SC-CR-67-2806

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CATALYST RESEARCH CORPORATION

Baltimore

CRC

VIA AIR MAIL

November 15, 1967

[redacted]

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
DOWNGRADING OR DECLASSIFICATION STAMP

CLASSIFICATION CHANGED TO U	AUTHORITY W C Logan
Emilda Sulph 7/14/96	
PERSON CHANGING MARKING & DATE	RECORD ID 96SN372
W C Logan 7-18-96	
PERSON VERIFYING MARKING & DATE	DATED 7-8-96

Sandia Corporation
P. O. Box 5800
Albuquerque, New Mexico

Attention: Mr. D. Bush, Division 1323

Reference: Purchase Order Number 13-065[illegible]

Subject: Progress Report Number 24
October 1, 1967 to November 1, 1967

Gentlemen:

The following work was accomplished during the reporting period:

Abstract

1. The technical problems encountered in obtaining internal thermocouple measurements on the light weight container were solved.

2. After the technical problems were solved, work was directed toward re-establishing the temperature profiles of the standard unit in the light weight can.

3. To establish the standard unit in the light weight container, the 4.4 gram cell heat, 3 heat pellet reservoir, was tested over the temperature range with three in-line thermocouples.

4. The above results were compared to units fabricated and tested over the temperature range containing a 4.2 gram cell heat and a 4 heat pellet reservoir.

5. The following improvements were noted when the 4.2 gram cell heat was compared to the 4.4 gram cell heat:

   a. An increase of 25°C in the cell temperature was recorded at 400 seconds.

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b. The temperature profile curve obtained from the center cell was flat for the first two hundred seconds.

c. The peak center cell temperatures were similar.

6. The 4.2 gram cell heat and four heat pellet reservoir was incorporated in our standard control since this modification improved both battery discharge and temperature profile curves.

7. Santo-cel and Glasrock insulation were compared with air insulation in the light weight can at room temperature.

a. Since Santo-cell insulation demonstrated similar performance when compared to the control at R.T., additional T.C. units were fabricated and tested over the temperature range.

b. Because Glasrock insulation was found to be inferior to our insulation at R.T., it was not tested over the temperature range.

8. To ruggidize the control unit under spin, the following modifications are being incorporated in the design:

a. A hardened steel mandrel.

b. The case bottom and header are being reinforced.

c. A solid insulation (Glasrock #50, a mica asbestos laminate) is being placed between the nickel sleeve and the cell stack.

9. Batteries incorporating the above change will be spun tested the week of November 16, 1967 at HDL.

Summary of Accomplishments

1. Establishing a standard unit in the light weight container. At the beginning of this year's work the standard method for obtaining T.C. measurements in the cold rolled can was to space three T.C.'s (24 gauge) at 120° from each other around the battery stack, and pass the resulting T.C. wires through individual two hole seals (purchased from E.I.) located around the outer diameter of the header.

Early thermocouple data on adopting the light weight tin can as standard was collected utilizing the above technique.

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The T.C. data was compared to that obtained on the old standard and the results judged good enough to adopt the light weight can as standard. It was decided to evaluate future changes in the light weight container by placing a single T.C. in the center cell. This decision was made by mutual consent of CRC and Sandia technical personnel, since we were looking for gross effects of changes and it appeared that a temperature profile of the center cell would be sufficient to evaluate the change. It was further decided that if the change improved the standard control battery, it would be incorporated in the control and additional T.C. measurements be made to further evaluate the change.

All changes were to be evaluated at room temperature and the most promising ones were evaluated at the temperature extremes (-65°F, +160°F) as well.

To standardize T.C. techniques at CRC and Sandia and to obtain more history on the temperature profiles obtained in the light weight container, it was decided to run additional internal T.C. measurements on the light weight container. By mutual consent of CRC and Sandia it was decided to standardize on three in-line T.C.'s running up one side of the cell stack, and passing them through the header by utilizing one large seal. This change precipitated the following difficulties:

a. Three in-line 24 gauge T.C. wires caused the battery stack to tilt.

b. The large seal vented due to the difficulties in potting the sealing compound around the three T.C. wires.

To eliminate the above problems, it was decided to utilize a smaller diameter T.C. wire. A 30 gauge wire was ordered but it was not available, so we purchased a 36 gauge wire.

The 36 gauge wire was found to be not compatible with our attenuator T.C. circuit (resistance of circuit was too low). The attenuator circuit was modified to be similar to Sandia's (the terminal resistance was increased from 50 to 705 ohms).

The venting problem around the T.C. seal was greatly reduced by adopting the following Hi-Sol potting procedures:

a. Place the potting compound through the T.C. tube on the underside of the header twice. The second coat not being applied until the first is hard.

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b. Turn header over and seal remaining voids from the top.

c. Place header and T.C. wires in an oven pre-set to 160°F over night.

During this period (August 18, 1967 to October 15, 1967), 35 batteries were fabricated and tested to correct our technical problems; the data was not reported due to the results being inconsistent.

To assure that the work outlined for the last quarter of the contract would be completed, an extension of time without additional funds was requested and granted from Sandia's contract administrators.

After the attenuator circuit was modified at CRC and the venting problem solved, work this month was directed toward re-establishing temperature profiles of the standard unit in the light weight can.

To establish the standard unit in the light weight can, the 4.4 gram cell heat, 3 heat pellet reservoir was tested over the temperature range. See Figures 1, 2, 3 and Table 1.

From previous battery discharge cycles (Sandia Monthly Progress Report #10) without T.C.'s, a group of batteries were tested over the temperature range with a 4.2 gm. cell heat and a four heat pellet reservoir. The life results over the temperature range were nearly balanced. Thermocouple tests were run during this period to evaluate this design change. Each time this type of arrangement was tested, a battery with a 4.4 gm. cell heat and 3 pellet reservoir was tested with it as a standard. See Table 2 for detailed battery and T.C. results (4.2 gm. cell heat, 4.2 gm. four pellet reservoir).

Figures 1 through 6 are T.C. comparisons of the 4.4 gm. cell heat, 3 heat pellet reservoir and the 4.2 gm., four heat pellet reservoir.

The following improvements were noted when the 4.2 gm. cell heat, 4 heat pellet reservoir was compared to the 4.4 gm. cell heat, 3 heat pellet reservoir:

a. A twenty-five degree centigrade cell temperature increase was noted at 400 seconds.

b. The temperature profile curve obtained from the center cell was flat for the first two hundred seconds.

c. The peak center cell temperatures were similar.

[redacted]

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Since the 4.2 gram cell heat, four pellet reservoir improved both battery discharge curves and temperature profiles, this modification will be incorporated in our standard control.

2. Heat loss study (light weight can). Eleven units were fabricated and tested to evaluate Santo-cel and Glasrock insulation versus air insulation in the light weight can. The batteries were constructed with a 4.2 gram cell heat and a four heat pellet reservoir. Each time a group of batteries was tested a battery with air insulation was tested as a control. The units with Santo-cel insulation demonstrated the following results:

	Air Insulation R.T.	Santo-cel Insulation R.T.
Number of tests		2
Battery life to 10.0V	422 secs.	415 secs.
Temp. at 400 sec.		
Center Cell	433°C	439°C
1st Cell	408	415
Buffer	395	394
Header	268	280
Case	205	204

See Figures 4 and 7 - Air insulation versus santo-cel insulation.

Since santo-cel insulation units demonstrated similar performance to the control at R.T., additional units were fabricated and tested over the temperature range. The following chart is a comparison of air insulation versus santo-cel insulation over the temperature range.

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	Air Insulation		Santo-cel Insulation	
	-60°F	+160°F	-60°F	+[illegible]°F
Number of tests			2	2
Battery life to 10.0V	316 secs.	467 secs.	364 secs.	43[illegible] secs.
Temp. at 400 sec.				
Center Cell	378°C	452°C	401°C	46[illegible]°C
1st Cell	355°C	444°C	383°C	43[illegible]°C
Buffer	354°C	432°C	377°C	440°C
Header	247°C	265°C	248°C	274°C
Case	180°C	204°C	181°C	205°C

See Figures 5 and 6; 8 and 9 - Air Insulation versus santo-cel insulation. See Table 3 for detailed battery and thermocouple data (santo-cel insulation).

