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FRAGMENTATION OF COMPLETE SULLPUP GUIDED MISSILES XASM-N-7 CONTAINING 260 LB. FRAGMENTATION BOMBS AN-M81 AS WARHEADS

FC
BAC

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

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U. S. Naval Proving Ground
Dahlgren, Virginia

Fragmentation of Complete BULLPUP Guided Missiles XASM-N-7 Containing 260 lb. Fragmentation Bombs AN-M81 as Warheads

by

F. D. Portner, Jr.
Warhead and Terminal Ballistics Laboratory

NPG REPORT NO. 1536

6 May 1957

APPROVED: G. H. WALES
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Ordnance Officer
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CONTENTS

ABSTRACT

Two BULLPUP Missiles XASM-N-7, with empty rocket motors and containing 260 lb. fragmentation bombs AN-M81 as warheads, were statically detonated in a 40 ft. - 60 ft. radius field arena for the determination of fragmentation pattern, mass distribution and associated fragment velocities to aid in the study of hazard to launching aircraft.

The second of the two missiles produced a low order detonation. The following is a summary of the results obtained from the high order detonation of the first missile:

a. The missile propulsion section, including wings, was blown to the rear, essentially intact, at a velocity less than 100 ft/sec.

b. The missile warhead section produced a well defined fragment beam spray similar to that which would be expected to be obtained from the bomb when not encased in the missile.

c. Approximately 40 large fragments, ranging in weight up to 2877 grams and in area up to 100 square inches, from the forward (guidance) section of the missile were recovered on the ground within the arena area.

d. The approximate weights of fragments and maximum fragment velocities recorded over a 40 ft. baseline were as follows:

	Fragments			
	Maximum Velocity	Weight (gms.)		
Polar Angle Zone	(ft/sec)	Spread	Average	Number
0° - 45°	- *	0.9 - 2877.0	213	54
45° - 90°	2640	0.5 - 557.6	54	35
90° - 135°	3350	0.5 - 125.6	28	69
135° - 180°	- *	18.4 - 43525.0	6250	7

*Fragment velocities in these polar angle zones were so low that no flash was produced by impact with the arena plates. As a result, accurate fragment velocities could not be computed.

FOREWORD

This is a partial report on BUAER Project TED-ADC-AR-46002 and the final report on the static detonation phase of the project requested by reference (a).

The purpose of this test was to obtain data on the fragmentation pattern, mass distribution and associated fragment velocities for the BULLPUP Guided Missile XASM-N-7.

This report was reviewed by:

F. W. KASDORF, Head, Technical Evaluation Division
Warhead and Terminal Ballistics Laboratory
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Warhead and Terminal Ballistics Laboratory
R. H. LYDDANE, Director
Warhead and Terminal Ballistics Laboratory

INTRODUCTION

Two BULLPUP Guided Missiles XASM-N-7 with empty rocket motors and containing 260 lb. fragmentation bombs as warheads have been statically detonated to obtain data for use in studies of the kill probability and for establishing minimum safe arming distance to prevent hazard to a launching aircraft in case of a premature missile-warhead detonation. Data were obtained on the fragmentation pattern, fragment mass distribution and fragment velocities for the missile-warhead combination.

DESCRIPTION OF MATERIAL

The BULLPUP missile XASM-N-7 as described in reference (b) and shown in Figure 1 is primarily a monocoque aluminum cylinder with frames located only at points of load concentration. The fuselage, or body, is divided into three major units: the guidance-control, warhead, and propulsion sections. The exterior sections are made of spot-welded formed aluminum skin, with the exception of the rocket motor case which is a welded steel pressure-vessel. The wing panels are made from solid extruded aluminum sections, the integral wing root fitting being machined, notched and drilled to permit attachment of the wing to the missile body.

Any of three standard 250 lb. bombs, the AN-M81 fragmentation, the Mk 81 Mod 0 low drag, or the AN-M57 general purpose, can be carried in the BULLPUP missile. The AN-M81 bomb, Ordnance Department Drawing No. 82-3-434, was used in this test. The outer wall of this bomb is composed of a 1 in. square spring steel helically-wound around a 1/4 in. thick steel inner liner tube. A more detailed description of the BULLPUP missile can be found in reference (b).

The two missiles used were environmental units received from the Glen L. Martin Company and were complete in all respects except for propulsion sections. In order to simulate a missile after burn out, they were assembled with

empty rocket motor cases (missile No. 0032 had an actual burned out motor whereas the motor case of missile No. 0031 was an empty new case) and burned out tracking flares. The total weight of each of the missiles as prepared for detonation was approximately 440 lbs., its length 10 ft. 6 in., and its diameter 12 in.

PROCEDURE

Each assembled missile was supported with its longitudinal axis horizontal, on a stand 11 ft. 6 in. high. The missile was oriented so that the nose pointed toward 0° and the base toward 180° in the arena shown in Figure 2. The polar zones subtended by the arena plates and the approximate fields of view of the cameras used are also indicated in Figure 2. Each missile warhead (AN-M81 bomb) was initiated by an AN-M103 A1 nose fuze which had been modified to permit static detonation. The modified nose fuze was initiated with a Hercules U. S. Special Blasting Cap. The reliability of this system of fuzing has been established in previous Naval Proving Ground field tests.

Fragment velocities were obtained by photographing the detonation and subsequent fragment impacts on the arena plates with high speed cameras.

Space distribution of the fragments was determined by counting the warhead and missile component penetrations of the arena plates and by plotting the missile components recovered on the ground in and around the arena.

Fragment mass distribution was determined by recovery of sample groups of fragments from each of seven celotex recovery packs placed about the arena circumference and by recovery of those larger fragments falling upon the ground in or near the arena.

Peak blast pressures were recorded by the use of a series of six pairs of copper indenter gauges placed at ground level on a 40 ft. radius circle about the missile.

RESULTS AND DISCUSSION

Although the fuze systems of the two missiles were identical, an apparent low order detonation was produced by the second missile (missile No. 0031) as will be shown in this discussion. For this reason no attempt has been made to average the results of the two missiles.

Fragment Velocity

Detailed fragment velocity results are given in Tables 1 through 3. The warhead of missile No. 0032 produced an average median fragment velocity of 3220 ft/sec and a maximum velocity of 3350 ft/sec over a 40 ft. baseline. Camera failures resulted in loss of the fragment velocity data over a 60 ft. baseline for this missile. The propulsion section was blown to the rear at an average velocity of approximately 63 ft/sec over a 40 ft. baseline with very little breakup except for the destroyed front wall of the rocket motor case.

The warhead of missile No. 0031 produced an average median fragment velocity of 1061 ft/sec and a maximum velocity of 1490 ft/sec over a 40 ft. baseline and an average median fragment velocity of 1250 ft/sec and a maximum velocity of 1660 ft/sec over a 60 ft. baseline. The low order of this detonation and the resulting small sample size are factors which may be responsible for this anomaly in fragment velocities.

Space Distribution

Detailed space distribution data taken from the arena plates are listed in Tables 4 through 7. Figures 3 through 11 are photographs of the arena and arena plates taken before and after detonation of the missiles. Missile No. 0032 produced a well defined beam spray centered in polar zone 65° to 120° with only a small number of fragments between 0° and 65° and no recorded fragments between 120° and 180°. The actual number of fragment plate penetrations is reduced somewhat by the absence of arena plate at the seven celotex recovery pack locations about the arena circumference. The detonation of missile No. 0031

produced a weak beam spray, the majority of which consisted of large fragments, in polar zone 65° to 120°, only one recorded fragment in zone 0° - 65° and none in zone 120° - 180°. Figures 12 and 13 are diagrams showing the location of all fragments recovered from the area in and around the arena with relation to the point of detonation. These figures may be used in connection with the photographs of Figures 14 through 19 for identification and further study of the fragmentation characteristics of the missiles.

Mass Distribution

Figures 14 through 19 are photographs showing the fragments recovered from each of the seven celotex recovery packs situated about the arena as well as those recovered from the ground in and around the arena. No fragments were found in pack No. 7 directly to the rear of missile No. 0032. The effect of the low order detonation of missile No. 0031 is again apparent in the fragment sizes produced.

Appendix (H) (Figures 20 through 35) is a series of 16 sequence photographs taken from immsdiately before until 0.56 seconds after the detonation of missile No. 0032. The general pattern of dispersion of the larger missile components can be viewed in these photographs.

Pressures

The average peak blast pressure recorded at ground level 40 ft. from the point of detonation with missile No. 0032 was 2.6 psi and with missile No. 0031 was 2.7 psi. The pressure recorded by each gauge as well as the location of each gauge with relation to the missile is included in Tables 8 and 9.

SUMMARY OF RESULTS

The following is a summary of the results obtained from the static detonation of two BULLPUP missiles XASM-N-7 assembled with 260 lb. fragmentation bombs AN-M81:

Missile No. 0032

a. The propulsion section, including wings, was blown to the rear, essentially intact, at a velocity less than 100 ft/sec.

b. The warhead section produced a well defined fragment beam spray similar to that which would be expected to be obtained from the bomb when not encased in the missile.

c. Approximately 40 large fragments, ranging in weight up to 2877 grams and in area up to 100 square inches, from the forward (guidance) section of the missile, were recovered on the ground within the arena area.

d. The approximate weights of fragments and maximum fragment velocities recorded over a 40 ft. baseline were as follows:

	Fragments			
	Maximum Velocity	Weight (gms.)		
Polar Angle Zone	(ft/sec)	Spread	Average	Number
0° - 45°	- *	0.9 - 2877.0	213	54
45° - 90°	2640	0.5 - 557.6	54	35
90° - 135°	3350	0.5 - 125.6	28	69
135° - 180°	- *	18.4 - 43525.0	6250	7

*Fragment velocities in these polar angle zones were so low that no flash was produced by impact with the arena plates. As a result, accurate fragment velocities could not be computed.

Missile No. 0031

a. The low order detonation of missile No. 0031 produced a greater breakup of its tail (propulsion) section with apparently greater velocity of the broken parts, and a lesser breakup of its warhead and forward (guidance) section, than did the high order detonation of missile No. 0032.

REFERENCES

(a) BUORD Conf ltr ReW4-d-TFG:bc X11 Ser 21409 of 23 May 1956
(b) Glen L. Martin Company Conf Report ER 6460 Model XASM-N-7 Guided Missile Weapon System of 15 Nov 1955

APPENDIX A

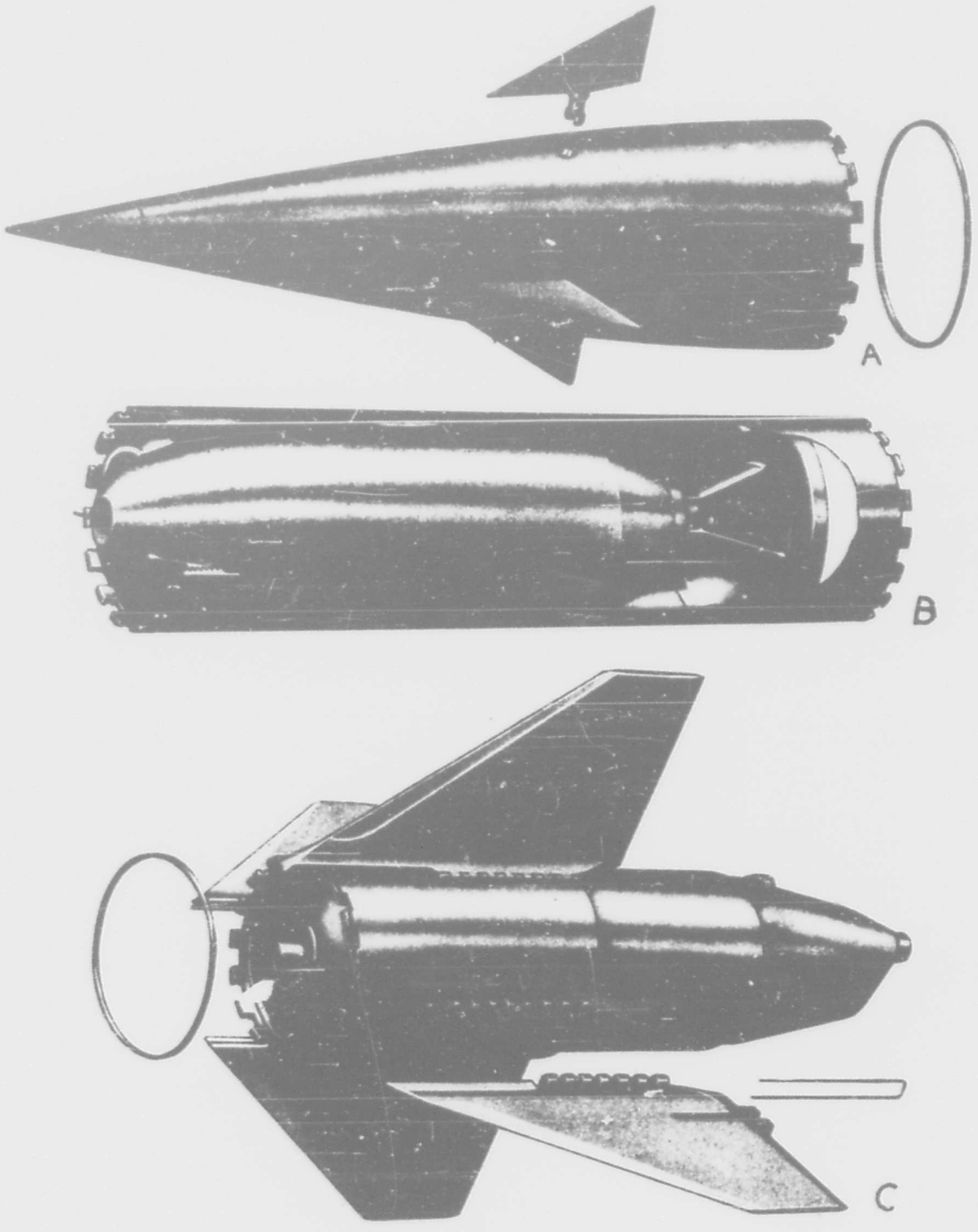

Figure 1
PHD-72539 - BULLPUP Missile XASM-N-7. Illustration showing major component breakdown and position of fragmentation bomb AN-M81 used as warhead. A: Guidance control section, B: Warhead section, C: Propulsion section.
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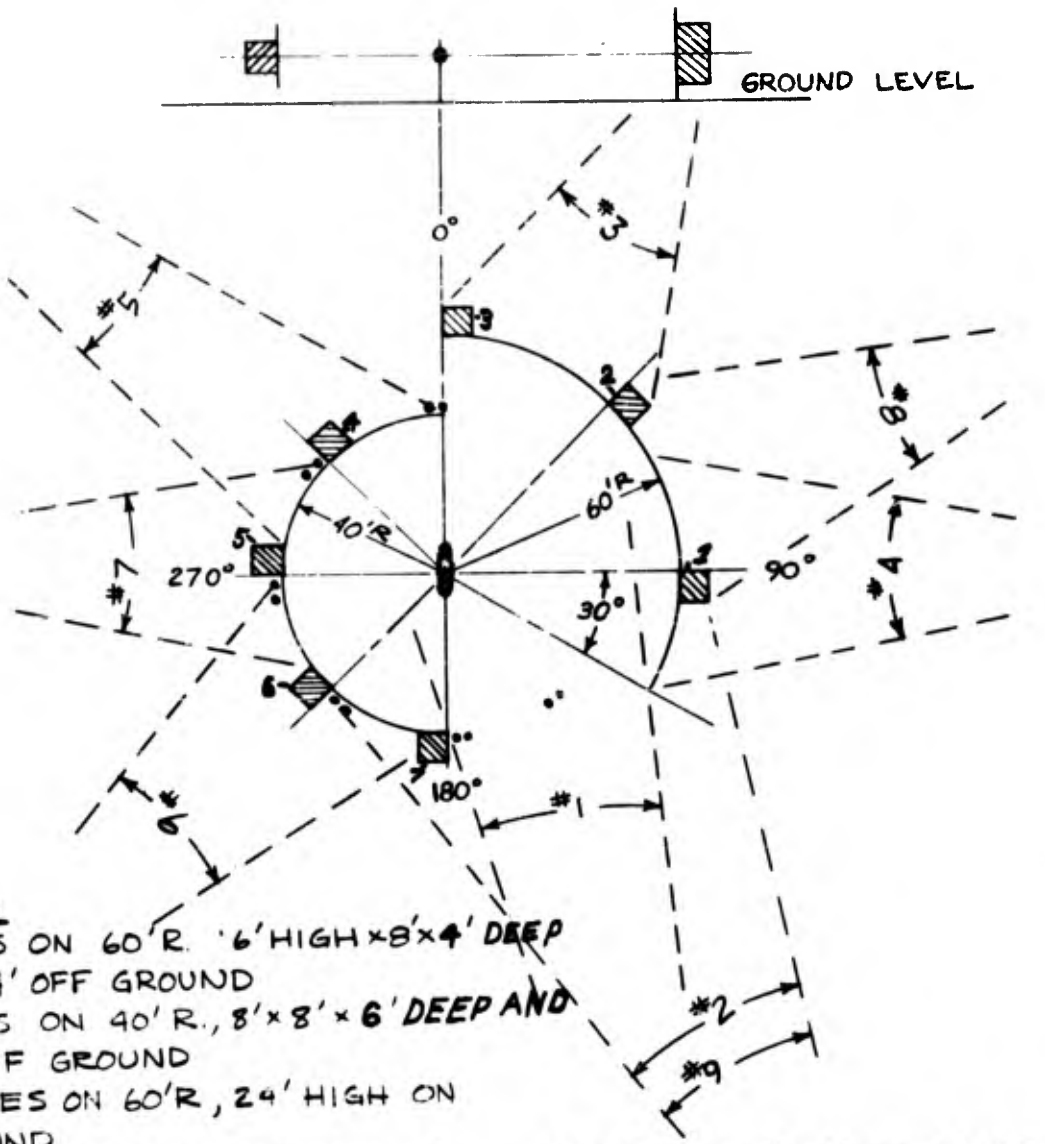
APPENDIX B

