BALLOON

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FINAL REPORT
ON
BALLAST STUDY

Project 147

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FINAL REPORT
ON
BALLAST STUDY

Contracts Nonr 2355(00) and ____________

Project 147

5 December 1957

FOR
OFFICE OF NAVAL RESEARCH
CODE 461
WASHINGTON, D.C.

Report No.________
Prepared by James A. Winker
James A. Winker
Sr. Engineer

Approved by: J.R. Smith
J. R. Smith
Contract & Sales Manager

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RAVEN INDUSTRIES, INC.
BOX 227
SIOUX FALLS, S.D.

FINAL REPORT
ON
PROJECT 147 - BALLAST STUDY
(Including Analysis of Proj. 126 Flights)

I. INTRODUCTION.

In April of 1957 a project was begun with the object of testing the accuracy of a combined timer-ballast unit which was designed for use on small balloon carriers. The work was done on Raven Industries Project 126 under Contract Nonr 2355(00). The units to be tested were supplied as GFE. Two progress reports have been written covering work done in the periods 1 April to 26 September and 27 September to 6 November 1957.

Thirty flights were to have been made on Project 126. It became clear from the outset that the project would involve more than the mere accumulation of statistical data. In addition to the discovery of a few minor "bugs" in the mechanism, it was found that the required ballast rate was dependent on a number of variables including balloon size, free lift, and atmospheric conditions. Actually, a total of thirty-five flights were made, the majority of which were efforts to pinpoint these variables and establish an optimum ballast rate.

Project funds were nearly exhausted before the results of the exploratory tests could be combined and checked in a final series of flights. For this reason, a new contract was written (dated 1 November 1957) and project 147 was instituted for the purpose of launching six additional balloons whose ballast units were programmed in accordance with the indications of the project 126 flights.

Because of the similarity in purpose of the two projects, the results of both have been tabulated and analyzed for presentation in this final report.

II. TEST PROGRAM.

The program included tests of two sizes of balloons. One, of 130 cu. ft. volume, carried a 2 lb. useful load and floated at approximately 20,000 ft. A 250 cu. ft. cell was used to carry a 4 lb. useful load in the cicinity of 25,000 ft. altitude. Because of a greater need, emphasis was placed on the accumulation of data for the smaller balloon. Twenty-eight such flights were made, as opposed to thirteen utilizing R-250 balloons. The P-130's were all flown in daylight hours, some under clear conditions and some in varying degrees of cloudiness. The R-250's were all flown in clear weather; 8 during the day and 5 at night.

Of the 41 flights which were made, 36 were recovered. This recovery ratio (88%) is remarkable, and may be attributed in large part to two factors. First, by careful selection of launching conditions, balloons can be sent into favorable recovery areas (flights of 12 September and 12 November are exceptions and were made in spite of poor conditions), and second, the flights were rigged so that the equipment would descend with the balloon attached. This made for greater visibility and eye catching power. The rigging neces to accomplish this consisted of a release hook which disconnected the timer from the base of the balloon (Figure 1) and a separate line running from the timer to a parachute which in turn was suspended from the top of the balloon (Figure 2). The release hook was opened by the jerk resulting when the payload falls. It was felt that this rigging, which would not be used in an operational situation, would not jeopardize the actual test being conducted. This assumption is believed to have been substantiated, with the exception of one instance (Flt. 189) where the hook opened accidentally early in the flight. Other malfunctions did occur, but none which affected the experimental phase of the flight. In a number of cases the timer failed to release from the balloon (parachute line probably fouled the release hook) and the system descended to the ground still inflated. While this has a much greater eye catching ability, it is undesirable because the additional distance traveled may take the balloon beyond a good recover area. Also, the hydrogen lifting gas presents a hazard to the finder. Late in the project an improved release was developed which was more satisfactory (See Figure 8).

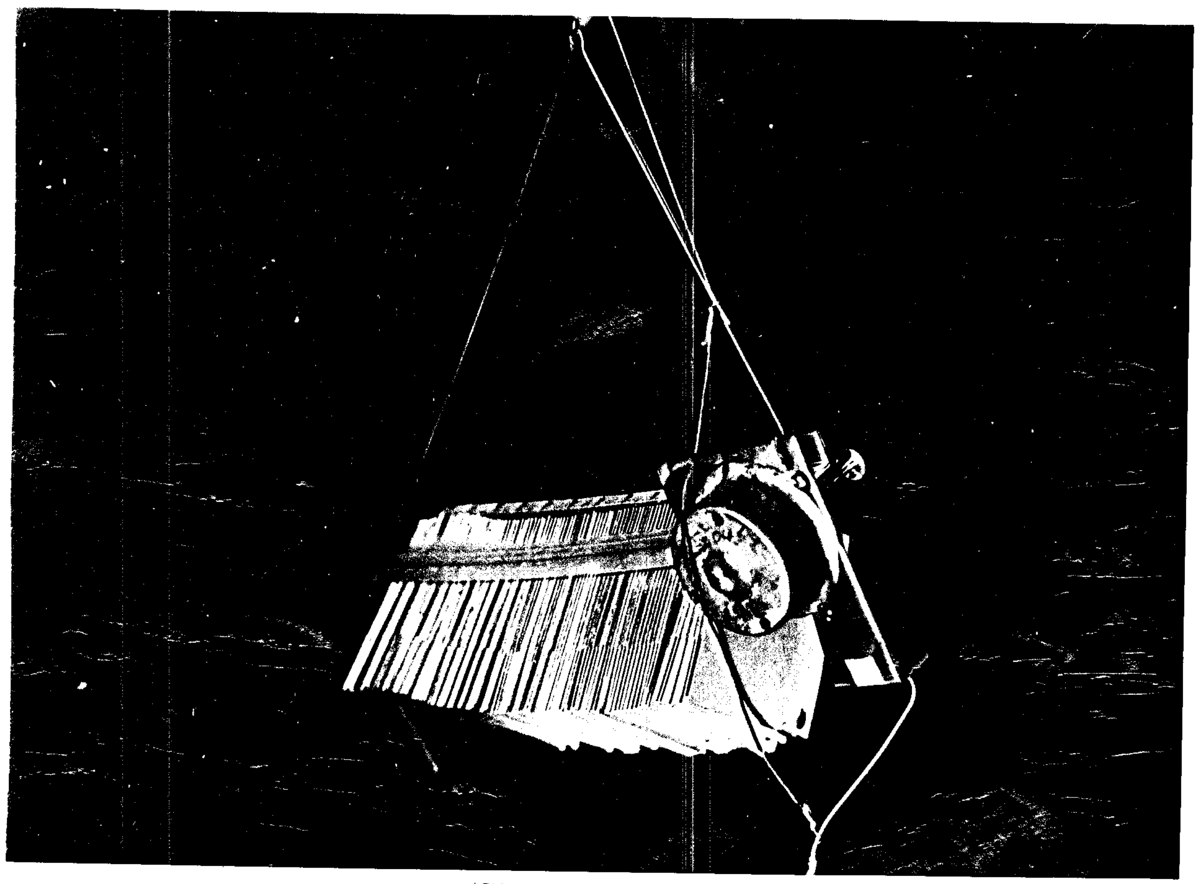

FIGURE 1

FIGURE 2

At the start of Project 126, flights were made for simple observation of actual duration vs. predicted duration and of altitude maintenance when dropping ballast at a standard rate of 38 grams per hour. It quickly became apparent that although the timer was operating very satisfactorily, the ballast rate would require some modification.

III. TIMER FUNCTION.

As previously mentioned, the timer was found to be very accurate. The error noted has been less than 3% in all except three of the cases where definite termination has been determinable. Of these three, one was 6% off and the others were in error by increments of whole hours. In all probability, the latter two operated properly, but the error was in setting the timer or recording the planned duration in the flight log.

Of the instances when definite termination was not observable by reason of some malfunction or non-recovery, indications exist in most cases to show that the timer could not have been in error by any large amount. The breakdown on timing accuracy is as follows:

Total flown	41
Accurate within 3%	18
Indications of good accuracy	13
Unknown	10

Some of the unknowns are the result of failure in the ballast function or the barograph, while others arise from malfunctions in the timer mechanism itself. Three types of malfunctions were observed and at least two can be eliminated.

These two malfunctions were caused by the slack portion of the load line which is wrapped around the hub of the timer shaft. On Flight No. 198 and possibly No. 178 this loop of line worked into the clock case and fouled the gear train. On several other occasions the loop was left taped in place, both intentionally and accidentally. It was found that this offered sufficient resistance so that the timer would stop about 15-25 minutes before termination was scheduled. This occured on Flights 186, 187, 190 and possibly 184.

On Flight No.188 the timer stopped during ascent. This did not appear to be similar to Flight 198, and no explanation could be found for the stoppage.

In one additional case, the payload struck a telephone pole at launch, spilling the droppable material. The resulting weight on the load line was insufficient to drive the timer. This cannot be considered a timer malfunction.

IV. BALLAST FUNCTION.

Early experience indicated that if a constant rate of ballast release was relied upon, a balloon launched with a moderate free lift would start to descend immediately after reaching peak altitude and generally would not recover itself until it had reached a point 3000-10,000 ft. below the peak. This was noted in flights where P-130's and R-250's had free lifts of 200 Gm. and 250 Gm. respectively. Experience on a previous project also pointed out that the post-ascent dip was to be expected on small balloons of the type used here. The explanation for this probably lies in the thermodynamic effects (or lack of same) on the balloon. As the balloon rises, its lifting gas tends to remain colder than the surrounding atmosphere because of expansion. When a vented balloon reaches ceiling it will valve its free lift, and in all probability overvalve, halting or reversing its travel. After the ascent has stopped, the gas begins to warm to the ambient temperature, and if it is a daytime flight, solar radiation will warm the gas still further. In large balloons these warming effects are sufficient to counter the effect of overvalving and the balloon will come into equilibrium and will remain at ceiling. This inherent stability appears to be proportional to balloon size and for P-130's and R-250's is insignificant.

Two approaches were made toward the elimination of the post-ascent dip. First, by lowering the free lift, overvalving can be reduced to the point where a ballast rate (38 Gm/hr) will provide an adequate restoring force. In this case a free lift of 100 grams was tried with satisfactory results (Flights 172, 174 and 182). A disadvantage that can be seen is that the ascent with such a low free lift is sluggish, and when moisture accretion is possible, might be insufficient to take the balloon to ceiling.

In the second approach, overvalving was counteracted by dropping a relatively large initial quantity of ballast during the period immediately after the balloon reached ceiling. Figure 3 indicates the type of performance to be expected with and without the initial ballast drop. Performance in the latter situation was actually observed in Flight No. 187. Most of the series of flights was devoted to the determination of the amount of initial ballast to be dropped and the delay after launch when this drop should begin. The initial ballast drop denoted on the time-altitude curves refers to weight <u>added to</u> the cards already on the rack (4.76 grams each). This weight was distributed over several cards to allow for variations in rate of rise. In the final flights (P-130's) a weight of 50 grams was distributed on four to six cards with the delay set so that dropping would start just before the attainment of peak altitude was expected. This would allow quick corrective action even if the balloon rose at an unusually high rate. Tentative delay times for various free lifts are shown in Figure 4. The amount of initial drop required actually will vary with free lift also, however, a standard amount can be adopted with consequent simplification in ballast preparation. The tentative standards are:

For P-130 First 5 cards, 10 grams each (total card wt.)
For R-250 First 5 cards, 15 grams each (total card wt.)

The continuing rate of ballast release after the initial drop is also dependent on some variable, most probably related to cloud cover and variations in radiation influx. As it is virtually impossible to predict the conditions which will be encountered along the flight path, a maximum practical rate should be used on all flights. Rates of 38 and 46 grams per hour were employed in tests. A number of very good flights were obtained with the lower rate, but poor performance was still encountered in some instances with

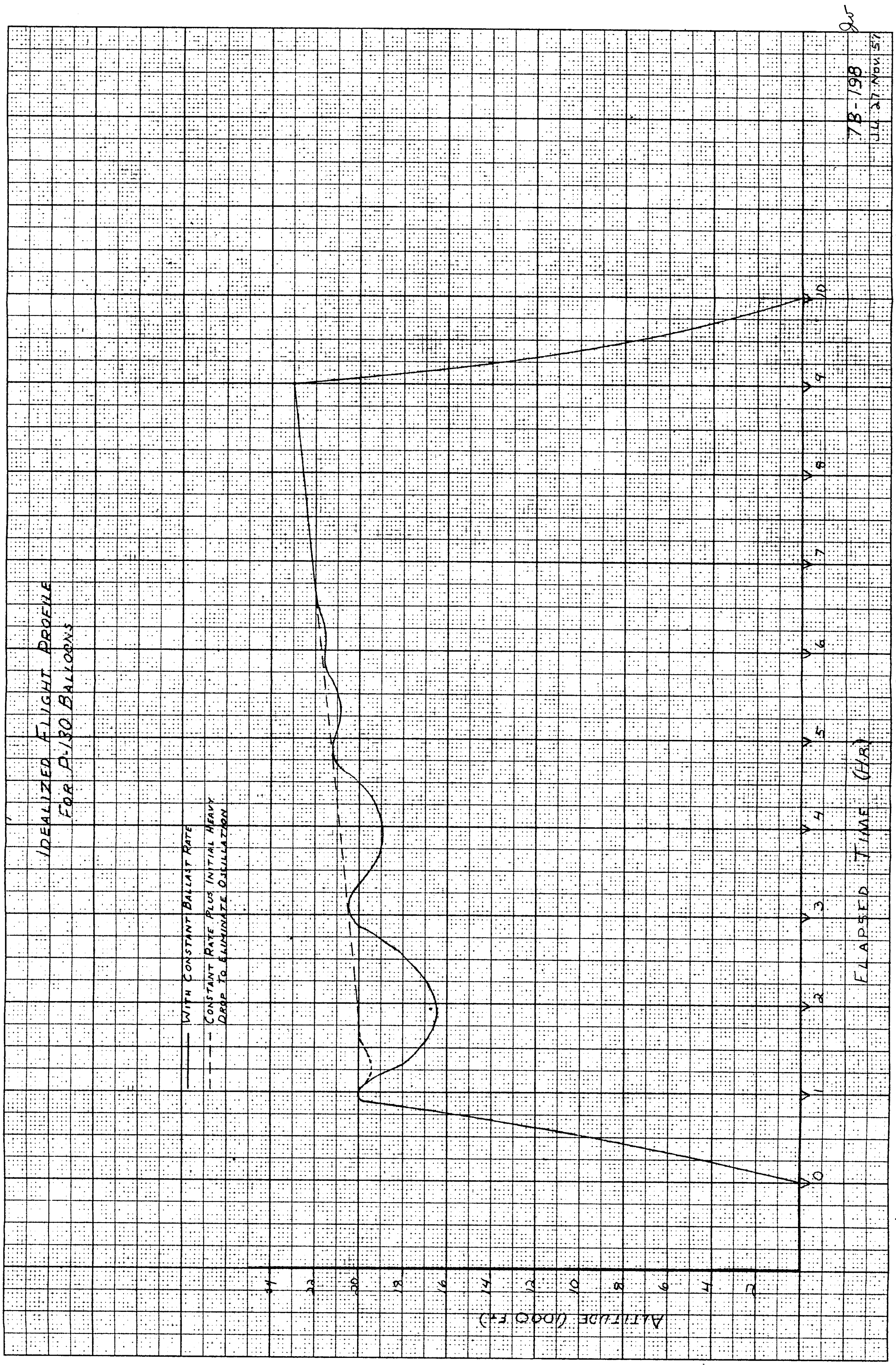
IDEALIZED FLIGHT PROFILE
FOR D-130 BALLOONS
—— WITH CONSTANT BALLAST RATE
- - - CONSTANT RATE PLUS INITIAL HEAVY DROP TO ELIMINATE OSCILLATION
ELAPSED TIME (HR)
0
1
2
3
4
5
6
7
8
9
10
ALTITUDE (1000 FT.)
2
4
6
8
10
12
14
16
18
20
22
24
7B-198
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Figure 3

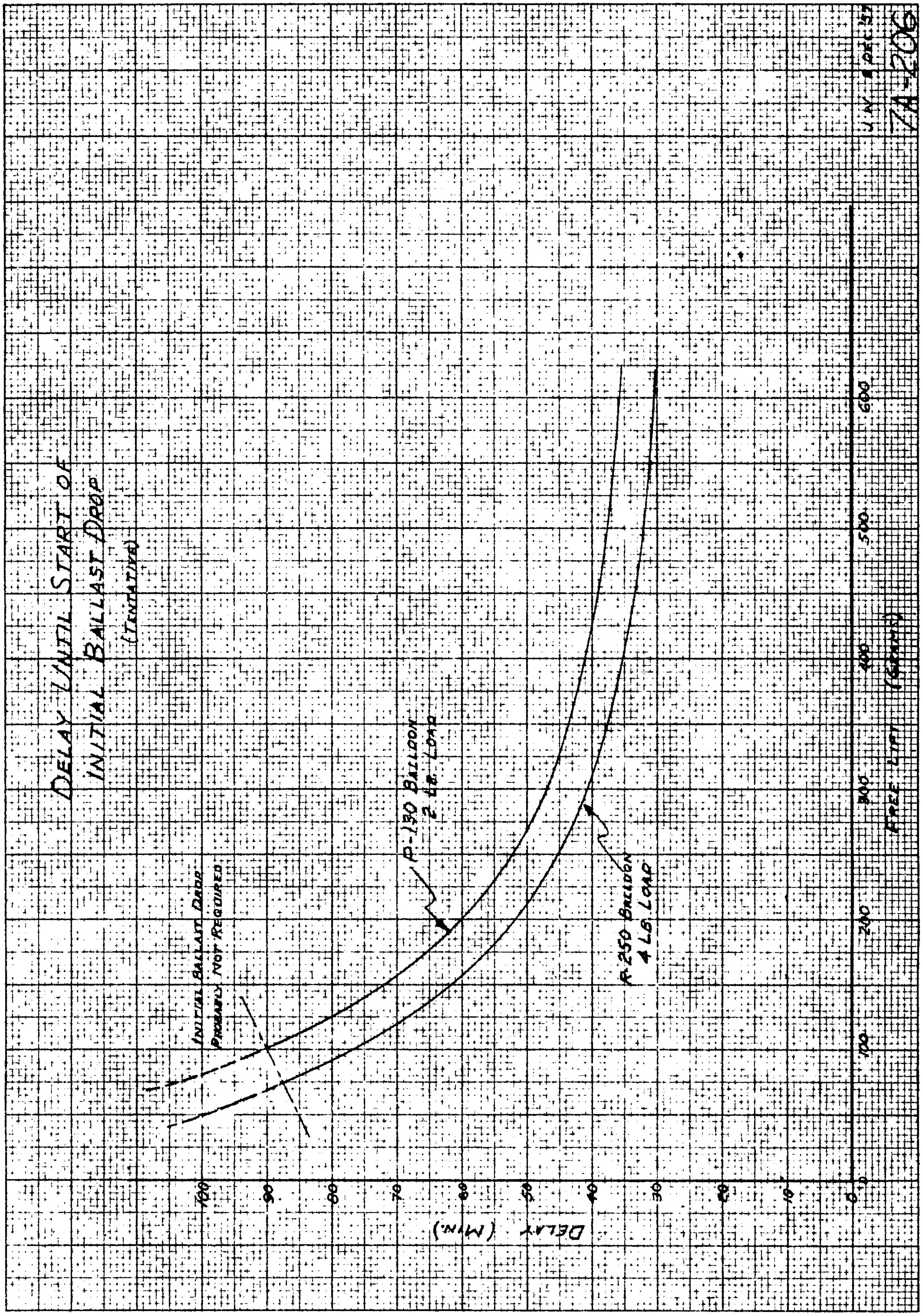
DELAY UNTIL START OF
INITIAL BALLAST DROP
(TENTATIVE)
INITIAL BALLAST DROP
PROBABLY NOT REQUIRED
R-130 BALLOON
2 LB. LOAD
R-250 BALLOON
4 LB. LOAD
FREE LIFT (GRAMS)
DELAY (MIN.)
100
200
300
400
500
600
0
10
20
30
40
50
60
70
80
90
100
7A-206

FIGURE 4

the high rate. It is felt that for overall efficiency the ballast cards should not weigh over 6 grams each, which provides a rate of 48 grams per hour. In most cases this should be adequate for both sizes of balloon.

It had been expected that the R-250 would have more natural stability than the P-130. Factors in favor of this hypothesis include:

1. Larger balloon should be more stable.
2. Larger appendix should reduce overvalving tendency.
3. Floating level is in higher, more stable air mass.

Experience might indicate that the hypothesis is not true, however, and in reconsidering the factors involved, several possible reasons were found.

1. A higher rate of rise was experienced than with P-130's, even though the percent of free lift was lower. This would result in a greater overvalving tendency.

2. The corrective ballast action taken was the same as for P-130's which proved inadequate. The limited number of R-250 flights did not allow for full exploration of the necessary corrections. In particular, delay times were generally late, so that the post-ascent dip had already begun before ballast release commenced.

3. There is a suggestion that the differences in construction between P-130 and R-250 balloons is causing the greater-than-expected fluctuations in R-250 flights. The larger balloon has a considerable amount of slack material in the lower portion where the film is gathered into the base enclosure. It has been noted on large balloons that slack material tends to cause unstable performance because of the ability of said slack material to "belly out", producing a greater, abnormal balloon volume. As the balloon valves gas, it relaxes and reverts to its customary volume which then is too small to support the balloon at its current altitude. This is nothing more than overvalving as has been previously referred to, but would be expected to be greater in this case than for a balloon with a tight skin. It had been assumed that this effect would not be appreciable in the R-250 balloon, however, there is a possibility that it does exist. In any case, with proper corrective action, performance should be at least as good as with P-130 balloons.

V. RECOMMENDATIONS.

There are several changes which may be made in the timer-ballast unit to improve its reliability and simplify preflight handling.

1. On two flights (Nos. 169, 170) the ballast string was dislodged from its slot resulting in loss of the ballast function. Figure 5 shows the cementing of the ballast string in place as was done on all subsequent flights. A permanent solution to the problem is to pass this string through a diametral hole in the shaft.

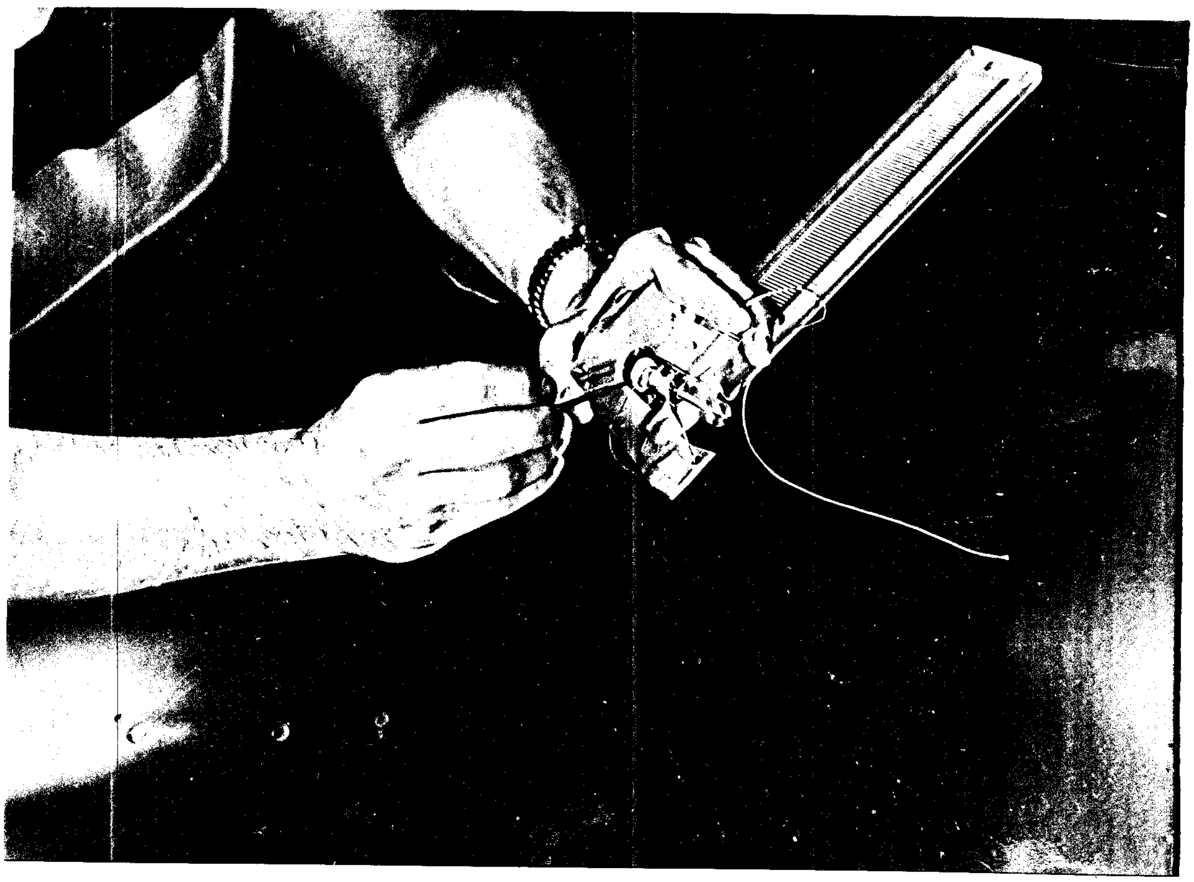

FIGURE 5

2. The box containing the ballast cards could be constructed so that it would open on a diagonal as shown in Figures 6 and 7. This greatly facilitates loading the cards in the rack.

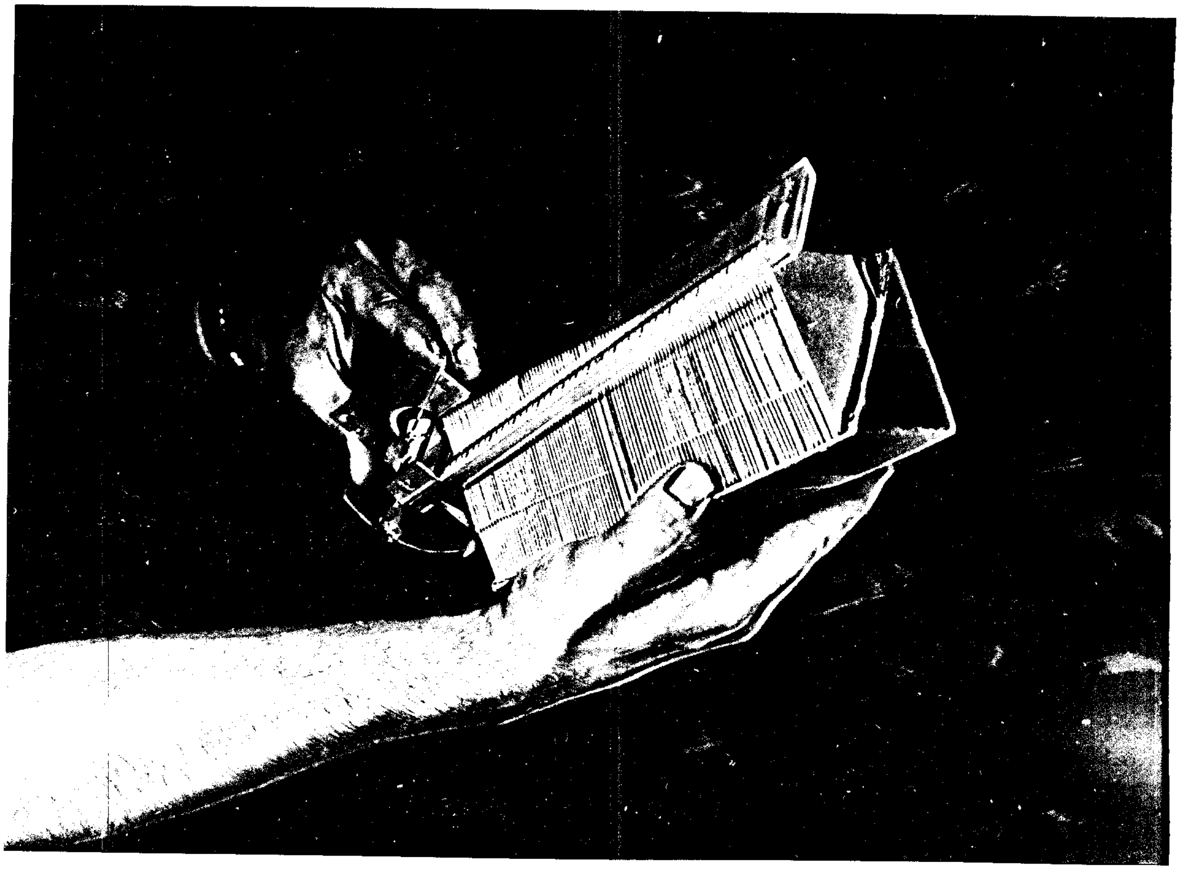

FIGURE 6

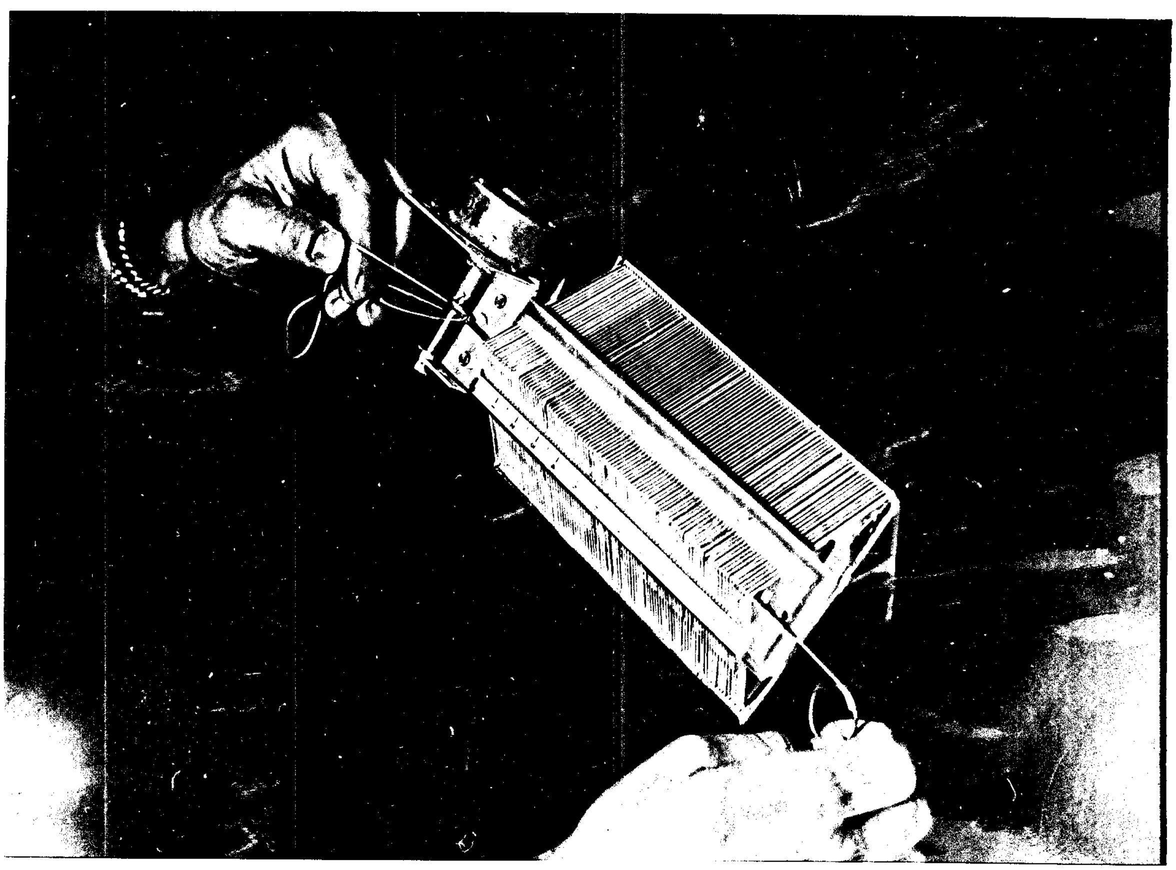

FIGURE 7

3. A combined snubber line and release link (See Figure 8) has been used to take the place of the load-line-loop which had been affixed to the hub of the timer shaft. This eliminates the possiblity of loose lines fouling the clock-works and provides a conveni t method of separating the timer from the balloon. A small inexpensive parachute can be used to slow the descent of the timer.

