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# DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150605

## PRELIMINARY DESIGN PACKAGE FOR SUNSPOT DOMESTIC HOT WATER HEATING SYSTEM

Prepared by

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Under Contract NAS8-32245 with

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

for the U. S. Department of Energy



(NASA-CR-150605) PRELIMINARY DESIGN PACKAGE  
FOR SUNSPOT DOMESTIC HOT WATER HEATING  
SYSTEM (Elcam, Inc., Santa Barbara, Calif.)  
116 p HC A06/MF A01 CSCL 10A

N78-27518

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# U.S. Department of Energy



**Solar Energy**

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1. REPORT NO. DOE/NASA CR-150605		2. GOVERNMENT ACCESSION NO.		3. RECIPIENT'S CATALOG NO.	
4. TITLE AND SUBTITLE Preliminary Design Package for Sunspot Domestic Hot Water Heating System				5. REPORT DATE November 1976	
				6. PERFORMING ORGANIZATION CODE	
7. AUTHOR(S)				8. PERFORMING ORGANIZATION REPORT #	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Elcam, Incorporated 5330 Debbie Lane Santa Barbara, CA 93111				10. WORK UNIT NO.	
				11. CONTRACT OR GRANT NO. NAS8-32245	
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, D. C. 20546				13. TYPE OF REPORT & PERIOD COVERED Contractor Report	
				14. SPONSORING AGENCY CODE	
15. SUPPLEMENTARY NOTES  This work was done under the technical management of Mr. Mitchell Cash, George C. Marshall Space Flight Center, Alabama.					
16. ABSTRACT  This report is a collation of documents that were submitted by Elcam, Inc., for the preliminary design review on the Sunspot Domestic Hot Water System. Included are a drawing list, auto-control logic, measurement definitions, and other documents pertaining to the preliminary design of the system.  Elcam, under NASA/MSFC Contract NAS8-32245, has developed two solar heated prototype hot water systems and two heat exchangers. The hot water systems consist of the following subsystems: collector, storage, control transport, auxiliary energy and government-furnished Site Data Acquisition.  The two systems are being installed at Tempe, Arizona, and San Diego, California.  A small amount of retyping and reformatting has been done for clarity.					
17. KEY WORDS			18. DISTRIBUTION STATEMENT Unclassified-Unlimited  <i>William A. Brooksbank Jr</i> WILLIAM A. BROOKSBANK, JR. Mgr, Solar Heating and Cooling Project Office		
19. SECURITY CLASSIF. (of this report) Unclassified		20. SECURITY CLASSIF. (of this page) Unclassified		21. NO. OF PAGES 112	
				22. PRICE NTIS	

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Section A

DRAWING LIST

CONTRACT NAS8-32245

ESC-7a

SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

ELCAM INC.

SANTA BARBARA, CA.

NOVEMBER 1976

A

LEVEL S - SYSTEM CONFIGURATIONS

DRAWING NUMBER

S1	Internal Heat Exchanger	ESS-1
S2	External Heat Exchanger	ESS-2
S3	Direct Heating System	ESS-3
S4	Dump Tank with Internal Heat Exchanger	ESS-4
S5	Dump Tank with External Heat Exchanger	ESS-5
S6	Direct Dump Option	ESS-6

Drawing List  
NAS8-32245

LEVEL E - ELEMENTSDRAWING NUMBER

E1	Collector	ESE-1
E2	Solar Tank	ESE-2
E3	Electric Tank	ESE-3
E4	Gas Tank	ESE-4
E5	Pump	ESE-5
E6	Cascade Autocontrol	ESE-6
E7	DTT Control	ESE-7
E8	S106 B Relay	ESE-8
E9	Cascade Valve	ESE-9
E10	Open for Gas Valve Actuator	ESE-10
E11	Heat Exchanger - Internal	ESE-11
E12	Heat Exchanger - External	ESE-12
E13	Dump Tank	ESE-13
E14	Expansion Chamber	ESE-14

Drawing List  
NAS8-32245



LEVEL P - PARTSDRAWING NUMBERCOLLECTOR

CP1	Absorber Snap Fin	ESP-C1
CP2	Absorber Waterway	ESP-C2
CP3	Side Channel	ESP-C3
CP4	Cove Strip	ESP-C4
CP5	Cross Channel	ESP-C5
CP6	Absorber Restraint	ESP-C6
CP7	Grommets and Gaskets	ESP-C7
CP8	Cover - Glasteel	ESP-C8
CP9	Open for Glass Cover	ESP-C9
CP10	Gaskets	ESP-C10
CP11	Rear Insulation/Aluminum Sheet	ESP-C11
CP12	Side Insulation	ESP-C12
CP13	Pop Rivets	ESP-C13
CP14	Corner Brackets	ESP-C14
CP15	Label	ESP-C15
CP16	Waterway Cap	ESP-C16

AUTOCONTROL

AP1	Cover	ESP-A1
AP2	Decals	ESP-A2
AP3	Base Plate	ESP-A3
AP4	Stand Off	ESP-A4
AP5	Screw	ESP-A5
AP6	Screw	ESP-A6

Drawing List  
NAS8-32245

LEVEL P - PARTSDRAWING NUMBERAUTOCONTROL (continued)

AP7	Circuit Board Assembly	ESP-A7
AP8	Circuit Board	ESP-A8
AP9	I.C. Socket	ESP-A9
AP10	L.M. 324 N.I.C. - Quad or Amp	ESP-A10
AP11	C.D. 4011 Logic Chip	ESP-A11
AP12	2N 4401 Transistor	ESP-A12
AP13	2N 4403 Transistor	ESP-A13
AP14	2N6070A Triac	ESP-A14
AP15	MC7812 Regulator	ESP-A15
AP16	LCIC-UA-DC12 Relay	ESP-A16
AP17	SPST Switch	ESP-A17
AP18	SPST Center Off Switch	ESP-A18
AP19	IN 4002 Diode	ESP-A19
AP20	IN 5231B ZENER Diode	ESP-A20
AP21	Light Emitting Diode	ESP-A21
AP22	Fuse Holder	ESP-A22
AP23	Fuse	ESP-A23
AP24	Capacitor 1000 MFD	ESP-A24
AP25	Capacitor 100 MFD	ESP-A25
AP26	Transformer and Bracket	ESP-A26
AP27	Power Cord and Plug	ESP-A27
AP28	Resistor 20K $\frac{1}{4}$ W 1%	ESP-A28
AP29	Resistor 75K $\frac{1}{4}$ W 5%	ESP-A29

Drawing List  
NAS8-32245

LEVEL P - PARTSDRAWING NUMBERAUTOCONTROL (continued)

AP30 Resistor 5.11K $\frac{1}{4}$ W 1%	ESP-A30
AP31 Resistor 0.8K $\frac{1}{4}$ W 1%	ESP-A31
AP32 Resistor 2.0K $\frac{1}{4}$ W 1%	ESP-A32
AP33 Resistor 1.2K $\frac{1}{4}$ W 1%	ESP-A33
AP34 Resistor 1.0K $\frac{1}{4}$ W 5%	ESP-A34
AP35 Resistor 10 K $\frac{1}{4}$ W 5%	ESP-A35
AP36 Resistor 0.390K $\frac{1}{4}$ W 10%	ESP-A36
AP37 Resistor 100K $\frac{1}{4}$ W 1%	ESP-A37
AP38 Resistor 2.2K $\frac{1}{2}$ W 5%	ESP-A38
AP39 Resistor 0.68K $\frac{1}{2}$ W 10%	ESP-A39
AP40 Resistor 2K $\frac{1}{4}$ W 5%	ESP-A40
AP41 Resistor 4.75K $\frac{1}{4}$ W 1%	ESP-A41
AP42 Resistor 4.62K $\frac{1}{4}$ W 1%	ESP-A42
AP43 Resistor 4.87K $\frac{1}{4}$ W 1%	ESP-A43
AP44 Resistor 160K $\frac{1}{4}$ W 5%	ESP-A44
AP45 Potentiometer	ESP-A45
AP46 Square Barrel Terminal	ESP-A46
AP47 Pump Recepticle	ESP-A47
AP48 Screw	ESP-A48
AP49 Fuse Mounting Bracket	ESP-A49
AP50 Sensor Lead Strain Relief Bracket	ESP-A50
AP51 NUT	ESP-A51
AP52 LM 3911 Sensor I.C.	ESP-A52

Drawing List  
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LEVEL P - PARTSDRAWING NUMBERAUTOCONTROL (continued)

AP53	Sensor Cartridge	ESP-A53
AP54	Resistor - Sensor Calibration	ESP-A54
AP55	Strain Relief	ESP-A55
AP56	Flag Terminal	ESP-A56
AP57	Sensor Assembly	ESP-A57
AP58	Flag Terminal	ESP-A58
AP59	Sensor Assembly	ESP-A59
AP60	Washer	ESP-A60

STORAGE TANK

TP1	Flange Plates for Direct System	ESP-T1
TP2	Sensor Restraint Plate	ESP-T2
TP3	Labels	ESP-T3

HEAT EXCHANGERS

HP1I	Heat Exchanger Tube	ESP-HI1
HP2I	Return Bend	ESP-HI2
HP3I	Copper Fittings	ESP-HI3
HP4I	Cross Over Connections	ESP-HI4
HP5I	Flange - Exploded View	ESP-HI5
HP6I	Flange	ESP-HI6
HP7I	Bolt & Washer	ESP-HI7

Drawing List  
NAS8-32245

LEVEL P - PARTSDRAWING NUMBERHEAT EXCHANGERS (continued)

HP8I Insulating Washer	ESP-HI8
HP9I Insulating Bushing	ESP-HI9
HP10I O Ring	ESP-HI10
HP11I	ESP-HI11
HP12I OPEN	ESP-HI12
HP13I	ESP-HI13
HP14E Heat Exchanger Tube	ESP-HE14
HP15E Shell	ESP-HE15
HP16E Tee	ESP-HE16
HP17E Tube Sheet	ESP-HE17
HP18E Flange	ESP-HE18
HP19E Bolt	ESP-HE19
HP20E O Ring	ESP-HE20
HP21E Nipples and Fittings	ESP-HE21
HP22E Primary Loop Pump	ESP-HE22
HP23E	ESP-HE23
HP24E	ESP-HE24
HP25E OPEN	ESP-HE25
HP26E	ESP-HE26

Drawing List  
NAS8-32245

LEVEL I - INSTALLATIONDRAWING NUMBER

I1	Pipe Hanger	ESI-1
I2	Check Valve	ESI-2
I3	P & T Valve	ESI-3
I4	Flow Restrictor	ESI-4
I5	Gate Valve	ESI-5
I6	Copper & Brass Fittings	ESI-6
I7	SI06B Relay Enclosure & Hardware	ESI-7
I8	Pressure Gauge	ESI-8
I9	Flexible Connection	ESI-9

Drawing List  
NAS8-32245

Section B

SUGGESTED PROTOTYPE DESIGN REVIEW DATA

ESC-7b

SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

ELCAM INC.

SANTA BARBARA, CA.

NOVEMBER 1976

## SUGGESTED PROTOTYPE DESIGN REVIEW DATA

### INTRODUCTION AND SUGGESTED REVIEW DATA

The Prototype Design Review (PDR2) is scheduled for the twenty-eighth week after award. This will be the week of April 4, 1977. The primary purpose of this review is to establish the government's approval of the contractor's plans to produce the two deliverable hardware items. Additional goals of this meeting include securing the government's approval of ancillary documentation including, but not limited to, documents which relate to:

- a. Performance specification
- b. Verification status
- c. Spare parts list
- d. Test data
- e. Procurement specification
- f. Drawing package
- g. Analysis package
- h. Site installation plans
- i. System instrumentation interface details
- j. Installation, operation and maintenance manuals

It is suggested that the data required to prepare this documentation be available at PDR2.



Section C  
AUTOCONTROL LOGIC  
CONTRACT NAS8-32245  
ESC-7d

SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

ELCAM, INC.  
SANTA BARBARA, CA.  
NOVEMBER 1976

## AUTOCONTROL LOGIC

### 1.0 INTRODUCTION

The SUNSPOT CASCADE autocontrol represents a departure from typical solar controllers. In general, most automatic controls employed by solar energy systems are differential thermostats. The only actuator in these systems is the coolant circulation pump which is always in one of two states, ON or OFF.

The CASCADE autocontrol is also a differential thermostat device. It controls three independent actuators, the coolant circulation pump, the CASCADE valve, and the electric immersion heating element. Figure 1 illustrates these elements schematically and displays their relationships and locations in a SUNSPOT CASCADE DWH system.

This document defines the control logic embodied in the CASCADE autocontrol.

### 2.0 CASCADE AUTOCONTROL LOGIC

Three temperatures are measured by the three sensors shown in Figure 1. Each sensor generates a voltage which is a function of the temperature being measured:

- $T_C$  in the collector
- $T_E$  in the electric tank
- $T_S$  in the solar tank.

AUTOCONTROL LOGIC  
CONTRACT NAS8-32245

Three fixed reference voltages are generated in the autocontrol.

These signals represent three reference temperatures:

- $T_{MAX}$  - The maximum temperature desired in the electric tank.
- $T_{MIN}$  - The temperature below which both solar and electric energy may simultaneously heat water in the electric tank.
- $T_F$  - 35°F. - 38°F.

These six temperature signals are compared with each other in seven distinct tests, illustrated in Figure 2, and listed below:

- $T_C$  and  $T_F$
- $T_C$  and  $T_S$
- $T_C$  and  $T_E$
- $T_E$  and  $T_{MAX}$
- $T_S$  and  $T_F$
- $T_C$  and  $T_{MIN}$
- $T_E$  and  $T_{MIN}$

The results of these tests are logically combined by one three input OR gate and four two input NAND gates. These combinations, which are depicted in Figure 2, have as their outputs, the three signals which control the PUMP, CASCADE VALVE and HEATER RELAY.

The state of these three control variables is completely described by the Boolean expressions presented below:

$$\text{HEATER ON*} = T_{\text{MIN}} > T_C + T_{\text{MIN}} > T_E$$

(\*In this condition, the internal electric element thermostat is enabled.)

$$\text{PUMP ON} = T_F > T_C + T_C > T_S + T_C > T_E$$

$$\text{VALVE ON} = (T_{\text{MAX}} > T_E + T_S > T_C)(T_C > T_E) + T_F > T_S$$

Note: Recall that in Boolean algebra, the + symbol indicates OR while parenthesis indicate AND.

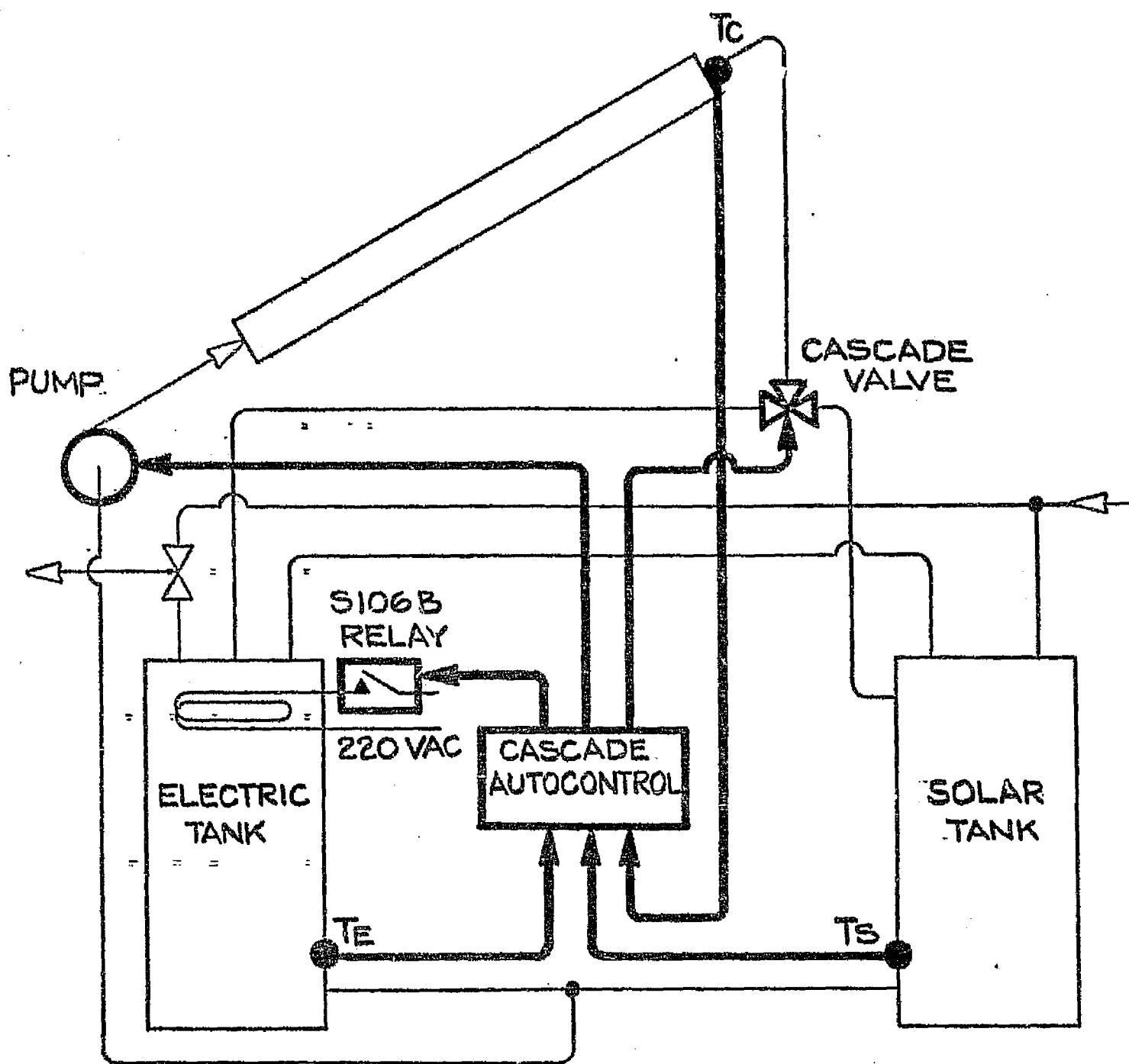
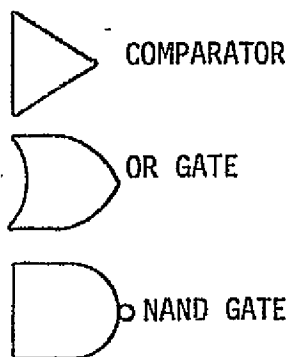
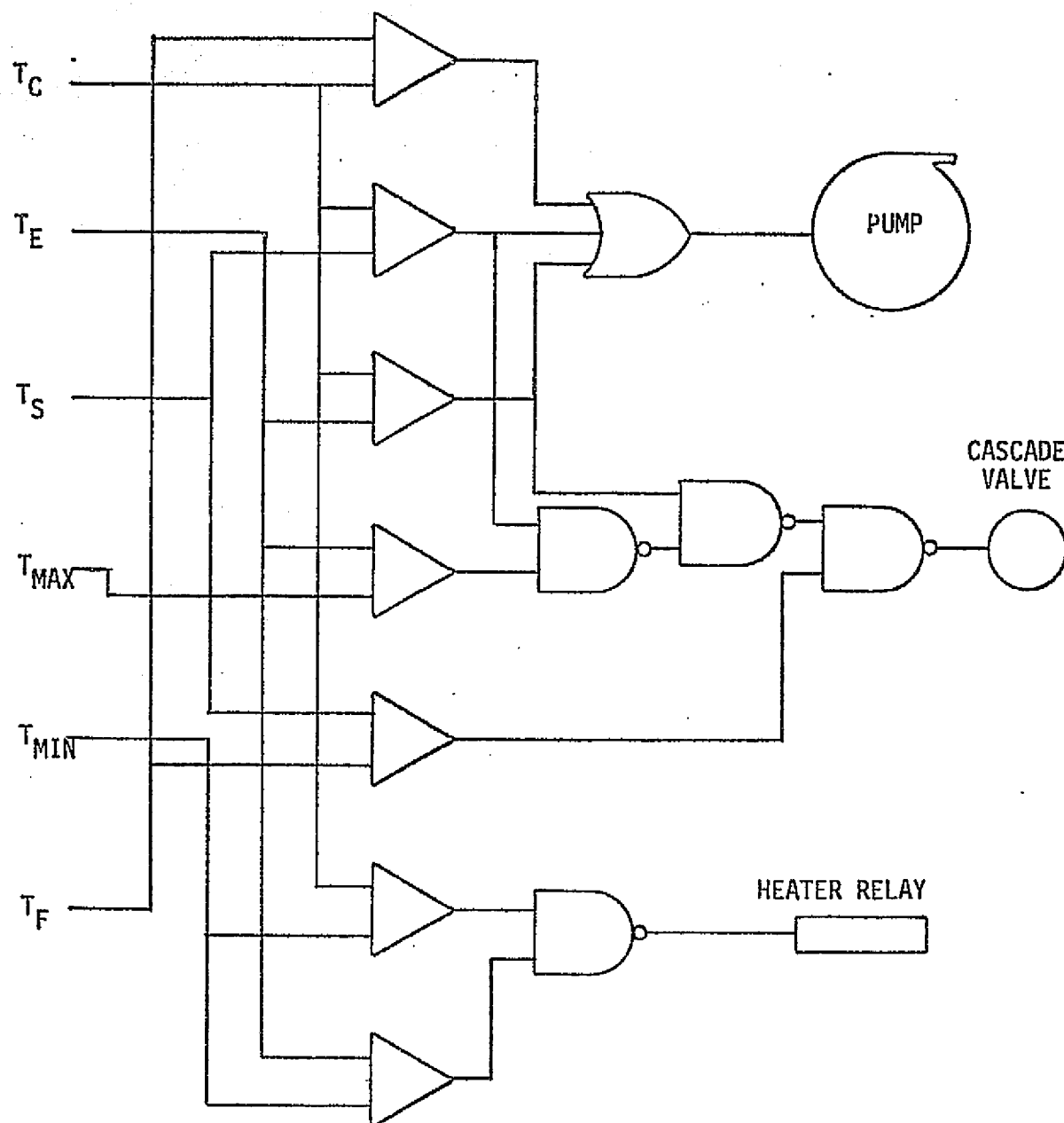



FIGURE 1  
CASCADE AUTOCONTROL, SENSOR  
LOCATIONS AND ACTUATORS

FIGURE 2  
LOGIC SCHEMATIC





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Section D  
MEASUREMENT DEFINITIONS

(MINI P.I.P.)

CONTRACT NAS8-32245

ESC-7e

SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

ELCAM INC.  
SANTA BARBARA, CA.  
NOVEMBER 1976

## MEASUREMENT DEFINITIONS

(MINI P.I.P.)

This document defines those measurements required to evaluate the performance of the SUNSPOT CASCADE domestic solar water heating systems to be supplied to NASA under contract No. NAS8-32245. Discussion of the brands of sensors to be used, their accuracy, resolution, precision and scales are specifically excluded from this document since the Site Data Acquisition Subsystem and its sensors are to be government furnished equipment.

The Measurement Definition Schematic illustrates the SUNSPOT CASCADE system diagrammatically. The circles shown with an alphanumeric code indicate the approximate location of each sensor. The following table is keyed to those alphanumerics, and defines the purpose of each measurement, suggested range, and adds appropriate comments. A discussion of the various operating modes is included in response to Section 2.3 of Document SHC-1006.

