DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150630

PRELIMINARY DESIGN PACKAGE FOR SOLAR COLLECTOR AND SOLAR PUMP

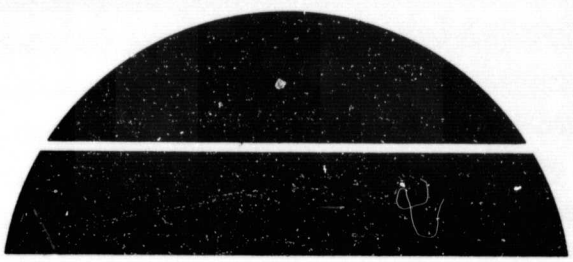
Prepared by

Calmac Manufacturing Corporation
150 S. Van Brunt Street
Englewood, New Jersey 07631

Under Contract NAS8-32253 with

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

For the Department of Energy



U.S. Department of Energy

Solar Energy

TECHNICAL REPORT STANDARD TITLE PAGE

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DOE/NASA CR-150630		

4. TITLE AND SUBTITLE	5. REPORT DATE
Preliminary Design Package for Solar Collector and Solar Pump	April 1978
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9. PERFORMING ORGANIZATION NAME AND ADDRESS Calmac Manufacturing Corporation 150 S. Van Brunt Street Englewood, New Jersey 07631	10. WORK UNIT NO.
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15. SUPPLEMENTARY NOTES

This work was done under the technical management of Mr. John Caudle, George C. Marshall Space Flight Center, Alabama.

16. ABSTRACT

Calmac Manufacuring is developing a solar-operated pump using an existing solar collector, for use on solar heating and cooling and hot water systems. These systems are for use in single-family, multi-family, or commercial buildings. This report contains the information necessary to evaluate the preliminary design of the Calmac collector and solar-powered pump, and is a collation of the following information: preliminary design drawings, Verification Plans, Hazard Analysis, and other information valuable in defining the design of the subsystem.

Renumbering of pages and some reformatting have been done in the interest of clarity.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
	Unclassified-Unlimited William A. Brooksbank, Jr. WILLIAM A. BROOKSBANK, JR. Mgr, Solar Heating and Cooling Project Ofc

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	41	NTIS

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PART I

Preliminary Design Review Data

Contract NAS8-32253

Project: Flat Plate Collector

CALMAC Manufacturing Corporation
150 South Van Brunt Street
Englewood, N.J. 07631

Contract NAS8-32253

Project: Flat Plate Collector

The following drawings are required to define the subsystem:

1. Twin tubing cross section
2. Header assembly
3. U-bend
4. Tubes for header takeoffs and U-bends
5. Standard straight Sunmat
6. Collector assembly, top view, lengthwise cross section and widthwise cross section.

See Section 3 for drawings.

Contract NAS8-32253

Project: Flat Plate Collector

Part Number: SI001

Nomenclature: Stimpson Clamp Driver

Description and Use: The tool consists of a short length of 3/8" ID pipe with a 5/16" slot cut in one side, fastened to a handle. The tool slips over the EPDM tubing and is used to push Stimpson clamps over header nipples and U-bends.

Manufacturer: CALMAC Manufacturing Corporation

Justification: The best alternative using standard tools is to use a pair of pliers as a pushing tool with the clamp between its grip. Applying enough pressure to hold the clamps easily, however, damages the clamps, and the pliers tend to slip off the round shape of the clamps.

1. Identification and Control of Hazards. The sources of hazard in the collector sybsystem are excess temperatures and pressures within the piping and tubing, and the toxicity of the ethylene glycol heat transfer fluid. The hazards are only to personnel and not to equipment or buildings -- the temperatures and pressures involved are not high enough to ignite, collapse or otherwise damage equipment or buildings. The potential hazards to personnel, however, are major as serious burns, or poisoning could result from a malfunction.

   The strategy for managing excess temperatures and pressures is primarily to relieve them before they build up to an excess. The use of a temperature and pressure relief valve in the system set at 225°F and 40 PSI accomplishes this objective. In addition, to minimize the risk of burns suffered from touching the cover panel which might reach to 180°F during no flow conditions, signs will be recommended when the collector is operated in areas subjected to public traffic. The toxicity of the glycol is managed by the use of a basin to catch fluid vented from the temperature/pressure relief valve. The other source of glycol contamination -- leaking from the collector or some other part of the system -- will be managed by recommending periodic inspection of the level of glycol in the system.

2. Residual Hazards. In a properly installed system -- and it should be made clear that the relief valve and the catch basin must be installed on site -- and a properly maintained system, residual hazards are low. These hazards are comparable to hazards associated with conventional systems -- the hazard of excess build up of hot water or steam pressure in hydronic heating systems, or the risk of leaks from gas stoves.

3. Component Failure. The malfunction of a temperature/pressure relief valve will significantly increase the hazard of excess temperature and pressure. Similarly, the malfunction of piping, tubing, gaskets, fittings or valves, or improper installation will increase the hazard from the toxicity of glycol.

Contract NAS8-32253

Project: Flat Plate Collector

We recommend use of the following data at the prototype design review:

1. Drawings:
   a. Twin tubing cross section
   b. Header assembly
   c. U-bend
   d. Tubes for header takeoffs and U-bends
   e. Standard straight SUNMAT
   f. Collector assembly, top view, lengthwise cross section and with wise cross section.
2. Test data:
   a. Collector efficiency
   b. operating temperature and pressure limits
   c. pressure drop through system
   d. freeze tolerance
   e. resistance to ponding
   f. fail-safe performance
   g. water potability
   h. resistance to solar degradation of EPDM
   i. resistance to fluttering by wind
   j. leakage
   k. resistance to thermal degradation
   l. resistance to structural damage

3. Analyses:

   a. noise and corrosion

   b. structural calculations

Contract NAS8-32253

Project: Flat Plate Collector

No government-furnished instrumentation is required.

Contract NAS8-32253

Project: Flat Plate Collector

We use design standards and symbology of the American Society of Mechanical Engineers. Symbols are published in American National Standard Graphical Symbols for Pipe Fittings, Valves and Piping.

Verification Plan

Contract NAS8-32253

Project: Flat Plate Collector

CALMAC Manufacturing Corporation
150 South Van Brunt Street
Englewood, N.J. 07631

1. Verification Matrix. See attached

2. Test Hardware. To perform tests at our location we will use the following hardware:

velometer - air velocity
rotometer - flow rate
potentiometer pyrometer - temperature
pressure gauges - pressure
pyranometer - insolation
manometer - pressure drop

This is all basic hardware for measuring the key parameters associated with plumbing and heating devices, except for the pyranometer, which is unique to the solar field.

Other testing requiring hardware and expertise outside our range of experience -- the chemical testing of water for potability, for example -- will be performed by outside laboratories. Testing to certify performance will be performed by an independent laboratory.

