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15. SUPPLEMENTARY NOTES

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

16. ABSTRACT

This document describes the design of a solar heating and hot water system for the New Castle Redevelopment Authority's single-family dwelling located at New Castle, Pennsylvania.

This package consists of documentation submitted by the contractor for Government review of plans, specifications, cost trade studies and verification status in order to provide the contractor with approval to commit the system to fabrication. Also included in the package are system integration drawings, major subsystems drawings, and architect's specifications and plans.

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CONTENTS

SECTION 1

1.0 COST TRADE STUDIES

A. Energy Conservation and Architectural Features

Energy conserving features were incorporated into the architectural design of the NASA New Castle solar home. The primary areas of concentration were:

- Glazing type and amount.
- Building insulation.
- Control of infiltration.
- Miscellaneous energy-conserving features.

Glass was used selectively in the design of the NASA New Castle solar home to admit light and views while minimizing detrimental effects of heat loss and heat gain. The primary glazing areas face south, and the total window area is only 10.5 percent of the building wall area. Of this glazing, 61 percent (or 160 square feet) occurs on the south elevation. Skylighting has been used selectively to maximize the benefit of natural light while minimizing the glass area. Windows used in the home are double-glazed units manufactured by Andersen Windows, Inc.

Building walls were of 2 x 6 construction with 6" foil-faced fiberglass batts. A tongue and groove styrofoam sheathing is used, giving an overall wall "U" value of 0.04. The roof insulation consists of two batts of 6" fiberglass insulation, with the lower-most batt being foil-faced, resulting in a "U" value of 0.037.

Several techniques are used to control infiltration of outside air. Tongue and groove styrofoam sheathing material has demonstrated effectiveness in control of infiltration on wall surfaces. Andersen window units were selected because of quality construction and minimal infiltration. An entry vestibule is used, which permits the users of the house to close the outer door before opening the inner door, thus minimizing infiltration in this area.

Various other considerations were incorporated into the building design to conserve energy. The building portions were arranged to present the largest wall area facing south. This maximizes the benefits of solar gain during the winter season and minimizes the detrimental effects of solar gain on the east and west elevations during the summer period. The south wall is 1.5 times the length of east or west walls. Studies have shown that this is the optimum building proportion for this climatic zone location. Berming is used selectively on exterior walls to control infiltration and to reduce solar heat gain during the summer. Attic space is adequately vented to minimize the impact of heat loss from the backside of the collectors on the cooling load during the summer portion of the year. In addition, water-saving fixtures are used to conserve water as a natural resource and to save the energy required to provide domestic hot water to the home.

B. Solar Heating System Design Year

A base year for solar and weather data was necessary to run computer simulations for this solar heating system and site location. The site, New Castle, Pennsylvania, is located in the extreme western portion of that state. As there is no weather data available for New Castle, Pennsylvania, nearby cities for which data was available were investigated. Cities on Lake Erie were eliminated due to the effect of the lake on weather data. This reduced the list of weather data locations to two, Pittsburgh, Pennsylvania, and Columbus, Ohio. The weather data available from Pittsburgh dates from the 1950s; however, because of relatively high air pollution levels in Pittsburgh during that time, the data would not provide a good simulation of conditions present in New Castle. Columbus was found to be a very acceptable location from which to obtain weather data. This was based on the following criteria:

- The effect of Lake Erie on Columbus weather should be similar to that for New Castle.
- The affect of local air pollution should also be similar.
- Weather data from the U.S. Army, Navy and Air Force shows that both Columbus and New Castle have the same values for 97½% and 99% design ambient temperatures, 4°F and -1°F respectively.

A Columbus weather tape for the year 1961 was found to be a close approximation of the normal heating season based on a calculation of yearly heating degree days from the weather tape data. A calculation of the annual degree days from the binned ambient temperature data from the 1961 Columbus weather tape is shown in Table 1-1. The bin data was taken from Table 1-6. The calculation indicates a total of 5088 degree days for 1961. This value compares favorably with the normal yearly total of 5211 as stated in the ASHRAE Handbook, 1973 Systems.

Based on the above investigation, the Columbus weather tape for 1961 was selected for use in computer simulations for the New Castle site.

Table 1-1. Degree-Day Calculation - 1961

AMBIENT TEMPERATURE F	TEMPERATURE DIFFERENCE 65 BASE, F	HOURS	DEGREE-HOURS
-10	75	3	225
- 5	70	3	210
0	65	12	780
5	60	29	1,740
10	55	82	4,510
15	50	167	8,350
20	45	151	6,795
25	40	252	10,080
30	35	408	14,280
35	30	676	20,280
40	25	737	18,425
45	20	765	15,300
50	15	722	10,830
55	10	710	7,100
60	5	642	3,210
65	--	---	-----
TOTAL DEGREE-HOURS			112,115

TOTAL DEGREE-DAYS $= \frac{112,115}{24} = 5088$

C. Solar Heating System Simulation and Optimization

The computer simulation for the Stillwater, Minnesota, site provided significant data and performance trends that resulted in the elimination of several variables for the New Castle, Pennsylvania, site. As a result, the following system components and design parameters were determined as final selections to be held constant for tradeoff of other variables:

- Collector tilt angle: 50° (New Castle is at 41°N latitude)
- Storage tank size: 1000 gallons
- Effectiveness of collector loop to water loop heat exchanger: 0.6
- Effectiveness of space heating coil: 0.6
- Flow rates - collector loop: 12 gpm
  - water loop: 8 gpm

A computer simulation model for the building and the solar heating system at the New Castle, Pennsylvania, site was developed. This provided system performance data for the following:

- Indication of the affect of collector area on yearly total solar contribution.
- Tradeoff of storage tank temperature set points for heating from storage mode, based on total solar contribution and auxiliary energy consumption.

Collector Area Selection--The effect of collector area on solar contribution can be seen in Figure 1. The baseline collector area of 504 square feet is shown. As expected, the solar contribution declines sharply for smaller collector areas and rises slowly for larger collector areas. A collector area in the range of the baseline configuration of 504 square feet was chosen as a reasonable compromise between architectual constraints and solar contribution.

Storage Tank Setpoint Temperature Selection--The tradeoff of storage tank setpoint temperature was based on yearly total auxiliary energy consumption by the following:

- Operation of the hydronic solar heating system
- Electrical input to the heat pump
- Electrical input to the auxiliary electric heating coil
- Electrical input to the domestic hot water heater

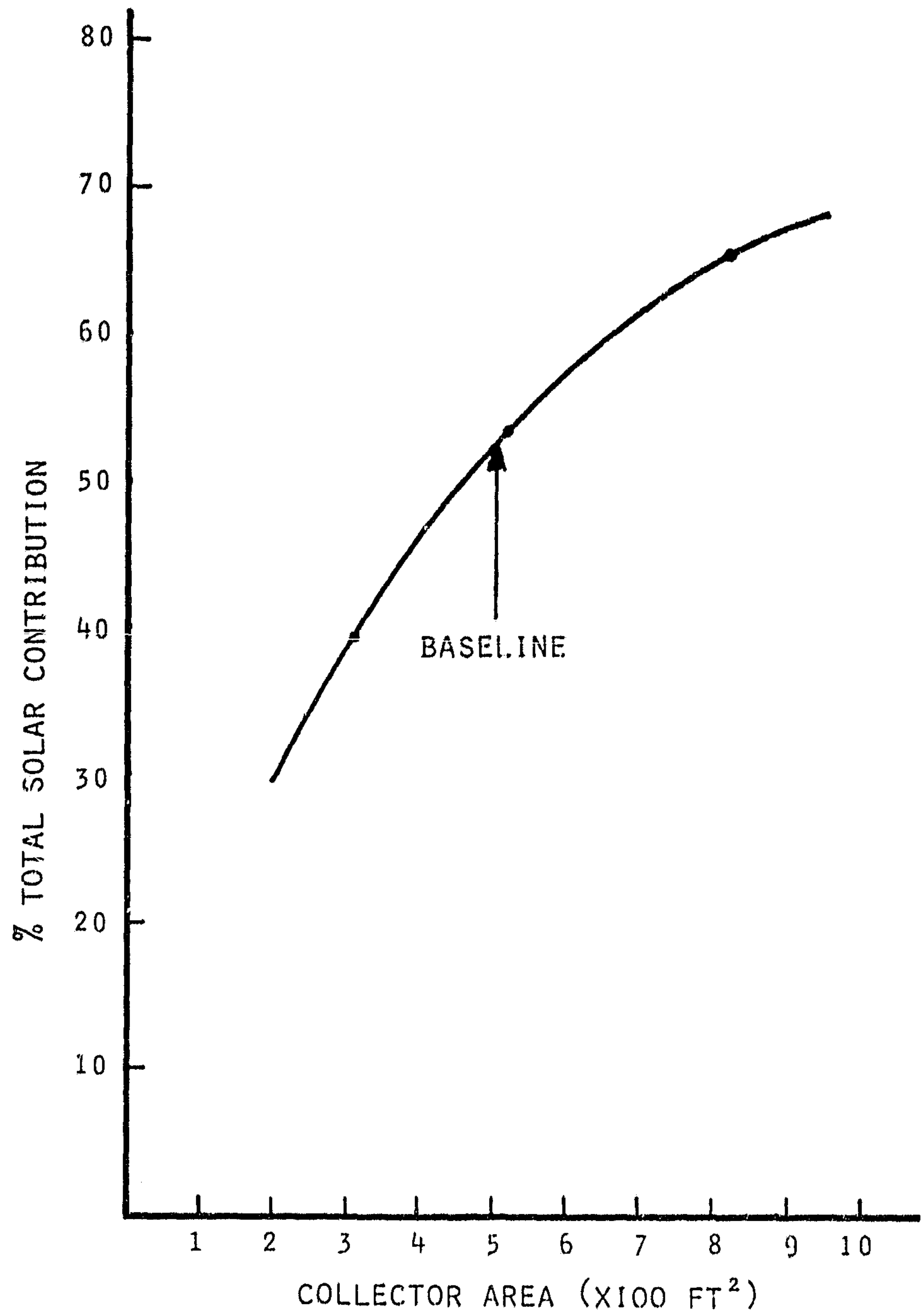


Figure 1. Solar Contribution vs. Collector Area

Results are shown in Table 1-2 and 1-3. Table 1-2 shows the distribution of space heating load and domestic hot water load between solar and auxiliary sources as a function of storage tank setpoint temperature. Table 1-3 shows the effect of storage tank setpoint temperature on yearly auxiliary energy consumption for each subsystem and overall total. The pertinent data is presented in Table 1-4 comparing percent of solar contributions and total auxiliary energy consumption for the various storage tank setpoints. Inspection of the data shows that this is the optimum range of storage tank setpoint temperatures and that the variation in auxiliary energy consumption is only about 1% thru the range. Based on this data, a 100°F setpoint for storage tank temperature was selected to provide the lowest auxiliary energy consumption and a total solar contribution of 53.0%.

Table 1-2 Yearly Space Heating and DHW Load
Supplied by Solar and Auxiliary Sources

Storage Setpoint Temp. (°F)	Space Htg. Load (MBTU)	DHW Load (MBTU)	Solar Contribution Space Htg. (MBTU)	Solar Contribution DHW (MBTU)	Solar Contribution Total (MBTU)	Output from Aux. Energy Sources Heat Pump (MBTU)	Output from Aux. Energy Sources Electric Coil (MBTU)	Output from Aux. Energy Sources DHW (MBTU)
100	48.3	21.0	22.4	14.3	36.7	22.9	3.0	6.7
95	48.3	21.0	23.2	13.9	37.1	22.2	2.9	7.0
90	48.3	21.0	24.0	13.6	37.6	21.4	2.9	7.3

Table 1-3 Yearly Auxiliary Energy Consumption

			100°F		95°F		90°F	
Mode	Operation	KW/Mode	Hours	KW-HRS	Hours	KW-HRS	Hours	KW-HRS
1	Idle	.025	6894	172	6814	170	6713	169
2	Direct Heating	1.095	163	178	163	178	163	178
3	Htg From Storage	.725	544	394	618	448	712	516
4	Charge Storage	.625	920	575	926	579	934	584
5	Purge	.585	212	124	212	124	212	124
	Total Solar Heating System			1443		1499		1571
	Aux Htg. - Heat Pump			3144		3047		2953
	Aux Htg. - Electric Heating Coil			865		856		838
	Total Aux Heating			4009		3903		3791
	DHW Auxiliary Energy			1965		2060		2151
	Total Aux. Energy Consumption			7417		7462		7513

Table 1-4. Yearly Performance Summary

Storage Setpoint Temp. (°F)	% Solar Contribution Space Heating	% Solar Contribution DHW	% Solar Contribution Total	Total Aux Energy KW-HRS
100	46.5%	68.1%	53.0%	7417
95	48.1%	66.5%	53.7%	7462
90	49.7%	65.0%	54.5%	7513

D. Component Selection

The component selection analysis done for the Stillwater, Minnesota, site is valid for the New Castle site in several areas. Therefore, the following component selections are the same as those for Stillwater, Minnesota, site:

- DHW preheat coil
- Pipe insulation
- Storage tank insulation
- Pumps
- The Energy Transport Module will be the same as that for the Stillwater, Minnesota, site, with the only difference being a different control panel as required for the heat pump.
- The space heating coil will also be the same except for a different enclosure to match the heat pump indoor unit.

This leaves the following component selections to be made:

- Heat transfer fluid
- Domestic hot water heater
- Heat pump
- Electric heating coil
- Heat pump indoor unit blower performance

Heat Transfer Fluid Selection--Based on the analysis done for the Stillwater, Minnesota, site, an aqueous ethylene glycol solution was selected as the heat transfer fluid. The ambient temperature data from the weather tape was binned as shown in Table 1-6. This indicates that the minimum ambient temperatures are in the -10°F range. The freezing points of Dowtherm SR-1 solutions are shown in Table 1-5. This indicates that, based on a minimum ambient temperature of -10°F, a 40% solution (minimum) is required. Due to the low cost of a system of this size, a 50% solution has been selected for the collector loop to provide more than adequate protection against freezing.

Table 1-5 Freezing Points of Aqueous Dowtherm SR-1 Solutions

Solution % by Vol SR-1	Freezing Point
20%	+16°F
30%	+ 4°F
33%	0°F
40%	-12°F
44%	-20°F
50%	-34°F
55%	-50°F

Domestic Hot Water Heater--Due to the unavailability of natural gas for the New Castle site, the domestic hot water will be an electric unit. Because electric domestic hot water heaters have a lower recovery rate a 52-gallon model was selected, having a 4500-watt upper element and a 4500-watt lower element. This is a standard size unit in the industry.

Heat Pump--The heat pump unit selection for the New Castle site was based on the peak cooling load. Table 1-7 indicates the peak cooling load to be 31,400 BTU/hr, just over 2½ tons. This verifies the need for a 2½-ton heat pump. The above analysis is accepted practice in the HVAC industry and results in a unit that provides efficient cooling and good latent heat capacity in the summer, which is necessary for an energy efficient dwelling such as that at the New Castle, Pennsylvania, site. Heating output of the heat pump declines as outside ambient temperature falls. As a result, an auxiliary electric resistance heating coil is required to meet space heating loads at lower ambient temperatures. Performance of the heat pump and the rest of the Auxiliary Energy and Space Heating Subsystem is shown on installation drawing SK-142102.

Table 1-6. Ambient Temperature Bin Data

TEMP BINS - HOURS WHEN THE TEMP (IN DEGF) IS WITHIN THE RANGE

RANGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
-17.5	0	0	0	0	0	0	0	0	0	0	0	0	0
-12.5	3	0	0	0	0	0	0	0	0	0	0	0	3
-7.5	3	0	0	0	0	0	0	0	0	0	0	0	3
-2.5	11	0	0	0	0	0	0	0	0	0	0	1	12
2.5	14	3	0	0	0	0	0	0	0	0	0	12	29
7.5	53	6	0	0	0	0	0	0	0	0	0	23	82
12.5	115	5	0	0	0	0	0	0	0	0	0	47	167
17.5	86	19	0	0	0	0	0	0	0	0	5	41	151
22.5	70	65	4	0	0	0	0	0	0	0	28	85	252
27.5	92	60	22	16	0	0	0	0	0	5	87	126	408
32.5	112	150	97	25	4	0	0	0	3	7	121	157	676
37.5	102	135	99	148	28	0	0	0	4	33	77	111	737
42.5	65	59	164	162	73	1	0	0	9	80	88	64	765
47.5	15	52	124	105	83	28	0	0	19	148	105	43	722
52.5	3	59	82	96	113	54	16	3	34	138	92	20	710
57.5	0	38	59	61	120	74	18	20	63	108	73	8	642
62.5	0	14	72	60	156	96	53	87	58	89	19	7	711
67.5	0	4	17	26	68	147	156	170	106	51	11	0	756
72.5	0	3	4	12	58	126	177	176	161	34	8	0	759
77.5	0	0	0	9	34	94	137	115	89	43	6	0	527
82.5	0	0	0	0	7	50	115	129	79	8	0	0	388
87.5	0	0	0	0	0	47	54	44	79	0	0	0	224
92.5	0	0	0	0	0	3	18	0	16	0	0	0	37
97.5	0	0	0	0	0	0	0	0	0	0	0	0	0
102.5	0	0	0	0	0	0	0	0	0	0	0	0	0
107.5	0	0	0	0	0	0	0	0	0	0	0	0	0

HOURS WHEN THERE WAS ZERO TEMP 5
HOURS WHEN THE TEMP WAS LESS THAN MIN 0
HOURS WHEN THE TEMP WAS GREATER THAN MAX 0

```
RANGE    TOTAL
 -17.5      0
 -12.5      3
  -7.5      3
  -2.5     12 *
   2.5     29 **
   7.5     82 *****
  12.5    167 ***********
  17.5    151 **********
  22.5    252 ****************
  27.5    408 ***************************
  32.5    676 *********************************************
  37.5    737 *************************************************
  42.5    765 ***************************************************
  47.5    722 ************************************************
  52.5    710 ***********************************************
  57.5    642 *******************************************
  62.5    711 ***********************************************
  67.5    756 **************************************************
  72.5    759 ***************************************************
  77.5    527 ***********************************
  82.5    388 **************************
  87.5    224 ***************
  92.5     37 **
  97.5      0
 102.5      0
 107.5      0
```

FOLDOUT FRAME 2 1

complished plate which le heat The I sealed with ile to tubes permanently ng high effi pecial black re radiation d on rubber e-metal con ifaces of the hat increase mpored, low ly strong In cover frame The collector ith a electro pletely lined both beneath en mounting ts installation re shipped in r has only to desired and eturn lines.

SR-1, produced a 50 50 ratio by cent heat trans therm should be uded.

ckel:

.54 in. i.d.)

5-5 Solder 18 fpt

3 to .7 gpm

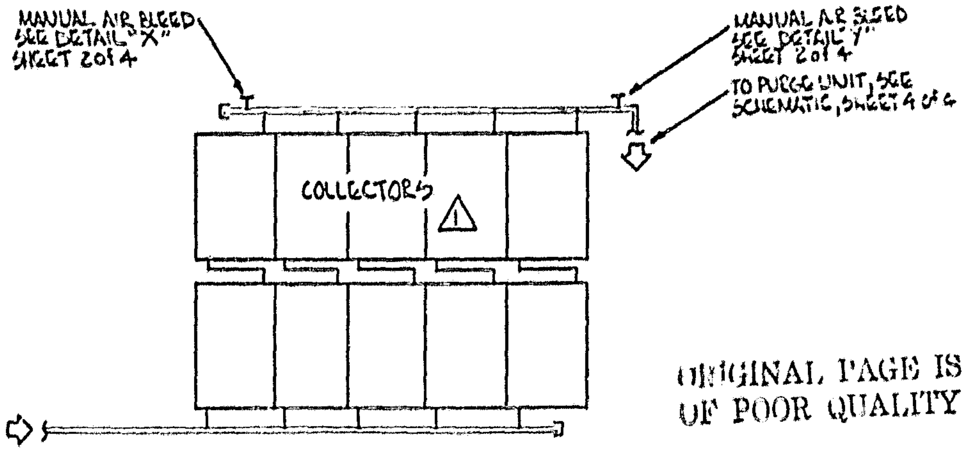
ivalent):

(at 160°F)

ft² (at 200°F)

out outgassing) ge)

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



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SCHEMATIC COLLECTOR SUBSYSTEM
NO SCALE

MATERIAL SCHEDULE

ITEM NO.	ITEM	MANUFACTURER	TYPE / PART NO.	QUAN.
1	COLLECTOR	LENNOX IND.	LSC-18-1S	28
2	PURGE COOLING UNIT	LENNOX IND.	HRW-1-130	1
3	HEADER ASSEMBLY	HONEYWELL	SK-142064	
4	HOSE KIT	HONEYWELL	SK-142066	11
5	COUPLING NOM. 3/8 fpt × 5/8" (HDR. TO COL.)	AEROQUIP	4738-6-6 (S or B)	34
6	COUPLING NOM. 3/8 fpt × 5/8 (COL. TO COL.)	AEROQUIP	FF462-0606B	22
* 7	INSULATION (3/4" THICK)	ARMSTRONG CORK CO.	ARMAFLEX	AS REQ'D
* 8	COPPER END CAPS NOM. 1" & 1 1/4"	NIBCO	617-1, -1 1/4	1 EACH
* 9	INSULATION ADHESIVE	ARMSTRONG CORK CO.	520	AS REQ'D
* 10	INSULATION WEATHERPROOFING	ARMSTRONG CORK CO.	ARMAFLEX FINISH	AS REQ'D
* 11	FLOW BALANCING VALVE	BELL & GOSSET	CB 1 (CB-1 1/4)	1 EACH
* 12	TEMPERATURE WELLS	PETERSON EQUIP. CO.	110	
* 13	FITTING REDUCER NOM. 1"×3/4" & 1 1/4"×3/4"	NIBCO	600-2-1×3/4, -1 1/4×3/4	3 EACH
* 14	FITTING DRAIN COUPLING NOM. 3/4"	NIBCO	701-2-D-3/4	4
* 15	FITTING PLUG NOM. 3/4"	NIBCO	616-3/4	2
* 16	BALL VALVE	NIBCO	S-580-1 (S-580-1 1/4)	1 EACH
* 17	PIPE COMPOUND		WHITE BAKERSEAL	AS REQ'D

* ITEMS LISTED "OR EQUIVALENT"

UNRELEASED DRAWING NOT ... TO E.C.O. CONTROL

NEXT ASSY	USED ON	TOLERANCES UNLESS NOTED OTHERWISE .X ± .XX ± .XXX ± ANGLES	DRAFTSMAN / CHECKER / DEV ENGR / ENGRG MGT	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
APPLICATION		MATERIAL	CONTRACT NO.	SINGLE FAMILY RESIDENCE COLLECTOR SUBSYSTEM	
		FINISH—SEE NOTE	NEWCASTLE	SIZE C, CODE IDENT NO. 55513	DRAWING NO. SK-142101
				SCALE NONE	SHEET 1 OF 4

CONTROL

Table 1-7. Heating and Cooling Load Bin Data

LOAD BINS - HOURS WHEN THE LOAD (IN BTUS) IS WITHIN THE RANGE

RANGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
-39000.0	0	0	0	0	0	0	0	0	0	0	0	0	0
-37000.0	0	0	0	0	0	0	0	0	0	0	0	0	0
-35000.0	0	0	0	0	0	0	0	0	0	0	0	0	0
-33000.0	0	0	0	0	0	0	0	0	0	0	0	0	0
-31000.0	0	0	0	0	0	1	1	0	1	0	0	0	3
-29000.0	0	0	0	0	0	0	3	2	3	0	0	0	8
-27000.0	0	0	0	0	0	3	2	3	8	0	0	0	16
-25000.0	0	0	0	0	0	1	4	7	8	0	0	0	20
-23000.0	0	0	0	0	0	2	4	7	9	0	0	0	22
-21000.0	0	0	0	0	1	4	11	7	19	2	0	0	42
-19000.0	0	0	0	1	4	10	10	9	35	11	0	0	79
-17000.0	0	0	1	0	3	8	18	18	48	22	0	0	116
-15000.0	0	2	1	0	2	17	31	[illegible]	42	14	1	0	137
-13000.0	0	1	2	4	6	32	53	72	52	21	1	0	241
-11000.0	0	3	3	3	7	33	67	74	54	17	3	0	262
-9000.0	0	5	8	5	17	49	90	86	46	15	3	0	322
-7000.0	1	9	8	11	28	69	113	75	60	22	12	2	407
-5000.0	5	10	8	10	32	70	78	68	47	24	17	4	367
-3000.0	9	7	20	10	41	54	32	36	21	23	13	5	269
-1000.0	14	7	29	21	45	38	16	2	16	31	23	6	246
1000.0	38	57	128	141	241	212	185	230	171	176	92	35	1705
3000.0	12	45	65	75	89	46	9	10	21	68	74	24	563
5000.0	26	48	81	73	76	40	16	4	33	81	80	36	592
7000.0	43	55	85	84	37	23	4	1	9	91	69	52	551
9000.0	57	66	114	110	75	13	0	0	14	74	71	67	660
11000.0	68	77	74	76	25	0	0	0	2	34	73	76	503
13000.0	76	93	53	74	19	0	0	0	3	16	63	109	504
15000.0	82	86	51	15	1	0	0	0	2	6	52	103	398
17000.0	60	43	13	8	0	0	0	0	0	3	54	75	255
19000.0	59	34	3	2	0	0	0	0	0	0	15	45	157
21000.0	59	20	0	0	0	0	0	0	0	0	8	46	133
23000.0	60	3	0	0	0	0	0	0	0	0	0	26	89
25000.0	39	4	0	0	0	0	0	0	0	0	0	17	60
27000.0	21	3	0	0	0	0	0	0	0	0	0	14	38
29000.0	6	0	0	0	0	0	0	0	0	0	0	6	12
31000.0	8	0	0	0	0	0	0	0	0	0	0	1	9
33000.0	3	0	0	0	0	0	0	0	0	0	0	0	3
35000.0	1	0	0	0	0	0	0	0	0	0	0	0	1
37000.0	0	0	0	0	0	0	0	0	0	0	0	0	0
39000.0	0	0	0	0	0	0	0	0	0	0	0	0	0

```
HOURS WHEN THERE WAS ZERO LOAD 1143
HOURS WHEN THE LOAD WAS LESS THAN MIN     0
HOURS WHEN THE LOAD WAS GREATER THAN MAX     0
PEAK LOAD  0.3525E 05  BTU/HR
ON   25    1
AMBIENT TEMP   -12.00  F
PEAK LOAD -0.3140E 05  BTU/HR
ON   11    9
AMBIENT TEMP    89.00  F
```

```
   RANGE      TOTAL
-39000.0         0
-37000.0         0
-35000.0         0
-33000.0         0
-31000.0         3
-29000.0         8
-27000.0        16
-25000.0        20 •
-23000.0        22 •
-21000.0        42 •
-19000.0        79 ••
-17000.0       116 •••
-15000.0       137 ••••
-13000.0       241 •••••••
-11000.0       262 ••••••••
 -9000.0       322 •••••••••
 -7000.0       407 ••••••••••••
 -5000.0       367 •••••••••••
 -3000.0       269 ••••••••
 -1000.0       246 •••••••
  1000.0      1705 ••••••••••••••••••••••••••••••••••••••••••••••••••••
  3000.0       563 ••••••••••••••••
  5000.0       592 •••••••••••••••••
  7000.0       551 ••••••••••••••••
  9000.0       660 •••••••••••••••••••
 11000.0       503 •••••••••••••••
 13000.0       504 •••••••••••••••
 15000.0       398 ••••••••••••
 17000.0       255 •••••••
 19000.0       157 •••••
 21000.0       133 ••••
 23000.0        89 •••
 25000.0        60 ••
 27000.0        38 •
 29000.0        12
 31000.0         9
 33000.0         3
 35000.0         1
 37000.0         0
 39000.0         0
```

COOLING

HEATING

Electric Heating Coil--The electric heating coil is sized to satisfy 100% of the design heating load. This will provide a backup source of heat in the event of a break down of the heat pump. Table 1-7 shows the heating load data for the year separated into load bins. The peak heating load was 35,250 BTU/hr. This resulted in selection of a Lennox electric heating coil with a rating of 39,600 BTU/hr at 220V.

Blower Performance--Airflow rate thru the heat pump indoor unit blower was selected at 1275 cfm. This was based on the following criteria:

- Analysis done for the Stillwater, Minnesota, site resulted in a flow rate of 1000 cfm for that site. The design of the house for the New Castle Pennsylvania site enabled the selection of 1275 cfm as the design air-flow rate. This will enhance slightly the performance of the solar space heating coil.
- Within recommended range for Lennox 2 1/2 ton heat pump to provide proper performance on both heating and cooling.
- Blower will deliver 1275 cfm at Med-High fan speed while providing at least 0.2 in W.G. external static pressure to overcome ductwork friction losses.

Document F3437-D-102
29 June 1977
Revised 7 July 77

SOLAR HEATING AND COOLING DEVELOPMENT PROGRAM

Verification Status
for
Operational Sites at
Stillwater, Minnesota
and
New Castle, Pennsylvania

A
Single Family Residence
Heating System

Contract NAS8-32093

Honeywell Inc.
Energy Resources Center
2600 Ridgway Parkway
Minneapolis, Minnesota 55413

Prepared by: Allen J Baldwin

Approved by: Glen L Merrill

2.0 VERIFICATION STATUS SUMMARY SINGLE FAMILY HEATING

A. General

Heating system design and development verification is the process of proving that the components and the system meet applicable physical and functional requirements as set forth in the Interim Performance Criteria (ref. Section II of the contract Statement of Work) and the System Performance Specification.

This document summarizes the present status of verification for a single family heating system.

Attached to this summary report are verification matrices for each of the functional subsystems in the heating system. Each matrix relates applicable subsystem and system performance requirements (interim criteria) to select verification methods. Each Interim performance criteria paragraph in the matrix has been, or is to be, verified by similarity, analysis, test or inspection. In the development and qualification phases, all verification is by similarity, analysis, test or inspection. In the development and qualification phases, all verification is by similarity, analysis or test. In the acceptance phase all verification is by inspection or test.

B. Matrices

On the attached matrices the method of verification is indicated by the following code:

1, = similarity
2, = analysis
3, = inspection
4, = test

The present status of each verification item is indicated by a code as follows:

C = complete
I = incomplete

ITEM (NAME & PART NO.) Collector Subsystem	VERIFICATION CROSS REFERENCE MATRIX	WBS 1.2.2.1.1

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 1.3.1 Efficiency	4-C	1-C	3, 4 -I	
IPC 2.1.2 Noise or Erosion-Corrosion Analysize Fluid Velocity	2-C	2-C	3-I	
IPC 2.1.3 Operating Conditions (P & T) Check Against ASHRAE Code	2-C	2-C	3-I	
IPC 2.1.4 Fluid Flow in Collectors Check Manifolding.	2-C	2-C	3-I	
IPC 2.2.5 Thermal Changes Check Thermal Stresses	2-C	2-C	3-I	
IPC 3.1.1 Applicable Standards HUD MPS & ANSI Structural STDS	2-C	2-C	3-I	
IPC 3.2.1 Ultimate Load Combinations Stress Analysis	2-C	2-C	3-I	
IPC 3.2.2 Ice Loads Stress Analysis	2-C	2-C	3-I	

PF01-3?9c

ITEM (NAME & PART NO.) Collector Subsystem	VERIFICATION CROSS REFERENCE MATRIX	WBS 1.2.2.1.1

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 3.3.1 Resistance to Damage Service Life Analysis	2-I	2-I	3-I	
IPC 3.3.2 Glasing Design MPS & ANSI A119.1 Compliance	2-C	2-C	3-I	
IPC 3.4.1 Deflection Limitations	2-C	2-C	3-I	
IPC 3.8.1 Foundation Settlement	2-I	2-I	3-I	
IPC 3.9.1 Design Provisions Effects of Ponding	2-C	2-C	3-I	
IPC 5.1.4 Dirt Retention	1-C	1-C	3-I	
IPC 5.1.5 Abrasive Wear	1-C	1-C	3-I	
IPC 5.1.6 Fluttering by Wind	1-C	1-C	3-I	
IPC 5.2.3 Thermal Cycling Stresses	1-C	1-C	3-I	
IPC 5.2.4 Leakage	1-C	1-C	3-I	
IPC 5.2.5 Deterioration of Gaskets and Seals	1-C	1-C	3-I	

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ITEM (NAME & PART NO.)

Collector Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.1

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 5.3.1 Metals/Transfer Fluid Compatability	1-C	1-C	3-I	
IPC 5.3.2 Corrosion of Dissimilar Metals	2-C	2-C	3-I	
IPC 5.3.3 Corrosion by Leachable Substances	2-C	1-C	3-I	
IPC 5.3.4 Effects of Decomposition Products	2-C	1-C	3-I	
IPC 11.2.1 Chemical Corrosion Effect on Building	2-I	1-I	3-I	
IPC 11.2.2 Heat and Moisture Effect on Building	2-I	2-I	3-I	
IPC 11.3.1 Material Compatibility-Connectors	2-I	2-I	3-I	
IPC 6.1.1 Access for Subsystem Maintenance	1-C	2-C	3-I	
IPC 6.1.2 Access for Subsystem Monitoring	1-C	2-C	3-I	
IPC 6.2.1 Install. Instructions	1-I	2-I	3-I	

ITEM (NAME & PART NO.) Collector Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.1

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 6.2.2 Maintenance & Operation Instructions	1-I	2-I	3-I	
IPC 6.2.3 Maintenance Plan	1-I	2-I	3-I	
IPC 6.2.4 Replacement Parts and Tools	1-I	2-I	3-I	

ITEM (NAME & PART NO.) Collector Qual. Tests

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.3.1

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 2.3.1 Pressure Test	2-C	4-C	3-I	
IPC 3.1.2 Service Loads	2-C	4-C	3-I	
IPC 3.7.1 Hail Size and Loading	2-C	4-C	3-I	
IPC 5.1.1 Solar Degradation	2-C	4-C	3-I	
IPC 5.1.3 Airborne Pollutants	2-C	4-C	3-I	
IPC 5.2.1 Thermal Degradation	2-C	4-C	3-I	
IPC 5.2.6 Transmission Losses Due to Out Gassing	2-C	4-C	3-I	

*All inspections will be on components.

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ITEM (NAME & PART NO.) Storage Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.2

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 1.4.1 Storage Capacity & Rate	2-C	1-C	3-I	
IPC 1.5.1 Heat Loss	2-C	1-C	3-I	
IPC 2.1.3 Operating Conditions	2-C	1-C	3-I	
IPC 2.1.6 Thermal Expansion	2-C	1-C	3-I	
IPC 2.2.4 Vacuum Relief	1-C	1-C	3-I	
IPC 2.2.5 Thermal Changes	1-C	1-C	3-I	
IPC 2.2.6 Flexible Joints	1-C	1-C	3-I	
IPC 2.3.1 Pressure/Leak Test	1-C	1-C	3-I	
IPC 2.6.3 Fluid Treatment	1-C	1-C	3-I	
IPC 2.8.1 Relief Valves & Vents	1-C	1-C	3-I	
IPC 4.1.1 Plumbing Codes & Standards	1-C	1-C	3-I	
IPC 4.3.1 Fire Standards	1-C	1-C	3-I	

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ITEM (NAME & PART NO.)
Storage Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.2

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 4.7.1 Heat Protection	1-C	1-C	3-I	
IPC 6.1.1 Access for Mainten-ance	1-C	1-C	3-I	
IPC 6.1.2 Access for Monitor-ing	1-C	1-C	3-I	
IPC 6.1.3 Draining & Filling	1-C	1-C	3-I	
IPC 6.1.4 Flushing of Liquids	1-C	1-C	3-I	
IPC 6.2.1 Install. Instructions	1-C	2-C	3-I	
IPC 6.2.2 Operation Instructions	1-C	2-C	3-I	
IPC 6.2.3 Maintenance Plan	1-C	2-C	3-I	
IPC 6.2.4 Replacement Parts	1-C	2-C	3-I	
IPC 6.3.1 Ease of Maintenance	1-C	2-C	3-I	

ITEM (NAME & PART NO.) Heating Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.3

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 1.1.1 Heating Design Temps.	1-C	1-C	3-I	
IPC 2.1.1 Equip. Capabilities	4-C	2-C	3-I	
IPC 2.2.5 Thermal Changes	1-C	1-C	1-I	
IPC 2.2.6 Flexible Joints	1-C	1-C	3-I	
IPC 2.3.1 Pressure Test	1-C	1-C	3-I	
IPC 2.6.1 Liquid Quality	1-C	1-C	3-I	
IPC 2.6.3 Fluid Treatment	1-C	1-C	3-I	
IPC 2.6.4 Freezing Protection	1-C	1-C	3-I	
IPC 2.7.1 Appl. Plumbing Stds	1-C	1-C	3-I	
IPC 4.1.1 Plumbing Codes & Stds	1-C	1-C	[illegible]	
IPC 4.1.2 Elect. Codes & Stds	1-C	1-C	[illegible]	
IPC 5.2.4 Leakage	1-C	1-C	3-I	
IPC 5.3.1 Matl. /Trans. Fluid Corp	1-C	1-C	3-I	

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ITEM (NAME & PART NO.)
Heating Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.3

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 6.2.1 Inst. Instr.	1-C	1-C	3-I	
IPC 6.2.2 M/D Manual	1-C	1-C	3-I	
IPC 6.2.3 Maintenance Plan	1-C	1-C	3-I	
IPC 6.2.4 Replacement Parts	1-C	1-C	3-I	
IPC 6.3.1 Maintenance of H Systems	1-C	1-C	3-I	

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ITEM (NAME & PART NO.)
Auxillary Energy Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.4

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 1.8.1 Design Loads	1-C	1-C	3-I	
IPC 2.1.1 Equipment Capabilities				

ITEM (NAME & PART NO.) Hot Water Subsystem	VERIFICATION CROSS REFERENCE MATRIX	WBS 1.2.2.1.5

VERIFICATION METHOD: 1. [illegible] 2. ANALYSIS [illegible] N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 1.2.1 Water Design [illegible]	[illegible]	1-C		
IPC 1.2.2 [illegible] Des. [illegible]		1-C		
IPC 1.2.3 [illegible]	[illegible]	1-C	[illegible]	
IPC 1.2.4 [illegible]	[illegible]	1-C	[illegible]	
IPC 1.5.1 Heat or Humidity Transfer Effects	[illegible]	1-C	[illegible]	
IPC 1.7.4 Hot Water Temp.	[illegible]	1-C	[illegible]	
IPC 1.8.1 Design Loads (Aux. Backup)	[illegible]	1-C	[illegible]	
IPC 2.1.2 Noise-Erosion Corrosion	1-C	1-C	[illegible]	
IPC 2.1.3 Operating Conditions	1-C	1-C	[illegible]	
IPC 2.1.6 Thermal Expansion of Fluids	1-C	1-C	[illegible]	
IPC 2.1.7 Pressure Drops	1-C	1-C	[illegible]	

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ITEM (NAME & PART NO.) Hot Water Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.5

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 2.2.1 Vibration Stress Levels	1-C	1-C	3-I	
IPC 2.2.3 Water Hammer	1-C	1-C	3-I	
IPC 2.3.1 Pressure Test: Non-potable Fluids	1-C	1-C	3-I	
IPC 2.3.2 Pressure Test: Potable	1-C	1-C	3-I	
IPC 2.5.1 Shutdown in Multi-Family Housing	1-C	1-C	3-I	
IPC 2.6.1 Liquid Quality	1-C	1-C	3-I	
IPC 2.8.1 Relief Valves & Vents	1-C	1-C	3-I	
IPC 4.2.1 System Failure Prevention	1-C	1-C	3-I	
IPC 4.2.2 Auto. Pres. Relief Valves	1-C	1-C	3-I	
IPC 4.6.1 Contamination by Materials	1-C	1-C	3-I	

ITEM (NAME & PART NO.) Hot Water Subsystem	VERIFICATION CROSS REFERENCE MATRIX			WBS 1.2.2.1.5
VERIFICATION METHOD:	1. SIMILARITY 2. ANALYSIS	3. INSPECTION 4. TEST	N/A NOT APPLICABLE	
PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 4.6.2 Separation of Circulation Loops	1-C	1-C	3-I	
IPC 4.6.3 Backflow Prevention	1-C	1-C	3-I	
IPC 4.7.1 Protection from Heated Components	1-C	1-C	3-I	
IPC 5.2.3 Thermal Cycling Stresses	1-C	1-C	3-I	
IPC 5.2.4 Leakage	1-C	1-C	3-I	
IPC 5.2.5 Deterioration of Gaskets & Sealants	1-C	1-C	3-I	
IPC 5.3.1 Materials/Transfer Fluid Compatibility	1-C	1-C	3-I	
IPC 5.3.2 Corrosion of Dissimilar Materials	1-C	1-C	3-I	
IPC 5.4.1 Wear and Fatigue (Watts Valve)	1-C	1-C	3-I	
IPC 6.1.1 Accessibility for Maint. & Service	1-C	1-C	3-I	

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ITEM (NAME & PART NO.) Hot Water Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.5

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 6.1.3 Draining & Filling of Liquids	1-C	1-C	3-1	
IPC 6.1.4 Flushing of Liquid System	1-C	1-C	3-I	
IPC 6.1.6 Potable Water Shut-off	1-C	1-C	3-1	
IPC 6.2.1 Install. Instructions	1-C	1-C	3-I	
IPC 6.2.2 Oper. Instructions	1-C	1-C	3-I	
IPC 6.2.3 Maint. Plan	1-C	1-C	3-1	
IPC 6.2.4 Replacement Parts	1-C	1-C	3-I	
IPC 6.3.2 Maint. of DHW System	1-C	1-C	3-I	

ITEM (NAME & PART NO.)
Energy Transport Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.6

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 1.1.5 Operational Impairment (H, H, C)	1-C	1-C	3-I	
IPC 1.2.4 Operational Impairment (DHW)	1-C	1-C	3-I	
IPC 1.5.1 Heat or Humidity Transfer Effects	1-C	1-C	3-I	
IPC 1.6.1 Thermal Losses & Electrical Power	2-C	2-C	3-I	
IPC 2.1.1 Equip. Capabilities	2-C	2-C	3-I	
IPC 2.1.2 Noise or Erosion Corrosion	2-C	2-C	3-I	
IPC 2.1.6 Thermal Expansion of Fluids	2-C	2-C	3-I	
IPC 2.1.7 Pressure Drops	2-C	2-C	3-I	
IPC 2.1.3 Operating Conditions	1-C	1-C	3-I	
IPC 2.1.5 Entrapped Air	1-C	1-C	3-I	
IPC 2.2.1 Vibrating Stress Levels	1-C	1-C	3-I	

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ITEM (NAME & PART NO.) Energy Transport Subsystem	VERIFICATION CROSS REFERENCE MATRIX	WBS 1.2.2.1.6

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 2.2.3 Water Hammer	1-C	1-C	3-I	
IPC 2.2.4 Vacuum Relief Protection	1-C	1-C	3-I	
IPC 2.2.5 Thermal Changes	1-C	1-C	3-I	
IPC 2.2.6 Flexible Joints	1-C	1-C	3-I	
IPC 2.2.2 Vibration from Moving Parts	1-C	1-C	3-I	
IPC 2.3.1 Pressure Test Non-potable Fluids	1-C	1-C	3-I	
IPC 2.6.1 Liquid Quality	1-C	1-C	3-I	
IPC 2.6.3 Fluid Treatment	1-C	1-C	3-I	
IPC 2.6.4 Freezing Protection	1-C	1-C	3-I	
IPC 2.7.1 Applicable Plumbing Standards	2-C	2-C	3-I	
IPC 2.8.1 Relief Valves & Vents	1-C	1-C	3-I	
IPC 3.5.1 Design Provisions	2-C	2-C	3-I	

ITEM (NAME & PART NO.) Energy Transport Sub-system

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.6

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 4.1.1 Plumbing Codes & Standards	1-C	1-C	3-I	
IPC 4.2.2 Automatic Pressure Relief Valves	1-C	1-C	3-I	
IPC 4.3.1 Applicable Fire Standards	1-C	1-C	3-I	
IPC 4.3.2 Penetrations Thru Fire-Related Assemblies	1-C	1-C	3-I	
IPC 4.4.1 Provision of Catch Basins	1-C	1-C	3-I	
IPC 4.4.2 Detection of Toxic & Flammable Fluids	1-C	1-C	3-I	
IPC 4.5.1 Emergency Egress & Access	1-C	1-C	3-I	
IPC 4.5.2 Identifications and Location of Controls	1-C	1-C	3-I	
IPC 4.6.1 Contamination by Materials	1-C	1-C	3-I	

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ITEM (NAME & PART NO.) Energy Transport Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.6

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 4.6.2 Separation of Circulation Loops	1-C	1-C	3-I	
IPC 4.6.3 Backflow Prevention	1-C	1-C	3-I	
IPC 4.7.1 Protection from Heated Components	1-C	1-C	3-I	
IPC 5.1.2 Soil Corrosion	1-C	1-C	3-I	
IPC 5.1.3 Airborne Pollutants	1-C	1-C	3-I	
IPC 5.2.1 Thermal Degradation	1-C	1-C	3-I	
IPC 5.2.2 Deterioration of Heat Transfer. Fluids	1-C	1-C	3-I	
IPC 5.2.3 Thermal Cycling Stresses	1-C	1-C	3-I	
IPC 5.2.4 Leakage	1-C	1-C	3-I	
IPC 5.2.5 Deterioration of Gaskets and Sealants	1-C	1-C	3-I	
IPC 5.3.1 Materials/Transfer Fluid Compatibility	1-C	1-C	3-I	

ITEM (NAME & PART NO.) Energy Transport Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1 2.2.1.6

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 5.3.2 Corrosion of Dissimilar Materials	1-C	1-C	3-I	
IPC 5.3.3 Corrosion by Leachable Substances	1-C	1-C	3-I	
IPC 5.4.1 Wear & Fatigue	1-C	1-C	3-I	
IPC 6.1.1 Access for System Maintenance	1-C	1-C	3-I	
IPC 6.1.2 Access for System Monitoring	1-C	1-C	3-I	
IPC 6.1.3 Draining & Filling of Liquids	1-C	1-C	3-I	
IPC 6.1.4 Flushing of Liquid Subsystems	1-C	1-C	3-I	
IPC 6.1.6 Potable Water Shutoff	1-C	1-C	3-I	
IPC 6.2.1 Install. Instructions	1-C	1-C	3-I	
IPC 6.2.2 Maintenance & Operation Instructions	1-C	1-C	3-I	
IPC 6.2.3 Maintenance Plan	1-C	1-C	3-I	

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ITEM (NAME & PART NO.)

Energy Transport Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.6

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 6.2.4 Replacement Parts	1-C	1-C	3-I	
IPC 6.3.1 Maintenance of H & HC Systems	1-C	1-C	3-I	
IPC 6.3.2 Maintenance of DHW Systems	1-C	1-C	3-I	

ITEM (NAME & PART NO.)	VERIFICATION CROSS REFERENCE MATRIX	
Control Subsystem		WBS 1.2.2.1.7

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 1.7.1 Installation and Maintenance	2,4 -C	2-C	3-I	
IPC 1.7.2 Manual Adjustment	2,4 -C	2-C	3-I	
IPC 1.7.3 Inhabited Space Temp. Control	2,4 -C	2-C	3-I	
IPC 1.7.4 Hot Water Temp.	2,4 -C	2-C	3-I	
IPC 2.2.5 Thermal Changes	1-C	2-C	3-I	
IPC 2.[illegible] Shutdown Multi Unit	1-C	2-C	3-I	
IPC 3.5.1 Design Provisions	1-C	2-C	3-I	
IPC 4.1.2 Electrical Codes	1-C	2-C	3-I	
IPC 4.2.1 System Failure Prevention	4-C	2-C	3-I	
IPC 4.3.1 Applicable Fire Standards	2-C	2-C	3-I	
IPC 4.3.2 Penetrations - Fire Rated Assemblies	2-C	2-C	3-I	

ITEM (NAME & PART NO.)
Control Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.7

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 4.5.2 Ident. and Location	2-C	2-C	3-I	
IPC 4.6.1 Contamination by Materials	1-C	2-C	3-I	
IPC 5.2.1 Thermal Degradation	1-C	2-C	3-I	
IPC 5.2.3 Thermal Cycling Stresses	1-C	2-C	3-I	
IPC 5.2.5 Deterioration of Gaskets and Sealants	1-C	2-C	3-I	
IPC 5.3.1 Materials/Transfer Fluid Compatibility	1-C	2-C	3-I	
IPC 5.3.2 Corrosion of Dis-similar Materials	1-C	2-C	3-I	
IPC 5.4.1 Wear and Fatigue	1-C	2-C	3-I	
IPC 6.1.1 Access for Maint.	1-C	2-C	3-I	
IPC 6.2.1 Install. Instructions	1-C	2-C	3-I	
IPC 6.2.2 Maintenance and Operation Instructions	1-C	2-C	3-I	

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ITEM (NAME & PART NO.) Control Subsystem	VERIFICATION CROSS REFERENCE MATRIX	WBS 1.2 2.1.7
VERIFICATION METHOD:	1. SIMILARITY 2. ANALYSIS	3. INSPECTION 4. TEST N/A NOT APPLICABLE

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 6.2.3 Maintenance Plan	1-C	2-C	3-I	
IPC 6.2.4 Replacement Parts	1-C	2-C	3-I	
IPC 6.3.1 Servicing H & HC	1-C	2-C	3-I	
IPC 6.3.2 Servicing HW	1-C	2-C	3-I	

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Page 1 of 1

ITEM (NAME & PART NO.)
Site Collection
Date System

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.8

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
n/a				

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ITEM (NAME & PART NO.) Electrical Subsystem

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.9

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 4.1.2 Electrical Codes	1-C	1-C	3-I	
IPC 8.3.2 Electrical Connections	1-I	1-I	3-I	
IPC 8.3.3 Lightning Protection	2-I	2-I	3-I	

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ITEM (NAME & PART NO.)

System Integration

VERIFICATION CROSS REFERENCE MATRIX

WBS 1.2.2.1.10

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 9.2.1. Loads	1-I	2-I	3-I	
IPC 9.2.2 Penetration of Structural Members	1-I	2-I	3-I	
IPC 9.3.1 Structural Connections	1-I	2-I	3-I	
IPC 9.3.3 Strength & Stiffness	1-I	2-I	3-I	

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ITEM (NAME & PART NO.)
System Development and Verification

VERIFICATION CROSS REFERENCE MATRIX

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 1.1.1 Heating Design Temp.	N/A	N/A	3	
IPC 1.1.3 RH & Water Vapor Pressure	N/A	N/A	3	
IPC 1.1.4 Solar Contribution	N/A	N/A	4	
IPC 1.1.5 Operation Impairment	N/A	N/A	3	
IPC 1.2.1 Draw & Temperature Design O/P (HW)	N/A	N/A	3	
IPC 1.2.3 Solar Contribution	N/A	N/A	4	
IPC 1.5.1 Heat or Humidity Transfer Effects	N/A	N/A	3	
IPC 1.8.1 Design Heat Loads (Aux.)	N/A	N/A	3	
IPC 2.3.3 Air Transport Systems	N/A	N/A	3	
IPC 2.4.2 Mutual Shadowing	N/A	N/A	3	
IPC 2.6.2 Air Quality	N/A	N/A	3	
IPC 3.2.3 Vehicular Loads	N/A	N/A	3	

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ITEM (NAME & PART NO.)
System Development and verification

VERIFICATION CROSS REFERENCE MATRIX

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

PERFORMANCE REQUIREMENT	VERIFICATION PHASE			REMARKS
	DEVELOPMENT	QUALIFICATION	ACCEPTANCE	
IPC 3.5.1 Design Provisions	N/A	N/A	3	
IPC 3.6.1 Deflection Limitations	N/A	N/A	3	
IPC 3.8.2 Foundation Settlement	N/A	N/A	3	
IPC 4.3.2 Penetrations	N/A	N/A	3	
IPC 4.5.1 Emergency Egress & Access	N/A	N/A	3	
IPC 6.1.5 Filters	N/A	N/A	3	
IPC 7.1 Design	N/A	N/A	3	
IPC 8.1 Interference with Mech. Operation	N/A	N/A	3	
IPC 9.1 Structural Integrity	N/A	N/A	3	
IPC 10.1 Safety	N/A	N/A	3	
IPC 11.1 Durability and Reliability	N/A	N/A	3	
IPC 12.1 Maintainability	N/A	N/A	3	

3.0 DRAWINGS AND HONEYWELL/GOVERNMENT FURNISHED EQUIPMENT LIST

Installation drawings of all single family heating subsystems are included in appendices A through K. Appendix A is entitled System Integration and serves as a top drawing for the subsystem designed by Honeywell, it lists the requirements for integration of the subsystems into the site and dwelling.

The installation drawings included in appendices A through K delineate the material needed to install the Solar Heating System. Only part of the material shown on these drawings will be furnished by Honeywell for NASA.

To assist the architect in preparation of the request for bids, the list of Honeywell/Government furnished equipment was compiled. This list is shown in the following table.

