

348
8-20-80
JW/JP
348
8-20-80

DOE/NASA CONTRACTOR
REPORT

Dr. 1652
DOE/NASA CR-161483

SOLAR HEATING AND HOT WATER SYSTEM INSTALLED AT OFFICE
BUILDING, ONE SOLAR PLACE, DALLAS, TEXAS - FINAL REPORT

Prepared from documents furnished by

Travis-Braun & Associates, Inc.
One Solar Place, Suite 200
4140 Office Parkway
Dallas, Texas 75204

Under DOE Contract EG-77-A-01-4093

Monitored by

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

For the U. S. Department of Energy

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

U. S. Department of Energy



Solar Energy

NOTICE

This report was prepared to document work sponsored by the United States Government. Neither the United States nor its agents the United States Department of Energy, the United States National Aeronautics and Space Administration, nor any federal employees, nor any of their contractors, subcontractors or their employees, make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed, or represent that its use would not infringe privately owned rights.

1. REPORT NO. DOE/NASA CR-161483	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE Solar Heating And Hot Water System Installed At Office Building, ONE SOLAR PLACE, Dallas, Texas - Final Report		5. REPORT DATE June 1980
7. AUTHOR(S)		6. PERFORMING ORGANIZATION CODE
9. PERFORMING ORGANIZATION NAME AND ADDRESS Travis-Braun & Associates, Inc. ONE SOLAR PLACE, Suite 200 4140 Office Parkway Dallas, Texas 75204		8. PERFORMING ORGANIZATION REPORT #
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Department of Energy, Conservation And Solar Energy Washington, DC 20585		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO. EG-77-A-01-4093
		13. TYPE OF REPORT & PERIOD COVERED Contractor Final Report
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This work was done under the technical management of Mr. Charles L. Greer,
George C. Marshall Space Flight Center, Alabama 35812.

16. ABSTRACT

This document is the Final Report of the Solar Energy System Installed at the First Solar Heated Office Building, ONE SOLAR PLACE, Dallas, Texas. The Solar System was designed to provide 87 percent of the space heating needs, 100 percent of the potable hot water needs and is sized for future absorption cooling. The collection subsystem consists of 28 Solargenics, series 76, flat plate collectors with a total area of 1,596 square feet. The solar loop circulates an ethylene glycol-water solution through the collectors into a hot water system heat exchanger. The hot water storage subsystem consists of a heat exchanger, two 2,300 gallon concrete hot water storage tanks with built in heat exchangers and a back-up electric boiler. The domestic hot water subsystem sends hot water to the 10,200 square feet floor area office building hot water fixtures. The building cold water system provides make-up to the solar loop, the heating loop, and the hot water concrete storage tanks. This report describes the design, construction, cost analysis, operation and maintenance of the solar system.

The project is part of the U.S. Department of Energy's solar demonstration program and became operational July 11, 1979.

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
ezB

17. KEY WORDS

18. DISTRIBUTION STATEMENT

UC59a

Unclassified-Unlimited

William A. Brooksbank Jr.
WILLIAM A BROOKSBANK, JR.
Mgr., Solar Energy Applications Projects

19. SECURITY CLASSIF. (of this report)

Unclassified

20. SECURITY CLASSIF. (of this page)

Unclassified

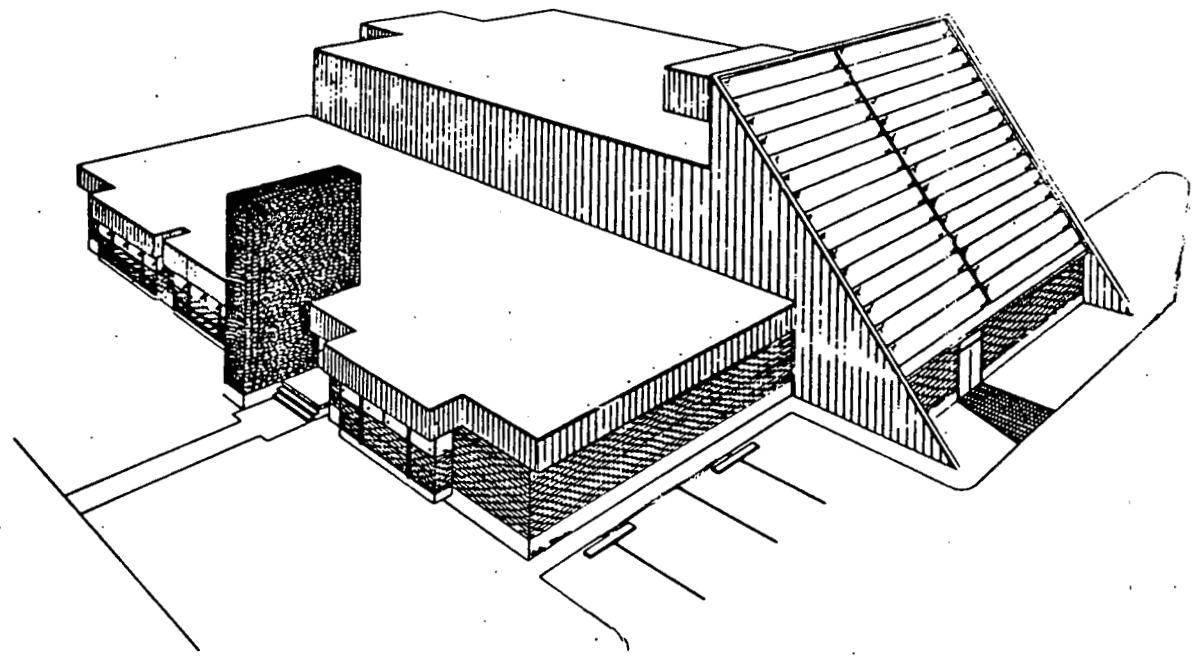
21. NO. OF PAGES

106

22. PRICE

NTJS

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK



ONE SOLAR PLACE

DALLAS' FIRST SOLAR HEATED OFFICE BUILDING
MADE POSSIBLE BY A GRANT FROM THE DEPARTMENT OF ENERGY

4140

OFFICE

PKWY

DALLAS

TEXAS

75204

214/821-4431

TABLE OF CONTENTS

INTRODUCTION	1
SUMMARY OF PROJECT INFORMATION.	3
PROJECT CHRONOLOGY.	5
PHOTOGRAPHS OF ONE SOLAR PLACE.	6
PROJECT COST.	13
BASIC SYSTEM DRAWINGS	14
ACCEPTANCE TEST PLAN AND RESULTS.	17
ACCEPTANCE TEST PLAN DATA.	31
ENERGY TABULATIONS.	35
SYSTEM DESIGN CHANGES AND CONSTRUCTION PROBLEMS.	40
START-UP PROCEDURE.	43
OPERATING AND MAINTENANCE INSTRUCTIONS.	45
TROUBLE-SHOOTING.	48
OPERATION, MAINTENANCE AND PRODUCT APPENDICES.	51
APPENDIX A - SOLAR COLLECTORS	
APPENDIX B - SOLAR HOT WATER HEATER	
APPENDIX C - OVER-TEMPERATURE CONTROL UNIT	
APPENDIX D - CHEMICAL FEEDER	
APPENDIX E - MAIN HEAT EXCHANGER	
APPENDIX F - STORAGE TANK HEAT EXCHANGERS	
APPENDIX G - PUMPS	
APPENDIX H - BACK-UP BOILER	
APPENDIX I - MULTIZONE VAV UNIT	
APPENDIX J - AS-BUILT DRAWINGS	

INTRODUCTION

- 1.0 The solar energy system of ONE SOLAR PLACE office building provides 87% of the space heating requirements, 100% of the potable hot water needs and is sized for future solar absorption cooling. The solar energy collection system consists of 28 Solargenics flat-plate collectors in two arrays. Each collector is 3' X 19' or a total of 1,596 square feet of collectors. One unique feature about the solar collectors is that they serve as the roofing over the office lobby.
- 2.0 The complete solar energy system includes a solar loop system, a hot water storage system, and a domestic hot water system. The solar loop circulates an ethylene glycol-water solution through the 28 Solargenics flat-plate collectors and into a heat exchanger to heat the hot water system. This loop also includes an over-temperature control unit (O.T.C.) which disposes excess and undesired heat into the atmosphere when temperatures in the solar loop reaches above 210⁰F, or the storage tank temperature reaches 200⁰F.
- 3.0 The hot water storage system consists of a heat exchanger where heat is absorbed from the solar loop, two 2300 gallon concrete hot water storage tanks with built-in heat exchangers, and a backup boiler.
- 4.0 The domestic hot water system sends hot water to the hot water fixtures throughout the office building. The building cold water system provides cold water make-up to the solar loop, the heating loop and the hot water concrete storage tanks. The domestic hot water system includes a domestic hot water heater, a hot water-cold water mixing valve, a pressure reducing valve and expansion tanks.

5.0 The office building at ONE SOLAR PLACE combines an existing one story red brick building with a newly constructed two-story building. Total floor area of the building is 10,200 square feet. The old existing building makes up 3,000 square feet with the new two-story addition making up 7,200 square feet. The new two-story addition blends red brick walls with redwood paneled walls; a flat roof combines with a 40 foot square collector roofing mounted over steel framing. The collector roofing is tilted at an angle of 42° from the horizon giving the office building an attractive "triangular" look. The general proximity of ONE SOLAR PLACE office building near downtown Dallas provides easy access for viewing and touring.

6.0 The ONE SOLAR PLACE office building has already been toured by several groups of people. These include North Texas State University graduate students, contractors, a local television station crew, journalists from the Dallas Morning News, and even foreign delegations from Israel, Japan, and West Germany. Elementary age school children from a Dallas public school will soon be given a tour of ONE SOLAR PLACE. So already, the ONE SOLAR PLACE installation is effective in educating the public about solar energy space heating and hot water heating.

7.0 This report describes the design, construction, cost analysis, operation, and maintenance of the solar system installed at ONE SOLAR PLACE in Dallas, Texas. This report is made on behalf of ERDA/DOE and Travis-Braun & Associates, Inc., to support solar energy as an effective means of providing supplemental energy to the energy needs of the United States. It is believed that the material available in this report will be beneficial to those readers interested in applying solar energy for hot water heating and/or space heating.

SUMMARY OF PROJECT INFORMATION

1.0 General Information

1.1 Owner/Location: Travis-Braun & Associates, Inc.
One Solar Place, Suite 200
4140 Office Parkway
Dallas, Texas 75204
Phone: 214-821-4431

1.2 Contractor: United Plumbing & Air Conditioning Co.
P.O. Box 31066
Dallas, Texas 75231
Phone: 214-341-9300

1.3 Engineer: Travis-Braun & Associates, Inc.
One Solar Place, Suite 200
4140 Office Parkway
Dallas, Texas 75204
Phone: 214-821-4431

1.4 Operational Date: July 11, 1979

1.5 Building:

1.5.1 Type: Two-story, combined flat roof and sloped

1.5.2 Wall Material: Old Building - red brick

New Addition - redwood

1.5.3 Floor Area: Old Building - 3,000 square feet

New Addition - 7,200 square feet

Total: 10,200 square feet

1.5.4 Wall Insulation: Urethane with "U" value of .08

2.0 Local Climatological Data - Dallas

2.1 Latitude: 32° N

2.2 Ambient Temperature: January - 46° F

August - 85° F

2.3 Heating Degree Days: Yearly - 2382

January - 626

2.4 Annual Cooling Hours: 1529

2.5 Peak Daily Insolation: 2358 BTU/Ft θ 42⁰ angle from horizon

2.6 Yearly Sunshine: 68%

3.0 SOLAR ENERGY SYSTEM

3.1 Application: Space Heating - 87%

Hot Water Heating - 100%

3.2 Solar Collector Description:

3.2.1 Type: Flat Plate (used as roof over lobby)

3.2.2 Fluid Medium: Water - 30% ethylene-glycol solution

3.2.3 Manufacturer/Model: Solargenics Series 76

3.2.4 Collector Dimension: 3' X 19' X 3-3/4"

3.2.5 Collector Glazing: Single glazed

3.2.6 Collector Area: 1,596 square feet

3.2.7 Collector Orientation:

a. Azimuth: 23⁰ West of South

b. Tilt Angle: 42⁰ from horizon

3.3 Hot Water Storage System:

3.3.1 Type: Cylindrical concrete tanks

3.3.2 Capacity: 2 tanks @ 2,300 gallons each

Total = 4,600 gallons

3.3.3 Dimensions: Diameter - 7'-0"

Height - 7'-6"

Wall Thickness - 10-3/4"

3.3.4 Insulation: 3" urethane

4.0 BACK-UP SYSTEM

4.1 Hot Water Heating: Electric boiler

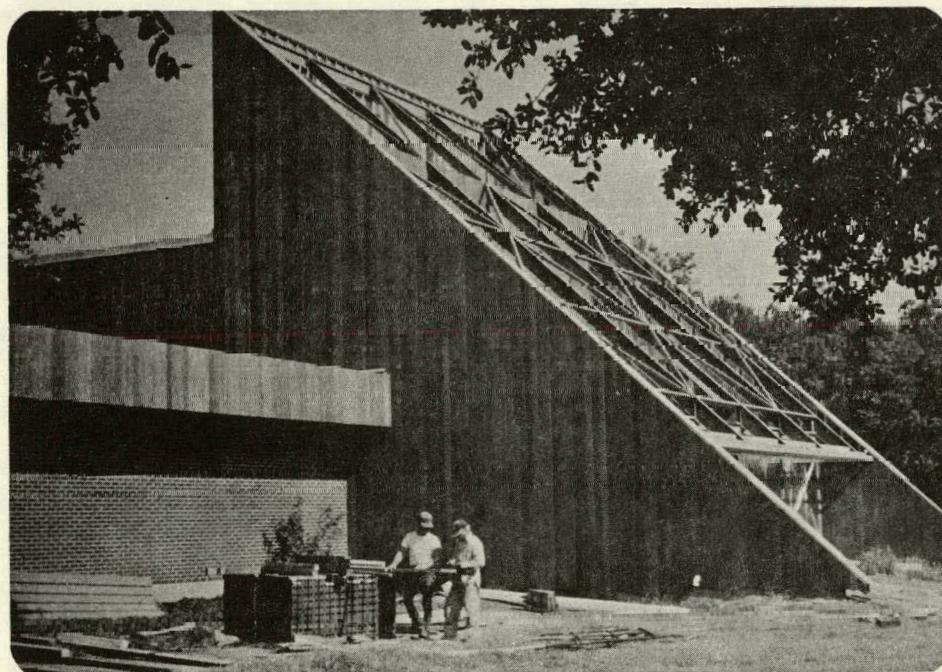
4.2 Space Heating: Multizone variable air volume unit

PROJECT CHRONOLOGY

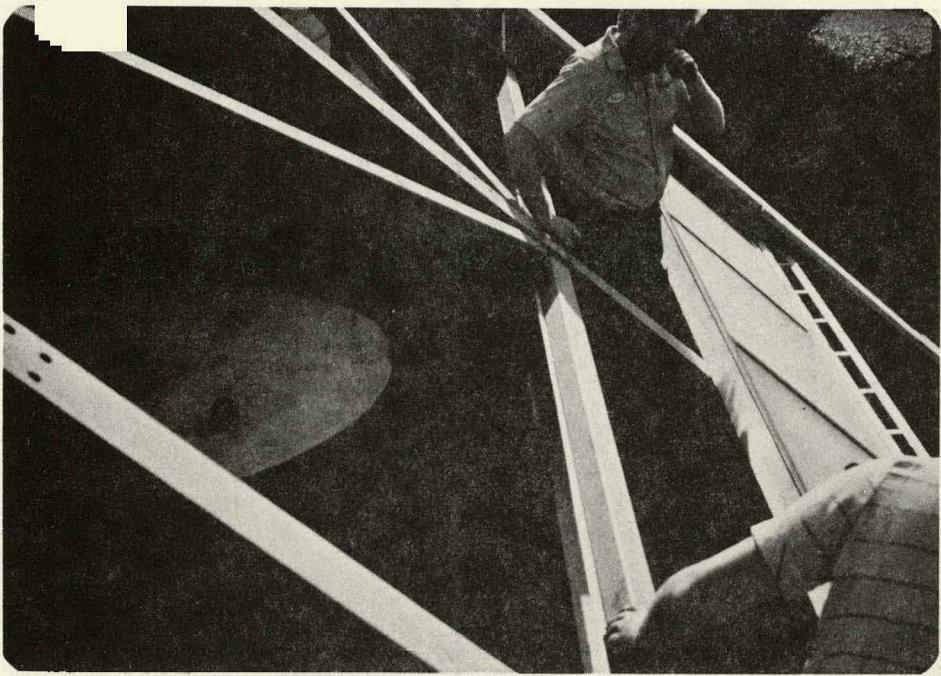
- 1.0 June, 1977 - Lon W. Travis/Earl E. Braun, Jr., Partnership was notified by ERDA (now DOE) that the proposed solar project has been selected for negotiation of a cooperative agreement.
- 2.0 Sept. 15, 1977 - Lon W. Travis/Earl E. Braun, Jr., Partnership was awarded a contract which stipulated that ERDA would finance 84.5% of the estimated total cost.
- 3.0 Nov. 14, 1977 - The building drawings and solar design drawings were finished.
- 4.0 Jan. 5, 1978 - Groundbreaking ceremonies at ONE SOLAR PLACE were held.
- 5.0 Feb., 1978 - A preconstruction meeting was held with the General Contractor to decide on construction scheduling and a construction start-up date.
- 6.0 April, 1978 - Site preparation began. The construction site was graded and foundation laid.
- 7.0 June, 1978 - The (2) two 2300 gallon concrete hot water storage tanks were installed.
- 8.0 July, 1978 - The steel framing skeleton was finished.
- 9.0 Oct., 1978 - All solar collectors were mounted.
- 10.0 March, 1979 - All electrical and plumbing work was completed.
- 11.0 July 11, 1979 - Acceptance testing was finished and ONE SOLAR PLACE was declared operational upon agreement between designated authorities from DOE and Earl E. Braun, Jr.



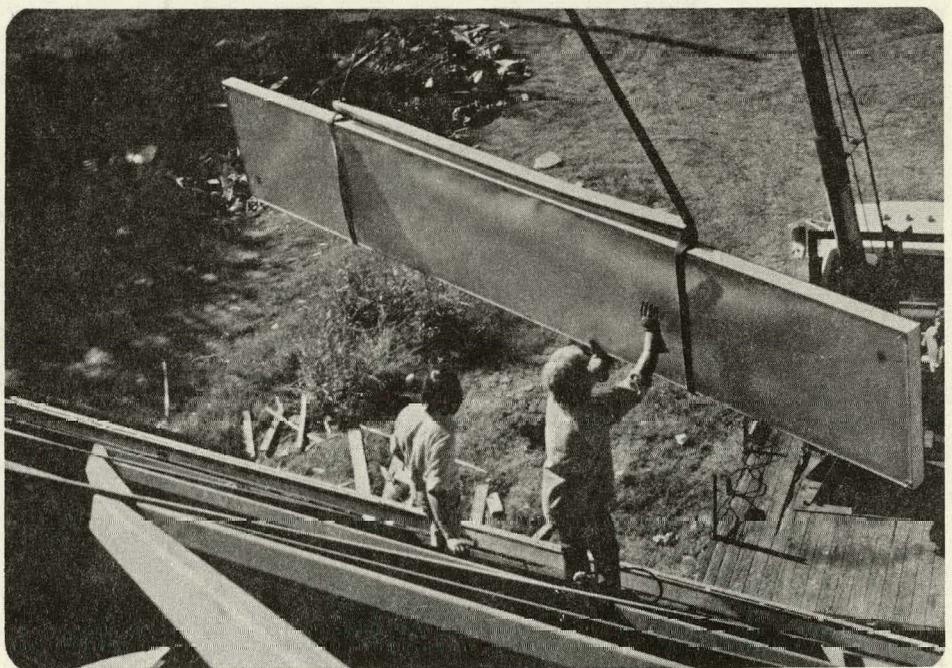
Steel Framing for Collector Roofing and Structure



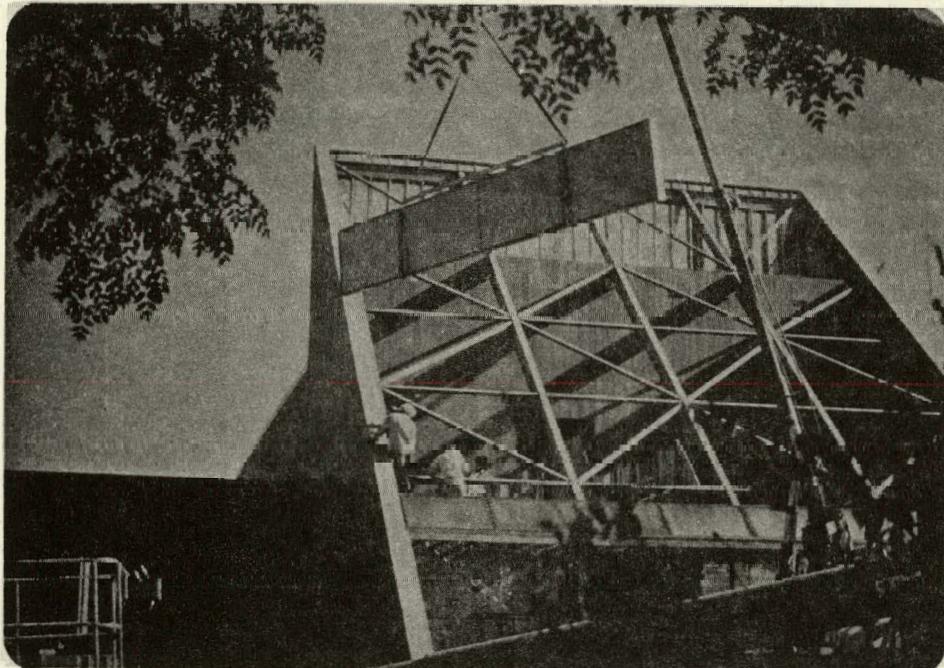
Wood Framing Finished



Alignment of Collectors



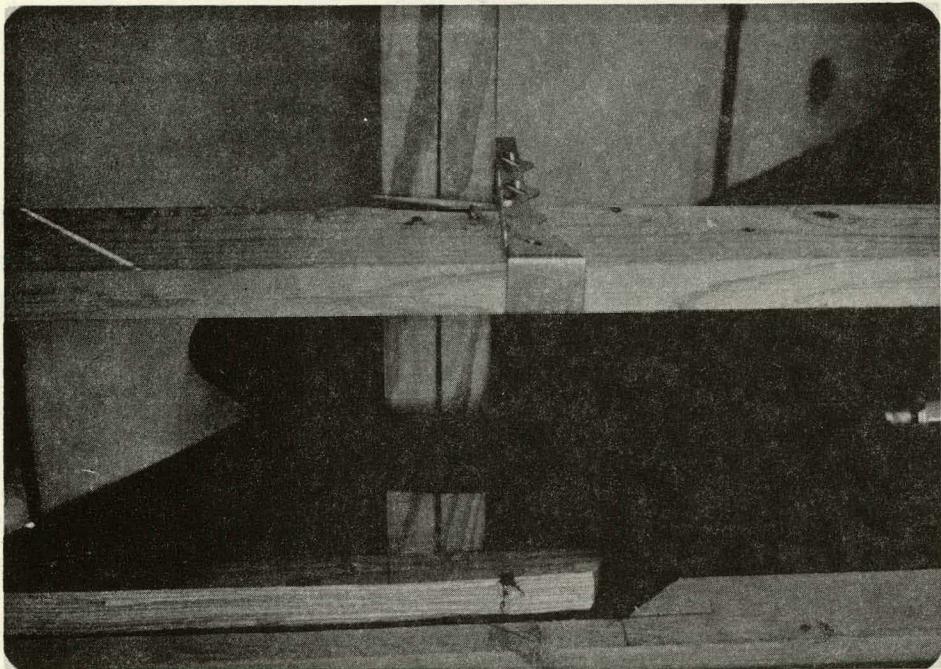
Mounting of Collectors With Crane



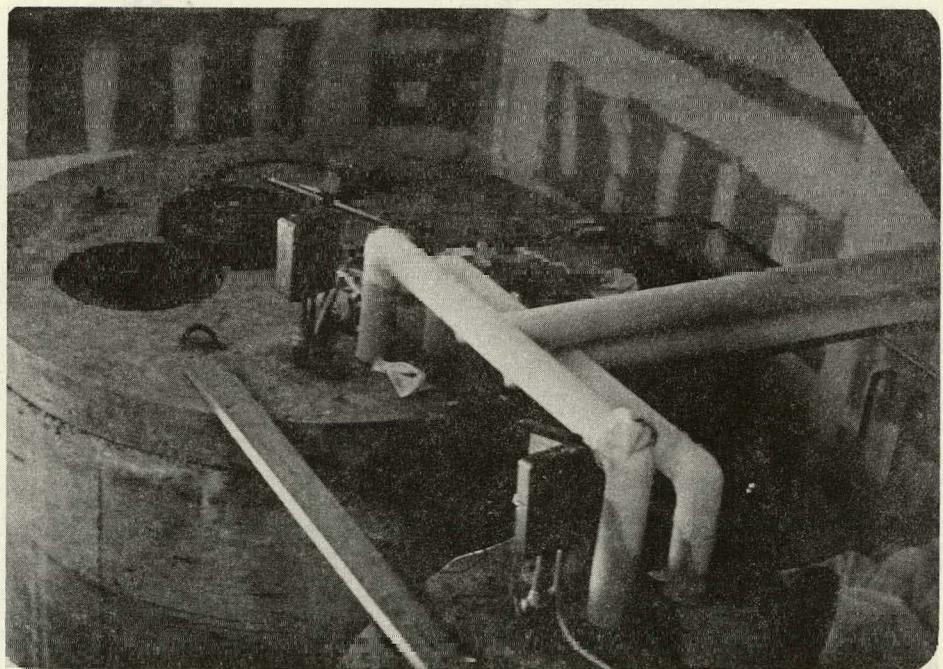
Mounting of Collectors With Crane



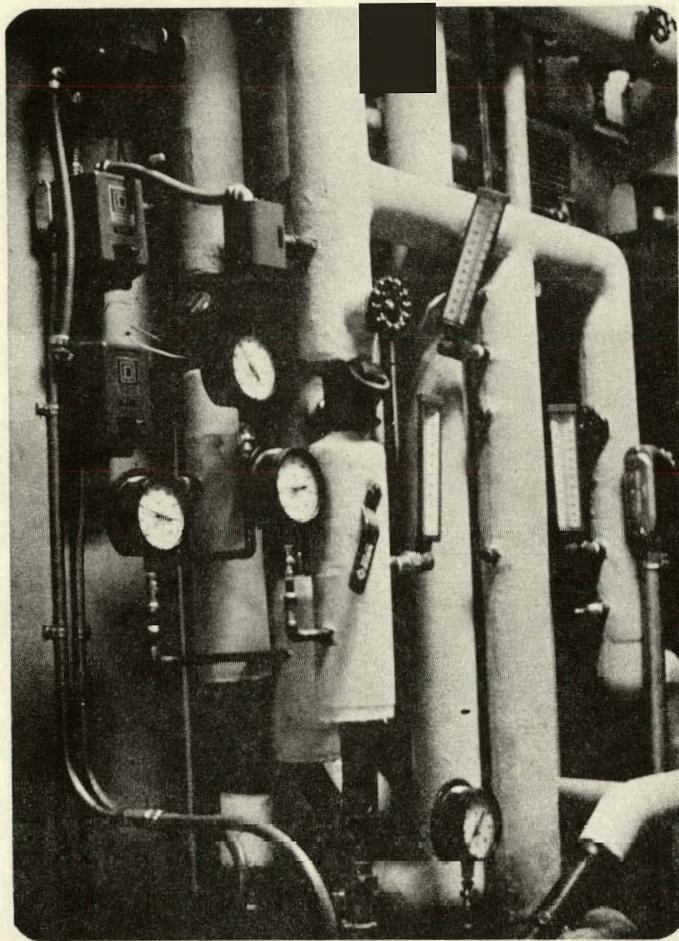
Alignment of Collectors



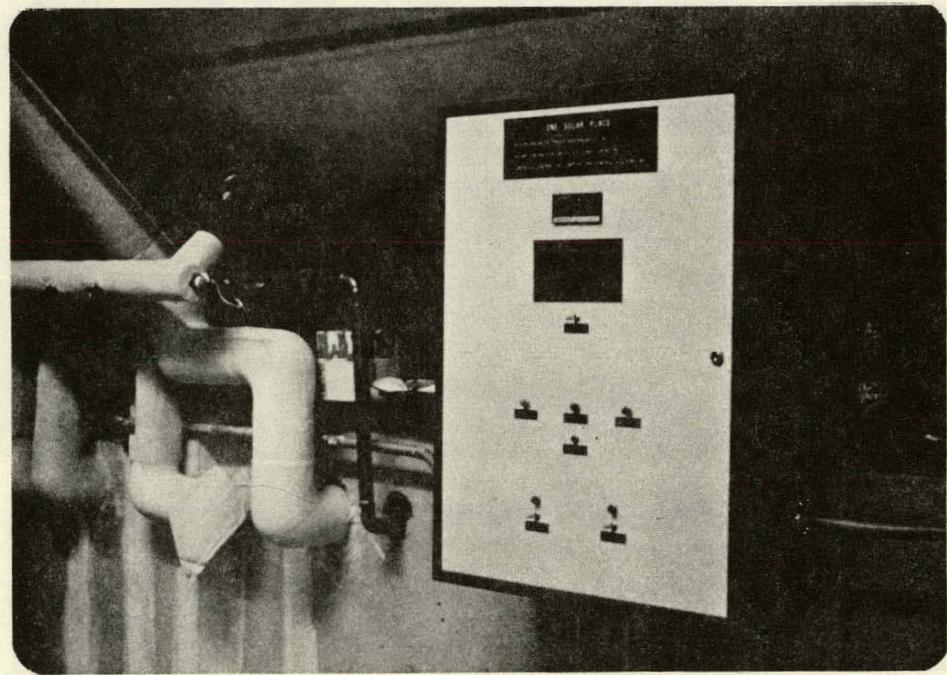
View of Collector Headers from Inside the Lobby



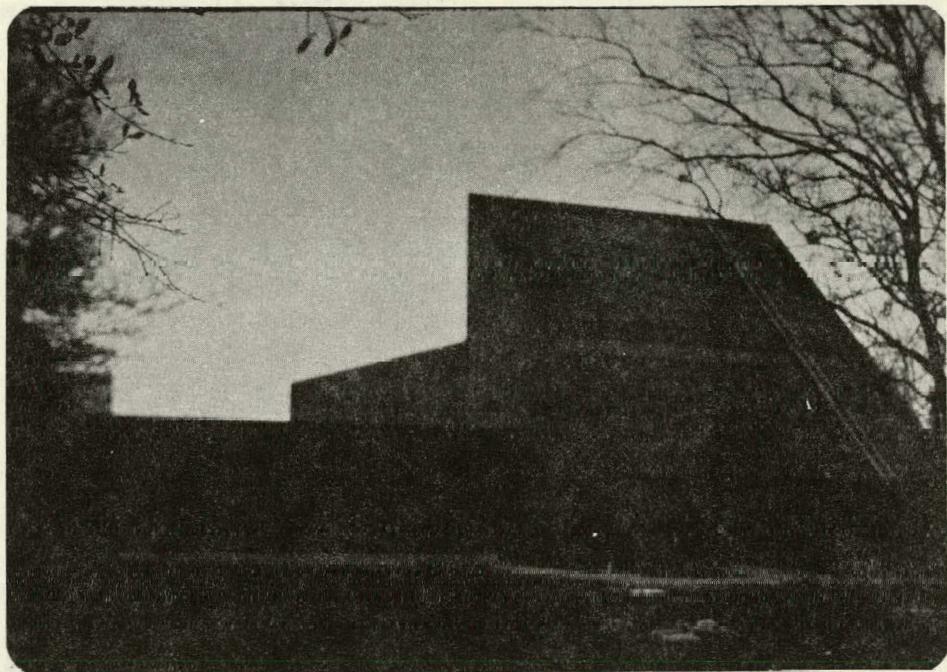
Hot Water Storage Tanks with Piping



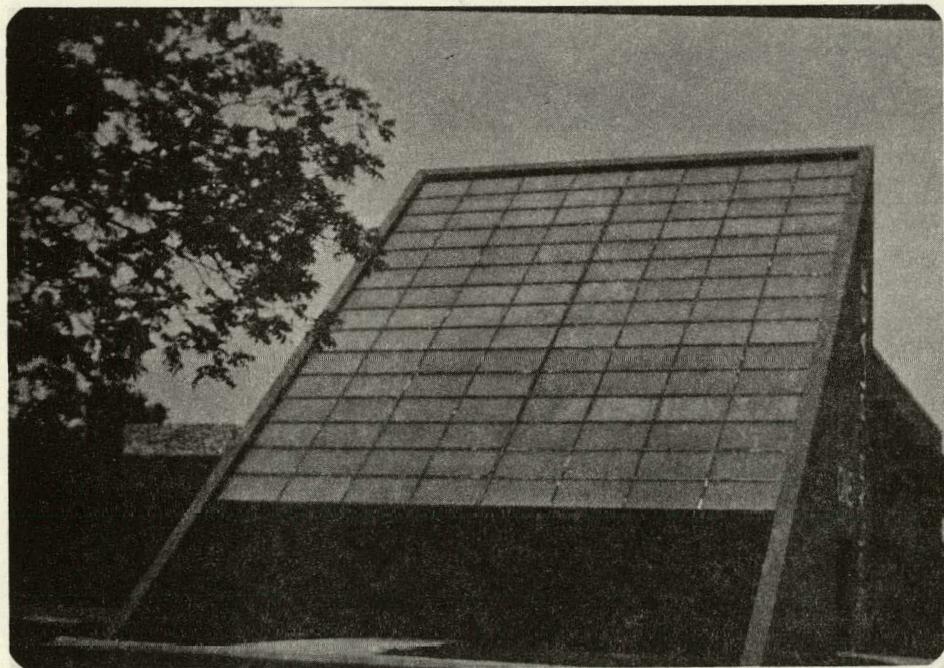
Piping, Gauges, Thermometers, Controls...
in Mechanical Room



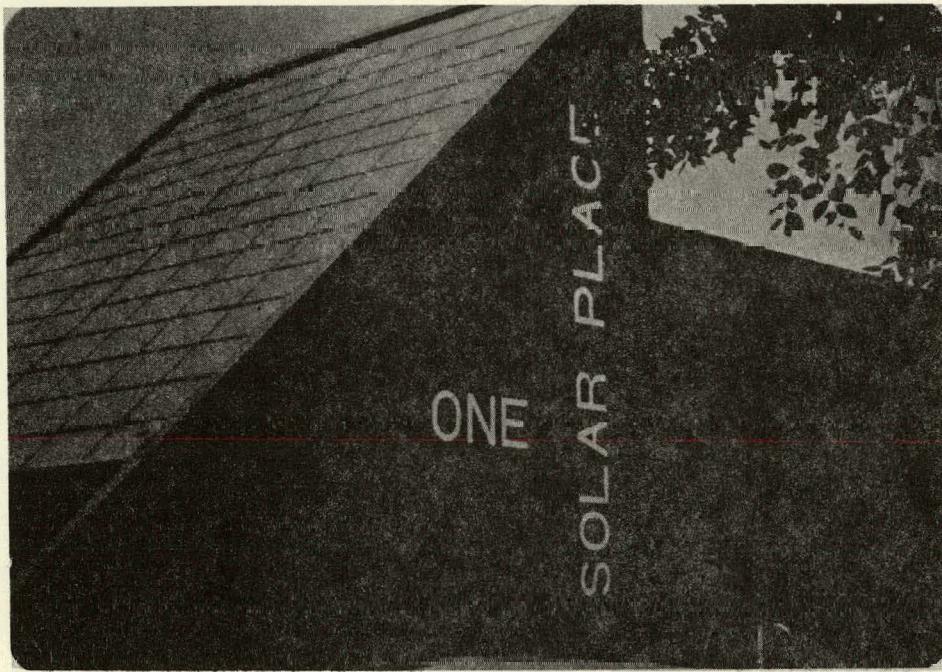
Digital Control Panel Box
in Mechanical Room



