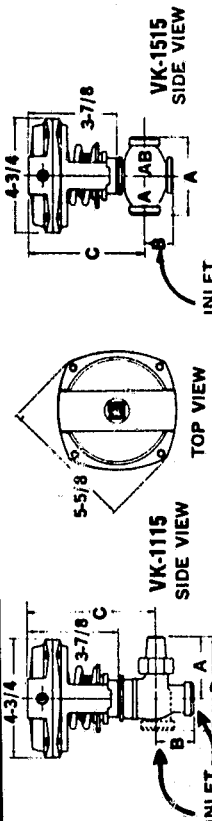
Installation: Valve may be mounted in any position. Actuator may be swiveled to any convenient position and can be removed from the valve body as a unit. Maximum ambient temperature 220 F. Minimum ambient temperature 0 F. Maximum control air pressure 30 psig.

Proportional Pneumatic Valves Using Number 11 Actuator

Valve Assembly Number	Valve Size	Flow Coefficient Cv		Close-Off Pressure Ratings*								Maximum Recommended Differential Pressure			Maximum Fluid Inlet Pressure psig		Dimensions (Inches)						
				15 psig Supply Air				20 psig Supply Air									Angle			Straightway			
				3-8 Spg Reg		8-13 Spg Reg		3-8 Spg Reg		8-13 Spg Reg		A			B								C
				Steam	Water	Steam	Water	Steam	Water	Steam	Water							Steam	Water	Steam	Water		
VK-1115	1/2	1	Angle	Stwy	35	150	35	40	35	150	35	150	25/16	1 1/8	5 1/4	2 3/4	3/4	6 1/4	4 1/8				
			64	1.4	1.4	2.5	35	150	35	150	35	150	2 3/16	1 1/16	5 1/4	2 3/4	3/4	6 1/4	4 1/8				
			2	1.4	1.4	2.5	35	150	35	150	35	150	2 3/16	1 1/16	5 1/4	2 3/4	3/4	6 1/4	4 1/8				
	3/4	5	Angle	Stwy	35	115	8	8	35	150	35	115	2 3/16	1 1/16	5 1/4	2 3/4	3/4	6 1/4	4 1/8				
			40	5.6	35	115	8	8	35	150	35	115	2 3/16	1 1/16	5 1/4	2 3/4	3/4	6 1/4	4 1/8				
			6	6.7	35	115	8	8	35	150	35	115	2 3/16	1 1/16	5 1/4	2 3/4	3/4	6 1/4	4 1/8				
	1	7	Angle	Stwy	35	60	—	—	35	125	35	60	3 1/8	2	5 1/2	3 3/8	1	6 5/8	5 1/2				
			7.0	8.5	35	60	—	—	35	125	35	60	3 3/8	2	5 1/2	3 3/8	1	6 5/8	5 1/2				
			8	8.7	35	60	—	—	35	125	35	60	3 3/8	2	5 1/2	3 3/8	1	6 5/8	5 1/2				
VK-1515	1 1/4	9	Angle	Stwy	35	35	—	—	35	75	35	35	—	—	—	—	—	—					
			8.5	9.7	35	35	—	—	35	75	35	35	—	—	—	—	—	—					
			11.4	9.7	35	35	—	—	35	75	35	35	—	—	—	—	—	—					
	3/2	4	Angle	Stwy	35	75	35	100	35	75	35	100	—	—	—	—	—	—					
			3.0	3.0	35	75	35	100	35	75	35	100	—	—	—	—	—	—					
			4	4	35	75	35	100	35	75	35	100	—	—	—	—	—	—					
	3/4	7	Angle	Stwy	30	30	35	100	30	30	35	100	—	—	—	—	—	—					
			6.8	6.8	30	30	35	100	30	30	35	100	—	—	—	—	—	—					
			9	9	30	30	35	100	30	30	35	100	—	—	—	—	—	—					
1	8	Angle	Stwy	20	20	35	70	20	20	35	70	—	—	—	—	—	—						
		9.7	9.7	20	20	35	70	20	20	35	70	—	—	—	—	—	—						
		14.5	14.5	20	20	35	70	20	20	35	70	—	—	—	—	—	—						
1 1/4	9	Angle	Stwy	10	10	35	35	10	10	35	35	—	—	—	—	—	—						
		14.5	14.5	10	10	35	35	10	10	35	35	—	—	—	—	—	—						
		14.5	14.5	10	10	35	35	10	10	35	35	—	—	—	—	—	—						

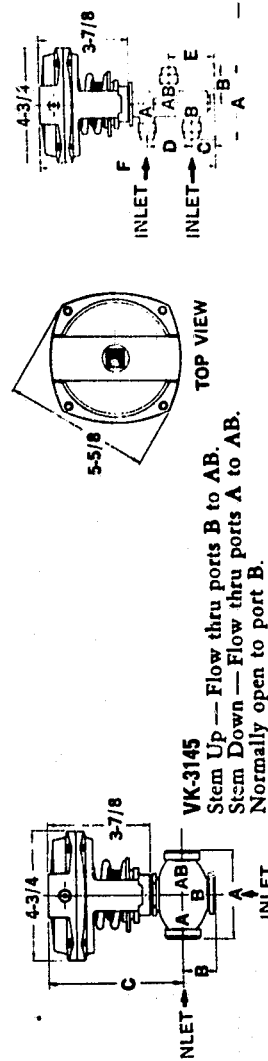
* Close-off pressure ratings apply when valves are installed with pressure under the seat. Close-off ratings are dependent on valve size and actuator spring range.

NOTE: Allow 3" clearance above actuator for removal



Valve Assembly Number	Valve Size	Flow Coefficient Cv	Close-Off Pressure Ratings *												Maximum Recommended Differential Pressure	Maximum Inlet Pressure psig	Dimensions (Inches)					
			15 psig Supply Air						20 psig Supply Air								A	B	C	D	E	F
			3-8 Spg Reg		8-13 Spg Reg		3-8 Spg Reg		5-10 Spg Reg		8-13 Spg Reg											
			Port 'A'	Port 'B'	Port 'A'	Port 'B'	Port 'A'	Port 'B'	Port 'A'	Port 'B'	Port 'A'	Port 'B'										
VK-3145	1/2	—	3.3	80	150	150	150	115	80	150	150	150	150	150	3 3/4	1 1/4	5	—	—	—		
	3/4	—	8.5	20	125	60	90	120	30	20	150	60	150	120	3 3/4	2 5/8	5 3/4	—	—	—		
	1	—	12.2	8	75	30	50	55	15	8	135	30	115	65	3 3/4	2 5/8	6	—	—	—		
VK-3345	1/2	—	1.5	—	—	120	200	—	—	—	—	120	250	—	3 1/4	1 17/32	1 1/4	1 7/8	2	7 3/4		

* "A" Port Ratings = Pressure at Port "A" minus Pressure at Port "B"
 "B" Port Ratings = Pressure at Port "B" minus Pressure at Port "A"



Stem Up — Flow thru ports B to AB.
 Stem Down — Flow thru ports A to AB.
 Normally open to port B.

Call for heat, stem retracts — Flow B to AB.
 Temperature in balance, stem in mid-position — No Flow.
 Call for cooling, stem down — Flow A to AB.

Barber-Colman Company
 CONTROLS DIVISION

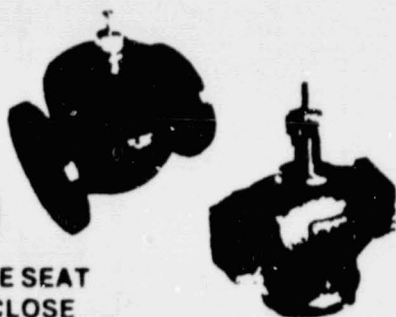
1300 Rock Street, Rockford, Illinois, U.S.A., 61101



Product Information

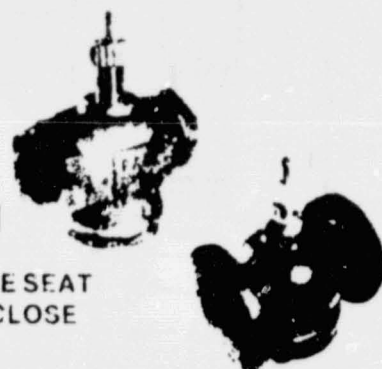
Two-Way & Three-Way Valves MK-4700 Series Or MK-6800 Series Pneumatic Operators VK Series

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VB-202 SERIES ☐ VALVE BODIES TWO-WAY, SINGLE SEAT STEM DOWN TO CLOSE

Sizes: 1/2" to 2" 2 1/2" to 4"
Body Pattern: 1/2" to 2" Globe Screwed 2 1/2" to 4" 125 lb. G.F.
Flow Type: 1/2" to 2" Equal Percentage 2 1/2" to 4" Linear
Body Material: 1/2" to 2" Brass 2 1/2" to 4" Iron
Seat Material: Brass
Stem Material: Stainless Steel
Plug Material: Brass
Disc: Composition
Stem Packing: Graphite
Max. Operating Press.—Steam: 35 psig
Max. Operating Press.—Water: 150 psig 1/2" to 2" 125 psig 2 1/2" to 4"
Recommended Diff. Press.—Steam: 25 psig*
Recommended Diff. Press.—Water: 35 psig*
Fluid Temps.—Steam: 138°C (281°F) Maximum
Fluid Temps.—Water: 4°C (+ 40°F) thru 149°C (300°F)
Factory Available Valve Assemblies: VK-2025, VK-2027



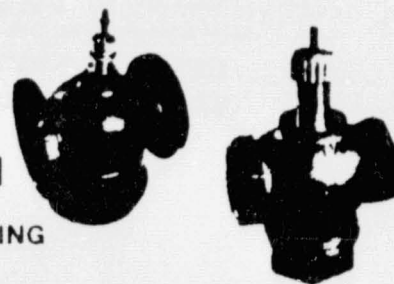
VB-252 SERIES ☐ VALVE BODIES TWO-WAY, SINGLE SEAT STEM DOWN TO CLOSE

Sizes: 1/2" to 2" 2 1/2" to 4"
Body Pattern: 1/2" to 2" Globe Screwed 2 1/2" to 4" 125 lb. G.F.
Flow Type: 1/2" to 2" Equal Percentage 2 1/2" to 4" Equal Percentage
Body Material: 1/2" to 2" Brass 2 1/2" to 4" Iron
Seat Material: Brass
Stem Material: Stainless Steel
Plug Material: Brass
Disc: Composition
Stem Packing: Graphite
Max. Operating Press.—Steam: 35 psig
Max. Operating Press.—Water: 150 psig 1/2" to 2" 125 psig 2 1/2" to 4"
Recommended Diff. Press.—Steam: 15 psig*
Recommended Diff. Press.—Water: 15 psig*
Fluid Temps.—Steam: 138°C (281°F) Maximum
Fluid Temps.—Water: 4°C (+ 40°F) thru 149°C (300°F)
Factory Available Valve Assemblies: VK-2525, VK-2527



VB-212 SERIES ☐ VALVE BODIES TWO-WAY, SINGLE SEAT STAINLESS STEEL TRIM STEM DOWN TO CLOSE

Sizes: 1/2" to 2"
Body Pattern: Globe Screwed
G.F.
Flow Type: Equal Percentage
Body Material: Brass
Seat Material: Stainless Steel
Stem Material: Stainless Steel
Plug Material: Stainless Steel
Disc: None
Stem Packing: Graphite
Max. Operating Press.—Steam: 150 psig
Max. Operating Press.—Water: 150 psig
Recommended Diff. Press.—Steam: 100 psig*
Recommended Diff. Press.—Water: 35 psig*
Fluid Temps.—Steam: 180°C (366°F) Maximum
Fluid Temps.—Water: 4°C (+ 40°F) thru 180°C (366°F)
Factory Available Valve Assemblies: VK-2125, VK-2127

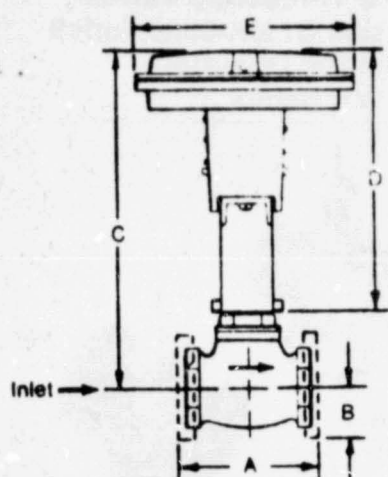


VB-804 SERIES ☐ VALVE BODIES THREE-WAY, MIXING

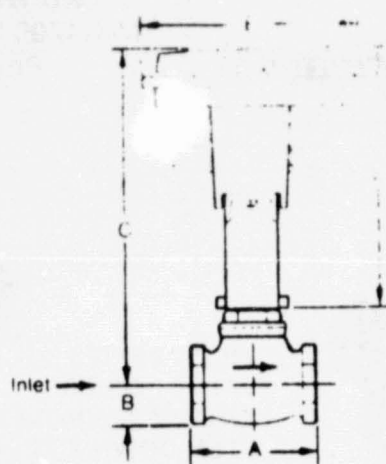
Sizes: 1/2" to 2" 2 1/2" to 4"
Body Pattern: 1/2" to 2" Globe Screwed 2 1/2" to 4" 125 lb. G.F.
Flow Type: 1/2" to 2" Mixing 2 1/2" to 4" Mixing
Body Material: 1/2" to 2" Brass 2 1/2" to 4" Iron
Seat Material: Brass
Stem Material: Stainless Steel
Plug Material: Brass
Disc: None
Stem Packing: Graphite
Max. Operating Press.—Steam: No Rating
Max. Operating Press.—Water: 150 psig 1/2" to 2" 125 psig 2 1/2" to 4"
Recommended Diff. Press.—Steam: No Rating*
Recommended Diff. Press.—Water: 35 psig*
Fluid Temps.—Steam: No Rating
Fluid Temps.—Water: 4°C (+ 40°F) thru 149°C (300°F)
Factory Available Valve Assemblies: VK-8045, VK-8047

*Maximum recommended differential pressure in full open position for mixing purposes and for steam service only.

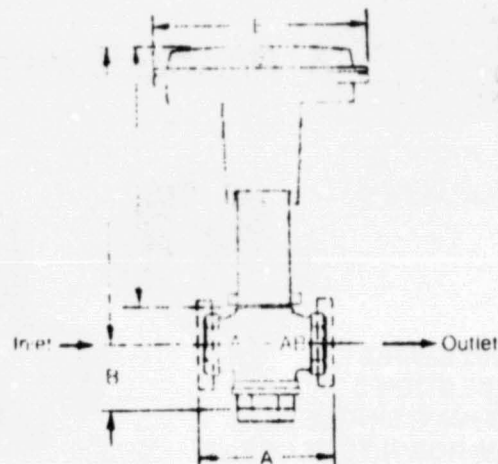
NOTE: No maximum differential rating



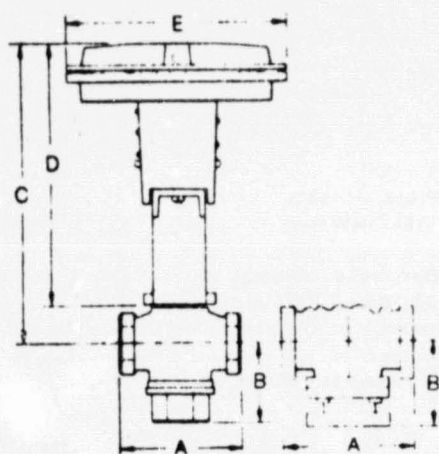
VK-2025 and VK-2027



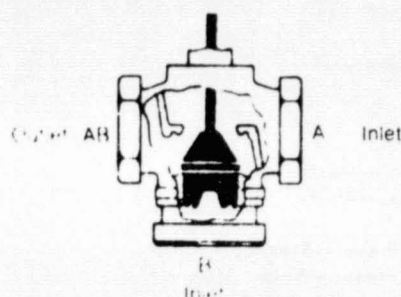
VK-2125 and VK-2127



VK-2525 and VK-2527



1/2"-2" 2-1/2"-4"
VK-8045 and VK-8047



Stem Up - Flow thru port B to port AB.
Stem Down - Flow thru port A to port AB.
Normally open to port B

Fluid Temperatures Versus Ambient Temperatures

Valve Assembly No.	Maximum Fluid Temperatures			
	71°C [160°F] Ambient		104°C [220°F] Ambient	
	Steam	Water	Steam	Water
VK-2025	138°C [281°F]	149°C [300°F]	126°C [260°F]	126°C [260°F]
VK-2027	138°C [281°F]	149°C [300°F]	126°C [260°F]	126°C [260°F]
VK-2125*	160°C [320°F]	160°C [320°F]	126°C [260°F]	126°C [260°F]
VK-2127*	160°C [320°F]	160°C [320°F]	126°C [260°F]	126°C [260°F]
VK-2525	138°C [281°F]	149°C [300°F]	126°C [260°F]	126°C [260°F]
VK-2527	138°C [281°F]	149°C [300°F]	126°C [260°F]	126°C [260°F]
VK-8045	—	149°C [300°F]	—	126°C [260°F]
VK-8047	—	149°C [300°F]	—	126°C [260°F]

*150 PSIG steam 180°C [366°F] at 45°C [114°F] ambient

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Part Number	Valve Size		Flow Coefficient Cv	Close Off Pressure Ratings												Dimensions (Inches)				
	Body Inches	Port		15 PSIG Supply Air						20 PSIG Supply Air										
				3-8 Spg Rng		5-10 Spg Rng		8-13 Spg Rng		3-8 Spg Rng		5-10 Spg Rng		8-13 Spg Rng						
				Steam	Water	Steam	Water	Steam	Water	Steam	Water	Steam	Water	Steam	Water					
VK-2025	1	8	8	35	150	—	—	10	10	35	150	—	—	35	150	3 1/4	1 1/4	1 1/4	10 1/4	4 1/4
	1 1/4	9	15	35	35	—	—	—	—	35	70	—	—	35	35	4 1/4	1 3/8	1 1/4	10 1/4	4 1/4
	1 1/2	10	22	20	20	—	—	—	—	35	50	—	—	20	20	4 1/4	1 1/2	1 1/4	10 1/4	4 1/4
	2	11	38	10	10	—	—	—	—	25	25	—	—	10	10	6	1 3/8	1 3/4	10 1/4	4 1/4
VK-2027	1 1/2	10	22	35	150	—	—	30	30	35	150	—	—	35	150	4 1/4	1 1/2	1 1/4	10 1/4	4 1/4
	2	11	38	35	85	—	—	15	15	35	150	—	—	35	85	6	1 3/8	1 1/4	10 1/4	4 1/4
	2 1/2	12	56	35	45	—	—	5	5	35	80	—	—	35	45	8 1/2	3 1/2	1 1/4	10 1/4	4 1/4
	3	13	85	30	30	—	—	4	4	35	60	—	—	30	30	9 1/2	3 3/4	1 1/4	10 1/4	4 1/4
VK-2125	4	14	145	15	15	—	—	1	1	30	30	—	—	15	15	11 1/2	4 1/2	1 1/4	10 1/4	4 1/4
	1/2	2	2	150	150	—	—	90	90	150	150	—	—	150	150	2 3/4	1	1 1/4	10 1/4	4 1/4
		3	2.8													2 3/4	1	1 1/4	10 1/4	4 1/4
		4	3.3													2 3/4	1	1 1/4	10 1/4	4 1/4
	3/4	7	5	140	140	—	—	35	35	150	150	—	—	140	140	3 1/8	1	1 1/4	10 1/4	4 1/4
	1	8	7.1	75	75	—	—	15	15	140	140	—	—	75	75	3 3/4	1 1/4	1 1/4	10 1/4	4 1/4
	1 1/4	9	16	40	40	—	—	5	5	80	80	—	—	40	40	4 1/4	1 3/8	1 1/4	10 1/4	4 1/4
1 1/2	10	22	25	25	—	—	2	2	50	50	—	—	25	25	4 1/4	1 1/2	1 1/4	10 1/4	4 1/4	
VK-2127	2	11	37	15	15	—	—	—	—	30	30	—	—	15	15	6	1 1/8	1 3/8	10 1/4	4 1/4
	1	8	7.1	150	150	—	—	95	95	150	150	—	—	150	150	3 3/4	1 1/4	1 1/4	10 1/4	4 1/4
	1 1/4	9	16	150	150	—	—	55	55	150	150	—	—	150	150	4 1/4	1 3/8	1 1/4	10 1/4	4 1/4
	1 1/2	10	22	150	150	—	—	35	35	150	150	—	—	150	150	4 1/4	1 1/2	1 1/4	10 1/4	4 1/4
VK-2525	2	11	37	80	80	—	—	15	15	150	150	—	—	80	80	6	1 1/8	1 1/4	10 1/4	4 1/4
	3/4	7	7.3	15	15	35	50	35	105	15	15	35	50	35	105	3 1/4	1 3/4	1 1/4	10 1/4	4 1/4
	1	8	12	8	8	25	25	35	55	8	8	25	25	35	55	3 3/4	1 1 1/2	1 1/4	10 1/4	4 1/4
	1 1/4	9	21	—	—	15	15	35	35	—	—	15	15	35	35	4 1/4	2 1/8	1 1/4	10 1/4	4 1/4
	1 1/2	10	29	—	—	8	8	25	25	—	—	8	8	25	25	4 1/4	2 1/4	1 1/4	10 1/4	4 1/4
VK-2527	2	11	46	—	—	5	5	15	15	—	—	5	5	15	15	5 1/8	2 1 1/2	1 1/4	10 1/4	4 1/4
	1	8	12	35	85	35	150	35	150	35	85	35	150	35	150	3 3/4	1 1 1/2	1 3/8	12 1/2	10 1/2
	1 1/4	9	21	35	55	35	120	35	150	35	55	35	120	35	150	4 1/2	2 1/8	1 1/4	12 1/2	10 1/2
	1 1/2	10	29	35	35	35	85	35	150	35	35	35	85	35	150	4 1/4	2 1/4	1 1/4	12 1/2	10 1/2
	2	11	46	20	20	35	45	35	80	20	20	35	45	35	80	5 1/8	2 1 1/2	1 1/4	12 1/2	10 1/2
	2 1/2	12	75	7	7	20	20	35	40	7	7	20	20	35	40	8 1/2	4 1/8	1 1/4	12 1/2	10 1/2
	3	13	109	4	4	15	15	30	30	4	4	15	15	30	30	9 1/2	4 1/8	1 1/4	12 1/2	10 1/2
	4	14	179	1	1	7	7	15	15	1	1	7	7	15	15	11 1/2	5 1/8	1 1/4	12 1/2	10 1/2

* Close-off pressure ratings apply when valves are installed with pressure under the seat. Close-off ratings are dependent on valve size and actuator spring range.

Part No.	Valve Size		Flow Coefficient Cv	Close-Off Pressure Ratings †												Dimensions (Inches)				
	Body Inches	Port		15 PSIG Supply Air Pressure						20 PSIG Supply Air Pressure										
				3-8 Spg Rng		5-10 Spg Rng		8-13 Spg Rng		3-8 Spg Rng		5-10 Spg Rng		8-13 Spg Rng		A	B	C	D	E
				Port 'A'	Port 'B'	Port 'A'	Port 'B'	Port 'A'	Port 'B'	Port 'A'	Port 'B'	Port 'A'	Port 'B'	Port 'A'	Port 'B'					
VK-80.5	½	4	5.1	15	120	45	80	100	25	15	150	45	150	100	120	3 ¼	2 ½	11 ¼	10 ¼	4 ¼
	¾	7	7.5	15	120	45	80	100	25	15	150	45	150	100	120	3 ¼	2 ½	11 ¼	10 ¼	4 ¼
	1	8	12	5	65	25	40	60	15	5	120	25	100	60	65	3 ¾	2 ¾	11 ¾	10 ¾	4 ¾
	1¼	9	21	0	40	10	20	35	5	0	70	10	60	35	40	4 ¼	2 ¾	11 ¾	10 ¾	4 ¾
	1½	10	32	0	25	5	15	20	2	0	45	5	40	20	25	4 ¾	2 ¾	11 ¾	10 ¾	4 ¾
	2	11	49	0	10	2	5	10	0	0	25	2	20	10	10	5 ¾	3 ½	12 ½	10 ¾	4 ¾
VK-8047	1	8	12	85	150	150	150	150	85	85	150	150	150	150	150	3 ¾	2 ¾	13 ¾	12 ½	1 ½
	1¼	9	21	50	150	110	135	150	50	50	150	110	150	150	150	4 ¼	2 ¾	14	12 ½	1 ½
	1½	10	32	35	140	80	90	145	35	35	150	80	150	145	140	4 ¾	2 ¾	14 ¾	12 ½	1 ½
	2	11	49	20	85	45	55	80	20	20	145	45	120	80	85	5 ¾	3 ½	14 ¾	12 ½	1 ½
	2½	12	74	8	45	22	34	45	10	8	85	22	70	45	45	8 ½	5 ¾	15 ¾	12 ½	1 ½
	3	13	101	4	30	15	23	30	6	4	55	15	45	30	30	9 ½	6 ¾	16 ¾	12 ½	1 ½
	4	14	169	2	20	8	15	20	3	2	35	8	30	20	20	11 ½	8 ½	16 ¾	12 ½	1 ½

† "A" Port Ratings = Pressure at Port "A" Minus Pressure at Port "B"
"B" Port Ratings = Pressure at Port "B" Minus Pressure at Port "A"

11 SQ. IN. ACTUATOR ON VK-2025 ☐
1"-2" VB-202
VALVE BODIES
TWO-WAY, SINGLE SEAT
NORMALLY OPEN

For proportional control of chilled or hot water and low pressure steam
 Actuators: MK-4700 Series



50 SQ. IN. ACTUATOR ON VK-2027 ☐
1"-4" VB-202
VALVE BODIES
TWO-WAY, SINGLE SEAT
NORMALLY OPEN

For proportional control of chilled or hot water and low pressure steam
 Actuators: MK-6800 Series



11 SQ. IN. ACTUATOR ON VK-2125 ☐
1/2" to 2" VB-212
VALVE BODIES
TWO-WAY, SINGLE SEAT
STAINLESS STEEL TRIM
NORMALLY OPEN

For proportional control of hot water and steam
 Actuators: MK-4700 Series



50 SQ. IN. ACTUATOR ON VK-2127 ☐
1"-2" VB-212
VALVE BODIES
TWO-WAY, SINGLE SEAT
STAINLESS STEEL
NORMALLY OPEN

For proportional control of hot water and steam
 Actuators: MK-6800 Series



11 SQ. IN. ACTUATOR ON VK-2525 ☐
1"-2" VB-252
VALVE BODIES
TWO-WAY, SINGLE SEAT
NORMALLY CLOSED

For proportional control of water or steam
 Actuators: MK-4700 Series



50 SQ. IN. ACTUATOR ON VK-2527 ☐
1"-4" VB-252
VALVE BODIES
TWO-WAY, SINGLE SEAT
NORMALLY CLOSED

For proportional control of water or steam
 Actuators: MK-6800 Series



11 SQ. IN. ACTUATOR ON VK-8045 ☐
1/2" to 2" VB-804
VALVE BODIES
THREE-WAY, MIXING

For proportional control of liquids or mixing applications. Used primarily for hot and chilled water or air conditioning systems, or as a mixing valve on hot water heating installations.
 Actuators: MK-4700 Series



50 SQ. IN. ACTUATOR ON VK-8047 ☐
1"-4" VB-804
VALVE BODIES
THREE-WAY, MIXING

For proportional control of liquids or mixing applications. Used primarily for hot and chilled water or air conditioning systems, or as a mixing valve on hot water heating installations.
 Actuators: MK-6800 Series



Actuator For All Assemblies

Actuator: A pneumatic spring return actuator consisting of a diaphragm and spring combination, yoke-mounted to the valve body. Diaphragm is neoprene. Springs are color coded to indicate spring range. Air inlet is 1/8" NPT female opening on side of diaphragm housing. Valve position indicator shows 1/8 increments of stroke between open and closed position. Spring raises valve stem on loss of air pressure. With maximum air pressure, valve stem moves down. Replacement valve linkage is AV-430.

VK-XXX5 Actuator 11 sq. in. effective area (MK-4700 Series)

VK-XXX7 Actuator 50 sq. in. effective area (MK-6800 Series)

Installation: Normally, connected with power unit upright and valve in horizontal position. Actuator can be rotated on valve bonnet for alignment with air supply piping. Actuator can be removed from valve body without disturbing spring setting. Minimum ambient temperature -179°C (-60°F) maximum is 164°C (320°F). Diaphragm is pressure tested at factory for 30 psi maximum control air pressure.

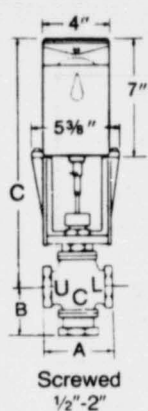
Barber-Colman Company
CONTROLS DIVISION

264 1300 Rock Street, Rock Hill, South Carolina, U.S.A. 29730



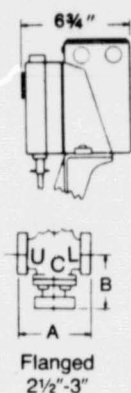
Product Information

Three-Way Diverting Valves VB-817, Series 1/2"-6" VK-8177 and VP-8174 Series Valve Assemblies

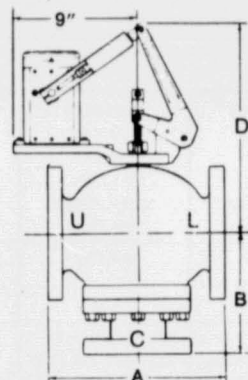


Screwed
1/2"-2"

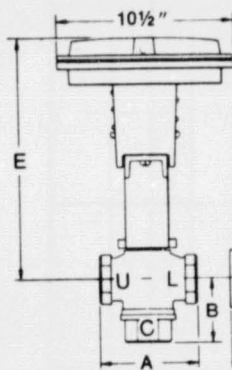
VP-8174



Flanged
2 1/2"-3"



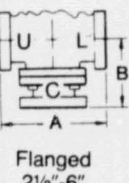
VP-8174 Flanged
4"-6"



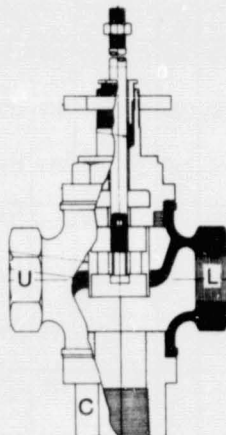
Screwed
1/2"-2"

Normally Open
To Port "L"

VK-8177



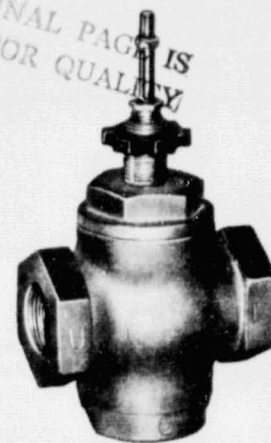
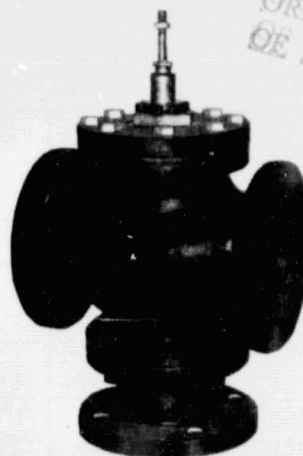
Flanged
2 1/2"-6"



C
Inlet

Stem Down Flow
Port "C" To Port "U"

Stem Up Flow
Port "C" To Port "L"



**VB-817 SERIES
VALVE BODIES
THREE-WAY, DIVERTING**

Sizes: 1/2" to 6"

Body Pattern: 1/2" to 2" Globe Screwed, 2 1/2" to 6" 125 lb. Globe Flanged

Flow Type: 1/2" to 6" Diverting

Body Material: 1/2" to 2" Brass, 2 1/2" to 6" Iron

Seat Material: Brass

Stem Material: Stainless Steel

Piston Material: Brass

Piston Seal: Teflon insert with Ethylene Propylene

"O" Ring

Disc: None

Stem Packing: Teflon Asbestos

Max. Operating Press.—Steam: No Rating

Max. Operating Press.—Water: 250 psig 1/2" to 2", 125 psig 2 1/2" to 6"

Recommended Diff. Press.—Steam: No Rating

Recommended Diff. Press.—Water: 35 psig*

Fluid Temps.—Steam: No Rating

Fluid Temps.—Water: -28°C (-20°F) thru 149°C (300°F)

Factory Available Valve Assemblies: VK-8177, VP-8174

*Maximum recommended differential pressure in full open position for sizing purposes and normal life of seat and disc. **Note:** Do not exceed close-off rating.

