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General Mills

THE GENERAL MILLS ELECTRONICS GROUP

ELECTRONICS DIVISION

REPORT 2454

SKYHOOK BALLOON FLIGHTS

FLIN FLON, CANADA

Flights 2628N thru 2643N
(30 August - 23 September 1963)

Contract Nonr-1589(26)
ARPA Order 215

Prepared for

Office of Naval Research
Washington 25, D.C.

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THEY REALLY MEAN IT!

VHF ANTENNA

DAVE MILTON, U. of C., and PACKAGE

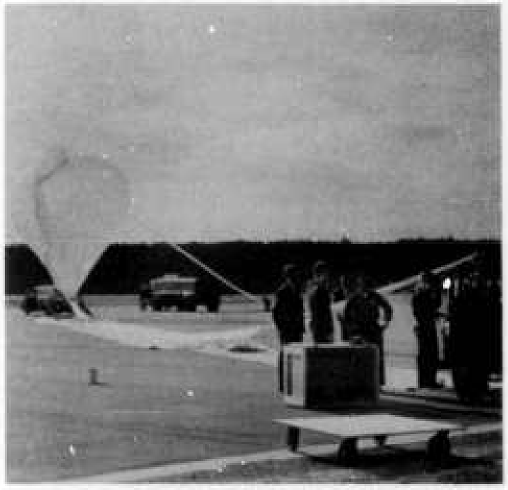
ROCK TEST and GMI PACKAGE

PROXIMITY TEST

U. of C. TELEMETRY TRAILER

(A) LAUNCH AREA (B) WORK AREA

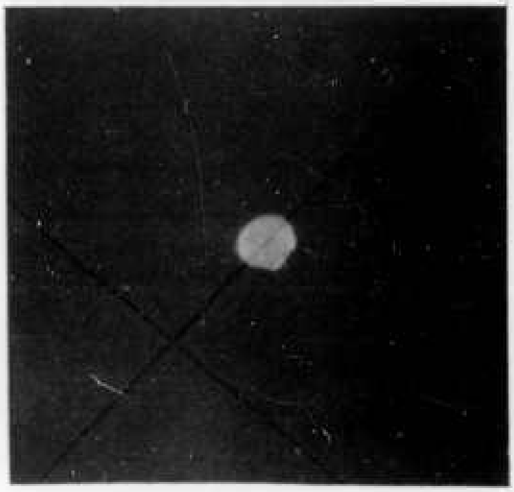
ATTACHMENT to LAUNCH TRUCK



INFLATION

FLIGHT LINE CHECK

LAUNCH (THE COVER COMES OFF)



111,000 FEET

(A) AIRCRAFT LANDING AREA (B) RECOVERY AREA

ACTUAL IMPACT

CESSNA 185's: BLUE and RED SHIPS

TAKING on GAS at GODS LAKE

ADC COMMAND STATION

WOULD LIKE TO TRY IN '64

REPORT NUMBER 2454

I. INTRODUCTION

This report concerns planning and execution of a series of balloon flights from Flin Flon, Manitoba, Canada,during August and September of 1963. This work was accomplished for the Office of Naval Research under Contract Nonr-1589(26). A series of seven flights was flown carrying gamma ray instrumentation for Dr. Kinsey Anderson of the University of California.

The initial proposal dated February 6, 1963 for this operation was based on a plan for a series of ten 10-hour flights at an altitude of 120,000 ft. ONR letter dated April 17 indicated acceptance of the proposal. However, this plan was subsequently changed to provide for five flights of 35-hours' duration at an altitude of 120K. A revised cost estimate on this basis was submitted June 14, 1963. The definitive contract Nonr 1589 (Task Order #26) was received July 18, 1963, and later amended to provide for accomplishment of work as follows:

1. Provide balloons and associated instruments and gear, and conduct five (5) SKYHOOK balloon flights at a minimum altitude of 110,000 ft of 35 hours' duration each, to be launched from a site at Flin Flon, Canada.

2. Provide the following:

   a. Furnishing of aircraft, pilots, and personnel for and the conducting of operations for the launching, tracking, and recovery of scientific equipment flown;

   b. maintaining close liaison with the scientific investigation and appropriate Canadian authorities to insure the performance of correct procedures for flight clearance, launch notification, and tracking information; and

   c. in the final report, documenting flight information on the performance of the balloon and its associated equipment.

In addition, ONR letter dated July 16, 1963, directed that two flights from Task Order 04, which were to have been flow from Minneapolis, should instead be flown from Flin Flon. These flights were to be of 14 hours' float duration through one sunset and sunrise.

II. FLIGHT PREPARATIONS

All planning was directed toward the basic objective of providing the scientist with balloon services needed to collect the desired data at minimum cost to the Navy. Flight train design was straightforward, with some emphasis on instrumentation package design to insure overnight operation. An innovation in balloon design for Navy projects was the inclusion of a rip panel for positive destruction of the balloon at payload release. A field survey was made by Mr. Charles Wise of General Mills,Inc. to arrange for launch site and facilities, housing, communications, Canadian government liaison, etc. Excellent cooperation by local and governmental authorities was obtained. A report of this trip is included as Appendix I.

Payload recovery planning was hampered by inability to predict balloon trajectory at this time of the year. It was therefore necessary to plan for a fluid operation in which recovery aircraft would be prepared to go in any direction to the maximum expected range. To this end, it was decided to base two Cessna 185 float planes at Flin Flon and to use one aircraft to track each balloon. (Original proposal -- one plane, later changed to two planes to expedite flight schedules). The aircraft would track the balloon from Flin Flon to termination, spot and record impact point, and land on the nearest water and recover the payload. If the situation developed that recovery by one plane crew was not feasible, the crew would obtain local help, or wait for a time when both aircraft could go in for the recovery. It was expected that difficult situations would be encountered; therefore, aircraft pilots were chosen who had considerable flight and Canadian bush experience, thus being able to provide an optimum adaptation to field requirements. Each plane would have an observer to assist the pilot.

We preferred to have experienced balloon technicians as the observers and flight monitors; however, in the interest of economy it was planned to train and utilize at least two University of California employees in these positions.

Aircraft leasing was arranged from Lysdale Flying Service of St. Paul, Minnesota. New aircraft were purchased for this operation so that a maximum of reliability was expected. Aircraft were equipped with floats and standard IFR instrumentation. A low frequency ADF set was provided in each airplane for balloon tracking.

Project instrumentation in each airplane consisted of a VHF transceiver for communications and radio command, and a 6750 MC transceiver for communications.

Auxiliary and survival equipment provided in aircraft is listed in Appendix II.

Close liaison with ONR representatives in Minneapolis considerably reduced time delays in technical and contractural matters requiring Navy assistance or concurrence, and in arranging for Government Bills of Lading, customs clearances, etc. Regular liaison with Dr. Anderson also eliminated many areas of potential error.

The field crew was selected shortly after contract notification and this crew was assigned primarily to preparations for the Flin Flon operation. The crew members not only assembled all necessary equipment but also cared for fabrication of the instrumentation. Thus, the field personnel were closely integrated into the operation during the entire preparation phase, a factor that contributed to good understanding and smooth operation in the field.

Balloons selected for the 35-hour duration flights were General Mills, Inc. designation 128-1-2, thickness .75 mil, volume 800,000 ft^3. Reliability of this category of balloon was well established.

Balloons for the 14-hour flights had already been built under Task Order 04. General Mills, Inc. designation was 141-1-2, thickness .55 mil, volume 1 million ft^3. These balloons had performed reliably on previous flights.

A discussion of instrumentation for the flights is given in Appendix III.

A list of equipment for the operation is included as Appendix IV. This list of basic equipment was increased by spare parts, tools, and miscellaneous rigging to insure adequate stocks for normal operations. However, commercial airshipment could supply parts from Minneapolis on a few hours' notice, so the amount of contingency spares was minimized. This arrangement worked out very well.

Movement planning involved primary shipment of equipment by rail, and ferry of personnel and last-minute equipment by tracking aircraft and commercial air.

A previous operation had alerted us to the possibilities of delay of shipments by Canadian Customs unless all papers were in order. Therefore, exceptional care was exercised to assure that all proper customs papers were prepared and properly forwarded. The local ONR representative assisted greatly in this matter and in arranging Government Bills of Lading, so that all shipments passed customs without incident. The rail shipment left Minneapolis August 16 and arrived in Flin Flon August 23.

The contract pilots for the operation, Mr. Robert Griffen and Lt. Col. Fitzwater,arrived in Minneapolis August 20 and spent the next few days in preparing their aircraft for the operation.

III. FIELD OPERATIONS

The advance party of two technicians, Mr. Wise and Mr. Chesebro, arrived Flin Flon August 24 and commenced setting up the base and unloading equipment. The two aircraft with the pilots, project leader, Mr. Ray Dungan, and technician, Mr. John McAleese, proceeded to Winnipeg August 25 for conference with Canadian Air Traffic Control on August 26. At this conference our crew and Canadian authorities discussed the operation; details of flight notifications, weather limitations, and the like were agreed upon. Canadian authorities were most cooperative, understanding, and helpful. Canadian Weather Service agreed to get sounding data to 110,000 ft during our period of operation. Normal soundings are only to 50,000 ft.

The aircraft party arrived at Flin Flon August 26, and all preliminary preparations were completed August 27. The launch site chosen was the aircraft parking ramp of the Flin Flon airport. This ramp is about 400 ft^2 with a smooth blacktop surface. It is free of aircraft except for two airline passenger stops per day. Balloon launches must be made at other-than-these-times to avoid interference. Launch from the runway would have been feasible but was not necessary. The Airport Manager, Mr. Thomas Kostiuk, was most helpful in making arrangements for a suitable base.

Temporary-type buildings owned by the airport were used for equipment shelter. A public dock suitable for seaplane usage was located about two miles from the airport; although this was a useful docking point for the planes, no other facilities were available so it became necessary to base out of Mitchell's Flying Service near Flin Flon -- about 20 miles north of the airport -- for other aircraft services.

The crew initially lived in the Royal Hotel in Flin Flon. Because of the distance from the airport, this arrangement proved very inconvenient; after a few days, lodging was arranged at "Paradise Lodge" -- a motel-type lodge about 3 miles from the airport. The lodge was located on a lake and provided good seaplane docking facilities as well as boats and other recreational facilities for the crew.

Communications at the airport were limited. A direct line to the RCAF Early Warning Station at Cranberry Portage 20 miles SE was available for scheduled weather information and notam filing, but could not be used for other calls except in emergency. Closest telephone for calling long-distance was in Flin Flon. Communications between crew quarters and base were set up with 6 MC equipment. Radio telephone service in the 4 MC band might have been provided for but its availability and possible usefulness were not appreciated until the operation was complete. Communications with the aircraft were by 6 MC equipment and VHF. VHF range was limited, of course, to line of sight. Six MC communications were intermittent and very unreliable. The lack of good long-distance communications with the aircraft was a serious hindrance to the tracking and recovery operation. Land-based long-distance communications were by 4 MC radio telephone which was never successful in getting a message through in time to be of use.

Major vehicle equipment used for the operation consisted of two trailers of helium, a tractor for the helium trailers rented from Gardwyne Trucking Company of Flin Flon, a 1-ton Navy panel truck with a front mounted "A" frame for launching, and a rented sedan for crew transportation.

The payload configuration, including scientific package and balloon instrumentation, is illustrated in Figure 1. Some minor changes to planned configuration were required in the field to accomplish proper system compatibility.

Very early in the operation it became apparent that weather factors would cause delays, and also that trajectories would be longer than anticipated. Therefore, the following rules were agreed to by General Mills, Inc. Navy, and University of California personnel.

1. Obtaining scientific data takes priority over recovery. Therefore, when launch was possible, the flight would be flown regardless of the conditions for recovery.

2. Due to difficult recovery terrain east of approximately 93W, the

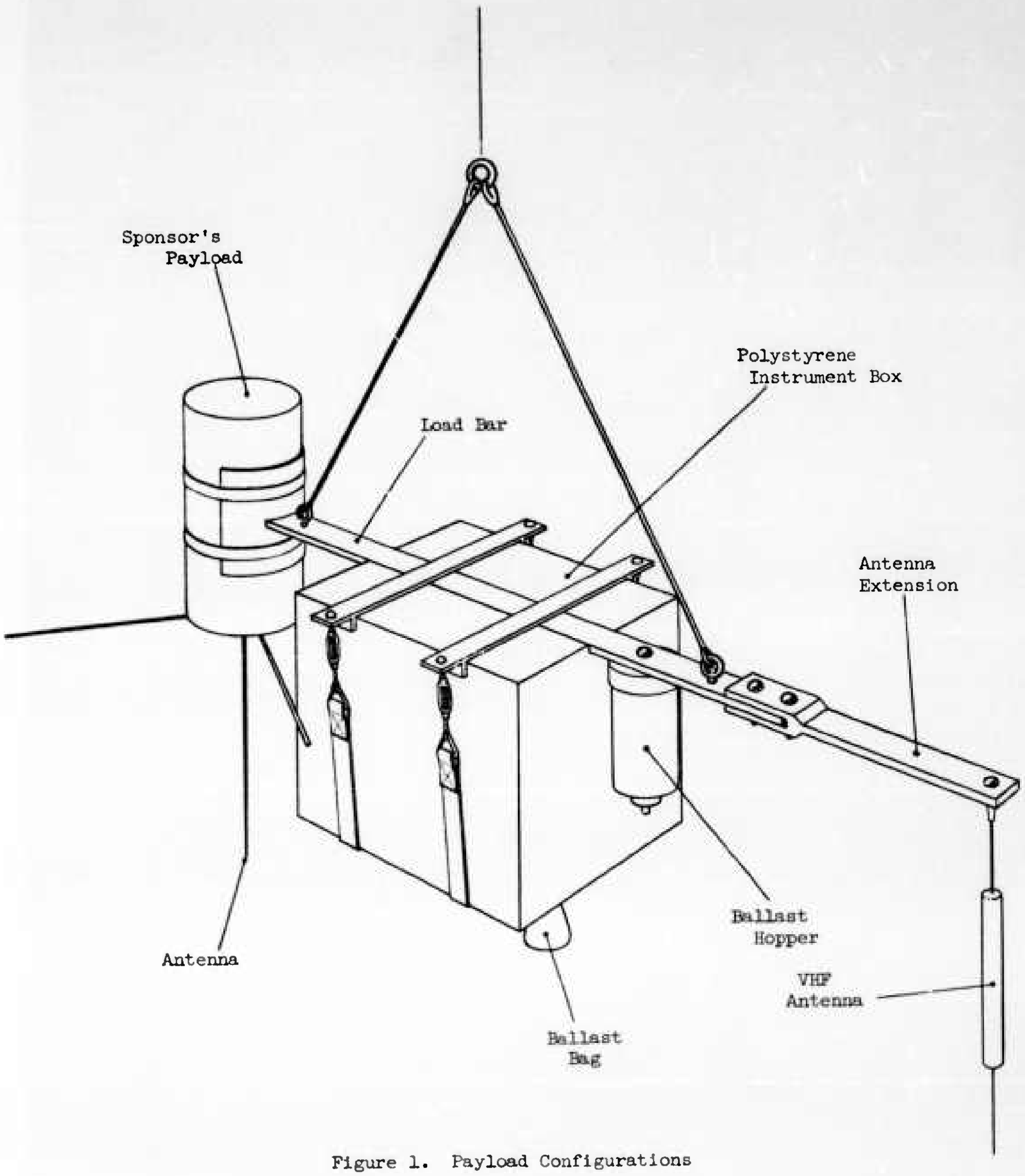


Figure 1. Payload Configurations

flights would be terminated by the tracking aircraft in time to avoid the bad terrain. It was expected that the 72 MC telemetry would be out of range by that distance. However, if communications were working, clearance would be obtained from base before terminating.

