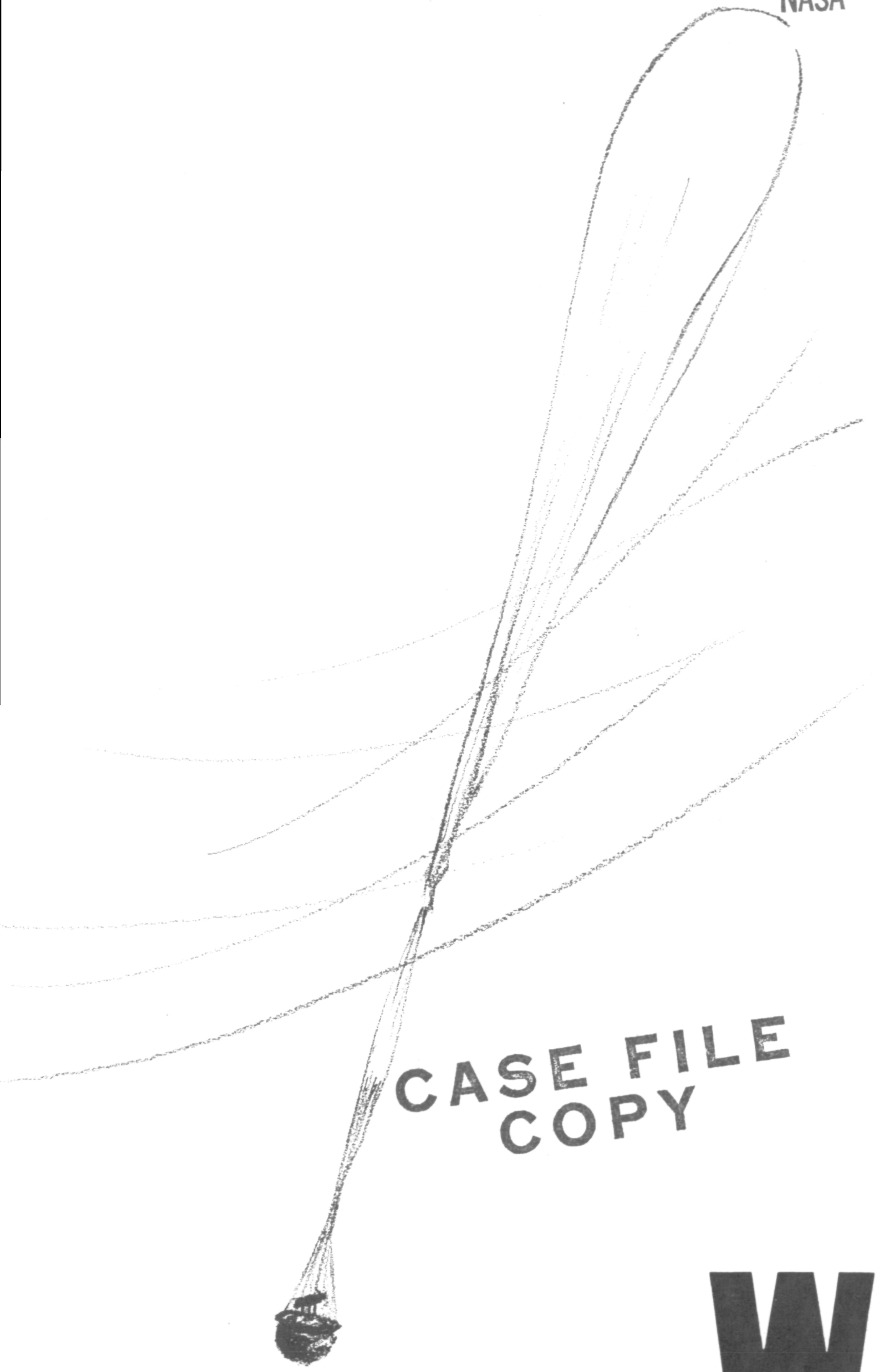

WINZEN RESEARCH INC., MINNEAPOLIS, MINNESOTA 55420

WRI

NASA CR 108383

FINAL REPORT

WINZEN RESEARCH INC.

