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(NASA-CR-161384) SOLAR HEATING AND HOT  
WATER SYSTEM INSTALLED AT THE SENIOR CITIZEN  
CENTER, HUNTSVILLE, ALABAMA Final Report  
(City of Huntsville, Ala.) 140 p CSCL 10B

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## REPORT

# SOLAR HEATING AND HOT WATER SYSTEM INSTALLED AT THE SENIOR CITIZEN CENTER, HUNTSVILLE, ALABAMA

Prepared by the

City of Huntsville  
125 Earl Street  
Huntsville, Alabama 35805

Under Contract EG-77-A-01-4071

Monitored by

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

For the U. S. Department of Energy



## U.S. Department of Energy



**Solar Energy**

## CONTENTS

|                                                                                                                                                               | <u>Page</u> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 1.0 Introduction                                                                                                                                              | 1 - 2       |
| 2.0 Summary of Project Information                                                                                                                            | 3 - 4       |
| 2.1 Summary of Project Cost                                                                                                                                   |             |
| 3.0 Project Chronological                                                                                                                                     | 5           |
| 4.0 Design Philosophy                                                                                                                                         | 6 - 7       |
| 5.0 Solar System Description and Hardware                                                                                                                     | 8 - 11      |
| 5.1 Solar Architectural Panels                                                                                                                                |             |
| 5.2 Manifolds and Piping                                                                                                                                      |             |
| 5.3 Collector Loop Transfer Fluid                                                                                                                             |             |
| 5.4 Pipe Insulation                                                                                                                                           |             |
| 5.5 Hot Water Storage For Heating                                                                                                                             |             |
| 5.6 Control System                                                                                                                                            |             |
| 6.0 Project Energy Conservation Measures                                                                                                                      | 12          |
| 7.0 Site Planning                                                                                                                                             | 13          |
| 8.0 Control Logic and Modes of Operation                                                                                                                      | 14 - 28     |
| 8.1 Conventional Backup Energy System                                                                                                                         |             |
| 8.2 Controls                                                                                                                                                  |             |
| 8.3 Direct Solar Heat                                                                                                                                         |             |
| 8.4 Domestic Hot Water                                                                                                                                        |             |
| 8.5 Heat From Storage                                                                                                                                         |             |
| 8.6 Stored Solar Heat                                                                                                                                         |             |
| 8.7 Equipment Control System                                                                                                                                  |             |
| 9.0 Acceptance Test Plan                                                                                                                                      | 29 - 49     |
| 9.1 Items to Be Tested: Pump PH, 1/2<br>HP and Valve VE1; Results                                                                                             |             |
| 9.2 Items to Be Tested: Distribution<br>Control System, including RB-DCA-1<br>and Thermostats; Results                                                        |             |
| 9.3 Items to Be Tested: Mechanical Collector<br>Array A & B Plumbing Lines; Results                                                                           |             |
| 9.4 Items to Be Tested: Mechanical Heat<br>Distribution Water Pipe Loop; Results                                                                              |             |
| 9.5 Items to Be Tested: Solar Collection<br>Pumps PA1 and PB1 (1 HP Pumps); Results                                                                           |             |
| 9.6 Items to Be Tested: Pumps PDHW1, PDHW2,<br>1/12 HP Pumps; Results                                                                                         |             |
| 9.7 Pumps PA2 and PB2, 1/3 HP Water Pumps<br>(Solar Storage); Results                                                                                         |             |
| 9.8 Items to Be Tested: Sensor Installations<br>for Solar Differential Temperature<br>Controllers: Sensors TCA1, TCB, TSA,<br>TSB, TCA2, TH, TSC, TR; Results |             |

CONTENTS (cont.)

|      |                                                |                        |
|------|------------------------------------------------|------------------------|
| 10.0 | Deviations from Baseline Configurations        | <u>Page</u><br>50 - 51 |
| 11.0 | Problems Encountered                           | 52                     |
| 12.0 | Recommendations                                | 53                     |
| 13.0 | Maintenance Plan for Solar System              | 54 - 57                |
| 14.0 | Major Components and Manufacturers' Literature | 58 -114                |
| 15.0 | As-Built Drawings                              | 115 -123               |
| 16.0 | IPC Certification                              | 124                    |
| 17.0 | Photographs                                    | 125 -130               |

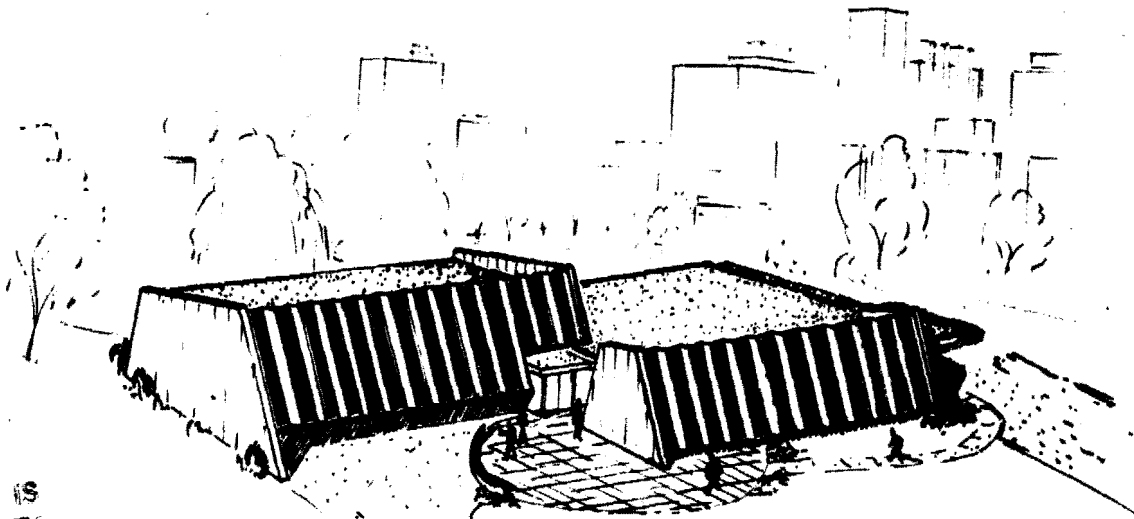


## 1.0 INTRODUCTION

This project is a retrofit solar system integrated with an existing building.

The original building was constructed in 1959 as a City of Huntsville central recreation facility. It included a gymnasium and other recreation program spaces totaling 12,000 sq. ft. of area. Subsequent municipal expansion required larger decentralized recreation centers which eventually relocated general recreation activities from this location.

In 1974, the original architect, W.R. Dickson, was commissioned to design an expansion and renovation project for the building to provide facilities for an active senior citizen's services and recreation program. The expanded total area completed in 1975 was 16,000 sq. ft. Concurrent with this design process, the City Council endorsed the architect's recommendations that the conversion project include heating and electrical modifications suitable for future interaction with a solar heating system and conservation modifications. These measures required an additional investment of about \$25,000 at that time.



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In 1976, the City of Huntsville sought and obtained a grant from the Energy Research and Development Administration for funding a solar demonstration project. The city provided necessary local funds. Total budget for the project from these combined funds was \$188,210.

The existing building is of conventional concrete block and brick bearing wall construction with flat roofs and insulating deck plank on steel joist structure. High bearing walls are reinforced with masonry pilasters accentuated on the exterior as an architectural motif. Floor structure is concrete slab on grade. Existing heating is by gas-fired hot water boiler and cooling is by conventional air-cooled refrigeration for chilled water. Distribution is by hot or chilled water pumped throughout the building typically to zone-controlled fan coil cabinet units.

1.0 (cont.)

The solar system was designed to provide 85% of the estimated annual space heating load and 85% of the estimated potable hot water requirement. The back-up hot water is provided by one 60 gallon gas hot water heater.

The solar energy architectural collection system consists of 1795 square feet of Halstead Mitchell fin tube absorber plates mounted in a box cast into Corotherm (prefabricated light weight concrete/fiberglass panel) with excellent thermal resistance. The absorber plate is covered with a single glaze, low iron, tempered glass pane. The 3,000 gallon water storage tank is located behind the Corotherm panels which are structurally self-supporting. The solar heat transfer fluid is Dow Corning Syltherm 444 Silicone Fluid which allows the fluid to be pumped at -121°F and generates essentially no vapor pressure at 600°F. This alleviates the need for freeze protection through the system draining procedures. The low vapor pressure allows for a simple closed loop design with no provisions for stagnation conditions. When the system load and storage capacity have been satisfied, the solar panels simply sit with the fluid in them.

The architectural solar collectors are grouped in two arrays. The solar collectors Array A consist of thirteen (13) collectors 26 feet in length mounted on a integral toe footing anchored with a continuous mounting angle. The solar collectors Array B consist of eleven (11) collectors 26 feet in length and four (4) collectors 19 feet in length mounted on angle stand-offs approximately eight feet above existing ground level grade. All of the solar collectors are facing due south at a fixed tilt angle of 60 degrees.

The project was initiated in May, 1978, and was operational in December, 1978, with the completion of the acceptance test. The solar project was dedicated December 19, 1978.

In addition to technological factors herein, the author places particular emphasis on architectural design considerations. The project is at the visual center point of the heart of Huntsville Civic Center park area, and the visual impact is significant.

## 2.0 SUMMARY OF PROJECT INFORMATION

Owner: City of Huntsville  
Huntsville, Alabama  
Project Manager: Glenn E. Wallace  
City of Huntsville, Alabama  
Designer: Project Architect - Dickson & Associates  
Huntsville, Alabama  
Solar System - Solar Unlimited, Inc.  
Huntsville, Alabama  
Contractor: Parker Construction Company  
DOE Technical Management: NASA/Marshall Space Flight Center, Alabama  
Operational Date: December, 1978  
Building: Senior Citizens Center  
16,000 square feet  
Location: City of Huntsville  
300 Church Street  
Huntsville, Alabama 35801

### CLIMATOLOGICAL DATA

Latitude: 34°-4'N  
Heating Degree Days: 3070 yearly  
Average Temperature: 60.8°F  
Average Insulation: 1400 BTU/ft<sup>2</sup>/day

### SOLAR ENERGY SYSTEM

Solar Collector Type: Flat Plate  
Glazing: 1/8" Single Pane Tempered Water White Crystal  
Absorber Description: Fin & Tube  
Absorber Coating: 3M Nextel  
Transfer Fluid: Dow Corning Silicone Oil  
Tilt Angle: 60°  
Total Area: 1795 ft.<sup>2</sup> Net  
Manufacturer: Solar Unlimited, Inc.  
Huntsville, Alabama  
Application: Heating - 85%  
Hot Water - 85%  
Storage Medium: Water  
Container: Above Grade Steel Tank  
Capacity: 3,000 gallon

### BACK-UP ENERGY SYSTEM

Space Heating: Gas Fired Boiler - Hot Water Type  
Hot Water: One 60 gallon Gas Heater

## 2.1 SUMMARY OF PROJECT COST

| <u>Cost Element</u> | <u>Estimated Cost</u> | <u>Actual Cost</u> |
|---------------------|-----------------------|--------------------|
| System Design       | \$ 12,000             | \$ 12,000          |
| Solar Hardware      | 76,834                | 79,834             |
| Construction        | <u>95,700</u>         | <u>96,376</u>      |
| Total Project Cost  | \$184,534             | \$188,210          |

|                    |           |
|--------------------|-----------|
| <u>DOE FUNDING</u> | \$121,937 |
|--------------------|-----------|

### **3.0 PROJECT CHRONOLOGICAL**

**February, 1977** - The City of Huntsville was advised that its proposal in response to Program Opportunity Notice DSE-76-2 for a solar energy demonstration project had been selected for negotiation of a cooperative agreement.

**September, 1977** - The City of Huntsville was awarded a contract which stipulated ERDA (DOE) would pay \$121,937 of the estimated cost.

**January, 1978** - The Final Design Review was held with Planning Research Company and Marshall Space Flight Center personnel.

**February, 1978** - A Pre-advertisement Conference was held to acquaint interested contractors with the proposed solar demonstration project.

**May, 1978** - A Pre-construction Conference was held with the General Contractor and his sub-contractors to discuss construction and scheduling.

**May, 1978** - The Notice to Proceed was given to the General Contractor, Parker Construction Company, Inc., and the Contractor immediately started site preparation and concrete foundation work for the ground mounted solar collectors.

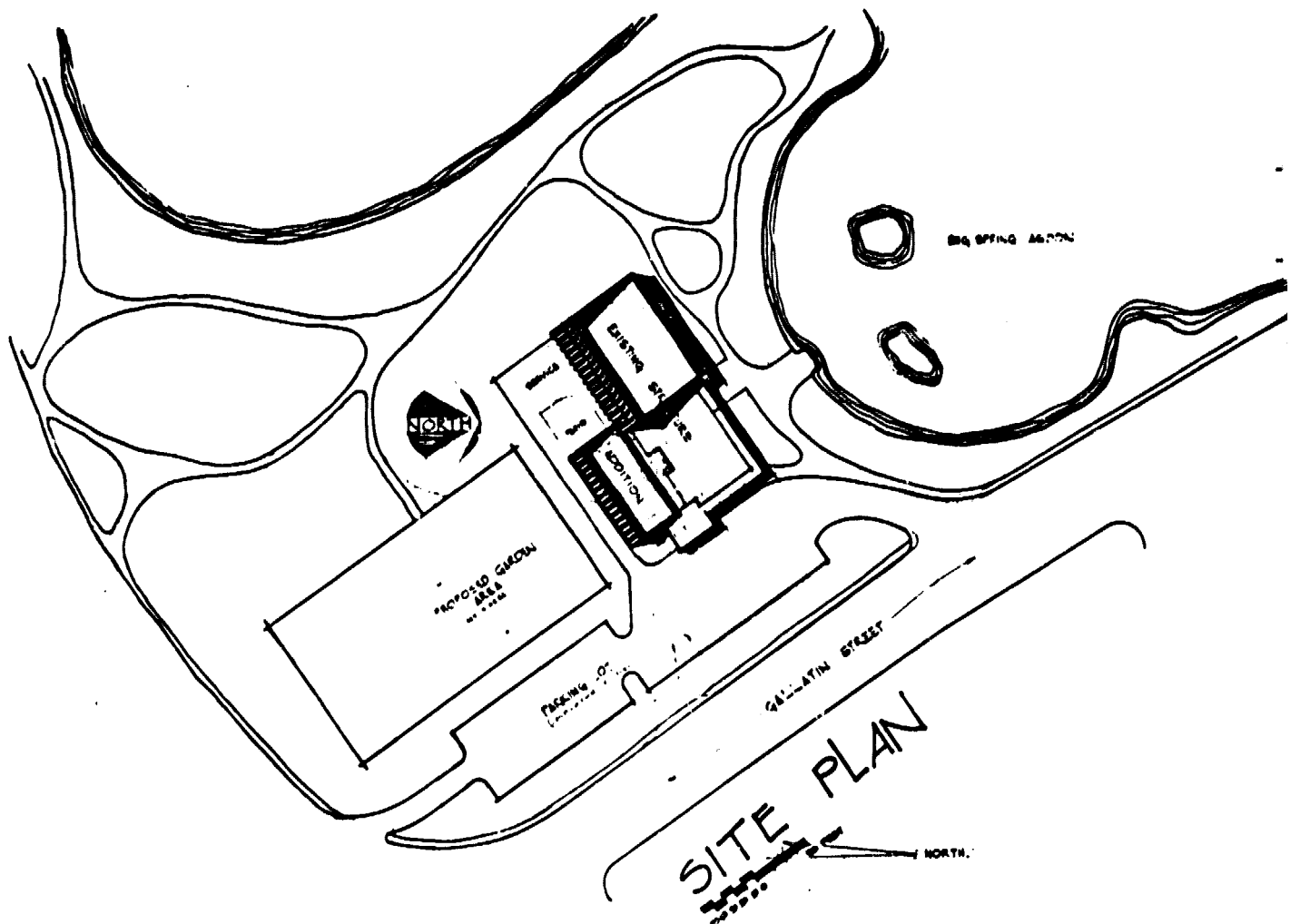
**June, 1978** - The collector supports were installed and 100% of the concrete work was completed.

**July, 1978** - 50% of the collectors were mounted to steel supports and the 3,000 gallon steel storage tank was installed.

**September, 1978** - The solar collectors were pressure tested for possible leaks with no substantial pressure loss.

**October, 1978** - The project was completed and the final inspection of the work was performed by the Owner, Architect and Solar Unlimited, Inc.

**December, 1978** - All acceptance tests were completed and the system was operational. The Open House and the Dedication Ceremony were held on December 19. Dr. William Lucas, Director of the National Aeronautics and Space Administration/George C. Marshall Space Flight Center, was key note speaker to a group of approximately 125 guests.



#### 4.0 DESIGN PHILOSOPHY

Basic requirements of the design criteria were to develop a cost effective solar system design to heat the building and its hot water supply with minimum back-up by the existing conventional gas-fired boiler system.

Criteria required 85% of heating to be provided by solar energy and solar preheating of hot water for 85% of requirement.

4.0 (cont.)        Uniquely affecting the design criteria were two project location factors.

1. As a major space technology center, the City of Huntsville is a community devoted to a "fail safe" philosophy. The design criteria developed, therefore, included a "fail safe" design approach.

2. The project is located at the visual center point of the Heart of Huntsville Civic Center park area surrounded by monumental civic building developments and civic activity. This required that the solar design must be integrated with the existing building without an add-on appearance. The design required should enhance rather than detract from the original building and its surroundings.

A third factor unique to this project is compass orientation of the existing building. The nearest-to-southward face of the rectangular building actually faces approximately 30° to the east of due south. This is a common situation for building sites in Huntsville, Alabama, because the original streets were laid out in directions rotated similarly away from due north, south, east or west. There is some conjecture that this was deliberately planned to provide some sunshine exposure to all building facades. This project criteria, therefore, included a requirement for a solution to this problem of orientation.

## 5.0 SOLAR SYSTEM DESCRIPTION & HARDWARE

The basic solar system selected is an active system which combines flat plate absorbers with specialized collector fluid transfer loops through heat exchangers which transfer heat to hot water storage loops and the storage tanks.

Domestic hot water is preheated by a separate double-walled heat exchanger in the collector fluid loops by way of a domestic water supply loop with pump and a standard hot water storage tank which supplies preheated water to a standard gas hot water heater.

### 5.1 SOLAR ARCHITECTURAL PANELS

The manner in which architectural effects and solutions to orientation problems are integrated with this solar system is of special note.

The integrated pre-assembled solar architectural panel design incorporates cover glass, solar absorber plate and insulation backing, all integrated into a precast, thin shell, glass reinforced concrete solar architectural panel.

Panels are mounted on the side of the building which faces 30° to the east of due south according to the existing orientation. Panels are formed into a triangular section. The exposed face is in two planes each at 30° from the plane of the panel back, placed opposite and symmetrical to form a ridge at the centerline. Absorber plates and glass covers are mounted into a preformed recess in the westward of these plane faces. This arrangement tilts the absorber plate face toward the south. (See Figure 3)

The single sheet cover glass used is of standard size, 34" x 76", 1/8" thick, tempered, water white crystal. One face has a diffusing texture. Glass is furnished and installed by Solar Unlimited, Inc.

Absorber plates are furnished and installed by Solar Unlimited, Inc.

These are aluminum fin and single-row copper tube construction. Fins on the back side are folded over to close the back. The absorbing faces are spray painted with flat black solar absorbing paint.

The fin tube configuration entraps diffused radiation from a wide range of directions and, consequently, test results have indicated that these absorbers maintain a relatively higher solar absorption rate under light overcast conditions.

The insulation system behind the absorber plates is integrated into the panel sandwiched into the glass-reinforced, thin shell concrete structure during the casting process. This insulation consists of a honeycomb paper with polystyrene beads all encased in the thin shell concrete.

Each panel contains an absorber plate 32" x 300", each with total absorber surface area of 66.7 square feet per panel. Twenty-four typical panels are used and four panels which are one-quarter shorter are adapted



5.1 (cont.) over a building exit. Total absorber surface provided is 1,795 square feet.

The weight of each 26' long, typical, fully-assembled architectural solar panel is approximately 3,000 lbs. Each completed panel assembly, including cover glass and seals, absorber plates which were pressure-tested during assembly and integral insulation system, was installed as a complete unit. These completely assembled units were furnished to the site by Solar Unlimited, Inc.

Each unit was placed on pre-installed steel mounting angles with a boom crane. Panel delivery and crane time were coordinated and the total crane time required is estimated at about 6 days.

Typical panels are 6.5 feet wide and 26 feet long and are self-spanning. These are provided with integral steel weld plates at bottom and at 5'9" from the top. These are welded to continuous horizontal steel angle mounts, supported by steel angle struts, anchored to masonry bearing walls. The panel supplier provided a special lifting harness for built-in lifting loops. The tops of the panels rise above and overhang the existing flat roof (2.5 feet). The entire system thereby requires no penetration of the flat roofs. Weather flashings are installed on the backs of panels to overlap existing roof edge flashings without modification to the existing flashings. (See Figures 3 & 4)

The existing bearing walls of the building and footings were analyzed for additional vertical load-carrying capacity and for resistance to lateral thrust of stand-off struts. The existing structure proved to be more than adequate without further reinforcement. Some oversizing of the original building pilaster system for decorative purposes contributed some useful margins of safety evidenced in these analyses.

Two solar architectural panel collector arrays are installed on the southward side of the building.

The westward array is mounted to the original high gymnasium masonry bearing wall. The bottoms of these panels are seated into a horizontal steel mounting angle with horizontal steel stand-off struts eight feet above floor level. A flat plywood soffit is installed below. This array contains 15 panels.

The eastward array is mounted into the masonry bearing wall of the more recent addition to the building. The bottoms of these mount on a new concrete slab edge. The 6" reinforced concrete slab with turn-down slab edge footing extends 10'4" from the wall at 2" below building floor level. This mounted array provides a generous enclosed space triangular in section behind the panels. This space is the location for main hot water storage and major portions of manifold piping, pumps, exchangers and other mechanical equipment and controls. The eastward array contains 13 typical panels.

The overall assembly provides a unique and bold architectural motif on the southward building facades.

## 5.2 MANIFOLDS AND PIPING

Main solar heat collector fluid supply and return manifolds are suspended behind panels with tee connections located 30 inches behind each supply and return stub-out connection from absorbers through the panel backs. Final connections from absorbers to manifolds are made with soft copper tubing adapted with long sweep bends and soldered connections throughout.

The entire piping system, therefore, is provided with complete freedom for expansion without the use of special expansion joints or any type of rubber or synthetic type of coupling material. All piping is copper with high temperature solder joints. Copper expansion loops only are used where needed at collector manifolds. Valves and mechanical joints are minimized.

## 5.3 COLLECTOR LOOP TRANSFER FLUID

The collector loop transfer fluid merits special note. A total of 230 gallons of Dow Corning Syltherm 444 silicone fluid is installed into two separate solar absorber collector loops. The high boiling point (600° F) and the low freezing point (below -121° F) of this fluid are relied on to prevent problems with high stagnation temperatures and extreme freezing conditions. This fluid is virtually inert chemically, non-toxic and non-corrosive and is intended to be permanently enclosed within the collector fluid loops. These loops were completely sealed after the fluid installation. Thermal expansion of the fluid is absorbed by a sealed air chamber expansion tank at an appropriate point in the loop. (See Figure 6)

Pumps in these loops are in-line canned types or types which incorporate mechanical seals. It is believed that this system will prove to be "fail safe" with virtually no maintenance other than pump replacements relating to pump life cycle expectancy. Isolation valves are provided to facilitate pump replacement. Heat exchangers are tube-in-shell type. These transfer heat from silicone oil in collector loops to water in storage loops to storage tanks.

The high initial cost of the silicone fluid is offset by a smaller investment being required for freeze control, fluid replacement and maintenance, and other preventive maintenance measures.

## 5.4 PIPE INSULATION

All piping and components except pumps are fully insulated with standard jacketed fiberglass or foam rubber insulation systems.

## 5.5 HOT WATER STORAGE FOR HEATING

A 3,000 gallon cylindrical steel tank provides the required hot water storage for building heating. This tank is insulated with blocks of 4" thick urethane foam insulation banded in place and wrapped with

5.5 (cont.) a 2" wide aluminum foil tape. The overall "R" factor is 32. The tank is connected to the main building hot water distribution loop with supply and return mains. A controlled by-pass valve system provides for the occasional operation of supplementary gas-fired heating from the existing building boiler. The hot water heating distribution system has an atmospheric-vented expansion tank and contains only water.

#### 5.6 CONTROL SYSTEM

The control system is a 24-volt system designed by Solar Unlimited, Inc. with sensors in each collector array and other components to operate pumps and valves in accordance with the control logic developed in their design. This system incorporates night set-back controls of the building thermostats.

## 6.0 PROJECT ENERGY CONSERVATION MEASURES

Previous conversion of the original gymnasium space for senior citizen's activities required subdivision of the space into numerous smaller rooms. New partition systems and a new suspended ceiling at 10' height was installed including four-inch batt insulation throughout. The combination of existing roof deck insulation factors, the remaining large volume of dead air space above the new rooms and new ceilings and insulation results in a much improved thermal barrier.

Included with this solar system project effort were other modifications to the building for energy conservation.

A continuous area of single-glazed existing windows totaling 945 square feet was reduced by half by applying 1" polystyrene bead board and interior and exterior facing panels and trim over alternate window units. The remaining window units were reglazed with thermopane glazing. In addition, 225 square feet of existing single 1/4 inch plate glass entry treatment was double glazed with the addition of another plate glass with a 1-inch air space between.

The exposure of the east and west walls was reduced by the installation of new screen wall architectural treatments. Although these are primarily architectural treatments, some thermal barrier assistance was calculated as a result.

Two inches of polystyrene board insulation was applied to a 12-foot height on the west end of the building behind new screen walls.

These combined conservation measures are calculated to reduce the building heat loss of 85,275 BTU/hour at standard design conditions.

## 7.0 SITE PLANNING

Within a two block radius and in direct line of site surrounding this project are a 12-story hotel, a modern 10-story bank building, a monumental antebellum Greek Revival bank building, a modern 10-story county courthouse complex, a 10-story city municipal building complex, a modern 4-story parking garage, a modern 3-story telephone company office building, a modern library, a modern chamber of commerce building, a large modern bank computer center, a major new office complex, a new Hilton Hotel and the recently completed \$13,000,000 Von Braun Civic Center Auditorium complex. This project is the only building situated in a 16 acre open park area which includes a large lagoon. It is surrounded by major streets and buildings listed above.

The solar design team, therefore, required appropriate architectural values.

In addition to technological solutions required of them, the solar architectural panels were exploited to provide a bold sculptured treatment to the southward facade of the building. Careful attention was given to proportioning and positioning. Panel height determination, etc. were studied in relation to establishing dimensional modules of solar glazing and absorber plates. The solar engineering determinations which established panel slopes were fixed criteria to which other building lines and massing must relate.

Screen wall closures were developed to close the ends of the two solar architectural panel arrays and were extended as new screen wall facing treatments over existing east and west building wall faces. These were developed with a sloped parapet effect above existing roofs with the high point at the tops of solar panel arrays. Low points in the parapet effect are only slightly above existing roofs toward the north side of the building.

From most viewpoints, this effectively screens existing roof-mounted equipment and the backs of solar panels exposed above the roofs.

The massing effects of this treatment tends to harmonize the unchanged portions of the existing building with the imposing scale of the solar installation. (See Figures 1 & 5)

The original building brick which remains exposed is a warm buff color and overhanging cornices have a sandy buff-colored exposed aggregate treatment. The solar architectural panels were constructed with an intergrally-colored cement to produce a blending buff color. The end screen wall panels were surfaced with a sandy buff, exposed aggregate surface matching existing cornice treatments.

All window and door frame and trim work is painted dark brown to blend with the brown patina of existing weathered copper cornice flashings and trim. Copper, treated to develop this patina, was used as a cap flashing and trim for new screen walls.

## 8.0 CONTROL LOGIC AND MODES OF OPERATION

### 8.1 CONVENTIONAL BACKUP ENERGY SYSTEM

The existing system provides both heating and cooling. Since this project deals with solar heating, little explanation will be given to the cooling system.

#### Transport Between Systems

Water is the medium of heat transfer. All piping is type L copper insulated with 3/4 inch thick closed-cell expanded-foam insulation. Piping design consists of a low-velocity chilled water loop interconnected with a hot water loop. Required quantities of water to handle the heat load and/or cooling load are determined by the respective chilled-water pump and hot-water pump.

The building is zoned with each zone having a copper piping system, commonly referred to as a reverse-return system. The pressure drop of each zone and terminal unit is handled by its respective zone pump. This type of system is commonly referred to as a primary-secondary pumping system.

#### Cooling System

Cooling is accomplished with a conventional system which pumps water through an air cooled chiller and into a multi-loop circulating water system. The cooling system is not solar or solar assisted.

#### Heating System

The existing system was designed to be used as auxiliary system to a solar system.

It consists of a gas-fired-sectional-cast iron boiler, a 1/2 horsepower circulating in-line pump and related expansion unit and air removal devices. The boiler is manufactured by Weil McLain and has a wet rating of 591.3 M BTU/hr.

#### System Operation

Based on outdoor temperature, either the chilled-water pump or the hot water pump is placed in operation. An adjustable deadband precludes either the hot pump or the chiller pump from operating. This occurs when the ambient air temperature is such that the internal building loads balance the heat loss through the walls. It is adjustable since the internal load caused by people is subject to variation. Each zone, office, craft room or meeting room has its temperature controlled by an individual unit-mounted thermostat. These thermostats are in series and are controlled by an automatic changeover thermostat. Room units which are exposed on an outside wall have a motor-operated damper which allows 25 percent fresh air to be introduced into the room. The unit thermostats (controlling the room air temperature) have a two stage heating

8.1 (cont.) and single-stage cooling mode of operation. If the system is in a cooling mode, a temperature drop of one degree below the setting will cause a three-way valve to by-pass chilled water to the return line. A further drop in temperature causes a mild weather electric heating coil to turn on even though the system as a whole is in a cooling configuration. When the outdoor thermostat changes the system from the cooling mode to the heating mode, the electric coil no longer functions and the changeover thermostat reverses the action of the room thermostat so the entire area is heated by hot water.

## 8.2 CONTROLS

The addition of solar heating capability to the Senior Citizen's Center requires special consideration be given to the operational controls. These controls are designed to maximize the benefits made available by the addition of the solar system while maintaining the identity of the present conventional gas based system. This permits use of the solar heating system as the primary system retaining the present heating system for peak load requirements and back-up.

The design of the control system provides for five modes of operation. Each operational mode is configured to make best use of the thermal and mechanical resources available for use during its particular portion of system operation. The five modes of operation are:

- Direct Solar Heat (DSH)
- Domestic Hot Water (DHW)
- Heat From Storage (HFS)
- Store Solar Heat (SSH)
- Back-up Heating System (BHS)

The present heating system utilizes a gas-fired boiler as the heat source for a multi-loop circulating water system. The boiler operates in an ON-OFF mode with the primary distribution loop temperature maintained by a thermal control valve. The excess temperature of the primary loop is set to a ratio of 1.5 times the difference between the interior temperature (70° F) and the outside ambient temperature. This variable operating temperature must be given proper consideration in this solar energy control system design.

The control system design is based upon the measurement of temperature at several points within the system, determining the requirements for heat transfer, and initiating the appropriate system actions. These actions take the form of selecting the proper paths through the system piping and turning on one or more pumps as appropriate. Provisions have been made to isolate the solar energy system from the current gas-fired heating system should this become necessary for back-up operation or system maintenance.

Before proceeding with the detail system discussion it seems appropriate to define the changes made to the current system. First, a 3-way valve, VE, was installed in the piping leading to the low temperature side of the gas fired boiler. (See Figure 6) This valve network permits the gas fired system to constructively aid the solar energy system in supplying the heat requirements for the building. During periods when the solar system cannot provide any useful heat, this valve network will

8.2 (cont.) allow the functional separation of the solar and conventional systems. Thus, the conventional system is not burdened with any thermal losses caused by the solar system equipment.

The control electronics package for the thermal control valve was modified to gain access to a control voltage which is proportional to the desired primary loop temperature. This signal is then compared with similar signals within the solar energy control system to determine if solar energy is available to supply a portion of all of the required building heat.

The remaining modification was accomplished by connecting the Hot Water Pre-Heat Tank in series with the supply side of the domestic hot water system. These three modifications are easily identified on the system diagram since they are located near the dashed line used to separate the solar system components from the currently installed system. The solar energy system components are arranged into three sub-systems: the collector loop, the hot water preheat loop and the primary heat transfer loop. Each of the system loops has its components arranged to perform one or more functions. These loops provide the transport mechanisms that are utilized to collect solar energy and move it to some useful point within the system. If the collected energy is not immediately useful, it is stored for later utilization. Each of the five operating modes will be discussed in detail and during these discussions the function of each component will be presented. The operational modes are shown in Figures 7, 8, 9 and 10.

The collector loop is enabled when the temperature measurements indicate that solar energy is available from the flat plate collectors. Pump PA provides the head pressure required to circulate the heat transfer fluid through the collector loop. The flow rate is approximately 100 GPM. After passing through the collector array the fluid passes through two series connected heat exchangers, HE1 and HE2. HE1 is a small diameter device, 1/2 inch piping, that serves to transfer heat to the domestic hot water preheat tank. The other exchanger, HE2, is a larger diameter device; 2 inch piping is used to transfer heat to the primary storage loop. A hand operated valve, VA, is used for controlled by-pass of HE1 for the major part of the flow in this loop. This particular configuration permits the use of a small size exchanger for HE1 that utilized double-wall construction for code compatibility while allowing the use of a single-wall, large diameter device for the primary loop transfer. An expansion tank and air purge valve are installed at the highest point of this loop. The control system connection to this loop consists of a temperature comparison of collector outlet temperature with the storage tank temperature or the hot water preheat temperature to give a single control command to turn pump PA on or off.

### 8.3 DIRECT SOLAR HEAT (DSH)

During the time when sufficient solar energy is available to meet the total heating requirements of the building, the DSH mode of operation is initiated. (See Figure 7) The energy available in the collector loop is transferred to the primary heat transfer loop by HE2. Pump PC transfer circulates the heated water throughout the primary loop. The thermal control valve will provide any adjustment required to maintain the appropriate loop temperature.



8.3 (cont.) The DSH mode is activated when the collector temperature, TC, is 20° above the temperature set point, TD, of the thermal control valve. This mode is terminated when the temperature difference drops to 10°F. Precautions are taken against any overtemperature condition existing within this loop. The current system design limit of 19° F and an excess ratio of 1.5 against the building temperature of 70° F gives a maximum working fluid temperature of 146° F. In those cases where the primary supply temperature, TP, exceeds 160° F, the direct mode is modified by changing the position of valve VB to return the supply water through the storage tank. This will provide near optimum sharing of the available solar energy by supplying building needs while at the same time storing excess heat for future use.

#### 8.4 DOMESTIC HOT WATER (DHW)

The solar energy system is used to supply domestic hot water. This mode is initiated when the collector temperature, TC, is 20° F greater than temperature of the water contained within the pre-heat tank, TH. The hot water preheat loop uses heat exchanger HE1, pump PB, and the preheat tank. (See Figure 8) This mode requires operation of the collector loop. The possibility of unsafe temperatures could be introduced in the DHW storage tank. To circumvent this problem, an independent thermal cut-out switch, TZ, is located near the pump inlet. This switch will open the power leads to pump PB when a temperature of 180° F is reached, and the DHW loop will be provided with an independent overtemperature control to prevent excessive temperature buildup.

#### 8.5 HEAT FROM STORAGE (HFS)

The solar energy reserve in the primary storage tank is used to provide heat when the level of solar insolation does not permit direct heating. In this mode of operation, See Figure 9, the primary heat transfer loop is enabled to transfer heated water from the primary bulk storage tank to the main building supply loop. This is accomplished by opening valve VB, turning on pump PC, and closing valve VE. The bulk storage temperature, TS, is composed with the set point temperature as indicated by the thermal control valve electronics package. When the demand temperature is higher than the water temperature in the bulk storage, the gas fired boiler is enabled. This permits the boiler to be used as a "super heater" thus providing the peak heating demand. The use of heat from bulk storage is continued until the temperature of the building return water, TR, is greater than the temperature, TS, of the bulk storage.

#### 8.6 STORED SOLAR HEAT

The excess solar energy available is stored in the primary bulk storage tank. This storage is accomplished by enabling the collector loop and certain components of the primary heat transfer loop. Pumps PA and PC are turned on and valve VB is opened along with closing valve VE. (See Figure 10) This mode of operation is enabled with the collector temperature, TC, is 20° F greater than the temperature of the bulk storage tank.

## 8.7 EQUIPMENT CONTROL SYSTEM

The control system proposed for operation of the solar energy system of the Senior Citizens Center gives due consideration to the optimization of the collection of solar energy, cost effective heat transfer operations and utilization of the existing investment in the current heating and cooling plant. The actual control signals required are derived from five temperature measurements and one control signal obtained from a thermal control valve in the existing equipment. An additional on-off thermal switch provides an over-temperature safety function for the domestic hot water preheat system. The control line leading to the gas valve on the gas-fired boiler is placed in series with a control output so that the boiler can be prevented from firing when sufficient solar energy is available to supply the building requirements.

Sensed temperatures will take the form of analog electrical signals. Electronic comparator devices will be used to translate the several temperatures and delta-temperatures to relay-logic levels. Relay-logic will then be used to derive the appropriate control signals. A manually operated switch is provided so that the system can be forced to operate in the back-up, gas-fired mode only. The mechanical engineer is then given the option of using the automatic solar energy system or the currently installed gas-fired system.

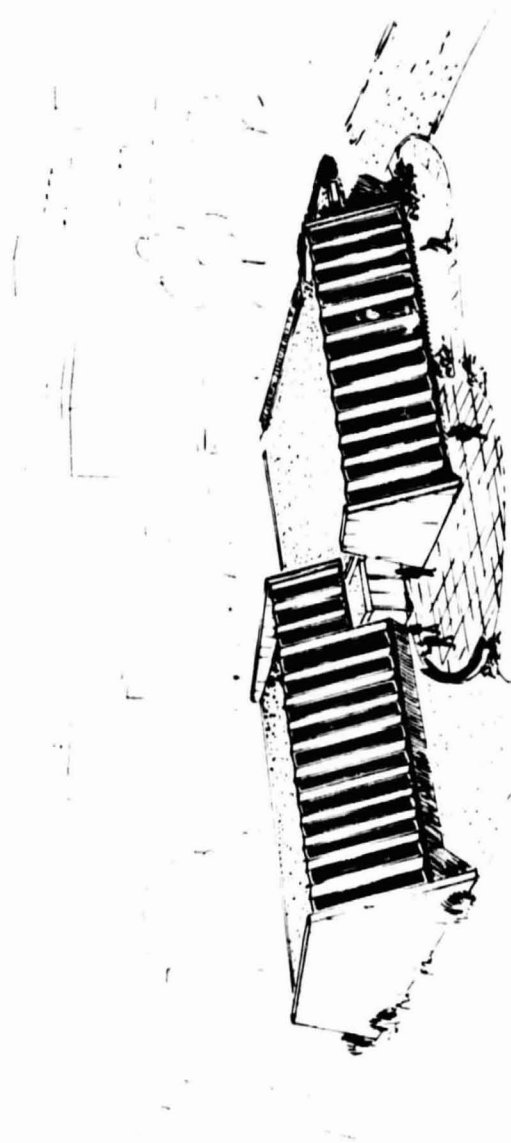


Figure 1

ORIGINAL PAGE IS  
OF POOR QUALITY

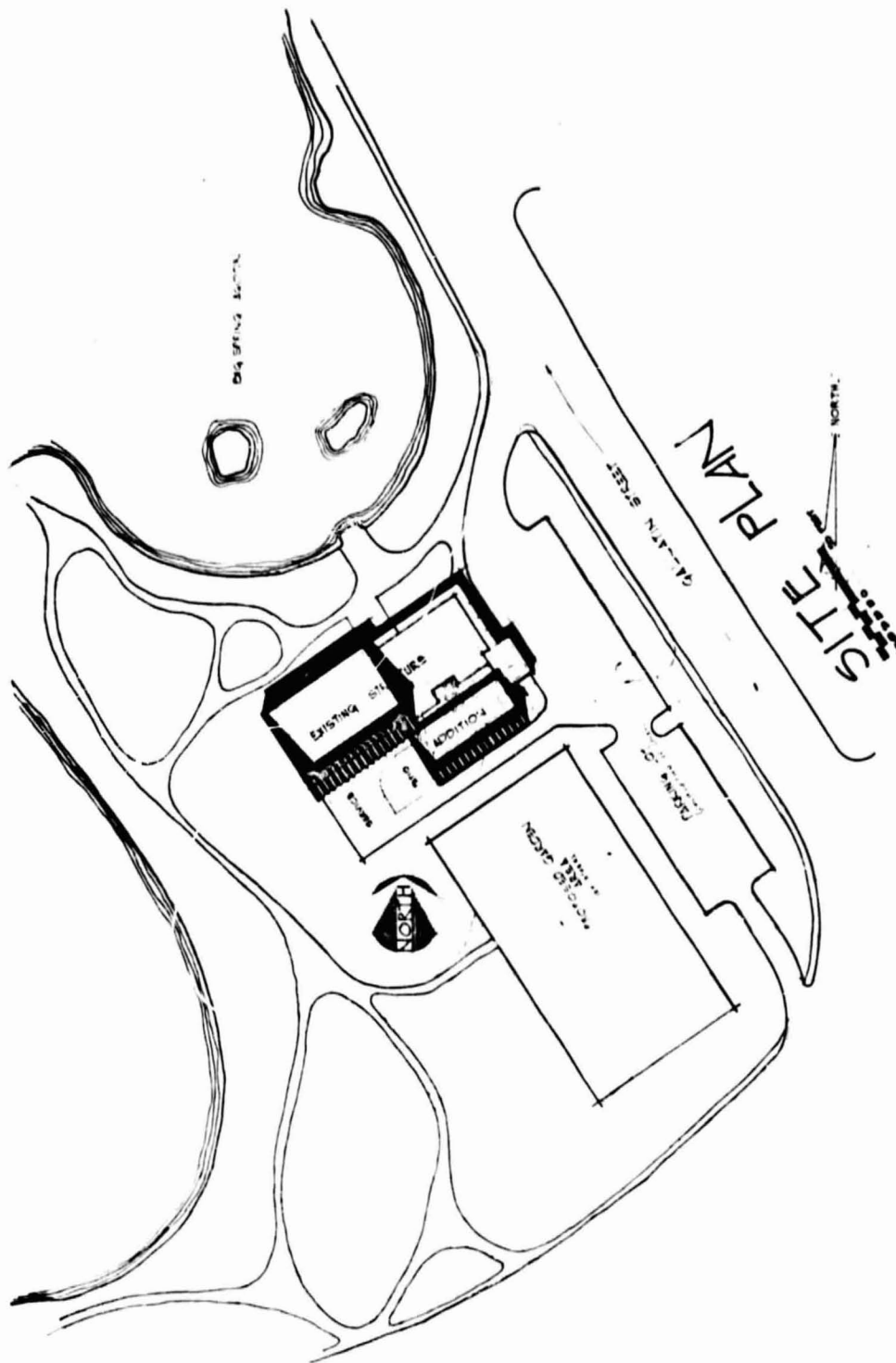


Figure 2  
Site Plan

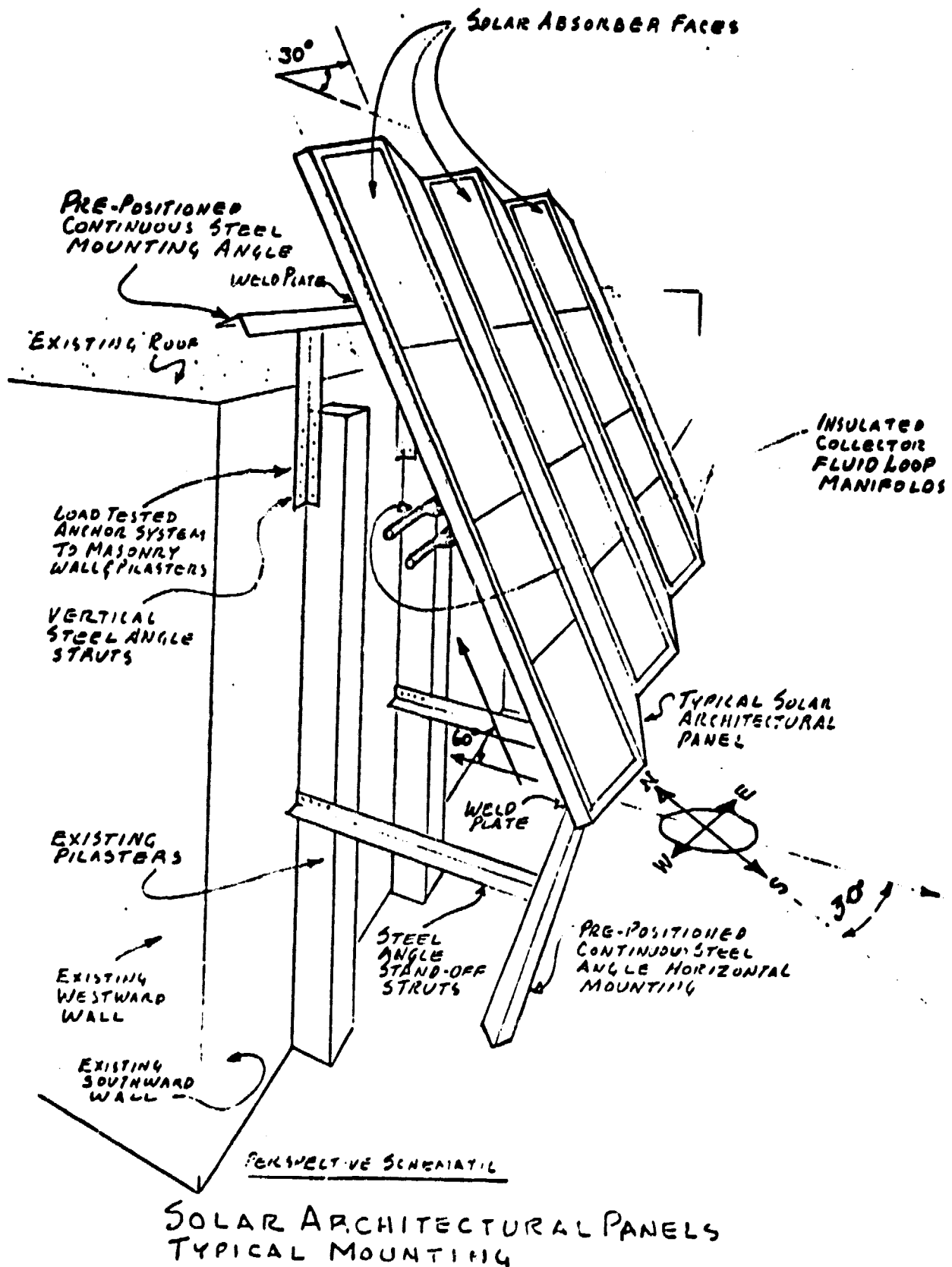


Figure 3

Cable lengths designed  
to lift panels in  
approximate mounting  
altitude.