HONEYWELL-GOVERNMENT FURNISHED EQUIPMENT

REF.: NAS8-32093
TOP DWG. NO.: SK- 142106
DATE: August 1, 1977
REVISED:

Single Family Residence

SYSTEM: Solar Heating LOCATION: New Castle, Pennsylvania

SUBSYSTEM	QUANTITY	UNIT DESCRIPTION	PART NO.	MANUFACTURER
Collector	28	Solar Collector	LSC-18-1	Lennox Industries
	6	Header Assembly	SK-142064-3C	Honeywell
	2	Header Assembly	SK-142064-3B	Honeywell
	6	Header Assembly	SK-142064-2C	Honeywell
	11	Hose Assembly	SK-142066	Honeywell
	34	3/8 npt Coupling	4738-6-6	Aeroquip
	22	3/8 npt Coupling	FF1162-0606B	Aeroquip
	1	Purge Cooling Unit	HRW-1-130	Lennox Industries
Storage	1	Tank-Hot Water Storage	SK 142008A	Honeywell
Auxiliary Energy & Space Heat	1	Space Heating Coil	CW 31-45	Lennox Industries
	1	Heat Pump Outdoor Unit	HP10-311V	Lennox Industries
	1	Heat Pump Indoor Unit	CBP10-41	Lennox Industries
	1	Refrigerant Line Set	L10-41-30	Lennox Industries
	1	Electric Heating Coil	ECB10-41-471	Lennox Industries
Domestic Hot Water	1	Heating-Hot Water	52-KP-10	Lochinvar
	1	Valve-Mixing	70 A - 3/4"	Watts Req.
Energy Transport	1	Module-Energy Transport	SK-142065	Honeywell
	20 gal.	Dowtherm SR-1		
Control	1	Aquastat	L6008C1065	Honeywell
	1	Aquastat	L4008B1013	Honeywell
	1	Thermostat	T872C1004	Honeywell
	1	Sub Base	Q672B1004	Honeywell
	1	Valve	V4331A1003	Honeywell

HONEYWELL-GOVERNMENT FURNISHED EQUIPMENT

REF.: NAS8-32093
TOP DWG. NO.: SK- 142106
DATE: August 1, 1977
REVISED:

Single Family Residence

SYSTEM: Solar Heating LOCATION: New Castle, Pennsylvania

SUBSYSTEM	QUANTITY	UNIT DESCRIPTION	PART NO.	MANUFACTURER
Control	1	Sensor Shield	SK-142067	Honeywell
	3	Sensor	C773B1005	Honeywell
	2	Wells	122555B	Honeywell
	1	Case assembly	112892F	Honeywell
	1	Controller - Diff Temp.	R7412	Honeywell
	2	Thermostats - Outdoor	P-8-10715	Lennox Industries
	1	Mounting Box	M-1595	Lennox Industries
	1	Bulb Guard	107323A	Honeywell
Site Data Acq.	1	Site Data Acq. Module		
	1	Junction Box & Cable Assy		
	1	Sensor - Total Radiation	I001	
	1	Sensor - Outdoor Ambient DB Temperature	T001	
	1	Sensor - Collector Inlet Temp	T100	
	1	Sensor - Coll. Diff. Temp.	TD101	
	1	Sensor - HX Solar Inlet Temp	T102	
	1	Sensor - HX Solar Differential Temp.	TD103	
	1	Sensor - HX HW Inlet Temp.	T200	
	1	Sensor - HX HW Diff. Temp.	TD201	
	1	Sensor - Storage Tank Temp. Top	T202	
	1	Sensor - Storage Tank Temp - Middle	T203	
	1	Sensor - Storage Tank Temp. - Bottom	T204	
	1	Sensor - Dom. CW Temp.	T300	

HONEYWELL-GOVERNMENT FURNISHED EQUIPMENT

REF.: NAS8-32093
TOP DWG. NO.: SK-142106
DATE: August 1, 1977
REVISED:

Single Family Residence

SYSTEM: Solar Heating LOCATION: New Castle, Pennsylvania

SUBSYSTEM	QUANTITY	UNIT DESCRIPTION	PART NO.	MANUFACTURER
Site Data Acq.	1	Sensor - Solar DHW Diff. Temp.	TD301	
	1	Sensor - Htg Coil HW Inlet Temp.	T400	
	1	Sensor - Heating Coil HW Diff. Temp.	TD401	
	1	Sensor - Space Return Air Temp.	T600	
	1	Sensor - Htg Coil Air Inlet Temp.	T601	
	1	Sensor - Htg Coil Air Diff. Temp.	TD602	
	1	Sensor - Space Supply Air Temperature	T603	
	1	Sensor - Coll. Flow Rate	W100	
	1	Sensor - Strg. Flow Rate	W200	
	1	Sensor - DHW Flow Rate	W300	
	1	Sensor - Htg Coil Flow Rate	W400	
	1	Sensor - Coll Pump Pwr	EP100	
	1	Sensor - Heat Rej Fan Pwr	EP101	
	1	Sensor - Strg Pump Pwr	EP200	
	1	Sensor - Dom HW Htr Pwr	EP300	
	1	Sensor - Htg Pump Pwr	EP400	
	1	Sensor - Elec Htr & Fan Pwr	EP401	
	1	Sensor - Heat Pump Pwr	EP402	

SECTION 2

Honeywell

ENERGY RESOURCES CENTER CODE IDENTIFICATION NO. 55513

HONEYWELL REQUIREMENTS SPECIFICATION NO. HRS SK-140021

THIS HONEYWELL REQUIREMENTS SPECIFICATION IS FOR:

System Performance Specifications

SIGNATURES	DATE
PREPARED BY	
APPROVED BY PROJECT ENGINEER	

REVISIONS

LTR	DESCRIPTION	DATE	APPROVAL	LTR	DESCRIPTION	DATE	APPROVAL
A	Madison, WI to Stillwater, MN Appendix A	6-30-77					
B	New Castle, PA Sections A-4 A-5 A-6	8-3-77					

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REVISION																	HRS										

HH-64

Specification No. SFRH-1
Page Date 6 February, 1976
Page 1 of 4
Revised 30 June, 1977
Revised 3 August, 1977

SYSTEM INDENTIFICATION

This Appendix defines the performance and installation drawings for Residential Heating System, Honeywell Inc., System Model Number SFR-756H-2.

SYSTEM PERFORMANCE SHEETS

Site-
The system shall be installed in a residence in the city of New Castle, in the county of Lawrence, state of Pennsylvania.

Heating Capacity-
The system will provide solar energy for 46.5% of the average total heating load[1] during the heating season[2] based on an average total heating load of 4.0×10^6 BTU/Month[3] and a peak heating load of 35,250 BTU/Hour on January 25, 1961 (-12°F).

Auxiliary Energy-
The average rate of auxiliary energy input used for heating shall be no greater than 2.6×10^6 BTU/Month of the total energy required for heating, including hot water.[4] This shall be no greater than 4% of the total energy required for heating.[5]

Footnotes:

1. Yearly heating (or cooling) load minus auxiliary supplied for heating (or cooling) divided by the yearly total heating (or cooling) load.

2. Based on the number of months that have a heating (or cooling) load.

3. Total yearly heating (or cooling) load divided by the number of months that have a heating (or cooling) load.

4. Average monthly auxiliary energy is the total auxiliary for heating and hot water (or cooling) divided by the number of months that have auxiliary for heating and hot water (or cooling).

5. Average monthly auxiliary energy divided by total yearly load for heating and hot water (or cooling).

SYSTEM PERFORMANCE SPECIFICATION

Specification No. SFRH-1
Page Date 6 February 1976
Page 2 of 4
Revised 30 June 1977
Revised 3 August 1977

Hot Water-
52 gallons of potable (or usable) hot water shall be delivered at no less than 3 gal/min at temperatures no less than 140°F. Recovery time shall be no greater than 1.3 hours. The average hot water heating load will be 1.8×10^6 BTU/Month of which 32 % is provided by auxiliary energy.

Operating Requirements-
The maximum electrical energy required to drive only the solar portion of the system at its rated capacity shall be no greater than .63 KW. The maximum electrical energy required to drive the complete system shall be no greater than 1.1 KW. The average yearly electrical energy, including auxiliary energy, required to drive the system shall be no greater than 7420 KWH.

Physical Data - Table III
The following subsystems shall have:

	Expected life no less than:	Weight (filled) no greater than:	Installation dimensions:
Heating	10 yrs.	34 lbs.	28" x 21" x 14"
Cooling	NA	NA	NA
Auxiliary Energy			
- Heat Pump Indoor Unit	10 yrs.	214 lbs.	28" x 21" x 53 1/2"
- Heat Pump Outdoor Unit	10 yrs.	325 lbs.	48 1/8" x 21 3/8" x 30 1/2"
Storage	10 yrs.	9500 lbs.	64" xia. x 72 " long
Potable Water Preheat	10 yrs.	40 lbs.	7 3/4" dia. x 30" long
Potable Water	10 yrs.	559 lbs	18" dia. x 58 9/16" high
Collector	10 yrs.	9.0 lbs/ft^2	3' x 6' x 6 1/2"ea.
Energy Transport	10 yrs.	TBD	NA
Controls	10 yrs.	TBD	NA

SYSTEM PERFORMANCE SPECIFICATION

INSTALLATION DRAWING SHEETS

SK-142106	SINGLE FAMILY RESIDENCE SYSTEM INTEGRATION

SUBSYSTEM DRAWING SCHEDULE

SK-142101	Collector Subsystem
SK-142050	Storage Subsystem
SK-142102	Auxiliary Energy and Space Heating Subsystems
SK-142052	Hot Water Subsystem
SK-142053	Energy Transport Subsystem
SK-142105	Control Subsystem
SK-142104	Site Data Aquisition Subsystem
SK-142103	Electrical Subsystem

Performance Analysis Summary for the residence in the city of New Castle, in the county of Lawrence, state of Pennsylvania.

	Load (10^6 Btu)		Auxiliary Energy Input (10^6 Btu)		
Month	Heating	Hot Water	Heat Pump Input	Elec. Coil Input	Hot Water Heater Input
1	10.4	2.0	2.4	1.8	1.1
2	6.8	1.8	2.1	0.2	1.1
3	4.8	2.0	0.7	0.0	0.9
4	4.5	1.9	0.7	0.0	0.9
5	2.3	1.8	0.0	0.0	0.3
6	0.7	1.6	0.0	0.0	0.0
7	0.2	1.5	0.0	0.0	0.0
8	0.1	1.6	0.0	0.0	0.0
9	0.5	1.5	0.0	0.0	0.0
10	2.7	1.6	0.0	0.0	0.2
11	5.4	1.7	1.3	0.0	0.9
12	9.9	2.0	3.5	1.0	1.3
TOTAL	48.2	21.0	10.7	3.0	6.7

SECTION 3

Document F3437-F-103
3 August 1977

SOLAR HEATING AND COOLING DEVELOPMENT PROGRAM

SPECIAL HANDLING INSTALLATION AND MAINTENANCE

TOOL LIST

for
Operational Site at
New Castle, Pennsylvania

A
Single Family Residence
Heating System

Honeywell Inc.
Energy Resources Center
2600 Ridgway Parkway
Minneapolis, Minnesota 55413

Prepared By

Allen J Baldwin

Approved By

Glen L Merrill

SPECIAL HANDLING INSTALLATION AND MAINTENANCE TOOL LIST

1.0 ANALYSIS

An analysis of subsystem installations was conducted to determine if special handling or installation tools are required for a single family solar heating system.

A tool or piece of equipment is assumed to be special if a typical HVAC contractor does not have the tool or equipment or that he cannot obtain an infrequently used tool or equipment through local hire. To assure complete analysis, the matrix presented in Figure 3-1 was used. Those blocks marked in the matrix with a note represent items deemed unusual or questionable as to their status as standard equipment, each item has been investigated in more detail. The results of this further investigation and the availability of tools or equipment is presented in the notes following the matrix.

2.0 CONCLUSIONS

The conclusion of this analysis is that there are no special purpose tools or equipment required in a single family solar heating system. All tools or equipment required would be possessed by a typical HVAC contractor or be available through local hire.

TITLE	LIFTING OR PLACING EQUIPMENT	SPECIAL FITTING	INSTALLATION	VACUUM OR PRESSURE TESTING	FLUID INSTALLATION	PERFORMANCE MEASUREMENTS	RECOMMENDATIONS
COLLECTOR SUBSYSTEM	NOTE 1	N/A	N/A	NOTE 2	NOTE 3	NOTE 4	
ENERGY STORAGE	NOTE 1	N/A	N/A	N/A	N/A	N/A	
SPACE HEATING	N/A	N/A	N/A	N/A	N/A	N/A	
AUXILIARY ENERGY SUBSYSTEM	NOTE 5	N/A	NOTE 6	N/A	N/A	N/A	
HOT WATER SUBSYSTEM	N/A	N/A	N/A	N/A	N/A	N/A	
ENERGY TRANSPORT SUBSYSTEM	N/A	N/A	N/A	N/A	N/A	N/A	
CONTROLS SUBSYSTEM	N/A	N/A	N/A	N/A	N/A	N/A	
ELECTRICAL SUBSYSTEM	N/A	N/A	N/A	N/A	N/A	N/A	
INTEGRATION HARDWARE	N/A	N/A	N/A	N/A	N/A	N/A	

Figure 3-1. Tool Analysis

3.0 NOTES

Note 1:
Collector and storage tank installation will require a crane or lift truck. This is available for local hire in any location.

Note 2:
Pressure testing will require an air compressor, which is either in the inventory of an HVAC contractor or is available on a daily rental basis.

Note 3:
Fluid installation in the collector loop will require a positive displacement pump and fittings. This is standard HVAC equipment used for filling hydronic heating systems.

Note 4:
Measurements made during system balancing will require pressure gauges and differential pressure gauges. These gauges are the same as those used for hydronic heating system balancing and should be in the possession of a typical HVAC contractor.

Note 5:
Placing of the heat pump outdoor unit will require a crane of lift truck. This is available for local hire in any location.

Note 6:
Installation of the heat pump system will require special tools normally required for such installations. These tools would be owned by a typical HVAC contractor.

SECTION 4

Document F3437-M-106
3 August 1977

SOLAR HEATING AND COOLING DEVELOPMENT PROGRAM

Spare Parts List for Operational Site at New Castle, Pennsylvania

Single Family Residence
Heating System

Honeywell Inc.
Energy Resources Center
2600 Ridgway Parkway
Minneapolis, Minnesota 55413

Prepared By

H W Berry

Approved By

Glen L Merrill

1.0 INTRODUCTION

This spare parts list is submitted under Data Item 16 for the Single Family Residential Solar Heating System being installed at the New Castle, Pennsylvania site.

2.0 DEFINITIONS

a) Spare parts are those repair parts NASA/MSFC should procure and have on hand in case of subsystem/component failure because the item is a "non-standard" device or "one of a kind" device and repair parts would probably not be available.

b) Replacement parts are those repair parts that the component supplier could be expected to provide normally as HVAC industry standard practice. These replacement parts are normally available for all standard/catalog items.

3.0 BASIS

This spare parts list was determined utilizing a support philosophy that relies upon the HVAC dealer/distributor/factory to provide replacement parts when required. Only in those subsystems/components where it is not a "standard" component will replacement parts be recommended as spare parts.

The screening criteria used classified all components that were passive, i.e., pipes, tanks, heat exchangers, coils, cabinetry, etc., with "P". Only active (A) components were reviewed to determine if the item was "standard/catalog" (std) or "special" (sp). Table 4-1 lists all the solar heating components and their classification and type.

4.0 RECOMMENDATIONS

There are no items recommended as spare parts for the SFR Solar Heating System at New Castle, Pennsylvania.

Table 4-1 Honeywell Furnished Equipment - Spares Selection Analysis

SINGLE FAMILY RESIDENCE

SYSTEM: Solar Heating   LOCATION: New Castle, Pennsylvania

SUBSYSTEM	QUANTITY	UNIT DESCRIPTION	PART NO	MANUFACTURER	CLASSIFICATION	TYPE	EXPECTED LIFE (IN YEARS)	SPARES RECOMMENDED
COLLECTOR	28	Solar Collector	LSC-18-1	Lennox Industries	P			
	6	Header Assembly	SK-142064-4C	Honeywell	P			
	2	Header Assembly	SK-142064-3B	Honeywell	P			
	6	Header Assembly	SK-142064-2C	Honeywell	P			
	11	Hose Assembly	SK-142066	Honeywell	P			
	34	3/8 npt Coupling	4738-6-6	Aeroquip	P			
	22	3/8 npt Coupling	FF1162-0606B	Aeroquip	P			
	1	Purge Cooling Unit	HRW-1-140	Lennox Industries	A	STD	>10	0
STORAGE	1	Tank-Hot Water Storage (includes Hot Water Coil)	SK-142003A	Honeywell	P			
AUXILIARY ENERGY AND SPACE HEAT	1	Space Heating Coil	CW 31-45	Lennox Industries	P			
	1	Heat Pump Outdoor Unit	HP10-3BV	Lennox Industries	A	STD	>10	0
	1	Heat Pump Indoor Unit	CBP10-41	Lennox Industries	P			
	1	Refrigerant Line Set	L10-41-30	Lennox Industries	P			
	1	Electric Heating Coil	ECB10-41-471	Lennox Industries	A	STD	>10	0
DOMESTIC HOT WATER	1	Heater-Hot Water	52-KP-10	Lochinvar	A	STD	>10	0
	1	Valve-Mixing	70A-3/4"	Watts Req.	A	STD	>10	0
ENERGY TRANSPORT	1	Module-Energy Transport as Listed Below	SK-142065	Honeywell				
	1	Pump 1/4 hp	Series 60-[illegible]	Bell and Gossett	A	STD	>10	0
	2	Pumps 1/6 hp	Series PR-1	Bell and Gossett	A	STD	>10	0
	1	Heat Exchanger	SK-140184	Honeywell	P			
	1	Tank-Expansion	Model 30 Extrol	Amtrol	P			
	1	Seperator-Air	Model 451	Amtrol	P			
	1	Vent-Air	Model 690	Amtrol	P			
	1	Valve-Air	1/8" Radiator Air	Hammond	P			
	1	Valve-Relief	Model 480-36	Bell and Gossett	P			
	1	Valve-Dual	V4331-A1003	Honeywell	A	STD	>10	0
	1	Valve-Balancing	Model CB-1 1/4	Bell and Gossett	P			
	2	Valve-Balancing	Model CB-1	Bell and Gossett	P			
	1	Valve-Lift Check	Model BA-1 1/4	Bell and Gossett	A	STD	>10	0
	2	Valve-Swing Check	Model B-309	Stockham	A	STD	>10	0
	1	Valve-Drain/Fill	Model 711-1/2	Hammond	P			
	2	Drain-Coupling	701-D-1	Nibco	P			
	1	Strainer-Pipeline	Style S-1 1/4	Strong	P			
	1	Switch-Low Pressure	P/N 3815936	General Motors	A	STD	>10	0
	1	Panel-Solar Control	Model W968A	Honeywell	A	STD	>10	0
	1	Cabinet-ETM	SK-142079	Honeywell	P			
CONTROL	1	Aquastat	L6008C1065	Honeywell	A	STD	>10	0
	1	Aquastat	L4008B1013	Honeywell	A	STD	>10	0
	1	Thermostat	T872C1004	Honeywell	A	STD	>10	0
	1	Sub Base	Q672B1004	Honeywell	P			
	1	Valve	V4331A1003	Honeywell	A	STD	>10	0
	1	Sensor Shield	SK-142067	Honeywell	P			
	3	Sensor	C773B1005	Honeywell	A	STD	>10	0
	2	Wells	122555B	Honeywell	P			
	1	Case Assembly	128921F	Honeywell	P			
	1	Controller-Diff Temp.	R7412	Honeywell	A	STD	>10	0
	2	Thermostats-Outdoor	P-8-10715	Lennox Industries	A	STD	>10	0
	1	Mounting Box	M-1595	Lennox Industries	P			
	1	Bulb Guard	107323A	Honeywell	P			

SECTION 5

Document F3437-IOM-102
3 August 1977

SOLAR HEATING AND COOLING DEVELOPMENT PROGRAM

Installation, Operation and Maintenance Manual Outline
for
Operational Site at
New Castle, Pennsylvania

A
Single Family Residence
Heating System

Honeywell Inc.
Energy Resources Center
2600 Ridgway Parkway
Minneapolis, Minnesota 55413

Prepared By

Approved By

MANUAL OUTLINE

Operation

I. System Function
II. System Components
(Refer to Appendices)

Maintenance

I. System Monitoring
II. Periodic Maintenance Schedule
III. System Components
(Refer to Appendices)

Installation Instructions

I. General
II. Subsystems and Components
(Refer to Appendices)
III. Start-up and Check-out
IV. Balancing

Appendices

Appendix A.	Manual - Solar Collector
Appendix B.	Manual - Purge Cooling Unit
Appendix C.	Manual - Heat Pump Indoor and Outdoor Units, and Auxiliary Electric Heating Coil
Appendix D.	Specification - Space Heat Coil
Appendix E.	Catalog Sheet Manual - Domestic Hot Water Heater
Appendix F.	Manual - Energy Transport Module
Appendix G.	Manual - Control Panel and All Other Control Components

APPENDIX A

SYSTEM INTEGRATION

DRAWING NO. SK 142106

PART NO.

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SINGLE-FAMILY RESIDENTIAL HEATING SYSTEM DESCRIPTION

The single-family residential heating system is a solar-assisted, hydronic-to-warm air heating subsystem with solar-assisted domestic water heating. The system is composed of the following major components:

- Liquid cooled flat plate collectors
- A water storage tank
- A solar hydronic space heating coil
- A passive solar fired domestic water preheater
- An electric hot-water heater
- A tube-and-shell heat exchanger, three pumps, and associated pipes and valving in an energy transport module.
- A control system
- An air-cooled heat purge unit
- Auxiliary heating sources
  - Conventional electric heat pump
  - Electric resistance heating coil

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The arrangements of components within the system is as shown on sheet 2. The system consists of a glycol/water collector loop which interfaces with a water storage/heating loop, through a tube-and-shell heat exchanger. A domestic hot-water preheat coil is located in the storage tank.

The glycol/water collector loop consists of the solar collectors, the shell side of the heat exchanger, the purge coil and pump P_1, and a control valve as required for the different modes of operation.

The water storage/heating loop consists of the storage tank, storage pump P_2, heating pump P_3, the tube side of the heat exchanger, the solar heating coil, and a control valve as required for the different modes of operation.

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The system control logic is as follows:

- Collect solar energy when available
  - Store energy under no load conditions
  - Provide energy directly to load on demand
- Use direct solar energy before stored energy
- Use stored energy when direct solar energy is not available
- Use direct or stored solar energy before auxiliary energy

The system provides 6 modes of operation:

- Direct heating from collectors
- Heating from storage
- Storage charging
- Purging excess energy
- Auxiliary heating
- Continuous domestic hot water preheating

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System Operation -- When solar energy is available and heating is required, the collectors supply heat directly to the system. Pump P_1 provides the heat transfer fluid movement in the collector loop, pump P_2 circulates the storage/heating loop, and the heat pump (indoor unit) blower moves the space air over the solar space heating coil. During periods of high solar radiation and no heating demand, both collector and storage loops operate simultaneously, with the storage charge pump P_2 charging the storage tank by removing water from the bottom, adding energy in the heat exchanger and returning it to the top of the storage tank, thus taking advantage of thermal stratification. During periods of high solar radiation and low heating demand and with the storage tank fully charged, the system temperatures will increas and, as an overtemperature protective device, the purge coil operates, controlling the downstream temperatures to a preselected value. When solar energy is not available and heating is required, storage supplies heat directly to the solar space heating coil. Pump P_3 extracts heat from the top of the storage tank and returns it to the bottom, again taking advantage of the tank stratification. If the storage tank temperature is not high enough to supply heating, or the heating load cannot be satisfied by the solar system, auxiliary space heating will be provided by the heat pump and/or the electric resistance heating coil.

SUBSYSTEM DRAWING SCHEDULE

DRAWING TITLE	DRAWING NUMBER	NUMBER OF SHEETS
COLLECTOR SUBSYSTEM	SK-142101	4
STORAGE SUBSYSTEM	SK-142050	2
AUXILIARY ENERGY AND SPACE HEATING SUBSYSTEM	SK-142102	5
HOT WATER SUBSYSTEM	SK-142052	1
ENERGY TRANSPORT SUBSYSTEM	SK-142053	1
CONTROL SUBSYSTEM	SK-142105	4
SITE DATA ACQUISITION SUBSYSTEM	SK-142104	3
ELECTRICAL SUBSYSTEM	SK-142103	1

E.C.J. CONTROL

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			CHECKER			
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			ENGRG MGT			
		MATERIAL	CONTRACT NO.			
			NEW CASTLE		SIZE C	CODE IDENT NO. 55513	DRAWING NO. SK-142106
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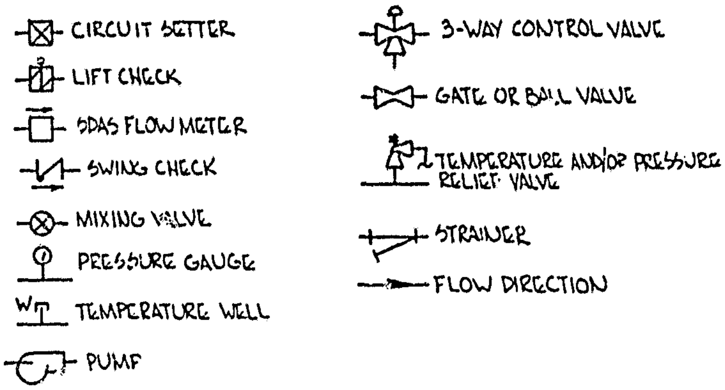

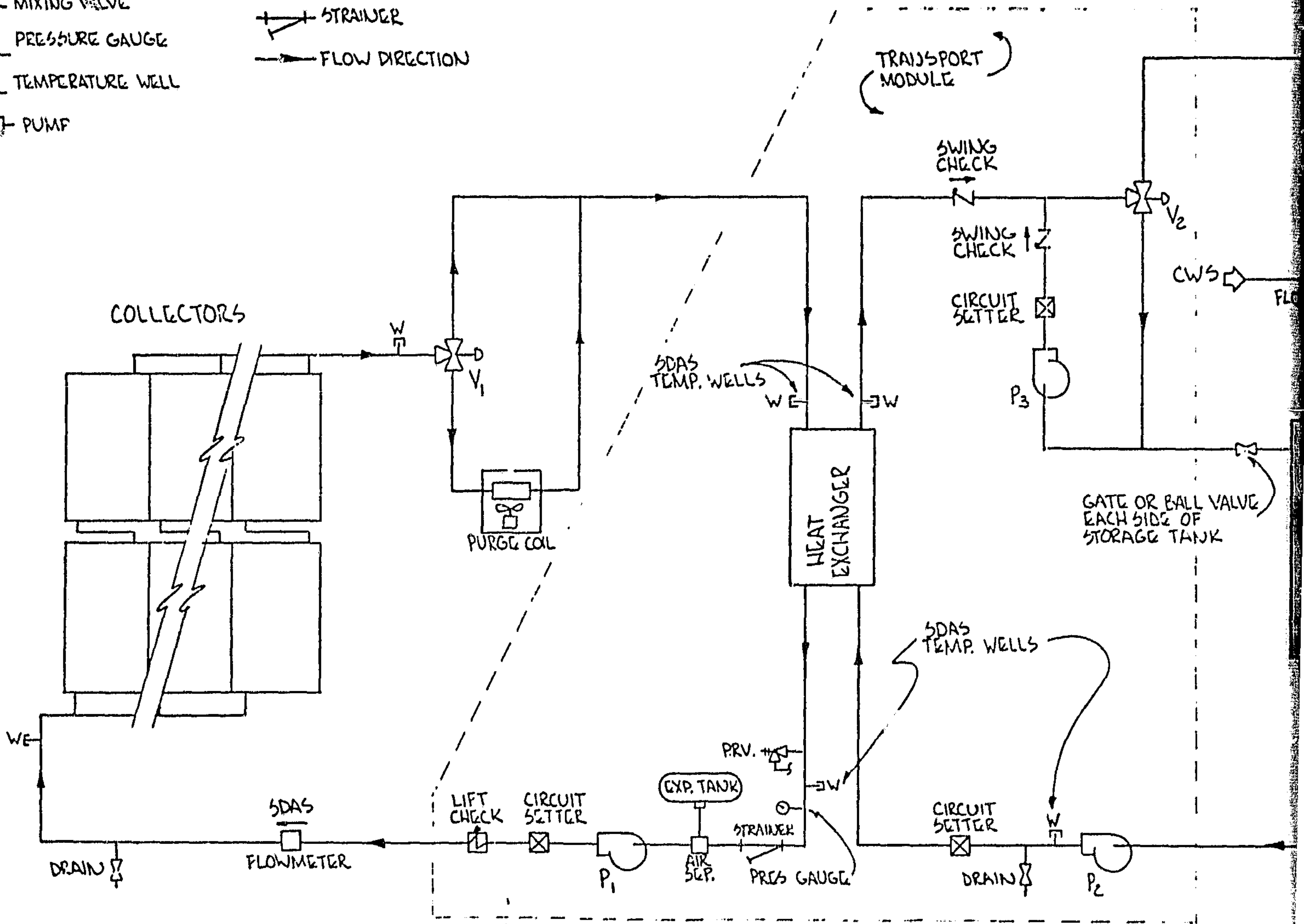

SOLAR HEATING SYSTEM SCHEMATIC

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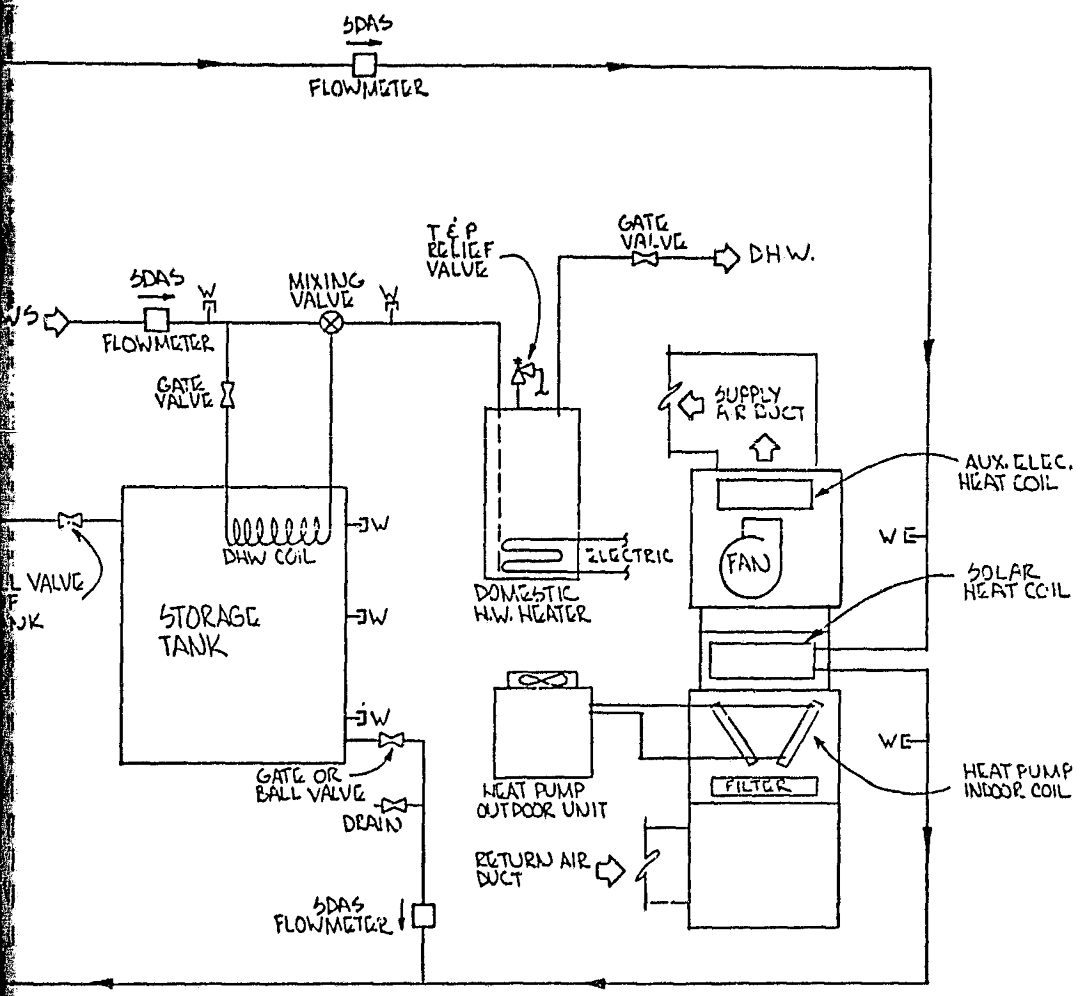

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INSTALLATION CRITERIA

SECTION 15.010 GENERAL PROVISIONS

15.040 STARTING OF PIPING SYSTEMS:

A. Collector Loop:

1) Complete testing of collector loop as called for elsewhere in three specifications.

2) Filling and Cleaning Precautions:

a) Cover collectors before filling or fill at night.
b) Do not operate pumps dry.
c) Do not over-pressurize system on initial fill.

3) Clean system with a solution of 1 gallon trisodium phosphate per 100 gallon water circulating for four hours. Check strainers periodically and clean as necessary to avoid damage to pump.

4) Drain cleaning solution and measure collector loop fluid volume so that correct amount ethylene glycol can be added.

5) Flush system with clean water for two hours.

6) Collector loop filling procedure:

a) Open vent at top of collectors
b) Fill system with proper amount of ethylene glycol to provide a 50% by volume solution.
c) Add corrosion inhibitor as per manufacturer's recommendations.
d) Operate control valves as necessary to fill all piping and remove all air from system.
e) Close vent and add fluid to provide a nominal 20 psi gauge pressure at module fill point.
f) Operate system and check all vents to eliminate all air from system.
g) Add water to pressurize system as shown on mechanical plans.

B. Storage/Heating Loop:

1) Complete testing of storage/heating loop as called for elsewhere in these specifications.

2) Filling and cleaning precautions: same as above.

3) Flush storage tank with a hose.

4) Flush piping with clean water for two hours.

5) Storage/heating loop filling procedure:

a) Add water to system up to proper level in storage tank.
b) Operate control valves as necessary to fill all piping and remove all air from system.
c) Recheck storage tank level and fill accordingly.
d) Add corrosion inhibitor in quantity specified.

C. System Operation:

Uncover collectors and operate system for several days under automatic control. Check system fluid levels, air vents, and operating pressure periodically.

D. Contractor will be assisted by systems engineer. Submit results of above work to architect.

15.042 TESTING

A. Solar Heating System Piping: (except collector headers, storage tank, and hose connections to collectors).

1) Test after erection and before concealing or covering. Any materials or workmanship found faulty shall be replaced or repaired and sections or systems retested.

2) These systems shall be proven tight under a hydrostatic pressure of 100 psig.

B. Collector Headers and Hose Connections to Collectors:

1) Test after erection and before concealing or covering. Any materials or workmanship found faulty shall be replaced or repaired and sections or systems retested.

2) Cover collectors or conduct test at night.

3) These systems shall be proven tight under a hydrostatic pressure of 50 psig.

C. Test results shall be submitted to architect.

15.043 BALANCING OF SYSTEMS

A. Hydronic Systems:

1) Balance flow rate of each pump to within 5% of specified flow as shown on plans.

2) Balance flow rate through each branch circuit to within 5% of specified flow as shown on plans.

B. Air Systems:

Balance air system so as to provide flow rate at Solar Space Heating Coil within 5% of specified flow rate as shown on plans.

C. Motor Amperages:

Measure all motor amperages and compare with nameplate ratings.

D. Balancing results shall be submitted to architect.

SECTION 15.050 BASIC MATERIALS AND METHODS

15.060 PIPE AND PIPE FITTINGS:

A. Solar Heating System:

Type "M" hard drawn copper tubing with wrought copper or cast bronze fittings. Solder joints made with 95-5 tin-antimony solder.

B. Installation Method:

According to manufacturer's instructions.

C. General Requirements:

1) All piping shall be run parallel to adjoining building surfaces and by the most direct route. Exposed piping shall be run as close to ceiling and/or walls as possible.

2) All piping shall be installed so as to allow for movement due to thermal expansion and contraction.

3) Install manual air vents as shown on plans and all high points in the system.

4) Anchor vertical piping for support as required. Install pipe hangars in horizontal piping at eight foot intervals. Pipe hangars shall be F&M No. 364 or No. 365, or Autogrip, or equal. Provide an eight inch section of rigid insulation for pipe saddle within each hanger.

15.100 VALVES:

A. Manufacture:

Valves shall be manufactured by Crane, Jenkins, Walworth, Powell, Lunkenheimer, or Stockham.

B. Valves - Solar Heating System:

1) Gate Valves, 2" and Smaller -- 125 lb. steam, bronze body, solder end, solid wedge, rising stem.

2) Check Valves, 2" and Smaller -- 125 lb. steam, bronze body, solder end, bronze disc, swing check.

3) Ball Valves, 2" and Smaller -- 150 lb. steam, brass body, screwed end or solder end, glass reinforced Teflon seats and stem seals, balancing stop, brass ball, blow out proof brass stem and vinyl grip on handle.

4) Drain Valves, 2" and Smaller -- 125 lb. steam, bronze body, globe valve, screwed end or solder end, composition disc.

C. Valve Tags:

Each system valve shall be identified with a stamped numbered brass tag. A schedule of valves including valve size, service, manufacture and location shall be submitted to architect.

15.175 SOLAR STO

A. Procurement:

The Solar Stora

B. Required Work:

The Mechanical
as shown on plan

SECTION 15.180 IN

15.181 GENERAL:

A. Scope:

This section per
supplied by the

B. Material:

Armstrong Arm

C. Installation:

Per manufacture

SECTION 15.400 PL

15.424 DOMESTIC

A. Procurement:

The Domestic W
Honeywell ERC.

B. Required Work:

The mechanical
and Mixing Valv

SECTION 15.600 PO

15.645 SOLAR COLL

A. Scope:

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B. Procurement:

These components
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flow rate at Solar Space Heating as shown on plans.

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AND METHODS

with wrought copper or cast with 95-5 tin-antimony solder.

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ort as required. Install pipe eight foot intervals. Pipe hangars 65, or Autogrip, or equal. Provide ulation for pipe saddle within each

rane, Jenkins, Walworth, Powell,

125 lb. steam, bronze body, stem.

125 lb. steam, bronze body, check.

150 lb. steam, brass body, ss reinforced Teflon seats and ss ball, blow out proof brass

125 lb. steam, bronze body, lder end, composition disc.

ied with a stamped numbered ncluding valve size, service, submitted to architect.

15.175 SOLAR STORAGE TANK:

A. Procurement:

The Solar Storage Tank will be supplied by Honeywell ERC.

B. Required Work:

The Mechanical Contractor shall install the Solar Storage Tank as shown on plans.

SECTION 15.180 INSULATION

15.181 GENERAL:

A. Scope:

This section pertains to insulation of all solar heating system piping supplied by the mechanical contractor.

B. Material:

Armstrong Armaflex, 3/4 inch thickness.

C. Installation:

Per manufacturers recommendations.

SECTION 15.400 PLUMBING

15.424 DOMESTIC WATER HEATER:

A. Procurement:

The Domestic Water Heater and Mixing Valve will be supplied by Honeywell ERC.

B. Required Work:

The mechanical contractor shall install the Domestic Water Heater and Mixing Valve as shown on plans.

SECTION 15.600 POWER OR HEAT GENERATION

15.645 SOLAR COLLECTOR SUBSYSTEM:

A. Scope:

The Solar Collector Subsystems consists of the solar collectors, collector header piping, flexible hose connections to each solar collector, and the purge coil.

B. Procurement:

These components of the collector subsystem to be supplied by Honeywell ERC are shown on plans. All other materials required for a complete installation shall be supplied by the Mechanical Contractor.

C. Required Work:

The Mechanical Contractor shall install all above equipment as shown on plans. Header assembly joints shall be made with 95-5 tin-antimony solder. During the joining process a heat sink shall be provided between the coupling and the pre-insulated header sections. The pre-insulated header sections shall not be at temperatures greater than 220°F.

15.649 ENERGY TRANSPORT MODULE:

A. Procurement:

The Energy Transport Module will be supplied by Honeywell ERC.

B. Required Work:

The Mechanical Contractor shall install the Energy Transport Module as shown on plans.

SECTION 15.700 LIQUID HEAT TRANSFER

15.763 SOLAR SPACE HEATING COIL:

A. Procurement:

The Solar Space Heating Coil will be supplied by Honeywell ERC.

B. Required Work:

The Mechanical Contractor shall install the Solar Space Heating Coil as shown on plans.

SECTION 15.800 AIR DISTRIBUTION

15.810 HEAT PUMP AND ELECTRIC HEATING COIL

A. Procurement:

The heat pump and electric heating coil will be supplied by Honeywell ERC.

B. Required Work:

The mechanical contractor shall install the heat pump and electric heating coil as shown on plans.

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PART NO.

SECTION 15900 CONTROL SUBSYSTEM

A. Scope: The Control Subsystem will include all controls necessary for operation of the solar heating system.

B. Required Work: The Mechanical Contractor will install and wire all controls as shown on control subsystem wiring schematic. This will include all line voltage wiring required.

C. Procurement of Control Devices: Control devices listed in Section (i.e., Solar Control Panel, Aquastats, Thermostat, etc.) will be provided by Honeywell ERC. This will include the control devices only, all other materials necessary for a complete installation shall be provided by the Mechanical Contractor.

D. Basic Materials:

1.) Control sensor wiring (T_p and T_{SB}): Wiring from solar control panel to control sensors T_p and T_{SB} shall be run in conduit in outdoor areas and shall be Belden #8762 or equal.

2.) Power and control wiring: All line and low voltage wiring shall be of size and type required by applicable codes, and supplied by Mechanical Contractor.

3.) Other Materials: All other materials required for a complete installation of the Control Subsystem shall be supplied by the Mechanical Contractor.

E. Basic Methods:

1.) Control device installation methods: As per applicable details and/or instructions included with equipment.

2.) Electrical wiring: As per all applicable codes.

SECTION 15990 SITE DATA ACQUISITION SUBSYSTEM

A. Purpose: A Site Data Acquisition Subsystem (SDAS) will be installed to evaluate the performance of the solar heating system as well as determine the contribution of collected solar energy in reducing the consumption of conventional energy. The Site Data Acquisition Subsystem components will be furnished by NASA, consisting of instrumentation sensors, junction box, Site Data Acquisition Subsystem Module and a telephone interface.

B. Required Work

1.) Instrumentation Installation - The Mechanical Contractor will install all sensors listed in the instrumentation schedule. The sensor locations are shown on the Site Data Acquisition Subsystem Schematic and the mechanical plans. The Mechanical Contractor shall install the sensors in the locations shown so as to provide for accessibility and ease of servicing.

2.) Instrumentation Wiring - The Mechanical Contractor shall perform all electrical wiring from each sensor back to the Junction Box as shown on details and described below.

3.) Watt Transducer Installation - Mechanical Contractor shall install and wire watt transducers on or near equipment served, and revise factory wiring as required. See Watt Transducer detail.

B. Required Work

4.) Site Data Acquisition Subsystem Module - The Site Data Acquisition Subsystem Module will be furnished by NASA, and installed by the Mechanical Contractor. The installation location will be as shown on mechanical plans.

5.) SDAS Telephone Interface - NASA will provide the telephone installation required for the SDAS.

6.) SDAS Electrical Interface - The SDAS will interface with a standard 110-125V, 60 Hertz, 1 phase, 3 amp service. A standard 3 wire interface (safety ground, power and return) with a standard twist lock outlet, located within six feet of the SDAS, shall be provided by the Mechanical Contractor. NASA shall provide a three pin twist lock connector and cable to interface the SDAS with the power outlet.

7.) Junction Box - NASA shall provide a Junction Box to the Mechanical Contractor for installation in a location as shown on mechanical plans. The Junction Box shall be located so that it is accessible for wiring connections from the sensors into the top and is within four feet of the SDAS location. At the required mounting location, the Junction Box shall be mounted using the four mounting feet located at the top and bottom of the unit. Depending on the characteristics of the mounting surface, molly bolts, wood screws or bolt/nut combinations shall be used to mount the unit. The Junction Box shall be installed in a top-up orientation.

8.) Junction Box/Sensor Interface - NASA will establish the wire run list which identifies where each sensor wire attaches to the Junction Box. The Junction Box will be prewired from the terminal strips to output connectors by NASA prior to delivery to the site. Each applicable sensor detail illustrates the sensor to Junction Box wiring. The Mechanical Contractor shall connect sensor wires to Junction Box terminals according to a wiring diagram to be provided by NASA.

9.) Junction Box/SDAS Module Interface Cables - NASA will install the cables between the Junction Box and the SDAS Module.

C. Restrictions on Use of Instrumentation
No monitoring, indicating or readout devices are to be connected to the instrumentation sensors, i.e., paralleled with the Site Data Acquisition Subsystem, without prior approval of NASA.

D. Failed Sensor Replacement
The improperly operating sensor will be identified to Honeywell ERC after examination of the sensor for signs of physical damage such as broken wires, loose connectors, loose terminals, etc. If no physical damage is apparent in the inspection, NASA shall be notified for further instructions. If mechanical damage is apparent, the sensor shall be replaced by the Mechanical Contractor with a sensor supplied by NASA. The defective sensor shall then be returned to NASA for failure analysis.

E. Installation Materials and Methods

1.) Wiring from the sensors to the Junction Box shall be performed by the Mechanical Contractor utilizing wire supplied by the Mechanical Contractor. The wire size and number of conductors required for each sensor type is specified in list below and each sensor type is specified in list below and each sensor detail. The Sensor-to-Junction Box wire shall be UL approved, color-coded, audio and instrumentation grade cable of the following manufacture or equal:

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quired Work

e Data Acquisition Subsystem Module - The Site Data quisition Subsystem Module will be furnished by NASA, installed by the Mechanical Contractor. The installation ation will be as shown on mechanical plans.

AS Telephone Interface - NASA will provide the telephone tallation required for the SDAS.

AS Electrical Interface - The SDAS will interface with a ndard 110-125V, 60 Hertz, 1 phase, 3 amp service. A ndard 3 wire interface (safety ground, power and return) h a standard twist lock outlet, located within six feet of SDAS, shall be provided by the Mechanical Contractor, SA shall provide a three pin twist lock connector and cable interface the SDAS with the power outlet.

ction Box - NASA shall provide a Junction Box to the chanical Contractor for installation in a location as wn on mechanical plans. The Junction Box shall be ated so that it is accessible for wiring connections from sensors into the top and is within four feet of the SDAS tion. At the required mounting location, the Junction shall be mounted using the four mounting feet located he top and bottom of the unit. Depending on the charac- istics of the mounting surface, molly bolts, wood screws bolt/nut combinations shall be used to mount the unit. e Junction Box shall be installed in a top-up orientation.

ction Box/Sensor Interface - NASA will establish the wire list which identifies where each sensor wire attaches to Junction Box. The Junction Box will be prewired from the m'nal strips to output connectors by NASA prior to delivery he site. Each applicable sensor detail illustrates the sensor unction Box wiring. The Mechanical Contractor shall nect sensor wires to Junction Box terminals according to iring diagram to be provided by NASA.

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Sensor Replacement
properly operating sensor will be identified to Honeywell ERC, amination of the sensor for signs of physical damage such as wires, loose connectors, loose terminals, etc. If no physical is apparent in the inspection, NASA shall be notified for instructions. If mechanical damage is apparent, the sensor replaced by the Mechanical Contractor with a sensor supplied A. The defective sensor shall then be returned to NASA for analysis.

tion Materials and Methods

ing from the sensors to the Junction Box shall be performed he Mechanical Contractor utilizing wire supplied by the chanical Contractor. The wire size and number of conductors uired for each sensor type is specified in list below and each sor type is specified in list below and each sensor detail. e Sensor-to-Junction Box wire shall be UL approved, color- ed, audio and instrumentation grade cable of the following nufacture or equal:

Alpha P/N 2421-18 gauge, 2 conductor
Dearborn P/N 972202-18 gauge, 2 conductor
Alpha P/N 2424-18 gauge, 4 conductor
Dearborn P/N 971804-18 gauge, 4 conductor

All externally exposed wire in the outdoor environment or buried will be in conduit.

Wire nuts will be utilized for terminations at the following sensors:

Temperature Sensors	3 each (single element)
Temperature Sensors	6 each (dual element)

Wire nuts shall be replaced with a butt splice in areas where the connections are exposed to vibration.

Ring terminals will be used to terminate the wires at the following sensors:

Flow Meter	5 each
Watt Transducer	2 each

If terminations conflict with local codes, local codes shall be applicable.

2.) Other Materials
All other materials necessary for installation of the sensors shall be provided by the Mechanical Contractor. This would include but not be limited to, pipe fittings, fasteners, electrical enclosures, terminal blocks, electrical wiring, electrical conduit, and any other materials necessary for a complete installation of all sensors.

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NEW CASTLE

HONEYWELL INC. — ENERGY RESOURCES CENTER, MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE SYSTEM INTEGRATION

SIZE	CODE IDENT NO.	DRAWING NO.
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IPC SYSTEM INTEGRATION CRITERIA

2.1 Requirement	System Design Conditions. The systems for heating (H) and combined heating and cooling (HC) and the domestic hot water (DHW) system/subsystem shall be capable of functioning at their designed flow rates, pressures and temperatures.
2.1.5 Criterion	Entrapped Air. When liquid heat transfer fluids are used, the system shall provide suitable means for air removal.
2.2 Requirement	Mechanical Stresses. Mechanical stresses that arise within the system shall not cause damage or malfunction of the system or its components.
2.2.1 Criterion	Vibration Stress Levels. Vibrations in piping, ducts, instrumentation lines, and control devices shall be controlled to reduce stress levels below those that could cause fatigue and subsequent component damage.
2.2.5 Criterion	Thermal Changes. The system components and assemblies shall be designed to allow for the thermal contraction and expansion that would occur over the service temperature range.
2.2.6 Criterion	Flexible Joints. All systems employing heat transfer fluids shall be designed to be capable of accommodating flexing of plumbing and fittings.
2.3 Requirement	Leakage Prevention. System assemblies containing heat transfer fluids shall not leak to an extent greater than that specified in the design when operated at the design conditions.
2.3.1 Criterion	Pressure Test: Nonpotable Fluids. Those portions of the H, HC and DHW systems which contain heat transfer fluids (other than air) and are not directly connected to the potable water supply shall not leak when pressures of not less than 1-1/2 times their working pressure are imposed for a minimum of 15 minutes.
2.3.2 Criterion	Pressure Test: Potable Water. Those portions of the H, HC and DHW systems that are directly connected to the potable water supply system shall not leak when tested in accordance with the code having jurisdiction in the area where the system is used. In areas having no building code, a nationally recognized model code shall be used.
2.7 Requirement	Piping Supports. Pipe hangars, pipe trenches, and other supports shall carry the static and operational loads normally imposed without impairing system function.
2.7.1 Criterion	Applicable Plumbing Standards. Piping shall be installed in accordance with Section 615 of the MPS (4900.1 and 4910.1).
3.2 Requirement	Failure Loads and Load Capacity. The structural elements and connections of the H, HC and DHW systems shall not fail under ultimate loads expected during the service life of the system.
3.2.1 Criterion	Ultimate Load Combinations. Non-conventional elements and connections shall comply with this criterion. (Conventional elements and connections are deemed to satisfy this criterion). Structural components, connections and supporting elements shall be designed to withstand a uniform load of 50 psf.
3.5 Requirement	Cutting of Structural Elements. Cutting of structural elements for the installation of H, HC and DHW system components shall not reduce the required load capacity of structural elements.

NEXT ASSY

APPLIC

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2

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FOLDOUT FRAME

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the design conditions.

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hall be installed
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upporting elements
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3.5.1 Criterion — Design Provisions. The effect on the size, shape or engineering properties of a load-bearing element resulting from holes, copes, notches, etc., shall be determined to insure that required safety margins against failure have been maintained.

3.6 Requirement — Constraint Loads. The structural elements and connections of H, HC and DHW systems shall comply with Criterion 3.2.1 while simultaneously subjected to constraint loads expected during the service life.

3.6.1 Criterion — Foundation Settlement, Contraction and Expansion. Non-conventional elements and connections shall comply with this criterion. (Conventional elements and connections are deemed to satisfy this criterion).

4.1 Requirement — Plumbing and Electrical Installation. The design and installation of the systems for heating (H), combined heating and cooling (HC) and the domestic hot water (DHW) system/subsystem and their components shall be in accordance with nationally recognized plumbing and electrical codes and standards for health and safety, where applicable.

4.1.1 Criterion — Plumbing Codes and Standards. Plumbing materials and equipment and their installation shall be in accordance with Sections 515 and 615 of the MPS (4900.1 and 4910.1).

4.1.2 Criterion — Electrical Codes and Standards. Electrical materials and equipment and their installation shall be in accordance with Sections 516 and 616 of the MPS (4900.1 and 4910.1).

C

4.3 Requirement — Fire Safety. The design and installation of the H, HC and DHW systems and their components shall provide a minimum level of fire safety consistant with applicable codes and standards.

4.3.2 Criterion — Penetrations through Fire-Rated Assemblies. Penetrations through fire rated walls, partitions, floors, roofs, etc. shall not reduce the fire resistance below the levels specified in Section 405 of the MPS (4900.1 and 4910.1) (1), where applicable.

4.5 Requirement — Safety Under Emergency Conditions. In the event of emergencies, the H, HC and DHW systems shall not unduly hinder the movement of occupants of the building or emergency personnel. Life safety hazards which could occur as a result of failures of the above systems shall not be greater than those imposed by conventional systems.

4.5.1 Criterion — Emergency Egress and Access. The design and installation of the H, HC and DHW systems shall not impair the emergency movement of occupants of the building or emergency personnel to an extent greater than that allowed by Sections 402 and 405 of the MPS (4900.1 and 4910.1) (1) and NFPA 101 (3), where applicable.

REV

6.1 Requirement — Accessibility for Maintenance and Servicing. The systems for heating (H), combined heating and cooling (HC) and the domestic hot water (DHW) system/subsystem shall be designed, constructed, and installed to provide sufficient access for general maintenance, convenient servicing and monitoring of system performance.

DWG NO.

6.1.1 Criterion — Access for System Maintenance. All individual items of equipment and components of the H, HC and DHW systems which may require periodic examination, adjusting, servicing and/or maintenance shall be accessible for inspection, service, repair, removal or replacement without dismantling of any adjoining major piece of equipment or subsystem.

B

6.1.5 Criterion — Filters. Filters shall be designed and located so that they can be cleaned or replaced with minimum disruption to the system and adjacent equipment. Cleaning frequencies shall be specified by the system manufacturer in the maintenance manual.

