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INSTALLATION GUIDELINES FOR SOLAR HEATING SYSTEM,
SINGLE-FAMILY RESIDENCE AT WILLIAM O'BRIEN STATE PARK,
STILLWATER, MINNESOTA

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For the U. S. Department of Energy
**Instal l ati on Guidelines for Solar Heating System, Single-Family Residence at William O'Brien State Park, Stillwater, Minnesota**

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10. **ABSTRACT**
   This document provides the Solar Heating System installer guidelines for each subsystem and includes testing and filling the system. This single-family residential heating system is a solar-assisted, hydronic-to-warm-air system with solar-assisted domestic water heating. It is composed of the following major components:
   - Liquid cooled flat plate collectors
   - Water storage tank
   - Passive solar-fired domestic water preheater
   - Electric hot water heater
   - Heat pump with electric backup
   - Solar hot water coil unit
   - Tube-and-shell heat exchanger, three pumps, and associated pipes and valving in an energy transport module
   - Control system
   - Air-cooled heat purge unit
   This document also provides information on the operating procedures, controls, caution requirements, and routine and schedule maintenance. Information consists of written procedures, schematics, detail drawings, pictures and manufacturer's component data.
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SECTION I
INTRODUCTION

A) SCOPE
This document provides the Solar Heating System installer guidelines for the installation of each subsystem as well as the testing and filling of the system, operation and maintenance instructions.

B) SINGLE-FAMILY RESIDENTIAL HEATING SYSTEM DESCRIPTION
The single-family residential heating system is a single-loop, solar-assisted, hydronic-to-warm air heating system with solar-assisted domestic water heating. The system is composed of the following major components:

- Liquid cooled flat plate collectors
- A water storage tank
- A passive solar-fired domestic water preheater
- A gas-fired hot water heater
- A gas-fired warm air furnace with hot-water coil unit
- A tube-and-shell heat exchanger, three pumps, and associated pipes and valving in an energy transport module.
- A control system
- An air-cooled heat purge unit

The arrangements of components within the system is as shown on Sheet 2 of SK 142057. The system consists of a glycol/water collector loop which interfaces with a water storage loop, through a tube-and-shell heat exchanger. A domestic hot water preheat coil is located in the storage tank.

The glycol/water collector loop consists of the solar collectors, the shell side of the heat exchanger, the purge coil and pump $P_1$, and a control valve as required for the different modes of operation.
The water side of the heat exchanger is a direct heating/storage loop consisting of the storage tank, control valve, pumps \( P_2 \) and \( P_3 \), the tube side of the heat exchanger and the solar heating coil.

The system provides six modes of operation:

- Direct heating from collectors
- Direct heating from storage
- Auxiliary heating (insufficient solar)
- Storage charging
- Continuous domestic hot water preheating
- Purging excess energy

C) SYSTEM OPERATION

When space heating is required and solar energy from the collectors is available, the collectors supply heat to the furnace. Energy transfer is through the heat exchanger then via the solar hot water coil in the return air duct. Pumps \( P_1 \) in the solar collector loop and \( P_2 \) in the water loop provide movement of the heat transport through valve \( V_2 \) to the heating coil. The blower moves the building air across this heating coil. When the heating demand is satisfied, valve \( V_2 \) diverts the water fluid to the top of the storage tank. Pumps \( P_1 \) and \( P_2 \) provide movement of the heat transport fluids to charge the storage tank. Storage charging occurs by circulating water from the tank bottom through the heat exchanger and returning the heated water to the top of the storage tank, thus taking advantage of stratification. During high solar insolation and low heating and storage demands, if surplus energy is collected, then valve \( V_1 \) diverts collector loop flow to the purge coil. The purge coil operates to maintain the system fluid temperatures below preselected values.

When space heating is required and direct solar energy is not available, thermal storage supplies heat to the furnace. Pump \( P_3 \) circulates the water from the top of the tank through the solar hot
water coil and returns the cooler water to the bottom of the storage tank, again taking advantage of tank stratification. If the storage tank temperature is not high enough to provide space heating, the second stage thermostat activates the auxiliary furnace to maintain a comfortable building temperature.

D) LIMITATIONS
These installation guidelines are intended as a general guide and do not supersede local codes in any way. Authorities having jurisdiction should be consulted before installation to comply with all applicable building codes.
The Solar Heating system consists of the following subsystems:

- Collector
- Storage
- Auxiliary Energy and Space Heating
- Hot water
- Energy transport
- Control

A description of each subsystem is given in the following sections. Information on the major components within each subsystem is provided in the Appendices under the same alphabetical tab.

A. Collector Subsystem

The collector subsystem consists of 33 Lennox LSC 18-1 solar collectors, a purge coil unit Lennox HRW-1-30, a diverting valve (V2), Honeywell Part Y534A, headers, supply/returns lines and isolation and balancing valves.

The solar collectors should operate without any special attention. However, excessive temperatures can be achieved if pumps P1 and P2 are in the off position and direct solar energy is available. Pump P2 can be turned off and pump P1 can be operated during daylight hours if flow is directed through the purge unit. Caution should be taken if pump P1 is left running at night during below freezing conditions as the water in the tube side of the heat exchanger can be frozen and rupture the unit.

A-1. Solar Collectors

The LSC 18-1 is double glass cover, flat plate collector. The tempered, low-iron glass has an acid etched surface to reduce reflection. The steel absorber plate has a special black chrome coating for high solar absorptivity. The absorber plate is formed around the copper fluid tubes and is all incased in an insulated, formed, galvanized steel box.
A-2. Purge Coil Unit

The purge coil unit is a fin and tube coil and blower unit that is mounted outside the dwelling. It is used to get rid of excess heat energy the collectors may be collecting.

A-2. Diverting Valve

The diverting valve is a dual unit consisting of two valve bodies which are plumbed together. These are controlled by two powerheads which move each valve separately. This valve is used to divert the liquid coming from the solar collectors to the purge coil unit as required.

See Appendix A for details on these components.

B. Storage Subsystem

The storage subsystem consists of a 1000 gallon lined steel tank. The tank is designed to operate at ambient pressure and is vented to the space enclosing it. The water in the tank is neutralized with an inhibitor to reduce corrosion of system components.

The storage tank is filled to a level which is 6 inches from the top of the tank. Initial fill level is marked with a red band on the sight glass. If the water level is more than 3 inches below this level additional water should be added to the storage tank. This is accomplished by removing manhole cover, using hose connected to domestic water, fill system until level in sight glass is up to red band on sight glass.

Components in the storage subsystem are standard "off-the-shelf" plumbing components. See Appendix B for parts list.

C. Auxiliary Energy and Space Heating Subsystem

This subsystem consists of a Lennox G11Q3-82V gas fired furnace and a Lennox CW3-45 solar heat coil. The furnace is a standard up flow unit with an output rating of 65,600 Btu/hr. The heat coil is a fin and tube unit designed to be inserted in the return air flow.

The furnace functions as an air handling unit when the solar heated water is above 90°F and there is a call for heat in the dwelling. If the solar heated water is not hot enough the furnace gas burner will turn on and provide heat until demand is satisfied.
C. (continued)
Various blower speeds are available on the furnace. However, a new speed which is lower than the initial speed set by the installer should not be used as this can result in less solar energy utilized and consequently higher fossil fuel consumption rates.

The G11Q3 furnace and CW3-45 heat coil maintenance and repair instructions are in Appendix C.

D. Hot Water Subsystem

The domestic hot water subsystem consists of a preheat coil submerged in the 1000 gallon storage tank, a 40 gallon gas fired water heater and a mixing valve. When hot water is utilized, make-up cold water from the domestic water supply flows through the preheat coil and undergoes an increase in temperature. If the storage tank temperature is below 150°-160°F the preheated water will be below 140°. The gas fired water heater will maintain water temperature at 140°. If the storage tank temperature is greater than 160°F then the preheated DH water may be over 140°F. In this case the mixing valve then adds cold water to bring the water temperature down to 140°F before entering the domestic hot water heater.

The temping valve setting should be kept at 140°F.

The hot water subsystem components are shown in Appendix D.

E. Energy Transport Subsystem

This subsystem contains most of the active components of the solar heating system, i.e., the Energy Transport Module (ETM). The pumps to move the fluid, the valve that diverts from storage to the heating coil, the heat exchanger, an expansion tank, the control panel, circuit setters and fill and drain valves are all in the ETM.

ETM Components and Functions (Appendix E)

Pumps 1, 2, and 3, located in the bottom section of the ETM, provides the required flow rates in the collector, heating, and storage loops. DO NOT RUN PUMPS WITHOUT FLUID IN SYSTEM.

The heat exchanger separates the freeze-protected collector loop from and transfers energy to the heating/storage water loop. Integrally plumbed and mounted into the top section of the ETM, it has no moving parts but is equipped with a manual air bleed and drain valve. Cleaning and flushing of the exchanger shell is possible without contaminating the entire collector loop.
E. (continued)
The diaphragm expansion tank absorbs the expansion of the transfer fluid from fill temperature (50-60°F) to purge temperature (210°F). It is mounted in the center of the ETM, with the charging air valve accessible on its bottom (relief pan removal provides additional access to the valve). Tank air pressure should not drop below its initial 20 psi charge; it will increase as the system pressure increases. Removal of expansion tank is through the top panel, after removing the air separator and strainer.

Located in the upper section in the collector line is an air separator. With no moving parts, it separates entrapped air from the collector fluid as it circulates.

The automatic, float-type air vent, attached to the air separator, eliminates the purged air only. Then, fluid fills the chamber and the float closes the vent port. During system start-up, this process may be expedited by removing the protective vent cap and manually depressing the vent system. During operation, leave vent cap 2-1/2 turns open.

Two air bleeds, located in the top section, allow for the manual venting of air from the ETM piping and heat exchanger during system start-up. A catch basin should be used when venting the air/fluid mixture from plumbing.

Located in the top section of the ETM is a pressure relief valve, used to protect the collector loop from overpressure during a system pump failure. When system pressure reaches 45 psig, the valve will begin to open. The discharge is directed through the pressure relief line into the holding pan. DO NOT REMOVE ETM PANELS WHILE RELIEF VALVE IS FUNCTIONING. Fluid (water/ethylene glycol mixture) may be at 210°F.

The dual diverting control valve, located in the lower section, directs the water flow into various storage and heating modes. This electrically driven valve is controlled by the Solar Control Panel, but does have manual override levers, one per powerhead. These levers should be in the unlocked position.

Located in the lower section are three circuit setters, used to reduce flow rates to the correct level in the collector, charge storage, and heat from storage loops (there is no setter in the Direct Heating loop). The reduction is made by turning the large nut, thus adjusting the internal valve body. ETM is shipped with the setters in the "open" position, adjustments should be made during initial system start-up. TURN PUMPS OFF AND SHIELD THEM AND THE ETM BASE FROM FLUID LEAKAGE WHEN CONNECTING OR DISCONNECTING PRESSURE METER FROM SETTER.
E. (continued)
The lift check valve, located in the collector supply line in the top section, is used to prevent thermosyphoning (backward gravity flow) of cold collector fluid into the heat exchanger during cold, cloudy days. It is designed to prevent freezing of the heat exchanger water loop. During operation, the system pump \((P_1)\) pushes liquid through the check valve, lifting the mechanism off the seat. When flow stops (the protect mode), the valve mechanism drops by gravity onto the seat, thus not allowing flow in the reverse direction. DURING OPERATION, THE VALVE MUST BE FIRMLY SCREWED DOWN ONTO THE SEAT.

Located in the bottom section are two swing check valves which, like hinged doors, allow flow in only one direction. Reversed flow causes the valve to seat more firmly. Check valves are a part of the overall flow control in the heating and storage loops.

There are four drain/fill valves, located in the ETM. These are used to flush, clean, and fill the system. These valves are similar to the drain on a residential hot water heater and have a standard garden hose threaded outlet. ANY SPILLED GLYCOL SOLUTION SHOULD BE IMMEDIATELY WIPE D UP.

Located in the top section of the ETM (in the collector return line) is a ball valve, used during flushing of collector loop. The valve must be open (handle in-line) during system operation, thus allowing full flow through it. By opening and closing (handle perpendicular to supply line) the valve as stated in the operational instructions, the collector loop and heat exchanger shell can be independently flushed and cleaned.

Located in the top section of the ETM (in the collector loop) is a strainer which removes most of the foreign matter from the fluid as it passes through the metal screen. Foreign material should be occasionally removed from the strainer. STRAINER SHOULD NOT BE OPENED PRIOR TO DRAINING OR ISOLATING THE COLLECTOR LOOP.

The low level indicator consists of an indicator lamp (mounted on the ETM) and the pressure gauge mounted in the top section of ETM. After charging the system to 20 psig, the gauge contact pointer should be adjusted to the proper setting (17 psig). When collector loop looses fluid the pressure will drop from the nominal operating 20-36 psig, to the 17 psig, the lamp will light. This indicates a possible system pressure leak, i.e., loss of fluid.

The lamp may also light if all collector fluid becomes very cold and contracts sufficiently to cause a drop in system pressure. If lamp remains lit when the system pump \((P_1)\) is automatically turned on, check for a leak.

NOTE: The indicator actually detects a pressure loss, and not a liquid level.
The Solar Control Panel located in the right side of the ETM, senses conditions throughout the system and requirements of the household (thermostat setting) and provides ETM operational control. When opening the Control Panel, care should be taken to avoid damage to the door or cabinet finish. Switches should remain in the "AUTO" position. Secure the door after closing it with the screw provided.

The holding pan, located on rails under the ETM, is provided to catch and hold the overflow from the relief valve. To remove pan, first disengage the relief line by pushing in at its mid-length and pulling the bottom out of the pan. Then grasp the pan handles and pull from under the ETM.

Control Subsystem

The control subsystem is composed of the collector plate temperature sensor, the upper and lower storage tank temperature sensors, the collector outlet temperature sensor and the central panel.

Operation of the control subsystem is as follows: (Refer to Figure 2-1)

Space heating is controlled by the two stage heating thermostat. First stage heating is set to utilize solar energy if available while second stage heating will supply the auxiliary energy if solar is not adequate. The system control logic is as follows:

- Collector solar energy when available
  - store energy under no load conditions
  - provide energy directly to load on demand
- Use direct solar energy before stored energy
- Use stored energy when direct solar energy is not available
- Use direct or stored solar energy before auxiliary energy

![Solar Heating System Control Schematic](image-url)
Direct Heating from Collectors
Whenever plate temperature $T_p$ is greater than 105°F (adjustable) and there is a call for heating from the space thermostat, pumps $P_1$ and $P_2$ are activated. Valve $V_2$ is positioned to direct flow to the heating coil. The furnace fan is activated to provide warm air to the space. A heating coil leaving-air high-limit controller will cause valve $V_2$ to direct flow to the storage tank if the heating coil leaving-air temperature exceeds 140°F (adjustable). Direct heating operation will continue until the space thermostat is satisfied or until the collector plate temperature has dropped to 90°F.

Heating from Storage
Whenever $T_p$ is less than 105°F (adjustable), $T_{ST}$ is greater than 90°F (adjustable), and there is a call for space heat, pump $P_3$ is activated to discharge the storage tank for space heating. Valve $V_2$ is positioned to direct flow to the heating coil. The furnace fan is activated to provide warm air to the space. Pumps $P_1$ and $P_2$ are not allowed to operate during this mode. The heating coil leaving-air high-limit controller functions as described above.

Storage Charging
Storage charging is accomplished whenever $T_p$ is greater than $T_{SB}$ by 18°F (adjustable). Pumps $P_1$ and $P_2$ are activated and valve $V_2$ is positioned to direct flow to the storage tank. If the above temperature difference falls to less than 3°F (adjustable), the storage charge mode is terminated.

Heat Rejector Control
Whenever the collector discharge temperature exceeds 210°F (adjustable) as sensed to $T_{CP}$, Valve $V_1$ is positioned to direct collector loop flow through the heat rejector, and the heat rejector fan is activated.

Auxiliary Heating
Whenever solar heating is being utilized, either direct or stored, auxiliary gas-fired heating will be available as controlled by the second heating stage of the space thermostat. When solar heating is not available, auxiliary gas-fired heating will be available as first stage heating. Auxiliary heating is provided by a conventional gas furnace utilizing conventional controls.
G. Site Data Acquisition Subsystem (SDAS)

To meet the data collection, performance evaluation, and data dissemination goals of the National Program for Solar Heating and Cooling, the solar heating system will include a comprehensive instrumentation subsystem.

Data Collection

The goal of ERDA's data collection activity is to provide the information necessary for evaluation of the performance and operation of solar systems and subsystems under different climatic conditions. The information generated as a result of this data collection activity will be utilized to stimulate industrial and commercial capability, including that of small business, to produce and distribute solar heating and cooling systems, and through widespread applications, to reduce the demand on conventional fuel supplies. This information will also be used to improve the general knowledge and understanding of solar energy systems, to develop definitive solar energy system performance criteria, to provide the basis for component system improvement and to estimate the economics of solar energy systems in reducing the consumption of conventional fuels. Results will be available for use by property owners, the building industry and related sections of the economy to compare costs and benefits of solar heating and cooling systems. This information will also provide the data base for design of new applications in the private sector. ERDA's Technical Information Center at Oak Ridge, Tennessee, will be the National Solar Heating and Cooling Data Bank and will be the focal point for distribution of this information.

Data System Overview

The Data System depicted in Figure 2-2 provides for the automatic gathering, conversion, transfer, reduction, and analysis of demonstration site data. This system is made up of three basic elements: installed sensors, a Site Data Acquisition Subsystem (SDAS), and a Central Data Processing System (CDPS).

The data will be gathered at each operational site at predetermined intervals of time and will be stored for transfer to the Central Processor. The collected data will be transferred via telephone communications upon request from the Central Data Processing Facility. At the Central Data Processing Facility, the collected data will be processed, analyzed, evaluated, and documented as Performance Evaluation Reports.

Locations of all SDAS sensors are shown in Figure 2-3.
Operation and Maintenance

All operation and maintenance work for the Site Data Acquisition Subsystem will be the responsibility of ERDA or its appointed representative.
Figure 2-2 Site Instrumentation Interface Hardware
Figure 2-3 HONEYWELL-STILLWATER SOLAR ENERGY SYSTEM SCHEMATIC
SECTION III
SUBSYSTEM INSTALLATION GUIDELINES

A) COLLECTOR SUBSYSTEM

The solar collectors, Lennox LSC18-1, are arranged in typical arrays as shown on sheet 2 of drawing SK 142049. The collectors and headers are interconnected as shown in the lower left of the drawing. Prior to collector placement on the support structure remove inlet and outlet plugs from the collector ends. Do not remove the "red" plastic plugs at each end of the collector. Install straight fittings at the collector inlet of lower-most collectors and collector outlet of upper-most collectors in the collector array (Detail A). Install elbow fittings facing inward at all other collector inlets and outlets (Detail B). Use pipe compounds on all threaded fittings suitable for aqueous ethylene glycol solutions, Rectorseal No. 7 or equivalent.

Collector mounting to the support structure is done chronologically by collector stacks one at a time proceeding from one end of the collector array. The lateral spacing between collectors should be approximately 1/8 inch. The mounting procedure is as follows:

1) Place the upper collector(s) of a collector stack approximately 6 inches above its (their) final position and retain by bracing against the support structure. The upper collector(s) may be offset laterally for easier interconnecting to the adjacent lower collector.

2) Place the first row collector on the support structure and bolt both lower-end mounting brackets to the structure allowing space for the supply header and its interconnecting hose.

3) At the upper end of the collector attach the tie-down clip to the mounting bracket and bolt to the support structure.
4) Connect adjacent ends of collectors by installing the 23-inch interconnecting hose using two clamps per end as shown on sheet 2 of drawing SK 142049 (Detail B).

5) Bring the upper collector into place by sliding its lower mounting bracket under the tie-down clip attached to the lower collector and support structure.

6) For a three-high collector stack repeat steps 3 through 5.

7) Bolt both upper-end mounting brackets of the highest collector to the support structure.

8) Repeat steps 1 through 7 for all remaining collector stacks in the array.

Header sections are placed into position and connected to the bottom and top collectors' fittings by the 6-inch long interconnecting hose using two clamps per end as shown on sheet 2 of drawing SK 142049 (Detail A). Header sections are connected to each other by means of a copper coupling. After all such interconnections have been made, the header sections are soldered together. During soldering the support structure should be shielded from the flame used to heat the copper headers and coupling. Also, it may be necessary to provide a heat block between the soldering flame and the insulated portion of the headers. Headers should be anchored securely only at ends where connected to supply and return lines. At other locations the headers should be supported or strapped but done in such a manner as to allow expansion and contraction movement.

Air bleed valves must be installed at both ends of the return header in each collector array as shown in drawing SK 142049 (Detail X and Y). Also air bleed valves are needed at the high points in the supply and
return lines, if such locations exist. All collector subsystem piping should be insulated with 3/4 inch thick armaflex insulation or equivalent and outdoor piping weatherproofed. A flow balancing valve should be installed in the return line for each collector array and a shut-off valve in the supply line to each array.

The purge unit, Lennox HRW-1-30, is located outside the dwelling on a concrete slab as shown on sheet 4 of drawing SK142049. Check sections E and F for control valve installation guidelines.

B) STORAGE SUBSYSTEM
The storage tank depicted on SK12050 Sheet 2 is to be installed above ground (i.e., not buried) and enclosed within a partition which allows the tank to be engulfed in blown fiberglass insulation. The tank should rest evenly on four 1-inch redwood boards. The tank should be leveled with a bubble level. All plumbing connections, control and SDAS sensors should be installed prior to engulfing Tank in insulation. See sections F and G for sensor information. Inlet and outlet lines should be insulated with 3/4" thick armaflex insulation or equivalent.

C) AUXILIARY ENERGY AND SPACE HEATING SUBSYSTEMS
The auxiliary energy unit is a Lennox gas fired furnace type G11Q3-82V. It is to be combined with a space heating coil Lennox type CW3-45. The installation of the furnace is outlined in Figures C-1 and C-2. Do not connect return air plenum or filter to furnace.

CAUTION: See SK 142054 Sheet 3 (Pg. III-21) for changes to furnace wiring.

The general dimensional information on the furnace is shown on drawing SK 142051 sheet 1. The installation information for the CW3-45 is shown on drawing SK 142051 sheet 3. This information is supplemented with detail cut out information shown in Figure C-3.
GL series

REQUIREMENTS — APPLICATION — INSTALLATION

I - SHIPPING AND PACKING LIST
A - Units with Direct Drive Blowers
B - Units with Belt Drive Blowers
C - Units with External Exhaust Blowers

II - SHIPING DAMAGE
Check unit for shipping damage. The receiving party should contact the last carrier immediately if any shipping damage is found.

III - GENERAL
These instructions are only intended as a general guide, and do not supersede local codes in any way. Authorities having jurisdiction should be consulted before installation.

IV - REQUIREMENTS

V - CUT OUT RETURN AIR OPENINGS
1. The return air can be brought in either side or at the bottom of the unit. Scribe lines are provided on each side and bottom showing the outline for the return air opening. Remove blower access door and cut out desired opening.

VI - INSTALL RETURN AIR PLENUM
Secure to furnace top with sheet metal screws. (Do not screw into filter.) After unit is level tighten this nut.

VII - INSTALL WARM AIR PLENUM
NOTE: The following are suggested procedures that should be followed when installing the warm air plenum:

1. Sealing strips of asbestos or fiberglass may be used.
2. In all cases, the plenum should be secured to the furnace or evaporator cabinet with sheet metal screws. In close installations, it may be impossible to install sheet metal screws from the outside. If this is the case, install screws from the inside. Cut an access panel in plenum if necessary.

VIII - INSTALL DUCT WORK
Install supply and return ductwork as desired.

IX - CONNECT FLUE
1. Install flue pipe over the collar on the cabinet top and connect to the chimney using least number of elbows and angles possible. See Figure 3.
2. The flue pipe should have a slight upward slope toward the chimney on all horizontal runs. Approximately 1/4 inch for each 1 foot of horizontal run. The flue pipe or vent connector must be

Figure C-1

ORIGINAL PAGE IS OF POOR QUALITY
Inseted into, but not beyond, the outside wall of the chimney flue. Where two or more appliances vent into a common flue, the area of the common flue should be at least equal to the area of the largest flue or vent connector plus 50% of the combined area of the additional flues or vent connectors.

**XIII - CONNECT GAS SUPPLY**
1. This unit is shipped standard for the piping to be installed through the left side of the unit. See Figure 4. All that is necessary for the installer to do is connect gas supply to the piping assembly.
2. If it is necessary to bring piping through the right side of the unit, a piping hole is furnished on the right side. See Figure 4 for connection.
3. When connecting the gas supply, the length of run from the meter must be considered in determining the pipe size so as to avoid excessive pressure drop. For correct sizing of gas delivering piping consult booklet "Specifications for Installations of Gas Piping and Gas Appliances" issued by the utility having jurisdiction. A drip leg should be installed in the vertical pipe run to the unit. See Figure 4.

In some localities, codes may require a manual main shut off valve and union (furnished by installer) be installed external to unit. Union must be of the ground joint type.

**NOTE - Compounds used on threaded joints of gas piping must be resistant to the actions of liquefied petroleum gases.**

**XIV - LEAK CHECK PIPING**
After gas piping is completed, carefully check all piping connections (factory and field) for gas leaks. Use a soap solution or other preferred means.

