(NASA-CR-161273) SOLAR ENERGY SYSTEM INSTALLED AT THE NORTH GEORGIA APDC OFFICE BUILDING (North Georgia Area Planning and) 131 p HC A07/MF A01 CSCL 10A

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DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-161273

SOLAR ENERGY SYSTEM INSTALLED AT THE NORTH GEORGIA APDC OFFICE BUILDING

Prepared by

North Georgia Area Planning and Development Commission
503 West Waugh Street
Dalton, Georgia 30720

Under DOE Contract No. EG-77-A-01-4075

Monitored by

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

For the U. S. Department of Energy

U.S. Department of Energy

Solar Energy

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PART I

DESCRIPTION OF THE SOLAR ENERGY SYSTEM AND BUILDING

Introduction

The North Georgia Area Planning and Development Commission (APDC) office building is equipped with a hydronic, automatic drain-down solar heating and cooling system. The system, providing solar heat exchange from a 2,001 square foot effective collector area, supplies 65-70% of the building's cooling demand and 90-95% of the heating demand. Domestic hot water is also provided, however, the demand is very nominal. Heating is accomplished by the direct flow of solar heated water to an exchange deck in the central air handler. The building is cooled by the direct flow of chilled water to a separate exchange deck. In the cooling mode, solar heated water is used to drive a 25 ton absorption chiller. Back-up or supplementary supply of heated water to drive the chiller or for building heat is provided by a conventional oil-fired boiler. Control sequencing for heating and cooling modes is accomplished by a multizone central processor. Day and night demands for heating and cooling are controlled by a standard automatic time clock and an override, low setting thermostat.

North Georgia APDC Office Building

The newly constructed office building, located on 1.5 acre lot near downtown Dalton, Georgia, is a modern, two-story structure containing 7,000 square feet of office and work space. The building has masonry exterior walls, steel frame floor and roof system, and type 4 fire-resistive construction.

The building has numerous energy conservation features incorporated into its construction. The western and northwestern, first floor elevations of the building are buried into the sloping contour of the lot reducing the summertime afternoon sun load and minimizing the cooling effect of the predominately northwestern winter wind. The square shape of the building produces the least amount of exterior wall area which reduces the heating and cooling load. Also, the two-story design of the building has minimized the roof area further reducing the loads on the building. Window area has been kept to a minimum. There are no windows in the west wall thus eliminating a potential source of heating load from the afternoon sun. Windows have been confined to the east wall and adjoining corners and are protected from the sun by generous roof overhang. All windows are operable so that under appropriate weather conditions natural ventilation is available. Window glass is the insulating type, double glazed, and shaded to prevent the impingement of direct sunlight.

The respective U factors for the roof and walls are .09 and .04.

Collector Array

The fifth, or southern most row of collectors, is not reflector augmented but is pitched at an angle of 25 degrees. The reason for the different configuration of this row is due to the limitation of roof area to accommodate the fifth collector. The design indicated that a fifth row would significantly enhance the summertime delivery of energy (the period of highest energy demand). Since the roof area was too small for the placement of both collectors and reflectors in this row, only the collector bank was used and was placed at an angle to absorb the maximum summertime energy.

Collectors are double glazed with special low iron glass and have an application of black chrome selective coating. Reflector panels were fabricated from stainless steel sheets (gage .02 inches) mounted with adhesive to 5/8 inch marine plywood.

The collector array support structure is fabricated from welded steel into a truss design and mounted to the roof on specially constructed roof curbs. The truss design, in addition to providing considerable strength against possible wind damage, facilitated the installation of the collectors and reflector panels. As each collector and panel, including their support frame was placed in position on the array structure, each was rotated from the vertical into the structure at the appropriate angle and welded into place. The steel support structure was coated with a corrosion resistant paint.

Absorption Chiller

Solar cooling of the North Georgia APDC building is accomplished with a model 300 Arkla absorption chiller. Water heated by solar or the oil-fired boiler is pumped to the chiller at 180°F at 54 GPM. to provide 16 tons of cooling. At this temperature and flow rate, the chiller produces chilled water at 45-50°F for circulation through the multizone air handling unit.

Supplementary Energy Source

Supplementary heating for hot water to operate the absorption chiller or heated water to the thermal deck in the air handling unit is provided by a Weil-Mclain oil-fired boiler, Model 576-EH. Number 2 fuel oil, drawn from a buried, 1,500 gallon storage tank is consumed at 2.95 gallons per hour.

Space Conditioning Equipment

The North Georgia APDC solar system is interfaced with a conventional seven zone multizone air handler unit (AHU) with ducted air distribution to each zone. Each zone has an independent thermostat for effecting desires set point conditions for the air which is ducted to each zone. This air is either heated, cooled, or recirculated through the multizone unit.

Two tube-in-fin heat exchanges are employed in the AHU. Hot and chilled water is circulated through their respective coils according to the demand of the seven-zone thermostats. The AHU's circulating fan operates continuously during the day when the building is occupied to provide air circulation and humidity control. An override setback switch is used to operate the system during off-duty hours. After the first cooling and heating seasons, the system was modified to prevent the simultaneous flow of hot and chilled water to the AHU. This was accomplished by installing manual selection switches for hot or chilled "only" switches.

System Controls and Modes of Operation [1]

The system employs a Multizone Central Processor (MCP) for establishing appropriate control sequencing depending on the heating and cooling demand placed on the system. Solar collection controls operate separately but in conjunction with the MCP.

Solar Collection - Pump P-1 circulates water through the solar collectors and is controlled through switching relay R-1 and motor starter relay C-1. Switching relay R-1 is controlled by a temperature difference sensing device with one sensor (TS-1) on the absorber plate of a particular collector. The other sensor (TS-2) is located in the bottom of the hot water storage tank

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[1] See page 1-8 for relay legend

(HWST). When TS-1 minus TS-2 reaches a level 15°F, relay R-1 closes, activating motor starter C-1. P-1 begins to fill the array and circulate water through the collectors. If TS-1 minus TS-2 drops to a level of 5°F, R-1 reopens and P-1 ceases operation allowing the water in the collectors to drain back into the HWST.

The only exception to this operation is when the chiller is being powered with solar heated hot water. In this case R-1 is overridden by R-6, hence P-1 is "locked on" until R-6 returns to its N.O. position and R-1 is again the sole controller of P-1. R-6 overrides R-1 because the position of R-1 is related to the temperature of the hot water tank which is not in the "system" during the AC mode.

Heating - Solar and Boiler - Heat is delivered to the building by a finned tube heat exchanger. Hot water is passed through the tubes and air is blown through the fins and then distributed to the appropriate areas by the multizone air handling unit. Heat for the building is called for in two stages (min. and max.) depending on how much heat is required to bring temperature back up to its set point. Minimum and maximum refers to the difference between the thermostat set point and the sensed room temperature which sets a priority on energy sources. Due to the nature of the building, it is possible to require heat in one area of the building and cooling in another. To save energy at the cost of slight discomfort, an isolation relay R_{18} has been installed so that when the chiller is operating, no heating equipment can be operated. Heat can be supplied through modulating valve V-6. (See page 1-9)

If min. heat is called for, R_{20} closes, assuming the chiller is off, the top of the HWST is checked to see if the temperature there (TS-3) is over 120°F (49°C). If it is, C-2 (motor starter) closes causing P-2 to circulate hot water through the heating coil. If TS-3 senses a temperature below 120°F (49°C), no heat is delivered. If and when max. heat is called for R_{9B} closes, if P-2 is operating nothing further occurs. When max. heat is called for and P-2 and the chiller are off, the boiler and boiler circulator are turned on by R_{19} closing.

Air Conditioning - Solar and Boiler - Cooling is delivered to the building by a finned tube heat exchanger, as chilled water is pumped through the tubes and air circulates through the fins. The cooled air is distributed to the appropriate areas by the multizone air handling unit. On the solar collector array, a solar intensity sensor is located in a position to measure the combined reflected, beam and diffuse radiation falling in the plane of the collector panels. When this reaches a preset amount, I_{on} (approximately 160 BTU/FT^2/HR), R_3 closes and activates time delay relay R_4. R_4 holds R_3 closed for three (3) minutes to prevent any rapid cycling. R_3 will open when the combined solar radiation drops to a level I_{off} (approximately 140 BTU/FT^2/HR), provided the three minute time delay has reopened. If the outside air temperature is above a preset limit T_{OA} (65°F), R_5 closes. If R_5 is closed and R_3 is closed, the following occurs simultaneously: R_6 locks on P-1, R_7 closes preparing to operate the chiller, R_8 operates V_1 and V_2 which begin to preheat the water in the piping, collectors, and buffer tank to operate the chiller. R_{12} closes, preventing the boiler from operating. When the outlet of the buffer tank reaches 165°F (74°C), R_{10} closes and the chiller begins operating. The chiller's own internal controls operate diverting valve V-3.

All of the above occurs without regard to the cooling load of the building. If cooling is called for, mixing valve V-5 begins to deliver chilled water to the cooling coil in the air handler in the solar A.C. mode.

Cooling is called for in two stages min. and max. depending on how far the senses room air temperature is above the set point. If the chiller is not operating from solar and min. cool is called for, R_{13} closes operating motor starter C-6 which operates P-6 the chilled water circulator. If the senses room temperature continues to rise sufficiently to call for max. cool, the boiler and boiler circulator and the chiller are all brought into full operation. As min. cool is always on when max. cool is, the chilled water circulator pump is still operating.

On weekends the building is not cooled and any solar chilled water is put into storage. When the bottom of the chilled water storage tank, (TS-4) reached 55°F (12.8°C), the boiler cannot operate for a maximum cooling demand as it would during the working week days.

Domestic Hot Water Heating - Domestic hot water is heated in the domestic hot water tank by either solar hot water or electrical resistance heat. Electrical heat is only used when the top of the tank is cold. P-7 circulates water from the top of the HWST through a heat exchanger in the domestic hot water tank and returns it to the bottom of the HWST. This pump is controlled through R_{22}, a differential temperature sensing device. This device compares the temperature (TS-5) at the top of the HWST and the temperature (TS-6) at the bottom of the domestic hot water tank. When TS-5 minus TS-6 reaches a value of T_{on} (15°F), R_{22} closes and P-7 begins operation. When TS-5 minus TS-6 drops to a value of T_{off} (5°F), R_{22} opens and P-7 ceases operation.

RELAY LEGEND

R_1	collector ΔT	NO	operates collector circulator pumps
R_{2B}	max. cool	NO	boiler A.C., SE2TV#1
R_3	solar cell	NO	close sufficient insolation for solar AC
R_4	time delay	NO	locks on R_3 at first turn on
R_5	O.A. temp.	NO	for solar AC, RDK#1
R_6	solar AC	NO	override R_1
R_7	solar AC	NC	preheat fluid for solar AC
R_8	solar AC	NO	operates V_1 and V_2
R_{9B}	max. heat	NO	boiler heat
R_{10}	solar AC	NO	buffer outlet sufficient for solar AC RDK#2
R_{11}	solar AC	NO	operates chiller for solar AC
R_{12}	boiler lockout	NC	will open circuit boiler circuit
R_{13}	min. cool	NO	operate C.W. circulating pump SE2TV#1
R_{14}	C.W. storage tank	NC	no boiler AC if open RDK#3
R_{15}	C.W. circulator	NO	operate C.W. circulator when boiler AC
R_{16}	boiler start	NO	operate boiler on max. AC if no solar AC
R_{17}	boiler AC	NO	operates chiller for boiler AC
R_{18}	heating lockout	NC	locks out heating equip. if chiller is on
R_{19}	boiler on	NO	boiler on for boiler AC or boiler heat
R_{20}	min. heat	NO	operate solar H.W. circulator
R_{21A}	no heat in storage	NO	allows boiler heat if no heat in storage
R_{21B}	heat in storage	NO	allow heating from solar H.W.
R_{22}	domestic HW ΔT	NO	operates DHW circulator pump
C_1	P-1	NO	collector circulator pump
C_2	P-2	NO	hot water circulator pump
C_3	P-3	NO	boiler circulator pump
C_4	P-4	NO	condensing water circulating pump
C_5	P-5	NO	evaporator circulator pump
C_6	P-6	NO	chilled water circulator pump
C_7	F-1	NO	cooling tower fan

Modifications

The North Georgia APDC solar system has undergone two modifications during the operational period May through December 1978. In both cases these modifications were changes from the original system design.

Under the original design specifications the system could operate simultaneously in both the heating and cooling modes. This was not a problem during the summer period when the system was operating under a maximum cooling load. However, during the fall, the building would require heating in the morning hours and cooling in the afternoon. Another noticeable situation during this period was the in balance between the first and second floors. Often the first floor would call for heating while the second floor would call for cooling. The overall situation created an ineffective, intermittent operation of the chiller. The controls were modified to include manual switches to keep the system in one specific mode.

The second modification resulted from the freezing of the collectors. To insure adequate, full drainage of the collectors, vacuum breakers have been installed on the supply headers on each row of collectors. (These can be seen in Photograph #5.)

PART 2

ACCEPTANCE TEST DATA

ACCEPTANCE TEST PLAN

NGAPDC

DALTON, GEORGIA

1. Demonstrate Fail Safe Controls

   The system will be placed in each mode of operation and the main power disconnect will be interrupted. Response of the overall system will be observed to insure that no unsafe conditions arise, that no equipment is damaged or rendered otherwise inoperable, and that the collector array drains fully. Power will be applied and the system observed to insure that normal operation resumes without external intervention.

2. Demonstrate Pressure Relief Valves

   The mechanical equipment loops with pressure relief valves will be isolated from the thermal storage tanks and their respective loops pressurized to insure that the pressure relief valves operate at their designated pressure.

3. Demonstrate No Leaks

   Prior to installation of insulation the overall system will be isolated from the thermal storage tank and pressurized to 15 psig and then isolated from the pressure source. Pressure will be observed for 6 hours to insure no leaks are present.

4. Demonstrate No Growth of Algae, Fungi, Mold or Mildew

   A similar system has been in operation at the Shenandoah, Georgia, Community Center for one year with no observef foreign growth. The water in Dalton, which is used in the NGAPDC system, has a very low calcium carbonate ($CaCO_3$) content, approximately 15 ppm.

5. Demonstrate Back-Flow Prevention

   The solar hydronic system is connected to the potable water supply in three places. One is at the inlet to the domestic hot water heater, back-flow is of no concern here. The second connection is through a gate valve to fill the solar system. This valve will be closed when the system is in operation, however a continuous pressure type back-flow preventer will be put in that line (Watts no.9D or equivalent). The third connection is at the cooling tower; at this connection the water is discharged to atmospheric pressure and the overflow level is below the make up water outlet, therefore back-flow will not occur here. No hard connection occurs between the solar system and the potable water supply. A hose is connected to fill the solar system and two must valves opened. The valves are closed and valves shut when filled. The solar system is not pressurized.

6. Demonstrate No Fluttering

   Only valves designed for flow control use (such as butterfly, globe, or ball valves) are operated partially open. The system will be observed during initial operation to insure no valve fluttering occurs.

7. Demonstrate Drain and Filling

   A closed sight glass will be installed at an appropriate location below the collector array for visual indication of complete drain down.

8. Demonstrate Temperature at Various Points

   Thermometer wells will be installed at the critical points indicated on the flow schematic. Temperature will be observed and recorded with mercury in glass thermometers.

9. Demonstrate Collector Flow GPM

   A "Flow Setter" will be installed in the main collector loop to determine the flow through the collectors.

10. Demonstrate Collector Flow Pressure Drop

    Gauge cocks will be installed in the array supply and return lines for measurement using a differential pressure gauge.

11. Demonstrate System Operates in All Modes of Operation

Manual control overrides will be provided in the control system so that the system can be placed in each mode of operation and observed for proper operation.

12. Demonstrate Pump and Fan Ampere Loads

The power wiring will be installed so that each branch circuit is accessible to measurement by an inductive ammeter. Current will be observed to insure operation at rated amperage and that conductor capacity is not exceeded.

13. Verify Heat Collection Performance

The flow rate through the array is measured as previously discussed. The temperature rise of collector water across the array will be measured with a differential thermopile. Insolation on the collector aperture will be measured by a pyranometer (Eppley model 2 or equivalent) mounted at the inclination of the collectors. Output from the differential thermopile and the pyranometer will be indicated on a strip-chart recorder. Ambient temperature will be measured by a mercury in glass thermometer. Steady state conditions will be obtained and the collector efficiency computed from these measurements for comparison with manufacturers efficiency data.

14. Verify All Equipment, Piping, Controls, etc., are Installed in the Manner Specified

Visual inspection of the installation will be performed and documented (photographs will be made as necessary) before and after installation of insulation or backfilling as applicable.

15. Verify All Pumps, Controls, Dampers, Fan, and Air Distribution Systems Operate as Specified

Fluid distribution will be monitored using appropriate flow measurement devices (Bell and Gossett Circuit-Setters or equivalent). Controls will be observed for operation under simulated conditions. Air distribution will be monitored by standard techniques using direct-reading pitot tube manometer. Air distribution was checked and set by the Mechanical Contractor, Calhoun Mechanical, Inc.

ATP RESULTS

1. All systems operated normally after power interruption.
2. The boiler pressure relief valve released at 30 PSI.
3. The collector circulator pump had a leak at its seal. The seal was replaced and the leak stopped.
4. No algae, fungi, mold or mildew has been observed in either storage tank. The sump of the cooling tower does show signs of algae growth as expected. The sump is to be drained and cleaned monthly when in use.
5. By virtue of the fact that there is no permanent connection between the potable water supply and solar water, back-flow is no problem.
6. No fluttering has been observed.
7. Filling and draining are visible by a 3" change in water level of the sight glass.
8. Typical temperature at various points were as follows on the days of the ATP:

Chiller:

generator inlet	176°F	(80°C)
generator outlet	164°F	(73°C)
condenser inlet	83°F	(28°C)
condenser outlet	101°F	(38°C)
evaporator inlet	59°F	(15°C)
evaporator outlet	49°F	(9.5°C)

Collectors:

inlet	164°F	(73°C)
outlet	176°F	(80°C)

Tanks:

top of hot water storage tank	162°F	(72°C)
bottom of hot water storage tank	151°F	(66°C)
bottom of chilled water storage tank	69°F	(20.5°C)

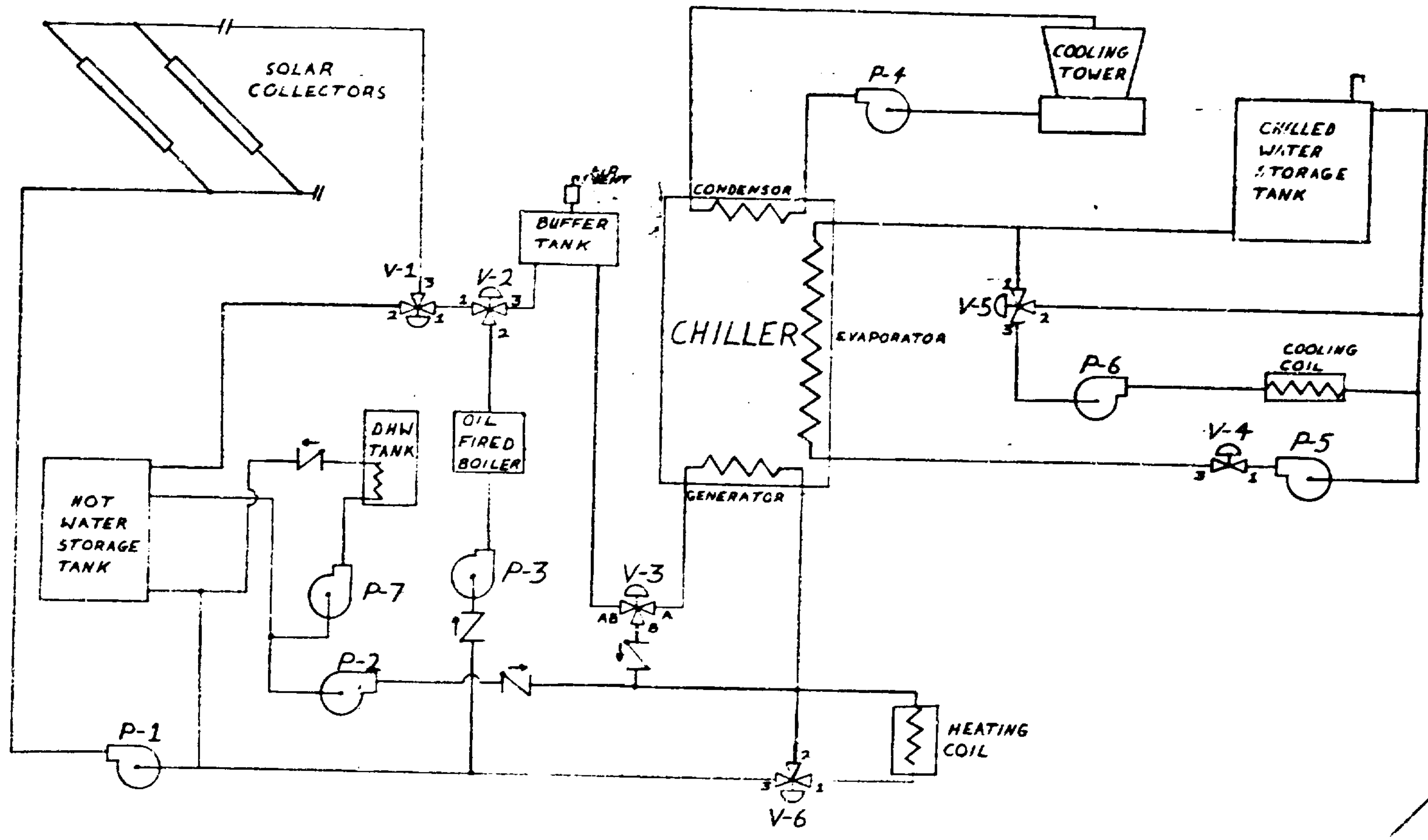
Coils:

chilled water coil inlet	50°F	(10°C)
chilled water coil outlet	58°F	(14.4°C)
hot water coil inlet	N/A	
hot water coil outlet	N/A	

9. The collector flow through the 115 collector panels was shown to be 54 GPM (3.4 l/s).
10. Collector flow pressure drop at 54 GPM (3.4 l/s) was demonstrated to be 4.3 PSI.
11. All systems were demonstrated on manual override and performed as specified.
12. Pump ampere loads demonstrated to be 4.5 and 5.5 amps on 5 and 6 amp rated pumps respectively. The cooling tower drew 4.0 amps. The aforementioned equipment is all 208 VAC 3 phase.
13. The test was performed and data taken for two (2) days of operation. At peak production heat from the collectors generated 204,000 BTU/HR (215 MJ/HR) of chilled water with an input of 284,000 BTU/HR (300 MJ/HR) of hot water at a chiller inlet temperature of 189°F (87°C) and a roof ambient of 88°F (31°C). The strip chart record of the collector temperature difference and solar radiation are on record at Independent Living, Inc.
14. Mr. Douglas W. Westrope of the George C. Marshall Space Flight Center acting for DOE witnessed and verified installation as specified.
15. Mr. Douglas W. Westrope witnessed and verified operation as specified.

PART 3

AS-BUILT DRAWINGS



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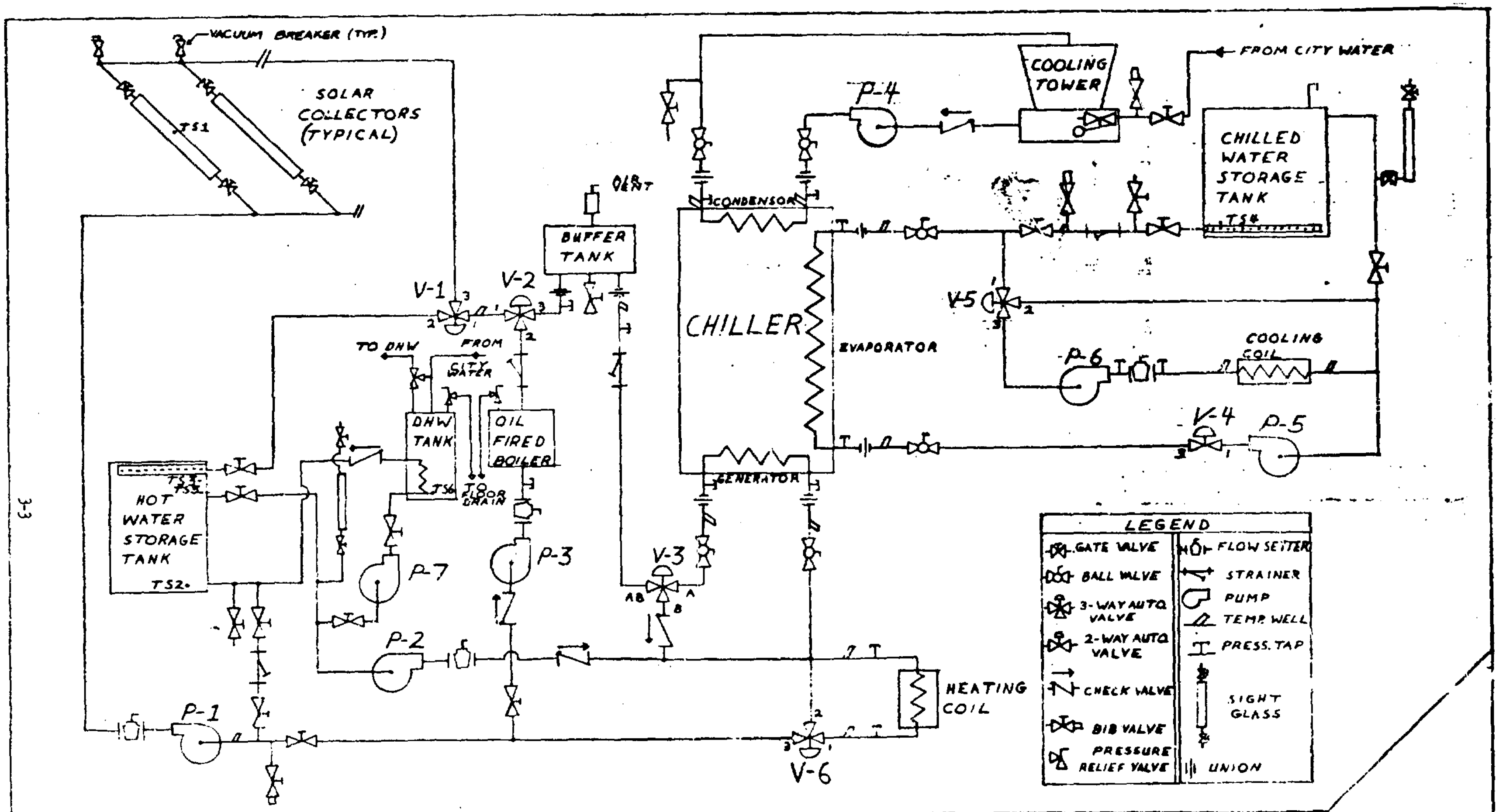

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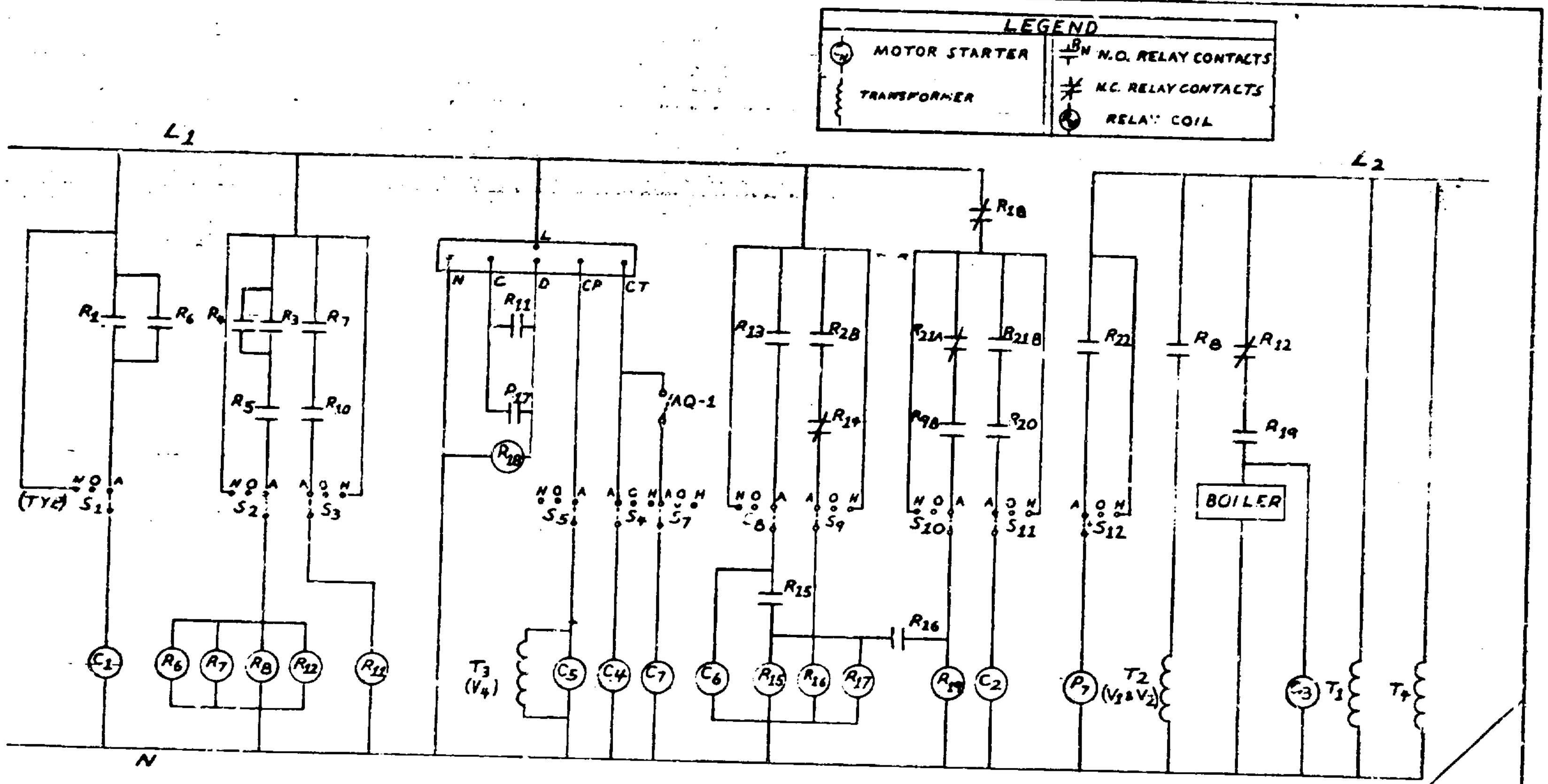

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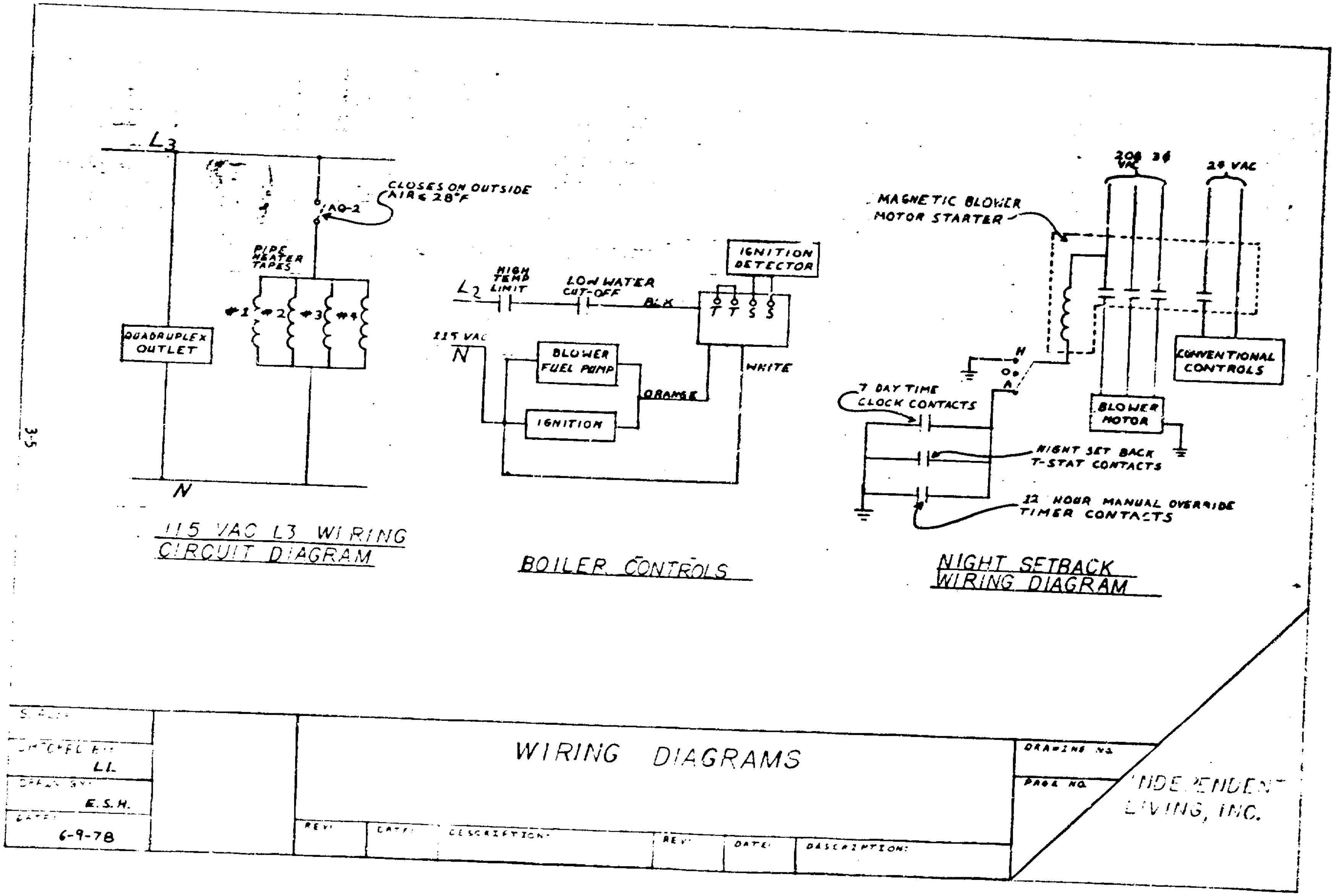
DATE: 6-9-78	REV: DATE: DESCRIPTION: REV: DATE: DESCRIPTION:	


L3
CLOSES ON OUTSIDE AIR ≤ 28°F
AO-2
PIPE HEATER TAPES
#1 #2 #3 #4
QUADRUPLEX OUTLET
N
115 VAC L3 WIRING CIRCUIT DIAGRAM
L2
HIGH TEMP LIMIT
LOW WATER CUT-OFF
BLK
IGNITION DETECTOR
T T S S
115 VAC
N
BLOWER FUEL PUMP
IGNITION
ORANGE
WHITE
BOILER CONTROLS
MAGNETIC BLOWER MOTOR STARTER
208 3Φ VAC
24 VAC
CONVENTIONAL CONTROLS
BLOWER MOTOR
H
O
A
7 DAY TIME CLOCK CONTACTS
NIGHT SET BACK T-STAT CONTACTS
12 HOUR MANUAL OVERRIDE TIMER CONTACTS
NIGHT SETBACK WIRING DIAGRAM
CHECKED BY: L.L.
DRAWN BY: E.S.H.
DATE: 6-9-78
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REV. DATE DESCRIPTION
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PROJ. NO.
INDEPENDENT LIVING, INC.

PART 4

SYSTEM OPERATION AND MAINTENANCE

The operation of the North Georgia APDC solar system has been in general, outstanding. The system was activated in late May of 1978 and was tested under the ERDA Acceptance Test Plan on May 24-25. The system has been in continuous operation since that date, and has provided excellent service during the hot, Georgia summer. There have been some problems, but not of such a nature as to interrupt the overall operation of the system, for any length of time.

As stated previously, the system was designed to produce approximately 60% of the cooling load. Although the operational record is incomplete, due to reasons which will be explained later, it appears that the system is operating at or exceeding this percentage of the cooling load. One indication that leads to this conclusion is the amount of time required to operate the boiler for supplementary heating of water to operate the chiller. Only an estimate is available at this time, however, the boiler appears to operate for approximately four hours per day during periods of full, unobstructed radiation. The building requires cooling for approximately ten hours each day and the solar system produces a sufficient amount of heated water to drive the chiller for air conditioning for about six hours, which is well within design limits. System performance is expected to improve as more operational experience becomes available.

Over the past nine months the system has provided effective cooling and heating on a continuous basis. The estimate cost of this service has been minimal in comparison to other non-solar cooling systems employed in the local area, and has alleviated the North Georgia APDC of a major operating expense during the summer months.

Maintenance on the system through February 1979 is as follows:

1. May 24-25, 1978. Seal failure on main circulation pump. Parts under warranty. Labor cost $100.
2. June 1, 1978. Solar sensor controls out of calibration. Materials cost, none. Labor $160.
3. June 5, 1978. Seal failure in pump P-1. Replacement high temperature seal. Materials cost, none. Labor $160.
4. June 20, 1978. Malfunction of boiler ignitor. Electrodes cleaned and reset. Materials cost, none. Labor cost $80.
5. July 10-August 7, 1978. Pump motor (P-1) shorted out. Pump pulled for factory repair. Materials cost, none. Labor cost $160.
6. August 15, 1978. Malfunction of control time clock. Clock replaced under warranty. Materials cost, none. Labor $300.
7. November 10, 1978. First floor thermostats were initially cross-wired. Materials cost, none. Labor $80.
8. December 8, 1978. Automatic drain down failed causing collector freeze. Piping repair and installation of vacuum breakers. Materials cost, $370. Labor $530.
9. January 8-25, 1979. Failure of transformer in boiler ignitor system. Transformer, pump, and seals P-2; P-3. Materials cost, $150. Labor $450.

Note: The above listed maintenance items were covered under a one year warranty. NGAPDC has not incurred any costs for parts or labor.

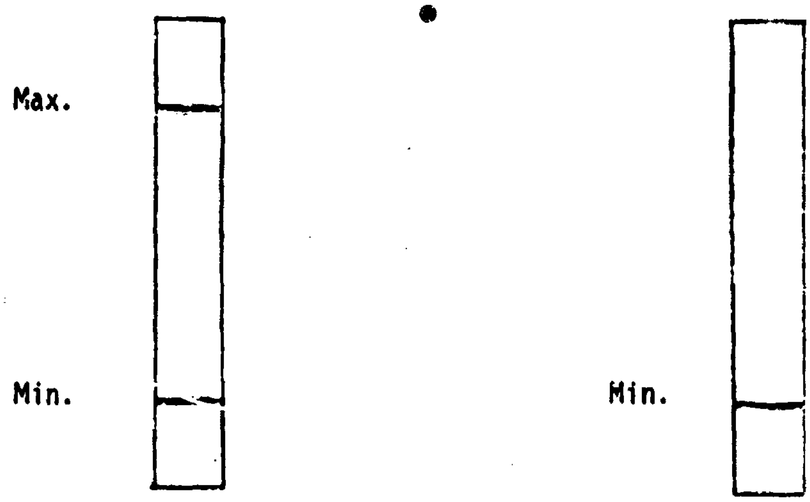
MAINTENANCE

The following contains information pertinent to the solar heating and cooling system installed by Independent Living, Inc. of Atlanta, Georgia on the office building of the NGAPDC in Dalton, Georgia. The system is operational as of May 9, 1978.

The following has three (3) sections. The first contains maintenance instructions and schedules to be performed according to the listed time tables. The second section contains manufacturers information on the equipment installed in this system. The third contains a description of modes of operation and control sequences.

WEEKLY CHECK LIST

1. With system off fill both HWST and CWST with water until flow is observed coming out of vent on top of each tank. This should be done monthly, in the winter only the HWST needs to be filled.



HOT WATER TANK

Water level must be between the two (2) silver bands.

CHILLED WATER TANK

Water level must be above the silver band.

2. Check to see that circuit breakers are all closed.

3. Observe floor for active leaks (not condensate drip spots!).

MONTHLY CHECK LIST

1. Check for correct setting of time clock.
2. Check array for leaks while in collection mode.
3. Check to insure all ten (10) array valves are fully open.
4. Check tempering valve setting (140°F).
5. Check room thermostat settings for tempering (21°F).
6. Check blower fan belt.
7. Check blower filters - replace if dirty.
8. Check fuel oil filter for water or dirt, drain if required.
9. Check fuel oil tank level - use a thin nine (9) foot rod.
10. Check storage tanks for vandalism (white seal penetrations).
11. Check C/T fan belt for excess looseness.
12. Check C/T bleed rate while pump is running.
13. Check C/T sump, drain and hose out if required.
14. Check visually boiler flue, push grey damper for movement.
15. Check control settings
    - a) O.A. temp 18°C
    - b) Buffer outlet 74°C
    - c) C.W. tank temp. 13°C
    - d) H.W. tank temp. 50°C

SPRING & FALL

1. Lubricate C/T fan with 20 W oil.
2. Lubricate C/T fan motor.
3. Check C/T float valve operation.
4. Drain and hose out C/T sump pan.
5. Lubricate boiler feed pump - fill (2) oil cups.
6. Lubricate circulator pumps.
7. Check heater tape (12 amp @ 115 VAC).
8. Check aquastat on C/T - fan on at $85^{O}F$ off at less than $85^{O}F$.

EACH SPRING

1. Check pumps and valves for operation.
2. Clean strainers (4).
3. Check damper actuator operation.
4. Check modes of operation - conventional and solar, record temperature at critical points.
5. Check boiler limits.
6. Check flow rates.
7. Change fuel oil filter.
8. Replace flow switch on Arkla. (Arkla part no. 14537-169)

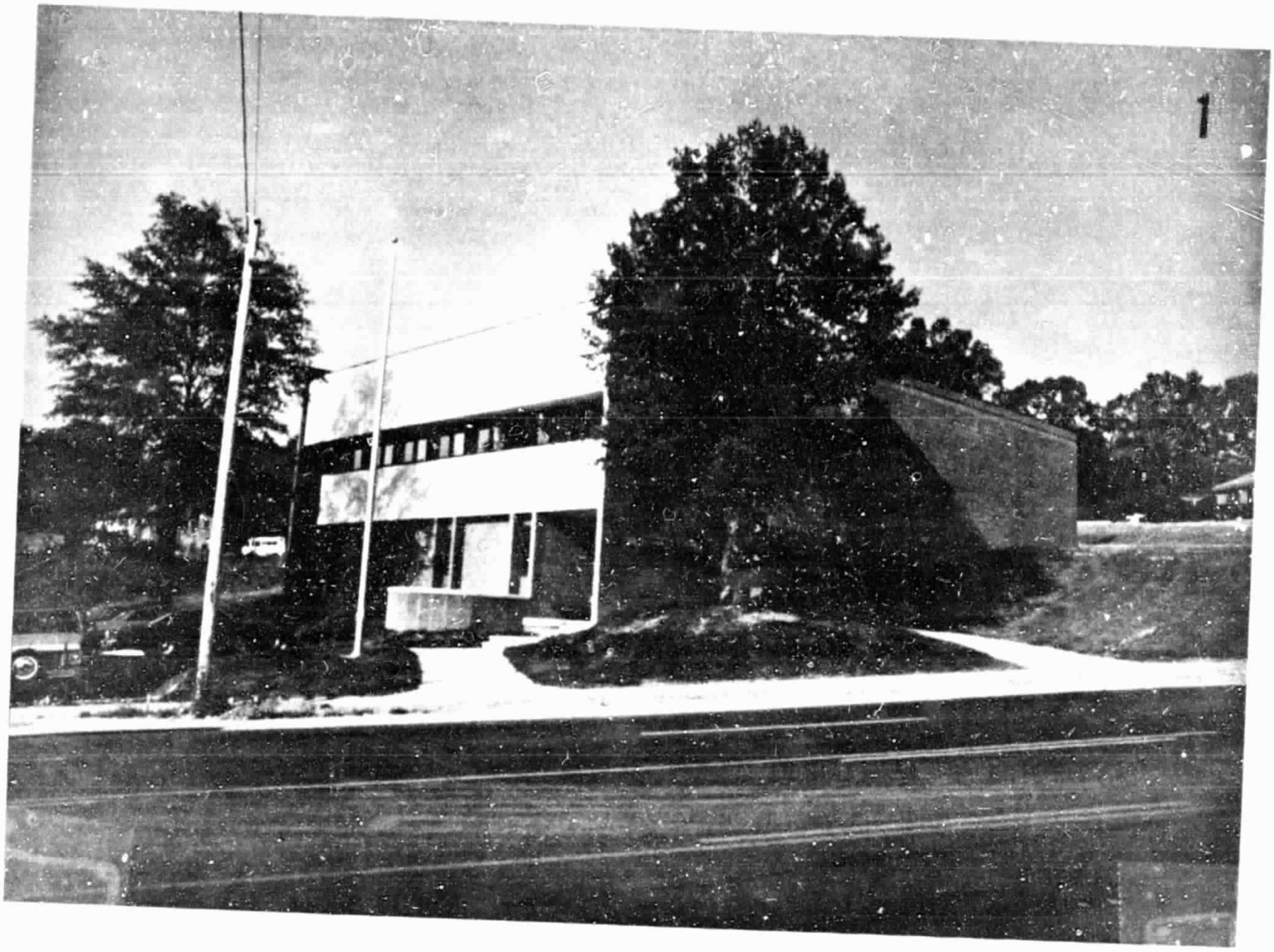
EVERY THREE (3) YEARS

1. Replace C/T fan belt.
2. Replace plastic case for fuel oil filter.
3. Repaint rubatex on roof.
4. Touch up any rust spots on array frame.