When units with Glasrock Insulation were compared to air insulation, the following results were obtained:

	Air Insulation R.T.	Glasrock Insulation R.T.
Number of tests		2
Battery life to 10.0V	422 secs.	364 secs.
Temp. at 400 sec.		
Center Cell	433°C	401°C
1st Cell	400°C	393°C
Buffer	395°C	371°C
Header	260°C	255°C
Case	205°C	206°C

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Glasrock insulation was found to be inferior to air insulation. Because it was inferior it was not tested over the temperature range. See Figures 4 and 10 - Air insulation versus Glasrock insulation. See Table 4 for detailed battery and thermocouple data (Glasrock insulation).

3. Performance study. In previous non-operational spin tests, the mandrel and mandrel connections to the case and header were found to be the weakest point in the design. Two groups of non-operational units are being fabricated at the present time. The first incorporates a harden steel mandrel, the second incorporates a harden steel mandrel and a reinforced case bottom and header. These tests should demonstrate whether the mandrel or the case and header connections were the cause of failures.

When the operational battery was spun tested, post mortems revealed that the cell stack needed more support. Two groups of operational spin units are being constructed with a solid insulation between the nickel sleeve and the cell stack. The solid insulations that will be tested are Glasrock #60 and a mica asbestos laminate.

The above spin tests will be conducted at NDL the week of November 16, 1967.

Future Work

1. Standard light weight units (4.2 gram cell heat, 4 heat pellet reservoir) will be tested over the following temperature ranges: -65, -40, -20, 0, R.T., +120, +140, and +160 degrees F.

2. Standard units will be shocked, accelerated, vibrated, and discharged at room temperature.

3. The ruggedized design will be spun tested at NDL.

APPROVED BY:

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Table 1

Light Weight Case (Air Insulation)

Internal Thermocouple Measurements
4.4 Gram Cell Heat - 3 Heat Pellet Reservoir

DEB Lot DE-11, EB23

Temperature	-65					RT		
Number of Tests	3					4		
Peak Voltage	12.94					13		
Sec. to 12.0V	145					20		
11.0V	259					31		
10.0V	318					35		
Open Circuit	12.90					12		
Start	1.55					1.		
Alloy	--					--		
Cell Heat Pellet Wt.	4.4					4.		
Heat Pellet Reservoir	3					3		
Temp. °C at:	Center Cell	First Cell	Buffer Cell	Header	Case	Center Cell	First Cell	Bu C
1 Second	-38	--	-39	--	--	25	26	
2 Seconds	195	200	90	--	--	283	260	2
3 Seconds	365	314	245	--	--	425	430	3
4 Seconds	428	433	355	--	--	485	493	4
5 Seconds	445	460	408	--	--	522	496	4
6 Seconds	448	468	430	--	--	525	500	4
7 Seconds	450	470	440	--	--	528	499	4
8 Seconds	456	473	445	--	--	529	498	4
9 Seconds	450	475	460	--	--	530	495	4
10 Seconds	452	477	464	--	--	531	494	4
15 Seconds	454	475	468	66	45	528	491	5
20 Seconds	457	470	467	89	67	525	495	5
30 Seconds	460	463	464	125	89	523	497	5
40 Seconds	465	461	460	158	111	521	505	4
50 Seconds	459	459	453	181	126	517	503	4
60 Seconds	458	458	450	198	137	515	501	4
70 Seconds	457	456	449	213	146	513	498	4
80 Seconds	455	453	448	223	150	511	495	4
100 Seconds	454	452	447	236	157	505	491	4
150 Seconds	447	450	430	253	173	488	474	4
200 Seconds	425	435	409	257	178	472	458	4
250 Seconds	404	414	389	253	179	453	441	4
300 Seconds	382	394	370	246	177	437	420	4
350 Seconds	364	373	351	241	172	412	402	3
400 Seconds	345	356	334	227	166	396	386	3

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ants
Reservoir

				RT					+160		
				4					3		
				13.15					13.20		
				20[illegible] 31[illegible] 353					262 387 440		
				12.[illegible]					12.4		
				1.2[illegible]					1.00		
				--					1.4		
				4.4					4.4		
				3					3		
ader	Case	Center Cell	First Cell	Buffer Cell	Header	Case	Center Cell	First Cell	Buffer Cell	Header	Case
.	--	25	26	25	--	--	63	62	62	--	--
.	--	283	260	200	--	--	337	326	180	--	--
.	--	425	430	358	--	--	483	478	345	--	--
.	--	485	493	404	--	--	530	523	413	--	--
.	--	522	496	435	--	--	554	538	439	--	--
.	--	525	500	445	--	--	562	539	452	--	--
.	--	528	499	457	--	--	566	538	467	--	--
.	--	529	498	470	--	--	568	536	476	--	--
.	--	530	495	473	--	--	571	534	483	--	--
.	--	531	494	493	84	50	573	533	490	87	67
56	45	528	491	50[illegible]	105	61	575	530	530	110	84
39	67	525	495	503	148	76	577	533	538	130	101
25	89	523	497	50[illegible]	172	101	573	541	539	167	131
58	111	521	505	49[illegible]	198	128	570	546	534	195	153
31	126	517	503	49[illegible]	212	135	566	546	527	212	165
98	137	515	501	4[illegible]	226	159	563	542	521	235	173
13	146	513	498	47[illegible]	226	164	560	540	515	255	180
23	150	511	495	47[illegible]	237	166	557	535	511	264	186
36	157	505	491	463	249	173	551	528	499	273	195
53	173	488	474	45[illegible]	263	188	527	502	478	281	204
57	178	472	458	44[illegible]	272	195	502	480	461	285	205
53	179	453	441	43[illegible]	272	198	479	463	448	282	205
46	177	437	420	4[illegible]	266	198	460	452	442	273	204
41	172	412	402	3[illegible]	258	192	447	433	430	269	200
27	166	396	386	3[illegible]	248	186	431	414	402	261	195

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Table 2

Light Weight Case (Air Insulation)

Internal Thermocouple Measurements
4.2 Gram Cell Heat - 4 Heat Pellet Reservoir

DEB Lot DE-11, EB23

Temperature	-65					R1		
Number of Tests	4*					6*		
Peak Voltage	13.30					13		
Sec. to 12.0V	155					21		
11.0V	268					34		
10.0V	318					42		
Open Circuit	13.0					12		
Start	1.52					1.		
Alloy	0					0		
Cell Heat Pellet Wt.	4.2					4.		
Heat Pellet Reservoir	4					4		
Temp. °C at:	Center Cell	First Cell	Buffer Cell	Header	Case	Center Cell	First Cell	Bu C
1 Second	--	--	--	--	--	25	27	
2 Seconds	--	--	--	--	--	320	265	1
3 Seconds	342	340	220	--	--	436	427	3
4 Seconds	420	436	334	--	--	480	475	4
5 Seconds	447	458	403	--	--	497	483	4
6 Seconds	456	460	429	--	--	507	486	4
7 Seconds	460	459	443	--	--	509	486	4
8 Seconds	462	458	457	--	--	510	486	4
9 Seconds	463	456	476	--	--	511	485	5
10 Seconds	465	455	485	43	30	512	484	5
15 Seconds	465	450	505	75	46	512	485	5
20 Seconds	462	451	506	102	63	512	490	5
30 Seconds	460	455	503	147	96	511	505	5
40 Seconds	460	462	494	182	120	508	512	5
50 Seconds	461	464	485	210	138	509	517	5
60 Seconds	463	465	480	227	148	511	515	5
70 Seconds	464	465	470	233	156	511	512	5
80 Seconds	467	462	462	243	163	513	511	5
100 Seconds	467	460	453	256	168	513	508	4
150 Seconds	463	454	446	263	180	518	488	4
200 Seconds	453	442	428	267	190	510	472	4
250 Seconds	440	422	408	267	193	487	459	4
300 Seconds	420	403	390	263	191	466	447	4
350 Seconds	400	383	371	255	186	450	425	4
400 Seconds	378	355	354	247	180	433	408	3

