DOE NASA CONTRACTOR REPORT

DOE NASA CR-150516

SYSTEM DESIGN PACKAGE - MAXI-THERM S-101 HEATING MODULE, PASSIVE HEAT EXCHANGER

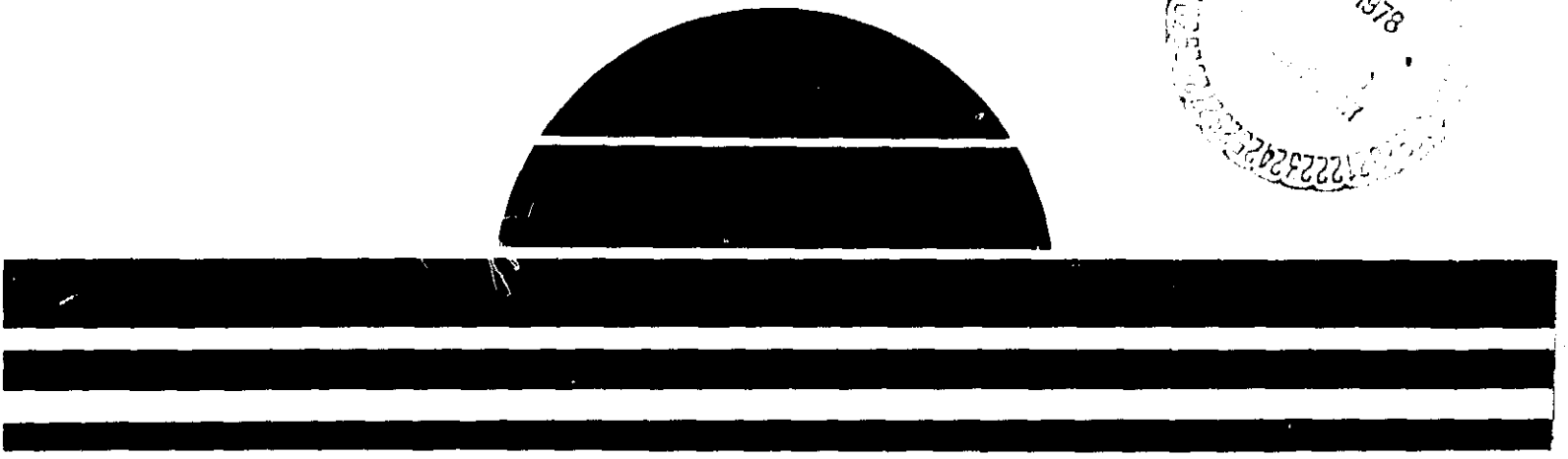
Prepared by

Sigma Research Inc.
2950 George Washington Way
Richland, Washington 99352

Under Contract NAS8-32260

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

for the U. S. Department of Energy



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This work was done under the technical management of James D. Hankins, Marshall Space Flight Center, Alabama.

16. ABSTRACT

This document is the specification which establishes the requirements for the design, installation, and performance of a passive heat exchanger module (Model S-101) with auxiliary heaters for use with solar heating systems. It designates the Interim Performance Criteria applicable to the subsystem and defines any deviations. This document also includes the manufacturing instructions and required materials and parts for the maxi-therm S-101 Heating Module.

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SUBSYSTEM PERFORMANCE SPECIFICATION
(DATA REQUIREMENT NO. 505-4, Type 1)

1.0 INTRODUCTION

This specification establishes the requirements for design, installation, and performance of a passive heat exchanger module (Model S-101) with auxiliary heaters for use with solar heating systems. It designates the Interim Performance Criteria applicable to the subsystem and defines any deviations.

2.0 APPLICABLE DOCUMENTS

Reference 1 (no number): Interim Performance Criteria for Solar Heating/Cooling Systems and Dwellings, January 1, 1975, U. S. Department of Housing and Urban Development.

3.0 APPLICATION OF INTERIM PERFORMANCE CRITERIA

The application of each paragraph of the Interim Performance Criteria to this subsystem is shown in Table 1-4. For convenience the particular paragraphs which are applicable to the passive heat exchanger are indicated by a solid dot (●) following the paragraph title.

4.0 DEVIATIONS FROM INTERIM PERFORMANCE CRITERIA

None.

5.0 GOVERNMENT FURNISHED PROPERTY

None.

6.0 GOVERNMENT DIRECTED REQUIREMENTS

Requirements and criteria as given in Reference 1 above and contract "Statement of Work - Exhibit A", except that therein Paragraph 3.0, item (5) "Have provisions to monitor performance" is deleted.

7.0 SUBSYSTEM GENERAL PERFORMANCE SPECIFICATION AND FEATURES

7.1 General

The Subsystem Performance Specification is detailed in the following paragraphs. It is for (1) a thermosyphon liquid-to-air heat exchanger subsystem for use in heating systems for single-family dwellings and (2) electric resistance heating element(s), which will be installed with the passive heat exchanger, to provide system backup heat. The subsystem is a pumpless heating module which, when attached to a water storage tank, comprises a self-contained heating unit for a single-family residence. The architect, engineer, or consumer is required to supply the storage tank, and two pipes welded to the tank for coupling to the thermosyphon inlet and outlet tubes. (A drain valve at the bottom of the storage tank is recommended but not mandatory for passive heat exchanger operation.) Provisions would also be required for mounting the electric auxiliary heater(s).

7.2 Heating Output

The performance of the Maxi-therm Model S-101 passive heat exchanger shall equal or exceed the rating point shown on Figure 1-4.1 and as given in Paragraphs 7.2.1, 7.2.2, and 7.3.

7.2.1 With water in system

tank fluid temperature mean	140°F
inlet air flow rate	1640 cfm
inlet air temperature	70°F
inlet air relative humidity	≤50% (58°F wb)
total air heating capacity	≥54,000 Btu/hr

7.2.2 With 20% ethylene glycol-water in system, all other conditions as in 7.2.1, the total air heating capacity shall be ≥ 50,900 Btu/hr as demonstrated by analytical correlations and test data for water as given in 7.2.1.

7.3 Auxiliary Heater

Electric resistance heater(s) shall be provided to supply auxiliary heat with a capacity of ≥41,000 Btu/hr (12 kW) or greater.

7.4 Physical Arrangement

The general arrangement and physical dimensions are shown on the S-101 Installation Drawing, as shown in Figure 1-4.2. The heating module width and length dimensions may be made smaller if tank connection dimensions are not compromised and if all other performance criteria are met.

7.5 Warranty

The passive heat exchanger subsystem shall be guaranteed against defects in materials and workmanship for a period of two years. 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 optional purchase price per subsystem as set forth in Article XIII of the contract.

TABLE 1-4.2

SPECIFICATION NO. 3068
REVISION 0
DATE 5/23/77

RESIDENTIAL SUBSYSTEMS. INTERIM PERFORMANCE CRITERIA SUMMARY

SUBSYSTEM APPLICATION

A – APPLICABLE TO TYPE SYSTEMS INDICATED

NA – NOT APPLICABLE

TYPE SYSTEMS

H - HEATING

HC – HEATING AND COOLING

HW – HOT WATER

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS H	HC	HW	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS H	HC	HW
1.1 H and HC Performance	NA			1.3.1 Collector Efficiency	NA		
1.1.1 Heating Design Temperatures	NA			1.4 Thermal Storage	NA		
1.1.2 Cooling Design Temperatures	NA			1.4.1 Storage Capacity	NA		
1.1.3 Relative Humidity and Water Vapor Pressure ●	A			1.5 Habitability of Occupied Spaces	A		
1.1.4 Solar Contribution	NA			1.5.1 Heat or Humidity Transfer Effects	A		
1.1.5 Operation Impairment ●	A			1.6 Energy Transport Efficiency ●	A		
1.2 HW System/Subsystem Performance	NA			1.6.1 Thermal Losses and Electrical Power ●	A		
1.2.1 Water Design Temperature	NA			1.7 Control	NA		
1.2.2 Storage Design Capacity	NA			1.7.1 Installation and Maintenance	NA		
1.2.3 Solar Contribution	NA			1.7.2 Manual Adjustment	NA		
1.2.4 Operational Impairment	NA			1.7.3 Inhabited Space Temperature	NA		
1.3 Collector Performance	NA			1.7.4 Hot Water Temperature	NA		
				1.8 Auxiliary Energy	NA		
				1.8.1 Design Loads	NA		

TABLE 1-4.2 (Continued)

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RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
2.1 System Design Conditions ●	A			2.3.1 Pressure Test: Nonpotable Fluids ●	A		
2.1.1 Equipment Capabilities ●	A			2.3.2 Pressure Test: Potable Water	NA		
2.1.2 Noise or Erosion - Corrosion ●	A			2.3.3 Air Transport Systems ●	A		
2.1.3 Operating Conditions ●	A			2.4 Collector Adjustment	NA		
2.1.4 Fluid Flow in Collectors	NA			2.4.1 Orientation and Tilt	NA		
				2.4.2 Mutual Shadowing	NA		
2.1.5 Entrapped Air ●	A			2.5 Subsystem Isolation	NA		
2.1.6 Thermal Expansion of Fluids ●	A			2.5.1 Shutdown in Multi-family Housing	NA		
2.1.7 Pressure Drops ●	A						
2.1.8 Condensate Removal	NA			2.6 Heat Transfer Fluid Quality ●	A		
2.2 Mechanical Stresses ●	A			2.6.1 Liquid Quality ●	A		
				2.6.2 Air Quality ●	A		
2.2.1 Vibration Stress Levels ●	A			2.6.3 Fluid Treatment	NA		
2.2.2 Vibration from Moving Parts ●	A			2.6.4 Freezing Protection ●	A		
				2.7 Piping Supports ●	A		
2.2.3 Water Hammer	NA			2.7.1 Applicable Plumbing Standards ●	A		
2.2.4 Vacuum Relief Protection ●	A			2.8 Excessive Pressure and Temperature Protection ●	A		
2.2.5 Thermal Changes ●	A			2.8.1 Relief Valves and Vents ●	A		
2.2.6 Flexible Joints ●	A						
2.3 Leakage Prevention ●	A			3.1 Structural Design Basis ●	A		

TABLE 1-4.2 (Continued)

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RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
3.1.1 Applicable Standards ●	A			3.8.1 Foundation Settlement	NA		A
3.1.2 Service Loads ●	A			3.9 Ponding Condition	NA		
3.2 Failure Loads and Load Capacity ●	A			3.9.1 Design Provisions	NA		
3.2.1 Ultimate Load Combinations	A			4.1 Plumbing and Electrical Installation ●	A		
3.2.2 Ice Loads	NA			4.1.1 Plumbing Codes ●	A		
3.2.3 Vehicular Loads	NA			4.1.2 Electrical Codes ●	A		
3.2.4 Load Capacity	NA			4.2 Fail-Safe Controls ●	A		
3.3 Damage Control	NA			4.2.1 System Failure Prevention ●	A		
3.3.1 Resistance to Damage	NA			4.2.2 Automatic Pressure Relief Valves ●	A		
3.3.2 Glazing Design	NA			4.3 Fire Safety ●	A		
3.4 Cyclic Loads	NA			4.3.1 Applicable Fire Standards ●	A		
3.4.1 Deflection Limitations	NA			4.3.2 Penetrations through Fire Rated Assemblies	NA		
3.5 Cutting of Structural Elements	NA			4.4 Toxic ●	A		
3.5.1 Design Provisions	NA			4.4.1 Provisions of Catch Basins	NA		
3.6 Creep and Residual Deflection	NA			4.4.2 Detection of Toxic and Flammable Fluids	NA		
3.6.1 Deflection Limitations	NA			4.5 Safety	NA		
3.7 Hail Resistance	NA			4.5.1 Emergency Egress and Access	NA		
3.7.1 Hail Size and Loading	NA			4.5.2 Identification and Location of Controls ●	A		
3.8 Constraint Loads	NA						