PART 5

PHOTOS OF BUILDING AND SOLAR SYSTEM

1. North Georgia APDC Building
2. Collector Array, Storage Tanks
3. Collectors - Reflectors
4. Collector Array Support Structure and Mounts
5. Drain-Down Vacuum Breaker
6. Control Panel
7. Control Module, Pumps, Valves, Buffer Tank
8. Control Module
9. Air Handler showing damper actuators
10. Mechanical Room - Control Module, Chiller, Air Handler, and Boiler



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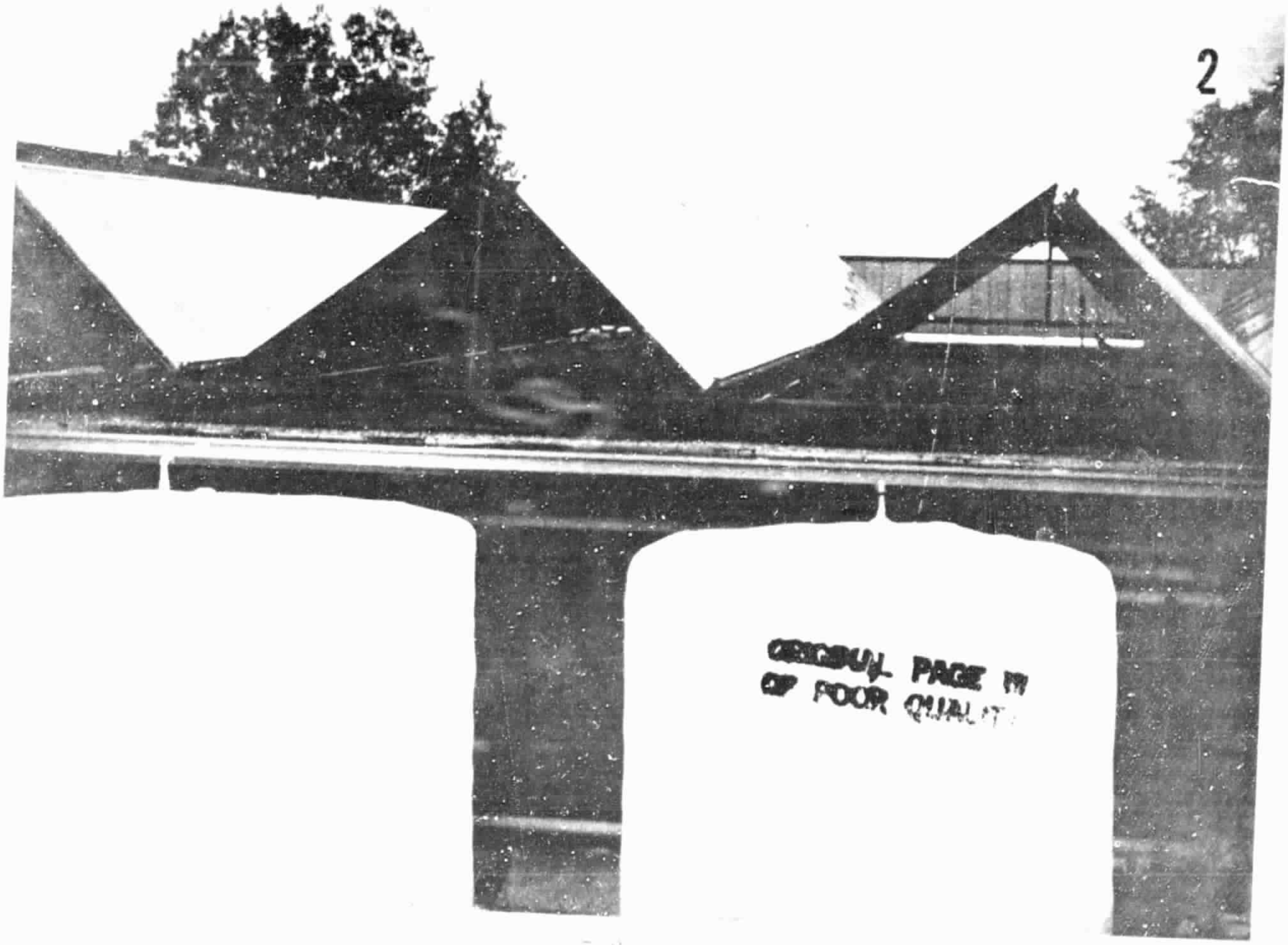

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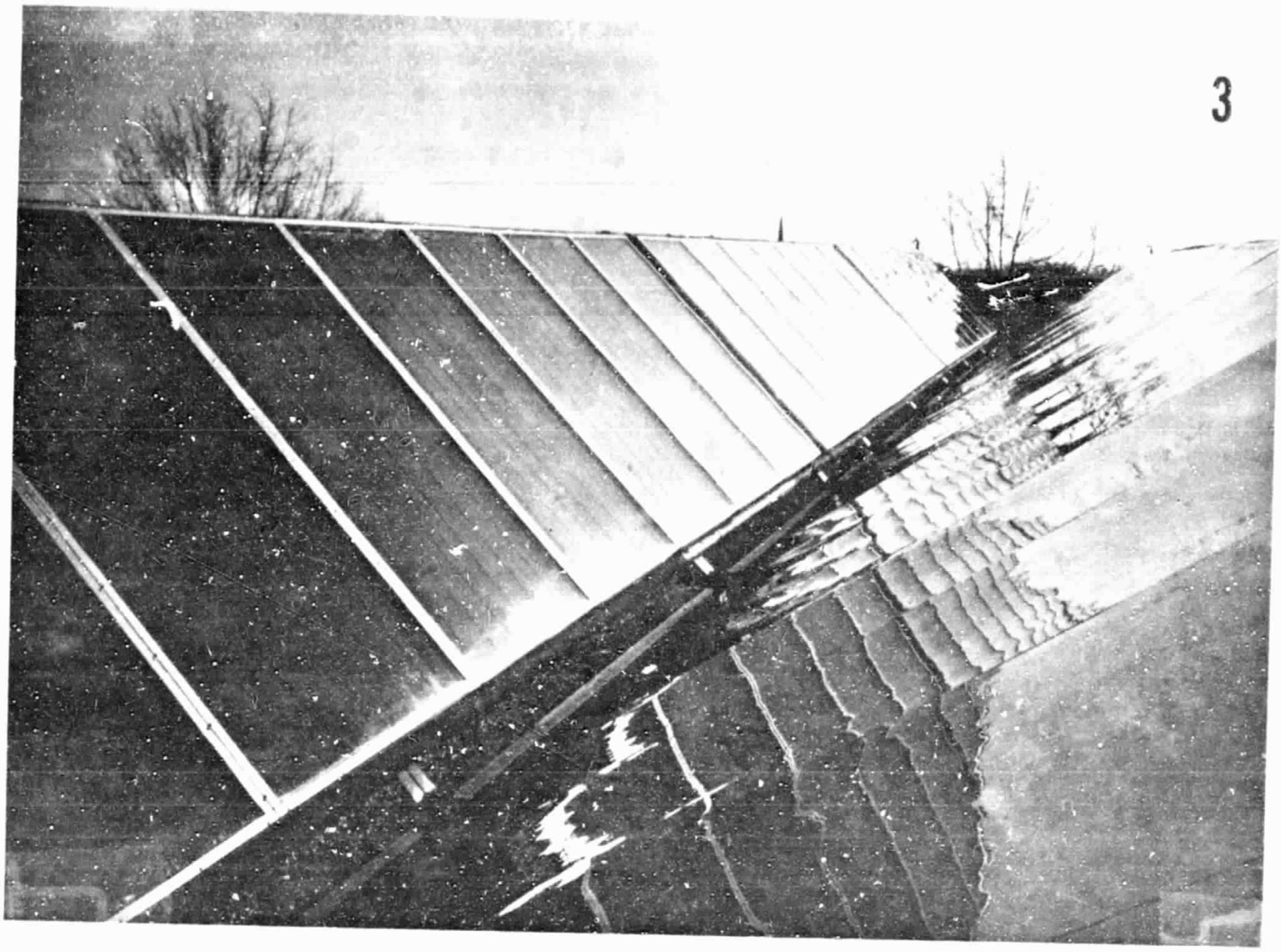
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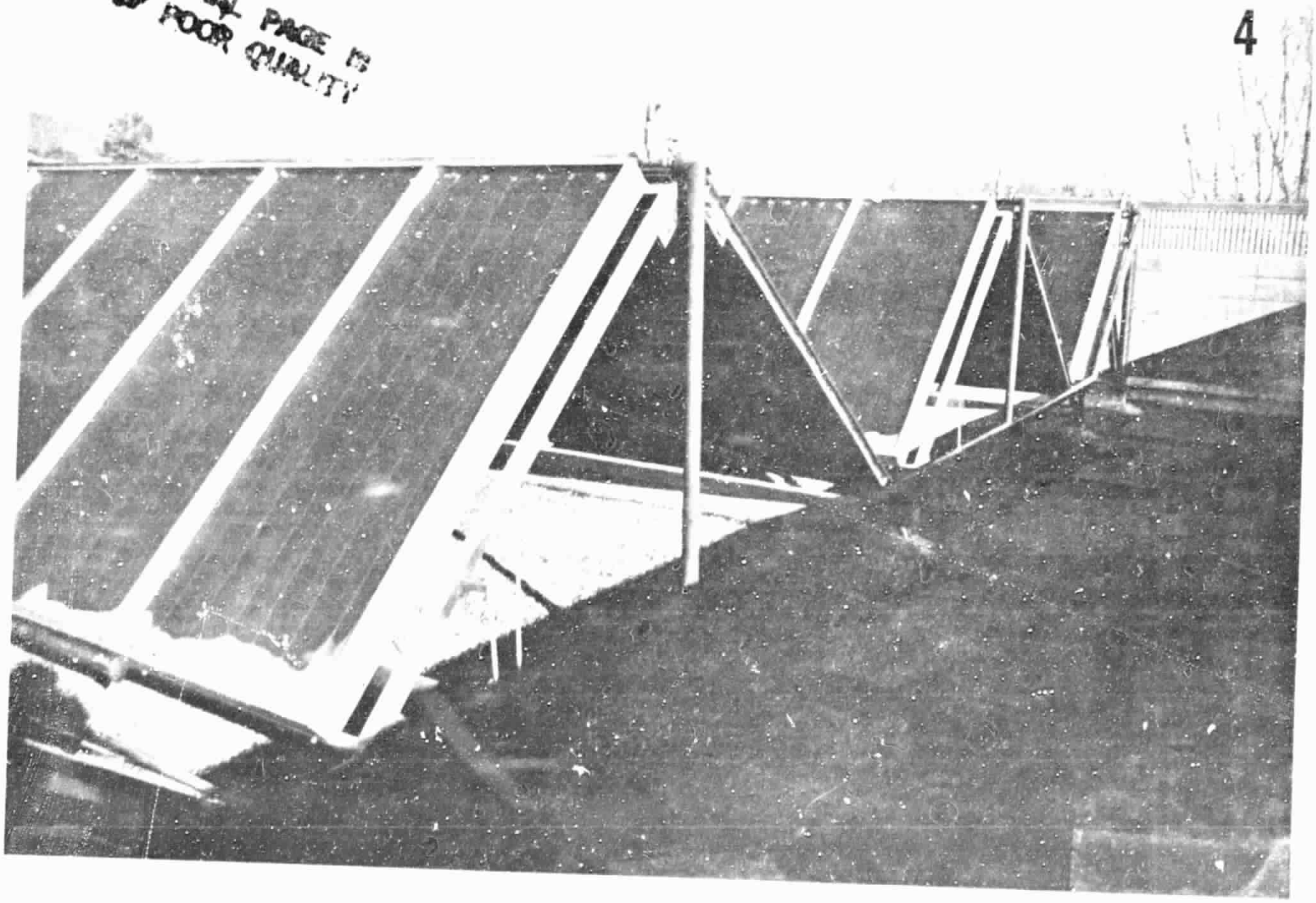
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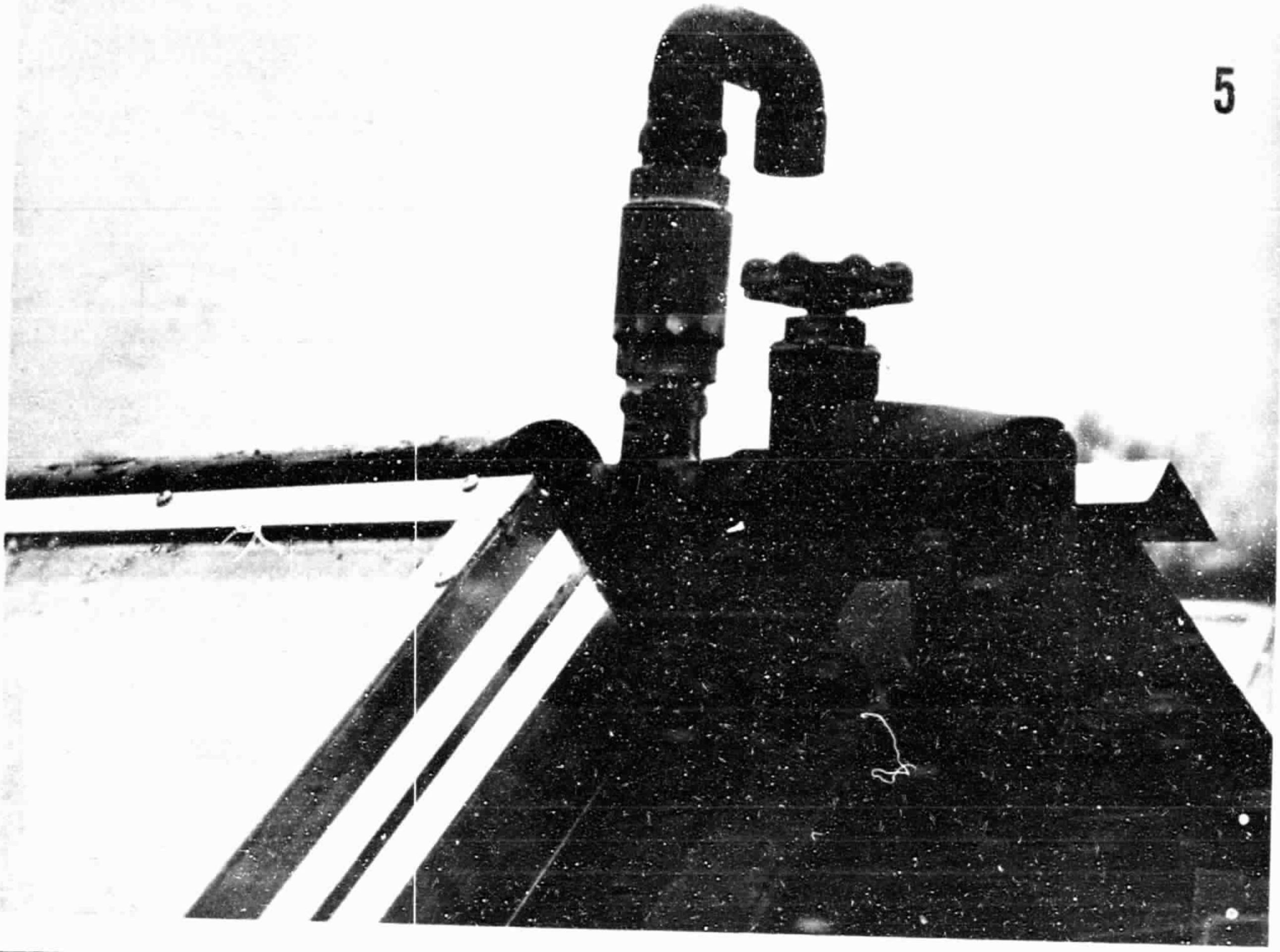

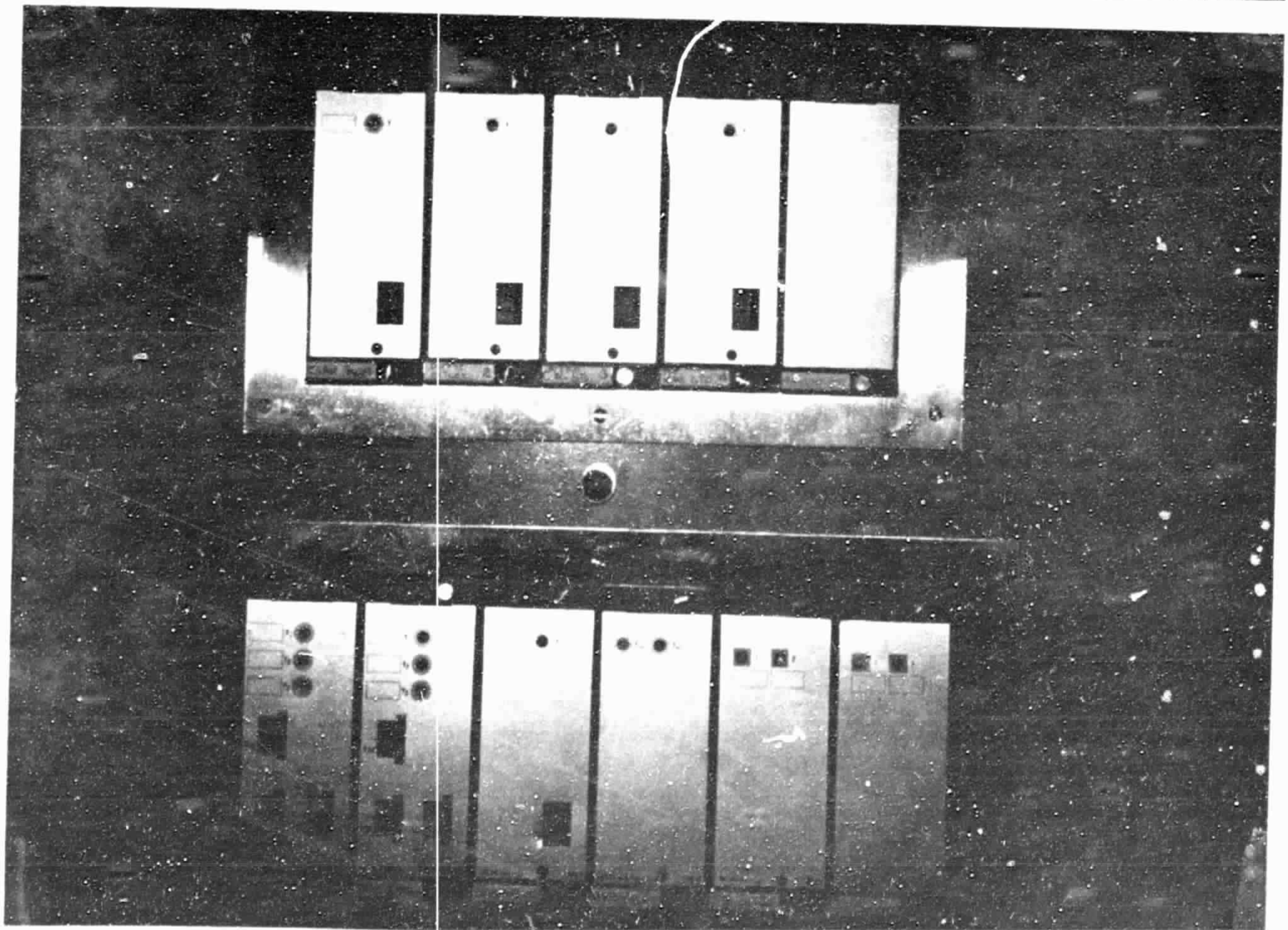

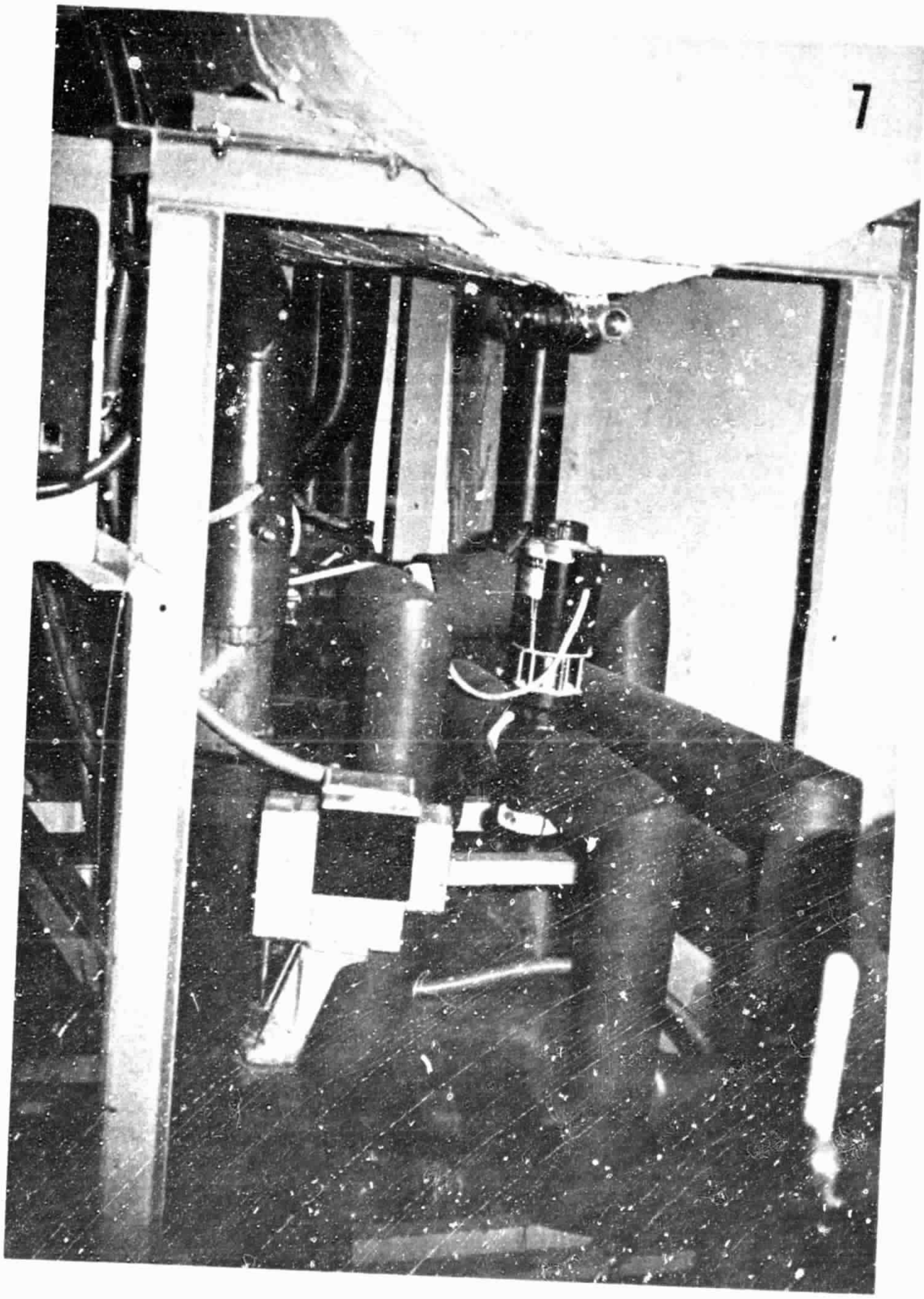
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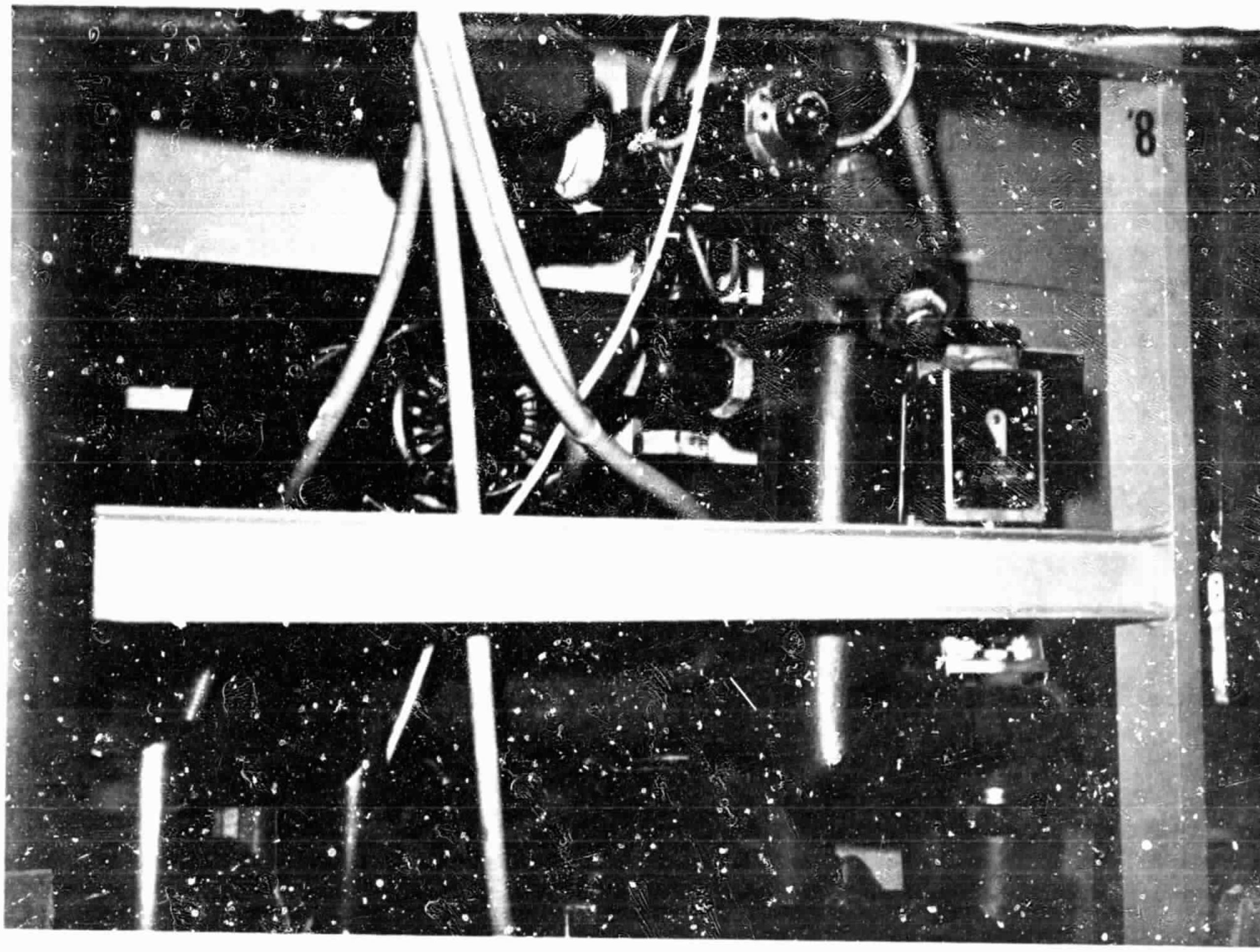
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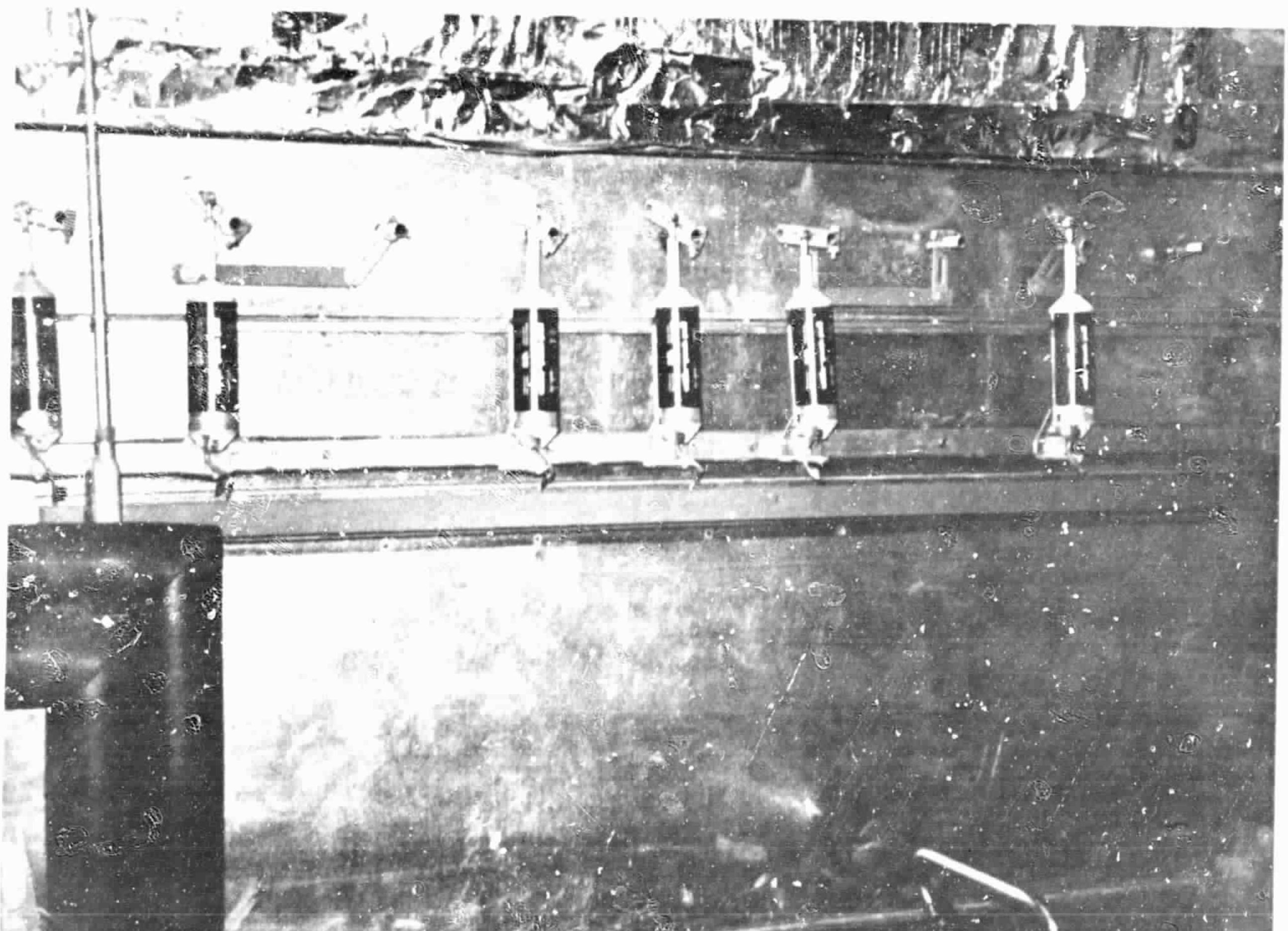
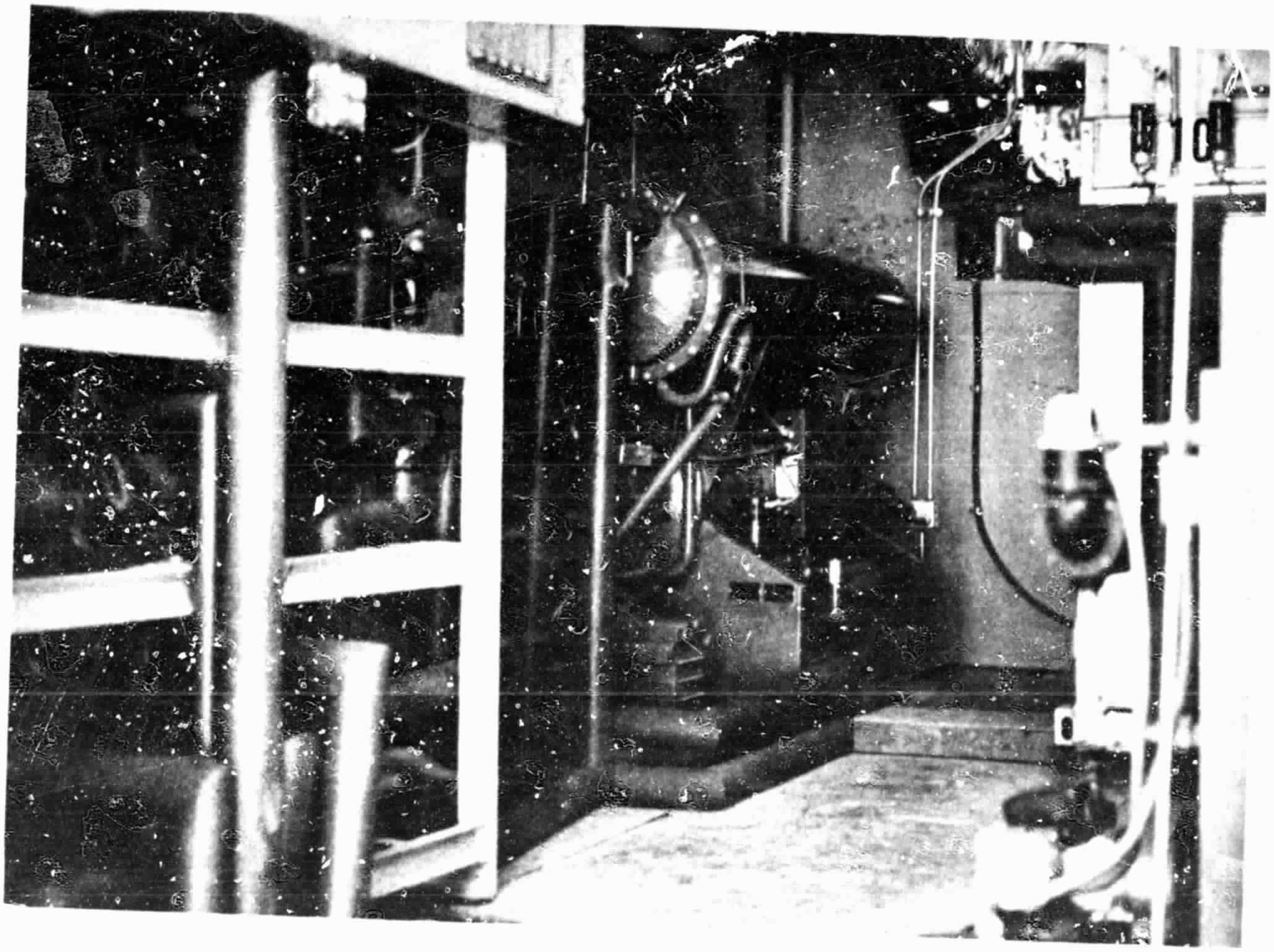




PART 6

PREDICTED SYSTEM PERFORMANCE

SYSTEM AND SUBSYSTEM PERFORMANCE/TECHNICAL DATA

CONTRACTOR SPECIFICATIONS-INDEPENDENT LIVING, INC.

System and Subsystem Performance/Technical Data*

A. *Climatalogical Data:*

For the proposed project site provide the following information:

1. Latitude 34.5
2. Heating degree days

   Yearly 2300

   January 715
3. Annual Cooling Hours 1700
4. Peak daily insolation 2335 BTU/ft²
5. Yearly sunshine 58 %

B. *Collector:* Commercial/Brand Name REVERE

1. Type of Collector
   a. Flate Plate YES
   b. Tubular N.A.
      i) Acceptance Angle N.A.
      ii) Concentration N.A.
      iii) Interception Area N.A.
      iv) Mirror Reflector Characteristics N.A.
   c. Concentrator N.A.
      i) Focusing N.A.
      ii) Non-Focusing N.A.
      iii) Tracking N.A.; Mode N.A.
      iv) Non-Tracking N.A.
      v) Concentration Ratio N.A.
      vi) Reflector Reflection N.A.

---

* All data requested in this Appendix must be supplied or a statement given as to why it was omitted. Data requested are specified for single system or subsystem. If more than one, specify and supply data for each.

System and Subsystem Performance/Technical Data—Continued

2. Transparent Cover

   a. Materials

      1. Type 1/8" thick tempered glass

      2. Composition Soda Lime

   b. Commercial Identification ASG-Clear or Fourco Clearlite / A.S.G. Water White

   c. Solar Spectrum Transmissivity 89.5% / 91.5 %

   d. Solar Spectrum Reflectivity 8 / 8 %

   e. Infrared Transmissivity * 87 / 91 %

   f. Infrared Reflectivity 8 / 8 %

   g. Number of Covers 2 XX

   h. Combustibility Noncombustible

   i. Edge Treatment Swiped - gasket enclosed

   j. Physical Properties**

      1. Density 155.4 lb/ft^3

      2. Linear Coefficient of Expansion 5.12×10^{-6}/°F

      3. Thermal Conductivity 1.1 Btu/h·ft^2·°F/ft.

      4. Specific Heat .273

      5. Tensile Strength 13,000 psi

      6. Compressive Strength 1,000,000 psi

      7. Weight 1.6 lb/ft^2

3. Absorber Plate

   a. Absorptive Coating

      1. Materials

         a. Type XXXXXXXXXXXXX / XXXXXXXX/Selective

** Properties of conventional materials that are available in standard references such as Mark's Engineering Handbook need not be restated here provided the material is adequately specified so that its properties can be determined from such references. Properties of materials not commonly available in standard references should be submitted with system data to the extent known.

* at 1050 millimicrons

System and Subsystem Performance/Technical Data—Continued

b. Alloy ~~Bkxxxkxxxxxx~~/~~Cxxxxxxxxxxxx~~/Nickel-Chrome

c. Commercial Identification ~~xxxxxxk~~/~~Kxxxxxxxx*K*~~/Black Chrome

2. Solar Spectrum Absorptivity ~~96%~~ / ~~90%~~ / 95 %

3. Infrared Emissivity ~~96%~~ / ~~12%~~ / 7 %

b. Base Plate

1. Materials

a. Type Integral Tubes in Copper Plate

b. Alloy DHP Copper #122

c. Commercial Identification Revere Tube-In-Strip

2. Thermal Properties

a. Thermal Conductivity 196 Btu/hr·ft^2 ^{o}F/ft.

b. Specific Heat 0.0942 Btu/lb ^{o}F

3. Physical Properties

a. Linear Coefficient of expansion 9.3×10^{-6} / ^{o}F

b. Density 558 lb/ft^3

c. Tensile Strength 50,000 psi

d. Compressive Strength 38,000 psi

4. Bonding Materials

a. Type (Brazed, Soldered, etc.) Brazed Headers

b. Composition Sil-Fos or Phos Copper

c. Commerical Identification Handy & Harman or equal

4. Insulation

a. Materials

1. Type Blanket

2. Composition Fiberglass

3. Commercial Identification Certain - Teed Ultralite

System and Subsystem Performance/Technical Data—Continued

b. Outgassing Characteristics

1. Outgassing Temperature $450^{\circ}F$
2. Gas given off Phenolic Resin
3. Any Condensation No

c. Physical Properties

1. Linear Coefficient of expansion None
2. Density $1.0\ lb/ft^3$
3. Thermal Conductivity 0.27 Btu - in/hr $ft^2\ ^{\circ}F$ @ $68^{\circ}F$
4. Specific Heat Not Known
5. Coefficient of Cubical expansion None
6. Dimensions 76" x 34" x 2-1/2"

5. Outer Base Enclosure

a. Materials

1. Type Extruded Aluminum
2. Composition 6063-T5
3. Commercial Identification Revere Aluminum
4. Combustibility N/A

b. Physical Properties (As Applicable)

1. Linear Coefficient of expansion $12.9 \times 10^{-6}/^{\circ}F$
2. Density $168.6\ lb/ft^3$
3. Thermal Conductivity 119 Btu/hr·$ft^2\ ^{\circ}F/ft.$
4. Specific Heat 0.224
5. Coefficient of Cubical expansion N/A
6. Dimensions 77" x 35" x 4"

c. Thermal Conductivity 119 Btu/hr·$ft^2\ ^{\circ}F/ft.$

System and Subsystem Performance/Technical Data–Continued

Passive systems require that sufficient calculations or test results to determine how effective the concepts will be in providing the necessary functions. As a minimum, the following should be provided.

1. Test method used NBSIR 74-635 and DSET 75 SE 2
2. Energy Collection Rate (BTU/Hr-ft²) Versus time for selected winter conditions and (if applicable) for selected summer conditions over a collection day. The following should be provided:

   a. Collector Orientation

      1. Azimuth normal to sun's rays Degrees
      2. Elevation normal to sun's rays Degrees

   b. Ambient Conditions

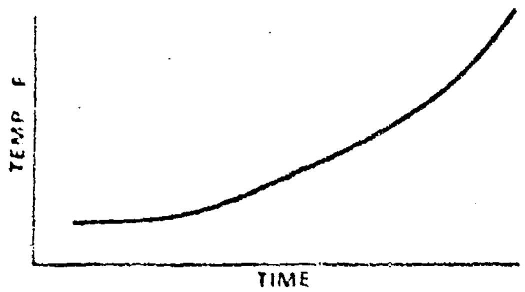
      1. Temperature see data °F
      2. Wind Velocity see data MPH
      3. Wind Direction see data Degree

   c. Insolution

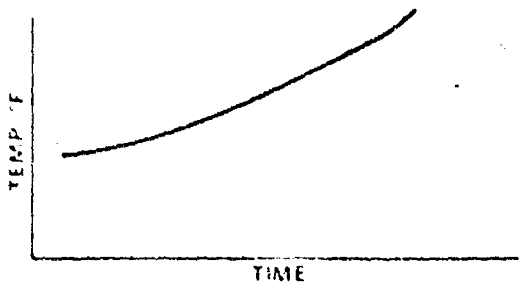
   d. Collection Period (Time of Day) see data to ______

      1. Provide Graph of Inlet Temperatures

         To obtain a distribution of data, the inlet temperatures were varied and are not a function of time.



      2. Provide Graph of Outlet Temperatures



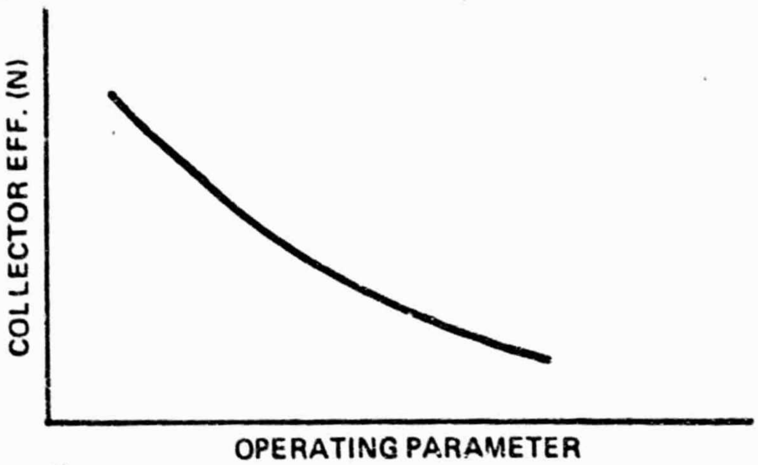
This is also the case for the outlet temperatures. The variation of inlet temperatures during the test does not permit a curve plot similar to that indicated above. However, the test data can be used to compute an inlet or outlet temperature graph for an assumed situation.

System and Subsystem Performance/Technical Data- Continued

3. Provide a graph of Collector efficiency (n) versus the parameter $\frac{Ti - Ta}{I}$.

$$\text{where } n = \frac{MC_p\,(T_o - T_i)}{A_c I}$$

See attached reports from Desert Sunshine Exposure Tests, Inc.



$$\frac{Ti - Ta}{I}$$

T_o = Collector transport media outlet temperature (°F)
*Ti = Collector transport media inlet temperature (°F)
Ta = Ambient Temp. (°F)
**I = Solar Insolation on the Collector plane ($BTU/HR - FT^2$)
M = Transport media mass flowrate (lb/hr)
C_p = Specific heat of transport media (BTU/LB °F)
A_c = Area of Collector (ft^2)

*Average Collector Temp. may be used $\frac{T_i + T_o}{2}$

**For concentrating collectors this value should be only the beam or direct component for the solar radiation.

4. Maximum expected temperature under no flow conditions 350°F *

5. Discuss provisions for protecting collector under no flow conditions.

6. Collector Array Characteristics

   a. Total Area 18.6 ft^2

   b. Solar Window Area 17.4 ft^2

   c. Weights of Collector and Framing ~~Single glass cover 4.6~~ lbs/ft^2
   Double glass cover 6.1 lbs/ft^2

* From Desert Sunshine data, no flow occurs at $\frac{T_f - T_a}{q} = .66$

If $q = 350\ Btu/hr \cdot ft^2$ and $T_a = 120°F$, then $T_f = 350°F$

System and Subsystem Performance/Technical Data–Continued

C. *Storage*

1. Type (Tank, Rock Bed, etc.) TANKS
2. Materials
   a. Type STEEL
   b. Finishes INTERIOR COAL TAR EPOXY
   c. Commercial Identification --
3. Physical Dimensions: THREE TANKS, EACH:
   a. Height 92" DIAMETER
   b. Width --
   c. Length 14'-10"
4. Thermal Properties*
   a. Thermal Conductivity (WATER)
   b. Coefficient of Thermal expansion (WATER)
5. Operating Temperature Range 40 - 200 °F
6. Operating Pressure Range* 15 - 25 PSI
7. Burst Pressure* 60 (Min.) PSI

D. *Cooling Subsystem*

1. Type CHILLER
2. Commercial Unit
   a. Type ABSORPTION
   b. Size 25 (WITH 195° HOT WATER ENTERING) TONS
   c. Identification ARKLA SOLAIRE 300
3. Materials
   a. Types --
   b. Commercial Identification --

---

* Properties of conventional materials that are available in standard references such as Mark's Engineering Handbook need not be restated here provided the material is adequately specified so that its properties can be determined from such references. Properties of materials not commonly available in standard references should be submitted with system data to the extent known.

System and Subsystem Performance/Technical Data—Continued

4. Fluids

   a. Types WATER

   b. Composition ---

5. Coefficient of performance (COP) data versus pertinent operating conditions (ambient temperature etc.) along with a definition of the COP used.
   C.O.P. = Output (Btu/Hr)/Input (Btu/Hr) = 0.6

6. Total Cooling Capacity

   Total cooling capacity of the solar system shall be no less than 196,300 BTU/HR (if it is a heating and cooling system). Sensible capacity shall be no less than 166,800 BTU/HR at 8000 CFM of entering evaporator air at 80.0 °F dry bulb and 67.0 °F wet bulb. For other systems such as desiccant cycling cooling, the terms evaporator and condensor are not applicable. These systems shall deliver the above cooling capacity at inlet air flow of N.A. CFM at °F dry bulb and N.A. °F wet bulb.

E. *Heating Subsystem*

1. Type SOLAR WITH BOILER FOR BACKUP

2. Commercial Unit

   a. Type GAS FIRED WATER TUBE

   b. Size 440 MBH OUTPUT

   c. Commercial Identification RITE

3. Coefficient of Performance (COP, if applicable, data versus pertinent operating conditions (ambient temperature etc.) BOILER EFFICIENCY 80%.

4. Total Heating Capacity

   The total heating capacity of the solar system shall be no less than 233,000 BTU/HR at 8000 CFM of air flow entering at 65 °F dry bulb and -- % relative humidity. Exposed heated panel (baseboard or ceiling) temperatures shall not exceed N.A. °F.

F. *Hot Water Subsystem*

1. Type DOMESTIC WATER HEATER

System and Subsystem Performance/Technical Data—Continued

2. Commercial Unit

   a. Type ELECTRIC

   b. Size 66 GAL.

   c. Commercial Identification RHEEM SOLARAIDE

3. Hot Water (Back Up System) : 66 gallons of potable (of useable) hot water shall be delivered at no less than 8 gal/min at temperature no less than 125 °F. Recovery time shall be no greater than 2 hours.

4. Code and Safety Standard Certified Under UNDERWRITERS' LABORATORIES

G. *Transport Between Subsystems*

1. Provide Sketch/Block diagram of Proposed Solar System giving dimensions and subsystems/components location and identification. NOTE: This project is in preliminary design & physical layout has not been established. See Schematic Flow Diagram for functional relationship of components.