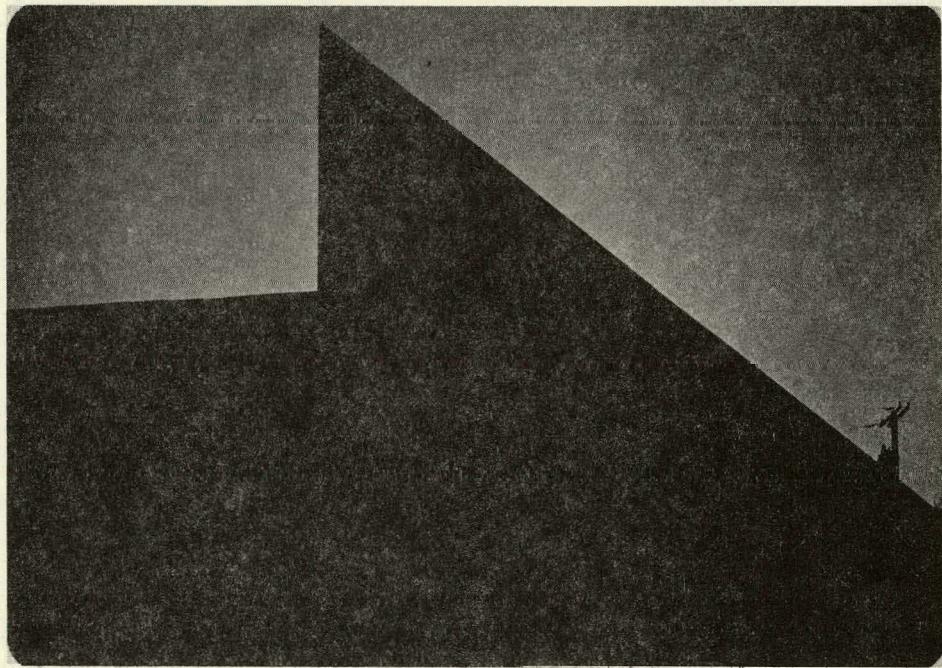
All Collectors Installed



Frontal View - ONE SOLAR PLACE



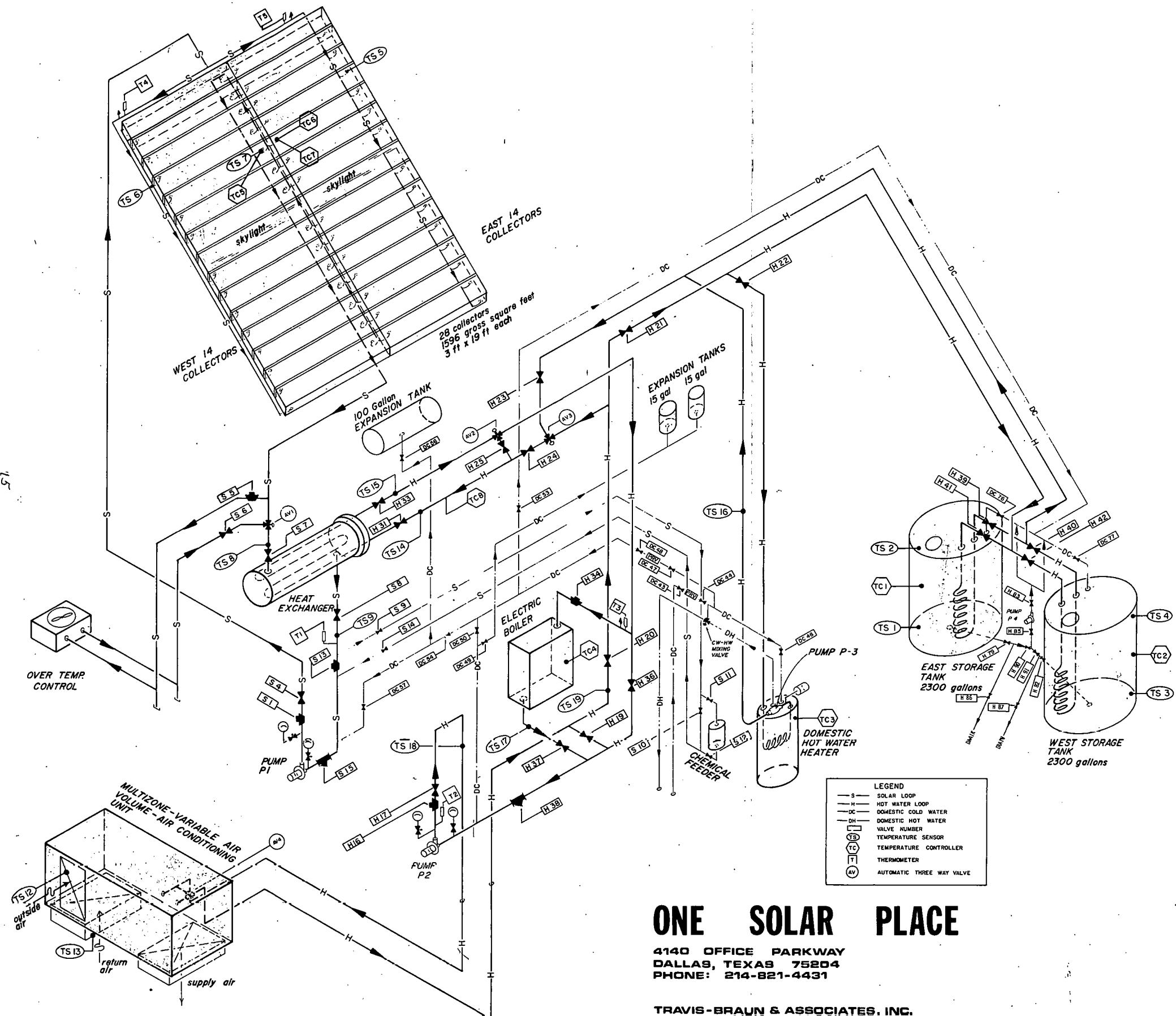
ONE SOLAR PLACE - Side View

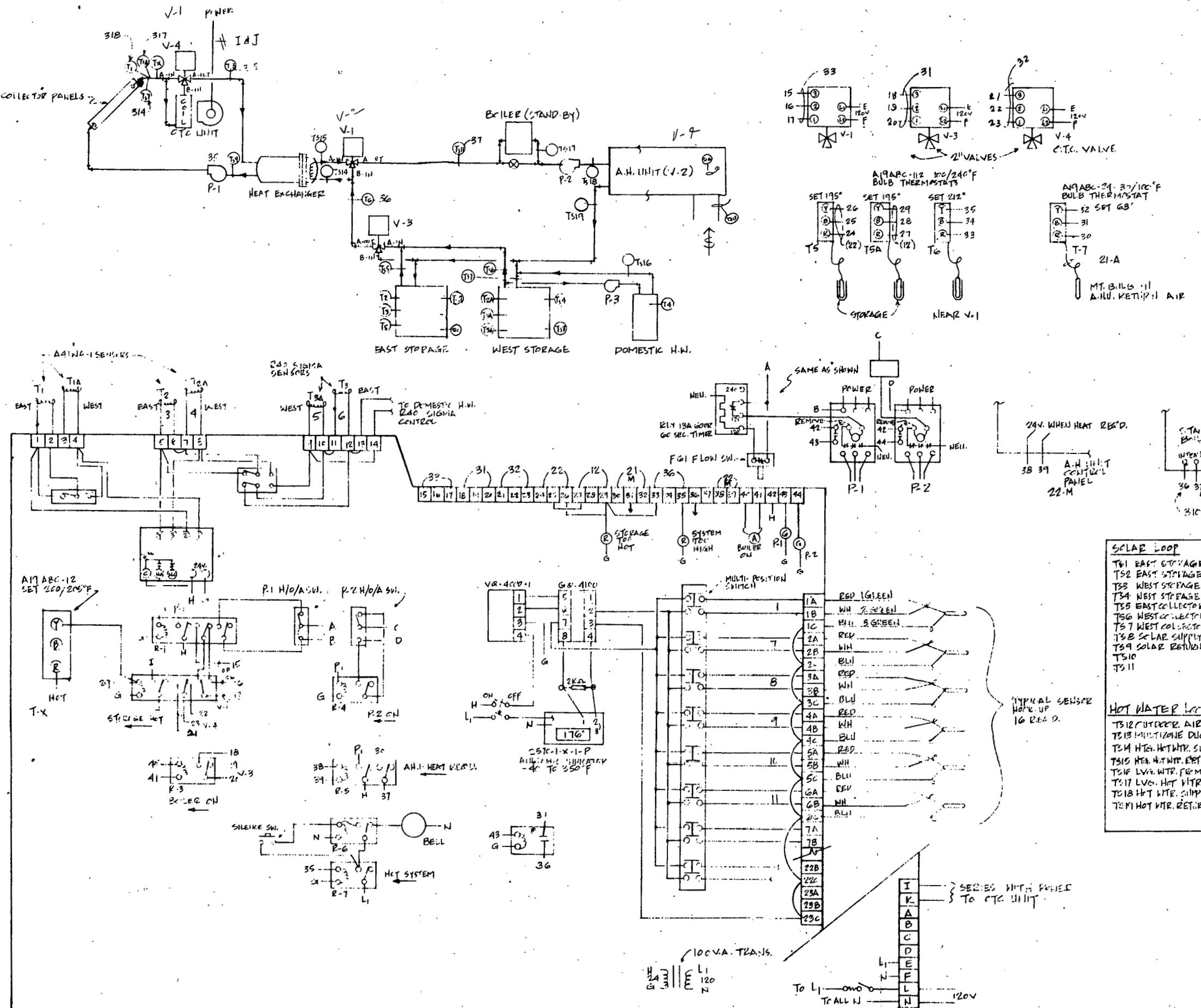


ONE SOLAR PLACE At Sun Rise

PROJECT COST

<u>ITEM</u>	<u>PLANNED (\$)</u>	<u>ACTUAL (\$)</u>
Collectors	\$26,000.00	\$28,950.00
• Storage Tank and Base	2,500.00	6,657.00
Supporting Structure for Collectors	2,000.00	2,100.00
Insulation	3,000.00	6,000.00
Pumps	1,100.00	1,100.00
Heat Exchanger	1,200.00	1,200.00
(2) Immersion Heat Exchangers	00.00	4,461.00
Controls	2,500.00	2,500.00
Piping and Valves	10,000.00	10,414.00
Construction Labor	15,000.00	15,000.00
Construction Overhead	<u>4,000.00</u>	<u>4,000.00</u>
Subtotal - Construction Cost	<u>\$67,300.00</u>	<u>\$82,382.00</u>
Direct Labor Overhead (Administration)	2,000.00	2,000.00
Engineer and Architectural Fees	7,500.00	7,500.00
Travel	<u>250.00</u>	<u>161.00</u>
Total Project Construction Cost	<u>\$77,050.00</u>	<u>\$92,043.00</u>





GENERAL NOTES AND EQUIPMENT SCHEDULE

SEQUENCE OF OPERATIONS:

SOLAR PUMP P-1 OPERATES UNDER THE FOLLOWING CONDITIONS:
A. - COLLECTOR TEMPERATURE IS GREATER THAN STCR. TANK.
B. - WATER ENTERING COLLECTOR IN EXCESS OF 200°F
(ADJ. ICO° - 240°).

HEAT EXCHANGER VALVE V-1 OPENS TO THE HEAT EXCHANGER
WHEN COLLECTOR TEMPERATURE IS WARMER THAN STOR. TANK
AND P-1 OPERATING.

BAILER OPERATES TO MAINTAIN A MINIMUM WATER TEMP-
ERATURE (120°F) WHEN AIR UNIT REQUIRES HEAT AND P-2
IS OPERATING.

AIR UNIT CONTROL VALVE V-2 OPERATES AS DIRECTED BY AIR UNIT CONTROL PACKAGE.

STORAGE TANK VALVE V-3 OPENS TO TANK WHEN COLLECTOR
TEMPERATURE IS GREATER THAN STORAGE TANK, P-2
TEMPERATURE.

DOMESTIC HOT WATER HEATER. P.I.M.P. OPERATES AS DIRECTED BY DIFFERENTIAL TEMPERATURE CONTROL. CONTROL HAS ONE CENSE: IN THE STORAGE TANK AND ONE IN THE HOT WATER HEATER. P.I.M.P. OPERATES AS ABOVE SUBJECT TO HIGH TEMPERATURE LIMIT. (45° A.D. ICS: 240°)

EXCESS HEAT CONTROL:
THERMOSTAT (105° 235°) T-G WITH SENSING ELEMENT LOCATED
IN STRAIGHT TANK WILL CLOSE HEAT EXCHANGER VALVE V-1.
UPON SENSING EXCESS TEMPERATURE.

THERMOSTAT - ENSING COLLECTOR WATER LOOP TEMPERATURE WILL ACTIVATE V-4 AND DIVERT WATER FLOW THRU OVER TEMPERATURE FAN COIL UNIT. RELAY ON V-4 WILL ENERGIZE FAN COIL UNIT FAN.

SOLAR LOOP
 T51 EAST STORAGE TANK - L. HIGH
 T52 EAST STORAGE TANK - UPPER
 T53 WEST STORAGE TANK - LOWER
 T54 WEST STORAGE TANK - UPPER
 T55 EAST COLLECTOR. SUPPLY WATER
 T56 WEST COLLECTOR SUPPLY WATER
 T57 WEST COLLECTOR RETURN WATER
 T58 SOLAR SUPPLY TO HEAT EXCHANGER
 T59 SOLAR RETURN FROM HEAT EXCHANGER
 T60

HOT WATER LOOP (NOT P.M. WTR.):
TS12 CUTTER, AIR TEMPERATURE
TS13 MULTIZONE DUCT RET. AIR TEMPERATURE
TM HTR. HOT WTR. SUPPLY TO HEAT EXCHANGER
TS15 HTR. H.T. WTR. RETURN FROM HEAT EXCHANGER
TS16 LGV. WTR. FROM DOMESTIC J.W. HEATER
T17 LGV. HOT WTR. FROM BOILER
T18 HOT WTR. SUPPLY TO MULTIZONE
TS19 HOT WTR. RETURN FROM MULTIZONE

TECHNICAL COMPUTER SYSTEMS INC.
800 N. MARY LANE
SAN ANTONIO, TEXAS 78205

<u>REVISIONS</u>		
<u>DATE</u>	<u>CHANGED</u>	<u>JOB NAME</u> <u>THE SILVER PLACE</u>
		<u>LOCATION</u> <u>1414 FLY E PARKWAY - DALLAS, TEXAS</u>
		<u>ARCHITECT</u>
		<u>ENGINEER</u>
		<u>CONTRACTOR</u> <u>UNITED FILM CONCRETE CO.</u>
		<u>DRAWN BY</u>
		<u>CHECKED BY</u>
		<u>DRAWING NO.</u> <u>TCS 78-128</u>

**ACCEPTANCE TEST PLAN
AND RESULTS**

I. INTRODUCTION:

This solar system Acceptance Test Plan describes procedures to be followed to verify that all components and subsystems are installed and functioning according to quality engineering practice. The Acceptance Test Plan also is performed to show that the complete system is free of irregularities and in accordance with design intention. The complete system includes a solar loop system, a hot water storage system and a domestic hot water system.

This test plan checks the following items:

A. Solar Loop System:

- A.1 GPM Flow through Solar Loop
- A.2 Heat Collection Performance of Collectors
- A.3 Over-Temperature-Control (O.T.C.)
- A.4 Chemical Feeder
- A.5 Operation of Pump P-1
- A.6 Backflow Prevention
- A.7 Collector Outgassing
- A.8 Collector Roof Leaks

B. Heating Hot Water System:

- B.1 Adequate Pump Pressure
- B.2 Back-up Boiler
- B.3 Drainage of Hot Water Storage Tanks
- B.4 Automatic Operation of Pump P-2
- B.5 Backflow Prevention
- B.6 Hot Water System Safety Alarm

C. Domestic Hot Water Loop:

- C.1 Expansion Tanks
- C.2 Cold Water-Hot Water Mixing Valve
- C.3 Pressure Reducing Valve (PRV)

D. Miscellaneous:

- D.1 Plumbing Leaks.
- D.2 Non-growth of Algae, Fungi, etc.
- D.3 Log of Temperatures
- D.4 Temperature Comparison
- D.5 Space Heating/Air Conditioning
- D.6 Master A/C Control Panel

II. TIMING:

This Acceptance Test Plan was performed on and before July 11, 1979, as mutually agreed upon by designated authorities from ERDA (DOE) and the Lon W. Travis/Earl E. Braun, Jr., Partnership. The ONE SOLAR PLACE office building solar energy system was declared operational on July 11, 1979.

III. PROCEDURE AND RESULTS:

A. Solar Loop:

This loop circulates an ethylene-glycol-water solution through 28 Solargenics' flat plate collectors and into a heat exchanger to heat the hot water system. This loop also includes an over-temperature control (O.T.C.).

A.1 GPM Flow Through Solar Loop: While solar loop is operating, measure pressure differential from gauges located on discharge and vacuum side of pump P-1 (solar loop pump). From pump manufacturer's pump curve, obtain corresponding flow rate through solar loop; i.e. net flow through collectors.

Results: The following information was recorded and calculated on July 2, 1979

Solar Loop

<u>TIME</u>	<u>ΔP(PSI)</u>	<u>GPM</u>
12:30 P.M.	32	45
1:30 P.M.	32	45
2:30 P.M.	32	45
3:30 P.M.	33	44
4:30 P.M.	32	45

A.2 Heat Collection Performance: On a normal operating day, with pumps P-1 and P-2 on, at any one instant measure BTU insolation, west collector supply water temperature (TS6), west collector return water temperature (TS7), and ambient temperature (TS12). BTU insolation is to be measured with a pyranometer on the west collector frame. Pyranometer must be at same angle as collectors. From this data and collector manufacturer specifications, calculate collector efficiency. Repeat this procedure three other times throughout the day. From net GPM flow through collectors (see A.1) and ΔT through collectors (TS7, TS6), BTU output of

collector may be found and thus the collector efficiency. Compare this efficiency with the efficiency obtained using collector manufacturer specifications as described above.

Results: Inaccurate results were obtained because of a small ΔT across the collectors. See Figure 1 for the collector efficiency curve furnished by the collector manufacturer.

A.3 Over-Temperature Control Unit (O.T.C.): To check to see that O.T.C. is functioning, set O.T.C. thermostat (inside control panel box) below west collector control temperature TC7. Go out on roof to check that O.T.C. unit comes on. Check to see that "Storage Too Hot" indicator light comes on (located on control panel box). Note: This light should also come on if storage tanks ever reach 200 degrees F.

Results: O.T.C. functions properly as commanded by the O.T.C. thermostat. "Storage Too Hot" indicator light functions properly.

A.4 Chemical Feeder: To insure freeze protection, chemical feeder must be supplying ethylene glycol to solar loop. To check, close valves S-11 and S-12 (with solar pump P-1 on). Immediately immerse a hydrometer into chemical feeder to measure gravity. From specific gravity, minimum operating temperature is obtained.

Results: At the time of the Acceptance Test Plan in July, 1979, no ethylene glycol was used in the solar loop because it is not needed for the summer months. In late September or early October of each fall season, ethylene glycol is added into the solar loop for a 30% ethylene-glycol-water solution, to give freeze protection down to 3° F.

A.5 Automatic Operation of Pump P-1: Pump P-1 (Solar Loop Pump) and P-2 (Heating Hot Water System Pump) are set automatically to come on simultaneously when collector temperature is 20 degrees F. greater than hot water storage tank temperature. Both pumps are set automatically to shut off when collector temperature drops to 5 degrees F. above storage tank temperature. However, there are two banks of collectors (east and west) and two hot water storage tanks (east and west). Two switches located inside the control panel box determine which bank of collectors and which hot water storage tank are to be used for temperature control. One switch is labeled "Solar Sensor" and switches collector temperature control to east (TC6) or west (TC5) bank of collectors. The second switch is labeled "Storage Sensor" and switches temperature control to east (TC1) or west (TC2) hot water storage tanks. Two differential thermostats inside the control panel box are used to accomplish automation of pumps P-1 and P-2. On a normal oper-

ating day, ΔT -On is set at 20 degrees F. for pumps to come on and ΔT -Off is set at 5 degrees F. for pumps to shut off. To verify automatic operation of pumps, switch "Solar Sensor" to "West" and "Storage Sensor" to "West". Set ΔT -On to zero. Check to see that pumps P-1 and P-2 come on; green indicator lights on control panel box should come on.* To see that pumps P-1 and P-2 shut off automatically, increase ΔT -Off from zero. Check to see that pumps P-1 and P-2 shut off; green indicator lights should go off. Automatic operation of pumps P-1 and P-2 may also be checked by switching "Solar Sensor" to "East" and "Storage Sensor" to "East" and repeating the above procedure.

Results: Both pumps P-1 and P-2 function automatically as commanded by differential thermostats ΔT -On and ΔT -Off. Both pump indicator lights operate properly.

A.6 Backflow Prevention: Visually inspect location of check valve to be on discharge side of Pump P-1.

A.7 Collector Outgassing: Visually inspect collectors for outgassing, looking for a thin film on the collector glazing.

*NOTE: The two differential thermostats, ΔT -On and ΔT -Off are not effective until collector temperature reaches hot water storage tank temperature, i.e., when TC7 approaches TC1.

Results: No observable collector outgassing was observed.

Temporary moisture, however, had condensed on a few collectors.

A.8 Collector Roof Leaks: During a rain storm, visually inspect collector roofing for rain leakage.

Results: Four rain water leaks were found between the collectors at the joints. One leak was found over the mechanical room and three leaks were found over the office lobby. These have been re-caulked and rain water leaks are now at a minimum, although still existent.

B. Heating Hot Water System:

The hot water system consists of a heat exchanger where heat is absorbed, two 2300 gallon storage tanks with heat exchangers, a back-up electric boiler, and a variable air volume multizone unit.

B.1 Adequate Pump Pressure: When hot water system pump P-2 is on, record pressure difference from two pressure gauges located on the discharge and vacuum side of pump P-2. From manufacturer specifications, obtain corresponding flow rate. Check to see that this flow rate exceeds 50 GPM, then pump pressure is adequate.

Results: A $\Delta P = 25$ psi across pump P-2 was found on July 8, 1979. This corresponds to a flow of 62 GPM which exceeds the minimum flow of 50 GPM for adequate heat transfer.

B.2 Back-up Boiler: Set boiler thermostat at or below TC4. Check to see that boiler comes on and that indicator light "Boiler On" (located on control panel box) comes on.

Results: Boiler comes on as commanded by differential thermostat.

B.3 Drainage of 2300 Gallon Hot Water Tanks: To drain east tank, close valves 90, 76, 39, and 41. Open valves 86 and 79. To fill east tank, close valve 86. Open valves 90, 76, 39, 41, 79. After east tank is filled to 6 inches below lid (see east sight glass), close valves 76 and 79. To drain west tank, close valves 91, 77, 40, and 42. Open valves 87 and 88. To fill west tank, close valve 87. Open valves 91, 77, 40, 42 and 88. After west tank is filled to 6 inches below lid (see west sight glass), close valves 77 and 88.

Results: All valves are intact. Both tanks were drained and filled. However, during filling operations, air pockets formed in both sight glasses and it took some time for the air pockets to "settle" out to give true sight glass readings.

B.4 Operation of Pump P-2: See A.5.

B.5 Backflow Prevention: Visually inspect location of check valve to be just above discharge side of pump P-2.

B.6 Hot Water System Safety Alarm: If the hot water loop temperature reaches the boiling point of water 212° F (and thus creates unwanted steam), a pipe thermostat (located next to valve H-25) sounds an alarm. To verify that the alarm is working, lower pipe thermostat to or below temperature TC 8. To silence alarm, push "Silence" button located on control panel box. Also, when alarm sounds, check to see that indicator light "System Too Hot" comes on.

Results: The hot water system safety alarm was not functioning. Pipe thermostat is suspect and is being checked on and will be repaired by General Contractor.

C. Domestic Hot Water Loop:

The domestic hot water loop sends hot water to hot water fixtures throughout the building. The building cold water system provides cold water make-up to the solar loop, the heating loop and the hot water storage tanks. This domestic hot water system includes a domestic hot water heater, hot water-cold water mixing valve, pressure reducing valve, and expansion tanks.

C.1 Expansion Tanks:

C.1a 100 Gallon Expansion Tank: Visually inspect sight glass on east side of 100 gallon expansion tank. For normal operation, expansion tank sight glass should show about one-half air and one-half water.

C.1b 15 Gallon Expansion Tanks (2): Visually inspect for leaks and check to see that expansion tanks are operating properly.

C.2 Cold Water-Hot Water Mixing Valve: Temperature is automatically set inside the valve. Visually inspect location near domestic hot water heater.

C.3 Pressure Reducing Valve (PRV): City pressure of supply water is usually around 75 psi. Check pressure gauge in solar loop on the vacuum side to be around 10-15 psi. This shows the PRV is functioning properly.

Results: The solar loop pump vacuum pressure gauge reads 15 psi; therefore, the PRV is functioning properly.

D. Miscellaneous:

D.1 Inspect all plumbing for leaks.

Results: All plumbing leaks were repaired.

D.2 Growth of Algae, Fungi, Mold, or Mildew: Visually inspect piping. Also inspect strainer valves S-15 and L-38.

Results: All piping was inspected as clean and free of any noticeable algae, fungi, mold or mildew.

D.3 Log of temperatures: A log of temperatures is recorded 3 or 4 times daily to check performance of various components and subsystems in the ONE SOLAR PLACE office building. All

temperature measuring devices are solid state thermistors. The following are a list of the temperatures recorded from the control panel box:

Solar Loop

- TS1 - East Storage Tank--Lower
- TS2 - East Storage Tank--Upper
- TS3 - West Storage Tank--Lower
- TS4 - West Storage Tank--Upper
- TS5 - East Collector Supply Water
- TS6 - West Collector Supply Water
- TS7 - West Collector Return Water
- TS8 - Solar Supply to Heat Exchanger
- TS9 - Solar Return from Heat Exchanger

Heating Hot Water Loop

- TS12 - Outdoor Air Temperature
- TS13 - Multizone Duct Return Air Temperature
- TS14 - Heating Hot Water Supply to Heat Exchanger
- TS15 - Heating Hot Water Return from Heat Exchanger
- TS16 - Leaving Water from Domestic H.W. Heater
- TS17 - Leaving Hot Water from Boiler
- TS18 - Hot Water Supply to Multizone
- TS19 - Hot Water Return from Multizone

Results: See Table 1 and Table 2.

D.4 Temperature Comparison: There are five thermometers located in various places to visually read and compare thermistor temperatures found on control panel box.

Results: Date July 3, 1979

<u>Thermometer Reading $^{\circ}$F.</u>	<u>Temperature Reading $^{\circ}$F. (Control Box)</u>
T1 - 164	TS9 - 169
T2 - 165	TS18 - 168
T3 - 162	TS17 - 165
T4 - 166	TS6 - 179
T5 - 166	TS5 - 177

D.5 Space Heating/Air Conditioning: The multizone Variable Air Volume controls space heating and air conditioning through the office building. To see that air conditioning comes on, during hot weather months, turn thermostats down to desired temperature. To check that space heating operates, turn all thermostats in building up to heating conditions.

Results: Space heating and air conditioning functioning properly.

D.6 Master A/C Control Panel: The Master A/C Control Panel (located first floor lobby) has automatic control over the air conditioning system. It also has an automatic switch to control the fan and compressor of the condensing unit. An after hours timer will shut air conditioning system off after a desired time period of up to 12 hours. There are four indicator lights on the Master A/C Control Panel. These include a "System" light, a "Heating Inoperative" light, a "Condensing Unit Inoperative" light and a "Dirty Filter" light. Check to see that these lights are functioning properly.

Results: Master A/C Control Panel functions properly.

- END -

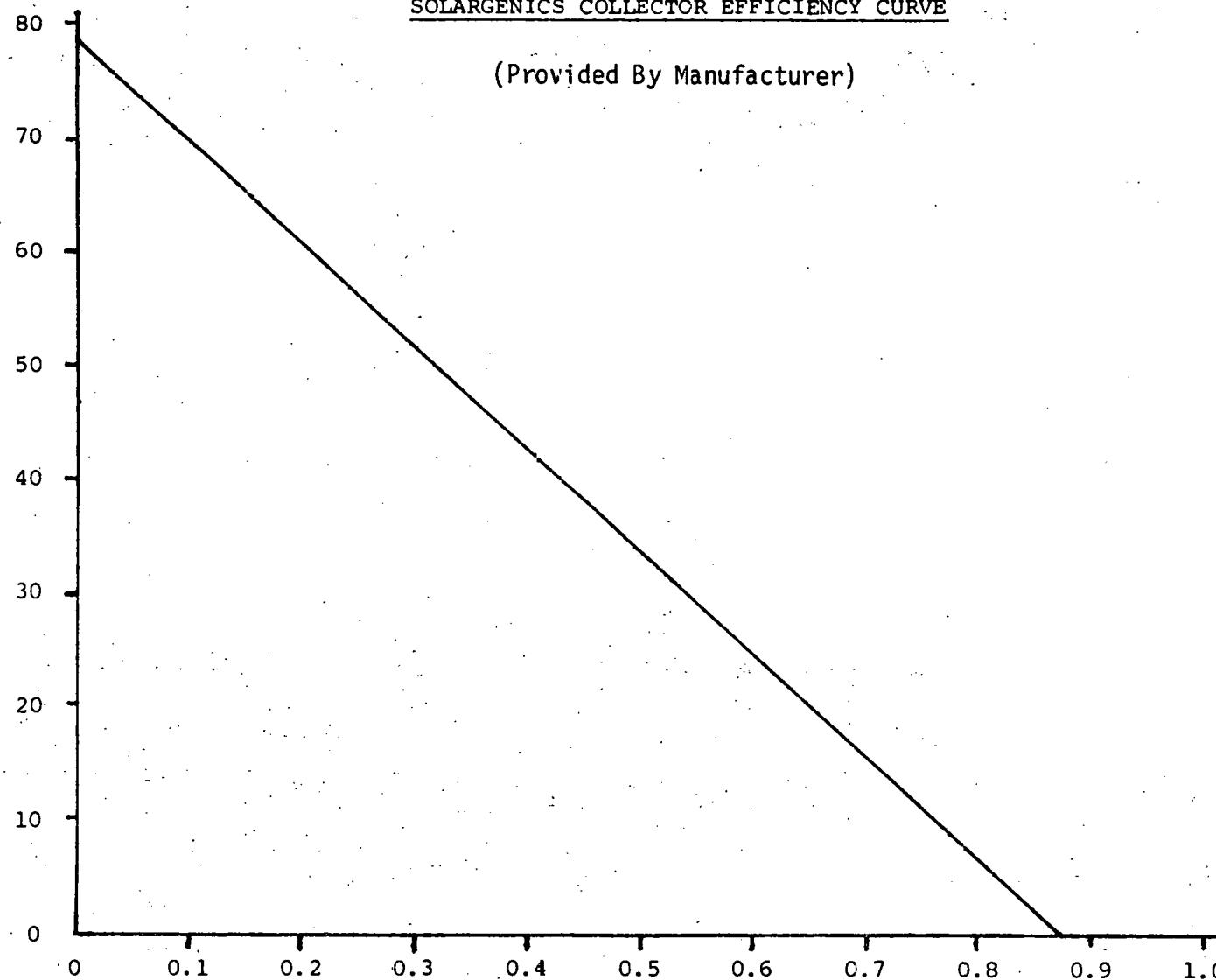
ACCEPTANCE TEST PLAN DATA

FIGURE 1

SOLARGENICS COLLECTOR EFFICIENCY CURVE

(Provided By Manufacturer)

Collector Efficiency (Percent)



$$\frac{T_i + T_o - T_a}{2} \left(\frac{\text{Hrs} \text{ } ^\circ\text{F. } \text{Ft}^2}{\text{BTU}} \right)$$

TABLE 1 - DAILY TEMPERATURES RECORDED
Temperatures recorded on July 2, 1979; Weather - Clear

	<u>Temperatures (°F)</u>			
	<u>8:40 A.M. (Pumps Off)</u>	<u>1:10 P.M. (Pumps On)</u>	<u>5:00 P.M. (Pumps On)</u>	<u>6:30 P.M. (Pumps Off)</u>
<u>SOLAR LOOP</u>				
TS 1 - East Storage Tank - Lower	173	170	181	180
TS 2 - East Storage Tank - Upper	*	-	-	-
TS 3 - West Storage Tank - Lower	164	162	170	170
TS 4 - West Storage Tank - Upper	173	169	182	182
TS 5 - East Collector Supply - Supply Water	85	175	182	174
TS 6 - West Collector Supply - Supply Water	82	181	183	178
TS 7 - West Collector Return - Return Water	84	184	183	175
TS 8 - Solar Supply to Heat Exchanger	97	186	185	178
TS 9 - Solar Return from Heat Exchanger	101	175	178	172
<u>HEATING HOT WATER LOOP</u>				
TS 12 - Ambient Temperature	79	92	91	90
TS 13 - Multizone Duct Return Air Temperature	76	81	82	85
TS 14 - Heating Hot Water Supply to Heat Exchanger	131	171	179	176
TS 15 - Heating Hot Water Return from Heat Exchanger	124	178	183	179
TS 16 - Leaving Water from Domestic H.W. Heater	92	170	178	169
TS 17 - Leaving Hot Water from Boiler	93	164	158	166
TS 18 - Hot Water Supply to Multizone	100	167	174	168
TS 19 - Hot Water Return from Multizone	101	173	178	173

*Temperature sensor TS 2 was not functioning properly on this day.

Table 2

STORAGE TANK TEMPERATURES

Month of June, 1979

(Temperatures Recorded About 5:00 p.m. Each Day)

<u>June</u>	<u>East Tank (Lower-6" from bottom)</u>	<u>East Tank (Upper-12" from top)</u>	<u>West Tank (Lower-6" from bottom)</u>	<u>West Tank (Upper-6" from top)</u>	<u>Weather</u>
1	136	141	132	141	Haze
4	154	161	148	161	Partly Cloudy
5	150	158	146	158	Rain
6	153	161	149	161	Cloudy
7	151	158	147	157	Cloudy
8	157	164	152	164	Mostly Cloudy
11	172	180	167	181	Clear
12	170	178	166	178	Cloudy
13	163	169	159	170	Cloudy
14	168	---*	157	169	Clear
15	174	---	161	174	Clear
18	175	---	163	175	Partly Cloudy
19	178	---	166	179	Cloudy
20	179	---	167	180	Cloudy
21	180	---	168	181	Cloudy
22	182	---	179	183	Cloudy
25	185	---	175	187	Rain
26	180	---	171	181	Mostly Cloudy
27	178	---	168	178	Cloudy
28	180	---	170	181	Cloudy
29	186	---	174	187	Clear

*Temperature probe for upper east tank not functioning properly.

ENERGY TABULATIONS

ENERGY REQUIREMENT TABULATIONS
(Including future Cooling)

MONTH	HEATING DEGREE - DAYS 65°F. Base	HEATING REQUIREMENTS * BTU X 10 ⁵	COOLING DEGREE - DAYS 70°F. Base	COOLING REQUIREMENTS ** BTU X 10 ⁶	DOMESTIC HOT WATER REQUIREMENTS BTU X 10 ⁶	YEARLY ENERGY TOTAL HEAT- ING ONLY 3 + 6	COOLING & HEAT- ING YEARLY ENERGY TOTAL 3 + 5 + 6 BTU X 10 ⁶
							1
JAN.	626	41.02	0	0	2.31	43.33	43.33
FEB.	456	29.88	0	0	1.97	31.84	31.84
MAR.	335	21.95	0	0	1.89	23.84	23.84
APR.	88	5.77	0	0	1.73	7.50	7.50
MAY	0	0	31	19.04	1.56	1.56	20.60
JUN.	0	0	333	78.27	1.37	1.37	79.64
JUL.	0	0	435	99.90	1.31	1.31	101.21
AUG.	0	0	465	109.30	1.34	1.34	110.64
SEP.	0	0	181	42.55	1.48	1.48	44.03
OCT.	60	3.93	34	7.99	1.56	5.49	13.48
NOV.	287	18.81	0	0	1.75	20.56	20.56
DEC.	530	34.73	0	0	2.06	36.79	36.79
TOTALS	2382	156.09	1519	357.05	20.33	176.42	533.47

* Based on Total Peak Heating Load of 150,164 BTU/hr

** Based on Total Peak Cooling Load of 244,850
BTU/hr

SOLAR ENERGY PARTICIPATION

MONTH	BTU X 10 ⁶ SOLAR ENERGY COLLECTED	DOMESTIC H.W. LOAD	SOLAR PARTICIPATION ON DOMESTIC H.W.	SPACE HEATING LOAD	SOLAR PARTICIPATION ON SPACE HEATING	SYSTEM HEAT LOSS BTU X 10 ⁶	AUXILIARY ENERGY BTU X 10 ⁶	D.H.W & SPACE HEATING PARTICI- PATION %
1	2	3	4	5	6	7	8	9
JAN	31.7	2.31	2.31	41.02	29.39	.54	12.17	72%
FEB	33.8	1.97	1.97	29.88	29.88	.45	0	100%
MAR	41.8	1.89	1.89	21.95	21.95	.52	0	100%
APR	37.2	1.73	1.73	5.77	5.77	.53	0	100%
MAY	34.8	1.56	1.56	0	0	.59	0	100%
JUN	35.4	1.37	1.37	0	0	.58	0	100%
JUL	36.9	1.31	1.31	0	0	.67	0	100%
AUG	39.9	1.34	1.34	0	0	.67	0	100%
SEP	40.7	1.48	1.48	0	0	.61	0	100%
OCT	39.8	1.56	1.56	3.93	3.93	.63	0	100%
NOV	30.9	1.75	1.75	18.81	18.81	.64	0	100%
DEC	28.7	2.06	2.06	34.73	26.64	.63	8.72	77%
TOTAL	431.6	20.33	20.32	156.09	136.37	7.06	20.89	87%

DOMESTIC HOT WATER REQUIREMENTS

MONTH	AVERAGE CITY WATER TEMP. °F.	BTU/LB AT CITY WATER TEMP.	BTU/LB @ 130°F.	BTU/DAY	AVERAGE DAYS OFFICE BLDG OPEN PER MONTH	BTU TO HEAT WATER TO 130°F.
1	2	3	4	5	6	7
JAN.	47°	15.06	97.97	103,596	22.3	2,310,000
FEB.	52°	20.07	97.97	97,336	20.2	1,966,000
MAR.	62°	30.08	97.97	84,828	22.3	1,892,000
APR.	66°	34.07	97.97	79,843	21.6	1,725,000
MAY	74°	42.06	97.97	69,859	22.3	1,558,000
JUN.	79°	47.06	97.97	63,612	21.6	1,374,000
JUL.	83°	51.05	97.97	58,626	22.3	1,307,000
AUG.	82°	50.05	97.97	59,876	22.3	1,335,000
SEP.	75°	43.06	97.97	68,610	21.6	1,482,000
OCT.	74°	42.06	97.97	69,859	22.3	1,558,000
NOV.	65°	33.08	97.97	81,080	21.6	1,751,000
DEC.	56°	24.08	97.97	92,325	22.3	2,059,000
TOTAL						20,317,000

* Based on 150 Gal/Day of Domestic Hot Water at 130°F

TOTAL SOLAR CONTRIBUTION TO 1596 SQ. FT. OF SOLAR COLLECTORS IN DALLAS, TEXAS

WITH A COLLECTOR TILT OF 42° AND BASED ON 32° NORTH LATITUDE

MONTH	AVERAGE SOLAR INSOLATION PER COLLECTOR ARRAY BTU x 10 ⁶ /mo.	COLLECTOR NET AREA	PERCENT OF POSSIBLE SUNSHINE		ATMOS- PHERIC CLEARNESS	AVERAGE COLLECTOR EFFICIENCY	TOTAL AMOUNT OF USEABLE SOLAR ENERGY BTU x 10 ⁶
			DIRECT	DIRECT & DIFFUSED			
1	2	3	4	5	6	7	8
JAN.	110.3	89%	56%	64%	95%	53.1%	31.7
FEB.	110.3	89%	57%	65%	95%	55.7%	33.8
MAR.	122.8	89%	65%	73%	95%	55.2%	41.8
APR.	111.2	89%	66%	74%	95%	53.5%	37.2
MAY	107.5	89%	67%	75%	95%	51.1%	34.8
JUN.	100.3	89%	75%	83%	95%	50.3%	35.4
JUL.	105.7	89%	78%	86%	95%	48.0%	36.9
AUG.	111.7	89%	78%	86%	95%	49.1%	39.9
SEP.	114.1	89%	74%	82%	95%	51.5%	40.7
OCT.	117.3	89%	70%	78%	95%	51.4%	39.8
NOV.	105.0	89%	63%	71%	95%	49.0%	30.9
DEC.	105.0	89%	58%	66%	95%	49.0%	28.7
TOTALS	1321.2	89%	68%	76%	95%	51.4%	431.6

SYSTEM DESIGN CHANGES FROM ORIGINAL PROPOSAL AND CONSTRUCTION PROBLEMS

1.0 DESIGN CHANGES

- 1.01 Perhaps the biggest change in design involves the hot water storage tanks. By original design, there were to be three hot water storage tanks located outside the ONE SOLAR PLACE office building, serving as supports for a porte cochere. It was decided, however, to use two larger 2300 gallon hot water tanks, installed on a concrete slab in the office lobby. This design change resulted in a more simple piping system and smaller storage tank heat losses and therefore, more cost effectiveness.
- 1.02 Heat exchangers were added to the inside of each 2300 gallon hot water storage tank. This gives a second protection from the ethylene glycol-water solution. More importantly, without the heat exchangers, hydrostatic pressure resulting from city water pressure of 15 psi on a 7 foot diameter concrete storage tank lid would result in an uplift force of 83,000 pounds, which greatly exceeds the weight of the concrete slab and would blow the lid off the hot water storage tank.

2.0 CONSTRUCTION PROBLEMS

- 2.01 Each concrete hot water storage tank has developed a slow seepage leak at one time or another. To solve this, each tank was drained at different times completely and allowed to dry for days. This stopped the seepage.
- 2.02 The temperature sensors in each hot water storage tank have malfunctioned but since have been repaired.

2.03 Pumps P-1 (solar loop pump) and P-2 (system loop pump) have tripped-off undesirably on hot days because the mechanical room gets too hot.

