NATIONAL BUREAU OF STANDARDS REPORT

10 547

PERFORMANCE EVALUATION OF A PROPANE-FIRED HOUSEHOLD-TYPE ABSORPTION REFRIGERATOR

Manufactured by
S & S Vending Machine Company
Milpitas, California

Report to

U. S. Army Natick Laboratories
Natick, Massachusetts

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

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NBS REPORT
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PERFORMANCE EVALUATION OF A PROPANE-FIRED HOUSEHOLD-TYPE ABSORPTION REFRIGERATOR

Manufactured by
S & S Vending Machine Company
Milpitas, California

by
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Report to
U. S. Army Natick Laboratories
Natick, Massachusetts

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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1.0 Introduction

This report presents results of a laboratory investigation of a household-type absorption refrigerator marketed by the S & S Vending Machine Company, Milpitas, California. According to nameplate information it was manufactured by AB Electrolux in Sweden. The refrigerator, designed to operate on propane or electricity, was tested to determine certain qualitative performance characteristics of particular interest in evaluating potential military field use of the device. The principal properties measured under propane-fueled operation included: a) the maximum ambient temperature (up to 125 °F) in which the refrigerator could function effectively in; b) the thermostat control of refrigerator performance under a specified ambient temperature range; c) fuel consumption rate as a function of the ambient conditions and thermostat settings; and d) the maximum angles that the refrigerator could be tilted and still function properly. Operating characteristics under electric power were also studied.

2.0 Background

This series of tests was conducted for the U. S. Army Natick Laboratories, Natick, Massachusetts, who requested the information outlined in the introduction to assist them in determining whether this S & S refrigerator would be suitable for military field use under high ambient temperature conditions. Also, the results from this test could be used in the development of criteria for standards and specifications for household-type absorption refrigerators (gas or electrically

operated).

3.0 Description of Test Specimen

The refrigerator was marketed by the S & S Vending Machine Company, Milpitas, California, and provided approximately 5 cubic feet of general and frozen food storage space.

This refrigerator had two information nameplates. One located on the front control panel contained the following information:

Model No. M70b

Production No. 9260014

Serial No. 840 0002

Volt 110, C/S 60, Amp 2.1

For LP-Gas equipped for propane

Input rate Btu/hr 1360

Inlet pressure in WC 11

For installation in mobile homes and travel trailers

Refrigerant NH_3 11.1 ozs.

Tested to 850 lbs per sq. in.

AB Electrolux, made in Sweden

Design complies with National Safety Standards

American Gas Association, Inc.

Certified

The second nameplate located on the heater box at the back of the refrigerator contained the following information:

S & S Vending Machine Company, Milpitas, California

Model No. AB71X

Serial No. 687026

Figures 1 - 4 show front, rear, and interior views of the refrigerator. The freezer compartment was equipped with three ice trays.

The exterior dimensions of this refrigerator are 24" x 25" x 60". The interior dimensions of the freezer compartment are 16" x 12" x 6 1/2". The general food compartment measures 38" x 12" x 18".

The interior of the refrigerator was equipped with five removeable shelves, two vegetable crispers, four narrow trays located on the door, and a condensate collector (Fig. 4) situated just beneath the general food compartment evaporator coil. The freezer compartment was separate from the general food compartment.

The doors to the general food and freezer compartments were sealed with rubberized magnetic gaskets.

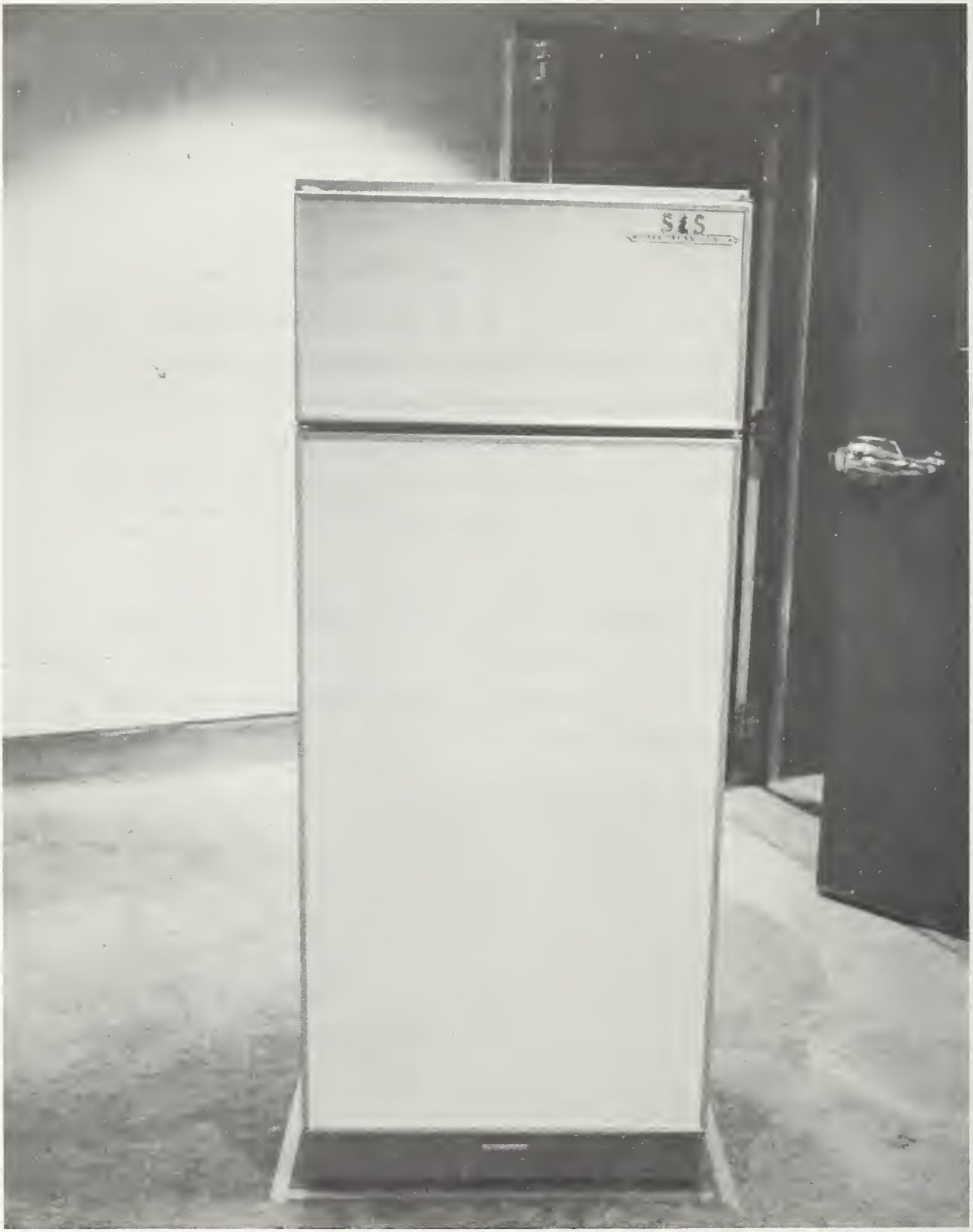


Figure 1 Front view, exterior - S & S refrigerator.

Figure 2 Absorption cooling system, back view of S & S refrigerator.

Figure 3 Front view, interior - S & S refrigerator.

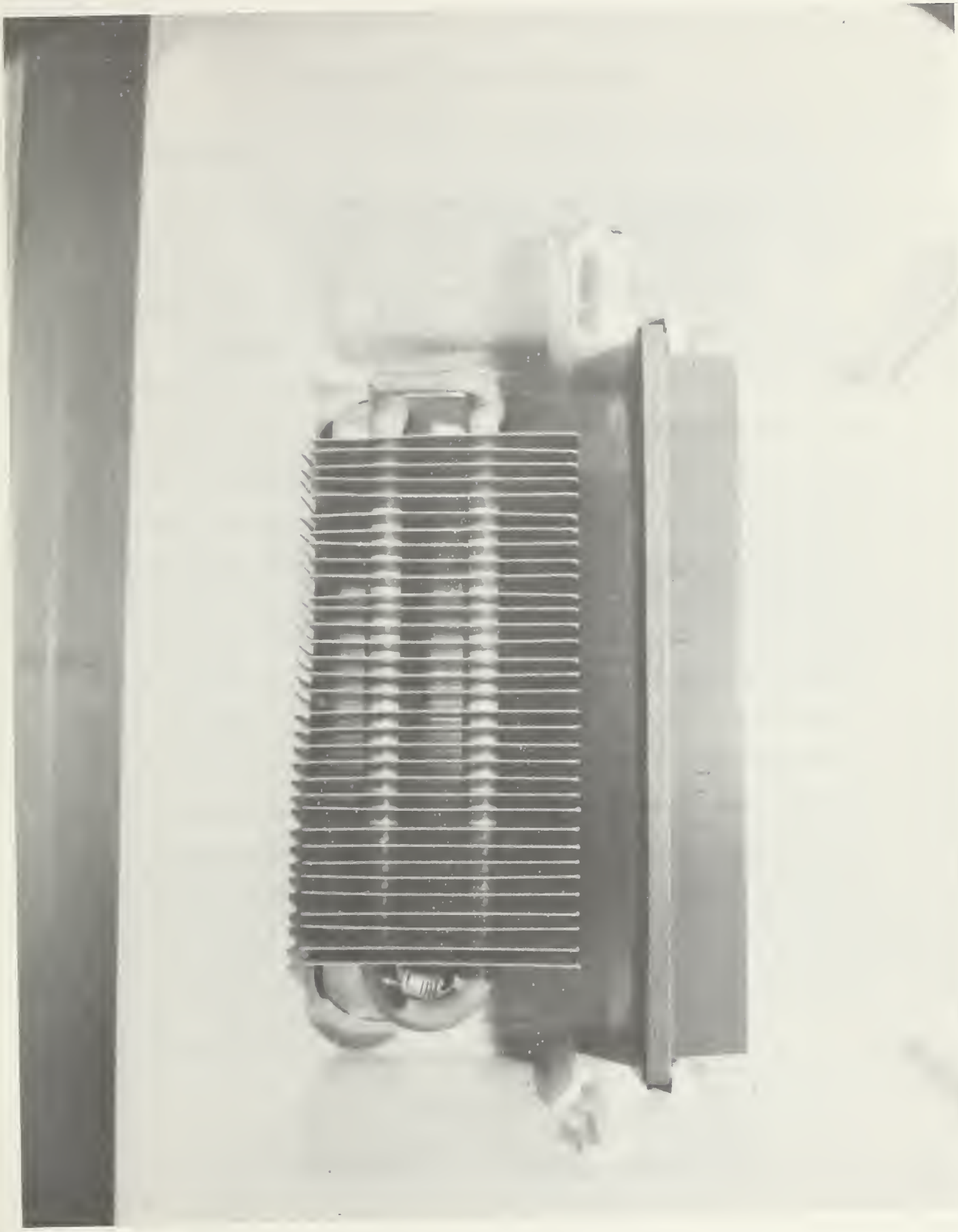


Figure 4 Condensate collector and general food compartment evaporato coil - S & S refrigerator.

4.0 Test Procedure and Apparatus

The refrigerator was placed for the tests in an environmental laboratory having provision for control of temperature from 40 °F up to 150 °F with corresponding control of the relative humidity. The back of the refrigerator was placed parallel to one of the laboratory walls, approximately six inches from the wall. The unit was levelled in the manner prescribed in the manufacturer's instruction manual furnished with the refrigerator.