Valve Size (Inches)	Flow Coefficient CV		Dimensions (Inches)				
	Port "L"	Port "U"	A	B	C	D	E
1/2	7	6	4 3/4	3 1/2	15 1/4	—	15 1/4
3/4	8	7	4 3/4	3 1/2	15 1/4	—	15 1/4
1	13	11	4 3/4	3 1/2	15 1/4	—	15 1/4
1 1/4	21	18	5 5/8	3 5/8	15 3/4	—	15 3/4
1 1/2	28	24	5 5/8	3 5/8	15 3/4	—	15 3/4
2	47	40	6 1/2	4	16	—	16
2 1/2	75	68	9	7 1/8	17 1/8	—	17 1/8
3	95	85	10	8	18	—	18
4	180	160	13	8 7/8	—	24 1/8	21
5	220	195	12	10 1/2	—	24 5/8	21 1/2
6	275	250	14 1/2	11 1/16	—	25 1/4	22 1/8

Fluid Temperatures Versus Ambient Temperatures

Valve Assembly	Maximum Fluid Temperature			
	37°C (100°F) Ambient		60°C (140°F) Ambient	
	Steam	Water	Steam	Water
VP-8174	—	149°C (300°F)	—	126°C (260°F)
Valve Assembly	71°C (160°F) Ambient		104°C (220°F) Ambient	
	Steam	Water	Steam	Water
	—	149°C (300°F)	—	126°C (260°F)

Actuator					Type I Electric Actuator	Type II Electric Actuator	Pneumatic 50 sq. in. Actuator 3-8 lbs. Spring Range MK-6801				Pneumatic 50 sq. in. Actuator 5-10 lbs. Spring Range MK-6811				Pneumatic 50 sq. in. Actuator 8-13 lbs. Spring Range MK-6821				Pneumatic 50 sq. in. Actuator 5-10 lbs. Spring Range MK-6911							
Linkage ½"-3" Valves					AV-300& AV-29	AV-300& AV-30	AV-430				AV-430				AV-430				—							
4"-6" Valves					AV-351-10	AV-351-10	—				—				—				AV-430							
Factory Available Valve Assembly (Actuator, Linkage and Valve Body)					VP-8174 ZZZ-P-S	VP-8174 ZZZ-P-S	VK-8177-101-P-S				VK-8177-111-P-S VK4-8177-111-P-S*				VK-8177-121-P-S				VK-8177-111-21-S VK4-8177-111-21-S*							
							15 Psig Supply Air	20 Psig Supply Air	15 Psig Supply Air	20 Psig Supply Air	15 Psig Supply Air	20 Psig Supply Air	15 Psig Supply Air	20 Psig Supply Air	15 Psig Supply Air	20 Psig Supply Air										
Valve Body				Desc.	Size (In)	CV Port		Close-Off Pressure Rating																		
	P ¹	S ¹	L			U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U
VB-817-0	-1	-4	Globe Screwed	½	7	6	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	—	—	—	—
VB-817-0	-1	-7	Globe Screwed	¾	8	7	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	—	—	—	—
VB-817-0	-1	-8	Globe Screwed	1	13	11	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	—	—	—	—
VB-817-0	-1	-9	Globe Screwed	1¼	21	18	250	250	250	250	100	100	100	100	250	250	250	250	100	100	250	250	—	—	—	—
VB-817-0	-1	-10	Globe Screwed	1½	28	24	250	250	250	250	100	100	100	100	250	250	250	250	100	100	250	250	—	—	—	—
VB-817-0	-1	-11	Globe Screwed	2	47	40	250	250	250	250	—	—	—	—	250	250	250	250	—	—	250	250	—	—	—	—
VB-817-0	-2	-12	Globe Flanged	2½	75	68	125	125	125	125	—	—	—	—	125	125	125	125	—	—	125	125	—	—	—	—
VB-817-0	-2	-13	Globe Flanged	3	95	85	125	125	125	125	—	—	—	—	125	125	125	125	—	—	125	125	—	—	—	—
VB-817-0	-2	-14	Globe Flanged	4	180	160	125	125	125	125	—	—	—	—	—	—	—	—	—	—	—	—	125	125	125	125
VB-817-0	-2	-15	Globe Flanged	5	220	195	125	125	125	125	—	—	—	—	—	—	—	—	—	—	—	—	125	125	125	125
VB-817-0	-2	-16	Globe Flanged	6	275	250	125	125	125	125	—	—	—	—	—	—	—	—	—	—	—	—	125	125	125	125

*VK4-8177-111-P-S has factory installed AK-52309 positive positioner. Start point is adjustable 2 to 10 psi with range adjustable 2 to 10 psi.

Factory Available Valve Assembly†				Sizes (Inches)	Actuator	Actuator Type	Type Control ††	Actuator and/or Valve Description
	ZZZ	P	S					
VK-8177	101	-1	-S	½"-1½"	MK-6801	—	Pneu	50 Sq. In. 3-8 Lbs. Spring Range***
VK-8177	-111	-P	-S	½"-3"	MK-6811	—	Pneu	50 Sq. In. 5-10 Lbs. Spring Range***
VK-8177	-111	-2	-S	4"-6"	MK-6911	—	Pneu	50 Sq. In. 5-10 Lbs. Spring Range***
VK4-8177	-111	-P	-S	½"-3"	MK-6811	—	Pneu	50 Sq. In. 5-10 Lbs. Spring Range*** Includes AK-52309 Positive Positioner†
VK4-8177	-111	-2	-S	4"-6"	MK-6911	—	Pneu	50 Sq. In. 5-10 Lbs. Spring Range*** Includes AK-52309 Positive Positioner†
VK-8177	-121	-P	-S	½"-3"	MK-6821	—	Pneu	50 Sq. In. 8-13 Lbs. Spring Range***
VP-8174	-101	-P	-S	½"-6"	MP-381	II	Elec S/S**	24 VAC Aux. Switch
VP-8174	-103	-P	-S	½"-6"	MP-485	II	Elec	120 VAC Built-in Trans., Aux. Switch
VP-8174	-106	-P	-S	½"-6"	MP-481	II	Elec S/S*	120 VAC Aux. Switch
VP-8174	-153	-P	-S	½"-6"	MP-371	I	Elec S/S**	24 VAC Spring Return, Aux. Switch***
VP-8174	-161	-1	-S	½"-2"	MP-2113	I	Elec S/S**	24 VAC
VP-8174	-163	-1	-S	½"-2"	MP-2150	I	Elec	120 VAC Built-in Trans.
VP-8174	-651	-1	-S	½"-2"	MP-2110-600	I	S/S	120 VAC, Solid State Drive
VP-8174	-662	-P	-S	½"-6"	MP-471-600	I	S/S	120 VAC, Solid State Drive, Spring Return***
VP-8174	-666	-P	-S	½"-6"	MP-481-600	II	S/S	120 VAC, Solid State Drive

† ZZZ= Actuator Code, P= Pattern Code, S= Size Code. When ordering valve assembly, fill in "P" and "S" codes to match "P" and "S" codes of selected valve body.

†† 2 Pos=2 Position, Pneu=Pneumatic, Elec - Proportional Electric, S/S=Solid State.

*Solid state requires CP-8301, solid state drive. Electric control requires both 24 Vac and 120 Vac power.

**Solid state requires CP-8301-024, solid state drive.

‡ Positive positioner has 2 to 10 psi adjustable start point and 2 to 10 psi adjustable range.

***Spring return stem up flow "C" to "L".

Typical solid state controllers are TP-8101 or CP-8102. Typical electric controllers are TP-100 thru 400 or PP-220 series.

ORDERING INFORMATION (Examples)

Required: S/S, 120 Vac, Type II Actuator, Valve, Cv-85

Options:

Actuator, Linkage and Valve Body

Valve Assembly

Order:

MP-481-600,
AV-300 & AV-30,
VB-817-0-2-13

VP-8174-666-2-13

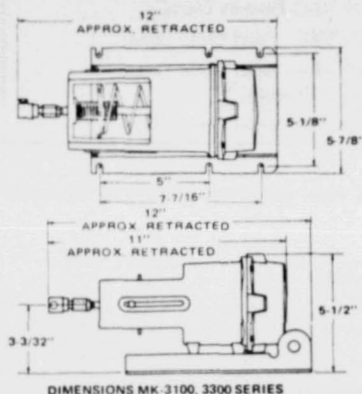
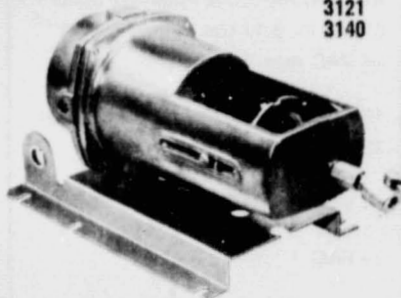


Product Information

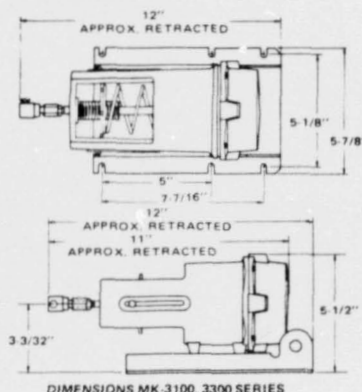
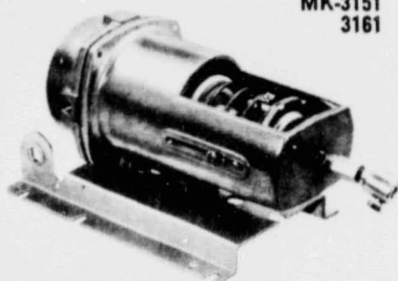
Proportional Pneumatic Damper Actuators

MK-3100 and 3300 Series No. 8

MK-3101
3111
3121
3140



MK-3151
3161



All Actuators

Effective Diaphragm Area: 8 square inches.

Maximum Safe Air Pressure: 30 psig.

Ambient Temperature Limits: 0 F minimum to 160 F maximum.

Air Connection: 1/4" NPT — Female.

Control Requirements: Uses any Barber-Colman pneumatic proportional controller.

Installation: Actuator may be mounted in any position. Mounting bracket and swivel connector for 5/16" diameter push rod included with actuator.

Power Unit: A compact spring-return pneumatic power unit actuated by a tough wear-resistant, easily-replaceable, molded neoprene diaphragm, with an effective area of 8 square inches. The housing is a sturdy die-cast aluminum case incorporating a beaded diaphragm seal. Integral spring returns the damper shaft to normal position on loss of air pressure. Adjustable start point provides accurate sequencing and parallel control.

Damper Ratings: Damper ratings are nominal, actual square footage which can be controlled depends on the quality of damper and the torque required to operate the dampers under job conditions. Ratings are approximate for static pressures up to 1" H₂O and velocities of 2000 fpm.

Damper Type	Proportional Control No Positioner	Proportional Control with Positioner or Two Position Control (8-13 Spring, 20 Psi Supply)
Parallel Blade	11.6 Sq Ft	34.8 Sq Ft
Opposed Blade	15 Sq Ft	45 Sq Ft

MK-3100 and 3300 Series Single Range

Uses: For proportional control of dampers and air valves.

Operating Range: 3-8, 8-13, 5-10 or 3-13 psig at 3 1/2" output shaft stroke.

Start Point: 3 psig adjustable \pm 1 psi for MK-3101, 5 psig adjustable \pm 1 psi for MK-3111, 3311, 8 psig adjustable \pm 1 psi for MK-3121, 3321, 3 psig non-adjustable for MK-3141, 3341.

Stroke Limiting Adjustment: Stroke may be adjusted from 4 inches maximum to 2 inches minimum. Stop point adjusted by limit stops positioned by clamp screws. Limiting actuator stroke changes operating range.

Net Force Exerted: At 0 psi the actuator will be held against its inner stop and will resist an opposing force of 24 lb on the MK-3141, MK-3341, MK-3101, and MK-3301, 40 lb on the MK-3111 and MK-3311, 64 lb on the MK-3121 and MK-3321. At 15 psi the actuator shaft is held against its outer stop and resists an opposing force of 16 lb on the MK-3141, MK-3341, MK-3121, MK-3321; 40 lb on the MK-3111, and MK-3311. 56 lb on the MK-3101 and MK-3301.

MK-3100 Series Dual Range

Uses: For two-stage proportional control of dampers in unit ventilator applications.

Operating Range: MK-3151, First Stage 3-6 psi, Second Stage 9-12 psi.

MK-3161, First Stage 3-6 psi, Second Stage 11-17 psi.

Start Point: 3 psig start point adjustable up to 6 psig.

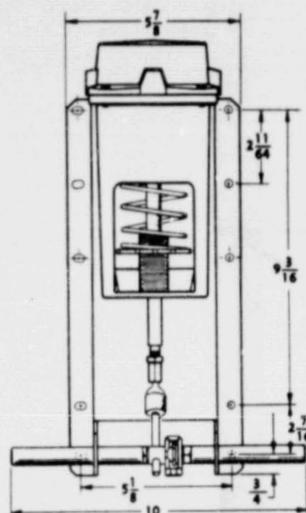
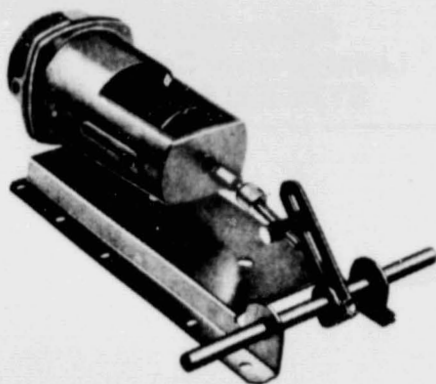
Stroke Limiting Adjustment: Maximum stroke is 2 3/4". Stop point adjusted by limit stops positioned by clamp screws. Limiting actuator stroke changes operating range.

Net Force Exerted: At 0 psi, the actuator will be held against its inner stop and will resist an opposing force of 24 lbs. With full supply pressure, the actuator shaft will be held against its outer stop and will resist an opposing force of 24 lb.

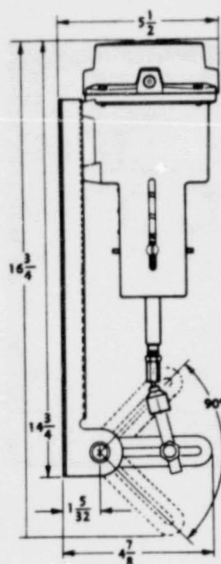
Actuator Part Number	Operating Range (psi)	Starting Pressure (psi)	Torque (lb-in.)		Work (in.-lb)		Nominal Torque* For Proportional Control
			Return Stroke	Power Stroke	Return Stroke	Power Stroke	
			With .15 psig Supply Pressure**				
MK-3101	3-8	3	42	98	84	196	21 lb. in.
MK-3301		Adj.					
MK-3111	5-10	5	70	70	140	140	
MK-3311		Adj.					
MK-3121	8-13	8	112	28	224	56	
MK-3321		Adj.					
MK-3141	3-13	3	42	28	84	56	
MK-3341		Adj.					
MK-3151	3-6 — 9-12	3	33	33	66	66	
MK-3161	3-6 — 11-17	Adj.					

* Based on a 1.5 psig pressure change at the actuator.

** Except MK-3161 (20 psig).



TOP VIEW



SIDE VIEW

Uses: For proportional control of high velocity mixing boxes or other applications requiring a rotary linkage.

Power Unit: A compact spring-return pneumatic power unit actuated by a tough, wear-resistant, molded, neoprene diaphragm. Sturdy die-cast aluminum case incorporating a beaded diaphragm seal. Integral spring returns the damper shaft to normal position on loss of air pressure. Adjustable start point provides accurate sequencing and parallel control. Output arm rotates approximately 90°.

Operating Range: 3-8, 8-13 or 5-10 psig at 3 1/2 inches output shaft stroke.

Start Point: 3 psig adjustable ± 1 psi for MK-3201, 5 psig adjustable ± 1 psi for MK-3211, 8 psig adjustable ± 1 psi for MK-3221.

Effective Diaphragm Area: 8 square inches.

Maximum Safe Air Pressure: 30 psig.

Ambient Temperature Limits: 0 F minimum to 160 F maximum.

Control Requirements: Uses any Barber-Colman pneumatic proportional controller.

Air Connection: 1/8 inch NPT — Female.

Stroke Limiting Adjustment: Stroke may be adjusted from 4 inches maximum to 2 inches minimum. Stop point adjusted by limit stops positioned by clamp screws. Limiting actuator stroke changes operating range.

Damper Ratings: Damper ratings are nominal, actual square footage which can be controlled depends on the quality of damper and the torque required to operate the dampers under job conditions. Ratings are approximate for static pressures up to 1" H₂O and velocities of 2000 fpm.

Damper Type	Proportional Control No Positioner	Proportional Control with Positioner or Two Position Control (8-13 Spring, 20 PSI Supply)
Parallel Blade	11.6 Sq Ft	34.8 Sq Ft
Blade Opposed	15 Sq Ft	45 Sq Ft

Installation: Factory installation on high velocity mixing boxes is recommended. Actuator may be mounted in any position. Normal installation is for hot valve to open when air pressure exhausts from the actuator. Mounting bracket and linkage assembly are included with the actuator.

Net Force Exerted: At 0 psi the actuator will be held against its inner stop and will resist an opposing force of 24 lb on the MK-3201, 40 lb on the MK-3211, and 64 lb on the MK-3221. At 15 psi the actuator shaft will be held against its outer stop and will resist an opposing force of 16 lb on the MK-3221, 40 lb on the MK-3211, 56 lb on the MK-3201.

Actuator Part Number	Spring Range (psi Equiv.)	Starting Pressure (psi)	Torque (lb-in.)		Work (in.-lb)		Nominal Torque* For Proportional Control	Barber Colman Mixing Box Sizes
			Return Stroke	Power Stroke	Return Stroke	Power Stroke		
			With 15 psig Supply Air Pressure					
MK-3201	3-8	3 Adj.	42	98	84	196	21 lb/in.	4 thru 16
MK-3211	5-10	5 Adj.	70	70	140	140		4 thru 10
MK-3221	8-13	8 Adj.	112	28	224	56		

* Based on a 1.5 psig pressure change at the actuator.

Barber-Colman Company
CONTROLS DIVISION

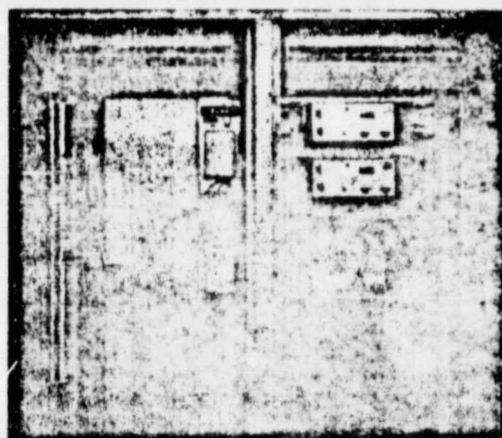
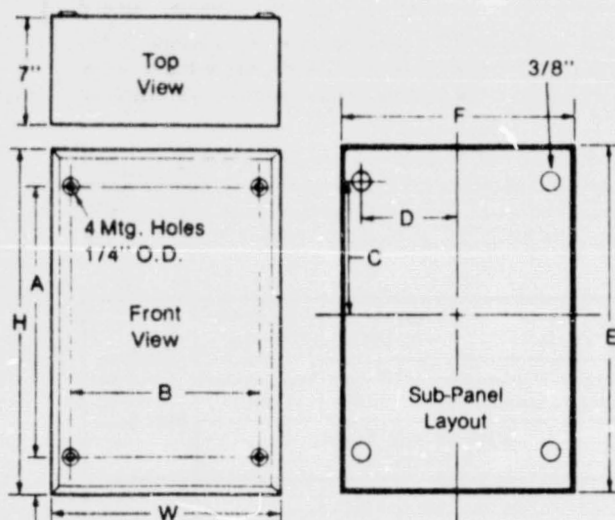
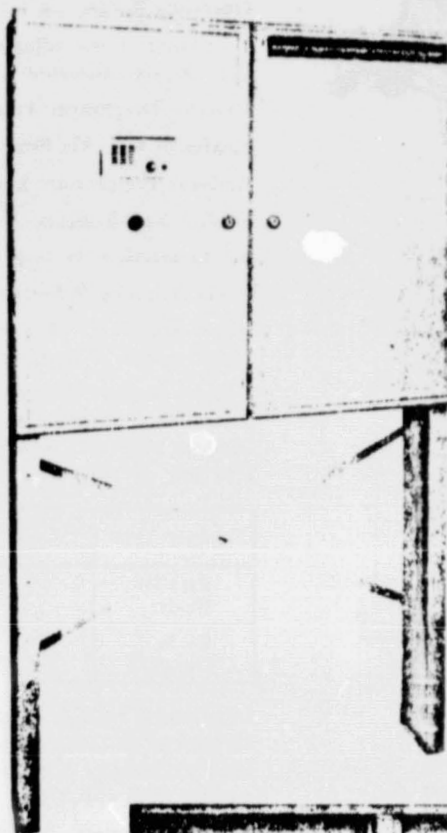
1300 Rock Street, Rockford, Illinois, U.S.A., 61101



Product Information

Accessories Local Control Cabinet SYZE-630 Series

For convenient mounting of pre-assembled or field assembled control panels. Cabinets may be used for pneumatic or electric controls. **Device:** SYZE-630 and SYZE-631 are 18 gage steel. SYZE-632 is 16 gage steel. All size cabinets have knockouts for 3/4-inch and 1-inch conduit. Knockouts are aligned so that a short nipple may be used to couple the panels together, and also for interconnecting wire. The door(s) consist basically of a frame and insert. The frame is made of extruded aluminum and comes mounted with six self-tapping screws. Door(s) supplied with key lock. Standard cabinets are painted steel with beige finish. **Installation:** Cabinets are shipped from the factory completely assembled and ready for mounting. They may be installed flush or surface mounted. Legs are available for floor mounting. **Options:** See charts for equipment description and proper part number. **Ordering:** See chart for cabinet sizes available and part numbers. Sub-panels must be supplied locally.



Description	Cabinet Size		
	16" x 24"	24" x 32"	42" x 36" Double Door
Complete Cabinet (without sub-panel) Painted Steel	SYZE-630	SYZE-631	SYZE-632
Painted Steel Legs for floor mounting above cabinets	SYZE-633	SYZE-633	SYZE-634
Bracket to accommodate light fixture	N/A	SYZE-600	SYZE-600
18" Fluorescent Fixture	N/A	.	.

Dimensions (Inches)							
Cabinet				Sub-Panel			
W	H	A	B	C	D	E	F
16	24	21	13	9 1/4	6 1/2	22	.
24	32	29	21	13 1/4	10 1/2	30	.
42	36	33	39	16 1/2	18	34	.

*UB 115, SIM/KAR light fixture. Purchase from local distributor, or direct from SIM/KAR Lighting Fixture Co., Philadelphia, Pa. 19134. Phone 215-425-7200.

Accessories
Miscellaneous Electrical
Components

Product Information



Toggle



Toggle
Switch

**Switches, Mounting and
Position Indicating Plates**
(Order All Parts Separately)



Rotary



Rotary
Switch

Switch Action	AC Rating		Switch Type	Switch Part No.	Mounting Plate (Flush)	Indicating Plate			
	Amp	Volt				Part No.	Position Markings	Size (Inch)	
DPDT	10	250	Toggle 2 Position	CYZP-11-1	SYZE-52-3	SYZE-74-1 SYZE-75-1 SYZE-76-1 SYZE-102-1 SYZE-189-1 SYZE-271-1 SYZE-300-1	On-Off Summer-Winter None Day-Night Open-Close Manual-Auto Occupied-Unoccupied	1-1/8	2-1/16
4PDT	5	24	Toggle 2 Position	CYZP-105					
DPDT (Center Off)	10	250	Toggle 3 Position	CYZP-268		SYZE-212-1 SYZE-255-1	On-Off-Automatic Summer-Off-Winter	1-7/8	2-1/16
4PDT (Center Off)	5	24	Toggle 3 Position	CYZP-427					
SPST N.O.	5	125	Push Button Momentary Contact	CYZP-346					
SPST N.C.				CYZP-347					

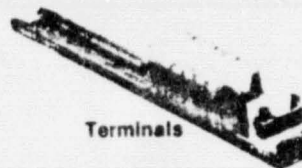
NOTE: All switches mount to standard switch box. 1/2" mounting hole required.

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Part Number	Description
AYZP-43-2	Circuit Breaker 10 Amp (Illustrated)
BYZP-145	12 Circuit Terminal Block (Illustrated)
BYZP-146	Marker Strip #1—12
BYZP-252	Marker Strip #13—24
BYZP-253	Marker Strip #25—36
BYZP-269-2	Mtg. Bracket for Circuit Breaker & Switch (Illustrated)
BYZP-599	Terminal End (Illustrated)
BYZP-600	Terminals (Approx. 4 per inch) (Illustrated)
BYZP-601	Terminal Channel (3') (Illustrated)
BYZP-602	Terminal Clamp (Illustrated)
BYZP-603	Terminal Marker (25') (Illustrated)
CYZP-183-1	Burnishing tool for Electric Contacts
CYZR-818-2	Arc Suppressor for SPDT Floating Switching
EYZP-504-1	Lamp, 24V, 0.073 Amp, 1.7 Watts
EYZP-504-2	Lamp, 120V, 0.025 Amp, 3.0 Watts
EYZP-504-3	Lamp, 48V, 0.053 Amp, 2.5 Watts
EYZP-721	Lamp Socket with Clip
EYZP-722-1	Lens, Red
EYZP-722-2	Lens, Green
EYZP-722-3	Lens, Amber
EYZP-722-4	Lens, Blue
EYZP-722-5	Lens, White
SYZE-81-1	Blank Nameplate 1-7/8" x 9/16"
SYZE-82-1	Blank Nameplate 2-1/2" x 3/4"
SYZE-83-1	Blank Nameplate 4" x 1-1/4"
SYZE-299-1	Tie Strap, plastic, for lacing wires, 4" long



Circuit
Breaker



Terminals



Mounting Bracket
(Shown with Disconnect Switch
and Circuit Breaker)



Terminal
Block



Pilot
Light

Barber-Colman Company
CONTROLS DIVISION

271 1300 Rock Street, Rockford, Illinois, U.S.A. 61101

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Product Information

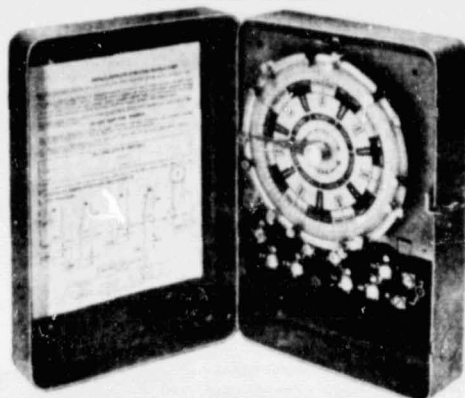
Accessories, Electric AE-100 Series Time Clocks Timers

Transformers

AE-174 ☐

AE-178 ☐

Seven Day Time Clock



Part Number	Clock Motor	Switch Rating
AE-174	120V., 60 Hz	1 hp at 120/240 Volts, A.C. only.
AE-178	120V., 60 Hz Spring Wound carryover	Pilot Duty 690 VA. Non-Inductive 40 amps at 120 or 240 volts. A.C. only.

For automatic circuit switching on a weekly schedule. Allows for individual daily settings as well as omission of days. Typical applications include, day-night switching, a building temperature control system. **Device:** Heavy duty synchronous timing mechanism operates up to 8 switch trippers (4 ON and 4 OFF) each day of the week. Trippers are readily adjusted and secured to outer edge of time dial by means of set screws. Large dial graduated every 30 minutes enables accurate setting of switch trippers. Timing motor has sealed-in mechanism and is permanently lubricated. Entire mechanism can be snapped out of painted steel control center installation. Large, coded, screw-type terminals. Case is 7-3/8 inches wide, 10-7/8 inches high and 3-5/8 inches deep. Three 1/4-inch diameter mounting holes in back of case. Top mounting hole centered 8 inches above two bottom holes which are 5 inches apart. Combination 1/2-inch, 3/4-inch knockouts provided. Spring wound carryover allows clock to continue normal operation ten hours after power interruption. Upon power resumption, timing motor automatically rewinds carryover. **Input:** 120 Volts, 60 Hz. **Output:** Four single-pole, single throw switches. Snap-acting. Two normally open; two normally closed. Formed brass jumpers included readily permit modifying switch action to SPDT, DPST, and DPDT.

Interval Timer



AE-182 ☐

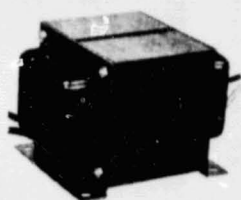
SPST, N.O., 6 hr., spring operated, for standard outlet box mounted. Includes wall plate and knob. Electrical rating: 20 amps at 120 Volts, 1/3 H.P.