* Numbers include standards run with Santo-cel & Glasrock insulation

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ents
Reservoir

		RT					+160				
		6*					3*				
		13.20					13.20				
		215 346 422					217 365 467				
		12.5					12.4				
		1.16					1.00				
		0					2.9				
		4.2					4.2				
		4					4				
ader	Case	Center Cell	First Cell	Buffer Cell	Header	Case	Center Cell	First Cell	Buffer Cell	Header	Case
-	--	25	27	25	--	--	62	62	62	--	--
-	--	320	265	140	--	--	340	325	188	--	--
-	--	436	427	310	--	--	470	462	340	--	--
-	--	480	475	409	--	--	513	518	423	--	--
-	--	497	483	436	--	--	529	529	444	--	--
-	--	507	486	452	--	--	537	528	468	--	--
-	--	509	486	473	--	--	543	526	491	--	--
-	--	510	486	497	--	--	548	524	510	--	--
-	--	511	485	503	--	--	552	522	524	--	--
43	30	512	484	519	73	49	553	520	540	85	71
75	46	512	485	545	100	66	559	523	578	113	91
02	63	512	490	543	127	85	559	532	579	139	110
47	96	511	505	543	173	116	559	548	574	184	143
82	120	508	512	539	209	149	560	557	567	216	168
10	138	509	517	530	235	159	561	559	560	235	183
27	148	511	515	520	248	172	563	557	552	249	193
33	156	511	512	511	255	182	566	553	545	261	201
43	163	513	511	504	266	190	567	552	540	267	207
56	168	513	508	490	267	200	573	545	527	276	215
63	180	518	488	467	280	207	563	529	503	285	222
67	190	510	472	453	283	213	540	510	482	284	222
57	193	487	459	439	282	212	513	488	464	278	217
53	191	466	447	430	280	212	490	470	454	274	213
55	186	450	425	412	275	209	468	454	441	270	209
47	180	433	408	395	268	205	452	444	432	263	207

Glasrock insulation

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Table 3

Light Weight Case (Santo-cel Insulation)

Internal Thermocouple Measurements

DEB Lot DE-11, EB23

Temperature	-65					RT		
Number of Tests	2					2		
Peak Voltage	12.77					1		
Sec. to 12.0V 11.0V 10.0V	139 280 364					2 3 4		
Open Circuit	12.85					1		
Start	1.6					1.		
Alloy	16.4					1.		
Cell Heat Pellet Wt.	4.2					4.		
Heat Pellet Reservoir	4					4		
Temp. °C at:	Center Cell	First Cell	Buffer Cell	Header	Case	Center Cell	First Cell	Bu (
1 Second	-35	-35	-39	--	--	25	25	
2 Seconds	125	200	190	--	--	285	300	1
3 Seconds	345	362	250	--	--	415	426	3
4 Seconds	420	425	345	--	--	468	473	3
5 Seconds	449	440	403	--	--	492	484	3
6 Seconds	458	441	427	--	--	502	483	4
7 Seconds	462	441	442	--	--	508	482	4
8 Seconds	463	441	457	--	--	511	481	4
9 Seconds	466	442	475	--	--	513	481	5
10 Seconds	466	443	485	32	--	514	480	5
15 Seconds	465	449	500	53	22	516	480	5
20 Seconds	461	450	500	73	33	515	482	5
30 Seconds	458	453	495	109	57	512	497	5
40 Seconds	455	459	490	141	80	512	507	5
50 Seconds	456	463	488	167	98	513	512	5
60 Seconds	459	468	481	186	112	517	513	5
70 Seconds	460	469	477	201	124	519	512	5
80 Seconds	461	468	470	213	133	521	511	4
100 Seconds	464	466	460	231	149	524	508	4
150 Seconds	465	460	451	253	173	516	492	4
200 Seconds	460	453	443	264	185	500	477	4
250 Seconds	450	439	426	267	190	482	464	4
300 Seconds	435	420	408	265	191	466	450	4
350 Seconds	419	403	391	258	186	452	431	4
400 Seconds	401	388	377	248	181	439	415	3

[redacted]

[redacted]

ulation)

ents

		RT					+160				
		2					2				
		13.02					12.99				
		200 325 415					248 362 438				
		12.55					12.45				
		1.18					1.00				
		1.6					32.4				
		4.2					4.2				
		4					4				
ader	Case	Center Cell	First Cell	Buffer Cell	Header	Case	Center Cell	First Cell	Buffer Cell	Header	Case
-	--	25	25	25	30	--	65	120	60	--	--
-	--	285	300	150	32	--	330	370	230	--	--
-	--	415	426	305	34	--	455	470	355	--	--
-	--	468	473	393	36	--	510	500	422	--	--
-	--	492	484	432	40	--	528	510	445	--	--
-	--	502	483	444	44	--	536	512	474	--	--
-	--	508	482	467	48	--	542	511	493	--	--
-	--	511	481	491	54	--	544	510	510	--	--
-	--	513	481	508	58	--	546	511	525	--	--
32	--	514	480	522	65	43	547	512	535	71	54
53	22	516	480	545	92	58	550	513	573	96	69
73	33	515	482	545	113	75	546	520	580	120	81
09	57	512	497	542	151	106	543	536	577	162	111
41	80	512	507	553	178	131	542	545	572	192	142
67	98	513	512	553	198	151	544	550	565	216	165
86	112	517	513	514	213	166	545	552	557	235	188
01	124	519	512	505	225	178	548	550	549	250	196
13	133	521	511	493	234	184	549	548	540	262	199
31	149	524	508	467	273	196	550	545	530	277	209
53	173	516	492	464	284	211	544	528	501	292	216
64	185	500	477	455	287	218	530	508	481	293	214
57	190	482	464	442	289	222	513	493	466	287	212
55	191	466	450	413	288	218	492	475	460	282	210
58	186	452	431	412	286	212	476	462	447	278	208
48	181	439	415	[illegible]	280	204	462	450	440	274	205

[redacted]

[redacted]

Table 4

Light Weight Case (Glasrock Insulation)

Internal Thermocouple Measurements

DEB Lot DE-11, EB23

Temperature	RT
Number of Tests	2
Peak Voltage	13.01
Sec. to 12.0V 11.0V 10.0V	167 285 364
Open Circuit	12.6
Start	1.24
Alloy	0
Cell Heat Pellet Wt.	4.2
Heat Pellet Reservoir	4

Temp. °C at:	Center Cell	First Cell	Buffer Cell	Header	Case
1 Second	26	25	25	--	--
2 Seconds	299	290	172	--	--
3 Seconds	412	425	303	--	--
4 Seconds	466	476	393	--	--
5 Seconds	484	488	430	--	--
6 Seconds	494	490	443	--	--
7 Seconds	500	487	461	--	--
8 Seconds	502	488	479	--	--
9 Seconds	505	487	489	--	--
10 Seconds	509	487	497	73	31
15 Seconds	512	485	519	98	35
20 Seconds	510	487	526	122	44
30 Seconds	506	495	527	161	68
40 Seconds	502	507	520	188	94
50 Seconds	500	504	512	208	114
60 Seconds	500	503	503	227	136
70 Seconds	501	501	495	238	150
80 Seconds	502	506	488	246	164
100 Seconds	502	506	474	258	181
150 Seconds	492	476	458	263	204
200 Seconds	474	462	443	265	215
250 Seconds	459	454	434	268	222
300 Seconds	441	433	409	267	221
350 Seconds	442	409	394	262	219
400 Seconds	401	393	371	254	206

[redacted]

K+E SEMI-LOGARITHMIC 46 5492
KEUFFEL & ESSER CO.