UNRELEASED DRAWING - NOT SUBJECT TO E.C.O. CONTROL

A

NEXT ASSY	USED ON	TOLERANCES UNLESS NOTED OTHERWISE .X ± .XX ± .XXX ± ANGLES ±	CRAFTSMAN Donahue 6/7/77 CHECKER DEV ENGR ENGRG MGT
APPLICATION		MATERIAL FINISH–SEE NOTE	CONTRACT NO. NEWCASTLE

HONEYWELL INC. — ENERGY RESOURCES CENTER, MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE SYSTEM INTEGRATION

SIZE C — CODE IDENT NO. 55513 — DRAWING NO. SK-142106

SCALE NONE — SHEET 5 OF 5

CONTROL A

APPENDIX B

COLLECTOR SUBSYSTEM
DRAWING NO. SK 142101

D

PART NO.

SOLAR COLLECTORS
LSC18-1S AND LSC18-1

The Lennox LSC18 solar collector is a development of the Lennox Research Laboratory Solar Design department, Lennox Manufacturing group and the Solar Research group of Honeywell Inc The LSC18 is a glass cover, selective absorber, modular collector adaptable to any type and size solar system. Lennox collectors are available with single (LSC18 1S) or two-glass (LSC18-1) covers and utilized to accumulate solar energy which may be used in systems for heating residences, commercial areas, domestic hot water, swimming pool water, etc. The LSC18 collector is a high thermal efficiency, flat plate collector applicable to new or retrofit installations. Collectors are designed for easy installation in separate supports or frames constructed of wood or metal. The solar collector structural framing system may be installed on a roof or at ground level. Collectors can be installed individually or in multiple banks end to end and/or side by side and assembled in parallel, series or series parallel combination. When collectors are installed the thermal expansion of each absorber plate is approximately 0 125 inch for a temperature difference of 200 F. Since the inlet and outlet from each collector are on opposite sides of the modules, the inter connection forms an expansion loop relieving thermal expansion forces. Service access to each collector may be accomplished without removing the entire module or disturbing the adjacent modules. All piping connections are located external to the collector enclosure. The high output to insolation ratio of the collector is accomplished primarily in the design of the steel absorber plate which captures solar energy and transfers it to usable heat. The plate is formed around the copper flow tubes and sealed with a solder filler. The wrap around contact of plate to tubes provides maximum heat transfer and the tubes, permanently sealed against oxide corrosion, have continuing high efficiency. In addition, the entire plate is given a special black chrome coating for high absorptivity and low re radiation loss. The absorber plate is completely isolated on rubber pads within the enclosure, eliminating metal to metal contact that would result in conductivity loss. Surfaces of the glass cover(s) have acid etched surface lines that increase light transmission by reducing reflection. Tempered low iron glass is abrasion resistant and structurally strong. In case of breakage, the weather tight aluminum cover frame can be easily dismantled for glass replacement. The collector enclosure is constructed of galvalume steel with a electrostatically dip painted finish. Enclosure is completely lined with high temperature fiberglass insulation both beneath and around the absorber plate. Two position mounting brackets on each corner of the enclosure permits installation either vertically or on flat surfaces. Collectors are shipped individually and factory assembled. The installer has only to mount collector in type of framing structure desired and make connections to system supply and return lines.

NOTE Specifications, Ratings and Dimensions subject to change without notice

C

FEATURES

Transparent Cover — Composed of one or two sheets of 1/8 inch thick tempered low iron glass. Both surfaces of the glass sheet are anti reflection surface etched to increase transmission. The glass sheet has a PVC (Poly Vinyl Chloride) weatherstrip seal around the edges and is enclosed in an extruded aluminum frame which may be disassembled for replacement of the glass. Vent holes are provided in the aluminum frame. The rugged glass cover is structurally strong enough to withstand heavy wind, rain and snow loads. The glass cover system provides transmission of the maximum amount of incident solar energy.

Absorber Plate — The solar absorber is an assembly of parallel copper flow tubes bonded to a formed steel plate and electroplated with a solar selective coating. The special coating (black chrome on bright nickel) applied to the absorber plate provides high solar absorptivity and minimum re radiation loss. In addition, the coating is extremely durable when exposed to severe ambient conditions, particularly humidity. The steel plate is formed around the copper flow tubes and a high temperature solder bead is added to each tube. This design results in high thermal heat transfer, permanently seals the tubing from oxide corrosion and allows high working pressures. The copper flow tubes are brazed to copper manifold pipes, one at each end. The manifold pipes are capped and have 3/8-18 fpt pipe fittings external to the enclosure, for connection to the supply and return lines of the system or adjacent collectors. Inlet and outlet connections are located in a Z flow pattern to improve the flow characteristics and facilitate installation.

B

Insulation — The solar collector has 3 1/2 inch thick insulation beneath the absorber plate and 1 inch around the sides of the collector enclosure. The insulation is a semi rigid fiberglass board without facing and is capable of withstanding unlikely temperatures up to 550°F without outgassing.

Collector Enclosure — The weather-tight enclosure is constructed of corrosion resistant heavy gauge galvalume steel with a special Lennox "Electro Deposition" process paint finish. Extruded aluminum cover frame is anodized for maximum protection against corrosion. Cover frame is easily removed for complete service access to interior of enclosure. Weep holes are furnished in the enclosure for ventilation and moisture removal in case of any condensation. The absorber plate is mounted on silicone rubber pads isolating the plate from metal to metal contact with the enclosure that would result in any conductivity loss. Two position mounting brackets on each corner of the enclosure provide flexibility of installation. Piping connections are located external to the enclosure and are equipped with piping collars which reinforce the pipe fittings and allows force to be applied to the connection without stressing the manifolds.

Collector (Transport or Cooling) Fluid — The heat transfer fluid used in the solar collector can range from water to various oils. However, the fluid should exhibit the following properties: low viscosity over the range of ambient temperatures encountered, noncorrosive (with inhibitors if necessary), chemically stable over 15 20 year life, good heat transfer properties, high heat capacity and low freezing point if low ambient temperatures are anticipated. Lennox recommends the use of ethylene glycol based antifreeze (Dowtherm SR 1, produced by the Dow Chemical Company). Mixed with water in a 50 50 ratio by volume, SR 1 yields a fluid capable of providing efficient heat transfer over a temperature range of -40 F to 300 F. Dowtherm should be analyzed once per year and inhibitors added if needed.

Specifications —

- Collector Model Numbers
  - — Single Glass Cover LSC18 1S
  - — Double Glass Cover LSC18 1
- Nominal Collector Area — 18 sq. ft.
- Effective Absorber Area — 15 4 sq. ft.
- Ratio Of Usable Absorber Area To Total Surface Covered — 86%
- Glass Cover(s):
  - — 1/8 in Thick
  - — Tempered Low Iron Clear
  - — Transmittance — .90
- Absorber Coating Black Chrome On Bright Nickel:
  - — Absorptivity — .94
  - — Emissivity — .10
  - — Stable To 650°F

Absorber Construction.

- — Steel Plate
- — Copper Flow Tubes — (10) 1/4 in o d. (.194 in. i d)
- — Tube Spacing — 3 in On Center
- — Tube Pattern — "Z" Flow
- — Manifold — 1-1/8 in o d (1 079 in. i d)
- — Tube Connections To Manifold: ASTM BCuP 3 Brazing Material
- — Bond Between Tubes & Steel Plate — 95 5 Solder
- — Piping Connections (inlet outlet) — 3/8-18 fpt
- — Manifolds & Tubes Pressure Tested: To 150 psig Working Pressure

- Recommended Flow Rate Thru Collector — .3 to .7 gpm
- Collector Fluid Capacity — .3 gal
- Collector Fluid (50 50 Dowtherm SR-1 or Equivalent).

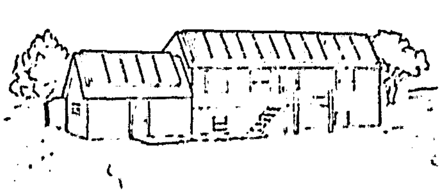
SR-1 Data:

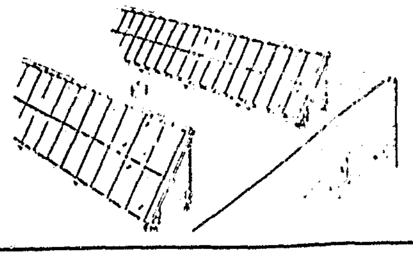
- — Density — 1 045 g/ml (at 160°F)
- — Viscosity — 1 4 centipoise (at 160°F)
- — Thermal Conductivity — 0 23 Btu/lb °F (at 160°F)
- — Specific Heat — 0 85 Btu/lb °F (at 160°F)
- — Boiling Point — 232°F
- — Freezing Point — -34°F

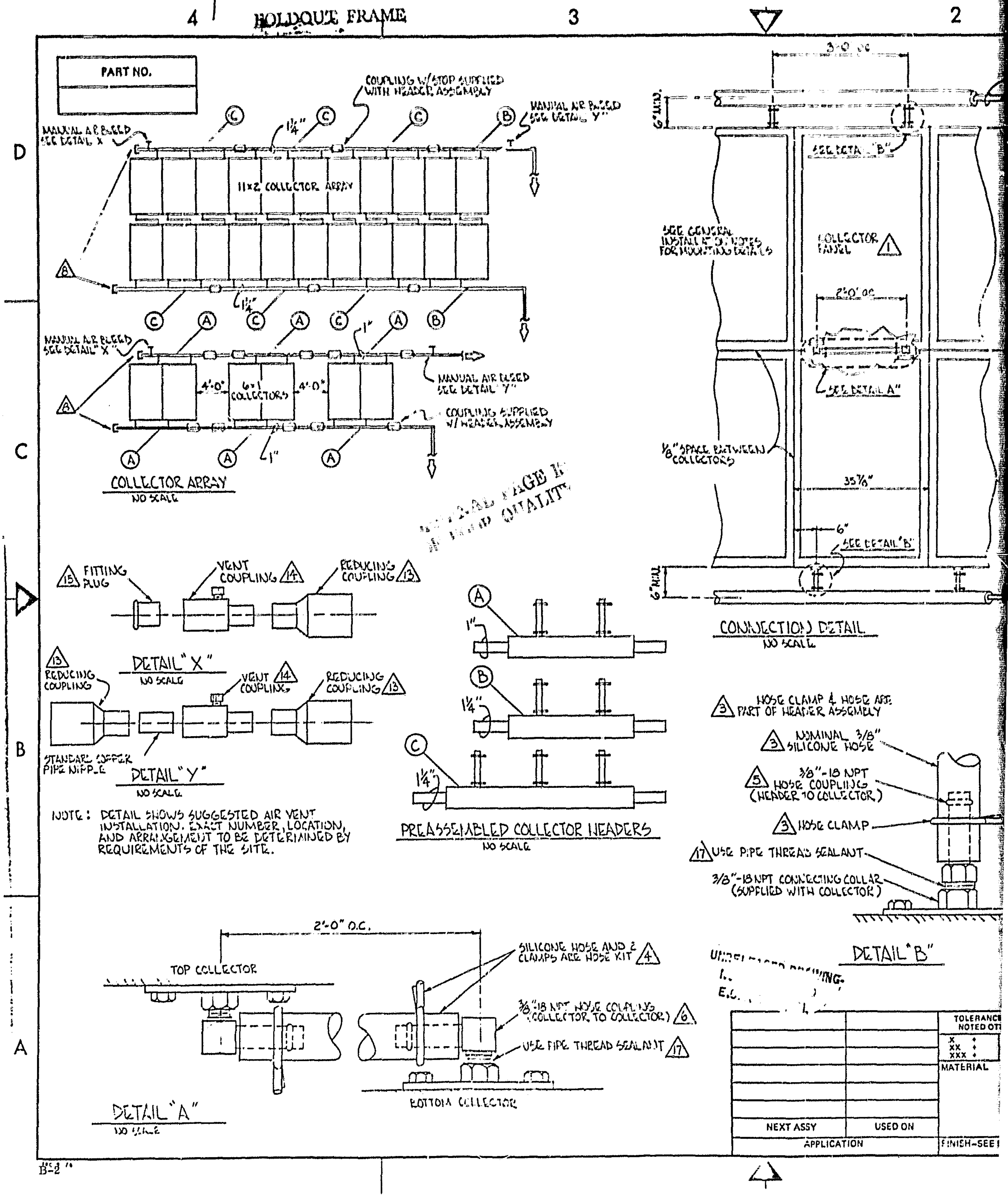
- Insulation — Semirigid Fiberglass Board:
  - — Density — 3 0 lb/ft³
  - — Thermal Conductivity — 0 28 Btu in/hr ft² (at 200°F) (R = 12 5)
  - — Specific Heat — 16 Btu lb °F
  - — Maximum Temperature — 550°F (without outgassing)
- Collector Shipping Weight (lbs) — (1 - Package)
  - LSC18 1S — 143
  - LSC18 1 — 170
- Collector Net Weight (lbs)
  - LSC18 1S — 123
  - LSC18 1 — 150

A

TYPICAL APPLICATIONS






HOLDOUT FRAME
4
3
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D
C
B
A
PART NO.
COUPLING W/STOP SUPPLIED WITH HEADER ASSEMBLY
MANUAL AIR BLEED SEE DETAIL "X"
MANUAL AIR BLEED SEE DETAIL "Y"
1¼"
11x2 COLLECTOR ARRAY
1"
4'-0"
6x1 COLLECTORS
MANUAL AIR BLEED SEE DETAIL "Y"
COUPLING SUPPLIED W/ HEADER ASSEMBLY
COLLECTOR ARRAY
NO SCALE
FITTING PLUG
VENT COUPLING
REDUCING COUPLING
DETAIL "X"
NO SCALE
STANDARD COPPER PIPE NIPPLE
DETAIL "Y"
NO SCALE
NOTE: DETAIL SHOWS SUGGESTED AIR VENT INSTALLATION. EXACT NUMBER, LOCATION, AND ARRANGEMENT TO BE DETERMINED BY REQUIREMENTS OF THE SITE.
PREASSEMBLED COLLECTOR HEADERS
NO SCALE
3'-0" OC
6" MIN.
SEE DETAIL "B"
SEE GENERAL INSTALLATION NOTES FOR MOUNTING DETAILS
COLLECTOR PANEL
2'-0" OC
SEE DETAIL "A"
⅛" SPACE BETWEEN COLLECTORS
35⅞"
6"
CONNECTION DETAIL
NO SCALE
HOSE CLAMP & HOSE ARE PART OF HEADER ASSEMBLY
NOMINAL 3/8" SILICONE HOSE
3/8"-18 NPT HOSE COUPLING (HEADER TO COLLECTOR)
HOSE CLAMP
USE PIPE THREAD SEALANT
3/8"-18 NPT CONNECTING COLLAR (SUPPLIED WITH COLLECTOR)
DETAIL "B"
2'-0" O.C.
TOP COLLECTOR
SILICONE HOSE AND 2 CLAMPS ARE HOSE KIT
3/8"-18 NPT HOSE COUPLING (COLLECTOR TO COLLECTOR)
USE PIPE THREAD SEALANT
BOTTOM COLLECTOR
DETAIL "A"
NO SCALE
TOLERANCE NOTED OT
X
XX
XXX
MATERIAL
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USED ON
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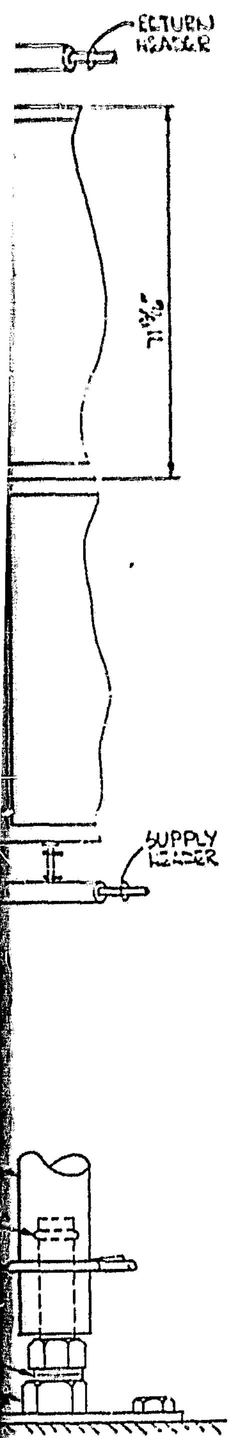

GENERAL INSTALLATION NOTES

Single-Stack Collector Array

1. Screw header-to-collector coupling into both collector ends, place collector on support structure, and fasten (bolts, etc.) collector to structure. Repeat for all collector modules.

2. Connect pre-assembled return header sections to top of collector array with section-to-section couplings placed at all joints. Lubricate bead at end of coupling with liquid detergent soap (or equivalent) prior to slipping hose over coupling. After proper alignment solder header sections together. Insulate and weatherproof uninsulated sections of header. Strap header to support structure.

3. Repeat #2 for pre-assembled supply header sections at bottom of collector array.

Double-Stack Collector Array

1. For bottom row collector screw header-to-collector coupling into bottom end of collector and collector-to-collector coupling into top end of collector. Place collector on support structure and fasten to structure (bolts at bottom end and insert clips at top end).

2. Place 2 x 4 wood stud at top end of collector with wide face flat against support structure.

3. For second stack collector screw collector-to-collector coupling into bottom end of collector and header-to-collector coupling into top end of collector.

4. Lower collector down structure until it rests against wood stud, and connect fluid lines with 24 in. silicone hose clamping each end to coupling. Lubricate bead at end of coupling with liquid detergent soap (or equivalent) prior to slipping hose over coupling.

5. Remove 2 x 4 wood stud and lower collector such that mounting brackets slide into clips. Fasten top mounting brackets (bolts) to structure.

6. Repeat #1 - #5 for entire collector array.

7. Connect pre-assembled return header sections same as #2 for single-stack array.

8. Connect pre-assembled supply header sections same as #2 for single-stack array.

Triple-Stack Collector Array

The procedure is an extension of the double stack collector array installation notes.

Insulation Notes

Put insulation tube around header. Apply insulation adhesive in longitudinal slit of insulation tube and between seams at ends of tubes.

TOLERANCES UNLESS NOTED OTHERWISE	CRAFTSMAN	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
.X ± .XX ± .XXX ±	CHECKER	SINGLE FAMILY RESIDENCE COLLECTOR SUBSYSTEM	
MATERIAL	DEV ENGR	SIZE C	CODE IDENT NO. 55513
	ENGRG MGT	DRAWING NO. [illegible]-142101	
	CONTRACT NO.		
	NEW CASTLE		
FINISH-SEE NOTE		SCALE	SHEET 2 OF 4

CONTROL A

4 3

D

C

B

A

FOLDOUT FRAME

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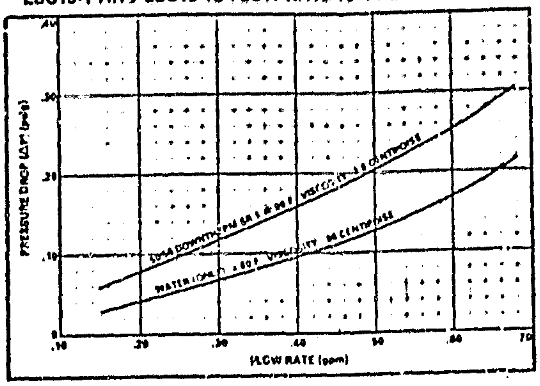
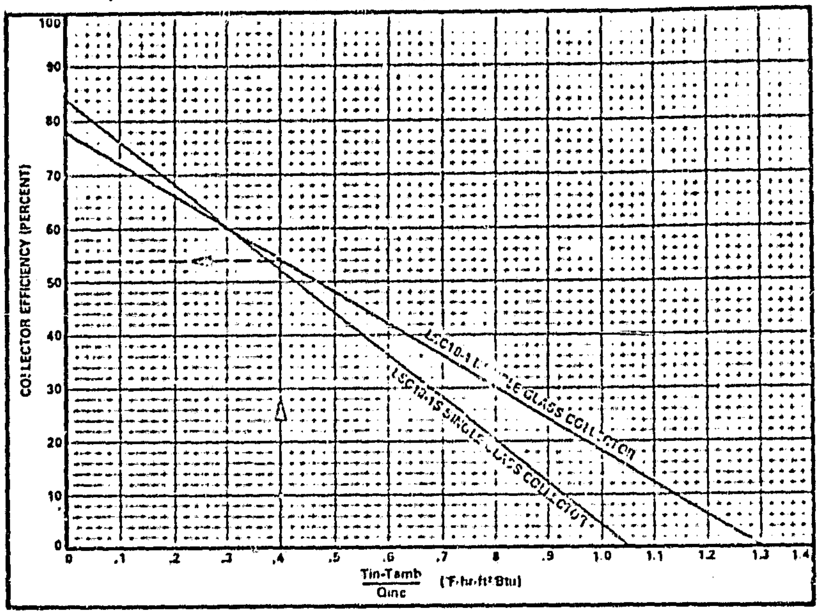
PART NO.

LSC18-1 AND LSC18-1S FLOW RATE vs. PRESSURE DROP



COLLECTOR PERFORMANCE



Tin = Fluid temperature at collector inlet (°F).

Tamb = Ambient temperature surrounding the collector (°F).

Qinc = Incident solar radiation (Btu/hr-ft²).

$$\frac{\text{Fluid Inlet Temperature} - \text{Ambient Temperature}}{\text{Incident Solar Radiation}}$$

EXAMPLE:

To determine the Btu capacity of the collector the fluid inlet temperature, ambient temperature and incident solar radiation (insolation) of the collector must be determined. Assuming an inlet temperature of 110°F and an ambient temperature of 10°F results in 100°F temperature difference. Dividing the temperature difference (100°F) by the incident solar radiation 250Btu/hr-ft² equals .40 (see sample calculation). Refer to the collector performance chart and following the example line shown from .40 (bottom scale) to the intersecting point with the collector curve and reading across to the collector efficiency scale read 54% efficiency. Thus 54% of the incident solar value of 250 Btu/hr-ft² results in 135 Btu hr-ft² output capacity of the collector under the conditions used in this example.

For representative values of Incident Solar Radiation (Q inc) see table below or the 1972 ASHRAE Handbook of Fundamentals, chapter 22, pages 388 thru 392.

SAMPLE CALCULATION:

$$\frac{Tin - Tamb}{Qinc} = \frac{110 - 10}{250} = 0.40$$

Qinc x 0.54 = 135 Btu/hr-ft² Output

ANNUAL MINIMUM AND MAXIMUM DAYS OF SOLAR INCIDENCE (Clear Sky)

SOLAR TIME	24 North Latitude		32 North Latitude		40 North Latitude		[illegible] North Latitude		56° North Latitude	
	[illegible] SOLAR RADIATION (Q inc) Btu hr ft²									
	Dec. 21	June 21	Dec. 21	June 21	Dec. 21	June 21	Dec. 21	June 21	Dec. 21	June 21
6 AM	—	[illegible]	—	[illegible]	...	[illegible]	...	172	...	[illegible]
7 AM	[illegible]	[illegible]	...	[illegible]	...	[illegible]	...	[illegible]	...	[illegible]
8 AM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	[illegible]	...	[illegible]
9 AM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	140	[illegible]	5	[illegible]
10 AM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	113	[illegible]
11 AM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	242	[illegible]	[illegible]	[illegible]
12 NOON	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1 PM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 PM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	214	[illegible]	113	[illegible]
3 PM	[illegible]	[illegible]	[illegible]	[illegible]	217	[illegible]	[illegible]	[illegible]	5	[illegible]
4 PM	[illegible]	242	[illegible]	[illegible]	[illegible]	[illegible]	...	[illegible]	...	[illegible]
5 PM	23	[illegible]	...	[illegible]	...	[illegible]		[illegible]		[illegible]
6 PM	...	97	...	[illegible]	...	[illegible]		172		[illegible]

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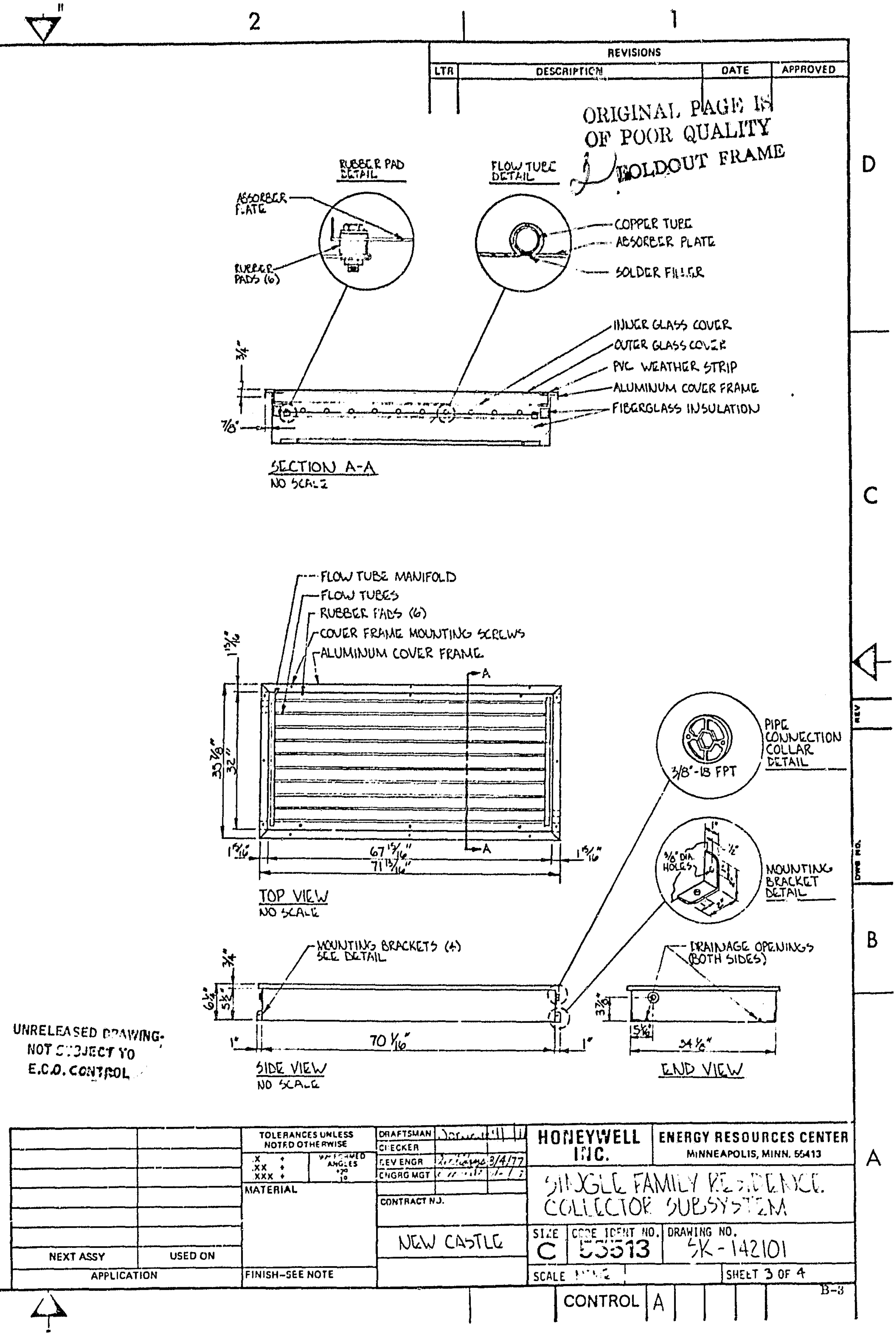
NEX[illegible]



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FOLDOUT FRAME
RUBBER PAD DETAIL
ABSORBER PLATE
RUBBER PADS (6)
FLOW TUBE DETAIL
COPPER TUBE
ABSORBER PLATE
SOLDER FILLER
INNER GLASS COVER
OUTER GLASS COVER
PVC WEATHER STRIP
ALUMINUM COVER FRAME
FIBERGLASS INSULATION
3/4"
7/8"
SECTION A-A
NO SCALE
FLOW TUBE MANIFOLD
FLOW TUBES
RUBBER PADS (6)
COVER FRAME MOUNTING SCREWS
ALUMINUM COVER FRAME
A
35 7/8"
32"
1 15/16"
67 15/16"
71 13/16"
TOP VIEW
NO SCALE
PIPE CONNECTION COLLAR DETAIL
3/8"-18 FPT
MOUNTING BRACKET DETAIL
3/8" DIA. HOLES
MOUNTING BRACKETS (4) SEE DETAIL
70 1/16"
1"
SIDE VIEW
NO SCALE
DRAINAGE OPENINGS (BOTH SIDES)
34 1/8"
END VIEW
UNRELEASED DRAWING-
NOT SUBJECT TO
E.C.O. CONTROL
TOLERANCES UNLESS NOTED OTHERWISE
ANGLES
MATERIAL
FINISH—SEE NOTE
NEXT ASSY
USED ON
APPLICATION
DRAFTSMAN
CHECKER
DEV ENGR
ENGRG MGT
3/4/77
CONTRACT NO.
NEW CASTLE
HONEYWELL INC.
ENERGY RESOURCES CENTER
MINNEAPOLIS, MINN. 55413
SINGLE FAMILY RESIDENCE
COLLECTOR SUBSYSTEM
SIZE
C
CODE IDENT NO.
53513
DRAWING NO.
SK-142101
SCALE
SHEET 3 OF 4
CONTROL
A

FOLDOUT FRAME 1

4 | 3 | 2

PART NO.

D

PURGE COIL DESCRIPTION

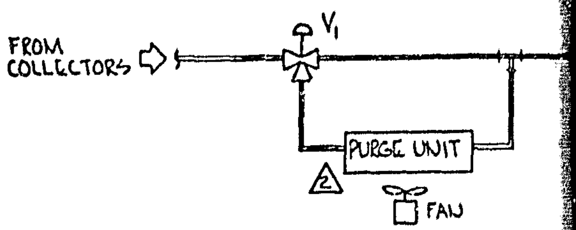
Heat Capacity and Pressure Drop

Height of the coil	=	25"
Length of the coil	=	20"
No. of rows	=	2
No. of fins/inch	=	15
Outer dia. of tubes	=	1/2"
No. of circuits	=	10
Air flow rate	=	2000 CFM
HP of fan motor	=	1/5

Assumed air temp. at the suction side of the fan = 60-120°F

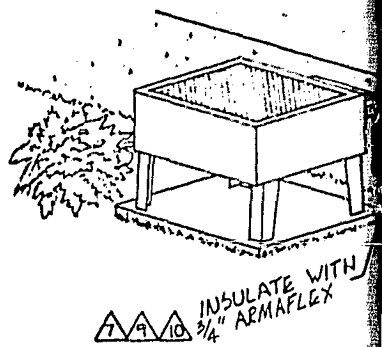
Calculated heat dissipated/hr = 101,000-156,000 Btu/hr. (Inlet Fluid Temp. = 230°F 50% glycol solution)

Pressure drop (calculated) in the Purge coil ≈ 9.0 ft. ≈ 3.9 PSI



SCHEMATIC - PURGE
NO SCALE

C

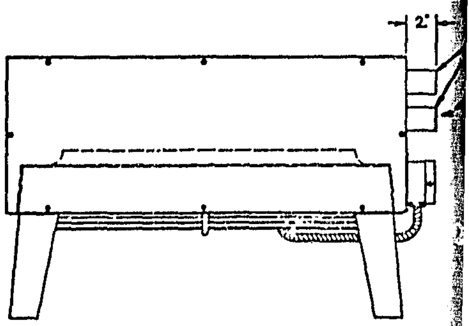


INSTALLATION NOTES

PLUMBING: Connect the inlet and outlet manifolds (1 5/8", O.D., copper tube) of the purge coil to the desired pipes in the collector loop.

ELECTRICAL: Connect the motor of the purge coil fan to the control panel.

B



PURGE COIL UNIT (HEAT REJECT...
1½" = 1'-0"

A

		TOLER. NOTES
		X ± / .XX ± / .XXX ±
		MATERIA
NEXT ASSY	USED ON	
APPLICATION		FINISH-

2

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2 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

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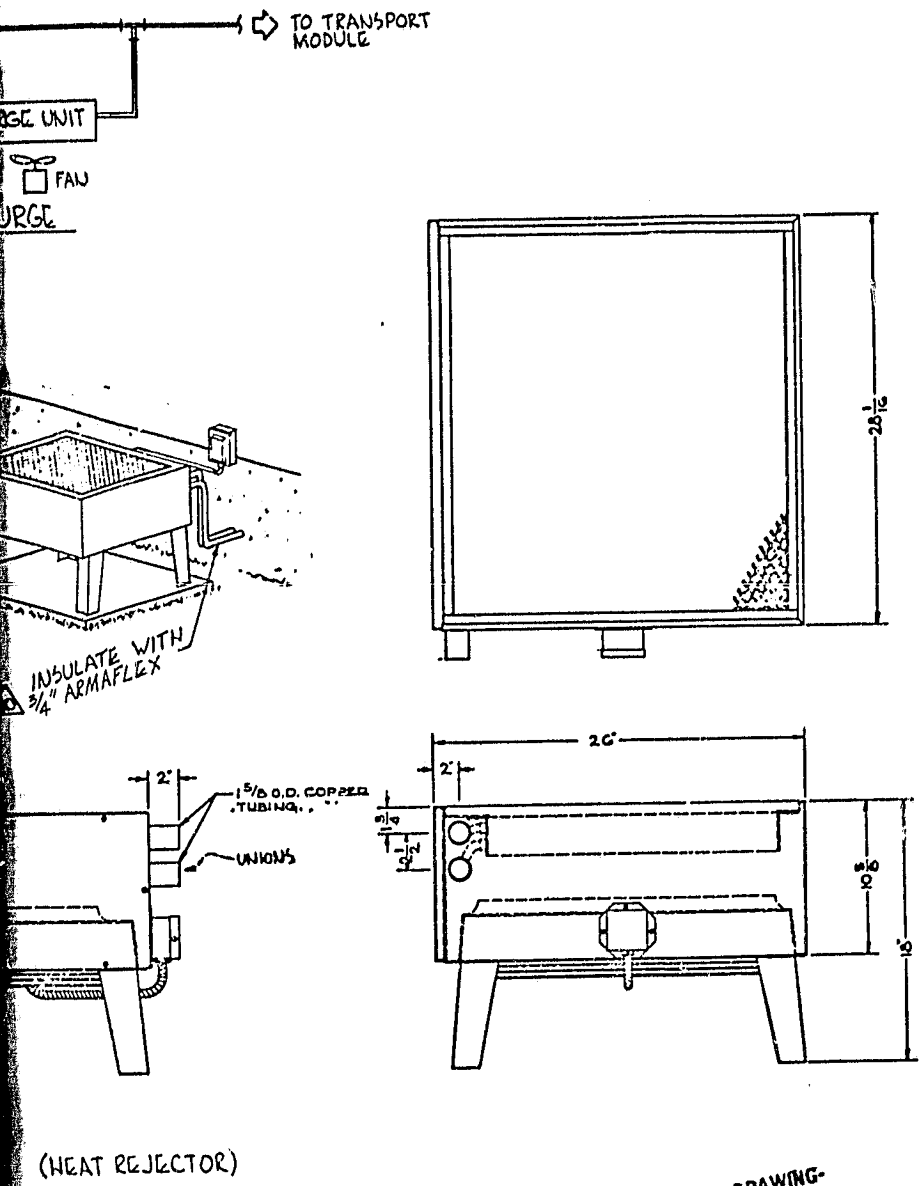

C

B

UNRELEASED DRAWING-
NOT SUBJECT TO
E.C.O. CONTROL

A

TOLERANCES UNLESS NOTED OTHERWISE	DRAFTSMAN		HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
.X ± .XX ± .XXX ± / 90° FORMED ANGLES ±2° ±1°	CHECKER		SINGLE FAMILY RESIDENCE COLLECTOR SUBSYSTEM	
	DEV ENGR			
	ENGRG MGT			
MATERIAL	CONTRACT NO.		SIZE C	CODE IDENT NO. 55513 — DRAWING NO SK-142101
USED ON	NEW CASTLE			
FINISH-SEE NOTE			SCALE	SHEET 4 OF 4

CONTROL A

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PART NO.
[illegible]-142064

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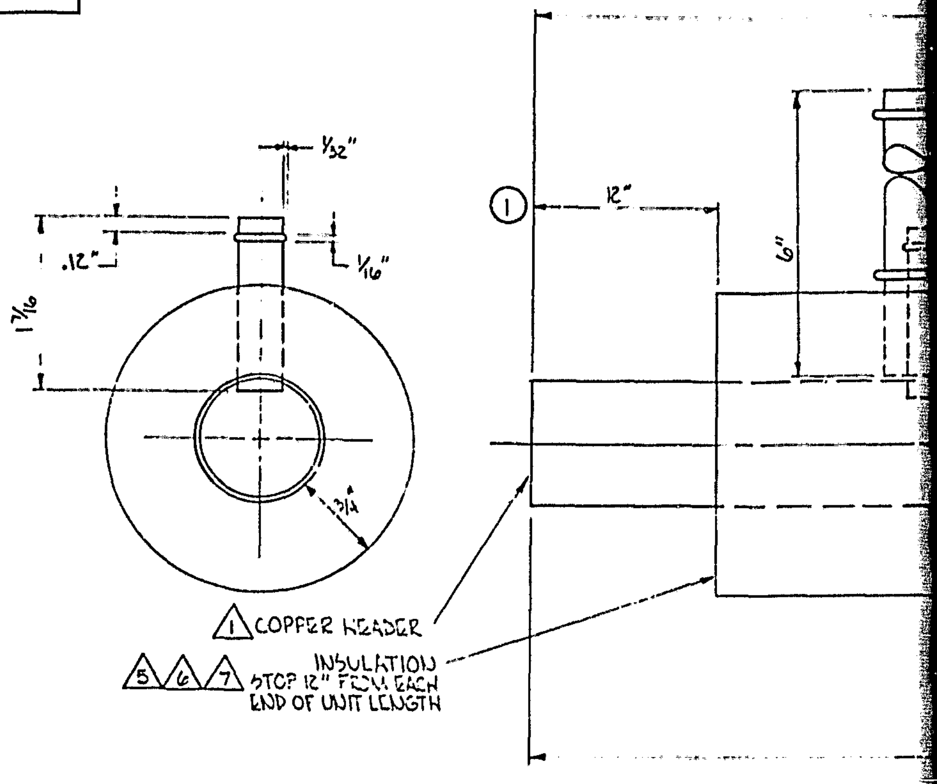

FABRICATION NOTES

1. 12" LEFT UNINSULATED ON EACH END OF UNIT LENGTH IN TABULATION
2. HOSE CLAMP LOCATED ADJACENT TO OUTER SURFACE OF INSULATION
3. SEAL SLIT ALONG INSULATION W/ INSULATION ADHESIVE

A PREFABRICATED

1) COPPER HEADER SECTIO
2) HOSE COUPLING (5) SOL
3) ONE 6" LONG SIL CONE
4) TWO HOSE CLAMPS (PER
5) FLEXIBLE INSULATION HEADER SIZE CHART)
6) ONE COPPER COUPLING (
7) 25" LONG PIECE OF FL PROOFED SURFACE)

MATERIAL SCHEDULE

ITEM *	ITEM	MANUFACTURER	TYPE/PART NO.	QUANTITY
* 1	COPPER HEADER	REVERE	M	PER CHART
* 2	NOM. 3/8" COUPLING	BAUER WELDING & METAL	CUSTOM MADE	PER CHART
3	NOM. 3/4" HOSE CLAMP	EATON CORP.	R-12	PER CHART
4	NOM. 3/8" SILICONE HOSE	AEROQUIP	FC252-6	PER CHART
* 5	INSULATION (3/4" THICK)	ARMSTRONG CORK CO.	ARMAFLEX	PER CHART
* 6	INSULATION ADHESIVE	ARMSTRONG CORK CO.	520 ADHESIVE	AS REQ'D.
* 7	INSULATION FINISH	ARMSTRONG CORK CO.	ARMAFLEX FINISH	AS REQ'D.
* 8	COPPER COUPLING W/ STOPS	NIBCO	600 SERIES	1/ASSEMBLY

* "ITEMS LISTED OR EQUIVALENT"

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REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	[illegible]	1-14-77	[illegible]

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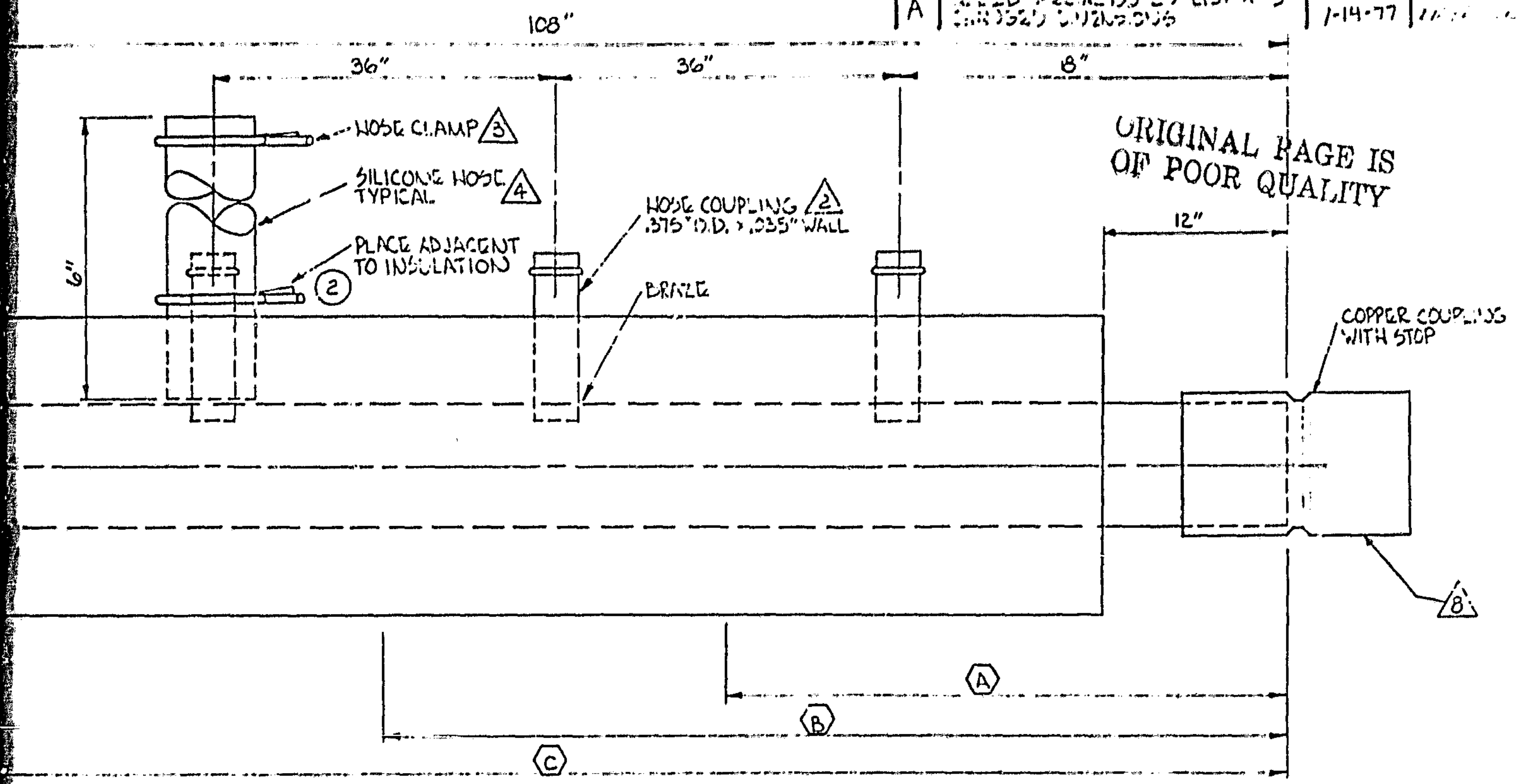


A PREFABRICATED HEADER ASSEMBLY CONSISTS OF THE FOLLOWING:

OPPER HEADER SECTION (DIAMETER & LENGTH PER HEADER SIZE CHART)
OSE COUPLING(S) SOLDER TO HEADER (PER HEADER SIZE CHART)
E 6" LONG SIL CONE HOSE (PER HOSE COUPLING)
O HOSE CLAMPS (PER HOSE COUPLING)
EXIBLE INSULATION 3/4" THICK (WITH WEATHERPROOF SURFACE PER
EADER SIZE CHART)
E COPPER COUPLING (PER HEADER ASSEMBLY)
5" LONG PIECE OF FLEXIBLE INSULATION 3/4" THICK (WITH WEATHER-
ROOFED SURFACE)

HEADER SIZE CHART

		DIAMETER				NUMBER OF HOSE COUPLINGS	WEATHERPROOFED INSUL. LENGTH
		-1	-2	-3			
		3/4"	1"	1¼"			
LENGTH	A	36"	36"	36"		1	12"
	B	72"	72"	72"		2	48"
	C	108"	108"	108"		3	84"
COPPER COUPLING WITH STOP		3/4"x3/4"	1"x1"	1¼"x1¼"			

ART NO.	QUANTITY
	PER CHART
MADE	PER CHART
	PER CHART
6	PER CHART
EX	PER CHART
ESIVE	AS REQ'D.
K FINISH	AS REQ'D.
IES	1/ASSEMBLY

UNRELEASED DRAWING NO. E.C.J. C... ...

NEXT ASSY	USED ON	TOLERANCES UNLESS NOTED OTHERWISE .X ± .XX ± .XXX ± ANGLES	DRAFTSMAN / CHECKER / DEV ENGR / ENGRG MGT
APPLICATION		MATERIAL / FINISH—SEE NOTE	CONTRACT NO.

HONEYWELL INC. — ENERGY RESOURCES CENTER, MINNEAPOLIS, MINN. 55413

HEADER ASSEMBLY - COLLECTOR

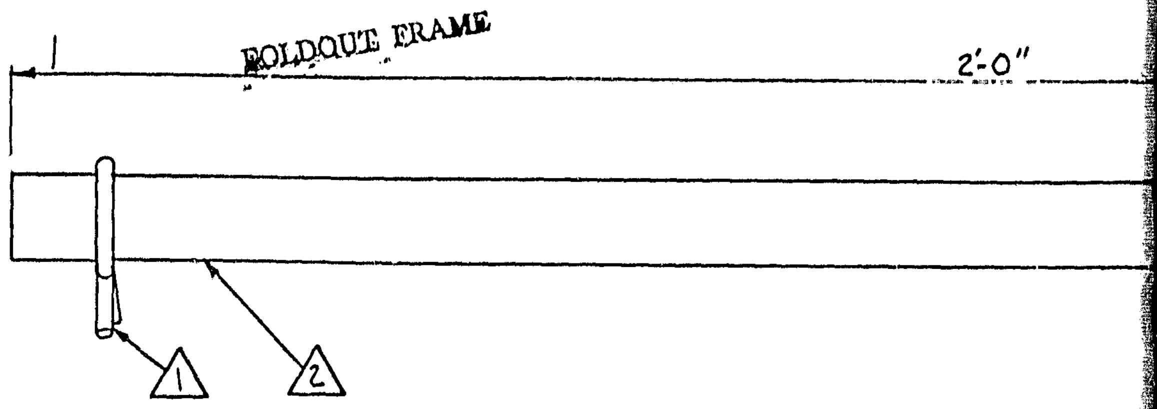
SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK 142064

SCALE NONE — SHEET 1 OF 1

CONTROL A

REV A — DWG NO. SK-142064

PART NO.



B-6

MATERIAL SCHEDULE

ITEM #	ITEM	MANUFACTURER	TYPE/PART NO.	QU
1	NOM. ¾" HOSE CLAMP	EATON CORP.	R-12	
2	NOM. ⅜" SILICONE HOSE	AEROQUIP	FC252-6	

		TOL NO
		.X .XX .XXX
		MATER
NEXT ASSY	USED ON	
APPLICATION		FINISH

IRC 9/76

DWG NO. SK-142066

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	ADDED MATERIAL SCHEDULE	7-14-77	[illegible]

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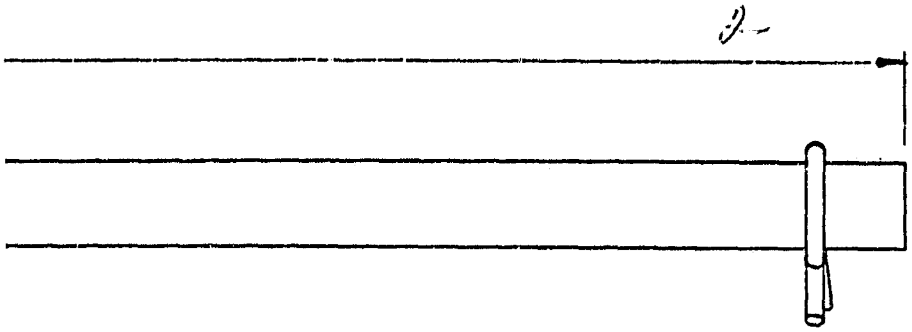


NTITY
2
2 FT.

IANCES UNLESS D OTHERWISE	DRAFTSMAN	Donahue	6/30/77	HONEYWELL INC. / ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
90° FORMED ANGLES ±2° .10	CHECKER			
	DEV ENGR			
	ENGRG MGT	[illegible]	[illegible]	HOSE ASSEMBLY - COLLECTOR TO COLLECTOR
AL	CONTRACT NO.			
SEE NOTE				

SIZE	CODE IDENT NO.	DRAWING NO.
B	55513	SK-142066
SCALE		SHEET 1 OF 1

CONTROL | A

APPENDIX C

STORAGE SUBSYSTEM
DRAWING NO. SK142050

PART NO.

D

STORAGE SUBSYSTEM

The solar energy which cannot be used for space heating/cooling is stored for future use. This stored energy will be available for domestic hot water heating and space heating at nite or on cloudy d This energy is stored in water, contained in a lined and insulated st tank. The capacity of the tank is 1000 gallons. It should be install at the residence above ground. Valves activated by the control sys permit charging or discharging.

C

Specifications

Nominal capacity - 1000 gallons
Material #10 gauge cold rolled steel
Size, 64" diameter x 72" long
Domestic hot water coil included in tank
Lining, coal tar epoxy
Exterior painted with primer and shop coat of enamel
Tank empty weights approx. 860 lbs.
Filled tank weights approx. 9,205 lbs.
18" manhole provided for internal access
11 penetrations are provided for inlets/outlets
and temperature sensor installations.

Installation Notes

1/1 — Above grade installation should be enclosed with partition and tank engulfed in blown fiberglass insulation.

2/1 — Tank should be filled with 1500 mg/l sodium nitrite corrosion inhib Norman Chemical, Product No. 284 or equivalent. (6GRAINS/GALL

3/1 — All sweat connections shall use only 95-5 solder.

B

A

2 FOLDOUT FRAME

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	REVISED MATERIAL SCHEDULE AND CORRECTED INSULATION NOTES	7-14-77	[illegible]

MATERIAL SCHEDULE

INSTALLATION NOTE NO.	ITEM*	ITEM	MANUFACTURER	TYPE/PART NO.	QUAN.
2/1	1	TANK - SOLAR H.W. STORAGE	HONEYWELL	SK-142008	1
1/1 *	2	TANK INSULATION (BLOWN FIBERGLASS)	CONWED CORP.	BW-0010	AS REQ'D
	3	INSULATING REDWOOD BOARDS	ANY	—	1
*	4	DRAIN VALVE W/HOSE BIB	NIBCO	BOILER DRAIN 74-3/4	1
3/1 *	5	COPPER ADAPTER NOM. 1"	NIBCO	604-1	2
*	6	COPPER PIPE NOM. 1"	REVERE	M	AS REQ'D
*	7	INSULATION (3/4" THICK)	ARMSTRONG CORK CO.	ARMAFLEX STANDARD	AS REQ'D
*	8	INSULATION ADHESIVE	ARMSTRONG CORK CO.	520	AS REQ'D
*	9	VENT CAP NOM. 1½"	CLAY & BAILEY	300-3/4	1
3/1 *	10	COPPER PIPE NOM. 1½"	REVERE	M	AS REQ'D
*	11	COPPER ELBOW NOM. 1½" x 1½"	NIBCO	607-1½	1
*	12	CAST BRONZE ADAPTER 1½"C x 3/4" MPT	NIBCO	704-1½ x 3/4	2

* ALL ITEMS LISTED "OR EQUIVALENT"

TOLERANCES UNLESS NOTED OTHERWISE .X ± .XX ± .XXX ±	CRAFTSMAN / CHECKER / DEV ENGR / ENGRG MGT	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413	
MATERIAL	CONTRACT NO.	SINGLE FAMILY RESIDENCE STORAGE SUBSYSTEM		
NEXT ASSY / USED ON	WILLIAM O'BRIEN	SIZE C	CODE IDENT NO. 55513	DRAWING NO. SK-142050
APPLICATION / FINISH-SEE NOTE	NEW CASTLE	SCALE		SHEET 1 OF 2

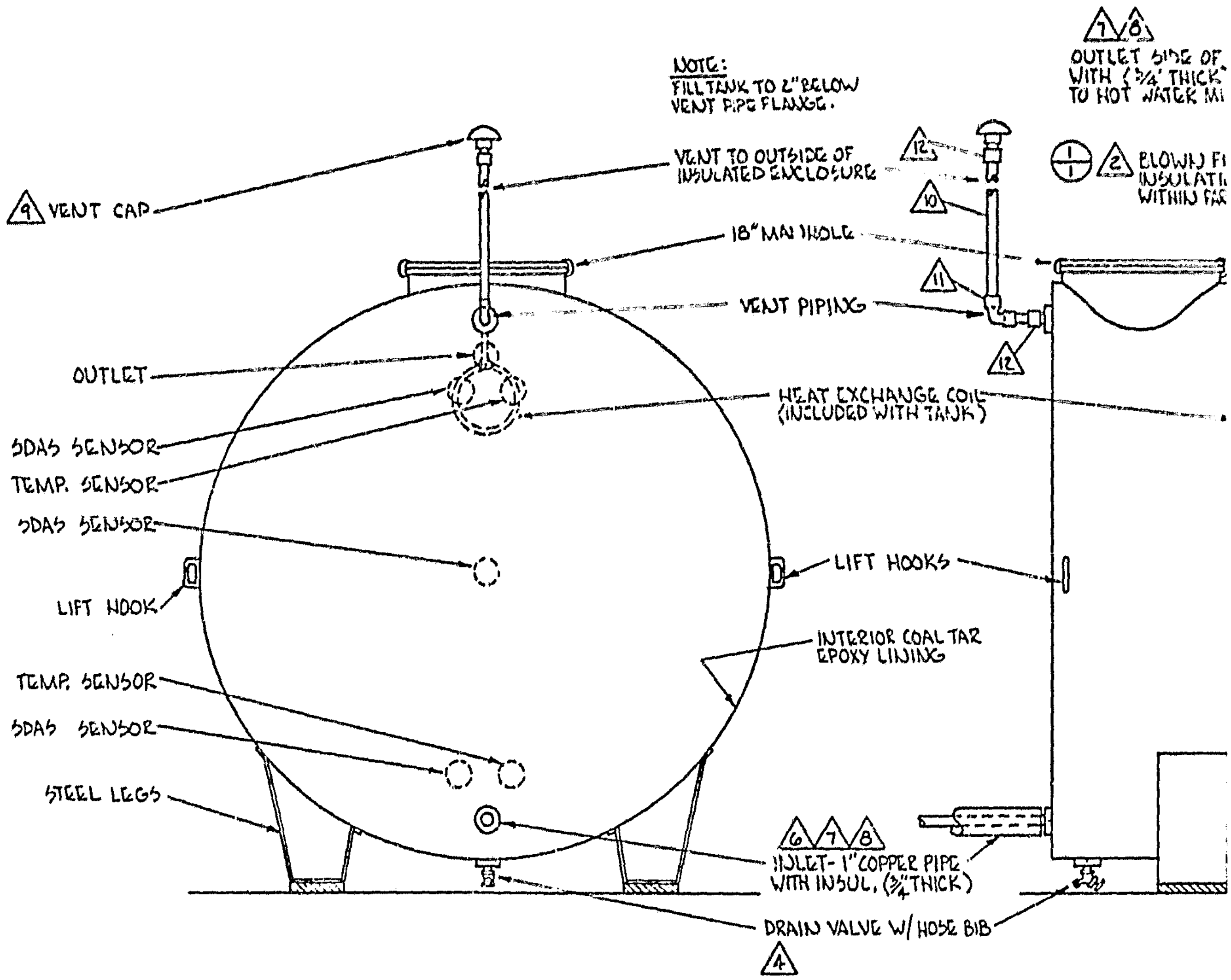
CONTROL A

C-1

REV A DWG NO. SK-142050

PART NO.

