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AERODYNAMIC CHARACTERISTICS OF DISK-GAP-BAND PARACHUTES IN THE WAKE OF VIKING ENTRY FOREBODIES AT MACH NUMBERS FROM 0.2 TO 2.6

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July 1972

PROPULSION WIND TUNNEL FACILITY
ARNOLD ENGINEERING DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
ARNOLD AIR FORCE STATION, TENNESSEE

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FOREWORD

The work reported herein was done at the request of the National Aeronautics and Space Administration (NASA), Langley Research Center, Hampton, Virginia, under Program Element 921E.

The test results presented were obtained by ARO, Inc. (a subsidiary of Sverdrup & Parcel and Associates, Inc.), contract operator of the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), Arnold Air Force Station, Tennessee, under Contract F40600-73-C-0004. The test was conducted in Tunnel 16T from June 29 to July 3, 1971, and in Tunnel 16S from August 12 to 13, 1971, under ARO Project No. PT1057. The manuscript was submitted for publication on October 8, 1971.

This technical report has been reviewed and is approved.

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ABSTRACT

Tests were conducted in the Propulsion Wind Tunnels (16T) and (16S) to determine the drag and performance characteristics of various disk-gap-band parachute configurations in the wake of a 0.10-scale Viking entry vehicle. The parachutes were also tested behind a small faired body to obtain minimum interference parachute performance characteristics. The results show that in general the parachutes had good inflation and stability characteristics in the wake of the entry forebodies at Mach numbers from 0.2 to 0.8 and from 1.2 to 2.0. Considerable loss in parachute performance was experienced in the wake of the forebodies in the vicinity of Mach number 1.0. Increasing the parachute trailing distance and suspension line length increased the parachute drag coefficient at each Mach number.

CONTENTS

APPENDIXES

NOMENCLATURE

A	Model reference area, sq ft
C_{D_o}	Parachute drag coefficient, $F_P/q_\infty S_o$
D_o	Parachute nominal diameter, 5.3 ft

d	Model reference diameter, 1.15 ft
F_p	Parachute drag force, lb
M_∞	Free-stream Mach number
q_∞	Free-stream dynamic pressure, psf
R	Riser line length, ft
S	Suspension line length, ft
S_o	Parachute reference area (based on nominal diameter), 22.06 sq ft
S/D_o	Ratio of parachute suspension line length to parachute nominal diameter
X	Axial distance between the entry vehicle and the parachute inlet, ft
X/d	Parachute trailing distance

SECTION I
INTRODUCTION

The purpose of the series of tests conducted in the Propulsion Wind Tunnels (16T) and (16S) was to determine the drag and performance characteristics of various disk-gap-band (DGB) parachute configurations in the wake of 0.10-scale Viking entry forebodies. The DGB parachutes were also tested behind a strut-mounted small faired body to provide minimum interference performance characteristics. The tests consisted of variations of both the parachute assembly trailing distance and suspension line length. Data were obtained at Mach numbers from 0.2 to 2.6 at a free-stream dynamic pressure of 80 psf.

SECTION II
APPARATUS

2.1 TEST FACILITY

Tunnels 16T (transonic) and 16S (supersonic) are continuous flow, closed-circuit wind tunnels capable of being operated within a Mach number range from 0.2 to 1.5 and 1.5 to 4.75, respectively. Tunnel 16T can be operated within a stagnation pressure range from 120 to 4000 psfa depending on the Mach number, and Tunnel 16S can be operated within a stagnation pressure range from 200 to 2000 psfa depending on the Mach number. The stagnation temperature can be varied from approximately 80 to a maximum of 160°F in Tunnel 16T and from approximately 100 to a maximum of 620°F in Tunnel 16S. The specific humidity of the air in both wind tunnels is controlled by removing tunnel air and supplying conditioned makeup air from an atmospheric dryer. A more complete description of the wind tunnels and their operating characteristics is contained in the Test Facilities Handbook.[1]

2.2 TEST ARTICLE

A sketch showing the model location in the wind tunnel test section is shown in Fig. 1 (Appendix I), and installation photographs of the models and the strut support system are presented in Fig. 2. The model represents a 0.10-scale entry vehicle with a maximum diameter of 13.8 in. The model had provisions to remove the 140-deg conical aeroshell and to install a representation of the Viking Lander Capsule (Fig. 2c). Major model details and dimensions of these models and the faired body are presented in Fig. 3.

The model was attached to the strut support arrangement through two internally mounted load cells that provided the entry vehicle drag and the combined entry vehicle-parachute drag, respectively. The parachutes were packed in a deployment bag and stowed in a tube mounted near the lower portion of the support strut. The suspension lines were led up the strut trailing edge and tied with break cord which severed as the

[1]Test Facilities Handbook (Ninth Edition). "Propulsion Wind Tunnel Facility, Vol. 4." Arnold Engineering Development Center, July 1971.

parachute was pneumatically deployed from the stowage tube. The parachute suspension lines were attached to the model through a swivel-tensiometer-bridle arrangement. A photograph showing the aft portion of the model and the bridle attachment is presented in Fig. 4.

Major dimensions and geometric properties of the DGB parachutes are shown in Fig. 5. The parachutes were constructed of Dacron® cloth (2.1 oz/yd^2), and the suspension lines were made of 200-lb-test braided nylon. All the DGB parachutes had a porosity of 12.5 percent and a nominal diameter of 5.3 ft. The parachute trailing distances were increased by increasing the suspension line lengths except for Configuration 2 behind the entry vehicle which increased the trailing distance by adding a 45.8-in. riser line.

2.3 INSTRUMENTATION

Load cells of 500- and 2000-lb capacity were used to measure the entry vehicle drag and the entry vehicle plus parachute drag, respectively, with an accuracy of ±30 lb. Also, a 2000-lb capacity tensiometer was used to measure the parachute drag. Motion-picture and television cameras, installed in the test section walls, were used to document and monitor the test.

The outputs from the two load cells and the tensiometer were digitized and permanently recorded on magnetic tape for on-line data reduction. These outputs were also continuously recorded on direct-writing and film pack oscillographs for monitoring the model and parachute dynamics.

SECTION III
PROCEDURE

The parachute package, which consists of a parachute enclosed in a deployment bag, was packed in a tube mounted on the model support strut before wind tunnel test operation was initiated. Once the desired test conditions were established, a countdown sequence procedure was used for data acquisition during parachute deployment. The deployment procedure consisted of activating the recording oscillographs, the test section cameras, and the analog tape recording system followed by pneumatically ejecting the parachute-bag combination into the airstream. Upon completion of the parachute deployment sequence, steady-state drag loads were calculated by averaging the analog output from the load cells and tensiometer over 1-sec intervals.

DGB parachutes of various S/D_o (ratio of suspension line length to parachute nominal diameter) values were tested at various X/d locations through the Mach number range from 0.2 to 2.6 at nominal free-stream dynamic pressures of approximately 80 psf. The parachutes were deployed at various Mach numbers, and after data acquisition was completed, the parachute performance was investigated at other Mach numbers. In some instances when the parachute failed, a backup parachute was deployed and additional data were obtained until the desired Mach number range was covered for that parachute configuration. A summary of the test conditions established for each parachute configuration is presented in Table I (Appendix II).

SECTION IV
RESULTS AND DISCUSSION

The primary purpose of this investigation was to determine the drag performance of the disk-gap-band (DGB) parachutes operating in the wake of the Viking Entry Vehicle (EV) or Lander (L) forebodies at various trail distances. The parachute performance was also obtained behind a small faired body to determine the parachute performance with minimum wake interference.

The data obtained from the tensiometer, which measures parachute drag only, are presented for the Mach number range from 0.2 to 1.4. The tensiometer malfunctioned during the Tunnel 16S test. Parachute drag was determined from the difference between the two load cells which measured the model axial loads and the model-plus-parachute axial loads at Mach numbers from 1.8 to 2.6. Tensiometer data before failure are presented at Mach number 2.2 for comparison.

4.1 PARACHUTE DYNAMIC CHARACTERISTICS

The parachute stability and inflation characteristics were visually evaluated from the motion pictures. Observations of the parachute performance for each test condition are presented in Table I. In general, the parachute configurations trailing the forebodies were well inflated and stable (oscillations less than 6 deg) or very stable (oscillations less than 3 deg) for the Mach number range from 0.2 to 0.8 and from 1.2 to 2.0. Unstable conditions were noted in the Mach number range from 0.9 to 1.1 and from 2.1 to 2.6, especially for the parachute configurations with the smaller X/d values. At the unstable conditions, the parachute exhibited underinflation with excessive canopy and suspension line dynamics resulting in a loss in drag.

Increasing the value of X/d reduced the parachute dynamics, and each parachute configuration had essentially the same performance trends when operating at the same trailing distance behind the forebodies. Sporadic pulsing of the parachute canopy occurred throughout the range of test conditions for the parachute configurations with X/d less than nine in the wake of the Viking forebodies. This effect was generally greater for the high Mach numbers and smaller trailing distances.

Canopy inflation and stability characteristics of the parachute were very good at all test conditions and trailing distances behind the faired body. Configuration 5 with an S/D_o of 1:85 exhibited the best inflation and stability characteristics of the four configurations tested behind the faired body. At Mach numbers of 1.2, 1.3, and 1.4, Configuration 5 exhibited the performance characteristics of an ideal parachute with no oscillations or distorting moments to disturb the parachute from its equilibrium position. None of the four parachute configurations trailing the faired body exhibited the unstable conditions in the vicinity of $M_\infty = 1.0$ as was noted for the parachute configurations trailing the forebodies. Photographs of various parachute configurations in the wake of the three forebodies are shown in Fig. 6 for a range of Mach numbers from 0.6 to 1.4.

4.2 PARACHUTE STEADY-STATE PERFORMANCE

The effects of the forebody shape on the parachute drag coefficient at X/d = 9.14 are presented in Fig. 7. At a given Mach number, the forebody wake effect produced by the entry vehicle and the lander resulted in essentially the same parachute drag coefficients. The parachute drag coefficient obtained in the wake of the forebodies in the vicinity of M_∞ = 1.0 was substantially less than the drag coefficient obtained behind the faired body. At M_∞ = 1.0, the parachute underinflation caused by the forebody wake resulted in parachute drag reductions of approximately 30 percent when compared to the drag coefficient obtained behind the faired body with minimum wake interference.

