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RECEIVED JUN 1971 NASA STI FACILITY INPUT BRANCH

WINZEN RESEARCH INC., MINNEAPOLIS, MINNESOTA 55420

WINZEN RESEARCH INC.
401 WEST EIGHTY-FOURTH STREET • MINNEAPOLIS, MINNESOTA 55420
TELEPHONE (612) 881-5871

CR-115028

FINAL REPORT

CONTRACT NO. NAS 9-10496

May 17, 1971

SUMMARY

During the report period of November, 1970, the balloon fabrication was completed and the balloon was shipped to Holloman Air Force Base on 11 November 1970.

If detailed information is required on the design, development and manufacturing of the two balloons covered under this contract, please refer to Monthly Progress Reports 1 through 5 on Contract No. NAS 9-10496.

Included with this report is a time/altitude curve, Appendix B, which shows the data collected from instrumentation discussed in Monthly Progress Report #3 during the flight tests of the two balloons built under this contract. Since the flight operations were conducted by Air Force Cambridge Research Laboratories, who will present their flight report on the balloon system performance, this data is provided for information on the performance of the instrumentation.

DISCUSSION

This Final Report on Contract No. NAS 9-10496 covers the work performed in Exhibits B and C, Statement of Work. The work under Exhibit A, Statement of Work, was reported in Final Report dated 27 March 1970.

The first balloon shape was designed on the computer with the following design criteria:

* Top loading from the launch balloon and transfer duct of 1500 pounds.
* Suspended payload of 13,808 pounds.
* Altitude of 108,000 feet.
* Fortisan load tapes.
* Factor of Safety of 5 or more on fittings.
* Tensile test of end fittings to be made with G.F.E. transfer duct.

The specification of this balloon, as built, is included in Appendix A.

This balloon was flown by Air Force Cambridge Research Laboratories, Detachment 1, at Holloman Air Force Base on 26 August 1970 and failed at approximately 48,000 feet. The failure was traced to a circumferential tear about a foot long at the apex close to the apex plate. This tear apparently resulted from a concentrated high-tensile load during inflation and/or let-up and launch.

The second balloon was redesigned as follows:

* The apex fitting was redesigned to provide increased protection from shipping and/or handling damage.

* The 800 lb. tensile load tape was changed from fortisan to polyester fibers.

* The middle cap length was increased from 198 to 250 feet.

* The computer shape was redetermined to include the effect of the changes in load tape and cap weight.

* The shipping box was modified to provide better support for the end fittings, to increase the walkway height for easier layout handling and to provide a split tailgate for ease in handling the transfer duct.

* Decreased design payload weight to 11,808 pounds.

The specification of this balloon as it was built is included in Appendix A.

The second balloon failed at 52,000 feet. Analysis of the balloon at impact site showed no damage to the balloon in the immediate vicinity of the apex fitting such as occurred on the first flight. Analysis of the flight data provided under this contract showed that at 18,500 feet there was a sudden increase of volume of the main balloon. It is theorized that a sudden large increase of volume, approximately 47%, could only occur if a large number of gores trapped inside the body of revolution formed by the highly tensioned load tapes suddenly popped outside, forming external flutes. This action abraded or tore one or more gores such that as the damaged area moved into a more highly stressed region of the flight bubble at 52,000 feet, complete failure occurred.

The full gore capped balloon is manufactured such that the gores would normally be fluted outside the column of load tapes, but during packaging, lay-out and other handling the load tapes could move external and trap gores inside the erect balloon load tape column.

It is concluded that if the deployment problem which led to the above failure can be solved, a polyethylene balloon can carry this size payload to 108,000 feet. It is recommended that a new launch technique using a single cell balloon be considered for this application. This would eliminate the abnormal, off-design stress situation generated by top and bottom tensile loading of the main balloon, and the excess weight penalty generated by the top balloon and transfer duct. The main balloon would thereby be smaller for the same altitude at float with the obvious saving in helium costs and complexity of ground handling equipment.