Accessories, Electric
AE-200 and 300 Series
Transformers, Power Boxes,
Power Relays, Time Relay

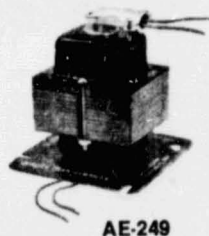
Product Information



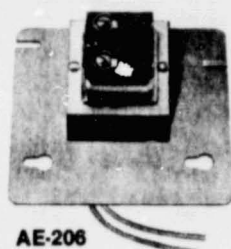
Transformers



AE-203-223



AE-249



AE-206

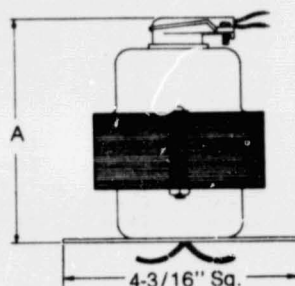


Figure 1

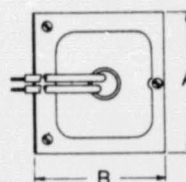
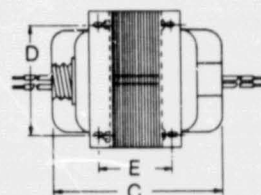


Figure 2

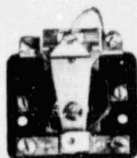


AE-203 ☐ AE-223 ☐
 AE-206 ☐ AE-249 ☐

For supplying low voltage power to operate control equipment. Primarily for mounting in control centers in conjunction with disconnect switch and overload circuit breaker. **Device:** AE-206 and AE-249 are provided with a plate on the primary side for mounting on standard 4-inch outlet box. Secondary connection is screw terminals for AE-206 and provision for flexible conduit connection on the AE-249. All 170 VA transformers are provided with mounting feet for panel mounting, and wire leads.

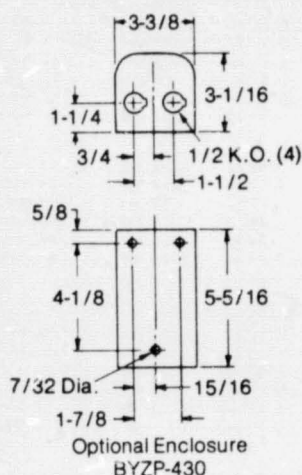
Part Number	Capacity VA	Primary Voltage	Sec. Volt.	Frequency (Hz)	Fig.	Dimensions (Inches)				
						A	B	C	D	E
AE-203	170	120	24	60	2	3-3/4	3-1/8	4-1/4	3-1/4	2-13/16
AE-206	10	120	24	60	1	1-7/8	—	—	—	—
AE-223	170	240	24	60	2	3-3/4	3-1/8	4-1/4	3-1/4	2-13/16
AE-249	50	480/277, 240/208	120	60	1	4-3/8	—	—	—	—

Power Relays DPDT



AE-304 ☐
 AE-314 ☐
 AE-334 ☐

Part Number	Coil Voltage 50/60 Hz
AE-304	24
AE-314	120
AE-334	240



Clapper type with screw terminals. Contact Rating: 1 hp, 16 amps at 120 volts, 8 amps at 240VAC; 25 amps noninductive at 120/240 VAC. Optional enclosure available. Order **BYZP-430** separately.

Time Delay Relay

AE-347 ☐

For control of circuits requiring 3 to 5 second time delay. **Device:** Two single pole double break relays having separate electronic time delay circuitry. All components mounted on a printed circuit board which includes screw type terminals. Complete with screws and spacers for panel mounting (not illustrated).

Power Boxes



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AE-253 ☐
 AE-273 ☐

For supplying an electrically protected and enclosed low voltage power supply to operate control equipment. **Device:** A step-down transformer with a disconnect switch in the primary side and a manually reset circuit breaker in the secondary side. Mounted in a surface type steel cabinet with four convenient 1/2-inch conduit knockouts and painted finish. 8 inches wide, 6 inches high, 3-1/2 inches deep. **Installation:** Surface mount through four holes in the back of the cabinet.

Part No.	Capacity VA	Primary Voltage	Secondary Voltage	Frequency (Hz)
AE-253	170	120	24	60
AE-273	170	240/208*	24	60

*240/208 Volt Power Boxes are normally factory wired to 240 volt winding.

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101

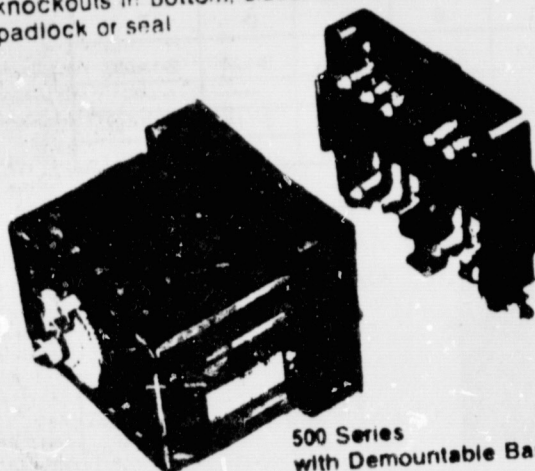
AUTOMATIC RESET TIMERS

ON-Delay, Interval,
OFF-Delay

- Motor Control
- Conveyor Control
- Staggered Load Starts
- Compressor Protection
- Farm Automation
- Process Timing

SPECIAL FEATURES

Three different operating sequences available: ON-delay, interval, or OFF-delay • Eight dial ranges cover timing range from 15 seconds to 24 hours • Repeat accuracy of $\pm 1\%$ of total dial range • Timing progress indicator resets to 0 at end of timed period assuring minimum recycle time • Timing motor can run continuously • Continuous duty solenoid starts timing • All wiring terminals located externally at base • Optional demountable base with quick-disconnect spring-loaded contacts may be permanently installed to give quick change of timers, when required, without rewiring • Optional moisture and dust resistant case available for surface mounting, knockouts in bottom, sides, and back; hasp for padlock or seal



500 Series
with Demountable Base

ACCESSORY SELECTOR GUIDE

Description	Model Number
Demountable base	A553
Nema Type 3 and/or outdoor case (Cannot be used with base A553)	500

HOW TO SPECIFY

Installer shall furnish and install AMF Paragon (Model No.) ON-delay Timer (Model No.) interval timer, or (Model No.) OFF-delay Timer with timing range from 0 to 15 seconds to 1 minute, 0 to 5 minutes, 0 to 12 hours, and repeat accuracy to $\pm 1\%$ of total dial range. Switch load capacity, 600 volts, 120 VA, 1/2 hp ac, motor, 3 watts, 120, 208, or 240 volts, 60 Hz ac. Optional demountable base (Model A553) or moisture and dust resistant case (Model 500)

ON-DELAY

0-15 sec	1/4 sec	1/2-15 sec	120	60	720
0-15 sec	1/4 sec	1/2-15 sec	208	60	720
0-15 sec	1/4 sec	1/2-15 sec	240	60	720
0-1 min	1 sec	2-60 sec	120	60	720
0-1 min	1 sec	2-60 sec	208	60	720
0-1 min	1 sec	2-60 sec	240	60	720
0-3 min	3 sec	6-180 sec	120	60	720
0-3 min	3 sec	6-180 sec	208	60	720
0-3 min	3 sec	6-180 sec	240	60	720
0-5 min	5 sec	10-300 sec	120	60	720
0-5 min	5 sec	10-300 sec	208	60	720
0-5 min	5 sec	10-300 sec	240	60	720
0-1 hr	1 min	2-60 min	120	60	720
0-1 hr	1 min	2-60 min	208	60	720
0-1 hr	1 min	2-60 min	240	60	720
0-5 hr	5 min	10 min-5 hr	120	60	720
0-5 hr	5 min	10 min-5 hr	208	60	720
0-5 hr	5 min	10 min-5 hr	240	60	720
0-12 hr	12 min	24 min-12 hr	120	60	720
0-12 hr	12 min	24 min-12 hr	208	60	720
0-12 hr	12 min	24 min-12 hr	240	60	720
0-24 hr	24 min	48 min-24 hr	120	60	720
0-24 hr	24 min	48 min-24 hr	208	60	720
0-24 hr	24 min	48 min-24 hr	240	60	720

INTERVAL

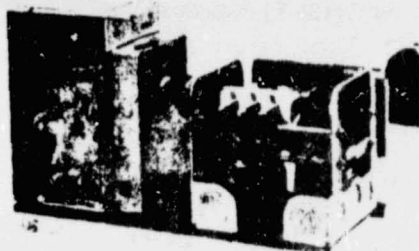
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0-15 sec	1/4 sec	1/2-15 sec	208	60	720	600
0-15 sec	1/4 sec	1/2-15 sec	240	60	720	600
0-1 min	1 sec	2-60 sec	120	60	720	600
0-1 min	1 sec	2-60 sec	208	60	720	600
0-1 min	1 sec	2-60 sec	240	60	720	600
0-3 min	3 sec	6-180 sec	120	60	720	600
0-3 min	3 sec	6-180 sec	208	60	720	600
0-3 min	3 sec	6-180 sec	240	60	720	600
0-5 min	5 sec	10-300 sec	120	60	720	600
0-5 min	5 sec	10-300 sec	208	60	720	600
0-5 min	5 sec	10-300 sec	240	60	720	600
0-1 hr	1 min	2-60 min	120	60	720	600
0-1 hr	1 min	2-60 min	208	60	720	600
0-1 hr	1 min	2-60 min	240	60	720	600
0-5 hr	5 min	10 min-5 hr	120	60	720	600
0-5 hr	5 min	10 min-5 hr	208	60	720	600
0-5 hr	5 min	10 min-5 hr	240	60	720	600
0-12 hr	12 min	24 min-12 hr	120	60	720	600
0-12 hr	12 min	24 min-12 hr	208	60	720	600
0-12 hr	12 min	24 min-12 hr	240	60	720	600
0-24 hr	24 min	48 min-24 hr	120	60	720	600
0-24 hr	24 min	48 min-24 hr	208	60	720	600
0-24 hr	24 min	48 min-24 hr	240	60	720	600

OFF-DELAY

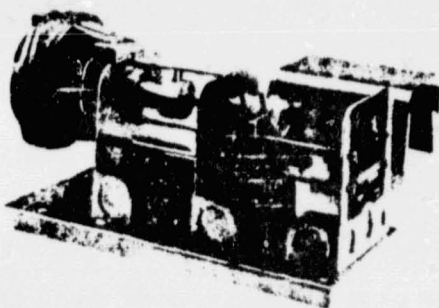
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0-15 sec	1/4 sec	1/2-15 sec	208	60	720	600
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0-1 min	1 sec	2-60 sec	120	60	720	600
0-1 min	1 sec	2-60 sec	208	60	720	600
0-1 min	1 sec	2-60 sec	240	60	720	600
0-3 min	3 sec	6-180 sec	120	60	720	600
0-3 min	3 sec	6-180 sec	208	60	720	600
0-3 min	3 sec	6-180 sec	240	60	720	600
0-5 min	5 sec	10-300 sec	120	60	720	600
0-5 min	5 sec	10-300 sec	208	60	720	600
0-5 min	5 sec	10-300 sec	240	60	720	600
0-1 hr	1 min	2-60 min	120	60	720	600
0-1 hr	1 min	2-60 min	208	60	720	600
0-1 hr	1 min	2-60 min	240	60	720	600
0-5 hr	5 min	10 min-5 hr	120	60	720	600
0-5 hr	5 min	10 min-5 hr	208	60	720	600
0-5 hr	5 min	10 min-5 hr	240	60	720	600
0-12 hr	12 min	24 min-12 hr	120	60	720	600
0-12 hr	12 min	24 min-12 hr	208	60	720	600
0-12 hr	12 min	24 min-12 hr	240	60	720	600
0-24 hr	24 min	48 min-24 hr	120	60	720	600
0-24 hr	24 min	48 min-24 hr	208	60	720	600
0-24 hr	24 min	48 min-24 hr	240	60	720	600



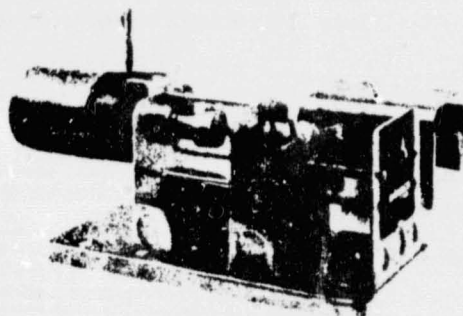
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ELECTRIC ACTUATED



PNEUMATIC ACTUATED



HYDRAULIC ACTUATED

Program Switches

For step control of refrigeration compressors, pump valves and electric heating elements, etc. Also for sequence operation. See "Actuator" below for drive unit.

Device: A series of individually adjustable cams operate the line voltage SPDT snap-acting switches. Switches are factory set for consecutive operation. Cams can easily be adjusted with the wrench included with each unit. All have a fixed differential with 5 angular degrees minimum. Cams are mounted on a common shaft rotated 180° by the actuator. An external pointer indicates the shaft position. Actuator and switching components are mounted on a common base. A metal snap-on cover protects switches and cams. Program switches are available with 6, 10, 16, 20, 26, 30 or 40 steps. Rating: 20 amperes at 125, 250 and 460 volt a-c, 1 hp at 120 volts and 2 hp at 240 volts.

Actuator:

Electric — A proportional, low voltage actuator with a Barber-Colman shaded pole motor and precision hobbled gears immersed in oil and sealed within a die cast case. 180° shaft rotation.

Pneumatic — Utilizes a compact spring-return unit with a neoprene diaphragm enclosed in a die cast case. 1/8 inch NPT female air supply connection. Available in four spring ranges (5-10 psi standard). Start point is field adjustable ± 2 psi.

Hydraulic — This compact unit has its spring-return power assembly sealed in an oil filled case. Driven by a Barber-Colman induction motor, a gear pump produces hydraulic pressure to move the power piston. Piston movement is proportioned according to the signal received by a transducer from a solid state thermostat.

Control Requirements:

SP-10,000 Normally TP-100 through 400 Series microtherm or CP-8301 solid state drive.

SP-30,000 Series Pneumatic thermostat or other proportional controller.

SP-40,000 Series 1 to 15 Vdc from System 80 controller.

Part Numbers

No. of Switches	Electric Unit (MP-381)	Pneumatic Unit (MK-4611)	Hydraulic Unit (MP-5210)
6	SP-10614	SP-30614	SP-40601
10	SP-11014	SP-31014	SP-41001
16	SP-11614	SP-31614	SP-41601
26	SP-12014	SP-32014	SP-42001

SEE REVERSE SIDE FOR ADDITIONAL SPECIFICATIONS



Program Switches Data

Installation: Upright position preferred, other positions may be acceptable depending on actuator.

Ambient Temperatures:

SP-10000 Series, 58°C [136°F] maximum, -40°C [-40°F] minimum

SP-30000 Series, 71°C [160°F] maximum, -18°C [0°F] minimum

SP-40000 Series, 60°C [140°F] maximum, -29°C [-20°F] minimum

Timing:

SP-10000 Series, 130 seconds/180° travel

SP-40000 Series, 60 seconds/180° travel to full "on," 35 seconds to full "off."

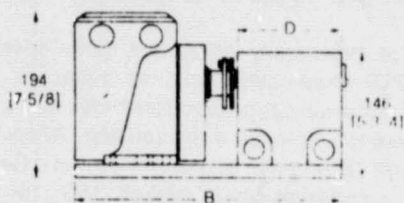
Power Requirements:

SP-10000 Series, 24 volts a-c, 60 Hz, 28 watts. Other voltages optional.

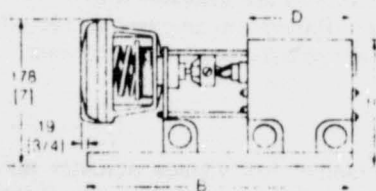
SP-30000 Series, 0-15 psi air pressure.

SP-40000 Series, 24, 120 volts a-c, 50/60 Hz, 10 watts.

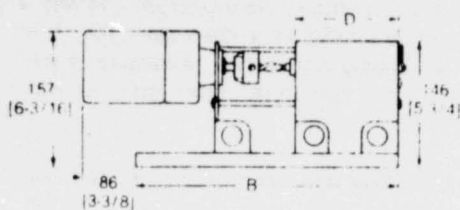
Recycling (SP-10000 Series): Protection against excessive starting loads following power interruption is provided by an interlocking circuit that returns the program switches to the "off" position before resuming the operating sequence. Interlock circuit requires one DPDT relay with coil voltage and contact rating equal to that of the load on the switches. Refer to Relay Data Sheet for selection of appropriate relay.



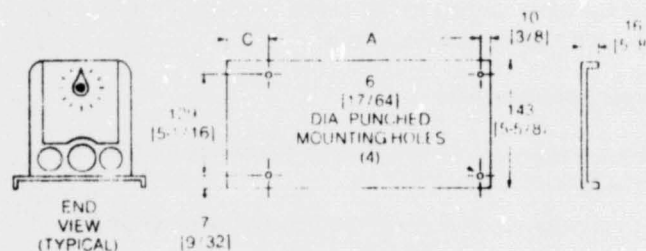
ELECTRICAL ACTUATED



PNEUMATIC ACTUATED



HYDRAULIC ACTUATED



BASE DIMENSIONS

Size Unit (Steps)	Dimensions mm (Inches)			
	A	B	C	D
6, 10	283 [11-1/8]	312 [12-9/32]	20 [25/32]	130 [5-1/8]
16, 20	378 [14-7/8]	407 [16-1/32]	20 [25/32]	225 [8-27/32]
26, 30	538 [21-3/16]	568 [22-11/32]	20 [25/32]	394 [15-1/2]
40	646 [25-7/16]	663 [26-3/32]	7 [9/32]	487 [19-3/16]

Series	Standard Actuator	Optional Actuators		
SP-10000 Electric	MP 381	Any similar actuator such as MU 48102, MUP 48101, MP 2113, etc.		
SP-30000 Pneumatic	MK 4611 5-10 psi spring range	MK 4601 3-8 psi spring range	MK 4621 8-13 psi spring range	MK 4641 3-13 psi spring range
SP-40000 Hydraulic	MP 5210 120 volts	MP 5211 204 volts	MP 5212 208 volts	MP 5213 24 volts

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



Product Information

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Solid State Controller Differential Controller With One Stage Relay



CC-8111

Two input solid state controller with a single stage relay output in a single package for use with direct, reset or differential media control. Accepts either 1000 ohm sensor(s) input, a 1 to 15 Vdc control signal or a 135 ohm slidewire input.

The CC-8111, being a combined controller and output device, needs only standard System 8000 sensor(s) or optional input signals and AC power supply to be placed into service. The components are all printed circuit board mounted, covered and placed in a track ready for a control panel.

Input bridge circuits are reversible by pin selection so sensor(s) may be set for direct or reverse acting functions. A third sensor may be connected by using the CN-8101 multipurpose bridge. Amplifier proportional voltage signal is available on pins OP1 and COM and can be used to control up to 5 other System 8000 de-

vices. Supplementary input voltages of 1 to 15 Vdc may be put into IV1 and COM for control of the output relay stage. Output power of 20 - 1.5, +1 Vdc at 35 ma and 6.2 \pm 0.5 Vdc at 4 ma is available between +20 and 6.2 terminals and COM. **WIRING CONNECTIONS.** Coded screw terminals. **AMBIENT LIMITS.** 41 to 140°F. **DIMENSIONS.** 4 in. wide x 7.5 in. long x 2.5 in. deep.

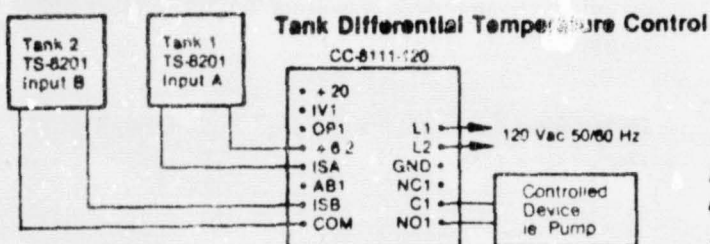
Accessories

AD-8122	Signal adaptor for dual outputs (D.A.-D.A.)
AD-8123	Signal adaptor for dual outputs (D.A.-R.A.)
AD-8124	Signal adaptor for dual outputs (R.A.-D.A.)
AD-8910	10" enclosure
AT-8122	Remote setpoint adjuster, dual scale 20 to 120°F (-6 to 49°C)
AT-8155	Remote setpoint adjuster, dual scale 50 to 250°F (10 to 66°C)
AT-8158	Remote setpoint adjuster, dual scale 55 to 85°F (13 to 29°C)
CN-8101	Multipurpose bridge
TS-8101	Room sensor
TS-8111	Room sensor with setpoint
TS-8131	Room button type sensor
TS-8201	Duct/Immersion sensor
TS-8204	High temp. sensor 450°F
TS-8241	Diffuser sensor
TS-8261	Light fixture sensor
TS-8331	Lagged sensor (CN-8101 is required)
TS-8405	5' averaging sensor
TS-8422	22' averaging sensor
TS-8501	Outdoor sensor
TS-8531	Solar sensor (CN-8101 is required)
TS-8533	Econostat sensor

Part Number Selection and Function Chart

Part Number	Power Req. 50/60 Hz	Adjustable Functions				Pin Selectable Functions		
		Setpoint "A"	Setpoint "B"	Diff. Range	Relay Dropout	Throttling Range	Authority Ratio	Relay Diff.
CC-8111-024	24	41 to 95°F 5 to 35°C	41 to 95°F 5 to 35°C	1 to 54°F Std.	2 to 12 Vdc (IV1 to Com)	3.6 or 9°F 1.6, 3.4 or 5°C	.5 75 1.0 15.0 Aux	.5 1.0 2.0 4.0 Vdc (IV1 to Com)
CC-8111-120	120			By Added Res.				
CC-8111-240	240			1-400°F				

TYPICAL APPLICATION



NOTE: For temperatures between 250 and 450°F use TS-8204

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A. 61101



Product Information

Pneumatic Room Thermostat Proportional Control



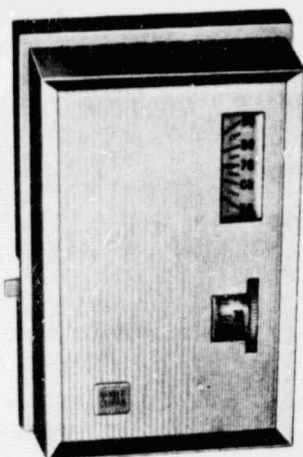
STANDARD
TK-1001, 1101, 1201

Uses: For proportional control of Barber-Colman pneumatic actuated valves and damper actuators to maintain room air temperatures in heating, ventilating and air conditioning systems.

Construction: Rugged cover with beige finish. Bimetal type thermometer indicates room temperature on wide scale. Proportional-control type of pneumatic instrument, using bimetal sensing. The small sensitive bimetal actuates a piloted non-bleed relay. Delicate balance and linear output are accomplished by an internal pneumatic feedback circuit. Main and branch connections are made by connecting plug-in plastic tubing which is attached to the base of the thermostat.

An accessory kit is available to effectively modify the thermostat, so as to prevent tampering with either the dial setting or the internal mechanism.

STANDARD
TK-1301, 1601



Adjustment: Large, round, easily-read temperature dial has serrated adjusting wheel for accurate set point selection. One degree graduations. Temperature range spread evenly over 180 degrees of knob rotation.

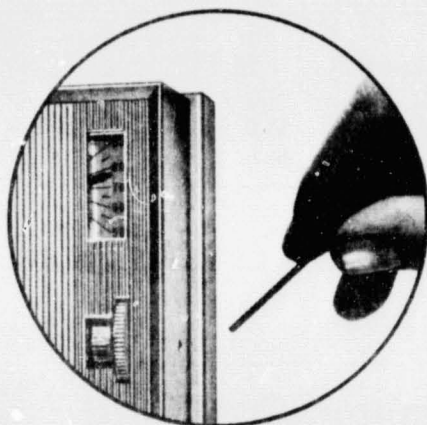
Throttling Range: Continuously adjustable from 2 to 10 F° for a 10 psi change in control branch line pressure, nominally 3-13 psi. Normal factory setting 4 F°.

Maximum Safe Air Pressure: 30 psig.

Maximum Safe Ambient Temperature: 150 F°.

Fittings: Order separately for type of wall construction. Mortar joint fittings for mounting in the seam of masonry walls. Wall box fittings for surface mounting on all walls and flush mounting on walls other than masonry.

Dimensions: Cover 2 $\frac{3}{4}$ " wide, 4 $\frac{3}{8}$ " high. Overall depth 1 $\frac{5}{8}$ ".



SEE REVERSE SIDE FOR ADDITIONAL INFORMATION

**Pneumatic Room Thermostat
Proportional Control**

Product Information



Part Number	Description and Action*	Mounting	Dial Range (F) **	Factory Set Point Setting (F)	Throttling Range	Supply Air Pressure (psig)
TK 1001	Heating DA	Wall	55 - 85	75	Adjustable 2-10F°/10 psi Factory Set 4F°/10 psi	15 or 20
TK 1101	RA Cooling					
TK 1201	Heating-Cooling DA — 20 psig RA — 15 psig					15 — RA* 20 — DA*
TK 1301	Day-Night DA					15 — Day 20 — Night
TK 1601	Night — 20 psig Day — 15 psig					

* Direct acting: Increases output pressure on temperature rise.
Reverse acting: Decreases output pressure on temperature rise.
** For 13-29°C Dial Range specify suffix -116.

Heating-Cooling — TK-1201

Change-over: Built-in change-over mechanism changes from reverse to direct acting on a change in supply main air pressure. 15 psig reverse acting*, 20 psig direct acting*.

Day-Night — TK-1301, 1601

Night Reset: A calibrated knob provides adjustable night setback or setup from 0 to 20 F° when the supply air pressure is changed from 15 to 20 psig.

A third tube (switch line) on TK 1601 passes full line pressure to position pressure electric switches, pilot three-way air valves, etc., on the night cycle.

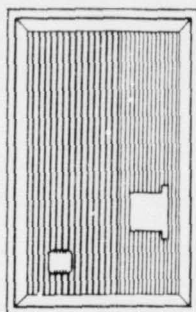
A manual lever is provided to change the thermostat to day cycle when the system is on night operation. The lever may be manually returned to "Night" or will automatically return on the next day cycle.

Change-over: Built-in change-over mechanism changes from day to night temperatures on a change in supply main air pressure. 15 psig day, 20 psig night.

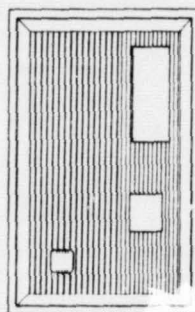
Fittings:

Order separately for type of wall construction. AT 507 mortar joint fitting and AT 506 wall box fitting available for TK-1001, 1101, 1201, 1301. Wall box fitting AT 508 is available for TK-1601 for surface mounting on walls and flush mounting on walls other than masonry. No mortar joint fitting is available for TK-1601.

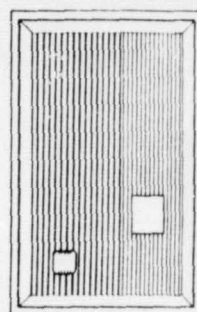
COVER OPTIONS



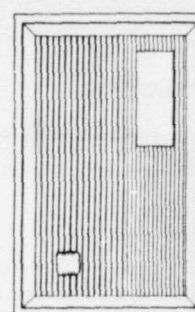
-400 (°F)
-410 (°C)



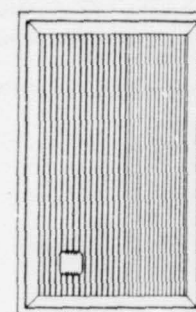
-401 (°F)
-411 (°C)



-402 (°F)
-412 (°C)



-403 (°F)
-413 (°C)



-404 (°F)
-414 (°F)

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



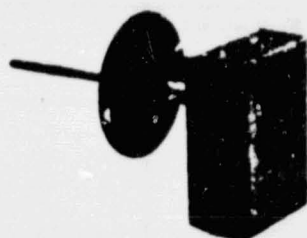
Product Information

Solid State Sensors — Bridges Transmitters — Controllers Controlled Devices

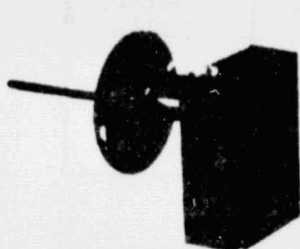
Temperature Sensing



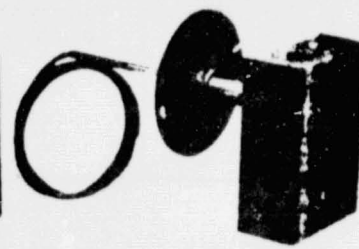
ROOM — TS-8101
TS-8111



DISCHARGE — TS-8001



DUCT/INCH — TS-8201



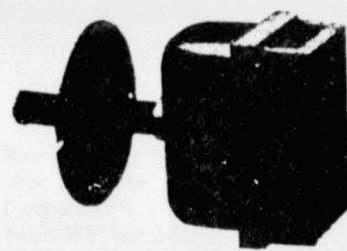
AVERAGE — TS-8405
TS-8422

Sensing: Sensing is accomplished by the use of a temperature sensitive Balco resistance wire packaged in room, duct, averaging and outdoor type configurations.

Humidity Sensing



ROOM — HS-8101



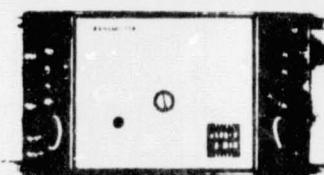
DUCT — HS-8201

Sensing is accomplished by the use of a nonorganic resistance type material which will be housed either in a room or duct type mounting base. Selection of the proper AH 100 series element will provide the capability of control over a 15% range. Elements are available through the span of 5% to 95% R.H.

Temperature Transmitter/Indication



TSP 8111
INDICATION ONLY
TRANSMITTER
(SHOWN MOUNTED ON ASP-500 METER)



TSP 8101
INDICATION AND
CONTROL TRANSMITTER

Temperature Transmitters: The TSP 8100 Series temperature transmitters are designed to meet applications where local indication and/or control is required.

TSP 8101 Indication and Control Transmitter: This temperature transmitter conditions the standard system 8000 sensing elements for operation, either direct or reverse, of the CP-8102 two input controller. Also provided are two linear 1 to 11 Vdc output signals. One output signal is produced over a -40 to 127°C

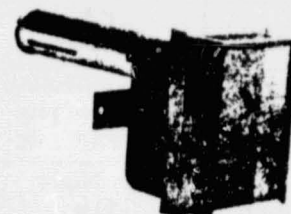
(-40 to 260°F) range and is used for remote digital indication. The other output signal is used with the ASP-500 Series meter readout indicators.

TSP 8111 Indication Only Transmitter: This temperature transmitter conditions the standard system 8000 sensing elements for operation of the ASP-500 Series meter readout indicators only.

Humidity Transmitter



HSP-4101



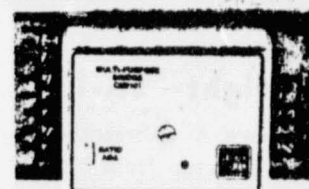
HSP-4201

Humidity Transmitter: The humidity transmitter is designed to meet applications where local indication and/or control is required plus producing a signal for use in automation centers.