The variation of parachute drag coefficient with Mach number at various values of X/d are presented in Fig. 8. For a given Mach number, the parachute drag coefficient increased with increasing X/d locations behind the Viking forebodies as shown in Figs. 8a and b, respectively. These data also show a considerable decrease in drag coefficient with Mach number as the Mach number approached 1.0, especially for the parachute configurations with the smaller X/d locations. Increasing the Mach number from 0.6 to 1.0 resulted in as much as 50-percent reduction in parachute drag coefficient as the parachute became underinflated in the wake of the forebody. Two parachute configurations (Configurations 2 and 4) were tested in the Mach number range above 1.8 in the wake of the entry vehicle. The drag coefficient for Configuration 4 with X/d = 8.53 decreased approximately 28 percent as the Mach number was increased from 1.8 to 2.6. The drag coefficient for Configuration 2 with X/d = 6.50 remained essentially the same in the Mach number range from 1.8 to 2.2. The parachutes were tested behind a faired body to obtain relatively interference-free parachute drag characteristics. As shown in Fig. 8c, increasing the value of S/D_o also increased the parachute drag coefficient at a given Mach number behind the faired body.

SECTION V
CONCLUDING REMARKS

Tests were conducted to determine the drag and performance characteristics of disk-gap-band parachute configurations with various trailing distance and suspension line lengths. The parachutes, attached to 0.10-scale Viking entry forebodies and a faired body, were investigated in the Mach number range from 0.2 to 2.6 at a nominal free-stream dynamic pressure of 80 psf. The following observations are a result of these tests:

1. Canopy inflation and stability were very good at all test conditions behind the faired body.

2. In general, the parachute had good inflation and stability characteristics in the wake of the entry vehicle and lander forebodies at Mach numbers from 0.2 to 0.8 and from 1.2 to 2.0.

3. Considerable loss in performance of the parachute was experienced in the wake of the Viking forebodies in the vicinity of Mach number 1.0.

4. Increasing the parachute trailing distance increased the parachute drag coefficient at each Mach number.

5. Increasing the Mach number from 0.6 to 1.0 resulted in as much as 50-percent reduction in parachute drag coefficient as the parachute became underinflated in the wake of the Viking forebodies.

APPENDIXES

I. ILLUSTRATIONS

II. TABLE

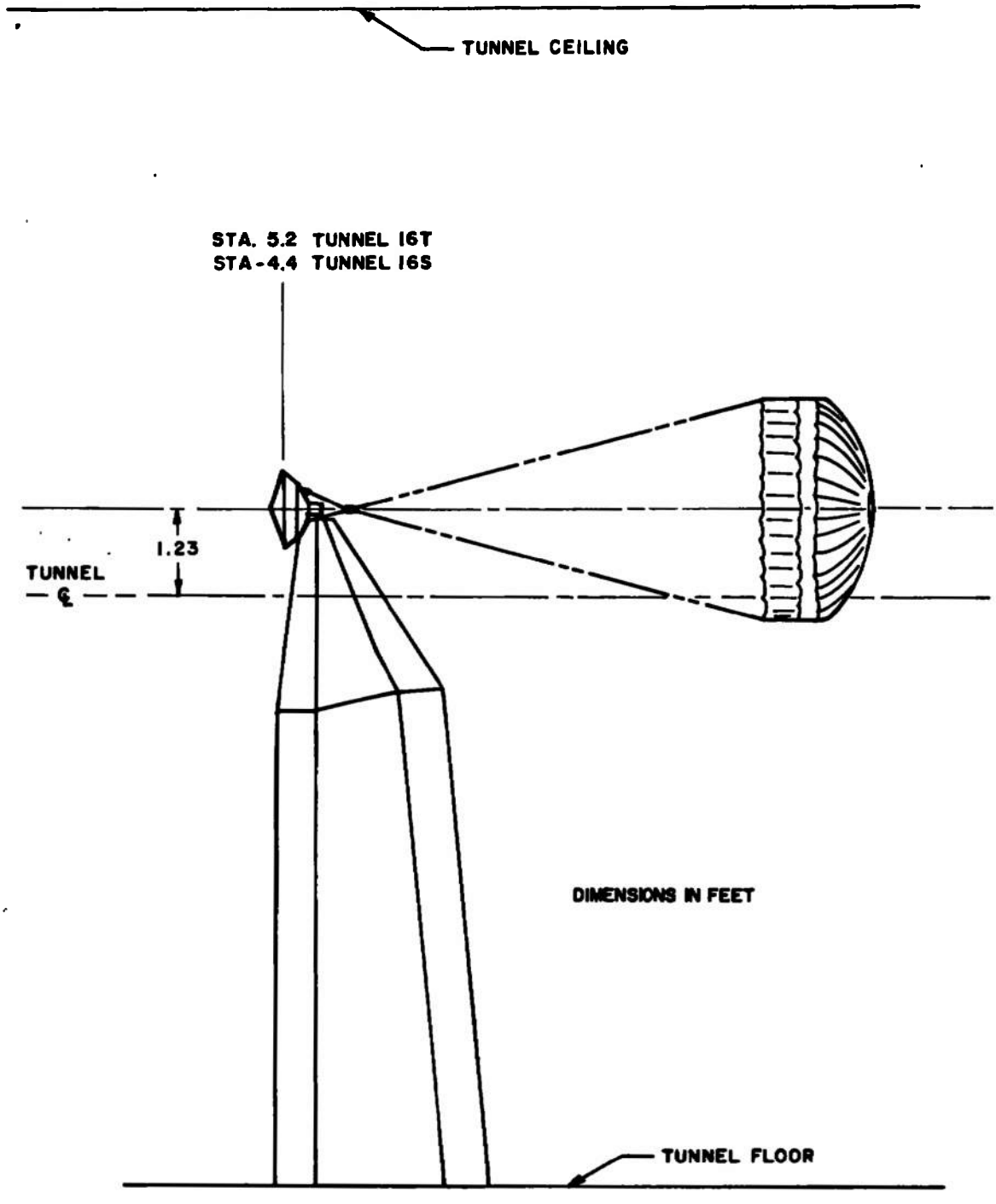
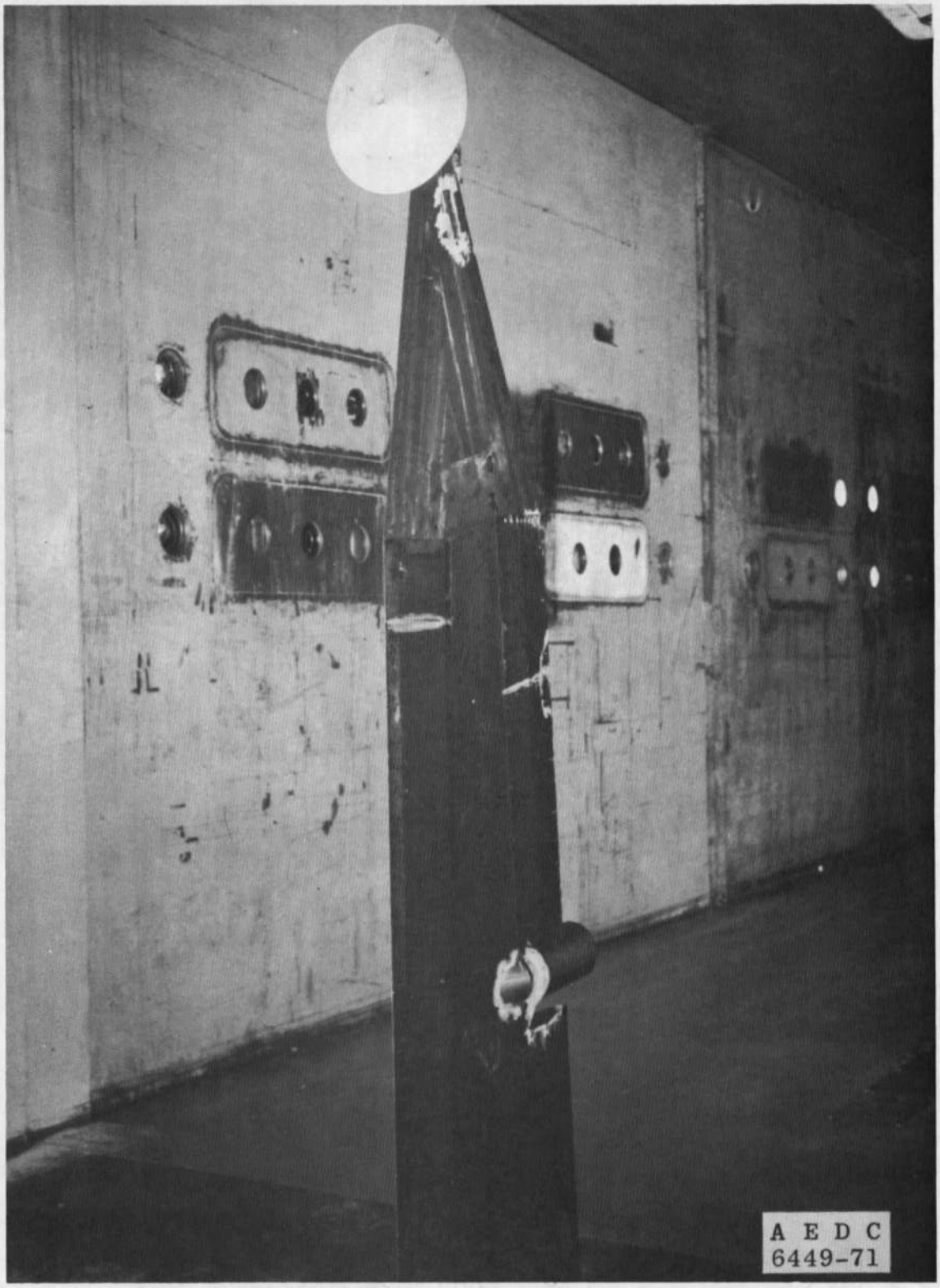
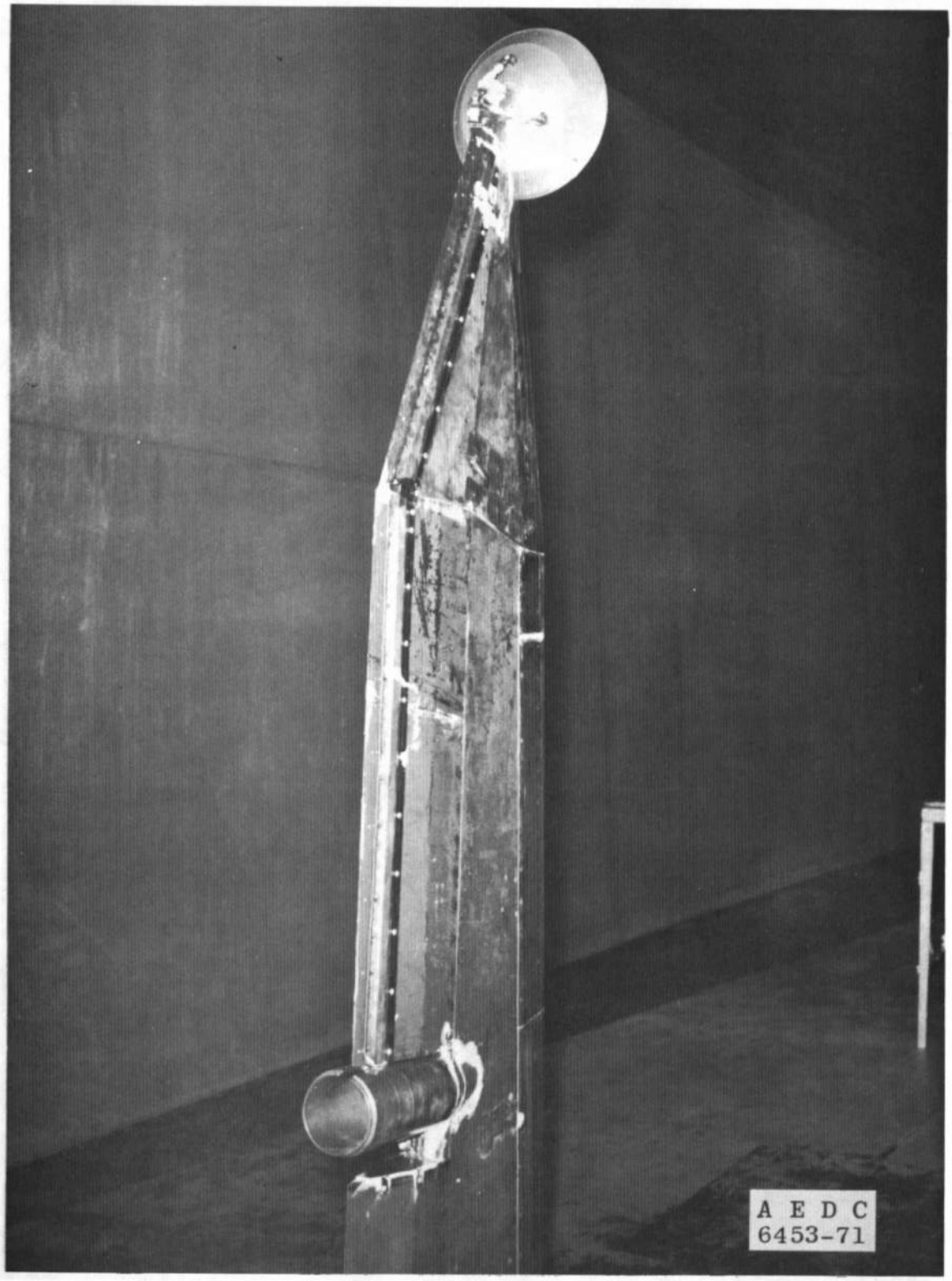