APPENDIX A

CO-9389
Balloon 1 of 2
WRI Serial No. 1

BALLOON SPECIFICATIONS

RFQ NO. Unsolicited DATE: August 21, 1970

1. MANUFACTURER: Winzen Research | 2. PROPOSAL NO: 12268P2 | 3. PROJECT NAME: CRISP

4. MATERIAL: StratoFilm® | 5. FILM GAUGE: 1.5 | 6. FILM MANUFACTURER: Winzen Research

BALLOON DESIGN 1500 *top
7a) Nominal Load: +13808 Lbs. | 7b) Nominal Altitude: 108,000 Ft. MSL (Attach Load-Altitude Curve)

7c) Balloon Volume: 38.19 MM | 7d) Type (Tailored, Taped, Etc.): Natural shape, taped, capped, tandem

7e) { = N.A. | 7f) No. of Gores: 220 | 7g) Half Gore Width: 0 Top: 3" Bottom

7h) Max. Gore Width: 79.265 In. | 7i) Gore Length: 645.96 Ft. | 7j) Surface Area: 570,872 Sq.Ft.

7k) Inflated Height: 366.9 Ft. | 7l) Inflated Diameter: 462.57 Ft. | 7m) Mfg. No.: SF 462.57-150-NSTC-P

7n) Balloon Wt.: 8358 Lbs. | 7o) Partial Bubble Weights: NA Lbs. @ Ft.

Lbs. @ Ft.; Lbs. @ Ft.; Lbs. @ Ft.

8. LOAD TAPES
8a) Type & Ultimate Tensile Strength: Fortisan Stratotape - 800 lb. tensile (F.S. = 5.63)

9. INFLATION TUBE(S)
9a) No. of Tubes: None | 9b) Material & Gauge: | 9c) Location from Top: Ft.

9d) Diameter: Ea. | 9e) Length: Ft. | 9f) Horizontal Location:

10. DUCT(S)
10a) No. of Ducts: 8 | 10b) Material & Gauge: StratoFilm® 1.5 mil | 10c) Area Each Duct: 100 Sq.Ft.

10d) Distance From Bottom End Fitting: 273 Ft. | 10e) Type of Duct: Tailored, attached

11. TOP FITTING Plate, double hoop & ring with adaptor
11a) Type (Attach Dwgs. If Non-Std) for transfer colla | 11b) Valve: No valve

11c) Dimensions: 5 feet O.D. | 11d) Weight: Incl. adapter 95 Lbs.

12. BOTTOM FITTING
12a) Type: Wedges & Collar | 12b) Dimensions: 9 1/2" I. D.

12c) Weight: 71 Lbs. | 12d) Load Attachments: 1 1/2" -6 UNC Eyenut

13. OTHER ATTACHMENTS (Cables, Destruct Device, Etc.): Attached reefing sleeve, 3 mil hi-slip Strato-film® with 1 mil rip panel. Destruct line to inverted "V" 40 feet from base fitting.
One electrical cable with four (4) No. 14 wire conductors in 2.0 mil StratoFilm® sheath.
One electrical cable with three (3) No. 14 wire conductors in 2.0 mil StratoFilm® sheath.
Two internal integrally sealed caps 1.5 mil each by 194 feet and 198 feet long.
*1500 lbs. is launch balloon and attachment fittings as top mounted load.
Approximate transfer altitude with 15% F.L. = 7500 ft., with 8% F.L. = 9700 feet.
We do not recommend use of more than 8% F.L.

AS BUILT

APPROVED BY
Lee S. Scheffler

BALLOON PRODUCTION RECORD SUMMARY

AFCRL Model No. NA

Manufacturer: Winzen Research Inc. Plant Location: Sulphur Springs, Texas

Contract No. NAS 9-10496, Balloon No. 1 of 2, Item No. ____

Material: 1.5 Mil, Vendor's Order No.: CO-9389

Duct Assembly Drawing No. 303559

Inflation Tube Assembly Drawing No. NA

Destruction Device Drawing No. 303645

Top End Fitting Assembly Drawing No.303591, Torque #10SOC. HD.Cap SCR. x 3/4"-38 ± 3 in. lbs. #22NE-048 ESNA Nut -60 ± 5 in. lbs. 1½"-6 HEX Nut-440 ± 10 ft. lbs.