TABLE 1-4.2 (Continued)

SPECIFICATION NO. 3068
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RESIDENTIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

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RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
4.6 Protection of Potable Water & Circulated Air ●	A			5.2.3 Thermal Cycling Stresses	A		
4.6.1 Contamination by Materials	NA			5.2.4 Leakage ●	A		
4.6.2 Separation of Circulation Loops ●	A			5.2.5 Deterioration of Gaskets and Sealants ●	A		
4.6.3 Backflow Prevention	NA			5.2.6 Transmission Losses Due to Outgassing	NA		
4.6.4 Growth of Fungi ●	A			5.3 Chemical Compatibility of Components ●	A		
4.7 Excessive Surface Temperatures ●	A			5.3.1 Materials/Transfer Fluid Compatibility ●	A		
4.7.1 Protection from Heated Components ●	A			5.3.2 Corrosion of Dissimilar Materials ●	A		
5.1 Effects of External Environment ●	A			5.3.3 Corrosion by Leachable Substance	A		
5.1.1 Solar Degradation	NA			5.3.4 Effects of Decomposition Products ●	A		
5.1.2 Soil Corrosion	NA			5.4 Components Involving Moving Parts	A		
5.1.3 Airborne Pollutants	NA			5.4.1 Wear and Fatigue ●	A		
5.1.4 Dirt Retention on Cover Plate Surface	NA			6.1 Accessibility for Maintenance ●	A		
5.1.5 Abrasive Wear	NA			6.1.1 Access for System Maintenance ●	A		
5.1.6 Fluttering by Wind	NA			6.1.2 Access for System Monitoring ●	A		
5.2 Temperature & Pressure Resistance	A			6.1.3 Draining and Filling of Liquids ●	A		
5.2.1 Thermal Degradation ●	A			6.1.4 Flushing of Liquids Subsystems ●	A		
5.2.2 Deterioration of Heat Transfer Fluids ●	A						

TABLE 1-4.2

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RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS H	HC	HW	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS H	HC	HW
8.3.2 Electrical Connections ●	A			11.2.2 Heat and Moisture	NA		
				11.2.3 Exterior Penetration	NA		
9.1 Structural Integrity	NA			11.3 Durability and Reliability of Connections	NA		
9.1.1 Movements in Adjacent Structures	NA			11.3.1 Material Compatibility	NA		
9.2 Structural Integrity of Dwelling	NA			12.1 Maintainability of H, HC, HW Systems	NA		
9.2.1 Loads	NA			12.1.1 Accessibility	NA		
9.2.2 Penetration of Structural Members	NA			12.1.2 Misuse	NA		
9.3 Structural Connections	NA			12.1.3 Permanent Maintainance Accessories	NA		
9.3.1 Structural Connections	NA			12.2 Maintainability of Dwelling and Site	NA		
9.3.2 Brittle Subsystem	NA			12.2.1 Accessibility	NA		
9.3.3 Strength and Stiffness	NA			12.2.2 Ice Dams	NA		
10.1 Safety of Dwelling and Site	NA			12.3 Connections	NA		
				12.3.1 Accessibility	NA		
10.1.1 Fire	NA			13.1 Visual Characteristics of Dwelling and Site	NA		
10.1.2 Accidents	NA			13.1.1 Dwelling	NA		
11.1 Durability	NA			13.1.2 Neighborhood	NA		
11.1.1 Vegetation	NA						
11.2 Durability and Reliability of Dwelling and Site	NA						
11.2.1 Chemical Corrosion ●	A						

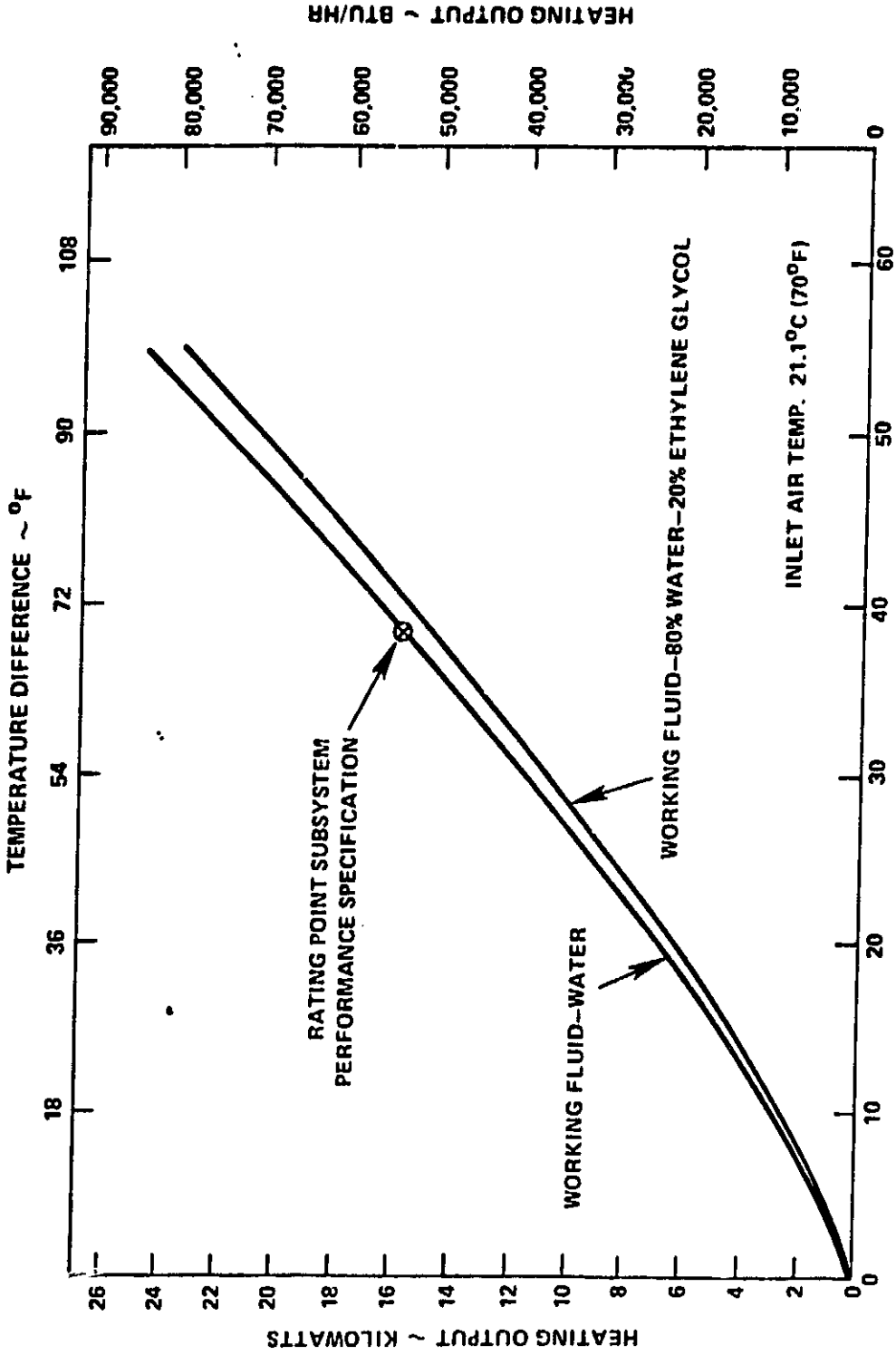


FIGURE 1–4.1 MINIMUM PERFORMANCE CHARACTERISTICS OF MAXI–THERM MODEL S–101. THE POINT DENOTED ⊗ IS THE SUBSYSTEM PERFORMANCE SPECIFICATION RATING POINT TO BE VERIFIED BY TEST. THE REMAINING PORTIONS OF LINES ARE TO BE DEMONSTRATED BY ANALYS'S BASED ON THE TEST RATING POINT.