New pump seals will be installed and a larger exhaust fan will be installed in the mechanical room to solve this problem.

2.04 Rain leaks through collector flashing joints. Approximately five leaks occur between the collector modules when there is a south blowing rain. During a light rain, several leaks can still be observed. The collectors will expand approximately 3/8" over the 20 foot length of the collector due to thermal expansion. Sealing was to be accomplished with sponge rubber gaskets compressed from 1/2" to 1/4" by the module cases. (Figure 1) However, the collector spacing was greater than 1/4" in some places.

Before finishing the space below the solar collector roof, all module joints should be leak tested from all directions with a pressurized hose. Floor tile or something other than carpet should be used as a floor below the collector array. Expansion and contraction provisions for the collectors should be provided. One possible way of sealing between collector modules might be accomplished with a gasketed mechanical interlock, if the module cover support was refabricated as shown in Figure 2. The solution to the present sealing problem is to apply generous amounts of silicone sealant under and around the flashing where a leak is found with the hose.

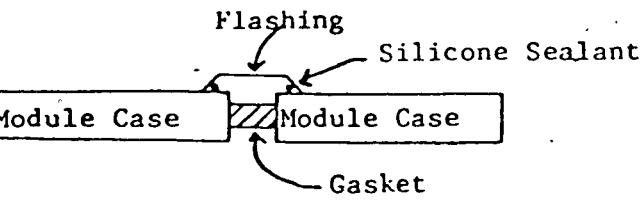


Figure One

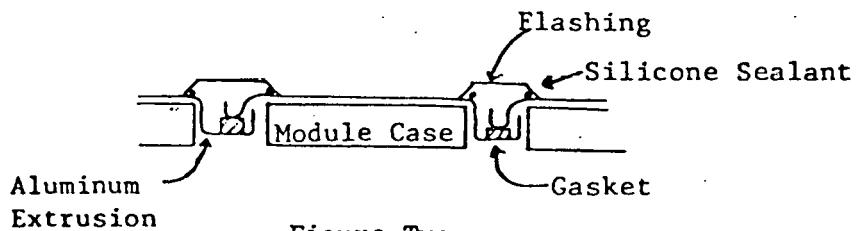


Figure Two

START-UP PROCEDURE

- I. Fill Hot Water Storage Tanks.
 - A. East Tank - Close valve 86. Open valves 90, 76, 39, 41, 79. After tank is filled to 6 inches below lid (use sight gage), close valves 76 and 79.
 - B. West Tank - Close valve 87. Open valves 91, 77, 40, 42 and 88. After tank is filled to 6 inches below lid, close valves 77 and 88.
- II. Add ethylene-glycol to solar loop to obtain a 30% glycol/70% water solution. Refer to Appendix D - "Manual Chemical By-Pass Feeders" for instructions.
- III Check to see that pump breakers are closed in electrical power panel.
- IV. Check to see that control panel breaker is closed in electrical power panel.
- V. Automatic operation of pumps P-1 and P-2. (Control Panel in Mechanical Room)
 - A. In control panel box, set ΔT -On differential thermostat to 20° F.
 - B. In control panel box, set ΔT -Off differential thermostat to 5° F.
 - C. Turn switch on control panel to "Auto" for Pumps P-1 and P-2.
- VI. Over Temperature Control - In control panel box, set O.T.C. to 200° F.
- VII. The remainder of the temperature controllers and sensors were set before installation.
- VIII. Fill all systems with water.
 - A. Heating Hot Water System - Open valve 49 and 50.
 - B. Domestic Hot Water System - Open valves 43, 44 and 46.
- IX. Set room thermostats at desired temperature.
- X. Verify that 7-day Time Clock is on desired setting.

XI. A/C Control Panel in Downstairs Lobby

- A. Set "System Switch" to "Auto".
- B. In cooling season, turn "Condensing Unit" switch to "Auto".
- C. In heating season, make sure night setback thermostat located above control panel is set at 45° F.

XII. Heating Season - Set boiler thermostat inside boiler at 110° F. for backup heating.

OPERATING AND MAINTENANCE
INSTRUCTIONS

- I. Chemical Feeder - Periodic and annual additions of ethylene-glycol to the solar loop are required to insure freeze protection in the winter months to 3⁰ F. (Refer to Appendix D for initial charge of Chemical Feeder).
 - A. Monitoring - During winter months, check every two weeks to insure system has 30% ethylene-glycol 70% water.
 - B. Add ethylene-glycol as needed.
 - C. At the beginning of each heating season, check PH factor of glycol solution and neutralize as required to a PH of 6.7 to 7.4.
 - D. During summer months no monitoring is required.
- II. Pumps - Refer to Appendix G. Pumps are life-time lubricated and do not require periodic oiling.
- III. Strainers - All strainers are to be cleaned monthly for the first six months and every three months thereafter.
- IV. Collectors - Location of collectors prevents operating personnel from performing any maintenance or trouble shooting. Solar contractor will perform these functions.
- V. Boiler - Refer to Appendix H.
 - A. Inspected, cleaned, and if necessary adjusted once a year by a qualified serviceman.
 - B. Frequently check the boiler operating pressure.
- VI. Multizone VAV Unit - Refer to Appendix I.
 - A. Night Setback Thermostat - Located in the main lobby of building above control panel. Set at 45⁰ F. Will automatically activate heating if temperature drops below 45⁰ F. in building.

B. Control Panel for heating and air conditioning is located in the main lobby and consists of the following: (Also refer to Appendix I, pgs. 10-13)

1. System On Light - Green indicates system is operating.
2. Heating Inoperative Light - Red light comes on, Refer to Appendix I, Page 8 for service instructions.
3. Condensing Unit Inoperative Light - Red light comes on, refer to Appendix I, page 9 for service instructions.
4. Dirty Filter Light - Red light comes on, change filter.
5. Auto/Off Switch - Set on Auto at all times, unless units are being serviced.
6. After Hours 12 Hour Timer - May be set for one to twelve hours manually. Turn this switch only when unit is off at night.
7. Condensing Unit Auto/Off Switch - Set at Auto in cooling season, and Off during heating season.

VII. Solar Hot Water Heater - Refer to Appendix B.

VIII. Over Temperature Control Unit- Refer to Appendix C.

Annually the purge coil system should be inspected and checked as follows:

1. Purge Coil

Clean and inspect the coil and coil guard to be sure they are free of obstructions. Turn off power to unit and wash coil and coil guard with a garden hose.

2. Oil fan motor:

a. Motor without oiling ports - Prelubricated and sealed. No further lubrication required under normal operation.

- b. Motor with oiling ports - Add a few drops of SAE No. 10 non-detergent oil in motor oiling ports. Access to the fan motor may require unbolting and lowering the fan motor/fan guard assembly.
- 3. Visually inspect connecting lines and coil for evidence of fluid leaks.
- 4. Check all wiring for evidence of loose connections.
- 5. Check for correct voltage at unit (unit operating).
- 6. Check amp-draw on fan motor.

TROUBLE-SHOOTING

I. Power:

Control Panel (Mechanical Room)

Problem - No power to panel.

1. Check electric power from power panel to insure that circuit breaker #16 is closed.
2. Check to see if fuse is blown inside control panel. (Fuse is white with an "L" on it.)

II. Pumps:

Solar Loop Pump P-1 and Hot Water System Pump P-2

A. Problem - Pump will not run.

1. Check motor starter/disconnect switch to make sure it is closed.
2. Check breakers in power panel to see if tripped.
Pump P-1: #22, 23, 24
Pump P-2: #19, 20, 21
3. Check to see if differential thermostat ΔT -On in control panel is set at 20° F. (Note: ΔT -On is not effective until collector temperature TC7 or TC5 reaches hot water storage tank temperature TC 1 or TC 2.)
4. Check to see if "Solar Sensor" and "Solar Storage" controllers in control panel are both turned to either East or West.

B. Problem - Pumps run continuously.

1. Check control panel switch to make sure it is on "Automatic Mode" not "On" position.

2. Check ΔT -Off is set at 5°F . (Note: ΔT -Off differential thermostat is not effective until collector temperature TC7 or TC 5 reaches hot water storage temperature TC1 or TC2).

III. Over Temperature Control Unit (OTC):

Problem - Unit will not function

1. Check electric power panel to see if breaker #3 is tripped.
2. Check OTC thermostat in control panel is set at 200° F . Lower setting to circulating water temperature to see that it turns on.

IV. Boiler:

Problem - Unit will not function

1. Check to see that 175 amp breaker in power panel is not tripped.
2. Refer to Appendix H-2 "Trouble-Shooting for Water Boilers".

V. Air Conditioning Unit:

Control Panel in Downstairs Lobby

Problem - "Heating Inoperative" red light comes on. - Refer to Appendix I-8.

Problem - "Condensing Unit Inoperative" red light comes on. - Refer to Appendix I-9.

Problem - None of system indicator lights are functioning. - Check to see if 225 amp breaker in power panel is tripped.

Problem - "Dirty Filter" red light comes on. - Change filter.

VI. Heating Hot Water System Safety Alarm:

Problem - Alarm sounds and "System Too Hot" light comes on.

1. Push "Silence" button located on control panel.
2. Check to see if Pump P-2 is operating. If it is not on in "Auto" mode, switch to "On". If it does not come on, refer to Section II- "Pumps".

VII. Storage Tanks:

Problem - Tank leaks.

Refer to page 25, B.3 "Drainage of 2300 Gallon Hot Water Tanks"

Allow tank to dry out for several days before refilling.

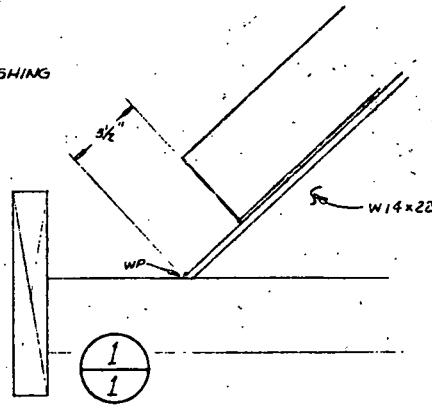
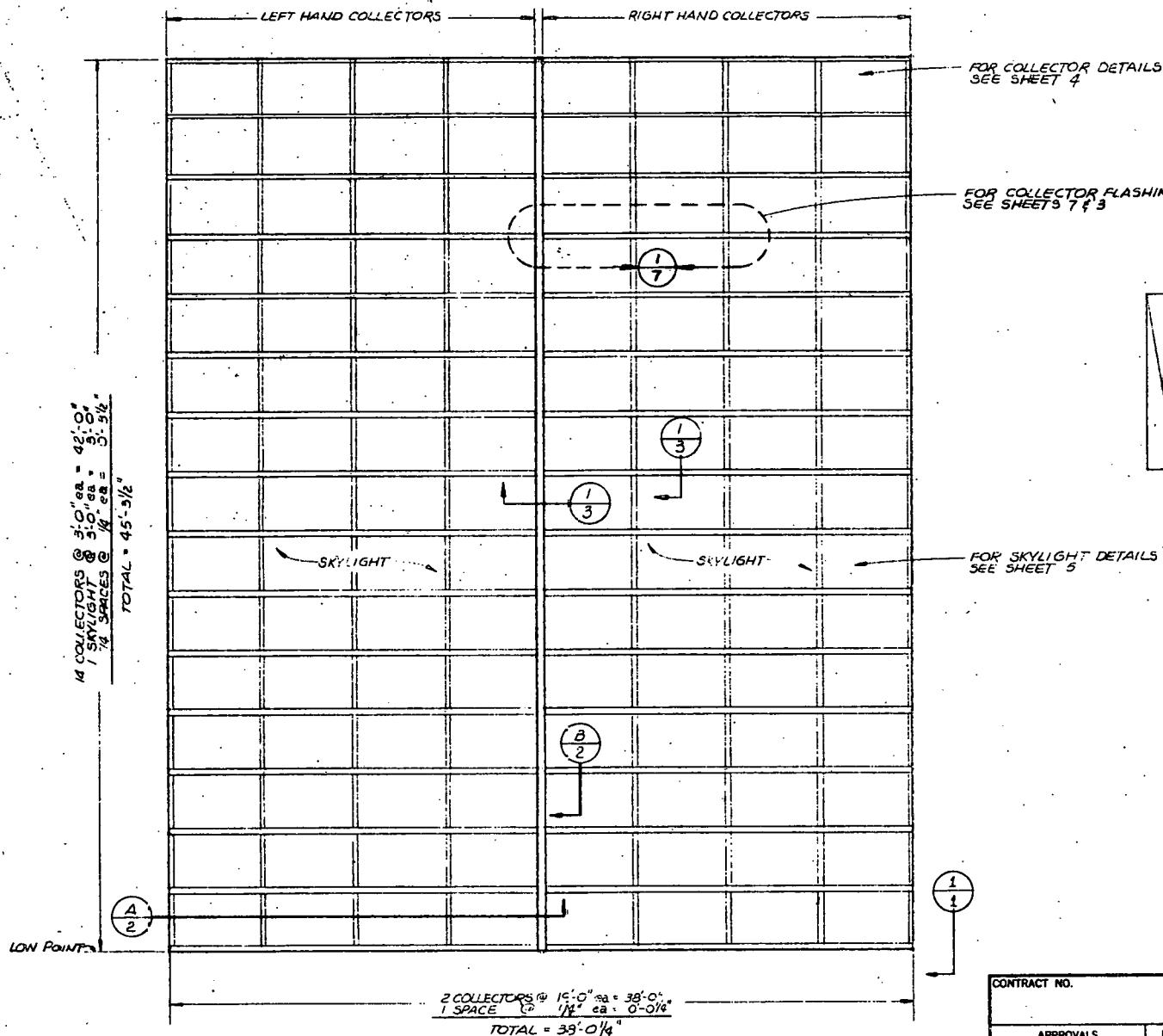
VIII Collectors:

Problem - Roof Leaks

1. Identify exact location on underside of collectors where water leaks.
2. Check caulking on top of collectors where leak appeared.
3. Recaulk area or identify more severe problem.

OPERATION, MAINTENANCE, AND
PRODUCT APPENDICES OF
ONE SOLAR PLACE SYSTEM COMPONENTS

APPENDIX A
SOLAR COLLECTORS
SOLARGENICS FLAT PLATE - SERIES 76



SCALE: 5° = 1'-0"

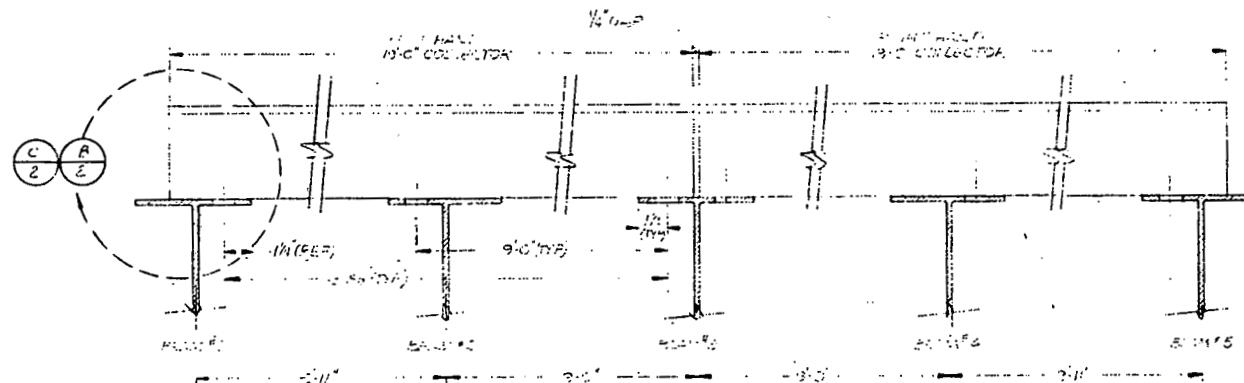
— FOR COLLECTOR DETAILS
SEE SHEET 4

— FOR COLLECTOR FLASHING
SEE SHEETS 7 & 3

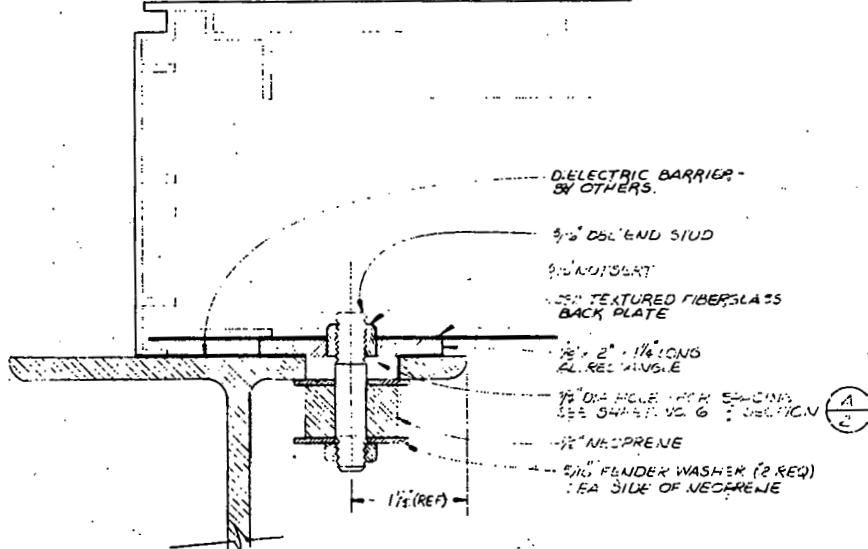
— FOR SKYLIGHT DETAILS
SEE SHEET 5

1

CONTRACT NO.		SOLARGENICS, INC.		
APPROVALS	DATE	9713 LURKING JAVE CHATSWORTH, CA 91311		
DRAWN A. DREYER	5-10-78	COLLECTOR MOUNTING		
CHECKED		CONFIGURATION		
		TRAVIS - BRAUN		
REVISION		SIZE	CODE IDENT NO.	DRAWING NO.
B	8-15-78	C	55449	RP 770400
		SCALE	1/4" = 1'-0"	



SECTION

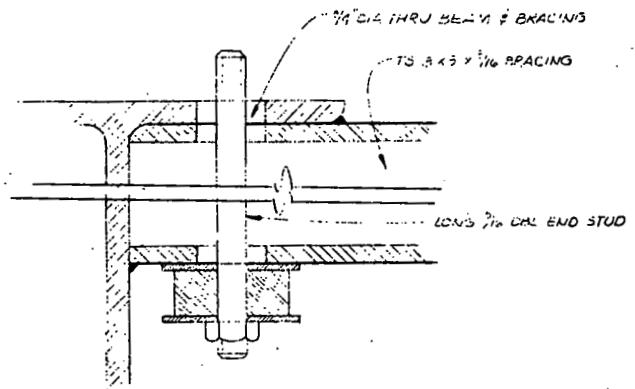


MOUNTING DETAIL

SCALE: FULL

NOTE:

- CONNECTION AT PLATE #1 SHOWN - PLATE 3 E 5 SIMILAR.
AT PLATE #2, PLATE #3 & PLATE #4 USE 1/2" NUT, ONE 1/2" STUD & ONE 1/2" STUD -
USE 3/8" BOLT & LOCK WASHER.
- NUTS, WASHERS & STUDS SHALL BE PLATED.



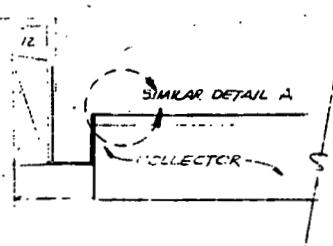
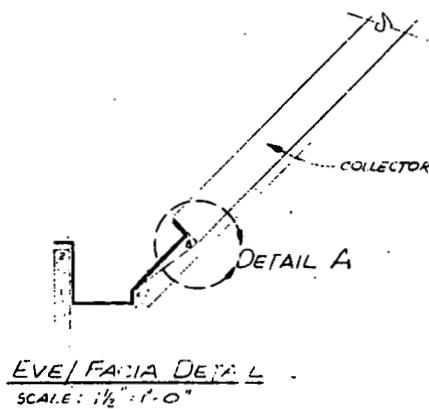
MOUNTING DETAIL @ BRACING
SAVE AS B EXCEPT AS NOTED
SCALE: FULL

NAME: FULL

XII: FULL

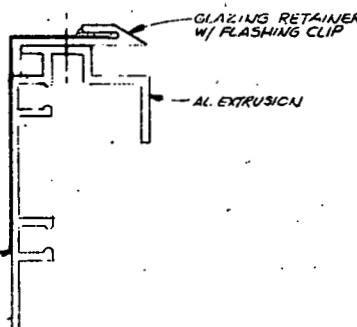
A-2

CONTRACT NO.		SOLARGENICS, INC.		
APPROVALS	DATE	9713 LURLINE AVE CHATSWORTH, CA 91311		
DRAWN A. DREYER	5-31-78	<u>COLLECTOR MOUNTING</u>		
CHECKED		<u>DETAILS</u>		
		TRAVIS-BRAUN		
REVISION		SIZE	CODE IDENT NO.	DRAWING NO.
A	8-10-78	C	55449	RP.770.6001
		SCALE	ACROSS	SHEET 26 OF



FLASHING

SCALE: 3" : 1'-0"



NOTE:

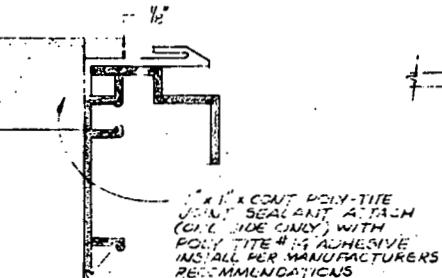
1. FLASHING DIMENSIONS TO BE DETERMINED AFTER COLLECTORS HAVE BEEN MOUNTED

DETAIL A

SCALE: FULL

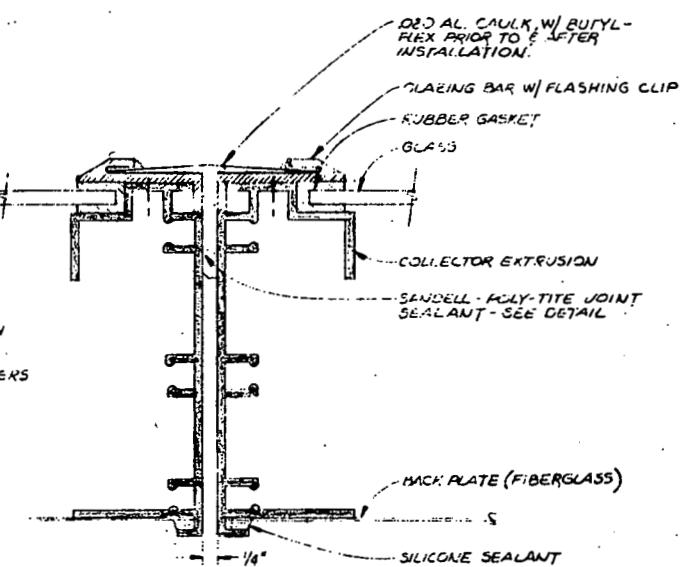
DETAIL - SANDELL POLY-TITE JOINT SEALANT

SCALE: FULL



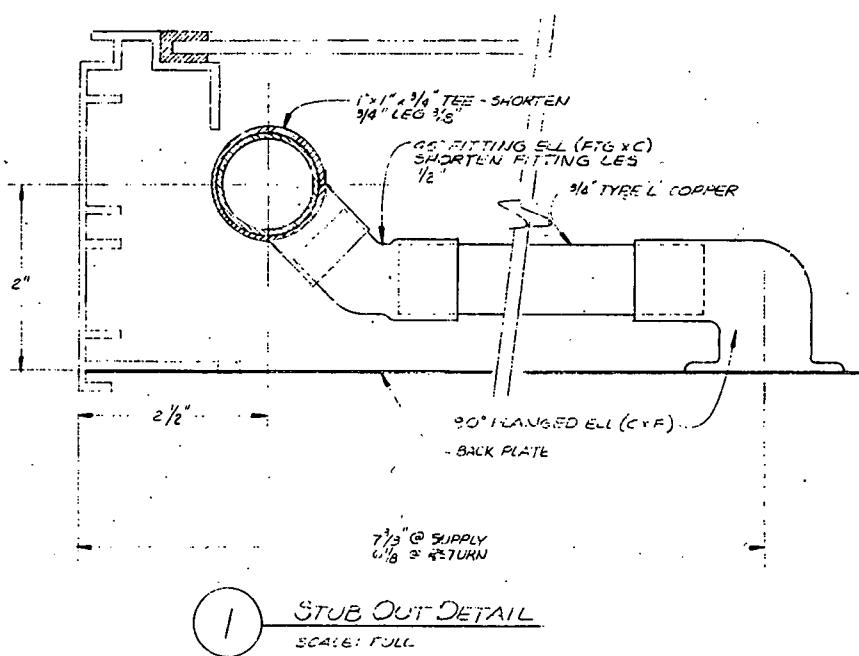
1/3 COLLECTOR SEAL DETAIL

SCALE: FULL

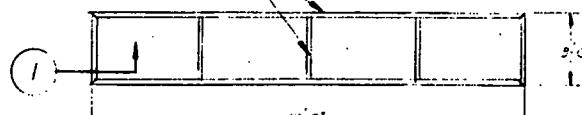


A-3

CONTRACT NO.		SOLARGENICS, INC.	
APPROVALS	DATE	9713 LURLINE AVE CHATSWORTH, CA 91311	
DRAWN A. DREYER	5-4-78	INTEGRAL COLLECTOR/ROOFING	
CHECKED		WEATHER SEAL DETAILS	
		TRAVIS-BRAUN	
REVISION		SIZE	CODE IDENT NO.
B	5-5-78	C 55449	RP 7706001
		SCALE NOTED	



ALL GLAZING RETAINERS
INSTALLED BY SOLAR GENICS

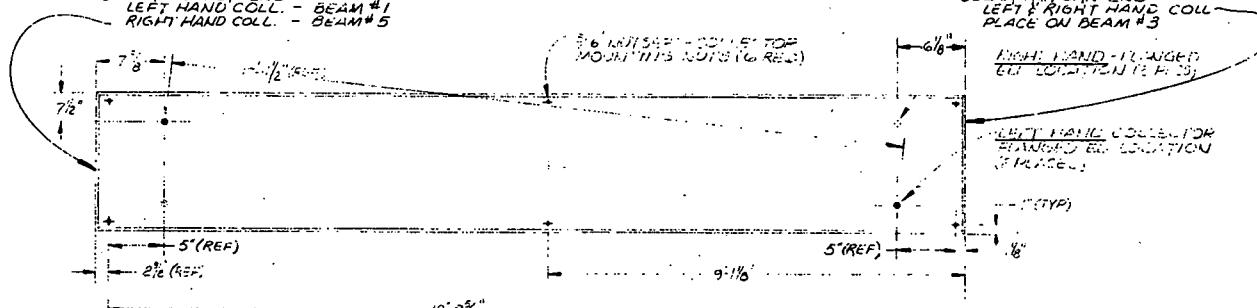


COLLECTOR, FRONT VIEW
SCALE: 1/8" = 1'-0"

Notes:

4. 22 COLLECTORS REQUIRED
14 - LEFT HAND
14 - RIGHT HAND
5. CLOTH CLOTHES 3 272 1 2' 6" F

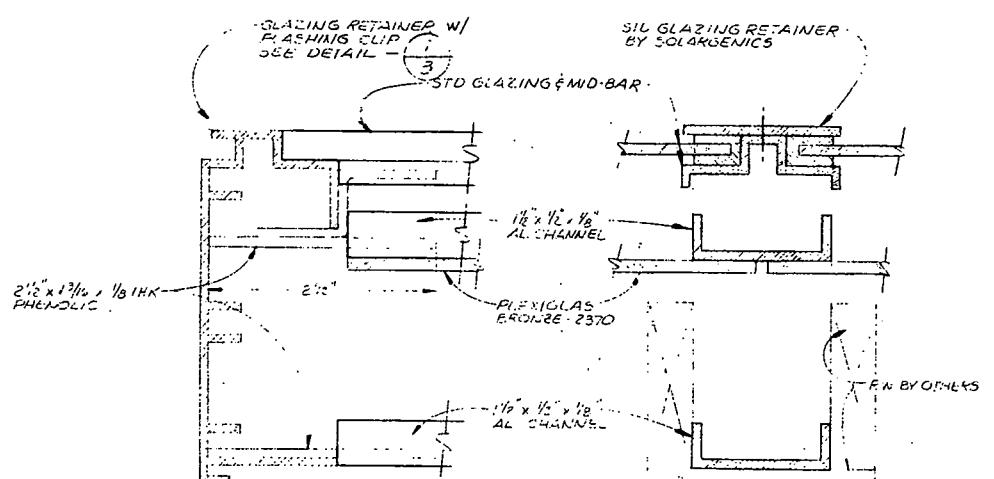
SOLAR SUPPLY END
LEFT HAND COLL. - BEAM #1
RIGHT HAND COLL. - BEAM #5



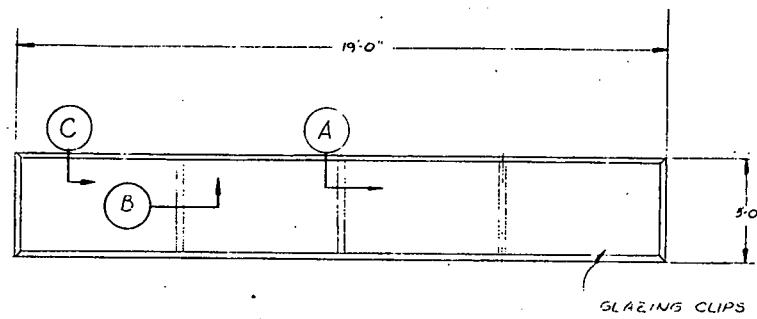
BACK VIEW - LEFT HAND COLLECTOR

(RIGHTHAND COLLECTOR- SAME EXCEPT ADDED)
SCALE: $\frac{1}{2}'' = 1'-0''$

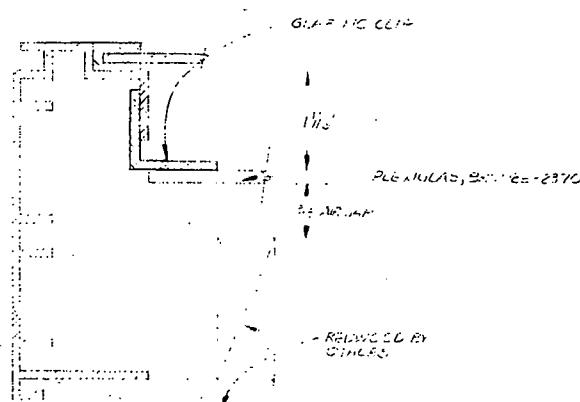
A-4



A-5
A SECTION
SCALE: 1/8"



SKYLIGHT PLAN (2 REG)
SCALE: 1/8 = 1'-0"

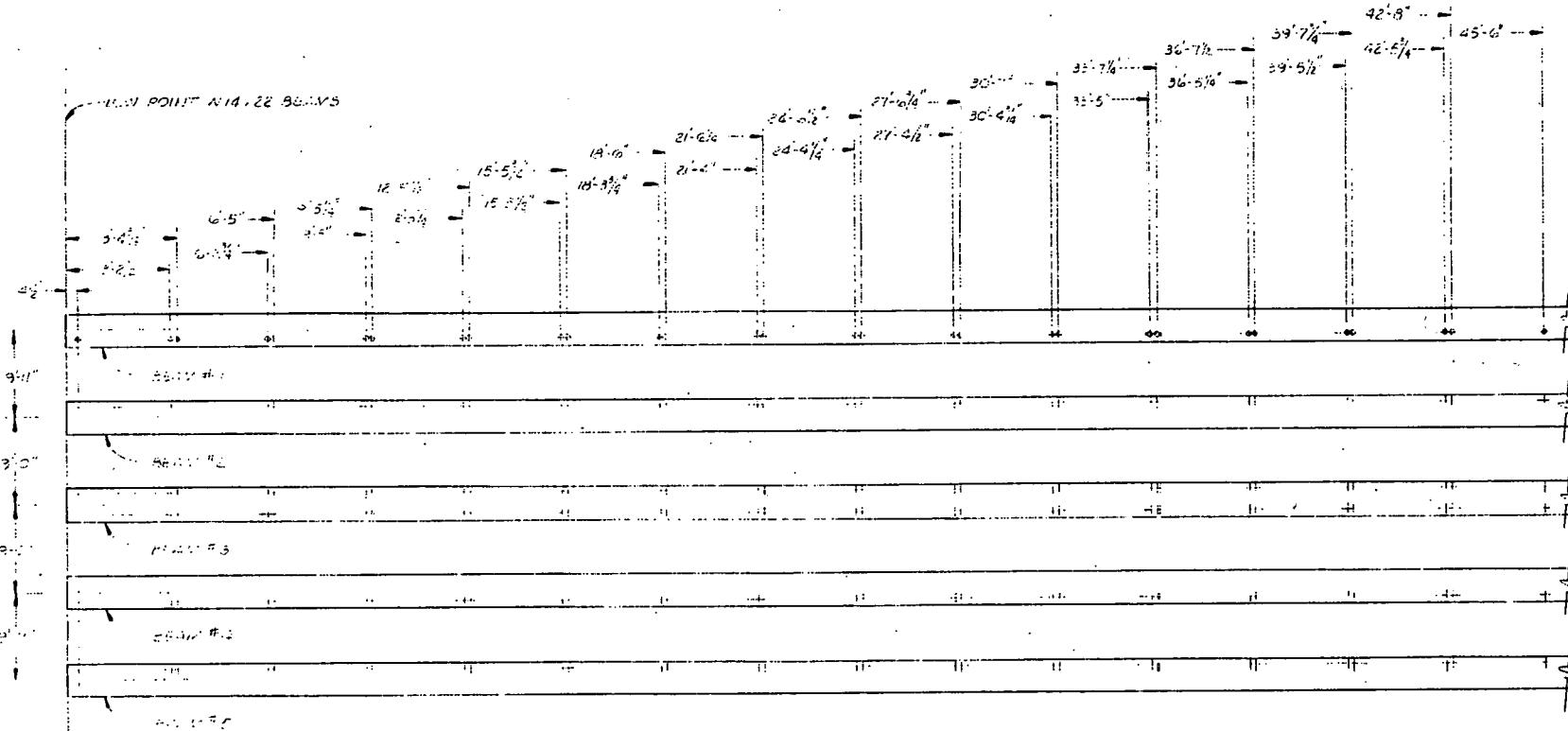


C GLAZING CLIP SECTION
SCALE: FULL

A-5

CONTRACT NO.		SOLARGENICS, INC.		
APPROVALS	DATE	9713 LURLINE AVE CHATSWORTH, CA 91311		
DRAWN A.DREYER	5-23-78	SKYLIGHT DETAILS		
CHECKED				
REVISION		TRAVIS-BRAUN		
A	8-15-78	SIZE	CODE IDENT NO.	DRAWING NO.
		C 55449	RP-7706001	REV A
SCALE NOTED		SHEET 5 OF		

1. CROWN POINT N14, 22 BEAMS



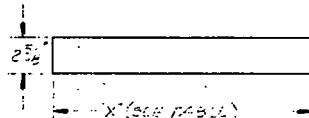
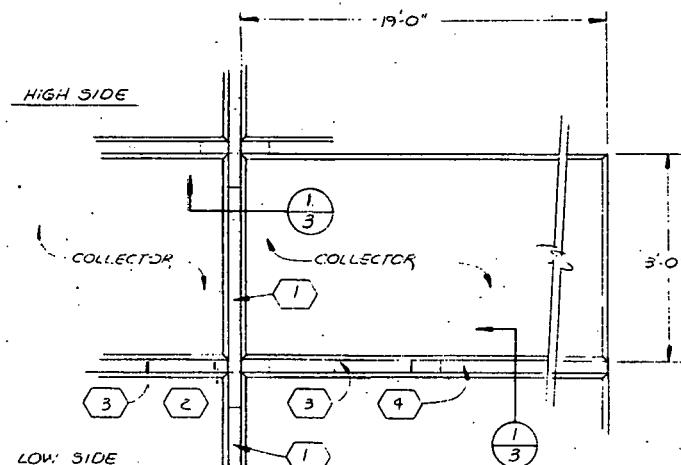
Note:

1. ALL DIMENSIONS ARE FROM THE RIGHT OF W. S. 22 BEAMS
2. ALL HOLES (+ OR -) SHALL BE $\frac{1}{8}$ IN. DIA.
3. FOR ADDITIONAL HOLE LOCATION INFORMATION SEE 1
4. VERIFY ALL LOCATIONS PRIOR TO PUNCHING HOLES.
A SHIFT IN THE COLLECTOR ARKET MAY BE NECESSARY
DO TO TS 3 X 3 X 3/8 IN. BRACING

A-6

CONTRACT NO.		SOLARGENICS, INC.		
APPROVALS	DATE	9713 LURLINE AVE CHATSWORTH, CA 91311		
DRAWN A DREYER	6-1-76	<u>STEEL BEAM</u>		
CHECKED		<u>HOLE LOCATIONS</u>		
		TRAVIS-BRAGN		
	SIZE	CODE IDENT NO.	DRAWING NO.	
	C	55449	RP. 7706001	
	SCALE $\frac{1}{16}$ = 1'-0"		SHEET 6 OF	

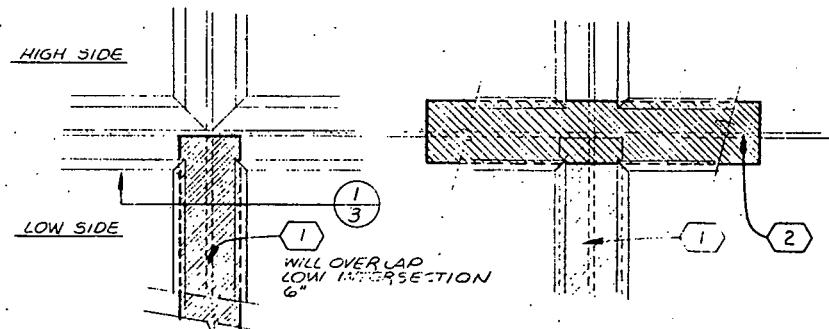
COLLECTOR FLASHING INSTALLATION. SEQUENCE



COLLECTOR FLASHING
MATERIAL - AL. 6061-T6, .020 THK

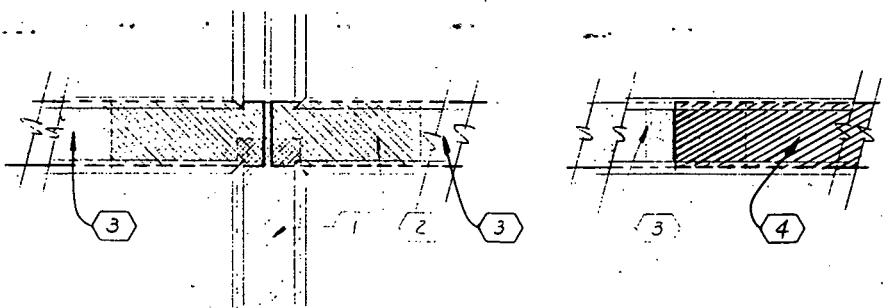
ITEM	"X"
1	3'-6"
2	1'-0"
3	10'-0"
4	9'-0"

