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DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150512 -

INSTALLATION PACKAGE MAXI-THERM S-101 HEATING MODULE

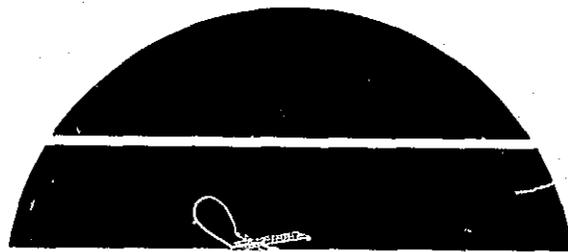
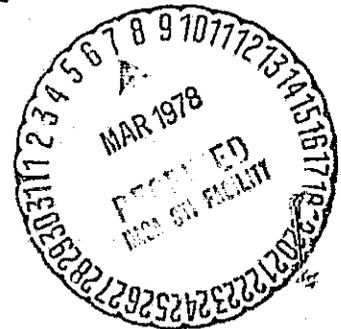
Prepared by

Sigma Research, Inc.  
2925 George Washington Way  
Richland, Washington 99352

Under Contract NAS8-32260 with

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

for the U. S. Department of Energy



(NASA-CR-150512) INSTALLATION PACKAGE  
MAXI-THERM S-101 HEATING MODULE (Sigma  
Research, Inc., Richland, Wash.) 33 p HC  
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16. ABSTRACT  This report covers the installation, operation and maintenance of the Maxi-Therm S-101 Thermosyphon Heating Module which was developed by Sigma Research, Inc., Richland, Washington, under Contract NAS8-32260.  The Maxi-Therm S-101 is a packaged unit, complete with air filter, blower, electrical controls, and a thermosyphon liquid-to-air heat exchanger. It is intended for use in residential solar heating systems and can utilize off-peak electrical power.			
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Revision C

OWNER'S

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

MAXI-THERM S-101 HEATING MODULE

SIGMA RESEARCH, INC.  
2950 George Washington Way  
Richland, Washington 99352

A NOTE TO THE HOMEOWNER:

We, at Sigma Research, are pleased that you have selected the Maxi-therm S-101 Heating Module as an integral part of your new solar heating system. It has been our desire to produce a unit of the highest quality so that you may enjoy many years of heating comfort. For this expressed purpose, the following booklet has been designed to assist you in all phases of installation, operation, and maintenance. To obtain the maximum benefit from the enclosed information, you should become familiar with all sections of this booklet. Should any questions arise which are not answered in the booklet, a representative of Sigma Research should be contacted at the address on the back cover. But before you install or operate the Maxi-therm, PLEASE READ PRECAUTIONS ON NEXT PAGE!

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PRECAUTIONS AND NOTES:

1. Water temperature used in the Maxi-therm shall not exceed 200°F (93°C).
2. A pressure-vacuum relief valve must be installed on the water storage tank to prevent possible system damage during filling, operating, or draining operations.
3. The Maxi-therm must be level for proper performance. See page 8.
4. Installation of sensors which restrict water or fluid flow will affect system performance and void warranty.
5. Protect the system from sub-freezing temperatures.
6. Do not operate the system without a filter installed in the inlet air stream.

## INDEX

SECTION I	INSTALLATION, OPERATION & MAINTENANCE MANUAL
SECTION II	SPECIAL INSTRUCTIONS FOR UNPACKAGING AND SET-UP
SECTION III	INSTALLATION DRAWING

SECTION I

INSTALLATION MANUAL  
FOR THE  
MAXI-THERM S-101  
HEATING MODULE

## A. INSTALLATION

The instructions given in the following sections have been prepared to assist you in the installation of your new Maxi-therm S-101 Heating Module. All instructions should be read carefully and understood before beginning installation. It is highly recommended that a qualified heating specialist or installer be employed to assist in performing this task since electrical, piping and air duct connections are required in the installation.

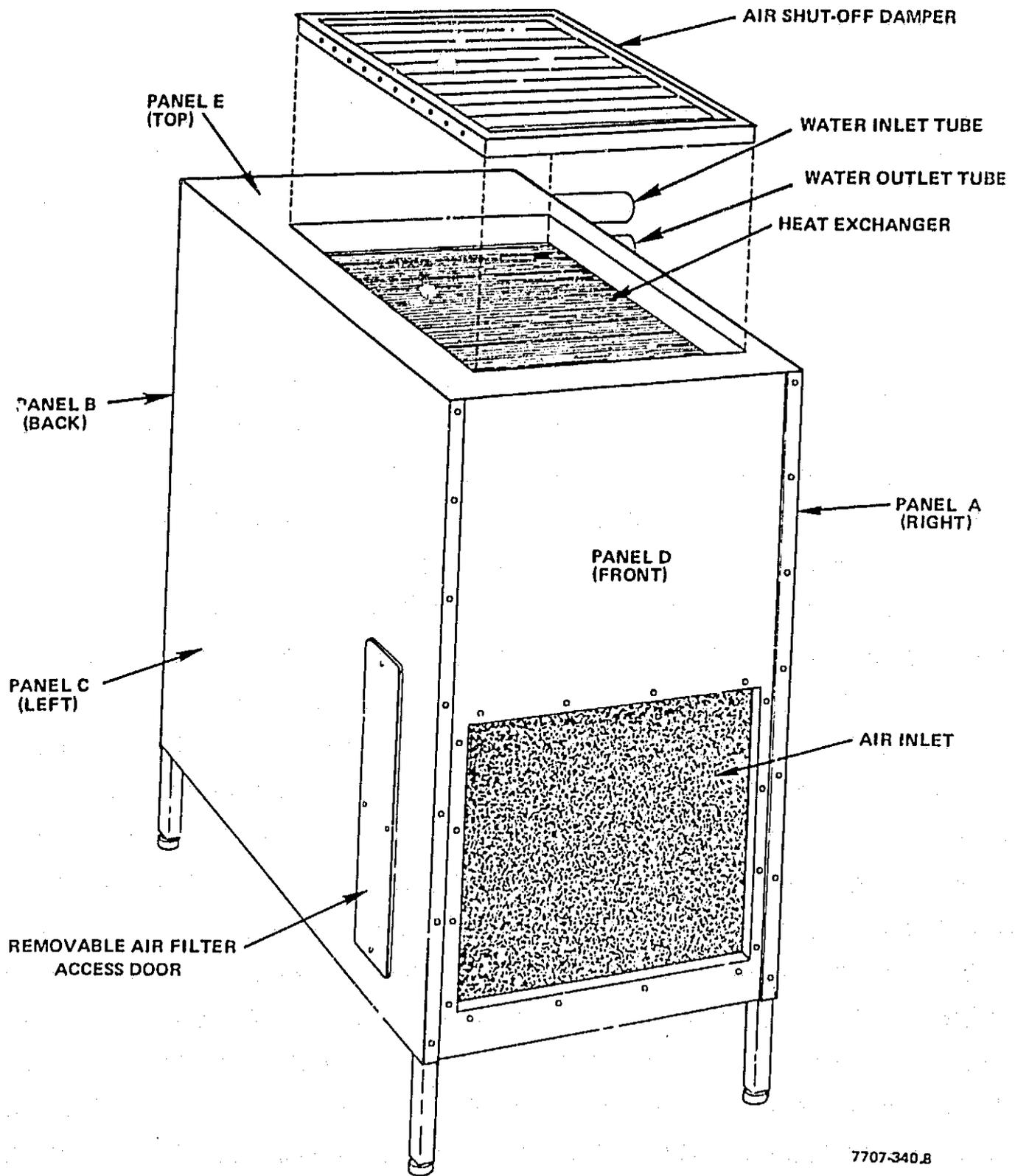
### 1. Initial Inspection of S-101 Module

After removing the shipping container, the heating module should be inspected thoroughly for shipping damage. Although small dents or scratches in the exterior cabinet (Figure A1) are undesirable in that they detract from the appearance, they will not necessarily affect module operation. Small scratches, in particular, can be touched up using the paint listed under S-101 Replacement Parts (Section C) in this booklet. If, after inspecting the module, you feel damage is excessive, Sigma Research, Inc. should be contacted immediately at the address shown on page 25 of this document. Arrangements can then be made for return of the module to the manufacturer.