7705-181.1

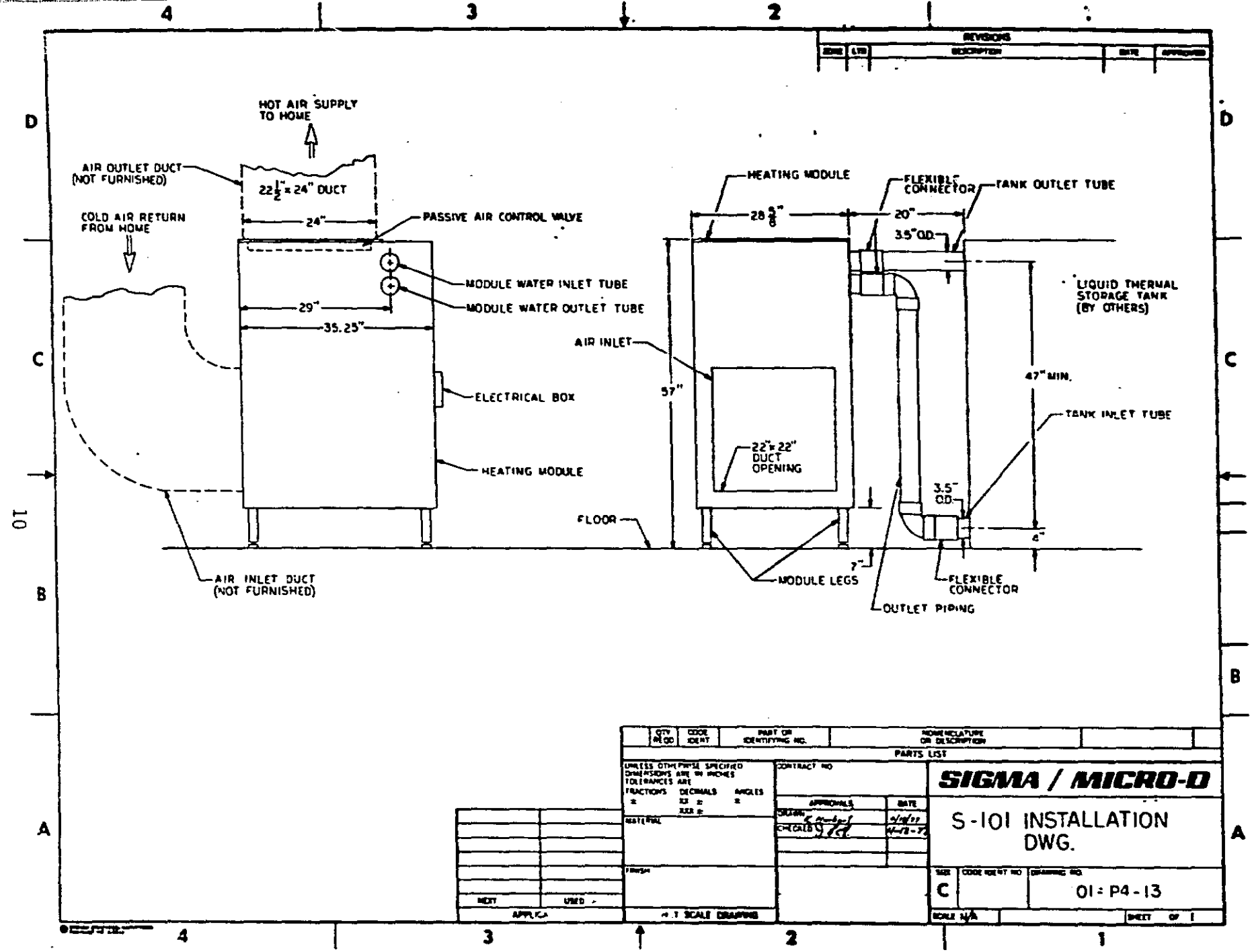
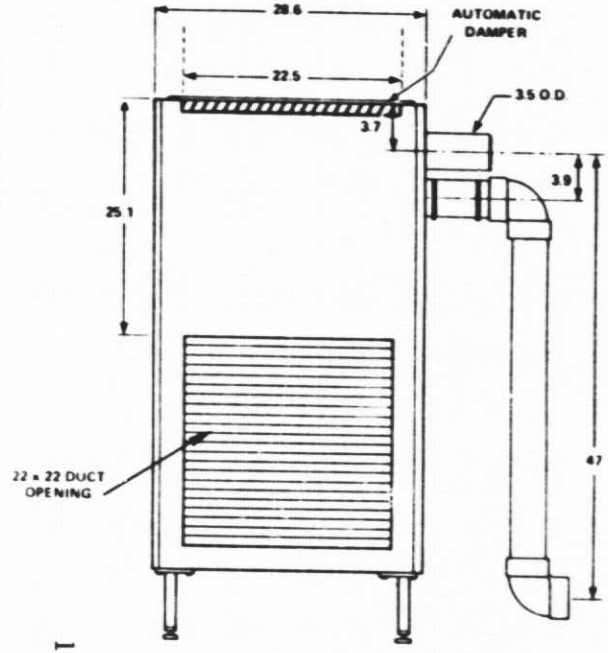
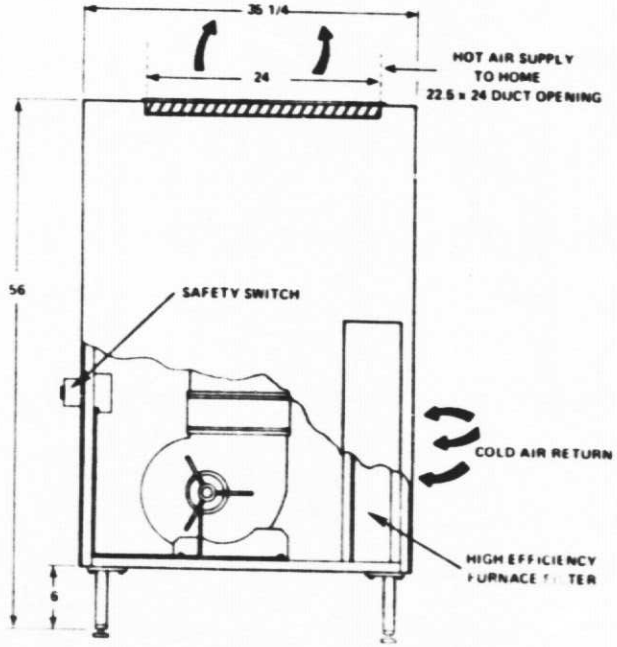


FIGURE 1-4.2 S-101 INSTALLATION DRAWING

7705-181.





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INSTALLATION

The Maxi-therm system includes a heat transfer module and automatic air damper. To minimize your costs, we suggest you purchase a storage tank separately and have necessary modifications done at a local shop. However, we can supply fully modified tanks and supplemental heaters, if you desire. The storage tank requires two 3.5 inch O.D. penetrations for the water inlet and outlet ducts, and three 1-inch female IPS holes for the heaters. To maximize convective flow, the water ducts must be mounted on the tank as shown in the illustration at the right. As part of the Maxi-therm package, explicit details are given in the Installation Manual for coupling to the home air duct system and the water storage tank.

WARRANTY

The Maxi-therm 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 situations 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.

INFORMATION

Further information on Sigma Research's Maxi-therm solar heating and cooling module concerning costs, delivery, etc., can be obtained from:

SIGMA
RESEARCH, INC.
2950 George Washington Way
Richland, WA 99352
(509) 946-0663

REV 2

MAXI-THERM

HEAT EXCHANGER MODULE FOR SOLAR HEATING SYSTEMS

SIGMA
RESEARCH, INC.

DESCRIPTION

The Maxi-therm is a heat transfer device which is used with a hot water storage tank as a direct replacement for the conventional home furnace. The Maxi-therm serves as a coupling between the hot water storage tank and the home air duct system, extracting heat from the hot water and distributing this heat through the home with a built-in blower.

PRINCIPLE OF OPERATION

You will find the Maxi-therm system to be one of the most reliable and quiet solar home heating units available - and for good reason. To circulate water from the solar tank to the heating unit, most solar heating units require an electrically driven pump. Sigma Research, however, has been able to eliminate the pump completely by designing the unit to operate as a thermosyphon. That is, hot water entering the Maxi-therm cools and increases in density as heat is extracted, creating a natural circulation pattern between the Maxi-therm and the water storage tank. By careful design, a turbulent flow has been created which is very effective in transferring heat.

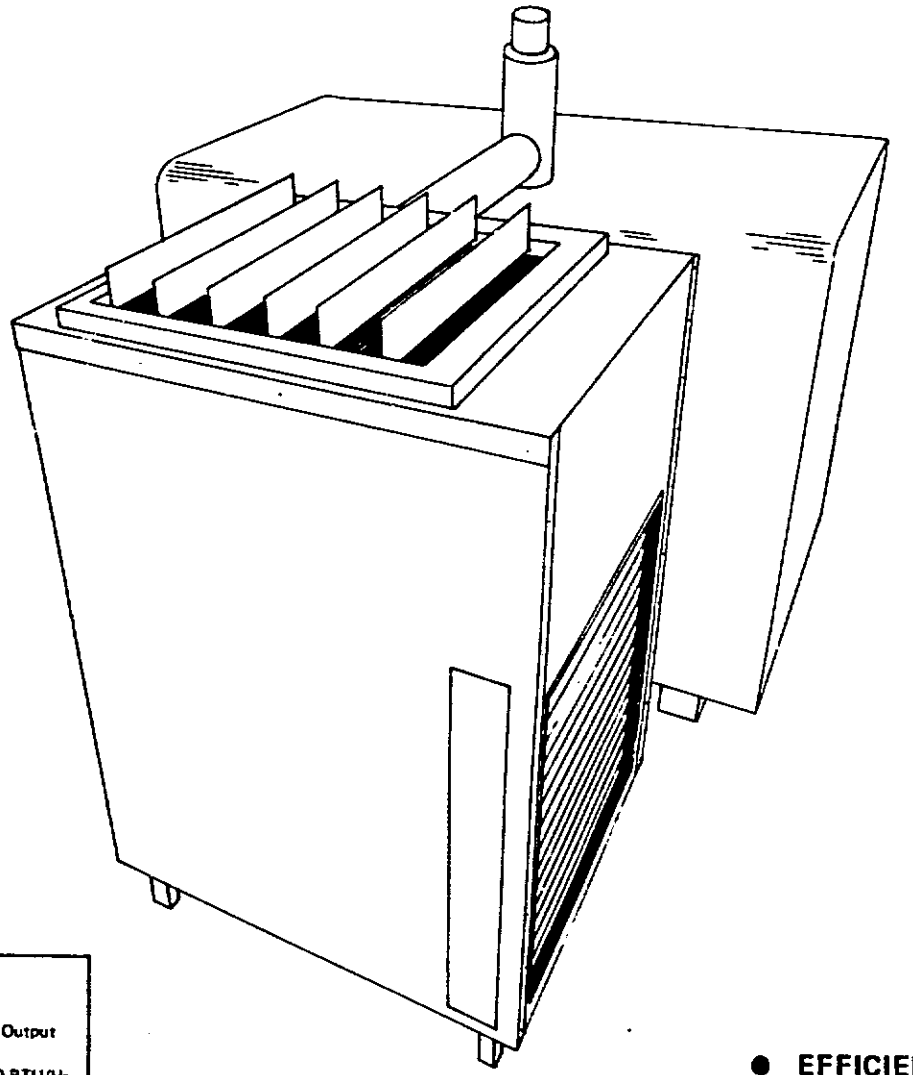
LOW COST

Natural convective circulation between the storage tank and the Maxi-therm replaces the conventional pumped loop. Gone are the problems of a pumped system including noise, leaking seals, bearing failure, and vapor locks. And you save electricity! On the basis of a 5000 degree-day heating season and 4¢/kw-hr electricity, this unit will cost less to own than an equivalent pumped system after 5 years of operation.

PERFORMANCE SPECIFICATIONS

The Maxi-therm will deliver more and more heat as the inlet water temperature increases. Heating performance for model S-101 is given in the table below.

The air handling fan is rated at 1640 CFM, and is operated by a 1/3-hp, 6.5 amp full load, 115 VAC motor. This air flow is delivered at 0.6 inch water static pressure to provide adequate air distribution throughout the home.



MAXI-THERM S-101 HEATING PERFORMANCE

Inlet Air Temperature	Tank Mean Water Temperature	Heat Output
70°F ↓	100°F	18,000 BTU/Hr
	110	26,000
	120	35,000
	140	54,000
	160	74,000

- EFFICIENT
- RELIABLE
- LOW COST

SIGMA

Drawing No. 101-P4-20
Date 10-12-77
Revision B

MANUFACTURING INSTRUCTIONS

AND

REQUIRED MATERIALS AND PARTS

MAXI-THERM S-101 HEATING MODULE

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

MANUFACTURING INSTRUCTIONS
AND
REQUIRED MATERIALS AND PARTS

INTRODUCTION

The following sections provide details of the manufacturing steps and operations necessary to produce a Maxi-therm S-101 Heating Module. In many instances, sufficient detail is included in the module drawings to facilitate production of the component and the appropriate drawing is simply referenced in the following text. Where additional detail is needed, it has been included.

To permit an overview of the manufacturing steps required, the flowchart shown in Figure 1 has been prepared. For convenience, the production steps have been broken into phases, which correspond to the headings for the following sections.