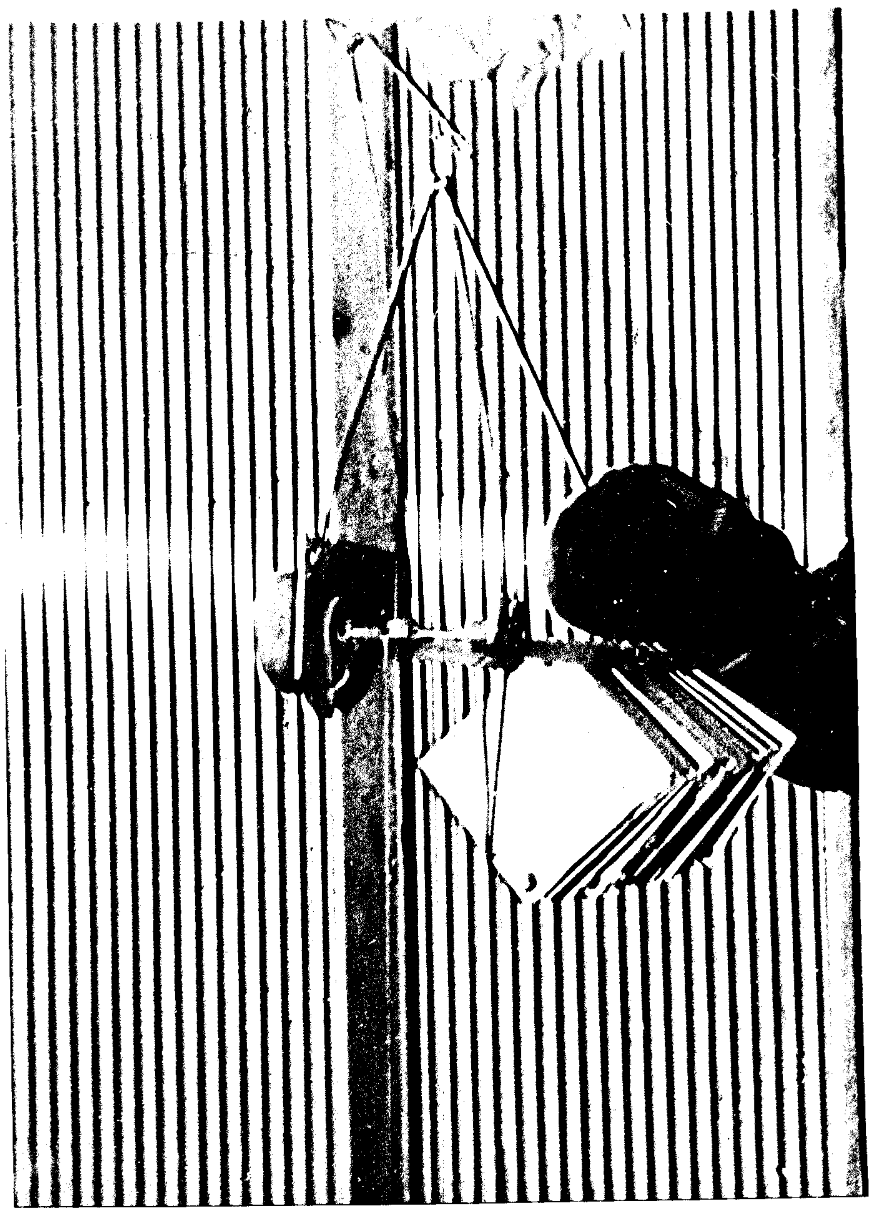

FIGURE 8

4. Setting the timer will probably be simpler if the procedure shown in Figures 9 and 10 is used. Figure 9 shows an indicator mark placed on the ballast string. To set the timer, the shaft is rotated until this mark approaches the desired duration as read on the side scale. Fine adjustment is then made by lining up the shaft-pin (left side of Figure 10) with minute markers placed on the chassis. Small marks could also be made at the end of the ballast rack to indicate the cutting point necessarytto achieve different ballast delays. The unit shown in Figure 10 is set for an 8 hour flight with a 60 minute delay until ballast release starts.

The above procedures permit use of a standard ballast pack for all flights of a given balloon size.

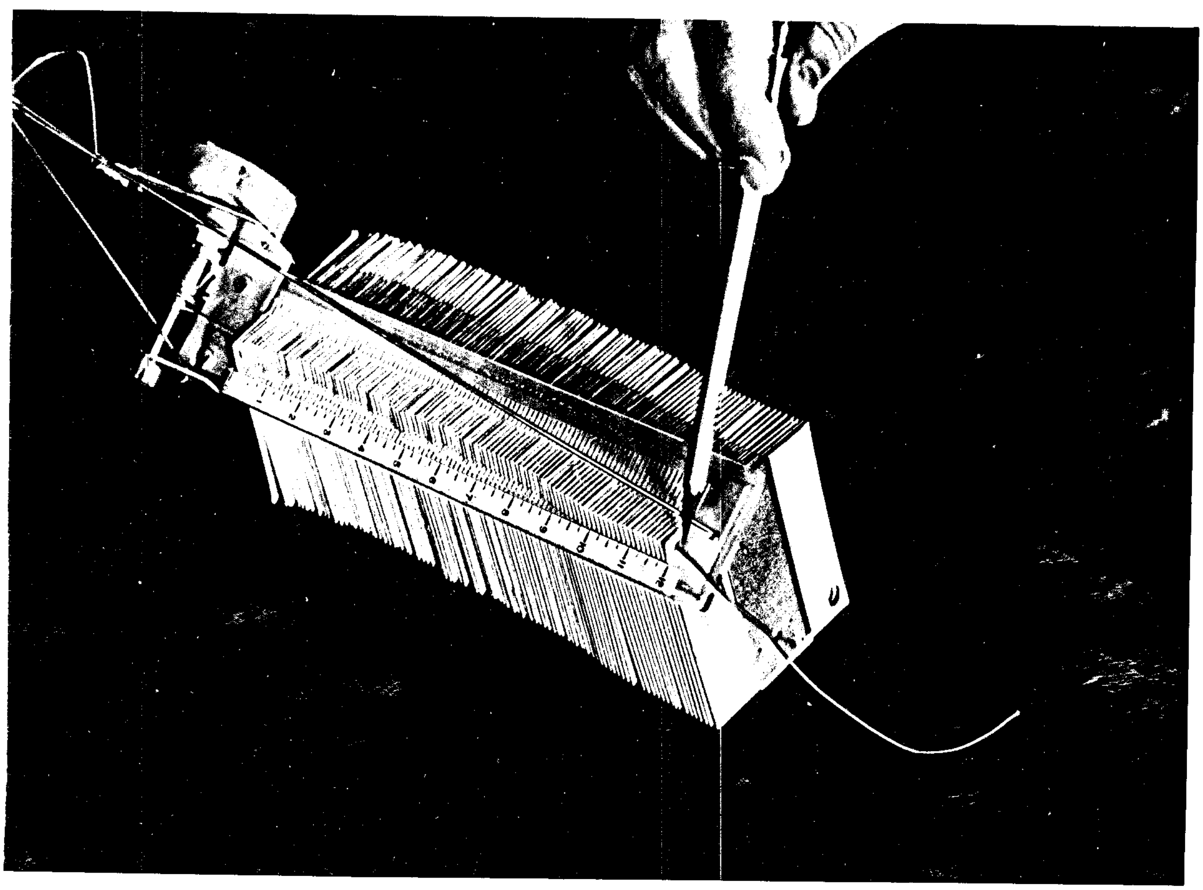

FIGURE 9

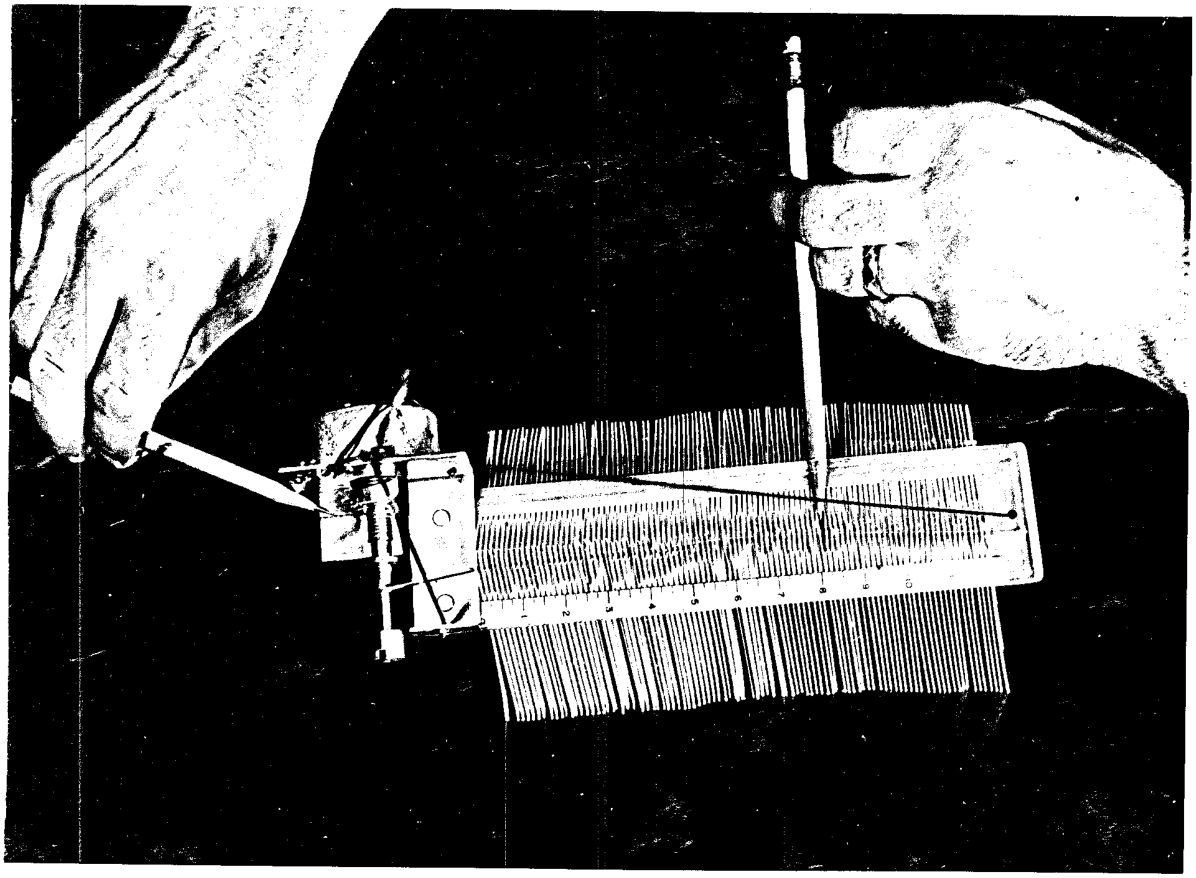

FIGURE 10

4. Inflation has been facilitated by the use of a semi-automatic gas control which stops gas flow when inflation is almost complete. Figure 11 shows a balloon at the nearly-complete stage of inflation. A dummy payload, short-coupled to the balloon, is used to reduce the ceiling height necessary for inflation and to make possible the simultaneous preparation of the payload at another location. The gas control shown is not of the ideal dimensions for the particular load train, involved. The dummy weight could include the timer weight if ballast load is standardized.

5. Figure 12 shows the balloon immediately prior to launching. The payload has just been attached to the load line with a simple wire link. This picture also shows an intermediate type of release device. The wire pull-pin released the timer from the balloon at flight termination.

FIGURE 11

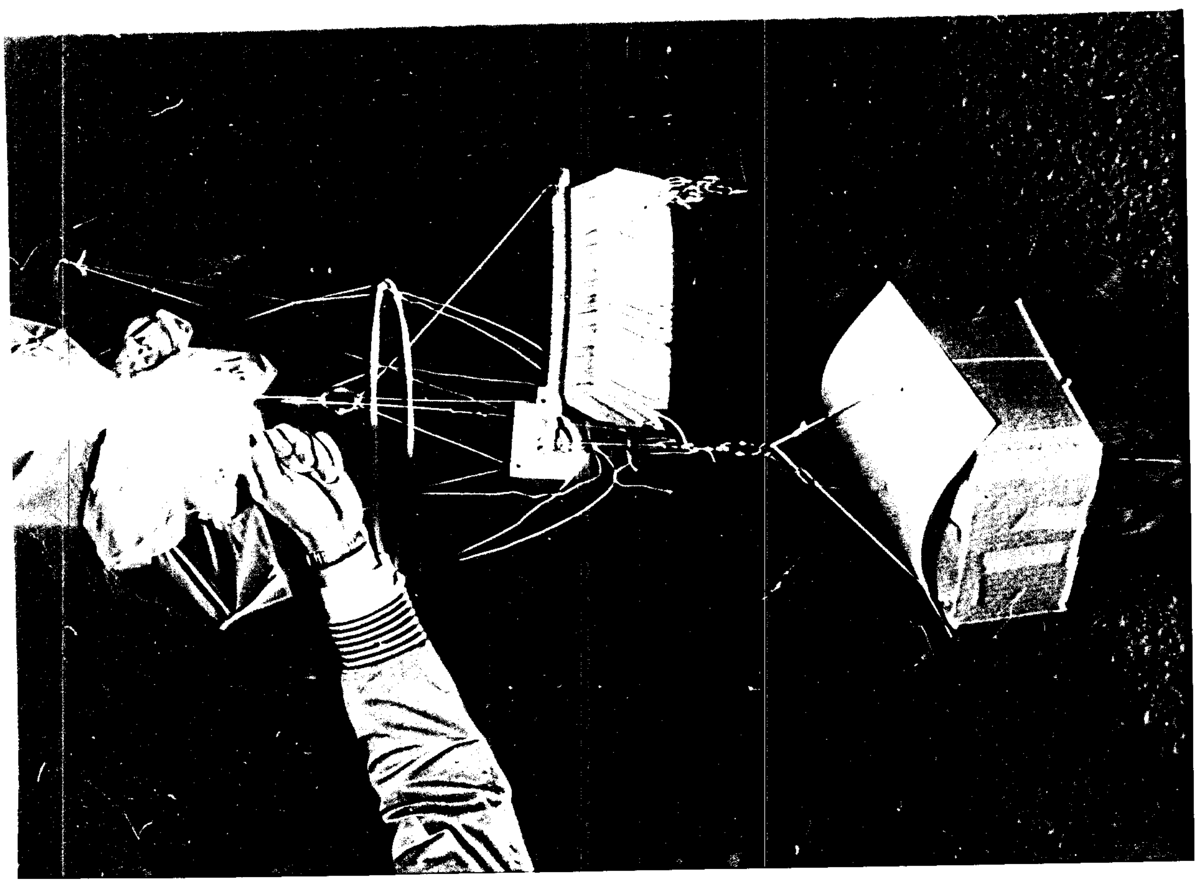

FIGURE 12

VI. SUMMARY.

The analysis of the 41 flights involved in Project 126 and 147, is felt to show conclusively that the timer is satisfactory for the purpose. It has proven to be both accurate and surprisingly dependable. Flights were made through clouds and at night, as well as on clear days. Only one truly unexplained stoppage occurred; all other malfunctions are deemed correctable as outlined in the recommendations.

The ballast action is less certain, but the recommended rates should produce good flights 60-80% of the time and passable performance in the remaining cases. These optimized rates have been tentatively set at:

Balloon	Initial Ballast	Steady Rate
P-130	50 Grams	48 Gm/hr.
R-250	75 Grams	48 Gm/hr.

The rate of ballast release necessary to eliminate all vertical oscillation was not determined, but would probably be prohibitive if any significant payload were to be carried. It is hoped that a simple demand ballast unit may be developed which will provide a high ballast rate when required but will release no ballast when the balloon is floating or rising.

One possible malfunction of the payload release was observed in Flight No. 197. Recovery information plus examination of the returned equipment indicated that the timer had operated properly but the payload did not spill. No proof of where the malfunction occured was available, however.

FLIGHT SUMMARY CHART

FLT. NO.	DATE	BALLOON TYPE	FREE LIFT (Gm)	BALLAST				DURATION		TIMER PERFORMANCE	ALTITUDE MAINTENANCE		COMMENTS
				RATE (Gm/hr)	INITIAL DROP* (Gm)	DIST-RIBUTION (No. cards)	DELAY (Min.)	PLANNED (Hr.)	ACTUAL (Hr.)		POST-ASCENT DIP (Ft.)	FLOATING PERFORMANCE	
168	29 July	R-250	250	38	None	-	None	8	7.95	OK	12,500	N.G.	
169	13 Aug	P-130	200	38	None	-	None	12	4.5	OK	N.A.	N.A.	Ballast string disengaged.
170	"	P-130	200	38	None	-	None	12	3.6	Unk.	N.A.	N.A.	" " "
172	22 Aug	P-130	100	38	None	-	75	12	11.9	OK	Neg.	Good 7 hr.	Oscillations late in flight.
173	"	P-130	100	38	None	-	75	10	Unk.	Prob. OK	Unk.	Unk.	Baro. not recovered. Leaflets found at expected distance.
174	"	P-130	100	38	None	-	75	8	8.0	OK	None	Good 3 hr.	Osc. last half of flt. .6 cloud cov. for Flts. 172-174.
176	5 Sept	P-130	200	38	30	3	80	8	7.8	OK	Neg.	Good	
177	"	P-130	200	38	None	-	75	8	5.2	Stopped	N.A.	N.A.	Payload spilled at launch. Timer stopped.
178	"	P-130	200	38	40	2	75	8	4.0	Stopped	N.A.	N.A.	Timer stopped early. Reason unknown.
181	12 Sept	P-130	100	38	None	-	75	10	Unk.	Unk.	Unk.	Unk.	Not recovered. Pt. cloudy Flts. 181-184.
182	"	P-130	100	38	None	-	75	8	8.0	OK	Neg.	Fair	Erratic, moderate oscillations.
183	"	P-130	200	38	30	3	80	10	9.9	OK	1400	Poor	Large descent at 5 hr. prob. caused by clouds.
184	"	P-130	200	38	27	3	75	8	7.6 #	Stopped	1500	Fair	Moderate osc. Timer stopped just before term.
186	24 Sept	P-130	200	38	None	-	75	10	9.7 #	Stopped	3800	Unk.	Baro. stopped. Distance indicates proper duration.
187	"	P-130	200	38	None	-	75	8	7.8 #	Stopped	2700	Good	Osc. damped out. Timer stopped as in 184 and 186.
188	"	P-130	200	38	None	-	75	8	3.5	Stopped	N.A.	N.A.	Stopped early. Reason unknown.
189	"	P-130	200	46	None	-	75	8	1.4	Unk.	N.A.	N.A.	Terminated early. Hook malfunction.
190	"	P-130	200	46	None	-	75	8	7.8 #	Stopped	9000	Fair	Moderate osc. after dip. Timer stopped as in 184.
191	"	P-130	200	46	None	-	75	8	8.0	OK	4000	Fair	Moderate osc. damped out.
192	"	R-250	250	38	40	4	75	8	3.0	Unk.	N.A.	N.A.	No ballast dropped. Ballast string not cut.
193	"	R-250	250	38	None	-	75	7	7.0	OK	1000	Good 6 hr.	Unexplained descent 1 hr. before term.
194	"	R-250	250	38	40	4	75	7	2.5	Unk.	N.A.	N.A.	Descended immediately. Possibly had hole.

FLT. NO.	DATE	BALLOON TYPE	FREE LIFT (Gm)	BALLAST: RATE (Gm/Hr)	BALLAST: INITIAL DROP* (Gm)	BALLAST: DIST-RIBUTION (No. cards)	BALLAST: DELAY (Min.)	DURATION: PLANNED (Hr.)	DURATION: ACTUAL (Hr.)	TIMER PERFORMANCE	ALTITUDE MAINTENANCE: POST-ASCENT DIP (Ft.)	ALTITUDE MAINTENANCE: FLOATING PERFORMANCE	COMMENTS
195	17 Oct.	P-130	200	46	30	3	75	10	9.8	OK	None	Very Good	
196	"	P-130	200	46	30	3	75	10	Unk.	Prob. OK	Unk.	Unk.	Baro. not recov. Leaflets at expected distance.
197	"	P-130	200	46	30	3	75	8	7.8	Prob. OK	Neg.	Very Good	Timer operated, but payload did not spill.
198	"	P-130	200	46	30	3	75	8	4.3	Stopped	N.A.	N.A.	Load line loop fouled in timer gears.
199	"	R-250	250	38	40	4	75	8	7.9	OK	4400	Poor	Continuing large oscillations.
200	"	R-250	250	38	40	4	75	8	7.5	OK	18000	N.G.	
201	"	R-250	250	38	40	4	75	8	8.1	OK	10000	N.G.	
202	"	R-250	250	38	40	4	75	8	9.0	Set wrong?	4000	N.G.	Descent more severe after initial dip.
203	30 Oct.	R-250	250	38	50	4	60	9	7	Set wrong?	1200	Fair	Flts. 203-207 - Night flights.
204	"	R-250	250	46	40	4	60	8	Unk.	Unk.	Unk.	Unk.	Not recovered.
205	"	R-250	250	38	57	6	50	10	Unk.	Prob. OK	7000	Unk.	Barograph stopped after 1.7 hr.
206	"	R-250	250	46	50	4	50	8	Unk.	Prob. OK	8000	Fair	Osc. damped out. Restarted after sunrise.
207	"	R-250	250	46	40	4	55	10	10	OK	None	Good	
208	9 Nov.	R-130	200	46	50	5	60	8	7.8	OK	Neg.	Good 5 hr.	Large oscillations near end of flight.
209	"	R-130	200	46	50	6	60	9	8.8	Prob. OK	Unk.	Unk.	Baro. not recov. Leaflets indicate proper distance.
210	"	R-130	200	46	50	5	60	8	Unk.	OK	None	6000 3 hr.	Large osc. near end of flight.
211	11 Nov.	R-130	200	46	50	5	60	8	7.8	OK	None	Poor	Very erratic. Overcast for Flts. 211-213.
212	"	R-130	200	46	50	5	60	8	7.9	OK	9000	Poor	Very erratic.
213	"	R-130	200	46	42	4	60	8	7.9				

* In addition to cards (4.7 Gm. each)
# Estimate or until stopped.

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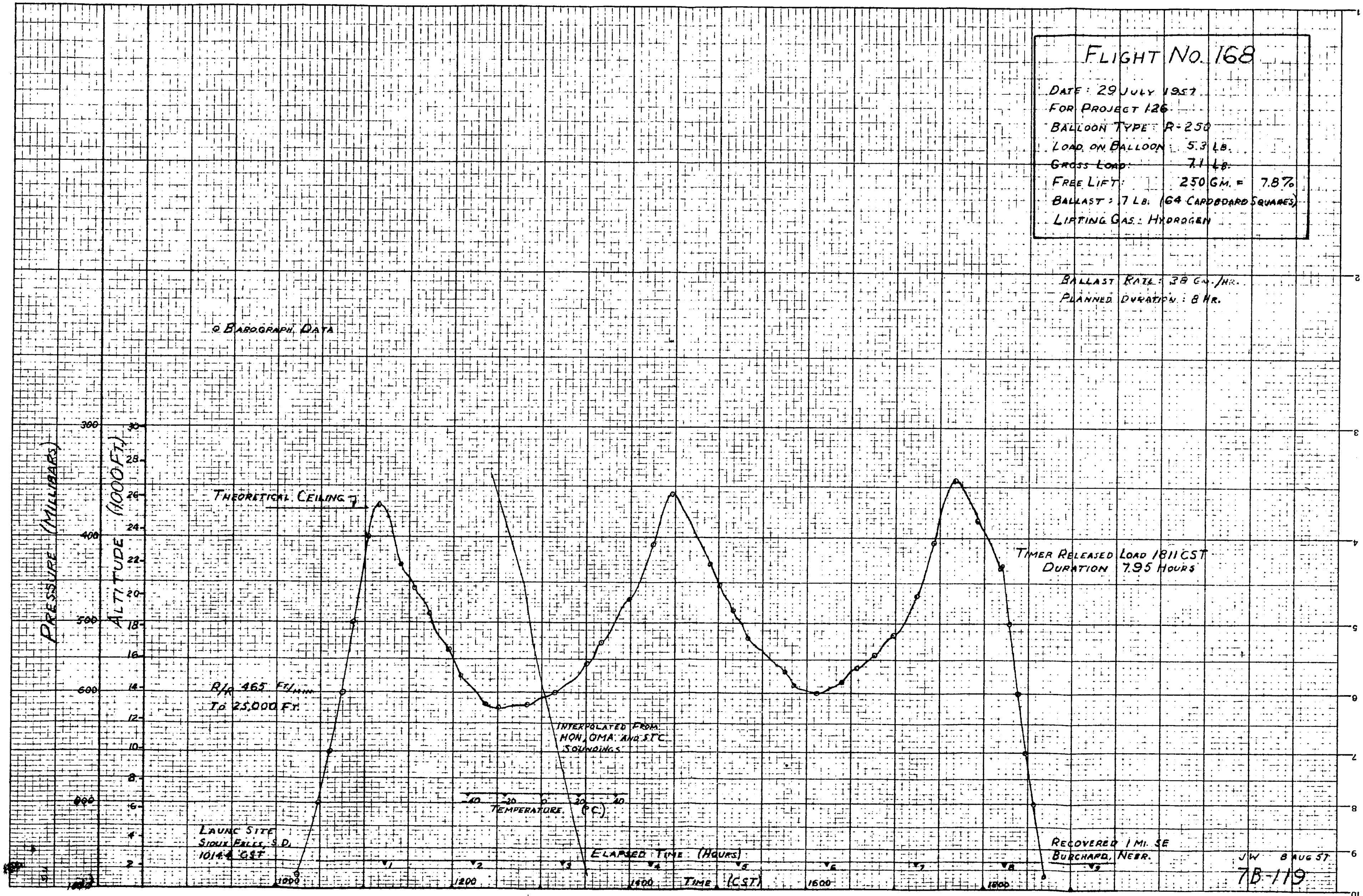

