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AUTHORITY

Air Force Materiel Command ltr., dtd May 23, 2000 and AFI 61-204, dtd July 27, 1994.

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UNANNOUNCED

OF

AIR PROVING GROUND

EGLIN AIR FORCE BASE, FLORIDA

RDB Document Section. S37657

TEST CONDUCTED AT
EGLIN AIR FORCE BASE, FLORIDA

AD895879

CLASSIFICATION CHANGED TO
UNCLASSIFIED
AUTHORITY: Air Proving Ground Command (Eglin) letter dtd July 1/54

SUBJECT

TEST TO DETERMINE THE EFFECT OF ALTITUDE ON THE VERTIC PATTERN OF QUICK OPENING FRAGMENTATION BOMB CLUSTER (BIG IV, PHASE III - BOMBING PHASE)

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(9) Termination rept.,

(10) Howard E./Heinecke
Charles G./Mathison
John H./Linebaugh

(12) 31p.

HEADQUARTERS
AIR PROVING GROUND
Eglin Air Force Base, Florida

(16) AF—

PROJECT NO. 5471-1-5

(11) 31 Jan[redacted]49

(6)

TEST TO DETERMINE THE EFFECT OF ALTITUDE ON THE VERTICAL PATTERN OF QUICK OPENING FRAGMENTATION BOMB CLUSTERS (BIG IV, PHASE III - BOMBING PHASE),

1. Inclosed is copy of Termination Report of Air Proving Ground, Eglin Air Force Base, Florida, subject as above.

2. Object: To determine the degree of sighting accuracy necessary for effective employment of the standard M26 quick opening fragmentation bomb cluster in air-to-air bombing, and to determine the probability of a hit on an aircraft flying through a vertical pattern of twenty-five M26 clusters released in train.

3. Description: This test was initiated in response to a request from representatives of Project CHORE for information on the spatial pattern of fragmentation bomb clusters in air-to-air bombing. The test was designed to determine the effect of release altitude and drop distance upon the vertical and horizontal distribution of 20-lb. fragmentation bombs released in the M26 cluster in order to determine the optimum release interval and degree of sighting accuracy necessary for effective air-to-air employment of this munition.

4. Synopsis: It was concluded that pattern widths and heights of the M26 cluster increase with drop distance and are independent of release altitude, and that pattern lengths increase with both drop distance and release altitude; that the optimum release interval is approximately 8 clusters per second; that for zero sighting error in deflection the probability of at least one hit on a B-29 type airplane flying through an M26 cluster pattern after 1000 feet of fall is 90%; and that a 45-ft. deflection error reduces this hit probability to 50%. It was recommended that the findings of this test be made available to Project CHORE for further study of the feasibility of use of this munition in air-to-air bombing.

5. Inclosures:

Inclosure 1 - Termination Report

Harry E. Wilson, Col. U.S.A.F.
For
W. E. KEPNER
Major General, USAF
Commanding
D/C

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HEADQUARTERS
AIR PROVING GROUND
Eglin Air Force Base, Florida

TERMINATION REPORT

ON

TEST TO DETERMINE THE EFFECT OF ALTITUDE ON THE VERTICAL PATTERN OF QUICK OPENING FRAGMENTATION BOMB CLUSTERS (BIG IV, PHASE III - BOMBING PHASE)

PROJECT NO. 5471-1--5

Inclosure 1

[redacted]

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1. OBJECT:

To determine the degree of sighting accuracy necessary for effective employment of the M26 clustered 20-lb. fragmentation bomb in air-to-air bombing, and to determine the probability of a hit on an aircraft flying through a vertical pattern of twenty-five M26 clusters released in train.

2. INTRODUCTION:

a. Purpose: This test was initiated for the purpose of determining the effect of release altitude and distance of fall upon the vertical and horizontal distribution of 20-lb. fragmentation bombs released in clusters, in order to determine the optimum release interval and the degree of sighting accuracy necessary for effective employment of M26 clusters in air-to-air bombing. This project was authorized by CG, APG, 10 March 1948, in response to informal request by representatives of Project CHORE.

b. Description:

(1) The munition used was the standard quick opening M26 fragmentation bomb cluster, consisting of twenty AN-M41A1 20-lb. fragmentation bombs assembled in the M13 cluster adapter. The cluster opens immediately upon release when the arming wire is withdrawn from the cluster. Extra length arming wires were used to allow the cluster to clear the bomb bay before separating.

(2) Clusters were released from a B-29 airplane and photographed for the first two thousand feet of free fall.

3. CONCLUSIONS:

a. The spatial pattern dimensions of the quick opening M26 fragmentation bomb cluster, in width and height, increase with drop distance but are independent of release altitude. Pattern lengths increase both with drop distance and with release altitude (see paragraph 6c).

b. For zero sighting error in deflection, the probability of at least one hit on a B-29 type airplane flying through the vertical pattern of an M26 cluster is 90% for 1000 feet of fall, and 61% for 2000 feet of fall.

c. The optimum release interval for M26 clusters in air-to-air train bombing is approximately 8 clusters per second.