3. Test Schedule and Location:

Date	Test	Location
Feb 15	Freeze tolerance of system	CALMAC factory
Mar 1-30	Potability of water run through system	Outside lab to be determined
Mar 1	Pressure drop through system	CALMAC factory
Mar 2	Leakage	" "
Mar 8	Resistance to ponding	" "
Mar 9	Resistance to structural damage	" "
Mar 15	Resistance to fluttering by wind	" "
Mar 22	Fail-safe protection	" "
Mar 29	Temperature and Pressure limits	" "
Mar 1-15	Collector efficiency	" "
Mar 15-May 15	Thermal degradation and collector efficiency	DSET, Phoenix, AZ

4. All this testing will be done during the qualification stage. We have enough experience with the operating characteristics of the collector, based on earlier models we have used, not to need testing at the development stage, and adequate data is available to verify all interim performance criteria at the development stage. Testing at the qualification stage is related primarily to durability and particularly to our use of the EPDM tubing, which, since it is manufactured especially for this application, is unique. The tests for freeze tolerance, potability, pressure drop, leakage, temperature and pressure limits, thermal degradation, and collector efficiency all stem from the use of EPDM. The need to test resistance to fluttering and ponding, on the other hand, stems from the unique structural design of the system. The fail-safe test is a precautionary measure to insure meeting safety requirements.

Testing at the acceptance stage should not be necessary, unless design changes are made following qualification testing. Our plan is to complete testing of all key areas here at our plant as early as possible in the qualification stage and then have DSET verify our findings to meet the need for certification by an independent agency.

PF01-358c

ITEM (NAME & PART NO.)

Flat Plate Collector

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION 4. TEST N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
Subsystem Specification	1	4	4	
Interim Performance Criteria				
1.2.4	3	3	3	
1.3	3	3	3	
1.3.1	1	1	3	
1.4	3	3	3	
1.4.1	2	3	3	
2.1	3	3	3	
2.1.1	2	3	3	
2.1.2	2	3	3	
2.1.3	2/1	4	3	
2.1.4	1	1	3	
2.1.5	3	3	3	
2.1.6	3	3	3	
2.1.7	1	4	3	
2.2	3	3	3	
2.2.1	3	3	3	
2.2.2	3	3	3	
2.2.4	3	3	3	
2.2.5	3	3	3	
2.2.6	3	3	3	

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ITEM (NAME & PART NO.)
Flat Plate Collector

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION 4. TEST N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
2.3	3	3	3	
2.3.1	1	4	3	
2.4	3	3	3	
2.4.1	1	1	3	
2.6.4	1	4	3	
2.8	3	3	3	
2.8.1	1	1	3	
3.1	3	3	3	
3.1.1	3	3	3	
3.1.2	2	3	3	
3.2	3	3	3	
3.2.1	2	2	3	
3.2.2	2	2	3	
3.2.4	2	2	3	
3.3	3	3	3	
3.3.1	2	4	3	
3.4	3	3	3	
3.4.1	2	2	3	
3.7				
3.7.1	2			
3.8	3	3	3	
3.8.1	2	2	3	
3.9	3	3	3	

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ITEM (NAME & PART NO.)

Flat Plate Collector

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION 4. TEST N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
3.9.1	1	4	3	
4.1	3	3	3	
4.1.1	3	3	3	
4.2	3	3	3	
4.2.1	1	4	3	
4.2.2	3	3	3	
4.3	3	3	3	
4.3.1	1	1	3	
4.3.2	1	3	3	
4.4	3	3	3	
4.4.1	3	3	3	
4.4.2	3	3	3	
4.6	3	3	3	
4.6.1	2	4	3	
4.6.3	3	3	3	
4.6.4	2	3	3	
4.7	3	3	3	
4.7.1	2	3	3	
5.1	3	3	3	
5.1.1	1	4	3	
5.1.3	1	3	3	
5.1.4	1	3	3	
5.1.5	1	3	3	

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ITEM (NAME & PART NO.)

Flat Plate Collector

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION 4. TEST N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
5.1.6	2	4	3	
5.2	3	3	3	
5.2.1	1	4	3	
5.2.2	1	1	3	
5.2.3	2	2	2	
5.2.4	1	4	3	
5.2.5	1	1	3	
5.2.6	1	1	3	
5.3	3	2	3	
5.3.1	1/2	3	3	
5.3.2	2	2	3	
5.3.3	2	2	3	
5.3.4	2	2	3	
6.1	3	3	3	
6.1.1	3	3	3	
6.1.2	3	3	3	
6.1.3	3	3	3	
6.1.4	3	3	3	
6.1.5	3	3	3	
6.2	3	3	3	
6.2.1	3	3	3	
6.2.2	3	3	3	
6.2.3	3	3	3	

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ITEM (NAME & PART NO.)

Flat Plate Collector

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION 4. TEST N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
6.2.4	3	3	3	
6.3	3	3	3	
6.3.1	3	3	3	
6.3.2	3	3	3	
11.2.1	2	2	3	
11.2.2	2	2	3	
11.3.1	1	1	3	

PART 2

Preliminary Design Review Data

Contract NAS8-32253

Project: Solar Pump

CALMAC Manufacturing Corporation
150 South Van Brunt Street
Englewood, N.J. 07631

Contract NAS8-32253

Project: Solar Pump

The following drawings are required to define the subsystem:

1. Pump top view and cross section
2. Vapor tube

Contract NAS8-32253

Project: Solar pump

No special installation and maintenance tools are required.

1. Identification and Control of Hazards. The sources of hazard in the pump subsystem are excess temperatures and pressures wihtin the piping and tubing, and the toxicity of the ethylene glycol heat transfer fluid. The hazards are hazards only to personnel and not to equipment or buildings -- the temperatures and pressures involved are not high enough to ignite, collapse or otherwise, damage equipment or buildings. The potential hazards to personnel, however, are major as serious burns, or poisoning could result from a malfunction.

   The strategy for managing excess temperatures and pressures is primarily to relieve them before they build up to an excess. The use of a temperature and pressure relief valve in the system set at 280°F and 28 PSI accomplishes this objective. In addition, to minimize the risk of burns suffered from touching the pump which might reach to 200°F during normal operation signs will be recommended when the pump is operated in areas subjected to public traffic. The toxicity of the glycol is managed by the use of a basin to catch fluid vented from the temperature/pressure relief valve. The other source of glycol contamination -- leaking from the pump or some other part of the system -- will be managed by recommending periodic inspection of the level of glycol in the system.

2. Residual Hazards. In a properly installed system -- and it should be made clear that the relief valve and the catch basin must be installed on site -- and a properly maintained system, residual hazards are low. These hazards are comparable to hazards associated with conventional systems -- the hazard of excess build up of hot water or steam pressure in hydronic heating systems, or the risk of leaks from gas stoves.

3. Component Failure. The malfunction of a temperature/pressure relief valve will significantly increase the hazards of excess temperature and pressure. Similarly, the malfunction of piping, tubing, gaskets, fittings or valves, or improper installation will increase the hazard from the toxicity of glycol.

Contract NAS8-32253

Project: Solar Pump

We recommend use of the following data at the prototype design review:

1. Drawings:

   a. Pump, top view
   b. Pump, cross section
   c. Vapor tube

2. Test data:

   a. Operating performance (flow rate, pressure output for various combinations of liquid temperature and steam pressure)
   b. Thermal degradation
   c. Fail-safe performance
   d. Leakage
   e. Vibration
   f. Water potability

3. Analyses:

   a. Noise and corrosion
   b. Structural calculations

Contract NAS8-32253

Project: Solar Pump

We use design standards and symbology of the American Society of Mechanical Engineers. Symbols are published in American National Standard Graphical Symbols for Pipe Fittings, Valves and Piping.

