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13. ABSTRACT

The effects of cloth permeability, number of suspension lines, suspension line length, and hem configuration on the spinning characteristics and aerodynamic drag force of the cross parachute were investigated in a wind tunnel. Forty-inch-diameter models with a canopy arm width-to-length ratio (W/L) of 0.264 were tested at various velocities from 50 feet per second to 300 feet per second. Tests were conducted with a conventional crcss parachute and with modifications to the skirt hem which represented an interpanel cord and a band of cloth. The width of the cloth band was ten percent of the canopy diameter. Results of these tests demonstrate that the parachute geometry does have an effect on the drag capability of a spinning cross parachute. While some trends were evident, the effects of geometry on the parachute spin rate for the different hem configurations varied.

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EFFECTS OF CANOPY GEOMETRY ON THE SPINNING CHARACTERISTICS OF A CROSS PARACHUTE WITH A W/L RATIO OF 0.264

Prepared by: William P. Ludtke

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NAVAL ORDNANCE LABORATORY SILVER SPRING, MARYLAND

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20 June 1972

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Effects of Canopy Geometry on the Spinning Characteristics of a Cross Parachute with a W/L Ratio of 0.264

The investigation presented in this report is related to the improvement of parachute technology.

> ROBERT WILLIAMSON II Captain, USN Commander

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LIST OF SYMBOLS

- D drag force, pounds
- C_D coefficient of drag

V velocity, feet per second

 ρ density of air, slugs/ft³

q dynamic pressure, lbs/ft².

So canopy reference area, ft^2

L length of canopy arm

- W width of canopy arm
- W/L canopy arm width-to-length ratio
- C denctes clockwise rotation of the canopy when viewed from behind the parachute
- CC denotes counterclockwise rotation of the canopy when viewed from behind the parachute
- RPM revolutions per minute

DEFINITIONS

permeability - rate of airflow through cloth in $ft^3/ft^2/min$ when measured under a pressure differential of 1/2 inch of water

percent reefed - ratio of the drag force produced in the reefed condition to the drag force of the fully inflated parachute at the same velocity

INTRODUCTION

Wind-tunnel tests and field tests of various cross parachute configurations have demonstrated reliable inflation and good aerodynamic efficiency at subsonic, transonic, and supersonic velocities. A serious problem, sometimes encountered, arises from the tendency of the inflated cross parachute to rotate about the parachute axis at such a rate as to twist the suspension lines into a single riser, thus causing collapse of the parachute compy. In some applications, this undesirable feature can be overcome by use of a swivel mechanism. However, in many high-performance applications, the required swivel can be very large and/or costly:

Observation of the cross parachute in field tests indicated that the spinning is affected by:

a. Cloth permeability

b. Suspension line length

c. Independent motion of the four arms of the canopy

A series of wind-tunnel tests were proposed to:

'a. Determine the effects of cloth permeability, suspension line length, number of suspension lines, and velocity on the spinning characteristics of the cross parachute

b. Determine the effect of modifying the canopy hem configuration by an addition of (1) hem wire and (2) hem band on the spinning characteristics of the cross parachute

c. Determine the drag coefficient of the various spinning configurations under test

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APPROACH

Three series of model cross parachutes were designed, using a canopy cloth of different air permeabilities for each series. All models consisted of two panels 40 inches in length with a W/L = 0.264. The two panels were arranged to form the configurations illustrated in Figure 1. Each series of models consisted of three parachutes with 8, 16, and 24 suspension lines, respectively, for the same canopy cloth. As initially installed, the suspension lines were 1.8 canopy diameters in length. These lines were later shortened to 1.6 and 1.4 canopy diameters. This approach provided 27 possible geometric configurations for each hem modification. Parachute construction details

are illustrated in Figure 2, and the materials used in construction of the models are enumerated in Table I.

The wind-tunnel tests were conducted at the University of Maryland 7-foot by ll-foot Cross Section Subsonic Wind Tunnel, College Park, Maryland. The wind-tunnel support system, Figures 3, 3A, and 3B, was designed to position the model canopies. To maintain a relatively aerodynamically uncluttered test section, guy wires were used to support the instrumented test body. In all tests, the parachute suspension lines were attached to a spider at the rear of the test body. The shaft of the spider was mounted to a swivel which was in turn connected to a tension-type force transducer ring for sensing aerodynamic drag force. The addition of a light source and photographic cell pickup counted the revolutions of the shaft. The instrumentation setup is shown schematically in Figure 4, and the readout equipment is pictured in Figure 4A.

