

STEAM TURBINE INFORMATION

TURBINE MISSILE REPORT

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WESTINGHOUSE ELECTRIC CORPORATION
STEAM TURBINE-GENERATOR DIVISION

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WESTINGHOUSE ELECTRIC CORPORATION
STEAM TURBINE INFORMATION

TURBINE MISSILE REPORT

1 INTRODUCTION

This report summarizes Westinghouse's evaluation of potential turbine missiles above the turbine deck from the high pressure (HP) rotor and the low pressure (LP) rotor discs of the turbine elements for Unit

The contents of this report supersede any previously issued information for this unit on turbine missile energies.

2 DESCRIPTION OF TURBINE ELEMENTS

2.1 High Pressure Turbine

The HP element is a double flow design similar to the HP double flow design shown in Figure 1, and consists of a forged single-piece double flow rotor, a cast steel outer cylinder, and four cast steel blade rings supported inside the outer cylinder. Steam from four control valves enters nozzle chambers at the center of the turbine element through four inlet pipes (two in the cylinder base and two in the cylinder cover). In these chambers, the steam is distributed equally to both halves of the rotor and flows axially through the blading to the exhaust chambers at each end of the HP cylinder.

BLADE RINGS

CYLINDER

ROTOR

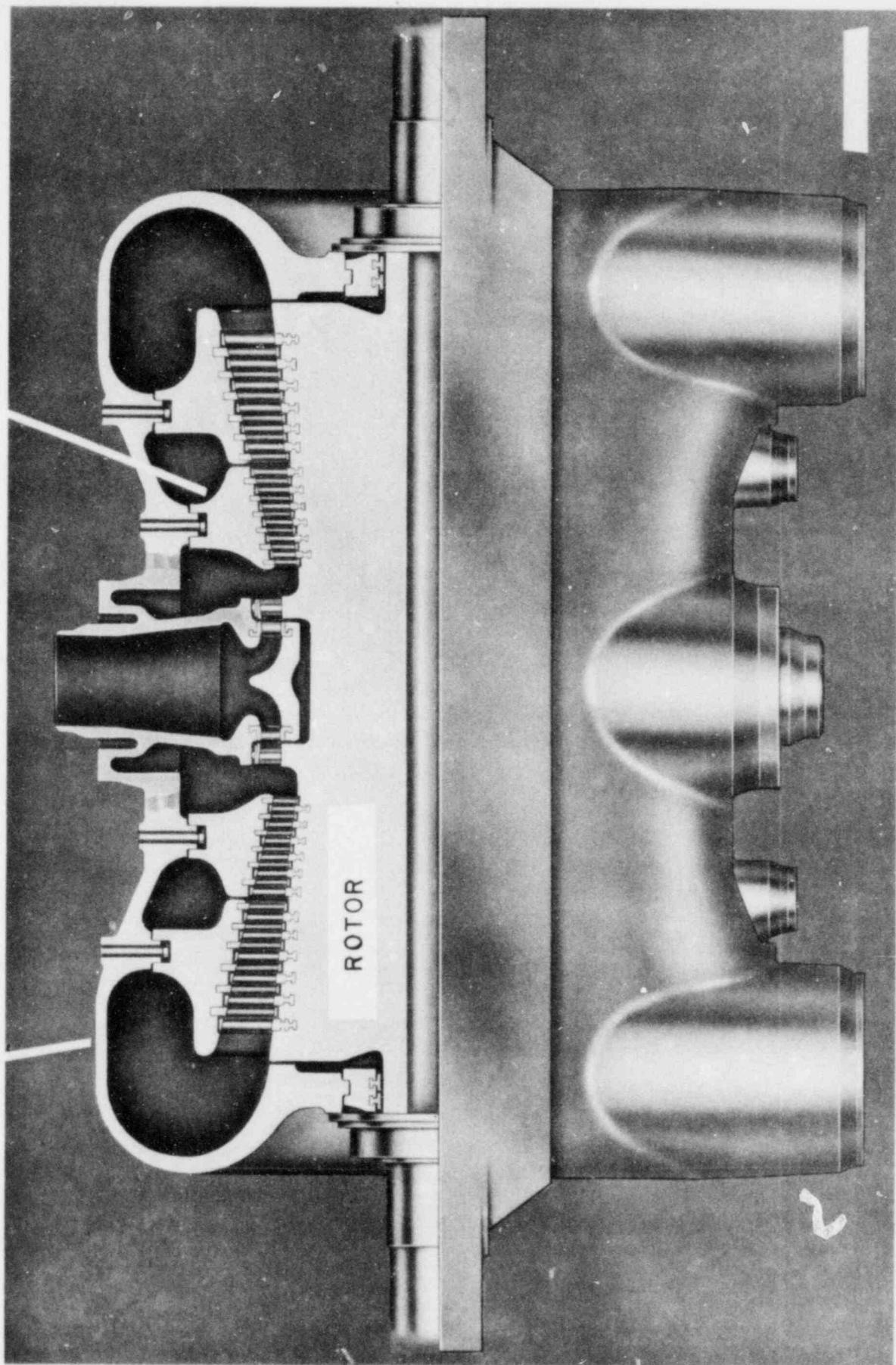


FIGURE 1
HP DOUBLE - FLOW TURBINE

2.2 Low Pressure Turbine

The LP turbines are of a double flow design similar to the double flow design shown in Figure 2. Each element consists of a double flow rotor assembly, an outer cylinder, two inner cylinders, and blade rings. The rotor assembly consists of a shaft with 12 shrunk-on discs made of low alloy steel and two shrunk-on couplings. Steam enters at the top of each outer cylinder where it flows to the inlet chamber of the inner cylinders. In the inlet chamber, the steam is distributed equally to both halves of the rotor and flows through the blading to the condenser. LP turbines are numbered from the HP element to the generator. The LP-1 element is next to the HP element, the highest numbered LP element is next to the generator.