2. Piping Details

   a. Diameter

   b. Length of Run

   c. Materials COPPER

3. Piping Insulation

   a. Type FIBERGLASS

   b. Thickness 1"

   c. Performance K = 0.26 AT 200°F

4. Transport Media for each element

   a. Type WATER

   b. Flow Rate -- GPM (Liquid) --- CFM (Air)

   c. Specify Pressure drop between components. ---

5. Provide Flow diagram for Proposed Solar Energy System. See "SCHEMATIC FLOW DIAGRAM".

H. *System*

1. Operating Requirements

   a. The maximum electrical energy required to drive the solar portion of the system at its rated

System and Subsystem Performance/Technical Data—Continued

capacity shall be no greater than 5 K.W. Water requirements for cooling condensers ~~and/or air humidification~~ shall be no greater than 100 gal/hr.

b. Subsystems/Components requiring electrical energy:

1. Pumps 2 kw, Function CHILLED WATER
2. Fans 3 kw, Function SUPPLY AIR
3. Controls 0.5 kw, Function AIR COMPRESSOR
4. Other -- kw, Function ---

2. Design Load Data:

ANNUAL SUMMARY TABLE

Month	Heating (BTU) (x 10^6)	Hot Water (BTU) (x 10^6)	Cooling BTU (x 10^6)
January	52.8	0.6	---
February	43.2	0.6	---
March	38.4	0.6	---
April	12.0	0.6	13.8
May	---	0.6	41.3
June	---	0.6	49.6
July	---	0.6	55.1
August	---	0.6	57.9
September	---	0.6	46.8
October	9.6	0.6	11.0
November	36.0	0.6	---
December	48.0	0.6	---
Yearly Total	240.0	7.2	275.5 *
Peak (BTU/HR)	207,000	13,300	196,300

*Calculated Building Cooling Requirement; Divide by 0.6 for Chiller Input (System Heat Loss)

System and Subsystem Performance/Technical Data–Continued

3. Provide the following summary of system performance data:

Month	Solar Energy Collected (BTU) (x 10^6)	Electrical Energy Req'd for Component (KWH)	Auxiliary Energy (BTU) (x 10^6)	System Heat Loss (BTU) (x 10^6)	Equivalent Energy Req'd for Conventional System (BTU) (x 10^6)
January	42.2	2320	11.2	53.4	53.4
February	43.2	2320	.6	43.8	43.8
March	39.0	2320	--	39.0	39.0
April	35.6	2320	--	35.6	23.5
May	39.3	2320	30.1	69.4	41.9
June	43.1	2320	40.2	83.3	50.2
July	46.9	2320	45.5	92.4	55.7
August	44.9	2320	52.2	97.1	58.5
September	42.9	2320	35.7	78.6	47.4
October	40.9	2320	4.6	45.5	21.2
November	36.6	2320	--	36.6	36.6
December	43.0	2320	5.6	48.6	48.6

4. Provide estimate of yearly energy savings in terms of BTU's and/or Dollars along with the rationale for the estimate.

$(519.8 - 225.7)(10^6) \div 3413 = 86170$ KWH x 0.04 = \$3445/Yr

5. Any subsystems or system energy conversion inefficiencies which have not been specified in the previous subsystem section should be provided now. For example, if an oil fired heater is used for an auxiliary energy source state its:

1. Commercial identification GAS FIRED BOILER SPECIFIED PREVIOUSLY
2. Size/Rating (BTU) ---
3. Efficiency 0.80
4. Electrical Power Requirements --

6. Provide summary of insolation data used for section II Analysis. See "SUPPORTING INFORMATION".

System and Subsystem Performance/Technical Data–Continued

7. Design Life and Maintenance

a. Describe Periodic Maintenance provisions and requirements.

b. Specify design life of all components (if available).

1. Heating	20	yrs.
2. Cooling	20	yrs.
3. Auxiliary Energy	25	yrs.
4. Storage	30	yrs.
5. Potable	20	yrs.
6. Collector	25	yrs.
7. Energy Transport	20	yrs.
8. Controls	25	yrs.
9. Hot Water	15	yrs.
10. Pumps	15	yrs.
11. Fans	20	yrs.
12. Other	--	yrs.

c. Provide Warranty period and extent of coverage of the proposed Solar Energy System and subsystems.

Contractor will provide a one year warranty on materials and workmanship, which is the normal under a general construction contract. In addition an extended warranty, for a total of five years, will be provided for major system components.

INTERIM PERFORMANCE CRITERIA

The installation will comply with the intent of the "Interim Performance Criteria for Commercial Solar Heating and Combined Heating/Cooling Systems and Facilities", NASA #98M10001, February 28, 1975.

ESTIMATED ENERGY AVAILABLE FROM SOLAR COLLECTORS FOR HEATING:

Assumptions:

Collectors at 50° from Horizontal

Average Daily Insolation 2150 $Btu/Ft^2 \pm$

Approximate % Sunshine 58

Average Hourly Insolation $= 0.58 \times \frac{2150}{11 \times 0.9} = 126$ Btu/Sq.Ft.Hr.

Average Ambient Temperature 45°

Flow Rate = 1 GPH/Sq.Ft.

Average Collector Efficiency 55% $\pm$

Average Output 69 $Btu/Hr.Ft^2$ for 8 Hours

(All available for storage when building is occupied)

Average Daily Unoccupied Heat Loss (January):

1,153,000 Btu

Sq. Ft. Collector Required $= \frac{1,153,000}{8 \times 69} = 2090$ Sq.Ft.

ESTIMATED ENERGY AVAILABLE FROM SOLAR COLLECTORS FOR COOLING

Based on collectors at 50^{o} to horizontal, reflector augmented, 190^{o} leaving water, estimated energy available is 880 Btu/Sq.Ft. per day (August):

Square Feet of collector required to handle peak cooling load:

$$\frac{328{,}000 \text{ Btu/Hr Input}}{100} \quad 3280 \text{ Sq.Ft.}$$

Physically practical array:

$$5 \text{ rows} \times 20 \text{ panels/row} \times 17.4 \ \frac{\text{Sq.Ft. Aperture}}{\text{Panel}} = 1740 \text{ Sq.Ft.}$$

Estimated peak collection rate (average for day):

$$\frac{1720 \text{ Sq.Ft.} \times 880}{12 \times 0.9} = 140{,}150 \text{ Btu/Hr}$$

43% of Peak Requirement

Collection for Peak Month:

$1720 \times 880 \times 31 = 46.9 \times 10^{6}$

BLOCK HEATING LOAD

Roof 66' x 62' x $(70^{o}-5^{o})$ x 0.13 = 34,575

Walls (256 x 24)(85%)(0.2)(65^{o}) = 67,890

Glass (256 x 24)(15%)(0.6)(65^{o}) = 35,940

Floor Perimeter 256 x 50 = 12,800

Transmission Subtotal 151,205 Btu/Hr

Outside Air 800 x 1.08 x 65 = 56,160

Calculated Heat Loss = 207,36'

$$\frac{207,365}{6000} = 34.5 \frac{\text{Btu}}{\text{Hr.Ft}^2}$$ Conditioned Area

Specify Minimum Heating Capacity of 207,365 x 120 =

248,840 Btu/Hr

BLOCK COOLING LOAD

Roof 3600 x 0.13 x 50 =	23,400
Lights 6000 x 3 x 3.4 =	61,200
Occupants 25 x 250 =	6,250
Glass	
Radiant 920 x 20 =	18,400
Transmission 920 x 0.6 x 20 =	11,040
Walls 5220 x 0.2 x 15 =	15,660
	135,950
+ 10%	13,595
RSH	149,545 Btu/Hr
RLH 25 x 200 =	5,000
OASH 800 x 1.08 x 20 =	17,280
OALH 800 x 0.68 x 45 =	24,480
Grand Total Heat	196,305 Btu/Hr
Tons Refrigeration	16.4

ESTIMATED HEATING ENERGY REQUIREMENTS

OCCUPIED HOURS

(October - April)

$$7 \text{ Mo.} \times 4.32 \frac{\text{Wks}}{\text{Mo}} \times 50 \frac{\text{Hrs}}{\text{Wk}} = 1510 \text{ Hours}$$

Average Outside Temperature During Occupied Heating Hours: 57.5°F

Average Heat Loss From Building (Occupied Hours)

(Assume No Heat Loss from Building above 65°F Outside):

$$207{,}365 \frac{\text{Btu}}{\text{Hr}} \text{ Design Loss} \times \frac{(65-57.5)}{(70-10)} = 25{,}920 \frac{\text{Btu}}{\text{Hr}}$$

Annual Heating Requirement, Occupied Hours:

$$25.92 \times 1.510 \times 10^6 = 39.1 \times 10^6 \text{ Btu}$$

Credit for Lighting:

$$66\text{-}2/3\% \times 6000 \text{ Sq.Ft.} \times \frac{3\text{W}}{\text{Sq.Ft.}} \times \frac{3.4 \text{ Btu}}{\text{W}} = 40{,}760 \text{ Btu/Hr}$$

Net Annual Heating Requirement, Occupied Hours = 0

UNOCCUPIED HOURS

$$(7/12 \times 365 \times 24 - 1510) = 3600$$

Average Outside Temperature During Unoccupied Hours: 42.5°F

Average Heat Loss from Building (Unoccupied Hours, Lights Off, Inside Temperature Set Back to 60°F):

$$207{,}365 \times \frac{(60-42.5)}{65} = 55{,}830 \frac{\text{Btu}}{\text{Hr}}$$

Annual Heating Requirement, Unoccupied Hours:

$$3600 \times 55{,}830 = 201 \times 10^6 \text{ Btu}$$

ESTIMATED COOLING ENERGY REQUIREMENTS

Peak Energy Input to Chiller =

$$\frac{16.4 \text{ Tons} \times 12{,}000}{0.6 \text{ (Average C.O.P.)}} = 328{,}000 \text{ Btu/Hr}$$

Heat Equivalent of HVAC Auxiliaries, Cooling Cycle:

10.5 KW x 3413 = 35,835 Btu/Hr

Average Monthly Energy Used by Auxiliaries:

17 Days x 13 Hrs/Day x 35,835 = 7.9×10^6 Btu

SOURCES

-- Heating degree days, equivalent full load operating hours: 1976 ASHRAE SYSTEMS HANDBOOK, Chapter 43.

-- Outside design conditions, transmission and solar load factors: 1972 ASHRAE FUNDAMENTALS HANDBOOK.

-- Daily solar inradiation to 45° collector surface: 1974 ASHRAE APPLICATIONS HANDBOOK, Chapter 59.

-- Average summer and winter insolation values: "Monthly Maps of Mean Daily Insolation for the United States", SOLAR ENERGY, 9, (3), pp 164-165 (1965).

-- Normal daily maximum and minimum temperatures, mean percentages of possible sunshine: ITT SOLAR HEATING SYSTEMS DESIGN MANUAL.

-- Collector performance: Manufacturer's published data.

-- "Design and Simulation Studies for the Shenandoah Community Center Large Scale Solar Cooling Demonstration" (ASME Publication).

PART 7

PROBLEMS

The North Georgia APDC solar system has operated continuously for eight months with a total down time (system out of commission) of approximately a week. Partial down time, where a subsystem malfunctioned, has been about six weeks. During the eight month period, the system has either effectively delivered the required heating or cooling from solar or from the back-up (supplementary) system, or as in one instance, during which the boiler was inoperative, heating was provided exclusively by the solar system.

The most significant problems encountered during the eight month operational period are the freezing of the collectors, failure of the main thermal circulation pump motor, and malfunction of the ignitor transformer on the boiler. Most problems, with the possible exception of the freeze damage to the collector, appear to be material failure and not necessarily associated with any design inadequacy. All problems have been handled in an expeditious manner by the design-installation contractor.

A detailed discussion of these problems is presented below.

1. System Freeze: Over the weekend of December 9-10, the North Georgia area experienced a sharp drop to below freezing temperatures, i.e., from 70°F to 10°F, as a rapidly moving cold front moved through the area. The cold frontal passage was preceded by record high temperature on December 7-8. During the freeze period the solar collector array experienced severe freeze damage to the supply headers. The extent of freeze damage was limited to the supply headers (primarily the two headers supplying the center collectors) where approximately 44 leaks were discovered. In addition, 4 leaks were found in one top return header, and 2 leaks in the bottom of one collector. Although

the freeze damage probably occurred on the weekend, the system appeared to operate satisfactorily on the 11th (operating on supplementary boiler). The first malfunction was noted on the morning of the 11th, i.e., the failure of a dry seal in the main circulation pump in the solar loop. A complete damage evaluation was conducted on December 13, 14, 15th. The system operated on supplementary boiler for approximately one week while repairs were made to the collector array.

A verified explanation for the system freeze has not been completely developed. The most reasonable explanation is that water vapor from the hot water storage tank was admitted to the system through the solar collector return lines by a siphoning action. The NGAPDC system employs an automatic draindown feature and if the return line was above the water level in the thermal storage tank, water vapor could follow this route into the collector. When the rapid change in outside temperature occurred, it is theorized that condensation in the collectors produced sufficient vacuum to drain water into the system, then freeze and produce the damage. System modifications that have been incorporated in the system as a result of the freeze were the installation of air vents on the top of each return header on the collector array and adding more water to the storage tank so that the collector return line was submerged below the tank water level.

2. Failure of the main collector circulation pump motor: The removal of the motor for repair under the warranty arrangement required over three weeks. During this period, heated water was supplied by the boiler (creating extra expense for the additional fuel oil) but the building remained comfortably cool. This situation could have ben avoided by having a spare motor on hand.

3. Boiler: During the period January 15-25, the supplementary heating system (oil fired boiler) developed problems in the ignition system. Once

the boiler had shut down on automatic control, it would not reignite. During this period, the boiler was started manually for heating the building in the morning hours. For approximately three days the building was heated strictly by solar. The trouble with the boiler was traced to the igniter transformer, which was replaced.

4. Instrumentation: The design of the North Georgia APDC solar system did not specify monitoring instrumentation, and from all overall design standpoint, this has been a serious omission. The cwner-operator of the system has found that a qualitative assessment of the operation of the system is impossible. The system provides the correct level of heating and cooling as required; however, any measure of operational efficiency is unavailable. In addition, the isolation of problems by the operator-owner has been made more difficult without this instrumentation. Hopefully, this situation will be corrected.

5. Miscellaneous: During the first few weeks of operation, operating controls, set points on thermostats, and balancing the various zones was a minor problem but obviously not an unexpected one. Minor adjustments have been required during the change over to fall weather, however, it is questionable whether this is a problem area. In all cases, the contractor responded to make appropriate adjustments.

PART 8

RECOMMENDATIONS

The North Georgia APDC solar system has proved to be an efficient, cost effective system primarily due to the special efforts of all members of the project team. It is indeed difficult to raise problem areas when the overall project is a success, however, it is our recommendation that future grantees pay very close attention to the development of the team, the lines of authority which are required in contractual arrangements and aspects of the solar field which are still experimental. It has been our experience that the owner-operator establish the appropriate line of contractual authority as soon as possible, so that all parties can perform effectively from an established position.

In the opinion of the owner-operator, the success of the North Georgia APDC solar system can be attributed to effective operational design. However, another important aspect of design was to specify quality materials and workmanship which has provided a relatively trouble-free system.

The design specified copper collectors, copper plumbing, welded steel collector array support, steel storage tanks, high quality pumps and valves, and quality control on all solder joints. In addition, all pipes and exposed surfaces are fully insulated, including exposed portions of the chiller. This attention to quality has resulted in an outstanding system.

Another noteworthy feature of the North Georgia APDC is the prefabrication process used by ILI. All major components such as the collector modules, reflector panels and the control module were preassembled off-site. These components were delivered to the site at the appropriate time for installation. In this way, installation of the system was completed in approximately four weeks with a minimum of difficulty. This also has attributed to the soundness of the system.

PART 9

VERIFICATION STATEMENT

Independent Living, Inc.
5965 Peachtree Corners East
Norcross, Georgia 30071 / Tel. (404) 449-5900

March 14, 1979

North Georgia Area Planning &
Development Commission
503 West Waugh Street
Dalton, Georgia 30720

Attention: Mr. Don Kolberg

Dear Mr. Kolberg:

The solar system installed at your facility in Dalton was installed per the "as built drawings" provided through your organization.

The system performed in accordance with the test plan provisions at the time of the System Acceptance Test in Dalton.

The system meets the intent of the interim performance criteria for solar commercial heating and cooling and heating/cooling systems, NASA document #98M10001, dated February 28, 1975.

Sincerely,

William T. Hudson

William T. Hudson
President

WTH:bp

APPENDIX A

MANUFACTURERS LITERATURE

SYSTEM COMPONENTS

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OF POOR QUALITY

solaire® 300

25 ton Absorption Chiller For Solar Air Conditioning

Model No. WFB-300

Installation
Start-Up
Data

ARKLA solaire®

SUN POWERED AIR CONDITIONING

a product of Arkla Industries Inc.

ORIGINAL PAGE IS
OF POOR QUALITY

[illegible] Description

[illegible] Arkla's Solaire 300 water chiller is designed primarily [illegible] solar cooling applications but can be used for a broad range of comfort air conditioning and industrial process applications. With firing water temperature between 160°F and 200°F, and with 85°F condensing water, the ma[illegible] can produce from 7.5 [illegible] to 26.5 tons of cooling [illegible].

[illegible]

[illegible] unit is nominally rated [illegible] 25 tons, but design [illegible] allows easy adap[illegible] for a wide range of [illegible].

[illegible] special lithium bromide [illegible] solution is installed [illegible] factory and each machine is given a complete [illegible] capacity test.

[illegible] low concentration of [illegible] solution reduces the [illegible] of crystallization [illegible] insignificant status.

[illegible] hermetically sealed [illegible] pump is magnet[illegible] driven. This pump [illegible] solution from the [illegible] pressure side to the [illegible] pressure side of the [illegible] cycle.

[illegible] combination of the [illegible] pump and an abun[illegible] heat transfer sur[illegible] permits this unit to [illegible] practical cooling [illegible] from relatively low [illegible] water temperatures.

[illegible] generator tubes and [illegible] vital areas are con[illegible] of type 304 stain[illegible] steel to insure years of [illegible] free service.

Operating Controls

- **Three [illegible] Hot Water Control Valve**—[illegible] of hot water to [illegible] controlled by the cooling load. With [illegible] cooling loads the hot water control valve is partially closed, and a portion of the hot water is diverted back to the [illegible] of the solar [illegible]. When [illegible] load drops [illegible] where hot water flow is minimal, the valve closes and an end switch will cause the unit to shut down.
- **Two Input Controller**—With two temperature sensing bulbs, one for leaving chilled water and one for returning chilled water, this solid state device controls the operation of the three-way hot water control valve.
- **Solution By-Pass Valve and Timer**—On start-up, this valve opens causing solution to by-pass the absorber for two minutes. Otherwise, excessively low temperatures could be produced until the chiller is presented a load.
- **Concentration Chamber Dump Valve**—If the temperature of the condensing water falls to approximately [illegible]°F, the concentration chamber dump valve will open and dilute the solution. This will permit the chiller to operate with lower condensing water temperatures.
- **Pump Control Relays**—Three relays are provided to energize motor starters for chilled water, hot water and condensing water circulating pumps.

Safety Controls

- **Evaporator Low Temperature Switch**—If the refrigerant in the flash chamber falls below minimum temperatures, this safety switch will cause the hot water control valve to close and divert all the hot water around the generator. It will also shut down both the solution pump and the condensing water pump.
- **Chilled Water Low Temperature Switch**—This safety switch performs the same function as the evaporator low temperature switch but senses the temperature of the leaving chilled water.
- **Condenser High Temperature Limit Switch**—If the temperature of the condenser rises above acceptable limits, this safety switch will also cause the hot water control valve to close and divert the firing water around the generator.
- **Chilled Water Flow Switch**—If the flow of chilled water returning to the chiller falls below established minimums, this safety switch will shut down the machine in the same manner as the evaporator low temperature switch.
- **Thermal Delay Relay, Lock-out Relay and Timer**—When activated by the end switch in the hot water control valve, these controls will "lock" the unit out of operation for a timed interval.

SPECIFICATIONS

MODEL WFB 300

DESIGN DELIVERED CAPACITY, Btu/h	306,000[1]
DESIGN DELIVERED CAPACITY, Tons I.M.E.	25.5[1]

ENERGY REQUIREMENTS

Design Hot Water Input, Btu/h	447,000
Design Hot Water Inlet Temperature, °F	195
Design Hot Water Outlet Temperature, °F	184.8
Permissible Range of Inlet Temp.	160 to 200
Design Hot Water Flow, gpm	90
Pressure Drop, Feet of Water, at 90 gpm	20.7
Permissible Range of Flow, gpm	50 to 100
Pressure Drop, Feet of Water, at 100 gpm	25.6
Maximum Working Pressure, psig	100
Electrical Voltage, 60 Hz, 1 Phase	115[2]
Maximum Wattage Draw	150

CHILLED WATER DATA

Design Inlet Temperature, °F	55
Design Outlet Temperature, °F	45
Design Flow, gpm	60
Pressure Drop, Feet of Water, at 60 gpm	9.8
Permissible Range of Flow, gpm	30 to 100
Pressure Drop, Feet of Water, at 100 gpm	26.9
Maximum Working Pressure, psig	100
Unit Water Volume, Gallons, Approx.	12
Fouling Factor	.0005

CONDENSING WATER DATA

Design Heat Rejection, Btu/h	753,000
Design Inlet Temperature, °F	85
Design Outlet Temperature, °F	101.7
Permissible Range of Inlet Temp.	75 to 90
Design Flow, gpm	90
Pressure Drop, Feet of Water, at 90 gpm	22.9
Permissible Range of Flow, gpm	50 to 110
Pressure Drop, Feet of Water, at 110 gpm	33.5
Maximum Working Pressure, psig	100
Unit Water Volume, Gallons, Approx.	20
Fouling Factor	.001

FOR COOLING TOWER SELECTION

Maximum Heat Rejection, Btu/h	853,000
Range, °F	16 to 17
Minimum Permissible Sump Temperature, °F	75[3]

SERVICE CONNECTIONS

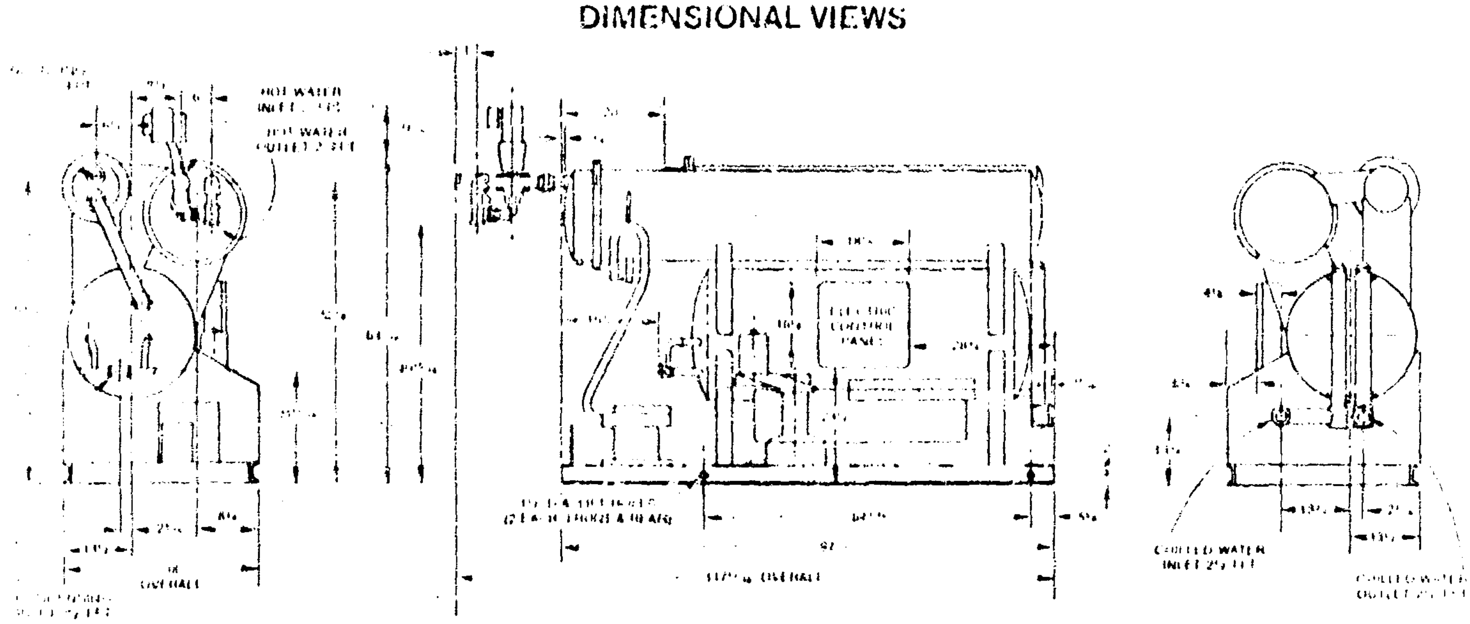
Hot Water Inlet and Outlet	2" FPT
Chilled Water Inlet and Outlet	2½" FPT
Condensing Water Inlet and Outlet	2½" FPT

PHYSICAL DATA, APPROXIMATES

Operating Weight, Pounds	3,420[4]
Shipping Weight, Pounds	3,145[5]
Crated Size, Inches	114 W, 45 D, 69 H

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

DIMENSIONAL VIEWS



LEFT VIEW FRONT VIEW RIGHT VIEW

Condensing Water Flow: 90 gpm
Chilled Water Flow: 60 gpm
Hot Water Flow: 90 gpm
Temperatures in Degrees Fahrenheit

	Hot Water Inlet Temp	Hot Water Outlet Temp	Energy Input Btu/h	Leaving Chilled Water Temp	DELIVERED CAPACITY Btu/h	DELIVERED CAPACITY Tons	Heat to be Rejected Btu/h
85° Inlet Condensing Water	160	157.0	132,000	40	66,000	5.5	198,000
		155.6	149,200	45	88,800	7.4	238,000
		156.2	175,900	50	102,000	8.5	277,900
	165	161.1	172,600	40	98,400	8.2	271,000
		160.5	197,900	45	129,600	10.8	347,500
		159.9	227,600	50	145,000	12.1	372,600
	170	165.1	214,300	40	132,000	11.0	346,300
		164.5	240,700	45	166,800	13.9	407,500
		164.0	262,400	50	180,000	15.0	442,400
	175	169.1	257,000	40	163,200	13.6	420,200
		168.7	277,600	45	196,800	16.4	474,400
		168.2	297,500	50	213,600	17.8	511,100
	180	173.1	302,400	40	192,000	16.0	494,400
		172.9	313,800	45	224,400	18.7	538,200
		172.2	341,200	50	246,000	20.5	587,200
	185	176.9	352,300	40	218,400	18.2	570,700
		176.8	354,900	45	252,000	21.0	606,900
		176.3	380,700	50	276,000	23.0	656,700
	190	180.9	396,000	40	237,600	19.8	633,600
		180.8	400,000	45	276,000	23.4	676,000
		180.4	421,500	50	306,000	25.5	727,500
	195	184.7	448,700	40	258,000	21.5	706,700
		184.8	446,700	45	306,000	25.5	752,700
		184.6	451,600	50	328,800	27.4	780,400
	200	188.7	490,900	40	270,000	22.5	760,900
		189.0	481,800	45	318,000	26.5	799,800
		188.6	493,200	50	360,000	30.0	853,200

Condensing Water Flow: 90 gpm
Chilled Water Flow: 60 gpm
Hot Water Flow: 90 gpm
Temperatures in Degrees Fahrenheit

	Hot Water Inlet Temp	Hot Water Outlet Temp	Energy Input Btu/h	Leaving Chilled Water Temp	DELIVERED CAPACITY Btu/h	DELIVERED CAPACITY Tons	Heat to be Rejected Btu/h
80° Inlet Condensing Water	160	156.1	174,200	40	108,000	9.0	282,200
	160	155.9	180,000	45	115,200	9.6	295,200
	165	160.3	210,000	40	138,000	11.5	348,000
	165	159.9	227,000	45	152,400	12.7	379,900
	170	164.1	259,000	40	174,000	14.5	432,900
	170	163.8	270,900	45	189,600	15.8	460,500
	175	168.0	306,700	40	206,400	17.2	513,100
	175	167.7	321,100	45	228,000	19.0	549,100
	180	172.0	351,800	40	236,400	19.7	588,200
	180	171.8	357,500	45	259,200	21.6	616,700
	185	176.0	395,700	40	260,400	21.7	656,100
	185	175.7	405,000	45	291,600	24.3	696,600
	190	179.8	446,200	40	282,000	23.5	728,200
	190	179.7	449,800	45	321,600	26.8	771,400
	195	183.6	500,000	40	300,000	25.0	800,000
	195	183.7	492,000	45	344,400	28.7	836,400
	200	187.3	547,400	40	312,000	26.0	859,400
	200	187.8	527,900	45	360,000	30.0	887,900

80° Inlet Condensing Water	165	162.8	96,800	45	60,000	5.0	156,800
	170	166.9	139,100	45	96,000	8.0	235,100
	175	170.7	188,000	45	134,000	11.2	322,400
	180	174.7	234,000	45	168,000	14.0	402,000
	185	178.7	274,000	45	195,600	16.3	469,600
	190	182.5	327,900	45	225,600	18.8	553,400
	195	186.6	365,500	45	237,600	19.8	603,100
	200	190.4	414,500	45	252,000	21.0	666,500

FOR 15 TON OPERATION

Data in following table are with flows adjusted for 15 ton operation
Condensing Water Flow: 54 gpm   Hot Water Flow: 54 gpm
Chilled Water Flow: 36 gpm   Temperatures in Degrees Fahrenheit

85° Inlet Condensing Water	165	160.4	122,000	45	72,000	6.0	194,000
	170	164.3	151,400	45	98,000	8.2	249,800
	175	167.9	186,600	45	128,400	10.7	315,000
	180	171.6	220,800	45	157,200	13.1	378,000
	185	175.4	253,300	45	182,400	15.2	435,700
	190	179.2	281,100	45	204,000	17.0	488,100
	195	183.1	312,700	45	222,000	18.5	534,700
	200	187.1	331,300	45	234,000	19.0	568,300

PRESSURE DROP for Pump Sizing
In Feet of Water at Flow Rate, Gallons per Minute

Flow - gpm	30	40	50	60	70	80	90	100	110
Hot Water Circuit	NA	NA	6.6	9.4	12.7	16.7	20.7	25.6	NA
Chilled Water Circuit	2.5	4.4	6.8	9.8	13.4	17.4	21.8	26.9	NA
Condensing Water Circuit	NA	NA	7.4	10.5	11.1	18.3	22.9	27.8	33.5

Where Progress Is Built On Quality

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

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MAINTENANCE

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

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

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

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

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

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

MONTHLY INSPECTIONS

COOLING:

1. Take a complete set of temperature readings (VI-15). If a problem is indicated, call servicing agency.

2. Check cooling tower;
   a. Cleanliness of sump.
   b. Cleanliness of sump screen.
   c. Condition of fan belt.
   d. Check water distribution system.

3. Check condensing water bleed-off flow rate (IV-35-2)

4. Check operation of condensing water chemical treatment equipment (if using).

5. Open all valves, on dirt legs and strainers long enough to flush out any dirt or trash.

6. Visually check piping for leaks.

7. Perform maintenance on auxiliary equipment as per manufacturer's instructions.

8. Check equipment and area for cleanliness.

SPRING START-UP

A. TOWER

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

5. Check operation of chilled water low temperature switch. (V-12-4)

6. Check operation of flow switch. (V-15-1)

7. Check operation of evaporator low temp switch. (V-11-3)

8. Check hot water valve modulation. (IV-43-10)

9. Check all external controls in the system.

D. OPERATIONAL CHECK

1. Place thermometers in all thermometer wells (VI-15-6(A),(B),(C)).

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

3. Record temperatures.

SHUT DOWN

A. TOWER

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

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

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

3. Clean and flush tower's distribution system.

4. Clean and flush tower sump.

5. Clean all strainers in condensing water system.

6. Circulate anti-freeze through condensing water circuit.

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

B. UNIT

1. Turn off unit.

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

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

4. Check anti-freeze concentration (IV-29-2) and close chilled water valves at unit.

5. Touch up all rusty areas on unit by painting. Arkla Part No. Z-3181 Pizzaz (Orange Paint), or Gliddens Poly Urethane Floor Enamel, Color No. 15157(Tinted).

MANUAL

Installation, Operation
and
Maintenance Instructions

SERIES 4600
STEEL AQUATOWERS

SEPTEMBER, 1975 OM-4600C

5800 Foxridge Drive – Mission, Kansas 66202

PRINTED IN U.S.A.

INSTALLATION, OPERATION, MAINTENANCE, DISASSEMBLY – STEEL AQUATOWERS

Installation, Operation and Maintenance Instructions

SERIES 4600

STEEL AQUATOWERS

TOWER LOCATION

Locate so prevailing wind will blow into the louvered face. Direct fan discharge away from building surfaces to eliminate the possibility of discoloration. Locate so there is free flow of air to and from the tower. Allow clearance on all sides for maintenance. Anchor in a level position to a stable foundation.

INDOOR INSTALLATION

A duct is required from the tower air discharge to the outside. In some cases it may also be desirable to install an inlet air duct. If ducts are used, the total draft loss should not exceed .10" water pressure. Draft losses can be minimized by:

a. Using 20% oversize ducts.
b. Avoiding sharp turns or abrupt changes in size.
c. Keeping duct length to a minimum.
d. Increasing the area of screened or louvered opening so the net free area is at least 20% greater than the tower discharge opening area.

Ducts should be attached to the tower using rubber or canvas connections. Access openings for servicing the mechanical equipment must be provided if air discharge ducts are installed. If the duct discharges into the prevailing wind, it may be necessary to install a windbreak or an elbow to serve as a deflector. Ducts installed on towers with year around usage should be water tight and insulated to prevent condensation.

TOWER INSTALLATION

The tower is shipped complete with the motor in a carton and miscellaneous parts package within the tower. Anchor tower by bolting a clip to the foundation and basin sides or through slots in legs using 3/8" or larger bolts.

PIPING TO TOWER (Summer Temperature Conditions)

1. Use pipes of sufficient size to provide minimum friction loss.
2. Connect Float Valve to make-up water supply.
3. Install bleed-off line. Bleed-off is the continuous wasting of a small amount of water during operation which retards scale and corrosion. A bleed-off line can be installed at any point in the system, however, the best point is in the hot water line near the top of the tower so water will be removed when the pump is operating. A copper tube, pinched down or with a pet cock can be used.

PIPING TO TOWER (Winter Freezing Conditions)

1. Where operating conditions require tower use during freezing weather, it is recommended that the towers be installed for "dry basin" operation. See Figure 1.
2. Provide an inside open-type storage tank with a capacity of four times the cooling tower GPM.
3. Connect tower suction to storage tank.
4. Install make-up water, bleed-off, overflow and drain lines on tank.
5. Insulate and heat water lines exposed to freezing temperatures.

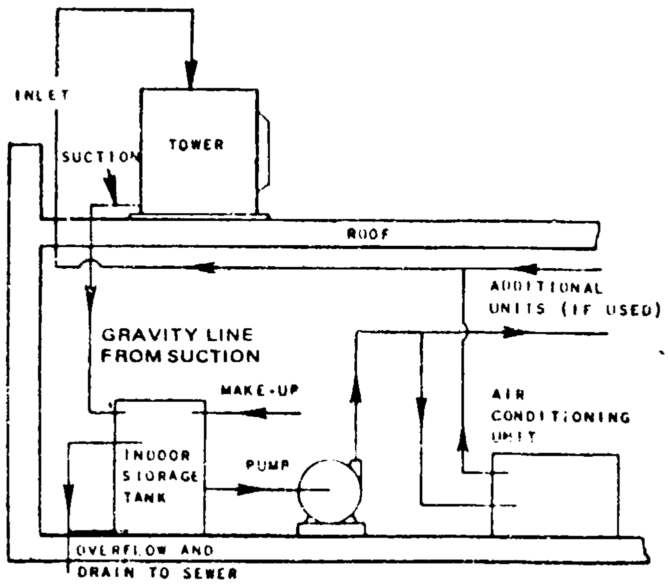


FIGURE 1. Flow Diagram for a Cooling Tower with Indoor Storage Tank. (Piping Is Arranged So That Tower Basin Will Drain When Pump Is Shut Off.)

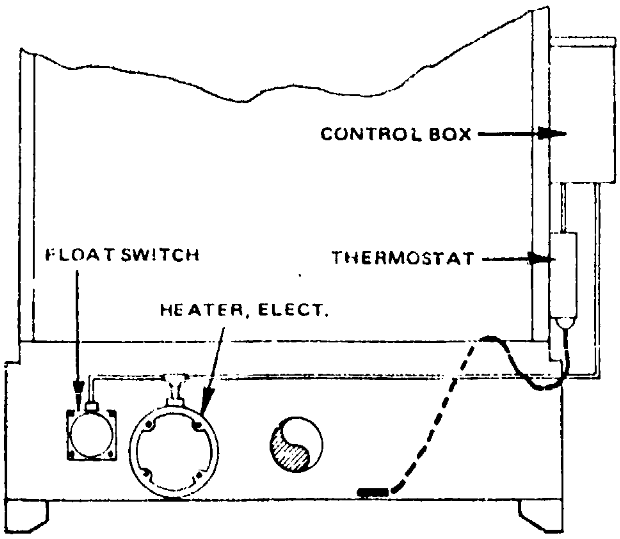


FIGURE 2. Electric heater systems are available as optional equipment to prevent freezing the cold water basin when it cannot be drained.

MECHANICAL EQUIPMENT INSTALLATION

MOTOR, SHEAVE AND V-BELT INSTALLATION

1. Check the motor name plate to be sure its voltage, phase and frequency ratings are the same as the power supply.
2. Check to insure that fan is tightly secured to bearing housing shaft and free to rotate and that bearing housing is secure to support.
3. Install all thread belt tension adjusting bolts in motor base cradle, see Detail A. Install lock washers and nuts, fastening adjusting bolts to motor base cradle. Run galvanized nuts about halfway down on bolts. Insert bolts through slots in motor base, install lock washers and run top nuts down, locking base in place. Bolt motor to motor base.
4. Install motor sheave and align it with fan sheave. A plumb line will be helpful in aligning sheaves. See Detail "B".
5. Install V-belt and adjust tension by means of belt tension adjusting bolts. A correctly tensioned belt does not slip when the fan is started; and, when running, the "tight" side is straight between sheaves. The "slack" side will have a slight bow. Correct tension can only be determined by trial runs at successively higher tensions until slipping has stopped.

   A small further increase in tension should be made to account for normal belt stretch. Avoid over tensioning. Too much tension reduces bearing and belt life.

   New belts must be retensioned after 8 to 12 hours operation since new belts stretch at a higher rate and "seat" into sheave grooves.
6. Connect motor to power supply using wiring, switching, short circuit protection and overload protection in accordance with the National Electric Code and local requirements. Failure to wire the motor correctly will void its warranty. The overload protection for Motors must be part of the control system, see Diagram "C".
7. Sleeve bearing motors are usually shipped without oil and must be oiled before operating. Ball bearing motors are lubricated for the initial operation by the manufacturer.
8. Install belt guard using sheet metal screws. See Figure 5 (page 8).

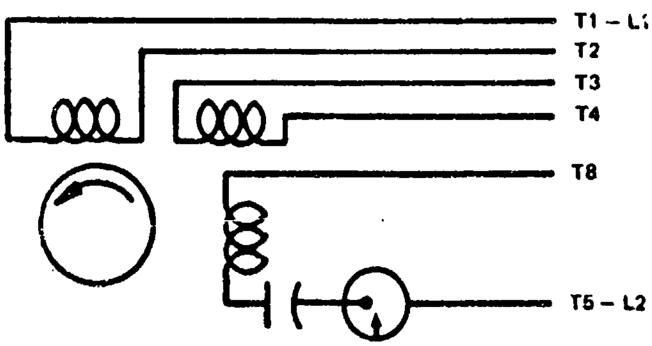
INSTALLATION OF OPTIONAL EQUIPMENT

AIR INLET SCREEN

Install hardware used to attach air inlet screen to side casing sheets. Set screen in position and install with wing nuts.

HOT WATER BASIN COVER

Install "S" strips at hot water basin sides. Remove from splash box cover those sheet metal screws indicated on installation drawing. Position basin cover segments and reinstall sheet metal screws.



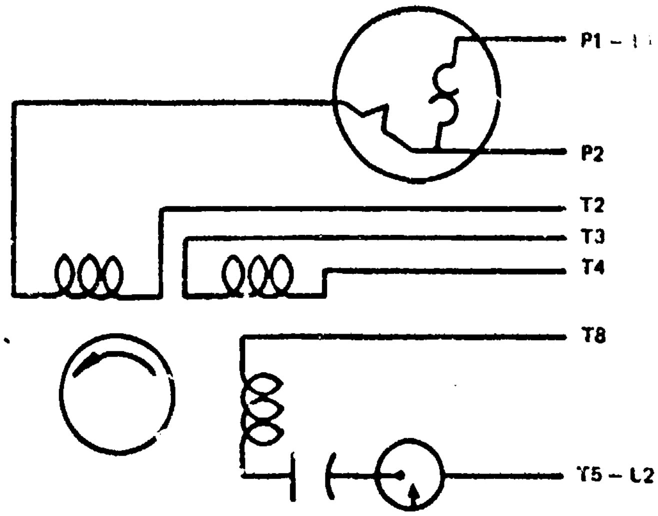
Without Thermal Overload (Integral HP)

HIGH VOLTAGE
1. Connect T1 and L1 and insulate.
2. Connect T2, T3 and T8 and insulate
3. Connect T4 and T5 and insulate.

LOW VOLTAGE
1. Connect T1, T3, T8 and L1 and insulate.
2. Connect T2, T4, T5 and L2 and insulate.

NOTE: Colors may be substituted for numbers as follows:

T1 – Blue	T5 – Black
T2 – White	T8 – Red
T3 – Green	P1 – No Color Assigned
T4 – Yellow	P2 – Brown



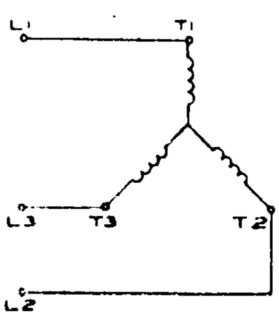
With Thermal Overload (Fractional HP)

HIGH VOLTAGE
1. Insulate P2.
2. Connect T2, T3 and T8 and insulate.
3. Connect T4, T5 and L2 and insulate.
4. Connect P1 and L1 and insulate.

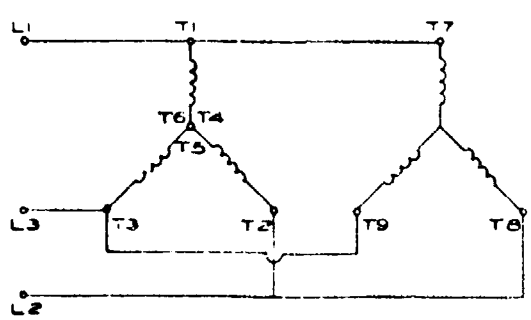
LOW VOLTAGE
1. Connect P1 and L1 and insulate.
2. Connect P2 and T3 and insulate.
3. Connect T1 and T8 and insulate.
4. Connect T2, T4 and T5 and insulate.

To reverse rotation, interchange leads T5 and T8.

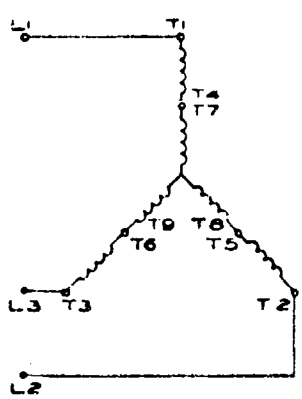
WIRING DIAGRAM CAPACITOR START MOTORS, REVERSIBLE, DOUBLE VOLTAGE



200 VOLT

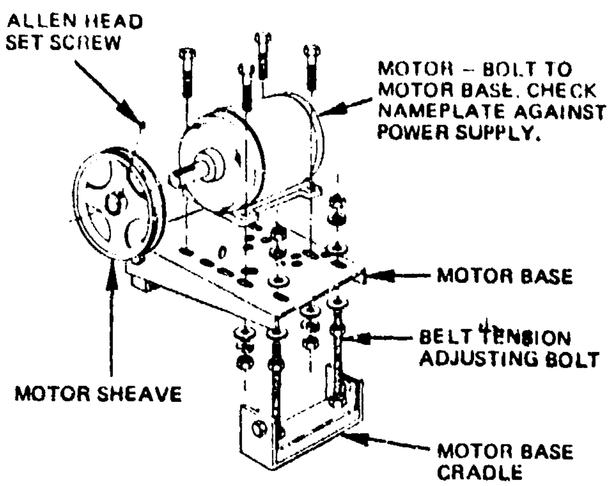


230 VOLT

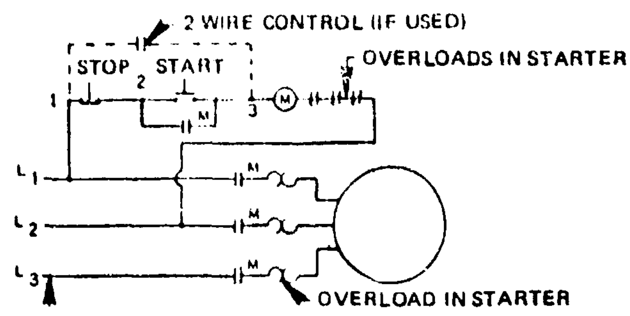


460 VOLT

WIRING DIAGRAM 3 PHASE MOTORS

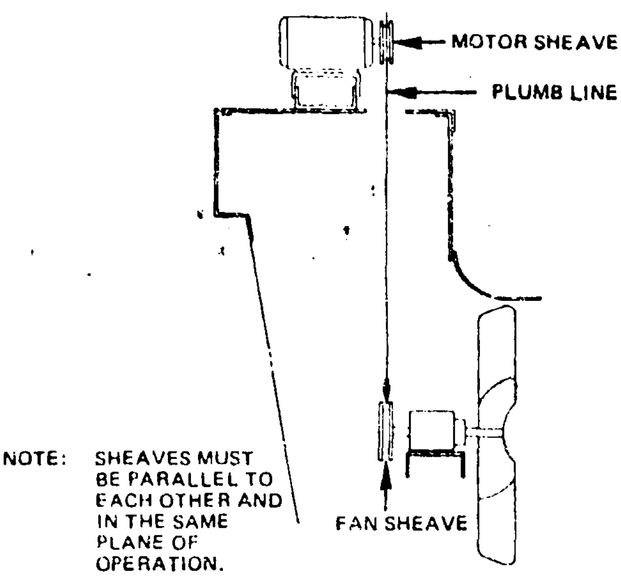


DETAIL "A"



L3 is used on 3 phase motor only.

Showing Overload in Starter
DIAGRAM "C"



DETAIL "B"

OPERATION INSTRUCTIONS

1. Wash foreign matter from fill and basin.
2. Fill circulating system with water.
3. Start pump and adjust float valve to maintain 4" (5" on models 4619 thru 4625 and 8" on models 4627 thru 4633) of water in cold water basin.
4. Check bleed-off line to make sure water is being discharged during operation.
5. Check fan for free rotation and oil level in Bearing Housing (see maintenance instructions). Start motor and check direction of rotation. Fan must rotate clockwise when viewed from the fan discharge side. If the rotation is incorrect, change any two of the three motor leads for a three-phase motor or interchange the connections of either the main or starter windings for single-phase capacitor start motor.
6. Depth of water in hot water basin should be uniform. If the basin overflows, reduce the flow rate. Do not pump more water than design capacity.
7. Do not cycle the motor so that the total of the starting times exceeds 30 seconds each hour.

MAINTENANCE INSTRUCTIONS

MOTOR LUBRICATION
Lubricate the motor according to the motor manufacturer's instructions shipped with the motor. Motor should be relubricated at the start and end of each operating season.

FAN BEARING LUBRICATION
Lubricate bearing housings with SAE 20 mineral oil.

Oil cups should be kept full to insure proper oil level in bearing housings.

BELT TENSION
Check belt tension every two to three weeks during peak operating season. Refer to page 4, item 5.

BLEED-OFF
Check the bleed-off for continuous water discharge.

BASIN AND SUCTION SCREEN
Drain and clean cold water basin and suction screen periodically.

FLOAT VALVE
Check float valve periodically for proper operation and maintenance of water level.

GENERAL

The following tables show the proper amount of bleed-off.

COOLING RANGE, DEGREES F	PERCENT BLEED-OFF OF TOTAL GPM
6	.15
7-1/2	.22
10	.33
15	.54
20	.75

CHEMICAL TREATMENT

The dissolved solids in the circulating water are concentrated by evaporation and must be limited by bleed-off of some of the water. Chemical treatment is not normally required if adequate bleed-off is maintained.

Algae and slime may occur and can be controlled by careful application of proper chemicals. Improper application of concentrated water treating chemicals may damage parts of the system. If scale or algae and slime accumulate, obtain the services of a competent water treating consultant.

WATER DISCOLORATION

Discoloration of water may occur when a cooling tower is placed in operation. This discoloration is not harmful and will normally disappear after several weeks of operation. Application of a common bleach solution or increased bleed-off will alleviate this condition.