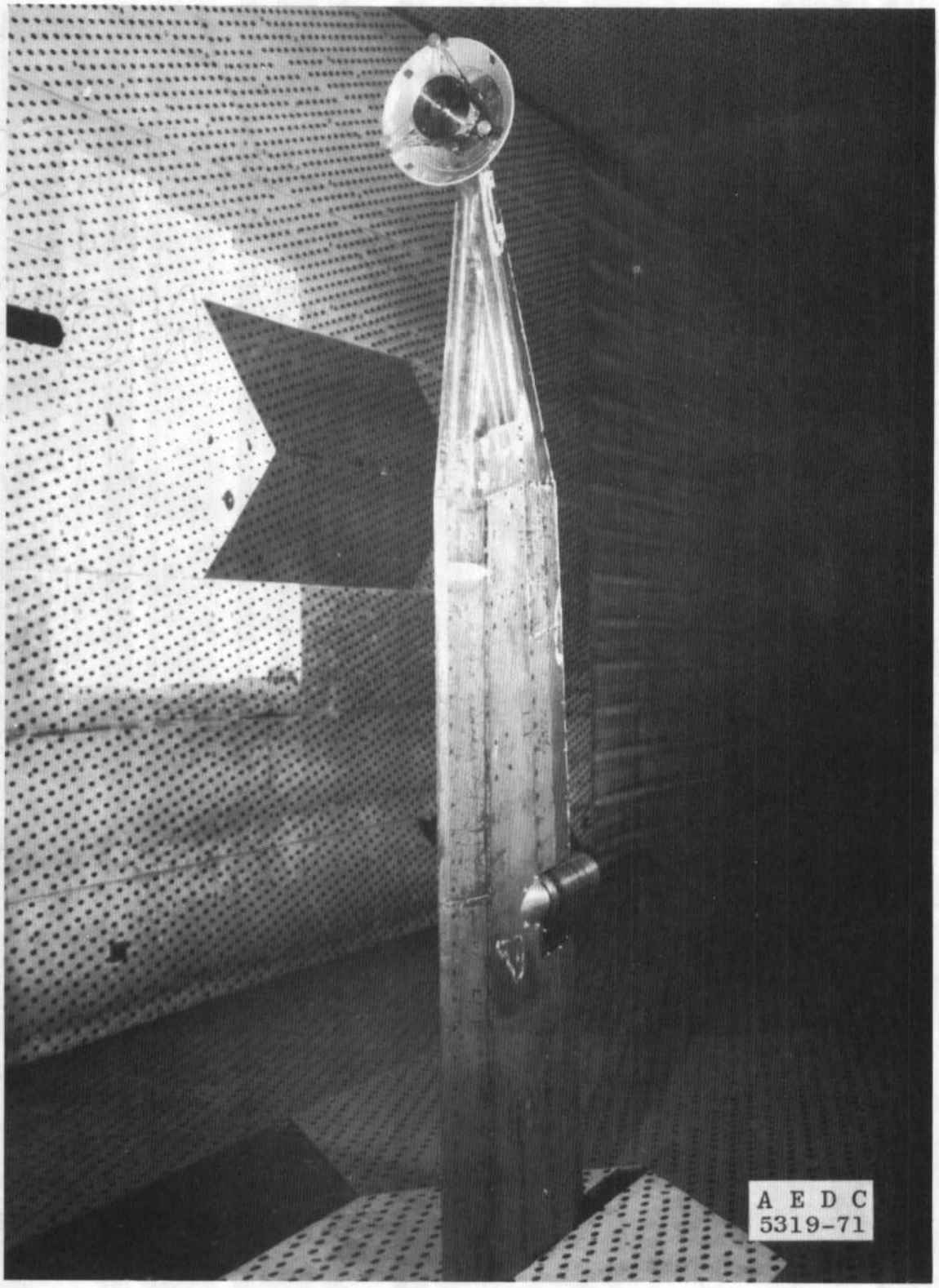
Fig. 1 Sketch of Model Installation



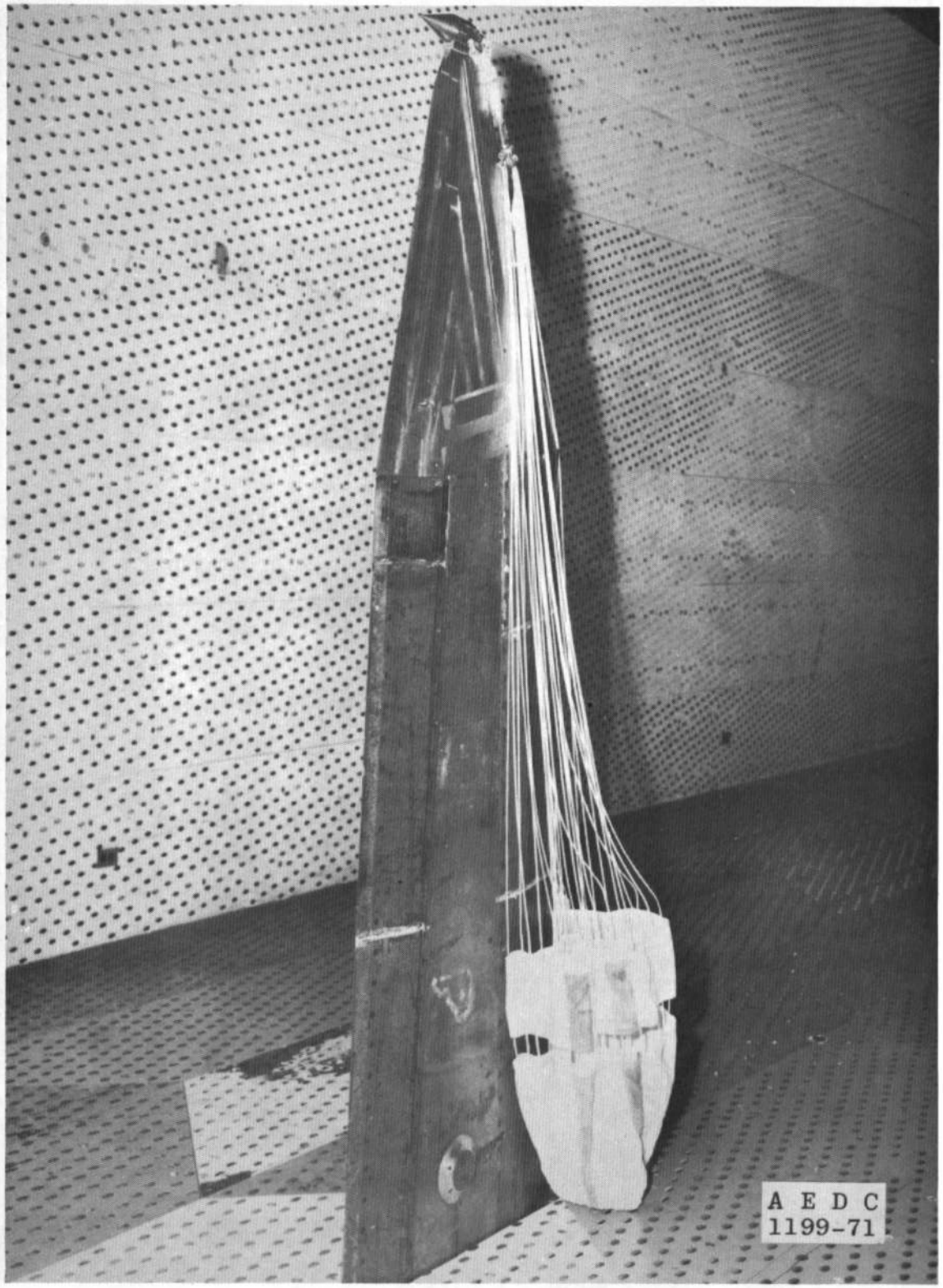
a. Entry Vehicle Model in Tunnel 16S
Fig. 2 Installation Photographs