FLIGHT NO. 1110

PARTIAL SUPPORT FROM:

ONR Contract No. N00014-69-C-0243

NASA Contract No. NAS 9-10496

March 27, 1970

CONTENTS

FLIGHT REPORT

WRI Balloon Flight No. 1110 was a 31.1 MM cubic foot single-cell StratoFilm® balloon carrying a total suspended load of 11,947 lbs. at launch. Balloon data is included in the appendix. The launch was attempted on the morning of February 25, 1970. The payload was ready for launch on the morning of February 20. It could have been ready for February 19 if the weather had been forecast to be favorable for launch on that day. The flight was cancelled on intervening days for the following weather reasons:

Feb. 20, surface winds and clouds
Feb. 22, surface winds and downrange weather
Feb. 23, downrange bad weather
Feb. 24, downrange bad weather

The wind from ground level to 700 feet was monitored for 10 hours before projected launch time with the WRI StratoFilm® blimp wind system. The launch event time schedule is included in the appendix, along with the actual times each task was performed. The operation was commenced somewhat ahead of schedule. It proceeded well according to plan until the balloon was about one-half erected. At this time the bubble of the balloon was at a height of about 250 feet, and encountered a cross-wind at about 90° with a speed estimated at two to four knots. This force on the bubble caused the undeployed part of the balloon to drag off the ground cloth and eventually off the airport runway and taxiway, and through the undeveloped area which contained grass and weeds. In spite of determined efforts by the crew to keep canvas ground cloth under this part of the balloon, damage to the reefing sleeve on the balloon was evident, although at this time no one detected any damage to the balloon itself. Subsequently, on leisurely close inspection, several small holes -- some about the size of a quarter -- were found. However, many places where the reefing sleeve was badly damaged with tears as much as a foot or so long, the balloon underneath showed no damage. The only significance of these observations is that they indicate that a reefing sleeve on a balloon not only helps prevent "sailing", but gives protection to the balloon against physical damage.

The balloon incorporated two new design features for balloons of this type. First was a fabric reinforced internal inflation tube in addition to two external ones of conventional type. The base fitting of the balloon had a high pressure helium hose connection which terminated on the inside surface of the fitting in a specially designed diffuser. The inflation tube was fastened around this diffuser. The fabric tube contained a StratoFilm® tube liner to a distance of four feet from its upper end. The fabric tube was sewn to a StratoFilm® flange which was in turn heat-sealed into a gore seam up to the top termination of the StratoFilm® liner. The balloon was packed so that when it was laid out, the inflation tube would be on the top side. The internal inflation tube was filled with helium with a minimum of difficulty before the external tubes were filled. Helium was allowed to flow continuously through it, the flow being gradually increased as the inflation progressed. Before stopping inflation, full trailer pressure was being applied with no apparent problems. Of prime concern before the flight was the possible pinching off of the internal tube in the arc between the balloon still flat on the ground and the bubble portion. The arc was found to be great enough that this was no problem. All operations personnel were impressed and pleased with the performance of the internal inflation tube.

The second new design feature of the balloon was two handling lines attached at the equator of the ground level inflation bubble at 90° to the external inflation tubes. The lines were attached by the same techniques used for lines on StratoFilm® tethered balloons. There was a considerable background of experience on these. In addition, the potential loads were simulated in a test under worst-case loading conditions, proving that one man on a line could not cause any damage to the balloon. These two different design features were incorporated because it was believed they would help the launching of these types of balloons, and also because development of new techniques were desirable for flying super-pressure balloons.

As the inflation proceeded and the balloon was fully erect from the helium lift, it became apparent to the Flight Director that the balloon must have a hole in it since the lift showing on the load cell was not increasing at a rate fast enough to coincide with the helium being used. Shortly thereafter when the load cell was reading 6800 lbs. (which was equivalent to 14,300 lbs. gross lift), the reading started to go down indicating the helium was leaking out faster than it was going in. The helium flow was stopped and the lift went down at a fairly rapid rate. By this time the winds up to 700 feet were all essentially calm, and so it was decided to bring the balloon down on the ground cloth for inspection. The helium leak rate was such that the balloon settled slowly and was guided back to its original lay-out position except for the very top section. This enabled a good inspection of the balloon. The source of trouble was found to be a section of gore seam about ten feet long which had split open. This was the seam to which the internal inflation tube was attached, and the opening started at the top attachment point of the tube and proceeded downward. It is difficult to assess whether the failure came primarily because of a weakened seal or because of undue pressure put on the seal by the pressurized tube, possibly with fluttering. There can be no doubt that the failure came about because of the two problems--either individually or working simultaneously. The top fitting and other parts of the balloon were inspected and showed no visible damage except for one external inflation tube. It showed a great number of longitudinal fractures in one area. Most of the fractures did not seem to cause openings, but most looked very weak. A few tiny holes were found. This observation shows that inflation tubes can be severely damaged from fluttering, probably in combination with a twist. Such damage could then cause leakage of helium.