**CAUTION: DO NOT USE MATCHES, CANDLES, FLAME OR OTHER SOURCES OF IGNITION TO CHECK FOR GAS LEAKS.**

**XIV - INSTALL BLOWER MOTOR AND DRIVES (BELT DRIVE MODELS ONLY)**
1. Mount motor on motor frame and secure with motor clamp, machine bolts and nuts provided. Be sure motor is rotated so oiling holes are accessible.
2. Install the motor pulley making sure it is aligned with the blower pulley.
3. Install blower belt. Refer to page 2 for correct motor pulley adjustment and belt tension.

4. Use wiring strain relief at motor and connect wiring leads at motor according to wiring make-up diagram on motor cover.
5. Connect the loose end of the green ground provided on blower housing to motor.

**Figure C-2**
ing to the setting stamped on the unit gas valve.
4 - Install a separate fused disconnect switch near the unit so power
supply can be turned off for servicing.
5 - Complete line voltage from disconnect switch to unit terminal
strip in make-up box.
6 - Multi-tap direct drive motors are wired for different heating and
cooling speeds. Speed may be changed by simply interchanging
motor connections at indoor blower relay. Refer to speed selec-
tion chart on unit wiring diagram.

CAUTION - To prevent motor burnout, never connect more than (1) 
motor lead to any one connection. Tape unused motor leads sepa-
ately.

XVI - CLEAN-UP
After unit is operating properly:
1 - Set room thermostat at desired setting.
2 - Leave this instruction with the unit.
3 - Pick up all shipping cartons, metal scraps, extra insulation and
generally clean-up the installation.

G11 FIELD WIRING DIAGRAM

Figure C-3
I. SHIPPING AND PACKING LIST
   Package 1 of 1 contains:
   1- Indoor coil in cabinet with slab filter
   1- Roll gasket material
       Screws

II. SHIPPING DAMAGE
   Check unit for shipping damage. If damage is found, receiving party should contact last carrier immediately.

III. GENERAL
   These instructions are intended as a general guide only and do not supersede local codes. Authorities having jurisdiction should be consulted before installation.

IV. APPLICATION
   CW3-45 indoor water coils provide a field installed space heating/cooling subsystem. Used in conjunction with an auxiliary gas or electric furnace unit, the CW3-45 coil will provide solar space heating. When connected with a water chiller, space cooling is available.

V. INSTALLATION (G11 or G12 Series Auxiliary Unit Installed)
   A. Cabinet Installation
      1. Remove return air plenum or cabinet. (If installed.)
      2. Remove filter hammock and media from G11 or G12 blower compartment. The air filter will now be in the CW3-45 cabinet, upstream from the water coil.
      3. Cut out return air opening on desired side of G11 or G12 cabinet. See Figure 3.

      4. Remove bottom (4) screws from base of G11 or G12 unit on the return air cutout side. See Figure 4.
      5. Install gasket material around cutout opening.
      6. Align CW3-45 unit with return air opening.
      7. From inside blower compartment drill and fasten CW3-45 cabinet to G11 or G12 cabinet with (4) sheet metal screws (use existing holes in G11 or G12 cabinet). Drill and screw the two cabinets together at (1) other accessible location.

      8. Drill and fasten with (2) screws at tabs on top of CW3-45 cabinet. See Figure 5.
      9. Attach return air plenum to CW3-45 coil cabinet being careful not to screw into filter.

B. ELECTRICAL
   Two leads from CW3-45 high limit switch are to be connected into the total system controls. Refer to total system control wiring instructions.

C. PLUMBING CONNECTION
   Refer to the total system instructions for proper plumbing requirements and procedures.

D. AUXILIARY ENERGY COMPONENTS
   Refer to the particular Operation, Maintenance, and Installation Instructions that apply to mating components.

Figure C-4

111-12
Insulate piping with 3/4" thick armaflex insulation or equivalent. Connect temperature limit control wiring to control panel on ETM unit as shown on SK142054 Sheet 3 in Section F.

D) DOMESTIC HOT WATER SUBSYSTEM
The domestic hot water subsystem installation consists of installing a conventional hot water heater (either gas or electric) connecting its outlet (hot) to the dwelling hot water line, connecting the inlet (cold) to the preheat coil in the storage tank. This line should have installed in it a tempering valve, see Figure D-1 for installation guidelines. The supply water (cold) is run to the preheat coil and to the mixing valve. The DHW piping is shown on SK 142052.

The hot water heater should be installed as shown in Figure D-2. Install pressure and temperature relief valve in water heater and discharge line to within 2-feet of floor.

CAUTION: Be sure to remove thermostatic assembly from tempering valve before sweating connections. Otherwise it will become damaged. Tempering valve should be set at 140°F.

E) ENERGY TRANSPORT SUBSYSTEM
The Energy Transport Subsystem consists of the Energy Transport Module (ETM) and the piping between it and the collectors, storage and heating subsystems. The ETM should be installed as outlined on SK 142053 Sheets 1 and 2. The piping installation should conform the Section 15.050 Basic Materials and Methods and Section 15.100 Valves on SK 142057 Sheet 3. Check Section F for control valve installation. It should be located in collector outlet piping where purge unit is to be piped in.
INSTALLATION

WARNING: The water heater must not be installed in small enclosure unless amply ventilated. In tightly constructed homes or basements, openings must be cut based on 1 sq. inch per 1,000 BTU/HR input. The heater must not be installed in bathroom, bedroom or any other occupied rooms normally kept closed. The water heater must be vented to the proper flue. Be sure your water heater is equipped to burn the particular type of gas you intended to use.

LOCAL CODES: Water heater installation must be in accordance with these instructions and all applicable local codes and gas utility requirements.

SAFETY: This heater is equipped with an automatic gas shutoff system actuated by high water temperature. A listed temperature and pressure relief valve shall be installed at the time of the installation of the heater. Local codes shall govern installation of relief devices.

A ½” tapping has been provided in the top of the heater for installing the relief valve. The pressure setting of the relief valve must not exceed the working pressure shown on the rating plate.

Pipe discharge outlet of relief valve to a suitable drain using pipe full size of relief valve outlet (see typical installation). Failure to install a properly rated ASME and A.G.A. certified temperature and pressure relief valve at the time of installation of this heater will release the manufacturer from any claim due to damages caused by excessive pressure or high temperature.

LOCATION

Install the water heater as close as possible to existing flues. On long horizontal runs use at least 1½” ris per foot of length.

Locate the heater in such a manner that should the tank or any connections leak, water damage would not result to adjoining areas. Under no circumstances is the manufacturer to be held liable for any water damages in connection with this heater.

Make certain the draft hood, packaged with this heater, is installed properly on top of the heater. The diameter of the flue pipe must match the diameter of the draft hood. Connect the ¾” water lines. Cold water inlet connects to right hand nipple at top of heater (facing heater), and hot water connects to left hand nipple.

Connect ¼” gas piping to gas thermostat. The installation should conform with American National Standard Installation of Gas Appliances and Gas Piping, Z 21.30 — 1964, or with the requirements of the authority having jurisdiction. Use a pipe joint compound that is resistant to the action of liquefied petroleum (LP) gases. Check for gas leaks with soap suds, not a flame.

MAINTENANCE

To assure long life and efficiency, the water heater tank must have a small amount of water drained periodically. Once a month the drain valve should be opened and the water allowed to run until it flows clean. This will help prevent sediment buildup in the tank bottom.

OPERATION

CONSDNATION: When the heater is first lit or during periods of heavy draw-offs, water vapor may condense on the cold tank and drop down on the burner causing a sizzling sound. THIS IS NOT A LEAK and will disappear when the tank warms.

TEMPERATURE REGULATION: For general household usage, the normal setting will be satisfactory. However, the knob may be set to any position which satisfies temperature requirements.

LIGHTING

Under no circumstances should the heater be operated unless it is filled with water. Lighting and operating instructions are located on the front of the heater.

TEMPERATURE LIMITING SWITCH

Your heater has a nonadjustable limit switch built into the thermostat that guards against excessive temperatures. If the limit switch operates, the pilot can not be relit until the water temperature drops to approximately 120° F. To relight, follow instructions on rating plate. If heater shuts down frequently contact your serviceman or local gas utility.
WATTS No. 70A SERIES
Adjustable Water Tempering Valves

IMPORTANT
BE SURE TO REMOVE THERMOSTATIC ASSEMBLY from valve before sweating connections. Otherwise it will become damaged.

INSTALLATION
1. Remove thermostatic assembly (which is handtight) from body and install valve body as illustrated in diagram.

NOTE: Be sure piston and Teflon disc do not drop out of thermostat, when removing thermostatic assembly.

2. Re-insert thermostatic assembly in body and tighten securely.

ADJUSTMENT
The No. 70A features a new adjustment means which permits you to "dial" a desired temperature, quickly and conveniently. To increase or decrease the water temperature, simply turn the adjusting cap as indicated by the arrow. The adjustment temperature range is 120°F to 160°F.

L70A SERIES
NOTE: For lower tempered water requirements at or below 130°F., use low temperature Model L70A Series which provides adjustment temperature range between 100°F - 130°F.
The piping should be leak tested prior to connecting to the collectors or the ETM unit as specified in Section 15.042 Testing on the same drawing.

Electrical connections to ETM are described on Drawing SK 142054 Sheet 3 and the SDAS connections on SK 142055 Sheet 4.

The Site Data Acquisition System (SDAS) temperature sensor that are located in the ETM are brought up to the top of the insulation under the top cover. These are to be connected to the SDAS J Box as shown on SK 142055 Sheet 1.

The watt transducers for the 3 motors in the ETM and the purge unit fan motor are to be connected to the ETM control panel as shown on SK 142055 Sheet 4.

F) CONTROL SUBSYSTEM

The installation of the control subsystem consists of installing 2 aquastat controllers, the thermostat, a motorized valve, 2 temperature sensors and wells, a shield over the temperature sensor on the collector and connecting these units with the control panel on the ETM unit. The overall control system schematic and sequence of operation is shown on Drawing SK 142054 Sheet 1.

The temperature sensor and shield installed on the collector should be positioned as shown in detail (upper right) on SK 142054 Sheet 2. This requires removal and reinstallation of the collector glass which is shown in Figure F-2 and F-3.

The two aquastats should be installed as shown on SK 142054 Sheet 2 detail for $T_{st}$ and $T_{cd}$.
1.0 GENERAL CONDITIONS

1.1 Scope: The Control Subsystem will include all controls necessary for operation of the solar heating system.

1.2 Required Work: The Mechanical Contractor will install and wire all controls as shown on control subsystem wiring schematic. This will include all line voltage wiring required.

1.3 Procurement of Control Devices: Control devices listed in Material List, (i.e., Solar Control Panel, Water Heater, Thermostat, etc.) will be provided by Honeywell ERC. This will include the control devices only, all materials necessary for a complete installation will be provided by the Mechanical Contractor.

2.0 BASIC MATERIALS AND METHODS

2.1 Basic Materials

2.1.1 Control panel wiring: Control panel wiring shall be run in conduit in indoor areas and shall be Romex #18/2 as required by applicable codes and supplied by Mechanical Contractor.

2.1.2 Power and control wiring: All line and low voltage wiring shall be of size and type required by applicable codes, and supplied by Mechanical Contractor.

2.1.3 Other Materials: All other materials required for a complete installation of the Control Subsystem shall be supplied by the Mechanical Contractor.

2.2 Basic Methods

2.2.1 Control device installation methods: As per applicable details and/or instructions included with equipment.

2.2.2 Electrical wiring: As per all applicable codes.

---

**SOLAR HEATING SYSTEM - SINGLE FAMILY RESIDENCE CONTROL SUBSYSTEM**

**ILLUSTRATION**

**HONEYWELL INC.**

**SUNNY HEATING SYSTEM**

**SINGLE FAMILY RESIDENCE**

**CONTROL SUBSYSTEM**

**MODEL**

**CONTROL A**
Solar Heating System - Studio Family Residence

**SEQUENCE OF OPERATION**

**GENERAL**
Space heating is controlled by the two stage heating thermostats. First stage heating is set to utilize solar energy if available while second stage heating will supply the auxiliary energy if solar is not adequate. The system control logic is as follows:
- Collect solar energy when available
- Store energy under load conditions
- Provide energy directly to load on demand
- Use direct solar energy before stored energy
- Use stored energy when direct solar energy is not available
- Use direct or stored solar energy before auxiliary energy

**DIRECT HEATING FROM COLLECTORS**
Whenever plate temperature \( T_P \) is greater than 100°F (adjustable) and there is a call for heating from the space thermostat pumps \( P_1 \) and \( P_2 \) are activated. Valve \( V_2 \) is positioned to direct flow to the heating coil. The furnace fan is activated to provide warm air to the space. A heating coil leaving-air high-limit controller will cause valve \( V_2 \) to direct flow to the storage tank if the heating coil leaving-air temperature exceeds 140°F (adjustable). Direct heating operation will continue until the space thermostat is satisfied or until the collector plate temperature has dropped to 100°F.

**HEATING FROM STORAGE**
Whenever \( T_P \) is less than 100°F (adjustable) and \( T_P \) is greater than 20°F (adjustable), and there is a call for space heat, pump \( P_2 \) is activated to discharge the storage tank for space heating. Valve \( V_2 \) is positioned to direct flow to the heating coil. The furnace fan is activated to provide warm air to the space. Pumps \( P_1 \) and \( P_2 \) are not allowed to operate during this mode. The heating coil leaving-air high-limit controller functions as described above.

**STORAGE CHARGING**
Storage charging is accomplished whenever \( T_P \) is greater than \( T_{CHG} \) by 10°F (adjustable). Pumps \( P_1 \) and \( P_2 \) are activated and valve \( V_2 \) is positioned to direct flow to the storage tank. If the above temperature difference falls to less than 10°F (adjustable), the storage charge mode is terminated.

**HEAT EXCHANGER CONTROL**
Whenever the collector discharge temperature exceeds 150°F (adjustable) as sensed by \( T_{COL} \), valve \( V_1 \) is positioned to direct collector loop flow through the heat exchanger, and the heat exchanger fans are activated.

** AUXILIARY HEATING**
Whenever solar heat is being utilized, either direct or stored, auxiliary gas-fired heating will be available as controlled by the secondary heating stage of the space thermostat. When solar heating is not available, auxiliary gas-fired heating will be available as first stage heating. Auxiliary heating is provided by a conventional gas furnace utilizing conventional controls.

**DOMESTIC HOT WATER HEATING**
Whenever domestic hot water is drawn from the water heater it is replenished by preheated water from a coil in the storage tank. A thermostatic mixing valve is used to regulate the hot water supply temperature to 140°F.

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**MATERIAL LIST**

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**HONEYWELL PREFERRED RESOURCES CENTER**

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**REMARKS**

- Description of system and components
- Control logic for heating and storage charging
- Auxiliary heating control
- Domestic hot water heating system
COLLECTOR COVER REMOVAL & REPLACEMENT

NOTE - The collector surface temperature can burn. Handle solar collector with caution.

1 - Use rubber gloves when handling solar collector to avoid finger prints on glass.

2 - To replace the glass, remove the collector as shown in Figure 19 and dismantle according to Figure 20. To re-assemble frame, insert the glass sheets and new gaskets into side pieces making sure the glass is centered and the ends are even. Next insert the glass into the end pieces and secure with existing screws. Use sealer compound on corner joints.

3 - If the glass cover becomes dirty, clean the glass using a soft clean cloth, mild soap or detergent and clean rinse water. Alkalies can stain the glass if allowed to remain in contact too long.

![Diagram of collector cover frame removal and replacement](image-url)
The Control Valve $V_1$ should be installed in the collector outlet piping where the purge unit is to be piped in.

The aquastats should be set as follows:

- $T_{cd}$ (on collector outlet piping) set at $210^\circ F$
- $T_{st}$ (top of storage tank) set at $100^\circ F$

The collector setpoint potentiometer in Control Panel should be set at $105^\circ F$. See Figure F-1.

![Figure F-1.](image)

G) SITE DATA ACQUISITION SUBSYSTEM (SDAS)

The installation of the SDAS involves the installation of 16 temperature sensors; a total radiation sensor, a watt transducer for the furnace blower and 7 flow rate meters. The list of sensors and system schematic showing their location is shown on SK 142055 Sheet 1. As noted on the list of sensors, some items are already installed but need to be connected to the SDAS Junction Box. The SDAS JB should be installed as shown in Figure G-1.

The return air flow sensor and Temp sensors T600 and TD601 should be installed as shown in Figure G-2 and the terminals wired as shown in detail 6 and 7 on SK 142055.
The storage tank temp sensors should be installed with T203 as the top sensor, T204 as the middle sensor and T205 as the bottom sensor. Sensor T401 is mounted in the inlet line at the bottom of the tank and TD401 is installed in the outlet line at the top of the tank -- opposite end to sight glass. These inline sensors should be installed as depicted in detail #9 and 10 on SK 142055 Sheet 2.

The total Radiation sensor 1001 (Pyramoneter) should be installed on the collector support structure as shown in detail on SK 142055 Sheet 3.

The ambient temperature sensor, T001, should be mounted under the eaves on the north side of the residence. See detail 3 on SK 142055 Sheet 3 for mounting instructions.

Three types of flow meters are to be installed. The gas flow meters are the most conventional looking. They are to be installed in the gas line to the furnace and to the hot water heater. The return air flow rate is to be installed in the return air duct as shown in Figure G-2. The liquid flow sensors are to be installed in the hydronic lines as depicted in detail 5 on SK 142055 Sheet 3. Flow sensor W100 can be installed in the collector supply line near where it connects to the ETM. The storage flow sensor W200 should be installed in the outlet line from the storage tank (bottom). The heating coil flow rate sensor should be installed in the return line from the space heating coil attached to the furnace. The DHW flow sensor should be installed where the hydrant line is tapped to provide the feed to the preheat coil in the storage tank.

The wiring connections for each sensor is shown on SK 142055. The sensor wiring is to be brought to the SDAS J Box. The types of wire connection and conduit requirements are called out on Sheet 1 of SK 142055.
Figure G-1

SDAS MODULE AND J-BOX INSTALLATION

NO SCALE
Figure G-2. Aux. Heat SDAS Sensor Installations

- Locate as far from duct elbow as possible.
- Contractor shall install air flowmeter in return air duct.
- 1/2" C.I. floor flange by contractor.
- Instrumentation box supplied by NASA mounted by contr.
- 14 AWG, 120 vac. elect. service by contractor.
- Wiring to J-box.
- Solar space heating coil.
- Wiring to J-box.
- Air flowmeter detail.

No scale.
1. All temperature sensors shall be located so as to avoid accidental damage to the sensor head assembly.

2. The piping EC-100 heat transfer system shall be applied to the bottom of the temperature gauge prior to insertion into the thermometer.

3. In areas where there is a danger of frost, the temperature sensor shall be covered with a hose 120 pipe diameter downstream of the point of sensing.

4. All temperature sensors shall be identified with a hose tag.

---

**Honeywell**

**Energy Savings Center**

**Solar Heating System - FR**

**Site Data Acquisition Subsystem**

**William O'Dea**

**Date 2 of 3**
SECTION IV
SYSTEM TEST AND FILLING

A) TESTING
As the hydronic loops are completed they should be tested to verify their integrity. The System Integration SK 142057 Sheet 3 (Pg. III-19) outlines the testing to be performed under 15.042 Testing.

B) FLUSHING AND CLEANING
After the testing of the hydronic loops is completed the following cleaning procedure should be used.

1) The collector loop and the space heat/storage loop are controlled by the ETM module. See SK 142053 sheet 2. (Pg. III-18)

Access to the various components in the ETM can be gained as described below. These items are shown in Figure 4-1, 4-2 and 4-3.

a) drain/fill valve #4 - remove side panel (opposite control box)
b) ball valve, flush valve #3, and lift check valve - remove top panel and insulation in front of coll. return inlet
c) HX drain - remove side panel (opp. control box); then remove galvanized insulation retainer
d) Pressure gauge (part of low level/pressure indicator system) and HX air bleed - remove top panel and insulation between the Control Panel and HX

Flushing and draining of the collector loop must be done thru drain/fill valve #4 and flush valve #3. To clean collector loop:
a) set all switches on control panel to stop
b) close ball valve adjacent to flush valve #3 and open balancing valves in collector supply lines and air vents at collectors
Figure 4-1. ETM Front View
Figure 4-3. ETM End View (Left)
c) Connect fill line from drum with 50 gal. of water mixed with 1/2 gal. trisodium phosphate to drain/fill valve #4
d) open valve #4 and using external pump
e) pump liquid into system.
CAUTION: Pressure should not exceed 40 psig
f) As liquid starts flowing open flush valve #3;
g) a drain hose should be connected to flush valve #3 and run to a large container (55 gal. drum) to catch flushing fluid;
h) start pump by moving switch marked P1 to P1 "ON". CAUTION: Do not run pump when no liquid is present
i) Continue feeding flushing fluid until it flows freely from drain hose;
j) close air vents at collector when air ceases to flow;
k) energize valve V1 (turn to ON position) and continue to feed fluid until it flows freely from drain hose.
l) open ball valve adjacent to flush valve #3 and close flush valve #3
m) continue to supply fluid until pressure gauge reads 20 psig
n) bleed air from HX bleed valve, then
o) close drain and fill valve #4. Shut external fluid supply and run system for 4 hours.

Monitor pressure gauge periodically to be sure it remains within 20-35 psi operating range.

When cleaning is completed drain total collector loop - HX fluid and measure volume so that correct amount of ethylene glycol can be mixed.
To completely drain collector loop, the Lift Check Valve (rear Circuit Setter (3) must be opened (turn knob counterclockwise till it stops). *After draining, insure knob is returned to the fully closed position.

After system is totally drained, remove drain plug from HX to empty shell side.

The strainer should be cleaned while system is drained.

The collector loop should now be flushed with clean water for two hours. This may be accomplished using the water system. Caution: assure supply pressure does not exceed 40 psi. It should be connected to the drain/fill valve No. 4. Pump P need not be energized but ball valve must be closed. A drain hose should be connected to flush valve No. 3 and run outside to an appropriate area.

The HX portion of the system should be flushed and it may be performed as follows:

a) Close ball valve and drain/flush valve 3
b) Open HX drain and connect drain hose to it
c) Pump fluid into drain/fill valve #4 and out of HX drain

2) The storage and heating system loop should be flushed and cleaned prior to filling
   a) The storage tank should be flushed first. Connect hose to drain valve on bottom of tank and open valve. Drain hose should be run to appropriate floor drain. Remove manhole cover and using hose connected to household water supply

*NOTE: Without isolation valves outside ETM, system must be drained before maintenance can be performed.
flush interior of tank.

CAUTION: Do not enter tank with shoes as interior lining could be damaged.

To flush heat coil loop, connect a drain hose to drain valve #1 in ETM, open valve, and connect to drain valve #2 in ETM a hose from household water supply. Close both isolation valves on inlet and outlet of storage tank. Turn water on and let water flow for 30 minutes.

b) When system is thoroughly flushed shut-off drain valve and fill tank to 6" below top of tank. Add inhibitor (1200 mg/l) which is 5 gallons of nitrate base made by Norman Chemical product no. 284, 1630 Carroll Ave, St. Paul, MN.

C) BALANCING

Connect Bell and Gossett Delta Pressure readout kit or equivalent to Bell and Gossett Circuit setter balance valve #1 in ETM (heat from storage loop). Proceed as per instructions included with readout kit. Manually start P3. Adjust flow to 8 GPM.

Repeat procedure with circuit setter balance valve #2 in ETM (storage charge loop). Run P.2. Adjust flow to 8 GPM.

Repeat procedure with circuit setter balance valve #3 in ETM (total solar collector loop) run P1. Adjust flow to 12 GPM.

Repeat procedure with circuit setter flow balance valve in supply line to 3 high collector array. (Not in ETM) with P-1 operating. Adjust flow to 5.5 GPM.

Repeat procedure with circuit setter flow balance valve in supply line to 2 high collector array (not in ETM) with P-1 running. Adjust flow to 6.5 GPM.
START-UP

1) Collector Loop

Fill the collector loop with a 50/50 solution of water and Dowtherm SR1 ethylene glycol. Mix the glycol and water in a 55 gallon drum. Connect fill hose to drain/fill valve #4. Connect inlet of external pump to 55 gal. drum, open fill valve #4 and start pump. Open all air bleeds in the system and fill slowly. It is imperative not to fill the system too rapidly. Close air bleeds as they begin to leak. Precautions should be taken to prevent the glycol mixture from spilling onto the building or collector array.

2) System Pressurization

Once the system is full and purged of air, it may be pressurized to 20 psig as shown on low water/pressure gauge using external pump and 50/50 mixed solution. Energize the collector system pump $P_1$ manually. Air that is trapped will tend to be separated by the air separator as the fluid circulates. This will cause a decrease in the fluid level within the collector loop. It is important to watch this pressure level to see that it does not get too low as the low fluid warning light will come on. If the pressure gets low, then add more fluid to the collector loop to maintain the same charge pressure. Low water/pressure gauge should be set to 15 psig.