MEASUREMENT DEFINITIONS  
CONTRACT NAS8-32245



<u>TEMPERATURES</u>	<u>RANGE TO BE MEASURED</u>	<u>COMMENTS</u>
T1	32-180°F.	Solar tank - top
T2	32-180°F.	Solar tank - bottom
T3	32-180°F.	Electric tank - top
T4	32-180°F.	Electric tank - bottom
T5	32-180°F.	Collector feed - at tank tee
T6	25-200°F.	Collector #1 - Input
T7	25-200°F.	Collector #1 - Exhaust Collector #2 - Input
T8	25-200°F.	Collector #2 - Exhaust
T9	32-100°F.	Cold Supply - Note this sensor must be far enough upstream to be thermally isolated from solar tank.
T10	32-180°F.	Crossover
T11	32-180°F.	Service hot water - upstream of tempering valve
T12	0-100°F	Ambient air temp. - above collectors
T13	25-200°F.	Collector #1 cover - top surface
T14	25-100°F	Collector #1 rear - bottom surface
T15	25-200°F	Collector #1 side - shaded
Note: T13-15 may be duplicated for Collector #2, and expanded in scope if collector performance is a specific requirement		

MEASUREMENT DEFINITIONS  
NAS8-32245

<u>PRESSURES</u>	<u>RANGE TO BE MEASURED</u>	<u>COMMENTS</u>
P1	0-125 psi	Collector #1 - Input
P2	0-125 psi	Collector #1 - Exhaust Collector #2 - Input
P3	0-125 psi	Collector #2 - Exhaust

#### ELECTRICITY CONSUMPTION

W1	5KW/220VAC	Electric Element
W2	50W/110VAC	Pump
W3	5W/110VAC	Autocontrol
W4	1W/24VAC	Cascade Valve
W5	1W/24VAC	Heater Relay

#### EVENT

E1	on/off time	Heater Relay
E2	on/off time	Pump
E3	on/off time	Cascade Valve

#### FLOW

F1	0-5 gpm	Flow Gauge
----	---------	------------

#### INSULATION

I1	0-400 btu/sq ft hr	Total
I2	0-400 btu/sq ft hr	Diffuse

#### WATER CONSUMPTION

C1	0-5 gpm	Water meter
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## OPERATING MODES

The CASCADE Autocontrol operates three actuators. There are thus three fundamental operating modes as follows:

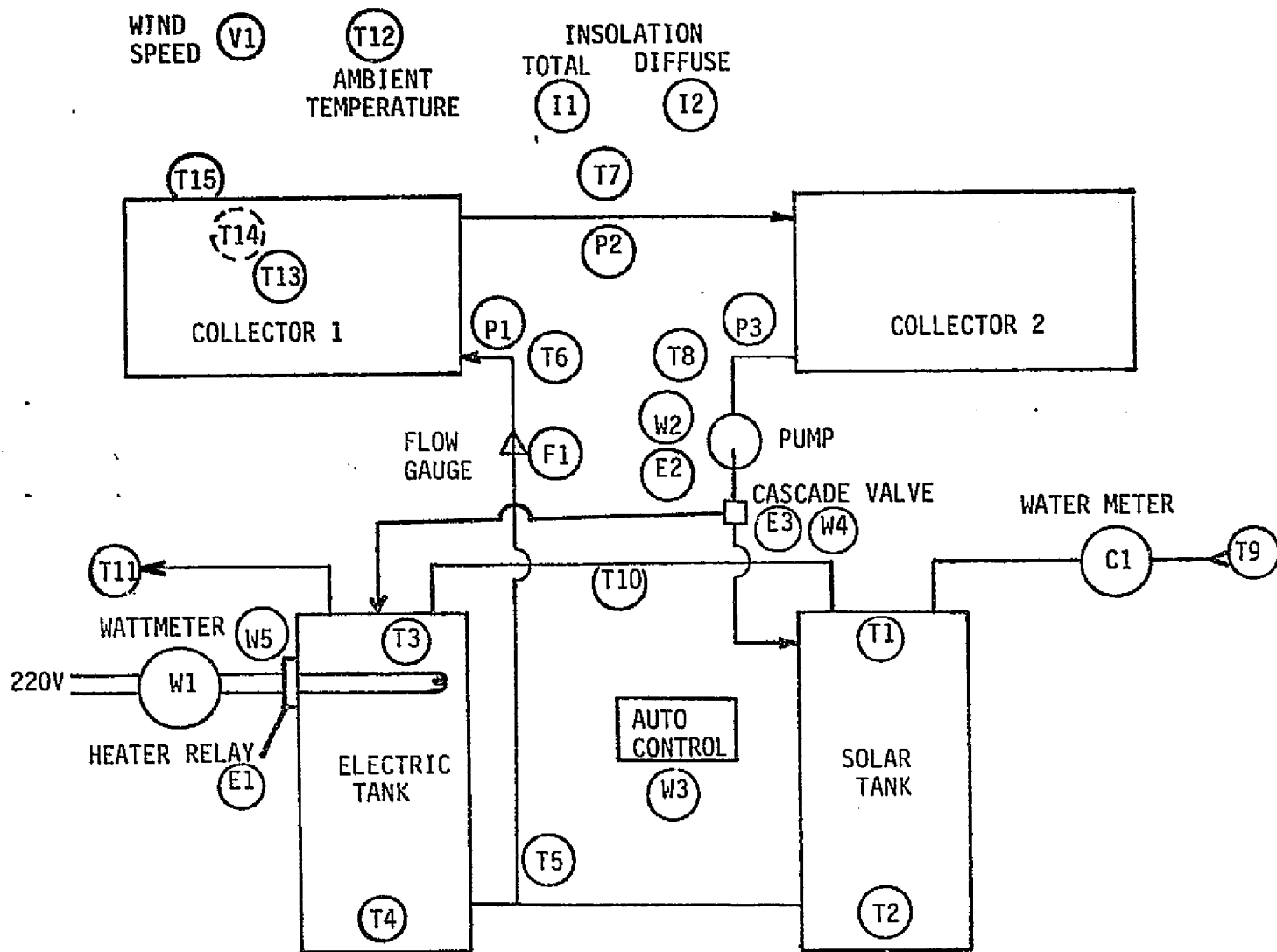
1. PUMP ON/OFF: When the pump is OFF, no energy is transferred from the collectors to storage. When the pump is ON, energy is transferred from the collectors to either of two storage tanks, depending on the state of the CASCADE valve.
2. CASCADE VALVE ON/OFF: When the CASCADE valve is OFF, the collector exhaust is transferred only to the solar tank. Since an equal volume of water is displaced from the solar tank the coolant flow loop is between the solar tank and collectors.

When the CASCADE valve is on, collector exhaust is transferred only to the electric tank, and because of equal displacement, the resultant coolant flow loop is between the electric tank and collectors.

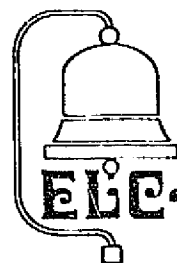
3. ELECTRIC ELEMENT ON/OFF: When insolation levels and electric tank temperature permit, the CASCADE Autocontrol disables the electric element by opening its power circuit. This operation in no way alters the coolant flow paths. The electric element may be either ON or OFF regardless of the state of the pump or the CASCADE valve.

\*Note: When the PUMP is ON because the collectors are approaching 32°F., the energy transfer is reversed due to the FROST CYCLE operation.

MEASUREMENT DEFINITIONS  
NAS8-32245



MEASUREMENT DEFINITION SCHEMATIC



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Section E  
PROPOSED MODIFICATIONS

TO,  
SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

CONTRACT NAS8-32245

ESC-7f

ELCAM INC.  
SANTA BARBARA, CA.

NOVEMBER 1976

E

PROPOSED MODIFICATIONS TO  
SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

1.0 INTRODUCTION

In its proposal and update, Elcam Inc. proposed to provide two identical SUNSPOT CASCADE Solar Domestic Water Heating (DWH) Systems to NASA. The final form of the proposed systems is shown schematically in Figure 1.

Since contract negotiations were completed, certain changes in system configuration have been proposed. This document describes these changes, and the reasons for change, their impact on contract performance, schedule and cost, and provides the rationale for their adoption.

2.0 CONFIGURATION MODIFICATIONS

Two configuration modifications are proposed. Both resulted from Elcam's contractual obligation to provide a preliminary design for a double walled heat exchanger.

2.1 External Heat Exchanger

The external heat exchanger was considered for two reasons:

- a. The difficulties encountered in producing reliable single walled internal heat exchanger.
- b. Significant improvements in flow balance (between collectors and heat exchangers) derives from external heat exchangers compared to internal heat exchangers of the type proposed. Figure 2 illustrates the external heat exchanger configuration.

PROPOSED MODIFICATION  
NAS8-32245

## 2.2 Direct Heating System

Figure 3 illustrates the simplifications resulting from the direct heating configuration. By dispensing with heat exchangers completely, the potable water is itself circulated through the collectors. In addition to fewer parts, the plumbing connections to the tanks have been improved, coolant flow rate increased and system efficiency raised. The reasons which initially resulted in a preference for have all been successfully challenged.

## 3.0 CONTRACT IMPACTS

The proposed system modifications each impact favorably on Contract NAS8-32245.

### 3.1 Contractual Performance

While reliable production and installation of single walled internal heat exchangers on a production line basis has yet to be demonstrated, there is no doubt that two systems could be produced. The added requirement of double walls however, imposes additional constraints and potential problems which render delivery of satisfactory products less certain.

Since the preliminary design of the external double walled heat exchanger employs standard plumbing equipment plus duplex Turbotec tubing in its simplest forms (straight or coiled), production and/or installation problems will be potentially reduced. The potential contractual performance will thus be significantly enhanced.

The direct configuration has already been successfully accomplished. No production or installation problems remain to be solved, and the resulting product is superior in both mechanical design and performance. Contractual performance is thus ensured.

### 3.2 Schedule

Because of the uncertainties involved in developing an internal double walled heat exchanger, some potential for system delivery must be recognized. The double walled external heat exchanger appears to be less problematical than its internal equivalent. As a result, less slippage, if any, should be expected. Since the Direct Heating configuration is now established, no departure from contract schedule should be expected. In fact, experience gained in producing and installing direct systems suggests that if direct systems are specified, shipment of the two systems may be accomplished earlier than previously expected.

### 3.3 Cost

The uncertainties involved in developing both internal and external heat exchanger designs in their double walled configurations create a risk factor which must be included in the fixed cost estimate of producing either heat exchanger. The risk factor associated with the internal design is of course greater than that from the external design. In either case, however, a cost increase will result from the direction to proceed with a double walled heat exchanger development. Proposed contract modification and cost estimates will nevertheless be prepared and submitted, since a heat exchanger system is required at this time for installations in colder climates.



No cost impact results from the adoption of a direct heating system. The small parts cost associated with the proposed single walled internal heat exchanger is matched by the cost of the improved hardware and additional components\* required by the direct heating configuration.

#### 4.0 RATIONALE

Valid reasons exist for developing the double walled heat exchanger instead of its internal equivalent, as well as adoption of the direct heating configuration.

##### 4.1 Double Walled External Heat Exchanger

The primary reason for retaining a heat exchanger configuration is to permit installation in colder climates where the autocontrol frost cycle is inadequate or inappropriate for climatic conditions. In areas which freeze regularly and frequently, some form of active freeze protection is required. Both non-toxic antifreeze solutions, and collector drain approaches require a heat exchanger. Elcam believes that even non toxic antifreeze coolants will be generally unacceptable to health authorities for some time. as a result, Elcam favors the dump tank approach to freeze protection.

Two disadvantages of the external heat exchanger have been suggested:

- a. A primary loop circulation pump is required.
- b. The external heat exchanger cannot be hidden inside the tank jacket, and thus results in a less attractive installation.

\* Flexible connectors, gate valves, check valves and flow restictor.

PROPOSED MODIFICATIONS  
CONTRACT NAS8-32245

Both objections can be answered:

- a. The additional pumping requirements are small (1/120 H.P.) and the extra investment and operating cost will probably be returned through improved heat exchanger performance (compared to the convective driven "primary" of the internal configuration).
- b. Suitable tube insulation jacketing and styling could express the external heat exchanger advantageously.

#### 4.2 Direct Heating System

Heat exchanger configurations were originally preferred because of the following reasons:

a. It was felt that thermal stratification in vertical tanks provided the opportunity to reduce coolant temperatures below equivalent mixed tank mean temperatures through the use of a heat exchanger in the lower portion of the storage tank. The significance of such a result is that the collector would have operated at lower temperatures and the system efficiency would thus have been increased.

b. A closed loop provides a limited amount of dissolved solids for deposition inside the collector's waterways. System fouling factors, it was felt, would therefore be lower than in direct heating systems.

Both suppositions have been successfully challenged. The convective flow which results from the internal heat exchanger is sufficient to completely mix the tank. The sink temperature is therefore no lower than in the equivalent mixed tank because stratification does not develop

as long as heat is exchanged from the collector loop into the storage volume. The net result is reduced system efficiency which results from the penalty resulting from the heat exchanger inefficiency.

The fouling of internal heat exchanger surfaces appears to vary from location to location. In all cases, however, fouling has been observed after even two months of operation. While an antifouling coating could be employed, it would probably reduce heat exchanger efficiency even further. Fouling is thus to be expected. It is not clear that fouling the outside surface of the heat exchanger is less damaging than fouling the internal surface of the collector waterways. It is clear, however, that the performance of the Direct Heating configuration will not suffer the performance penalty of the heat exchanger system.

If it is assumed that the fouling factor occurring in the Direct Heating configuration is approximately the same as that associated with the heat exchanger system, then the former will always out perform the latter.

It is highly likely that because of relatively higher rates of flow inside the collector waterways (compared to outside the heat exchanger) the resulting fouling factor will increase more slowly and reach a maximum that is always less than in the heat exchanger. The basis for this assumption is the observation that old copper hot water distribution lines exhibit significantly less fouling than internal heat exchangers removed after only two months. A questionable benefit of internal deposits is the lower Reynolds Number required to achieve turbulent flow.

## 5.0 CONCLUSIONS

### 5.1 Internal Double Walled Heat Exchanger

Of the three alternatives, internal double walled heat exchangers offer the least potential for performance improvement, could cost more and require more time to develop, and involve the greatest risk of successful contractual performance. The internal double walled heat exchanger should therefore be developed no further at this time.

### 5.2 External Double Walled Heat Exchanger

Since a heat exchanger configuration is required, and because of the low risk factor associated with its development, a contract modification will be proposed to enable delivery of at least one external double walled heat exchanger system. In the event that one of the two test sites is a colder climate, the heat exchanger configuration could be provided with a dump tank.

### 5.3 Direct Heating Configuration

A Direct Heating system should be installed in at least one of the two test sites. Because of positive contract impacts, improved system performance and the successful challenges to the original preference for heat exchangers, the Direct configuration offers valuable advantages that should not be disregarded.

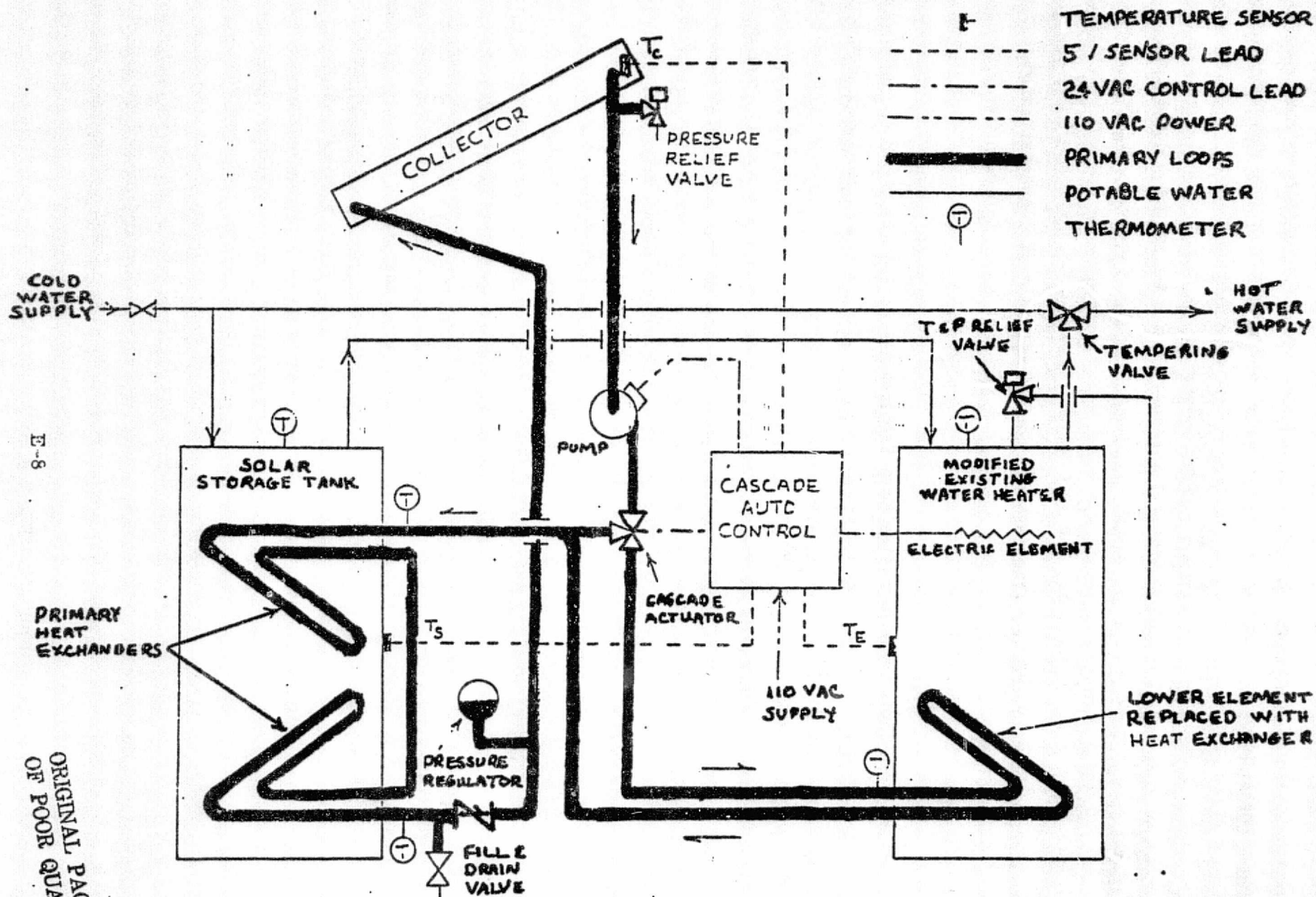


FIGURE 1 - FINAL CONFIGURATION OF PROPOSED SYSTEM

6-1

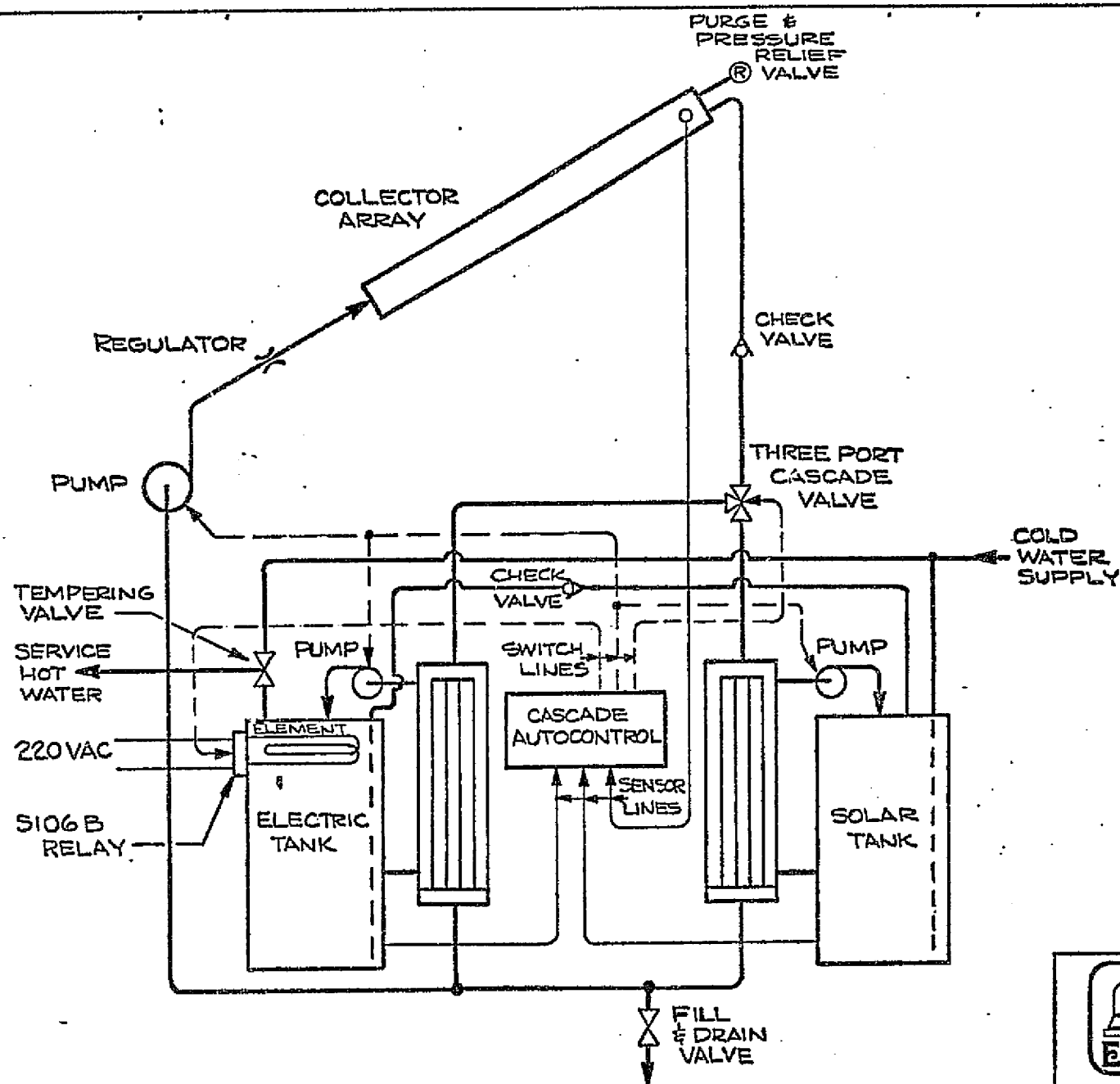



FIGURE 2 - PROPOSED EXTERNAL HEAT EXCHANGER CONFIGURATION

 <b>ELEM. INC.</b> <small>SALES, SERVICE, REPAIR, MAINT. PHONE 800-833-8333</small>		<small>DATE: 10/1/76</small>	
		<small>DESIGNED BY: JAC</small>	
<small>TOLERANCES: UNLESS OTHERWISE SPECIFIED DECIMAL .005 .010 .015 .020 .030 .040 .050 .060 .070 .080 .090 .100 .125 .150 .175 .200 .250 .300 .375 .500 .625 .750 .875 1.000 1.250 1.500 1.750 2.000 2.500 3.000 3.750 4.000 5.000 6.000 7.000 8.000 10.000 12.500 15.000 17.500 20.000 25.000 30.000 37.500 40.000 50.000 60.000 70.000 80.000 100.000 125.000 150.000 175.000 200.000 250.000 300.000 375.000 400.000 500.000 600.000 700.000 800.000 1000.000 1250.000 1500.000 1750.000 2000.000 2500.000 3000.000 3750.000 4000.000 5000.000 6000.000 7000.000 8000.000 10000.000 12500.000 15000.000 17500.000 20000.000 25000.000 30000.000 37500.000 40000.000 50000.000 60000.000 70000.000 80000.000 100000.000 125000.000 150000.000 175000.000 200000.000 250000.000 300000.000 375000.000 400000.000 500000.000 600000.000 700000.000 800000.000 1000000.000 1250000.000 1500000.000 1750000.000 2000000.000 2500000.000 3000000.000 3750000.000 4000000.000 5000000.000 6000000.000 7000000.000 8000000.000 10000000.000 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Section F

LIST OF MATERIALS IN CONTACT WITH POTABLE WATER

ESC-7g

SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

ELCAM INC.

SANTA BARBARA, CA.

NOVEMBER 1976



## LIST OF MATERIALS IN CONTACT WITH POTABLE WATER

### 1.0 INTRODUCTION

SUNSPOT CASCADE Domestic Water Heating (DWH) Systems will be available in two fundamentally different configurations: Direct Heating and Heat Exchanger systems. In Heat Exchanger systems, potable water will be circulated through a copper heat exchanger which is attached directly to the tank flanges. The circulating pump has yet to be selected.

This report documents the materials with which potable water comes into contact in Direct Heating systems.

### 2.0 DIRECT HEATING SYSTEM MATERIALS

The materials contacted by potable water are listed below by system part.

#### 2.1 Collector

- a. Waterways - copper
- b. Waterway joints - 45% silver solder

#### 2.2 CASCADE Valve

- a. Body - brass
- b. Ball - Ethylene propylene

MATERIALS IN CONTACT WITH POTABLE WATER  
CONTRACT NAS8-32245

### 2.3 Tanks

- a. Walls - glass lined
- b. Anode - magnesium
- c. Dip tube - solar tank - stainless steel  
- electric tank - PVC or stainless steel
- d. O-ring - rubber

2.4 Pump: The proposed pump for Direct Systems is the TACO #102B which has been specifically designed for potable water circulation.

- a. Body- bronze
- b. Front - stainless steel
- c. Seal - alumina ceramic/carbon and stainless steel
- d. Gaskets - ethylene propylene (E P rubber)
- e. Impellor - phenolic plastic with brass hub.

### 2.5 Regulator

- a. Orifice - Nitrile Rubber

### 2.6 Valves

- a. Bodies - brass
- b. Inserts - brass or stainless steel

MATERIALS IN CONTACT WITH POTABLE WATER  
CONTRACT NAS8-32245

## 2.7 Connecting Plumbing

- a. Main lines - copper
- b. Nipples - brass
- c. Slip joints - lead solder
- d. Threaded joints - Teflon and dipe dope

MATERIALS IN CONTACT WITH POTABLE WATER  
CONTRACT NAS8-32245

Section G

SPECIAL HANDLING, INSTALLATION & MAINTENANCE TOOLS LIST

CONTRACT NAS8-32245

ESC-15

SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

ELCAM INC.

SANTA BARBARA, CA.

NOVEMBER 1976

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## SPECIAL HANDLING, INSTALLATION & MAINTENANCE TOOLS LIST

### 1.0 INTRODUCTION

Special tools are those not generally available off the shelf from hardware and tool suppliers.

No special tools are required for handling, installation or maintenance of SUNSPOT CASCADE solar domestic water heating (DWH) systems.

### 2.0 INSTALLATION & MAINTENANCE TOOLS & EQUIPMENT

Most of the tools required for installation and maintenance of SUNSPOT systems are standard plumbing and or electrical tools. One tool, however, might not be in general use by tradespeople - the thread insert tap and tool. The 5/16" - 18 bolts used on tank flanges are self tapping. As a result, they can very easily strip the female thread in the flange. In order to save the tank, a stripped flange thread can be replaced with a thread insert. The stripped thread is drilled out, and then tapped oversize to admit the thread insert. The insert is fed into the oversize hole with an insert tool.

The following part numbers have provided satisfactory service:

- a. Insert - Helicoil 5/16 - 18 x 0.312
- b. Insert Tool - Helicoil 7551-5, 5/16-18
- c. Insert Tap - Helicoil 5/16-18 STI-NC

TOOLS LIST  
CONTRACT NAS8-32245

The following list identifies the tools required by the installer of SUNSPOT systems.