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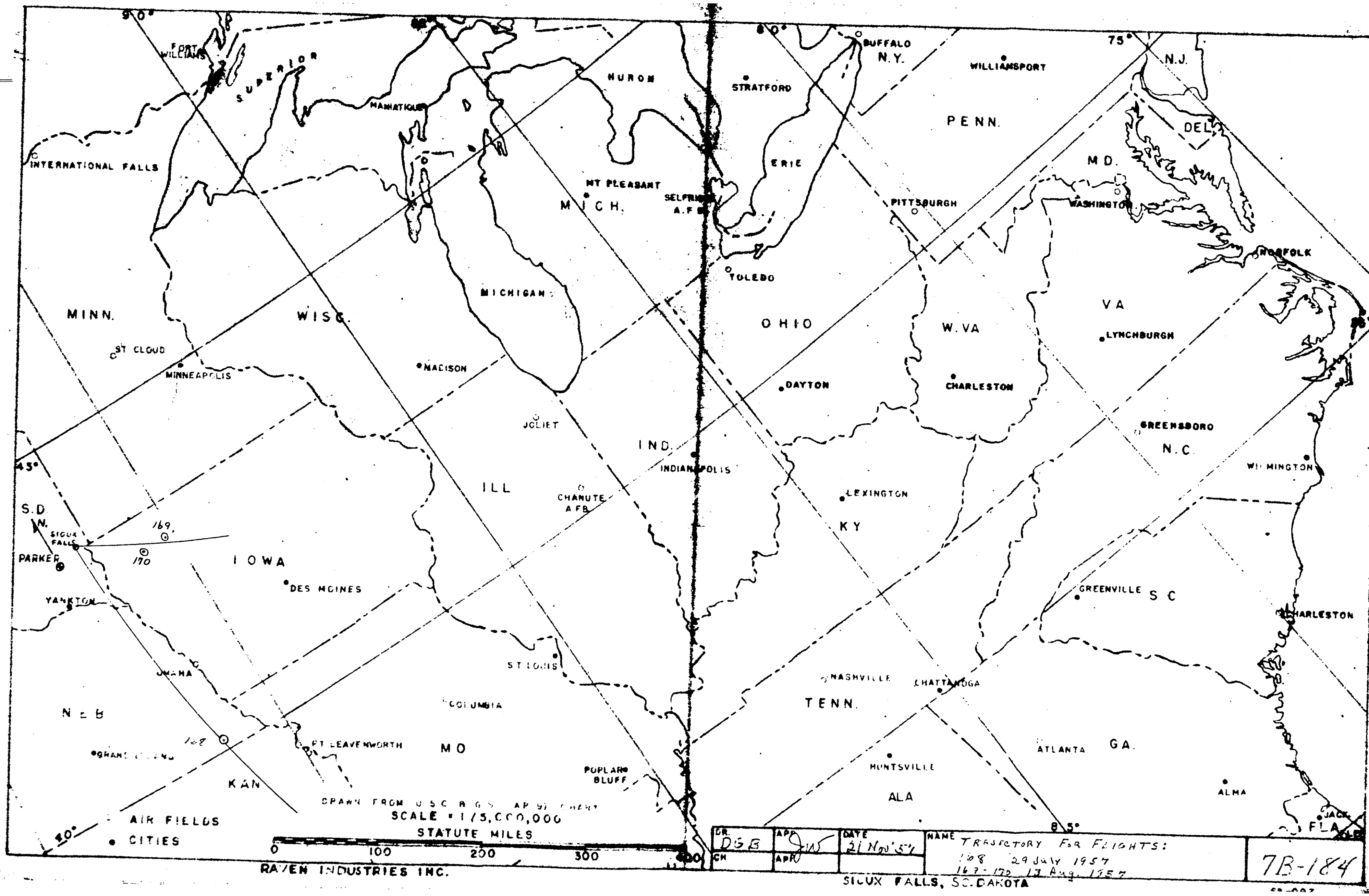
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DR. DSB
APP. JW
DATE 21 Nov '57
NAME TRAJECTORY FOR FLIGHTS:
168 29 July 1957
169-170 13 Aug. 1957
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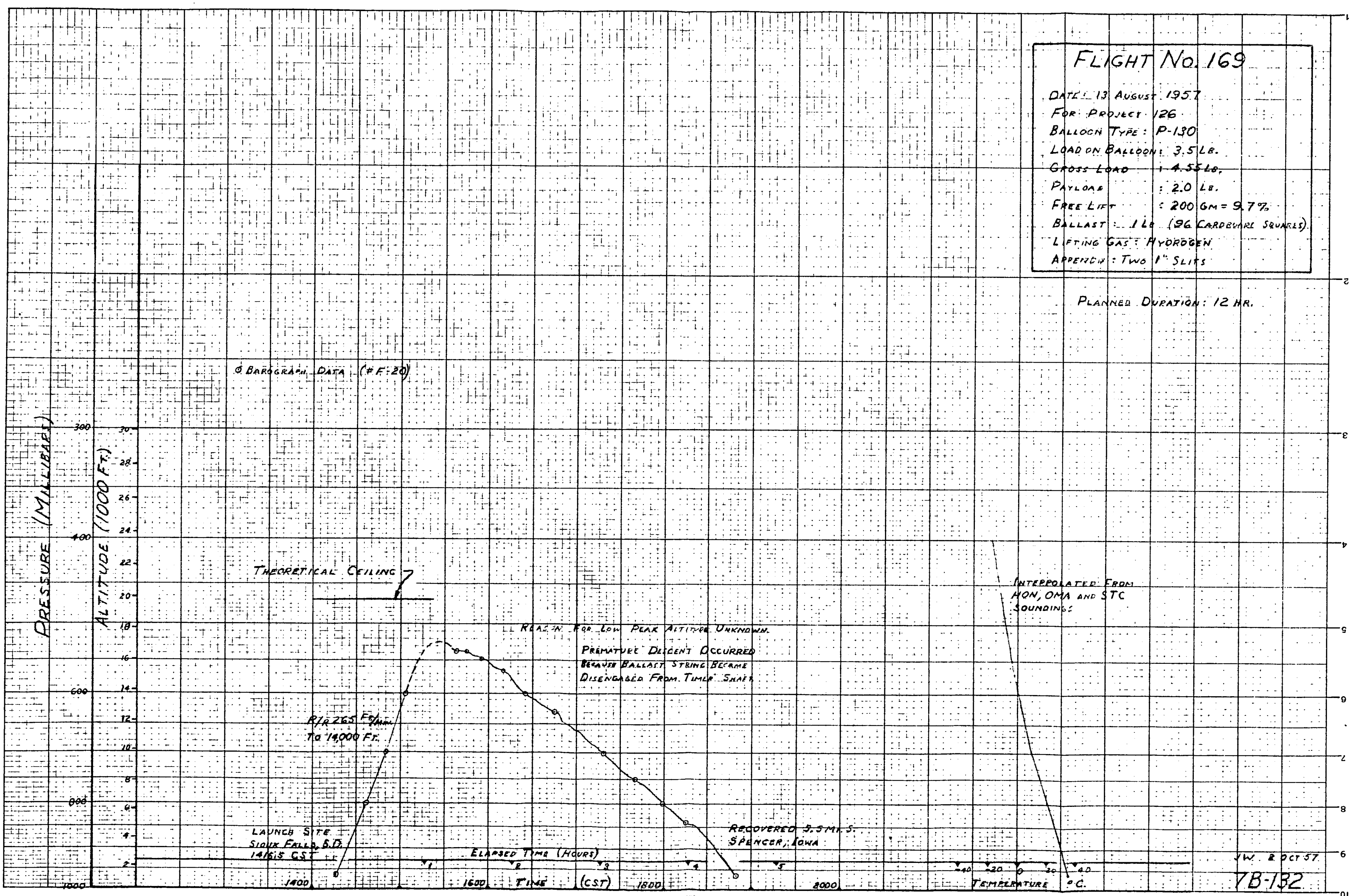
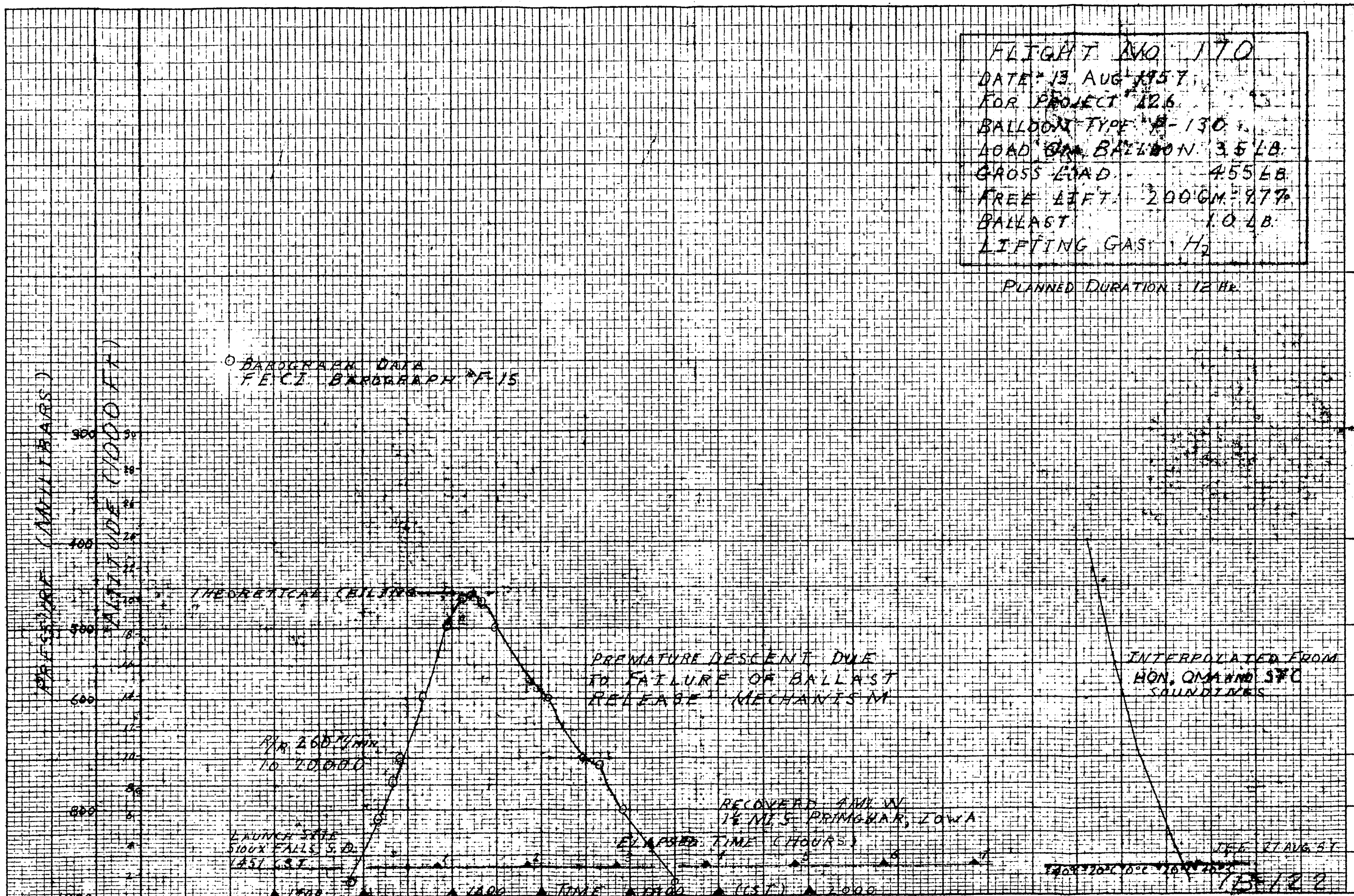
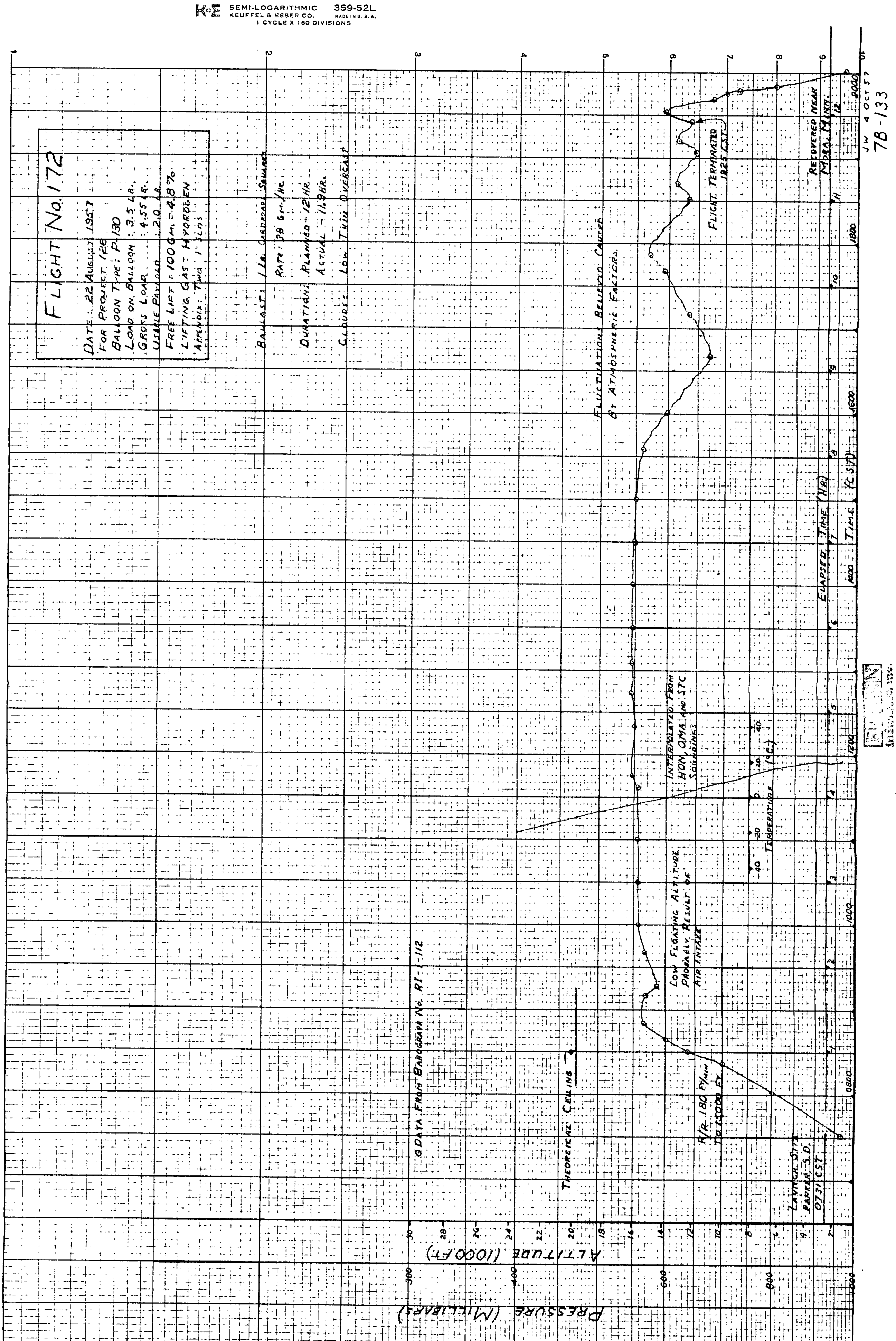
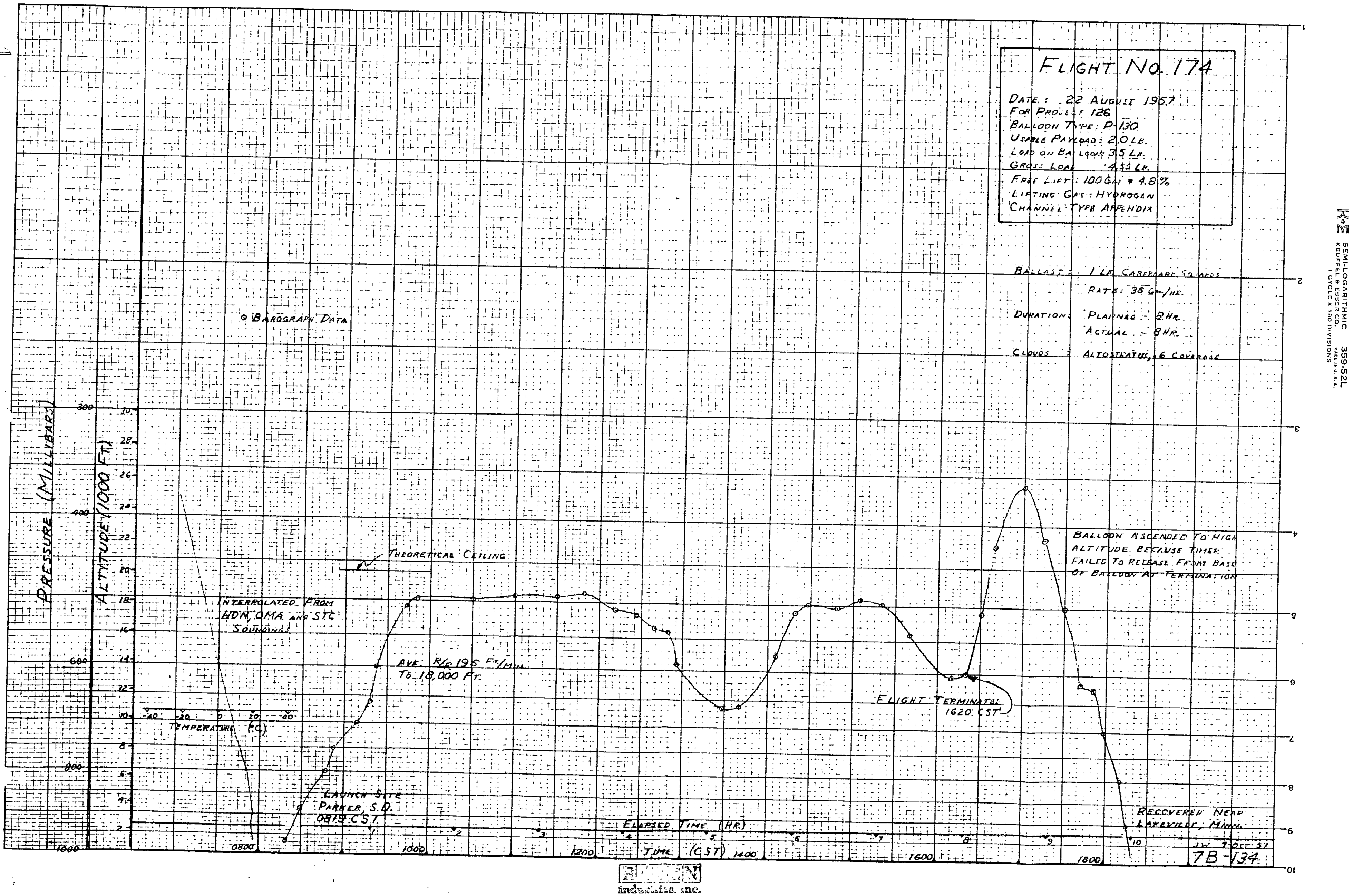
SIOUX FALLS, SO. DAKOTA

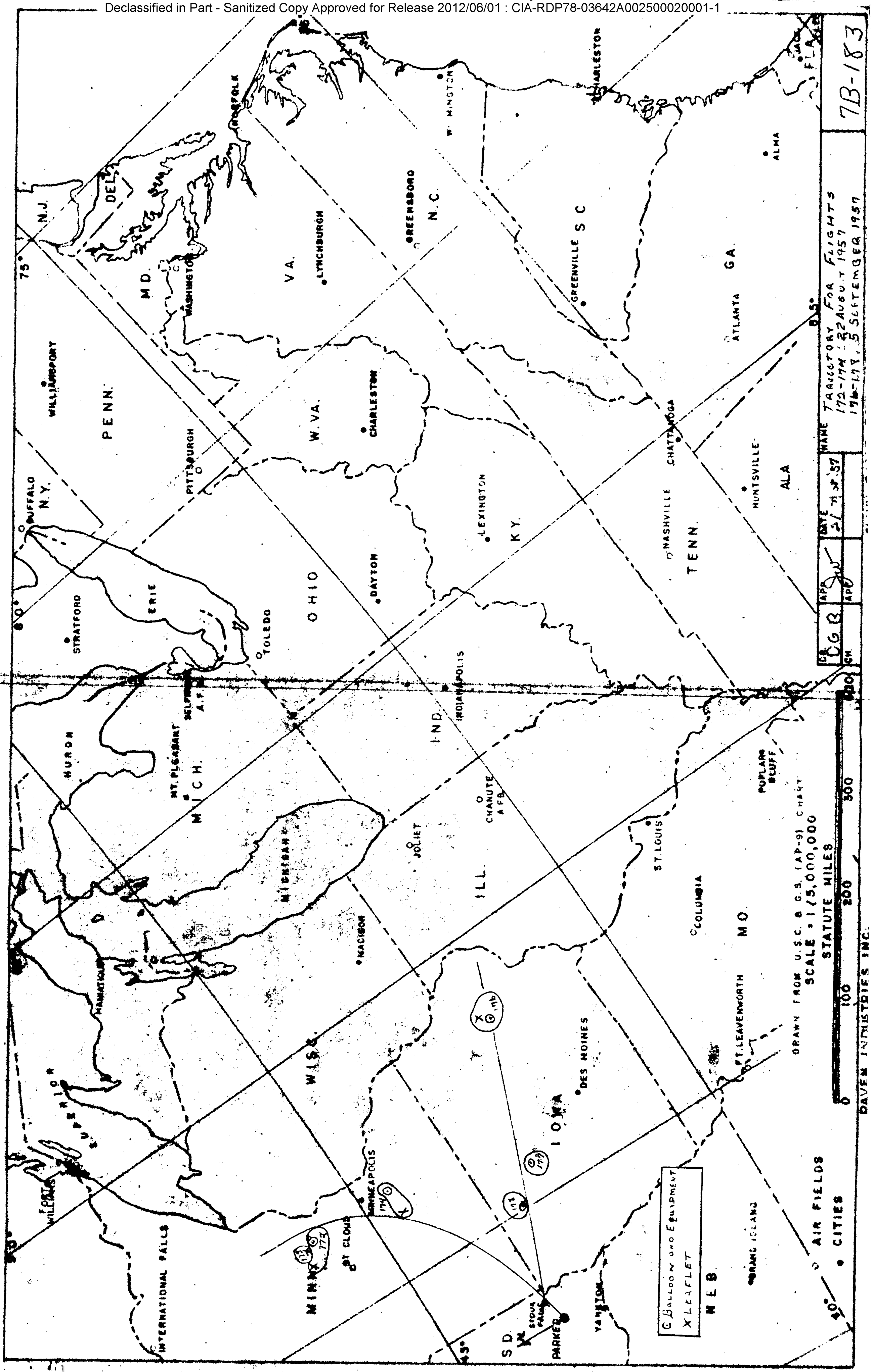

FLIGHT No. 169
DATE: 13 AUGUST 1957
FOR: PROJECT 126
BALLOON TYPE: P-130
LOAD ON BALLOON: 3.5 LB.
GROSS LOAD : 4.55 LB.
PAYLOAD : 2.0 LB.
FREE LIFT : 200 GM = 9.7%
BALLAST : 1 LB (96 CARDBOARD SQUARES)
LIFTING GAS: HYDROGEN
APPENDIX: TWO 1" SLITS
PLANNED DURATION: 12 HR.
⊙ BAROGRAPH DATA (#F-20)
THEORETICAL CEILING
REASON FOR LOW PEAK ALTITUDE UNKNOWN.
PREMATURE DESCENT OCCURRED
BECAUSE BALLAST STRING BECAME
DISENGAGED FROM TIMER SHAFT.
R/R 265 FT/MIN. TO 14,000 FT.
LAUNCH SITE
SIOUX FALLS, S.D.
1416:15 CST
RECOVERED 3.5 MI. S.
SPENCER, IOWA
INTERPOLATED FROM
HON, OMA AND STC
SOUNDINGS
ELAPSED TIME (HOURS)
TIME (CST)
TEMPERATURE °C.
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT.)
JW. 2 OCT 57
7B-132



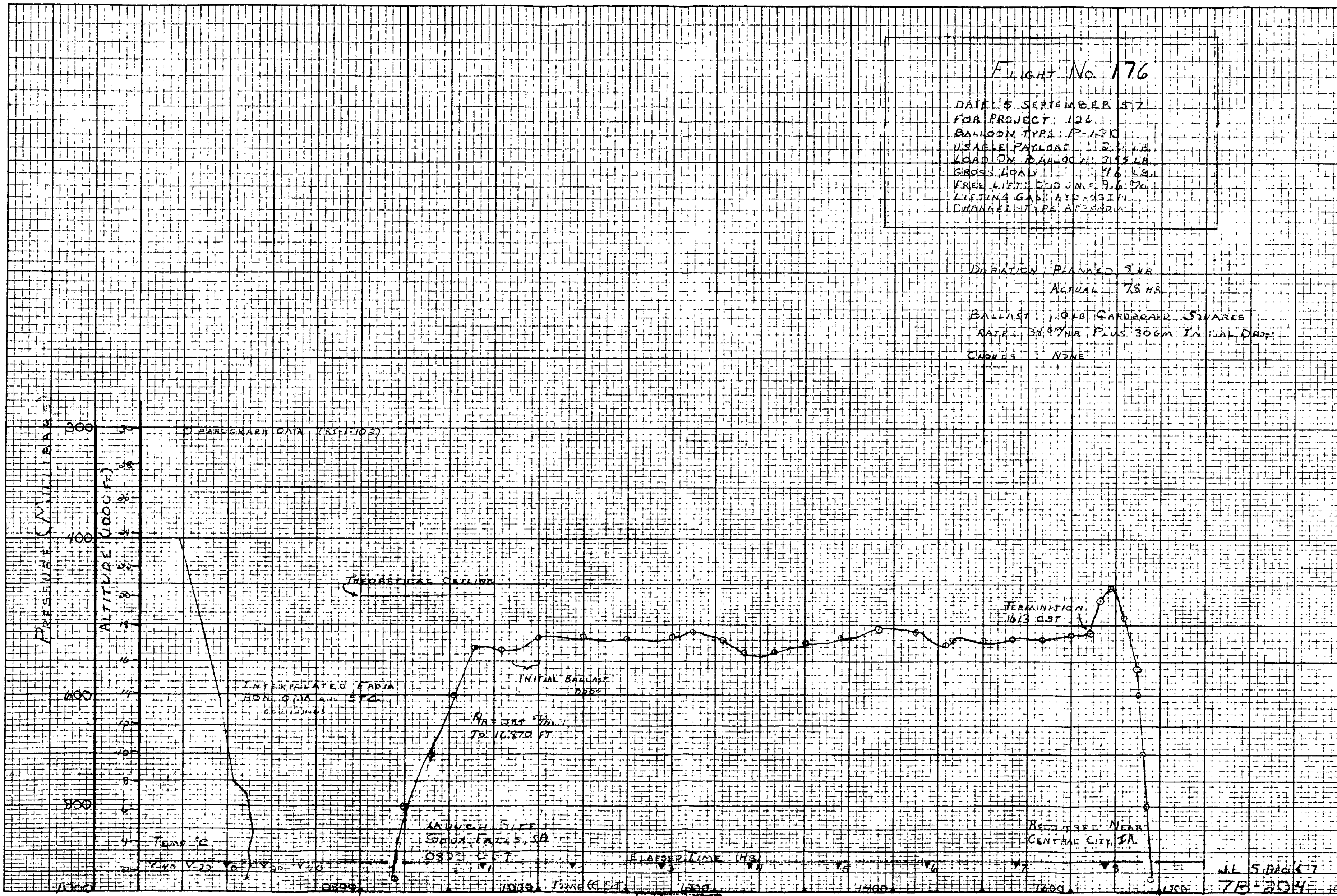
RAVEN INDUSTRIES INC.

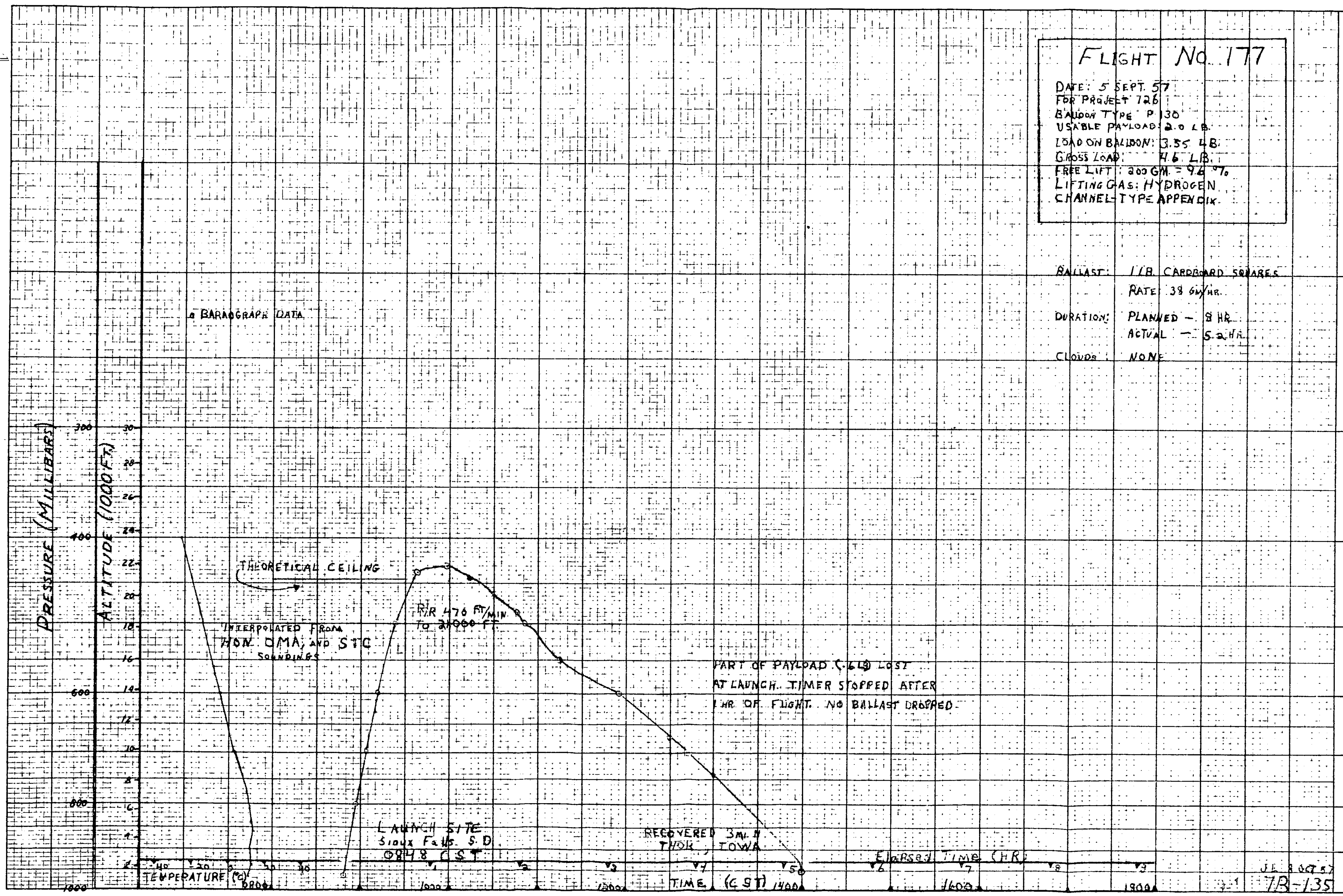

K&E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 172
DATE: 22 AUGUST 1957
FOR PROJECT 126
BALLOON TYPE: P 130
LOAD ON BALLOON: 3.5 LB.
GROSS LOAD: 4.55 LB.
USABLE PAYLOAD: 2.0 LB.
FREE LIFT: 100 GM. = 4.8%
LIFTING GAS: HYDROGEN
APPENDIX: TWO 1" SLITS
BALLAST: 1 LB. CARDBOARD SQUARES
RATE: 38 GM./HR.
DURATION: PLANNED - 12 HR.
ACTUAL - 11.9 HR.
CLOUDS: LOW THIN OVERCAST
FLUCTUATIONS BELIEVED CAUSED BY ATMOSPHERIC FACTORS.
FLIGHT TERMINATED 1825 CST
RECOVERED NEAR MORA, MINN.
INTERPOLATED FROM HON, OMA AND STC SOUNDINGS
LOW FLOATING ALTITUDE PROBABLY RESULT OF AIR INTAKE
DATA FROM BAROGRAPH No. RI-112
THEORETICAL CEILING
R/R 180 FT/MIN TO 15000 FT.
LAUNCH SITE PARKER, S.D. 0731 CST
TEMPERATURE (°C)
ELAPSED TIME (HR.)
TIME (CST)
ALTITUDE (1000 FT)
PRESSURE (MILLIBARS)
JW 4 OCT 57
7B-133