Should damage to either the inlet or outlet water tubes (Figure A1) be apparent, the module will require return to the manufacturer for repair or replacement, preceded by written or telephone notice. Damage to other portions of the module, including the damper and outlet piping (Figures A1 and A2), can generally be repaired using replacement parts. These parts are available from Sigma Research, Inc. at the address listed and can be installed by a local service technician.

In addition to the inspection of the module, a check should be made to assure that all required parts are included with the unit. The following Table A1 lists all necessary parts, with Figures A2-A4 being included to aid in identifying a number of the parts.

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( ) PANEL NOTED WHEN FACING AIR INLET

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FIGURE A 1. SCHEMATIC VIEW OF PROTOTYPE MAXI-THERM S-101 W. CABINET INSTALLED.

TABLE A1. MAXI-THERM S-101 SHIPPING PARTS LIST

Item	Number Required
Module	1
Module Leg	4
Outlet Piping Assembly	1
Piping Flexible Connector	3
Piping Flexible Connector Clamp	6
Leg Attachment Bolt (3/8-16 x 1 inch)	12
Leg Attachment Bolt Washer (3/8 - Flat)	12
Electrical Spring Connector (wire twist nut)	1

## 2. Attachment of Legs

To prepare for attachment of the legs, the module should be lifted above the floor and placed on blocking having a minimum height of 8 inches. (\*)

It is important that the top blocking member run the full width of the module and extend slightly past Side Panels A and C (Figure A1) so that damage will not occur to the central portion of the module. The blocking should also be positioned approximately 8 inches away from Panels B and D on each end to allow sufficient clearance for attachment of the legs. Care should be exercised in blocking up the unit to insure a strong, stable support for the module. When attaching the legs, a second person should be present to assist.

When the module is resting securely on the blocking, the legs are then attached as shown in Figure A5. The bolts necessary for attachment are listed in Table A1 and supplied with the module.

Following installation of the legs, the module can be lifted off its blocking and allowed to rest on the support legs.

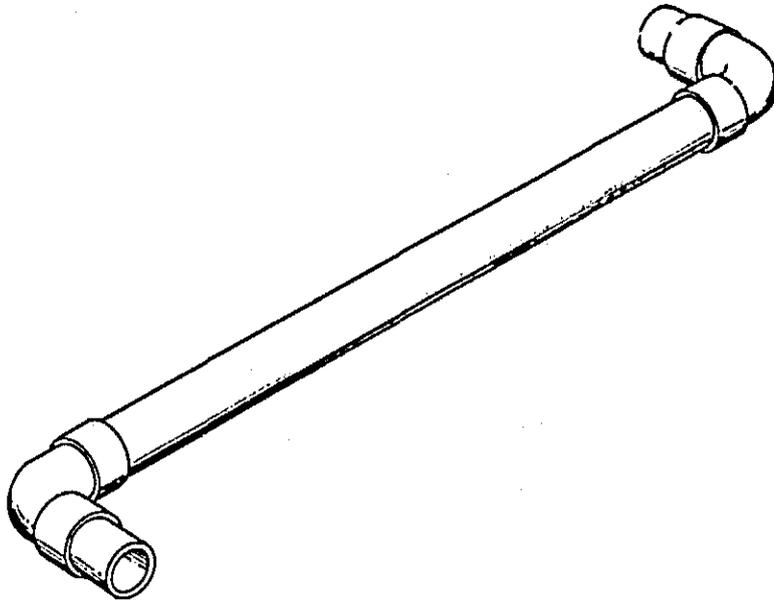
## 3. Installation of Piping

The outlet piping supplied with the module (Figure A2) should next be assembled, with a flexible coupling (Figure A3) being placed over the short tubes at each end of the piping. The coupling should be pushed on until contact is made between the end of the coupling and the elbow. This operation is sometimes easier if the outside of the short tube is coated with a thin layer of liquid detergent. Oil or a petroleum base lubricant should never be used since it may cause damage to the piping or other parts of the system.

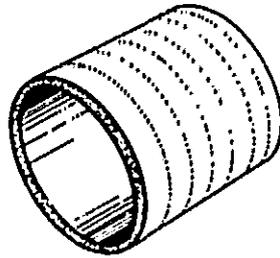
A hose clamp should be slipped over each of the flexible couplings and positioned approximately 1 inch from the end of each elbow and tightened.

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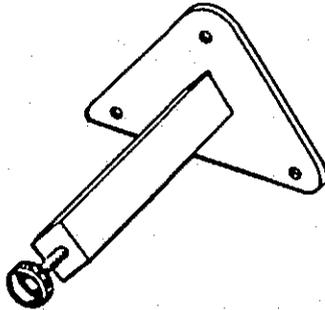
(\*) An alternate to blocking is to tilt the module to the left (with Panel C down) and attach the legs. Two people can tilt the module down and up for leg placement.