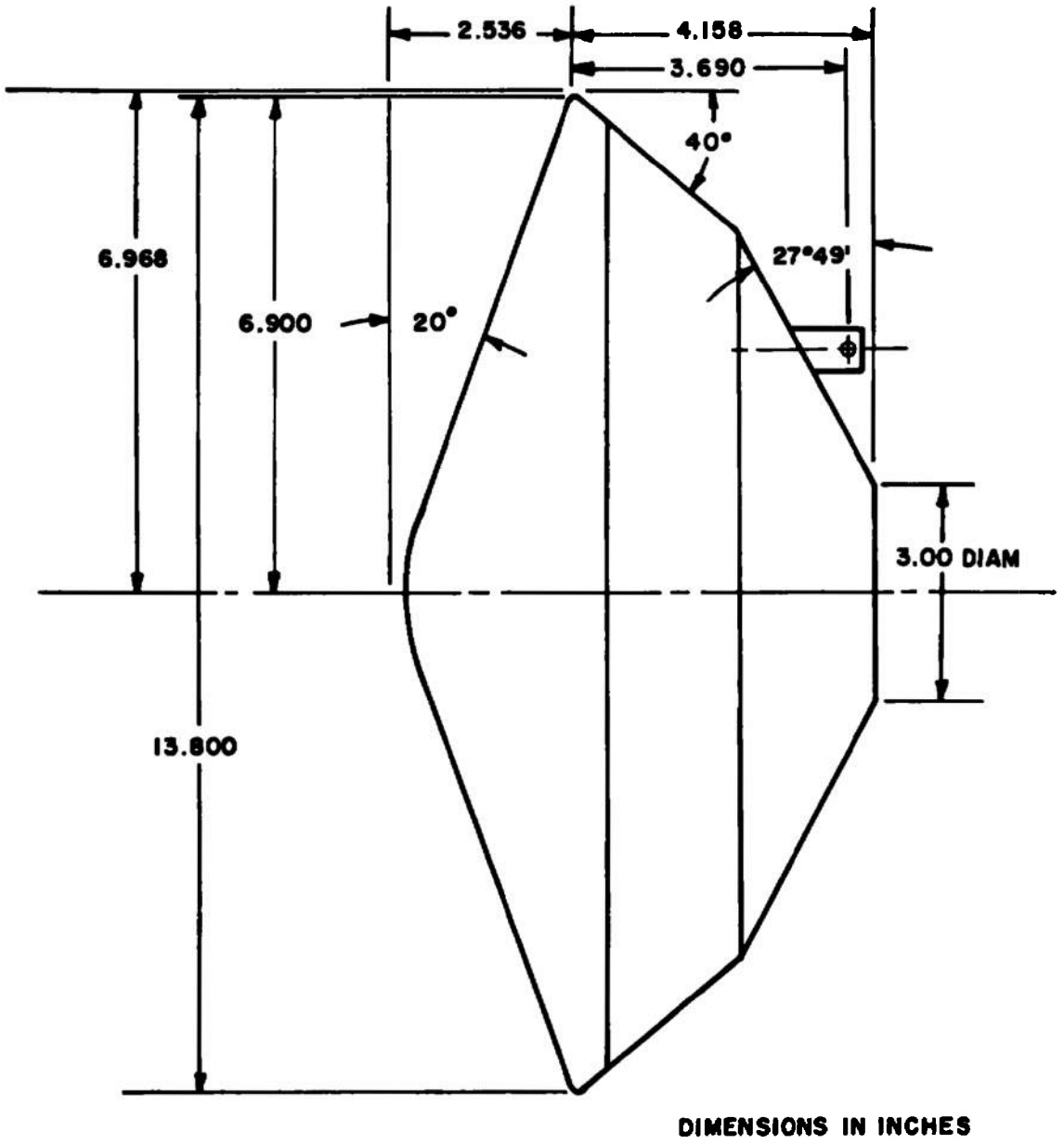
b. Rear Three-Quarter View Showing the Deployment Tube
Fig. 2 Continued