Thermocouples were placed in the following locations: a) one couple was placed in the center of an ice cube cavity in an ice tray in the freezer compartment, b) a couple was placed to measure surface temperature of each of the side walls, floor, and ceiling of the freezer compartment (not averaging thermocouples); c) thermocouples were placed at the inlet point, midpoint, and exit point of the general food compartment evaporator coil; d) a three-in-one averaging thermocouple was placed in air in the general food compartment; and e) a two-in-one averaging couple to measure ambient temperature was situated approximately a food from the outside top and side of the refrigerator. These temperatures (in the latter two cases, average temperatures) were measured with a self-balancing electronic potentiometer that displayed the temperature in degrees Fahrenheit on chart paper.

4.1 Elevated Ambient Temperature Test

The propane fuel line pressure was held at 11 inches W.G. as recommended by the manufacturer. This particular pressure was also found to be optimum in a series of previous tests of other absorption refrigerators, and provided sufficient heat to the absorption system.

The purpose of the first test conducted on this refrigerator was to determine the maximum ambient temperature (up to 125 °F) in which this refrigerator could operate effectively. The test procedure followed was to operate the refrigerator effectively in a certain ambient temperature. The ambient temperature was then increased, in five or ten degree F increments, holding each ambient temperature for a sufficient time to allow the refrigerator to attain steady-state operation. This procedure was to be followed until the refrigerator failed, or until the temperature of 125 °F was reached without failure.

In order to assure that the refrigerator was operating at its maximum capacity, the thermostat sensors (separate thermostats were provided for gas and electric operation) were removed from their receptors inside the refrigerator and exposed to the ambient atmosphere. It was assumed that the thermostat would call for maximum refrigeration if the thermostat sensors were exposed to a 70 °F or higher ambient temperature.

4.2 Fuel Consumption Rate Test

Concurrently with the test described above and all subsequent tests was a daily determination of the fuel consumption rate. The fuel consumption rate was calculated by dividing the mass of gas consumed during a time interval (usually 24 hours) by the number of hours in that time interval. When the electric mode of operation was used, a watt-hour meter was used to measure the electric power usage.

4.3 Thermostat Test

Performance of the thermostat was investigated in the third test. The purpose of this test was to determine whether the thermostat could maintain acceptable temperatures inside the refrigerator while the ambient temperature fluctuated. The thermostat sensors were placed back in their receptors for this test. The range of thermostat settings was calibrated into low, medium and high positions. The refrigerator was operated at one of these positions with the ambient temperature maintained at 70 °F for several days; increased to 90 °F for several days; and then raised to 110 °F for a number of days. This procedure was then repeated for the other two thermostat settings. The resulting general food compartment temperatures were compared to the suggested temperature criteria in the American National Standard Test Procedures for Household Electric Refrigerators (Mechanically Operated) (B38.2-1961).

4.4 Tilt Test

The fourth test investigated the ability of the S & S refrigerator to operate while inclined in pitch and yaw positions. The refrigerator was tilted in one degree increments until failure due to tilt occurred. To measure the degree of tilting two large protractors, accurate to $\pm$ .5°, were drawn on construction paper. These protractors were trued vertically with a plumb bob and secured to the front and side of the refrigerator. Figure 5 shows one of these protractors attached to the front of the unit. The refrigerator was tilted by lifting one of its base edges at a time with a hydraulic jack. Figure 6 shows the hydraulic jack in position to tilt the refrigerator backward. The amount the refrigerator had been tilted was measured with the protractor and plumb bob.

4.5 Electric Mode Operation Test

The last test conducted was to be a rerun of the thermostat test with the refrigerator operating in its electric mode. After several attempts at making this test, it was discontinued. The electric heating element supplied with the refrigerator burned out after several hours of operation. The tube designed to receive the heating element warped such that intended ease of removal and replacement of the element was not obtained. The failed element was removed, a new one purchased from S & S Vending Machine Company, and installed. The new element failed and an attempt to remove it for replacement resulted in a ruptured refrigerant line.

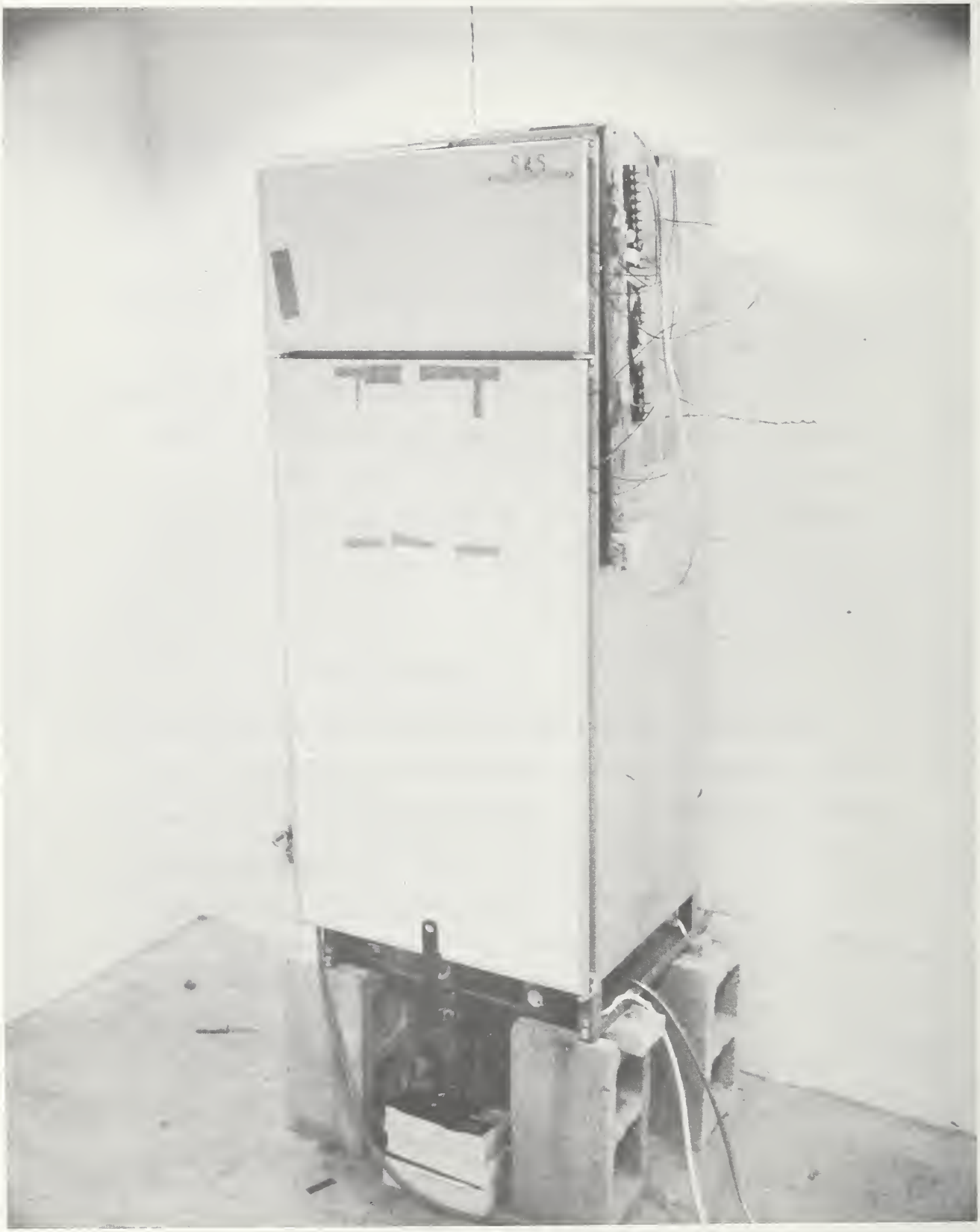


Figure 5 S & S refrigerator setup for tilt test.

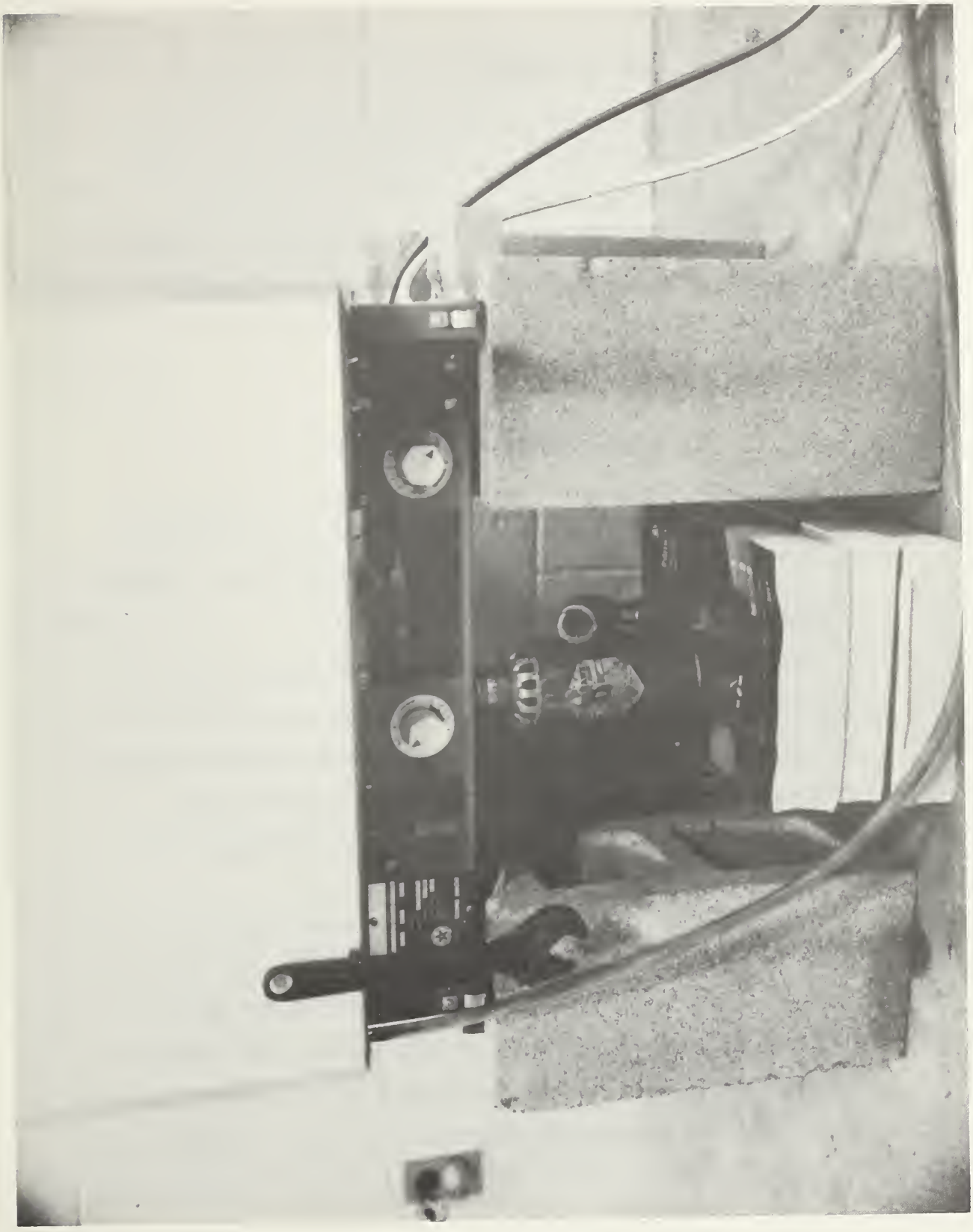


Figure 6 Hydraulic jack in position to tilt S & S refrigerator backwards.