CELOTEX PACKS
INDENTER GAUGES



NOTES:

(1) PACKS ON 60'R. 6'HIGH×8'×4' DEEP AND 4' OFF GROUND
(2) PACKS ON 40'R., 8'×8'×6' DEEP AND 8' OFF GROUND
(3) PLATES ON 60'R, 24' HIGH ON GROUND
(4) PLATES ON 40'R., 16' HIGH, 4' OFF GROUND
(5) WARHEAD 12' HIGH CENTER-LINE
(6) 12 INDENTER GAUGES

CAMERA 1&2: 16MM COLOR
CAMERA 3-8: 16MM FASTAX 7000 fr./sec.
CAMERA 9 : 70 MM

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Figure 2

APPENDIX C

TABLE 1 FRAGMENT VELOCITY DATA

Date: 1-28-57
40 Ft. Radius Arena
35mm Fastax Camera No. 5
Rd. No. 1 Bullpup Assembly No. 0032

4450 Frames per second
Fuze Modified AN M103 Al Nose
Filler Comp. B
Filler Weight 34.0 lbs.
Total Weight 440 lbs.

Frames in Which Hit Occurred	Polar Angle Zone	Plate No.	No. Fragments	Location on Plates	Velocity (f/s)	Average
68	75-80	10	1	Bottom	2640	2640
82	55-60	8	1	Bottom	2190	2190
Average					2420	

TABLE 1 (Continued)

Date: 1-28-57
40 Ft. Radius Arena
16mm Fastax Camera No. 7
Rd. No. 1 Bullpup Assembly No. 0032

6200 Frames per second
Fuze Modified AN M103 Al Nose
Filler Comp. B
Filler Weight 34.0 lbs.
Total Weight 440 lbs.

Frames in Which Hit Occurred	Polar Angle Zone	Plate No.	No. Fragments	Location on Plate	Total Hits	Velocity (f/s)	Average
74	92-95	11	2	Center	2	3350	3350
75	92-95	11	3	Center		3310	
	92-95	11	2	Bottom		3340	
	95-100	11	2	Center	7	3310	3320
76	92-95	11	1	Top		3290	
	92-95	11	1	Center		3260	
	92-95	11	2	Bottom		3290	
	95-100	11	2	Center		3260	
	115-120	14	1	Center	7	3260	3270
77	92-95	11	1	Top	1	3250	3250
78	92-95	11	1	Top		3210	
	95-100	11	1	Top		3210	
	95-100	11	1	Bottom		3210	
	120-125	15	1	Top	4	3210	3210
79	95-100	11	1	Top		3170	
	115-120	14	1	Top	2	3170	3170
80	92-95	11	1	Top		3130	
	92-95	11	1	Center		3100	
	95-100	11	1	Top		3130	
	95-100	11	1	Center	4	3100	3120
82	92-95	11	1	Top		3050	
	92-95	11	1	Center		3020	
	115-120	14	1	Center		3020	
	115-120	14	1	Bottom	4	3050	3040
83	92-95	11	1	Center		2990	
	115-120	14	1	Center		2990	
	115-120	15	1	Top	3	3010	3000
84	92-95	11	1	Top	1	2980	2980
85	92-95	11	1	Bottom	1	2940	2940
87	115-120	14	1	Top	1	2880	2880

TABLE 1 (Continued)

Frames in Which Hit Occurred	Polar Angle Zone	Plate No.	No. Fragments	Location on Plate	Total Hits	Velocity (f/s)	Average
89	100-105	12	1	Center	1	2790	2790
91	115-120	14	1	Top	1	2750	2750
92	92-95	11	1	Bottom	1	2720	2720

	Top	Center	Bottom	(T.C.B.)
Median	3150	3220	3220	3220
Average	3100	3190	3150	3150

TABLE 2 FRAGMENT VELOCITY DATA

Date: 2-5-57
40 Ft. Radius Arena
16mm Fastax Camera No. 6
Rd. No. 2 Bullpup Assembly No. 0031

6900 Frames per second
Fuze Modified AN M103 Al Nose
Filler Comp. B
Filler Weight 34 lbs.
Total Weight 440 lbs.

Frames in Which Hit Occurred	Polar Angle Zone	Plate No.	No. Fragments	Location on Plates	Total Hits	Velocity (f/s)	Average
192	65-70		1	Top	1	1450	1450
265	70-75		1	Bottom	1	1050	1050
338	95-100		2	Top	2	820	820
361	95-100		1	Middle	1	760	760
364	110-115		1	Middle	1	760	760
Median						950	
Average						940	

TABLE 2 (Continued)

Date: 2-5-57
40 Ft. Radius Arena
16mm Fastax Camera No. 7
Rd. No. 2 Bullpup Assembly No. 0031

6700 Frames per second
Fuze Modified AN M103 Al Nose
Filler Comp. B
Filler Weight 34 lbs.
Total Weight 440 lbs.

Frames in Which Hit Occurred	Polar Angle Zone	Plate No.	No. Fragments	Location on Plates	Total Hits	Velocity (f/s)	Average
182	115-120		1	Top	1	1490	1490
229	115-120		1	Top	1	1180	1180
Average						1340	

TABLE 3 FRAGMENT VELOCITY DATA

Date: 2-5-57
60 Ft. Radius Arena
16mm Fastax Camera No. 4
Rd. No. 2 Bullpup Assembly No. 0031

5900 Frames per second
Fuze Modified AN M103 Al Nose
Filler Comp. B
Filler Weight 34 lbs.
Total Weight 440 lbs.

Frames in Which Hit Occurred	Polar Angle Zone	Plate No.	No. Fragments	Location on Plates	Total Hits	Velocity (f/s)	Average
213	85-89		1	Middle	1	1660	1660
222	80-85		1	Middle	1	1590	1590
252	80-85		1	Top		1420	1420
252	85-89		1	Top	2	1420	1420
253	75-80		1	Top	1	1410	1410
254	85-89		1	Top	1	1400	1400
330	80-85		1	Middle	1	1070	1070
345	100-105		1	Middle	1	1030	1030
360	75-80		1	Middle	1	980	980
367	85-89		1	Top	1	970	970
376	85-89		1	Middle	1	940	940
Median						1250	
Average						1260	

TABLE 3 (Continued)

Date: 2-5-57
60 Ft. Radius Arena
16mm Fastax Camera No. 8
Rd. No. 2 Bullpup Assembly No. 0031

5800 Frames per second
Fuze Modified AN M103 Al Nose
Filler Comp. B
Filler Weight 34 lbs.
Total Weight 440 lbs.

Frames in Which Hit Occurred	Polar Angle Zone	Plate No.	No. Fragments	Location on Plate	Total Hits	Velocity (f/s)	Average
314	70-75		1	Middle	1	1110	1110
Average						1110	

APPENDIX D

TABLE 4 SPACE DISTRIBUTION DATA

Fired: 1-28-57
40 Ft. Radius Space Arena
1/8" MS panels 16' high
Bullpup Assembly No. 0032

Polar Zone Degrees	No. Fragments
0-5	
5-10	
10-15	
15-20	1
20-25	
25-30	
30-35	
35-40	
40-45	
47-50	1
50-55	1
55-60	
60-65	
65-70	6
70-75	1
75-80	2
80-85	
85-90	
92-95	43
95-100	27
100-105	4
105-110	1
110-115	3
115-120	12
120-125	1
125-130	
130-135	
135-140	
140-145	
145-150	
150-155	
155-160	
160-165	
165-170	
170-175	
175-180	

TABLE 5 SPACE DISTRIBUTION DATA

Fired: 1-28-57
60 Ft. Radius Space Arena
1/8" MS panels 24' high
Bullpup Assembly No. 0032

Polar Zone Degrees	No. Fragments
0-5	
5-10	
10-15	
15-20	
20-25	
25-30	
30-35	1
35-40	1
40-45	4
45-50	
50-55	
55-60	
60-65	
65-70	6
70-75	1
75-80	5
80-85	3
85-90	22
90-95	
98-100	3
100-105	
105-110	6
110-115	1
115-120	16
120-125	
125-130	
130-135	
135-140	
140-145	
145-150	
150-155	
155-160	
160-165	
165-170	
170-175	
175-180	

TABLE 6 SPACE DISTRIBUTION DATA

Fired: 2-5-57
40 Ft. Radius Space Arena
1/8" MS panels 16' high
Bullpup Assembly No. 0031

Polar Zone Degrees	No. Fragments
0-5	
5-10	
10-15	1
15-20	
20-25	
25-30	
30-35	
35-40	
40-45	
45-50	
50-55	
55-60	
60-65	
65-70	1
70-75	1
75-80	
80-85	
85-90	
90-95	
95-100	3
100-105	1
105-110	
110-115	2
115-120	2
120-125	
125-130	
130-135	
135-140	
140-145	
145-150	
150-155	
155-160	
160-165	
165-170	
170-175	
175-180	

TABLE 7 SPACE DISTRIBUTION DATA

Fired: 2-5-57
60 Ft. Radius Space Arena
1/8" MS panels 24' high
Bullpup Assembly No. 0031

Polar Zone Degrees	No. Fragments
0-5	
5-10	
10-15	
15-20	
20-25	
25-30	
30-35	
35-40	
40-45	
45-50	
50-55	
55-60	1
60-65	
65-70	
70-75	1
75-80	3
80-85	3
85-89	7
90-95	
98-100	1
100-105	2
105-110	
110-115	
115-120	
120-125	
125-130	
130-135	
135-140	
140-145	
145-150	
150-155	
155-160	
160-165	
165-170	
170-175	
175-180	

APPENDIX E

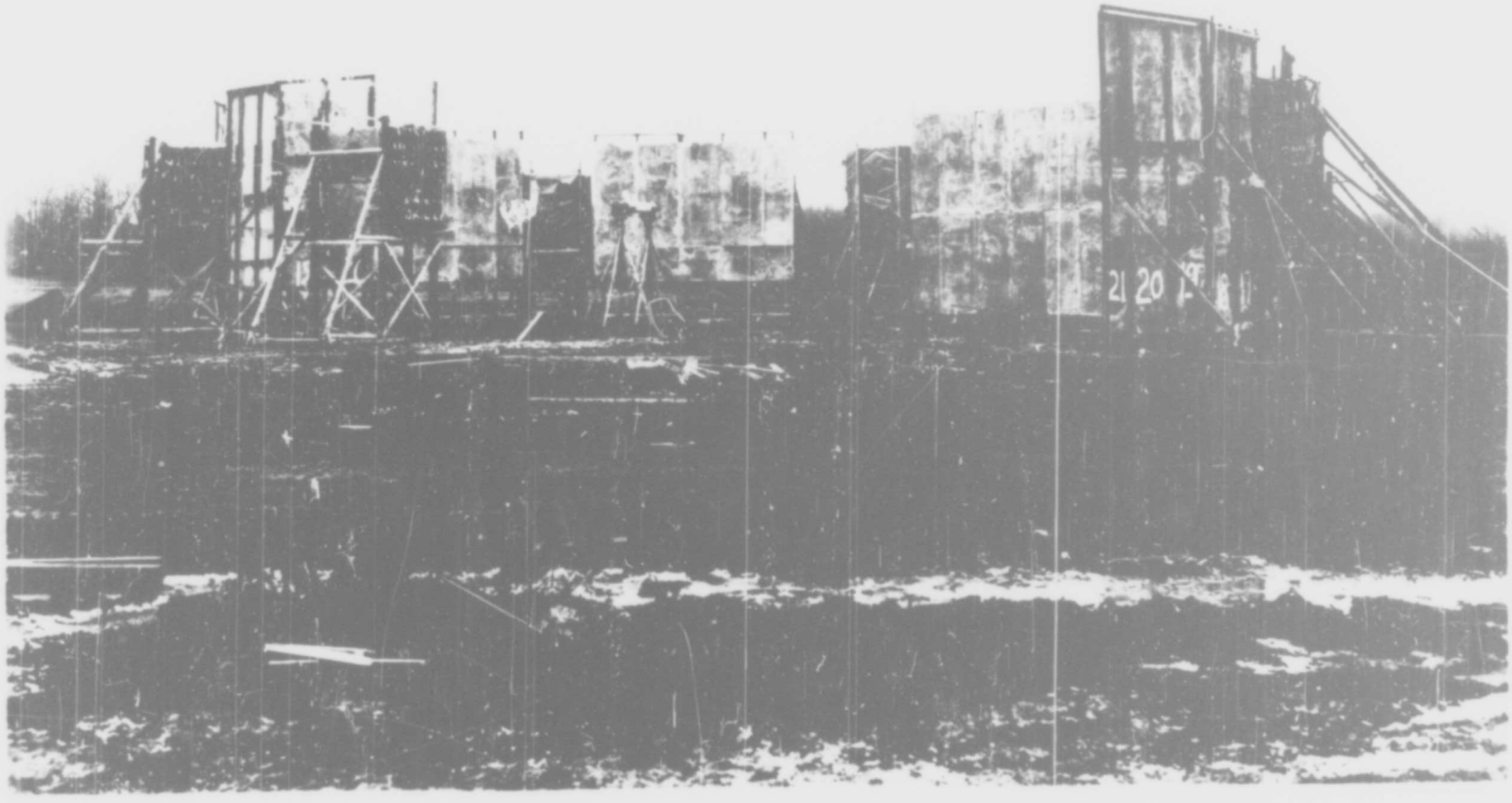

Figure 3

PHD-72548 - BULLPUP Missile, XASM-N-7. Missile in position in arena prior to detonation.
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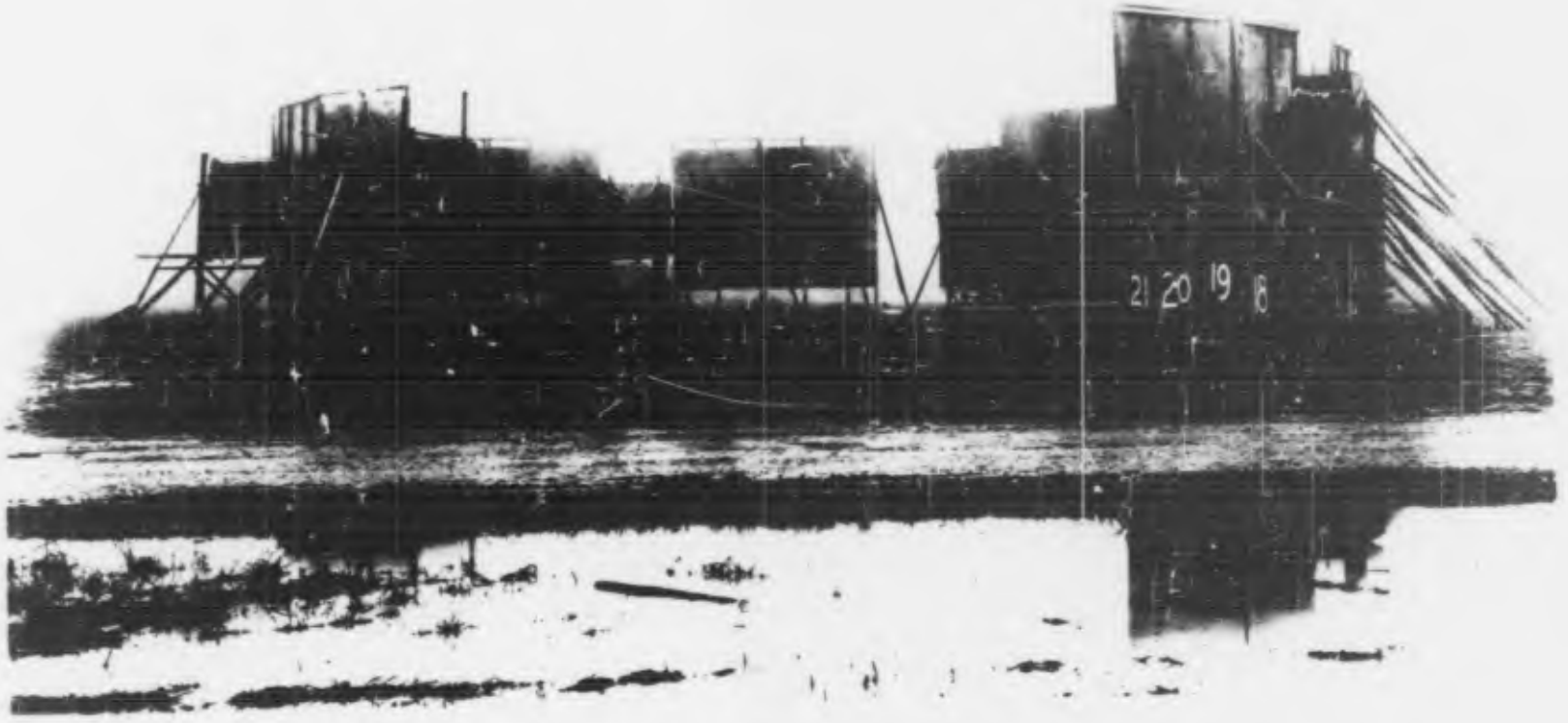

Figure 4
Arena and missile components immediately after detonation of Missile No. 0032.