3 COMMENTS AND ASSUMPTIONS

3.1 High Pressure/Low Pressure Turbines

3.1.1

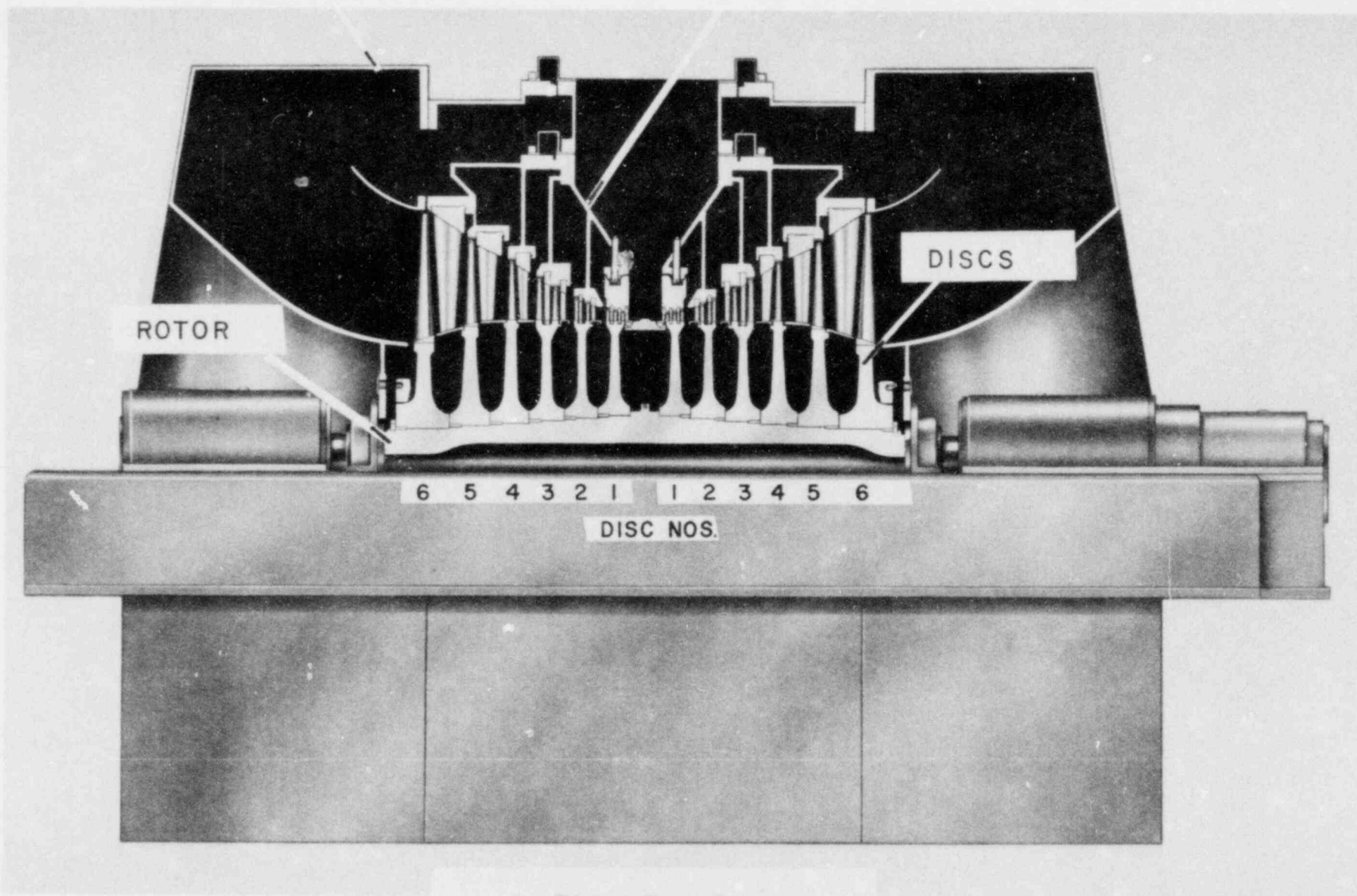
When a disc or rotor fails in quarters, the failure occurs in steps with the result that two fragments gain velocity and two lose velocity. The velocities and energies given are for the higher velocity fragments.

3.1.2

In predicting the ability of the fragment to penetrate the turbine casing, test results and analytical considerations indicate that the translational kinetic energy of a fragment is of much greater importance than the rotational kinetic energy. Rotational kinetic energy tends to be dissipated as a result of friction forces developed between the surface of the disc or rotor fragment and the stationary part; therefore, rotational kinetic energy was not considered in the penetration calculations.

OUTER CYLINDER

INNER CYLINDER



ROTOR

DISCS

6 5 4 3 2 1 1 2 3 4 5 6

DISC NOS.

FIGURE 2
LP DOUBLE-FLOW TURBINE

3.1.3

The analysis considers the energy absorbed by the inner and outer cylinders, blade rings, and cylinder rings where appropriate. The results of R&D tests, including the 1979 non-symmetrical tests, are incorporated into the analysis.

3.1.4

When missile energies exiting the turbine are less than 100,000 ft-lb, they are not reported in the Analysis Results section of this report.

3.1.5

Minimum ultimate strength was used to establish the dynamic strength of the cylinders and blade rings for the missile penetration calculations.

3.2 High Pressure Turbine

3.2.1

The calculations for this unit show that there are no external missiles from the HP rotor at 100% speed nor at design overspeed.

3.2.2

It is not necessary to calculate missiles at the ductile bursting speed of the HP rotor since this bursting speed is higher than the theoretical terminal speed of the unit.

3.3 Low Pressure Turbine

3.3.1

In evaluating the capability of LP turbine structures to contain fragments, it is assumed that a single disc fails and fractures into several parts. Segments of 90, 120

and 180 degrees have been considered but only 90 and 120 degree segment properties are reported. Because of kinematic considerations, a 180 degree disc segment will have a lower initial translational energy and more of the energy is absorbed by the internal structures. As a result, the likelihood of generating missiles is less than for the other segments, and exit energies will be lower. LP turbine missile impact areas and dimensions are given in Figure 3 and tabulated in TABLES 1 and 2.

The potential for distributed bore cracks and field experience indicate that an LP disc burst may result in major segments (hub to rim fractures) varying in size from approximately 30 to 200 degrees. Although missile data for only 90 and 120 degree segments are presented in this report, an assessment was made to determine if smaller, larger, or intermediate size disc segments could exit with higher energies. The results of this assessment indicate that 90 and 120 degree segments are reasonable approximations for the highest exiting energy disc segment.