Absorber and  
cover glass  
pre-installed

Typical solar architectural  
panel

Lifting-loops and hooks

Isometric lifting harness

No Scale

Figure 4

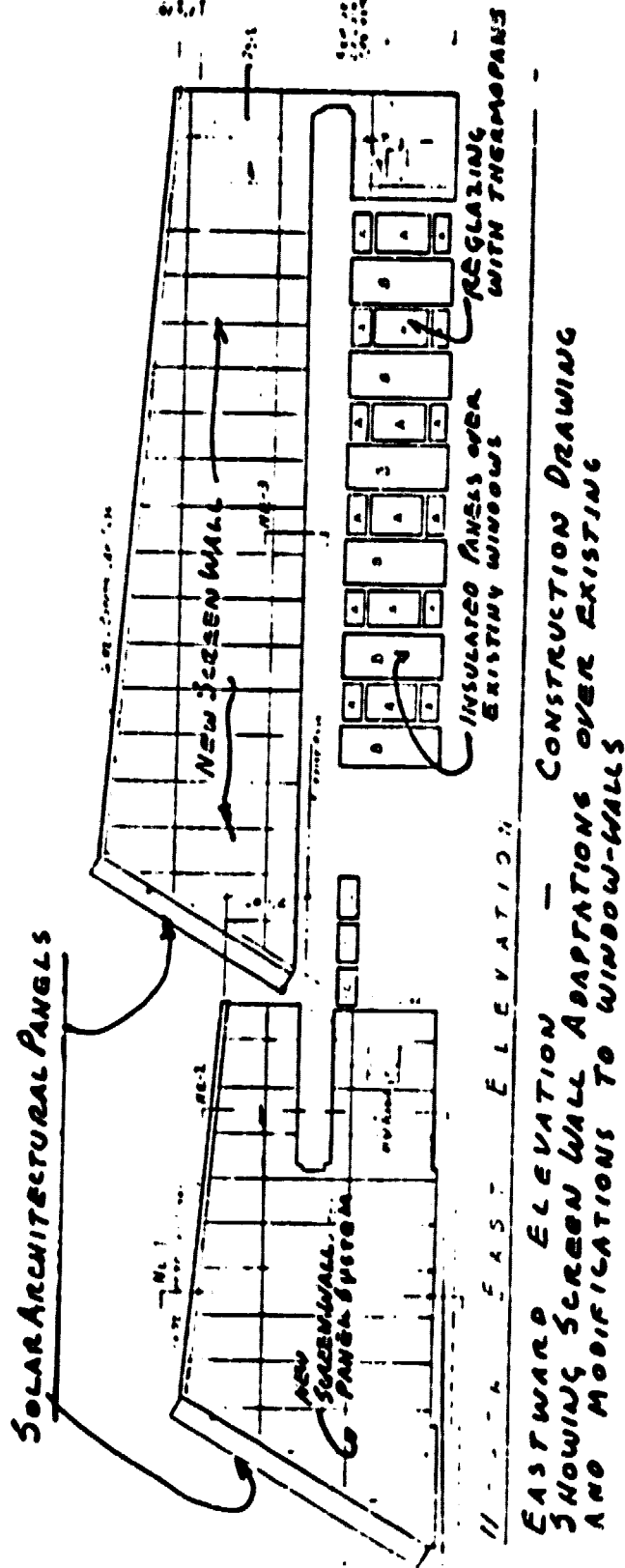
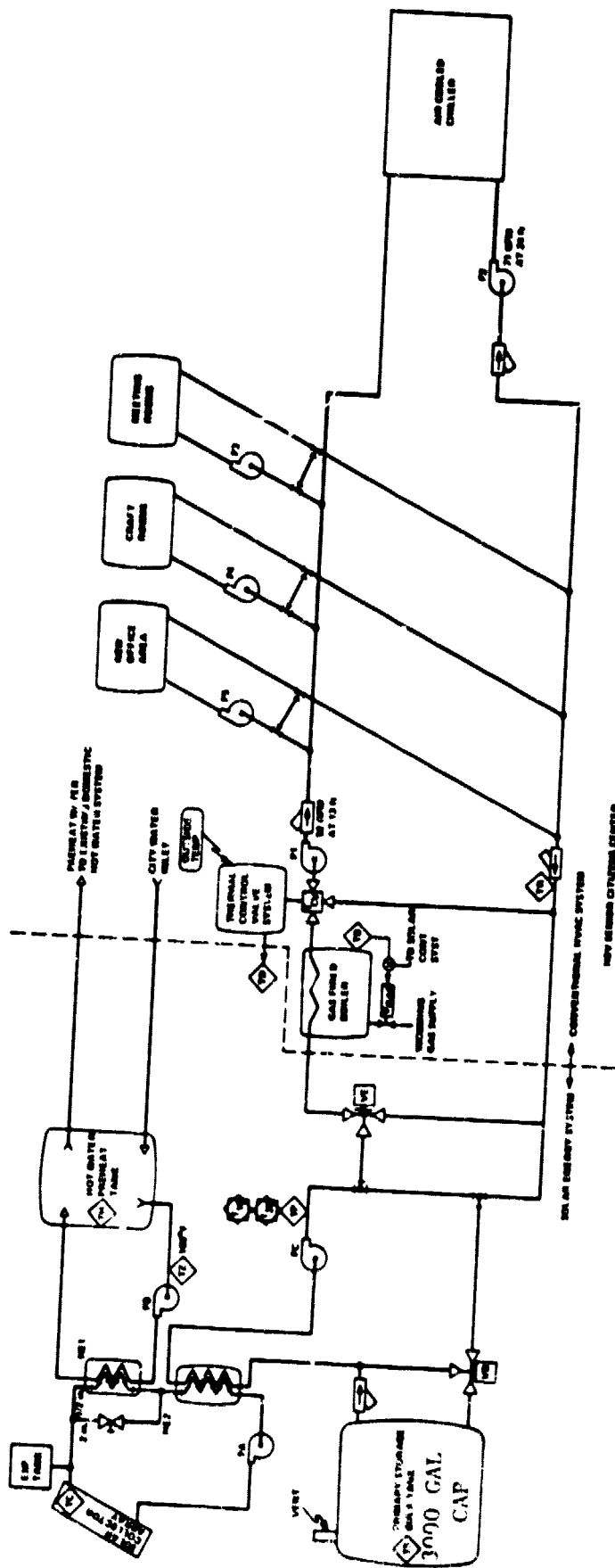


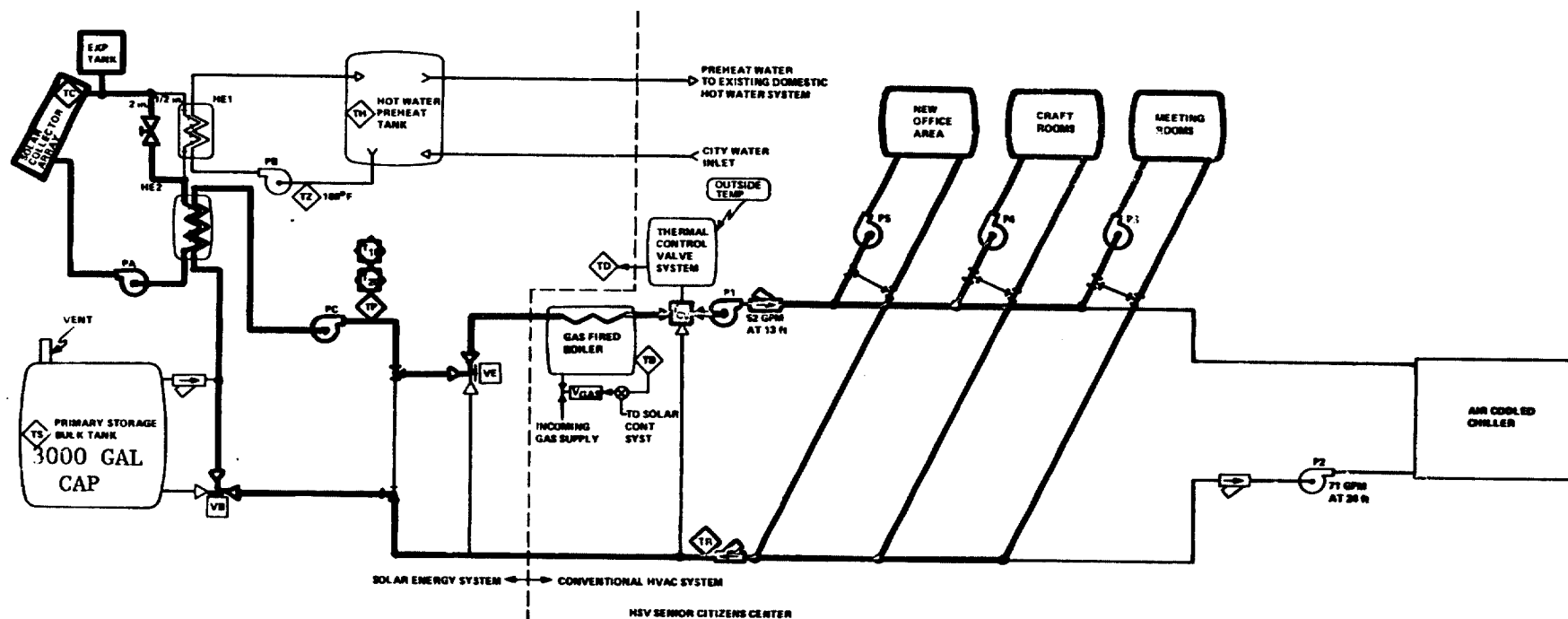
Figure 5



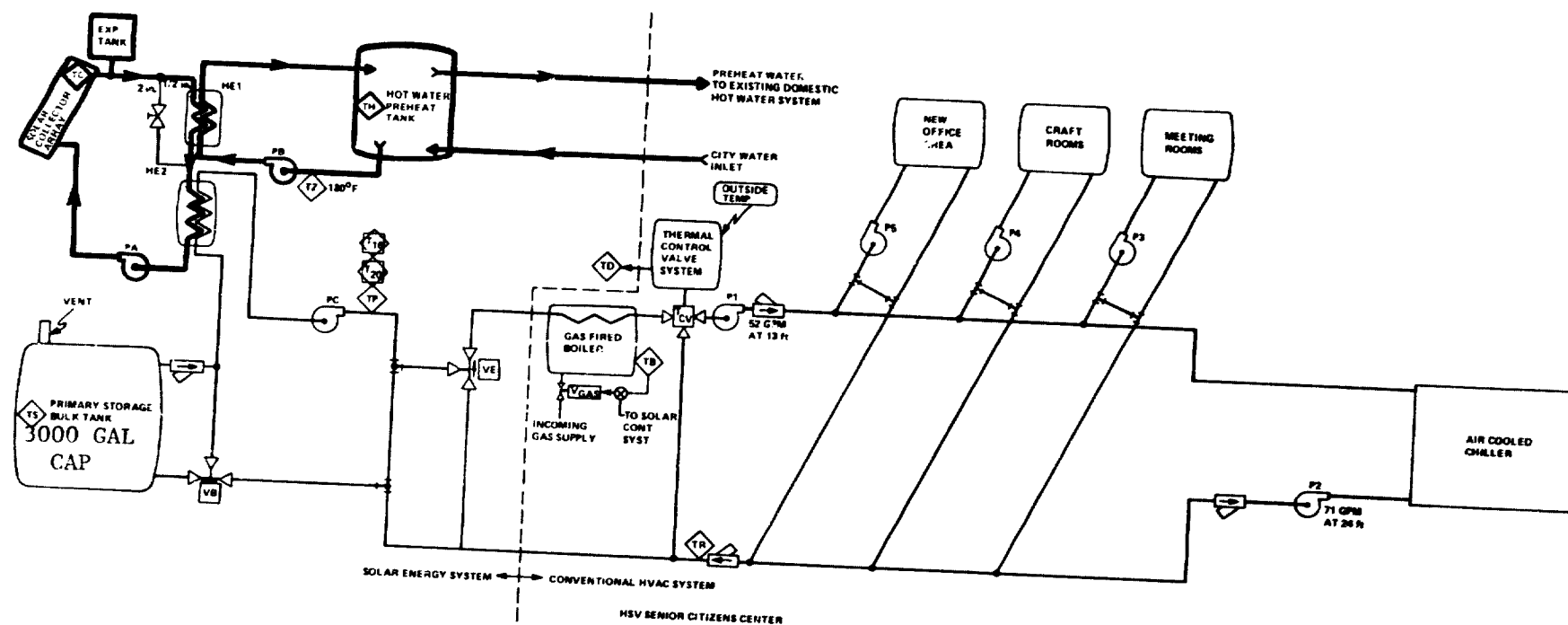
Total System Schematic

Figure 6

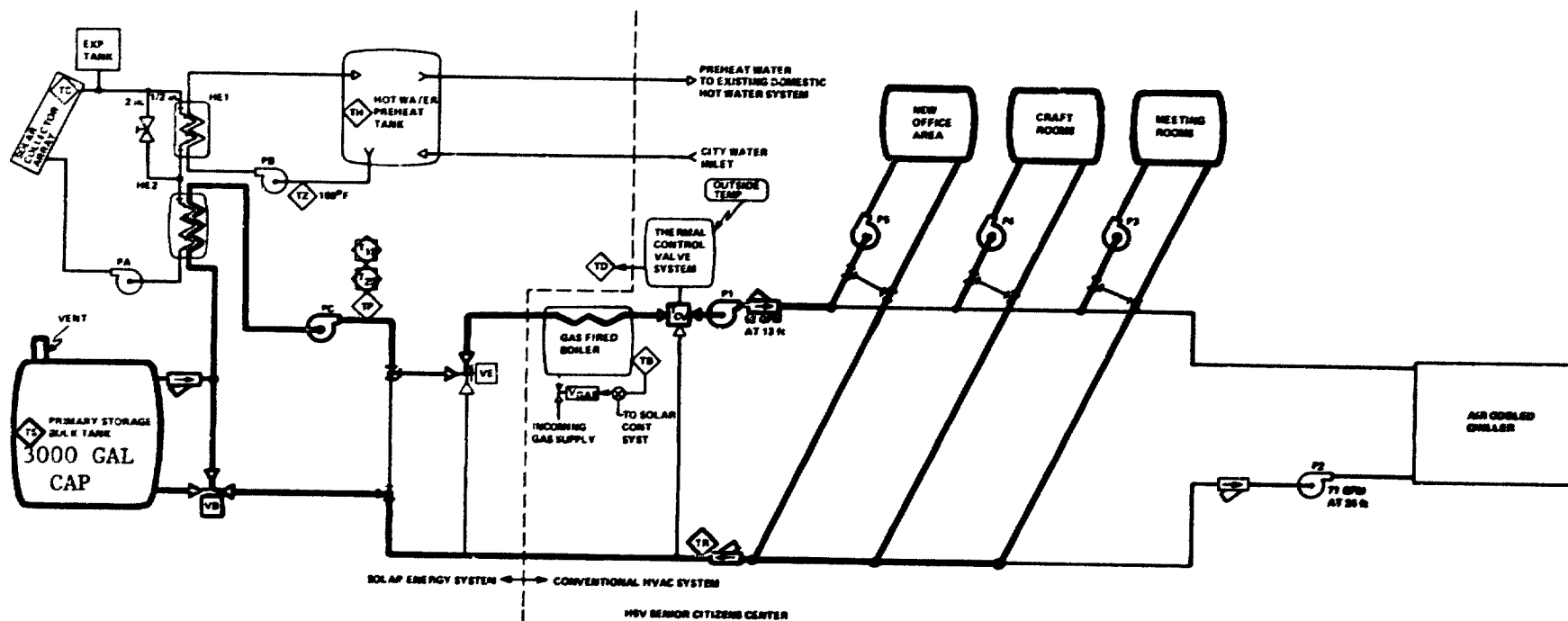




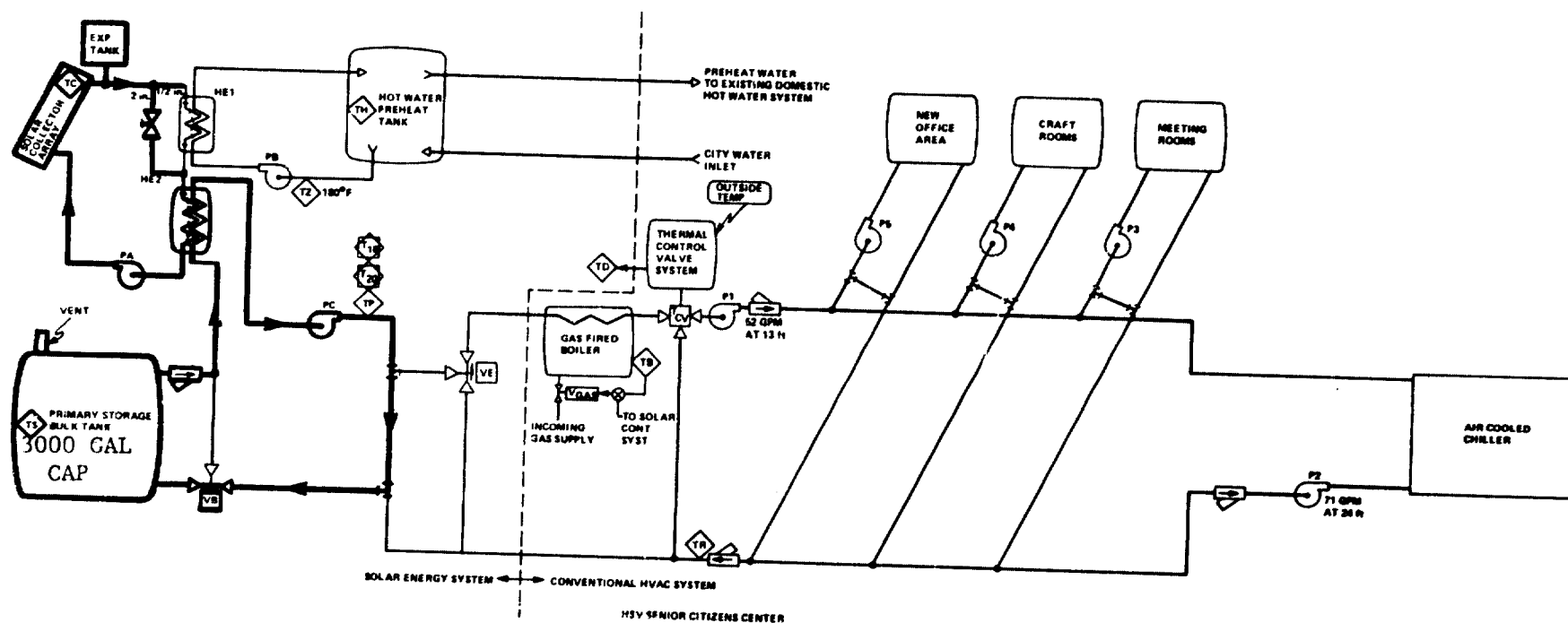
Direct Solar Heat Schematic  
Figure 7



Domestic Hot Water Schematic  
Figure 8



Heat From Storage Schematic  
Figure 9



Store Solar Heat Schematic

Figure 10

## 9.0 ACCEPTANCE TEST PLAN

### Test Objectives

The objectives of the acceptance test, through compliance with the acceptance test plan, are to 1) verify that each system component responds and functions within the manufacturer's specified limits; and 2) that the system responds and functions within the manufacturers' specified limits.

To achieve these objectives, each mechanical component and each electrical component was functionally inspected on site as an entity; and, finally, the system as a whole was inspected for function and for compliance with design specifications.

### OPERATIONAL MODES OF THE SYSTEM

|                                       | Direct<br>Solar<br>Heat | Domestic<br>Hot<br>Water | Heat<br>From<br>Storage | Store<br>Solar<br>Heat | Back-up<br>Heating<br>System | Summer<br>Cooling<br>System |
|---------------------------------------|-------------------------|--------------------------|-------------------------|------------------------|------------------------------|-----------------------------|
| Solar System<br>Equipment             | Pump DHW1               | -                        | ON                      | -                      | -                            | -                           |
|                                       | Pump PDHW2              | -                        | ON                      | -                      | -                            | -                           |
|                                       | Pump PA1                | ON                       | -                       | OFF                    | ON                           | OFF                         |
|                                       | Pump PA2                | ON                       | -                       | OFF                    | ON                           | OFF                         |
|                                       | Pump PB1                | ON                       | -                       | OFF                    | ON                           | OFF                         |
|                                       | Pump PB2                | ON                       | -                       | OFF                    | ON                           | OFF                         |
|                                       | Pump PH                 | ON                       | -                       | ON                     | -                            | OFF                         |
|                                       | Heat Exchanger HEDHW    | -                        | ON                      | -                      | -                            | -                           |
|                                       | Heat Exchanger HE1      | ON                       | -                       | OFF                    | ON                           | OFF                         |
|                                       | Heat Exchanger HE2      | ON                       | -                       | OFF                    | ON                           | OFF                         |
| Existing<br>Conventional<br>Equipment | 3-Way Valve VE          | THRU                     | -                       | THRU                   | BYPASS                       | BYPASS                      |
|                                       | Pump P1                 | ON                       | -                       | ON                     | OFF                          | ON                          |
|                                       | Pump P2                 | OFF                      | -                       | OFF                    | OFF                          | ON                          |
|                                       | Pump P3                 | ON                       | -                       | ON                     | OFF                          | ON                          |
|                                       | Pump P4                 | ON                       | -                       | ON                     | OFF                          | ON                          |
|                                       | Pump P5                 | ON                       | -                       | ON                     | OFF                          | ON                          |
|                                       | Boiler                  | OFF                      | -                       | OFF                    | OFF                          | ON                          |
|                                       | Chiller                 | OFF                      | -                       | OFF                    | OFF                          | ON                          |

## 9.1 ITEMS TO BE TESTED: PUMP PH, 1/2 HP AND VALVE VE1

TEST OBJECTIVE: Verify proper installation and operation

TEST PREREQUISITES:

- a) Proper physical mounting
- b) Prior piping pressure test
- c) Verify proper pump orientation
- d) Verify proper valve orientation and valve VE1 orientation for fluid flow direction
- e) Open all water distribution line valves and isolation valves to assure free water flow path
- f) Insure that water is in piping at or above pump level

PASSING: 1. Pumps

- a) Pump operates with proper water pressure
- b) Pump operates with proper electric voltage and current valves
- c) Pump operates with no leaks

2. Valve VE

- a) Valve VE operates in proper direction
- b) Valve does not leak or chatter

TEST PROCEDURE:

1. Turn off pump disconnecting device and verify that 120 volt ac is not present at motor starter contact terminals.
2. Turn off 10 amp circuit breaker which supplies 120 volt ac to 24 volt transformer T1 and T2.
3. Measure voltage at coil terminals for ph motor starter. Voltage should be 0.
4. Measure voltage at valve VE terminal. Voltage should be 0.
5. Disconnect solar heat available control connections from control RB-DCA-1 terminals SHA.
6. Turn on 10 amp circuit breaker which supplies 24 volt transformers T1 and T2. Zero voltage should be observed at points measured in 3 and 4.
7. To simulate solar heat available, place a jumper wire across RB-DCA-1 terminals SHA. Valve VE and PH motor starter should operate. Verify visually and audibly. Valve VE should, when no 24 volt power is applied to terminal, be in position that bypasses water fed from pump PH. When 24 volts is applied, valve should switch to accept water from pump PH and flow to gas fired boiler intake.
8. Measure and record voltage at coil terminals for PH motor starter and for valve VE terminals. 24 volts ac should be present.
9. Temporarily remove jumper from SHA terminals on RB-DCA-1.

9.1 (cont.)

10. Turn on pump PH disconnect device, and verify that PH motor starter contact input terminals has 120 volt ac present. Measure and record.
11. Replace jumper SHA, which was removed in step 9.
12. Pump Ph should start.
13. Measure and record voltage and current at pump PH terminals. Running valves should be within 10% of name plate ratings.
14. By use of pressure gauge, verify that water downstream of valve VE is at least 8 psi greater than when measured with the pump off.
15. Verify after pump operates 10 minutes that no leaks occur in pump or valve VE.
16. Remove jumper from SHA terminals (step 11) and replace lead wires removed in step 5.

9.1 (cont.) TEST RESULTS

| <u>Procedure No.</u> | <u>Result</u>         |
|----------------------|-----------------------|
| 1.                   | Turned Off            |
| 2.                   | Turned Off            |
| 3.                   | 0 Voltage Verified    |
| 4.                   | 0 Voltage Verified    |
| 5.                   | Disconnected          |
| 6.                   | 0 Voltage Verified    |
| 7.                   | Verified              |
| 8.                   | 24 Volts AC Verified  |
| 9.                   | Removed               |
| 10.                  | 120 Volts AC Verified |
| 11.                  | Replaced              |
| 12.                  | Pump Starts           |
| 13.                  | 120 Volts Verified    |
| 14.                  | 12 psi Verified       |
| 15.                  | No Leaks Occurred     |
| 16.                  | Accomplished          |



**9.2 ITEMS TO BE TESTED: DISTRIBUTION CONTROL SYSTEM, INCLUDING RB-DCA-1 AND THERMOSTATS**

**TEST OBJECTIVE:** To insure proper operation of distribution control system

**TEST PREREQUISITES:** a) Installation of RB-DCA-1 control, associated thermostats and wiring  
b) Installation and wiring of all distribution pumps and valves

**TEST PROCEDURE:**

1. Turn Off 10 amp breaker which supplies power to 24 volt transformer T1 and T2.
2. Turn off pump motor disconnect devices for pumps PH, P1, P2, PZ2, PZ1, PZ3.
3. Verify that no voltage exists at the following points:
  - a) Between terminals "C" and "R" on the RB-DCA-1
  - b) Between terminals "Cp" and "Rp" on the RB-DCA-1
  - c) Starter coil terminals on each motor starter for pumps listed in step 2
  - d) Input terminals for valve VE
  - e) Input terminals for gas valve relay coil
4. Remove zone thermostat covers so that mercury switch operation can be observed.
5. Adjust all thermostats and the differential control "SHA" to the OFF position. This means:
  - a) that the three zone thermostats will be set lower than room temperature
  - b) the heat on thermostat will be set greater than 75°F
  - c) the cool on thermostat will be set lower than 60°F
6. Turn on the 10 amp breaker which was turned off in step 1.
7. Measure and record voltage between RB-DCA-1 terminals "R" and "C" and between terminals "Rp" and "Cp". Voltages should be 24 volts ac  $\pm$  10%.
8. Install a temporary jumper (to remain in place for the remainder of this test) across terminal "TC". This simulates time clock "ON" conditions. Instead of using a jumper, the timeclock can be adjusted to insure an ON or contact closed condition.
9. Measure and record terminal input voltages at motor starters for P1, P2, PZ1, PZ2, PZ3, the relay coil input for the gas valve relay and the coil terminal for valve VE. These voltages should be 0.
10. Raise the "Heat-ON" thermostat to above room temperature to insure that it is calling for heat and its contacts are closed. A jumper across the HO terminals will simulate this condition.

9.2 (cont.)

11. Raise the thermostat setting of the Zone 1 thermostat to a setting above room temperature. Physically observe that the first stage mercury bulb only has made contact.
12. Measure and record the coil input voltage for the following controls:

Pump Motor Starter No. - Input Coil Voltage

|     | <u>Should be</u> |
|-----|------------------|
| P1  | 24V ac           |
| P2  | 0V ac            |
| PZ1 | 24V ac           |
| PZ2 | 0V ac            |
| PZ3 | 0V ac            |

Valves

|                      |        |
|----------------------|--------|
| VE                   | 0V ac  |
| Gas Valve Relay Coil | 24V ac |

13. Increase the thermostat setting of the zone 2 thermostat to above the room temperature. Verify that only the first stage mercury bulb has made contact.
14. Measure and record the pump PZ2 coil input terminal voltage. This voltage should be 24V ac  $\pm$  10%.
15. Increase the setting of the zone 3 thermostat to insure that only the first stage mercury bulb has made contact.
16. Measure and record the starter coil terminal input voltage for pump PZ3. This should read 24V ac  $\pm$  10%.
17. Turn the solar heat available (SHA) differential temperature control to Manual On.
18. Measure and record the coil input voltages at the following points:

INPUT COIL VOLTAGE

| <u>Control</u>       | <u>Should Read</u> |
|----------------------|--------------------|
| Pump PH Starter      | 24V ac             |
| Valve "VE"           | 24V ac             |
| Gas Valve Relay Coil | 0V ac              |
| Pump P1              | 24V ac             |

19. Increase the zone 1 thermostat to insure that the first and second stage heat mercury bulbs make contact.
20. Measure and record voltage input at gas valve relay coil input terminals. This voltage should now be 24V ac  $\pm$  10%.
21. Readjust all controls and thermostats as set in Step 5.
22. Turn on pump motor disconnect devices.

9.2 (cont.)

23. Verify that motor starter contact input terminals have proper input voltage; measure and record:

| <u>Starter For</u> | <u>Specified Voltage</u> |
|--------------------|--------------------------|
| P1                 | 208V ac *1Ø              |
| PZ1                | 208V ac *1Ø              |
| PZ2                | 208V ac *1Ø              |
| PZ3                | 208V ac *1Ø              |
| P2                 | 208V ac 3Ø               |
| PH                 | 120V ac 1Ø               |

24. Lower the "cooling" thermostat to below room temperature to insure its contacts close. This can be simulated with a jumper across the "CO" terminals.
25. Verify that pumps P2, PZ1, PZ2, and PZ3 start. No other distribution pumps should operate.
26. Raise the cooling thermostat to above room temperature and verify that the pumps stop.
27. Turn the solar heat available (SHA) control to "Manual On". No pump should start.
28. Adjust the zone 1 thermostat to a temperature setting that will close only the first stage mercury bulb. The following pumps should start: a) P1; b) PH; c) PZ1. Valve "VE" should be energized and in the solar heating distribution position.
29. Increase the zone 1 thermostat setting to close the second stage mercury bulb.
30. The gas boiler should operate and the pumps in step 28 should continue to operate.
31. Reduce the zone 1 thermostat to turn off both stages of heat. Pumps and boiler should be off.
32. Increase the zone 2 thermostat setting to close the first stage only mercury bulb. Pumps P1, PH and PZ2 should start. Valve VE will be energized.
33. Increase the zone 3 thermostat setting to close the first stage only mercury bulb. Pump PZ3 should start.
34. Turn off the "SHA" control.
35. Pump PH should stop. Valve VE should deenergize; the gas boiler should start.
36. Adjust all thermostats and controls to normal settings and remove the jumper across terminals TC and any other jumper installed.

\* Existing pump motors are rated at 230V ac; however, existing power is 120/208 volts 3 phase.

9.2 (cont.) TEST RESULTS

Procedure No.

Results

1. Turned Off
2. Turned Off
3. 0 Voltage Verified at All Points
4. Removed
5. All thermostats adjusted
6. Turned Off
7. 24V ac Verified
8. Accomplished
9. 0 Voltage Verified
10. Verified
11. Verified
12.
  - P1 - 24V ac
  - P2 - 0V ac
  - PZ1 - 24V ac
  - PZ2 - 0V ac
  - PZ3 - 0V ac

Valves

VE - 0V ac  
Gas Valve Relay Coil - 24V ac

13. Verified
14. 24V ac
15. Verified
16. 24V ac
17. Accomplished
18.
  - Pump PH Starter - 24V ac
  - Valve "VE" - 24V ac
  - Gas Valve Relay Coil - 0V ac
  - Pump P1 - 24V ac
19. Verified
20. 24V ac
21. Accomplished

9.2 (cont.) TEST RESULTS CONTINUED

| <u>Procedure</u> | <u>Results</u>                                                                                  |
|------------------|-------------------------------------------------------------------------------------------------|
| 22.              | Accomplished                                                                                    |
| 23.              | P1 - 208V ac<br>PZ1 - 208V ac<br>PZ2 - 208V ac<br>PZ3 - 208V ac<br>P2 - 208V ac<br>PH - 120V ac |
| 24.              | Accomplished                                                                                    |
| 25.              | Verified                                                                                        |
| 26.              | Verified                                                                                        |
| 27.              | Verified                                                                                        |
| 28.              | Verified                                                                                        |
| 29.              | Accomplished                                                                                    |
| 30.              | Verified                                                                                        |
| 31.              | Accomplished                                                                                    |
| 32.              | Accomplished                                                                                    |
| 33.              | Verified                                                                                        |
| 34.              | Accomplished                                                                                    |
| 35.              | Verified                                                                                        |
| 36.              | Accomplished.                                                                                   |

### **9.3 ITEMS TO BE TESTED: MECHANICAL COLLECTOR ARRAY A AND B PLUMBING LINES**

**TEST OBJECTIVE:** Test pressure integrity of all components and joints.

**TEST PREREQUISITES:** All components and connections must be attached and ready for filling, including collector, heat exchanger, pump, pressure and temperature gauges.

**PASSING:** Collector loop plumbing holds 150 psi pressure for 24 hours with a pressure loss of less than 5 psi.

**FAILING:** Collector loop A plumbing drops more than 5 psi when 150 psi is applied and held for 24 hours.

#### **TEST PROCEDURE:**

1. All connections to the collector Array A plumbing loop have been made and joints sealed, including collectors, heat exchanger, pump, manifold, supply and return pipe, expansion tank, and pressure and temperature gauges. This test should be performed before the pipe insulation is applied.
2. Close and plug 1" drain valve on mechanical platform.
3. Thread a bushing or elbow with a gas schrader valve into the 1" female end of the fill valve, sealing the threads with teflon pipe tape.
4. Open the fill valve and apply nitrogen pressure to the collector lines through the schrader valve until the pressure in the line is 150 psi as indicated by collector loop pressure gauge located on the mechanical platform.
5. It is desirable to apply the pressure test in the early morning when sun on the collectors will not create temperature pressure effects.
6. The person performing the test should record the pressure shown on the collector loop gauge, time, date and his name, and also the witness representing the owner should confirm the data recorded and sign the test report.
7. After allowing 24 hours to pass, recheck the pressure indicated on the same collector loop pressure gauge. Record the pressure indicated on this gauge along with the time, date, name of person performing the test, The witness should verify this information and sign the report.
8. If the pressure on the gauge is not less than 145 psi, then the collector loop pressure integrity is acceptable. Otherwise, the contractor should inspect all the loop joints to find any leaks.

9.3 (cont.) TEST RESULTS

Procedure

1 - 8

Results

Pressure test on Mechanical Collector Array  
A & B plumbing lines at 150 psi pressure for  
24 hours was accomplished with minor pressure  
loss not greater than 5 psi.

#### 9.4 ITEMS TO BE TESTED: MECHANICAL HEAT DISTRIBUTION WATER PIPE LOOP

**TEST OBJECTIVE:** Test pressure integrity of all components and joints

**TEST PREREQUISITES:** All pipes and components must be connected and sealed ready for filling without insulation.

**PASSING:** Holds 5 psi of water pressure for 24 hours without pressure loss.

**FAILING:** Plumbing line pressure drops to below 5 psi after 24 hours from the initial 5 psi pressure.

**TEST PROCEDURE:**

1. All collector Array A water line components are connected, but not insulated, including heat exchangers, heating storage tank with water pumps, lines, water expansion tank, 3-way valve.
2. Heating storage tank is filled from the makeup water supply line until the pressure gauge at pump PH indicates 5 psi. Close the makeup water supply valve.
3. Visually inspect all plumbing lines and component connections for obvious water leakage.
4. Turn off the boiler make-up water supply.
5. Record the gauge pressure, time and date, along with the name of the person performing the test, and with a witness verifying this information.
6. After 24 hours, recheck the pressure at the pump PH pressure gauge and record the pressure indicated along with the time, date, and name of test operators and witness.
7. If the pressure indicated on this gauge shows 5 psi or greater, then the water line plumbing is acceptable.
8. If the pressure indicated on the gauge is less than 5 psi, the water piping loop is rejected.
9. Inspect all water line components and connections for evidence of water leakage.
10. Repair and retest.
11. Open the boiler water make-up line valve and set the makeup water control to 5 psi.



9.4 (cont.) TEST RESULTS

Procedure

1 - 11

Results

Mechanical heat distribution water pipe loop  
pressure tested at 5 psi for 24 hours without  
pressure loss.

**9.5 ITEMS TO BE TESTED: SOLAR COLLECTION PUMPS PA1 and PB1 (1HP pumps)**

**TEST OBJECTIVE:** Verify proper installation and operation.

**TEST PREREQUISITES:**

- a) Proper physical mounting
- b) Prior piping pressure testing to verify all connections tight
- c) Verify pump orientation for proper fluid flow direction
- d) Verify that all valves are in proper position (open in flow path)
- e) All tubing must be filled with silicone heat transfer fluid

**PASSING:**

- a) Pump operates with proper pressure
- b) Pump operates with proper current and voltage requirements (name plate data)
- c) Pump operates with no silicone oil leaks at any pump part or connection to pump

**TEST PROCEDURE:**

1. With pump disconnecting device (breaker) off, verify that 120 volts is not supplied to pump electrical terminal or motor starter terminals.
2. Activate (turn on) solar differential control (manual on). This should supply 24 volts ac to motor starter. Measure motor starter coil input voltage. Verify and record 24 volt ac input.
3. Deactivate differential control (manual off) starter coil input voltage should be 0.
4. Measure and record silicone oil line pressures with no silicone pumps running.
5. Turn on pump motor disconnecting device. Verify and record that 120 volts ac is supplied to motor starter input terminals.
6. Turn solar differential control to manual ON. Motor starter should activate and pump start.
7. Measure and record pump input voltage and current. Voltage and current should be within 10% of running nameplate ratings.
8. Measure and record silicone pump output side pressure with 1 hp pump running. A pressure of about 13 psi greater than that recorded in step 4 should be attained.
9. Operate pumps at least 10 minutes and verify that no pump connection or pump part leaks.

9.5 (cont.) TEST RESULTS

Procedure

Results

- |    |                                              |
|----|----------------------------------------------|
| 1. | Verified                                     |
| 2. | Verified; 24V ac supplied                    |
| 3. | 0 Voltage Verified                           |
| 4. | PA1 - 8 psi<br>PBI -13 psi                   |
| 5. | 124V at both                                 |
| 6. | Verified                                     |
| 7. | PA1 - 120V - 11 amps<br>PBI - 124V - 12 amps |
| 8. | PA1 - 9 psi Delta<br>PBI -10 psi Delta       |
| 9. | No leaks verified                            |

**9.6 ITEMS TO BE TESTED: PUMPS PDHW1, PDHW2, 1/12 HP PUMPS**

**TEST OBJECTIVE:** Verify proper installation and operation

**TEST PREREQUISITES:**

- a) Proper physical mounting
- b) Prior piping pressure test
- c) Verify proper pump orientation for fluid flow direction
- d) Verify that all valves are open (check pump isolation valves)
- e) Place pump flow rate control in maximum position
- f) Verify that piping is filled with fluid

**PASSING:**

- a) Audible verification of pump operation
- b) Verification of proper electric operating current
- c) Absence of leaks
- d) Quiet operation

**TEST PROCEDURE:**

1. With pump disconnecting device off, verify that the 120 volt supply is not present at relay (starting device) or pump terminals.
2. Activate (turn on) solar differential control manual. This should supply 24 volts ac to coils of pump starting relay. Verify and record relay coil voltage.
3. Deactivate solar control (manual off) and verify that no voltage is supplied to pump starter relay coils.
4. Turn on pump disconnecting device (breaker). Verify that 120 volts ac is supplied to pump starter relay contact terminal input.
5. Turn on solar differential control to activate pump relays. Pumps should start.
6. Measure and record pump input voltage and current. Voltage and current readings should be within 10% of running name plate ratings.
7. Measure and record silicone pump (PDHW2) output side pressure with 1/12 hp pump off and with it running. An increase of about 4 psi should be observed with PDHW2 running.
8. Verify that no pump connection or bearing leaks after 10 minutes of operation.

9.6 (cont.) TEST RESULTS

Procedure

Results

- |    |                      |
|----|----------------------|
| 1. | Verified             |
| 2. | 26 volts ac Verified |
| 3. | Verified             |
| 4. | Verified             |
| 5. | Verified             |
| 6. | Verified             |
| 7. | Delta 5 psi Verified |
| 8. | Verified No Leaks    |

**9.7 ITEMS TO BE TESTED: PUMPS PA2 AND PB2; 1/3 HP WATER PUMPS (SOLAR STORAGE)**

**TEST OBJECTIVE:** Verify proper installation and operation

**TEST PREREQUISITES:**

- a) Proper physical mounting
- b) Prior piping pressure test
- c) Verify pump orientation for proper flow direction
- d) Verify all valves open in flow path
- e) Verify that water is in pipes above pump level

**PASSING:**

- a) Pump operates with proper fluid flow pressure
- b) Pump operates with proper electric voltage and current requirements
- c) Pump operates with no leaks

**TEST PROCEDURE:** (Note: first three steps can be done simultaneously with test for PA1 and PB1)

1. With pump disconnecting device (breaker) off, verify that 120 volts is not supplied to motor starter terminals.
2. Activate (turn on) solar differential control (manual on). This should supply 24 volts ac to motor starter coil. Measure and record motor starter input voltage.
3. Deactivate differential control (manual off). Starter coil input voltage should be 0.
4. Measure and record down pump side of water pressure (pump off).
5. Turn on pump motor disconnecting device. Verify and record that 120 volts ac is supplied to motor starter contact input terminals.
6. Turn solar differential control to manual On. Motor starter should activate and pumps start.
7. Measure and record pump input voltage and current. These values should be within 10% of running nameplate ratings.
8. Measure and record downstream water pressure with 1/3 hp pump running. A pressure of about 10 psi greater than that recorded in step 4 should be attained.
9. Measure and record water flow for each loop - a flow of at least 15 gpm should be read.

9.7 (cont.) TEST RESULTS

| <u>Procedure</u> | <u>Results</u>                             |
|------------------|--------------------------------------------|
| 1.               | Verified                                   |
| 2.               | 24V ac Verified                            |
| 3.               | 0 Voltage Verified                         |
| 4.               | PA2 - 5 psi<br>PB2 - 4 psi                 |
| 5.               | Verified                                   |
| 6.               | Verified                                   |
| 7.               | PA2 - 8 amps - 124V<br>PB2 - 9 amps - 124V |
| 8.               | PA2 - 20 psi<br>PB2 - 15 psi               |
| 9.               | 35 gpm                                     |

9.8 ITEMS TO BE TESTED: SENSOR INSTALLATIONS FOR SOLAR DIFFERENTIAL TEMPERATURE CONTROLLERS: Sensors TCA1, TCB, TSA, TSB, TCA2, TH, TSC, TR

TEST OBJECTIVE: To insure that sensor installations work properly

TEST PREREQUISITES: All sensors to be tested must be installed with wires attached and run to controller location.

TEST PROCEDURE:

1. Measure and record resistances at controller location sensor wire terminals for each sensor listed. The following values will be considered acceptable:

| <u>Sensor</u> |               | <u>Resistance in OHMS</u> |    |      |
|---------------|---------------|---------------------------|----|------|
| TCA1          | With Sunlight | 3600                      | to | 5000 |
| TCA2          | With Sunlight | 3600                      | to | 5000 |
| TCB           | With Sunlight | 3600                      | to | 5000 |
| TSA           |               | 3300                      | to | 3900 |
| TSB           |               | 3300                      | to | 3600 |
| TH            |               | 3300                      | to | 3900 |
| TSC           |               | 3300                      | to | 3900 |
| TR            |               | 3300                      | to | 3900 |



9.8 (cont.) TEST RESULTS

Procedure No.

Results

1.

|      |   |      |
|------|---|------|
| TCA1 | - | 4200 |
| TCA2 | - | 4200 |
| TCB  | - | 4000 |
| TSA  | - | 3900 |
| TSB  | - | 3600 |
| TH   | - | 3800 |
| TSC  | - | 3900 |
| TR   | - | 3900 |

## 10.0 DEVIATIONS FROM BASELINE CONFIGURATIONS

1. The original construction documents of the solar system design specified three 1,000 gallon insulated fiberglass storage tanks. After much effort and a number of manufacturing attempts, Solar Unlimited, Inc. was not able to procure tanks of this design that would pass Solar Unlimited's stringent leak test criteria. Resulting in a decision to procure one 3,000 gallon steel tank fully insulated with 4" of urethane foam and a 2" fiberglass foil backed blanket to substitute for the three fiberglass tanks.
2. The proposed one 80 gallon expansion tank to be located in the solar mechanical storage area was replaced with two 40 gallon expansion tanks because of procurement problems with the manufacturing company that was to supply the 80 gallon expansion tanks.
3. The horizontal joints on the epoxy aggregate end walls were not installed as originally designed due to moisture problems recognized by the sub-contractor, Accounti Engineering. This resulted in the modifying of the end walls to be constructed only with vertical joints.
4. In the final system design, the heat distribution operated with three possible heat distribution modes, boiler to load; solar to load and solar preheat to boiler to load. The control function that determined the switch over between heat supplied from the solar storage or the boiler is determined by the two-stage room thermostats in the three zones. That is if any of the three thermostats were calling for 1st stage heat then the load will be supplied by solar. If any of the three zone thermostats were calling for 2nd stage heat then the solar storage is not sufficiently carrying the load and the heat distribution is switched to supply heat from the boiler. In addition, the final design included a mode that would direct the building distribution return water into the solar storage and provide solar preheated water to the boiler which would then boost the temperature and heat the load. This mode was initiated when the building distribution return water (measured by Sensor TR) was cooler than the solar storage tank temperature (measured by Sensor TS) and any building zone was calling for 2nd stage heat.

However, after the system had been installed, checked out and was operating, it was found that the system rarely switched to the solar to load or solar preheat to boiler mode. It was discovered that the return distribution water was usually above 140° F due to the nature of the cabinet unit heaters and the building hot water distribution system.

Further, the control logic in the solar to load mode also uses the comparison of the temperatures of the return distribution water (TR) and the solar storage water (TS) to determine whether the solar storage is warm enough to heat the building in 1st stage heating. This combination of control logic resulted in the heat distribution staying

10.0 (cont.)

in the conventional boiler to load mode a majority of the time. Because the building return water was warmer than the solar storage water when the boiler was heating, the building and the solar mode never got a chance to try to carry the load.

To rectify these problems, the building distribution return sensor, TR was moved into the fan room adjacent to the boiler room, so that the TR sensor now senses the temperature of the building ambient air. This allows the solar system to try to supply the load in the first stage heat condition whenever the solar storage tank is warmer than the building (nearly always). Then if the load is not being carried by the solar system and the building temperature begins to drop further when it reaches the 2nd stage thermostat setpoint, the distribution system switches to supply heat from the boiler. When the boiler brings the building temperature up to 1st stage heat again, then the solar continues to supply heat to the building. The solar preheat to boiler mode was disabled in favor of alternative heating by solar and the boiler so that when the solar was supplying the heat the boiler was off.

This control function has a particular advantage with regard to night setback and early morning startup. Since the control logic gives solar the first chance at heating the building and since the building is cooler than 65° F after night setback, the solar can both warm the building early in the morning and at the same time reduce the solar storage tank temperature immediately for solar collection. This allows the solar system to start collecting earlier than it would otherwise and allows slightly improved collection efficiency due to lower collector inlet temperature. In the early morning warmup period, the 2nd stage (boiler) heat is inhibited for a period by a time delay relay to allow the solar to chance to warmup the building before occupancy.

## 11.0 PROBLEMS ENCOUNTERED

1. Bidders interest was a point of concern with members of the solar design team because local construction contractors had limited or no experience in the construction of solar space heating and domestic hot water systems. Therefore, the design team made special efforts to inform and educate the construction trades through the cooperation of F.W. Dodge reports and builders associations. The design team constructed scale models of the project and separate models detailing typical solar hardware material and its mounting system.

Also, a pre-bid conference was held to acquaint approximately 60 persons of the construction industry with the proposed solar project which we believed gave us a realistic bid on the project.

2. Scheduling and coordination of subcontract activities and delivery of materials and equipment were common problems but these were not greater than is normal to general construction practice and no serious delays resulted.
3. Some minor disputes arose between general contractor, subcontractors, and solar hardware suppliers relative to responsibility for furnishing certain items of labor and material. These were resolved amicably through frequently-called meetings to clarify and negotiate points in question.
4. During the installation of the first pre-assembled architectural solar panel, a lifting hook swung free and broke two cover glasses. Light control lines were attached to the lifting harness hooks by the general contractor to prevent this and more care was exercised. This accident did not recur.
5. Several improvements in the automatic distribution control have also been implemented to further enhance energy conservation, and solar utilization by taking full advantage of a night setback time clock.
6. We had poor joint seals between the architectural solar panels due to ratio of joint width and depth of backer rod. This was corrected by the Contractor by replacing the backer rod at the proper depth and recaulking.
7. Care was not taken on assuring that the interior side of the pre-installed cover glass on the architectural solar panels was clean; therefore, we are having to remove, clean and install all glass.

## 12.0 RECOMMENDATIONS

This project has progressed from the very beginning very smoothly. The people and the organizations involved worked very well together and responded to their responsibilities as were originally outlined in the proposal. The system has so far proved to be well designed and is working even better than was anticipated. The total project costs remained within budget limits and the project was completed essentially on schedule. A number of things appear to be responsible for the overall recommendations for similar type projects in the future:

- A. That specific responsibilities for all participating organizations be identified at the very beginning of a project.
- B. That a formal Pre-Bid Conference be held after the publication of the plans and specifications to increase interests and in the case of solar energy to eliminate the scare factor of constructing something new.
- C. That the advantages of Silicone Oil as a heat transfer fluid be considered in the design of future solar systems.
- D. The system should be instrumented so as to show energy savings from this design.

**I. Scope**

This plan covers the maintenance and inspection requirements for the electrical and mechanical equipment used in the Huntsville Senior Citizens Center for solar heat collecting and solar heat distribution. Previously existing mechanical equipment used in connection with the conventional gas boiler and chiller system is not affected by this plan, although certain mutual use of this interfacing mechanical equipment is involved. Previously existing maintenance procedures should continue to be used for such equipment.

The solar heating mechanical equipment affected by this plan is:

**A. Solar Collector Group A (west bank collector group)****1. Silicone solar heat transfer fluid system.**

- a. Copper tubing piping system
- b. Expansion tank A
- c. 1 h.p. Model 3196 Gould pump (TA-1)\*
- d. 1/12 h.p. Grundfos pump (PDHW-2)\*
- e. Heat exchangers (2)

\* Located in attic over kitchen area

**2. Domestic water preheat system**

- a. Copper tubing pipe system
- b. Domestic hot water storage tank
- c. 1/12 h.p. Grundfos water pump (PDHW-1) (located in domestic water tank closet)

**3. Bulk heat storage piping system**

- a. Copper tubing pipe system
- b. 1/3 h.p. Bell and Gossett water pump (PA2) (located under east bank collectors)

**B. Solar Collector Group B (East Bank Collector Group)****1. Silicone solar heat transfer fluid system**

- a. Copper tube piping
- b. Expansion tank
- c. 1 h.p. Model 3196 Gould Pump (PB1)
- d. Heat exchanger

2. Bulk heat storage piping system
  - a. Copper tube piping
  - b. 1/3 h.p. Bell and Gossett water pump (PB2)
- C. Heat Distribution System
  1. Heating water piping system
    - a. 1/2 h.p. Bell and Gossett pump (PH) (east end of storage tank)
    - b. Three-way motorized valve (VE) (located in gas boiler mechanical room)

## II. General Maintenance Requirements

The solar heating system selected for this center is virtually maintenance free. However, due to the requirement for larger than normal silicone fluid pumps, it is recommended that a monthly inspection program be implemented to insure that no silicone fluid leak occurs around the pump seal. Less frequent inspections can be scheduled after adequate operating experience with this type pump using a silicone fluid has been obtained. A summary outline of maintenance and inspection requirements is as follows:

- A. Gould pumps (PA1 and PB1) - monthly -
  1. Inspect to insure no silicone heat transfer fluid leaks.
  2. Inspect lubricating oil reservoir. Add SAE #20 premium grade, non-detergent oil when oiler is less than 1/3 full.
- B. Bell and Gossett 1/2 h.p. pump (PH) each October - add SAE #20 premium grade, non-detergent oil
- C. Other pumps; quarterly during operating season. Inspect for normal operation.
- D. Piping and tanks - quarterly during operating season. Inspect to insure leak-free operation.
- E. Electrical controls require no maintenance inspection.

## III. Maintenance and Inspection Requirement

- A. Monthly Inspection
  1. Inspect the two 1 h.p. Gould pumps (PA1 and PB1) to make sure that there are no visible signs of silicone heat transfer oil leaks. Any sign of leak should be reported to the solar heating equipment supplier.
  2. Check lubricating oil reservoir. Oil should be visible in the reservoir; if not, immediately add #20 SAE premium, non-detergent oil. Oil level in reservoir should be maintained at least 1/3 full. Normally,

Normally, extra oil should not be required more frequently than four times per year.

3. Using the Honeywell Controller, turn "ON" the heat transfer fluid pump. The pump should operate smoothly with no significant noise or vibration present. Any unusual noise or vibration should be reported to the supplier of the solar equipment. Record the pressure reading of the 0-100 PSI gauge. This reading should normally be from 15 to 30 psi.
4. Turn the pumps OFF and record the pressure reading. Depending upon heat transfer fluid temperatures, the pressure should normally be between 5 lbs. and 10 lbs.

Note: The first year's record of pressures can be used in the future to detect system deviations or pending failures.

B. Quarterly Inspections (January, April, July, October)

1. Inspect heat transfer fluid piping where connections are made to:
  - a. Pumps
  - b. Valves
  - c. Gauges, and
  - d. Expansion tanks. Verify that no silicone fluid leaks exist. Any sign of leaks should be reported and actions taken for repair.
2. Check the Grundfos 1/12 h.p. pump in the attic (pump PDWH2) and the 1/12 h.p. Grundfos water pump located in the closet with the domestic water heater. These pumps should operate quietly. These two pumps may be manually started by turning the differential control in the domestic water heater closet to "ON". Place the control to "AUTO" after the check is completed.
3. The two Bell and Gossett 1/2 h.p. water pumps should be checked for vibration-free, leak-free operation during the October, January, and April inspection. Any vibration or water leaks should be investigated and/or repaired.

Note: The Bell and Gossett pumps (PA2 and PB2) can be manually started by switching the Honeywell differential controller to "ON". Return the switch to "AUTO" after inspections are completed.

4. The Bell and Gossett 1/2 h.p. water pump (PH) located to the east of the 3,000-gallon storage tank should be visually inspected during the October, January, and April inspection. This pump also requires annual servicing during the October inspection. This pump is turned on by fully automatic system interface controls and cannot be manually



turned on and off for inspection purposes at this level of maintenance. Records should be kept of the pumps' condition of operation, i.e. that it was or was not running during inspection, and if running whether any noise or vibration was detected. Output pressure readings should be recorded and notation made as to whether or not the pump was running at the time of the reading. Pressure readings of from 0 to 8 psi may be expected with the pump off and from 12 to 18 psi with the pump on.

**C. Annual Maintenance**

1. The 1/2 h.p. Bell and Gossett water pump "PH" should have oil added at the beginning of each heating season. During the October inspection, this pump should have #20 SAE premium grade, non-detergent oil added through the flip cap in the top of the bearing frame. Add oil until oil is indicated at the overflow hole on the side of the frame.

#### 14.0 MAJOR COMPONENTS AND MANUFACTURERS' LITERATURE

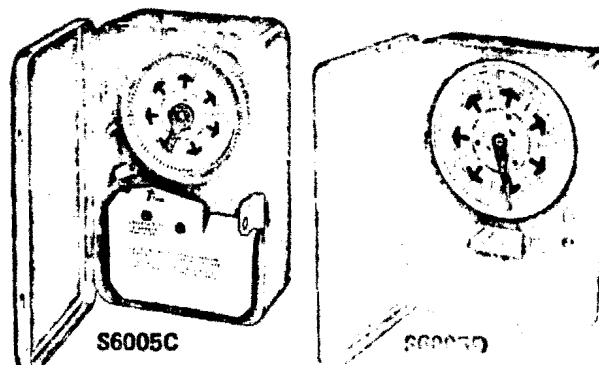
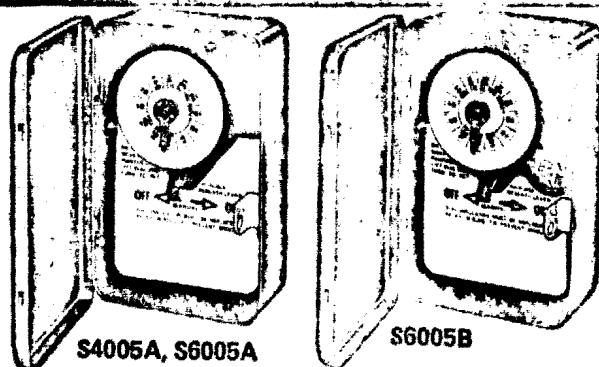
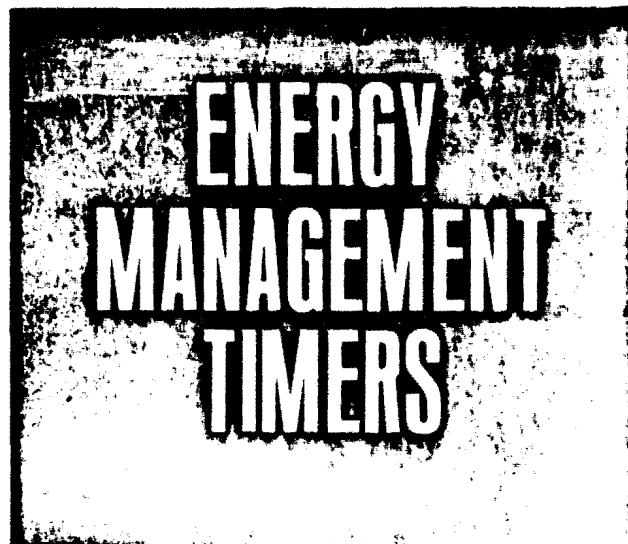
# Honeywell

THE S4005 AND S6005 ENERGY MANAGEMENT TIMERS PROVIDE AUTOMATICALLY TIMED, ELECTRICAL SWITCHING.

- ☐ S4005A provides spst switching; S6005A,B, and C provide spdt switching; S6005D provides dpdt switching.
- ☐ S4005A and S6005A,B have a 24 hour dial.
- ☐ S6005C and D have a 7 day dial.
- ☐ S6005B has skip-a-day feature which allows you to omit operation on any selected day or days of the week.
- ☐ S6005D has a spring wound carry-over mechanism to keep the timer on schedule during a power failure of up to 10 hours; mechanism automatically rewinds itself when power is restored.
- ☐ 120 volt or 208-240 volt models available.
- ☐ Settings can be changed as desired.
- ☐ Snap-out, replaceable time clock mechanism.
- ☐ Heavy duty, synchronous, quiet, self-lubricating motors do not require service or attention.
- ☐ Drawn steel case has hinged door with spring hasp and hole for lock. NEMA Type 1 enclosure.
- ☐ Large terminal screws for fast, easy wiring.
- ☐ Switch contact electrically isolated from clock motor terminals.

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J.B.  
12-77 (.08)



S4005A;  
S6005A-D

12-77 (.08)

60-2442

# 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.

## TRADELINE MODELS

TRADELINE models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value.