The humidity transmitter uses a wide range humidity detector and conditions the resulting sensor signal for operation of a 2 input controller or indicating meter. A linear 1 to 11 Vdc signal is produced over a 20 to 80% R.H. range for remote digital indication.

Multi-Purpose Bridge

CN-8101



Multi-purpose Bridge: The multi-purpose bridge is designed to be used in applications of a complex nature meeting specific cycles of operation.

The multi-purpose bridge has adjustments for the calibration of the sensing element to the bridge. A ratio adjustment is available for setting ratios of .5 to 25:1 with respect to the main element of the 2 input controller.

Room Controller

TP-8101

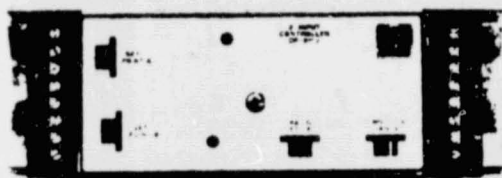


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Room Controller: The room controller design is such that it can be mounted directly to a 2 x 4 handy box located on the wall. It is a self contained unit which includes a sensing element and amplifier. The room controller is completely factory calibrated and requires no field calibration. Throttling range is adjustable from 1.1 to 11°C (2-20°F) by merely selecting the proper throttling range pin. The unit contains a combination setpoint and calibration potentiometer with a range of 13 to 29°C (55-85°F).

Terminals are available on the back which permit access to important parts of the solid state circuitry. This permits the capability of meeting auxiliary selective ratio elements, remote setpoint, remote sensing, and summer/winter changeover applications.

2-Input Controller



CP-8102 Series

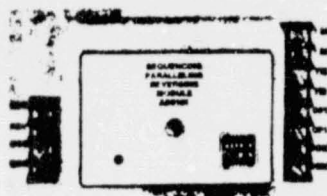
2 Input Controller: The 2 input controller is a self-contained package incorporating an integrated circuit amplifier and associated solid state discrete components with two bridges labeled A and B. These are arranged on a printed circuit board designed to be vinyl track mounted.

The adjustments available will permit calibration and selection of the proper ratio and throttling range to meet specific application.

The setpoint is adjustable from -6 to 49°C (20 to 120°F) with 1° adjustability. Also contained in bridge B is a ratio adjustment which can be set from 5 to $25:1$.

A throttling range potentiometer can change the throttling range of the system from $1:1$ to 55°C ($2 \times 10^{\circ}\text{F}$) measured when the output voltage varies from 6 to 9 Vdc.

Sequencing/Paralleling/Reversing Module



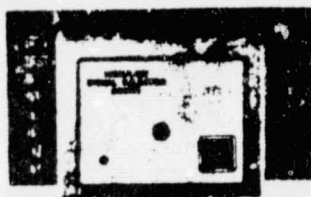
AD-8101

Paralleling: Parallel operation of several controlled devices can be accomplished by using this module.

Sequencing: In the sequence mode the signal from the controller is connected to the sequence terminal of the module. The output is adjustable above or below the output voltage of the controller, permitting sequencing of two controlled devices.

Reversing: When the controller output is connected to the reverse terminal, the output of the module is reversed with respect to the input.

Hi-Lo Signal Selector

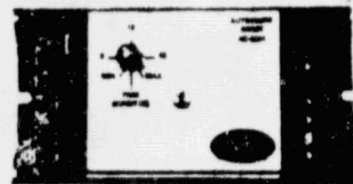


AD-4201

Hi-Lo Signal Selector: This module is designed to accomplish either high or low signal selection. It has the capability of selecting either the highest or lowest signal produced by the controllers.

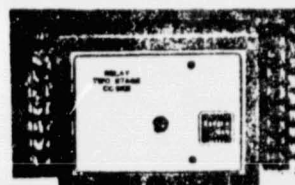
Automatic Reset Adaptor

AD-8501



Automatic Reset Adaptor: This module is designed to obtain accurate control by eliminating the offset error normally associated with proportional control systems. The input signal for the automatic reset adaptor is obtained from System 8000 controllers. The automatic reset adaptor's output drives System 8000 controlled devices.

Staging Relays



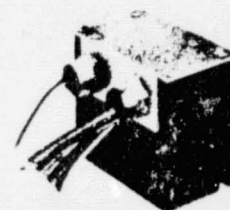
CC-8101
CC-8102
CC-8103

Staging Relays: The staging relay is offered in various configurations which include single stage, dual stage, and dual stage with heat anticipation.

The staging relay receives a $1-15$ Vdc input signal and by means of adjusting the pull-in voltage of each stage, the output relays may be made to operate at any voltage in this $1-15$ volt span. The differential of the relays is adjustable by selecting the proper pin on the printed circuit board.

Actuator Drive

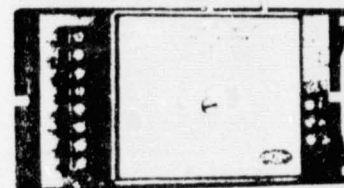
CP-8301 Series



Actuator Drive: The actuator drive is a self-contained package which may be mounted on the side of the actuator or by using a panel mounting accessory, be located in a local control panel. The actuator drive is used to position a Barber Colman electric actuator.

Electronic-Pneumatic Transducer

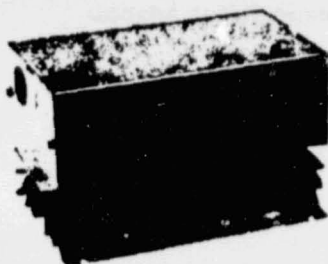
CP-8502



The CP-8502 Electronic Pneumatic Transducer accepts either 1000 ohm sensor input(s), a $1-15$ Vdc signal input, or a 135 ohm slidewire input and produces a proportional $3-13$ psig pneumatic output signal for the control of pneumatic actuators.

Electric Heat Controller

CP-6425-126
CP-6425-277
CP-6425-408



Electric Heat: The electric heat controller is designed to operate on line power voltages from 120 to 480 Vac. This single phase controller has the capability of operating loads from 1 up to 25 amperes. Either a 1000 ohm Balco sensing element (System 8000 sensors), a 135 ohm slidewire transducer, or a 6 to 9 or 11 to 14 Vdc control signal can be used for detecting temperature changes in the controlled media. Changes produced by the various input sensors will vary the load from 0 to 100%.

Solid State Sequencing Controller



CC-8104

Solid State Sequencing Controller: The solid state four step sequence controller operates up to four external ac power handling relays or loads in sequence. The four controller outputs can each handle a maximum load current of 9 amps at 24 Vac. Either a 1000 ohm Balco sensing element, a 135 ohm slidewire transducer, or a 6 to 9 or 11 to 14 Vdc control signal can be used for detecting temperature changes in the controlled media. Changes produced by the various input sensors are amplified by an integrated circuit operational amplifier. The operational amplifier then controls a timing circuit whose output then controls, in sequence, four solid state output stages which turn on or off power handling relays or loads.



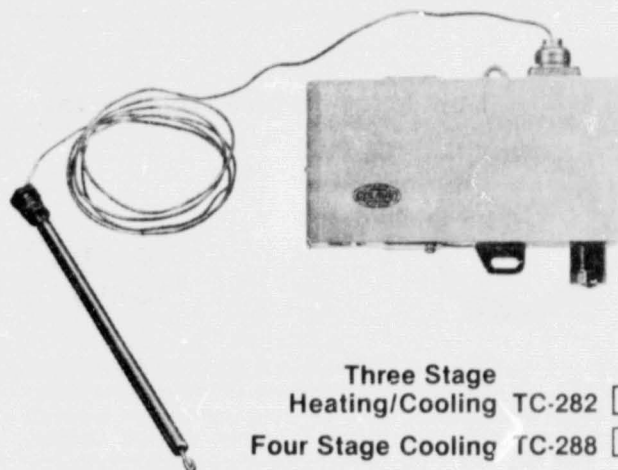
Product Information

Bulb Thermostats TC Series Enthalpy Control THC Series

Bulb Thermostats

For ON-OFF control of media temperature in ducts, tanks, etc. TC-282 can be used for staging up to three heating or cooling loads. TC-288 can be used for staging up to four cooling loads. **Device:** Mechanism enclosed in rugged die cast case with metal cover. Half inch conduit openings at top and bottom. Large coded terminals. Liquid filled thermal element actuates one snap-acting SPDT per stage. Setpoint adjustment knob is clearly marked, and has recessed locking screw. A 3/4-inch water tight fitting for the thermal element, included, is suitable for immersion or duct mounting. **Output:** Switch action is adjustable. See Performance Table. **Options:** 6 m (20 ft) and 14 m (45 ft) capillary lengths are available.

Accessories: AT-201 Copper bulb well
AT-203 Stainless steel bulb well
AT-208 Bulb duct mounting kit
AT-211 Outside bulb shield



Three Stage
Heating/Cooling TC-282 ☐
Four Stage Cooling TC-288 ☐

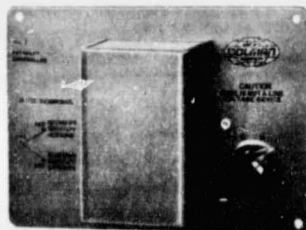
Performance Table

Part No.	Description	Capillary Tube and Bulb (Copper)	Scale	Maximum Safe Bulb Temp. °C (°F)	Volts	Switch Ratings (AC Only) * • 50/60 Hz				Thermal Differential °C (°F)
						FLA Amps	LRA Amps	Resistive Amps	Pilot Duty VA	
TC-282	3-Stage Heating or Cooling	Bulb 10 mm x 241 mm (3/8" x 9-1/2") Capillary 1.3 m (6')	10 to 90°F*	110 (230)	24	3.8	22.8	15	25	1.1 to 4 (2 to 7) Factory Set at 1.1 (2) Between High & Low Stage 0 to 11 (0 to 20) Factory Set at 1.6 (3)
TC-288	4-Stage Cooling Only				120	3.8	22.8	15	125	
					240	2.9	17.4	15	125	
					277	—	—	15	—	

*Celsius scale is available as an option. Specify -216 Suffix.

* • 1600 V. A. Maximum Load

Enthalpy Control



THC-2 ☐

For control of the amount of air brought into the cooling system with respect to the "total" heat or enthalpy of the outside air. **Device:** SPDT switch actuated by a bimetal and a nylon humidity sensor mounted on a metal plate suitable for duct mounting. Switch rating 2.5 amp (max) at 24 Vac. Dial knob for selection of control ranges. **Output:** See Performance Table for control ranges; differential is approximately 8% RH and 1.1°C (2°F). **Ordering:** Device is supplied complete with mounting hardware. THC-2 has color coded leads and wiring compartment with 1/2-inch conduit hole. **Options:** For unit less cover with spade connections, specify THC-1.

Performance Table

Dial Range	Control Point		
	10% RH	50% RH	80% RH
A	31°C (88°F)	28°C (83°F)	23°C (74°F)
B	28°C (83°F)	26°C (78°F)	21°C (70°F)
C	26°C (78°F)	23°C (73°F)	18°C (64°F)
D	23°C (73°F)	20°C (68°F)	15°C (59°F)

Change-Over and Limit Thermostats TC Series

Product Information



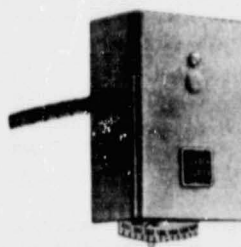
Low Temperature Thermostat



TC-5131 ☐

TC-5141 ☐

For ON-OFF control of low temperatures in ducts. **Device:** Rugged metal case with 1/2-inch conduit opening. Screw type terminals. Snap-acting SPDT switch. Vapor pressure type thermal element. 6 m by 3 mm (20 feet by 1/8-inch) OD copper element. **Output:** Thermostat responds to the lowest temperature sensed by any one foot section of its element. Max. safe bulb 121°C (250°F). Ambient at case 2.8°C (5°F) above setpoint to a maximum of 66°C (150°F). **Ordering:** Device is complete.



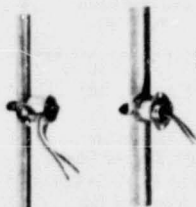
Limit Thermostats

TA-3431 ☐

TC-3411 ☐

TC-3413 ☐

For ON OFF limit control of media temperatures in ducts, tanks, etc. **Device:** Sturdy steel case with 1/2-inch conduit opening. Large screw type terminals. Helical bimetal element 13 mm (1/2-inch) diameter with 191 mm (7-1/2-inch) insertion length. **Output:** See Performance Table. **Accessories:** AT-223 brass bulb well for tank and wet pipe installations. **Ordering:** Type TA has SPST, TC has SPDT switch.



Strap On Change-Over

TC-2931 ☐

TC-2942 ☐

For unit heater or unit cooler installations. Prevents operation of fan unless heating or cooling media is available. **Device:** Hermetically sealed. Enclosed type has 1/2-inch adaptor for 1/2-inch conduit. Mounting springs for easy mount on up to 1-1/2-inch pipe. Fast responding bimetal metal actuates snap-acting SPDT with silver contacts. Three color coded 16 ga. leads .9 m (3 ft) long. **Output:** Setpoint fixed at approximately 21°C (70°F). See Table. **Ordering:** Supplied complete, with mounting springs.



Strap On Change-Over Thermostat

TC-2974 ☐

For unit heater or unit cooler installations. Prevents operation of fan unless heating or cooling media is available. **Device** is enclosed in sturdy steel case. 1/2-inch to 3/4-inch conduit opening on bottom. Liquid filled thermal element actuates heavy duty SPDT switch. Graduated external adjustment. **Output:** See Table. **Ordering:** Complete, including strap for mounting on pipe up to 102 mm (4 inches) O.D. **Accessories:** For concealed setpoint and lock cover screw, order AT-210, concealed adjustment kit.

Performance Table

Part No.	Device Type	Scale °C (°F)	Differential °C (°F)	Switch Ratings (AC Only)			
				Voltage (Vac)	FLA (Amps)	LRA (Amps)	Pilot Duty (VA)
TC-2974	Strap On	10 to 99 (50 to 210) <input type="checkbox"/>	Fixed 5.5 (10)	120 240	9.8 8	58.8 48.0	360
TC-5131	Low Temp.	1 to 15 (34 to 60) <input type="checkbox"/> Stop at 1 (34)	Fixed 2.8 (5)	24 120 208 240	— 13.8 9.6 8.3	— 82.8 57.6 49.8	100 650 750 750
TC-5141	Low Temp. Manual Reset	1 to 15 (34 to 60) <input type="checkbox"/> Stop at 1 (34)	Fixed 2.8 (5)†				
TC-2931	Strap On	Set Point Fixed 21 (70)	Fixed 8.0 (15) Approx.	120 240	5.8 2.9	34.8 17.4	125
TC-2942	Strap On Enclosed	Set Point Fixed 21 (70)	Fixed 8.0 (15) Approx.	120 240	5.8 2.9	34.8 17.4	125
TC-3411	Limit	(0 to 120)*	1.1-4.6 (2-8) Set at 1.1 (2)	120 240	3.8 1.9	22.8 11.4	125
TC-3413	Limit	(120 to 240)*	1.1-4.6 (2-8) Set at 1.1 (2)	120 240	3.8 1.9	22.8 11.4	125
TA-3431	Limit Manual Reset	(100 to 160)* Set at (125)	Fixed 2.8 (5)†	120 240	16 8	96 48	720

† Reset cannot be accomplished until the sensed temperature is at least 5° below setpoint on TA-3431 and 5° above on TC-5141.

☐ The scale is dual marked in degrees C and degrees F.

*The scale is marked in degrees F only.

Celsius scale available as an option. Specify -116 Suffix.

Barber-Colman Company
CONTROLS DIVISION

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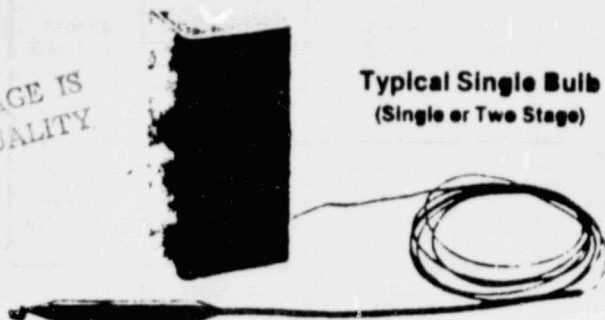
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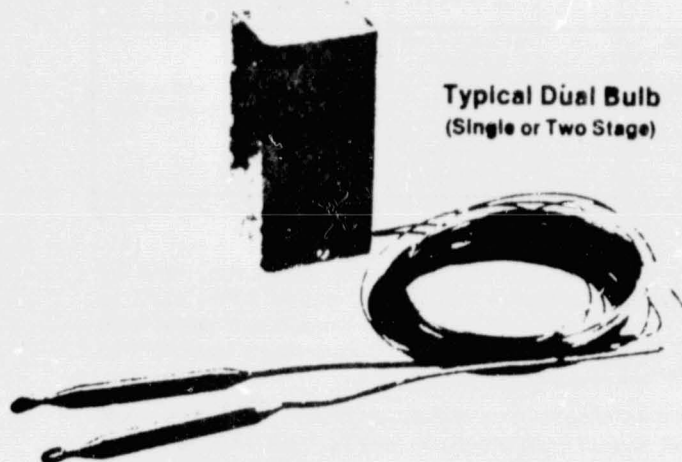
Product Information

Bulb Thermostats TC-4000 Series

ORIGINAL PAGE IS
OF POOR QUALITY



Typical Single Bulb
(Single or Two Stage)



Typical Dual Bulb
(Single or Two Stage)



Bulb Duct Mounting Kit
AT-208



Liquid Line or Tank
Bulb Mounting Kit
AT-209

(Also Required with
AT-201 or AT-203 Well)

Concealed Adjustment Kit
AT-210

For on-off control of media temperature in ducts, tanks, liquid lines, etc.

TC-4100 Series **one stage** units control one electrical circuit. Available in single or dual bulb configurations. (See Performance Table.)

TC-4200 Series **two stage** units control two electrical circuits in sequence. Available in single or dual bulb configurations. (See Performance Table.)

Dual bulb units are used to vary the control point of the controlled media as a function of outside air temperature. One bulb senses the controlled media, the second bulb senses the outside air temperature. The ratio specified is outdoor to indoor. A unit with a 1 to 1-1/2 ratio will increase the water temperature 1-1/2°F for a 1°F decrease in outdoor temperature. **Device:** Liquid filled thermal element actuates one snap acting SPDT switch per stage. Large color coded terminals. Setpoint adjustment dial plate is marked in °F on one side and °C on the other. The thermal differential is adjustable within the limits shown in the performance table. The mechanism is enclosed in a metal case and the cover, and has 1/2-inch to 3/4-inch conduit opening in the bottom of the case. The ambient rating at the case is -40 to 60°C (-40 to 140°F). Remote bulbs are suitable for immersion, duct, or outside air mounting. **Outputs:** See performance table. **Options:** Single bulb units are available with optional capillary lengths of 6M (20') or 13.7M (45').

Accessories: (Order Separately)

Part No.	Description	
AT-201*	Bulb Well	Copper, 3/4" MNPT 9-1/2"
AT-203*		Stainless, 3/4" MNPT 9-1/2"
AT-206		Copper, 1/2" MNPT 4-1/2"
AT-208	Duct Mounting Kit for Bulb	
AT-209	Liquid Line, or Tank, Bulb Mounting Kit A Bulb Well is recommended. (Required with AT-201 or AT-203)	
AT-210	Concealed Adjustment Kit Includes plate to conceal setpoint adjustment and lock cover screw	
AT-211	Outside Bulb Shield	

*Requires AT-209 Bulb Mounting Kit

Electrical Rating: All Units Except TC-4115*

Switch Rating (50/60 Hz)	24V	120V	240V	277V
Full Load Amps	—	9.8	8.0	—
Locked Rotor Amps	—	58.8	48.0	—
Pilot Duty VA	60	360	360	—
Non-Inductive Amps (Resistive)	—	—	—	—
Single Stage	22	22	22	22
Two Stage	16	16	8.3	7.2

*TC-4115 for System 8000 and dry circuit switching.
Electrical Rating: 1.0 amp at 24 Vac, 25 amp at 24 Vdc.

Performance and Selection Table

Type	Part Number	Set Point Adjustment Range °C (°F)	Dual Bulb Ratio	Dimensions		Differential		Maximum Safe Bulb Temperature °C (°F)	Case Ambient Temperature °C (°F)	
				Capillary Copper	Bulb Copper	Factory Set	Adjustable			
Single Stage Single Bulb	TC-4111	-40 to 49 (-40 to 120)	1 1/2	1.8M (6')	10 x 100 mm (3/8 x 4')	1.6°C (3°F)	1.6 to 8.5°C (3 to 16°F)	77 (170)	-40 to 60 (-40 to 140)	
	TC-4111-020	-40 to 120		6M (20')						
	TC-4112	38 to 127 (100 to 260)		1.8M (6')						
	TC-4115*	-40 to 49 (-40 to 120)		3M (10') Armored						
	TC-4121	-40 to 120								
	TC-4122	38 to 127 (100 to 260)								
	TC-4123	88 to 176 (190 to 350)								
Single Stage Dual Bulb	TC-4151	21 to 49 (70 to 120)	1 1/2	9M (30') Each Bulb	Outdoor 10 x 100mm (3/8 x 4')	Indoor 10 x 140mm (3/8 x 5 1/2')	1.6°C (3°F)	8 to 5.5°C (1 1/2 to 10°F)	Total of indoor and outdoor temperatures must not exceed 138°C (280°F)	-40 to 60 (-40 to 140)
	TC-4152	1:1	10 x 100mm (3/8 x 4')		10 x 100mm (3/8 x 4')	1.6 to 8.5°C (3 to 16°F)				
	Two Stage Single Bulb	TC-4211	-40 to 49 (-40 to 120)	1 1/2	1.8M (6')	10 x 100 mm (3/8 x 4')	1.6°C (3°F)	Per Stage Fixed Between Stages: 1.1 to 5.5°C (2 to 10°F)		
TC-4221		-40 to 120	3M (10') Armored							
TC-4222		38 to 127 (100 to 260)								
TC-4223		88 to 176 (190 to 350)								
Two Stage Dual Bulb	TC-4251	21 to 49 (70 to 120)	1 1/2	9M (30') Each Bulb	Outdoor 10 x 100mm (3/8 x 4')	Indoor 10 x 140mm (3/8 x 5 1/2')	1.6°C (3°F)	8 to 3.5°C (1.5 to 6.5°F)	Total of indoor and outdoor temperatures must not exceed 138°C (280°F)	-40 to 60 (-40 to 140)
	TC-4252	1:1	10 x 100mm (3/8 x 4')		10 x 100mm (3/8 x 4')	1.1 to 5.5°C (2 to 10°F)				

*TC-4115 for System 8000 and dry circuit switching. Electrical Rating: 10 amp at 24 Vdc, 25 amp at 24 Vdc.
 **TC-4151 and TC-4251 — For 1 1/2:1 ratio reverse bulbs and use extra dial supplied with unit.

For Dual Bulb:

To select Ratio it is necessary to know only (1) Outdoor design temperature, (2) Maximum water temperature at outdoor design temperature, and (3) Desired water temperature at 70°F outdoors.

Example Select ratio for panel installation with a -10°F design temperature and estimated supply water temperatures of 75°F at 70°F outdoors, and 125°F at -10°F outdoors.

From chart below, -10°F for 1 1/2 to 1 ratio, note by interpolation (70°F to 123°F with dial at 70°F; 80°F to 133°F with dial at 80°F) that water temperature varies from 75°F to 128°F as outdoor temperature drops from 70°F to -10°F, when dial is set at 75°F.

By similar means, note that a control with 1 to 1 ratio would result in water temperatures varying from 75°F to 155°F. For this application the 1 1/2 to 1 ratio should be selected.

Outdoor Temperature (F)	Ratio	Change in Water Temperature for Different Ratios as Outdoor Temperature Drops from 70°F to Design Temperature					
		Dial Set at 70°F					
		Dial Set at 70°F	Dial Set at 80°F	Dial Set at 90°F	Dial Set at 100°F	Dial Set at 110°F	Dial Set at 120°F
-30	1 to 1 1/2	70 to 220	80 to 230	90 to 240	100 to 250	110 to 260	120 to 270
	1 to 1	70 to 170	80 to 180	90 to 190	100 to 200	110 to 210	120 to 220
	1 1/2 to 1	70 to 137	80 to 147	90 to 157	100 to 167		
-20	1 to 1 1/2	70 to 205	80 to 215	90 to 225	100 to 235	110 to 245	120 to 255
	1 to 1	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1 1/2 to 1	70 to 130	80 to 140	90 to 150	100 to 160		
-10	1 to 1 1/2	70 to 190	80 to 200	90 to 210	100 to 220	110 to 230	120 to 240
	1 to 1	70 to 150	80 to 160	90 to 170	100 to 180	110 to 190	120 to 200
	1 1/2 to 1	70 to 123	80 to 133	90 to 143	100 to 153		
0	1 to 1 1/2	70 to 175	80 to 185	90 to 195	100 to 205	110 to 215	120 to 225
	1 to 1	70 to 140	80 to 150	90 to 160	100 to 170	110 to 180	120 to 190
	1 1/2 to 1	70 to 117	80 to 127	90 to 137	100 to 147		
+10	1 to 1 1/2	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1 to 1	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1 1/2 to 1	70 to 110	80 to 120	90 to 130	100 to 140		
+20	1 to 1 1/2	70 to 145	80 to 155	90 to 165	100 to 175	110 to 185	120 to 195
	1 to 1	70 to 120	80 to 130	90 to 140	100 to 150	110 to 160	120 to 170
	1 1/2 to 1	70 to 103	80 to 113	90 to 123	100 to 133		
+30	1 to 1 1/2	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1 to 1	70 to 110	80 to 120	90 to 130	100 to 140	110 to 150	120 to 160
	1 1/2 to 1	70 to 97	80 to 107	90 to 117	100 to 127		

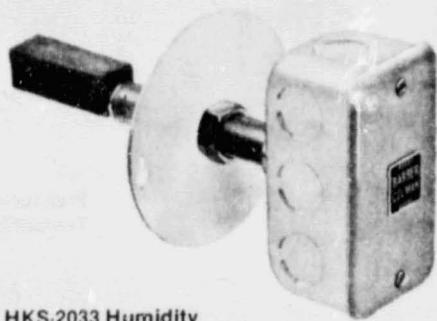
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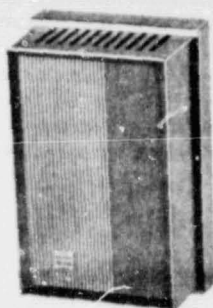


Product Information

Proportional Pneumatic Transmitters HKS and TKS



HKS-2033 Humidity
Duct Type Transmitter



HKS-5033 Room Type
Humidity Transmitter
or
TKS-5001 Room Type
Temperature Transmitter



TKS-6001
Light Troffer
Temperature Transmitter



TKS-7001 Diffuser
Temperature Transmitter

Humidity and Temperature Transmitters

For proportional control used with the RKS Series Receiver-Controllers for control of pneumatically actuated valves or dampers. The transmitter may be used with one or more calibrated gauges for continuous indication at local or remote stations.

Device: Wall mounted unit has rugged cover. Duct mounted unit (humidity) is enclosed in rugged housing. Connection easily made with plug-in plastic tube fittings. Temperature transmitter uses bimetal element, humidity transmitter uses highly sensitive nylon humidity element. **Output:** 3 to 15 psig. **Installation:** Order fittings separately for type of wall construction. Wall box fitting (AT-516) is used for surface or flush mounting on walls other than masonry. Mortar joint fitting (AT-517) is used for mounting in the seam of masonry walls. No fitting is required for temperature light troffer transmitters. Duct type of humidity transmitter installation is simplified by using push-on air connections for 6mm (1/4") OD Plastic tubing. Maximum safe ambient temperature 66°C (150°F).

Dimensions

HKS-2033 Width 102mm (4"), height 106mm (4-3/16") and depth 52mm (2-1/16").

Tube mounting hole diameter is 35mm (1-3/8") and tube insertion length is 108mm (4-1/4").

HKS-5033 Width 70mm (2-3/4"), height 111mm (4-3/8") and depth 41mm (1-5/8").

TKS-5001 Width 70mm (2-3/4"), height 111mm (4-3/8") and depth 41mm (1-5/8").

TKS-7001 Requires a 10mm (3/8") min. _____ 22mm (7/8") maximum hole in the diffuser face. Unit protrudes from face approximately 38mm (1-1/2").

Part No.	Action	Mounting	Range	Output Signal (psig)
Humidity Transmitters				
HKS-2033	Direct-Acting	Duct	Non-Adj.	3-15
HKS-5033		Wall	10-90% RH	
Temperature Transmitters				
TKS-5001	Direct-Acting	Wall	Non-Adj.	3-15
TKS-6001		Light Troffer	10-38°C	
TKS-7001		Diffuser	50-100°F	

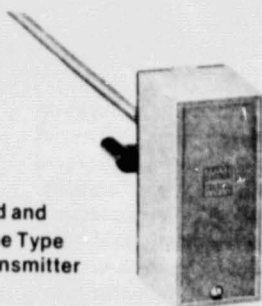
Table 1

Proportional Pneumatic Transmitter TKS and PKS

Product Information



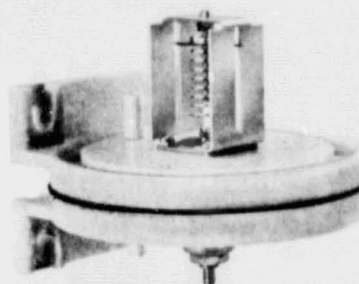
Rod and
Tube Type
Transmitter



Averaging
Bulb Type
Transmitter



Pressure
Transmitter



Temperature Transmitters

For proportional control used with RKS Series Receiver-Controllers. Transmitters may be used with one or more calibrated gauges for continuous pressure or temperature indication at any local or remote position. **Device:** Direct acting proportional sensors. TKS-8000 and 9000 Series use sensitive rod and tube insertion assembly. The TKS-2000 and 4000 Series use a liquid filled element. Rugged gray cover mounted on sturdy die-cast aluminum base. **Output:** 3 to 15 psig. **Mounting:** Rod and tube may be duct or well (pipe) mounted. Averaging type is normally duct mounted with 7.4m (24 ft) element in duct. Straight bulb has a 0.9m (3 ft) capillary normally used to pass through walls to sense outside temperature.

Air Connection: NPT female 3mm (1/8")

Dimensions:

Case — 64mm (2-1/2") wide X 102mm (4") high X 76mm (3") deep.

Rod & tube elements

Duct Mounted — 10mm (3/8") OD X 368mm (14-1/2") long

Immersion — 10mm (3/8") OD X 235mm (9-1/4") long.

Remote Bulb elements

Averaging — 2mm (5/64") OD by 7.3m (24') long.

Outdoor (Straight) — 4mm (11/64") OD X 23mm (9") bulb
0.9m (3 ft) capillary.