3.3.2

The bursting speed of each shrunk-on disc is calculated. The criterion used is that the disc will fail when the average tangential stress equals the maximum temperature corrected tensile strength of the disc material. The maximum value was taken as the minimum specification value plus 20 KSI. Upon failure of the initial disc, further acceleration is assumed to halt because of damage to the turbine. For purposes of calculating and reporting the energies of missiles, all other discs are assumed to fail at the same speed as the initial disc.

3.3.3

The calculated value of destructive overspeed for this unit is 194% of rated speed. This is the speed at which the initial LP disc fails. The No. 3 disc, LP-2, both ends, is the initial disc to fail on this unit.

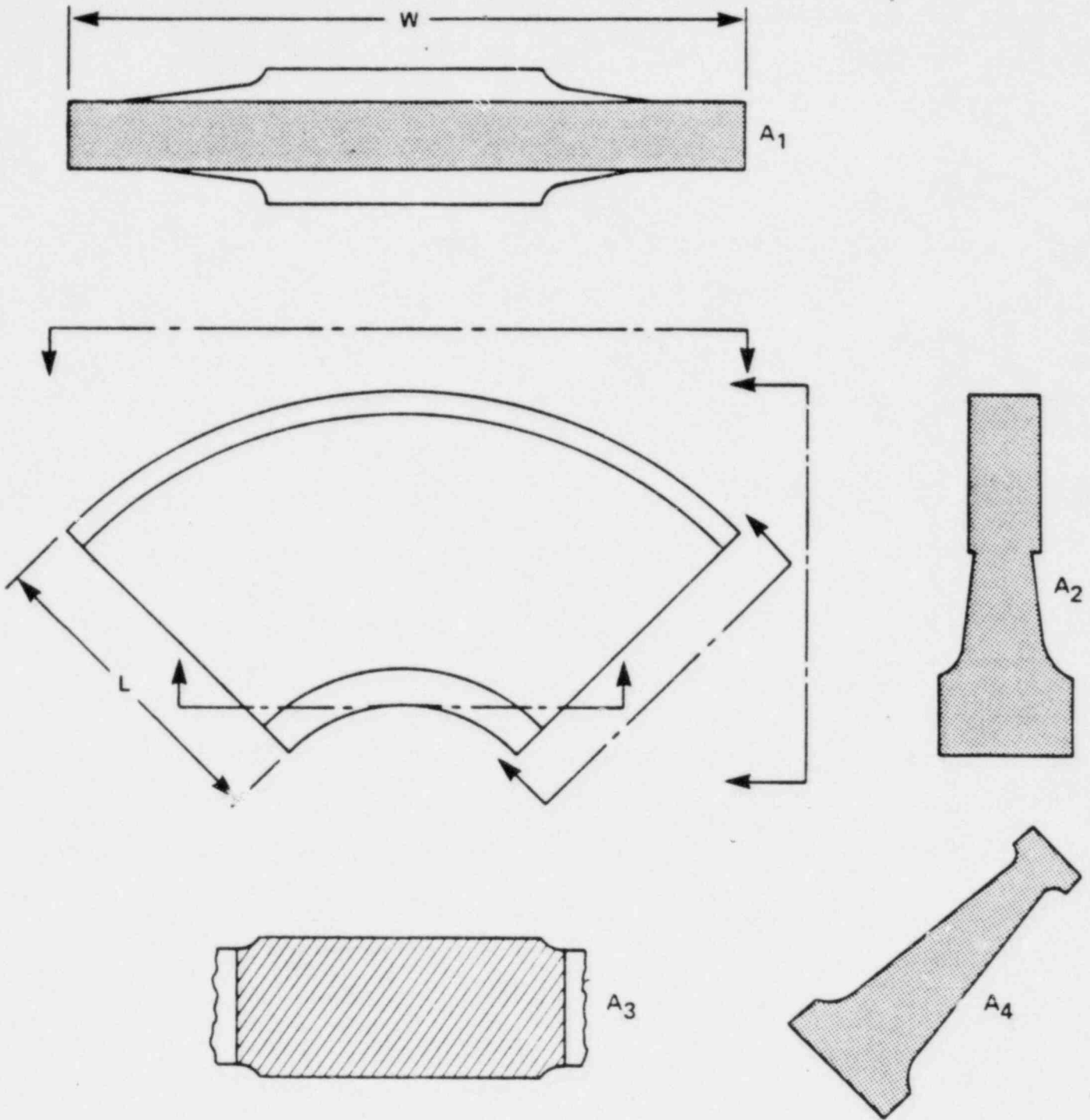


FIGURE 3
LP DISC MISSILES (See tables 1 and 2)

TABLE 1A (LP-1)
 DIMENSIONS AND IMPACT AREAS FOR 90° LP DISC FRAGMENTS
 (REFER TO FIGURE 3)

DISC NO.	1	2	3	4	5	6
A ₁ (ft ²)	2.79	2.72	4.02	1.65	2.88	3.10
A ₂ (ft ²)	1.73	1.72	2.07	1.78	2.18	2.64
A ₃ (ft ²)	2.85	2.89	2.77	2.98	3.13	3.85
A ₄ (ft ²)	1.02	0.99	1.21	1.32	1.56	1.92
W (ft)	6.08	6.08	6.08	6.08	5.88	5.32
L (ft)	2.63	2.72	2.80	2.88	2.83	2.51

TABLE 2A (LP-1)
 DIMENSIONS AND IMPACT AREAS FOR 120° LP DISC FRAGMENTS
 (REFER TO FIGURE 3)

DISC No.	1	2	3	4	5	6
A ₁ (ft ²)	3.41	3.34	4.93	2.02	3.53	3.80
A ₂ (ft ²)	2.16	2.19	2.68	2.11	2.53	3.06
A ₃ (ft ²)	3.98	3.94	3.86	4.21	4.49	5.65
A ₄ (ft ²)	1.02	0.99	1.21	1.32	1.56	1.92
W (ft)	7.45	7.45	7.45	7.44	7.20	6.52
L (ft)	2.63	2.72	2.80	2.88	2.83	2.51

TABLE 1B (LP-2)

DIMENSIONS AND IMPACT AREAS FOR 90° LP DISC FRAGMENTS

(REFER TO FIGURE 3)