E) SYSTEM CHECK-OUT

To verify system operation have both loops of system filled and electrical power to ETM. Position all Auto-Stop-On switches in Auto position. This allows the indicator lights to function correctly. Using system check-out matrix on Figure 4-4 verify each mode operates as shown.
<table>
<thead>
<tr>
<th>OPERATING MODE</th>
<th>DISCONNECT</th>
<th>ADJUST</th>
<th>ENERGIZE</th>
<th>PUMP 1</th>
<th>PUMP 2</th>
<th>PUMP 3</th>
<th>VALVE 1</th>
<th>VALVE 2</th>
<th>GAS VALVE</th>
<th>FAN</th>
<th>CONTROL PANEL LIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
<td></td>
<td></td>
<td>C on Space Thermostat</td>
<td>DE</td>
<td>DE</td>
<td>DE</td>
<td>DE</td>
<td>DE</td>
<td>E</td>
<td></td>
<td>Hi</td>
</tr>
<tr>
<td>Ventilation</td>
<td></td>
<td></td>
<td>C on Space Thermostat</td>
<td>DE</td>
<td>DE</td>
<td>DE</td>
<td>DE</td>
<td>DE</td>
<td>E</td>
<td></td>
<td>Hi</td>
</tr>
<tr>
<td>Free</td>
<td></td>
<td></td>
<td>Low Temperature Sensor on Differential Controller Terminal C</td>
<td>Aquastat Tank Sensor Set Point at Minimum (5°F)</td>
<td>DE</td>
<td>DE</td>
<td>E</td>
<td>DE</td>
<td>DE</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>
SECTION V

OPERATION

This section outlines the operation of the single family residence Solar Heating System. The system is automatically controlled by the space thermostat to provide energy to satisfy heating requirements. When no heat is required in the dwelling the system will automatically store the collector solar energy or will dissipate it if the storage is fully charged.

The following sections describe in detail how the system and subsystems operate.


System Operation

General (Refer to Pg. I-2)

Once the solar system has been installed, fluids added to collector and storage loops and system checked out by the installer, the complete system will operate automatically. Lights on the control panel will indicate in which mode the system is operating. For normal operation, set all switches in the control panel to the "Auto" position. The On and Stop positions should only be used for manually controlling the system such as during maintenance or system checkout.

The space thermostat can call for heat in two stages. The first stage will utilize solar energy if it is available. If this is not sufficient to heat the building the thermostat will switch automatically to second stage heating which energizes the gas furnace. Solar heated water is available from the collector if sufficient solar energy is available or from energy stored in the solar storage tank.

When heating directly from the collectors to the heating coil located in the return air section of the furnace, the collectors must be at least 105°F. The energy will continue to be supplied from the collectors as long as there is a call for heat and the collectors are greater than 90°F. In this mode pumps P₁ and P₂ are energized and water is heated by the heat exchanger and circulated around the storage tank to the furnace coil through valve V₂.

If sufficient energy is not available from the collectors and the storage tank is greater than 90°F, then pumps P₁ and P₂ are off, pump P₃ is energized and hot water is supplied to the furnace coil from the top of the storage tank and is returned to the bottom of the tank.

When there is no call for heating and solar energy is available from the collectors the system will charge storage as long as the collectors are greater than 30°F above the storage tank after initial start.

When the storage is fully charged the system will operate the purge coil whenever the collector outlet is greater than 220°F. The purge will control the collector outlet temperature to prevent over heating of the system.
SECTION VI

MAINTENANCE

This section outlines the maintenance of the single family residence Solar Heating System. The maintenance required is outline in two sections - Section I Routine Maintenance covering ordinary and preventive maintenance; - Section II Maintenance Schedule which provides a chart of maintenance activities for the system and the subsystems.

Repair and parts replacement for the components are provided in the appendices A thru F.
ROUTINE MAINTENANCE

The Solar Heating System requires only a small amount of routine maintenance. The elements requiring maintenance are broken down by subsystems and described below.

A. Collector Subsystem

The components requiring routine maintenance are the:

- Solar Collectors (LSC 18-1)
  Normal rainfall will usually suffice for cleaning however, inspect spring and fall for dirty cover glass. Clean glass using a soft clean cloth, mild soap or detergent and clean rinse water. Alkalines can stain the glass if allowed to remain in contact too long.

- Purge Unit (HRW-1-30)
  Inspect spring and fall for debris on coil. Clear debris from coil with brush - unit may be flushed with water hose if necessary. Lubricate motor in accordance with guide on motor.

B. Storage Subsystem

The water in the storage tank should have the inhibitor checked and water condition checked annually. If the tank water has a pungent odor, or dark discolorization, drain tank and refill with clean water adding inhibitor as called out in Section V under Start-Up part 2 Storage Loop.

The inhibitor pH level should be between 7.0 and 9.0 Draw a small amount of water from the storage tank drain valve. Using a pH test kit dip a short piece of test paper in the fluid drain off. Observe the color of the moistened portion and compare to color chart with kit. The desired pH is 8.0 or higher. If the pH is less than 8.0 add 5 gallons of Product No. 284 made by Norman Chemical Co., 1630 Carroll Ave., St. Paul, or equivalent to reach a value of 1200 mg/l. (1200 ppm) of nitrite base.

Adding of inhibitor and filling tank may be done thru manhole in top of tank. Tank may be drained by connecting drain hose to tank drain on bottom of tank.
C. Auxiliary Energy and Space Heat Subsystem

- The furnace should have the following checked annually:
  - check and clean blower wheel
  - lubricate blower motor
  - replace filter media
  - check furnace operation

D. Hot Water Subsystem

To assure long life and efficiency, the water heater tank should have a small amount of water drained periodically. Once every month or two the drain valve should be opened and the water allowed to run until it flows clean. This will help prevent sediment buildup on the bottom of the tank.

E. Energy Transport Subsystem

- The Energy Transport Module (ETM-1) has three pumps that should be lubricated every three months. Proper lubrication is the most important single factor in obtaining long life and trouble free operation. Each oil cup, two on motor and one on the pump should be filled with #20 non-detergent motor oil.

- Transfer Fluid (SR-1) - The ethylene glycol and water mixture contains corrosion inhibitors. An annual test of the fluid is necessary to avoid plumbing decay. "Do not add chromate inhibitors to system". Using a standard pH test kit, dip a short piece of test paper in a small amount of fluid drawn from drain and fill valve #4 in ETM. Observe the color of the moistened portion and compare to color chart with kit. The desired transfer fluid pH is 8 or higher. If the pH is less than 8 acids are forming in the fluid. The dwelling owner should call the solar system service man to add inhibitor to system. Use Figure 6-E-1 to determine the correct quantity of inhibitor to be added. After system operation for 30 minutes recheck pH level for proper value.

- Replenishing Inhibitor - If the pH is less than 8, the inhibitor is becoming depleted, and adding inhibitor to protect the system is recommended. Such inhibitor is readily available from the Dow Chemical Company in five gallon lots. Since the inhibitors are specially designed for Dowtherm SR-1 heat transfer medium, other type inhibitors should never be mixed with this material.

* Filter should be checked monthly during heavy operation and replaced as needed.
F. Control Subsystem

The control subsystem does not require any periodic maintenance. This subsystem can be used to check system operation as shown in Section IV System Test and Filling.
Figure 7-1 outlines the routine maintenance required or the single family Solar Heating System.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Activity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly every 3 months</td>
<td>Check furnace air filter</td>
<td>3C C</td>
</tr>
<tr>
<td></td>
<td>Hot Water heater sediment drain</td>
<td>3D D</td>
</tr>
<tr>
<td></td>
<td>ETM Pump lubrication</td>
<td>3E E</td>
</tr>
<tr>
<td>Semi-Annual or seasonal</td>
<td>Clean Collector Glass</td>
<td>3A A</td>
</tr>
<tr>
<td></td>
<td>Clean Purge unit</td>
<td>3A A</td>
</tr>
<tr>
<td>Annual</td>
<td>Storage tank fluid check</td>
<td>3B B</td>
</tr>
<tr>
<td></td>
<td>Service furnace</td>
<td>3C C</td>
</tr>
<tr>
<td></td>
<td>Solar collector fluid check</td>
<td>3E E</td>
</tr>
</tbody>
</table>

Figure 7-1. Routine Maintenance
APPENDIX A

COLLECTOR SUBSYSTEM

LSC18-1        Solar Collectors
HRW-1-30       Purge Unit
Y534A          Diverting Valve (page E-10)
FRAMING - FLASHING - COLLECTOR MOUNTING

I - SHIPPING AND PACKING LIST
Package 1 of 1 Contains
1 - Assembled solar collector

II - SHIPPING DAMAGE
Check unit for shipping damage. Contact the last carrier immediately if any damage is found.

III - GENERAL
These instructions are intended as a general guide and do not supersede local codes. Authorities having jurisdiction should be consulted before installation.

IV - APPLICATION
The consulting engineer, architect or dealer must determine the solar collector application including number required, placement, mounting angle and piping sequence. This instruction outlines one typical method of framing and installing the solar collectors. Other designs can be substituted if the basic guidelines within the instruction are followed. Figure 1 illustrates a typical residential application.

V - SOLAR COLLECTOR
The collectors must mount on a watertight roof. Roof construction must be adequate to support the collectors and mounting frame. Solar collectors must be installed with the flow tubes in the vertical direction.

FIGURE 1

FIGURE 2

FIGURE 3
position. Figure 2 illustrates details for a typical mounting frame. Install the frame and solar collectors as follows:

1. Center sleepers over trusses and secure to roof. Figure 3 shows the sleeper flashed into the roof.
2. Length of sleepers required for two rows of collectors is 162-5/8 inches.

Figure 4 illustrates typical framing construction for one row of collectors. Figure 5 illustrates construction for two rows of collectors. 2" x 8" dimensional lumber is utilized.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>162-5/8</td>
<td>68-1/2</td>
<td>6-1/4</td>
<td>6-3/4</td>
<td>6-1/4</td>
<td>3/4</td>
<td>6</td>
</tr>
<tr>
<td>mm</td>
<td>4131</td>
<td>1740</td>
<td>159</td>
<td>171</td>
<td>159</td>
<td>19</td>
<td>152</td>
</tr>
</tbody>
</table>

**Figure 4**

MOUNTING FRAME FOR SINGLE ROW COLLECTORS

**Figure 5**

MOUNTING FRAME FOR DOUBLE ROW COLLECTORS

USE 2" x 8" DIMENSIONAL LUMBER FOR MOUNTING FRAME

"X" EQUALS NUMBER OF COLLECTORS MULTIPLIED BY 3 FEET PLUS 8 INCHES

DRILL DRAIN HOLES IN THE BOTTOM OF MOUNTING FRAME (3 1/4" on 24" centers)
3. Position first collector 4-7/8 inches from end of frame and then maintain 1/8 inch between remainder of collectors. Refer to Figure 6. Secure collectors to frame with lag bolts (4 per collector). If desired the inside spacing could enclose the supply and return header runs where they penetrate through roof.

NOTE: Solar collectors can be piped individually as they are set or if working area permits, piped after all collectors are set.

4. The temperature control system has a sensor which secures directly to one absorber plate. Remove the collector frame from desired collector and install the sensor in the center of absorber plate. Refer to manufacturer's installation instructions. Drill a hole through collector cabinet and route wiring to sensor.

5. After the system has been leak tested and the insulation has been installed on outdoor piping, flash the frame and solar collectors as illustrated in Figure 7. This flashing prevents air flow around collectors minimizing convection losses. This trim can bolt directly to the collector frame.

---

**FIGURE 6**

**INSTALLING COLLECTORS IN MOUNTING FRAME**

- 1/8" (3mm) EXPANSION TOLERANCE BETWEEN COVER FRAMES
- SOLAR COLLECTOR
- SPACE COLLECTOR 4-7/8" (124 mm) FROM SIDE AND SECURE TO STRIPPING WITH LAG BOLTS
- BASE FRAMING
- DETAIL OF MOUNTING FRAME SIDE
- SLEEPER
- LAG BOLT (one per corner) 4-7/8" (124 mm)

**FIGURE 7**

**INSTALLING TRIM FLASHING**

- SECURE 1" x 2-1/4" TRIM STRIPS BETWEEN COLLECTORS
- 1" x 10 TRIM COVER
- 1" x 6" TRIM
- COVER FRAME MOUNTING SCREW (1/4-20 x 5/8 HHMS)
- BASE FRAMING
- DETAIL OF BOTTOM TRIM COVER
- SECURE TRIM TO MOUNTING FRAME WITH WOOD SCREWS
- GLASS
- (1" x 10") TRIM COVER
- MOUNTING FRAME
VI - PIPING FOR SOLAR COLLECTORS
A - Basic Piping Fundamentals
1 - Flared Connections
   a - Cut pipe to size with a roller type tubing cutter. See Figure 8.
   b - Remove any burrs with knife or reaming tool as shown in Figure 9.
   c - Flare tubing with a flaring tool as illustrated in Figure 10.

   ALIGN PARTS AND THEN PUSH FLARE ONTO FITTING
   FIGURE 11

   TIGHTEN NUT USING TWO WRENCHES
   FIGURE 12

2 - Soldered Connections
   a - Cut the pipe to size.
   b - Remove burr.
   c - Fit tubing into coupling maintaining a tight and proper clearance. See Figure 13.
   d - Align parts as shown in Figure 11 and tighten using two wrenches to prevent twisting lines. Figure 12 shows cutaway of flared connections.
   e - Use minimum 95-5 rated solder.
   f - Make joint using proper amount of heat to draw solder into joint.
   g - Cool and clean the joint with wet cloth.

B - General Guidelines
1 - The solar collectors can be assembled in parallel, series or series-parallel combinations. Figure 14 illustrates various sequencing arrangements. The supply header is always positioned at the bottom side of collectors while the return header is on the top.

NOTE - For residential applications, no more than two collectors should be connected in series.

TABLE 1

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single family heating and heating</td>
<td>1-1/4&quot; (38 mm)</td>
</tr>
<tr>
<td>Multi-family heating and heating</td>
<td>3&quot; (76 mm)</td>
</tr>
<tr>
<td>Commercial heating and heating</td>
<td>4&quot; (102 mm)</td>
</tr>
</tbody>
</table>
Table 1 lists information for sizing headers. Avoid dissimilar metals. Where copper piping connects to different piping materials, dielectric insulating couplers should be used to prevent corrosion.

**TYPICAL PIPING ARRANGEMENTS**

- PARALLEL "Z" FLOW (2 ROW)
- SERIES - PARALLEL "Z" FLOW
- PARALLEL "C" FLOW (2 ROW)
- SERIES - PARALLEL "C" FLOW
- PARALLEL "Z" FLOW (SINGLE ROW)
- PARALLEL "C" FLOW (SINGLE ROW)
- PARALLEL GROUPS IN SERIES FLOW

**Installation of Piping**
1. Remove the plug from each end of solar collector.
2. The collector either pipes to another collector or into a header. The 1/2 inch copper tubing must be field provided.
   - Figure 15 illustrates two solar collectors piped in series. Install a flare male elbow at the bottom collector and a flare male straight connection at the top collector.
   - A 1 1/4 inch to 1 1/2 flare fitting must be soldered onto each header at 40 to 60 intervals. Install a flare male elbow at the collector and connect piping as shown in Figure 16. In a two row parallel application, the return and supply headers can be piped according to Figure 17 to minimize collector spacing.
3. Route the supply and return headers into the interior of building and then flash completely to waterproof the opening.

**Figure 14**

**Connecting Two Collectors in Series**

- TOP SOLAR COLLECTOR
  - FLARE NUT
  - FLARED MALE ELBOW
  - STRAIGHT FLARED CONNECTION
  - 6" (152 mm) MINIMUM

- BOTTOM SOLAR COLLECTOR
  - FLARE NUT
  - 1/2" (13 mm) TUBING

**Figure 15**
4. An air bleed valve must be installed at each end of the return header for the top row of collector cells. Solder a sweat to flare fitting into the ends of return header. Connect a short length of 3/8 inch tubing to flared connection and then secure to a "B" valve with a nut and ferrule. Refer to Figure 18.

5. Leak test the installation thoroughly and make any needed repairs. Insulate all outdoor piping with 3/4 inch thick foamed plastic insulation. Waterproof outdoor pipe insulation with two coats of plastic finish reinforced with glass mesh. Install per manufacturer's recommendations.
MAINTENANCE

1. If the glass cover becomes dirty, clean the glass using a soft clean cloth, mild soap or detergent and clean rinse water. Alkalies can stain the glass if allowed to remain in contact too long.

NOTE: The collector surface temperature can burn. Handle solar collector with caution.

2. Use rubber gloves when handling solar collector to avoid finger prints on glass.

3. To replace the glass, remove the collector as shown in Figure 19 and dismantle according to Figure 20. To re-assemble frame, insert the glass sheets and new gaskets into side pieces making sure the glass is centered and the ends are even. Next insert the glass into the end pieces and secure with existing screws. Use sealer compound on corner joints.

4. To replace an absorber plate refer to following sequence and Figure 21.
   a. Drain collector.
   b. Remove collector frame.
   c. Remove plate seal and gasket on each end of collector.
   d. Disconnect flare fitting on each end of collector.
   e. Remove 6 screws securing absorber and left plate from cabinet. Avoid touching coating on plate.
   f. When re-assembling absorber plate, tighten screws between 10 lbs and 15 lbs torque.

5. The ethylene glycol/water mixture should be checked once a year by your Lennox service organization for proper freeze protection and inhibitor level.
DISCONNECT FLARE FITTING TO REMOVE ABSORBER PLATE

REMOVE (6) SCREWS SECURING ABSORBER PLATE TO COLLECTOR
(Re-install at 10 lbs to 15 lbs torque)

REMOVE PLATE SEAL AND GASKET

DETAIL OF PAD INSERTION

ABSORBER PLATE

SOLAR COLLECTOR

NUT RETAINER

REMOVING ABSORBER PLATE

FIGURE 21
PURGE UNIT  HRW-1-30

The HRW-1-30 is an air to water heat exchanger. The finned tube coil and the blower are mounted in a cabinet designed for outdoor installation. The air is drawn in through the bottom and exhausted out the top of the unit. When connected to the collector outlet line, the purge unit will lower the fluid temperature. The unit is rated at 2000 CFM and should dissipate 100,000 Btu's per hour.

Maintenance

At the beginning of each heating or cooling season the system should be cleaned as follows:

A. HRW-1-30 Unit

1. Clean and inspect both sides of coil. Coil may be flushed with water hose if necessary.

2. Oil outdoor fan motor: always relubricate motor according to manufacturers lubrication instructions on each motor. If no instructions are provided, use the following as a guide.
   a. Motors With Oiling Ports - Prelubricated for an extended period of operation. For extended bearing life, relubricate with a few drops of SAE No. 10 non-detergent oil once every two years.
   b. Motors Without Oiling Ports - Prelubricated and sealed. No further lubrication required.

3. Visually inspect all connecting lines, joints and coils for evidence of fluid leaks.

4. Check all wiring for loose connections.

5. Check for correct voltage at unit (unit operating).
APPENDIX B

STORAGE SUBSYSTEM

SK-142050  Storage Tank Installation Drawing
(sheet 2)
APPENDIX C

AUXILIARY ENERGY AND SPACE HEATING SUBSYSTEM

G11 Series Furnaces

CW3-45 Series Coils
operation
maintenance
and
installation
instructions

GAS UNITS
501,172M
1276
Supersedes 476
**Parts Arrangement**

- Flue Pipe
- Burner Access Panel
- Fan/Limit Control
- A.G.A. Rating Plate
- Gas Valve
- Pilot
- Burners
- Wiring Make-Up Box
- Blower Motor
- Blower Access Panel
- Liners
- Heat Exchanger
- Filter
- Blower Belt

**Models**

G11 (Belt Drive), G11D2, G11Q3, G11Q4 and G11Q5 (Multi-Speed Direct Drive) Series Units

**Dimensions**

- **Model No.**
- **A**
- **B**
- **C**
- **D**
- **E**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>G11-82</td>
<td>49 in</td>
<td>16-1/4 in</td>
<td>14-1/8 in</td>
<td>14 in</td>
<td>11 in</td>
</tr>
<tr>
<td></td>
<td>(1245 mm)</td>
<td>(413 mm)</td>
<td>(359 mm)</td>
<td>(356 mm)</td>
<td>(279 mm)</td>
</tr>
<tr>
<td>G11-110</td>
<td>49 in</td>
<td>21-1/4 in</td>
<td>19-1/8 in</td>
<td>14 in</td>
<td>16 in</td>
</tr>
<tr>
<td></td>
<td>(1245 mm)</td>
<td>(540 mm)</td>
<td>(486 mm)</td>
<td>(356 mm)</td>
<td>(406 mm)</td>
</tr>
<tr>
<td>G11-137</td>
<td>53 in</td>
<td>26-1/4 in</td>
<td>24-1/8 in</td>
<td>18 in</td>
<td>21 in</td>
</tr>
<tr>
<td></td>
<td>(1346 mm)</td>
<td>(667 mm)</td>
<td>(613 mm)</td>
<td>(457 mm)</td>
<td>(533 mm)</td>
</tr>
<tr>
<td>G11-165</td>
<td>53 in</td>
<td>31-1/4 in</td>
<td>29-1/8 in</td>
<td>18 in</td>
<td>26 in</td>
</tr>
<tr>
<td></td>
<td>(1346 mm)</td>
<td>(740 mm)</td>
<td>(660 mm)</td>
<td>(457 mm)</td>
<td>(660 mm)</td>
</tr>
<tr>
<td>G11-200</td>
<td>53 in</td>
<td>31-1/4 in</td>
<td>29-1/8 in</td>
<td>18 in</td>
<td>26 in</td>
</tr>
<tr>
<td></td>
<td>(1346 mm)</td>
<td>(740 mm)</td>
<td>(660 mm)</td>
<td>(457 mm)</td>
<td>(660 mm)</td>
</tr>
</tbody>
</table>

**Table of Contents**

- **Start Up - Operation - Adjustment**
- **Annual Maintenance**
- **Requirements - Application - Installation**
- **Installing Belt Drive Blower Motor - Wiring**
START-UP AND PERFORMANCE CHECK LIST

Job Name ____________________________ Job No. ____________________________ Date ____________________________

Job Location __________________________ City ____________________________ State ____________________________

Installer ____________________________ City ____________________________ State ____________________________

Unit Model No. __________________________ Serial No. ____________________________ Serviceman ____________________________

HEATING SECTION

Electrical Connections Tight? □
Supply Voltage _______ Blower Motor Amps _______ Blower Motor H.P. _______
Blower Motor Lubrication O.K.? □
Gas Piping Connections Tight & Leak-Tested □
Fuel Type: Natural? □ Propane? □
Furnace BTU Input _______

Regulator Pressure (3.5 Factory Setting, Nat. Only) _______
Air Shutters Properly Adjusted (Propene Only)? □
Flue Connections Tight? □ Proper Draft? □
Fan Control Setting (90° Factory Setting) _______
Limit Control Cutout _______ Temperature Rise _______
Filters Clean & Secure? □

Thermostat

I - START-UP AND OPERATION

CAUTION: Before proceeding with lighting instructions, make sure that the main gas valve and pilot valve at unit have been closed for at least five minutes and that room thermostat is at lowest setting.

A - To Light Unit
Refer to lighting instructions on A.G.A. rating plate.

B - Burner Operation
1 - After pilot is lighted, set thermostat at desired temperature.
2 - If during normal operation pilot goes out, relight according to instructions on A.G.A. rating plate.

II - FAILURE TO OPERATE
If unit fails to operate check the following:
1 - Is thermostat calling for heat?
2 - Is main disconnect switch closed?
3 - Is there a blown fuse?
4 - Is filter dirty or plugged? Dirty or plugged filters will cause unit to go off on limit control.
5 - Is gas turned on at meter?
6 - Is pilot lit?
7 - Is manual main shut-off valve open?

III - ADJUSTMENTS

A - Fan and Limit Control Settings
1 - Limit Control - Do not adjust from factory settings.
2 - Fan Control - Refer to Figure 1 to determine the type of control used on this unit and the correct setting.

B - Air Shutters (If Used)
The G11 is not factory equipped with air shutters. If air shutters are desired, the optional G11 Propane Changeover Kit must be ordered. Minor adjustments for flame lifting, burner noise, etc., may be necessary. Refer to Figure 2.

C - Proper Gas Flow
To check for proper gas flow to combustion chamber, determine btu input from the A.G.A. rating plate. Divide this input rating by the btu per cubic foot of available gas. Result is the number of cubic feet per hour required. Determine the flow of gas through gas meter for 2 minutes and multiply by 30 to get the actual flow of gas to burner for the hour.

D - Gas Pressure Setting
Adjust regulator pressure to 3 to 4 inches water for a natural gas or 10 3/4 inches water for a propane gas. Turn fuel gas pressure adjusting screw clockwise, then counterclockwise, to obtain proper pressure. Adjust belt tension so that belt is as loose as possible without allowing slippage. See Figure 3.

START-UP - OPERATION - ADJUSTMENTS - MAINTENANCE

FIGURE 1

FIGURE 2

C-3

ORIGINAL PAGE IS OF POOR QUALITY
F. Temperature Rise

Adjust blower speed for proper air temperature rise listed on A.G.A. rating plate. To measure this temperature rise, place plenum thermometers in warm air and return air plenums. See Figure 4. Locate thermometer in warm air plenum where thermometer will not “see” heat exchanger, thus picking up radiant heat. Turn up thermostat as high as possible to start unit. After plenum thermometers have reached their highest and steadiest readings, subtract the readings. The difference should be in the range listed on A.G.A. rating plate. If this temperature is low, decrease blower speed; if temperature is high, increase blower speed. Refer to the following for adjustment of belt or direct drive units:

1. Belt Drive (G11 units) - Loosen nut on the blower motor housing and push motor up to relieve belt tension. See Figure 5. Remove belt as shown in Figure 6. Then loosen motor pulley with Allen wrench as illustrated. Figure 7 and open adjustable pulley to decrease blower speed or close to increase speed. Refer to Figure 8.

CAUTION: Be sure that Allen screw is lined up with flat side of motor shaft before retightening. Adjust belt tension as outlined in “E. Belt Adjustment.”