### TRADELINE MODELS AVAILABLE:

| MODEL NO. | DIAL DURATION | TIMING RANGE (HOURS) |     |            |     | MAX ON-OFF OPERATIONS |                 | SKIP-A-DAY FEATURE <sup>d</sup> | 10-HOUR SPRING CARRY-OVER <sup>e</sup> | SWITCH ACTION |
|-----------|---------------|----------------------|-----|------------|-----|-----------------------|-----------------|---------------------------------|----------------------------------------|---------------|
|           |               | "ON" TIME            |     | "OFF" TIME |     | PER DAY               | PER WEEK        |                                 |                                        |               |
|           |               | MIN                  | MAX | MIN        | MAX |                       |                 |                                 |                                        |               |
| S4005A    | 24 Hr         | 1                    | 23  | 1          | 23  | 12 <sup>a</sup>       | —               | No                              | No                                     | spst          |
| S6005A    | 24 Hr         | 1                    | 23  | 1          | 23  | 12 <sup>a</sup>       | —               | No                              | No                                     | spdt          |
| S6005B    | 24 Hr         | 1                    | 23  | 1          | 23  | 12 <sup>a</sup>       | —               | Yes                             | No                                     | spdt          |
| S6005C    | 7 Days        | 2                    | 22  | 2          | 22  | 6                     | 42 <sup>b</sup> | —                               | No                                     | spdt          |
| S6005D    | 7 Days        | 6                    | 166 | 2          | 162 | 3                     | 21 <sup>c</sup> | —                               | Yes                                    | dpdt          |

<sup>a</sup>The basic timer includes only 1 set of trippers to provide 1 ON-OFF operation. A set of trippers must be added for each additional ON-OFF operation. See Accessories.

<sup>b</sup>The basic timer includes 84 permanent trippers; no additional trippers are needed.

<sup>c</sup>The basic timer includes 7 sets of trippers to provide 7 ON-OFF operations per week. A set of trippers must be added for each additional ON-OFF operation. See Accessories.

<sup>d</sup>Skip-a-day feature locks out automatic "ON" or manual "ON" switch operation on selected days of the week.

<sup>e</sup>A spring wound carry-over mechanism keeps the timer on schedule during a power failure of up to 10 hours. When power is restored, the mechanism automatically rewinds itself.

**TIMER MOTOR VOLTAGE AND FREQUENCY:** Separate models for 120 volts ac, or for 208-240 volts ac; 60 Hz.  
**SWITCH CONTACT RATINGS PER POLE** (approved by Underwriters Laboratories Inc.):

| MODEL NO.           | PILOT DUTY <sup>a</sup><br>(VOLT-AMPERES) | LIGHTING<br>(AMPERES) |          | MOTOR   |                 |                    |         |                 |                    |
|---------------------|-------------------------------------------|-----------------------|----------|---------|-----------------|--------------------|---------|-----------------|--------------------|
|                     |                                           | INDUCTIVE             | TUNGSTEN | AT 120V |                 |                    | AT 240V |                 |                    |
|                     |                                           |                       |          | hp      | FULL LOAD (AMP) | LOCKED ROTOR (AMP) | hp      | FULL LOAD (AMP) | LOCKED ROTOR (AMP) |
| S4005A;<br>S6005A,B | 690                                       | 40                    | 35       | 2       | 24              | 144                | 3       | 20              | 102                |
| S6005C              | 345                                       | 20                    | 20       | 1/2     | 8               | 48                 | 1       | 8               | 48                 |
| S6005D              | 690                                       | 40                    | 40       | 1       | 16              | 96                 | 1       | 8               | 48                 |

<sup>a</sup>At 24 volts ac: 125 VA maximum; 4 VA minimum for the S4005A, S6005A,B,D; 1 VA minimum for the S6005C.

(continued on page 3)

## ORDERING INFORMATION

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

1. Order number; specify TRADELINE model.
2. Timer motor voltage and frequency.
3. Replacement parts, if desired.
4. Accessories, if desired.

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) 542-7500

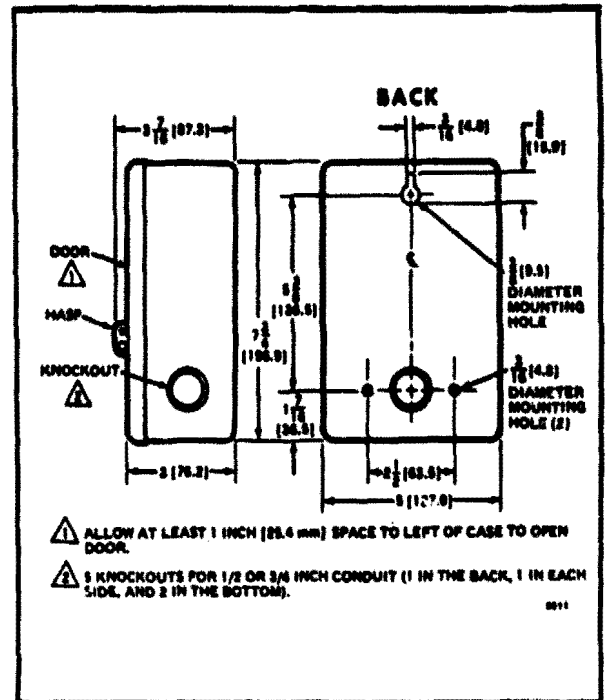
(IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)  
 INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

**SHIPPING WEIGHT:**

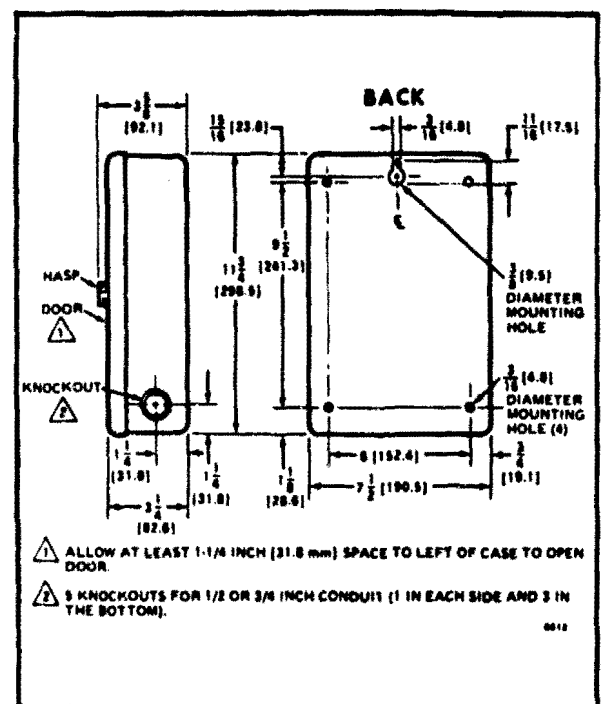
| MODEL            | lb    | kg   |
|------------------|-------|------|
| S4005A; S6005A,B | 2-1/2 | 1.13 |
| S6005C           | 2-3/4 | 1.25 |
| S6005D           | 7     | 3.18 |

S6005D-192516.

2. **Shipping screws for the S6005B (3 per package)—192544.**



**FIG. 1—APPROXIMATE DIMENSIONS OF THE CASE FOR THE S4005A AND S6005A,B, AND C MODELS, IN INCHES [MILLIMETRES IN BRACKETS].**



**FIG. 2—APPROXIMATE DIMENSIONS OF THE CASE FOR THE S8005D MODEL, IN INCHES [MILLIMETRES IN BRACKETS].**

# INSTALLATION

## CAUTION

1. Disconnect power supply before beginning installation to prevent electrical shock and equipment damage.
2. All wiring must comply with applicable local electrical codes, ordinances, and regulations.
3. Voltage and frequency of the power supply connected to the timer motor must match the electrical ratings of the motor.
4. Loads connected to the switch terminals must not exceed those listed in the SPECIFICATIONS section.
5. Replace the insulator covering the terminal board when wiring is completed.
6. Perform all required checkout tests after installation is complete.

## LOCATION

The case is designed for indoor mounting. If the S4005 or S6005 is installed outdoors, it must be protected. Do not install the S4005 or S6005 where it could be subject to extreme vibration. Vibration could loosen the trippers and cause erratic switch operation.

## MOUNTING

The S4005 or S6005 Timer can be mounted on any flat surface in any position. The case has 3 or 5 mounting holes in its back (see Fig. 1 or 2).

## WIRING

Make sure all power is disconnected from the timer. As the timer motor and load contacts are isolated, more than one disconnect switch may be required. Open the door on the case and remove the insulator covering the terminal board. (On the S4005A, S6005A, and S6005B, tabs on the white insulator snap into 2 slots, one at each end of the terminal board. On the S6005C, the white insulator is held in by 2 nuts. On the S6005D, the gray insulator snaps over 2 posts on the terminal board.) Use

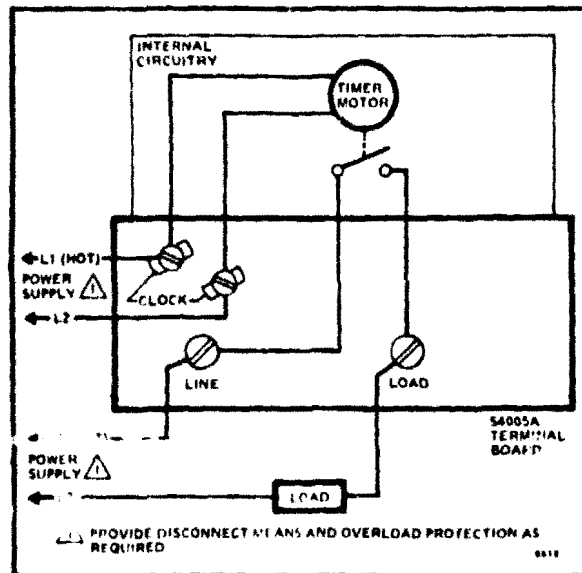


FIG. 3—WIRING DIAGRAM FOR AN S4005A TIMER.

copper wire suitable for at least 167 F [75 C]. Connect the wires to the proper screw terminals on the terminal board and tighten the screws securely. (Wiring diagrams are shown in Figs. 3-6.) Run the wires out through an appropriate knockout (or knockouts) provided in the case. Replace the insulator and set the timer (see the next section).

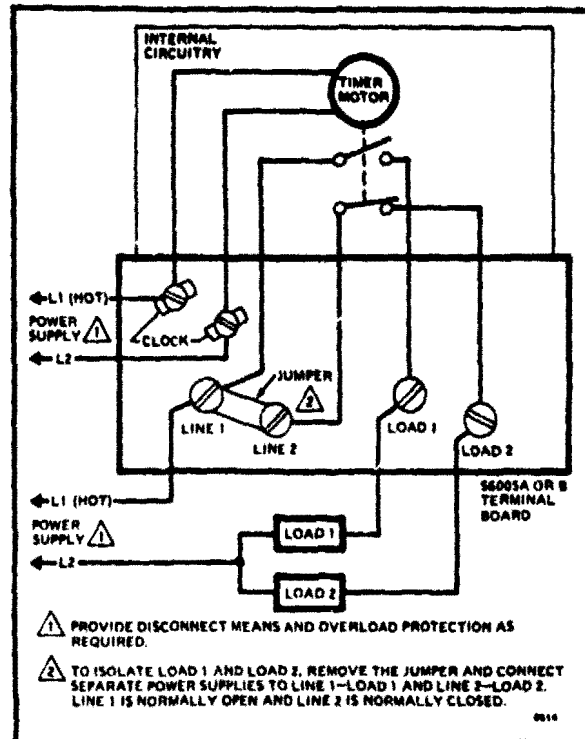


FIG. 4—WIRING DIAGRAM FOR AN S6005A OR B TIMER.

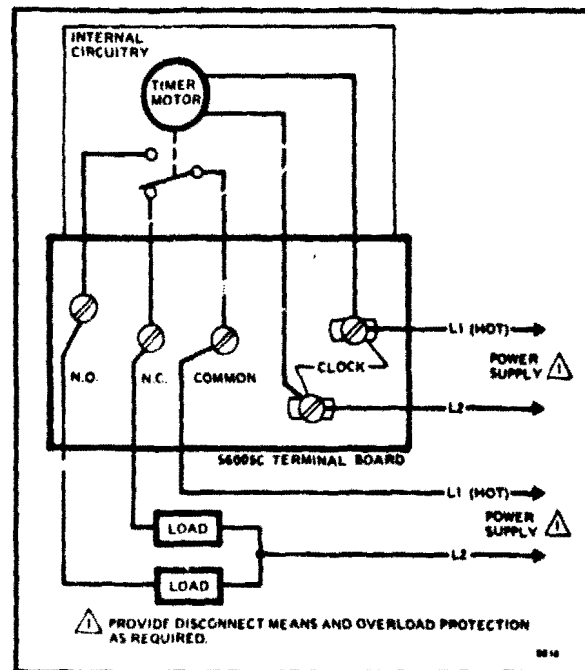


FIG. 5—WIRING DIAGRAM FOR AN S6005C TIMER.

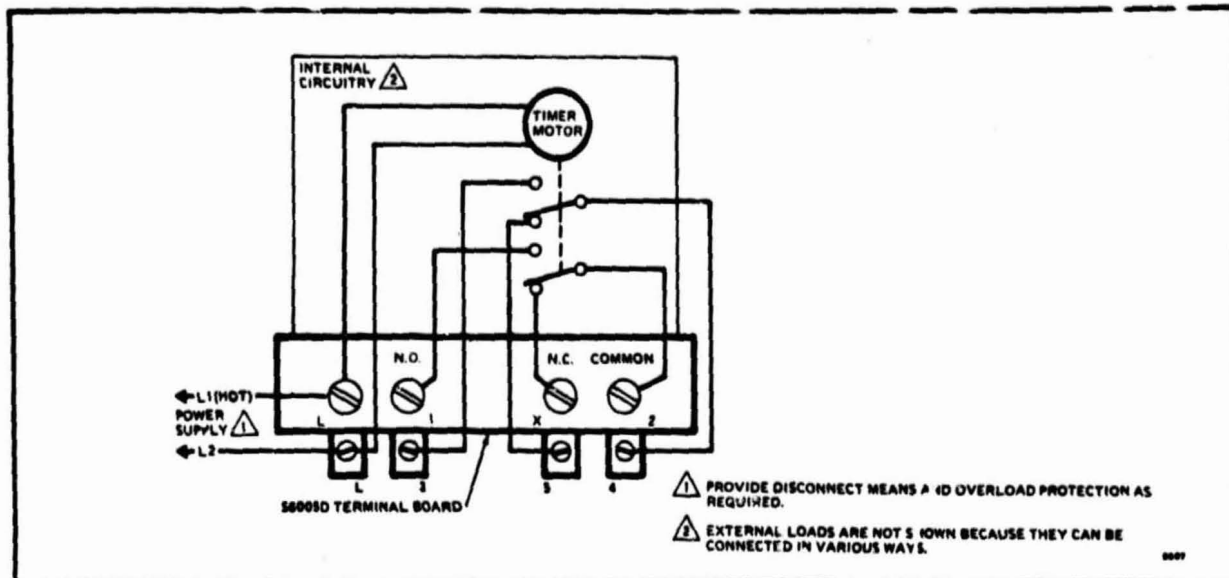


FIG. 6—WIRING DIAGRAM FOR AN S6005D TIMER.

## SETTING

### CAUTION

- Do not move the TIME pointer; turn the dial to set clock to correct time of day.
- On the S6005C:
  - All trippers not used to set an operation must be in the maximum OUT position. Be careful not to pull them all the way out of the dial.
  - Do not turn the dial counterclockwise.
- On the S6005D:
  - Do not use pliers to tighten the knurled setting screws; tighten them by hand.
  - Do not place an OFF tripper less than 6 hours after an ON tripper; minimum time from ON to OFF is 6 hours.
  - Do not turn the dial clockwise.

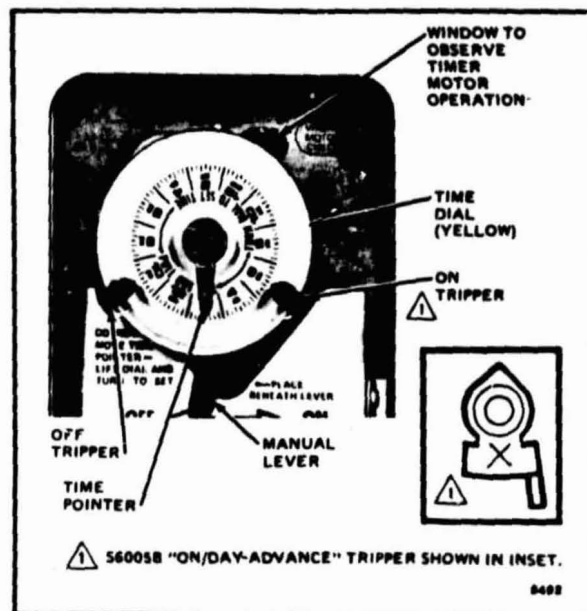


FIG. 7—SETTING 24 HOUR TIMERS (S4005A; S6005A,B).

NOTE: The dial will turn clockwise when power is connected.

3. Hold the tripper firmly against the edge of the dial, and tighten the screw securely.

4. Repeat steps 1 through 3 for the OFF tripper and the time you desire the switch to turn off (normally open contacts will open, and normally closed contacts will close).

5. You can set the S4005A or S6005A or B for up to 12 ON-OFF operations per day. Place additional tripper pairs around the edge of the dial at the desired times of operation and tighten their screws securely.

(continued on next page)

### 24 HOUR TIMERS (S4005A; S6005A,B)

#### SETTING "ON" AND "OFF" TIMES (FIG. 7)

NOTE: 2 trippers (1 set) are included with the S4005A and S6005A and B. If more than 1 daily ON-OFF operation is required, additional trippers can be ordered (see Accessories in the SPECIFICATIONS section).

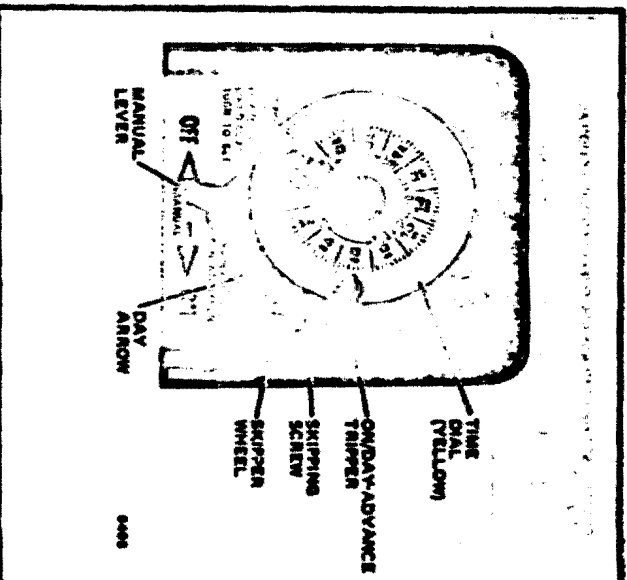
1. Loosen the screw in the tripper labeled ON (or X for the S6005B).

2. Move the ON tripper (or X tripper for the S6005B) around the edge of the time dial until it points to the time (AM or PM) you desire the switch to turn on. (When the switch is turned on, the normally open contacts will close, and the normally closed contacts will open.)

# **IMPORTANT**

- a. The minimum time between ON and OFF operations is limited to 1 hour by the width of the trippers; they cannot be set any closer together.
- b. For the S6005B with the Skip-A-Day feature, use the ON/DAY-ADVANCE tripper (labeled X, furnished with the S6005B) for the first ON operation of the day.

## **SETTING THE SKIP-A-DAY FEATURE (S6005B ONLY—FIG. 8)**



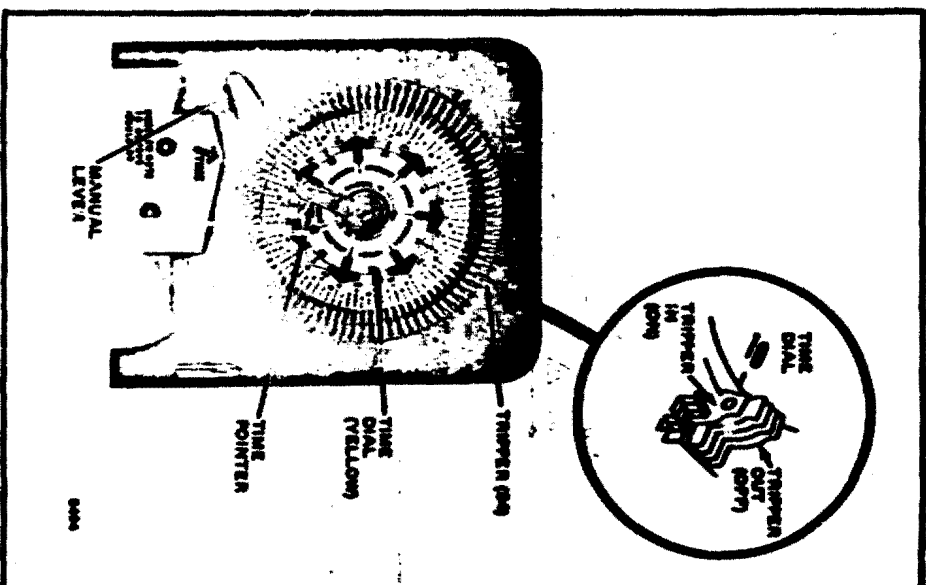
**FIG. 8—SETTING THE SKIP-A-DAY FEATURE  
(S6005B ONLY).**

1. Manual lever should be in the OFF position.
2. Insert a skipping screw (or screws) in the skipper wheel for the day (or days) on which automatic switch operation is not required. (The skipper wheel has 1 hole marked for each day of the week.)
3. Tighten the screw(s) firmly.
4. Rotate the skipper wheel until the day arrow points to the correct day of the week on the skipper wheel. (If the ON/DAY-ADVANCE tripper has not yet advanced the skipper wheel, the day arrow should point to the previous day. For example, if the day is Saturday, the arrow should point to Friday.)
5. Move the manual lever to the desired position.

## **SETTING THE TIME OF DAY (FIG. 7)**

1. Apply power to the timer motor.
2. Pull the time dial outward, turn it in either direction until the TIME pointer is aligned with the correct time of day, and let the dial snap back into position. Do not turn the TIME pointer.

## **S6005C—7 DAY TIMER**



**FIG. 9—SETTING THE 7 DAY S6005C TIMER.**

## **SETTING "ON" AND "OFF" TIMES (FIG. 9)**

**NOTE:** There are 84 permanent trippers included with the S6005C. No additional trippers are needed. The dial will turn clockwise when power is connected.

1. For an ON operation, push in the tripper opposite the desired time. Each tripper will turn the switch on for 2 hours.
2. For an OFF operation, leave the tripper in the OFF position. Do not pull the tripper all the way out of the dial. All trippers not pushed in will result in the switch being off (normally open contacts open, and normally closed contacts closed).
3. You can set the S6005C for up to 6 ON-OFF operations per day or 42 per week.

## **SETTING THE TIME OF DAY (FIG. 9)**

1. Apply power to the timer motor.
2. Turn the time dial clockwise until the TIME pointer is aligned with correct time and day. Do not turn the time dial counterclockwise, and do not move the TIME pointer.



## 8600SD-7 DAY TIMER

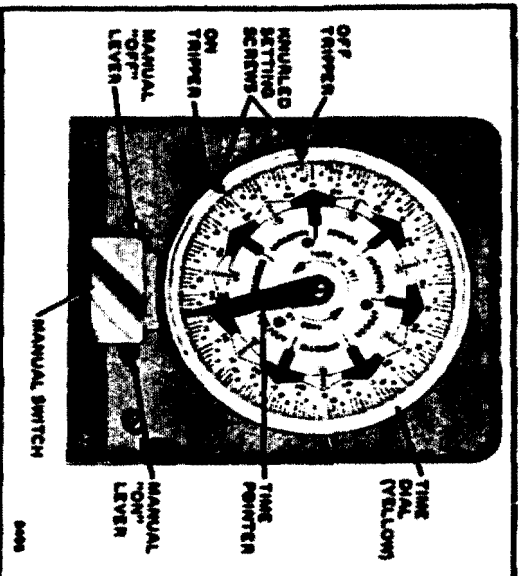


FIG. 10—SETTING THE 7 DAY 8600SD TIMER.

### SETTING "ON" AND "OFF" TIMES (FIG. 10)

NOTE: 14 trippers (7 sets, 1 set for each day) are included with the 8600SD. If more than 7 ON-OFF operations per week are required, additional trippers can be ordered (see Accessories in the SPECIFICATIONS section).

1. For setting an ON time, hold a tripper so you can read the ON label. Insert a knurled setting screw into the tapped hole and screw it a few turns into the tripper.
2. Slip the ON tripper over the edge of the time dial, and move it around the edge of the dial until it points to the day of the week and the time of the day (AM or PM) you desire the switch to turn on. (When the switch is

turned on, the normally open contacts will close, and the normally closed contacts will open.)

NOTE: The dial will turn counterclockwise when power is connected.

3. Hold the tripper firmly against the edge of the dial, and tighten the knurled screw securely by hand. (Do not use a pliers.)
4. For an OFF operation, hold a tripper so you can read the OFF label, and repeat steps 1 through 3 for the time you desire the switch to turn off (normally open contacts will open, and normally closed contacts will close).
5. You can set the 8600SD for up to 3 ON-OFF operations per day or 21 per week. To omit operation on any day(s), don't put any trippers on the dial for that day(s).

### IMPORTANT

- a. The minimum time from an ON operation to an OFF operation is 6 hours; do not place an OFF tripper less than 6 hours after an ON tripper.
- b. The minimum time from an OFF operation to an ON operation is limited to 2 hours by the width of the trippers; they can't be set any closer together.

## OPERATION AND CHECKOUT

### OPERATION

#### AUTOMATIC SWITCHING

When the ON tripper actuates the timer switch, the normally open contacts close and the normally closed contacts open. The contacts will stay in this position until the OFF tripper actuates the timer switch. Then the normally open contacts again open and the normally closed contacts again close. The switching times can be changed as desired (see the SETTING section).

The 84005A has an spst (single-pole, single-throw) switch. The 86005A, B, and C have an spdt (single-pole, double-throw) switch. The 86005D has a dpdt (double-pole, double-throw) switch.

#### MANUAL SWITCHING

The 84005's and 86005's can be switched manually by moving the manual lever under the time dial. The manual lever operates the timer switch the same way the ON and OFF trippers do during automatic switching.

On the 84005A, 86005A, and 86005B (Fig. 7), move the lever to the right to switch to the ON position, and to the left to the OFF position (as indicated by arrows on the lever). The timer resumes automatic operation after completion of that cycle.

On the 86005C (Fig. 9), move the lever up to the

### SETTING THE TIME OF DAY (FIG. 10)

1. Apply power to the timer motor.
2. Turn the time dial counterclockwise until the TIME pointer is aligned with the correct time and day. Do not turn the time dial clockwise, and do not move the TIME pointer.

permanent ON position (indicated by an arrowhead on the mechanism plate), and down to the AUTOMATIC position.

On the 86005D (Fig. 10), move down the lever on the right of the manual switch for the ON position, and move down the lever on the left of the manual switch for the OFF position. The timer resumes automatic operation after completion of that cycle.

#### SKIP-A-DAY

The 86005B has a skipping wheel which allows you to omit automatic operation on any selected day or days of the week (see SETTING section). On the 86005C and D (7 day models), skipping a day or days can be accomplished by simply omitting trippers for the selected day(s).

#### POWER FAILURE

The 86005D has a spring wound carry-over mechanism which will keep the timer on schedule during a power failure of up to 10 hours. When power is restored, the mechanism automatically rewinds.

For the other models, in case of power failure, reset the time dial to the correct time and day after power has been restored. (See SETTING section.)

## CAUTION

1. Make sure the insulator has been installed over the terminal board.
2. Use utmost care while testing or troubleshooting the timer; line voltage is present on contacts when power is on.
3. Disconnect power before removing or replacing the mechanism or timer motor.

### S4005A, S6005A, AND S6005B

1. Observe the motor gears through the window in

is operating.

2. Move the manual lever to its ON and OFF positions and observe that the loads are being switched properly.

### S6005C AND S6005D

Manually rotate the yellow time dial (clockwise  on the S6005C and counterclockwise  on the S6005D) and observe that the loads are being switched properly.

If the Energy Management Timer does not operate properly during Checkout, refer to the following TROUBLESHOOTING CHART.

## TROUBLESHOOTING CHART

| PROBLEM                                                 | CHECK                                                                                                                                                                         | SOLUTION                                                                                                                                                                                                                 |
|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TIME DIAL DOES NOT ADVANCE                              | <ol style="list-style-type: none"> <li>1. Is timer motor running?</li> <li>2. Is proper power supply connected to the CLOCK terminals (L terminals on the S6005D)?</li> </ol> | <ol style="list-style-type: none"> <li>1. If motor is not running, check power supply.</li> <li>2. If power supply is connected properly but timer motor is still not running, replace the motor.<sup>a</sup></li> </ol> |
| TIME DIAL ADVANCES, BUT LOADS ARE NOT SWITCHED PROPERLY | —                                                                                                                                                                             | Replace the mechanism. <sup>a</sup>                                                                                                                                                                                      |

<sup>a</sup>If the timer motor or mechanism has to be replaced, refer to the following SERVICE section.

## SERVICE

### CAUTION

1. Disconnect power before removing or replacing the mechanism or timer motor.
2. Replace the insulator covering the terminal board before reconnecting power, to prevent electrical shock.

### REPLACING THE MECHANISM

Before replacing the mechanism, disconnect all power from the timer, remove the insulator covering the terminal board, and remove the wires from the terminal board.

The mechanism in each timer is held in place by a spring clip. To remove the mechanism, depress the spring, grasp the time dial, and pull the mechanism outward.

To avoid jamming the mechanism in the case when replacing it, make sure the notches in the terminal board (or mechanism plate on the S6005C) fit over the ears in the case. (In the S6005D, the 2 tabs on the mechanism plate should fit into the 2 slots in the left side of the case).

After replacement, connect the wires to the terminal board, replace the insulator over the terminal board, and reconnect the power.

### REPLACING THE TIMER MOTOR

#### S4005A, S6005A,B,C

The timer motor in each timer is attached to the back of the mechanism plate by 2 screws. To remove the timer motor, first remove the mechanism as described

previously. Then disconnect the 2 motor wires from the CLOCK terminals on the terminal board, and remove the 2 mounting screws from the motor. Mount the new motor using the 2 mounting screws, and connect the 2 motor wires to the CLOCK terminals on the terminal board. Then replace the mechanism.

#### S6005D

The spring carry-over and motor assembly is attached to the mechanism plate by 3 screws that protrude through the mechanism plate and are secured with 3 nuts. To remove the carry-over assembly, first remove the mechanism as described previously. Then proceed as follows:

1. Make a mark on the manual switch right at the end of the TIME pointer. (The pointer must be lined up with this mark later.)
2. Unscrew the Phillips screw in the middle of the yellow time dial, and remove the dial.
3. Cut the 2 yellow leadwires that go from the spring carry-over and motor assembly to the "L" terminals on the terminal board.
4. Remove the 3 nuts from the screws that hold the assembly to the mechanism, and remove the assembly.
5. Mount the new assembly, replace the 3 nuts on the mounting screws, and tighten them securely.
6. Splice the 2 yellow leadwires on the new assembly to the 2 yellow leadwires still connected to the "L" terminals on the terminal board.
7. Replace the yellow time dial. Make sure the TIME pointer is lined up with the mark on the manual switch, and then tighten the Phillips screw in the center of the dial.

## type V90CA THREE-WAY VALVES FOR DIVERTING SERVICE

### APPLICATION

These three-way valve bodies are to be used for diverting service. They have 1-inlet and 2-outlets and are recommended for two position (on/off) service. Common applications are summer-winter changeover, cooling tower by-pass, etc.

The diverting valves have a quick opening flow characteristic. Because of this, they will have a tendency to "hunt" when applied to proportional control modes.

*We recommend the V90DB mixing valves listed in Bulletin 3626 be used on proportional control application. These valves must be piped for mixing service (2-inlets and 1-outlet).*

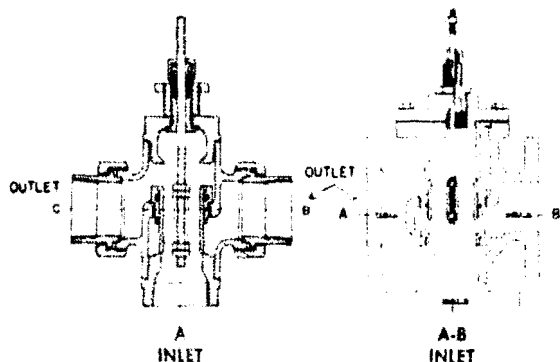
### GENERAL DESCRIPTION

#### Motor Actuators and Linkage

These valves are positioned by Penn Series M40A or M81 motor actuators. The actuators are adapted to the valve bodies by a linkage which not only fastens the valve body and actuator together, but also transforms the angular movement of the actuator output shaft to the straight-line motion required to position the inner valve plug of the valve body. A pinion gear on the actuator output shaft drives a gear rack that is connected to the valve stem. This construction maintains the designed flow characteristics of the valve body. Clockwise motor rotation drives valve stem down.

### SPECIFICATIONS

Sizes 1/2" to 2" have 150 lb. ASA bodies with bronze trim. Cylinder shaped inner valve plug gives a quick opening flow characteristic. They have union type pipe connections on the two side ports "C" and "B" and a screwed end connection on bottom port "A", metal-to-metal seating and asbestos rope packing.



Cross section view of typical Three-Way Valve in sizes 1/2" to 2".

Cross section view of typical Three-Way Valve in sizes 2 1/2" to 6".

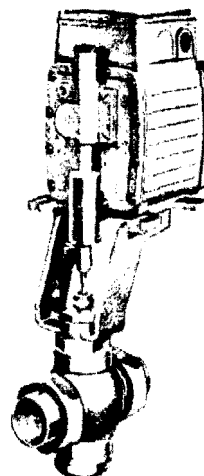


Fig. 1 — Motor Actuated Valve

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Sizes 2 1/2" to 6" are the same as above except 125 lb. ASA flanged semi-steel body with bronze trim. All diverting valves have a maximum media temperature of 281° F.

### VALVE SIZING

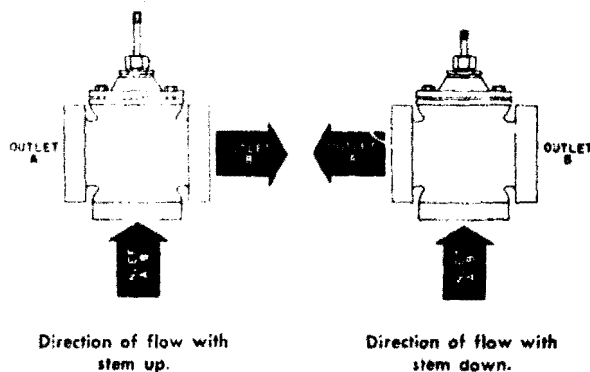
For liquid applications, see Bulletin 3334 (valve size selection chart).

### ORDERING INFORMATION

To order, specify:

1. Valve Body Product Number.
2. Valve Linkage Product Number.
3. Motor Actuator Product Number.
4. Factory assembled, if required.
5. Water temperature and pressure.

*Example: One V90CA-1 Valve Body, one Y20AAA-1 Valve Linkage and one M81AAA-12 Motor Actuator with 60 sec. timing completely factory assembled; for 180° F. water at 25 psi.*



Direction of flow with stem up.

Direction of flow with stem down.

## SPECIFICATIONS

| Valve Size (Inches) | Valve Weight (Lbs.) | Valve Body Weight (Lbs.) | Linkage Required (Order separately to match valve and motor selected) |                          |             | Max. Pressure Difference Outlet "A" to Outlet "B" | Valve Lift (Inches) | Shipping Wt. - Lbs. (Valve Only) |
|---------------------|---------------------|--------------------------|-----------------------------------------------------------------------|--------------------------|-------------|---------------------------------------------------|---------------------|----------------------------------|
|                     |                     |                          | Standard Series MB1                                                   | Spring Return Series MB1 | Series M40A |                                                   |                     |                                  |
| V90CA-1             | 1/2                 | 3.5                      | Y20AAA-1                                                              | Y20ABA-1                 | Y20EAA-1    | 50                                                | 3/4                 | 3.5                              |
| V90CA-2             | 3/4                 | 9.0                      | Y20AAA-1                                                              | Y20ABA-1                 | Y20EAA-1    | 50                                                | 3/4                 | 3.8                              |
| V90CA-3             | 1                   | 18.0                     | Y20AAA-1                                                              | Y20ABA-1                 | Y20EAA-1    | 50                                                | 3/4                 | 5.3                              |
| V90CA-4             | 1 1/2               | 27.0                     | Y20AAA-1                                                              | Y20ABA-1                 | Y20EAA-1    | 50                                                | 3/4                 | 7.4                              |
| V90CA-5             | 1 3/4               | 32.0                     | Y20AAA-1                                                              | Y20ABA-1                 | Y20EAA-1    | 50                                                | 3/4                 | 9.8                              |
| V90CA-6             | 2                   | 80.0                     | Y20AAA-1                                                              | Y20ABA-1                 | Y20EAA-1    | 50                                                | 3/4                 | 15.8                             |
| V90CA-7             | 2 1/2               | 51.0                     | Y20AAB-2                                                              | Y20ABB-1                 | None        | 50                                                | 3/4                 | 63                               |
| V90CA-8             | 3                   | 75.0                     | Y20AAB-2                                                              | Y20ABB-1                 | None        | 50                                                | 3/4                 | 70                               |
| V90CA-9             | 4                   | 152.0                    | Y20AAB-2                                                              | None                     | None        | 50                                                | 1                   | 75                               |
| V90CA-10            | 5                   | 220.0                    | Y20AAB-2                                                              | None                     | None        | 50                                                | 1 1/2               | 140                              |
| V90CA-11            | 6                   | 302.0                    | Y20AAB-2                                                              | None                     | None        | 50                                                | 1 1/2               | 160                              |

## INSTALLATION

Upright mounting is recommended but valve assemblies can be mounted in other positions provided the output shaft is horizontal.

Ambient temperature plus heat transferred from the valve through the linkage must not cause the motor temperature to exceed its limit of 135° F.

Motor-actuated valves are available either completely factory assembled and tested or as individual components; valve body, valve linkage, and motor actuator.

## CHECKOUT PROCEDURE

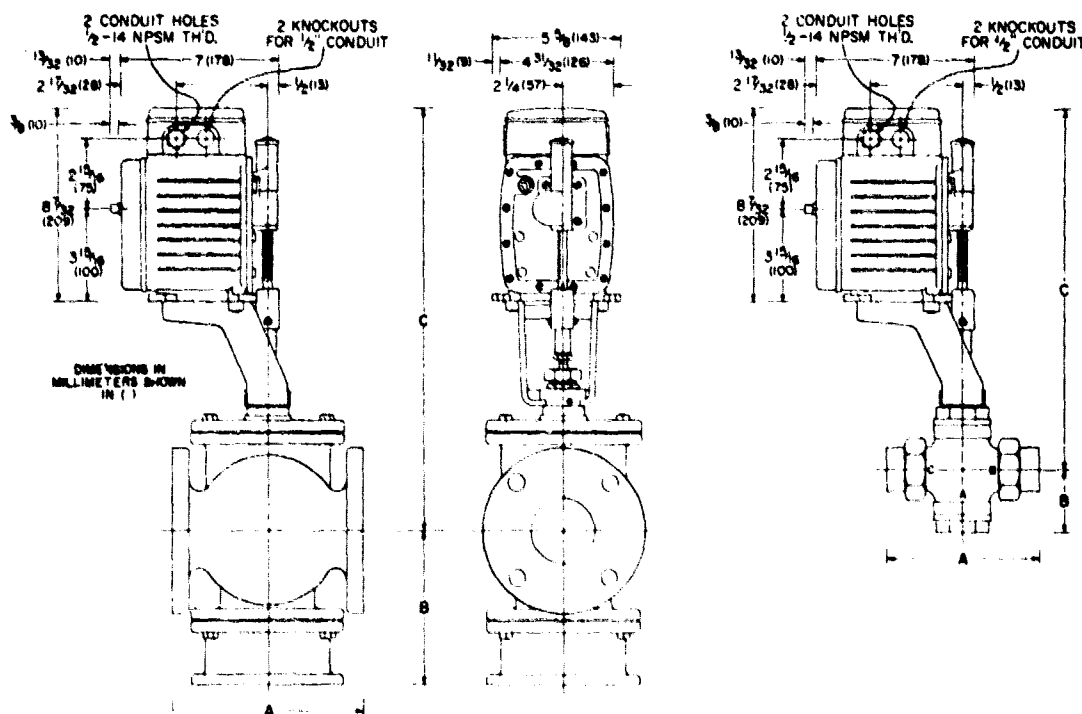
Make sure valve stem moves freely after valve is installed. The valve joints and seals should be checked to be sure there are no leaks.

After linkage and motor actuator are assembled to the valve, a complete operating cycle should be observed to be sure all components are functioning properly.

## REPAIRS AND REPLACEMENT

Replacement of valve stem, valve plug and packing may be made in the field. When ordering replacement parts, give Valve Body Number and complete description of the part required.

## DIMENSIONS



| Valve Size | A            | B           | C             | Valve Size | A             | B             | C             |
|------------|--------------|-------------|---------------|------------|---------------|---------------|---------------|
| 1/2"       | 4 1/8" (124) | 2" (51)     | 14 3/8" (371) | 2 1/2"     | 9" (229)      | 7 1/8" (179)  | 17 1/4" (438) |
| 3/4"       | 5 1/4" (133) | 2 3/8" (56) | 14 1/2" (376) | 3"         | 10" (254)     | 7 1/8" (202)  | 18" (457)     |
| 1"         | 5 1/2" (140) | 2 3/8" (59) | 14 3/8" (379) | 4"         | 13" (330)     | 10 1/8" (257) | 18 7/8" (479) |
| 1 1/4"     | 6 3/4" (171) | 2 5/8" (67) | 15 1/4" (387) | 5"         | 12" (305)     | 10 1/8" (271) | 19 1/8" (492) |
| 1 1/2"     | 7 1/8" (189) | 3 1/8" (79) | 15 1/4" (394) | 6"         | 14 1/8" (359) | 11 1/4" (286) | 20 3/8" (518) |
| 2"         | 8 1/8" (214) | 3 3/8" (81) | 15 1/4" (400) |            |               |               |               |

Performance specifications appearing herein are nominal and are subject to accepted manufacturing tolerances and application variables.

## series Y20

### AUTOMATIC HEATING-COOLING

Change-over Linkage  
(Was Series MV)

#### APPLICATION

This linkage set, used with a proportional motor actuator and selected auxiliary switch kit operates a heating valve and up to four stages of mechanical cooling in sequence. The room thermostat should be a proportional electronic or electric (135 ohm) type.

A typical application is sequencing a steam coil control valve with travel through a given dead band and then actuating (with an auxiliary switch kit) one, two, three or four compressors or refrigerant solenoid valves.

Figure 1 illustrates the assembly of the automatic change-over linkage set to the motor and valve.

#### GENERAL DESCRIPTION

The linkage fastens the valve body and a 60 second speed motor actuator together and also provides the means for transforming the angular movement of the actuator output shaft to the straight-line motion required to position the inner valve of the valve body.

#### LINKAGE SELECTION TABLE

| Valve Bodies *               | Valve Linkage Number     | Remarks                                             |
|------------------------------|--------------------------|-----------------------------------------------------|
| V90CA-1<br>thru<br>V90CA-6   | Y20ADA-1<br>(Was MV1036) | 1/2" to 2"<br>3-way bodies<br>For Diverting service |
| V90AA-10<br>thru<br>V90AA-15 | Y20ADA-2<br>(Was MV1043) | 1/2" to 2"<br>2-way bodies                          |
| V90DB-1<br>thru<br>V90DB-6   |                          | 1/2" to 2"<br>3-way bodies<br>For Mixing service    |
| V90AA-7<br>thru<br>V90AA-9   | Y20ADB-1<br>(Was MV1042) | 2 1/2" to 4"<br>2-way bodies                        |
| V90DB-7<br>thru<br>V90DB-9   |                          | 2 1/2" to 4"<br>3-way bodies<br>For Mixing service  |

\* The max. close-off ratings are 1/3 of that specified in Bulletins 3624, 3626, 3627 and 3690.

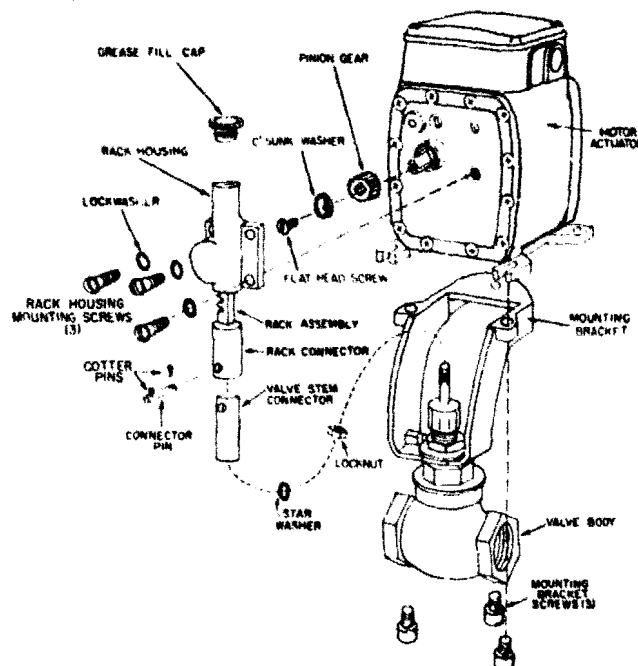


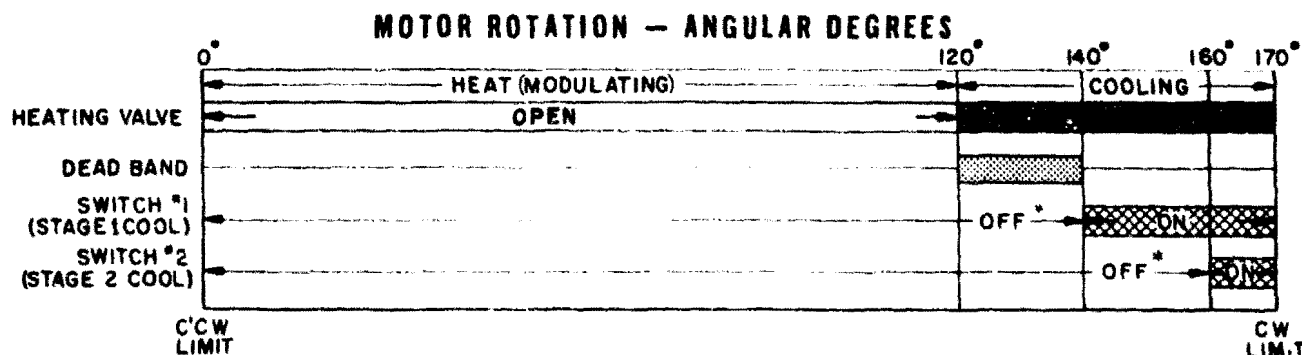
Fig. 1 — Diagram showing assembly of valve linkage set connecting valve body to motor actuator.

#### ORDERING INFORMATION

To order specify:

1. Linkage Number (see Specification Table.)
2. Motor actuator (see Series M80, M81 Bulletins.)
3. Valve body (see Series V90 Bulletin.)
4. Auxiliary switch kit (see Series S91 Bulletin.)
5. Factory assembly, if required.

Example: One V90CA-3 Valve Body, one Y20ADA-1 Valve Linkage, one M80BAA Motor Actuator and one S91BA Switch Kit.



\* NOTE: (1) If two or more stages of cooling are used, increase motor stroke to 170°. (2) Readjust auxiliary switch differentials to 10°.

# PENN SERIES Y20 CHANGE-OVER LINKAGE

## INSTALLATION AND MOUNTING

WHEN INSTALLING TO A SERIES M81 WITH SNAP-ACTING TRAVEL LIMIT SWITCHES OR SERIES M80F MOTOR ACTUATOR, FOLLOW THE INSTRUCTIONS PACKED WITH THE MOTOR.

Install the motor-actuated valve in a location where the ambient temperature does not exceed 125° F. Valve medium temperatures above 250° F. are permissible only if the maximum ambient temperature at the motor is reduced to 105° F. Valve controlling mediums exceeding 320° F. must be equipped with cooling fins or extension bonnets to reduce the motor housing temperature to 160° F. maximum.

The motor-actuated valve should be mounted in an upright position. Positions other than upright are acceptable if the motor actuator output shaft is kept horizontal.

Two-way globe valves should be installed with pressure under the seat unless a direction arrow on the valve body indicates otherwise. Refer to three-way valve installation instructions for proper valve body installation.

To field assemble this valve linkage:

1. Assemble the pinion gear to the main shaft of the motor actuator with screw and washer provided. Liberally apply a heavy transmission grease to the pinion gear. Remove the position indicator cover.
2. Electrically power motor actuator to clockwise limit by connecting 24 V. A.C. to terminals 2 and 7.



Fig. 2 — Pinion gear and screw.

3. Slide the rack assembly into the rack housing with the first scribe mark on rack flush with lower edge of rack housing.
4. Assemble rack housing to motor (holding the rack scribe line position as shown in Figure 3) to mesh the pinion and rack teeth.

**NOTE:** The scribe lines may disappear into the rack housing or both lines may just be visible depending

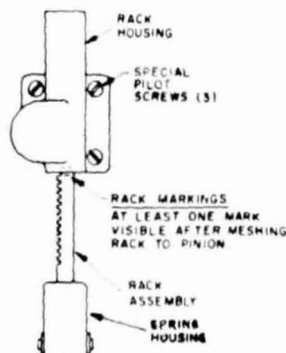


Fig. 3 — Rack assembly and rack housing. Note rack marking position.



Fig. 4 — Interior close-up of motor actuator showing travel adjusting screw.

upon the teeth engagement. The lower scribe mark should be visible.

5. Lock the assembly to the motor housing using the three rack housing mounting screws supplied in the linkage kit.
6. Adjust motor travel to minimum by rotating travel adjustment screw (Fig. 4) 10 complete turns clockwise.
7. Assemble parts as shown in Figure 5. Tighten the valve jam nut (not the packing nut).
8. Assemble valve and mounting bracket assembly to

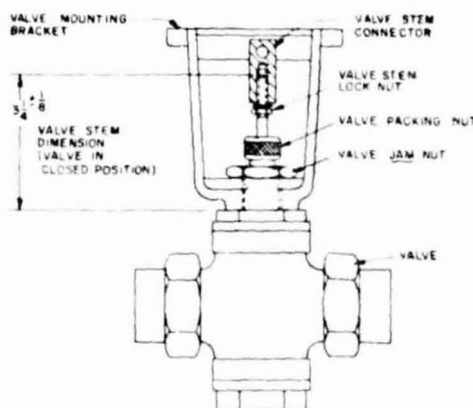


Fig. 5 — Valve body mounted to bracket.

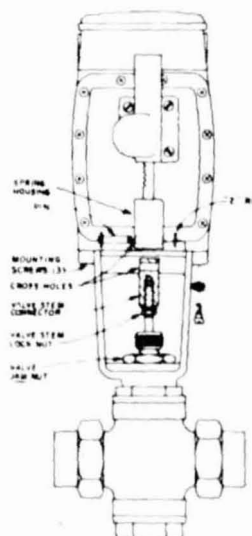


Fig. 6 — Motor assembled to valve body.

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# SERIES Y20 CHANGE-OVER LINKAGE

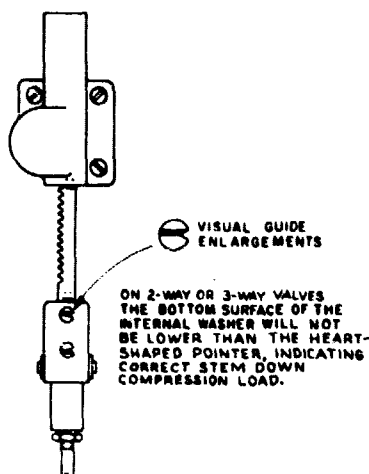


Fig. 7 - Properly assembled linkage will have the visual guide in the position shown.

the motor actuator housing with the three mounting bracket screws.

9. Motor travel adjustment.
  - a. Determine valve stem travel of valve — Pull valve stem up and then push down as far as possible and measure the amount of valve stem movement that is available.
  - b. Single stage cooling — the amount of rack "lift" required equals the actual valve travel + .250 inches.
  - c. Two or more stages of cooling — the amount of rack "lift" required equals the actual valve travel + .325 inches.
10. Electrically power the motor actuator to the "rack up" position by connecting 24 V. A.C. to terminals 3 and 7. Allow it to run until it stops itself. (Measure this movement.)
11. Slowly rotate the travel adjustment screw counter-clockwise until the rack has moved up the same total distance as determined in paragraphs 9b or 9c.
12. Pull the valve stem up. Rotate the valve stem connector until the crosshole of the connector lines up with the cross-hole in the spring housing. Insert the pin in place with the snap rings.
13. Three-way valves — Rotate travel adjustment an

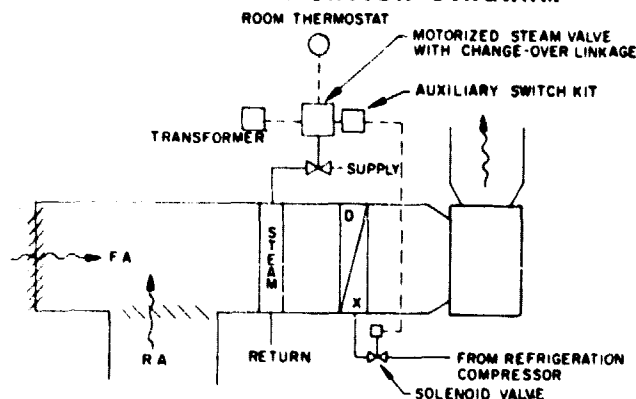
additional revolution counter-clockwise. This assures tight closure on both the upper and lower valve seats.