Contract NAS8-32253

Project: Solar Pump

No government-furnished instrumentation is required.

Verification Plan

Contract NAS8-32253

Project: Solar Pump

CALMAC Manufacturing Corporation
150 South Van Brunt Street
Englewood, N.J. 07631

1. Verification Matrix. See attached.

2. Test Hardware. To perform tests at our location we will use the following hardware:

rotometer - flow rate
potentiometer pyrometer - temperature
pressure gauges - pressure
manometer - pressure drop

These instruments are all basic hardware for measuring the key parameter associated with plumbing and heating devices.

Other testing requiring hardware and expertise outside or range of experience -- the chemical testing of water for potability, for example -- will be performed by outside laboratories. Testing to certify performance will be performed by an independent laboratory.

3. Test Schedule and Loaction:

Date	Test	Location
Mar 1-30	Potability of water run through system	Outside lab to be determined
Mar 1-30	Thermal degradation	CALMAC factory
Mar 8	Leakage	" "
Mar 15	Vibration	" "
Mar 22	Fail-safe performance	" "
Mar 15-30	Operating performance and limits	" "
Ap 1-30	Operating performance and limits	DSET, Phoenix, AZ

4. All this testing will be done during the qualificaiton stage. The critical problem in the case of the pump is the development of a design that will meet operating performance requirements -- pumping at specified pressures and flow rates -- not the development of designs that meet ruggedness and durability requirements. Solving this problem involves analyzing different shapes and designs of the cylinder chamber, valves, vapor tube and so forth, and does not lend itself to testing. Once the design is set and operating performance requirements met, then we can test rigorously both the pump's operating characteristics and its durability during the qualification stage. Unless design changes develop during this period we can proceed readily to certification by an outside angency (DSET) towards the end of the qualification stage.

PF01-358c

ITEM (NAME & PART NO.)

Pump

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION 4. TEST N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
Technical Performance Requ ements	2	4	3	
Interim Performance Criteria				
1.2.4	3	3	3	
2.1	3	3	3	
2.1.1	2	3	3	
2.1.2	2	3	3	
2.1.3	2	4	3	
2.1.5	3	3	3	
2.1.6	3	3	3	
2.2	3	3	3	
2.2.1	2	3	3	
2.2.2	2	4	3	
2.2.4	3	3	3	
2.2.5	2	3	3	
2.2.6	3	3	3	
2.3	3	3	3	
2.3.1	2	4	3	
2.6	3	3	3	
2.6.1	1	3	3	
2.6.3	3	3	3	
2.6.4	1	3	3	
2.7	3	3	3	

PF01-358c

ITEM (NAME & PART NO.)

Pump

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION N/A NOT APPLICABLE 4. TEST

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
2.7.1	3	3	3	
2.8	3	3	3	
2.8.1	1	1	3	
3.1	3	3	3	
3.1.1	3	3	3	
3.1.2	2	3	3	
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3.3	3	3	3	
3.3.1	2	2	3	
3.4	3	3	3	
3.4.1	2	2	3	
3.8	3	3	3	
3.8.1	2	2	3	
3.9.1	3	3	3	
4.1	3	3	3	
4.1.1	3	3	3	
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4.2.2	3	3	3	
4.3	3	3	3	ORIGINAL PAGE IS OF POOR QUALITY
4.3.1	2	1	3	
4.4	3	3	3	

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ITEM (NAME & PART NO.)

Pump

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION 4. TEST N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
4.4.1	3	3	3	
4.5	3	3	3	
4.5.2	3	3	3	
4.6	3	3	3	
4.6.3	3	3	3	
4.6.4	2	3	3	
4.7	3	3	3	
4.7.1	2	3	3	
5.1	3	3	3	
5.1.1	1	3	3	
5.1.3	1	3	3	
5.2	3	3	3	
5.2.1	1	4	3	
5.2.2	1	1	3	
5.2.3	2	2	3	
5.2.4	1	4	3	
5.2.5	1	1	3	
5.3	3	3	3	
5.3.1	1/2	3	3	
5.3.2	2	2	3	
5.3.3	2	2	3	
5.3.4	2	2	3	
5.4	3	3	3	

ITEM (NAME & PART NO.)