**FIGURE A2 OUTLET PIPING ASSEMBLY**



**FIGURE A3 PIPING FLEX COUPLING**



**FIGURE A4 MODULE LEG**

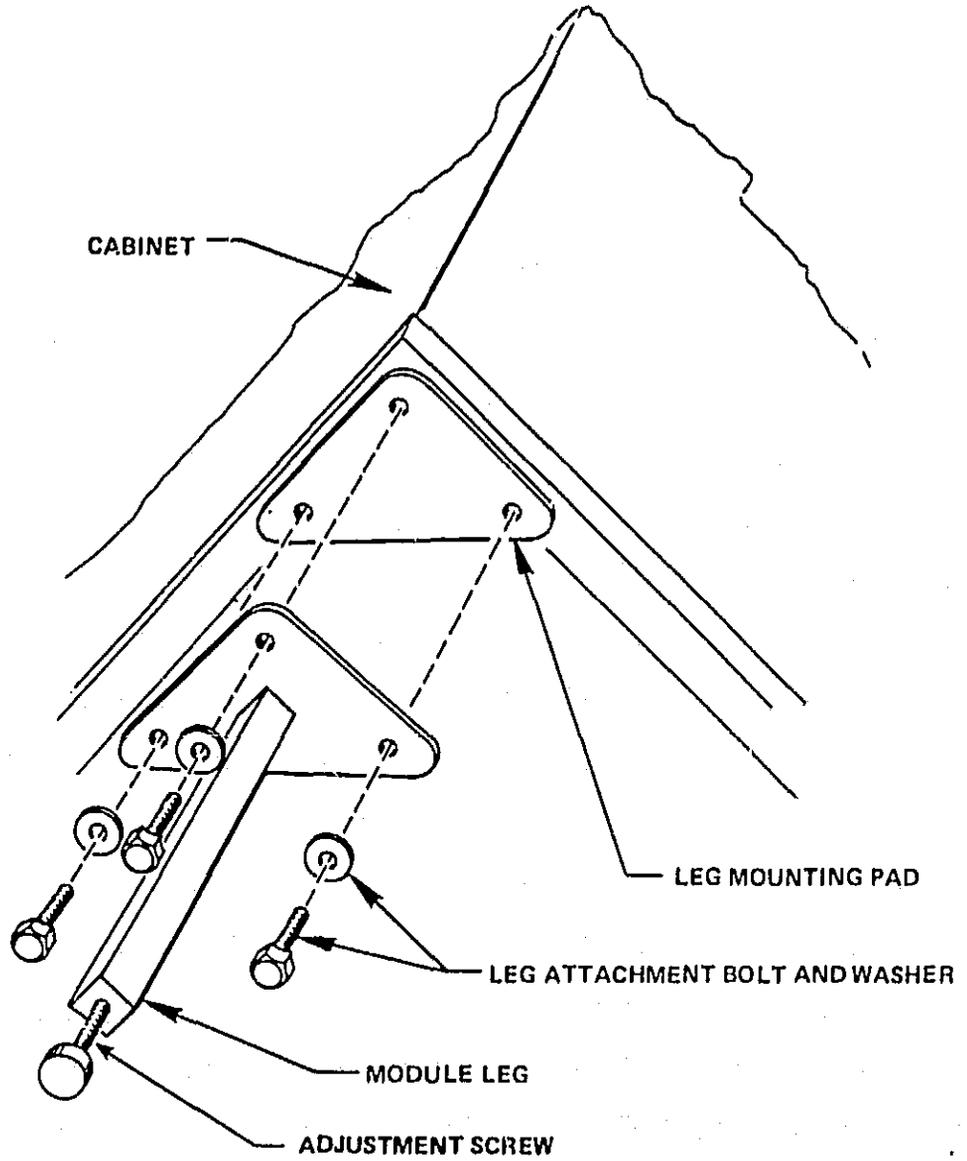


FIGURE A5. LEG ATTACHMENT DETAIL

Another hose clamp should be slipped over one of the couplings prior to attaching the coupling to the outlet (lower) tube on the heating module. This coupling should be pushed on until contact is made between the end of the coupling and Panel A. This hose clamp should not be tightened completely so that rotation of the outlet piping is possible.

A third flexible coupling should next be installed on the module inlet (upper) tube and pushed on until contact is made between the coupling and Panel A. This coupling should be securely attached with a hose clamp.

#### 4. Positioning and Connection to Tank

The S-101 heating module is now assembled and ready for connection to the thermal storage tank. The first step in this process is to carefully slide the unit into position beside the tank such that the flexible couplings line up with the tank inlet and outlet tubes attached to the storage tank (see Figure A11).

The remaining hose clamps should now be slipped over the flexible couplings (one per coupling) that will attach to the tank. The module can then be carefully slid up to the tank such that the flexible couplings just touch the ends of the tank inlet and outlet tubes. The module is now ready for final leveling.

The adjustment screw on each module leg (Figure A4) should first be adjusted to bring the flexible couplings into horizontal alignment with the tank inlet and outlet tubes. If the tank inlet and outlet tubes have been installed correctly, both sets of couplings and tubes should come into alignment at the same time. The module legs should then be adjusted to permit Panels A and C to come into vertical alignment (Figure A6) while maintaining the alignment between the tubes and couplings. The final alignment consists of adjusting the legs until the end containing Panel B is in vertical alignment with the end containing Panel D, as shown in Figure A7.

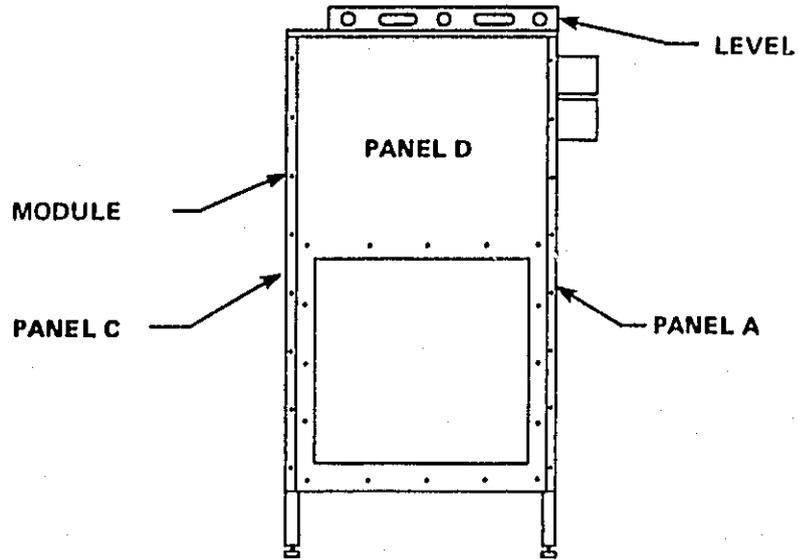


FIGURE A6. MODULE LEVELING - STEP 1

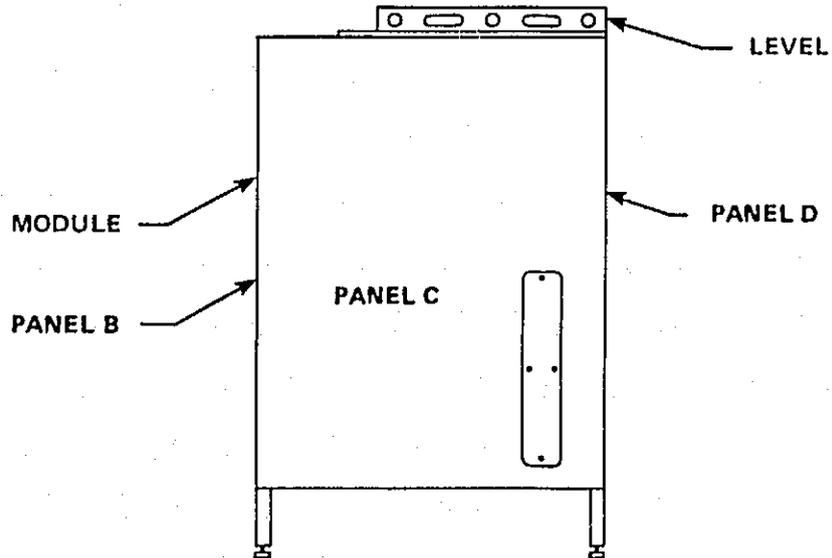


FIGURE A7. MODULE LEVELING - STEP 2

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When these operations are completed, the flexible couplings can be aligned with the inlet and outlet tubes and the module can be carefully slid toward the tank until the tubes within the couplings touch. The hose clamps can then be positioned approximately 1 inch from their respective end of the coupling and tightened. (Note: Do not forget the hose clamp at the top of the outlet piping which was not completely tightened previously.)

If the floor is relatively flat and level, the final movement of the module will not have affected either module orientation or stability. If the module shows some degree of instability, or "rocking," minor adjustments can be made to the legs. Recheck to insure the module is level and adjust as necessary. Note: It is important to accurately level the module to obtain proper performance.

#### 5. Installation of Duct Work

Duct work for the Maxi-therm S-101 is not included with the module, since these items are generally fabricated on-site by an HVAC or sheet metal specialist. To facilitate this operation, which should be performed following attachment of the Maxi-therm unit to the storage tank, dimensions and clearances for the inlet and outlet duct attachments are given in Figures A8 and A9.

#### 6. Electrical Connections

To permit operation of the Maxi-therm S-101, it is necessary to connect the module to both the home thermostat and a 115 VAC line. See Figure A10-A. As shown in Figure A10-B, the wires from the home thermostat are connected to the terminal block in the middle positions indicated. The three wires\* of the 115 VAC line from the breaker panel are then connected to the system within the on-off safety switch enclosure. The remaining wires in the circuit are furnished with the S-101 and have been installed at the factory.

To assure proper grounding of the module, it is essential that the home ground system (green wire) be connected to the ground screw in the switch enclosure. Failure to do so may create a shock hazard.

\*AWG size 14 or larger wire should be used.