IV. FLIGHT CHRONOLOGY

A listing of pertinent data and a discussion for each flight is given below. Flight time-altitude curves for each flight are attached as Appendix V.

<u>Flight No. 2628N</u>

Date - August 30, 1963
Launch Time - 08:08 CDT
Launch Site - Municipal Airport Flin Flon, Manitoba
Balloon Code No. - 128-1-2
Balloon Size - 800,000 cu ft, .75 mil
Balloon Type (taped or not taped unusual design features) - not taped
Balloon Weight - 213 lbs.
Scientific Payload Weight - 22 lbs
Balloon Instrumentation Weight - 157.5 lbs
Total Weight - 392.5 lbs
Free Lift Used - 8%, 31.4 lbs
Rate of Ascent to 50K - 843 ft/min
Rate of Ascent to Altitude - 800 ft/min average
Floating Altitude - 111,100 ft
Floating Duration - 29 hours 32 min
Total Duration - 31 hours 52 min
Descent time - 50 min
Ballast on Board - 32 lbs
Ballast Flow Rate - 4 lbs/min
Impact Location - 53-40N 80-00W (estimated)
Scientific Group - University of California
Scientist Present at Launch - David Milton
Frequency of Beacon 1750 KC
Estimated Helium Used - 6,423 cu ft
Weather Conditions at Launch - Good
Special Remarks - U of California lost signal at 02:30 CDT 8/31/63

Preflight trajectory prediction based on available upper wind information indicated a 35-hour trajectory 130 miles to the NW. However, all upper winds turned out to be westerlies of about 15 to 20 knots velocity. It was evident that weather bureau upper air wind reports could not be relied upon at this time of the year.

On this flight a harmonic frequency interference developed in which the radio command receiver was blocked by the 72-MC telemetry signal from the scientific payload. This trouble was corrected for subsequent flights by a slight change in telemetry frequency.

Scientific data were received until telemetry signal was lost after 18-1/2 hours.

The balloon descended during the night into the troposphere and altitude beacon signal was lost; the assumption was made from extrapolated descent rates that the balloon landed at 0430 Flin Flon time (0930 GMT). The tracking aircraft landed at Ilford for the night; its crew had also lost the beacon signal and had assumed the balloon down. During search on August 29, one aircraft picked up weak beacon signals indicating the balloon was still airborne at about 50,000 ft; descent signals were heard at 2100 GMT, indicating cutdown by timer at some considerable distance west of the aircraft location at 53N and 90W. The search was continued to the west the next day with negative results and, in view of the uncertainty of impact location and need for the aircraft for forthcoming flights, the search was abandoned.

Flight No. 2629N

Date - September 1, 1963

Launch Time - 09:20 CDT

Launch Site - Municipal Airport Flin Flon, Manitoba

Balloon Code No. - 128-1-2

Balloon Size - 800,000 cu ft, .75 mil

Balloon Type (taped or not taped unusual design feature) - not taped

Balloon Weight - 216 lbs
Scientific Payload Weight - 22 lbs
Balloon Instrumentation Weight - 159 lbs
Total Weight - 397 lbs
Free Lift Used - 8% 32 lbs.
Rate of Ascent to 50 K - 659 ft/min
Rate of Ascent to Altitude - 546 ft/min average
Floating Altitude - 110,900 ft
Floating Duration - 22 hrs
Total Duration - 25 hrs, 23 min
Descent Time - 50 min
Ballast on Board - 32 lbs
Ballast Flow Rate - 4 lbs/min
Impact Location - 56°-15'N 92°-30'W
Scientific Group - University of California
Scientist Present at Launch - David Milton
Frequency of Beacon - 1750 KC
Estimated Helium Used - 6,499 cu ft
Weather Conditions at Launch - 4K Wind
Special Remarks - U of California lost signal at 02:00 CDT - 9-2-63

The balloon was tracked with some difficulty due to frontal type weather. The aircraft stopped overnight at Ilford, resumed tracking at sunrise. The balloon was sighted and, since it was approaching swamp areas, termination by radio command was accomplished. The package was spotted down; however, the nearest suitable landing spot was several miles away and intervening terrain was mainly muskeg. Therefore, immediate recovery attempts were abandoned. Arrangements were made with the Manager of the Hudson Bay Store at Shamatawa for possible recovery by local trappers after freeze-up.

<u>Flight No. 2630N</u>

Date - September 6, 1963

Launch Time - 17:26 CDT
Launch Sight - Municipal Airport, Flin Flon, Manitoba
Balloon Code No. 141-1-2
Balloon Size - 1,000,000 cu ft, 155 mil
Balloon Type (taped or not taped unusual design features) - not taped
Balloon Weight - 163 lbs
Scientific Payload Weight - 22 lbs
Balloon Instrumentation Weight - 143 lbs
Total Weight - 328 lbs
Free Lift Used - 8%, 26 lbs
Rate of Ascent to Altitude - 581 ft/min average
Rate of Ascent to 50 K - 674 ft/min
Floating Altitude - 114,500 ft
Floating Duration - 15 hrs 03 min
Total Duration - 18 hrs 20 min
Descent Time - 50 min
Ballast on Board - 32 lbs
Ballast Flow Rate - 4 lbs/min
Impact Location 54°-10'N 97°5'W
Scientific Group - University of California
Scientist Present at Launch - David Milton
Frequency of Beacon - 1750 KC
Estimated Helium Used - 5,363 cu ft
Weather Conditions at Launch - 4 knots wind
Special Remarks - Recovery was made and excellent scientific data were obtained.

Several days of adverse weather delayed this flight. After launch the balloon commenced its trajectory to the east and the chase aircraft went ahead to God's Lake for the night. The following morning the sky was overcast and the balloon was tracked by ADF until cutdown by radio command shortly before programmed termination. The parachute and package was picked up visually after descent beneath the clouds, and impact in a lake was subsequently observed. The winds were an estimated 20 knots so that the parachute did not collapse but dragged the load to the downwind shore. The aircraft was maneuvered into a sheltered area and recovery was made by foot.

The instrument packages were insulated with sufficient foam plastic to insure floatation and were tight enough to prevent water damage. Despite the severe dragging through water, the packaging successfully prevented water damage.

<u>Flight No. 2631N</u>

Date - September 10, 1963
Launch Time - 06:49 CST
Launch Site - Municipal Airport, Flin Flon, Manitoba
Balloon Code No. - 128-1-2
Balloon Size - 800,000 cu ft,.75 mil
Balloon Type (taped or not taped unusual design features) - not taped
Balloon Weight - 215 lbs
Scientific Payload Weight - 22 lbs
Balloon Instrumentation Weight - 159.5 lbs
Total Weight - 396.5 lbs
Free Lift Used - 8%,31.7 lbs
Rate of Ascent to 50 K - 907 ft/min
Rate of Ascent to Altitude - 861 ft/min average
Floating Altitude - 111,300 ft
Floating Duration - 23 hrs 45 min
Total Duration - 25 hrs 25 min
Descent Time - 50 min
Ballast on Board - 32 lbs
Ballast Flow Rate - 2 lbs/min
Impact Location - 54°-30'N 96°-30'W
Scientific Group - University of California

Scientist Present at Launch - David Milton

Frequency of Beacon - 1750 KC

Estimated Helium Used - 6,487 cu ft

Weather Conditions at Launch - Good

Special Remarks - The flight was recovered and excellent scientific data was received.

Adverse weather prevailed on September 8 and 9 and prevented launch. Generally cloudy skies throughout the area after launch led to decision to use two aircraft for chase. The aircraft RONed at God's Lake, and intercepted the balloon the next morning in the vicinity of Cross Lake. Generally, low ceilings prevailed so one aircraft stayed on top at 6000 ft. The low ceilings finally forced the second aircraft to abandon the chase. When it became apparent the balloon would drift into an area inaccessible for recovery, the payload was released by radio command from the chase aircraft. High winds drifting the parachute sometimes required full power by the aircraft to stay abreast. The aircraft descended through the overcast with the package breaking out at 900 ft above terrain. The package was observed to impact on land about 1-1/2 miles from a small lake suitable for landing. Because of the difficult terrain, recovery was delayed until the next day, when both aircraft returned and a ground party, directed from the air by radio, recovered the package.

Flight No. 2632N

Date - September 18, 1963

Launch Time - 16:05 CST

Launch Site - Municipal Airport, Flin Flon, Manitoba

Balloon Code No. 128-1-2

Balloon Size - 800,000 cu ft,.75 mil

Balloon Type (taped or not taped unusual design features) - not taped

Balloon Weight - 209 lbs

Scientific Payload Weight - 22 lbs

Balloon Instrumentation Weight - 168.5 lbs

Total Weight - 399.5 lbs

Free Lift Used - 8%, 32 lbs

Rate of Ascent to 50 K - 870 ft/min

Rate of Ascent to Altitude - 723 ft/min average

Floating Altitude - 110,000 ft

Floating Duration - 20 hrs 22 min

Total Duration - 22 hrs 55 min

Descent Time - 50 min

Ballast on Board - 42 lbs

Ballast Flow Rate - 4 lbs/min

Impact Location - 54°-20'N 91°-30'W

Scientific Group - University of California

Scientist Present at Launch - David Milton

Frequency of Beacon - 1750 KC

Estimated Helium Used - 6,537 cu ft

Weather Conditions at Launch - 6K Wind

Special Remarks - University of California lost signal at 03:00 CST 9-19-63

Several days of wind, rain, and snow delayed this flight. On day of flight, launch postposed from early AM due to intermittent rain and snow. Chase aircraft RON'ed at Flin Flon due to late launch. Next morning chase aircraft found upper winds had carried balloon well east of God's Lake and the decision, based on lack of known fuel sources and marginal flying weather, was made to suspend tracking. Radio communications link via second aircraft disclosed 72 MC telemetry had ceased, so the package was cut down by radio command.

Flight No. 2633N

Date - September 20, 1963

Launch Time - 06:38 CST

Launch Site - Municipal Airport, Flin Flon, Manitoba

Balloon Code No. - 128-1-2

Balloon Size - 800,000 cu ft,.75 mil

Balloon Type (taped or not taped unusual design features) - not taped

Balloon Weight - 218 lbs

Scientific Payload Weight - 22 lbs

Balloon Instrumentation Weight - 162 lbs

Total Weight - 402 lbs

Free Lift Used - 8%,32 lbs

Rate of Ascent to 50 K - 925 ft/min

Rate of Ascent to Altitude - 916 ft/min average

Floating Altitude - 111,000 ft

Floating Duration - 24 hrs 52 min

Total Duration - 26 hrs 52 min

Descent Time - 50 min

Ballast on Board - 42 lbs

Ballast Flow Rate - 4 lbs/min

Impact Location - 53°N 91°-30'W

Scientific Group - University of California

Scientist Present at Launch - David Milton

Frequency of Beacon - 1750 KC

Estimated Helium Used - 6,575 cu ft

Weather Conditions at Launch - 9K wind

Special Remarks - University of California lost their signal at 15:30 CST 9-20-63; no recovery excellent scientific data received

Chase plane proceeded ahead to God's Lake. High winds aloft caused balloon to overfly God's Lake during the night and by dawn it was well to the east. With marginal flying weather and uncertain fuel sources to the east it was decided to terminate the flight without tracking. Flight was terminated by radio command.