FOAMING

Foaming may occur when the concentration of dissolved solids in the circulating water is high. Increasing the bleed-off rate or application of commercial foam depressants will alleviate the problem. Foam depressants slightly alter the physical properties of the circulating water and may affect the tower operating characteristics. Dosages should not exceed manufacturer's recommended amounts. Trial of several brands may be necessary to achieve optimum foam control and tower operation.

SEASONAL SHUTDOWN INSTRUCTIONS

BASIN AND FRAME

Drain the tower basins and all exposed piping. Leave the basin drain open. Water may be left in cold water basin if tower is located in a non-freezing area.

During shutdown, clean the tower and make any necessary repairs. Apply protective coating as required to all metal parts. Particular attention should be given to bearing supports.

MECHANICAL EQUIPMENT

V-BELTS AND SHEAVES

1. At shutdown, remove and store belts in a cool, dark, dry room. Clean and coat sheave grooves with rust preventive, lacquer, or paint.
2. Before putting belts back on sheaves, remove rust preventive. Replace belts with excessive wear.
3. When putting tower back into service refer to "Mechanical Equipment Installation" page 4 for belt installation and tensioning instructions.

BEARING HOUSING, Oil Lubricated Type

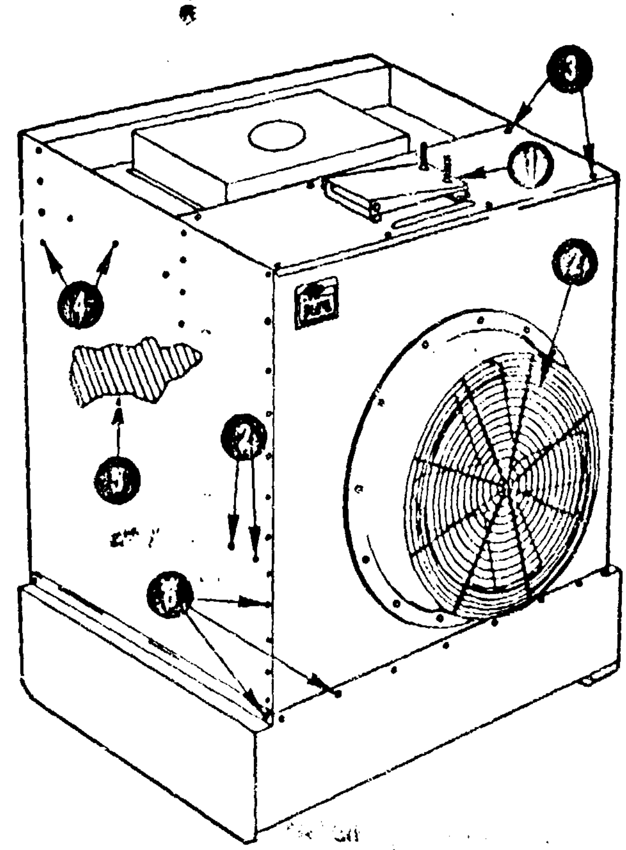
1. At shutdown, operate until oil is warm; drain and refill. Use SAE 20 mineral oil.
2. Each month, drain water condensate at the drain plug. Check oil level and add oil if necessary.
3. At start-up, operate until oil is warm; drain and refill.

ELECTRIC MOTORS

Do not start motor without determining that fan is free to rotate.

Refer to motor manufacturer's recommendations for lubrication and maintenance instructions.

If shutdown period is longer than seasonal, contact The Marley sales office or representative in your area for additional information. Always refer to tower serial number when writing for information or ordering parts. The serial number is stamped on the tower name plate.



DISASSEMBLY AND REASSEMBLY INSTRUCTIONS

Never disassemble the Aquatower more than necessary; for example, if removal of the motor base is sufficient to get the tower to the installation site, remove only that part. When disassembling, remember how each part is screwed, bolted and set in place; fasten screws and bolts for each part with each section. Be careful not to mar galvanized coating.

DISASSEMBLY – 4619 thru 4633 (sequence is similar for 4613 thru 4617)

1. Remove motor base.
2. Remove fan guard, fan and all hardware attaching bearing housing support channel to casing sheets.
3. Remove screws attaching top sheet, then remove sheet.
4. Remove screws attaching distribution basin then remove basin.
5. Remove fill.
6. Remove screws from collection basin and side casing sheets at fan sheet. Remove side casing sheets and fan sheet with fan cylinder attached.

REASSEMBLY

Reassembly of the Aquatower is the reverse of the steps noted above.

The following precautions are important:

1. Fill must be installed level to assure full tower performance.
2. Bolts which use rubber sealing washers under head should be tightened securely to prevent leaks.
3. Be sure mechanical equipment is installed correctly and fan rotates freely.

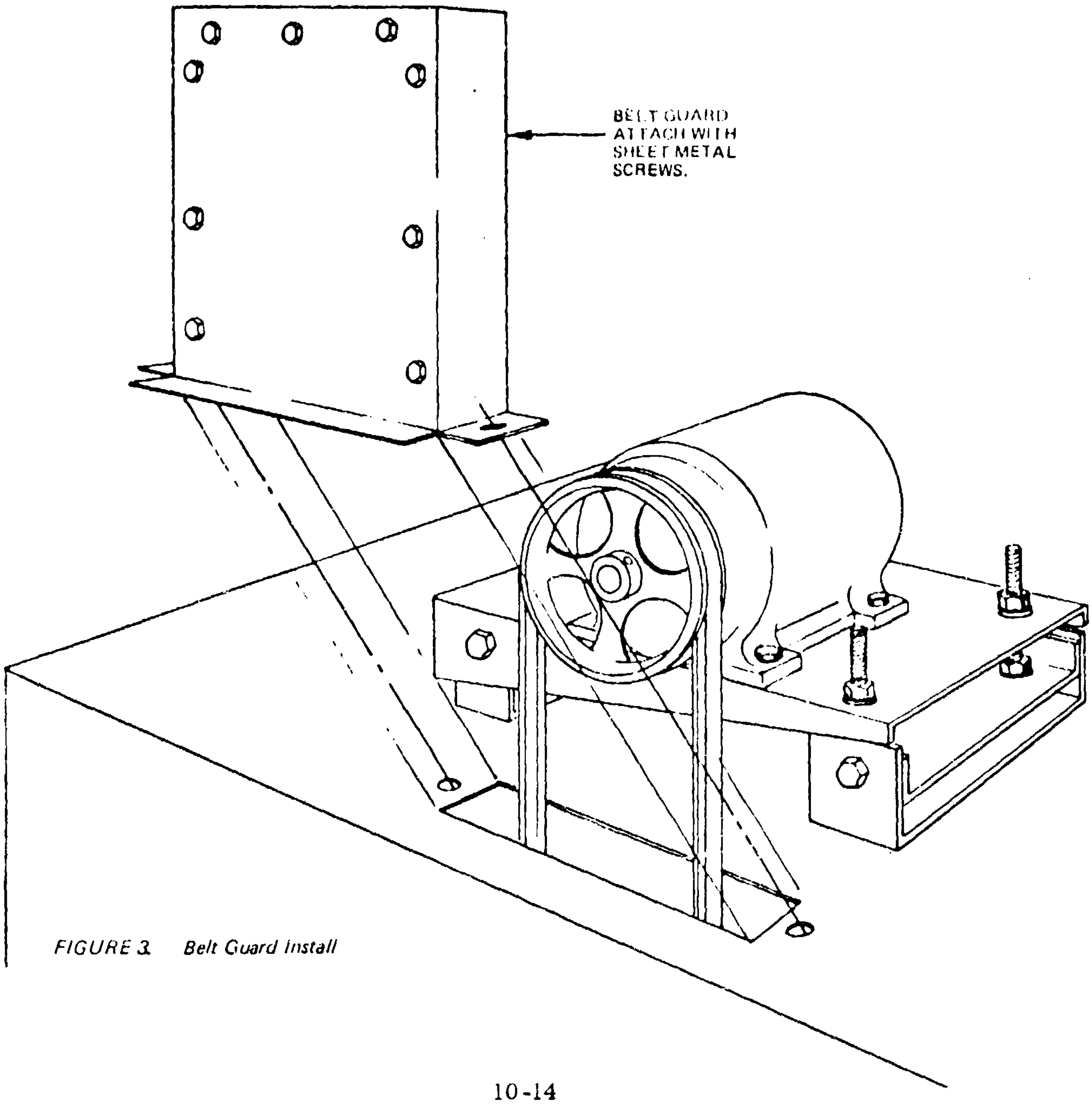


FIGURE 3. Belt Guard Install

PENN CONTROLS
DIVISION OF JOHNSON SERVICE COMPANY

INSTALLATION AND OPERATION INSTRUCTIONS

SERIES T26

FORM 996-49.1

LINE VOLTAGE THERMOSTATS

Heating, Cooling, Combination Heating and Cooling

APPLICATION

These line voltage thermostats control heating, cooling, or year 'round air conditioning units in commercial, industrial or residential installations.

Where critical or high value products are to be maintained at a specific temperature, a single thermostat should not be applied to perform as both an operating and a limit control. In these applications a separate limit control with alarm contacts should be wired to indicate when the limit control operates.

LOCATION

The thermostat should be mounted 4 to 5 feet above the floor in a location where it will be subjected to and affected by average room temperature. Do not mount thermostat where it may be affected by ***heat*** from lamps, sunlight, fireplaces, registers, radiators, pipes, etc. or by ***cold*** from windows, doors, registers, pipes, etc.

On unit heater applications, locate the thermostat below and behind the heater in the path of the air entering the unit, ***not*** in the path of the discharge air.

WIRING AND MOUNTING

All wiring should conform to the National Electrical Code and local regulations. Loads exceeding the rating of the thermostat can be handled with a relay or motor starter.

CAUTION: Disconnect power supply before wiring connections are made to prevent possible electrical shock or damage to equipment.

The thermostats are supplied with factory installed vertical faceplates as standard. If horizontal mounting is desired, a faceplate to convert the vertical thermostat is packed with the thermostat for on-the-job installation. If any other version is desired (concealed adjustment, less thermometer, etc.) separate faceplate kits are available for on-the-job installation.

The following procedure should be followed in the installation. *Do not remove the thermostat cover to install.* All wiring and mounting can be completed without removing the cover. Thermostat terminal identification is under mounting plate.

1. Select the proper mounting location.
2. Install a 2 x 3 vertical or horizontal (as required) outlet box.
3. Run wire in conduit or BX to a standard 2 x 3 outlet box located in the wall. A standard shallow switch and receptacle box can be used where surface mounting and exposed conduit wiring are necessary, such as on a concrete or brick wall. Allow about 6 inches of wire for connections to thermostat terminals.
4. Remove mounting plate, see Figs. 2 and 3, and fasten plate to outlet box with screws provided in mounting plate.
5. Make the necessary wiring connections to the contact unit at the rear of the thermostat. (See Typical Application Diagrams.) Use terminal screws supplied in the contact unit. Screws longer than 1/4" can damage the switch.
6. Hook two slots in back of thermostat over formed

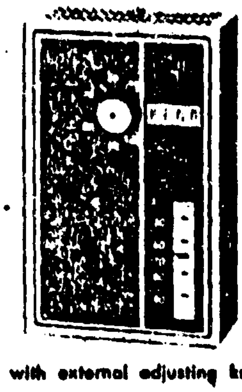


Fig. 1 — Thermostat with external adjusting knob and thermometer.

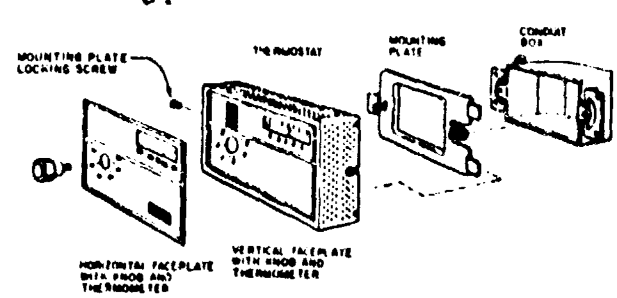


Fig 2 — Line drawing illustrating method of mounting a vertical thermostat to a horizontal outlet box and installing a horizontal faceplate.

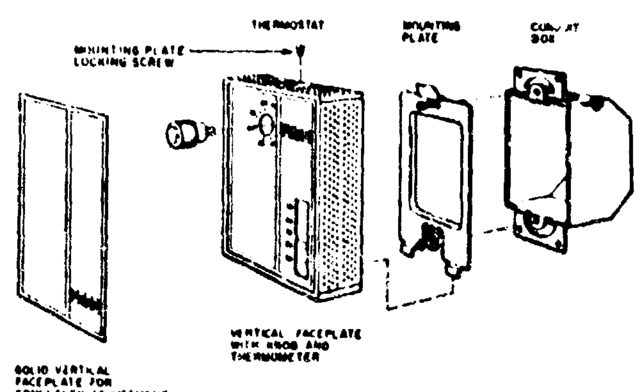


Fig. 3 — Line drawing illustrating method of mounting a vertical thermostat to outlet box. Also shown is a solid vertical faceplate for concealed adjustment when desired.

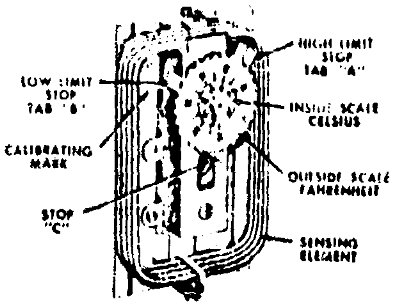


Fig. 4 — Dial stops are shown above. High limit stop is set by tab "A"; low limit stop is set by tab "B".

prongs on mounting plate and swing thermostat into position against mounting plate.

7. Tighten mounting plate locking screw, Figs. 2 and 3.

Optional Faceplate Installation

1. Mount the thermostat.
2. Loosen screw in center of knob with a 1/16" Allen wrench and remove knob.
3. Peel off backing strip from selected faceplate.
4. Position plate over factory installed plate with one long edge and two corners aligned straight and even with installed plate.
5. Retain position and firmly press selected faceplate onto cover.
6. Replace knob, when required.

ADJUSTMENTS

Models with external knob permit thermostat adjustment by rotating knob. Indicator line on knob denotes thermostat dial setting.

For concealed dial models (with cover removed), dial setting desired should be lined up with reference mark on base of thermostat. This will put desired setting at a 9 o'clock clock-face position when thermostat is held vertically. Dial settings on Series T26 heating and SPDT thermostats indicate point at which contacts make to start heating system. Dial setting on Type T26J indicates point at which contacts make to start cooling system.

For key adjustment, remove screw in center of knob, adjust to set point desired and retain knob as "key" for future readjustment.

LIMIT STOPS

High limit and low limit stops are an integral feature of these thermostats. Stops may be set in the following manner:

High Limit Stop

1. Set dial to maximum stop setting desired.
2. Loosen screw in center of knob with a 1/16" Allen wrench and remove knob.
3. Remove thermostat cover by loosening cover screws. Remove cover.
4. While holding dial firmly in position depress tab "A," Figure 4 and rotate clockwise until tab is against stop "C."
5. Release tab making sure tab fits into nearest notch. Notches in dial are approximately 2½° F apart.

Low Limit Stop

1. Follow the same steps as outlined under "High Limit Stop" above but rotate tab "B," Figure 4 counterclockwise.
2. Replace cover and tighten cover screws. Assemble knob. Rotate knob to desired normal operating setting.

DIAL LOCK

The high limit stop and low limit stop can be set to prevent dial from rotating. Rotate dial to set point desired and move both tabs to a position against either side of Stop "C." as outlined in the above "High Limit" and "Low Limit" paragraphs.

CALIBRATION

The Series T26 thermostats are factory calibrated and no field calibration should be attempted.

CHECKOUT PROCEDURE

Before leaving installation, a complete operating cycle should be observed to see that all components are functioning properly.

REPAIRS AND REPLACEMENT

The knob, faceplate and cover are field replaceable. Other field repairs must not be made. Replacement thermostats may be obtained from the nearest Penn-Baso Wholesaler. When ordering a replacement thermostat, specify Product Number and Serial Number as shown on the cover label of the thermostat.

FACEPLATES

Faceplates are available in separate kits for on-the-job installation. All plates have peel-off backing strips. Faceplates are available in all combinations shown in the following table.

Kit Number	Mounting Position		Type of Adjustment		Thermometer	
	Vertical	Horizontal	Knob	Concealed	Yes	No
PLT213-5		X		X		X
PLT213-6	X			X		X
PLT213-9*	X		X		X	
PLT213-11*		X	X		X	
PLT213-15	X			X	X	
PLT213-16		X		X	X	
PLT213-17	X		X			X
PLT213-18		X	X			X

* Supplied with standard wholesaler models (vertical is factory installed).

TYPICAL APPLICATION DIAGRAMS

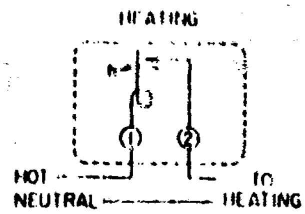


Fig. 5 — Internal diagram of Type T26A and Type T26B (no selector).

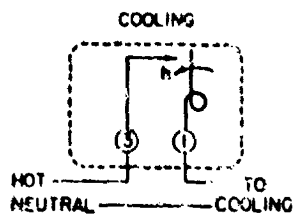


Fig. 6 — Internal diagram of Type T26J (no selector).

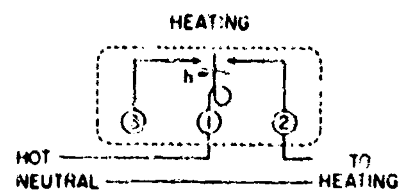


Fig. 7 — Types T26S, T26T (no selector) wired for heating application.

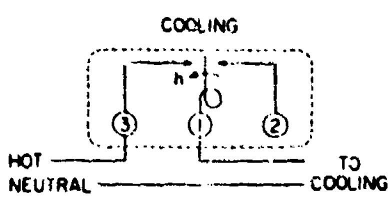


Fig. 8 — Types T26S, T26T (no selector) wired for cooling application.

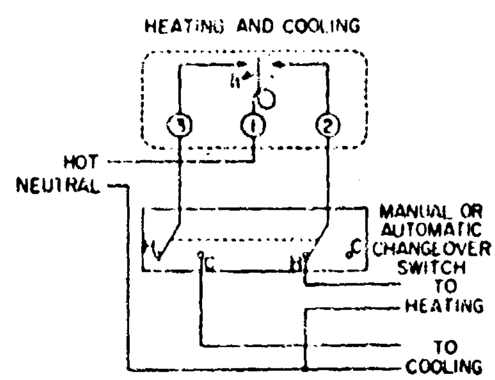


Fig. 9 — Types T26S, T26T (no selector) wired for heating and cooling with manual or automatic changeover switch.

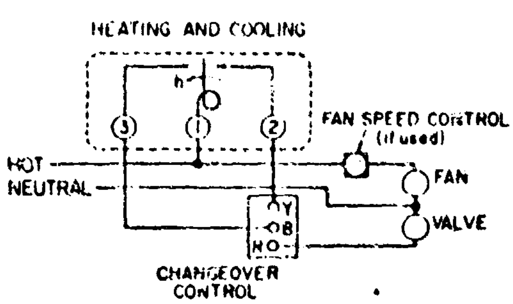


Fig. 10 — Type T26S, T26T (no selector) on fan-coil unit with cycling valve, continuous fan. Terminal markings shown for Type A19CAC changeover control

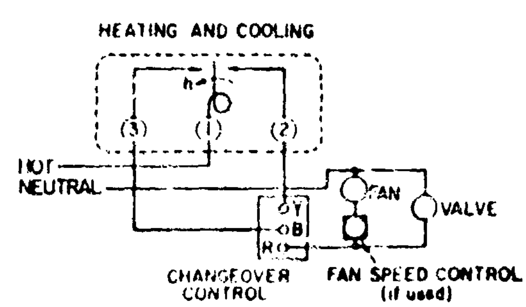


Fig. 11 — Type T26S, T26T (no selector) on fan-coil unit with cycling fan and valve. Terminal markings shown for Type A19CAC changeover control.

REVERE

COPPER AND BRASS INCORPORATED

REVERE

BUILDING PRODUCTS DEPARTMENT
P.O. Box 151
ROME, NEW YORK 13440
315-338-2101

Subject: PERFORMANCE CURVES FOR REVERE "SUN-AID" MODULAR SOLAR COLLECTORS

The attached plots demonstrate the performance characteristics of the several models of Revere "Sun-Aid" Modular Solar Energy Collectors available.

SURFACES: Revere offers three surface treatments for the copper Tube-In-Strip absorber plate. The table below lists these surface options with their respective absorptance and emittance values.

Surface Option	Solar Spectrum Absorptance	Infrared Emittance
Nextel Black Velvet Paint	0.96	0.95
Revere "E" Cuprous Oxide Selective	0.88-0.91	0.12-0.30
Black Chrome Selective	0.95	0.07

Plot number one demonstrates the difference for the various surface options. The three curves shown are for a collector with a single special low iron glazing.

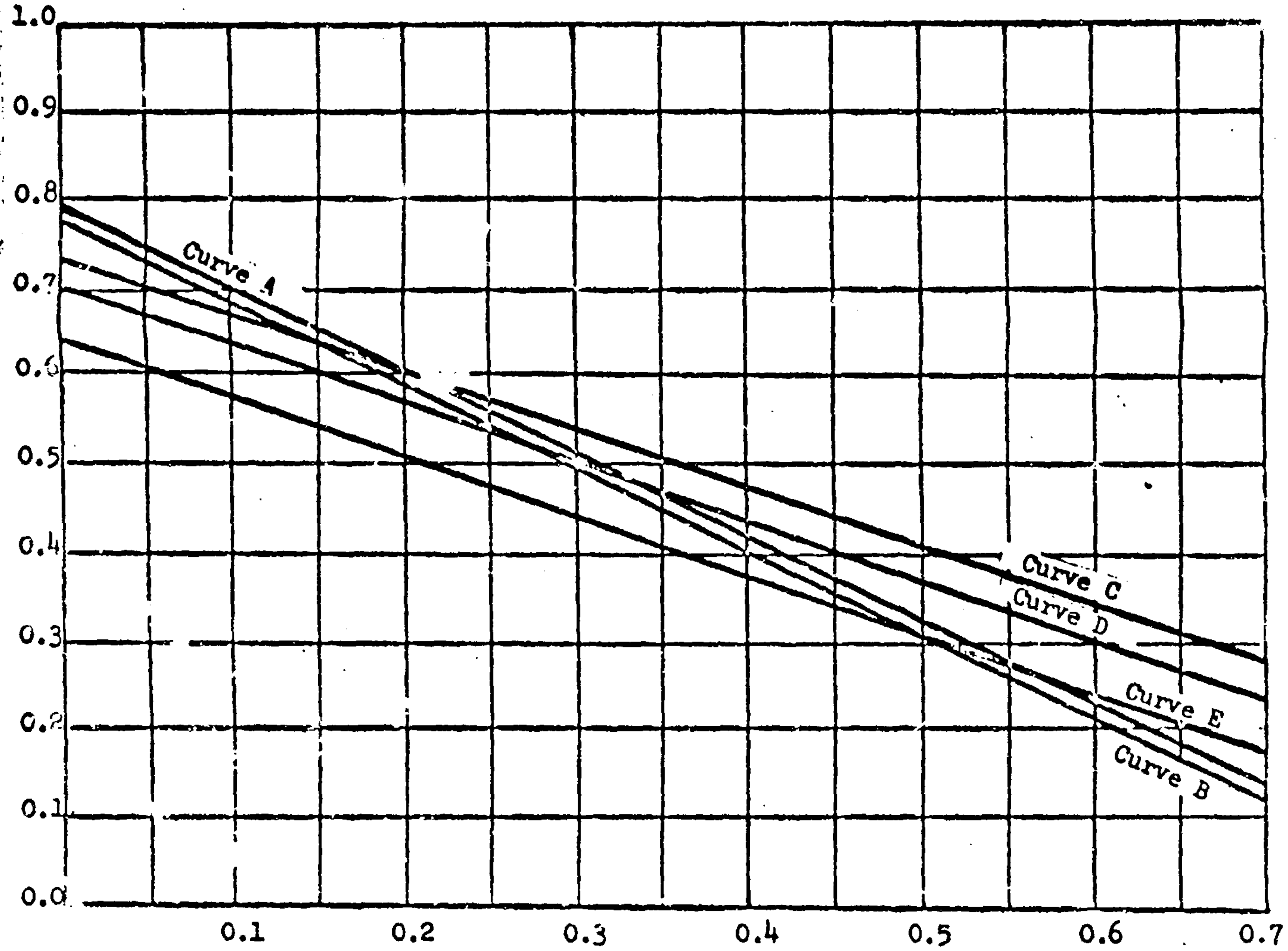
GLAZINGS: Revere offers five glass cover options. All glass is 1/8" thick, tempered. The double glazed units are the sealed type with an enclosed desiccant. The table below lists the various glass options with their respective solar spectrum transmissivity.

Cover Option	Percent Solar Spectrum Transmissivity
Single Special Low Iron	89.5%
Single Water White Crystal	91.5%
Double Low Iron	73.1%
Double Special Low Iron	80.1%
Double Water White Crystal	83.7%

Plot #2

REVERE 'SUN-AID' MODULAR SOLAR ENERGY COLLECTORS

BLACK CHROME SELECTIVE SURFACE



FLUID PARAMETER, $X_1 = \left[\frac{(T_{in} + T_{out})}{2} - T_{amb} \right] / I$, °F·ft²·hr/BTU

Curve A Tempered Single Water White Glass, NBS Tested, $N_1 = .792 - .933\, X_1$

Curve B Tempered Single Special Low Iron Glass, $N_1 = .775 - .933\, X_1$

Curve C Tempered Double Water White Glass, $N_1 = .735 - .669\, X_1$

Curve D Tempered Double Special Low Iron Glass, $N_1 = .703 - .669\, X_1$

Curve E Tempered Double Low Iron Glass, $N_1 = .642 - .609\, X_1$

Urethane Safety Group Bulletin

(U-100R)

Fire Safety Guidelines for Use of Rigid Polyurethane Foam Insulation in Building Construction

POLYURETHANE FOAM AND COMBUSTIBILITY

Rigid foam, polyurethane or isocyanurate based, is an exceptionally effective insulation material for the construction industry. Inch for inch, it provides greater resistance to the transfer of heat and cold than any other commercially available insulating material. This leads to maximum energy savings while permitting such design options as thinner walls and roofs or smaller heating and cooling equipment. Because of its closed-cell structure, it has low moisture permeability and thus retains its insulating value effectively. It is light in weight, versatile, self-supporting and easily installed by properly trained and equipped craftsmen.

Depending on formulation, combustibility characteristics of polyurethane foams vary widely, as do those of other organic materials. At the present stage of development, all organic foams, whether they contain fire retardants or not, should be considered combustible and handled accordingly. Experience demonstrates that certain precautions must be taken to minimize the fire hazard in handling, storage and use.

How polyurethane is used in a building system ultimately determines its fire safety. Exposed polyurethane foam must be protected from accidental ignition by completely covering it with a flame barrier as soon as possible after installation, preferably the same day. Sprinkler protection may also be desirable.

Rigid polyurethane can be formulated on site from liquid chemicals which are foamed in place by pouring or spraying. It also is available as a rigid boardstock which can be cut and fitted into place, or as preformed panels, some of which are laminated with materials that shield against ignition.

SAFETY DURING CONSTRUCTION

Fire is a serious concern during construction. Good practices suggest the following safety precautions:

1. Foamed-on-site polyurethane should be mixed and applied only by applicators trained in its proper use and familiar with its limitations. It should be foamed in accordance with the supplier's recommendation.

2. Prohibit open flames, cutting and welding torches, electric heaters, high intensity lamps, and smoking materials such as cigarettes, pipes and cigars, from foam storage and installation areas. If hot work must be done near exposed polyurethane, shield the foam from heat and sparks by a thermal barrier such as asbestos cement board. A fire watch is desirable. Do not weld or cut metal which is in contact with polyurethane.

3. Provide fire extinguishing equipment at both storage and installation sites. Water in a fine spray usually is an effective method of extinguishing polyurethane foam fires.

4. Store foam boardstock in limited quantities, in a location free from any ignition hazard and preferably protected by a sprinkler system. Do not stack more than 8 feet high. Provide adequate aisle space for access between stacks.

5. Store and open liquid foam materials out of direct sunlight at temperatures not exceeding 85°F in a well-ventilated location. Do not mix liquid waste components together for disposal because spontaneous combustion could occur. Decontaminate empty drums by filling with water out of doors and allowing to stand 48 hours uncapped.

6. Waste foam should be disposed of daily in a designated location with due regard for its combustible characteristics.

SAFETY IN DESIGN

Each formulation of polyurethane foam has its own maximum service temperature which should be observed. Consult your supplier for this information.

The most important consideration is to make sure that a suitable flame barrier covers all surfaces of polyurethane foam insulation. Additionally, certain applications may require sprinkler protection. Local building code and fire code officials, insurers, and manufacturers' specifications and installation instruction should be checked in each specific instance.

Further guidance may be obtained from provisions of three national model building codes[1] which specify requirements for foams used in specific application:

(over)

ORIGINAL PAGE IS OF POOR QUALITY

Published by Urethane Safety Group, September, 1976
The Society of the Plastics Industry, Inc., 355 Lexington Avenue, New York, N.Y. 10017

SAFETY IN DESIGN (cont'd.)

Following are some fire safety design guides for the architect and contractors based on these model codes and recommendations of the Urethane Safety Group.

For Interior Use

1. Polyurethane foam used in all interior wall and/or ceiling construction or concealed spaces should not be left exposed but should be covered with at least ½ inch of cement plaster or fire-rated gypsum wallboard or an equivalent 15-minute thermal barrier.

2. Polyurethane foam installed above a suspended ceiling, such as in a refrigerated building requires protection by a thermal barrier above the foam, i.e., between the top side of the foam and the underside of the floor above. The result should be a thermal barrier on both sides of the foam.

3. For panels comprising metal facings on foam cores, the model building codes specify minimum thicknesses of steel or aluminum facings, and maximum flame spread and smoke developed ratings for the cores, and require automatic sprinkler protection. The codes provide for exceptions to these requirements based on acceptable diversified testing.

4. The high insulating value of polyurethane foam on a ceiling or roof can result in rapid heat buildup under the high points of the structure if a fire should occur beneath this surface. Automatic heat vents at high points of ceiling are recommended to provide for release of heat and smoke before dangerous buildup occurs.

5. Fire stops should be provided for large warehouse ceiling areas, between floors in multi-story buildings, in concealed spaces, and at penetrations into pipe chases and ventilation shafts.

6. Polyurethane foam should not be used in contact with chimneys, heater vents, steam pipes (unless specifically designed for this application) or other areas which could be subject to service temperatures exceeding ratings recommended by supplier.

7. Polyurethane foam may be used to fill cavities within masonry walls or under grade level concrete floors.

NOTE: In all construction, new total system concepts to provide effective fire safety for buildings—incorporating automatic early detection, alarm and suppression devices—are recommended.

For Exterior Use

1. Polyurethane foam may be used as a roof covering over concrete, poured gypsum, tongue-and-groove wood or other properly prepared roof decks if the foam insulation is part of a class A, B or C roof assembly as tested by ASTM E-108.

2. Foam insulation may be used as part of a roof assembly over bare metal decks provided, (a) a fire-rated underlay of perlite, gypsum board or other approved thermal barrier material is applied between the foam and the deck to provide protection from fire inside the building, or (b) the roof assembly meets the requirements for protection from fire inside the building of the code authorities who have jurisdiction over the specific application.

3. For other types of roofing applications, refer to local or model codes.

4. When used as an exterior insulating material on such structures as tanks or chemical processing equipment, polyurethane foam requires protection from the weather and ultra-violet rays of the sun and incidental ignition, depending on the circumstances. Consult your materials manufacturer, insurer and fire officials.

COMBUSTIBILITY TESTS, RATINGS AND HAZARDS

Numerous federal regulations and regional, state and local building codes make reference to combustibility tests and standards such as ASTM E-84 (or UL 723) the Steiner Tunnel test. While tests, and numerical flame spread ratings derived from these tests, are the most common means available today to compare the various combustibility characteristics of plastics and other materials, and to communicate these characteristics to knowledgable consumers, they are valid only as measurements of the performance of materials under specific, controlled test conditions and are not intended to reflect hazards under actual fire conditions. More than one test, and possibly a full-scale room or corner test, may be necessary to qualify a material for intended or proposed use.

It also should be understood that rigid polyurethane foam, as other organic materials used in construction, are combustible and, if ignited, will release smoke, toxic gases (the most significant of which usually is carbon monoxide), and flammable gases which could result in flashover, all of which may cause hazards to life as well as damage to property. While the recommendations contained herein are generally recognized by federal agencies, the model building codes and other regulatory bodies as providing requisite levels of safety to life and property, the National Bureau of Standards has stated that no standard test methodology is currently available to evaluate the hazards presented by the toxic off-gases of combustion.

The Urethane Safety Group, in conjunction with The Society of the Plastics Industry, Inc., is engaged in research to evaluate present tests and to develop new tests that will more accurately predict performance of tested materials in actual fire conditions.

[1]Information on the model building codes may be obtained from:

Uniform Building Code
International Conference of Building Officials
5360 South Workman Mill Road
Whittier, California 90601

Basic Building Code
Building Officials Conference of America
1313 East 60th Street
Chicago, Illinois 60637

Standard Building Code
Southern Building Code Congress
3617 8th Avenue, South
Birmingham, Alabama 35222

Further information on the proper application of rigid urethane foam may be obtained from your materials supplier and:

The Society of the Plastics Industry, Inc.
355 Lexington Avenue, New York, New York 10017

National Fire Protection Association
470 Atlantic Avenue, Boston, Massachusetts 02210.

Factory Mutual Research Corporation
P.O. Box 688, Norwood, Massachusetts 0~~62.

National Bureau of Standards
U.S. Department of Commerce, Washington, D.C. 20234.

SPECIFICATIONS and Technical Data

URETHANE

NOTE: For information on Urethane Foam, including specifications and manufacturers, contact the Urethane Foam Contractors Association (UFCA) at
1406 Third National Building — Dayton, Ohio 45402 — phone (513) 223-0419

DIATHON

PHYSICAL PROPERTIES:

1. VOLUME SOLIDS: 60%
   This high solids by volume of 60% results in 9.5 mils per gallon per 100 sq. ft. of surface. Coverage figures are based on smooth surfaces. Textured surfaces such as urethane foam may require 15% to 30% more material. 20 to 28 dry mils, properly applied, is usually sufficient to protect a polyurethane foam roof.
2. ELONGATION: (ASTM D-2370)
   120% at 0°F.
   200% at 40°F.
   280% at 75°F.
   360% at 100°F.
3. FLEXIBILITY:
   Films aged under simulated 10 year weathering conditions retain their ability to be flexed 180° without cracking. (ASTM D-822)
4. SHORE A HARDNESS:
   45 (ASTM D-2240)
5. DRY PEEL ADHESION:
   20 pli (ASTM D-413)
   Adhesive strength is greater than cohesive strength.
6. HIGH TEMPERATURE STABILITY:
   Resists roof temperature heat and does not age harden or slump at roof temperatures up to 200°F. (ASTM D-794)

PERFORMANCE

WEATHER PROTECTIVE COATING

Provide type of elastomeric coating that when applied to exterior sprayed urethane foam surfaces, will meet following requirements:

a. Will have excellent resistance to all forms of weather between 180°F. to −70°F. and will retain elastomeric properties for a time period equivalent to 15 to 20 years as tested in accord with ASTM D-822.
b. Will prevent absorption of exterior moisture into pores of urethane foam as tested using wind driven rain machine in accord with Fed. Spec. Standard TTC-555-B.
c. Will have excellent resistance to "coastal" salt spray weather as tested in accord with ASTM D-1654.
d. Will allow moisture vapor from building interior to pass through coating and will provide a perm rating of 3.0 at 20 dry mils, as tested in accord with ASTM E-398 or ASTM D-1653.
e. Will not oxidize as tested in accord with ASTM D-822.
f. Will show no appreciable change in color after 1000 hours of testing in accord with ASTM D-822.
g. Will resist roof temperature heat up to 200°F. in accord with ASTM D-794 and will not age harden or slump up to 200°F.
h. Will retain ability to be flexed 180°F. without cracking after simulated 10 year weathering test as tested in accord with ASTM D-822.
i. Will have a dry peel adhesion strength of minimum 20 pli as tested in accord with ASTM D-413.
j. Will have minimum elongation of 120% at 0°F., 200% at 40°F., 280% at 75°F., 360% at 100°F. as tested in accord with ASTM D-2370.
k. Will have minimum Shore A hardness of 45 as tested in accord with ASTM D-2240.
l. Will conform to all local and federal air pollution requirements.
m. Will conform to requirements for a Class A rating on non-combustible substrates as tested in accord with U.L. 790.
n. Will have a flame spread of 20 or less on non-combustible substrates as tested in accord with ASTM E-84.
o. Will prevent degradation of urethane foam substrates due to ultra violet penetration when foam is coated with a continuous film without pinholes or voids as tested in accord with ASTM D-822.

CERTIFICATION

A notarized certification, quart sample, and coated urethane foam sample shall be submitted from the manufacturer ten days prior to bid opening. Certification shall state that properties specified above are met.

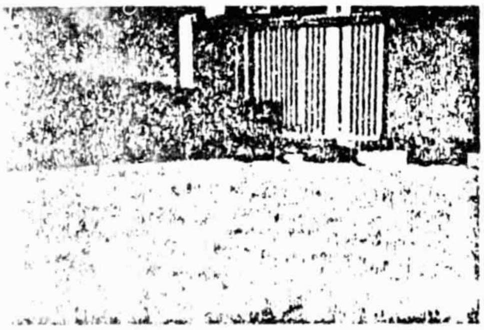
PRODUCT COMPOSITION SPECIFICATION

WEATHER PROTECTIVE COATING

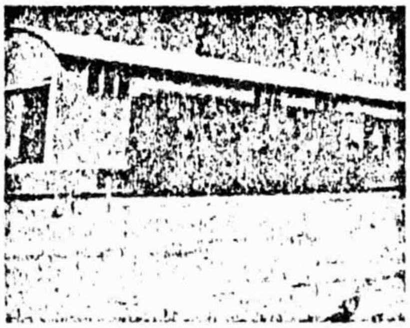
Shall be a high solids elastomer rubber produced by an emulsion polymerization technique combining elastomer acrylic, reinforcing laminar pigments, and non-migrating fire retardants. There shall be no solvents or migratory plasticizers used. Use of non-elastomeric acrylic resins will not be permitted.

Additional Minimum Physical Properties of Coating Shall Be:

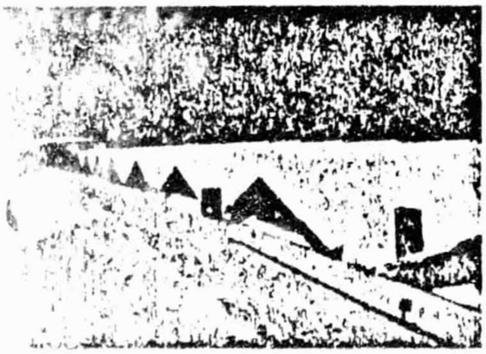
a.	Solids by volume	60%
b.	Dry mils per gallon per 100 sq. ft. of surface	9.5
c.	Weight per gallon	11.6 lbs.



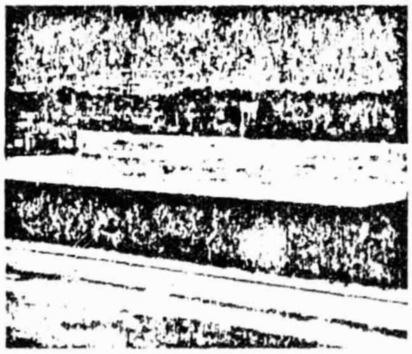
...AS CONVENTION CENTER
Las Vegas, Nev.



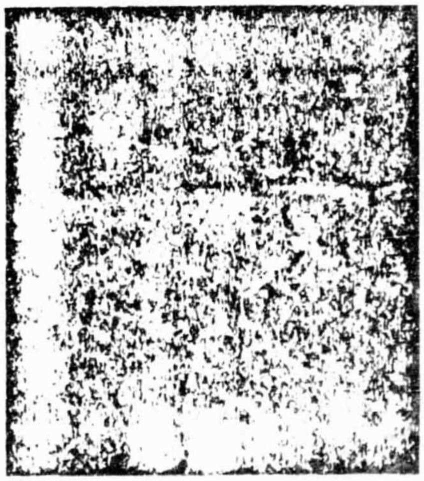
FEDERAL SERVICE CENTER (GSA)
Los Angeles, Calif.



...ERK RESEARCH
...Cruz, Calif.

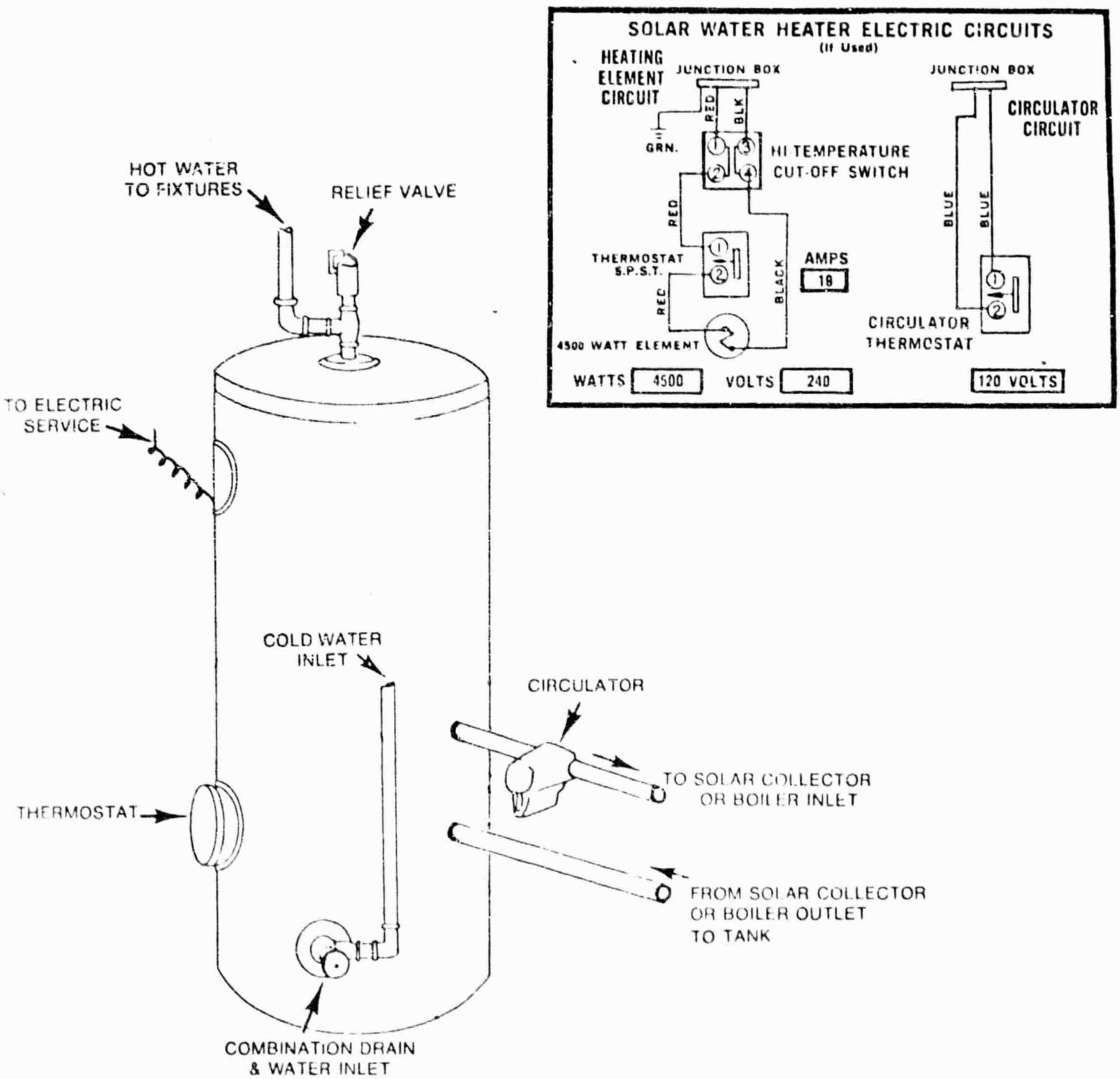


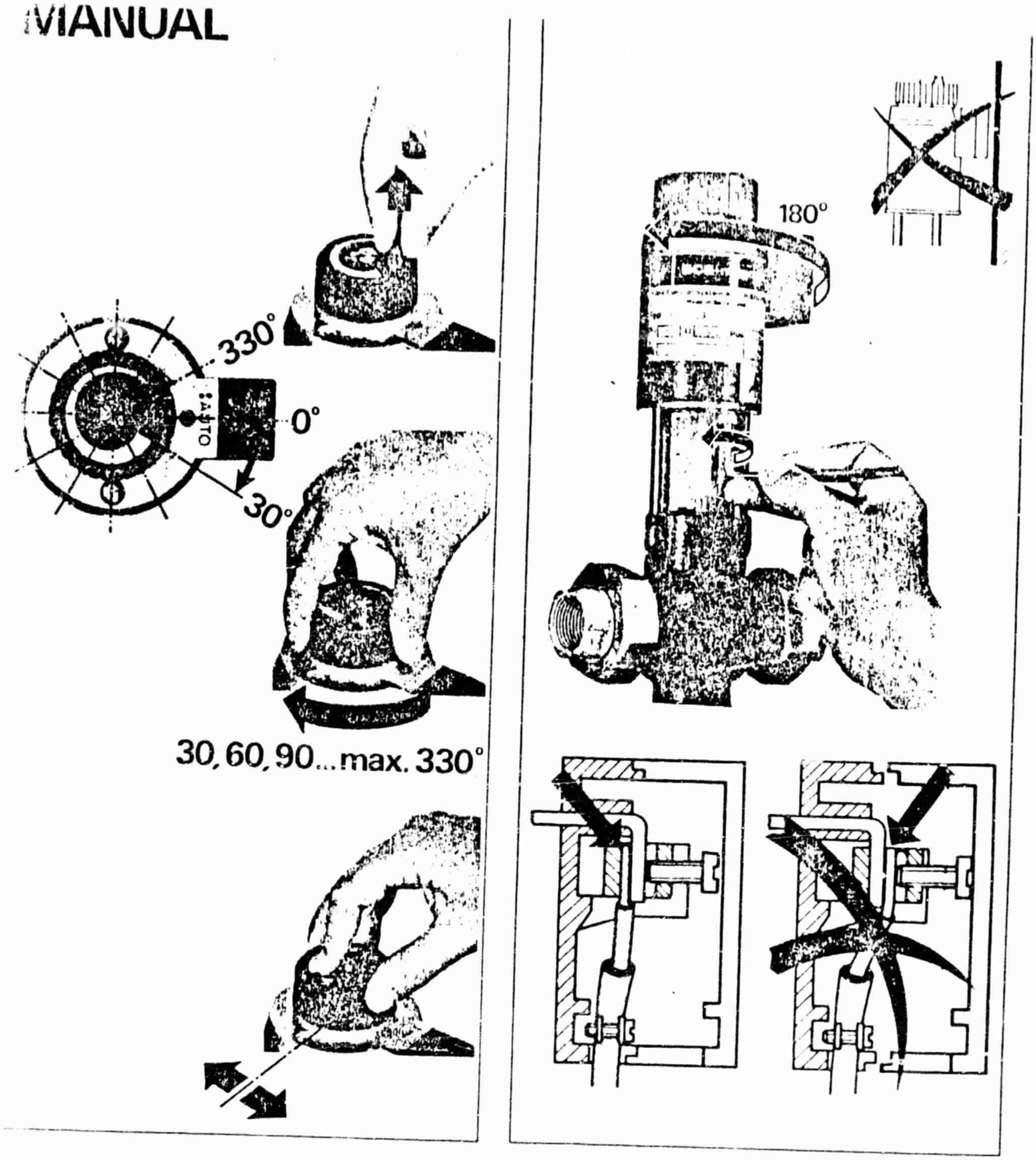
SHOPPING CENTER
Defiance, Ohio



...CMA WINERY
Fresno, Calif.