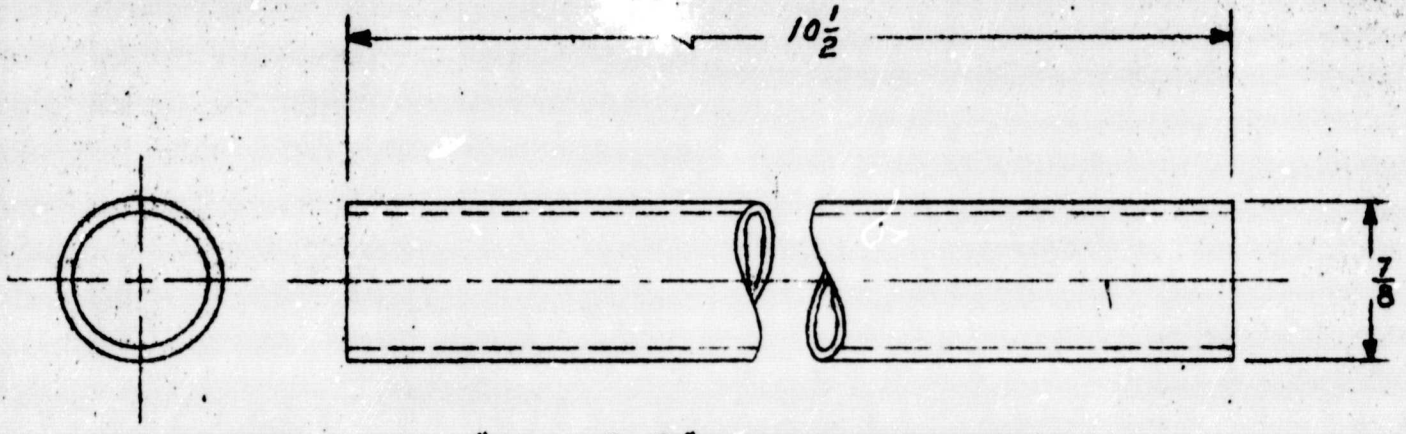
Pump

VERIFICATION CROSS REFERENCE MATRIX

VERIFICATION METHOD: 1. SIMILARITY 2. ANALYSIS 3. INSPECTION 4. TEST N/A NOT APPLICABLE

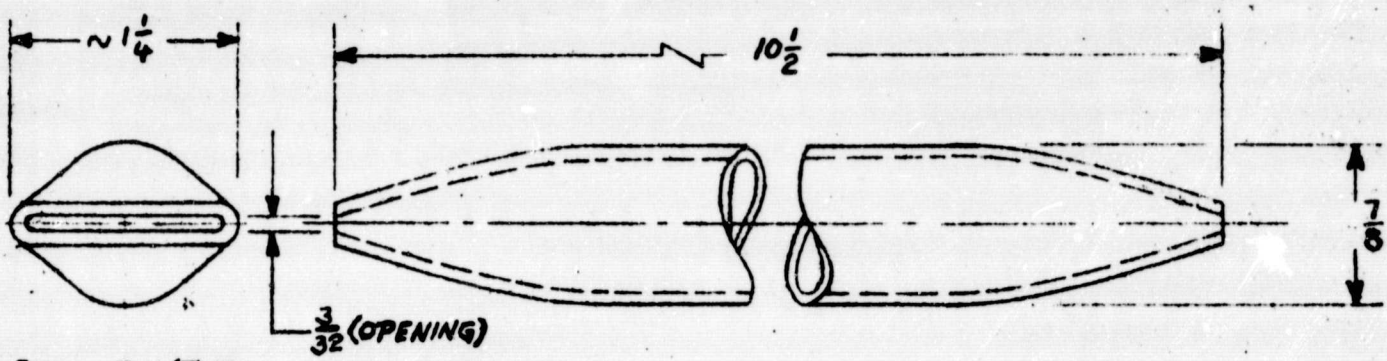
PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
5.4.1	1	3	3	
6.1	3	3	3	
6.1.1	3	3	3	
6.1.2	3	3	3	
6.1.3	3	3	3	
6.1.4	3	3	3	
6.1.5	3	3	3	
6.2	3	3	3	
6.2.1	3	3	3	
6.2.2	3	3	3	
6.2.3	3	3	3	
6.2.4	3	3	3	
6.3	3	3	3	
6.3.1	3	3	3	
6.3.2	3	3	3	
8.3.1	3	3	3	
11.2.1	2	2	3	
11.2.2	2	2	3	
11.3.1	1	1	3	

PART 3



END VIEW (TYP.)

"BLANK" - 3/4" COPPER PIPE, TYPE 'L'



END VIEW (TYP)

"FINISHED" DRIER TUBE

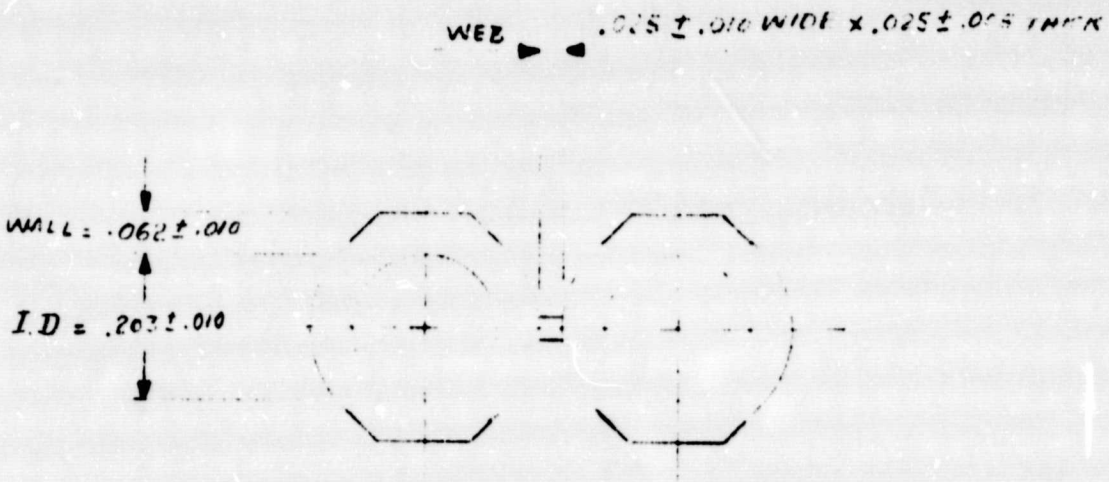
INSTRUCTIONS

1. CUT PIPE TO SIZE i.e. 10½" LG.
2. REMOVE BURRS
3. PRESS ONE END (USE 3/32 SHIM FOR OPENING)
4. FILL WITH SILICA GEL, SIZE 3 ON 8 MESH
5. PRESS OTHER END (USE 3/32 SHIM FOR OPENING)
6. SEAL BOTH ENDS WITH REMOVABLE TAPE

Rev	By	Date	Revisions

TOLERANCES: FRACTIONAL, ± 1/64 ; DECIMALS, ± .005 ; ANGLES, ± 1/2°

TITLE DRIER TUBE, SOL. COLL.	Tool No.	DRN. 5-12-76	CALMAC MFG. CORP. Englewood, N.J.
MATERIAL 3/4 COPPER PIPE, TYPE 'L'	Blank Size	CHK.	
		PRO. SOL ENGY	A-SE0001
		SCALE FULL	



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Rev	By	Date	Revisions

TOLERANCES : FRACTIONAL, ± 1/64 ; DECIMALS, ± .005 ; ANGLES, ± 1/2°

TITLE *TWIN TUBING - CROSS SECTION*

MATERIAL *80-85 DUROMETER EPDM*

Tool No.

Blank Size

DRN. *12-13-75*

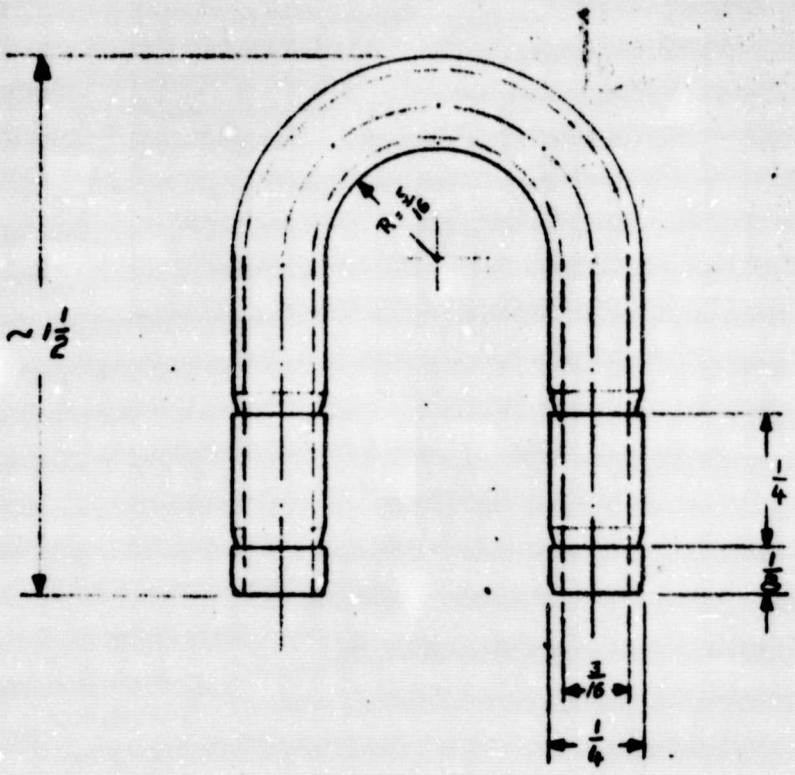
CHK

PROJ. SOL. ENERGY

SCALE *4 = 1*

CALMAC MFG. CORP.
Englewood, N.J.