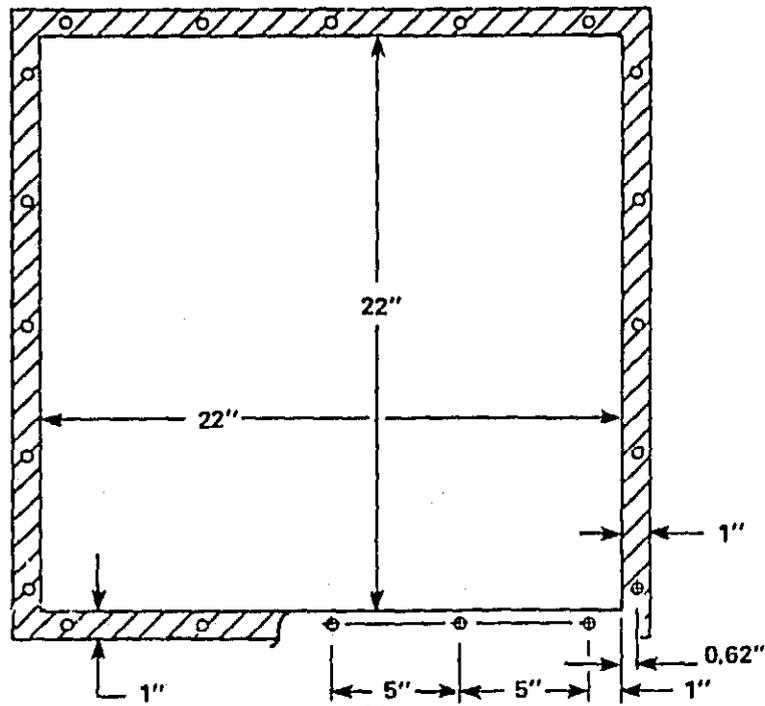


FIGURE A8. AIR INLET DUCT ATTACHMENT TEMPLATE. CROSS-HATCHED AREA INDICATES PERMISSIBLE POSITION FOR DUCT FLANGE.

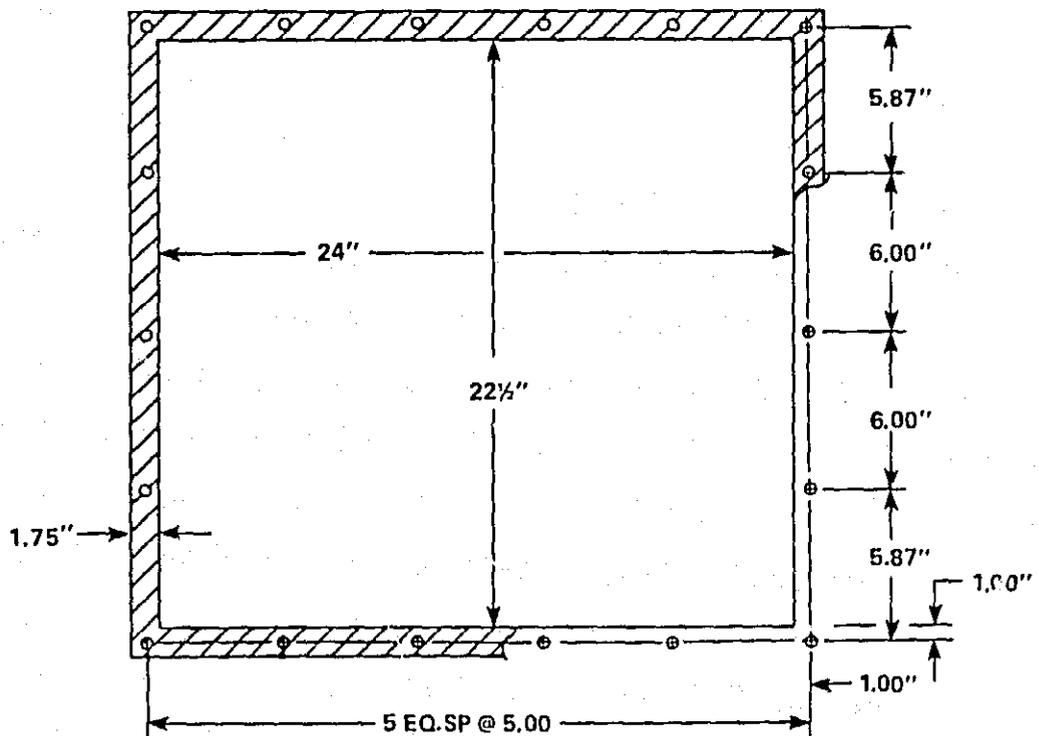
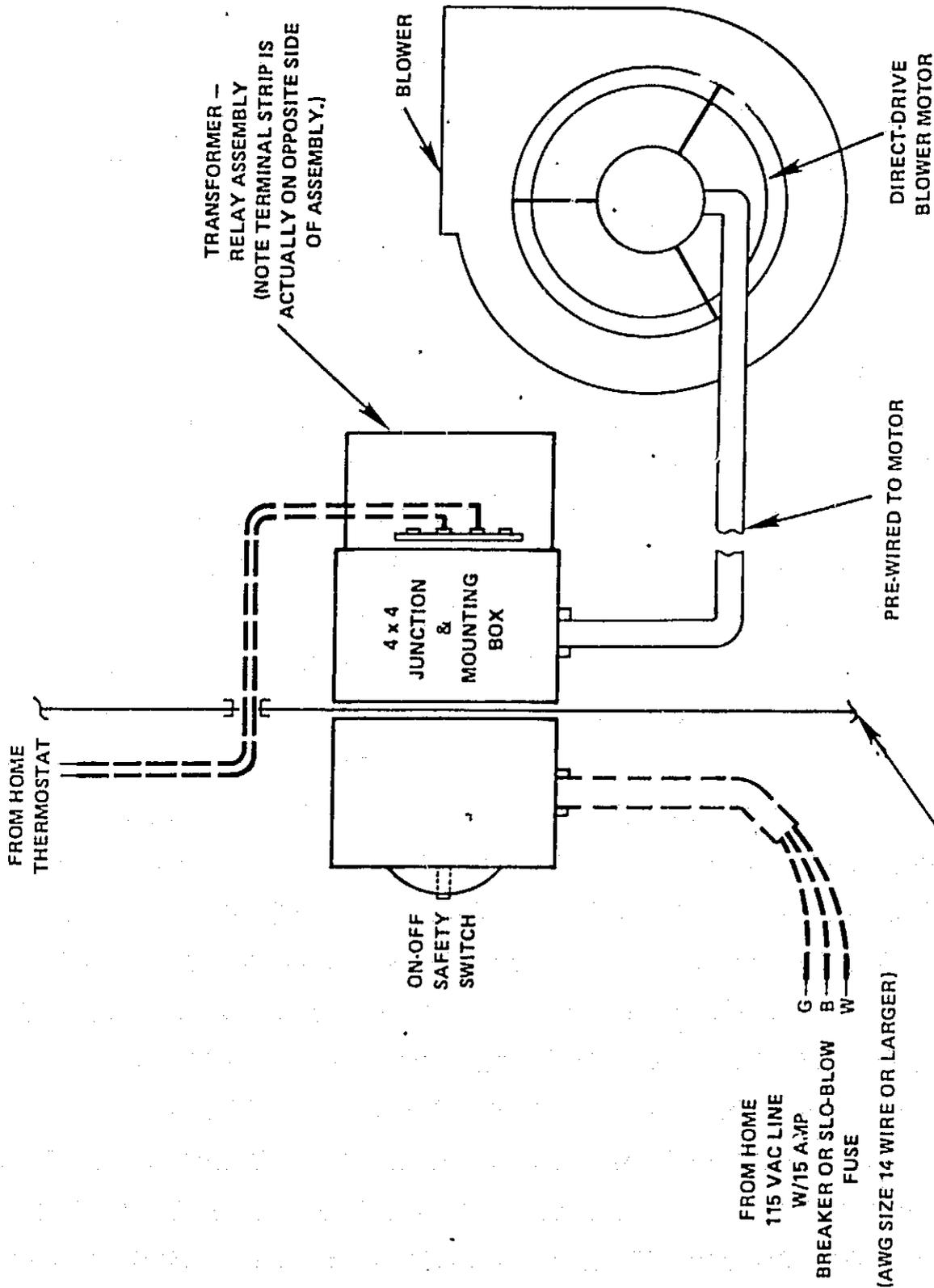


FIGURE A9. AIR OUTLET DUCT ATTACHMENT TEMPLATE. CROSS-HATCHED AREA INDICATES PERMISSIBLE POSITION FOR DUCT FLANGE.