Materials and Parts Lists are shown at the end of the text.

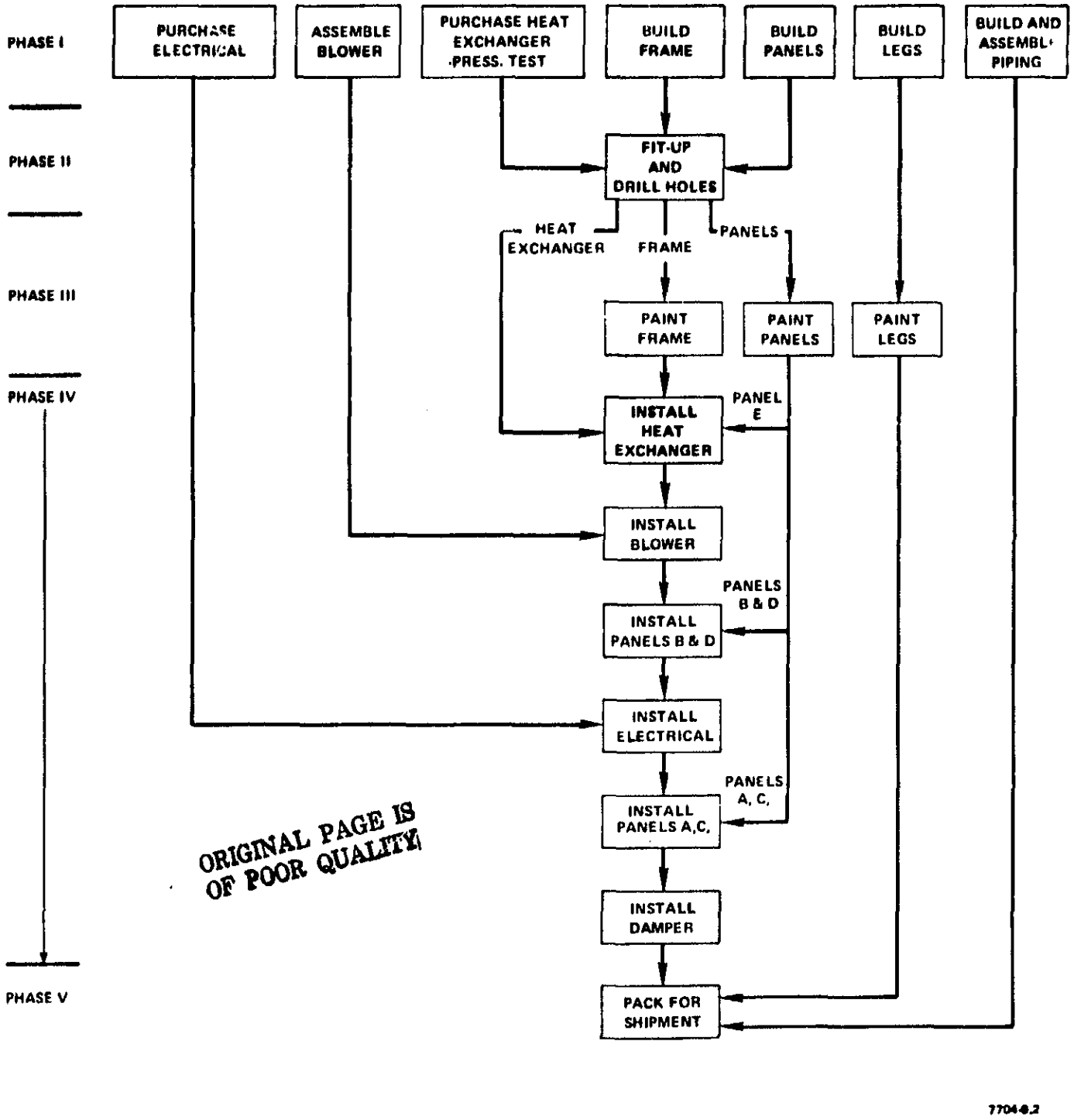


FIGURE 1. PRODUCTION FLOW-CHART FOR S-101 HEATING MODULE.

PHASE II - ASSEMBLY FIT-UP

To facilitate accurate hole alignment, the heat exchanger and cabinet panels are assembled and match-drilled with the frame prior to final section preparation. To clearly understand the order of this assembly, the designations for the various sides of the heat exchanger (A, B, C, D and E) should be noted in Drawing Nos. 101-P4-02 and 101-P4-06.

1. Heat Exchanger Mounting

The heat exchanger (Drawing No. 101-P4-02) is first mounted to Panel E. Before proceeding with this operation, a 1/8" thick cork gasket should be cut from stock to match the exchanger flange. With this gasket in place, Panel E is positioned on the top of the heat exchanger flange. Care should be exercised at this point, that the aluminum fins are not bent or crushed. With the panel in position, these three parts (frame, gasket, and exchanger flange) can be match-drilled and attached as indicated in Drawing No. 101-P4-01. This assembly is now placed on top of the module frame and match-drilled for attachment. Panels B and D (Drawing No. 101-P4-06) are then positioned on the frame, followed by Panels A and C. After aligning all panels, the frame and panels are match-drilled as detailed in Drawing No. 101-P4-06. The panels and exchanger are then removed in the reverse order of assembly.

PHASE III - PAINTING

The frame, panels, and legs should be completely deburred, then degreased and cleaned using solvent (Dupont Prep-Sol #3919S). A metal etch solution (Dupont #5717S) should next be used on the bare parts, with the solution being mixed and applied as per manufacturer's recommendations. A final cleaning with enamel reducer is necessary to remove traces of the etching solution and grease. One coat of primer-sealer (DPE-1202 Red Oxide) and two coats of Delstar acrylic enamel are then required to complete the components.

PHASE IV - MODULE ASSEMBLY

The blower is first installed as shown in Drawing 101-P4-01, with the flexible boot connector (Item 5 Drawing 101-P4-01) being produced from stock and clamped securely. Foam stripping (Item 8 - Drawing 101-P4-06) is next applied to the frame at the locations shown in Drawing 101-P4-06. This operation is followed by positioning of Panels B and D on the frame assembly. Insulation from a stock roll (Johns-Manville Lina-Coustic H - 1½ inch) is then fitted to the inside of Panels B and D above the frame divider (Item 8 Drawing No. 101-P4-05) and extending to the upper part of the frame member. The insulation is attached to the metal with spray-applied Miracle Adhesive PF102 and edges are sealed suing Nashua Tape #357. Sufficient overlap of the insulation at the frame uprights should be provided to permit contact with insulation on Panels A and C. An insulation piece should be cut to cover the underside of Panel E around the heat exchanger. Be certain that this insulation extends to fill the corner of the frame rails on sides A and C. Attachment of insulation to Panels A and C is done as noted above and over the same portion of the module. Sufficient clearance (1.25 inches) should be provided between the panel edge and the insulation to facilitate proper mounting of the panels to the frame.

Before proceeding with the attachment of Panels A and C, the electrical components must be installed on Panel B. The 4" x 4" junction box is installed on the interior of Panel B using the holes shown in Drawing 101-P4-06. Both the 4" x 4" electrical box (interior) and switch enclosure box (exterior) should be installed at the same time using a chase-nipple and lock nut. To prevent rotation of the boxes, #10-24 x 3/4" round head machine screws are installed in the holes indicated. The two motor leads (white and black) can then be inserted through a knockout hole in the 4" x 4" box after installing a bushing (Heyco Mfg. Type UB625) in the hole. Wire connections and routing can then be done as shown in Figure 2 prior to attachment of the transformer-relay assembly. The exterior safety switch can then be installed in the switch enclosure after attaching the relay lead. The white wires extending into the switch enclosure are not connected, since this will be done at the time of installation. When completed, the components should appear as indicated in Figure 3.

PHASE IV - MODULE ASSEMBLY

The heat exchanger is mounted to the frame first, with the method of assembly being as previously detailed in Phase II. The blower is then installed as shown in Drawing 101-P4-01, with the flexible boot connector (Item 5 Drawing 101-P4-01) being produced from stock and clamped securely. Foam stripping (Item 8 - Drawing 101-P4-06) is next applied to the frame at the locations shown in Drawing 101-P4-06. This operation is followed by positioning of Panels B and D on the frame assembly. Insulation from a stock roll (Johns-Manville Lina-Coustic H - 1½ inch) is then fitted to the inside of Panels B and D above the frame divider (Item 8 Drawing No. 101-P4-05) and along the underside of the heat exchanger case. The insulation is attached to the metal with spray-applied Miracle Adhesive PF102 and edges are sealed using Nashua Tape #357. Sufficient overlap of the insulation at the frame uprights should be provided to permit contact with insulation on Panels A and C. Attachment of insulation to Panels A and C is done as noted above and over the same portion of the module. Sufficient clearance (1.25 inches) should be provided between the panel edge and the insulation to facilitate proper mounting of the panels to the frame.

Before proceeding with the attachment of Panels A and C, the electrical components must be installed on Panel B. The insulation should be trimmed to provide clearance for the 4" x 4" box, which is installed on the interior of Panel B using the holes shown in Drawing 101-P4-06. Both the 4" x 4" electrical box (interior) and switch enclosure box (exterior) should be installed at the same time using a chase-nipple and lock nut. To prevent rotation of the boxes, #10-24 x 3/4" round head machine screws are installed in the holes indicated. The motor leads (2 - white and black) can then be inserted through a knockout hole in the 4" x 4" box after installing a bushing (Heyco Mfg. Type UB625) in the hole. Wire connections and routing can then be done as shown in Figure 2 prior to attachment of the transformer-relay assembly. The exterior safety switch can then be installed in the switch enclosure after attaching the relay lead. The white wires extending into the switch enclosure are not connected, since this will be done at the time of installation. When completed, the components should appear as indicated in Figure 3.