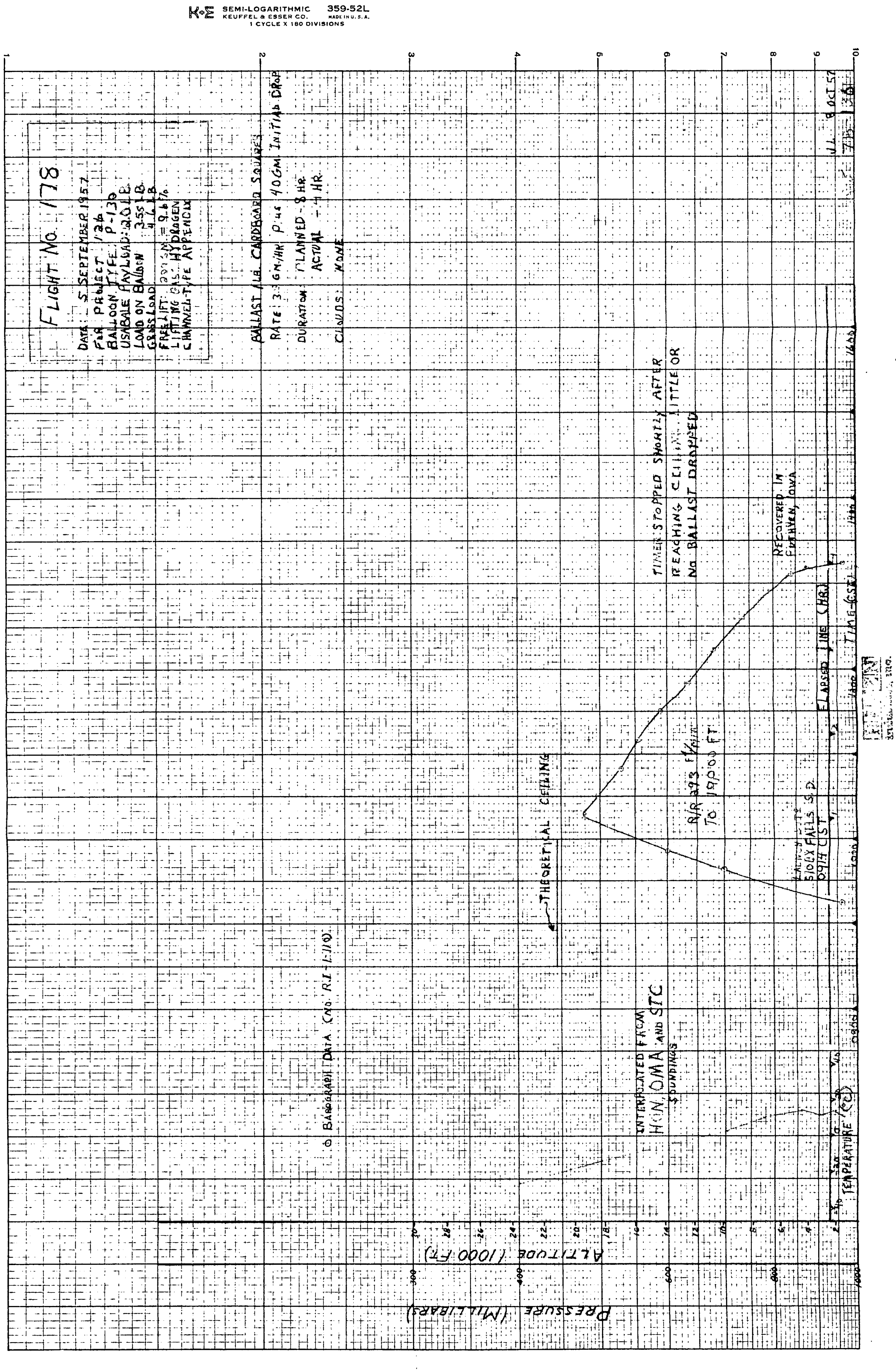

K+E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 174
DATE: 22 AUGUST 1957
FOR PROJECT 126
BALLOON TYPE: P-130
USABLE PAYLOAD: 2.0 LB.
LOAD ON BALLOON: 3.5 LB.
GROSS LOAD 4.55 LB.
FREE LIFT: 100 GM = 4.8%
LIFTING GAS: HYDROGEN
CHANNEL TYPE APPENDIX
BALLAST: 1 LB. CARDBOARD SQUARES
RATE: 36 GM./HR.
DURATION: PLANNED - 8 HR.
ACTUAL - 8 HR.
CLOUDS: ALTOSTRATUS, .6 COVERAGE
○ BAROGRAPH DATA
THEORETICAL CEILING
INTERPOLATED FROM HON, OMA AND STC SOUNDINGS
AVE. R/R 195 FT./MIN. TO 18,000 FT.
LAUNCH SITE PARKER, S.D. 0819 CST.
FLIGHT TERMINATED 1620 CST
BALLOON ASCENDED TO HIGH ALTITUDE, BECAUSE TIMER FAILED TO RELEASE FROM BASE OF BALLOON AT TERMINATION
RECOVERED NEAR LAKEVILLE, MINN.
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT.)
TEMPERATURE (°C)
ELAPSED TIME (HR.)
TIME (CST)
0800
1000
1200
1400
1600
1800
JW 9 OCT 57
7B-134

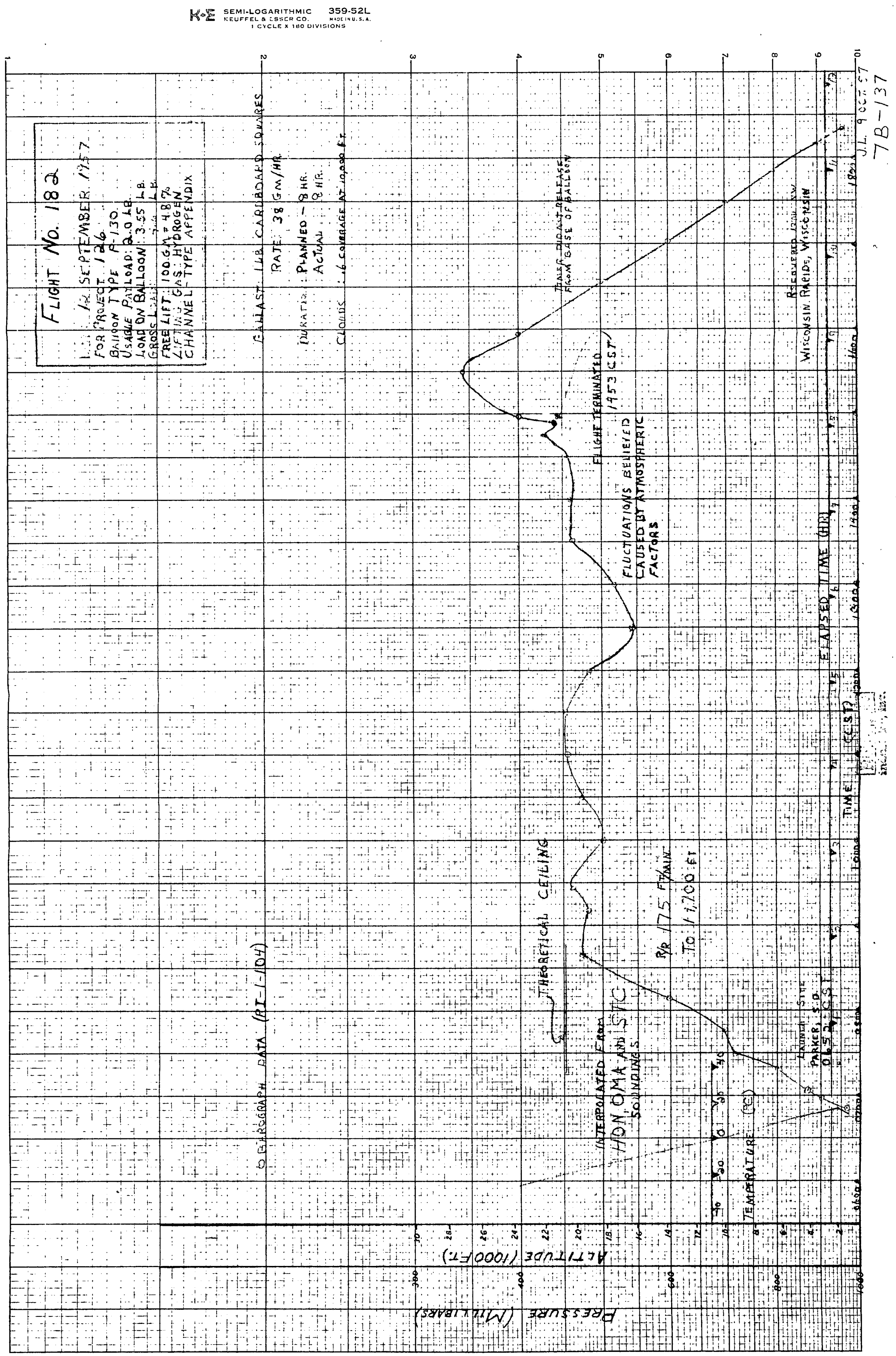

TRAJECTORY FOR FLIGHTS
172-174 22 AUGUST 1957
176-178 5 SEPTEMBER 1957
7B-183
NAME
DATE
APR
CK
DGB
G BALLOON AND EQUIPMENT
X LEAFLET
AIR FIELDS
CITIES
DRAWN FROM U.S.C. & G.S. (AP-9) CHART
SCALE = 1/5,000,000
STATUTE MILES
0
100
200
300
400
DAVEN INDUSTRIES INC.
N.J.
DEL
MD.
WASHINGTON
NORFOLK
VA.
LYNCHBURG
GREENSBORO
N.C.
WILMINGTON
CHARLESTON
S C
GREENVILLE
GA.
ALMA
ATLANTA
PENN.
WILLIAMSPORT
PITTSBURGH
W. VA.
CHARLESTON
N.Y.
BUFFALO
ERIE
STRATFORD
OHIO
DAYTON
TOLEDO
LEXINGTON
KY.
NASHVILLE
TENN.
CHATTANOOGA
HUNTSVILLE
ALA
HURON
MT. PLEASANT
SELFRIDGE A.F.B.
MICH.
IND.
INDIANAPOLIS
CHANUTE AFB
JOLIET
ILL.
MICHIGAN
MADISON
WISC.
MANITOWOC
SUPERIOR
FORT WILLIAMS
INTERNATIONAL FALLS
MINN.
ST. CLOUD
MINNEAPOLIS
IOWA
DES MOINES
ST. LOUIS
POPLAR BLUFF
COLUMBIA
MO.
FT. LEAVENWORTH
NEB.
GRAND ISLAND
YANKTON
S.D.
SIOUX FALLS
PARKER
75°
80°
85°
90°
95°
40°
45°
172
173
174
176
177
178

K+E SEMI-LOGARITHMIC 359-52L KEUFFEL & ESSER CO. MADE IN U.S.A. 1 CYCLE X 180 DIVISIONS

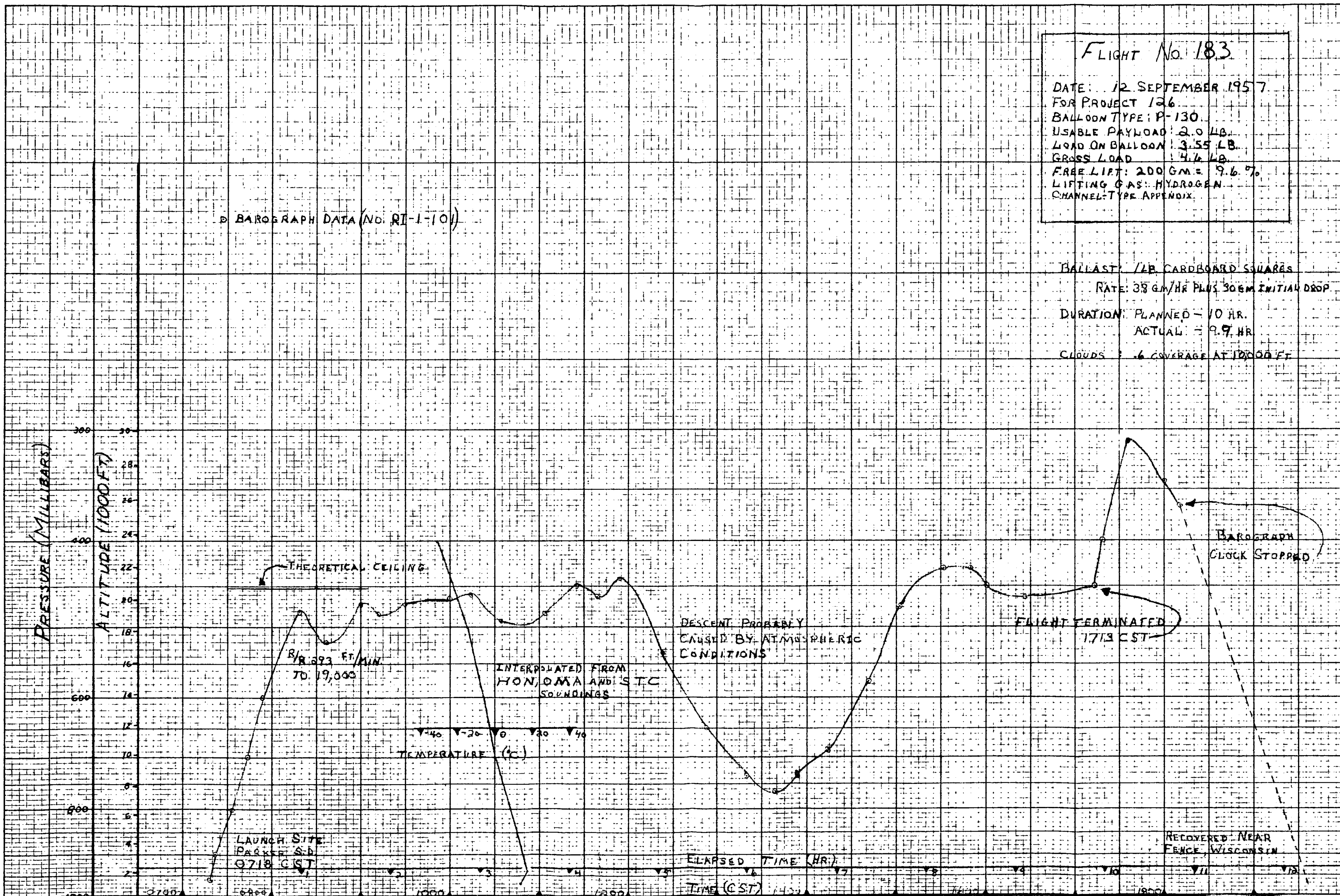



FLIGHT No. 177
DATE: 5 SEPT. 57
FOR PROJECT 726
BALLOON TYPE P 130
USABLE PAYLOAD: 2.0 LB.
LOAD ON BALLOON: 3.55 LB.
GROSS LOAD: 4.6 LB.
FREE LIFT: 200 GM. = 9.6 %
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX.
BALLAST: 1 LB. CARDBOARD SQUARES
RATE: 38 GM/HR.
DURATION: PLANNED — 8 HR.
ACTUAL — 5.2 HR.
CLOUDS: NONE
BARAGRAPH DATA
THEORETICAL CEILING
INTERPOLATED FROM HON. OMA, AND STC SOUNDINGS
R/R 476 FT/MIN TO 21000 FT.
PART OF PAYLOAD (.6 LB) LOST AT LAUNCH. TIMER STOPPED AFTER 1 HR. OF FLIGHT. NO BALLAST DROPPED.
LAUNCH SITE Sioux Falls S.D. 0848 CST
RECOVERED 3 MI. N THOR, IOWA
ELAPSED TIME (HR)
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT.)
TEMPERATURE (°C)
TIME (CST)
0800
1000
1200
1400
1600
1900
JE 8 OCT 57
7B-135

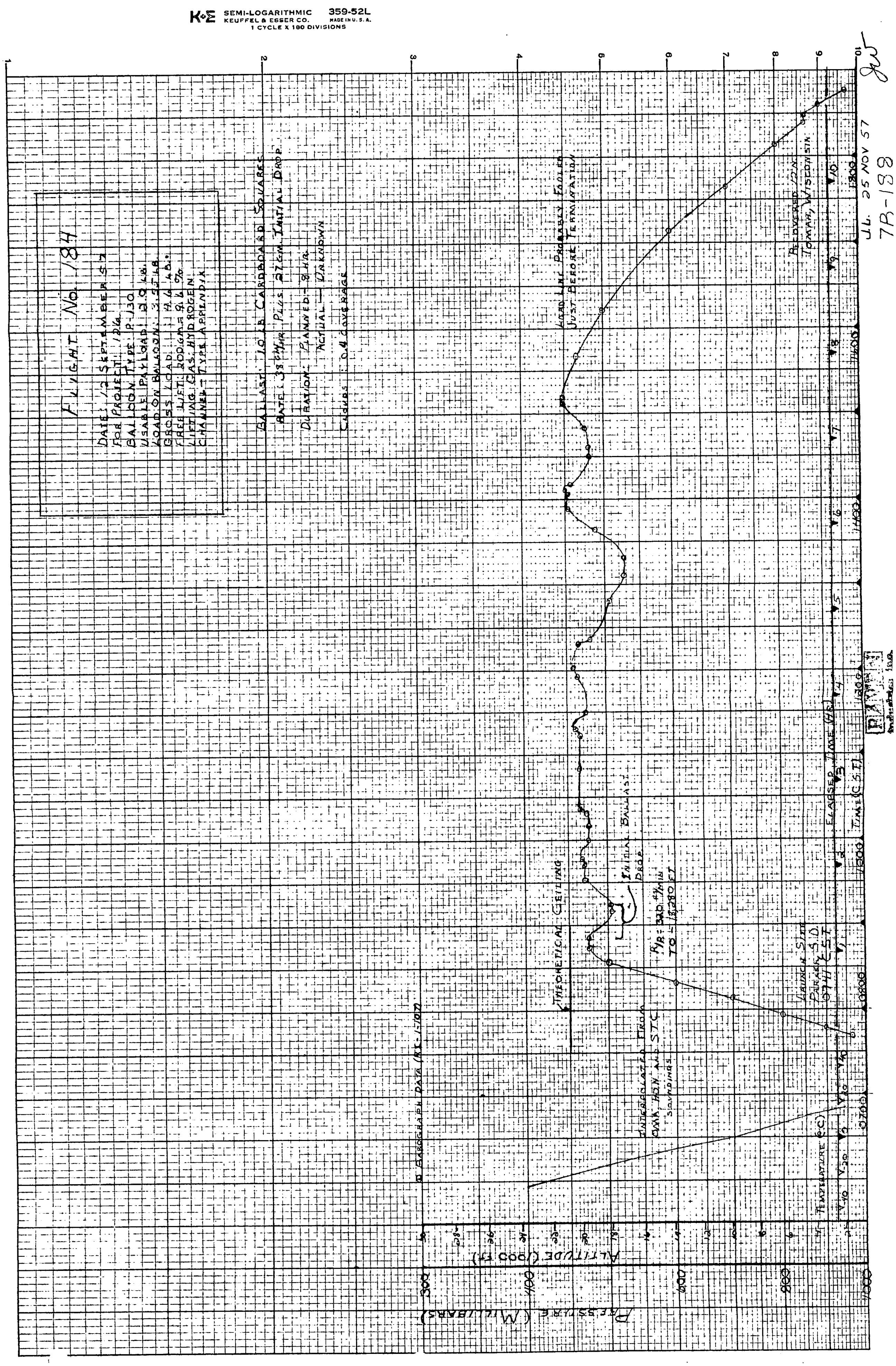

K+E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT NO. 178
DATE: 5 SEPTEMBER 1957
FOR PROJECT 126
BALLOON TYPE P-130
USABLE PAYLOAD: 20 LB
LOAD ON BALLOON 35.5 LB
GROSS LOAD 46.6 LB
FREE LIFT: = 9.6%
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST 1 LB. CARDBOARD SQUARES
RATE: 3.3 GM/HR P: 45 40 GM INITIAL DROP
DURATION PLANNED - 8 HR
ACTUAL - 4 HR
CLOUDS: NONE
TIMER STOPPED SHORTLY AFTER REACHING CEILING. LITTLE OR NO BALLAST DROPPED
RECOVERED IN
THEORETICAL CEILING
R/R 373 FT/MIN TO 19000 FT
SIOUX FALLS S.D. 0914 CST
ELAPSED TIME (HR)
TIME (CST)
BAROGRAPH DATA (NO. RI-1110)
INTERPOLATED FROM HON, OMA AND STC SOUNDINGS
TEMPERATURE (°C)
ALTITUDE (1000 FT)
PRESSURE (MILLIBARS)

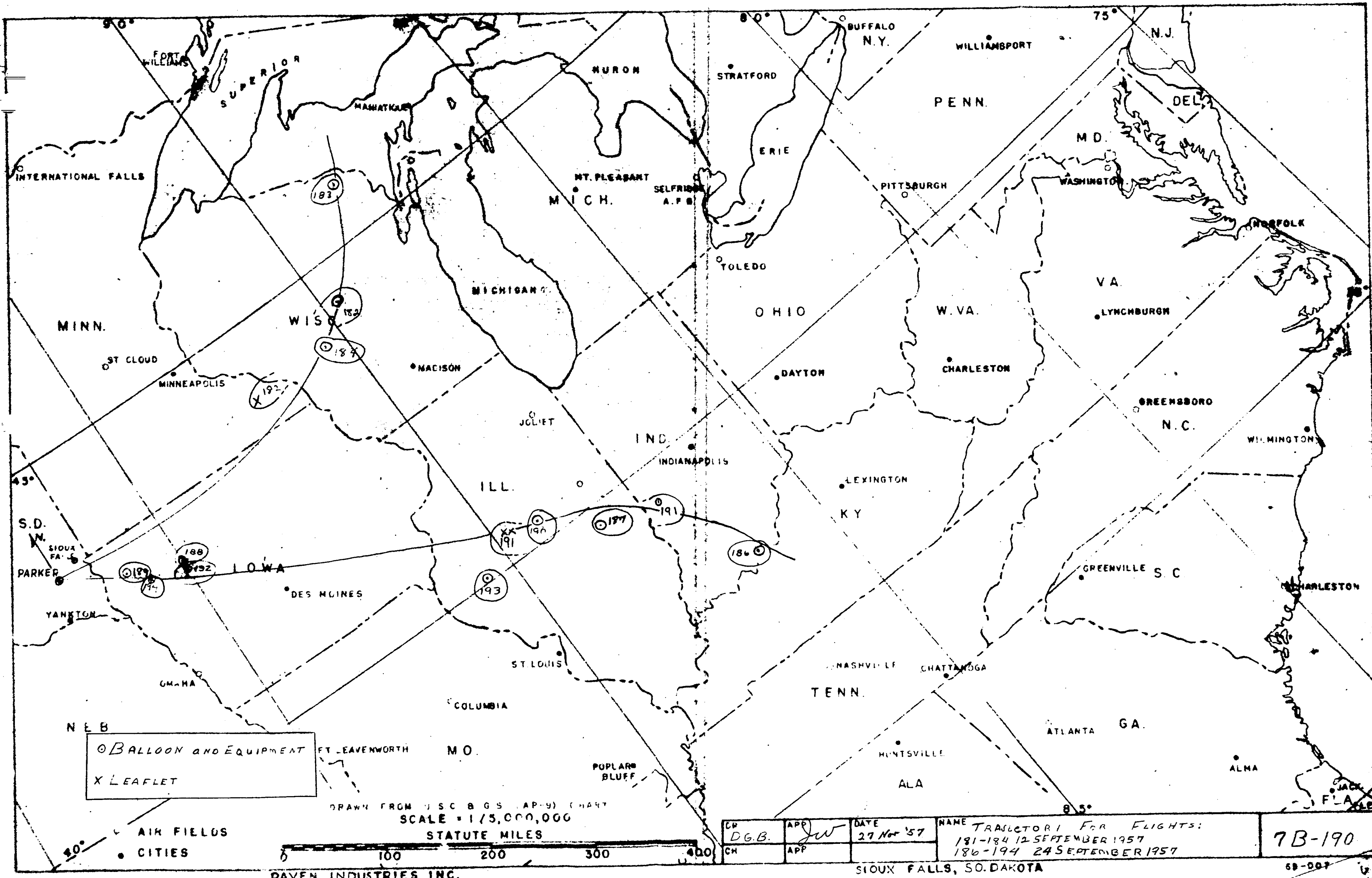

K&E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT NO. 182
14 SEPTEMBER 1957
FOR PROJECT 126
BALLOON TYPE P-130
USABLE PAYLOAD: 2.0 LB.
LOAD ON BALLOON: 3.55 LB.
FREE LIFT: 100 GM = 4.8%
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST: 1 LB CARDBOARD SQUARES
RATE: 38 GM/HR.
DURATION: PLANNED - 8 HR. ACTUAL - 8 HR.
CLOUDS: .6 COVERAGE AT 10,000 FT.
TIMER DID NOT RELEASE FROM BASE OF BALLOON
FLIGHT TERMINATED 1453 CST
FLUCTUATIONS BELIEVED CAUSED BY ATMOSPHERIC FACTORS
RECOVERED 12 MI. NW WISCONSIN RAPIDS, WISCONSIN
THEORETICAL CEILING
R/R 175 FT/MIN TO 11,700 FT
INTERPOLATED FROM HON, OMA AND STC SOUNDINGS
BAROGRAPH DATA (RI-1-104)
LAUNCH SITE PARKER, S.D. 0652 CST
TEMPERATURE (°C)
ELAPSED TIME (HR)
TIME (CST)
ALTITUDE (1000 FT.)
PRESSURE (MILLIBARS)
J.L. 9 OCT 57
7B-137

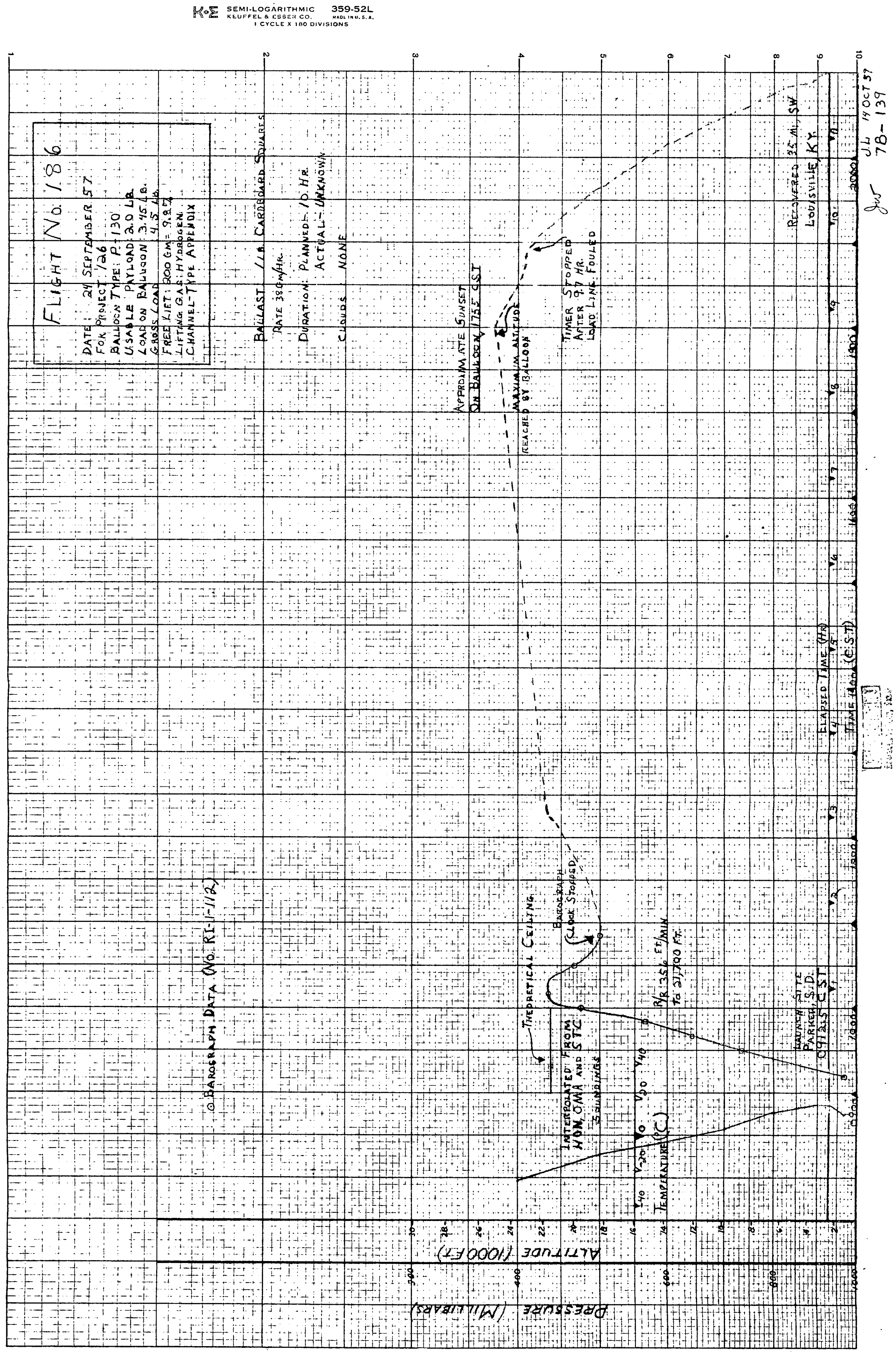
K+E SEMI-LOGARITHMIC 359-52L KEUFFEL & ESSER CO. MADE IN U.S.A. 1 CYCLE X 180 DIVISIONS