IV. Annual Maintenance

At the beginning of each heating season, the system should be checked as follows:

A. Blower
   1. Check and clean blower wheel.
   2. Lubricate blower motor
      Always relubricate motor according to the manufacturer’s lubrication instructions on each motor. If no instructions are provided, use the following as a guide:
      a. Motors Without Oiling Ports - Prelubricated and sealed. No further lubrication required.
b - Belt Drive Motors With Oiling Ports - Add a few drops of SAE No. 10 non-detergent oil yearly. Refer to Figure 9.

c - Direct Drive Motors With Oiling Ports - Prelubricated for an extended period of operation. For extended bearing life, relubricate with a few drops of SAE No. 10 non-detergent oil once every two years. It may be necessary to remove blower assembly for access to oiling ports.

3 - Lubricate Blower Bearings (Belt Drive Models)
   a - Bearings With No Fittings - These bearings are prelubricated and sealed. No further lubrication required.
   b - Bearings With Grease Cups - Grease cups are packed with lubricant. Turn grease cups down about one turn yearly to relubricate bearings. Use only special lubricant for refilling grease cups, such as Gulf E or Lennox P-8-2638 (available through Lennox dealers).

4 - Belt Drive Blowers - Check belt for wear and proper tensions.

5 - If blower speed has been altered during the cooling season, the unit should be adjusted for the proper air temperature rise at the beginning of the heating season. Refer to "Temperature Rise" section in this manual.

B - Filter
   1 - Replace media in hammock type filter with 1 inch thick fiberglass of the same size. Refer to Figure 10.

C - Fan And Limit Control
   Check fan and limit controls for proper operation and settings. For settings, refer to the "Fan and Limit" section in this manual.

D - Burner
   1 - Check gas pressure (both inlet and manifold).
   2 - Inspect burners and clean, if necessary.
   3 - Check gas valve for proper operation.
   4 - Adjust pilot and main burner flame.

E - Electrical
   1 - Check all wiring for loose connections.
   2 - Check for correct voltage at unit (unit operating).
   3 - Check amp-draw on blower motor.
   Motor Nameplate _______ Actual _______

F - Flue And Chimney
   1 - Check flue pipe, chimney and all connections for tightness and to make sure there is no blockage.
   2 - Check unit for proper draft.

NOTE: See page III-8 for additional information.
I. OPERATION

A. Water Coil and Auxiliary Energy Subsystem
The CW3-45 coil can be used as either a heating or cooling coil depending on application. In a heating application, solar heated water in the coil serves as the first stage heat source. When the room thermostat demands heat, solar heated water is circulated through the CW3-45 and the blower circulates air. If solar water heat is sufficient the thermostat requirement will be met. If sufficient heat is not available from the coil the thermostat will activate the second stage heat source, the auxiliary gas heat, to meet the heating demand.

The CW3-45 coil is usable alternatively with a chiller system to provide space cooling. Chilled water circulated through the coil cools the system air being drawn through the coil by the blower.

B. High Limit Switch
A high limit switch, located on the downstream side of the coil provides overheating protection for the subsystem blower motor. If the temperature of air discharged form the coil reaches 140°F (60°C) the switch stops the water flow through the coil. No additional heat will be available from the coil and the blower motor will not be subjected to excessive air temperature.

C. Condensate Drain
The condensate run-off drain (3/4 npt) needs to be connected only if the CW3-45 is used for cooling purposes. A condensate line should be run from the stub at CW3-45 coil to an open drain. (Never connect the condensate drain line directly to a waste line.)

D. Drain Plugs
Two drain plugs are provided on the side of the CW3-45 coil for draining of the coil. One plug connects to the inlet water line and the other — the outlet water line.

II. ADJUSTMENTS

A. Air Flow Capacities
Refer to Tables 1 and 2 for flow capacities relating external static pressure and blower air volumes for specific applications.

B. Fluid Pressure Drop
Table 3 is four related tables which provide information to adjust actual pressure drops involved based on temperature and % glycol solution.

C. Heating and Cooling Capacity
Figure 1 provides performance standards which can be traced from supply fluid temperature to air volume to cooling capacity for cooling determination. Figure 2, for heating monitoring, shows resultant Btu heating capacity based on water flow rate, inlet water temperature, entering air temperature and blower air volume.
Table 1

BLOWER PERFORMANCE
G1204-110V FURNACE, CW3-45
COIL AND SLAB FILTER

<table>
<thead>
<tr>
<th>External Static Pressure (in. H2O)</th>
<th>Air Volume @ Various Speeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>0.00</td>
<td>1446</td>
</tr>
<tr>
<td>0.05</td>
<td>1424</td>
</tr>
<tr>
<td>0.10</td>
<td>1395</td>
</tr>
<tr>
<td>0.15</td>
<td>1367</td>
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<tr>
<td>0.20</td>
<td>1337</td>
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<tr>
<td>0.25</td>
<td>1307</td>
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<tr>
<td>0.30</td>
<td>1271</td>
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<tr>
<td>0.35</td>
<td>1201</td>
</tr>
<tr>
<td>0.50</td>
<td>1130</td>
</tr>
<tr>
<td>0.60</td>
<td>1055</td>
</tr>
</tbody>
</table>

Table 2

BLOWER PERFORMANCE
G1103-82V FURNACE, CW3-45
COIL AND SLAB FILTER

<table>
<thead>
<tr>
<th>External Static Pressure (in. H2O)</th>
<th>Air Volume (CFM) @ Various Speeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
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<tr>
<td>0.00</td>
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<tr>
<td>0.05</td>
<td>1270</td>
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<td>1240</td>
</tr>
<tr>
<td>0.15</td>
<td>1219</td>
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<tr>
<td>0.20</td>
<td>1189</td>
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<tr>
<td>0.25</td>
<td>1160</td>
</tr>
<tr>
<td>0.30</td>
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<td>1064</td>
</tr>
<tr>
<td>0.45</td>
<td>1031</td>
</tr>
<tr>
<td>0.50</td>
<td>998</td>
</tr>
<tr>
<td>0.55</td>
<td>965</td>
</tr>
<tr>
<td>0.60</td>
<td>932</td>
</tr>
<tr>
<td>0.65</td>
<td>900</td>
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<tr>
<td>0.70</td>
<td>868</td>
</tr>
<tr>
<td>0.80</td>
<td>826</td>
</tr>
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</table>

Table 3

Table A: Temperature Correction Factor to be Multiplied with Fluid Pressure Drop at 100°F (38.7°C)

<table>
<thead>
<tr>
<th>Fluid: Water</th>
<th>Temp.</th>
<th>Correction Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>1.08</td>
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<tr>
<td></td>
<td>200</td>
<td>1.15</td>
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Table B: Calculated Pressure Drop Across the Residential Solar Coil (20° x 18") (588 mm x 381 mm)

<table>
<thead>
<tr>
<th>GPM</th>
<th>L/SEC</th>
<th>Head Loss</th>
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<tbody>
<tr>
<td>5.0</td>
<td>316</td>
<td>2.41</td>
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<tr>
<td>7.5</td>
<td>473</td>
<td>2.50</td>
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<tr>
<td>10.0</td>
<td>631</td>
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<tr>
<td>15.0</td>
<td>940</td>
<td>3.07</td>
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Table C: Correction Factor to be Multiplied With the Water Pressure Drop at 100°F (38.7°C) to get Pressure Drop for Ethylene Glycol Solution (25% by Weight)

<table>
<thead>
<tr>
<th>°F</th>
<th>Correction Factor</th>
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</thead>
<tbody>
<tr>
<td>40</td>
<td>1.36</td>
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<tr>
<td>50</td>
<td>1.20</td>
</tr>
<tr>
<td>60</td>
<td>1.09</td>
</tr>
<tr>
<td>70</td>
<td>0.95</td>
</tr>
<tr>
<td>80</td>
<td>0.82</td>
</tr>
<tr>
<td>90</td>
<td>0.71</td>
</tr>
<tr>
<td>100</td>
<td>0.60</td>
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<tr>
<td>110</td>
<td>0.51</td>
</tr>
<tr>
<td>120</td>
<td>0.44</td>
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<tr>
<td>140</td>
<td>0.32</td>
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<tr>
<td>160</td>
<td>0.22</td>
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</tbody>
</table>

Table D: Collection Factors

<table>
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<tr>
<th>°F</th>
<th>Correction Factor</th>
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</thead>
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<tr>
<td>40</td>
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</tr>
<tr>
<td>50</td>
<td>1.00</td>
</tr>
<tr>
<td>60</td>
<td>0.95</td>
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<tr>
<td>70</td>
<td>0.90</td>
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<tr>
<td>80</td>
<td>0.85</td>
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<tr>
<td>110</td>
<td>0.70</td>
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<tr>
<td>120</td>
<td>0.65</td>
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<tr>
<td>140</td>
<td>0.55</td>
</tr>
<tr>
<td>160</td>
<td>0.50</td>
</tr>
</tbody>
</table>

III. MAINTENANCE

A. CW3-45 Unit

1. The CW3-45 slab filter, 18" x 25" x 1" (457 x 635 x 25 mm), is a disposable type which should be replaced semi-annually or more frequently if circumstances require. Remove screw from top of filter bracket and lift filter assembly from cabinet. New filter installs with fibrous side away from auxiliary furnace unit.

2. Inspect unit for evidence of coil leaks.

B. Auxiliary Energy Unit

Refer to the Operation and Maintenance book accompanying the auxiliary energy unit for its proper maintenance requirements.
Coil for residential units:
Outer diameter of tubes = 1/2" (12.7 mm)
Size of coil = 20" x 15" (503 mm x 381 mm)
Number of fins/inch = 13
Number of rows = 3
Face area = 2.083 ft² (1935 cm²)
Circulated fluid: 50% glycol

Chilled Water Capacity Correction Chart (To Be Multiplied with the Capacity of 50% Glycol Solution)

<table>
<thead>
<tr>
<th>% Glycol</th>
<th>Correction Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.190</td>
</tr>
<tr>
<td>10</td>
<td>1.179</td>
</tr>
<tr>
<td>20</td>
<td>1.155</td>
</tr>
<tr>
<td>30</td>
<td>1.107</td>
</tr>
<tr>
<td>40</td>
<td>1.060</td>
</tr>
<tr>
<td>50</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**Cooling Capacity Chart**
Solar Coil of Residential Unit
50% Glycol Solution Circulating Fluid

**FIGURE 1**
HEATING CAPACITY CHART
Solar Coil of Residential Units
Water Circulating Fluid

Hot Water With Glycol Solution Capacity
Correction Factor Chart
Multiply rating in hot water capacity chart by correction factor below:

<table>
<thead>
<tr>
<th>% Glycol</th>
<th>Correction Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>10</td>
<td>0.97</td>
</tr>
<tr>
<td>20</td>
<td>0.94</td>
</tr>
<tr>
<td>30</td>
<td>0.91</td>
</tr>
<tr>
<td>40</td>
<td>0.87</td>
</tr>
<tr>
<td>50</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Coil for residential units:
Outer diameter of tubes = $1/2"$ (12.7 mm)
Size of coil = $20" \times 15"$ (503 mm $\times$ 381 mm)
Number of fins/in = 13
Number of rows = 3
Face area = $2.033 \text{ ft}^2$ (193.5 cm$^2$)
Circulated fluid: water

FIGURE 2
APPENDIX D

INSTALLATION OF DOMESTIC HOT WATER SUBSYSTEM

40 Gal. Water Heater (page III-15)
SK142047 Preheat Coil
70A Tempering Valve (page III-15)
NOTES

1) The seller will inspect each coil to the requirements of this specification and for evidence of poor workmanship.

2) The heat coils shall be packaged in suitable protective containers that prevent damage to coil when shipped by United Parcel Service.

Approved Source

Vender/PN
Wolverine Tube Division
17200 Southfield Rd.
Allen Park, Michigan 48101

Truffin Type W/H
Catalog No. 66-116036-01
With type 1 ends
APPENDIX E

ENERGY TRANSPORT SUBSYSTEM

Energy Transport Module ETM-1
Specifications

Electrical:
- Power Supply: 115 VAC, 60 Hz, 3 phase
- Minimum supply circuit conductor: 35 amperes
- Maximum circuit overcurrent protection: 35 amperes

Pumps:
- 1750 rpm, centrifugal impeller, open drip-proof motor, built-in thermal overload protection.

Subsystem | Capacity (flow of head) | Full Load Current | Starting Current
--- | --- | --- | ---
Collector (Fy) | 1/4 Hp | 12 gpm @ 24 ft | 6.8 amp | 12 amp
Heating (Fy) | 1/4 Hp | 8 gpm @ 17 ft | 3.3 amp | 6 amp
Storage (Fy) | 1/4 Hp | 8 gpm @ 17 ft | 3.3 amp | 6 amp

NOTE: A 1/3 Hp fan, located outside of the cabinet in the Purge Unit, is controlled and powered by the ETM Control Panel.

Installation
- ETM may be fast-attached as indicated on shipping crate. Before moving unit when uncrated, the two small lower panels and pressure relief holding pan should be removed. Holding pan will slide from under the ETM after the pressure relief line is removed from pan. ETM can be carefully fast-attached after interference between FLR and cabinet undercoats is checked out. IMPORTANT: Removable panels and Control Panel will be damaged if uncrated unit is hand-trucked on its side or top.
- ETM size is 38" x 22" x 42" and weighs 550 lbs. (operating weight is 600 lbs). Position on level surface (adjustable legs provided) over storage and space heating subsystems. Consult manufacturer when ETM is to be located above the collector array or storage tank.
- Orient ETM with its back towards wall. Heat ventilation clearance is required around the unit, two feet minimum in front and at the sides. Adequate clearance for service access through front, top and side panels shall be provided. Panels are removed with a sharp or "red pull on the recessed tab.

Plumbing Connections
- Five 1 1/4" inch copper nipples are provided for system piping connections (see drawing). Do NOT APPLY HEAT to ETM piping nipples. Sweat solder tubing to the removable union pieces BEFORE connecting to ETM nipples.
- External plumbing shall conform to applicable codes. Isolation/Shutoff valves and air bleeds shall be installed, as necessary.

Electrical Connections
- ETM is internally pre-wired.
- External wiring must conform to National Electrical Code and local codes. Line voltage supply to ETM shall be from properly sized branch circuit and overcurrent protection device. Use wire suitable for at least 90°C (194°F). Wiring diagrams are shown on this drawing and on SK-142546, Rev. A (Control Subsystem).
- Three 1/2" inch flexible conduit are provided to the Control Panel terminals for 115 VAC electrical service and the line voltage control wiring. Low voltage sensor wires may be run from the upper right side of the Control Panel through the end hole provided in cabinet top. (Additional openings are provided for the SDAS with wiring diagrams shown on SK-142555, Rev. B.)
# ETM-1. Energy Transport Replacement Parts

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Manufacturer</th>
<th>Type/Part</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pump 1</td>
<td>Bell &amp; Gossett</td>
<td>60-11S, 1 1/4AA, 1/4hp</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Pump 2 &amp; 3</td>
<td>Bell &amp; Gossett</td>
<td>PR-1 1/4, 1/6 hp</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Heat Exchanger</td>
<td>Honeywell</td>
<td>SK-140184</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Expansion Tank</td>
<td>Amtrol</td>
<td>30, Diaphragm</td>
<td>1</td>
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<tr>
<td>5</td>
<td>Air Separator</td>
<td>Amtrol</td>
<td>444-1 1/4</td>
<td>1</td>
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<tr>
<td>6</td>
<td>Air Vent</td>
<td>Amtrol</td>
<td>690</td>
<td>1</td>
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<tr>
<td>7</td>
<td>Air Bleed</td>
<td>Hammond</td>
<td>1/8 Radiator</td>
<td>2</td>
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<tr>
<td>8</td>
<td>Relief Valve</td>
<td>Bell &amp; Gossett</td>
<td>480-45 psi</td>
<td>1</td>
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<tr>
<td>9</td>
<td>Control Valve, Dual Diverting</td>
<td>Honeywell</td>
<td>V4331-A1003, (115 VAC)</td>
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<tr>
<td>10</td>
<td>Circuit Setter Balancing Valve</td>
<td>Bell &amp; Gossett</td>
<td>CB-1 1/4</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>SDA Sensor Wells</td>
<td>Mueller</td>
<td>Bronze, 1 1/4</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>Lift Check Valve</td>
<td>Bell &amp; Gossett</td>
<td>BA-1 1/4</td>
<td>1</td>
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<td>Swing Check Valve</td>
<td>Stockholm</td>
<td>B-309-1 1/4</td>
<td>2</td>
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<tr>
<td>14</td>
<td>Drain/Fill Valve</td>
<td>Hammond</td>
<td>710-3/4</td>
<td>1</td>
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<tr>
<td>15</td>
<td>Ball Valve</td>
<td>Hammond</td>
<td>Sweat-1 1/4</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>Strainer</td>
<td>Strong</td>
<td>S-1 1/4</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>Low Level Indicator w/Lamp</td>
<td>F. W. Murphy</td>
<td>20-PC, 50 psi, 24 VAC.</td>
<td>1</td>
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<tr>
<td>18</td>
<td>Solar Control Panel</td>
<td>Honeywell</td>
<td>W968A</td>
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</table>

**NOTE:** See page IV-2, IV-3 and IV-4 for photograph on ETM system
This page has been removed because of copyright information. For information on the PD Boosters and Series "60" In-Line Centrifugal Pumps, contact Bell and Gossett, 8200 N. Austin Ave., Morton Grove, Ill. 60053.
**PART NO.**

---

**MATERIAL SCHEDULE**

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<th>ITEM</th>
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<th>TYPE</th>
<th>FABRICATION</th>
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<td>HONEYWELL INC.</td>
<td>SK-14278</td>
<td>1</td>
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<tr>
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<td>HONEYWELL INC.</td>
<td>SK-14278</td>
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**TOLERANCES UNLESS NOTED OTHERWISE**

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<tr>
<td>Y</td>
<td>+/- 5/32</td>
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---

**VENT**

**5/8" SPACE FOR FLOW**

**EXTENSION FINISH - DIRECT, PERM & 1 COAT SHOP ENAMEL**

**SHELL INLET**

**SHELL OUTLET**

**TUBE OUTLET**

**SWELL INLET**

**INNER CORE OR PLEX 1/4 OD.**

**COILS PLACED INSIDE EACH OTHER**

**COILS SHOULD BE SEPARATED BY APPROX. 1/8 TO ALLOW FREE FLOW.**

**COILS PLACED INSIDE EACH OTHER**

**COILS SHOULD NOT TOUCH EACH OTHER, SPACERS ARE ACCEPTABLE IF REQ'D.**

---

**HONEYWELL INC.**

**ENERGY RESOURCES CENTER**

**MINNEAPOLIS, MN 55413**

**HEAT EXCHANGER FOR SOLAR HEATING SYSTEM**

---

**CONTRACT NO.**

**SIZE CODE IDENT NO. DRAWING NO.**

**B 55513 SK-140184**

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**SHEET 1 OF 3**

---

**CONTROL**

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---
**Selection Data**

### EX-TROL TANKS

<table>
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<th>Model No.</th>
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### EX-TROL COMBINATION PACKAGES

- INCLUDES: EX-TROL, Purger, Vent
- Shipping Wt. Lbs.

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<th>Model No.</th>
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<th>Vent</th>
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<td>3000</td>
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<td>or</td>
<td>#700</td>
</tr>
<tr>
<td>6000</td>
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<td>1¼&quot;</td>
<td>#700</td>
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</tbody>
</table>

*Specify type and size required*

### FILL-TROL COMBINATION PACKAGE

- INCLUDES: FILL-TROL, Purger, Vent
- Shipping Wt. Lbs.

<table>
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<th>Model No.</th>
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*Specify type and size required*

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**Dimensional Data**

- **EX-TROL TANKS**
- **EX-TROL WITH FILL-TROL**
- **FILL-TROL COMBINATION PACKAGE**

**Distributed by**

AMTROL INC.

1000 DIVISION ROAD - WEST WARWICK, R.I. 02891

E-G
The EX-TROL Tank is a modern, pressurized diaphragm-type expansion tank for all hot water heating systems.

It is of welded steel construction; compact and neat in appearance. A rugged, flexible diaphragm of a material specially compounded for long life in hydronic service is the heart of the EX-TROL tank.

This diaphragm separates system water from the (standard 12-lb.) air charge, assuring a permanent air cushion. Because the diaphragm permits the tank to be pressurized, the EX-TROL tank can be smaller than conventional units.

The EX-TROL Tank may be installed into a tee or any other suitable tapping anywhere on a hot water heating system.

It may also be remotely located and piped to convenient point on the system.

An "ideal" EX-TROL installation is to screw it into the bottom of an American Air Purger. A single ½" nipple serves as both pipe connection and mounting.

The EX-TROL Tank controls expansion of heating system water. See Figure 3

A. When the system is first filled to the setting of the automatic fill valve, no water enters the EX-TROL Tank because of the charge pressure behind the diaphragm.

B. When the system comes up to temperature, the EX-TROL tank receives the expanded volume of water.

C. When the boiler water temperature rises to its maximum, the EX-TROL diaphragm simply flexes against the air cushion.

The American Air Purger continuously separates air from heating system water.

It is a one-piece cast iron chamber with two passages through which boiler water flows. Internal contours and baffles are designed for low flow resistance characteristics and efficient separation of the air from the water.

The Air Purger should be installed horizontally on the main as close to the boiler as possible. It must be installed so that water flows through it in the direction indicated by the arrow.

All models have tappings for installation of #700 Float Vents to provide complete continuous purging and venting. Spare tappings are also provided for easy mounting of an EX-TROL for expansion control or FILL-TROL for combining automatic fill valve and expansion control.

EX-TROL system venting

After initial purging and venting of air from the system more air will be released from the water as it is heated. The American #700 Float Vent is an advanced type valve designed for venting all hydronic heating and cooling systems. It has a unique construction which insures: Fastest Venting — Positive shut off — Venting through the complete pressure range (0-48) — Long continuous operation — Trouble free performance — No splintering or unsightly stains from leaking. No separate air chamber is required.

Even with Air Purger and Float Vent installed on the main or mains, it is recommended the American #700 Float Vent to be installed on each return at the elbow that drops to the circulator.

While seldom required, it is also recommended that manual (key or coin type) air vents be installed at high points on the radiation.
This page has been removed because of copyright information. For information on the Installation Instructions Ex-Trol Expansion Tanks contact Amtrol, 1400 Division Road, West Warwick, R. I. 02893.
This page has been removed because of copyright information. For information on the Relief Valves-ASME Valves and Fittings contact Bell and Gossett, 8200 N. Austin Ave., Morton Grove Ill. 60053.
THE Y534A DUAL DIVERTING VALVE ASSEMBLY CONSISTS OF TWO VALVE BODIES WHICH ARE SWEATED TOGETHER AND TWO POWERHEADS WHICH CONTROL EACH VALVE BODY SEPARATELY. WHEN ASSEMBLED, THE Y534A OFFERS FLOW CHARACTERISTICS WHICH ARE COMPATIBLE WITH SOLAR ENERGY SYSTEMS.

☐ Available for line or low voltage applications (specify when ordering).

☐ Assembly provides a flow capacity of 14 Cv (12 kv).

☐ Sweat copper end connections may be installed without disassembling the valve.

☐ Manual opener for valve operation on power failure. Valve returns to automatic position when power is restored.

☐ Complete powerhead may be removed without breaking the line connections.

☐ Motor actuator may be replaced without removing the valve body or draining the system.

R.L.
9-77 (.05)
SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

MODEL:

Y534A-2-position dual diverting valve. The two powerheads must be assembled to the two valve bodies which are shipped welded together.

Available for line or low voltage applications.

TEMPERATURE AND FLOW RATINGS:

Capacity Rating—14 CV (12 kV).

Maximum Closeoff Pressure—10 psi [69 kPa].

Static Pressure Rating—125 psi [862 kPa].

Maximum Fluid Temperature—

- Line voltage model—200°F [93°C].
- Low voltage model—240°F [115°C].

Maximum Ambient Temperature—125°F (52°C).

ELECTRICAL RATINGS:

Line voltage models—

- 0.16 amps at 120V ac, 60 Hz.
- 0.03 amps at 220/240V ac, 50 Hz.

Low voltage model—

- 0.64 amps at 24V ac, 50/60 Hz.

WIRING PROVISIONS: 18 in. (457.2 mm) leadwires and 1/2 in. conduit openings.


DE-ENERGIZED POSITION: Port A normally closed.

TIMING: Diverts flow in 30 seconds.

MANUAL OPENER: Allows valve to be opened in case of power failure. Valve returns to automatic position when power is restored.

DIMENSIONS: See Fig. 1.

UNDERWRITERS LABORATORIES INC. LISTING APPLIED FOR.

REPLACEMENT PARTS:

- O- ring Part No. 802344.
- Powerhead—
  - Line voltage model—Part No. 130441ARG.
  - Low voltage model—Part No. 130441ARA.

DETERMINATION OF WATER FLOW CHARACTERISTICS: The pressure drop in psi [kPa], equivalent feet [metres] of pipe, or feet of water [kPa] may be determined by calculating the flow rate, referring to Fig. 2, and using the following procedures.

Pressure drop in psi [kPa]—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line upward from the flow rate until it intersects the curve on the graph.
3. Draw a line from the intersection to the left-hand edge of the graph and read the pressure drop in psi [kPa].

Pressure drop in equivalent feet [metres] of pipe—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line vertically to the top of the graph. Read the pressure drop in equivalent feet [metres] of pipe on the 3/4 in. pipe scale.

Pressure drop in feet of water [kPa]—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line upward from the flow rate until it intersects the curve on the graph.
3. Draw a line from the intersection to the right-hand edge of the graph and read the pressure drop in feet of water [kPa].

When purchasing replacement and modernization products from your tradeline wholesaler or your distributor, refer to the tradeline catalog or price sheets for complete ordering number, or specify—

1. Order number (specify line voltage or low voltage model).
2. Replacement part, if required.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell residential division sales office (check white pages of phone directory).