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d. An optimum train of twenty-five M26 clusters allows for a margin of error of ± 1.5 seconds in the release point.

e. A deflection error exceeding 45 feet for a drop distance of 1,000 feet and 25 feet for a drop distance of 2,000 feet will reduce the probability of hitting to below 50% for an optimum spaced train of M26 clusters.

4. RECOMMENDATION:

That the findings of this test be made available to Project CHORE for further study of the feasibility of use of the M26 fragmentation bomb cluster in air-to-air bombing.

5. RECORD OF TEST:

a. Testing was begun 21 April 1948 in accordance with Phase I of the Mission Schedule of the Test Program (Inclosure 2). On this phase a total of thirty-eight M26 clusters was individually released, resulting in twelve assessable drops from 10,000 feet and eleven from 25,000 feet. All releases were made at an indicated airspeed of 200 mph. No drops were made from 35,000 feet.

b. Phase II of the Mission Schedule was omitted.

c. Two missions of Phase III of the Mission Schedule were accomplished, in which one train of five M26 clusters was dropped from 10,000 feet and a similar train was dropped from 25,000 feet. The drop from 25,000 feet was not assessable.

d. Test was terminated on 11 January 1949 because of continuous difficulties involved in testing (photographic, aircraft maintenance and personnel shortages), and because it was felt that sufficient data had been obtained from Phase I of the test to form the basis for further theoretical studies.

6. DISCUSSION:

a. Photography:

(1) A preliminary mission of ten drops of M26 fragmentation clusters was run to determine the best camera arrangements for obtaining the necessary photographic coverage of the patterns. It was determined that side view photographs should be taken from a position 1,800 feet out to the side and 1,000 feet below the bombing airplane, using a horizontally mounted, remotely operated K-27 camera with 12-inch focal length lens, shooting out of the side door of the

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photographic airplane. This produced a photograph eighteen inches high and nine inches wide which showed both the bombing airplane (near the top of the picture) and the bombs of the cluster for approximately 2,000 feet of fall. Because of the relatively slow rate of recycling of this camera, not more than three exposures of any one cluster could be obtained, usually after approximately 500, 1,000 and 2,000 feet of fall.

(2) Front view photography was found to require a camera position 3,600 feet ahead and 1,000 feet below the bombing airplane, using a horizontally mounted, remotely operated K-18 camera with 24-inch focal length lens, installed in the tail section of a second photographic airplane. This also produced a picture eighteen inches high and nine inches wide, with bombing airplane near the top of the picture.

(3) The bombing airplane was equipped with a K-22 camera with 40-inch focal length lens, mounted with a 10° tilt to the rear of the vertical.

(4) Positioning of the two photographic airplanes relative to the bombing airplane was accomplished by use of optical stadiameters, the bombing airplane ranging on the photographic airplane ahead of it, and the side photographic airplane ranging on the bombing airplane.

(5) As the test progressed, front view photography proved to be impractical because the projected area of the individual bombs from this view was too small to be visible in the photographs. Because of the low percentage of assessable exposures obtained from this position, use of the forward photographic airplane was abandoned.

b. <u>Method of Assessment</u>:

Pattern lengths and widths were obtained from assessment of the vertical camera photographs, and heights from the side views. Since overall dimensions were susceptible to wide variations (particularly in length) because of occasional erratic bombs, overall dimensions were not used as an index of pattern size. Instead, the approximate 95% limits of the distribution were used to express pattern dimensions. These limits were obtained statistically by computation of the standard deviation (σ) about the pattern MPI ($\bar{X}$), the approximate 95% limits for any dimension being $\bar{X} \pm 2\sigma$. Hence, $4\sigma_L$ was taken as representing the pattern length, $4\sigma_W$ as pattern width, and $4\sigma_H$ as pattern height. This parallelepiped, on the average, included 17 bombs (.95 x 95 x 95 = .85%) of the 20-bomb cluster.

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c. **Cluster Pattern Dimensions:**

(1) Following is a tabulation of computed pattern sizes for the twelve assessable clusters released from 10,000-ft. altitude. Eleven measurements of pattern length and width, and five measurements of pattern height were obtained for drop distances of 1,000 feet and for 2,000 feet.

	CLUSTER PATTERN DIMENSIONS - RELEASE ALTITUDE 10,000 FT.					
	DROP DISTANCE 1,000 FT.			DROP DISTANCE 2,000 FT.		
	Length Ft.	Width Ft.	Height Ft.	Length Ft.	Width Ft.	Height Ft.
	77	39	—	160	48	—
	108	50	—	174	93	—
	100	43	—	177	71	—
	47	41	—	76	76	—
	63	43	—	134	89	—
	54	40	61	97	67	133
	61	38	—	89	60	—
	100	33	47	164	56	78
	92	43	—	166	61	—
	—	—	38	—	—	89
	82	25	72	148	41	130
	102	51	46	170	86	79
Mean	80.5	40.5	52.8	141.4	68.0	101.8
3σ **Mean**	±19.5	±6.8	±18.2	±33.5	±15.3	±36.8

(2) Following is a tabulation of computed pattern sizes for the eleven assessable drops from 25,000-ft. altitude. Nine measurements of pattern length and width and seven measurements of pattern height were obtained for each drop distance.