Pressure Transmitters

For proportional control used with RKS Series Receiver-Controllers. Transmitters may be used with one or more calibrated gauges for continuous pressure or temperature indication at any local or remote position. **Device:** A proportional type transmitter with a highly sensitive forced balance diaphragm assembly which varies pressure signal to receiver-controller. Unit is constructed of rugged molded plastic. **Mounting:** Transmitter must be mounted with diaphragm in horizontal position and setpoint screw on top. Accessories are available for static or differential pressure installations.

Air Connections: Simplified installation using push-on air connections 6mm (1/4") I.D. for high and low pressure taps, 6mm (1/4") O.D. plastic tubing for output connection.

Dimensions: 133mm (5-1/4") length and depth, 133mm (5-1/4") high (overall).

Setpoint Scale Range: Adjustable from -5 to 150mm of water (-25 to 6 inches of water). Field adjustment is easily made by a slotted set screw.

Span: 51mm (2") of water non-adjustable for 3 to 15 psig.

Maximum Static Pressure: 711mm (28") water column.

Device	Part No.	Action	Mounting	Max. Safe Temp. at Element	Range (Non-Adjustable)	Output Signal (psig)
Straight Bulb	TKS-2031	Direct- Acting	Wall or Duct	200°F 93°C	-40 to 160°F, -40 to 71°C	3-15
Averaging Bulb	TKS-4014		Duct	300°F 149°C	0 to 100°F, -18 to 38°C	
	TKS-4017				50 to 150°F, 10 to 66°C	
Rod & Tube	TKS-8014		Immersion		0 to 100°F, -18 to 38°C	
	TKS-8033		Immersion		40 to 240°F, 4 to 116°C	
	TKS-9014		Duct		0 to 100°F, -18 to 38°C	
	TKS-9017		Duct		50 to 150°F, 10 to 66°C	
Pressure Transmitter	PKS-2011		Wall or Duct	120°F, 49°C	See Above	

Table 2

Barber-Colman Company
CONTROLS DIVISION

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Remote Setpoint Adjustor Receiver Gauges

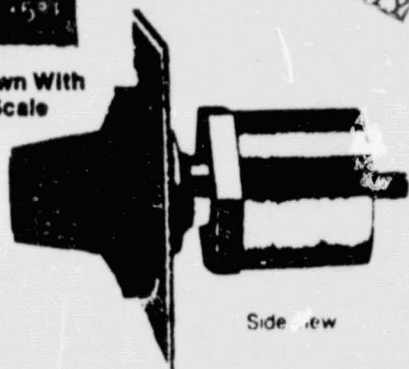
Product Information



Remote Setpoint Adjustor



AKS-1100 Shown With
AKS-1129 Scale



Side View

For use with RKS receiver controllers for remote adjustment of setpoint of the receiver controller. May also be used to manually pilot pneumatic relays.

Device: Consists of rugged aluminum housing a precision flapper-nozzle assembly which produces a linear 3-15 psig output signal. **Mounting and Connections:** May be panel or wall box mounted. Panel requires 16mm [5/8"] hole for mounting of remote setpoint adjustor. Maximum panel thickness 10mm [3/8"]. Thicker panels must be back cut to the 10mm [3/8"] dimension. Panel space required 57mm [2-1/4"] wide X 60mm [2-3/8"] high, 64mm [2-1/2"] minimum depth. Barbed connection for 6mm [1/4"] O.D. plastic scales must be ordered separately.

Ambient Temperature Limits: 4 to 49°C (40° to 120°F)

Safe Supply Air Pressure: 30 psig.

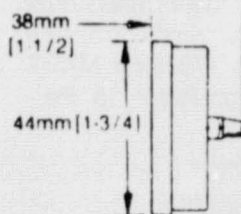
Output Signal: 3-15 psig.

Part No.	Description
AKS-1100	Remote Setpoint Adjustor Less Scale
AKS-1129	Scale Only +5°F
AKS-1139	Scale Only +2.8°C
AKS-1141	Scale Only +10°F
AKS-1149	Scale Only +5.5°C
AKS-1169	Scale Only +20°F
AKS-1179	Scale Only +11°C
AKS-1189	Scale Only +A% RH
AKS-1191	Scale Only +5mm H ₂ O
AKS-1199	Scale Only +2 in H ₂ O

Receiver Gauges



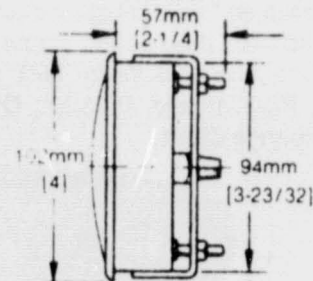
AKS-6000



Stem Mounted
Back-Connected
Receiver Gauge



AKS-9000



Flush Panel Mount
With U Clamp

All Dimensions are in Millimeters with inches following in brackets

For highly accurate temperature indication, pressure, or humidity in conjunction with a transmitter-receiver system. **Device:** Receives a 3-15 psig signal for continuous indication of the variable being sensed (temperature, pressure, humidity). See table below for dial ranges available. Gauges are easily field adjusted. Dial sizes are 38mm [1-1/2"] and 89mm [3-1/2"]. **Mounting and Connections:** Back connected 3mm [1/8"] NPT male. 89mm [3-1/2"] size designed for flush mounting in panels up to 19mm [3/4"] thick.

Operating Pressures: Input Air Pressure — 3-15 psig.
Maximum Safe Pressure — 25 psig

Part No.		Scale Range
38mm (1-1/2") Gauge (Stem Mounted)	89mm (3-1/2") Gauge (Flush Panel Mounted)	
AKS-6221	AKS-9021	50 to 100°F, 10 to 37°C
AKS-6244	AKS-9044	0 to 100°F, -18 to +37°C
AKS-6247	AKS-9047	50 to 150°F, 10 to 66°C
AKS-6251	AKS-9051	-40 to +160°F, -40 to +71°C
AKS-6263	AKS-9063	40 to 240°F, 4 to 116°C
AKS-6281	AKS-9081	10 to 90% RH
—	AKS-9091	-25 to +175 H ₂ O -5 to +45mm H ₂ O
—	AKS-9092	1 to 3 H ₂ O 25 to 75mm H ₂ O
—	AKS-9093	2.5 to 4.5 H ₂ O 60 to 110mm H ₂ O
—	AKS-9094	4 to 6 H ₂ O 100 to 150mm H ₂ O

Barber-Colman Company
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Product Information

Humidistat - Pressure Two-Position Pressure Electric Switches PC 100 Series

PC-110

PC-132

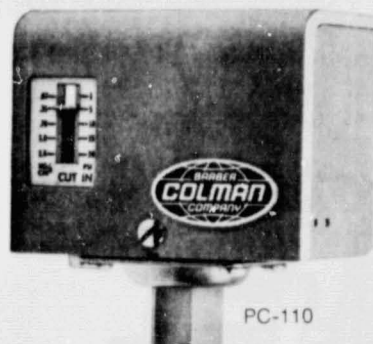
PC-131

PC-141

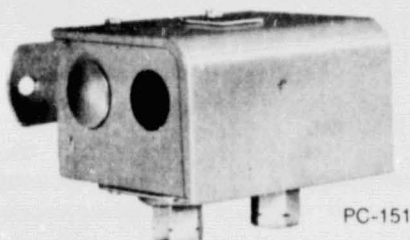
PC-151

For: ON-OFF control of electrical devices by air pressure signals. Typical applications include the control of air compressors, fans, pilot lights, etc.

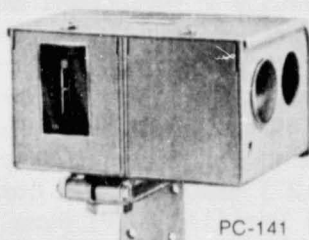
Device: Rugged metal case. Non-metallic diaphragm positioned by air pressure changes actuates heavy duty switches. Large coded screw type terminals. Pressure connection 1/8 inch FNPT except 1/8 inch MNPT on PC-131 and PC-132. **Ordering:** Refer to Performance Chart.



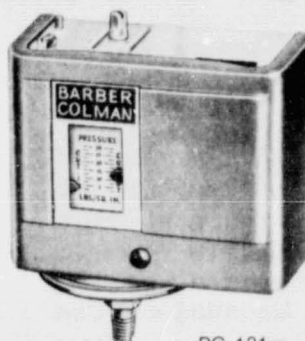
PC-110



PC-151



PC-141



PC-131

PC-132

PERFORMANCE CHART

Part No.	Switch Action	Scale Range psig		Differential psig		Volts (Vac)	Switch Rating (AC)				Ambient Temp. Limits °F	Max. Input psig	Mounting	
							FLA Amps	LRA Amps	Non Ind. Amps	Pilot Duty VA				
PC-110	SPDT Makes N.O. Contact to Common on Pressure Increase	1-20		1-5 Adjustable Factory Set @ 2		24	—	—	16	100	-40 to 150	50	Surface Or Track*	
						120	13.8	82.8	16	650				
						208	9.6	57.6	9.6	750				
						240	8.3	49.8	8.3	750				
PC-131	DPST Opens on Pressure Rise	3-30		1½—20 Adjustable		120	12	72	12	125	32 to 140	50	Surface	
PC-132	DPST Opens on Pressure Drop					208	12	72	12	@				
						240	12	72	12	120/600				
						277	—	—	12	VAC				
PC-141	DPDT Makes N.O. Contacts to Common on Press. Incr.	3-20		5 Fixed At Mid Scale		120	16	96	16	125		150		
						208	9.2	55.2	9.2	@				
						240	8	48	8	24/277				
PC-151	3 SPST Opens on Pressure Rise	Sw.	Open	Switch	Fixed	120	6	36	10	VAC				
		1	6	1	3	208/240	3	18	8	Max. Load				
		2&3	18	2&3	.5	277	—	—	7.2	2000 VA				

*Order PNC-112-1 Bracket for mounting on SYZE-567 Track in Control Cabinets

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



Product Information

Receiver-Controller RKS

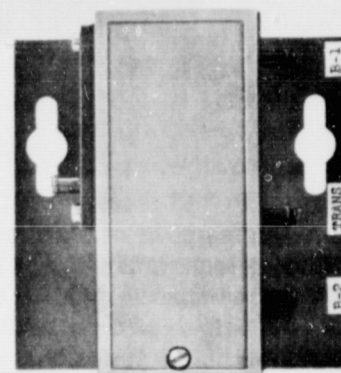
For use in conjunction with remote proportional transmitters to control pneumatic actuated dampers, valves, etc. in air conditioning systems. The transmitter-receiver-controller system may be used to control temperature, humidity, or pressure. Appropriate transmitters are available for each application. In addition to the indicating gauges at the receiver-controller, one or more remote gauges may be used between the transmitter and receiver-controller to indicate temperature, humidity or pressure. **Device:** The receiver-controllers are force balance, pneumatic amplifiers; a feedback signal from a remote transmitter is amplified to control a pneumatic actuator. The dual input receiver-controller (RKS-3000 and 4000 Series) allows a compensated signal to reset the setpoint of the receiver-controller. All models except the RKS-5001 are furnished with integral gauge ports. Proportional band, direct or reverse-action and authority are easily field adjustable. Mechanisms are mounted on a sturdy base. The RKS-5001 can be used as a 1:1 reverse acting relay. In this mode the transmitter signal is reversed to accomplish direct reset of a dual input receiver-controller where necessary. A sturdy cover is available for protection when mounting receiver-controllers remote from cabinet or where susceptible to damage. **Air Connections:** 3mm (1/8") FNPT on all models except the RKS-5001 which has barbed connector (which requires no clamp) for 6mm (1/4") O.D. X 1mm (.030) wall polyethylene tubing. **Installation:** RKS-1001 thru RKS-4002 have mounting feet with holes provided in the base assembly for surface mounting on wall or panel. RKS-5001 had integral mounting bracket with keyhole slots for mounting on wall or panel. Unit may also be snapped into mounting track for panel installation. **Options:** For remote setpoint adjuster and receiver gauge, see reverse side.

Pneumatic-Proportional Control



RKS-1001 thru 4002
Receiver-Controller
Shown W/Cover

RKS-5001
Shown W/Cover



Optional Covers: AKS-4 for RKS-1001 Thru 4002
AKS-5 for RKS-5001

Ambient Temperature Limits: 4 to 66°C (+ 40 to 150°F).

Operating Air Pressures:

Supply Air Pressures: 18 psig.

Input Signals (all ports): 3 to 15 psig.

Maximum Safe Pressure: 30 psig.

Part Number		Remote SPA	Action*	Authority	Proportional Band	
Single Input	RKS-5001	None	DA	None	4 to 40% of Input Transmitter Span. Adj.	
	RKS-1001	None	DA		2-1/2% to 40% of Primary (Input 1) Transmitter Span. Adjustable	
	RKS-2001	±10% of Primary Transmitter Span	DA			
Dual Input	RKS-3002	None	DA	10% to 200% of Primary (Input 1) Transmitter Span. Adjustable.		
	RKS-4002	±10% of Primary Transmitter Span	DA			

*Direct-Acting (DA): Increases output pressure on rise in input 1 pressure. Field changeable to Reverse Acting (RA): Decreases output pressure on rise in input 1 pressure.

Remote Setpoint Adjustor Receiver Gauges

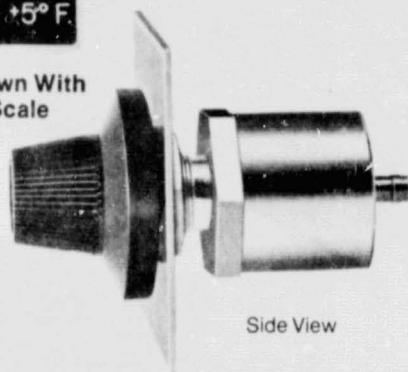
Product Information



Remote Setpoint Adjustor



AKS-1100 Shown With
AKS-1129 Scale



Side View

For use with RKS receiver controllers for remote adjustment of setpoint of the receiver controller. May also be used to manually pilot pneumatic relays. **Device:** Consists of rugged aluminum housing a precision flapper-nozzle assembly which produces a linear 3-15 psig output signal. **Mounting and Connections:** May be panel or wall box mounted. Panel requires 16mm [5/8"] hole for mounting of remote setpoint adjustor. Maximum panel thickness 10mm [3/8"]. Thicker panels must be back cut to the 10mm [3/8"] dimension. Panel space required 57mm [2-1/4"] wide X 60mm [2-3/8"] high, 64mm [2-1/2"] minimum depth. Barbed connection for 6mm [1/4"] O.D. plastic scales must be ordered separately.

Ambient Temperature Limits: 4 to 49°C (40° to 120°F)

Safe Supply Air Pressure: 30 psig.

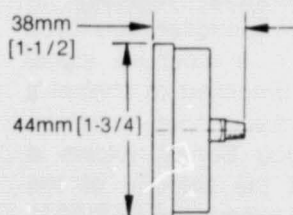
Output Signal: 3-15 psig.

Part No.	Description
AKS-1100	Remote Setpoint Adjustor Less Scale
AKS-1129	Scale Only +5°F
AKS-1139	Scale Only +2.8°C
AKS-1141	Scale Only +10°F
AKS-1149	Scale Only +5.0°C
AKS-1169	Scale Only +20°F
AKS-1179	Scale Only +11°C
AKS-1189	Scale Only +8% R. H.
AKS-1191	Scale Only +5mm H ₂ O
AKS-1199	Scale Only +2 in H ₂ O

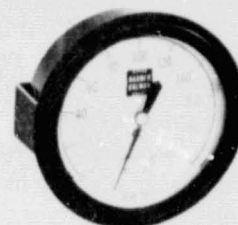
Receiver Gauges



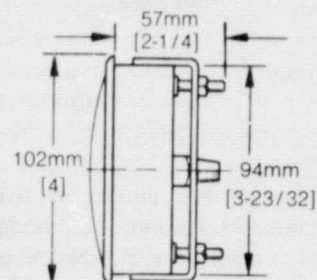
AKS-6000



Stem Mounted
Back-Connected
Receiver Gauge



AKS-9000



Flush Panel Mount
With U Clamp

All Dimensions are in Millimeters with Inches following in brackets.

For highly accurate temperature indication, pressure, or humidity in conjunction with a transmitter-receiver system. **Device:** Receives a 3-15 psig signal for continuous indication of the variable being sensed (temperature, pressure, humidity). See table below for dial ranges available. Gauges are easily field adjusted. Dial sizes are 38mm [1-1/2"] and 89mm [3-1/2"]. **Mounting and Connections:** Back connected 3mm [1/8"] NPT male. 89mm [3-1/2"] size designed for flush mounting in panels up to 19mm [3/4"] thick.

Operating Pressures: Input Air Pressure — 3-15 psig.
Maximum Safe Pressure — 25 psig.

Part No.		Scale Range
38mm (1-1/2") Gauge (Stem Mounted)	89mm (3-1/2") Gauge (Flush Panel Mounted)	
AKS-6221	AKS-9021	50 to 100°F, 10 to 37°C
AKS-6244	AKS-9044	0 to 100°F, -18 to +37°C
AKS-6247	AKS-9047	50 to 150°F, 10 to 66°C
AKS-6261	AKS-9061	-40 to +160°F, -40 to +71°C
AKS-6263	AKS-9063	40 to 240°F, 4 to 116°C
AKS-6281	AKS-9081	10 to 90% RH
—	AKS-9091	-25 to +1.75" H ₂ O, -5 to +45mm H ₂ O
—	AKS-9092	1 to 3" H ₂ O, 25 to 75mm H ₂ O
—	AKS-9093	2.5 to 4.5" H ₂ O, 60 to 110mm H ₂ O
—	AKS-9094	4 to 6" H ₂ O, 100 to 150mm H ₂ O

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



Product Information

Pneumatic Relays AK Series Accessories

Uses: Barber-Colman pneumatic relays are used in conjunction with Barber-Colman pneumatic controls to perform various control functions as determined by system requirements. Refer to table for specific functions obtained from the various relays.

Construction: The Barber-Colman pneumatic relays are constructed of a rugged housing which protects the internal parts from abuse. The diaphragms are of a neoprene coated, continuous fiber fabric which provides durability and precision operation. The unique inner valving produces a linear relationship between the input signals and the output signal with less than .25 psig required charge in input to obtain a change in output pressure.

Linkage for AK-51309. Order separately.

AM-502 for MK-3000 Damper Actuators

AM-504 for MK-4700 Valve Actuators

AM-508 for MK-6800 Valve Actuators (1/2-2")

AM-509 for MK-6800 Valve Actuators (2 1/2-4")

AM-510 for MK-6900 Valve Actuator

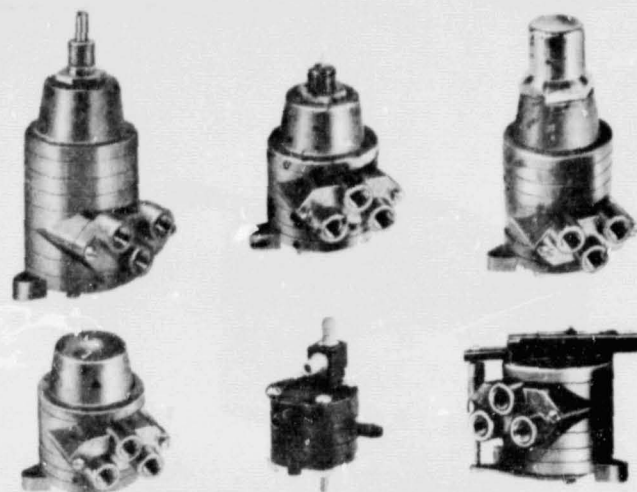
AM-516 for MK-7000 Damper Actuators

Maximum Safe Air Pressure: 30 psig — normal supply air is 15 to 20 psig.

Maximum Safe Ambient: 150°F.

Air Connections: 1/8" FNPT on all except AK-51632, AK-51642, AK-52032 and AK-52042 which have barbed connections for 1/4" O.D. x .030 wall plastic tube.

Installation: Mounting may be in line, wall, or panel mounted. All except AK-51632, AK-51642, AK-52032



VARIOUS PNEUMATIC RELAYS
(See Part No. Relay
and Description
in Table Below)

and AK-52042 have an integral mounting foot. Bracket for AK-51632, AK-51642, AK-52032 and AK-52042 is ordered separately, one bracket PNC-112-1 for each 2 relays used. The bracket may be wall or track mounted by use of SYZE-567 track.

AK-53098 and AK-53198 scale kits are available for the AK-50605 relay. The AK-53098 is graduated from 0 to 20 psig. The AK-53198 is marked close-open, min. O.A. and is graduated for a 5 psig change in output from close to open.

Part No.	Function
AK-50301	3 way snap acting switching—set point adj: 3-20 psig. Diff. adj: 1.5-6.5 psig
AK-50401	3 way switching—set point adj: 1.5-18.5 psig. Diff. fixed 2 psig
AK-50603	Direct acting — 1:1 ratio
AK-50604	Maximum output limiter — direct acting — 1:1 ratio
AK-50605	Minimum output limiter — direct acting — 1:1 ratio
AK-50607	Biased start — direct acting — 1:1 ratio
AK-50613	Reverse acting — 1:1 ratio
AK-50703	Direct acting — 1:2 ratio
AK-51306	Averaging — two input — direct acting
AK-51309	Positive positioning — direct acting
AK-51632	Higher of two pressures selector — direct acting
AK-51642	Lower of two pressures selector — direct acting
AK-52032	Higher of ten pressures selector — direct acting
AK-52042	Lower of ten pressures selector — direct acting

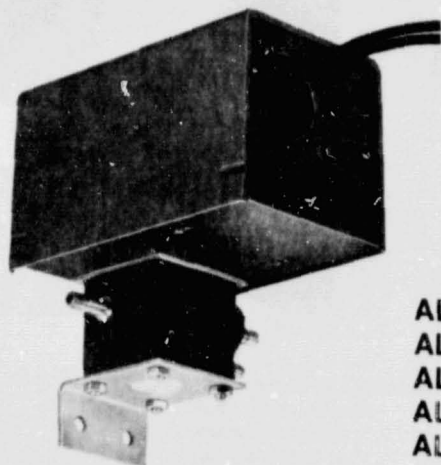
Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



Product Information

Accessories Electric Pressure AL 100 Series Three-Way Solenoid Valve



- AL 100 ☐
- AL 110 ☐
- AL 120 ☐
- AL 125 ☐
- AL 140 ☐



For use in applications where an electrical circuit is used to control a pneumatically operated device. It may be used to direct supply air to a pneumatic device when the coil is energized or de-energized depending on the supply and exhaust air connections. **Device:** Valve consists of plastic body incorporating the barbed brass connectors for 1/4 inch OD plastic tubing. The electrical coil is enclosed in a corrosion resistant metal housing. An opening is provided for connecting 1/2 inch conduit. When current flows in the solenoid coil, the permeable plunger attached to the valve mechanism is drawn into an electromagnetic field. The inner valve rises when the coil is energized, opening an air passage between COM (Common) and N.C. (Normally Closed). Without any current flow to the coil, the valve is in its normal position, opening an air passage between COM and N.O. (Normally Open). **Installation:** See Figure 1 and Figure 2 for mounting instructions.

Ambient Temperature: 5°C [40°F] min. to 54°C [130°F] max.

Fluid (air) Temperature: 5°C [40°F] min. to 54°C [130°F] max.

Power consumption (when energized): 7 watts.

Maximum inlet pressure: 30 psig.

Flow capacity (air): .5 scfm @ 15 psig. supply 1 psig. drop.

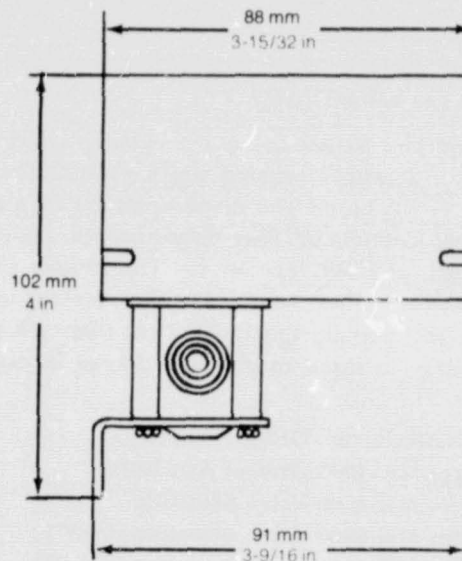


Figure 1

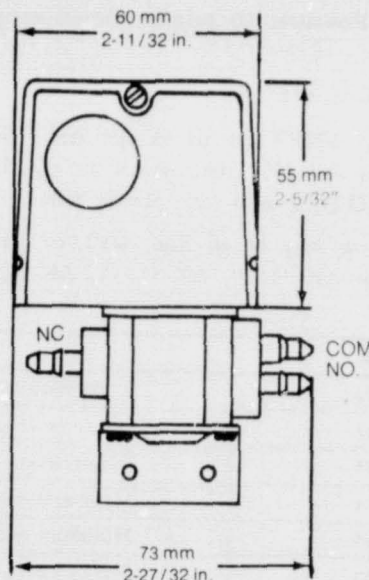


Figure 2

Part Number	Voltage, 50/60 Hz
AL 100	24
AL 110	120
AL 120	208
AL 125	240
AL 140	480

Barber-Colman Company
CONTROLS DIVISION

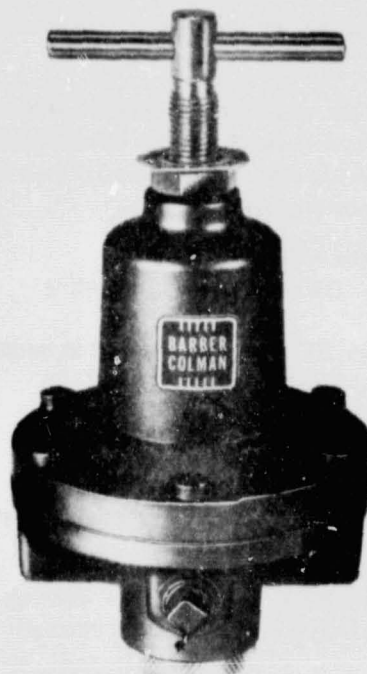
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Product Information

Pressure Regulators And Air Filter AL-400 Series

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PRESSURE REGULATORS

Uses: An accurate pressure regulator with large flow capacity to reduce supply air pressure from the compressor down to the requirements of the system.

Construction: Design facilitates in-line installation. Maximum input pressure rating is 400 psig. Output pressure range is 0 to 50 psig. Operating temperature range is -40°F to 200°F.

A gauge port is provided on all regulators (this port cannot be used as an outlet as it does not provide full-flow). These regulators are of the relieving type ... the regulated pressure is reduced by backing off the regulating adjustment screw. This also prevents built-up of excessive pressure in the regulated system.

Part Number	Pipe Size (Inches)	Capacity SCFM
AL-481	1/8*	1
AL-483	1/4*	0-16
AL-487	3/8*	16-22
AL-484	1/2*	22-32

*NPT Female, adaptors are provided to reduce to 1/2" & 1/4" FNPT.

AIR FILTER

Uses: To provide clean, oil free air for pneumatic control systems.

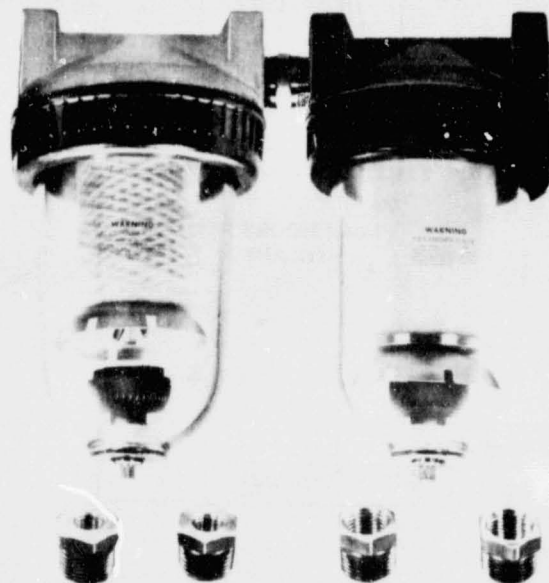
Construction: Unit is a dual filter station combining a 5 micron absorbent pre-filter and a coalescing .03 micron oil removal filter. Filters are provided with automatic drains, to drain collected liquids from the filter bowl.

Units are constructed of an aluminum housing and polycarbonate bowl. Elements are easily replaced when necessary.

Maximum operating conditions: 250 psig or 150°F.

Part Number	Pipe Size (Inches)	Maximum SCFM
AL-439	3/4*	30
AL-437-0-1-1	3/8	15

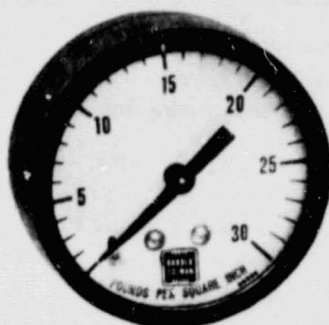
*NPT Female, adaptors are provided to reduce to 1/2" & 1/4" FNPT.



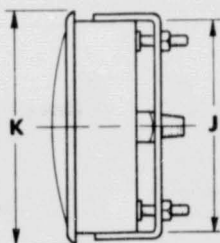
AL-439 SHOWN

**Pressure Gauges
AL 300 Series**

Product Information



BACK CONNECTED



**FLUSH MOUNT WITH
U CLAMP**

Size	J	K
2	2	2-1/4
3-1/2	3-23/32	4

Uses: For indicating air pressure in pneumatic control systems.

Construction: Case and ring drawn steel phosphated for rust resistance and finished in oven baked black enamel. Green Merlon plastic case available in 1-1/2-inch model. All models have plastic crystals.

Bourdon Tube — Phosphor Bronze

Movement — Brass-independent mounting

Accuracy: Within 2% of total scale range in middle half of scale and 3% elsewhere.

Pipe Connections: 1/8-inch or 1/4-inch NPT Standard as shown below.

Pressure Range: 0 through 30 and 0 through 100 psig.

Total Graduations — 30 to 100

Numeric Intervals — 5 psi and 10 psi intervals

Graduation Marks — 1 psi and 2 psi intervals

Part Number	Air Connection	Mounting	Dial	Range (psig)
STEEL CASE — 1/8" NPT CONNECTION				
AL-322	Back	Stem	2"	0-30
AL-323	Back	Panel (Flush)	2"	0-30
AL-327	Back	Stem	2"	0-100
AL-328	Back	Panel (Flush)	2"	0-100
STEEL CASE — 1/4" NPT CONNECTION				
AL-353	Back	Panel (Flush)	3-1/2"	0-30
PLASTIC CASE — 1/8" NPT CONNECTION				
AL-362	Back	Stem	1-1/2"	0-30

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



Control

Pneumatic Actuator Accessories Descriptive Data

MK-3000 AND MK-4400 DAMPER LINKAGE

Description	Part Number	Construction	
Crank Arms	AM-111	For 5/16" Diameter Shaft	Slot provides for adjustable radius from 7/8" minimum to 3-1/8" maximum.
	AM-112	For 3/8" Diameter Shaft	
	AM-113	For 1/2" Diameter Shaft	
	AM-115	For 7/16" Diameter Shaft	
Linkage Connector	AM-122	Straight Type—5/16" dia. hole. Use for linking parallel shafts.	
	AM-132	Ball Joint Type—5/16" dia. hole. Use for linking non parallel shafts.	
Damper Rod	AM-125	5/16" dia. steel rod 20" long. (Not illus.)	
	M-11-380	5/16" diameter cold rolled steel rod for damper connecting links. Shipped in random lengths of 10 to 12 feet. Minimum ordering quantity 50 feet.	
Bushing	AM-133	For building 7/16" shaft size up to 1/2" so that standard AM-113 crank arm may be used.	