A- 130P - A



NOTE: STRAIGHT LENGTH OF TUB. BEFORE BENDING 3½"; SEE DWG A-6438, ITEM-3. STRAIGHT PC ANNEALED @ 500°F PRIOR TO BENDING.

Rev	By	Date	Revisions

TOLERANCES: FRACTIONAL, ± 1/64; DECIMALS, ± .005; ANGLES, ± 1/2°

TITLE COPPER 'U'-BEND

MATERIAL ¼ O.D. HARD COPPER TUB TYPE 'L'

Tool No.

Blank Size

DRN. 11-19-75

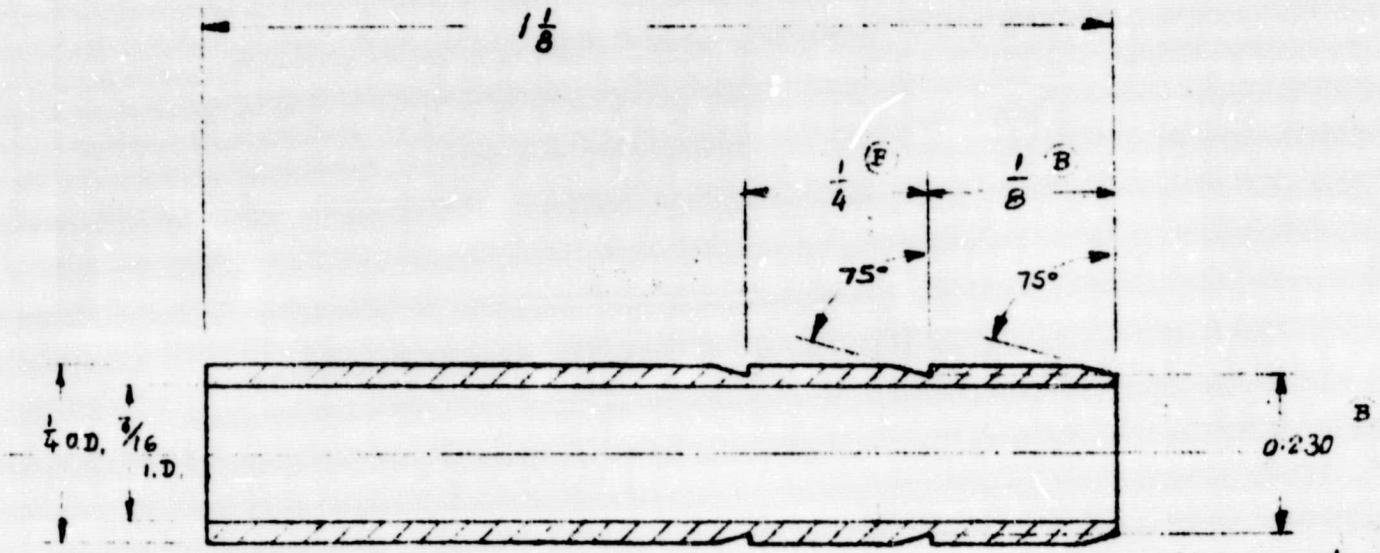
CHK.

PROJ. STANDARD

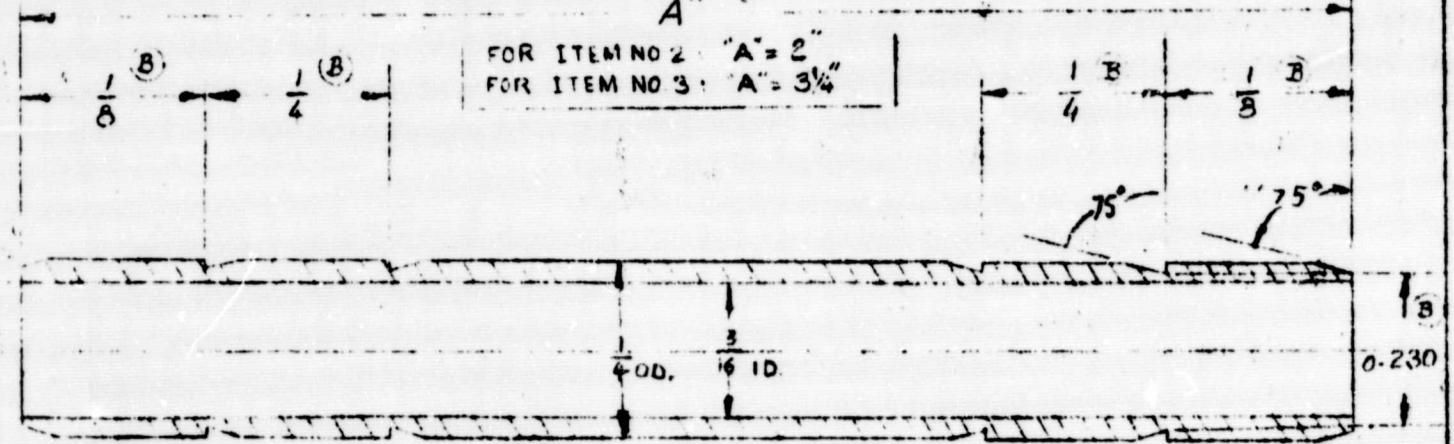
SCALE 1"=2"

CALMAC MFG. CORP.
Englewood, N.J.

A-ST 239



ITEM 1



ITEMS NO 2 & 3

Rev	By	Date	Revisions
			ADDED ITEM NO. 3
B	[illegible]	12474	½ WAS ¼ ; ¼ WAS ⅛ ; .230 WAS .220
A	[illegible]	9/13-71	CHANGED UNDERCUTS

TOLERANCES: FRACTIONAL, ±1/64 ; DECIMALS, ±.005 ; ANGLES, ±½°

TITLE: [illegible] FOR 'U' BEND

MATERIAL: COPPER ¼" O.D.

Tool No.

Blank Size

DRN. 12-23-70

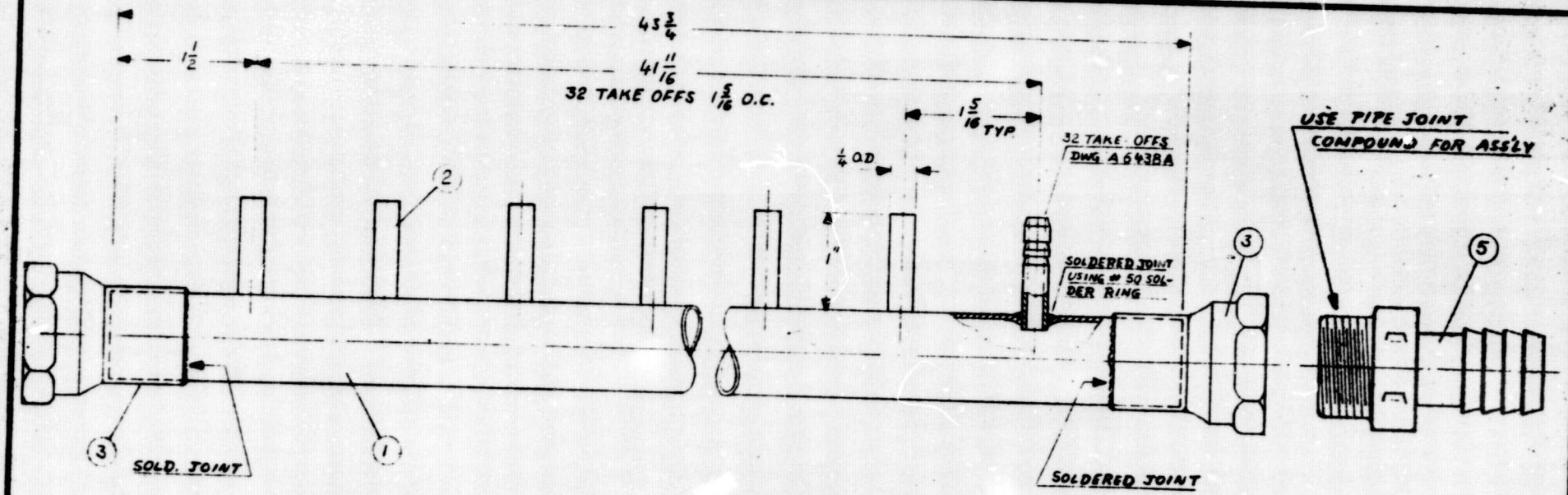
CHK. [illegible]