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Each parachute was mounted onto the spider, and measurements of the spin rate and aerodynamic drag force were made at various windtunnel velocities from 50 feet per second through 300 feet per second. Upon completion of one hem configuration, the hem was modified, and the tests were repeated. The first series of tests was conducted without any constraints on the canopy hem. The hem was then modified by the addition of a 1/16-inch flexible steel cable which was added between rings attached to the hem of the canopy at the outer suspension lines. This hem wire was to preclude independent motion of the canopy arms. In order to assure a tersile load in the hem wire, the canopy was partially reefed. A typical hem wire installation is shown in Figure 5. The second hem modification consisted of a fourinch wide band of cloth, the same cloth as the canopy, attached around the skirt hem of each configuration. A typical hem band installation is shown in Figure 6.

Test data were reduced to coefficient form by means of the following formulae:

$$C_{11} = \frac{D}{qSo}$$
$$Q = \frac{1}{2} \rho V^2$$

$$So = 2LW - W^2$$

percent reefed = $\frac{\text{drag of parachute in reefed condition at velocity V}}{\text{drag of fully opened parachute at same velocity}}$

The reference area of all parachute models used in this test is 5.092 ft^2 .

RESULTS

From observation of previous field tests and wind-tunnel tests of the cross parachute, it was anticipated that the results of this investigation would indicate the following:

a. Parachute spin rate would increase as cloth permeability decreases

b. Parachute spin rate would increase as suspension line length increased

c. Modification of the hem would produce a reduction in spin rate

d. Effect of the number of suspension lines was unknown

The wind-tunnel test series was run with the $208 \text{ ft}^3/\text{ft}^2/\text{min}$ permeability canopies tested first, since their inherent stability put the least amount of undue strain on the swivel and strain gage link in the test body. The $80 \text{ ft}^3/\text{ft}^2/\text{min}$ canopies, which were tested next, showed some tendency to cone. Finally, the relatively impervious $8 \text{ ft}^3/\text{ft}^2/\text{min}$ canopies were mounted on the test body. These parachutes were very unstable in that they exhibited a coning motion about the wind-tunnel center line at an angle of 30 degrees + 10 degrees and oscillated back and forth. The swivel mechanism failed under this strain. It was not deemed feasible to continue testing the low permeability parachutes.

All of the parachute configurations, except one (eight suspension line, 80 permeability, canopy), rotated in a clockwise direction when viewed from a position downstream of the parachute. The aforementioned parachute rotated in a counterclockwise direction for all hem modifications. As a comparison, a 24-gore, 16 percent geometri-cally porous, 37-1/2-inch flat diameter, 5-ribbon ring slot parachute and a 24-gore, 24 percent geometrically porous, 37-1/2-inch flat diameter, 9-ribbon ribbon parachute were tested through the velocity range of 50 to 300 feet per second. As the velocity was increased on the ring slot parachute, the rotation rate increased until the spinning canopy was distinguishable only as a blur. This was a much faster spin rate than any of the cross parachutes had achieved. Upon reaching 300 feet per second constant velocity, the ring slot parachute ceased rotation then reversed direction and spun at a low constant rate. The ribbon parachute, when subjected to the same test, exhibited a slow constant roll in the same direction for all test conditions.

The cross parachutes, when turned inside out, would reverse their direction of rotation; however, the ring slot and ribbon canopies continued to rotate in the same direction.

The effects of velocity on the parachute spin rate for the various test parameters (number of suspension lines, suspension line length, hem configuration) are illustrated in Figures 7 through 12. It is difficult to draw general conclusions from these data. Some of the configurations confirm the pretest expectations, but other configurations are contrary to expectation. It is interesting to note that the use of a hem cord, in place of a hem wire, in several field test configurations has reduced the rotation of the cross parachute and maintained full canopy inflation. This is believed to be due to the control of the independent action of the four canopy arms.

In view of the variation in performance for the configurations, further testing is necessary before firm conclusions can be drawn as to the rotational properties of the cross parachute.