AM-113
CRANK ARM



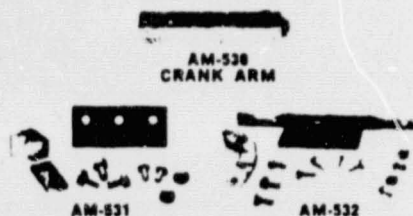
LINKAGE CONNECTORS
SHOWN ASSEMBLED
TO DAMPER ROD



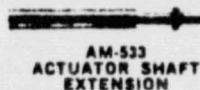
AM-133 BUSHING

MK-3000 AND MK-7000 DAMPER LINKAGE

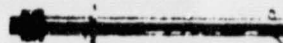
Crank Arm	AM-530	For 1/2" Diameter Shaft, holes for 3-1/2" and 4-1/2" stroke. For pivot mounted actuators.
Frame Mounting Kits	AM-531	Weld on Frame Lug and Blade Clip. Used with MK-7000 or Pivot Mounted MK-3000.
	AM-532	Bolt on Frame Lug and Blade Clip. Used with MK-7000 or Pivot Mounted MK-3000.
Actuator Shaft Extension	AM-533	Package of 25 Actuator Shaft Extensions for MK-7000 or MK-3000-0-2.
Pivot Stud	AM-534*	For pivot mounting of MK-7000 or MK-3000-0-2.
Clevis	AM-535*	Used for mounting MK-7000 and pivot mounting MK-3000-0-2.
Mounting Plates	AM-536*	Used for mounting MK-7000 and pivot mounting MK-3000-0-2 on ducts or damper frame.
	AM-301	Use for floor mounting of MK-7000 or pivot mounted MK-3000-0-2.



AM-531 AM-532
FRAME MOUNTING KITS



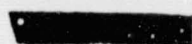
AM-533
ACTUATOR SHAFT
EXTENSION



AM-534
PIVOT STUD



AM-535
CLEVIS



AM-536



AM-301
MOUNTING PLATES

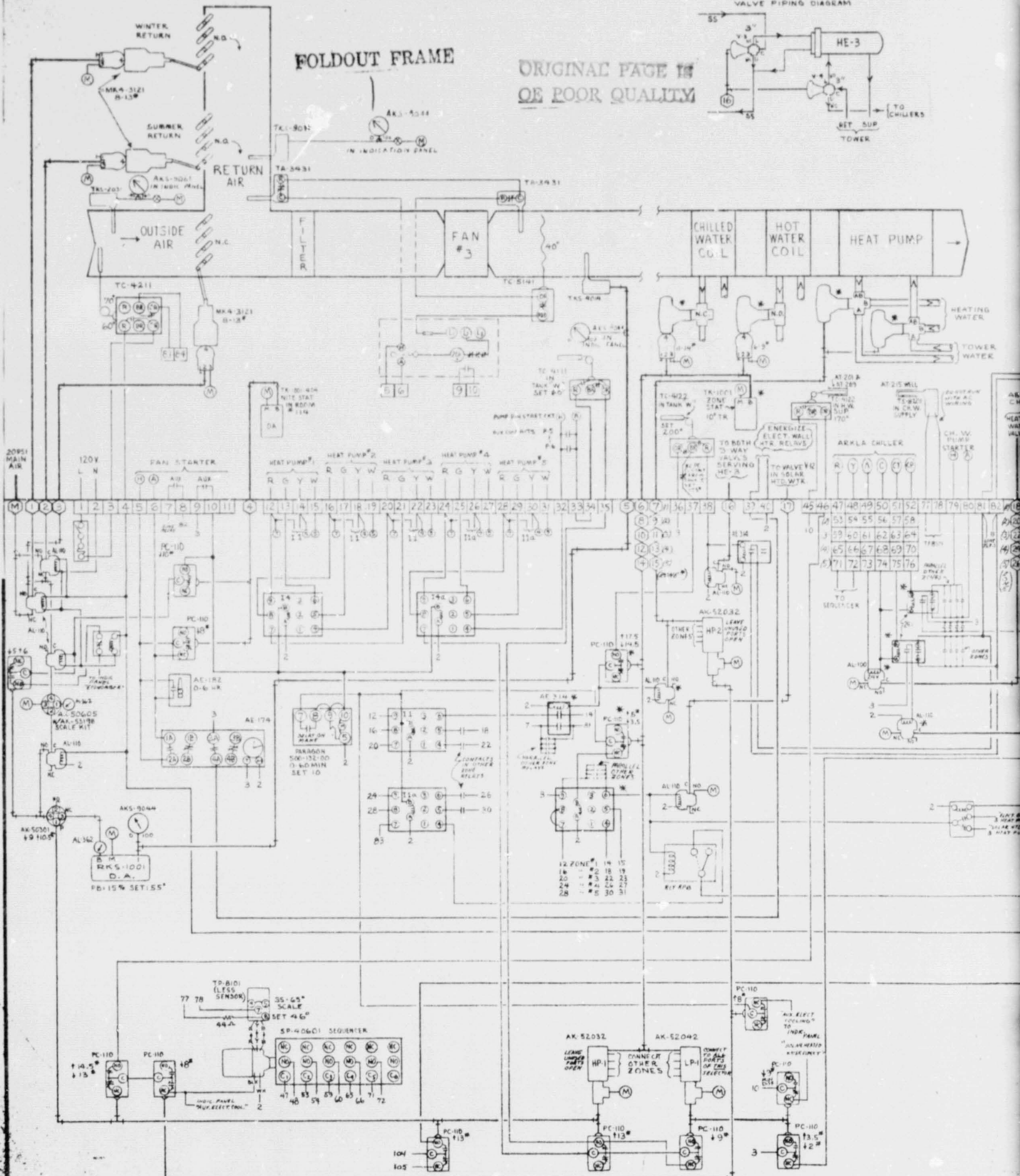
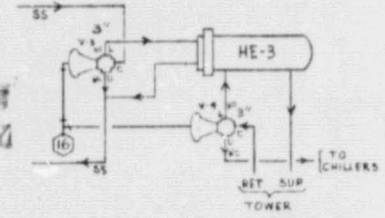
* Provided as standard with MK-7000-0-0-1, must be ordered to obtain pivot mounting of MK-3000-0-2.

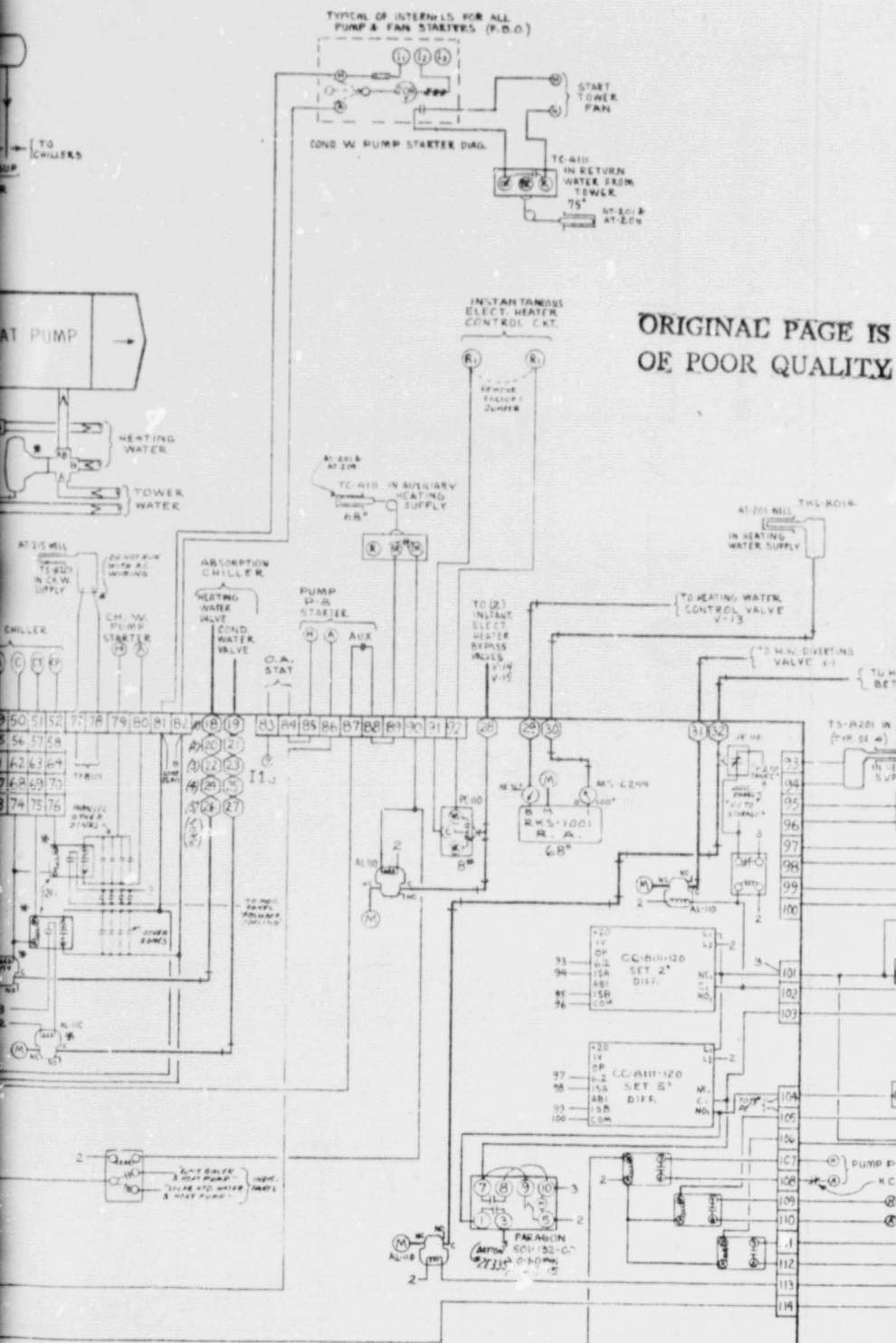
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VALVE PIPING DIAGRAM



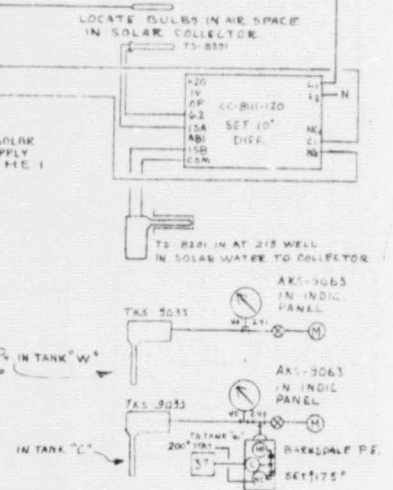
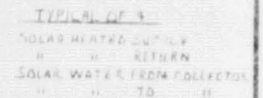
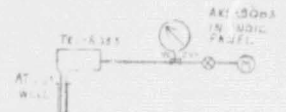
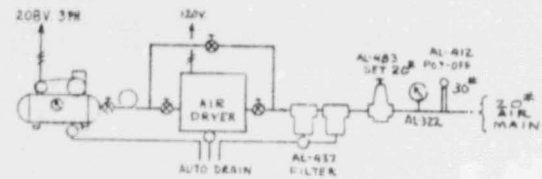


GENERAL NOTES AND EQUIPMENT SCHEDULE

* INDICATES ITEM TYPICAL OF FIVE (ONE PER ZONE)



SEE DWG'S. M-3 & M-5 FOR LOCATIONS OF EQUIPMENT



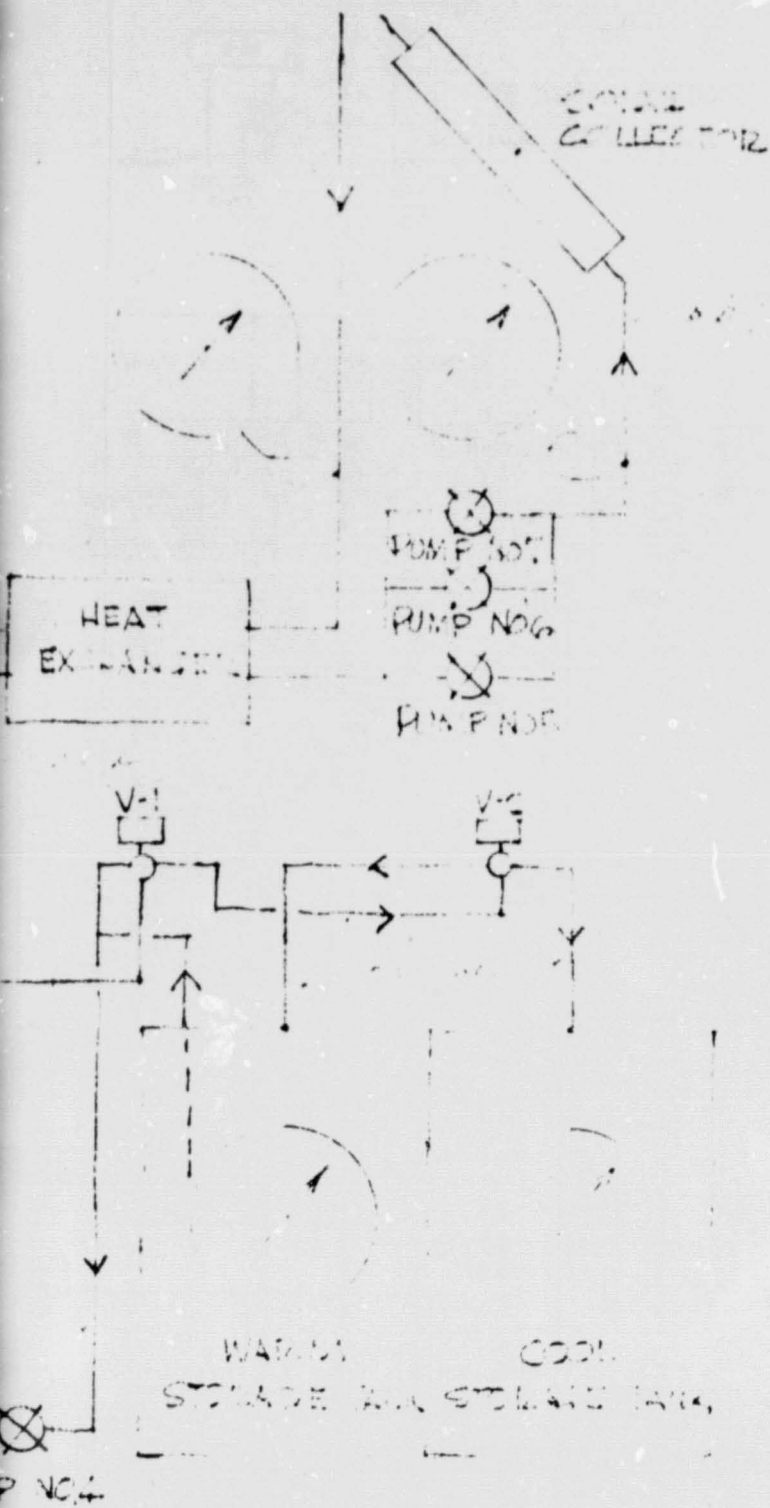
<div style="border: 1px solid black; padding: 5px; text-align: center;"> BARBER COLMAN <small>ARCHITECTS</small> </div> <p> BARBER COLMAN COMPANY NO. 64, LENEXA BUSINESS CENTER 9900 PFLUMM ROAD LENEXA, KANSAS 66215 </p> <p> Field Office 4-98 - 5600 </p>		<p>— REVISIONS —</p> <table border="1"> <thead> <tr> <th>DATE</th> <th>CHANGES</th> </tr> </thead> <tbody> <tr> <td>9-12-78</td> <td>4E-3</td> </tr> <tr> <td>11-17-78</td> <td>PER TEC</td> </tr> <tr> <td>1-3-79</td> <td>29B + CDIL</td> </tr> <tr> <td>1-5-79</td> <td>AM START</td> </tr> <tr> <td>3-9-79</td> <td>AS BUILT</td> </tr> <tr> <td>3-16-79</td> <td>FLYKPB</td> </tr> <tr> <td>8-21-79</td> <td>INCREASED PANELS</td> </tr> <tr> <td>2-12-79</td> <td>175° DE</td> </tr> </tbody> </table>	DATE	CHANGES	9-12-78	4E-3	11-17-78	PER TEC	1-3-79	29B + CDIL	1-5-79	AM START	3-9-79	AS BUILT	3-16-79	FLYKPB	8-21-79	INCREASED PANELS	2-12-79	175° DE
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3-16-79	FLYKPB																			
8-21-79	INCREASED PANELS																			
2-12-79	175° DE																			
<p>JOB NAME CITIZENS MUTUAL SAVINGS & LOAN ASSN.</p> <p>LOCATION LEAVENWORTH, KANSAS</p> <p>ARCHITECT PETERS, WILLIAMS, KUBOTA</p> <p>ENGINEER TEC, INC.</p> <p>CONTRACTOR NORRIS BROS., INC.</p> <p>DRAWN BY WWH</p> <p>CHECKED BY <i>SWH</i></p> <p>DATE 7-18-78</p>		<p>DRAWING NO.</p> <p>KC-78-1094-EC1</p>																		

☒ HEATING WITH AUX. ELEC. BOILER & HEAT PUMP.

☒ HEATING WITH SOLAR HTO. WTR. & HEAT PUMP

☒ HEATING WITH SOLAR HEATED WTR. DIRECT

- ☒ ECONOMIC - ()
☒ SOLID - ABSENT
☒ AUXILIARY -



WARM (NATURAL) COOLING
 2 - AIR-TO-AIR COOLING
 3 - COOLING

ELEC. BOILER & HEAT PUMP

SOLAR HEAT & WIND TOWER

SOLAR AIR-TO-AIR COOLING

SOLAR COOLING PUMP 5

VALVE IN COOLING TOWER

FOLDOUT FRAME

2

EXHAUST

ORIGINAL PAC OF POOR QUALITY

AIR-TO-AIR COOLING

SOLAR COOLING PUMP 6

VALVE IN COOLING TOWER



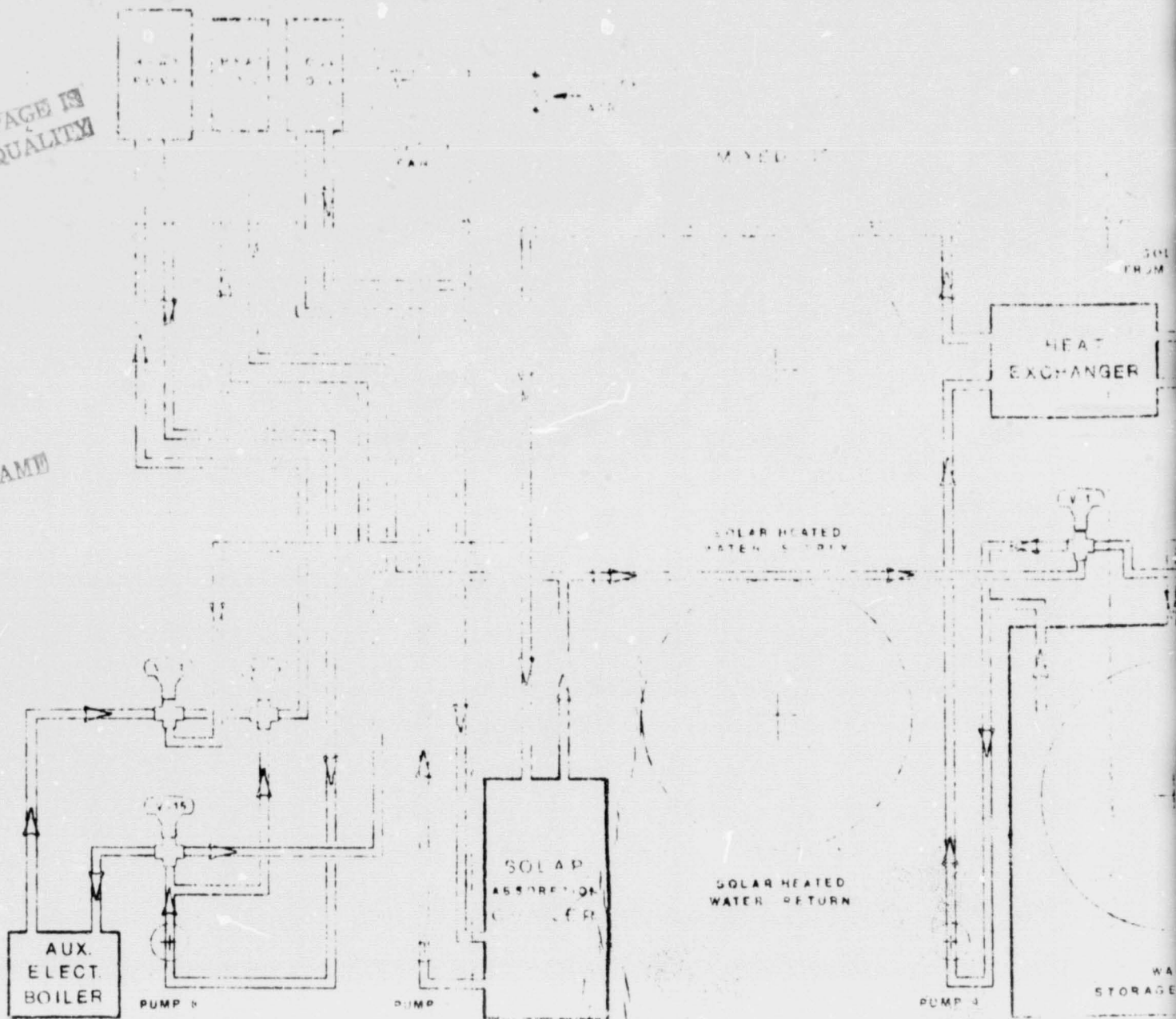
HEAT AIR

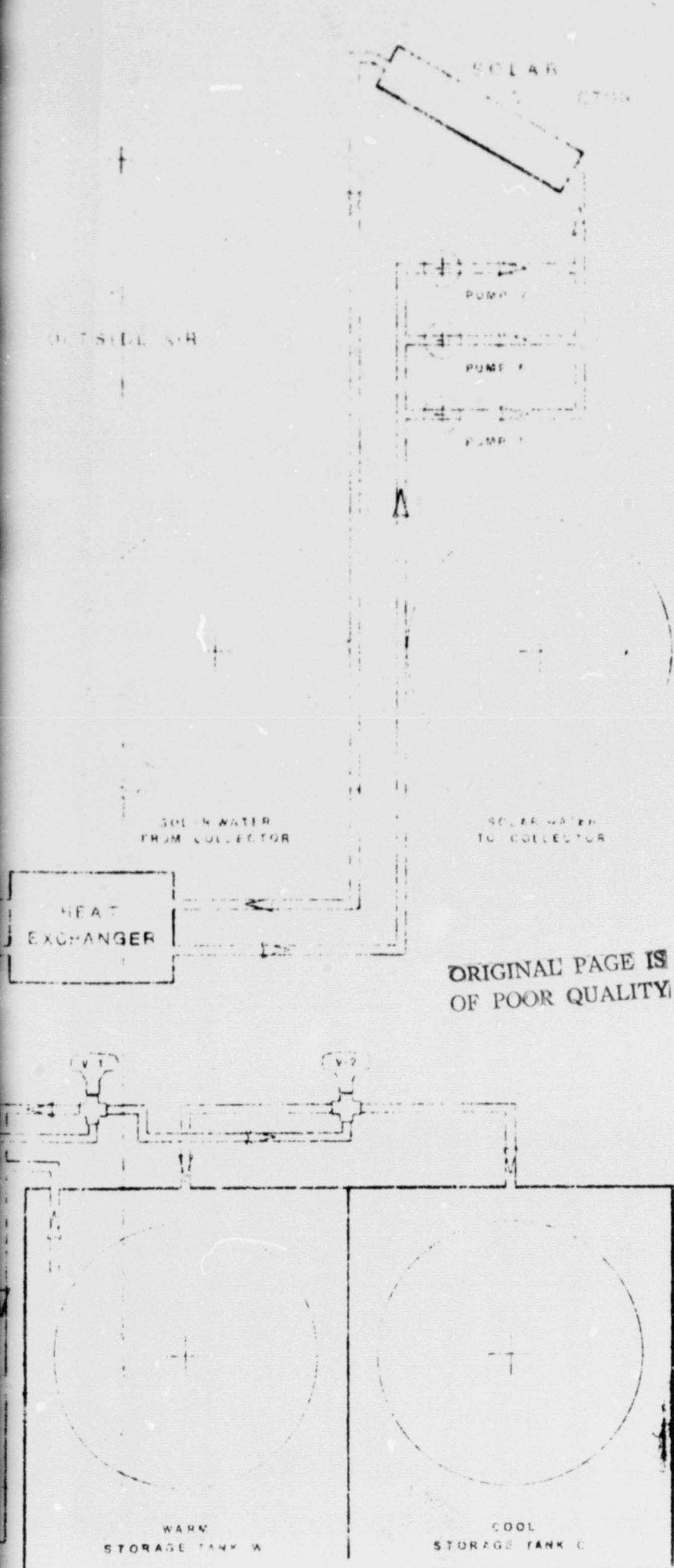
OUTSIDE AIR

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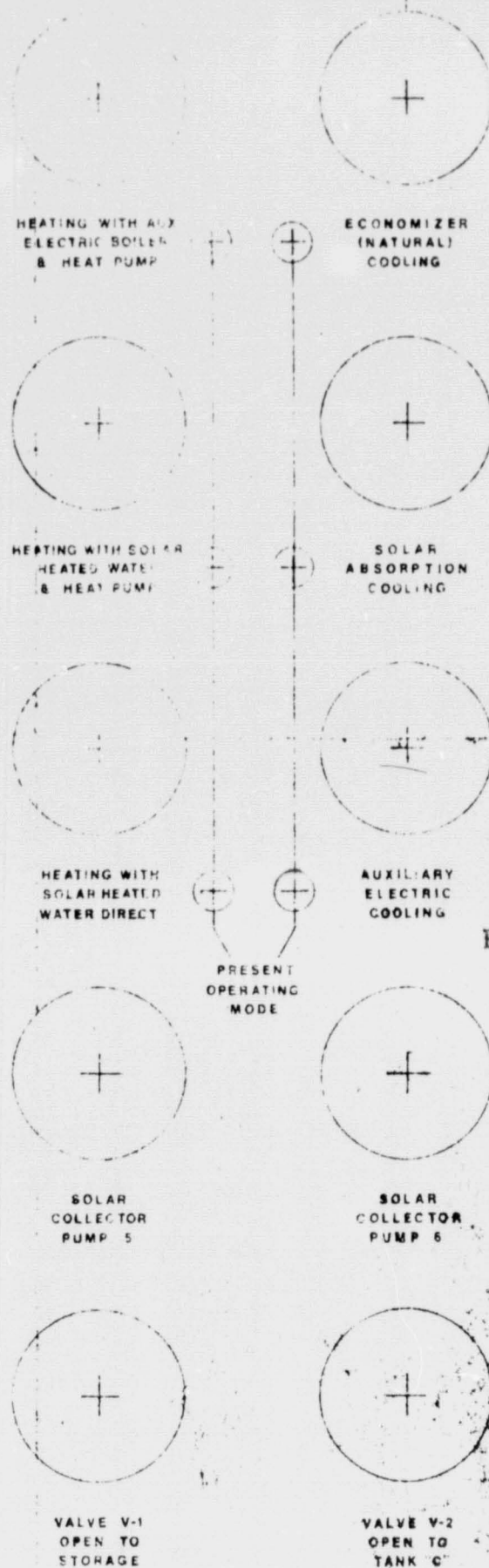
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FOLDOUT FRAME





INDICATION
PANEL
OPERATING HOURS THIS YEAR



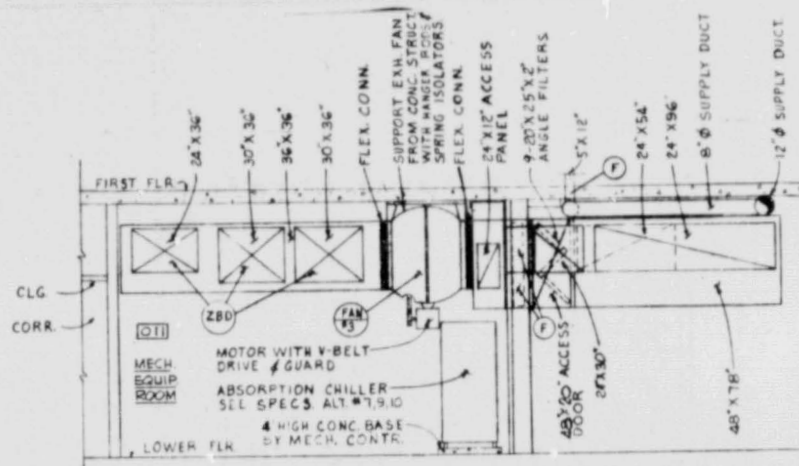
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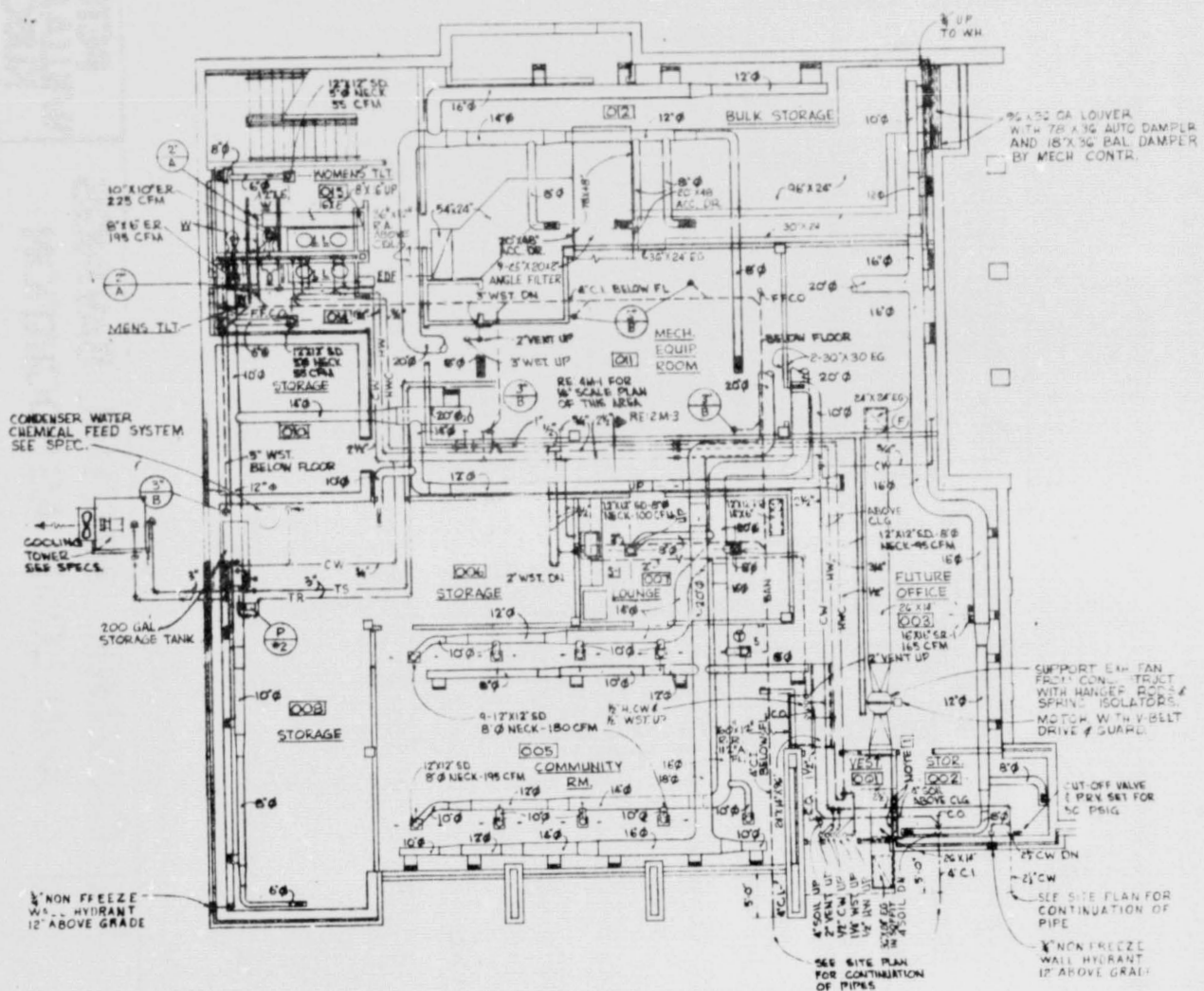
TEC ENGINEERING
NOT APPROVED - PRELIMINARY
REVISION 1
DATE 12/1/77
BY J. R. B. / J. R. B.
NOTE: APPROVAL FOR ANY REVISIONS MUST BE OBTAINED FROM THE DESIGNER. NO REVISIONS TO BE MADE WITHOUT THE DESIGNER'S APPROVAL. THE DESIGNER'S APPROVAL IS REQUIRED FOR ANY REVISIONS TO BE MADE.