[redacted]

	CLUSTER PATTERN DIMENSIONS - RELEASE ALTITUDE 25,000 FT.					
	DROP DISTANCE 1,000 FT.			DROP DISTANCE 2,000 FT.		
	Length Ft.	Width Ft.	Height Ft.	Length Ft.	Width Ft.	Height Ft.
	—	—	45	—	—	84
	96	41	48	182	56	70
	88	35	55	135	56	89
	109	32	—	167	52	—
	139	47	—	224	69	—
	111	31	—	175	54	—
	130	46	—	204	76	—
	126	50	59	244	84	118
	74	42	47	125	66	95
	118	48	54	212	79	96
	—	—	43	—	—	67
Mean	110.1	41.3	50.1	185.3	65.8	88.4
3σ Mean	±21.7	±7.2	±6.7	±39.7	±11.9	±19.6

(3) From a comparison of the mean dimensions and their 3σ (99.7%) confidence limits tabulated at the bottom of the two foregoing tables, it appears that pattern width and pattern height increase with drop distance, and are more or less independent of release altitude. Pattern length, however, increases with both drop distance and release altitude, the pattern length for a given drop distance being some 30% to 40% greater when released from 25,000 feet than when released from 10,000 feet. Since all drops were made at approximately the same indicated airspeed (200 mph), the effect of indicated airspeed, if any, on pattern dimensions was not measurable. The average cluster pattern is characterized by being long in length and narrow in width. Height averages about 25% greater than width for a drop distance of 1,000 feet, and 40% greater for a drop distance of 2,000 feet. Combining the drops from 10,000 and 25,000 feet and considering only width and height, the average pattern dimensions become as follows:

Drop Distance	Pattern Width	Dimensions Height
1000'	41'	51'
2000'	67'	94'

d. Pattern Densities:

The distribution of bombs in the average cluster pattern after 1,000 feet and 2,000 feet of fall is shown in Inclosure 3. In width and depth the bombs are more or less normally distributed about the pattern center. In length, however, the distribution tends to be flat-topped and with long tails on either end.

e. Vertical Plane Patterns:

By use of the distribution curves of Inclosure 3 and the pattern dimensions of paragraph 6c, it was possible to construct vertical plane bomb patterns as seen by the target airplane. Since pattern widths and depths were approximately the same for 10,000-ft. releases as for 25,000-ft., the distribution curves for these two altitudes were combined to obtain the vertical plane pattern densities shown in Inclosure 4. The vertical plane patterns have been sub-divided into cells 10 feet wide and 10 feet high, except for the end cells in each row and column which are smaller. The upper figure in each cell represents the cell density (bombs per cell), while the lower figure represents the contribution of that cell towards producing hits on a B-29 type airplane flying centrally through the given cell row (cell density times fraction of cell area occupied by airplane silhouette). The lower figure is also assumed to be the probability of a hit occurring in the given cell. Subtracting this figure from unity gives the probability of a miss for the cell.

f. Hit Probabilities:

(1) The total number of expected hits for a given cell row is the sum of the lower figures for the row (tabulated in the first column to the right of the pattern in Inclosure 4, Page 1). Although the expected hits may exceed unity for a cell row, the probability of hitting for that row is not necessarily 100%. To arrive at the probability of hitting for any row, the probabilities of missing for each of the cells of the row must be multiplied together (second column to the right of the pattern) and subtracted from unity. This result is tabulated in the third column to the right of the pattern. Since the target airplane has an equal chance of passing through any one of the cell rows, and since there are five rows to the pattern, the cell row probabilities are added together and divided by 5. This gives a probability of 90.04% of at least one hit for the pattern as a whole, while the expected number of hits is 2.02.

(2) From the vertical plane pattern for the 2,000-ft. drop distance (Inclosure 4, Page 2) a similar procedure, not illustrated, gives a probability of only 61% of at least one hit for the pattern as a whole. In this case the expected number of hits is 0.94.

(3) The above hit probabilities were computed on the basis of zero deflection error (flight path of target airplane centered laterally with respect to the bomb pattern). The hit probabilities for various assumed deflection errors are given in Inclosure 5. Because of the narrow width of the pattern, hit probabilities fall off fast with increasing deflection error, reducing to zero for a 90-ft. deflection error in the case of the 1,000-ft. drop distance, and for 104-ft. error in the case of the 2,000-ft. drop. If the deflection error exceeds 45 feet for a 1,000-ft. drop or 25 feet for a 2,000-ft. drop, the probability of hitting becomes less than 50%. Hence, extreme accuracy in deflection is required if this method of attack is to be effective.