Tables II through XX enumerate the drag coefficients of the various configurations, together with the respective spin rates, etc. Some general observations can be made concerning the drag coefficients of the spinning parachutes as affected by the various test parameters.

a. An increase in the canopy cloth permeability is accompanied by a reduction in the drag coefficient.

b. For any given suspension line length, the drag coefficient increases as the number of suspension lines increases. This effect is evident for all hem configurations and cloth permeabilities. and a state of the stat

c. For all hem configurations and cloth permeabilities, the drag coefficient increases as the suspension line length is extended.

Comparison of the drag coefficients of the hem wire configurations was made on configurations having the same hem wire length. Comparison of the hem band configurations, due to the several hem band lengths, was made on the basis of configurations having the same percent reefing.

MATERIALS USED IN MODEL PARACHUTE CONSTRUCTION TABLE |

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MATERIAE SERIES	NUMBER 2 NUMBER 3 NUMBER 2 NUMBER 3	CLOTH MIL-C-7020, TYPE 1 A.75 OZ./YD ² , DOBBY WEAVE, HEAT SET, AIR PERMEABILITY BFT ³ /FT ² /MIN @ 1/2 INCH WATER PRESSURE DIFFERENTIAL	TAPE MIL-T-5038, TAPE III, MIL-T-5038, TAPE III, MIL-T-5038, TYPE III, 1/2 INCH WIDE 1/2 INCH WIDE 1/2 INCH WIDE 1/2 INCH WIDE	USPENSION ¹ MIL-C-17183 MIL-C-17183 MIL-C-17183 LINE	STITCHES ² TYPE 301, FED STD 751, 9 TO 12 STITCHES PER INCH, 2 ROWS ON 1/4 INCH NEEDLE GAUGE.	STITCHES TYPE 301, FED STD 751, 9 TO 12 STITCHES PER INCH, SINGLE ROW
AATEDIAL		CLOTH	TAPE	SUSPENSION ¹ LINE	STITCHES ²	STITCHES

TYPE VI, 500-LB TENSILE STRENGTH TYPE IV, 300-LB TENSILE STRENGTH TYPE III, 200-LB TENSILE STRENGTH 8 SUSPENSION LINE CANOPIES USE, 16 SUSPENSION LINE CANOPIES USE, 24 SUSPENSION LINE CANOPIES USE,

ALL THREAD, V-T-295. TYPE I OR II, CLASS I OR 2, SIZE B 2

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TABLE II PARACHUTE TEST DATA

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CLOTH PERMEABILITY 80 FT³/FT²/MIN 8 SUSPENSION LINES HEM CONFIGURATION - UNMODIFIED

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TABLE IX PARACHUTE TEST DATA CLOTH PERMEABILITY 80 F13/F12/MIN 24 SUSPENSION LINES HEM CONFIGURATION - UNIMODIFIED

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TABLE X PARACHUTE TEST DATA CLOTH PERMEABILITY 80 FT3/FT2/MIN 8 SUSPENSION LINES HEM CONFIGURATION - HEM WIRE

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TABLE X PARACHUTE TEST DATA

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TABLE VII PARACHUTE TEST DATA

CLOTH PERMEABILITY 80 FT³/FT²/MIN 24 SUSPENSION LINES HEM CONFIGURATION - HEM WIRE

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300080 31	18 30 48 102 102	8 6 7 9 0 8 4 8 0 7 4 8 0
101.4 90.5 90.4 90.6 91.7	102.1 97.9 98.2 94.1 94.1	103.9 100.4 93.9 89.1 80.1
.642 .600 .605 .605 .609 .609	. 727 . 697 . 702 . 714 . 705	719 719 729 729 719
50 100 250 300	50 150 300 300	50 150 250 300
6"Wire	7 3/4" Wire	7 3/4" Wire
1.0D	1.4D	1. 8D
93	ນ	20
	63 1.0D 6"Wire 50 .642 101.4 6 C 100 .600 90.5 0 150 .605 90.7 0 200 .609 90.4 0 300 .620 91.7 30	53 1.0D 6"Wire 50 :642 101.4 6 C 150 :605 90.5 0 0 0 0 0 20 10 150 :605 90.7 0 0 0 100 :605 90.4 0 <t< td=""></t<>

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TABLE VIII PARACHUTE TEST DATA

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CLOTH PERMEABILITY 80 FT3/FT2/MIN 8 SUSPENSION LINES HEM CONFIGURATION - HEM BAND