- a. drill
- b. 1/4" masonry bit
- c. 3/16" wood bit
- d. 1/8" wood bit
- e. 1/4" metal bit
- f. 5/8" hole saw
- g. 7/8" hole saw
- h. 1-3/8" hole saw
- i. 1-3/8" hole saw
- j. 1-5/8" hole saw
- k. hammer
- l. rubber mallet
- m. hacksaw and blades
- n. knife
- o. screw driver - flat
- p. screw driver - Phillips
- q. crescent wrench 8"
- r. crescent wrench 12"
- s. pipe wrench 10"
- t. channel locks 14"
- u. electrical pliers
- v. needle nose pliers
- w. 5/16" nut driver

- x. 7/16" nut driver
- y. 7/16" socket (3/8" drive)
- z. 3/8" socket driver with drill adapter
- aa. tape measure 12' to 20'
- bb. propane torch (Turb torch)
- cc. two propane tanks (one spare)
- dd. solder - resin core 1/8" and 1/32"
- ee. flux and flux brush
- ff. emery cloth or equivalent copper pipe cleaner
- gg. striker
- hh. Voltmeter 15 VAC to 250 VAC
- ii. continuity test light
- jj. soldering iron - 30 Watt (cordless preferred)
- kk. calking gun
- ll. thread insert tool
- mm. thread insert tap and drill bit
- nn. thread tap driver
- oo. extension cord, 100' and 20'
- pp. plug adapter - 2 prong to 3 prong
- qq. trouble light
- rr. pop rivet gun
- ss. tin snips
- tt. truck mounted vise
- uu. pressure gauge
- vv. plumbing adapter - 3/4" garden hose to 3/4" I.P.T.
- ww. garden hose 3/4", 25'

Section H  
INSTALLATION, OPERATION AND MAINTENANCE MANUAL:

CONTRACT NAS8-32245

ESC-17

SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

ELCAM. INC.  
SANTA BARBARA, CA

MARCH 1977

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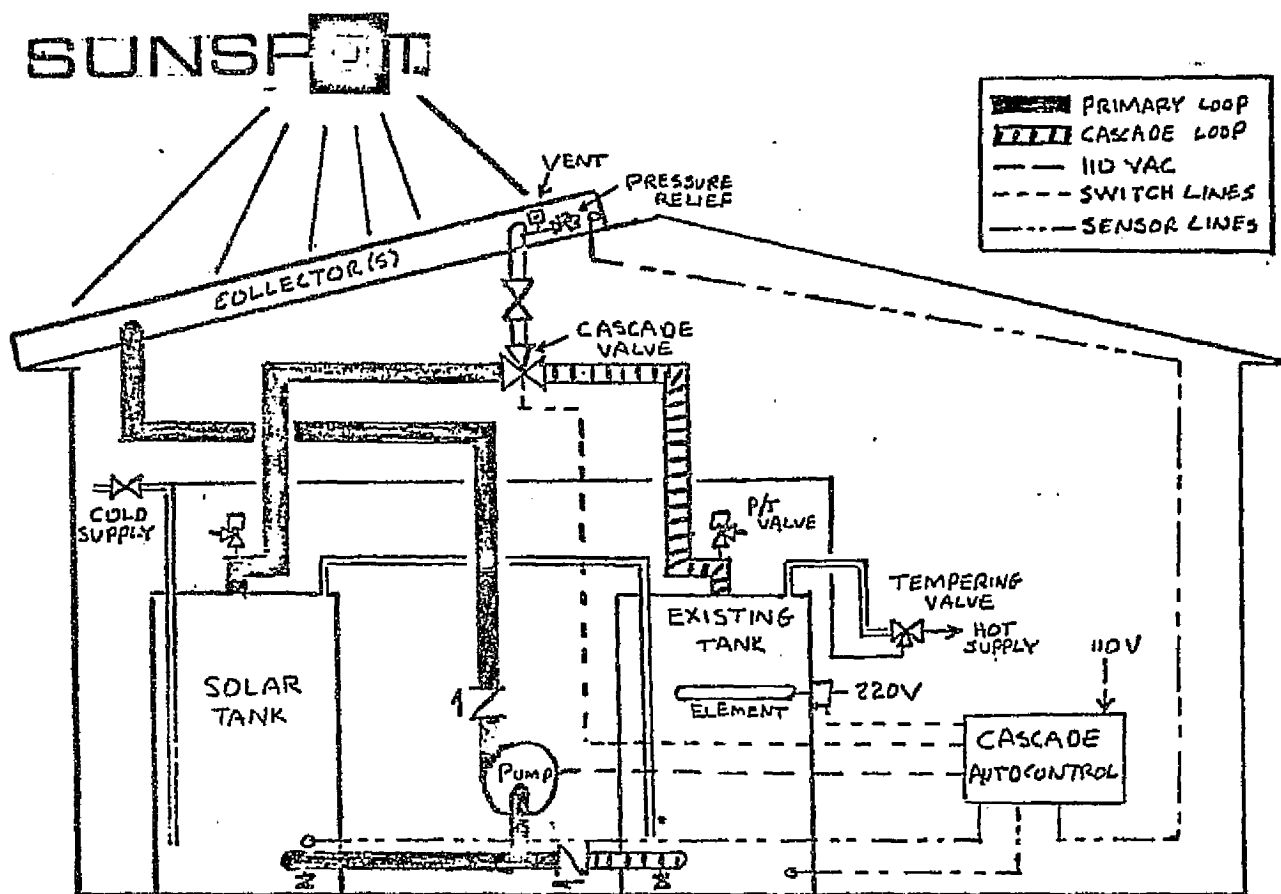


Figure 1. SUNSPOT CASCADE Direct System Components

## 1.0 INTRODUCTION

The SUNSPOT CASCADE Water Heating System (see Figure 1) may be retrofitted to an existing electric or gas water heating system. It may also be installed in a new dwelling. The Direct Heating System is suitable for areas that do not experience either frequent or hard freezes. The Direct Heating - Dump System option is suitable for most areas of the Continental United States where freezing weather is a problem. Please consult the system specification for details.

Installation of the SUNSPOT System involves installing SUNSPOT solar collectors on a suitably oriented roof or on a specially constructed rack; connecting to the existing water heater; adding a solar heated storage tank; and installing the necessary piping, pump, valves and CASCADE automatic control system.

The SUNSPOT CASCADE System is designed to minimize the use of conventional electric or gas energy for water heating by automatically managing the available solar and conventional energy. Please refer to the Operation Section of this manual for a more complete discussion of the various modes of operation.

Each SUNSPOT System is tailored to specific needs. The configuration and size of the system is a function of several variables, including the hot water load, climatic conditions, and available space. Typical systems require from one to three collectors, and a solar storage tank from between 50 and 120 gallons capacity. The solar storage tank may be omitted because of a lack of space or other reasons. In such systems the CASCADE Valve is also omitted and the system is known as a SUNSPOT BASIC System.

The installer should read this manual carefully before beginning any part of the installation. In this way the various operations will be better understood as a whole. The steps do not have to be performed in the exact order described, but doing so should result in a fast, more efficient installation with minimal interruption to the hot water supply.

## 1.1 System Specifications

### 1.1.1 SUNSPOT 3200 Series Collectors

Dimensions: 97-1/2" x 49-1/2" x 3-3/8"

Weight: 93 pounds dry, 100 pounds full of water

Roof Loading: 3.2 lb per square foot

Color: Shake bronze

Transparent Cover: UV filtered acrylic, transmissivity 86%

Absorber: Aluminum fin coated with siliconized polyester, absorptivity =.95.

Waterways: silver brazed, Type M copper tubing.

Pressure: Tested to 150 psi, design working pressure 320 psi.

Flow: P = 0.3 psi at 2 gpm. From 1 to 5 gpm is acceptable.

Design Max. Temperature: Able to withstand no-flow conditions where temperatures may reach 350°F.

Corrosion Resistance: Collector is designed for use with any potable water suitable for use in copper plumbing.

### 1.1.2 SUNSPOT Model 100 CASCADE Autocontrol

Dimensions: 8-3/8" x 7-1/2" x 2-5/8"

Pump Voltage: 110 VAC

Actuator and Sensor Voltage: 0-24 VDC

Frost Cycle: suitable for location in which minimum temperature is 25°F. and where temperature is 32°F. or less for 30 days, or fewer. For more severe weather conditions, specify the Direct Dump Option.

### 1.1.3 Storage Tank

A.O. Smith glass-lined "Conservationist" storage tank of from 50 to 120 gallons capacity, or equivalent.

#### 1.1.4 Pump

Grundfos UP25-42SF, 1/20 HP 120 VAC stainless steel circulator, or equivalent.

#### 1.1.5 Cascade Valve

Barber Colman 24VAC two position diverting valve, with manual opener, or equivalent.

#### 1.1.6 Override Actuators

For electric tanks - Cam-Stat S106-B time delay relay, 240VAC primary, 24VAC control. For gas tanks - White Rogers solenoid gas valve (25A11-227), 24VAC operating voltage.

### 2.0 INSTALLATION

#### 2.1 Safety Precautions

Note: Elcam provides installation, operation and maintenance information in this manual in good faith. Since Elcam cannot anticipate every contingency or procedure, it is important that the installer and operator make certain that any procedures or steps undertaken conform to all local codes and to common sense safety practices. Particular attention should be paid to the following:

- a. Where using an open flame such as in sweating copper, always have a properly charged fire extinguisher available for immediate use.
- b. Install pumps and any other exposed equipment that may be hot in such a manner as to minimize any burn hazard, particularly with respect to children.

- c. Make sure that all plumbing lines are installed so that they may be fully drained.
- d. Collectors can reach very high temperatures when coolant is not flowing. Be extremely careful when handling exposed collectors and when cutting into piping that may not be fully drained. Keep collectors covered during installation to minimize temperatures and thermal shock when first filling.
- e. Always turn off electrical power at the breaker/fuse box before working on the electric element, control relay, or sensor for electrical tank.
- f. Do not run any pump, or have electrical power available to electric heating elements when there is no water in the system. Note: Do not use the Heater Override switch to secure power to the heating elements.
- g. When using power tools and extension cords on roofs, make sure that the cord is secured to the roof so that its weight will not cause an unattended tool to be dragged off. Ensure that all unattended tools are placed in such a way as to avoid accidentally dropping them from the roof.

## 2.2 Collector Installation:

The following cautions should be observed when installing the collectors:

- a. Extreme caution should be exercised when handling collectors, particularly in transferring them to a roof and handling them on a roof. In most instances two persons can handle a collector satisfactorily, but for high or steep roofs a third person and/or a lift may be necessary.
- b. When exposed to the sun without coolant flow, the cover, absorber, and pipes can become very hot.
- c. The collector cover is durable and can withstand a degree of rough handling, but this should be held to a minimum. Whenever possible, transport and store the collector with its face up, or on its edge.
- d. When it is necessary to stack collectors, place them one above the other, with all covers facing up.

2.2.1 Determine location of the collector(s) and ensure that the area is appropriate. (If special mounting procedures are needed - for example, rack construction or tile roofs - refer to Elcam Instruction Sheet: "SUNSPOT Collector Special Mounting Procedures".) Determine actual layout of collector(s) and piping before proceeding. See Figure 2 for various piping schemes.

2.2.2 Carefully transfer collector(s) to the roof.

2.2.3 Secure the collector(s) to the roof using the steps outlined below. If the roof is steep or if a steep rack is used, temporarily block the collectors in place.

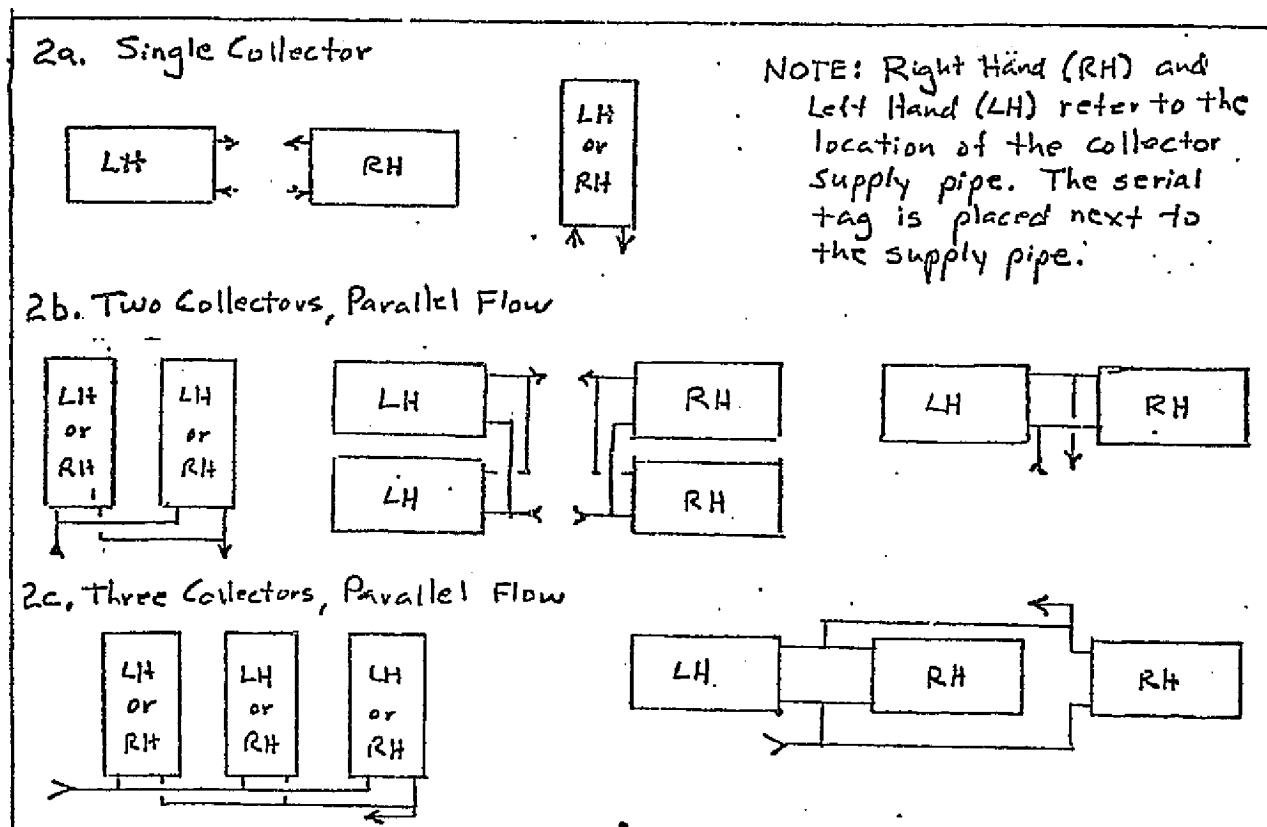


Figure 2 - Plumbing the Collectors, Representative Examples

- a. Locate the roof structural members (beams and/or battens suitable for accepting 1/4" lag screws.
- b. Using a 1/4" drill bit, (Figure 3a), drill through the collector tiedown flanges along the guide mark at appropriate locations above roof structural members. A minimum of four tiedown points are required, preferably one near each corner of the collector. If high winds are expected, or if the roof or rack is steep, additional tiedown points are advisable.

c. Using a 1/8" drill bit, (Figure 3b), drill pilot holes through the tiedown holes into the roof structural member.

d. Inject a generous bead of polysulfide sealant into the pilot hole. (Figure 3c.) Note: Whenever any hole is drilled into a roof, immediately inject a bead of sealant into the hole to insure that no hole will be inadvertently left unsealed.

e. Secure collector(s) to the roof or rack using 1/4" lag bolts of sufficient length to provide a good grip in the roof structural member. (Figure 3d.) Generally it is best to have dry surface to make a good seal.

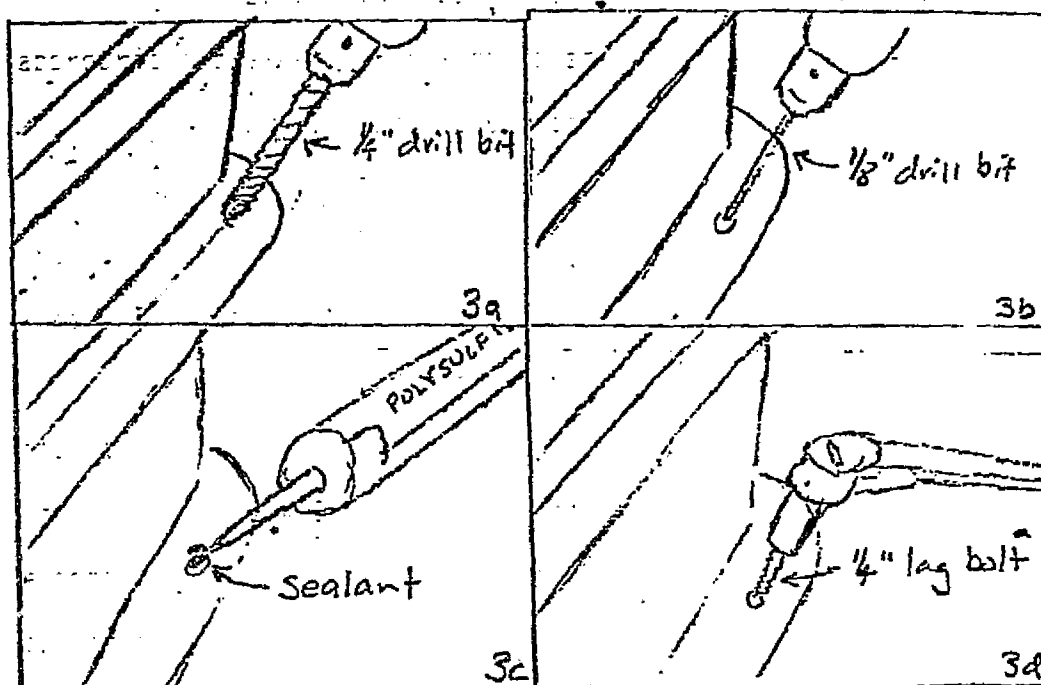


Figure 3: Securing Collector to Roof



2.2.4 Refer to Piping Instruction for connecting the collectors and tanks.

### 2.3 Storage Connections and Installation

2.3.1 Determine where the storage tank will be located if one is to be installed. It should be located close to the existing tank if possible, but this is not absolutely necessary.

2.3.2 Remove the storage tank from its carton and carefully position it so that plumbing can be readily attached.

2.3.3 Before proceeding, determine where the various components will be installed. A little planning at this point can save considerable time later. Note: Controls and shut off valves should be located in accessible locations.

### 2.4 Tank Modification

2.4.1 Turn power to existing heater OFF, by opening the appropriate breaker. For a gas system, close the shut-off valve.

2.4.2 Isolate the cold water supply to the tank.

2.4.3 To drain the tank, connect a hose, if necessary, and make sure that the hot water is drained into a safe receptacle or area. To facilitate draining, the P and T valve may be opened.

2.4.4 While the tank is draining, disconnect the flex pipes from the tanks and inspect to determine if gaskets or pipes need replacing.

2.4.5 Connect the storage tank HOT connection to the existing tank COLD connection with appropriate 3/4" flex tubing and 3/4" copper tubing as necessary. Note: All connections from the tank to wall mounted plumbing should be made with flex piping.

2.4.6 Connect the cold water supply to the storage tank COLD connection, and run a line from the cold supply to the tempering valve location.

2.4.7 The tempering valve (see Figure 4) should be located in a convenient place at least six inches below the tank top (to prevent thermal syphoning and reduction of the valve life.) Note: Before soldering the tempering valve, remove the valve insert from the body, making sure not to lose the metal washer.

- a. Connect the HOT port of the tempering valve to the HOT connection of the existing tank.
- b. Connect the COLD port of the tempering valve to a line from the cold water supply.
- c. Connect the MIXED port of the tempering valve to the service HOT water system (leading back into the building.)
- d. Carefully assemble the tempering valve and set it to 140°F.

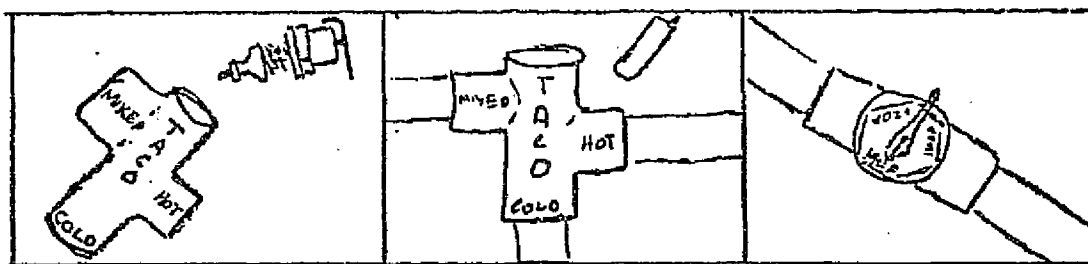


Figure 4: Tempering Valve

2.4.8 Remove the drain valves and nipples from each tank.

Note: After opening fully, some drain valves require a sharp pull to engage a left hand thread, followed by clockwise rotation for removal.

2.4.9 Make up new drain connections and solar loop supply lines by connecting the drains and a 1/2 x 3/4 copper x male NPT adapter to a 3/4" brass tee. The tee should be connected to a 2" brass nipple and the entire assembly threaded into the drain connections. (See Figure 5.)

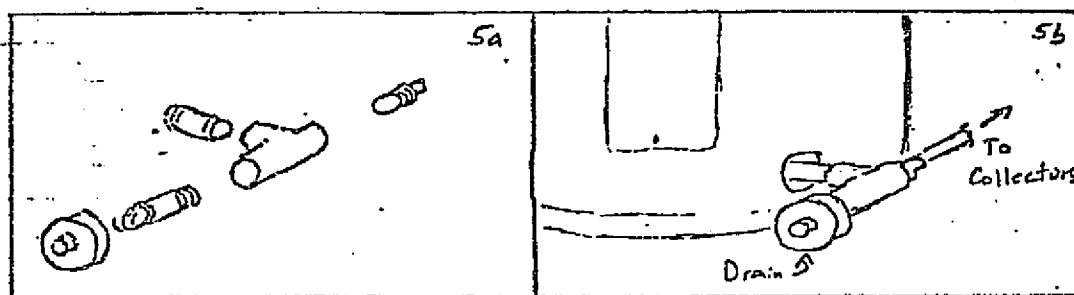


Figure 5: Tank Drain Modification

2.4.10 Remove the P & T valve from the existing tank. If the valve's temperature sensor bulb is at least 4" long, it may be reinstalled after the following modifications. If it is not long enough, replace it with a P & T valve with a sensor bulb long enough to be inside the tank shell when reassembled.

2.4.11 In both tanks, connect a 3/4" brass tee to a 2" brass nipple. Install long stem P & T valves in one end of the tees and 1/2" x 3/4" copper x Male NPT adapters in the branches for solar loop returns. Plumb the P&T exhausts according to applicable codes. (See Figure 6.)

2.4.12 Install sensor clips (Figure 7) at the lower element port of the electric tank and the lower blank flange of the storage tank.

2.4.13 Insure that all flanges, heater elements, and plumbing connections are tight. Be careful, however, to not strip threads.

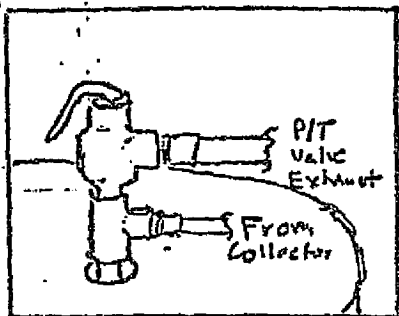


Figure 6: P&T Valve Modification

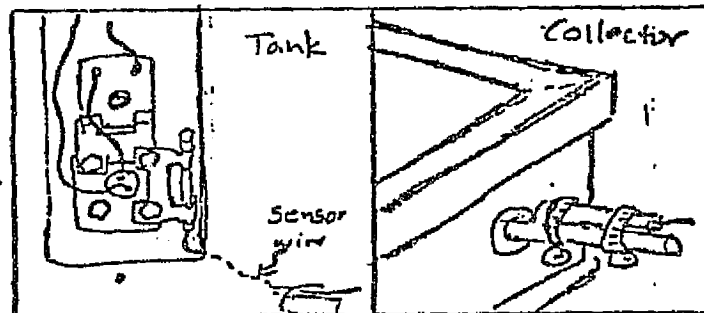


Figure 7: Sensor Installations

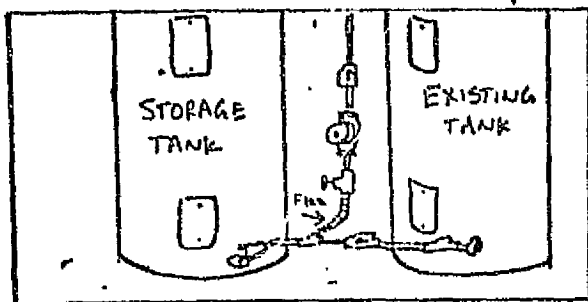
## 2.5 Plumbing and Hardware Installation

### Notes:

- a. Plumb the system as directly as possible, minimizing piping and fittings. This reduces the chances for leaks and minimizes pumping load.
- b. Plumb the system so that all components and lines will drain fully.
- c. Plumb the system in accordance with local codes and recognized national codes such as the Uniform Plumbing Code and the HUD Minimum Property Standards.
- d. A maximum of 6' of unsupported piping is permissible. Closer support may be necessary under special circumstances.
- e. Whenever possible, slip insulation over the unfinished piping sections and temporarily secure with clamps while making final solder connections.