(4) Accuracy in range is not as critical as in deflection because the depth of the pattern can be extended by releasing a large number of clusters in train. (The B-45 can carry twenty-seven M26 clusters.) Inclosure 6 shows a side view plot of five M26 clusters released in train from 10,000 feet at the rate of 4.5 clusters per second. The drop distance in this case is approximately 540 feet to the uppermost cluster and 800 feet to the lowermost cluster. The total height of the pattern is 279 feet. Pattern densities for each ten feet of height are indicated by the bar diagram at the right of the plot. It is seen that several gaps have occurred in the lower part of the pattern, an indication that the release frequency was too slow for optimum pattern densities. Since the drop distance was less than 1,000 feet, the pattern would have thinned out still more at 1,000 feet. It is therefore believed that a more effective release interval would have been about eight per second. Using this interval, a train of 25 clusters would allow for a margin of error of ± 1.5 seconds in the release point. However, unless a sighting means or bombing technique can be devised which will eliminate the possibility of deflection errors exceeding 50 feet, the chance of hitting will remain below 50% despite the large number of bombs dropped. The possibility of the target

airplane employing evasive action further complicates the sighting problem in deflection.

7. INCLOSURES:

Inclosure 1 - Test Historical Data
Inclosure 2 - Test Program
Inclosure 3 - Pattern Density Curves
Inclosure 4 - Vertical Plane Patterns
Inclosure 5 - Hit Probabilities
Inclosure 6 - Train Pattern

APG PROJECT NO. 5471-1--5

TEST TO DETERMINE THE EFFECT OF ALTITUDE ON THE VERTICAL PATTERN OF QUICK OPENING FRAGMENTATION BOMB CLUSTERS (BIG IV, PHASE III - BOMBING PHASE)

Prepared by: Howard E. Heinecke
HOWARD E. HEINECKE
Physicist
Project Officer

Concurred in: James P. Martin
JAMES P. MARTIN
1st Lt., USAF
Test Officer

Approved by: James T. Stewart
JAMES T. STEWART
Lt. Colonel, USAF
Chief, Bombing Projects Branch

Approved by: Thomas C. Conroy
THOMAS C. CONROY
Lt. Colonel, USAF
Asst. Deputy for Operations
Chief, Proof Test Division

Approved by: K K Compton
K. K. COMPTON
Colonel, USAF
Deputy for Operations

Harry E. Wilson, Col. USAF
D/C
For
W. E. KEPNER
Major General, USAF
Commanding

TEST HISTORICAL DATA

APG PROJECT NO. 5471-1—5

1. AUTHORITY:

Commanding General, Air Proving Ground, Eglin Air Force Base, Florida.

2. ACTIVATION DATE: 27 May 1948

3. EQUIPMENT RECEIVED: M26 clusters on hand at Eglin AF Base.

4. SUSPENSION: None

5. TERMINATION: 11 January 1949

6. FLYING HOURS: 46:45

7. GROUND HOURS: None

8. CLIMATIC CONDITIONS:

This test was conducted only under temperate climatic conditions.

9. RELATED TESTS: None

Inclosure 1

HEADQUARTERS
AIR PROVING GROUND
Eglin Air Force Base, Florida

26 April 1948

SUBJECT: Test to Determine the Effect of Altitude on the Vertical Pattern of Quick Opening Fragmentation Bomb Clusters, Project No. 5-47-1-2B.

TO: Commanding Officer
611th AF Base Unit
Eglin Air Force Base, Florida

1. GENERAL:

a. Introduction—It is desired to determine the effect of the altitude of release and the distance of fall upon the vertical and horizontal distribution of bombs released in clusters. This information is needed to determine the optimum release interval and the degree of sighting accuracy necessary when employing M26 clusters in air-to-air bombing.

b. Description—The vertical plane pattern of the 20-lb. fragmentation bomb, when used in a quick opening M26 frag cluster, will be determined for drop heights of 1000 and 2000 feet beneath the bombing aircraft when released at altitudes of 10,000, 25,000 and 35,000 feet.

c. Classification: Secret

d. Priority of Test: 1B

e. Project Officer: 1st Lt. Charles G. Mathison

f. Test Officer: Capt. John H. Linebaugh

2. OBJECT: To determine the degree of sighting accuracy necessary for successful employment of the M26 clustered 20-lb. fragmentation bombs in air-to-air bombing, and to determine the probability of a hit on an aircraft flying through a vertical pattern of twenty-five M26 clusters released in train.

3. SCOPE OF TEST:

a. Determine the vertical plane pattern of the quick opening M26 frag cluster.

b. Determine the optimum release interval for M26 fragmentation clusters in air-to-air bombing.

c. Establish the vertical pattern of 20-lb. fragmentation bombs when used in the 500-lb. frag cluster (M26) released in train from various altitudes using the optimum interval.

d. Determine the probability of a hit on a P-80B or B-29 aircraft flying through the 90 per cent vertical pattern. This involves determining the vertical and horizontal dispersions and the areas of the vertical plane pattern containing 90 per cent of the frag bombs.