RUN NO.	LINE LENGTH	НЕМ	ърS К	р С	жеегео К	ROI RATE RPM	'ATION DIRECTION	REMARKS
100	1. QD	7 3/4" Band	50 150 250 300 300	.681 .586 .601 .592 .585 .585	99.0 91.6 97.2 99.8 99.8 100.5	12 242 266 286 204 204 204 204 204 204 204 204 204 204	С С	
0 6	1.4D	8 1/2" Band	50 100 250 300 350	.754 .681 .643 .644 .635	102.9 99.6 97.3 99.7 99.7	22000	Cand CC	
0	1.8D	8 1/2" Band	50 150 250 300	.745 .745 .681 .661 .653	98.0 99.2 95.1 95.1	0000°50	U	

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TABLE IX PARACHUTE TEST DATA CLOTH PERMEABILITY 80 FT³/FT²/MIN 16 SUSPENSION LINES HEM CONFIGURATION - HEM BAND

$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	NN	LINE		>	U	%	ROT/ RATE	ND I L	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		LENGTH	МЭН	FРS	a ,	REFED	RPM	DIRECTION	REMARKS
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		1.0D	7 3/4" Band	50 100	. 630 . 635	101.0 100.5	6 24	υ	Coning
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$!	150	. 644	100.0	24		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				200	.631	97.4	48		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				250	.619	95.5	24		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				300	. 618	94.2	24		
Band 100 $.691$ 98.7 54 150 $.706$ 97.5 66 200 $.686$ 94.2 78 200 $.663$ 93.0 78 300 $.667$ 91.1 84 300 $.667$ 91.1 84 300 $.671$ 91.1 84 300 $.741$ 98.1 4850 $.706$ 82.7 24 C 3300 $.741$ 98.1 48 150 $.732$ 95.6 60 300 $.711$ 91.5 72 200 $.771$ 24 $.72$		1.4D	8 1/2"	50	. 585	76.3	30	υ	
150 .706 97.5 66 200 .686 94.2 78 250 .668 93.0 78 250 .667 91.1 84 300 .667 91.1 84 300 .706 82.7 24 C 3and 100 .741 98.1 48 220 .711 91.5 72 230 .694 89.9 78 300 .678 85.6 78			Band	100	. 691	98.7	54		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				150	. 706	97.5	66		
250 .668 93.0 78 300 .667 91.1 84 300 .667 91.1 84 300 .667 91.1 84 300 .667 91.1 84 300 .706 82.7 24 150 .711 98.1 48 150 .732 95.6 60 150 .711 91.5 72 200 .711 91.5 72 200 .711 91.5 72 200 .711 81.5 72 200 .711 81.5 72 200 .711 81.5 72 200 .778 85.6 78				200	. 686	94.2	78		
300 .667 91.1 84 1.8D 81/2" 50 .706 82.7 24 C 3and 100 .741 98.1 48 150 .732 95.6 60 200 .711 91.5 72 250 .694 89.9 78 300 .678 85.6 78				250	. 668	93.0	78		
1.8D 8.1/2" 50 .706 82.7 24 C Sand 100 .741 98.1 48 150 .732 95.6 60 200 .711 91.5 72 250 .694 89.9 78 300 .678 85.6 78				300	.667	91.1	84		
1.8D 81/2" 50 .706 82.7 24 C Sand 100 .741 98.1 48 C 150 .732 95.6 60 200 .711 91.5 72 250 .694 89.9 78 300 .678 85.6 78									
Band 100 741 98.1 48 150 .732 95.6 60 200 .711 91.5 72 250 .694 89.9 78 300 .678 85.6 78		1.8D	8 1/2"	50	. 706	82.7	24	U	
150 . 732 95.6 60 200 . 711 91.5 72 250 . 694 89.9 78 300 . 678 85.6 78			Band	100	. 741	98.1	48		
200 .711 91.5 72 250 .694 89.9 78 300 .678 85.6 78				150	. 732	95.6	60		
250 . 694 89. 9 78 300 . 678 85. 6 78				200	. 711	91.5	72		
300 .678 85.6 78				250	.694	89.9	78		
				300	.678	85.6	78		

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TABLE X PARACHUTE TEST DATA

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CLOTH PERMEABILITY 80 FT³/FT²/MIN 24 SUSPENSION LINES HEM CONFIGURATION - HEM BAND