The apex and base fittings of the balloon were recovered. Also, the internal inflation tube was removed for further tests on the seams. Tests to determine diffusing rate versus back pressure and possible fluttering modes of the internal inflation tube will also be made. It must be remembered that in this first balloon the internal inflation tube was only installed for testing of the concept. When it was found to work so well and the exterior tubes were causing difficulties, the helium flow was increased in the interior tube more than had been anticipated.

BACKGROUND

This balloon flight was conceived on the premise that simpler, less expensive balloon systems should be evaluated for carrying payloads in excess of a few thousand pounds. Such payloads have generally been carried on tandem mylar-scrim systems. Based on engineering design data and on previous tests and flights of heavy loads on polyethylene and StratoFilm® balloons, WRI confidence was great enough to propose making an engineering test flight of a single cell StratoFilm® system designed to the requirements of the CRISP system.

Prior to this, Winzen Research Inc. had manufactured a tandem StratoFilm® balloon system under ONR contract to test an alternate concept for carrying heavy loads. Funds to fly this balloon were short, and NASA-MSC indicated an interest in seeing this balloon flight tested in a short time period. Their interest was in selecting a system for the CRISP flights, especially after the failure of a mylar scrim tandem system which was at least five times more expensive that the comparable StratoFilm® balloons. A proposal was made to NASA-MSC to underwrite the cost of making the launch at a location in the southwestern United States so it could be made in February or March rather than waiting till May or June for launch in the Minneapolis area. The proposal was accepted and a contract written. ONR furnished the balloon and helium under their contract with WRI, and agreed to let the balloon be launched in Arizona with the cost of the field operation being borne under the MSC contract. At this point WRI had been studying the alternative of single cell balloons for the heavy loads, and made an additional proposal to MSC. WRI proposed to furnish a 31 million single cell balloon at its own expense. The balloon was to carry the equivalent of the CRISP payload. The offer was conditioned on the premise that MSC would stand the cost of flying it while WRI was in the field flying the tandem system. They agreed to this, but felt they did not have sufficient funds for helium. ONR, NCAR, and CRL were solicited for funds for helium without success. Finally, with the help of NASA Headquarters, Goddard Space Flight Center agreed to furnish funds for helium for the test and accomplished the fact by transferring funds to ONR, who then made arrangements for helium delivery to the site.

In suggesting the single cell balloon, WRI recognized that certain design changes to allow modification of launch techniques were necessary. It was felt that different ideas on balloon launching techniques needed to be evaluated in light of present technology. Experience of recent years indicated that large complicated systems designed to operate in moderate wind speeds in the range of 10 knots just are not feasible. It was felt more desirable to select launch sites with the most favorable wind situations and evaluate the idea of refining the simplest launch technique with the simplest, most efficient balloon.

CONCLUSIONS

While the weather during the field operation was far worse than the ten year average, it is still felt that the Casa Grande area is close to an optimum balloon launch site. Weather Bureau data shows Phoenix to be the best location for no clouds and low winds of all stations reported and studied to date. A comparison of some locations is given in the appendix. Case Grande area is far enough away to the southeast of Phoenix so that there is no problem of overflying heavily populated areas on climb-out. It is also close enough to Phoenix for easy transportation and communication connections with the home plant at Minneapolis. The area is a little better wind-wise than Phoenix because it is further removed from the mountains, being almost in the middle of the large valley. This makes for less night-time winds from drainage from the mountain slopes.

On the performance of the balloon one must conclude the failure was due to a manufacturing defect traceable to a new component designed in this balloon, or to the fact that this new component was not satisfactorily designed, or to a combination of these two possibilities. Confidence is very high that further tests can correct any design deficiencies and knowledge of the problem will eliminate any further manufacturing weaknesses. Thus the balloon should have very high reliability in the future.