4. METHOD OF CONDUCTING TEST:

a. PRELIMINARY PHASE:

(1) A K-27 still camera will be mounted horizontally in the tail section of a photographic aircraft so as to obtain photographs approximately 90 degrees to the heading of the bombing aircraft. A K-24 still camera will be mounted horizontally in the tail gunner's position of a second photographic airplane so as to obtain photographs 180 degrees to the heading of the bombing aircraft. The bombing aircraft will be equipped with a vertical still camera capable of obtaining photographs of individual bombs from M26 clusters, from point of release to a point 2000 feet beneath the bombing aircraft. Cameras will be started innediately on "bombs away".

(2) All bomb clusters, each individual fragmentation bomb, and fins and arming wires will be inspected prior to each mission.

(3) Prior to each mission a briefing will be held with the bombardier, pilots, and photographers of all participating aircraft to familiarize all personnel with purpose and details of mission.

(4) All frag bombs and fins will be painted to produce maximum photographic contrast if this appears necessary after the trial mission(s).

(5) All inert frag bombs will contain black powder spotting charges and will be sand-loaded to 19.5-lbs. ± .5-lbs.

(6) Bombing aircraft will be equipped with Radio Release Point Indicator.

(7) At least five drops will be made on one or more trial missions to perfect the technique of flying the photo ship in relation to the dropping aircraft, to

check both the boresighting of the cameras and the photographic definition, and to help the assessment personnel work out their procedures. Any trial mission which is successful photographically will be accepted as a mission of the main phase, providing all test conditions for the mission are met.

b. <u>MAIN PHASE</u>:

(1) All missions for record will be run in accordance with the Mission Schedule attached as Inclosure 1. Additional missions will be scheduled as required after study of results of Phase III.

(2) Bombing aircraft used on missions at 35,000 feet will be B-50 type. Missions conducted at 10,000 and 25,000 feet may employ either B-50 or B-29 aircraft. Photographic aircraft will be B-29's.

(3) Bomb runs will be made on a heading which will produce maximum photographic coverage (i.e., perpendicular to the line of the sun).

(4) The aerial phase of the test will be divided into three phases.

(a) Phase I will consist of dropping individual M26 frag clusters to determine the dispersion of the bombs within the cluster. Five clusters will be dropped at 180 m.p.h. IAS and five clusters will be dropped at 220 m.p.h. IAS at each altitude.

(b) Phase II will consist of dropping five M26 clusters in train at each altitude at 220 m.p.h. IAS to determine the train pattern. From a comparison of the results of Phases I and II, the optimum train interval will be determined and all successive missions will use this optimum train release interval.

(c) Phase III will consist of dropping twenty-five M26 frag clusters in train using the optimum release interval at 220 m.p.h. IAS from the three test altitudes.

(5) Bombing aircraft will take vertical photographs of each of the bomb trains from release to 2000 feet beneath the aircraft. Photographic aircraft A will fly 1000 feet below, 2000 feet to the side (toward

sun), and parallel to the bombing aircraft and photographic aircraft B will fly 1000 feet below and 1000 feet ahead of the bombing aircraft, and photograph cluster trains from time of release to a point 2000 feet beneath the bombing aircraft.

(6) Minor deviations from the Test Program may be made upon concurrence of the Project and Test Officers.

c. FINAL PHASE:

(1) Photographs will be analyzed to determine the dispersion in pattern area of the M26 frag cluster and the cluster trains for each altitude and airspeed employed.

(2) Vertical patterns will be analyzed to determine the probability of a hit on a P-80 or B-29 aircraft flying through the pattern which includes 90 per cent of the frag bombs dropped.

(3) The following will be determined from analysis of information obtained: the probability of a hit for head-on, beam and stern attack when employing optimum spaced trains of twenty-five quick opening 500-lb. M26 frag clusters released from various altitudes against P-80 or B-29 type aircraft flying 1000 and 2000 feet below the attacking aircraft.

(4) The Project Officer, in conjunction with the Test Officer, will prepare a Final Report.

5. RECORDS:

a. Records will be maintained by the Project Officer, Test Officer and flight crews to fully record all data obtained or observed during these tests.

b. Any unusual phenomena will be thoroughly investigated and reported.

c. Complete Bombing Flight Records will be accomplished for each mission.

d. Continuous photographs will be taken by the bombing aircraft and photographic aircraft of all bombs dropped, from point of release until bombs are 2000 feet beneath the bombing aircraft.

e. Photographers will keep accurate logs of all missions and all releases and will make sure that all exposed film is properly labeled.

Negatives will be titled to include project number, mission number, date, time and altitude.

f. Necessary diagrams, bomb plots, charts, tabulations of data collected, and analysis of all information will be accomplished by Measurement and Analysis Branch.

g. Test Trouble Reports will be accomplished when necessary.