Base End Fitting Assembly Drawing No.303606, Torque 1½"-6UNC Eyenut -10 ± 5 ft. lbs. ½" bands-70 ± 5 in. lbs. #10-32 UNFX 1" cap screw -28 ± 2 in. lbs.

Number of Gore Reseals: 1

Number of Heat Sealed Patches: 14

Number of Adhesive Patches: 81

Number of Repairs Within Thirty-Five (35) Feet of Apex: 9

Type & Weight of Lubricant: 1/2 pounds of Cornstarch

Special Features: Cable, # 303562 attached to flange of seal 218; Cable # 303561 attached to flange of seal 219. Destruct device # 303645 installed on gore 219, located 40 ft. from balloon base. Balloon encased in a 3 mil highslip reefing sleeve, #303649. Black Circumferential marks at duct ellipses and destruct device.

Gore Layup Started: 7-21-70; Balloon Packaged: 8-21-70

Balloon Weight: 8358 pounds

Partial Weights: NA

____ feet ____ pounds

____ feet ____ pounds

____ feet ____ pounds

____ feet ____ pounds

____ feet ____ pounds

Box Dimensions & Gross Weight: with catwalk Cube of Box-772 cu. ft.

L 235 inches

W 80 inches

H 71 inches

Wt 10,978 pounds

APPROVED BY

W S Scheffler

APPENDIX B

Project No. 9389 B
Balloon 1 of 1
Serial No. 1

BALLOON SPECIFICATIONS

RFQ NO.

DATE: 11-19-70

1. MANUFACTURER: Winzen Research	2. PROPOSAL NO: (12275) 12268P2	3. PROJECT NAME: CRISP
4. MATERIAL: StratoFilm®	5. FILM GAUGE: 1.5 mil	6. FILM MANUFACTURER: Winzen Research
7. BALLOON DESIGN 7a) Nominal Load: 1500 * + 11808 Lbs.	7b) Nominal Altitude: 109,700 Ft. MSL (Attach Load-Altitude Curve)	
7c) Balloon Volume: 38.3 MM	7d) Type (Tailored, Taped, Etc.): Natural shape, tandem taped, capped,	
7e) { = N/A	7f) No. of Gores: 220	7g) Half Gore Width: 0 Top; 3" Bottom
7h) Max. Gore Width: 79.45 In.	7i) Gore Length: 648.55 Ft.	7j) Surface Area: 571,766 Sq.Ft.
7k) Inflated Height: 363.93 Ft.	7l) Inflated Diameter: 463.6 Ft.	7m) Mfg. No.: SF 463.6-150-NSTC-01
7n) Balloon Wt.: 8840 Lbs.	7o) Partial Bubble Weights: N/A Lbs. @ Ft.	
Lbs. @ Ft.;	Lbs. @ Ft.;	Lbs. @ Ft.
8. LOAD TAPES 8a) Type & Ultimate Tensile Strength: Polyester Stratotape - 800 lb. tensile		
9. INFLATION TUBE(S) 9a) No. of Tubes: NA	9b) Material & Gauge:	9c) Location from Top: Ft.
9d) Diameter: Ea.	9e) Length: Ft.	9f) Horizontal Location:
10. DUCT(S) 10a) No. of Ducts: 8	10b) Material & Gauge: 1.5 mil StratoFilm®	10c) Area Each Duct: 100 Sq.Ft.
10d) Distance From Bottom End Fitting: 273 Ft.	10e) Type of Duct: Tailored, attached	
11. TOP FITTING Plate, hoop & segmented clamp ring 11a) Type (Attach Dwgs. If Non-Std) w/adaptor for transfer collar.	11b) Valve: NA	
11c) Dimensions: 5 ft. O.D.	11d) Weight: 95 lbs. (including adaptor)	
12. BOTTOM FITTING 12a) Type: Wedge & collar	12b) Dimensions: 9½" I.D.	
12c) Weight: 71 Lbs.	12d) Load Attachments: 1½" - 6 UNC Eyenut	

13. OTHER ATTACHMENTS (Cables, Destruct Device, Etc.):
Attached reefing sleeve, 3 mil hi-slip StratoFilm with 1 mil tear panel. Destruct line to inverted "V" 608 ft. from apex. One electrical cable with four (4) #14 wire conductors in 2.0 mil StratoFilm® sheath. One electrical cable with three (3) #14 wire conductors in 2.0 mil StratoFilm® sheath. Two (2) integrally sealed caps (1.5 mil each) 196 feet and 250 feet long.