DISC NO.	1	2	3	4	5	6
A ₁ (ft ²)	2.92	2.85	4.02	1.66	2.66	3.10
A ₂ (ft ²)	1.74	1.75	2.06	1.80	2.13	2.64
A ₃ (ft ²)	2.84	2.88	2.77	3.02	3.14	3.85
A ₄ (ft ²)	1.01	1.01	1.20	1.33	1.55	1.92
W (ft)	6.08	6.08	6.08	6.08	5.88	5.32
L (ft)	2.63	2.71	2.80	2.88	2.82	2.51

TABLE 2B (LP-2)

DIMENSIONS AND IMPACT AREAS FOR 120° LP DISC FRAGMENTS

(REFER TO FIGURE 3)

DISC No.	1	2	3	4	5	6
A ₁ (ft ²)	3.57	3.49	4.92	2.03	3.25	3.80
A ₂ (ft ²)	2.18	2.23	2.67	2.12	2.47	3.06
A ₃ (ft ²)	3.97	3.96	3.86	4.25	4.50	5.65
A ₄ (ft ²)	1.01	1.01	1.20	1.33	1.55	1.92
W (ft)	7.44	7.44	7.44	7.44	7.20	6.52
L (ft)	2.63	2.71	2.80	2.88	2.82	2.51

TABLE 1C (LP-3)
 DIMENSIONS AND IMPACT AREAS FOR 90° LP DISC FRAGMENTS
 (REFER TO FIGURE 3)

DISC NO.	1	2	3	4	5	6
A ₁ (ft ²)	3.10	2.72	4.02	1.65	2.88	3.10
A ₂ (ft ²)	1.78	1.72	2.07	1.78	2.18	2.64
A ₃ (ft ²)	2.85	2.89	2.77	2.98	3.13	3.85
A ₄ (ft ²)	1.02	0.99	1.21	1.32	1.56	1.92
W (ft)	6.08	6.08	6.08	6.08	5.88	5.32
L (ft)	2.63	2.72	2.80	2.88	2.83	2.51

TABLE 2C (LP-3)
 DIMENSIONS AND IMPACT AREAS FOR 120° LP DISC FRAGMENTS
 (REFER TO FIGURE 3)

DISC No.	1	2	3	4	5	6
A ₁ (ft ²)	3.80	3.34	4.93	2.02	3.53	3.80
A ₂ (ft ²)	2.25	2.19	2.68	2.11	2.53	3.06
A ₃ (ft ²)	3.98	3.94	3.86	4.21	4.49	5.65
A ₄ (ft ²)	1.02	0.99	1.21	1.32	1.56	1.92
W (ft)	7.45	7.45	7.45	7.44	7.20	6.52
L (ft)	2.63	2.72	2.80	2.88	2.83	2.51

3.3.4

The ejection angles of the disc missiles are given by the following guidelines (refer to Figure 4):

- o Discs 1, 2, 3, 4 and 5: ± 5 degrees measured from the vertical radial plane passing through the disc.

- o Disc 6: 5 degrees to 25 degrees measured from the vertical radial plane passing through the disc. Fragments from this disc will eject only towards the cylinder end wall.

3.3.5

Blade ring and cylinder exiting fragments vary significantly in shape. Fragments of equivalent area are reported rather than furnishing separate tables and sketches for the numerous possible configurations (refer to Figure 5). LP turbine cylinder and blade ring fragment equivalent areas are tabulated in TABLE 3.

ANALYSIS RESULTS

This section gives the weights, velocities, and translational kinetic energy for the potential LP missiles described in this report. The data for this section is presented in tabular form and it applies to LP No. 1, LP No. 2, and LP No. 3; the following is a breakdown of these tables:

- o Internal Missile Properties are given in TABLE 4, and,
- o Exit Missile Properties are given in TABLES 5 through 10, and