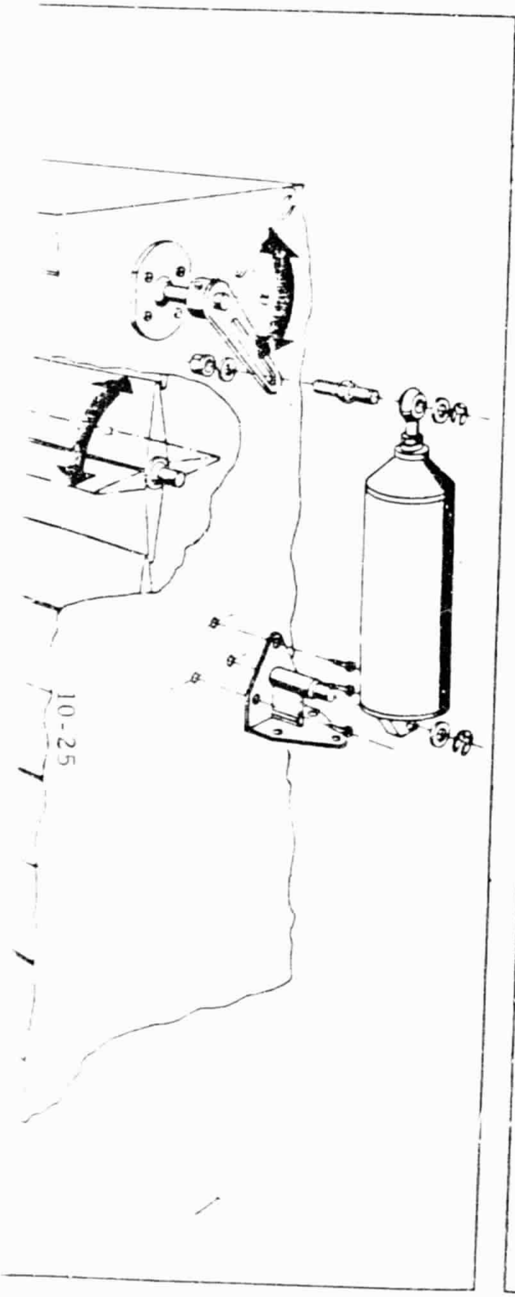
Aqua Coil
Installation Diagram

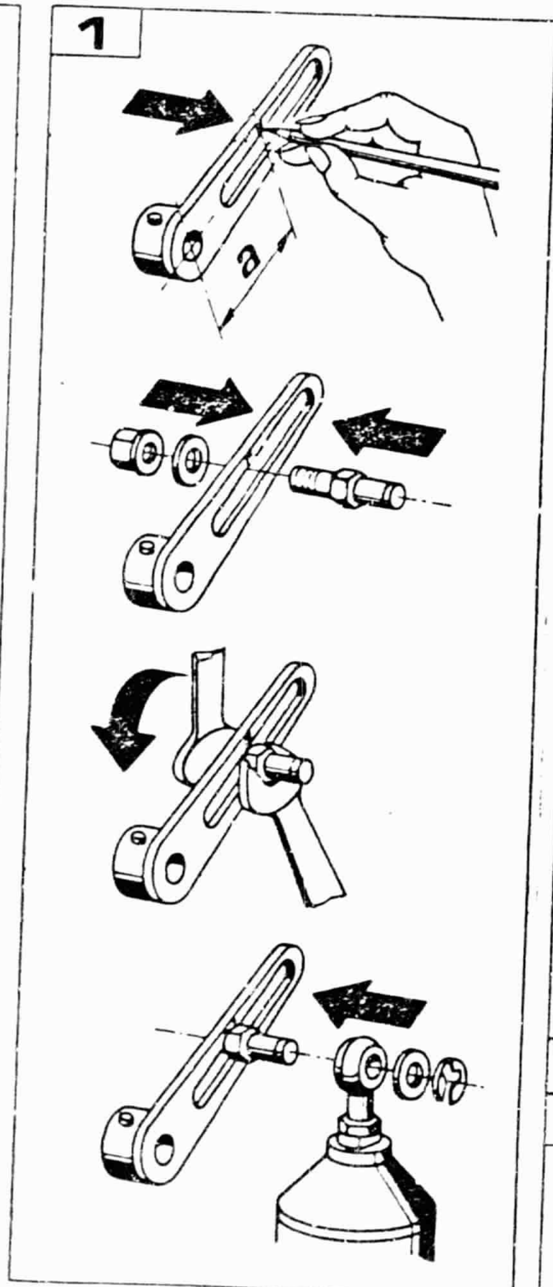


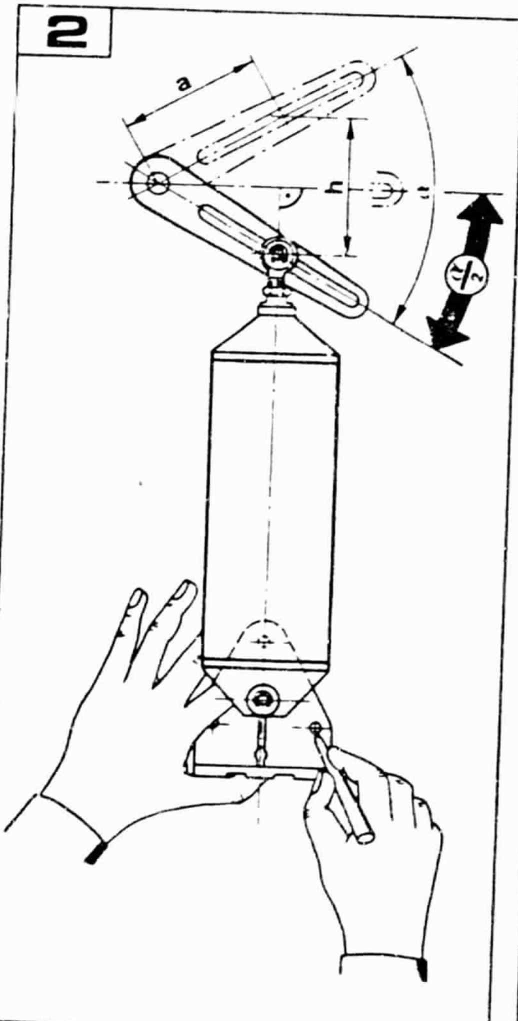


PROCEDURE FOR ADJUSTING A 3-WAY VALVE

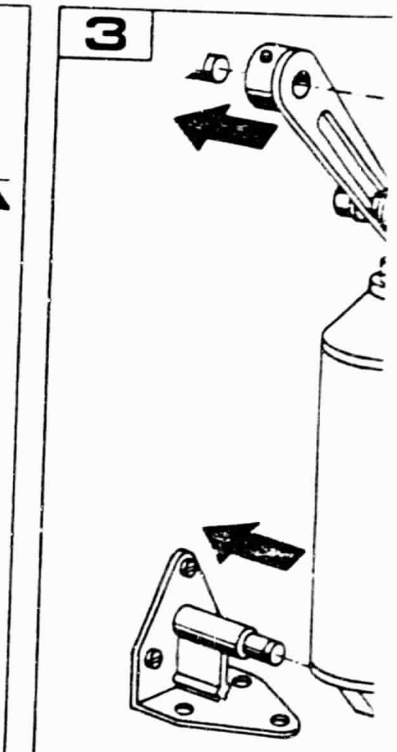
PROCEDURE FOR MOUNTING AND ADJUSTING PNEUMATIC ACTUATORS

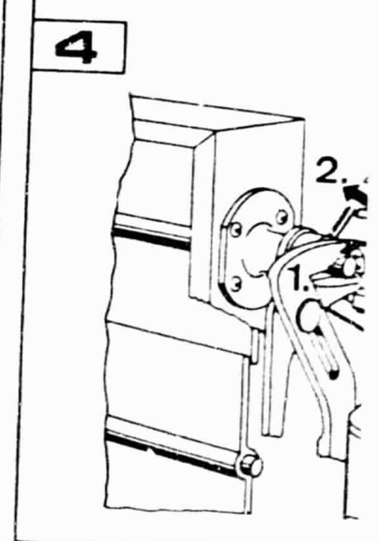






A.H20			A.H30		
α	a (mm)	h (mm)	α	a (mm)	h (mm)
90 80 70 60 45	45 48 54 62 80	60	90 80 70 60 45	72 80 90 102 133	100





SCS-klimo

Three-in-one controller for ventilation and air conditioning

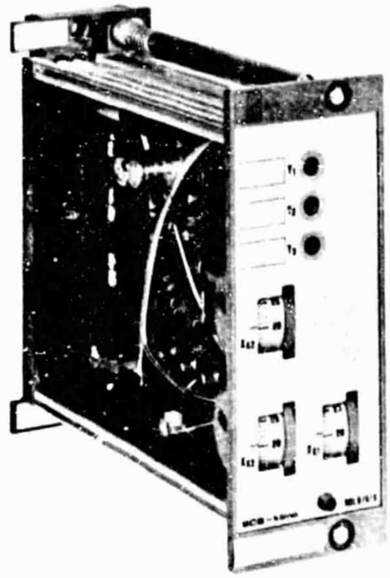
A5/1.8

Application

RDL9/9/9

The SCS-klimo electronic controller, type RDL9/9/9 is used to control temperature and humidity in ventilation and air conditioning systems.
They may be used in conjunction with the following:

- Valves
  - SCS-magnetic
  - SCS-motoric
- Motors
  - SCS-push pull
- Electronic controlled devices
  - step controllers



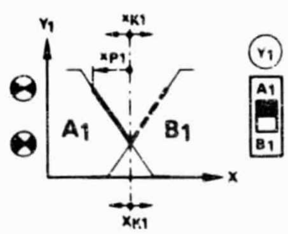
Type code

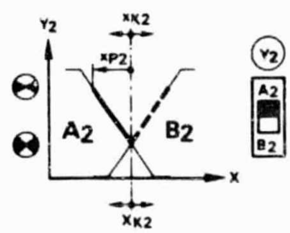
R D L 9 / 9 / 9

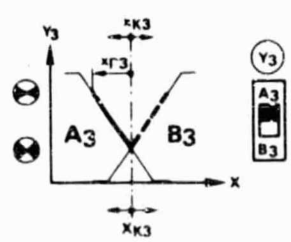
- R — Controller
- D — Application in ventilation and air conditioning
- L — Three-fold controller
- 9 — Proportional output 0...20V DC
- 9 — Proportional output 0...20V DC
- 9 — Proportional output 0...20V DC

Type

RDL9/9/9 — System 1: 1 proportional output
System 2: 1 proportional output
System 3: 1 proportional output







All controller outputs can be adjusted over the full scale range with the relevant X_K potentiometers.

Technical data

Supply voltage	24V $^{+15}_{-10}$ % 50 ... 60 Hz
Output signal	proportional (ref: 9) Y_1, Y_2, Y_3: each 0 ... 20 V DC phase cut indicated by indicator lamp
Output power	max. 40 W at 20 V DC for all outputs added together
Compatible sensors	temperature, humidity and pressure sensors
Measuring ranges	temperature: 0 ... 30 °C humidity: 30 ... 80 % rH
Proportional band x_{P1}, x_{P2}, x_{P3}	adjustable 0.5 ... 9 K 1 ... 18,% rH
Direction of operation	all outputs are reversible
Ambient temperature	0 ... 50 °C

Devices which may be used for supplementary control functions

- WKK2 — reset transmitter for summer or winter compensation for gradual increase in room temperature (for max. of 5 control loops).
- WSK1 — reset transmitter for summer and winter compensation (for max. of 100 control loops)
- WSU1 — universal reset transmitter for more complex reset/interference programmes
- SCS-indicate — indicators for monitoring

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Printed in Switzerland

Adjustments

The setpoints are adjustable externally.

The controller is supplied with temperature scale strips. These have a scale for relative humidity on the back and should therefore be reversed for humidity measurements. For pressure measurements the scale strip should be replaced by the one supplied with pressure sensors.

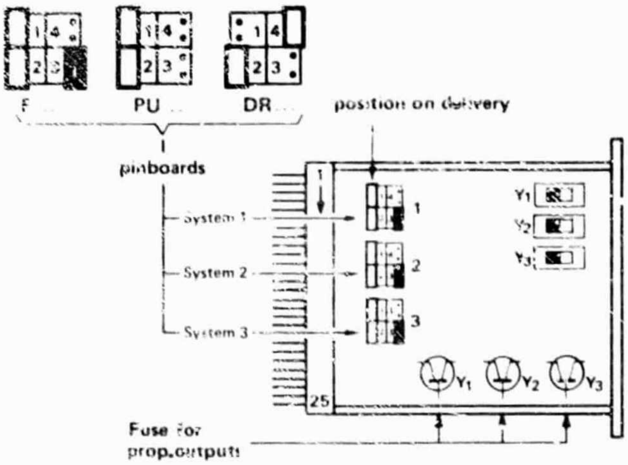
The front plate can be removed by applying light pressure to the red knob ab its lower edge. All the potentiometers are now accessible (proportional band x_{P1}, x_{P2}, x_{P3}, calibration x_{K1}, x_{K2}, x_{K3}). Indicator lamps indicate the operating status, thus facilitating adjustment considerably.

There are operating switches on the printed circuit board, for changing the direction of operation of each individual controller output.

On the printed circuit board there are also 3 pinboard with plug in resistors. Sensor-setpoint combinations are achieved by altering the position of a maximum of three resistors (in order, for example, to render the built-in potentiometer inoperative when a remote setpoint potentiometer is used). The position of the resistors should be altered to suit the type of sensor, setpoint potentiometer or setpoint potentiometer combination in question.

Pinboard

On the printed circuit board in the controller there are three pinboards with plug-in resistors. The position of the resistors is altered to suit the type of sensor used.



Principle of operation

The RDL9/9/9 controller is a self-contained module comprising

- power supply
- 2 measuring loops
- 3 control amplifiers (assigned to the measuring loops)

Integrated circuits amplify the signal from a temperature, humidity or pressure sensor to give a proportional output signal 0 ... 20 V DC (reference 9). This allows direct connection of all controlled devices (e.g. valves), damper motors, step controllers and power controllers. There is a separate indicator lamp for each individual controller output.

Construction

The RDL9/9/9 controller is compact in design and takes up the minimum of space in the front of the control panel while making optimum use of its depth.

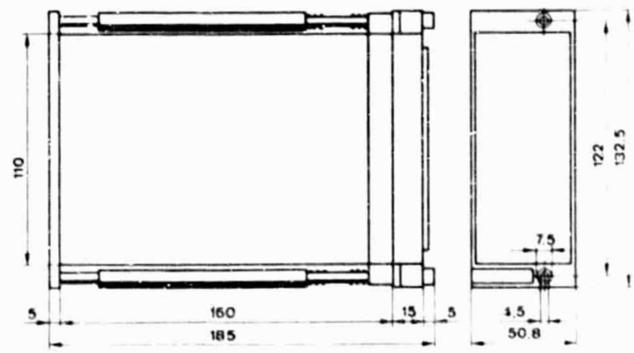
It comprises a baseplate and a plug-in control unit. Keyed sockets and pins on the baseplate and the control unit prevent the wrong equipment from being plugged in by mistake.

Two retaining rods ensure a secure connection between the control unit and the baseplate.

Mounting

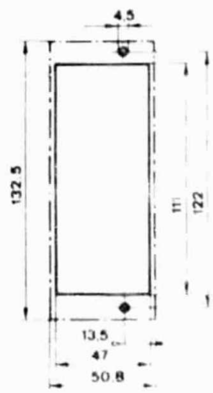
First the baseplate is mounted and connected up. The control unit is then plugged into the baseplate and secured with the retaining rods.

Dimensions [mm]



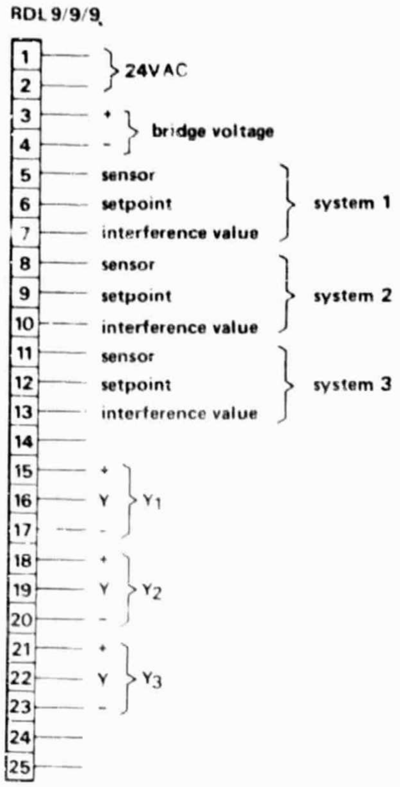
Baseplate
(drilling diagram)

Front panel installation dimensions



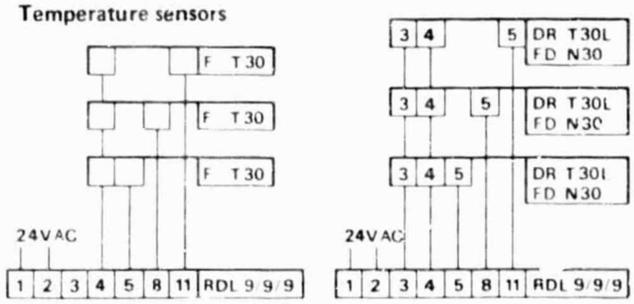
Connection diagrams

Terminal lay-out RD⁽L 9/9/9

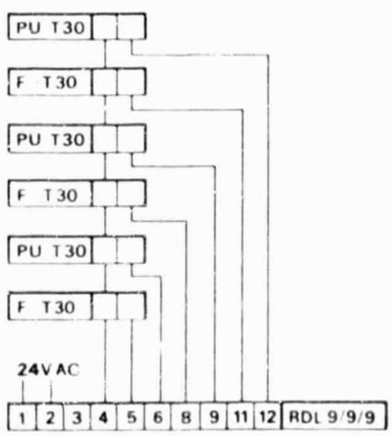


Controller inputs

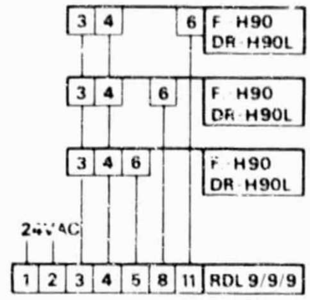
Temperature sensors



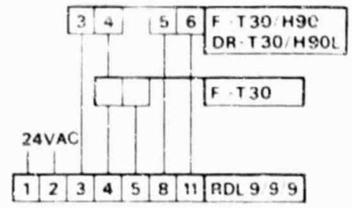
Setpoint potentiometer for temperature



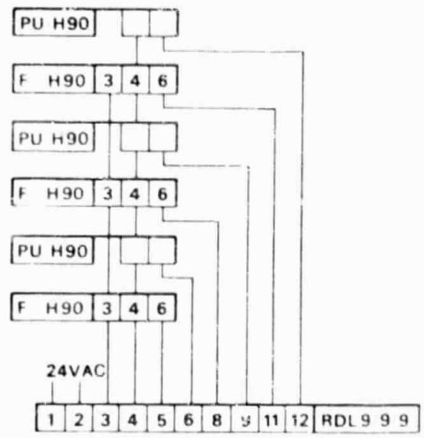
Humidity sensors



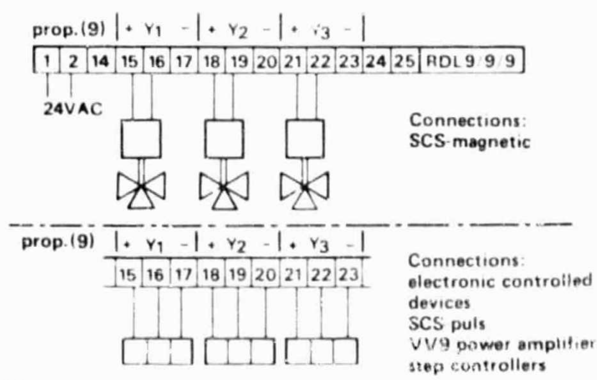
Temperature and humidity sensors



Setpoint potentiometer for humidity



Controller outputs

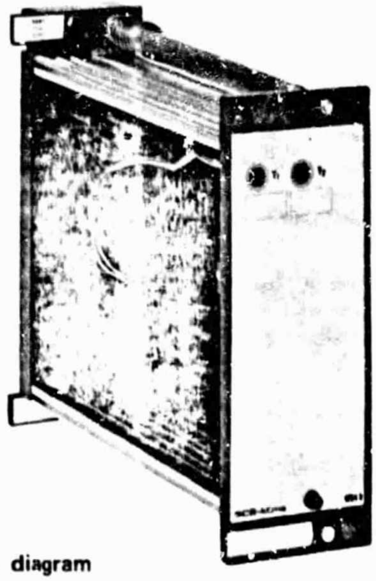


WSA3

Application

The WSA3 averaging controller is used in multizone systems. It forms the average of a maximum of 10 control signals and passes the resultant control signal, which is equivalent to the average energy requirement of the plant, to either output Y_1 (heating) or output Y_2 (cooling).

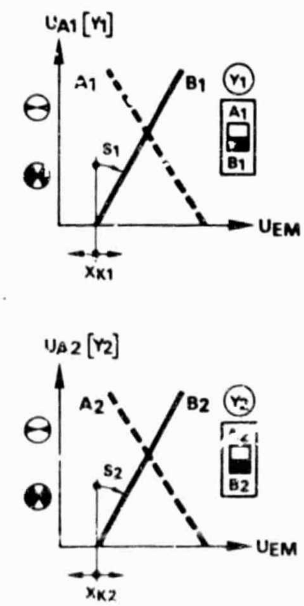
This signal is transmitted to the RDE2 controller which compares the energy available in the outside or return air with the actual demand and selects the optimum sequence of operation.



Technical data

Supply voltage		24V $^{+15}_{-10}$ %, 50 ... 60 Hz
Control voltage		0 ... 20 V DC phase cut
Power consumption		6 VA
Output voltage	Y_1	0 ... 20V DC phase cut
	Y_2	0 ... 20V DC phase cut
Output power	Y_1	40 VA (max. 40 VA)
	Y_2	40 VA (max. 40 VA)
Starting point	X_{K1}	adjustable 0 ... 20V DC
	X_{K2}	adjustable 0 ... 20V DC
Steepness $\left[\frac{\Delta U_{EM}}{\Delta U_A}\right]$	S_1	adjustable 0.15 ... 1
	S_2	adjustable 0.15 ... 1
Direction of operation		reversible
Number of inputs	U_E	max. 10
Ambient temperature t_{amb}		0 ... 50 °C

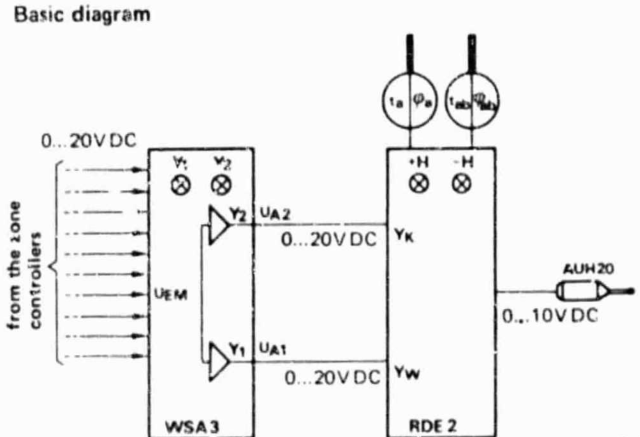
Function diagram



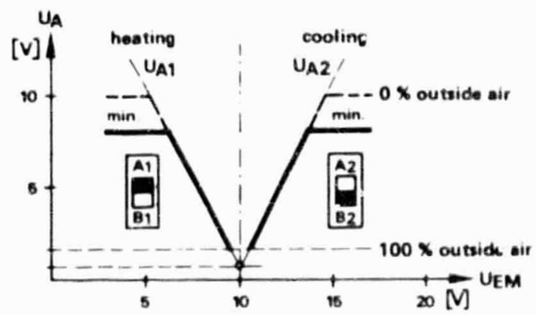
Indication

Two indicator lamps Y_1 and Y_2 on the front of the controller indicate the output voltages U_{A1} and U_{A2} in proportion to their brightness.

Basic diagram



Adjustment example



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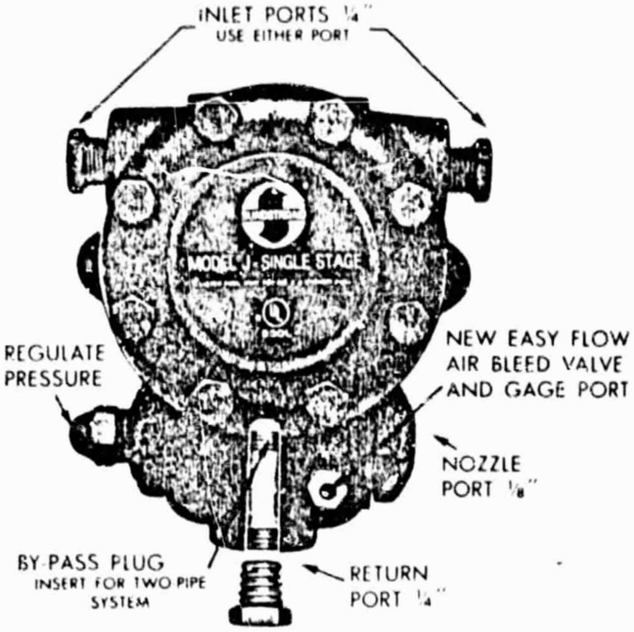
IMPORTANT . . . SUNDSTRAND INSTALLATION INFORMATION

SUNDSTRAND ROTA-ROLL® FUEL UNITS

MODEL J SINGLE STAGE AND MODEL H TWO STAGE



ONE-PIPE SYSTEM (Inlet line only)

Check to see that by-pass plug has not been installed for two-pipe system. Units are set for a one-pipe system. Line length under 50 feet use ⅜" O.D. copper tubing. Line length 50-100 feet use ½" O.D. copper tubing.

TWO-PIPE SYSTEM (Inlet and Return line)

Remove internal by-pass plug from cloth bag. Insert as shown in illustration and tighten securely. Refer to line size information on reverse side.

ALL SYSTEMS — General Information

1. Oil lines should consist of not smaller than ⅜" O.D. copper tubing. See line size and installation data.

2. Oil lines must be absolutely air tight. Check all connections and joints.

3. Return line and inlet pressures must not exceed 10 P.S.I. Higher pressures may cause the seal to leak.

4. The model "J" pump should be used where inlet vacuum does not exceed 10" Hg. The model "H" pump should be used where inlet vacuum does not exceed 20" of Hg at 1725 rpm. The maximum inlet vacuum at 3450 rpm is 15" of Hg.

AIR BLEED PROCEDURE WITH NEW EASY FLOW AIR BLEED VALVE

One-Pipe System

Start burner: Loosen Easy Flow Air Bleed Valve CCW just ¼ turn for fast purging.

For clean bleed in restricted spaces, an easily attached hose can be used to direct bleed oil into a container. A 3/16" I.D. hose can be slipped directly over end of valve.

Optional Procedure: On gravity feed systems, before starting burner, loosen unused intake port plug until there is a flow of oil from the port.

Two-Pipe Systems

Air bleeding is automatic. Opening Easy Flow Air Bleed Valve will allow oil to be pulled up faster.

MOUNTING POSITION

Model "J" may be mounted in any position.

Note: Direction of rotation and nozzle port location determined from shaft end with valve at bottom.

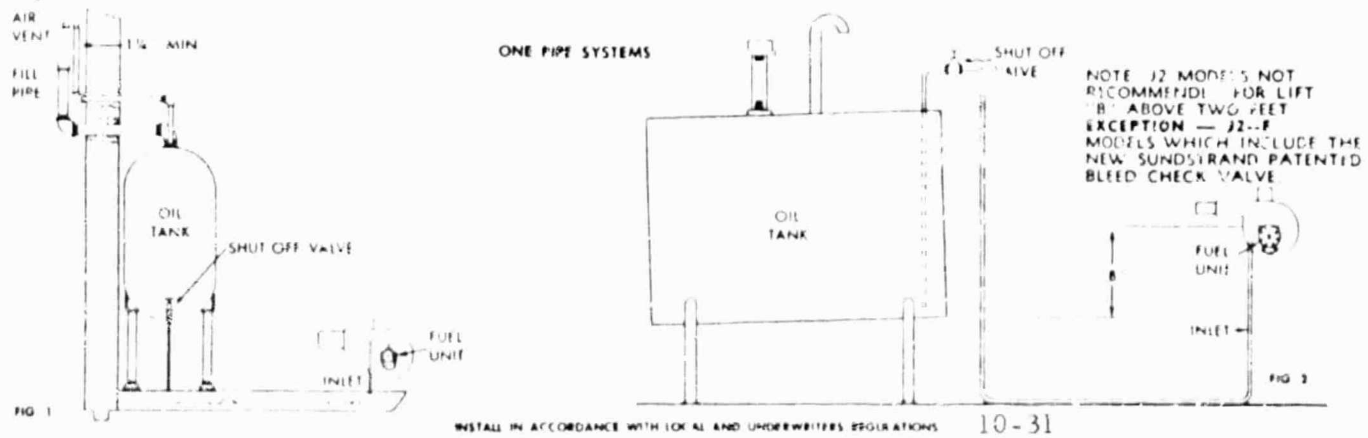
Current Model "H" with arrows on cover may be mounted with the valve horizontal at either top or bottom.

Valve may be mounted vertical providing the adjusting screw is at the top on CW rotation-left nozzle and CCW rotation-right nozzle models, or adjusting screw at bottom on CW rotation-right nozzle and CCW rotation-left nozzle models.

Earlier "H" models having a designation ending in -1 -2 and -3 were only intended for mounting with valve underneath.

ADDITIONAL INSTALLATION INFORMATION

Model E and F for HEAVY OIL	Form No. 1011
Piping of fuel lines for oil fired WATER HEATER	Form No. 1..5
Sundstrand Boost Pump — SIMPLIFIED CIRCUIT	Form No. 450012
Sundstrand QUICK PURGE VALVE	Form No. 450015
Hum Eliminator for RETURN LINE	Form No. 450021



INSTALL IN ACCORDANCE WITH LOCAL AND UNDERWRITERS REGULATIONS

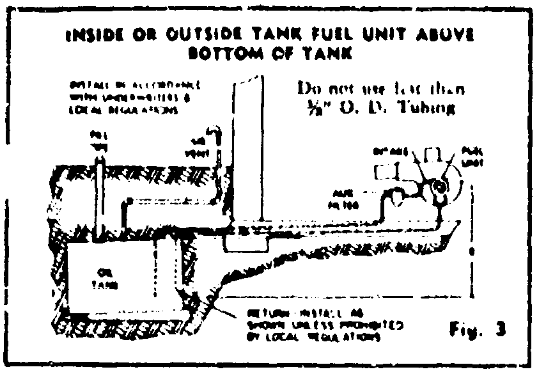


Fig. 3

TWO PIPE INSTALLATION

MAXIMUM ALLOWABLE LENGTH OF TOTAL INTAKE OR RETURN LINE IN FEET. (CALCULATED FOR FUEL OIL, VISCOSITY 57SSU)

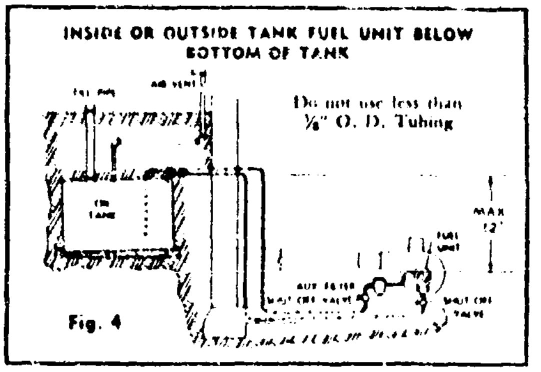


Fig. 4

LIFT CONDITION (FIG. 3)

Lift "B" Fig 3	5/8" O D Tubing (1725 RPM)										1/2" O D Tubing (1725 RPM)											
	J_2	J_3	J_4	J_5	J_6	H_2	H_3	H_4	H_5	H_6	J_2	J_3	J_4	J_5	J_6	H_2	H_3	H_4	H_5	H_6	H_7	H_8
0'	65'	65'	53'	42'	31'	75'	77'	75'	63'	55'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	73'
1'	60'	60'	49'	38'	29'	72'	74'	72'	61'	53'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	71'
2'	55'	55'	45'	35'	27'	69'	71'	70'	58'	51'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	68'
3'	50'	50'	41'	32'	24'	67'	69'	67'	56'	49'	100'	100'	100'	100'	96'	100'	100'	100'	100'	100'	100'	65'
4'	45'	45'	37'	29'	22'	64'	66'	64'	53'	47'	100'	100'	100'	100'	87'	100'	100'	100'	100'	100'	100'	63'
5'	40'	40'	33'	26'	20'	61'	63'	61'	51'	45'	100'	100'	100'	100'	78'	100'	100'	100'	100'	100'	96'	60'
6'	36'	36'	29'	23'	17'	58'	60'	58'	49'	43'	100'	100'	100'	90'	68'	100'	100'	100'	100'	100'	92'	57'
7'	31'	31'	25'	20'	15'	55'	57'	55'	46'	41'	100'	100'	99'	78'	59'	100'	100'	100'	100'	100'	87'	54'
8'	26'	26'	21'	17'	13'	52'	54'	53'	44'	39'	100'	100'	83'	66'	50'	100'	100'	100'	100'	100'	83'	51'
9'	21'	21'	17'	14'		50'	51'	50'	42'	37'	83'	83'	68'	55'	49'	100'	100'	100'	100'	100'	79'	49'
10'	16'	16'	13'			47'	48'	47'	39'	35'	64'	64'	52'	41'	31'	100'	100'	100'	100'	100'	74'	46'
11'						44'	45'	44'	37'	33'						100'	100'	100'	100'	100'	70'	43'
12'						41'	42'	41'	35'	31'						100'	100'	100'	100'	100'	65'	40'
13'						38'	39'	38'	32'	28'						100'	100'	100'	100'	100'	61'	37'
14'						35'	37'	36'	30'	26'						100'	100'	100'	100'	99'	56'	35'
15'						33'	34'	33'	28'	24'						100'	100'	100'	100'	91'	52'	32'

Lift "B" Fig 3	1/2" O D Tubing (3450 RPM)															
	JJ_2	JA_2	JB_2	J	J_3	J_4	J_5	J_6	HH_2	HA_2	HB_2	H_2	H_3	H_4	H_5	H_6
0'	100'	100'	100'	100'	100'	99'	77'	59'	100'	100'	100'	100'	100'	94'	81'	69'
1'	100'	100'	100'	100'	100'	91'	72'	55'	93'	93'	93'	93'	93'	89'	77'	65'
2'	100'	100'	100'	100'	100'	84'	66'	50'	88'	88'	88'	88'	88'	85'	73'	62'
3'	93'	93'	93'	93'	93'	77'	60'	46'	83'	83'	83'	83'	83'	80'	69'	58'
4'	84'	84'	84'	84'	84'	69'	54'	41'	78'	78'	78'	78'	78'	75'	64'	55'
5'	75'	75'	75'	75'	75'	62'	48'	37'	73'	73'	73'	73'	73'	70'	60'	51'
6'	66'	66'	66'	66'	66'	54'	42'	32'	69'	69'	69'	69'	69'	66'	56'	48'
7'	57'	57'	57'	57'	57'	47'	37'	28'	64'	64'	64'	64'	64'	61'	52'	44'
8'	48'	48'	48'	48'	48'	40'	31'	24'	59'	59'	59'	59'	59'	56'	48'	41'
9'	39'	39'	39'	39'	39'	32'	25'	19'	54'	54'	54'	54'	54'	52'	44'	38'
10'	30'	30'	30'	30'	30'	25'	19'	15'	49'	49'	49'	49'	49'	47'	40'	34'
11'								—	44'	44'	44'	44'	44'	42'	36'	31'
12'									39'	39'	39'	39'	39'	37'	32'	27'
13'									34'	34'	34'	34'	34'	33'	28'	24'
14'									29'	29'	29'	29'	29'	28'	24'	20'
15'									24'	24'	24'	24'	24'	23'	20'	17'

LIFT CONDITION (FIG. 3)

Lift "B" Fig 3	5/8" O D Tubing (3450 RPM)															
	JJ_2	JA_2	JB_2	J_2	J_3	J_4	J_5	J_6	HH_2	HA_2	HB_2	H_2	H_3	H_4	H_5	H_6
0'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'
1'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'
[illegible]	100'	100'	100'	100'	100'	100'	100'	100'	90'	100'	100'	100'	100'	100'	100'	100'
[illegible]	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'
4'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'
5'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'	100'
6'	100'	100'	100'	100'	100'	100'	100'	90'	100'	100'	100'	100'	100'	100'	100'	100'
7'	100'	100'	100'	100'	100'	100'	100'	78'	100'	100'	100'	100'	100'	100'	100'	100'
8'	100'	100'	100'	100'	100'	100'	85'	65'	100'	100'	100'	100'	100'	100'	100'	100'
9'	100'	100'	100'	100'	100'	90'	69'	53'	100'	100'	100'	100'	100'	100'	100'	100'
10'	83'	83'	83'	83'	83'	69'	53'	41'	100'	100'	100'	100'	100'	100'	100'	95'
11'	—	—							100'	100'	100'	100'	100'	100'	100'	86'
12'	—	—							100'	100'	100'	100'	100'	100'	90'	76'
13'									95'	95'	95'	95'	95'	91'	78'	67'
14'									82'	82'	82'	82'	82'	78'	67'	57'
15'									68'	68'	68'	68'	68'	65'	56'	48'

GRAVITY CONDITION (FIG. 4)

Distance "C" Fig 4	5/8" O D Tubing (1725 RPM)											
	J_2	J_3	J_4	J_5	J_6	H_2	H_3	H_4	H_5	H_6	H_7	H_8
0'	64'	64'	53'	41'	31'	75'	75'	70'	60'	51'	30'	20'
1'	69'	69'	[illegible]	45'	34'	78'	78'	72'	62'	52'	31'	21'
2'	74'	74'	61'	48'	36'	80'	80'	75'	64'	54'	32'	22'

Distance "C" Fig 4	5/8" O D Tubing (3450 RPM)															
	JJ_2	JA_2	JB_2	J_2	J_3	J_4	J_5	J_6	HH_2	HA_2	HB_2	H_2	H_3	H_4	H_5	H_6
0'	31'	31'	31'	31'	31'	25'	19'	15'	25'	25'	25'	25'	25'	23'	20'	17'
1'	33'	33'	33'	33'	33'	27'	21'	16'	26'	26'	26'	26'	26'	25'	22'	18'
2'	35'	35'	35'	35'	35'	29'	23'	17'	27'	28'	28'	28'	29'	26'	23'	19'

Distance "C" Fig 4	1/2" O D Tubing (3450 RPM)															
	JJ_2	JA_2	JB_2	J_2	J_3	J_4	J_5	J_6	HH_2	HA_2	HB_2	H_2	H_3	H_4	H_5	H_6
0'	100'	100'	100'	100'	100'	99'	77'	59'	100'	100'	100'	100'	100'	94'	81'	69'
1'	100'	100'	100'	100'	100'	100'	83'	63'	100'	100'	100'	100'	100'	99'	85'	72'
2'	100'	100'	100'	100'	100'	100'	89'	68'	100'	100'	100'	100'	100'	100'	89'	76'

J PUMP

Model	Max. Nozzle Capacity (GPH) At Rated Pressure 1725 RPM	3450 RPM	Rated Pressure (PSI)
JA2B	0	7	100
JA2P	0	7	100
JB2B	0	10	100
JJ2B	0	3	100
J2B	3	16	100
J2P	3	16	100
J3B	7	20	100
	0	14	200
	0	15	300
[illegible]	10	40	100
J5B D	20	55	80
J5B	16	40	100
J5P	16	40	100
J5P B	0	15	200
J6B B	15	50	200
J6B A	30	[illegible]	40
J6B D	25	55	80
J6B	20	55	100
J6B C	7	40	300
J6K	20	55	100

PUMP USAGE IDENTIFICATION

EXAMPLE

J3 B 2 C 100

- MOUNTING
- PRESS RATING (NO LETTER - 100PSI)
- ROTATION
- STRAINER TYPE
- MODEL

Strainer Type	UL Strainer Rating (GPH) ★ #1 Fuel Oil	#2 Fuel Oil	#4 Fuel Oil
B	18	7	
P	20	16	16
K	80+	80+	30

H PUMP

Model	Max. Nozzle Capacity (GPH) At Rated Pressure 1725 RPM	3450 RPM	Rated Pressure (PSI)
HH2B	0	3	100
HA2B	0	7	100
HA2P	0	7	100
HB2P	0	10	100
HH2B	0	3	100
H2B	3	16	100
H2P	3	16	100
H3B B	0	14	200
H3B	7	25	100
H3B C	0	7	300
H3P	7	20	100
H3P	7	20	100
H3P B	0	14	200
[illegible] C	0	14	300
H3P C	0	16	300
H3K N C	0	22	300
[illegible]	10	30	100
[illegible] N C	[illegible]	20	400
[illegible]	16	40	100
[illegible] N C	5	40	400
[illegible]	16	40	100
[illegible]	30	62	200
[illegible] C	7	40	300
[illegible]	20	55	100
[illegible] C	7	40	300
[illegible] B	30	80	200
[illegible]	[illegible]	No	100
[illegible]	80	No	100

★ Max. Firing Rate Not to Exceed Max. Nozzle Capacity or Strainer Rating, Whichever is Less. A Greater Firing Rate Requires a Suitable External Strainer

C-2

INSTRUCTIONS FOR INSTALLING

FIELD TYPE M + MG2 BAROMETRIC DRAFT CONTROLS

This is a dual purpose control.

Single Acting Control — The control is designated as Type M when the stop and two cover plates are in place. This control is for use with oil or solid fuels. **Double Acting Control** — The control is designated Type MG2 when the stop and two cover plates are removed. The control is then for use with gas.

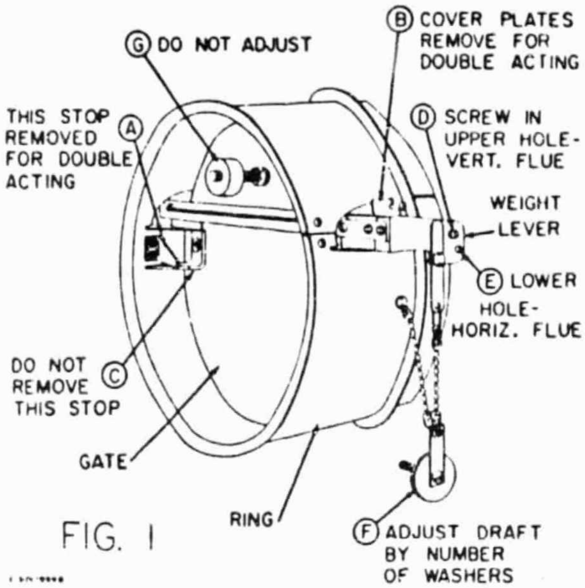


FIG. 1

The stop and two cover plates are painted a different color for easy identification. To remove the stop simply remove the two screws that hold it to the ring (Fig. 1 A). To remove the cover plates, (Fig. 1 B) bend or break off the tab that goes through the small hole in the ring. DO NOT REMOVE THE STOP ATTACHED TO THE GATE (Fig. 1 C).

Installation and Adjustment — See sections on control locations and collar installation.
Insert the draft control into the collar. The front face of the control MUST BE PLUMB. The bearing surfaces MUST BE LEVEL whether the control is on a horizontal, vertical or sloping flue pipe. Use a spirit level, plumb and level accurately. Secure the control in the collar by tightening the clamping screws. If the collar is supplied locally, the control may be held in place by small bolts or sheet metal screws. If the control has any tendency to sag, support it from the ceiling by wire or by strapping.

Vertical Flues - The control is shipped for installation in a vertical flue. The screw should be left in the top hole of the weight lever (Fig. 1 D).

Horizontal Flues — For horizontal flues, remove the screw from the upper hole in the weight lever and insert it in the lower hole. (Fig. 1 E).

Adjusting the Control — The control must be adjusted to the desired draft setting by adding or removing the washer-type weights supported by the two chains (Fig. 1 F). DO NOT MOVE THE LARGE WEIGHTS ATTACHED DIRECTLY TO THE GATE (Fig. 1 G) as they are used only for adjustment at the factory.

Control Locations

For gas fired equipment, the preferred installation is in a bull-head tee (see fig. A, B, C). Fig. D thru J show acceptable locations if it is not feasible to locate the control as per Fig. A, B, C.

Fig. D thru J are the best locations for oil or solid fuel.

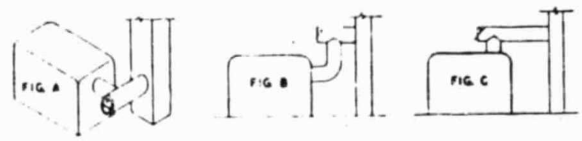
Locate the control as close as possible to the appliance but at least 12" toward the chimney beyond a stack switch. It must also be located at least 18" from a combustible ceiling or wall.

Do not install in a room separated from the appliance.

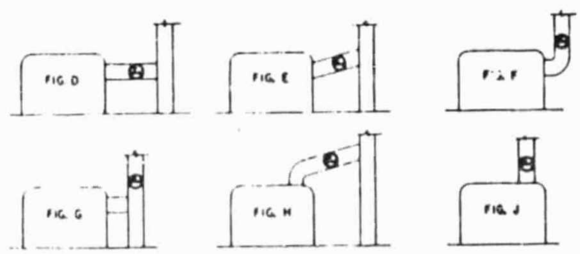
Avoid installations in a chimney below where the flue enters unless no other space is available.

When this control is used on a gas-fired unit, consult your local gas company and/or city inspectors to obtain necessary approval before making the installation. Inspect the heating plant and building for conditions which might cause PROLONGED down drafts and have these conditions corrected. A chimney with its top lower than other parts of the roof or too close to a higher building may cause prolonged downdrafts. An exhaust fan of sufficient size and location may pull air down the chimney.

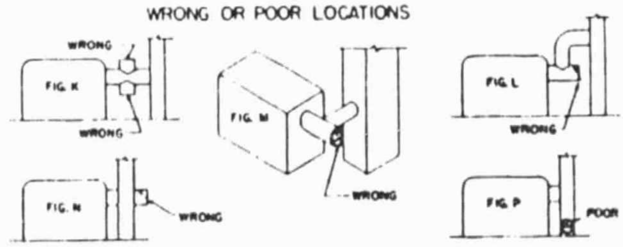
BEST LOCATIONS FOR GAS



BEST LOCATIONS FOR OIL OR SOLID FUELS



WRONG OR POOR LOCATIONS



What Draft Setting to Use

The regulator should be set to maintain as low a draft as will give good combustion. If the desired over-fire draft, taken through a small hole in the combustion chamber, is not known, smoke readings, CO_2 and flue-gas temperature should be taken to determine if the draft setting is correct on oil equipment. CO_2 readings and a check to see that no CO is present are essential on gas fired equipment.