- f. In long runs of piping, make provision for thermal expansion.

2.5.1 Tank Area Piping (Refer to Figure 1 and Figure 8)



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Figure 8: Tank Area Plumbing

- a. Install a check valve in the line coming out of the existing tank modified drain line.
- b. Connect a line from the storage tank modified drain to a tee which connects the two tank return lines. If the pump does not have shut off flanges, install a gate valve on the tank or suction side of the pump.
- c. Install the pump in a convenient location in the panel supply line. (See Figure 8) Follow manufacturer's instructions. If the pipe is secured satisfactorily before and after the pump, and if the space is not greater than 6', no further support is necessary. The pump should be close enough to the expected location of the autocontrol to permit connection with the supplied power cord.

- d. Install a check valve downstream from the pump.
- e. Connect the solar loop return line to the collectors according to the instructions given below.
- f. Move the CASCADE valve lever to MANUAL OPEN before putting heat on the valve.
- g. Place the CASCADE Valve so that its inlet (Port AB) is facing down. (Figure 9) Connect AB to the panel outlet line.
- h. Connect Port A to the existing electric or gas P & T valve port modified previously. (Figure 6).

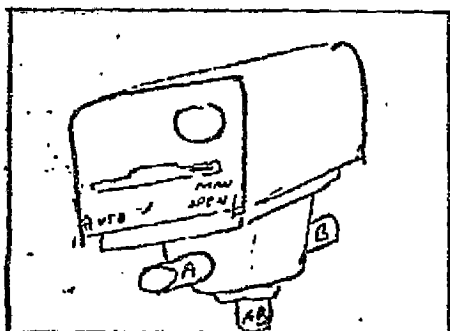


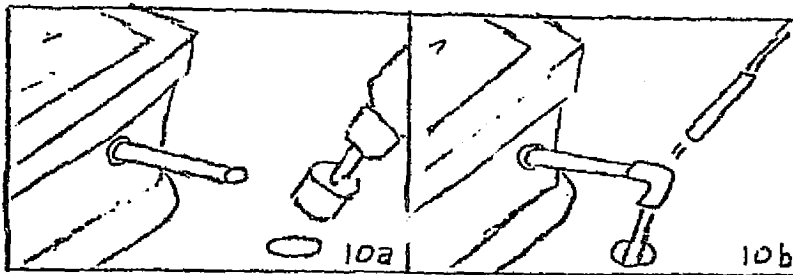
Figure 9: CASCADE Valve

- i. Connect Port B to the storage tank modified P & T valve port.

2.5.2 Piping between tanks and collectors - hang the insulated piping according to code. Beams, studs, joists, or other structural members are appropriate. Secure the piping at intervals of no more than six feet.

### 2.5.3 Piping through roof

- a. Select location for supply and return pipes and drill through the roof at those points using a  $3/4$ " hole saw for  $1/2$ " piping or a 1" hole saw for  $3/4$ " piping. (See Figure 10)



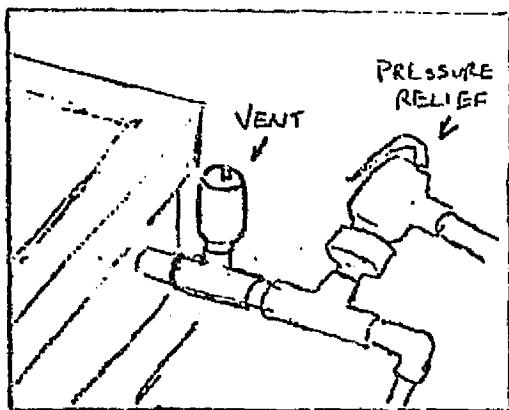
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Figure 10: Piping Through Roof.

- b. Install a pressure relief valve and an air vent at the high point of the system plumbing. (See Figure 11) Since very hot water and even steam may be discharged from the valve, it should be plumbed so that it does not present a hazard to passersby.
- c. Stub the plumbing through the holes and make the appropriate connection to the collector, guarding against burning the roof, collector gasket or cover, or the worker with the torch. (Figure 10b) Note: If union couplings are not used and if two or more collectors are plumbed side by side, it will be necessary to make the final fit-up of piping prior to securing the second collector to the roof.

- d. Before weatherproofing the piping, run the sensor lead through the roof hole nearest the most convenient collector outlet and secure the sensor to a straight piece of tubing as close to the collector outlet as feasible, using two worm gear clamps or acceptable substitutes. (See Figure 7)
- e. Seal the roof holes by injecting polysulfide between the pipe and the internal surface of the roof hole and between the pipe and insulation. Work the excess caulking into a raised bead above the roof surface to prevent any water build-up. Note: If silicone rubber is used, rub a layer into the exposed internal surface of the hole prior to stubbing the pipes through. Then proceed as above.
- f. Insulate and weatherproof the piping, making sure that the sensor is well insulated. Once the insulation is in place and secured, an outdoor paint such as Sherwin-Williams' A-100 Latex House Paint (Fairfax Brown AGN81) should be painted on all exposed insulation. To insure no leaks through the piping access, a plastic roof cement such as Henry's #208 may be used.





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Figure 11: High Point Pressure Relief/Vent

2.5.4 Direct Dump Option Plumbing: The Direct Dump allows use of the SUNSPOT System in areas where the Frost Cycle is not feasible, providing the collectors and all exposed piping can be fully drained when the Dump Feature is actuated. Installation of this option is identical with the Frost Cycle Option with the following differences.

- a. Install a modified CASCADE control. (Refer to Section 2.6.)
- b. Install the dump valve (See Figure 12) in the panel supply line as close to the building envelope as possible to minimize the amount of water dumped.
- c. Connect Port P (pressure) of the Dump Valve to the outlet line from the pump.
- d. Connect Port A (actuator) to the panel supply.
- e. Install an air vent between check valve C & port AB of the CASCADE Valve. (See Figure 12.)

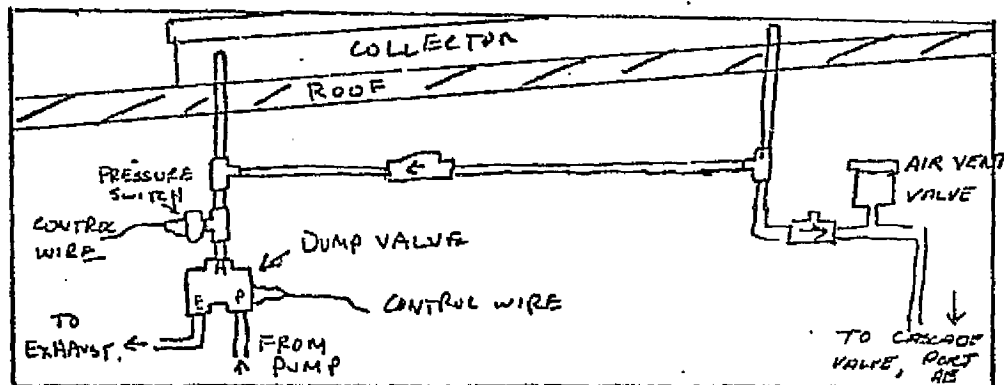
- e. Connect Port E (exhaust) to a drain line. If allowed by code, this line may tap into the P&T lines from the tanks (make sure that it is well downstream of the P&T valves). The line may also be plumbed to a catch basin or other suitable location.
- f. Install the pressure switch in the line between the collector and the dump valve. This switch requires a 1/4" tapered thread connection.
- g. Connect the valve and switch electrically according to instructions in Section 2.6.

## 2.6 CASCADE Autocontrol Installation

2.6.1 Remove the Autocontrol cover by placing the three switches in the OFF (center) position, loosening the two screws on either side of the unit, and carefully pulling cover off. Note: Use care to not bend or break the indicator lights, or to apply excessive pressure to the board mounted switches and wiring connectors.

2.6.2 Sensor Installation: There are three sensors in the CASCADE System. Each sensor is marked, but it may be necessary to determine where each sensor connects in the field. The two sensors with ten-foot leads are for the existing and storage tanks. The sensor with the thirty-foot lead is for the collector. (See Figure 13 for Auto-control connections.) Note: Should a sensor lead need to be lengthened, splice a section of 22 gauge, 3 strand (red, black, white) intercom cable in the lead. The splice cut should be made at least 12" from either end of the cable.

Caution: Care should be taken when removing or replacing sensor leads on terminals since a trim resistor is in each sensor lead close to the terminals.



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Figure 12: Direct Dump Valve and Associated Hardware

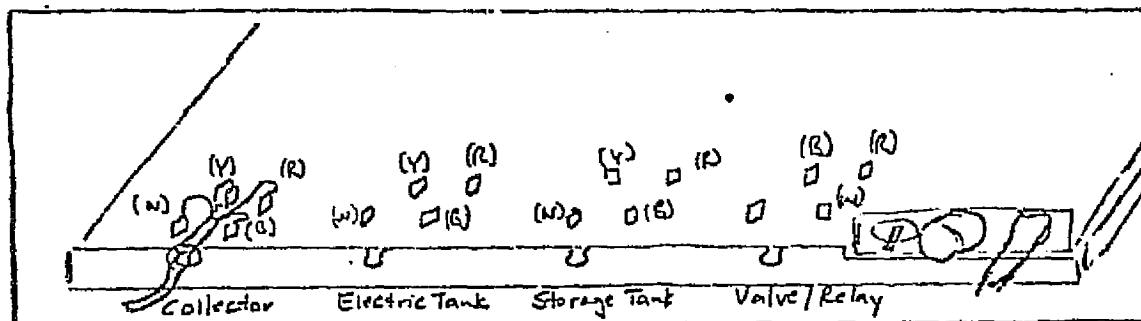


Figure 13: Autocontrol Connections

- a. Collector Sensor: This should be installed at the collector - refer to instructions in the section on Piping Through Roof. Connect the leads to the terminals as shown in Figure 12.
- b. Storage Tank Sensor: Snap the sensor in place using the clip installed at the bottom port. Route the lead from the sensor through the drain line access in the tank jacket.

(See Figure 7.)

c. Existing Tank Sensor

- (1) For electric tanks - install in same manner as the storage tank.
- (2) For gas tanks - install on the outlet piping as close to the tank as possible, using worm gear clamps in the same manner as used for the collector sensor.

- d. Route the sensor wires along piping when possible, taping or otherwise securing the wires to the piping in a neat manner.

2.6.3 Electric tank relay installation - (See Figure 14)

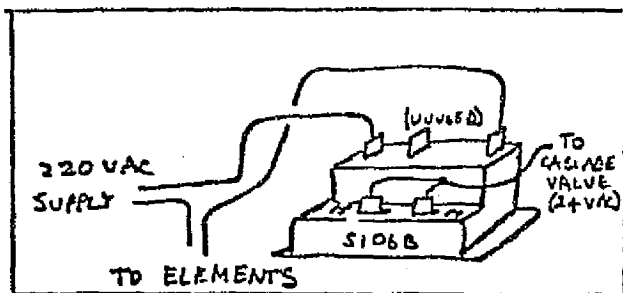


Figure 14: Relay Connections

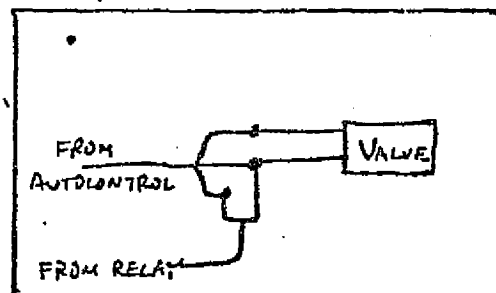


Figure 15: CASCADE Valve Electrical Connections

- a. Install and secure the S106B relay in a junction box on the top of the tank.
- b. Disconnect the 220V supply wires to the heater. Run one wire through the junction box and reconnect it. Connect the remaining 220V wire to one of the outer terminals of the relay, after soldering it to an insulated spade terminal connector. The remaining heater wire should be connected to the other outer terminal after soldering to an insulated spade terminal connector.

- c. Pass the two-wire relay control lead into the junction box and connect to the two terminals marked H.
- d. Secure the wires to the box with appropriate Romex wire supports.
- e. Place the insulating card between the 220V and 24V portions of the relay and install cover on the box.

#### 2.6.4 Gas Tank Override Valve Installation

- a. Shut off gas to the heater by closing the main supply valve or gas cock.
- b. Install the solenoid actuated valve (See Figure 14) in the gas supply line to the burner. This will require cutting the line, connecting the appropriate flared fittings to the line, and connecting the valve in the line.
- c. Connect the two-wire relay control lead to the solenoid valve wire. Then follow the applicable steps in the following section.

#### 2.6.5 CASCADE Valve Electrical Connections

- a. Route the valve heater control wire from the Autocontrol to the CASCADE Valve. Route the relay control lead to the CASCADE Valve.
- b. Remove the valve cover and install a Romex wire support.

c. Pass both leads through the Romex and connect together as follows: (See Figure 15)

- (1) One valve wire to the valve/heater control wire marked "Valve".
- (2) One relay control wire to the valve/heater control wire marked "Relay".
- (3) Join the two remaining wires to the wire marked "Common".

#### 2.6.6 Direct Dump Electrical Connections

CASCADE autocontrols which are modified for Direct Dump operation have two additional leads marked "DD Valve" and "P Switch",

The three wires in the lead marked "DD Valve" are color coded and should be connected to the same color wires leading from the Direct Dump Valve: these are white, red and black.

The two wires in the lead marked "P Switch" are to be connected to the terminals of the pressure switch. Their polarity is not critical.

## 2.7 Clean-up

2.7.1 Check that all holes in the roof are properly caulked.

2.7.2 Insure that all piping insulation and control wires are properly installed and secured.

2.7.3 Remove all trash and clean up area around tanks.

2.7.4 Make sure that all exhaust hoses from water softener, washer and other appliances are replaced in correct positions after working in the area.

## 3.0 OPERATION

### 3.1 Normal Operation

Both SUNSPOT CASCADE and BASIC Systems are designed for completely automatic operation, supplying the specified quantity of hot water at the rated/selected temperature. The CASCADE Autocontrol makes operating decisions based on temperatures sensed at three locations:

- a. SUNSPOT Collector(s)
- b. Modified Electric (or Gas) Tank, and
- c. SUNSPOT Storage Tank

When the collector outlet temperature is greater than the electric/gas tank temperature, the CASCADE valve is positioned to supply the electric/gas tank with solar heater water. If at the same time, the existing tank temperature is greater than 100°F, the electric elements or gas flow are overridden, preventing unnecessary supplemental energy consumption.

When the collector outlet temperature is less than the electric tank temperature, but greater than the storage tank temperature, the CASCADE valve is positioned to supply solar heated water only to the SUNSPOT Storage Tank. The net result is a more efficient use of the solar water heating system and a further reduction in supplemental energy usage compared to that attainable by a conventional (preheater) solar water heating system.

The CASCADE Autocontrol has a power switch and three function switches to facilitate start-up, shut-down, and maintenance of the system. In addition, there are four LED (Light Emitting Diode) status lights. (See Figure 16.)

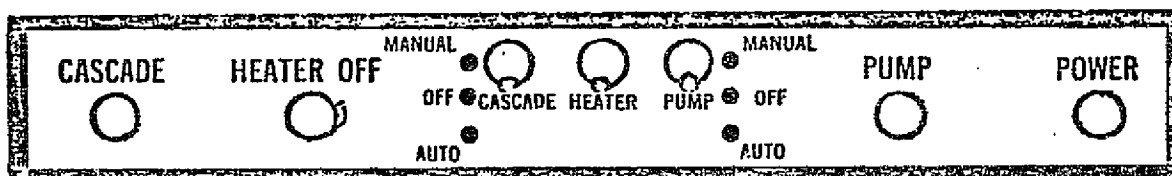


Figure 16: CASCADE Autocontrol Switches and Indicators

3.1.1 Power switch and indicator: This is a two position, ON or OFF switch with the indicator light ON when the power is ON.

3.1.2 Function switches and indicators: Each function switch has three positions: MANUAL, OFF and AUTO.



Pump operating modes:

- a. OFF - will not operate
- b. MANUAL - operates regardless of system temperatures.
- c. AUTO - operates as programmed.

Whenever the pump is powered, the indicator light will be ON.

Heater Switch: This switch controls the 220V power supply to the heater's electric elements, or the gas override valve.

- a. OFF - heater relay will not interrupt power to the elements or gas flow.
- b. MANUAL - heater relay will interrupt 220 V power to the elements or gas flow.
- c. AUTO - heater relay or gas valve is governed by the autocontrol.

The heater status light is ON whenever the relay has interrupted power to the heater elements or whenever the gas valve interrupts the gas flow.

CASCADE Switch: This switch controls the 3-way CASCADE valve.

- a. OFF - Valve is de-energized and a path will be open from the collectors to the SUNSPOT Storage Tank.
- b. MANUAL - Valve is energized and a path will be open from the collectors to the electric tank.
- c. AUTO - operates as determined by system conditions.

The CASCADE status light will be ON whenever the valve is energized.

During normal operation, the power switch should be ON and the function switches in AUTO.

A "Vacation Conservation Feature" is available by placing the HEATER switch in MANUAL whenever the dwelling will be vacant for longer than a few days and returning it to AUTO upon return. This ensures that no electricity or gas will be used to heat the water. Unless there are more than a couple of days of cloudy weather immediately before returning to the house, the water heater should have some hot water. Even if solar conditions are poor, the electric elements or gas burner has the capability of heating the tank to desired temperature in less than an hour.

Frost Cycle is actuated whenever there is danger of water freezing in the collectors. During Frost Cycle operation, the pump uses stored energy from the tanks to keep the collectors from freezing. When the danger is passed, the pump automatically stops.

3.1.2 Dump System Operation: When a freeze condition is sensed by the autocontrol, the dump valve is actuated, causing the collectors and exposed piping to drain. The dump valve will also be actuated when there is a power failure or when the autocontrol power switch is turned to OFF. If a freeze condition occurs and the dump valve does not actuate, the pressure switch senses this and the Frost Cycle is actuated.

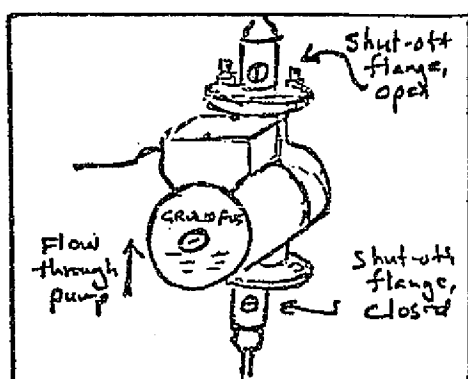
### 3.2 System Start-Up

3.2.1 Initial start-up or after maintenance from complete system shut-down - Frost Cycle

#### a. Filling and Venting

- (1) Insure that all joints are completed and that all connections are secure.
- (2) Open all gate valves except the cold supply valve. If the pump has shut-off flanges, open them. (Figure 17)
- (3) Position the CASCADE Valve lever to MAN OPEN (Figure 9.)
- (4) Open the cold supply valve. To facilitate filling the tanks, their respective P & T valves should be opened until all air is out of the tanks. Note: The storage tank will fill first, and then the electric/gas tank.

- (5) When each tank is filled and vented, close its P & T valve. Caution: If the collectors have had the sun shining on them for any length of time, they are likely to be very hot. As a result, the water that passes through the collector initially is likely to get very hot, even to the point of becoming steam.



- (6) Check system for leaks.  
(7) Place the CASCADE valve lever in AUTO (Figure 9).

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Figure 17: Circulating Pump

b. CASCADE Autocontrol start-up and checkout.

- (1) Place all switches in the OFF position.
- (2) Plug the pump power cord into the receptacle, holding the receptacle in one hand to avoid stressing the PC board.
- (3) Replace cover.
- (4) Plug the autocontrol power cord into a 110 V receptacle.

- (5) Turn the power switch ON and verify that the power light is ON.
- (6) Turn the pump switch to MANUAL and verify that the pump runs and that the pump light is ON. Note: It may be necessary to vent the pump. If so, follow manufacturer's instructions included with the pump. When vented and operating properly, the pump should be only barely audible when operating.
- (7) Turn the pump switch to OFF.
- (8) Check that the CASCADE Valve lever is in AUTO. Turn the CASCADE switch to MANUAL. Check that the light goes on and that the valve operates. Caution: It is important that the valve not be actuated unless the lever at the valve is in AUTO.
- (9) Turn the CASCADE switch to OFF.
- (10) Check that power has not been restored to the electric tank. Set the upper element thermostat to 140°F. Set the lower element thermostat to 110°F.

- (11) Restore power to the electric heater.  
The element may be heard operating, or it may be verified by observing the Watt Hour meter disk. For gas tanks, turn gas shut off valve ON and set thermostat to 140°F.
- (12) Turn the HEATER OFF switch to MANUAL and verify that the light goes on.  
The S106B relay should interrupt power to the elements within two minutes.  
An audible click can be heard when this happens. This can be verified by checking the Watt Hour meter. For gas systems, the solenoid valve will operate with an audible click without delay.
- (13) When satisfied that all parts of the system are operating properly, turn all switches to AUTO and observe that the appropriate lights come on and that the pump, valves, and heater relay operate as required.

3.2.2 Start-up from partially filled condition (when work such as removal of a collector or other component on the solar loop side of the isolation valves has been accomplished) - Frost Cycle.

- a. Open the system hi-point vent.
- b. Open the isolation valves or pump shut-off flanges.
- c. Repeat steps 3 - 7 under Initial Start-up.
- d. Repeat the CASCADE Autocontrol Start-up sequence as necessary.

### 3.2.3 Start-up from a non-draindown condition - Frost

#### Cycle

- a. If the autocontrol or other associated electrical components have been worked on, repeat the appropriate steps under the CASCADE autocontrol start-up sequence.
- b. If the switches have merely been turned off, return all function switches to AUTO.

### 3.2.4 Start-up with Dump Cycle

- a. Before filling the system, place all autocontrol switches in the OFF position.
- b. Plug the autocontrol power cord into a 110V receptacle.
- c. Turn the power switch ON and observe that the power light is ON.
- d. Follow the appropriate steps under Frost Cycle start-up.
- e. The operation of the Dump Valve may be checked by turning the Power Switch to OFF. Before doing so place the pump switch in OFF to prevent the pump from running immediately after power is restored but before the system has vented.

### 3.3 System Shut-Down

#### 3.3.1 Non-drain down shut-down.

- a. Turn power switch to OFF for Frost Cycle.
- b. Turn function switches to OFF for Dump Cycle.

#### 3.3.2 Partial draindown shut-down

- a. Turn off 220V power to electric tank, or gas shut-off valve to OFF.
- b. Turn autocontrol power switch OFF. In addition, the autocontrol may be unplugged.
- c. If the system is a Direct Dump and the collectors or the ropf equipment are to be worked on, turning the power OFF and allowing the Dump to operate will be sufficient drain-down.
- d. Close the cold supply valve (see Figure 1).
- e. Open the hi-point vent unless the Direct Dump option is installed.
- f. Connect a drain hose and open the storage tank drain valve.
- g. Close the drain valve when the desired level has been attained.
- h. Close the solar loop isolation valves.
- i. Open the cold supply valve and vent the tanks as necessary.



- j. Restore 220V power to the electric tank or turn the gas shut off valve to ON and relight the pilot.
- 3.3.3 Complete drain-down shut-down
- a. Repeat steps a. through f. under Partial drain down.
  - b. Completely drain all piping and both tanks.
  - c. To facilitate draining the solar loop lines, place the CASCADE valve lever in MANUAL OPEN until drained.. Then return to AUTO.

#### 4.0 MAINTENANCE

The system does not normally require periodic maintenance. Any maintenance that may become necessary is most likely to be due to a failed component. Failure that requires replacement, such as a tank, pump, or collector failure, should normally be performed by an authorized dealer or plumbing firm. If such replacement becomes necessary, follow the appropriate shut-down procedure outlined in the Operation section of this manual.

##### 4.1 Trouble-Shooting Guide

When it is suspected that the system is not working properly, first check the obvious:

- a. Is the power on?
  - (1) Power to the electric tank, or gas to the gas tank and pilot lit..

- (2) Autocontrol plugged into 110V receptacle.
  - (3) Pump plugged into autocontrol.
- b. Is the 3 amp fuse in the autocontrol burned out?
- c. Are the switches in their proper positions?
  - (1) Normally all switches should be in AUTO.
  - (2) If the Vacation Energy Saving Feature has been in operation, the HEATER OFF switch may be in MANUAL. Return to AUTO.

Section I  
HAZARDS ANALYSIS

ESC-18

SUNSPOT CASCADE SOLAR DOMESTIC WATER HEATING SYSTEMS

ELCAM INC.  
SANTA BARBARA, CA.  
NOVEMBER 1976

## HAZARDS ANALYSIS

This document is intended to analyse the hazards associated with the installation, operation and maintenance of SUNSPOT CASCADE solar systems. Potential and existing hazards to personnel, equipment and structures are identified. In each case, the control or elimination of the hazard is discussed. Hazards are classified as MINOR if the damage or injury that might result is less than serious. MAJOR hazards are those that could result in serious injury or damage. In some cases, a known hazard is accepted. These hazards are known as RESIDUAL HAZARDS and the rationale for their acceptance is provided.

Where hazards result from the failure of equipment or system components, the failure mode and redundant or back up safety features are described.

Six sections cover Pressure, Electrical, Toxicity, Flammability, Gas Systems and Hot Water/Steam hazards. Each system is summarized by a CONCLUSION statement. While this document reports on all of the known hazards, no warranty of completeness is either given or implied.