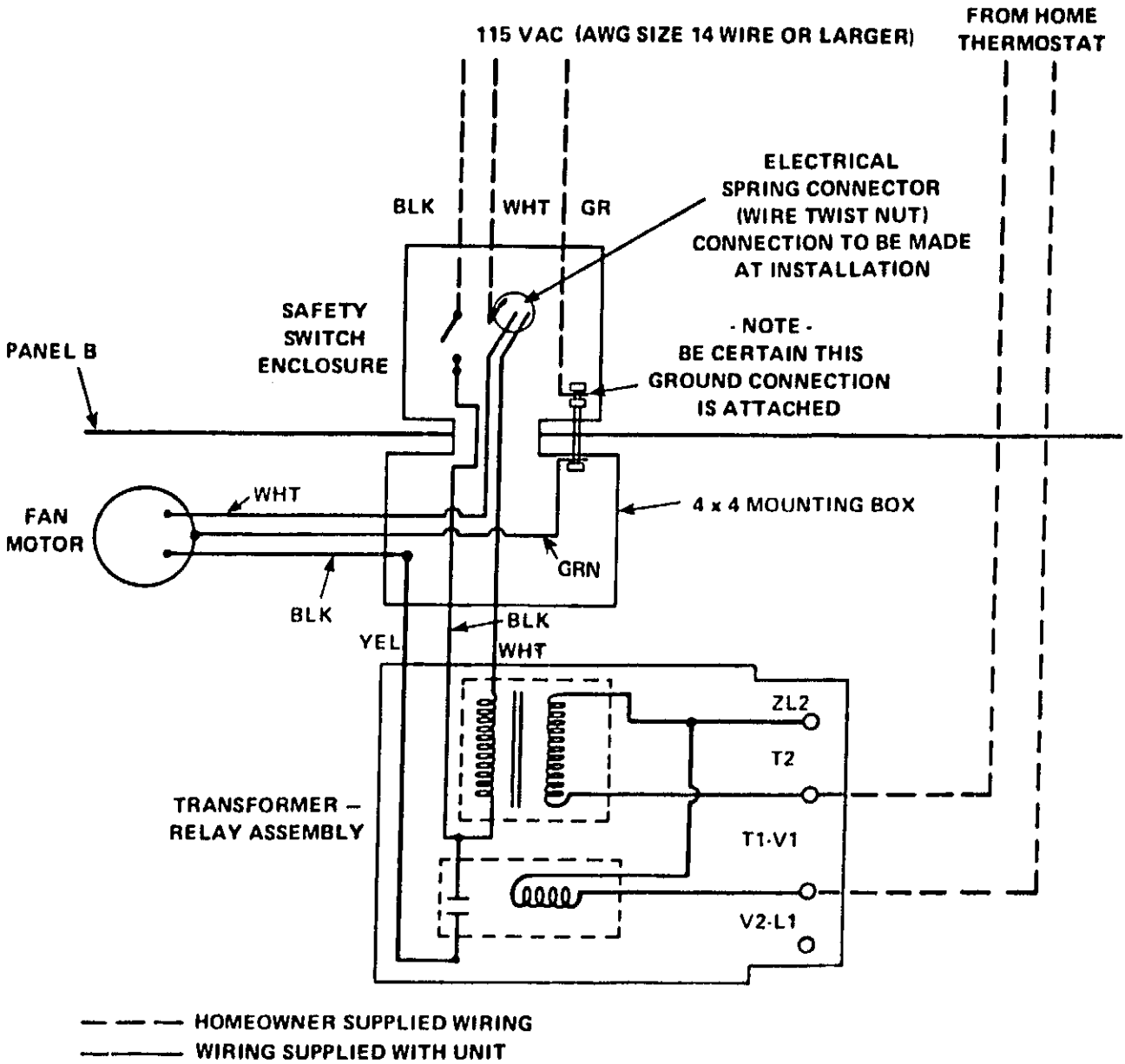


FIGURE 2. ELECTRICAL SCHEMATIC FOR MAXI-THERM S-101 HEATING MODULE

7707-340.1

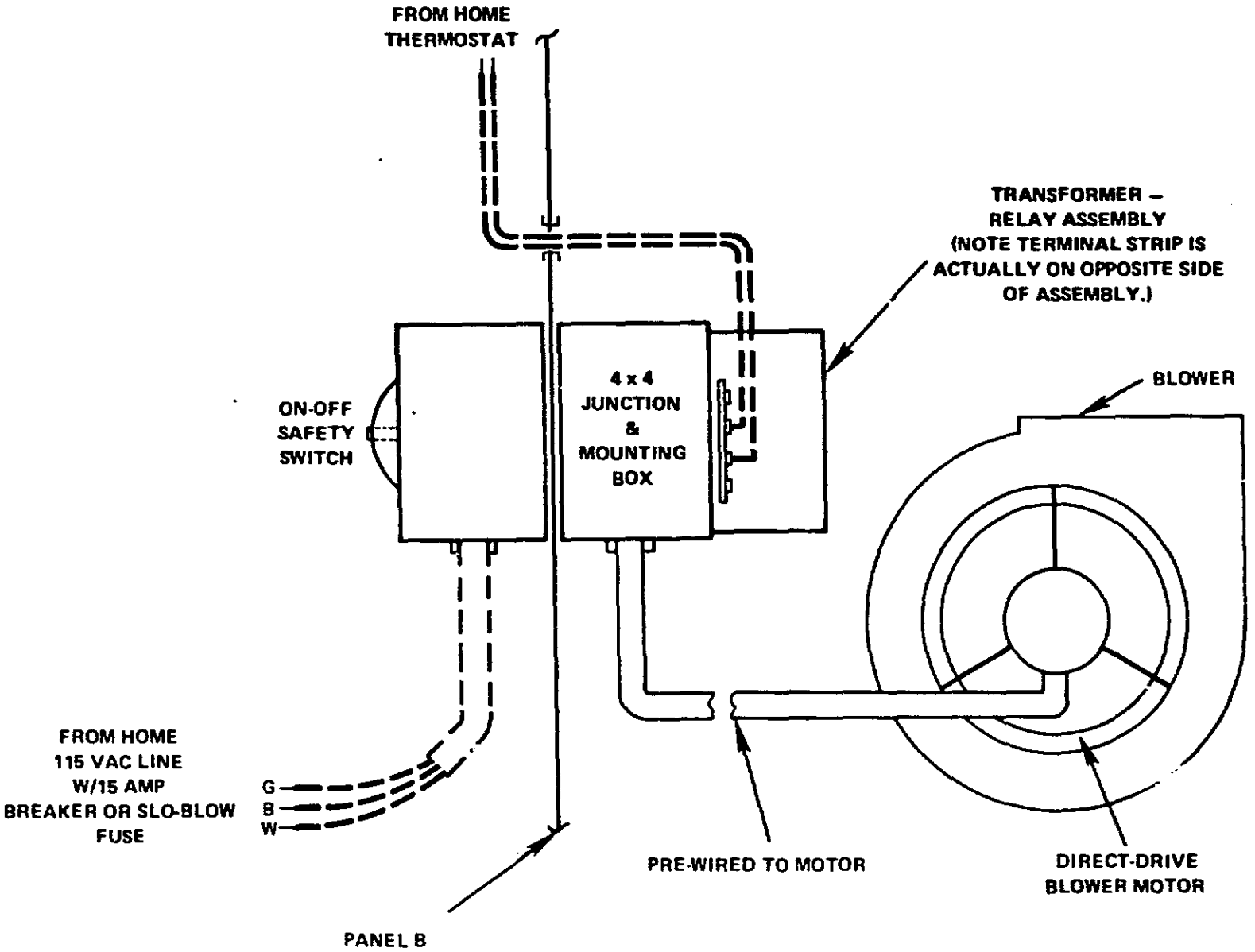


FIGURE 3. ELECTRICAL CONNECTIONS OF MAXI-THERM TO HOME ELECTRICAL SYSTEM

7707-340.3

The final step in the assembly is to place the damper in the heat exchanger outlet opening, as shown in Figure 4, and attach the unit with #8-18 Type B panhead screws 3/8" long at the locations indicated.

PHASE V - PACKAGING FOR SHIPMENT

The details of packaging will not be completed until prototype testing has been completed and module design finalized.

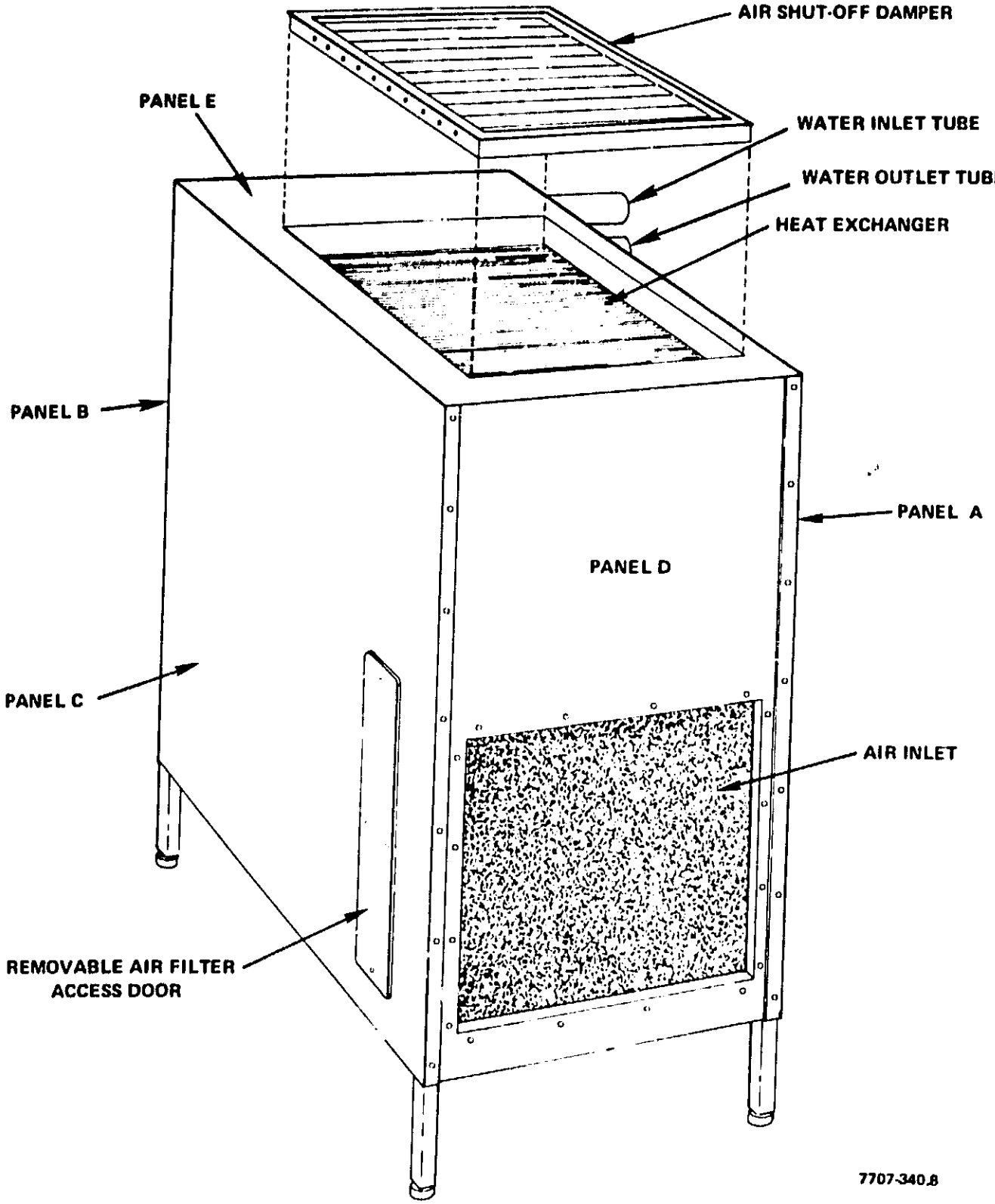


FIGURE 4. SCHEMATIC VIEW OF PROTOTYPE MAXI-THERM S-101 WITH CABINET INSTALLED.