Agreement on evaluation of vertical launch technique is not complete. However, when viewed as an evaluation of possibilities, it must be concluded that further evaluation is in order. Two main areas of improvement seem quite obtainable. First is further study to optimize the WRI developed reefing sleeve to strongly contain the bubble to prevent "sails". This cuts the effect of any winds by large amounts. The second is to launch from a large, smooth, clear area with some way of protecting the unerected portion of the balloon during inflation. Ideas for improvement on both problem areas are being investigated, and it is highly recommended that further support be given to this program.

Republic Photo by Yul Conaway

On the high rocks of Papago Park, a couple enjoy the solitude of a winter rain

Half-inch rain keeps Valley soaked

Phoenix became the center of the Valley of the Sog yesterday as the second soaking rain in four days fell.

Stations in Maricopa County reported the most precipitation in Arizona for the 24-hour period ending at 5 p m. yesterday.

Sky Harbor Airport had 52 of an inch, Buckeye 55, Gila Bend 58 and Youngtown 52.

Since Sunday, 1 9 inches of rain have fallen at Sky Harbor, bringing the total for the year to 2 2 inches—almost a half-inch more than normal.

The Weather Bureau says there is a 30 per cent chance of more showers today, but the skies should clear by tonight.

Heavy snows were predicted for last night in the White Mountains, with accumulations up to 4 inches Pinetop reported snow yesterday afternoon with 12 to 18 inches already on the ground

Snow showers also were reported in valleys in the southeastern part of the state, with the Cochise County sheriff's office in Bisbee estimating a snowfall of 4 to 7 inches in three hours, from 4 30 to 7 30 p m yesterday

The snow temporarily forced closing of U S 80 in the Bisbee area and chains were required for travel last night. But the sheriff's office said the snow was melting Power failures also were reported in Bisbee, one lasting for 45 minutes

Prescott had 4 inches of snow on the ground by noon yesterday, but most of it had melted before nightfall.

Flagstaff received 3 inches of new snow, putting a total of slightly more than 3 feet on the ground since Sunday

The weather Bureau predicted a chilly, but mostly clear, weekend in the mountains, with some scattered snow showers possible.

Ajo reported a shower of grape-size hailstones yesterday morning and 2 of an inch of precipitation Tucson had 22 of an inch of rain

U S Soil Conservation Survey experts say the latest moisture has improved runoff in the state's watersheds, but it is still falling far short of normal

WEATHER DATA FROM U.S. WEATHER BUREAU

SUMMARY OF HOURLY OBSERVATIONS OVER 5 TO 10 YEAR PERIODS

% of readings 0-.3 cloud/0-3 mph wind (calm%)