2. Residential division customer service
   Honeywell Inc., 1885 Douglas Drive North
   Minneapolis, Minnesota 55422 (612) 642-7600

   (In Canada—Honeywell Controls Limited, 740 Ellesmere Road, Scarborough, Ontario M1P 2V9)

   International sales and service offices in all principal cities of the world.

E-11

continued on page 3
FIG. 1—Y534A DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

FIG. 2—FLOW CHARACTERISTICS OF Y534A DUAL DIVERTING VALVES.
INSTALLATION

1. Installer must be a trained, experienced service technician.
2. Disconnect power supply before connecting wiring to prevent electrical shock and equipment damage.
3. Always conduct a thorough checkout when installation is complete.

ASSEMBLY

Each powerhead controls each valve body separately. To assemble a powerhead to a valve body, place an O-ring in the circular slot on the top of the valve body (Fig. 3). Assemble the powerhead to the valve body by placing the manual opening lever on the powerhead in the MAN. OPEN position.

Align the powerhead by fitting the hex head screw on the bottom of the powerhead into the hole on the top of the valve body. The guide pins and the positioning pin in the powerhead should fit the holes in the valve body. Tighten securely and repeat this procedure for the other powerhead and valve body.

MOUNTING

FIG. 3—POWERHEAD MUST BE ALIGNED SO THAT THE GUIDE PINS AND THE POSITIONING PIN IN THE POWERHEAD FIT THE HOLES IN THE VALVE BODY.

FIG. 4—MOUNTING POSITIONS.
The valve may be mounted in any position on a vertical line. If valve is mounted horizontally, the powerhead must be even with or above the center line of the pipe. Make sure that enough room is provided above the powerhead to remove the cover for servicing. See Fig. 4.

The 3 fittings or ports of the dual diverting valves are labeled on the bottom of the valve body castings. Port A is connected to the purge coil piping and is closed when the valve is de-energized. Port B is connected to the system bypass and is open when the valve is de-energized. Port AB is the inlet and is open at all times. See Fig. 4.

**SWEAT COPPER MODELS**

1. Use new, properly reamed pipe, free from dents or corrosion.
2. Place valve onto the pipe. Set the manual opener lever to MAN. OPEN before applying heat. This will protect the plug inside the valve by removing it from the heat.
3. Sweat joints keeping the outer surface free from solder. DO NOT use silver solder because of the high melting temperatures required.

**TO INSTALL REPLACEMENT POWERHEAD**

**IMPORTANT**

Installation of new powerhead does not require the removal of the valve body from the pipe line. It is, however, necessary to drain the water from the system before beginning the installation.

1. Disconnect the valve from the electrical power source and remove the conduit connections if fitted.
2. Place the manual opening lever on the old powerhead in the MAN. OPEN position.
3. With the cover off, remove the 4 screws securing the powerhead to the valve body. Remove the old O-ring from the valve body.
4. Place the new O-ring in the circular slot on the top of the valve body.
5. Install the new powerhead—
   - Place the manual opening lever on the new powerhead in the MAN. OPEN position.
   - Align the powerhead by fitting the hex head screw on bottom of powerhead into the hole on top of valve body (see Fig. 3).
6. Reconnect electrical connections.

Inspect the powerhead installation and the valve body to insure that all connections and adjustments have been correctly made. Adjust the thermostat or controller connected to the valve so the valve runs through its cycle. Make sure the valve runs smoothly and positively from closed to open to closed again.

**WIRING**

All wiring must agree with local codes and ordinances. See Fig. 5 for a typical wiring hookup.

**FIG. 5—TYPICAL WIRING FOR Y534 DUAL DIVERTING VALVES.**

**OPERATION**

**AUTOMATIC OPERATION**

When the valve is energized, port B, the bypass, closes and port A opens. Port A closes by integral spring return when the valve is de-energized.
MANUAL OPERATION

The motorized dual diverting valves (two with each assembly) can be opened manually by lifting the manual opener lever over the stop and pushing slowly and firmly to the MAN. OPEN position. The stop permits the valve to be locked in the open position. The valve will return to automatic position when the valve is energized.

CHECKOUT

1. Lower the set point of the high limit controller below the temperature of the collector fluid.
2. Observe that port A of the valve should be open and port B of the valve should be closed.
3. Raise the set point of the high limit controller above the collector fluid temperature.
4. Observe that port A of the valve should close and port B of the valve should be open.

SERVICE

This valve should be serviced by a trained, experienced service technician.

1. If the valve is leaking, check to see if the O-rings need to be replaced.
2. If the gear train is damaged or the motor is burned out, it is necessary to replace the entire powerhead assembly. See INSTALLATION.

NOTE: Honeywell zone valves are designed and tested for silent operation in properly designed and installed systems. However, water noises may occur as a result of excessive water velocity or piping noises may occur in high temperature (over 212°F [100°C]) systems with insufficient water pressure.
This page has been removed because of copyright information. For information on the Flo-Control Valves contact Bell and Gossett, 8200 N. Austin Ave, Morton Grove, Ill. 60053.

Additional pages have been removed because of copyright information. For information on the Circuit Setter Balance Valves contact Bell and Gossett, 8200 N. Austin Ave., Morton Grove, Ill. 60053.
SCREWED CAP

SEE PAGE 36 FOR PRESSURE-TEMPERATURE RATING.

SERVICE FEATURES

Recommended for prevention of backflow in general services. * Solder ends recommended for non-flammable liquids or gases with Types K, L, and M copper tubing.

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<td>4</td>
<td>HINGE PIN</td>
<td>BRASS</td>
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<td>SIDE PLUG</td>
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*Not Shown

†B-309, SOLDER ENDS

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*Saturated Steam Pressure for Solder End Valves Should Not Exceed 15 PSI.

*B-319, THREADED

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†Piping Make-Up Dimension

76  K-17
Semi-Steel Y-Type Strainers

High Tensile Semi-Steel Body ASTM A126 Class B.

**Sizes**: 1/4" thru 3"

**Operating Pressures and Temperatures**:

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<th>Connections &amp; Sizes</th>
<th>Screen Openings</th>
<th>Screen Material</th>
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<td>Liquid</td>
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<td>Stainless Steel</td>
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<tr>
<td>Steam</td>
<td>Screwed 1/4&quot; thru 2&quot;</td>
<td>20 mesh</td>
<td>Stainless Steel</td>
</tr>
</tbody>
</table>

**Standard Screens**:

- Liquid 20 mesh (Stainless Steel)
- Steam 20 mesh (Stainless Steel)

**Blow-Off Outlets**:

NPT tapped in sizes specified on dimension table. Not normally furnished plugged.

**Construction**:

Constructed of high tensile ASTM A126 Class B semi-steel with blow-off connections and easily removable cylindrical screens. A tapered seat allows the screen to be self-aligning and assures a perfect fit. 2 1/2" and 3" sizes have a flanged blow-off cover. Strainer with gasketed blow off plug and straight thread available in 1/4" thru 2" size. 188 stainless steel screens.

**Military Specifications**:

Model with gasketed blow off plug conforms to MIL-S-16293E, Type 1, Style Y, Class 250 when equipped with a brass plug in the blow off connection. State service when ordering.

**Packaging**:

Screwed strainers in sizes thru 2" can be packaged in multiple unit cartons for certain industries. Write for specific information.

**Dimensions**:

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</table>
Pressure Monitoring 
SWICHGAGES®

These rugged, pressure monitoring SWICHGAGES® are designed for any critical pressure control function.

Recommended specifically for safety shutdown on oil field, irrigation and industrial engines or as alarm systems on construction equipment, trucks and marine engines.

Offers constant visual indication.

These instruments offer a constant visual indication of the condition of your lubrication system, or any other vital pressures on your equipment. Their precision construction meets the specifications of those applications which require a higher degree of accuracy and dependability than is available in most standard 2" diameter instruments.

A SWICHGAGE® performs the job of two ordinary instruments (a gauge and a switch), thus this instrument greatly reduces necessary inventory and installation time.

In addition, each instrument is available with a lockout feature to hold the indicating pointer away from the shut-down contact for start-up. When the oil pressure reaches the normal operating level, the lockout is automatically disengaged.

Durability

The entire working mechanism of the SWICHGAGE® is assembled completely independent from the case and therefore is not affected by case damage or abuse in normal operation. Also, all moving parts are machined to close tolerance and many parts are interlocking to retard damage from vibration or shock. The unique design of the diaphragm and bearing plate prevent normal overpressures from harming the accuracy of the instrument.

Model 20-P-7

This model features a "tamperproof" front adjustable contact which can be set with an Allen-Head wrench (also available with standard screwdriver adjustment — specify), and a pushbutton for lockout.

Model 20-P-27

A side mounted micrometer — adjustment type contact screw and convenient side lockout are features of this model. It also has a stand-off ring which holds the instrument away from the panel to give access to the contact adjustment and lockout pushbutton.

Warranty

Like all Murphy instruments, Pressure SWICHGAGES® carry a full one year warranty against defective materials and workmanship. Consult the Murphy Service department for product repairs.

CONTACT RATINGS: 2 amp. @ 30 v.a.c. 2 amp. @ 30 v.d.c.

SHIPPING WEIGHTS: 20-P-7 7.8 Oz. — 20-P-27 13 Oz.

COMPATIBILITY: These simple one-wire to ground SWICHGAGES® are compatible with all Murphymatic Controls and can be used with any Murphy "Nerve Center:"

- To interrupt ignition circuit — Section 25
- To start and start stop engines — Section 40
- To start and stop elec. tric. motors — Section 45
- For fuel shut-off — Section 55
SPECIFICATIONS

A. PORT: Machined from brass bar stock. It is accurately threaded for connection to the pressure line. Together with the diaphragm, it forms the pressure chamber.

B. PULSATION DAMPENER: A restricting orifice designed to minimize hydraulic shock within the pressure transmitting fluid, preventing undesirable pointer chatter. It is accessible for cleaning, or removal.

C. DIAPHRAGM: Beryllium copper, procured to very close physical and metallurgical specs. The material is die formed and close control heat treated to insure consistent reliability. Each pressure range is designed to operate well below its maximum capability in order to maintain long life and consistent reliability.

D. MOUNTING PLATE: Machined from brass bar stock. The mounting plate performs threefold function. First, together with the port, clamps back diaphragm in position. Second, it provides a strong back stop for the diaphragm, thereby preventing damage should the gauge experience high over pressure. Lastly, it also provides a stable platform upon which to mount the pointer post and the mechanism which amplifies the diaphragm movement into pointer travel.

E. RECAL SCREW: Provides a measure of adjustment to compensate for wear or disturbances that may result if gauge is operated in unusually severe environment.

F. BRIDGE PLATE: Tempered nickel silver provides corrosion resistance and dimensional stability.

G. SPRING ANCHOR & POINTER ZERO STOP: Stainless Steel.

H. POINTER: Tempered nickel silver for strength and corrosion resistance. It is mounted on a machined brass post. The return spring is helically wound of spring temper stainless steel.

J. CRANK ARM: K-Monel. Senses and amplifies diaphragm movement and transmits it to the pointer.

K. BEARING PLATE: Beryllium copper. Provides fulcrum for crank arm. It is free to lift off the bridge plate should the pointer be restrained by stationary contacts, etc. It returns to original position when strain is relieved.

L. JOINT AND SEAL: The carefully designed peripheral edges of the diaphragm and port, and the radiused channel in the mounting plate provide consistently accurate parts alignment. The annular solder channel provides optimum conditions for producing a combination structural joint, and seal, with maximum integrity.

---

DESCRIPTION MODEL NO. RANGES

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>MODEL NO.</th>
<th>RANGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; Dia. Pressure Switchgage</td>
<td>20-P</td>
<td>0-30, 0-75, 0-100 p.s.i</td>
</tr>
<tr>
<td>0-150, 0-200, 0-300 p.s.i</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front Contact — No Lockout</td>
<td>20-P-7</td>
<td>All Ranges</td>
</tr>
<tr>
<td>20-P w/Front Lockout</td>
<td>20-P-75</td>
<td>All Ranges</td>
</tr>
<tr>
<td>0-30, 0-75, 0-100 p.s.i</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slide Contact — No Lockout</td>
<td>20-P-75</td>
<td>All Ranges</td>
</tr>
<tr>
<td>0-200, 0-300 p.s.i</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-P-75 w/side Lockout</td>
<td>20-P-27</td>
<td>All Ranges</td>
</tr>
<tr>
<td>2&quot; Dia Vacuum Switchgage</td>
<td>20-V-3</td>
<td>0-20 inches Vacuum</td>
</tr>
<tr>
<td>Hi-Lo Contacts — No Lockout</td>
<td>20-V-3</td>
<td>0-30 inches Vacuum</td>
</tr>
</tbody>
</table>

OPTIONAL EXTRAS

- Additional Contact (except 20-V) add-HL All Ranges
- (C) Contacts — 2 wire ungrounded (Not available with Lockout) add-C All Ranges
- Circuit (rated 1 amp at 125V A.C.) add-C All Ranges
- Illumination slots (Front contact only) add-I All Ranges

Also available in explosion proof case — see bulletin No EX-5838 Available on front contact models only

murphy

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P.O. BOX 45248 • TULSA, OKLAHOMA • 74145 • 918 (627-3550)
RATING - 1 AMP 120VAC - 2 AMP 30V AC/DC
WIRE - (1) RED, (1) WHITE, 12 X 18 GA
CONTACT SETTING - SEE ABOVE
TYPE ADJUSTMENT - NYLON KNOB
DIAL - WHITE ON BLACK
CLAMP - LCYG P/N 05 05-789
MOUNTING HOLE - 2-1/16 DIA.
MAX PANEL THICKNESS - 1/4" 
PORT - BRASS 1/8-27 NPT
MAX PRESSURE - (0 = 300PSI)(A = 500PSI)
PULSATION DAMPER - BUILT IN (REMOVABLE)
BEZEL - STAINLESS STEEL
CASE - STEEL, CAD & IFRITE
CRYSTAL - LEXAN
STUDS - 10-24 NC

RANGES AVAILABLE

<table>
<thead>
<tr>
<th>PSI</th>
<th>CONTACT SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>3 PSI</td>
</tr>
<tr>
<td>0-30</td>
<td>7</td>
</tr>
<tr>
<td>0-50</td>
<td>10</td>
</tr>
<tr>
<td>0-75</td>
<td>15</td>
</tr>
<tr>
<td>0-100</td>
<td>20</td>
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<tr>
<td>0-150</td>
<td>30</td>
</tr>
<tr>
<td>0-200</td>
<td>50</td>
</tr>
<tr>
<td>0-300</td>
<td>75</td>
</tr>
</tbody>
</table>

*STANDARD

CALIBRATION CONFORMS TO USAS CLASS B - FIRST & LAST 1/3 OF SCALE
±3%, MIDDLE OF SCALE ±2%

NOTE: NO CUSTOMER REPLACABLE PARTS
Honeywell

W968A SOLAR CONTROL PANEL CONTAINS A DIFFERENTIAL TEMPERATURE CONTROLLER, TRANSFORMER, AND SWITCHING RELAYS WHICH CONTROL EITHER A 3-PUMP, 2-VALVE OR A 2-PUMP, 4-VALVE SOLAR HYDRONIC HEATING SYSTEM.

- Manual AUTO-STOP-ON switches aid in installation and provide emergency control of the heating system.
- Available with lights that indicate the operating mode of the system when manual switches are in the AUTO position.
- Plug-in type switching relays are easily replaceable.
- Ample terminal connections make wiring hookup convenient.
- Collector set point potentiometer adjustable from 75 to 125°F [24 to 52°C].
- Complies with the requirements of the HUD Interim Performance Criteria for Solar Heating.
SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

MODEL: W968A Solar Control Panel contains a differential temperature controller, transformer, switching relays, manual switches and field wiring terminals for use in controlling either a 3-pump, 2-valve or a 2-pump, 4-valve solar hydronic system.

ELECTRICAL RATINGS:
- Input and Output Voltage and Frequency: 120V ac, 60 Hz.
- Load Relay Contacts:
  - 1 N.O. Pole: 12 AFL/60 ALR at 120V ac.
  - 1 N.C. Pole: 125 VA at 120V ac.

DIFFERENTIAL TEMPERATURE CONTROLLER:
- Adjustable ON and OFF differentials from minus 10 to plus 40 F (minus 5.6 to plus 22.2 C). Factory set for 18 F (10 C) temperature difference ON and 3 F (1.7 C) temperature difference OFF. Plug-in resistors vary settings.

COLLECTOR SET POINT POTentiOMETER RANGE:
- 75 to 125 F [24 to 52 C]. Indicates minimum temperature at which energy is used from the collector.

SHIPPING TEMPERATURE RANGE:
- Minus 30 to plus 150 F [minus 34 to plus 56 C].

AMBIENT TEMPERATURE RANGE:
- Plus 30 to plus 115 F [plus 1 to plus 46 C].

MOUNTING:
- 4 holes in back of case.

WIRING CONNECTIONS:
- Pressure-type terminals.

DIMENSIONS:
- See Fig. 1.

ADDITIONAL EQUIPMENT REQUIRED:
- L6051B Solar Aquastat Controller. High limit controller that prevents excessive temperatures in the collector system is combined with tankstat which controls first stage heating from storage.
- Y534A Dual Diverting Valve. Provides flow characteristics which are compatible with solar energy systems.
  - C773A is a single sensor for storage tank or solar collector mounting.
  - C773B contains a double sensor for storage tank or solar collector mounting.
  - C773C contains a single sensor with a flattened end and mounting hole for solar collectors.
  - C773D is a double sensor with flattened end and mounting hole for collector installation.
- Immersion Well. For mounting C773 Electronic Temperature Sensor in storage tank. See Fig. 2 and Table 1.
- T872 Thermostat. Provides low voltage control of multi-stage heating and cooling systems.
- Q572 Subbase. Required for operation of T872 Thermostat.

(continued on page 3)

ORDER INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. Order number.
2. Additional equipment required and optional specifications.
3. Replacement parts, if needed (see back cover).

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).
2. RESIDENTIAL DIVISION CUSTOMER SERVICE
   HONEYWELL INC., 1886 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422 (612) 642-7600
   (IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

E-23
FIG. 1—W966A CASE DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

TABLE 1—IMMERSION WELL TABLE

<table>
<thead>
<tr>
<th>IMMERSION LENGTH</th>
<th>INSULATION LENGTH</th>
<th>SELECT WELL MATERIAL AND ORDER NUMBER BELOW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>COPPER</td>
</tr>
<tr>
<td>in.</td>
<td>mm</td>
<td>in.</td>
</tr>
<tr>
<td>3-3/8</td>
<td>85.7</td>
<td>1-1/2</td>
</tr>
<tr>
<td>3-3/8</td>
<td>85.7</td>
<td>1-1/2</td>
</tr>
<tr>
<td>3-3/8</td>
<td>85.7</td>
<td>3</td>
</tr>
<tr>
<td>3-3/8</td>
<td>85.7</td>
<td>4</td>
</tr>
<tr>
<td>6-3/8</td>
<td>136.5</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>152.4</td>
<td>1-1/4</td>
</tr>
</tbody>
</table>

^aHas plastic sleeve on insertion well.
MOUNTING CONTROL CABINET

The panel should be mounted on a convenient wall. Make certain that the desired location does not exceed the ambient temperature rating of 30 to 115°F [minus 1 to plus 46°C].

Remove the two chassis screws which are located on each side of the cabinet. Allow the chassis to rest at the bottom of the cabinet.

Fasten the cabinet to the wall using the two mounting holes at the top of the cabinet and two mounting screws (not provided). Replace the chassis and chassis screws.

Secure the cabinet to the wall using the two mounting holes at the bottom of the cabinet and two mounting screws (not provided).

MOUNTING ELECTRONIC TEMPERATURE SENSORS

Follow the system manufacturer’s recommendations for the best location of the sensor. Each sensor should be located so it experiences the most useful temperature for proper system operation.

Use C773A,B as a storage tank sensor using an immersion well as follows:

1. Drain system fluid to a point below the sensor fitting.
2. Screw the well into the threaded fitting. Use an approved pipe dope or Teflon tape to seal the threads.
3. Install system and check for leaks.
4. Insert the sensor probe into the immersion well until it bottoms. See Fig. 2.
5. Attach retainers clamp over groove on well spud. Fit wire in clamp groove and lightly tighten screw. Do not over-tighten. If a remote sensor wiring compartment is used, secure the sensor with the spring clip instead of the retaining clamp.

Install C775A,B as a collector sensor using the mounting clip provided and No. 8 screw. Mount C775C,D as a collector sensor using the flatened end with mounting hole and a No. 8 or 10 screw. On unglazed collectors mount the sensor with leadwires down to keep sensor from accumulating water.

Temperatures in excess of 450°F [232°C] will damage the sensor. Shield the sensor against possible overtemperature conditions prior to system operation. Do not mount collector sensor to collector fluid channels.

WIRING

All wiring must comply with applicable codes and ordinances. The panel has four 1/2 inch conduit knockouts and two 3/4 inch conduit knockouts on the bottom of the case. It has one 7/8 inch [22.2 mm] opening for conduit on the right side of the case.

Pressure terminal connections are used for the wiring hookup. Refer to Fig. 2 for a wiring diagram.

If the amount of electronic temperature sensor cable used exceeds 100 feet [30.5 m], use No. 14 wire and grounded metallic conduit or shielded cable. Connect the shield to ground at the panel. Grounded metallic conduit and shielded cable (such as Belden 8752 or equivalent) minimize possible radio frequency signal interference. Wire additions to the leadwires must be capable of withstanding maximum collector stagnation temperatures if installed within the collector.

OPTIONAL SPECIFICATIONS

111692F Remote Sensor Wiring Compartment. For wiring C773 Electronic Temperature Sensor to storage tank.
Caution
See SK142054 sheet 3 for changes to control wiring.

FIG. 3—WIRING THE W968A SOLAR CONTROL PANEL.
ADJUSTMENTS

AUTO-STOP ON SWITCHES

For normal operation, the panel switches should remain in the AUTO position. The ON and STOP positions of these switches are useful during installation and calibration of the heating system. They may also be used for manually operating the system if the differential temperature controller fails.

COLLECTOR SET POINT POTTIOMETER

The collector set point potentiometer establishes the minimum fluid temperature which the heating system will accept from the collector for direct heating of the house. Set the collector set point potentiometer to the desired setting, 90°F [32°C] is the recommended setting. This set point may be readjusted in accordance with individual preferences. Lower settings will generally result in the solar system carrying a higher percentage of the total heating load.

DIFFERENTIAL TEMPERATURE SELECTION

The control settings may be adjusted by changing the ON and OFF plug-in resistors and sensor connections (Fig. 4). The standard R7412 is factory-set for pull-in at 18°F [10°C] temperature difference with a 4750 ohm ON resistor. Dropout is set for 3°F [1.7°C] temperature difference with a 9760 ohm OFF resistor.

To change the setting refer to Table 3 to select the resistors needed. See Fig. 5 to prepare resistor for installation. Remove the old ON resistor and plug in the replacement. Repeat for the OFF resistor. Be sure the correct resistor is inserted in the proper position. Use 1/8 watt, 1 percent resistors, available locally.

CHECKOUT

One by one, set the AUTO-STOP-ON switches in the ON position to check that the valves and pumps have been wired correctly and that they are operating properly.

<table>
<thead>
<tr>
<th>OPERATING MODE</th>
<th>SYSTEM RESPONSE (E = ENERGIZED, DE = DE-ENERGIZED)</th>
<th>W968A PANEL LIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector Heat Heating House</td>
<td>E</td>
<td>Collector Heat Heating House</td>
</tr>
<tr>
<td>Collector Heat Heating House and Auxiliary Heat Heating House</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Heat Heating House</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Heat Heating House and Auxiliary Heat Heating House</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary Heat Heating House</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector Heat to Storage Tank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

May be used for valve 3 and 4.

TABLE 2 - W968A WIRING CHECKOUT
Next, set all W968A AUTO-STOP-ON switches in the AUTO position. The indicator lights function correctly only if the panel switches are in the AUTO position. Check differential temperature controller operation as follows:

1. Disconnect wire to high temperature terminal C (see Fig. 3). Relay should pull in.

2. Reconnect sensor wire to high temperature terminal C and disconnect wire to low temperature terminal A. Relay should drop out. Reconnect sensor wire.

Check out the wiring of the W968A to a 3-pump, 2-valve solar heating system according to the procedures in Table 2.

**TABLE 3—DIFFERENTIAL TEMPERATURE CONTROL**

<table>
<thead>
<tr>
<th>FOR TEMP. DIFFERENCE OF:</th>
<th>USE RESISTANCES BELOW FOR BOTH ON AND OFF RESISTORS (IN OHMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>C</td>
</tr>
</tbody>
</table>

*Do not exceed 25 F [14 C] for OFF setting.*

To trace the relay operation of the W968A, refer to the internal wiring of the panel given in Fig. 3. The following information describes how the W968A operates within a 3-pump, 2-valve solar heating system (Fig. 6). Fig. 7 depicts a 2-pump, 4-valve solar heating system.

**COLLECTOR HEAT TO STORAGE TANK**

Collector heat begins to be transferred to the storage tank whenever the collector plate temperature is 18 F warmer than the storage tank temperature and there is no call for heat from the space thermostat. Pumps 1 and 2 conduct heated water to the storage tank through valve 2. Pumps 1 and 2 are controlled by the differential temperature controller within the W968A and they will run as long as the collector temperature is at least 3 F [1.7 C] hotter than the storage tank temperature.

**COLLECTOR HEAT HEATING THE HOUSE**

On a call for heat from the space thermostat, 2 control relays direct valve 2 to allow flow of heated water to the solar coil.