PANEL B SEE FIGURE A11

FIGURE A10-A. ELECTRICAL CONNECTIONS OF MAXI-THERM TO HOME ELECTRICAL SYSTEM

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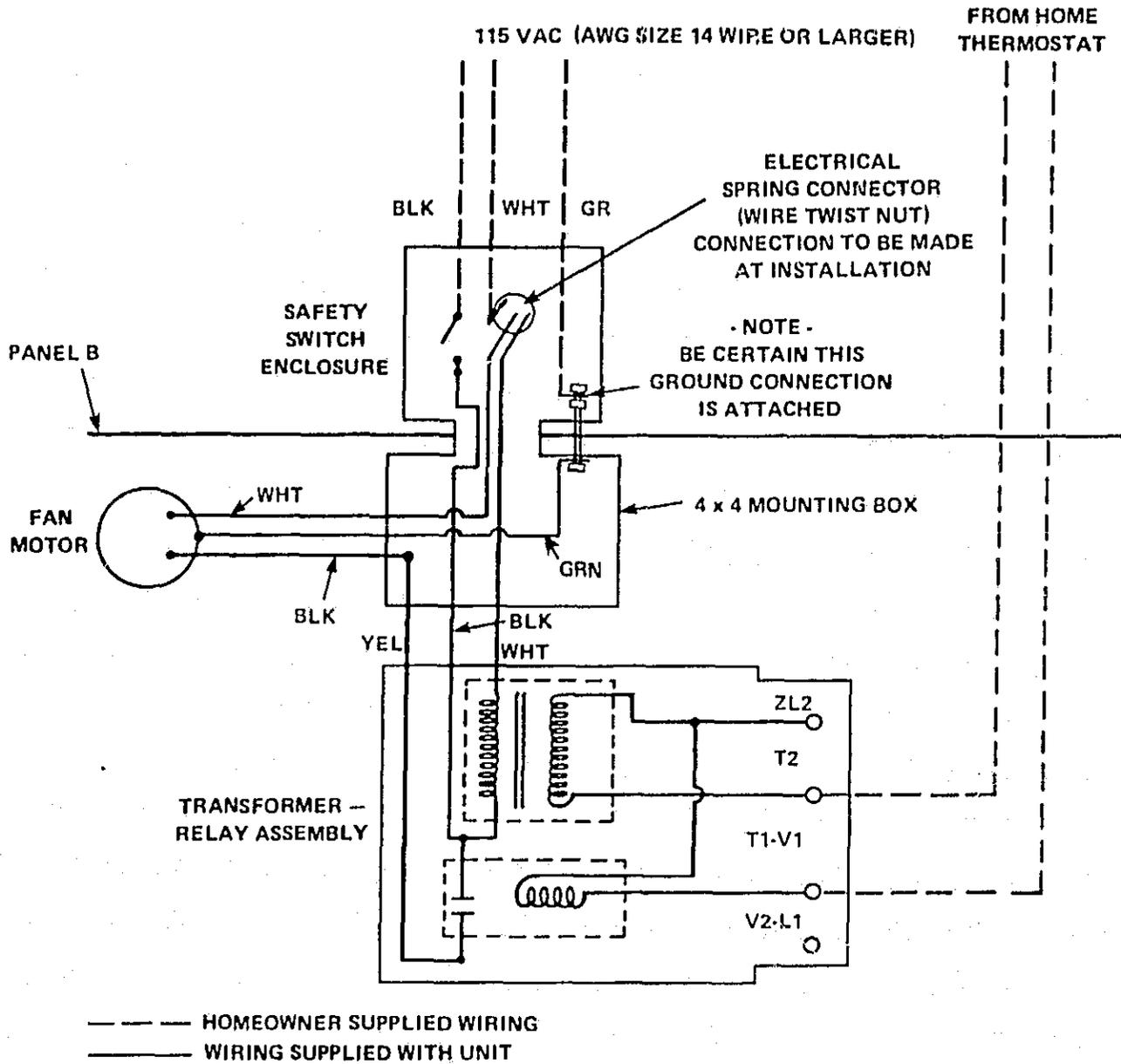


FIGURE A10-B. ELECTRICAL SCHEMATIC FOR MAXI-THERM S-101 HEATING MODULE

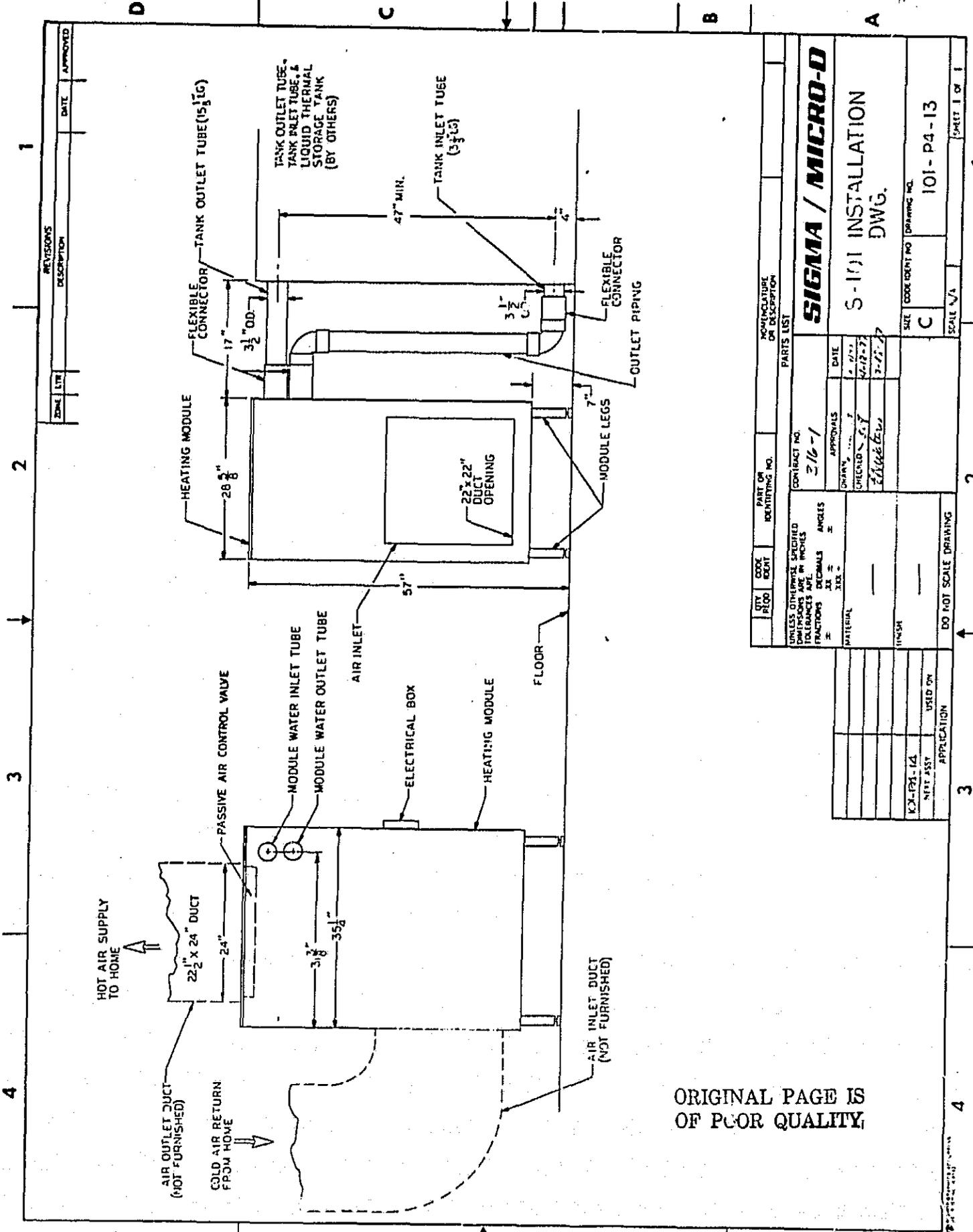
It is important, also, that the 115 VAC power supply for the module include a breaker switch or fuse so that power will be shut off in the event of motor failure or short circuiting. A separate 15 amp circuit should be provided for this purpose.