[redacted]

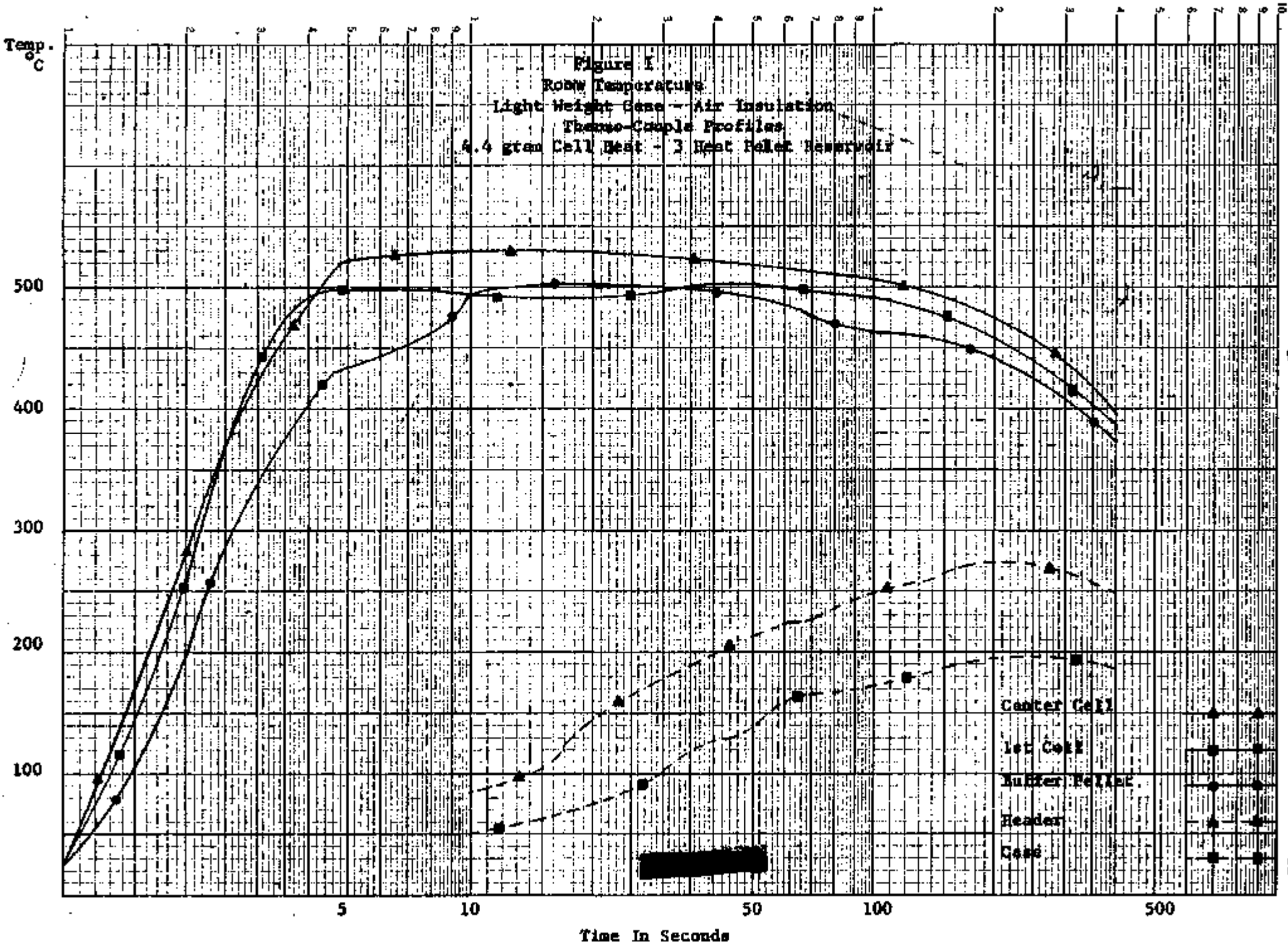

Figure I
Room Temperature
Light Weight Case - Air Insulation
Thermo-Couple Profiles
6.4 gram Cell Heat - 3 Heat Pellet Reservoir

[redacted]

K+E SEMI-LOGARITHMIC 359-71
KEUFFEL & ESSER CO. MADE IN U.S.A.
3 CYCLES X 70 DIVISIONS

[redacted]

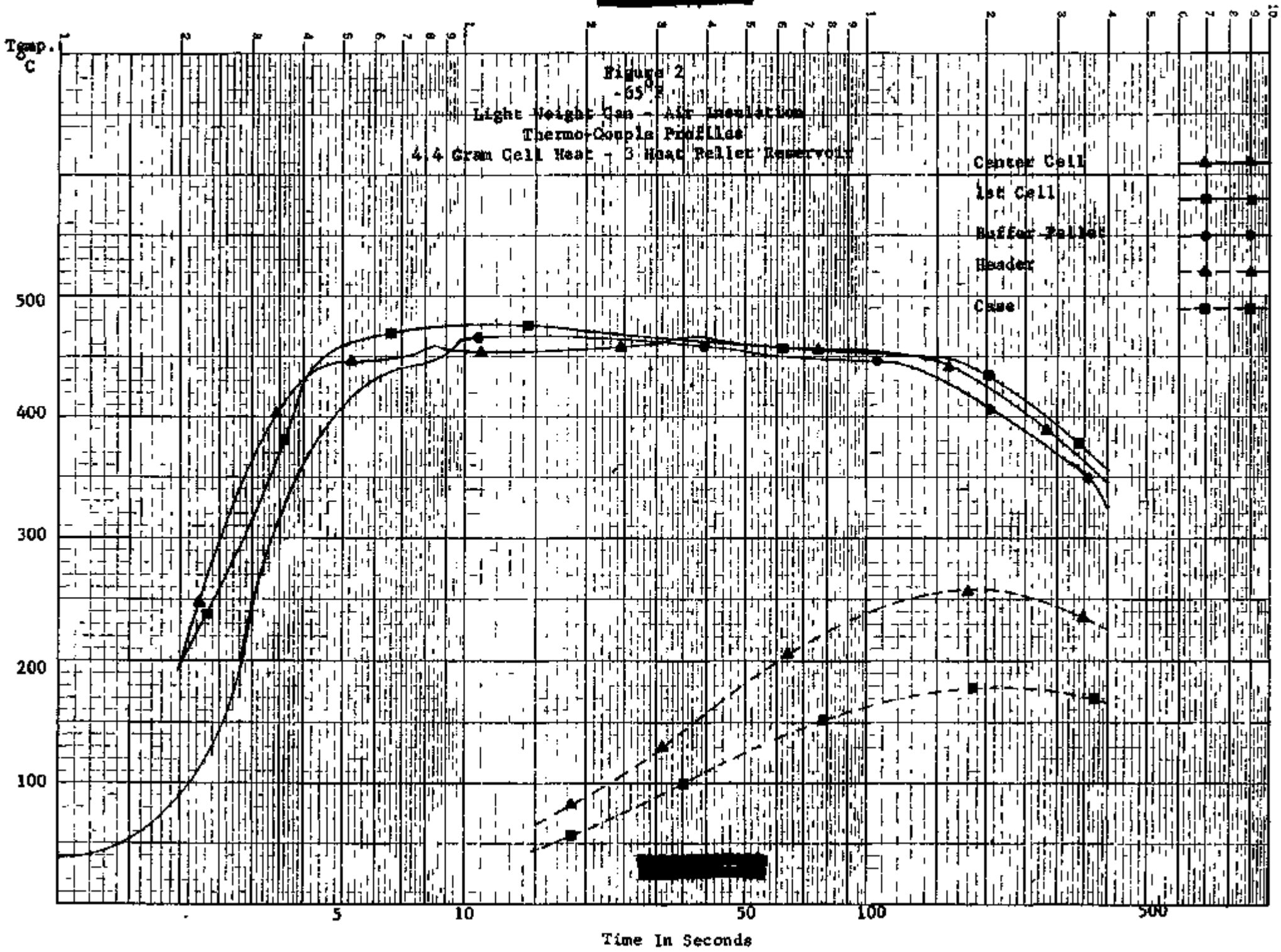

Figure 2
-65°F
Light Weight Can - Air Insulation
Thermo-Couple Profiles
4.4 Gram Cell Heat - 3 Heat Pellet Reservoir

[redacted]

SEMI-LOGARITHMIC 46 5492
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[redacted]