<u>Flight No. 2634N</u>

Date - September 23, 1963

Launch Time - 06:20 CST

Launch Site - Municipal Airport, Flin Flon, Manitoba

Balloon Code No. - 141-1-2

Balloon Size - 1,000,000 cu ft, .55 mil

Balloon Type (taped or not taped unusual design features) - not taped

Balloon Weight - 167 lbs

Scientific Payload Weight - 22 lbs

Balloon Instrumentation Weight - 154.5 lbs

Total Weight - 341.5 lbs

Free Lift Used - 8%, 27.3 lbs

Rate of Ascent to 50 K - 584 ft/min

Rate of Ascent to Altitude - 605 ft/min average

Floating Altitude - 118,100 ft

Floating Duration - 10 hrs 15 min

Total Duration - 13 hrs 30 min

Descent Time - 50 min

Ballast on Board - 42 lbs

Ballast Flow Rate - 4 lbs/min

Impact Location - 54°-30'N 91°-05'W

Scientific Group - University of California

Scientist Present at Launch - David Milton

Frequency of Beacon - 1750 KC

Estimated Helium Used - 5,587 cu ft

Weather Conditions at Launch - 10 K wind

Special Remarks - University of California lost signal at 16:00 9-23-63; no recovery, moderate scientific success; telemetry signal lost after nine hours.

Weather had continued as unsatisfactory and this launch was accomplished during a temporary break; taking off just as a squall was moving in.

Early loss of telemetry signals, 1300 CST for the low frequency beacon and 1500 CST for 72 MC signal, indicated that upper winds were continuing to accelerate, giving the balloon a long trajectory to the east.

It was necessary for the planes to ferry back to Minneapolis leaving on September 23. Thus, aircraft tracking and recovery services were not available.

V. COMPLETION OF PROJECT

September 23 and 24 were spent in breaking camp, preparing shipments, and area clean-up. Canadian Pacific Railroad handled the freight shipment. The aircraft with pilots and one GMI man departed on September 23, encountered weather delays, and arrived Minneapolis on September 25. Remaining crew of three departed Flin Flon by commercial air on the 25th. Mr. Dungan, the crew leader, stopped in Winnipeg to close out business with Canadian authorities who were pleased with the notifications and liaison concerning our activities.

VI. CONCLUSIONS

Seven successive flights, each of which produced scientific success, is considered overall to be a highly successful program. Flight preparation, launches, instrumentation performance, and scientific data gathered were highly satisfactory.

The scientific crew was under the direction of Mr. David Milton of the University of California. Coordination and cooperation between the crews was accomplished smoothly and efficiently. The natural ease with which joint problems were solved and decisions made greatly contributed to the success of the project.

The chosen launch technique resulted in smooth shock-free launches under all conditions encountered and is believed to be the best technique that could have been selected for this operation. In this technique, the bubble is positioned downwind, and the payload is mounted on a mast on the front end of a truck. The truck then moves forward as the bubble rises and releases the load when the system is vertical. The particular advantages are that (1) the entire system is constantly under tension, thus avoiding shocks and, (2) the entire system is constantly in full view of the driver so that response to system demands is immediate. Running distance for launch is a function of driver technique, but generally the load is released in the near vicinity of the bubble original position. At Flin Flon, the flight trains were about 140 ft long, and the longest launch truck run was 300 ft in 14 knots of wind (Flight No. 2634N).

Instrumentation planning proved adequate with only one discrepancy. It turned out that Dr. Anderson's telemetry for the first flight was on about 74 MC, while balloon radio command was on 149.4 MC. During flight, the 74 MC signal increased in frequency and, it is believed, that this resulted in a harmonic blockage of the 149 MC receiver. The problem was resolved for subsequent flights by returning the telemetry to about 75 MC so that any upward frequency drift would not block radio command.

The aircraft tracking and recovery operation was first hindered by lack of fore-knowledge of balloon trajectory at that time of the year, which prevented establishment of remote recovery losses and, second, by the lack of good communications when the aircraft went beyond VHF range from base. A further difficulty was shortage of personnel when it turned out that University of California team could not spare personnel for monitoring and tracking as had been tentatively planned. These two factors created problems in obtaining maximum efficiency from the aircraft since a certain amount of otherwise unnecessary travel resulted from returning to base for communications and to have adequate personnel available for balloon launch preparations.

In addition, weather elements adversely affected recovery operations inasmuch as recovery considerations were secondary to obtaining scientific data whenever possible. Resultant adverse recovery weather and long balloon trajectories led to loss of several payloads.

The Cessna 185-type aircraft is an excellent low-cost aircraft for these flights. The requirement for 100-octane gasoline for these aircraft, however, became a serious obstacle to full utilization. Several chases were handicapped because the aircraft were necessarily tied to known fuel supplies. Of the few settlements which had 100-octane on hand, many were reluctant to sell it without pre-arrangement. On the other hand, 80-octane gasoline appeared to be in plentiful supply at all settlements. The performance advantage of the 100-octane burning engine appears not to be sufficient to offset the difficulties of obtaining the fuel. For future operations, either 80-octane gasoline should be usable in the aircraft chosen, or detailed supply arrangements for higher octane gasoline must be made in advance throughout the possible area of operation. An early arrangement to permit supply by caterpillar sled trains would avoid high cost of flying in the gasoline.

With trajectory to east, the best bases for aircraft layovers became Ilford on the railroad line, and God's Lake Narrows where several Canadian Government and Hudson Bay Company personnel form a community able to cope with most problems. One hundred-octane gasoline was available at a resort (Kanachuan) 20 miles to the south. This fuel was available only by chance since the resort had inadvertently oversupplied. The next good base to the east was Big Trout Lake in Ontario where 100-octane is available only by pre-arrangement. Ground communications throughout the area is by 4 MC radio telephone, and during our operation this system was useless owing to adverse atmospheric conditions which eliminated long-range transmissions.

Conclusions as to ballasting experience unfortunately are not possible as records of ballast drops by radio command from the airplane were lost. The ballast drops, indicated on the attached curves, represent drops initiated by the ground station and flight programmer only and therefore are in error, in most cases, by the amount dropped by aircraft. Total ballast carried for early flights was 32 lbs (8 to 10 percent). This appeared inadequate and was increased to 42 lbs (10 to 12%), but appraisal of its effectiveness is not possible with the inadequate records. Flights tended to indicate a loss of lift with loss of sun heating, and subsequent further loss of lift with decreasing earth radiation during the night.

Some discussion of the terrain might be of value for future operations. In general, the terrain in the impact areas was a combination of lake, muskeg, and densely wooded hills. As the area south of Hudson Bay is approached, muskeg predominates. Small and large lakes dot the whole area. The densely wooded areas are difficult to traverse, but are negotiable if one is not in a hurry. Muskeg on the other hand may be impassible for novices, and we were cautioned by local people that dangers exist such as "falling through the crust" and not being able to get out. Indians who live in the area know the "signs" and are able to traverse muskeg, but must be given lots of time, perhaps a week for a few miles.

Without a helicopter, recovery is possible -- but each case requires study of the situation and careful planning. Accurate position of impact must be noted, routes of approach planned, proper personnel (possibly to include local reliable Indians) flown in, and the recovery covered by aerial surveillance, as needed. Time to engage in such activities must be provided for in overall project planning.

VII. RECOMMENDATIONS FOR FUTURE OPERATIONS

The program, successful as it was, indicated that improvements could be made. Recommendations which should aid in realizing such improvements are summarized below.

Base Operations

1. Better communications by radio or telephone for weather, flight clearances, and administration would be desirable. A 4 MC radio telephone would help for many short-range communication requirements.
2. Upper atmosphere wind forecasting was unreliable. Provision for special soundings in the area would be desirable.
3. Proximity of ground-based scientific and balloon radio equipment produced some interference problems. These equipments should be separated by 50 to 100 yards.
4. If balloon trajectories can be anticipated, a downwind telemetry station would increase the total data received from the balloon flights.

Instrumentation

1. Direct personal liaison between the scientist and balloon project personnel at various stages of preparation is urged to insure complete mechanical and electronic compatibility upon mating of equipments in the field.
2. Instrument containers should be designed to combine floatation, easy access, and outside manual switching (when needed) -- in addition, of course, to providing adequate protection from cold, heat, and impact.

Aircraft Operations

1. Maps of two scales (8 miles to inch, and area maps) should be provided to each aircraft. Maps should be covered with clear plastic waterproofing.

2. Aircraft employed should be able to use 80-octane fuel. If 100-octane aircraft are used, pre-arrangement of a number of fuel caches should be made. Cessna 180-type aircraft would have performed satisfactorily for this operation.

3. If funding permits, a helicopter for package pickup would be desirable.

4. For overall best cost effectiveness in use of the aircraft, positive communications via balloon-borne VHF transponder should be provided, unless some other reasonably priced positive communication system should become available.

5. Where aircraft may track singly, dual ADF installations should be provided as insurance against the most likely failure that could negate the tracking mission.

6. Aircraft should carry communications frequencies for Canadian Department of Transport and Air Defense Network stations, and for the Radio Telephone Network.

7. Each aircraft should be equipped with a very small portable gasoline-engine-driven generator to permit radio monitoring without expending plane's battery while the plane is on the water.

8. Aircraft should be equipped with two high quality-canoe paddles with provision for quick storage on the floats.

9. Each aircraft should be provided with an itemized list of equipment and cargo. This list should be numbered and indicate contents and weight.

10. Facility survey -- a mail survey of all communities and aircraft operators should be made prior to the operation so that

the exact extent of various facilities and supplies may be known and planned for.

11. Aircraft crew -- each aircraft should have a crew of two -- preferably two men who are independent of other duties.

APPENDIX I

Winnipeg and Flin Flon Survey Trip

Winnipeg and Flin Flon Survey Trip

To: K. Stefan May 21-23, 1963

From: C. N. Wise

Subject: Winnipeg and Flin Flon Survey Trip

Winnipeg

Tuesday morning I went to the Department of Mines and Natural Resources to see Mr. J. Klaponski. He seemed to think the maps we wanted would suit our purpose the best. I picked up 180 maps of the area we wanted. The cost was $72.00. He said there would be no charge for the other maps he sent to us.

Next I went to see the District Supervisor of Air Traffice Control, Mr. C. R. Brereton. He was very helpful and said we could use the same forms for filing Notams there that we use here. He would like a letter to his office stating when we will be operating at Neepawa and at Flin Flon. He would also like us to send some FAA forms along so that he can given them to the Air Control Center at the airport. He would also like the pilots to stop at the Winnipeg National Airport and see Mr. Vic Skinner, Chief of Air Traffic Control at the airport. He wants Mr. Skinner to inform the pilots of Canadian air regulations. I went back on Friday to see if Mr. Brereton could give me some information on emergency frequency and points to contact. He gave me some copies of the following pamphlets: Air Navigation Radio Aids (Volume XVII No. 2) and the Aeronautics Act (Air Navigation Order, Series V, No. 14) which can be obtained from the Queen's Printer, Ottawa, Ontario. He also gave me a copy of the Radio Navigation Chart - ICAO (LE1 and LE2 - LE5 and LE6) which can be obtained from the Survey and Mapping Branch, Department of Mines and Technical Surveys, Ottawa, Ontario.

The Sarah equipment was not handled in Winnipeg, but information could be obtained by contacting Field Aviation Co. Ltd., Toronto Airport, Box 1001, Malton, Ontario, telephone BU 6-3651.

It was recommended by Mr. Brereton that we get our weather data through Trans-Air Limited or, better, through Mid-Canada Cranberry Portage. He also told me to contact Group Captain Willis at the RCAF Base at Winnipeg. When I talked to him about radar tracking he told me to contact Squadron Leader Green at Cranberry Portage and let it go through channels.

Mr. C. R. Brereton's address is:

Regional Director of Air Services
Attention: Supervisor Air Traffic Control
266 Graham Avenue
Winnipeg, Manitoba

Mr. Vic Skinner's address is:

Air Control Center
Building 16
Winnipeg National Airport
Winnipeg 12, Manitoba

Telephone Numbers:

Chief of Air Traffic Control at airport:	SU 3-7623
General number of ATC	SP 2-4920
Unlisted number of ATC	SU 6-2488
Unlisted number of ATC	SU 6-2489

Flin Flon

Airport manager's name is Thomas Kostiuk (Area Code 204, 687-3554) 18 Island Drive, Flin Flon, Manitoba, Canada. We can use the airport for launching, but have to stay off the runways. There is no rental charge and we can use all the buildings we need. If we use the parking ramp we can launch in about any direction. From what the manager says, the winds are predominately from the NW. He has a direct line to Cranberry Portage, to file our ATC (FAA) NOTAMS. There is a place where we can tie down the planes about a mile away at a government landing. He also has gas (100 Octane) and oil available at the airport for $.61 per gallon. The power is 110V 60 and if we use his setup the center building is insulated and we could run power into that building. There are no poles to mount the antenna on but he said we could put one up real easy. (That goes for VHF and 2 meg.)

The Royal Hotel looks like about the best place to stay as all the motels are small and I don't think we could get all the people in one motel.

Talked to the Mayor, Jim Connors,and asked about the old strip outside of town; he said there is only one building, the old terminal building that is still there. We would have to get permission from Manning Company. The runways are crushed rock so it doesn't look too good. They are rough and things look like it would give you more grief than anything.

Talked to the Mayor of Flin Flon, Mr. Jim Connors, and he seems to be very cordial. He said that we would be better off out at the Flin Flon airport as far as buildings and communications with ATC. There is a weather vane and wind speed indicator at the airport.

Went to see Frank Parsons at Parson Airways; he said that it would cost $2.00 to $3.00 per plane tie down. From the impression I got, he didn't much care whether we came there or not. He told me to go down the road and see a Mr. Gordon Mitchell about our gas. He quoted me a price of $.59 per gallon on 100 octane gas and $.65 a quart on oil. He also informed me that I should go see the Gasoline Tax Branch in Winnipeg and find out about a tax exampt for our planes. If we don't get it,the price on our gas will be $.71 per gallon. I told him we would drop him a line and let him know when we would be there and how much gas we would need. He will have no problem of getting us gas. He also said if we were going to stay at his place with our planes that there would be nor parking charge. If we go in and out too much, it would be $1.50 per day per plane.