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4 SUSPENSION LINES	EM CONFIGURATION

	REMARKS	Coning	Serving slipped slightly.	· · ·
ATION	DIRECTION	U	΄υ	י י ט י
ROT PATTE	RPM	000000		6 12 30 42 8 48 8
67	" REEFED	112.5 99.4 95.4 93.9 92.3	94.0 96.6 92.8 91.9 91.1	103. 0 99. 7 97. 4 89. 7 86. 0 91. 2
Ç	ر D	. 712 . 659 . 643 . 651 . 629 . 624	. 669 . 683 . 711 . 699 . 682	712 714 756 756 888 735
	к РS	50 100 200 300 300	50 100 150 200 300	50 100 150 200 300
	МЭН	7 3/4" Band	8 1/2" Band	8 1/2" Band
LINE	LENGTH	1.0D	1.4D	1. 8D
MIIG	NO.	. 103	တ	8

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	REMARKS	• • • •		Some coning, de- creased as speed went up.
	·	· •		
· · · · · · · · · · · · · · · · · · ·	ration DIRECTIO	ບ	ΰ	υ
ST DATA ∵T3/FT2/MIN JNMODIFIED	RATE RPM	, 2000 2000 2000 2000 2000 2000 2000 200	0 1 3 1 5 6 8	24 30 54 66 78
PARACHUTE TE FARACHUTE TE FEABILITY 208 F ON LINES GURATION - L	% REEFED	100 1000 1000 1000	100 100 100 100	100 100 100 100
TABLE XI LOTH PERM SUSPENSIO	υ ^Ω	.648 .613 .598 .584 .584 .579	. 727 . 663 . 670 . 645 . 633	. 724 . 698 . 681 . 681 . 668
ΰωΞ	F PS	50 100 200 300 300	50 150 250 300 300	50 150 250 300
	HEM	None	None	None
•	LINE LENGTH	1.0D	1.4D	1.8D
	RUN NO.	9	6 ១	64

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TABLE XTI PARACHUTE TEST DATA CLOTH PERMEABILITY 208 FT3/FT2/MIN 16 SUSPENSION LINES HEM CONFIGURATION - UNMODIFIED

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DTATION	DIRECTION	U						υ							υ					
R(B Amn	RPM	0 6	24	36	48	60		9	24	30	42	66	96		9	24	24	42	60	06
ŧ	% REEFED	100	100	100	100	100		100	100	100	100	100	100		100	100	100	100	100	100
C	р Д	.557 609	. 602	.610	. 606	. 605		.775	. 661	.667	.681	.678	.679		. 803	.714	.719	. 725	. 731	. 732
;	۲ ۲ ۲ ۲ ۲	50	150	200	250	300		50	100	150	200	250	300		50	100	150	200	250	300
	HEM	None						None							None					
	LENGTH	1.0D						1.4D							1.8D					
	RUN NO.	46						45	1						44					

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REMARKS

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CLOTH PERMEABILITY 208 FT³/FT²/MIN 24 SUSPENSION LINES HEM CONFIGURATION - UNMODIFIED

	REMARKS	Coning	Coning nearly gone.	Very slight coning.
TATION	DIRECTION	, U	U	U
RO	RATE RPM	30 48 66 108 144	0 8∉ 90 132 162	0 60 114 126 180 240
	% REEFED	100 1000 1000 1000	100 100 100 100 100	100 100 100 100 100
	с С	.660 .618 .620 .613 .613 .624 .632	.691 .675 .699 .695 .706	. 787 . 712 . 754 . 764 . 772 . 779
	V FPS	50 150 200 300 300	50 150 250 300	50 100 250 300
	НЕМ	None	None	None
	LINE LENGTH	1.0D	1.4D	1.8D
	RUN NO.	43	42	5 2

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TABLE XIV PARACHUTE TEST DATA

CLOTH PERMEABILITY 208 FT3/FT2/MIN 8 SUSPENSION LINES HEM CONFIGURATION - HEM WIRE

REMARKS

or a trion Direction	υ	U	υ
RATE RATE RPM	30 54 102 132 132	18 42 66 102 120	30 48 72 114 132
CIATAAN %	97,7 90,2 92,3 91,3 90,7	95.0 98.7 99.1 94.0 94.3	96.7 96.7 91.3 91.9 91.9
с D	633 555 555 539 533 533 533 533 533 533 5	. 691 . 588 . 604 . 597 . 593	.700 .614 .625 .622 .615
ऽत.ग >	50 150 250 300	50 100 300 300 300	50 100 200 250 300
HEM	6 3/4" Wire	8 1/4" Wire	8 1/4" Wire
HLDNAL LINE	1.0D	1.4D	1.8D
RUN NO.	* L	70	71