NOTE
[X] - INDICATES FLASHING PART NUMBER
& INSTALLATION SEQUENCE NUMBER



STEP NO. 1

STEP NO. 2



STEP NO. 3

STEP NO. 4

A-7

CONTRACT NO.		SOLARGENICS, INC.	
APPROVALS	DATE	9713 LURLINE AVE CHATSWORTH, CA 91311	
DRAWN <i>A. DREYER</i>	8-18-78	CHECKED	
COLLECTOR FLASHING			
TRAVIS BRAUN		SIZE CODE IDENT NO. DRAWING NO.	
C. 55449		RP 7706001	
SCALE	1:16	1:16	SHEET 7 OF

AVERAGE PREDICTED COLLECTOR EFFICIENCY (Collector Manufacturer)

MONTH	Ambient Mean Temp. °F.	Temperature In °F.	Temperature Out °F.	Average Insolation	** F_t	** Collector Efficiency (Water Only)	Collector * Efficiency With $C_p = .9$ BTU/LB °F.
							1 2 3 4 5 6 7 8
JAN	46	90	96	236	.199	59.0%	53.1%
FEB	49	90	96	261	.170	61.9%	55.7%
MAR	57	100	106	262	.176	61.3%	55.2%
APR	65	110	116	246	.195	59.4%	53.5%
MAY	72	120	126	230	.222	56.8%	51.1%
JUN	81	130	136	222	.234	55.6%	50.3%
JUL	85	140	146	226	.257	53.3%	48.0%
AUG	85	140	146	239	.243	54.6%	49.1%
SEP	78	130	136	252	.218	57.2%	51.5%
OCT	68	120	126	251	.219	57.1%	51.4%
NOV	56	110	116	232	.246	54.4%	49.0%
DEC	48	100	106	224	.246	54.4%	49.0%
Monthly Average	66	115	121	240	.219	57.1%	51.4%

* Based on Solution of 70% Water and 30% Ethylene Glycol

** Formula For Collector Efficiency Based on Physical Science Test
Facility - New Mexico State University

$$\text{Eff (For water)} = 77.19 + 84.65 \times F_t + 32,82 F_t^2 \text{ where } F_t = \frac{T_i - T_a}{I}$$

APPENDIX B
SOLAR HOT WATER HEATER

DIMENSIONS (inches)

Water Heater	A	B
66 gal.	24-1/4	64-1/4
82 gal.	28-1/4	56
120 gal.	30-1/4	67-1/4

COLLECTOR
TRANSFER FLUID
RETURN CONNECTION

SOLAR HEATED
WATER OUT
CONNECTION

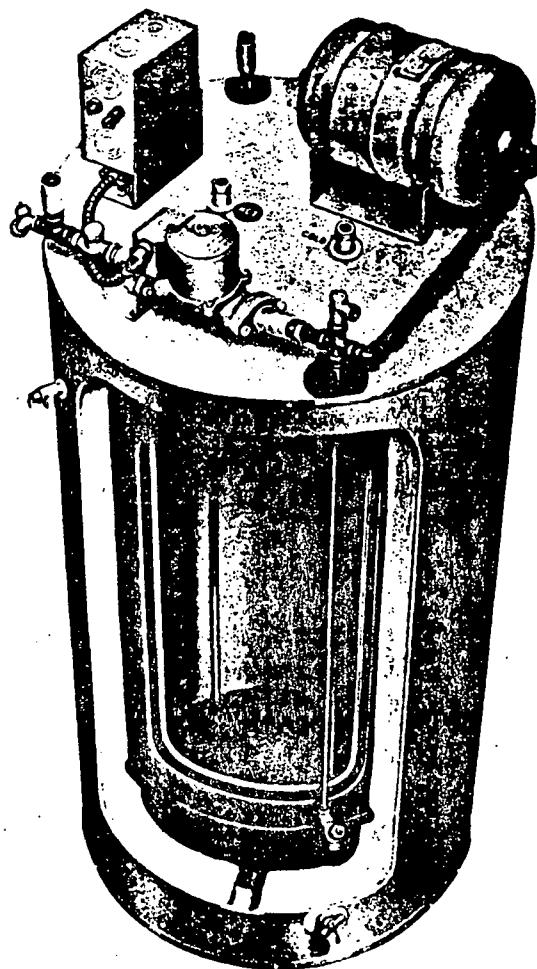
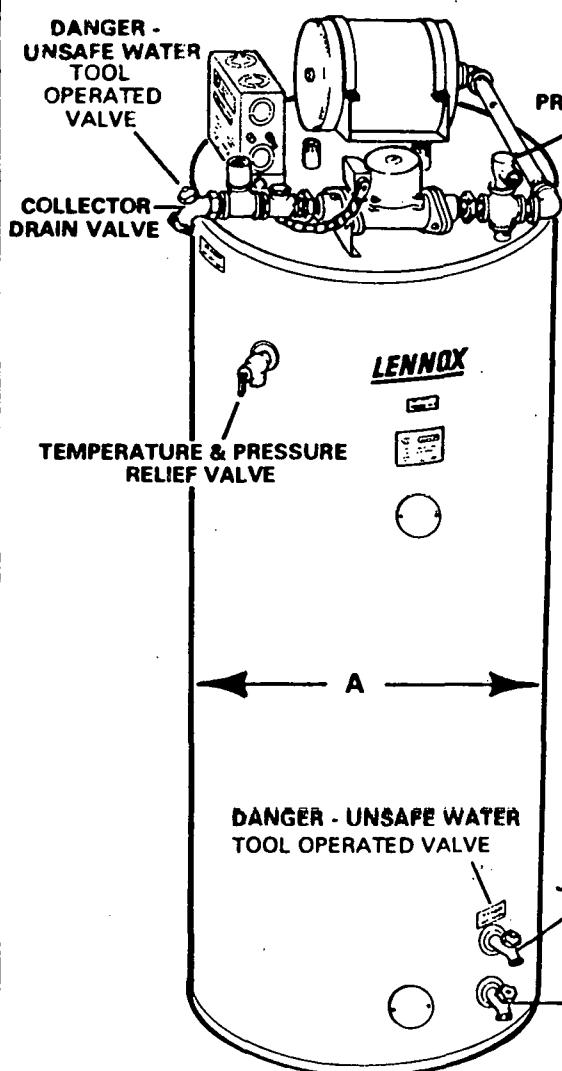
From
Collector

COLLECTOR
TRANSFER FLUID
SUPPLY CONNECTION

To
Collector

COLD WATER
INLET CONNECTION

TOP VIEW



SPECIFICATIONS

Model No.	LSHW1-1	LSHW1-2	LSHW1-3	LSHW1-4	LSHW1-5
Number of collectors	1	2	3	4	5
No. of packages in shipment	2	3	4	5	6
Approx. shipping weight (lbs.)	570	713	864	1140	1283
Water tank capacity (gal.)	66	82	120		
Water piping connections mpt (in.)	3/4-18	3/4-18	3/4-18		
Collector piping connections fpt (in.)	1/2-18	1/2-18	1/2-18		
Electrical characteristics	115 volt/60 Hertz/1 phase				

Figure 1

CONTENTS

OPERATION AND MAINTENANCE

- I - Operation
- II - Maintenance

INSTALLATION INSTRUCTIONS

- I - Shipping and Packing List
- II - Shipping Damage
- III - General
- IV - Application
- V - Lennox LSC18 Solar Collectors
- VI - Solar Water Heater Module LSM1

OPERATION AND MAINTENANCE

I - OPERATION

A - System Function

Once the entire Lennox LSHW solar water heating system has been installed and the transfer fluid and storage tank systems are filled, the system will operate by itself. The pump controller will register temperatures from the collector sensor and the storage tank sensor, activating the pump as required. Important in the operation is the temperature difference between the two sensors, referred to as the "ΔT". If the temperature at the collector is equal to the temperature of the storage tank the pump will be off. When the ΔT between the collector and the tank increases (example: the sun begins to heat the collectors) to $3^\circ \pm 1^\circ$, the pump will run intermittently, providing an amount of fluid circulation proportional to the ΔT. As the temperature difference between sensors increases so does the rate at which the pump provides circulation. When the temperature difference reaches 11° the pump will be on steadily and will continue until the ΔT becomes less than 11° . The pump will then proportionally circulate less fluid until the ΔT is again 3° or less. At this point the pump will shut off until the sensor temperatures require transfer fluid circulation.

B - Components and Functions

1 - Air Vent Valve

Located at the top of the transfer fluid system, this valve is a float type valve which will release air only. As fluid enters the valve, the float rises and closes the vent port. Any air in the system will be allowed to escape at this valve particularly when filling the system. See Figure 13.

2 - Pressure Relief Valve

Located at the top of the LSM1 module, (Figure 1), this valve will release any pressure in the transfer fluid system in excess of 50 psi (345 kPa). The discharge from this valve may exceed 200°F (93°C). Because of this temperature, the Pressure Relief Valve must be plumbed to an open drain. Water released from this valve is unsafe, glycol contaminated water.

3 - Temperature and Pressure Relief Valve

Located at the side of the LSM1 module, (Figure 1), this valve will discharge water from the Storage Tank when the stored water reaches a temperature of 210°F (99°C). This valve purges excess heat accumulated in the transfer fluid by releasing heater water from the storage tank and replacing it with cold supply water. This addition of cold water will cool the collectors and transfer fluid. The Temperature and Pressure Relief Valve must be plumbed to an open drain.

4 - Expansion Tank

The expansion tank absorbs the expansion and contraction of the transfer fluid which may vary from -20°F (-29°C) in winter to 240°F (116°C) in summer. The expansion tank is a diaphragm type which is pressurized to 12 psi (82.7 kPa) and sealed. Do not open tank. If tank should ever be opened or depressurized, recharge with 12 psi (82.7 kPa) of air.

C - Pump Controller

1 - "AUTO" position —

The pump controller has 3 positions. "AUTO" is the switch position for normal operation. If the temperature difference between the tank and the collector is great enough, 11° or more the pump

will run steadily (indicator light is on continuously) to circulate fluid through collectors. The pump will run intermittently (indicator light is "blinking") to circulate a proportional amount of fluid through collectors as temperature of tank approaches temperature of collectors — ΔT is between 3° and 11° . When indicator light is off (switch still in "Auto" position) the storage tank is up to a proper temperature and the pump is off.

2 - "ON" and "OFF" positions —

The "ON" and "OFF" controller switch positions are for service operations only. With switch in "ON" position the pump will run continuously. With switch in "OFF" position pump will not operate. **DO NOT LEAVE PUMP IN OFF POSITION FOR EXTENDED PERIOD OF TIME.** In summer the collectors may overheat without circulation.

D - Pump Motor

A two speed pump motor is provided with the LSM1 module. Low speed is recommended for the most satisfactory operation. The switch is located on the backside of motor electrical connection box. "1 Dash" position is the recommended speed. Check to be sure the "1 Dash" side of the switch is depressed. Set mechanical head adjustment (bottom of pump) on "5" or MAXIMUM. See Figure 2.

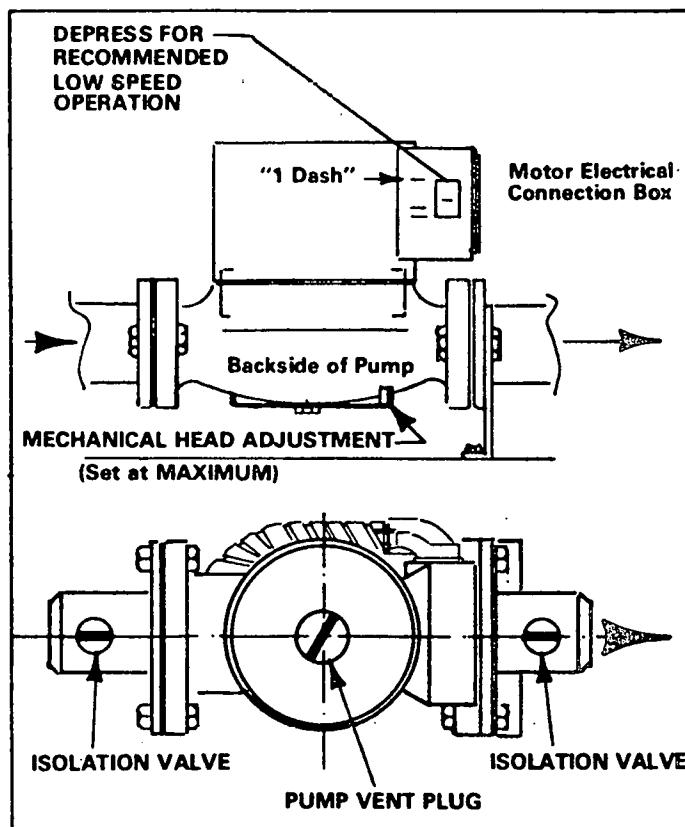
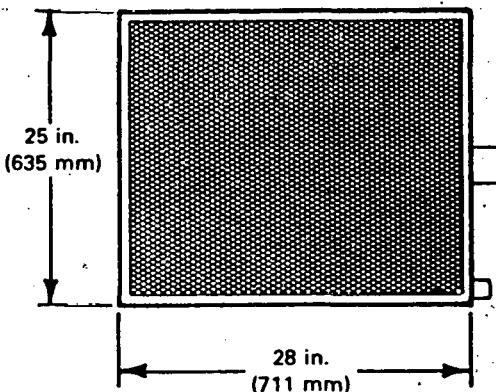


Figure 2

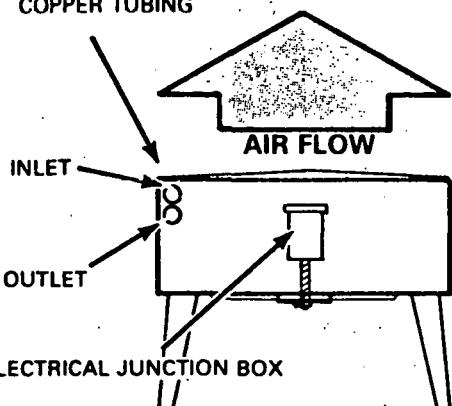
APPENDIX C
OVER TEMPERATURE CONTROL UNIT
(PURGE COIL)

DIMENSIONS

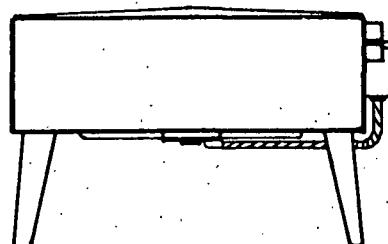
TOP VIEW



1-3/8 in. (35 mm) OD. DIAMETER
COPPER TUBING



REAR VIEW



SIDE VIEW

(VERTICAL AIR DISCHARGE SHOWN)

OPERATION/MAINTENANCE

I. - OPERATION

The HRW1 purge coil is an automatically controlled high temperature limiting device. Its function is to prevent an excessive buildup of heat in the collector loop fluid. When there is no demand for space heating or domestic hot water and the storage tank is charged to its designed temperature, any heat gathered by the solar collectors is retained in the collector loop fluid. When the temperature of the collector loop fluid reaches the setting of the purge aqua-stat (not supplied with purge coil unit) the collector loop fluid is routed through the purge coil and the fan is energized. Heat is dissipated to the outside air at the coil, lowering the collector loop temperature and preventing over heating of the collectors and collector fluid. The purge coil will automatically activate and deactivate as it cools the collector loop to the designed safe temperature or until other heat requiring demands can absorb the collector solar energy.

II - MAINTENANCE

Annually the purge coil system should be inspected and checked as follows:

- 1 - **Purge Coil**
Clean and inspect the coil and coil guard to be sure they are free of obstructions. Turn off power to unit and wash coil & coil guard with a garden hose.
- 2 - **Oil fan motor:**
 - a - **Motor without oiling ports** - Prelubricated and sealed. No further lubrication required under normal operation.
 - b - **Motor with oiling ports** - Add a few drops of SAE No. 10 non-detergent oil in motor oiling ports. Access to the fan motor may require unbolting and lowering the fan motor/fan guard assembly.
- 3 - Visually inspect connecting lines and coil for evidence of fluid leaks.
- 4 - Check all wiring for evidence of loose connections.
- 5 - Check for correct voltage at unit (unit operating).
- 6 - Check amp-draw on fan motor.

Unit nameplate _____ Actual _____

INSTALLATION

I - SHIPPING AND PACKING LIST

Package 1 of 1 contains:

- 1 - HRW1 Coil Unit
- 4 - Legs (Vertical discharge)

Plastic Bag Containing:

- 2 - Mounting brackets (Horizontal discharge)

24 - #6 Lockwashers

24 - #6 - 32 x 1/2" Screws

II - SHIPPING DAMAGE

Carefully inspect unit for shipping damage. If any damage is found, immediately consult the last carrier.

III - GENERAL

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

IV - APPLICATION

The HRW1 Purge Coil is intended for application with other Lennox solar equipment in a designed solar energy system. The purge coil may be installed outdoors with vertical discharge or indoors with horizontal discharge and is for use with a maximum of 30 Lennox solar collectors.

V - LOCATING AND SETTING UNIT

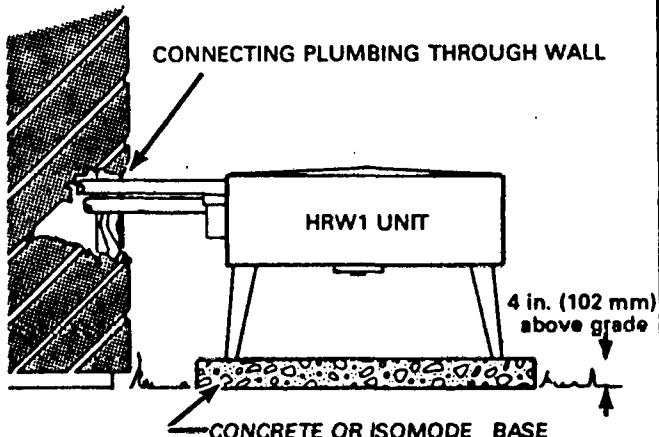
A sound absorbing material (such as Isomode) should always be used under unit if it is installed in a position or location that will transmit sound or vibration to the living area or to adjacent buildings. Refer to unit dimension drawing to size mounting slab, platforms or supports.

A - Vertical Discharge Outdoor Application

1 - Slab Mounting

When installing unit at grade level, install on a level slab high enough above the grade to allow adequate drainage of water. Top of the slab should be located so run-off water from higher ground will not collect around unit.

OUTSIDE APPLICATION



Refer to "Dimensions" illustration on Page 1 to determine pad size.

FIGURE 1

2 - Roof Mounting

Install the unit a minimum of 4 inches above the surface of the roof. Care must be taken to insure that the weight of unit is properly distributed over roof joints and rafters. Either redwood or steel supports are recommended.

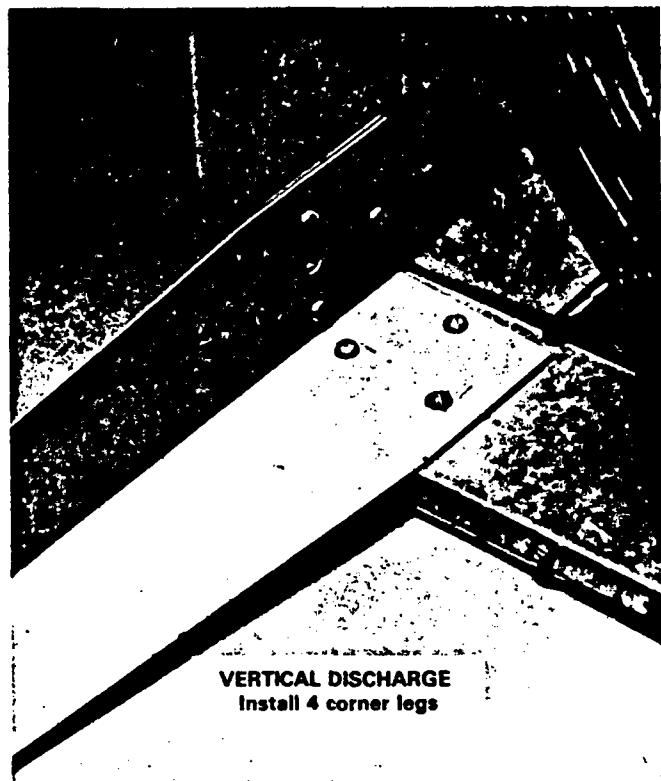


FIGURE 2

3 - Service Clearances

Refer to Figure 3 for proper service/installation clearances. Unobstructed air flow to and from the unit is important for proper unit performance.

SERVICE CLEARANCES (VERTICAL DISCHARGE)

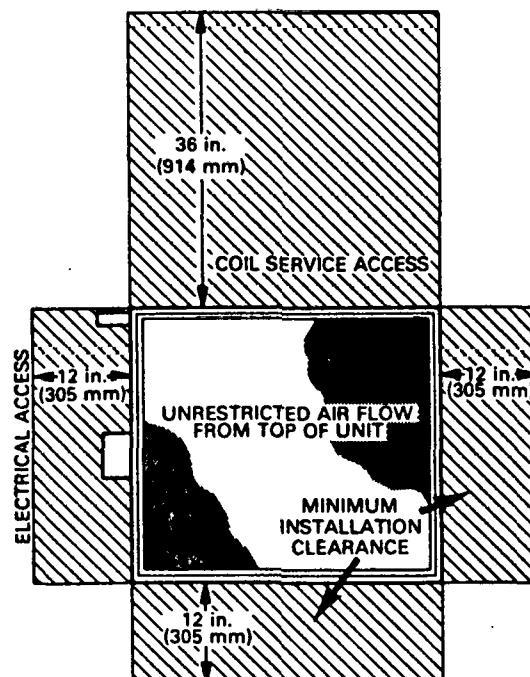


FIGURE 3

B - Horizontal Discharge Indoor Application

Certain applications may require installation of the HRW1 Purge Coil in an attic or other interior location. Figure 5 shows a representative attic installation with the purge coil fan exhausting air through the coil to the outdoors. Install the coil as follows:

- 1 - Provide an opening 23 in (234mm) by 26 in. (264mm) and a field

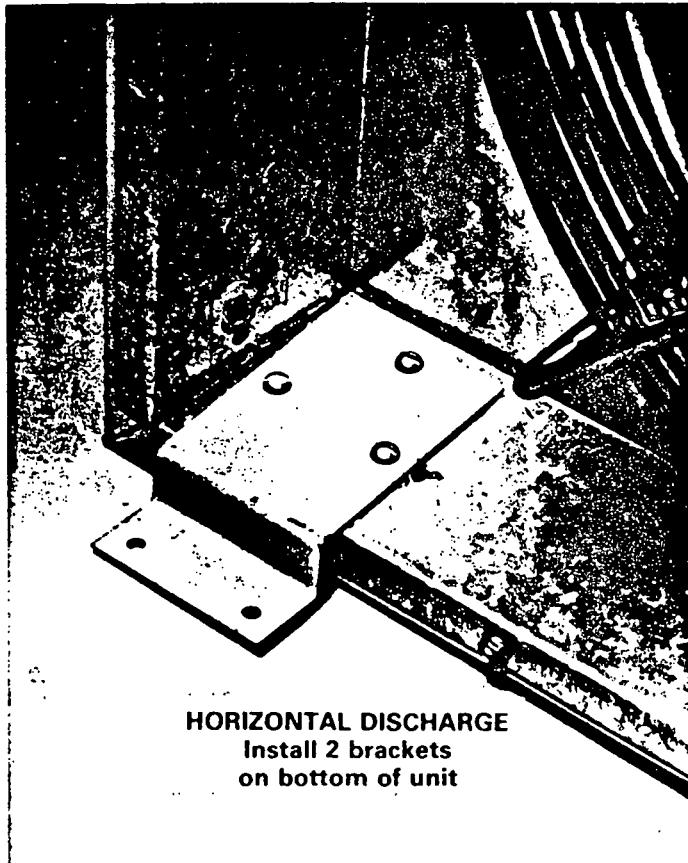


FIGURE 4

ATTIC APPLICATION HORIZONTAL DISCHARGE

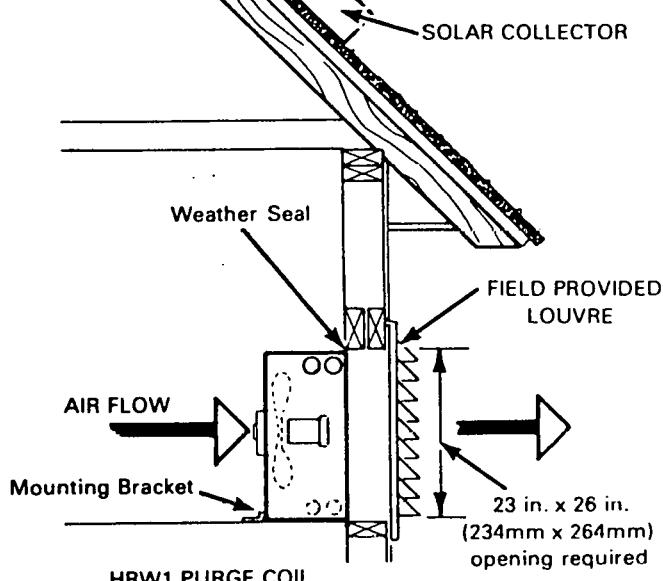


FIGURE 5

provided and installed louvre.

- 2 - Position HRW1 Purge Coil unit against opening in desired position (determined by installer).
- 3 - Fasten unit at bottom using (2) provided mounting brackets.
- 4 - HRW1 fan will exhaust 2100 cfm (0.99 m³/s). If attic air infiltration is not a sufficient supply, an additional louvre/intake vent may be required.

VI - PLUMBING CONNECTION

The inlet and outlet pipes can be identified in the "Dimensions" illustration on Page 1. Both inlet and outlet are 1-3/8 in. (35 mm) O.D. copper tube. Use proper copper sweat plumbing techniques to debur, clean, flux and solder connecting piping to the inlet and outlet tubes. Install valves and test ports as required by the total designed system schematic.

VII - ELECTRICAL CONNECTION

Wiring must conform to the National Electric Code (NEC) (NFPA No. 70-1975/ANSI C1-1975) and any local codes.

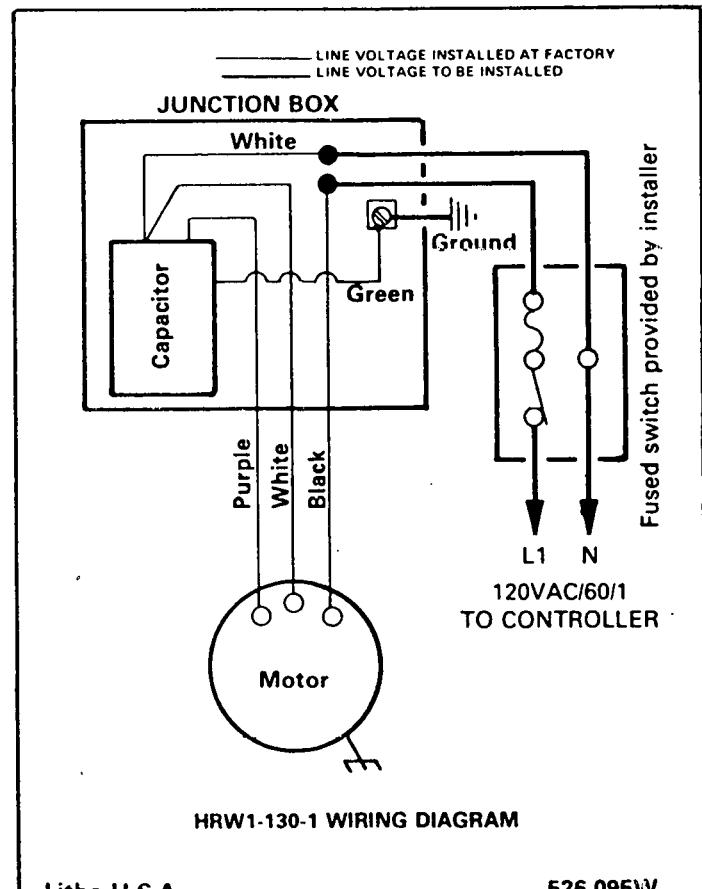
Note - National Electric Code (NFPA No. 70-1975/ANSI - C1 - 1975 is available from:

National Fire Protection Association
470 Atlantic Ave., Boston, Mass., 02210

An application diagram is provided in this instruction. Local or other codes may require the installation of a fused disconnect switch in the power circuit to unit. Refer to the designed total system instruction for proper connection of wiring to central controller.

VIII - CLEANUP

- 1 - Replace all electrical covers and access panels.
- 2 - Turn on power to unit.
- 3 - Refer to the total system instruction for operational check procedures.
- 4 - Generally cleanup installation.

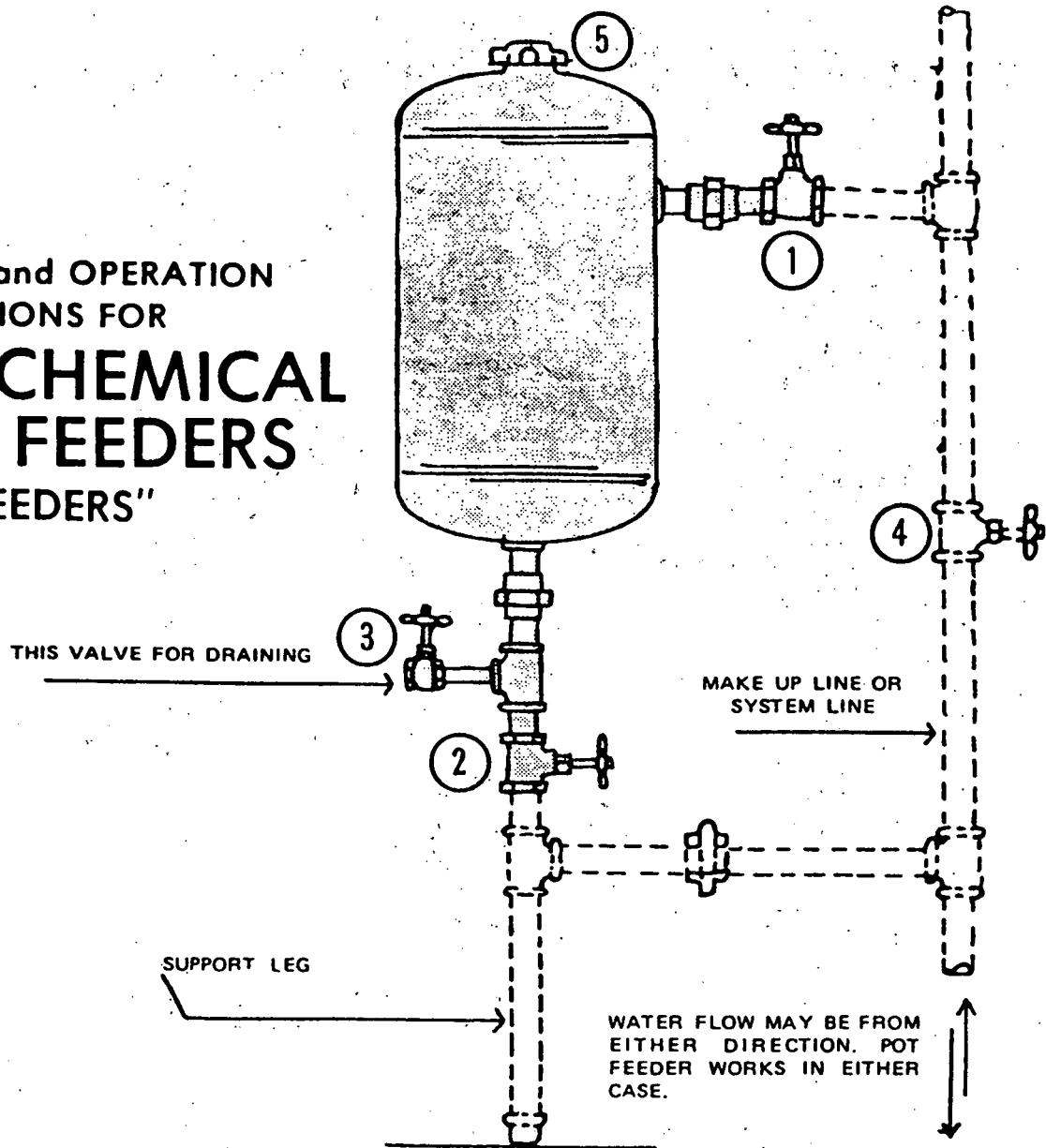


Litho U.S.A.

526,095W

APPENDIX D
CHEMICAL FEEDER

INSTALLATION and OPERATION
INSTRUCTIONS FOR
**MANUAL CHEMICAL
BY-PASS FEEDERS**
"POT FEEDERS"



NOTE: PIPE AND FITTINGS IN
DOTTED AREA ARE NOT SUPPLIED.

- A. Pot feeder should be empty when not in use. To empty, close valves (1) and (2), open valve (3) and loosen filler cap (5).
- B. To fill pot feeder, close valves (1), (2), (3). Remove filler cap (5) and fill with treatment.

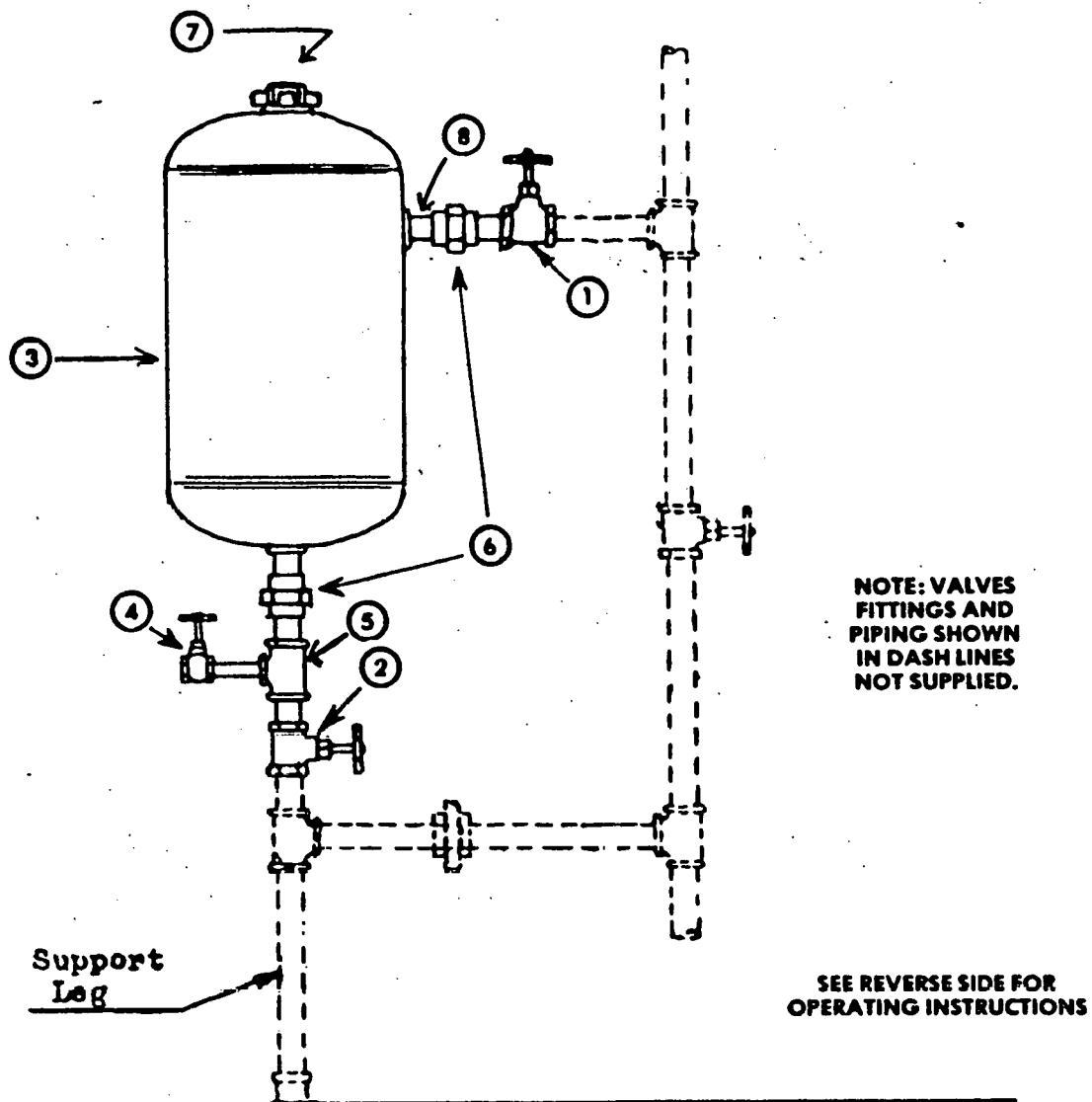
NOTE: IF YOU DO NOT FILL POT FEEDER TO THE
TOP WITH TREATMENT, YOU MUST TOP OFF WITH
WATER. THIS IS TO AVOID INTRODUCING AIR INTO
THE SYSTEM.

- C. To add treatment into boiler, close filler cap (5), close valve (4), open valves (1) and (2).

After treatment has left the feeder (not more than 30 seconds is required to accomplish this), open valve (4), close valves (1) and (2). Follow procedure A. to drain pot feeder.

MANUAL CHEMICAL BY-PASS FEEDERS

"POT FEEDERS"



PART & NAME	SPECIFICATIONS
#1 Valve, 3/4" Gate	
#2 Valve, 3/4" Gate	
#3 Tank	
#4 Valve, 1/2" Gate	
#5 Red. Tee, 3/4" x 1/2"	
#6 Unions 3/4" (2 reqd.)	
#7 Top Cover (3/4" Fleckenstein)	
#8 Nipples (6)	

MODEL NUMBER

6 1/2-10
1016

SIZE INCHES
DIA.—LGTH

6 1/2 — 10
10 — 16

APPROX. CAP.
(GAL.)