c. Lander Model in Tunnel 16T
Fig. 2 Continued

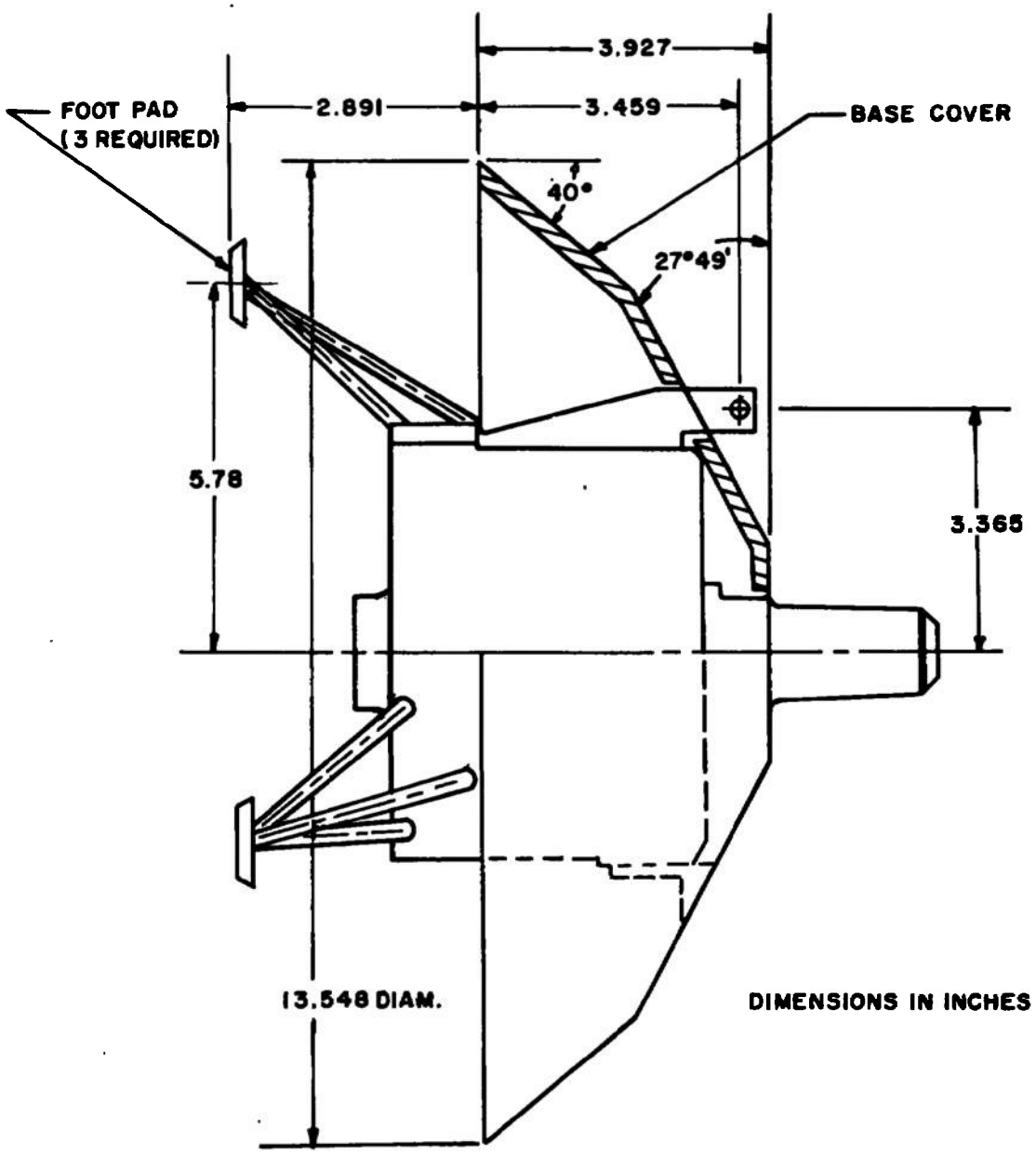


d. Faired Body Model in Tunnel 16T
Fig. 2 Concluded

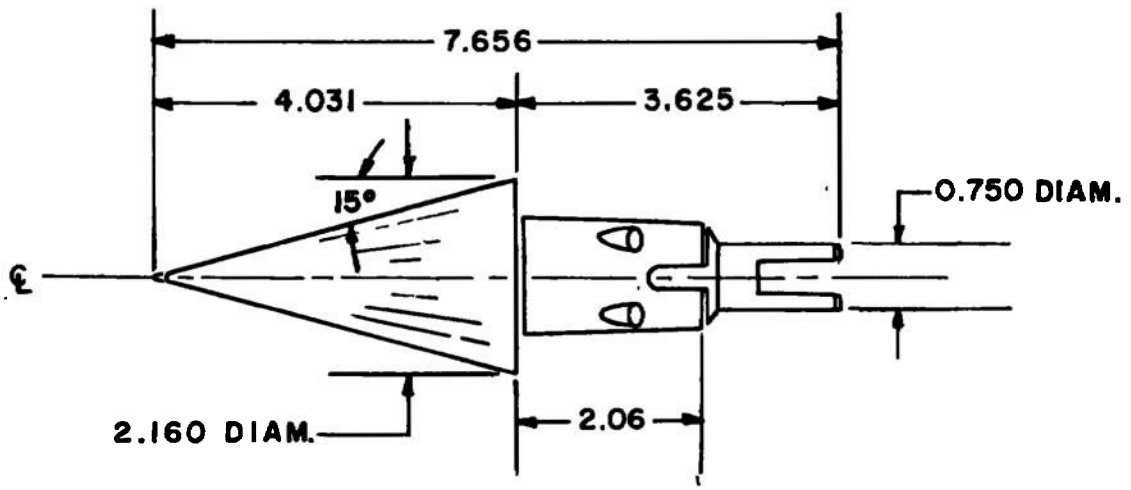


a. Entry Vehicle

Fig. 3 Major Model Details



b. Lander
Fig. 3 Continued



c. Faired Body
Fig. 3 Concluded

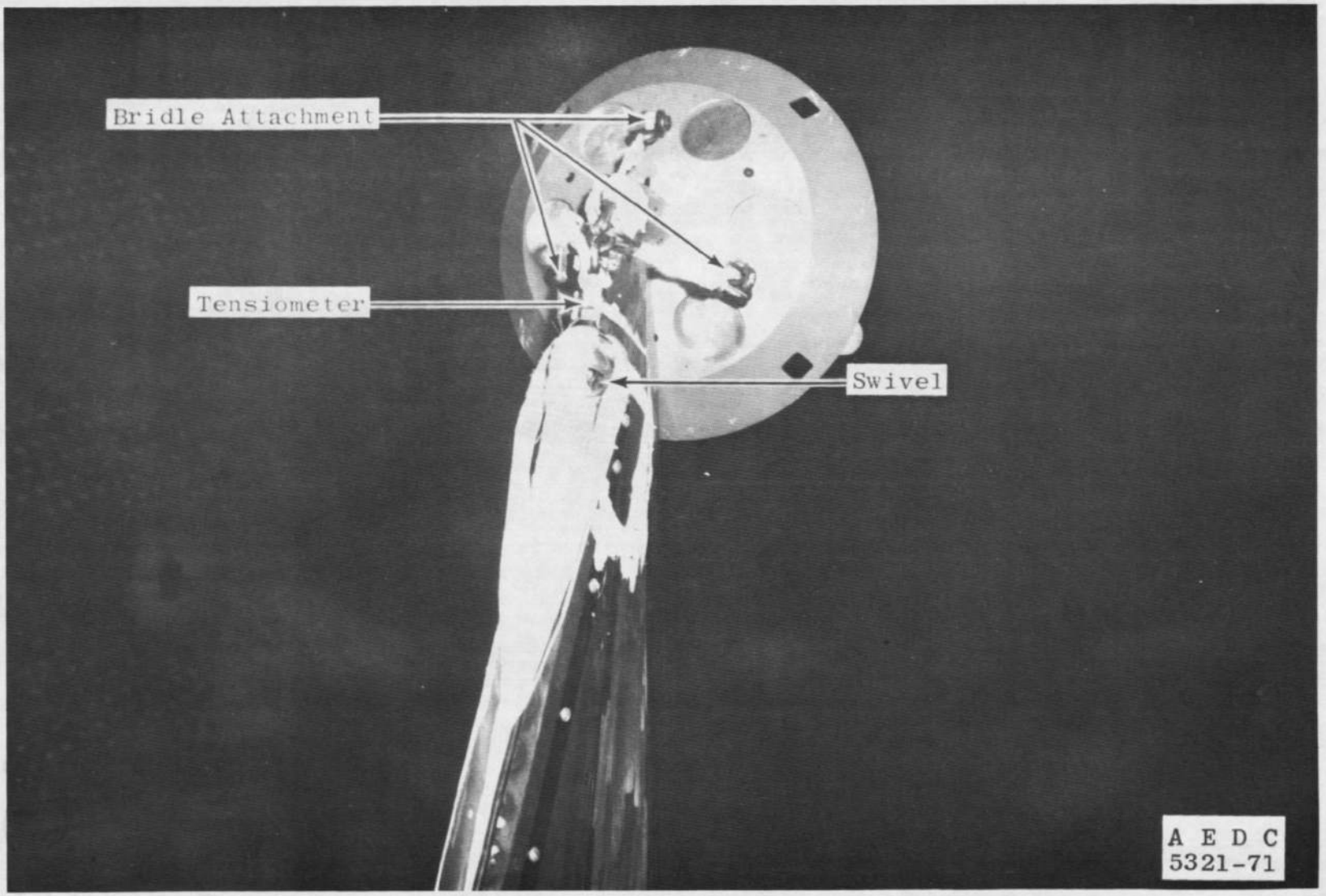
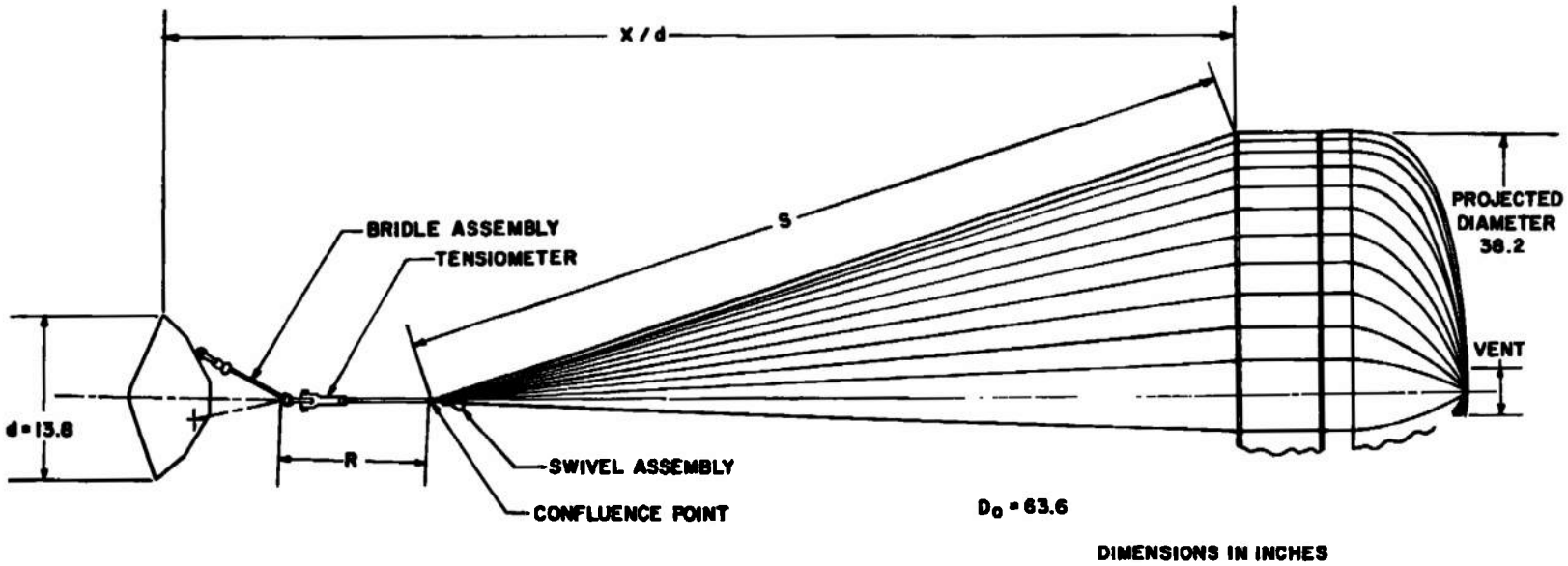


Fig. 4 Photograph of Parachute Attachment



a. Drawing of Parachute Assembly

Fig. 5 Disk-Gap-Band Parachute Assembly

GEOMETRIC PROPERTIES OF PARACHUTE

Item	Relative Value	Value
Nominal Diameter	D_o	5.3 ft
Total Area (S_o)*	$\pi D_o^2/4$	22.06 ft^2
Geometric Porosity**	0.125 S_o	2.76 ft^2
Disk Area***	0.53 S_o	11.69 ft^2
Disk Diameter	0.726 D_o	3.85 ft
Gap Area	0.12 S_o	2.65 ft^2
Gap Width	0.042 D_o	0.223 ft
Band Area	0.35 S_o	7.72 ft
Band Width	0.121 D_o	0.641 ft
Vent Area	0.005 S_o	0.110 ft^2
Vent Diameter	0.07 D_o	0.371 ft
Number of Suspension Lines	---	48
Thickness of Suspension Lines	0.00011 D_o(FS)	0.07 in.
Thickness of Suspension Lines Actually Tested	0.00157 D_o (model)†	0.100 in.
Suspension Line Lengths (S)	1.00 D_o	5.300 ft
	1.16 D_o	6.148 ft
	1.52 D_o	8.056 ft
	1.73 D_o	9.169 ft
	1.85 D_o	9.805 ft
	2.26 D_o	11.980 ft

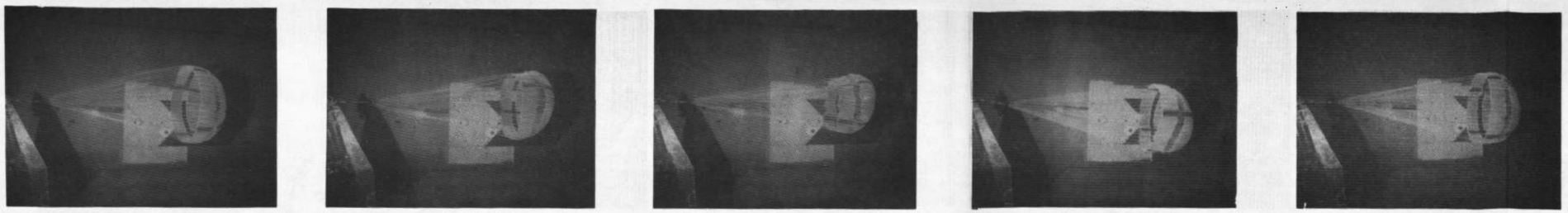
* Disk + Gap + Band

** Gap + Vent provide 12.5 percent geometric porosity

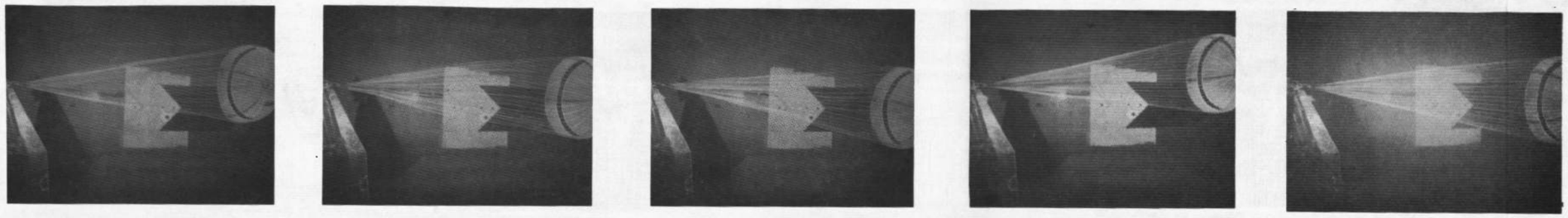
*** Includes Vent

† Based on wide edge dimension

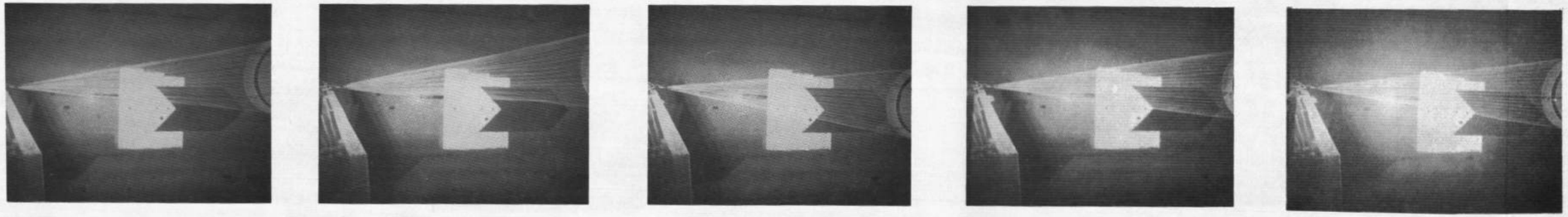
b. Geometric Properties of Parachute
Fig. 5 Concluded