DRAWING LIST

Title	Drawing No.	Sheets
S-101 Thermosyphon Heating Module Assembly	101-P4-01	1
Heat Exchanger	101-P4-02	1
S-101 Module Frame Assembly	101-P4-05	2
Cabinet Panel Assembly	101-P4-06	2
Module Support Leg	101-P4-07	1
Outlet Intermediate Piping System	101-P4-11	1
S-101 Installation Drawing	101-P4-13	1
Installation, Operation, and Maintenance Manual	101-P4-14	29
Manufacturing Instructions and Required Materials and Parts	101-P4-20	12

PARTS LIST

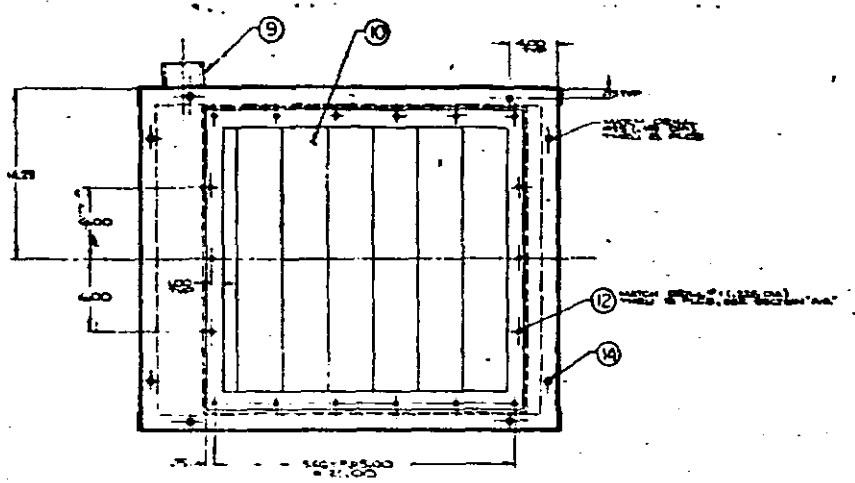
Part	Source	Required	Drawing No.
Mak-A-Clamp #4002	Breeze Corporation Union, New Jersey	2	101-P4-01
Threaded Stem Glide #2180XTS-3/8-16x1-1/2 RP	Bassick Div. - Stewart-Warner Corp. Bridgeport, Connecticut	4	"
Electrical Junction Box 4" x 4" x 1-3/8"	Gaylord Manufacturing Co. Modesto, California	1	"
Ventglass Duct Boot Material	Ventfabric, Inc. Chicago, Illinois	As Required	"
#8-18x3/4" Type B Pan Head, Self Tapping Screw	ITT Harper, Inc. Morton Grove, Illinois	8	"
3/8 - 16 UNC Hx Bolt 1" long w/flat and lock washer	"	16	"
hi 40a, 24" x 24" x 4" Filter	Servodyne Corporation Santa Rosa, California	1	"
Model PRD-100AL Damper	Pacific Air Products Santa Ana, California	1	"
#10-24x1" UNC Round Head Screw w/hex nut and lock washer	ITT Harper, Inc. Morton Grove, Illinois	19	"
Direct Drive Blower #4C058 w/mtg. supports #2C335	Dayton Electric Mfg. Co. Chicago, Illinois	1	"
1/8" Cork Gasket	McMaster-Carr Supply Co. Santa Fe Springs, Calif.	As Required	"
Switch Enclosure #5X546	W. W. Grainger Spokane, Washington	1	"
#2E143 Switching Relay	"	1	"
Water Heating Coil as per Drawing	Brod-McClung-Pace Co. Portland, Oregon	1	101-P4-02

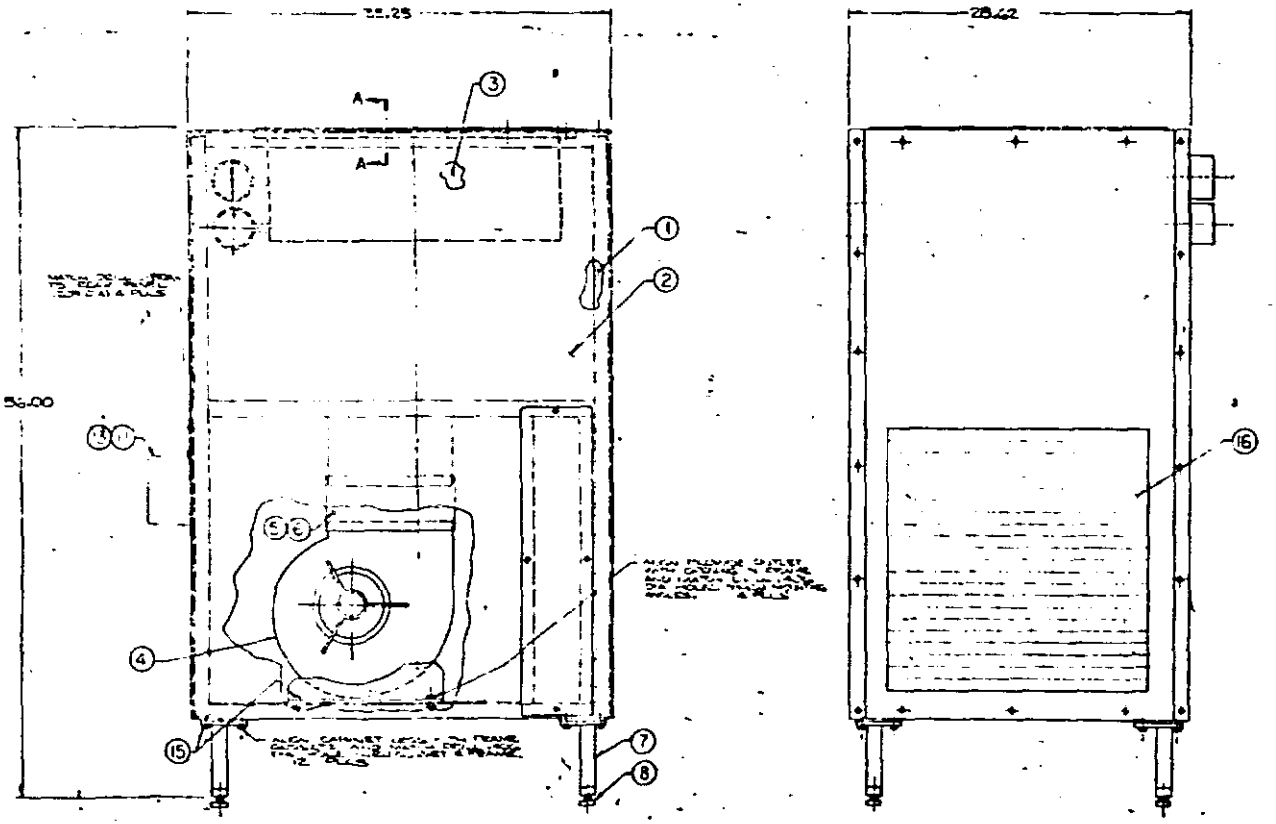
PARTS LIST (Continued)

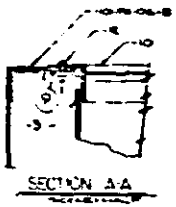
Part	Source	Required	Drawing No.
16 Gage Hot Roll Steel	Stack Steel & Supply Co. Spokane, Washington	As Per Drawing	101-P4-05
12 Gage Hot Roll Steel	"	"	"
16 Gage Hot Roll Steel	Stack Steel & Supply Co. Spokane, Washington	As Per Drawing	101-P4-06
1/8" x 1" Adhesive Backed Foam #6A1800V	Arlon Prod., Inc. Compton, California	As Required	"
#8-18x3/4" Type B Pan Head, Self Tapping Screw	"	48	"
1/2" x 1-1/4" Hot Roll Steel Bar 1-1/4" Long	Stack Steel & Supply Co. Spokane, Washington	4	101-P4-07
1-1/4" square x 1/8" Wall Steel Tubing, 5-1/4" Long	"	4	"
1/4" x 4" Hot Roll Steel Bar 4" Long	"	4	"
3" Schedule 40 CPVC Pipe, 38-3/4" Long	Ryerson Steel Seattle, Washington	1	101-P4-11
3" Schedule 40 CPVC Pipe, 3-7/8" Long	"	2	"
3" Schedule 80 CPVC 90^{o} elbow	"	2	"
CPVC (Hi-Temp) Solvent Cement	Harvel Plastics, Inc. Easton, Pennsylvania	As Required	"
Hose Clamps - #QS 200M-60H	Breeze Corporation Union, New Jersey	6	Not Shown
#14 AWG Wire, U.L. Style 1015, CSA Type TEW, FR-1 PVC	Anixter Corporation Seattle, Washington	As Required	"
#5X542 Switch	W. W. Grainger Spokane, Washington	1	"
Type 58 Marine Hose 3½" I.D. x 8" Long	B. F. Goodrich Akron, Ohio	3	Not Shown

PARTS LIST (Continued)

Part	Source	Required	Drawing No.
Electrical Spring Connectors	3M Company St. Paul, Minnesota	As Required	Not Shown
#10-32x3/4" Round Head w/hex nut and flat washer	ITT Harper, Inc. Morton Grove, Illinois	2	"
1/2" Chase Nipple w/Locking Nut	Gaylord Manufacturing Co. Modesto, California	1	"
Type UB625 Bushing	Heyco Manufacturing Co. Waukesha, Wisconsin	1	"
1-1/2" Thick Lina-Acoustic A	Johns-Manville Denver, Colorado	As Required	"
FSK Facing Tape 700U	Nashua Corporation Nashua, New Hampshire	"	"
PF-102 Duct Liner Adhesive	Miracle Adhesives Corp. Long Island, New York	"	"
#3919S Prep-Sol Solvent	E. I. Dupont DeNemours & Co. Wilmington, Delaware	"	"
#5717S Metal Etch	"		
DPE - 1202 Red Oxide Primer-Sealer	PPG Industries Detroit, Michigan	"	"
Delstar Acrylic Enamel	"	"	"







NOTE TO CHILD DRAWING FOR INSTALLATION INFORMATION.