PHD-72541 - BULLPUP Missile, XASM-N-7.
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Figure 5
Beam spray plate penetration centered about 90°

PHD-72542 - BULLPUP Missile, XASM-N-7. Polar Zone, 40 ft. radius. Missile No. 0032.
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Figure 6
Beam spray plate penetration centered about 90°

PHD-12543 - BULLPUP Missile, XASM-N-7. Polar Zone, 60 ft. radius. Missile No. 0032.
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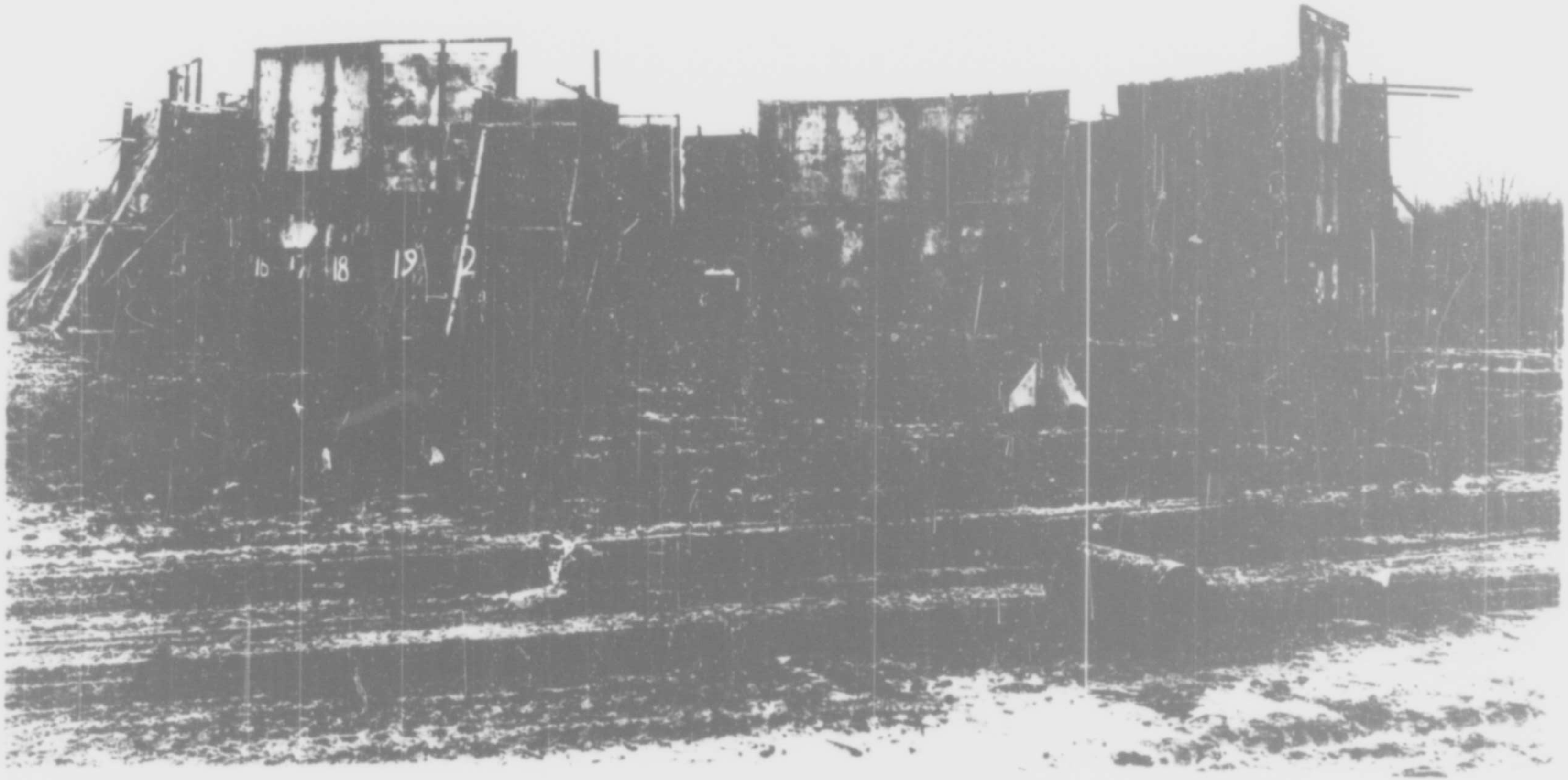

Figure 7

NWD-72535 - BULLPUP Missile XASM-N-7. Arena and Missile Components Immediately after Detonation of Missile No. 0031.

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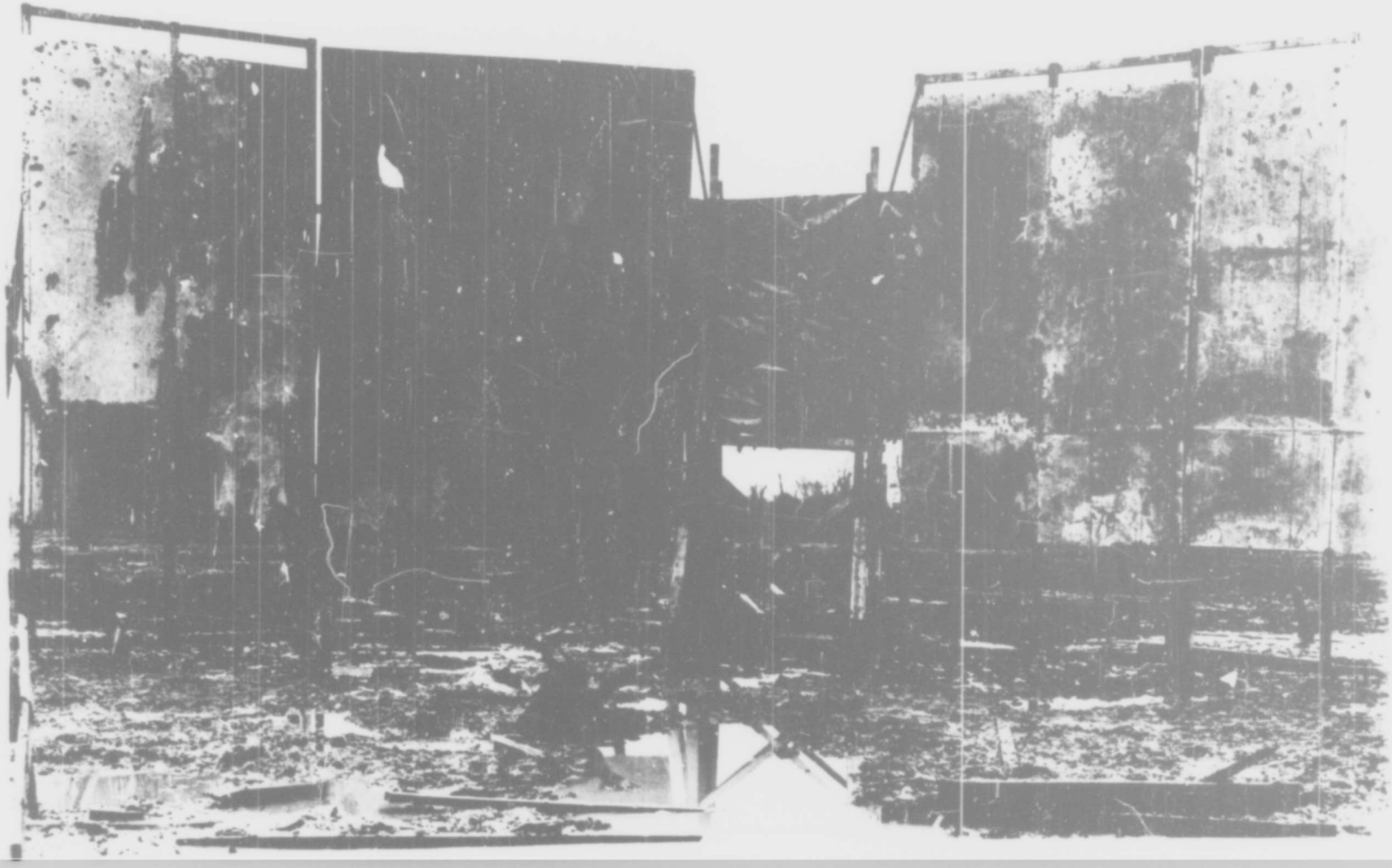

Figure 8
Beam spray plate penetration centered about 90°

PHD-72544 - BULLPUP Missile, XASM-N-7. Polar Zone, 40 Ft. Radius. Missile No. 0031.
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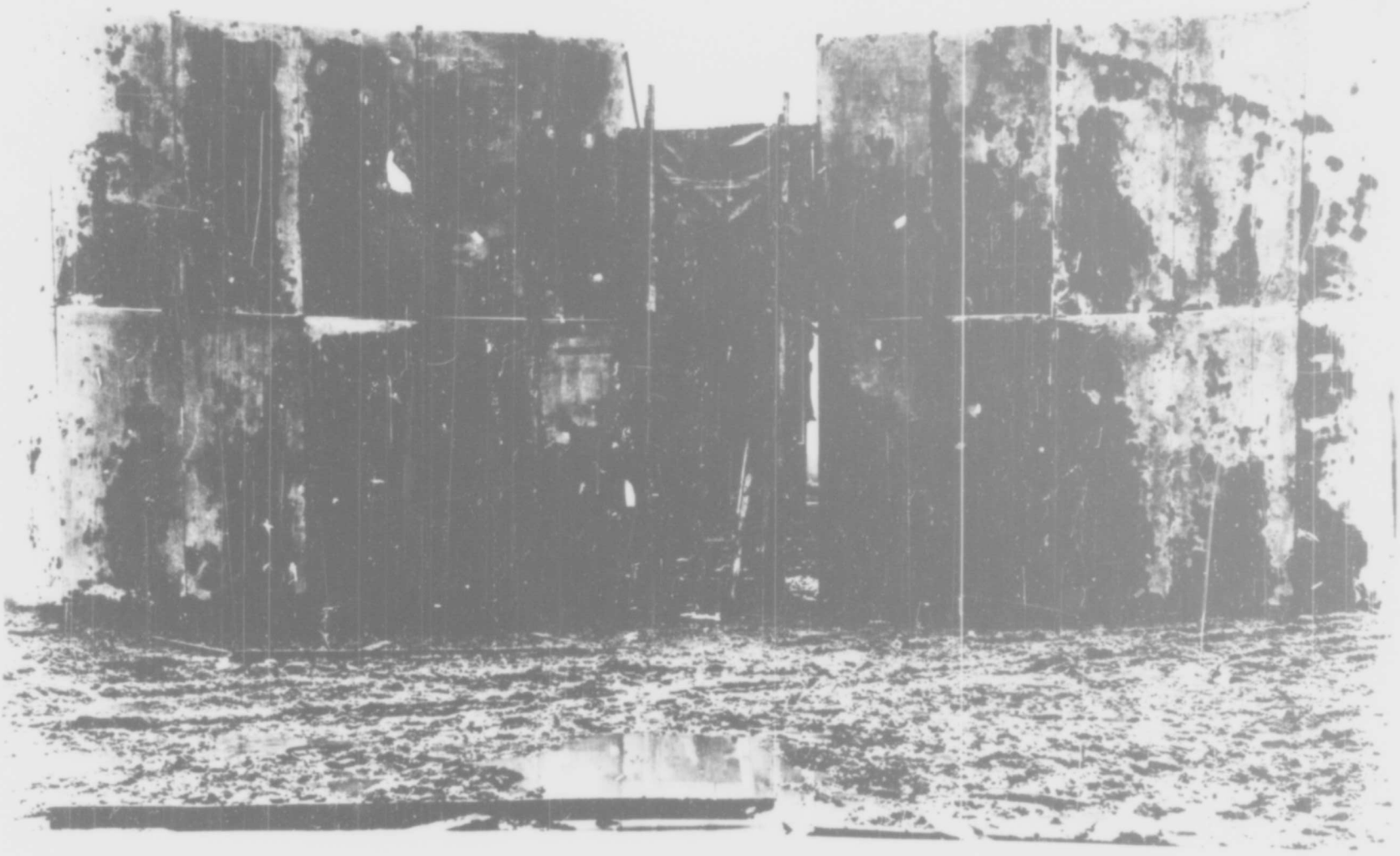

Figure 5

AWP-72515 - POLLUX Missile, XASM-N-7. Room spray plate penetration centered [illegible]
Polar Zone, [illegible] Warhead Missile No. 0031.
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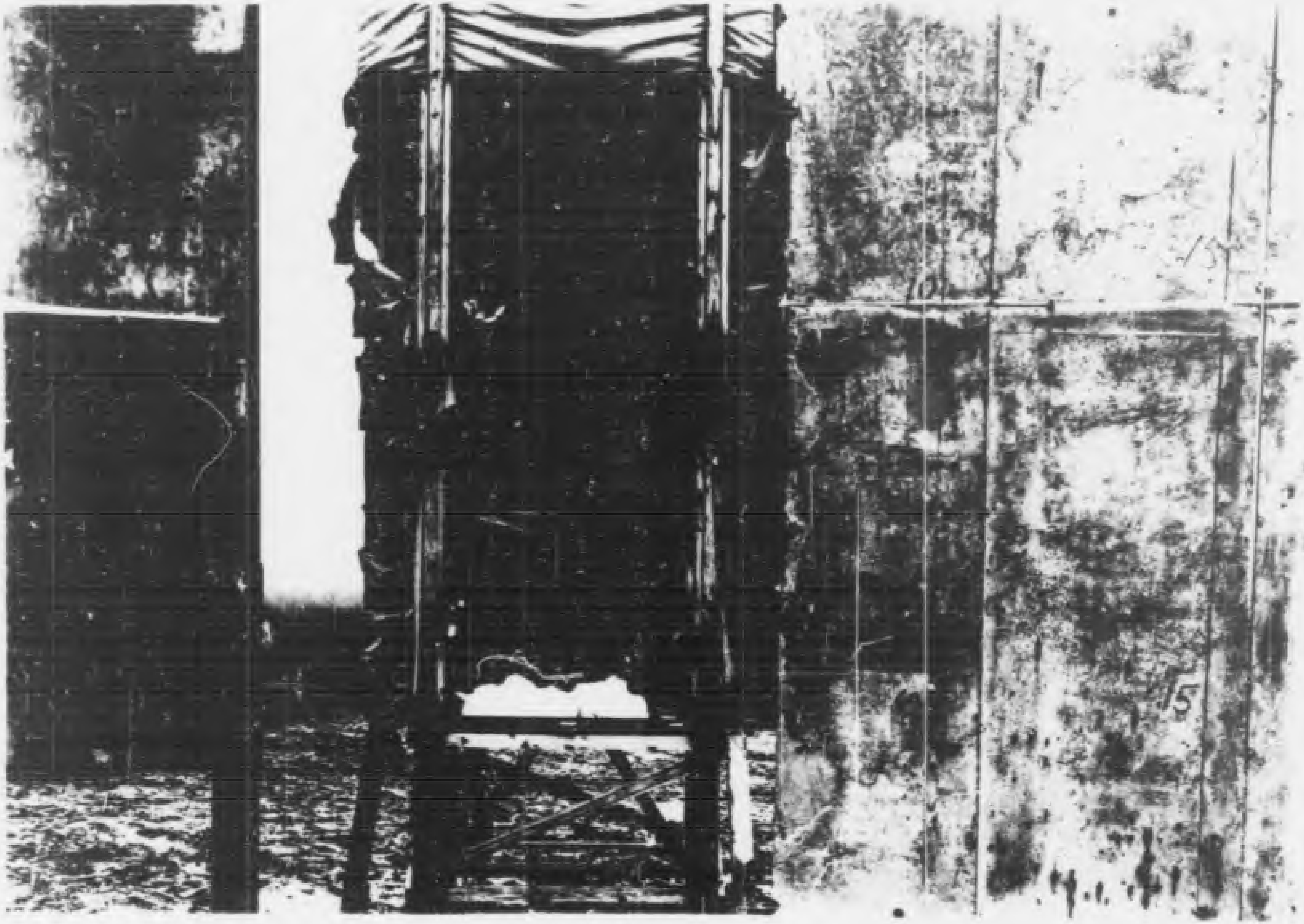

Figure 10

[illegible] - BULLPUP Missile [illegible]-7. Celotex recovery pack located directly forward of missile. Photograph taken after detonation of Missile No. C 31.
[illegible]