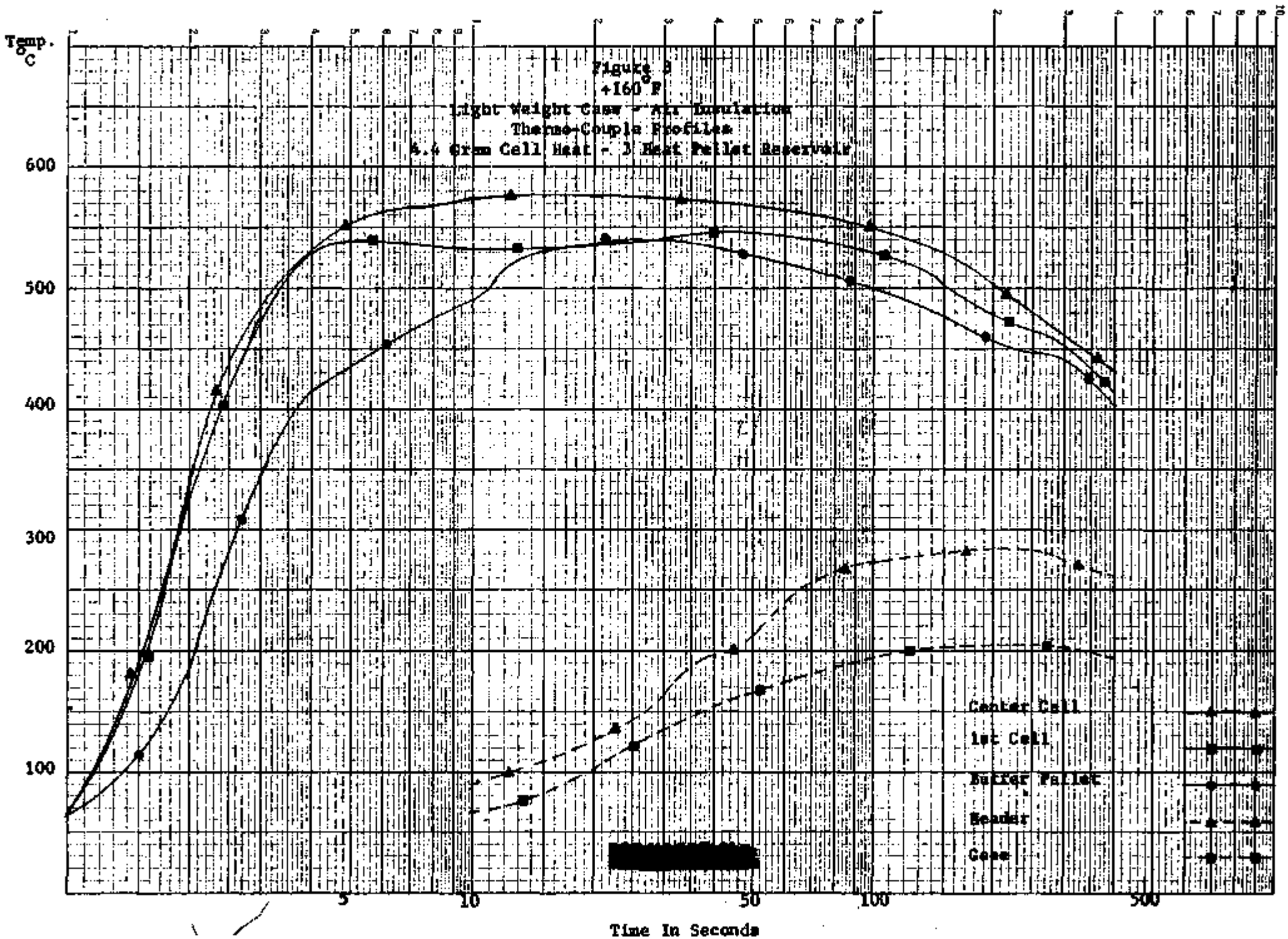
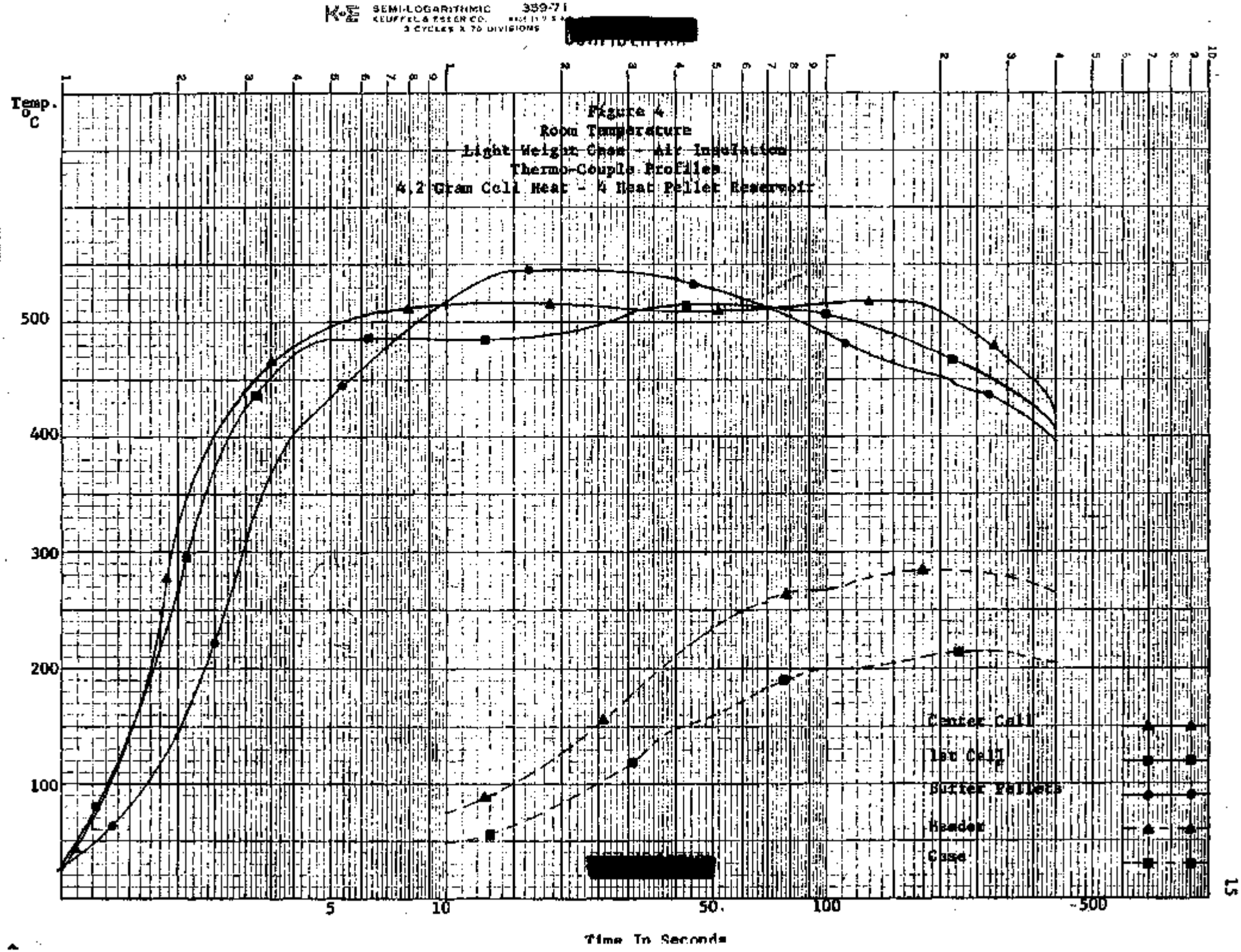


Figure 3
+160°F
Light Weight Case - Air Insulation
Thermo-Couple Profiles
4.4 Gram Cell Heat - 3 Heat Pellet Reservoir

[redacted]


SEMI-LOGARITHMIC 359-71
KEUFFEL & ESSER CO.
3 CYCLES X 70 DIVISIONS
[redacted]
Figure 4
Room Temperature
Light Weight Case - Air Insulation
Thermo-Couple Profiles
4.2 Gram Cell Heat - 4 Heat Pellet Reservoir
Temp. °C
500
400
300
200
100
5
10
50
100
500
Time In Seconds
Center Cell
1st Cell
Buffer Pellets
Header
Case
[redacted]