## 1. PRESSURE

System pressures generally fluctuate as a function of system temperature. In heat exchanger systems, the collector loop pressure rise is tempered by an expansion chamber containing air. Direct heating systems operate at supply or street pressures. The collector temperature increase is generally limited to street pressure which seldom exceeds 100 psi. Since the tank, copper pipe and associated fitting design pressures are 150 psi or greater, pressure fluctuations up to street pressures present no hazard.

In one case, however, system pressure could exceed street pressure during normal operation of direct systems when the CASCADE valve is energized, it, and the tank cross-over check valve isolate the collector loop and service hot water plumbing from the supply. Significant temperature increases could result in significant pressure increases in both the collector loop and the service hot water plumbing. During normal operation, however, the highest observed pressure has been less than 100 psi.

A failure mode could exacerbate this condition however: should the pump fail while the CASCADE valve is held ON, it is possible that the water in the collector might boil. If this were to occur, and if the system pressure increased to 125 psi, two pressure relief valves, each set to open at 125 psi, would relieve the overpressure. It

should be noted that a power failure would not produce the failure modes described in this paragraph, since power is required to maintain the CASCADE valve ON.

In the event that all safety devices fail simultaneously, naturally limiting influences apply. At 124 psi, the boiling temperature of water is 343.7<sup>0</sup>F. Thus as the temperature and pressure increase, the potential for steam generation is naturally limited. Mark's Standard Handbook for Mechanical Engineers indicates a pressure rise of about 125 psi for steam generated at about 350<sup>0</sup>F.

Excess pressure which would result from freezing is guarded against by the autocontrol's frost cycle or a collector dump tank system, whichever is appropriate. Should either safety system fail for any reason, the hazard would be limited to the collector waterways which would probably crack.\*

CONCLUSION: NO PRESSURE HAZARD EXISTS.

## 2. Electricity

Three levels of voltage are used in SUNSPOT systems:

1. 220 VAC drives the electric element.

\*Note: An interesting passive freeze protection system deserves attention. The introduction into the waterways, of a flexible tube (whose flexibility was retained at freezing temperatures) would permit repeated collector freezing without damage to the waterways.

2. 110 VAC drives the pump and autocontrol.

3. 24 VAC drives the CASCADE valve and heater relay. This voltage presents no hazard.

During installation, the normal safety precautions usually observed (opening circuit breakers) will preclude any danger of electrical shock. Proper installation of each of the standard insulating barriers and ground leads minimize the danger of shock during routine maintenance. Covers, isolation and ground leads preclude any danger of shock during normal operation.

CONCLUSION: A MAJOR HAZARD EXISTS WITH RESPECT TO INSTALLATION AND MAINTENANCE PERSONNEL. THIS HAZARD IS CONTROLLED AND/OR ELIMINATED BY OBSERVATION OF STANDARD PROCEDURES AND BY USE OF APPROPRIATE INSULATORS, COVERS AND GROUND CONNECTIONS. NO RESIDUAL HAZARD EXISTS WITH RESPECT TO NORMAL OPERATION.

3. TOXICITY

Two forms of toxicity might result from the installation and use of a DWH system. The potable water supply might be polluted and toxic fumes might be generated by the system during normal operations, installation, or during a fire.

Potable water drawn from the public supply (or a private suppliers well, river course or spring, etc.) is the only fluid introduced into SUNSPOT systems. All materials with which the water comes into contact are approved for use in potable water systems by the California State Health Department. These materials include:

- copper
- brass
- nylon and rubber (gaskets and valve inserts)
- magnesium (anode)
- Stainless steel (dip tube)
- other materials detailed in Document ESC-7g

An uninformed owner might add a toxic fluid (e.g. antifreeze solution) to the collector loop in heat exchanger systems. If a heat exchanger leak occurred the potable water could be polluted. It is our opinion that double walled heat exchangers will not remove the reason for, or cause of, such a leak. There is little that a manufacturer can do to preclude the hazardous use of its products, other than placarding and printing precautions and warning.

Toxicity resulting from fumes during installation must be guarded against by adequate ventilation. Fire appears to produce no toxic fumes from any of the flammable materials. See Section 4: Flammability.

CONCLUSION: NO TOXICITY HAZARD EXISTS.

ESC-18



#### 4. FLAMMABILITY

The exposed metallic surfaces used in SUNSPOT Systems include aluminum, copper, brass and zinc-coated steel. None of these are flammable.

The exposed non-metallic materials include:

- Tedlar/acrylic sandwich - collector cover
- Rubber - pipe insulation
- Latex paint - exterior pipe insulator coating
- Vinyl - electrical insulation
- Goodyear Flame Resistant ABS - Autocontrol cover

Each of these is covered below:

Tedlar/acrylic sandwich - Flammable. Ignites with cigarette lighter.

Flame propagates at 1.82 inches per minute.

Rubber insulation - Flammable. Ignites with propane torch. Self extinguishing horizontally and vertically.

Latex paint - Flammable. Ignites with cigarette lighter. Manufacturer (Sherwin-Williams) claims 3B flammability rating. i.e. Paint will not ignite with torch. Our tests indicate this is not so. When paint fuel is consumed, rubber insulation on which it was applied becomes blistered, but does not ignite.

Vinyl electrical insulation - Flammable. Ignites with cigarette lighter. Self extinguishing horizontally and vertically.

Goodyear Flame Resistant ABS - Flammable. Ignites with cigarette lighter. Self extinguishing horizontally and vertically.

The collector side and back insulation is urethane foam which is flammable. The closed cell vinyl gasket and double backed adhesives are also flammable. Because these components are completely within the collector enclosure, its flammability hazard is considered to be less than minor.

CONCLUSION: A LESS THAN MINOR FLAMMABILITY HAZARD EXISTS WITH RESPECT TO PERSONNEL, EQUIPMENT AND STRUCTURES. SINCE THESE HAZARDS ARE EQUIVALENT TO, OR LESS THAN THE FLAMMABILITY HAZARDS COMMON TO STANDARD RESIDENTIAL CONSTRUCTION. THESE HAZARDS ARE ACCEPTED.

5. GAS SYSTEMS

In many cases gas tanks (natural or propane) will become a constituent part of SUNSPOT CASCADE systems. Since the CASCADE autocontrol cannot command the gas valve, the gas system will not be interfered with in anyway. A gas valve actuator will be developed.

CONCLUSION: NO GAS HAZARD EXISTS.

6. HOT WATER AND/OR STEAM

Scalding water and/or steam present a potentially major hazard to personnel during installation, maintenance, and even normal operation. Normal operating temperatures often exceed 160°F. and a bare copper pipe at this temperature can cause a first degree skin burn. The opportunity to inadvertently contact bare copper pipes is greatly

reduced through the use of heavy rubber insulation around all exposed pipes. Valve bodies are generally not insulated, however, so this hazard remains to some extent. Because the valve bodies are small, and because they are usually placed in less than casually accessible positions, this minor hazard is accepted.

During installation and/or maintenance, or whenever the pump is inoperative during high rates of insolation, the collector temperature may exceed 212°F. Water in the collector may become steam. Any openings in the collector loop can thus become the source of a jet of scalding water mixed with steam. To reduce the hazard of being exposed to such a jet, the following precautions are recommended:

1. Keep children and pets away from valves and unfinished plumbing connections during installation or repair.
2. Remove valve handles after system is returned to service, and store them beyond the reach of children.
3. Keep collector covered with cardboard or other opaque material (taped in place) during installation and maintenance.
4. Install collectors to permit good drainage.
5. Drain collector loop thoroughly prior to cutting into loop.
6. When draining collector loop in heat exchanger models, use a hose to take the effluent from the drain valve to a safe location such as a street gutter or storm water drain. Direct systems drain through the tanks and are thus not hazardous.

7. Remain clear of the pressure relief valve drain normally installed in the vicinity of the collectors.

CONCLUSION: A MINOR PERSONNEL HAZARD EXISTS WITH RESPECT TO CONTACTING BARE COPPER OR BRASS SURFACES WHICH ARE HEATED BY HOT WATER OR STEAM. THIS HAZARD IS RENDERED ACCEPTIBLE BY INSULATION AND BY LOCATING UNINSULATED SURFACES REMOTELY.

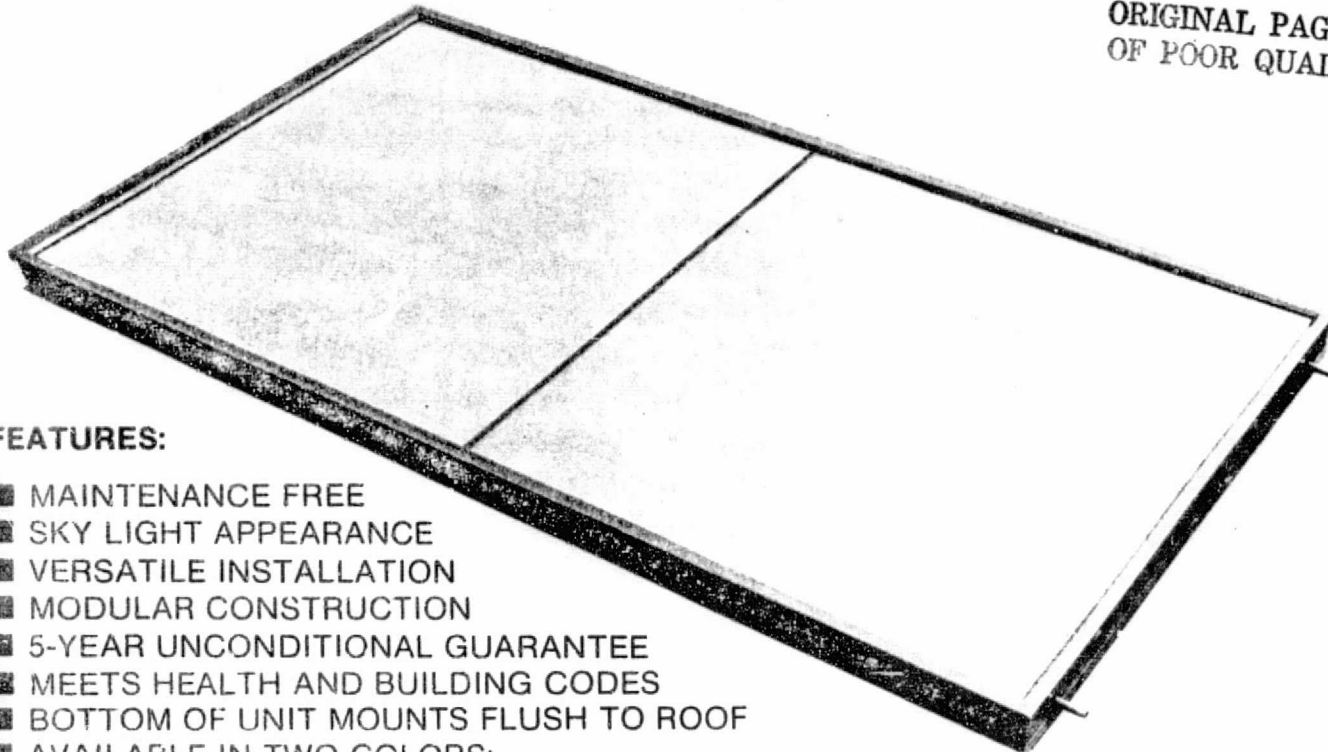
A MAJOR PERSONNEL HAZARD EXISTS WITH RESPECT TO SCALDING WATER AND/OR STEAM JETS. THIS HAZARD EXISTS AS A RESULT OF THE FUNDAMENTAL PHYSICS OF A GOOD SOLAR COLLECTOR. CONSEQUENTLY THIS HAZARD CANNOT BE ELIMINATED. IT IS RENDERED ACCEPTABLE BY OBSERVING THE LIST OF RECOMMENDED PRECAUTIONS.

Section J

# SUNSPOT<sup>TM</sup>

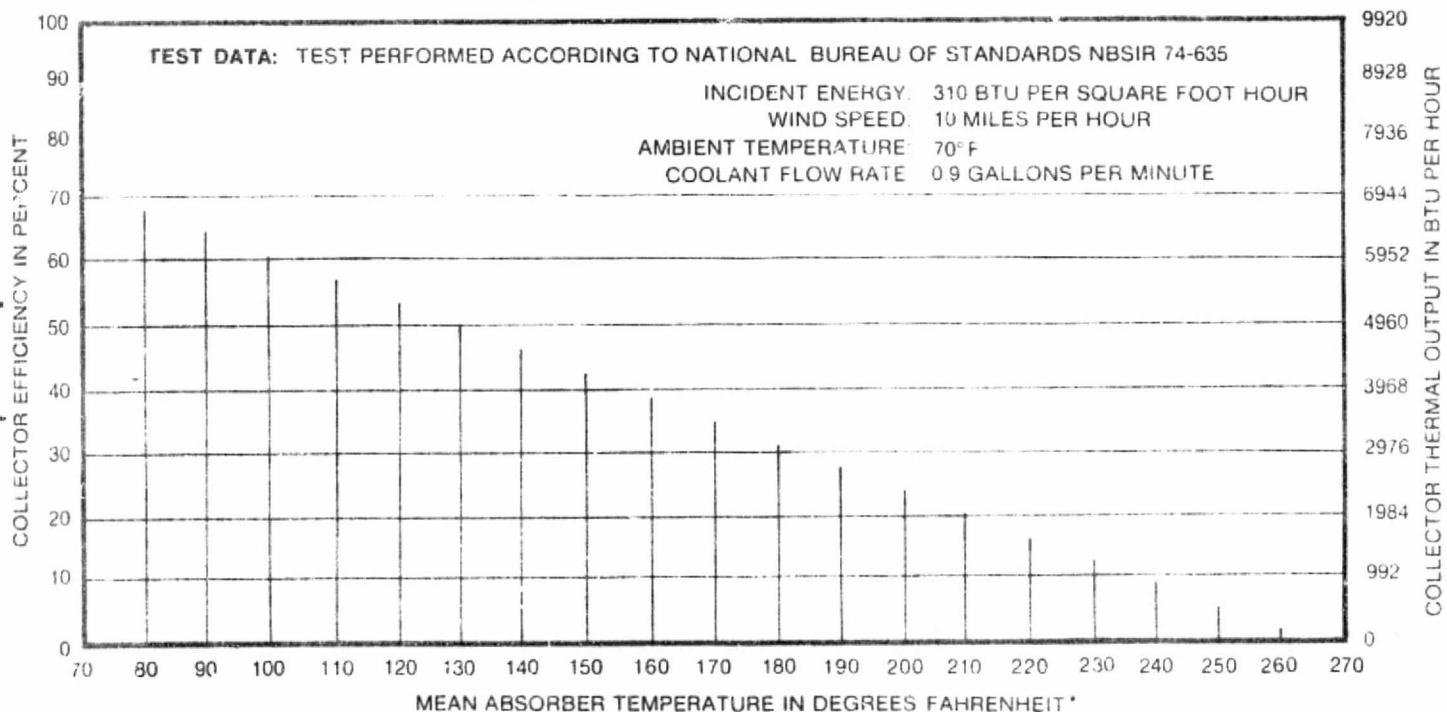
## MODEL 3200 SOLAR COLLECTOR

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OF POOR QUALITY



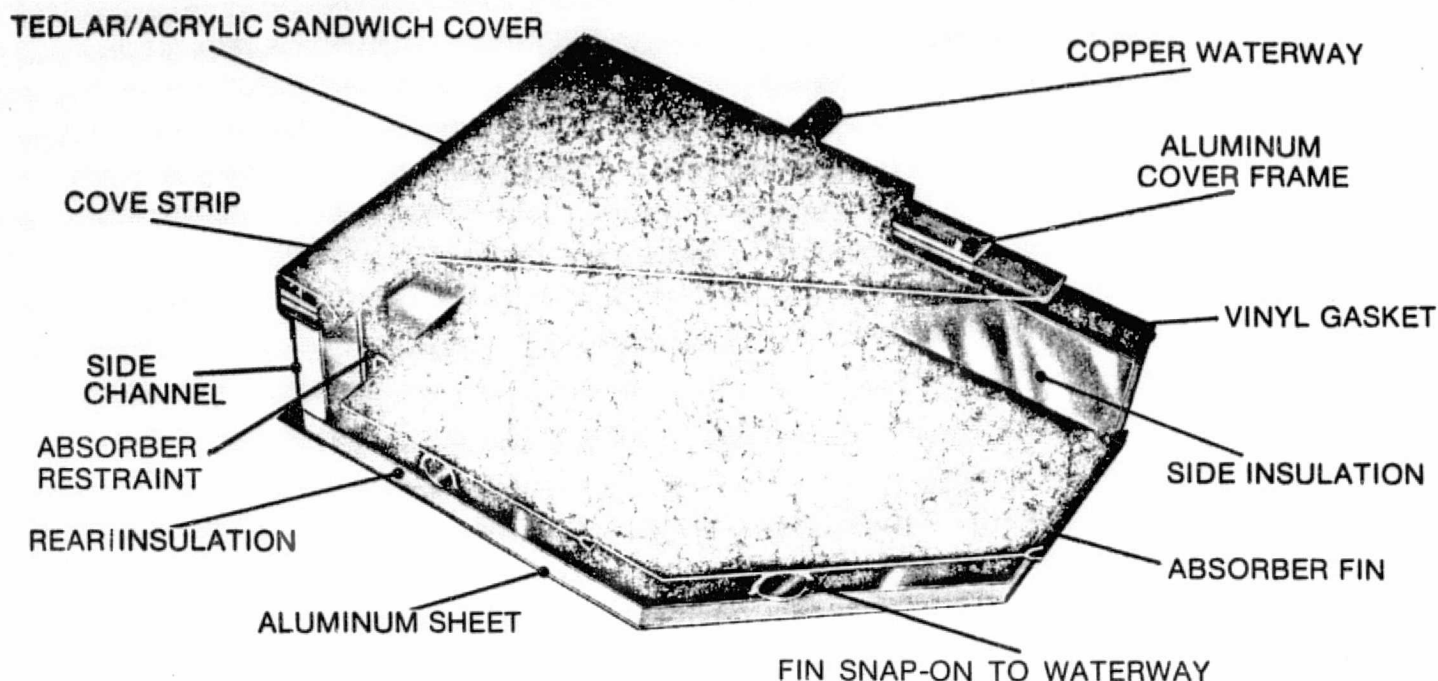
### FEATURES:

- MAINTENANCE FREE
- SKY LIGHT APPEARANCE
- VERSATILE INSTALLATION
- MODULAR CONSTRUCTION
- 5-YEAR UNCONDITIONAL GUARANTEE
- MEETS HEALTH AND BUILDING CODES
- BOTTOM OF UNIT MOUNTS FLUSH TO ROOF
- AVAILABLE IN TWO COLORS:  
SHAKE SHINGLE BRONZE AND ROOF TILE RED
- COMPATIBLE WITH EXISTING STANDARD PLUMBING HARDWARE



\*NOTE: NBSIR 74-635 SPECIFIES ABSCISSA TO BE  $\frac{1}{2}(t_{f,i} + t_{f,e}) - t_a$  WHERE  $t_{f,i}$ ,  $t_{f,e}$  &  $t_a$  ARE INLET, EXHAUST & AMBIENT TEMPERATURES & I IS INSOLATION.

## TECHNICAL DETAILS



### SUNSPOT COLLECTOR: \*(Metric units in parentheses)

#### Dimensions:

**Overall:** 48 $\frac{3}{4}$ " x 96 $\frac{3}{4}$ " x 3-7/16" (123.8 cm x 245.75 cm x 8.73 cm)

**Absorber:** 46" x 94" = 30.3 square feet (116.84 cm x 238.76 cm = 2.79 square meters)

#### Weight:

100 lbs. (45.4 kg)

#### Materials:

**Absorber Surface:** Honda black baked onto alodined aluminum fin.

**Absorbtivity**  $\alpha = 0.95$

**Waterways:**  $\frac{1}{2}$ " Type M copper, silver brazed joints, pressure tested to 125 p.s.i.

**Insulation:**  $\frac{1}{2}$ " isocyanurate, aluminum foil clad one side.

**Collector back:** 0.019" aluminum sheet bonded to rear insulation.

**Collector sides and cove strip:** aluminum extrusions

**Cover:** Tedlar® UV Filter bonded to 5 oz. crystal clear acrylic.  $\tau = 0.92$ . Cover stretched between and bonded to aluminum frame members.

**Gasket:** Closed cell vinyl foam.

**Weatherproofing:** Rubber grommets, silicone rubber, closed end blind rivets.

**SUNSPOT**™  
SOLAR WATER HEATING SYSTEMS

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OF BETTER QUALITY

Section K

Drawings

**NOTES:**

**1. MATERIAL:**

VYNIL RUBBER STRIP,

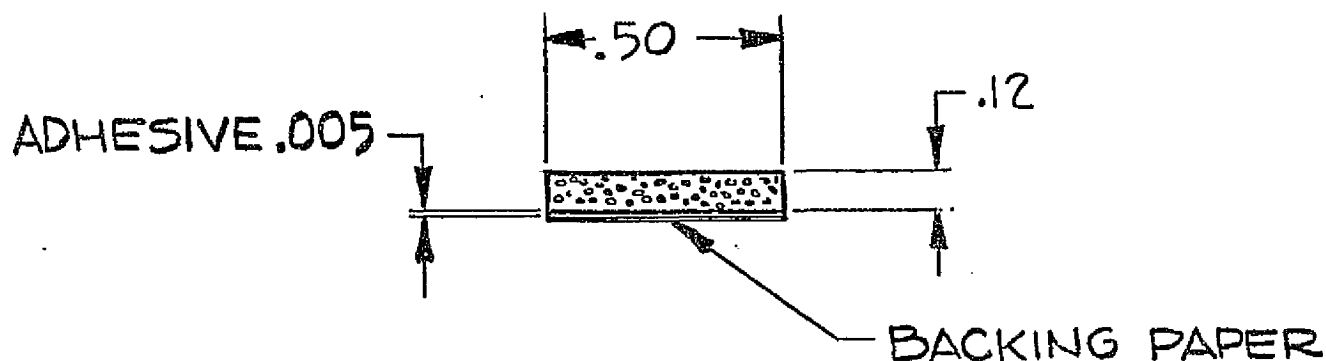
CLOSED CELL SPONGE

DUROMETER 40-50

COLOR BLACK. PRESSURE-SENSITIVE

ADHESIVE BACKED WITH

PROTECTIVE BACKING PAPER.