	Nov.	Dec.	Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
Winter Sites												
Phoenix	70/48(21)	64/50(21)	54/51(19)	60/42(16)	59/36(13)	64/32(11)	72/31(10)	80/29(9)	55/30(10)	55/33(11)	82/38(14)	72/42(18)
Pueblo	59/42(4)	57/35(3)	54/30(2)	56/29(2)	46/21(2)	42/20(2)	40/22(2)	61/21(2)	46/24(2)	51/30(2)	63/34(2)	67/39(3)
Bakers-field	64/47(43)	48/51(47)	31/46(44)	38/49(42)	47/34(33)	53/30(29)	62/24(23)	85/21(20)	87/27(26)	88/28(25)	86/29(26)	69/37(34)
Las Vegas	71/29(25)	66/32(27)	49/33(29)	53/22(19)	62/18(15)	61/10(9)	64/10(8)	83/10(9)	69/9(8)	74/11(9)	78/15(13)	68/21(17)
Albu-querque	69/21(3)	61/19(3)	50/18(4)	54/17(2)	52/12(2)	54/10(1)	57/9(1)	67/9(1)	45/11(1)	56/13(3)	71/14(2)	76/15(2)
Ama-rillo	65/6(2)	57/6(2)	49/5(2)	45/5(2)	47/4(1)	49/3(1)	43/4(1)	55/3(1)	49/4(2)	55/5(1)	69/4(1)	64/5(2)
Dallas	55/15(4)	50/12(2)	41/13(3)	41.10(2)	42/6(1)	41/4(1)	44/6 (1)	58/4 (0)	60.5(1)	63/6(1)	66/9(2)	59/13(3)
Little Rock	50/13(4)	42/10(3)	34/9(3)	36/9(2)	38/6(2)	39/8(2)	39/11(3)	49/13(4)	43/14(4)	54/17(5)	60/17(5)	56/19(5)
SUMMER SITES												
Tulsa	56/9(4)	46/8(4)	38/8(4)	40/8(4)	40.7(3)	39/7 (3)	39/10(5)	47/9(5)	50.11(5)	59/9 (4)	63/12(6)	56/12(5)
Memphis	48/16(4)	40/9(2)	31/9 (1)	33/9 (2)	35/7 (1)	39/8 (2)	41/11 (3)	47/14(3)	42/16(3)	53/21(4)	58/29(5)	56/23(6)
Minnea-polis	34/6 (1)	33/8 (1)	39/8 (1)	43/8 (1)	37/7 (1)	38/6 (1)	40/6 (1)	42/7 (1)	51/10 (2)	46/12 (2)	48/8(2)	48/8 (2)
Spring-fld, Mo.	52/3 (1)	40/3 (1)	34/3 (1)	35/3 (1)	36/3(1)	37/4(1)	38/4 (1)	43/5(1)	44/6 (1)	54/5(1)	62/5 (1)	54/5(1)
Sioux City	42/9 (2)	38/9(2)	37/11(2)	39/9(2)	32/7(1)	39/7(2)	37/8 (2)	43/10(2)	43/12(3)	50/11(2)	57/11(2)	53/11(2)
Sioux Falls	39/9 (2)	32/11(3)	33/9 (2)	23/8(2)	28/7(2)	32/6 (2)	38/11(4)	41/11 (3)	47/15(4)	42/15(5)	50/15(6)	52/12(4)

Data on many other locations studied. The above are listed as typical of the area in which they are located.

APPENDIX A

Time Schedule - Single Cell Heavy Load

SCHEDULED AND ACTUAL

SINGLE CELL HEAVY LOAD

TIME SCHEDULE - LAUNCH DAY

Scheduled/Actual Time (MST)		Event		Responsibility
0200	Cont.	Weather check		Johnson, Keuser
	1000	Trajectory plot		Keuser
	1230	File pre-flight NOTAM		Keuser
	0000	Erect blimp		Buresch, Boatman
	0100	Inflate Pi-balls		Keuser, Johnson
	Cont.	Plot winds 700', 350', ground-15 min.		Ray
0300	0200	Call crane operator		Johnson
0400	0230	Call crew		Keuser
0500	0340	Crew arrives at launch site		
		Move vehicles to launch area:		
		a.	Trailer with balloon	G. Polakoski
		b.	Winch tractor and flat bed	Johnson
		c.	Helium tractors and trailers	Kelley
		d.	Crane and Gondola	Swenson, Mielke, Contractor
		e.	Car and small trailer (misc. ground cloth, supplies)	Schardin
		f.	Pick-up truck with blimp	J. Polakoski
0530	0500	Lay out ground cloth		Boatman, J. Polakoski, Schardin, Swenson
		Sweep ground cloth		same
		Set up visitor control		Williams

	Schedule / Actual Time			
ntinued)	0530	0525	Move balloon and trailer to position.	Keuser, G. Polakoski
		0530	DECISION POINT	Keuser
		0535	Lay out balloon	Johnson, G. Polakoski, Schardin, Boatman, J. Polakoski
	0600	0555	Roll out inflation tubes with poly ground cloth	Swenson, Mielke, Buresch, R. Ray
		0630	Spot Helium trailers	Johnson, Kelley
		0640	Roll out handling lines and connect extensions	Keuser, Howard
		0625	Check out balloon helium valves on apex fitting	Keuser, Thon, Utick, Howard
			Tie Apex handling line	Keuser
		0610	Attach diffusers to external inflation tubes (tape)	Swenson, Mielke, Buresch, R. Ray
		0615	Inflation tubes (tape)	Buresch, R. Ray
		0610	Spot Winch trailer	Johnson, G. Polakoski
		0620	Ground Winch trailer	Johnson, G. Polakoski
			Spot crane with gondola	Johnson, G. Polakoski
			Ground crane	Johnson, Contractor
		0640	Connect load cell, cable and parachute to balloon	Johnson, J. Polakoski, Schardin, Boatman
		0645	Connect Safety cable	Swenson
			Interconnect helium trailers	G. Polakoski, Kelley
		0650	Open trailer helium valves	G. Polakoski, Kelley
		0650	Instrumentation and electrical systems final checkout	Thon, Howard
			Weather Check	Keuser