*1500 lbs is wt. of top mounted payload including launch balloon and attachment fittings.

AS BUILT

APPROVED BY
L. L. Lee
L. L.

Project 2111B

Balloon 1 of 1

Serial No. 1

BALLOON PRODUCTION RECORD SUMMARY

AFCRL Model No. NA

Manufacturer: Winzen Research Inc. Plant Location: Sulphur Springs, Texas

Contract No. NAS 9-10496, Balloon No. 1 of 1, Item No. ____

Material: 1.5 Mil, Vendor's Order No.: CO-9389 B

Duct Assembly Drawing No. 303559

Inflation Tube Assembly Drawing No. NA

Destruction Device Drawing No. 303645

Top End Fitting Assembly Drawing No.303591, Torque #10SOC. HD.Cap SCR. x 3/4"-38 ± 3 in. lbs. #22NE-048 ESNA Nut -60 ± 5 in. lbs.

Base End Fitting Assembly Drawing No.303606, Torque 1¼"-6 HEX Nut-440 ± 10 ft. lbs. 1½"-6UNC Eyenut -10 ± 5 ft. lbs. ½" bands-70 ± 5 in. lbs. #10-32 UNFX 1" cap screw -28 ± 2 in. lbs.

Number of Gore Reseals: 6

Number of Heat Sealed Patches: 32

Number of Adhesive Patches: 92

Number of Repairs Within Thirty-Five (35) Feet of Apex: 7

Type & Weight of Lubricant: 1/2 pounds of Cornstarch

Special Features: Cable, # 303562 attached to flange of seal 219; Cable # 303561 attached to flange of seal 218. Destruct device # 303645 installed on gore 219, located 608ft. from balloon apex Balloon encased in a 3 mil highslip reefing sleeve, #303649. Black Circumferential marks at duct ellipses and destruct device.

Gore Layup Started: 10-14-70; Balloon Packaged: 11-19-70

Balloon Weight: 8840 ✓ pounds

Partial Weights: NA

____ feet ____ pounds

____ feet ____ pounds

____ feet ____ pounds

____ feet ____ pounds

____ feet ____ pounds

Box Dimensions & Gross Weight with catwalk.

Cube 772 cu. ft.