8330 DEBBIE LANE  
SANTA BARRERA, CALIF. 93111  
PHONE 964 8653

**ELCAM, INC.**

Contractors License No. 290399

TOLERANCES	REVISIONS			PART NUMBER	
	NO	DATE	BY	CP7	
UNLESS OTHERWISE SPECIFIED DECIMAL XX ± 0.0 XXX ± 0.0 ANGULAR ± DRAFT K-1	1			PART NAME	
	2			GASKET	
	3			DRAWN BY	SCALE NONE
	4			THOMSON	DATE 14 NOV 76
	5			CHK D	DRAWING NO
				TRACED	APP D
					ESP-C7



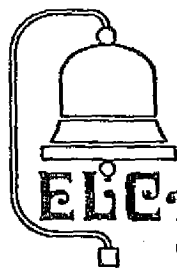
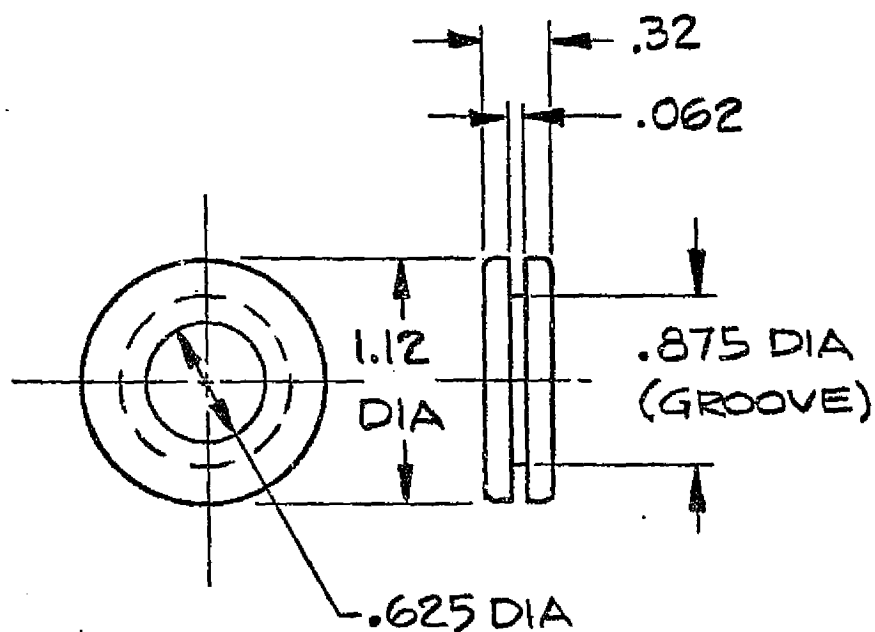
# NOTES:

## 1. MATERIAL:

RUBBER, SYNTHETIC  
COLOR BLACK

## 2. VENDOR(S)

RUBBERCRAFT



8330 DEBBIE LANE  
SANTA BARBARA, CALIF. 93112  
PHONE 964-2693

**ELCAM, INC.**

Contractors License No. 290399

TOLERANCES		REVISIONS			PART NUMBER		
UNLESS OTHERWISE SPECIFIED DECIMAL		NO	DATE	BY	CP10		
XXX ± 0.0		1			PART NAME		
XXX ± 0.0		2			RUBBER GROMMET		
ANGULAR ±		3			DRAWN BY		
DRAFT		4			THOMSON		
K-2		5			SCALE FULL		
					DATE DEC NOV 76		
					TRACED		
					MATERIAL SEE NOTE 1		
					DRAWING NO		
					ESP-C10		

# NOTES:

## 1. MATERIAL:

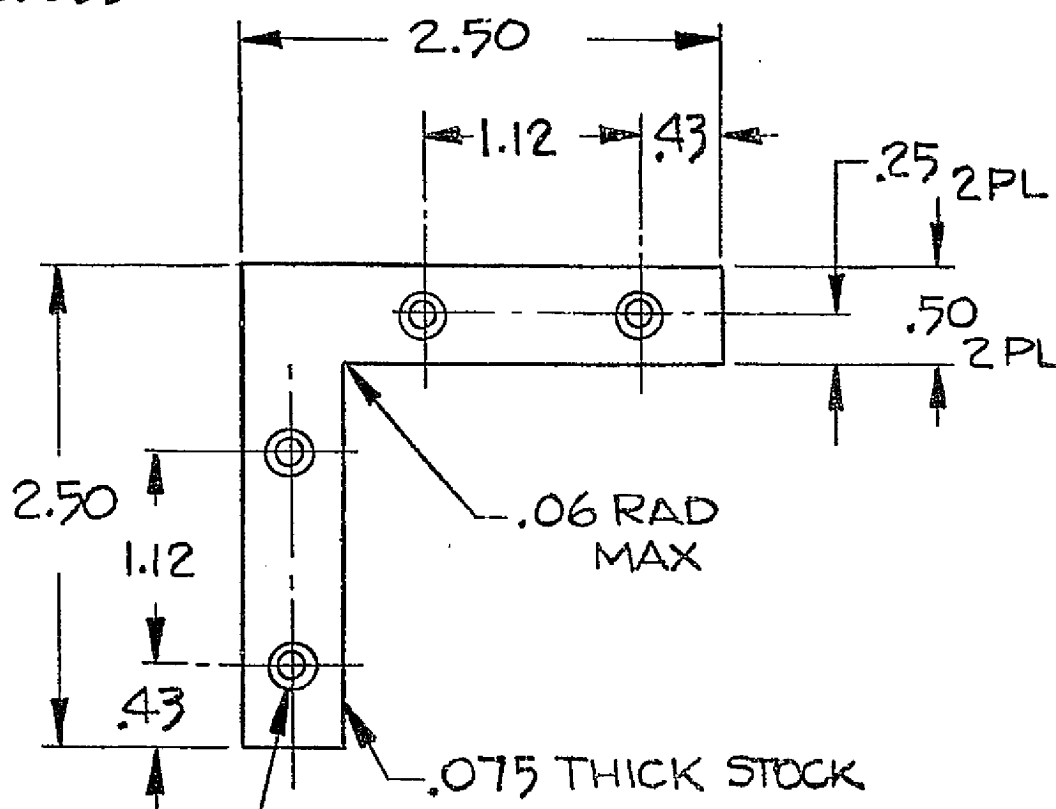
CARBON STEEL

## 2. PROTECTIVE FINISH:

ZINC PLATE

## 3. MFG PART NO.

STANLEY NO. 999



.198-.204 DIA  
CSK 120° TO .25 DIA  
4 HOLES



5530 DEBBIE LANE  
SANTA BARBARA, CALIF 93111  
PHONE 964 8693

**ELCAM, INC.**

Contractors License No 290399

TOLERANCES		REVISIONS			PART NUMBER		
UNLESS OTHERWISE SPECIFIED DECIMAL		NO	DATE	BY	CP 14		
.XX ± .00		1			PART NAME CORNER BRACKET		
XXX ± .00		2					
ANGULAR ±		3			DRAWN BY THOMSON		
DRAFT		4					
K-3		5			SCALE FULL		
					DATE 14 NOV 76		
					SEE NOTE 1		
					ESP-C14		

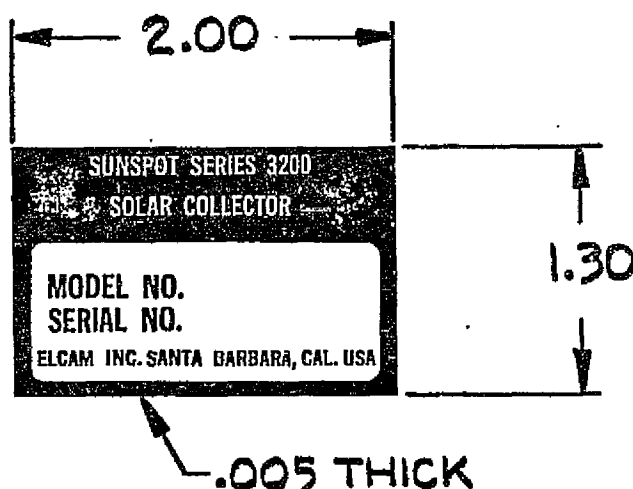
**NOTES:**

**1. MATERIAL:**

**PHOTOGRAPHIC PAPER.  
PRESSURE-SENSITIVE  
ADHESIVE BACKED WITH  
PROTECTIVE BACKING  
PAPER.**

ORIGINAL PAGE IS  
OF POOR QUALITY

C-2



6330 DEBBIE LANE  
SANTA BARBARA, CALIF. 93111  
PHONE 964-8663

**ELCAM, INC.**

Contractors License No. 290199

TOLERANCES		REVISIONS		PART NUMBER	
UNLESS OTHERWISE SPECIFIED DECIMAL		NO	DATE	BY	
XX ± 0.0		1			
XXX ± 0.0		2			
ANGULAR ±		3			
DRAFT		4			
K-4		5			
				PART NAME	
				CP15	
				DRAWN BY	
				THOMSON	
				SCALE	
				FULL	
				DATE	
				12 NOV 76	
				DRAWING NO	
				ESP-C15	
				TRACED	
				APP	

NOTES:

# 1. MATERIAL:

VINYL PLASTIC

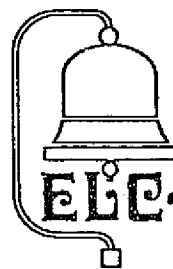
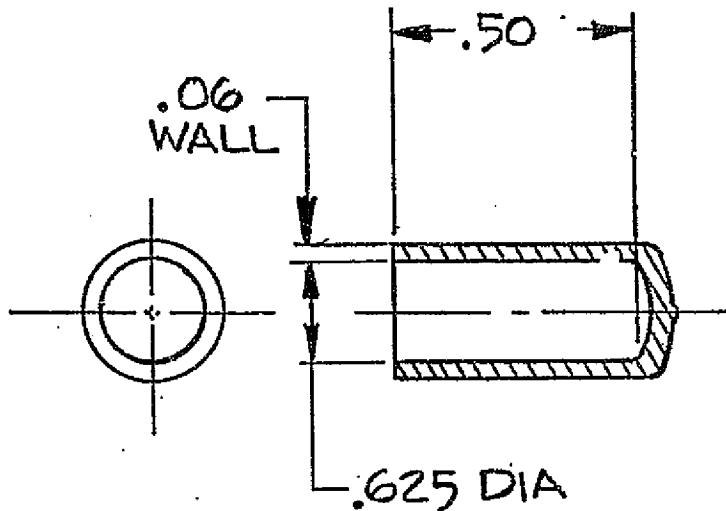
COLOR RED

2. VENDOR:

SINCLAIR & RUSH INC.

FSCM NO

PART NO. 625-8



8330 DIEBIE LANE  
SANTA BARBARA, CALIF. 93111  
PHONE 964 8693

# ELCAM, INC.

Contractors License No. 290399

<b>TOLERANCES</b>	<b>REVISIONS</b>			<b>PART NUMBER</b> CP16		
UNLESS OTHERWISE SPECIFIED DECIMAL .XX ± 0.0 .XXX ± 0.0 ANGULAR ± DRAFT  K-5	<b>NO</b>	<b>DATE</b>	<b>BY</b>	<b>PART NAME</b> VINYL CLOSURE		
	1			<b>DRAWN BY</b> THOMPSON		
	2			<b>SCALE</b>	NONE	<b>MATERIAL</b> SEE NOTE 1
	3			<b>CNH D</b>	<b>DATE</b>	<b>DRAWING NO</b> ESP-C16
	4			<b>TRACED</b>	<b>APP D</b>	
	5					

NOTES:

1. MATERIAL:

ALUMINUM ALLOY EXTRUSION  
CMP5N 6063 TEMPER T5  
DIE SECTION 66890

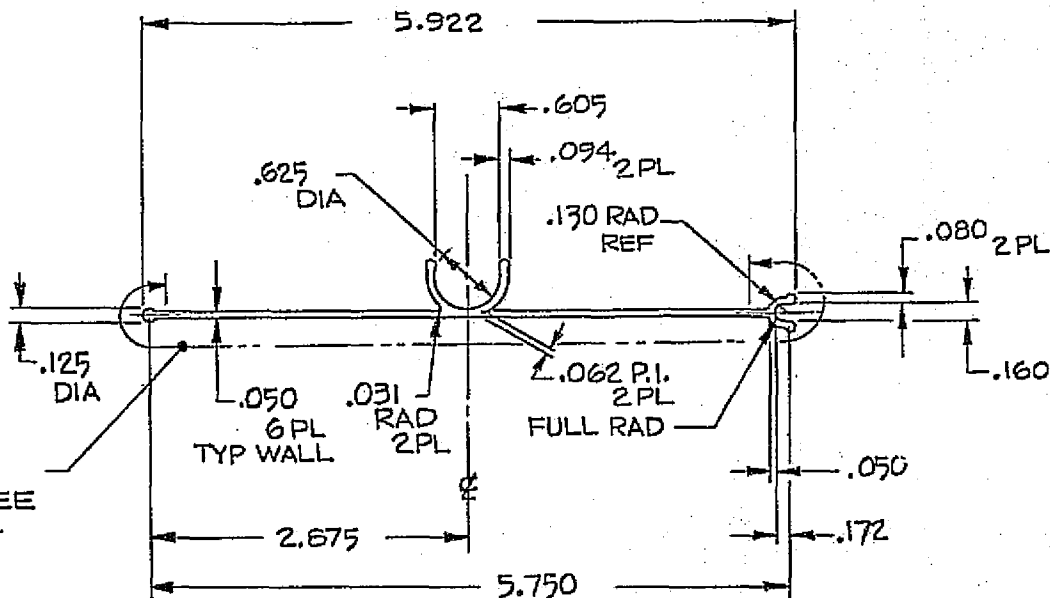
2. VENDOR:

REYNOLDS METALS CO.  
FSCM NO.

3. PROTECTIVE FINISH:

CHEM FILM (ALODINE) ENTIRE  
PART, FINISH COAT WITH MARTIN NO.23  
(LUSTERLESS BLACK) ON  
INDICATED AREA.

BLACK  
FINISH THIS  
SURFACE, SEE  
NOTE 3



K-6



2220 OCEAN BLVD.  
SANTA BARBARA, CALIF. 93101  
PHONE 944-1222

**ELCAM, INC.**

Contractors License No. 730799

REVISIONS			PART NUMBER	
NO.	DATE	BY	CPI	
1			PART NAME	
1			ABSORBER SNAP FIN	
1			DESIGNED BY	
1			THOMPSON	
1			CHECKED BY	
1			FULL	
1			DATE	
1			14 NOV 76	
1			DRAWN BY	
1			ESP-CI	

K-6

**NOTES:**

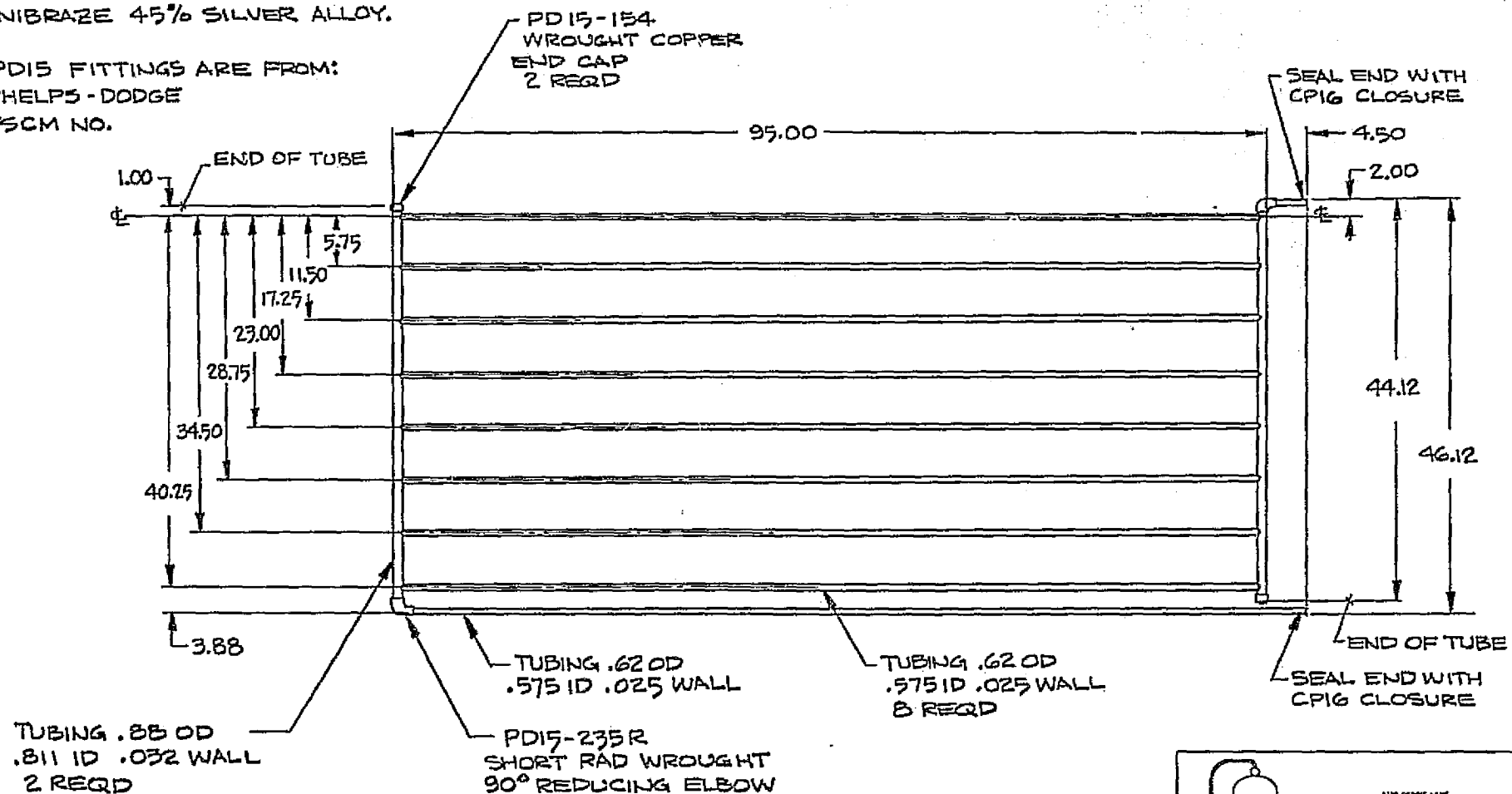
**1. MATERIAL:**


COPPER TUBE, ROUND SEAMLESS, HARD  
DRAWN, TYPE M - OPTION ALLOY 330.

**2. ALL SEAMS SHALL BE BRAZED USING  
UNIBRAZE 45% SILVER ALLOY.**

**3. PD15 FITTINGS ARE FROM:  
PHELPS - DODGE  
FSCM NO.**

K-7

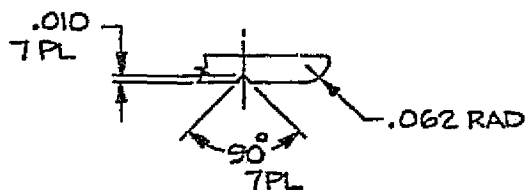
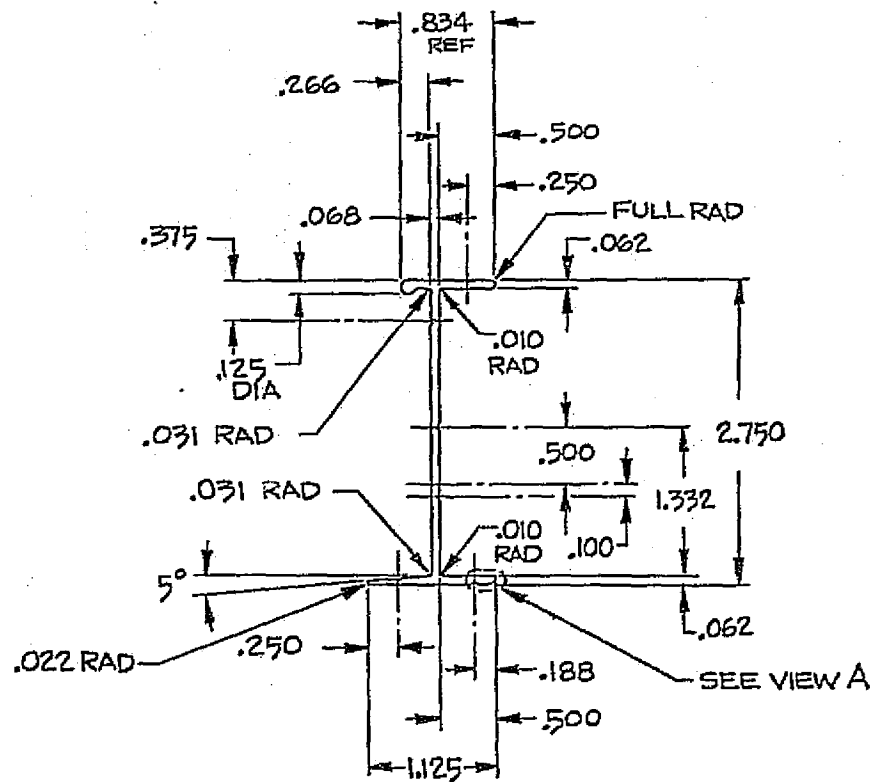


 <p><b>ELEM, INC.</b> 5100 DEBBIE LANE SANTA ANITA, CALIF. 92111 PHONE 548-0483</p>		PART NUMBER	
		CP2	
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES		PART NAME	
ALL DIMENSIONS ARE TO CENTERLINE UNLESS OTHERWISE SPECIFIED		ABSORBER WATERWAY	
TOLERANCES		THOMPSON	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
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TOLERANCES		1/2	
FRACTIONS		1/10	
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ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
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RADIUS		1/2	
TOLERANCES		1/2	
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ANGLES		1/2	
RADIUS		1/2	
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FRACTIONS		1/10	
DECIMALS		1/100	
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RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
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RADIUS		1/2	
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RADIUS		1/2	
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FRACTIONS		1/10	
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RADIUS		1/2	
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FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
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FRACTIONS		1/10	
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ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
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RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES		1/2	
RADIUS		1/2	
TOLERANCES		1/2	
FRACTIONS		1/10	
DECIMALS		1/100	
ANGLES			

ALUMINUM ALLOY EXTRUSION  
CMPNSN 6063 TEMPER T5  
DIE SECTION 67026-A

REYNOLDS METALS CO.  
FSCM NO.

3. PROTECTIVE FINISH:  
ELECTRO-DEPOSITED  
COMMERCIAL DARK  
BROWN



VIEW A  
SCALE: 4/1



LINE NUMBER 4400  
SANTA BARBARA, CALIF. 93101  
FROM 042 001

**TELEAM, INC.**

Continued from page 38

TELEPHONE		REVIEWS		PART NUMBER	
NO.	DATE	BY			
UNLESS OTHERWISE SPECIFIED BY MICHAEL			CP3		
JUL 25 83			PART NAME		
JUL 25 83			SIDE CHANNEL		
JUL 25 83			REVISION		
JUL 25 83			FULL SCALE		
JUL 25 83			DATE		
JUL 25 83			TIME		
JUL 25 83			LOCATION		
JUL 25 83			JOB		
JUL 25 83			ESP-C3		

K-5

NOTES:

1. MATERIAL:

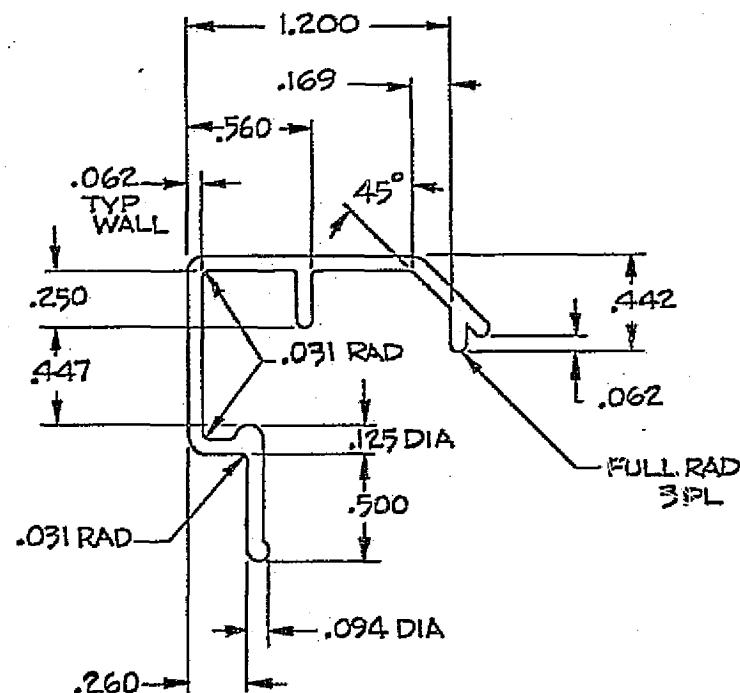
ALUMINUM ALLOY EXTRUSION  
CMPSN 6063 TEMPER T6  
DIE SECTION NO. 67025

2. VENDOR:

REYNOLDS METALS CO.  
FSCM NO.

3. PROTECTIVE FINISH:

ELECTRO-DEPOSITED  
COMMERCIAL DARK  
BROWN



K-9



1230 BENDIS LANE  
SANTA BARBARA, CALIF. 93101  
PHONE 344-0000

Continuation Drawing No. 700107

TOLERANCES	REVISE	DATE	BY	PART NUMBER
UNLESS OTHERWISE SPECIFIED DECIMALS	10			CP4
XX 2 1/2	11			PART NAME
XX 2 1/2	12			COVE STRIP
XX 2 1/2	13			
XX 2 1/2	14			
XX 2 1/2	15			
XX 2 1/2	16			
XX 2 1/2	17			
XX 2 1/2	18			
XX 2 1/2	19			
XX 2 1/2	20			
XX 2 1/2	21			
XX 2 1/2	22			
XX 2 1/2	23			
XX 2 1/2	24			
XX 2 1/2	25			
XX 2 1/2	26			
XX 2 1/2	27			
XX 2 1/2	28			
XX 2 1/2	29			
XX 2 1/2	30			
XX 2 1/2	31			
XX 2 1/2	32			
XX 2 1/2	33			
XX 2 1/2	34			
XX 2 1/2	35			
XX 2 1/2	36			
XX 2 1/2	37			
XX 2 1/2	38			
XX 2 1/2	39			
XX 2 1/2	40			
XX 2 1/2	41			
XX 2 1/2	42			
XX 2 1/2	43			
XX 2 1/2	44			
XX 2 1/2	45			
XX 2 1/2	46			
XX 2 1/2	47			
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XX 2 1/2	92			
XX 2 1/2	93			
XX 2 1/2	94			
XX 2 1/2	95			
XX 2 1/2	96			
XX 2 1/2	97			
XX 2 1/2	98			
XX 2 1/2	99			
XX 2 1/2	100			

K-9



NOTES:

1. MATERIAL:

ALUMINUM ALLOY EXTRUSION  
CMP5N 6063 TEMPER T5  
DIE SECTION NO.