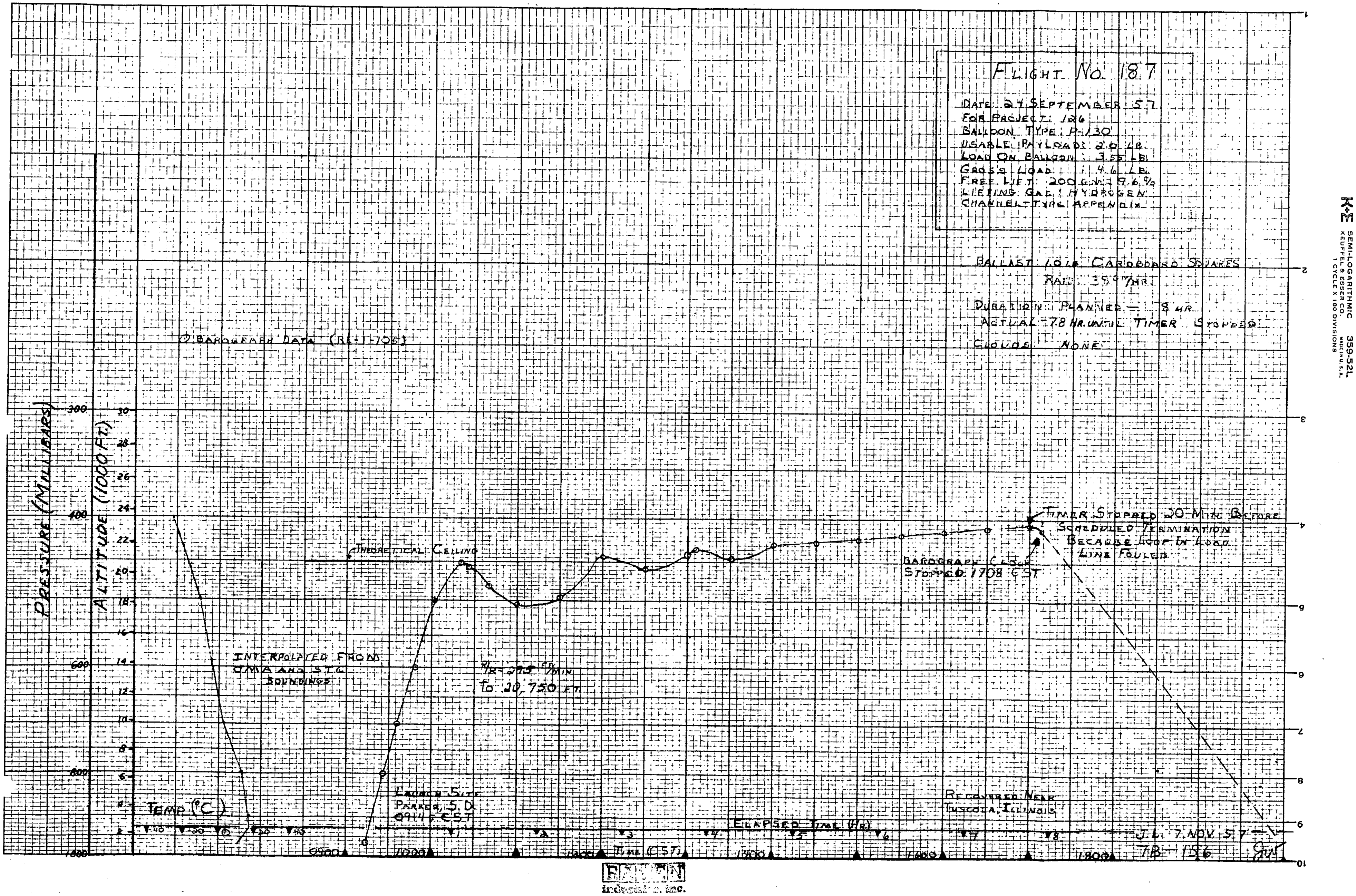


JL 7 OCT 57
7F-139

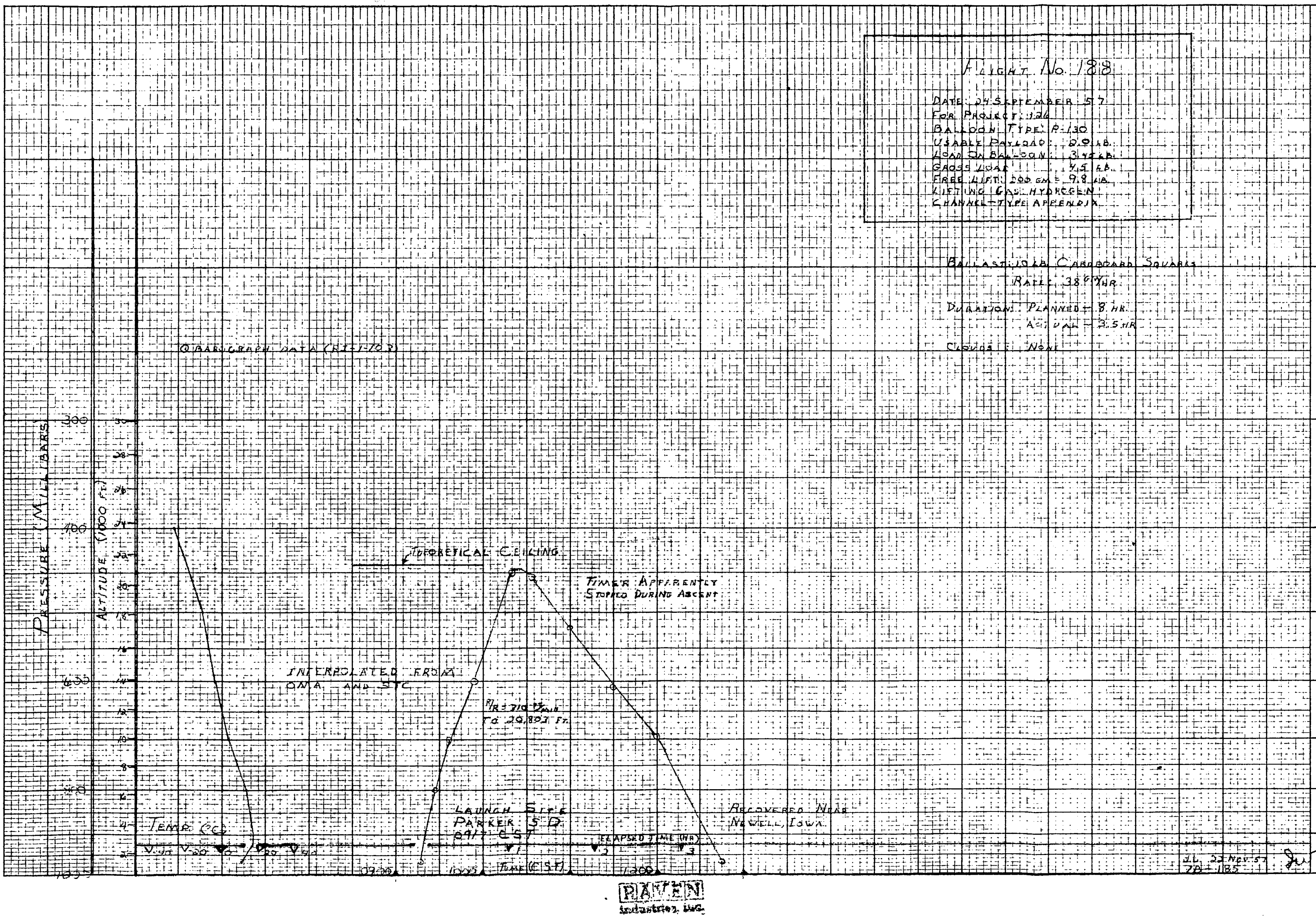

K&E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 184
DATE: 12 SEPTEMBER 57
FOR PROJECT: 126
BALLOON TYPE: P-130
USABLE PAYLOAD: 2.0 LB.
LOAD ON BALLOON: 3.55 LB.
GROSS LOAD: 4.6 LB.
FREE LIFT: 200 GM = 9.6 %
LIFTING GAS: HYDROGEN
CHANNEL - TYPE APPENDIX
BALLAST: 1.0 LB CARDBOARD SQUARES
RATE: 38 GM/HR PLUS 27 GM. INITIAL DROP
DURATION: PLANNED - 8 HR.
ACTUAL - UNKNOWN
CLOUDS: 0.4 COVERAGE
BAROGRAPH DATA (RS-1-107)
THEORETICAL CEILING
INITIAL BALLAST DROP
R/R = 320 FT/MIN TO - 18,280 FT
INTERPOLATED FROM OMA, HON AND STC SOUNDINGS
LOAD LINE PROBABLY FOULED JUST BEFORE TERMINATION
LAUNCH SITE PARKER, S.D. 0741 C.S.T.
RECOVERED 12 N TOMAH, WISCONSIN
TEMPERATURE (°C)
ELAPSED TIME (HR)
TIME (C.S.T.)
PRESSURE (MILLIBARS)
ALTITUDE (000 FT)
0700
0800
1000
1200
1400
1600
1800
300
400
600
800
1000
J.L. 25 NOV 57
7B-188
RAVEN Industries Inc.

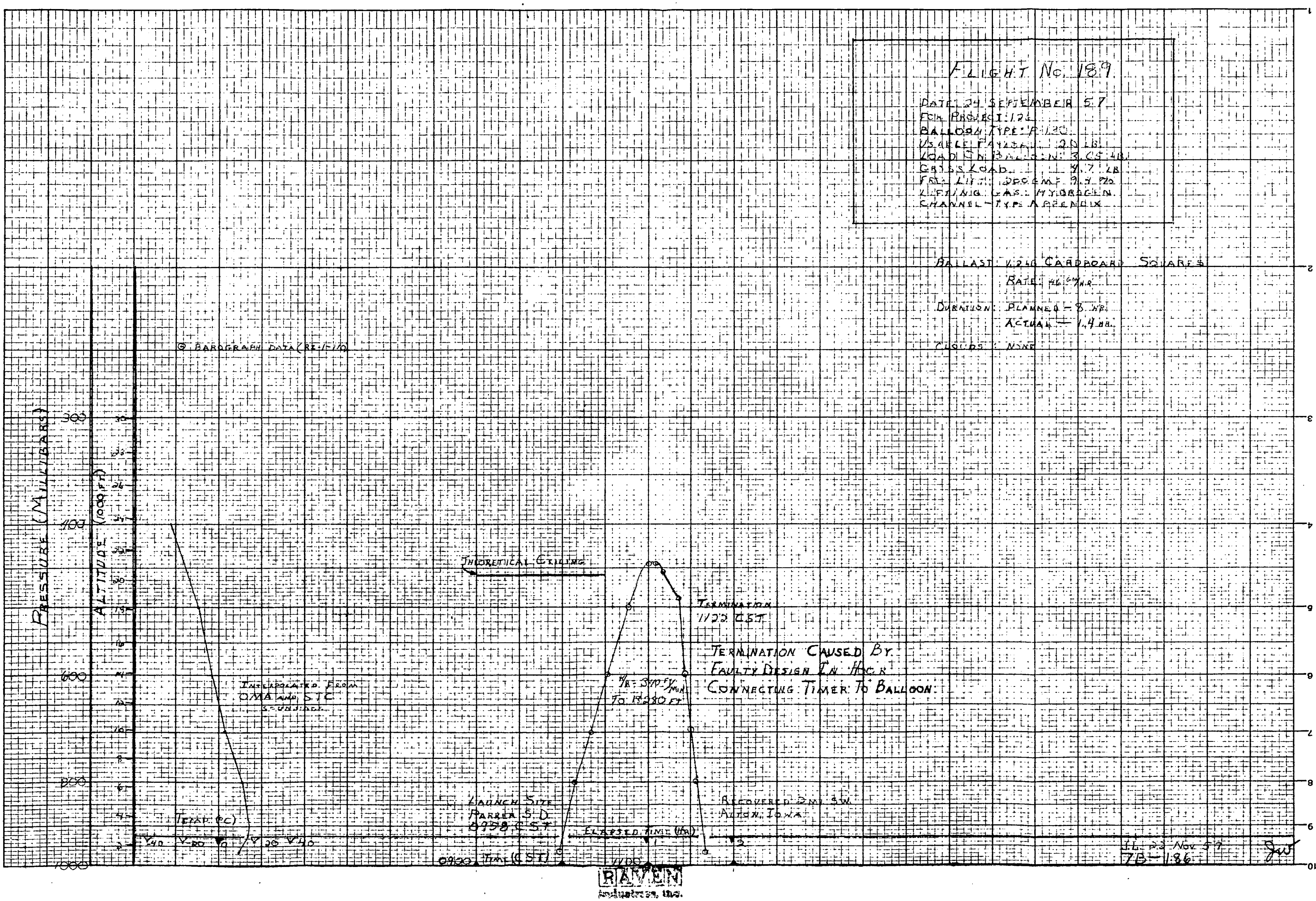

FORT WILLIAMS
SUPERIOR
INTERNATIONAL FALLS
MINN.
ST CLOUD
MINNEAPOLIS
WISC.
MANATKAR
HURON
MICH.
MT. PLEASANT
SELFRIDGE A.F.B.
MICHIGAN
MADISON
JOLIET
ILL.
IND.
INDIANAPOLIS
STRATFORD
ERIE
TOLEDO
OHIO
DAYTON
BUFFALO
N.Y.
PENN.
WILLIAMSPORT
PITTSBURGH
W. VA.
CHARLESTON
MD.
WASHINGTON
DEL.
N.J.
NORFOLK
VA.
LYNCHBURGH
GREENSBORO
N.C.
WILMINGTON
KY.
LEXINGTON
S.C.
GREENVILLE
CHARLESTON
TENN.
NASHVILLE
CHATTANOOGA
GA.
ATLANTA
ALMA
ALA.
HUNTSVILLE
FLA.
S.D.
SIOUX FALLS
PARKER
YANKTON
IOWA
DES MOINES
OMAHA
NEB.
ST LOUIS
COLUMBIA
MO.
FT. LEAVENWORTH
POPLAR BLUFF
90°
80°
75°
45°
40°
85°
183
182
184
192
188
189
192
194
191
190
197
191
186
193
⊙ BALLOON AND EQUIPMENT
X LEAFLET
DRAWN FROM USC&GS (AP-9) CHART
SCALE = 1/5,000,000
STATUTE MILES
0 100 200 300 400
AIR FIELDS
• CITIES
RAVEN INDUSTRIES INC.
CH DGB
APP
DATE 27 Nov '57
NAME TRAJECTORI FOR FLIGHTS:
181-184 12 SEPTEMBER 1957
186-194 24 SEPTEMBER 1957
7B-190
SIOUX FALLS, SO. DAKOTA
69-007


K&E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No 186
DATE: 24 SEPTEMBER 57
FOR PROJECT: 126
BALLOON TYPE: P-130
USABLE PAYLOAD: 3.0 LB.
LOAD ON BALLOON: 3.45 LB.
GROSS LOAD: 4.5 LB.
FREE LIFT: 200 GM = 9.8%
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST: 1 LB CARDBOARD SQUARES
RATE 380 GM/HR.
DURATION: PLANNED - 10 HR.
ACTUAL - UNKNOWN
CLOUDS: NONE
APPROXIMATE SUNSET ON BALLOON 1735 CST
MAXIMUM ALTITUDE REACHED BY BALLOON
TIMER STOPPED AFTER 9.7 HR.
LOAD LINE FOULED
RECOVERED 35 MI. SW LOUISVILLE, KY.
J.L. 14 OCT 57
7B-139
ELAPSED TIME (HR)
TIME (C.S.T.)
LAUNCH SITE PARKER, S.D. 0912.5 CST
R/R 350 FT/MIN TO 21,700 FT.
THEORETICAL CEILING
BAROGRAPH (CLOCK STOPPED)
INTERPOLATED FROM HON, OMA AND STC SOUNDINGS
⊙ BAROGRAPH DATA (No. KI-1-112)
TEMPERATURE (°C)
ALTITUDE (1000 FT.)
PRESSURE (MILLIBARS)

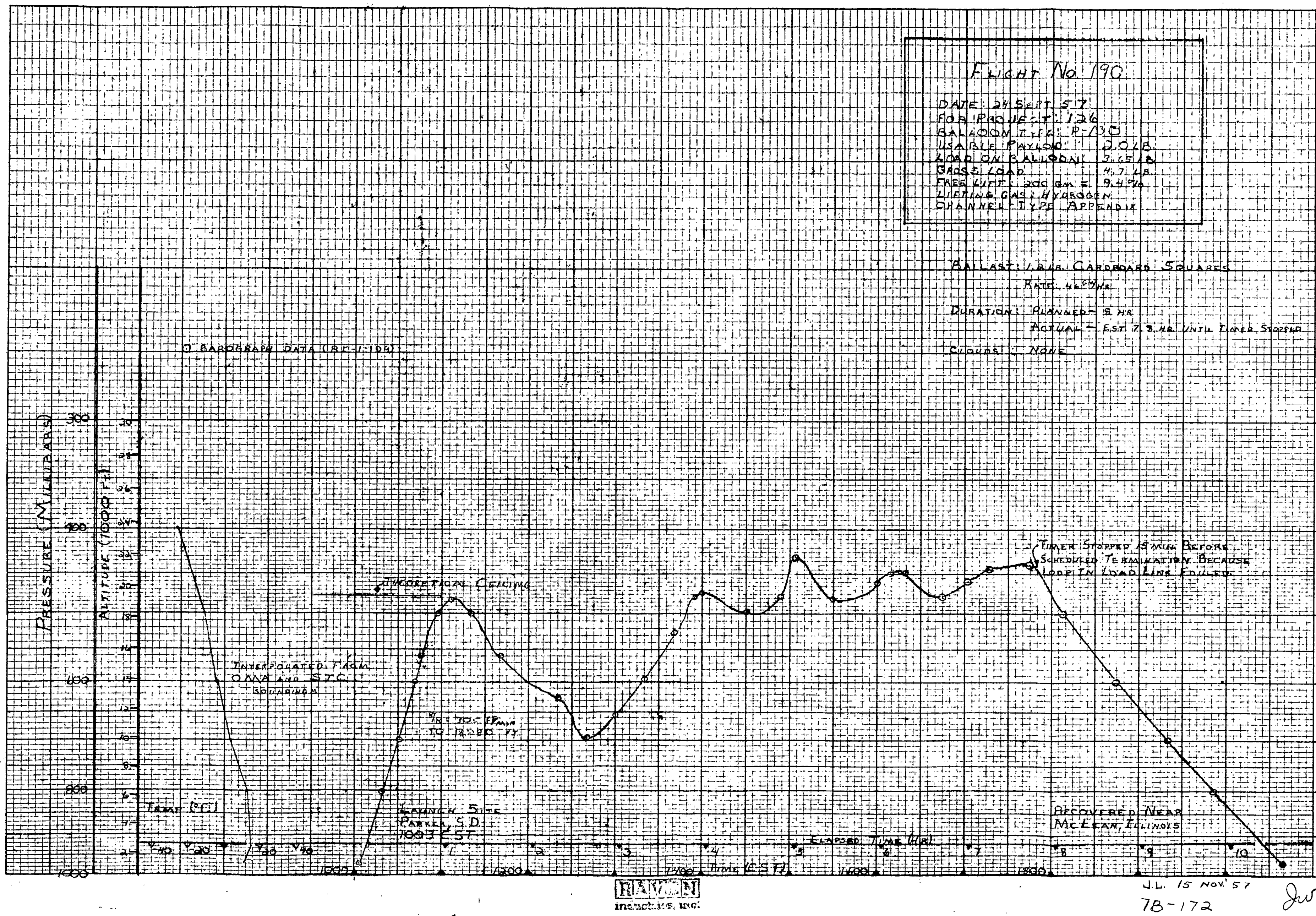


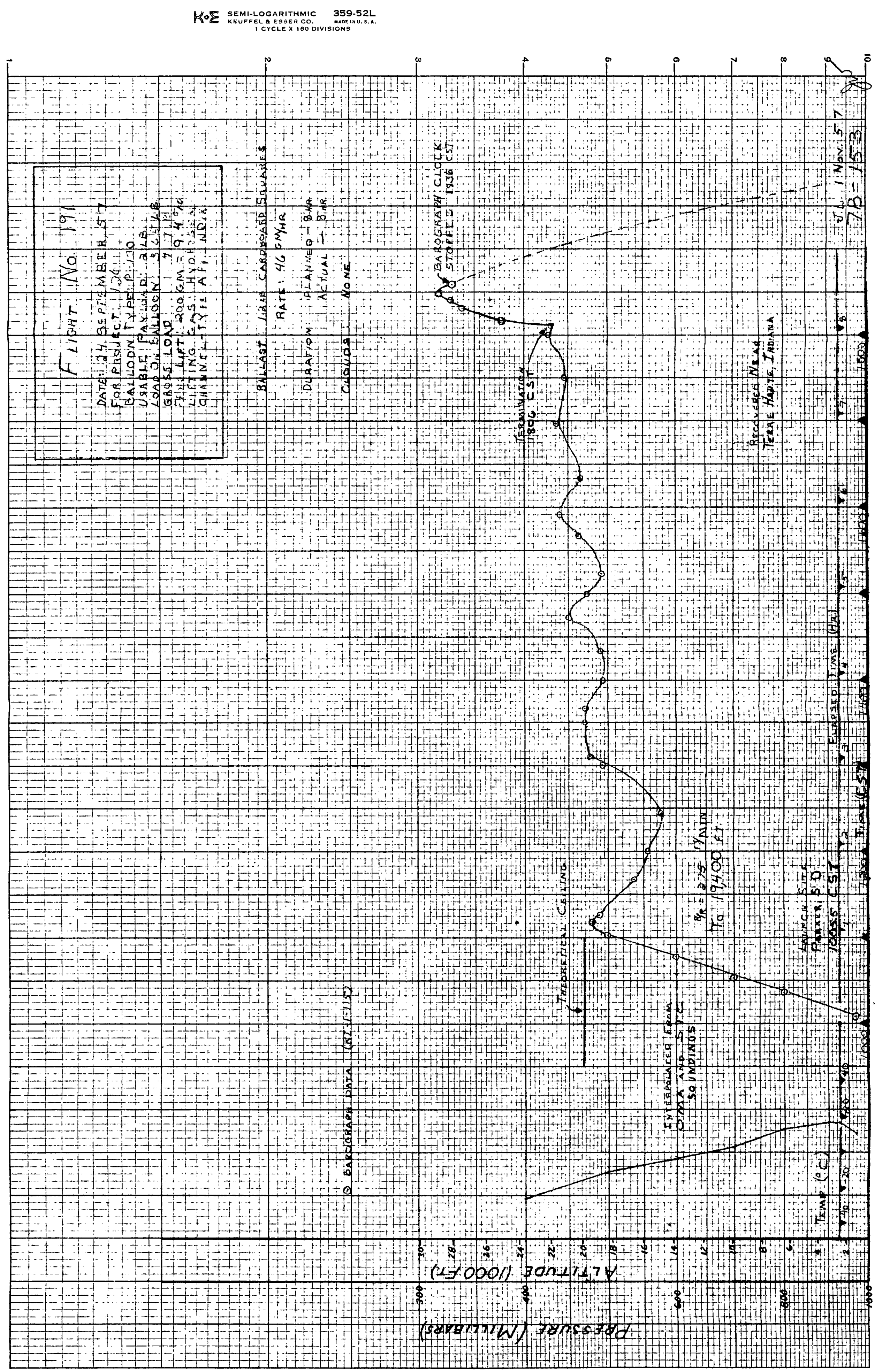
K&E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 187
DATE: 27 SEPTEMBER 57
FOR PROJECT: 126
BALLOON TYPE: P-130
USABLE PAYLOAD: 2.0 LB.
LOAD ON BALLOON: 3.55 LB.
GROSS LOAD: 4.6 LB.
FREE LIFT: 200 G.M.: 9.6%
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST: 10 LB CARDBOARD SQUARES
RATE: 35 G/HR.
DURATION: PLANNED - 8 HR.
ACTUAL - 7.8 HR. UNTIL TIMER STOPPED
CLOUDS: NONE
⊙ BAROGRAPH DATA (RL-1-705)
THEORETICAL CEILING
TIMER STOPPED 20 MIN. BEFORE SCHEDULED TERMINATION BECAUSE LOOP IN LOAD LINE FOULED
BAROGRAPH CLOCK STOPPED 1708 CST
INTERPOLATED FROM OMA AND STC SOUNDINGS
R/R = 275 FT/MIN TO 20,750 FT.
LAUNCH SITE PARKER, S.D. 0914 CST
RECOVERED NEAR TUSCOLA, ILLINOIS
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT.)
TEMP (°C)
ELAPSED TIME (HR)
TIME (CST)
0900
1000
1200
1400
1600
1800
J.L. 7 NOV 57
TB-156

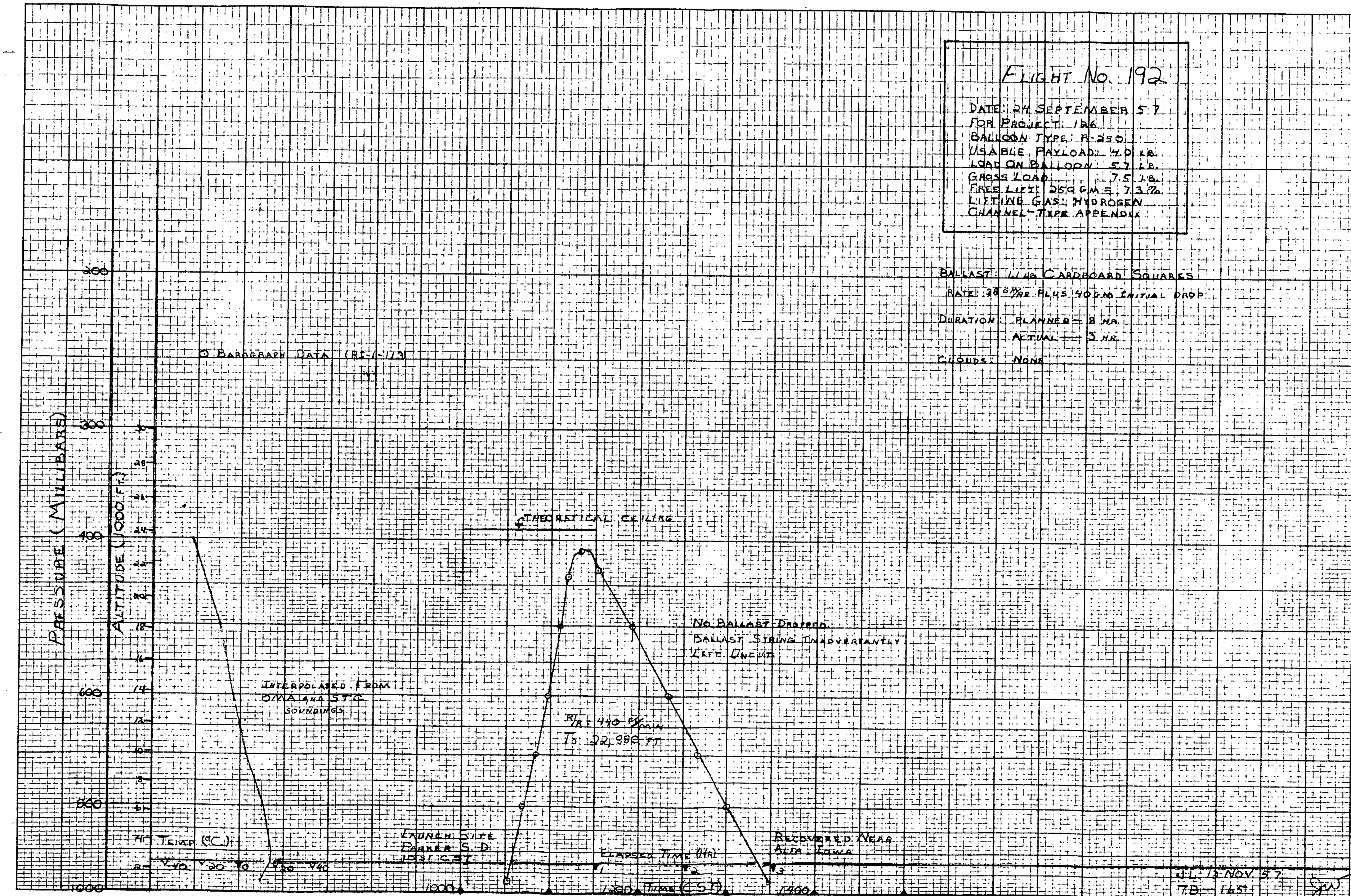

FLIGHT No. 188
DATE: 24 SEPTEMBER 57
FOR PROJECT: 126
BALLOON TYPE: P-130
USABLE PAYLOAD: 2.9 LB.
LOAD ON BALLOON: 3.45 LB.
GROSS LOAD: 4.5 LB.
FREE LIFT: 200 GM = 9.8 LB.
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST: 10 LB. CARDBOARD SQUARES
RATE: 38 GM/HR
DURATION: PLANNED - 8 HR.
ACTUAL - 3.5 HR
CLOUDS: NONE
BAROGRAPH DATA
THEORETICAL CEILING
TIMER APPARENTLY STOPPED DURING ASCENT
INTERPOLATED FROM ONA AND STC
R/R = 710 Ft/MIN TO 20,893 FT.
LAUNCH SITE PARKER, S.D. 0917 CST
RECOVERED NEAR NEWELL, IOWA
ELAPSED TIME (HR)
TIME (CST)
TEMP (°C)
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT)
JL 22 Nov 57
TD 185