Gordon Mitchell (Gas)
Channing Post Office
Flin Flon, Manitoba 687-5631

Mr. J. R. Conner
Mayor's Office
Flin Flon, Manitoba — 687-4549

Gardewine & Sons Ltd. (Trucking)
Channing and Wanless
Flin Flon, Manitoba — 687-4024

Squadron Leader Ray H. Green (Met)
Commanding Officer
RCAF Station
Cranberry Portage Manitoba — GRanite 2-3200 or 1

Fiteler Rent-a-Car Service
Flin Flon, Manitoba — 687-5511

Checked on plane rental from Parson and it was $.50 a mile on a 180 and $.75 a mile on a Norseman which comes out to about $70 an hour on a 180. He said we might get a helicopter but it would cost through the nose. I tried to contact Athabask Airways at Prince Albert, but didn't have any luck. They have got two Bells, but I don't know what the cost would be.

The Royal Hotel's manager is Mr. Glen E. McCrimmon, Royal Hotel, 93 Main, Flin Flon, Manitoba (687-3437). He will be waiting to hear from us when we will be there and how many.

Talked with Squadron Leader Ray Green at Cranberry Portage. He is going to find out what kind of weather information he can give us as far as upper winds and prog. for the next day. He will also check on radar tracking and see what they can work up for us. We will probably have a little trouble getting in over there. They have some top secret stuff around there so it could be kind of hard. He said that if we could have some kind of clearance letter it might help. He said that we could probably get in the first time to see him but after that they would probably bring the stuff to us. So when he told me this I didn't even bring up the subject of launching from there. We should be hearing from Ray within the next couple of weeks.

As far as car rental and pickup 1/2 ton, I don't think there will be any sweat. The people there said when they got a letter from us they would let us know what they could line up. I told them for now all we would need would be one car and a pickup. If there would be any more needed we would let them know. These rental charges are $45 a week and $.12 per mile for the car and the same on the pickup. We also get a 10 percent discount by the week. This will be rented from Tilden Rent-A-Car.

Saw Gardewine & Sons about trucking. They have four trips a day to and from Winnipeg. So we have no sweat. Asked about renting a tractor and got a price of $5.00 an hour or $150 for two weeks which is a pretty good price. So, I don't think there is any sweat there. I told them we would let them know when we would be there.

I talked to the airport manager before I left and told him we would be launching from there. He told me if I would write him a letter and let him know when we would be there that he would get power run into the building we will be using for our telemetry shack. I've got to draw up a plan on how we want the antenna placed. He said we could go 40 ft on our straight wire and 50 ft on our whip. The diameter of the poles at the top will be about 4 in. for our VHF mounting. He will install them for us so that when we get there all we have to do is put up our antenna. He should be treated with care because he doesn't want to charge us for anything. Also local help comes for $1.45 an hour for casual labor. The parking area is about 400 ft wide by 550 ft long so we should have no problems.

APPENDIX II

Tracking Airplane
Survival Equipment List
(Per Plane)

Tracking Airplane
Survival Equipment List
(Per Plane)

Code	Item	Description	Quantity
E	1	Survival Food Ration Kit	2 cans
E	2	Survival Fishing Tackle Kit	1
E	3	50-110 First Aid Kit	1
E	4	Resusitube	1
E	5	Signal Mirror	1
E	6	Hand Compass	1
E	7	May-Wests (incl. 2 flares, whistle, 2 CO_2 cartridges	3
E	8	Spare CO_2 cartridges for Item 7	4
E	9	Signal (distress day and night) Spares	6
E	10	Safety Wire for Snares	-
A,C	11	Eveready Flashlight (batteries and bulb included)	1
A,C	12	Spare Industrial "D" Batteries for Item 11	2
A	13	Tool Kit	
		a. 8" blade screw driver	1
		b. 10" blade screw driver	1
		c. 6" Phillip screw driver	1
		d. 8" Phillip screw driver	1
		e. 3/8-7/16 open end wrench	1
		f. 1/2-8/16 box end wrench	1
		g. 8" crescent wrench	1
		h. 7/8" deep socket	1
		i. 1/2" drive - 6" extension	1
		j. 1/2" drive pivot wrench	1
		k. 6" common long nose pliers	1
		l. canvas bag - tool kit	1
A	14	Sea Anchor	1
A	15	Danforth Anchor	1
A	16	Canoe Paddle	1
A	17	12 volt aircraft battery	1
A	18	Aircraft spark plugs	6
A	19	Jerri-Cans	3
A	20	Filter nozzle for Item 19	1
A	21	Maps	-
A	22	890 Tape	2 rolls
A	23	Nylon tow rope	-
A	24	Charging unit for batteries of Item 42	1
C	25	Mosquito lotion	-
C	26	Two-men pup tents	1
C	27	Sleeping bags	2
C	28	Cooking Kits	2
C	29	Knife, fork and spoon set	2
C	30	2-1/4 galloon plastic water bottle	1

Survival Equipment List (Cont'd.)

Code	Item	Description	Quantity
C	31	Insta-lite all-weather lantern	1
C	32	Pressurized liquid gas for Item 31	6
C	33	Spare mantle for Item 31 (2 per package)	1 pkg.
R,C	34	All-steel camper's axe with leather sheath	1
R,C	35	3-1/2 pound head single bit axe - 30 inch	1
C	36	Water-tight match container	1
C	37	Matches for Item 36	-
C	38	Head type mosquito netting	2
C	39	One-quart canteen and cover	1
C	40	Duffle bag for tents and sleeping bags	1
R	41	White cotton twine (packaged balls)	20 pkgs.
R	42	UHF transceiver	1

Code

A - Aircraft Equipment

C - Camping Equipment

E - Emergency Equipment

R - Recovery Equipment

APPENDIX III

Instrumentation for the 1963 Flin Flon Operation

Instrumentation for the 1963 Flin Flon Operation

Safety Timers

The Model S-14 and S-15 Safety Switches were developed specifically to meet the requirements of OP NAV INST 3710.18A to ensure that the flight complies with the regulation governing rate of ascent and descent below 44,000 ft. The switches also included a "backup" timer that would cut down the flight at a pre-set time if radio command had not terminated the flight prior to that time. The switches use a separate battery and squib circuit so that their operation is independent of other equipment on the flight. The S-14 is a long-duration electric timer featuring extremely high reliability and accuracy. It contains a spare control circuit which, on the overnight flights, was used for a programmed bulk ballast drop to overcome the normal decrease in altitude at sunset. The S-15 is a mechanical timer useful for flights of less than 24 hours in duration; it features dual timers and simple design for good reliability on shorter duration flights.

Command Receiver

A VHF-FM transistor receiver/decoder, designated Model R-16, was used for remotely controlling the balloon. This unit responds only to a correct pre-set sequence of audio pulses of a specific frequency and a particular pulse spacing and grouping to obtain a contact closure. Five contacts allow five separate balloon functions to be controlled. The decoder can be easily set up to any of 59,000 codes and coding can be changed at any time; it provides under- and over-count protection and will not respond to the sum of the individual code digits. If more than one balloon is in the air simultaneously, five functions can be commanded on each balloon by merely setting up five codes for each balloon from the 59,000 codes available. On these flights three functions were commanded: bulk ballast drop, ballast hopper valve control, and balloon release. Four receivers of this type were assembled and two Model R-13 receivers on 6700.5 KC were set up as spares.

Barotransmitter

The transmitter section of this instrument was our Model T-12 unit, an all-transistor 5-watt unit. This transmitter provides up to five times the power output of previously used models, yet normally requires a battery pack of less weight than many lower-powered units. The high power output provides a safety factor when operating under marginal atmospheric conditions and at increased distances.

The altitude coder was the Model B25 Barocoder. This device uses a system of several aneroid diaphragms driving two pen-arms across a revolving code drum. The pen-arm/drum contacts key the beacon in Morse code; the code group transmitted thus is proportional to the pressure/altitude of the payload. In addition to altitude, this device was used to verify receipt of radio commands. Verification of ballasting is obtained via a temporary frequency shift of the beacon transmitter. Balloon release verification is, of course, obtained via a telemetered sudden altitude change.

Ballast and Light Control

A controller was included in the instrument package containing circuitry enabling an aircraft-type rotating red beacon light to automatically turn on during system descent at 44,000 ft. In addition to its primary use for aircraft warning, the light beacon is used to aid recovery crew in locating the payload. The controller also contains circuitry, coupling the radio command ballast function to the frequency shift, telemetry control of the beacon transmitter and to the ballast valve. Also included are light and frequency shift test circuits for preflight checkout.

Power

Power for the instrumentation was obtained from alkaline type dry batteries. This type battery provides good cold temperature reliability at low cost and creates no preflight charging or handling problems. Further, an alkaline battery is able to deliver high current when required and provides enough of a safety factor, after its rates capacity is is consumed, to power the beacon transmitter so that the latter's output can still be picked up by a search plane many hours after payload impact.

Packaging and Suspension

The safety switch was housed in an insulated bag atop the parachute. All other instrumentation and powersupplies were placed in a floatable container, constructed of 4-inch thick expanded polysyrene with overall dimensions of 24 x 24 x 22 inches. Water cans were placed in the package as a source of latent heat. A plywood base on the container was painted black to take advantage of radiant heating. This package design enables the instrumentation to withstand the severe night as well as daytime environmental conditions encountered on the balloon flights. A load bar was devised to mount our instrument container, the scientific payload, telemetry and receiving antennas, etc., on a single plane. This suspension enabled the total payload to be launched with comparative ease from an "A" frame mounted on the front end of a panel truck.

APPENDIX IV

Equipment List for Flin Flon

Equipment List for Flin Flon

The following is a general list of equipment that was required for the Flin Flon Operation:

1. Ballast System
   a. Ballast - 230 lbs to be strained, dried and repacked with desiccant and sealed
      - 100 lbs (unstrained)
   b. Night time ballast unit - squibs, etc
   c. Ballast hopper - altitude control -six (6) units
   d. Radio command ballast control - four (4) units

2. Safety Unit
   a. S-14 four units - to be built
   b. S-15 two units to be checked out

3. Barocoders B 25
   a. Two units - to be built
   b. Four units to be checked and calibrated
   c. One unit (from Neepawa) to be modified, checked out and calibrated

4. 2 Meg Transmitter T-12
   a. Two units - to be built
   b. Four units to be modified and tested
   c. Antennas for T-12 - seven units (special)

5. VHF Radio Commands - four units to be built

6. VHF Radio Antenna - seven units

7. Squib Connector on gray panel

8. R-13 Radio Commands - two units rework and check out, plus two antennas

9. Modulators for R-13
   a. Base station
   b. Plane

10. Airplane communication and radio command package - two units to be built

11. Squib assemblies

    a. "A" frame release (7 flights)
    b. Anchor cable (hand launch - parts for four launches)
    c. Nighttime ballast (5 units)

12. Quick releases

    a. Anchor line (hand launch - parts for four assemblies)
    b. Payload release with squib assembly (assembly for eight flights)

13. Main electronic cable - seven sets to be built
14. Parachute cable - eight sets to be built
15. Parachutes - eight units to be rigged
16. Rotating beacon (four units with two extra lenses and 4 spare bulbs)
17. Bell jar and associated equipment
18. Balloon destruct unit (for the two 141-1-1 balloons; 14 hour float overnight)

    a. Nichrome wire, batteries, timers, insulation, water can, etc. - two units to be built

19. Water cans - 2 dozen quart cans (scrounge)
20. Instrument container - five units to be built

    a. Plywood
    b. Strapping
    c. Polystyrene

21. Load bar and suspension unit - five units to be built
22. Corner reflectors - six units
23. Base station

    a. 6 meg transmitter
    b. 6 meg receiver
    c. 2 meg receiver
    d. VHF transceiver

e. Coaxial cable leads

1. 6 meg
2. VHF

f. Antennas

1. 2 and 6 meg
2. VHF

24. G.E. voice command - two units lease

    a. extra batteries

25. Power supplies - seven flights
26. Extension cords - telemetry station and for panel
27. Space heaters - two units, telemetry station
28. Reward tags
29. Light bulbs - telemetry station and ground
30. Weigh off scale
31. NOTAMS
32. Climbers
33. Safety belts
34. Maps
35. Navy panel