17. AS BUILT DESIGN PRINTS

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2 SECTION
SCALE 1/4"=0'

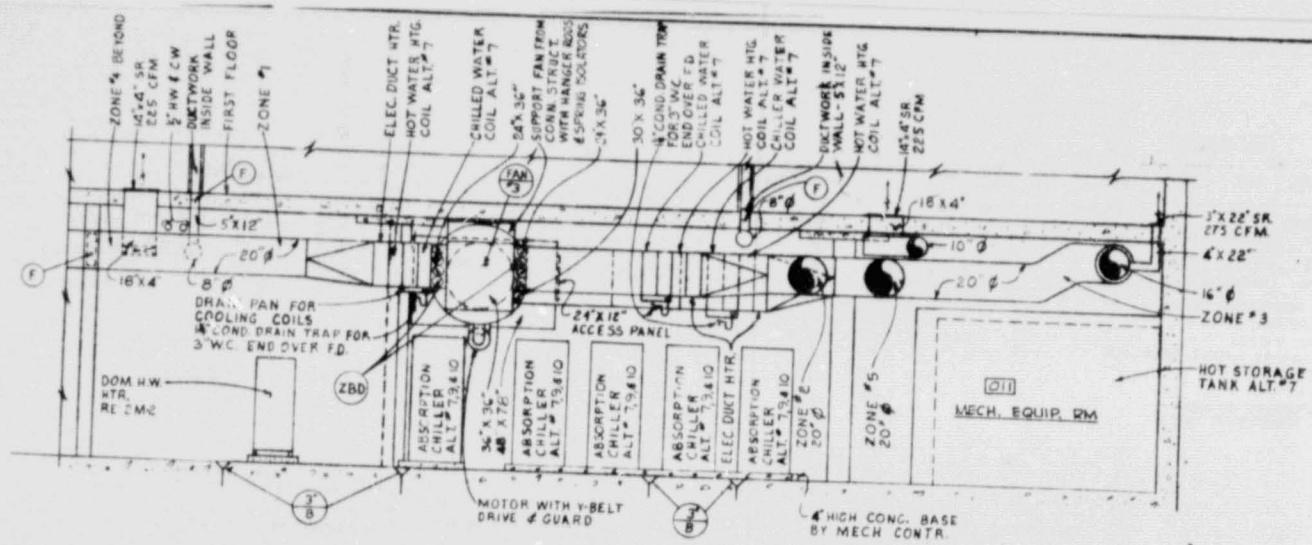


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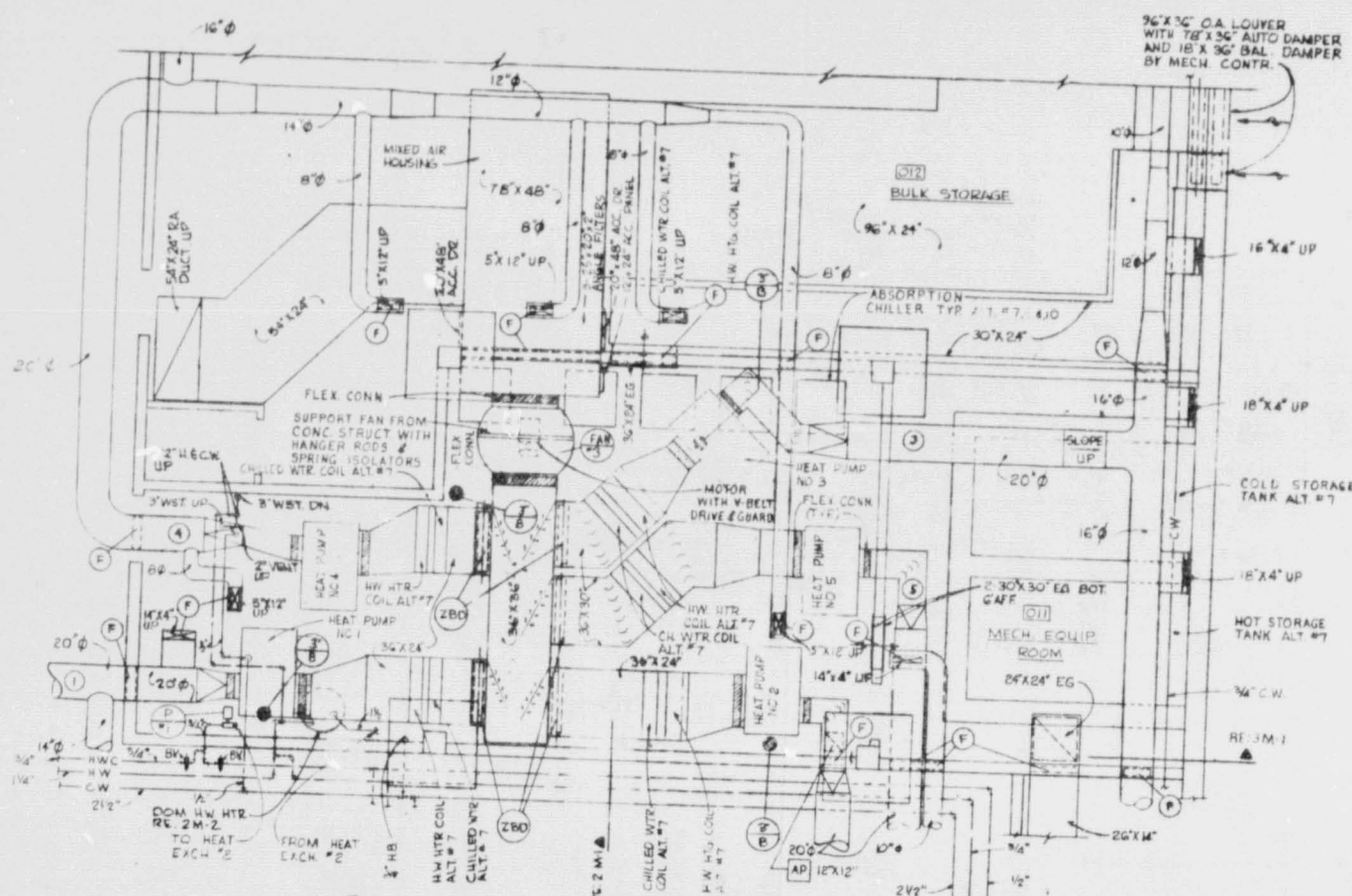
1 LOWER FLOOR PLAN
SCALE 1/8"=0'

NOTE (1) ELEC. WTS. SEE ELEC. FLOOR PLAN SHEET 2





3 SECTION
SCALE 1/4\"/>



4 PLAN OF MECH EQUIP ROOM (BASE BID)
SCALE 1/4\"/>

FOLDOUT FRAME
2

WATER TO WATER HEAT EXCHANGER

HE	USAGE	MAXIMUM FOULING FACTOR	CAPACITY BTU/HR	TUBE SIDE			SHELL SIDE		
				GPM	ENT. WTR TEMP. °F	LVG. WTR TEMP. °F	MAX. PD FT. H ₂ O	GPM	ENT. WTR TEMP. °F
1	SOLAR HEATING	.0005	320,000	138	210°	205°	4.0	60	189°
2	DOMESTIC H.W. HTG	.0005	25,900	1.0	40°	120°	5.0	5	200°
3	SOLAR HEAT DISSIPATION	.0005	320,000	138	210°	205°	4.0	100	94.5°

NOTE: HEAT EXCHANGERS SHALL NOT BE ANY LONGER THAN SHOWN IN MECH EQUIP RM. FLOOR PLAN.

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REVISIONS
1/14/78 JCE
5-20-80 AS BUILT

DATE: SEPT 20, 1977
PROJECT NO. 77015
DRAWN BY J.B.
CHECKED BY A.R.H.

TECHNOLOGY
ENGINEERING
CONSULTING
TEC. INC. 426 W. 5TH ST. KANSAS CITY, MO. 64105

1
OF 5 SHEETS



PLANNING
DESIGN
CONSTRUCTION SERVICES
(813) 843-8664

**PETERS
WILLIAMS
KUBOTA**
PROFESSIONAL ASSOCIATION

**CITIZENS MUTUAL SAVINGS
AND LOAN ASSOCIATION**

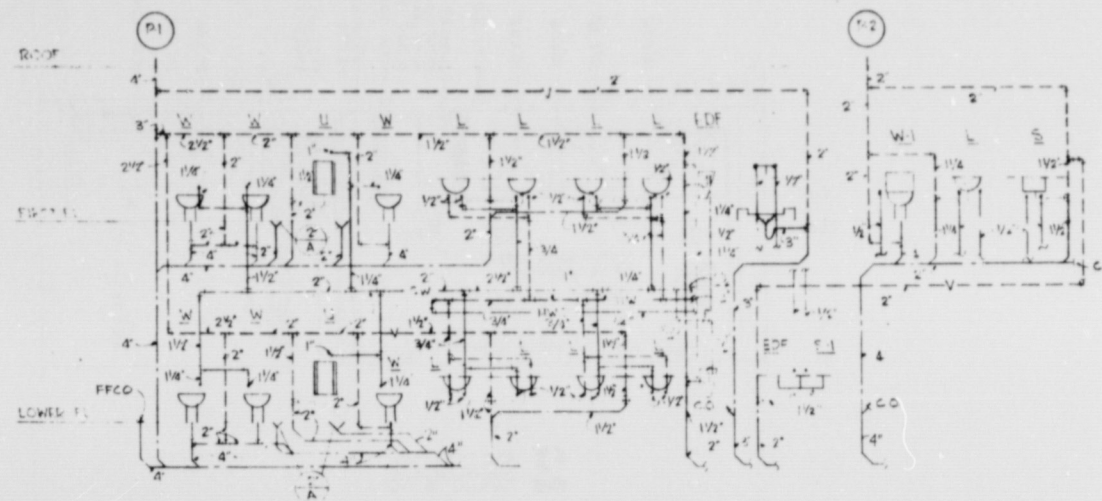
LEAVENWORTH, KANSAS

REVISIONS
1/14/78 D.O.E
5-20-80 AS BUILT

DATE: SEPT 20 1977
PROJECT NO. 77015
DRAWN BY J.G.
CHECKED BY R.P.H.

DATE: 1/2/82
BY: J.G.
CHECKED BY: R.P.H.

**TECHNOLOGY
ENGINEERING
CONSULTING**
TEC. INC. 426 W. 5TH ST., KANSAS CITY, MO 64105



3 PLUMBING FLOOR PLAN

PLUMBING FLOOR PLAN
1. SEE FLOOR PLAN FOR ALL ROOM DRAINAGE, WALL, FLOOR, ROSE, SINKS, ETC.
2. PLUMBING CONTRACTOR SHALL FURNISH ALL SUPPLY RISERS, STOPS & TRAPS FOR TOILETS FURNISHED BY OTHERS.
3. FIXTURE WHERE HOT & COLD WATER ARE SHOWN ON CLOSING TO BE OF NORMAL CONNECTIONS ARE SHOWN FROM THE BACK.

FIXTURE ABBREVIATIONS

W-WATER CLOSET
U-URINAL
L-LAVATORY
S-SINK
J-JANITOR SINK
EDF-ELECTRIC DRINKING FOUNTAIN

HEAT PUMP SYSTEM DATA

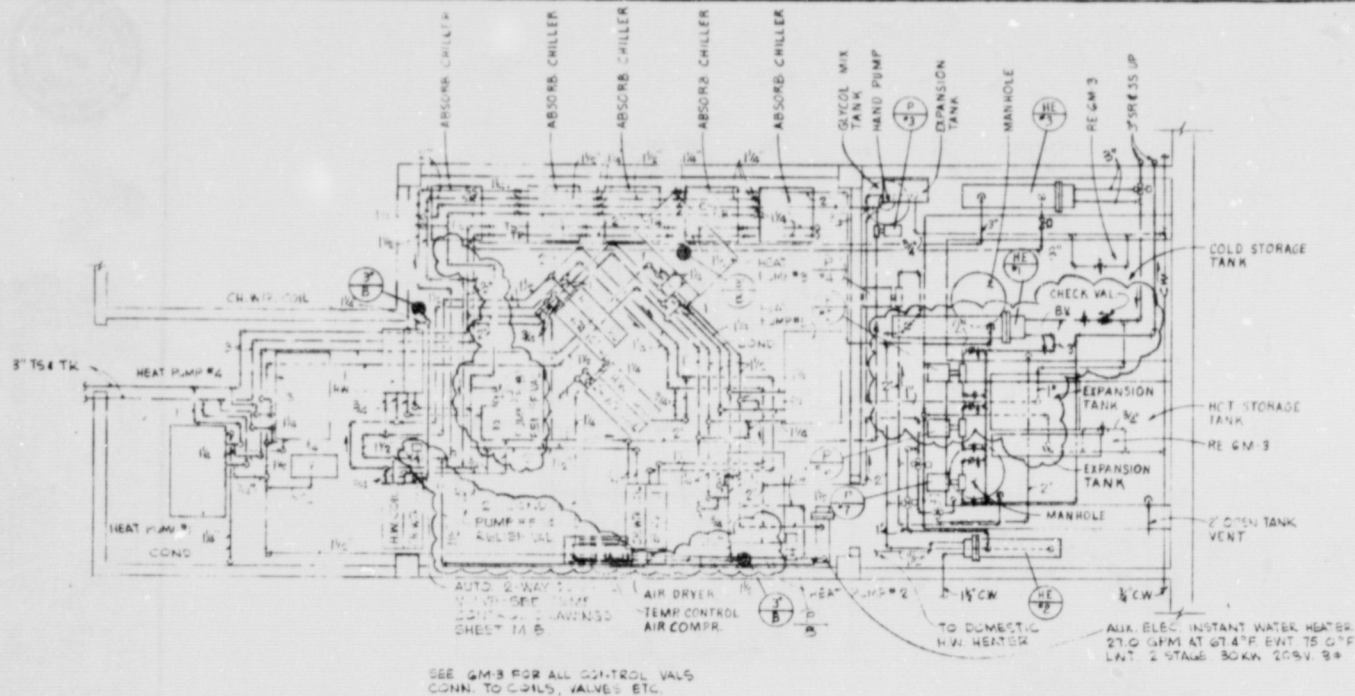
DATA	ZONE NO. 1	ZONE NO. 2	ZONE NO. 3	ZONE NO. 4	ZONE NO. 5
MODEL NUMBER	101	102	103	104	105
CHILLED WATER GPM	10	10	10	10	10
SENSIBLE CAPACITY (BTU/H)	26,450	29,000	31,900	26,700	32,500
TOTAL CAPACITY (BTU/H)	27,700	32,600	35,700	30,000	34,500
AIR TEMP (°F) ENTERING COIL	60°FDB 58°FWB	60°FDB 58°FWB	60°FDB 58°FWB	60°FDB 58°FWB	60°FDB 58°FWB
AIR TEMP (°F) LEAVING UNIT	60°FDB 58°FWB	60°FDB 58°FWB	60°FDB 58°FWB	60°FDB 58°FWB	60°FDB 58°FWB
TOTAL HTG REQD (BTU/H)	22,450	37,850	57,680	10,450	25,300
CONDENSER WATER FLOW (GPM)	12.0 GPM	12.0 GPM	12.0 GPM	12.0 GPM	12.0 GPM
CONDENSER WATER TEMP (°F)	120°F	120°F	120°F	120°F	120°F
HEAT PUMP OPERATING VOLT/PHASE	208/3Ø	208/3Ø	208/3Ø	208/3Ø	208/3Ø
HW HEATING COIL CAPACITY (BTU/H)	22,450	37,850	57,680	10,450	25,300
TOTAL HTG CAP. W/ 32° F ΔT H ₂ O	41,000	41,000	55,500	41,000	47,000
HTG WTR FLOW TO HT PUMP	4.0 GPM	4.0 GPM	10.0 GPM	4.0 GPM	5.0 GPM
TOTAL HTG CAP. W/ 32° F ΔT H ₂ O	42,500	42,500	58,000	42,500	51,500
CONDENSER WATER FLOW (GPM)	12.0 GPM	12.0 GPM	12.0 GPM	12.0 GPM	12.0 GPM
CONDENSER WATER TEMP (°F)	120°F	120°F	120°F	120°F	120°F

NOTE: MAX VELOCITY THRU CHILLED WATER COIL & HOT WATER HTG COIL SHALL BE 300 FPM. COOLING COIL TO BE MIN. 6 ROWS & HTG COIL MIN. 4 ROWS

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FOLDOUT FRAME
2

- WALL & WASTE PIPING
- PIPELINE FLOOR
- PIPELINE
- WATER PIPING
- HOT WATER PIPING
- COLD WATER PIPING
- CHILLED WATER SUPPLY PIPING
- CHILLED WATER RETURN PIPING
- COLD WATER SUPPLY PIPING
- CONDENSER WATER RETURN PIPING
- FLOOR DRAIN CLEANOUT
- CLEANOUT
- FLOOR GRADE CLEANOUT
- FLOOR DRAIN SHOWING SIZE & TYPE
- WASTE PIPING
- WALL HYDRANT
- RISE & DROP IN PIPING
- GRADE VALVE
- BALANCING VALVE
- CHECK VALVE
- TOP TEE CONNECTION
- BOTTOM TEE CONNECTION
- SUPPLY DIFFUSER
- SUPPLY REGISTERS
- EXHAUST REGISTERS
- RETURN GRILLE
- FIRE DAMPERS
- ACCESS PANEL IN DUCTWORK
- ACCESS PANEL IN CEILING OR WALL
- PLUMBING STACK NUMBER
- SECTION CUT SHOWING DETAIL NUMBER ON SHT. NUMBER
- FAN NUMBER
- THERMOSTAT
- SOLAR HEATING WATER SUPPLY PIPING
- SOLAR HEATING WATER RETURN PIPING
- UNION
- REG. 1/4" REGISTERS
- REG. 1/2" REGISTERS
- PUMP NUMBER - SEE SCHEDULE ON SHEET M-8
- HEAT EXCHANGER NUMBER - SEE SCHEDULE



FOLDOUT FRAME

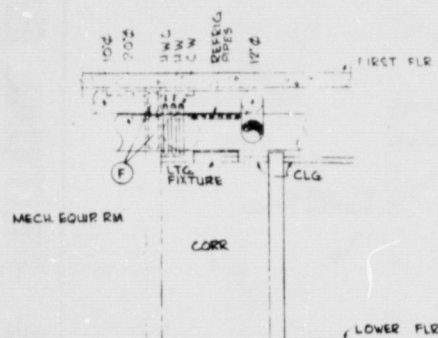
1 PLAN OF MECH EQUIP ROOM ALT #7 SCALE: 1/4"=1'-0" RE: GMB-3

PUMP SCHEDULE

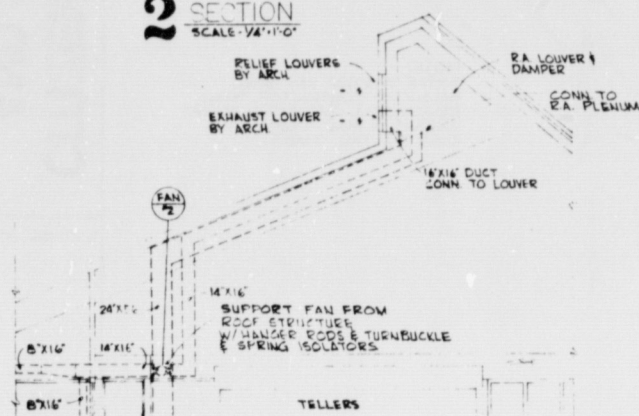
P	LOCATION	USAGE	DUTY	GPM	FT HD	HP	VOLT	PH	MOTOR SPEED	MOTOR CONTROL	NOTES
1	MECH EQUIP	H.W. CIRC	5	15	1/2	120	1	1750 RPM	①	IN-LINE	
2	RM OOB	COND. WTR	100	63	3	208	3		① ② ③	ALT #7 BASE MTD.	
3	MECH EQUIP	CHILLED WTR	55	46	1 1/2	208	3		① ②	ALT #7 IN-LINE	
4	MECH EQUIP	H.W. HTG.	60	66	3	208	3		① ②	ALT #7 IN-LINE	
5	MECH EQUIP	SOLAR	22	64	1 1/2	208	3		① ②	ALT #7 BASE MTD.	
6	MECH EQUIP	SOLAR	58	64	3	208	3		① ②	ALT #7 IN-LINE	
7	MECH EQUIP	SOLAR	58	64	3	208	3	1750 RPM	① ②	ALT #7 IN-LINE	
8	MECH EQUIP	AUX. HTG.	27	82	1/2	120	1	1750 RPM	① ②	ALT #7 IN-LINE	

- ① WOA SWITCH
- ② FVNR MAG STARTER
- ③ LNO INTERLOCK CONTACT IN STARTER

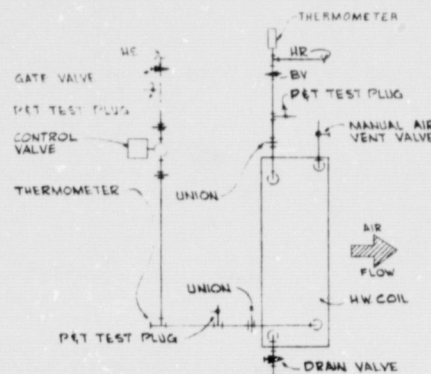
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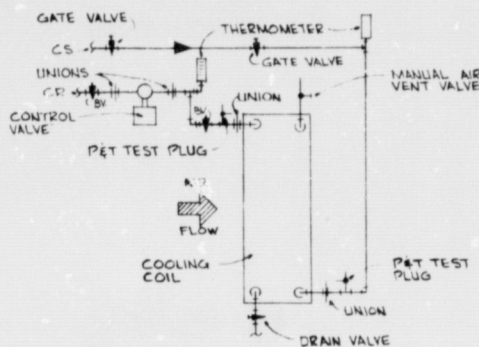
2 SECTION SCALE: 1/4"=1'-0"



4 SECTION SCALE: 1/8"=1'-0"



3 COOLING COIL

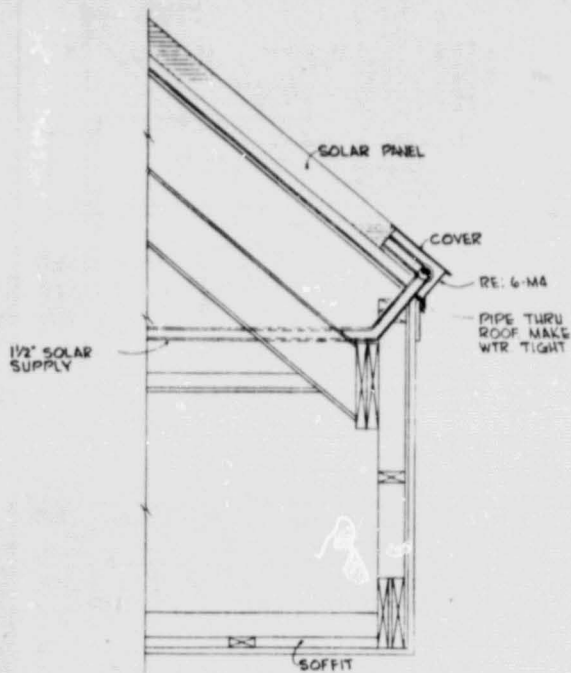


5 HEATING COIL

COOLING
TOWER
SEE SPECS

200 GAL
STORAGE
TANK
LOCATE IN RM
#00B

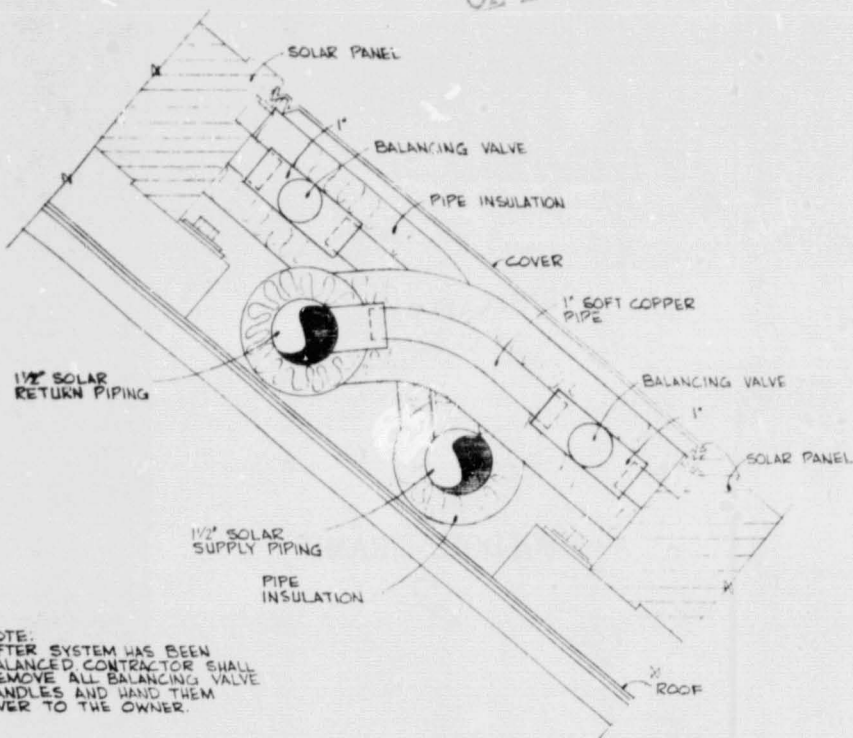
STAIR



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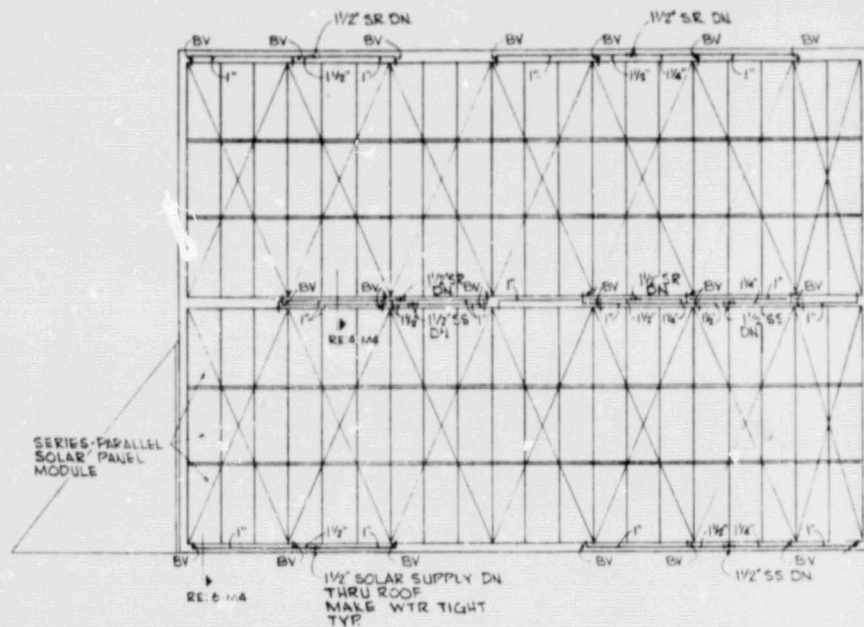
1 SECTION
SCALE 1/8" = 1'-0"

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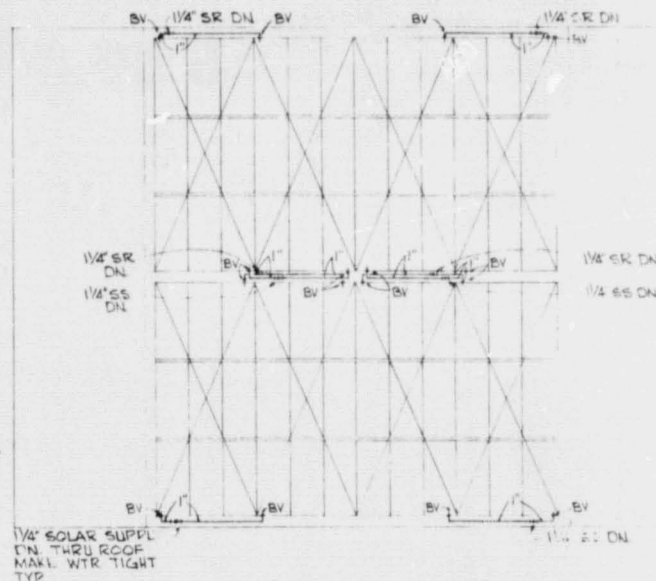


NOTE:
AFTER SYSTEM HAS BEEN
BALANCED CONTRACTOR SHALL
REMOVE ALL BALANCING VALVE
HANDLES AND HAND THEM
OVER TO THE OWNER.