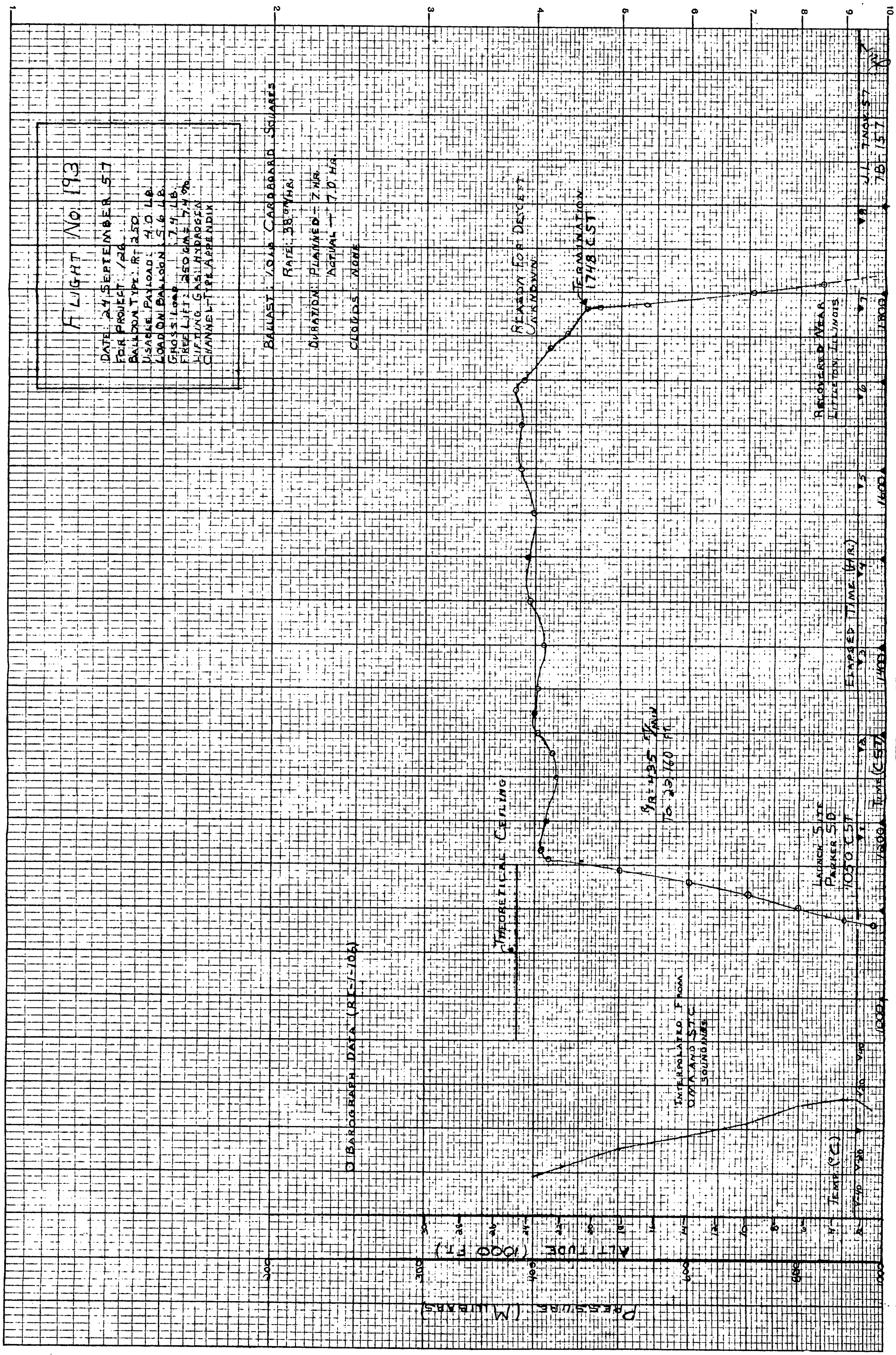


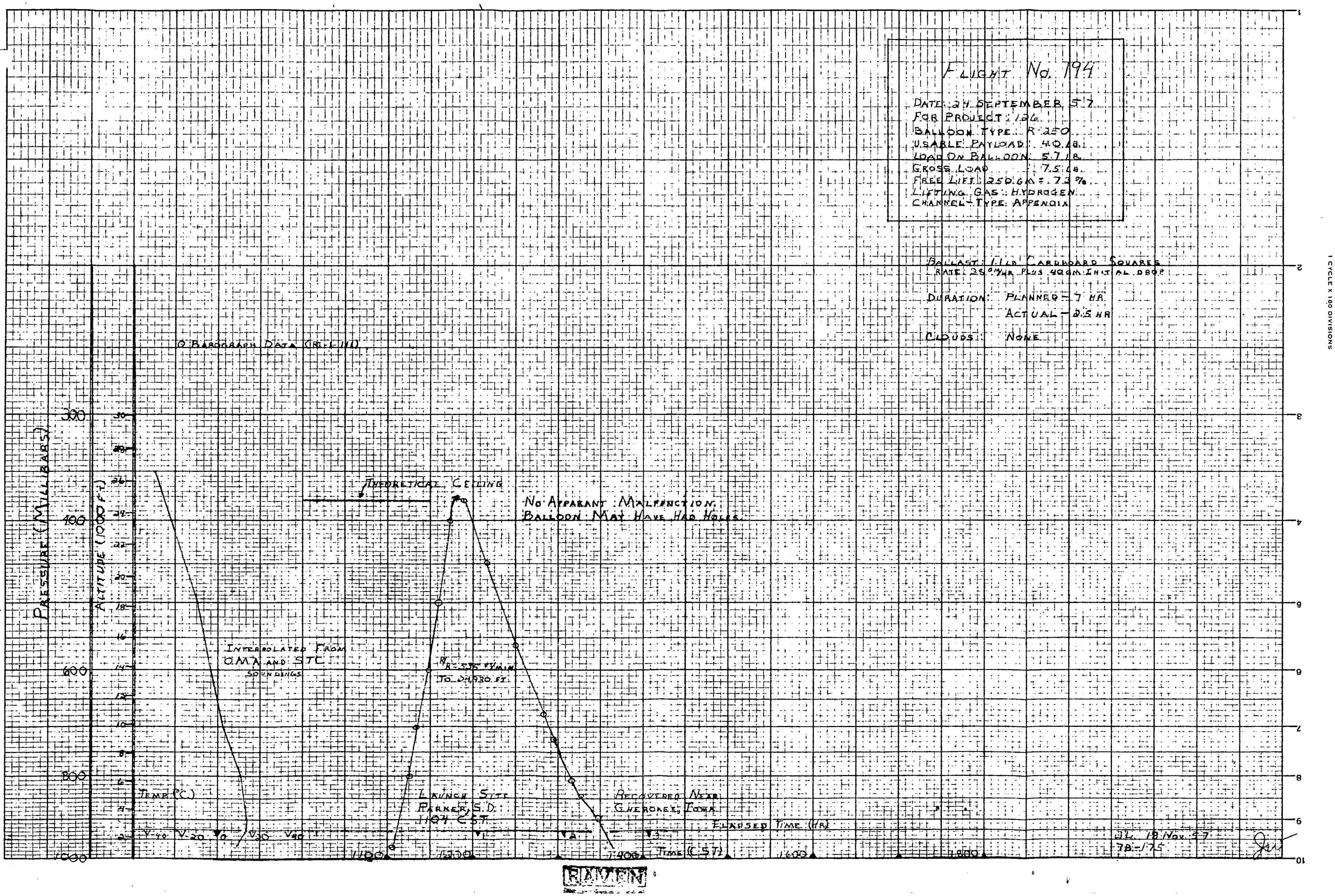
FLIGHT No. 189
DATE: 24 SEPTEMBER 57
FOR PROJECT: 121
BALLOON TYPE: R-130
USABLE PAYLOAD: 2.0 LB.
LOAD ON BALLOON: 3.05 LB.
GROSS LOAD: 4.7 LB
FREE LIFT: 300 GM = 9.4 %
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST: 1,240 CARDBOARD SQUARES
RATE: 46 GM/HR
DURATION: PLANNED - 8 HR.
ACTUAL - 1.4 HR.
CLOUDS: NONE
BAROGRAPH DATA (RE-1510)
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT)
THEORETICAL CEILING
TERMINATION
1123 CST
TERMINATION CAUSED BY
FAULTY DESIGN IN HOOK
CONNECTING TIMER TO BALLOON.
INTERPOLATED FROM
OMA AND STC
SOUNDINGS
V_R = 340 FT/MIN
TO 19,280 FT
LAUNCH SITE
PARKER, S.D.
0958 CST
RECOVERED 2 MI SW
ALTON, IOWA
TEMP. (°C)
ELAPSED TIME (HR)
0900 TIME (CST) 1100
IL 23 NOV 57
7B-186
RAVEN Industries, Inc.
K+E SEMI-LOGARITHMIC 359-52L KEUFFEL & ESSER CO. MADE IN U.S.A. 1 CYCLE X 180 DIVISIONS

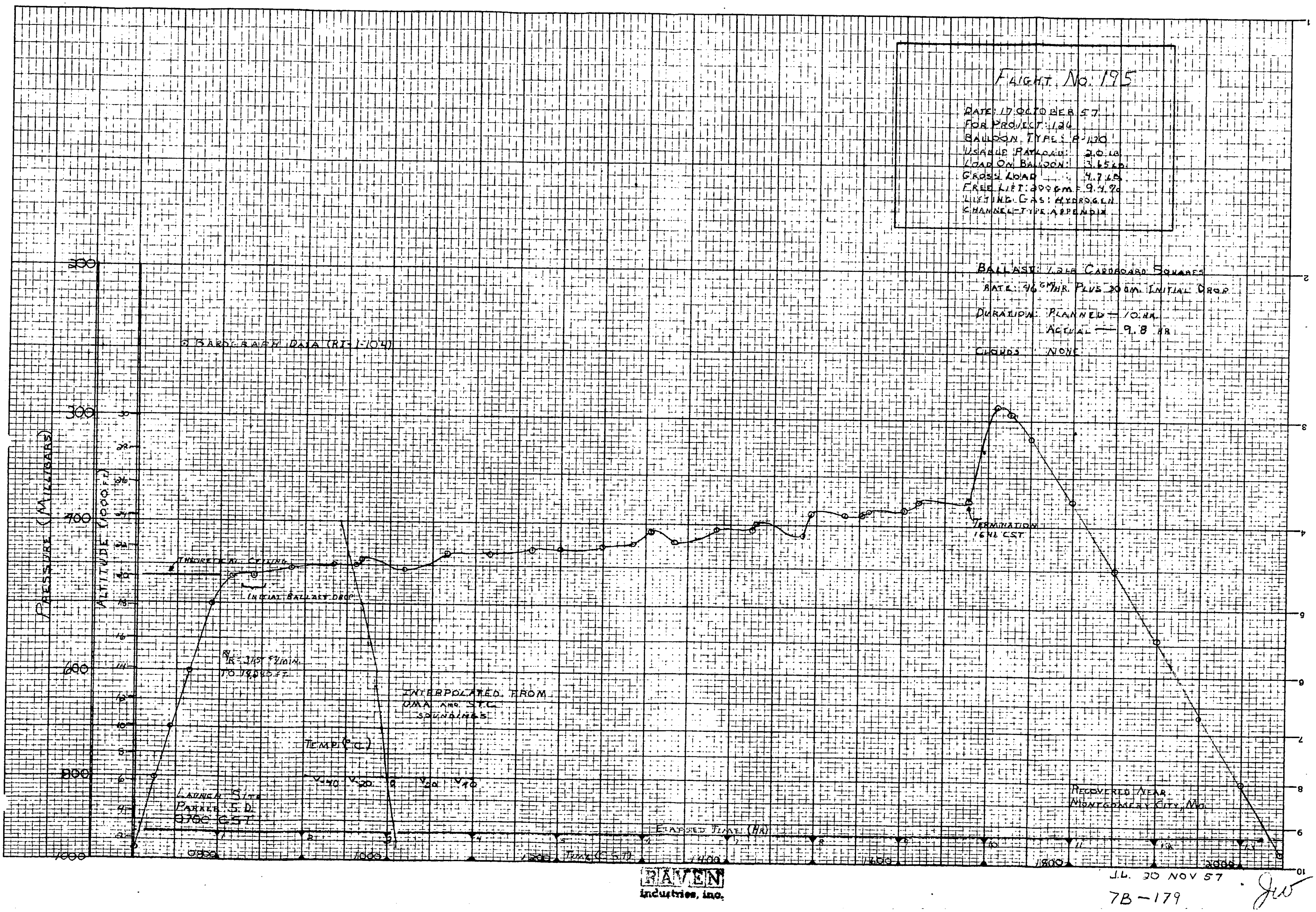

K&E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No 190
DATE: 24 SEPT 57
FOR PROJECT: 126
BALLOON TYPE: P-130
USABLE PAYLOAD: 2.0 LB
LOAD ON BALLOON: 3.65 LB
GROSS LOAD: 4.7 LB
FREE LIFT: 200 GM = 9.4%
LIFTING GAS: HYDROGEN
CHANNEL TYPE APPENDIX
BALLAST: 1.2 LB CARDBOARD SQUARES
RATE 46 GM/HR
DURATION: PLANNED - 8 HR
ACTUAL - EST 7.3 HR UNTIL TIMER STOPPED
CLOUDS: NONE
O BAROGRAPH DATA (RE-1-108)
THEORETICAL CEILING
INTERPOLATED FROM OAWA AND STC SOUNDINGS
W/R = 50 FT/MIN TO 12,880 FT
TIMER STOPPED 15 MIN BEFORE SCHEDULED TERMINATION BECAUSE LOOP IN LOAD LINE FOULED
LAUNCH SITE PARKER, S.D. 1003 CST
RECOVERED NEAR McLEAN, ILLINOIS
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT)
TEMP (°C)
ELAPSED TIME (HR)
TIME (CST)
1000
1200
1400
1600
1800
RAVEN INDUSTRIES, INC.
J.L. 15 NOV 57
7B-172


K+E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 191
DATE: 24 SEPTEMBER 57
FOR PROJECT: 136
BALLOON TYPE: P-130
USABLE PAYLOAD: 2 LB.
LOAD ON BALLOON: 3.65 LB
GROSS LOAD: 7.7 LB
FREE LIFT: 200 GM = 9.4 %
LIFTING GAS: HYDROGEN
CHANNEL TYPE: AFI, NDIR
BALLAST: 1/2 LB CARDBOARD SQUARES
RATE: 46 GM/HR
DURATION: PLANNED - 8 HR
ACTUAL - 8 HR
CLOUDS: NONE
BAROGRAPH CLOCK STOPPED 1936 CST
TERMINATION 1806 CST
RECOVERED NEAR TERRE HAUTE, INDIANA
THEORETICAL CEILING
R_R = 275 FT/MIN
To 19400 FT
INTERPOLATED FROM OMA AND STC SOUNDINGS
LAUNCH SITE PARKER, S.D.
1005 CST
ELAPSED TIME (HR)
TIME (CST)
TEMP (°C)
BAROGRAPH DATA (RI-1-115)
ALTITUDE (1000 FT)
PRESSURE (MILLIBARS)
J.L. 1 Nov. 57
7B-153

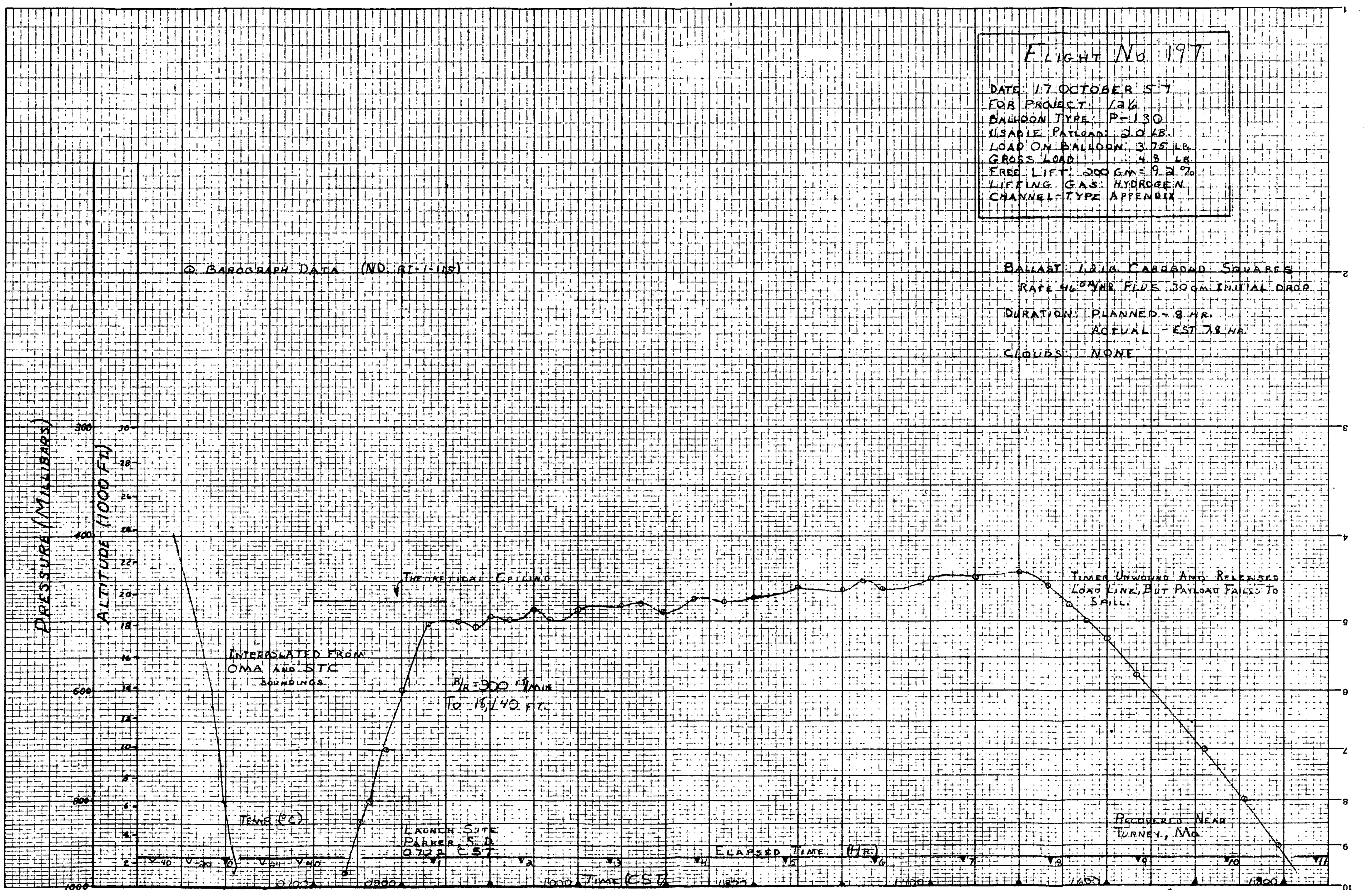

FLIGHT NO. 192
DATE: 24 SEPTEMBER 57
FOR PROJECT: 126
BALLOON TYPE: R-250
USABLE PAYLOAD: 4.0 LB.
LOAD ON BALLOON: 5.7 LB.
GROSS LOAD: 7.5 LB.
FREE LIFT: 259 GM = 7.3%
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST: 1.1 LB CARDBOARD SQUARES
RATE: 38 GM/HR PLUS 40 GM INITIAL DROP
DURATION: PLANNED = 8 HR.
ACTUAL = 3 HR.
CLOUDS: NONE
O BAROGRAPH DATA (RS-1-173)
THEORETICAL CEILING
NO BALLAST DROPPED.
BALLAST STRING INADVERTANTLY
LEFT UNCUT.
INTERPOLATED FROM
OMA AND STC
SOUNDINGS
R/R: 440 FT/MIN
Ts: 22,990 FT
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT)
TEMP (°C)
LAUNCH SITE
PARKER, S.D.
1031 CST
ELAPSED TIME (HR)
TIME (CST)
RECOVERED NEAR
ALTA, IOWA
1000
1200
1400
200
300
400
600
800
1000
J.L. 12 NOV 57
TB-165
JW


K&E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No 193
DATE: 24 SEPTEMBER 57
FOR PROJECT: 126
BALLOON TYPE: R-250
USABLE PAYLOAD: 4.0 LB.
LOAD ON BALLOON: 5.6 LB.
GROSS LOAD: 7.4 LB.
FREE LIFT: 250 GMS = 7.4%
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST: 1.0 LB CARDBOARD SQUARES
RATE: 38 GM/HR.
DURATION: PLANNED - 7 HR.
ACTUAL - 7.0 HR.
CLOUDS: NONE
O BAROGRAPH DATA (RI-1-106)
THEORETICAL CEILING
REASON FOR DESCENT UNKNOWN
TERMINATION 1748 CST
VR = 435 FT/MIN TO 23,160 FT
INTERPOLATED FROM OMA AND STC SOUNDINGS
LAUNCH SITE PARKER S.D. 1050 CST
RECOVERED NEAR LITTLETON, ILLINOIS
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT.)
TEMP. (°C)
ELAPSED TIME (HR.)
TIME (CST)
1000
1200
1400
1600
1800
J.J. 7 NOV 57
7B-157


K+E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 194
DATE: 24 SEPTEMBER 57
FOR PROJECT: 126
BALLOON TYPE: R 250
USABLE PAYLOAD: 40 LB.
LOAD ON BALLOON: 5.7 LB.
GROSS LOAD: 7.5 LB.
FREE LIFT: 250 GM = 7.3%
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
BALLAST: 1.1 LB CARDBOARD SQUARES
RATE: 25 g/HR PLUS 400 GM INITIAL DROP
DURATION: PLANNED - 7 HR.
ACTUAL - 2.5 HR
CLOUDS: NONE
⊙ BAROGRAPH DATA (RL-L-111)
THEORETICAL CEILING
NO APPARENT MALFUNCTION.
BALLOON MAY HAVE HAD HOLES.
INTERPOLATED FROM OMA AND STC SOUNDINGS
R = 575 FT/MIN TO 24,930 FT.
LAUNCH SITE PARKER, S.D. 1104 CST.
RECOVERED NEAR CHEROKEE, IOWA
TEMP (°C)
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT.)
ELAPSED TIME (HR)
TIME (CST)
1100
1200
1400
1600
1800
300
400
600
800
1000
JL 18 Nov 57
78-175
RAVEN



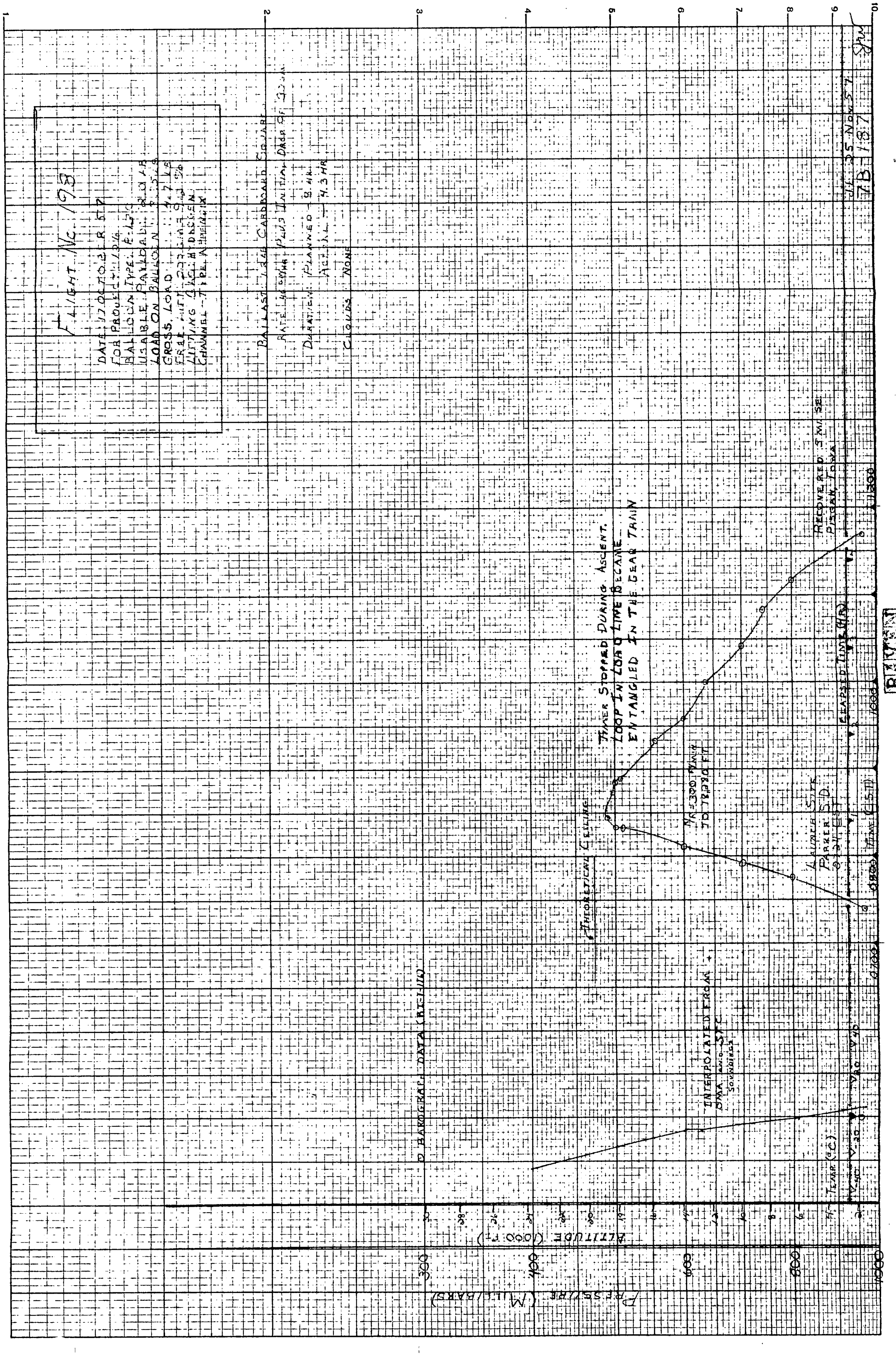
RAVEN Industries, inc.

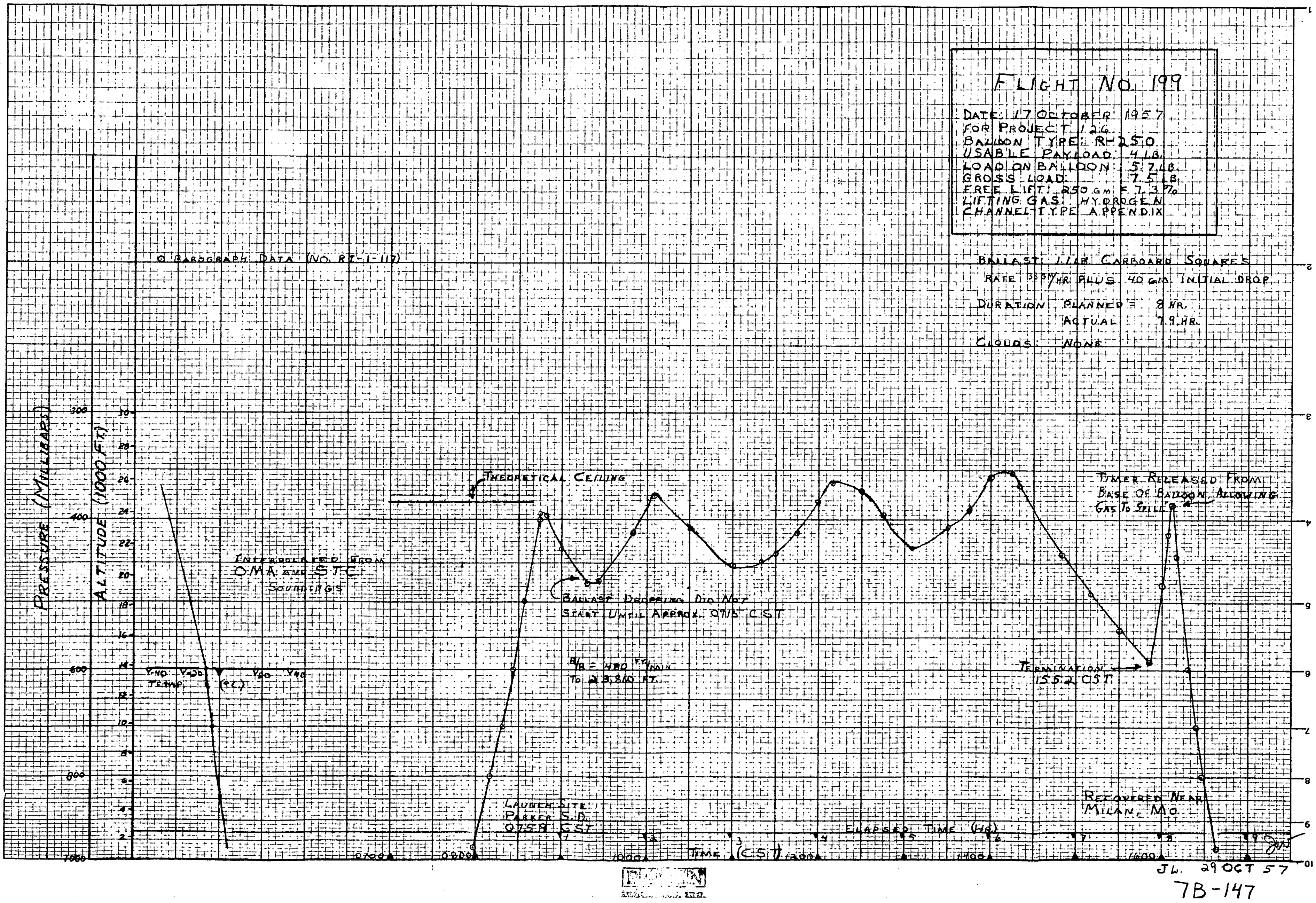


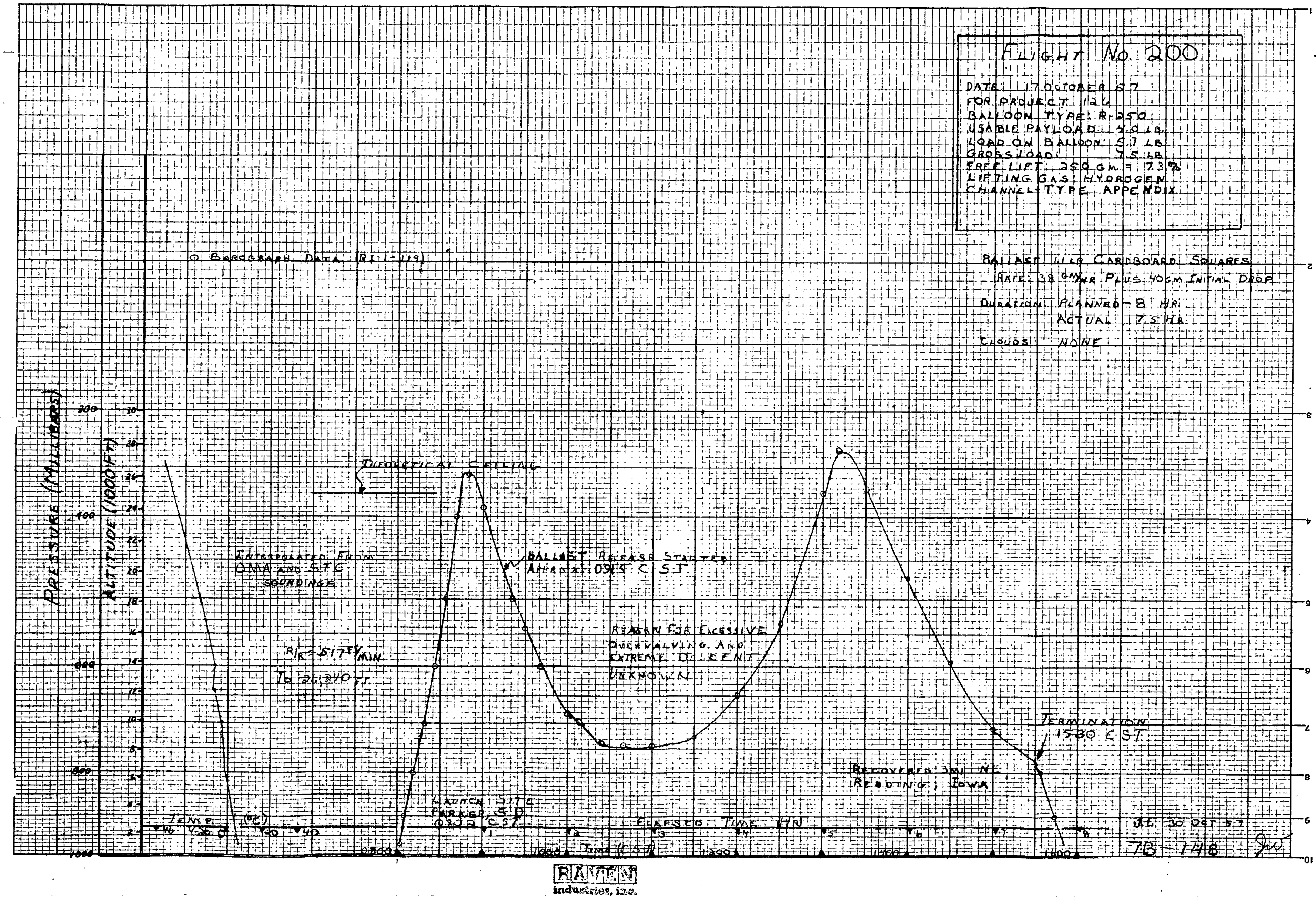
RAVEN Industries, Inc.