1 1/2
6

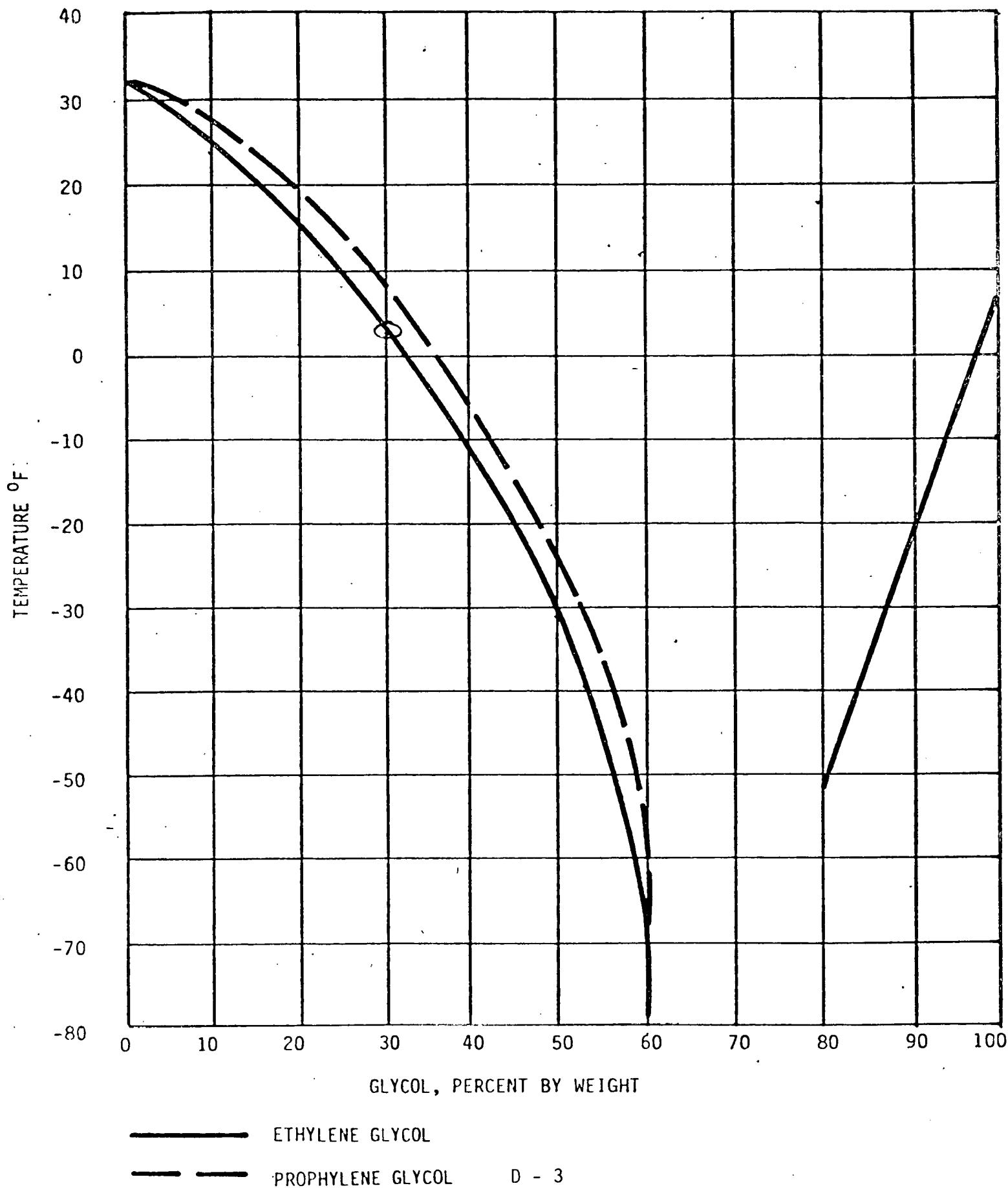
APPROX. SHIPPING
WGT

20 Lbs.
35 Lbs.

BUILT FOR 125 LBS. MAXIMUM PRESSURE

FREEZING POINTS OF AQUEOUS SOLUTIONS
OF ETHYLENE GLYCOL AND PROPYLENE GLYCOL

Reprinted from ASHRAE



APPENDIX E
MAIN HEAT EXCHANGER

MAIN HEAT EXCHANGER

TYPE: Water to water heat exchanger with steel shell and copper tube.

MANUFACTURER: TACO - Model No. B-12408-L
1160 Cranston Street
Cranston, Rhode Island 02920

TUBING: 3/4" copper

NO. OF PASSES: 4

TUBE CAPACITY: 30 GPM

TUBE TEMPERATURE "IN": 111°F

TUBE TEMPERATURE "OUT": 120°F

SHELL CAPACITY: 50 GPM

SHELL TEMPERATURE "IN": 130°F

SHELL TEMPERATURE "OUT": 124°F

PRESSURE DROP - TUBES: 1 Foot

PRESSURE DROP - SHELL: 2 Feet

HEAD MATERIAL: Cast Iron

TUBE PLATE MATERIAL: Cast Iron

APPENDIX F
STORAGE TANK HEAT EXCHANGERS

STORAGE TANK HEAT EXCHANGER

TYPE: Helical wound copper

LOCATION: One in each storage tank

FLOW: Reverse return

SURFACE AREA: 82.3 square feet

MANUFACTURER: Thermo-Pak, Inc.
P.O. Box 13223
Memphis, Tennessee
901-942-4684

PIPE CONNECTION: 2" union

PIPE SIZE: a) Helical pipe is 3/4", type "L" soft copper
b) Header (supply and return) is 2", type "L" hard drawn

PHYSICAL DATA: a) 16" in diameter
b) 62" in height
c) Four sections of closely wound 3/4" pipe around the
2" supply and return riser

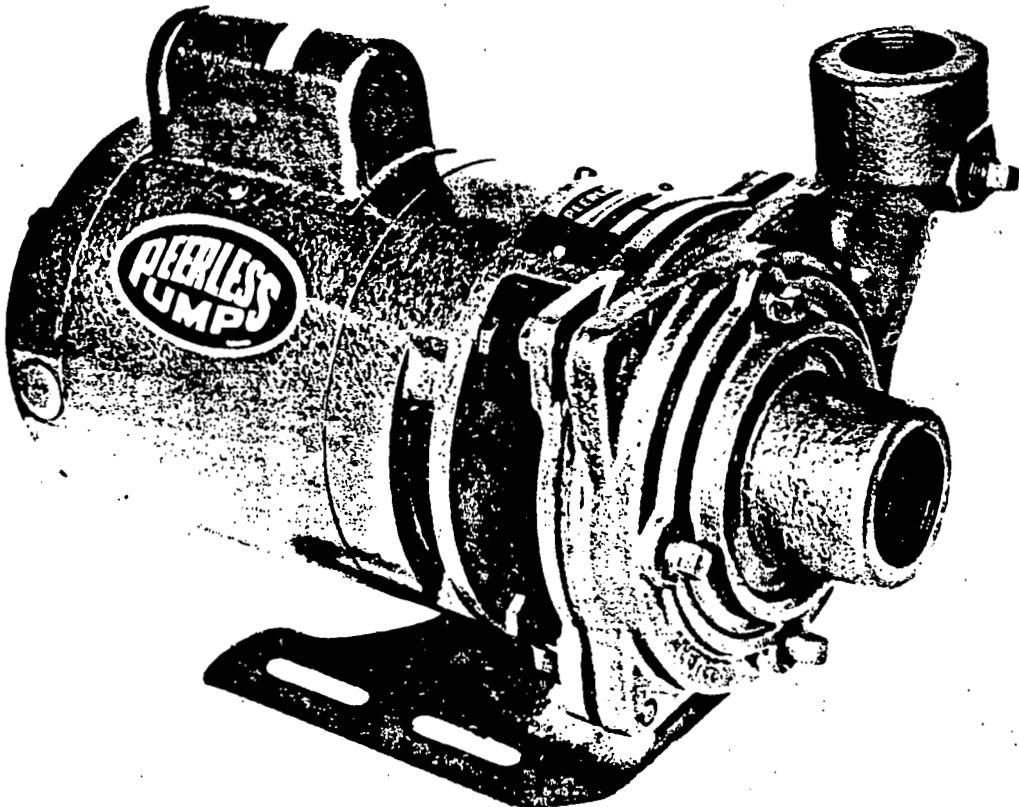
APPENDIX G

PUMPS

INSTALLATION
SERVICE AND
OPERATION
INSTRUCTIONS

Fluidyne® FRACTIONAL
HORSEPOWER

Types PE-B & PE-C PUMPS



HYDRODYNAMICS DIVISION

PEERLESS PUMP

© Los Angeles, California 90031 • Indianapolis, Indiana 46208

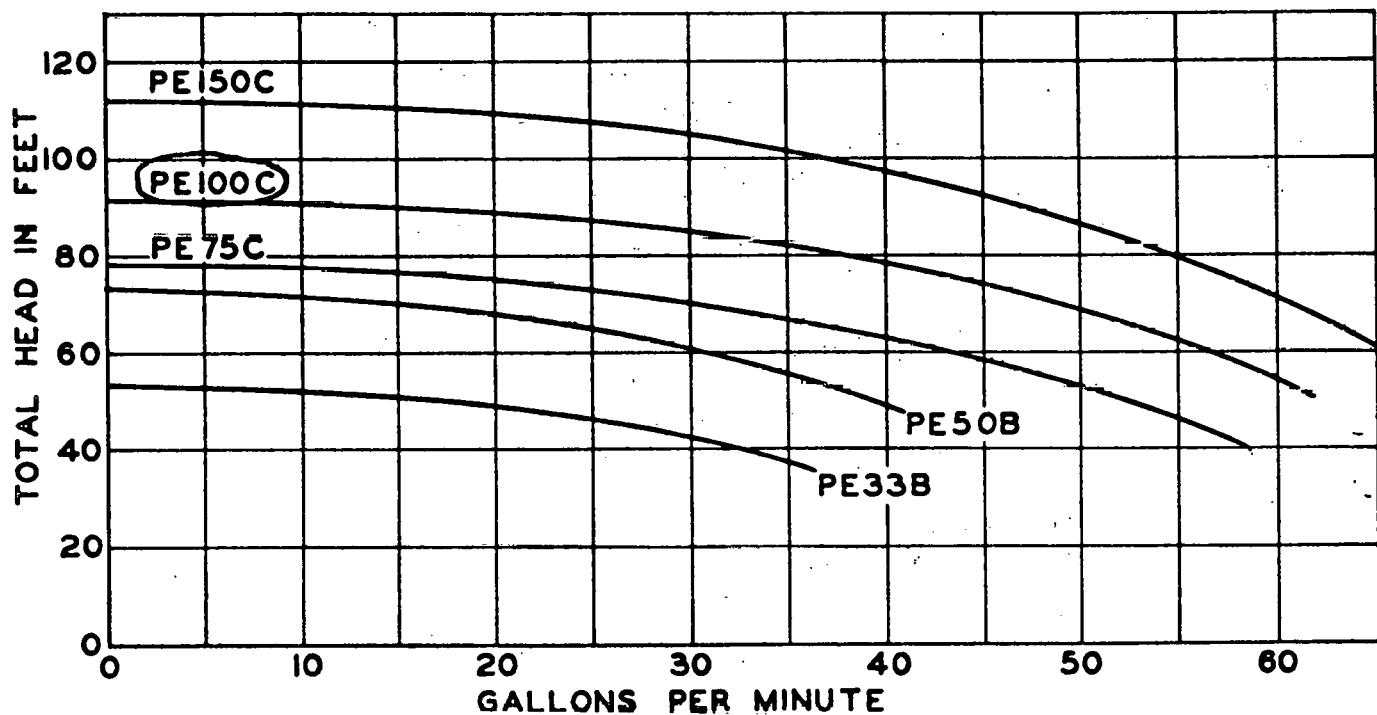
PERFORMANCE AT 3450 RPM

Types PE-B and PE-C

Fractional Horsepower Fluidyne Pumps

Impellers selected for maximum service factor of motor rating
based on handling clear water

160° F max temperature 80 psi max pressure



2892753

PE33B -- 1/3 hp

PE50B -- 1/2 hp

PE75C -- 3/4 hp

PE100C -- 1 hp

PE150C -- 1-1/2 hp

Installation and Operation

INTRODUCTION -- Your Peerless Fluidyne Pump will give the best possible service when installed according to instructions. Be sure to read this entire bulletin carefully before starting any installation operations. The Peerless Pump carries a one-year warranty against defects in manufacture. This warranty, however, does not apply to parts damaged in transit. Check the shipment carefully and report any damage or shortage to the transportation company immediately.

LOCATION -- Place the pump as close as possible to the water supply, considering suction specifications for the pump, accessibility for installation, inspection, and service operations. The most direct and simple piping is best, especially for the suction line. If possible, locate the pump so that the water flows by gravity into the pump suction.

FOUNDATION -- The pump foundation should be strong enough to support the pump solidly and permanently in position. A concrete foundation is recommended.

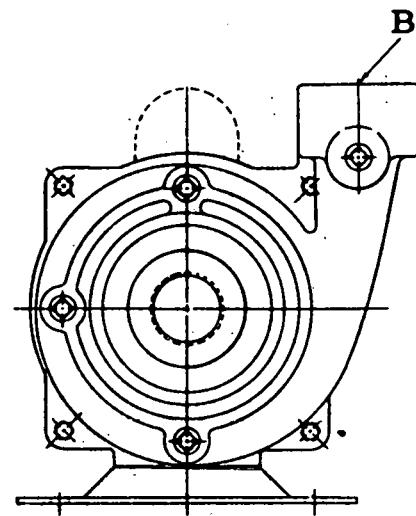
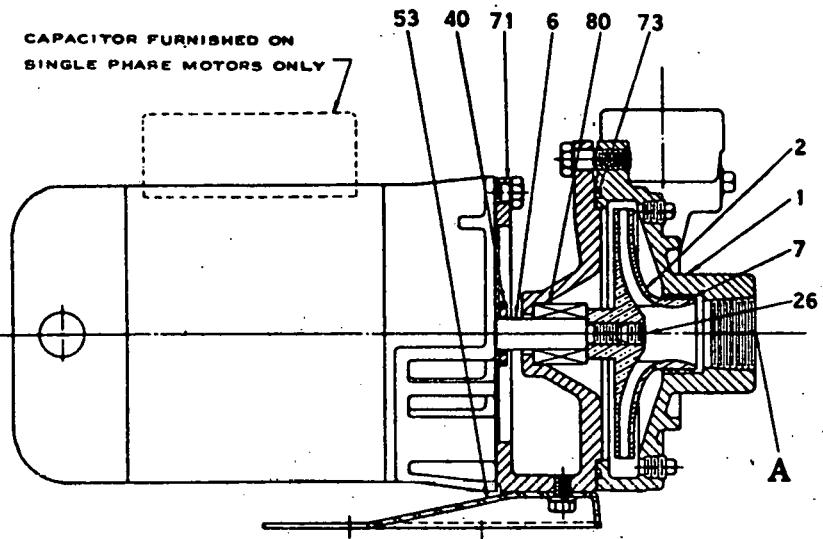
PIPING -- To facilitate and simplify piping, the volute casing and discharge flange can be rotated to any one of 4 positions by removing the 4 adaptor-to-casing cap screws and rotating to the desired position. The bleeder air vent should be moved to the position at the top of the casing in any change from the normal factory-assembled position. Suction piping should not contain any low points which can trap air. When the pump is located above the level of the water, a check-valve or foot-valve should be installed in the suction line to maintain prime, and a priming tee should be so located at the discharge flange of the pump that the case and suction line can be completely filled. If debris is apt to be present, a combination foot-valve strainer should be used. When the suction is under pressure, or the level of the water is above the pump, a valve and union should be installed in both the suction and discharge pipes to permit inspection and service of the pump at any time. To obtain optimum performance, suction pipe joints must be made up with pipe joint com-

pound to insure that there are no air leaks. When the pump is located above the liquid or operating with a suction lift, even a small air leak in the suction line will materially reduce capacity of the pump or cause a loss of prime. If a union is required, use a gasket type and seal it with pipe joint compound. Also, the pump must not support heavy suction or discharge piping, and piping must not be forced into place because this could result in distortion and binding of rotating parts.

ELECTRICAL CONNECTIONS -- Be sure the motor terminals are connected for the voltage to be used. Connection diagrams can be found on the nameplate or inside the terminal cover. Single phase, 1/4 and 1/3 horsepower motors are wired for 115 volts only. 1/2 thru 1-1/2 horsepower may be wired for either 115 volts or 230 volts as desired; standard factory connections you receive should be 230 volts. Three phase motors may be of other voltage and are not pre-connected. Local electrical codes governing wiring should be observed.

MOTOR -- The motor supplied with the Peerless Fluidyne Pump does not require lubrication -- it is life-time lubricated. It also has built-in overload protection which will automatically reset as the motor cools, therefore the main switch should always be open when working on the motor. If for any reason the motor is serviced or reconditioned, its rotation should be checked to be clockwise when looking toward the pump at the end opposite the shaft extension. Also, this end of the shaft, covered by a plug, has a screw driver slot referred to elsewhere for holding or turning the motor shaft, pump, etc.

IMPELLER -- The impeller rotating in the pump casing is the only moving part of a centrifugal pump. In case of reduced pressure or reduced capacity requiring service traceable to the impeller, its water passages should be inspected by passing a flexible wire etc. from the outside toward the center to dislodge any obstructions. See DISASSEMBLY as required for this operation.



1 casing - cast iron
 2 impeller - bronze
 6 shaft - stainless steel
 7 casing ring - bronze
 40 deflector - rubber
 53 base - steel
 71 adapter - cast iron
 73 "o" ring seal
 80 mechanical seal

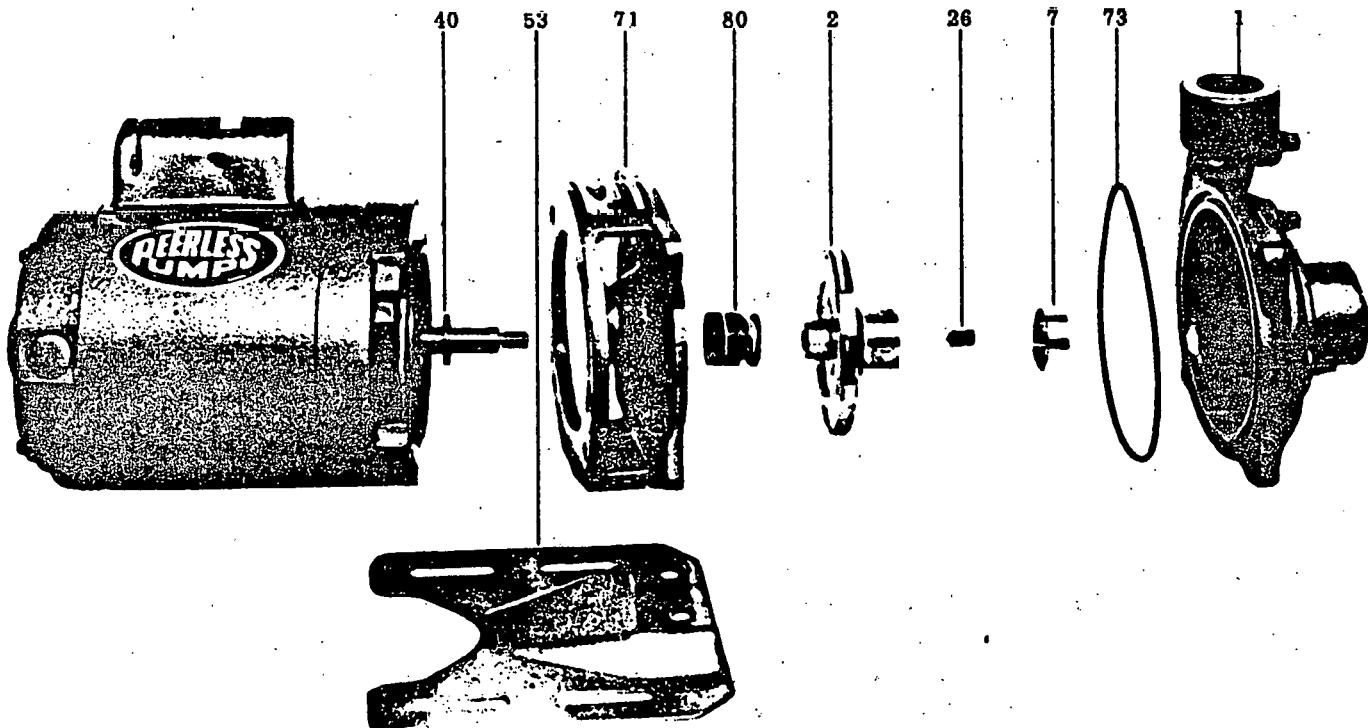
A suction
 B discharge
 26 impeller screw
 - stainless steel

Type PE-B

1-1/4 NPT
 1 NPT
 not used

Type PE-C

1-1/2 NPT
 1-1/4 NPT
 3 ph only



MECHANICAL SHAFT SEAL -- A short run-in period may be required when a new unit is placed in operation before a perfect seal is effected in the mechanical shaft seal. However, there should be no leakage at the seal during normal operation. If considerable grit, etc., is present in the water, the seal may eventually become scored and develop a leak. In such case, the seal should be disassembled and all parts cleaned thoroughly. The rubber bellows should be examined for leaks and the seal faces for scratches. Worn parts should be replaced, but emergency repairs may be made of the seal faces by smoothing these on No 500 grit carborundum paper placed on plate glass to provide a flat surface. See **DISASSEMBLY** as required for this operation also.

PRIMING & STARTING -- When the pump is located above the level of the liquid, the pump must be primed by filling the case and suction line through the tee installed at the discharge flange. Be sure all the air has been expelled from the suction pipe and pump case. Plugs are provided for the release of air trapped at the top of the impeller cavity.

The rotation of single-phase motors is predetermined by internal wiring, but the rotation of 3-phase motors must be checked at installation by momentarily closing the electric service switch and observing the rotation. It should be clockwise when looking toward the pump from the free end of the motor. Interchange of any 2 of the 3 power leads will reverse a 3-phase motor.

DISASSEMBLY -- It is advisable that a competent pump mechanic be employed for disassembly and reassembly operations. Before starting disassembly of the pump, re-check to make certain that this operation is necessary. Close any valves that may be installed in the suction or discharge piping. Remove a plug at the bottom of the pump case and a plug at the top to admit air and expedite draining. Remove the (4) case-to-adapter screws and the mounting foot screws. This permits removal as an assembly: the motor, the adapter, the foot, and the impeller. The impeller is now exposed for inspection and cleaning. See paragraph on impeller. The impeller is assembled to the motor shaft by 7/16-20 R.H. thread. On 3-phase units, impellers are locked in place with a 7/16-20 hex socket set screw. If disassembly is necessary, hold the motor shaft with a screwdriver engaging the slot which is covered by a cap at the opposite end, remove the set-screw, if provided, and turn the impeller counter-clockwise. The mechanical shaft seal can now be removed for inspection, service, or replacement.

REPLACEMENT PARTS -- When ordering replacement parts be sure to give both the Model No and Serial No appearing on the nameplate on the top of the adapter, as well as the part name.

REASSEMBLY -- Cleanliness is essential in the reassembly of any pump, especially to make sure that no grit, etc., is included between the surfaces of the mechanical shaft seal. Also, all connections should be made air and water tight.

DO NOT RUN A PUMP
NOT FILLED WITH WATER
(It keeps the seal lubricated)

TROUBLE SHOOTING GUIDE

PROBABLE CAUSES	SOLUTIONS
MOTOR WILL NOT START OR RUN	
Circuit incomplete, wiring incorrect.	Check wiring and instruction on ELECTRICAL CONNECTIONS .
Motor or capacitor defective.	See dealer for service.
Impeller or seal stuck.	Turn motor shaft with screw-driver engaging slot end of shaft.
Overload tripped.	See MOTOR OVERHEATS (below).
MOTOR OVERHEATS	
Voltage low, wrong connections.	See instructions on ELECTRICAL CONNECTIONS .
Head or lift exceeds unit rating.	Reduce lift -- increase pipe size.
Viscosity or specific gravity exceeds rating -- water.	See dealer for proper application.
Mechanical defect in motor or pump.	See dealer for service.
Ventilation -- poor.	Vacuum clean motor air passages, ventilate surrounding area.
MOTOR RUNS * NO WATER * LOW CAPACITY * LOW PRESSURE	
Pump not primed.	See PRIMING & STARTING instructions.
Speed rpm below motor tag specification.	Check for incorrect voltage or motor overload.
Rotation reversed.	Reverse any (2) of (3) leads for (3) phase.
Lift or head total exceeds unit rating.	Reduce lift -- increase pipe size.
Air leak in shaft seal.	See instructions on MECHANICAL SHAFT SEAL .
Air leak in suction pipe.	Make up tight with pipe joint compound.
Air trapped in suction pipe.	See instructions on PIPING .
Plugged foot-valve or screen.	Clean.
Plugged impeller.	See instructions on IMPELLER & DISASSEMBLY .
Impeller wear or damage.	See instructions on IMPELLER & DISASSEMBLY .
PUMP LOSES PRIME AFTER STARTING	
Air leak -- suction piping.	Make up tight with pipe joint compound.
Suction lift excessive.	Reduce lift -- increase pipe size.
Screen or foot-valve plugged.	Clean.
Air leak -- mechanical shaft seal	See instructions on MECHANICAL SHAFT SEAL .
PUMP VIBRATES OR IS NOISY	
Insecure footing.	Re-work.
Air leak in suction pipe.	Make up tight with pipe joint compound.
Cavitation due to excessive lift.	Reduce lift.
Clogged impeller.	See instructions on IMPELLER & DISASSEMBLY .
Bent shaft.	Remove from motor and straighten or replace.
Motor bearing wear.	Replace bearings.

APPENDIX H
BACK-UP BOILER

The A.S.M.E. safety valve is shipped on the boiler. Pipe the safety valve outlet to a drain or near to the floor; do not pipe safety valve discharge to any area where freezing temperatures could occur.

Two or more boilers may be utilized where necessary to obtain the desired capacity. Standard industry piping practices should be used for headering the steam and condensate return piping. The waterlines of all boilers should be at the same level. A boiler water-level controller and boiler feed pump system is recommended in order to provide best service. Locate the "body mark" of the boiler water level controller 1-1/2" below the centerline of the boiler's water gauge glasses.

WIRING THE BOILER

The Model CE boiler is pre-wired at the factory. Please see wiring diagram for internal and external wiring. The Model CE electric boiler contains internal overload protection. Provisions are made in the upper left hand corner of the boiler cabinet to accept the power input wiring. Listed in the table are the minimum recommended wire sizes according to the boiler capacity. The wire size listed for each boiler size is based on using a copper conductor for runs of 50 feet or less; for runs in excess of 50 feet consult National or Local Electrical Code Manual. Bring the power input wiring from the disconnect panel through the conduit opening in the boiler cabinet and connect the wires to the fuse blocks shown in wiring diagram. Please note that the power input wiring must have at least a 90°C rating.

Up to seven (7) thermal time delays and up to six (6) heating element contactors are prewired in the boiler cabinet. Each thermal time delay is wired in series with its respective heating element contactor to prevent a sudden inrush of electrical current. On a "call for heat", only one contactor at a time is allowed to become energized.

A low voltage (24 volt secondary) transformer is mounted in the boiler cabinet to provide a power source for the control circuit. The CE boiler is provided with both an operating control and a limit control, and the steam boiler also has a low water cutoff. Our wiring diagram also shows the use of a low voltage thermostat or controller which should be used to obtain proper control function and safety of operation. Note that high limit controls must be set at least 2 PSIG or 20°F higher than operating control settings.

EXTERNAL CONTROL WIRING- WATER BOILERS

If it is desirable to utilize outdoor thermostats to provide control of the heating elements, the outdoor bulb of such a controller must be located to sense outdoor temperature, but the bulb should not be exposed to the sun, rain, snow or the warm air from ventilating openings.

Where only one zone is utilized, the relay, circulator, thermostat, etc., should be wired according to the controls employed (refer to manufacturer's instruction for application information). For single zone applications where only one (1) low voltage operating control is utilized, the operating control must be wired across terminals 1 and 2 of the low voltage terminal board.

On radiant panel systems, heat pumps, etc., where optimum control of the water temperature is desired, placing the operating control (bulb) in the return water piping near the boiler is desirable, as is constant water circulation through the system.

EXTERNAL CONTROL WIRING- STEAM BOILERS

For single zone applications where only one (1) low voltage operating control is utilized, the operating control must be wired across terminals 1 and 2 of the low voltage terminal board.

No. OF BRANCH CIRCUITS REQUIRED AND MINIMUM WIRE SIZE (90°C WIRE)

For the number of branch circuits required and the wire size, please refer to the appropriate column on page 6. Do not use aluminum conductors.

SEQUENCE OF OPERATION

Call for Heat —

1. The thermostat contacts close (external operating control) energizing the first contactor (1K) and the heater in the first thermal time delay (TD1).
2. Approximately 30 seconds later, the thermal time delay contacts close, energizing the second contactor (2K) and the heater in the second thermal time delay (TD2).
3. Approximately 30 seconds later, the second thermal delay contacts close, energizing the third contactor (3K) and the heater in the third thermal time delay (TD3).
4. This sequence continues until all contactors are energized or until the call for heat ends.

End of Call for Heat —

5. The thermostat (external operating control) contacts open, de-energizing the first contactor (1K) and the heater in the first thermal time delay (TD1).

Installation Instructions

MODEL CE, SERIES 1 ELECTRIC - HYDRONIC WATER AND STEAM BOILERS

Weil-McLain

6. After a minimum of 10 seconds the contacts in the first thermal time delay open, de-energizing the second contactor (2K) and the heater in the second thermal time delay (TD2).
7. This sequence continues until all contactors are de-energized.
8. When the boiler temperature or pressure exceeds the operating control setting, the thermostat circuit is opened and the elements are de-energized in a normal off sequence. If the high limit setting is exceeded, the transformer secondary circuit is open and all element contactors are de-energized instantly.

TROUBLE SHOOTING GUIDE

(Refer to Wiring Diagram)

I. Symptom — No Heat

A. Check fuses.

Fuses F1 and F5 supply power to the control circuit.

B. If fuses are good, jumper the thermostat terminals. If boiler starts, check the thermostat and associated wiring.

C. If thermostat and wiring are good, check the "Limit" and operating control.

1. Jumper terminals of High Limit Control together. If the boiler starts, replace the limit control.

2. If the boiler does not start in Step 1, jumper the terminals on the operating control. If the boiler starts, replace the operating control.

D. If the Limit and Operating controls are good, check the transformer.

1. Measure the transformer secondary voltage from control tray to transformer side of the "High limit" control; it should measure 24 volts a.c. $\pm 10\%$.

2. If the voltage is 0, replace the transformer (the transformer is fused, behind the insulated cover of the transformer, and replacement of the fuse is possible if care is exercised.)

E. If the secondary voltage is low, the primary voltage is correct, remove the transformer secondary lead from the limit control.

1. If the voltage remains low, replace the transformer.
2. If the voltage increases, reconnect the transformer lead to the Limit control, and disconnect the contactor coils one by one while observing the voltmeter. If voltage returns to normal upon disconnecting one of these, replace the defective contactor.

II. Symptom — Low Heat

One or more contactors do not energize. Operation of any contactor, beyond the first is dependent upon the operation of two components:

1. Thermal time delay.

2. Contactor itself.

Observe the sequence of operation and note the contactor where the sequence stops. Proceed as follows:

Disconnect the wire going from the contactor coil to the thermal time delay, using a jumper wire, reconnect the contactor coil terminal to terminal 1 of the thermostat terminal strip.

1. If the contactor energizes, replace the thermal time delay.

2. If the contactor fails to energize, replace it.

III. Symptom — Boiler Does Not Shut Down

One or more contactors remain on after call for heat ends.

A. Check contactors.

Lower the temperature setting on the "High Limit" control to simulate a limit of operation.

1. If all contactors instantly de-energize, the contactors are good.

2. If one or more contactors fail to de-energize, replace the contactors that failed to de-energize.

B. If all contactors de-energized check the thermal time delays.

Return the temperature setting on the "High Limit" control to its original setting. Allow the boiler to sequence on with a normal call for heat. When all contactors are energized, lower the setting on the operating control to satisfy the call for heat. Observe the shut down sequence and note the contactor at which it stops. Replace the thermal time delay supplying power to that contactor.

PLEASE HANG THESE INSTRUCTIONS NEAR THE BOILER

OPERATING INSTRUCTIONS FOR WEIL-MCLAIN ELECTRIC BOILER

Mr. Boiler Owner:

Below, the procedure is outlined for starting your Weil-McLain Boiler including instructions for the care of your heating system. All mechanical equipment needs occasional attention. The boiler should be inspected, cleaned and if necessary, adjusted once a year. We recommend that a qualified serviceman be called as he has been trained for the job and will have the necessary instruments to check your boiler. This will assure you that the operation of your heating system will remain highly efficient. Your Weil-McLain boiler will give you many years of heating comfort, if you follow the few simple suggestions listed in this instruction sheet.

FILLING STEAM AND WATER BOILERS

Do not fill the boiler (except for leakage tests) until the boiler is ready to be fired. **CAUTION:** Do not add large quantities of cold feed water to any hot boiler!

Steam Systems: The boiler should be filled to the normal water line and fired for about 15 minutes at a low rate sufficient to keep the boiler at steaming temperature with the steam vented to drive off dissolved gases (also see Skimming Steam Boilers).

Water Systems: The boiler and the entire system should be filled to about 12 pounds per square inch and heated to approximately 210°F for about 15 minutes to drive off dissolved gases. Before filling the system, make sure all the system air vents are closed. Open the hand water feed valve and beginning on the lower floor, open the air vents (one at a time) until water starts to flow; then, close the vent. Repeat this throughout the building until all heat distributing units are filled with water.

Close the hand water feed valve when the correct boiler pressure is reached. After the system is in operation, keep the system filled with water by occasionally opening the air vents allowing any entrapped air to escape and adding enough make up water to maintain the correct system pressure. If your system is provided with a purge valve located in the system return piping, connect a garden hose to the drain valve located above the purge valve. Close the purge valve and open the hand water feed valve and allow the system to purge all air. Where the system has more than one circuit, purge each circuit separately by opening each balancing valve one at a time. When the system is purged of all air, close the drain cock located above the purge valve and open the purge valve. Fill the boiler and the entire system to the correct pressure. Air in the system can interfere with circulation of water and prevent the heat distributing units from properly heating.

TO START THE BOILER

1. Be sure the main electric switch in the boiler electrical circuit is turned to the off position.
2. The boiler must be filled to the correct water level or pressure as outlined above.
3. Set the limit control at desired setting as recommended in these instructions.
4. Turn the thermostat to its lowest setting so there is no call for heat and close the main electric switch in the boiler electrical circuit.
5. Turn the thermostat above the actual room temperature and observe that the heating elements sequentially become energized.
6. Check operation of all limit controls.
7. Set the thermostat to the desired room temperature.
8. If boiler operates incorrectly (see Sequence of Operation) or fails to start, refer to Trouble Shooting Guide in these instructions.

SKIMMING STEAM BOILERS

All new boilers and steam and water piping contain oil, grease, chips, and other foreign matter. It is essential to clean new heating systems to remove these materials in order to avoid overheating of boiler metal, foaming and priming, and high maintenance costs on strainers, traps, and vents. The boiler installer should use the following procedure to clean oil, grease, and other impurities from the new boiler:

1. Close the valves in the building steam supply main(s).

2. Provide at least a 1 1/4" skim line, with valve, from the boiler skim tapping and run this line to a convenient floor drain.
3. Energize the boiler for a period sufficient to keep the boiler at steaming temperature allowing the steam, along with entrained water and impurities, to discharge through the skim piping to the drain.
4. Feed the water to the boiler as required to maintain

proper water level in the gauge glass. It may be necessary to cycle the boiler to prevent a rise in steam pressure above several pounds.

5. Continue the boiling and skimming process for at least two hours or until the water leaving the skim line is clear of all grease, oil and impurities. On unusual jobs, the skimming procedure may require repeating one or more times.

CAUTION: THE USE OF CHEMICAL CLEANERS IS NOT RECOMMENDED!

6. Drain boiler and, while the boiler is warm but NOT HOT, remove safety valve and insert a hose nozzle into the opening. Flush all interior surfaces of the boiler with water under full pressure until all traces

—of dirt and impurities are removed and the drain water runs clear.

7. Replace safety valve; close drain cocks, fill with fresh water to the water-line. Start boiler and steam for 15 minutes to remove all dissolved gases; stop boiler.
8. Drain boiler sufficiently to remove skim piping; plug skim tapping; refill boiler to water-line.
9. To prevent the return of impurities to the boiler from new or old piping systems, waste all condensate for several days or until no impurities are contained in the condensate. **NOTE: IT IS IMPERATIVE THAT FEEDWATER BE SUPPLIED TO MAINTAIN THE CORRECT WATER LEVEL AND THAT A LOW WATER CUTOFF IS OPERATIVE.**

BOILER SERVICE AND MAINTENANCE

Leaks in the boiler and piping system must be repaired at once. The use of makeup water in large quantities is undesirable and may damage the boiler after an extended period of time. If serious leaks occur, stop the boiler and gradually reduce boiler pressure or temperature. Do not attempt to make repairs while a steam boiler has pressure or hot water boiler temperatures are above 130°F.

Foaming or priming may occur in a steam boiler and cause large quantities of water to pass out into the steam main(s). It can be observed by violent fluctuations of water level, in the gauge glass. This trouble may be caused by dirt, oil, or precipitates in the boiler water, too high a boiler water level, a high overload on the boiler (i.e., the sudden release of boiler steam pressure into the mains by action of fast operating valves), or the addition of too much boiler water treatment. With serious foaming or priming, stop the boiler and decrease boiler load. Then alternately blowdown and slowly feed fresh water several times. If trouble persists, it may be necessary to skim the boiler one or more additional times.

Any problem in regard to large amounts of makeup water, extreme foaming or priming, scale in the boiler, or internal corrosion or pitting, should be referred to a company specializing in boiler water chemistry.

Frequently check the boiler water level in the gauge glass of steam boilers, and check the boiler operating pressure of steam or water boilers. Test the low water

cutoff by opening its blowdown valve to remove dirt, rust, and sediment, and observe that burner stops as the water level approaches the bottom of the water gauge glass (gauge glass on steam boilers only).

DO NOT DRAIN BOILER during periods of shutdown unless heating system is exposed to freezing temperatures. On steam boilers, open boiler blowdown valve and flush till clear while under steam pressure. On water boilers, open boiler drain cock to remove impurities that have settled to the bottom of the boiler. Refill as required to the correct water line for steam boilers or the correct pressure for water boilers. Turn off all electrical power connections to the boiler. If the water side of the boiler must be cleaned or inspected, open the blowdown valve and drain the boiler.

Remove plugs from the boiler and open the drain cock. Hose the inside of the boiler with high pressure water to remove sludge and sediment, flush again. Dry insides of boiler thoroughly, or refill with fresh water and heat to release dissolved gases (see Filling Steam and Water Boilers). Repeated draining and filling of the boiler and/or the heating system can lead to the same consequences as adding too much makeup water.

Refer to Water Boiler Controls or Steam Boiler Controls for specific service requirements.

Periodically check and if necessary, tighten any gasket bolts.

CHANGING HEATING ELEMENTS

1. If the boiler will not get hot enough to properly heat the building, it is possible that one or more heating elements are burned out.
2. Open the main electric switch in the boiler electrical circuit.
3. Your serviceman can determine whether any of the heating elements are burned out by disconnecting the wires to each element and checking the resistance and continuity with an Ohmmeter.
4. Close the system valves located at each side of the boiler.
5. Open the boiler drain cock and completely drain the boiler.

6. Remove the four (4) cap screws which secure the burned out heating element to the boiler casting and remove the burned out element.
7. Use a new heating element gasket and insert a new heating element of the same type (voltage, dimensions and KW or watts rating) into the opening in the boiler casting. Secure the element to the casting using the four (4) cap screws.
8. Fill the boiler with water to the correct level or pressure.
9. Open the system valves located at each side of the boiler.
10. Close the main electric switch in the boiler electrical circuit.