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TABLE XY PARACHUTE TEST DATA CLOTH PERMEABILITY 208 FT3/FT2/MIN 16 SUSPENSION LINES HEM CONFIGURATION - HEM WIRE

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DTATION	DIRECTION	υ							υ							υ					
R(BATE	RPM	18	24	36	48	66	78		24	36	48	99	84	108		9	24	36	48	60	72
<i>0</i> 7	REFED	114.2	94.4	94.5	93.8	93.4	94.7		87.9	98.3	95.8	95.0	94.8	95.6		86.4	93.7	94.4	93.1	91.2	91.5
C	о О	. 636	.575	. 569	.572	. 566	. : 73		.681	.650	.639	.647	.643	.649		.694	. 669	.679	. 675	.667	.670
11	FPS	50	100	150	200	250	300		50	100	150	200	250	300		50	100	150	200	250	300
	HEM	6" Wire							7 3/4"	Wire						73/4"	Wire				
	LENGTH	1.0D							1.4D							1.8D					
	NO.	62							52							53					

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Section 2

REMARKS

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TABLE XXI PARACHUTE TEST DATA LOTH PERMEABILITY 208 FT³/FT²/M

CLOTH PERMEABILITY 208 FT3/FT2/MIN 24 SUSPENSION LINES HEM CONFIGURATION - HEM WIRE

	RIEM A RISS											-	-			•	•		-		•		•		-
TATION	DIRECTION	U)					U					-	ז ט -	-					U	-			1	•
ROI	RPM	18	54	54	72	96	120	18	36	54	78	102 "	126	- 18	00	<u>6</u> 6	- 84 -	114	144	9	. 36 -	42	00	00	. 114
18	REEFED	93.6	98.2	100.0	100.2	98.4	97.6	101.8	07.4	96.6	<u> 08.9</u>	97.1	95.1	101.7	. 99.6	98.6	100.3	95.2	95. 5-	101.3	96.9	93.8	52.0	90.2	50.6
ر	ς D	.618	.607	. 620	.614	.614	.617	.672	. 602	. 509	. 606	. 606	. 601	703	.672	.689	. 697	. 672	- 677	. 797	-690	. 707	., 703	. 696	698
>	FPS	50	100	150	200	250	300	50	100	150	200	250	300	50	100	150	. 200	250	300	50	100	150	200	250	300
	HEM	63/4"	Wire					6"Wire					:	7 3/4"	Wire	I			,	- 7 3/4" .	Wire				1
1 JNF	LENGTH	1.0D						1.0D				;	:	.1.4D						1.8D					:
NIIA	NO.	54						57						50	-				1	51	:	!		;	

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TABLE XVII PARACHUTE TEST DATA

CLOTH PERMEABILITY 208 FT3/FY2/MIN 8 SUSPENSION LINES HEM CONFIGURATION - HEM, BAND

NOLÉCENON ROTATION RATE ... RPM υ -12 144 165 174 174 % Riចំនេះទោ 106.3 94.3 96.8⁻ 98.3 98.1 . 689 . 578 . 579 . 577 . 568 പ്പ ۲ PS 100 100 200 200 200 200 200 HEM . 7 1/4" Band 1,0D_. LENGTH . 96 RUN NO.

RENARKS

83 1.41) 8 1/8" 50 .624 85.8 18 Band 100 .611 92.2 42 130.0 .624 93.0 48 200 .624 96.7 66 300 .614 97.6 97.3 78 300 .614 97.6 90

82

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8 1/8" Band

1.8D

05.0 00.5 01.5 03.6

604 632 632 632 632 632 632

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DATA	/GT2/A
TEST	6T37
PARACHUTE	200 11 12 200
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TABLE XXIII PARACHUTE TEST DATA CLOTH PERMEABILITY 208 FT3/FT2/MIN 16 SUSPENSION LINES HEM CONFIGURATION - HEM BAND