FOLDOUT FRAME



STORAGE TANK 1
1" = 1'-0"

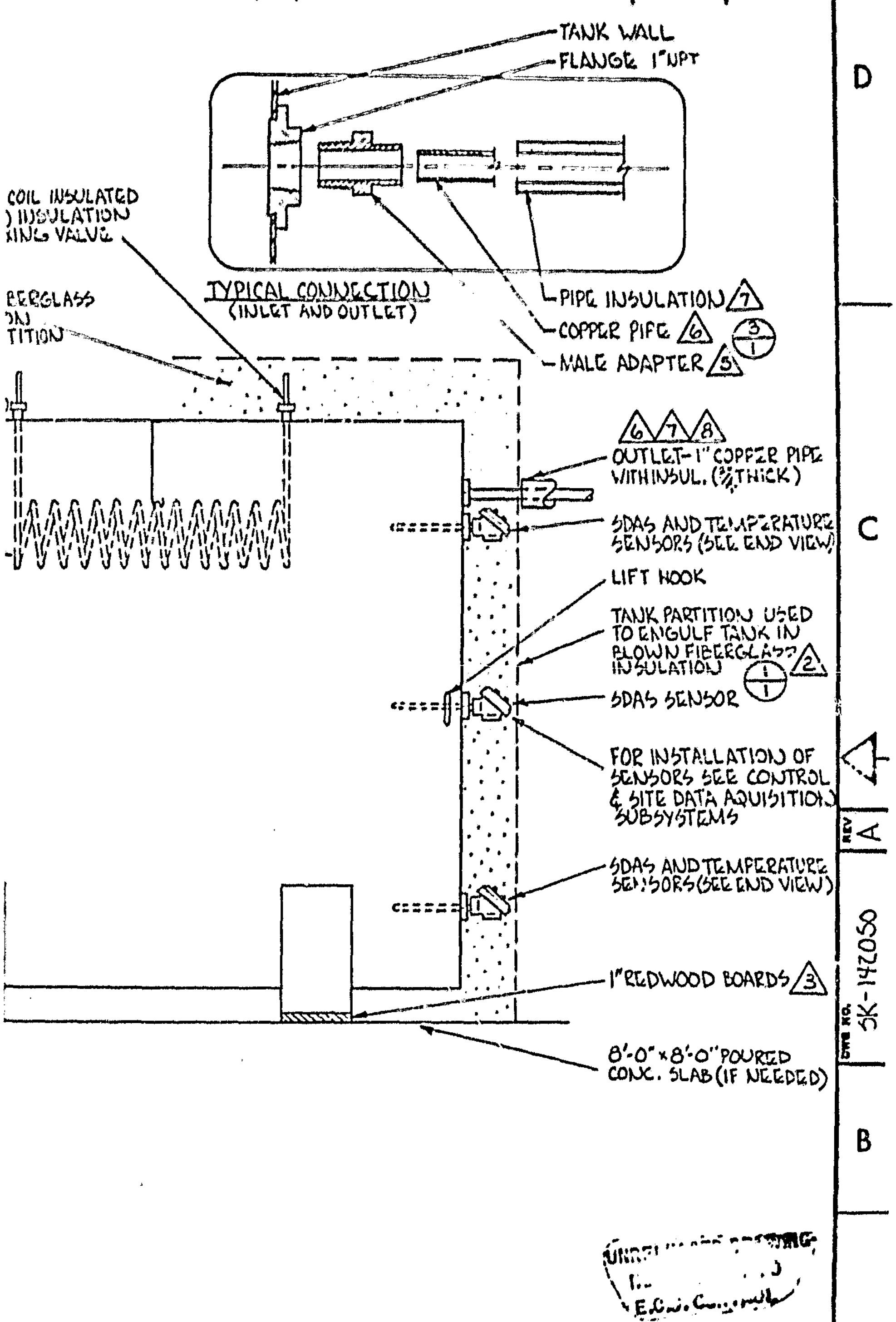
64" DIA. 72" LONG
1000 GALLONS

NEXT ASSY	USED ON
APPLICATION	

2

FOLDOUT FRAME

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



TOLERANCES UNLESS NOTED OTHERWISE
X ±
XX ±
XXX ±
90° FORMED ANGLES

ATERIAL

NISH–SEE NOTE

DRAFTSMAN	6/25/77
CHECKER	
DEV ENGR	
ENGRG MGT	
CONTRACT NO.	

WILLIAM O'BRIEN

NEW CASTLE

HONEYWELL INC. | **ENERGY RESOURCES CENTER** MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE STORAGE SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142050

SCALE | SHEET 2 OF 2

CONTROL A

PART NO.

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED
A	STRAIGHTENED ENDS OF COIL	8/3/77	

Specifications

Material - copper alloy-ASTM-B359-B111
Length - approx. 33 feet
No. of Coils - 17
Coil I.D. - 5 3/4" (± 1/8")
Tubing Diam. - nom. 3/4"

NOTES

1) The seller will inspect each coil to the requirements of this specification and for evidence of poor workmanship.

2) The heat coils shall be packaged in suitable protective containers that prevent damage to coil when shipped by United Parcel Service.

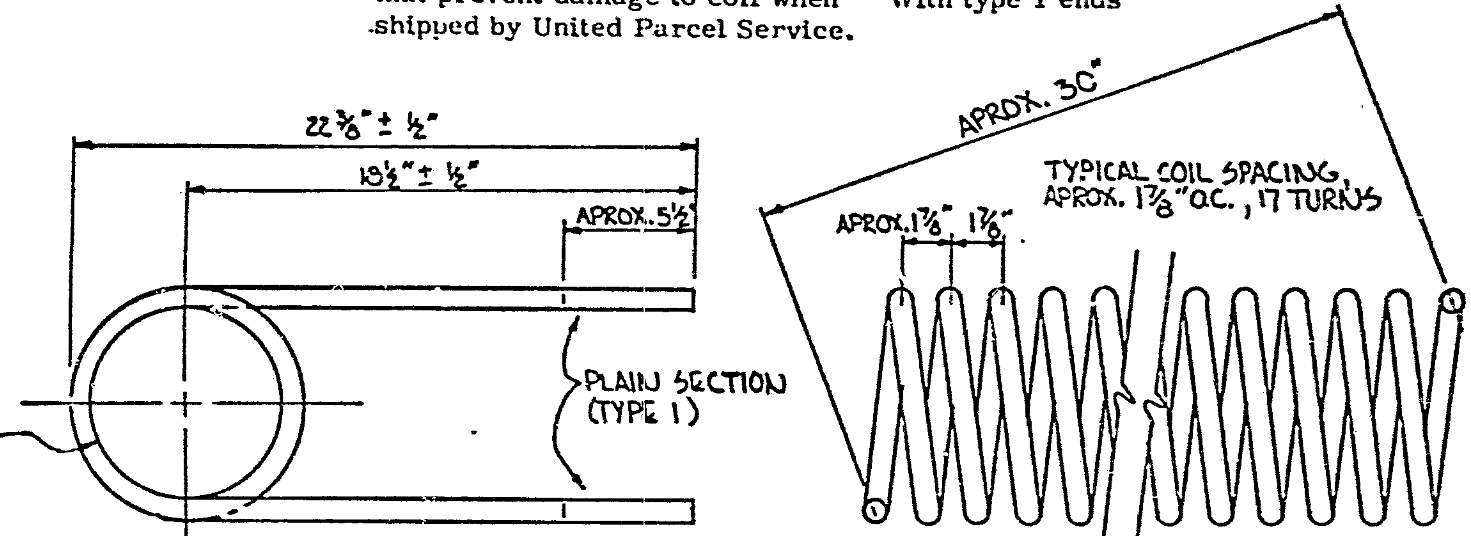
Approved Source

Vender/PN
Wolverine Tube Division
17200 Southfield Rd.
Allen Park, Michigan 48101

Truffin Type W/H
Catalog No. 66-116038-01
With type 1 ends

PROVIDE PLASTIC CAPS TO PROTECT ENDS OF COIL.

TOTAL COIL LENGTH APROX. 33 FT.



		TOLERANCES UNLESS NOTED OTHERWISE	DRAFTSMAN	8/3/77	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
		.X ± .XX ± .XXX ± / 90° FORMED ANGLES ±2° ±1°	CHECKER		HOT WATER COIL	
			DEV ENGR			
		MATERIAL	ENGRG MGT			
			CONTRACT NO.			
			SOURCE CONTROL		SIZE A	CODE IDENT NO. 55513 / DRAWING NO. SK-142047
NEXT ASSY	USED ON				SCALE NONE	SHEET 1 OF 1
APPLICATION		FINISH-SEE NOTE			CONTROL A	

REV A

DWG NO. SK-142047

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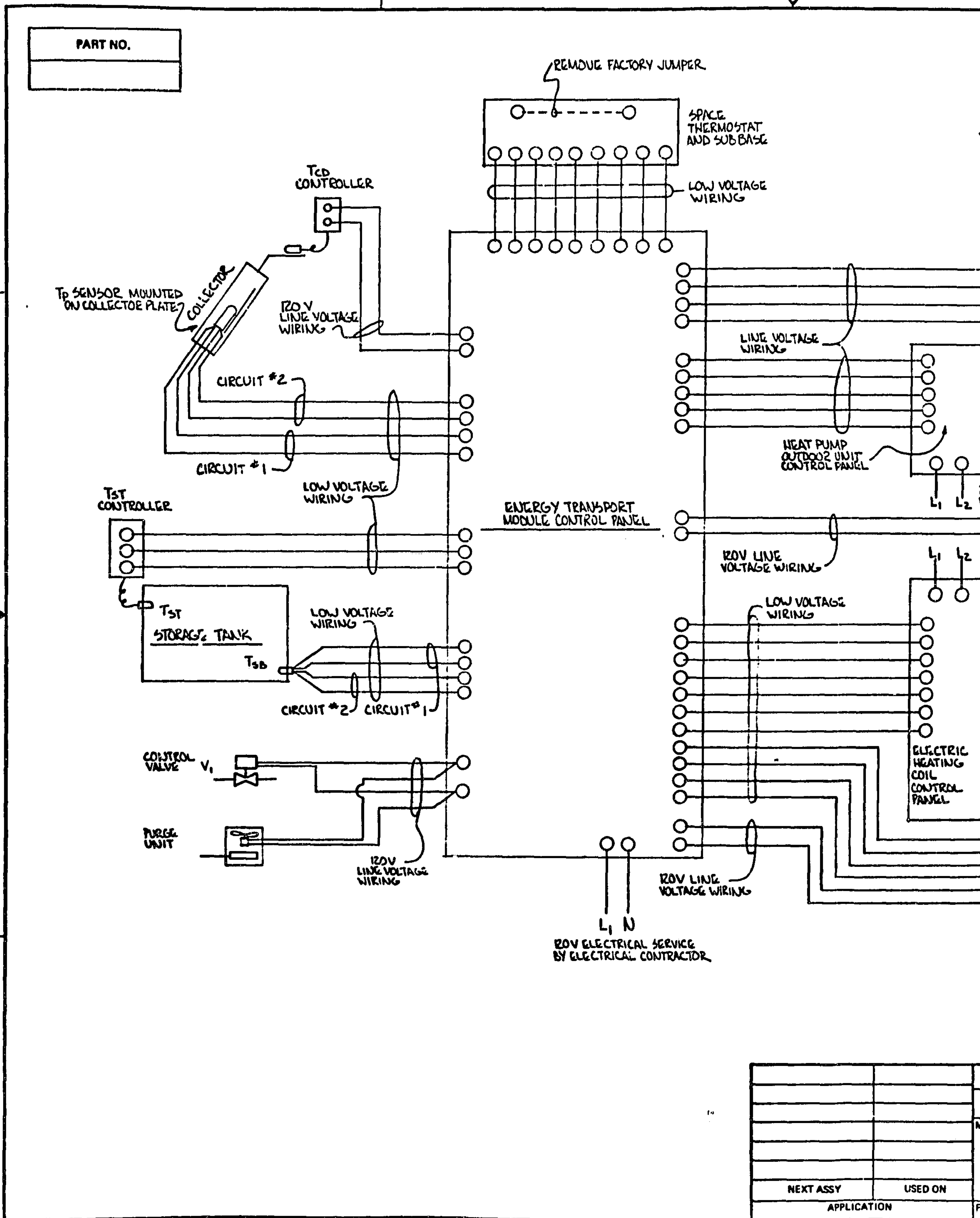


REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME

HEATING SYSTEM - SINGLE FAMILY RESIDENCE
ELECTRICAL SUBSYSTEM

L CONDITIONS

e: The Electrical Subsystem will involve all field
rical wiring necessary to complete the solar heating
em and make it ready for operation.

ired Work: The Electrical Contractor shall provide a
rate branch circuit to each of the following. Values
n are minimum circuit ampacity.

230 V single phase

1.) Heat Pump Outdoor Unit: 24.3 amps

2.) Electric Heating Coil and Heat Pump Indoor Unit: 79.2 amps

3.) Domestic HW Heater: 39.1 amps

120V single phase

1.) Energy Transport Module: 12.9 amps

h branch circuit shall have a circuit breaker or fuse at
n electrical panel, sized per all applicable codes. A
onnect switch shall be provided if required by code.

IATERIALS AND METHODS

ic Materials: All materials shall be supplied by the
ctrical Contractor. All materials shall be as specified
he Architect and required by all applicable codes.

ic Methods: All work shall conform with all applicable
s.

NEXT ASSY	USED ON
APPLICATION	

TOLERANCES UNLESS NOTED OTHERWISE

MATERIAL

FINISH–SEE NOTE

DRAFTSMAN Donahue

CHECKER

DEV ENGR

ENGRG MGT

CONTRACT NO.

NEW CASTLE

HONEYWELL INC. ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE
ELECTRICAL SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142103

SCALE NONE SHEET 1 OF 1

CONTROL A

H-1

2.5 Appurtances

Four tie down lugs also used as lift hooks shall be provided. They shall be made of the same material as the tank shell and sized and located approximately as shown on Figure 2. They shall be attached with continuous double welded joints full length of the lug. Four support saddles shall be fabricated and welded at the tank 1/4 points. The saddles shall be capable of supporting the tanks when filled to capacity with water at 8.3 lbs/gallon.

2.6 Internals

A rod of 1/8" min diameter shall be formed as shown in Figure 2 and welded to the top of the tank to support the heat coil. It should be installed prior to applying the interior lining. The heat coil, Honeywell SK 142047, shall be furnished by buyer and installed by the tank manufacturer. It should be installed after the interior lining is applied.

2.7 Finishes

After final testing the tank shall be dried and cleaned thoroughly inside and outside to remove grease, loose scale, rust, and foreign material.

The interior shall be sandblasted and then a coal tar epoxy (Chem-mastic 2203 or equivalent) shall be applied for a minimum thickness of 0.012".

The exterior shall be primed and painted with a coat of enamel for rust protection.

All welds shall be cleaned of welding slag prior to priming and painting.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL
A	Heat Coil P/N	6-21-77	

3.0 INSPECTION & TESTING

3.1 Drawings

The tank manufacturer, after receipt of purchase order, shall furnish shop drawings to the buyer for approval. These drawings, as well as the Purchase Order and specification, may be used by the buyer to inspect the tank during or after fabrication. An "as built" drawing will be required if changes are authorized during tank fabrication.

3.2 Workmanship

The tank manufacturer shall assure that a) all welds show no evidence of poor workmanship such as porosity, inclusions, cracks, lack of fill, blow holes, incompleteness, etc. b) the location and size of all appurtances,openings, threads and internals meet the print requirements, c) the diameter, length and wall thickness meet the print requirements.

3.3 Inspections

The tank manufacturer shall visually inspect each tank 100% both inside and outside after cleaning and before applying the finishes.

a. After finishing and installation of the heat coil the tank shall be reinspected visually for lack of evidence of use of incorrect materials or poor workmanship such as incomplete coverage, cracks, thin spots, lack of adhesion, runs, etc.

b. Verify that the minimum thickness of the coal tar epoxy is 0.012 inches at random points inside the tank and on the hook or measure the build-up on witness plugs used in the threaded openings and the change in diameter of the hook.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL

3.4 Testing

The tank shall be pressure tested for leaks using air pressure or vacuum and a suitable material such as soap suds or linseed oil for the detection of leaks. All leaks shall be corrected and retested for not less than 15 minutes. The test pressure shall be 3 psi (min) and shall be held for an adequate time to permit thorough inspection in any case not less than 30 minutes.

3.5 Records

The tank manufacturer shall record the results of the inspections and tests of paragraphs 3.3, 3.4. These records shall be mailed to the Buyer at the time of shipment. Each tank shall be identified for record purposes including Purchase Order number and item number.

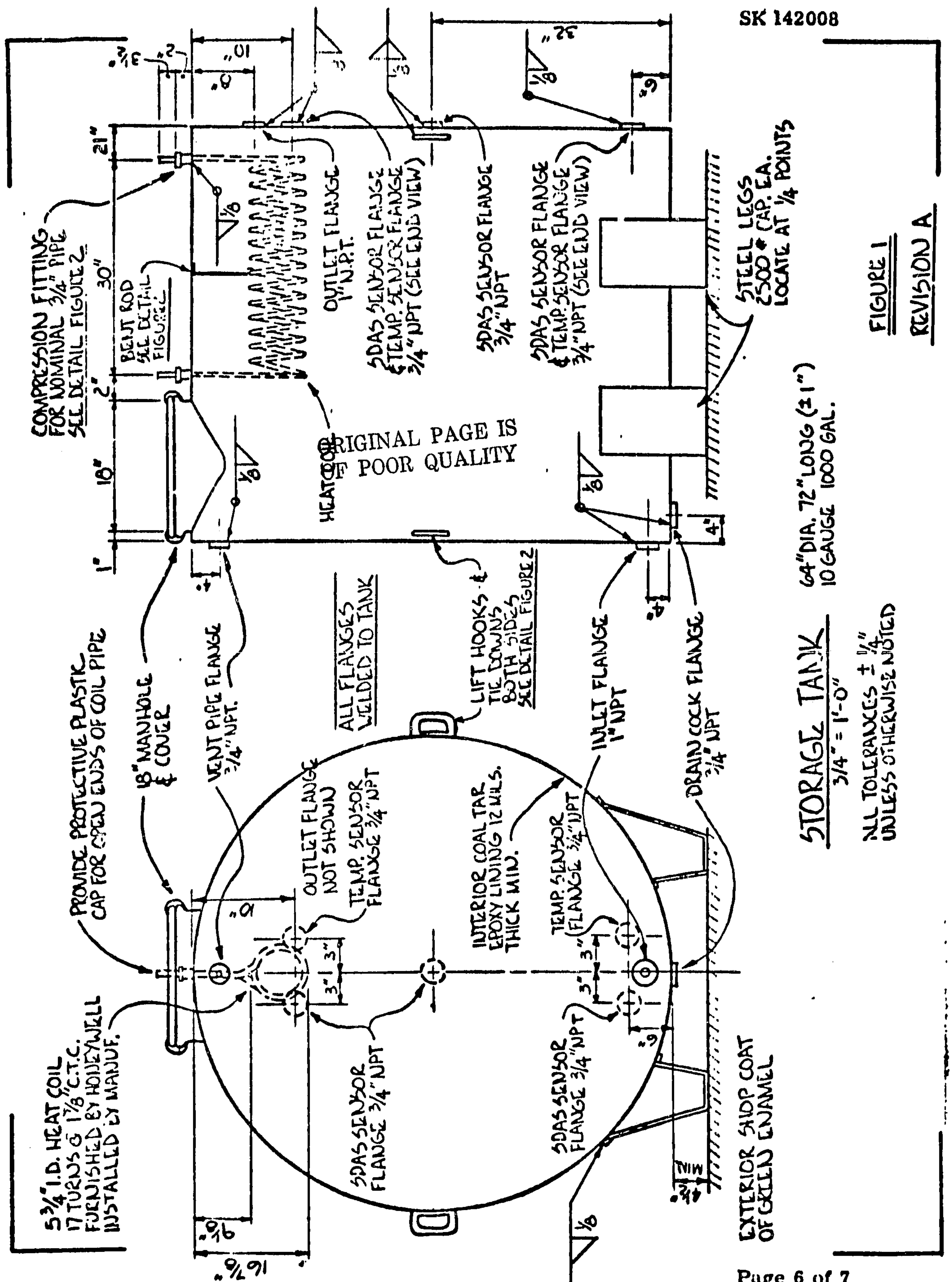
4.0 PREPARATION FOR SHIPMENT

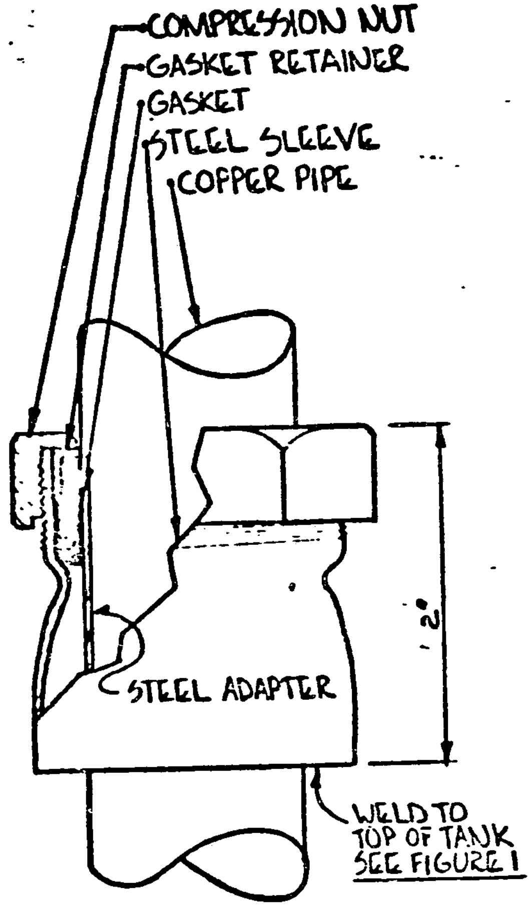
All finished surfaces not otherwise protected shall be coated with rust preventive. Threaded opening shall be plugged and pipes extending beyond tank shall be capped and suitably supported to avoid damages during shipment. Tank shall be clearly identified with purchase order number and item number.

5.0 GUARANTEE

Manufacturer guarantees that the vessel fulfills all conditions as stated in this Specification and that it is free from fault in design, construction, workmanship and material. Should any defect develop during the first year of operation, the manufacturer agrees to make all necessary alterations, repairs and replacements free of charge.

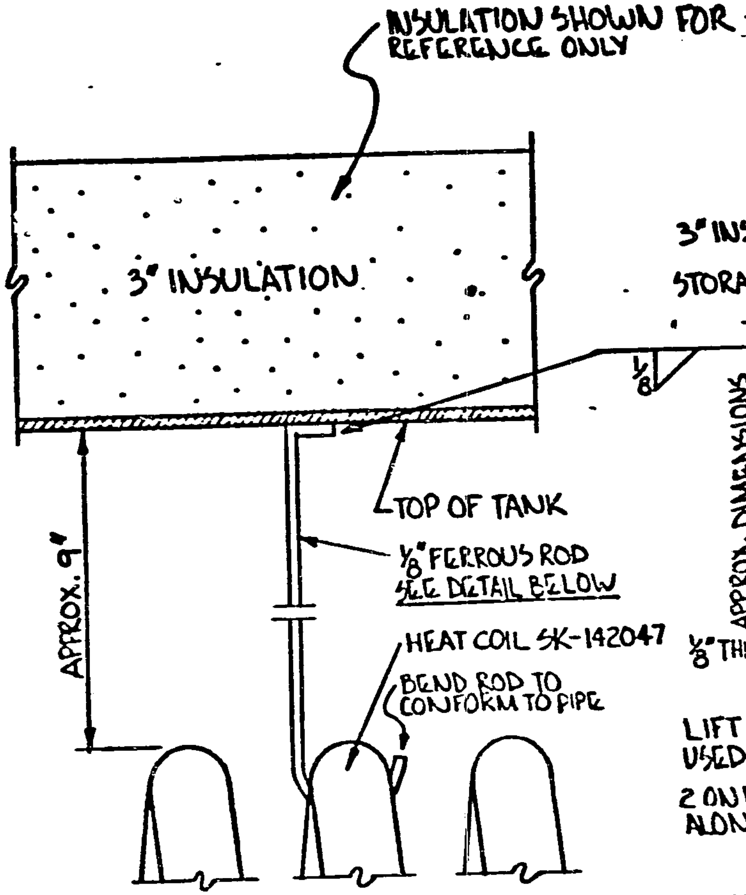
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL


COMPRESSION FITTING FOR NOMINAL 3/4" PIPE SEE DETAIL FIGURE 2
BENT ROD SEE DETAIL FIGURE 2
OUTLET FLANGE 1" N.P.T.
SDAS SENSOR FLANGE & TEMP. SENSOR FLANGE 3/4" NPT (SEE END VIEW)
SDAS SENSOR FLANGE 3/4" NPT
SDAS SENSOR FLANGE & TEMP. SENSOR FLANGE 3/4" NPT (SEE END VIEW)
STEEL LEGS 2500# CAP. EA. LOCATE AT 1/4 POINTS
HEATCOIL
21"
30"
2"
18"
1"
10"
32"
4"
ALL FLANGES WELDED TO TANK
LIFT HOOKS & TIE DOWNS BOTH SIDES SEE DETAIL FIGURE 2
INLET FLANGE 1" NPT
DRAIN COCK FLANGE 3/4" NPT
PROVIDE PROTECTIVE PLASTIC CAP FOR OPEN ENDS OF COIL PIPE
18" MANHOLE & COVER
VENT PIPE FLANGE 3/4" NPT
OUTLET FLANGE NOT SHOWN
TEMP. SENSOR FLANGE 3/4" NPT
INTERIOR COAL TAR EPOXY LINING 12 MILS. THICK MIN.
TEMP. SENSOR FLANGE 3/4" NPT
5 3/4" I.D. HEAT COIL 17 TURNS @ 1 1/8" C.T.C. FURNISHED BY HONEYWELL INSTALLED BY MANUF.
SDAS SENSOR FLANGE 3/4" NPT
SDAS SENSOR FLANGE 3/4" NPT
EXTERIOR SHOP COAT OF GREEN ENAMEL
STORAGE TANK
3/4" = 1'-0"
64" DIA. 72" LONG (±1") 10 GAUGE 1000 GAL.
ALL TOLERANCES ± 1/4" UNLESS OTHERWISE NOTED
FIGURE 1
REVISION A

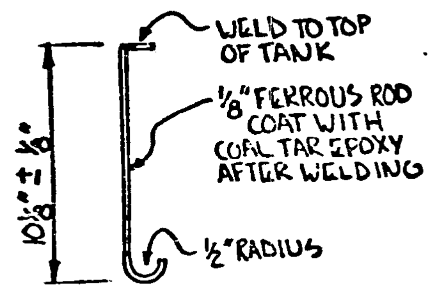


DETAIL COMPRESSION FITTING
FULL SIZE

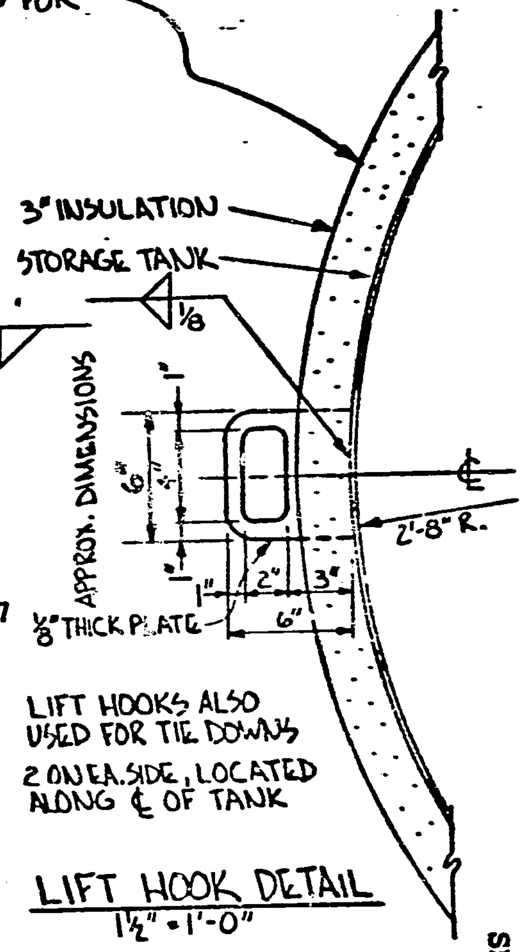
MAKE FROM :
SMITH-BLAIR COMPRESSION FITTING STYLE 521 COUPLING 3" LONG, PART NO. 521-10500-003 WITH ADAPTER PART NO. 300-30640-075
NOTE
LOCAL VENDOR - ITT GRINNELL CORP.
1201 WEST 96th ST.
BLOOMINGTON, MN.



COIL SUPPORT DETAIL
1/2" = 1"



COIL SUPPORT ROD
NO SCALE



LIFT HOOKS ALSO USED FOR TIE DOWNS
2 ON EA. SIDE, LOCATED ALONG ℄ OF TANK

LIFT HOOK DETAIL
1 1/2" = 1'-0"

FIGURE 2

ALL TOLERANCES ± 1/4" UNLESS OTHERWISE NOTED

REVISION A

SK 142008

APPENDIX D

AUXILIARY ENERGY AND SPACE HEATING SUBSYSTEM
DRAWING NO. SK 142102

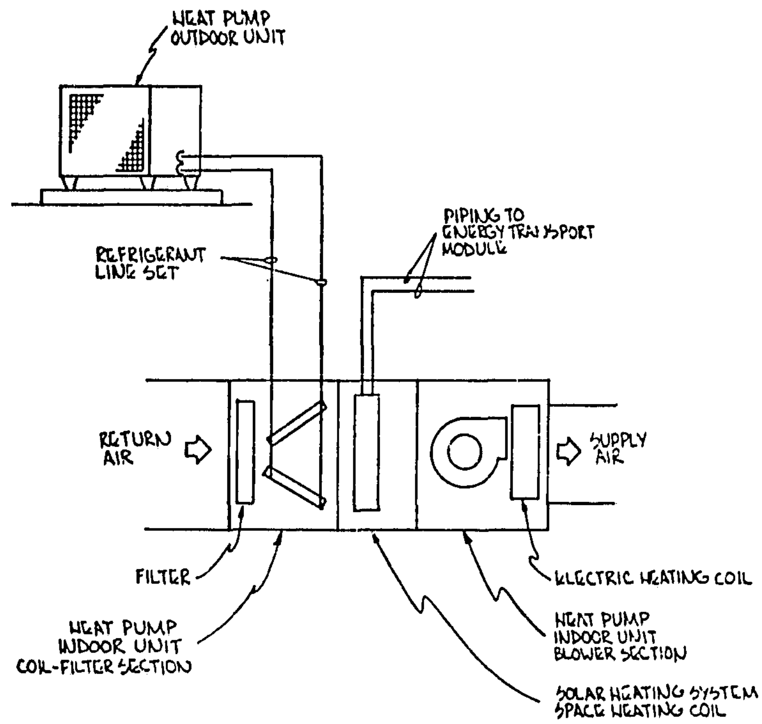
4 3

PART NO.

D

FOLDOUT FRAME

C



B

AUX.-ENERGY AND SPACE HEATING SCHEMATIC

NO SCALE

A

2 | 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME

D

MATERIAL SCHEDULE				REFER TO SHEET NUMBER
ITEM	MFGR.	MODEL No.	QUAN.	
SPACE HEATING COIL	LENNOX	CW31-45	1	2 of 5
HEAT PUMP OUTDOOR UNIT	LENNOX	HP10-311V	1	5 of 5
HEAT PUMP INDOOR UNIT	LENNOX	CBP10-41	1	3 of 5
REFRIGERANT LINE SET	LENNOX	L10-41-30	1	5 of 5
ELECTRIC HEATING COIL	LENNOX	ECB10-41-471	1	4 of 5

C

DESCRIPTION

The Auxiliary Energy and Space Heating Subsystem consists of the Solar Heating System Space Heating Coil integrated with a conventional (non-solar assisted) electric-heat pump, and auxiliary electric heating coil.

The heat pump is a matched remote system consisting of an outdoor unit and an indoor unit. The Space Heating Coil will be field installed between the separable halves of the heat pump indoor unit. The auxiliary electric heating coil will be field installed in the heat pump indoor unit. The indoor portion of this subsystem may be installed in a horizontal or vertical position.

B

UNRELEASED DRAWING
NO.
E.C.O. CONTROL

A

NEXT ASSY	USED ON	TOLERANCES UNLESS NOTED OTHERWISE .X ± .XX ± .XXX ± 90° FORMED ANGLES	DRAFTSMAN 7/11/77	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
APPLICATION		MATERIAL	CHECKER	SOLAR HEATING SYSTEM - SFR AUXILIARY ENERGY AND SPACE HEATING SUBSYSTEM	
		FINISH-SEE NOTE	DEV ENGR 8/4/77		
			ENGRG MGT		
			CONTRACT NO. NEW CASTLE	SIZE C	CODE IDENT NO. 93513 / DRAWING NO. SK-142102
				SCALE	SHEET 1 OF 5

CONTROL A

D-1

4 | 3

PART NO.

D

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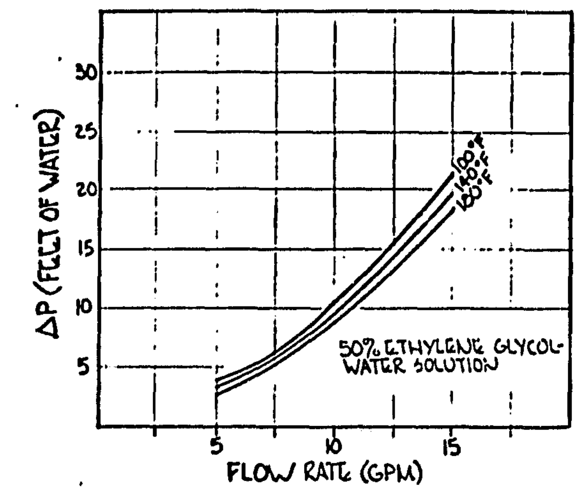
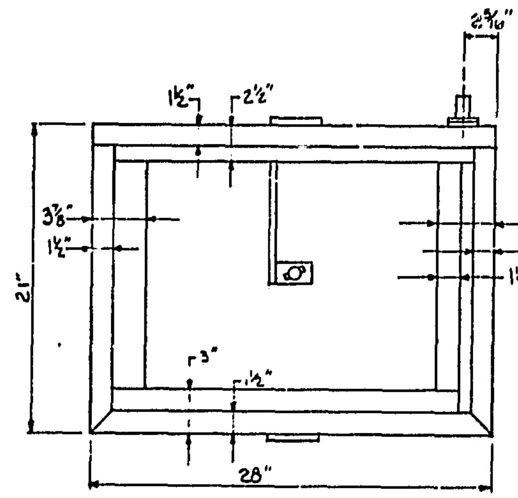
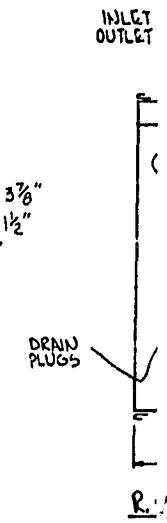


SPACE HEATING COIL - WATER PRESSURE DROP



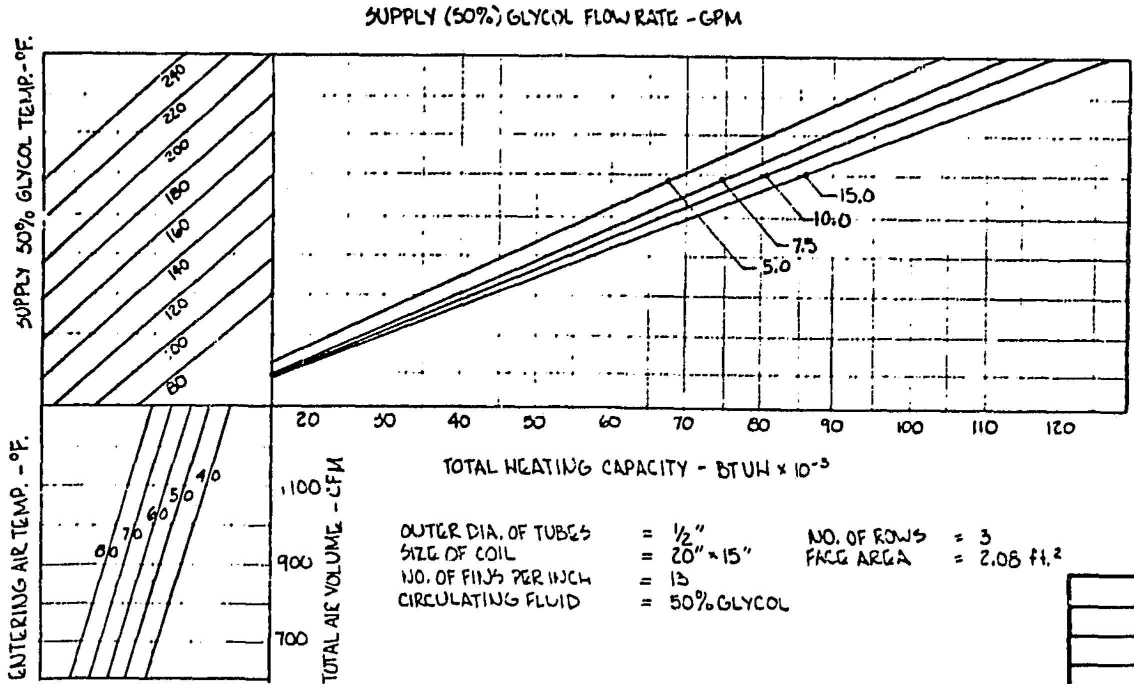
FRONT VIEW



C

SPACE HEATING COIL
1½" = 1'-0"

SUPPLY (50%) GLYCOL FLOW RATE - GPM



B

1. For o
site o

2. Assen
halves
cleats

3. Assen
shown
cleara

OUTER DIA. OF TUBES	= ½"	NO. OF ROWS	= 3
SIZE OF COIL	= 20" × 15"	FACE AREA	= 2.08 ft.²
NO. OF FINS PER INCH	= 13		
CIRCULATING FLUID	= 50% GLYCOL		

A

NEXT ASSY	USED ON
APPLICATION	

2 1

LTR	DESCRIPTION	DATE	APPROVED
REVISIONS			

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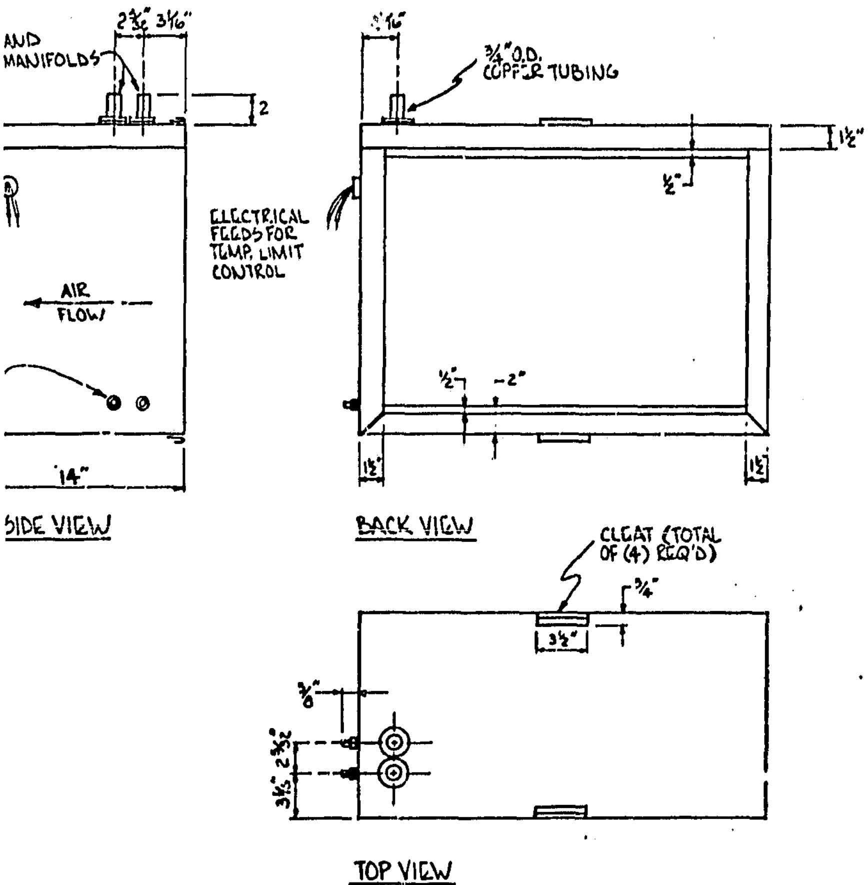
OUT FRAME

D



C

B

A

INSTALLATION NOTES

rientation piping connections see
wner/architect mechanical plans.

nble space heating coil between the
of the heat pump indoor unit using
and drive slips provided.

ible according to airflow direction
, provide maximum possible
ince between coil and fan scroll.

UNRELEASED DRAWING-
NOT SUBJECT TO
E.C.O. CONTROL

TOLERANCES UNLESS NOTED OTHERWISE	DRAFTSMAN	7/12/77
.X ± / .XX ± / .XXX ± — 90° FORMED ANGLES	CHECKER	
	DEV ENGR	5/4/77
MATERIAL	ENGRG MGT	
	CONTRACT NO.	
	NEW CASTLE	
FINISH–SEE NOTE		

HONEYWELL INC. — ENERGY RESOURCES CENTER, MINNEAPOLIS, MINN. 55413

SOLAR HEATING SYSTEM - SFR
AUXILIARY ENERGY AND
SPACE HEATING SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142102

SCALE | SHEET 2 OF 5

CONTROL A

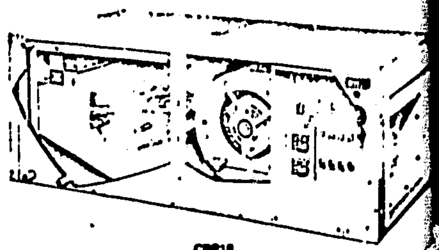
FOLDOUT FRAME

FOLDOUT FRAME

PART NO.

D

LENNOX Industries Inc.



CBP10
(With Optional Electric Heat)

C

CBP10 INDOOR UNITS

Durable Cabinets — The blower and coil-filter cabinets are in separate sections and constructed of heavy gauge galvanized steel. The cabinets are subject to a five station zinc phosphate metal wash process before painting. This preparation process results in a perfect bonding surface for the attractive finish coat of baked-on enamel. Cabinets are completely lined with thick fiberglass insulation. Removable panels provide complete service access. Positive and quick securing of cabinets together is accomplished with drive cleats. For down-flo applications field modification of the coil filter cabinet is required. The coil drain pan assembly and front panels must be removed from the cabinet, rotated 180 and replaced by the installer. Blower cabinet supply air opening has flanges for ease of connecting duct. Electrical inlets are located in the blower section, see dimension drawing.

Lennox Indoor Coil — Lennox designed and fabricated coils are constructed of precisely spaced ripple-edged aluminum fins machine fitted to copper tubes. Twin coils assembled in an "A" configuration provides extra large surface and contact area for maximum efficiency. Coils are circuited to maximize the flow rate when defrost cycle is required. Fins are strengthened to resist bending, which can restrict air flow and reduce efficiency. Fins have collars that grip tubing for maximum contact area resulting in excellent heat transfer. Flared shoulder tubing joints and silver soldering provide tight leak proof joints. Coils are thoroughly tested under pressure to insure leak proof construction.

Drain Pan — Deep pan is constructed of corrosion resistant heavy gauge galvanized steel. Equipped with dual (primary and secondary) galvanized pipe (3/4 mpt) drain outlets extended outside of cabinet for ease of connection. Down-flo applications require field repositioning of the drain pan by removing and rotating the coil drain pan assembly 180° and replacing in the cabinet. Field modifications are not required for up-flo or horizontal installations.

Cleanable Air Filter — Washable aluminum frame filter with mu layered expanded aluminum mesh media coated with a water so ble adhesive with a high dust holding capacity is furnished as stan ard. Use RP products coating number 418 (P-8-5069) for reoil media after cleaning. 1 inch thick filter is furnished as standard. Fi is easily removed and replaced when cleaning is required.

Powerful Blower — Equipped with a Lennox designed and built rect drive blower. Each blower is statically and dynamically balanc as an assembly before it is installed in the unit. This special attenti to design details and assembly balancing adds up to the quietest a most efficient direct drive blower in the industry. Multispeed mo is resiliently mounted. A choice of blower speeds is available. S blower performance charts. Change of blower speeds is easily a complished by a simple change in wiring.

Blower Cooling Relay (Furnished) — A blower cooling relay is fu nished as standard equipment and is factory installed in the blow cabinet section.

Refrigerant Line Connections — Vapor and liquid lines are equipp with flare fittings on CBP10-41 model. Liquid line has flare fittin and vapor line requires sweat connection on the CBP10-51 mod Lines are extended outside of the cabinet for ease of connection. S dimension drawing for location.

Expansion Valve and Check Valve — Factory installed expansi valve is designed and sized for use in heat pump system. Valve equipped with bleed port which permits pressure to equalize a compressor stops, allowing it to start in an unloaded conditi Check valve is furnished and factory installed in the liquid line.

B

CBP10-41 SPECIFICATIONS

Model No.		CBP10-41
Blower section		B10-41
Indoor coil section		CP10-41
Nominal cooling capacity (tons)		3
Indoor Coil	Net face area (sq. ft.)	4.47
	Tube diam. (in.) & no. of rows	1/2 — 3
	Fins per inch	13
	Vapor line conn. (in.)	3/4 (flare)
	Liquid line conn. (in.)	3/8 (flare)
Refrigerant		R-22
Condensate drain (mpt) in.		3/4
Blower wheel nom. diam. x width (in.)		10 x 8
Blower motor hp		1/3
No. & Size of filters (in.)		(1) 16 x 25 x 1
Electrical Characteristics		208/230v — 60 hz — 1ph
*Number of packages in shipment		2
Net Weight (lbs.)	Blower section	92
	Indoor coil section	94

BLOWER

CBP10-41 WITH CW3
COIL AND ECB10-41-
HEATING COIL.

A

2 1

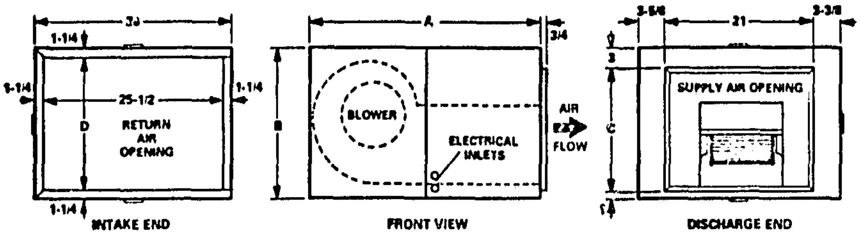
FOLDOUT FRAME

2. FOLDOUT FRAME

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

D

B10 SERIES BLOWER SECTION



Model No.	A	B	C	D
B10-41	32-1/2	21	17	18-1/2

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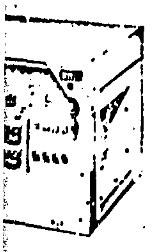
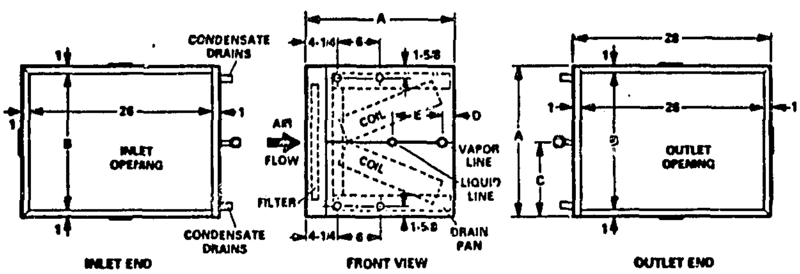


CP10 SERIES COIL-FILTER SECTION

C



Model No.	A	B	C	D	E
CP10-41	21	19	10-1/2	1-3/4	7

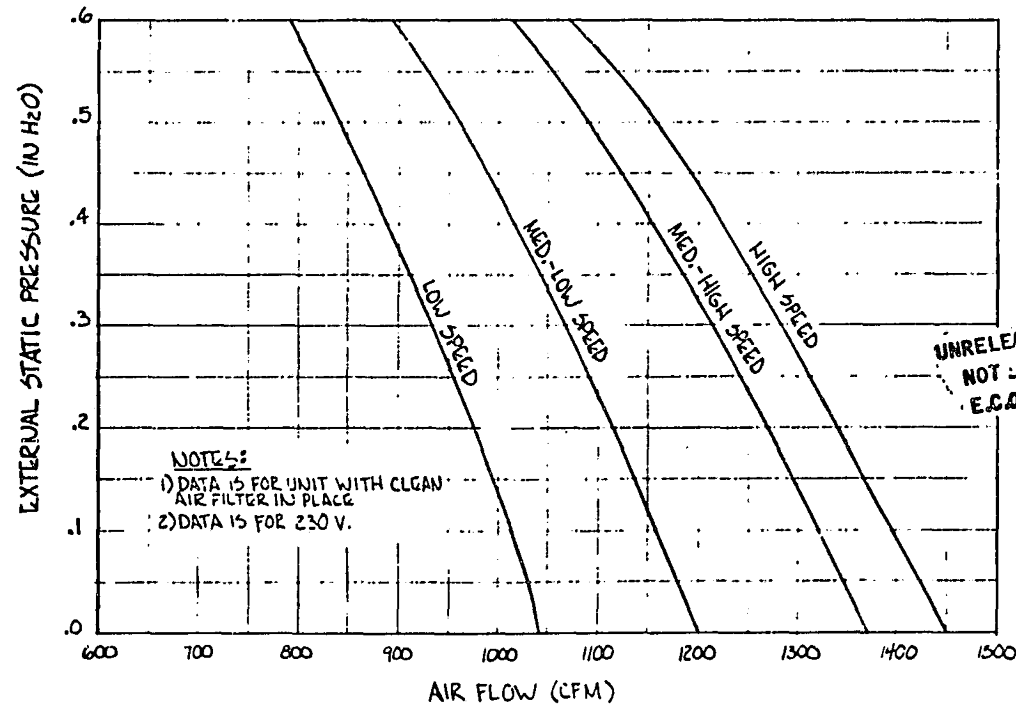
...e frame filter with multi- ...coated with a water solu- ...city is furnished as stand- ...(P-8-5069) for reoiling ...nished as standard. Filter ...ning is required.

...ex designed and built di- ...nd dynamically balanced ...nit. This special attention ...ds up to the quietest and ...dustry. Multispeed motor ...speeds is available. See ...wer speeds is easily ac-

...wer cooling relay is fur- ...ry installed in the blower

...liquid lines are equipped ...uid line has flare fittings ...en the CBP10-51 model. ...rease of connection. See

...ory installed expansion ...pump system. Valve is ...ressure to equalize after ...en unloaded condition. ...led in the liquid line.



NOTES:
1) DATA IS FOR UNIT WITH CLEAN AIR FILTER IN PLACE
2) DATA IS FOR 230 V.