0650 (cont.)		Clear area of spectators and equipment that is not needed		All crew members
	0655	Clear internal inflation tube		Johnson, Swenson, G. Polakoski
0710 (approx.)		SUNRISE		
0700	0700	START INFLATION		
		Positions:		
		a.	Diffuser #1	Schardin, Howard (with radio)
		b.	Diffuser #2	G. Polakoski, Utick (with radio)
		c.	Balloon walk up	Johnson, Swenson, J. Polakoski (Johnson with radio)
		d.	Inflation tube guides Tube #1	Boatman, Mielke, Nelson
			Tube #2	Williams, R. Ray, Winzen
		e.	Apex handling line	Keuser (radio)
		f.	Top fitting	Thon, Buresch
		g.	Handling line #1	Buresch, Nelson
			Handling line #2	Williams, R. Ray (Note: After balloon fully erect, Nelson & Williams leave this station)
0745	0735	Balloon erected		

0815 (cont.)		Increase helium in internal inflation tube	Keuser, Johnson, J. Polakoski
0845	0800	Tie off external inflation tubes and hold as balloon guide	G. Polakoski, Boatman Schardin, Williams
	LAUNCH ABORTED		
		Make electrical connection parachute cable to termination device	Utick, Howard
0920		Final weigh-off	Swenson
		Disconnect load cell hose	Johnson
		Disconnect Internal inflation hose	Keuser
0925		Personnel to launch position:	
		a. Winch truck	Johnson in cab, G. Polakoski with radio
		b. Parachute guides	Swenson, J. Polakoski
		c. Crane operator in driver cab	Swenson (with radio)
		d. Inflation tubes	Schardin, Boatman
		e. Handling lines	Buresch, R. Ray
		f. Blimp vehicle	Mielke
		g. Observer, binoculars	Nelson
		h. Observer, binoculars	Williams
0930		Start let-up	
0935		Let-up complete	
		Check lift at dog bone	Keuser

0940	Fire let-up cable	Keuser to Thon
	Fire handling lines	Keuser to Buresch, Keuser to R. Ray
0945	Release gondola (launch)	Swenson, Keuser
	Notify FAA	Howard

POST LAUNCH

Telemetry trailer	Thon, Utick, Keuser
GMD-1 Receiver	Howard
Aircraft tracking to 60,000 feet	R. Ray, Johnson

Note: Sunset about 5:45 p.m. in Amarillo area.

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APPENDIX B

BALLOON FLIGHT INFORMATION

SKYHOOK BALLOON FLIGHT INFORMATION
AVEXOS 3900/2 (Rev.11-63)

1. Company Winzen Research Inc. Flight number 1110

2. Scientist Dr. D. Hagge Organization NASA MSC

3. Launch: Site Casa Grande, Arizona Date/time 2-25-70 (not launched0

Technique Vertical Director Keuser

4. Weather: Clear SW 2 Tropopause: Height ____ Temp ____ °C
(Sky - Temp - Wind - Press)

5. Balloon Ceiling: Theoretical ____ Mbs ____ Ft. Actual: ____ Ft. ____ Mbs
How altitude determined Baracoder

6. Ascent: Surface to tropopause - fpm. Tropopause to ceiling - fpm.

7. Flight duration: Total - hrs. - min. At ceiling - hrs. - min.

8. Termination: Time - Z Altitude - ft. Cause -

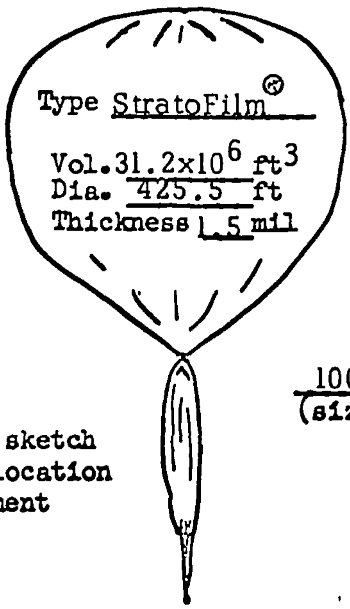
9. Balloon destruction - confirmed Visual - at launch site.
(visual - unknown - etc.)