L 235 inches

W 80 inches

H 71 inches

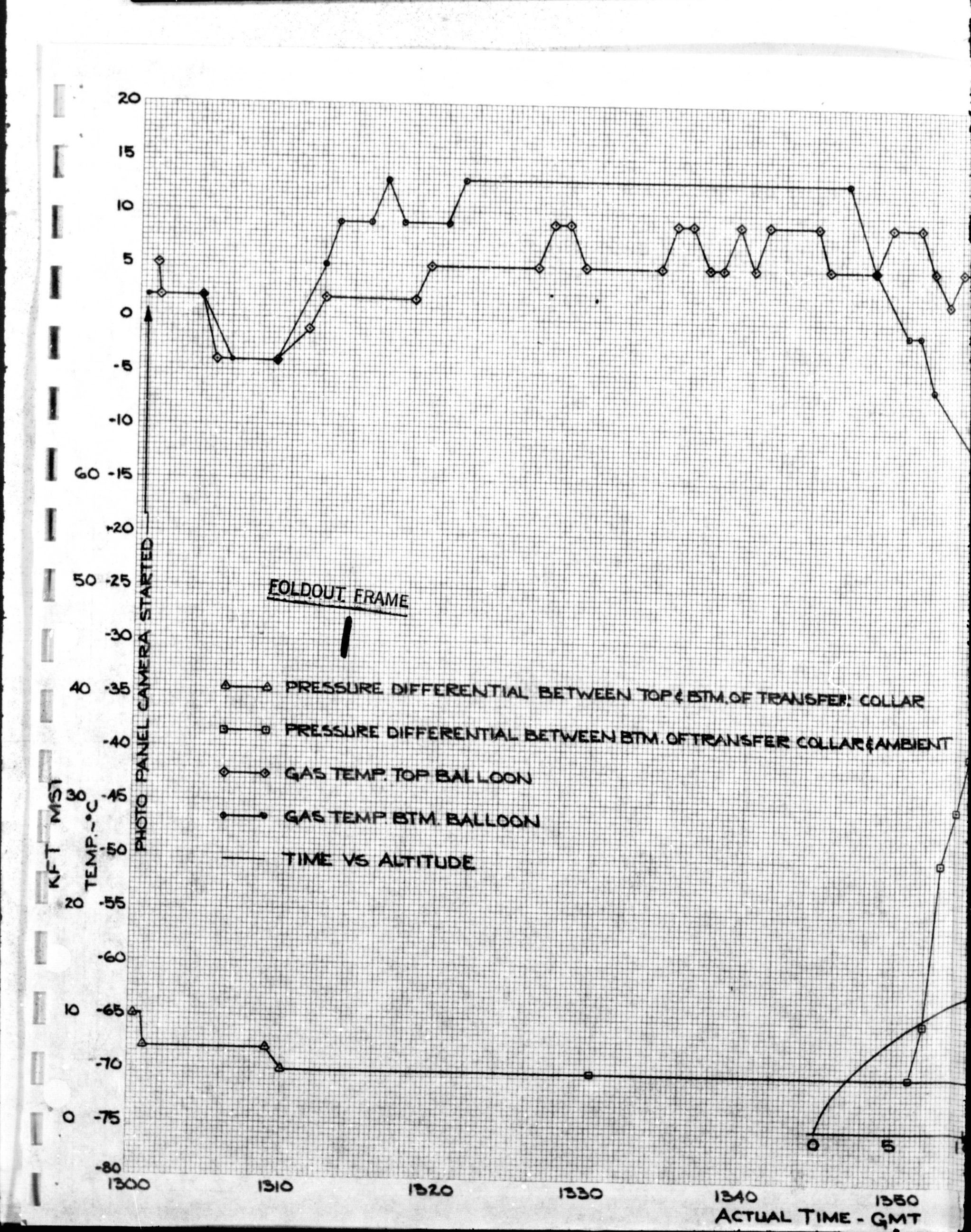
Wt 11,684 pounds

APPROVED BY

L. W. Scheffler

L.W.

APPENDIX C


20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
60
50
40
30
20
10
0
KFT MSL
TEMP.-°C
PHOTO PANEL CAMERA STARTED
FOLDOUT FRAME
PRESSURE DIFFERENTIAL BETWEEN TOP & BTM. OF TRANSFER COLLAR
PRESSURE DIFFERENTIAL BETWEEN BTM. OF TRANSFER COLLAR & AMBIENT
GAS TEMP. TOP BALLOON
GAS TEMP. BTM. BALLOON
TIME VS ALTITUDE
1300
1310
1320
1330
1340
1350
ACTUAL TIME - GMT
0
5