BLOWER DATA ⇨
...0-41 WITH CW3-45 SPACE HEATING ... AND ECB10-41-471 ELECTRIC ...TING COIL.

UNRELEASED DRAWING - NOT SUBJECT TO E.C.O. CONTROL

B

A

NEXT ASSY	USED ON	TOLERANCES UNLESS NOTED OTHERWISE: .X ± .XX ± .XXX ± ; 90° FORMED ANGLES ±2°	DRAFTSMAN / CHECKER / DEV ENGR 8/4/77 / ENGRG MGT 8/4/77
APPLICATION		MATERIAL / FINISH–SEE NOTE	CONTRACT NO. / NEW CASTLE

HONEYWELL INC. — ENERGY RESOURCES CENTER, MINNEAPOLIS, MINN. 55413

SOLAR HEATING SYSTEM - SFR
AUXILIARY ENERGY AND
SPACE HEATING SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142102
SCALE		SHEET 3 OF 5

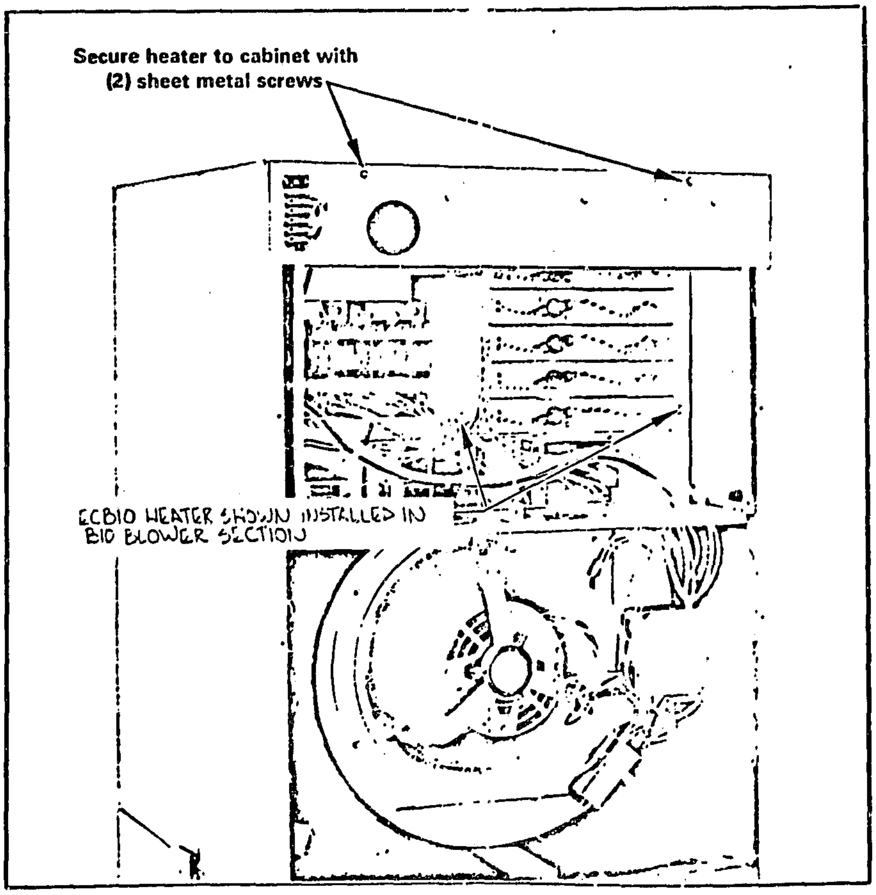
CONTROL A

PART NO.

LENNOX
Industries Inc.

ECB10 ELECTRIC HEATING COIL

Blower-Coil Unit Model No.	Electri Unit Mode & Net We
CB?10-41	ECB10-41 (28 lbs



ELECTRIC HEATING COIL INSTALLATION

NEXT ASSY	USED ON
APPLICATION	

2 1 2 FOLDOUT FRAME

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

D

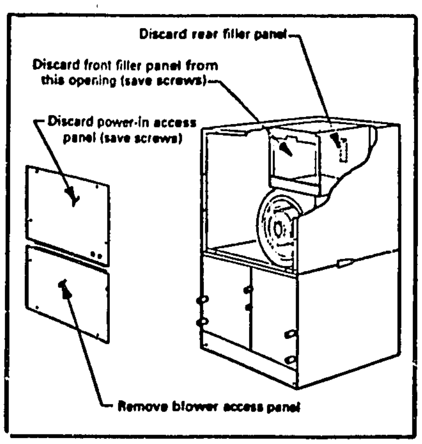
Electric Heat (Optional) — Additive electric heaters are available to supplement heating capacity of indoor unit ECB10 series electric heaters are available in several Kw sizes, see Electric Heat table Heaters field install in space provided in blower cabinet The helix wound nichrome bare wire heating elements are exposed directly in the air stream resulting in instant heat transfer, lower element temperatures and long service life Heaters are equipped with sub-fusing to meet NEC requirements Each heating element is equipped with accurately located limit control with a fixed temperature off setting and automatic reset In addition, elements have supplemental thermal cutoff safety fuses providing positive protection in case of excessive temperatures Cutoff fuses are mounted external to the element face plate for quick and easy replacement Thermal sequencer relay brings the heating elements on and off the line in sequence and equal increments, with a time delay between each element Sequencer also initiates and terminates blower operation. Heating control relay(s), defrost heat relay, 24 volt transformer and terminal block are furnished as standard equipment

Control box and access cover are constructed of heavy gauge galvanized steel Heaters are completely factory assembled with the controls installed and wired.

C

ELECTRIC HEAT DATA

c I No. ight	Elements (No. of Steps) & Phase	Volts Input	Electric Heat Kw Input	Electric Heat Btuh Output	*Minimum Circuit Ampacity Circuit 1	Circuit 2	Circuit 3
-471 .)	3 (3 steps) (1 phase)	208	10 4	35 400	**67	---	—
		220	11 6	33,600	**76	--	—
		230	12 7	43,300			
		240	13 8	47,100			



INSTALLATION DETAIL
NO SCALE

UNRELEASED DRAWING- NOT ... TO E.C.O. CONTROL

B

A

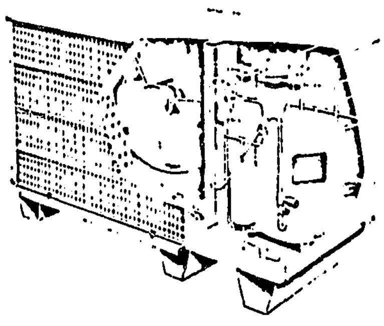
TOLERANCES UNLESS NOTED OTHERWISE	DRAFTSMAN	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
.X ± .XX ± .XXX ± 90° FORMED ANGLES ±1/2°	CHECKER	SOLAR HEATING SYSTEM - FOR AUXILIARY ENERGY AND ... SYSTEM	
	DEV ENGR		
	ENGRG MGT		
MATERIAL	CONTRACT NO.	SIZE C	CODE IDENT NO. 55513 · DRAWING NO. SK-142102
	NEW CASTLE		
FINISH–SEE NOTE		SCALE	SHEET 4 OF 5

CONTROL A

D

PART NO.

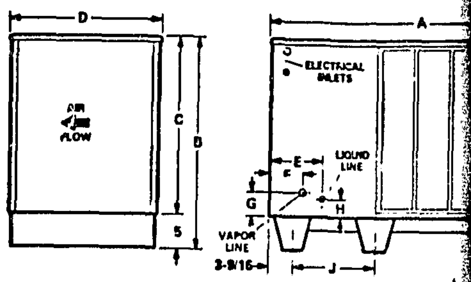
LENNOX



HP10 Series Outdoor Units

DIMENSIONS (inches)

HP10 OUTDOOR UNITS



Model No	A	B	C	J	E	F	G
HP10-311V HP10-411V	48-1/8	30-1/2	25-1/2	21-3/8	8	5	3-1

C

HP10 OUTDOOR UNITS

Weather Resistant Cabinet — Heavy gauge galvanized steel cabinet is subject to a five station zinc phosphate metal wash process. This preparation results in a perfect bonding surface for the finish coat of baked on enamel. Attractive enamel finish gives the cabinet long lasting all weather protection. Top panel is lined with thick acoustical fiberglass insulation. A rugged steel outdoor coil guard is furnished as standard. Drain holes in the base section provide condensate and defrost drainage. Base is sloped to assure rapid removal of water. Heavy duty support channels under the base raise the unit off of the mounting surface away from damaging moisture.

Compressor and Controls Compartment — Separate compressor and controls compartment isolates the compressor and controls from the weather and sound transmission. End or top panel can be removed for complete service access.

Control Box — Large size and conveniently located in the compressor and controls compartment for easy access. Pre-wired at the factory. Electrical inlet holes are provided in the cabinet for wiring entry.

Efficient Condenser Fan — Direct drive fan moves large air volumes uniformly thru the entire outdoor coil resulting in high refrigerant cooling and heating capacity. Louvered panel is removable for complete service access to the fan and motor. Air enters unit thru the louvered panel and is discharged thru the coil. Straight thru flow of outdoor coil air results in both minimum restriction and operating cost.

B

Large Outdoor Coil — Lennox designed and constructed outdoor coil provides large surface and contact area for maximum efficiency. Inverted coil circuiting prevents ice buildup at coil base in low ambients. Discharge gas enters bottom of coil during defrost and heat of refrigerant flows counter to water drainage resulting in extremely clean and unobstructed fins and tubes. Coil is constructed of precisely spaced ripple-edged fins machine fitted to copper tubes. Fin spacing allows rapid and complete water drainage. Fins are strengthened to resist bending and are equipped with collars that grip tubing for maximum contact area resulting in excellent heat transfer. Flared shoulder tubing joints and silver soldering provide tight leak proof joints. Coil is thoroughly tested under pressure to insure leak proof construction.

Dependable and Quiet Compressor —

Rugged and reliable compressor is hermetically sealed. Suction cooled, overload protected and equipped with internal pressure relief valve. Internally protected from excessive current and temperature. Suction gas is routed over the motor resulting in low in-winding temperatures. Maintains oil and discharge temperatures within safe limits. Operates efficiently at low outdoor temperatures during heating mode. A crankcase heater is furnished as standard equipment and provides protection from slugging. The running gear is spring mounted within the sealed housing. In addition, the compressor is installed on resilient rubber mounts in the unit, assuring quiet and vibration free operation.

Suction Line Accumulator — Factory installed and piped. Traps and prevents large amounts of liquid refrigerant from flooding directly into the compressor and causing damage on start-ups and refrigerant cycle change.

A

Reversing Valve — 4-way interchange reversing valve effects a rapid change in direction of refrigerant flow resulting in quick changeover from cooling to heating and vice versa. Valve operates on pressure differential between outdoor unit and indoor unit of the system. Quiet operating and built for years of trouble-free service. Factory installed and piped.

Expansion Valve — Designed and sized specifically for use in heat pump system. Sensing bulb is located on the true suction line between reversing valve and compressor thus sensing true suction temperature in any cycle. Factory installed and piped.

Discharge Temperature Thermostat — Protects system in case of refrigerant charge loss. Factory wired and installed on the discharge line. Manual reset.

Hi-Capacity Two Way Drier — Unique two way drier with internal check valves is utilized in both the cooling and heating cycles. Factory installed in the liquid line assuring a clean system at all times.

High Pressure Switch — Factory installed and wired. Protects system from abnormal operating conditions. Manual reset.

Defrost Control — Units are equipped with an air pressure differential defrost control system. Factory installed air pressure switch activated by the pressure difference across the outdoor coil, due to frost accumulation, automatically initiates the defrost cycle. The defrost cycle is terminated by a temperature sensing element which senses the refrigerant temperature leaving the outdoor coil. A defrost cycle is called for only when sufficient frost has accumulated on the coil to cause the necessary air pressure difference. Unit operation will not be interrupted by an unnecessary defrost cycle caused by changes in other parts of the system due to malfunction. The defrost control is factory set.

Refrigerant Line Connections, Electrical Inlets and Service Valves — Vapor and liquid lines extend outside of cabinet for ease of field connections. Refrigerant line connections and field wiring inlets are all conveniently made at one central location on the unit. Furnished and factory installed are a check valve, a schrader fitting in the suction and discharge lines, shutoff valve with gauge ports on the vapor and liquid lines.

Start Kits (Optional) — Available as optional equipment for field installation on the HP10-211V and HP10-411V single phase units. Provides assistance for compressor start under loaded conditions or in the event of low voltage. Specify complete unit model number when ordering.

Outdoor Thermostat Kit (Optional) — Thermostat(s) maintains the heating load on the heat pump as long as possible before allowing the optional auxiliary electric heat to come on. Kit (LB-44376BA) contains one outdoor thermostat and mounting bracket with provisions for mounting two thermostats. If the installation requires two thermostats an additional thermostat (P-8-10715) must be ordered extra.

Approvals — Outdoor units have been thoroughly tested with matching indoor units in the Lennox Research Laboratory environmental test room and accurately rated according to ARI Standard 240 conditions. In addition, units have been sound tested in the Lennox reverberant sound test room and rated according to ARI Standard 270 conditions. Units coming within the scope of this standard (135,000 Btuh or less) carry the ARI certification seal. Outdoor units and components within are bonded for grounding to meet safety standards for servicing required by U.L. and NEC. Units are also U.L. Listed and listed by C.S.A. as certified

FOLDOUT FRAME

2 | 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

HP10 SPECIFICATIONS

Model No.		HP10-311V
Outdoor Coil	Net face area (sq. ft.)	9.64
	Tube diam. (in.) & No. of rows	1/2 — 3
	Fins per inch	10
Outdoor Fan	Diameter (in.) & No. of blades	22 — 4
	Motor hp	1/3
	Cfm (factory setting)	2840
	Rpm (factory setting)	838
	Watts (factory setting)	360
Refrigerant 22 (charge furnished)		9 lbs. 3 oz.
Liquid line connection (sweat)		3/8
Vapor line connection (sweat)		3/4
Net weight (lbs.) & No. of packages		325 — 1

ELECTRICAL DATA

Model Number		HP10-311V
Line voltage data		230v 60hz 1ph
Compressor	Rated load amps	17.0
	Power factor	.90
	Locked rotor amps	85.0
Outdoor Coil Fan Motor	Full load amps	3.0
	Locked rotor amps	6.6
*Minimum circuit ampacity		24.3

*Refer to National Electrical Code manual to determine wire, fuse and disconnect size requirements.
NOTE — Extremes of operating range are plus and minus 10% of line voltage.

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SELECTOR

Lennox Outdoor Unit Model No. ●(ARI Standard 270 SRN)	*ARI Standard 240 Ratings										Lennox Indoor Unit
	Cooling Capacity (Btuh)	High Temp. Heating Capacity (Btuh)	Low Temp. Heating Capacity (Btuh)	**Total Unit Watts						Dehumidifying Capacity	Up-Flo
				Cooling	EER (Btu/Watt)	High Temp. Heating	C.O.P.	Low Temp. Heating	C.O.P.		
HP10-311V (20)	30,500	31,000	18,000	3950	7.7	3400	2.7	2750	1.9	27%	CBP10-41

●Rated in accordance with ARI Standard 270.
*Rated in accordance with ARI Standard 240. At 450 cfm (maximum) indoor air volume per ton of cooling capacity and 30 ft. of connecting refrigerant lines.
Cooling Ratings — 95F outdoor air temperature and 80F db/67F wb entering indoor coil air.
High Temp. Heating Ratings — 47F db/43F wb outdoor air temperature and 70F db entering indoor coil air.
Low Temp. Heating Ratings — 17F db/15F wb outdoor air temperature and 70F db entering indoor coil air.
**Wattage for blower motor included in total unit watts listed.

HP10-311V HEATING PERFORMANCE at 1125 cfm Indoor Coil Air Volume (CBP10-41)

*Outdoor Temperature (Degree F)	Compressor Motor Watts Input	Total Output (Btuh)
65	[illegible]	[illegible]
60	[illegible]	[illegible]
55	[illegible]	[illegible]
50	[illegible]	[illegible]
45	[illegible]	[illegible]
40	[illegible]	[illegible]
35	[illegible]	[illegible]
30	[illegible]	[illegible]
25	[illegible]	[illegible]
20	[illegible]	[illegible]
15	[illegible]	[illegible]
10	[illegible]	[illegible]
5	[illegible]	[illegible]
0	[illegible]	[illegible]

*Outdoor temperature at 70% relative humidity. Indoor temperature at 70°.

HP10-311V HEAT PUMP OUTDOOR UNIT HEATING CAPACITY

Indoor Unit Model No.	Indoor Coil Air Volume (cfm) 70F db	Air Temperature Entering Outdoor Coil (F)							
		65		45		25		5	
		Total Heating Capacity (Btuh)	Comp. Motor Watts Input	Total Heating Capacity (Btuh)	Comp. Motor Watts Input	Total Heating Capacity (Btuh)	Comp. Motor Watts Input	Total Heating Capacity (Btuh)	Comp. Motor Watts Input
CBP10-41	1000	40,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1775
	1125	41,[illegible]	[illegible]	[illegible]	2325	[illegible]	[illegible]	14,000	1695
	1250	42,[illegible]	[illegible]	[illegible]	2315	[illegible]	2010	14,[illegible]	1665

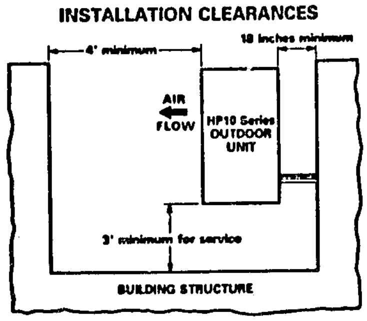
NOTE — Heating capacities include the effect of defrost cycles in the temperature range where they occur.

HP10-311V HEAT PUMP OUTDOOR UNIT COOLING CAPACITY

Indoor Unit Model No.	Indoor Coil 80F Dry Bulb: Entering Wet Bulb Degrees (F)	Total Air Volume (cfm)	85: Total Cooling Capacity (Btuh)	85: Sensible To Total Ratio (S/T)	85: Comp. Motor Watts Input	95: Total Cooling Capacity (Btuh)	95: Sensible To Total Ratio (S/T)	95: Comp. Motor Watts Input	105: Total Cooling Capacity (Btuh)	105: Sensible To Total Ratio (S/T)	105: Comp. Motor Watts Input	115: Total Cooling Capacity (Btuh)	115: Sensible To Total Ratio (S/T)	115: Comp. Motor Watts Input
CBP10-41	63	1000	[illegible]	83	[illegible]	[illegible]	87	[illegible]	26,100	90	[illegible]	[illegible]	[illegible]	[illegible]
		1125	[illegible]	87	[illegible]	[illegible]	91	[illegible]	27,[illegible]	93	[illegible]	[illegible]	[illegible]	3215
		1250	[illegible]	91	[illegible]	[illegible]	95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3225
	67	1000	[illegible]	67	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71	[illegible]	[illegible]	73	[illegible]
		1125	33,[illegible]	70	[illegible]	[illegible]	72	[illegible]	31,[illegible]	74	[illegible]	[illegible]	76	3275
		1250	[illegible]	71	[illegible]	[illegible]	75	[illegible]	32,[illegible]	73	[illegible]	[illegible]	[illegible]	[illegible]
	71	1000	[illegible]	52	[illegible]	[illegible]	52	[illegible]	34,700	53	[illegible]	[illegible]	54	[illegible]
		1125	37,[illegible]	51	[illegible]	[illegible]	55	3140	35,700	56	3225	33,[illegible]	57	3325
		1250	38,[illegible]	54	[illegible]	37,[illegible]	57	[illegible]	36,500	58	3245	35,[illegible]	59	3345

NOTE — All values are gross capacities and do not include indoor coil blower motor heat deduction.

INSTALLATION CLEARANCES



Refrigerant Line Kits — Lines are available in several lengths and must be ordered extra. See Refrigerant Line Kit table for selection. The refrigerant lines (vapor and liquid) are shipped refrigeration clean. Lines are cleaned, dried and pressurized at the factory and sealed by means of a rubber plug. Plug fits tight enough to hold high pressure in the lines. These plugs should not be removed until connections are ready to be made. Thus the system is assured of completely clean and dry lines for the installation. Vapor line is fully insulated. Lines are furnished with a flare fitting (indoor unit connection) on one end and less any fitting (stubbed) on the opposite end for connection to the outdoor unit.

REFRIGERANT LINE KITS

Outdoor Unit Model No.	Line Set Model No.	Length of Vapor & Liquid Lines (ft.)	Liquid Line (o.d. in.)	Vapor Line (o.d. in.)
HP10-311V	L10-41-20	20	3/8	3/4
	L10-41-30	30		
	L10-41-40	40		
	L10-41-50	50		

(inches)

R UNITS

E	F	G	H	J
8	5	3-1/4	2-1/2	12-1/2

3-9/16

for use in heat suction line between true suction ed.

em in case of the discharge

with internal ng cycles. Factor at all times.

Protects system reset.

ssure differential pressure switch door coil, due to frost cycle. The element which door coil. A de-accumulated on. Unit operation cycle caused malfunction. The

and Service panel for ease of field wiring inlets the unit. Further fitting in the ports on the

ment for field phase units. conditions or model number

maintains the before allowing (LB-44376BA) with provision requires two be ordered

tested with factory environ-Standard 240 in the Lennox ARI Standard this standard Outdoor units meet safety are also U.L.

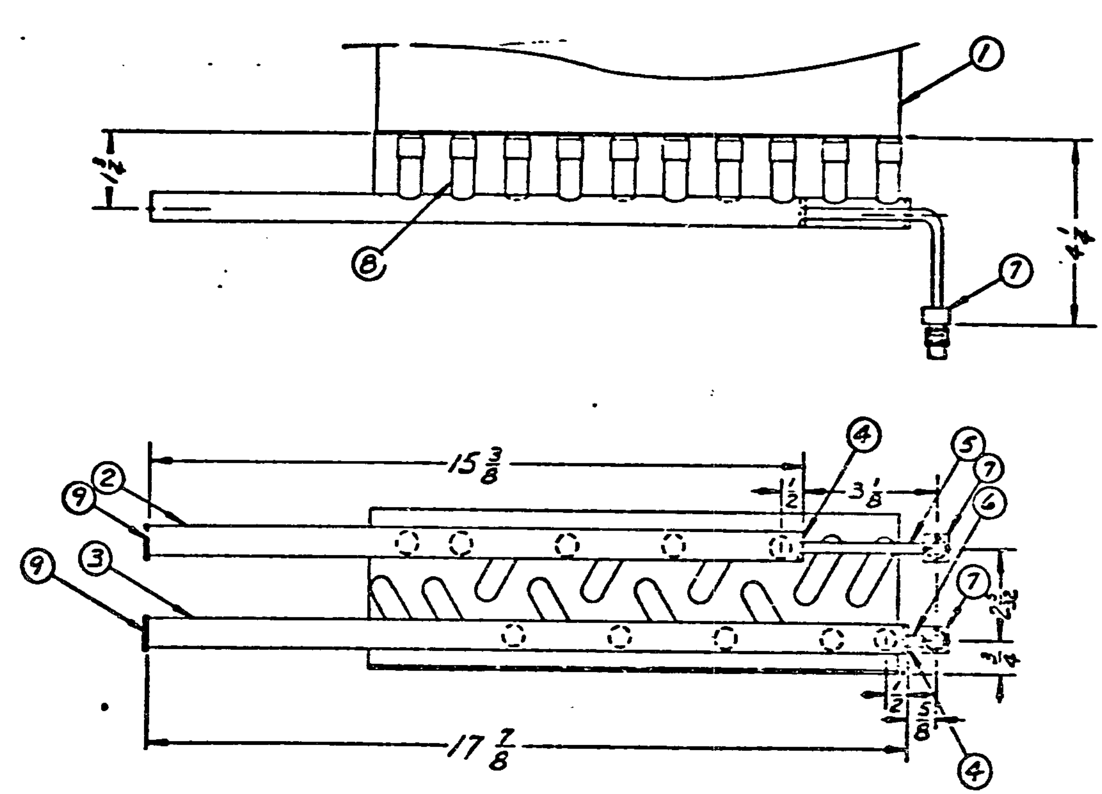
UNRELEASED DRAWING-NOT SUBJECT TO E.C.O. CONTROL

		TOLERANCES UNLESS NOTED OTHERWISE	DRAFTSMAN		HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
		.X ± .XX ± .XXX ± ; 90° FORMED ANGLES ±2° ±1°	CHECKER			
			DEV ENGR	5-4-77	SOLAR HEATING SYSTEM - SFR AUXILIARY ENERGY AND SPACE HEATING SUBSYSTEM	
		MATERIAL	ENGRG MGT			
			CONTRACT NO. NEW CASTLE		SIZE C	CODE IDENT NO. 55513 — DRAWING NO. SK-142102
NEXT ASSY	USED ON					
APPLICATION		FINISH—SEE NOTE			SCALE	SHEET 5 OF 5

CONTROL A

D-5

Item	Description	Part No.	Qty
	CATALOG NO.		
	UNIT MODEL NO.		
	S.A. CONTROL NO.	LB-32691BA	
1	COIL SUB ASSY.	LB-32692C	1
2	INLET MANIFOLD	LB-32693C	1
3	OUTLET MANIFOLD	LB-32694C	1
4	END PLUG	LB-32695D	2
5	VENT LINE INL. MAN.	LB-32696D	1
6	VENT LINE OUTL. MAN.	LB-32697D	1
7	LIQUID VENT VALVE	LB-8026	2
8	OUTLET TUBE	LB-41827DF	10
9	CAP PLUG	P-B-1006	2



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Change Record Sheet

ALTERATIONS	ALTERATIONS	ALTERATIONS	USAGE	REF PRINT
				25-530A

LENNOX Industries Inc.
RESEARCH LABORATORY

COIL ASSY.

DATE 2-11-71

LB-32691B

APPENDIX E

HOT WATER SUBSYSTEM

DRAWING NO. SK 142052

FOLDOUT FRAME

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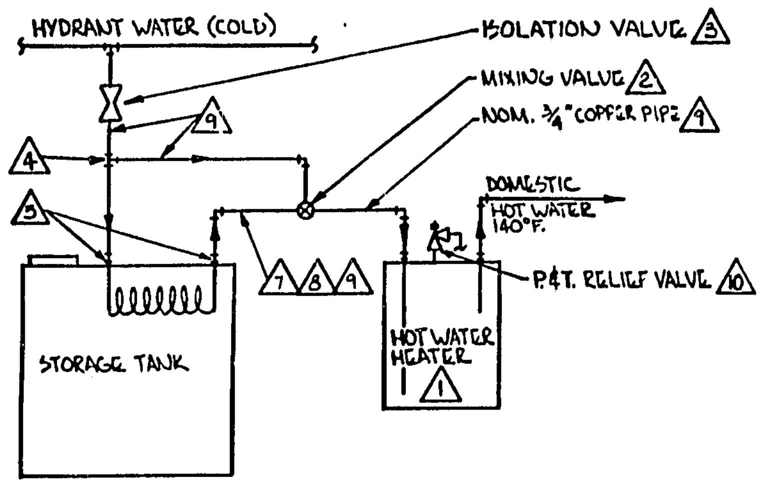
4 | 3

PART NO.



SCHEMATIC H.W. SUBSYSTEM
NO SCALE

IN

1) DHW prehe
tank and ha

2) Tighten ada

3) Solder coil

I

1) Insulate cop
water mixi

ALL ITEMS LISTED "OR EQUIVALANT"

MATERIAL SCHEDULE

ITEM #	ITEM	MANUFACTURER	TYPE /PART NO.	Q
1	HOT WATER HEATER	LOCHINVAR	40 GK3TC	
2	3-WAY MIXING VALVE	WATTS REGULATOR CO.	70A - 3/4"	
3	BALL VALVE	NIBCO	S-580 - 3/4"	
4	COPPER TEE NOM. 3/4" x 3/4" x 3/4"	NIBCO	611 - 3/4	
5	COPPER COUPLING W/ STOP NOM. 3/4"	NIBCO	600 - 3/4	
6	COPPER ELBOW NOM. 3/4" x 3/4"	NIBCO	607 - 3/4	AS
7	INSULATION (3/4" THICK)	ARMSTRONG CORK CO.	ARMAFLEX STANDARD	AS
8	INSULATION ADHESIVE	ARMSTRONG	520	AS
9	COPPER PIPE 3/4" NOM.	REVERE	M	AS
10	PRESSURE & TEMP. RELIEF VALVE	WATTS PLUMBING SPEC.	40 XL	

2 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	REVISED INSTALLATION & INSULATION INFO	7-14-77	[illegible]

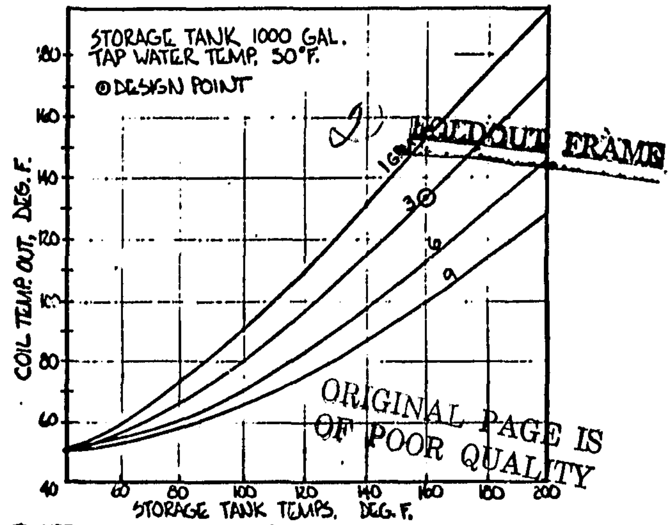


FIGURE 1. HEATING COIL PERFORMANCE

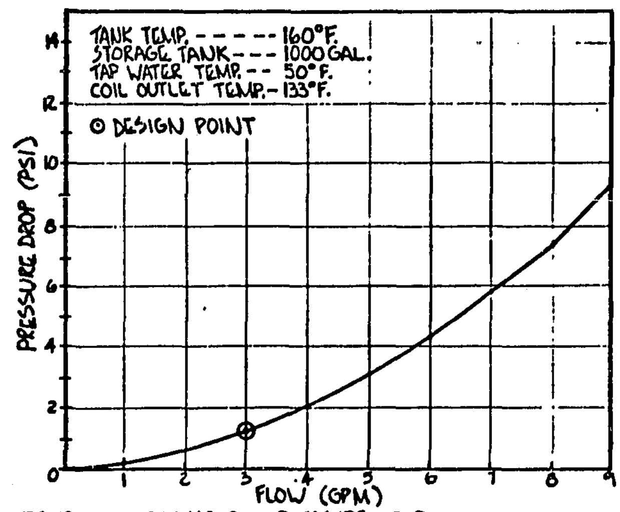


FIGURE 2. HEATING COIL PRESSURE DROP

INSTALLATION INFORMATION

1) DHW preheat coil will be previously installed in storage tank and has ends protruding from top of tank.

2) Tighten adapter on compression fitting.

3) Solder coil ends to copper tubing using coupling.

INSULATION INFORMATION

1) Insulate copper tubing from storage tank outlet to hot water mixing valve.

DOMESTIC HOT WATER (DHW) Subsystem

The DHW subsystem consists of two hot water heaters in series. The 1st heater is the coil immersed in the storage tank, and the 2nd heater is a conventional domestic hot water heater. The storage tank is heated with the surplus solar energy not required for space heating. This stored heat is transferred to city water via a coil which preheating the water before it goes to the conventional hot water heater. When the storage tank is at it's maximum temperature 200°F no additional heat will be required from the conventional heater at flow rates of 7 gpm or less. The capacity of preheat coil is shown in Figure 1 and 2. To limit the output of the heaters to 140° a self contained 3 way mixing valve tempers the hot water to the user with city water.

PART NO.	QUAN.
3TC	1
3/4"	1
-¾"	1
/4	1
/4	2
/4	AS REQ'D
EX STANDARD	AS REQ'D
	AS REQ'D
	AS REQ'D
	1

NEXT ASSY	USED ON
APPLICATION	

TOLERANCES UNLESS NOTED OTHERWISE
.X ± .XX ± .XXX ± — SUPPLEMENTED ANGLES ±0 ±10
MATERIAL
FINISH–SEE NOTE

DRAFTSMAN	[illegible]	4/20/77
CHECKER		
DEV ENGR	[illegible]	8/4/77
ENGRG MGT	[illegible]	6/1/77

CONTRACT NO.

WILLIAM O' BRIEN

NEW CASTLE

HONEYWELL INC. — ENERGY RESOURCES CENTER, MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE HOT WATER SUBSYSTEM

SIZE C | CODE IDENT NO. 55513 | DRAWING NO. 5K-142052

SCALE NONE | SHEET 1 OF 1

REV A | 5K-142052

CONTROL A

E-1

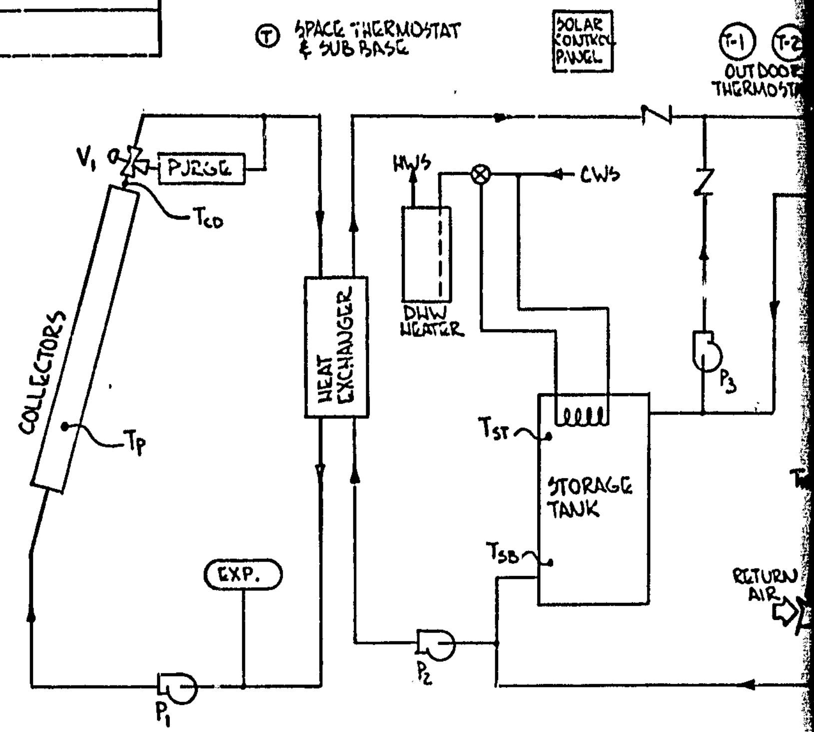
APPENDIX F

CONTROL SUBSYSTEM

DRAWING NO. SK 142105

FOLDOUT FRAME

PART NO.



SOLAR HEATING SYSTEM CONTROL SCHEMATIC

NO SCALE

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FOR REFERENCE ONLY PREMOUNTED ON TRANSPORT MODULE SK-142053

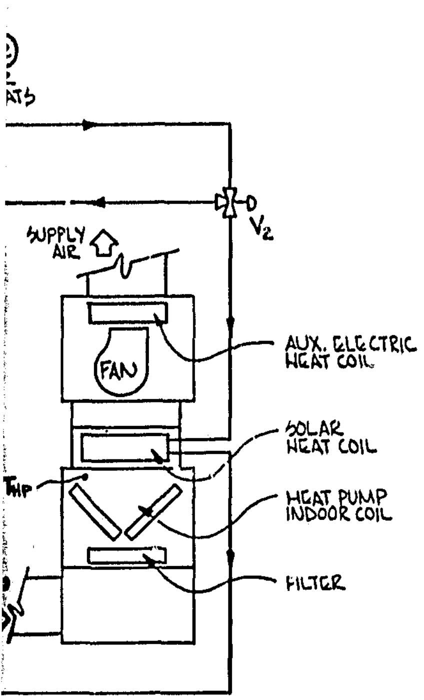
MATERIAL LIST

ITEM	QUAN.	DESCRIPTION	TYPE/PART NO.
	1	SOLAR CONTROL PANEL	W968A1009
T_{ST}	1	AQUASTAT CONTROLLER	L6008C1065
T_{CD}	1	AQUASTAT CONTROLLER	L4008B1013
	1	MULTISTAGE THERMOSTAT	T872C1004
	1	THERMOSTAT SUBBASE	Q672B1004
V_1	1	MOTORIZED VALVE	V4331A1003
V_2	1	MOTORIZED VALVE	V4331A1003
	2	IMMERSION WELL	122555B
	1	CASE ASSEMBLY	112892F
T_P, T_{SB} & T_{HP}	3	SENSOR	C773B1005
	1	COLLECTOR SENSOR SHIELD	SK-142067
	1	DIFF. TEMP. CONTROLLER	R7412
T-1 & T-2	2	THERMOSTAT	P-8-10715
	1	MOUNTING BOX	M-1595
	1	BULB GUARD	107323A

2 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2



Solar Heating System - Single Family Residence

SEQUENCE OF OPERATION

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GENERAL

The solar heating system and the auxiliary heat source (heat pump and electric coil) are controlled by the space thermostat. The control logic is as follows:

- Collect solar energy when available
  - Store energy under no load conditions
  - Provide energy directly to load on demand
- Use direct solar energy before stored energy
- Use stored energy when direct solar energy is not available
- Use direct or stored solar energy before auxiliary energy

DIRECT HEATING FROM COLLECTORS

Whenever plate temperature T_p is greater than 105°F (adjustable) and there is a call for heating from the space thermostat, pumps P_1 and P_2 are activated. Valve V_2 is positioned to direct flow to the heating coil. The furnace fan is activated to provide warm air to the space. A heating coil leaving air high limit controller will cause valve V_2 to direct flow to the storage tank if the heating coil leaving air temperature exceeds 140°F. Direct heating operation will continue until the space thermostat is satisfied or until the collector plate temperature has dropped to 90°F.

HEATING FROM STORAGE

Whenever T_p is less than 105°F (adjustable), T_{ST} is greater than 100°F (adjustable) and there is a call for space heat, pump P_3 is activated to discharge the storage tank for space heating. Valve V_2 is positioned to direct flow to the heating coil. The furnace fan is activated to provide warm air to the space. Pumps P_1 and P_2 are not allowed to operate during this mode. The heating coil leaving air high limit controller functions as described above.

STORAGE CHARGING

Storage charging is accomplished whenever T_p is greater than T_{SB} by 18°F (adjustable). Pumps P_1 and P_2 are activated and valve V_2 is positioned to direct flow to the storage tank. If the above temperature difference falls to less than 3°F (adjustable), the storage charge mode is terminated.

HEAT REJECTOR CONTROL

Whenever the collector discharge temperature exceeds 210°F (adjustable) as sensed by T_{CD} valve V_1 is positioned to direct collector loop flow through the heat rejector, and the heat rejector fan is activated.

AUXILIARY HEATING

Whether or not, solar heating is being utilized, either direct or stored, auxiliary heating will be available, if required, from the heat pump. Additional auxiliary heat will be available, if required, from the electric heating coil as determined by the control logic and outdoor thermostats T-1 and T-2.

DOMESTIC HOT WATER HEATING

Whenever domestic hot water is drawn from the water heater it is replaced by preheated water from a coil in the storage tank. A thermostatic mixing valve is used to regulate the hot water supply temperature to 140°F.

UNRELEASED DRAWING, NO. ... E.C.O. CONTROL

MFGR.
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
HONEYWELL
LENNOX
LENNOX
HONEYWELL

TOLERANCES UNLESS NOTED OTHERWISE
.X ± .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH-SEE NOTE

NEXT ASSY | USED ON

APPLICATION

DRAFTSMAN | CHECKER | DEV ENGR | ENGRG MGT

CONTRACT NO.

NEW CASTLE

HONEYWELL INC. ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE CONTROL SUBSYSTEM

SIZE C | CODE IDENT NO. 55513 | DRAWING NO. [illegible]-142105

SCALE | SHEET 1 OF 1

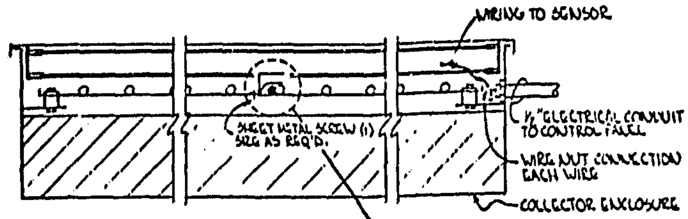
CONTROL A

F-1

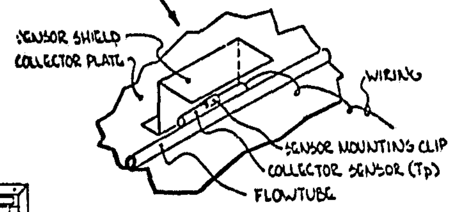
4 FOLDOUT FRAME 3 2

D C B A

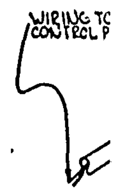
PART NO.

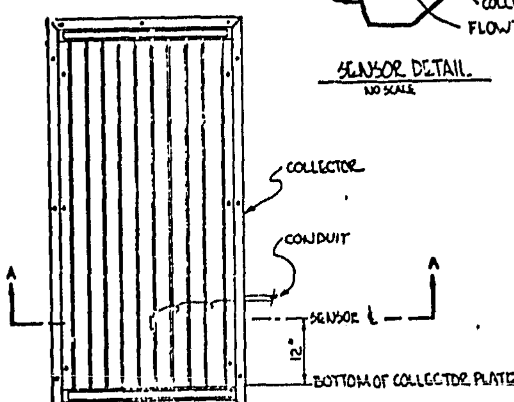


SECTION A-A
NO SCALE

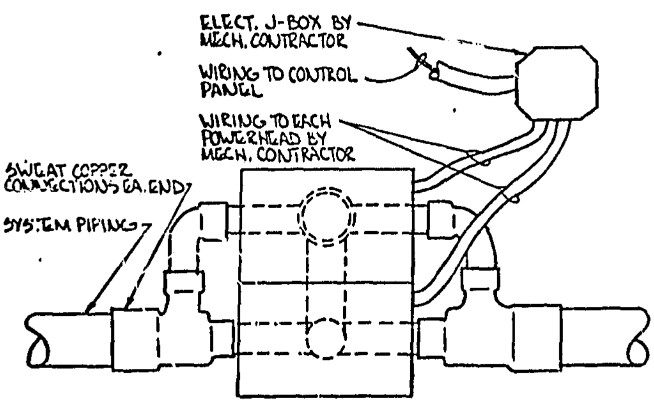


SENSOR DETAIL
NO SCALE

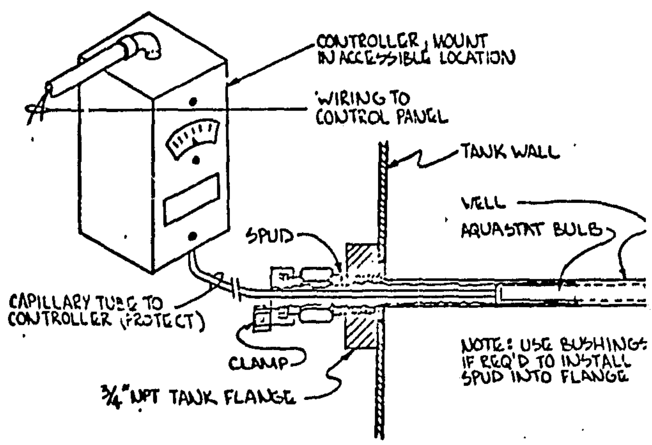




COLLECTOR PLATE SENSOR (Tp) DETAIL (TOP VIEW)
NO SCALE



CONTROL VALVE DETAIL (V_1)
NO SCALE



STORAGE TANK AQUASTAT MOUNTING DETAIL
INDOOR INSTALLATION (T_{ST})
NO SCALE

NEXT ASSY	USED ON	
APPLICATION		FINI

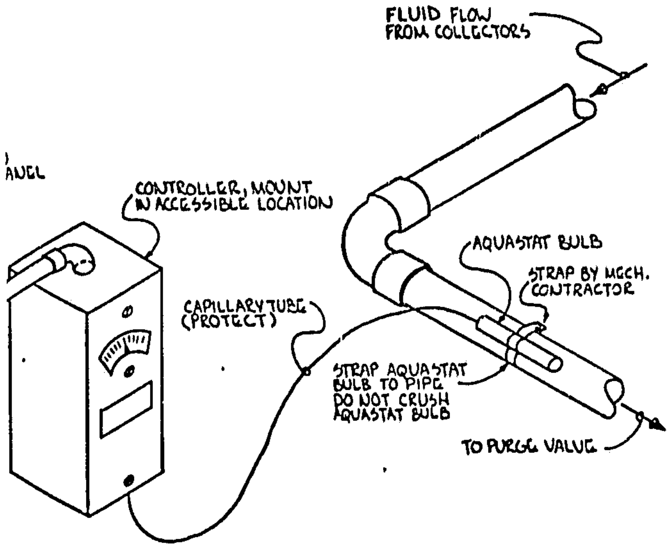
1

2

FOLDOUT FRAME

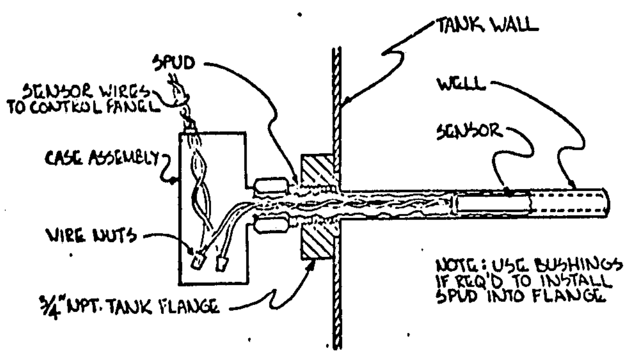
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

D



C

PURGE VALVE AQUASTAT MOUNTING DETAIL (T_{CD})
NO SCALE



B

STORAGE TANK SENSOR MOUNTING DETAIL
INDOOR INSTALLATION (T_{SB})
NO SCALE

UNRELEASED DRAWING-
NOT ... TO
E.C.O. CONTROL

A

TOLERANCES UNLESS NOTED OTHERWISE
90° FORMED ANGLES
ERIAL
SH–SEE NOTE

DRAFTSMAN
CHECKER
DEV ENGR
ENGRG MGT
CONTRACT NO.
NEWCASTLE

HONEYWELL INC.
ENERGY RESOURCES CENTER
MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE
CONTROL SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142105

SCALE NONE | SHEET 2 OF 4

CONTROL | A

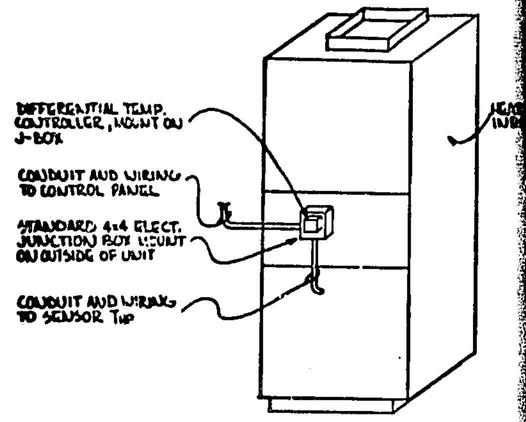
4

3

PART NO.

FOLDOUT FRAME

D

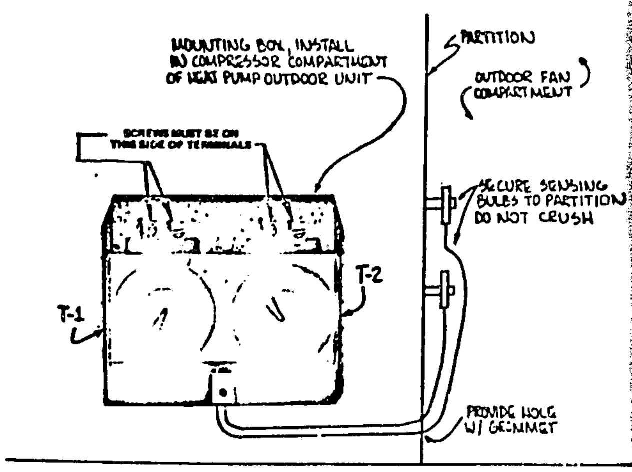


DIFFERENTIAL TEMPERATURE CONTROLLE

NO SCALE

C

B



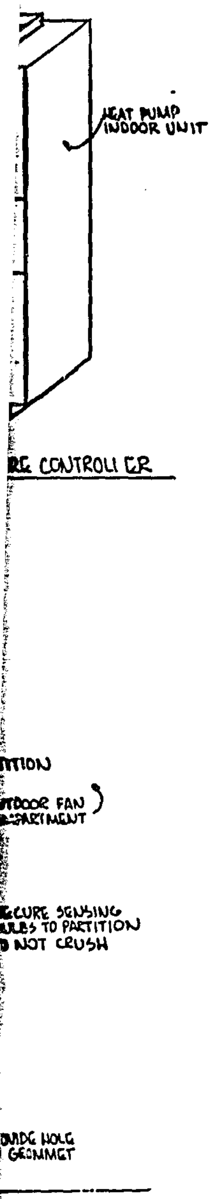
OUTDOOR THERMOSTAT INSTALLATION

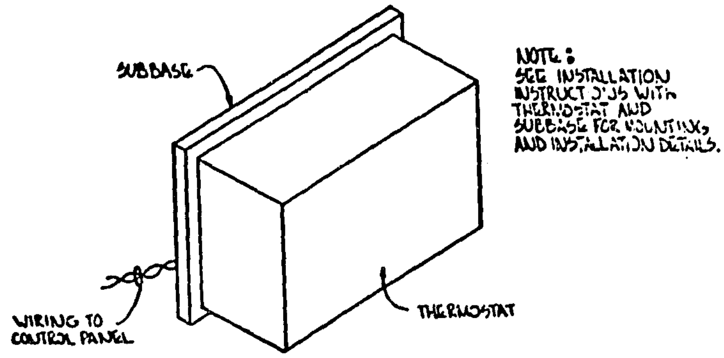
NO SCALE

A

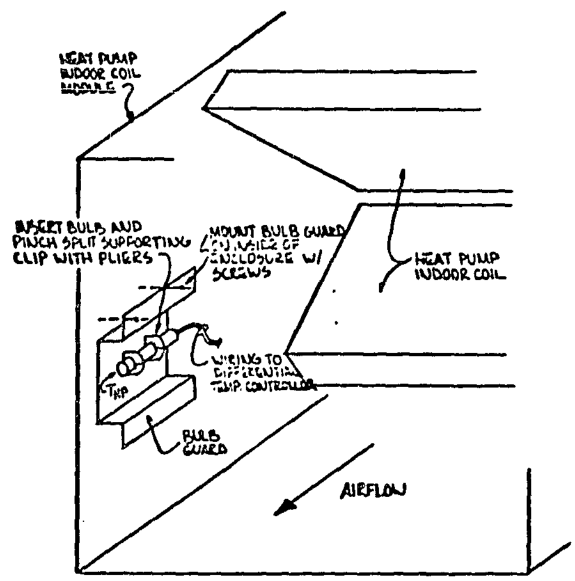
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME





THERMOSTAT AND SUBBASE DETAIL
NO SCALE



BULB GUARD INSTALLATION
NO SCALE

UNRELEASED DRAWING:
E.C.O. CONTROL

		TOLERANCES UNLESS NOTED OTHERWISE	DRAFTSMAN	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
		.X ± .XX ± .XXX ± / FORMED ANGLES	CHECKER		
			DEV ENGR		
			ENGRG MGT		
		MATERIAL	CONTRACT NO.	SINGLE FAMILY RESIDENCE CONTROL SUBSYSTEM	
			NEW CASTLE	SIZE C	CODE IDENT NO. 55513 / DRAWING NO. [illegible] 142105
NEXT ASSY	USED ON			SCALE	SHEET 3 OF 4
APPLICATION		FINISH–SEE NOTE			

CONTROL A

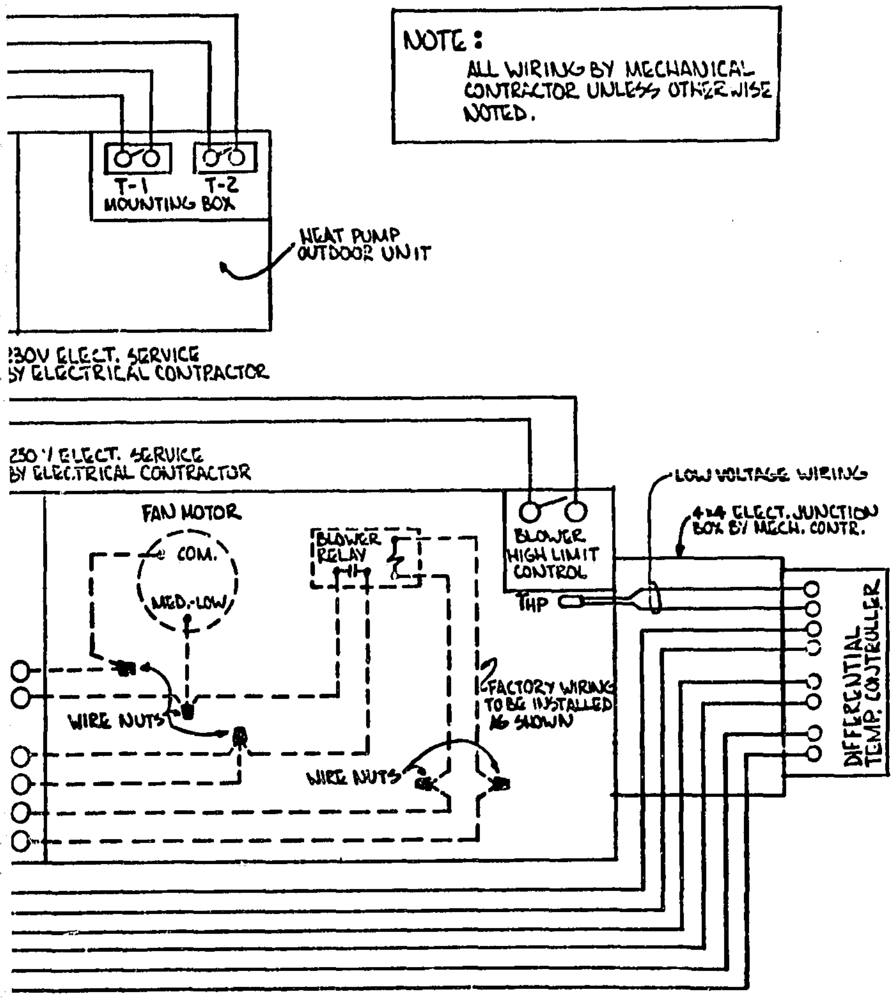
F-3

2

FOLDOUT FRAME

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

NOTE:
ALL WIRING BY MECHANICAL CONTRACTOR UNLESS OTHERWISE NOTED.