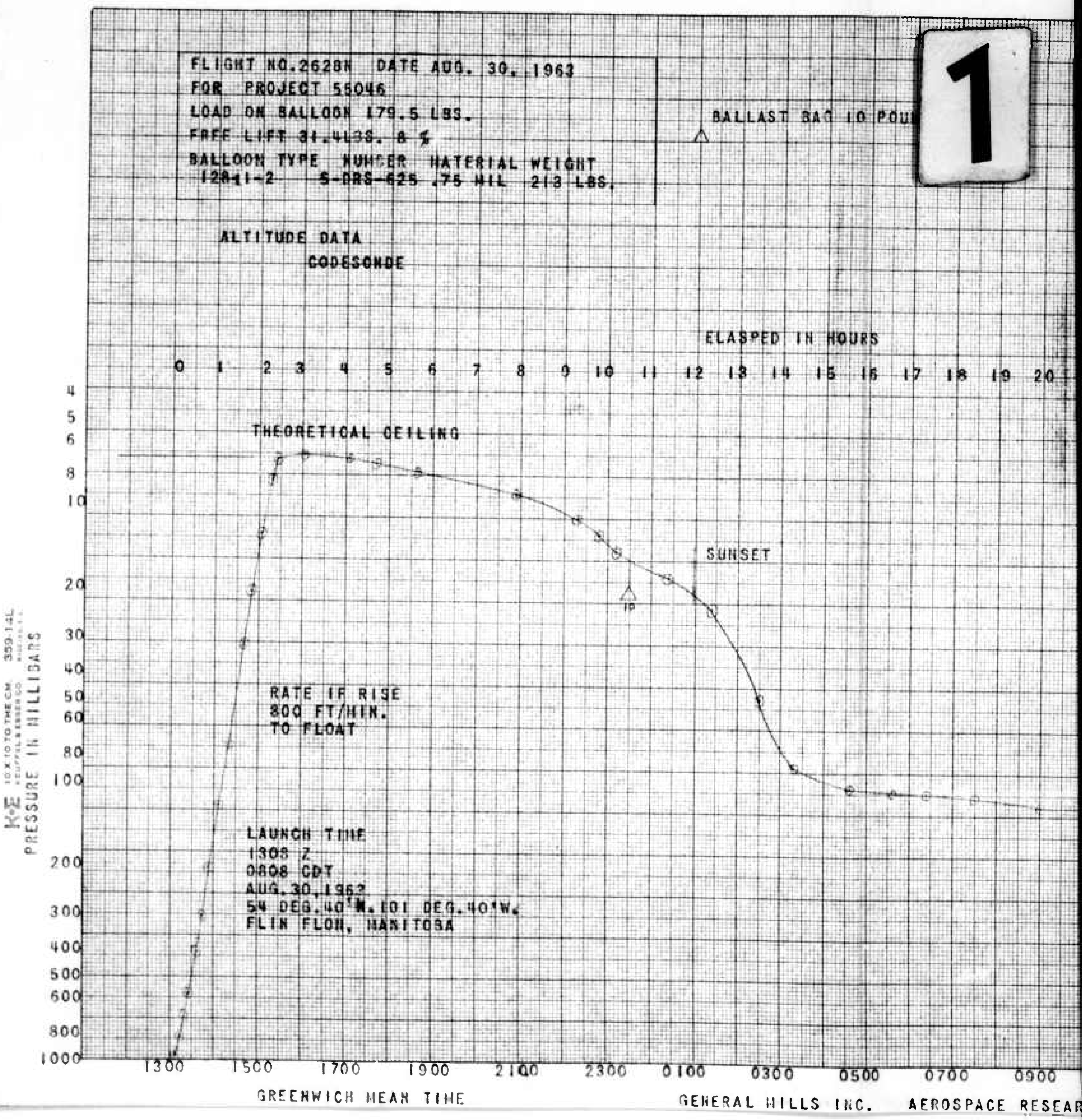
    a. Mechanically (checkout)
    b. ADF (checkout)

36. Helium inflation equipment
37. Icewater can - 5 gallon
38. Coffee maker
39. Flight jackets
40. Three army cots
41. Helium equipment (hose, diffuser, gauge, etc.)
42. Launch equipment
43. First aid kits

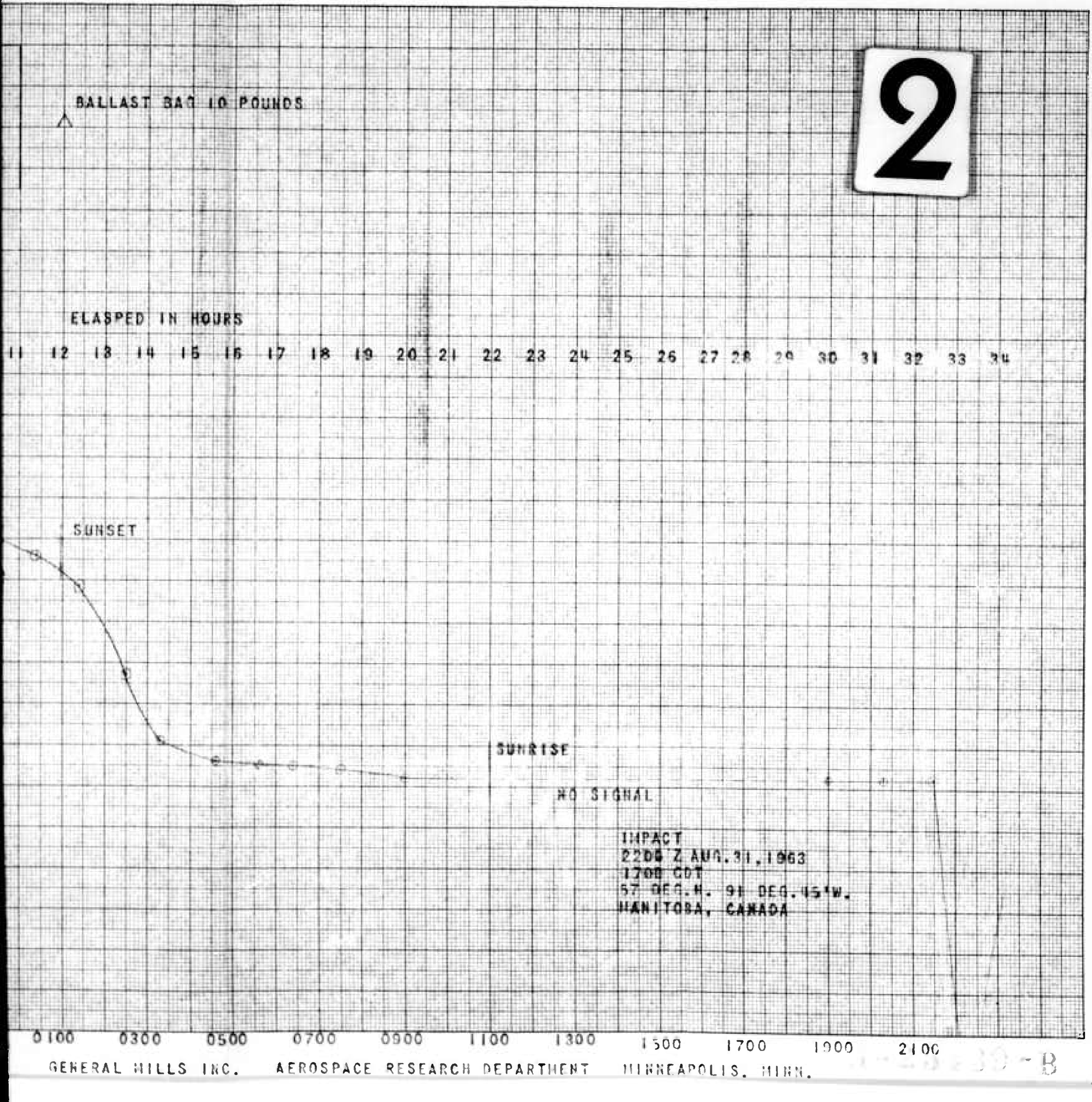
    a. Two units for the airplanes
    b. One unit for the base

APPENDIX V

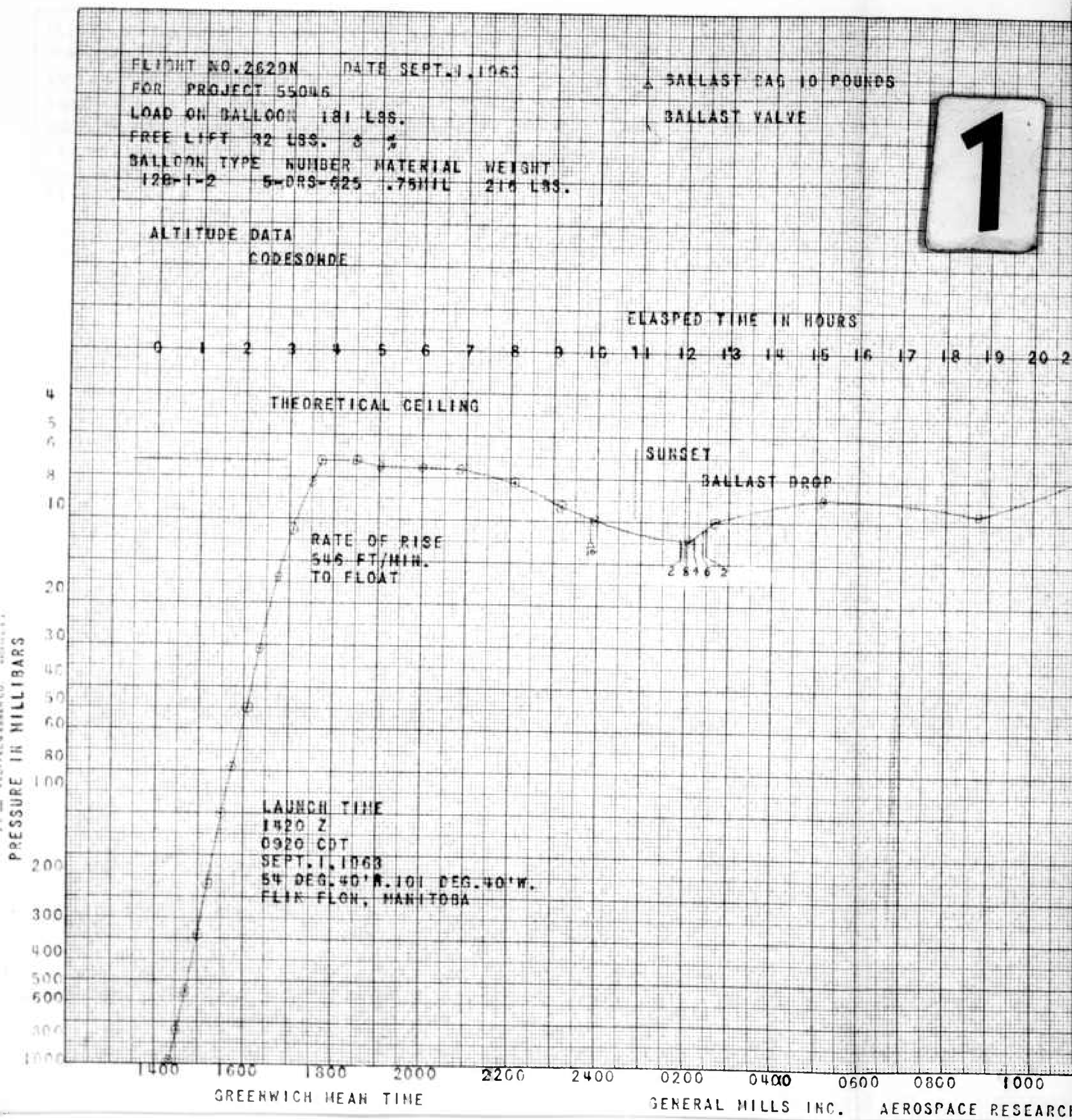
Flight Profiles

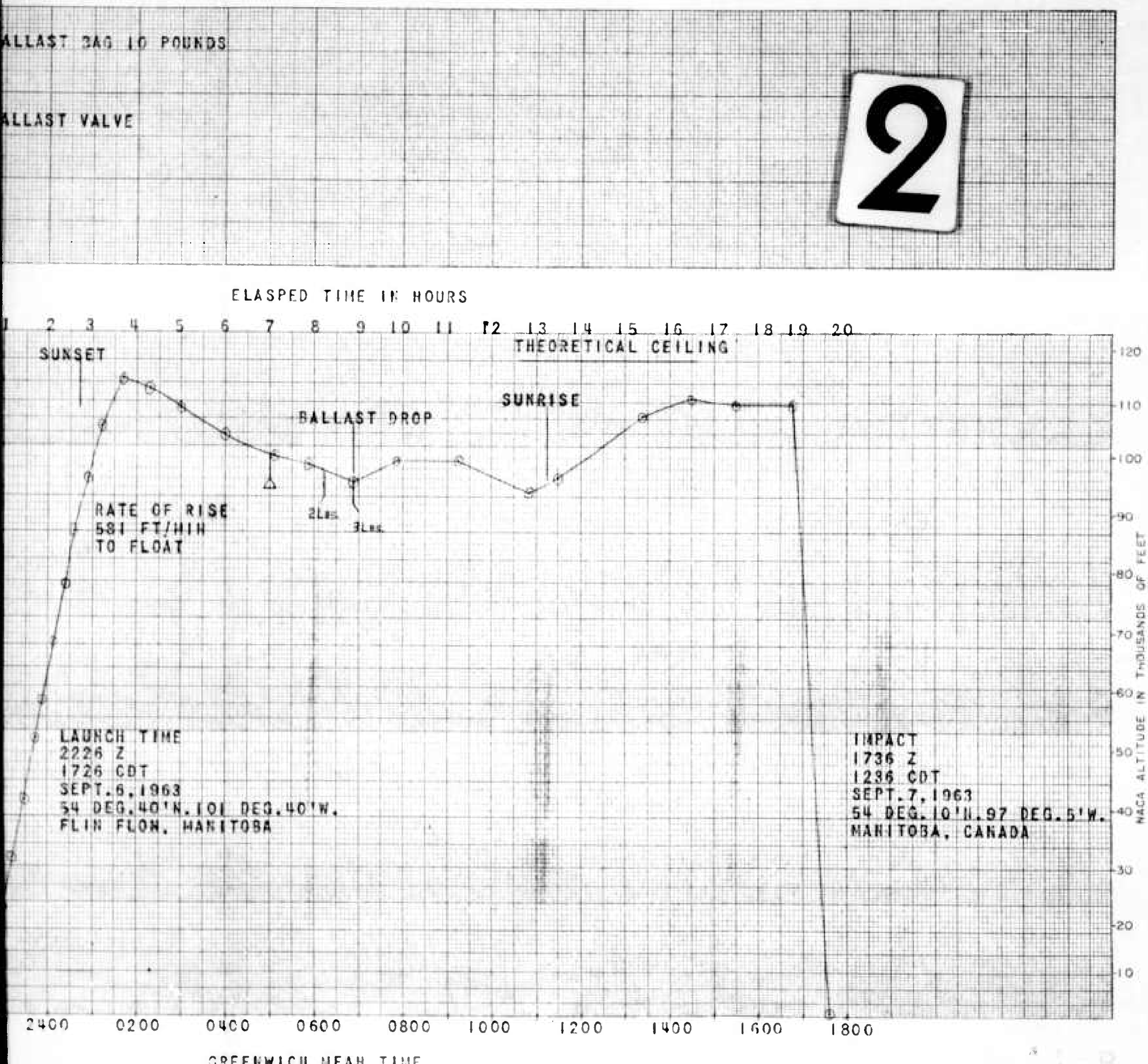


GENERAL MILLS INC. AEROSPACE RESEAR



GENERAL MILLS INC. AEROSPACE RESEARCH DEPARTMENT MINNEAPOLIS, MINN.