10. Impact: Date/time - Z Location Launch site

11. Frequency used:

(Kcs, Mcs)	(purpose)	(Total Time)
230.4 + 231.9	telemetry	2.2 + .7
1675	"	2.4
138.54	command	.2
138.84	communications	.3

12. Balloon: Code number SF 425.51-150-NSC-01 Serial number 1



100 ft. chute
(size)

complete sketch showing location of equipment

		WEIGHT
Gondola	Balloon	7431
	~~FAA Termination Timer~~	1550
	Parachute	355
	Instrumentation	150
	Ballast	3600
Sand	~~Scientific package~~	6210
	Other ~~Load cell~~	82
	Gross Weight	19,378
	Free Lift -6%	1,162
	Gross Inflation	20,540
	Helium used	246,040 cu. ft.

Remarks:

1. Balloon weight includes instruments & valves on apex fitting.
2. Heat seal opened during inflation.
3. Total inflation was not completed.

Copy to:
ONR/FldRep/Minn
ONR/Code 421

APPENDIX C

BALLOON SPECIFICATIONS

BALLOON SPECIFICATIONS

Q No. Unsolicited — Date: 12-4-69

Manufacturer Winzen | 2. Proposal No. 12275-P | 3. Project Name: CRISP

Material: StratoFilm® | 5. Film Gauge: 1.5 mil | 6. Film Manufacturer: Winzen

Balloon Design

) Nominal Load: 11818.9 lbs. | 7b) Nominal Altitude: 108,000 Ft.MSL (Attach Load-) (Altitude Curve)

) Balloon Volume: 31.16 MM | 7d) Type (Tailored, Taped, etc.): Natural shape, taped, capped

) ξ = N.A. | 7f) No. of Gores: 190 | 7g) Half Gore Width: 0 Top; 3" Bottom.

) Max. Gore Width: 84.43 In. | 7i) Gore Length: 609.49 Ft. | 7j) Surface area: 494,901 sq.ft.

) Inflated Height: 360.62 Ft. | 7l) Inflated Diameter: 425.5 Ft. | 7m) Mfg. No.: SF 425.5-150-NSC-01

) Balloon Wt.: 7335 Lbs. | 7o) Partial Bubble Weights: Lbs. @ Ft.

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

Load Tapes

) Type and Ultimate Tensile Strength: Fortisan Stratotape 800 lb. tensile (F.S.= 5.75)

Inflation Tube(s)

a) No. of Tubes: 2 ext.* | 9b) Material & Gauge: StratoFilm® 3 mil | Location from Top: 65 Ft.

d) Diameter: 12.75 Ea. | 9e) Length: 800 Ft. | 9f) Horizontal Location: Gores 1 & 95

. Duct(s)

a) No. of Ducts: 10 | 10b) Material & Gauge: StratoFilm® 1.5 mil | 10c) Area each duct: 60 sq.ft.

d) Distance from bottom end fitting: 275 Ft. | 10e) Type of Duct: Tailored - attached

Top Fitting

a) Type (Attach Dwgs. If Non-Std): Plate, hoop & ring | 11b) Valve: Two Hev. valves.

c) Dimensions: 60" O.D. | 11d) Weight: 50 lbs. (w/o valves) Lbs.

. Bottom Fitting

a) Type: Wedges & collar | 12b) Dimensions: 19" OD

c) Weight: 65 Lbs. | 12d) Load Attachments: 1" - 8 eyenut

OTHER ATTACHMENTS (Cables, Destruct Device, etc.):

Two internal integrally sealed caps 1.5 mil each and 150 feet and 220 ft. long.
Reefing sleeve 3 mil with 1 mil rip panel 409 feet long.
External handling lines attached to balloon wall with appropriate construction for StratoFilm®.
Destruct rip panel per 302496.

*(1) Internal tube - 594' lg. x 20" layflat x 3 mil poly reinforced with 1.8 oz. nylon ripstrip attached to gore seam 190, from bottom end fitting.