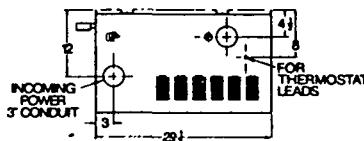
Boiler Model No.	Boiler Capacity BTU/Hr. [†]	Kw	Lbs. of Steam per hour @ 212° F.	No. & Size of Elements		No. of Circuits Required*		208 V.				240 V.				480 V.	
								1 Phase		3 Phase		1 Phase		3 Phase		3 Phase	
				1 Phase	3 Phase	1 Phase	3 Phase	Amps [○]	Wire ⁺								
WATER CE-48-W	163,824	48	—	6-8KW	3-16KW	2	1	116/116	0/0	135	00	100/100	1/1	117	0	58	4
CE-56-W	191,128	56	—	7-8KW	—	2	—	154/116	000/0	—	—	134/100	00/1	—	—	—	—
CE-64-W	218,432	64	—	8-8KW	4-16KW	2	1	154/154	000/000	180	0000	134/134	00/00	155	000	78	3
CE-80-W	273,040	80	—	—	5-16KW	—	2	—	—	135/90	00/2	—	—	117/78	0/3	58/40	4/6
CE-96-W	327,648	96	—	—	6-16KW	—	2	—	—	135/135	00/00	—	—	117/117	0/0	58/58	4/4
CE-112-W	382,256	112	—	—	7-16KW	—	2	—	—	180/135	0000/00	—	—	155/117	000/0	78/58	3/4
CE-128-W	436,864	128	—	—	8-16KW	—	2	—	—	180/180	0000/0000	—	—	155/155	000/0000	78/78	3/3
STEAM																	
CE-16-S	54,608	16	56.3	2-8KW	1-16KW	1	1	78	3	45	6	67	4	39	8	20	8
CE-24-S	81,912	24	84.5	3-8KW	—	1	—	117	0	—	—	102	1	—	—	—	—
CE-32-S	109,216	32	112.6	4-8KW	2-16KW	2	1	78/78	3/3	90	2	67/67	4/4	78	3	39	8
CE-40-S	136,520	40	140.8	5-8KW	—	2	—	117/78	0/3	—	—	102/67	1/4	—	—	—	—
CE-48-S	163,824	48	169.0	6-8KW	3-16KW	2	1	117/117	0/0	135	00	102/102	1/1	117	0	59	4
CE-64-S	218,432	64	225.3	—	4-16KW	—	2x	—	—	90/90	2/2	—	—	78/78	3/3	78	3
CE-80-S	273,040	80	281.6	—	5-16KW	—	2x	—	—	135/90	00/2	—	—	117/78	0/3	98	1
CE-96-S	327,648	96	337.9	—	6-16KW	—	2x	—	—	135/135	00/00	—	—	117/117	0/0	117	0

[†]Gross output ratings. Piping loss not confined to the heated space should be added to the building loss to determine total heating requirement.

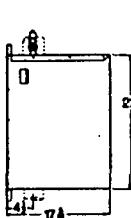
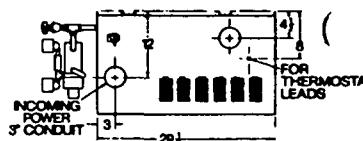
- * Number of circuits required to supply power to the boiler.
- Total amperes in each circuit supplying power to the boiler.
- + Minimum U.S. Gauge wire sizes based on runs of 50 feet or less using 90° C. copper only. Consult national or local electrical code manuals for temperature ratings of conductors other than 480V. boilers require only one circuit.
- Fuse Sizes: 208/240V. - 60 Amps; 480V. - JKS 30 Amps.
- Boiler Water Content (all sizes): Water - 10.2 gals.; Steam - 7.0 gals.
- Approximate Shipping Weight (all sizes): 300 lbs.

DIMENSIONS

WATER TOP

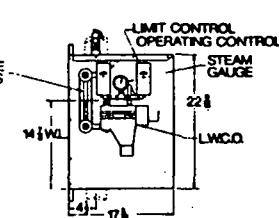
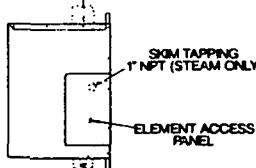


STEAM TOP



WATER FRONT

WATER / STEAM RIGHT SIDE



STEAM FRONT

*24" minimum wall clearance required for element removal.

STANDARD EQUIPMENT

Jacket with Wall-Mounting Brackets
One-Piece Insulated Casting
Incoloy-Sheathed, Low-Watt-Density Elements
24 Volt Control System
Fuse for Each Element Leg
Thermostat Terminal Block
Power Input Terminal and Fuse Block
Thermal Time-Delay Relays
Heavy-Duty Contactors

For Water Boilers

ASME Safety Relief Valve
Combination Pressure and Temperature Gauge
Combination Operating and High-Limit Control

For Steam Boilers

ASME Safety Valve
High-Limit Pressure Control
Operating Control
Low-Water Cutoff
Water Gauge Glass
Gauge Cocks
Steam Pressure Gauge

U EIL-Mc A N

Michigan City
Indiana 46360

A Division of Wylain, Inc.



APPENDIX I
MULTIZONE VAV UNIT

BASIC RVZ1 SEQUENCE OF OPERATION

I - BLOWER OPERATION

- 1 - During normal operation the indoor blower motor (B3) runs continuously. The blower speed is determined by the EA5 integrating analyzer and inverter (A8). If the unit has optional night setback but does not have smoke detectors, the blower motor cycles in response to heating demands during night operation. When the heating demand is satisfied, the fan control (S6) allows blower to run until the heat dissipates from heat exchanger (gas heat only). If the unit has both night setback and smoke detectors, the blower motor operates in two modes:
 - a - Day Operation — The blower motor runs at the speed dictated by the integrating analyzer.
 - b - Night Operation — Without a heating demand the motor continues to run, but the speed is determined by the night blower control (R1). With a heating demand the blower motor speed is again dictated by the integrating analyzer. These provisions allow the utilization of smoke detection during periods of night setback. Refer to page 74 for additional information on the night blower control.
- 2 - The return-air blower (B4 - optional) runs whenever the indoor blower is operating.
- 3 - Fire protection thermostats (S24 & S25) are located in the return air compartment and blower compartment. Thermostats terminate all unit operation at temperatures above setting.
- 4 - All other systems are dependent upon the blower operation. The blower proving switch (S31), located in the indoor blower airstream, senses a blower failure and shuts down all systems within the unit.
- 5 - With the presence of smoke, the smoke detection system (optional) terminates heating and cooling functions and provides four options of controlling blower and damper operation. See Figure 19.

Option 1 - "Shutdown"

- a - Supply blower stops.
- b - Return blower stops.
- c - Outside dampers close.
- d - Return dampers close.

Option 2 - "Exhaust"

- a - Supply blower stops.
- b - Return blower continues to run.
- c - Outside dampers close.
- d - Return dampers close.

Option 3 - "Intake"

- a - Supply blower continues to run.
- b - Return blower stops.
- c - Outside dampers open.
- d - Return dampers close.

Option 4 "Intake and Exhaust"

- a - Supply blower continues to run.
- b - Return blower continues to run.
- c - Outside dampers open.
- d - Return dampers close.

Upon power failure or during nite setback conditions, the return and outside dampers close. A remote smoke detector test station simulates smoke conditions to check performance of smoke detectors. A direct acting actuator (B9) drives the outside dampers while a reverse acting actuator (B10) drives the return air dampers.

II - THE LENNOX ELECTRONIC ENERGY SAVING SYSTEM

The RVZ1 is equipped with a solid-state control system which cycles the unit to match its output to the load requirements. The control has two functions:

- 1 - To modulate zone dampers to provide conditioned supply air that satisfies the heating or cooling demands in each zone without override.
- 2 - To maintain hot and cold deck temperatures in the unit that satisfy the requirements of the zone with the largest heating load and the zone with the largest cooling load.

A - Zone Damper Control

Two air temperature sensors are used for each zone — one located in the conditioned space (A4 room sensor) and one mounted in the supply duct (RT4 discharge sensor). An electronic circuit compares the temperatures at room sensor and discharge air sensor to control the position of zone dampers. See Figure 20.

SMOKE DETECTION SYSTEMS

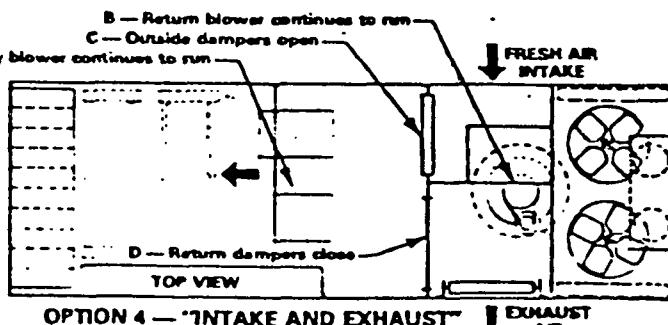
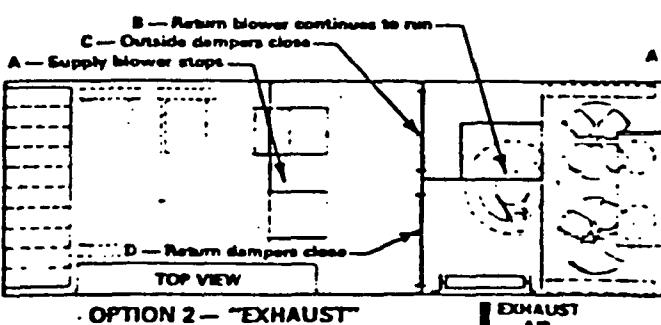
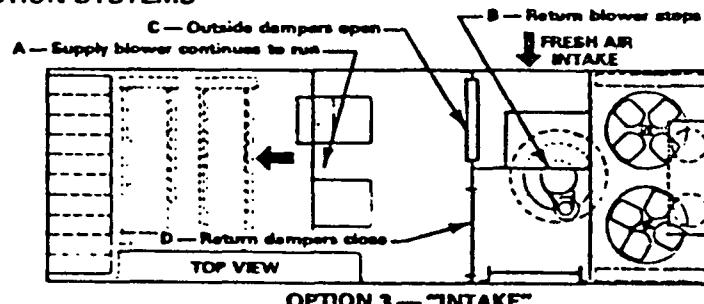
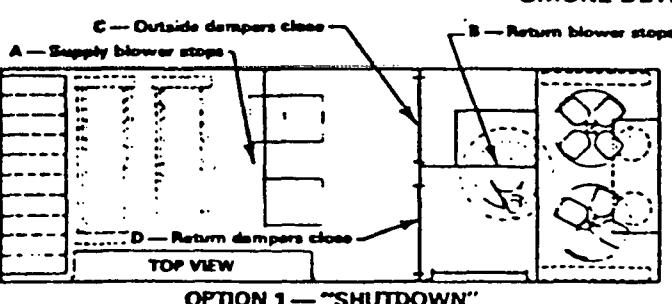


FIGURE 19

8 - In multiple unit installations, the following guidelines are recommended for mixing perimeter and core zones:

Maximum Load Diversity

For optimum energy efficiency, install an RVZ1 equipped with condenser heat and outside air discriminator in applications with maximum load diversity. See Figure 17. By intermixing perimeter and core zones, the heat rejected into the return air from core zones will be recirculated into the supply air stream. A cooling demand will initiate DX cooling and bring additional heat into the hot deck.

Minimize Load Diversity

Minimize load diversity in installations less condenser heat and outside air discriminator. If possible design system so perimeter zones go to one unit and core zones go to another. See Figure 17.

APPLIC

VI - ROOM SENSOR

Two types of room sensors are offered: the standard and a wide no-load band type. On a typical heating/cooling day, the load demand swings from morning heating to midday cooling and back to late day heating. The standard room sensor controls the heating/cooling demand through the day within plus or minus 2 degrees of set point. The wide no-load room sensor gives approximately 6 degrees range between the heating and cooling demand. The unit coasts within the no-load band. Temperature control remains plus or minus 2 degrees at either end of the band. Refer to graph.

A - Installation

1 - Room sensor mounts on a standard 2" x 4" (51 mm x 102 mm)

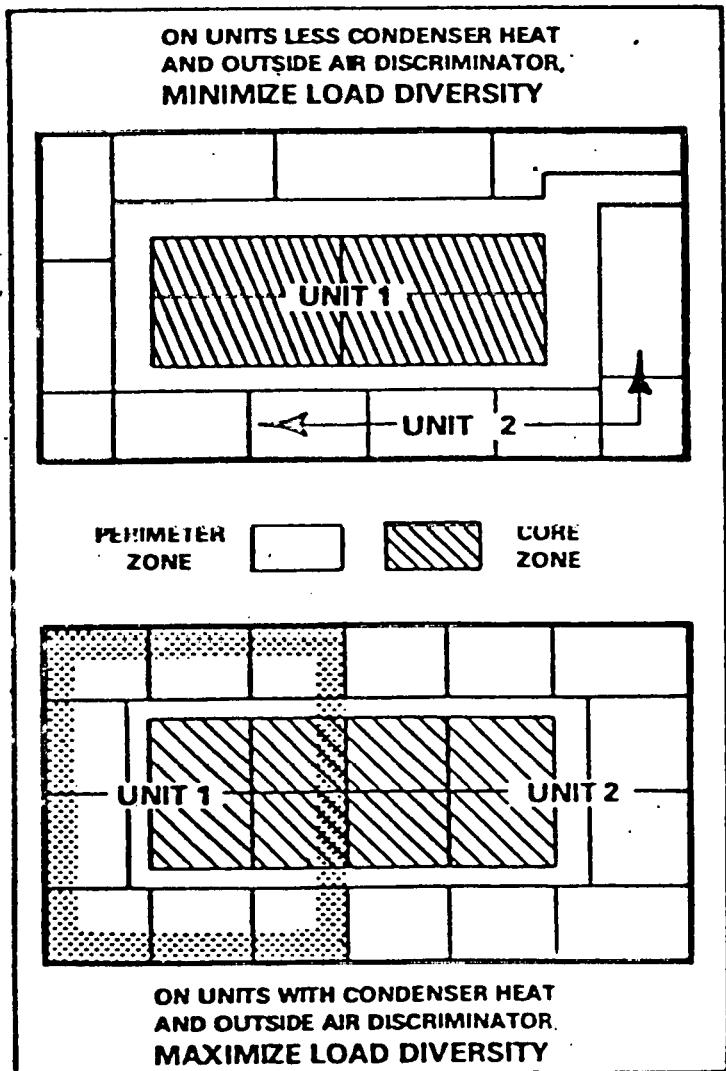
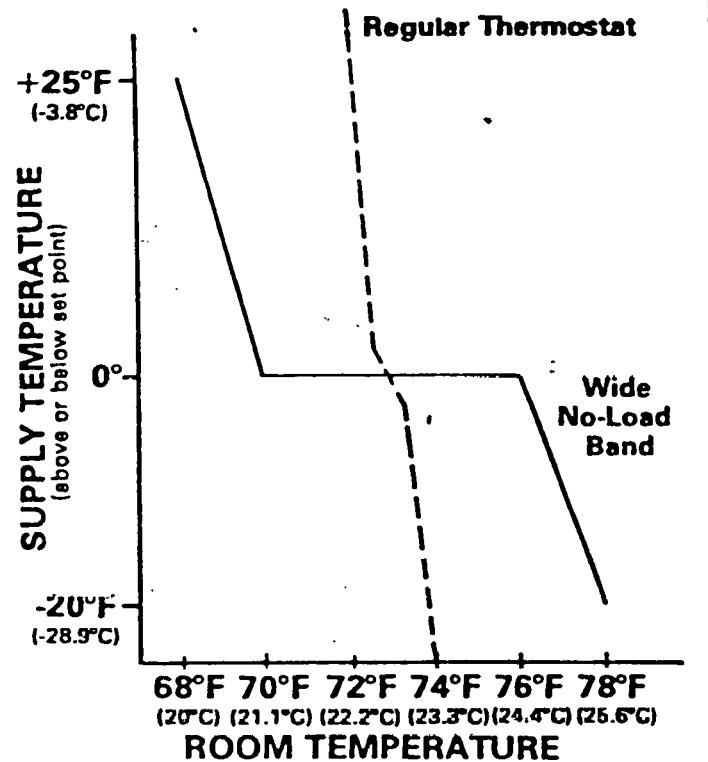


FIGURE 17

outlet box. Wall plate, decorator plate, wiring subbase, electrical frame and cover make up the sensor assembly. See Figure 18.

- 2 - Do not locate room sensor on an exterior wall, in an entryway, or in direct sunlight. See Figure 16.
- 3 - Make certain room sensor or sensors are located where they sample air in the occupied space for a particular zone, however, direct impingement by discharged air upon the room sensor should be avoided or minimized. See Figure 16.
- 4 - All room sensors should be maintained at approximately the same set point.

REGULAR THERMOSTAT COMPARED TO WIDE NO-LOAD BAND THERMOSTAT.



SENSOR (THERMOSTAT)

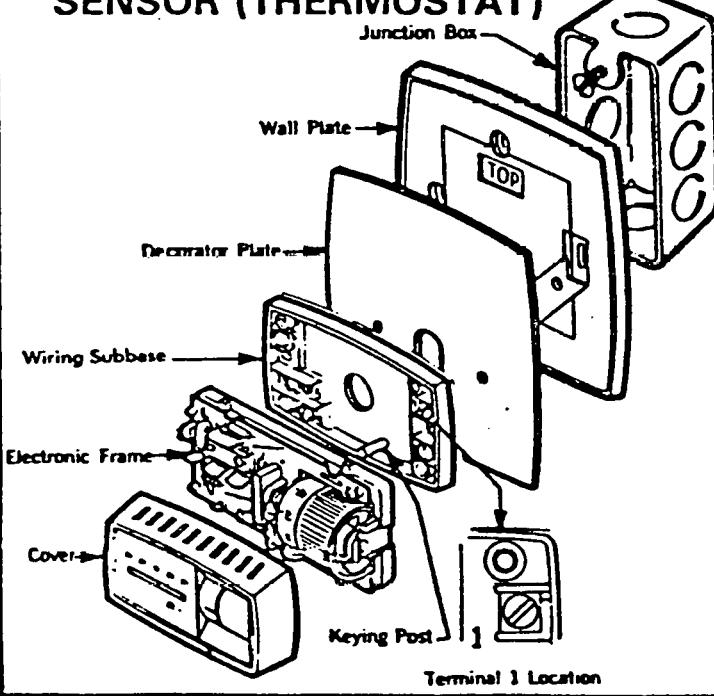
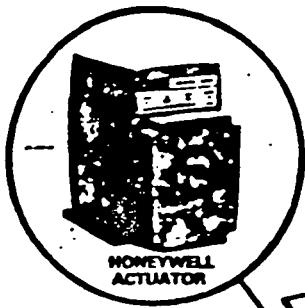


FIGURE 18

DAMPER ACTUATOR



ZONE DAMPER CONTROL

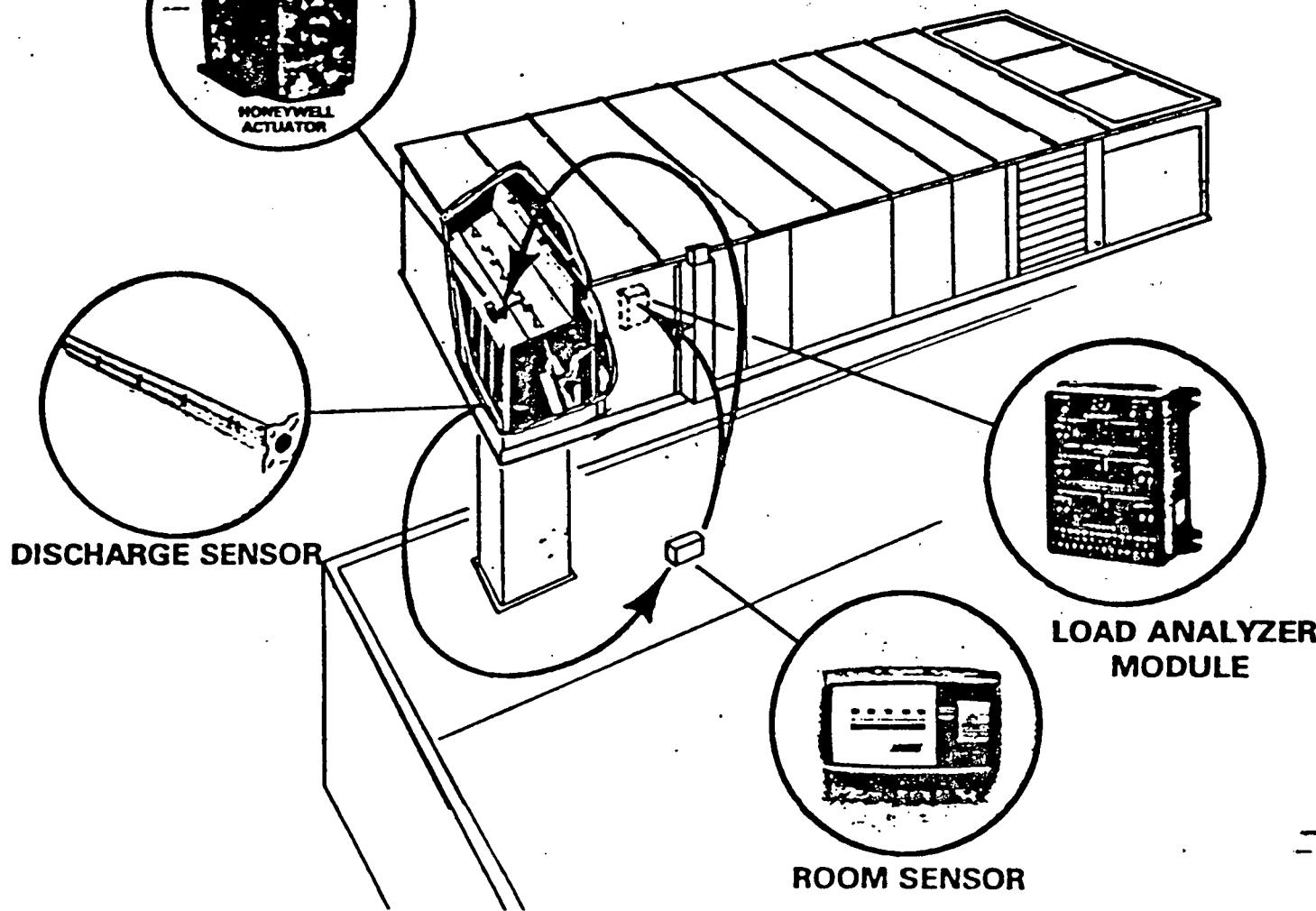


FIGURE 20

The zone dampers in the Varizone are designed so the hot and cold damper blades operate independently. A magnetic/spring overdrive mechanism will allow one blade to remain at closed or at minimum position while the other is opening. The minimum position is adjustable from zero to 45 degrees. This feature minimizes air mixing between the two decks, thus allowing treated air to go to the zones that require it.

As the room temperature changes from the room sensor set point, the zone dampers will move to satisfy the demand. On a change in discharge air temperature, the zone damper will reposition in anticipation of the effect on room temperature.

In addition to the standard room sensor, an optional "no load" band room sensor allows a wide temperature differential of 6 degrees before cycling the heating or cooling in the RVZ1.

If the conditioned zone requires more CFM than a particular damper opening can deliver, two or more dampers must be linked together to provide the needed CFM. Adjacent dampers can be slaved together using mechanical linkage. Non-adjacent dampers can be electrically slaved together. Only three dampers may be mechanically linked to one actuator. If more than 3 dampers are required for a zone, use 2 or more actuators and slave electrically. Although several dampers may be linked together, they still constitute one zone

and are consequently controlled by one room sensor. Refer to "Electronic Zone Control" on page 87 for additional information on slaving dampers.

Two zone control options are available:

1 - ZC17 Zone Control System - Actuator modulates in response to the variable voltage signal transmitted by the demands of the room sensor and discharge sensor.

2 - ZC8 - This actuator is used with remote mixing boxes for dual duct applications.

B - Hot And Cold Deck Controls

The EA3 load analyzer module cycles the unit in response to the zone with the greatest heating demand and the zone with the greatest cooling demand. Any zone can generate these demands. See Figure 20. If no zone has a demand of sufficient magnitude to actuate either the heating or cooling functions, the system will coast with only the blowers running.

Overriding controls monitor cold and hot deck temperatures to protect unit from problem zones (a zone which transmits a constant heating or cooling demand).

III - VARIABLE AIR

In addition to zone temperature control, the RVZ1 incorporates

BLOWER MOTOR CONTROL

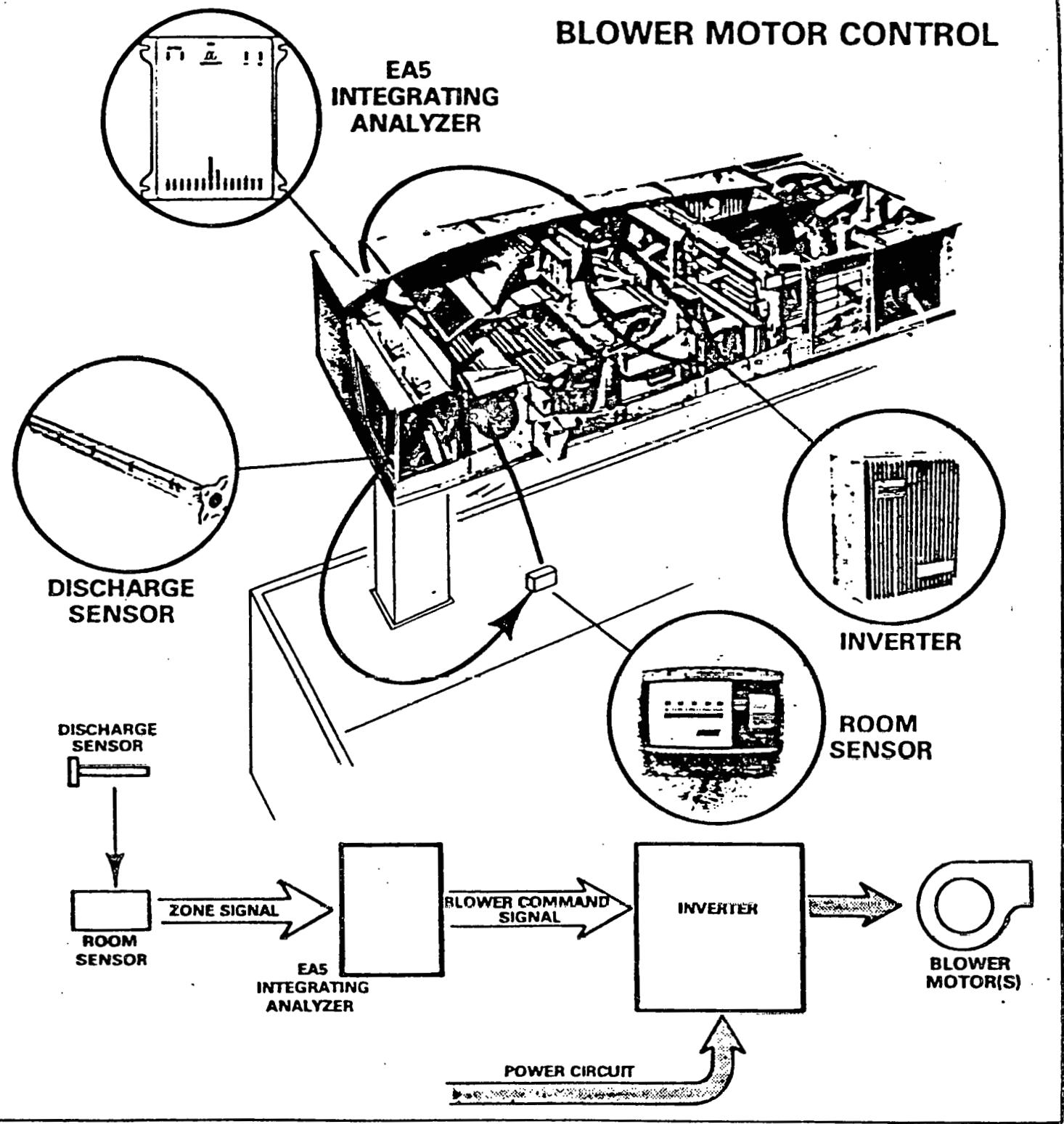


FIGURE 21

energy conservation features which lower the watt consumption of indoor blower motor and return air blower motor (if used). These controls regulate blower motor speed in proportion to zone demands. The EA5 integrating analyzer receives the zone signals from the room sensors. It analyzes these signals to determine the units air requirements and then transmits a DC volt blower command signal to the inverter. The inverter responds to this signal and changes blower motor RPM correspondingly. The EA5 has a minimum speed adjustment which is factory set at 45% of full air. Figure 21 illustrates the blower command signal.

If individual zones require a constant air volume, the RVZ1 zone dampers can be field adjusted to provide the desired amount of air flow.

For a detailed explanation of the blower operation, refer to "BLOWERS" on page 72.

JII - CONDENSER HEAT

The condenser heat option is used in conjunction with Outside-Air-Discriminator and Power Saver. The condenser heat coil within the hot deck gives off heat from the No. 1 refrigerant circuit whenever

compressor 1 is running and there is a heating demand. The function chart in each respective heating section illustrate staging of condenser heat. The "Refrigerant Cooling" section on page 57 explains condenser heat operation. The following table lists the available heat vs size unit.

CONDENSER HEAT CAPACITY		
Size Unit	Btuh Available	Kcal/hr Available
RVZ1-185	85,000	23 940
RVZ1-185/275		
RVZ1-275	125,000	31 500
RVZ1-300	155,000	39 060
RVZ1-360		
RVZ1-415	125,000	31 500
RVZ1-600	155,000	39 060

IV - GAS HEAT

Gas heat capacities range from 275,000 through 850,000 Btuh input.

- 1 - On a heating demand, the combustion air blower is energized to provide a prepurge period to clear combustion chamber. A time delay brings on the first stage of gas heat after the prepurge period has elapsed.
- 2 - An additional heat demand brings on the second stage of gas heat after 5 minute delay.
- 3 - A power burner, with individual electronic safety controls monitor flame conditions, is incorporated on each heat exchanger used. Two high limit controls shut down burner(s) at excessive hot deck temperatures.

V - ELECTRIC HEAT

Electric heaters range in size from 45 KW to 150 KW. Each element has 15 KW capacity. A five switch EA5 electric heat sequencer controls stepping of elements to satisfy the heating demand. Lockout relays balance the load between electric elements and compressors prevent overloading the main switch.

VI - HOT WATER AND STEAM HEAT

The motorized valve controls flow through the hot water and steam coils.

- 1 - A heating demand will open valve.
 - a - The steam coil uses a two way valve.
 - b - The hot water coil uses a three way valve to either direct hot water to coil or by-pass coil.
 - c - An auxiliary circulator pump (optional) continuously circulates water through coil.
- 2 - Both coils are equipped with air bleed valves. The hot water coil has a drain valve.
- 3 - The freeze protection thermostat (S40) monitors the coil manifold temperature and opens the valve at a set point to prevent coil freezing.

VII - POWER SAVER

- 1 - The Power Saver consists of outside and return air dampers which are linked together. These dampers open and close in reverse relationship to each other. A cooling demand modulates the outside dampers open. If the fresh air cannot satisfy the demand, mechanical cooling will be engaged.
- 2 - The Power Saver actuator has a minimum air adjustment to set for a specific amount of fresh air.

- 3 - The enthalpy control (S18) senses both temperature and humidity or the heat content of the outdoor air. When the heat content rises above control set point, the outside dampers close to minimum position.
- 4 - The Outside-Air-Discriminator (optional) holds the outside dampers at minimum position at a given switch point in the heating mode.
- 5 - The morning warm-up control (S16) holds outside dampers at closed position until the return air temperature has risen above the set point.
- 6 - On nite setback, the outside air dampers are in the fully closed position.
- 7 - The sandstorm switch (S17-optional) is a manual switch which closes the outdoor dampers.

VIII - REFRIGERANT COOLING

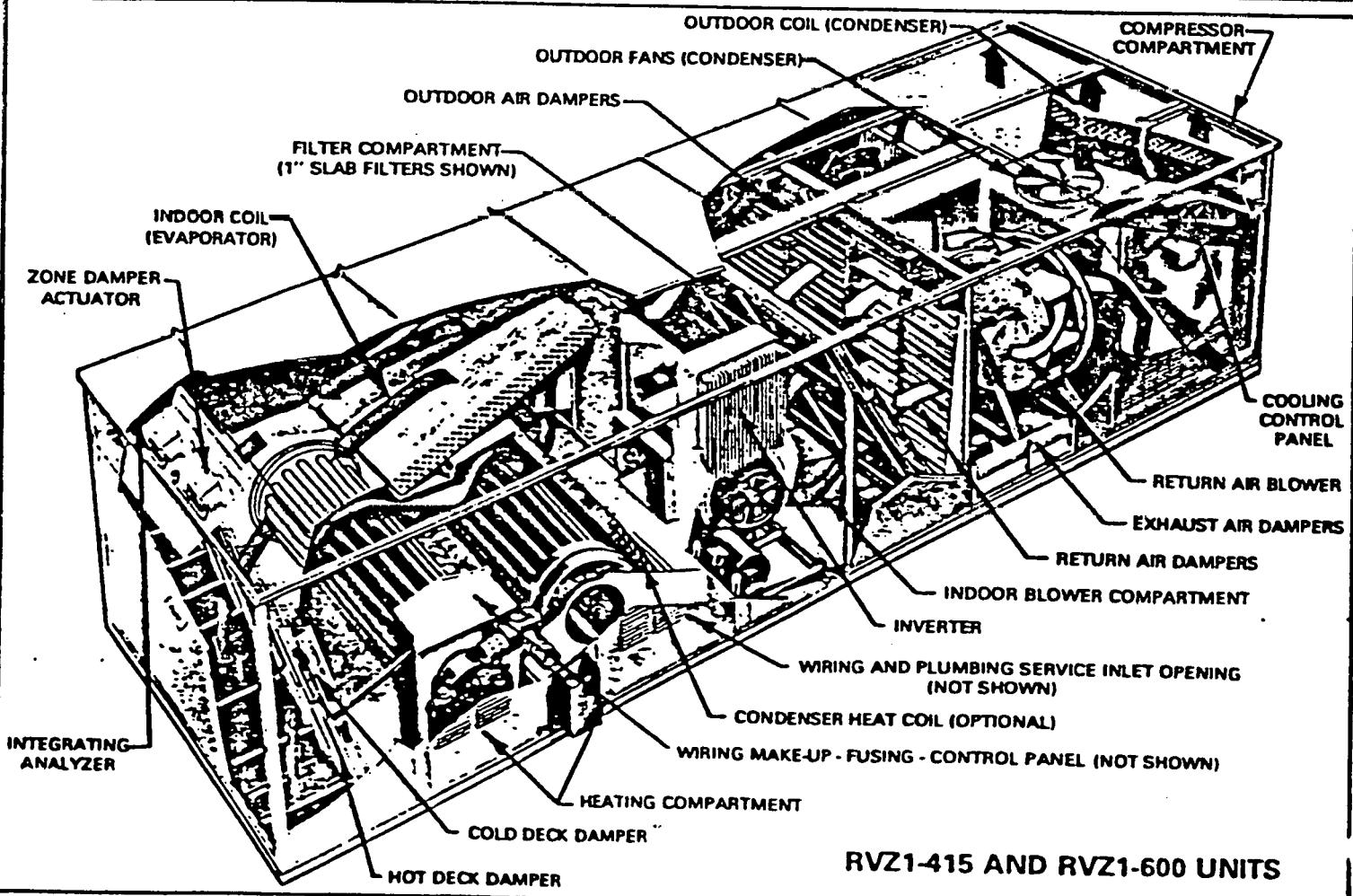
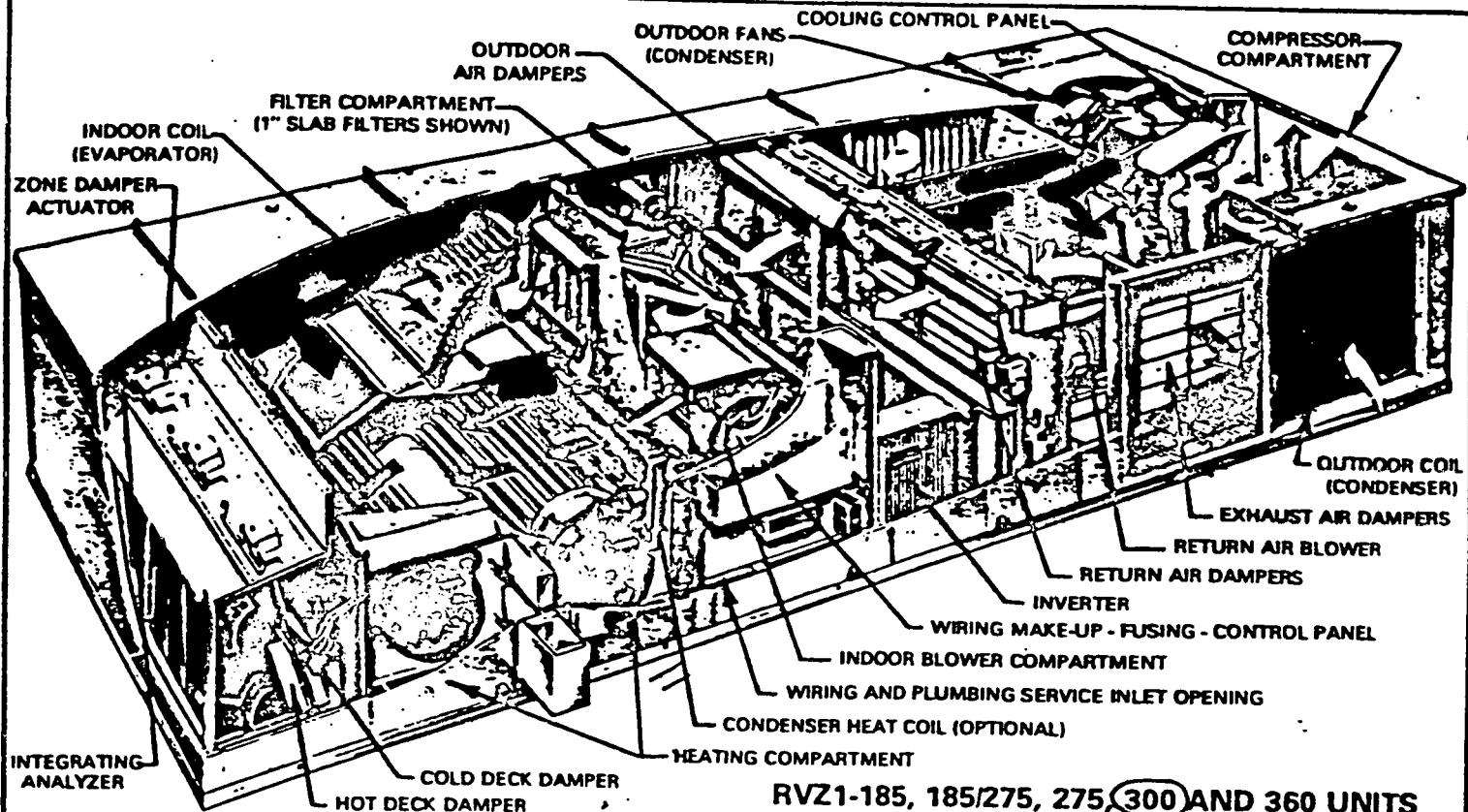
The operating sequence and cooling functions vary according to the size of the unit.