FLIGHT NO.2620N DATE SEPT.1.1963
FOR PROJECT 55046
LOAD ON BALLOON 181 LBS.
FREE LIFT 32 LBS. 8 %
BALLOON TYPE NUMBER MATERIAL WEIGHT
128-1-2 5-DRS-625 .75MIL 216 LBS.
BALLAST BAG 10 POUNDS
BALLAST VALVE
1
ALTITUDE DATA
CODESONDE
ELASPED TIME IN HOURS
THEORETICAL CEILING
SUNSET
BALLAST DROP
RATE OF RISE
546 FT/MIN.
TO FLOAT
LAUNCH TIME
1420 Z
0920 CDT
SEPT.1.1963
54 DEG.40'N.101 DEG.40'W.
FLIN FLON, MANITOBA
PRESSURE IN MILLIBARS
GREENWICH MEAN TIME
GENERAL MILLS INC. AEROSPACE RESEARCH

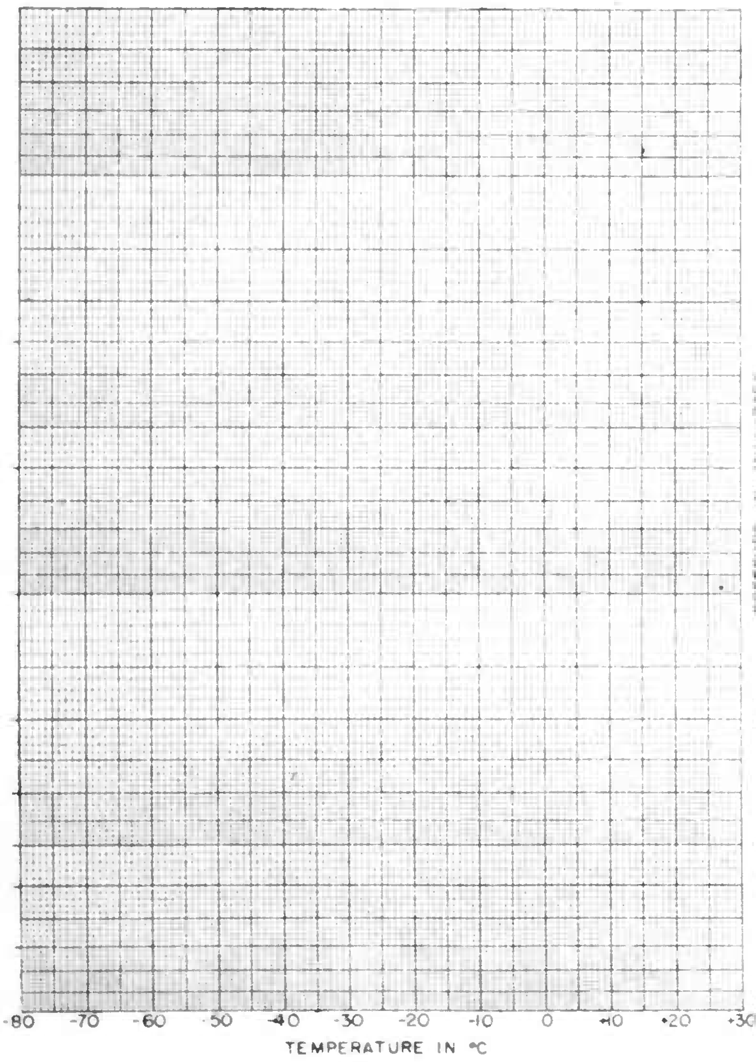


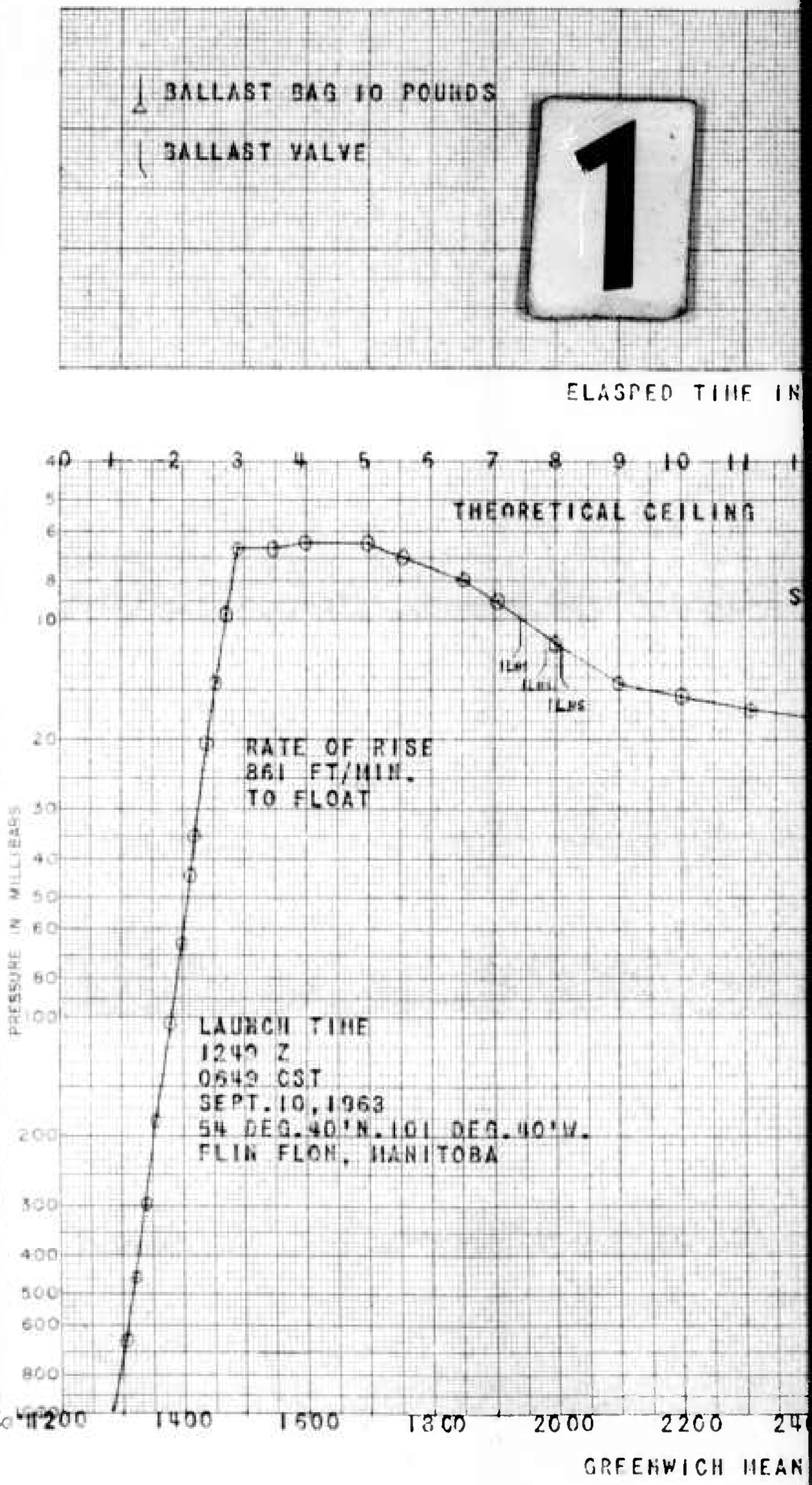
GENERAL MILLS INC. AEROSPACE RESEARCH DEPARTMENT MINNEAPOLIS, MINN.

FLIGHT NO. 2631 N DATE SEPT. 10, 1963
FOR PROJECT 55046
LOAD ON BALLOON 181.5 LBS.
FREE LIFT 31.7 LBS= 8 %

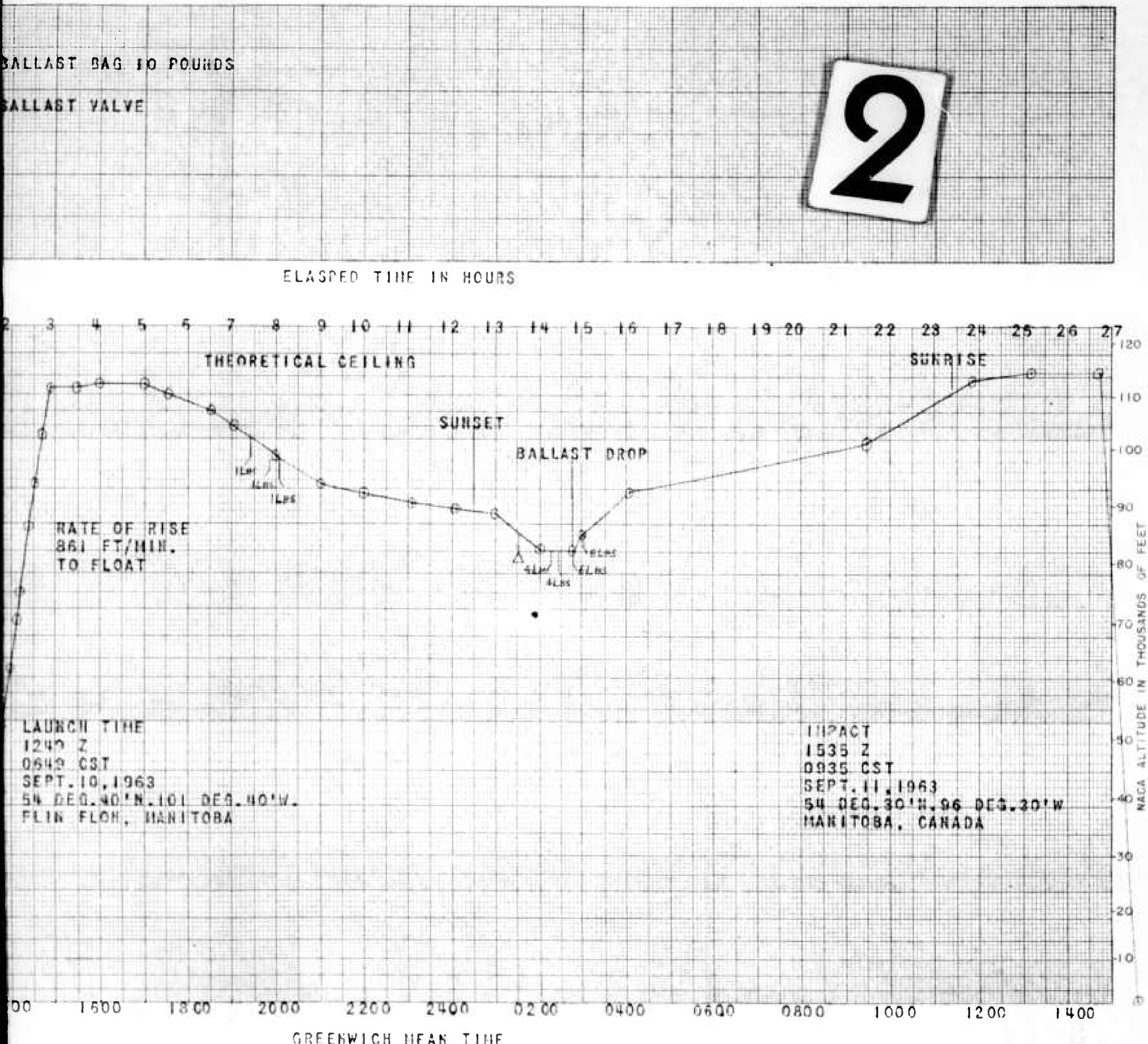
BALLOON TYPE	NUMBER	MATERIAL	WEIGHT
128-1-2	5-DRS-625	.75 MIL.	215 LBS.

ALTITUDE DATA
CODESINDE





GENERAL MILLS INC. AER



GENERAL MILLS INC. AEROSPACE RESEARCH DEPARTMENT MINNEAPOKIS, MINN.

FLIGHT NO. 2632 H DATE SEPT. 18, 1963

FOR PROJECT 55046

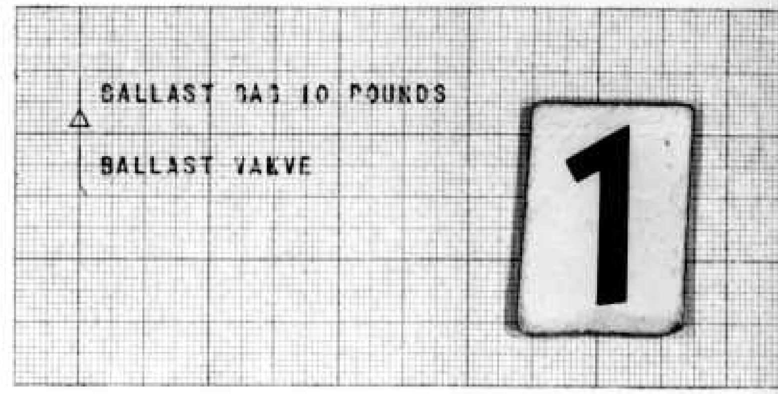
LOAD ON BALLOON 190.5 LBS.