14. Replace the position indicator cover.
15. Re-apply 24 V. A.C. power to terminals 2 and 7 until motor stops. See Figure 7 for visual means to denote properly assembled units.

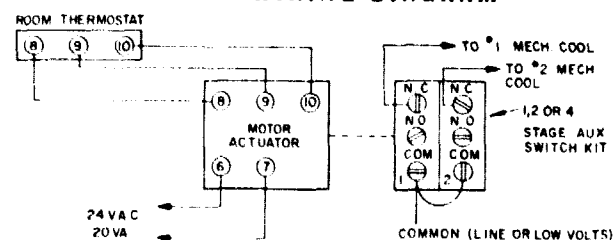
## SEQUENCE OF OPERATION

Room thermostat modulates a steam valve to maintain temperature. A rise in room temperature causes the valve to close. On a continued temperature rise, motor actuator continues to rotate and turns on mechanical cooling. When room temperature drops reverse procedure occurs.

## TYPICAL APPLICATION DIAGRAM



## TYPICAL WIRING DIAGRAM



**NOTE:** If a low limit is required, select a proportional controller with two 135 ohm potentiometers in series and wire as a 270 ohm control. Wire in series with the room thermostat in the number 9 leg. The low limit must be removed from circuit during cooling cycle.

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**PENN** CONTROLS, INC.

## INSTALLATION AND OPERATION INSTRUCTIONS

### SERIES Y20

FORM 997-739

## ADJUSTMENT INSTRUCTIONS FOR NORMALLY CLOSED SPRING RETURN VALVE ACTUATOR

Use Linkage Y20ABA-1, -2, Y20ABB-1, -2  
(Was Series MV)

### APPLICATION

Valve Linkage sets are used with a Series M80 or M81 Motor Actuator and selected valve bodies to electrically control steam, water, gas, etc. Valve bodies are single seat, double seat, three-way, pilot balanced, or other similar construction.

### DESCRIPTION

The linkage sets include the parts necessary to mount motor actuators directly to valve bodies.

The motor actuator is secured to the valve body by a die cast mounting bracket (see Fig. 3). Usually the bonnet or stuffing box of the valve body is threaded and a jam nut secures the bracket to the body. Each bracket has the proper hole size to accommodate the bonnet of the specific valve body being used.

A rack and pinion gear arrangement transforms the rotary movement of the motor actuator output shaft to the straight-line movement necessary to position the valve stem. On one end of the rack assembly is a threaded valve stem adapter which secures the mechanism to the valve stem. A series of disc type springs insure positive valve closure.

**NOTE:** The rack assembly movement can easily be changed from  $\frac{1}{2}$ " to  $\frac{7}{8}$ " by adjusting the motor actuator travel limits (see Fig. 2). Since the valve stem travel varies with valve size and type, this feature allows the use of one motor actuator on almost any valve body.

The motor is factory set for a valve stroke of  $\frac{7}{8}$ ".

### LOCATING AND MOUNTING

WHEN INSTALLING TO A SERIES M81 WITH SNAP-ACTING TRAVEL LIMIT SWITCHES OR SERIES M80F MOTOR ACTUATOR, FOLLOW THE INSTRUCTIONS PACKED WITH THE MOTOR.

Install the motor-actuated valve in a location where the ambient temperature does not exceed 125° F. Valve



Fig. 1 — Valve linkage set fully assembled to motor actuator and valve body.

medium temperatures above 250° F. are permissible only if the maximum ambient temperature at the motor is reduced to 105° F. Valve controlling mediums exceeding 320° F. must be equipped with cooling fins or extension bonnets to reduce the motor housing temperature to 160° F. maximum.

Upright mounting is recommended, but valve assemblies can be mounted in other positions if the motor actuator output shaft is kept horizontal.

Two-way globe valves should be installed with pressure under the seat unless a directional arrow on the valve body indicates otherwise. Three-way valves should be installed as mixing valves; namely, two inlets and one outlet whenever possible.

Motor-actuated valves are available either factory assembled and tested or as individual components; valve body, valve linkage, and motor actuator. If shipped "knocked down" or if for any reason the motor actuator must be field assembled to the valve body, refer to assembly diagram (Fig. 3) and proceed as follows.

#### 1. Assemble mounting bracket to valve body.

Valves with threaded bonnets — Remove jam nut and, where necessary, packing nut from valve body. Slip mounting bracket on valve bonnet and insert tool "A" between bottom of bracket and top of valve mounting surface. Tool "A" should be inserted so its two fingers lie flat on valve mounting surface with one finger on each side of the threaded bonnet. Secure mounting bracket to valve body with the jam nut with tool "A" in place. Replace packing nut (if it was necessary to remove).

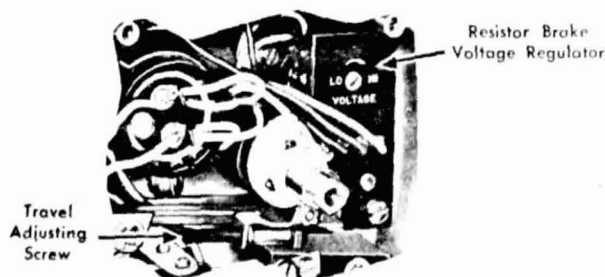


Fig. 2 — Interior of motor actuator showing travel adjusting screw.

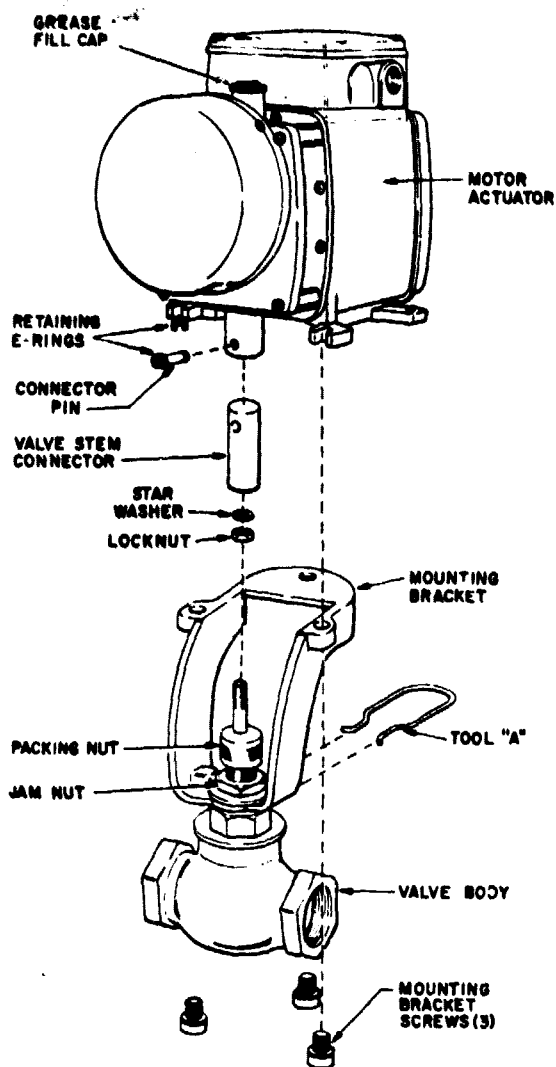


Fig. 3 - Drawing showing assembly sequence.

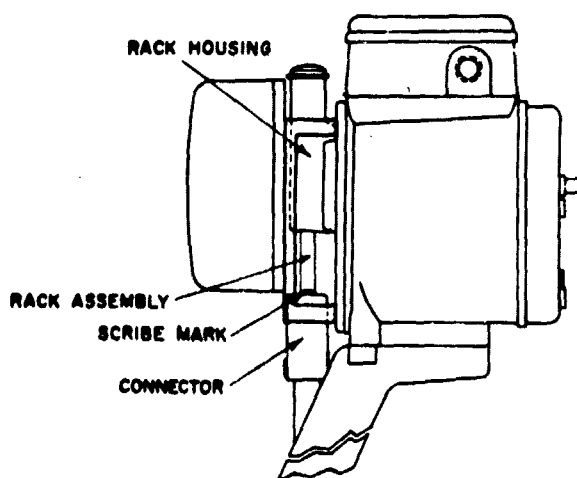


Fig. 4 - Drawing showing scribe mark.

2. Pull valve stem up and then push down as far as possible and measure the physical stem travel that is available.
3. Thread connector lock nut and valve stem connector as far down the valve stem as possible. Secure the motor actuator to the mounting bracket with the three screws provided. Next, start turning the valve stem connector counterclockwise while keeping the valve stem from moving. As soon as the through hole of the connector lines up with the mating pin and snap in the retaining E-rings. Now tighten the connector lock nut up against the valve stem connector.
4. Apply 24 V. A.C. power to terminals 6 and 7, apply a jumper between terminals 1 and 3 until valve stem rises approximately  $\frac{1}{4}$  inch. Loosen the valve bonnet jam nut and remove tool "A." Re-tighten valve bonnet jam nut against valve mounting bracket. Re-apply the jumper to terminals 1 and 2 until motor stops running. **NOTE:** At this point if all settings have been properly made, the bottom scribe mark will be in line with the top of the spring housing.
5. Remove back cover from motor actuator and refer to the "limits of travel adjusting screw" (Fig. 2). If, from step 2, the available valve stem travel was found to be less than  $\frac{7}{8}$  inch, turn travel adjusting screw clockwise approximately 8 complete turns.
6. Connect a jumper to terminals 1 and 3 on motor actuator and allow it to run until it stops itself. Measure the distance the valve stem has traveled. If additional stem travel is required, slowly turn adjusting screw counter-clockwise until the exact amount of valve stem travel occurs. **NOTE:** On three-way valves, an additional .040 of an inch movement in the rack assembly should be provided for, when setting the travel adjusting screw. This assures positive valve closure in the stem-up as well as the stem-down position.
7. Replace cover on motor actuator.

### RESISTOR BRAKE VOLTAGE REGULATOR

Occasionally, incoming voltage to the transformer will be above or below the normal 10% allowance on line voltages. When this occurs, the valve stem will oscillate up and down continuously on either the CW or C'CW electrical travel limit.

A brake voltage regulation potentiometer is built into the motor actuator. Place a volt meter across terminals 6 and 7. Read the *operating voltage*. If this voltage is above 26.5 V. A.C., rotate the regulator potentiometer towards "HI" until oscillation stops. The opposite is done if the voltage on terminals 6 and 7 is less than 22.5 V. A.C.



CONTROLS, INC.

JOHNSON  
CONTROLSJohnson Controls, Inc.  
Penn Division2221 Camden Court  
Oak Brook, IL 60521

## Series M81 Motor Actuator On-Off and Floating Control Action

### APPLICATION

These motor actuators position air dampers, control valves, programming devices, burner fuel valves, and similar equipment in heating, air conditioning and industrial applications.

### FEATURES

- Enclosed, snap acting travel limit switches.
- Travel limits are field adjustable by adjusting internal cam.
- All motor actuators have weather-resistant enclosure as standard.
- Models available with an internal, adjustable differential auxiliary switch.
- Oil immersed gear train provides minimum maintenance, quiet operation and long life.

### GENERAL DESCRIPTION

These motor actuators have a capacitor-run motor enclosed in a gasketed die cast case with mounting feet. An output shaft actuates cam-operated, snap acting switches which stop the shaft rotation at predetermined limits of travel.

There are three basic Series M81 motor actuators; standard on-off, spring return damper and spring return valve.

The spring return damper model has a heavy gauge built-in spring mechanism to return the motor shaft to its full CCW limit on power failure or interruption. An electrical holding circuit prevents the return spring from driving the motor actuator towards its normal position unless the power is interrupted. The external spring housing and optional internal auxiliary switch are installed on opposite sides of the motor actuator. At no time is it

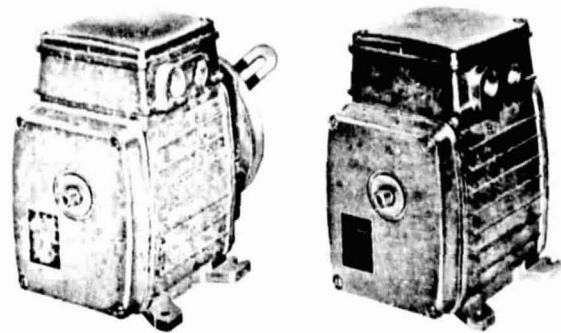


Fig. 1 — Back view of motor actuator. Spring return damper (left) and non-spring return (right).

necessary to disconnect the damper and remove the spring housing for access to the auxiliary switch.

An adjustable crank arm on the output shaft for easy connection is standard on the spring return damper motor. It is slotted to allow an adjustable radius from  $1\frac{1}{8}$ " to  $2\frac{7}{8}$ ". The crank arm can be secured to the motor actuator shaft in position increments of  $22\frac{1}{2}$  angular degrees.

The spring return valve model has a heavy gauge built-in spring mechanism to return the valve to its normal position on power failure or interruption. It has the same holding circuit as the spring return damper motor actuator.

The spring return valve motor actuator is available for normally open (N.O.) and normally closed (N.C.) valve operation. The field adjustable travel is from 0.4" to 1.3" valve stem movement for both spring return and non-spring return valve applications.

The motor actuator can be mounted in any position except upside down. However, mounting with the output shaft horizontal is recommended, and upright mounting is preferred. Spring return actuators must be mounted within  $30^\circ$  of upright.

The motor should travel through its full stroke (determined by its limit switches) while performing its function, even though the motor's full range may not be employed. Motor may be damaged if it is not free to complete its full stroke. The motor should be stopped at the end of its stroke by the limit switch, *not* stalled by the damper or valve.

### SPECIFICATIONS

**Shaft Specifications:** Double ended,  $\frac{3}{8}$ " square.

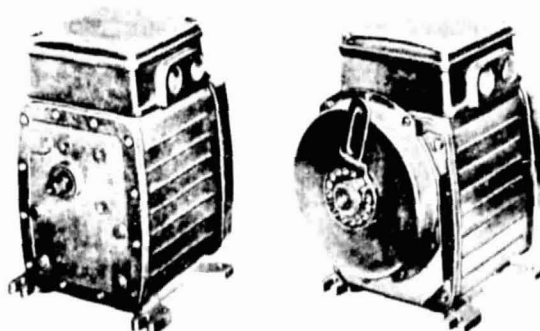


Fig. 2 — Load end view of non-spring return motor actuator (left) and spring return damper motor actuator (right).

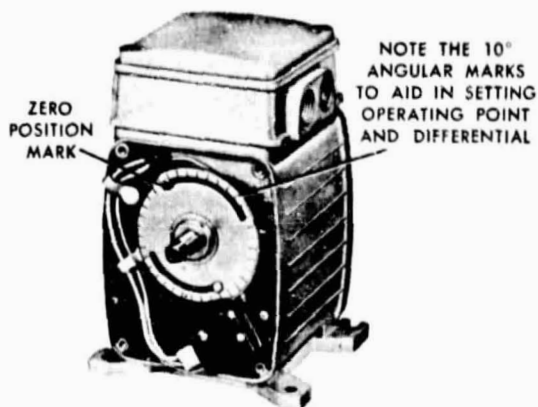


Fig. 3 — Interior view showing auxiliary switch adjusting cam.

**Control Requirements:** SPDT On-Off or floating control with minimum three-wire rating of 1 amp. at 24 V. A.C.

**Power Requirement:** 20 VA., 24 Volts A.C., 50/60 Hz. Spring return damper models with internal heater require 50 VA.

**Enclosure:** Die cast natural aluminum provides a light and rugged case. This time proven construction is used in all models.

**Built-in Auxiliary Switch:** SPDT, adjustable range from 0 to 160°, adjustable differential from 5 to 90°.

#### Electrical Ratings at 131° F (55° C) Ambient

| Volts A.C.                              | 120 V. | 240 V. | 277 V. |
|-----------------------------------------|--------|--------|--------|
| Full Load Amps.                         | 5.8    | 2.9    | 2.6    |
| Locked Rotor Amps.                      | 34.8   | 17.4   | 15.6   |
| Non-Inductive Amps.                     | 10.0   | 8.3    | 7.2    |
| Pilot Duty 125 VA. at 24 to 300 V. A.C. |        |        |        |
| Maximum Connected Load 2000 VA.         |        |        |        |



Fig. 4 — Interior view showing travel limit cam on spring return damper actuator.

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**Internal Heater (M81AFA Spring Return Damper Motor):** The thermostat control closes circuit to heater when ambient temperature drops below 20° F (−7° C) and opens circuit when temperature rises above 50° F (10° C). It cannot be field installed.

**Conduit Openings:** Two threaded openings for 1/2" conduit.

#### Ambient Temperature

| Type Number                    | Minimum |     | Maximum |     |
|--------------------------------|---------|-----|---------|-----|
|                                | °F      | °C  | °F      | °C  |
| M81AAA, M81AAB, M81AFA*        | −40     | −40 | +131    | +55 |
| M81ACA, M81ACB, M81ADA, M81AEA | +10     | −12 | +131    | +55 |

\*Includes internal heater.

### PRODUCT NUMBER SELECTION

| Product Number | Timing (1)<br>Secs./160° | Travel<br>Standard Factory<br>Setting | Auxiliary<br>Switches | Internal<br>Heater | Application                                     |
|----------------|--------------------------|---------------------------------------|-----------------------|--------------------|-------------------------------------------------|
| *M81AAA-12     | 60                       | 90°                                   | None                  | No                 | Valve or damper                                 |
| *M81AAB-5 (2)  | 60                       | 90°                                   | 1                     | No                 | Valve or damper                                 |
| *M81ACA-3      | 60                       | 90°                                   | None                  | No                 | Spring return damper CCW                        |
| *M81ACB-1 (2)  | 60                       | 90°                                   | 1                     | No                 | Spring return damper CCW                        |
| *M81ADA-2      | 60                       | 0.4" lift                             | None                  | No                 | Valve stem normally down<br>Spring return valve |
| *M81AEA-2      | 60                       | 0.4" lift                             | None                  | No                 | Valve stem normally up<br>Spring return valve   |
| *M81AFA-2      | 60                       | 90°                                   | None                  | Yes                | Spring return damper CCW                        |

(1) See Specification Table for additional timing information.

(2) U.L. Listed.

\*Models available from stock.

### SPECIFICATIONS

| Type Number                  | Timing in seconds<br>(Nominal)<br>Angular travel<br>160° (2.8 rad) | Torque (1)<br>lb.-inches<br>Newton Meters in ( ) | Damper (3)<br>Rating - Sq. ft.<br>Sq. Meters in ( ) | Field Adjustable<br>Rotational Travel |
|------------------------------|--------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------------------|---------------------------------------|
| M81AAA,<br>M81AAB            | 15                                                                 | 40 (4.5)                                         | 17.5 (1.6)                                          | 65° to 270°<br>(1.1 to 4.7 rad)       |
|                              | 30                                                                 | 80 (9)                                           | 35 (3)                                              |                                       |
|                              | 60                                                                 | 150 (17)                                         | 70 (6.5)                                            |                                       |
| M81ACA,<br>M81ACB,<br>M81AFA | 60                                                                 | 30 (3.4)                                         | 35 (3)                                              | 65° to 180°<br>(1.1 to 3.2 rad)       |
| M81ADA,<br>M81AEA            | 60 seconds for 1" valve lift                                       | 75 lb. valve stem thrust                         | —                                                   | 0.4" to 1.3" (2)                      |

(1) Torque ratings are for load end of shaft.

(2) Includes 0.1" overtravel for seating of 2-way valves or 0.2" overtravel for 3-way valves.

(3) For dampers incorporating extensive seals for low leakage, these figures should be reduced to as much as 1/4. Contact damper manufacturer.

Auxiliary output shaft is limited to a maximum dead weight of 25 lbs.

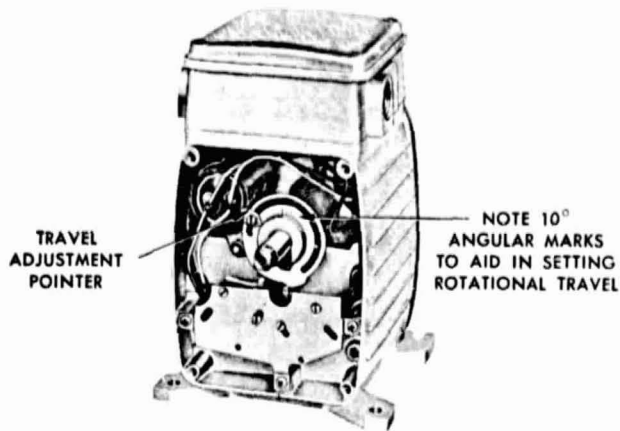


Fig. 5 — Interior view showing travel limit cam on non-spring return actuator.

## OPTIONAL CONSTRUCTION

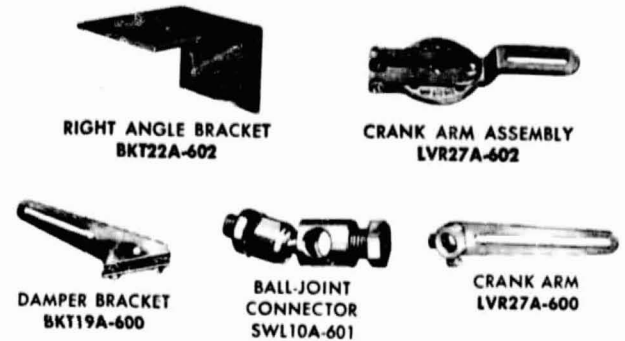
**Position Indicator:** Kit No. PTR11A-600 is available, if required. It contains an indicator pointer and two pressure sensitive mylar decals. For field installation only. Available no charge when ordered with motor actuator.

**Travel Limit Setting:** Standard setting is 90 angular degrees. Other factory settings are available at increased cost. Consult Customer Service.

## ACCESSORIES

**Damper Linkage Components:** A variety of crank arms, ball joint connectors, push rods and a right angle mounting bracket provide easy connection of the motor actuator to a damper. Two complete sets are offered to simplify selection of proper components.

| Description          | Part No.   | Application or Construction                                                                                                        |
|----------------------|------------|------------------------------------------------------------------------------------------------------------------------------------|
| Damper Linkage Set   | Y20DAA-2   | For mounting of actuator to top of duct or any flat surface. Contains LVR27A-602, LVR27A-600, SWL10A-601 (2 ea.), and ROD16-3.     |
|                      | Y20DAB-2   | For mounting of actuator to side of duct or wall. Contains LVR27A-602, LVR27A-600, SWL10A-601 (2 ea.), ROD16-3, and BKT22A-602.    |
| Crank Arms           | LVR27A-600 | For use on $\frac{1}{2}$ " or $\frac{7}{16}$ " diameter damper shafts. Adjustable radius from $\frac{3}{4}$ " to $4\frac{1}{2}$ ". |
|                      | LVR27A-602 | For use on motor actuator. Adjustable radius from $1\frac{1}{16}$ " to $2\frac{7}{8}$ ".                                           |
|                      | BKT19A-600 | Damper angle bracket to connect linkage to damper blade                                                                            |
| Ball Joint Connector | SWL10A-601 | With $\frac{1}{4}$ "-28 diameter stud—use with LVR27A-602, LVR27A-600, and BKT19A-600 crank arms.                                  |
| Push Rods            | ROD16-2    | $\frac{5}{16}$ " diameter x 48" long plated steel shaft.                                                                           |
|                      | ROD16-3    | $\frac{5}{16}$ " diameter x 24" long plated steel shaft.                                                                           |
| Mounting Bracket     | BKT22A-602 | Right angle mounting bracket.                                                                                                      |



**Externally Mounted Auxiliary Switch Kits:** Use Penn Series S91 switch kit. These kits are available with one, two or four SPDT snap acting switches. They can be mounted on either shaft end of the motor actuator and incorporate the time proven, reliable, Pennswitch construction.

Contacts are rated at 9.8 amps. at 120 V. A.C. and 8.0 amps. at 240 V. A.C. at 125° F. (52° C.) ambient.

For complete information, refer to Penn Series S91 Bulletin No. 3650.

**Transformers:** A transformer is required to provide motor actuators with the necessary 24 Volt A.C. power supply. Plate mounted transformers mount on a 4" electrical box. Transformers No. Y65AS-1, Y65BS-1 and Y65CS-1 have a  $\frac{1}{2}$ " conduit fitting on the primary and secondary to permit direct mounting into the conduit opening in the motor wiring compartment. See Penn Series Y63, Y64 and Y65 Bulletin No. 3742 for additional information.

| Transformer Capacity | Type Mounting | Primary Power Supply (V. A.C.) | Transformer Part No. |
|----------------------|---------------|--------------------------------|----------------------|
| 40 VA.               | Plate         | 120                            | Y65AJ-1              |
|                      |               | 208                            | Y65CS-1              |
|                      |               | 240                            | Y65BJ-1              |
|                      | Foot          | 120                            | Y65AS-1              |
|                      |               | 208                            | Y65CJ-1              |
|                      |               | 240                            | Y65BS-1              |
| 50 VA.               | Plate         | 120                            | Y63AJB-1             |
|                      |               | 480                            | Y63KJB-1             |
|                      |               | 208/240                        | Y63SJB-1             |
|                      | Foot          | 120                            | Y63ALB-2             |
|                      |               | 208/240                        | Y63SLB-2             |
|                      |               | 208/240                        | Y64AJ-1              |
| 100 VA.              | Plate         | 120                            | Y64AJ-1              |
|                      | Foot          | 208/240                        | Y64SJ-1              |
|                      |               | 120                            | Y64AL-2              |
|                      |               | 208/240                        | Y64SL-1              |

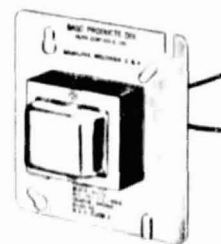
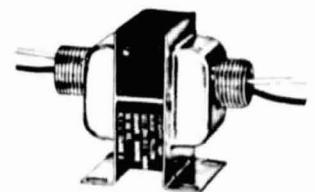


Plate mounted transformer



Foot mounted 40 VA. transformer.





Fig. 6 — Motor actuator assembled to a two-way valve.

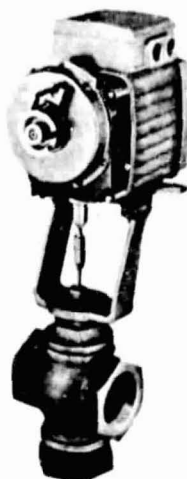


Fig. 7 — Spring return motor actuator assembled to a three-way valve.

**Valves:** Penn provides a complete line of two-way single seat and double seat, three-way diverting and mixing valves to meet your control application.

Refer to the following bulletins to select the valve and linkage required:

| Valve Number | Description              | Bulletin Number |
|--------------|--------------------------|-----------------|
| V90AA, V90AD | 2-way, single seat globe | 4283            |
| V90BA        | 2-way, double seat       | 3625            |
| V90CA        | 3-way, diverting         | 3627            |
| V90DB, V90DD | 3-way, mixing            | 4284            |
| V90SA        | Butterfly                | 3428            |

### SHIPPING WEIGHTS (Approx.)

| Type Number                            | Individual Pack   |
|----------------------------------------|-------------------|
| M81AAA, M81AAB                         | 11.0 lbs (5 kg)   |
| M81ACA, M81ACB, M81AFA, M81ADA, M81AEA | 15.1 lbs (6.8 kg) |

### ORDERING INFORMATION

To order specify:

1. Complete Product Number, if available.

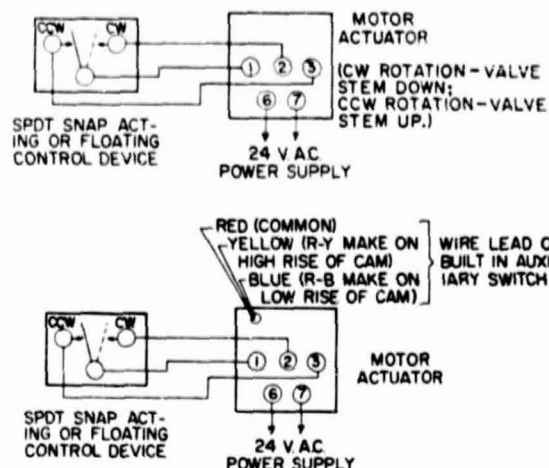


Fig. 8 — Typical wiring diagrams.

2. Position indicator Kit No. PTR11A-600, if desired.
3. If complete Product Number is not available, specify Type Number and the following:
  - a. Torque (40, 80 or 150 lb.-inches) if model is other than spring return valve or damper actuator.
  - b. Travel setting, if other than standard 90°.
4. Accessories required.

Example: M81AAA

150 lb.-inches

160° travel

Y65AJ-1 transformer

Y20DAB-2 damper linkage set

PTR11A-600 position indicator kit.

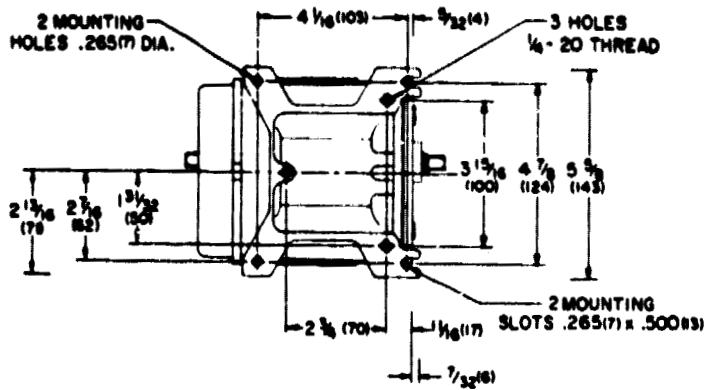
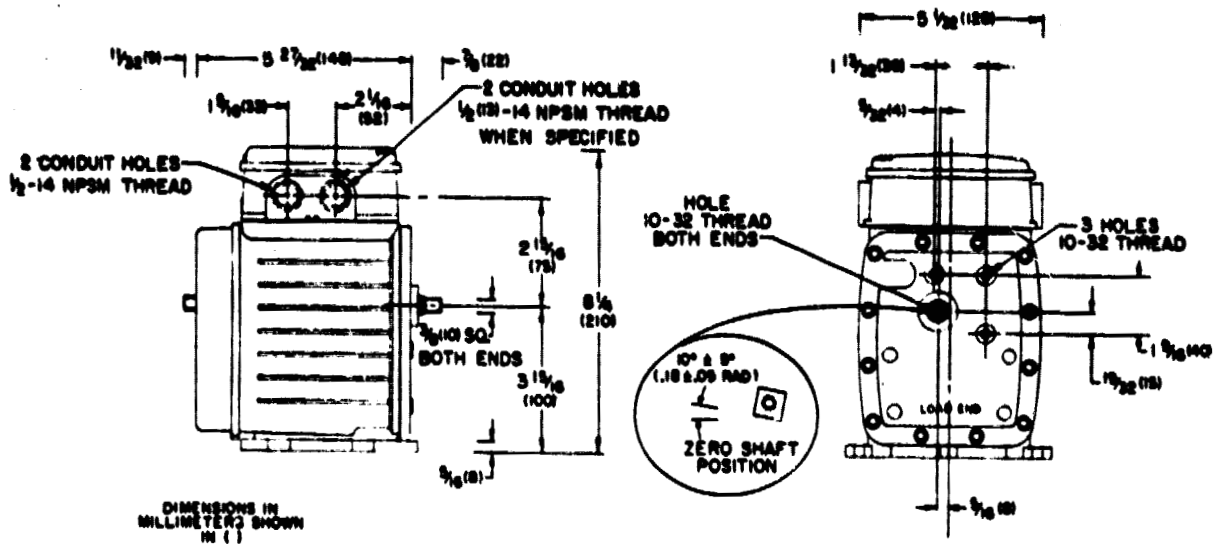
### REPAIRS AND REPLACEMENT

As the drive motor and gear train are immersed in oil and sealed in a die cast case, periodic maintenance is not required.

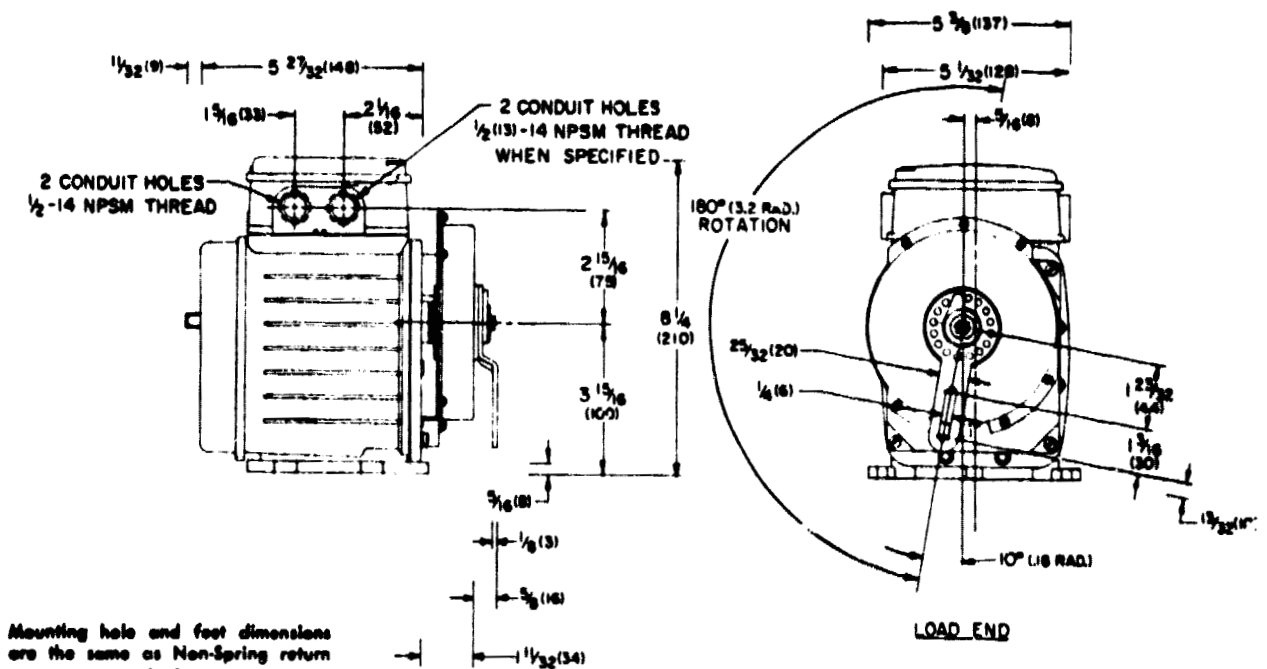
Field repairs must not be made. Replacement actuators may be obtained through the nearest Penn Commercial Wholesaler. When ordering a replacement actuator, specify Product Number and Serial Number shown on the actuator.

SEE PAGES 5 AND 6 FOR DIMENSIONS

## DIMENSIONS

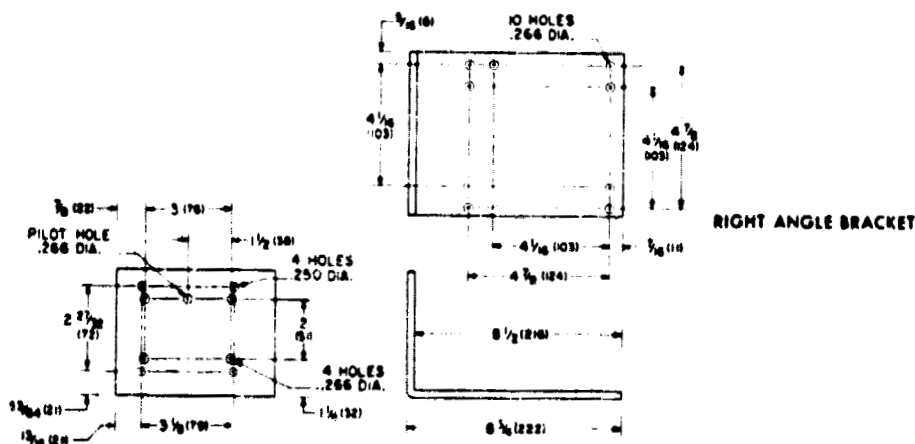
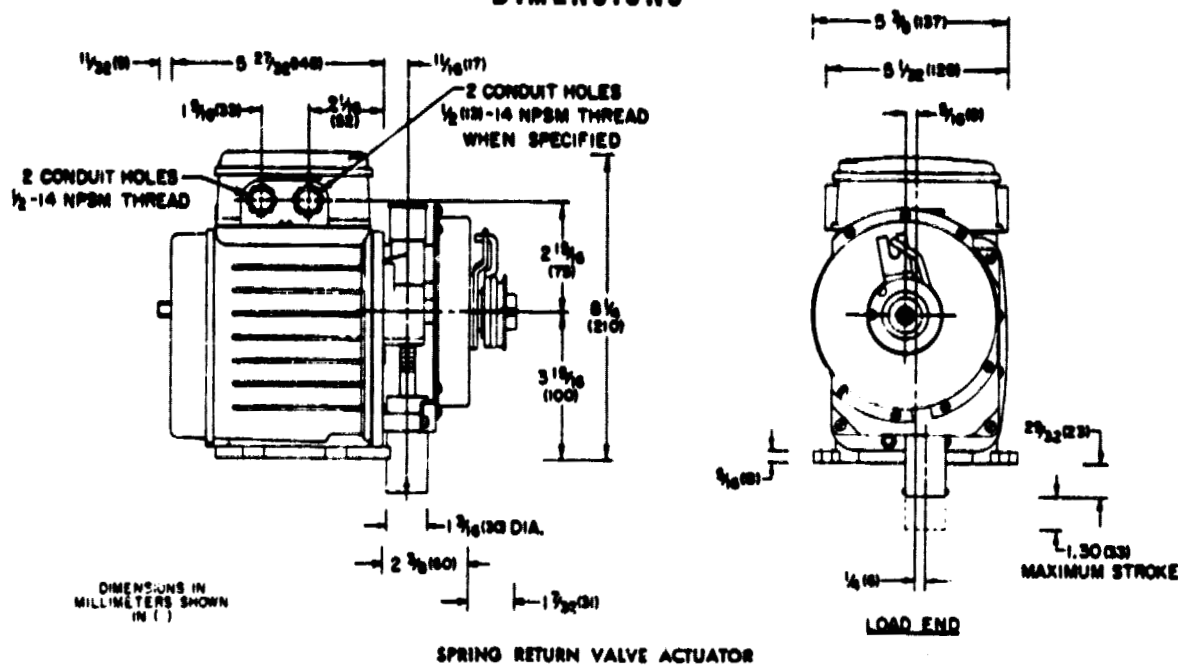


NON-SPRING RETURN VALVE AND DAMPER ACTUATOR



SPRING RETURN DAMPER ACTUATOR

## DIMENSIONS



Performance specifications appearing herein are nominal and are subject to accepted manufacturing tolerances and application variables.

MB1AAB, MB1ACB: U.L. Guide No. XAPX  
File E6688



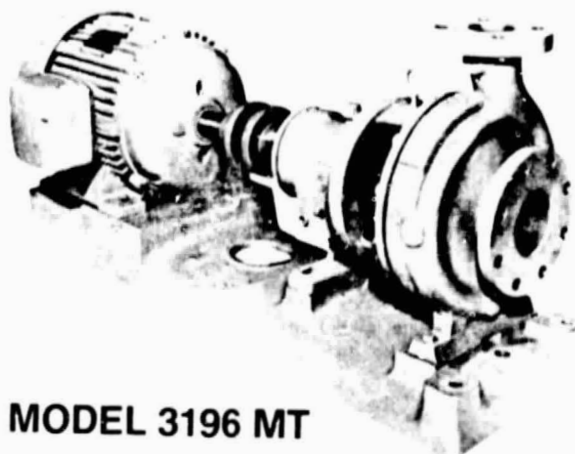


# GOULDS PUMPS

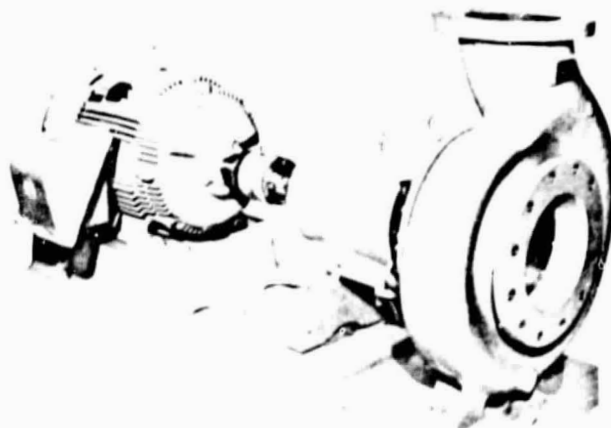
## Installation, Operation and Maintenance Instructions



MODEL 3196 ST



MODEL 3196 MT



MODEL 3196 XLT

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# TABLE OF CONTENTS

| <b>SECTION I—GENERAL</b>                                |  | <b>PAGE</b> |
|---------------------------------------------------------|--|-------------|
| Introduction .....                                      |  | 3           |
| I-A Importance of Instructions .....                    |  | 3           |
| I-B Special Warnings .....                              |  | 3           |
| I-C Receiving Inspection—Shortages .....                |  | 3           |
| I-D Preservation and Storage .....                      |  | 3           |
| I-E Handling Techniques .....                           |  | 3           |
| <b>SECTION II—INSTALLATION</b>                          |  |             |
| II-A Location .....                                     |  | 3           |
| II-B Foundations .....                                  |  | 3           |
| II-C Leveling and Grouting of Baseplate .....           |  | 4           |
| II-D Piping Practices .....                             |  | 4           |
| II-E Alignment—Preliminary .....                        |  | 4           |
| II-F Stuffing Box .....                                 |  | 5           |
| <b>SECTION III—OPERATION</b>                            |  |             |
| III-A Startup .....                                     |  | 5           |
| III-B Operation Checks .....                            |  | 6           |
| III-C Shutdown Procedure .....                          |  | 6           |
| <b>SECTION IV—PREVENTIVE AND CORRECTIVE MAINTENANCE</b> |  |             |
| IV-A Lubrication .....                                  |  | 6           |
| IV-B Stuffing Box .....                                 |  | 6           |
| IV-C Vibration .....                                    |  | 6           |
| IV-D Alignment—Final .....                              |  | 6           |
| IV-E Performance .....                                  |  | 6           |
| <b>SECTION V—DISASSEMBLY AND REASSEMBLY</b>             |  |             |
| V-A Disassembly .....                                   |  | 7           |
| V-B Inspection and Parts Replacement Guidelines .....   |  | 7           |
| V-C Reassembly Procedures .....                         |  | 7           |
| V-D Additional Details .....                            |  | 9           |
| <b>SECTION VI—PRODUCT DESCRIPTION</b> .....             |  | 9,10,11     |
| <b>SECTION VII—TROUBLE SHOOTING</b> .....               |  | 12          |
| <b>SECTION VIII—ORDERING SPARE PARTS</b>                |  |             |
| VIII-A Spare Parts .....                                |  | 13          |
| VIII-B Instructions for Ordering Spare Parts .....      |  | 13          |

P20637 GOULDS PUMPS, INC. REPLACEMENT PARTS DATA SHEET  
 ORDER NUMBER 782280 3196ST 1X1-1/2-6 CONST. DI  
 IMP. DIAMETER 5-5/8  
 CUST. P.O. NUMBER 703 ITEM

Solar Unlimited

Huntsville AL

| NO   | PUMP | PART NAME    | JULDS<br>PART NO. | MATL     | NET<br>PRICE<br>EACH | MANUFACTURERS<br>IDENTIFICATION |
|------|------|--------------|-------------------|----------|----------------------|---------------------------------|
| 100  | 1    | CASING       | 104-421           | 1012     | 209.25               |                                 |
| 101  | 1    | IMPLR W/O-RG | R76777            | 1013     | 85.25                |                                 |
| 112A | 1*   | BALL BRG OB  | 8055 30600        |          | 20.54                | MRC-5306                        |
| 113A | 1    | BREATHER     | 9008 31365        |          | 3.10                 | ALEMITE 313650                  |
| 119A | 1    | BRG END COV  | 76771             | 2210     | 6.98                 |                                 |
| 122  | 1*   | SHAFT ASSY   | R104-435          | 2238     | 128.65               |                                 |
| 123  | 1    | DEFLECTOR    | 76776             | 1        | 3.88                 |                                 |
| 126  | 1*   | SHAFT SLEEVE | 76772X            | 2229     | 77.50                |                                 |
| 134A | 1    | BRG HOUSING  | 104-433           | 1001     | 46.50                |                                 |
| 136  | 1*   | BRG LK NUT   | 8601 0006         |          | 1.40                 | MRC N-06                        |
| 168A | 1*   | BALL BRG 1.8 | 8050 20760        |          | 5.19                 | MRC-207S                        |
| 184  | 1    | SB COV ASSY  | R104-429          | 1012     | 116.25               |                                 |
| 228A | 1    | FRAME        | 259- 57           | 1000     | 240.25               |                                 |
| 250  | 1    | GLAND MS     | 077231            | 1 2229   | .00                  |                                 |
| 251  | 1    | SIGHT OILER  | 072531            | 5 8683   | 32.55                | TRICO=3                         |
| 332A | 1    | OIL SEAL     | 8690 62020        |          | 2.09                 | VICTOR 63647K5                  |
| 333A | 1    | OIL SEAL     | 8690 62019        |          | 2.09                 | VICTOR 64448K3                  |
| 351  | 1    | GASKET CASE  | 70782             | 81 5128  | 2.17                 |                                 |
| 353  | 4    | GLAND STUD   | 27177             | 604 2229 | 4.65                 |                                 |
| 355  | 4    | HEX NUT      | 49507             | 104 2228 | .00                  |                                 |
| 361A | 1    | RTNG RING    | 58101             | 281      | 2.02                 | N002-281                        |
| 370  | 4    | H CAP SCREW  | 49511             | 252 2210 | .39                  |                                 |
| 370C | 3    | H TAP BOLT   | 49521             | 104 2210 | .16                  |                                 |
| 370D | 3    | H TAP BOLT   | 49521             | 104 2210 | .16                  |                                 |
| 370H | 2    | STUD         | 27177             | 663 2228 | 2.33                 |                                 |
| 382  | 1*   | BRG LK WSHR  | 8910 0006         |          | .70                  | MRC W-06                        |
| 383R | /*   | KTRY UNIT    | 90890 1137        |          | .00                  |                                 |
| 383S | /*   | STA SEAT     | 90890 0201        |          | .00                  |                                 |
| 412A | 1    | O-RING IMPLR | 70721             | 137      | 2.02                 | ARP 568-023TEFLON               |
| 469D | 1    | KOLL PIN     | 80860             | 5        | .16                  |                                 |
| 496  | 1    | O-RING       | 70721             | 144      | .78                  | ARP 568-236BUNA-N               |
| 600  |      | SECTIONAL    | 259-55            |          | .00                  |                                 |

\* RECOMMENDED SPARE PARTS

RUN DATE 07/12/78  
 PAGE 1



P.O. Box 3393-A  
Birmingham, Alabama 35205  
205-939-0533

April 17, 1978

Solar Unlimited  
4310 Governors Drive S.W.  
Huntsville, Alabama 35805

Attn: Bruce Noval

RE: Proposal BP4141B

Dear Mr. Noval:

Enclosed is the quotation which you requested for the Silcon Oil Service. Both pumps quoted are model 3196ST groups. These pumps have a mechanical seal which will be mounted inside and require no flushing at all. However we have supplied a special vent and drain gland so as, to prevent any leakage into the mechanical seal while in operation or, in case of failure. The drain off of this gland should go back to the reservoir or to the collection basin.

Inspection of both the pump and the mechanical seal may be done on a monthly basis. Inspection of the mechanical should be done visually. Signs of mechanical seal failure would be leakage to the mechanical seal. During normal operation mechanical seals should have zero leakage. Only at the time of failure will it start to leak.

This quote will be valid for 30 days, with all standard terms as stated on the reverse side of this quotation form.

Yours very truly,

Robert G. Bloom  
District Engineer

RGB:ls

ORIGINAL PAGE 1  
OF POOR QUALITY



**CENTRIFUGAL PUMP  
QUOTATION**

REPLY TO:

**GOULDS PUMPS, INC.**  
P.O. Box 8898-A  
Birmingham, AL 35205  
Phone: 205-989-0588

All quotations subject to terms and conditions on the reverse side except as noted on Page \_\_\_\_\_ attached.

SHIPMENT: Our best estimate at this time is 6 weeks after complete engineering and manufacturing information and full approval to proceed with work.

To: **Solar Unlimited**  
4310 Governors Drive West  
Huntsville, Alabama 35805

Date: 4/14/78  
Proposal No.: BP4141B

Page: 1 of 2

Revision No.:

Copies: Mobile, Seneca Falls

Attention: Bruce Novak  
Inquiry Date:  
Inquiry No.:

In answer to your inquiry, we propose to furnish GOULDS PUMPS as described below:

| ITEM NO.<br>EQUIP. NO.<br>SERVICE |             |            |           | OPERATING CONDITIONS AND PERFORMANCE |              |                   |                   |
|-----------------------------------|-------------|------------|-----------|--------------------------------------|--------------|-------------------|-------------------|
|                                   |             |            |           | Liquid                               |              | Temp. °F          | Sp. Gr. @ P.T     |
|                                   |             |            |           | Dow Chem. Silicon Q21132             |              | 350               | 1.0               |
| Quantity                          | Model       | Size       | Rotation  | G.P.M.                               | T.D.H.       | V.P.              | Visc.             |
| 2                                 | 3196        | 1x1 1/2-6  | CW        | 40                                   | 30           | 12 CS             |                   |
| Casing                            | Impeller    | Shaft      | Sleeve    | Eff.                                 | Rated B.H.P. | Max. B.H.P.       | Suct. Press       |
| DI                                | DI          | STEEL      | 316SS     | 46                                   | .66          | .86               |                   |
| Wear Plate                        | Lubrication | Base Plate | Coupling  | Disch. Press                         | Perf. Curve  | NPSH <sub>R</sub> | NPSH <sub>A</sub> |
| -                                 | Oil         | CI         | Woods     | C1-2075-2                            |              | 2.25'             |                   |
| Mechanical Seal -- Packing        |             |            | Imp. Type | Impeller Diameter                    |              | Bulletin          |                   |
| Dura. Seal ROTT                   |             |            | Open      | Rated                                | Min.         | Max.              |                   |
| EU5EVT                            |             |            |           | 5 1/2                                | 3 1/2        | 6 1/16            | 725.1             |

| DRIVER-- |        |                   |              |                 | ITEM       | *PRICE     | WEIGHT |
|----------|--------|-------------------|--------------|-----------------|------------|------------|--------|
| H.P.     | R.P.M. | Enclosure         | Frame        | S.F. Insulation | Pump       | \$926. ea  | 160    |
| 1        | 1780   | TEFC<br>ODRIP DRY | 143T         |                 |            | 65.00      |        |
| Phase    | Hertz  | Voltage           | Furnished By |                 | Driver     | 76. ea     | 45     |
|          |        |                   |              |                 | Total Unit | \$1002. ea | 205    |

WITH THE FOLLOWING ADDITIONS, MODIFICATIONS AND/OR REQUIREMENTS

Price & Weight

PRICE  
BEING  
REVIEW  
BY  
ROBERT BLOOM  
BOSTON TAG LINE  
BID.

THIS QUOTATION VALID FOR 30 DAYS FROM  
DATE OF PROPOSAL SHOWN ABOVE.  
\* PRICES SHOWN ARE F.O.B. SHIPPING POINT  
TERMS: NET 30 DAYS

Robert Bloom

# STANDARD TERMS AND CONDITIONS

GOULDS PUMPS, Inc., Seneca Falls, N.Y., U.S.A.

All Sales and Transactions with Goulds Pumps, Inc., are subject to its Standard Terms and Conditions

**1. Warranty:** The Company warrants that its pumps, when properly installed and cared for as stated in the appropriate instruction manual issued by the Company, will operate in accordance with its proposal.

Goulds Pumps are warranted to be made of first-class material, and in a skillful and workmanlike manner. They are additionally warranted against any defective material or workmanship and any part, even defective within one year from the date of shipment, after inspection by and to the satisfaction of the Company, will be replaced free of charge F.O.B. Shipping Point, on return of such defective part to the Company, transportation charges prepaid. No parts, however, shall be returned without the express authority of the Company so to do.

There are no warranties, express or implied, except such warranties as are definitely set forth herein. The Company shall not be liable for damage or wear to pump caused by abnormal conditions, vibration, failure to properly prime or to operate pump without flow or caused by corrosives, abrasives or foreign objects. No obligations other than those herein set forth shall be binding upon the Company. No warranties apply to other than the original user.

The Company shall in no event be held liable for damages or delay caused by defective material and no allowance will be made for repairs or alterations, unless made by its written consent or approval. In the event the pumps are altered or repaired by others without prior written approval by the Company all warranties are void. Equipment and accessories not manufactured by the Company are warranted only to the extent of and by the original manufacturer's warranty.

Under no circumstances shall the Company be held liable for any consequential or other damages, losses or expenses arising from installation, use, or any other causes, regardless of advice or recommendations that may have been rendered concerning such installation or use of its products, nor shall the Company be liable for penalties of any description.