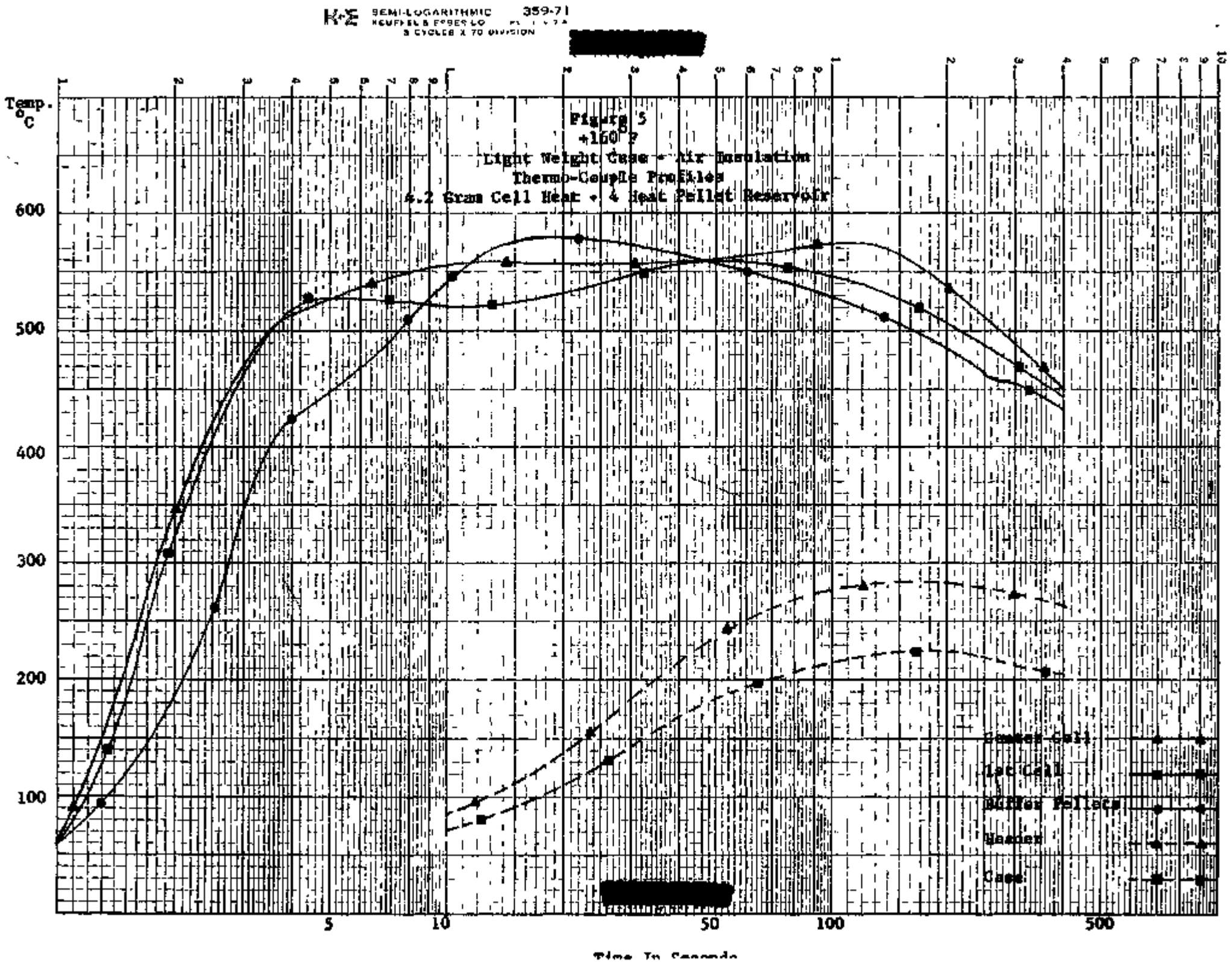
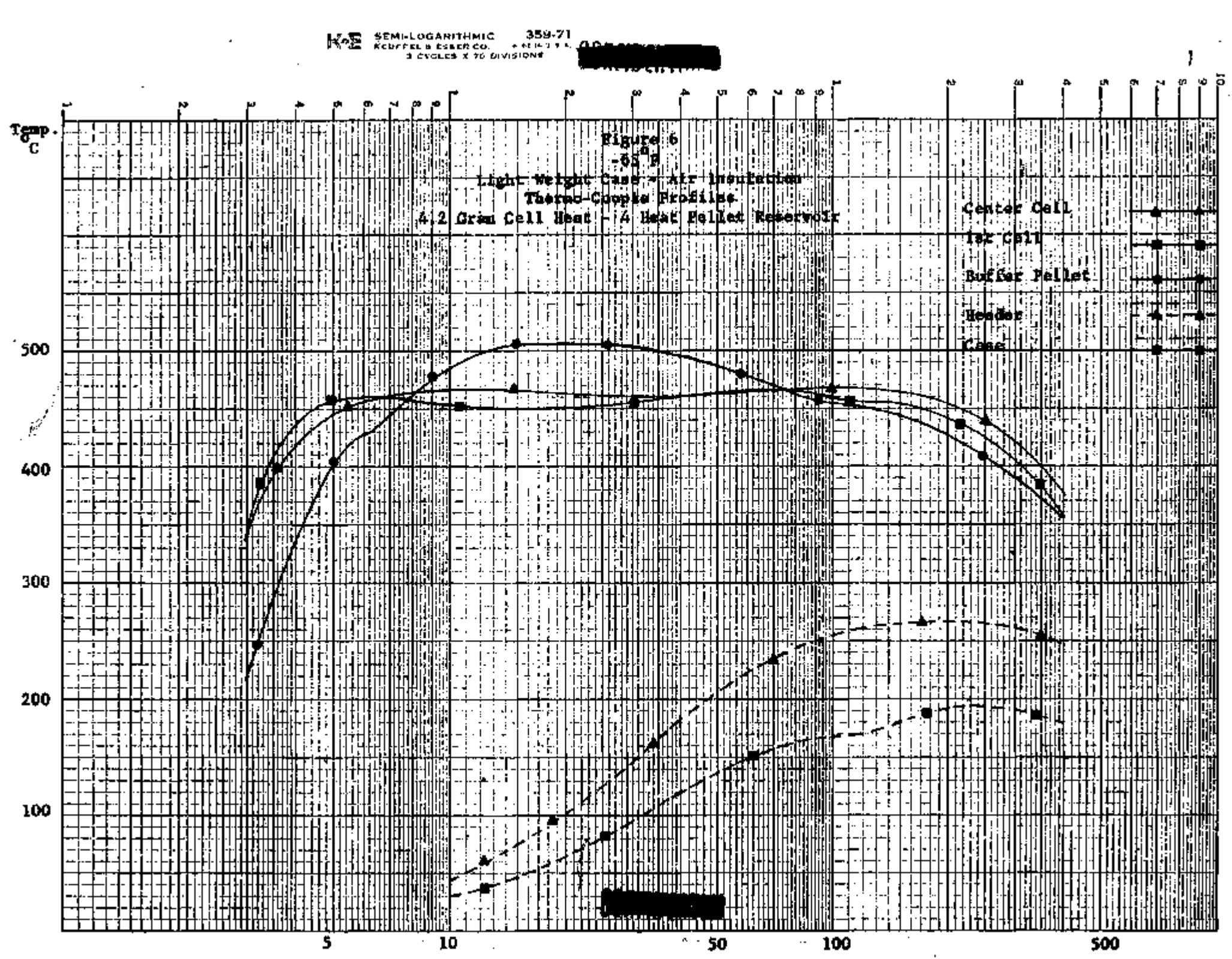


Figure 5
+160°F
Light Weight Case - Air Insulation
Thermo-Couple Profiles
4.2 Gram Cell Heat + 4 Heat Pellet Reservoir


K&E SEMI-LOGARITHMIC 359-71
KEUFFEL & ESSER CO.
3 CYCLES X 70 DIVISIONS
[redacted]
Temp. °C
Figure 6
-65°F
Light Weight Case - Air Insulation
Thermo-Couple Profiles
4.2 Gram Cell Heat - 4 Heat Pellet Reservoir
Center Cell
1st Cell
Buffer Pellet
Header
Case
500
400
300
200
100
5
10
50
100
500
[redacted]

SEMI-LOGARITHMIC 46 5492

[redacted]