### 7. Initial Operation

Following completion of Step 6, the Maxi-therm S-101 will be ready for operation (Figure A11). After filling the storage tank and heat exchanger with water, all piping connections should be checked for leaks and clamps tightened as necessary. The electrical power line (115 VAC) can now be energized and the thermostat setting lowered to start the blower. If the blower does not start, the power line circuit should be opened (remove fuse or breaker) and all electrical connections rechecked. Should the unit still fail to operate after making this check, Section C (Maintenance) should be consulted. In the event that the blower operates, but air does not come out of the home's registers, Section C should be consulted. If further problems are encountered, or the problem is not covered in this booklet, a consultant at Sigma Research, Inc. should be contacted.

When the system has been checked thoroughly and operation is satisfactory, the piping system connecting the module and tank should be covered with foil-backed fiberglass insulation. A 2-inch thick blanket is recommended. Attachment may be made with commercial "duct" tape or an equivalent.

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QTY	COOK	PART OR IDENTIFYING NO.	NON-INCULCATIVE OR DESCRIPTION
FLOOR	BOAT		
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MATERIAL			
11254			
DO NOT SCALE DRAWING			
CONTRACT NO. 216-1		PARTS LIST	
APPROVALS	DATE	SIGMA / MICRO-D	
DRYAN	4-12-77	S-101 INSTALLATION DWG.	
CHECKED	4-12-77	DRAWING NO. 101-P4-13	
DATE	3-12-77	SCALE 3/4"	
NET ASSY		USED ON	
APPLICATION		DRAWING NO. 101-P4-13	
		SCALE 3/4"	
		SHEET 1 OF 1	

FIGURE A11 S-101 INSTALLATION DRAWING

SECTION II

OPERATION MANUAL  
FOR THE  
MAXI-THERM S-101  
HEATING MODULE

## B. OPERATION OF MAXI-THERM S-101 HEATING MODULE

This portion of the manual is included to acquaint you with a number of the operating features of the Maxi-therm S-101 heating module and also to make you aware of certain precautions that should be taken to insure trouble-free operation.

### OPERATING FEATURES

#### 1. Heat Output

The amount of heat transferred from the storage tank water to the room air is strongly dependent on the temperature of the tank. As tank temperature rises and falls, so does the heat output, as shown in Figure B1. At a nominal tank temperature of 140°F, the air temperature supplied to the room will be about 100-105°F if air duct losses are not excessive. If the unit does not appear to be providing sufficient heat, Section C (Maintenance) of this manual should be consulted. Caution: Water temperatures over 200°F (93°C) shall not be used in the Maxi-therm Heating Module.

#### 2. Normal Operating Sounds

Unlike conventional hot water heating systems, the Maxi-therm S-101 heating module does not require the use of a water pump and thus operates much quieter. Some sounds are still present, however, such as that from the blower and motor. In addition, a faint, metallic click may be heard when the blower starts and stops. This sound is due to the opening and closing of the air damper and should be considered normal.

#### 3. Single Thermostat--Instant-On Operation

The only control employed on the Maxi-therm S-101 module is the room thermostat. No valves or manual switches are used, so operation is as simple as that of a conventional furnace. Since an air damper is used to stop air flow when the blower is not operating, the heat exchanger remains hot so long as the tank water is hot. When the thermostat is turned up, or switches on automatically, the supply of hot air to the home registers is immediate and "heat-up" times are eliminated.

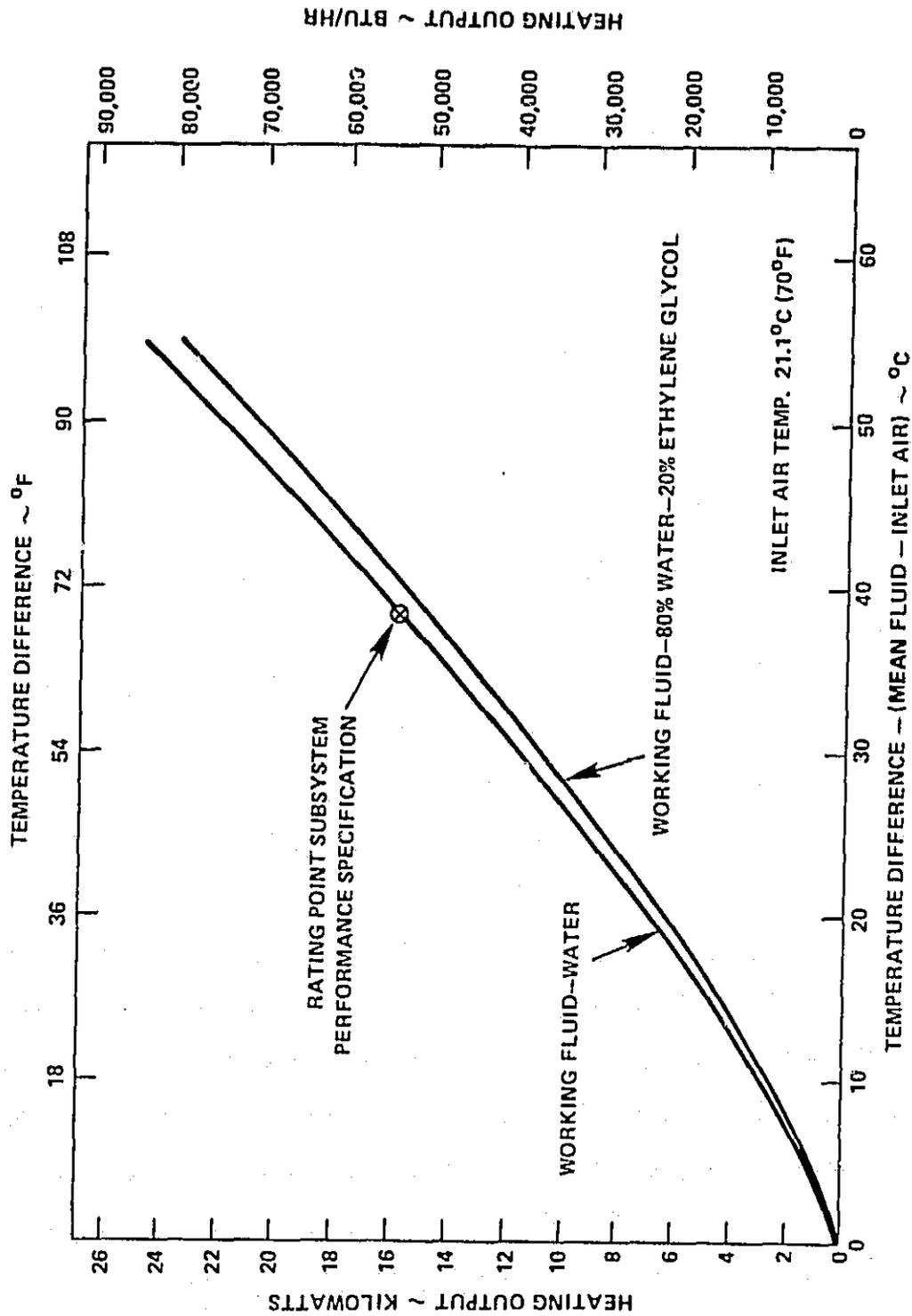


FIGURE B.1: MINIMUM PERFORMANCE CHARACTERISTICS OF MAX1-THERM MODEL S-101.

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## PRECAUTIONS TO INSURE TROUBLE-FREE OPERATION

### 1. Clean Water

The water, or water-ethylene glycol mixture used in the storage tank should be kept clean and free of contaminants at all times. This is essential to the performance of the module, since rust, dirt, grease, etc., can coat the inside of the heat exchanger tubes and thereby decrease module heat output. Should fouling be suspected, consult Section C (Maintenance) for repair details. Note: Use of ethylene glycol mixtures which contain leak stop additives may cause fouling of heat exchanger; hence, use of such solution or additives may degrade thermal performance below specified rating.