**2. Shipment:** Promised shipping dates are approximate, and are from point of manufacture. Such dates are estimated from (a) the date of receipt of order with complete manufacturing information at Company's factory, and (b) the date of entry of such order by the Company. Shipping dates are subject to revision at the time of the entry of order and the shipping schedule then given is approximate and subject to any action Company must take in connection with priorities or other orders or regulations issued by the United States Government, or any department thereof.

The Company will not be liable for loss, damage, detention, or delay in manufacture or delivery or necessity to substitute materials, resulting from causes beyond its reasonable control, including but not limited to casting failures, war, fire, strikes, lockouts, or other labor difficulties, civil or military authority, insurrection or riot, embargoes, car or ship shortages, acts of governments, wrecks or delays in transportation, including any delays caused by inability to obtain necessary labor, materials or manufacturing facilities due to such causes, or from action taken by the Company in connection with priorities or preference orders or other production orders issued by the United States Government or any department thereof, or from delay in obtaining or failure to obtain manufacturing financing, export or other licenses required by the United States Government or any department thereof, or in any event for consequential damages.

Acceptance of material by common carrier constitutes a waiver of any claim against the Company for delay or damage in transit, or for lost goods.

When quotation includes equipment not of Company's manufacture, Company's promise of shipment is based on manufacturer's promise to Company and shipment is contingent on the fulfillment of their promise.

**3. Prices:** All prices are subject to change without notice and are subject to any increase which may be in effect on the date of shipment of the goods, such increase, if any, to be within any applicable government regulations. Prices are F.O.B. Shipping Point, unless otherwise specified. When price includes transportation and other charges pertaining to the shipment of the goods, any increase in transportation rates and other charges will be for the account of the purchaser. There will be an extra charge for any test other than that which may be normally run by the Company, or for any test performed to suit the convenience of the purchaser.

**4. Terms of Payment:** Terms and conditions of payment will be shown on invoices rendered by the Company at time of shipment or as may be otherwise stated in writing by an officer of the Company.

**5. Orders:** All illustrations and specifications are descriptive and are not intended as warranties. The acceptance of all orders taken by the Company's sales representatives or branches is subject to approval by Company's office at Seneca Falls, New York, U.S.A., or City of Industry, California, U.S.A.

**6. Cancellation of Orders:** Orders once placed with and accepted by Company can be cancelled only with Company's consent and upon terms that will indemnify Company against loss.

**1. Company may forthwith cancel the order or contract without recourse**

(a) if conditions are such that shipment from Company's factory may be delayed beyond the date estimated at the time of entry of order or contract.

(b) if the Purchaser is in default with the Company on this or any other order or contract;

(c) if Purchaser is or becomes insolvent, or if at any time Company is not fully satisfied with the credit of Purchaser, it may at any time after the order has been entered, or during the manufacturing period, or at the time the goods are ready for shipment, require payment in advance of shipping regardless of original terms, or if after shipment, has been made and before actual delivery and acceptance at destination, (regardless of F.O.B. point), it may recall the shipment and cancel this and any and all other orders and contracts which may be outstanding, and shall be entitled to receive reimbursement for its reasonable and proper cancellation charges.

(d) if the order or contract is for the direct account of one of its sales representatives, distributors or dealers, and Company terminates or alters such relationship.

**11. The Company shall have at all times a right of set-off as to any and all accounts between it and Purchaser**

**7. Claims:** No claims for allowances will be entertained unless presented immediately on receipt of goods; nor will Company be held responsible for breakage or shortage after goods are delivered to and accepted by the common carrier.

**8. Equipment Returned:** Goods can be returned for credit only after receiving Company's authorization and shipping instructions. Consignor's name and address must be plainly written on the shipping tag.

**9. Taxes:** All Federal, State, Local and Municipal taxes now in effect or hereafter enacted that are applicable to this transaction shall be paid for the account of the Purchaser, and if paid or required to be paid by the Company, the amount thereof shall be added to and become a part of the price payable by the Purchaser hereunder.

**10. Minimum Charge:** A minimum charge of \$20.00 will be made in the case of any order, the items on which at the net prices total less than this amount.

**11. General:** All sales and transactions are subject to Company's Standard Terms and Conditions, and they shall prevail in the event of any conflict or variance with those of the Purchaser's, unless otherwise agreed to in writing.

All previous agreements, either written or oral, which are subject matter hereof, are hereby cancelled.

Stenographic or clerical errors are subject to correction.

*If this transaction involves EXPORT, the following additional terms and conditions shall apply:*

**12. Packing:** Equipment will be packed, boxed or crated in accordance with the Company's standard commercial practice, for underdeck export shipment, unless otherwise agreed.

**13. Payment:** Unless otherwise specified in writing, payment shall be made by irrevocable letter of credit in form acceptable to Company, confirmed by a New York or Los Angeles Bank acceptable to Company, and providing for payment in full in United States dollars in New York or Los Angeles against presentation of United States inland shipping documents and invoices, such letter of credit to be established prior to Company's acceptance of the order. The letter of credit shall provide also that in the event Company is, for any reason beyond its control, prevented from making shipment from Company's factory or delivery at the port of embarkation, a certificate of manufacture of the whole or any part of the goods shall constitute delivery of such whole or any part of the goods and payment in full of any and all drafts drawn against the letter of credit for the goods so "delivered", shall be made upon presentation of such certificate of manufacture in lieu of United States inland shipping documents. In the event that Company is prevented by law, or otherwise, from making shipment from Company's factory or delivery at port of embarkation of the goods or any part thereof, on completion of manufacture, Company reserves the right to place the goods in storage for the purchaser's account and risk. Any charges incurred in this connection will be for the account of the purchaser at cost and will be payable upon demand.

**14. Company as Agent:** If Company makes or arranges for ocean shipment, Company shall act as agent for the purchaser and reserves the right to procure full insurance coverage, including war risk insurance, at the expense of the purchaser. All expenses incurred in this connection will be payable upon demand to the Company.

If Company applies for or secures manufacturing, financing, exporting or other licenses required by the United States Government, or any department thereof, Company shall make such applications or secure such licenses solely as agent for the purchaser, and assumes no responsibility therefor.

STC 1070

PRINTED IN U.S.A.

**GOULDS PUMPS, INC.**  
SENECA FALLS, NEW YORK 13148

## CENTRIFUGAL PUMP QUOTATION

To: Solar Unlimited  
4310 Governors Drive West  
Huntsville, Alabama 35805

REPLY TO:

**GOULDS PUMPS, INC.**  
P.O. Box 8398-A  
Birmingham, AL 35205  
Phone: 205-939-0588

All quotations subject to terms and conditions on the reverse side except as noted on Page \_\_\_\_\_ attached.

SHIPMENT: Our best estimate at this time is 6 weeks after complete engineering and manufacturing information and full approval to proceed with work.

**Date: 4/14/78**

Page: 2 of 2

**Proposal No.:BP4141B**

Revision No.:

Copies: Mobile, Seneca Falls

**Attention: Bruce Noval**

**Inquiry Date:**

**Inquiry No.:**

*In answer to your inquiry, we propose to furnish GOULDS PUMPS as described below:*

| ITEM NO.<br>EQUIP. NO.<br>SERVICE |               |                |                | OPERATING CONDITIONS AND PERFORMANCE |              |                   |                       |
|-----------------------------------|---------------|----------------|----------------|--------------------------------------|--------------|-------------------|-----------------------|
|                                   |               |                |                | Liquid<br>Dow Chem. Silicon Q21132   |              | Temp. °F<br>350   | Sp. Gr. @ P.T.<br>1.0 |
| Quantity                          | Model<br>3196 | Size<br>1x1½-8 | Rotation<br>CW | G.P.M.<br>70                         | T.D.H.<br>40 | V.P.<br>12 CS     | Visc.                 |
| Casing                            | Impeller      | Shaft          | Sleeve         | Eff.                                 | Rated B.H.P. | Max. B.H.P.       | Suct. Press           |
| DI                                | DI            | Steel          | 316SS          | 51                                   | 1.39         | 1.6               |                       |
| Wear Plate                        | Lubrication   | Base Plate     | Coupling       | Disch. Press                         | Perf. Curve  | NPSH <sub>R</sub> | NPSH <sub>A</sub>     |
| -                                 | Oil           | CI             | Woods          |                                      | C1-2101      | 4.5               |                       |
| Mechanical Seal -- Packing        |               |                | Imp. Type      | Impeller Diameter                    |              |                   | Bulletin<br>725.1     |
| DuraMetallic<br>POTTS F155577/M   |               |                | Open           | Rated<br>7"                          | Min.<br>5½"  | Max.<br>8         |                       |

| DRIVER-                                                         |        |           |              |                 | ITEM           | *PRICE    | WEIGHT |
|-----------------------------------------------------------------|--------|-----------|--------------|-----------------|----------------|-----------|--------|
| H.P.                                                            | R.P.M. | Enclosure | Frame        | S.F./Insulation | Pump           | \$997.ea  | 180    |
| 2                                                               | 1800   | TEFC      | 145T         |                 |                |           |        |
| Phase                                                           | Hertz  | Voltage   | Furnished By |                 | Driver         | 94.ea     | 50     |
|                                                                 |        |           |              |                 | Total Unit     | \$1091.ea | 230    |
| WITH THE FOLLOWING ADDITIONS, MODIFICATIONS AND/OR REQUIREMENTS |        |           |              |                 | Price & Weight |           |        |
|                                                                 |        |           |              |                 |                |           |        |

THIS QUOTATION VALID FOR 30 DAYS FROM  
DATE OF PROPOSAL SHOWN ABOVE.  
\* PRICES SHOWN ARE F.O.B. SHIPPING POINT  
**TERMS: NET 30 DAYS**

Robert Bloom

## STANDARD TERMS AND CONDITIONS

GOULDS PUMPS, Inc., Seneca Falls, N.Y., U.S.A.

All Sales and Transactions with Goulds Pumps, Inc., are subject to its Standard Terms and Conditions.

**1. Warranty:** The Company warrants that its pumps, when properly installed and cared for as stated in the appropriate instruction manual issued by the Company, will operate in accordance with its proposal.

Goulds Pumps are warranted to be made of first-class material, and in a skillful and workmanlike manner. They are additionally warranted against any defective material or workmanship and any part proven defective within one year from the date of shipment, after inspection by and to the satisfaction of the Company, will be replaced free of charge F.O.B. Shipping Point, on return of such defective part to the Company, transportation charges prepaid. No parts, however, shall be returned without the express authority of the Company so to do.

There are no warranties, express or implied, except such warranties as are definitely set forth herein. The Company shall not be liable for damage or wear to pump caused by abnormal conditions, vibration, failure to properly prime or to operate pump without flow or caused by corrosives, abrasives or foreign objects. No obligations other than those herein set forth shall be binding upon the Company. No warranties apply to other than the original user.

The Company shall in no event be held liable for damages or delay caused by defective material and no allowance will be made for repairs or alterations, unless made by its written consent or approval. In the event the pumps are altered or repaired by others without prior written approval by the Company all warranties are void. Equipment and accessories not manufactured by the Company are warranted only to the extent of and by the original manufacturer's warranty.

Under no circumstances shall the Company be held liable for any consequential or other damages, losses or expenses arising from installation, use, or any other causes, regardless of advice or recommendations that may have been rendered concerning such installation or use of its products, nor shall the Company be liable for penalties of any description.

**2. Shipment:** Promised shipping dates are approximate, and are from point of manufacture. Such dates are estimated from (a) the date of receipt of order with complete manufacturing information at Company's factory, and (b) the date of entry of such order by the Company. Shipping dates are subject to revision at the time of the entry of order and the shipping schedule then given is approximate and subject to any action Company must take in connection with priorities or other orders or regulations issued by the United States Government, or any department thereof.

The Company will not be liable for loss, damage, detention, or delay in manufacture or delivery or necessity to substitute materials, resulting from causes beyond its reasonable control, including but not limited to casting failures, war, fire, strikes, lockouts, or other labor difficulties, civil or military authority, insurrection or riot, embargoes, car or ship shortages, acts of governments, wrecks or delays in transportation, including any delays caused by inability to obtain necessary labor, materials or manufacturing facilities due to such causes, or from action taken by the Company in connection with priorities or preference orders or other provisions or permits issued by the United States Government or any department thereof, or from delay in obtaining or failure to obtain manufacturing, foreign, export or other licenses required by the United States Government or any department thereof, or in any event for consequential damages.

Acceptance of material by common carrier constitutes a waiver of any claim against the Company for delay or damage in transit, or for lost goods.

When quotation includes equipment not of Company's manufacture, Company's promise of shipment is based on manufacturer's promise to Company and shipment is contingent on the fulfillment of their promise.

**3. Prices:** All prices are subject to change without notice and are subject to any increase which may be in effect on the date of shipment of the goods, such increase, if any, to be within any applicable government regulations. Prices are F.O.B. Shipping Point, unless otherwise specified. When price includes transportation and other charges pertaining to the shipment of the goods, any increase in transportation rates and other charges will be for the account of the purchaser. There will be an extra charge for any test other than that which may be normally run by the Company, or for any test performed to suit the convenience of the purchaser.

**4. Terms of Payment:** Terms and conditions of payment will be shown on invoices rendered by the Company at time of shipment or as may be otherwise stated in writing by an officer of the Company.

**5. Orders:** All illustrations and specifications are descriptive and are not intended as warranties. The acceptance of all orders taken by the Company's sales representatives or branches is subject to approval by Company's office at Seneca Falls, New York, U.S.A., or City of Industry, California, U.S.A.

**6. Cancellation of Orders:** Orders once placed with and accepted by Company can be cancelled only with Company's consent and upon terms that will indemnify Company against loss.

1. Company may forthwith cancel the order or contract without recourse:

(a) if conditions are such that shipment from Company's factory may be delayed beyond the date estimated at the time of entry of order or contract

(b) if the Purchaser is in default with the Company on this or any other order or contract,

(c) if Purchaser is or becomes insolvent, or if at any time Company is not fully satisfied with the credit of Purchaser, it may at any time after the order has been entered, or during the manufacturing period, or at the time the goods are ready for shipment, require payment in advance of shipping regardless of original terms, or if after shipment has been made and before actual delivery and acceptance at destination (regardless of F.O.B. point), it may recall the shipment and cancel this and any and all other orders and contracts which may be outstanding, and shall be entitled to receive reimbursement for its reasonable and proper cancellation charge.

(d) if the order or contract is for the direct account of one of its sales representatives, distributors or dealers, and Company terminates or alters such relationship.

2. The Company shall have at all times a right of set-off as to any and all accounts between it and Purchaser.

**7. Claims:** No claims for allowances will be entertained unless presented immediately on receipt of goods, and the Company be held responsible for breakage or shortage after goods are delivered to and accepted by the common carrier.

**8. Equipment Returned:** Goods can be returned for credit only after giving Company's authorization and shipping instructions. Consignor's name and address must be plainly written on the shipping tag.

**9. Taxes:** All Federal, State, Local and Municipal taxes now in effect or hereafter enacted that are applicable to this transaction shall be paid for the account of the Purchaser, and if paid or required to be paid by the Company, the amount thereof shall be added to and become a part of the price payable by the Purchaser hereunder.

**10. Minimum Charge:** A minimum charge of \$20.00 will be made in the case of any order, the items on which at the net prices total less than this amount.

**11. General:** All sales and transactions are subject to Company's Standard Terms and Conditions, and they shall prevail in the event of any conflict or variance with those of the Purchaser's, unless otherwise agreed to in writing.

All previous agreements, either written or oral which are subject matter hereof, are hereby cancelled.

Stenographic or clerical errors are subject to correction.

*If this transaction involves EXPORT, the following additional terms and conditions shall apply:*

**12. Packing:** Equipment will be packed, boxed or crated in accordance with the Company's standard commercial practice, for underdeck export shipment, unless otherwise agreed.

**13. Payment:** Unless otherwise specified in writing, payment shall be made by irrevocable letter of credit in form acceptable to Company, confirmed by a New York or Los Angeles Bank acceptable to Company, and providing for payment in full in United States dollars in New York or Los Angeles against presentation of United States inland shipping documents and invoices, such letter of credit to be established prior to Company's acceptance of the order. The letter of credit shall provide also that in the event Company is, for any reason beyond its control prevented from making shipment from Company's factory or delivery at the port of embarkation, a certificate of manufacture of the whole or any part of the goods shall constitute delivery of such whole or any part of the goods and payment in full of any and all drafts drawn against the letter of credit for the goods so "delivered" shall be made upon presentation of such certificate of manufacture in lieu of United States inland shipping documents. In the event that Company is prevented by law, or otherwise, from making shipment from Company's factory or delivery at port of embarkation of the goods or any part thereof, on completion of manufacture Company reserves the right to place the goods in storage for the purchaser's account and risk. Any charges incurred in this connection will be for the account of the purchaser at cost and will be payable upon demand.

**14. Company as Agent:** If Company makes or arranges for ocean shipment, Company shall act as agent for the purchaser and reserves the right to procure full insurance coverage, including war, risk insurance, at the expense of the purchaser. All expenses incurred in this connection will be payable upon demand to the Company.

If Company applies for or secures manufacturing, financing, exporting or other licenses required by the United States Government, or any department thereof, Company shall make such applications or secure such licenses solely as agent for the purchaser, and assumes no responsibility therefor.

STC 1070

PRINTED IN U.S.A.



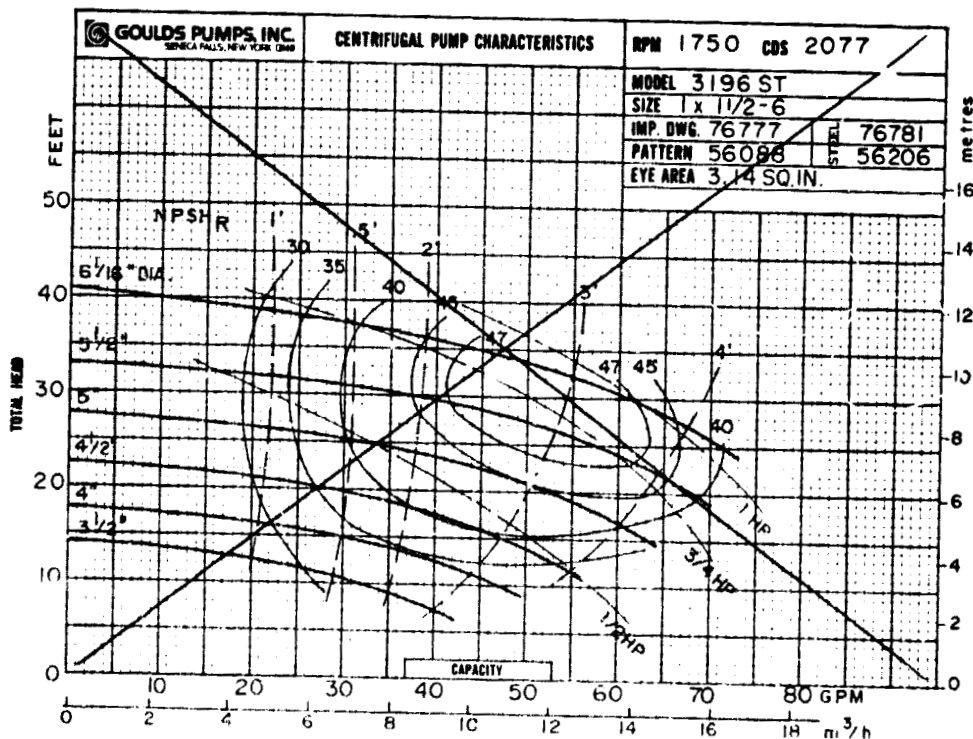
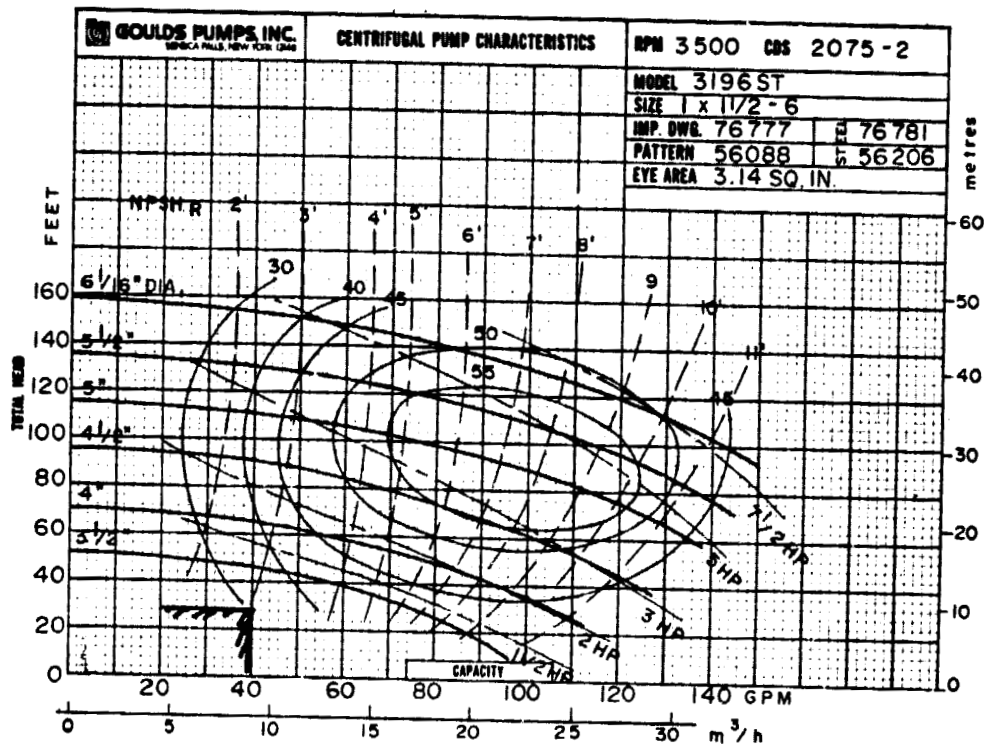


# Goulds Model 3196 ST 60 Hz Performance Curves

## 725.1C1

June 2, 1976  
(Sup. 8/4/72)

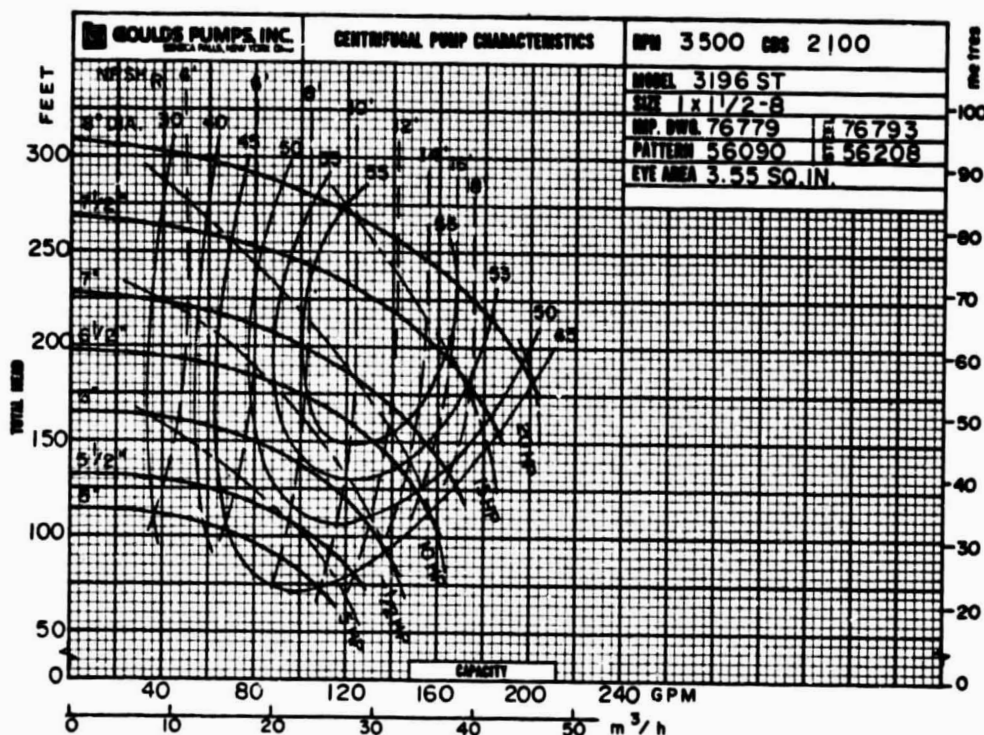
Customer Solar Unlimited Inquiry No. \_\_\_\_\_ Date 4/14/78  
Service \_\_\_\_\_ Item No. \_\_\_\_\_ P.O. No. \_\_\_\_\_ Date \_\_\_\_\_  
F.O. No. \_\_\_\_\_ : 40 GPM; 30 TDH; 1780 RPM; 46 % Eff.; CDS No. \_\_\_\_\_



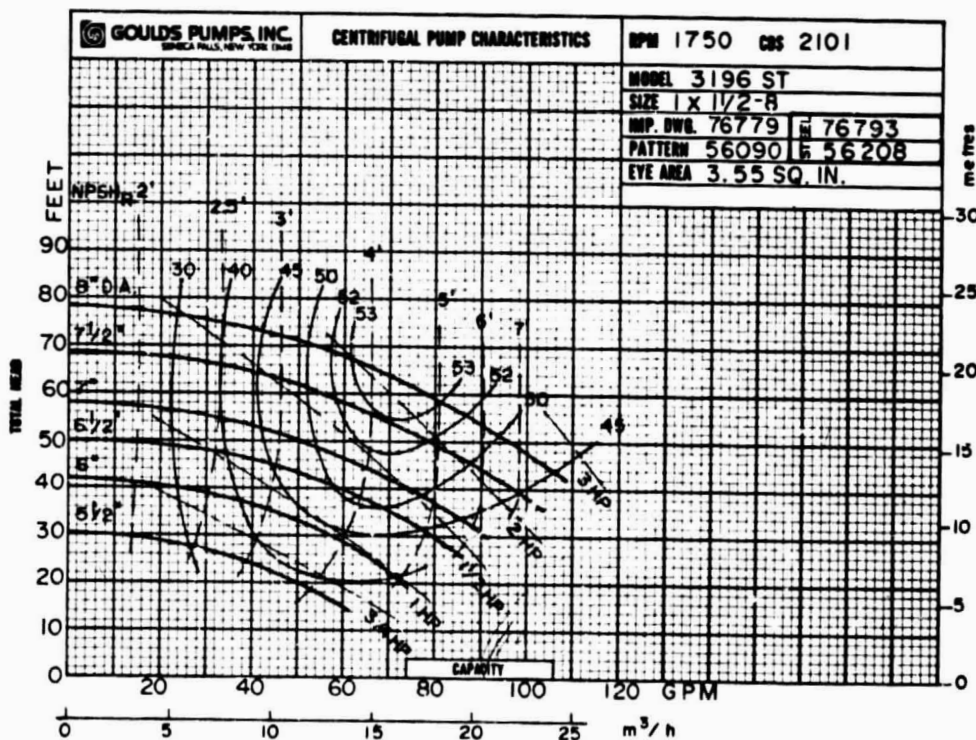
W. G. B. PAGE 13  
13 PAGES TOTAL

Customer \_\_\_\_\_ Inquiry No. \_\_\_\_\_ Date \_\_\_\_\_  
 Service \_\_\_\_\_ Item No. \_\_\_\_\_ P.O. No. \_\_\_\_\_ Date \_\_\_\_\_  
 F.O. No. \_\_\_\_\_ ; \_\_\_\_\_ GPM; \_\_\_\_\_ TDH; \_\_\_\_\_ RPM; \_\_\_\_\_ % Eff.; CDS No. \_\_\_\_\_

**3500  
R.P.M.**



**1750  
R.P.M.**



**GOULDS PUMPS, INC.**  
 SENECA FALLS, NEW YORK 13148

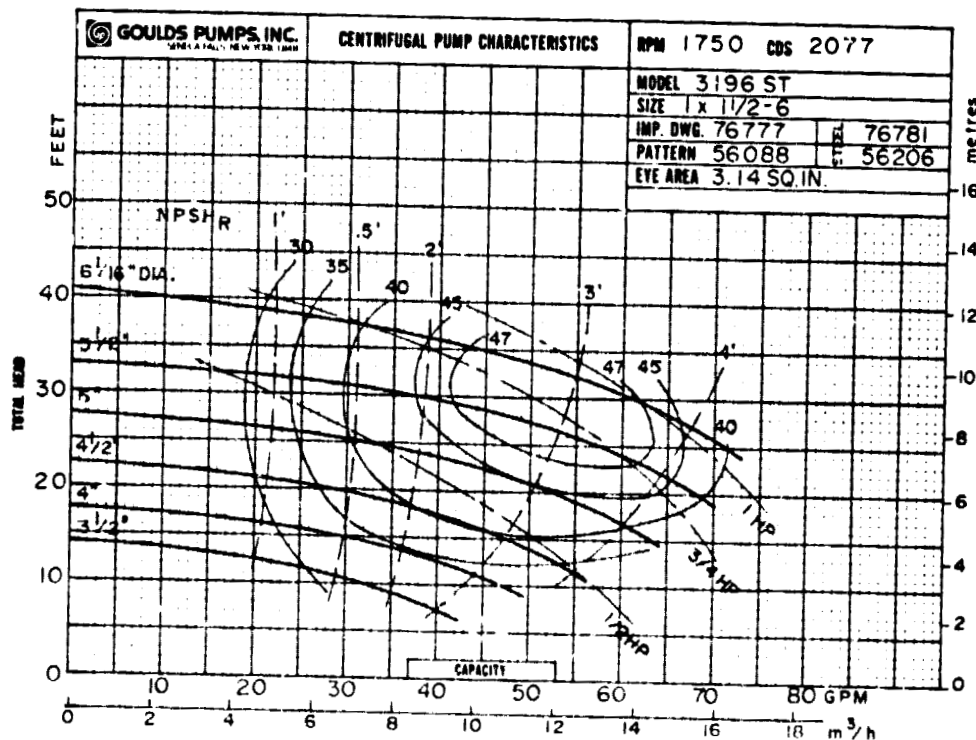
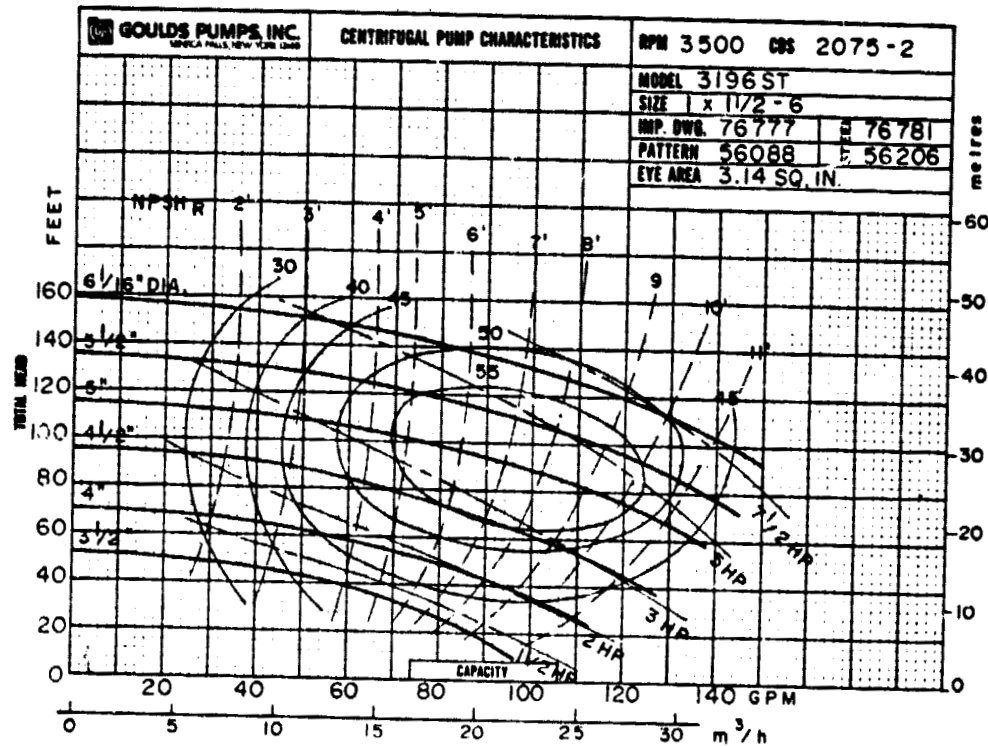


# Goulds Model 3196 ST 60 Hz Performance Curves

## 725.1C

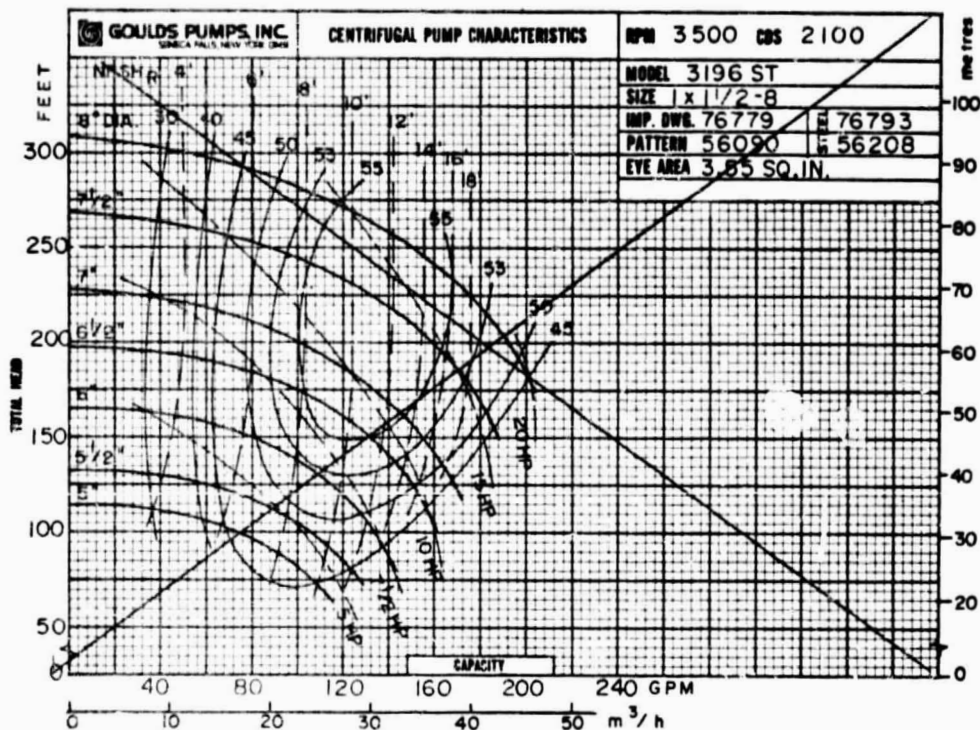
June 2, 1  
(Sup. 8/4/72)

Customer Solar Inquiry No. \_\_\_\_\_ Date \_\_\_\_\_  
Service \_\_\_\_\_ Item No. \_\_\_\_\_ P.O. No. \_\_\_\_\_ Date \_\_\_\_\_  
F.O. No. \_\_\_\_\_ GPM; \_\_\_\_\_ TDH; \_\_\_\_\_ RPM; \_\_\_\_\_ % Eff.; CDS No. \_\_\_\_\_

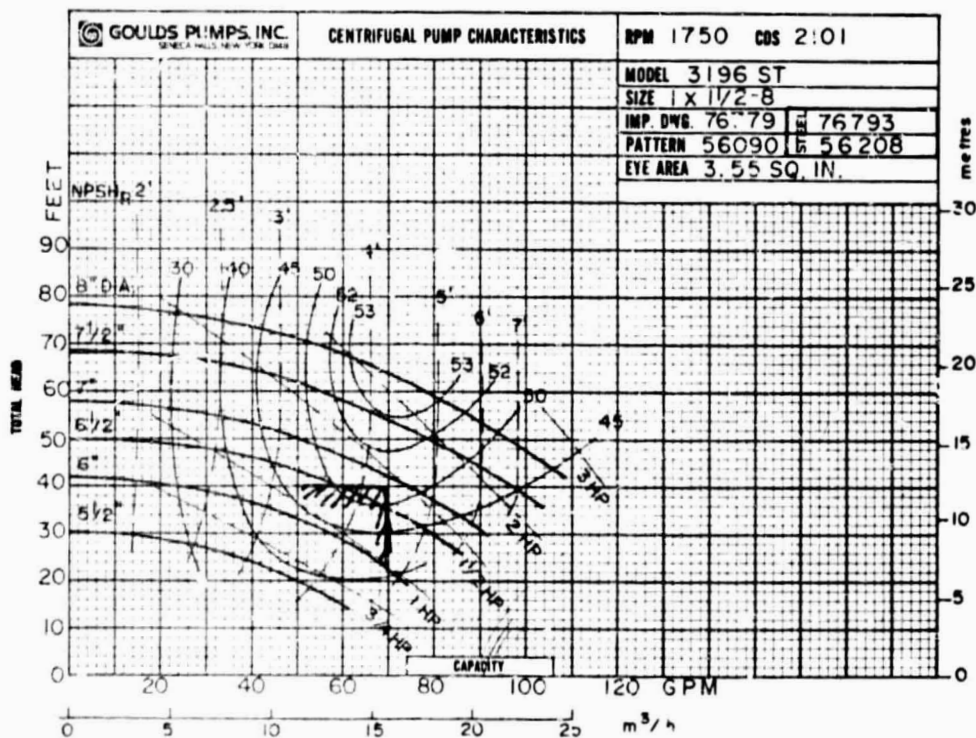


Customer Solar Unlimited Inquiry No. \_\_\_\_\_ Date 4-14-78  
 Service \_\_\_\_\_ Item No. \_\_\_\_\_ P.O. No. \_\_\_\_\_ Date \_\_\_\_\_  
 F.G. No. \_\_\_\_\_ : 70 GPM, 40 TDH, 1800 RPM, 51 % Eff.; CDS No. 2101

**3500  
R.P.M.**



**1750  
R.P.M.**



**GOULDS PUMPS, INC.**

ETHEL A. FAULKNER NEW YORK 13148



## SECTION I—GENERAL

### Introduction

This instruction manual is intended to assist those involved with the installation, operation and maintenance of Goulds' Model 3196 pumps. It is recommended that this manual be thoroughly reviewed prior to installing or performing any work on the pump or motor.

### I-A. Importance of Instructions

The design, material and workmanship incorporated in the construction of Goulds' pumps make them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by periodic inspection and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and correct methods of installing, operating, and maintaining these pumps.

Study thoroughly Sections I, II, III, and carefully follow the instructions for installation and operation. Sections IV, V, VI, VII, and VIII are answers to trouble and maintenance questions. Keep this instruction manual handy for reference. Further information can be obtained by contacting the Engineered Products Division, Goulds Pumps, Inc., Seneca Falls, N.Y. 13148 or your local branch office.

### I-B. Special Warnings

Goulds Pumps, Inc. will not be liable for any damages or delay caused by failure to comply with the provisions of this instruction manual. This pump is not to be operated at speeds, working pressures, discharge pressures, or temperatures higher than, nor used with liquids other than, stated in the original order acknowledgment without written permission of Goulds Pumps, Inc.

### I-C. Receiving Inspection—Shortages

Care should be taken when unloading pumps. If shipment is not delivered in good order and in ac-

cordance with the Bill-of-Lading, note the damage or shortage on both receipt and freight bill. **MAKE ANY CLAIMS TO THE TRANSPORTATION COMPANY PROMPTLY.**

Instruction sheets on various components as well as the Instruction Book for the pump are included in the shipment. **DO NOT DISCARD!**

### I-D. Preservation and Storage

Goulds' normal domestic shipping and storage preparation is suitable for protecting the pump during shipment in covered trucks. It also provides protection during covered storage at the jobsite, and for a short period between installation and start-up. If the pump is to be idle and exposed to the elements for an extended period, either before or after installation, special precautions are required. One approach is to provide special preservatives and wrapping before shipment. However, after installation the protective wrappings will have been removed. Therefore, application of preservatives after installation is considered a good practice. Information about various long term preservation and storage options available can be obtained from your local Goulds' representative.

The driver, coupling, and mechanical seal manufacturers should be contacted for their recommendations on preservations and protection procedures.

### I-E. Handling Techniques

Care should be used in moving pumps. Pumps should *not* be hoisted by eyebolts. These eyebolts are intended for removing the back pull-out assembly for maintenance and inspection. A: assembled pump should be hoisted using a sling under suction flange and under rear of bearing frame. Bedplate mounted units should be hoisted using slings under bedplate below both pump and driver.

## SECTION II—INSTALLATION

### II-A. Location

Pumping unit should be placed as close as practical to the source of supply. Floor space and head room allotted to the unit must be sufficient for inspection and maintenance. Be sure to allow for crane or hoist service.

### II-B. Foundations

1. **Grouted**—Bedplate mounted units are normally grouted-in on a concrete foundation, which has been poured on a solid footing. This allows a permanent, vibration absorbing base for the unit. The location and size of foundation bolts are shown on the outline assembly drawings supplied for the unit. Fig. 1 illustrates a typical foundation bolt installation

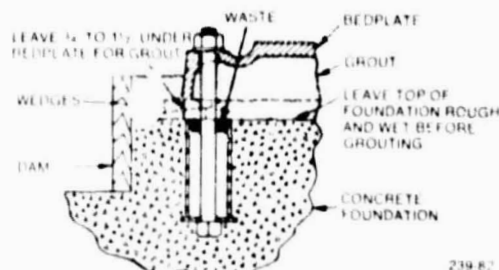


Figure 1

2. **Flexibly Mounted**—Installation and leveling of the optional flexibly-mounted bedplate should be carried out in accordance with assembly drawings supplied in the data package for the unit.

## II-C. Leveling and Grouting of Baseplate—Initial Alignment Check

1. Put the unit in place on wedges located at four points as shown in Fig. 2. Some long installations may require additional wedges near center of bedplate.

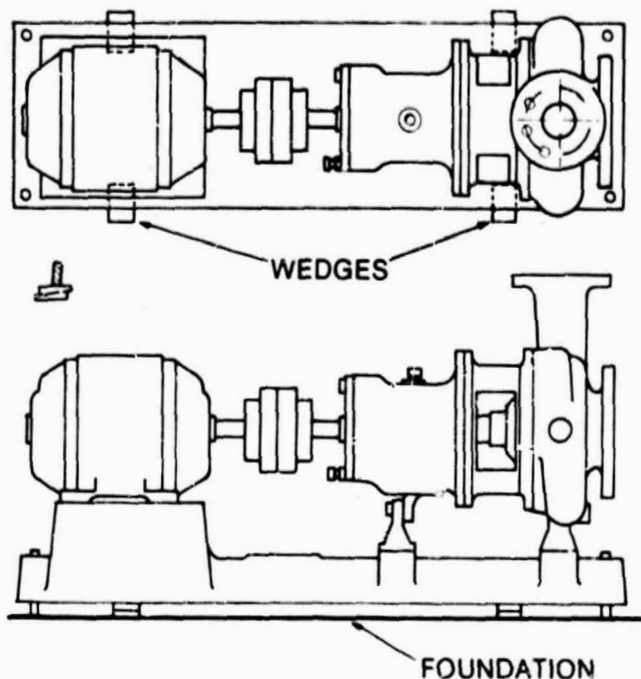


Figure 2

2. Adjust wedges to level unit (approximately), placing unit between  $\frac{3}{4}$ " and  $1\frac{1}{2}$ " above foundation. Level or plumb suction and discharge flanges. Then, bring the coupling halves into reasonable alignment by adjusting the wedges as needed.

3. Make sure that the baseplate is not distorted and that final accurate coupling alignment can be established within the limits of movement of motor and by shimming motor if necessary.

4. Tighten foundation bolts finger tight. Build dam around foundation and pour grout through hole provided in top of bedplate. Fill to level of grout hole making sure that the areas under the pump and motor feet are filled solid. Allow grout to harden at least 48 hours before further tightening foundation bolts. Tighten pump hold down bolts.

## II-D. Piping Practices

Guidelines for piping are given in the "Hydraulic Institute Standards" and should be reviewed prior to pump installation. All piping should be supported independently of, and line up naturally with, the pump flanges. **NEVER DRAW PIPING INTO PLACE BY USE OF FORCE AT THE FLANGED CONNECTIONS OF THE PUMP.**

Both suction and discharge piping should be as short and direct as possible to minimize friction losses.

Foundation, pump and driver hold-down bolts should be tightened prior to connecting suction or discharge piping to the pump.

On units handling corrosives, the piping can be arranged to allow flushing of the pump prior to opening of the unit for servicing. After connecting suction and discharge piping to the pump, rotate pump by hand to be sure that there is no binding.

## II-E. Alignment—Preliminary

Alignment of the pump and driver is of extreme importance for trouble-free mechanical operation.

Alignment should be obtained by adding or removing shims from under the motor feet. The pump bearing frame foot should never be adjusted to obtain alignment. The proper shimming is installed under the bearing frame foot at the factory on units shipped with bedplates. Changing the pump casing or bearing frame in the field will require a reshimming of the frame foot. The proper number of shims is installed when the pump shaft is level and parallel to the bedplate surface. Proper shimming is achieved by loosening frame foot and tightening casing foot. This should create a gap between the frame foot and bedplate between 0 and .040 inches (1 mm). This must be filled with shims and the frame foot retightened. If this procedure is not followed, mechanical problems can result. The final alignment is done after the unit has been run under actual operating conditions. The following are suggested steps for aligning the unit, prior to initial startup.

**1. Parallel Alignment:** The unit is in parallel misalignment when the shaft axes are parallel, but not concentric. During initial alignment, vertical parallel alignment may be different, due to thermal expansion of the unit at actual operating conditions. The following is a suggested cold setting for motor driven units:

| Pumpage Temperature Above Ambient | Set Motor Shaft              |
|-----------------------------------|------------------------------|
| Ambient                           | .002-.004" low (.05-.10 mm)  |
| 100° F.                           | .000-.002" high (.00-.05 mm) |
| 200° F.                           | .004-.006" high (.10-.15 mm) |
| 300° F.                           | .008-.010" high (.20-.25 mm) |
| 400° F.                           | .012-.014" high (.30-.35 mm) |
| 500° F.                           | .016-.018" high (.40-.45 mm) |

2. To check the parallel alignment of "spider-insert" couplings, place a straight edge across both hubs at four points, 90° apart (see Fig. 3). To check the parallel alignment of flexible spacer couplings, place a dial indicator on one hub and rotate that hub 360° while taking readings on the outside diameter of the other hub. Alignment occurs when indicator deflection does not exceed .002" T.I.R. (see Fig. 4) of the recommended cold setting in elevation and not more than .002" T.I.R. side to side.

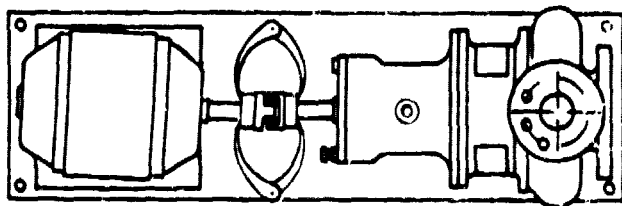


Figure 3

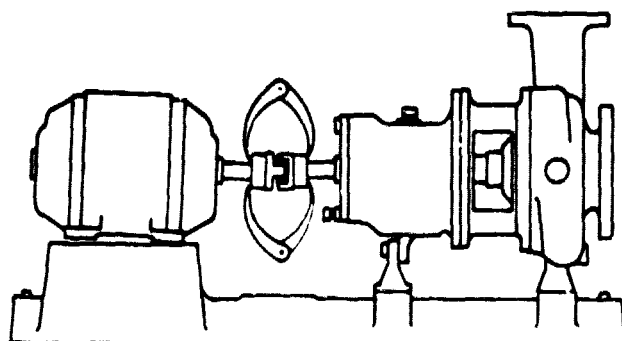


Figure 4

To check angular alignment of a "spider-insert" coupling, use calipers at 90° intervals on the circumference on the outer end of hubs. When caliper measurements are identical, the unit is in angular alignment. The correct gap between the hub and insert will be given in the coupling manufacturer's instructions supplied for the pump.

To check angular alignment of flexible spacer couplings, place a dial indicator on one shaft hub and rotate the hub 360°. Take readings from the face of the other hub. Alignment is achieved when deflection does not exceed .002" (see Fig. 5).

**PRIOR TO COUPLING DRIVER TO PUMP, ROTATION OF DRIVER SHOULD BE CHECKED! Serious damage can result if pump is rotated in wrong direction. Once motor rotation is checked, connect coupling, following the manufacturer's instructions. If a coupling guard is furnished with the unit, ensure that it is securely fastened in place.**

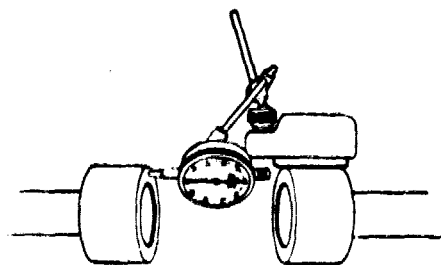


Figure 5

## II-F. Stuffing Box

**1. Packing:** Stuffing box packing, lantern ring and gland are in box of fittings supplied with the pump. Install in proper sequence as shown in drawing in Part VI. Twist rings sideways to place them over shaft—never spread rings straight out. Seat each ring firmly as it is installed, staggering joints 90°. Gland should be installed finger tight only.

Packing cannot run dry, it must be lubricated. If the pumpage is clean, cool fluid, it may be used through a bypass off the discharge to the lantern ring connection to lubricate the packing.

If the pumpage is dirty or hot, it is not suitable to lubricate the packing. An external source must be utilized, unless the bypass is equipped with proper separator, filter, and/or cooling system. This must be piped into the lantern ring connection, also (refer to packing recommendations).

**2. Mechanical Seals:** When mechanical seals are supplied, they are installed and adjusted at the factory. They must not run dry or in abrasives. Connect recirculation, flush and/or cooling lines as required, following instructions on the seal print supplied for the unit.

## SECTION III—OPERATION

### III-A. Startup

#### 1. Check List

- a. Lubrication—Pump bearings are normally oil lubricated. (THE BEARINGS ARE NOT LUBRICATED AT THE FACTORY.) These pumps are supplied with an oiler which maintains a constant oil level in the bearing frame. Locate oiler as shown on the outline drawings supplied for the unit. See Fig. 6 for correct adjustment of oiler.

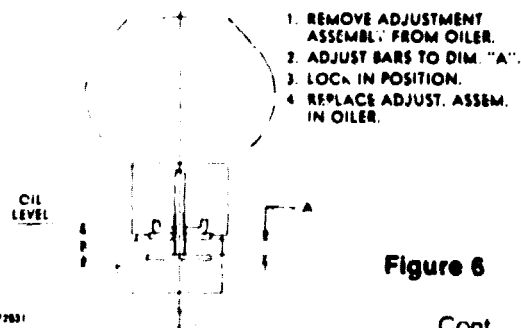


Figure 6

Cont

| GROUP      | OILER SIZE | A                 | B               |
|------------|------------|-------------------|-----------------|
| ST, MT, LT | #3 (4 Oz.) | 19/32"<br>(15 mm) | 1/2"<br>(13 mm) |
| XLT        | #5 (8 Oz.) | 9/16"<br>(14 mm)  | 1/2"<br>(13 mm) |

- b. A high quality turbine type oil with rust and oxidation inhibitors should be used. Under normal operating conditions, an oil of 300 SSU viscosity at 100° F. (approximately SAE 20) should be used. Fill oiler bottle and replace in oiler housing. Repeat until oil remains visible in bottle. Do not add oil through the vent or breather. Optional grease lubricated bearings are lubricated at the factory and need lubrication only after 2,000 hours of operation, or every 3 months, whichever occurs first. On pumps supplied with greased-for-life bearings, no additional lubrication is required for the life of the bearing.
- c. Priming—Pump and suction piping must be full of liquid before pump is started. Usually suction supply will be primed when shutoff valves are opened, if pump is below suction supply. If suction supply is below pump, priming by other means, such as a foot valve or ejector, will be required.
- d. Free Rotation—Rotate shaft by hand to make sure it is free. Drag from packing or seal is normal but, if pump cannot be rotated by hand or binding or rubbing is noticed, correct before starting pump.

## 2. Startup

- a. Valves—Be sure suction valve is fully open. Normally, discharge valve should be at least partially closed for flow control.
- b. Rotation Check—If not already done, uncouple the unit and jog the motor to check for proper rotation (refer to Section II-E-2, page 5).

## III-B. Operation Checks

Inspect pump carefully and frequently during the first few hours of operation. If packing runs hot, shut pump down, allow box to cool, loosen gland if necessary. (Do not loosen gland until packing has cooled.) Mechanical seal may weep slightly, but should "run-in" in a few hours. Be sure all auxiliary lines (cooling, flushing, sealing, etc.) are functioning properly. Check pump bearings for excessive heating. Check complete unit for excessive vibration and unusual noises. Do not run pump at greatly reduced flow because damage can result.

## III-C. Shutdown Procedure

Back flow through pump will cause reverse rotation. If backflow is excessive, and there is a possibility of the pump being turned on during this period of reverse rotation, then precautions should be taken to prevent the backflow. This can be done by installing a check valve in the discharge line, or by closing a discharge valve immediately prior to shutting down the pump. NOTE: IT IS NOT RECOMMENDED THAT THE PUMP RUN LONGER THAN ABSOLUTELY NECESSARY AGAINST A CLOSED DISCHARGE VALVE.