The marketers of this refrigerator, the S & S Vending Machine Company, were contacted immediately after the refrigerant line had broken. It was hoped that they could supply information that would assist in the repair and recharging of the absorption refrigerant system. However, as a result of this attempted communication, it was learned that the S & S Vending Machine Company had declared itself bankrupt.

5. Discussion and Results

5.1 Fuel Consumption Rate Results

The fuel consumption rate results are graphically illustrated in Appendix D. In these graphs the fuel consumption rate has been plotted for each day of testing. Frame numbers seven through twelve in Appendix D display the fuel consumption rate results.

The average fuel consumption rate during the elevated ambient temperature test was .0554 lb/hr. The fuel consumption rate stayed within the interval .0540 - .0588 lb/hr 88.5% of the elevated ambient temperature testing days. The maximum and minimum fuel consumption rates occurring during the balance of the elevated ambient temperature test were .0421 lb/hr and .0860 lb/hr, respectively.

The fuel consumption rate for the duration of the entire test was exceptionally level. Minimum fuel consumption rates occurred when small or no demands were made on the refrigerator's cooling capacity, e.g., defrosts and low ambient temperatures. Maximum fuel consumption rates did not appear to have any simultaneously occurring event that would explain the increased consumption.

5.2 Elevated Ambient Temperature Test Results

The elevated ambient temperature test was to be concluded when the refrigerator failed as a result of too high an ambient temperature, or when an ambient temperature of 125 °F was attained. The S & S refrigerator continued to refrigerate in ambient temperatures up to 125.5 °F. Consequently the elevated ambient temperature test was terminated at this point.

5.3 Thermostat Test Results

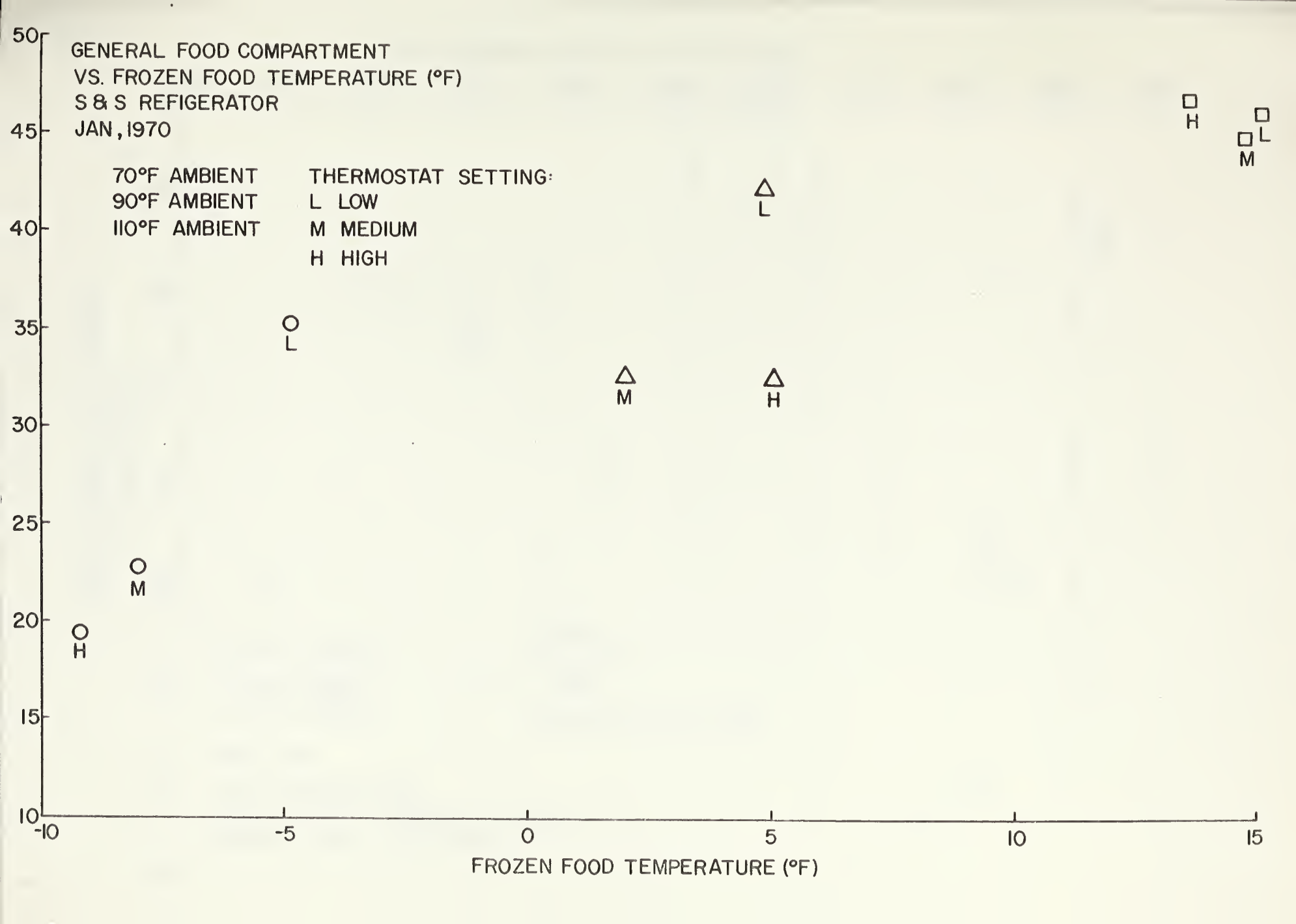
The results of the thermostat test are tabulated in Table 1. This table shows the refrigerator temperatures and corresponding fuel consumption rates as a function of the thermostat settings and ambient temperatures. The ANSI B38.2 standard test procedure suggests maximum general food compartment temperatures for each of the three ambient temperatures used in this thermostat test. These temperatures are shown in Table 2. The data from this investigation was plotted in the following manner. The frozen food temperature (i.e., ice tray temperature) was plotted against the general food compartment temperature for each of the three ambient temperatures (Graph 1). Also, the fuel consumption rate was plotted against the general food compartment temperatures for each of the three ambient temperatures (Graph 2). Beneath each data point on these plots is a letter, L, M. H. These letters correspond to the thermostat settings, LOW, MEDIUM, and HIGH (coldest), respectively.

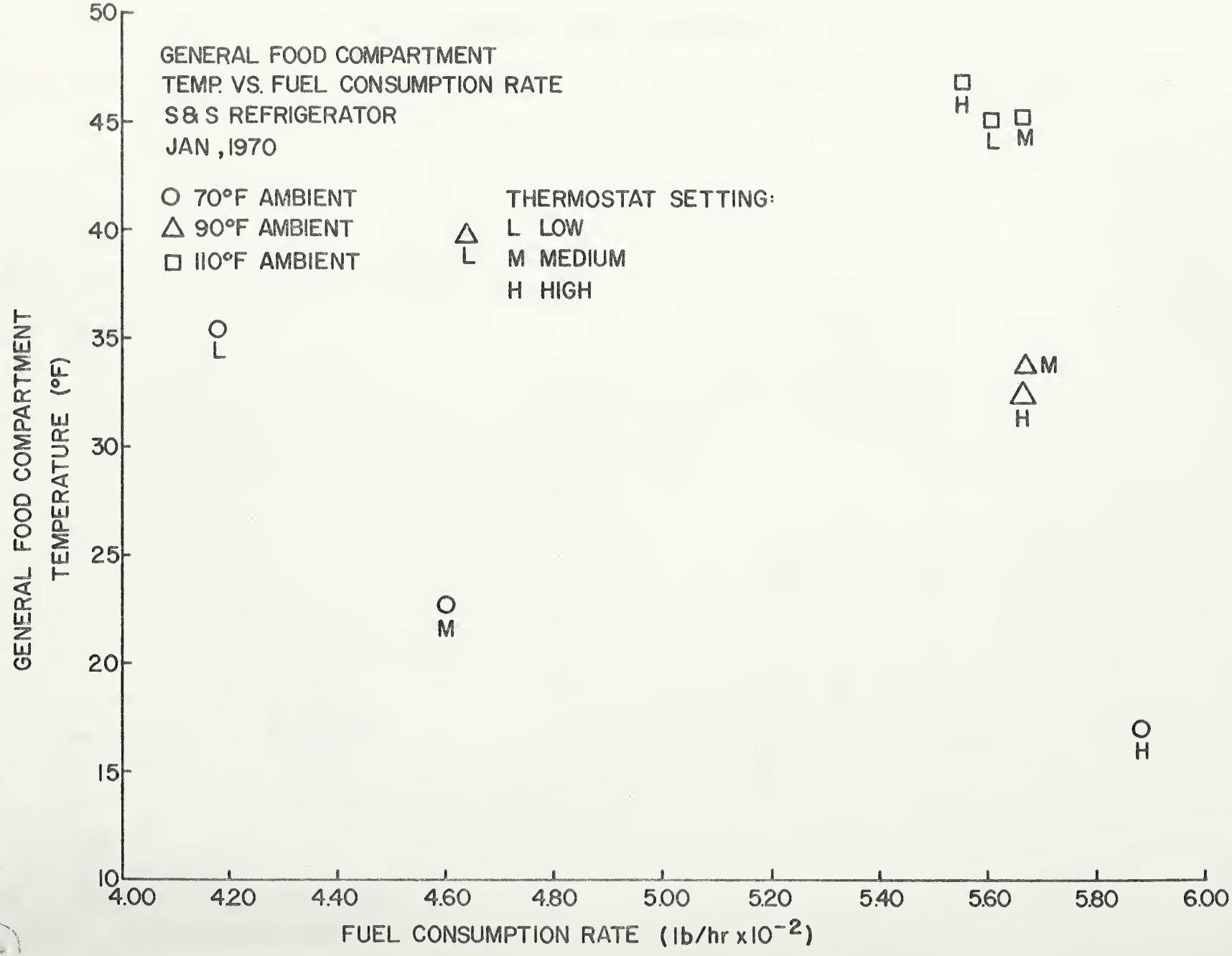
The S & S refrigerator did not satisfy the ANSI suggested thermostat performance in that a single thermostat setting did not maintain the general food compartment temperature within the suggested limits at the three ambient temperatures. It did however produce suggested temperatures below 41 °F at 70 °F and 90 °F ambient temperature but not at 110 °F.

The fuel consumption rate increased proportionately to the cooling load, for the 70 °F and 90 °F cases. However, at an ambient of 110 °F there appears to be no correlation between fuel consumption rate and cooling load.