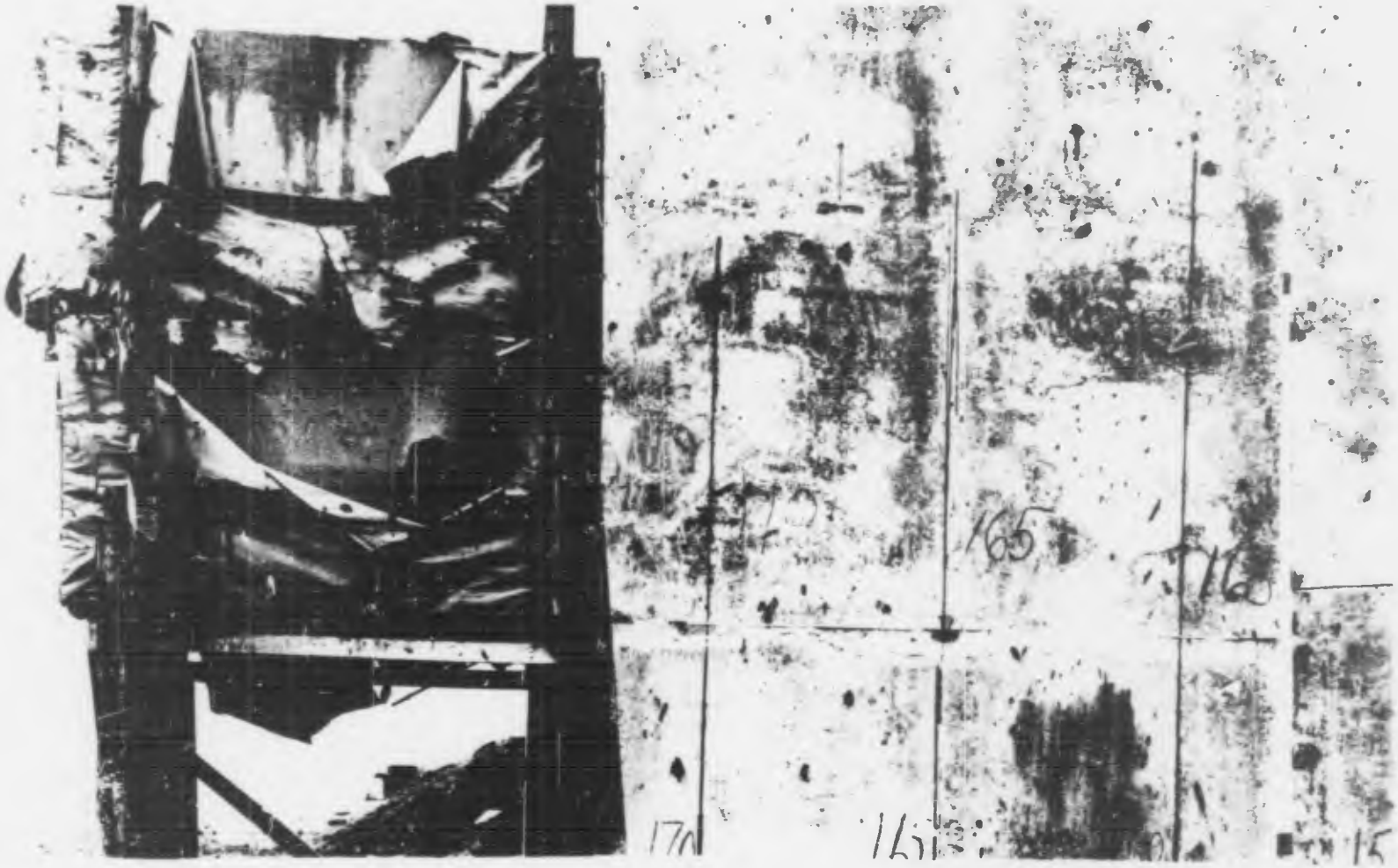

Figure 11
PHD-72547 - BULLPUP Missile, XASM-N-7. Celotex recovery pack located directly rearward of Missile. Photograph taken after detonation of Missile No. 0031.
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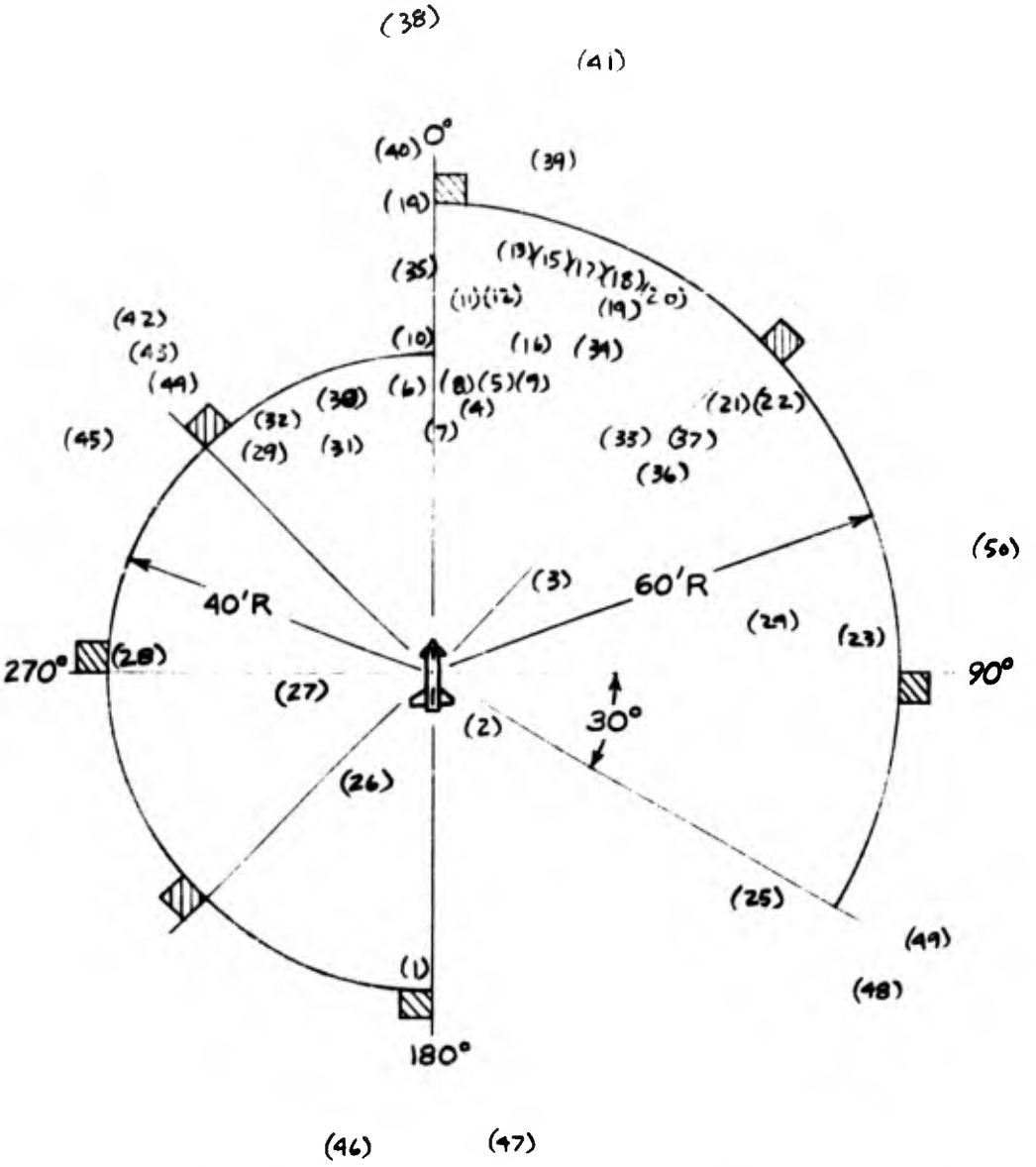
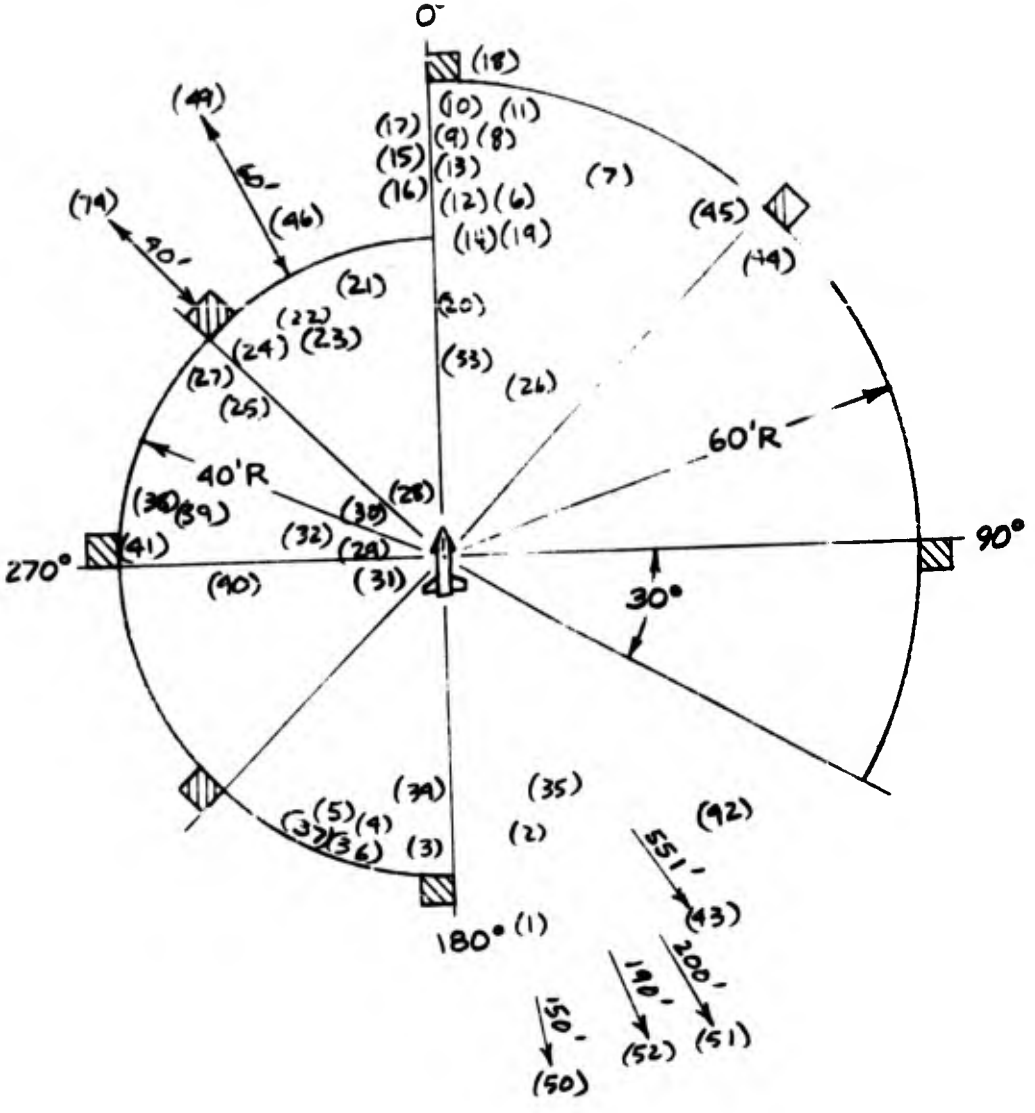
APPENDIX F



BULLPUP Missile XASM-N-7 Distribution of Fragments Recovered from Ground in and around Arena Area after Detonation.

Missile No. 0032

(Bracketed numbers identify fragments shown in Figures 14 and 15)



BULLPUP Missile, XASM-N-7 Distribution of Fragments Recovered from Ground in and around Arena Area after Detonation.

Missile No. 0031

(Bracketed numbers identify fragments shown in Figures 17 and 18)

APPENDIX G

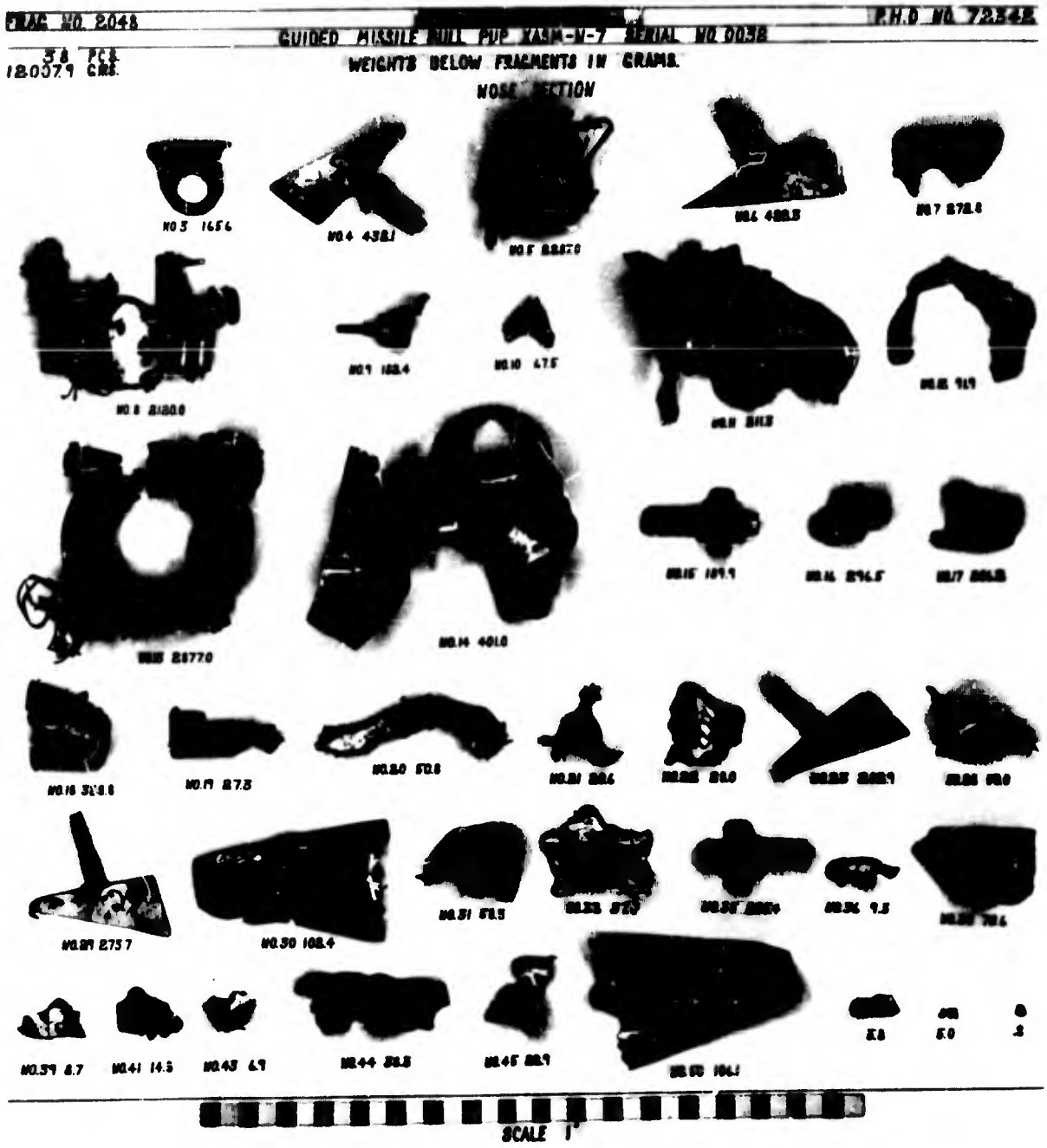


Figure 14
PHD-72342 - PULLPUP Missile XASM-N-7 Nose Section Fragments recovered from ground in and around arena area as shown in Figure 15, Missile No. 0032
CONFIDENTIAL

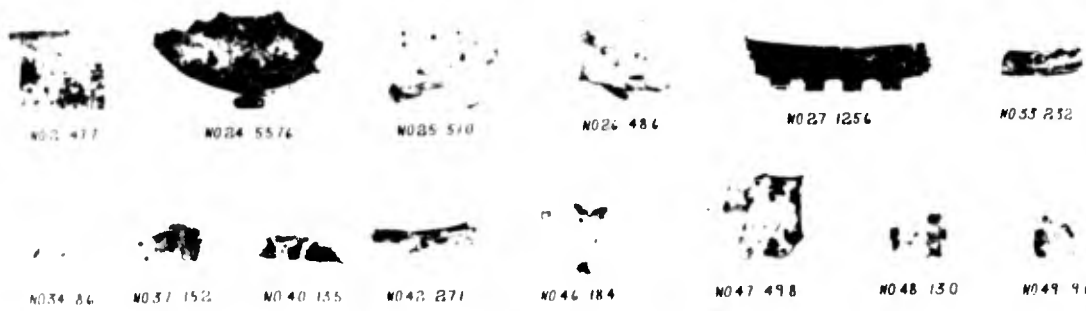
FRAG NO. 2048

14 PCS
10089 GMS

[redacted]

GUIDED MISSILE BULL PUP XASM-N-7 SERIAL NO 0032
WEIGHTS BELOW FRAGMENTS IN GRAMS
SHROUD

PHD NO 72410



8 PCS
448332 GMS

TAIL SECTION

SCALE 1"

Figure 1.

PHD-72410 - BULLPUP Missile XASM-N-7. Shroud and Tail Section fragments recovered from Ground in and around area as shown in Figure 18. Missile No. 0032.

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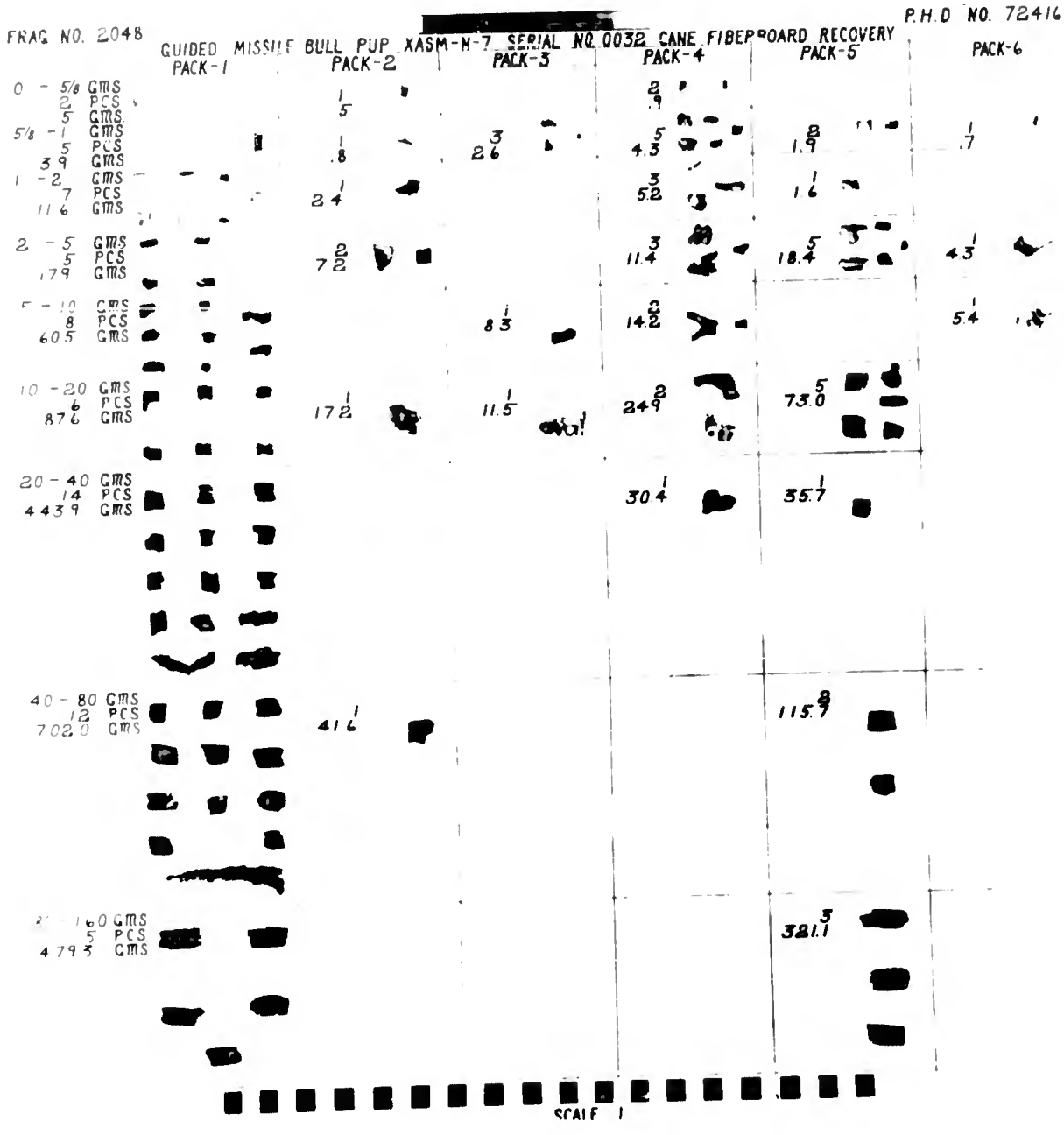

Figure 16

PHD-72416 - BULLPUP Missile XASM-N-7. Fragments recovered from each of the Celotex recovery packs placed about the Arena. Missile No. 0032. Note: No fragments were found in pack No. 7.