# SECTION IV—PREVENTIVE AND CORRECTIVE MAINTENANCE

## IV-A. Lubrication

Oil lubricated units require only that oil be visible in reservoir or the oiler. Grease lubricated units should be regreased every 2,000 hours or 3 month intervals, whichever occurs first. Use a sodium or lithium grease and fill until grease comes out grease relief fittings. Follow motor and coupling manufacturers' lubrication instructions.

## IV-B. Stuffing Box

**1. Packing Stuffing Box:** Periodically inspect stuffing box to see that there is sufficient leakage to lubricate the packing and maintain a cool box. Never restrict the leakage from the packing as this will cause damage to both packing and shaft sleeve. Draw up gland nuts slowly and evenly and only while pump is running.

After pump has been in operation for some time and the packing has been completely "run-in", a leakage of 40 to 60 drops per minute of the liquid should be allowed to flow from the stuffing box at all times for cooling and lubricating the packing and shaft sleeve.

**2. Stuffing Boxes with Mechanical Seal:** This type of box requires no attention other than to make sure that the circulating lines do not become clogged.

## IV-C. Vibration

It is a good practice to periodically monitor vibration of the pump. Normally, the vibration level will be well within accepted standards. Of equal importance is that the vibration level not increase. If a problem with vibration is encountered, refer to Trouble Shooting, Section VII.

## IV-D. Alignment—Final

Alignment should be checked after unit has reached operating temperature, following startup. Repeat alignment procedures outlined in Section II-E. Check alignment again after one week of operation.

## IV-E. Performance

If performance deteriorates, refer to Trouble Shooting, Section VII.

C-2



## SECTION V—DISASSEMBLY AND REASSEMBLY

### V-A. Disassembly (refer to Sectional Views in Part VI)

1. Prepare pump for disassembly as follow:
  - a. Lock out power supply to motor.
  - b. Shut off valves controlling flow to and from pump.
  - c. Flush pump of all corrosive or toxic liquid, if required.
  - d. Remove all auxiliary tubing and piping.
  - e. Disconnect coupling and remove coupling spacer.
  - f. Drain oil.
  - g. On units with packed stuffing box, unbolt and remove split gland (107).
2. Disassemble pump as follows:
  - a. Place sling from hoist through eyebolt (132). On ST units, place sling through frame (228A) above shaft (122).
  - b. Remove frame foot hold down bolts.
  - c. Remove bolts (370) holding frame (228A) or frame adapter (108) to casing (100).
  - d. Slide back pull-out assembly from casing, using jacking bolts (418) provided.
  - e. Remove casing gasket (351).
  - f. Unscrew impeller (101) from shaft (122). The threads are right hand. Remove O-ring (412A) which seals between the impeller and shaft or sleeve.
  - g. (1) On units with inside mechanical seal, remove gland stud nuts (355) and carefully slide gland toward bearing frame (228A).  
(2) On units with outside mechanical seal, loosen set screws holding rotary portion of seal to shaft and slide seal toward bearing frame. Remove gland stud nuts and carefully slide gland off studs.
  - h. Remove stud nuts (370H) which hold stuffing box cover (184) to frame adapter. Pull stuffing box cover from frame or adapter. Slide sleeve (if any) off shaft.
  - i. On units with mechanical seal, loosen set screws holding rotary portion of seal to shaft, and carefully slide seal and gland assembly off shaft. On units having a shaft sleeve, it is not necessary to remove rotary portion of seal from sleeve unless replacement of seal is required.
  - f. Slide deflector (123) off shaft.
  - k. Scribe shaft at coupling hub for proper positioning of hub during reassembly and remove hub.
  - l. Remove bearing housing bolts (370C). Using impeller adjustment bolts (370D) for jacking, remove shaft and bearing assembly from frame. This will include the shaft, both bearings (112A) and (168A), and bearing housing (134A). Do not lose or damage O-ring (496).
  - m. Remove inboard bearing (168A) using a bearing puller. Never use a hammer to drive shaft through bearing! Protect bearing from contamination.
  - n. On ST and MT models, remove bearing housing retaining ring (361A) and slide bearing

housing off ball bearing. Do not damage oil seal (332A). On XLT units, remove bearing end cover bolts (109A) and slide cover off shaft. Do not damage oil seal (332A). Slide bearing housing off shaft.

- o. Straighten tang in lockwasher and remove bearing locknut (136) and lockwasher. Remove ball bearing (112A) using a bearing puller. Protect bearing from contamination.
- p. On units with stuffing boxes, remove lantern ring (105) and packing rings (106) from stuffing box cover (184).

### V-B. Inspection and Parts Replacement Guidelines

1. **Impeller**—Replace if impeller shows excessive erosion, corrosion, extreme wear, or vane breakage. O-ring groove and impeller hub must be in good condition. Check impeller balance if possible. Reduction in hydraulic performance and reduced mechanical seal, packing or thrust bearing life may be caused by excessive impeller wear.
2. **Shaft**—Check for runout (.005" max) to see that shaft has not been bent. On pumps without shaft sleeves, shaft surface in stuffing box area must be smooth and free of grooves. Bearing seats and oil seal area must be smooth and free of scratches or grooves. Shaft threads must be in good conditions. Metalize or replace shaft if necessary.
3. **Shaft Sleeve**—Sleeve surface in stuffing box must be smooth. If grooved, replace.
4. **Mechanical Seal**—Seal faces, gaskets, and shaft sealing members must be in perfect condition or leakage may result. Replace worn or damaged parts.
5. **Ball Bearings**—Replace if worn, loose or rough and noisy when rotated.
6. **Oil Seals**—Replace if worn or otherwise damaged.
7. **General**—All parts should be clean before assembly. All burrs should be removed.

### V-C. Reassembly Procedures

This procedure covers reassembly of pump after complete disassembly. Make sure all directions outlined in Section V-B have been followed.

1. Oil shaft at thrust bearing fit on coupling end of shaft (122). Slide thrust (coupling end) bearing (112A) on shaft as far as possible by hand. Place pipe or driving sleeve over shaft, making sure it rests against inner face only. Make sure bearing is "square" on shaft. Tap or press evenly until bearing is seated firmly against shaft shoulder. Do not mar the shaft.
2. Place lockwasher and bearing locknut (136) on shaft and tighten firmly. Bend "tang" of lockwasher into slot in locknut.
3. Slide bearing housing (134A), with O-ring (496) in place, on shaft and over bearing (112A) as far as possible. Do not damage oil seal (332A) on ST and MT models.

4. On ST and MT models, insert retaining ring (361A) into groove in bearing housing (134A). Flat side of retaining ring must be against bearing (112A). On XLT units, slide bearing end cover (109A) and gasket (360C) on shaft. Ensure the "top" of end cover (109A) lines up with the "top" of bearing housing (134A). Bolt end cover to housing.

5. Oil inboard bearing seat on shaft. Slide inboard ball bearing (168A) on shaft (122) as far as possible by hand. Continue as in Step 1 above.

6. Place a small amount of O-ring lubricant on inside of bearing frame (228A) at bearing housing (134A), at inboard bearing seats (168A), on O-ring (496), and on inboard oil seal (333A). Carefully slide shaft assembly into bearing frame. Do not damage inboard oil seal (333A). Screw bearing housing bolts (370C) about 1/2" into bearing frame (228A).

7. Slide deflector (123) on shaft (122).

8. If unit has packed stuffing box, place stuffing box cover (184) against adapter (108), making sure that studs (370H) align with proper holes in adapter. Replace nuts and firmly tighten. Slide sleeve (if any) on shaft. Make sure grooves in end of sleeve engage drive pin on shaft. Continue assembly at Step 10.

9. If unit has mechanical seal:

The following instructions refer to pumps equipped with mechanical seals, either with or without sleeves.

If the unit has a single inside or double seal, a preliminary impeller adjustment must be performed to assure proper positioning of mechanical seal.

- (1) Position sleeve (126), if any, on shaft (122) and engage groove in sleeve with drive pin (469) on shaft. Place stuffing box cover (184) against frame (228). Make sure studs (370H) align with proper holes in frame. Firmly tighten nuts or bolts.
- (2) Screw impeller (101) with O-ring (412A) in place on shaft. Make sure that shaft assembly extends through stuffing box cover (184) so that the impeller will NOT contact face of stuffing box cover.
- (3) Using impeller adjusting bolts (370C and 370D), adjust the impeller clearance until a .020" (0.51mm) feeler gauge can be inserted between the back of the impeller and the face of the stuffing box cover.

The following instructions are for three basic seal types: Single Inside, Single Outside, and Double Seals. Refer to seal manufacturer's drawing seal type and positioning dimension. Follow pertinent procedures.

#### a. Single Inside Seal

- (1) Scribe the shaft (122) or shaft sleeve (126) lightly at the face of the stuffing box.
- (2) Remove the impeller and stuffing box.
- (3) Assemble the gland (250) with gaskets and stationary seat and slide the assembly over the shaft (122) or shaft sleeve (126).

(4) Slide the rotary portion of the seal on the shaft (122) (or shaft sleeve) (126) establishing its location from the scribe line to the dimension as shown on the seal manufacturer's drawing. Tighten set screws.

(5) Reinstall the stuffing box cover and tighten. Do not damage the seal parts.

(6) Reinstall the impeller with O-ring.

(7) Slide the gland assembly against the stuffing box and tighten the nuts evenly. Do not damage the seal parts.

(8) Refer to step 12 for further assembly details.

#### b. Double Seals

(1) Scribe the shaft (122) or shaft sleeve (126) lightly at the face of the stuffing box.

(2) Remove the impeller and stuffing box.

(3) Assemble the gland (250) with gaskets and stationary seat and slide the assembly over the shaft (122) or shaft sleeve (126).

(4) Slide the rotary portion of the seal on the shaft (122) or shaft sleeve (126) establishing its location from the scribe line to the dimension as shown on the seal manufacturer's drawings. Tighten set screws.

(5) Place inboard stationary seat and gaskets into bottom of stuffing box.

(6) Reinstall the stuffing box cover and tighten. Do not damage seal parts.

(7) Reinstall the impeller with O-ring.

(8) Slide the gland assembly against the stuffing box and tighten the nuts evenly. Do not damage seal parts.

(9) Refer to step 12 for further assembly details.

#### c. Single Outside Seal

Preliminary impeller adjustment is not necessary with this type of mechanical seal.

(1) If unit has shaft sleeve (126), slide on shaft (122) and engage groove in sleeve with drive pin (469) on shaft.

(2) Lubricate rotary portion of seal and slide on shaft sleeve. Do not tighten set screws.

(3) Assemble gland (250), gaskets, and stationary seat and slide assembly on shaft or sleeve.

(4) Place stuffing box cover (184) against frame making sure that the studs (370H) align with the proper holes in frame. Firmly tighten nuts.

(5) Screw impeller with O-ring on shaft making sure impeller does not make contact with stuffing box cover. If the impeller does hit, use impeller adjusting cap screws to correct.

(6) Place gland assembly against face of stuffing box and firmly tighten stud nuts.

(7) Slide rotary portion toward gland until it contacts stationary seat. Compress the rotary. Tighten screws.

10. Screw impeller (101) with O-ring (412A) in place, on the shaft (122).

11. On units with stuffing box packing (106), re-pack stuffing box as outlined in Section II-F. Assemble gland stud nuts finger tight.

12. Install and position coupling hub at scribe mark on shaft.

13. Place casing gasket (351) against shoulder in casing.

14. Slide the pullout assembly into the casing (100). Drain slot in stuffing box cover (184) should line up with drain connection in casing. Install frame-to-casing bolts (370) and tighten evenly while rotating shaft (122) by hand. If impeller ceases to turn freely, stop tightening operation and adjust the impeller setting with the adjusting bolts (370C and 370D) before resuming tightening of frame-to-casing bolts (370).

**15. Impeller Clearance**

The impeller clearance is an important factor in maintaining optimum pump performance. The nominal clearance is .015" with the recommended minimum being .008". The actual clearance setting is dependent on the specific operating conditions, taking into account temperature, solids, etc. For maximum service flexibility pumps are shipped from the factory with the clearance set at .015".

The desired clearance is obtained in the following manner:

- a. Loosen bolts (370C and 370D).
- b. Tighten bolts (370C) while turning shaft until impeller starts to rub against casing.
- c. Loosen bolts (370C) until a feeler gauge, corresponding to the desired clearance, can be placed between the bolt head and bearing housing.
- d. Tighten bolts (370D) evenly. Bearing housing shaft and impeller will be jacked to proper clearance from casing. Tighten bolts (370C) and jam nuts on bolts (370D).
- e. If desired, a dial indicator can be used instead of a feeler gauge to check that the bearing

housing has been moved the correct distance.

**V-D. Additional Details**

An alternate method for setting inside mechanical seals is the "Modified Visegrip Method".

1. Follow assembly up to step 7.
2. Assemble the gland with stationary seat and gaskets.
3. Install the shaft sleeve, if used on the shaft, and engage groove in sleeve with drive pin (469) on shaft.
4. Slide gland assembly over the shaft or shaft sleeve.
5. Install the stuffing box cover and impeller. Establish a preliminary rotor adjustment (refer to Section V-C-9).
6. Slide gland assembly against stuffing box. Do not bolt the gland to the stuffing box.
7. Clamp the modified visegrip on the shaft or sleeve directly behind and against the gland.
8. Leave the visegrip in place and remove the impeller and stuffing box cover.
9. Lubricate the rotary portion of seal and slide it on the shaft until it comes in contact with the stationary seat in the gland.
10. Compress rotary portion of seal to correct dimension as shown on seal manufacturer's drawing. Tighten set screws.
11. Remove visegrip and reinstall stuffing box cover and tighten.
12. Reinstall impeller with O-ring.
13. Slide the gland assembly against the stuffing box and tighten nuts evenly.
14. Refer to Step 12, etc.

**SECTION VI—PRODUCT DESCRIPTION**

See pages 10 & 11 for  
Sectional Views, Parts List  
and Materials of Construction.

# Parts List and Interchangeability List

| Item | Qty   | Part Name                              | Material               |          |                         |          |          |           |          |             | INTERCHANGEABILITY BY SIZE & CASING CLASS |                |              |              |              |                |  |  |  |  |
|------|-------|----------------------------------------|------------------------|----------|-------------------------|----------|----------|-----------|----------|-------------|-------------------------------------------|----------------|--------------|--------------|--------------|----------------|--|--|--|--|
|      |       |                                        | AI Ductile Iron        | AI 316SS | AI CD4M                 | AI GA-20 | AI Monel | AI Nickel | AI Hast  | AI Titanium | MODEL 3196 ST                             | MODEL 3196 HT* |              |              |              | MODEL 3196 XLT |  |  |  |  |
| 100  | 1     | Casing                                 | D I                    | 316      | CD4M                    | GA-20    | Monel    | Nickel    | Hast     | Titanium    | 6 8 10 13 15                              | 6 8 10 13 15   | 6 8 10 13 15 | 6 8 10 13 15 | 6 8 10 13 15 |                |  |  |  |  |
| 101  | 1     | Impeller                               | C I                    | 316      | CD4M                    | GA-20    | Monel    | Nickel    | Hast     | Titanium    | 6 8 10 13 15                              | 6 8 10 13 15   | 6 8 10 13 15 | 6 8 10 13 15 | 6 8 10 13 15 |                |  |  |  |  |
| 105  | 1     | Lantern Ring                           | Glass Filled Teflon    |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 106  | 1 Set | Stuffing Box Packing                   | White Afr. Asbes *     |          | White African Asbestos* |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 107  | 1     | Gland Packed Box                       | 316                    |          | GA-20                   | GA-20    | Monel    | Nickel    | Hast     | Titanium    | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 108  | 1     | Frame Adapter                          | Cast Iron              |          |                         |          |          |           |          |             | NR                                        | 6              | 8            | 10           | 13           | 13A 15         |  |  |  |  |
| 109A | 1     | Bearing End Cover—Coupling End         | Cast Iron              |          |                         |          |          |           |          |             | NR                                        | NR             |              |              |              | XLT            |  |  |  |  |
| 112A | 1     | Ball Bearing—Outboard End              | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 113A | 1     | Bearing Frame Breather                 | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | MT             |  |  |  |  |
| 119A | 1     | Bearing End Cover—Inboard              | Steel                  |          |                         |          |          |           |          |             | ST                                        | NR             |              |              |              | NR             |  |  |  |  |
| 122  | 1     | Pump Shaft (Less Sleeve)               | SAE4150†               | 316      | C-20                    | Monel    | Nickel   | Hast      | Titanium | ST          | MT                                        |                |              |              | XLT          |                |  |  |  |  |
| 122A | 1     | Pump Shaft (with Sleeve)               | SAE4140                |          |                         |          | 316      |           |          | ST          | MT                                        |                |              |              | XLT          |                |  |  |  |  |
| 123  | 1     | Deflector                              | Glass Reinforced Nylon |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 126* | 1     | Shaft Sleeve                           | 420†                   | 316      | CD4M                    | C-20     | Monel    | Nickel    | Hast     | Titanium    | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 131  | 1     | Casing Foot                            | Cast Iron              |          |                         |          |          |           |          |             | †                                         | 6              | 8            | 10           | 13           | †              |  |  |  |  |
| 132  | 1     | Eye Bolt                               | Steel                  |          |                         |          |          |           |          |             | NR                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 134A | 1     | Bearing Housing                        | Cast Iron              |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 136  | 1     | Bearing Locknut                        | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 168A | 1     | Ball Bearing—Inboard                   | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 184  | 1     | Stuffing Box Cover—Standard            | D I                    | 316      | CD4M                    | GA-20    | Monel    | Nickel    | Hast     | Titanium    | 6ST 8ST                                   | 6              | 8            | 10           | 13           | 13A 15         |  |  |  |  |
| 184A | 1     | Stuffing Box Cover—Water Jacketed      | D I                    | 316      | CD4M                    | GA-20    | Monel    | Nickel    | Hast     | Titanium    | 6ST 8ST                                   | 6              | 8            | 10           | 13           | 13A 15         |  |  |  |  |
| 210  | 1     | Gland Packing                          | White Asbestos*        |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 228A | 1     | Bearing Frame                          | Cast Iron              |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 241  | 1     | Bearing Frame Foot                     | Cast Iron              |          |                         |          |          |           |          |             | †                                         | MT             |              |              |              | XLT            |  |  |  |  |
| 247  | 1     | Drip Basin                             | 316                    |          |                         |          |          |           |          |             | —                                         | MT             |              |              |              | XLT            |  |  |  |  |
| 251  | 1     | Constant Level Oiler (Not Illustrated) | Glass and White Metal  |          |                         |          |          |           |          |             | MT                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 261  | 1     | Gasket—Adapter to Stuffing Box         | Manila Paper           |          |                         |          |          |           |          |             | NR                                        | NR             |              |              |              | XLT            |  |  |  |  |
| 332A | 1     | Oil Seal—Coupling End                  | Buna Rubber            |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 333A | 1     | Oil Seal—Inboard End                   | Buna Rubber            |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 351  | 1     | Gasket—Casing                          | White Asbestos*        |          |                         |          |          |           |          |             | 6ST 8ST                                   | 6              | 8            | 10           | 13           | 13A 15         |  |  |  |  |
| 353  | 2     | Gland Stud                             | 316                    |          |                         |          | Monel    |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 355  | 2     | Gland Stud Nut                         | 304                    |          |                         |          | Monel    |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 360C | 1     | Gasket—Brg. End Cover to Brg. Hsg      | Manila Paper           |          |                         |          |          |           |          |             | NR                                        | NR             |              |              |              | XLT            |  |  |  |  |
| 360D | 1     | Gasket—Bearing Frame to Adapter        | Vellumoid              |          |                         |          |          |           |          |             | NR                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 360U | 1     | Gasket—Jacket Cover                    | Asbestos               |          |                         |          |          |           |          |             | NR                                        | NR             |              |              |              | XLT            |  |  |  |  |
| 361A | 1     | Retaining Ring—Bearing Housing         | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | NR             |  |  |  |  |
| 370  | 4 24  | Cap Screw—Frame/Adapt. to Casing       | Steel                  | 304      |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 370B | 4     | Cap Screw—Adpt./Adapt. Ring to Frame   | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 370C | 3-4   | Tap Bolt—Bearing Housing               | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 370D | 3-4   | Tap Bolt—w/Jam Nut—Impeller Adjust     | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 370E | 2     | Cap Screw—Casing Foot                  | Steel                  |          |                         |          |          |           |          |             | NR                                        | MT             |              |              |              | NR             |  |  |  |  |
| 370F | 1-2   | Cap Screw—Frame Foot                   | Steel                  |          |                         |          |          |           |          |             | NR                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 370H | 2     | Stud & Nut—Cover to Adapter            | 304                    |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 371D | 8     | Cap Screw                              | Steel                  |          |                         |          |          |           |          |             | NR                                        | NR             |              |              |              | XLT            |  |  |  |  |
| 412A | 1     | O-Ring—Impeller                        | Teflon                 |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 418  | 2-3   | Tap Bolt—Jacking                       | Steel                  |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 469B | 2     | Dowel Pin—Frame to Adapter             | Steel                  |          |                         |          |          |           |          |             | NR                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 469D | 1     | Drive Pin—Shaft Sleeve                 | 420                    |          |                         |          |          |           |          |             | ST                                        | ST             |              |              |              | ST             |  |  |  |  |
| 490* | 1     | Water Jacket Cover                     | Cast Iron              |          |                         |          |          |           |          |             | NR                                        | NR             |              |              |              | XLT            |  |  |  |  |
| 492  | 1     | Plug                                   | Steel                  |          |                         |          |          |           |          |             | NR                                        | NR             |              |              |              | XLT            |  |  |  |  |
| 496  | 1     | O-Ring—Bearing Housing                 | Buna Rubber            |          |                         |          |          |           |          |             | ST                                        | MT             |              |              |              | XLT            |  |  |  |  |
| 503  | 1     | Adapter Ring                           | D I                    |          |                         |          |          |           |          |             | NR 8ST                                    | NR             |              |              |              | NR             |  |  |  |  |

†Cast integral with casing

‡Cast integral with frame

\*Optional

NR—Not required except on 300# flange casings and titanium construction

\*\* Available in Hast-B or Hast-C Material

NR—Not required

NOTES: Not available on all sizes

\*Model 3196 LTC with 2-1/8 shaft available on 10" and 13" pumps. LTC standard on 3 x 4-13 at 3500 RPM

and 2900 RPM. 2 x 3-13 at 3500 RPM. LTC would then replace MT on interchangeability chart

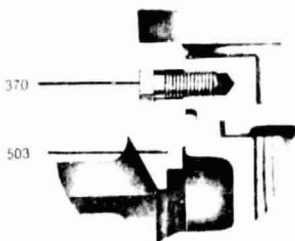
†Graphite impregnated white African asbestos

\*Teflon impregnated white African asbestos

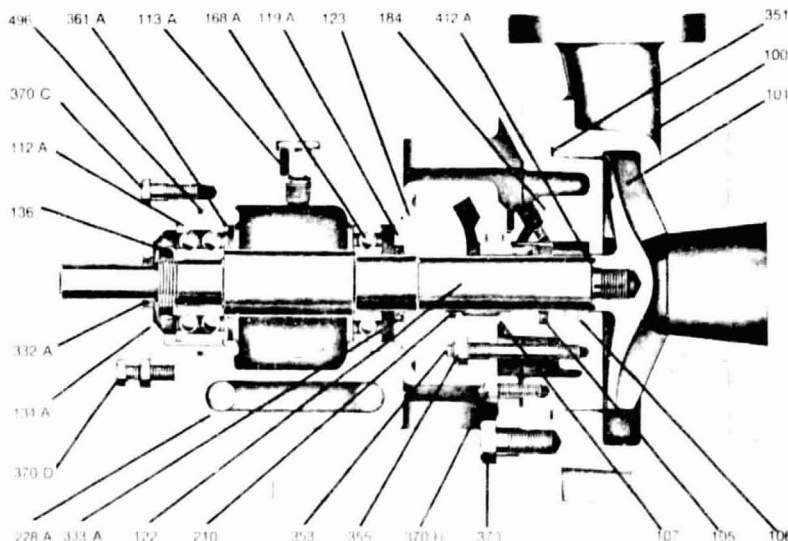
†Flame hardened to 500 Brinell through stuffing box

\*White chrysotile asbestos with acid resistant binders

## Sectional View Model 3196 ST

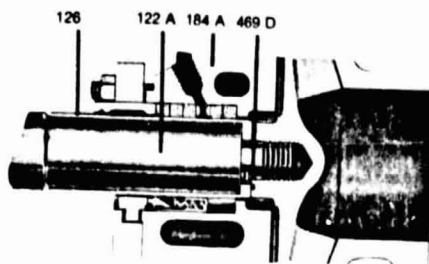


Assembly View of 1x1 1/2-8 & 1 1/2x3-6



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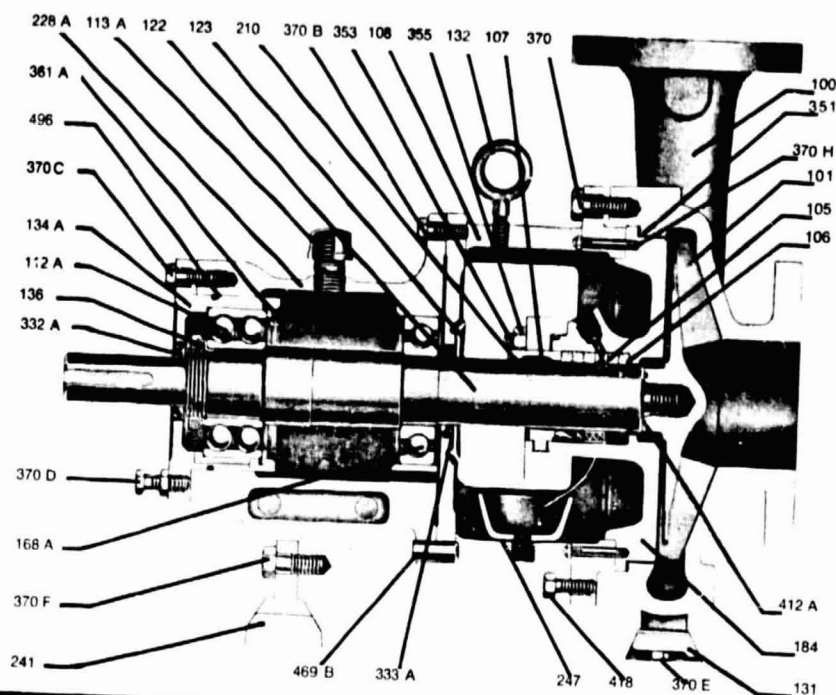
## Model 3196 MT



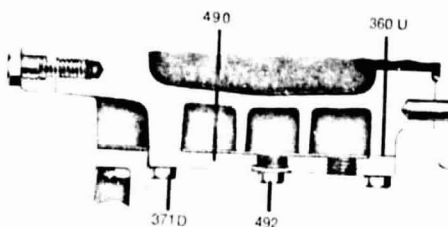
Optional Jacketed Stuffing Box  
Optional Shaft Sleeve

Available on all Model 3196 pumps

248-95 #3

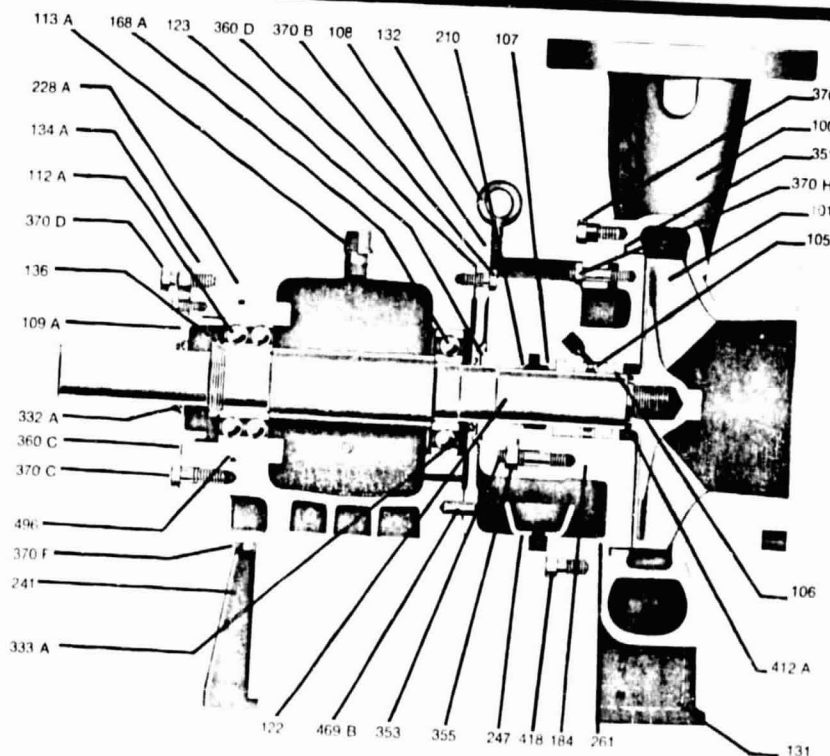


## Model 3196 XLT



Optional Water Cooled Bearing Frame

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256-46

## Materials of Construction

| Code   | Material and Specification                                                 |
|--------|----------------------------------------------------------------------------|
| 01     | Cast Ductile Iron, Heat Treated — ASTM A536                                |
| 316    | Cast Stainless ASTM A296 Gr. CF 8M<br>Wrought Stainless ASTM A276 Type 316 |
| CD4M   | Cast Chrome — Nickel Alloy<br>A.C.I. CD4MCu, 250 270 Brinell               |
| GA 20  | Cast Gould A. Loy. 20 ASTM A296 Gr. CN 7M                                  |
| Mono   | Cast Monel ASTM A296 Gr. M 35<br>Wrought Monel ASTM B164 Cl. A             |
| Nickel | Cast Nickel ASTM A296 Gr. CZ 100<br>Wrought Nickel ASTM B160               |
| Hast C | Cast Hast C ASTM A296 Gr. CW 12M                                           |
| Hast B | Cast Hast B ASTM A296 Gr. N 12M                                            |
|        | Wrought Hast C ASTM B336<br>Wrought Hast B ASTM B335                       |

| Code             | Material and Specification                                          |
|------------------|---------------------------------------------------------------------|
| Titanium         | Cast Titanium ASTM B367 Gr. C 4<br>Wrought Titanium ASTM B348 Gr. 4 |
| Cast Iron (C.I.) | Cast Iron ASTM A48 Class 25                                         |
| SAE 4150         | Wrought Steel ASTM A322 Gr. 4150                                    |
| SAE 4140         | Wrought Steel ASTM A322 Gr. 4140                                    |
| 420              | Wrought Stainless ASTM A276 Type 420                                |
| C 20             | Wrought Carpenter 20 CB3 ASTM B473                                  |
| 304              | Wrought Stainless ASTM A276 Type 304                                |



## SECTION VII—TROUBLE SHOOTING

| Problem                                                                     | Possible Causes & Corrections                              |
|-----------------------------------------------------------------------------|------------------------------------------------------------|
| A. No liquid delivered, not enough liquid delivered, or not enough pressure | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19, 20. |
| B. Pump works a while and then quits                                        | 4, 5, 7, 8, 9, 11, 12, 20.                                 |
| C. Pump takes too much power                                                | 6, 13, 14, 15, 16, 21, 22, 23, 24, 31.                     |
| D. Pump is noisy or vibrates                                                | 15, 16, 17, 28, 31.                                        |
| E. Pump leaks excessively at stuffing box                                   | 8, 24, 25, 26, 27.                                         |
| F. High bearing temperature                                                 | 15, 16, 17, 29, 30, 31.                                    |
| G. Stuffing box overheating                                                 | 8, 24, 25, 26, 27.                                         |

### Causes & Corrective Measures

1. Pump not primed or properly vented—check that casing and suction pipe are completely filled with liquid.
2. Speed too low—check whether motor wiring is correct and receives full voltage or turbine receives full steam pressure.
3. System discharge head too high—check system head (particularly friction losses).
4. Suction lift too high—check NPSH available (suction piping too small or long may cause excessive friction losses). Check with vacuum or compound gauge.
5. Impeller or piping obstructed—check for obstructions.
6. Wrong direction of rotation—check rotation.
7. Air pocket or leak in suction line—check suction piping for air pockets and/or air leaks.
8. Stuffing box packing or seal worn allowing leakage of air into pump casing—check packing or seal and replace as required. Check for proper lubrication.
9. Not enough suction head for hot or volatile liquids—increase suction head, consult factory.
10. Foot valve too small—install correct size foot valve.
11. Foot valve or suction pipe not immersed deep enough—consult factory for proper depth. Use baffle to eliminate vortices.
12. Entrained air or gases in liquid—consult factory.
13. Impeller clearance too great—check for proper clearance.
14. Impeller damaged—inspect and replace as required.
15. Rotating parts bind—check internal wearing parts for proper clearances.
16. Shaft bent—straighten or replace as required.
17. Coupling or pump and driver misaligned—check alignment and realign if required.
18. Impeller diameter too small—consult factory for proper impeller diameter.
19. Improper pressure gauge location—check correct position and discharge nozzle or pipe.
20. Casing gasket damaged—check gaskets and replace as required.
21. Speed too high—check motor winding voltage or steam pressure received by turbine.
22. Head lower than rating; pumps too much liquid—consult factory. Install throttle valve, cut impeller.
23. Liquid heavier than anticipated—check specific gravity and viscosity.
24. Stuffing box not properly packed (insufficient packing, not properly inserted or run in, packing too tight)—check packing and repack stuffing box.
25. Incorrect packing or mechanical seal—consult factory.
26. Damaged mechanical seal—inspect and replace as required. Consult factory.
27. Shaft sleeve scored—remachine or replace as required.
28. Cavitation—increase NPSH available. Consult factory.
29. Pump capacity too low—consult factory for minimum continuous flow.
30. Excessive vibration—See Section D.
31. Improper bearing lubrication or bearings worn out—inspect and replace as required.

## SECTION VIII—ORDERING SPARE PARTS

### VIII-A. Spare Parts

To insure against possible long and costly down-time periods, especially on critical services, it is advisable to have spare parts on hand.

1. For critical services: It is recommended that a "back pull-out assembly" be kept on hand. This is a group of assembled parts which includes all parts except the casing and the coupling.
  - a. If this unit is equipped with stuffing box packing, the following parts should be on hand:
    - (1) Stuffing box packing (item 106)—one set.
    - (2) Stuffing box gland packing (item 210)—one set.
2. An alternative, though not as desirable as that stated above, can be used on non-critical services. This involves having on hand parts that are most

likely to wear and can be used as needed. See Section VI-A, Parts List, for these recommended spares.

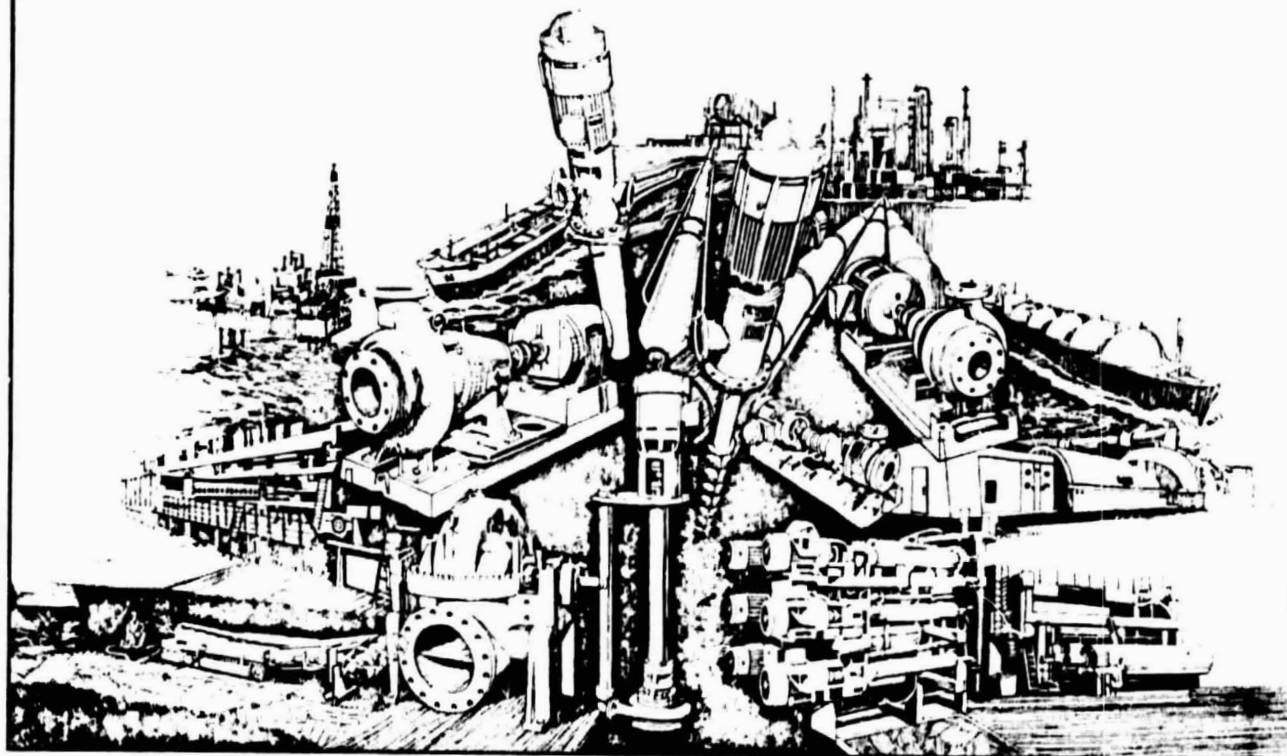
### VIII-B. Instructions for Ordering Spare Parts

Repair orders will be handled with the minimum of delay if the following directions are followed:

1. Give model number, size of pump, and serial number. These can be obtained from the name-plate on the pump.
2. Write plainly the name, part number, and material of each part required. These names and numbers should agree with those on the sectional drawing in Section VI.
3. Give the number (quantity) of parts required.
4. Give complete shipping instructions.

# Pumps, and nothing but.

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Goulds Pumps built its first pump in 1851 and has since grown to the largest manufacturer dealing exclusively with centrifugal pumps.

#### Branch Sales Offices

Atlanta—3406 Oak Hill Rd. Atlanta, Georgia 30340  
Baltimore—2701 Chesapeake Ave. Baltimore, Maryland 21211  
Baton Rouge—4506 Airway Drive, Baton Rouge, Louisiana 70806  
Beverly Hills—2360 Carder Ave., Beverly Hills 90210, California 91606  
Birmingham—2112 11th Ave. South, Suite 400, Birmingham, Alabama 35205  
Boston—One Washington St., Suite 201, Woburn, Massachusetts 02181  
Buffalo—3435 Marham Rd., Cheektowaga, New York 14225  
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Charlotte—4150 Park Road, Charlotte, North Carolina 28209  
Chicago—2430 Lincoln Dr., Brookfield, Illinois 60015  
Cincinnati—6901 Winton Place, Cincinnati, Ohio 45227  
Cleveland—24700 Center Ridge Road, Westlake, Ohio 44145  
Dallas—4615 E. Arapaho Rd., Richardson, Texas 75081  
Denver—1902 East Hampden Ave., Suite 402, Englewood, Colorado 80150  
Detroit—26417 Greenfield Road, Southfield, Michigan 48076  
Houston—5630 Main Lane, Houston, Texas 77057  
Jacksonville—1919 Beachway Drive, Suite 4A, Jacksonville, Florida 32207  
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Los Angeles—3521 San Gabriel Riverway, 401 River, Gardena, California 90247  
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Monroe—20015 Markey St., Monroe, Louisiana 70131  
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Philadelphia—3625 Chicago Road, Northeast, Suite 100, Philadelphia 19125  
Pittsburgh—Two Parkway Center, Suite 117, Pittsburgh, Pennsylvania 15229  
Portland—1100 N.W. 5th St., Suite 140, Beaverton, Oregon 97005  
St. Louis—1401 N. Brentwood Blvd., St. Louis, Missouri 63104  
San Francisco—1740 Sutter St., 10th Floor, San Francisco, California 94109  
Seattle—Suite 207, North West Blvd., Seattle, Washington 98107  
Tampa—7402 North 58th St., Tampa, Florida 33637  
Tulsa—8175 East 43rd St., Tulsa, Oklahoma 74116  
Wilmington—17 Holly Drive, Delaware, Delaware 19801

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#### International Sales Offices

Goulds Pumps Inc., Export Dept., Seneca Falls, New York 13148  
Goulds Pumps Southeast Asia Office—P.O. Box 144, Manila, Philippines  
Goulds Pumps European Office—Morgartenstrasse 6, CH 6003 Luzerne, Switzerland  
Regional Office—Western Europe & North Africa—Schiedstrasse 1, B-2230 Schied, Belgium  
Regional Office—Middle East—P.O. Box 339, Khorram, Athens 179, Greece  
Goulds Pumps Latin American Office—Aparicio Arce 9016, Bogota, Colombia  
Goulds Pumps Central American Office—411 E. Monte Mar, Hato Rey, Puerto Rico 00918

#### Manufacturing Plants

Main Plant and Headquarters—Seneca Falls, New York 13148  
Vertical Pump Division—City of Industry, California 91747  
Texas Division—Lubbock, Texas 79401  
Bombede Goulds de Mexico, S.A. de C.V.—Condomio 96, Mexico 20, D.F.  
Goulds Bombas e Equipamentos LTDA—Avenida Item Te V. 184 Indianapolis, Sao Paulo, S.P., Brazil  
Goulds Pumps (Phil) Inc.—P.O. Box 7157, Manila International Airport, Philippines  
Goulds Pumps Europe AG—CH 4000 Zolingen, Switzerland

#### Manufacturing Licensees

Allen Gwynnes Pumps LTD—Queens Engineering Works, Bedford, England  
Belot Canada Ltd—Goulds Pump Division, 1800 Avenue, Pointe Claire, Quebec, Canada  
Goulds Hidenex, Hidenex Comercial C.A., Apartado No. 451, Caracas, Venezuela  
Goulds D.P. Drakos Pumps Manufacturers Inc.—P.O. Box 24, Kifissia, Greece  
Lathi Engineering Co. Ltd—25 Great Street, Dublin, Ireland  
Miguel Schmitt & Cia S.R.L.—Buenos Aires 3459-69, Buenos Aires, Argentina

#### Pump Service Facility

Goulds Leasing Division—Ferry and Main Streets, Newark, New Jersey 07102  
Stocking and Sales Office



## GOULDS PUMPS, INC.

Main Plant and Headquarters, Seneca Falls, N.Y. 13148

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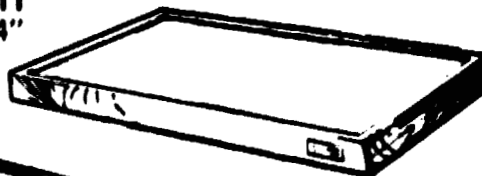
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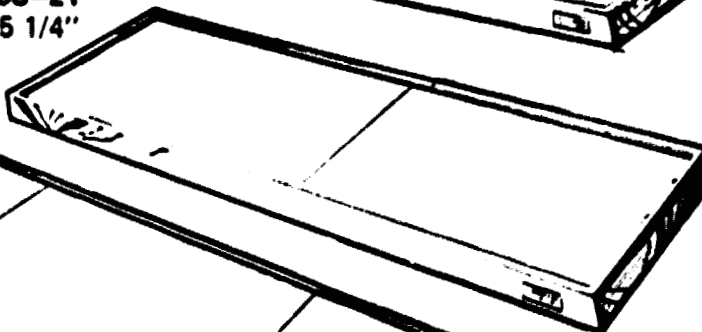


## STANDARD SOLAR COLLECTOR PANELS

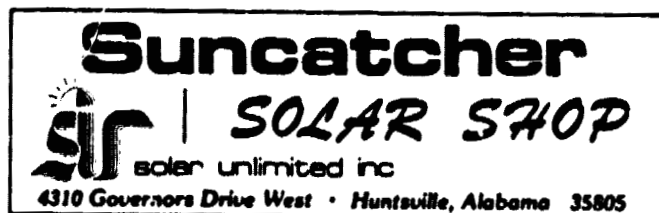
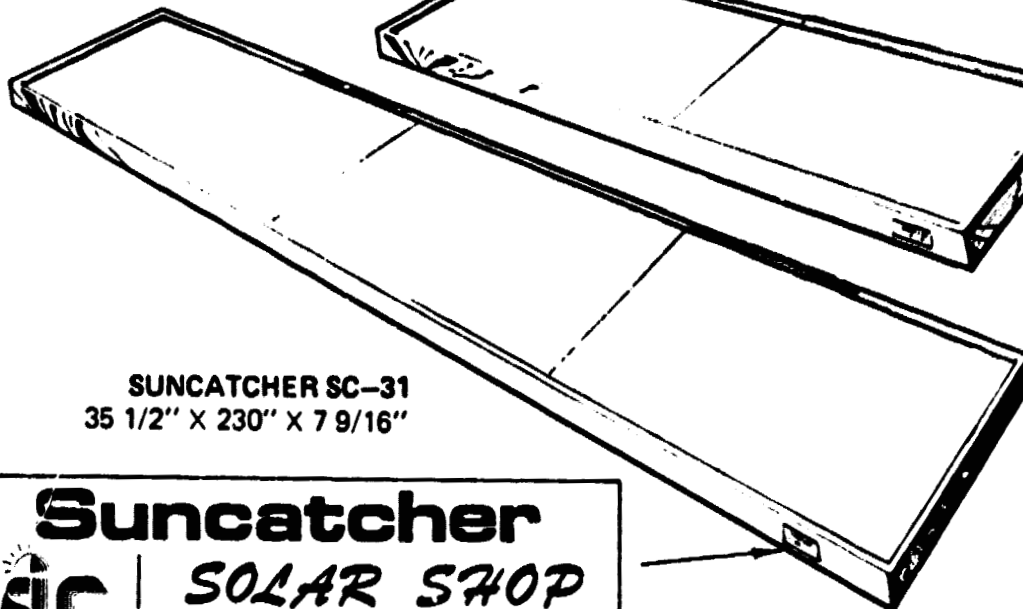
**SUNCATCHER SC-11**  
35 1/2" X 77" X 5 1/4"



**SUNCATCHER SC-21**  
35 1/2" X 154" X 5 1/4"



**SUNCATCHER SC-31**  
35 1/2" X 230" X 7 9/16"

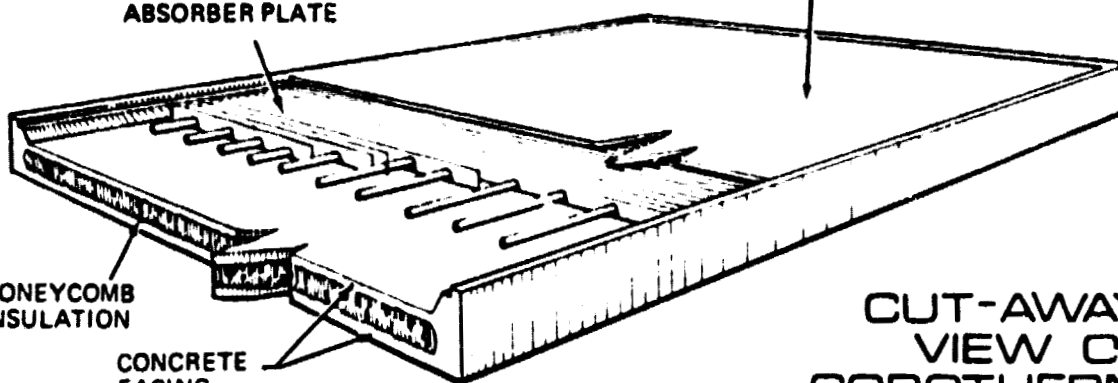


SOLAR-GLASS  
GLAZING

FINNED COPPER TUBE  
ABSORBER PLATE

HONEYCOMB  
INSULATION

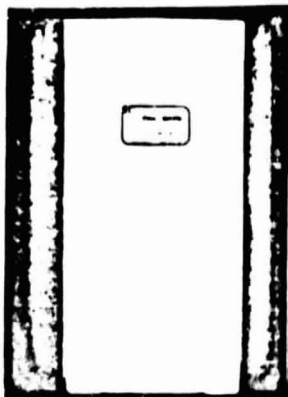
CONCRETE  
FACING



**CUT-AWAY  
VIEW OF  
COROTHERM**  
(PATENT PENDING)



# HEAT EXCHANGER ASSEMBLY MODEL HEA-01



BEAUTIFUL FIBERGLASS COVER  
MAKES THIS AN ATTRACTIVE  
APPLIANCE TO THE MOST DIS-  
CRIMINATING HOMEOWNER.

PLYWOOD COVER IS STANDARD-  
FIBERGLASS IS OPTIONAL

## NOTE THIS !!

Quickly fill entire system, including collec-  
tors, using these three convenient valves and  
two ports. Just connect a service pump to  
1/2" NPT and follow a simple procedure. Not  
necessary to fill from on top of roof.

## EXCLUSIVE !!

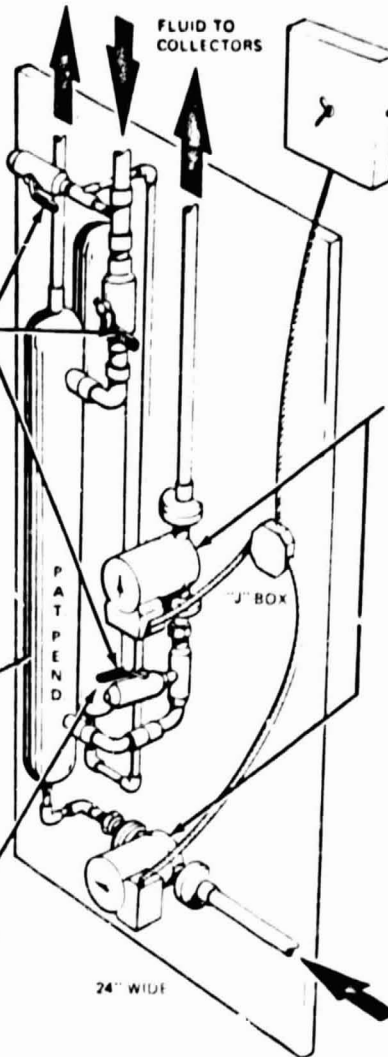
All-copper counterflow high efficiency heat  
exchanger. Double wall with an external vent  
path between walls gives absolute protection  
from contamination of drinking water by  
fluid in collector loop!! Don't settle for less!!

COPPER EXPANSION  
TANK

Stainless steel water pump that will not rust.

Chrome plated ball valves

HEATED  
WATER  
FLUID FROM  
COLLECTORS  
FLUID TO  
COLLECTORS



- COMPACT
- EFFICIENT
- VERSATILE
- PROVEN
- ATTRACTIVE

U.L. listed differential controller

All power completely pre-wired to National  
Electric Code, ready to plug into standard  
120-volt outlet.

Self lubricating, 1/12 h.p. U.L. listed  
Grundfos pumps, "can" type extra reliable

## !! SIMPLE !!

No solenoids, no relief valves, and no  
motorized valves to stick or fail.

NOW HIGH EFFICIENCY CAN  
BE OBTAINED USING LOW  
SPECIFIC HEAT FLUIDS.

- SAFE •
- SAFE •
- SAFE •

WATER TO  
BE HEATED

Model HEA 01

Fiberglass cover for model above (white)

Stock # 13111

Stock # 13109



## **SOLAR SHOP HEAT EXCHANGERS**

**PATENT PENDING**

### **DOUBLE-WALL HEAT EXCHANGERS**

- Operates efficiently with low-specific-heat fluids
- Designed and built specifically for solar water heating systems
- All-copper construction ensures corrosion free long life and efficient heat transfer
- Double-wall construction completely protects domestic hot water from heat transfer fluid
- External vent between tube walls gives positive leak detection and eliminates contamination in either direction in case of failure of either tube.
- Large shell side heat transfer area and low pressure drop
- Meets all U.S. plumbing codes
- Satisfies HUD Intermediate Minimum Property Standards, 4930.2 requiring double-wall contamination protection between potable water and nonpotable liquid
- Sized to operate efficiently with up to 100 sq. ft. of solar collectors
- Designed for use with viscous heat-transfer fluids such as silicone fluid
- Operates efficiently with water and antifreeze solutions
- Water connections are 1/2" nominal standard copper tubing
- Heat transfer fluid connection 1 1/4" nominal copper tubing
- Water loop pressure tested to 250 PSI
- PATENT PENDING Model No. HE 332D . . . . . Stock No. 13205

### **SINGLE-WALL HEAT EXCHANGERS**

Solar Shop also manufactures a single wall heat exchanger similar in construction (except for the double wall) to the heat exchanger above. It is all copper construction, has a large shell side heat transfer area and low pressure drop, and operates efficiently with high-viscosity and low-specific-heat fluids.

Single wall heat exchanger - Model HE 332S . . . . . Stock No. 13204

#### **. . . Non-Solar Applications . . .**

Solar Shop's Heat Exchangers can also be used in heat recovery systems to transfer heat from toxic fluids (including gases) to water. The double wall heat exchanger provides a safe means of transferring heat from such fluids to potable water.

### **EXPANSION TANKS FOR SOLAR**

**DESIGNED FOR CLOSED SYSTEMS**

- All Copper construction for corrosion free long life
- Compact size 3" OD x 31"
- 1 gallon capacity
- Connection size 1/2" Nominal Standard Copper Tubing
- Rated for Pressures up to 150 PSI

Stock No. 13301



# Domestic Circulators from **GRUNDFOS**

## Versatile, Efficient and Reliable

Here's why over 2,000,000 Grundfos Domestic Circulators were purchased last year alone by contractors and manufacturers all over the world...