UNRELEASED DRAWING NOT SUBJECT TO E.C.O. CONTROL

TOLERANCES UNLESS NOTED OTHERWISE .X ± .XX ± .XXX ±	DRAFTSMAN		
	CHECKER		
	DEV ENGR		
	ENGRG MGT		
MATERIAL	CONTRACT NO.		
	NEW CASTLE		
FINISH—SEE NOTE			

HONEYWELL INC.

ENERGY RESOURCES CENTER
MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE CONTROL SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142105

SCALE NONE | SHEET 4 OF 4

CONTROL | A

D C B A

FOLDOUT FRAME

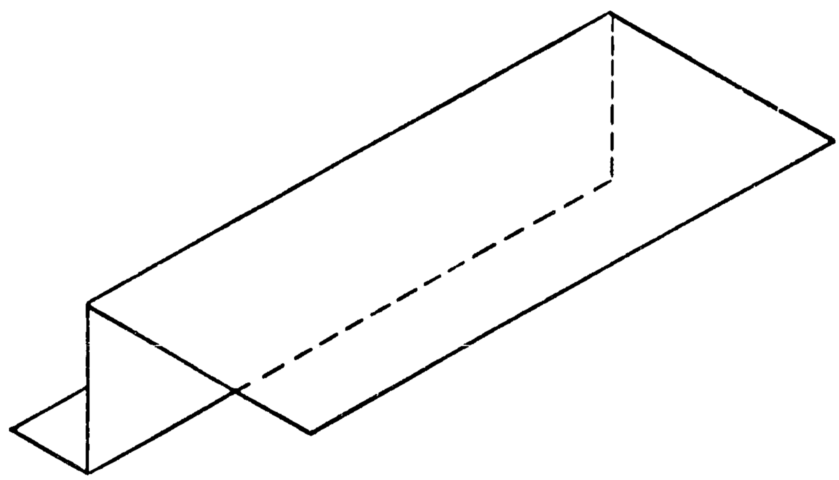
PART NO.

FINISH INSTRUCTIONS

A) DEGREASE MATERIAL

B) PRIME WITH ZINC CHROMATE

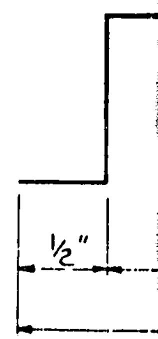
C) SPRAY FINISH -2 COATS OF 3M-"NEXTEL" BLACK VELVET



F-5

ISOMETRIC

FULL SIZE



L. SIDE VIEW

MATERIAL SCHEDULE				
ITEM#	ITEM	MANUFACTURER	TYPE / PART NO.	QUAN.
1	SENSOR SHIELD	ANY	20 GA. COLD RLD. STEEL	10½ IN.
2	BLACK VELVET SPRAY	3M	NEXTEL 101-C10	1 CAN
3	SHEET METAL SCREW	ANY	#10-½"	1

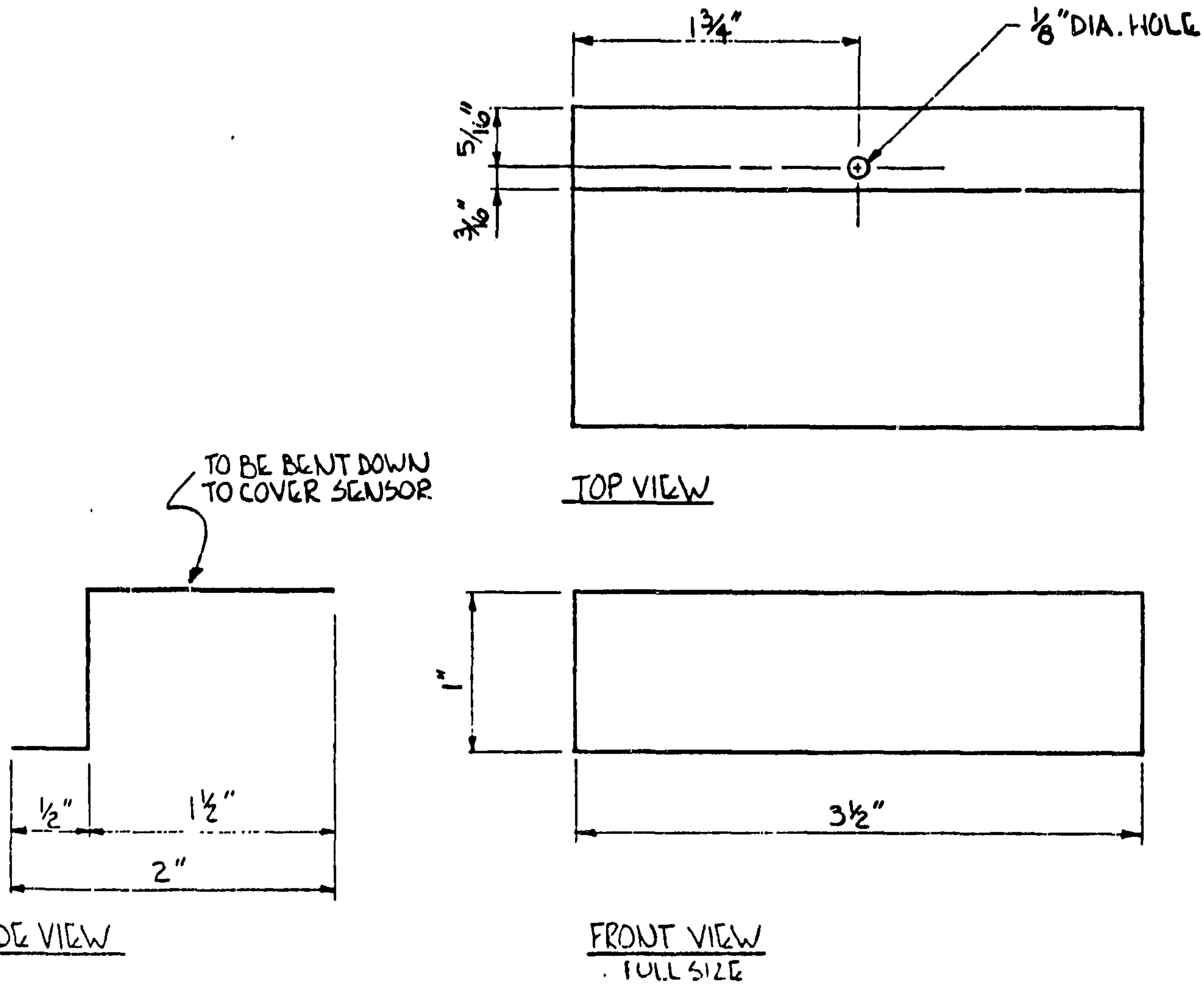
NEXT ASSY	USED ON
APPLICATION	

FOLDOUT FRAME 2

DWG NO. SK-142067 REV A

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED
A	ADDED FINISHING NOTES & MATERIAL SCHEDULE	7-20-77	A.M. Kuidzij



TOLERANCES UNLESS NOTED OTHERWISE .X ± / .XX ± / .XXX ± 90° FORMED ANGLES ±2° .1°	DRAFTSMAN CHECKER DEV ENGR ENGRG MGT	HONEYWELL INC. — ENERGY RESOURCES CENTER, MINNEAPOLIS, MINN. 55413
MATERIAL 20 GAUGE COLD ROLLED STEEL	CONTRACT NO.	SENSOR SHIELD - COLLECTOR
USED ON		SIZE B — CODE IDENT NO. 55513 — DRAWING NO. SK-142067
FINISH–SEE NOTE		SCALE FULL — SHEET 1 OF 1

CONTROL

APPENDIX G

SITE DATA ACQUISITION SUBSYSTEM

DRAWING NO. SK 142104

FOLDOUT FRAME

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4

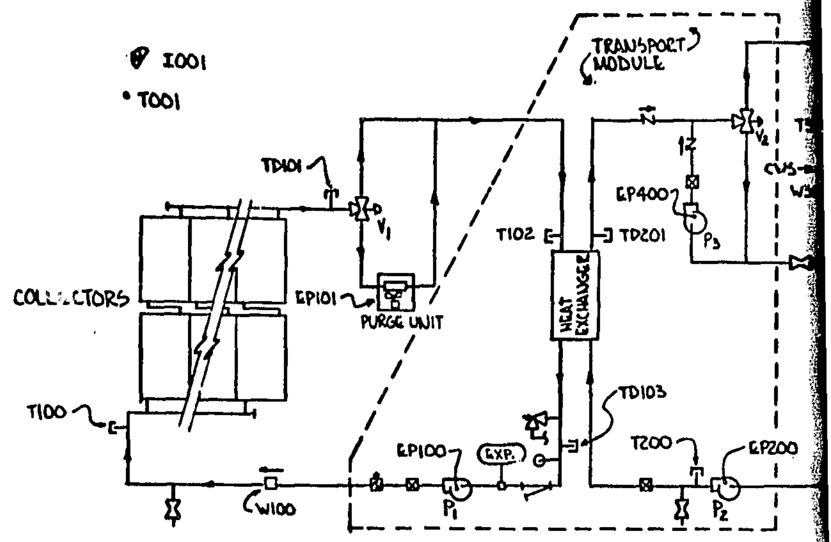
PART NO.

D

C

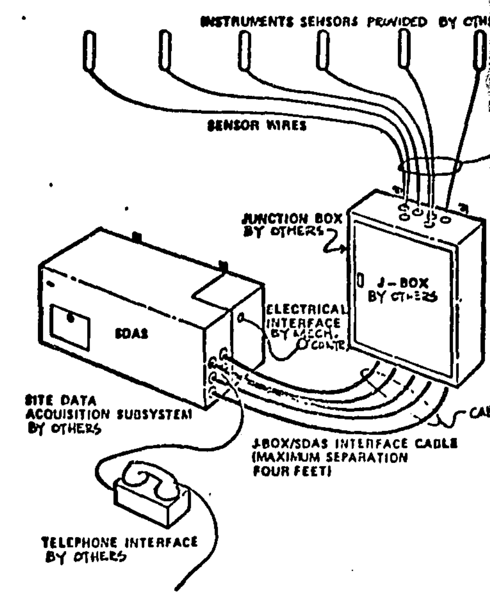
B

A



SITE DATA AQUISITION SUBSYSTEM SCHEMATIC

NO SCALE



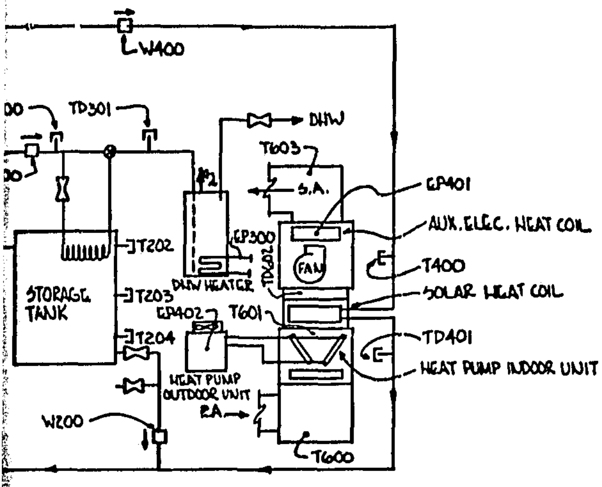
SITE DATA AQUISITION SUBSYSTEM COMPONENTS

NO SCALE

3 2 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME



SITE DATA ACQUISITION SUBSYSTEM MATERIAL LIST

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Site Data Acquisition Subsystem Module
Junction Box
Instrumentation Sensors as follows:

SENSOR	FUNCTION	DETAIL
I001	Total Radiation	1
T001	Outdoor Ambient DB Temperature	3
T100	Collector Inlet Temperature	10
TD101	Collector Differential Temperature	9
T102	HX Solar Inlet Temperature	10
TD103	HX Solar Differential Temperature	9
T200	HX Hot Water Inlet Temperature	10
TD201	HX Hot Water Differential Temperature	9
T202	Storage Tank Temperature - Top	8
T203	Storage Tank Temperature - Middle	8
T204	Storage Tank Temperature - Bottom	8
T300	Domestic Cold Water Temperature	10
TD301	Solar DHW Preheat Differential Temperature	9
T400	Heating Coil HW Inlet Temperature	10
TD401	Heating Coil HW Differential Temperature	9
T600	Space Return Air Temperature	7
T601	Heating Coil Air Inlet Temperature	7
TD602	Heating Coil Air Differential Temperature	6
T603	Space Supply Air Temperature	7
W100	Collector Flow Rate	5
W200	Storage Flow Rate	5
W300	DHW Flow Rate	5
W400	Heating Coil Flow Rate	5
EP100	Collector Pump Power	2
EP101	Heat Rejector Fan Power	2
EP200	Storage Pump Power	2
EP300	Domestic HW Heater Power	4
EP400	Heating Pump Power	2
EP401	Electric Heater and Fan Power	4
EP402	Heat Pump Power	4

...ERS INSTALLED BY MECH. CONTRACTOR

WIRING TO SENSORS BY MECH. CONTRACTOR.

...BLE BY OTHERS

NEXT ASSY	USED ON
APPLICATION	

TOLERANCES UNLESS NOTED OTHERWISE
.X ± .XX ± .XXX ± ANGLES ±
MATERIAL
FINISH—SEE NOTE

DRAFTSMAN	Donahue	1/6/77
CHECKER		
DEV ENGR		3-4/77
ENGRG MGT		3/4/77

CONTRACT NO.

NEWCASTLE

HONEYWELL INC. ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE SITE DATA AQUISITION SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142104

SCALE NONE SHEET 1 OF 3

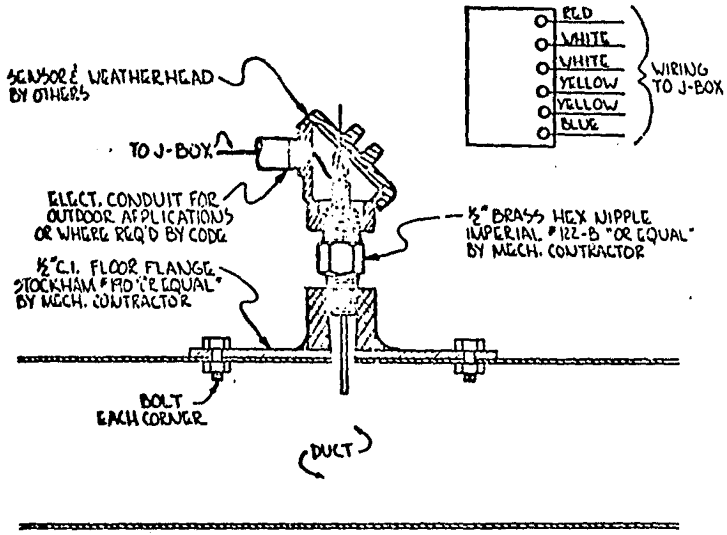
CONTROL A

G-1

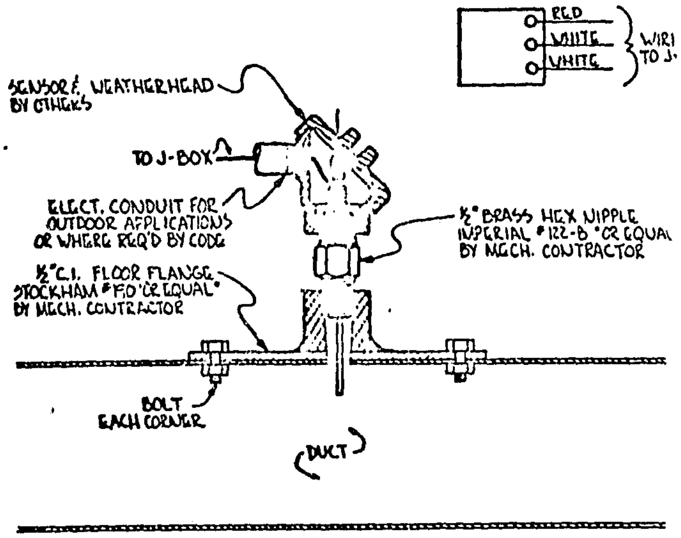
4 3 2

PART NO.

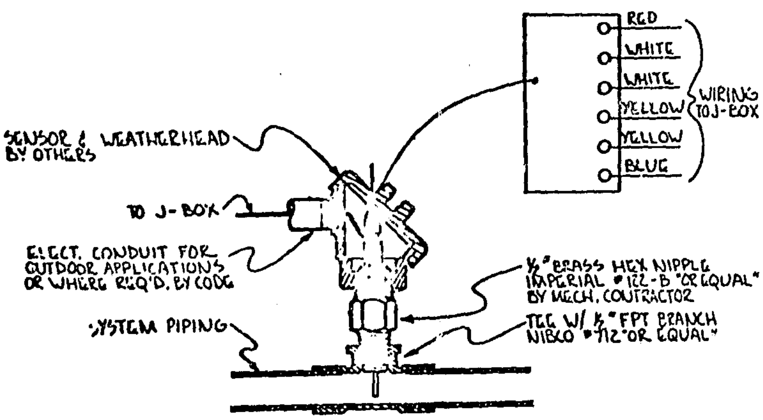
FOLDOUT FRAME



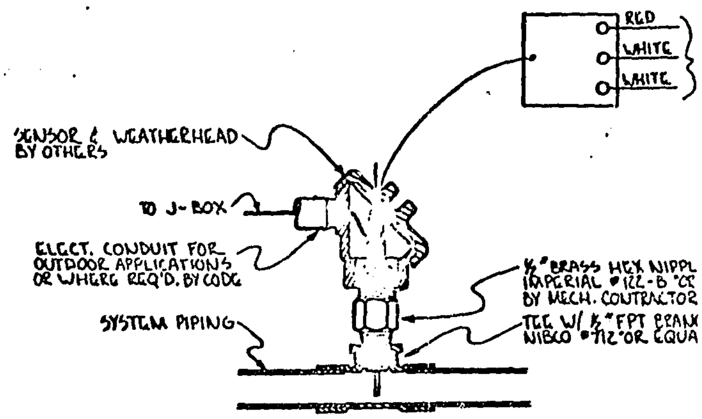
DUAL ELEMENT
(6) TEMPERATURE SENSOR
NO SCALE



SINGLE ELEMENT
(7) TEMPERATURE SENSOR
NO SCALE



DUAL ELEMENT
(9) TEMPERATURE SENSOR
NO SCALE

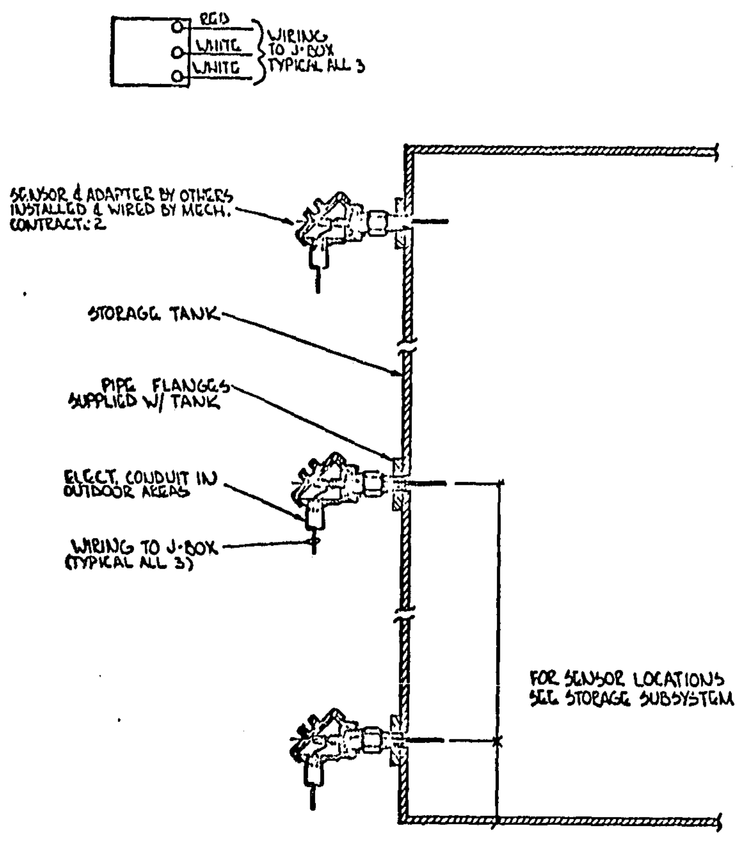


SINGLE ELEMENT
(10) TEMPERATURE SENSOR
NO SCALE

NEXT ASSY	USED ON
APPLICATION	

FOLDOUT FRAME 2

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



WIRING TO J-BOX

(B) TEMPERATURE SENSORS AT TANK
NO SCALE

TEMPERATURE SENSOR INSTALLATION

1. All temperature sensors shall be located so as to avoid accidental damage to the sensor head assembly.
2. Dow Corning DC-340 heat transfer grease shall be applied to the bottom of the temperature probe prior to insertion into the thermowell.
3. In areas where there is a mixing of flows, the temperature sensor shall be mounted a minimum of twenty (20) pipe diameters downstream of the point of mixing.
4. All temperature sensors shall be identified with a brass tag.

D

C

B

A

TOLERANCES UNLESS NOTED OTHERWISE	
DRAFTSMAN	Donahue 7/23/77
CHECKER	
DEV ENGR	J. Coll 8/4/77
ENGRG MGT	8/4/77
CONTRACT NO.	
	NEWCASTLE
-SEE NOTE	

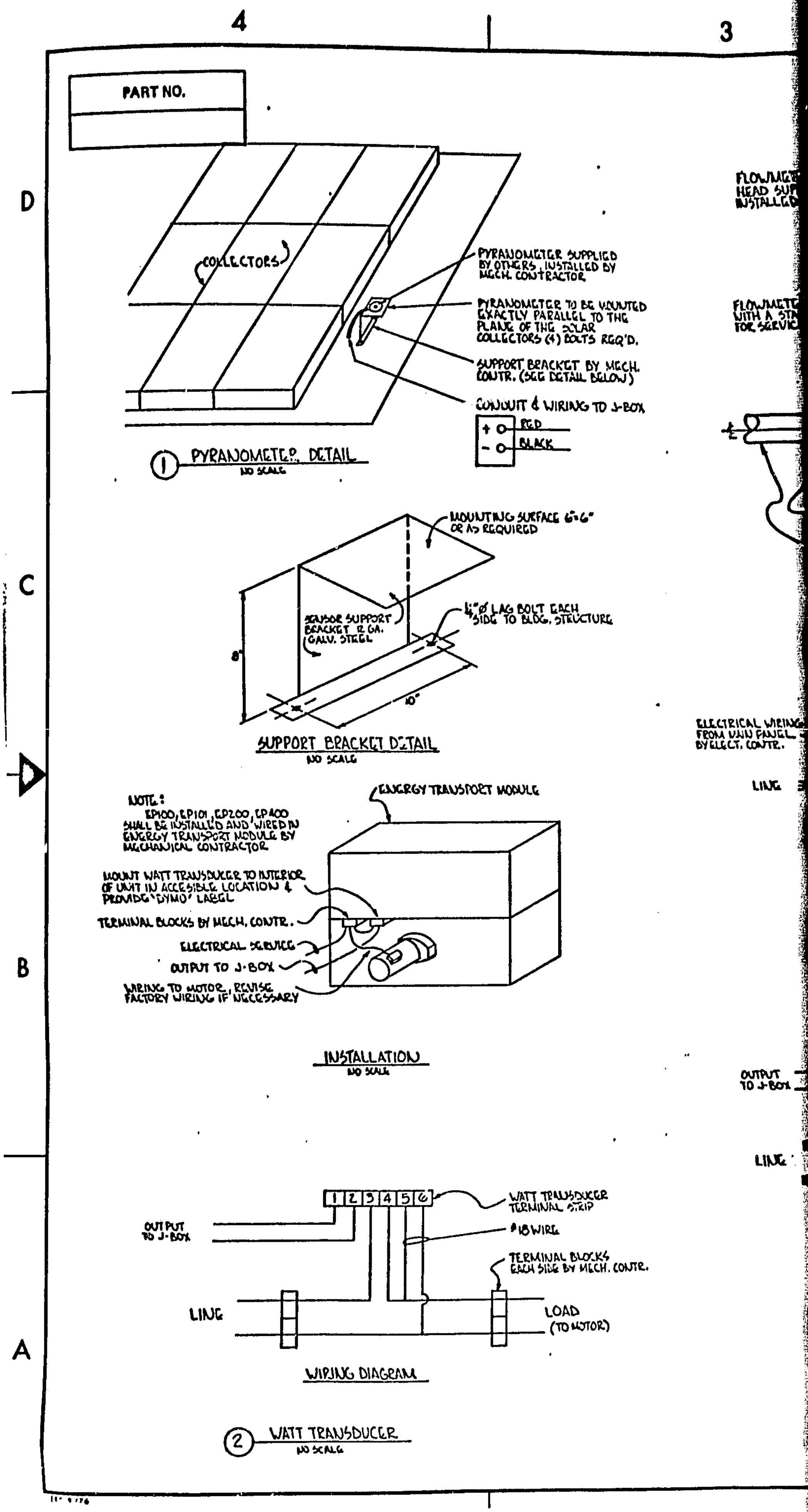
HONEYWELL INC.
ENERGY RESOURCES CENTER
MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE
SITE DATA AQUISITION SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142104
SCALE NONE		SHEET 2 OF 3

CONTROL A

FOLDOUT FRAME



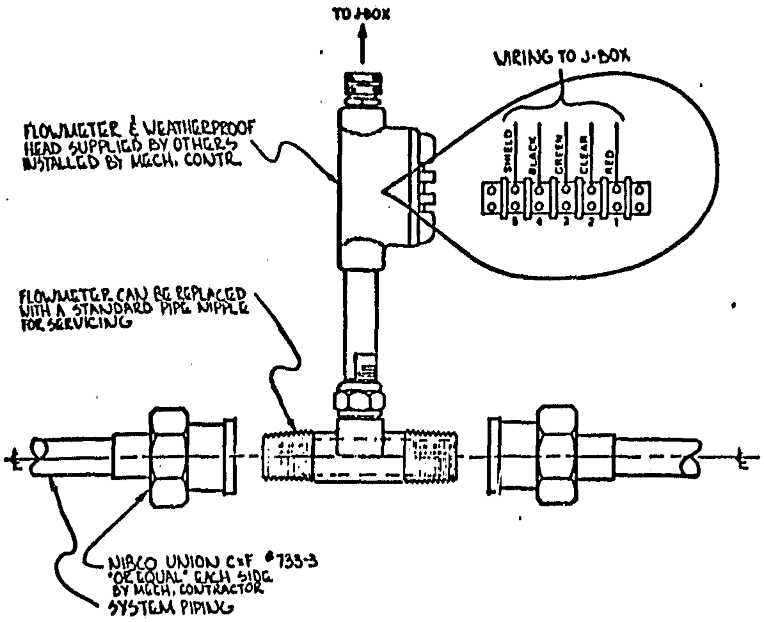
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
	FOLDOUT FRAME		

FLOWMETER INSTALLATION INSTRUCTIONS

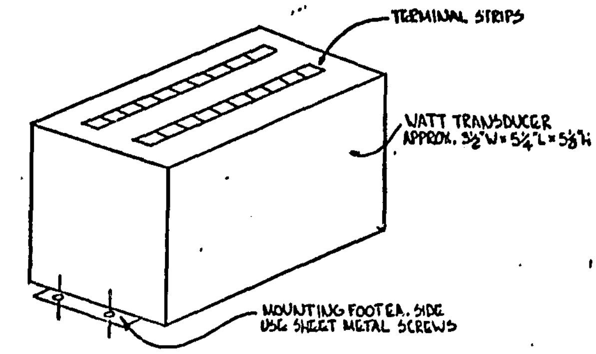
1. Flowmeters shall be preceded by a minimum of twenty (20) pipe diameters of uninterrupted flow line upstream, and followed by a mimimum of ten (10) pipe diameters of uninterrupted flow line downstream. These sections shall have no elbows, valves, thermometers or temperature sensors, or other obstructions.

2. Flowmeters shall be located in the horizontal position.

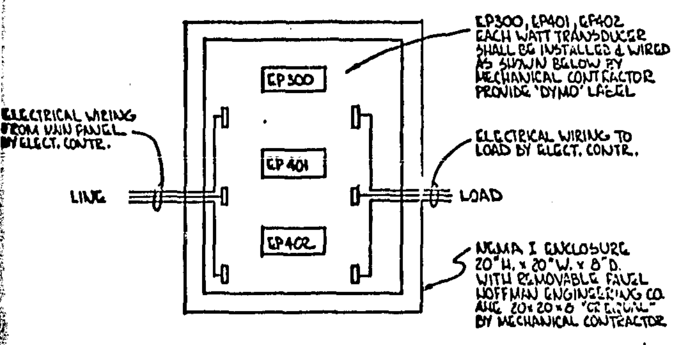
3. All flowmeters shall be identified with a brass tag.



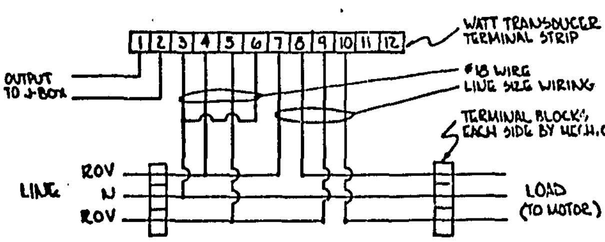
(5) FLOWMETER DETAIL
NO SCALE



WATT TRANSDUCER
NO SCALE

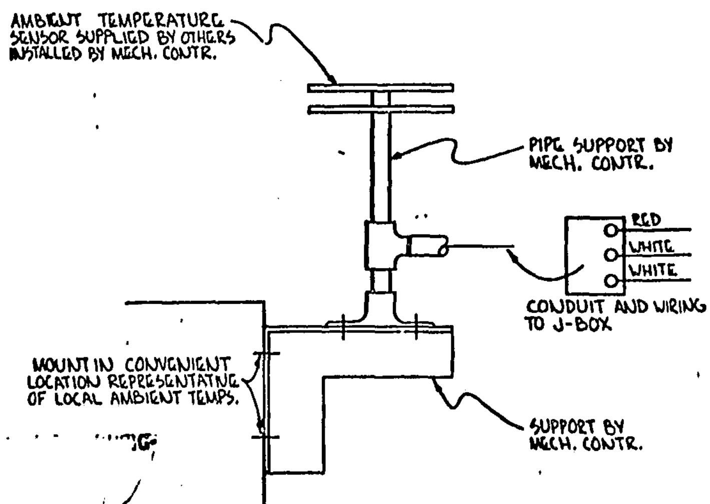


INSTALLATION
NO SCALE



WIRING DIAGRAM

(4) WATT TRANSDUCER
NO SCALE



(3) AMBIENT TEMPERATURE SENSOR
NO SCALE

NEXT ASSY	USED ON
APPLICATION	

TOLERANCES UNLESS NOTED OTHERWISE
.X ± .XX ± .XXX ± ANGLES ±
MATERIAL
FINISH–SEE NOTE

CRAFTSMAN	Dorgan	7/29/77
CHECKER		
DEV ENGR	J. Cull	8/1/77
ENGRG MGT		8/1/77

CONTRACT NO.
NEWCASTLE

HONEYWELL INC. ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE SITE DATA AQUISITION SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	55513	SK-142104

SCALE NONE SHEET 3 OF 3

CONTROL A G-3

APPENDIX H

ELECTRICAL SUBSYSTEM

DRAWING NO. SK 142103

4

3

PART NO.

FOLDOUT FRAME (

SOLAR

1.0 GENERA

1.1 Scop
elec
syst

1.2 Req
sepe
giv

a.)

b.)

Eac
ma
disc

2.0 BASIC M

2.1 Bas
Elec
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2.2 Bas
code

SC 9/76

FOLDOUT FRAME

SOLAR HEATING SYSTEM - SINGLE FAMILY RESIDENCE
ELECTRICAL SUBSYSTEM

GENERAL CONDITIONS

1.1 Scope: The Electrical Subsystem will involve all field electrical wiring necessary to complete the solar heating system and make it ready for operation.

1.2 Required Work: The Electrical Contractor shall provide a separate branch circuit to each of the following. Values given are minimum circuit ampacity.

a.) 230 V single phase

1.) Heat Pump Outdoor Unit: 24.3 amps

2.) Electric Heating Coil and Heat Pump Indoor Unit: 79.2 amps

3.) Domestic HW Heater: 39.1 amps

b.) 120V single phase

1.) Energy Transport Module: 12.9 amps

Each branch circuit shall have a circuit breaker or fuse at main electrical panel, sized per all applicable codes. A disconnect switch shall be provided if required by code.

BASIC MATERIALS AND METHODS

2.1 Basic Materials: All materials shall be supplied by the Electrical Contractor. All materials shall be as specified by the Architect and required by all applicable codes.

2.2 Basic Methods: All work shall conform with all applicable codes.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

NEXT ASSY	USED ON
APPLICATION	

TOLERANCES UNLESS NOTED OTHERWISE
.X ±
.XX ±
.XXX ±
ANGLES ±

MATERIAL

FINISH–SEE NOTE

DRAFTSMAN Donahue
CHECKER
CSV ENGR
ENGRG MGT

CONTRACT NO.

NEW CASTLE

HONEYWELL INC.
ENERGY RESOURCES CENTER
MINNEAPOLIS, MINN. 55413

SINGLE FAMILY RESIDENCE
ELECTRICAL SUBSYSTEM

SIZE	CODE IDENT NO.	DRAWING NO.
C	53513	SK-142103

SCALE NONE | SHEET 1 OF 1

CONTROL A

H-1

APPENDIX I

ARCHITECT'S SOLAR HEATING SYSTEM SPECIFICATIONS

DIVISION 15 - MECHANICAL

1. PROJECT DESCRIPTION

1.1 The work included in this contract consists of the installation of a solar energy system to provide space and domestic water heating for a single-family residence at the intersection of Long & Hamilton Streets, in the City of New Castle, Pennsylvania.

1.2 Honewell, Inc., under contract to the U.S. National Aeronautics and Space Administration will provide at no cost to the contractor components for the following subsystems:

a. Collector
b. Storage
c. Auxiliary Energy & Space Heat
d. Domestic Hot Water
e. Energy Transport
f. Control

In addition, Honeywell will provide componets for another subsystem, the site data acquisition subsystem. All costs related to this subsystem for materials and labor must be identified as an alternate to the base bid.

2. WORK BY OTHERS

2.1 The following is work that will be performed by others. The contractor shall be responsible to coordinate his work to provide proper interfacing between his work and the work of others.

a. General construction of the residence including all necessary site work, utility service, distribution ductwork for the space heating system to and from the heat pump unit, and distribution pipework for the plumbing system from the domestic water heater and cold water inlet to the plumbing fixtures.

3. SCOPE OF WORK

3.1 This specification covers all labor, tools, and materials necessary for the complete installation of the work shown on the heating drawings and described in these specifications. The installation shall be guaranteed against defects in material and workmanship for one year.

4. LAWS, REGULATIONS AND FEES

4.1 This work shall comply with all applicable laws and regulations. The Contractor shall secure and pay for all necessary permits.

5. HONEYWELL - GOVERNMENT FURNISHED EQUIPMENT

5.1 The following is a list of the system components which will be furnished at not cost to the contractor.

HONEYWELL-GOVERNMENT FURNISHED EQUIPMENT

SUBSYSTEM	UNIT DESCRIPTION	PART NO.	MANUFACTURER
Collector	Solar Collector	LSC-18-1S	Lennox Industries
	Header Assembly	SK-142064-3C	Honeywell
	Header Assembly	SK-142064-3B	Honeywell
	Header Assembly	SK-142064-2C	Honeywell
	Hose Assembly	SK-142066	Honeywell
	3/8 npt Coupling	4738-6-6	Aeroquip
	3/8 npt Coupling	FF1162-0606B	Aeroquip
	Purge Cooling Unit	HRW-1-130	Lennox Industries
Storage	Tank-Hot Water Storage	SK 142008A	Honeywell
Auxiliary Energy & Space Heat	H.P. Outdoor Unit	HP10-311V	Lennox Industries
	H.P. Indoor Unit	CBP10-41	Lennox Industries
	Solar Coil	CW31-45	Lennox Industries
	Electric Coil	ECB10-41-471	Lennox Industries
	Refrig. Line Set	L10-41-30	Lennox Industries
Domestic Hot Water	Heater-Hot Water	52-KP-10	Lochinvar
	Valve-Mixing	70 A - 3/4"	Watts Req.
Energy Transport	Module-Energy Transport	SK-142065	Honeywell
	Dowtherm SR-1		
Control	Aquastat	L6008C1065	Honeywell
	Aquastat	L4008B1013	Honeywell
	Thermostat	T872C1004	Honeywell
	Sub Base	Q672B1004	Honeywell
	Valve	V4331A1003	Honeywell
	Sensor shield	SK-142067	Honeywell
	Sensor	C773B1005	Honeywell
	Wells	122555B	Honeywell
	Case assembly	112892F	Honeywell
	Differential Temperature Control	R7412	Honeywell
	Bulb guard	107323A	Honeywell
	Thermostat (outdoor)	P-8-10715	Lennox Industries
	Mounting box	M-1595	Lennox Industries

HONEYWELL-GOVERNMENT FURNISHED EQUIPMENT

SUBSYSTEM	UNIT DESCRIPTION	PART NO.	MANUFACTURER
Site Data Acqu.	Site Data Acq. Module		
	Junction Box		
	Sensor - Total Radiation	(1001)	
	Sensor - Outdoor Ambient DB Temperature	(T001)	
	Sensor - Collector Inlet Temperature	(T100)	
	Sensor - Collector Differential Temp.	(TD101)	
	Sensor - HX Solar Inlet Temperature	(T102)	
	Sensor - HX Solar Differential Temp.	(TD103)	
	Sensor - HX Hot Water Inlet Temperature	(T200)	
	Sensor - HX Hot Water Differential Temp.	(TD201)	
	Sensor - Storage Tank Temperature - Top	(T202)	
	Sensor - Storage Tank Temperature - Middle	(T203)	
	Sensor - Storage Tank Temperature - Bottom	(T204)	
	Sensor - Domestic Cold Water Temperature	(T300)	
	Sensor - Solar DHW Preheat Differential Temperature	(TD301)	
	Sensor - Heating Coil HW Inlet Temp.	(T400)	
	Sensor - Heating Coil HW Differential Temperature	(TD401)	
	Sensor - Space Return Air Temperature	(T600)	
	Sensor - Heating Coil Air Inlet Temp.	(T601)	
	Sensor - Heating Coil Air Differential Temperature	(TD602)	
	Sensor - Space Supply Air Temperature	(T603)	
	Sensor - Collector Flow Rate	(W100)	
	Sensor - Storage Flow Rate	(W200)	
	Sensor - DHW Flow Rate	(W300)	
	Sensor - Heating Coil Flow Rate	(W400)	
	Sensor - Collector Pump Power	(EP100)	
	Sensor - Heat Rejector Fan Power	(EP101)	
	Sensor - Storage Pump Power	(EP200)	
	Sensor - Domestic HW Heater Power	(EP300)	
	Sensor - Heating Pump Power	(EP400)	
	Sensor - Electric Heater & Fan Power	(EP401)	
	Sensor - Heat Pump Power	(EP402)	
	Junction Box & Cable Ass'y		

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Job 7727

6. STARTING OF PIPING SYSTEMS

6.1 Collector Loop

a. Complete testing of collector loop as called for elsewhere in three specifications.

b. Filling and Cleaning Precautions
   (1) Cover collectors before filling or fill at night
   (2) Do not operate pumps dry
   (3) Do not over-pressurize system on initial fill

c. Clean system with a solution of 1 gallon trisodium phosphate per 100 gallon water circulating for four hours. Check strainers periodically and clean as necessary to avoid damage to pump.

d. Drain cleaning solution and measure collector loop fluid volume so that correct amount ethylene glycol can be added.

e. Flush system with clean water for two hours.

f. Collector loop filing procedure:
   (1) Open vent at top of collectors
   (2) Fill system with proper amount of ethylene glycol to provide a 50% by volume solution.
   (3) Add corrosion inhibitor as per manufacturer's recommendations.
   (4) Operate control valves as necessary to fill all piping and remove all air from system.
   (5) Close vent and add fluid to provide a nominal 30 psi gauge pressure at module fill point.
   (6) Operate system and check all vents to eliminate all air from system.
   (7) Add water to pressurize system as shown on mechanical plans.

6.2 Storage/Heating Loop

a. Complete testing of storage/heating loop as called for elsewhere in these specifications.

b. Filling and cleaning precautions: same as above.

c. Flush storage tank with a hose.

d. Flush piping with clean water for two hours.

e. Storage/heating loop filling procedure:
   (1) Add water to system up to proper level in storage tank.
   (2) Operate control valves as necessary to fill all piping and remove all air from system.
   (3) Recheck storage tank level and fill accordingly.
   (4) Add corrosion inhibitor in quantity specified.

6.3 System Operation

a. Uncover collectors and operate system for several days under automatic control. Check system fluid levels, air vents, and operating pressure periodically.

6.4 Contractor will be assisted by systems engineer. Submit results of above work to architect.

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7. TESTING

7.1 Solar Heating System Piping: (except collector headers, storage tank, and hose connections to collectors.)

a. Test after erection and before concealing or covering. Any materials or workmanship found faulty shall be replaced or repaired and sections or systems retested.

b. These systems shall be proven tight under a hydrostatic pressure of 100 psig.

7.2 Collector Headers and Hose Connections to Collectors

a. Test after erection and before concealing or covering. Any materials or workmanship found faulty shall be replaced or repaired and sections or systems retested.

b. Cover collectors or conduct test at night.

c. These systems shall be proven tight under a hydrostatic presure of 50 psig.

7.3 Test results shall be submitted to Architect.

8. BALANCING OF SYSTEMS

8.1 Hydronic Systems

a. Balance flow rate of each pump to within 5% of specified flow as shown on plans.

b. Balance flow rate through each branch circuit to within 5% of specified flow as shown on plans.

8.2 Air Systems

a. Balance air system so as to provide flow rate at Solar Space Heating Coil within 5% of specified flow rate as shown on plans.

8.3 Motor Amperages

a. Measure all motor amperages and compare with nameplate ratings.

8.4 Balancing results shall be submitted to Architect.

9. PIPE AND PIPE FITTINGS

9.1 Solar Heating System

a. Type "M" hard drawn copper tubing with wrought copper or cast bronze fittings. Solder joints made with 95-5 tin-antimony solder.

9.2 Installation Method

a. According to manufacturer's instructions.

9.3 General Requirements

a. All piping shall be run parallel to adjoining building surfaces and by the most direct route. Exposed piping shall be run as close to ceiling and/or walls as possible.

b. All piping shall be installed so as to allow for movement due to thermal expansion and contraction.

c. Install manual air vents as shown on plans and all high points in the system.

d. Anchor vertical piping for support as required. Install pipe hangers in horizontal piping at eight foot intervals. Pipe hangers shall be F&M No. 364 or No. 365, or Autogrip, or equal. Provide an eight inch section of rigid insulation for pipe saddle within each hanger.

10. VALVES

10.1 Manufacturer

a. Valves shall be manufactured by Crane, Jenkins, Walworth, Powell, Lunkenheimer, or Stockham, except as indicated.

10.2 Valves - Solar Heating System

a. Gate Valves, 2" and Smaller

(1) 125 lb. steam, bronze body, solder end, solid wedge, rising stem.

b. Check Valves, 2" and Smaller

(1) 125 lb. steam, bronze body, solder end, bronze disc, swing check.

c. Ball Valves, 2" and Smaller

(1) 150 lb. steam, brass body, screwed end or solder end, glass reinforced Teflon seats and stem seals, balancing stop, brass ball, blow out proof brass stem and vinyl grip on handles.

d. Drain Valves, 2" and Smaller

(1) 125 lb. steam, bronze body, globe valve, screwed end or solder end, composition disc.

e. Balance Valves

(1) Circuit setter balance valves as manufactured by Bell & Gossett and sized as shown on the drawings.

10.3 Valve Tags

a. Each system valve shall be identified with a stamped numbered brass tag. A schedule of valves including valve size, service, manufacturer and location shall be submitted to Architect.

11. SOLAR STORAGE TANKS

11.1 Procurement

a. The Solar Storage Tank will be supplied by Honeywell ERC.

11.2 Required Work

a. The Mechanical Contractor shall install the Solar Storage Tank as shown on plans.

11.3 The Mechanical Contractor shall provide and install the position shown on the drawings, one Consolidated Brass (#20-207) self-cleaning water gauge, rough body, aluminum wheels with two rods. Tested for pressure to 200 pounds.

12. INSULATION

12.1 General

a. Scope

(1) This section pertains to insulation of all solar heating system piping supplied by the Mechanical Contractor.

b. Material

(1) Armstrong Armaflex, 3/4 inch thickness with waterproof coating.

c. Installation

(1) Per manufacturer's recommendations. Waterproof all sections exposed above the roof.

13. PLUMBING

13.1 Domestic Water Heater

a. Procurement

(1) The Domestic Water Heater and Mixing Valve will be supplied by Honeywell ERC.

b. Required Work

(1) The Mechanical Contractor shall install the Domestic Water Heater and Mixing Valve as shown on plans.

14. SOLAR COLLECTOR SUBSYSTEM

14.1 Scope

a. The Solar Collector Subsystem consists of the solar collectors, collector header piping, flexible hose connections to each solar collector, and the purge coil.

14.2 Procurement

a. These components of the collector subsystem to be supplied by Honeywell ERD are shown on plans. All other materials required for a complete installation shall be supplied by the Mechanical Contractor.

14.3 Required Work

a. The Mechanical Contractor shall install all above equipment as shown on plans. Header assembly joints shall be made with 95-5 tin-antimony solder. During the joining process a heat sink shall be provided between the coupling and the pre-insulated header sections. The pre-insulated header sections shall not be at temperatures greater than 220°F.

15. ENERGY TRANSPORT MODULE

15.1 Procurement

a. The Energy Transport Module will be supplied by Honeywell ERC.

15.2 Required Work

a. The Mechanical Contractor shall install the Energy Transport Module as shown on plans.

16. SOLAR SPACE HEATING COIL

16.1 Procurement
a. The Solar Space Heating Coil will be supplied by Honeywell ERC.

16.2 Required Work
a. The Mechanical Contractor shall install the Solar Space Heating Coil as shown on plans.

17. ELECTRIC HEAT PUMP

17.1 Procurement
a. The Heat Pump will be supplied by Honeywell ERC.

17.2 Required Work
a. The Mechanical Contractor shall install the Heat Pump Components as shown on plans.

18. CONTROLS AND INSTRUMENTATION

18.1 General
a. Refer to Solar Control Subsystem, Site Data Acquisition Subsystem (SDAS).

18.2 Basic Materials and Methods
a. Refer to Solar Control Subsystem, Site Data Acquisition Subsystem.

18.3 Sequence of Operation
a. Refer to Solar Control Subsystem plans.

19. CONTROL SUBSYSTEM

19.1 Scope
a. The Control Subsystem will include all controls necessary for operation of the solar heating system.

19.2 Required Work
a. The Mechanical Contractor will install and wire all controls as shown on control subsystem wiring schematic. This will include all line voltage wiring required.

19.3 Procurement of Control Devices
a. Control devices listed in Section (i.e., Solar Control Panel, Aquastats, Thermostat, etc.) will be provided by Honeywell ERC. This will include the control devices only, all other materials necessary for a complete installation shall be provided by the Mechanical Contractor.

19.4 Basic Materials
a. Control sensor wiring (T_p and T_{SB}): Wiring from solar control panel to control sensors T_p and T_{SB} shall be run in conduit in outdoor areas and shall be Belden #8762 or equal.

Job 7727

b. Power and control wiring: All line and low voltage wiring shall be of size and type required by applicable codes, and supplied by Mechanical Contractor.

c. Other Materials: All other materials required for a complete installation of the Control Subsystem shall be supplied by the Mechanical Contractor.

19.5 Basic Methods

a. Control device installation methods: As per applicable details and/or instructions included with equipment.

b. Electrical wiring: As per all applicable codes.

20. SITE DATA ACQUISITION SUBSYSTEM

20.1 Purpose

a. A Site Data Acquisition Subsystem (SDAS) will be installed to evaluate the performance of the solar heating system as well as determine the contribution of collected solar energy in reducing the consumption of conventional energy. The Site Data Acquisition Subsystem components will be furnished by NASA, consisting of instrumentation sensors, junction box, Site Data Acquisition Subsystem Module and a telephone interface.

20.2 Note that all materials and labor in the Site Data Acquisition Subsystem are to be clearly identified as an alternate to the Base Bid..

20.3 Required Work

a. Instrumentation Installation

(1) The Mehcanical Contractor will install all sensors listed in the instrumentation schedule. The sensor locations are shown on the Site Data Acquisition Subsystem Schematic and the mechanical plans. The Mechanical Contractor shall install the sensors in the locations shown so as to provide for accessibility and ease of servicing.

b. Instrumentation Wiring

(1) The Mechanical Contractor shall perform all electrical wiring from each sensor back to the Junction Box as shown on details and described below.

c. Watt Transducer Installation

(1) Mechanical Contractor shall install and wire watt tranducers on or near equipment served, and revise factory wiring as required. See Watt Transducer detail.

d. Site Data Acquisition Subsystem Module

(1) The Site Data Acquisition Subsystem Moduel will be furnished by NASA, and installed by the Mechanical Contractor. The installation location will be as shown on mechanical plans.

e. SDAS Telephone Interface

(1) NASA will provide the telephone installation required for the SDAS.

f. SDAS Electrical Interface

(1) The SDAS will interface with a standard 110-125V, 60 Hertz, 1 phase, 3 amp service. A standard 3 wire interface (safety ground, power and return) with a standard twist lock outlet, located within six feet of the SDAS, shall be provided by the Mechanical Contractor. NASA shall provide a three pin twist lock connector and cable to interface the SDAS with the power outlet.

20.4 Required Work

a. Junction Box

(1) NASA shall provide a Junction Box to the Mechanical Contractor for installation in a location as shown on mechanical plans. The Junction Box shall be located so that it is accessible for wiring connections from the sensors into the top and is within four feet of the SDAS location. At the required mounting location, the Junction Box shall be mounted using the four mounting feet located at the top and bottom of the unit. Depending on the characteristics of the mounting surface, molly bolts, wood screws or bolt/nut combinations shall be used to mount the unit. The Junction Box shall be installed in a top-up orientation.

b. Junction Box/Sensor Interface

(1) NASA will establish the wire run list which identifies where each sensor wire attaches to the Junction Box. The Junction Box will be prewired from the terminal strips to output connectors by NASA prior to delivery to the site. Each applicable sensor detail illustrates the sensor to Junction Box wiring. The Mechanical Contractor shall connect sensor wires to Junction Box terminals according to a wiring diagram to be provided by NASA.

c. Junction Box/SDAS Module Interface Cables

(1) NASA will install the cables between the Junction Box and the SDAS Module.

20.5 Restrictions On Use of Instrumentation

a. No monitoring, indicating or readout devices are to be connected to the instrumentation sensors, i.e., paralleled with the Site Data Acquisition Subsystem, without prior approval of NASA.

20.6 Failed Sensor Replacement

a. The improperly operating sensor will be identified to Honeywell ERC after examination of the sensor for signs of physical damage such as broken wires, loose connectors, loose terminals, etc. If no physcial damage is apparent in the inspection, NASA shall be notified for further instructions. If mechanical damage is apparent, the sensor shall be replaced by the Mechanical Contractor with a sensor supplied by NASA. The defective sensor shall then be returned to NASA for failute analysis.

20.7 Installation Materials and Methods

a. Wiring from the sensors to the Junction Box shall be performed by the Mechanical Contractor utilizing wire supplied by the Mechanical Contractor. The wire size and number of conductors required for each sensor type is specified in list below and each sensor type is specified in list below and each sensor detail. The Sensor-to-Junction Box wire shall be UL approved, color-coded, audio and instrumentation grade cable of the following manufacture or equal:

Alpha P/N 2421-18 gauge, 2 conductor
Dearborn P/N 972202-18 gauge, 2 conductor
Alpha P/N 2424-18 gauge, 4 conductor
Dearborn P/N 971804-18 gauge, 4 conductor

All externally exposed wire in the outdoor environment or buried will be in conduit.

Wire nuts will be utilized for terminations at the following sensors:

Temperature Sensors	3 each (single element)
Temperature Sensors	6 each (dual element)

Wire nuts shall be replaced with a butt splice in areas where the connections are exposed to vibration.

Ring terminals will be used to terminate the wires at the following snesors:

Flow Meter	5 each
Watt Transducer	2 each

If terminations conflict with local codes, local codes shall be applicable.