### 2. Freezing Temperatures

When filled with water, the module should never be exposed to freezing or subfreezing temperatures. This can cause damage to the heat exchanger tubes and render the unit inoperable. If an ethylene-glycol mixture is being used, the manufacturer's data should be consulted to determine the freezing point. Exposure to temperature at or below this level should be avoided.

### 3. Explosive Fumes

The Maxi-therm S-101 should never be operated in the presence of explosive fumes since the blower motor may cause ignition of the fumes.

### 4. Operation with Panels Removed

If it is ever deemed necessary to operate the module with a cabinet panel removed, caution should be exercised to insure that the blower and blower drive mechanism do not contact hands or clothing. Also, care should be exercised so that contact is not made with the electrical circuitry within the module. Under no circumstances, other than maintenance, should the module be operated with any of the panels or the electrical box cover removed.

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C

MAINTENANCE MANUAL  
FOR THE  
MAXI-THERM S-101  
HEATING MODULE

## C. MAINTENANCE

The maintenance portion of this manual is included to provide you with information needed in the performance of general module maintenance. In addition, information is also included to assist in making major repairs, should they become necessary with time. For many of the major repairs, it is recommended that qualified assistance be obtained.

### PERIODIC MAINTENANCE

The air filter in the Maxi-therm S-101 is accessible through the removable filter door cover (Figures A1 and C1). After removing the attachment screws and door, the filter can be slipped out and a new filter inserted. The module should never be operated with the filter removed, since dirt may become lodged in the blower motor and heat exchanger. The filter should be changed about every three months or as required. A new filter should be kept on hand for prompt replacement. (See Replacement Parts list the end of this manual).

Motor bearings should be oiled once a year with 10 to 20 drops of electric motor oil or nondetergent SAE 20W (Type ML) motor oil. To do this, turn off blower motor switch, remove Panel C (Figure A1 or A7), and remove rubber protective plugs located near top of front and back motor end shields. Be sure to replace rubber plugs after adding oil.

### MAJOR MAINTENANCE

Note: It is recommended that major maintenance and repairs be performed by a qualified service technician.

#### 1. Electric Motor and Blower

In the event of blower or blower motor failure, all electrical power to the module should be shut off and the Panel C removed. Before beginning the actual removal of the blower, it is necessary to disconnect the electrical wiring to the blower motor. Referring to Figure A10-B, it is necessary to disconnect the black and white wires from the electrical system contained within the electrical boxes mounted on Panel B. The connection for the black wire is within the 4 x 4 mounting box on the interior side of Panel B. The connection for the white motor lead is within the switch enclosure box. When the wires have been disconnected, the flexible boot and blower mounting bolts (4) can be removed to allow removal of the blower.

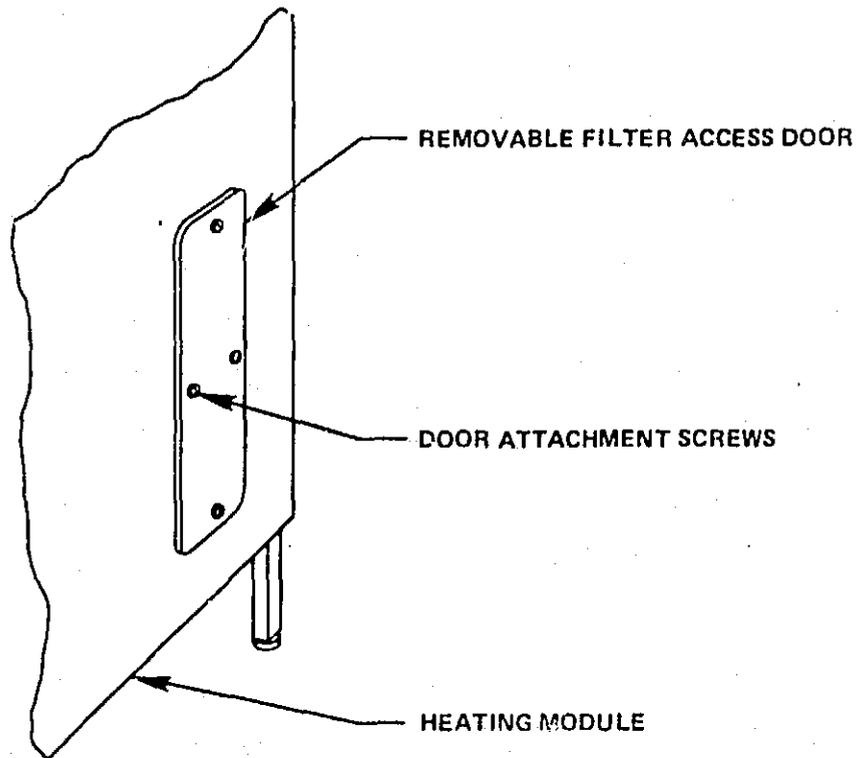


FIGURE C1 FILTER ACCESS DOOR DETAIL

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Should it be necessary to remove the blower motor from the blower, the square head set screw which fastens the fan to the motor shaft is loosened first, the three bolts on the triangular motor mount are then removed to permit the blower motor to slide out. For reassembly, these operations are reversed.

## 2. Heat Exchanger

Should repairs be necessary to the heat exchanger portion of the Maxi-therm S-101, electrical power to the module should be interrupted, followed by the removal of the outlet air duct, the air damper, and Panels A, and C. Disconnection of water piping is also required, with the tank first being drained to a level slightly lower than the heat exchanger outlet tube (Figure A11). The attachment bolts around Panel E exchanger can then be removed to permit Panel E and the exchanger to be raised away from the frame. Care should be exercised during this operation due to the weight of the exchanger. Two people should normally be present, with a third person doing the fastener removal. This will insure the safety of the workers, as well as that of the heat exchanger.

If the seal between the frame and heat exchanger (1/8" cork) is damaged during the removal procedure, a new unit can be fabricated from sheet stock or ordered from the factory.

Repairs to the heat exchanger, such as leak sealing or dirt removal, can generally be performed by a reputable automotive radiator shop. Should more extensive repairs be necessary, the factory should be contacted.

## 3. Troubleshooting Maxi-therm S-101 Heating Modules

Blower doesn't run - Three common failure points exist in a blower system which can render the unit inoperative. The first is the fuse or breaker switch. In particular, if the blower is on the same circuit as other electrical devices, overloading may cause power interruption. If

replacement of the fuse or breaker position results in immediate failure, and other devices on the circuit are deemed operable, then the second failure point, the blower electric controls, should be checked. With the fuse removed, the wiring and components within the module electrical box (Figure A10-B), as well as the home thermostat, should be tested. If all units pass the electrical tests, the blower motor must be removed and tested. The procedure for removing the motor was previously given under 1, above.

Blower Runs But Air Doesn't Come Out - The most common cause of a lack of air flow is a plugged air filter. Since this is also the easiest item to check, it should be done first. If the filter is found to be clean, or is replaced, and air still does not come out of the heating vents, the air damper should then be checked. This operation requires removal of the outlet air duct from the top of the heating module. After removing this duct assembly, the damper should be checked for damage, debris, or binding during opening and closing movements.

Blower Works But Cold Air Comes Out of Heating Duct - If the storage tank temperature is high enough to produce measurable heating, a blockage within the heat exchanger or piping system should be suspected. After draining the tank, all water connections should be removed and checked for obstructions. If none are found, the heat exchanger should be removed and tested. Removal procedure was previously outlined under Major 1 in this section.

If the cause of the problem cannot be located, or repaired, please contact Sigma Research, Inc. at the address listed on the back cover.

#### 4. Maxi-therm S-101 Replacement Parts List

The following list includes the specification, or model number, for replaceable parts found in the Maxi-therm S-101 heating module. Most are available from local outlets, or from the manufacturers listed. In addition to the suppliers listed, all parts are available from Sigma Research, Inc. at the address shown on page 25.