Table 1

Thermostat Setting	Ambient Temp. (°F)	General Food Comp. Temp. (°F)	Frozen Food Comp. Temp. (°F)	Fuel Consumption Rate (lb/hr x 10^2)
HIGH (coldest)	70	19.2	-9.3	5.88
	90	32.5	5.3	5.66
	110	46.9	13.5	5.54
MEDIUM	70	22.7	-8.0	4.60
	90	33.5	2.0	5.66
	110	45.0	14.6	5.61
LOW	70	35.5	-5.1	4.81
	90	39.9	4.8	4.64
	110	45.5	15.0	5.66


GENERAL FOOD COMPARTMENT
VS. FROZEN FOOD TEMPERATURE (°F)
S & S REFIGERATOR
JAN, 1970
70°F AMBIENT
90°F AMBIENT
110°F AMBIENT
THERMOSTAT SETTING:
L LOW
M MEDIUM
H HIGH
50
45
40
35
30
25
20
15
10
-10
-5
0
5
10
15
FROZEN FOOD TEMPERATURE (°F)


GENERAL FOOD COMPARTMENT
TEMP. VS. FUEL CONSUMPTION RATE
S& S REFRIGERATOR
JAN , 1970
O 70°F AMBIENT
Δ 90°F AMBIENT
□ 110°F AMBIENT
THERMOSTAT SETTING:
L LOW
M MEDIUM
H HIGH
GENERAL FOOD COMPARTMENT TEMPERATURE (°F)
FUEL CONSUMPTION RATE (lb/hr x10⁻²)
50
45
40
35
30
25
20
15
10
4.00
4.20
4.40
4.60
4.80
5.00
5.20
5.40
5.60
5.80
6.00

Graph 2

Table 2

Ambient Temp. (°F)	Suggest Gen. Food Comp. Temp. (°F)
70	36
90	38
110	41

5.4 Tilt Test Results

The refrigerator was tilted in one degree increments, forward, backward, right, and left. The results of this test are shown in Table 3. The angle shown beside each direction of tilt in Table 3 is the maximum inclination prior to inducing failure.

Table 3

Direction of Tilt	Angle (degrees)
Backward	3°
Forward	3°
Right	2°
Left	2°

5.5 Electric Mode Operation Test Results

These results have been summarized in paragraph 4.5 of the Test Procedure and Apparatus Section.

Repeated failure of the electric heating element prevented meaningful evaluation of this test

6. Conclusions and Recommendations

6.1 Conclusions

Compared to other absorption refrigerators examined in this series, the S & S refrigerator exhibited better performance characteristics. It continued to operate without establishing a primary failure mode at elevated ambient temperatures up to 125 °F; the thermostat control was better; and the refrigerator was less sensitive to tilt. Separate freezer and general food compartments were provided.

6.2 Recommendations

The S & S refrigerator requires redesign or modification in several regards, however, if it should be considered for field use.

1. Ability to hold reasonably constant general food compartment temperatures for a given thermostat setting at various ambient temperature levels should be improved. Note that at the warmest setting the temperature spreads at various ambient temperatures were reasonable.

2. Cooling capacity should be increased at the 110 °F ambient temperature level (or refrigerator insulation improved, or both). It is important that satisfactory interior temperatures be maintained at 110 °F ambient temperature.
3. Refrigerating system should be made less sensitive to tilt, or ease of leveling improved. The following suggestion regarding leveling is offered.

   Manufacturers of absorption refrigerators for field use should consider building a leveling device into the refrigerator. Presently, a bubble type level is needed to level one of these refrigerators, and may not readily be available in the field. Consequently, an alternative method of leveling that would require no special tools should be available. One possible method would require manufacturers to affix onto the front and sides of the refrigerator a decal or other indication of a true vertical line. The refrigerator could easily be plumbed to a level position by using a plumb bob. A suitable plumb bob could be made simply from readily available material, e.g., a small weight and some string.

4. If electric mode operation is needed in addition to the gas-fired mode, the type of electric heating element and its method of installation should be improved. Access to the element for replacement also should be improved.

5. Refrigerant system joint strength and/or ruggedness should be improved. Rupture of the piping system as a consequence of heating element replacement indicates inadequate ruggedness.

7. Acknowledgment

The authors appreciate the technical assistance of Mr. John Grimes. He helped assemble the testing apparatus and was responsible for the environmental control of the testing laboratory.

Appendix A - Temperature Data Listings

	Frame Numbers
Elevated Ambient Temperature Test	1, 2, 3, 4
Thermostat Test	5, 6

FRAME NUMBER 1 S AND S REFRIGERATOR

DAY	AMBIENT TEMP	GEN FOOD COMPART TEMP	GEN EVAP COIL IN TEMP	GEN EVAP COIL OUT TEMP	ICE TRAY TEMP	FREEZER BOTTOM TEMP
1	********	********	********	********	********	********
2	81.00	74.00	24.00	60.50	-2.50	-5.00
3	88.00	31.50	7.00	19.00	-.50	-3.00
4	89.50	32.50	8.50	20.00	1.00	-2.50
5	96.00	36.50	35.50	23.50	4.50	1.50
6	90.00	29.00	5.00	16.50	-1.50	-4.50
7	********	********	********	********	********	********
8	********	********	********	********	********	********
9	90.00	31.00	6.50	19.00	-.50	-4.50
10	89.00	31.50	32.00	28.50	.50	.50
11	89.00	31.50	6.50	20.00	.00	-3.00
12	73.50	26.00	1.00	13.50	-6.00	-9.50
13	********	********	********	********	********	********
14	********	********	********	********	********	********
15	********	********	********	********	********	********
16	74.00	27.00	3.00	17.00	-5.00	-8.50
17	88.00	29.00	50.00	26.00	3.00	-2.00
18	87.50	26.00	28.00	19.50	-3.50	-6.00
19	88.00	32.00	8.50	22.50	3.00	-3.00
20	88.00	31.00	7.00	19.00	1.50	-4.00
21	********	********	********	********	********	********
22	********	********	********	********	********	********
23	87.50	27.50	4.00	15.00	-2.00	-5.00
24	98.50	30.00	6.50	17.50	.50	-4.00
25	88.00	28.00	5.00	16.00	-1.00	-5.00
26	101.00	39.00	16.00	25.50	8.50	5.00
27	102.00	39.00	14.00	26.00	8.50	4.50
28	********	********	********	********	********	********
29	********	********	********	********	********	********
30	********	********	********	********	********	********
31	101.50	38.00	14.50	25.50	8.50	5.00
32	********	********	********	********	********	********
33	101.50	42.00	16.00	28.00	10.50	6.50
34	101.50	40.50	14.50	27.00	9.00	5.50
35	********	********	********	********	********	********
36	********	********	********	********	********	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 2 S AND S REFRIGERATOR

DAY	AMBIENT TEMP	GEN FOOD COMPART TEMP	GEN EVAP COIL IN TEMP	GEN EVAP COIL OUT TEMP	ICE TRAY TEMP	FREEZER BOTTOM TEMP
36	********	********	********	********	********	********
37	101.50	38.50	14.00	26.00	8.50	4.50
38	102.00	39.00	14.00	26.50	8.00	4.00
39	102.50	47.00	23.50	28.50	13.50	11.00
40	106.50	42.00	16.50	29.50	11.00	7.00
41	********	********	********	********	********	********
42	********	********	********	********	********	********
43	********	********	********	********	********	********
44	********	********	********	********	********	********
45	********	********	********	********	********	********
46	106.50	47.00	18.00	33.50	13.00	9.50
47	107.50	46.00	17.50	32.50	12.00	8.00
48	106.50	44.00	17.00	31.50	11.50	8.00
49	********	********	********	********	********	********
50	********	********	********	********	********	********
51	106.50	46.50	17.50	33.00	12.50	8.50
52	106.50	49.50	20.00	36.00	14.00	10.00
53	102.00	45.00	17.50	32.00	12.00	8.50
54	107.50	44.50	17.50	32.00	12.50	9.00
55	107.50	44.00	17.50	31.50	12.50	9.00
56	********	********	********	********	********	********
57	********	********	********	********	********	********
58	108.50	54.00	30.00	54.00	19.00	15.50
59	107.50	48.50	19.00	35.00	14.50	10.50
60	107.00	4.50	17.50	32.00	12.50	9.00
61	106.50	44.00	17.00	31.00	12.00	8.00
62	107.00	53.00	24.50	45.00	11.50	12.00
63	********	********	********	********	********	********
64	********	********	********	********	********	********
65	********	********	********	********	********	********
66	107.00	60.10	49.00	58.00	11.50	11.00
67	********	********	********	********	********	********
68	********	********	********	********	********	********
69	108.00	48.00	19.00	35.00	13.00	9.00
70	********	********	********	********	********	********
71	********	********	********	********	********	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 3 S AND S REFRIGERATOR

DAY	AMBIENT TEMP	GEN FOOD COMPART TEMP	GEN EVAP COIL IN TEMP	GEN EVAP COIL OUT TEMP	ICE TRAY TEMP	FREEZER BOTTOM TEMP
71	********	********	********	********	********	********
72	********	********	********	********	********	********
73	105.50	27.50	4.00	16.50	-4.00	-6.50
74	109.00	45.00	18.50	32.50	12.00	8.50
75	109.50	45.50	19.00	32.50	12.50	9.00
76	109.00	51.00	21.50	38.00	15.00	11.00
77	********	********	********	********	********	********
78	********	********	********	********	********	********
79	77.00	24.00	.00	13.00	-7.00	-10.00
80	111.00	45.50	19.00	32.50	12.50	9.00
81	111.00	47.00	19.50	34.00	13.00	10.00
82	********	********	********	********	********	********
83	112.00	46.50	20.00	33.50	13.50	10.00
84	********	********	********	********	********	********
85	********	********	********	********	********	********
86	111.00	48.00	20.00	34.50	13.50	9.50
87	113.50	51.00	22.00	32.00	15.50	12.00
88	112.50	48.50	21.00	35.00	14.00	10.50
89	113.50	47.50	20.50	34.50	13.50	10.00
90	112.50	49.00	20.50	35.50	14.00	10.00
91	********	********	********	********	********	********
92	********	********	********	********	********	********
93	117.00	53.00	24.00	40.00	17.00	13.00
94	116.50	52.00	35.50	39.50	17.00	13.00
95	116.50	56.50	26.00	42.50	18.00	14.00
96	117.50	52.00	23.50	39.00	16.50	19.50
97	117.00	51.50	23.50	38.50	16.00	12.50
98	********	********	********	********	********	********
99	********	********	********	********	********	********
100	117.00	51.00	22.50	38.00	16.00	12.50
101	119.00	54.00	24.50	41.00	17.50	14.00
102	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
103	120.50	54.00	25.50	41.50	19.00	15.00
104	120.50	56.00	26.00	42.50	19.50	15.50
105	********	********	********	********	********	********
106	********	********	********	********	********	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 4 S AND S REFRIGERATOR