6. DISTRIBUTION LIST FOR TEST PROGRAM, ANNEX, AND APPENDICIES WILL BE AS FOLLOWS:

a.	Chief, Bombing Projects Branch	2 copies
b.	Commanding Officer, 611th AF Base Unit	1 copy
c.	Operations Officer, 611th AF Base Unit	1 copy
d.	Asst. A-3 (Climatic)	1 copy
e.	Air Ordnance Officer	1 copy
f.	Naval Liaison Officer	1 copy
g.	611th BU, Sq G (Photographic)	1 copy
h.	611th BU, Sq G (M&A)	1 copy
i.	611th BU, Sq E (Heavy)	1 copy
j.	611th BU, Sq A, Hqs. (Range)	1 copy

2 Incls:

Incl 1 - Mission Schedule
Incl 2 - Test Program Annex (w/d)

PROJECT NO. 5-47-1-2B

TEST TO DETERMINE THE EFFECT OF ALTITUDE ON THE VERTICAL PATTERN OF QUICK OPENING FRAGMENTATION BOMB CLUSTERS

Prepared by: Charles G. Mathison
CHARLES G. MATHISON
1st Lt., USAF
Project Officer

Prepared by: John H. Linebaugh
JOHN H. LINEBAUGH
Captain, USAF
Test Officer

Reviewed by: Robert R. Swain
for WILLIAM J. KILPATRICK, JR.
Major, USAF
Chief, Measurement & Analysis

Approved by: Theodore W. Tucker
THEODORE W. TUCKER
Lt. Colonel, USAF
Chief, Bombing Projects Branch

Approved by:
HARRY L. DONICHT
Colonel, USAF
Chief, Proof Test Division

MISSION SCHEDULE

PHASE I

MISSION NO.	RANGE	TRUE ALTITUDE	INDICATED AIRSPEED	BOMB LOAD	FUZING	METHOD OF RELEASE	TRAIN INTERVAL	REMARKS
1	40	10,000	180 (5 releases) 220 (5 releases)	10 M26	AN-M110A1	Individual Clusters	None	Photograph bombs from release to a point 2000 ft. below bombing aircraft from the side (photographic aircraft) and from above (bombing aircraft). Load bombs in quadrants 1 and 3, if weight and balance permit. Arming wire will be of sufficient length to permit all clusters to open after leaving bomb bay.
2	40	25,000	180 (5 releases) 220 (5 releases)	10 M26	AN-M110A1	Individual Clusters	None	Same as mission #1.
3	40	35,000	180 (5 releases) 220 (5 releases) or maximum.	10 M26	AN-M110A1	Individual Clusters	None	Same as mission #1.

MISSION SCHEDULE (cont'd)

PHASE II

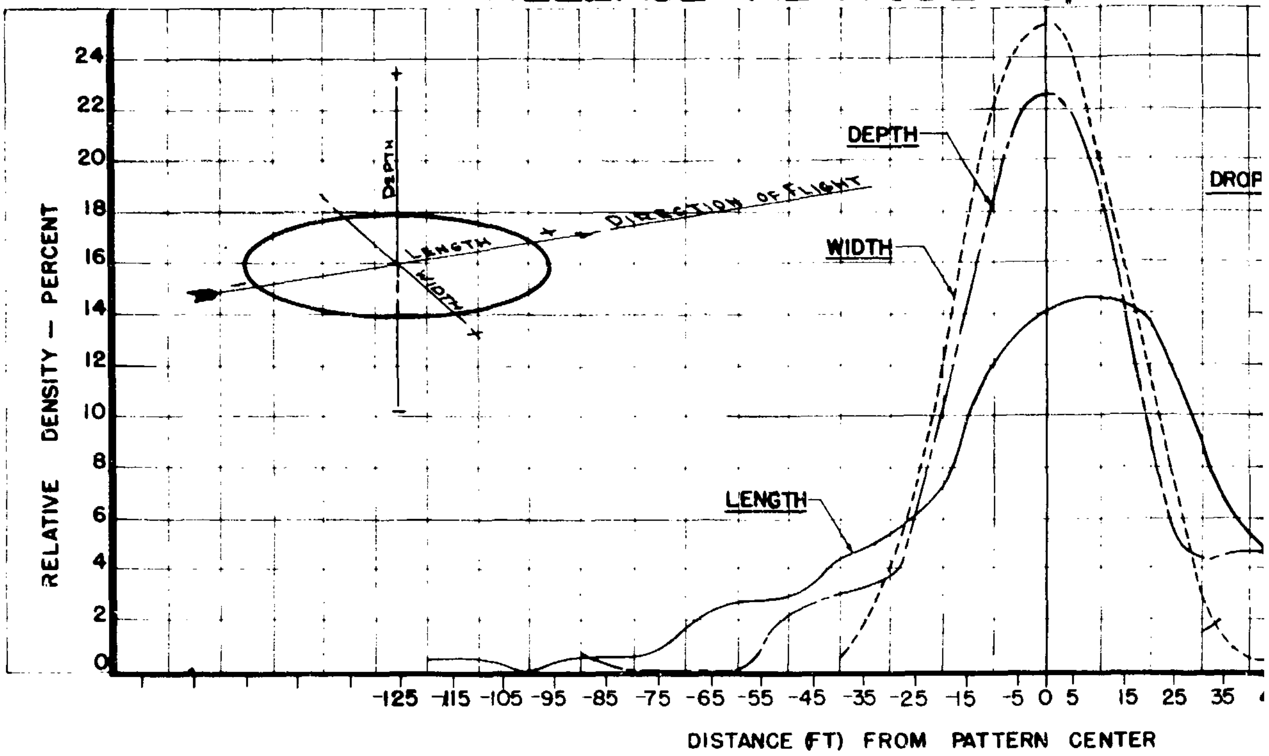
MISSION NO.	RANGE	TRUE ALTITUDE	INDICATED AIRSPEED	BOMB LOAD	FUZING	METHOD OF RELEASE	TRAIN INTERVAL	REMARKS
4	40	10,000	220	15 M26 inert, black spotting charge.	AN-M110A1	5 Clusters in train. 5 Clusters in train. 5 Clusters in train.	1/20 sec. 1/10 sec. 1/6 sec.	Photograph bombs from release to a point 2000 ft. below bombing aircraft from the side (photographic aircraft) and from above (bombing aircraft). Load bombs in quadrants 1 and 3, if weight and balance permit. Arming wire will be of sufficient length to permit all clusters to open after leaving bomb bay.
5	40	25,000	220	15 M26 inert, black spotting charge.	AN-M110A1	5 Clusters in train. 5 Clusters in train. 5 Clusters in train.	1/20 sec. 1/10 sec. 1/6 sec.	Same as mission #4.
6	40	35,000	220	15 M26 inert, black spotting charge.	AN-M110A1	5 Clusters in train. 5 Clusters in train. 5 Clusters in train.	1/20 sec. 1/10 sec. 1/6 sec.	Same as mission #4.