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<u>Component</u>	<u>Specification</u>	<u>Manufacturer</u>
Air Filter	Servodyne hi E 40a 24" x 24" x 4"	Servodyne Corporation P. O. Box 6447 Santa Rose, CA 95406
	DP440 - 24"x24"x4"	Air Guard Corporation Louisville, Kentucky
Blower Motor	Model 3M118 1/3 hp - 1100 RPM 4 spd. - 115 VAC	Dayton Electric Mfg. Co. Chicago, Illinois 60648
Blower	Model 4C058 9-1/2" wheel diameter Direct drive - 4 spd.	Dayton Electric Mfg. Co. Chicago, Illinois 60648
Air Damper	Model PRD 100 AL Frame Type OW 22-1/2" x 24" opening	Pacific Air Products Co. 3133 West Havard Santa Ana, CA 92704
Paint (Touch-Up)	DAR-71657	PPG Industries Detroit, Michigan 48235

#### D. WARRANTY

The Maxi-therm S-101 Heating Module is warranted against defects in materials and workmanship for a period of two years after date of purchase under normal home use. Any part which is determined to be defective in material or workmanship and returned to Sigma or authorized service location, as Sigma designates, will be repaired or replaced at Sigma's sole option. Sigma's liability in all events is limited to the original purchase price paid for the Maxi-therm S-101 Heating Module. This warranty is the sole warranty provided by Sigma and is in lieu of all other warranties expressed or implied.

If any problems do occur which you believe may be covered under this warrantee, we urge you to contact a Sigma representative immediately.

Further information can be obtained by contacting:

Maxi-therm Representative  
SIGMA RESEARCH, INC.  
2950 George Washington Way  
Richland, Washington 99352  
Tel: 509-946-0663

SPECIAL INSTRUCTIONS  
FOR UNPACKAGING AND SET-UP

REMOVAL FROM CRATE

AFTER MOVING THE CRATE NEAR THE LOCATION WHERE THE MAXI-THERM WILL BE INSTALLED, CAREFULLY LOOSEN AND REMOVE THE BOARDS WHICH FORM THE UPPER PORTION OF THE CRATE AND AVOID SCRATCHING OR DAMAGING THE PAINTED SURFACES.

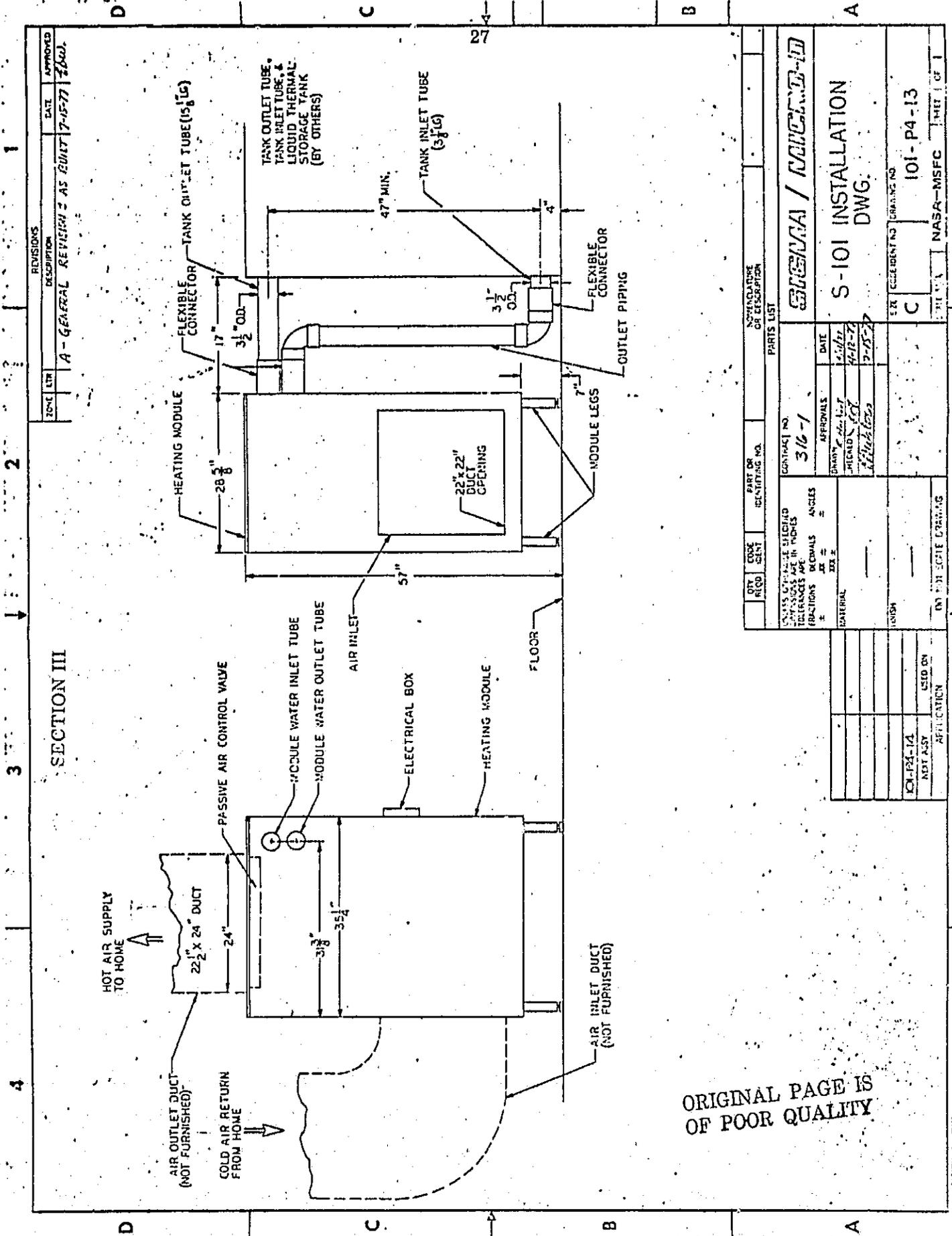
THE MAXI-THERM CAN NOW BE SEPARATED FROM THE PALLET AFTER REMOVING FOUR STUD BOLTS (ONE AT EACH CORNER) WHICH FASTENED THE UNIT TO THE PALLET FOR SHIPPING. (THESE BOLTS CAN BE DISCARDED AS THEY ARE NOT NEEDED AGAIN.)

PARTS

THERE ARE SEPARATE AND SMALL PARTS WHICH ARE USED IN SET-UP AND CONNECTION OF THE MAXI-THERM S-101. THESE PARTS ARE PACKAGED WITHIN THE UPPER SECTION OF THE MODULE AND ARE ACCESSIBLE BY REMOVAL OF THE FILTER ACCESS DOOR AND THE ENTIRE SIDE PANEL WHICH HAS THE NAMEPLATE ON.

INCLUDED WITH THOSE PARTS IS THE OWNER'S INSTALLATION, OPERATION, AND MAINTENANCE MANUAL WHICH INCLUDES FURTHER INSTRUCTIONS FOR INSTALLATION OF THE MAXI-THERM. PLEASE READ THOSE INSTRUCTIONS BEFORE PROCEEDING.

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REVISIONS		
ZONE LET	DESCRIPTION	DATE
A	GENERAL REVISION 2 AS BUILT 7-15-77 (360)	APPROVED

SECTION III

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NOTES		PARTS LIST	
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES FRACTIONS DECIMALS ANGLES		CONTRACT NO. 316-1	
DRAWN BY: [Signature]		APPROVALS: [Signature]	
CHECKED BY: [Signature]		DATE: 4-18-77	
MATERIAL:		DATE: 7-15-77	
FINISH:		DATE: 7-15-77	
UNIT PRICE DRAWING		EXHIBIT NO. 101-P4-13	
APPLICATOR: NASA-MSFC		NET OF 1	