DAY	AMBIENT TEMP	GEN FOOD COMPART TEMP	GEN EVAP COIL IN TEMP	GEN EVAP COIL OUT TEMP	ICE TRAY TEMP	FREEZER BOTTOM TEMP
106	********	********	********	********	********	********
107	119.50	55.00	25.00	41.50	18.50	14.50
108	119.00	53.00	24.00	40.00	17.50	13.50
109	121.00	57.00	26.50	43.50	19.50	15.50
110	120.50	57.00	27.50	43.50	20.50	16.50
111	121.00	61.00	30.50	48.50	21.50	17.00
112	********	********	********	********	********	********
113	********	********	********	********	********	********
114	122.00	63.00	33.00	51.00	22.50	18.00
115	123.00	58.00	30.00	45.00	21.00	17.50
116	122.50	55.50	28.50	42.50	20.00	16.00
117	123.00	61.50	32.50	49.00	22.00	18.00
118	123.00	57.50	29.50	44.00	20.50	16.50
119	********	********	********	********	********	********
120	********	********	********	********	********	********
121	********	********	********	********	********	********
122	********	********	********	********	********	********
123	********	********	********	********	********	********
124	********	********	********	********	********	********
125	122.00	56.00	30.50	43.00	21.50	17.50
126	********	********	********	********	********	********
127	********	********	********	********	********	********
128	124.50	59.50	31.50	46.50	24.00	20.00
129	124.50	60.50	31.50	47.00	24.00	19.50
130	124.50	60.00	31.50	46.50	24.00	20.50
131	125.50	60.50	32.00	47.00	24.50	20.50
132	125.50	60.50	32.00	47.00	24.50	21.00
133	********	********	********	********	********	********
134	********	********	********	********	********	********
135	********	********	********	********	********	********
136	********	********	********	********	********	********
137	********	********	********	********	********	********
138	********	********	********	********	********	********
139	********	********	********	********	********	********
140	********	********	********	********	********	********
141	********	********	********	********	********	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 5 S AND S REFRIGERATOR

DAY	AMBIENT TEMP	GEN FOOD COMPART TEMP	GEN EVAP COIL IN TEMP	GEN EVAP COIL OUT TEMP	ICE TRAY TEMP	FREEZER BOTTOM TEMP
1	********	********	********	********	********	********
2	********	********	********	********	********	********
3	********	********	********	********	********	********
4	92.50	30.50	11.00	23.00	4.50	1.50
5	92.50	35.00	11.00	22.50	4.00	1.00
6	92.50	35.00	11.00	23.00	4.00	1.00
7	********	********	********	********	********	********
8	********	********	********	********	********	********
9	89.00	32.50	14.00	20.00	8.00	3.50
10	********	********	********	********	********	********
11	90.00	32.00	13.00	20.00	6.00	3.00
12	111.00	46.00	20.50	33.00	13.00	10.00
13	111.50	46.50	21.50	33.50	13.00	9.50
14	********	********	********	********	********	********
15	********	********	********	********	********	********
16	112.00	47.00	20.50	34.00	13.50	10.00
17	112.00	46.50	21.00	33.50	14.50	10.50
18	112.00	47.00	20.50	34.50	13.50	9.50
19	111.50	48.50	21.00	35.50	13.50	9.50
20	69.50	24.50	-1.50	12.00	-11.00	-13.00
21	********	********	********	********	********	********
22	********	********	********	********	********	********
23	68.00	16.50	-1.00	6.50	-8.50	-12.00
24	68.50	16.50	-1.50	6.00	-8.50	-12.00
25	70.00	25.50	2.00	14.50	-8.00	-12.00
26	********	********	********	********	********	********
27	********	********	********	********	********	********
28	********	********	********	********	********	********
29	********	********	********	********	********	********
30	70.50	26.00	3.50	19.50	-8.50	-12.50
31	91.50	31.00	8.50	19.50	.50	-3.00
32	92.50	33.50	10.00	21.50	2.50	-1.50
33	89.00	31.50	13.50	19.50	.50	-3.50
34	90.00	38.00	13.00	27.00	4.50	1.00
35	********	********	********	********	********	********
36	********	********	********	********	********	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 6 S AND S REFRIGERATOR

DAY	AMBIENT TEMP	GEN FOOD COMPART TEMP	GEN EVAP COIL IN TEMP	GEN EVAP COIL OUT TEMP	ICE TRAY TEMP	FREEZER BOTTOM TEMP
36	********	********	********	********	********	********
37	109.00	45.50	21.00	33.00	15.00	11.50
38	110.00	45.00	21.00	32.00	14.50	11.00
39	110.00	45.00	21.00	33.00	14.50	11.00
40	110.00	45.50	21.00	32.50	15.00	11.50
41	109.50	45.50	21.50	33.00	15.00	11.50
42	********	********	********	********	********	********
43	********	********	********	********	********	********
44	90.50	39.50	16.00	34.00	3.50	.00
45	81.50	40.00	17.00	33.80	5.00	1.50
46	81.60	40.00	17.00	34.60	4.80	1.20
47	91.40	40.30	17.00	32.00	5.50	2.20
48	91.00	40.00	16.00	29.50	5.00	2.00
49	********	********	********	********	********	********
50	********	********	********	********	********	********
51	69.50	36.00	9.00	29.50	-6.00	-9.50
52	71.00	36.50	-.30	28.00	-2.00	-7.00
53	70.50	35.50	-.50	28.40	-4.00	-8.00
54	********	********	********	********	********	********
55	72.00	38.50	16.00	37.00	2.50	.50
56	********	********	********	********	********	********
57	********	********	********	********	********	********
58	69.00	35.00	8.00	29.00	-7.00	-10.00
59	71.00	36.00	-1.50	29.00	-6.50	-10.00
60	********	********	********	********	********	********
61	********	********	********	********	********	********
62	********	********	********	********	********	********
63	********	********	********	********	********	********
64	********	********	********	********	********	********
65	********	********	********	********	********	********
66	********	********	********	********	********	********
67	********	********	********	********	********	********
68	********	********	********	********	********	********
69	********	********	********	********	********	********
70	********	********	********	********	********	********
71	********	********	********	********	********	********