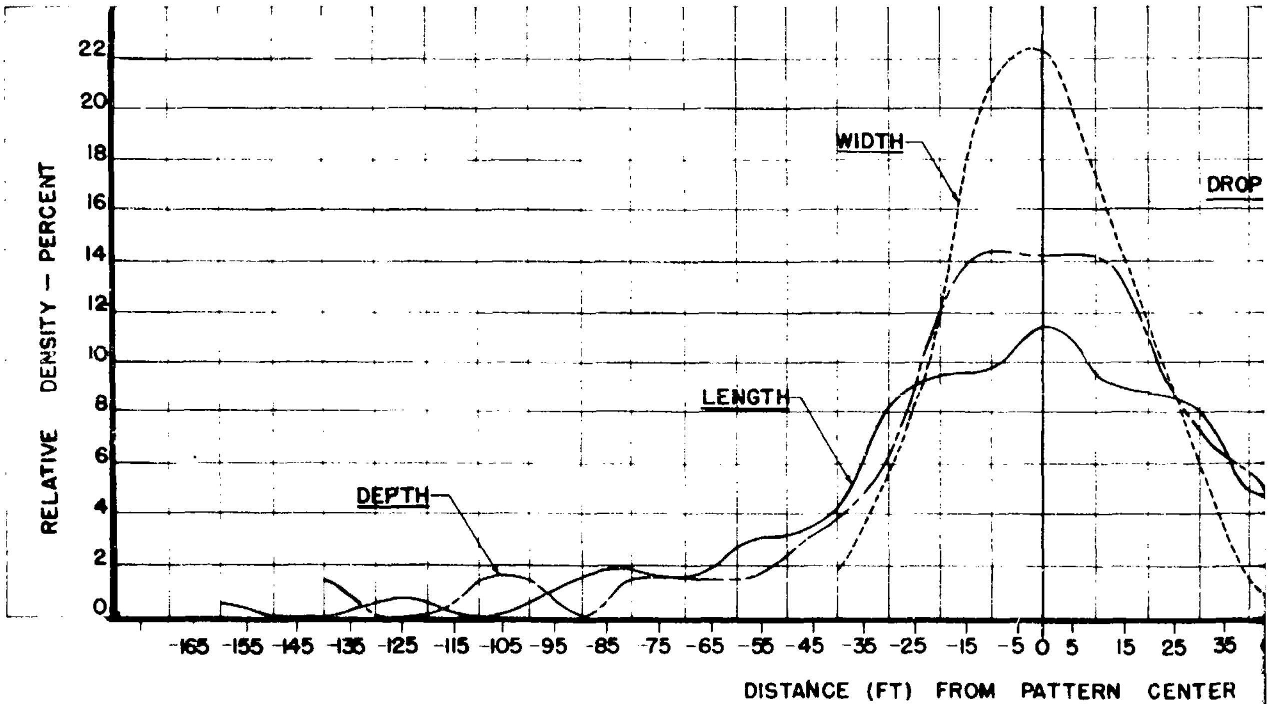
MISSION SCHEDULE (cont'd)