2. VENDOR:

3. PROTECTIVE FINISH:

ELECTRO-DEPOSITED  
COMMERCIAL DARK  
BROWN

K-10

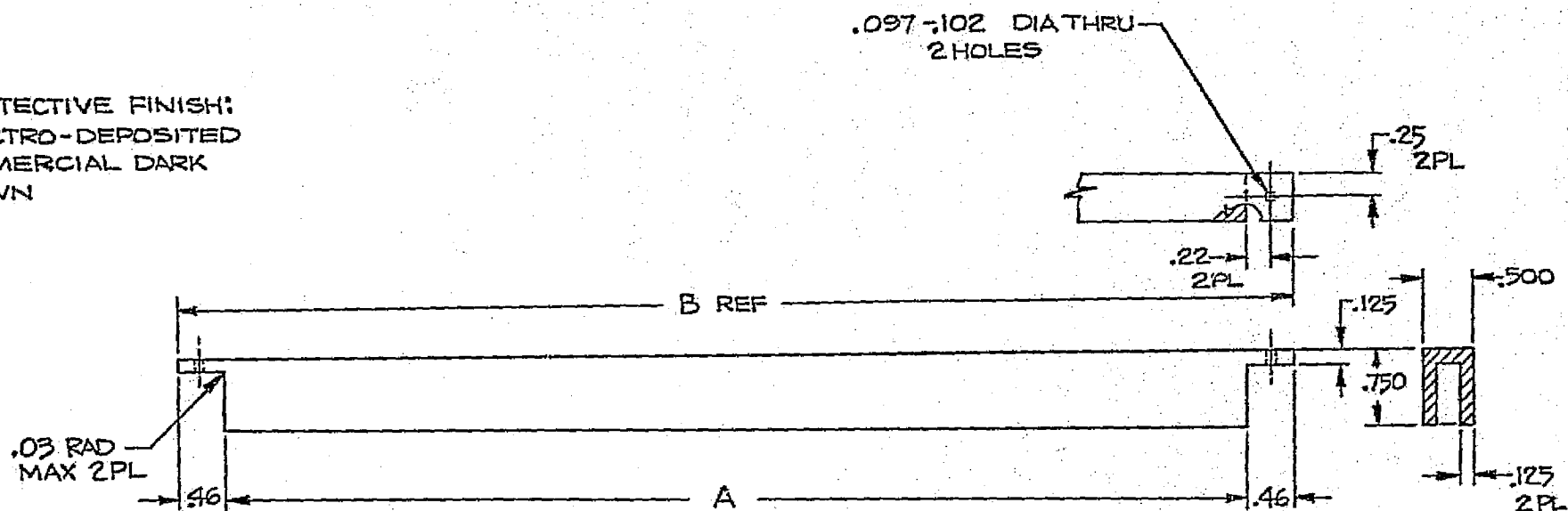



TABLE I

PART NO.	NOTCHED LENGTH A	CUT LENGTH B REF	REMARKS
CP5-001	47.38	48.30	

 <p><b>ELEM, INC.</b> CORPORATION, LIMITED NO. 70029</p>		<p>1220 SHAW LANE SANTA BARBARA, CALIF. 93115 PHONE 344-0886</p>	
		<p>PART NAME: CP5</p>	
<p>UNLESS OTHERWISE SPECIFIED MATERIAL IS 6063-T5</p>		<p>PART NAME: CROSS CHANNEL</p>	
<p>SECTION: A-A</p>		<p>THICKNESS: .125</p>	
<p>SECTION: B-B</p>		<p>THICKNESS: .125</p>	
<p>SECTION: C-C</p>		<p>THICKNESS: .125</p>	
<p>SECTION: D-D</p>		<p>THICKNESS: .125</p>	
<p>SECTION: E-E</p>		<p>THICKNESS: .125</p>	
<p>SECTION: F-F</p>		<p>THICKNESS: .125</p>	
<p>SECTION: G-G</p>		<p>THICKNESS: .125</p>	
<p>SECTION: H-H</p>		<p>THICKNESS: .125</p>	
<p>SECTION: I-I</p>		<p>THICKNESS: .125</p>	
<p>SECTION: J-J</p>		<p>THICKNESS: .125</p>	
<p>SECTION: K-K</p>		<p>THICKNESS: .125</p>	
<p>SECTION: L-L</p>		<p>THICKNESS: .125</p>	
<p>SECTION: M-M</p>		<p>THICKNESS: .125</p>	
<p>SECTION: N-N</p>		<p>THICKNESS: .125</p>	
<p>SECTION: O-O</p>		<p>THICKNESS: .125</p>	
<p>SECTION: P-P</p>		<p>THICKNESS: .125</p>	
<p>SECTION: Q-Q</p>		<p>THICKNESS: .125</p>	
<p>SECTION: R-R</p>		<p>THICKNESS: .125</p>	
<p>SECTION: S-S</p>		<p>THICKNESS: .125</p>	
<p>SECTION: T-T</p>		<p>THICKNESS: .125</p>	
<p>SECTION: U-U</p>		<p>THICKNESS: .125</p>	
<p>SECTION: V-V</p>		<p>THICKNESS: .125</p>	
<p>SECTION: W-W</p>		<p>THICKNESS: .125</p>	
<p>SECTION: X-X</p>		<p>THICKNESS: .125</p>	
<p>SECTION: Y-Y</p>		<p>THICKNESS: .125</p>	
<p>SECTION: Z-Z</p>		<p>THICKNESS: .125</p>	
<p>SECTION: AA-AA</p>		<p>THICKNESS: .125</p>	
<p>SECTION: BB-BB</p>		<p>THICKNESS: .125</p>	
<p>SECTION: CC-CC</p>		<p>THICKNESS: .125</p>	
<p>SECTION: DD-DD</p>		<p>THICKNESS: .125</p>	
<p>SECTION: EE-EE</p>		<p>THICKNESS: .125</p>	
<p>SECTION: FF-FF</p>		<p>THICKNESS: .125</p>	
<p>SECTION: GG-GG</p>		<p>THICKNESS: .125</p>	
<p>SECTION: HH-HH</p>		<p>THICKNESS: .125</p>	
<p>SECTION: II-II</p>		<p>THICKNESS: .125</p>	
<p>SECTION: JJ-JJ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: KK-KK</p>		<p>THICKNESS: .125</p>	
<p>SECTION: LL-LL</p>		<p>THICKNESS: .125</p>	
<p>SECTION: MM-MM</p>		<p>THICKNESS: .125</p>	
<p>SECTION: NN-NN</p>		<p>THICKNESS: .125</p>	
<p>SECTION: OO-OO</p>		<p>THICKNESS: .125</p>	
<p>SECTION: PP-PP</p>		<p>THICKNESS: .125</p>	
<p>SECTION: QQ-QQ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: RR-RR</p>		<p>THICKNESS: .125</p>	
<p>SECTION: SS-SS</p>		<p>THICKNESS: .125</p>	
<p>SECTION: TT-TT</p>		<p>THICKNESS: .125</p>	
<p>SECTION: UU-UU</p>		<p>THICKNESS: .125</p>	
<p>SECTION: VV-VV</p>		<p>THICKNESS: .125</p>	
<p>SECTION: WW-WW</p>		<p>THICKNESS: .125</p>	
<p>SECTION: XX-XX</p>		<p>THICKNESS: .125</p>	
<p>SECTION: YY-YY</p>		<p>THICKNESS: .125</p>	
<p>SECTION: ZZ-ZZ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: AAA-AAA</p>		<p>THICKNESS: .125</p>	
<p>SECTION: BBB-BBB</p>		<p>THICKNESS: .125</p>	
<p>SECTION: CCC-CCC</p>		<p>THICKNESS: .125</p>	
<p>SECTION: DDD-DDD</p>		<p>THICKNESS: .125</p>	
<p>SECTION: EEE-EEE</p>		<p>THICKNESS: .125</p>	
<p>SECTION: FFF-FFF</p>		<p>THICKNESS: .125</p>	
<p>SECTION: GGG-GGG</p>		<p>THICKNESS: .125</p>	
<p>SECTION: HHH-HHH</p>		<p>THICKNESS: .125</p>	
<p>SECTION: III-III</p>		<p>THICKNESS: .125</p>	
<p>SECTION: JJJ-JJJ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: KKK-KKK</p>		<p>THICKNESS: .125</p>	
<p>SECTION: LLL-LLL</p>		<p>THICKNESS: .125</p>	
<p>SECTION: MMM-MMM</p>		<p>THICKNESS: .125</p>	
<p>SECTION: NNN-NNN</p>		<p>THICKNESS: .125</p>	
<p>SECTION: OOO-OOO</p>		<p>THICKNESS: .125</p>	
<p>SECTION: PPP-PPP</p>		<p>THICKNESS: .125</p>	
<p>SECTION: QQQ-QQQ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: RRR-RRR</p>		<p>THICKNESS: .125</p>	
<p>SECTION: SSS-SSS</p>		<p>THICKNESS: .125</p>	
<p>SECTION: TTT-TTT</p>		<p>THICKNESS: .125</p>	
<p>SECTION: UUU-UUU</p>		<p>THICKNESS: .125</p>	
<p>SECTION: VVV-VVV</p>		<p>THICKNESS: .125</p>	
<p>SECTION: WWW-WWW</p>		<p>THICKNESS: .125</p>	
<p>SECTION: XXX-XXX</p>		<p>THICKNESS: .125</p>	
<p>SECTION: YYY-YYY</p>		<p>THICKNESS: .125</p>	
<p>SECTION: ZZZ-ZZZ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: AAAA-AAAA</p>		<p>THICKNESS: .125</p>	
<p>SECTION: BBBB-BBBB</p>		<p>THICKNESS: .125</p>	
<p>SECTION: CCCC-CCCC</p>		<p>THICKNESS: .125</p>	
<p>SECTION: DDDD-DDDD</p>		<p>THICKNESS: .125</p>	
<p>SECTION: EEEE-EEEE</p>		<p>THICKNESS: .125</p>	
<p>SECTION: FFFF-FFFF</p>		<p>THICKNESS: .125</p>	
<p>SECTION: GGGG-GGGG</p>		<p>THICKNESS: .125</p>	
<p>SECTION: HHHH-HHHH</p>		<p>THICKNESS: .125</p>	
<p>SECTION: IIII-IIII</p>		<p>THICKNESS: .125</p>	
<p>SECTION: JJJJ-JJJJ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: KKKK-KKKK</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: NNNN-NNNN</p>		<p>THICKNESS: .125</p>	
<p>SECTION: OOOO-OOOO</p>		<p>THICKNESS: .125</p>	
<p>SECTION: PPPP-PPPP</p>		<p>THICKNESS: .125</p>	
<p>SECTION: QQQQ-QQQQ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: RRRR-RRRR</p>		<p>THICKNESS: .125</p>	
<p>SECTION: SSSS-SSSS</p>		<p>THICKNESS: .125</p>	
<p>SECTION: TTTT-TTTT</p>		<p>THICKNESS: .125</p>	
<p>SECTION: UUUU-UUUU</p>		<p>THICKNESS: .125</p>	
<p>SECTION: VVVV-VVVV</p>		<p>THICKNESS: .125</p>	
<p>SECTION: WWWW-WWWW</p>		<p>THICKNESS: .125</p>	
<p>SECTION: XXXX-XXXX</p>		<p>THICKNESS: .125</p>	
<p>SECTION: YYYYY-YYYY</p>		<p>THICKNESS: .125</p>	
<p>SECTION: ZZZZ-ZZZZ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: AAAAA-AAAAA</p>		<p>THICKNESS: .125</p>	
<p>SECTION: BBBBB-BBBBB</p>		<p>THICKNESS: .125</p>	
<p>SECTION: CCCCC-CCCCC</p>		<p>THICKNESS: .125</p>	
<p>SECTION: DDDDD-DDDD</p>		<p>THICKNESS: .125</p>	
<p>SECTION: EEEEE-EEEE</p>		<p>THICKNESS: .125</p>	
<p>SECTION: FFFFF-FFFF</p>		<p>THICKNESS: .125</p>	
<p>SECTION: GGGGG-GGGG</p>		<p>THICKNESS: .125</p>	
<p>SECTION: HHHHH-HHHH</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: JJJJJ-JJJJ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: KKKKK-KKKK</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: SSSS-SSSS</p>		<p>THICKNESS: .125</p>	
<p>SECTION: TTTT-TTTT</p>		<p>THICKNESS: .125</p>	
<p>SECTION: UUUU-UUUU</p>		<p>THICKNESS: .125</p>	
<p>SECTION: VVVV-VVVV</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: OOOOO-OOOO</p>		<p>THICKNESS: .125</p>	
<p>SECTION: PPPPP-PPPP</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: TTTTT-TTTT</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: YYYYYY-YYYY</p>		<p>THICKNESS: .125</p>	
<p>SECTION: ZZZZZ-ZZZZ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: AAAAAA-AAAAA</p>		<p>THICKNESS: .125</p>	
<p>SECTION: BBBBBB-BBBBB</p>		<p>THICKNESS: .125</p>	
<p>SECTION: CCCCCC-CCCCC</p>		<p>THICKNESS: .125</p>	
<p>SECTION: DDDDDDD-DDDD</p>		<p>THICKNESS: .125</p>	
<p>SECTION: EEEEEEE-EEEE</p>		<p>THICKNESS: .125</p>	
<p>SECTION: FFFFFFF-FFFF</p>		<p>THICKNESS: .125</p>	
<p>SECTION: GGGGGG-GGGG</p>		<p>THICKNESS: .125</p>	
<p>SECTION: HHHHHH-HHHH</p>		<p>THICKNESS: .125</p>	
<p>SECTION: IIIIIII-IIII</p>		<p>THICKNESS: .125</p>	
<p>SECTION: JJJJJJJ-JJJJ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: KKKKKK-KKKK</p>		<p>THICKNESS: .125</p>	
<p>SECTION: LLLLLL-LLLL</p>		<p>THICKNESS: .125</p>	
<p>SECTION: MMMMM-MMMM</p>		<p>THICKNESS: .125</p>	
<p>SECTION: NNNNN-NNNN</p>		<p>THICKNESS: .125</p>	
<p>SECTION: OOOOO-OOOO</p>		<p>THICKNESS: .125</p>	
<p>SECTION: PPPPP-PPPP</p>		<p>THICKNESS: .125</p>	
<p>SECTION: QQQQQ-QQQQ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: RRRRR-RRRR</p>		<p>THICKNESS: .125</p>	
<p>SECTION: SSSSS-SSSS</p>		<p>THICKNESS: .125</p>	
<p>SECTION: TTTTT-TTTT</p>		<p>THICKNESS: .125</p>	
<p>SECTION: UUUUU-UUUU</p>		<p>THICKNESS: .125</p>	
<p>SECTION: VVVVV-VVVV</p>		<p>THICKNESS: .125</p>	
<p>SECTION: WWWW-WWWW</p>		<p>THICKNESS: .125</p>	
<p>SECTION: XXXXX-XXXX</p>		<p>THICKNESS: .125</p>	
<p>SECTION: YYYYYY-YYYY</p>		<p>THICKNESS: .125</p>	
<p>SECTION: ZZZZZ-ZZZZ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: AAAAAA-AAAAA</p>		<p>THICKNESS: .125</p>	
<p>SECTION: BBBBBB-BBBBB</p>		<p>THICKNESS: .125</p>	
<p>SECTION: CCCCCC-CCCCC</p>		<p>THICKNESS: .125</p>	
<p>SECTION: DDDDDDD-DDDD</p>		<p>THICKNESS: .125</p>	
<p>SECTION: EEEEEEE-EEEE</p>		<p>THICKNESS: .125</p>	
<p>SECTION: FFFFFFF-FFFF</p>		<p>THICKNESS: .125</p>	
<p>SECTION: GGGGGG-GGGG</p>		<p>THICKNESS: .125</p>	
<p>SECTION: HHHHHH-HHHH</p>		<p>THICKNESS: .125</p>	
<p>SECTION: IIIIIII-IIII</p>		<p>THICKNESS: .125</p>	
<p>SECTION: JJJJJJJ-JJJJ</p>		<p>THICKNESS: .125</p>	
<p>SECTION: KKKKKK-KKKK</p>		<p>THICKNESS: .125</p>	
<p>SECTION: LLLLLL-LLLL</p>		<p>THICKNESS: .125</p>	
<p>SECTION: MMMMM-MMMM</p>		<p>THICKNESS: .125</p>	
<p>SECTION: NNNNN-NNNN</p>		<p>THICKNESS: .125</p>	
<p>SECTION: OOOOO-OOOO</p>		<p>THICKNESS: .125</p>	
<p>SECTION: PPPPP-PPPP</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: VVVVV-VVVV</p>		<p>THICKNESS: .125</p>	
<p>SECTION: WWWW-WWWW</p>		<p>THICKNESS: .125</p>	
<p>SECTION: XXXXX-XXXX</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: AAAAAA-AAAAA</p>		<p>THICKNESS: .125</p>	
<p>SECTION: BBBBBB-BBBBB</p>		<p>THICKNESS: .125</p>	
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<p>SECTION: DDDDDDD-DDDD</p>		<p>THICKNESS: .125</p>	
<p>SECTION: EEEEEEE-EEEE</p>		<p>THICKNESS: .125</p>	
<p>SECTION: FFFFFFF-FFFF</p>		<p>THICKNESS: .125</p>	
<p>SECTION: GGG</p>			

# NOTES:

## 1. MATERIAL:

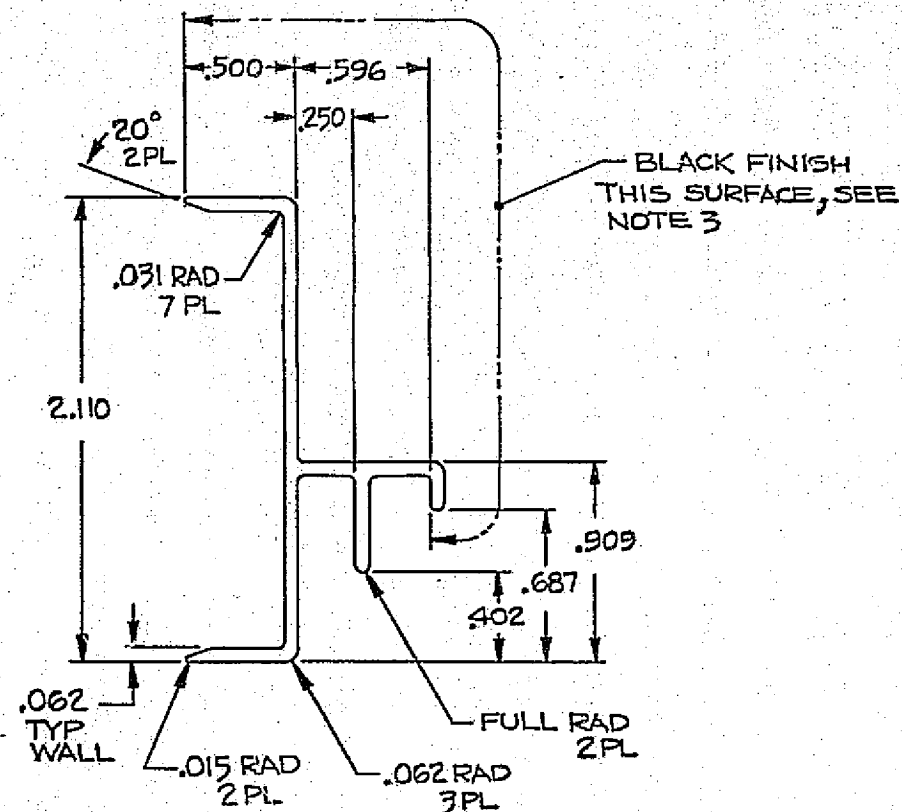
ALUMINUM ALLY EXTRUSION  
CMP5N 6063 TEMPER T5  
DIE SECTION NO. 67106

## 2. VENDOR:

REYNOLDS METALS CO.  
FSCM NO.

## 3. PROTECTIVE FINISH:

CHEM FILM (ALODINE) ENTIRE PART,  
COAT INDICATED AREA WITH  
MARTIN NO. 4 (LUSTERLESS BLACK)  
AIR DRY.



3300 DEBBIE LANE  
SANTA BARBARA, CALIF. 93101  
PHONE 944-0000

**ELEM, INC.**

Continued Sheet No. 79109

TOLERANCES	REVISED	PART NUMBER
UNLESS OTHERWISE SPECIFIED DECIMAL	DATE	CP6
XX ± .01		
XXX ± .02		
ANGULAR ±		
DATE		
VENDOR'S		
STD TOL		
APPLY		

PART NAME  
**ABSORBER RESTRAINT**

THICKNESS 2/1 SEE NOTE 1  
REV 76  
ESP-C6

K-11



7

CASCADE CONTROL  
ELCAM INC.

PUMP

6

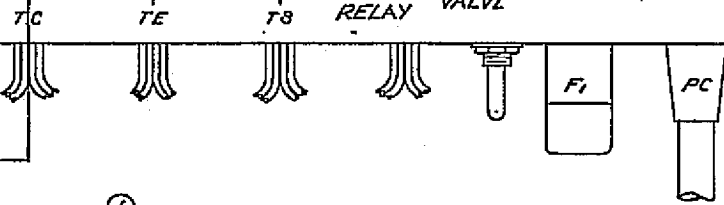
VALVE HEATER OFF HEATER VALVE PUMP PU 1P POWER ON



SENSORS

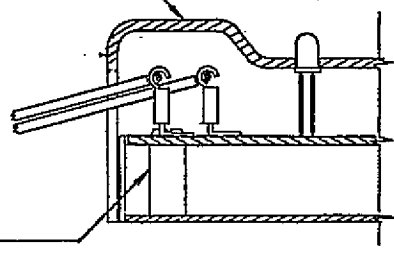
HEATER RELAY VALVE

POWER



A

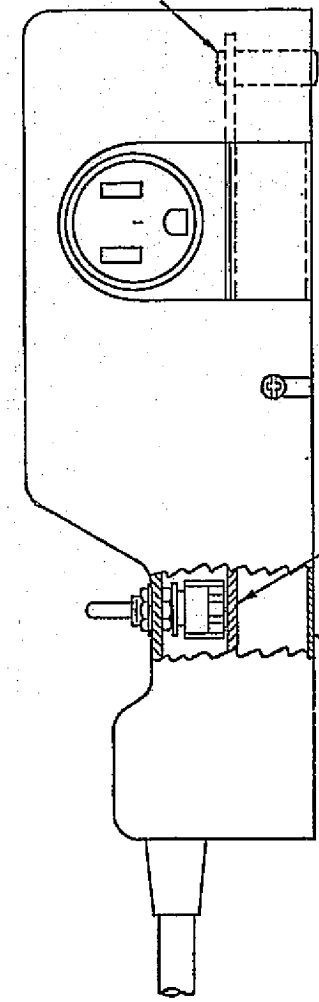
1



2

ITEM	PART NO.	DESCRIPTION	QTY.
1	X52B0-2	COVER	1
2	X52B0-2A	CIRCUIT BOARD ASSY.	1
3	X52B0-4	BASE PLATE	1
4	X52B0-41	STAND-OFF	5
5	X52B0-40	SCREW	5
6	GB-D708-0	SCREW	2
7	X52B0-50	LOGO	1

SECTION A-A



2

3



5200 DEBBIE LANE  
SANTA BARBARA, CALIF. 93111  
PHONE 544-5475

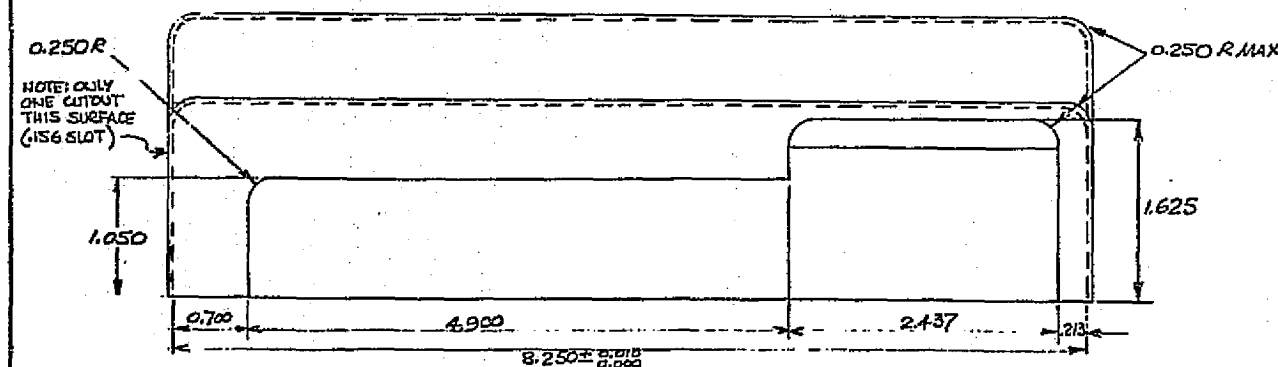
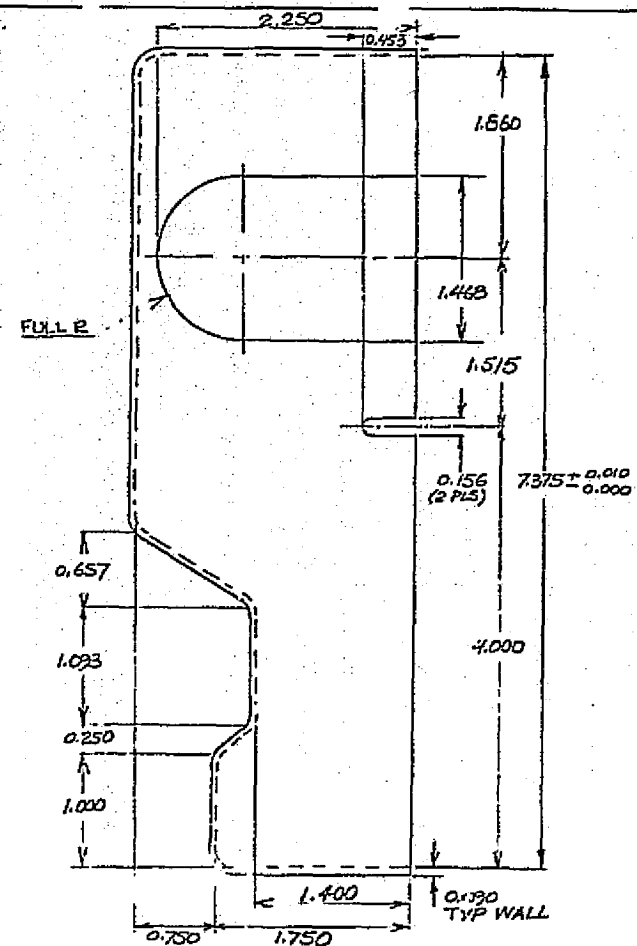
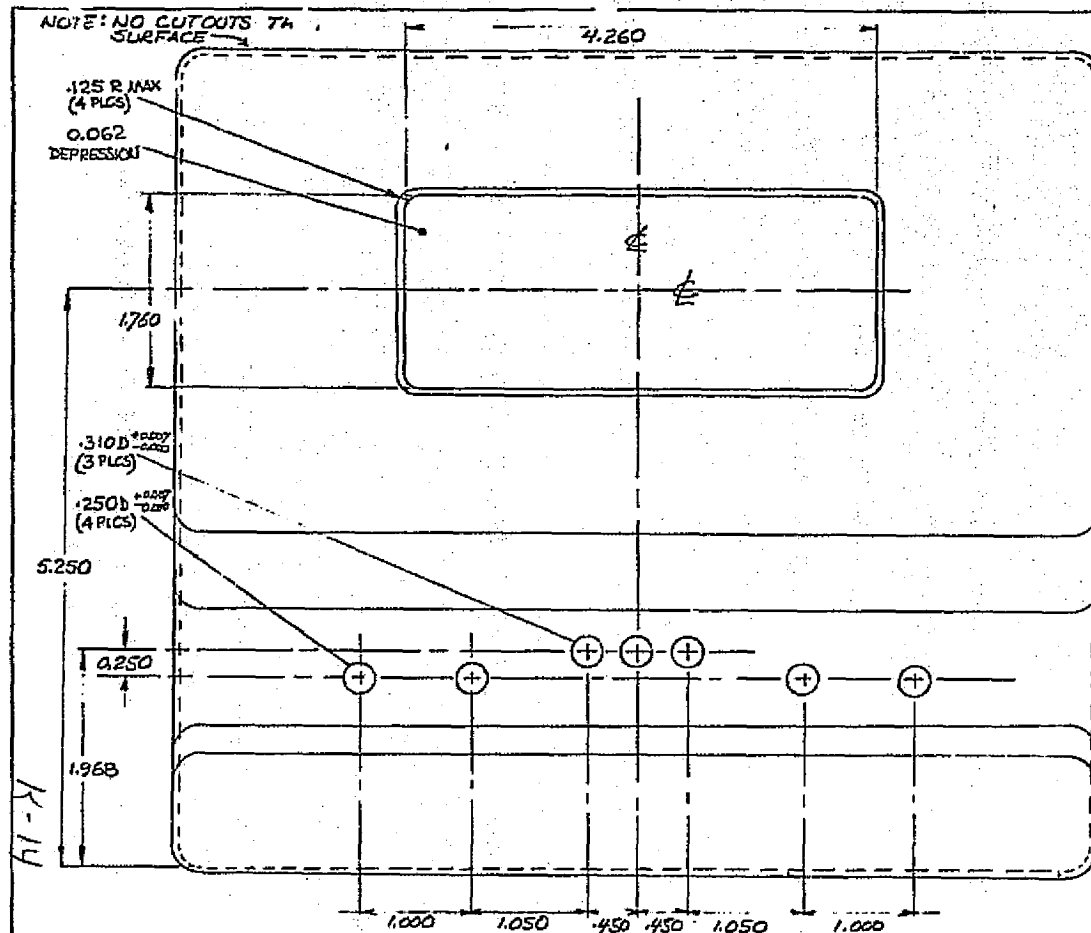
ELCAM, INC.