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SIGMA / MICRO-D

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101-P1 01

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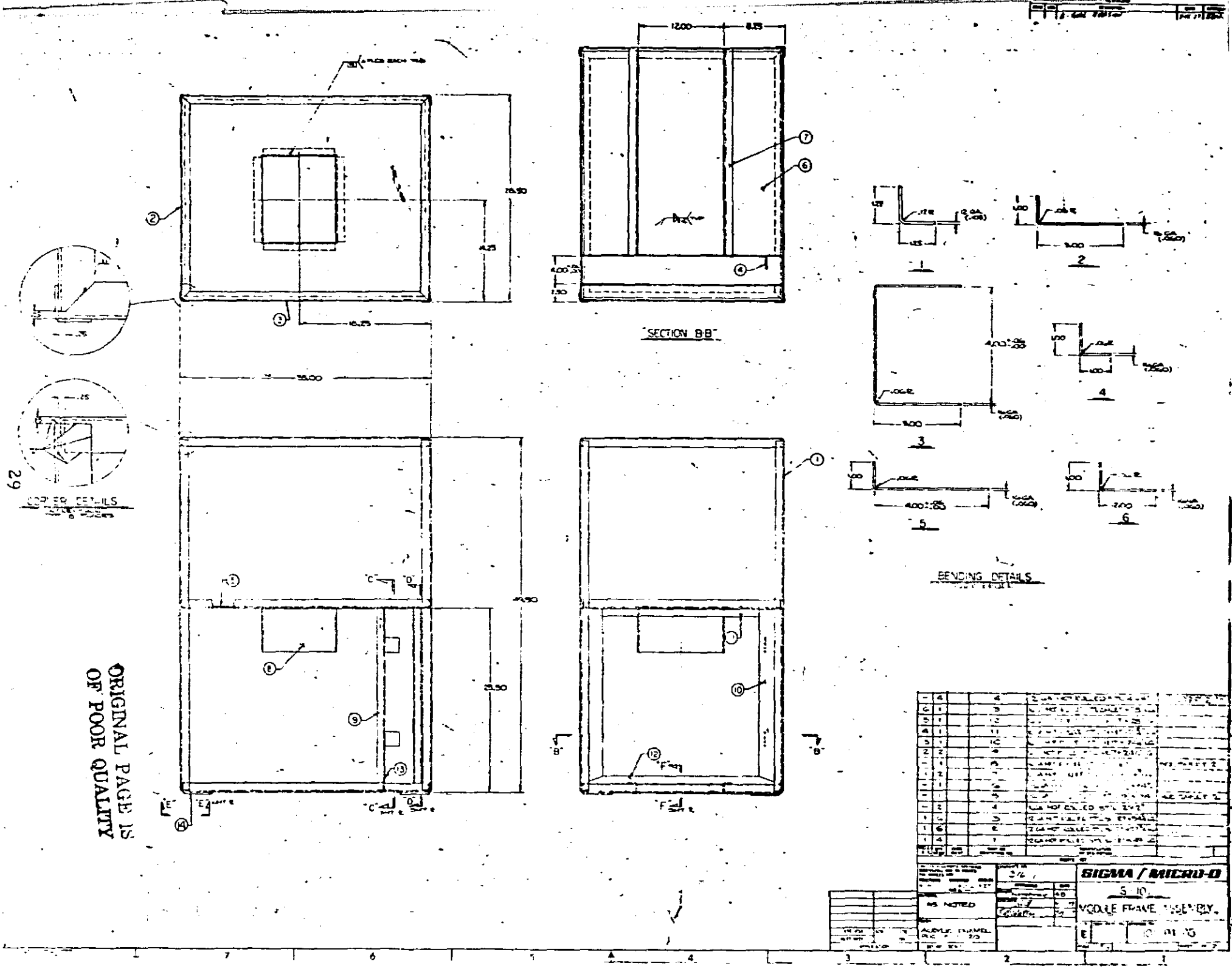
NOTE: Contact Sigma Research, Inc. (Richland, Washington) for latest configuration of Heat Exchanger, Drawing Number 101-P4-02.

SIGMA RESEARCH, INC.
Drawing No.: 101-P4-02



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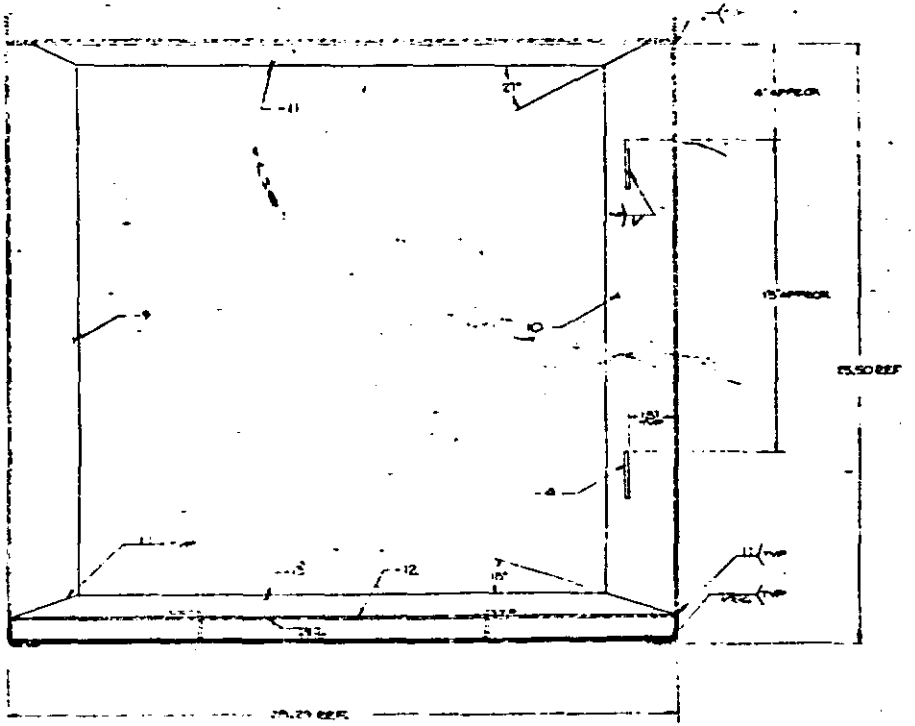

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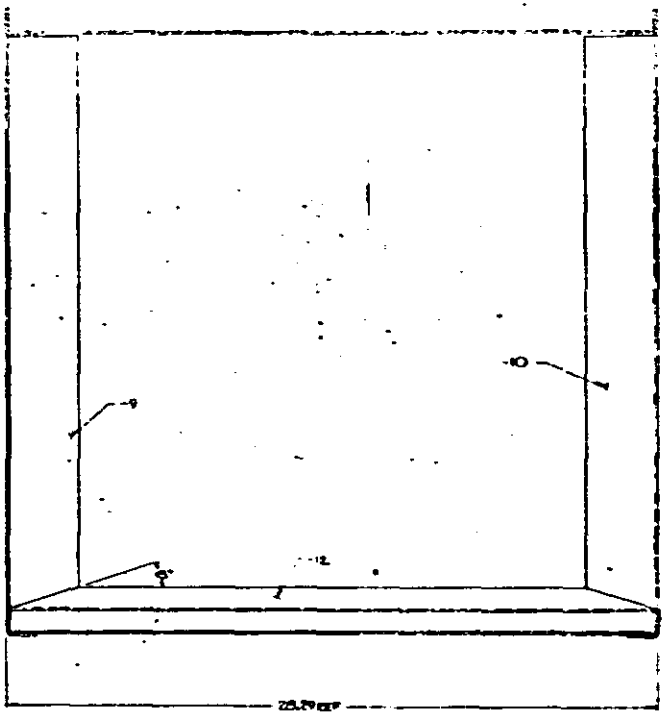

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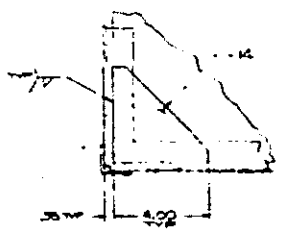

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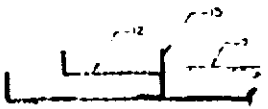

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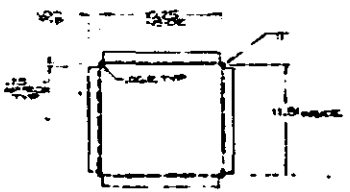

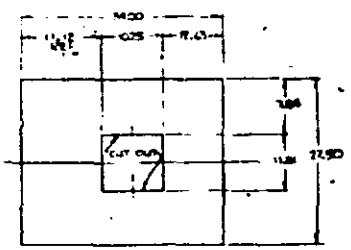

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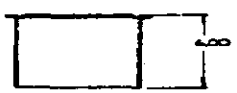

ITEM 8 DETAIL

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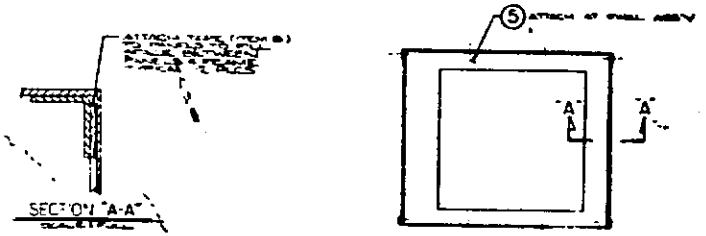
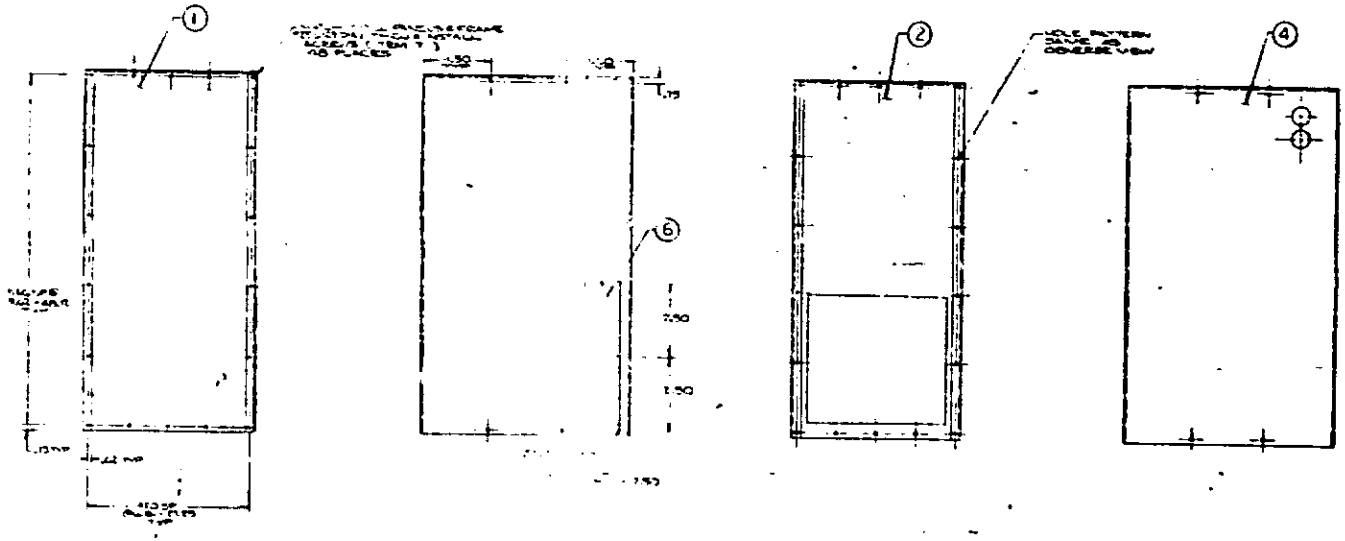
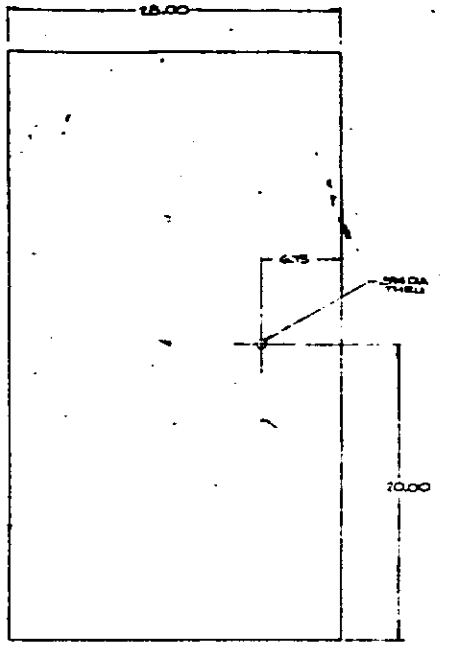