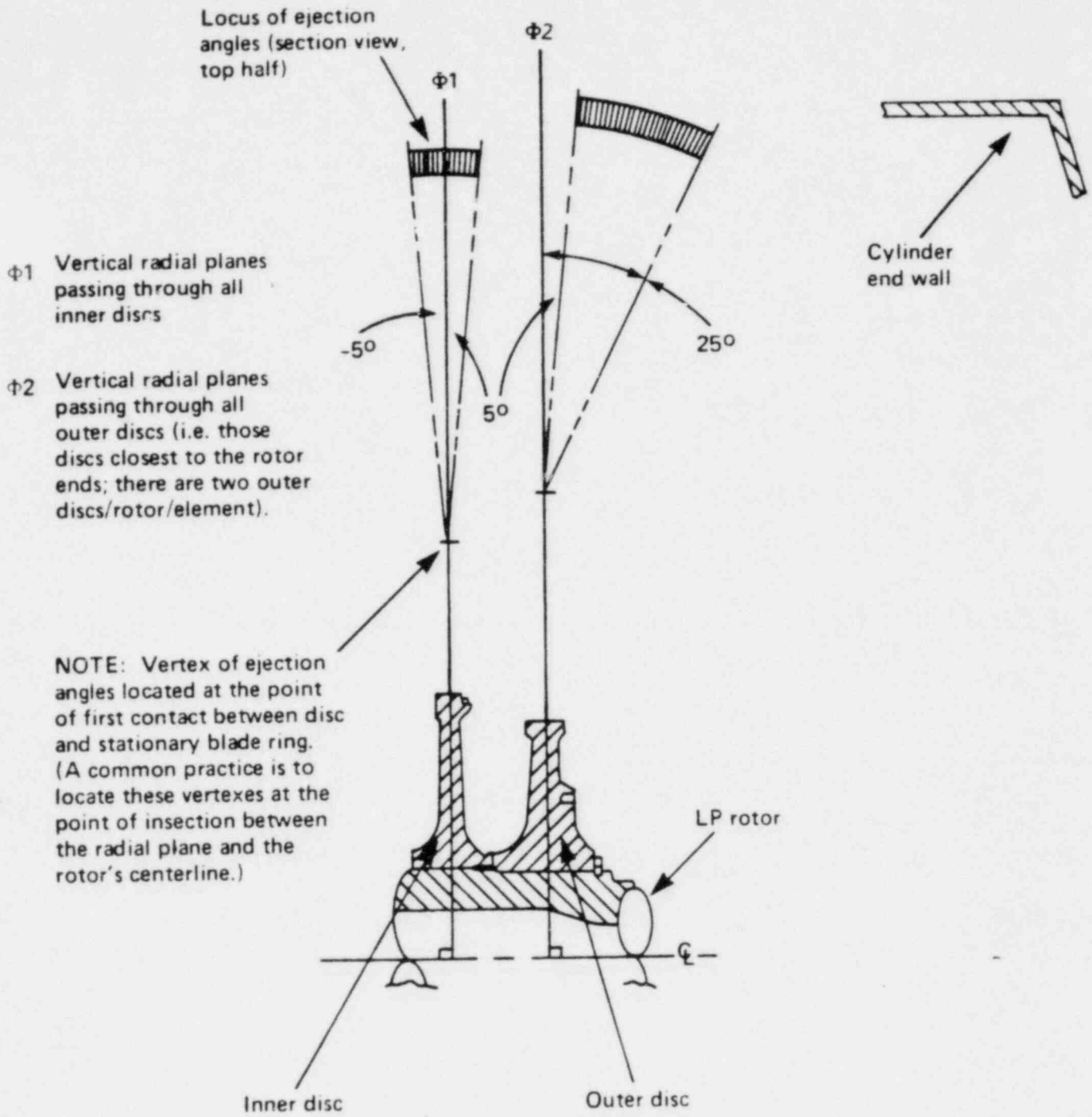


FIGURE 4
EJECTION ANGLES FOR LP MISSILES

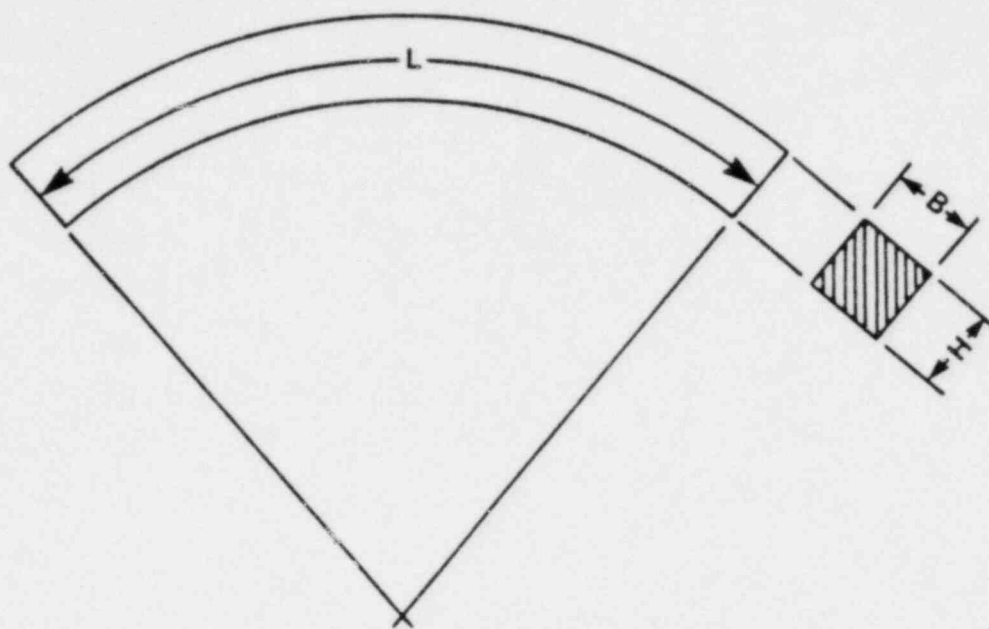


FIGURE 5
LP CYLINDER & BLADE RING FRAGMENTS

TABLE 3A (LP-1)
 LP CYLINDER AND BLADE RING FRAGMENT DIMENSIONS
 (REFER TO FIGURE 5)

<u>FRAGMENT NUMBER</u>	<u>L (in) 90° SEGMENT</u>	<u>L (in) 120° SEGMENT</u>	<u>B (in)</u>	<u>H (in)</u>	<u>NOTES</u>
1.1*	90.0	120.0	8.9	11.3	(c)
1.2	109.0	145.0	9.0	7.3	(c)
1.3	39.2	52.2	3.9	4.5	(c)
2.1	99.7	134.9	10.1	10.0	
2.2	38.4	51.2	3.7	7.0	
3.1	92.5	124.3	12.1	9.6	
3.2	35.6	47.6	3.4	2.8	
4.1	83.3	111.1	4.3	3.0	
4.2	85.5	114.0	9.4	3.1	
5.1	80.0	106.0	5.0	3.1	
6.1	73.8	98.5	5.7	3.4	
6.2	73.8	98.5	13.3	3.8	

*Except as indicated by the following notes, dimensions apply to 100% and 120% speed and destructive overspeed.

- (a) 100% speed
- (b) Design overspeed
- (c) Destructive overspeed

TABLE 3B (LP-2)
 LP CYLINDER AND BLADE RING FRAGMENT DIMENSIONS
 (REFER TO FIGURE 5)

<u>FRAGMENT</u> <u>NUMBER</u>	<u>L (in)</u> <u>90° SEGMENT</u>	<u>L (in)</u> <u>120° SEGMENT</u>	<u>B (in)</u>	<u>H (in)</u>	<u>NOTES</u>
1.1*	90.0	120.0	8.9	11.3	(c)
1.2	109.0	145.0	9.0	7.3	(c)
1.3	39.2	52.2	3.9	4.5	(c)
2.1	99.7	134.9	10.1	10.0	
2.2	38.4	51.2	3.7	7.0	
3.1	92.5	124.3	12.1	9.6	
3.2	35.6	47.6	3.4	2.8	
4.1	83.3	111.1	4.3	3.0	
4.2	85.5	114.0	9.4	3.1	
5.1	80.0	106.0	5.0	3.1	
6.1	73.8	98.5	5.7	3.4	
6.2	73.8	98.5	13.3	3.8	

*Except as indicated by the following notes, dimensions apply to 100% and 120% speed and destructive overspeed.