	REMARKS															Sugnerion lines	uneyen.	1			
OLATION	NOILE: STRIC	υ							U	,						υ					
RAT'S	INELSI	18	-12	09	72	78	84		U	12	18	36	36	42		0	9	18	18	24	30
÷,	CLAREN	117.4	01.0	07.2	P 6. 6	07.7	97, 2		97.3	96.5	96.7	81- 1 . 0	84. I	03.7		06.1	80.4	1.10	00, 0	08.6	00.6
ت	2	. 654	. 603	. 585	. 589	. 592	. 588		. 754	. 638	. 645	. 640	. 638	. 636		. 772	. 638	. 650	. 659	. 648	. 656
2	SdA	50	100	150	200	250	000		50	100	150	200	250	300		50	100	150	200	250	300
	INEIH	7 1/4"	Band						8 1/8"	Band						8 1/8"	Band				
ELINE	LENGTH	1.0D							U1.1D							1.8D					
RUN	.0 V	95							85							8-1					

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	REMARKS			Some confirm										
NOITAT	NO ITECTION		U	ξ)				ບ					
ON.	AT'NE Metri	12 75 75	20 20 20 20 20 20 20 20 20 20 20 20 20 2	5	18	54	72	108 108	12	24	54	00	00	108
ā	% REEFRD	104.7 96.1 96.6	90.0 94.1 94.5		91.4 91.4	90.6	03. 4 6: 6	91.6 91.3	66, 6	88.6	88.1	87.8	85.8	85. 9
	С U	. 691 . 594 . 599	. 587 . 587	YO U	.001	. 633	. 649	. 647	. 575	. 620	. 654	. 660	. 661	. 662
:	V F PS	50 150	250 300	C U	100	150	200	250 300	50	100	150	200	250	300
	HEM	7 1/4" Band		- 0/ - 0	o 1/0 Band				8 1/8"	Band				
	LINE	1.0D		<u>,</u>	1.41				1.8D					
	RUN NO.	0 0		ę	20				91					

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BLE XX PARACHUTE TEST DATA	TH PERMEABILITY 8 FT3/FT2/MIN	SPENSION LINES CONFIGURATION - UNMODIFIED
TABLE	CLOTH F	8 SUSPEI HEM CO

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Coning greatly. Rotation data in- accurate due to oscilla. tion in mech. (Approx. 300 from axis	Coning greatly. (Approx. 30 ⁰ from axis	Coning greatly. (Approx. 30 ⁰ from axis
υ	U	ΰ
174 288 324 282	42 66 180	1 2 4 2 4 3 6 1 0 2 1 0 2
001100	100 100 100	100 1000 1000
. 818 . 746 . 740 . 740	906 786 789	. 915 . 812 . 828 . 808
50 100 200	50 100 200	50 150 250 250
None	None	None
1. 0D	1.4D	1.8D
105	104	103
	105 1.0D None 50 .818 100 174 C Coning greatly. 100 .746 100 288 C Rotation data in- 150 .740 100 324 accurate due to oscilla 200 .740 100 282 (Approx. 300 from axis	105 1.0D None 50 818 100 174 C Coning greatly. 105 1.0D None 50 818 100 288 Coning greatly. 150 740 100 324 100 324 Inon in mech. 200 .740 100 282 Inon in mech. Inon in mech. 200 .740 100 282 Inon in mech. Inon in mech. 200 .740 100 282 Inon in mech. Inon in mech. 200 .740 100 282 Inon in mech. Inon in mech. 104 1.4D None 50 906 100 42 C Coning greatly. 104 1.4D None 50 906 100 42 C Coning greatly. 200 .767 100 120 20 Inon in 20 Inon in 20 Inon in 20 200 .767 100 120 120 Inon in 20 Inon in 20 Inon in 20

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HEM WIRE RING

1/4 O.D. x 3/16 1.D. x 1/8 LONG

HEM WIRE RINGS INSTALLED ON OUTER SUSPENSION LINES



SKIRT HEM - SUSPENSION LINE ASS'Y

FIG. 2 MODEL PARACHUTE CONSTRUCTION DETAILS SEE TABLE | FOR MATERIALS IDENTIFICATION



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FIG. 3 WIND-TUNNEL SUPPORT SYSTEM

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FIG. 4 SCHEMATIC OF TEST INSTRUMENTATION

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