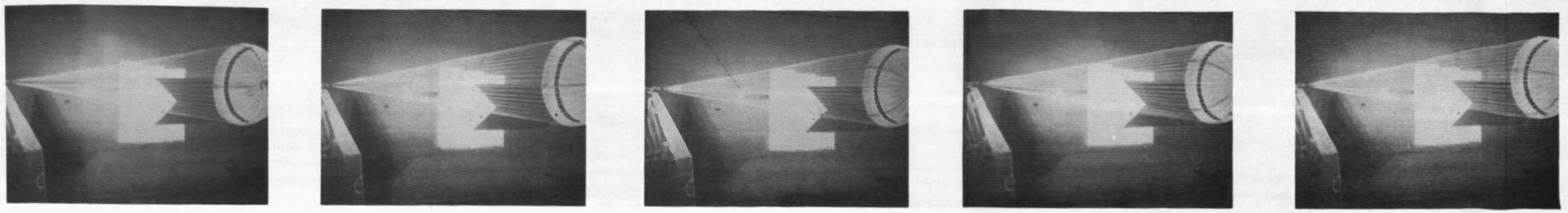
Configuration 2
X/d = 6.50
Lander Forebody



Configuration 5
X/d = 9.14
Lander Forebody



Configuration 6
X/d = 11.02
Entry Vehicle Forebody



Configuration 5
X/d = 9.14
Faired Forebody

$M_\infty = 0.6$ $M_\infty = 0.8$ $M_\infty = 1.0$ $M_\infty = 1.2$ $M_\infty = 1.4$

Fig. 6 Photographs of the Disk-Gap-Band Parachute at Various Trailing Distances and Mach Numbers

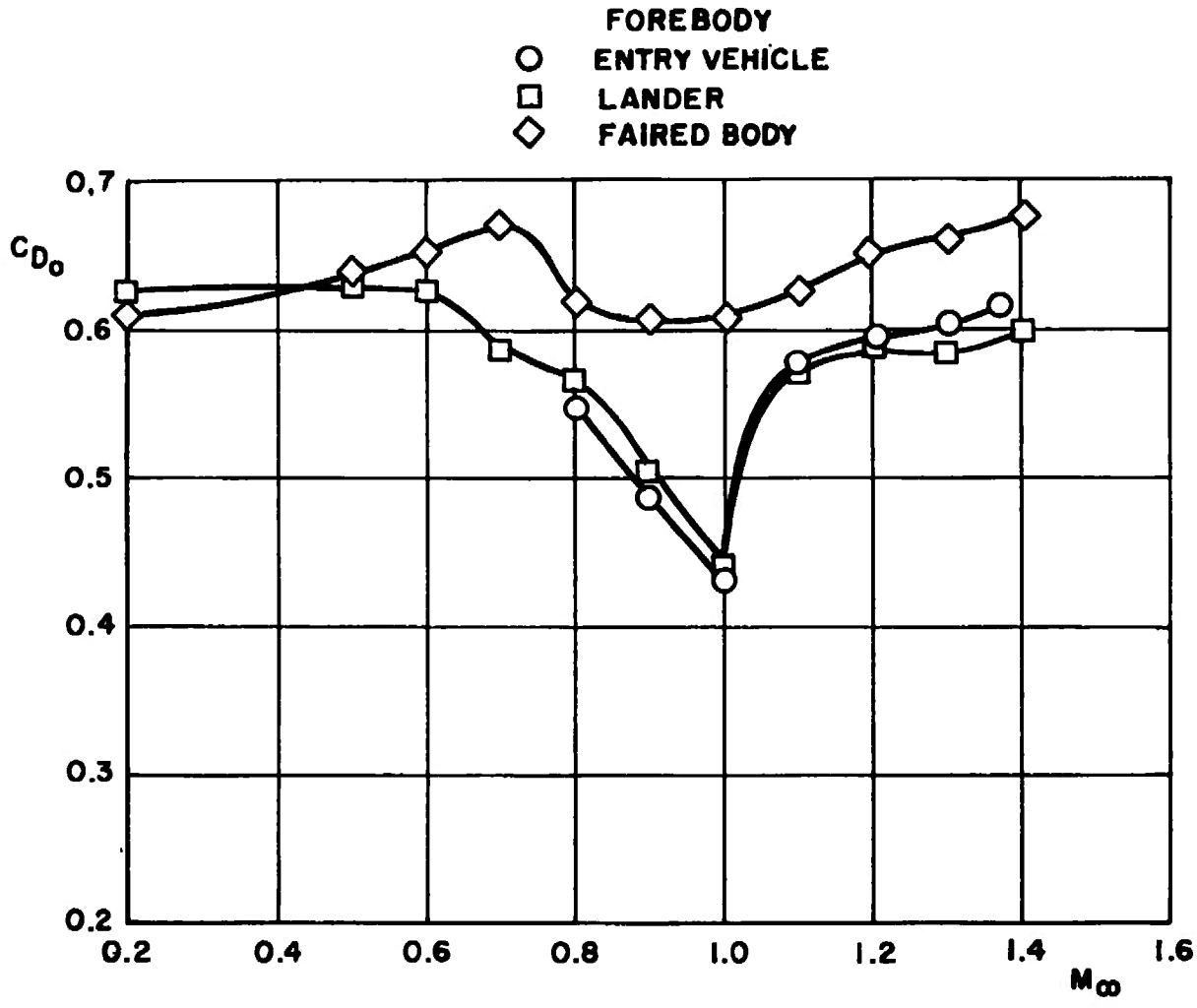
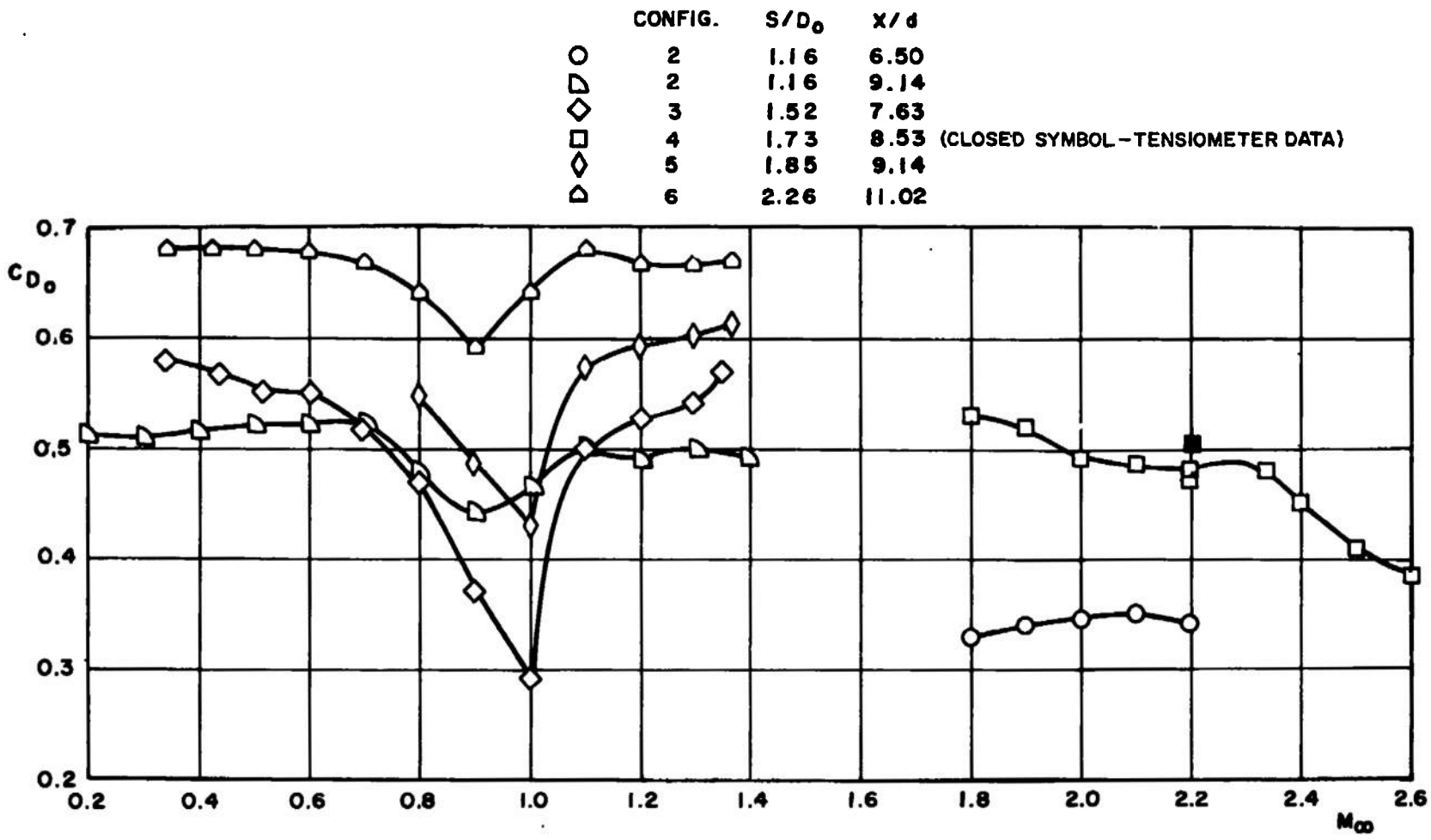
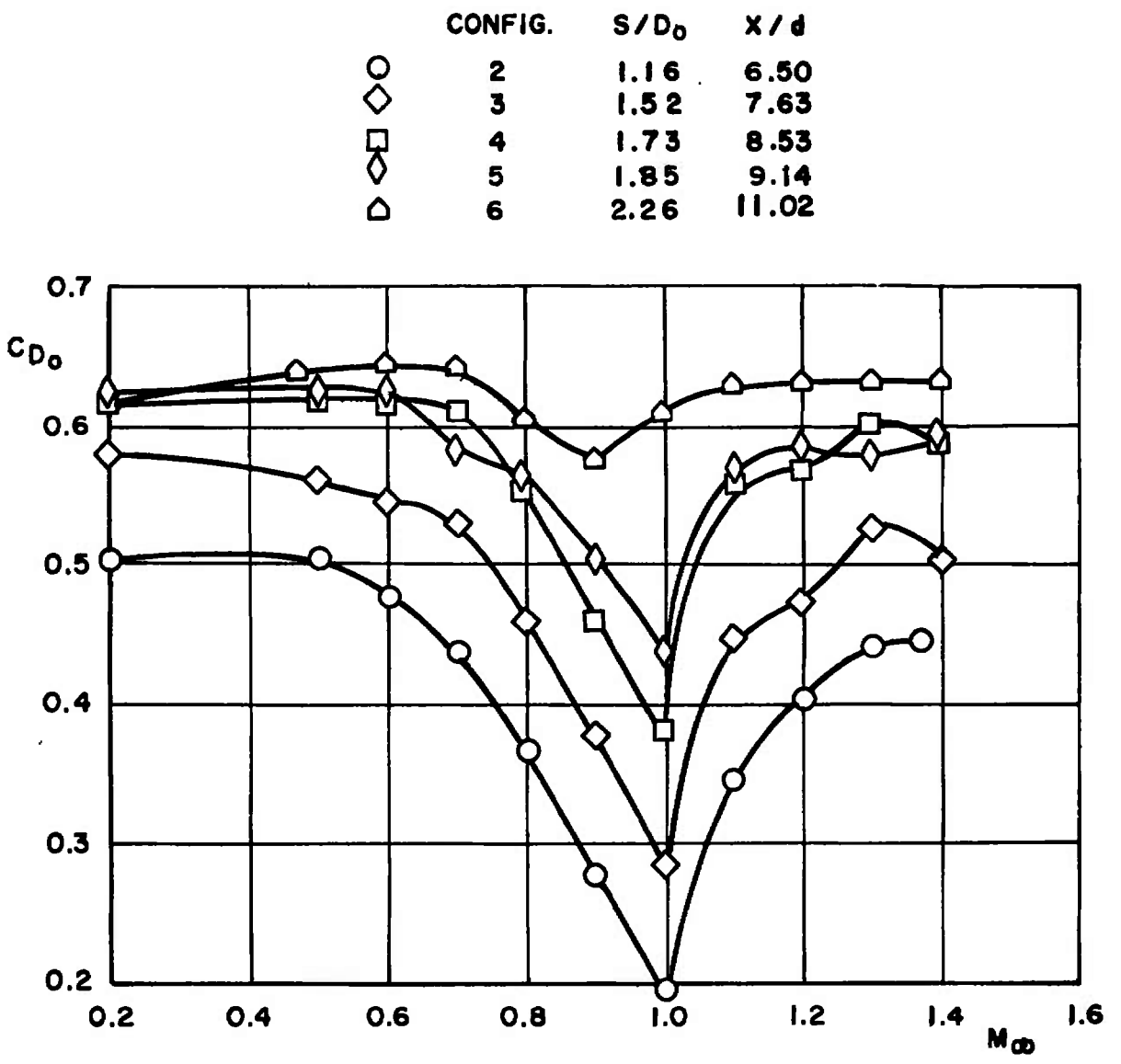