PROJECT CRISP 6448
FLIGHT NO H70-50
AFCRL HOLLOMAN AIR FORCE BASE
26 AUG 70
TRANSFER DUCT DATA

FOLDOUT FRAME 2

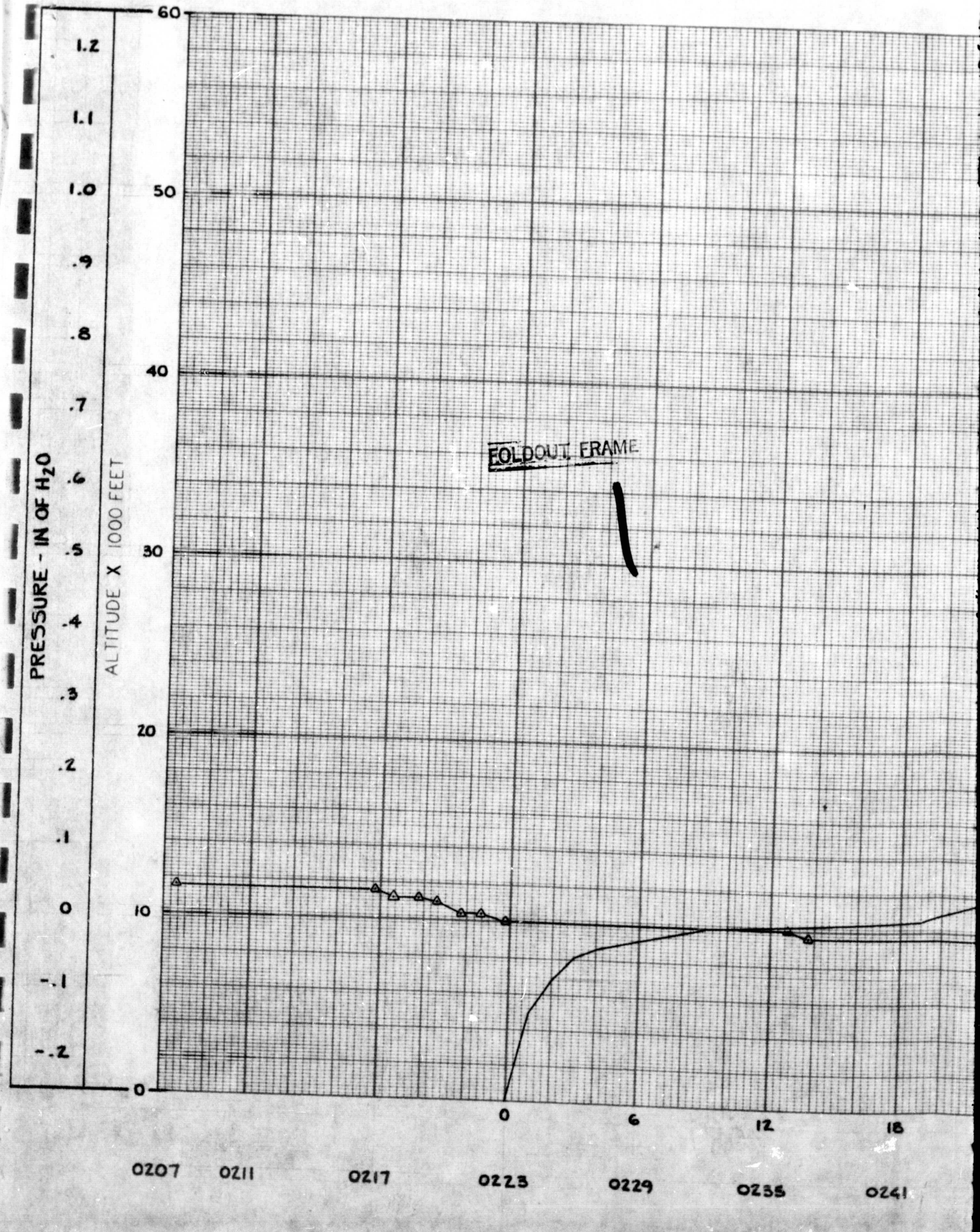
PRESSURE - IN. OF WATER

.7
.6
.5
.4
.3
.2
.1
0
-.1
-.2

10 15 20 25 30 35 40 45 50 55 60
ELAPSED TIME FROM LAUNCH

1400 1410 1420 1430 1440

100814


PRESSURE - IN OF H_2O
1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
-.1
-.2
ALTITUDE X 1000 FEET
60
50
40
30
20
10
0
FOLDOUT FRAME
0
6
12
18
0207
0211
0217
0223
0229
0235
0241