- 1 - The Lennox L6 compressor has two speeds which run at 1,800 RPM at low speed and 3,600 RPM at hi speed. Each L6 compressor has a positive interlock between speeds to prevent both speeds from being energized simultaneously. There is a time delay between speeds.
- 2 - Each compressor has an individual refrigerant circuit. The No. 1 refrigerant circuit is equipped with a hot gas by-pass valve for conditions requiring reduced capacity. As the suction pressure drops below the hot gas valve set point, the valve opens to prevent an evaporator coil freeze-up. RVZ1-300/360/600 units are also equipped with an additional solenoid valve (L1) which only permits hot gas by-pass when the L6 compressor is on low speed.
- 3 - Each compressor is protected by a high gas pressure switch (S32), low gas pressure switch (S34), ambient thermostat (S33) and a crankcase heater. In addition 8 and 11 ton compressors use internal cutout thermostats (S35) and overload relays while the 15 ton compressors use inwinding thermistors with a protection module (A1).
- 4 - The compressor monitor (S38) locks out compressors whenever the outdoor air falls below set point.
- 5 - The evaporator low limit (S41) control locks out compressors when cold deck temperature drops below set point.
- 6 - The following list matches compressor usage to unit size.
 - a - RVZ1-185 uses two L2, 8 ton compressors.
 - b - RVZ1-185/275 uses two L2, 8 ton compressors but has a larger evaporator for 19 tons of cooling.
 - c - RVZ1-275 uses two L2, 11 ton compressors.
 - d - RVZ1-300 uses one L6, 15 ton compressor and one L2, 11 ton compressor.
 - e - RVZ1-360 uses one L6, 15 ton compressor and one L2, 15 ton compressor.
 - f - RVZ1-415 uses three L2, 11 ton compressors.
 - g - RVZ1-600 uses one L6, 15 ton compressor and two L2, 15 ton compressors.

IX - CHILLED WATER

A motorized valve controls flow through coil. The valve is located on the return line from the coil and has three ports — inlet, outlet and by-pass. Each chilled water coil is equipped with an air-bleed and a drain valve.

PARTS ARRANGEMENT



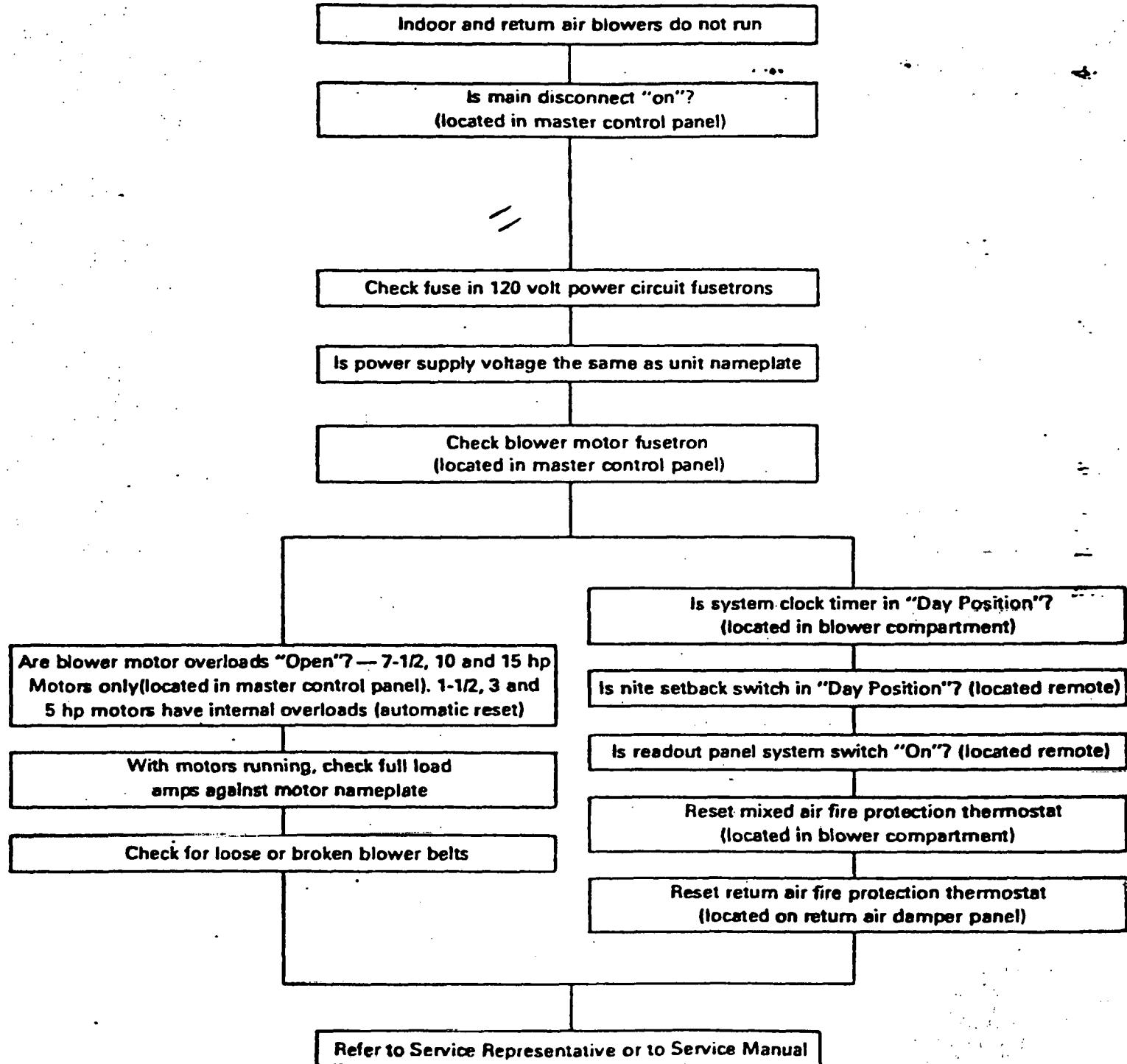
SERVICE FLOW CHARTS

With a piece of equipment as sophisticated as the RVZ1 unit, it can often be difficult to locate the source of trouble from a given set of conditions.

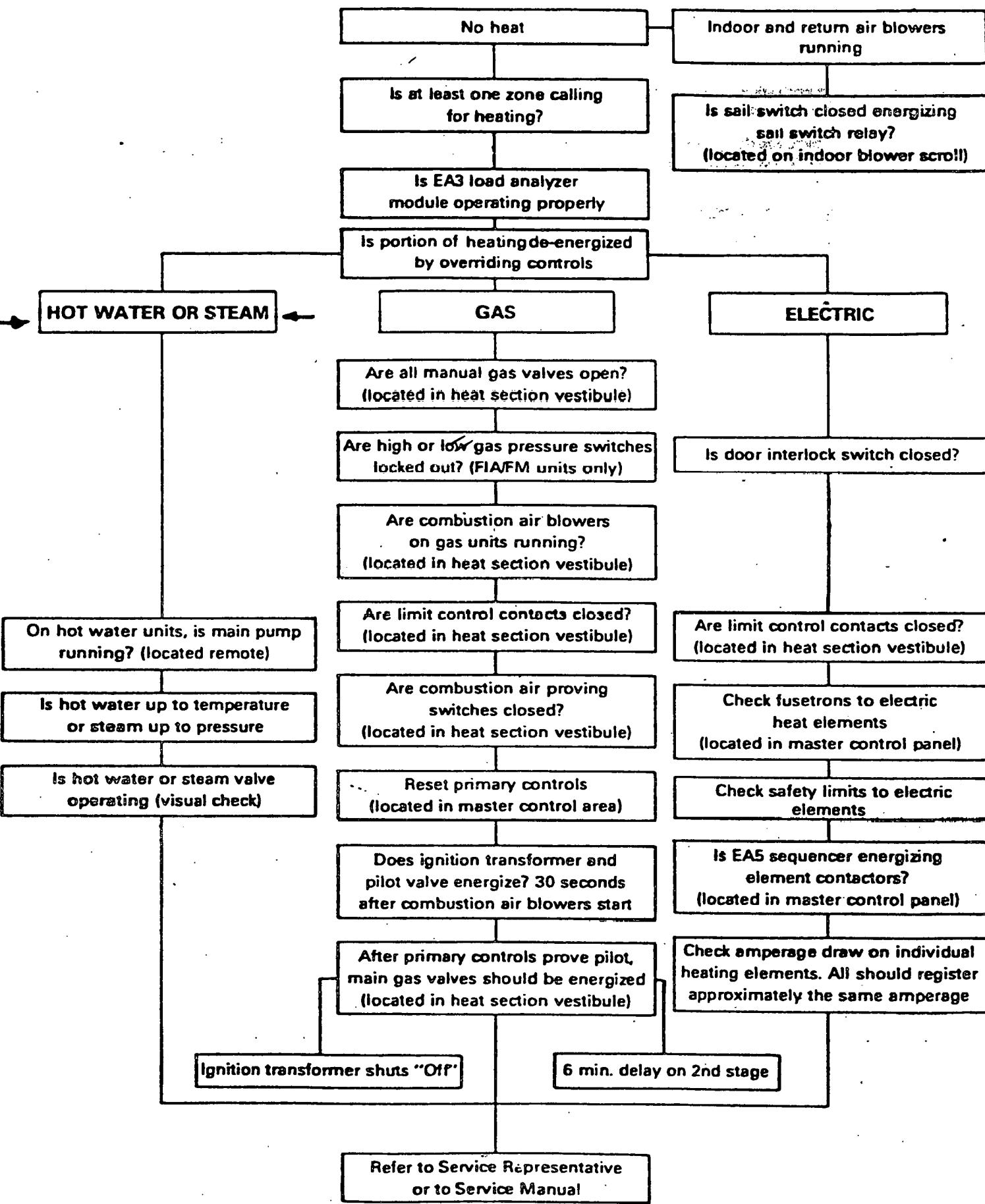
The following service flow charts are designed to direct you to the likely source of trouble from certain observed or readily determined conditions.

When going through the following service flow charts, always start with "Supply And Return Air Blower Operation." Once the indoor and return air blowers are running, go to the flow charts for "Hot Deck" or "Cold Deck." The schematic wiring diagrams provided on the unit are to assist you in understanding the various circuits.

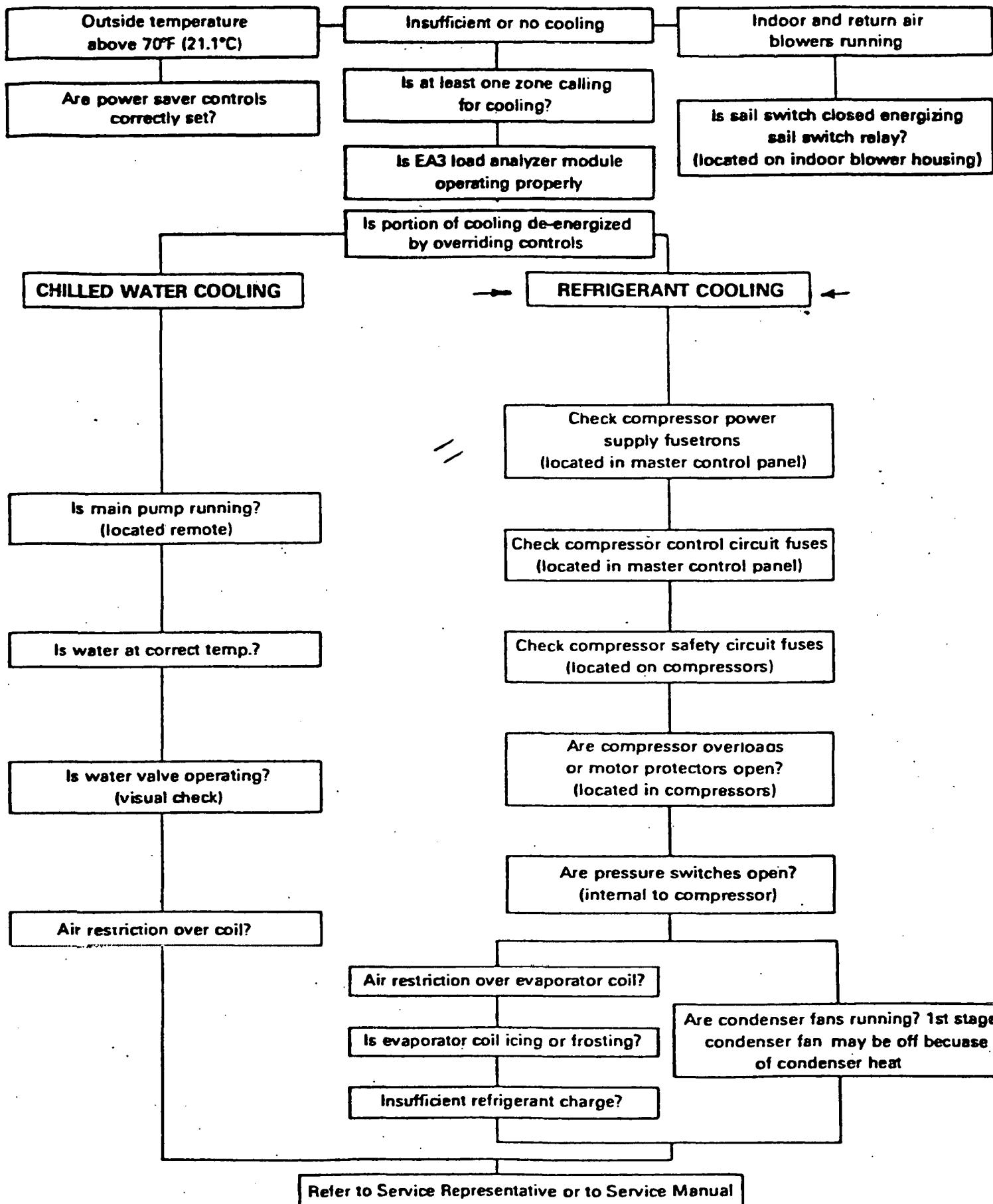
SERVICE FLOW CHART FOR INDOOR AND RETURN AIR BLOWERS



SERVICE FLOW CHART FOR HOT DECK OR HEATING SECTIONS



SERVICE FLOW CHART FOR COLD DECK OR COOLING SECTIONS





REMOTE READOUT PANELS

For All Season Equipment

ENGINEERING DATA

ACCESSORIES

Page 71

December 15, 19

Supersedes 5-15-70

Central Station Check of Heating-Cooling Equipment

The operation of heating-cooling equipment can be checked at a glance on a Remote Readout Control Panel conveniently located within the conditioned area. Complete panel consists of a control panel and rough-in box. The rough-in box may be installed during building construction and the control panel added at a later date. One panel is required for each heating-cooling unit. Panel may be installed individually or in multiples. See typical installation sketch.

Signal lights on the panel indicate "System On", "Combustion Lockout", "Condensing Unit Inoperative" and "Dirty Filter". Check switches are provided to prove signal light operation. Two on-off switches control "System Auto-Off" and "Condensing Unit Auto-Off" operation. Panel is equipped with a manually operated 12 hour clock timer. Timer overrides night setback controls providing normal operation for the time period set. The combustion lockout signal circuit operates a relay that can be connected to a telephone circuit signalling the serviceman of a failure. An adjustable compressor monitor thermostat (not required on DMS3 applications) is required to complete the condensing unit operation signal. A filter flag is required to provide the "Dirty Filter" signal light.

Field wiring will vary depending on type of system and unit used in installation. 6 to 12 class II field wiring connections are required from the heating-cooling equipment to the remote readout panel. See field wiring diagrams. See Installation Instructions for complete wiring diagrams.

One Remote Readout Control Panel and Rough-In Box is available for all applications. Specify BM number when ordering.

RP00-1 Rough-In Box (BM1-5358)

RP2-1 Remote Readout Control Panel (BM2-5358)

Additional controls are required for use with the Readout Panel and must be specified when ordering.

DMS2 and DMSR2 Applications

Filter Flag (BM-4338)

Compressor Monitor Thermostat (BM-4875)

DMS3 Applications:

Filter Flag (BM-4338)

GCS3 And OCS3 Applications:

Remote Readout Panel Kit (BM-5817)

Consists of: 1-Filter Flag

1-Compressor Monitor Thermostat

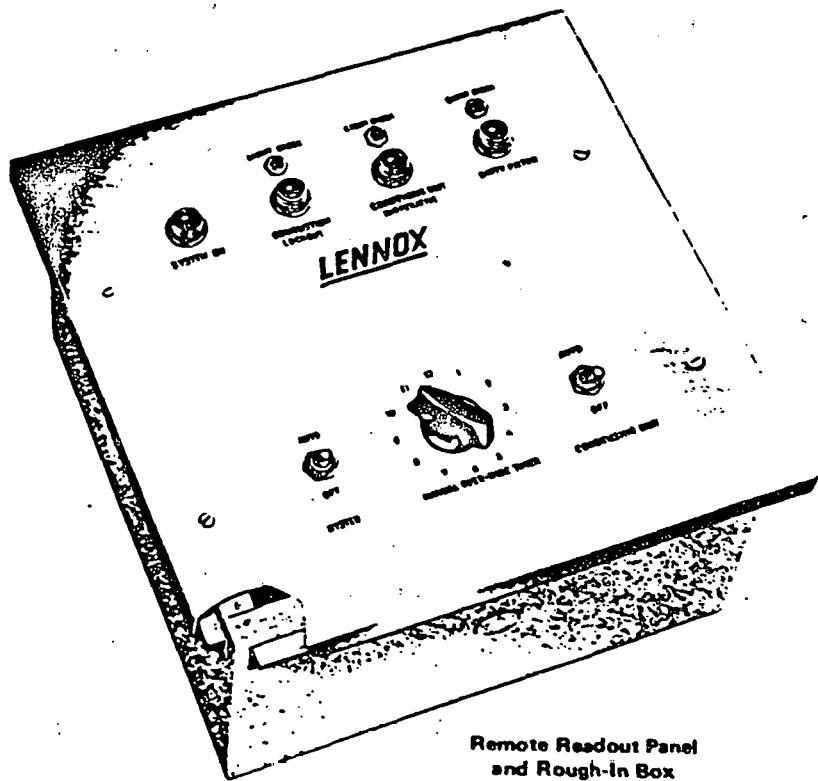
1-Relay Control Panel

CHA8 Applications:

Remote Readout Panel Kit (BM-5893)

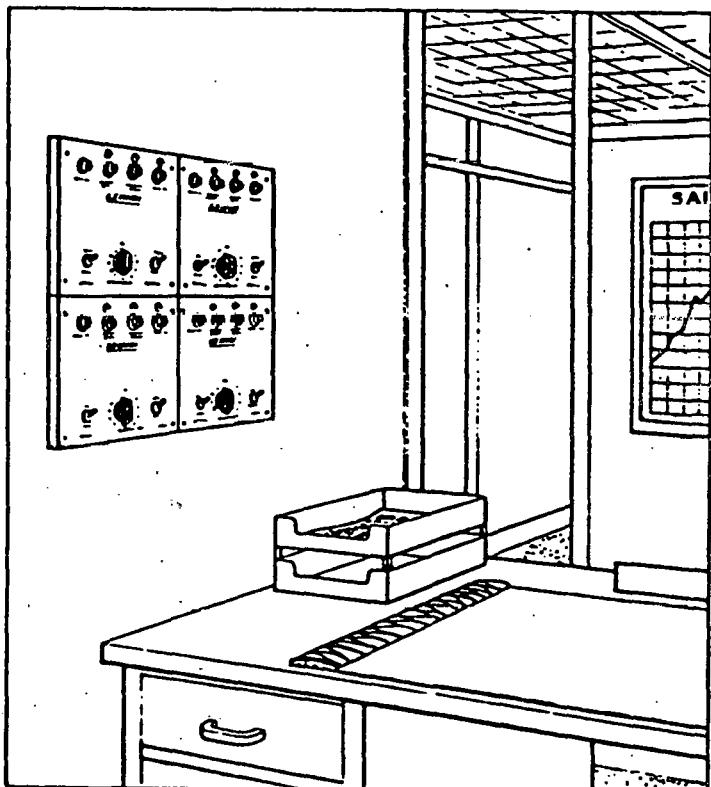
Consists of: 1-Filter Flag

1-Compressor Monitor Thermostat



Remote Readout Panel
and Rough-In Box

Typical Installation

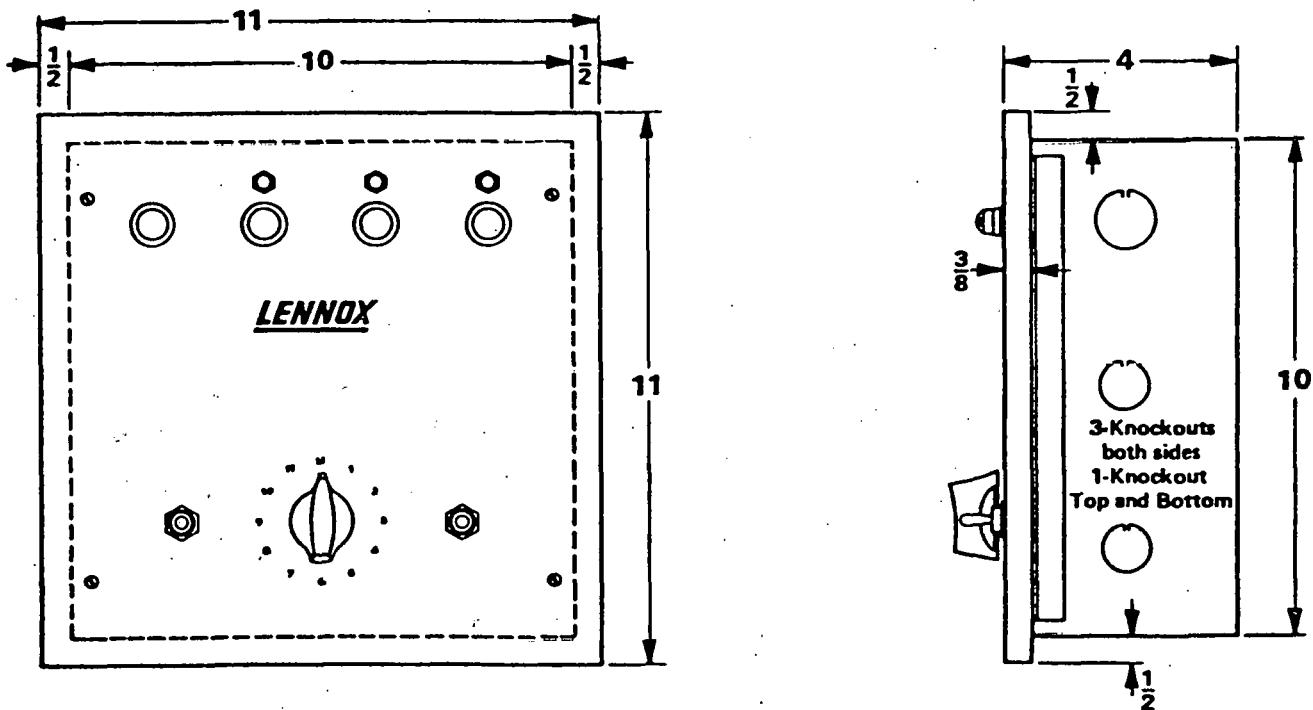


Bank of panels installed on an office wall.

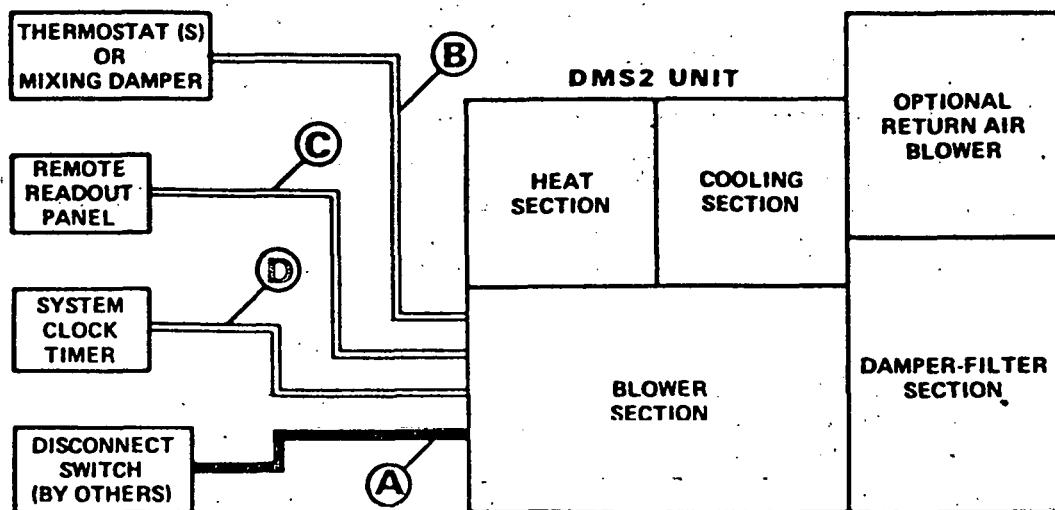
SEQUENCE OF OPERATION

READOUT PANEL SIGNAL LIGHTS	SYSTEM ON	Indicates blower is operating and system is giving normal "occupied" operation. When this light is out, system is inoperative or equipment is on night setback control.
	COMBUSTION LOCKOUT	Light will come on whenever flame sensor control locks out. (Gas or Oil fired units only.)
	CONDENSING UNIT INOPERATIVE	When system calls for cooling this light will come on in approximately 45 seconds if suction line doesn't cool down. Due to delayed starting of the condensing unit through the timed off control, this light may come on for a short period and then shut off indicating proper operation. DMS3 applications - light will come on if any compressor safety control opens, indicating that a compressor is not running.
	DIRTY FILTER	When filter becomes excessively dirty the light will come on indicating a requirement to change or clean filters.
READOUT PANEL SWITCHES	SYSTEM "AUTO" "OFF"	Shuts down entire system except for the combustion air motor on gas fired units and the water pump on hot water units.
	MANUAL OVER-RIDE TIMER	Overrides night setback controls. Set the 12 hour clock timer to give the required hours of system operation during any period when the system is on night setback. When the timer shuts off, the system returns to night thermostat control or off if night setback controls are not used.
	CONDENSING UNIT "AUTO" "OFF"	Overrides the condensing unit control circuit.

DIMENSIONS (in.)
For All Season Equipment
 (Net Weight 6 lbs.)



DMS2 and DMSR2 UNITS
NOTE—Up-Flo Model Shown (Down-Flo Model Same)



A—Power Source (See DMS Bulletin for complete Field Wiring)

B—Two wire low voltage (Thermostat)

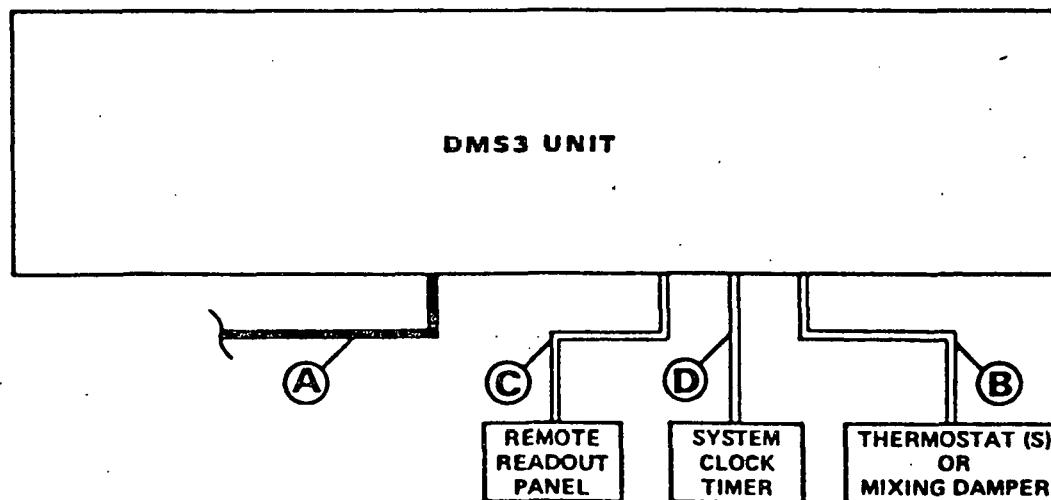
Three wire low voltage (Modulating Damper Motor)
Two or three wire low voltage (Mixing Boxes)

C—Ten wire low voltage

D—Two wire low voltage

All wiring must conform to NEC and local electrical codes.

DMS3 UNITS



A—Power Source (See DMS Bulletin for complete Field Wiring)

B—Two wire low voltage (Thermostat)

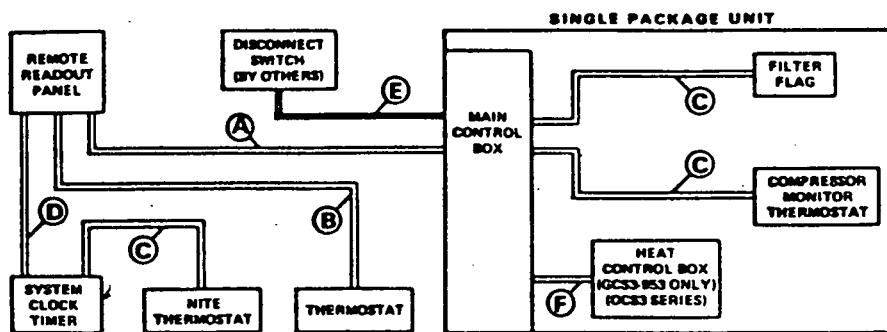
Three wire low voltage (Modulating Damper Motor)
Four wire low voltage (Mixing Boxes with Load Sensor)

C—Nine wire low voltage

D—Two wire low voltage

All wiring must conform to NEC and local electrical codes.

GCS3 SERIES UNITS AND OCS3 SERIES UNITS



A—*Nine wire low voltage (Single Stage Heat and Single Stage Cool)
 *Ten wire low voltage (Two Stage Heat and Single Stage Cool)
 (Single Stage Heat and Two Stage Cool)
 *Eleven wire low voltage (Two Stage Heat and Two Stage Cool)
 *If POWER SAVER and Nite Setback Controls
 are used one additional wire is required.

B—Four wire low voltage (Single Stage Heat and Single Stage Cool)
 Five wire low voltage (Two Stage Heat and Single Stage Cool)
 (Single Stage Heat and Two Stage Cool)
 Six wire low voltage (Two Stage Heat and Two Stage Cool)

C—Two wire low voltage

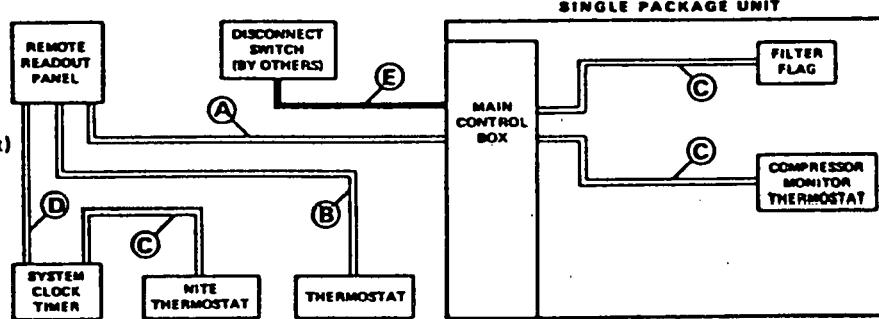
D—Two wire low voltage (Without POWER SAVER)
 Three wire low voltage (With POWER SAVER)

E—Three wire power (See Unit Electrical Data Table)

F—One wire (120 voltage) (GCS3-953 only and OCS3 series)

All wiring must conform to NEC and local electrical codes.
 If local electrical code permits may be class 2 wiring.

CHA8 SERIES COOLING ONLY CHA8 SERIES COOLING AND ELECTRIC HEAT CHA8-1853 AND CHA8-2753 COOLING ONLY



A—*Six wire low voltage (Single Stage Cool)
 *Seven wire low voltage (Two Stage Cool)
 (Single Stage Cool and Single Stage Heat)
 *Eight wire low voltage (Two Stage Cool and Single Stage Heat)
 (Single Stage Cool and Two Stage Heat)
 *Nine wire low voltage (Two Stage Cool and Two Stage Heat)
 *If POWER SAVER and Nite Setback Controls
 are used one additional wire is required.

B—Three wire low voltage (Single Stage Cool)
 Four wire low voltage (Two Stage Cool)
 (Single Stage Cool and Single Stage Heat)
 Five wire low voltage (Two Stage Cool and Single Stage Heat)
 (Single Stage Cool and Two Stage Heat)
 Six wire low voltage (Two Stage Cool and Two Stage Heat)

C—Two wire low voltage

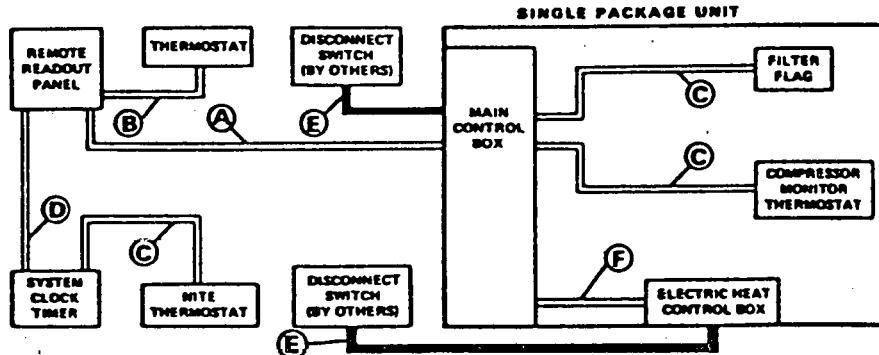
D—Two wire low voltage (Without POWER SAVER)
 Three wire low voltage (With POWER SAVER)

E—Two or three wire power (See Unit Electrical Data Table)

F—Five wire low voltage (Single Stage Heat)
 Six wire low voltage (Two Stage Heat)

All wiring must conform to NEC and local electrical codes.
 If local electrical code permits may be class 2 wiring.

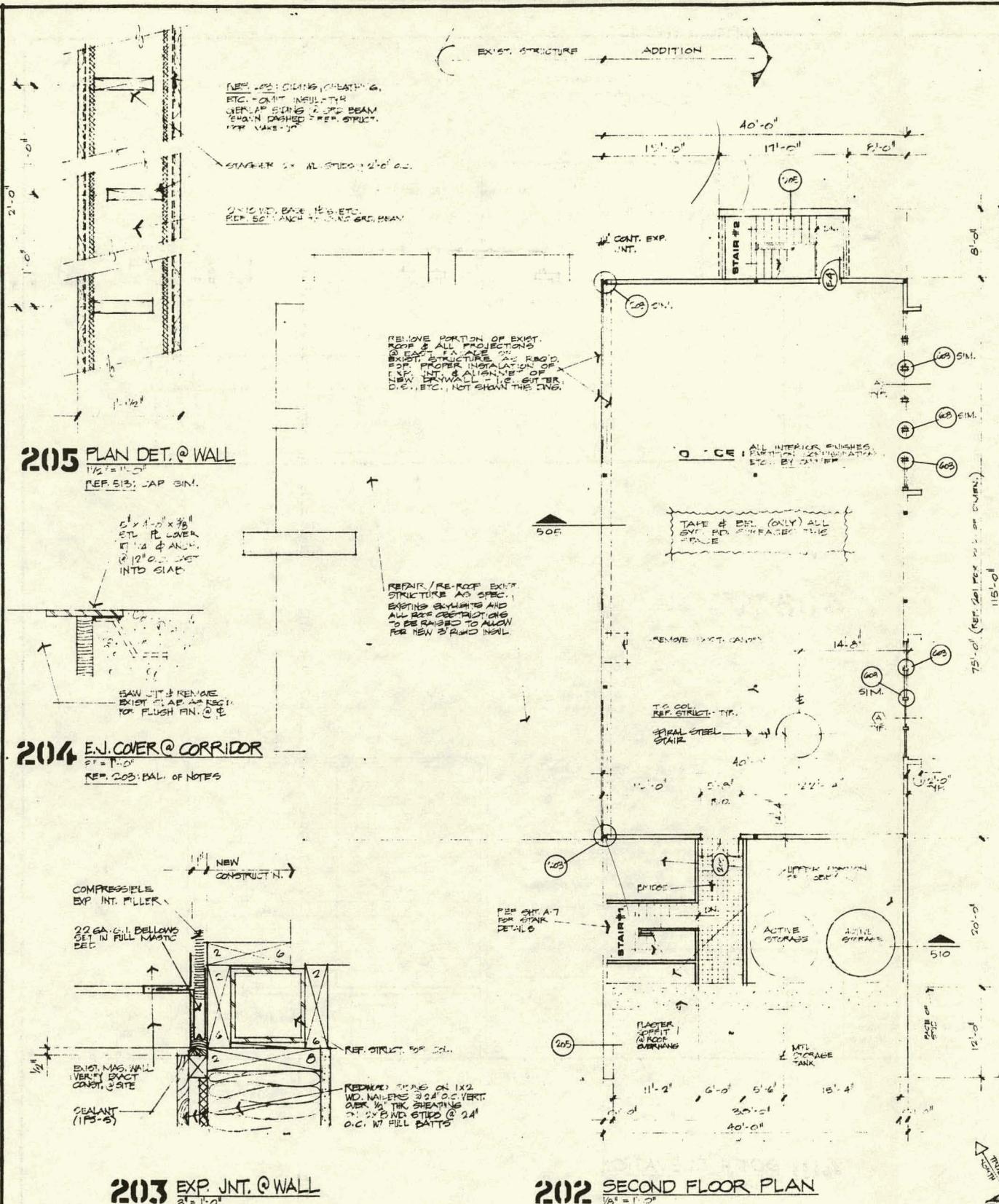
CHA8-1853 AND CHA8-2753 COOLING AND ELECTRIC HEAT



APPENDIX J
AS-BUILT DRAWINGS

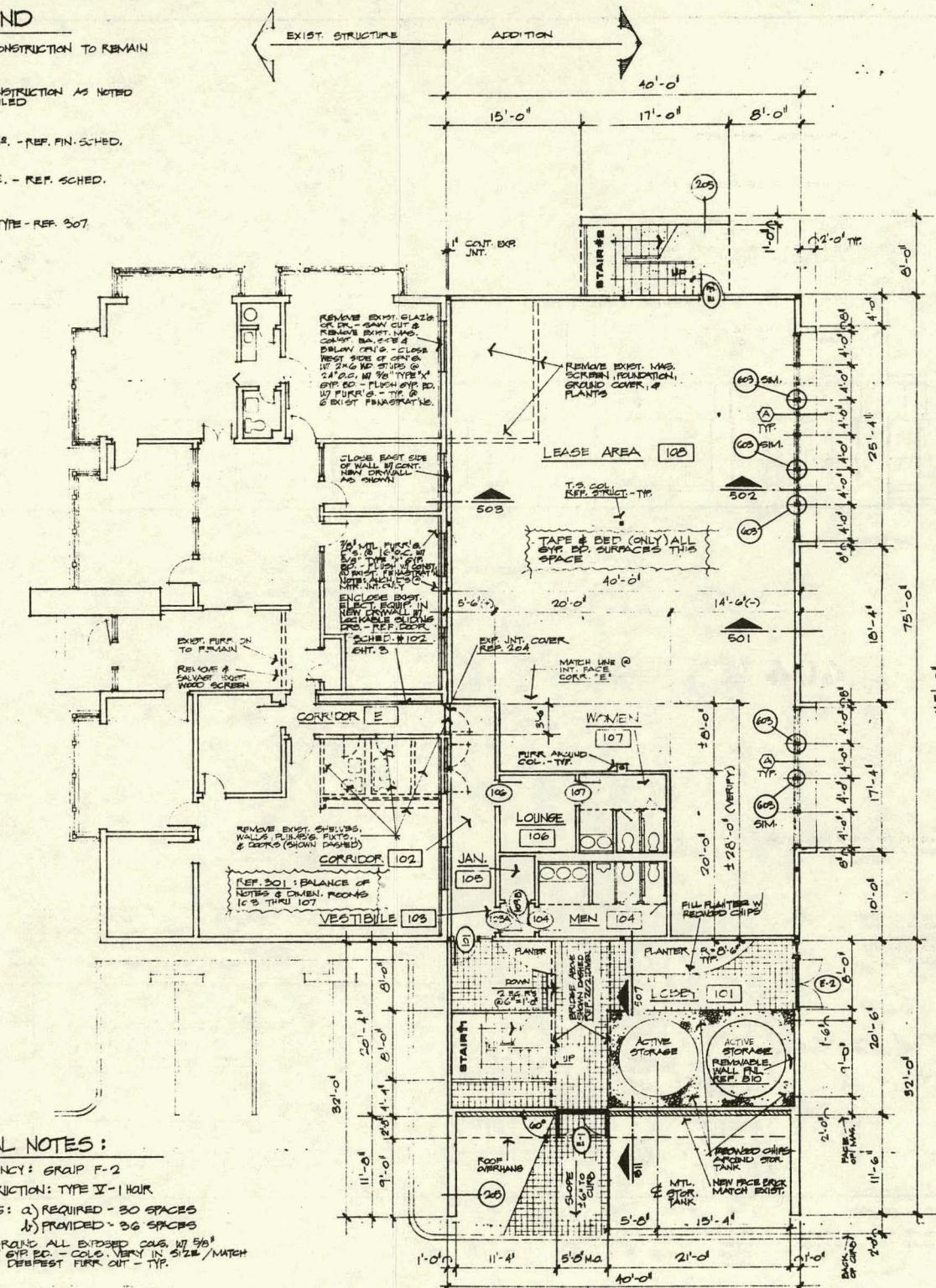
LIST OF AS-BUILT DRAWINGS

- J-1: Architectural Floor Plans
- J-2: Architectural Elevations
- J-3: Solar System Equipment Schedule
- J-4: Storage Tank Details
- J-5: Storage Tank Floating Slab
- J-6: Solar Panel Flashing and Gutter Details
- J-7: Storage Tank Heat Exchangers