Fig. 7 Effect of Forebody Shape on the Parachute Drag Coefficient, S/D_o = 1.85, X/d = 9.14

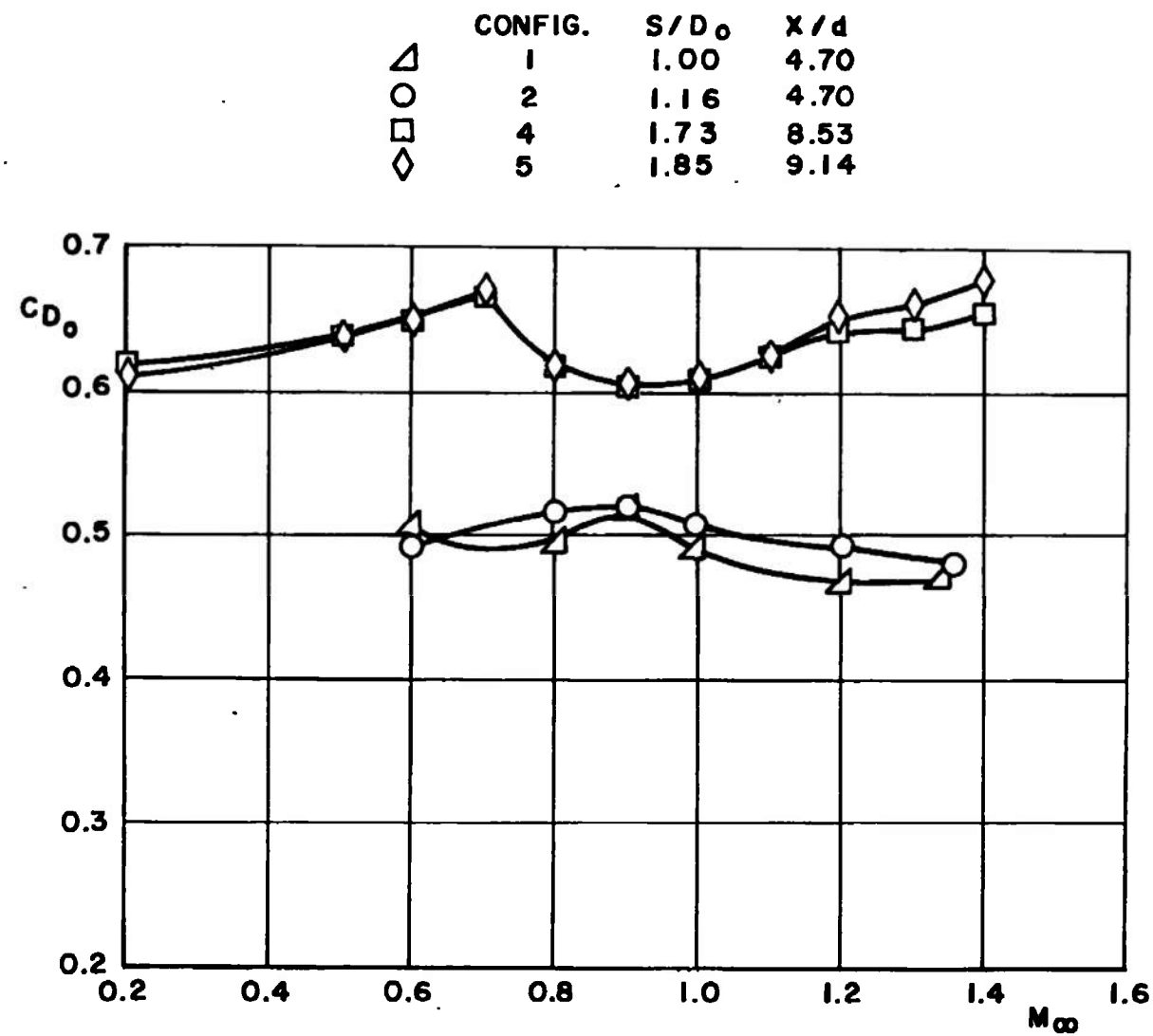


a. Entry Vehicle Forebody

Fig. 8 Variation of Parachute Drag Coefficient with Free-Stream Mach Number



b. Lander Forebody
Fig. 8 Continued



c. Faired Forebody
Fig. 8 Concluded

TABLE I
SUMMARY OF PARACHUTE TEST CONDITIONS AND PERFORMANCE RESULTS

Parachute Configuration	Forebody Configuration	M_∞	q_∞, psf	S/D_o	X/d	C_{D_o}	Observations
1	Faired Body	0.60	100.4	1.00		0.507	Very stable and well inflated, little or no canopy pulsing
		0.80	100.2			0.492	Same as M_∞ = 0.6
		0.90	100.2			0.514	Same as M_∞ = 0.6
		1.00	101.5			0.490	Same as M_∞ = 0.6
		1.20	100.2			0.467	Same as M_∞ = 0.6
		1.37	100.5			0.471	Same as M_∞ = 0.6
2	Faired Body	0.60	100.0	1.16		0.490	Very stable and well inflated; little or no canopy pulsing
		0.80	99.5			0.512	Same as M_∞ = 0.6
		0.90	101.0			0.517	Same as M_∞ = 0.6
		1.00	100.8			0.504	Same as M_∞ = 0.6
		1.20	99.0			0.493	Same as M_∞ = 0.6
		1.38	100.1			0.487	Same as M_∞ = 0.6
2	Lander	1.37	80.0	1.16	6.50	0.446	Stable and well inflated, light canopy pulsing
		1.30	80.0			0.440	Same as M_∞ = 1.38 except medium canopy pulsing
		1.20	80.2			0.405	Fair stability and fair inflation, intermittent squidding
		1.10	80.0			0.345	Fair stability and poor inflation, intermittent heavy squidding
		1.00	80.3			0.193	Stable and very poor inflation, canopy assumed a full reefed condition
		0.90	79.7			0.275	Stable and poor inflation, intermittent heavy squidding
		0.80	79.1			0.365	Fair stability and fair inflation, light squidding
		0.70	80.2			0.437	Stable and well inflated
		0.60	78.6			0.474	Same as M_∞ = 0.70
		0.50	79.4			0.504	Very stable and well inflated, light pulsing
		0.20	56.7			0.505	Same as M_∞ = 0.50
2	Entry Vehicle	2.20	77.8	1.16	6.50	0.341	Fair stability and poor inflation, intermittent heavy squidding
		2.10	78.9			0.350	Same as M_∞ = 2.20
		2.00	79.3			0.347	Fair stability and fair inflation, intermittent canopy pulsing
		1.90	81.0			0.339	Fair stability and well inflated, medium canopy pulsing
		1.80	80.2			0.330	Same as M_∞ = 1.90

TABLE I. (Continued)