4 SECTION
SCALE 1/2" = 1'



2 ROOF PLAN-SOLAR PANEL LAYOUT
SCALE 1/8" = 1'-0"
ALT #7



5 ROOF PLAN-SOLAR PANEL LAYOUT
SCALE 1/8" = 1'-0"
ALT #10



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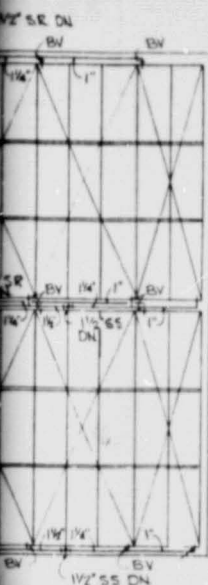
LEAVENWORTH, KANSAS

5-20-80 AS BUILT

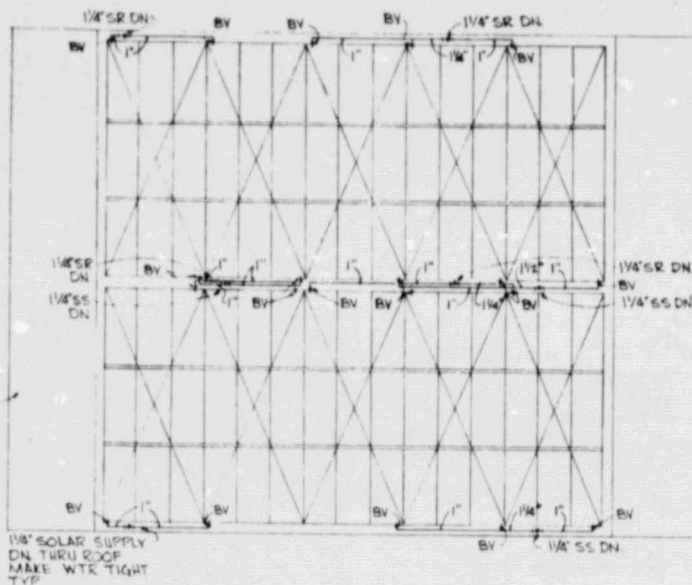
DATE: SEPT 20, 1977
PROJECT NO: 77015
DRAWN BY: J.G.
CHECKED BY: A.P.H.

SHEET NO:
NI 41
SHEET

TE TECHNOLOGY
ENGINEERING
CONSULTING
INC., 426 W. 5TH ST., KANSAS CITY, MO. 64105



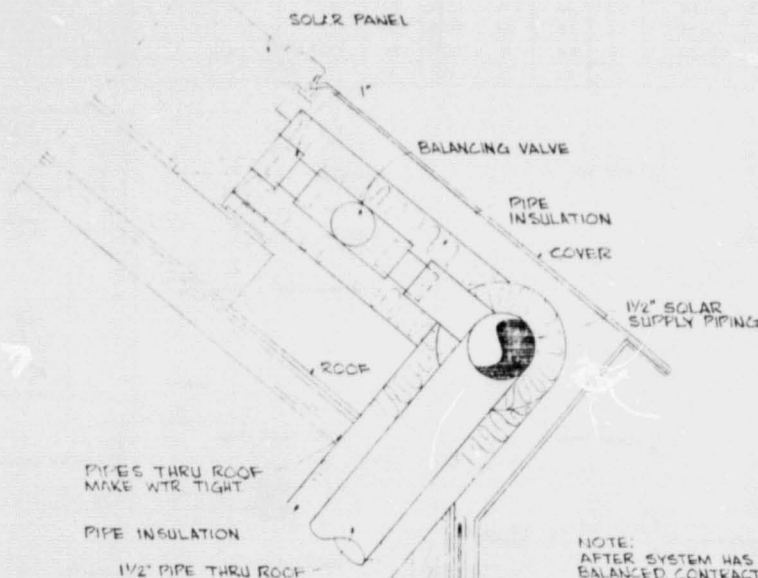
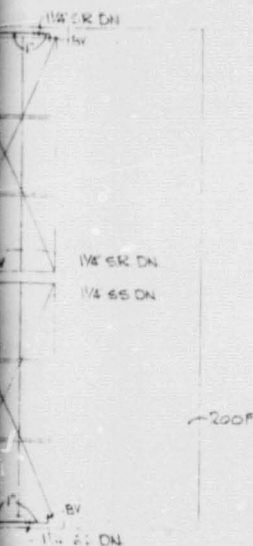
ROOF



3 ROOF PLAN - SOLAR PANEL LAYOUT
SCALE - 1/8" = 1'-0"
ALT. # 9

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2

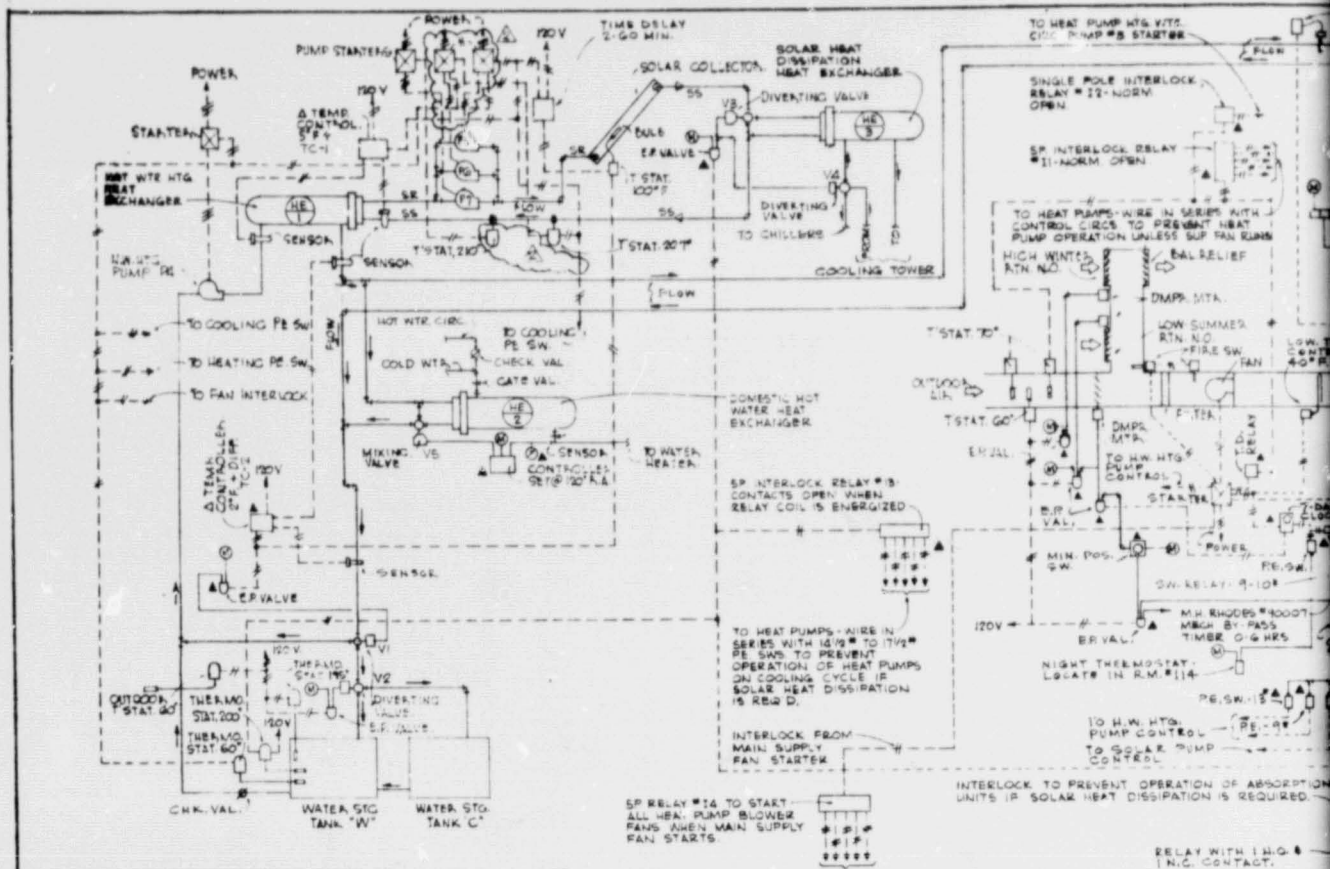


NOTE:
AFTER SYSTEM HAS BEEN
BALANCED CONTRACTOR SHALL
REMOVE ALL BALANCING VALVE
HANDLES & HAND THEM
OVER TO THE OWNER.

6 SECTION
SCALE - 1/2" = 1'

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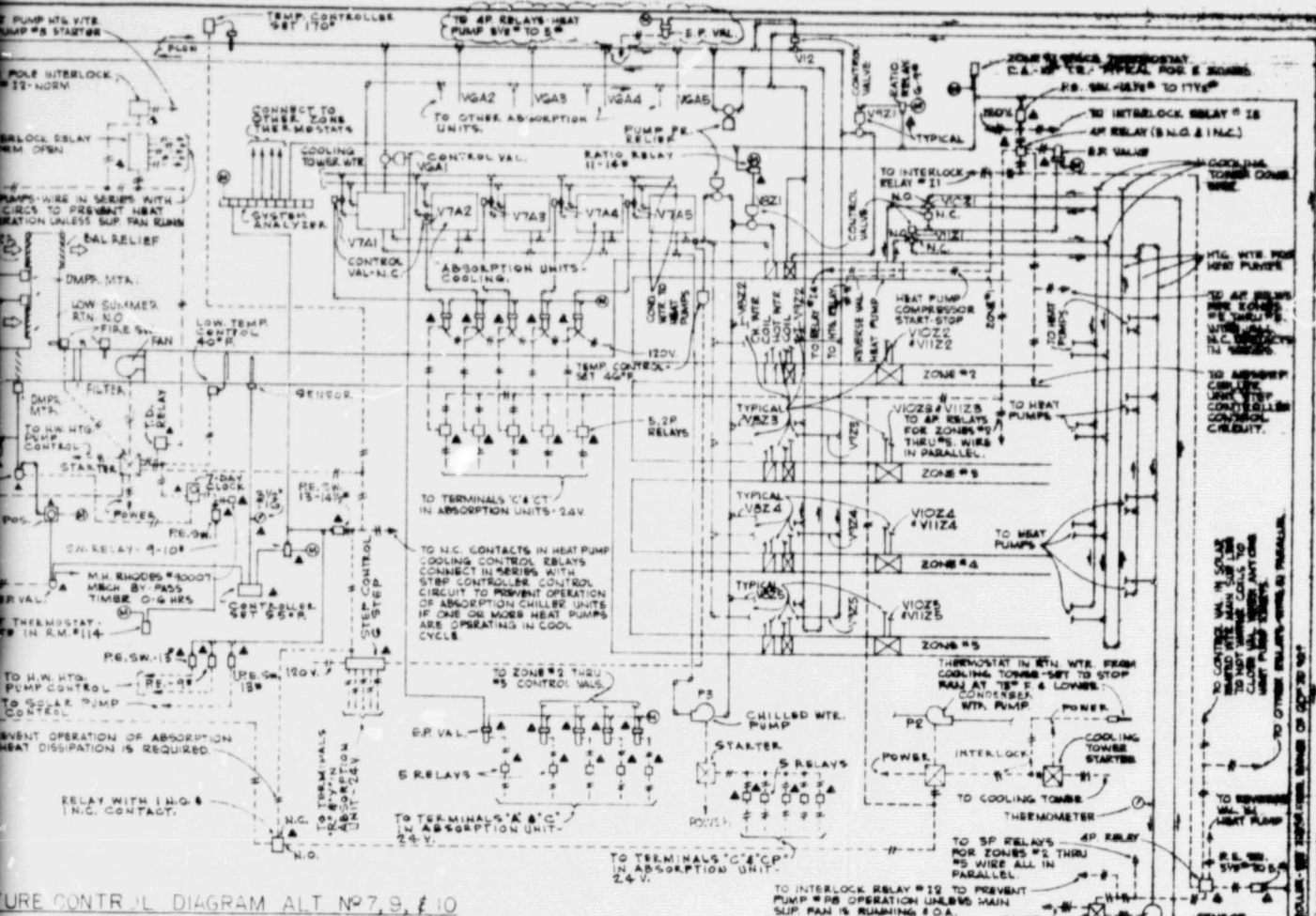
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TEMPERATURE CONTROL DIAGRAM

TEMPERATURE CONTROL LOGIC

1. SOLAR STORAGE SUMMER - IF AMBIENT TEMPERATURE WITHIN SOLAR COLLECTOR IS LESS THAN 100°F VALVE IS OPEN TO STORAGE TANK "W". IF SOLAR COLLECTOR TEMP. IS ABOVE 100°F THEN VALVE POSITION IS DETERMINED BY DELTA TEMPERATURE CONTROLLER. IF TEMP. DIFFERENCE BETWEEN SENSORS IS LESS THAN 20° THE DIVERTING VALVE IS OPEN TO STORAGE TANK "W".
 2. SOLAR STORAGE WINTER - IF STORAGE TANK "W" TEMPERATURE IS 120°F OR GREATER THE DIVERTING VALVE WILL POSITION TO ALLOW WATER TO GO INTO STORAGE TANK "C". OUTDOOR THERMOSTAT WILL POSITION DIVERTING VALVE TO ALLOW WATER TO GO INTO STORAGE TANK "C" ANYTIME OUTDOOR TEMPERATURE IS BELOW 60°.
 3. HEAT DISSIPATION - ANYTIME STORAGE TANK "W" TEMPERATURE IS 200°F OR GREATER THEN DIVERTING VALVE WILL OPEN TO ALLOW FLOW THROUGH HEAT DISSIPATION HEAT EXCHANGER, AND WILL START CONDENSER WATER PUMP. INTERLOCK WILL PREVENT OPERATION OF ABSORPTION UNITS AND WATER-TO-AIR HEAT PUMPS IF STORAGE TANK "W" TEMPERATURE IS 200°F OR GREATER.
 4. DOMESTIC HOT WATER HEATING - SENSOR IN WATER LEAVING HEAT EXCHANGER HE-2 WILL POSITION (MODULATE) MIXING VALVE V-5 TO MAINTAIN SET POINT OF 120°. SET ELECTRIC ELEMENT THERMOSTAT IN DOMESTIC ELECTRIC WATER HEATER AT 115°.
 5. SOLAR PUMPS P5, P6, P7 - IF AMBIENT TEMP. WITHIN SOLAR COLLECTOR IS 100°F OR GREATER, THEN SOLAR PUMP P5 OR P6 WILL BE STARTED THROUGH TIME DELAY RELAY. TIME DELAY RELAY IS SET FOR 15 MINUTES TO PREVENT SHORT CYCLE. DELTA TEMP. CONTROLLER THROUGH SENSORS IN SOLAR WTR. AND H.W. WTR. WILL CAUSE SOLAR PUMPS P5 AND P6 TO STOP IF SOLAR WTR. IS NOT 5° OR MORE HIGHER THAN H.W. WTR. UNLESS THERE IS A CALL FOR COOLING, PUMP P6 WILL RUN IF THE FOREGOING CONDITIONS ARE MET. ON A CALL FOR COOLING, P.E. SWITCH WILL CAUSE SOLAR PUMPS P6 AND P7 TO STOP AND PUMP P5 TO RUN. IF SOLAR WTR. TEMP. RISES TO 210° THEN SOLAR PUMP P6 WILL RESTART. (PUMP P5 WILL STOP WHEN PUMP P6 STARTS) AND A CONTINUED RISE IN SOLAR WTR. TEMP. TO 210° WILL CAUSE SOLAR PUMP P7 TO START.
 6. HOT WATER HEATING PUMP IS STARTED BY AUXILIARY CONTACTS IN SOLAR PUMP P5 OR P6 STARTER OR BY TEMPERATURE CONTROLLER IN STORAGE TANK "W" SET AT 60° IF THE SUPPLY FAN IS RUNNING AND THERE IS A CALL FOR HEATING OR COOLING.
 7. SPACE HEATING AND COOLING - HEATING AND COOLING CONTROL FUNCTIONS FOR EACH OF THE 5 ZONES ARE INITIATED FROM THE RESPECTIVE SPACE THERMOSTAT FOR EACH ZONE. THE CONTROLLING FUNCTIONS FOR EACH ZONE SPACE THERMOSTAT SHALL BE IDENTICAL AS HEREIN DESCRIBED AND AS INDICATED IN THE DIAGRAMS. THE 7-DAY PROGRAM TIME CLOCK SHALL PROVIDE "NIGHT" SETBACK FOR NIGHTS AND WEEKEND DAYS FOR SELECTED DAYS AND SELECTED HOURS AS DIRECTED.
- "DAY" OPERATION**
- A. THE MAIN AIR SUPPLY FAN AND ALL 5 ZONE HEAT PUMP AIR SUPPLY FANS SHALL OPERATE CONTINUOUSLY WHEN THE 7-DAY PROGRAM CLOCK IS IN THE "DAY" CYCLE, UNLESS ABNORMAL TEMPERATURES ARE SENSED BY THE FIRE SWITCHES (HIGH TEMPERATURE) OR THE LOW TEMPERATURE CONTROL (FREEZE STAT). IF ABNORMAL TEMPERATURES ARE SENSED BY THE FIRE SWITCHES OR THE FREEZE STAT, ALL SUPPLY FANS SHALL STOP.
 - B. WHEN AIR SUPPLY FANS ARE NOT OPERATING THE OUTSIDE AIR DAMPERS SHALL GO COMPLETELY CLOSED AND THE RETURN AIR DAMPERS SHALL GO FULLY OPEN.
 - C. 94 TO 104 CONTROL AIR PRESSURE (SET ZONE SPACE THERMOSTAT FOR 74°F. AT 94°F. CONTROL SYSTEM SHALL PROVIDE AUTOMATIC CHANGEOVER FROM HEATING TO COOLING CYCLE).
 - D. 104 TO 134 CONTROL AIR PRESSURE - IF ALL ZONES ARE IN THE COOLING CYCLE (AS DETERMINED BY THE ZONE SPACE THERMOSTATS), THE OUTSIDE AIR DAMPERS AND THE SUMMER RETURN AIR DAMPERS SHALL MODULATE TO MAINTAIN THE MAIN SUPPLY FAN DISCHARGE TEMPERATURE AS SET ON THE DISCHARGE TEMPERATURE CONTROLLER (SET AT 55°F.). IF THE OUTSIDE AIR TEMPERATURE IS ABOVE THE SETTING OF THE OUTSIDE AIR THERMOSTAT (SET AT 60°F.) AND THE FAN DISCHARGE AIR TEMPERATURE IS ABOVE THE SETTING ON THE DISCHARGE TEMPERATURE CONTROLLER, THE OUTSIDE AIR DAMPERS SHALL CLOSE DOWN TO THE MINIMUM POSITION AS SET ON THE MINIMUM POSITION SWITCH (SET FOR 10 PERCENT OUTSIDE AIR). ANY TIME ONE OR MORE ZONES ARE OPERATING IN THE MECHANICAL COOLING CYCLE (ABSORPTION UNIT OR HEAT PUMP COOLING IS OPERATING), THE OUTSIDE DAMPERS SHALL CLOSE DOWN TO MINIMUM POSITION.
 - E. 134 TO 14-1/24 CONTROL AIR PRESSURE - THE HOT WATER HEATING PUMP P4 IS OPERATED AS CALLED FOR IN NOTE 6 ABOVE. IF THE SOLAR HEATED WATER TEMPERATURE IS AT 170°F. OR HIGHER, THE ABSORPTION CHILLER UNITS WILL BE CYCLED ON AND OFF IN SEQUENCE (THRU THE STEP CONTROLLER) TO MAINTAIN CHILLED WATER TEMPERATURE SETTING ON CHILLED WATER TEMPERATURE CONTROLLER (SET AT 46°F.), EXCEPT IF HEAT DISSIPATION FROM THE SOLAR HEATED WATER SYSTEM IS REQUIRED THE ABSORPTION CHILLER UNITS WILL BE LOCKED-OUT OF OPERATION AS CALLED FOR IN NOTE 3 ABOVE. CHILLED WATER PUMP, CONDENSER WATER PUMP AND COOLING TOWER WILL BE AUTOMATICALLY STARTED AND STOPPED AND CONDENSER WATER CONTROL VALVE AND HOT WATER CONTROL VALVE FOR EACH CHILLER UNIT OPENED AND CLOSED FROM PILOT CONTROL CIRCUITS IN EACH ABSORPTION CHILLER UNIT AND FROM OTHER COILS AND INTERLOCKS SHOWN IN TEMPERATURE CONTROL DIAGRAM. AN EMERGENCY THERMOSTAT IN THE RETURN WATER FROM THE COOLING TOWER SHALL PREVENT THE OPERATION OF THE COOLING TOWER FAN IF RETURN WATER TEMPERATURE IS AT OR BELOW THE THERMOSTAT SETTING (SET AT 75°F.). THE CONTROL VALVE FOR EACH ZONE CHILLED WATER COIL SHALL BE OPENED AND CLOSED BY ITS RESPECTIVE ZONE SPACE THERMOSTAT TO SATISFY SETTING OF THE SPACE THERMOSTAT.
 - F. 14-1/24 TO 17-1/24 CONTROL AIR PRESSURE - EACH ZONE HEAT PUMP (COOLING CYCLE) SHALL BE CYCLED ON AND OFF TO SATISFY THE SETTING OF ITS RESPECTIVE ZONE SPACE THERMOSTAT. THE CONDENSER WATER PUMP AND THE COOLING TOWER SHALL BE AUTOMATICALLY STARTED IF ONE OR MORE OF THE HEAT PUMPS ARE OPERATING ON THE COOLING CYCLE. IF ANY ONE OR MORE HEAT PUMPS ARE STARTED ON COOLING CYCLE, ALL ABSORPTION CHILLER UNITS SHALL BE LOCKED OUT OF OPERATION BY BREAKING THE CONTROL CIRCUIT TO THE STEP CONTROLLER CONTROLLING THE START-STOP OPERATION OF THE ABSORPTION CHILLERS. ALL ABSORPTION CHILLER UNIT CONDENSER WATER CONTROL VALVES SHALL ALSO BE CLOSED THRU THE PILOT CIRCUITS FROM THEIR RESPECTIVE ABSORPTION CHILLER UNITS. IF HEAT DISSIPATION FROM THE SOLAR HEATED WATER SYSTEM IS REQUIRED, ALL HEAT PUMP UNITS IN THE COOLING CYCLE SHALL BE LOCKED OUT OF OPERATION AS CALLED FOR IN NOTE 3 ABOVE. AN EMERGENCY THERMOSTAT IN THE RETURN WATER FROM THE COOLING TOWER SHALL PREVENT THE OPERATION OF THE COOLING TOWER FAN IF THE RETURN WATER TEMPERATURE IS AT OR BELOW THE THERMOSTAT SETTING (SET AT 75°F.). THE CONTROL VALVES IN THE WATER CONNECTIONS TO EACH HEAT PUMP WATER-TO-REFRIGERANT HEAT EXCHANGER WILL BE OPENED TO COOLING TOWER WATER AND CLOSED TO HEATING WATER FOR EACH HEAT PUMP THAT IS IN THE COOLING CYCLE.
 - G. 17-1/24 TO 24-1/24 CONTROL AIR PRESSURE - HOT WATER HEATING PUMP P4 IS OPERATED AS CALLED FOR IN NOTE 6 ABOVE. HOT WATER HEATING COIL CONTROL VALVE IS OPENED AND CLOSED BY ITS RESPECTIVE ZONE SPACE THERMOSTAT TO SATISFY THE SETTING OF THE THERMOSTAT.



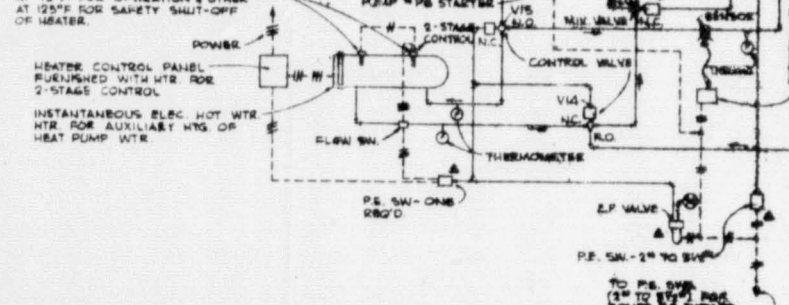
H. 3-1/2" TO 5" CONTROL AIR PRESSURE: HOT WATER HEATING PUMP #4 IS OPERATED AS CALLED FOR IN NOTE 6 ABOVE. HOT WATER PUMP #4 WILL AUTOMATICALLY START. HEAT PUMP REVERSING VALVE WILL CHANGE OVER TO HEATING CYCLE AND HEAT PUMP COMPRESSOR WILL CYCLE ON AND OFF TO SATISFY THE SETTING ON ITS RESPECTIVE ZONE SPACE THERMOSTAT. HEATING WATER TO THE HEAT PUMPS WILL BE SUPPLIED FROM THE SOLAR HEATED WATER SYSTEM. HEATING WATER TEMPERATURE TO HEAT PUMPS WILL BE CONTROLLED WITH MIXING CONTROL VALVE TO MAINTAIN WATER TEMPERATURE SETTING FOR IMMERSION SENSOR AND CONTROLLER (SET FOR 60°F.) IN THE SUPPLY PIPE TO THE HEAT PUMPS. THE CONTROL VALVES IN THE WATER CONNECTIONS TO EACH HEAT PUMP WATER-TO-REFRIGERANT HEAT EXCHANGER IS NORMALLY OPEN TO THE HEATING WATER AND WILL BE CLOSED TO THE COOLING TOWER WATER FOR EACH HEAT PUMP THAT IS NOT IN THE COOLING CYCLE. IF OUTSIDE AIR TEMPERATURE IS ABOVE THE SETTING OF THE THERMOSTAT IN THE OUTSIDE AIR DUCT (SET AT 70°F.), THE HEAT PUMPS AND WATER HEATING PUMP #4 WILL BE PREVENTED FROM OPERATING.

I. 2" TO 3-1/2" CONTROL AIR PRESSURE: HOT WATER PUMP #4 IS OPERATING (FROM "H" ABOVE). HEAT PUMP REVERSING VALVE IS IN HEATING CYCLE AND HEAT PUMP IS OPERATING (FROM "H" ABOVE). IF THE WATER TEMPERATURE OF THE SOLAR HEATED WATER IS BELOW THE SETTING OF THE SENSOR AND CONTROLLER (SET AT 60°F.) IN THE SOLAR HEATING WATER SUPPLY PIPE CONNECTION TO THE HEAT PUMP HEATING WATER CIRCUIT, THE AUXILIARY INSTANTANEOUS ELECTRIC WATER HEATER ELEMENTS SHALL BE ENERGIZED TO MAINTAIN THE HEATER WATER TEMPERATURE SETTING OF THE IMMERSION CONTROLLER IN THE HEATER (SET AT 75°F.) AND THE CONTROL VALVES IN THE PIPING CONNECTIONS BETWEEN THE AUXILIARY HEATER WATER CIRCUIT AND THE SOLAR HEATED WATER CIRCUIT WILL BE CLOSED TO THE SOLAR HEATED WATER AND OPEN TO THE AUXILIARY HEATER WATER. THE AUXILIARY HEATER SHALL NOT BE ENERGIZED IF PUMP #4 IS NOT OPERATING, OR IF THE FLOW SWITCH CONTACTS IN THE AUXILIARY HEATER SUPPLY PIPE IS NOT CLOSED, OR IF THE SAFETY EMERGENCY THERMOSTAT IN THE HEATER SENSES 125°F. WATER TEMPERATURE, OR IF THE SENSOR AND CONTROLLER IN THE SOLAR HEATED WATER IS AT OR ABOVE ITS SETPOINT (60°F.). IMMERSION CONTROLLER FOR HEATER WATER TEMPERATURE SHALL PROVIDE FOR 2-STEPS OF HEATER ELEMENT CONTROL.

J. WHEN THE OUTSIDE AIR TEMPERATURE IS BELOW SETTING ON THE OUTSIDE AIR THERMOSTAT (SET AT 60°F.), THE WINTER RETURN AIR DAMPERS WILL FULLY OPEN, THE SUMMER RETURN AIR DAMPERS WILL COMPLETELY CLOSE, AND THE OUTSIDE AIR DAMPERS WILL COMPLETELY CLOSE.

K. WHEN THE 7-DAY PROGRAM TIME CLOCK IS IN THE "NIGHT" SETBACK CYCLE, ALL SUPPLY FANS SHALL BE SHUT-DOWN; THE OUTSIDE DAMPERS SHALL BE COMPLETELY CLOSED; THE RETURN AIR DAMPERS SHALL BE FULLY OPEN; ALL SPACE COOLING EQUIPMENT SHALL BE SHUT-DOWN; AND THE HEAT PUMPS AND AUXILIARY ELECTRIC WATER HEATER FOR HEAT PUMP HEATING WATER SHALL BE SHUT-DOWN. THE "NIGHT" SETBACK CYCLE MAY BE BY-PASSED BY OPERATION OF THE MECHANICAL BY-PASS TIMER SWITCH FOR ONE TO SIX HOUR OPERATION AS SELECTED. BY-PASSING THE "NIGHT" SETBACK CYCLE SHALL PUT ALL SPACE HEATING AND COOLING SYSTEMS IN THE "DAY" MODE OF OPERATION. WHEN IN THE "NIGHT" SETBACK CYCLE THE SPACE CONDITIONING SYSTEMS SHALL NOT OPERATE FOR COOLING REQUIREMENTS UNLESS "NIGHT" SETBACK CYCLE, ALL SUPPLY FANS AND HEATING SYSTEMS AS DESCRIBED IN "G", "H" AND "I" SHALL PROVIDE HEATING AS REQUIRED TO SATISFY SETTING OF THE "NIGHT" THERMOSTAT (SET AT 62°F.) LOCATED IN ROOM #114.

L. A TIME-DELAY RELAY WITH 2 MINUTE TO 60 MINUTE ADJUSTMENT (SET FOR 10 MINUTES) AND WITH DELAY ON ENERGIZATION SHALL BE INSTALLED IN THE MAIN FAN INTERLOCK CIRCUIT TO PREVENT HEAT PUMP COMPRESSORS AND HEATING WATER PUMP #4 FROM STARTING UNTIL FAN HAS STARTED AND THE TIME DELAY HAS ELAPSED.



ORIGINAL PAGE IS
 OF POOR QUALITY

FOLDOUT FRAME
 2

REVISIONS
 1-14-78 B.G.R.
 2-24-78
 3-20-80 A.M.L.
 DATE: 3-20-80
 PROJECT: 60-1000
 DRAWN BY: J.M.
 CHECKED BY: J.M.
 SHEET: 10