- (a) 100% speed
- (b) Design overspeed
- (c) Destructive overspeed

TABLE 3C (LP-3)
 LP CYLINDER AND BLADE RING FRAGMENT DIMENSIONS
 (REFER TO FIGURE 5)

<u>FRAGMENT</u> <u>NUMBER</u>	<u>L (in)</u> <u>90° SEGMENT</u>	<u>L (in)</u> <u>120° SEGMENT</u>	<u>B (in)</u>	<u>H (in)</u>	<u>NOTES</u>
1.1*	89.7	119.6	9.0	11.4	(c)
1.2	109.0	145.0	9.0	7.3	(c)
1.3	39.2	52.2	3.9	4.5	(c)
2.1	99.8	135.1	9.6	10.2	
2.2	38.0	50.6	3.6	7.0	
3.1	92.8	124.8	12.1	9.5	
3.2	35.6	47.6	3.4	2.8	
4.1	83.3	111.1	4.3	3.0	
4.2	85.5	114.0	9.4	3.1	
5.1	80.0	106.0	5.0	3.1	
6.1	73.8	98.5	5.7	3.4	
6.2	73.8	98.5	13.3	3.8	

*Except as indicated by the following notes, dimensions apply to 100% and 120% speed and destructive overspeed.

- (a) 100% speed
- (b) Design overspeed
- (c) Destructive overspeed

TABLE 4A (LP-1)

INTERNAL DISC SEGMENT PROPERTIES FOR LP DISCS 1 THROUGH 6

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC SEGMENT</u>							
DISC No. 1	2070	526	8.88	636	13.00	1056	35.86
DISC No. 2	2115	539	9.54	652	13.97	1084	38.60
DISC No. 3	2625	566	13.04	684	19.08	1138	52.77
DISC No. 4	2845	541	12.95	655	18.97	1091	52.56
DISC No. 5	3295	542	15.06	656	22.05	1092	61.00
DISC No. 6	3800	529	16.50	639	24.12	-	-
DISC No. 6*	3530	-	-	-	-	955	49.97
<u>120° DISC SEGMENT</u>							
DISC No. 1	2760	463	9.18	556	13.23	897	34.50
DISC No. 2	2820	474	9.84	569	14.18	919	36.98
DISC No. 3	3500	497	13.44	597	19.35	964	50.47
DISC No. 4	3795	475	13.30	570	19.16	921	49.96
DISC No. 5	4395	477	15.52	572	22.34	924	58.28
DISC No. 6	5065	468	17.19	561	24.76	-	-
DISC No. 6*	4705	-	-	-	-	817	48.72

*Weight change due to loss of blades prior to reaching destructive overspeed.

TABLE 4B (LP-2)

INTERNAL DISC SEGMENT PROPERTIES FOR LP DISCS 1 THROUGH 6

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC SEGMENT</u>							
DISC No. 1	2070	527	8.91	637	13.04	1059	35.98
DISC No. 2	2135	538	9.60	651	14.05	1082	38.82
DISC No. 3	2705	571	13.68	691	20.03	1149	55.43
DISC No. 4	2795	535	12.41	647	18.18	1078	50.38
DISC No. 5	3295	542	15.06	656	22.05	1092	61.00
DISC No. 6	3800	529	16.50	639	24.12	-	-
DISC No. 6*	3530	-	-	-	-	955	49.97
<u>120° DISC SEGMENT</u>							
DISC No. 1	2760	464	9.22	557	13.28	899	34.62
DISC No. 2	2850	473	9.90	568	14.26	917	37.19
DISC No. 3	3605	502	14.08	602	20.28	972	52.89
DISC No. 4	3725	470	12.75	563	18.36	910	47.89
DISC No. 5	4395	477	15.52	572	22.34	924	58.28
DISC No. 6	5065	468	17.19	561	24.76	-	-
DISC No. 6*	4705	-	-	-	-	817	48.72

*Weight change due to loss of blades prior to reaching destructive overspeed.

TABLE 4C (LP-3)

INTERNAL DISC SEGMENT PROPERTIES FOR LP DISCS 1 THROUGH 6

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC SEGMENT</u>							
DISC No. 1	2085	529	9.06	640	13.26	1063	36.58
DISC No. 2	2115	539	9.54	652	13.97	1084	38.60
DISC No. 3	2625	566	13.04	684	19.08	1138	52.77
DISC No. 4	2845	541	12.95	655	18.97	1091	52.56
DISC No. 5	3295	542	15.06	656	22.05	1092	61.00
DISC No. 6	3800	529	16.50	639	24.12	-	-
DISC No. 6*	3530	-	-	-	-	955	49.97
<u>120° DISC SEGMENT</u>							
DISC No. 1	2780	466	9.36	559	13.49	903	35.18
DISC No. 2	2820	474	9.84	569	14.18	919	36.98
DISC No. 3	3500	497	13.44	597	19.35	964	50.47
DISC No. 4	3795	475	13.30	570	19.15	921	49.96
DISC No. 5	4395	477	15.52	572	22.34	924	58.28
DISC No. 6	5065	468	17.19	561	24.76	-	-
DISC No. 6*	4705	-	-	-	-	817	48.72

*Weight change due to loss of blades prior to reaching destructive overspeed.

TABLE 5A (LP-1)
EXIT MISSILE PROPERTIES FOR NO. 1 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 1	2070	Contained		Contained		147	0.69
FRAGMENT No. 1.1	2560	Contained		Contained		147	0.86
FRAGMENT No. 1.2	2025	Contained		Contained		147	0.68
FRAGMENT No. 1.3	195	Contained		Contained		*	*
<u>120° DISC BURST</u>							
DISC No. 1	2760	Contained		Contained		81	0.28
FRAGMENT 1.1	3415	Contained		Contained		81	0.34
FRAGMENT 1.2	2700	Contained		Contained		81	0.27
FRAGMENT 1.3	260	Contained		Contained		*	*

*Exit missile energies of less than 100,000 ft-lb are not reported.