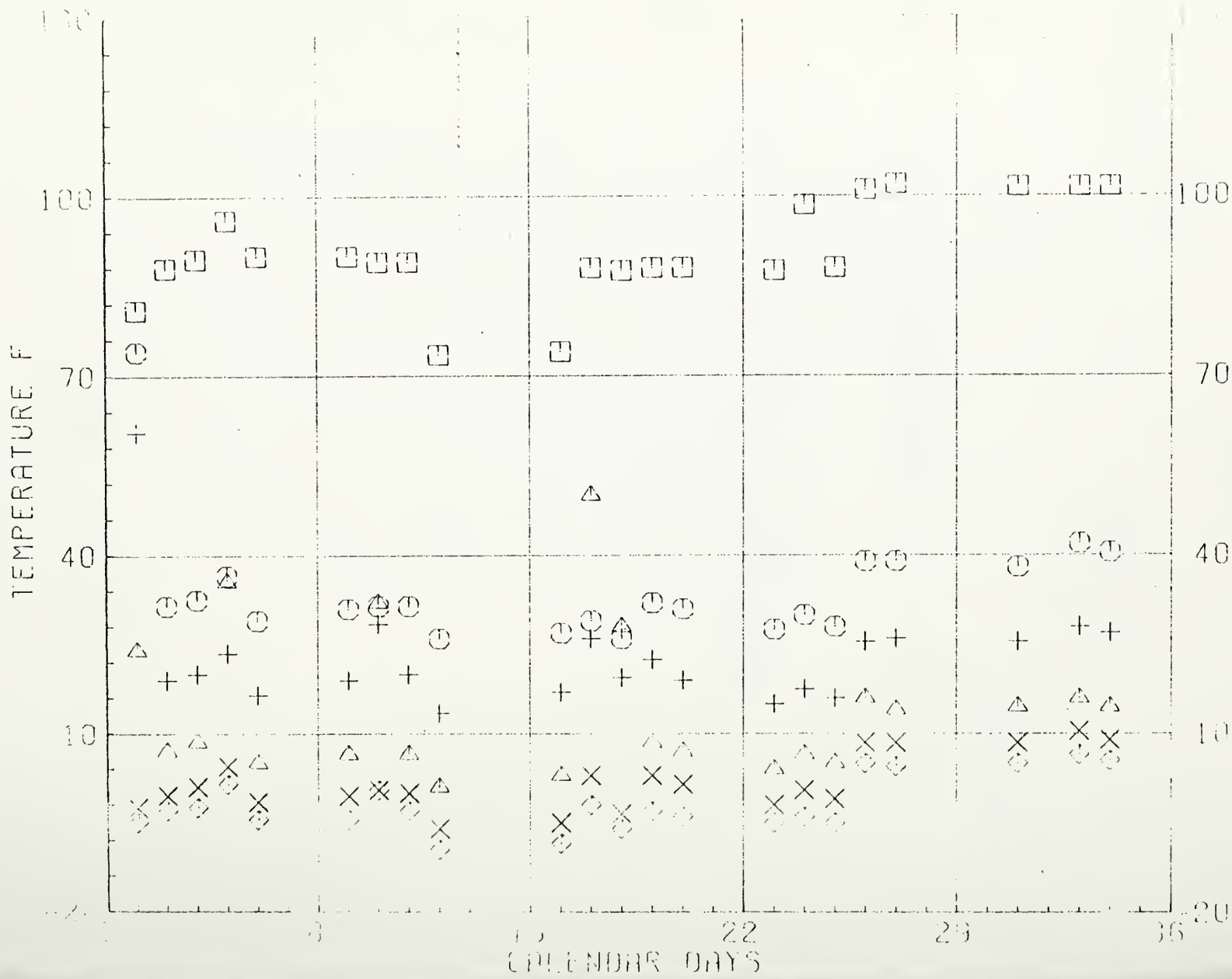
NOTE--ASTERISK DENOTES NO DATA

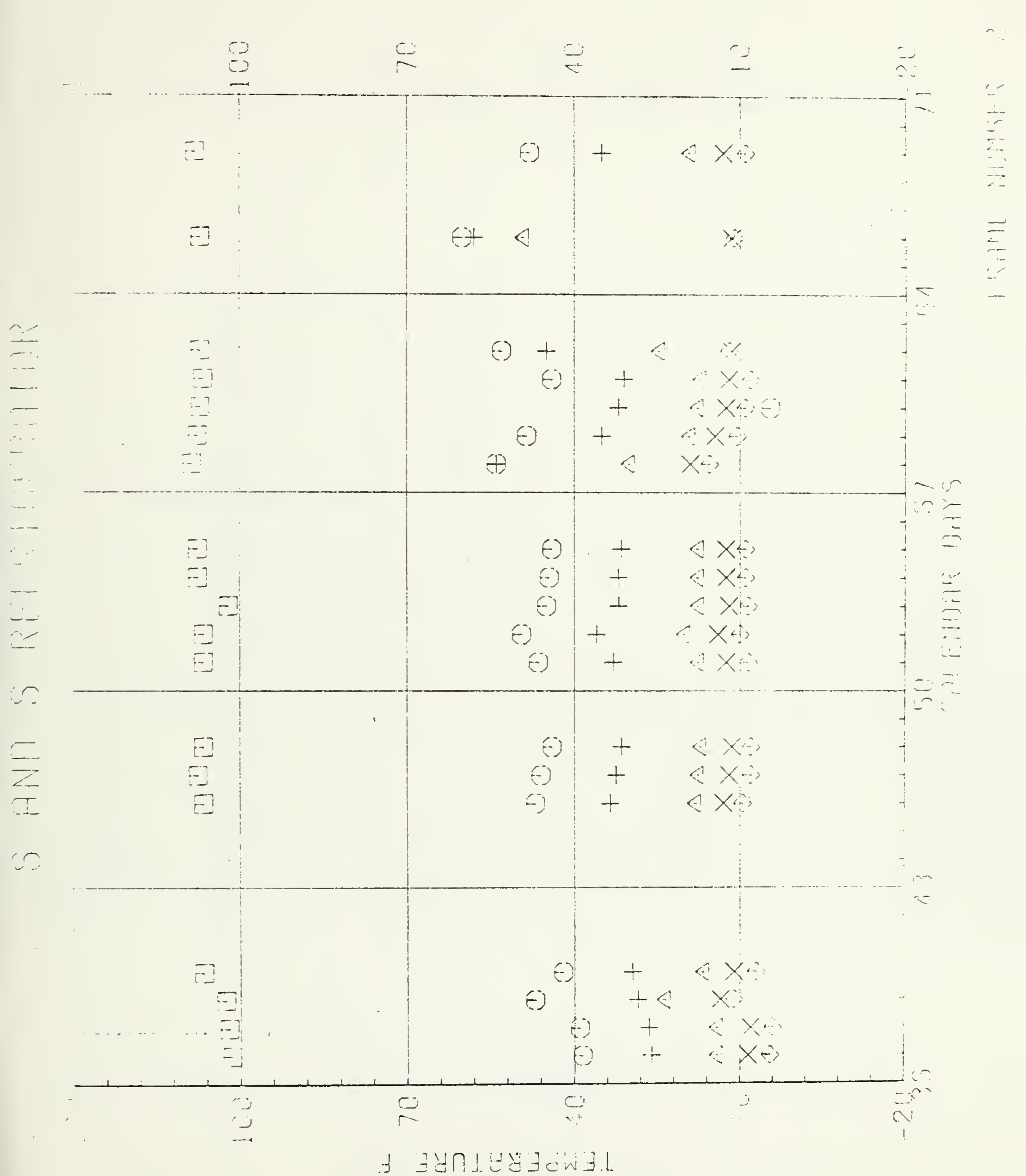
Appendix B - Temperature Plots

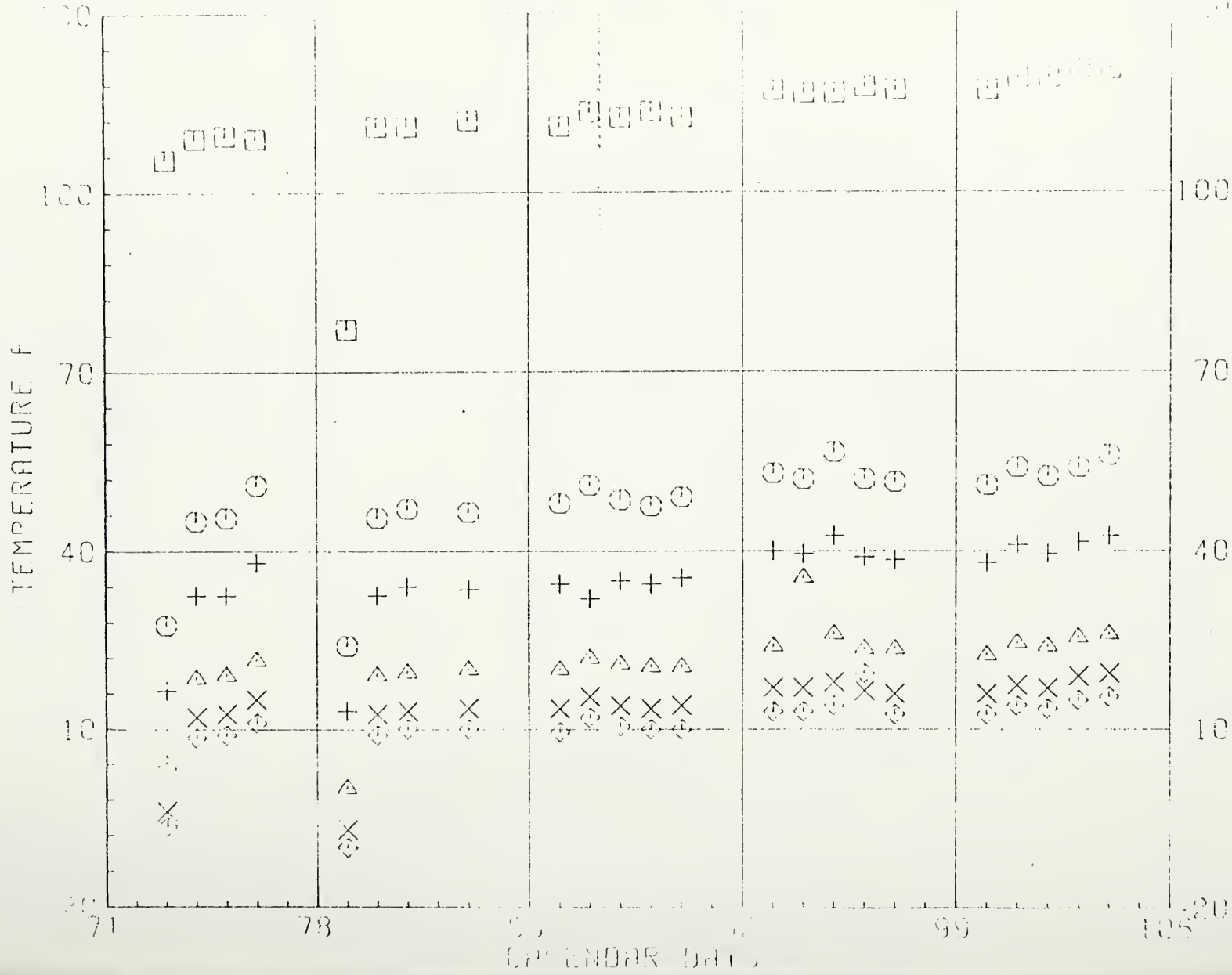
	Frame Numbers
Elevated Ambient Temperature Test	1, 2, 3, 4
Thermostat Test	5, 6

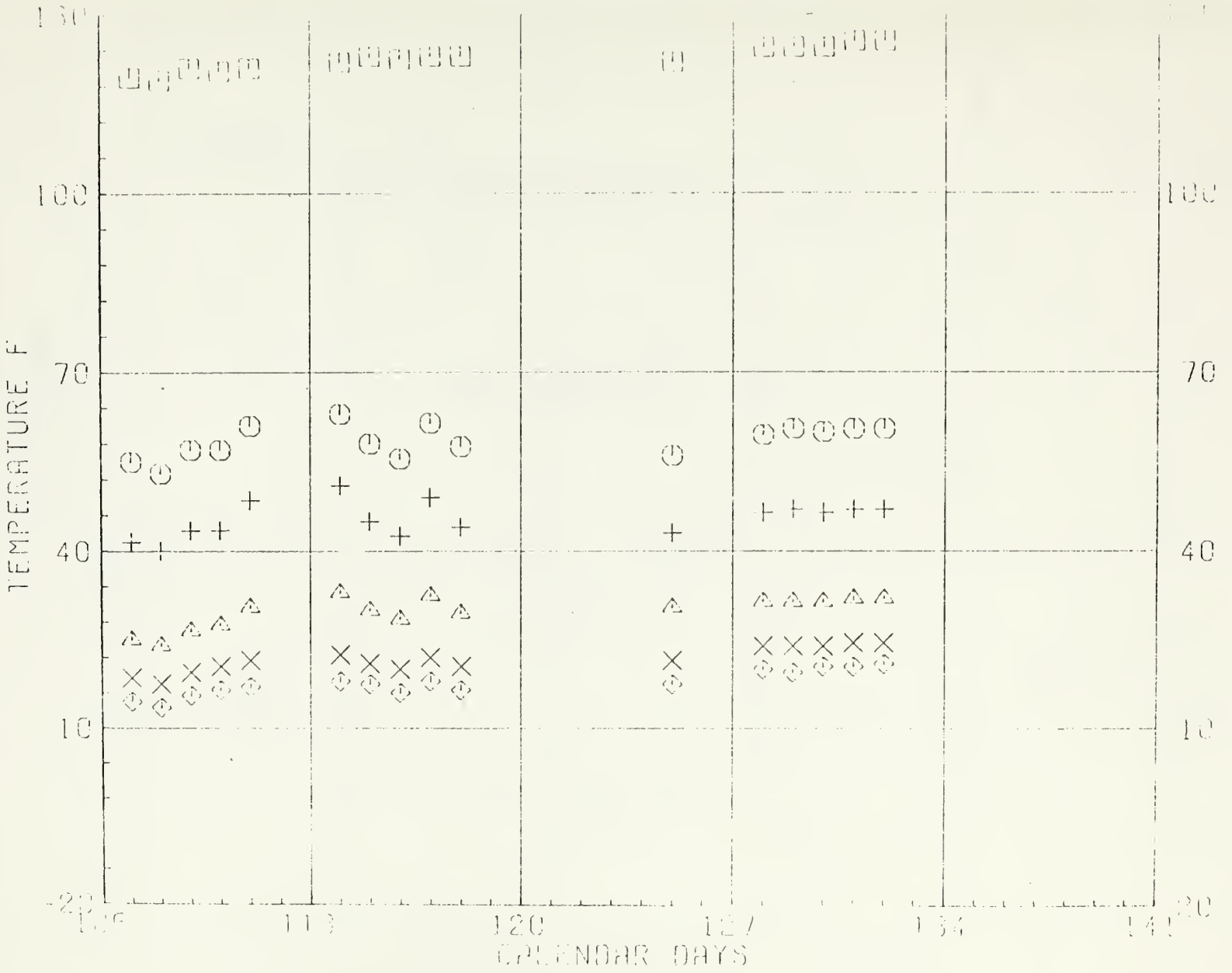
SYMBOL LEGEND

□ AMBIENT TEMPERATURE
○ GENERAL FOOD COMPART TEMP
△ GEN EVAP COIL INLET TEMP
+ GEN EVAP COIL EXIT TEMP
× ICE TRAY TEMPERATURE
◇ FREEZER BOTTOM TEMP