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Figure 16

PHD-72416 - BULLPUP Missile XASM-N-7. Fragments recovered from each of the Celotex recovery packs placed about the Arena. Missile No. 0032. Note: No fragments were found in pack No. 7. CONFIDENTIAL

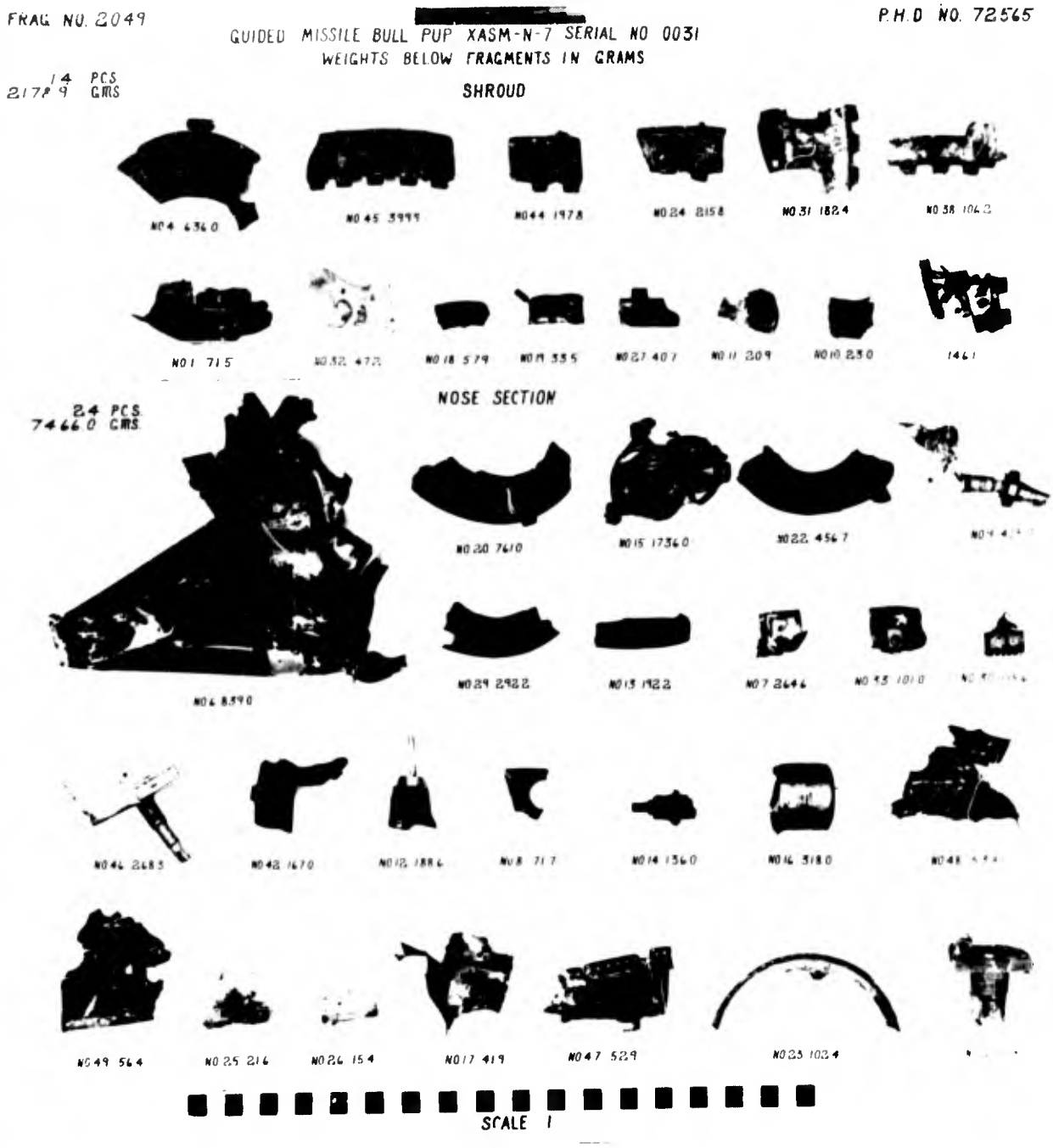

Figure 17

PHD-72565 - BULLPUP Missile XASM-N-7. Shroud and nose section fragments recovered from ground in and around arena area as shown in Figure 13. Missile No. 0031.

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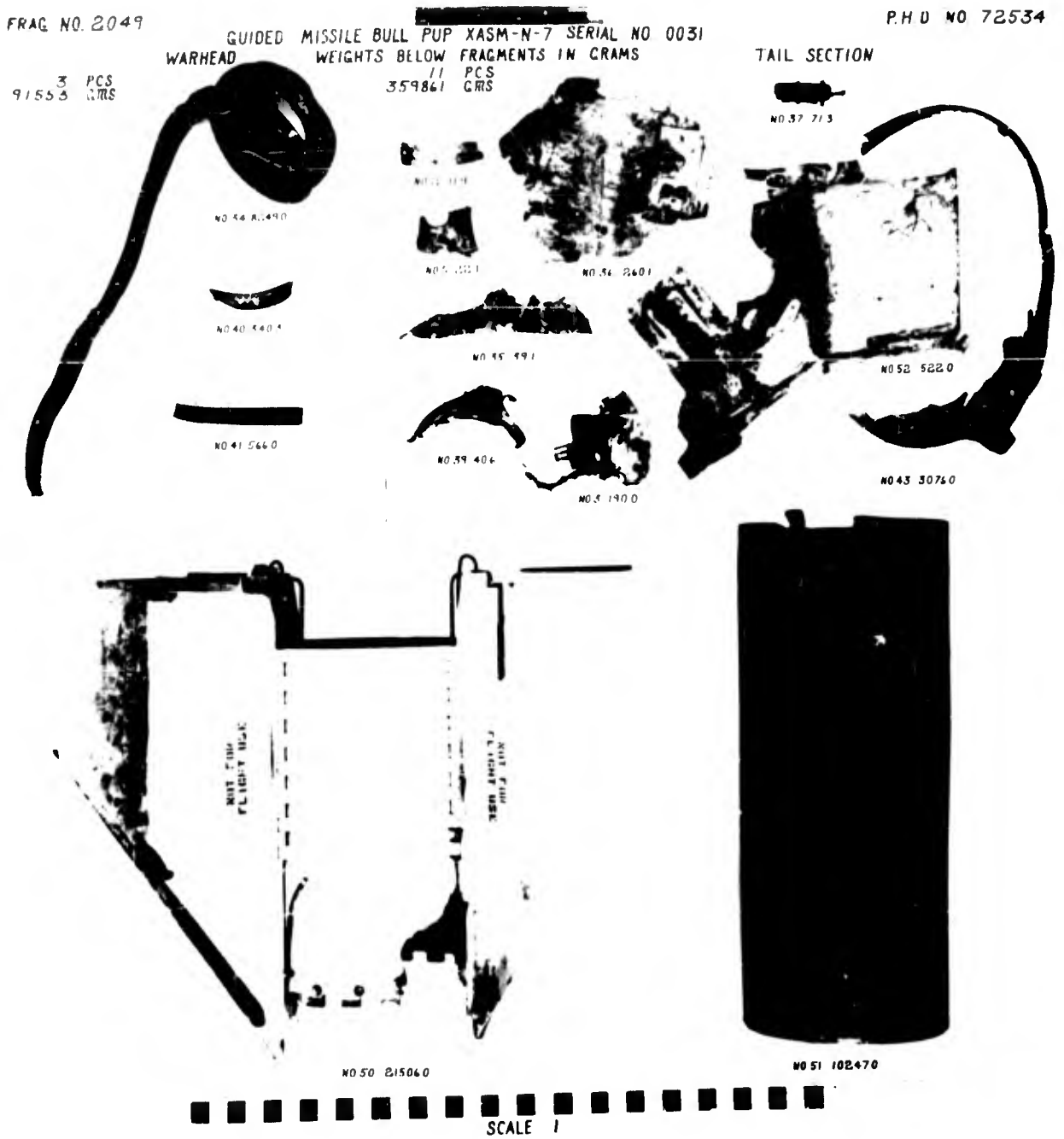

Figure 18

PHD-72534 - BULLPUP Missile XASM-N-7. Warhead and tail section fragments recovered from ground in and around arena area as shown in Figure 13. Missile No. 0031.

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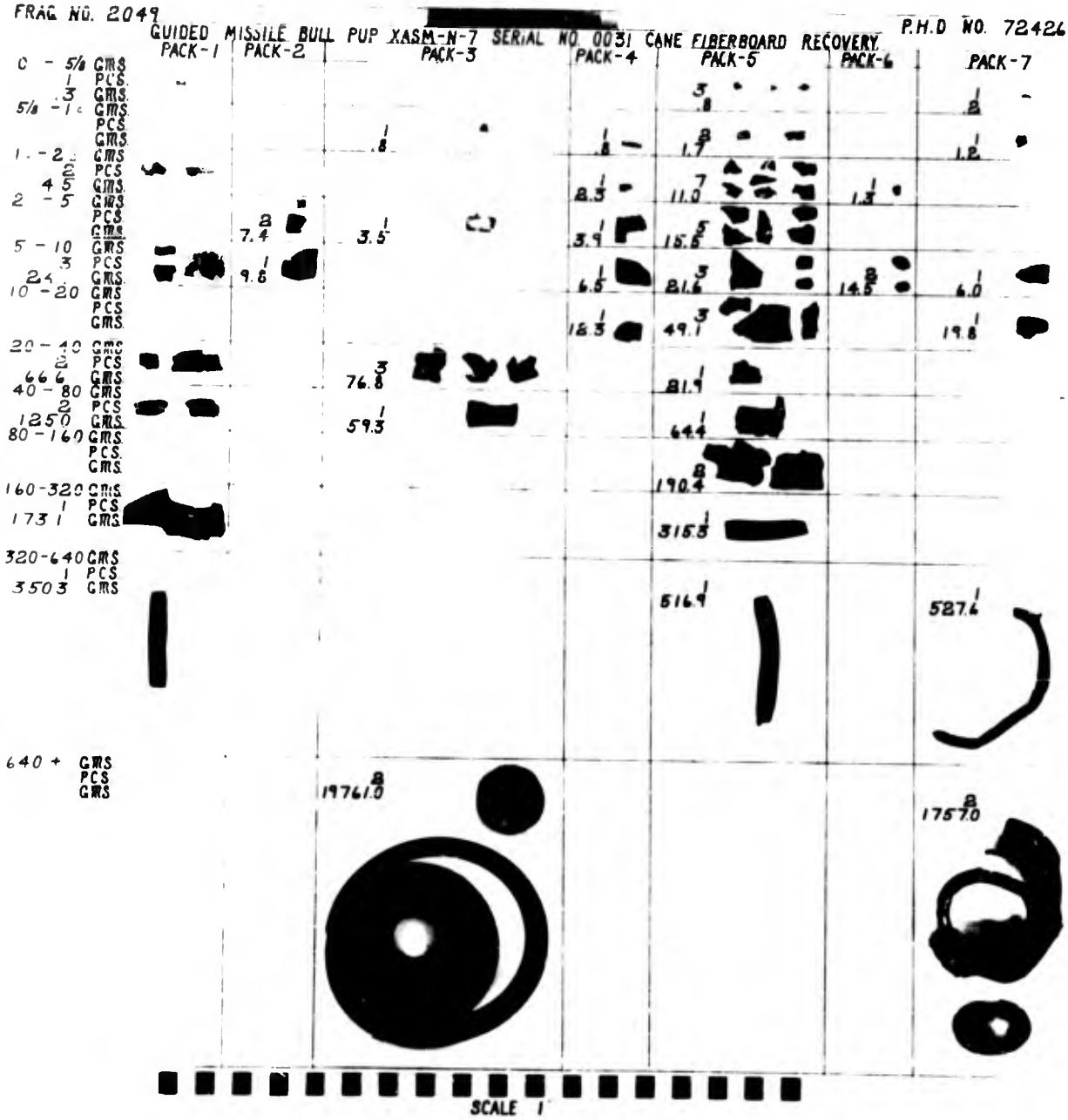

Figure 19
PHD-72426 - BULLPUP Missile XASM-N-7. Fragments recovered from each of the Celotex Recovery Packs placed about the arena. Missile No. 0031.
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APPENDIX H

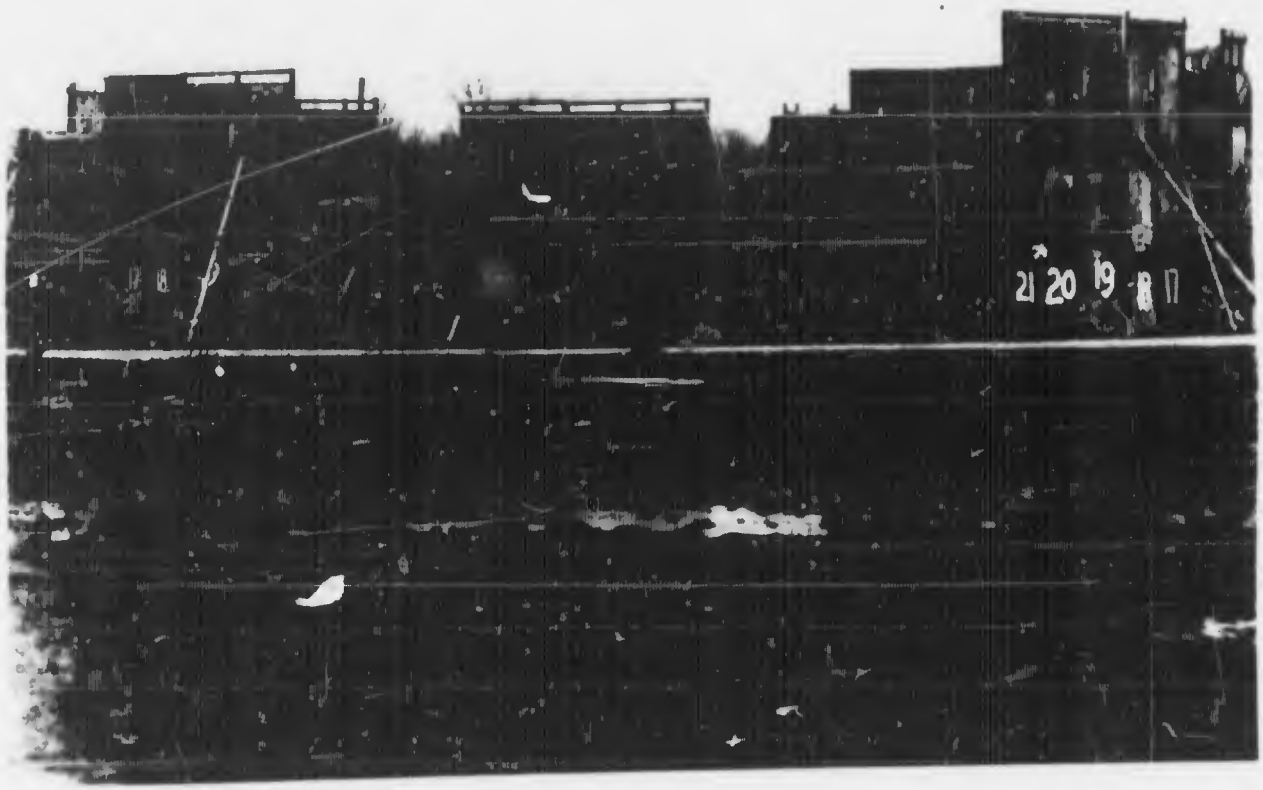

Figure 20

PHD-7[illegible] - BUILDUP Missile, XASM-N-7. Time: Immediately before warhead detonation. Missile No. [illegible]32.
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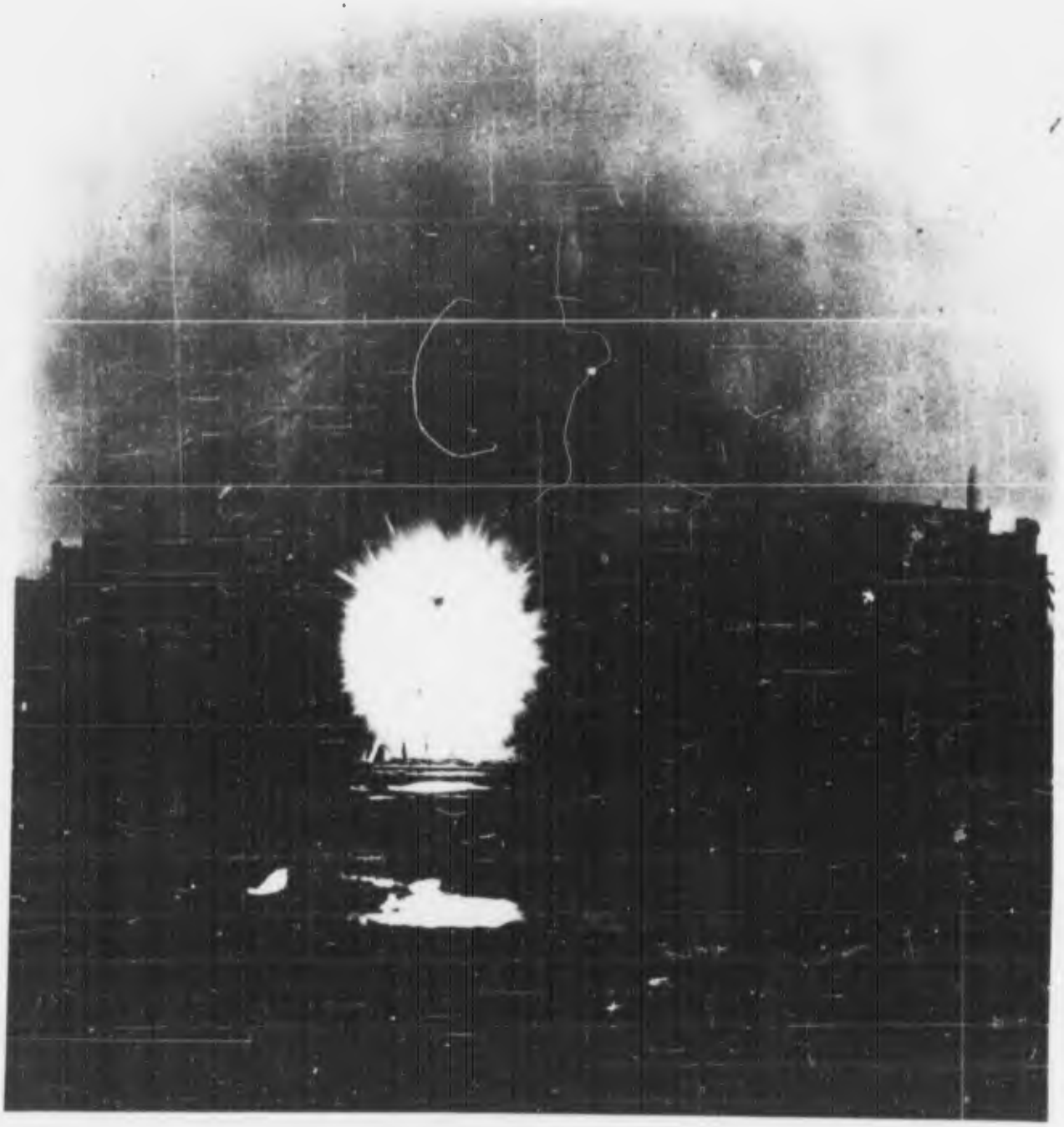