### Stainless Steel Construction...

All vital motor and pump components, including shafts and impellers, are constructed of high-grade stainless steel. Grundfos open system pumps also feature an all stainless steel volute, so that water passing through the pump touches nothing but corrosion-resistant stainless.

### 18 Month Warranty...

Each Grundfos pump is warranted for continuous circulation of water up to 230°F. We are able to make this guarantee because we test each and every pump we make under extreme operating conditions. But, if for some reason, one of our pumps should fail, we'll give you a new one to replace it. We don't expect you to spend valuable time and money fixing up our mistake.

### Variable Speed Motors...

You no longer have to stock a wide range of pumps. The Grundfos UPS 20-42 with its variable speed motor, for example, does the job in the majority of residential and light commercial applications.

### Fast, Easy Installation...

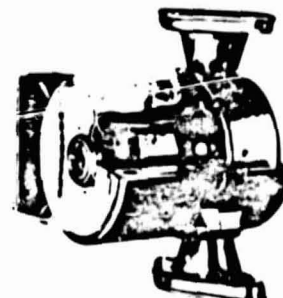
Grundfos pumps can be easily matched to the individual requirements of most heating and solar systems, and their light weight and small size make them a cinch to install.

### Efficient and Quiet...

Our largest selling model the UPS 20-42 uses less power than it takes to run a 100-watt lightbulb! And due to the Grundfos patented self-lubrication system, and ceramic bearings, Grundfos circulators are the quietest-running pumps available today.

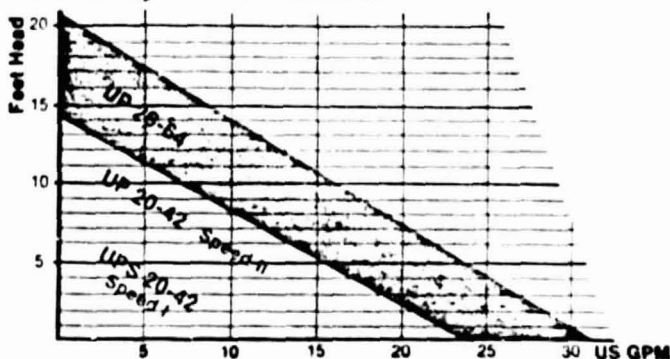
### Competitively Priced...

Check with your Distributor or Grundfos Representative today. You'll find it hard to believe that a pump with all these features could cost so little.



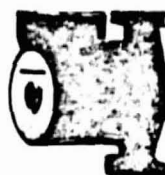
## GRUNDFOS

### Closed System Circulators



UP 26-64 1/12 HP

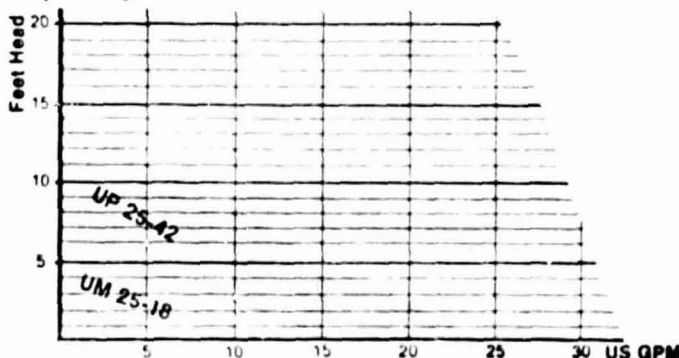
UPS 20-42 1/20 HP



For domestic hydronic heating, and closed system solar water and space heating systems...

Designed for easy pump selection, reduced stocking problems, fast installation and total reliability and efficiency, Grundfos Closed System Circulators produce heads to 21 feet or flows to 31 GPM using energy efficient 1/12th or 1/20th HP motors.

### Open System Circulators



UP 25-42 1/20 HP

UM 25-18 1/35 HP



For domestic open system solar water and space heating and "Instant Heat" hot water loop systems.

Water passing through Grundfos Open System Circulators touches only high-grade, corrosion-resistant stainless steel. These pumps produce heads to 14 feet or flows to 23 GPM using energy efficient 1/20th or 1/35th HP motors.



# SOLAR CONTROLS AND INSTRUMENTATION

## CONTROLS AND INSTRUMENTATION MANUFACTURED BY RHO SIGMA

### Control Systems

For regulation of liquid and air flows in solar systems designed for heating and cooling. UL Listed.

### Sensors

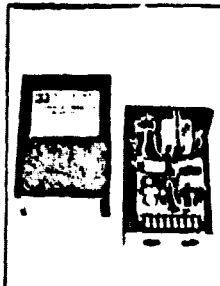
Compatible with standard plumbing fittings. Designed to withstand solar collector stagnation temperature. Designed for easy installation.

RS 106



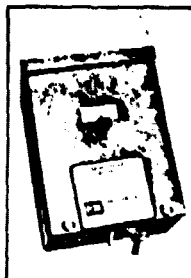
Differential Thermostat  
Input: 120 VAC  
Standard Output:  
SPDT Relay rated at 10 amps  
1/3 hp at 120 VAC  
1/2 hp at 240 VAC  
Switch with manual ON/OFF/AUTO positions  
Relay contacts make when  
JT on = T(collector) - T(storage)  
> 20 ± 3°F  
Relay contacts break when  
JT off = T(collector) - T(storage)  
< 3 ± 1°F  
Housed in standard NEMA box to ensure compatibility with standard electrical trade hardware  
Wiring connections made by standard electrical trade procedures  
UL Listed  
RS 106 - Stock #14103

RS 12



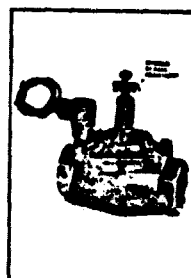
Provides differential control identical to the RS 106. Relay switches 120 VAC at 10 amps directly to the pumps.  
(Input U.L. Listed)  
RS 12 - Stock #14102

RS 240



Bubbling Pool Solar Control  
Input: 220 VAC Standard: 120 VAC (optional)  
Output: 12 VDC, 5 amps continuous  
Thermostatic setting to prevent pool overheating (adjustable 56°F-120°F)  
Turns on solar heater when solar collectors are 5°F hotter than pool temperature when pool temperature is below thermostatic setting. When pool temperature is above the thermostatic setting, then water by passes the solar collectors.  
Easily wired into pump timers so that the control unit functions only when the pump is operating. Rain tight enclosure.  
Easy retrofit installation into existing pool filtration systems.  
Optional configurations available for normally open valves and 24 VAC solenoids  
UL Listed  
RS 240 - Stock #14150

RS 950



Material: Brass  
Port Diameters: 1 1/2" and 2"  
Low voltage solenoid  
Pressure drop: 1 psi and 40 gpm (1 1/2" valve)  
Internal Bypass: Valve modified to Rho Sigma's specifications. Unique adjustment on stem enables installer to conveniently limit the amount of valve closure. Thus, high back pressure (developed within the collector array) on the pump may be relieved through the internal bypass of the valve. Internal bypass also provides a drain down path for the collector supply line when the pump turns off.  
The valve may also be effectively used in gravity return systems.  
Positive opening ensured by connection to suction side of pump.  
RS 950 - Stock #16301

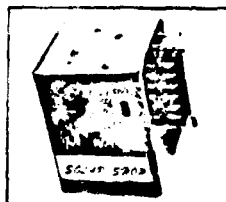
SENSORS



All Rho Sigma sensors are electrically identical and interchangeable and are designed to withstand stagnation temperatures of solar collectors. Two and only two sensors are required with each differential thermostat.  
The SA Sensor is the temperature sensing element encased in epoxy.  
The ST Sensor has a copper housing with a hole punched in it for bolting directly to the collector plate or suspending inside air ducts. Alternatively, a radiator hose pipe clamp may be used to secure the rugged sensor to the surface of a pipe. Or it may be slipped inside the insulation of the storage tank.  
The SF Sensor is a 1" x 1" x 2" sandblasted and black anodized aluminum sensor designed for use with unglazed solar collectors or in high flow rate, low delta T systems. The screw provided with the sensor may be used to mount the sensor near the collector where it will sense the temperature and availability of solar energy at the collector.  
The SP Sensor is epoxied into a rugged brass housing with standard 1/2" pipe threads for easy installation into standard plumbing fixtures.  
SA Sensor - Stock #14205  
ST Sensor - Stock #14201  
SF Sensor - Stock #14202  
SP Sensor - Stock #14204

These controllers turn the solar collection system on when solar energy is available and turn the system off when solar energy is not available. This ensures maximum efficiency of the solar heating system.

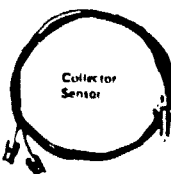
## MODEL DT-2-1 SOLID-STATE SOLAR HOT WATER CONTROLLER



UL Listed

**Description**  
The model DT-2-1 is a solid-state differential thermostat capable of fully controlling a solar hot water heating system. The unit is designed for a lifetime of maintenance free service, and incorporates freeze and boil protect circuitry.

Water probes have 1/2" NPT thread, in lengths from 2 3/4" to 28"



Model DT-2-1 Controller - Stock #14121  
Collector Sensor - Stock #14211  
LUG Mount Sensor - Stock #14212  
Water Probe Sensor - Stock #14214

### Specifications

|                              |                                                                                                                 |
|------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Input Voltage                | Either 120 VAC ± 10V or 24 VAC ± 4V                                                                             |
| Input Power                  | 3 watts, no load                                                                                                |
| Control Relay                | SPDT, 10A (resistive) at 28 VDC or 120 VAC. Higher ratings available.                                           |
| Output Voltage               | Either 120 VAC or 24 VAC                                                                                        |
| Sensors                      | Matched thermistors (±1°C over range from 0°C to +100°C) in a metal housing, with high-temperature teflon leads |
| Differential Turn-off Offset | Typically 4 ± 2°F @ 100°F (can be adjusted by a resistor change).                                               |
| Differential Turn-on Offset  | Typically 20 ± 2°F @ 100°F (can be adjusted by a resistor change).                                              |
| Temperature Range            | Controller chassis -40°F to 140°F<br>Sensors -40°F to +300°F<br>±5°F over entire operating range                |
| Tracking Accuracy            | 1500 V                                                                                                          |
| Isolation Protection         | 4" x 4" x 3 1/2"                                                                                                |
| Weight                       | 2 lbs                                                                                                           |
| Mounting                     | Mounts on 4" x 4" J box                                                                                         |



## Q2-1132 SILICONE HEAT TRANSFER FLUID

### Design Choices

Three general classes of materials can be considered as potential heat transfer candidates:

1. Water and Water/Glycol Mixtures
2. Hydrocarbon Oils
3. Silicone Liquids

#### 1. Water and Water Glycol Mixtures

Water is usually the first choice for a heat transfer fluid. It has the inherent property of being extremely inexpensive, readily available and having no adverse biological, environmental, or building material effects.

The liquid range of water (32°F-212°F) is too narrow, it is easily contaminated with ionic minerals and is a poor dielectric.

To overcome these deficiencies propylene or ethylene glycols and corrosion inhibitors are added. These do not solve the vapor pressure problem. At 400°F pressures over 150 psi are generated. As the inhibitors are sacrificial, a regular maintenance schedule is required to maintain the system. Draindown systems or waste heat dumping hardware must be added to the collection loop increasing the overall capital cost. Water and water/organic mixtures are not premium solar heat transfer fluids.

The superior thermal properties of water are of marginal value as the low heat flux levels of flat plate collectors result in very low fluid flow rates. Increased flow rates for less efficient fluids result in negligible increased pumping costs.

#### 2. Hydrocarbon Oils

In industrial use, hydrocarbon oils are normally considered as a second choice for a heat transfer fluid. While there are many mixtures of "hot oils" to choose from, a typical example of a premium hydrocarbon would be mineral oil such as that used in outdoor transformers as a dielectric coolant.

Mineral oils of this type are excellent dielectric materials, are non-ionic, exhibit only minor biological, environmental, and building material problems and are non-corrosive at temperatures up to 220°F. While paraffinic-based mineral oils freeze at relatively high temperatures, naphthanic stocks can be formulated to operate down to the -20°F range provided that high viscosity increases can be coped with in the pumping loop.

Unfortunately, most mineral oils have flash- and fire-points in the 300-330°F range. In addition, at elevated temperatures they readily

oxidize forming tars which can coat the collector panel walls reducing both heat transfer characteristics and flow rates. Oxidation is quite frequently accompanied by the formation of acid by-products which can attack and corrode copper, aluminum, and steel. The acceptance of hydrocarbon oils under general residential building codes and fire insurance regulations is unknown.

A naphthanic-based transformer-grade mineral oil would appear to be a superior product to water and water/glycols, provided that panel stagnation temperatures could be kept below 220°F and oxidation inhibitors could be added to prevent tar and acid buildup.

Specialized aromatic and terphenyl organic heat transfer fluids used at temperatures up to 650°F in industrial heat transfer loops are the premium fluids of the hydrocarbon class. These offer acceptable viscosities at temperatures as low as 0°F, exhibit excellent thermal stability in a closed system up to 400°F and are, in themselves, non-corrosive to common engineering materials. They tend to oxidize at 400°F even with limited oxygen exposure, and tars and/or acids can be generated, and they can adversely affect house construction materials. The flashpoints are in the general range of 310-360°F.

#### 3. Q2-1132 Silicone Fluid

Dow Corning Q2-1132 Silicone Heat Transfer Liquid comfortably exceeds each of the basic design parameters as they relate to freezing, vapor pressure, corrosion, flashpoint, long term stability, toxicity, and compatibility with materials of house construction.

Silicone fluids have extremely wide liquid ranges with a flat temperature-viscosity slope. They are non-freezing and have very low vapor pressures.

Current evidence indicates that Dow Corning Q2-1132 Silicone Heat Transfer Liquid is non-corrosive leaving the designer free to use a variety of metals in designing his system.

It has a high flash- and fire-point, 460°F & 500°F, respectively.

Both laboratory testing and field experience indicate that silicone fluids such as Q2-1132 do not attack common building materials. They are one of the least toxic chemicals sold in industry.

At operating temperatures of 150-200°F with occasional exposure to 400°F in closed loops, silicone fluids should last for the life of the solar system. Periodic maintenance and replacement of the fluid should not be required.

Dow Corning Q2-1132 Silicone Heat Transfer Liquid is designed to operate in closed-loop medium temperature collector systems which do not normally operate over 250°F and stagnate below 400°F.

|                    |                 |
|--------------------|-----------------|
| 1 Gallon           | Stock No. 16101 |
| 5 Gallon Container | Stock No. 16105 |
| 55 Gallon Drum     | Stock No. 16115 |



## ABOUT COROTHERM

It is apparent that a construction material and building system serving both for solar energy collection and as the primary building material would greatly reduce the cost and complexity of new construction. Corotherm, which Solar Unlimited, Inc. is now marketing, satisfies these requirements.

The primary goals in this product development were to reduce cost while maintaining a high standard of building quality. Consideration had to be given to important features such as type of materials, production methods, thermal qualities, construction techniques, weight and strength.

There are other products now on the market that offer one or two outstanding characteristics, but none that can offer all in one versatile product like Corotherm.

Corotherm is a patent-pending product made by sandwiching a layer of structural honeycomb filled with sound and thermal insulation between layers of reinforced concrete.

The list below reveals why Corotherm is, in reality, a new and beautiful way to construct solar facilities and building components.

### corotherm features

- **Lightweight** — Honeycomb core eliminates heavy internal weight while maintaining structural strength.
- **Low Thermal Conductivity** — Honeycomb core filled with insulation greatly reduces heat-transfer losses.
- **Low Material Cost** — Unique and precast manufacturing methods combine low-cost materials into a completed integral building panel.
- **Low Construction Cost** — Complete building panel arrives at job site ready for quick installation thus eliminating costly and time-consuming job site construction activities.
- **Reduced Shipping Costs** — Light-weight panels permit shipment of large square foot quantities on one truck load.
- **Unlimited Architectural Flexibility** — Shape, thickness, interior and exterior facings are all features that can be widely varied to suit the designer.
- **Fire Resistant** — Non-combustible concrete facings provide effective fire resistance.
- **High Durability** — Concrete virtually unaffected by weather, salt air, wind and blowing sand.
- **Low Sound Conductivity** — Concrete facings separated by insulated honeycomb provide excellent sound barrier.
- **Low Maintenance** — Natural facing materials require no periodic painting or coatings.



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# DOUBLE-WALL HEAT EXCHANGER

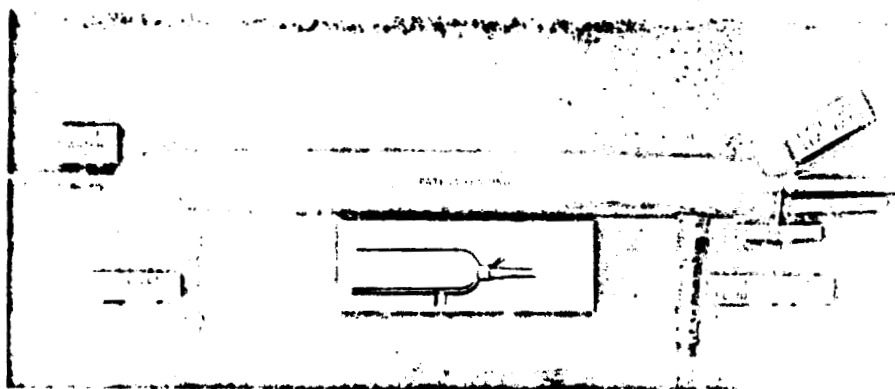
## ABSOLUTE PROTECTION

Absolute protection of your water supply from collector fluid contamination is assured by using an external leak path between dual tubes inside heat exchanger.

## HIGH EFFICIENCY

High-efficiency heat transfer using high surface area counterflow patent pending design. This all-copper unit efficient even with low-specific-heat fluids such as silicone.

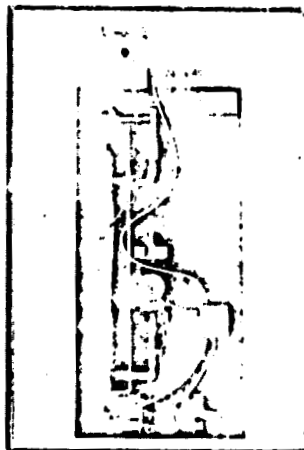
**PHOTO DEMONSTRATES EXTERNAL  
LEAKAGE PATH IF EITHER TUBE FAILS\***



\*A hole was drilled through the outer wall of the dual water tube to prove that the external leakage path works.

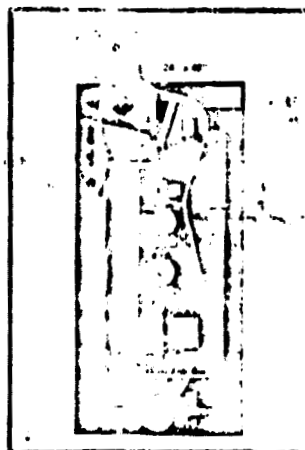
## \*\*HEAT EXCHANGER ASSEMBLIES\*\*

COMPLETELY ASSEMBLED, TESTED  
AND READY TO PLUG IN



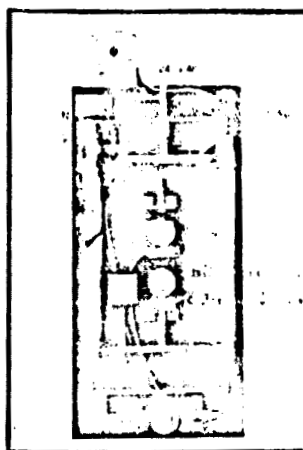
HEA-01

Water Heater



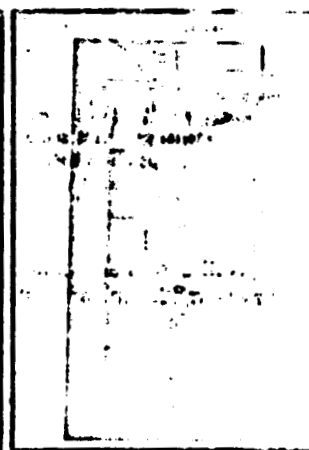
HEA-02

Solar Room Heater



HEA-03

Multi Room Solar Heater



HEA-31

Central Solar Heater

15.0 AS-BUILT DRAWINGS

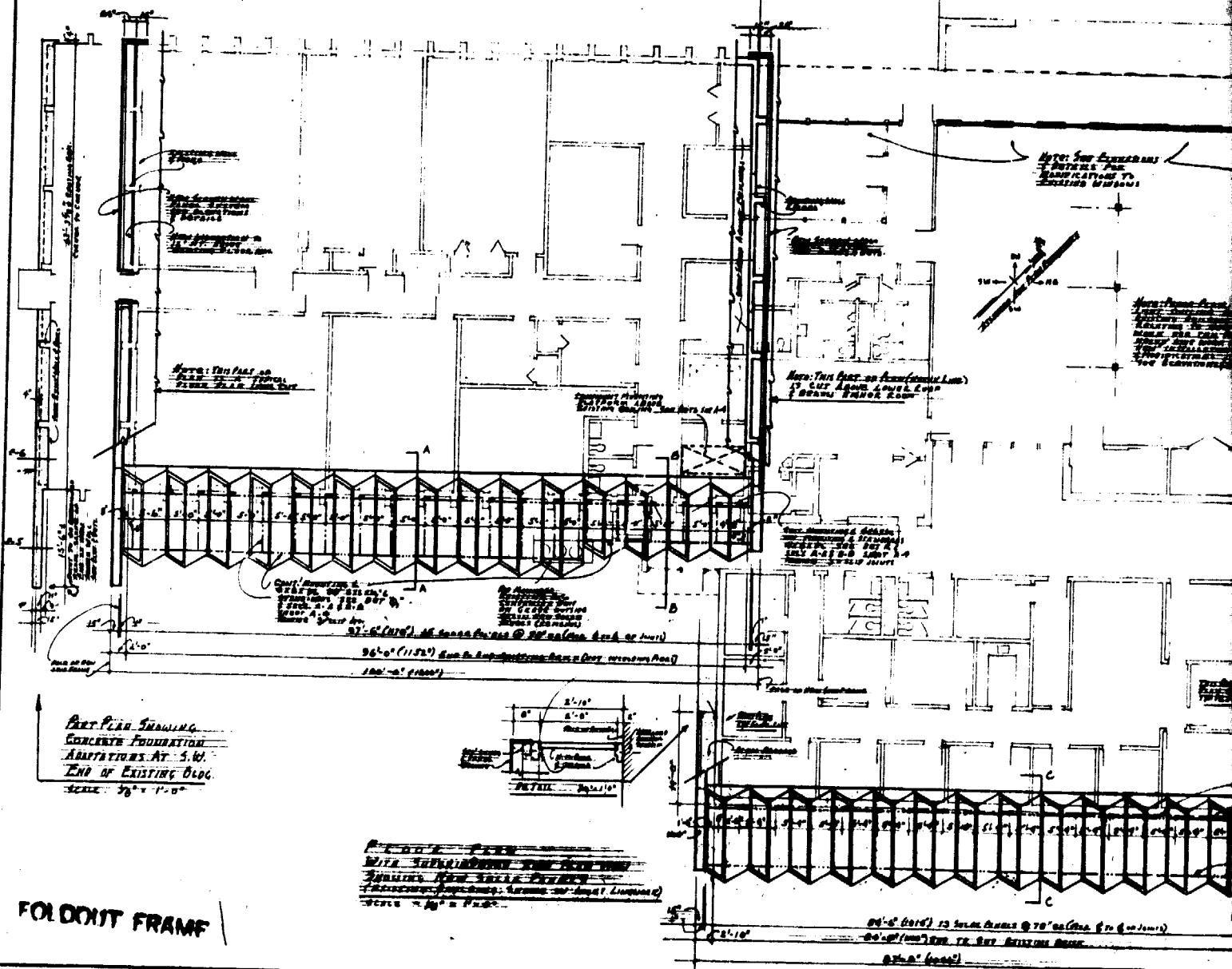
(Pages 1 through 8 comprise the drawings for this project.)

# INDEX TO SHEETS

| Sheet No. | Title                           |
|-----------|---------------------------------|
| A-1       | PLAN FOR FOUNDATION AND FOOTING |
| A-2       | FOUNDATION ADAPTATIONS          |
| A-3       | SECTION ARCHITECTURAL PLAN      |
| A-4       | SECTION ARCHITECTURAL PLAN      |
| A-5       | SECTION ARCHITECTURAL PLAN      |
| B-1       | SECTION ARCHITECTURAL PLAN      |
| B-2       | SECTION ARCHITECTURAL PLAN      |
| B-3       | SECTION ARCHITECTURAL PLAN      |
| B-4       | SECTION ARCHITECTURAL PLAN      |
| B-5       | SECTION ARCHITECTURAL PLAN      |

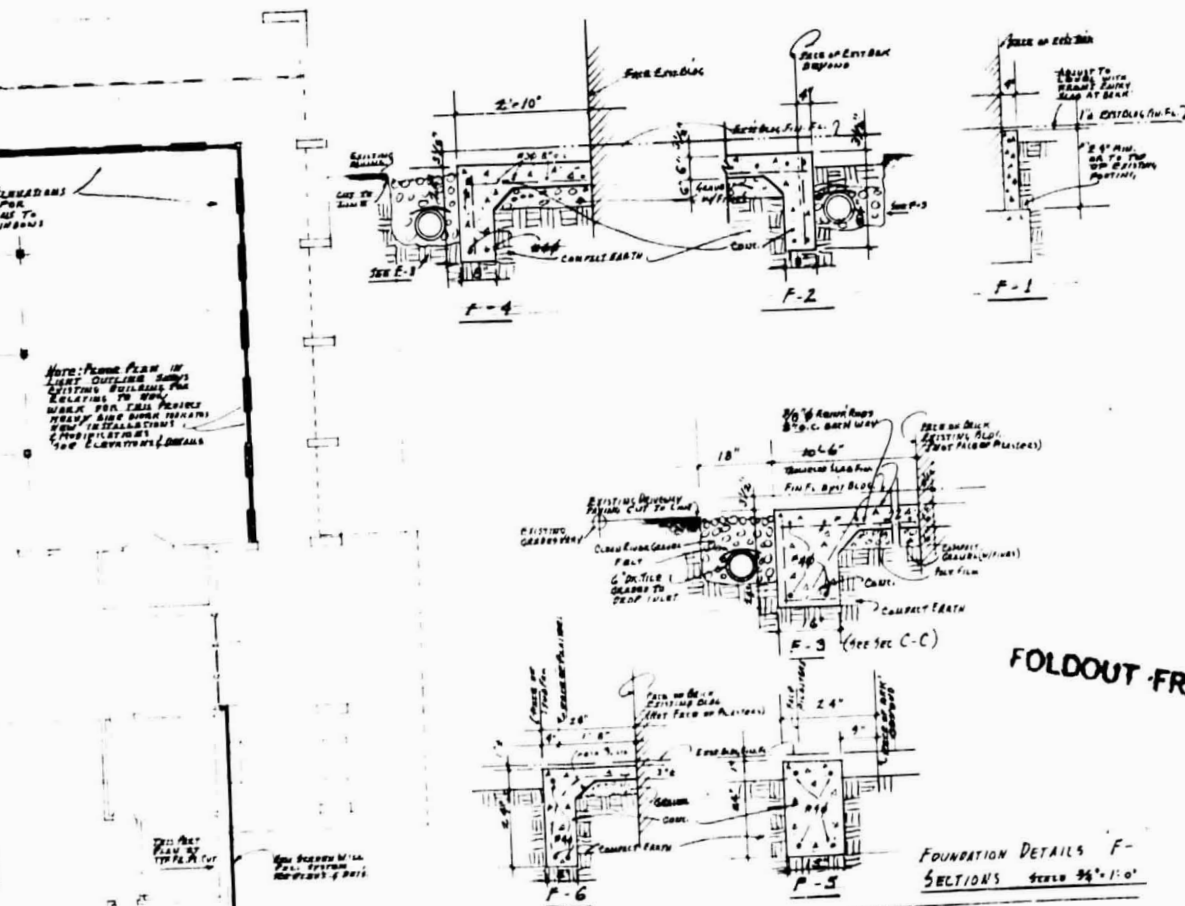
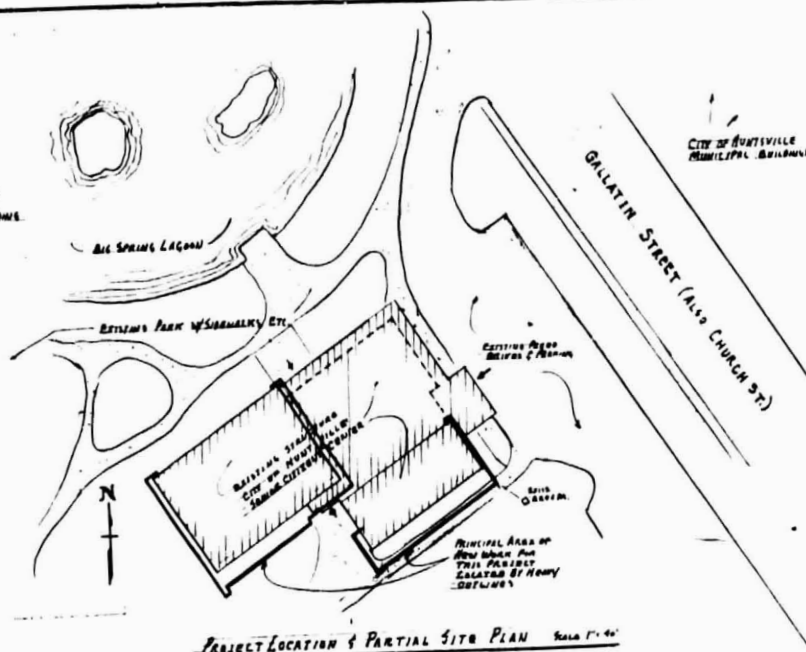
ORIGINAL PAGE IS OF POOR QUALITY

PART PLAN SHOWING CONCRETE SLAB FOUNDATION ADAPTATIONS FOR SOLAR PANELS AT SOUTH EAST SIDE OF EXISTING BUILDING  
SCALE 3/8" = 1'-0"



FOLDOUT FRAME

# E IS LITY



FOLDOUT FRAME

FOUNDATION DETAILS F-  
SECTIONS SCALE 3/4" = 1'-0"

**DICKSON AND ASSOCIATES  
ARCHITECTS**



SHEET  
A-1  
Of 6

DRAWN  
3/7/78  
CHECKED  
DATE  
1/25/78

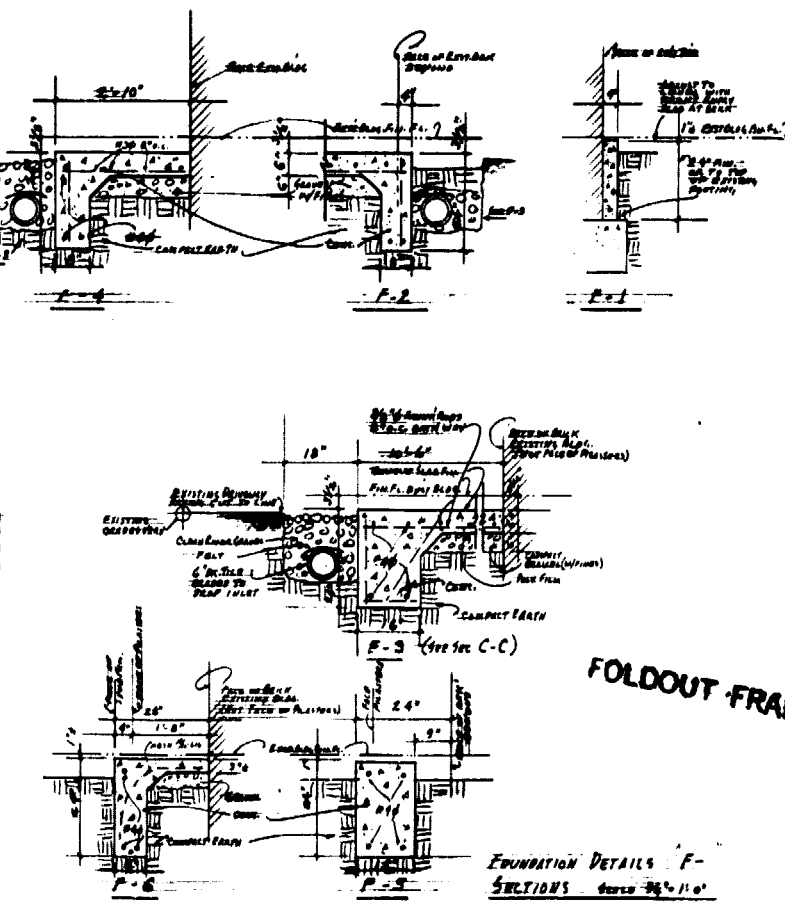
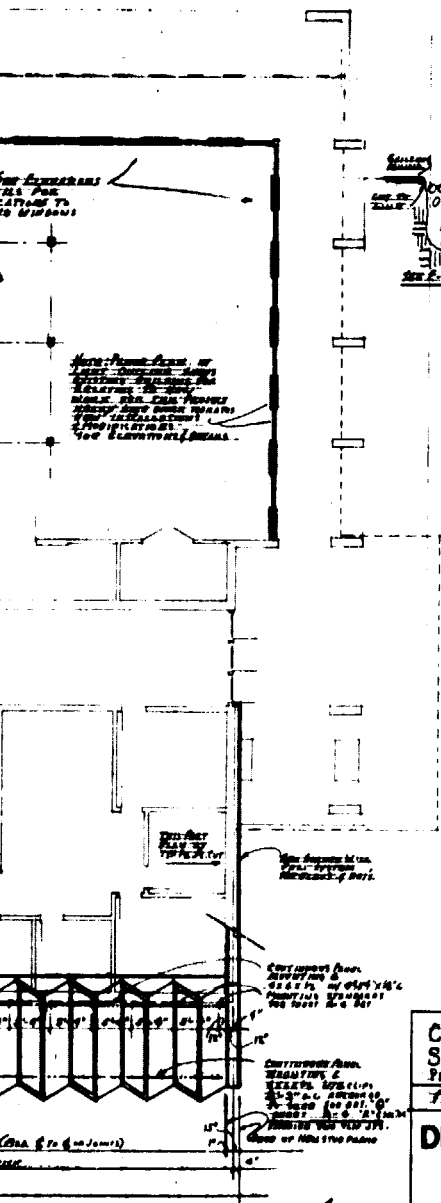
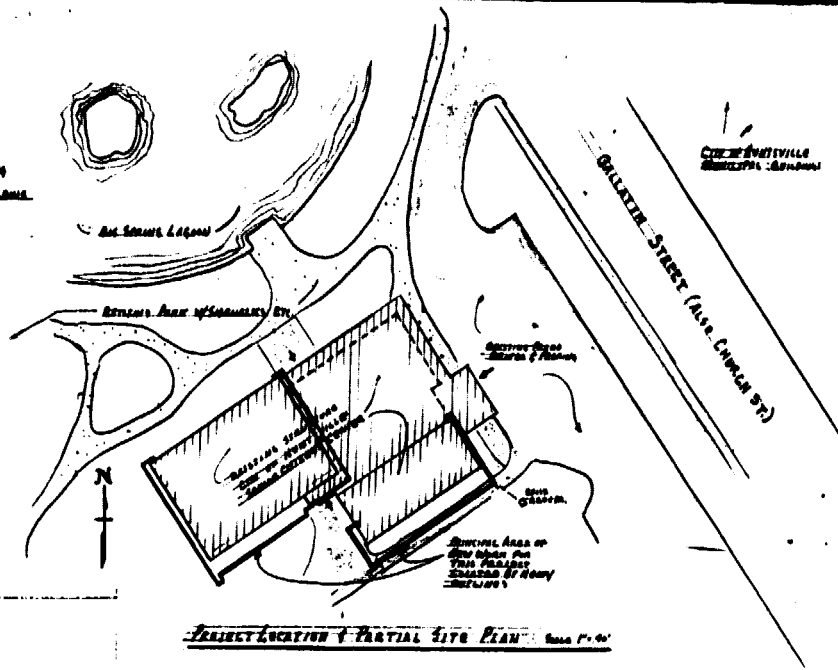
|              |
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| REVISED      |
| March 28, 70 |
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JOB NO. 719

# SHEETS

- PLAN (FOUNDATION AND PILING) DETAILS
- STRUCTURAL DETAILS
- ARCHITECTURAL FLOOR DETAILS
- STRUCTURAL CONNECTION TO EXISTING BUILDING
- SCREEN WALL PILING CONNECTION TO EXISTING BUILDING
- FOUNDATION DETAILS
- MECHANICAL DETAILS
- ELECTRICAL PLAN & DETAILS

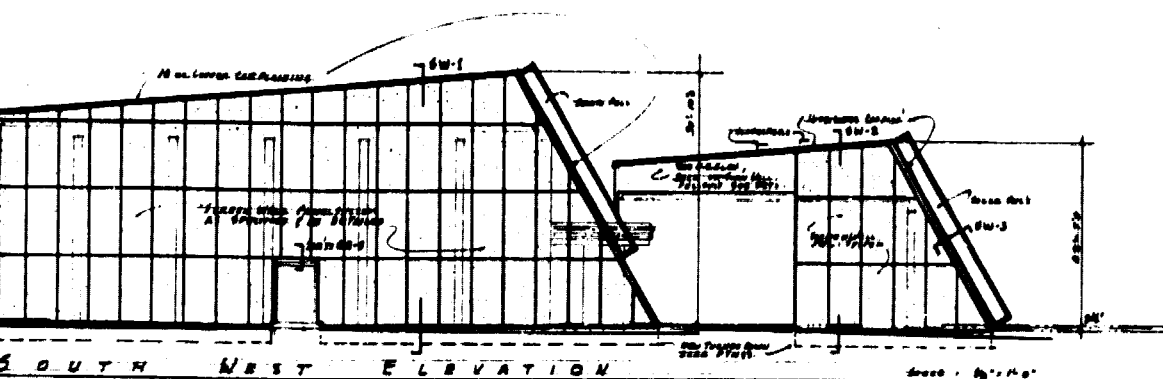
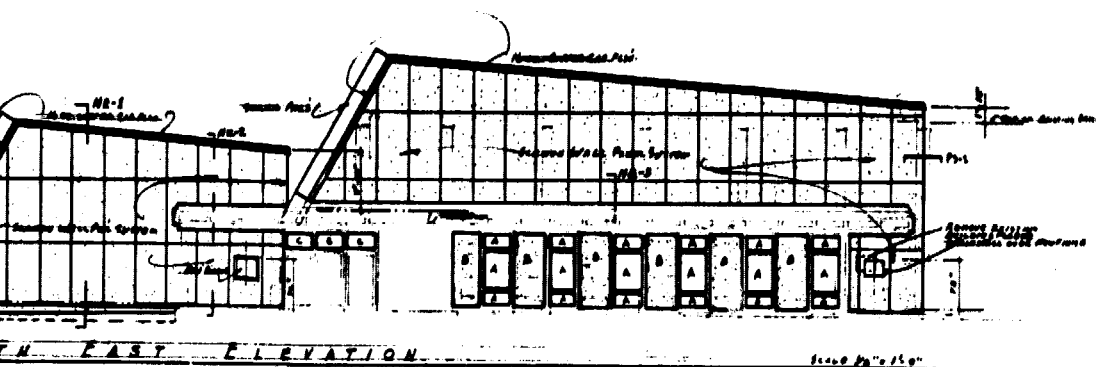
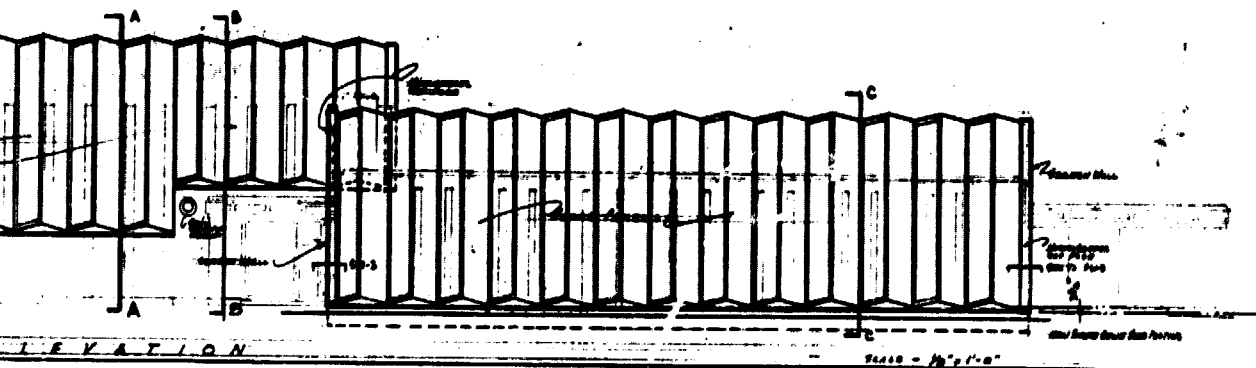
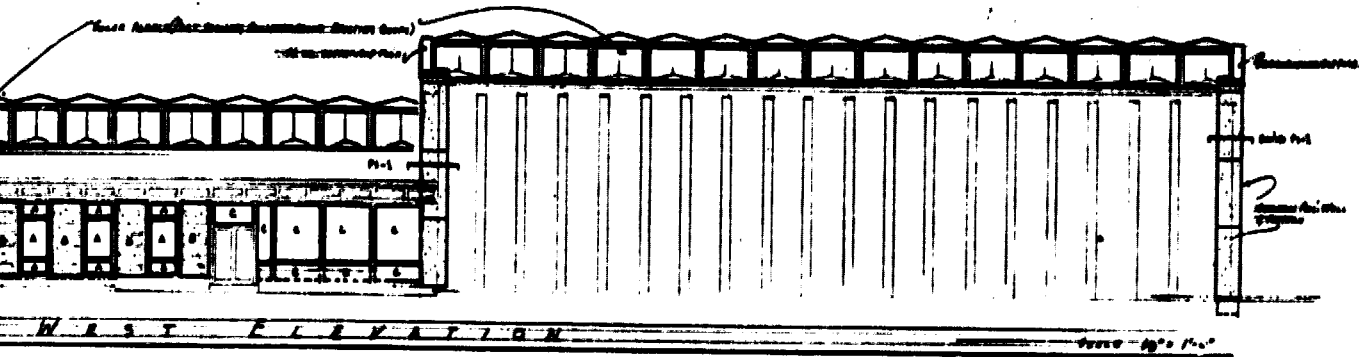
PAGE 13  
QUALITY



FOLDOUT FRAME 2

|                                                                                                                                           |  |                         |                       |                         |                         |
|-------------------------------------------------------------------------------------------------------------------------------------------|--|-------------------------|-----------------------|-------------------------|-------------------------|
| <p>CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER<br/>SOLAR HEATING AND HOT WATER SYSTEM<br/>PROJECT NO. 77-A-81-GATI HUNTSVILLE, ALABAMA</p> |  |                         |                       |                         |                         |
| <p>FLOOR PLAN &amp; FOUNDATION PART PLANS &amp; DETAILS</p>                                                                               |  |                         |                       |                         |                         |
| <p>DICKSON AND ASSOCIATES<br/>ARCHITECTS</p> <p>HUNTSVILLE ALABAMA</p>                                                                    |  | <p>SHEET<br/>A-1</p>    | <p>DRAWN<br/>RAC</p>  | <p>REVISED<br/>None</p> | <p>JOB<br/>NO. 77-3</p> |
|                                                                                                                                           |  | <p>DATE<br/>1/25/78</p> | <p>CHECKED<br/>LD</p> | <p>DATE<br/>1/25/78</p> | <p>DATE<br/>1/25/78</p> |





FOLDOUT FRAME

2

CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER  
SOLAR HEATING AND HOT WATER SYSTEM  
PROJECT NO. 77-A-181-0071 HUNTSVILLE, ALABAMA  
ELEVATION & DETAILS

DICKSON AND ASSOCIATES  
ARCHITECTS

HUNTSVILLE

ALABAMA

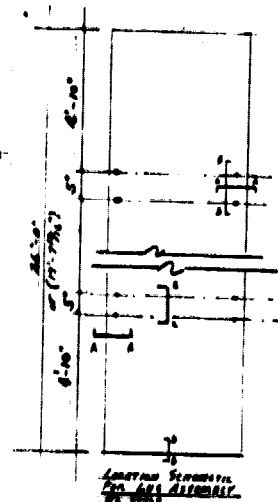
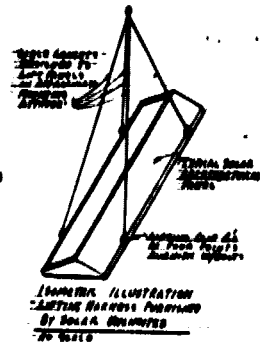
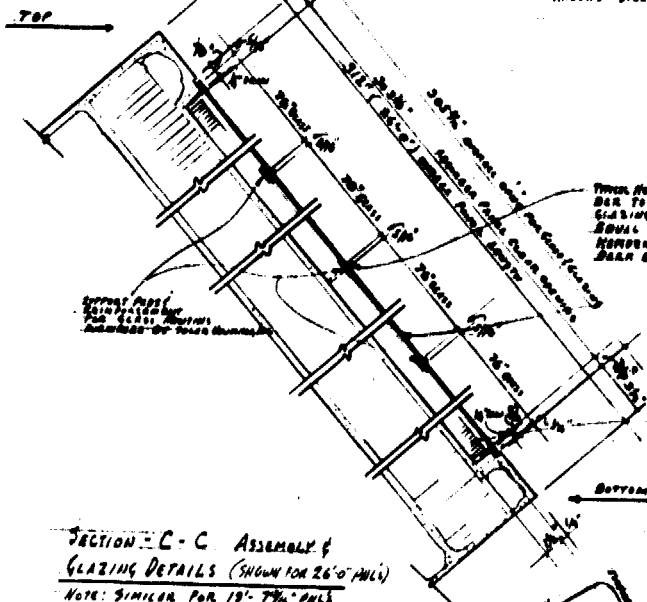


SHEET  
A-2  
DATE  
1/25/78

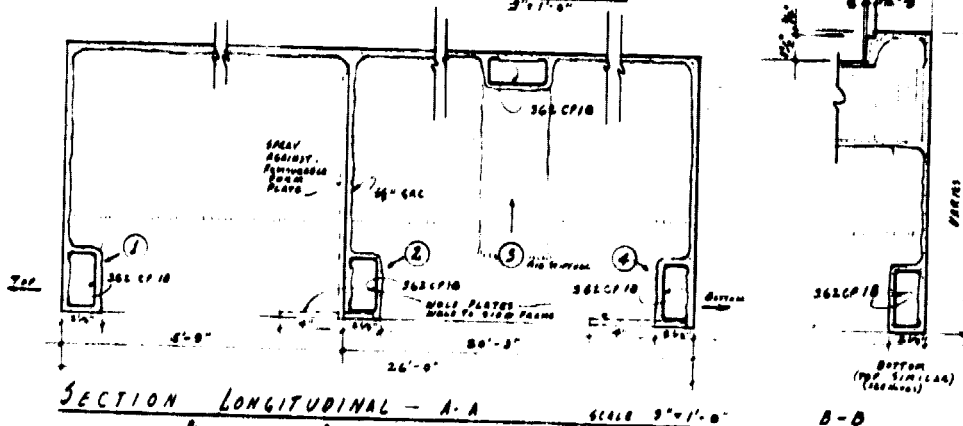
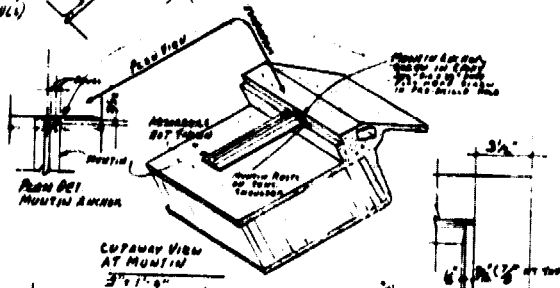
CHECKED  
DATE  
1/25/78

REVISIONS  
DATE  
1/25/78

JOB NO.  
77-0



SECTION - C - C Assembly & GLAZING DETAILS (SHOWN FOR 26'-0" PANEL)  
NOTE: SIMILAR FOR 10'-0" PANEL



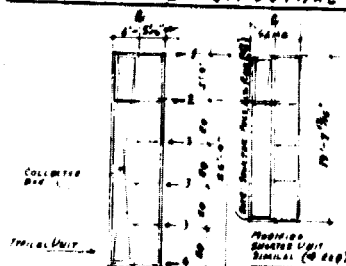
SECTION LONGITUDINAL - A - A

SCALE 3/4" = 1'-0"

B - B

PLAN SECTION

SCALE -



PANEL ELEVATIONS 1/4" = 1'-0" SHOWING REINFORCING LOCATIONS

QUANTITIES:  
26'-0" Long PNLs - 2400 lbs.  
10'-0" Long PNLs - 400 lbs.

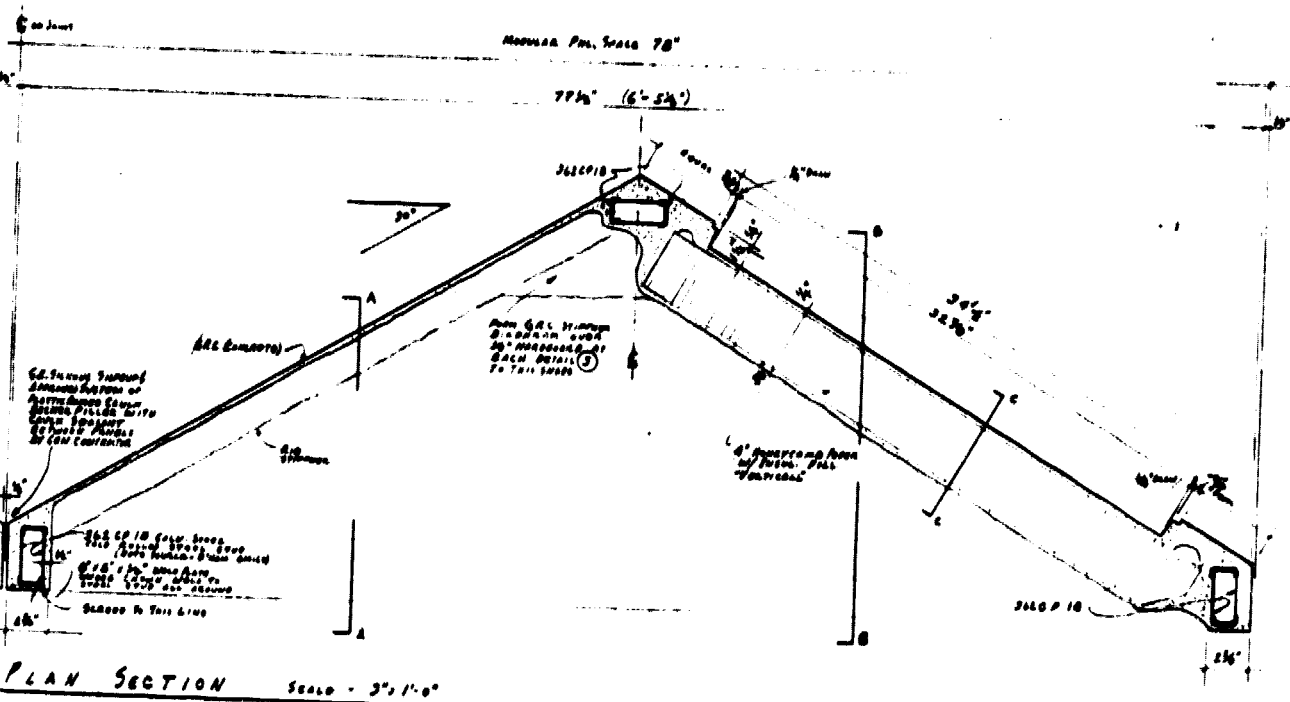
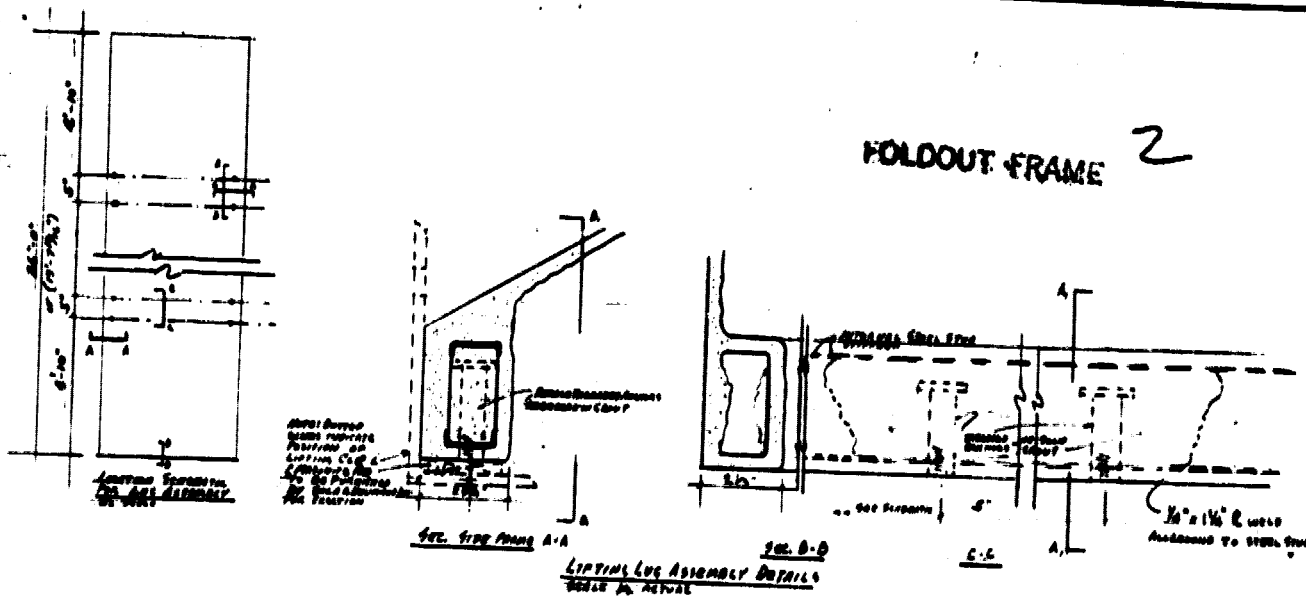
NOTE: SOLAR COLLECTOR BUILT SHOWN IN THIS DRAWING ARE TO BE FURNISHED BY SOLAR UNIMETER, INC. INSTALLED AT THE PROJECT SITE BY THE GENERAL CONTRACTOR (SEE NOTES RE: ASSEMBLY OF OTHER RELATED ITEMS AS NOTED & AS SPECIFIED)

NOTE: COLD ROLLED STEEL STUDS DESIGNATIONS (SEE SPECIFICATIONS) WITH SIZES FROM CATALOGUE OF AMICO - BIRMINGHAM, ALA.