If the collector plate temperature is greater than 90 F [32 C] (adjustable), then pump 1 will operate through the appropriate relays (Fig. 3). Pump 2 operates only when pump 1 is operating and they are both controlled by the differential temperature controller.

When the call for heat is satisfied, valve 2 diverts flow to the storage tank.

**STORAGE HEAT HEATING HOUSE**

Heating from storage is accomplished on a call for heat when sufficient energy is not present on the collector plate, but energy is available from storage.
On a call for heat, pump 3 brings heat from storage if the storage temperature at the top of the tank is greater than 90°F (32°C) (adjustable). Pumps 2 and 3 cannot operate at the same time.

**AUXILIARY HEAT HEATING HOUSE**

On a call for heat, if none is available from the collector panels or the storage tank, relay contacts energize the gas furnace.

Also, if the "collector heat heating the house" or the "storage heat heating the house" cannot satisfy a call for heat from the thermostat, relay contacts will start the gas furnace. Collector or storage heating may continue during auxiliary heating.

If heat is available from the collectors or storage tank, auxiliary heating operates when the thermostat senses a space temperature 2°F (1.1°C) below the set point.

---

**TRoubleshooting**

When the W968A Solar Control Panel does not appear to be operating properly, the following steps may be taken to troubleshoot system problems:

1. Determine the temperatures at the differential temperature controller and solar aquastat controller sensors. For the differential temperature controller, use a high resistance ohmmeter to measure the resistance across terminals E-F (storage sensor) and F-G (solar panel sensor) located in the W968A panel (Fig. 3). Refer to Fig. 6 to convert the resistance measurement to a temperature reading.

   Determine the temperature which the solar aquastat is experiencing by adjusting the set points with a screwdriver and listening for the relays to operate. Aquastat may not cause a relay to operate when the relay in the aquastat changes state. Observe temperature scale for temperature reading.

2. Read the OPERATION section to determine which mode(s) the heating system should be operating in based on the sensor temperatures and the space temperature.

3. Check the location of the sensors for the differential temperature controller and solar aquastat controller. Make certain that each sensor is located so as to measure the most appropriate temperature for proper system operation. If the sensors are not providing correct temperature readings, change the location and mount properly.

4. Check that the solar aquastat is operating properly by adjusting the control points of the tankstat and high limit controller and listening for the relays to operate. Reset to the proper temperature.

5. Check that the differential temperature controller relay is operating properly by disconnecting the wire to high temperature terminal C (Fig. 3). Relay should pull in. Reconnect sensor wire to high temperature terminal C and disconnect wire to low temperature terminal A. Relay should drop out. Reconnect sensor wire to low temperature terminal A.

6. Check that the four W968A switching relays are operating properly by plugging in a new R8222 dpdt relay in place of the low voltage relays in the panel and a new R4222 dpdt relay in place of the line voltage relay in the panel. If the substituted relay causes the system to change modes, the original panel relay is faulty. Do not install a low voltage relay in a line voltage receptacle.

7. Check system operation on a mode by mode basis using the procedures of Table 2.
FIG. 8—CONVERTING SENSOR RESISTANCE INTO DEGREES F (C).

REPLACEMENT PARTS LIST

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DESCRIPTION</th>
<th>ORDER NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Differential Temp. Controller</td>
<td>R7412A1012</td>
</tr>
<tr>
<td>2</td>
<td>Switching Relay (2)</td>
<td>R8222H1007</td>
</tr>
<tr>
<td>3</td>
<td>Switching Relay (1)</td>
<td>R8222S1000</td>
</tr>
<tr>
<td>4</td>
<td>Switching Relay (1)</td>
<td>R422V1044</td>
</tr>
<tr>
<td>5</td>
<td>Transformer</td>
<td>AT40A1121</td>
</tr>
<tr>
<td>6</td>
<td>Manual AUTO-STOP-ON Switch</td>
<td>113700</td>
</tr>
<tr>
<td>7</td>
<td>Indicator Lamp (2)</td>
<td>192061</td>
</tr>
<tr>
<td>8</td>
<td>Indicator Lamp (2)</td>
<td>118543A</td>
</tr>
</tbody>
</table>
APPENDIX F

CONTROL SUBSYSTEM

Parts List

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
<th>Honeywell Model No.</th>
<th>Component Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tst</td>
<td>1</td>
<td>Solar Control Panel*</td>
<td>W968A1009</td>
<td>Appendix E</td>
</tr>
<tr>
<td>Tcd</td>
<td>1</td>
<td>Aquastat Controller</td>
<td>L6008C1065</td>
<td>Appendix F</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Aquastat Controller</td>
<td>L4008B1013</td>
<td>Appendix F</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Multistage Thermostat</td>
<td>T872C1004</td>
<td>Appendix F</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Thermostat Subbase</td>
<td>Q672B1004</td>
<td>Appendix F</td>
</tr>
<tr>
<td>V1</td>
<td>1</td>
<td>Motorized Valve</td>
<td>V4331A1003</td>
<td>Appendix A &amp; E</td>
</tr>
<tr>
<td>V2</td>
<td>1</td>
<td>Motorized Valve*</td>
<td>V4331A1003</td>
<td>Appendix A &amp; E</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Immersion Well</td>
<td>122555B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Case Assembly</td>
<td>112892F</td>
<td></td>
</tr>
<tr>
<td>Tp &amp; Tsb</td>
<td>2</td>
<td>Sensor</td>
<td>C773B1005</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Collector Sensor Shield</td>
<td>SK-142067</td>
<td></td>
</tr>
</tbody>
</table>

SK142054 (sheet 3) - Control System Wiring Diagram

*For reference only, premounted on transport module SK142053.
SOLAR HEATING SYSTEM - SINGLE FAMILY RESIDENCE
CONTROL SUBSYSTEM

1.0 GENERAL CONDITIONS

1.1 Scope: The Control Subsystem will include all controls necessary for operation of the solar heating system.

1.2 Required Work: The Mechanical Contractor will install and wire all controls as shown on control subsystem wiring schematic. This will include all line voltage wiring required.

1.3 Procurement of Control Devices: Control devices listed in Material List, (i.e., Solar Control Panel, Aquastat, Thermostat, etc.) will be provided by Honeywell ERC. This will include all control devices only, all materials necessary for a complete installation will be provided by the Mechanical Contractor.

2.0 BASIC MATERIALS AND METHODS

2.1 Basic Materials:

2.1.1 Control sensor wiring (T) and (Tgph): Wiring from solar control panel to control sensors (Tgph) and (T) shall be run in conduit to outdoor areas and shall be Belden #8712 or equal.

2.1.2 Power and control wiring: All line and low voltage wiring shall be of material required by applicable codes, and supplied by Mechanical Contractor.

2.1.3 Other Materials: All other materials required for complete installation of the Control Subsystem shall be supplied by the Mechanical Contractor.

2.3 Basic Methods:

2.3.1 Control device installation methods: As per applicable details and/or instructions included with equipment.

2.3.2 Electrical wiring: As per all applicable codes.

[Diagram of solar heating system control subsystem]
THESE THERMOSTATS AND SUBBASES PROVIDE LOW VOLTAGE CONTROL OF MULTISTAGE HEATING AND COOLING SYSTEMS INCLUDING HEAT PUMP SYSTEMS.

- T872 Thermostat requires a Q672 Subbase.
- Q672 Subbase provides system and fan switching, wiring terminals, and mounting base for T872 Thermostat.
- T872 Thermostat has silent dust-free mercury switches operated by coiled bimetal elements.
- Q672 Subbase mounts on wall or horizontal outlet box.
- Adapter plate available for mounting Q672 Subbase on vertical outlet box.
- Heat anticipator(s) are adjustable or fixed; cooling anticipator(s) are fixed.
- External levers and scale for temperature setting located on top of thermostat case.
- Cover thermometer on most T872 Thermostat models.
- Locking cover and locking lever screws available for T872 Thermostats.
- Plastic thermostat guards available for T872 Thermostats.
- Key lock cover with tumbler lock available for T872 Thermostats.
SPECIFICATIONS

SUPER TRADELINE / TRADELINE MODELS

Super Tradeline controls offer features not available on Tradeline or standard models, and are designed to replace a wide range of Honeywell and competitive controls.

Tradeline models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value. Specifications of Super Tradeline and Tradeline controls are the same as those of standard models except as noted below.

SUPER TRADELINE MODELS

T872 THERMOSTAT

T872D1300 Thermostat. Provides 2 stages of heating and 2 stages of cooling.

SUPER TRADELINE FEATURES:

- Includes 130821 Adapter Plate Assembly for mounting T872-Q672 on a vertical outlet box.
- Super Tradeline package with cross reference label and special instruction sheet.

TRADELINE MODELS

T872 THERMOSTAT

T872 Thermostat Tradeline models provide 1 or 2-stage heat and/or cool operation as shown in the chart below.

<table>
<thead>
<tr>
<th>T872</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEATING STAGES</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>COOLING STAGES</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Q672 SUBBASE

Q672 switching subbases provide system and fan switching as listed.

TRADELINE FEATURE:

- Tradeline package with cross reference label and special instruction sheet.

TRADELINE FEATURES:

- Tradeline package with cross reference label and special instruction sheet.
- T872A model with adjustable temperature locking stops.
- All Tradeline T872 models are supplied with locking lever and locking cover accessories.
- All Tradeline thermostat models are compatible with all Tradeline switching subbase models.

<table>
<thead>
<tr>
<th>Q672</th>
<th>SYSTEM</th>
<th>FAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Heat-Auto-Cool</td>
<td>Auto-On</td>
</tr>
<tr>
<td>B</td>
<td>Heat-Off-Cool</td>
<td>Auto-On</td>
</tr>
<tr>
<td>E</td>
<td>Off Heat-Auto-Cool</td>
<td>Auto-On</td>
</tr>
</tbody>
</table>

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. Order number:
   - T872 Thermostat, Tradeline, or Super Tradeline, if desired.
   - Q672 Subbase, Tradeline, if desired.

2. Optional T872 specifications, as required.

3. Optional Q672 specifications, if desired.

4. Accessories, as required.

5. Optional temperature scale range, if desired.

YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).

2. RESIDENTIAL DIVISION CUSTOMER SERVICE
   HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422  (612) 542-7500

(IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)

INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

(continued on page 3)
STANDARD MODELS

T872 THERMOSTATS

MODELS: See Table 1.

ELECTRICAL RATING: 24 to 30V ac.

SWITCHING: Coiled bimetal elements operate mercury switches.

TEMPERATURE ADJUSTMENT: Heating and cooling setting levers, with common scale located on top of thermostat base. Common lever for heating and cooling on T872R, 1 cooling lever on T872E, and 1 heating lever on T872F.

TEMPERATURE SCALE RANGE: 44 to 86 F [7 to 30 C], standard; optional ranges available.

THERMOMETER RANGE: 52 to 98 F (11 to 36 C).

CHANGEOVER DIFFERENTIAL: 3 F [2 C] minimum between heating and cooling. Levers may be set apart for greater separation.

INTERSTAGE DIFFERENTIAL:
Standard Models—mechanical differential is 1 F [0.6 C] between heating or cooling stages; operating differential is approximately 1.9 F [1 C] between stages in heating or cooling.

Special Models—have other differential requirements.

FINISH: Silver bronze.

MOUNTING MEANS: T872 Thermostat mounts on Q672 Subbase. Subbase mounts horizontally on wall or outlet box. Mounts on vertical outlet box with optional 130821A Adapter Plate Assembly.

ACCESSORIES:

1. Locking cover and locking lever assembly—Part No. 133627AA with thermometer, 133627AC without thermometer. Includes cover, two screws and Allen wrench for locking cover, plus two No. 4 X 1/4 inch (6.4 millimetre) panhead screws to lock set point levers.

2. Universal thermostat guard
   - Part No. 133722A, clear plastic cover and beige plastic mounting base.
   - Part No. 133722D, clear plastic cover and clear plastic “ring type” mounting base. Thermostat need not be removed from wall to install guard.
   - Part No. 133723A, beige plastic cover and beige plastic mounting base.
   - Part No. 133723B, beige plastic cover and clear plastic “ring type” mounting base.

3. Key lock cover with tumbler lock—mounts on T872 base and covers thermostat set levers and subbase switches. Two keys included. Should not be used with 130821A or B adapter plate.
   - 190103C blank face, internal thermometer.
   - 190903D external thermometer.

FIG. 1—DIMENSIONS OF T872 THERMOSTAT MOUNTED ON Q672 SUBBASE.

OPTIONAL SPECIFICATIONS (T872 only):


3. Celsius scale; 6 to 29 C (43 to 85 F).


5. Locking cover and locking lever (see Accessories).

6. Thermostat cover less thermometer.

7. Adjustable locking temperature stops.

8. Voltage heat anticipation—first or second stage heat or both (Table 1).

9. Fast cycling on heating stage(s) for electric heat applications.

FIG. 2—T872 THERMOSTAT ACCESSORIES.
<table>
<thead>
<tr>
<th>MODELS AND OPTIONS</th>
<th>REPLACES</th>
<th>APPLICATION</th>
<th>SYSTEM STAGES</th>
<th>HTG (ADJ)</th>
<th>COOLING (FIXED)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>STAGE 1</td>
<td>STAGE 2</td>
<td>STAGE 1</td>
</tr>
<tr>
<td>T872A — Standard and Tradeline</td>
<td>STD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— 75 F scaleplate stop w/locking cover</td>
<td>STD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— Adj anticipator set .4 amp</td>
<td>STD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— Adjustable locking temperature stops (T/L)</td>
<td>STD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— 75 F scaleplate stop w/locking cover, no thermometer (for DODI).</td>
<td>STD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>T872B — Standard and Tradeline</td>
<td>STD</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— Adj anticipator set .4 amp</td>
<td>STD</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>T872C — Standard and Tradeline</td>
<td>STD</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— 75 F scaleplate stop w/locking cover</td>
<td>STD</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— Fast cycling</td>
<td>ELE. HEAT</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>0.12-0.6A</td>
</tr>
<tr>
<td>— 75 F scaleplate stop w/locking cover, no thermometer (for DODI).</td>
<td>STD</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— 12 F differential between HT and H2 stages (T872C368)</td>
<td>STD</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>T872D — Standard and Tradeline</td>
<td>STD</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— Adjustable locking temperature stops (T/L)</td>
<td>STD</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>T872E — Standard and Tradeline</td>
<td>T870E</td>
<td>2 Stage Cool</td>
<td>2</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— Locking cover</td>
<td>T870F</td>
<td>2 Stage Heat</td>
<td>2</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>— Fast cycling</td>
<td>T870C</td>
<td>2</td>
<td>-</td>
<td>0.12-0.6A</td>
<td>0.12-0.6A</td>
</tr>
<tr>
<td>T872F — Heat pump, cool changeover, with fast cycling</td>
<td>T870G</td>
<td>Ht Pump</td>
<td>2</td>
<td>1</td>
<td>1A</td>
</tr>
<tr>
<td>T872H — Use with T872C</td>
<td>New</td>
<td>Ht Pump</td>
<td>1</td>
<td>1</td>
<td>1A</td>
</tr>
<tr>
<td>T872M — Motel heating-cooling application (requires manual changeover remote switching)</td>
<td>T870M</td>
<td>Remote Panel Switching</td>
<td>1</td>
<td>1</td>
<td>1C</td>
</tr>
<tr>
<td>T872N — Heat pump, heat changeover</td>
<td>New</td>
<td>Ht Pump</td>
<td>2</td>
<td>1</td>
<td>1C</td>
</tr>
<tr>
<td>T872Q — Night setback heating</td>
<td>T870Q</td>
<td>STD</td>
<td>1</td>
<td>-</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>T872F — Standard</td>
<td>T870F</td>
<td>Ht Pump</td>
<td>2</td>
<td>1</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>T872S — Heat pump, heat changeover</td>
<td>New</td>
<td>Ht Pump</td>
<td>2</td>
<td>1</td>
<td>0.1-1.2A</td>
</tr>
<tr>
<td>T872T — Representative model</td>
<td>New</td>
<td>STD—Vent Stage</td>
<td>1</td>
<td>2</td>
<td>1D</td>
</tr>
</tbody>
</table>

0 Changeover stage operates with heating.
1 Fixed voltage type anticipation.
2 Nonadjustable heating changeover stage set at 16 °C (60 °F).
3 Manual changeover stage—use Q8728, L subbase.
4 Provides night setback used with standard T872 and timer operated remote switching.
5 Ventilating stage (See Fig. 31.)
6 Second stage. Also available with fast cycle anticipation (0.12 0.6A) with voltage heater, or without anticipation.
7 Changeover stage operates with heating.
8 Department of Defense.
MODELS: See table in form 70-6208.
ELECTRICAL RATING:
Switch contacts - 2.5 amp at 30V ac (7.5 amp inrush).
Malfunction light (optional) - 24 to 30V ac.
SWITCHES: Two snap-acting switches (one switch, Q672G and K, no switches on Q672D), operated by
levers. Switch position is shown on scaleplate.
MOUNTING: Designed to mount horizontally on an
outlet box or wall. Adapter plate assembly available
for mounting on a vertical outlet box (see Accessories).
FINISH: Silver bronze.
DIMENSIONS in inches [millimetres]: 3-9/16 [90]
high; 5-5/8 [142] wide; 5/16 [8] deep (Fig. 1).
OPTIONAL SPECIFICATIONS (Q672 only):
1. Malfunction indicator light with replaceable bulb
available on all models. Indicator can show FILTER,
CHECK, EM. HT. (emergency heat), or LK. OUT
(lockout). Specify indication when ordering.
2. External jumper between RC-RH for common
heating-cooling transformer. Jumper is field removable.
3. System switching marked HEAT-OFF/RESET
COOL for systems requiring impedance relay reset.
Available on Q672B only.
4. "G" terminal related on heating to provide fan
relay operation from external low voltage fan switch
(Q672B only).
5. Auto fan operation on both heat and cool (Q672B
only).
7. External O and B terminal jumper (Q672C only).
8. Jumper between W2-X2 terminals (Q672F only).
9. Jumper between E-X2 terminals (Q672F only).
10. Changeover in cool or heat made for heat pumps.
11. Auto fan in EM. HT. for heat pumps.
ACCESSORIES:
1. Adapter plate assembly, Part No. 130821A, for
mounting on vertical outlet box. Assembly includes
adapter ring and cover plate.
2. Adapter plate assembly, Part No. 130821B, for
covering old thermostat marks on wall. Cover plate only.
3. Indicator replacement bulb, Part No. 129571.
4. Field addable indicator light assembly, Part No.
135734A. Assembly includes retainer plate, 2 self-
tapping screws, light bulb with 2-3/4 inch [70 milli-
metres] leadwires with spade terminals and lenses. The
Q672 lenses indicate FILTER, CHECK or EM. HT.

LOCATION
Locate the thermostat about 5 feet [1.5 metre] above
the floor in an area with good air circulation at average
temperature.
Do not mount the thermostat where it may be
affected by:
- drafts, or dead spots behind doors and in corners.
- hot or cold air from ducts.
- radiant heat from the sun or appliances.
- concealed pipes and chimneys.
- unheated (uncooled) areas behind the thermostat.

SUBBASE MOUNTING
The subbase is designed for mounting on a wall or
horizontal outlet box. (Adapter assembly, Part No.
130821B, with cover plate only is available for covering
wall marks from old thermostat.) An adapter assembly,
Part No. 130821A, with adapter ring and cover plate is
available for mounting on a vertical outlet box. To
mount subbase, proceed as follows:
1. At the location selected, prepare an opening for
the thermostat wires.
2. Run low voltage thermostat wires to the location,
and pull about 4 inches [100 millimetres] through
the wall opening.
NOTE: Use color-coded thermostat cable for proper
wiring.
3. If mounting the subbase on a vertical outlet box
(Fig. 3), install the adapter ring with the 2 screws
provided.
WIRING

All wiring must comply with local electrical codes and ordinances.
A letter code is near each terminal for easy identification. Typical terminal designation and wiring connections are listed in Tables 2 and 3.

---

4. Pull thermostat cable through cover plate (if used) and subbase opening. Secure the cover plate and subbase with the 2 screws provided, but do not tighten.

Thermostats are calibrated at the factory using subbases mounted at true level. Inaccurate subbase leveling will cause thermostat control deviation.

5. The subbase mounting slots provide for minor out of level adjustments. Level the subbase using a spirit level, as shown in Fig. 4 and tighten subbase mounting screws.

---

**FIG. 3—INSTALLATION OF Q672 SUBBASE ON OUTLET BOX.**

---

**FIG. 4—LEVELING THE SUBBASE.**

---

**TABLE 2—TYPICAL DESIGNATIONS**

<table>
<thead>
<tr>
<th>TERMINAL</th>
<th>TYPICAL CONNECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Heating damper motor, changeover valve (if used).</td>
</tr>
<tr>
<td>E</td>
<td>Emergency heat relay.</td>
</tr>
<tr>
<td>G</td>
<td>Fan relay coil.</td>
</tr>
<tr>
<td>O</td>
<td>Contactor damper motor changeover valve (if used).</td>
</tr>
<tr>
<td>R</td>
<td>Power connection to transformer fan externally connected for cooling and heating.</td>
</tr>
<tr>
<td>R(c)</td>
<td>Power connection to cooling transformer.</td>
</tr>
<tr>
<td>R(h)</td>
<td>Power connection to heating transformer.</td>
</tr>
<tr>
<td>W(h)</td>
<td>Stage 1 heating control.</td>
</tr>
<tr>
<td>W(c)</td>
<td>Stage 2 cooling control.</td>
</tr>
<tr>
<td>V(h)</td>
<td>Stage 1 cooling control.</td>
</tr>
<tr>
<td>V(c)</td>
<td>Stage 2 cooling control.</td>
</tr>
<tr>
<td>X X1 X2 C</td>
<td>Stopped filter switch.</td>
</tr>
</tbody>
</table>

---

**TABLE 3—ALTERNATE CONTROL CIRCUIT TERMINAL DESIGNATIONS**

<table>
<thead>
<tr>
<th>ALTERNATE DESIGNATIONS</th>
<th>STANDARD DESIGNATION</th>
<th>TYPICAL CONNECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>V</td>
<td>24 volt power supply.</td>
</tr>
<tr>
<td>H1</td>
<td>V</td>
<td>Stage 1 heating.</td>
</tr>
<tr>
<td>H2</td>
<td>Y</td>
<td>Stage 2 heating.</td>
</tr>
<tr>
<td>C1</td>
<td>M</td>
<td>First stage relay.</td>
</tr>
<tr>
<td>C2</td>
<td>Y</td>
<td>Second stage relay.</td>
</tr>
<tr>
<td>E</td>
<td>G</td>
<td>Fan.</td>
</tr>
<tr>
<td>F</td>
<td>B</td>
<td>Heating champion.</td>
</tr>
<tr>
<td>R</td>
<td>O</td>
<td>Cooling champion.</td>
</tr>
</tbody>
</table>

---

The shape of the terminal barrier permits insertion of straight or conventional wrap-around (Fig. 5) wiring connections. Either method is acceptable. When making connections, strip wires to the length specified in Fig. 5.

Follow the equipment manufacturer’s wiring instructions, if available, when wiring the subbase. If not available, Figs. 15 and up show typical TH72 Q672 system hookups.

---

**FIG. 5—BARRIER CONFIGURATION.**
Run wires as close to the subbase as possible. To prevent interference with the thermostat linkage, keep wire length to a minimum, and make certain wires do NOT protrude outward beyond standoffs, (Fig. 6). Push excess wire back into the hole, and plug hole to prevent drafts from affecting thermostat operation.

HEAT ANTICIPATOR SETTING

Set the heat anticipator scale to match the primary control rating. When using a T872 Thermostat with 2 stages of heating, set both heat anticipators to match their respective primary control rating. If the primary control nameplate has no rating or if further adjustment is necessary, use the following procedure to determine the current draw of each stage.

The current draw of each heating stage must be measured with the thermostat removed.

1. Connect an ac ammeter of appropriate range between the heating terminals of the subbase—
   Stage 1—between W1 and RH or R;
   Stage 2—between W2 and RH or R.
2. Move the system switch to HEAT or AUTO.
3. After 1 minute, read the ammeter and record the reading,
   Stage 1—amp;
   Stage 2—amp.
4. After mounting the thermostat (see Thermostat Mounting, next paragraph), set the adjustable heat anticipator to match the respective reading measured in step 3.

If equipment cycles too fast, set the anticipator to a higher current rating, not more than 1/2 division at a time, and recheck cycle rate. Most conventional 2-stage heating equipment is designed to operate at 3 cycles per hour, and 1-stage heating equipment at 6 cycles per hour, at 50 percent load conditions. When using a T872 Thermostat in heat pump systems, set the heat anticipator at 140% of the actual primary control current draw to reduce the cycling rate.

Most heat pump systems should cycle 2-1/2 to 3 times per hour.

THERMOSTAT MOUNTING

1. Remove the thermostat from the polystyrene shipping container.
2. Remove the thermostat cover by pulling the bottom edge of the cover upward until it snaps free of the locking springs.
   NOTE: The cover is hinged at the top and must be removed by pulling up at the bottom.
3. Carefully remove and discard the polystyrene packing insert which protects the mercury switches during shipment.
4. Turn the thermostat base over and note the spring fingers which engage the subbase contacts. Make sure the spring fingers are NOT bent preventing proper electrical contact with the subbase.

If equipment cycles too fast, set the anticipator to a higher current rating, not more than 1/2 division at a time, and recheck cycle rate. Most conventional 2-stage heating equipment is designed to operate at 3 cycles per hour, and 1-stage heating equipment at 6 cycles per hour, at 50 percent load conditions. When using a T872 Thermostat in heat pump systems, set the heat anticipator at 140% of the actual primary control current draw to reduce the cycling rate.