J.L. 31 OCT 57
7B-150

K&E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS




K+E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT NO. 199
DATE: 17 OCTOBER 1957
FOR PROJECT 126
BALLOON TYPE: R-250
USABLE PAYLOAD 4 LB.
LOAD ON BALLOON: 5.7 LB.
GROSS LOAD: 7.5 LB.
FREE LIFT: 250 GM. F 7.3 %
LIFTING GAS: HYDROGEN
CHANNEL TYPE APPENDIX
BALLAST: 1.1 LB CARBOARD SQUARES
RATE 33 GM/HR PLUS 40 GM. INITIAL DROP
DURATION: PLANNED = 8 HR.
ACTUAL 7.9 HR.
CLOUDS: NONE
⊙ BAROGRAPH DATA (NO. RT-1-117)
INTERPOLATED FROM OMA AND STC SOUNDINGS
THEORETICAL CEILING
BALLAST DROPPING DID NOT START UNTIL APPROX. 0915 CST
R/R = 480 FT./MIN TO 23,860 FT.
LAUNCH SITE PARKER S.D. 0758 CST
TIMER RELEASED FROM BASE OF BALLOON ALLOWING GAS TO SPILL
TERMINATION 1552 CST
RECOVERED NEAR MILAN, MO.
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT.)
TIME (CST)
ELAPSED TIME (HR)
JL. 29 OCT 57
7B-147



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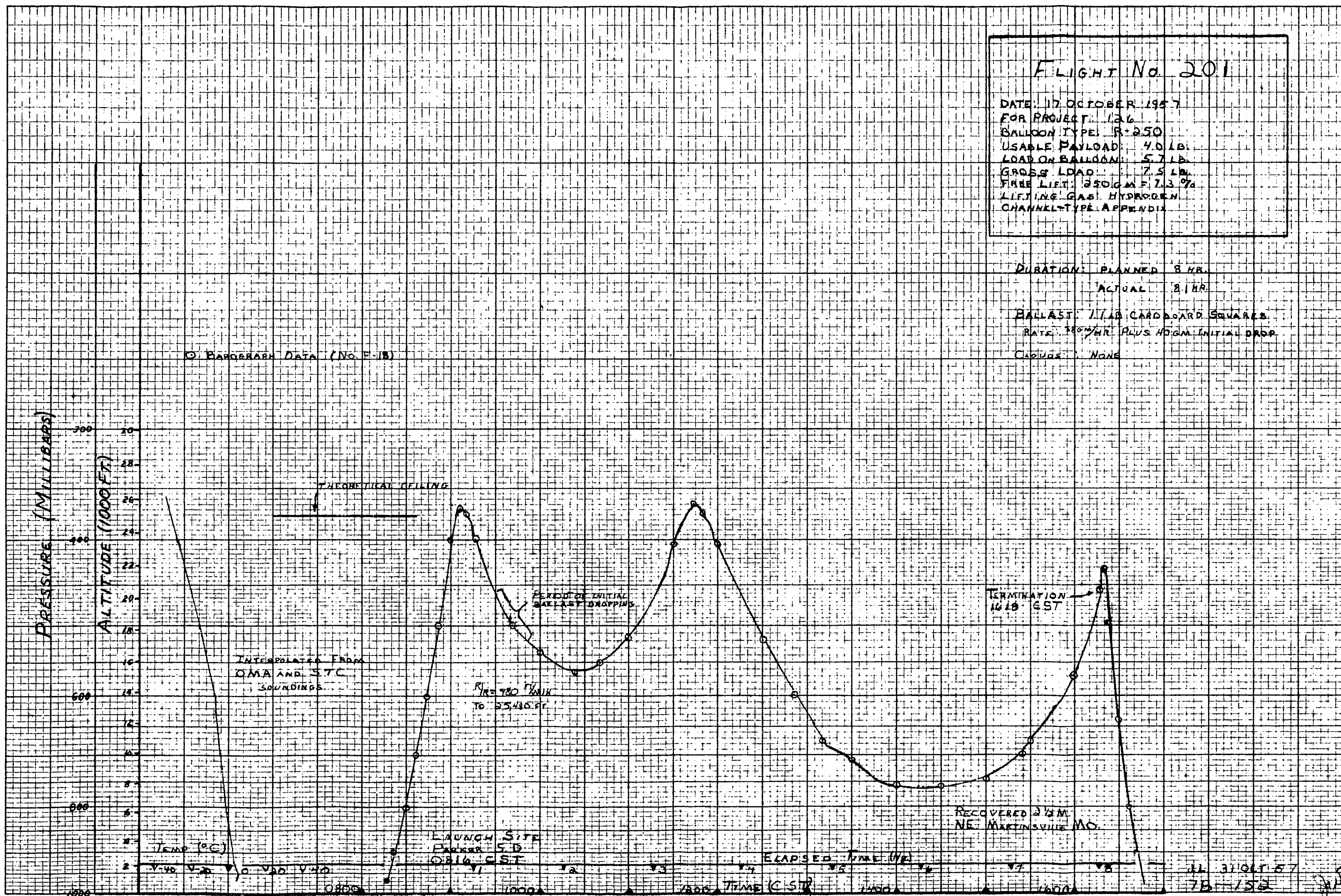
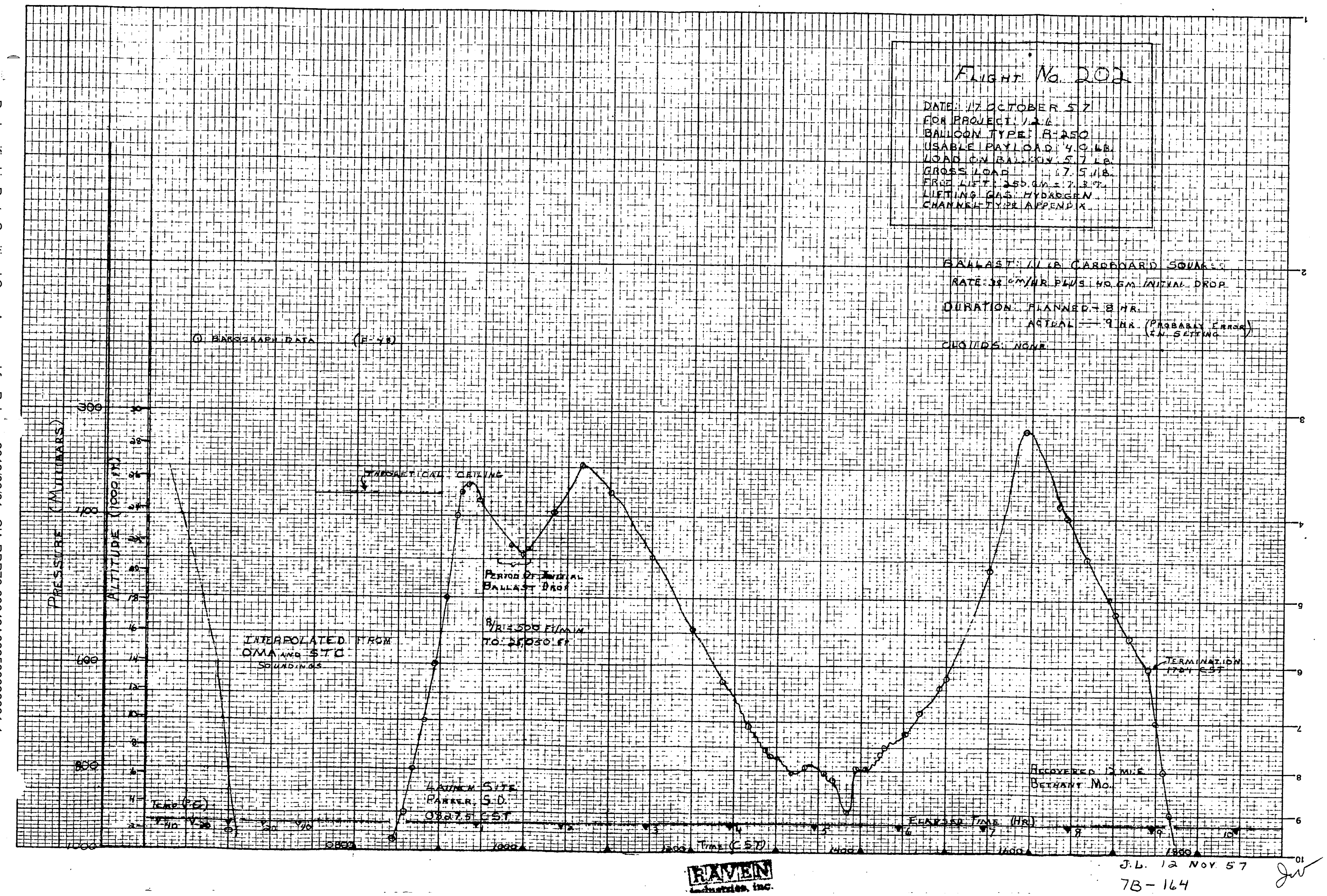
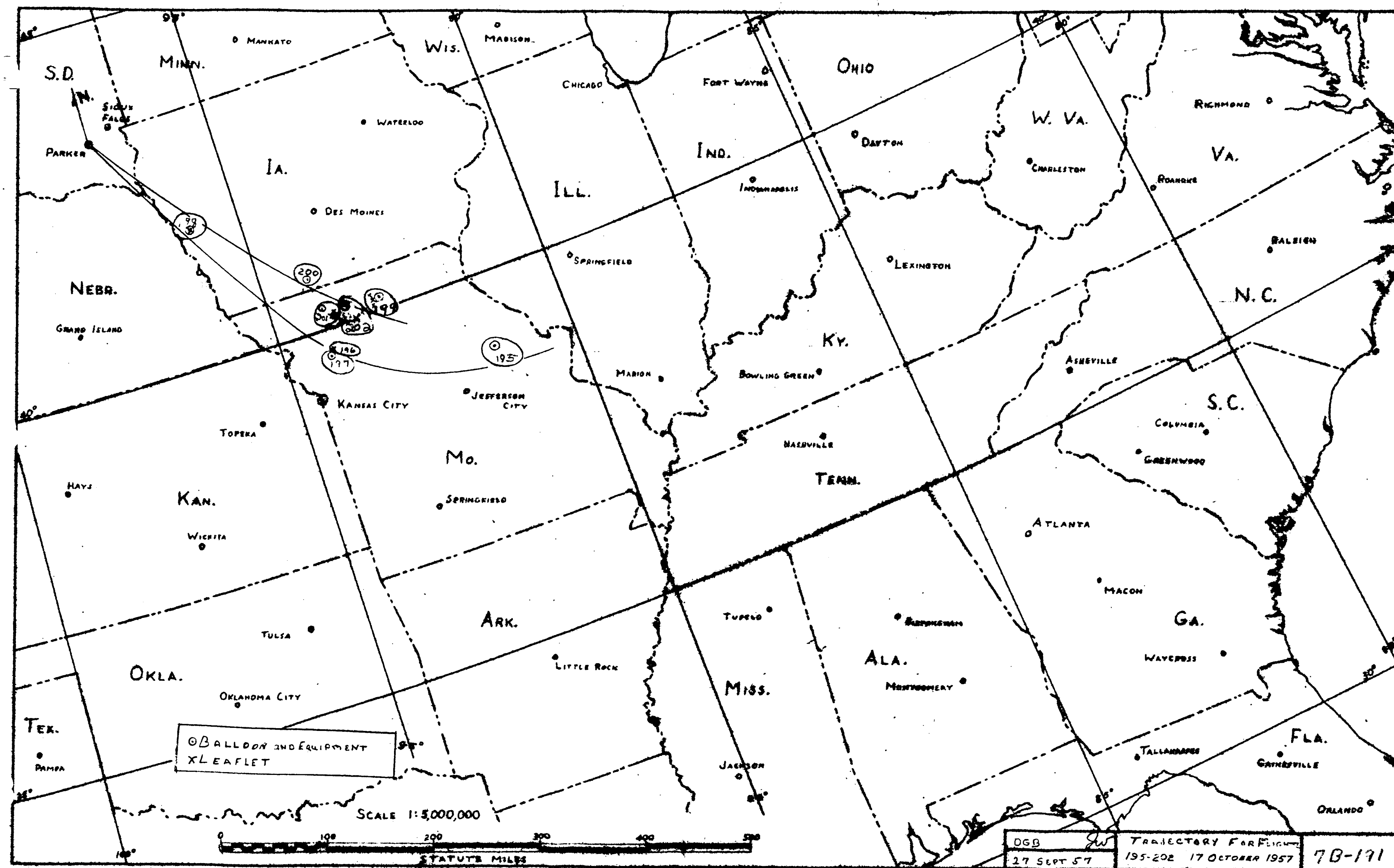
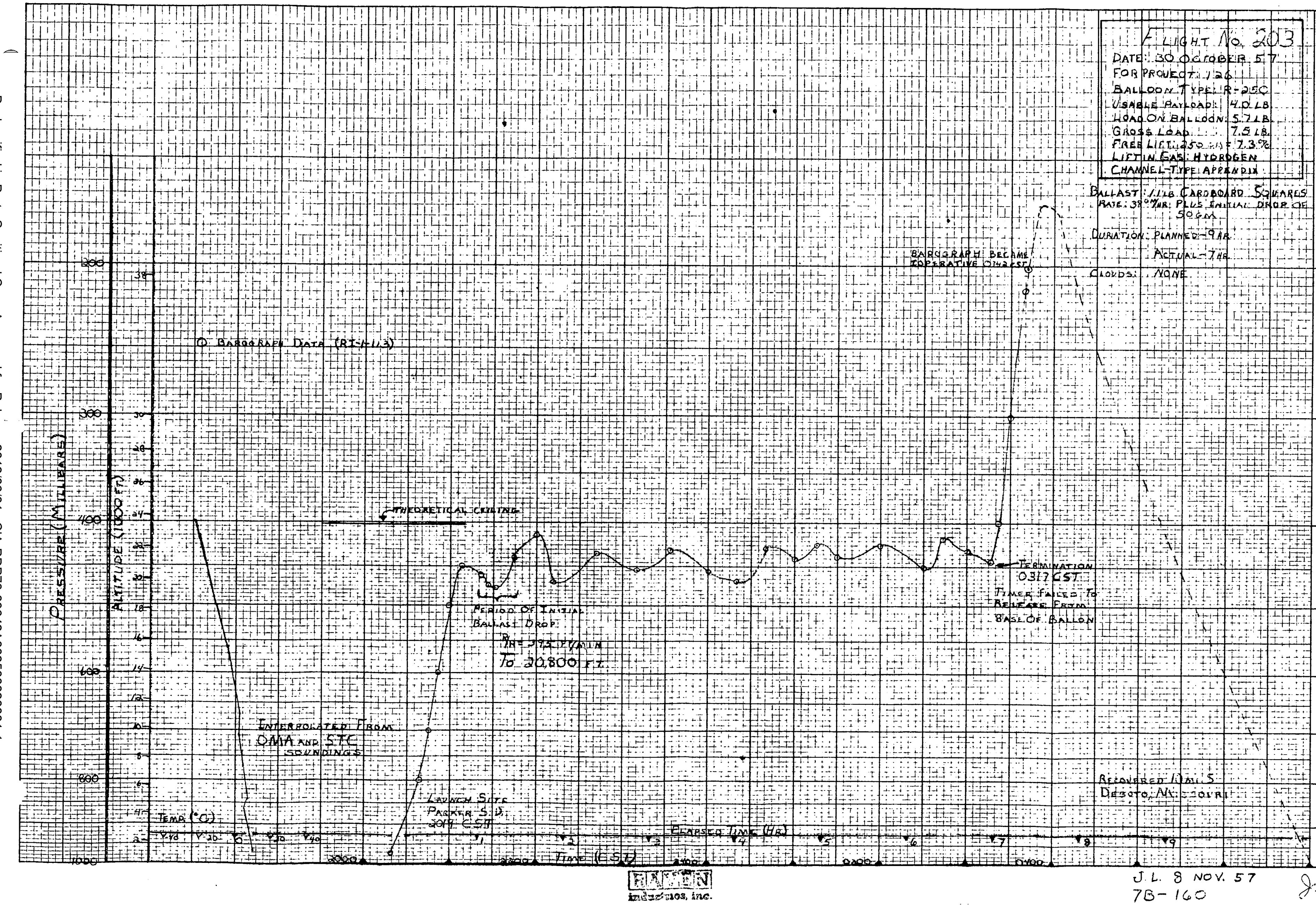

FLIGHT No. 201
DATE: 17 OCTOBER 1957
FOR PROJECT: 126
BALLOON TYPE: R-250
USABLE PAYLOAD: 4.0 LB.
LOAD ON BALLOON: 5.7 LB.
GROSS LOAD: 7.5 LB.
FREE LIFT: 250 GM = 7.3 %
LIFTING GAS: HYDROGEN
CHANNEL-TYPE APPENDIX
DURATION: PLANNED 8 HR.
ACTUAL 8.1 HR.
BALLAST: 1.1 LB CARDBOARD SQUARES
RATE: 380 GM/HR PLUS 40 GM INITIAL DROP
CLOUDS: NONE
O BAROGRAPH DATA (No. F-18)
THEORETICAL CEILING
PERIOD OF INITIAL BALLAST DROPPING
R/R = 980 FT/MIN TO 25480 FT.
INTERPOLATED FROM OMA AND STC SOUNDINGS
TERMINATION 1618 CST
RECOVERED 2 1/2 M. NE MARTINSVILLE MO.
LAUNCH SITE PARKER S.D. 0816 CST
TEMP (°C)
-40 -20 0 20 40
ELAPSED TIME (HR)
1 2 3 4 5 6 7 8
TIME (CST)
0800 1000 1200 1400 1600
PRESSURE (MILLIBARS)
300 400 600 800 1000
ALTITUDE (1000 FT.)
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
JL 31 OCT 57
7B-152



J.L. 12 NOV 57
7B-164

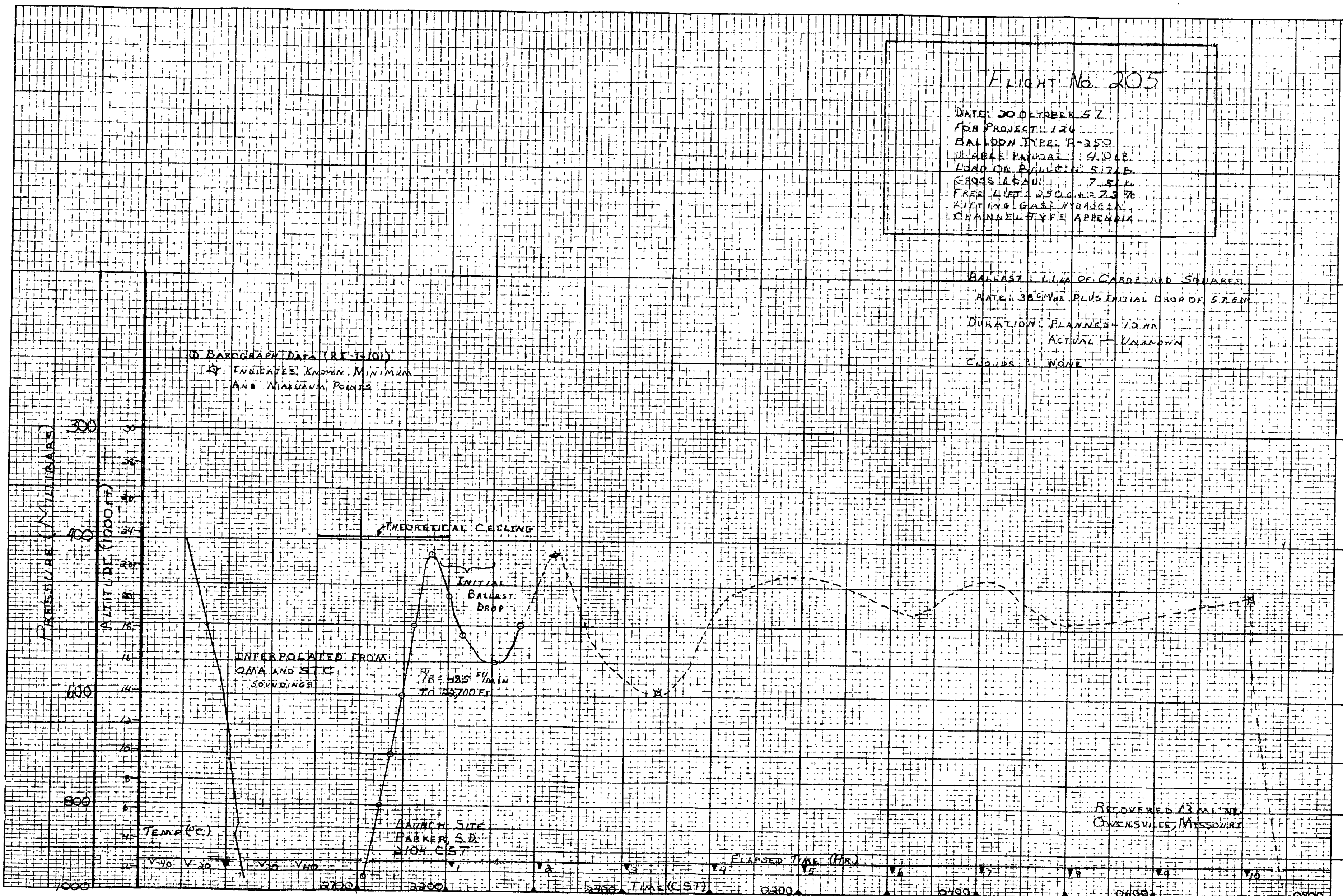

TRAJECTORY FOR FLIGHT
195-202 17 OCTOBER 1957
7B-171
DGB
27 SEPT 57
78-010
⊙ BALLOON AND EQUIPMENT
x LEAFLET
SCALE 1:5,000,000
STATUTE MILES
0
100
200
300
400
500
S.D.
MINN.
WIS.
IA.
NEBR.
KAN.
MO.
ILL.
IND.
OHIO
KY.
TENN.
W. VA.
VA.
N.C.
S.C.
GA.
ALA.
MISS.
ARK.
OKLA.
TEX.
FLA.
PARKER
SIOUX FALLS
MANKATO
MADISON
WATERLOO
DES MOINES
GRAND ISLAND
KANSAS CITY
JEFFERSON CITY
TOPEKA
HAYS
WICHITA
SPRINGFIELD
TULSA
OKLAHOMA CITY
PAMPA
LITTLE ROCK
CHICAGO
FORT WAYNE
INDIANAPOLIS
MARION
DAYTON
LEXINGTON
BOWLING GREEN
NASHVILLE
CHARLESTON
RICHMOND
ROANOKE
RALEIGH
ASHEVILLE
COLUMBIA
GREENWOOD
ATLANTA
MACON
WAYCROSS
TUPELO
BIRMINGHAM
MONTGOMERY
JACKSON
TALLAHASSEE
GAINESVILLE
ORLANDO
195
196
197
199
200
202



J.L. 8 NOV. 57
7B-160

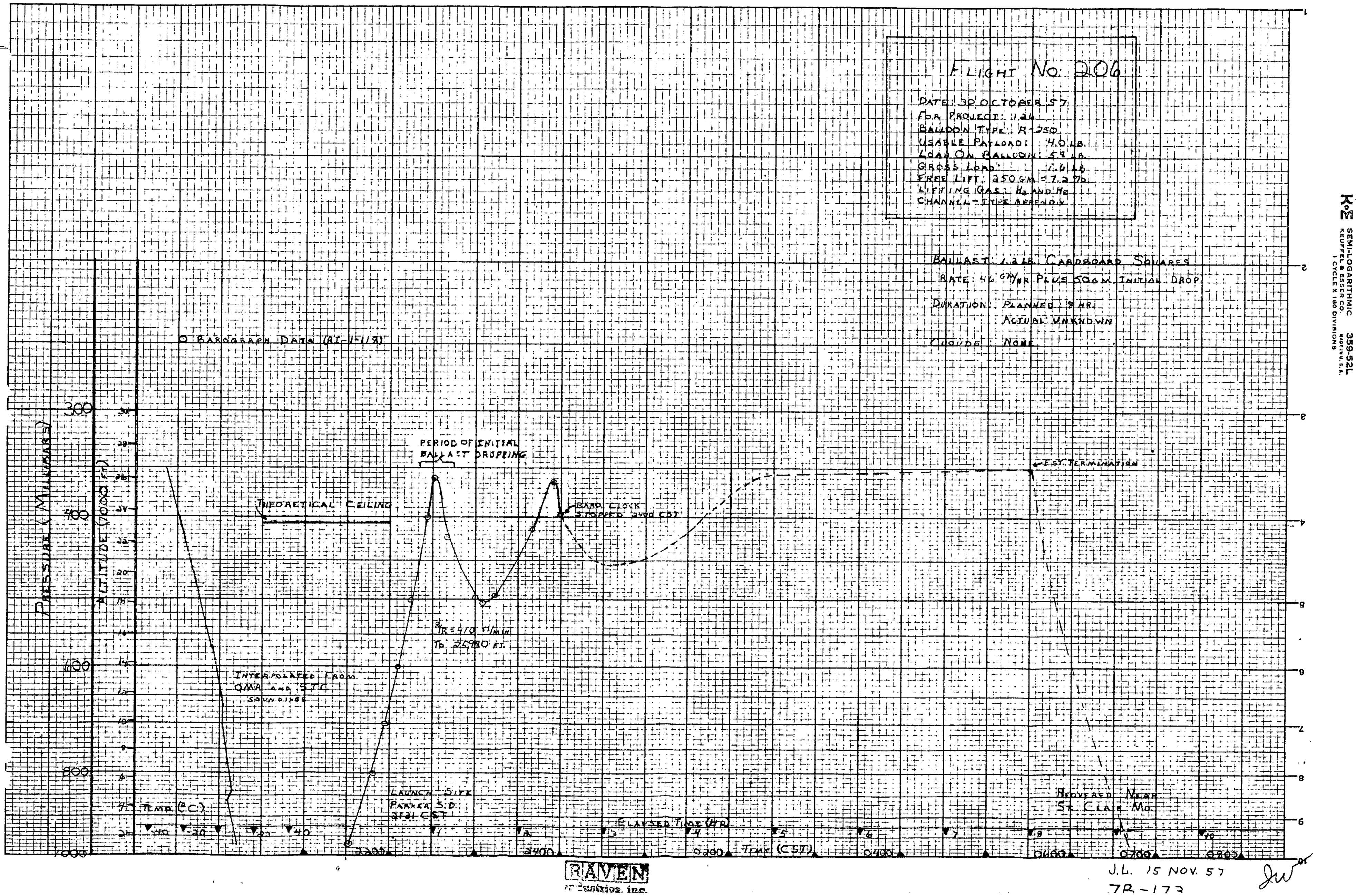
K+E SEMI-LOGARITHMIC 359-52L KEUFFEL & ESSER CO. MADE IN U.S.A. 1 CYCLE X 180 DIVISIONS

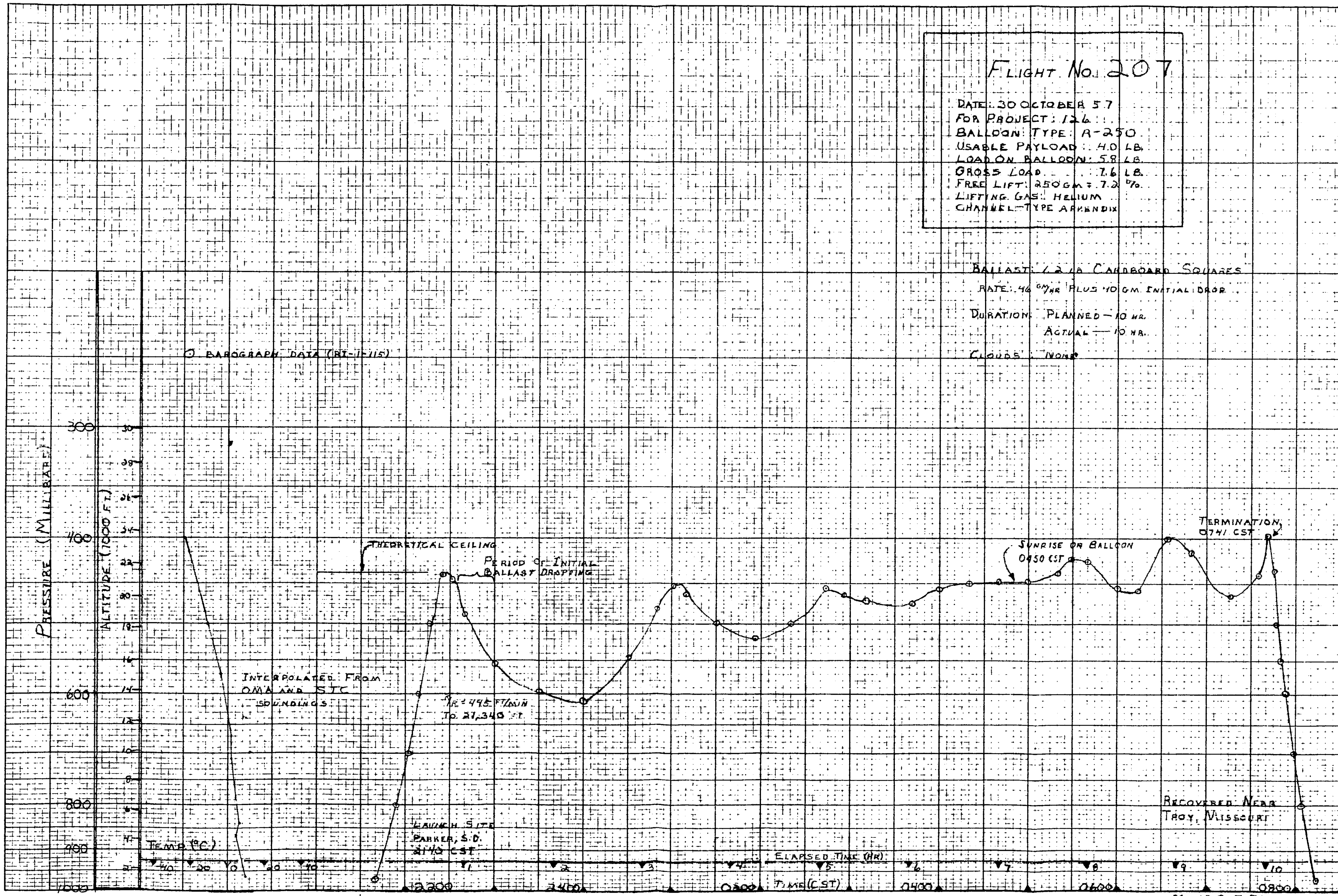
K+E SEMI-LOGARITHMIC 359-52L KEUFFEL & ESSER CO. MADE IN U.S.A. 1 CYCLE X 180 DIVISIONS



RAVEN industries, inc.