NOTE: SOLAR ARCHITECTURAL PANELS ARE TO BE FABRICATED TO FINAL DETAIL PER PARAGRAPH 200 DRAWING SUBMITTED TO FINAL APPROVAL BY SOLAR UNIMETER, INC. THE ARCHITECT. PARAGRAPH 200 DRAWING ARE TO INCLUDE ANY PROPOSED VARIATIONS FROM DETAILS SHOWN & ADDITIONAL DETAILS OF MOUNTING, GLASS & GLAZING SYSTEM.



# FOLDOUT FRAME 2



NOTE: Cold Rolled Steel Stud  
Dimensions are standard  
units selected from catalogue  
see AISC, Simpson, etc.

SOLAR ARCHITECTURAL PANEL DETAILS

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OF POOR QUALITY

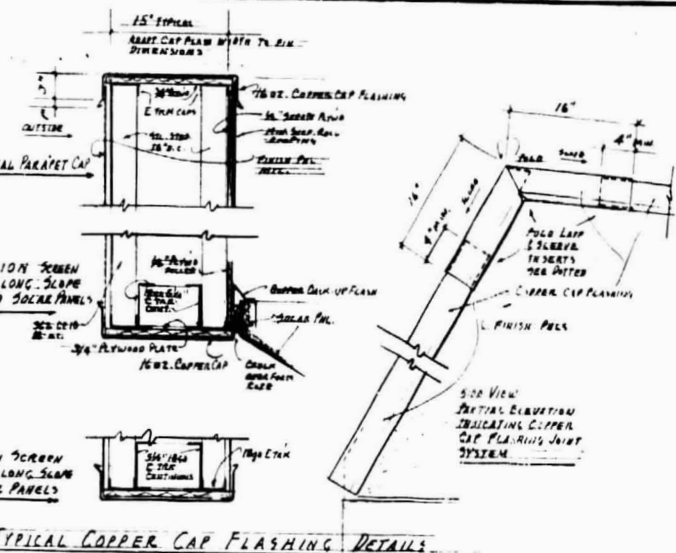
NOTE: SOLAR ARCHITECTURAL PANELS ARE  
TO BE FABRICATED TO THESE DETAILS  
FOR FABRICATOR SHOP DRAWING SUBJECT  
TO FINAL APPROVAL BY SOLAR UNIVERSITY  
OF THE ARCHITECT, FABRICATOR SHOP  
DRAWING SET TO INCLUDE ANY REQUIRED  
MODIFICATIONS FROM DETAILS HEREON &  
ADDITIONAL DETAILS OF HANGING MOUNTING &  
LIFTING / HANDLING SYSTEM.

|                                                                                                                                                                         |  |                                 |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------|--|
| CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER<br>SOLAR HEATING AND HOT WATER SYSTEM<br>PROJECT 86-77-A-01-0071<br>HUNTSVILLE, ALABAMA<br>SOLAR ARCHITECTURAL PANEL DETAILS |  | DRAWING No. 1.00                |  |
| DICKSON AND ASSOCIATES<br>ARCHITECTS<br>HUNTSVILLE<br>ALABAMA                                                                                                           |  | SHEET<br>A-3<br>DATE<br>1/15/78 |  |
| CHECKED<br>1/15/78                                                                                                                                                      |  | REVISION<br>1/15/78             |  |

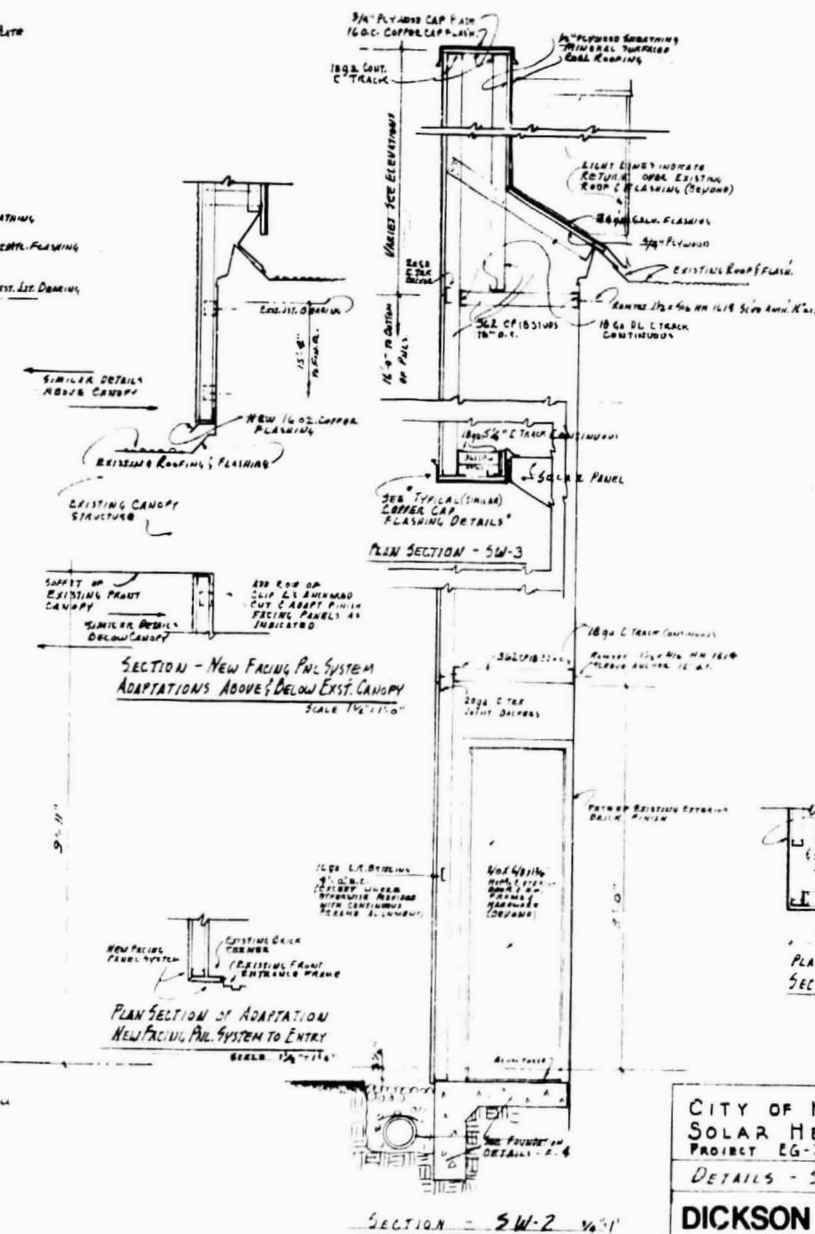








TYPICAL COPPER CAP FLASHING DETAILS



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POOR QUALITY

FOLDOUT FRAME 2

CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER  
SOLAR HEATING AND HOT WATER SYSTEM  
PROJECT EG-77-A-01-4071 HUNTSVILLE, ALABAMA  
DETAILS - SCREEN WALL FACING, FRAMING, FLASHING, ETC.

DICKSON AND ASSOCIATES  
ARCHITECTS

HUNTSVILLE

ALABAMA



SHEET  
A-5

DRAWN  
CHECKED

REVISED

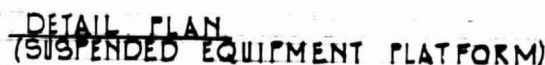
JOB NO.

DATE

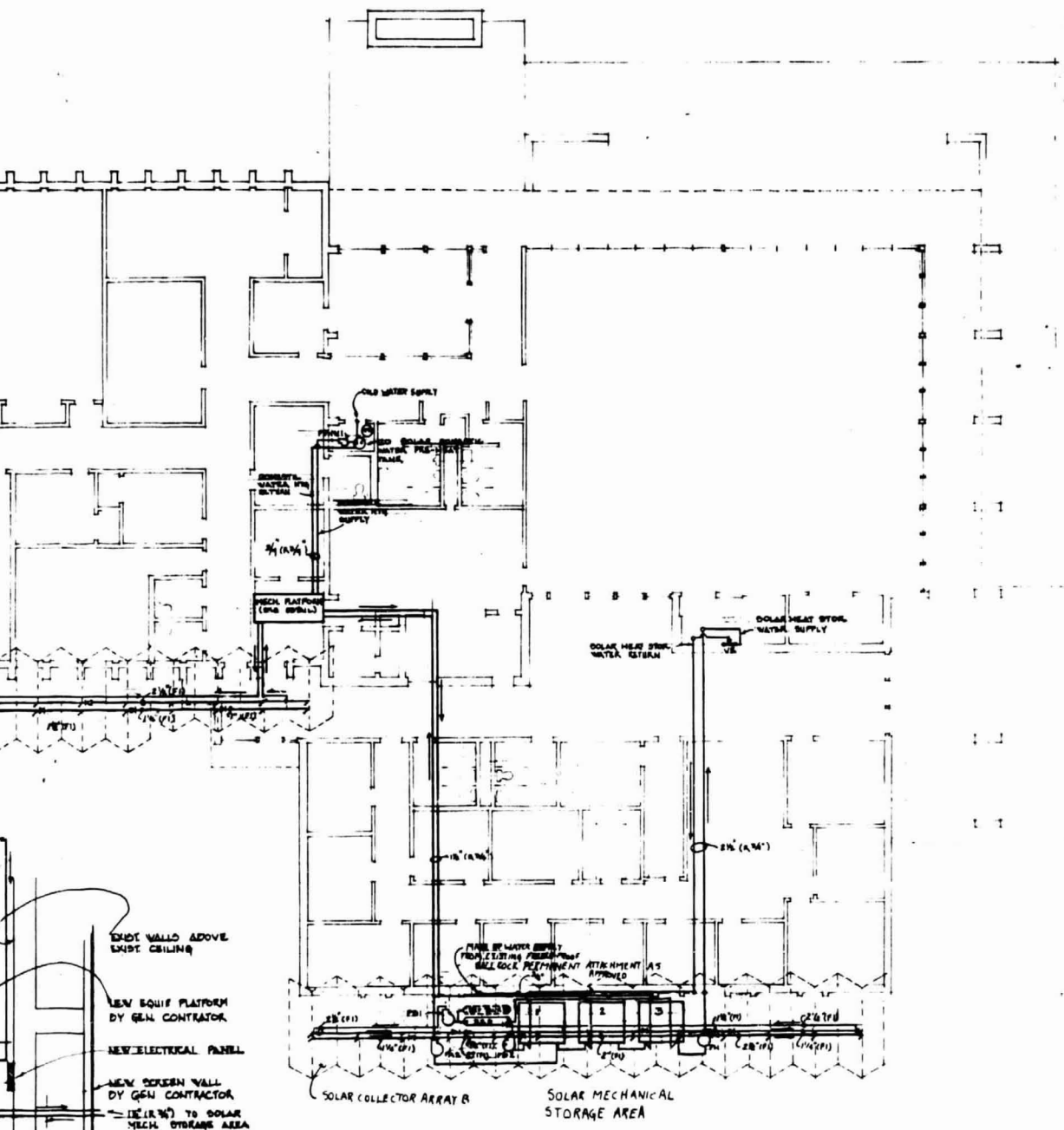
OF 8



1. COLLECTOR FIELD LINES - SUPPLY (RETURN FROM CYCLOVOLT) TO EXPANSION TANKS
2. HEAT EXCHANGERS TO MANIFOLDS, ALL MANIFOLDS
3. HOT WATER SUPPLY & RETURN LINES FROM CYCLOVOLT TO STORAGE
4. PUMPS - NO INSULATION (REAL BORN 31001)
5. VALVES - NO INSULATION (REAL BORN 31001)



## FOLDOUT FRAME



# NOTES:

- 2" (R1) = 2" CL. TYPE M PIPE WITH 1" THICK FIBERGLASS INSULATION
- 1 1/2" (R40) = 1 1/2" CL. TYPE M PIPE WITH 3/4" THICK EXPANDED RUBBER INSULATION

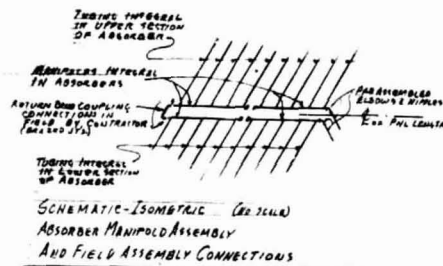
FOLDOUT FRAME 2

|                                                                                                                                                   |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |       |          |         |     |     |         |      |      |         |  |  |  |    |  |  |  |      |  |  |  |         |  |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------|----------|---------|-----|-----|---------|------|------|---------|--|--|--|----|--|--|--|------|--|--|--|---------|--|--|
| <p>ALBERT R. WILSON<br/>REGISTERED ARCHITECT<br/>SINCE 1968<br/>MEMBER AIA, AIAA, ASCE<br/>1000 11TH AVENUE, S.W.<br/>ALBUQUERQUE, N.M. 87102</p> | <p>CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER<br/>SOLAR HEATING AND HOT WATER SYSTEM<br/>PROJECT NO. 24-77-A-01-4071 HUNTSVILLE, ALABAMA</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |       |          |         |     |     |         |      |      |         |  |  |  |    |  |  |  |      |  |  |  |         |  |  |
| <p>ALABAMA<br/>REGISTERED ARCHITECT<br/>SINCE 1968<br/>MEMBER AIA, AIAA, ASCE<br/>ALBERT R. WILSON</p>                                            | <p><b>DICKSON AND ASSOCIATES</b><br/><b>ARCHITECTS</b><br/>HUNTSVILLE ALABAMA</p>                                                            | <p>SEAL OF THE STATE OF ALABAMA<br/>REGISTERED ARCHITECT<br/>SINCE 1968<br/>MEMBER AIA, AIAA, ASCE<br/>ALBERT R. WILSON</p> <table border="1"> <tr> <td>SHEET</td> <td>DRAWN</td> <td>REVIEWED</td> <td>JOB NO.</td> </tr> <tr> <td>M-1</td> <td>JRB</td> <td>1/15/78</td> <td>77-9</td> </tr> <tr> <td>OF 0</td> <td>CHECKED</td> <td></td> <td></td> </tr> <tr> <td></td> <td>DN</td> <td></td> <td></td> </tr> <tr> <td></td> <td>DATE</td> <td></td> <td></td> </tr> <tr> <td></td> <td>1/15/78</td> <td></td> <td></td> </tr> </table> | SHEET   | DRAWN | REVIEWED | JOB NO. | M-1 | JRB | 1/15/78 | 77-9 | OF 0 | CHECKED |  |  |  | DN |  |  |  | DATE |  |  |  | 1/15/78 |  |  |
| SHEET                                                                                                                                             | DRAWN                                                                                                                                        | REVIEWED                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | JOB NO. |       |          |         |     |     |         |      |      |         |  |  |  |    |  |  |  |      |  |  |  |         |  |  |
| M-1                                                                                                                                               | JRB                                                                                                                                          | 1/15/78                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 77-9    |       |          |         |     |     |         |      |      |         |  |  |  |    |  |  |  |      |  |  |  |         |  |  |
| OF 0                                                                                                                                              | CHECKED                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |       |          |         |     |     |         |      |      |         |  |  |  |    |  |  |  |      |  |  |  |         |  |  |
|                                                                                                                                                   | DN                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |       |          |         |     |     |         |      |      |         |  |  |  |    |  |  |  |      |  |  |  |         |  |  |
|                                                                                                                                                   | DATE                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |       |          |         |     |     |         |      |      |         |  |  |  |    |  |  |  |      |  |  |  |         |  |  |
|                                                                                                                                                   | 1/15/78                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |       |          |         |     |     |         |      |      |         |  |  |  |    |  |  |  |      |  |  |  |         |  |  |



## SCHEDULE

| LABEL | ITEM                 | MANUFACTURER          | MODEL                             | DESCRIPTION                                                                              | NO. REQUIRED | UNIT PRICE | TOTAL PRICE |
|-------|----------------------|-----------------------|-----------------------------------|------------------------------------------------------------------------------------------|--------------|------------|-------------|
| PA1   | PUMP                 | GOULD                 | 8765T-104-0-A                     | CENTRIFUGAL FLEXIBLE COUPLED CDM. PROCESS PUMP 1/2" NPT                                  | 1            | 0.00       |             |
| PA2   | PUMP                 | GOULD                 | 8765T-104-0-A                     | CENTRIFUGAL FLEXIBLE COUPLED CDM. PROCESS PUMP 1/2" NPT                                  | 1            | 0.00       |             |
| EB1   | PUMP                 | BELL & GOSSETT        | 1000-301 S                        | CLOSE COUPLED CENTRIFUGAL 1/2" NPT NPT OUTLET                                            | 1            | 0.00       |             |
| FD2   | PUMP                 | BELL & GOSSETT        | 1000-301 S                        | CLOSE COUPLED CENTRIFUGAL 1/2" NPT, 1/2" NPT OUTLET                                      | 1            | 0.00       |             |
| PH    | PUMP                 | BELL & GOSSETT        | 1000-301 AAB                      | CLOSE COUPLED CENTRIFUGAL 1/2" NPT, 1/2" NPT OUTLET 1/2" NPT                             | 1            | 0.00       |             |
| PDW1  | PUMP                 | GRUNDFOS              | UP18-02 SF                        | CANFRO IN LINE 1/2" NPT, 1/2" FLANGE, STAINLESS STEEL                                    | 1            | 0.00       |             |
| PDW2  | PUMP                 | GRUNDFOS              | UP18-02 F                         | CANFRO IN LINE 1/2" NPT, 1/2" FLANGE, CAST IRON BOSSING                                  | 1            | 0.00       |             |
| HEA   | HEAT EXCHANGER       | YOUNG RADIATOR        | FR008Y4F                          | SMALL TUBE BEASS U TUBE 1/2" DIA. X 1/2" NPT                                             | 1            | 0.00       |             |
| HEB   | HEAT EXCHANGER       | YOUNG RADIATOR        | FR008Y4F                          | SMALL TUBE BEASS U TUBE 1/2" DIA. X 1/2" NPT                                             | 1            | 0.00       |             |
| HEI   | HEAT EXCHANGER       | SOLAR UNLIMITED       | HE 232 D                          | COPPER TUBE H BESS, OIL WALL, INTERNALLY VENTED 2" DIA. X 1/2" NPT                       | 1            | 0.00       |             |
|       | EXPANSION TANK A     | BELL & GOSSETT        | GO                                | 60 GALLON 1/2" NPT STEEL 1/2" DIA. X 1/2" NPT                                            | 1            | 0.00       |             |
|       | EXPANSION TANK B     | BELL & GOSSETT        | GO                                | 60 GALLON 1/2" NPT STEEL 1/2" DIA. X 1/2" NPT                                            | 1            | 0.00       |             |
|       | HOT WATER PUMP TANK  | A. O. SMITH           | STJ 120                           | 120 GALLON 1/2" NPT STEEL 1/2" DIA. X 1/2" NPT                                           | 1            | 0.00       |             |
|       | BULK HEAT STOR. TANK | SOLAR UNLIMITED       | 1850C                             | 1000 GAL. FERRUGLASS LINED STEEL, HEAVILY INSULATED                                      | 1            | 0.00       |             |
|       | SOLAR COLLECTOR A    | SOLAR UNLIMITED       | SCT 21                            | COROTHERM TL BECT. SOLAR COLLECTOR 1/2" NPT                                              | 9            | 0.00       |             |
|       | SOLAR COLLECTOR A    | SOLAR UNLIMITED       | SCT 21                            | COROTHERM TL BECT. SOLAR COLLECTOR 1/2" NPT                                              | 11           | 0.00       |             |
|       | SOLAR COLLECTOR B    | SOLAR UNLIMITED       | SCT 21                            | COROTHERM TL BECT. SOLAR COLLECTOR 1/2" NPT                                              | 4            | 0.00       |             |
|       | SOLAR COLLECTOR B    | SOLAR UNLIMITED       | SCT 21                            | COROTHERM TL BECT. SOLAR COLLECTOR 1/2" NPT                                              | 15           | 0.00       |             |
| TC1   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC2   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC3   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC4   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC5   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC6   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC7   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC8   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC9   | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC10  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC11  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC12  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC13  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC14  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC15  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC16  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC17  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC18  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC19  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC20  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC21  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC22  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC23  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC24  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC25  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC26  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC27  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC28  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC29  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC30  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC31  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC32  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC33  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC34  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC35  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC36  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC37  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC38  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC39  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC40  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC41  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC42  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC43  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC44  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC45  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC46  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC47  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC48  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC49  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC50  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC51  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC52  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC53  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC54  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC55  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC56  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC57  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC58  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC59  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC60  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC61  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC62  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC63  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC64  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC65  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC66  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC67  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC68  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC69  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC70  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC71  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC72  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC73  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC74  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC75  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC76  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC77  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC78  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC79  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC80  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC81  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC82  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC83  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC84  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC85  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC86  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC87  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC88  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC89  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC90  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC91  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC92  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC93  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC94  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC95  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC96  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC97  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC98  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC99  | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| TC100 | TEMP. SENSOR         | RHO SIGMA             | SA                                | BRASS CASSED 1/2" DIA. X 1" THERMISTOR                                                   | 1            | 0.00       |             |
| VE    | THREE WAY VALVE      | PIRIN D800 OR EQUAL   | NOHARA-2<br>YEO ABB-2<br>V90 CA-7 | 3/4" MOTORIZED MIXING VALVE.<br>MOTOR AND LINKAGE.<br>2 POSITION SPRING RETURN, STEM UP. | 1            | 0.00       |             |
|       | TERMOMETER           | ROCHESTER OR EQUAL    | 1740                              | 3" DIA. BIMETALLIC 30"-600" F, 1/2" NPT, 3/16" STEM                                      | 8            | 0.00       |             |
|       | TERMOMETER           | ROCHESTER OR EQUAL    | 1760                              | 3" DIA. BIMETALLIC 30"-600" F, 1/2" NPT, 3/16" STEM                                      | 8            | 0.00       |             |
| OM    | PRESSURE GAUGE       | INTER-1 & 3A OR EQUAL | 47495                             | 0-60 PSI, 1/2" DIA., 1/2" LOWER MOUNT                                                    | 0            | 0.00       |             |
|       | PRESSURE SWITCHES    | KAT SWITCHES OR EQUAL | 1                                 | Piston Shock + PNEUMATION SWITCHES 1/2" NPT BEASS                                        | 4            | 0.00       |             |
|       | PRESSURE SWITCHES    | KAT SWITCHES OR EQUAL | 2                                 | Piston Shock + PNEUMATION SWITCHES 1/2" NPT BEASS                                        | 4            | 0.00       |             |
|       | FLOW METER           | METRAPLEX OR EQUAL    | 15                                | IMPACT TUBE TYPE 1/2" PIPE SIZE 10-80 GPM                                                | 2            | 0.00       |             |
| NJ    | FLEXIBLE CONNECTOR   | ANCAODON OR EQUAL     | 5454 F                            | 1/4" X 1/4" COPPER VIBRATION ELIMINATOR SOLAR CAC                                        | 5            | 0.00       |             |
| PK    | GATE VALVE           |                       |                                   |                                                                                          |              |            |             |
| DOX   | BALL VALVE           |                       |                                   |                                                                                          |              |            |             |
| FL    | FLANGES              |                       |                                   |                                                                                          |              |            |             |
| UN    | UNION                |                       |                                   |                                                                                          |              |            |             |
| MA    | MALE ADAPTER         |                       |                                   |                                                                                          |              |            |             |
| RED   | REDUCER              |                       |                                   |                                                                                          |              |            |             |
| CV    | CHECK VALVE          |                       |                                   |                                                                                          |              |            |             |

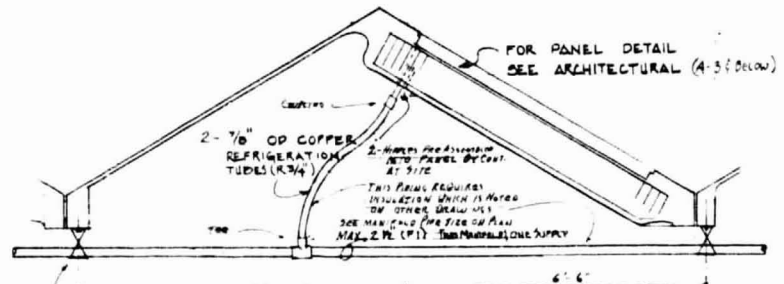


TYPICAL CROSS  
COMPONENT ASSEMBLY  
ARCHITECTURAL  
MANIFOLDS, ABSORBER  
- scale - 3" = 1'-0"

**FOLDOUT FRAME**

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OF POOR QUALITY





NOTE: MANIFOLD PIPING TO BE SUPPORTED FROM BACK OF SOLAR ARCHITECTURAL PANELS AT THESE TYPICAL LOCATIONS WITH TIEPIED OR APPROVED PIPE HANGERS. TIEPIED WITH SHAPED AND USED SUPPORT WITH 1\"/>

### SOLAR COLLECTOR MANIFOLD DETAIL

1/2\"/>

ABSORBER MANIFOLD ANCHORS CLAMPED AND SECURED FOR INSTALLATION BY CONTRACTOR INTO PRE-CAST HOLES

IN 1\"/>

GLASS ANCHORS IN CORNER, SET IN PLACE, LATE, TIGHTENED PROVISION BY CONTRACTOR (SEE SHEET A-3)

NOTE: 2\"/>

2\"/>

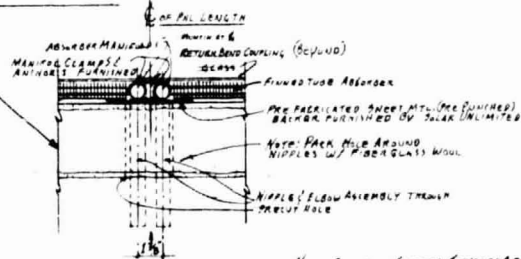
PER CAST SOLAR ARCHITECTURAL PANEL MANUFACTURED BY HUNTER SOLAR (HUNTER, INC.) WITH TIE-INS REQUIRED

2\"/>

NOTE: PRIOR TO INSTALLATION OF GLASS, PROVISIONING TESTS ARE TO BE CONDUCTED ON ASSEMBLED ABSORBERS IN PLACE. INTERNAL MANIFOLD CONNECTIONS - TEST TO BE CONDUCTED BY SOLAR UNLIMITED, INC.

TYPICAL CROSS SECTION DETAILS COMPONENT ASSEMBLY OF ARCHITECTURAL SOLAR PANELS, MANIFOLDS, ABSORBERS, GLASS, ETC.

SCALE - 3\"/>

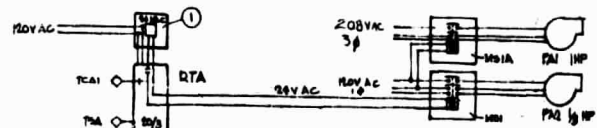


NOTE: CONTROL SYSTEM SENSORS ARE TO BE INSTALLED IN SELECTED PANELS BY CONTRACTOR IN ACCORD WITH PROVISIONS & INSTRUCTIONS BY SOLAR UNLIMITED, INC. (2 SENSORS PER ARRAY OF PANELS) APPROXIMATE LOCATIONS ARE ATTACHED TO ABSORBER MANIFOLD BELOW GLASS AT CENTER

FOLDOUT FRAME 2

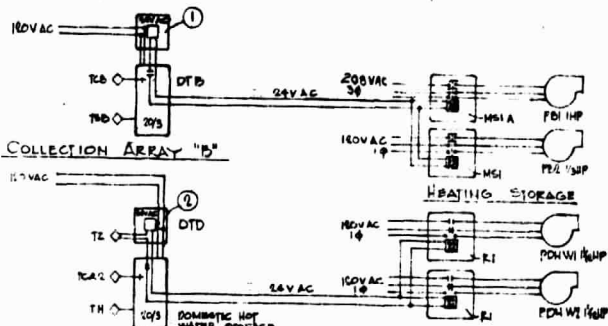
|                                                                                                           |                                                                                                                                                                   |                                                                                     |
|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| PROJECT: EIGHTHLY<br>PERMANENTLY, ALA.<br>SOLAR UNLIMITED, INC.<br>9310 CHURCH RD. W.<br>HUNTSVILLE, ALA. | CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER<br>SOLAR HEATING AND HOT WATER SYSTEM<br>PROJECT NO. EG-77-A-01-4071 HUNTSVILLE, ALABAMA<br>SOLAR MECHANICAL - DETAILS | SHEET<br>M-2<br>DRAWN<br>JRD<br>CHECKED<br>DM<br>DATE<br>1/25/78                    |
|                                                                                                           | <b>DICKSON AND ASSOCIATES</b><br><b>ARCHITECTS</b><br>HUNTSVILLE ALABAMA                                                                                          | SHEET<br>M-2<br>DRAWN<br>JRD<br>CHECKED<br>DM<br>DATE<br>1/25/78<br>JOB NO.<br>77-5 |

# SOLAR COLLECTION CONTROL CENTER



COLLECTION ARRAY "A"

HEATING STORAGE

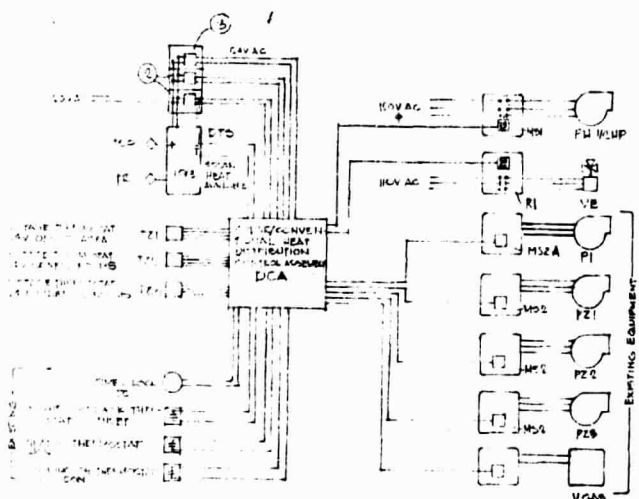


COLLECTION ARRAY "B"

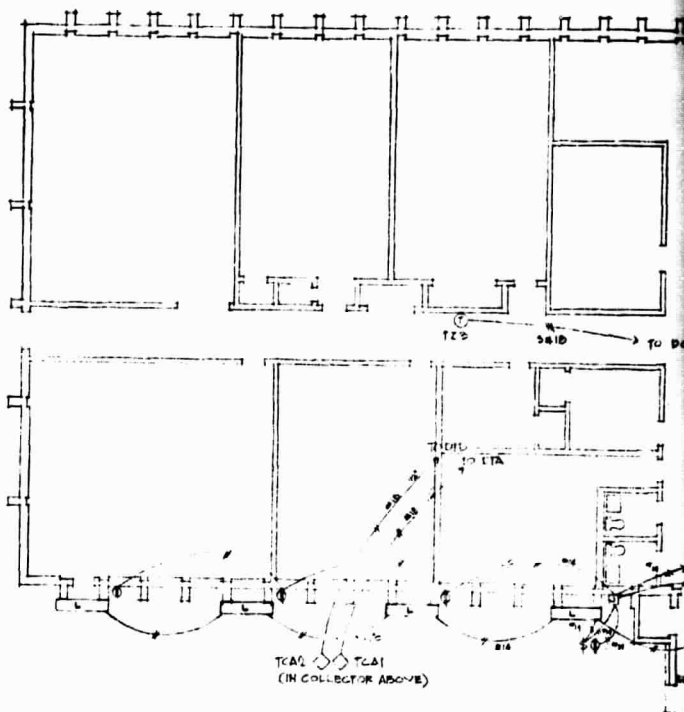
HEATING STORAGE

COLLECTION ARRAY "A"  
DOMESTIC HOT WATER

DOMESTIC WATER  
HEATING



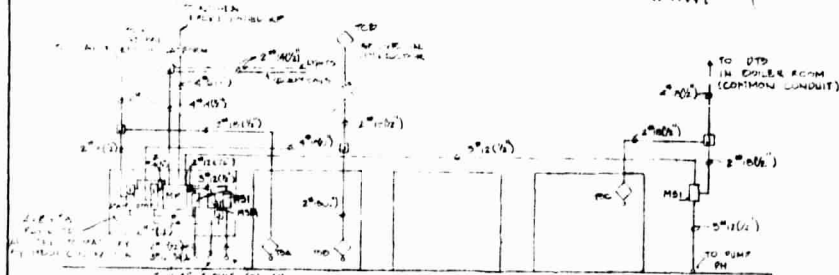
HEAT DISTRIBUTION CONTROL SYSTEM



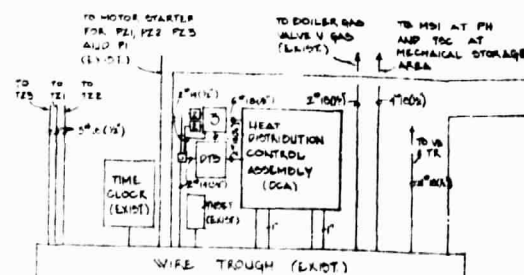
WATER HEATER STORAGE RM.  
ELECTRICAL DETAIL

SOLAR MECH. PLATFORM  
ELECTRICAL DETAIL

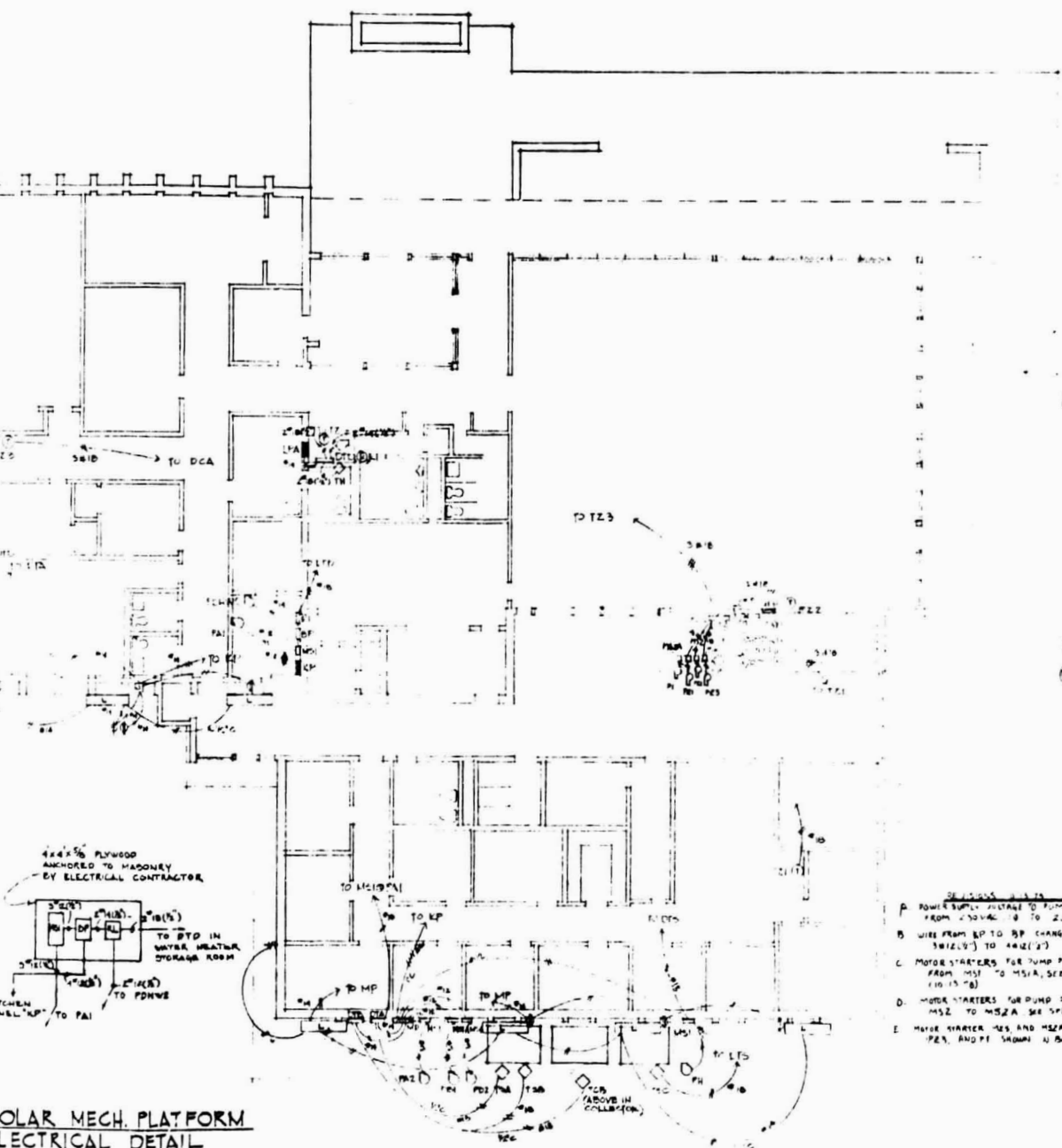
## FOLDOUT FRAMES



SOLAR STORAGE AREA ELECTRICAL DETAIL



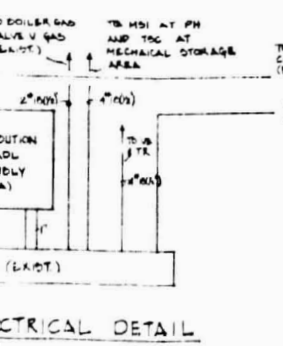
BOILER ROOM ELECTRICAL DETAIL



FOLDOUT FRAME 2

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SOLAR MECH. PLATFORM ELECTRICAL DETAIL



ELECTRICAL DETAIL

- REVISIONS
- A. POWER SUPPLY VOLTAGE TO PUMP PA AND PBI CHANGED FROM 230VAC 0 TO 208VAC 3Ø
  - B. WIRE FROM EP TO SP CHANGED FROM 3/4" (12) TO 1/2" (12)
  - C. MOTOR STARTERS FOR PUMP PA AND PBI CHANGED FROM MS1 TO MS1A, SEE SPEC REVISIONS (10-15-78)
  - D. MOTOR STARTERS FOR PUMP PI CHANGED FROM MS2 TO MS2A, SEE SPEC REVISIONS 01-15-78
  - E. WATER TANKER MS3 AND MS3A TO PUMP PE, PE2, PE3, AND PE4 SHOWN IN BOILER ROOM

### LEGEND

- SERVICE PANEL BOX EXISTING
- SERVICE PANEL BOX ADDITION
- 3 CONDUCTOR #12 WIRE IN 3/4" CONDUIT
- 2 CONDUCTOR #12 WIRE IN 1/2" CONDUIT UNLESS OTHERWISE NOTED
- SERVICE OUTLET
- SWITCH
- JUNCTION BOX
- LIGHTING FIXTURE (FLUORESCENT) EQUAL TO THOSE SHOWN ON SHEET 17-A 01-4271
- THERMOSTAT

CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER  
SOLAR HEATING AND HOT WATER SYSTEM  
PROJECT NO. 17-A 01-4271 HUNTSVILLE, ALABAMA

SOLAR ELECTRICAL PLANS & DETAILS

**DICKSON AND ASSOCIATES**  
ARCHITECTS

HUNTSVILLE

ALABAMA



| SHEET | DATE     | REVISED  | BY       |
|-------|----------|----------|----------|
| 1     | 10/15/78 | 10/15/78 | 10/15/78 |

16.0

INTERIM PERFORMANCE CRITERIA

CERTIFICATION

CONTRACT NO. EG-77-A-01-4071

DEMONSTRATION CONTRACTOR CITY OF HUNTSVILLE

SYSTEM LOCATION HUNTSVILLE, ALABAMA

SYSTEM TYPE SPACE HEATING AND HOT WATER

I certify that his solar system complies with the IPC Document

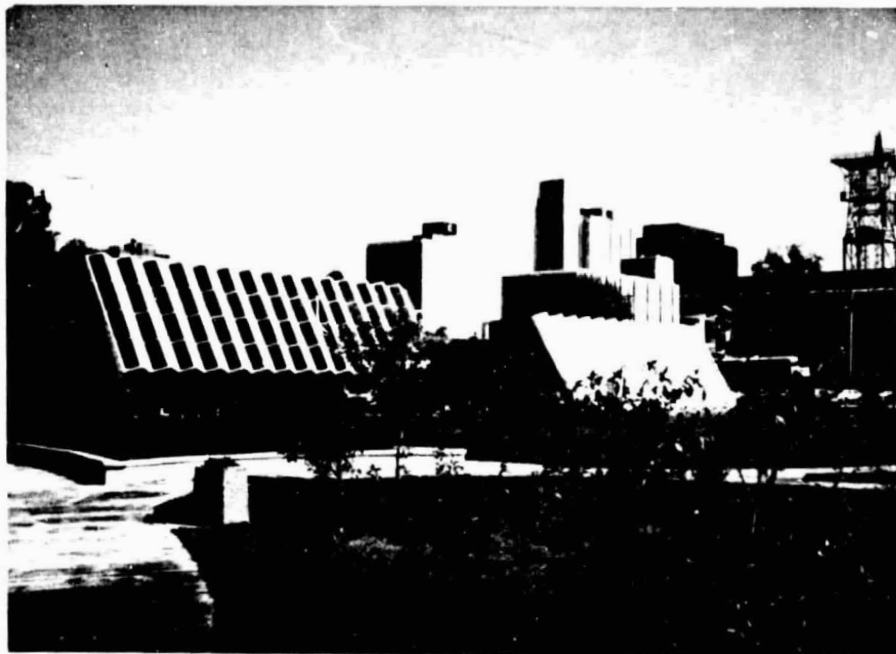
No. 98 M10001

CERTIFIED BY

Samuel R. Borden  
Authorized Representative

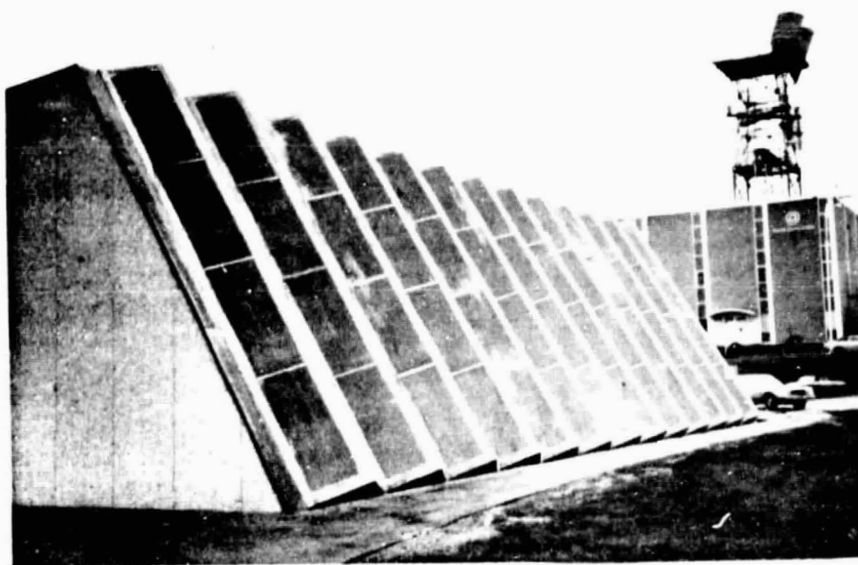
Date

4/27/79



COMPLETED INSTALLATION OF  
ARCHITECTURAL SOLAR COLLECTORS

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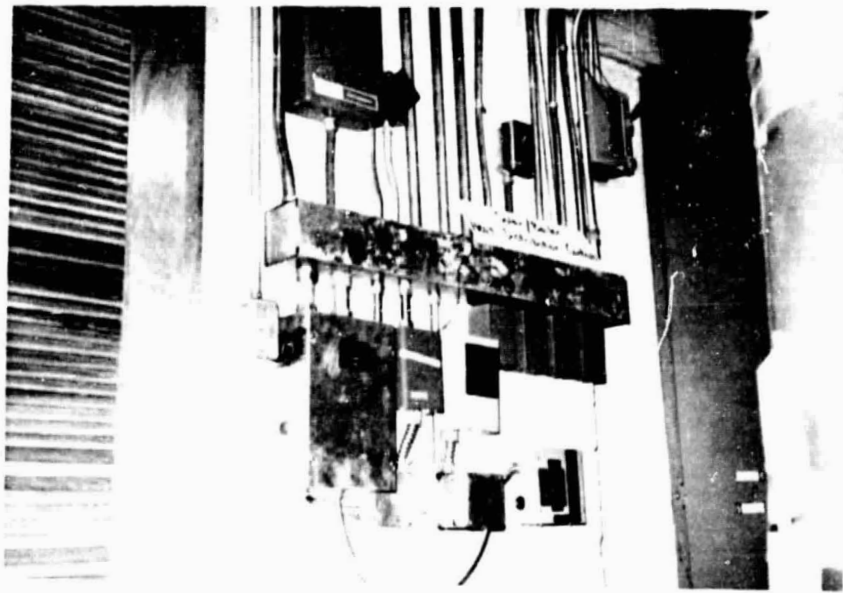


SOLAR COLLECTOR ARRAY B

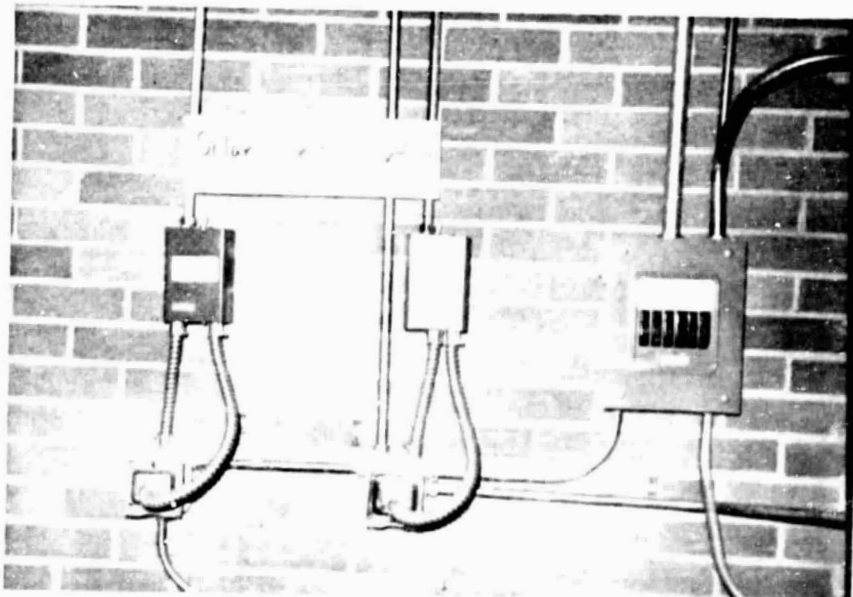


SOLAR COLLECTOR ARRAY A

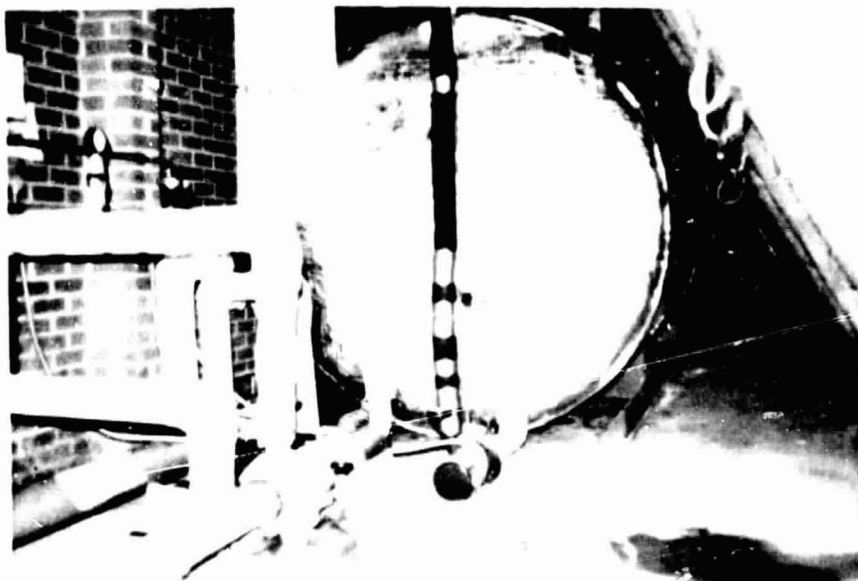
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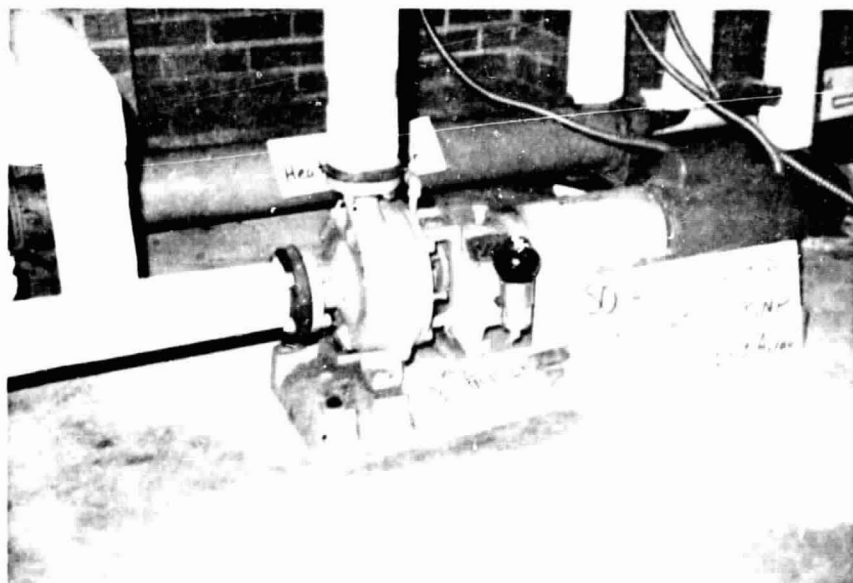
SOLAR SYSTEM DISTRIBUTION  
CONTROLS



SOLAR COLLECTION CONTROLS



3,000 GALLON POTABLE  
WATER STORAGE TANK



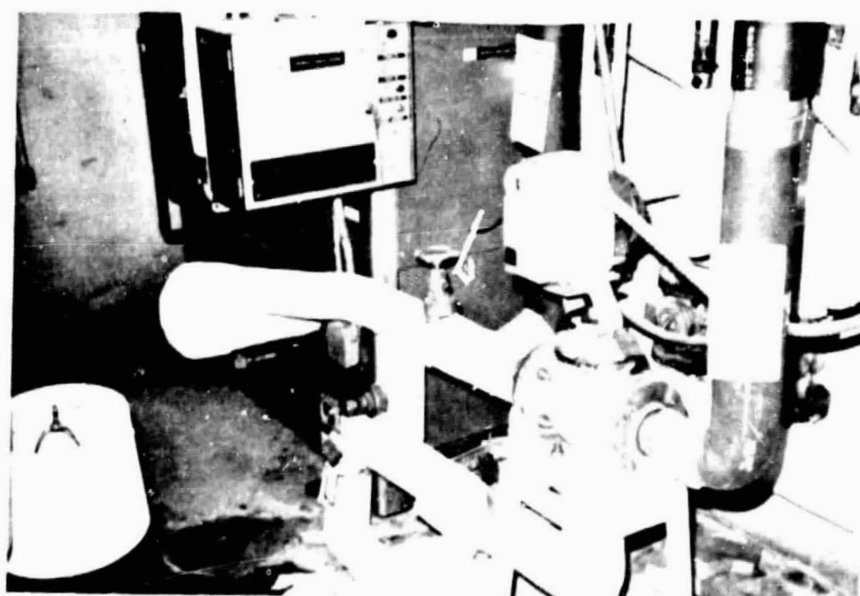
SOLAR COLLECTOR CIRCULATION  
PUMP AND HEAT EXCHANGER FOR SOLAR ARRAY B

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SOLAR HEAT EXCHANGER



AUTOMATIC THREE-WAY VALVE TO  
ACTIVATE SOLAR HEATING