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   NOTE: The cover is hinged at the top and must be removed by pulling up at the bottom.
3. Carefully remove and discard the polystyrene packing insert which protects the mercury switches during shipment.
4. Turn the thermostat base over and note the spring fingers which engage the subbase contacts. Make sure the spring fingers are NOT bent preventing proper electrical contact with the subbase.

If equipment cycles too fast, set the anticipator to a higher current rating, not more than 1/2 division at a time, and recheck cycle rate. Most conventional 2-stage heating equipment is designed to operate at 3 cycles per hour, and 1-stage heating equipment at 6 cycles per hour, at 50 percent load conditions. When using a T872 Thermostat in heat pump systems, set the heat anticipator at 140% of the actual primary control current draw to reduce the cycling rate.

Most heat pump systems should cycle 2-1/2 to 3 times per hour.

THERMOSTAT MOUNTING

1. Remove the thermostat from the polystyrene shipping container.
2. Remove the thermostat cover by pulling the bottom edge of the cover upward until it snaps free of the locking springs.
   NOTE: The cover is hinged at the top and must be removed by pulling up at the bottom.
3. Carefully remove and discard the polystyrene packing insert which protects the mercury switches during shipment.
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Most heat pump systems should cycle 2-1/2 to 3 times per hour.
6. If the thermostat provides the optional locking lever assembly, install the 2 self-tapping screws (Fig. 8) in the lever arms, if desired.

7. If the thermostat provides optional locking cover assembly, start the 2 Allen locking screws in the cover with the wrench provided (Fig. 9).

8. Note the tabs along the top inside edge of the thermostat base. The tabs fit the subbase sockets. Hang the thermostat on the subbase and tighten the captive mounting screws (Figs. 3-4) on the thermostat base. Do NOT overtighten thermostat captive mounting screws. This may damage the threads in the subbase.

9. Hang the upper edge of the thermostat cover on the base and swing cover downward until it engages with spring clips on base. Tighten the locking cover screws, if assembly is provided.

FIG. 9—INSTALLATION LOCKING COVER SCREWS ASSEMBLY.

SETTING AND CHECKOUT

CAUTION
On systems using a gas valve, never apply a jumper across the valve coil terminals, even temporarily. This may burn out thermostat heat anticipator(s).

SETTING TEMPERATURE SETTING
Move the H (heating) and C (cooling) levers (see Fig. 10) to the desired positions. On models with 2 stages of heating or cooling, the same lever controls both stages. The minimum differential between heating and cooling set points is 3 °F [2 °C] at midscale.

If model has optional screws to lock temperature control levers, loosen these screws before making temperature adjustment; tighten when levers are set at desired position.

SUBBASE SETTING
SYSTEM SWITCHING positions control thermostat operation as follows (see listing of models for positions applicable to model being installed):
OFF—both the heating and cooling systems are off.
If the fan switch is at AUTO position, the cooling fan is also off.
HEAT—heating system is controlled by the thermostat. Cooling system is off.
AUTO—completely automatic -heating or cooling controlled by the thermostat.
COOL—thermostat controls the cooling system. Heating system is off.
EM. HT.—emergency heat relay is energized. Cooling system is off.
FAN SWITCHING positions control fan operation as follows:
ON—fan operates continuously.
AUTO—fan operates with cooling equipment as controlled by the thermostat or with the heating equipment as controlled by the plenum switch.

CHECKOUT
HEATING
Move the system switch on the Q672 Subbase to HEAT or AUTO. Move the H lever on the T872 (Fig. 10) about 10 °F [6 °C] above room temperature. Both stages of heating system should start and the fan should run after a short delay. Move the H lever about 10 °F [6 °C] below room temperature. The heating equipment should shut off, and the fan should run for a short time, then shut off.

FIG. 10—INTERNAL VIEW OF T872D (WITH 2 STAGES OF HEATING AND COOLING).

COOLING
Move the system switch on the Q672 Subbase to COOL or AUTO. Move the C setting lever on the T872 Thermostat (Fig. 10) about 10 °F [6 °C] below room temperature. The cooling equipment and fan should start. If the system has 2 stages of cooling, both stages should start. Move the C lever about 10 °F [6 °C] above room temperature. The cooling equipment and fan should stop.

FAN
Move the system switch to COOL, OFF, or AUTO. If necessary, position both temperature setting levers near midscale so that the heating and cooling equipment are off. Move the fan switch to ON. The fan should run continuously. When the fan switch is in the AUTO position, fan operation is controlled by the heating or cooling system.

F-9
SERVICE

CAUTION

Before servicing, disconnect power supply to prevent electrical shock or equipment damage.

THERMOSTAT

T872 Thermostats are accurately calibrated at the factory; THEY DO NOT HAVE PROVISION FOR FIELD CALIBRATION.

THERMOMETER

To calibrate the thermometer:
1. Remove thermostat cover by pulling up from the bottom until it clears the locking springs. If cover has optional locking screws, these must be backed out before cover can be removed.
2. Set the cover on a table near an accurate thermometer.
3. After allowing 5 or 10 minutes for stabilization, compare the readings. If they are the same, replace cover and put system into operation. If they are different, recalibrate the thermostat thermometer, step 4.
4. Insert a small screwdriver in the thermometer shaft (Fig. 11) and turn it until the thermometers read the same. When thermometer is calibrated, replace cover and place system and fan switches for desired operation.
NOTE: Hand heat will offset the thermometer reading. After making each adjustment, wait 5 or 10 minutes for the thermometer to stabilize before comparing.

FIG. 11—THERMOMETER CALIBRATION.

BULB REPLACEMENT

Before replacing bulb, shut off the power supply to prevent shorting out the transformer at the bulb terminals, or move subbase system switch to “OFF.”

Replace bulb in subbases with optional malfunction light as follows:
1. Remove the thermostat from the subbase.
2. Remove the snap-on shield that covers the light.
3. Disconnect the field wire from the “X” terminal to prevent shorting out the transformer at the bulb terminals.
4. Snap out the old bulb and replace it with a new bulb, Part No. 129571. The bulb contact should seat in the depression in the socket base. The bulb may be screwed in farther, if necessary, for a better electrical connection. When installing bulb, use needlenose pliers.
5. Reconnect the field wire to terminal “X.”
6. Replace the shield and mount the thermostat.

INDICATOR LIGHT ASSEMBLY

INSTALLATION

The 135734A Indicator Light Assembly may be added to most Q672 Subbases. The assembly mounts directly on the subbase and may be installed before or after the subbase is mounted. To install the indicator light assembly, use the following procedure.

FIG. 12—INSTALLATION OF INDICATOR LIGHT ASSEMBLY.

1. If the thermostat is mounted on the Q672 Subbase, remove the thermostat cover. NOTE: If the cover has optional locking screws, these must be backed out before cover can be removed.
2. Loosen 2 captive screws and remove thermostat.
3. Select either FILTER, CHECK, or EM. HT. lens.
4. Place the lens over the recess cavity on the subbase, and place the black retainer plate over the lens.
5. Start 1 self-tapping screw through the left-hand hole of the retainer plate and lens.
6. Pivot lens and plate out of way as shown in Fig. 12. Insert bulb into recessed cavity, and route wires toward left-hand side of subbase.
7. Pivot lens and retainer plate into position, and start second self-tapping screw in right-hand retainer hole.
To wire indicator light assembly, use the following procedure:

1. Route 1 indicator light leadwire to the R or RH subbase terminal, and fasten beneath the terminal screw (Fig. 13).
2. Route second indicator light leadwire to right retainer screw.

3. Route wire from indicator light control switch to right retainer screw. Attach both indicator switch wire and indicator light leadwire to right retainer screw.
4. Connect remaining indicator light control switch wire to common secondary leg of heating transformer (Fig. 14).

![FIG. 13-CONNECTING 135734A LEADWIRES.]

Remount the thermostat, and restore the power supply. To check indicator light operation, jumper the indicator light control. The indicator lamp should light. After removing the jumper, the lamp should go out.

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**THERMOSTAT-SUBBASE APPLICATION**

The schematics on the following pages are divided into four groups:


Within groups, schematics are generally arranged alphabetically by subbase model, then thermostat model. For additional information on Q672 Subbas/T872 Thermostat combinations, see form 70.6208.

Circuit descriptions and terminology is defined as follows.

For standard heating-cooling circuits:
- **AUTO CHANGEOVER**—refers to the presence of an AUTO position in the system switching (EXAMPLE: Q672E with OFF-HEAT-AUTO-COOL switching); does not require switch movement to change mode.
- **MANUAL CHANGEOVER**—requires a system switch movement to change mode. (EXAMPLE: Q672B with HEAT-OFF-COOL switching).

T872D thermostats with 2 heat and 2 cool switches are shown on most standard circuits. Most standard or Tradeline subbases (Q672 A-E, G) can be used with T872A-F standard Tradeline thermostats. The schematics can be field-modified as required.

For heat pump circuits:

- **CHANGEOVER VALVE**—operates on Cooling. The reversing valve or relay is activated either by moving the system switch to COOL (manual changeover) or by a mercury switch which makes on a temperature rise (auto changeover).
- **CHANGEOVER VALVE**—operates on heating. The reversing valve or relay is activated either by moving the system switch to HEAT (manual changeover) or by a mercury switch which makes on a temperature fall (auto changeover).

For all circuit components:

Each mercury switch is identified by function, as follows:
- H1—Stage 1 heating
- H2—Stage 2 heating
- C1—Stage 1 cooling
- C2—Stage 2 cooling
- C/O—Changeover (heat pumps)

Each anticipator is identified as adjustable or fixed, as well as naming which switch it affects. FOR EXAMPLE: H1 adjustable anticipator, C1 fixed anticipator.

All T872 thermostats use mercury switches. Each schematic will indicate switch operation by being drawn in the open position with an arrow indicating operation with a temperature RISE or FALL.
STANDARD CIRCUITS WITH AUTO HEAT-COOL CHANGEOVER

FIG. 16—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672C SUBBASE WITH T872D THERMOSTAT. SUBBASE PROVIDES OFF-AUTO SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 17—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672C SUBBASE WITH T872E THERMOSTAT. SUBBASE PROVIDES OFF-AUTO AND AUTO-ON FAN SWITCHING. RC TERMINAL FOR COOLING ONLY.

FIG. 18—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672E SUBBASE WITH T872D THERMOSTAT. SUBBASE PROVIDES OFF-HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING. RC-RH TERMINALS FOR SEPARATE HEATING AND COOLING CIRCUITS.
Flt. 21—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672E SUBBASE AND T8720 THERMOSTAT. SUBBASE PROVIDES OFF-HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

Fig. 21—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672E SUBBASE AND T8720 THERMOSTAT. SUBBASE PROVIDES OFF-HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

Flt. 22—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672F SUBBASE AND T872D THERMOSTAT. SUBBASE PROVIDES OFF-EM.HT.-HEAT-AUTO-COOL SYSTEM AND FAN SWITCHING. EMERGENCY HEAT RELAY AND LIGHT ARE ENERGIZED WHEN SWITCH IS IN EM. HT. POSITION.

Fig. 22—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672F SUBBASE AND T872D THERMOSTAT. SUBBASE PROVIDES OFF-EM.HT.-HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING. EMERGENCY HEAT RELAY AND LIGHT ARE ENERGIZED WHEN SWITCH IS IN EM. HT. POSITION.
FIG. 23—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672F SUBBASE AND T872D THERMOSTAT. SUBBASE PROVIDES OFF-EM. HT-. HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING. EMERGENCY HEAT RELAY IS ENERGIZED WHEN SYSTEM SWITCH IS IN EM. HT. POSITION; LIGHT OPERATES WITH SECOND STAGE OF HEATING.

FIG. 24—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672F SUBBASE WITH T872C THERMOSTAT. SUBBASE PROVIDES OFF-EM. HT-. HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING. EMERGENCY HEAT RELAY ENERGIZED WHEN SWITCH IS IN EM. HT. POSITION; LIGHT OPERATES WITH SECOND STAGE HEATING.
FIG. 25—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672F SUBBASE AND T872C THERMOSTAT. SUBBASE PROVIDES OFF-AUTO SYSTEM SWITCHING ONLY.

FIG. 26—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672G SUBBASE AND T872D THERMOSTAT. SUBBASE PROVIDES OFF-AUTO SYSTEM SWITCHING ONLY.
FIG. 27—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q872K SUBBASE AND T872D THERMOSTAT. SUBBASE PROVIDES OFF-HEAT-AUTO-COOL SYSTEM SWITCHING ONLY.

FIG. 28—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q872D SUBBASE AND T872D THERMOSTAT. SUBBASE PROVIDES HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 29—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672B SUBBASE AND T872D THERMOSTAT. SUBBASE PROVIDES HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING. G TERMINAL IS ISOLATED ON HEATING TO PROVIDE FAN RELAY OPERATION FROM EXTERNAL LOW VOLTAGE FAN SWITCH.

FIG. 30—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672B SUBBASE AND T872D THERMOSTAT. SUBBASE PROVIDES HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING, AND automatic FAN operation in HEATING AND COOLING FOR ELECTRIC FURNACE.
it'SLS 1

TAGE HEATING, 1-STAGE VENTILATION, AND 2-STAGE COOLING. SUBBASE PROVIDES HEAT-OFF-COL SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 31—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q6728 SUBBASE AND T672T THERMOSTAT. THERMOSTAT PROVIDES 1-STAGE HEATING, 1-STAGE VENTILATION, AND 2-STAGE COOLING. SUBBASE PROVIDES HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 32—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q6728 SUBBASE AND T672C THERMOSTAT. SUBBASE PROVIDES HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.
POWER SUPPLY. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

REMOVABLE JUMPER (OPTIONAL). REMOVE JUMPER FOR SEPARATE HEATING AND COOLING TRANSFORMER.

8 TERMINAL OPTIONAL

FIG. 33—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672D SUBBASE AND T672D THERMOSTAT. NO SUBBASE SWITCHING IS PROVIDED.

EXTERNAL SWITCHING CONTROL REQUIRED

POWER SUPPLY. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

JUMPER SUBBASE TERMINALS RC AND RH FOR COMMON HEATING AND COOLING TRANSFORMER

FIXED TO MAKE AT 60 F [16 C].

FIG. 34—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672D SUBBASE AND T872D THERMOSTAT. SYSTEM SWITCHING TO BE PROVIDED EXTERNALLY, SECOND-STAGE HEAT IS FIXED TO MAKE AT 60 F [16 C].
HEAT PUMP CIRCUITS WITH AUTOMATIC CHANGEOVER ON COOLING

FIG. 38—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672C/T872H IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 1-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. SUB-BASE PROVIDES OFF-AUTO SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 39—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672E/T872G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 3-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. SUB-BASE PROVIDES OFF-HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 37—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672E/T672G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING (SECOND-STAGE HEAT IS FAST CYCLING) AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. SUBBASE PROVIDES OFF-EM, HT-HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 38—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672F/T672G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING (SECOND-STAGE HEAT IS FAST CYCLING) AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. SUBBASE PROVIDES OFF-EM, HT-HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 39—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q472F/T872G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING (SECOND-STAGE HEAT IS FAST CYCLING) AND 1-STAGE COOLING. CHANGEOVER VALVE OPERATES WITH COOLING. SUBBASE PROVIDES OFF-COOL-AUTO-HEAT-EMHT SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 40—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR GS32P/TS72G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. ENSURE PROVIDED OFF-COOL-AUTO-HEAT-EMHT SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 41—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672F/7072G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. OFF-COOL-AUTO-HEAT-EM-HS. SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 42—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672F/7072G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. OFF-COOL-AUTO-HEAT-EM-HS. SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 43—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672/T872C IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. SUBBASE PROVIDES OFF-COOL-AUTO-HEAT SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 44—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672/T872C IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. SUBBASE PROVIDES EM-HI-AUTO-OFF SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 49—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672J/T872G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. SUBBASE PROVIDES EM-HT/AUTO-OFF SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 46—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672J/T872G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH COOLING. SUBBASE PROVIDES EM-HT-ON-OFF SYSTEM AND AUTO-ON FAN SWITCHING.
HEAT PUMP CIRCUITS WITH MANUAL CHANGEOVER ON COOLING

FIG. 47—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672B/T872R IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; MANUAL CHANGEOVER OPERATES ON COOLING. SUBBASE PROVIDES HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 48—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR Q672B/T872R IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; MANUAL CHANGEOVER OPERATES ON COOLING, FAST CYCLING STAGE 2 HEAT HAS ISOLATED CIRCUIT AND SEPARATE TRANSFORMER. SUBBASE PROVIDES HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 49–INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR G672L/T872R IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; MANUAL CHANGEOVER OPERATES ON COOLING. FAST CYCLING STAGE 2 HEAT HAS ISOLATED CIRCUIT AND SEPARATE TRANSFORMER. EMERGENCY HEAT RELAY AND LIGHT ARE ENERGIZED IN EM-HEAT SWITCH POSITION. SUBBASE PROVIDES EM-HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 50–INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF G672L/T872R IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; MANUAL CHANGEOVER OPERATES ON COOLING. FAST CYCLING STAGE 2 HEAT HAS ISOLATED CIRCUIT AND SEPARATE TRANSFORMER. EMERGENCY HEAT RELAY AND LIGHT ARE ENERGIZED IN EM-HEAT SWITCH POSITION. SUBBASE PROVIDES EM-HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 51—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672L/T672G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; MANUAL CHANGEOVER OPERATES ON COOLING. SUBBASE PROVIDES EM-HIT-HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 52—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672L/T672G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; MANUAL CHANGEOVER OPERATES ON COOLING. SUBBASE PROVIDES EM-HIT-HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

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SWITCHING TO DESIGNATED POSITIONS ONLY

POWER SUPPLY, PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED

FIG. 53—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672L/T872R IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; MANUAL CHANGEOVER OPERATES ON COOLING. SUBBASE PROVIDES EM. HT.-HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 54—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672L/T872G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 2-STAGE COOLING. SUBBASE PROVIDES EM. HT.-HEAT-OFF-COOL SYSTEM AND AUTO-ON FAN SWITCHING.
HEAT PUMP CIRCUITS WITH AUTOMATIC CHANGEOVER ON HEATING

FIG. 55—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672C/T8725 IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH HEATING. SUBBASE PROVIDES OFF-AUTO SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 56—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672F/T672N IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH HEATING. SUBBASE PROVIDES OFF-COOL-AUTO-HEAT-EM.HT.SYSTEM AND AUTO-ON FAN SWITCHING.

FIG. 57—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672E/T672C IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 1-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH HEATING. SUBBASE PROVIDES OFF-HEAT-AUTO-COOL SYSTEM AND AUTO-ON FAN SWITCHING.
FIG. 58—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672G/T872G IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 1-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH HEATING. SUBBASE PROVIDES OFF-AUTO SYSTEM SWITCHING AND NO FAN SWITCHING FOR FAN CIRCUIT.

FIG. 59—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672N/T872C IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 1-STAGE COOLING; CHANGEOVER VALVE OPERATES WITH HEATING. SUBBASE PROVIDES HEAT-OFF-COOL-EVAP. SYSTEM AND ON-AUTO FAN SWITCHING.
FIG. 66—INTERNAL SCHEMATIC AND TYPICAL HOOKUP OF Q672/J872A OR D IN HEAT PUMP APPLICATION. THERMOSTAT PROVIDES 2-STAGE HEATING AND 2-STAGE COOLING. CHANGEOVER VALVE OPERATES WITH HEATING. SUBBASE PROVIDES EM. HT-AUTO-OFF SYSTEM AND AUTO-OFF FAN SWITCHING.
Honeywell

AQUASTAT CONTROLLERS ARE IMMERSSION TYPE DEVICES FOR LIMITING OR REGULATING THE TEMPERATURE OF LIQUIDS IN BOILERS, STORAGE TANKS, AND OTHER APPLICATIONS WHERE TEMPERATURE CONTROL OF LIQUIDS IS REQUIRED. AS THE TEMPERATURE OF THE CONTROLLED MEDIUM RISES TO THE SET POINT, EXPANSION OF THE FLUID IN THE SENSING ELEMENT OPERATES THE INTERNAL SWITCH OR SWITCHES.

- The L4006, 7, and 8 provide spst switching for high or low limit control of a burner.

- The L4006G model has two spst switches that make and break in sequence to provide boiler sequencing.

- The L6006 and 8 provide spdt switching for low limit and circulator control.

- Models which break contact on a temperature rise to the set point are calibrated for high limit use. They are also suitable for low limit control if a separate high limit control is used.

- Ambient compensated models are available to prevent control-point shift caused by temperature fluctuation at the case.

- Visible control point scale and external adjustment screw permit easy setting.

- Models are available for either horizontal or vertical insertion of the sensing element. The sensing element may be directly immersed or placed in an immersion well.

- Remote bulb models are available if the controller must be mounted at a location away from the sensing element.

- Remote bulb models may also be used to sense air temperature in ducts and in outside air sensing applications.

- Totally enclosed Micro Switch snap-acting switches are used in all models.

S.K.
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### SPSY MODELS:

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<th>MODEL</th>
<th>APPLICATION</th>
<th>RANGE (F)</th>
<th>MIDSCALE DIFFERENTIAL (F)</th>
<th>INSERTION</th>
<th>SWITCHING ON TEMP. RISE</th>
<th>AVAILABLE OPTIONS</th>
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<td>L4006A</td>
<td>high or low limit</td>
<td>40 to 180 or 100 to 240</td>
<td>2 or 5 fixed or 5 to 30 adj.</td>
<td>horizontal</td>
<td>breaks</td>
<td>Tradeline models which include wall and tube of heat conductive compound, Plastic shield for covering well in water heater applications. 3/4 in. NPT brass spud. Centigrade scale markings. Factory set stops at 180 F, 165 F, 100 F, 200 F, or 220 F. Dial marked WARM, NORMAL, HOT, Insulation depths of 1-1/2, 3, or 5 inch.</td>
</tr>
<tr>
<td>L4006B</td>
<td>circulator</td>
<td>40 to 180 or 100 to 240</td>
<td>5 fixed or 5 to 30 adj.</td>
<td>horizontal</td>
<td>makes</td>
<td>3 inch insulation depth. 3/4 inch NPT brass spud. 10 in. element. Factory set stop at 200 F.</td>
</tr>
<tr>
<td>L4006C</td>
<td>high or low limit</td>
<td>100 to 240</td>
<td>2 or 5 fixed or 5 to 30 adj.</td>
<td>horizontal</td>
<td>direct</td>
<td>3/4 in. NPT brass spud, 5 in. insulation depth.</td>
</tr>
<tr>
<td>L4006E</td>
<td>high limit</td>
<td>110 to 250</td>
<td>manual reset</td>
<td>horizontal or vertical</td>
<td>breaks</td>
<td>3/4 in. NPT brass spud, 3 in. insulation depth.</td>
</tr>
<tr>
<td>L4006F</td>
<td>sequencing</td>
<td>100 to 240</td>
<td>5 fixed</td>
<td>horizontal or vertical</td>
<td>breaks</td>
<td>3 in. insulation depth. 5 ft. 6 in., 8 ft. 6 in., or 10 ft. remote capillary. Factory set scale stop at 120 or 200 F. External adjusting knob. Centigrade scale markings.</td>
</tr>
<tr>
<td>L4007A</td>
<td>high or low limit</td>
<td>100 to 240</td>
<td>2 or 5 fixed or 5 to 30 adj.</td>
<td>vertical</td>
<td>breaks</td>
<td>Centigrade scale markings.</td>
</tr>
<tr>
<td>L4007B</td>
<td>circulator</td>
<td>100 to 240</td>
<td>5 fixed or 5 to 30 adj.</td>
<td>vertical</td>
<td>makes</td>
<td>5 ft. 6 in., 8 ft. 6 in., or 10 ft. remote capillary. Factory set scale stop at 120 or 200 F. External adjusting knob. Centigrade scale markings.</td>
</tr>
<tr>
<td>L4008A</td>
<td>high or low limit</td>
<td>40 to 180 or 100 to 240</td>
<td>2 or 5 fixed or 5 to 30 adj.</td>
<td>remote bulb</td>
<td>breaks</td>
<td>8 ft. 6 in. capillary.</td>
</tr>
<tr>
<td>L4008B</td>
<td>circulator</td>
<td>100 to 240</td>
<td>5 fixed or 5 to 30 adj.</td>
<td>remote bulb</td>
<td>makes</td>
<td>7 ft. 6 in., 20 ft. capillary or fast response element. External adj. knob. 150 va rating at 120, 240v ac. High limit stamped on case scale lock.</td>
</tr>
<tr>
<td>L4008C</td>
<td>ambient compensated high limit</td>
<td>0 to 70 or 40 to 180</td>
<td>2 or 5 fixed or 5 to 30 adj.</td>
<td>remote bulb</td>
<td>breaks</td>
<td>7 ft. 6 in., 20 ft. capillary or fast response element. External adj. knob. 150 va rating at 120, 240v ac. High limit stamped on case scale lock.</td>
</tr>
</tbody>
</table>

L4008 models continued on page 3

a Copper well or fitting is supplied with all models except remote bulb type. When ordering, specify boiler tapping size (1/2 or 3/4 inch) and insulation depth.
b Manual reset (trip-free)—Switch breaks circuit and locks out when controlled medium reaches set point. Controlled temperature must drop 20 degrees below set point before contacts can be manually reset.