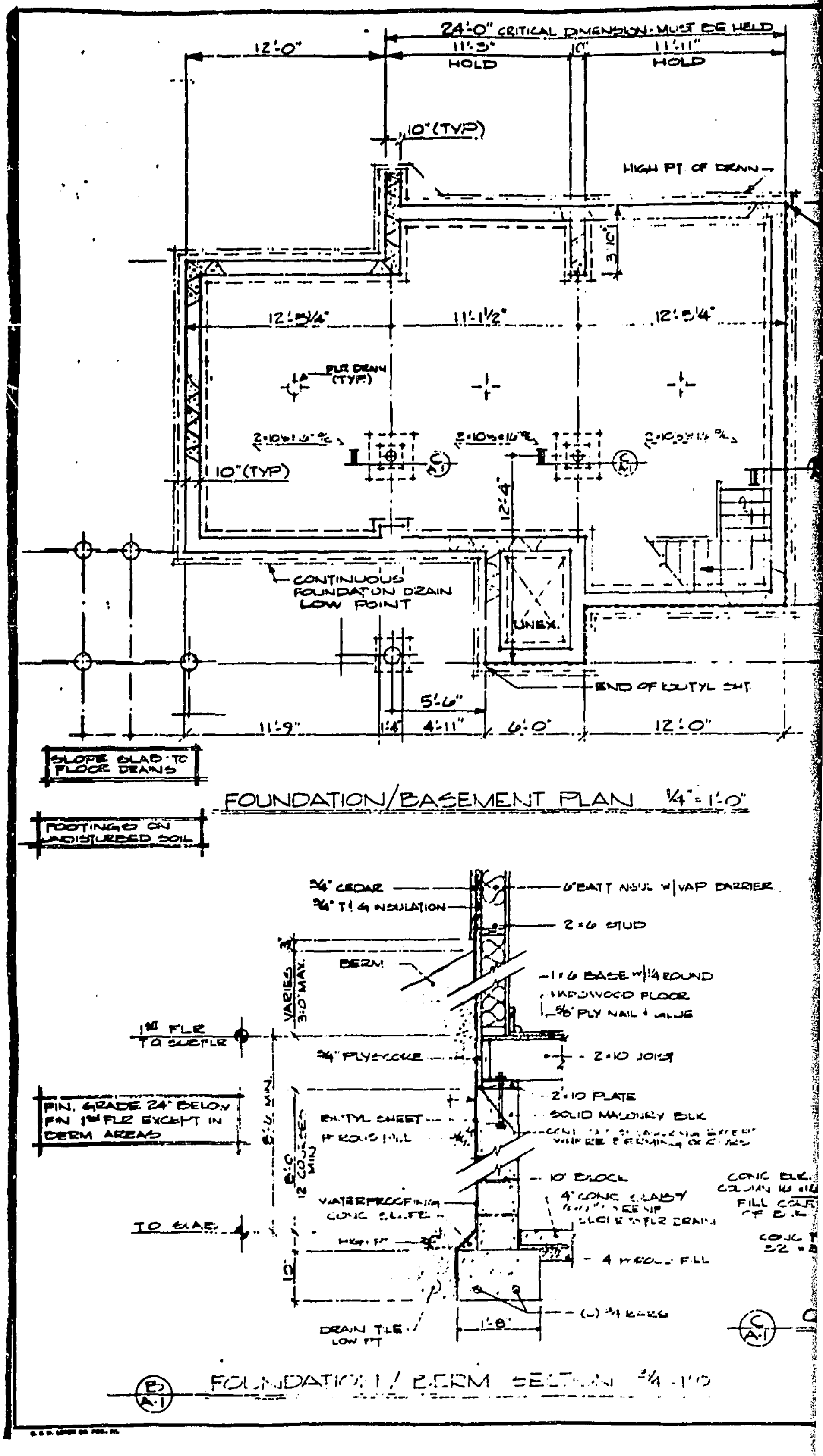
b. Other Materials

(1) All other materials necessary for installation of the sensors shall be provided by the Mechanical Contractor. This would include but not be limited to, pipe fittings, fasteners, electrical enclosures, terminal blocks, electrical wiring, electrical conduit, and any other materials necessary for a complete installation of all sensors.

APPENDIX J

ARCHITECTURAL AND SOLAR HEATING SYSTEM PLANS

FOLDOUT FI



24'-0" CRITICAL DIMENSION - MUST BE HELD
12'-0"
HOLD
10"(TYP)
HIGH PT OF DRAIN
CONTINUOUS FOUNDATION DRAIN LOW POINT
UNEX.
END OF BUTYL SHT.
SLOPE SLAB TO FLOOR DRAINS
FOOTINGS ON UNDISTURBED SOIL
FOUNDATION/BASEMENT PLAN 1/4"=1'-0"
5/8" CEDAR
3/4" T & G INSULATION
6" BATT INSUL W/VAP BARRIER
2×6 STUD
BERM
HARDWOOD FLOOR
2×10 JOIST
2×10 PLATE
SOLID MASONRY BLK
BUTYL SHEET
10" BLOCK
FIN. GRADE 24" BELOW FIN 1st FLR EXCEPT IN BERM AREAS
WATERPROOFING
DRAIN TILE LOW PT
FOUNDATION / BERM SECTION

2) FOLDOUT FRAME

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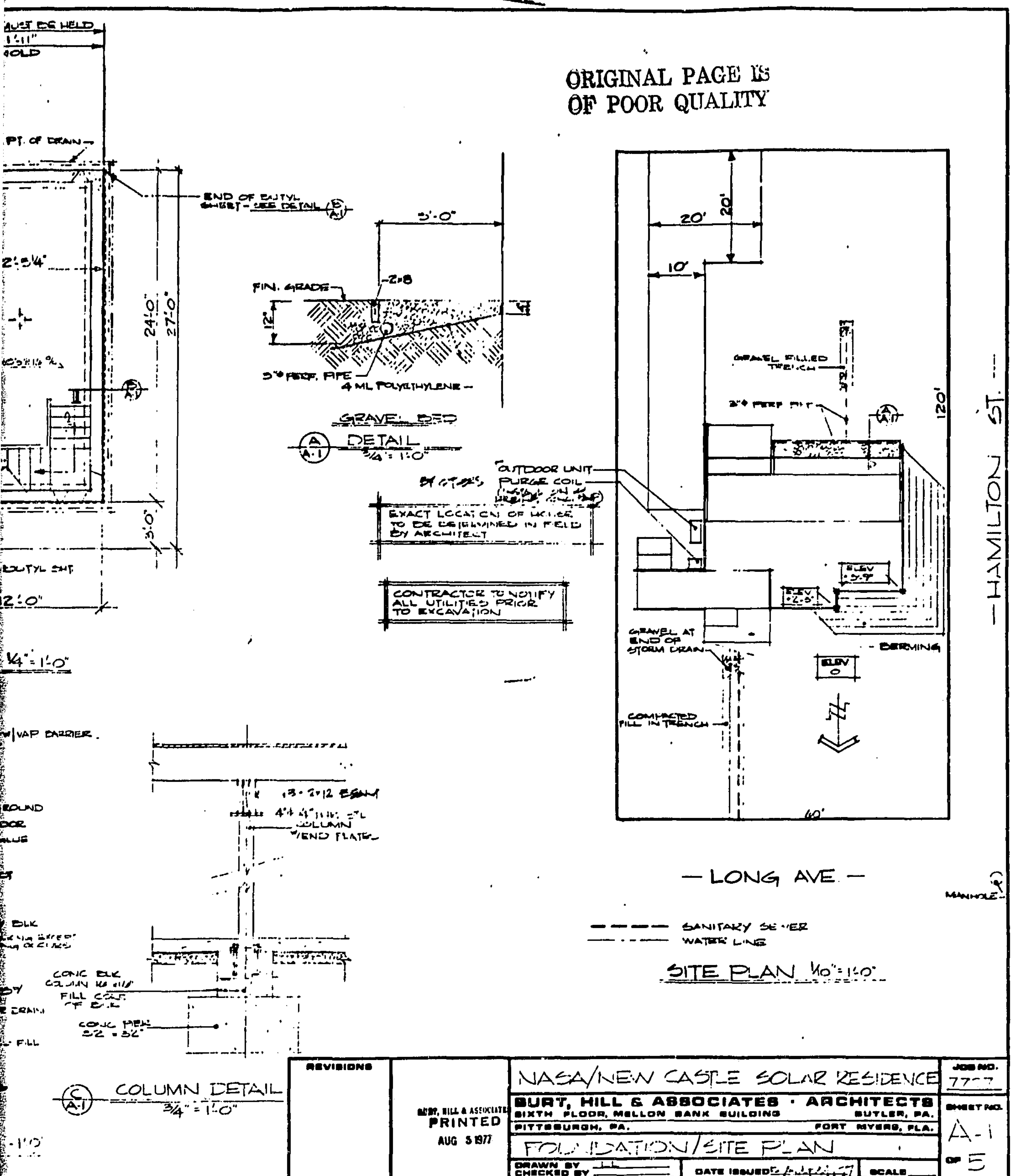

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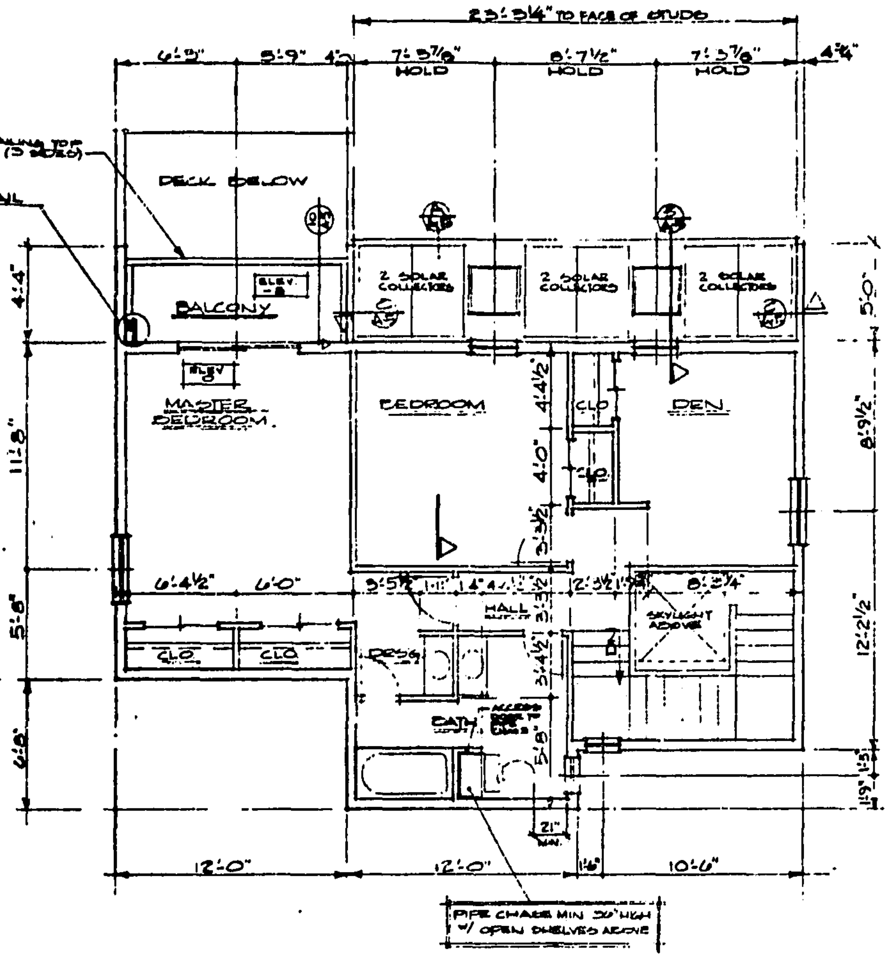
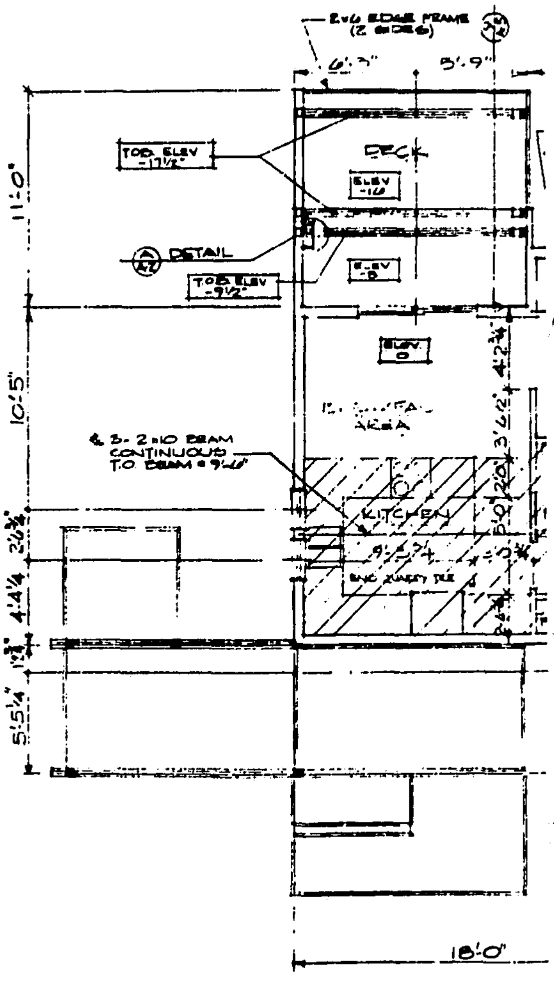


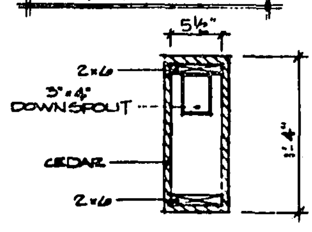
SECOND FLOOR PLAN 1/4" = 1'-0"

WINDOW SCHEDULE				
ELEV.	WINDOW NO.	NO. REQD.	RO DIM	MFG
NORTH	1	2	2'-0 5/8" × 3'-5 3/8	ANDERSE
	6	1	4-7 × 4'-7 × 1 5/8 CURB	WASCO
SOUTH	7	2	2'-4 7/8" × 3-5 3/8	ANDERS
	4	2	2'-4 7/8" × 5'-0 3/8	ANDERS
	5	2	2'-7 1/4" × 4'-7 1/2"	VELUX
EAST	2	2	3'-5 1/4" × 3'-5 3/8	ANDERS
	3	1	2'-0 5/8 × 6'-0 5/8	ANDERS
	1	2	2'-0 5/8" × 3'-5 3/8	ANDERS
WEST	2	2	3'-5 1/4" × 3'-5 3/8	ANDERS
	1	2	2'-0 5/8 × 3'-5 3/8"	ANDERS



FIRST FLO

USE 3/4" PLYSCORE INSTEAD OF T & G STYROFOAM FOR LATERAL SUPPORT AT ALL CORNERS - GLUE & NAIL MIN. 4' FROM EA. CORNER IN EA. DIRECTION.



ENCLOSED DOWNSPOUT

A/A-2 DETAIL 1 1/2" = 1'-0"

FINISH AND DOOR SCHEDULES: SECOND LEVEL					
SPACE	FLOOR	BASE	WALLS	CL'G.	DOORS
STAIRS	CARPET	WD	DRYWALL	DRYWALL	—
HALL	CARPET	WD	DRYWALL	DRYWALL	—
DEN	CARPET	WD	DRYWALL	DRYWALL	—
DEN CLOSET	CARPET	WD	DRYWALL	DRYWALL	3'-0" W SLIDER
BEDROOM	CARPET	WD	DRYWALL	DRYWALL	1 3/8" × 2'-6" × 6'-8"
BEDROOM CLO	CARPET	WD	DRYWALL	DRYWALL	3'-0" W. SLIDER
BATH	SHEET VINYL	WD	DRYWALL	DRYWALL	(2) 1 3/8" × 2'-0" × 6'-8"
DRESSING AREA	CARPET	WD	DRYWALL	DRYWALL	—
MASTER BEDROOM	CARPET	WD	DRYWALL	DRYWALL	1 3/8" × 2'-6" × 6'-8" 6'-0" × 6'-8" GLASS SLIDER
MSTR. BDRM. CLO'S	CARPET	WD	DRYWALL	DRYWALL	(2) 4'-0" W SLIDER

REVISIONS		NAS
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		CHECKED

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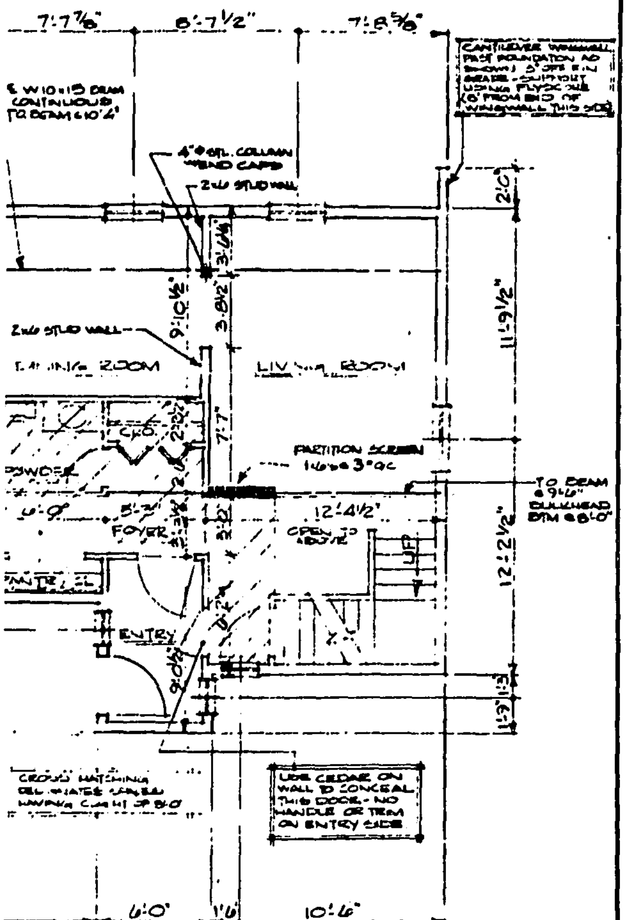
MFG Nº	FINISH AND DOOR SCHEDULES · FIRST LEVEL					
	SPACE	FLOOR	BASE	WALLS	CLG	DOORS
N C135	ENTRY	SHEET VINYL	WD	CEDAR	DRYWALL	(2) 1¾"×3'-0"×6'-8" 1¾"×2'-6"×6'-8"
DOSI-6000	ENTRY CLOSET	WOOD	WD	DRYWALL	DRYWALL	1⅜"×4'-0"×6'-8 BI-F
N CX135	FOYER	WOOD	WD	DRYWALL	DRYWALL	——
N CX15	POWDER RM	SHEET VINYL	WD	DRYWALL	DRYWALL	1¾"×2'-0"×6'-8"
6GL-2	PANTRY CLO	WOOD	WD	DRYWALL	DRYWALL	4'-0" W SLIDER
N CN235	KITCHEN	QUARRY TILE	WD	DRYWALL	DRYWALL	1⅜"×2'-6"×6'-8" POCKET DOOR
N C16	BREAKFAST AREA	WOOD	WD	DRYWALL	DRYWALL	ANDERSEN SLIDER MFG Nº T/6OAB-10
N C135	DINING ROOM	WOOD	WD	DRYWALL	DRYWALL	——
N CN235	LIVING ROOM	WOOD	WD	DRYWALL	DRYWALL	——
N C135	STAIRS	CARPET	WD	DRYWALL	DRYWALL	1⅜"×2'-6"×6'-8"



OR PLAN 1/4" = 1'-0"

PRINTED
AUG 5 1977

JOB NO. 7727

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LOOR, MELLON BANK BUILDING — BUTLER, PA.
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SHEET NO. A-2 OF 5

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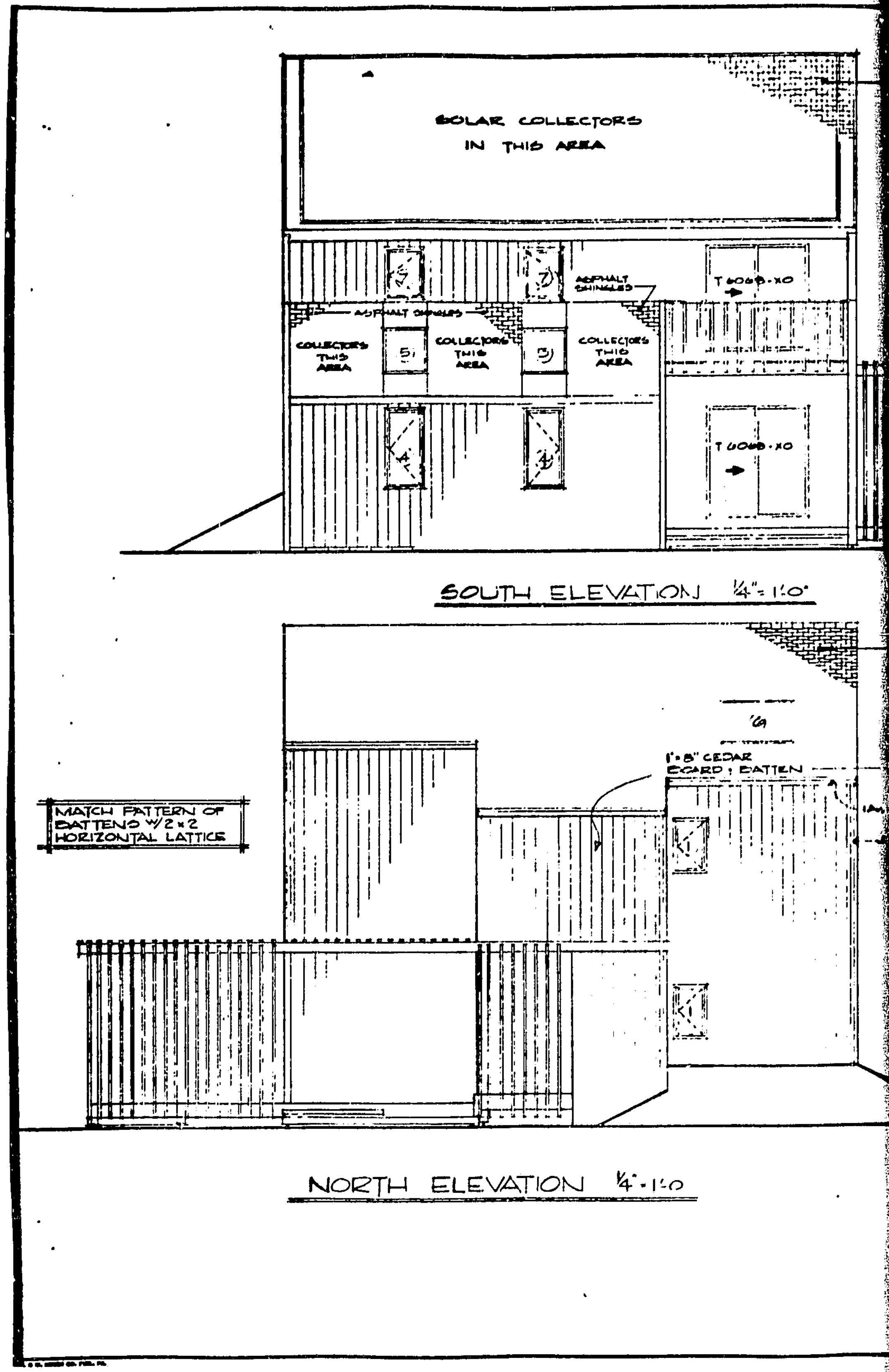

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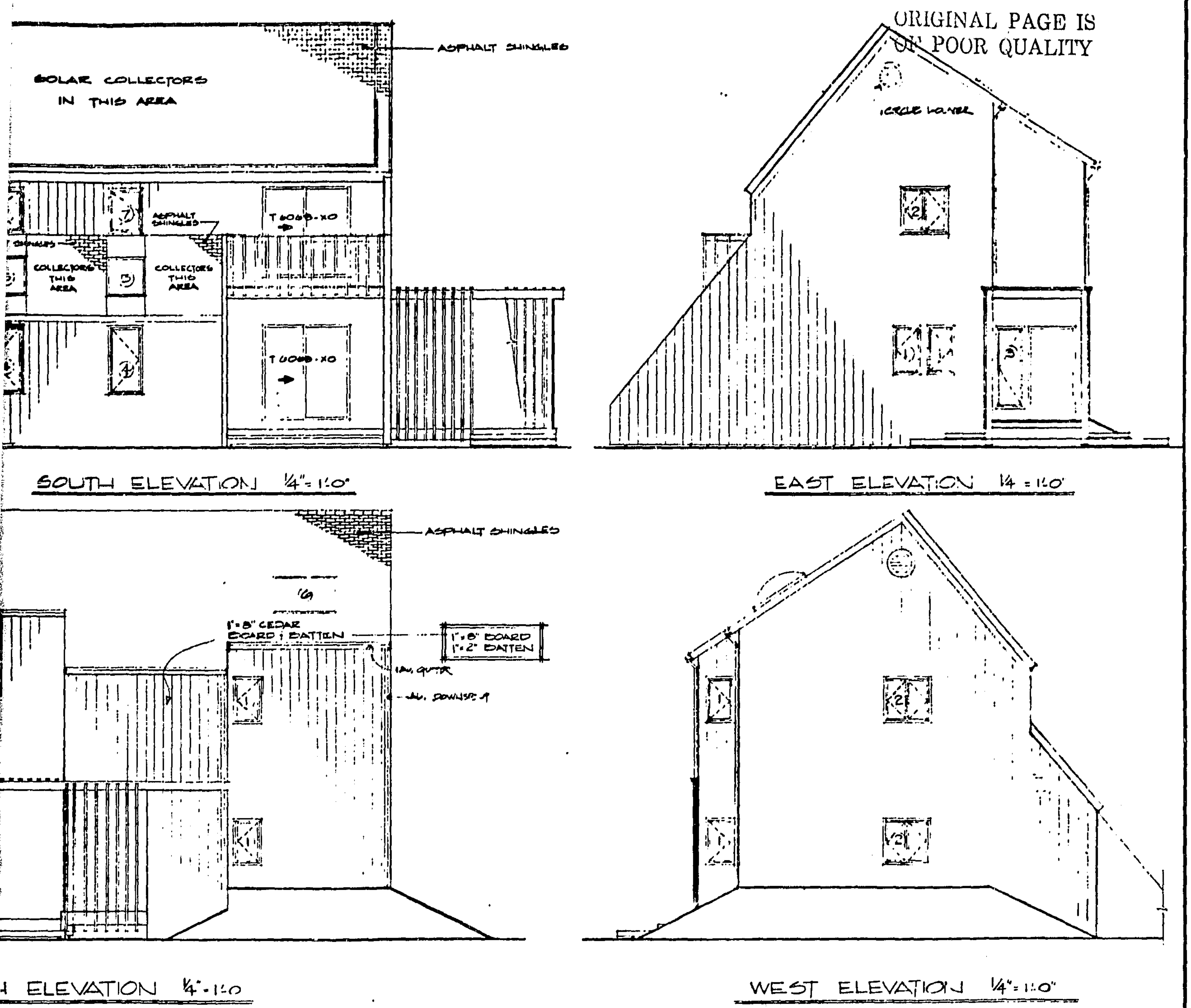

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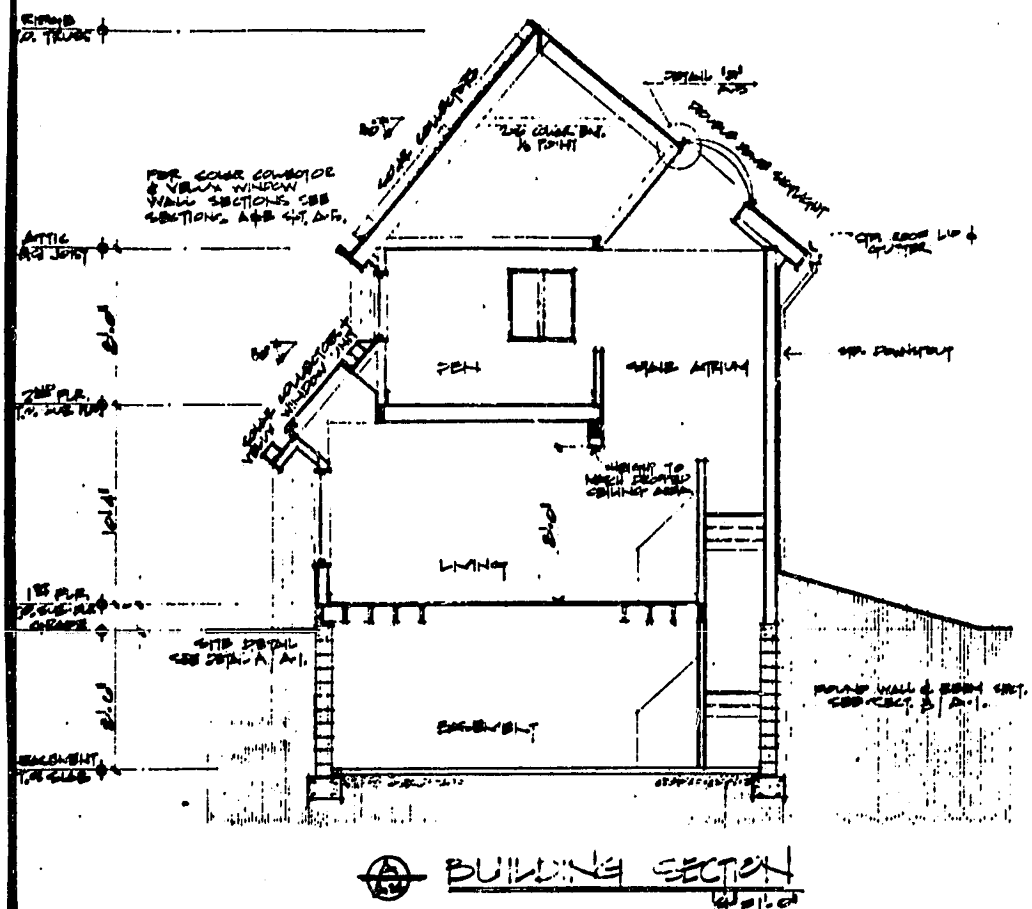

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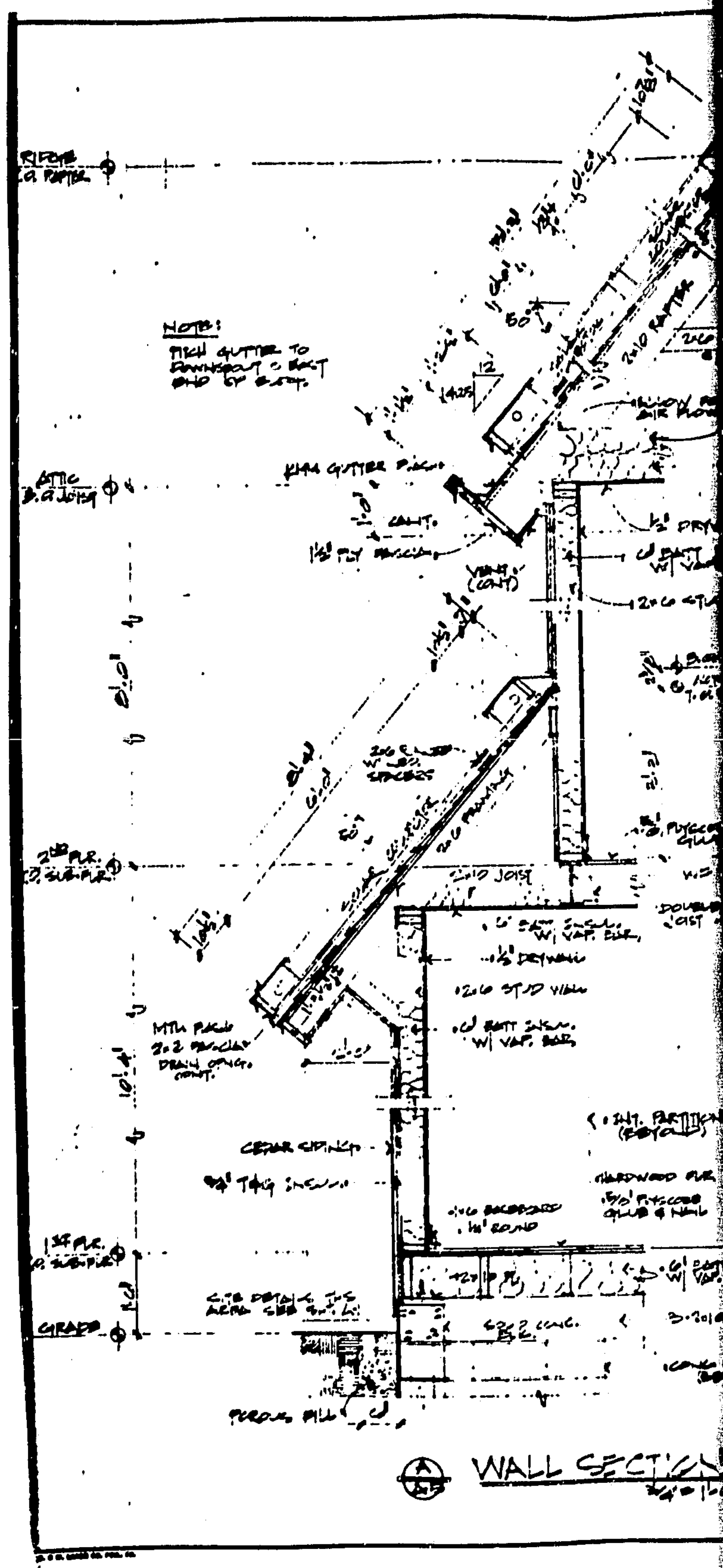

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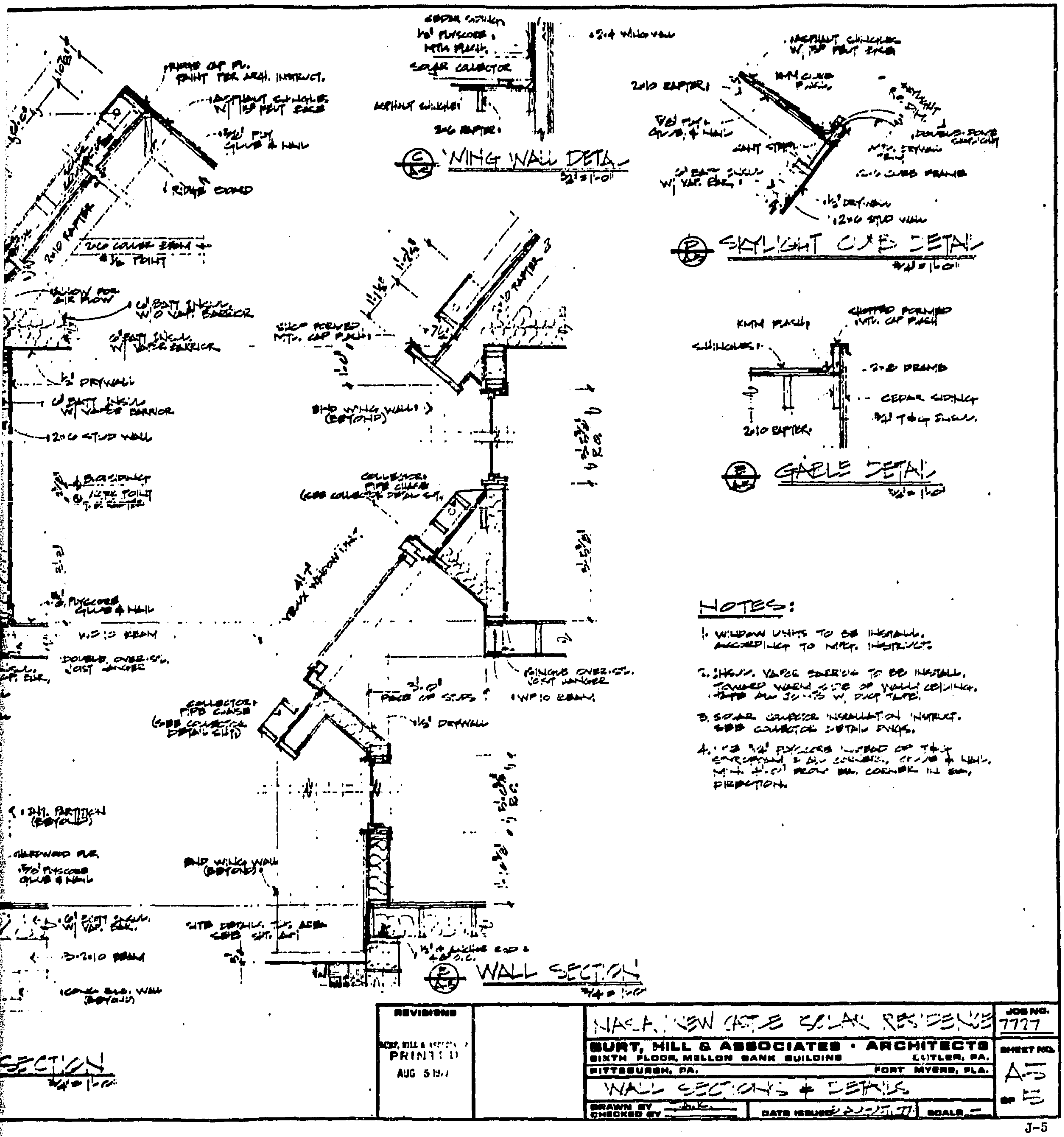

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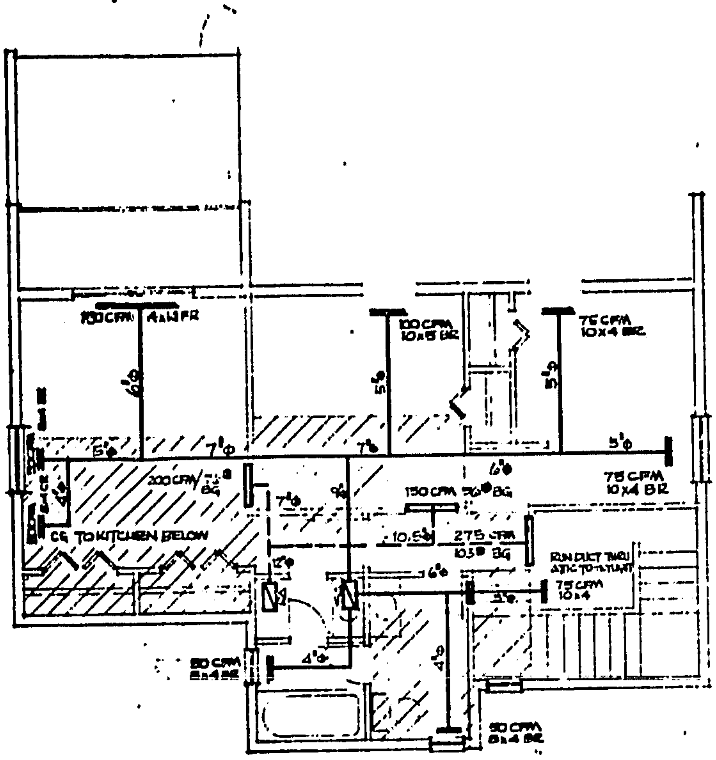
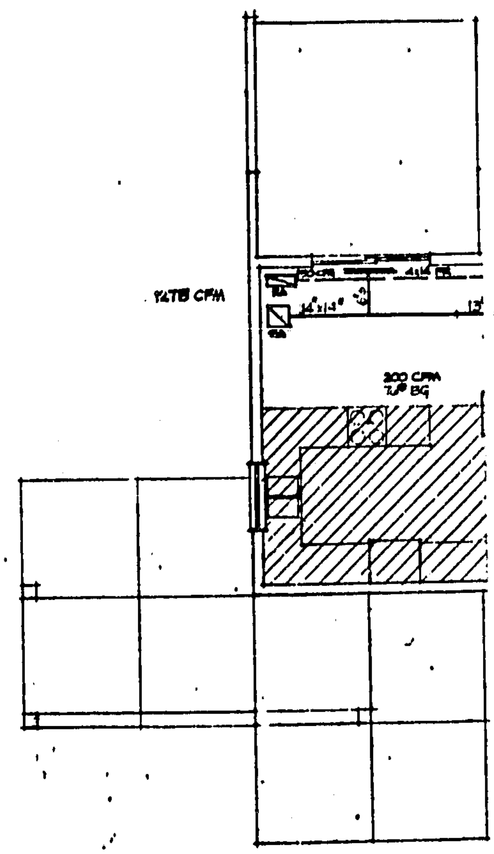


2ND FLOOR DUCT LAYOUT

PROPORTIONS & SHAPE OF DUCTWORK MAY BE CHANGED TO EQUIVALENT RECTANGULAR SECTIONS AT THE CONTRACTORS OPTION, MAINTAIN EQUAL FRICTION



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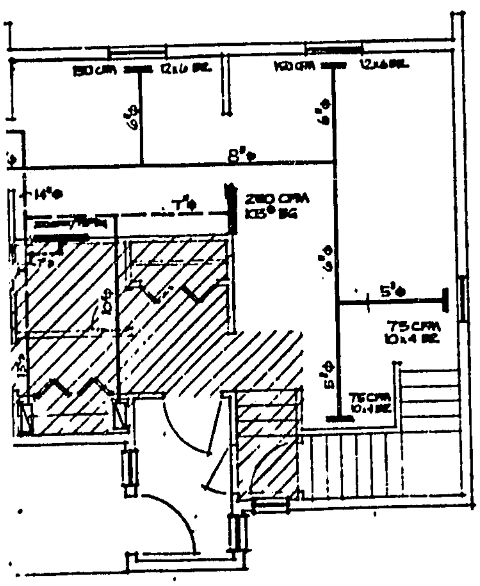

1st FLOOR DUCTWORK LAYOUT

SA / NEW CASTLE SOLAR HOME

JOB NO. 7727

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URGH, PA. · FORT MYERS, FLA.

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CTWORK LAYOUT

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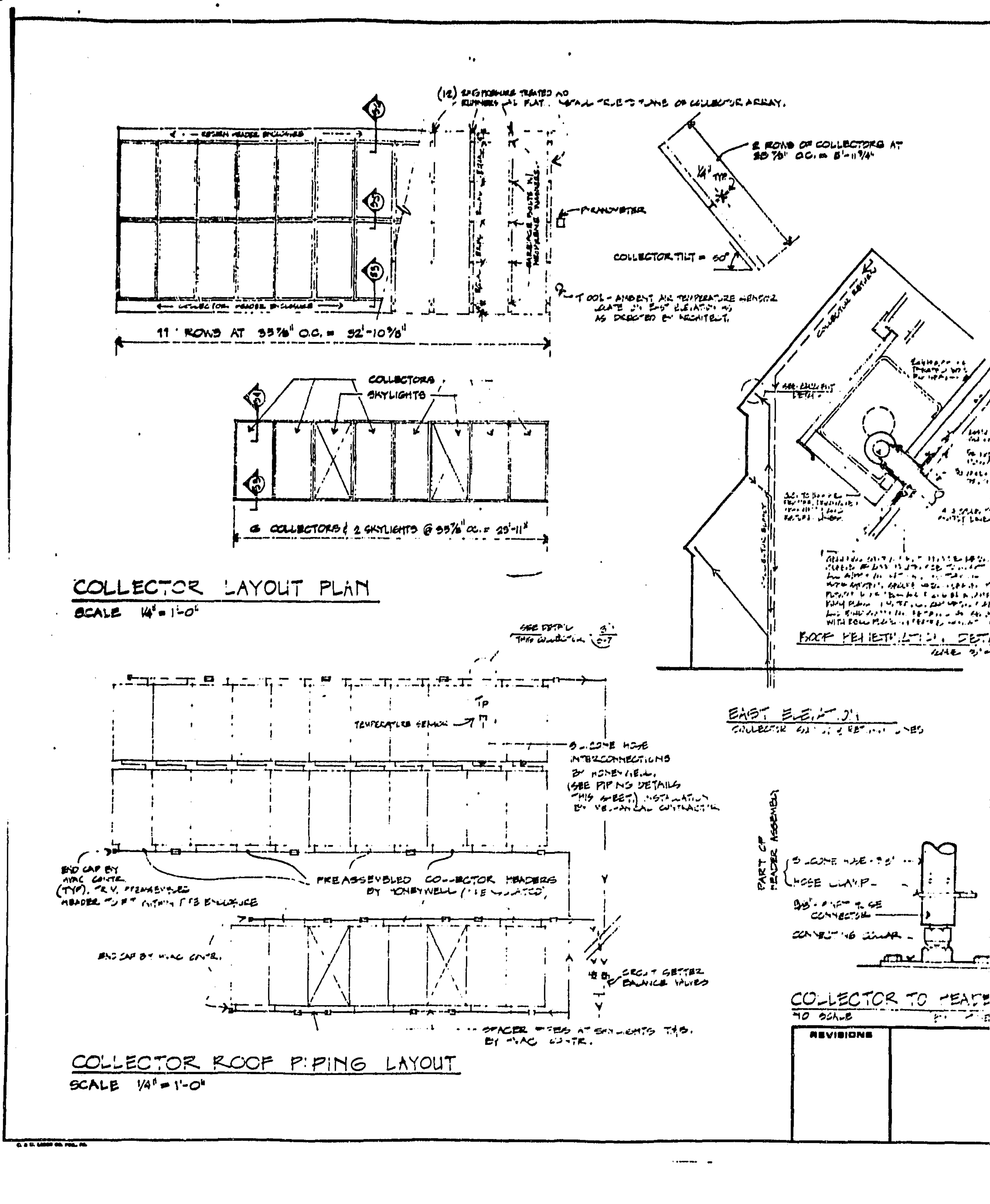

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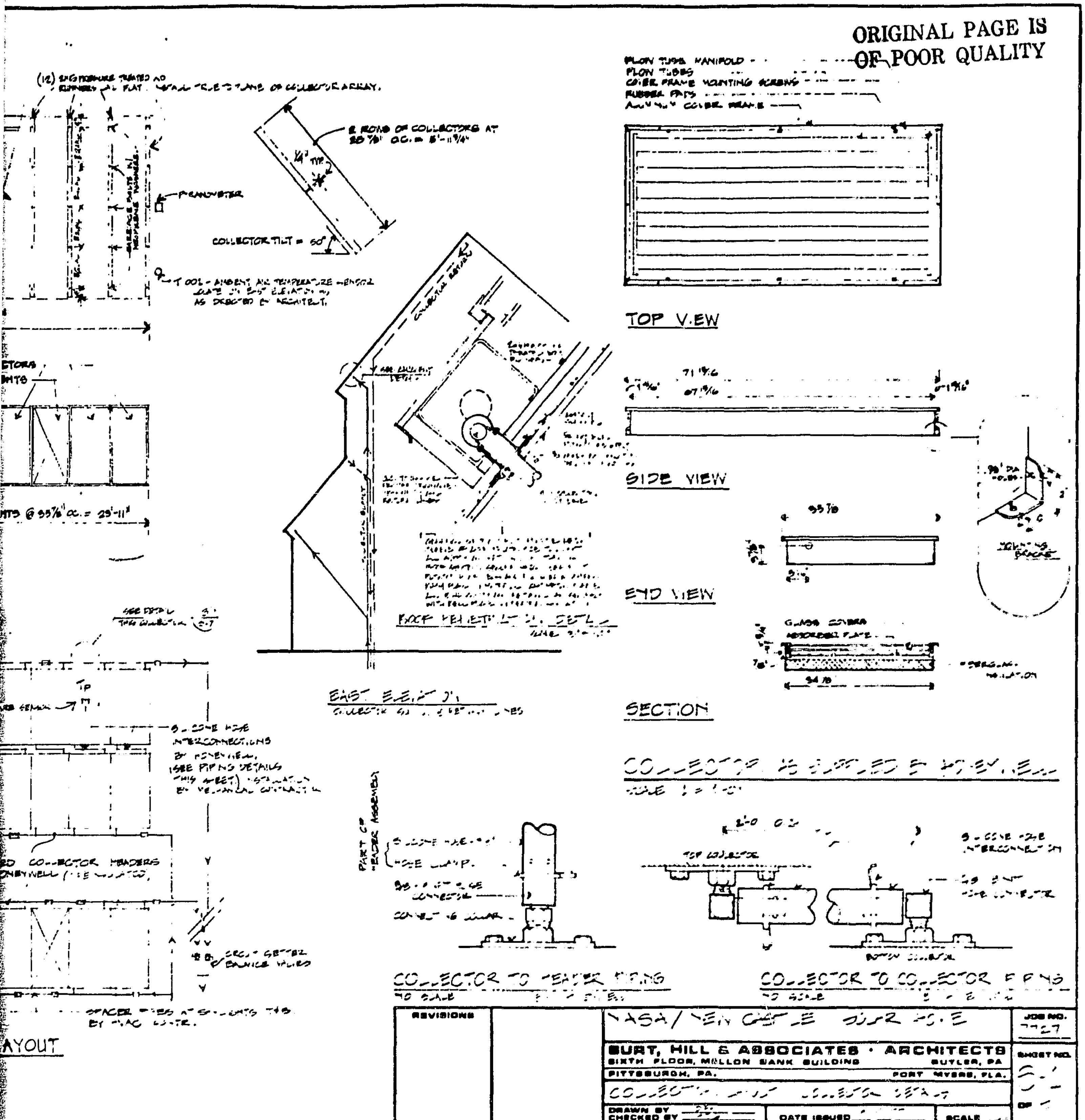

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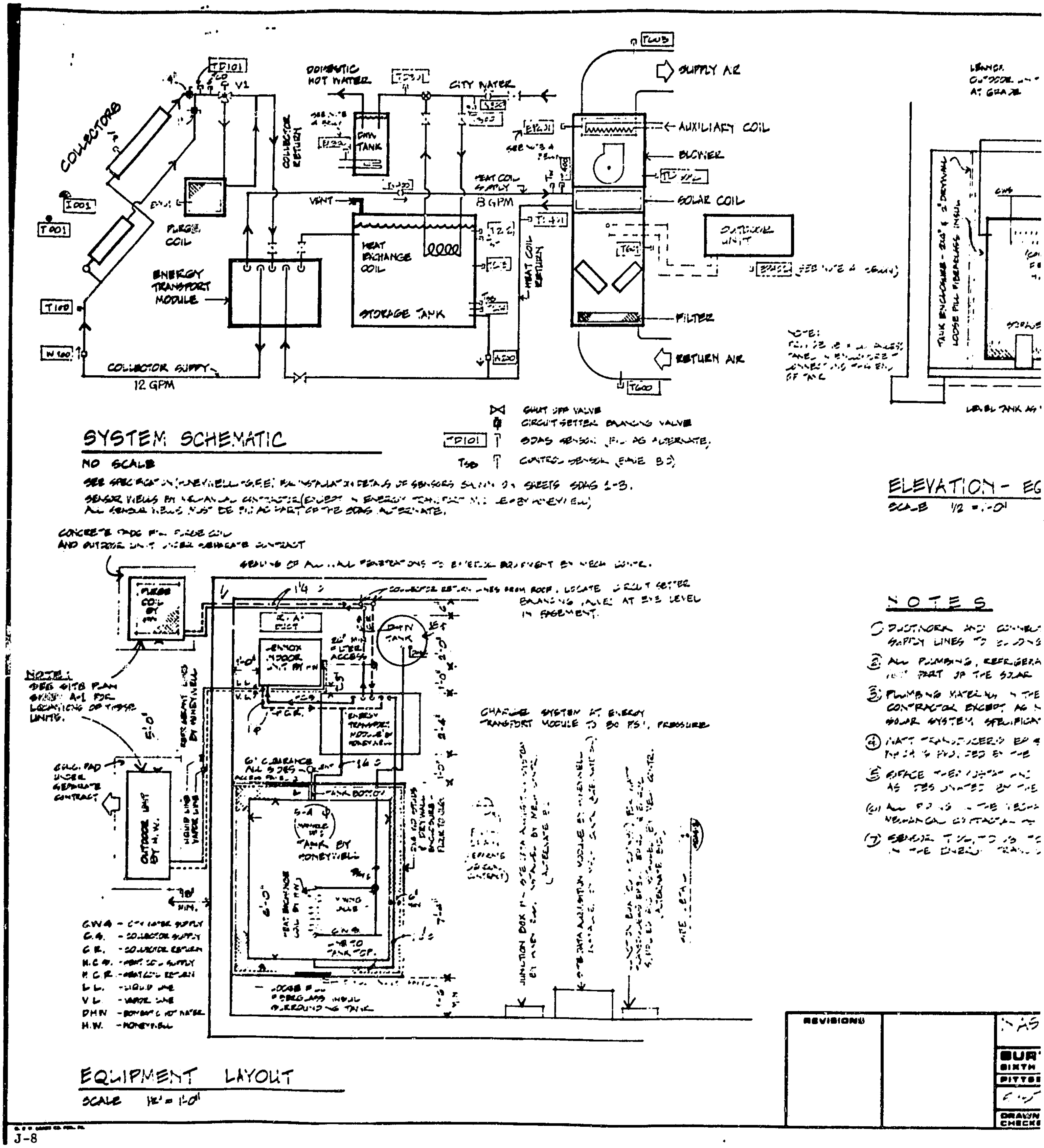

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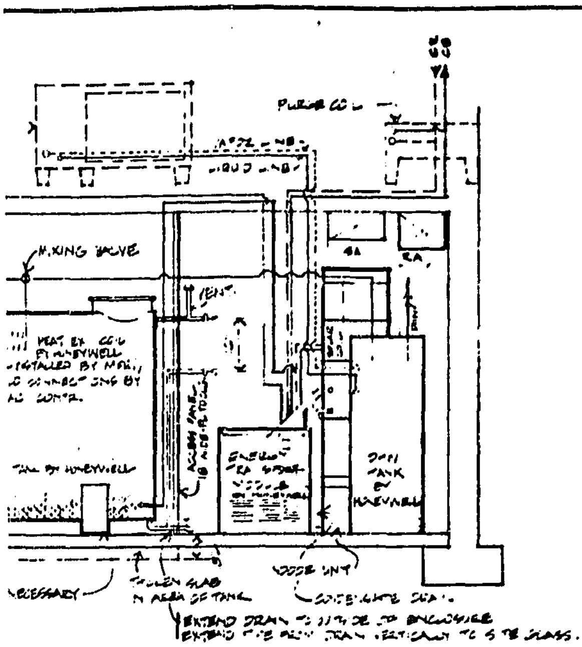

UIPMENT LAYOUT

...IONS TO HEATPUMP AND PLUMBING
... FIXTURES ARE PART OF A SEPARATE GENERAL CONTRACT.