PROJ. 590+591

SCALE: [illegible]

CALMAC MFG. CORP.
Englewood, N.J.

A-6438 B



ITEM	QTY	MATERIAL
5	1	HOSE ADAPTER 3/4 MPT X INSERT PVC
4	1	3/4 THREADED PLUG (NOT SHOWN) STEEL
3	2	ADAPTER 3/4 INSERT COPPER
2	32	COPPER TUBING TYPE L HARD 1/4 DIA 1 5/8 LG
1	1	COPPER TUBING TYPE L HARD 3/4" DIA X 43 3/4 LG

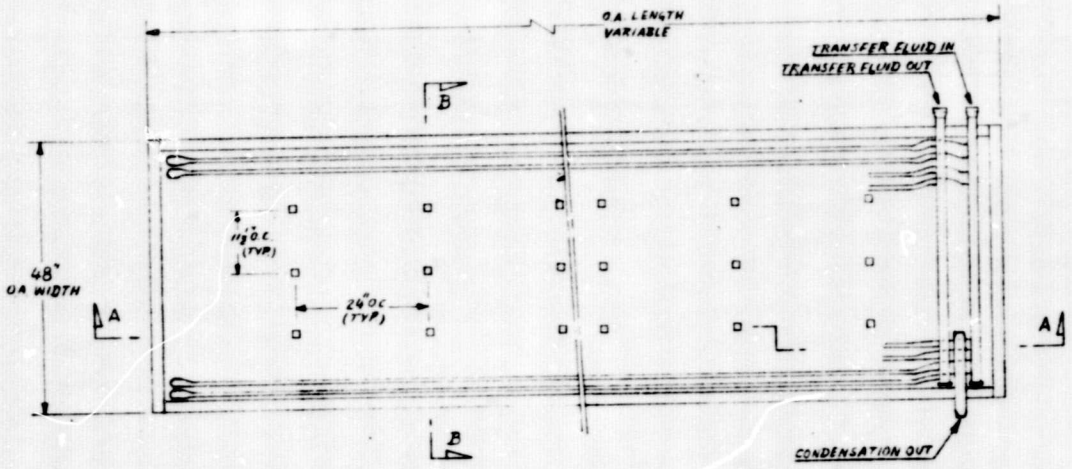
BILL OF MATERIAL

NOTE:

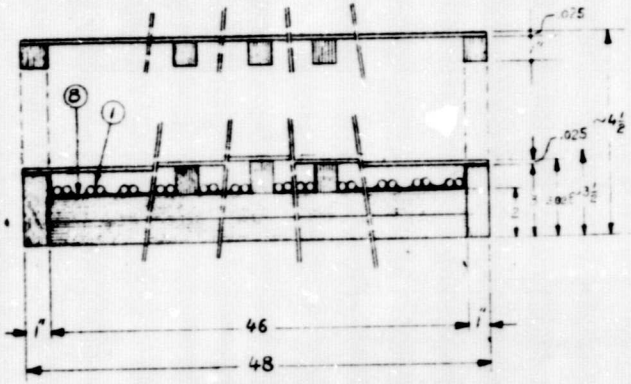
- EACH SUNMAT REQUIRES TWO SUB HEADERS OF THIS DESIGN ONE SUPPLY AND ONE RETURN.
- ON ONE END OF THE SUB HEADER HOSE ADAPTER IS INSTALLED FOR RUBBER HOSE CONN. ON THE OTHER END A STEEL PLUG IS INSTALLED FOR CLEANOUT (NOT SHOWN)

DO NOT SCALE THIS DRAWING.
TOLERANCES UNLESS OTHERWISE NOTED
FRACTIONAL ± 1/64 DECIMAL ± .005 ANGULAR ± 1/2°
NAME: SUBHEADER ASS'LY (NEW DESIGN)
MATERIAL: AS SPEC.

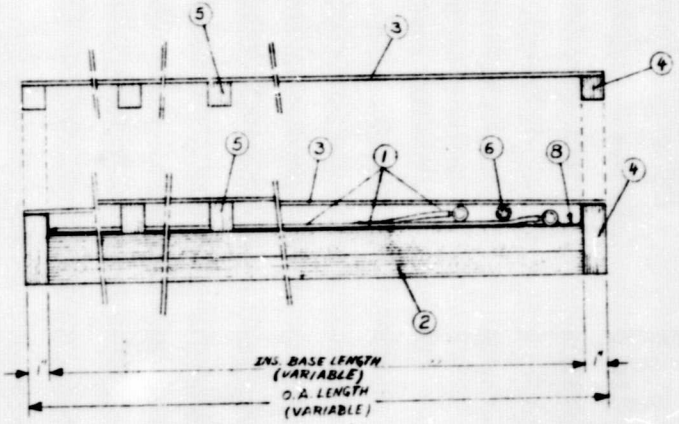
REV	BY	DATE	Revisions
DR:		11-20-75	CALMAC MFG. CORP. Englewood, N.J.
CHK			
APP			
PROJ. STANDARD			B-ST 243
SCALE FULL			



TOP VIEW
SCALE: NONE



SECTION-BB
SCALE: ½"=1"



SECTION-AA
SCALE: ½"=1"

BILL OF MATERIAL

ITEM	QTY.	MATERIAL
1	1	SUNMAT ASSLY, COMPL WITH HDRS & U-BANDS
2	1	INSULATION BASE - 2.1" THK. MKS. BDS. #703 WITH 5MIL THK AL FOIL FACING ON ONE SIDE
3	1 OR 2	COVER PANEL, KALWALL SUNLITE PREMIUM, .025" THK.
4	1 OR 2	SET INSULATION PERIMETER, MATERIAL AS ITEM 2
5	1	SET INSUL. SPACER BLOCKS, MATERIAL AS ITEM 2
6	1	DESICCANT DRYER TUBE
7		RUBBER ADHESIVE, 3M'S # 1300
8		INSULATION ADHESIVE, 3M'S # 4230

NOTE.