Figure 21

PHD-72549 - BULLPUP Missile, XASM-N-7. Time: 0.02 seconds after warhead detonation. Missile No. 0032.
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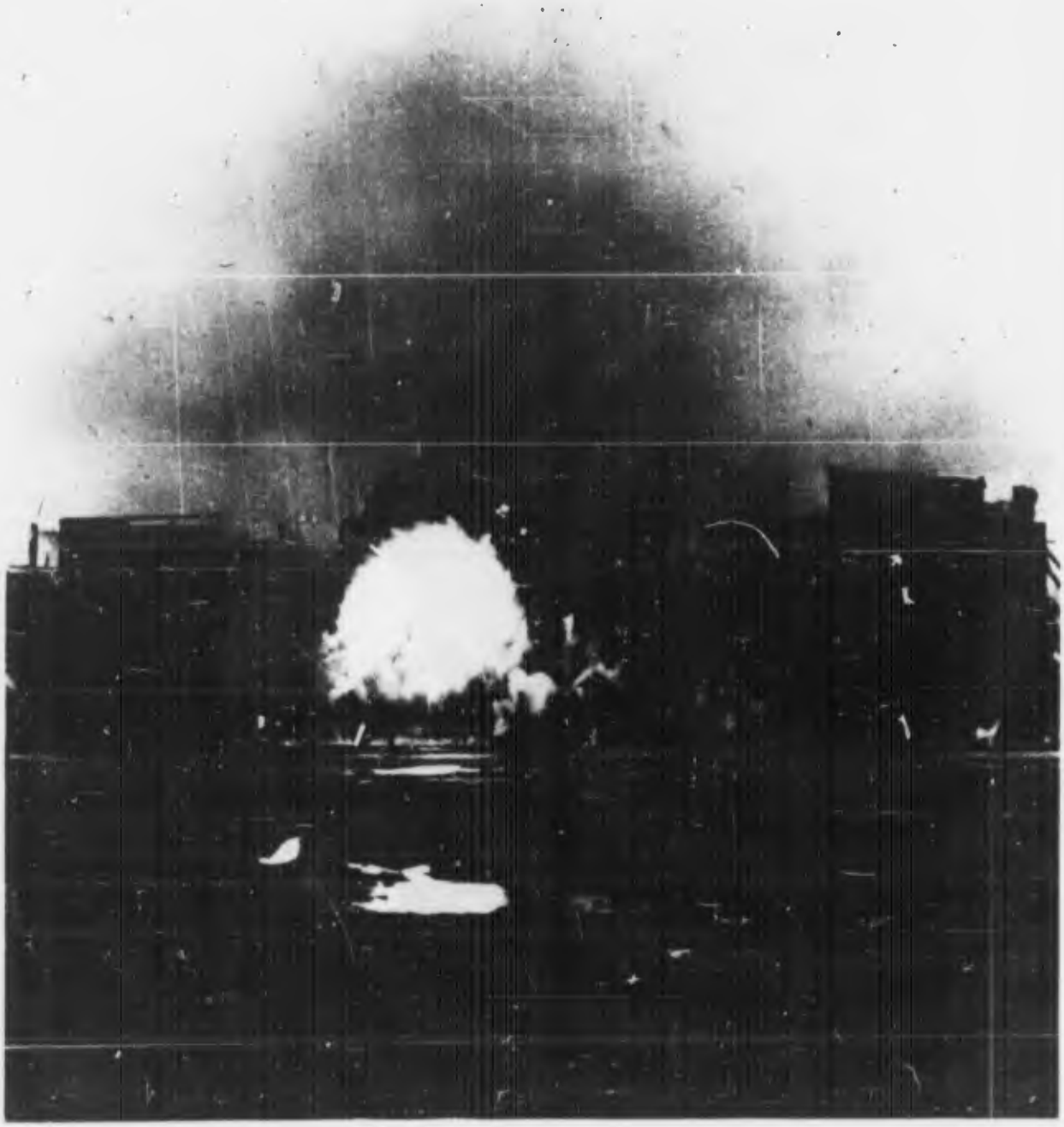

Figure 22

FHD-72559 - PULLPUP Missile, XASM-N-7. Time: 0.04 seconds after warhead detonation. Missile No. 0032.
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Figure 23

PHD-72551 - BULLPUP Missile, XASM-N-7. Time: .06 seconds after warhead detonation. Missile No. 0032.

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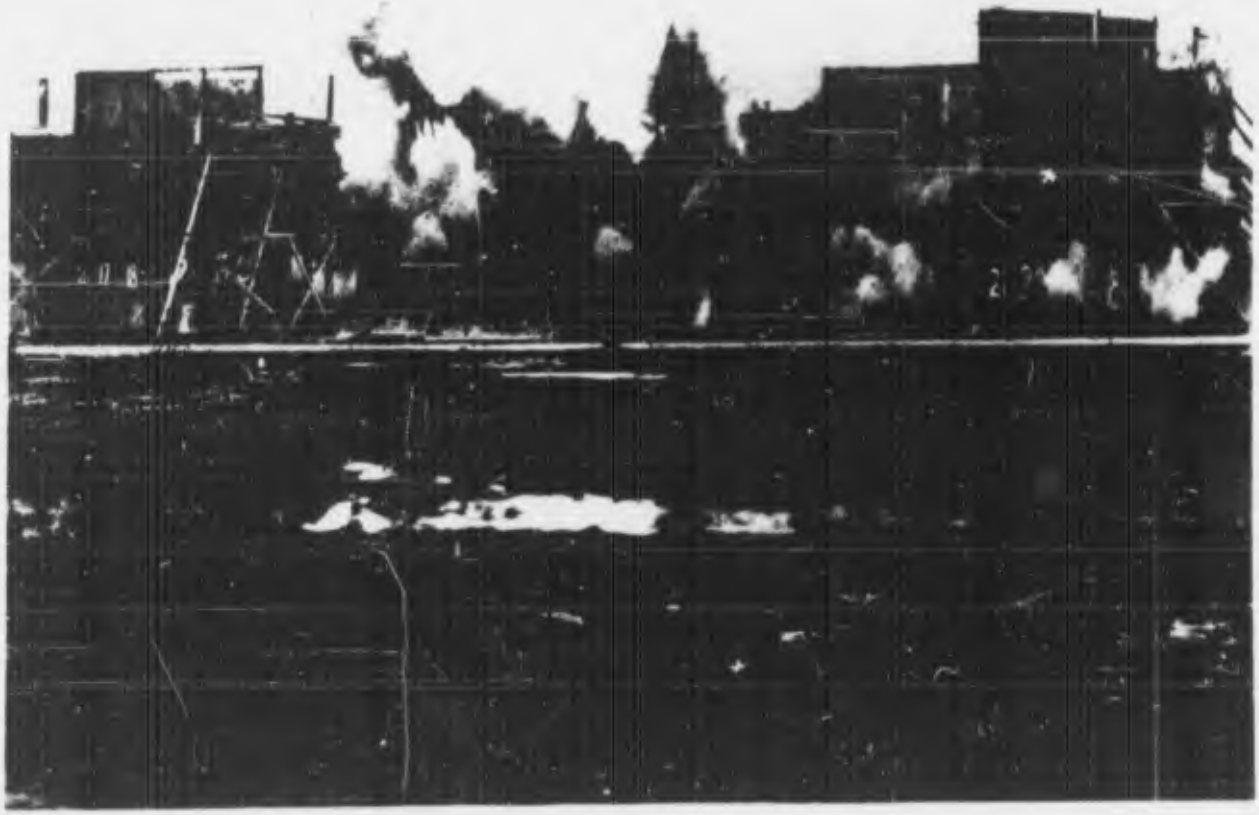

Figure 24

[illegible] - SPILPUP Missile, XASM-N-7. Time: [illegible] seconds after warhead detonation. Missile No. [illegible].

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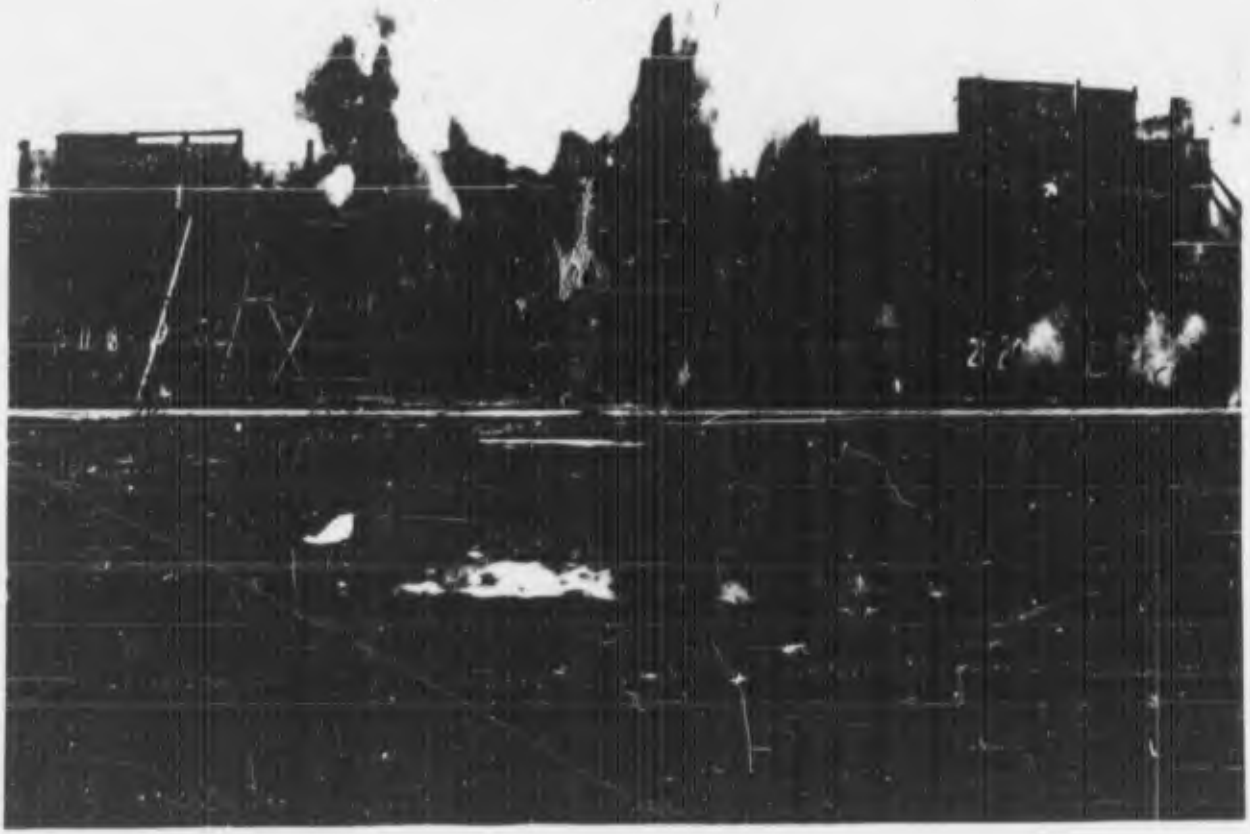

Figure 25

[illegible] - BULLPUP Missile, AGM-12B-7. Time [illegible] seconds [illegible] normal operation. Missile No. [illegible].

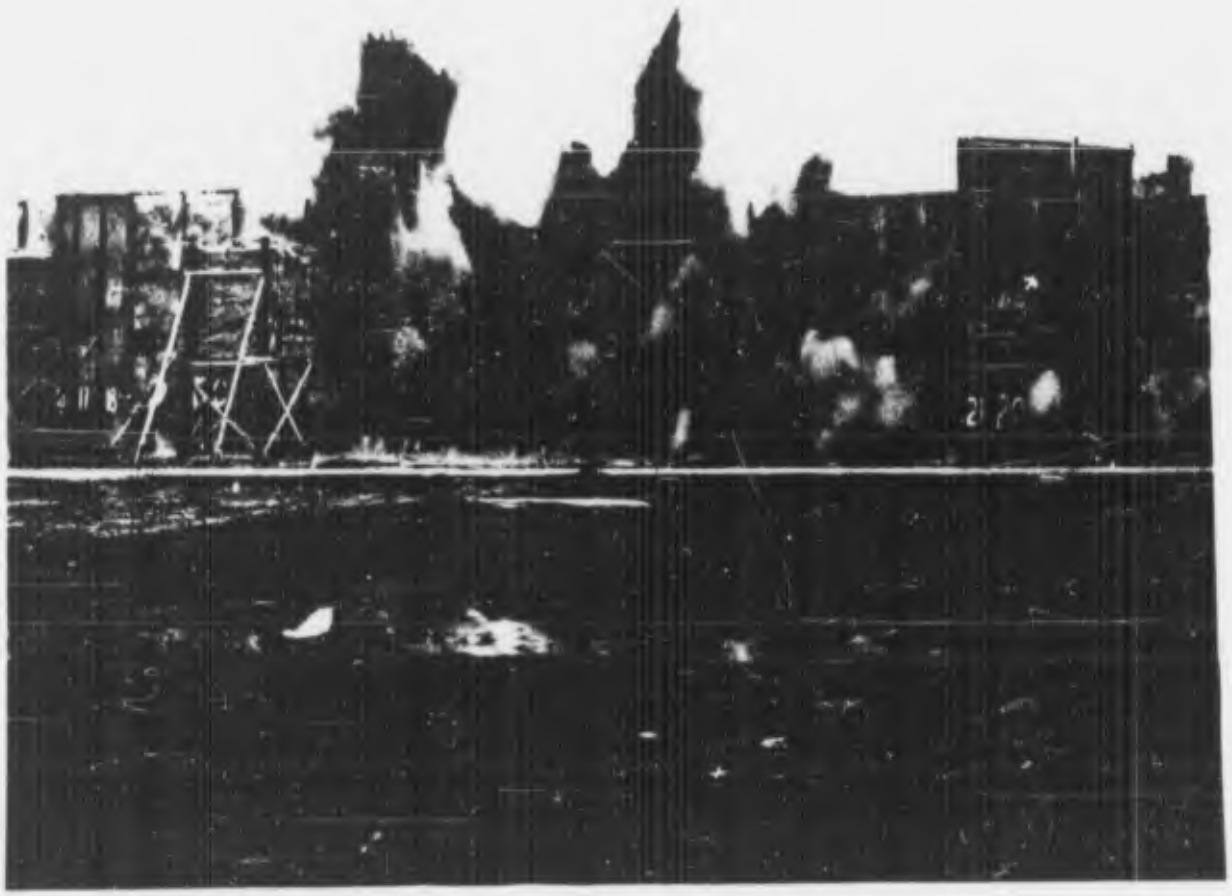

Figure 26

PHD-72454 - PULLPUP Missile, XASM-N-7. Time: [illegible].12 seconds after warhead detonation. Missile No. [illegible]032.