FOLDOUT FRAME

2

60
50
40
30
20
10
2

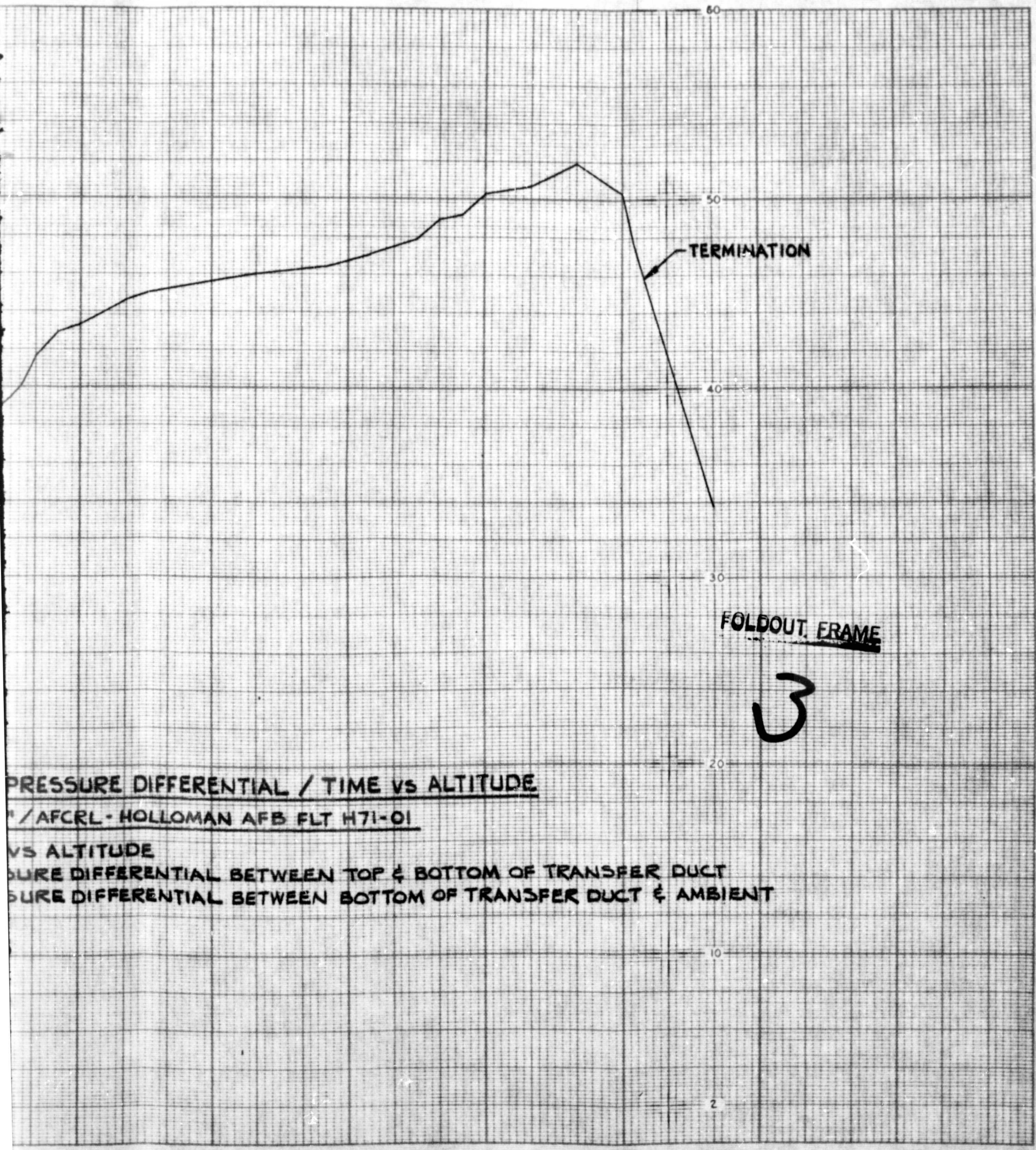
TRANS
PROJE

24 30 36 42 48 54 60 66

ELAPSED TIME - MIN (FROM LAUNCH)

0247 0253 0259 0505 0511 0517 0523 0529

MST - 16 JAN 71



FOLDOUT FRAME

3

PRESSURE DIFFERENTIAL / TIME vs ALTITUDE

' / AFCRL - HOLLOMAN AFB FLT H71-01

VS ALTITUDE
SURE DIFFERENTIAL BETWEEN TOP & BOTTOM OF TRANSFER DUCT
SURE DIFFERENTIAL BETWEEN BOTTOM OF TRANSFER DUCT & AMBIENT