TABLE 5B (LP-2)
EXIT MISSILE PROPERTIES FOR NO. 1 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 1	2070	Contained		Contained		147	0.69
FRAGMENT No. 1.1	2560	Contained		Contained		147	0.86
FRAGMENT No. 1.2	2025	Contained		Contained		147	0.68
FRAGMENT No. 1.3	195	Contained		Contained		*	*
<u>120° DISC BURST</u>							
DISC No. 1	2760	Contained		Contained		81	0.28
FRAGMENT 1.1	3415	Contained		Contained		81	0.34
FRAGMENT 1.2	2700	Contained		Contained		81	0.27
FRAGMENT 1.3	260	Contained		Contained		*	*

*Exit missile energies of less than 100,000 ft-lb are not reported.

TABLE 5C (LP-3)

EXIT MISSILE PROPERTIES FOR NO. 1 LP DISC AND FRAGMENTS

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 1	2085	Contained		Contained		150	0.73
FRAGMENT No. 1.1	2605	Contained		Contained		150	0.92
FRAGMENT No. 1.2	2025	Contained		Contained		150	0.71
FRAGMENT No. 1.3	150	Contained		Contained		*	*
<u>120° DISC BURST</u>							
DISC No. 1	2780	Contained		Contained		83	0.30
FRAGMENT 1.1	3475	Contained		Contained		83	0.37
FRAGMENT 1.2	2700	Contained		Contained		83	0.29
FRAGMENT 1.3	200	Contained		Contained		*	*

*Exit missile energies of less than 100,000 ft-lb are not reported.

TABLE 6A (LP-1)
EXIT MISSILE PROPERTIES FOR NO. 2 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 2	2115	130	0.56	183	1.11	356	4.16
FRAGMENT No. 2.1	2850	130	0.75	183	1.49	356	5.61
FRAGMENT No. 2.2	280	*	*	*	*	257	0.29
<u>120° DISC BURST</u>							
DISC No. 2	2820	91	0.37	143	0.89	289	3.67
FRAGMENT No. 2.1	3855	91	0.50	143	1.22	289	5.02
FRAGMENT No. 2.2	375	*	*	*	*	223	0.29

*Exit missile energies of less than 100,000 ft-lb are not reported.

TABLE 6B (LP-2)
EXIT MISSILE PROPERTIES FOR NO. 2 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 2	2135	132	0.57	185	1.13	358	4.25
FRAGMENT No. 2.1	2850	132	0.77	185	1.51	358	5.67
FRAGMENT No. 2.2	280	*	*	*	*	258	0.29
<u>120° DISC BURST</u>							
DISC No. 2	2850	93	0.38	144	0.92	291	3.75
FRAGMENT No. 2.1	3855	93	0.52	144	1.25	291	5.07
FRAGMENT No. 2.2	375	*	*	*	*	224	0.29

*Exit missile energies of less than 100,000 ft-lb are not reported.

TABLE 6C (LP-3)

EXIT MISSILE PROPERTIES FOR NO. 2 LP DISC AND FRAGMENTS

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 2	2115	133	0.58	187	1.15	362	4.30
FRAGMENT No. 2.1	2765	133	0.76	187	1.50	362	5.62
FRAGMENT No. 2.2	270	*	*	*	*	264	0.29
<u>120° DISC BURST</u>							
DISC No. 2	2820	94	0.39	146	0.94	294	3.79
FRAGMENT No. 2.1	3745	94	0.52	146	1.25	294	5.03
FRAGMENT No. 2.2	360	*	*	*	*	229	0.29

*Exit missile energies of less than 100,000 ft-lb are not reported.

TABLE 7A (LP-1)
EXIT MISSILE PROPERTIES FOR NO. 3 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		<u>VELOCITY</u> (ft/sec)	<u>ENERGY</u> (10 ⁶ ft-lb)	<u>VELOCITY</u> (ft/sec)	<u>ENERGY</u> (10 ⁶ ft-lb)	<u>VELOCITY</u> (ft/sec)	<u>ENERGY</u> 10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 3	2625	183	1.36	234	2.22	420	7.20
FRAGMENT No. 3.1	3040	183	1.58	234	2.58	420	8.34
FRAGMENT No. 3.2	95	*	*	*	*	399	0.24
<u>120° DISC BURST</u>							
DISC No. 3	3500	150	1.22	194	2.05	348	6.59
FRAGMENT No. 3.1	4085	150	1.42	194	2.39	348	7.70
FRAGMENT No. 3.2	130	*	*	*	*	334	0.22

*Exit missile energies of less than 100,000 ft-lb are not reported

TABLE 7B (LP-2)

EXIT MISSILE PROPERTIES FOR NO. 3 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 3	2705	190	1.52	242	2.46	433	7.88
FRAGMENT No. 3.1	3040	190	1.71	242	2.77	433	8.87
FRAGMENT No. 3.2	95	*	*	*	*	411	0.25
<u>120° DISC BURST</u>							
DISC No. 3	3605	157	1.37	202	2.27	359	7.22
FRAGMENT No. 3.1	4085	157	1.56	202	2.58	359	8.19
FRAGMENT No. 3.2	130	*	*	*	*	345	0.24

*Exit missile energies of less than 100,000 ft-lb are not reported

TABLE 7C (LP-3)
EXIT MISSILE PROPERTIES FOR NO. 3 LP DISC AND FRAGMENTS

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 3	2625	182	1.35	233	2.21	421	7.21
FRAGMENT No. 3.1	3020	182	1.55	233	2.55	421	8.30
FRAGMENT No. 3.2	95	*	*	*	*	396	0.23
<u>120° DISC BURST</u>							
DISC No. 3	3500	149	1.21	194	2.05	349	6.62
FRAGMENT No. 3.1	4060	149	1.40	194	2.37	349	7.68
FRAGMENT No. 3.2	130	*	*	*	*	332	0.22

*Exit missile energies of less than 100,000 ft-lb are not reported

TABLE 8A (LP-1)

EXIT MISSILE PROPERTIES FOR NO. 4 LP DISC AND FRAGMENTS

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 4	2845	321	4.55	408	7.35	722	23.01
FRAGMENT No. 4.1	305	321	0.49	408	0.79	722	2.47
FRAGMENT No. 4.2	705	232	0.59	294	0.95	521	2.97
<u>120° DISC BURST</u>							
DISC No. 4	3795	250	3.68	321	6.06	562	18.61
FRAGMENT No. 4.1	405	250	0.39	321	0.65	562	1.99
FRAGMENT No. 4.2	940	196	0.56	252	0.93	441	2.84