- SECOND LAYER OF ITEM 3, KALWALL COVER PANEL IS OPTIONAL.
- RUBBER ADHESIVE # 1300 IS USED TO JOIN INSULATION PERIMETER TO EASE AND FOR JOINT BETWEEN INSL. PERIMETER AND COVER PANEL (KALWALL) AND SPACER BLOCKS AND COVER PANEL.
- INSULATION ADHESIVE #4230 IS USED TO JOIN INSULATION BASE TO INSTALLATION SURFACE, TWO LAYERS OF INSL BASE TOGETHER, SUNMAT TO INSULATION BASE AND TO FILL THE SPACES BETWEEN SUNMAT TUBS. IT IS USED TO WATER PROOF ALL AROUND OUTSIDE

Rev	By	Date	Revisions

TOLERANCES FRACTIONAL ± 1/64 DECIMALS ± .005 ANGLES ± 1/2°

TITLE SUNMAT SOLAR COLLECTOR ASSLY

MATERIAL AS SPEC.

Tool No.

Blank Size

DRN. 12-29-76

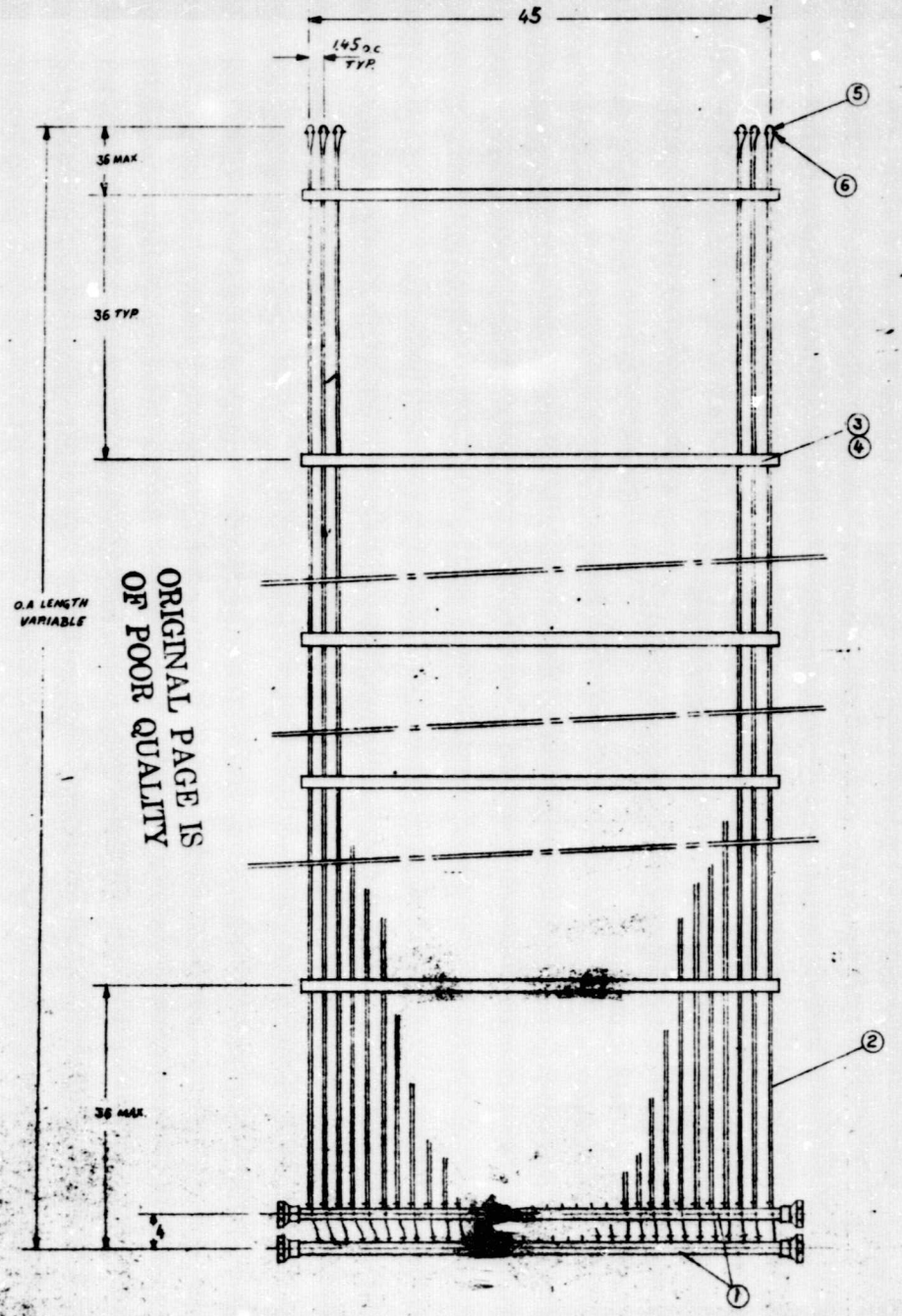
CHK.

PROJ. SOL ENGY

SCALE GIVEN

CALMAC MFG. CORP.
Englewood, N. J.

C-155 P



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BILL OF MATERIAL

ITEM	QTY	MATERIAL
1	2	COPPER HEADER ASS'LY. WITH 2 ADAPTERS & 32 NIPPLES
2	*	EPDM TWIN TUBING ¼" I.D. ⅜" O.D. (BLACK)
3	*	FLEXIBLE VINYL SPACER STRIP, .030" x 1" x 49"
4	*	RIGID VINYL SPACER STRIP, .040" x 1" x 49"
5	32	COPPER U-BEND, FROM ¼" O.D. .032" WALL COPPER TUB.
6	128	STIMPSON BUTTON CLAMP, # A2098 (COPPER)

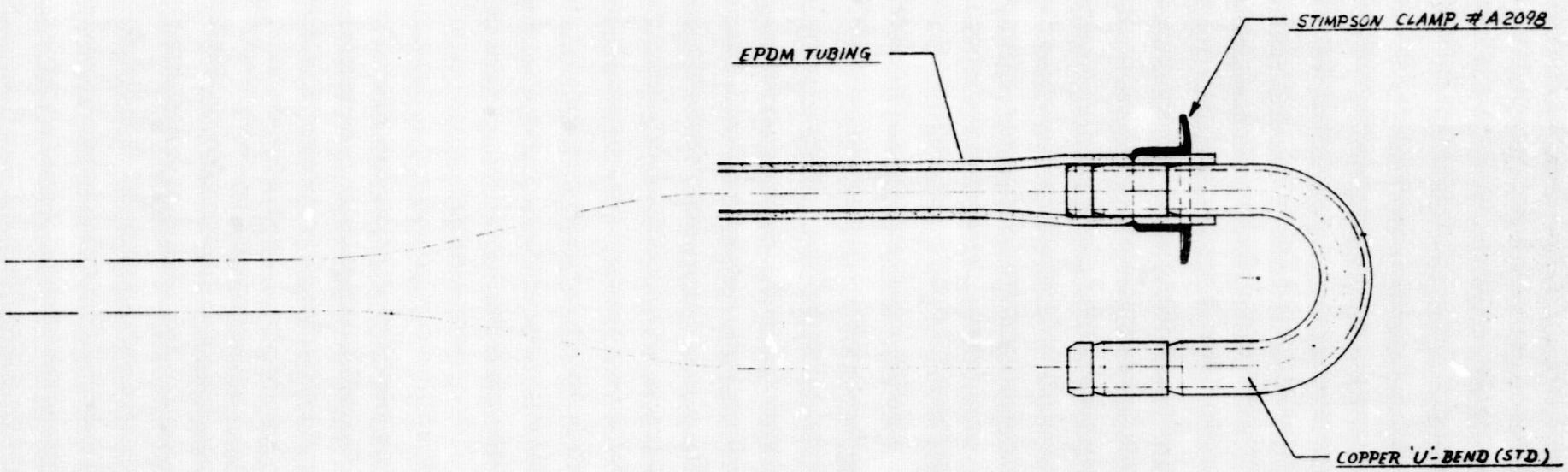
* QUANTITY VARIOUS AS PER SPECIFIED LENGTH OF THE SUNMAT