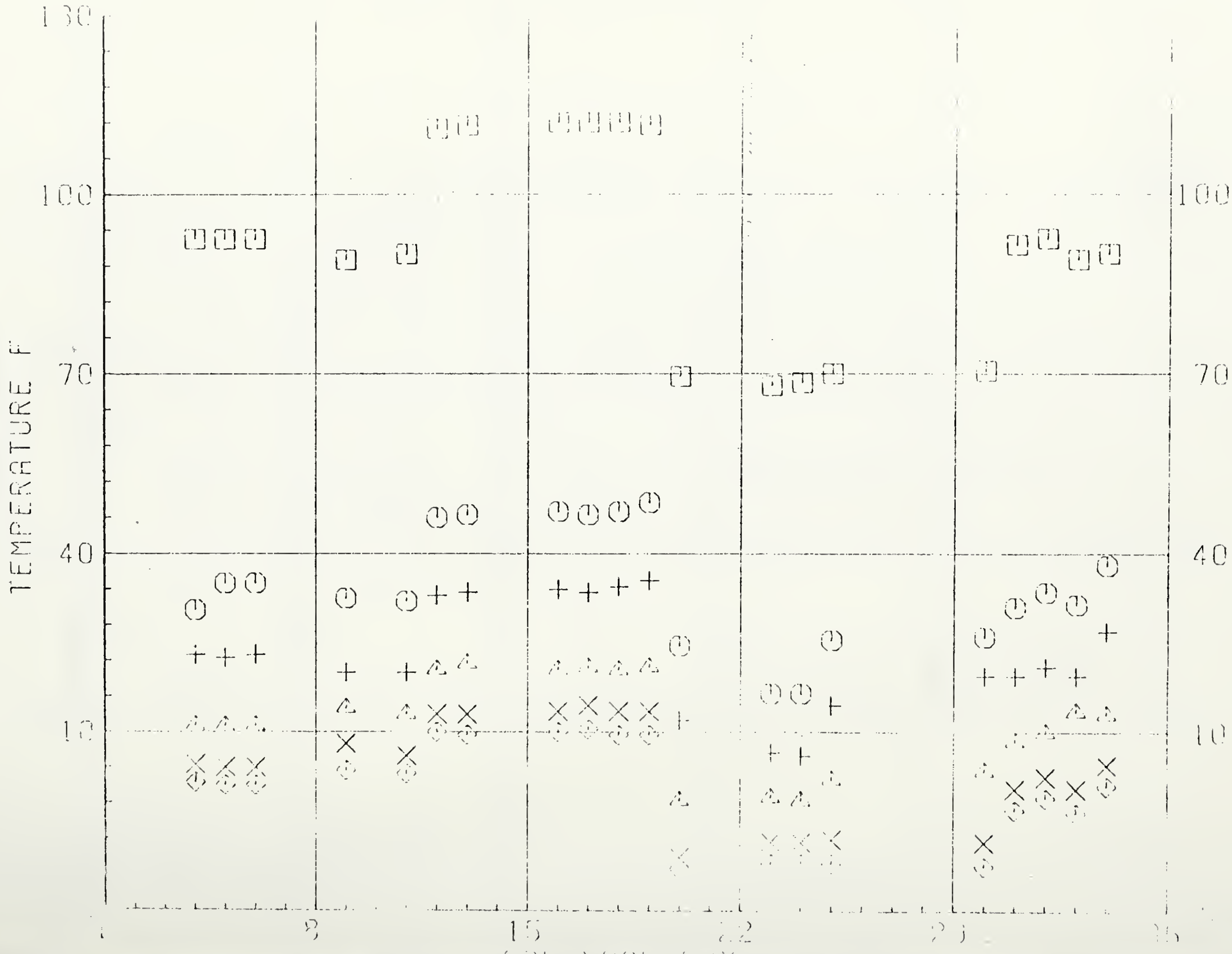

TEMPERATURE VS. TEST PERIOD
S AND S REFRIGERATOR
TEMPERATURE F
100
70
40
10
22
23
CALENDAR DAYS

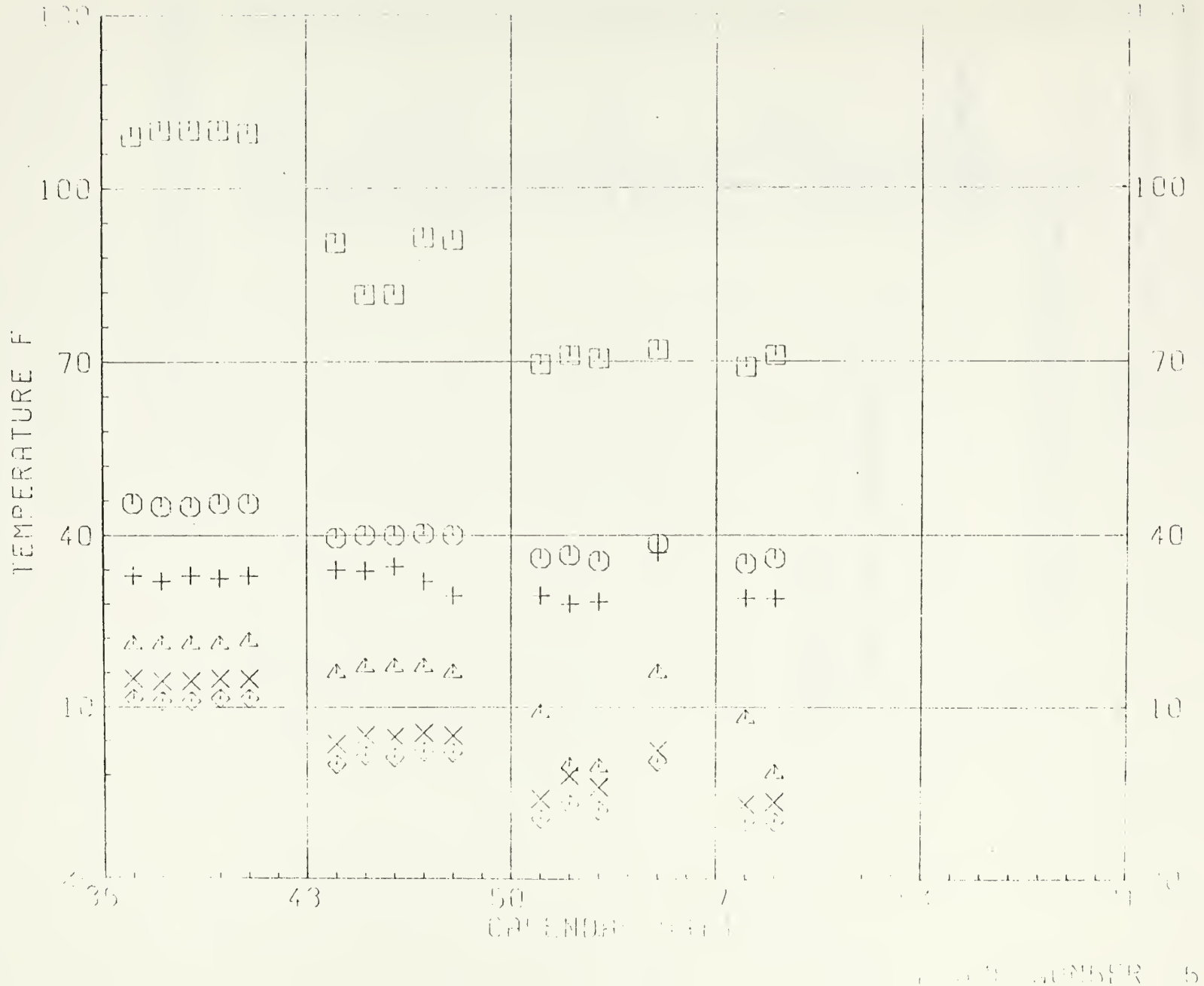

S AND S REFRIGERATOR
CALENDAR DAYS
TEMPERATURE F
100
70
40
10
-20
36
43
50
57
64
71


TEMPERATURE VS. TEST PERIOD
S AND S REFRIGERATOR
TEMPERATURE F
100
70
40
10
71
78
99
105
CALENDAR DATE


S AND S REFRIGERATOR
TEMPERATURE F
130
100
70
40
10
-20
CALENDAR DAYS

TEMPERATURE VS. TEST PERIOD
S AND S REFRIGERATOR




S AND S REFRIGERATOR
TEMPERATURE F
100
70
40
10
43
50

Appendix C - Fuel Consumption Rate

	Frame Numbers
Elevated Ambient Temperature Test	7, 8, 9, 10
Thermostat Test	11, 12

FRAME NUMBER 7 S AND S FUEL

DAY	CONSUMPTION RATE (LBM/HR)
1	********
2	.0552
3	.0529
4	.0555
5	.0558
6	.0548
7	********
8	********
9	.0550
10	.0558
11	.0554
12	.0556
13	********
14	********
15	********
16	.0555
17	.0573
18	.0554
19	.0558
20	.0557
21	********
22	********
23	.0570
24	.0581
25	.0571
26	.0571
27	.0552
28	********
29	********
30	.0558
31	********
32	.0556
33	.0472
34	
35	********
36	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 8 S AND S FUEL

DAY	CONSUMPTION RATE (LBM/HR)
36	********
37	.0557
38	.0558
39	.0570
40	.0406
41	********
42	********
43	********
44	********
45	.0532
46	.0575
47	.0564
48	********
49	********
50	********
51	.0547
52	.0871
53	.0663
54	.1095
55	.1116
56	********
57	********
58	.0571
59	.0562
60	.0660
61	********
62	********
63	********
64	********
65	.0493
66	********
67	.0600
68	********
69	.0594
70	********
71	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 9 S AND S FUEL

DAY	CONSUMPTION RATE (LBM/HR)
71	********
72	.0565
73	.0563
74	.0546
75	.0557
76	********
77	********
78	********
79	.0547
80	.0561
81	.0342
82	********
83	.0551
84	********
85	********
86	.0545
87	.0551
88	.0562
89	.0532
90	.0558
91	********
92	********
93	.0546
94	.0558
95	.0550
96	.0560
97	.0544
98	********
99	********
100	.0549
101	.0554
102	.0504
103	.0554
104	.0551
105	********
106	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 10 S AND S FUEL

DAY	CONSUMPTION RATE (LBM/HR)
106	********
107	.0550
108	.0533
109	.0556
110	.0545
111	.0546
112	********
113	********
114	.0541
115	.0555
116	.0553
117	.0544
118	.0527
119	********
120	********
121	********
122	********
123	.0560
124	********
125	.0535
126	********
127	********
128	.0548
129	.0538
130	.0526
131	.0550
132	.0539
133	********
134	********
135	********
136	********
137	********
138	********
139	********
140	********
141	********

NOTE--ASTERISK DENOTES NO DATA

FRAME NUMBER 11 S AND S FUEL

DAY	CONSUMPTION RATE (LBM/HR)
1	********
2	********
3	.0590
4	.0554
5	.0560
6	.0559
7	********
8	********
9	.0570
10	********
11	.0547
12	.0533
13	.0551
14	********
15	********
16	.0565
17	.0566
18	.0566
19	.0593
20	.0582
21	********
22	********
23	.0589
24	********
25	.0458
26	.0459
27	********
28	********
29	********
30	.0551
31	.0563
32	.0575
33	.0576
34	.0560
35	********
36	********