Gas -- The usual practice with commercial and industrial gas fired plants is to adjust for CO_2 readings between 9% and 10%, or even higher, but this will depend upon the analysis of the gas and the type of burner equipment. Consult with the burner manufacturer.

Oil — Forced or induced draft burners can operate with low over-fire drafts. With a burner that depends entirely upon natural draft, the draft in the breeching may need to be quite high (.20" to .50") to obtain proper over fire conditions. It is essential that CO_2 readings be taken to determine the proper adjustment.

Coal — With a stoker, the fuel must be of normal thickness, and the stoker running, with its fan adjusted to approximately the correct setting. Drafts over the fire of .08" to .10" (or more) usually are sufficient. Have just enough draft so that no appreciable amount of gas puffs back into the room through cracks around the fire door at the time that the stoker starts. If there is objectionable smoke, increase drafts slightly. (Consult the stoker manufacturer for proper fuel bed and fan adjustment.)

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Conco 4028

FORM NO. A-31DC19770

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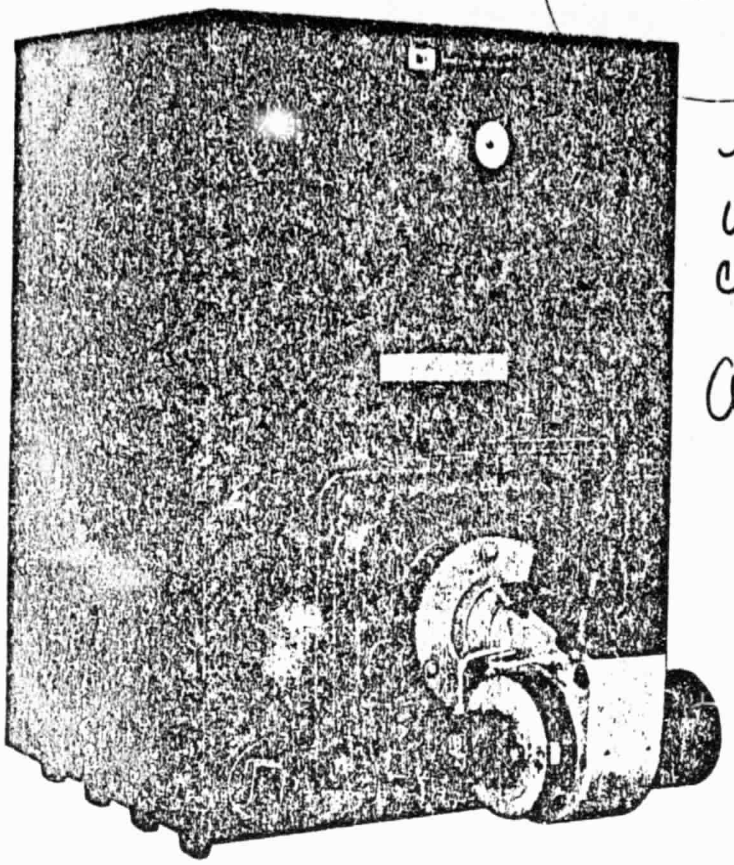
Conco 4028

FORM NO. A-31DC18770

WEIL-McLAIN

Buy fuel oil anti-siphon valve



low water cutoff

Alt

NO. 76

OIL-FIRED BOILER-BURNER UNIT AND OIL-FIRED BOILER FOR APPROVED BURNERS

NET LOAD RANGE
HOT WATER:
229,600 to
542,600 BTU/Hr
STEAM:
825 to
2,550 sq. ft.

I B R

[illegible]
The Hydronics Institute

H

Built in accordance
with the requirements
of the ASME Boiler and
Pressure Vessel Code

AMERICA'S MOST COMPLETE LINE OF CAST IRON BOILERS
RESIDENTIAL . . . COMMERCIAL . . . INDUSTRIAL . . . INSTITUTIONAL

WEIL-McLAIN

Buy fuel oil anti-siphon valve

low water cuttoff

Alt

ORIGINAL PAGE IS OF POOR QUALITY

No. 76

OIL-FIRED BOILER-BURNER UNIT AND OIL-FIRED BOILER FOR APPROVED BURNERS

NET LOAD RANGE
HOT WATER
229,600 to
512,680 BTU/H
STEAM
[illegible]

Built in accordance with the requirements of the ASME Boiler and Pressure Vessel Code

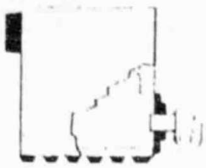
AMERICA'S MOST COMPLETE LINE OF CAST IRON BOILERS
RESIDENTIAL . . . COMMERCIAL . . . INDUSTRIAL . . . INSTITUTIONAL

NO. **76** BOILER AND BOILER-BURNER UNIT

MICHIGAN CITY INDIANA

The Weil-McLain No. 76 is available as a boiler burner unit with flame retention burner (BL Unit) or as a boiler only (H Unit) for use with light oil burners approved by the Weil-McLain Engineering Department. H-76 ratings are approved by I-B-R when fired with one of the following flame retention burners.

BURNER	MODEL	BOILER
Wayne	FR	476
	FH	376-976
AHC	93C	476-576
	93C-[illegible]	676-976
Carlin	101CRD	476
	200CRD	576-676
	201CRD	776-976



"BL" UNIT

Boiler-Burner Unit furnished with flame retention burner.

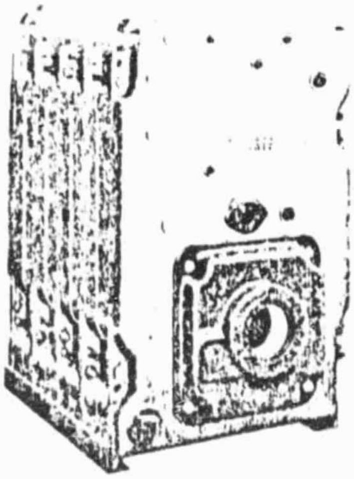
"H" UNIT

Boiler only with mounting plate for approved burners.

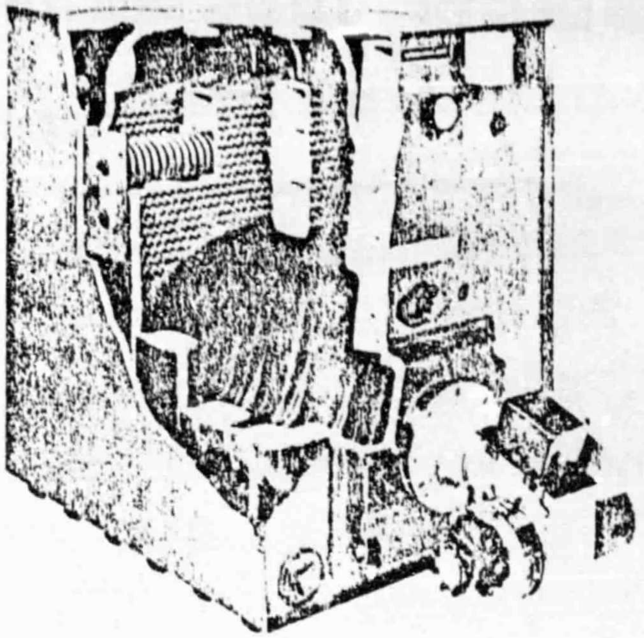
FACTORY-ASSEMBLED NO. 76

In addition to individual sections, the No. 76 Boiler is also available with sections, burner mounting plate and flue collar factory assembled. Individual sections as well as the assembled block are hydrostatically tested before shipment.

Lifting hooks are cast on the sides of the front and back sections so the assembled boiler can be lifted by crane or hoist. Steel skids on the bottom of the boiler permit moving the unit with pipe rollers.



NO. 76 DESIGN FEATURES



Hydro-Wall design with water circulating completely around the combustion area . . . no refractory combustion chamber, no separate base.

Cast iron sections for corrosion resistance and extra long life . . . sealed with asbestos rope.

Available in individual sections or with factory-assembled sections.

Patented section sealing method assures a watertight seal . . . reduces installation time.

Short draw rods for faster assembly and a strain-free boiler.

Built-in air eliminator in water boilers . . . air is diverted to the expansion tank through a 1-inch tapping located next to the supply outlet.

Multiple tankless heaters. Up to four heaters can be installed on the left side of the largest No. 76 Boiler.

Built-in horizontal flueway eliminates the need for a separate sheet metal collector hood.

Steel jacket finished in attractive blue hammerloid . . . completely insulated . . . designed for fast installation.

Designed for easy cleaning through top cleanout openings.

FLAME RETENTION BURNER

The BL-76 Boiler Burner Unit is furnished with a Wayne flame retention burner which thoroughly mixes the oil with the combustion air to achieve complete combustion and maximum efficiency. Standard equipment includes a factory-installed and wired protectorelay with cadmium sulfide flame detector.

The burner mounting plate, with refractory which fits around the burner blast tube, is bolted to the front section. The burner is positioned on the plate with three studs. An observation port above the plate permits close study of the flame.

GENERAL INSTRUCTIONS

If the boiler was ordered as completely packaged, thoroughly check the boiler for any concealed damage. If the boiler was ordered as factory assembled or field assembled, open all boxes and check the contents against the packing lists. In the event of shortage or damage, notify the transportation company immediately. As you face the front of the boiler, the side of the boiler to your right will be referred to in these instructions as the Right Hand Side (RH); the side of the boiler to your left will be referred to as the Left Hand Side (LH). **Boiler(s) must be installed in accordance with these instructions so as not to void our warranty.**

AIR SUPPLY FOR BOILER ROOM

Provisions must be made to supply sufficient air to the boiler room at all times for combustion, for ventilation, for operation of the barometric draft regulator (where used), and to prevent less-than-atmospheric air pressure in the boiler room. An opening to the outside with a free cross sectional area of at least 20 square inches for each gallon per hour burner firing rate is recommended (CSA requires 1 sq. in. per 5000 BTUH input). For each 1,000 feet above sea level, increase the fresh air opening by 4 per cent. The boiler room should be isolated from any area served by exhaust fans. **DO NOT INSTALL AN EXHAUST FAN IN THE BOILER ROOM.**

CHIMNEY
(also refer to Breeching Erection)

The No. 76 boiler is designed for natural draft firing. The chimney must be at least of the equivalent diameter indicated on the last page of these instructions under **RATING-DATA-DIMENSIONS.** On multiple boiler instalations using one chimney, consult Weil-McLain Customer Services Department for additional venting information.

BOILER FOUNDATION

A boiler foundation is recommended where the boiler room floor is not level or where the boiler room floor can not support the weight of the boiler. Locate the boiler foundation to provide proper clearances around the boiler for installation of the piping, burner, and internal water heater(s); allow a minimum clearance of 22" from the back of the foundation for breeching erection. Allow 18" clearance to the left side for internal heaters if used. A level concrete pad or curb foundation is suggested of the size shown in the chart and Figure 1.

BOILER FOUNDATION SIZES			
BOILER NO.	L	BOILER NO.	L
476	24"	776	42"
576	30"	876	48"
676	36"	976	54"

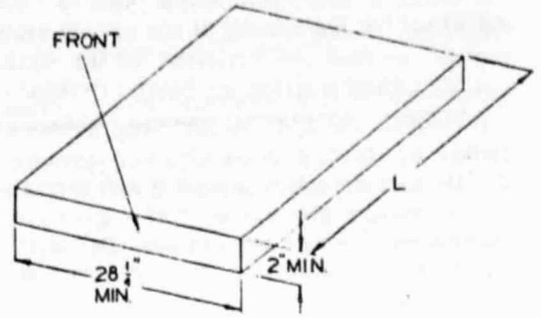


FIGURE 1

If the boiler was ordered as completely packaged or with the sections factory assembled, locate the unit on the boiler foundation or on the boiler room floor according to the separate instructions furnished and Figure 1. After the boiler has been positioned in the selected location, proceed to "Hydrostatic Pressure Test of Boiler".

ASBESTOS ROPE

Listed in the Asbestos Rope Usage Table are the places asbestos rope must be used and the diameter and length of each piece. Asbestos rope must be used where indicated. For expediency, the asbestos rope can be pre-cut prior to starting the section assembly.

ASBESTOS ROPE USAGE TABLE		
*NOMINAL DIAMETER OF ASBESTOS ROPE	CUT LENGTHS	ROPE USAGE AND LOCATION
3/8" Stranded	26" 98" 42" 58"	Cleanout Plates Perimeter of each Section Drafthood Collar Burner Mounting Plate
1/4"	12"	Observation Port Frames (Front and Back)

*Approximate diameter of uncompressed 1/4" nominal diameter rope is 5/16", 3/8" stranded rope is 7/16".

SECTION ASSEMBLY

1. Prepare the back section for erecting the boiler.
   a. Lay back section on floor with ports facing up. Apply water-glass, as an adhesive, to the target wall area (i.e., back end of firebox) of the section. Press flexible refractory blanket into position.
   b. Screw a piece of 3" diameter pipe, at least 22" long, into the 3" return tapping in the back section.
   c. Locate the back section on the boiler foundation shown in Figure 1. Block under the 3" pipe to hold the back section up right without additional support. These sections are top-heavy and will not stand individually without support. Make sure that the section remains in plumb. The 3" pipe can be removed after several sections have been erected.

2. Make a small continuous bead of "Asbestos Rope Adhesive" in the bottom of the curved sealing grooves located around the perimeter of the section. Smooth out the adhesive using the brush provided.

3. Position the 3/8" by 98" long asbestos rope on the section by starting at the cleanout opening (See Figure 2). Be sure the asbestos rope is well seated at all points in the sealing grooves so that a gas-tight seal will be maintained between the sections. **DO NOT APPLY** adhesive to the opposing sealing grooves of the next boiler section.

4. Wipe the port openings with a clean rag to remove any grit from the machined surfaces. Do not use any cleaner that contains a petroleum base distillate (oil) to clean ports. Place the nominal 7-1/2" and nominal 3-1/2" elastomer sealing rings in the appropriate port openings (see Figure 2).

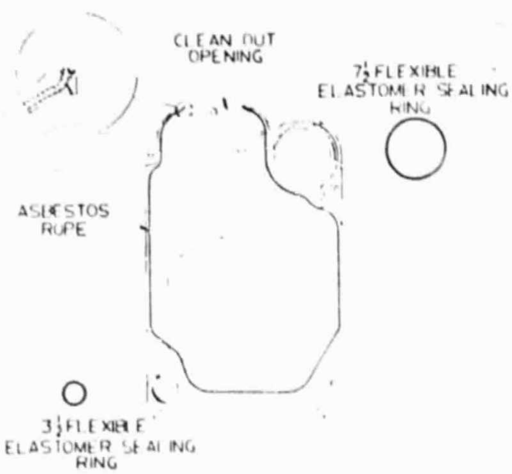


FIGURE 2

5. Prepare the port openings in an intermediate section. The "TI" intermediate sections (if used) must be installed in the order given in the Section Arrangement Table With Indirect Water Heaters. Note that 18" clearance must be provided on the left side for heater installation.

6. Discard the 3/8" diameter rods which are required only during shipment; these rods must not be used to draw the sections together.

a. Position the intermediate section (see Figure 3). Oil the threads of four (4) of the draw rods (5/8" x 9") and slip them through the lugs on the top and sides of each section. Place a washer (only one washer per draw rod) under each nut which is to be tightened, with a drop of oil between washer and nut.

b. Starting with the draw rods nearest the port openings, draw the sections together uniformly until the metal around the ports touch and the pads at the opposite corners touch. When properly pulled together the gap around the port openings should be less than 0.032". Check with a feeler gauge.

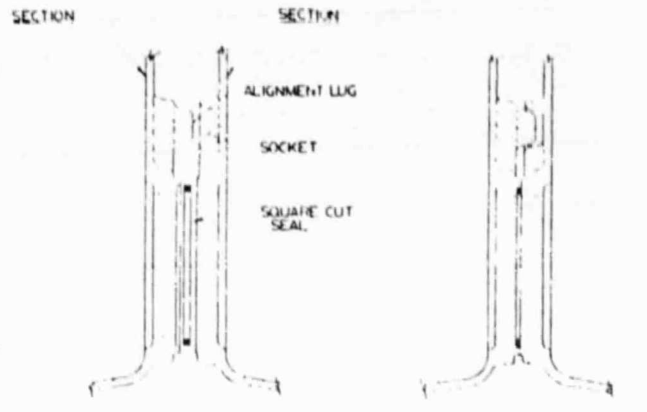


FIGURE 3

c. Do not "back off" the draw rod nuts.

7. Set the remaining boiler sections into position with the "TI" sections placed (If used) in the proper order given in the Section Arrangement Table. Check the asbestos rope seal of each section before proceeding to the next section; the boiler must be sealed gas-tight.

WARNING Use of chemical cleaners or sealants in any Weil McLain boiler is not recommended. **IN PARTICULAR, PRODUCTS CONTAINING PETROLEUM DISTILLATES MUST NEVER BE USED IN TYPE 76 BOILERS!**

8. Four 1/2" x 4-1/4" studs are provided to secure the Burner Mounting Plate to the front section (see Figure 4).

a. Thread two 1/2" nuts on the rounded end of a 1/2" x 4-1/4" stud locking them together, and thread the flat end of the stud into one of the four tapped holes located around the Burner Mounting Plate opening in the front section.

b. Remove the nuts from the stud.

c. Repeat steps "a" and "b" for the remaining three studs.

d. Hang one Refractory Retainer (stainless steel plate) over each mounting stud.

9. Using Asbestos Rope Adhesive in the groove around the Burner Mounting Plate opening in the front section, position the 3/8" diameter by 58" long rope in the groove making sure the ends overlap, and install the Burner Mounting Plate using the 1/2" washers and nuts provided. Make sure Burner Plate is installed with the round secondary air opening to the left (see Figure 4).

10. Using Asbestos Rope Adhesive, position the 1/4" diameter by 12" long Asbestos Rope in the sealing groove making sure the ends overlap at least 1". Install the front Observation Port Assembly using the number 10 - 32 x 1" Truss head screws as illustrated in Figure 4.

2. Make a small continuous bead of "Asbestos Rope Adhesive" in the bottom of the curved sealing grooves located around the perimeter of the section. Smooth out the adhesive using the brush provided.

3. Position the 3/8" by 98" long asbestos rope on the section by starting at the cleanout opening (See Figure 2). Be sure the asbestos rope is well seated at all points in the sealing grooves so that a gas-tight seal will be maintained between the sections. **DO NOT APPLY** adhesive to the opposing sealing grooves of the next boiler section.

4. Wipe the port openings with a clean rag to remove any grit from the machined surfaces. Do not use any cleaner that contains a petroleum base distillate (oil) to clean ports. Place the nominal 7-1/2" and nominal 3-1/2" elastomer sealing rings in the appropriate port openings (see Figure 2).

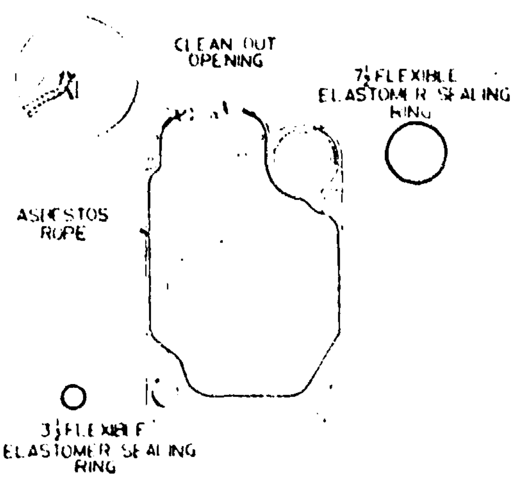


FIGURE 2

5. Prepare the port openings in an intermediate section. The "TI" intermediate sections (if used) must be installed in the order given in the Section Arrangement Table With Indirect Water Heaters. Note that 18" clearance must be provided on the left side for heater installation.

6. Discard the 3/8" diameter rods which are required only during shipment; these rods must not be used to draw the sections together.

   a. Position the intermediate section (see Figure 3). Oil the threads of four (4) of the draw rods (5/8" x 9") and slip them through the lugs on the top and sides of each section. Place a washer (only one washer per draw rod) under each nut which is to be tightened, with a drop of oil between washer and nut.

   b. Starting with the draw rods nearest the port openings, draw the sections together uniformly until the metal around the ports touch and the pads at the opposite corners touch. When properly pulled together the gap around the port openings should be less than 0.032". Check with a feeler gauge.

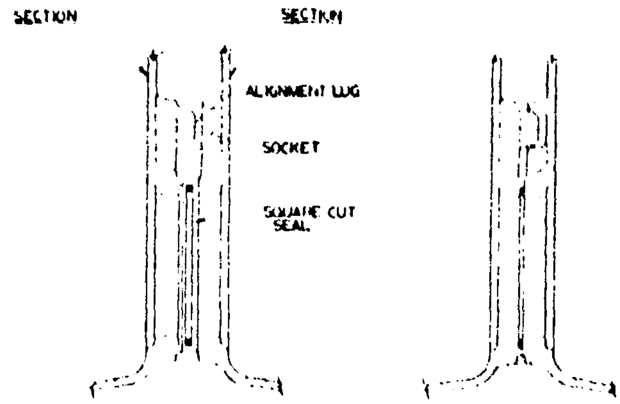


FIGURE 3

   c. Do not "back off" the draw rod nuts.

7. Set the remaining boiler sections into position with the "TI" sections placed (if used) in the proper order given in the Section Arrangement Table. Check the asbestos rope seal of each section before proceeding to the next section; the boiler must be sealed gas-tight.

WARNING Use of chemical cleaners or sealants in any Weil-McLain boiler is not recommended. **IN PARTICULAR, PRODUCTS CONTAINING PETROLEUM DISTILLATES MUST NEVER BE USED IN TYPE 76 BOILERS!**

8. Four 1/2" x 4-1/4" studs are provided to secure the Burner Mounting Plate to the front section (see Figure 4).

   a. Thread two 1/2" nuts on the rounded end of a 1/2" x 4-1/4" stud locking them together, and thread the flat end of the stud into one of the four tapped holes located around the Burner Mounting Plate opening in the front section.

   b. Remove the nuts from the stud.

   c. Repeat steps "a" and "b" for the remaining three studs.

   d. Hang one Refractory Retainer (stainless steel plate) over each mounting stud.

9. Using Asbestos Rope Adhesive in the groove around the Burner Mounting Plate opening in the front section, position the 3/8" diameter by 58" long rope in the groove making sure the ends overlap, and install the Burner Mounting Plate using the 1/2" washers and nuts provided. Make sure Burner Plate is installed with the round secondary air opening to the left (see Figure 4).

10. Using Asbestos Rope Adhesive, position the 1/4" diameter by 12" long Asbestos Rope in the sealing groove making sure the ends overlap at least 1". Install the front Observation Port Assembly using the number 10 - 32 x 1" Truss head screws as illustrated in Figure 4.

SECTION ARRANGEMENT TABLE WITH INDIRECT WATER HEATERS

BOILER NO.	MAXIMUM NO. OF HEATERS	SECTION ASSEMBLY ALL HEATERS MUST BE ON LEFT SIDE OF BOILER
476W & S	1	F-TI-I-B
576W & S	2	F-TI-I-TI-B
676W & S	2	F-TI-I-TI-I-B
776W & S	3	F-TI-I-*-I-TI-B
876W & S	3	F-TI-I-TI-I-I-TI-B
976W & S	4	F-TI-I-TI-I-*-I-TI-B

F = Front Section; B = Back Section; I = Intermediate Section; TI = Intermediate Section with Tankless Heater Opening.

*A TI section can be located in this position instead of regular intermediate section, but installer must cut jacket side panel to accommodate heater opening - no knockout is provided.

11. If the boiler was ordered with "TI" intermediate section(s), install the indirect water heater(s) or heater opening cover plate(s) using the gasket(s), 3/8" - 16 x 3/4" Hex Head Screws and washers as shown in Figure 4. If the water heater piping is installed as shown in Figure xx, the jacket can be erected either before or after the piping.

12. Using Asbestos Rope Adhesive, position the 3/8" x 26" long Asbestos Rope around the inside perimeter of the cleanout plates. Mount the cleanout plates over the openings as shown in Figure 4.

13. Using Asbestos Rope Adhesive, position the 3/8" diameter by 42" long asbestos rope in the groove on the Draft Hood Collar making sure the ends of the rope overlap at least 1".

14. Secure the Draft Hood Collar to the back section using the 3/8" x 1" Hex Head Cap Screws and Washers as illustrated in Figure 4.

HYDROSTATIC PRESSURE TEST OF BOILER

1. Secure a drain cock (not supplied) to the 3/4" drain tapping.

2. Install a water pressure gauge in one of the boiler tappings.

3. Install a bleed valve in boiler tapping K to vent air as the boiler is filled.

4. Plug all remaing boiler tappings. Refer to the Control Tapping Table.

5. Fill the boiler with water and completely vent all air. Test the boiler with water pressure at 45 pounds per square inch.

6. Thoroughly inspect the entire boiler for water leaks.

7. Drain the boiler and remove plugs from those tappings which will be used. Refer to the Control Tapping Table.

SUPPLY AND RETURN PIPING

It is recommended that the system supply and return piping be installed and the piping connections attached to the boiler before erecting the Jacket or installing the controls to avoid any possible damage to the Jacket or Controls. Recommended piping arrangements for No. 76 water and steam boilers are shown in Figures 5, 6 and 7 and the minimum recommended pipe sizes are listed for each piping arrangement. The supply and return piping will not interfere with the erection of the boiler jacket.

WATER BOILER SUGGESTED PIPING CONNECTIONS

Figure 5 and the accompanying chart show the recommended piping connections and minimum recommended pipe sizes for No. 76 water boilers. In most cases, it is advisable to pump water away from the boiler by connecting the supply piping, as illustrated in Figure 5, to the suction or inlet side of the circulator.

In sizing the supply and return piping, start with the minimum recommended pipe size and proceed at full diameter for 10 times that diameter before making any reduction. An example of this would be a 3" return would not be reduced any closer to the boiler return tapping than 30". Horizontal expansion tank piping must pitch upward at least 1" for each 5 feet of piping from the boiler to the tank. Where system

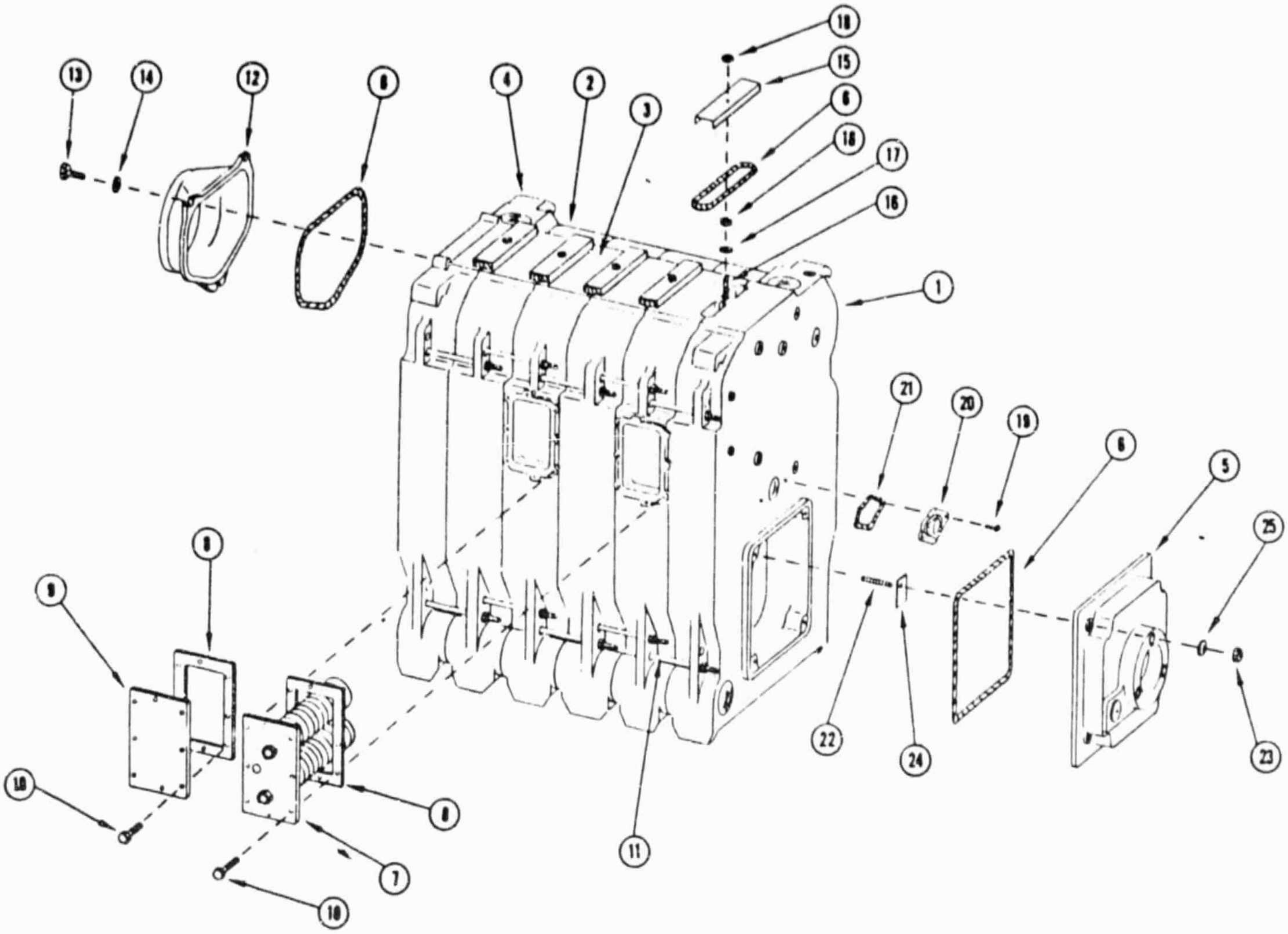


FIGURE 4

1 Front Section
2 Regular Intermediate Section
3 Tankless Intermediate Section
4 Back Section
5 Burner Mounting Plate
6 Asbestos Rope, 3/8" Stranded
7 Tankless Heater
8 Tankless Heater Gasket
9 Heater Cover Plate
10 Cap Screw, 3/8" - 16 x 3/4"
11 Draw Rod, 5/8" x 9"
12 Draft Hood Collar
13 Cap Screw 3/8" - 16 x 1"
14 Washer, 3/8"
15 Cleanout Plate
16 Carriage Bolt 1/4" - 20 x 1-1/2"
17 Washer, 1/4"
18 Nut, Hex, 1/4" - 20
19 Screw, S TP Type F Pan Hd.
20 Observation Port Assembly
21 Asbestos Rope, 1/4" Stranded
22 Stud, Tap End, 1/2" x 4-1/4"
23 Nut, Hex, 1/2"
24 Retainer, Front Refractory
25 Washer, 1/2"

temperature modulation is achieved by means of three-way valves, care must be exercised in piping the system to protect the boiler from thermal shock which could result from returning room temperature water at high velocities to the hot boiler. Where three-way valves are employed, consult Weil-McLain Customer Services Department for piping recommendations; primary-secondary pumping is preferred.

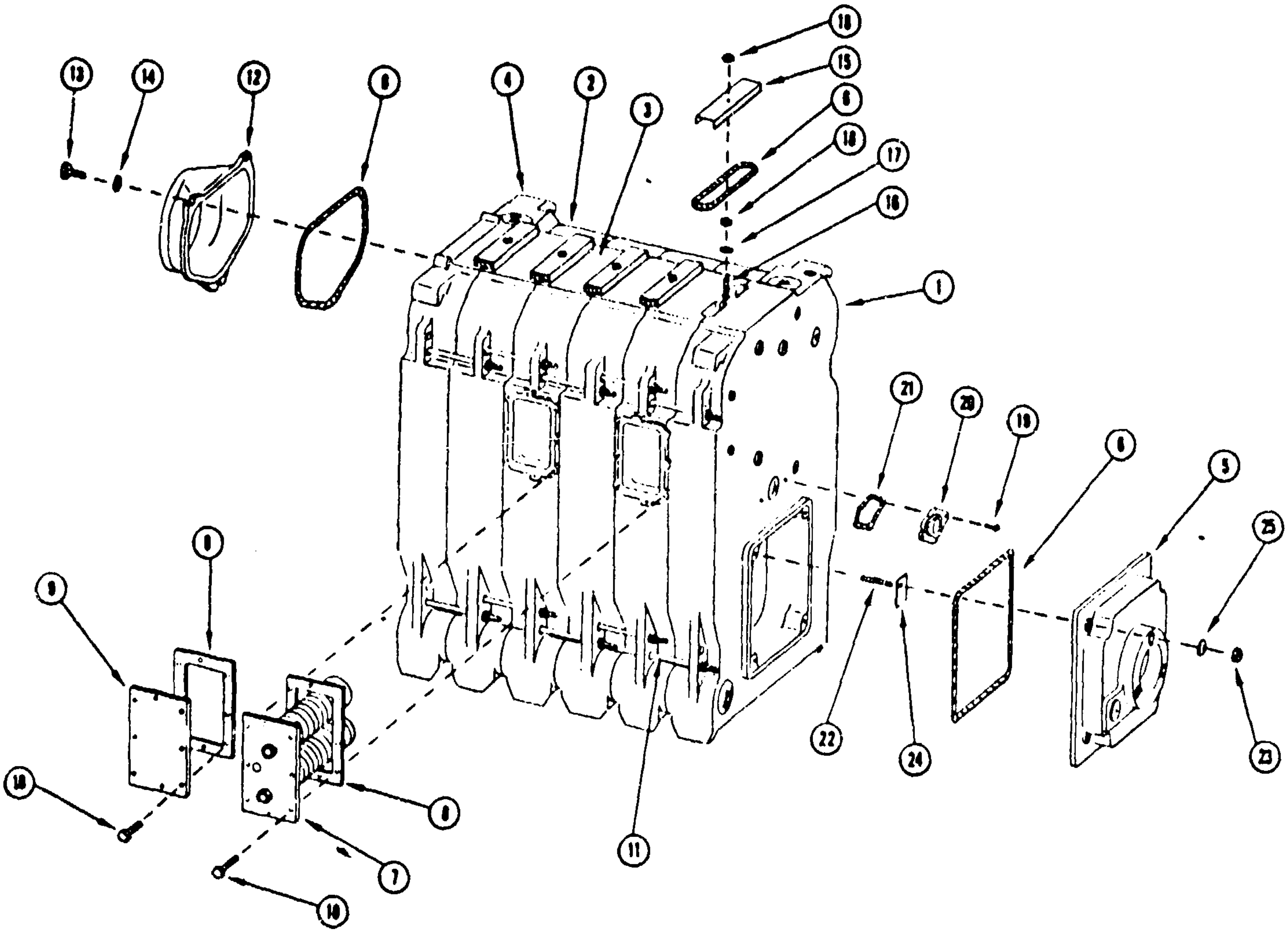


FIGURE 4

1. Front Section
2. Regular Intermediate Section
3. Tankless Intermediate Section
4. Back Section
5. Burner Mounting Plate
6. Asbestos Rope, 3/8" Stranded
7. Tankless Heater
8. Tankless Heater Gasket
9. Heater Cover Plate
10. Cap Screw, 3/8" - 16 x 3/4"
11. Draw Rod, 5/8" x 9"
12. Draft Hood Collar
13. Cap Screw 3/8" - 16 x 1"
14. Washer, 3/8"
15. Cleanout Plate
16. Carriage Bolt, 1/4" - 20 x 1-1/2"
17. Washer, 1/4"
18. Nut, Hex, 1/4" - 20
19. Screw, S TP Type F Pan Hd.
20. Observation Port Assembly
21. Asbestos Rope, 1/4" Stranded
22. Stud, Tap End, 1/2" x 4-1/4"
23. Nut, Hex, 1/2"
24. Retainer, Front Refractory
25. Washer, 1/2"

temperature modulation is achieved by means of three-way valves, care must be exercised in piping the system to protect the boiler from thermal shock which could result from returning room temperature water at high velocities to the hot boiler. Where three-way valves are employed, consult Weil-McLain Customer Services Department for piping recommendations; primary-secondary pumping is preferred.

RECOMMENDED PIPING CONNECTIONS FOR WATER BOILERS

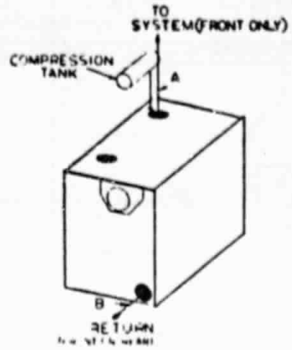


FIGURE 5

WATER BOILER PIPING RECOMMENDED MINIMUM PIPE SIZES

TABLE I
FOR KNOWN FLOW RATES*

WATER FLOW RATE GPM	SUPPLY PIPE SIZE A	RETURN PIPE SIZE B
To 9 GPM	1"	1"
10 - 16 GPM	1¼"	1¼"
17 - 21 GPM	1½"	1½"
22 - 35 GPM	2"	2"
36 - 50 GPM	2½"	2½"
51 - 76 GPM	3"	3"

*High temperature rise through boiler is permissible when boiler piping connections are sized using above Table I. INTERMITTENT flow at HIGH velocities may damage any boiler.

TABLE II
FOR UNKNOWN FLOW RATES**

BOILER NUMBER	SUPPLY PIPE SIZE A	RETURN PIPE SIZE B
476 and 576	2"	2"
676 and 776	2½"	2½"
876 and 976	3"	3"

**All piping sizes are based upon 20 deg. F. temperature rise through the boiler. For use of other temperature rises through the boiler (i.e. higher flow rates) determine the flow rate and use Table I for pipe sizes.

STEAM BOILER PIPING AND HEADERS

Figures 6 and 7 and the accompanying chart show recommended piping connections and minimum recommended pipe sizes for No. 76 steam boilers. The supply and return steam piping is not supplied with No. 76 steam boilers but should be installed as illustrated. Controls (safety valve, low water cut-off, gauge glass, etc.) are not shown on the steam piping diagrams in order to show more clearly the steam piping and Hartford Loop.

WARNING The satisfactory operation of any steam heating boiler depends upon adequate return of condensate to the boiler to maintain a steady water level. In rambling buildings with extended system piping, nuisance shutdowns sometimes result when the condensate returning from the system lags behind the evaporation capacity of the boiler. To maintain a steady water line, avoid the introduction of excessive amounts of raw make-up water, and to prevent nuisance shut-downs due to a temporary low water level, it is recommended that a low water cutoff and pump control, condensate receiver, and condensate boiler feed pump be installed. Consult Weil-McLain Customer Services Department for application information.

RECOMMENDED PIPING CONNECTIONS FOR STEAM BOILERS

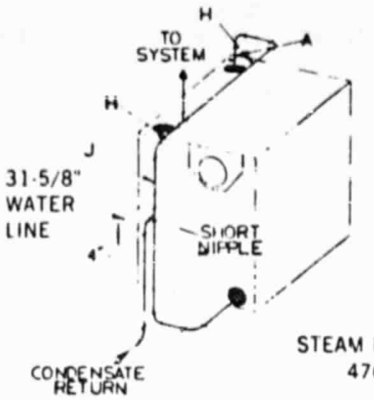


FIGURE 6

STEAM BOILER PIPING
476 and 576

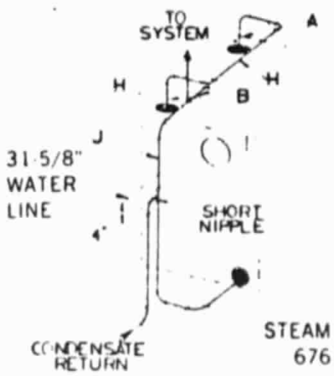


FIGURE 7

STEAM BOILER PIPING
676 through 976

STEAM BOILER PIPING
MINIMUM RECOMMENDED PIPE SIZES

Fig No.	Boiler Size	Riser Pipe Size A	Riser Pipe Size B	Header* H	Equalizer J
6	476	3"		3"	1½"
6	576	3"		3"	1½"
7	676	2½"	2½"	4"	1½"
7	776	2½"	2½"	4"	1½"
7	876	3"	3"	4"	2"
7	976	3"	3"	4"	2"

*24" Minimum from waterline to header.

RECOMMENDED PIPING CONNECTIONS FOR WATER BOILERS

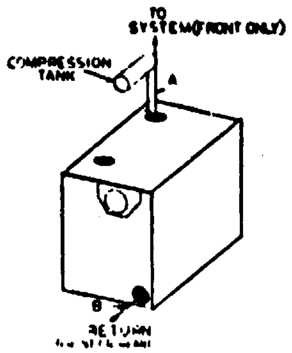


FIGURE 5

WATER BOILER PIPING RECOMMENDED MINIMUM PIPE SIZES

TABLE I
FOR KNOWN FLOW RATES*

WATER FLOW RATE GPM	SUPPLY PIPE SIZE A	RETURN PIPE SIZE B
To 9 GPM	1"	1"
10 - 16 GPM	1¼"	1¼"
17 - 21 GPM	1½"	1½"
22 - 35 GPM	2"	2"
36 - 50 GPM	2½"	2½"
51 - 76 GPM	3"	3"

*High temperature rise through boiler is permissible when boiler piping connections are sized using above Table I. INTERMITTENT flow at HIGH velocities may damage any boiler.

TABLE II
FOR UNKNOWN FLOW RATES**

BOILER NUMBER	SUPPLY PIPE SIZE A	RETURN PIPE SIZE B
476 and 576	2"	2"
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876 and 976	3"	3"

**All piping sizes are based upon 20 deg F. temperature rise through the boiler. For use of other temperature rises through the boiler (i.e. higher flow rates) determine the flow rate and use Table I for pipe sizes.

STEAM BOILER PIPING AND HEADERS

Figures 6 and 7 and the accompanying chart show recommended piping connections and minimum recommended pipe sizes for No. 76 steam boilers. The supply and return steam piping is not supplied with No. 76 steam boilers but should be installed as illustrated. Controls (safety valve, low water cut-off, gauge glass, etc.) are not shown on the steam piping diagrams in order to show more clearly the steam piping and Hartford Loop.

WARNING The satisfactory operation of any steam heating boiler depends upon adequate return of condensate to the boiler to maintain a steady water level. In rambling buildings with extended system piping, nuisance shutdowns sometimes result when the condensate returning from the system lags behind the evaporation capacity of the boiler. To maintain a steady water line, avoid the introduction of excessive amounts of raw make-up water, and to prevent nuisance shut-downs due to a temporary low water level, it is recommended that a low water cutoff and pump control, condensate receiver, and condensate boiler feed pump be installed. Consult Weil-McLain Customer Services Department for application information.

RECOMMENDED PIPING CONNECTIONS FOR STEAM BOILERS

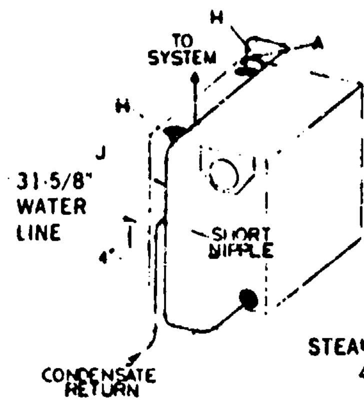


FIGURE 6

STEAM BOILER PIPING
476 and 576

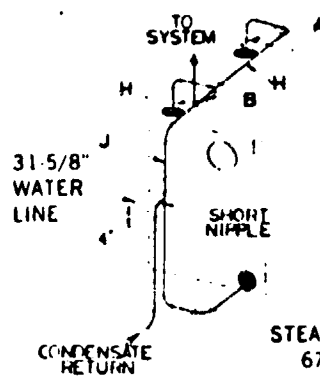


FIGURE 7

STEAM BOILER PIPING
676 through 976

STEAM BOILER PIPING
MINIMUM RECOMMENDED PIPE SIZES

Fig No.	Boiler Size	Riser Pipe Size A	Riser Pipe Size B	Header* H	Equalizer J
6	476	3"		3"	1½"
6	576	3"		3"	1½"
7	676	2½"	2½"	4"	1½"
7	776	2½"	2½"	4"	1½"
7	876	3"	3"	4"	2"
7	976	3"	3"	4"	2"

*24" Minimum from waterline to header.

ATTACHING THE JACKET

The boiler should be pressure tested before the jacket is erected. Follow the Jacket Erecting Instructions packed in the jacket carton which contains the Front and Back Jacket Panels for jacket installation procedures.

TANKLESS HEATER HOOK-UP

Where the boiler was ordered with (a) tankless heater(s) it is recommended that the piping to and from the heater be sized no smaller than the heater inlet and outlet piping connections. The tankless heater piping should be installed as illustrated in Figure 8. It is recommended that a Flow Regulating Valve be installed in the cold water supply piping to each heater. Each Flow Regulating Valve should be sized according to the intermittent draw rating of each tankless heater. Do not pipe multiple indirect water heaters in series. An Automatic Mixing Valve may be installed in the domestic hot water supply piping from the heater(s) to permit regulation of the domestic hot water temperature. Install the operating control in the control tapping in the heater plate. In hard water areas, it is advisable to soften the cold water to the heater(s).

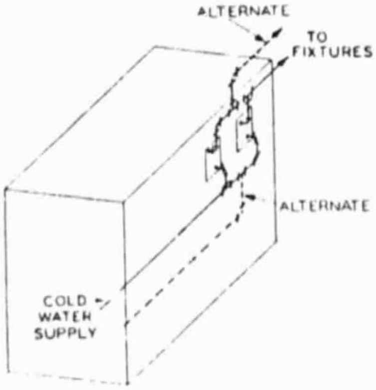


FIGURE 8

WARNING INSTALL BOILER CONTROLS

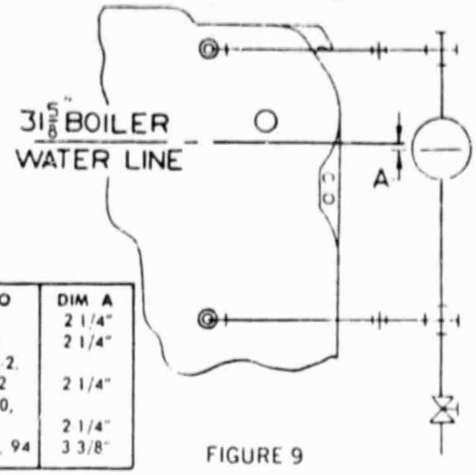
Steam Boiler:

1. Install the Steam Safety Valve in the proper tapping as indicated in the Control Tapping Table. The safety valve outlet should be piped to a floor drain or near to the floor. Do not pipe the safety valve discharge to any area where freezing temperatures could occur.

2. A low water cutoff must be installed on this boiler to meet ASME code requirements.

3. Where an optional 1/2" low water cut-off is employed, install the control in the gauge glass tappings (using the quick connections furnished with the low water cut-off) in accordance with the Control Tapping Table.

4. Where an optional 1" low water cut-off, combination low water cut-off and feeder, or combination low water cut-off and pump control is employed, install



LWCO	DIM A
No. 61	2 1/4"
No. 63	2 1/4"
No. 51-2, 51-S2	2 1/4"
No. 150, 157	2 1/4"
No. 93, 94	3 3/8"

FIGURE 9

Note: The schematic hook up shown provides for the proper location of the low water cut-off level, feeder operating level, or pump control operating level only where a single control is applied to the boiler. Where multiple controls are to be applied (such as a primary low water cut-off and a separate low water cut-off and feeder combination, or a separate low water cut-off and pump control), the primary low water cut-off operating level must be set lower than the feeder or pump control operating levels. Refer to the separate manufacturer's instructions or contact Weil-McLain Customer Services Department for locating the feeder or pump control operating levels in relation to the primary low water cut-off operating level.

the control in accordance with the Control Tapping Table using fittings (not furnished). If a low water cut-off is to be used that is not dimensionally diagrammed in Figure 9, locate the cast-on body mark of the control 2" below the normal water line.