Company Label No. 214000

TOLERANCES			REVISES			PART NUMBER		
UNLESS OTHERWISE SPECIFIED DECIMAL	NO.	DATE	BY	DATE	BY	PART NAME	SCALE	MATERIAL
XXX 0.00	1					AUTOCONTROL ASSEMBLY	1:1	
ANGULAR 2	2							
DRAFT	3					DRAWN BY TDB	DATE 9-22-76	DATE 9-22-76
	4					CHK'D TCH		
	5					TRACED		
	6					APP'D		

ORIGINAL PAGE IS  
OF POOR QUALITY

K-13

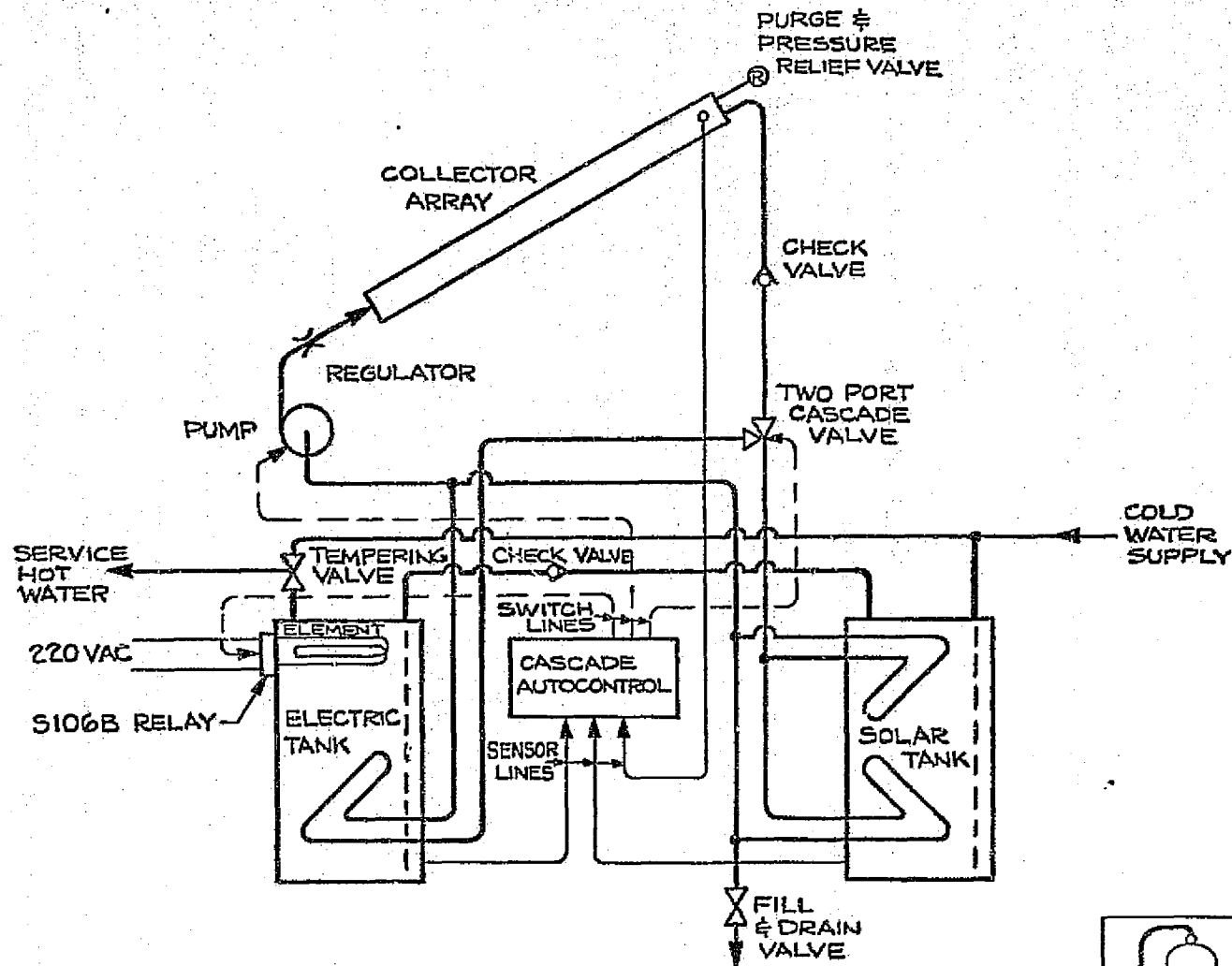


- ② COLOR: BLACK  
① FINISH: HAIRCELL



TOLERANCES		REVISIONS		PART NUMBER	
UNLESS OTHERWISE SPECIFIED	DECIMAL	DATE	BY	ESC-A2	
1	9-24-78	TCH		PART NAME	
2				COVER - AUTOCONTROL	
3				DRAWN BY TCH	
4				CHECKED WRM	
5				DATE 9-21-78	
6				SCALE 1:1	
7				EVALUATION	

K-14

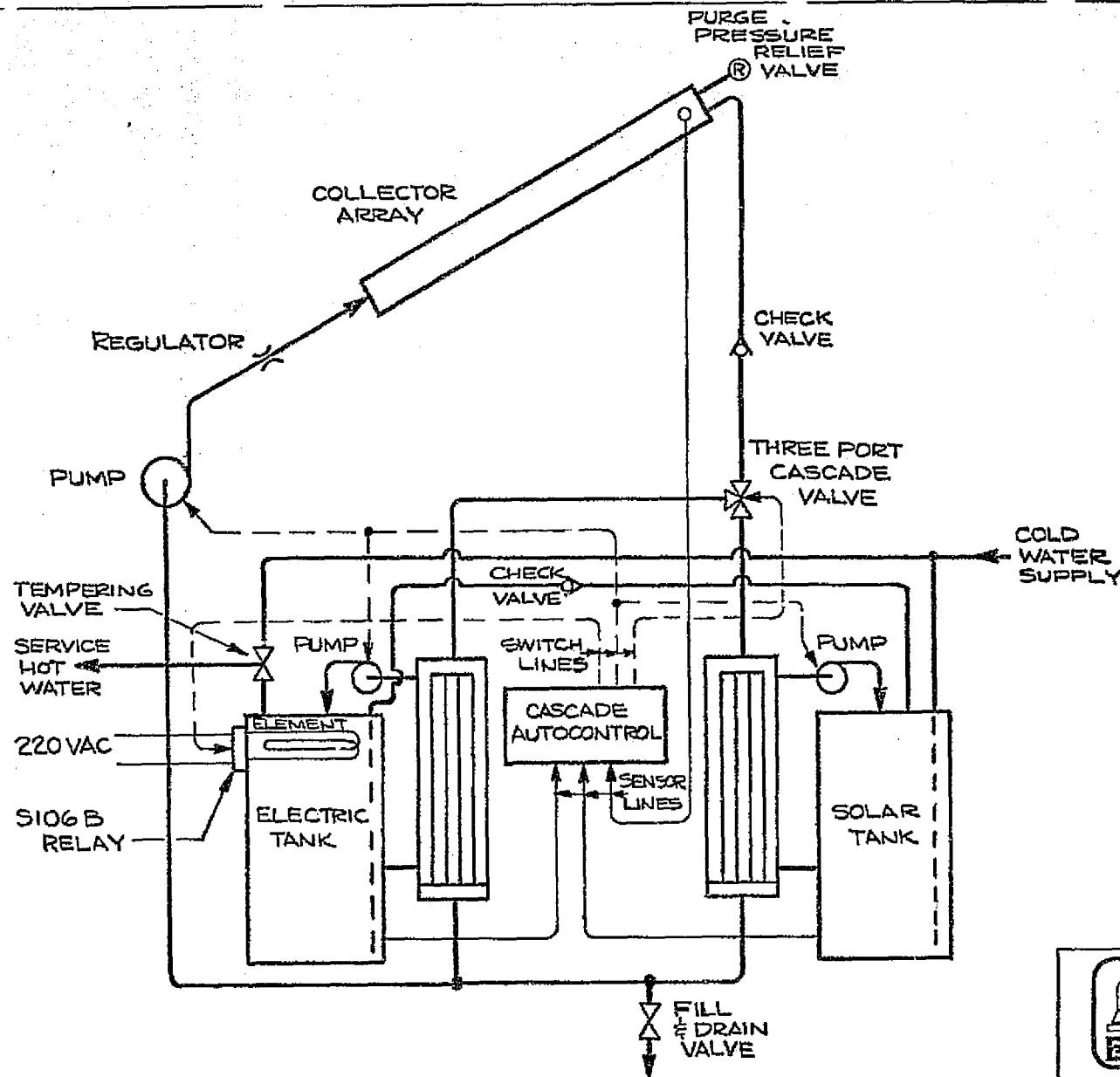


6230 NE 2ND AVE.  
SANTA BARBARA, CALIF. 93111  
PHONE 964-6883

**ELECM, INC.**  
Copyright © 1976

REVISIONS	REVISIONS		PART NUMBER
	NO.	DATE	
1			INTERNAL HEAT EXCHANGER
2			REVISION
3			NOV 76
4			ESS-1

K-15

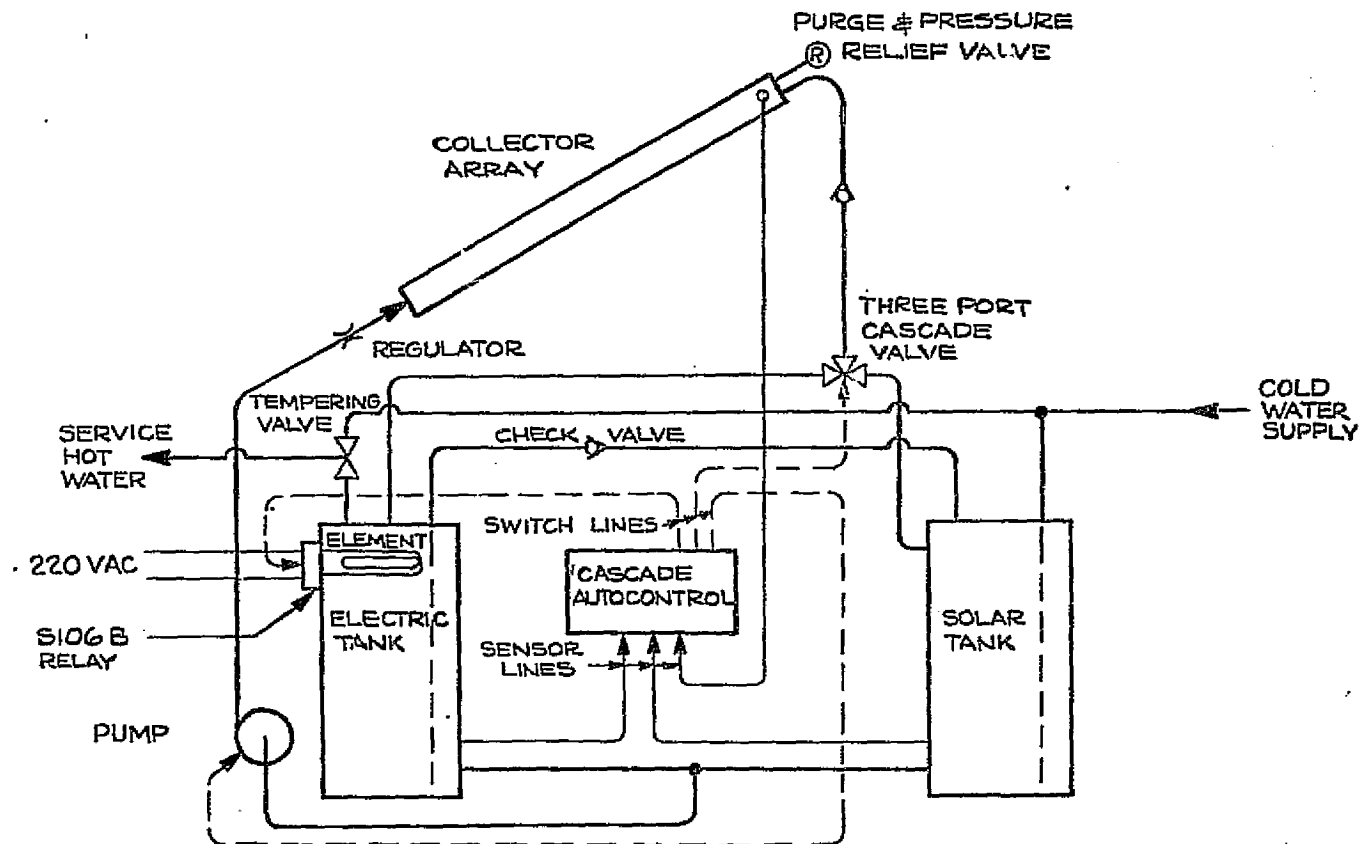


1130 DENVER LANE  
SANTA BARBARA, CALIF. 93101  
PHONE 961-6600

**ELECAM, INC.**  
Construction License No. 95889

TELEVISIONS	REVISED	DATE	BY	PART NUMBER
UNLESS OTHERWISE SPECIFIED BY CHAS. J. JONES, JR. ANGULAR 2 DRAFT	1			PART NAME
	2			<b>EXTERNAL HEAT EXCHANGER</b>
	3			DESIGNER
	4			<b>THORSON</b>
	5			DATE
	6			<b>NOV 76</b>
	7			REVISION
	8			<b>ESS-2</b>

K-16



1120 DEBBE LANE,  
SANTA BARBARA, CALIF. 93101  
PHONE 944-0407

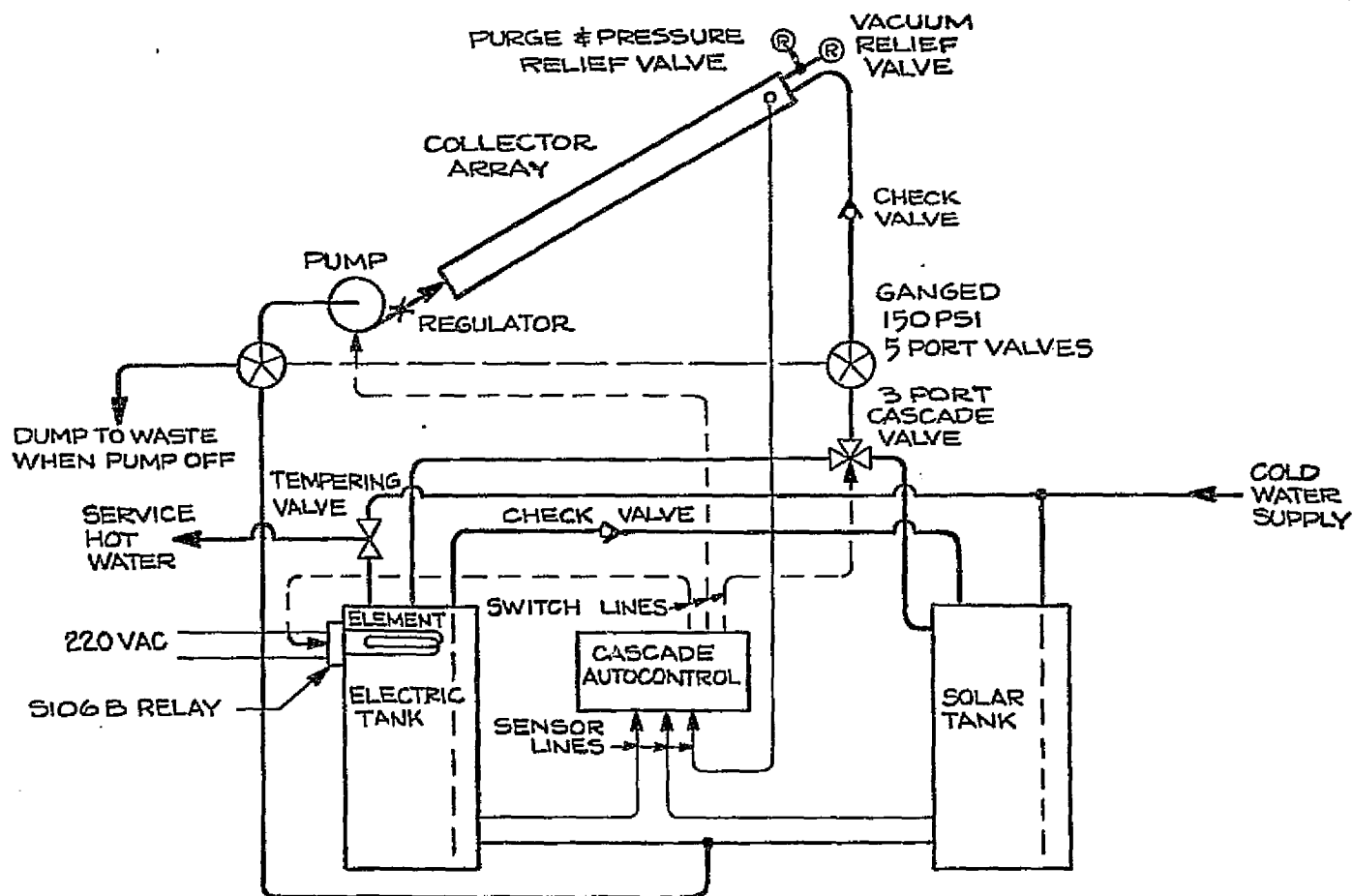
**ELCAM, INC.**  
COMMERCIAL LICENSE NO. 70000

TOLERANCES UNLESS OTHERWISE SPECIFIED DECIMAL AS SHOWN JES 2-68 MODIFIED DRAFT	REVISIONS		PART NUMBER
	NO.	DATE	
	1		PART NAME <b>DIRECT HEATING SYSTEM</b>
	2		DESIGNED BY <b>THOMSON</b> CHECKED BY <b>NOVE</b> MATERIALS BY <b>15 Nov 76</b>
	3		DATE <b>ESS-3</b>

K-17







1130 DESIRE LANE  
SANTA BARBARA, CALIF. 93101  
PHONE 964 0095

**ELECAM, INC.**

Continuation of Form No. 70000

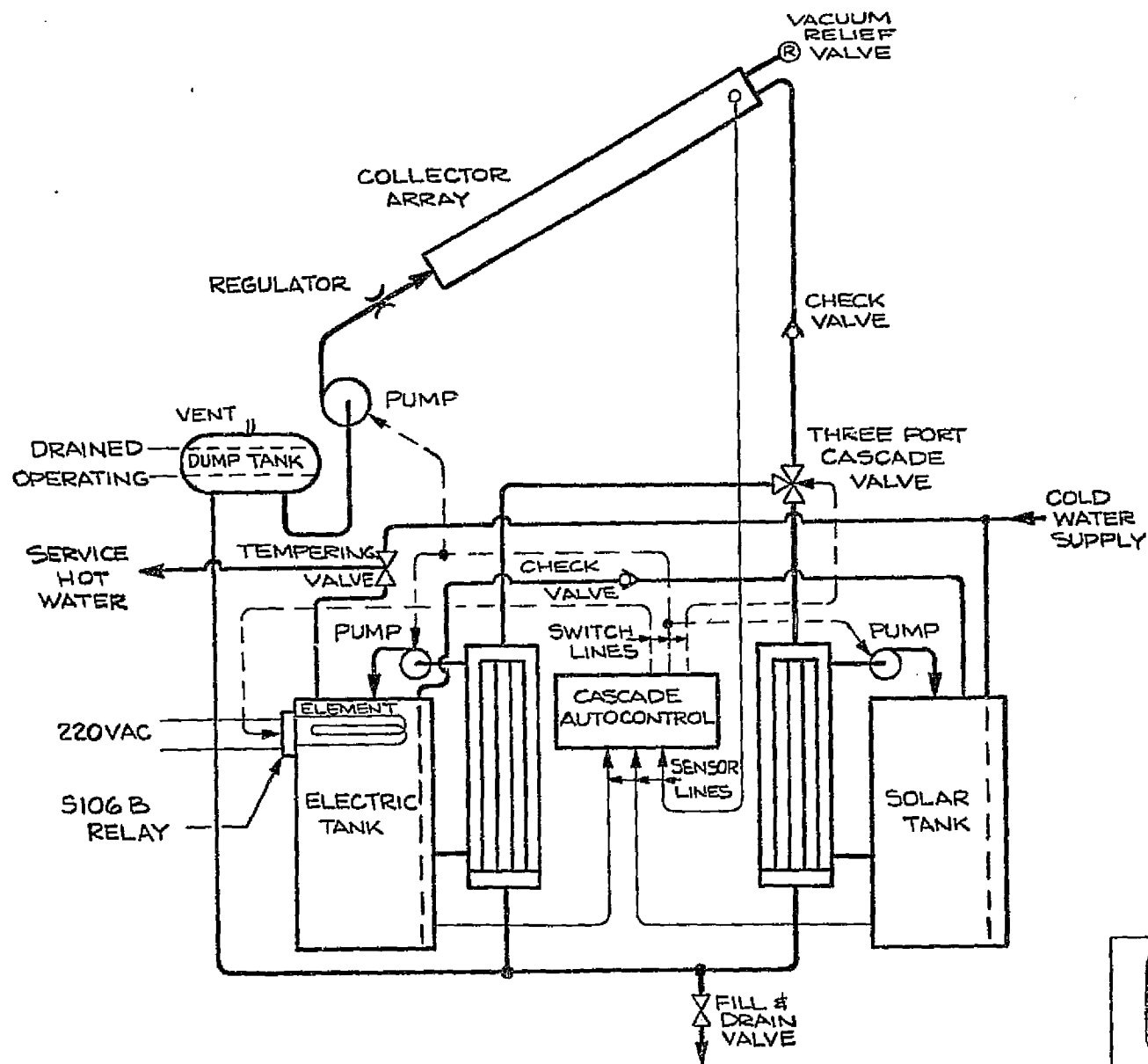
TOLERANCES	WEIGHTS	PART NUMBER
UNLESS OTHERWISE SPECIFIED DECIMAL	IN	DATE
XX ± 0.1	1	
XX ± 0.2	2	
APPLICABLE TO	3	
DRAW	4	
	5	
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PART NAME  
**DIRECT DUMP OPTION**

DATE  
**15 NOV 76**

REVISION  
**ESS-5**

K-19



3200 OLIVER LANE  
SANTA BARBARA, CALIF. 93101  
PHONE 964-0001

**ELECM. INC.**  
Commercial Equipment Division

TOLERANCES		REVISIONS		PART NUMBER
UNLESS OTHERWISE SPECIFIED	DECIMAL	DATE	BY	
1				PART NAME DUMP TANK WITH EXTERNAL HEAT EXCHANGER
2				THOMPSON
3				DATE 15 NOV 76
4				ESS-6

K-20