Parachute Configuration	Forebody Configuration	M_∞	q_∞, psf	S/D_o	X/d	C_{D_o}	Observations
2	Entry Vehicle	1.40	80.0	1.16	9.14	0.490	Stable and well inflated, light canopy pulsing
		1.30	80.2			0.498	Same as M_∞ = 1.40
		1.20	80.4			0.489	Fair stability and fair inflation, intermittent squidding
		1.10	80.2			0.500	Stable and well inflated
		1.00	79.6			0.466	Fair stability and well inflated
		0.90	80.3			0.440	Stable and well inflated
		0.80	79.2			0.481	Same as M_∞ = 0.90
		0.70	80.3			0.520	Same as M_∞ = 0.90
		0.60	79.9			0.521	Very stable and well inflated
		0.50	75.8			0.521	Same as M_∞ = 0.60
		0.20	67.0			0.514	Same as M_∞ = 0.60
3	Entry Vehicle	1.35	85.3	1.52	7.63	0.571	Very stable and well inflated
		1.30	83.0			0.542	Stable and well inflated, light canopy pulsing
		1.20	80.4			0.527	Same as M_∞ = 1.30
		1.10	80.3			0.501	Fair stability and fair inflation, intermittent squidding
		1.00	80.8			0.293	Fair stability and poor inflation, heavy squidding
		0.90	80.3			0.370	Same as M_∞ = 1.00
		0.80	80.0			0.470	Stable and well inflated
		0.70	79.4			0.515	Same as M_∞ = 0.80
		0.60	80.0			0.550	Same as M_∞ = 0.80
		0.52	73.3			0.551	Same as M_∞ = 0.80
3	Lander	1.40	79.8	1.52	7.63	0.504	Very stable and well inflated
		1.30	80.4			0.527	Same as M_∞ = 1.40 with slight canopy pulsing
		1.20	82.0			0.474	Fair stability and well inflated, heavy canopy pulsing
		1.10	79.6			0.447	Same as M_∞ = 1.20 with intermittent squidding
		1.00	80.0			0.284	Fair stability and poor inflation, continuous squidding
		0.90	80.1			0.377	Fair stability and fair inflation, intermittent squidding

TABLE I (Continued)

Parachute Configuration	Forebody Configuration	M_∞	q_∞, psf	S/D_0	X/d	C_{D_0}	Observations
3	Lander	0.80	79.8	1.52	7.63	0.458	Stable and well inflated, medium canopy pulsing
		0.70	79.8			0.531	Good Stability and well inflated
		0.60	80.6			0.544	Same as M_∞ = 0.70
		0.50	79.2			0.562	Ssme as M_∞ = 0.70
		0.20	56.1			0.582	Same as M_∞ = 0.70
4	Lander	1.40	81.1	1.73	8.53	0.590	Very stable and well inflated
		1.30	80.7			0.602	Same as M_∞ = 1.40
		1.20	80.7			0.569	Stable and well inflated
		1.10	81.2			0.556	Stable and fair inflation, intermittent squidding
		1.00	81.4			0.379	Stable and poor inflation, heavy squidding
		0.90	80.2			0.460	Fair stability and fair inflation, intermittent squidding
		0.80	80.0			0.552	Fair stability and well inflated, slow parachute oscillations
		0.70	79.8			0.610	Same as M_∞ = 0.80
		0.60	79.7			0.613	Same as M_∞ = 0.80
		0.50	80.2			0.619	Same as M_∞ = 0.80
		0.20	60.0			0.618	Same as M_∞ = 0.80
4	Entry Vehicle	2.60	70.5	1.73	8.53	0.379	Fair stability inflation, medium squidding
		2.40	70.0			0.449	Poor stability and poor inflation, heavy squidding
		2.20	79.8			0.480	Fair stability and fair inflation, intermittent squidding
		2.10	78.6			0.486	Same as M_∞ = 2.20
		2.00	78.5			0.491	Same as M_∞ = 2.20
		1.90	78.6			0.519	Stable and well inflated
		1.80	79.0			0.528	Same as M_∞ = 1.90
4	Faired Body	0.22	59.7	1.73	8.53	0.618	Stable and well inflated
		0.50	79.0			0.637	Same as M_∞ = 0.20
		0.60	79.0			0.651	Same as M_∞ = 0.20
		0.70	80.0			0.667	Same as M_∞ = 0.20
		0.80	79.8			0.616	Same as M_∞ = 0.20
		0.90	80.1			0.602	Same as M_∞ = 0.20
		1.00	80.0			0.809	Same as M_∞ = 0.20
		1.10	80.0			0.624	Same as M_∞ = 0.20

TABLE I (Continued)

Parachute Configuration	Forebody Configuration	M_∞	q_∞, psf	S/D_o	X/d	C_{D_o}	Observations
4	Faired Body	1.20	80.7	1.73	8.53	0.641	Same as M_∞ = 0.20
4	Faired Body	1.30	79.2	1.73	8.53	0.643	Very stable and well inflated, light pulsing
4	Faired Body	1.40	80.3	1.73	8.53	0.657	Very stable and well inflated
5	Entry Vehicle	1.37	85.3	1.85	9.14	0.615	Very stable and well inflated
↓	↓	1.30	80.2	↓	↓	0.600	Same as M_∞ = 1.40
↓	↓	1.20	80.2	↓	↓	0.593	Stable and well inflated
↓	↓	1.10	79.2	↓	↓	0.576	Same as M_∞ = 1.20
↓	↓	1.00	79.1	↓	↓	0.425	Stable and fair inflation, heavy canopy pulsing
↓	↓	0.90	79.5	↓	↓	0.486	Same as M_∞ = 1.0
↓	↓	0.80	78.6	↓	↓	0.546	Stable and well inflated, medium canopy pulsing (swivel connection failed)
5	Lander	1.40	80.5	1.85	9.14	0.590	Very stable and well inflated
↓	↓	1.30	80.5	↓	↓	0.580	Same as M_∞ = 1.40
↓	↓	1.20	79.7	↓	↓	0.585	Stable and well inflated, light canopy pulsing
↓	↓	1.10	79.5	↓	↓	0.568	Fair stability and well inflated, medium canopy pulsing
↓	↓	1.00	79.6	↓	↓	0.438	Fair stability and fair inflation, intermittent squidding
↓	↓	0.90	80.0	↓	↓	0.503	Same as M_∞ = 1.00
↓	↓	0.80	79.9	↓	↓	0.564	Stable and well inflated, medium canopy pulsing
↓	↓	0.70	80.3	↓	↓	0.583	Stable and well inflated
↓	↓	0.60	79.6	↓	↓	0.625	Same as M_∞ = 0.70
↓	↓	0.50	80.0	↓	↓	0.625	Same as M_∞ = 0.70
↓	↓	0.20	54.5	↓	↓	0.625	Same as M_∞ = 0.70
5	Faired Body	0.20	58.3	1.85	8.53	0.614	Stable and well inflated, slow intermittent oscillations
↓	↓	0.50	80.1	↓	↓	0.638	Same as M_∞ = 0.2
↓	↓	0.60	80.2	↓	↓	0.651	↓
↓	↓	0.70	79.5	↓	↓	0.670	↓
↓	↓	0.80	80.4	↓	↓	0.616	↓
↓	↓	0.90	79.4	↓	↓	0.606	↓
↓	↓	1.00	79.5	↓	↓	0.609	↓
↓	↓	1.10	80.4	↓	↓	0.626	↓
↓	↓	1.20	79.5	↓	↓	0.652	Very stable and well inflated
↓	↓	1.30	80.3	↓	↓	0.663	Excellent stability and inflation
↓	↓	1.40	80.0	↓	↓	0.678	Same as M_∞ = 1.30

TABLE I (Concluded)

Parachute Configuration	Forebody Configuration	M_∞	q_∞, psf	S/D_o	X/d	C_{D_o}	Observations
6	Entry Vehicle	1.37	79.5	2.26	11.02	0.668	Excellent stability and inflation
		1.30	79.9			0.664	Same as M_∞ = 1.40
		1.20	80.1			0.665	Very stable and well inflated
		1.10	79.6			0.678	Stable and well inflated
		1.00	80.4			0.640	Same as M_∞ = 1.10 with light canopy pulsing
		0.90	79.7			0.592	Same as M_∞ = 1.00
		0.80	80.5			0.639	Same as M_∞ = 1.00
		0.70	80.1			0.667	Stable and well inflated
		0.60	80.0			0.678	Same as M_∞ = 0.70
		0.50	80.0			0.681	Same as M_∞ = 0.70
6	Lander	1.40	78.8	2.26	11.02	0.631	Very stable and well inflated
		1.30	80.3			0.632	Same as M_∞ = 1.40
		1.20	80.4			0.630	Stable and well inflated, light canopy pulsing
		1.10	80.1			0.630	Same as M_∞ = 1.20
		1.00	80.2			0.608	
		0.90	80.2			0.576	
		0.80	80.1			0.602	
		0.70	80.3			0.644	
		0.60	79.6			0.643	
		0.50	79.5			0.637	
		0.20	59.5			0.618	

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Arnold Engineering Development Center
Arnold Air Force Station, Tennessee 37389

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP
N/A

3. REPORT TITLE
AERODYNAMIC CHARACTERISTICS OF DISK-GAP-BAND PARACHUTES IN THE WAKE OF VIKING ENTRY FOREBODIES AT MACH NUMBERS FROM 0.2 TO 2.6

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final Report - June 29 to August 13, 1971

5. AUTHOR(S) *(First name, middle initial, last name)*
David E. A. Reichenau, ARO, Inc.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
July 1972	37	1

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	AEDC-TR-72-78
c. Program Element 921E	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	ARO-PWT-TR-71-192

10. DISTRIBUTION STATEMENT
Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
Available in DDC	NASA Langley Research Center Viking Project Office, Mail Stop 159 Hampton, Virginia 23365

13. ABSTRACT

Tests were conducted in the Propulsion Wind Tunnels (16T) and (16S) to determine the drag and performance characteristics of various disk-gap-band parachute configurations in the wake of a 0.10-scale Viking entry vehicle. The parachutes were also tested behind a small faired body to obtain minimum interference parachute performance characteristics. The results show that in general the parachutes had good inflation and stability characteristics in the wake of the entry forebodies at Mach numbers from 0.2 to 0.8 and from 1.2 to 2.0. Considerable loss in parachute performance was experienced in the wake of the forebodies in the vicinity of Mach number 1.0. Increasing the parachute trailing distance and suspension line length increased the parachute drag coefficient at each Mach number.

DD FORM 1 NOV 65 1473

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
parachutes -- Performance						
entry vehicles						
VIKING spacecraft						
Mars (planet)						
drag						
performance characteristics						
stability						
wind tunnels						
transonic flow						
supersonic flow						
subsonic flow						

2. Parachutes -- Drag

3. Disk-gap-band parachutes