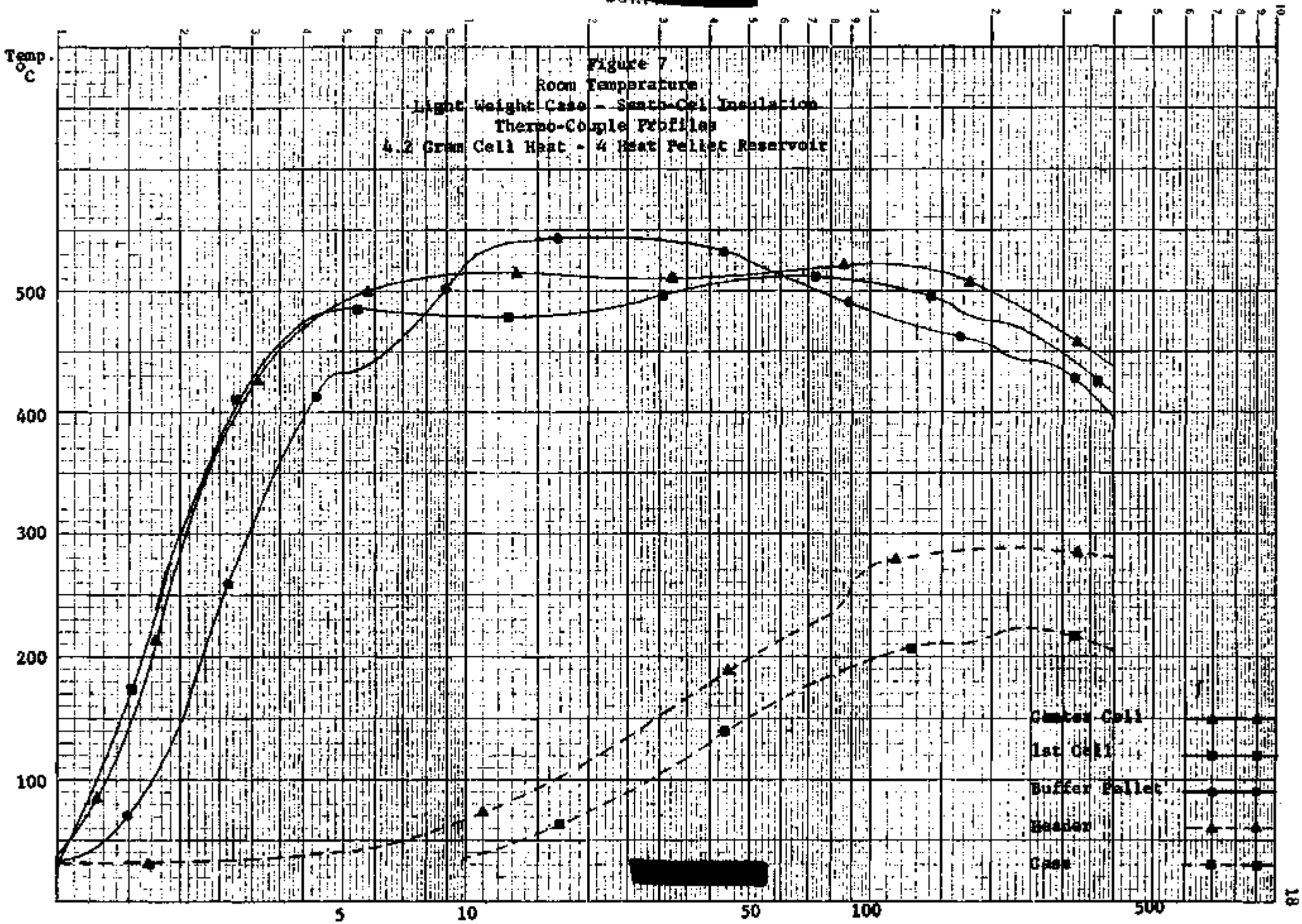


Figure 7
Room Temperature
Light Weight Case - Sonth-Cel Insulation
Thermo-Couple Profiles
4.2 Gram Cell Heat - 4 Heat Pellet Reservoir

[redacted]

K&E SEMI-LOGARITHMIC 46 5492 [redacted]
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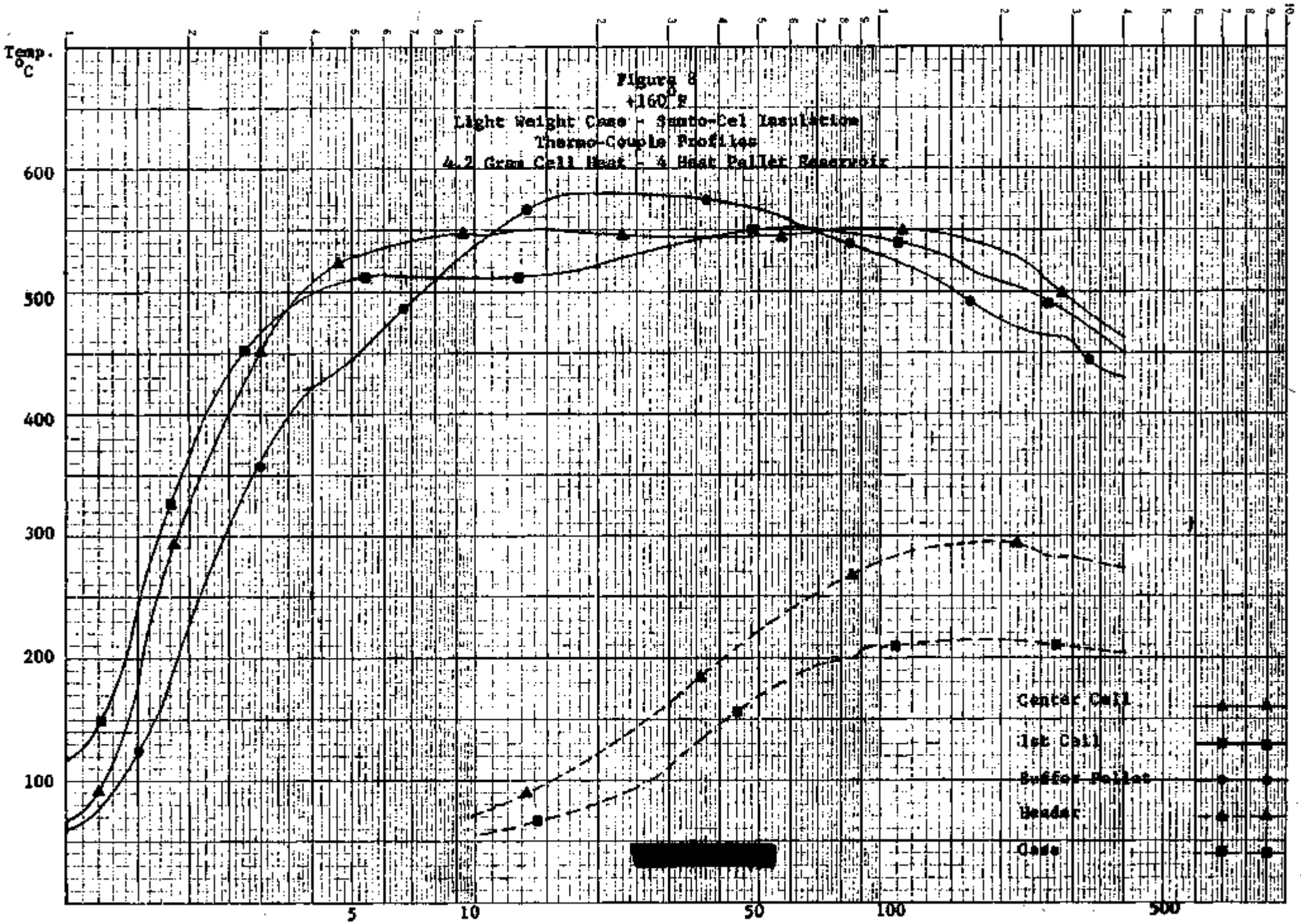

Figure 8
+160°F
Light Weight Case - Sauto-Cel Insulation
Thermo-Couple Profiles
4.2 Gram Cell Heat - 4 Heat Pellet Reservoir

[redacted]

SEMI-LOGARITHMIC 46 5492
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[redacted]