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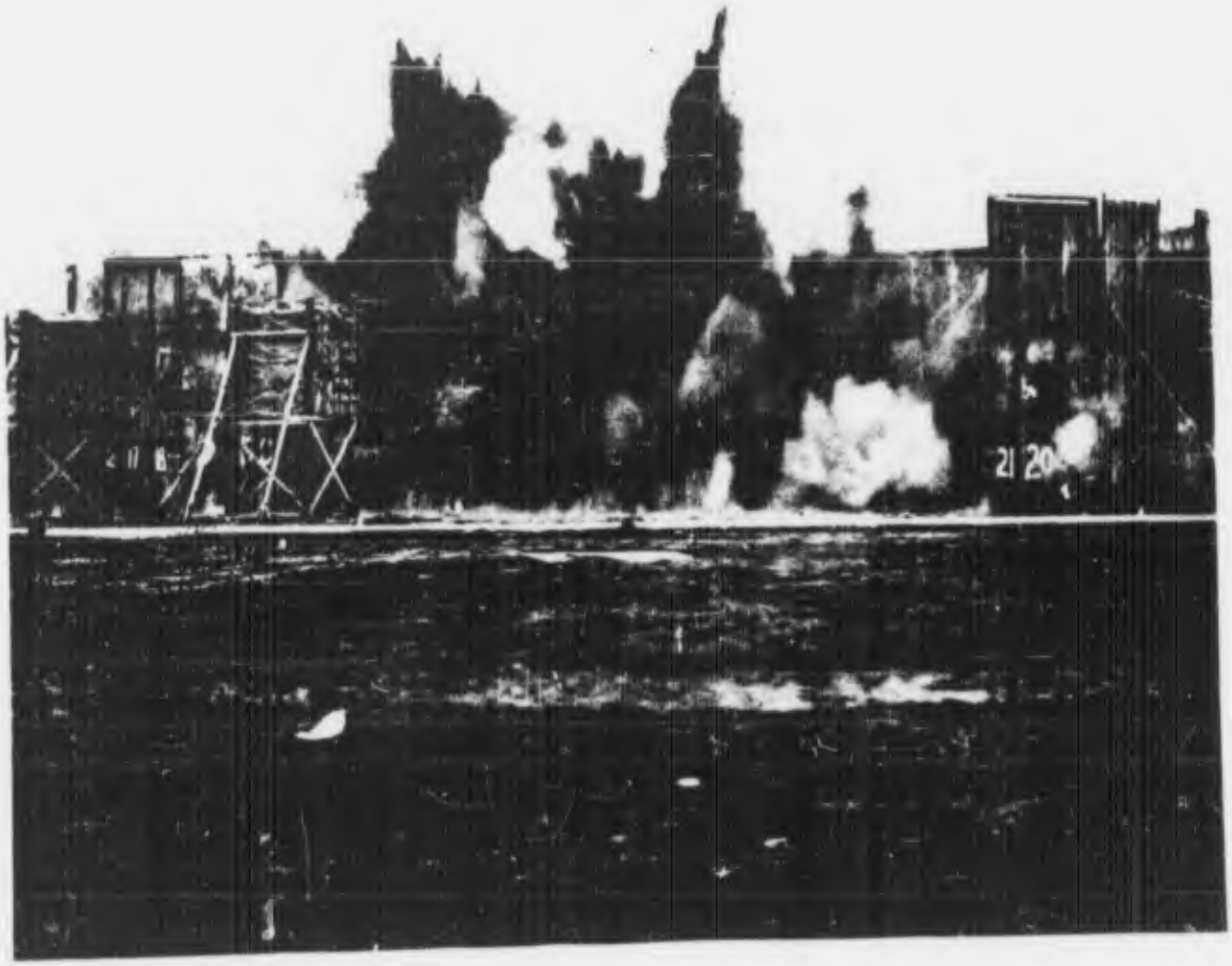

Figure 27

BHD-72559 - [illegible] Missile, XASM-N-7[illegible] Time: [illegible].14 seconds after warhead detonation. Missile No. [illegible]03.

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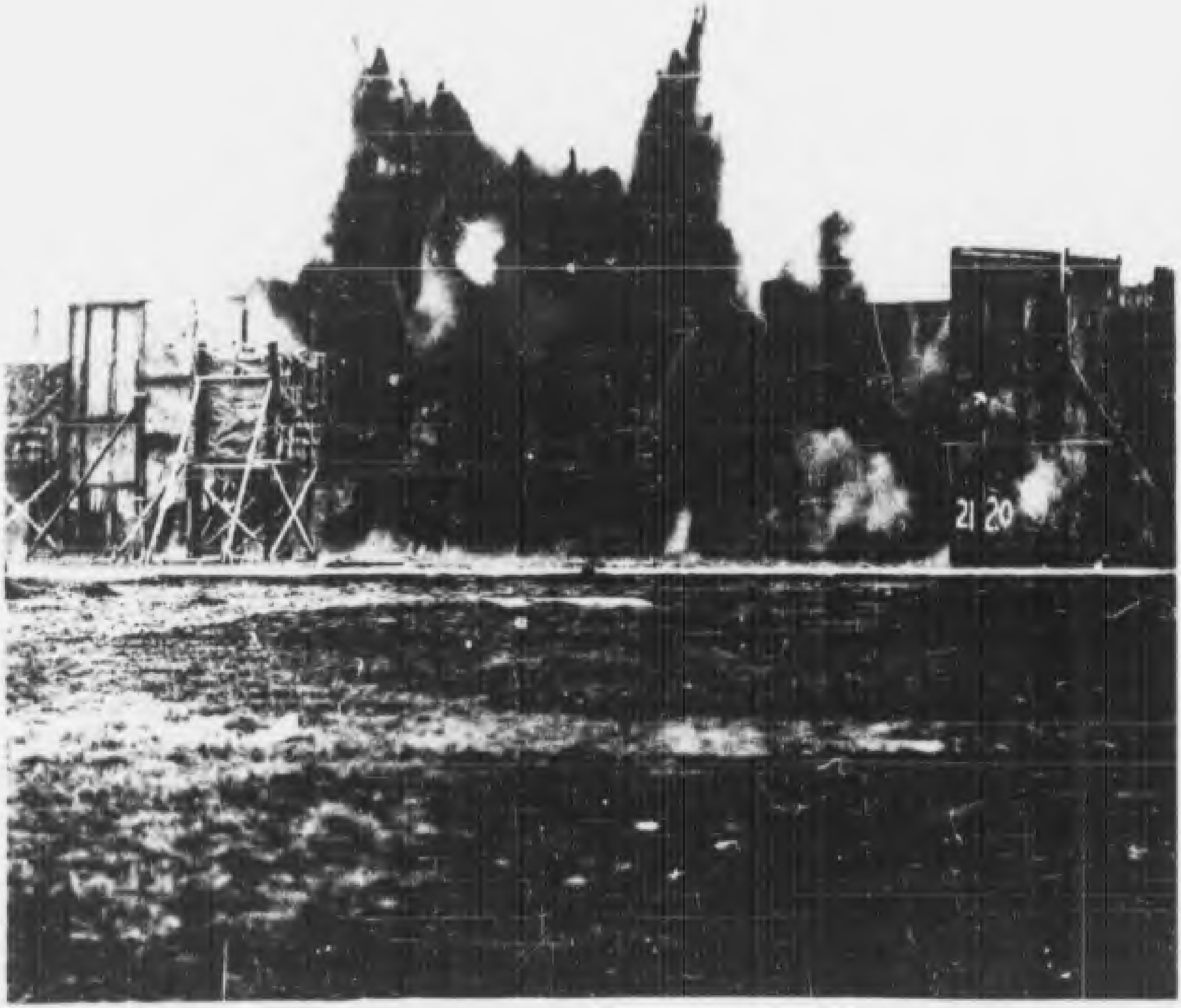

Figure 2[illegible]

[illegible]-[illegible] - BULLPUP Missile, XASM-N-7. Time: .1[illegible] seconds after Warhead Detonation. Missile No. [illegible]
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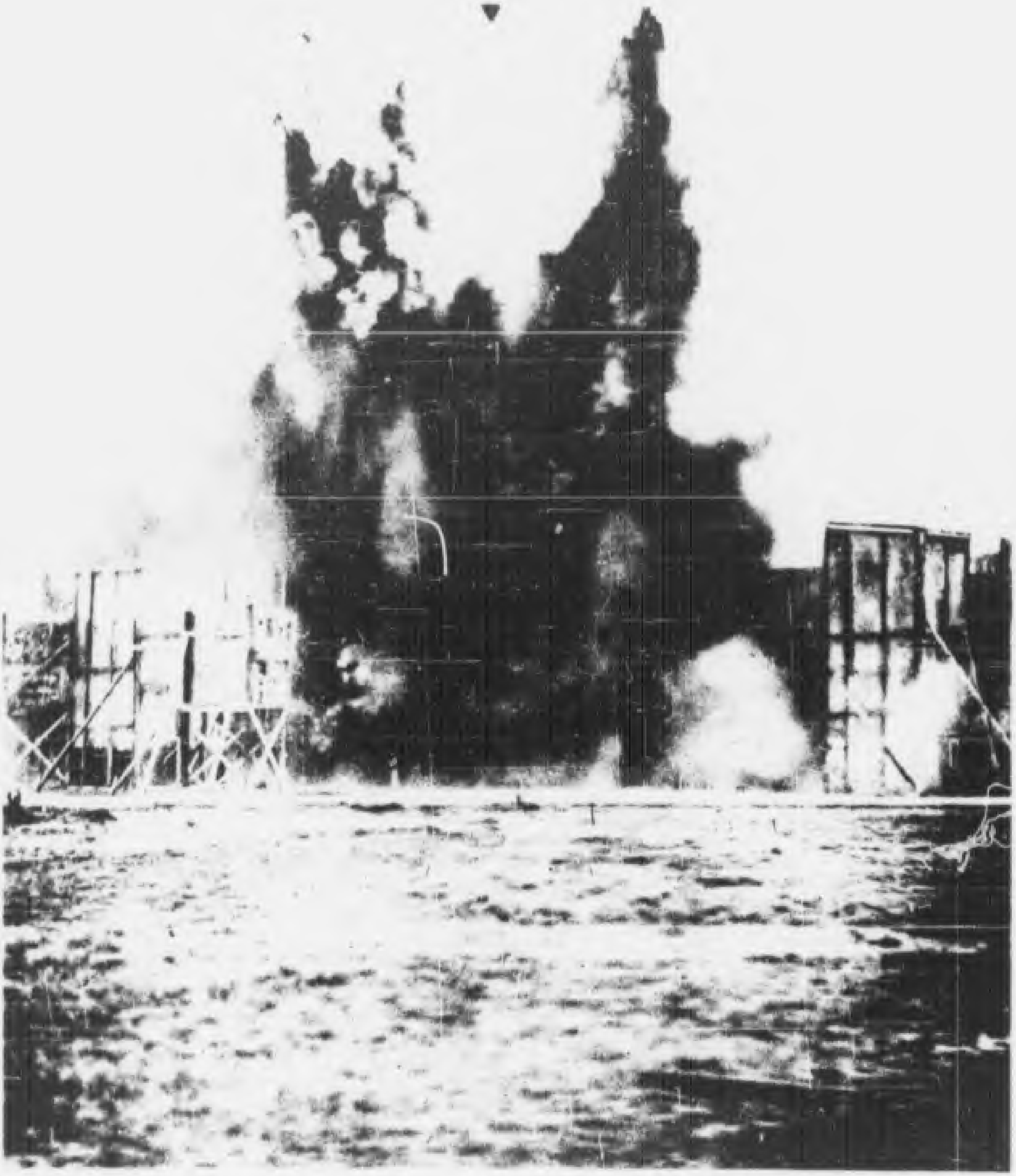

Figure 2?
PHD-7 557 - BULLPUP Missile, XASM-N-7. Time: [illegible].36 seconds after warhead detonation. Missile No. [illegible]3?.
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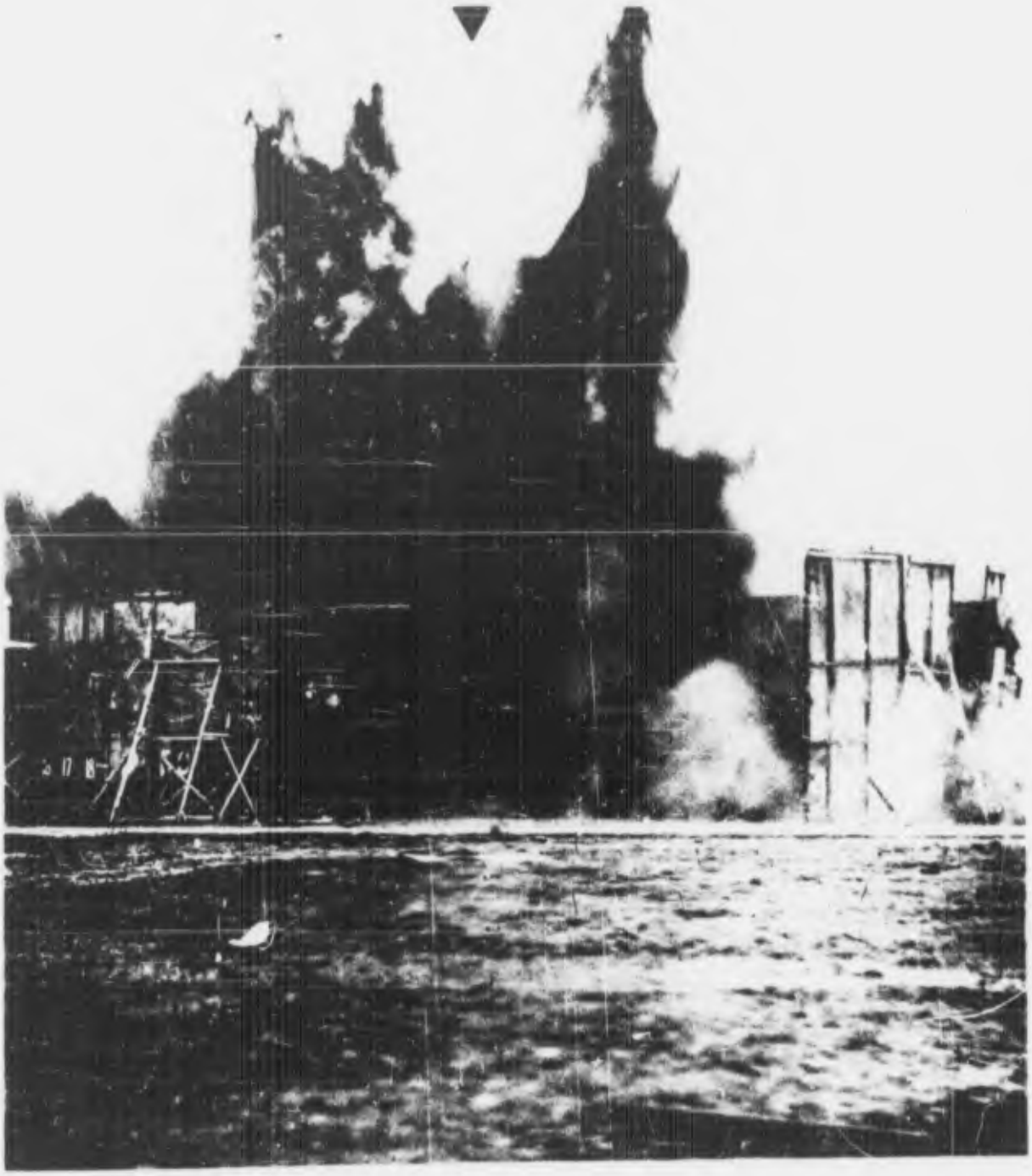