NOTE"-ASTERISK DENOTES NO DATA

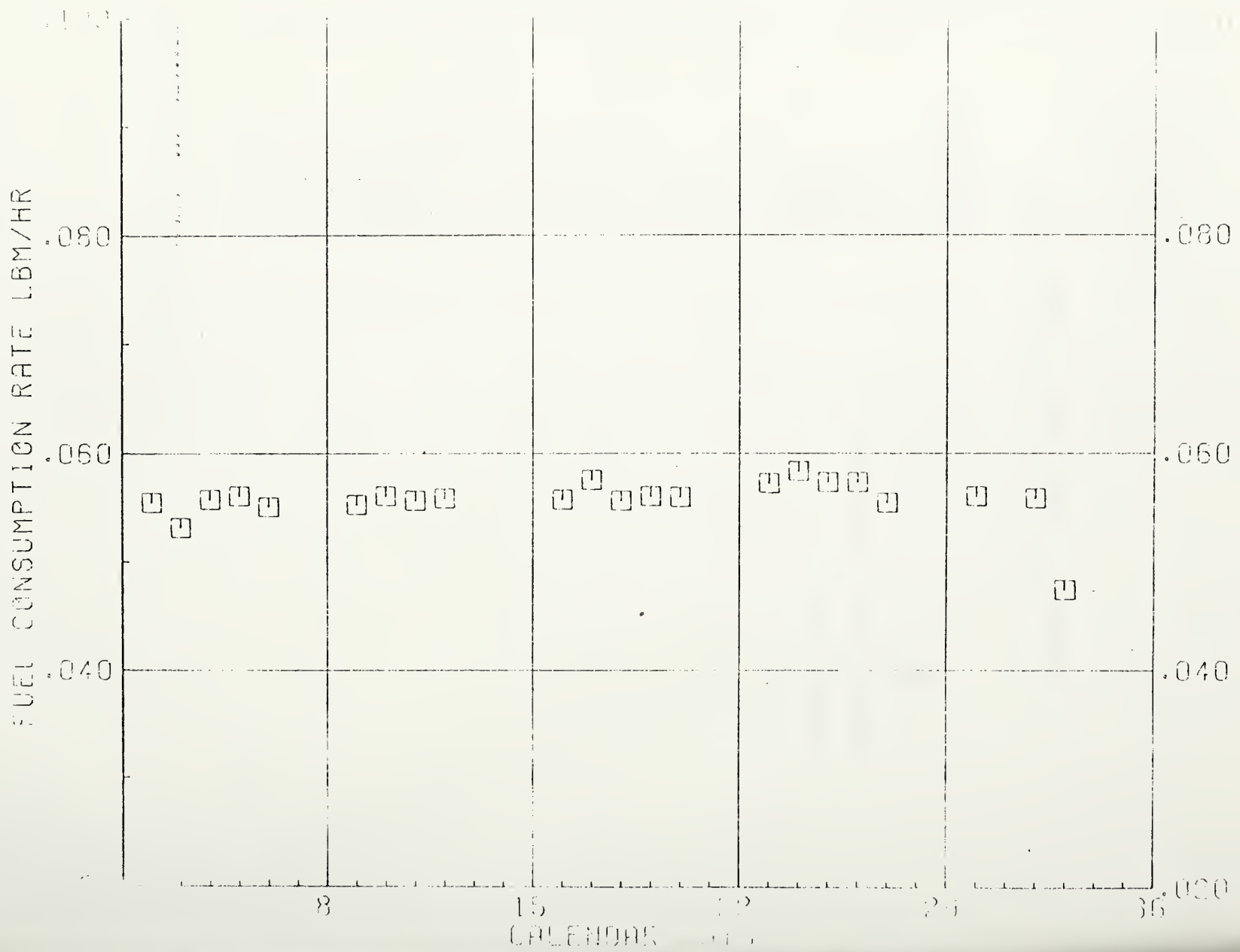
FRAME NUMBER 12 S AND S FUEL

DAY	CONSUMPTION RATE (LBM/HR)
36	********
37	.0575
38	.0550
39	.0561
40	.0571
41	.0482
42	********
43	********
44	.0469
45	.0446
46	.0465
47	.0459
48	.0426
49	********
50	********
51	.0411
52	.0422
53	.0420
54	********
55	.0413
56	********
57	********
58	.0421
59	********
60	********
61	********
62	********
63	********
64	********
65	********
66	********
67	********
68	********
69	********
70	********
71	********

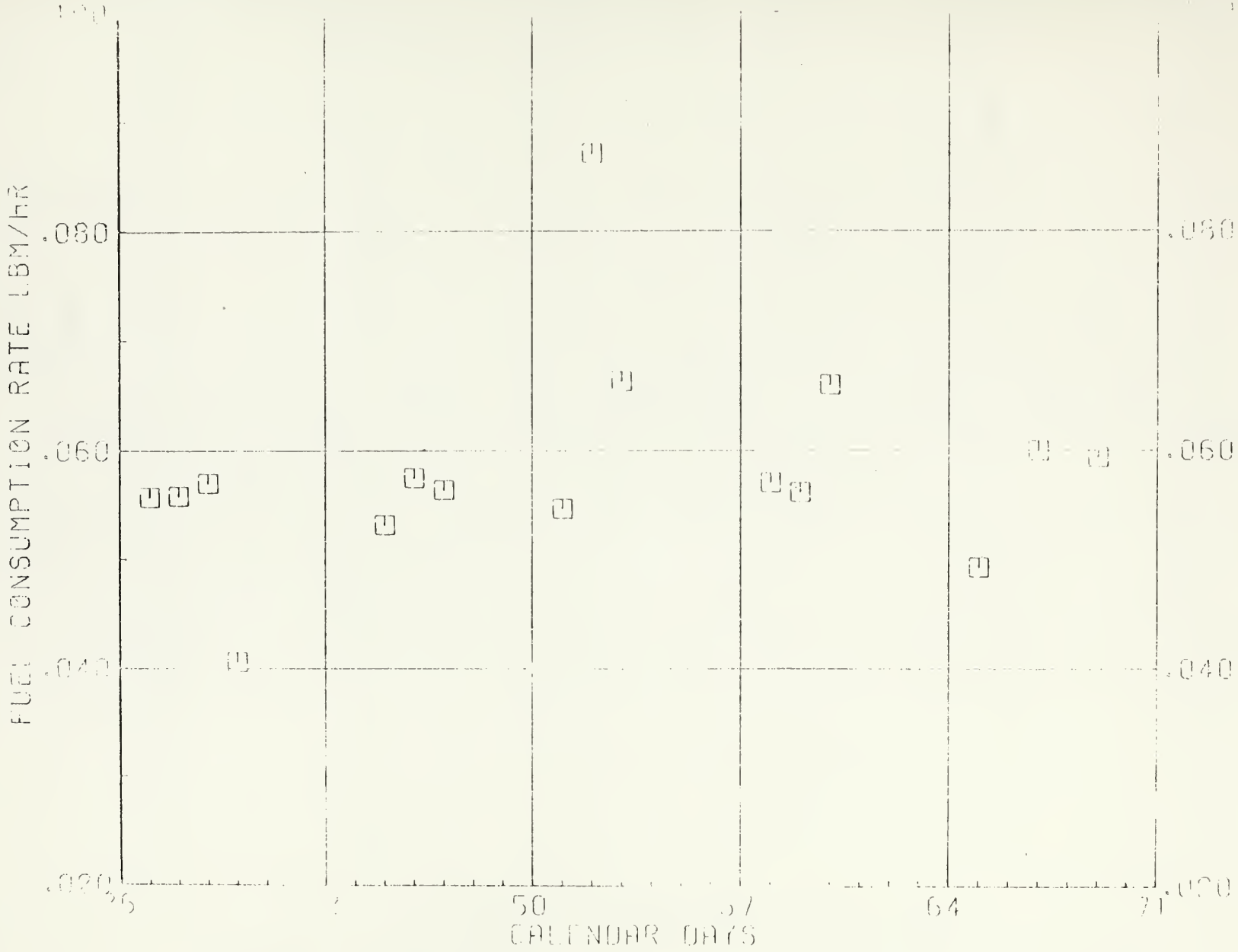
NOTE--ASTERISK DENOTES NO DATA

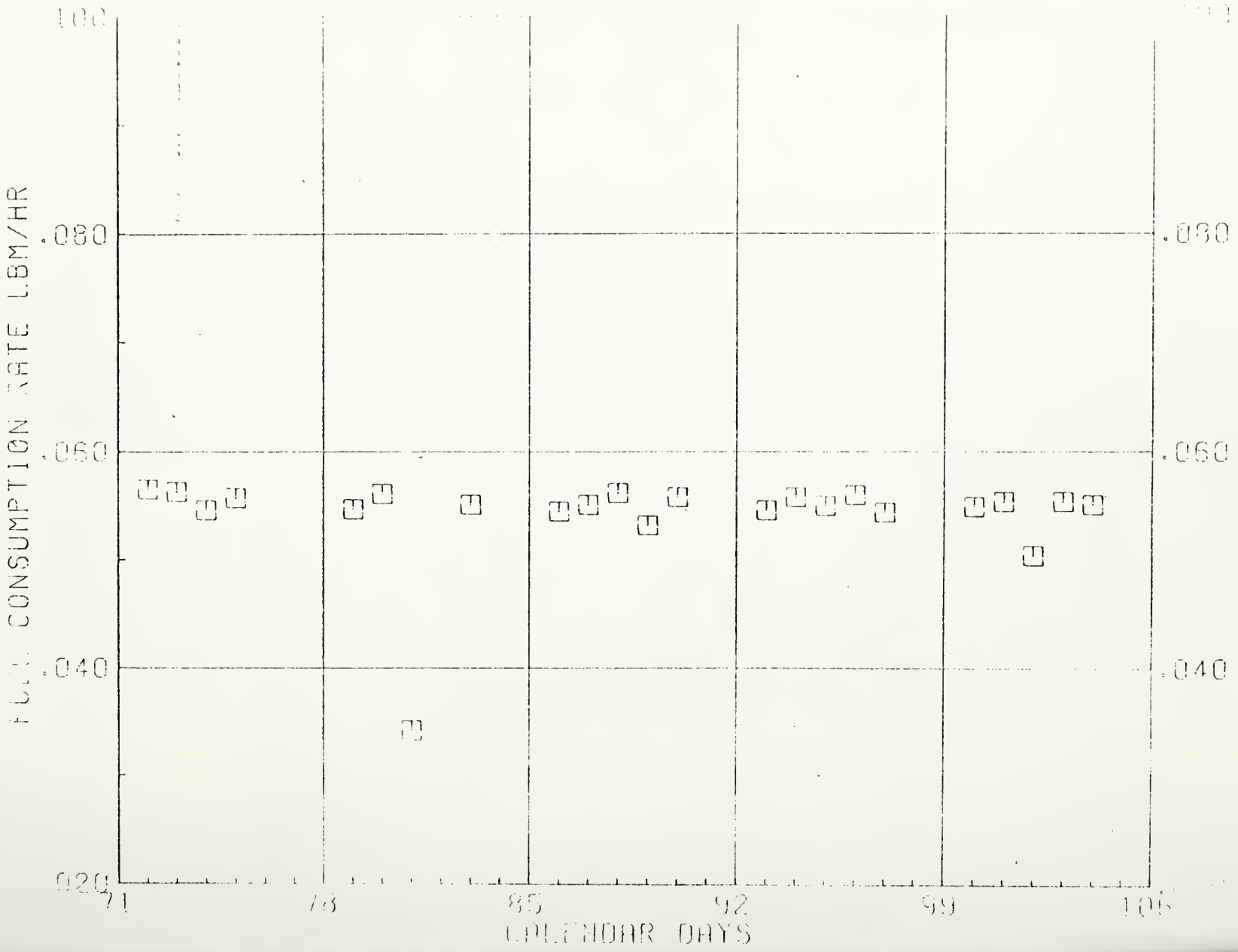
Appendix D - Fuel Consumption Rate Plots

	Frame Numbers
Elevated Ambient Temperature Test	7, 8, 9, 10
Thermostat Test	11, 12


FUEL CONSUMP RATE VS TEST PERIOD
S AND S REFRIGERATOR
FUEL CONSUMPTION RATE LBM/HR
.080
.060
.040
.020
8
15
22
29
36
CALENDAR

FUEL CONSUMP RATE VS TEST PERIOD
S AND S REFRIGERATOR




FUEL CONSUMP RATE VS TEST PERIOD
S AND S REFRIGERATOR
FUEL CONSUMPTION RATE LBM/HR
.100
.080
.060
.040
.020
.030
.060
.040
71
78
85
92
99
106
CALENDAR DAYS

S AND S REFRIGERATOR
.080
.090
120
CONSUMPTION RATE LBM/HR

FUEL CONSUMP RATE VS TEST PERIOD
S AND S REFRIGERATOR
.080
.060
.040
.080
.060
.040
FUEL CONSUMPTION RATE LBM/HR

S AND S REFRIGERANT
FUEL CONSUMPTION RATE LBM/HR
.080
.060
.040
.020
DAYS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