SYMBOL LEGEND

	EXIST. CONSTRUCTION TO REM.
	NEW CONSTRUCTION AS NOTED OR DETAILED
101	ROOM NO. - REF. FIN. SCHED.
(106)	DOOR NO. - REF. SCHED.
(A)	WINDOW TYPE - REF. 307

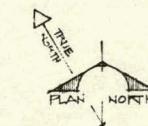


GENERAL NOTES

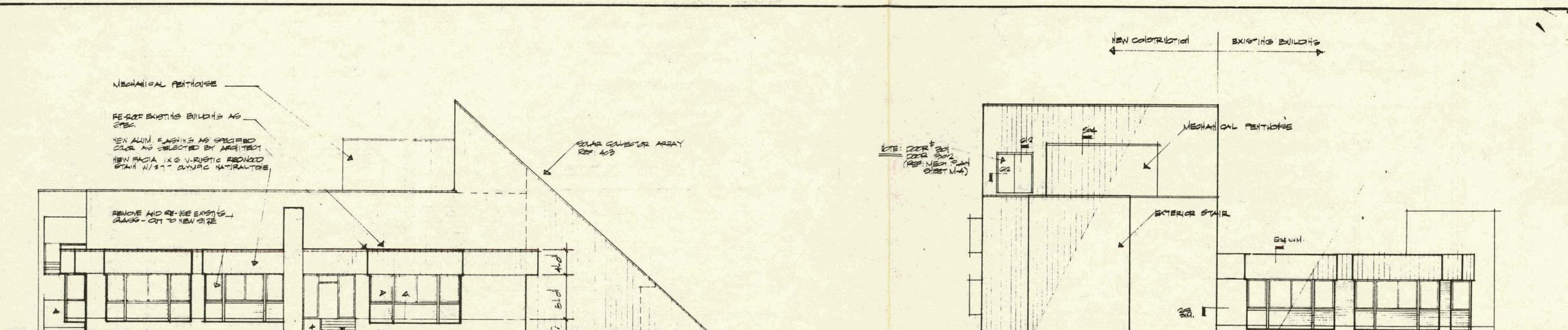
1. OCCUPANCY: GROUP F-2
2. CONSTRUCTION: TYPE II - 1-HOUR
3. PARKING: a) REQUIRED - 30 SPACES
b) PROVIDED - 36 SPACES
4. PURK ARCTIC ALL BIDDED 246, W7¹
THE X GIVE 200 COLOR IN SIZE/MAT
LUMINOSITY DIFF. CO. NEW

203 EXP. JNT. @ WALL

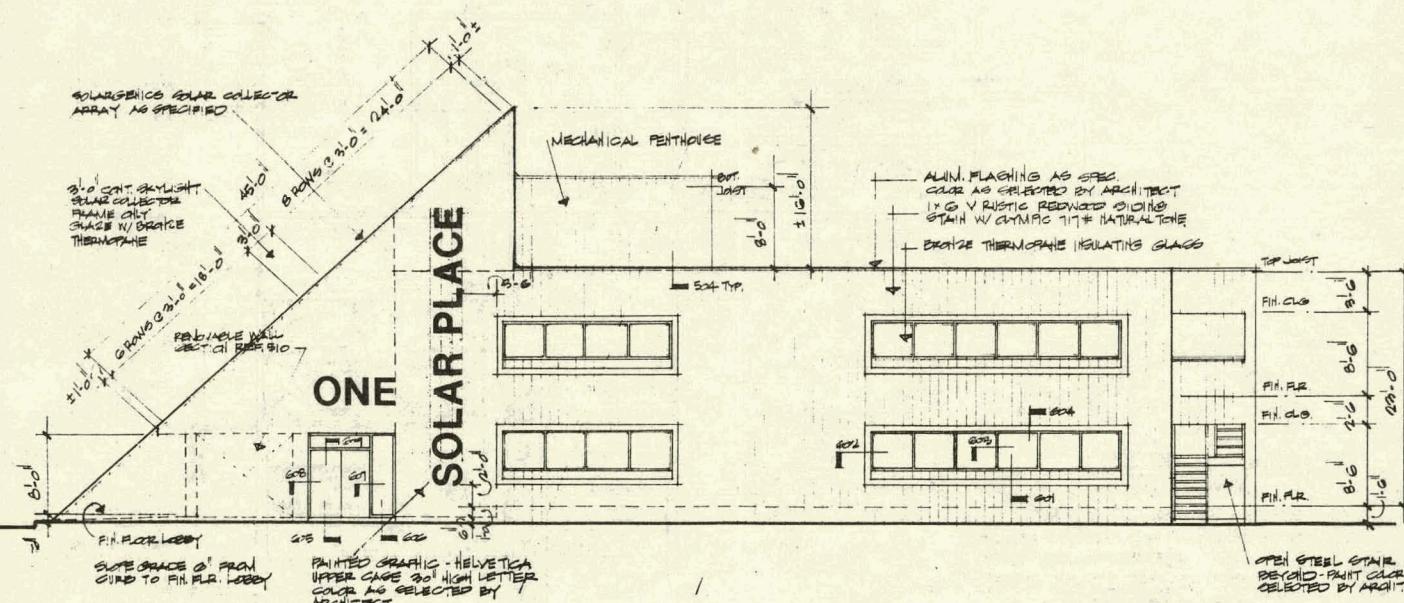
202 SECOND FLOOR PLAN



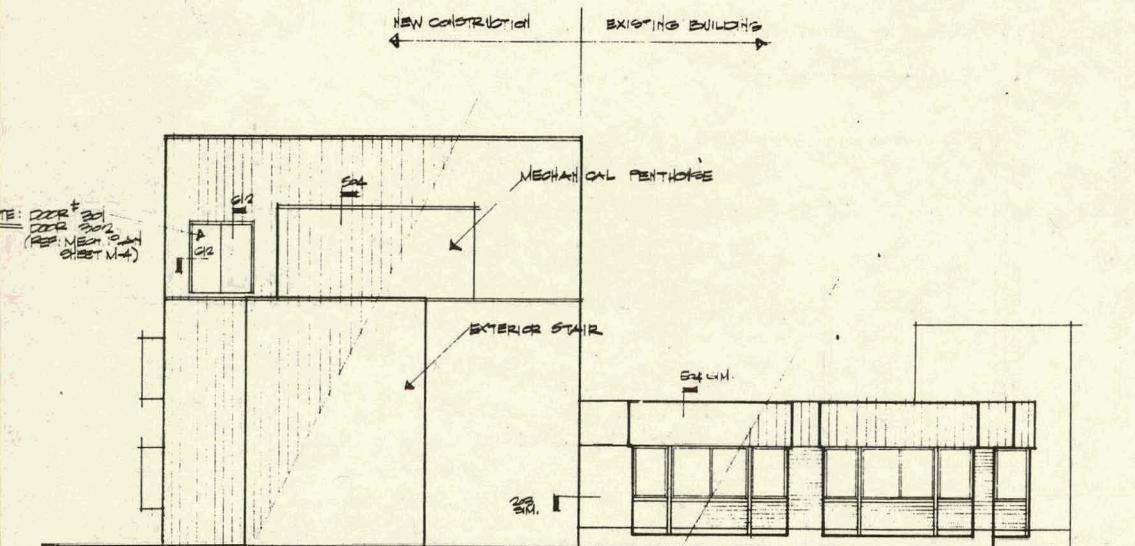
201 FIRST FLOOR PLAN



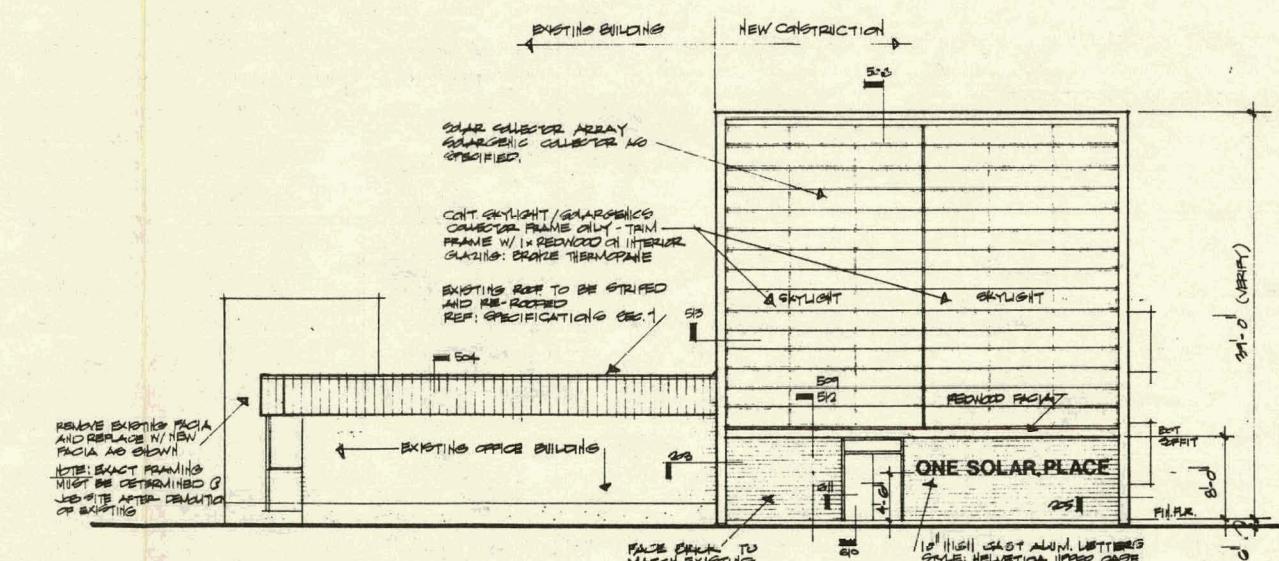
404 WEST ELEVATION



403 EAST ELEVATION



402 NORTH ELEVATION



401 SOUTH ELEVATION

J-2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	82

I. EQUIPMENT SCHEDULE - MULTI-ZONE A/C UNIT

MODEL #	MANUFACTURER	CAPACITY BTUH	CFM	ELECTRICAL CHARACTERISTICS			
				VOLTAGE	EVAP. FAN MOTOR	R.A. FAN MOTOR	MIN. CIRCUIT AMPACITY
RVZ1-300	LENNOX	300,000 BTUH COOLING	10,000	208V-3Φ-60Hz	10 H.P.	3 H.P.	199.4

2. PLUMBING CONNECTION & FIXTURE SCHEDULE

MARK	MODEL	MANUFACTURER + DESCRIPTION	ALLOWANCE
WC	F-2109	AM STD BOHOM DISCHARGE FLOOR MOUNT	
SS		FLAT SVC SINK 2'x3'	
URN.	F-6500	AM STD	
EWC		EXISTING EWC WHICH IS BEING RELOCATED	
NFHB		JOSAM 71000-12 WALL HYDRANT - JOSAM 01400N - 2' DEPTH FLUSH MOUNT IN GRADE	
W.H.		LENNOX 66 GAL NO SUPPLEMENTAL HEAT	
HB		EXISTING ON NE. CORNER OF EXISTING BLDG	
FDA	300 SERIES	JOSAM OR WADE	
FDB	300 "	" "	

3. GRILLE, DIFFUSER & REGISTER SCHEDULE

MARK	MFG. & MODEL	DESCRIPTION	VOL. CONT.	DEFL. DEVICE	FINISH	REMARKS	A K FACT
A	TITUS-272B5	24 X 8	YES	YES	SATIN ALUM FIN		.78
	METALAIRE	60" X 24" SLOT, SERIES 6000-A1	NO	NO	SILVER	RETURN AIR SURFACE MOUNT	
	TITUS - FLO	6 X 6 EXHAUST GRILLE	NO	NO	SATIN ALUM FIN	SURFACE MOUNT	

4. PUMP SCHEDULE*

UNIT NO	GPM	HP	HEAD	VOLT	MFR. & MODEL NO.	REMARKS
P1	50	1	30'	208/340	PEERLESS PE100C-3	SOLAR LOV1 115MP
P2	30	1	60'			CIRCULATING PUMP

* ISOLATION IS WITH PUMP

5. MAIN HEAT EXCHANGER

UNIT # SOLAR WATER SOLAR WATER SW HOT WAT. HOT W. HW PD MODEL # MANUF.
EWT LWT GPM EWT GWT GFM 3' TACO MODEL B-124CB-L
P-1 190°F 183°F 50 120°F 180°F 30 3' TACO MODEL B-124CB-L

6 AIR COOLED HEAT EXCHANGER (OT E)

UNIT # FWT LWT BTU RELEASED S/N FAN RPM VOLTAGE MODEL #
MANUFACT.

(A) * BASED ON 30% GLYCOL SOLUTION

7. VIBRATION ISOLATION

EQUIPMENT	LOAD (LBS.)	MM DEFLECTION	BASED TYPE	ISOLATOR TYPE	MOD.	REMARKS
PUMPS P-1, P-2	—	—	—	—	—	INERTIA PADS

8. EXHAUST FAN SCHEDULE

UNIT #	CFM	SP	HP	VOLTAGE	MANUF.	MOD.	REMARKS
EF-1	800	14"	1/4	110V-1-60	COOK	—	ROOF MTD.
EF-2	600	18"	1/4	110V-1-60	"	—	WALL MTD.

9. SOLAR HOT WATER HEATER SCHEDULE

NI #	GAL CAP	KW6PM	MOD.	MANUFAC.	REMARKS
1	66	0	LSHWI-1	LENNOX	115V-60-14

STORAGE TANK SCHEDULE

UNIT #	GAL CAP	MOD & MANU.	REMARKS
1	2150	CCNC TANK BY WIFFERD MFG CO.	W/HATCH & BOT DRAIN
2	2150	"	"

II BACKUP BOILER

UNIT #	KW	VOLT.	GPM	GAL CAP-	BTUH CAP	MOD & MAN	REMARKS
1	48	208-3-60	20*	10.2	163,824	WEIL-McCLAIN CE-48W (3) 16 KW ELEMENTS, 135 AMPS, #26 WIRE	

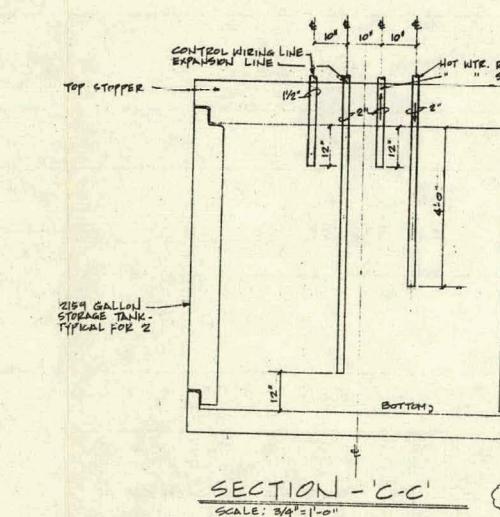
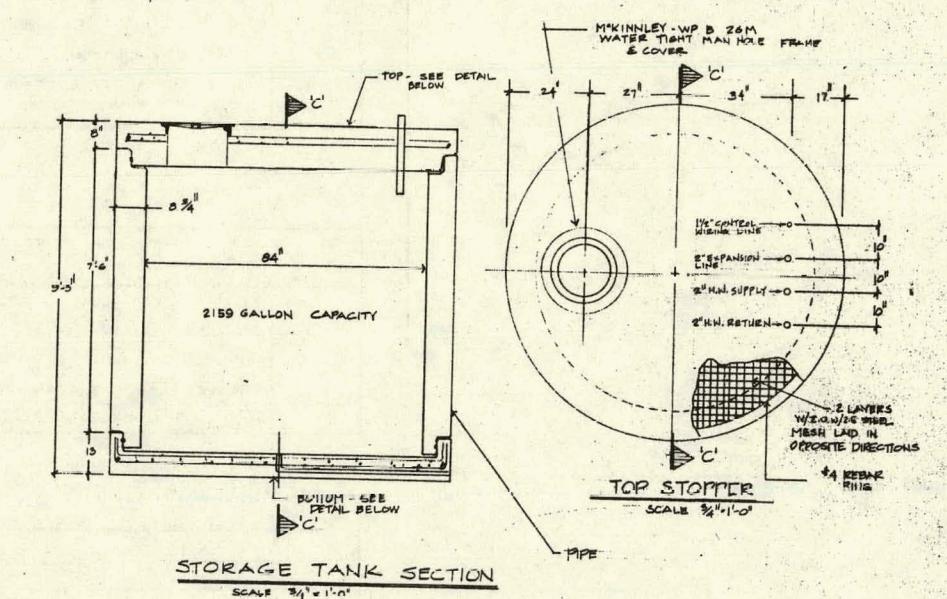
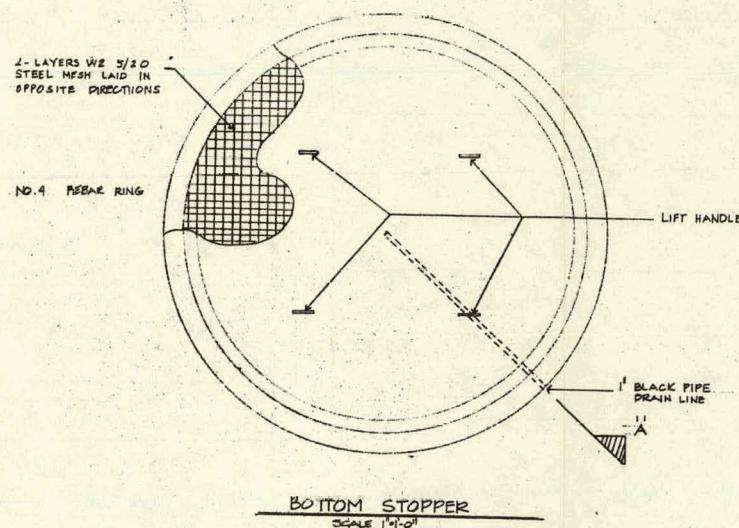
19 RETURN AIR FAN

MARK	TYPE	CFM	S.P.	H.P.	VOLTAGE	MFR. & MODEL
R.A.	IN-LINE	1500	3/8 ²	1/3	115V 1Φ-60~	COOK 12CV17D

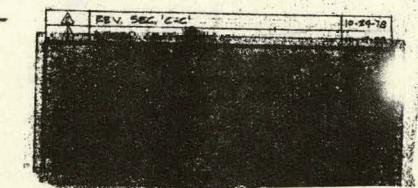
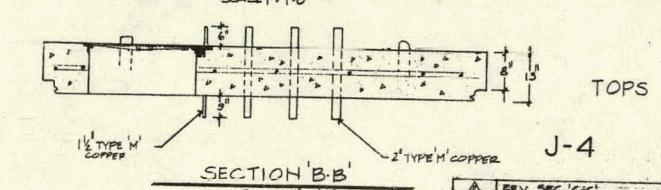
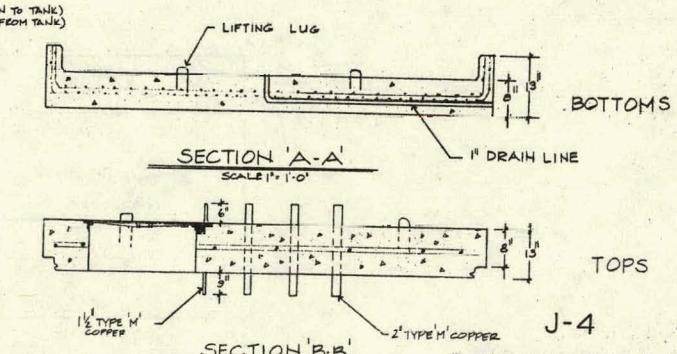
3. VENT-A-HEAD-(1 ONLY)

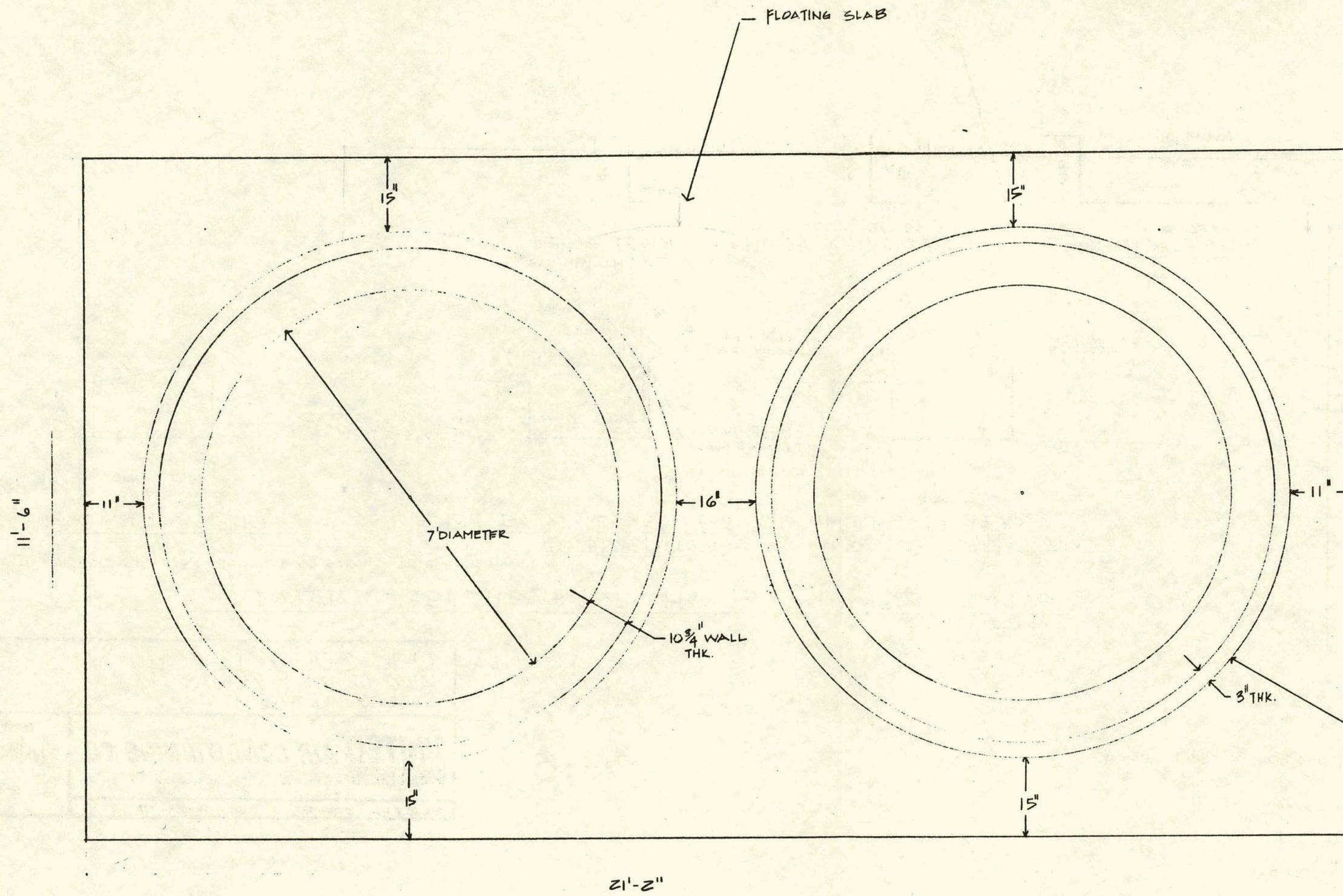
ELECTRICAL CHARACTERISTICS

1-3



STORAGE TANK DETAILS





④ STORAGE TANK LOCATION ON FLOATING SLAB

SCALE 1"=1'-0"

STORAGE TANK Specs *

ITEM	WEIGHT	CAPACITY	DESCRIPTION
TANK(EMP)		2159 GAL	GIFFORD HILL
LID			II
BOTTOM			II
TANK(FULL)		2159 GAL	IV

* SEE SHEET FOR TANK DETAILS

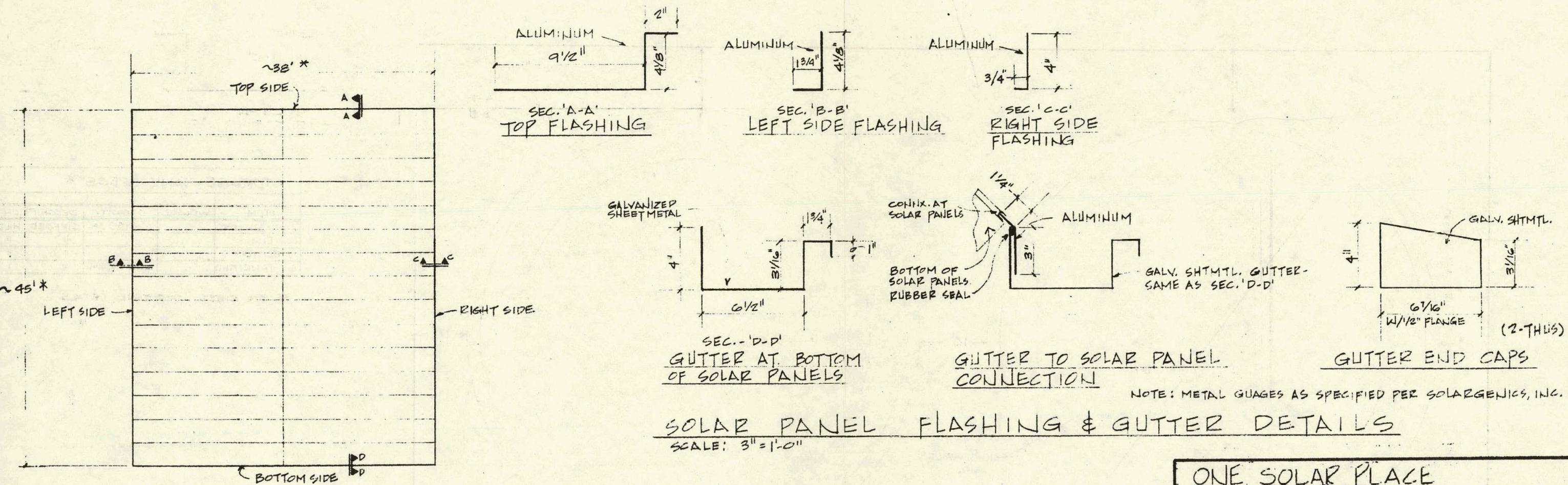
INSULATION TO BE 3" THK,
VARY THICKNESS AS REQ'D
BUT NO LESS THAN 3" IN ORDER
TO MAKE SIDES PERFECTLY VERTICAL
SEE SPECS.

INSULATION TO BE ACFLEX FOAM
TYPE INSULATION WITH A PERFECTLY
SMOOTH OUTER GAGING FINISH.
U-FACTOR TO EQUAL .05 BTU
hr-ft² °F

J-5

▲ GEN. REV. 10-24-18

ONE SOLAR PLACE 4140 OFFICE PARKWAY DALLAS TEXAS
UNITED AIR CONDITIONING CO. P. O. BOX 21000 • DALLAS, TEXAS 75211 • 972-231-0111 PROJECT NO. 13-76-077
12
013



SOLAR PANELS - PLAN VIEW

SCALE: $1/8'' = 1'-0''$

* EXACT LENGTH TO BE VERIFIED FROM ARCHITECTURAL DRAWINGS
BY SOLAR GENICS, INC.

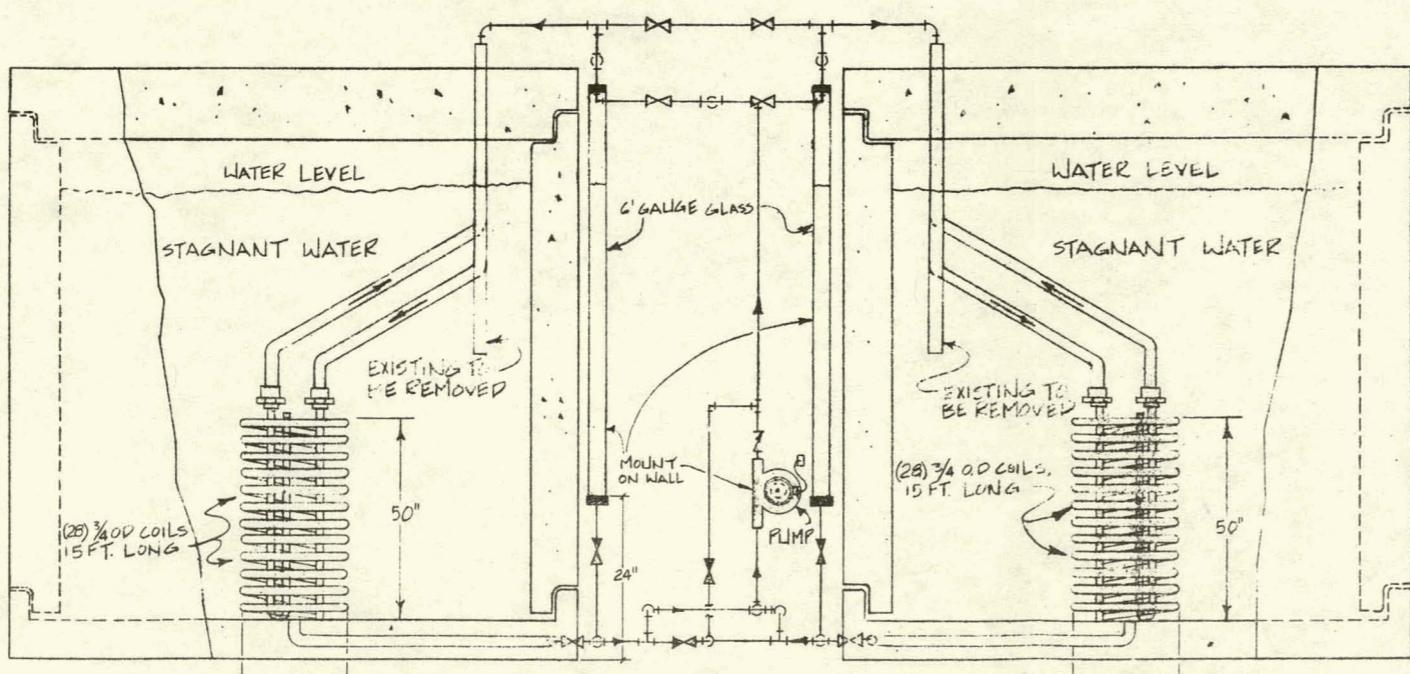
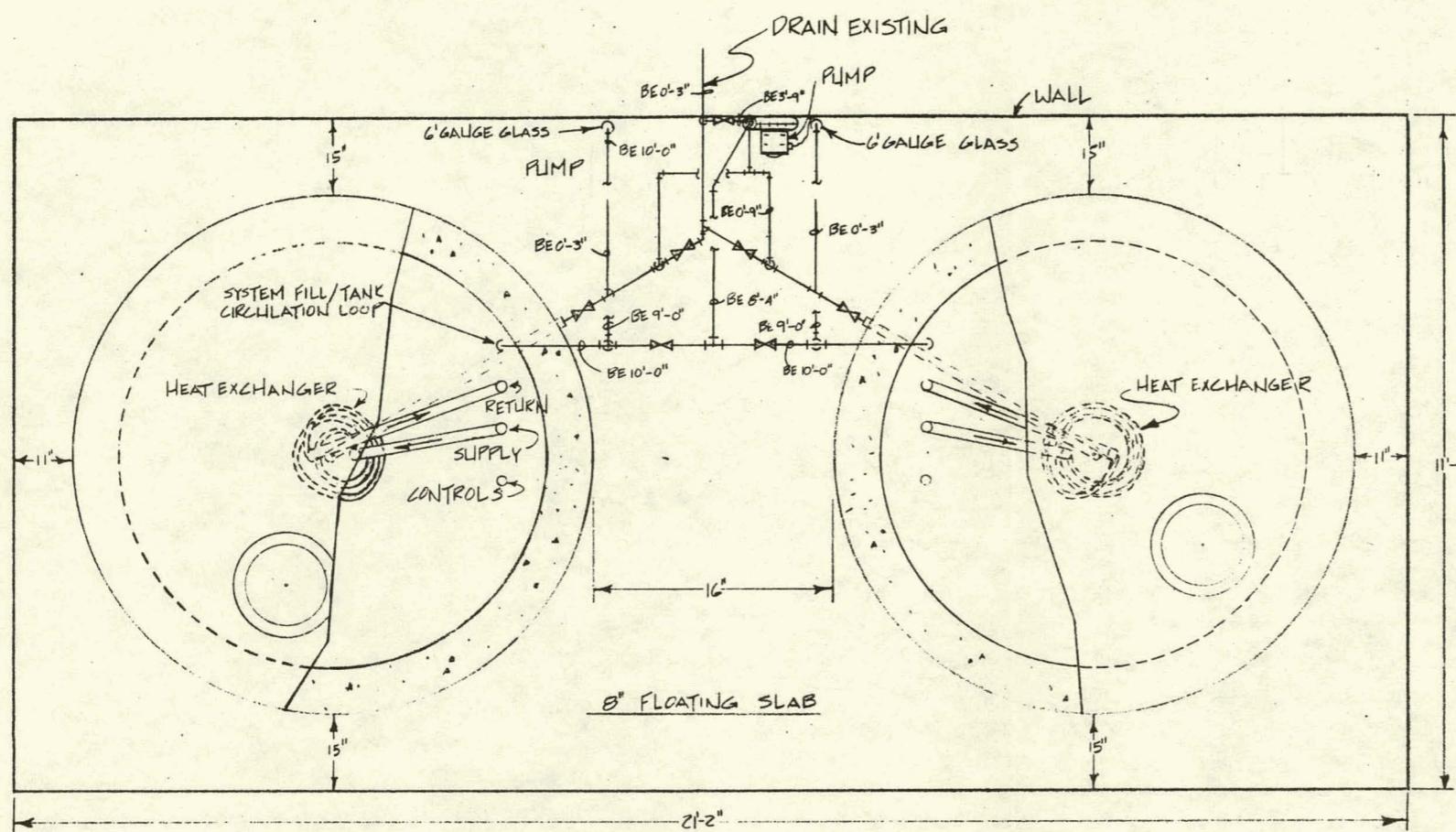
J-6

ONE SOLAR PLACE
4140 OFFICE PARKWAY
DALLAS, TEXAS

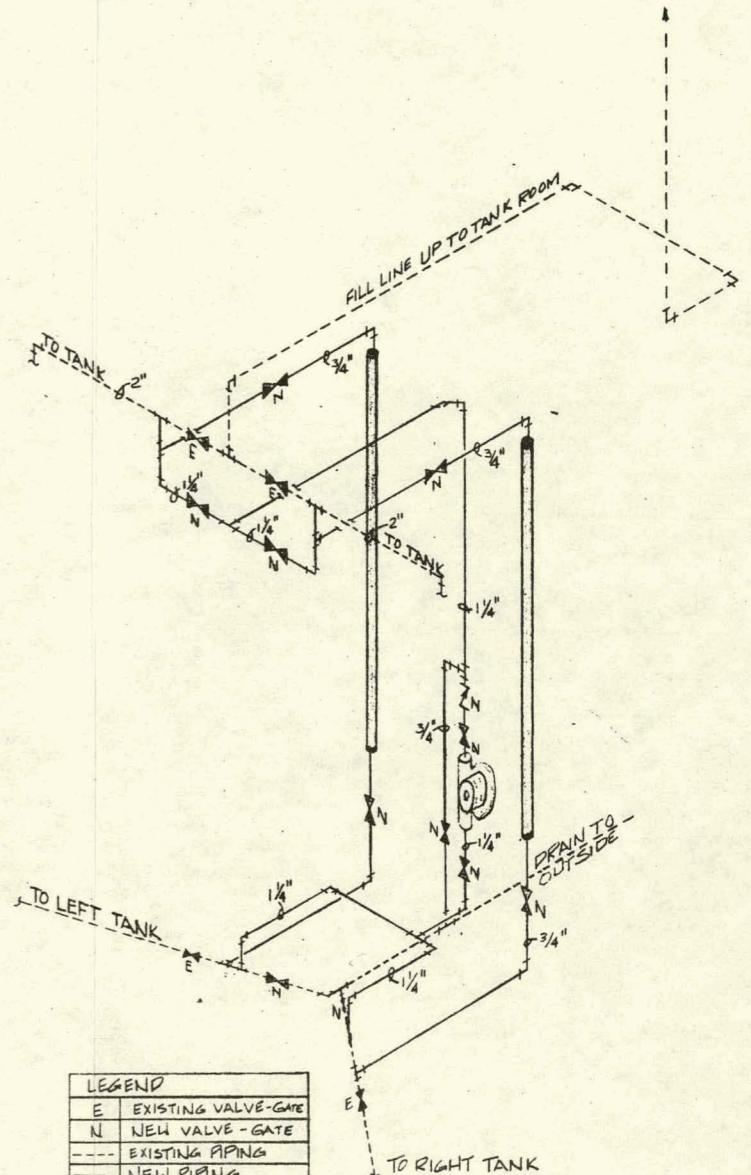
UNITED AIR CONDITIONING CO.
P. O. BOX 31088 • DALLAS, TEXAS 75231 • 341-8300

14 -
OP 15

PROJECT NO.: B78-077 DATE: 11-29-78



IMMERSION TYPE HEAT EXCHANGER
SCALE: $\frac{3}{4}'' = 1'-0''$



J-7

ONE SOLAR PLACE
4140 OFFICE PARKWAY
DALLAS, TEXAS

UNITED AIR CONDITIONING CO.
P. O. BOX 31068 • DALLAS, TEXAS 75231 • 341-8300

四