5. Install the Gauge Glass Cocks, Water Gauge Glass Guards in accordance with the Control Tapping Table.

6. Install the Steam Pressure Operating and Pressure Limit Controls and the Pressure Gauge in the proper tapping as indicated in the Control Tapping Table using the Pigtail Syphon and fittings furnished as illustrated in Figure 10.

7. Install any additional or optional steam boiler controls according to the component manufacturer's instructions furnished with the control.

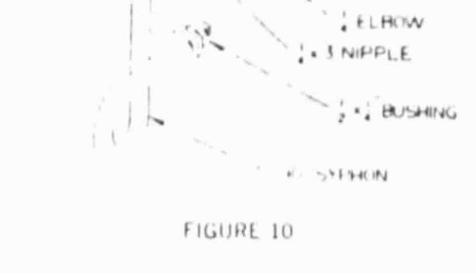


FIGURE 10

Water Boiler:

1. Install the Pressure Relief Valve in the proper tapping as indicated in the Control Tapping Table. The relief valve outlet should be piped to a floor drain or near to the floor. Do not pipe the relief valve discharge to any area where freezing temperatures could occur.

2. Install the Pressure-Temperature Gauge as indicated in the Control Tapping Table.

3. Where an optional 1" low water cut-off is employed, install the control in accordance with the Control Tapping Table using the fittings (not furnished) as illustrated in Figure 9. If a low water cut-off is to be used that is not dimensionally diagrammed in Figure 9 refer to the separate manufacturer's instructions for locating the control.

4. Install the Combination Limit Control as indicated in the Control Tapping Table.

5. Install any additional Limit Controls in the proper tappings as indicated in the Control Tapping Table.

6. Install any additional or optional water boiler controls according to the component manufacturer's instructions furnished with the control.

WARNING BREECHING ERECTION (also refer to Chimney)

Long horizontal breechings, excessive numbers of elbows or tees or other obstructions which are restrictive to the flow of combustion gases should be avoided.

Fit a piece of full sized heavy gauge steel breeching (same diameter as Draft Hood Collar) over the Draft Hood Collar and connect to chimney.

BURNER INSTALLATION

Carefully unpack the burner from its shipping container and check the contents. In case of shortage or damage, notify the transportation company immediately. The envelope of papers enclosed with the burner is to be used, preserved, and turned over to the owner and/or the owner's representative.

Secure the Burner Mounting Flange to the Burner Mounting Plate using the bolts provided until a rigid installation is accomplished. A gas-tight seal must be maintained between the burner mounting flange and the burner mounting plate or damage to the burner air tube will result.

WARNING WIRING THE BOILER

All wiring should be installed in compliance with the rules of the National Electrical Code, for installation in the U.S.A. or Canadian Electrical Code C22.2 Part 1 for Canadian installations, and any local, state, or insurance requirements or codes having jurisdiction. Operating and safety circuit wiring may be No. 14 gauge wire. Power supply wiring to the burner shall be No. 14 gauge or heavier, as required, and shall have a properly sized fused disconnect switch. Where the burner motor electrical current requirements are for some other voltage than the control electrical current requirements, care must be taken to be sure the proper voltage is supplied to the controls, the burner motor, and any auxiliary equipment.

FUEL LINE PIPING

Refer to the separate Burner Installation and Service Manual and any local or national code requirements which may apply to sizing and installing the fuel line piping and fuel tank.

WARNING BOILER MUST BE GAS-TIGHT

For proper combustion efficiency and for safety, be sure the boiler is sealed gas-tight. Correct any areas that are not gas-tight by wiping the outer surface of the asbestos rope with asbestos shorts dissolved in water-glass.

BURNER ADJUSTMENT

Start the burner and adjust the air band so that a clear yellow oil burner flame with slightly smoky tips or a clean gas flame with slightly yellow tips is established. Use combustion test instruments for final adjustment of the burner flame. A smoke reading of a trace to No. 1 on the Shell Bacharach scale is recommended with 11-1/2 percent to 12-1/2 percent CO_2 for No. 2 fuel oil. A CO_2 reading of 9 to 10 percent is recommended for natural gas. A CO test should be taken to assure that CO does not exceed .04 percent in the flue gases.

BAROMETRIC DAMPER ADJUSTMENT

When the burner is adjusted to the above combustion conditions, adjust the Barometric Draft Control to provide -0.02 inches of draft overfire (below atmospheric pressure).

WARNING CLEAN THE NEW STEAM BOILER

New steam boilers must be cleaned properly previous to or during the first few days of operation. Follow the cleaning recommendations listed on the Operating Instructions. Do not use chemical cleaners in this boiler!

ADDITIONAL INSTRUCTIONS

Before leaving the job, make sure the unit checks electrically and make sure the proper main burner flame is secured. Be sure the room thermostat or operating control is adjusted to provide the desired room temperature.

BOILER SERVICE AND MAINTENANCE

The boiler Operating Instructions contain information for the owner; review this information with the owner and/or the owner's representative and be sure he receives all instructions.

ABL-573 W not hi-lo [redacted]

NO. 76 RATINGS

$^{3}\!/\!_{4}$ PRV P: T gauge & limit

Boiler Unit Number	I B R Burner Capacity Light Oil GPH ♦■	Gross I B R Output BTU/Hr. **	Net I B R Ratings†			Net Sq Ft Water ▲	Boiler H.P	Net Firebox Volume Cu. Ft	Stack Gas Volume CFM	Draft Loss thru Boiler in H_2O △	I B R Chimney ⊕	
			Steam Sq. Ft.	Steam BTU/Hr.	Water BTU/Hr						Size Inches	Height Feet
BL-476-*	2.35	264,000	825	198,000	229,600	1,510	7.9	4.25	147	.01	8 x 12	15
BL-576-*	2.95	336,000	1,050	252,100	292,200	1,950	10.0	5.51	185	.02	8 x 12	15
BL-676-*	3.60	408,000	1,275	306,100	354,800	2,365	12.2	6.81	226	.03	12 x 12	17
BL-776-*	4.25	480,000	1,500	360,100	417,400	2,785	14.3	8.09	266	.04	12 x 12	19
BL-876-*	4.90	552,000	1,725	414,100	480,000	3,200	16.5	9.37	307	.05	12 x 12	21
BL-976-*	5.55	624,000	1,950	468,100	542,600	3,615	18.6	10.65	348	.06	12 x 16	24

NOTE: Add prefix "A" to designator for No. 76 Boiler with factory assembled sections (example: ABL 476).

*Substitute "S" for steam, "W" for water. For T intermediate sections and tankless heaters, add suffix "(number required) TIH". For T intermediate sections with cover plates only, add suffix "(number required) TIP".

♦ Burner input based on maximum of 2,000 ft. altitude—for other altitudes, consult Weil McLain Customer Services Department.

■ No. 2 fuel oil—Commercial Standard Spec. CS12-48, Heat value of oil — 140,000 BTU/G.

**At combustion condition of 12¼ ± ¼% CO_2

†Net I B R Ratings are based on net installed radiation of sufficient quantity for the requirements of the building and nothing need be added for normal piping and pick up. Steam ratings are based on a piping and pick up allowance of 1.333; water ratings on an allowance of 1.15. An additional allowance should be made for gravity hot water systems or for unusual piping and pick up loads. Consult Customer Services Department.

▲ Based on average water temperature of 170°F. in radiators.

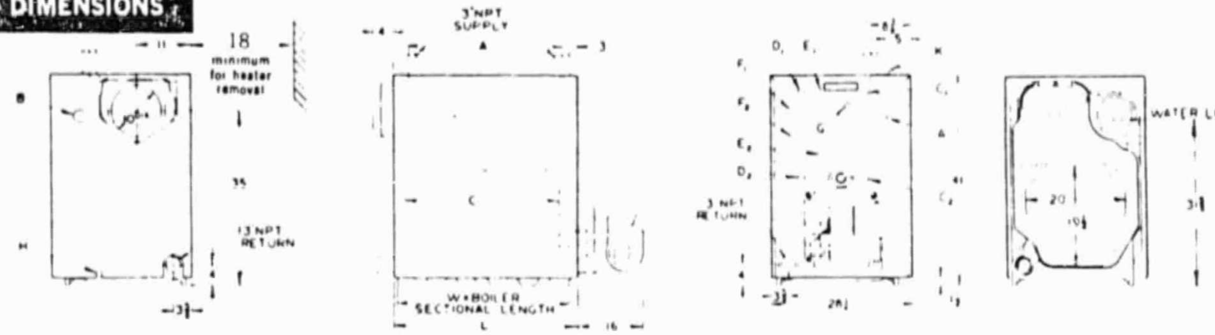
Stack gas volume at outlet temperature.

△ Draft over fire must be added to obtain draft required at smoke collar.

⊕ When chimney is lined with the largest standard clay chimney tile, the equivalent area is considered the same as the unlined chimney area.

NOTE: Water boilers available upon special request at 80 P.S.I. working pressure.

DIMENSIONS



BACK SIDE FRONT INTERMEDIATE

Boiler Number	Supply Tappings Number & Size	Return Tappings Number & Size	Dimensions (Inches)			
			A	C	L	W
476	2—3"	2—3"	17¼	17½	24¼	22
576	2—3"	2—3"	23¼	23½	30¼	28
676	2—3"	2—3"	29¼	29½	36¼	34
776	2—3"	2—3"	35¼	35½	42¼	40
876	2—3"	2—3"	41¼	41½	48¼	46
976	2—3"	2—3"	47¼	47½	54¼	52

DOMESTIC WATER HEATER CAPACITIES
TANKLESS HEATERS*

Heater Number	**Intermittent Draw GPM 100° Average Temperature rise	***Continuous Draw GPM 100° Temperature rise	Inlet and Outlet Tappings
35 S 29	4.5 GPM	4.0 GPM	¾"

*Weil McLain Ratings
**Gallons of Water per min. heated from 40° to 140° with 200 F. boiler water temp
***Continuous Draw—no recovery period

CONTROL TAPPINGS

Location	Size	Steam	Water
A	1½"	Safety Valve and/or Skim Tapping	High Limit Control
B	1½"	Safety Valve	Safety Relief Valve
C_1	1"	—	Combination High Limit and Low Limit Control
C_1 & C_2	1"	Water Level Controls	Low Water Cutoff
D_1 & D_2*	1"	Water Level Controls	Low Water Cutoff
E_1 & E_2	½"	Gauge Glass	—
F_1 & F_2*	¾"	Try Cock Tappings	—
G	½"	Pressure Limit Control, Pressure Operating Control and Pressure Gauge	Combination Pressure Temperature Gauge
H	¾"	Drain	Drain
K	¾"	—	Piping to Compression Tank or Automatic Air Vent

*Available on special request only

STANDARD EQUIPMENT

Insulated Flush Jacket
Flame Retention Oil Burner with Cadmium Cell and Primary Control. Burner Mounted
Burner Mounting Plate with Refractory
Observation Port on Front Section
Flue Collar
Balanced Draft Damper
Low Voltage Thermostat
Flue Brush

WATER BOILERS

30 P.S.I. ASME Safety Relief Valve (boilers tested for 50 P.S.I. working pressure)
High Limit Control
Combination Pressure/Temperature Gauge
Built In Air Eliminator

STEAM BOILERS

ASME Side Outlet Safety Valve
High Limit Pressure Control
Steam Pressure Gauge
90° Syphon
Gauge Cocks
Gauge Glass
Gauge Guards

OPTIONAL EQUIPMENT

Factory Assembled Sections
Tankless Heaters - for Water or Steam
Heater Opening Cover Plates
Intermediate Section with Opening for Tankless Heater
Low Water Cutoff
Low Water Cutoff and Feeder Combination
Low Water Cutoff and Pump Control
Barometric Damper
1½" Side Inspection Tappings with Brass Plugs—2 per section

WEIL-McLAIN Michigan City Indiana 46360 A Division of Wylain, Inc.

HYDRO-WALL DESIGN

The No. 76 Boiler has a water-backed combustion area with water circulating completely around the firebox. The crown sheet, sidewalls, and studs on the flue passages enlarge prime heating surface for maximum heat transfer.

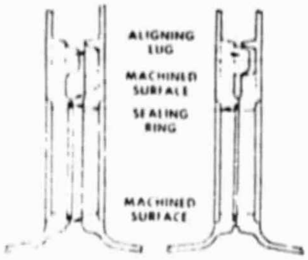
In addition to larger heating surface, Hydro-Wall section design also permits lower height, reduces heat loss through the bottom of the boiler, eliminates the need for a refractory combustion chamber, and permits installation on any floor.

The cast iron sections are not face-ground; the tough outer skin is retained to protect against corrosion. The 76 Boiler is sealed with asbestos rope.

TOP CLEANING

The No. 76 can be cleaned from the top of the boiler by removing the top jacket panels. The steel cleanout plates are sealed with asbestos rope and are easily removed to expose the section heating surfaces for cleaning and inspection.

Patent No. 3,626,908



SECTION SEALING METHOD

A flexible elastomer sealing ring is used in each port opening of the No. 76 Boiler to assure a permanent, watertight seal between sections. This sealing method, combined with the use of short draw rods to tie sections together, also permits faster section assembly.

As shown in the illustrations, the machined surface of the port opening controls the compression ratio of the sealing ring for a watertight seal. The aligning lugs assure proper section alignment during assembly and positive locking of the sections.

CAST IRON FLUE COLLAR

A horizontal flueway, cast into No. 76 sections, serves as a flue gas collector. This feature eliminates the need for a separate sheet metal collector hood.

The standard equipment cast iron flue collar permits a straight-through connection to the chimney.

MULTIPLE TANKLESS WATER HEATERS

Tankless heaters for the No. 76 Boiler are installed in the left side of the boiler in intermediate sections with heater openings.

Multiple heaters offer these advantages: (1) increased domestic hot water, (2) hot water at different temperatures, and (3) one heater for snow melting application.

SECTION ASSEMBLY FOR TANKLESS HEATERS

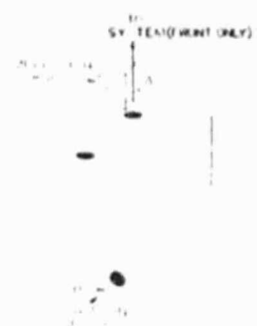
Boiler No.	Maximum No. of Heaters	Section Assembly All heaters must be on left side of boiler
476	1	F TI I B
576	2	F TI I TI B
676	2	F TI I TI I B
776	3	F TI I * I TI B
876	3	F TI I TI I TI I B
976	4	F TI I TI I * I TI B

F Front Section B Back Section I Intermediate Section
TI Intermediate Section with Tankless Heater Opening

TANKLESS HEATER LOCATIONS — If TI sections are ordered, it is important to position them in the boiler section assembly exactly as shown by the TI symbols in the table above to match jacket knockouts and assure proper operation. An asterisk (*) in the table for the 776 and 976 indicates a TI section can be installed in this position but the installer must cut the jacket opening since a knockout is not provided.

RECOMMENDED PIPING CONNECTIONS

WATER BOILERS



STEAM BOILERS

FIG. 1

FIG. 2

NOTE: Supply and return sizes for water boilers refer to minimum size of pipe connected to boiler for 20° or higher temperature drop between supply and return.

Water Boiler Size	Pipe Size* A (Supply)	Pipe Size* B (Return)
476 and 576	2"	2"
676 and 776	2½"	2½"
876 and 976	3"	3"

*For minimum of 10 pipe diameters from boiler

Fig. No.	Steam Boiler Size	Riser Pipe Size A	Riser Pipe Size B	Header* H	Equalizer J
1	476 and 576	3"	—	3"	1½"
2	676 and 776	2½"	2½"	4"	1½"
2	876 and 976	3"	3"	4"	2"

*24" minimum from waterline to header.

NO. 76 RATINGS

Boiler Unit Number	I B R Burner Capacity Light Oil GPH ◆■	Gross I B R Output BTU/Hr. **	Net I B R Ratings† Steam Sq. Ft.	Net I B R Ratings† Steam BTU/Hr.	Net I B R Ratings† Water BTU/Hr.	Net Sq. Ft. Water ▲	Boiler H.P.	Net Firebox Volume Cu. Ft.	Stack Gas Volume CFM ††	Draft Loss thru Boiler in H_2O ‡	I B R Chimney ‡ Size Inches	I B R Chimney ‡ Height Feet
-476-*	2.35	264,000	825	198,000	229,600	1,530	7.9	4.25	147	.01	8 x 12	15
-576-*	2.95	336,000	1,050	252,100	292,500	1,950	10.0	5.53	185	.02	8 x 12	15
+-676-*	3.60	408,000	1,275	306,100	354,800	2,365	12.2	6.81	226	.03	12 x 12	17
+-776-*	4.25	480,000	1,500	360,100	417,400	2,785	14.3	8.09	266	.04	12 x 12	19
+-876-*	4.90	552,000	1,725	414,100	480,000	3,200	16.5	9.37	307	.05	12 x 12	21
+-976-*	5.55	624,000	1,950	468,100	542,600	3,615	18.6	10.65	348	.06	12 x 16	24

+Substitute "BL" for boiler burner unit or "H" for oil fired boiler for use with approved flame retention burners (see page 2). Add prefix "A" to designator for No. 76 with factory-assembled sections (example: ABL-476 or AH 476).

*Substitute "S" for steam, "W" for water. For 1 intermediate sections and tankless heaters, add suffix "(number required) TH". for 1 intermediate sections with cover plates only, add suffix "(number required) TIP".

◆Burner input based on maximum of 2,000 ft. altitude - for other altitudes, consult Weil McLain Customer Services Department.

■No. 2 fuel oil. Commercial Standard Spec. CS12 48. Heat value of oil — 140,000 BTU/G.

**At combustion condition of 13% - 13½% CO_2.

†Net I B R Ratings are based on net installed radiation of sufficient quantity for the requirements of the building and nothing need be added for normal piping and pick up. Steam ratings are based on a piping and pick up allowance of 1.333; water ratings on an allowance of 1.15. An additional allowance should be made for gravity hot water systems or for unusual piping and pick up loads. Consult Customer Services Department.

▲Based on average water temperature of 170°F. in radiators.

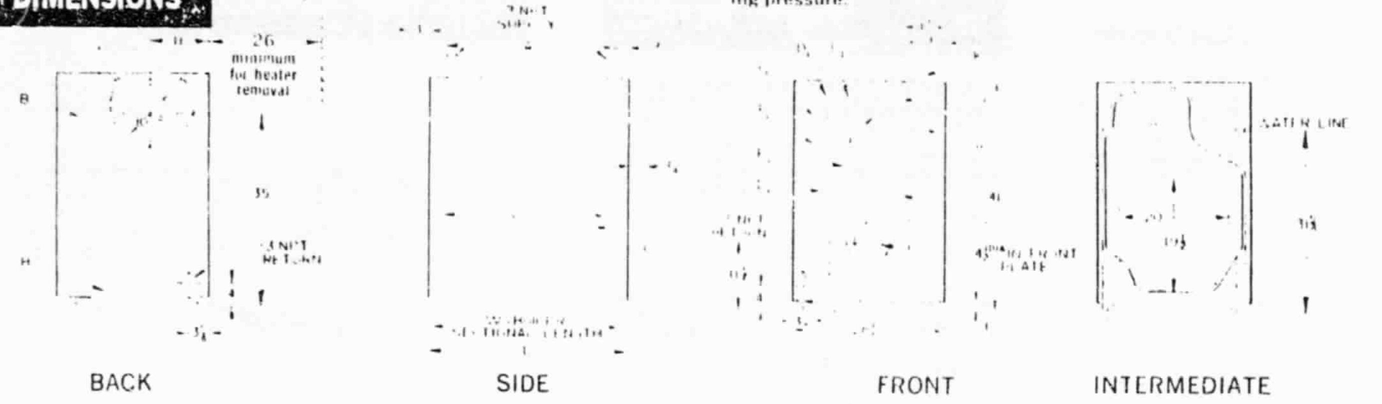
††Stack gas volume at outlet temperature.

‡Draft over fire must be added to obtain draft required at smoke collar.

‡When chimney is lined with the largest standard clay chimney tile, the equivalent area is considered the same as the unlined chimney area.

NOTE: Water boilers available upon special request at 80 P.S.I. working pressure.

DIMENSIONS



Boiler Number	Supply Tappings Number & Size	Return Tappings Number & Size	Dimensions (Inches) A	C	I	W
476	2—3"	2—3"	17¼	17½	24¼	22
576	2—3"	2—3"	23¼	23½	30¼	28
676	2—3"	2—3"	29¼	29½	36¼	34
776	2—3"	2—3"	35½	35½	42¼	40
876	2—3"	2—3"	41¼	41½	48¼	46
976	2—3"	2—3"	47¼	47½	54¼	52

DOMESTIC WATER HEATER CAPACITIES
TANKLESS HEATERS*

Heater Number	**Intermittent Draw GPM 100° Average Temperature rise	***Continuous Draw GPM 100° Temperature rise	Inlet and Outlet Tappings
35 S 29	4.5 GPM	4.0 GPM	¾"

*Weil McLain Ratings

**Gallons of Water per min. heated from 40° to 140° with 200°F boiler water temp.

***Continuous Draw—no recovery period

CONTROL TAPPINGS

Location	Size	Steam	Water
A	1½"	Safety Valve and or Skim Tapping	High Limit Control
B	1½"	Safety Valve	Safety Relief Valve
C_1	1"	—	Combination High Limit and Low Limit Control
C_1 & C_2	¾"	Water Level Controls	Low Water Cutoff
D_1 & D_2*	1"	Water Level Controls	Low Water Cutoff
E_1 & E_2	½"	Gauge Glass	—
F_1 & F_2*	¾"	Try Cock Tappings	—
G	½"	Pressure Limit Control, Pressure Operating Control and Pressure Gauge	Combination Pressure Temperature Gauge
H	¾"	Drain	Drain
K	¾"	—	Piping to Compression Tank or Automatic Air Vent

*Available on special request only

STANDARD EQUIPMENT

ALL BOILERS

Insulated Flush Jacket
Burner Mounting Plate with Refractory
Observation Port on Front Section
Flue Collar
Balanced Draft Damper
Flue Brush
For BL-76 Only
Flame Retention Oil Burner with Cadmium Cell and Primary Control—Burner Mounted
Low Voltage Thermostat

ALL WATER BOILERS

30 P.S.I. ASME Safety Relief Valve (boilers tested for 50 P.S.I. working pressure)
Combination Pressure/Temperature Gauge
Built In Air Eliminator
For BL-76-W Only
High Limit Control

ALL STEAM BOILERS

ASME Side Outlet Safety Valve
Steam Pressure Gauge
Syphon
Gauge Cocks
Gauge Glass
Gauge Guards
For BL-76-S Only
High Limit Pressure Control

OPTIONAL EQUIPMENT

Factory Assembled Sections
Tankless Heaters—for Water or Steam
Heater Opening Cover Plates
Intermediate Section with Opening for Tankless Heater
Low Water Cutoff
Low Water Cutoff and Feeder Combination
Low Water Cutoff and Pump Control
Barometric Damper
1½" Side Inspection Tappings with Brass Plugs—2 per section

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Form No. C 5 C R3 (976)

Litho in U.S.A.

NO. 76 RATINGS

Boiler Unit Number	I-B-R Burner Capacity Light Oil GPH ◆■	Gross I-B-R Output BTU/Hr. **	Net I-B-R Ratings† Steam Sq Ft	Net I-B-R Ratings† Steam BTU/Hr.	Net I-B-R Ratings† Water BTU/Hr.	Net Sq Ft Water ▲	Boiler H.P.	Net Firebox Volume Cu Ft	Stack Gas Volume CFM ‡	Draft Loss thru Boiler in H_2O ∴	I-B-R Chimney ⁝ Size Inches	I-B-R Chimney ⁝ Height Feet
+-476-*	2.35	264,000	825	198,000	229,600	1,530	7.9	4.[illegible]	147	.01	8 x 12	15
+-576-*	2.95	336,000	1,050	252,100	29[illegible],500	1,960	10.0	5.5[illegible]	185	.02	8 x 12	15
+-676-*	3.60	408,000	1,275	306,100	351,800	2,345	12.2	6.81	226	.03	12 x 12	17
+-776-*	4.25	480,000	1,500	360,100	417,400	2,785	14.3	8.00	266	.04	12 x 12	19
+-876-*	4.90	552,000	1,725	414,100	480,000	3,200	16.5	9.17	307	.05	12 x 12	21
+-976-*	5.55	624,000	1,950	468,100	542,600	3,615	18.6	10.65	348	.06	12 x 16	24

+Substitute "BL" for boiler burner unit or "H" for oil fired boiler for use with approved flame retention burners (see page 2). Add prefix "A" to designator for No. 76 with factory-assembled sections (example: ABL-476 or AH 476).

*Substitute "S" for steam, "W" for water. For 1 intermediate sections and tankless heaters, add suffix "(number required) TIH". For 1 intermediate sections with cover plates only, add suffix "(number required) TIP."

◆Burner input based on maximum of 2,000 ft. altitude - for other altitudes, consult Weil-McLain Customer Services Department.

■No. 2 fuel oil - Commercial Standard Spec. CS12-48. Heat value of oil = 140,000 BTU/G.

**At combustion condition of 13% - 13½% CO_2

†Net I-B-R Ratings are based on net installed radiation of sufficient quantity for the requirements of the building and nothing need be added for normal piping and pick-up. Steam ratings are based on a piping and pick-up allowance of 1.333; water ratings on an allowance of 1.15. An additional allowance should be made for gravity hot water systems or for unusual piping and pick-up loads. Consult Customer Services Department.

▲Based on average water temperature of 170°F. in radiators.

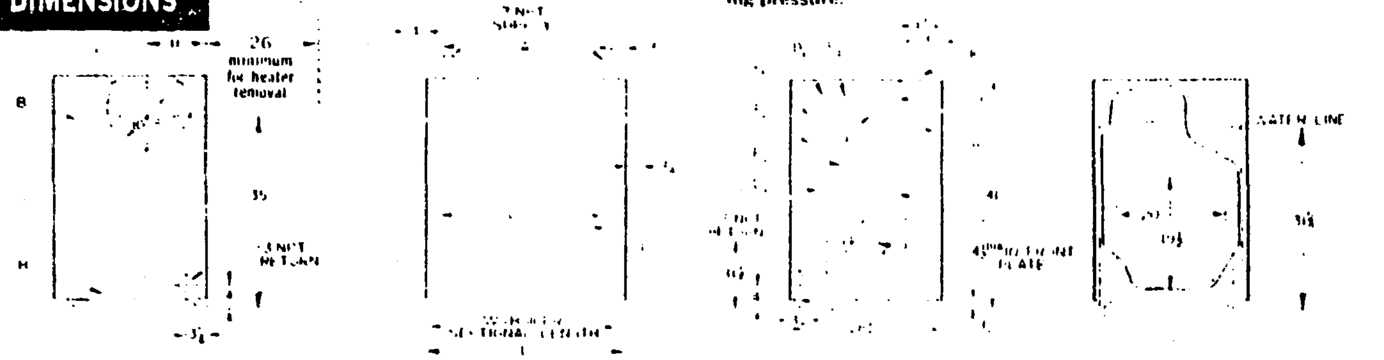
‡Stack gas volume at outlet temperature.

∴Draft over fire must be added to obtain draft required at smoke collar.

⁝When chimney is lined with the largest standard clay chimney tile, the equivalent area is considered the same as the unlined chimney area.

NOTE: Water boilers available upon special request at 80 P.S.I. working pressure.

DIMENSIONS



BACK SIDE FRONT INTERMEDIATE

Boiler Number	Supply Tappings Number & Size	Return Tappings Number & Size	Dimensions (Inches) A	C	I	W
476	2-3"	2-3"	17¼	17½	24¼	22
576	2-3"	2-3"	23¼	23½	30¼	28
676	2-3"	2-3"	29¼	29½	36¼	34
776	2-3"	2-3"	35¼	35½	42¼	40
876	2-3"	2-3"	41¼	41½	48¼	46
976	2-3"	2-3"	47¼	47½	54¼	52

DOMESTIC WATER HEATER CAPACITIES
TANKLESS HEATERS*

Heater Number	**Intermittent Draw GPM 100° Average Temperature rise	***Continuous Draw GPM 100° Temperature rise	Inlet and Outlet Tappings
35-S-29	4.5 GPM	4.0 GPM	¾"

*Weil-McLain Ratings

**Gallons of Water per min. heated from 40° to 140° with 200°F. boiler water temp.

***Continuous Draw—no recovery period

CONTROL TAPPINGS

Location	Size	Steam	Water
A	1½"	Safety Valve and/or Skim Tapping	High Limit Control
B	1½"	Safety Valve	Safety Relief Valve
C_1	1"	—	Combination High Limit and Low Limit Control
C_1 & C_2	1"	Water Level Controls	Low Water Cutoff
D_1 & D_2*	1"	Water Level Controls	Low Water Cutoff
E_1 & E_2	½"	Gauge Glass	—
F_1 & F_2*	¾"	Try Cock Tappings	—
G	½"	Pressure Limit Control, Pressure Operating Control and Pressure Gauge	Combination Pressure Temperature Gauge
H	¾"	Drain	Drain
K	1"	—	Pipe to Compression Tank or Automatic Air Vent

*Available on special request only

STANDARD EQUIPMENT

ALL BOILERS

Insulated Flush Jacket
Burner Mounting Plate with Refractory
Observation Port on Front Section
Flue Collar
Balanced Draft Damper
Flue Brush
For BL-76 Only
Flame Retention Oil Burner with Cadmium Cell and Primary Control - Burner Mounted
Low Voltage Thermostat

ALL WATER BOILERS

30 P.S.I. ASME Safety Relief Valve (boilers tested for 50 P.S.I. working pressure)
Combination Pressure/Temperature Gauge
Built In Air Eliminator
For BL-76-W Only
High Limit Control

ALL STEAM BOILERS

ASME Side Outlet Safety Valve
Steam Pressure Gauge
"U" Syphon
Gauge Cocks
Gauge Glass
Gauge Guards
For BL-76-S Only
High Limit Pressure Control

OPTIONAL EQUIPMENT

Factory Assembled Sections
Tankless Heaters—for Water or Steam
Heater Opening Cover Plates
Intermediate Section with Opening for Tankless Heater
Low Water Cutoff
Low Water Cutoff and Feeder Combination
Low Water Cutoff and Pump Control
Barometric Damper
1½" Side Inspection Tappings with Brass Plugs - 2 per section

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Form No. C-5??-R3 (976) Litho in U.S.A.

ATTENTION HEATING CONTRACTOR: This warranty is for the building owner and should be given to him or placed in sight near the boiler.

WEIL-McLAIN

A Division of Wylain, Inc.

Michigan City, Indiana 46360

Limited Warranty

Weil-McLain warrants that its cast iron boilers are free from defects in materials and workmanship for one year after installation only, and only to the extent of furnishing new parts for any found to be defective in manufacture.

This warranty does not cover:

1. Components that are part of the heating system but were not furnished by Weil-McLain as a part of the product.
2. The workmanship of any installer of Weil-McLain cast iron boilers. In addition, this warranty does not assume any liability of any nature for unsatisfactory performance caused by improper installation. The boiler must have been installed by a heating contractor whose principal occupation is the sale and installation of plumbing, heating and/or air conditioning equipment.
3. Any costs for labor for removal and re-installation of the alleged defective part, transportation to Weil-McLain if necessary, and any other materials necessary to perform the exchange.
4. Improper burner adjustments, control settings, care, or maintenance. Information is included in the Installation Instructions, Start-Up, Service and Maintenance Instructions, and other printed technical material furnished by Weil-McLain with the boiler.

This warranty does not extend to anyone except the first purchaser at retail, and only when the boiler is in the original installation site.

IMPLIED WARRANTIES FOR PARTICULAR PURPOSE AND MERCHANTABILITY SHALL BE LIMITED TO THE DURATION OF THE EXPRESS WARRANTY. MANUFACTURER EXPRESSLY DISCLAIMS AND EXCLUDES ANY LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY.

Some states do not allow the exclusion of limitation of incidental or consequential damages, so the above limitations may not apply to you.

For prompt warranty service, notify the installer who, in turn, will notify the Weil-McLain distributor from whom he purchased the boiler. If this action does not result in warranty service, contact Weil-McLain Customer Services Department, Blaine Street, Michigan City, Indiana 46360 with details in support of the warranty claim. Alleged defective part or parts must be returned through trade channels in accordance with the Weil-McLain procedure currently in force for handling returned goods for the purpose of inspection to determine cause of failure. Weil-McLain will furnish the new part(s) to an authorized Weil-McLain distributor who, in turn, will furnish the part(s) to the heating contractor who installed the boiler. If you have any questions about the coverage of this warranty, contact Weil-McLain at the address below.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

WEIL-McLAIN

A Division of Wylain, Inc.
Customer Services Department
Blaine Street
Michigan City, Indiana 46360

Form MC-3299(677)

PLEASE HANG THIS CARD NEAR THE BOILER

OPERATING INSTRUCTIONS
for
WEIL-McLAIN
OIL, GAS OR GAS/OIL 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. Your boiler and burner should be inspected, cleaned and if necessary, adjusted once a year. We recommend that you utilize a qualified serviceman who 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 a lifetime of heating comfort, if you follow the few simple suggestions listed on this card.

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.**

IMPORTANT: CHECK BEFORE STARTING THE UNIT

Make sure the boiler heating surfaces have been cleaned and that the boiler is filled to the correct water level or pressure. It is recommended that your burner serviceman be called to service your burner and check the following points:

1. Clean the fuel strainer, where used.
2. If there is a filter in the fuel oil line, clean it and change the cartridge.
3. Clean all lint and dust out of the fan and blower housing.
4. Check the ignition electrodes and clean or replace the nozzle where used.
5. Oil the burner motor with detergent free automobile engine oil.
6. Rotate the blower wheel by hand to make certain it turns free.

TO START THE UNIT

CAUTION: Do not start the burner when the firebox is hot or when fuel vapor is present in the boiler. Do not operate the Fuel Oil Pump for more than 2 minutes without fuel oil.

1. Make sure all fuel valves are open.
2. For one-pipe fuel oil piping systems, bleed the air out of the piping by opening the unused intake port on the Fuel Oil Pump and waiting for the oil to flow. For two-pipe fuel oil piping systems, air is automatically bled from the system piping.
3. With the main electric switch in the burner electrical circuit in the **off** position, set the thermostat or operating control at a point which will start the burner.
4. Push the safety reset lever on the burner primary control and release.
5. Turn the main electric switch to the **on** position. If the burner does not start instantly, turn the main electric switch back to the off position and refer to the following section titled If Burner Fails To Start.
6. If the burner starts to operate normally, leave the main electric switch on and reset the thermostat or operating control to desired position.

IF BURNER FAILS TO START, CHECK THE FOLLOWING

1. Check for loose connections and blown fuses.
2. Make sure the thermostat temperature setting is above the room temperature.
3. Be sure all fuel valves are open.
4. Be sure there is sufficient fuel oil in the tank to supply the burner.
5. Reset burner primary control by pushing the safety reset lever and releasing.
6. Push reset button on the burner motor.
7. If the burner does not start after observing the above checks, call your serviceman.

FORM MC-1558-876 WM

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 a 1¼" to 2½" skim line, with valve, from the boiler skim tapping and run this line to a convenient floor drain.
3. Fire the boiler at a low rate 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 burner 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 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 cock; fill with fresh water to the water-line. Start burner and steam for 15 minutes to remove all dissolved gases; stop burner.
8. Drain boiler sufficiently to remove skim piping; plug skim tapping; refill boiler to waterline.
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 CUT-OFF 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 burner 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. **Petroleum based products should not be used for cleaning or sealing this boiler.**

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 (ie, 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 burner 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. DO NOT try "homemade cures" or boiler "patent medicines" on the market under various trade names, as serious damage to the boiler, personnel, and property may result.

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).

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

Refer to Cleaning Boiler Heating Surfaces for periodic cleaning of your boiler.

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.

SHUT DOWN OF BOILER

DO NOT DRAIN BOILER during periods of shutdown unless heating system is exposed to freezing temperatures.

1. Turn off the main electric switch.
2. Close all fuel valves in the fuel lines.
3. Cover the burner to protect it from dust and dampness.
4. Open the boiler drain cock to remove impurities that may have settled to the bottom of the boiler; it may be necessary to drain one or two gallons of water until all traces of sediment are gone. Refill the boiler to the proper water level or pressure (see Filling Heating System). Boiler water does not have to be crystal clear for proper operation, but should be free from any sludge or sediment.
5. During severe winter weather have heating system operation checked periodically or thoroughly drain your heating system.

Where it becomes necessary to drain the heating system for an extended period, follow items 1, 2 and 3 above. Then, clean all carbon, rust, and other deposits from the fire-side of the boiler heating surfaces in order to protect the boiler from the corrosive action of combustion deposits (see Cleaning Boiler Heating Surfaces). Apply a thin coating of oil or grease if the boiler is to remain out of service for extended periods of time. 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 – this is mainly true where the makeup water is "hard" and the same precautions must be used as indicated in the third paragraph of this section.

CLEANING BOILER HEATING (fire-side) SURFACES

At the end of every heating season, it is advisable to clean the flueways in the boiler. Soot is an effective insulator and prevents the hot gases from heating the boiler water as efficiently as possible. The frequency of cleaning will depend upon the fuel used, the burner adjustments, boiler temperature, draft conditions, and other job factors.

Normally the boiler flueways will be cleaned as described below:

1. Remove the flueway opening cover(s).
2. Cover the burner and controls.
3. Insert the wire flue brush supplied with the boiler into the flueways and thoroughly brush the flueways at all angles.
4. Remove any soot or scale from the horizontal flueways, the boiler firebox and the base of the chimney using a vacuum cleaner or brush. **Do not brush or vacuum the firebox or combustion chamber area of those boilers using fiberous combustion chamber material!**
5. Replace the flueway opening cover(s) making sure the original gas-tight seal is maintained.

Chemical additives which can be procurred from most heating supply houses or from your fuel oil supplier can be effectively used to clean the boiler flueways; certain types of chemical additives can be added to the fuel oil while other types can be placed on the floor of the firebox. **The use of stick type thermal bombs is not recommended.** Consult your heating contractor or fuel oil supplier before using any chemicals in the boiler.

The boiler flueways can also be cleaned by heating the boiler to 180° F.; then, removing the flueway opening cover(s). Use a garden sprayer or connect a spray nozzle to a garden hose and spray the sooted flueways with a fine mist of water; the soot will become loosened and fall to the floor of the firebox and around the horizontal flueways. Remove the loosened soot from the horizontal flueways and from the floor of the firebox using a vacuum cleaner or brush except those boilers using fiberous combustion chamber material.

BURNER ADJUSTMENT

Refer to the burner manual for proper burner adjustment; your serviceman should properly use combustion test instruments for efficient operation. **The flame must not strike (impinge) against any heating surfaces within the boiler firebox.**

WATER BOILER CONTROLS

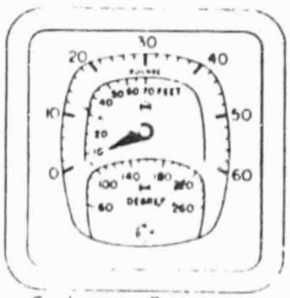
CIRCULATOR CARE:
Never operate the circulator without water.

A. Follow lubricating instructions on circulators that are provided with oil cups or oil holes.
B. Follow venting instructions on circulators with water lubricated bearings which require no oil.

BOILER PRESSURE: The initial fill pressure of a hot water system is generally to 12 pounds per square inch. When the system is heated to the limit control setting, the pressure may range up to 30 pounds per square inch. Normal system pressure will fluctuate between the fill pressure, when the system is cold; and up to 20 to 28 pounds per square inch when the system is hot.

BOILER WATER TEMPERATURE: Modern hot water heating systems with "closed" type expansion tanks may operate at water temperatures up to 250° F. Set the high limit control at 220° F; during severe weather you may find this temperature setting needs to be raised or lowered, depending upon the characteristics of your heating system. Those heating systems furnishing hot faucet water must have a low limit control set at a temperature which will furnish an adequate supply of domestic hot water; set low limit control 20° F below high limit setting and use a 15° F differential setting.

PRESSURE-TEMPERATURE-ALTITUDE GAUGE: This gauge indicates the boiler pressure in pounds-per-square-inch and in feet of water column (altitude) above the boiler by the moveable hand. The fixed hand may be changed to indicate the proper position for the moveable hand on manually filled hot water heating systems. For those systems with automatic fill valves, the fixed hand is usually left at the zero setting. The third hand indicates the boiler water temperature in degrees fahrenheit.

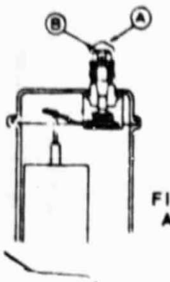


Combination Pressure – Temperature – Altitude Gauge

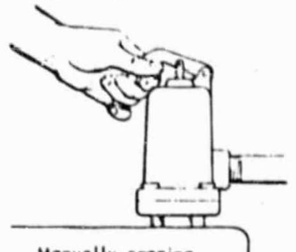
FLOAT TYPE AIR VENT: If your system is provided with a Float Type Air Vent(s) which automatically expells air from the heating system, when the system is filled with water, loosen cap Ⓐ slowly so that particles of dirt or scale are not deposited on the valve seat by the escaping air. Should dirt or scale lodge on the valve seat causing it to leak, remove cap and push the valve core Ⓑ in by hand to permit water to flush the valve seat clean. Release the valve core quickly and replace cap. For normal operation and venting, unscrew the cap at least two turns.

WATER RELIEF VALVE: Check the relief valve at least once a year by pulling the handle and allowing a small quantity of water to flow. Be sure the relief valve reseats properly and is entirely free from seepage. If the relief valve sticks or appears to be damaged, it should be repaired or replaced immediately.

COMPRESSION TANK: Compression tank(s) are employed with hot water heating systems to accept the increased water volume which results from heating the system water. The compression tank on a closed hot water heating system should provide adequate pressurization under all system operating conditions. Frequent opening of the pressure relief valve can be the result of an undersized compression tank because provision for the necessary expanded water volume has not been provided. Compression tanks may be of the open, closed or closed diaphragm type.



Float Type Air Vent


Manually opening Pressure Relief Valve.

Open Type Expansion Tank: Open type expansion tanks are located above the highest heat distributing unit in the system usually in a closet or attic space and equipped with a gauge glass and an overflow pipe to a drain. The open type expansion tank and drain piping should not be located in any area where freezing temperatures could occur.

Closed Type Expansion Tank: Closed type expansion tanks are welded gas-tight and are usually located just above the boiler but may be located at any point in the heating system. In order to utilize the built-in air elimination system on certain boilers, the closed type compression tank must be piped to the air elimination tapping on the boiler. When the system is initially filled with water, a cushion of air is trapped within the tank and this air cushion is compressed to provide the initial fill pressure. When the system is heated, the expansion of the system water further compresses the air cushion and provides the additional space required for the additional water volume. A rapid increase in boiler pressure with frequent opening of the pressure relief valve during warm-up of the boiler and heating system usually indicates a "waterlogged" compression tank. Your serviceman should be called to correct this condition by partially draining the compression tank to again establish an air cushion.

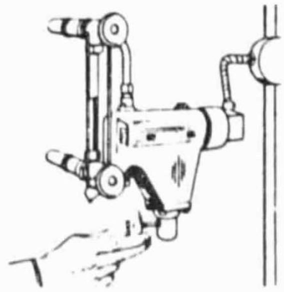
Closed Diaphragm Type Compression Tank: Closed diaphragm type compression tanks are welded gas-tight and a rubber diaphragm is employed to separate the air cushion from the system water. The closed diaphragm type expansion tank may be located at any point within the heating system but is usually located as close to the boiler as possible. Where a closed diaphragm type expansion tank is employed, an automatic air-eliminating device should be installed in the air elimination tapping(s) on certain boilers to provide system air control. Before the initial fill of the heating system, the closed diaphragm type compression tank should be charged with air (by means of a tire pump) to a pressure equal to the initial fill pressure; the tank pressure may be checked by means of an air pressure gauge. As the system is filled, water will not enter the tank until the system pressure exceeds the tank charge. When the system is heated, the expansion of the system water causes the diaphragm to flex and further compress the air cushion and additional space is provided for the additional water volume. Since the system water is separated from the air cushion by means of the diaphragm, absorption of the air cushion by the system water is eliminated.

Pressure Gauge.

STEAM BOILER CONTROLS

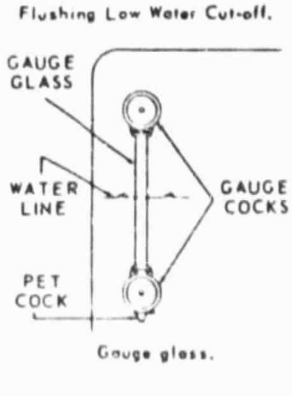
BOILER PRESSURE. Steam boiler pressures may range up to 15 psig maximum, but in normal service usually will not exceed 5 psig and may even operate under vacuum conditions at certain times.

The compound gauge used for steam boilers indicates steam pressure in pounds per square inch (psig) and boiler vacuum in inches of mercury (hg).


Flushing Low Water Cut-off.

CLEANING LOW WATER CUT-OFF. Accumulated sediment in the low water cut-off should be flushed out through a blow-off valve provided for this purpose at least once each month of heating system operation.

CLEANING THE GAUGE GLASS. This may be done by closing the lower gauge glass cock and carefully opening the petcock below the glass to blow water and sediment out of the gauge glass by steam pressure. Then slowly open the lower gauge glass cock, allowing a small amount of water to flush out through the open petcock. Close petcock and fully open the lower gauge cock. The water level should immediately rise to its proper level. If gauge glass breaks, close off both gauge cocks and loosen glass retaining nuts to remove gauge glass. Replace broken gauge glass with new gauge glass made of heavy walled pyrex. DO NOT USE THIN GLASS TUBING!



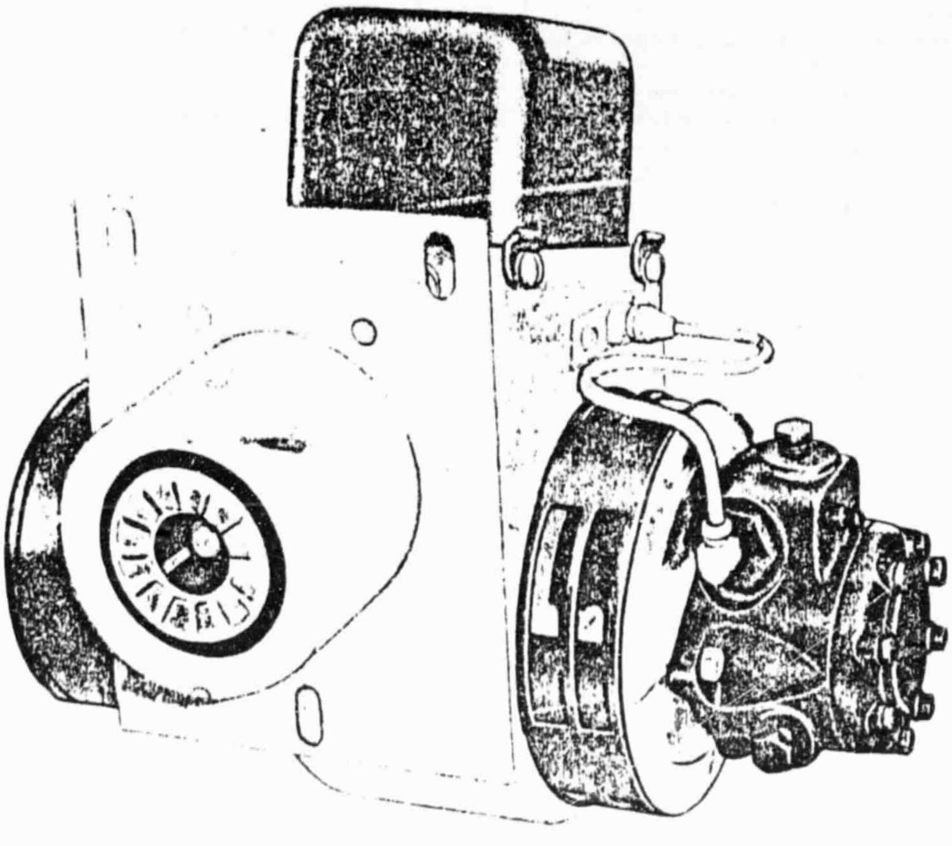
Gauge glass.