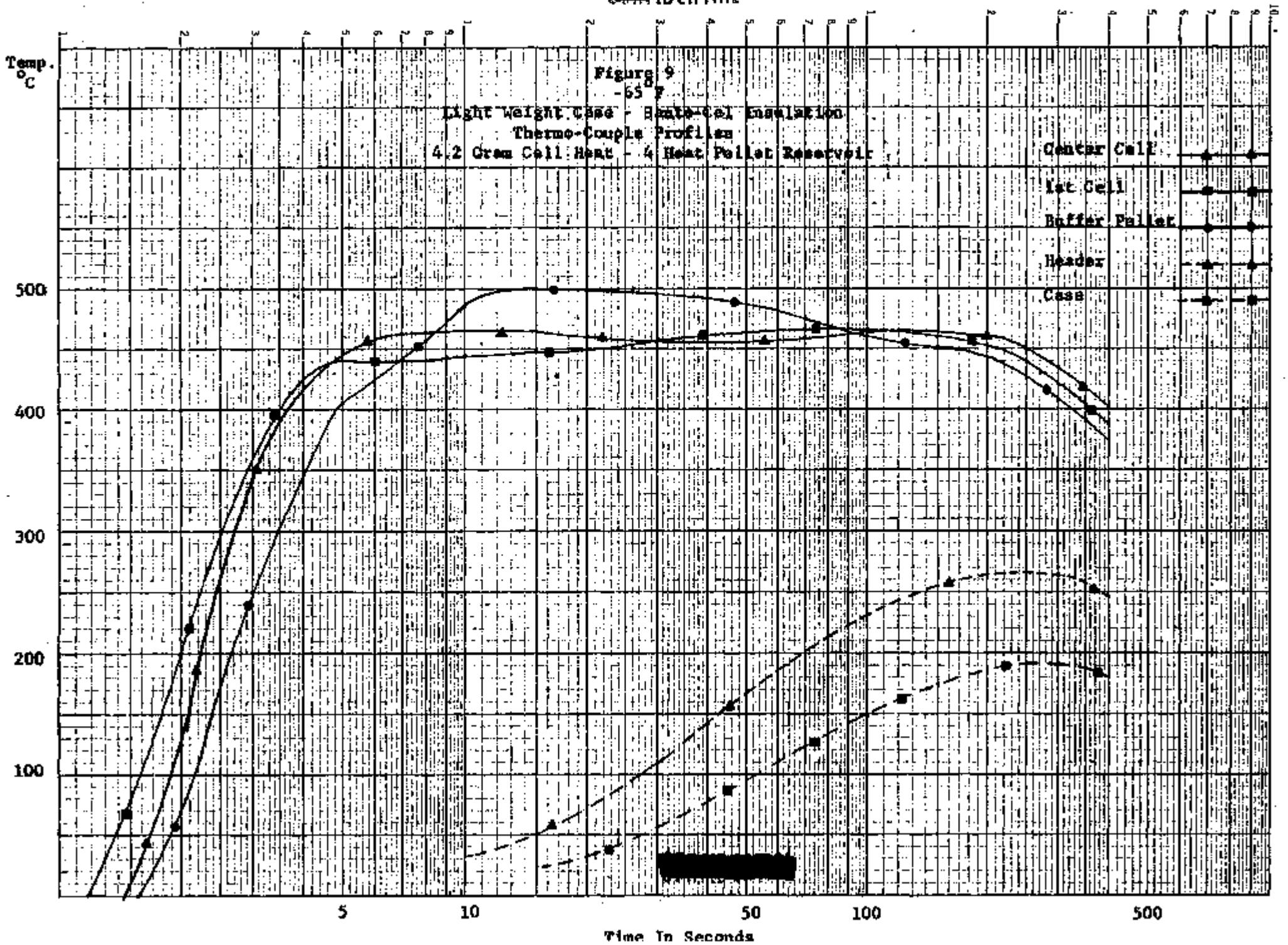

Figure 9
-65°F
Light Weight Case - Beato-Cel Insulation
Thermo-Couple Profiles
4.2 Gram Cell Heat - 4 Heat Pellet Reservoir

[redacted]

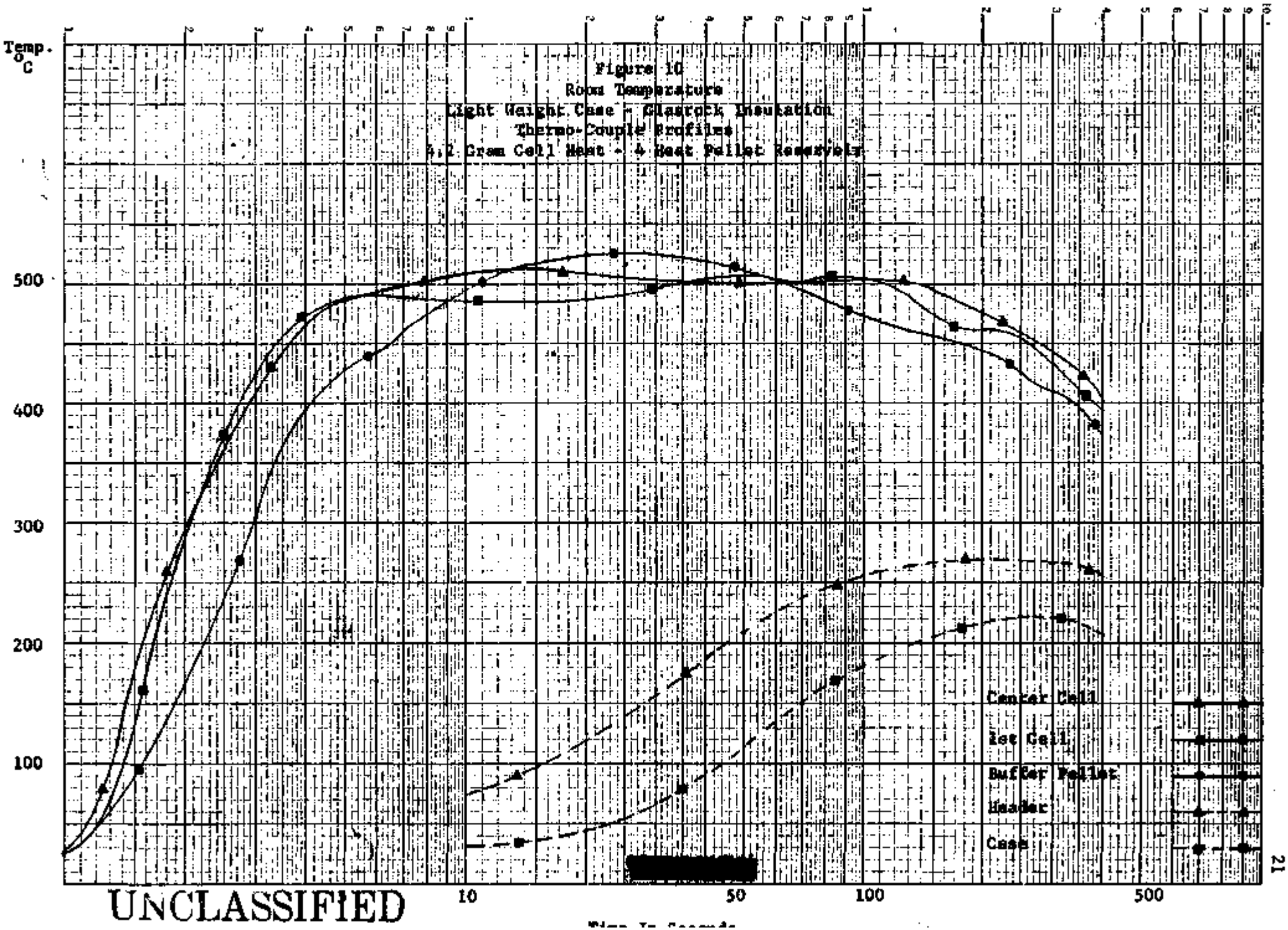

Figure 10
Room Temperature
Light Weight Case - Glastrek Insulation
Thermo-Couple Profiles
4.2 Gram Cell Heat - 4 Heat Pellet Reservoir

[redacted]

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