...NT, & ELECTRICAL LINES FOR THE MECHANICAL EQUIPMENT CONTRACT.

...MECHANICAL SYSTEM ARE BY THE SOLAR (HVAC)
...

...

...	JOB NO.
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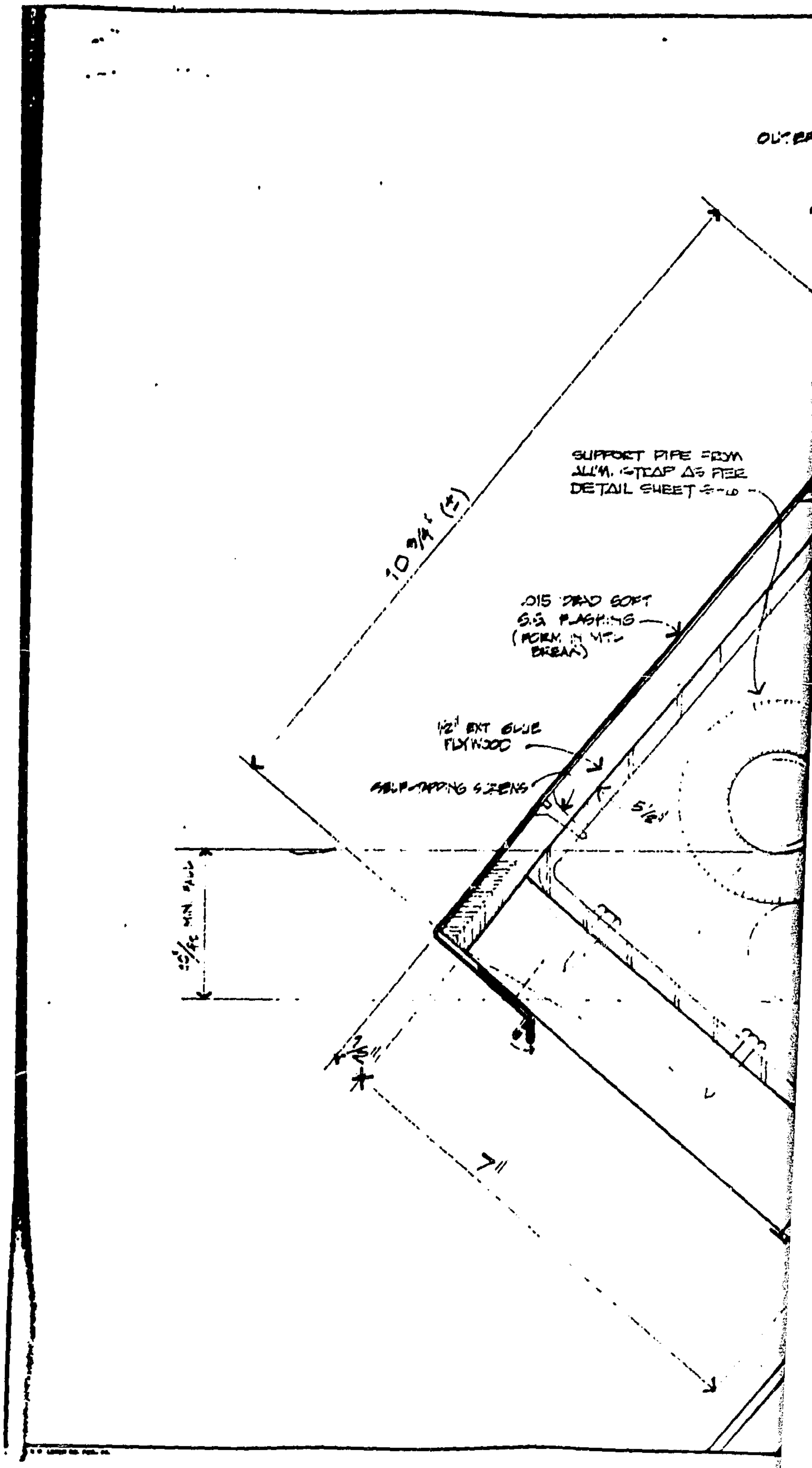

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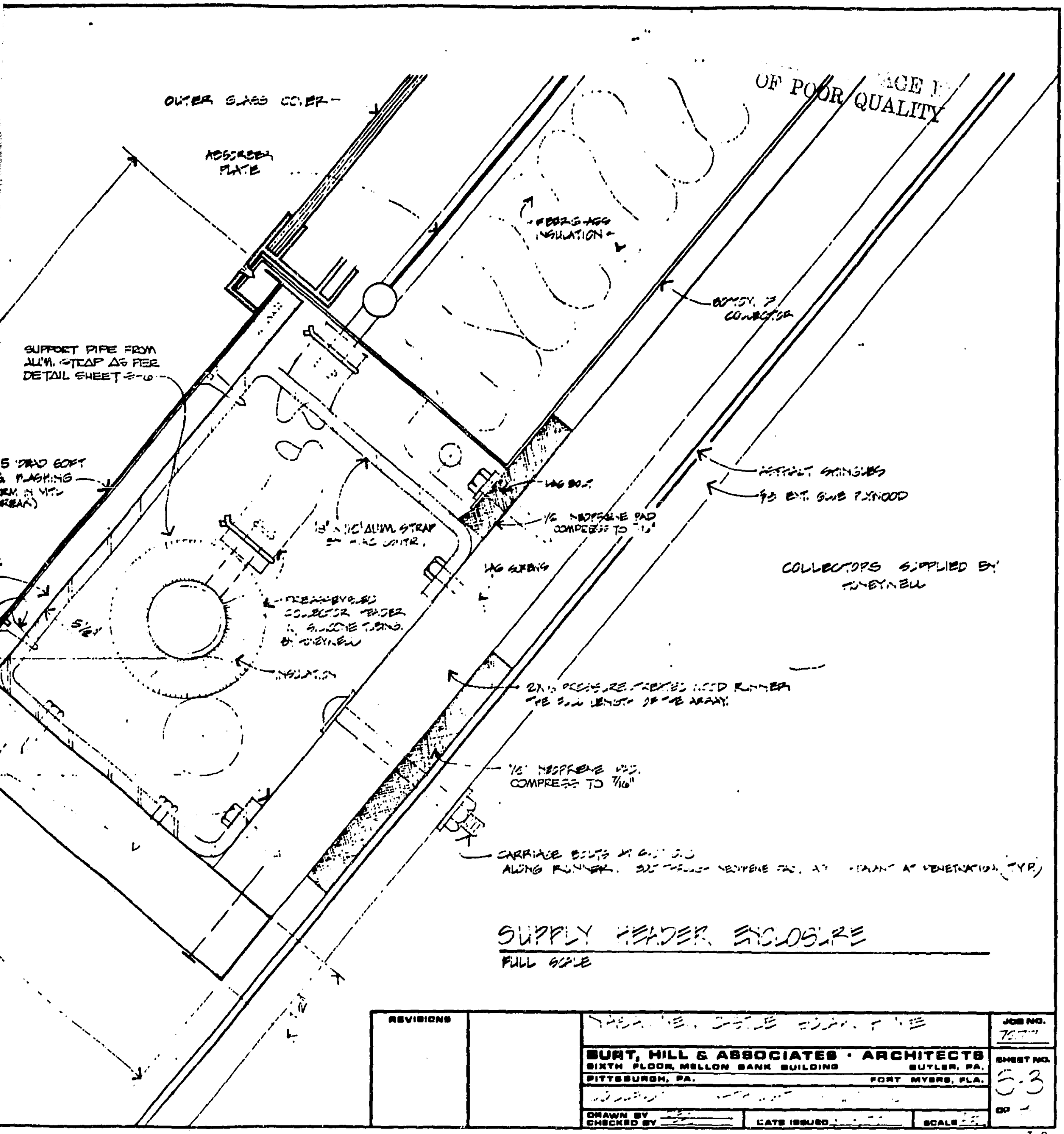

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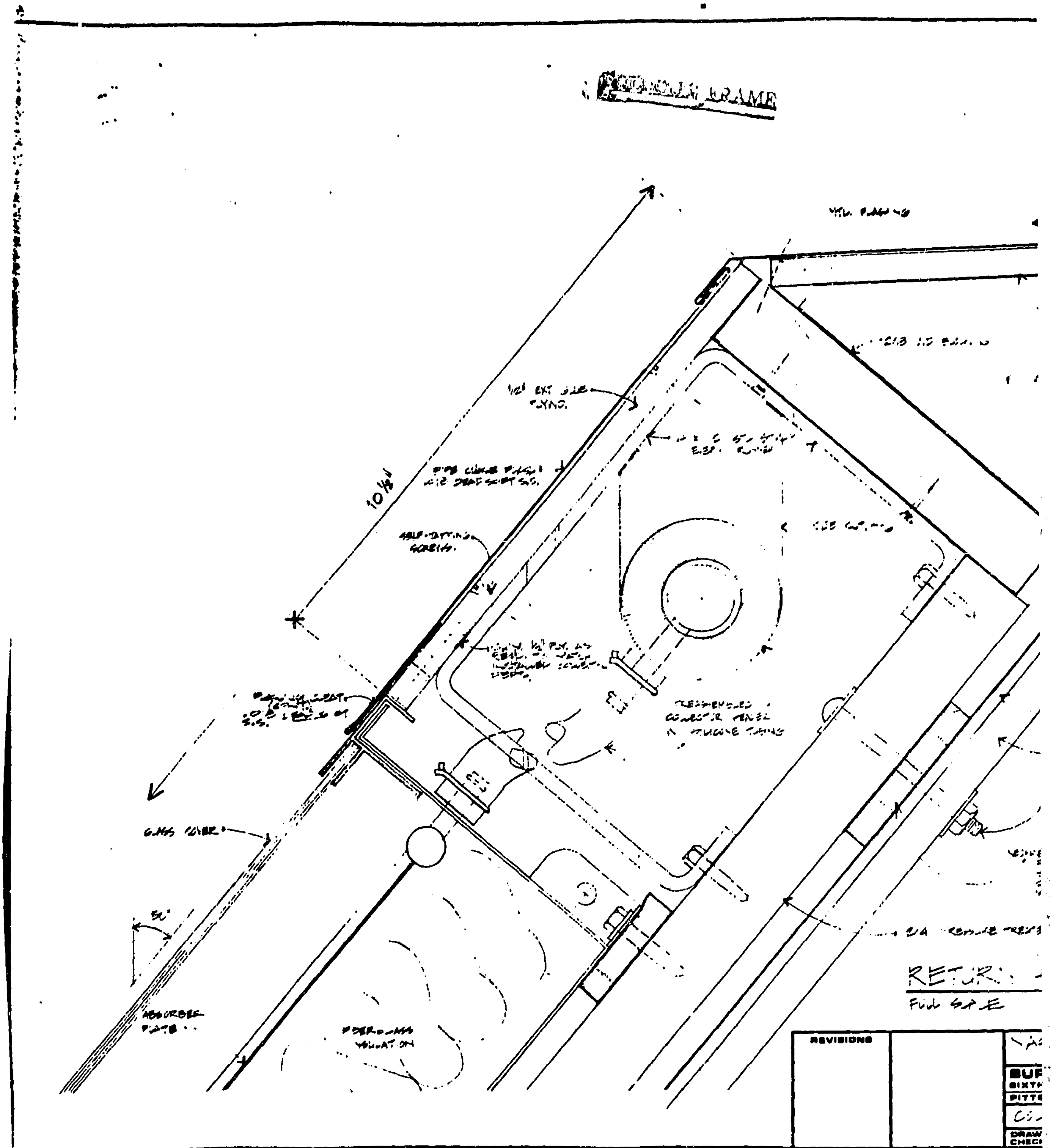

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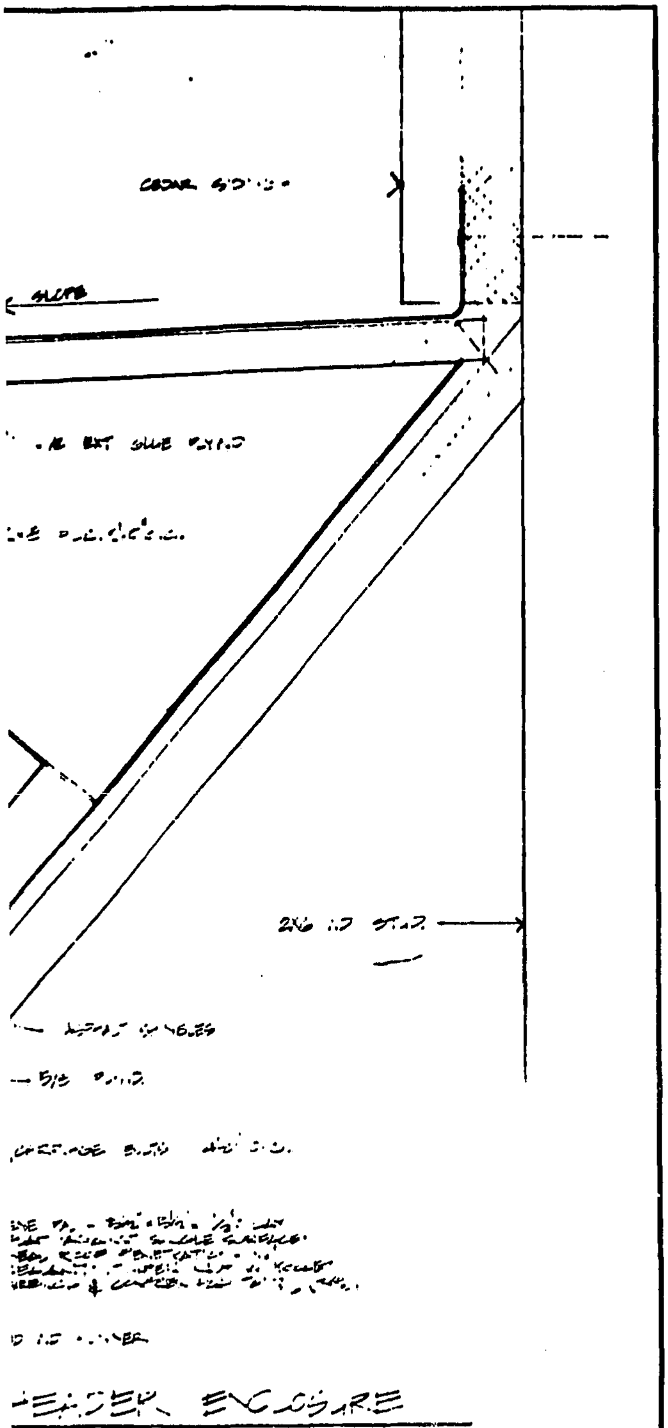

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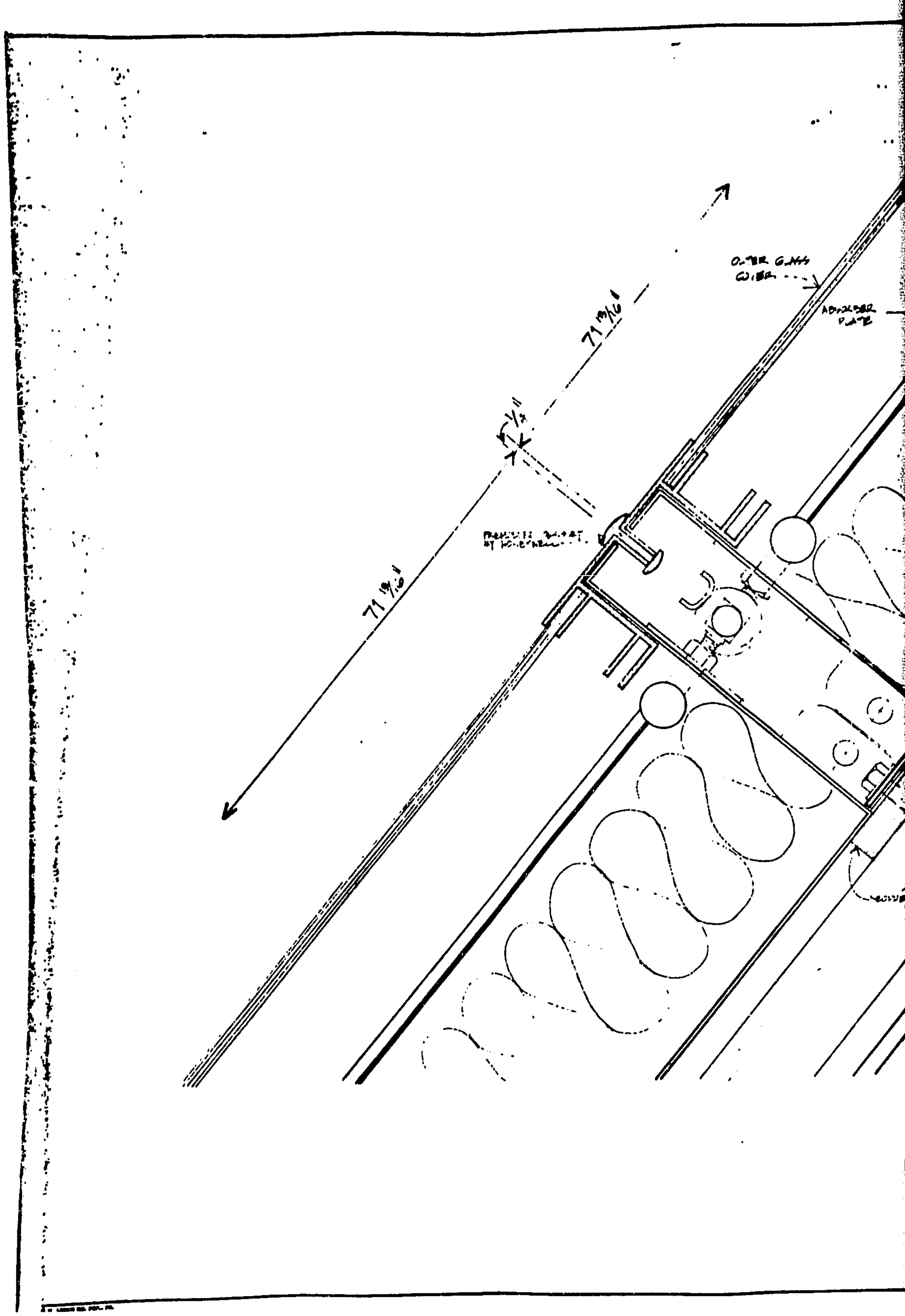

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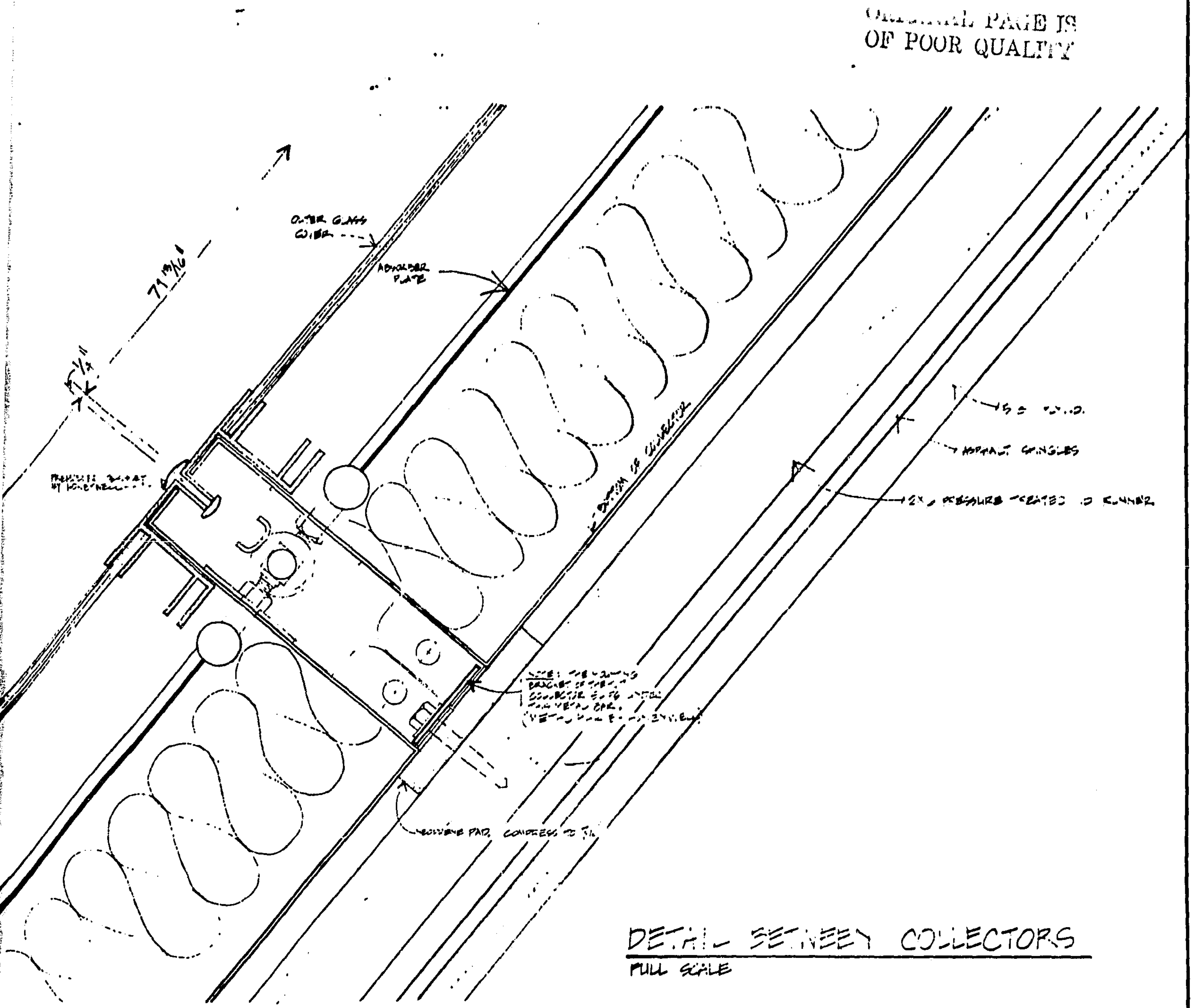

DETAIL BETWEEN COLLECTORS

FULL SCALE

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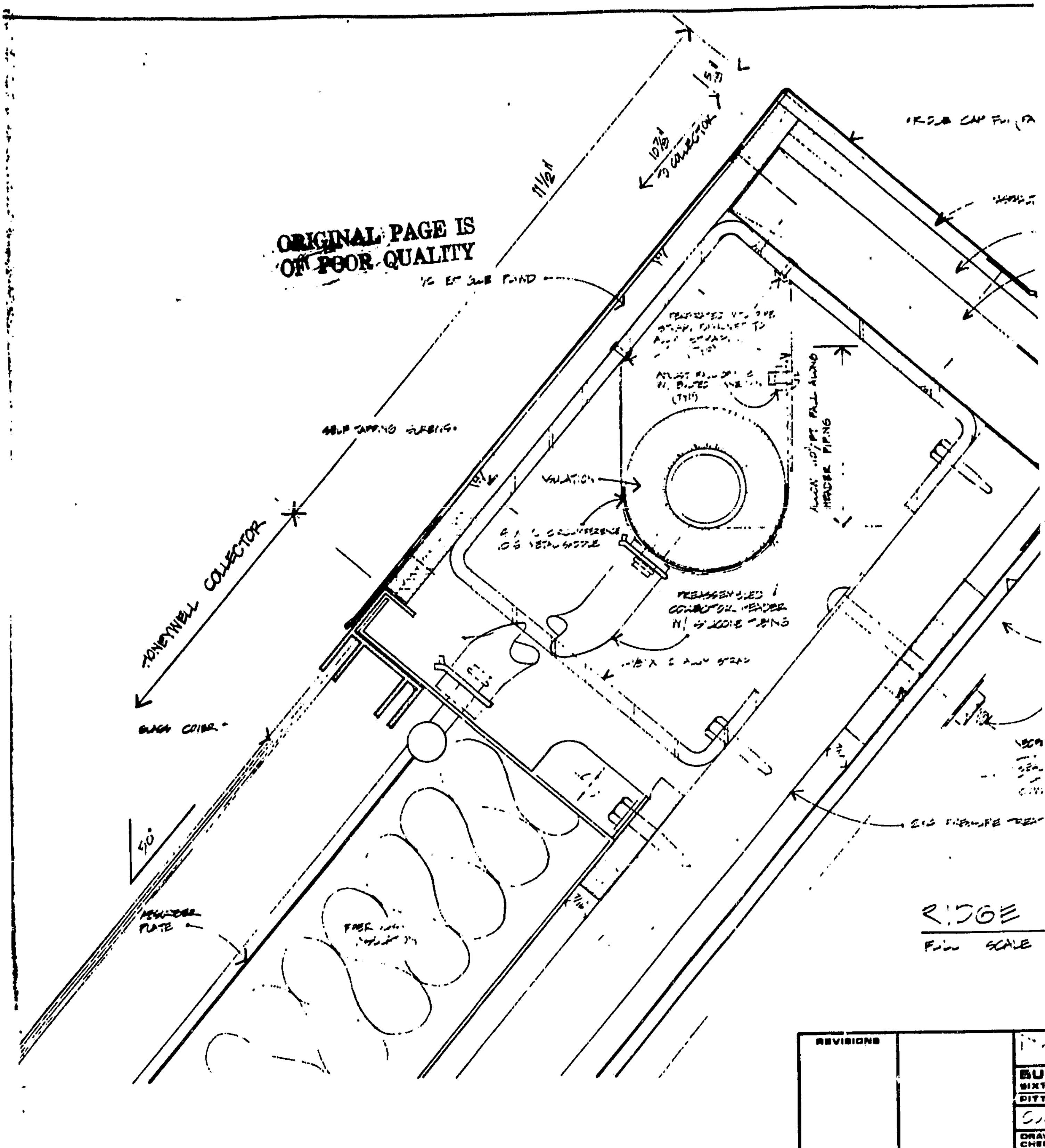

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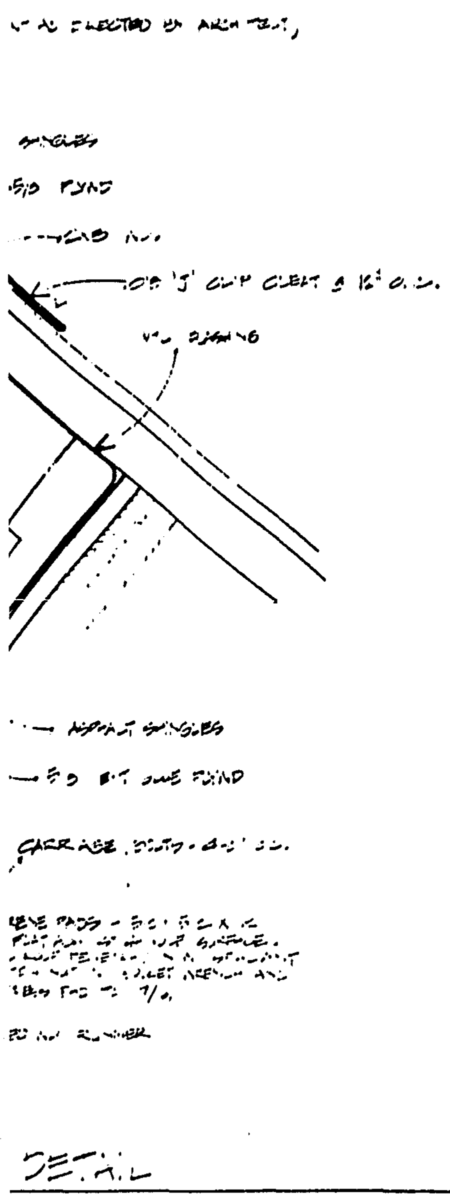

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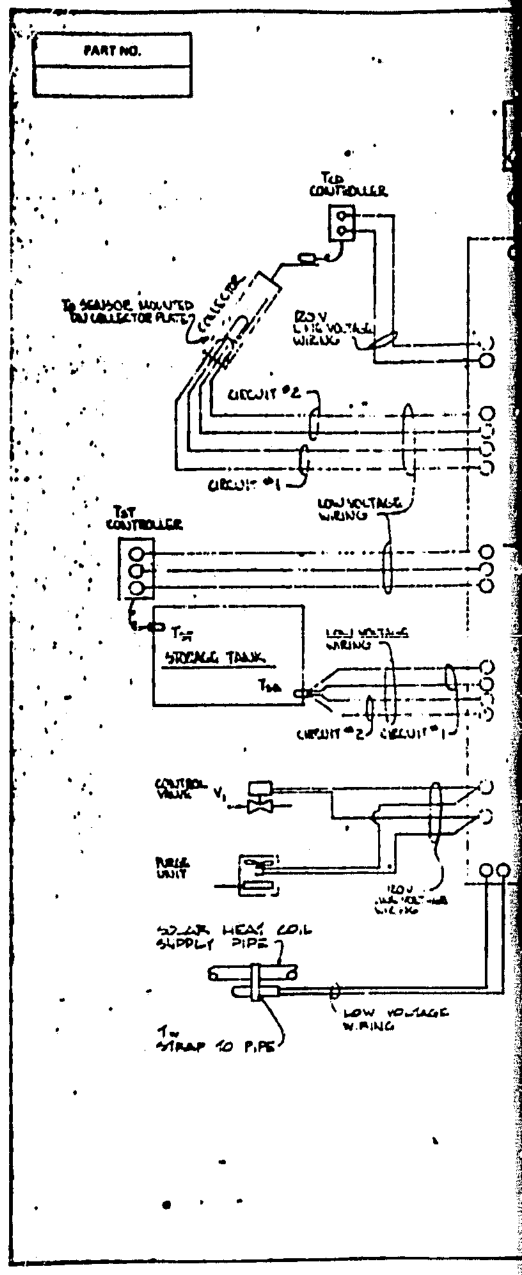
PART NO.
CONTROLLER
COLLECTOR
CIRCUIT #2
CIRCUIT #1
LOW VOLTAGE WIRING
CONTROLLER
STORAGE TANK
LOW VOLTAGE WIRING
CIRCUIT #2
CIRCUIT #1
CONTROL VALVE
PURGE UNIT
SUPPLY PIPE
LOW VOLTAGE WIRING
STRAP TO PIPE

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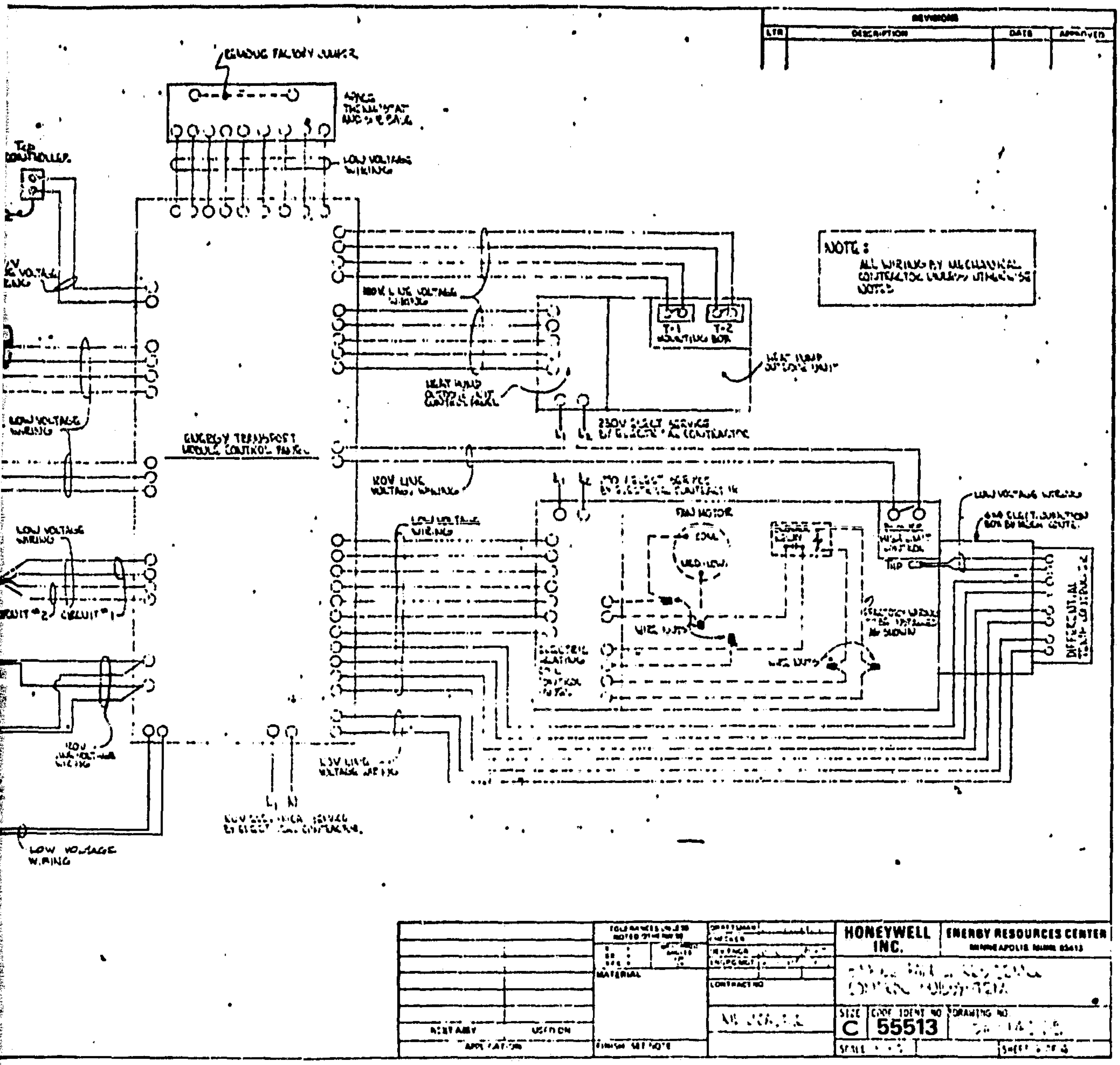

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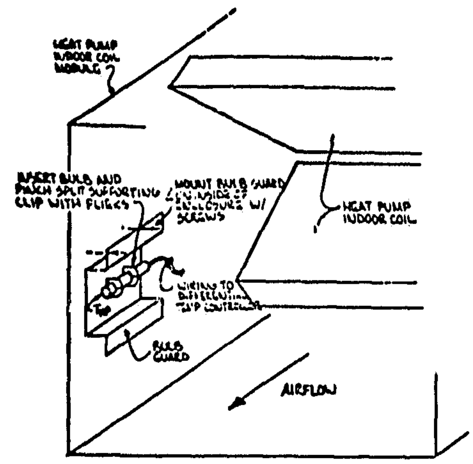
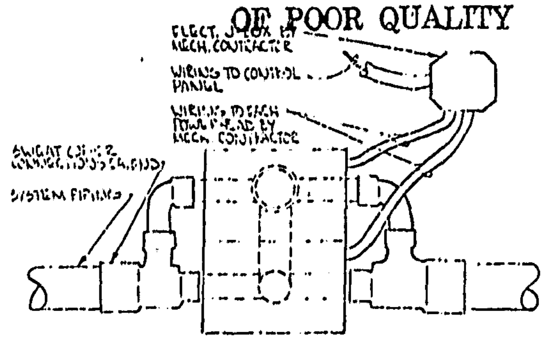


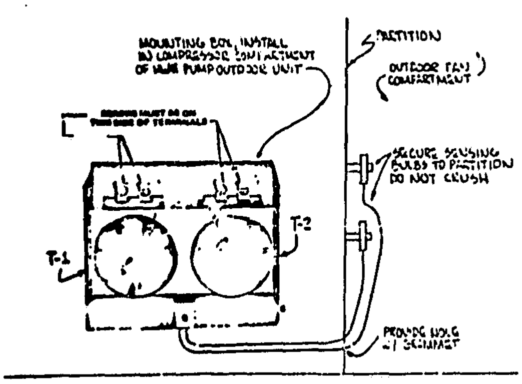
BULB GUARD INSTALLATION
NO SCALE

DETAIL



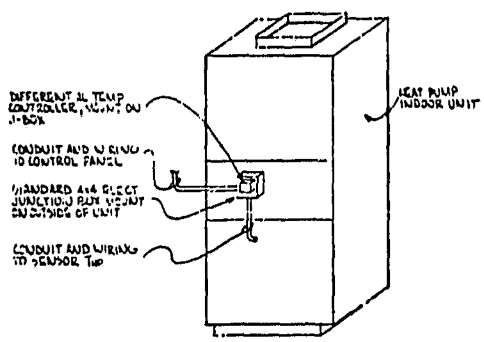
CONTROL VALVE DETAIL (V1)
NO SCALE

DETAIL



OUTDOOR THERMOSTAT INSTALLATION
NO SCALE

DETAIL



DIFFERENTIAL TEMPERATURE CONTROLLER
NO SCALE

DETAIL

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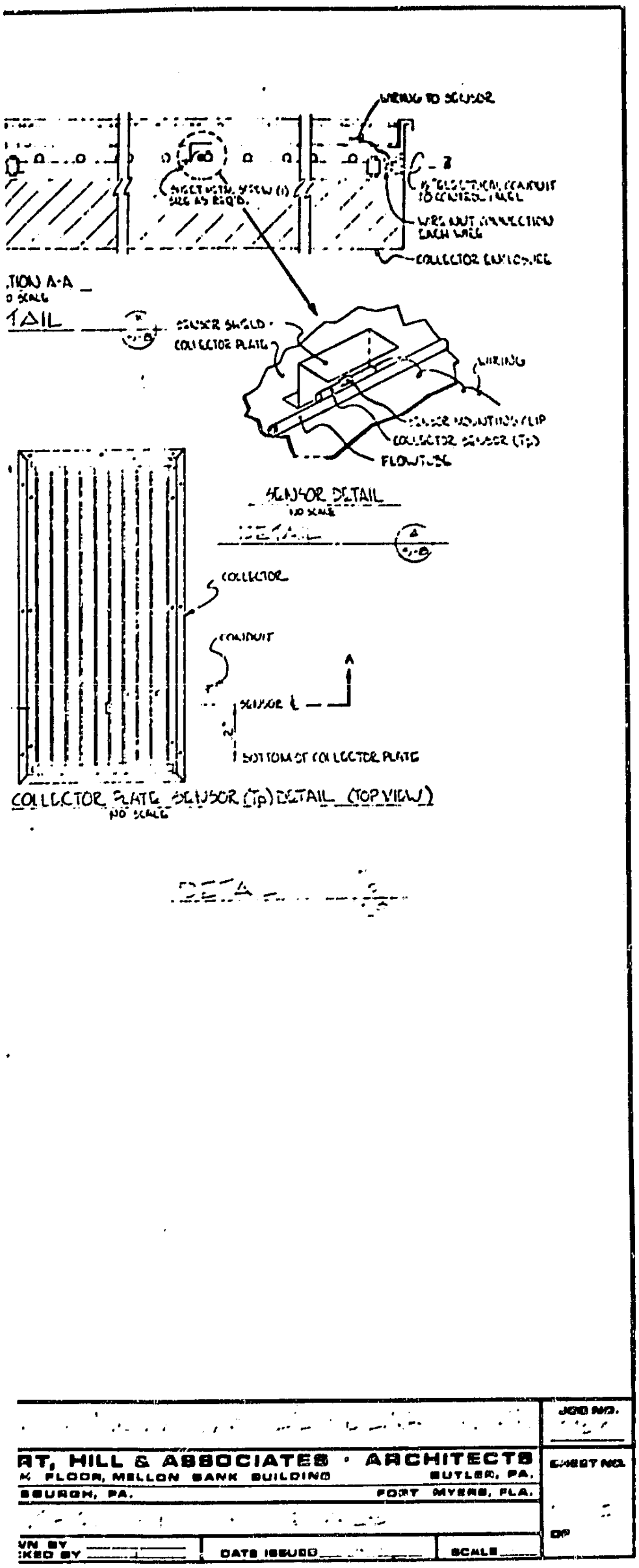

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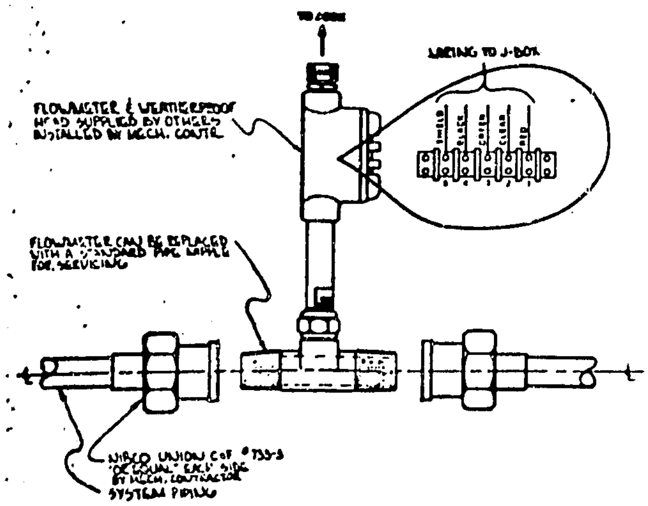

FLOWMETER DETAIL
NO SCALE

DETAIL

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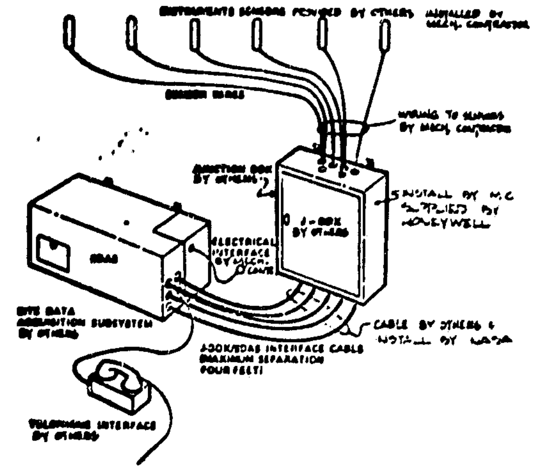

SITE DATA AQUISITION SUBSYSTEM COMPONENTS

NO SCALE

DETAIL 1

FLOWMETER INSTALLATION INSTRUCTIONS

1. Flowmeters shall be preceded by a minimum of twenty (20) pipe diameters of uninterrupted flow line upstream, and followed by a minimum of ten (10) pipe diameters of uninterrupted flow line downstream. These sections shall have no elbows, valves, thermometers or temperature sensors, or other obstructions.

2. Flowmeters shall be located in the horizontal position.

3. All flowmeters shall be identified with a brass tag.

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		SITE DATA ACQUISITION DETAILS	
		DRAWN BY / CHECKED BY — DATE ISSUED — SCALE	

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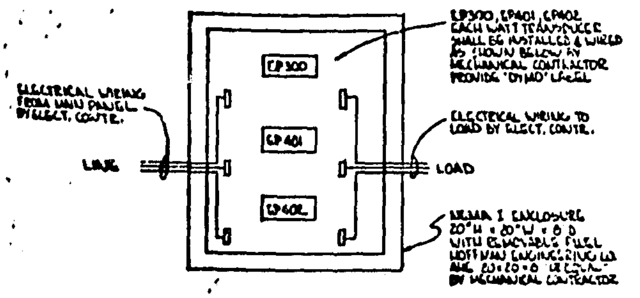
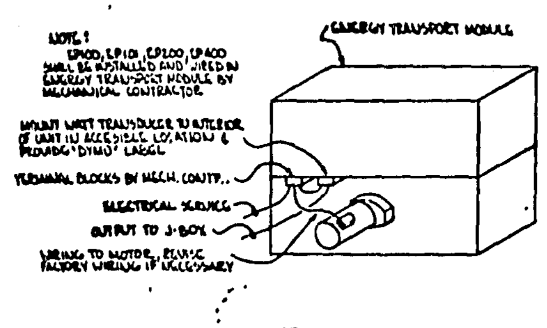


INSTALLATION
NO SCALE

DETAIL 1 SCALE 2



INSTALLATION
NO SCALE

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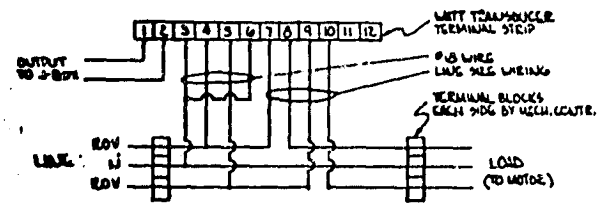
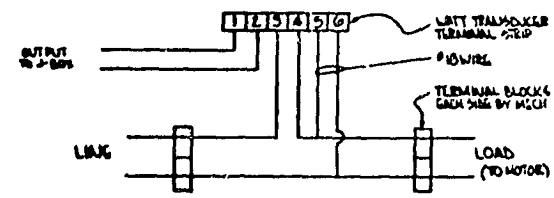


WIRING DIAGRAM

WATT TRANSDUCER
NO SCALE

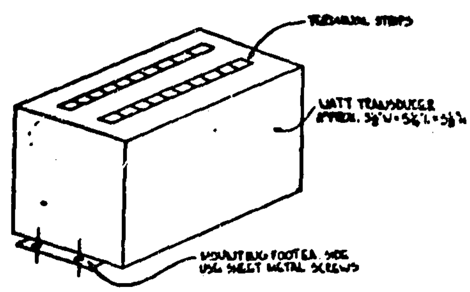
DETAIL 2 SCALE 2



WIRING DIAGRAM

WATT TRANSDUCER
NO SCALE

DETAIL 3 SCALE 2



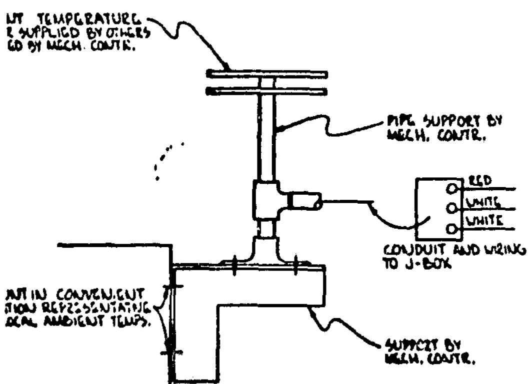
WATT TRANSDUCER
NO SCALE

DETAIL 7 SCALE 2

REVISIONS

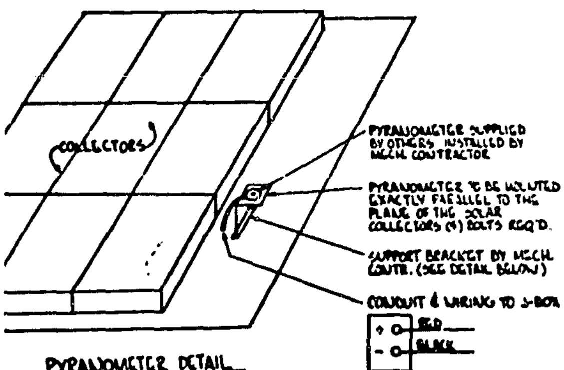
PRINTED
AUG 1977

1 FOLDOUT FRAME



AMBIENT TEMPERATURE SENSOR
NO SCALE

DETAIL 3 SDAS-2



PYRANOMETER DETAIL
NO SCALE

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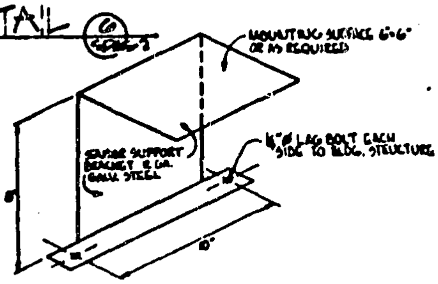

SUPPORT BRACKET DETAIL
NO SCALE

DETAIL B SDAS-2

NEW CASTLE SOLAR HOME	JOB NO. 7727
...RT, HILL & ASSOCIATES · ARCHITECTS ...H FLOOR, MELLON BANK BUILDING BUTLER, PA. ...SBURGH, PA. FORT MYERS, FLA.	SHEET NO. SDAS-2
...E DATA ACQUISITION DETAILS	OF 2
...WN BY ...CKED BY	DATE ISSUED	SCALE

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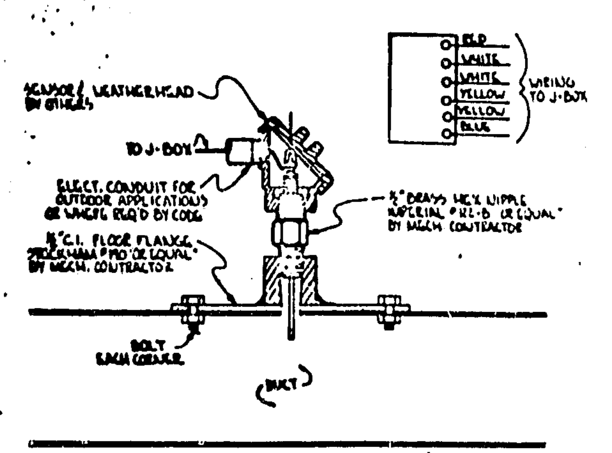
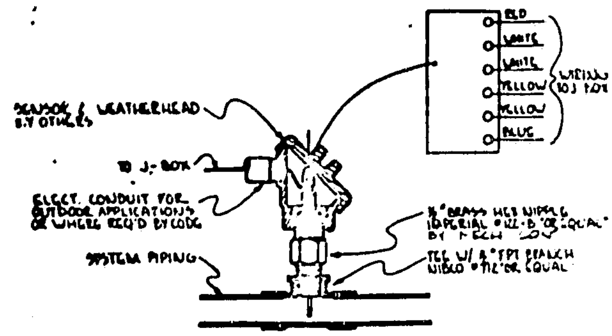


DUAL ELEMENT
TEMPERATURE SENSOR
NO SCALE

DETAIL 1



DUAL ELEMENT
TEMPERATURE SENSOR
NO SCALE

DETAIL 4

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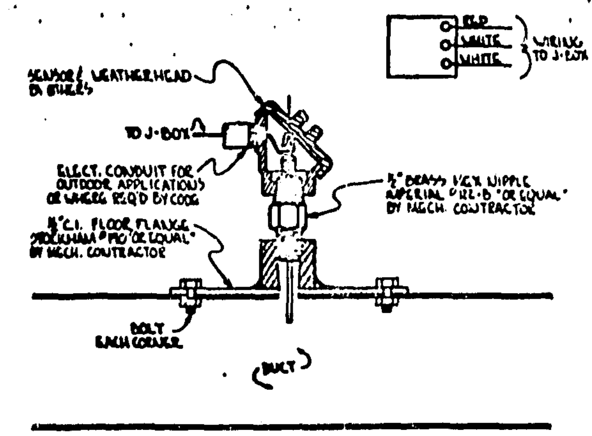
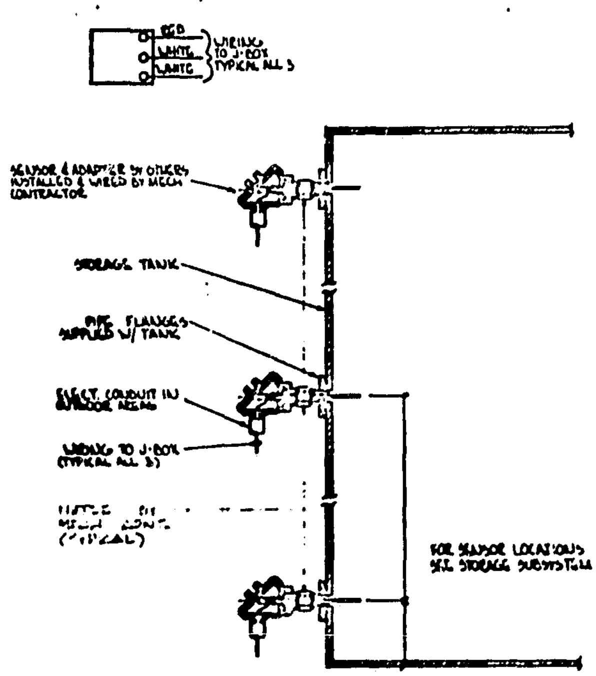


SINGLE ELEMENT TEMPERATURE SENSOR

NO SCALE

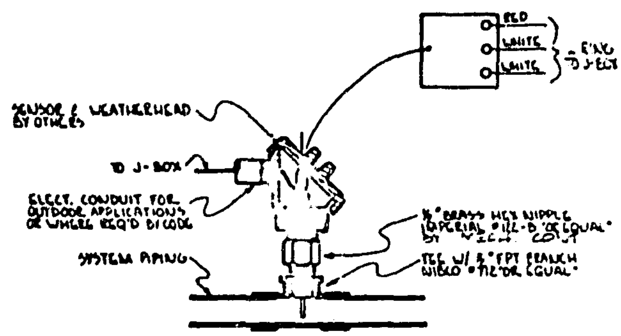
DETAIL 2



TEMPERATURE SENSORS AT TANK

NO SCALE

DETAIL 3



SINGLE ELEMENT TEMPERATURE SENSOR

NO SCALE

DETAIL 5

TEMPERATURE SENSOR INSTALLATION

1. All temperature sensors shall be located so as to avoid accidental damage to the sensor head assembly.
2. Dow Corning DC-340 heat transfer grease shall be applied to the bottom of the temperature probe prior to insertion into the thermowell.
3. In areas where there is a mixing of flows, the temperature sensor shall be mounted a minimum of twenty (20) pipe diameters downstream of the point of mixing.
4. All temperature sensors shall be identified with a brass tag.

REVISIONS	BURT, HILL & ASSOCIATES PRINTED AUG 5 1977	NASA/NEW CASTLE SOLAR HOME
		BURT, HILL & ASSOCIATES · ARCHITECTS
		SIXTH FLOOR, MELLON BANK BUILDING BUTLER, PA.
		PITTSBURGH, PA. FORT MYERS, FLA.
		SITE DATA ACQUISITION DETAILS
		DRAWN BY CHECKED BY DATE ISSUED SCALE