Mod.	By	Date	Revisions

DWN. 12-29-76
CHK.
PROJ. SOL. ENGR.
SCALE NONE

TITLE "SUNMAT" ASS'LY.
MATERIAL AS SPEC.

CALMAC MFG. CORP.
Englewood, N. J.
C-156P



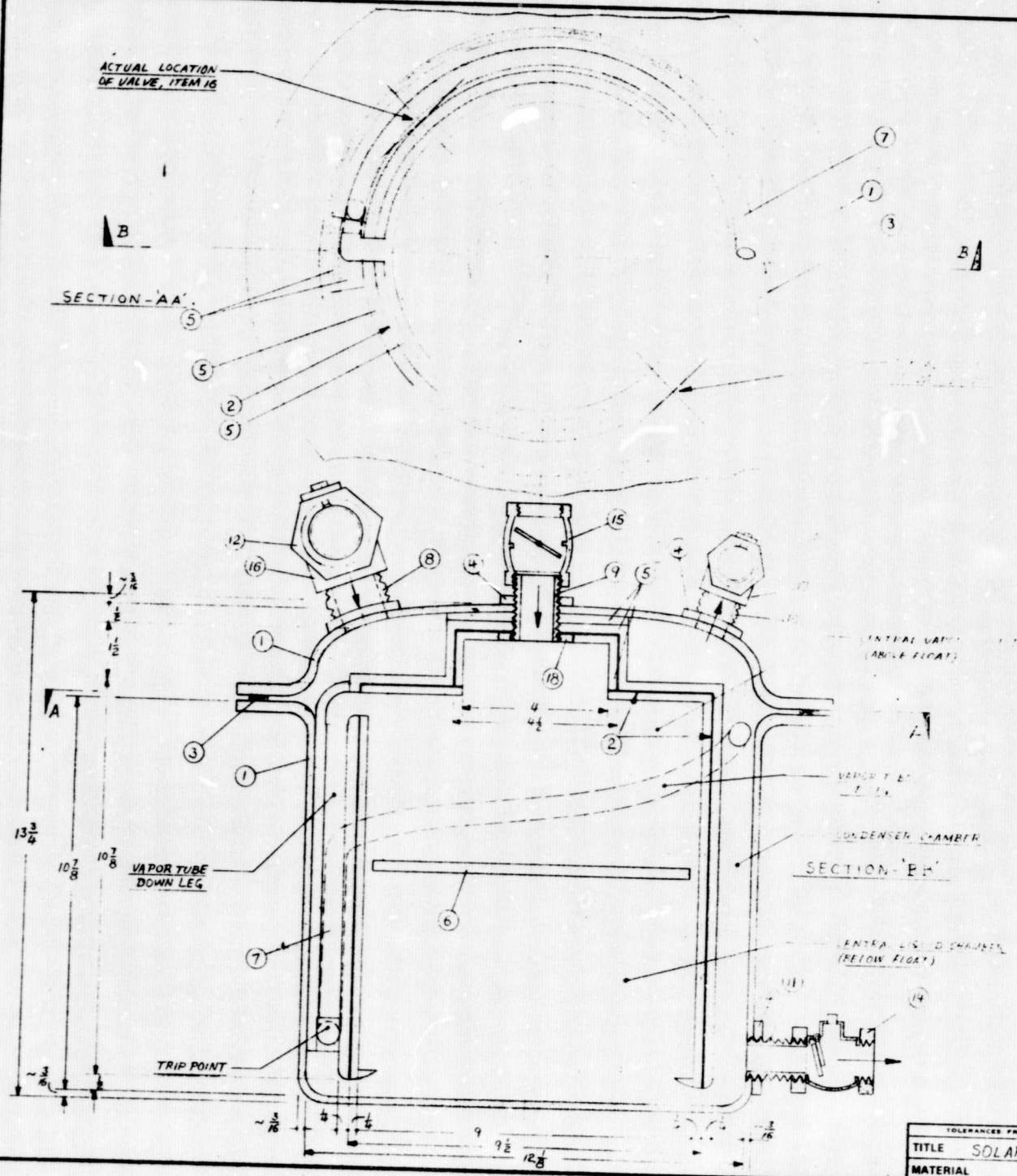
REV	BY	DATE	Revisions

DO NOT SCALE THIS DRAWING.
TOLERANCES UNLESS OTHERWISE NOTED
FRACTIONAL ± 1/64 DECIMAL ± .005 ANGULAR ± 1/2°
NAME: ASSEMBLY DETAIL, SUMMAT
MATERIAL:

DRN 12-29-76
CHK
APP.
PROJ. SOL ENGY
SCALE 2:1

CALMAC MFG. CORP.
Englewood, N.J.

B- 157P



BILL OF MATERIAL

ITEM	QTY	MATERIAL
1	1	22-QTS PRESSURE COOKER, MIRRO-MATIC DELUXE TYPE, PT NO M-0528 AL ALLOY CONSTRUCTION
2	1	METAL CONTAINER #304 SS
3	1	PRESS COOKER GASKET
4	4	AL BOSS (WELD TO COOKER)
5	1	SET CORK INSULATION, 1/4" THK
6	1	CORK FLOAT, 1/4 THK, 8 1/2" DIA
7	1	1/2" ID COPPER TUBE ASSLY
8	1	1 1/2" X CLOSE NIPPLE (GALV)
9	1	1" X NIPPLE (GALV)
10	1	1" X CLOSE NIPPLE (GALV)
11	1	1/4 X CLOSE NIPPLE (GALV)
12	1	1/2" CHECK VALVE (FOR RETURN LIQUID TO PUMP)
13	1	1" CHECK VALVE (FOR SUPPLY LIQUID FROM PUMP)
14	1	1/4 [illegible] VALVE (FOR MAKE UP LIQUID TO SOL COLL.)
	1	VALVE (FOR STEAM FROM SOL COLL)
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]

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OF POOR QUALITY

TOLERANCES FRACTIONAL ± 1/64. DECIMALS ± .005. ANGLES ± 1°

TITLE	SOLAR PUMP	Tool No.	
MATERIAL	AS SPEC.	Blank Size	

Rev	By	Date	Revisions
DRN	12-30-76		CALMAC MFG. CORP. Englewood, N. J.
CHK			
PROJ. SOL. ENGR			
SCALE	HALF		C158P