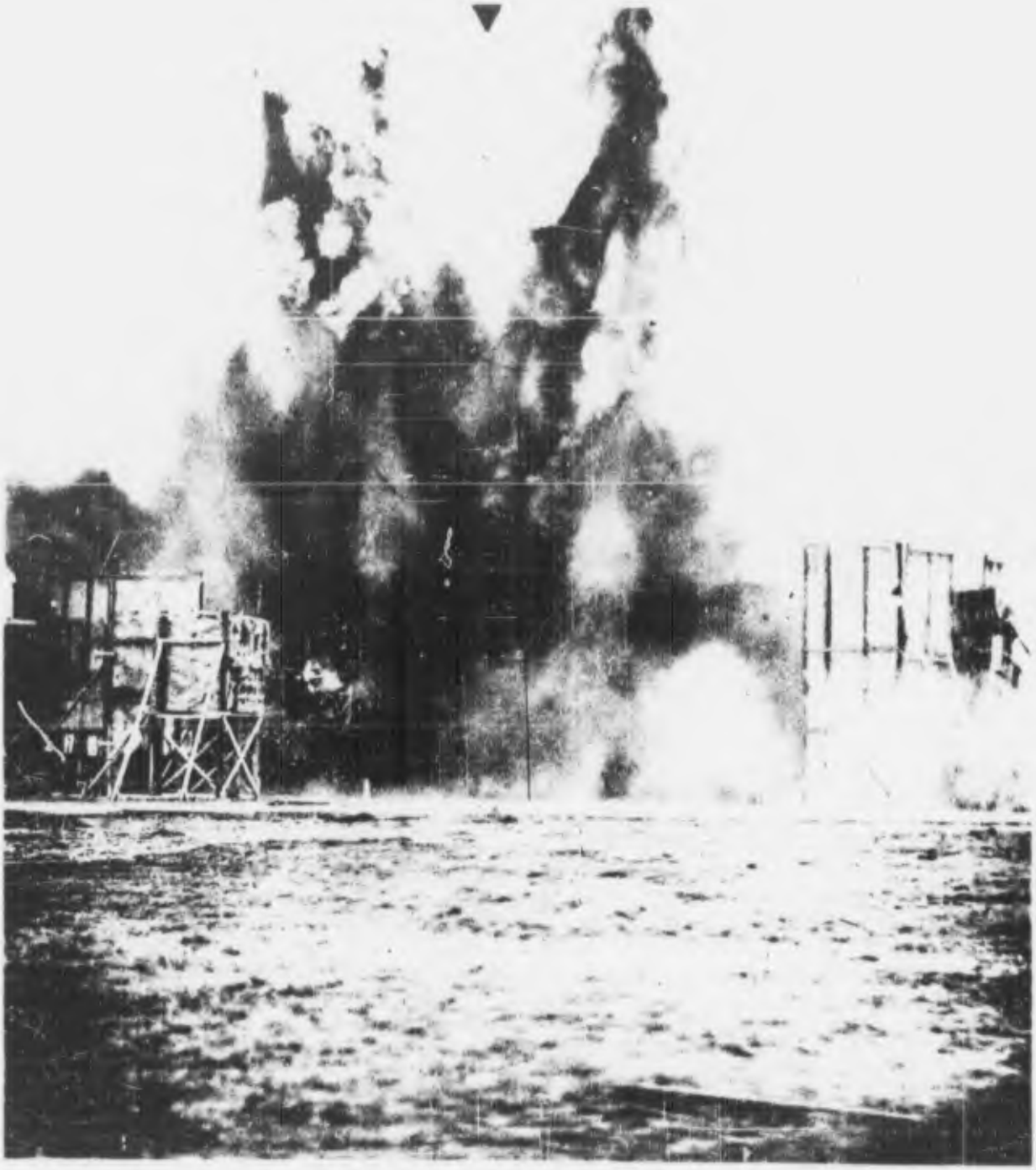

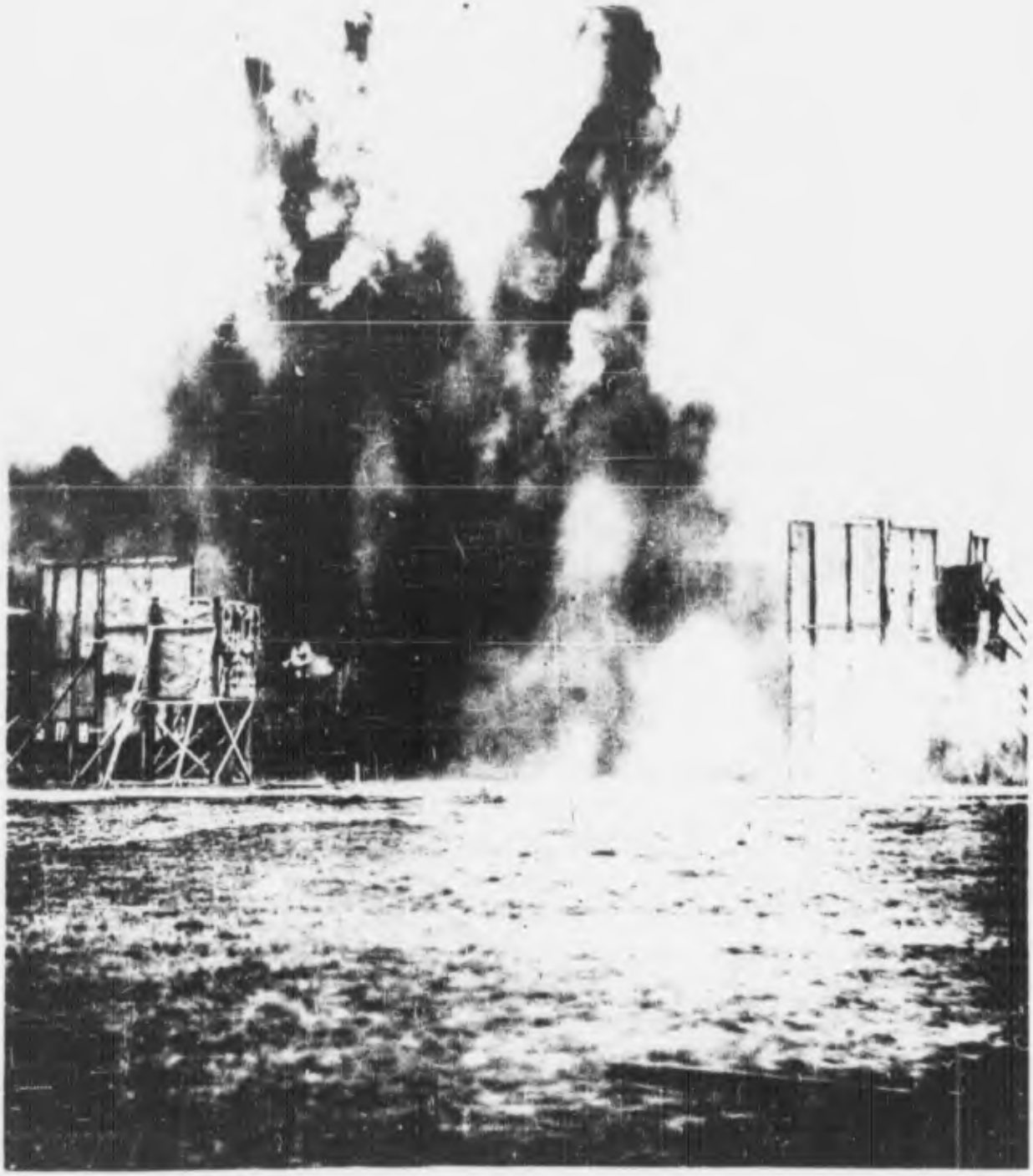

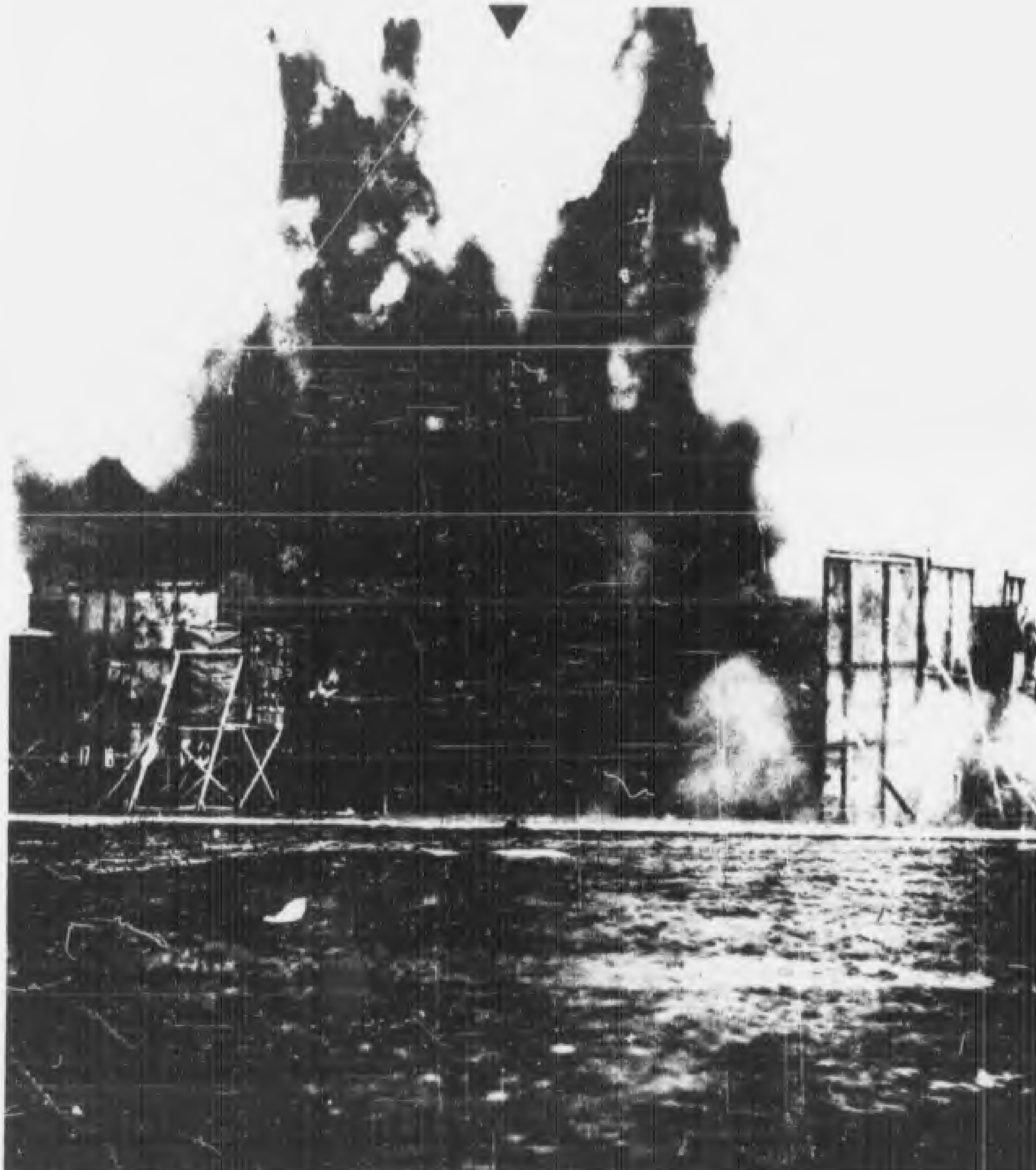

Figure 33
[illegible]D-72[illegible] - [illegible] issile, AAS[illegible]-1-7. Time: 0.[illegible] seconds after warhead jet cutting. Missile No. 1032.
[illegible]

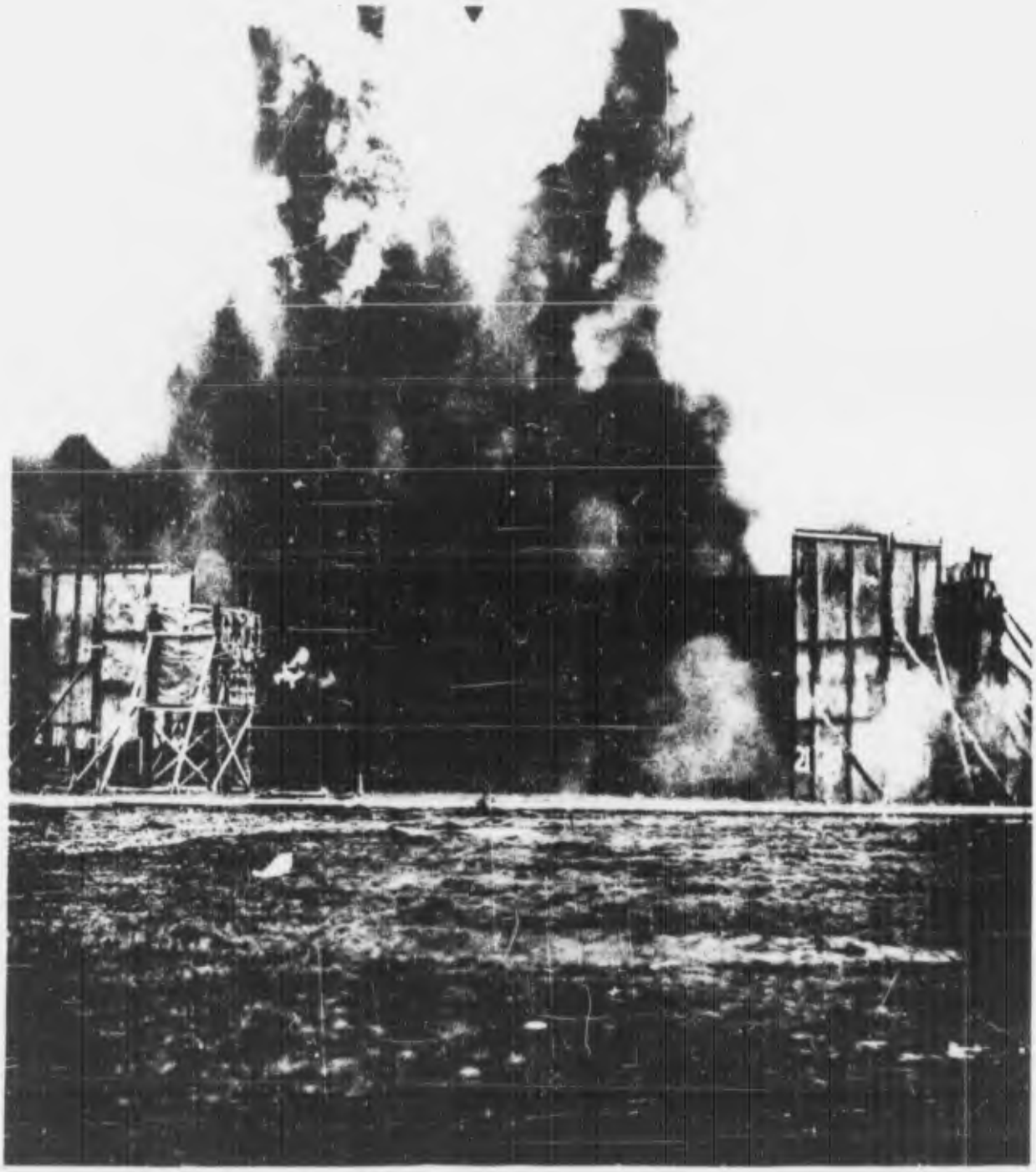

Figure 34
DDB-72562 - BULLPUP Missile XASM-N-7. Time: 0.46 seconds after warhead detonation. Missile No. 0032.
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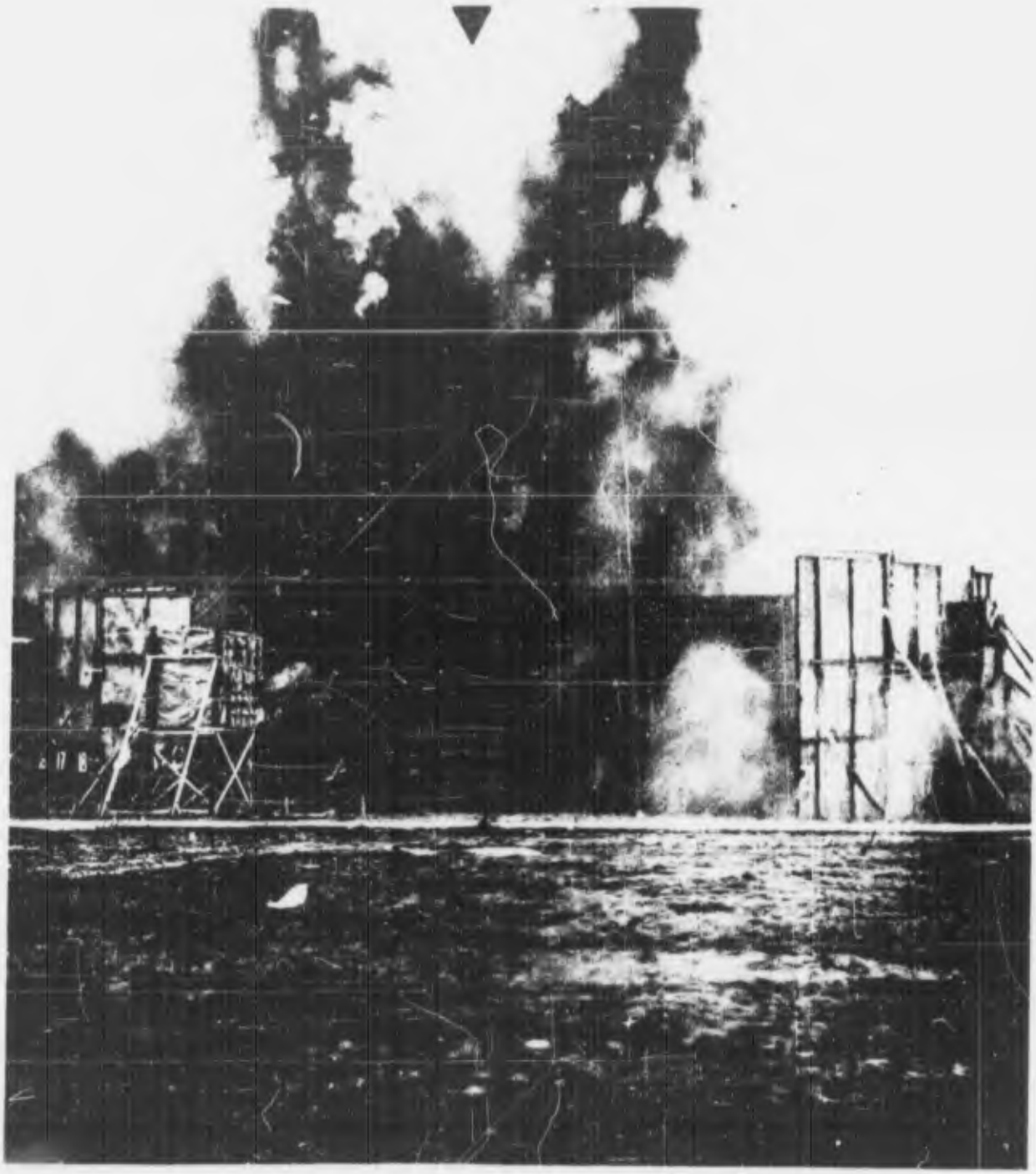

Figure 35

TMD-74563 - BULLPUP Missile, XASM-N-7. Time: 0.56 seconds after warhead detonation. Missile No. 0032.

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APPENDIX I

TABLE 8 PEAK PRESSURE DATA

40 Ft. Distances Fired 1-21-57 Missile No. 0032

		H.	V.		Avg.		P.S.I.		Avg. P.S.I.
(A)									
	1	.247	.243	=	.245	=	2.0	=	2.2
	2	.268	.265	=	.267	=	2.3		
(B)									
	1	.167	.171	=	.169	=	0.9	=	1.8
	2	.281	.289	=	.285	=	2.7		
(C)									
	1	.279	.288	=	.284	=	2.6	=	3.0
	2	.318	.328	=	.323	=	3.4		
(D)									
	1	.311	.314	=	.313	=	3.2	=	3.4
	2	.327	.336	=	.332	=	3.6		
(E)									
	1	.246	.255	=	.251	=	2.1	=	2.2
	2	.299	.234	=	.267	=	2.3		
(F)									
	1	.281	.280	=	.281	=	2.6	=	3.0
	2	315	.321	=	.318	=	3.3		

(A) Gauges at 0°

TABLE 9 PEAK PRESSURE DATA

40 Ft. Distances Fired 2-4-57 Missile No. 0031

		H.	V.		Avg.		P.S.I.		Avg. P.S.I.
(A)									
	1	.278	.294	=	.286	=	2.7	=	2.6
	2	.264	.284	=	.274	=	2.5		
(B)									
	1	.305	.308	=	.307	=	3.1	=	3.2
	2	.291	.335	=	.313	=	3.2		
(C)									
	1	.285	.267	=	.276	=	2.5	=	2.3
	2	.262	.249	=	.256	=	2.1		
(D)									
	1	.516	.509	=	.513	=	8.6	=	6.2
	2	.397	.341	=	.339	=	3.8		
(E)									
	1	.286	.291	=	.289	=	2.7	=	2.4
	2	.249	.243	=	.246	=	2.0		
(F)									
	1	.285	.293	=	.289	=	2.7		

APPENDIX J

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FRAGMENTATION OF COMPLETE BULLPUP GUIDED MISSILES XASN-N-7 CONTAINING 260 LB. FRAGMENTATION BOMBS AN-M81 AS WARHEADS, by F. D. Portner. 6 May 1957. 5 p. 9 tables, 35 figs.

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Two BULLPUP Missiles XASN-N-7, with empty rocket motors and containing 260 lb. fragmentation bombs AN-M81 as warheads, were statically detonated in a 40 ft. - 60 ft. radius field arena for the determination of fragmentation pattern, mass distribution and associated fragment velocities to aid in the study of hazard to launching aircraft.

I. Guided missile warheads - Fragmentation
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II. Title: BULLPUP

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