---

### INFORMATION

1. Specif... 2. OPERATE. 3. DIFFERENTI. 4. CALIB. 5. ADJUST. 6. APPLY AND INSULATION DEPTH. 7. ADJUST.
### SPST MODELS: CONTINUED

<table>
<thead>
<tr>
<th>MODEL</th>
<th>APPLICATION</th>
<th>RANGE (F)</th>
<th>MIDSCALE DIFFERENTIAL (F)</th>
<th>INSERTION</th>
<th>SWITCHING ON TEMP. RISE</th>
<th>AVAILABLE OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>L4008D^a</td>
<td>ambient compensated circulator</td>
<td>0 to 70 or 40 to 180</td>
<td>2 or 5 fixed</td>
<td>remote bulb</td>
<td>makes</td>
<td>Tradeline model available. Centigrade scale markings. Hot tinned 8 ft. capillary. Electrical rating: 2.3 amp at 120–240v ac, full load. Fast response, 10 ft armored capillary with 3 ft. bulb. External adjustment knob. Factory set scale stops at 120, 220, or 250 F. Plastic shield for covering well in water heater applications.</td>
</tr>
<tr>
<td>L4008E^ab</td>
<td>high limit</td>
<td>40 to 80 or 110 to 290</td>
<td>manual reset</td>
<td>remote bulb</td>
<td>breaks</td>
<td>Factory set scale stop at 350 F. 8 ft.6 in. capillary.</td>
</tr>
<tr>
<td>L4008a</td>
<td>high limit</td>
<td>100 to 240</td>
<td>5 fixed</td>
<td>remote bulb</td>
<td>breaks</td>
<td>All models less case and cover. 18 in. capillary and 1/2 in. well assy. Factory set scale stop at 220 F.</td>
</tr>
<tr>
<td>L4008K^a</td>
<td>circulator</td>
<td>40 to 180</td>
<td>5 fixed</td>
<td>remote bulb</td>
<td>makes</td>
<td>All models less cover.</td>
</tr>
</tbody>
</table>

### SPDT MODELS:

<table>
<thead>
<tr>
<th>MODEL</th>
<th>APPLICATION</th>
<th>RANGE (F)</th>
<th>MIDSCALE DIFFERENTIAL (F)</th>
<th>INSERTION</th>
<th>AVAILABLE OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>L6006A^a</td>
<td>circulator and low limit or high limit</td>
<td>100 to 240 or 110 to 290</td>
<td>5 fixed or 5 to 30 adj.</td>
<td>horizontal</td>
<td>Tradeline model which includes well adaptor and tube of heat conductive compound. 3/4 in. NPT brads spud. 3 in. insulation depth. Horizontal or vertical mount available on same models.</td>
</tr>
<tr>
<td>L6006B</td>
<td>circulator and low limit or high limit</td>
<td>100 to 240</td>
<td>5 fixed or 5 to 30 adj.</td>
<td>horizontal</td>
<td>3/4 in. brass bulb compression fitting.</td>
</tr>
<tr>
<td>L6008A^a</td>
<td>circulator and low limit cooling</td>
<td>100 to 240 or -30 to 70</td>
<td>5 fixed or 5 or 30 adj.</td>
<td>remote bulb</td>
<td>Tradeline model with 5 ft. capillary. Range of -30 to 70 F. Centigrade scale markings. Without cover.</td>
</tr>
<tr>
<td>L6008Ca</td>
<td>dual fuel changeover</td>
<td>0 to 70 or 40 to 180</td>
<td>2 or 5 fixed</td>
<td>remote bulb</td>
<td>Tradeline model. 150 va switch rating. Centigrade scale markings. 7 ft.6 in. armored capillary. External adjustment knob. Lock type cover. 20 ft. element. Averaging element.</td>
</tr>
<tr>
<td>L6008Da</td>
<td>ambient compensated</td>
<td>40 to 180</td>
<td>5 fixed</td>
<td>remote bulb</td>
<td>All models less enclosure. Front mounted.</td>
</tr>
</tbody>
</table>

*a* Conner (or fitting is supplied with all models except remote bulb type. When ordering, specify boiler tapping size (1/2 or 3/4 inch) and insulation depth.

*b* Manual reset (trip-free)—Switch breaks circuit and locks out when controlled medium reaches set point. Controlled temperature must drop 20 degrees below set point before contacts can be manually reset.

**NOTE:** The following specifications are standard. Variances, available as options, are noted in the preceding table.

**ELECTRICAL RATING (AMPS):**

<table>
<thead>
<tr>
<th>Models with 2 F fixed differential—</th>
<th>120v ac</th>
<th>240v ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>FULL LOAD</td>
<td>2.6</td>
<td>1.3</td>
</tr>
<tr>
<td>LOCKED ROTOR</td>
<td>15.6</td>
<td>7.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Models with 5 F differential—</th>
<th>120v ac</th>
<th>240v ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>FULL LOAD</td>
<td>8</td>
<td>5.1</td>
</tr>
<tr>
<td>LOCKED ROTOR</td>
<td>48</td>
<td>30.6</td>
</tr>
<tr>
<td>INDUCTIVE CURRENT</td>
<td>.25 at 1/4 to 12v dc</td>
<td></td>
</tr>
</tbody>
</table>
PRESSURE RATING:
Capillary bulb (direct immersion)—200 psi.
Immersion well—255 psi.

SENSING BULB MATERIAL: Copper.

SENSING BULB FULL: Liquid, Toluene or Silicone.

CAPILLARY LENGTH (including bulb): Remote bulb models—60 inches.

SENSING BULB DIMENSIONS (inches): 2-7/8 long, 3/8 diameter.

INSERTION DEPTH: 3-3/8 inches.

INSULATION: Brass. 1-1/2 or 3 inches. Specify when ordering.

PROVISION FOR WIRING: Screw terminals.

MOUNTING: Horizontal and vertical models mount directly to an immersion well installed in a boiler fitting. Remote bulb models have 3 mounting holes in rear of case for screw mounting to a vertical surface.

FINISH: Gray.

INSTALLATION DIMENSIONS: See Figs. 1 and 2.

IMMERSION WELL DIMENSIONS: See Fig. 3.

BOILER FITTING AND BULB DIMENSIONS: See Fig. 4.

ACCESSORIES:
Weatherproof enclosure—Q615.

Immersion wells—
- Copper, 1/2 NPT, 1-1/2 inch insulation—Part No. 121371A.
- Copper, 1/2 NPT, 3 inch insulation—Part No. 121371L.
- Copper, 3/4 NPT, 1-1/2 inch insulation—Part No. 121371B.
- Copper, 3/4 NPT, 3 inch insulation—Part No. 121371M.
- Copper, 3/4 NPT, 1-1/2 inch insulation, plastic sleeve—Part No. 12131K.
- Copper, 3/4 NPT, 3 inch insulation, plastic sleeve—Part No. 12131M.
- Stainless steel, 1/2 NPT, 1-1/2 inch insulation—Part No. 121371E.
- Stainless steel, 3/4 NPT, 1-1/2 inch insulation—Part No. 121371F.

Bulb Compression Fittings (see Fig. 6)—
- Brass, 1/2 NPT plug, 1-1/2 inch insulation—Part No. 104466B.
- Brass, 3/4 NPT plug, 1-1/2 inch insulation—Part No. 104466C.

Capillary Compression Fittings (see Fig. 7)—
- Copper, 1/2 NPT plug, 1-1/2 inch insulation—Part No. 104486C.
- Copper, 3/4 NPT plug, 1-1/2 inch insulation—Part No. 104484B.

FIG. 1—INSTALLATION DIMENSIONS.

FIG. 2—INSTALLATION DIMENSIONS FOR REMOTE BULB MODELS. OTHER DIMENSIONS SAME AS FIG. 1.

FIG. 3—IMMERSION WELL DIMENSIONS FOR ALL MODELS EXCEPT L4006C, L4007D, AND L6008B.

FIG. 4—BOILER FITTING AND BULB DIMENSIONS FOR L4006C, L4007D, AND L6008B.
INSTALLATION

The manufacturer usually provides a tapping for insertion of the controller's sensing element. This tapping is located at a point where typical water temperature can be measured. Depending on model, the element is inserted in an immersion well, through a boiler fitting, or directly immersed.

Installation should be made by a qualified serviceman. Follow the instructions furnished by the system manufacturer, if available. Otherwise, refer to appropriate procedure listed below.

**IMPORTANT**
Controller may be used with or without immersion well. Well, if used, must fit sensing bulb snugly for good thermal response. Insert bulb until it rests against bottom of well, then hold it there while tightening the tubing clamp.

MOUNTING REMOTE BULB MODELS

The remote temperature-sensing bulb can either be installed in an immersion well (Fig. 5) that extends into the boiler or tank, or it can be directly immersed in the liquid. For installations not using a well, secure the remote bulb with a bulb compression fitting (Fig. 6), or capillary compression fitting (Fig. 7).

Well, bulb compression fitting or capillary compression fitting must be ordered separately. Sizes available: 1/2 in., 3/4 in. NPT spud. Well, if used, must fit sensing bulb snugly for good thermal response. Insert bulb until it rests against bottom of well, then hold it there while tightening the tubing clamp. (See Fig. 5.)

The boiler manufacturer generally provides a tapping for the insertion of the Aquastat controller's sensing element. This tapping should be located at a 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 a steam coil.

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

The bulb can also be installed in the supply line of an indirect water heater, in the direct water heater itself, or in the feed riser, about 6 in. above the boiler. If the riser is valved, the bulb can be installed between the boiler and the valve.

**NOTE:** Avoid making sharp bends or kinks in the capillary. Bends should be no sharper than 1 inch radius.

After installing, carefully coil excess capillary at the bottom of the controller case.

IMMERSION WELL MOUNTING

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 securely in place.

**CAUTION:**

Do not secure draw nut so tightly that retainer clamp could collapse tubing.

---

**FIG. 5—IMMERSION WELL FITTING.**

**MOUNTING WITH 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 CAPILLARY COMPRESSION 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. 7. Turn brass washers so that slots are 180 degrees apart.
5. Slide seal assembly into fitting and tighten packing nut.

DUCT MOUNTING

1. Drill a 3/4 inch hole in the duct wall large enough to admit the sensing bulb into the holder.
2. Using the holder as a template, mark and drill holes for bulb holder mounting screws.
3. Break holder to desired length (Fig. 9).

NOTE: Holder must be long enough to hold sensing bulb in freely circulating air away from duct wall. Neatly coil excess capillary at controller case or at bulb holder.

4. Place capillary in bulb holder channel. Pinch top edges of holder together at each segment (Fig. 10).
5. Insert bulb holder into controlled area through hole prepared in step 1 above.
6. Fasten bulb holder to duct wall with screws furnished.

MOUNTING DIRECT IMMERSION MODELS

FOR MODELS USING AN IMMERSION WELL

The well of the Aquastat controller must always be exposed to circulation of the medium under control, but must never be located close to a hot or cold inlet or steam coil. Where the tapping is on the side of the boiler, use an Aquastat controller with horizontal well. Where the tapping is on top of the boiler, use a model with a vertical well.

INSTALLING THE IMMERSION WELL

On existing installations, shut off the power and remove the old control. If the old immersion well appears suitable, and if the adapter clamp on the Aquastat controller fits the old well spud, the well need not be replaced.

1. If the system is filled, drain system to a point below the boiler tapping.
2. Remove plug (or old well) from boiler tapping.
3. Install the No. 121371 Immersion Well supplied with the controller. If boiler tapping is greater than 1/2 inch a reduction fitting must be used to adapt the boiler opening to the 1/2 inch threads that are standard with the well or fitting. Fittings with 3/4 inch threads are also available.
4. Fill the system. Make sure that the well is screwed in tightly enough to prevent leakage. Do NOT tighten or apply force to case after controller is secured to well.
INSTALLATION OF SENSING BULB IN IMMERSION WELL

a. Loosen screw (at top of case, above scale-setting), and remove cover. Loosen two screws that secure adapter clamp. See Fig. 11.

b. Insert the sensing element into the immersion well.

c. Fasten the case of the Aquastat controller to the well with the adapter clamp. Make certain that the clamp is properly positioned over the groove of the well spud. Also be sure the flange at the opening of the well fits snugly into the opening of the case. The sensing element bulb must bottom in the well.

MODELS WITH FIXED DIFFERENTIALS DO NOT INCLUDE ADJUSTING WHEEL.

MODELS WITH VERTICAL MOUNTING OF IMMERSION WELL, IT IS ATTACHED TO BOTTOM OF THE CASE.

MODELS DESIGNED FOR DIRECT IMMERSION (WITHOUT WELL)

Some models, which provide direct immersion of the sensing element into the boiler, include a No. 104486 bulb compression fitting assembly instead of an immersion well. Install fitting in boiler tapping. Be sure sealing washer is in place as shown in Fig. 12. Make sure that spud of bulb compression fitting is screwed in tightly enough to prevent leaking. Insert immersion bulb (sensing element) through bulb compression fitting. Adjust the adapter clamp so that it fits over the groove at the opening of the bulb compression fitting. Tighten adapter clamp screws so that Aquastat controller is firmly attached to bulb compression fitting.

MOUNTING DUAL FUEL CHANGEOVER MODELS

These models have a five foot capillary. This capillary establishes the maximum distance between the case and the outdoor mounting.

The bulb should be installed on the outside of the building in the shield provided (see Fig. 13) where it will be exposed to representative air temperature, but not to direct sunlight. It should be mounted high enough so that accumulated snow, leaves, or other debris cannot obstruct circulation of air around it, and where children cannot reach it. Avoid vents from the building.

Install the case at the indoor location selected, fastening with screws through holes in back of the case. Bring the bulb and tubing out through a 3/4 inch hole in the outside wall. In uncoiling the tubing, carefully avoid sharp bends or kinks. Excess tubing should be left coiled near the case. Do not make sharp bends near the case or bulb.

Slip the bulb through the supports in the shield. Pinch the split supporting clip until it holds the bulb firmly in position. If the seal-off tube protrudes from under the shield, it may be bent under as shown in Fig. 13.

Hold the shield over the mounting position and form a small-radius bend in the tubing. Place the split plug around the tubing and move the shield into mounting location as a unit. Push the split plug into the hole until it is wedged securely in place. Fasten the shield in place on the wall with the screws provided.

NOTE: If the tubing is properly shaped and the split plug installed as directed, the shield will cover the split plug, and the hole in the wall will be hidden from sight.
Mounting the L6006A Remote Bulb Cooling Thermostat

Mounting with Guard Bracket

Mount the bulb in the guard bracket as shown in Fig. 14. Locate the bulb and bracket combination in freely circulating air in the controlled area. With screws provided, fasten the bracket in place.

Mounting on Suction Line

1. In cooling units with more than one suction line, sensing bulb should be placed on the common line.
2. Make certain the bulb is at least 2 feet from the point at which the suction line leaves the cooler. This will prevent the outside temperature from being transmitted to the remote bulb through the copper tubing of the suction line.
3. Place the remote sensing bulb on the side of the horizontal suction line between the coil and trap (not on the trap).
4. Attach the sensing bulb to the suction line with clips or straps.
5. Coil the excess length of capillary tubing near the L6006A case.

Wiring

All wiring must comply with local codes and ordinances regarding wire size, type of insulation, enclosure, etc. Figures 16 through 23 show typical hook-up diagrams.
For proper selection of settings, follow the boiler manufacturer's recommendations.

**HIGH LIMIT CONTROLLER**

Shuts off burner if water temperature exceeds high limit setting. Burner restarts when temperature drops to high limit setting, less differential.

**LOW LIMIT CONTROLLER**

Maintains minimum boiler temperature for domestic hot water. Turns on boiler at temperature setting, minus differential.

**CIRCULATOR CONTROLLER**

Prevents circulation of water that is below the desired heating temperature. Breaks circulator circuit on temperature drop below setting minus differential, remines on rise to setting.
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 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.

**L6008A LOCATION DIFFERENTIAL CALIBRATION**

The L6008A1093 is calibrated for applications with both the bulb and case located in the room in which the temperature is being controlled. A correction will be necessary if the temperature of the case is different from the desired dial setting.

1. If the case is at a higher temperature than the desired dial setting, raise the desired dial setting by the correction determined from the table at right.

2. If the case is at a lower temperature than the desired dial setting, lower the desired dial setting by the correction determined from the table below.

<table>
<thead>
<tr>
<th>Temperature difference between desired room temperature and case temperature (°F)</th>
<th>Correction (Degrees F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>3/4</td>
</tr>
<tr>
<td>10</td>
<td>1-1/2</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>2-1/2</td>
</tr>
<tr>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>3-1/2</td>
</tr>
<tr>
<td>35</td>
<td>4</td>
</tr>
<tr>
<td>40</td>
<td>4-1/2</td>
</tr>
<tr>
<td>45</td>
<td>5</td>
</tr>
<tr>
<td>50</td>
<td>5-1/2</td>
</tr>
<tr>
<td>55</td>
<td>6</td>
</tr>
<tr>
<td>60</td>
<td>6-1/2</td>
</tr>
<tr>
<td>70</td>
<td>7</td>
</tr>
<tr>
<td>75</td>
<td>8</td>
</tr>
<tr>
<td>80</td>
<td>8-1/2</td>
</tr>
</tbody>
</table>

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 control of the system as described under OPERATION. Further adjustments then can be made to meet more exact comfort requirements.
APPENDIX G

GENERAL SDAS INSTALLATION
INSTRUMENTATION INTERFACE REQUIREMENTS

To transmit data from each sensor to the Central Data Processing System, the hardware components shown in Figure 1 are utilized at each site. A typical layout of the work space required around the SDAS mounting area is shown in Figure 2.

NOTE: All ERDA responsibilities will be performed by NASA.

Hardware Components

1. Sensor wire (supplied and installed by site contractor)
2. Junction box (supplied by ERDA and installed by site contractor)
3. Junction box/SDAS interface cables (supplied and installed by ERDA)
4. Site Data Acquisition Subsystem (SDAS) (supplied by ERDA and installed by site contractor)
5. SDAS telephone interface (supplied by ERDA)
6. SDAS and telephone electrical power interface (supplied by site contractor)

Sensor to Junction Box Wiring

All wiring from sensors to junction box (J-box) terminal block connections shall be performed by the site contractor in accordance with these guidelines utilizing wire procured by the site contractor and prepared for each sensor according to instructions in Figure 3. The wire size and number of conductors required for each sensor is specified in Table 1. The sensor-to-junction-box wire shall be color-coded, audio and instrumentation grade cable to minimize noise problems. Conduit shall be used only in accordance with local codes.
Figure 1. Site Instrumentation Interface Hardware
120 VAC POWER - NEMA type L5 15R receptacle and standard 3 wire/Double outlet -

NOTES:

1. J-Box (A) is to be located within a cable run of 4 ft of the SDAS (B)
2. NEMA type L5 15R receptacle to be within 6 ft of SDAS (B)
3. Telephone Interface (Coupler) is located within 3 ft of SDAS (B)

Figure 2. Typical SDAS Installation Layout Profile
Figure 3. Sensor Wire Preparation Procedure

1. Trim cable jacket and foil shield to expose wires to length as required (usually less than 2”), both ends.
2. Trim foil shield back to jacket, both ends.
3. Cut shield wire next to jacket, sensor end only.
4. Wrap cable at trim point with tape to cover shield, both ends.
5. Label sensor end and J-box end according to instrumentation list “designation.”

Sensor End

Insulation stripped for connection to sensor (see page B-2 in Appendix B for terminations).

J-box End

Crimp terminal lugs furnished with J-box.

Route bare shield wire to minimize contact with J-box terminals, sensor end only, cover bare wire with sleeving if available.

Foil shield and bare shield wire completely covered (insulated), sensor end only.
<table>
<thead>
<tr>
<th>SENSOR TYPE</th>
<th>CONDUCTORS</th>
<th>AMERICAN WIRE GAUGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Single element RTD</td>
<td>3 + shield</td>
<td>#18-3</td>
</tr>
<tr>
<td>- Dual element RTD</td>
<td>3 + shield (2)</td>
<td>#18-3</td>
</tr>
<tr>
<td>Flow rate (liquid)</td>
<td>4 + shield</td>
<td>#18-4</td>
</tr>
<tr>
<td>Air velocity</td>
<td>2 + shield</td>
<td>#18-2</td>
</tr>
<tr>
<td>Solar radiation</td>
<td>2 + shield</td>
<td>#18-2</td>
</tr>
<tr>
<td>Electric power</td>
<td>2 + shield</td>
<td>#18-2</td>
</tr>
</tbody>
</table>

**NOTE:**
1. Typical wire part numbers include:
   - Alpha P/N 2422-18 gauge, 2 conductor or equivalent
   - Alpha P/N 2423-18 gauge, 3 conductor or equivalent
   - Alpha P/N 2424-13 gauge, 4 conductor or equivalent
   - Dearborn P/N 971804-18 gauge, 4 conductor or equivalent
   - Dearborn P/N 971803-18 gauge, 3 conductor or equivalent
   - Dearborn P/N 971802-18 gauge, 2 conductor or equivalent
   - Manhattan P/N M1242-18 gauge, 2 conductor or equivalent
   - Manhattan P/N M1243-18 gauge, 3 conductor or equivalent
   - Manhattan P/N M1244-18 gauge, 4 conductor or equivalent
2. Two (2) cables required for dual element RTDs.
3. Wire exposed to the outdoor environment or buried shall be in conduit.
4. Rigid conduit runs to all sensors shall be terminated with flexible conduit. All connections shall be made watertight.
CAUTION

AC POWER LINES AND OTHER POTENTIAL NOISE INDUCING LINES SHOULD NOT BE PLACED IN THE SENSOR WIRING CONDUIT OR ROUTED NEAR THE INSTRUMENTATION CABLES. ALSO, THE INSTRUMENTATION CABLES SHOULD NOT BE ROUTED NEAR NOISE GENERATING EQUIPMENT.

Junction Box

ERDA will provide a junction box (Figure 4) to the site contractor for installation in a central location with respect to the solar energy system. The installation location shall be selected by the site contractor and shall be specified in the ISPI.

As defined by ERDA, noise suppression may be required at the sensor, J-Box or both to provide acceptable data. Remote signal conditioning may be required to improve the signal-to-noise ratio that would improve data accuracy.

Junction Box Location -- The junction box, Figure 4, shall be mounted by the site contractor so that it is accessible for wiring connections from the sensors and is within four feet of the SDAS location on the same side of the wall.

Junction Box Mounting -- At the predefined mounting location, the junction box shall be mounted by the site contractor using the four mounting holes located at the back of the unit. Figure 4 provides the dimensional information for mounting. Depending on the characteristics of the mounting surface, Molly bolts, wood screws, or bolt/nut combinations shall be used to mount the unit. The junction box shall be installed in a top-up orientation.

Junction Box Interfaces -- ERDA will establish the wire run list which identifies where each sensor wire attaches to the junction box terminal strips. This wire run list will be a part of the AIP which the site contractor will implement. A typical example of a wire run list and the connection of typical measurements
Figure 4. Junction Box/SDAS Interface with typical Sensor connection.
is shown in Table 2. The junction box will be prewired from the terminal strips to the output connectors of the SDAS prior to delivery to the site. Five conductor terminals will be provided for each sensor input. Either two, three, or four conductor (18 gauge) and shield will be connected between the sensors and the junction box depending on the interface characteristics of the sensors. Figure 5 illustrates the sensor-to-junction-box interconnections for each of the approved sensors.

**Junction Box/SDAS Interface Cables**

ERDA will provide and install the junction box/SDAS interface cables.

**Site Data Acquisition Subsystem**

The Site Data Acquisition Subsystem (SDAS) location at each demonstration project will be selected by the site contractor and shall be specified in the ISPI for approval.

**SDAS Location** — The SDAS, Figure 5, shall be mounted by the site contractor in a central position with respect to the solar energy system sensors. It shall be located in an indoor environment having temperature limits between $32^\circ F$ and $100^\circ F$ and relative humidity limits of 5-80% without condensation. The SDAS shall be located to minimize contamination by elements such as dust or other pollutants. To the extent possible, the SDAS shall be located in an area that minimizes the variations in temperature, relative humidity, and vibration to the SDAS. The SDAS shall be located in an area easily accessible for installation and maintenance.

**SDAS Mounting** — The SDAS shall be mounted in accordance with the installation drawings supplied by ERDA. The mounting space required for the SDAS is dependent on the model as shown in Figure 6. Either unit will weigh approximately 70 pounds. The SDAS shall be wall mounted using dimensions in Figure 6 both top and bottom. Either Molly bolts, wood screws, or bolt/nut combination shall be used.
Table 2. Typical Wire Run List for J-Box Terminal Connection

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*Either Wire

**Jumper added prior to shipment
Figure 6. Site Data Acquisition Subsystem
to mount the unit depending on the characteristics of the mounting surface. The SDAS shall be mounted between two feet and four feet above floor level measured from the bottom of the SDAS.

**SDAS Telephone Interface**

ERDA will arrange for the telephone installation required for the SDAS. The SDAS shall interface with a standard Bell System CBS Data Access Arrangement (DAA), Series 5 or later, or equivalent. The DAA shall be located within three feet of the SDAS on the same side of wall. The DAA connection with the SDAS shall be performed by ERDA. The site contractor shall provide a standard 120 VAC three (3) wire receptacle for power to the coupler.

**SDAS Electrical Interface**

The SDAS interfaces with 110-125V, 60 Hertz, 1 phase, 3 amp service. A standard 3 wire interface (safety ground, power and return) with a standard power cord and twist lock connector shall be provided on the SDAS. A 120 VAC three pin twist lock outlet (actual receptacle should be NEMA Part Numbers L6-15R, 250V, 15 amps for Mod 1 and L5-15R, 120V, 15 amps for Mod II) shall be provided by the site contractor and located within six feet of the SDAS.