TABLE 8B (LP-2)
EXIT MISSILE PROPERTIES FOR NO. 4 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 4	2795	313	4.24	399	6.90	708	21.73
FRAGMENT No. 4.1	305	313	0.46	399	0.75	708	2.37
FRAGMENT No. 4.2	705	226	0.56	288	0.91	512	2.86
<u>120° DISC BURST</u>							
DISC No. 4	3725	243	3.41	313	5.66	550	17.52
FRAGMENT No. 4.1	405	243	0.37	313	0.62	550	1.91
FRAGMENT No. 4.2	940	191	0.53	246	0.88	433	2.73

TABLE 8C (LP-3)
EXIT MISSILE PROPERTIES FOR NO. 4 LP DISC AND FRAGMENTS

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 4	2845	321	4.55	408	7.35	722	23.01
FRAGMENT No. 4.1	305	321	0.49	408	0.79	722	2.47
FRAGMENT No. 4.2	705	232	0.59	294	0.95	521	2.97
<u>120° DISC BURST</u>							
DISC No. 4	3795	250	3.68	321	6.06	562	18.61
FRAGMENT No. 4.1	405	250	0.39	321	0.65	562	1.99
FRAGMENT No. 4.2	940	196	0.56	252	0.93	441	2.84

TABLE 9A (LP-1)
EXIT MISSILE PROPERTIES FOR NO. 5 LP DISC AND FRAGMENTS

WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)

90° DISC BURST

DISC No. 5	3295	379	7.35	469	11.26	803	33.03
FRAGMENT No. 5.1	350	379	0.78	469	1.19	803	3.50

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120° DISC BURST

DISC No. 5	4395	326	7.23	402	11.03	674	31.00
FRAGMENT No. 5.1	465	326	0.77	402	1.17	674	3.29

TABLE 9B (LP-2)
 EXIT MISSILE PROPERTIES FOR NO. 5 LP DISC AND FRAGMENTS

WEIGHT	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
	VELOCITY	ENERGY	VELOCITY	ENERGY	VELOCITY	ENERGY
(lb)	(ft/sec)	(10 ⁶ ft-lb)	(ft/sec)	(10 ⁶ ft-lb)	(ft/sec)	(10 ⁶ ft-lb)

90° DISC BURST

DISC No. 5	3295	379	7.35	469	11.26	803	33.03
FRAGMENT No. 5.1	350	379	0.78	469	1.19	803	3.50

120° DISC BURST

DISC No. 5	4395	326	7.23	402	11.03	674	31.00
FRAGMENT No. 5.1	465	326	0.77	402	1.17	674	3.29

TABLE 9C (LP-3)
EXIT MISSILE PROPERTIES FOR NO. 5 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 5	3295	379	7.35	469	11.26	803	33.03
FRAGMENT No. 5.1	350	379	0.78	469	1.19	803	3.50
<u>120° DISC BURST</u>							
DISC No. 5	4395	326	7.23	402	11.03	674	31.00
FRAGMENT No. 5.1	465	326	0.77	402	1.17	674	3.29

TABLE 10A (LP-1)
EXIT MISSILE PROPERTIES FOR NO. 6 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 6	3800	418	10.28	511	15.40	-	-
DISC No. 6*	3530	-	-	-	-	783	33.61
FRAGMENT No. 6.1	405	418	1.09	511	1.64	783	3.85
FRAGMENT No. 6.2	1055	183	0.55	223	0.82	343	1.93
<u>120° DISC BURST</u>							
DISC No. 6	5065	360	10.20	439	15.15	-	-
DISC No. 6*	4705	-	-	-	-	659	31.69
FRAGMENT No. 6.1	540	360	1.09	439	1.61	659	3.63
FRAGMENT No. 6.2	1410	192	0.81	234	1.20	352	2.71

*Weight change due to loss of blades prior to reaching destructive overspeed.

TABLE 10B (LP-2)
EXIT MISSILE PROPERTIES FOR NO. 6 LP DISC AND FRAGMENTS

	WEIGHT (lb)	<u>100% SPEED</u>		<u>120% SPEED</u>		<u>DESTRUCTIVE OVERSPEED</u>	
		<u>VELOCITY</u> (ft/sec)	<u>ENERGY</u> (10 ⁶ ft-lb)	<u>VELOCITY</u> (ft/sec)	<u>ENERGY</u> (10 ⁶ ft-lb)	<u>VELOCITY</u> (ft/sec)	<u>ENERGY</u> (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 6	3800	418	10.28	511	15.40	-	-
DISC No. 6*	3530	-	-	-	-	783	33.61
FRAGMENT No. 6.1	405	418	1.09	511	1.64	783	3.85
FRAGMENT No. 6.2	1055	183	0.55	223	0.82	343	1.93
<u>120° DISC BURST</u>							
DISC No. 6	5065	360	10.20	439	15.15	-	-
DISC No. 6*	4705	-	-	-	-	659	31.69
FRAGMENT No. 6.1	540	360	1.09	439	1.61	659	3.63
FRAGMENT No. 6.2	1410	192	0.81	234	1.20	352	2.71

*Weight change due to loss of blades prior to reaching destructive overspeed.

TABLE 10C (LP-3)
EXIT MISSILE PROPERTIES FOR NO. 6 LP DISC AND FRAGMENTS

	WEIGHT (lb)	100% SPEED		120% SPEED		DESTRUCTIVE OVERSPEED	
		VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)	VELOCITY (ft/sec)	ENERGY (10 ⁶ ft-lb)
<u>90° DISC BURST</u>							
DISC No. 6	3800	418	10.28	511	15.40	-	-
DISC No. 6*	3530	-	-	-	-	783	33.61
FRAGMENT No. 6.1	405	418	1.09	511	1.64	783	3.85
FRAGMENT No. 6.2	1055	183	0.55	223	0.82	343	1.93
<u>120° DISC BURST</u>							
DISC No. 6	5065	360	10.20	439	15.15	-	-
DISC No. 6*	4705	-	-	-	-	659	31.69
FRAGMENT No. 6.1	540	360	1.09	439	1.61	659	3.63
FRAGMENT No. 6.2	1410	192	0.81	234	1.20	352	2.71

*Weight change due to loss of blades prior to reaching destructive overspeed.