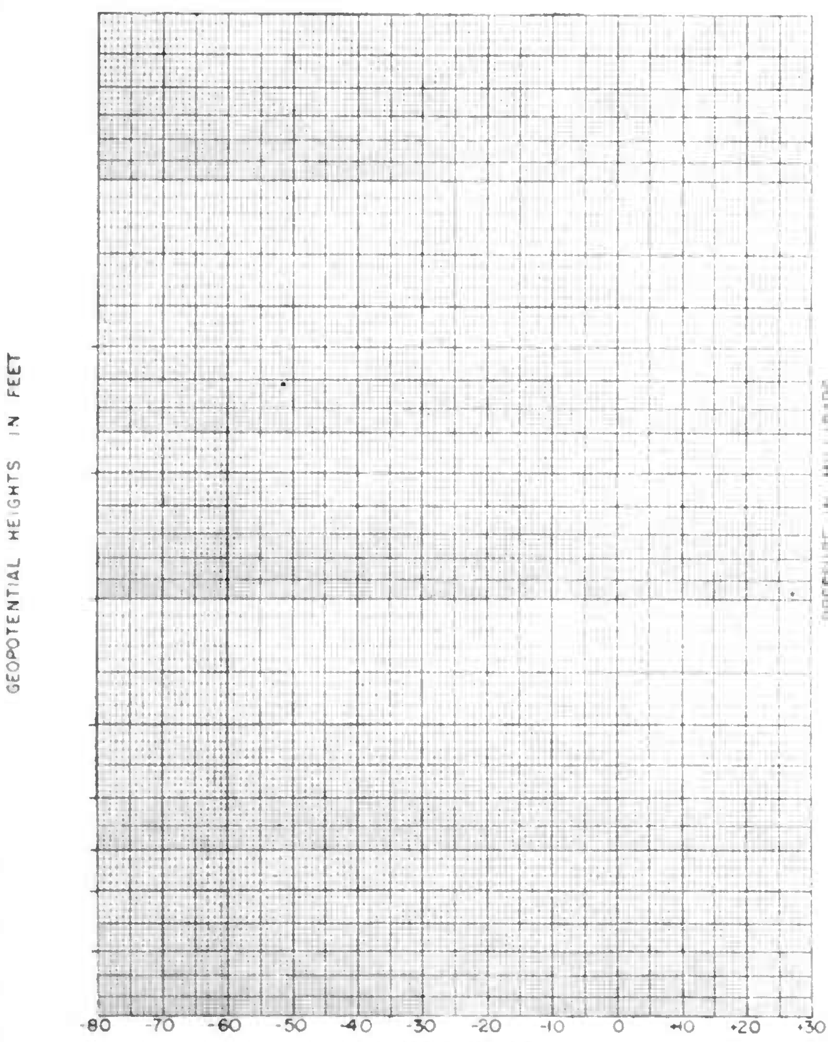
FREE LIFT 32 LBS= 8 %

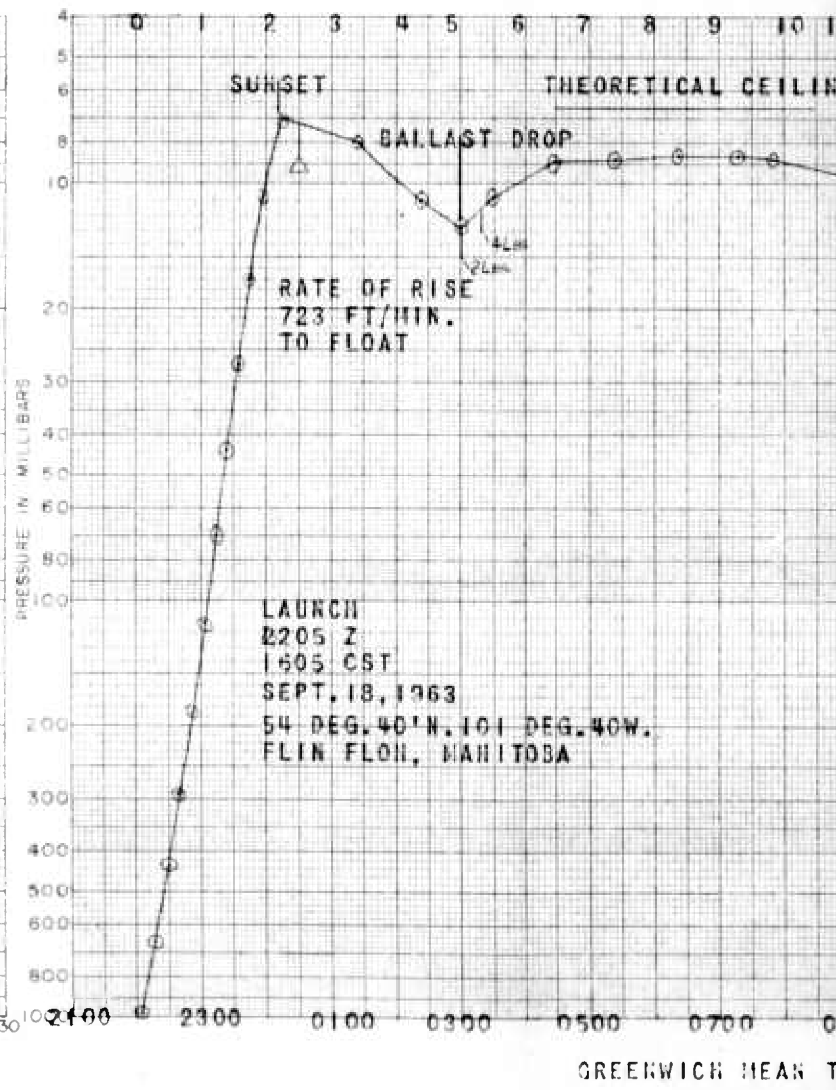
BALLOON TYPE	NUMBER	MATERIAL	WEIGHT
128-1-2	5-DRS-625	.75MIL	200 LBS.

ALTITUDE DATA

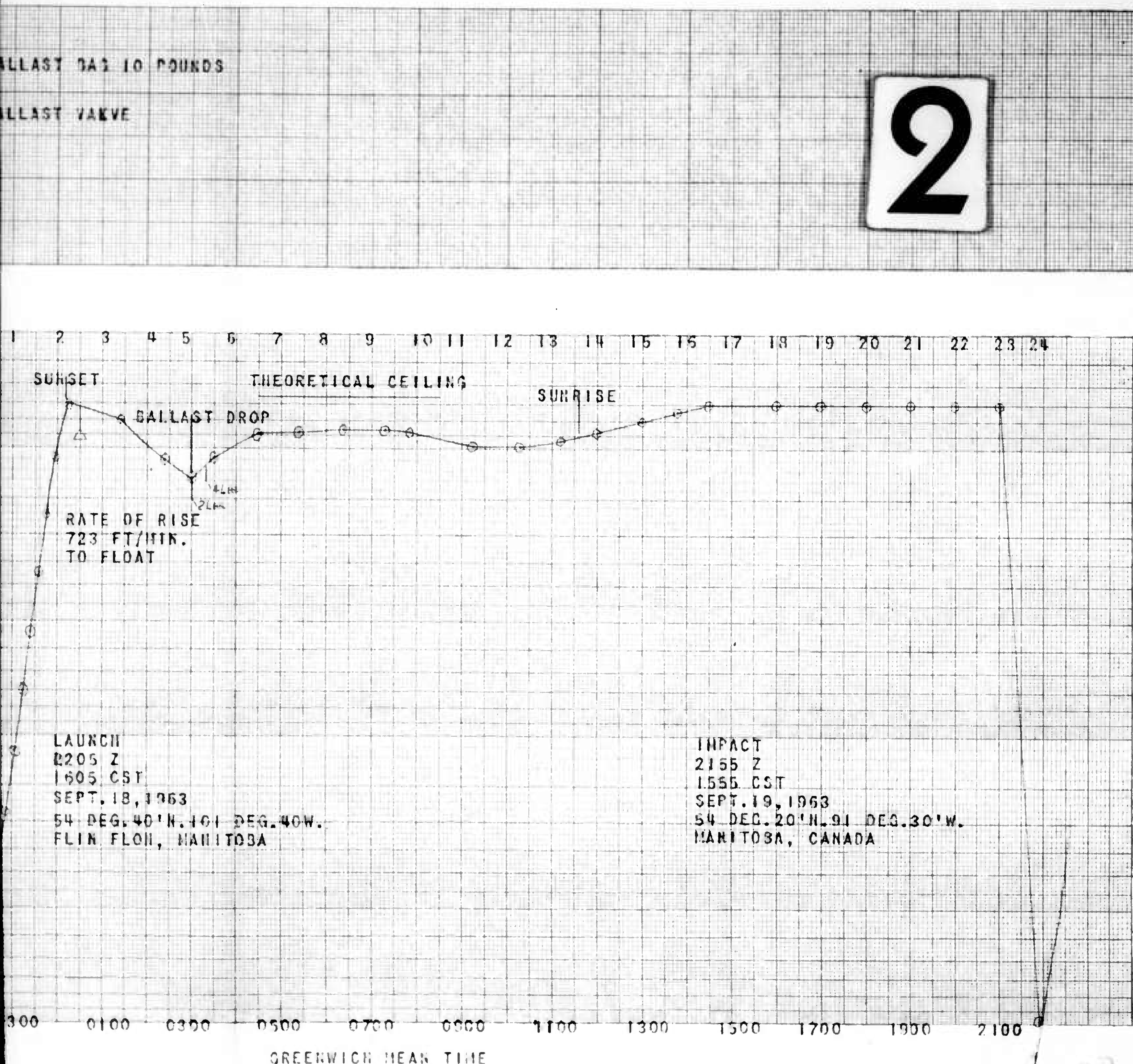
CODESONDE







GENERAL MILLS INC. AEROSPACE RE

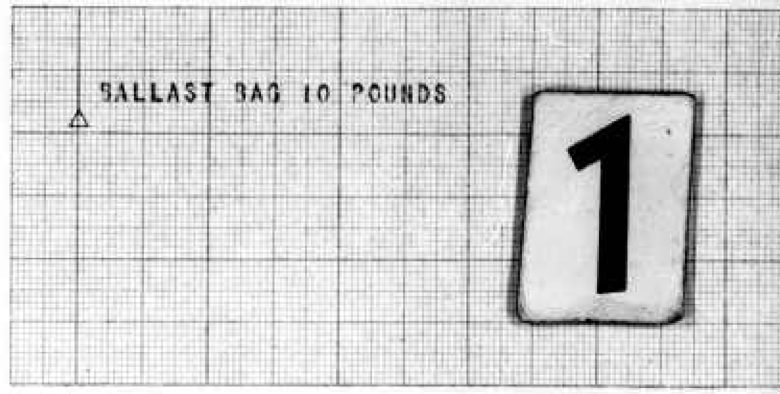


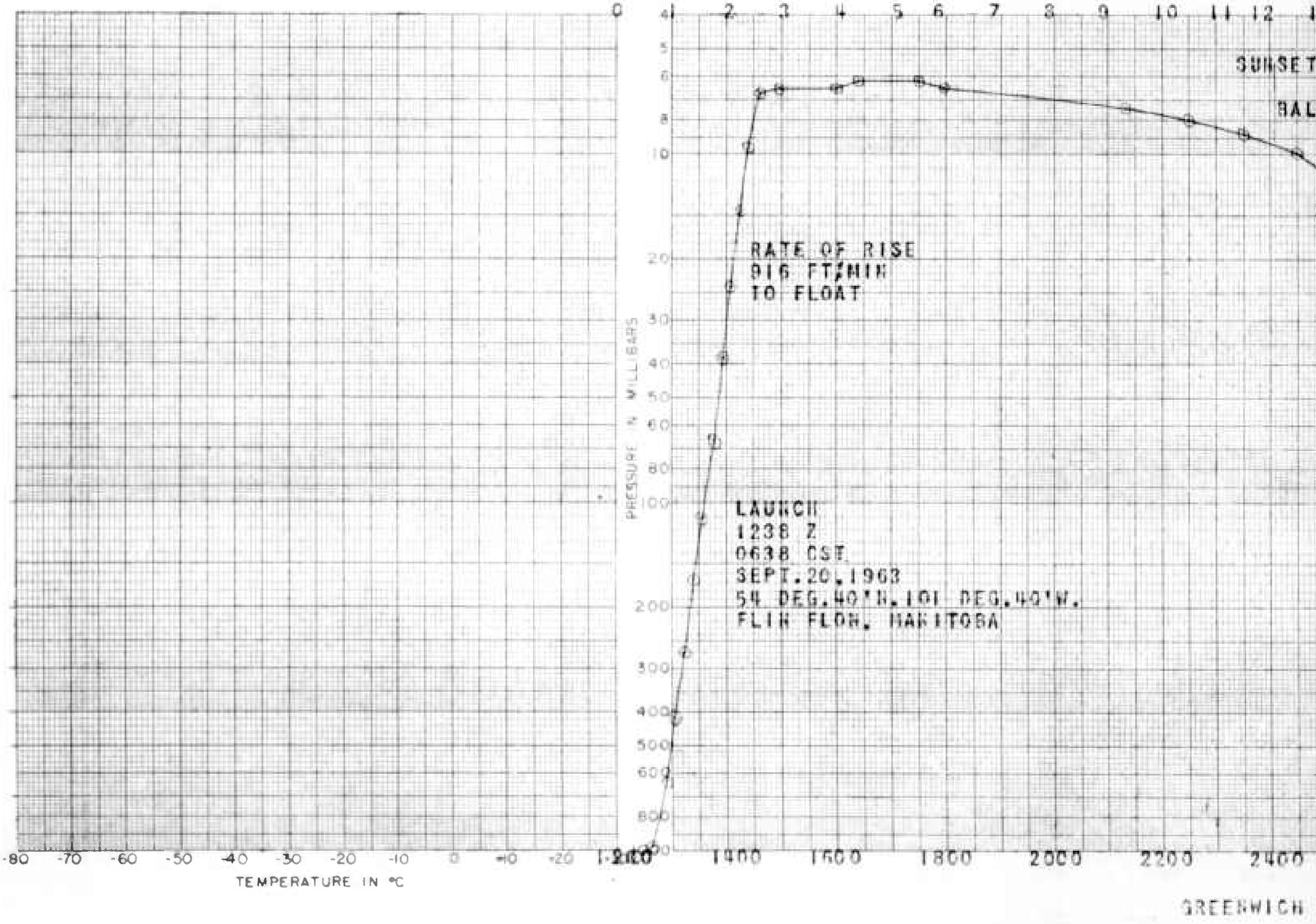
GENERAL MILLS INC. AEROSPACE RESERACH DEPARTMENT MINNEAPOLIS, MINN.