SIGMA / MICRO-D

CABINET PANEL ASSEMBLY



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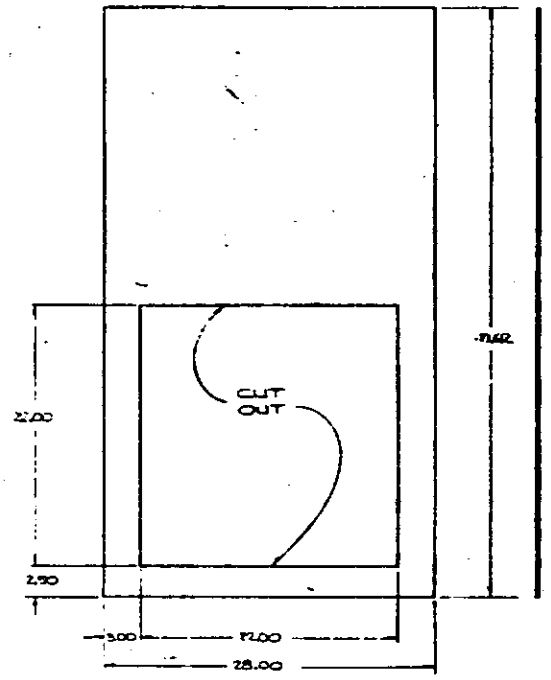
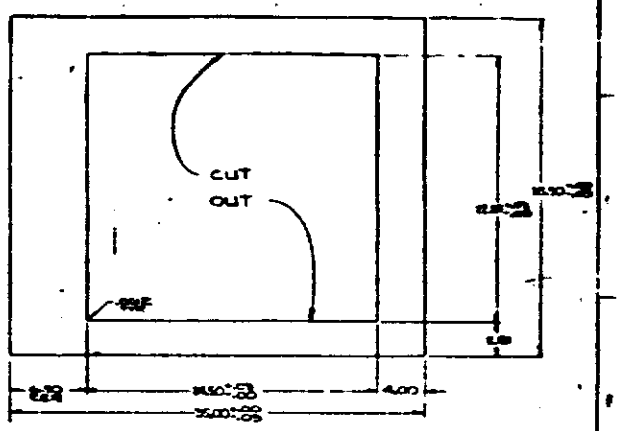
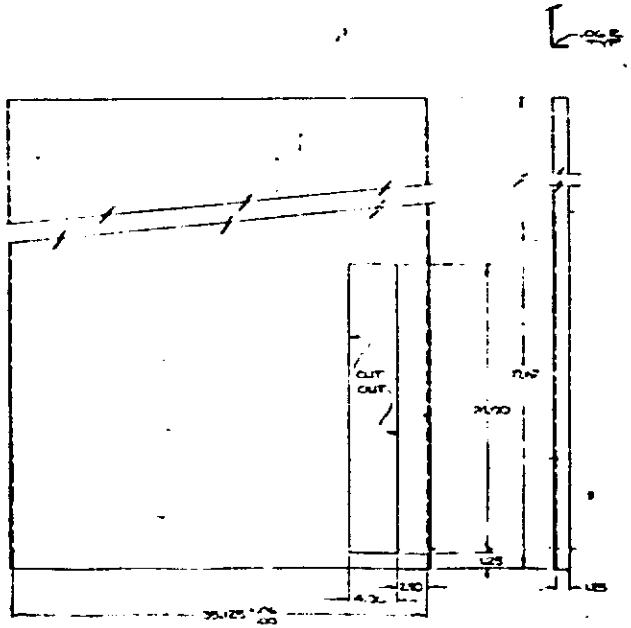


2 CABINET PANEL "D"

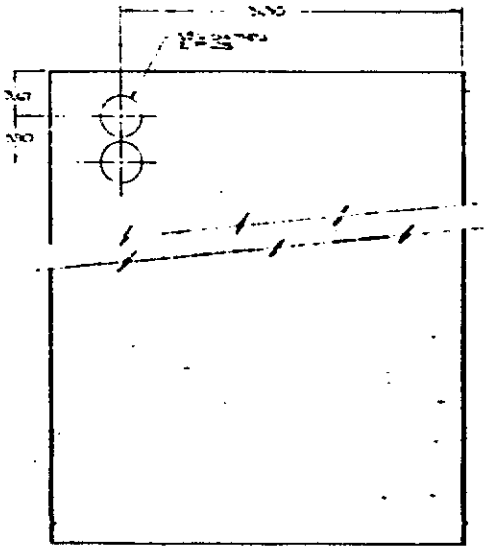


5 TOP PANEL "E"

6 FILTER ACCESS COVER



3 CABINET PANEL "C"



4 CABINET PANEL "A"

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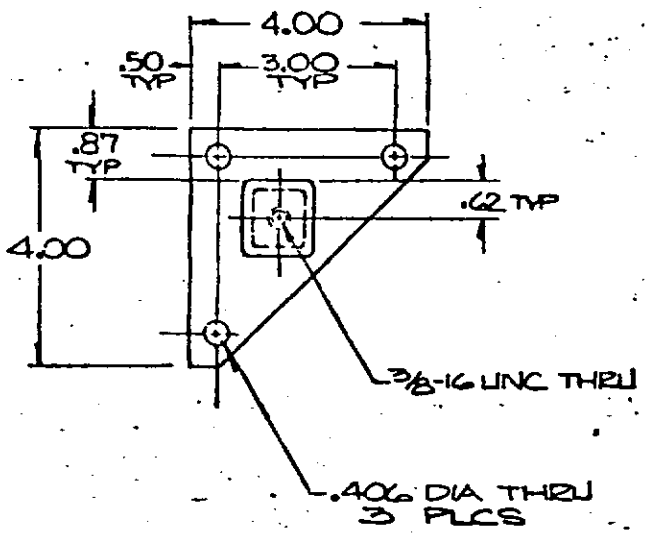
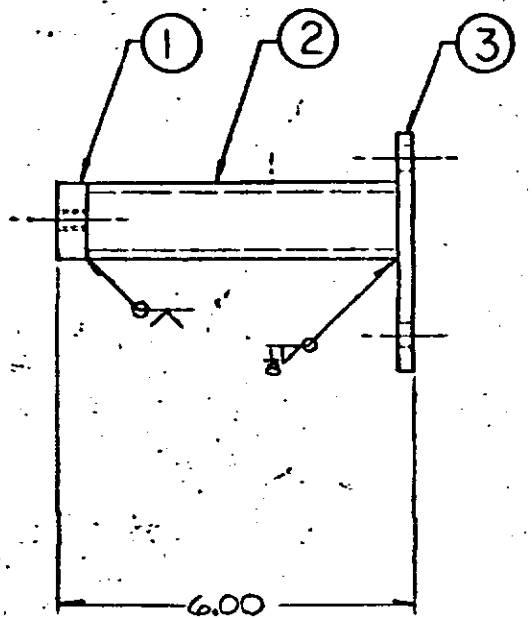
	CABINET PANEL DETAILS	
	P4	

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE





QTY REQD	PART NO	DESCRIPTION
1	3	1/4" x 4" HOT ROLLED STL BAR - " LG.
1	2	1 1/4" SQ x 1/8 WALL STEEL TUBING, - 1/2" LG
1	1	1/2 x 1 1/4 HOT ROLLED STEEL BAR - 1 1/4" LG.

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101-P4-01	101-P4-01
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
± — XX ±.06 ± —
XXX ± —

MATERIAL: AS NOTED

FINISH: AT ASSY

DO NOT SCALE DRAWING

CONTRACT NO 376-1

APPROVALS	DATE
DRAWN Humphrey	4-11-77
CHECKED [illegible]	11-12-77
[illegible]	7-15

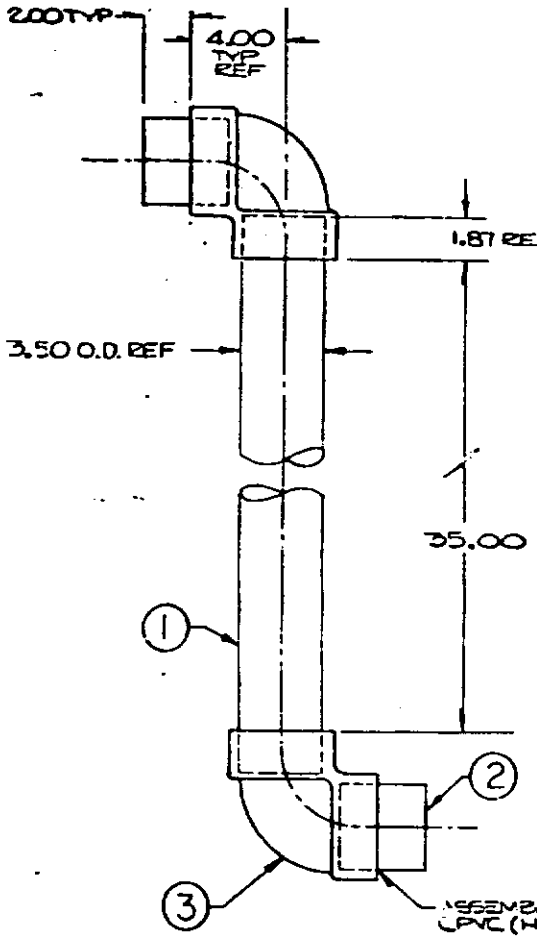
SIGMA / NICAD-D

MODULE SU[illegible]RT LEG

SIZE	CODE IDENT NO	DRAWING NO
B		10[illegible]P4-07

SCALE 1/2 SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SOURCE
2		3	3" SCH 80 CPVC 90° PIPE ELBOW	"RYERSON
2		2	3" SCH 40 CPVC PIPE x 3⅜" LG	"RYERSON"
1		1	3" SCH 40 CPVC PIPE x 36¾" LG	"RYERSON"

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS ± —
DECIMALS XX ± .06 XXX ± —
ANGLES ± —

MATERIAL: AS NOTED

FINISH: NOT REQ'D

CONTRACT NO: 316-1

APPROVALS	DATE
DRAWN Humphrey	4 2 77
CHECKED	4-12 77
	7 15 77

SIGMA / MICRO-D

OUTLET INTERMEDIATE PIPING SYSTEM

C | CODE IDENT | DRAWING NO 101 P4-11

SCALE | SHT 1

01 P4 3
NEXT ASSY | USED ON | APPLICATION | DO NOT SCALE DRAWING