CHECKING THE SAFETY VALVE. The safety valve should open at 15 psig to prevent excessive boiler pressure. Manually open the safety valve once each year by pulling the valve lever or handle and allowing a small amount of steam to escape. This will help to assure proper operation of the safety valve if boiler pressures reach 15 psig. Be sure that the valve reseats properly and does not leak steam. If the safety valve sticks or appears to be clogged it should be repaired or replaced immediately by your serviceman.

WEIL-McLAIN

MODELS EH, ER

FLAME RETENTION OIL BURNER
START-UP, SERVICE AND MAINTENANCE MANUAL
FOR
76 SERIES BOILERS



BURNER MANUFACTURED BY
WAYNE HOME EQUIPMENT CO., INC.
FORT WAYNE, INDIANA
FOR

WEIL-McLAIN
HYDRONIC DIVISION
MICHIGAN CITY INDIANA

5/3/76

OIL BURNER CERTIFICATE

AS REQUIRED BY COMMERCIAL STANDARD CS75-56

The .... Oil Burner Model No. ...., Serial No. ...., installed at
(Make)

.... bears a label evidencing compliance with commercial Standard CS75-56, and
(Address of Installation)
has been installed in accordance with the instructions in the manufacturer's installation manual and in conformity with local regulations, codes, and ordinances.

The boiler ( ), furnace ( ), is a .... No. ...., and the heating load consists of :
(Make)

1. .... Btu, or .... square feet steam ( ), hot water ( ) radiation; and
2. .... Btu, or .... square feet of equivalent steam ( ), hot water ( ) radiation in domestic hot water load; or
3. .... Btu, or .... square inches of cross-sectional area of warm air supply pipes measured at the furnace take off; or
4. .... Btu, or .... square feet of equivalent steam ( ), hot water ( ) radiation in the following special load:

....

All necessary permits have been secured, and the installation has been tested in accordance with the test procedure of Commercial Standard CS75-56 and the following readings taken:

CO { Over Fire...
At Breaching.. }

Stack Temperatures at breeching.............................°F

Draft { Over Fire...
At Breaching.. } inches H_2O.

Firing Rate...gals./hr.

All controls and limiting devices have been checked for proper operation...................................

Fuel used, Grade No. .... of Commercial Standard CS12-48.

Field service equipment smoke scale reading ....

The above test results are certified to be true:

For service call:

....
(Name of Company making installation)

....
(Name)

Per ....
(Signature)

....
(Address)

....
(Address)

....
(Telephone)

....
(Telephone)

Date ....

76 BOILER RATINGS AND DATA

BOILER NUMBER*	I=B=R OIL FIRING RATE GPH	GROSS I=B=R OUTPUT BTU/Hr +	WATER NET I=B=R OUTPUT BTU/Hr●	STEAM NET I=B=R OUTPUT BTU/Hr●	NET SQUARE FEET‡ WATER	NET SQUARE FEET STEAM	DRAFT LOSS THROUGH BOILER-INCHES WATER COLUMN	I=B=R CHIMNEY SIZE INCHES	HEIGHT FEET
476	2.35	264,000	229,600	198,000	1530	825	.01	8 x 12	15
576	2.95	336,000	292,200	252,100	1950	1050	.02	8 x 12	15
676	3.60	408,000	354,800	306,100	2365	1275	.03	12 x 12	17
776	4.25	480,000	417,400	360,100	2785	1500	.04	12 x 12	19
876	4.90	552,000	480,000	414,100	3200	1725	.05	12 x 12	21
976	5.55	624,000	542,600	468,100	3615	1950	.06	12 x 16	24

* Add to boiler number "W" for water boiler without water heater; "WT" for water boiler with tankless heater; "WS" for water boiler with storage heater. "S" for steam boiler and "ST" for steam boiler with tankless heater.

\+ Ratings are based on 10% CO_2 ($\pm$ 0.2%) in the combustion gases.

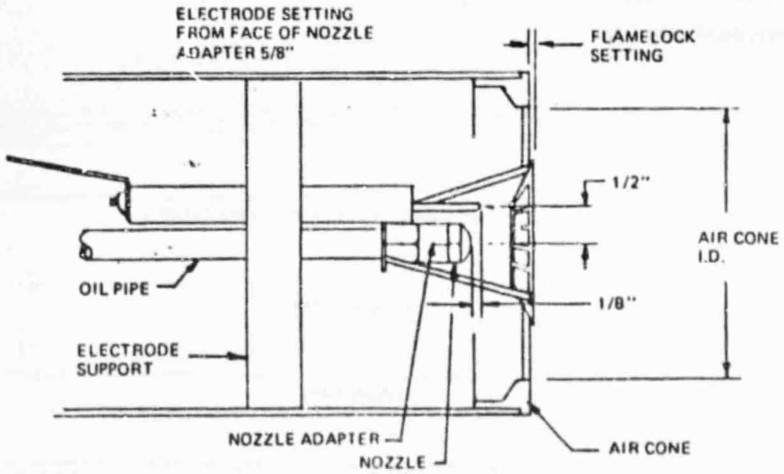
● Net I=B=R Ratings are based on net installed radiation of sufficient quantity for the requirements of the building and nothing need be added for normal piping and pick-up. Ratings are computed on a piping and pick-up factor of 1.15 for water and 1.33 for steam. An additional allowance should be made for unusual piping and pick-up loads.

‡ Based on an average water temperature of 170°F in the Heat Distribution Units.

76 BURNER DATA

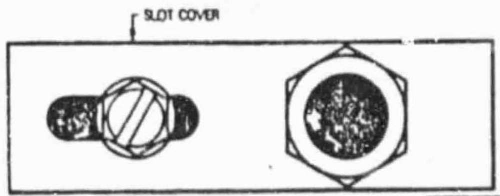
BOILER MODEL NO.	BURNER MODEL NO.	BURNER SPEC. NO.	NOZZLE SIZE	NOZZLE ANGLE/TYPE	AIR CONE I.D. & TYPE	BAFFLE PLATE O.D.	ELECTRODE SUPPORT	FLAMELOCK SETTING from FACE of AIR CONE
476	ER	163-51	2.25	80° Hollow	3-1/4" 8 Vane	None	Stabilizer	1/8" Ahead
476	EH	163-53	2.25	80° Hollow	3" 8 Vane	3"	Tripod	1/8" Ahead
576	EH	163-53	3.00	80° Hollow	3" 8 Vane	3"	Tripod	1/4" Ahead
676	EH	163-55	3.50	80° Solid	3-1/4" Taper	2-1/2"	Tripod	1/4" Ahead
776	EH	163-57	4.00	80° Solid	3-1/4" 8 Vane	None	Stabilizer (Reversed)	3/16" Ahead
876	EH	163-57	5.00	70° Solid	3-1/4" 8 Vane	None	Stabilizer (Reversed)	3/16" Ahead
976	EH	163-59	5.50	70° PLP	3-9/16" Taper	2"	Tripod	1/4" Ahead

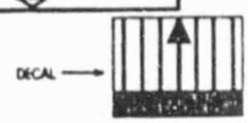
All of the above capacities are based on operation at sea level, with 115/60 current, 3450 RPM motor (excepting Spec. No. 163-39A ER Burner - 1725 RPM).



Adjustments:

The adjustments of the Flame Lock with the Air Cone could vary slightly depending upon the job conditions.





NOTE: Gun Assembly is pre-set at factory. End of slot cover is set with arrow on decal as shown.

On reinstalling gun assembly, slot cover to be set as shown.

5/3/76

GENERAL REQUIREMENTS

The fuel oil tank, fuel line piping, and power input wiring must be installed in accordance with the requirements of the National Board of Fire Underwriters', Underwriters' Laboratories, and any additional national or local codes or requirements having jurisdiction. This burner is listed for use with either No. 1 or No. 2 fuel oil by the Underwriters' Laboratories, Inc., the New York Board of Standards and Appeals, the State Fire Marshall of the Commonwealth of Massachusettes, the Department of State Police in Connecticut, and others. The burner is manufactured in accordance with the National Bureau of Standards, Commercial Standard No. CS75-56.

CHIMNEY REQUIREMENTS

The natural draft chimney or vent must be at least of the size indicated on Page 3 under the 76 Boiler Ratings and Data. Where the cross sectional area or height of the natural draft chimney or vent is smaller than the published dimensions, or where excessive resistance to the flow of combustion gases can be expected, it may be necessary to purchase and install an inexpensive induced draft fan for best operation. For elevations above 1,000 feet, the published chimney cross sectional area and height should be increased by at least four (4) per cent for each 1,000 feet above sea level.

The chimney should be examined before the connection of the boiler to be certain that it is properly constructed, clear, and will freely conduct the products of combustion to the atmosphere. The chimney or vent should extend high enough above the building or any other obstructions so that wind from any direction will not strike the chimney or vent from an angle above horizontal and thus produce down drafts. Unless the obstruction is of great magnitude, it is the usual experience that a chimney or vent extended at least two feet above flat roofs or two feet above the highest part of wall parapets and peaked roofs which are within thirty feet will be reasonably free from down drafts.

BREECHING REQUIREMENTS

In entering the chimney, the breeching connection must be sufficiently above the extreme bottom of the chimney to avoid any danger of stoppage. The breeching connection must not project beyond the inner wall of the chimney. A thimble or slip joint may be used to facilitate removal of the breeching for cleaning. Do not place a damper or any other obstruction in the breeching. The breeching should slope upward toward the chimney at least ¼ inch per lineal foot of breeching and must be at least of the same equivalent diameter as the published dimensions of the rectangular or square chimney. Long horizontal breechings, excessive numbers of elbows or tees, or other obstructions which are restrictive to the flow of combustion gases should be avoided.

Be sure the barometric draft control is installed in the breeching between the boiler and chimney according to the manufacturer's instructions packaged with the control. A small hole should be drilled in the breeching just beyond the boiler smoke outlet to facilitate measuring the stack temperature, CO_2, breeching draft, and for taking a smoke reading.

AIR SUPPLY FOR COMBUSTION

Provisions must be made to supply sufficient clean air to the boiler room at all times for combustion, for ventilation, for operation of the barometric draft control, and to prevent less than atmospheric air pressures in the boiler room. If there is a lack of combustion air in the boiler room, the burner flame will be yellow and formation of soot will occur on the boiler flue passages. In buildings of conventional frame, brick or stone construction without enclosed utility rooms, basement storm windows, or tight stair doors, infiltration is normally adequate to provide air for combustion and for operation of the barometric draft control.

For installations in an enclosed utility room or boiler room without an outside wall, a fresh air opening to the outside with a free cross sectional area of at least twice the area of the flue outlet is recommended. For each 1,000 feet above sea level, increase the fresh air opening by at least four (4) per cent. The boiler room should be isolated from any area served by exhaust fans. Do not install an exhaust fan in the boiler room.

BURNER AND SAFETY CIRCUIT WIRING

The burner motor, ignition transformer, circulator and combination burner primary control, limit control, and circulator control are prewired at the factory. If any additional electrical safety controls are employed, No. 14 gauge wire in conduit may be used. The power input supply wiring to the boiler should be No. 14 gauge or heavier wire in conduit, as required, and should have a properly sized fused disconnect switch. All wiring should be installed in accordance with the requirements of the National Electrical Code and any additional state or local code requirements having jurisdiction. Refer to the separate wiring diagram packaged in the envelope with these instructions for wiring the boiler.

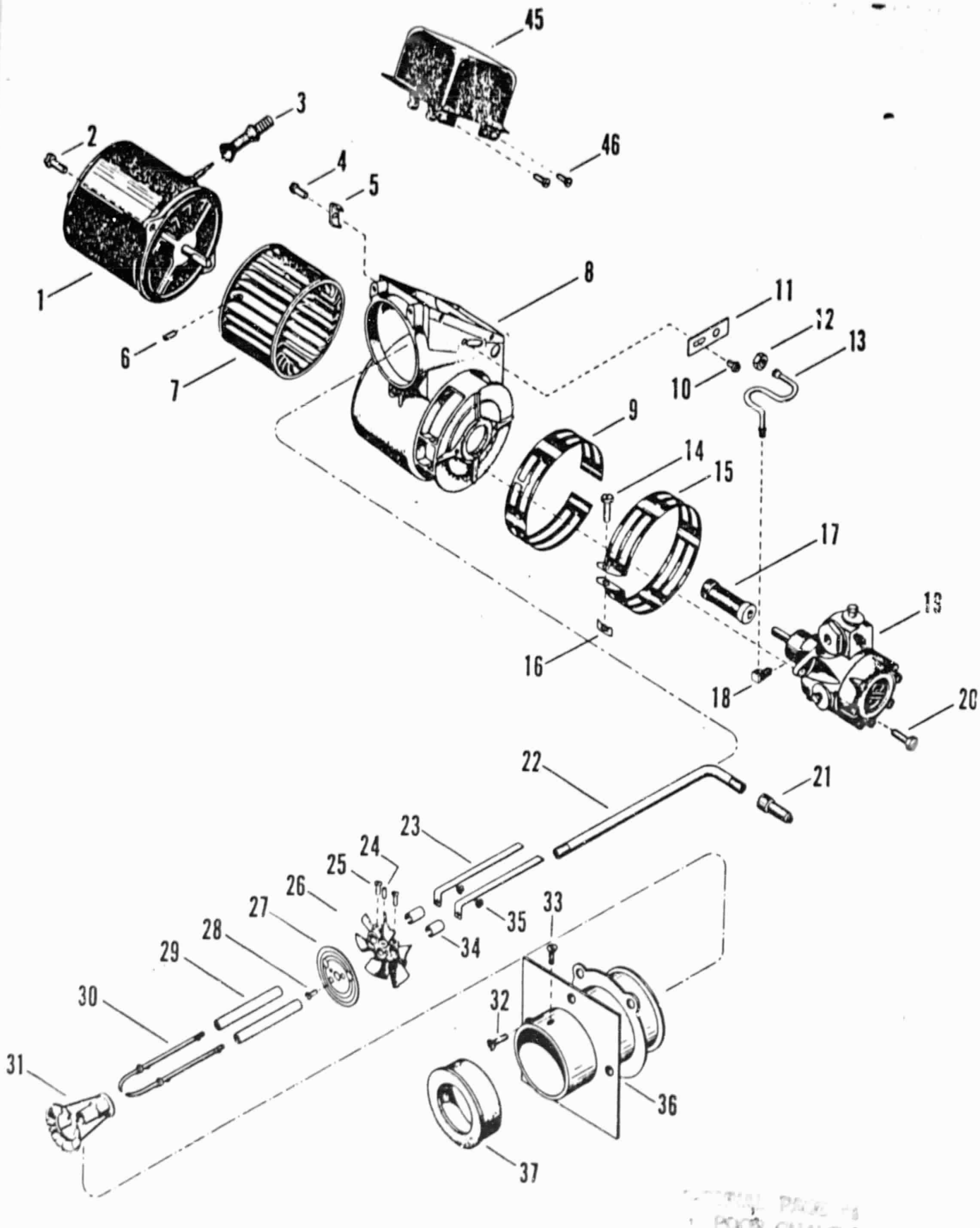
NOTICE TO INSTALLER

NEW BURNER SPEC FOR 676 BOILER

BOILER MODEL NUMBER	BURNER MODEL NUMBER	BURNER SPEC NUMBER	NOZZLE SIZE	NOZZLE ANGLE/TYPE	AIR CONE I.D. & TYPE	BAFFLE PLATE O.D.	ELECTRODE SUPPORT	FLAMELOCK SETTING FROM FACE OF AIR CONE
676	EH	163-57	3.50	80° Solid	3½" 8 Vane	None	Stabilizer (Reversed)	3/16" Ahead

. TS LIST - WEIL-MCLAIN CO.
/o SERIES BOILERS

ITEM	DESCRIPTION	ER 163-51	EH 163-53	EH 163-55	EH 163-57	EH 163-59
		BURNER MODEL NO. / BURNER SPEC NO.		PART NO.		
1	Motor 1/8 HP 1/115/60/1725	20382	-	-	-	-
-	Motor 1/4 HP 1/115/60/3450	-	20383	20383	20383	20383
2	Screw, Motor Mounting	12701	12701	12701	12701	12701
3	Cover, Motor Cord	13029	13029	13029	13029	13029
4	Screw, Trans. Hold Down Clip	13044	13044	13044	13044	13044
5	Clip, Trans. Hold Down	13038	13038	13038	13038	13038
6	Screw, Fan Set (Included W/Fan	-	-	-	-	-
7	Fan	20289T	20288	20288	20289T	20289T
8	Housing, Fan	4725	4725	4725	4725	4725
9	Band, Air - Inner	2669	2669	2669	2669	2669
10	Screw, Slot Cover	12697	12697	12697	12697	12697
11	Plate, Slot Cover	13392	13392	13392	13392	13392
12	Locknut, Oil Line	14296	14296	14296	14296	14296
13	Line, Oil	14452	14452	14452	14452	14452
14	Screw, Air Band	12701	12701	12701	12701	12701
15	Band, Air - Outer	2668	2668	2668	2668	2668
17	Coupling	20280	20280	20280	20280	20280
	Elbow	13494	13494	13494	13494	13494
19	Pump, Fuel - Sundstrand "J"	12336	13164	13164	13248	13248
20	Screw, Fuel Pump Mounting	12701	12701	12701	12701	12701
21	Fitting, Oil Pipe	14295	14295	14295	14295	14295
22	Pipe, Oil	13654	13654	13654	13654	13654
23	Buss Bar	12458	12458	12458	12458	12458
24	Screw, Set (Included W/Support)	-	-	-	-	-
25	Screw, Rd. Head #10-24 x 3/8"	12694	12694	12694	12694	12694
26	Support, Electrode - Stabilizer	14310	-	-	14310	-
-	Support, Electrode - Tripod(not as shown)	-	14308	14308	-	14308
27	Plate, Baffle	None	13408	13409	None	13407
28	Screw, Rd. Head #4-40 x 5/16"	12695	12695	12695	12695	12695
29	Insulator, Electrode	12354	12354	12354	12354	12354
30	Stem, Electrode	13163	13163	13163	13163	13163
31	Assembly, Flamelock	12988	12988	12988	12988	12988
32	Screw, Flange	12903	12903	12903	12903	12903
33	Screw, Air Cone #8-32 x 5/16"	12699	12699	12699	12699	12699
34	Bushing, Insulator	12408	12408	12408	12408	12408
35	Pal Nut	13110	13110	13110	13110	13110
36	Assembly, Air Tube & Flange Assy	21118	21118	21118	21118	21118
37	Cone, Air	13702	12329	12990	13702	13008
45	Transformer	20358	20358	20358	20358	20358
46	Screw, Trans. Hinge 5/16"-18 x 1/2"	13045	13045	13045	13045	13045
-	Assembly, Gun - Replacement	20734	20733	20733	20734	20733
	Assembly Gun - Symbol	637ER	637JR	637KR	638ER	637LR
	Assembly, Electrode - Replacement	13286	13286	13286	13286	13286
-	Gasket, Air Tube (not shown)	13745	13745	13745	13745	13745
-	Gasket, Flange (not shown)	12484	12484	12484	12484	12484



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FUEL OIL STORAGE TANK

The fuel oil supplier should be consulted regarding the fuel oil storage tank capacity for the burner firing rate employed. The rules of the National Board of Fire Underwriters' and any state or local codes which may apply should be followed in locating and installing the fuel oil tank. Underwriters' Laboratories requirements stipulate a bottom outlet on all 275 gallon and larger fuel oil tanks so the tank can be drained. This is to prevent the accumulation of condensate which causes the tank to rust. It is recommended that a water trap be installed at the tank outlet to prevent any water from entering the burner. There are a number of additives on the market that can be put into the fuel oil tank with the fuel oil; these additives hold the water in suspension and allow it to pass into the burner. Consult the local fuel oil supplier for information concerning the use of these additives.

FUEL OIL SUPPLY PIPING

A single stage fuel oil pump is furnished as standard equipment with the boiler. Refer to the fuel oil pump instruction sheet packaged in the envelope with these instructions for additional instructions on sizing and installing the fuel oil supply piping. The rules of the National Board of Fire Underwriters' and any state or local code requirements which may apply should be followed in locating, and installing the fuel oil piping.

For all installations, it is recommended that an oil filter of the proper capacity be installed in the fuel oil supply piping. Where practical, the oil filter should be located as close as possible to the oil storage tank, but not outside the building.

Copper tubing should be used in preference to iron pipe as it has less possibility for leaks and does not scale off on the inside. Flare type fittings are recommended as the soldered type may melt in case of fire.

The fuel oil piping from the tank to the burner should be sized no smaller than 3/8 inch O.D. copper tubing. Where the fuel oil tank is located a considerable distance from the burner, the fuel oil piping should be sized larger so that less friction loss will be encountered. Refer to fuel oil pump instruction sheet.

Connections to the buried fuel oil storage tanks must be made with swing joints to prevent the fuel oil piping from breaking in case the tank settles. If the job requirements stipulate that iron pipe be used, swing joints made up with elbows and nipples several inches long should be employed and located as close as possible to the tank. The swing joints should be installed so they will tighten as the tank settles.

Particular care should be exercised not to create an air trap in the fuel oil supply piping. There is always a slight amount of air in suspension in fuel oil and if traps are present, they will gradually fill with air and the fuel oil pump will lose its prime. It is good piping practice to install a tee and plug at the highest point in the fuel oil supply piping to aid in priming the fuel unit and in expelling air.

Manual shut-off oil valves should be provided in the fuel oil supply piping near the burner and at the tank or near where the fuel oil supply piping enters the building from an outside tank.

One-Pipe System: Where the fuel oil storage tank is located above the burner and gravity oil flow to the burner is permissible, a one-pipe fuel oil piping system may be employed. Refer to the fuel oil pump instruction sheet for preparing the pump for a one pipe system. The fuel oil piping should be connected at the bottom of the storage tank and should slope downward toward the burner at least ½ inch per lineal foot. The gradual slope in the fuel oil piping will help to prevent the formation of air pockets and the collection of air bubbles in the piping which could interfere with the operation of the burner. Where rigid iron piping is employed for the fuel oil supply piping, the supply piping should be run to a point directly below the burner and copper tubing should be used for connecting from the iron pipe to the inlet port on the fuel oil pump; where copper tubing is employed for the fuel oil supply piping, the tubing can be run directly to the inlet port on the fuel oil pump. One complete loop should be made in the copper tubing directly below the connection to the fuel oil pump; this loop will help to reduce transmission noise and prevent strain on the burner. A one-pipe fuel oil piping system is not recommended where it is necessary to lift the oil.

Two-Pipe System: A two pipe fuel oil piping system is recommended where it is necessary to lift the oil or where gravity flow of the oil to the burner is not permissible. Refer to the fuel oil pump instruction sheet for preparing the pump for a two-pipe system. Slip fittings should be installed at the top of the tank for both the supply and returning piping. The supply and return piping should be run to within four (4) to six (6) inches from the bottom of the tank. The return piping should be of the same size as the supply piping and run as directly as possible from the return opening in the fuel oil pump to the tank. The supply piping should be pitched slightly back toward the tank whenever possible and particular care should be exercised not to create air traps in the supply piping. If any manual shut off oil valves are installed in the return piping, a bypass relief to the tank with an oil pressure relief valve must be provided.

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If any part of the fuel oil tank is above the level of the burner, the supply piping should be run to a point above the burner where an anti-siphon device must be installed to prevent the flow of oil in case of a break in the oil line.

If the top of the fuel oil tank is below the level of the burner, use a check valve in the supply piping on the burner side of the manual shut off oil valve nearest the tank; the check valve will prevent the flow of oil back to the tank during the burner off period.

Where rigid iron pipe is employed for the fuel oil supply piping, the supply piping should be run to a p. directly below the burner and copper tubing should be used for connecting from the iron pipe to the inlet port . the fuel oil pump; where copper tubing is employed for the fuel oil supply piping, the tubing can be run directly to the inlet port on the fuel oil pump. One complete loop should be made in the copper tubing directly below the inlet connection to the fuel oil pump; this loop will help to reduce transmission noise and prevent strain on the burner.

FUEL OIL PIPING TEST

The fuel oil piping and all fittings should be thoroughly tested for leaks. Be sure to tighten the cover on the oil filter because the oil filter gasket sometimes shrinks. Check for any loose connections, kinks, and possible air pockets in the fuel oil piping. Tighten the packing nuts on any valves installed in the supply piping to minimize the possibility of drawing air into the piping while the pump is operating.

OPERATING AND SAFETY CHECK OUT SEQUENCE

1. Be sure the boiler and the heat distributing units are filled with water to the proper pressure and that the system is completely purged of all air (see Filling Steam and Water Boilers on the boiler operating instruction card).
2. Be sure the main electric switch in the oil burner electrical circuit is turned to the off position.
3. Disconnect the burner drawer oil line at the fan housing and remove the lock nut on the copper tube fitting. Remove the hold down screw in the upper right hand corner of the ignition transformer and swing the transformer to the left to provide access into the burner drawer.
4. Remove the burner gun assembly and refer to Oil Burner Specifications and Ratings Data on Page 3.
   a. Check the air handling parts and ignition electrodes to be certain they are properly adjusted for the size boiler being installed.
   b. Check the oil burner nozzle to make sure it is the proper size, type, and spray angle for the size boiler being installed.
   c. Be sure the nozzle is tightly secured to the nozzle adapter.
5. Rotate the blower wheel by hand to make certain that the burner motor and the fuel oil pump turn freely.
6. Insert the gun assembly into the burner drawer, replace the lock nut, and connect the burner drawer oil line to the gun oil pipe. Swing the ignition transformer to the right and replace the hold down screw in the upper right hand corner.
7. Oil the burner motor with one or two drops of good detergent free automobile oil.
8. Be sure there is sufficient fuel oil in the storage tank to supply the burner.
9. Make sure all manual oil valves in the fuel oil piping are open.
10. Move the indicator on the room thermostat above the actual room temperature so there is a call for heat.
11. Push the safety reset lever on the burner primary control and release.
12. Turn the main electric switch in the burner electrical circuit to the on position and the burner motor should start.
13. Prime the fuel oil pump by purging all the air out of the fuel line piping. If the burner primary control goes out on safety before all the air is completely purged from the fuel oil piping, it will be necessary to push the safety reset lever on the primary control to again start the burner motor.
    a. For one pipe fuel oil piping systems, purge the air out of the fuel line piping by loosening the bleed port fitting on the fuel oil pump and wait for the oil to flow.
    b. For two pipe fuel oil piping systems, air is automatically purged and diverted back to the tank by means of the return line. Loosen the bleed port fitting on the fuel oil pump and ascertain that all the air has been purged from the suction line piping.
14. When all the air has been eliminated from the suction line piping, turn the main electric switch in the boiler electrical circuit to the off position to stop the burner.
15. Install an oil pressure gauge in the gauge port on the fuel oil pump.
16. Adjust the air inlet band on the burner to about a half open position.
17. Turn the main electric switch in the boiler electrical circuit to the on position. The burner motor should start and a burner flame should be established.
18. While the burner is operating, check and if necessary, adjust the oil pressure. The normal oil operating pressure should be 100 P.S.I.G. To adjust the operating oil pressure, turn the adjusting screw clockwise to increase the operating oil pressure or counter-clockwise to decrease the pressure.
19. Adjust the air inlet band so that a clean yellow burner flame with slightly smoky tips is established. Refer to Burner Adjustment for adjusting the barometric draft control and for final adjustment of the burner flame. Use combustion test instruments for final adjustment of the burner flame.
20. While the burner is operating, move the indicator on the limit control below the actual boiler water temperature; the burner should stop. Move the indicator on the limit control to the normal setting and the burner should again start.
21. Test the action of the room thermostat and any additional safety controls.
22. Stop the burner and remove the oil pressure gauge from the gauge port on the fuel oil pump and replace the gauge port plug.
23. Before leaving the job, be sure the room thermostat, limit control, and any additional safety controls are properly set.

BURNER ADJUSTMENT

After making the necessary preliminary burner adjustments, use combustion test instruments for final adjustment of the burner flame after the boiler water temperature has been raised to approximately the design conditions. A smoke reading of a trace to a No. 1 on the Shell Bacharach scale is recommended. Set the air inlet band on the burner for the highest CO_2 consistent with a low smoke reading.

For the initial measurements, measure the per cent of CO_2 in the combustion gases over-fire and in the breeching. If the per cent of CO_2 measured in the breeching and over-fire are approximately equal, then any succeeding CO_2 measurements can be made in the stack. If the per cent of CO_2 measured over-fire is greater than the per cent of CO_2 measure in the breeching, locate and seal any areas of the boiler that are not gas-tight.

Insert a small flame mirror into the observation opening in the base front panel and view the flame front making sure the fire burns off the spinner (flamelock assembly) approximately 1/8 inch. If the fire burns on the spinner, pull the drawer assembly back; if the fire burns ahead of the spinner by more than 1/8 inch, move the gun assembly forward.

After a high CO_2 and a low smoke reading have been obtained, adjust the barometric draft control to provide at least a -0.02 inches water column over-fire draft. The draft in the breeching should also be measured to determine whether there is an abnormally high draft loss through the boiler. To obtain the draft loss through the boiler, subtract the measured over-fire draft from the measured breeching draft. Compare the calculated draft with the published draft loss under Ratings and Data on Page 3 for the size boiler employed. A high draft loss may be caused by overfiring or too much excess air and the result could be a low CO_2, high smoke reading, and back pressure. It may be necessary to again measure the per cent of CO_2 and take a smoke reading after the barometric draft control has been adjusted.

After the proper combustion test results are achieved, tighten the adjustment screw on the air inlet band to assure permanent positioning. Record the measurements obtained in the space provided on Page 2 of this manual.

DIRECTIONS FOR THE OPERATION AND CARE OF

OIL BURNER

Read Instructions Carefully and Hang This Card Near Burner for Future Reference

(A) TO START BURNER:

1. Check for oil in the storage tank.
2. Fuses in the main switch must be good.
3. Have oil burner switch open.
4. Set room thermostat about 10 degrees higher than room temperature to make sure the thermostat contacts are made. Limit control must be set high enough to make contact also.
5. Oil valve at the tank should be open and the check valve in return line properly installed so oil can return to tank.
6. Be sure nozzle of proper size for heater is in the adapter and tightly screwed down, and that the electrodes are properly spaced (See Manual). With heating plant door open, close the burner switch; and if wiring is properly done and all controls properly installed and adjusted, the burner should start. If not, check primary relay first to be sure it is properly set; and if burner does not start, recheck wiring and all controls thoroughly.
7. If burner is installed with a single oil line, the fuel unit will have to be purged of the entrapped air in the oil lines and fuel unit before the oil will flow to the nozzle (See fuel unit instruction sheet for this operation). If a return line is used, purging will not be necessary, although this will speed the starting of the burner if done. If this is done, the pump should pick up its oil in less than a minute (which is the setting for the lockout switch in the primary control). If ignition does not take place during this time, check the nozzle and electrodes.

STARTING BURNER AFTER IGNITION FAILURE.

1. Do not attempt to restart burner when excess oil has accumulated, when heating unit is full of vapors, or when the combustion chamber is very hot.
2. Press reset button on primary control and burner should start. Do not attempt this more than twice. If burner fails to operate call serviceman.

(B) FUEL OIL SPECIFICATIONS:

1. This burner is approved for oil not heavier than No. 2 The commercial standards for this oil are: Flash 110° minimum or legal; Maximum 230°F; Pour point 20°F; Water and sediment not more than 0.1%; Distillation temperature 600°F minimum and 675°F maximum at 90% of recovery. Viscosity at 100°F Saybolt Universal of 40 seconds maximum.

DO NOT USE GASOLINE, CRANKCASE OIL, OR ANY OIL CONTAINING GASOLINE.

(C) LUBRICATION:

1. The two oil cups on the oil burner motor should be lubricated every three months with a few drops of good grade light motor oil, No. 10 or 20 S.A.E.

(D) AT THE END OF THE HEATING SEASON:

1. Shut off electric current to burner at oil burner switch.
2. If oil strainer has not been cleaned recently, it should be removed and cleaned (consult instructions card furnished with fuel unit).
3. Oil storage tank should be kept filled to prevent water vapor from collecting. It is suggested the valve in the suction line be closed and oil burner switch opened. Oil storage tank should be cleaned every 2 or 3 years to remove any sediment or water that has collected in the tank. Your Fuel Oil Dealer has the equipment to do this.

(E) AT THE START OF THE HEATING SEASON:

1. It is advisable to have the Dealer inspect and service your burner for the coming heating season.
2. Heating plant, smoke pipe and chimney should be cleaned and checked for repairs.
3. Lubricate burner as directed under "C" above.
4. It is advisable to have the entire electrical system inspected before putting the burner into operation after it has been standing idle for the summer months. This should include primary relay, limit control, thermostat (clean dust from contact points), and check the electrodes for carbon and cracks in insulators, and corrosion on all terminals of the electrodes and transformer.

(F) EMERGENCY STOPS:

1. CUT OFF ALL CURRENT TO THE BURNER BY MOVING LEVER ON THE OIL BURNER ELECTRIC SWITCH TO THE "OFF" POSITION.

CAUTION

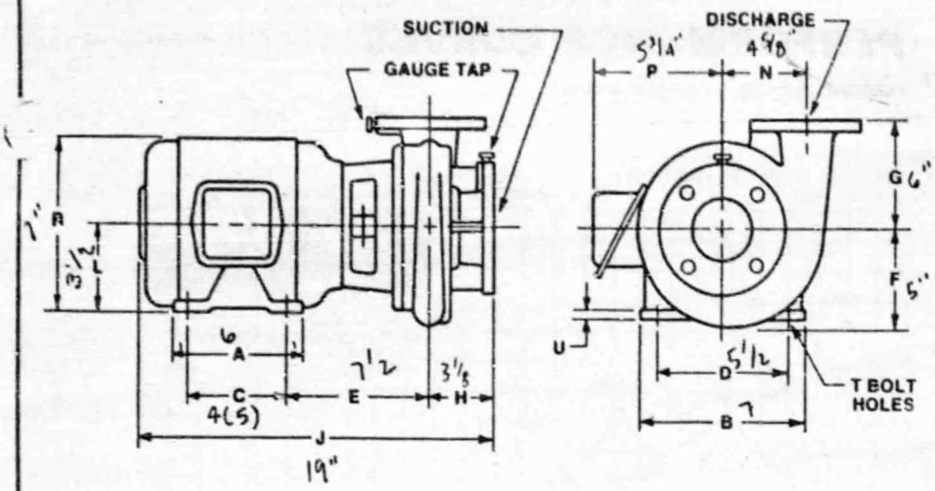
1. Check the gauge in oil storage tank periodically. Keep tank filled.
2. Don't attempt to burn garbage or refuse in your heating unit.
3. Don't fill storage tank while burner is operating.
4. Don't start burner if there is oil or vapor in the heating unit.
5. Don't attempt to burn crankcase drainings or crude oil.
6. DON'T TAMPER WITH BURNER OR CONTROLS—CALL YOUR SERVICEMAN.

DEALER .... Day Phone ....

Night Phone ....

Burner Serial No .... Date installed ....

BE SURE TO GIVE US SERIAL NUMBER OF BURNER WHEN ORDERING REPAIR PARTS



PUMP CONSTRUCTION:
BRONZE FITTED,
MECHANICAL SEAL

MOTOR: 200-208 OR
230/460 VOLT, 60 CYCLE
3 PHASE DRIPPROOF
ENCLOSURE

MAXIMUM WORKING PRESSURE 175 PSI

UNIT NO.	DISCHARGE	SUCTION	PUMP DIMENSIONS (INCHES)			
			F	G	H	N
311T	1½AB NPT	2 NPT	5	6	3⅛	4⅝
312T	1½AB NPT	2 NPT	5	6	3⅛	4⅝
313T	1½BB NPT	2 NPT	6¼	6½	3⅛	5¾
314T	1½BB NPT	2 NPT	6¼	6½	3⅛	5¾
315T	1½BB NPT	2 NPT	6¼	6½	3⅛	5¾
316T	2½A FLGD	3 FLGD	5½	6	3⅝	4 11/16
317T	3AB FLGD	4 FLGD	6¼	6	4⅛	5
318T	2½B FLGD	3 FLGD	6⅞	6¾	3½	6
319T	2½B FLGD	3 FLGD	6⅞	6¾	3½	6
3110T	4BB FLGD	5 FLGD	7⅝	7½	4¾	6⅝
3111T	4BB FLGD	5 FLGD	7⅝	7½	4¾	6⅝
3112T	4BB FLGD	5 FLGD	7⅝	7½	4¾	6⅝
3113T	1¼AB NPT	1½ NPT	4¾	5	2⅞	4½
3114T	1¼AB NPT	1½ NPT	4¾	5	2⅞	4½
3115T	1¼AB NPT	1½ NPT	4¾	5	2⅞	4½
3116T	2AB FLGD	2½ FLGD	5¼	6½	3	4¾
3117T	2AB FLGD	2½ FLGD	5¼	6½	3	4¾
3118T	2AB FLGD	2½ FLGD	5¼	6½	3	4¾
3119T	3AB FLGD	4 FLGD	6¼	6	4⅛	5
3120T	3AB FLGD	4 FLGD	6¼	6	4⅛	5
3121T	3AB FLGD	4 FLGD	6¼	6	4⅛	5

UNIT NO.	MOTOR			MOTOR DIMENSIONS (INCHES)										
	FRAME	H.P.	R.P.M.	A (Max.)	B (Max.)	C	D	E	J (Max.)	L	P	R	T	U
311T	143JM	1	1750	6	7	4	5½	7½	18⅞	3½	5¾	7	11/32	¼
312T	145JM	1.5	1750	6	7	5	5½	7½	18⅞	3½	5¾	7	11/32	¼
313T	145JM	2	1750	6	7	5	5½	7½	18⅞	3½	5¾	7	11/32	¼
314T	182JM	3	1750	6½	9	4½	7½	8¼	21¾	4½	8⅛	9¼	13/32	7/16
315T	184JM	5	1750	7½	9	5½	7½	8¼	21¾	4½	8⅛	9¼	13/32	7/16
316T	145JM	2	1750	6	7	5	5½	7 9/16	19⅜	3½	5¾	7	11/32	¼
317T	182JM	3	1750	6½	9	4½	7½	8½	23	4½	8⅛	3¼	13/32	7/16
318T	184JM	5	1750	7½	9	5½	7½	8⅜	22¼	4½	8⅛	9¼	13/32	7/16
319T	213JM	7.5	1750	7½	10½	5½	8½	9¼	24⅜	5¼	8¾	10¾	13/32	½
3110T	184JM	5	1750	7½	9	5½	7½	8¾	23¾	4½	8⅛	9¼	13/32	7/16
3111T	213JM	7.5	1750	7½	10½	5½	8½	9⅝	26	5¼	8¾	10¾	13/32	½
3112T	215JM	10	1750	9	10½	7	8½	9⅝	27½	5¼	8¾	10¾	13/32	½
3113T	145JM	3	3500	6	7	5	5½	7½	18½	3½	5¾	7	11/32	¼
3114T	182JM	5	3500	6½	9	4½	7½	8¼	21⅜	4½	8⅛	9¼	13/32	7/16
3115T	184JM	7.5	3500	7½	9	5½	7½	8¼	21⅜	4½	8⅛	9¼	13/32	7/16
3116T	182JM	5	3500	6½	9	4½	7½	8¼	21⅝	4½	8⅛	9¼	13/32	7/16
3117T	184JM	7.5	3500	7½	9	5½	7½	8¼	21⅝	4½	8⅛	9¼	13/32	7/16
3118T	213JM	10	3500	7½	10½	5½	8½	9⅛	23¾	5¼	8¾	10¾	13/32	½
3119T	213JM	10	3500	7½	10½	5½	8½	9 7/16	25¼	5¼	8¾	10¾	13/32	½
3120T	215JM	15	3500	9	10½	7	8½	9 7/16	26¾	5¼	8¾	10¾	13/32	½
3121T	254JP	20	3500	10¾	12½	8¼	10	13¾	33½	6¼	9⅞	13	17/32	¾

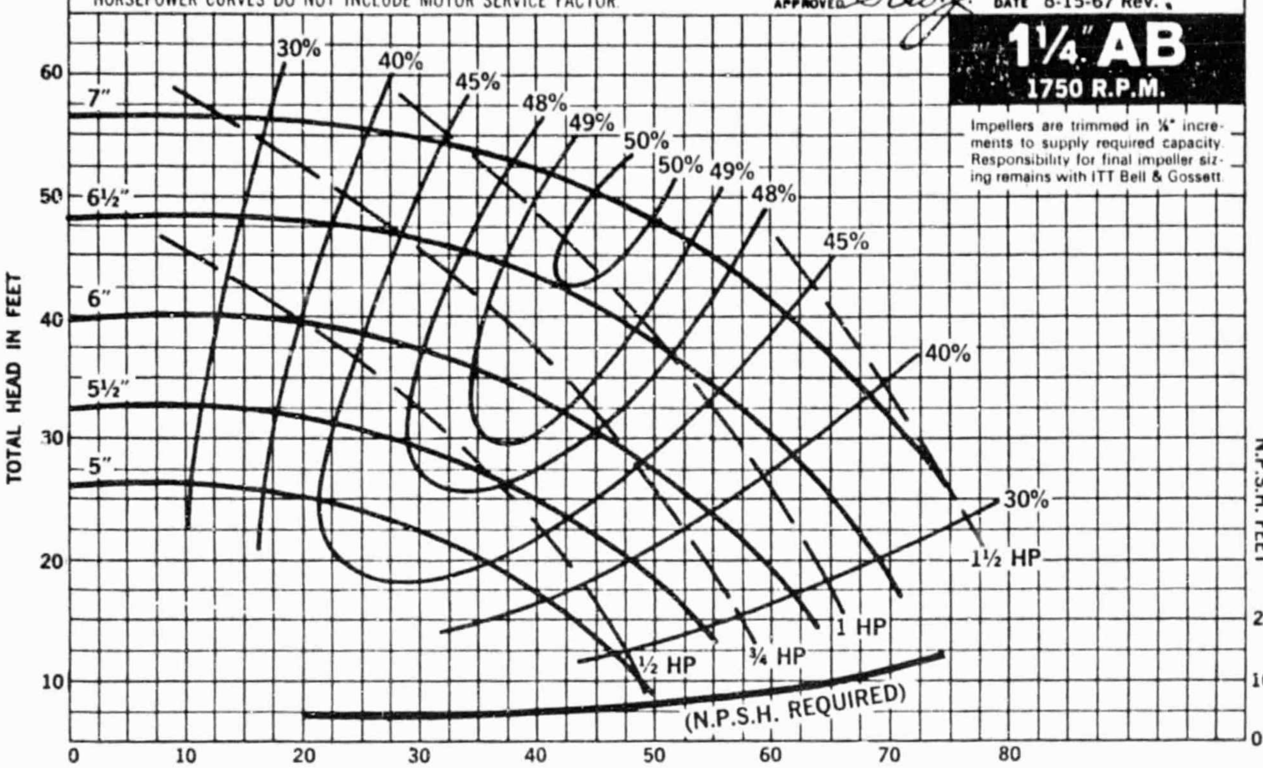
1531 *PERFORMANCE CURVES*

PERFORMANCE CHARACTERISTIC CURVE

FOR 1¼"AB CENTRIFUGAL PUMP FIG. NO. 1531 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY. HORSEPOWER CURVES DO NOT INCLUDE MOTOR SERVICE FACTOR.

APPROVED R.W.J. DATE 8-15-67 Rev.



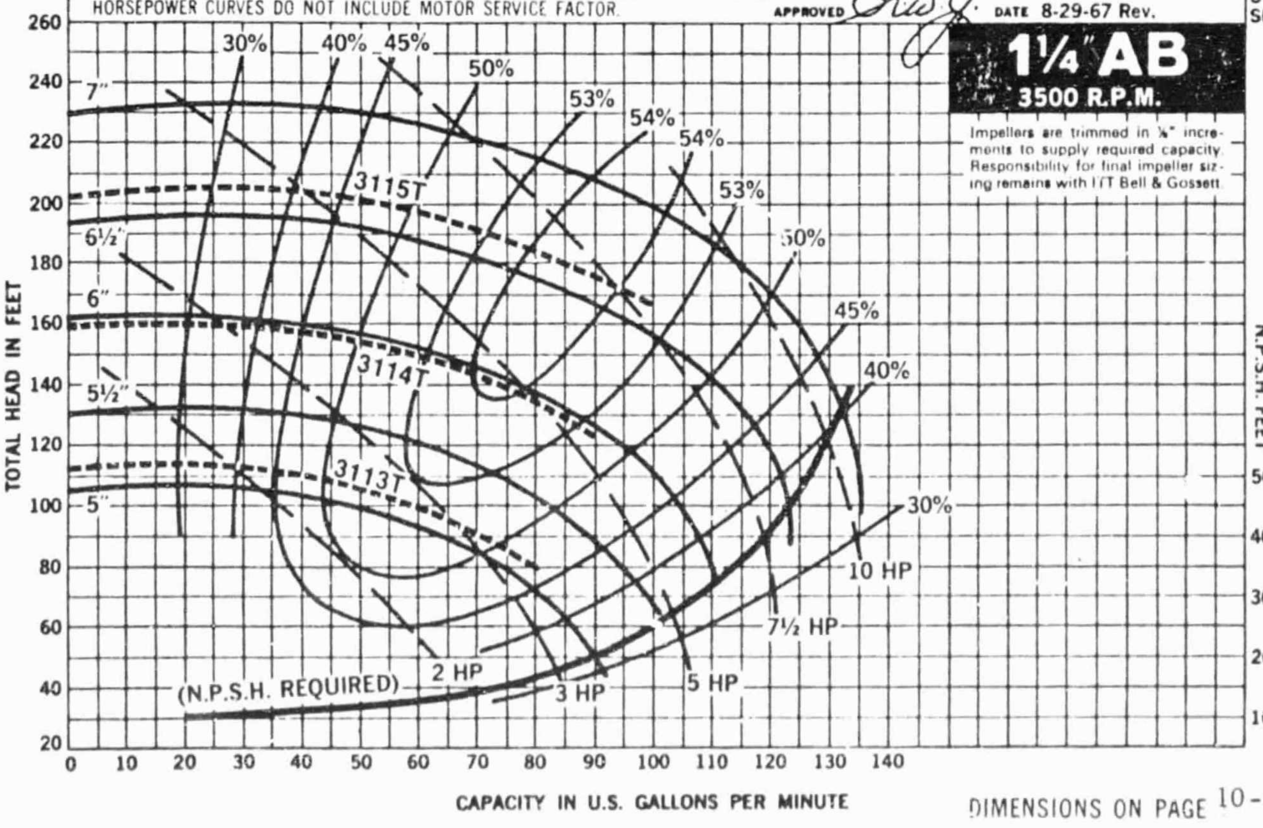
PERFORMANCE CHARACTERISTIC CURVE

FOR 1¼"AB CENTRIFUGAL PUMP FIG. NO. 1531 SPEED 3500 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY. HORSEPOWER CURVES DO NOT INCLUDE MOTOR SERVICE FACTOR.

APPROVED R.W.J. DATE 8-29-67 Rev.

DOTTED-IN CURVES REPRESENT STOCK PUMP SELECTIONS



DIMENSIONS ON PAGE 10-63

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