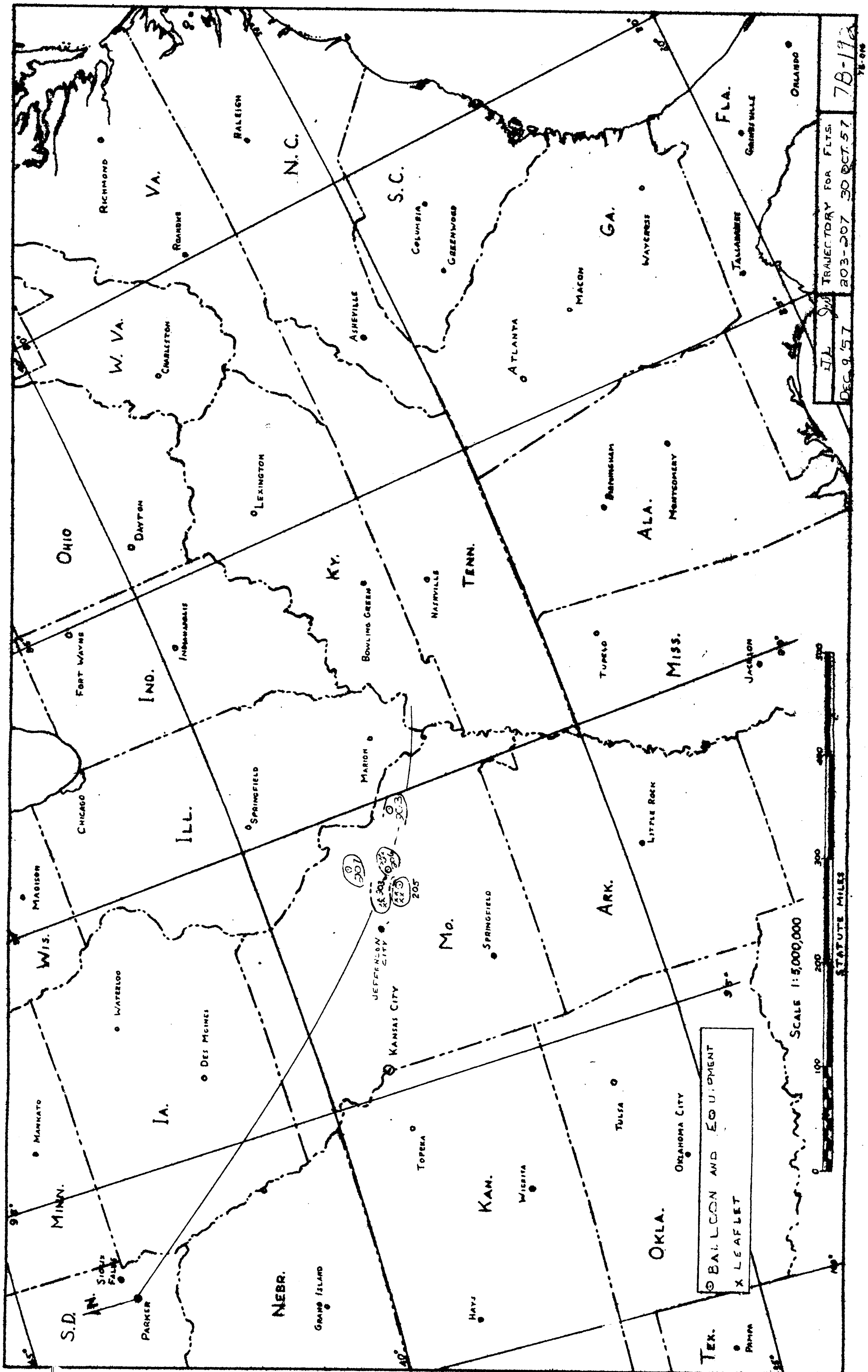
J.L. 19 NOV. 57
7R-177


K+E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 206
DATE: 30 OCTOBER 57
FOR PROJECT: 1.24
BALLOON TYPE: R-250
USABLE PAYLOAD: 4.0 LB.
LOAD ON BALLOON: 5.8 LB.
GROSS LOAD: 7.6 LB.
FREE LIFT: 250 GM = 7.2%
LIFTING GAS: H2 AND He
CHANNEL-TYPE APPENDIX
BALLAST: 1.2 LB. CARDBOARD SQUARES
RATE: 46 GM/HR PLUS 506 M. INITIAL DROP
DURATION: PLANNED: 9 HR.
ACTUAL: UNKNOWN
CLOUDS: NONE
O BAROGRAPH DATA (RI-1-118)
PERIOD OF INITIAL BALLAST DROPPING
THEORETICAL CEILING
BARO. CLOCK STOPPED 2400 CST
EST. TERMINATION
R/R = 410 FT/MIN
To 25980 FT.
INTERPOLATED FROM OMA AND STC SOUNDINGS
LAUNCH SITE PARKER S.D. 2131 CST
RECOVERED NEAR ST. CLAIR MO.
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT)
TEMP (°C)
ELAPSED TIME (HR)
TIME (CST)
RAVEN INDUSTRIES, INC.
J.L. 15 NOV. 57
7R-173

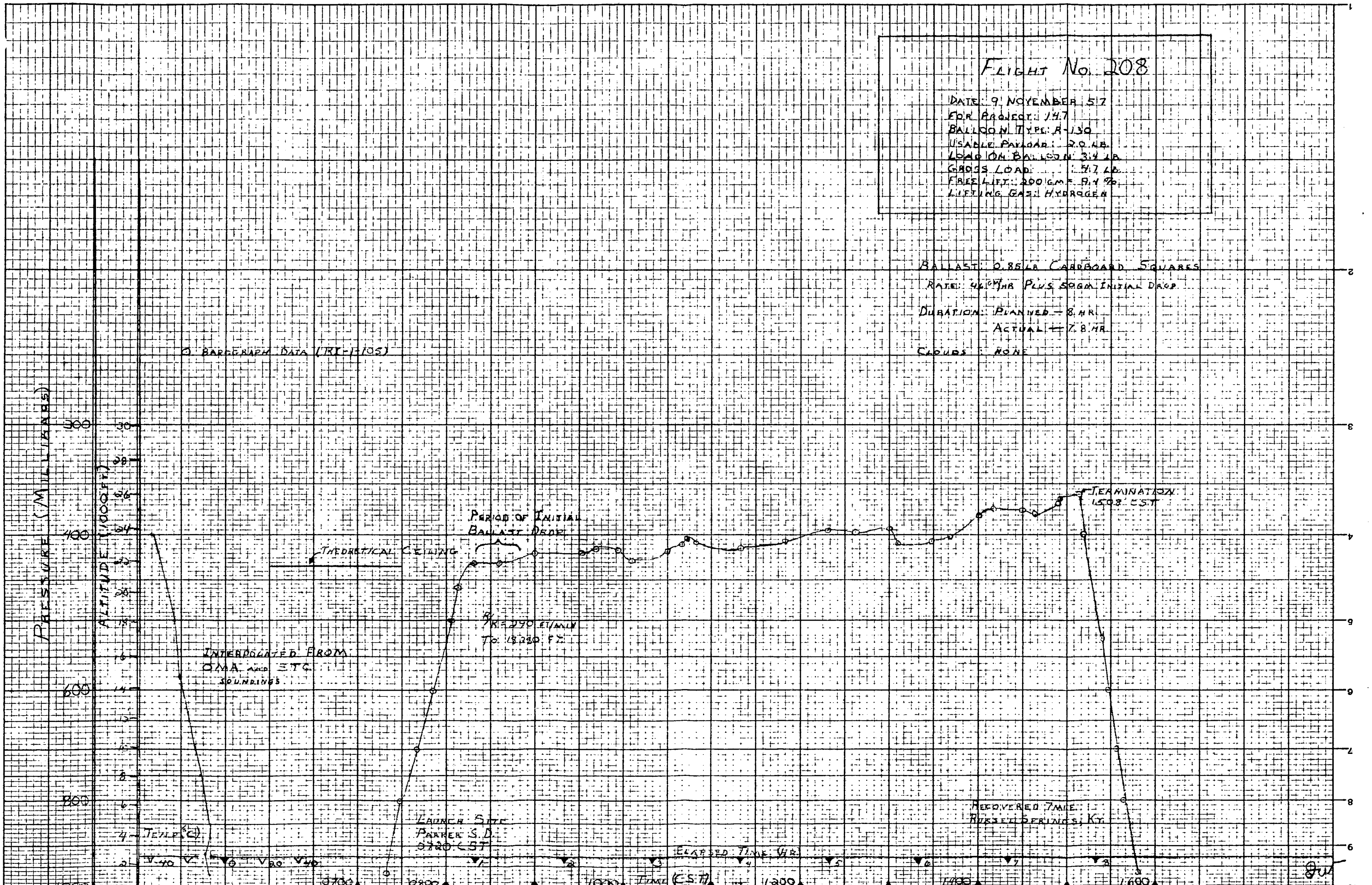


RAVEN Industries, Inc.

J.L. 13 OCT 57
7B-167



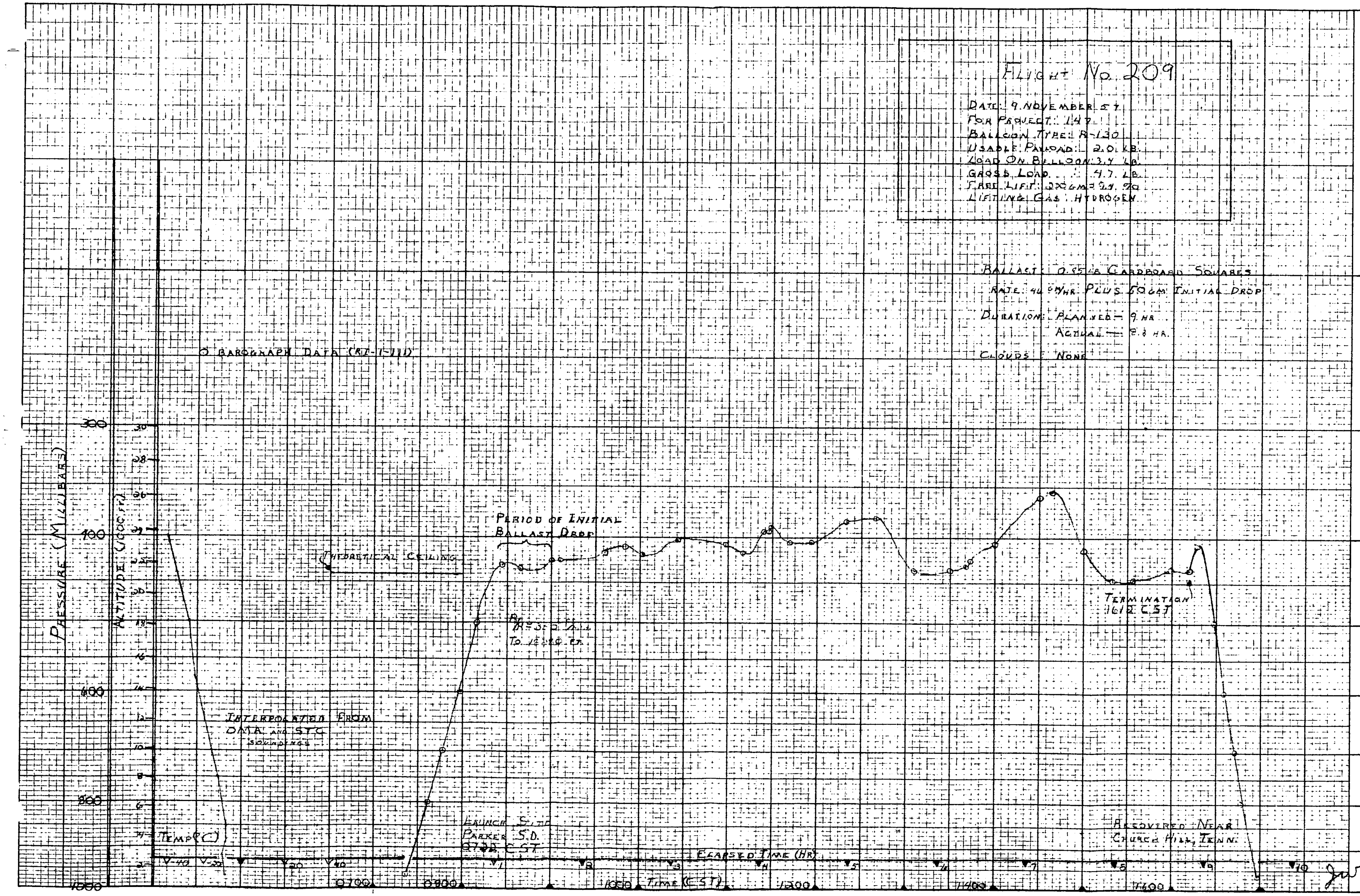
TRAJECTORY FOR FLTS.
203-207 30 OCT. 57
7B-17a
DEC 9 '57
BALLOON AND EQUIPMENT
X LEAFLET
SCALE 1:5,000,000
STATUTE MILES
0
100
200
300
400
500
203
204
205
206
207
S.D.
MINN.
WIS.
IA.
NEBR.
KAN.
MO.
ILL.
IND.
OHIO
W. VA.
VA.
N.C.
S.C.
GA.
FLA.
ALA.
TENN.
KY.
MISS.
ARK.
OKLA.
TEX.
PARKER
SIOUX FALLS
MANKATO
MADISON
WATERLOO
DES MOINES
GRAND ISLAND
HAYS
TOPEKA
WICHITA
KANSAS CITY
JEFFERSON CITY
SPRINGFIELD
CHICAGO
MARION
FORT WAYNE
INDIANAPOLIS
DAYTON
LEXINGTON
BOWLING GREEN
NASHVILLE
CHARLESTON
ROANOKE
RICHMOND
RALEIGH
ASHEVILLE
COLUMBIA
GREENWOOD
ATLANTA
MACON
WAYCROSS
TALLAHASSEE
GAINESVILLE
ORLANDO
BIRMINGHAM
MONTGOMERY
TUPELO
JACKSON
LITTLE ROCK
TULSA
OKLAHOMA CITY
PAMPA



J.L. 21 NOV. 57

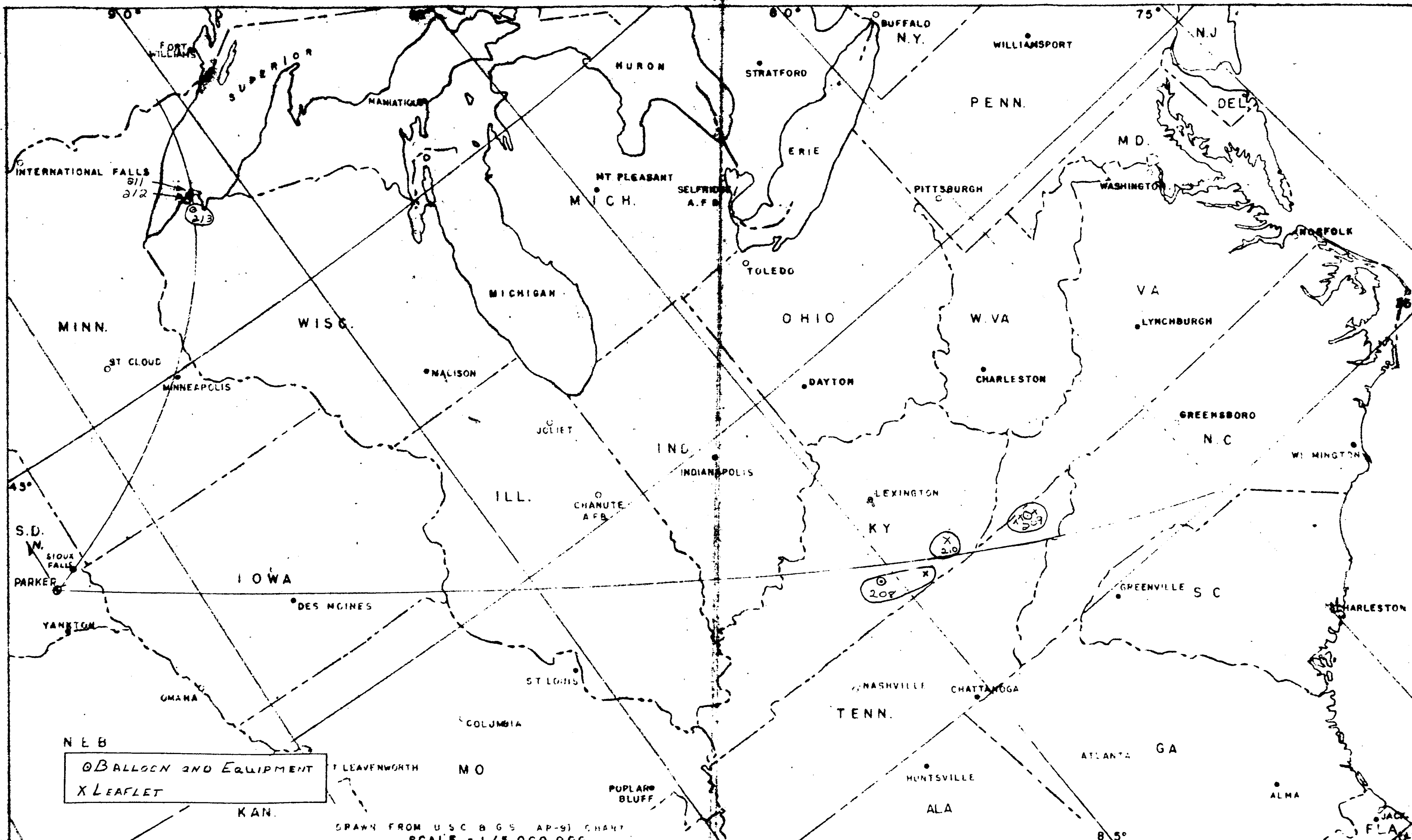
7B-182

RAVEN INDUSTRIES, INC.

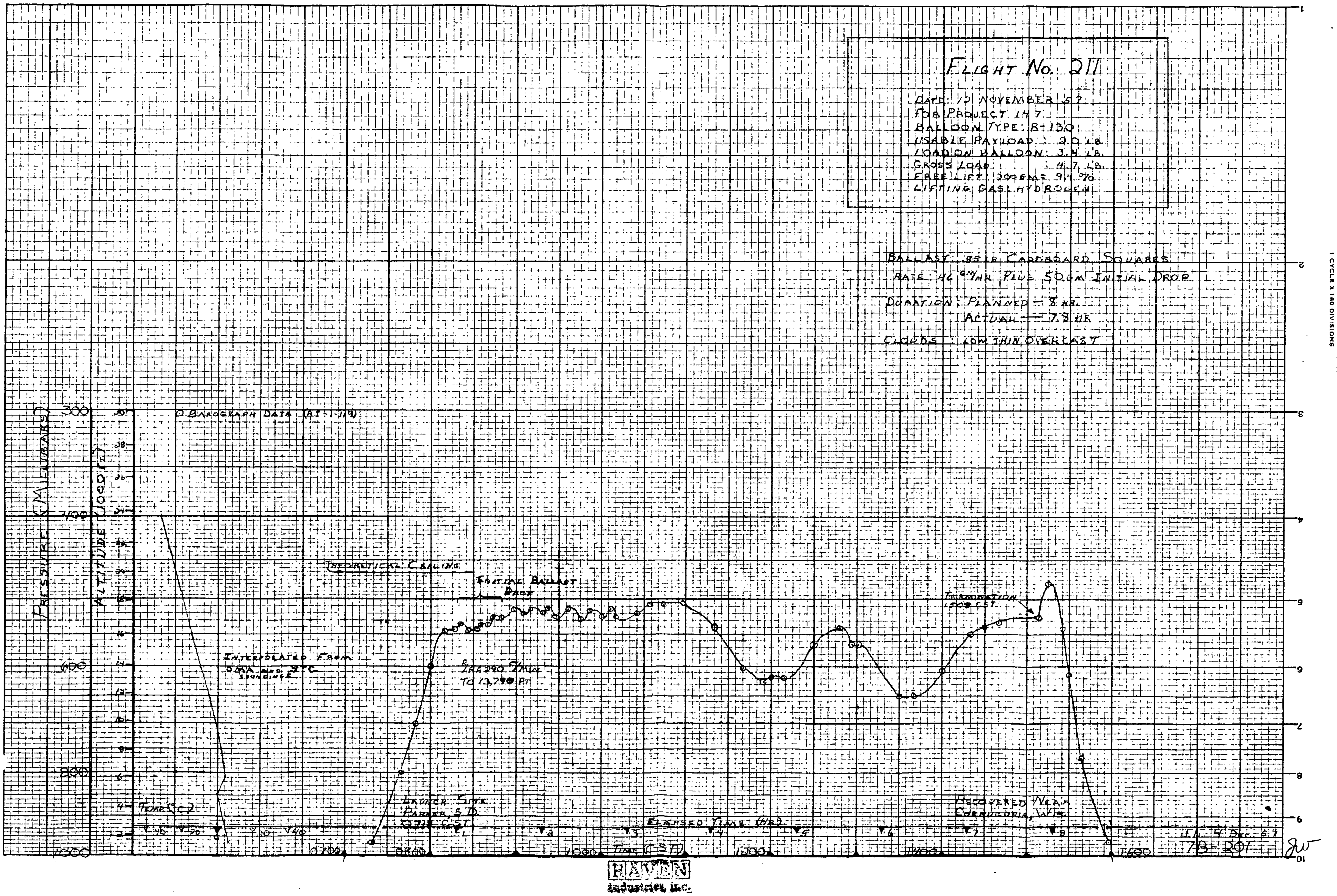


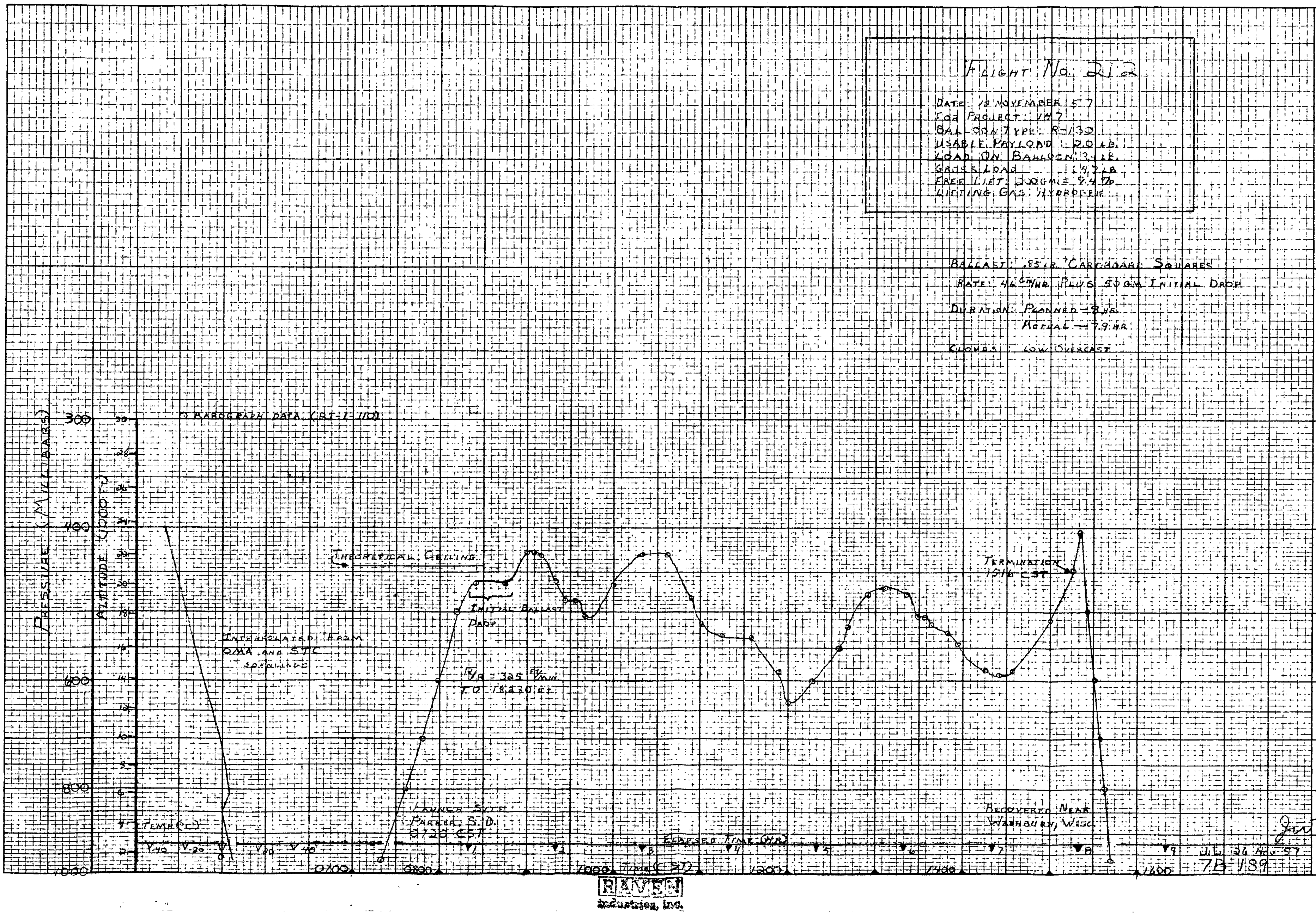
J.L. 31 NOV. 57

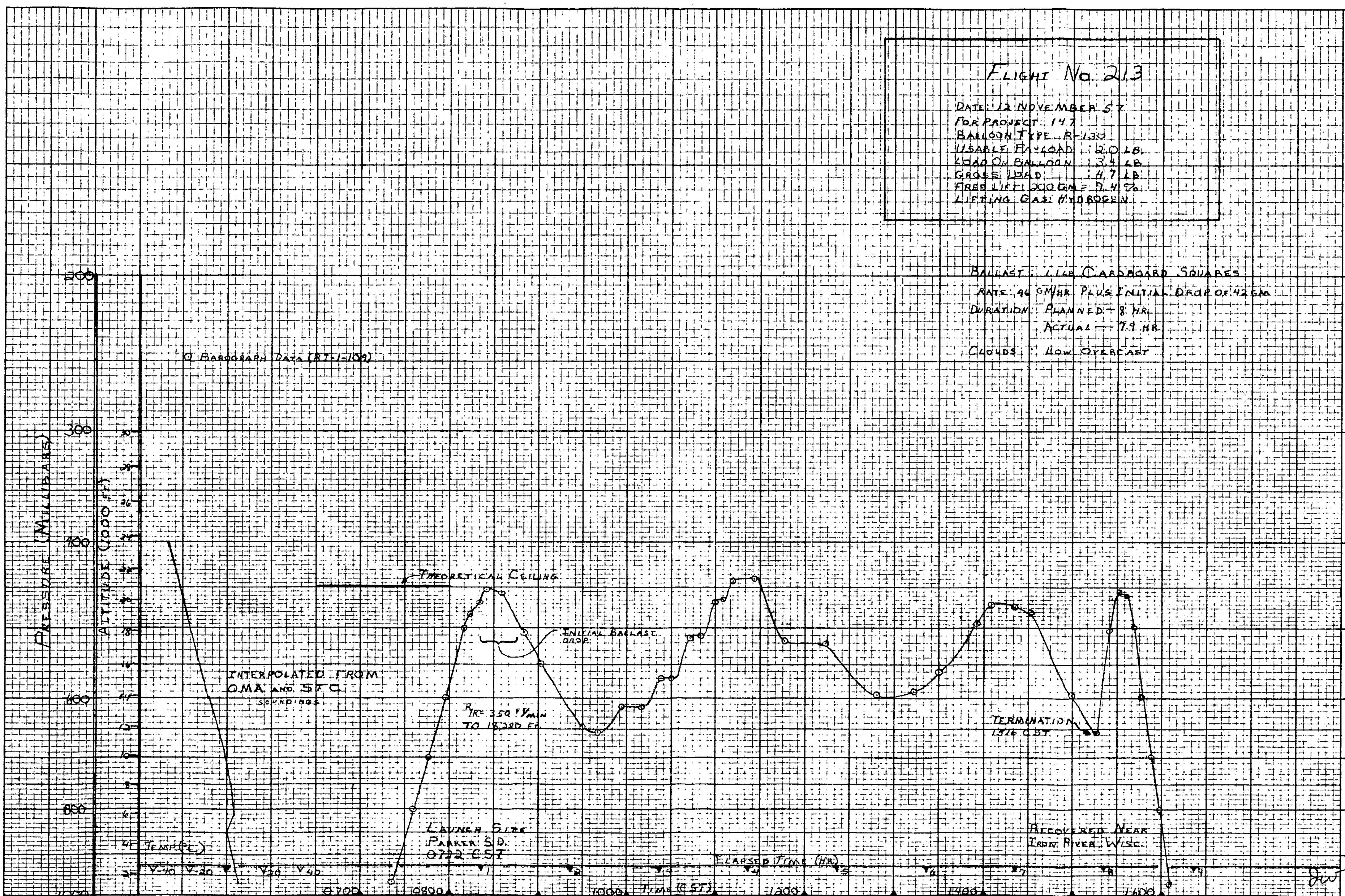
7B - 18C



DR	APP	DATE	NAME	
D.G.B.		27 Nov. '57	Trajectory For Flights 208-209 - 9 November 1957 211-213 - 12 November 1957	7B-193.
CH	APP			


K+E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 211
DATE: 12 NOVEMBER 57
FOR PROJECT 147
BALLOON TYPE: B-130
USABLE PAYLOAD: 2.0 LB.
LOAD ON BALLOON: 3.4 LB.
GROSS LOAD: 4.7 LB.
FREE LIFT: 209 GMS 9.4 %
LIFTING GAS: HYDROGEN
BALLAST: 85 LB CARDBOARD SQUARES
RATE: 46 GM/HR. PLUS 50 GM INITIAL DROP
DURATION: PLANNED — 8 HR.
ACTUAL — 7.8 HR
CLOUDS: LOW THIN OVERCAST
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT)
O BAROGRAPH DATA (RI-1-119)
THEORETICAL CEILING
STARTING BALLAST DROP
TERMINATION 1508 CST
INTERPOLATED FROM OMA AND STC SOUNDINGS
TEMP (°C)
LAUNCH SITE PARKER S.D. 0718 CST
RECOVERED NEAR CORNUCOPIA, WIS.
ELAPSED TIME (HR.)
TIME (CST)
RAVEN Industries, Inc.
7B-201


K+E SEMI-LOGARITHMIC 359-52L
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 180 DIVISIONS
FLIGHT No. 212
DATE: 12 NOVEMBER 57
FOR PROJECT: 147
BALLOON TYPE: R-130
USABLE PAYLOAD: 2.0 LB.
LOAD ON BALLOON: 3. LB.
GROSS LOAD: 14.7 LB.
FREE LIFT: 200 GM = 9.4 %
LIFTING GAS: HYDROGEN
BALLAST: .85 LB CARDBOARD SQUARES
RATE: 46 GM/HR PLUS 50 GM INITIAL DROP
DURATION: PLANNED – 8 HR.
ACTUAL – 7.9 HR.
CLOUDS: LOW OVERCAST
BAROGRAPH DATA (RT-1-110)
THEORETICAL CEILING
INITIAL BALLAST DROP
INTERPOLATED FROM OMA AND STC SOUNDINGS
R/R = 325 FT/MIN
T.O. 18,230 FT.
TERMINATION 1516 CST
LAUNCH SITE PARKER, S.D. 0728 CST
RECOVERED NEAR WASHBURN, WISC.
PRESSURE (MILLIBARS)
ALTITUDE (1000 FT)
TEMP (°C)
ELAPSED TIME (HR)
TIME (CST)
0700
0800
1000
1200
1400
1600
J.L. 26 Nov. 57
7B 189
RAVEN Industries, Inc.



J.L. 19 NOV. 57
7B-178

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