FLIGHT NO. 2633N DATE SEPT. 20, 1963
FOR PROJECT 55046
LOAD ON BALLOON 184 LBS.
FREE LIFT 32 LBS= 8 %

BALLOON TYPE	NUMBER	MATERIAL	WEIGHT
128-1-2	5-DRS-625	.75MIL	213 LBS.

ALTITUDE DATA
CODESONDE





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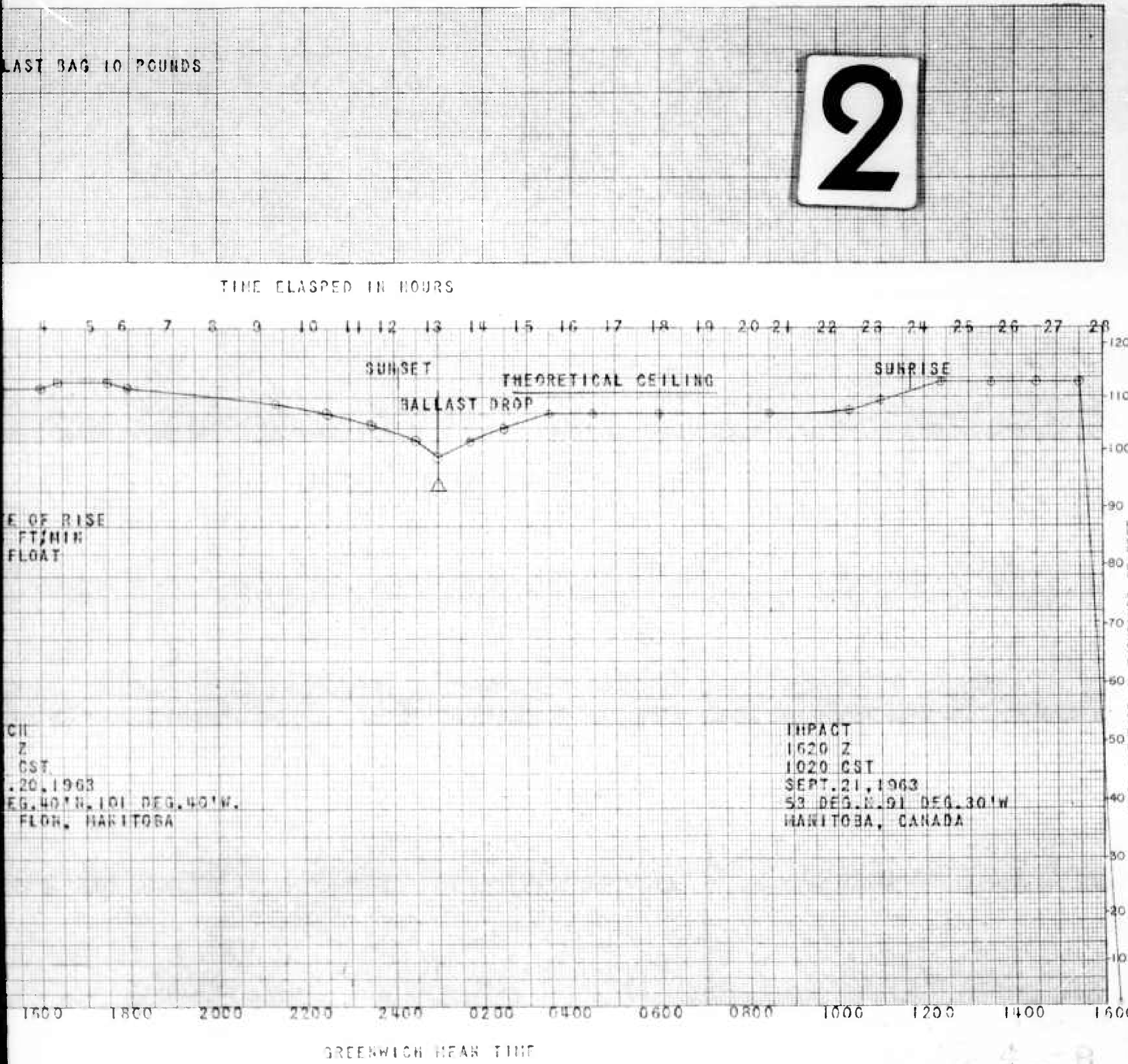
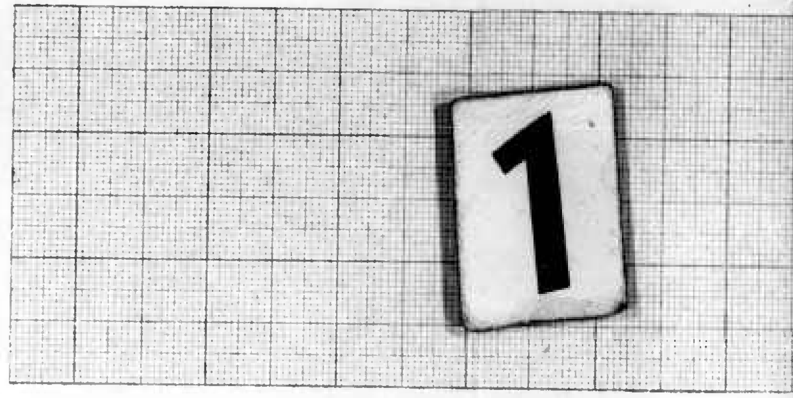


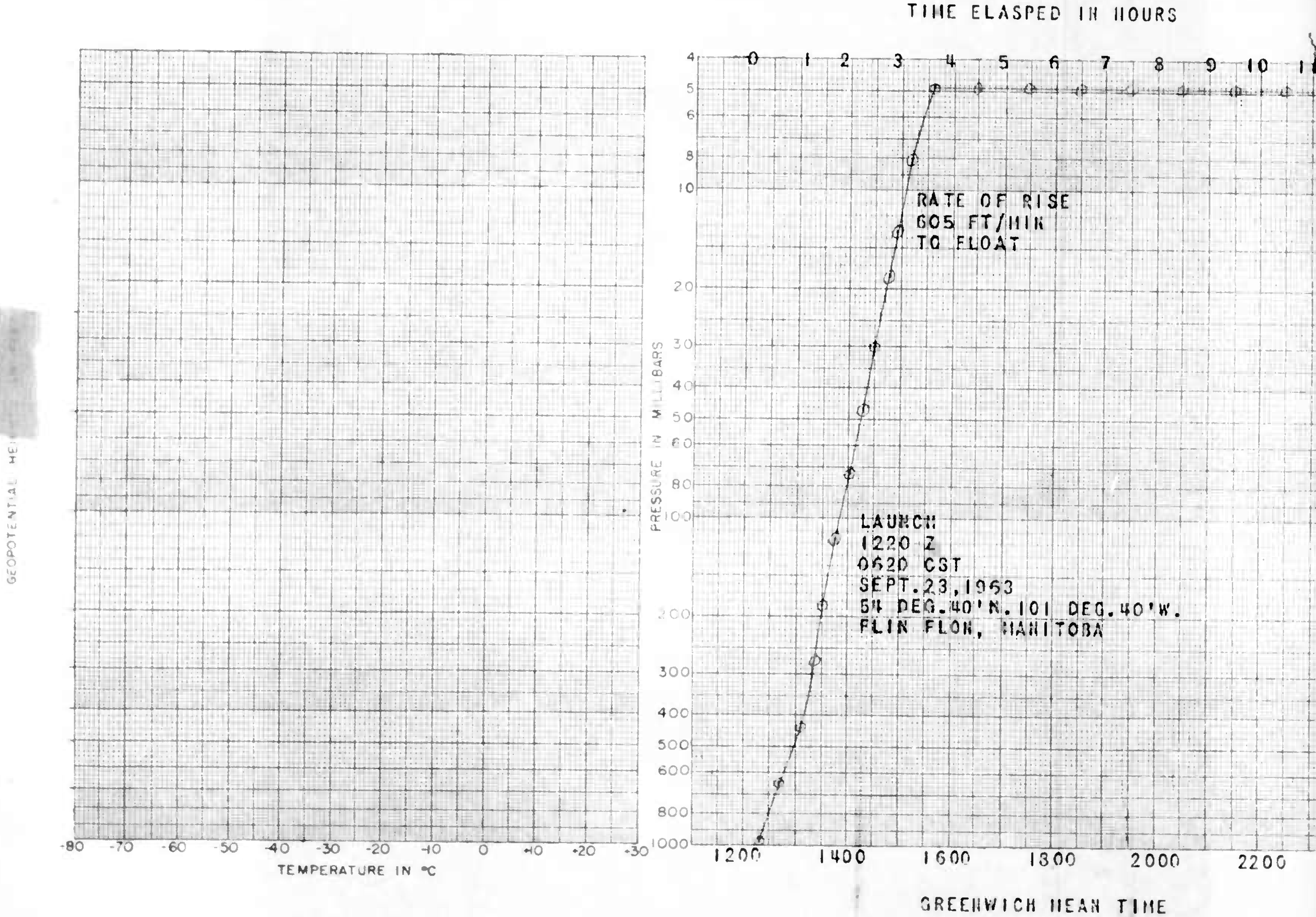
GENERAL MILLS INC. AEROSPACE RESEARCH DEPARTMENT MINNEAPOLIS, MINN.

FLIGHT NO. 2634H DATE SEPT.23, 1963
FOR PROJECT 55046
LOAD ON BALLOON 176.5 LBS.
FREE LIFT 27.3 LBS= 8 %

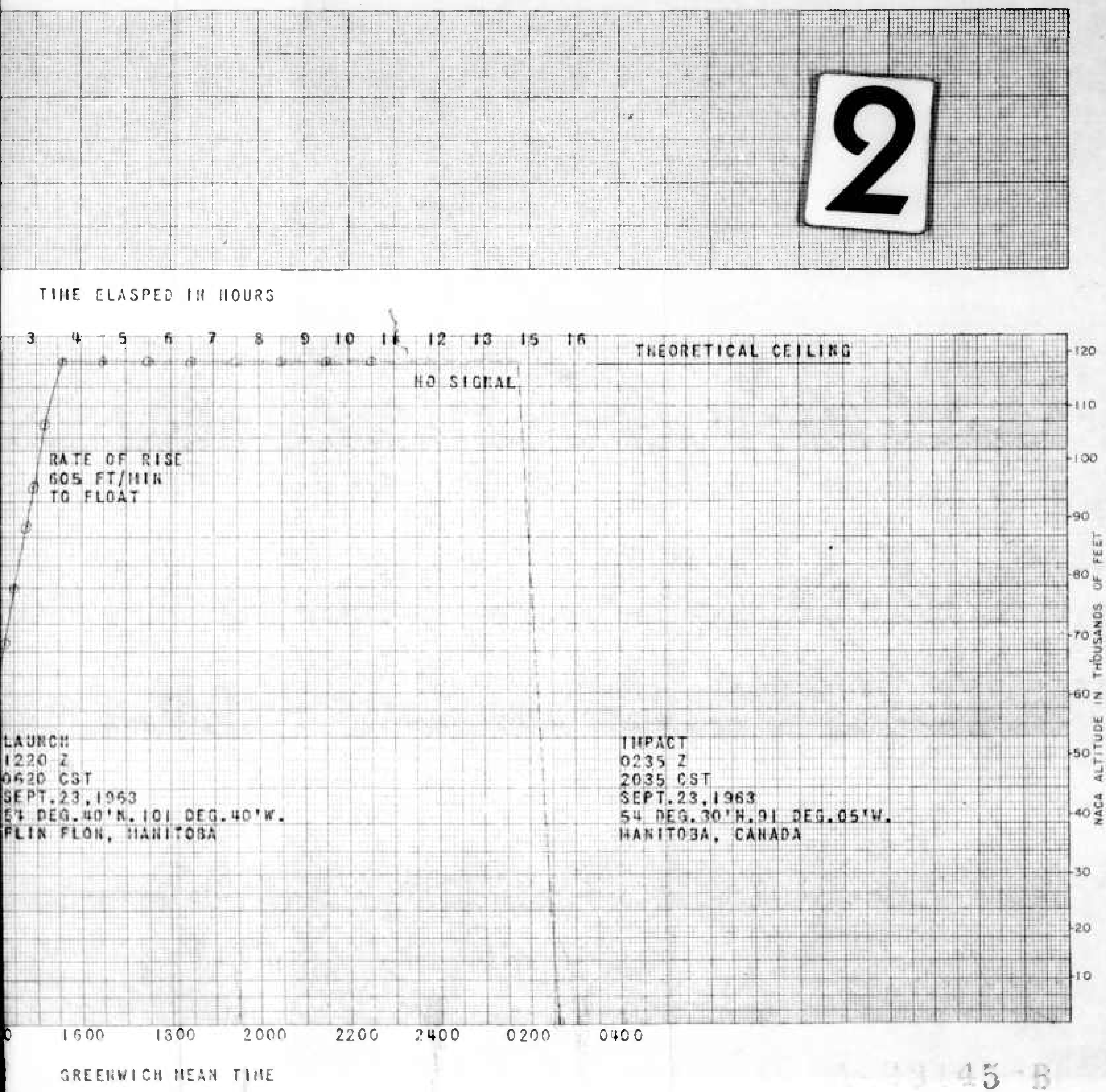
BALLOON TYPE	NUMBER	MATERIAL	WEIGHT
141-1-2	4-DRS-553	.55MIL	167 LBS.

ALTITUDE DATA
CODESONDE





GENERAL MILLS INC. AEROSPACE RESERACH DEP



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MILLS INC. AEROSPACE RESERACH DEPARTMENT MINNEAPOLIS, MINN.