PHASE III

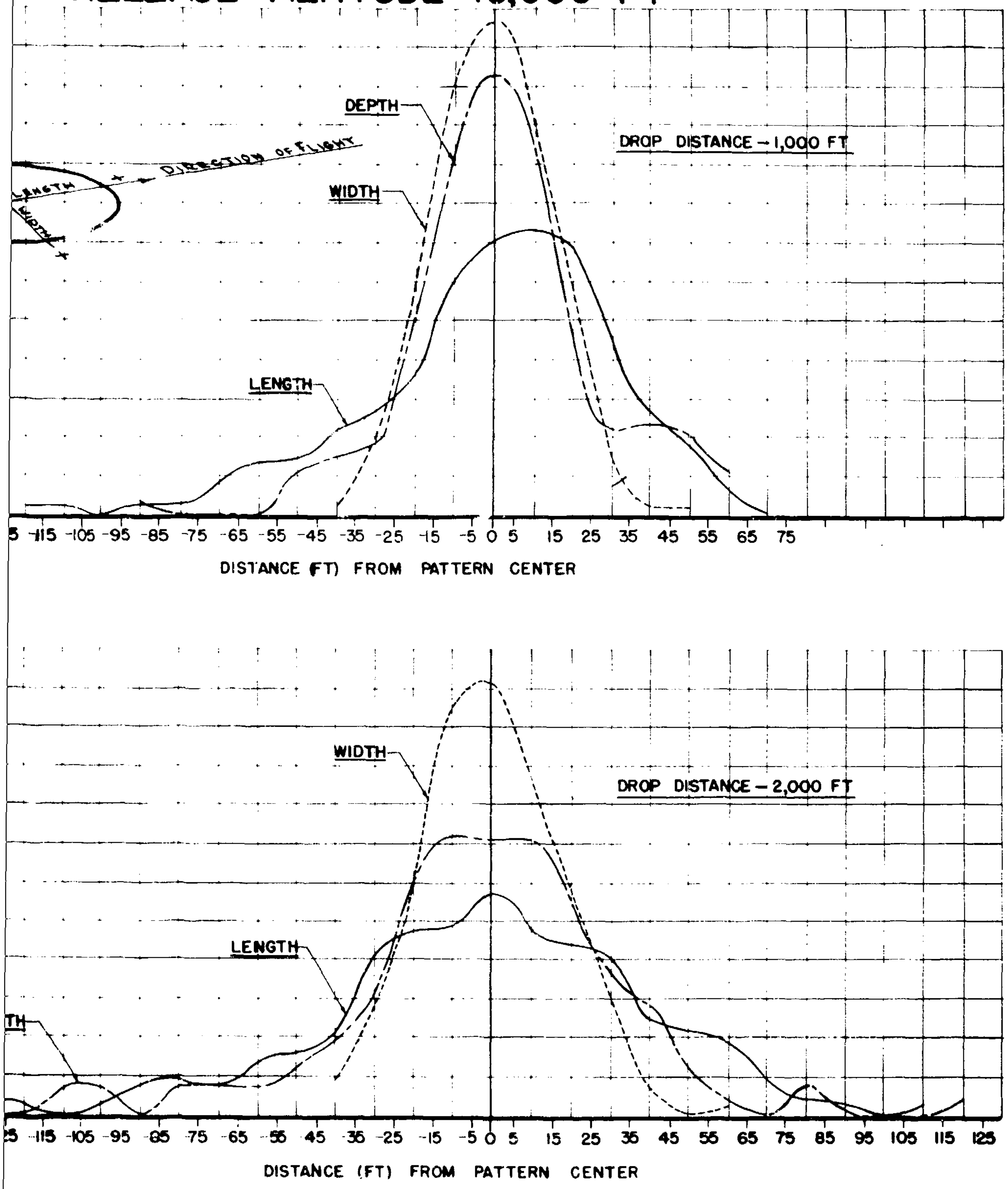
MISSION NO.	RANGE	TRUE ALTITUDE	INDICATED AIRSPEED	BOMB LOAD	FUZING	METHOD OF RELEASE	TRAIN INTERVAL	REMARKS
7	40	10,000	220	25 M26 inert, black spotting charge.	AN-M110A1	25 Clusters in train.	Optimum (to be prescribed)	Same as mission #4, except load bombs in quadrants 1, 2, and 3.
8	40	25,000	220	25 M26 inert, black spotting charge.	AN-M110A1	25 Clusters in train.	Optimum (to be prescribed)	Same as mission #7.
9	40	35,000	220	25 M26 inert, black spotting charge.	AN-M110A1	25 Clusters in train.	Optimum (to be prescribed)	Same as mission #7.
10	40	35,000	220	25 M26	AN-M110A1	25 Clusters in train.	Optimum (to be prescribed)	Same as mission #7.

PATTERN DENSITIES *for* DROP DISTANCES OF 1,
RELEASE ALTITUDE 10,000 FT



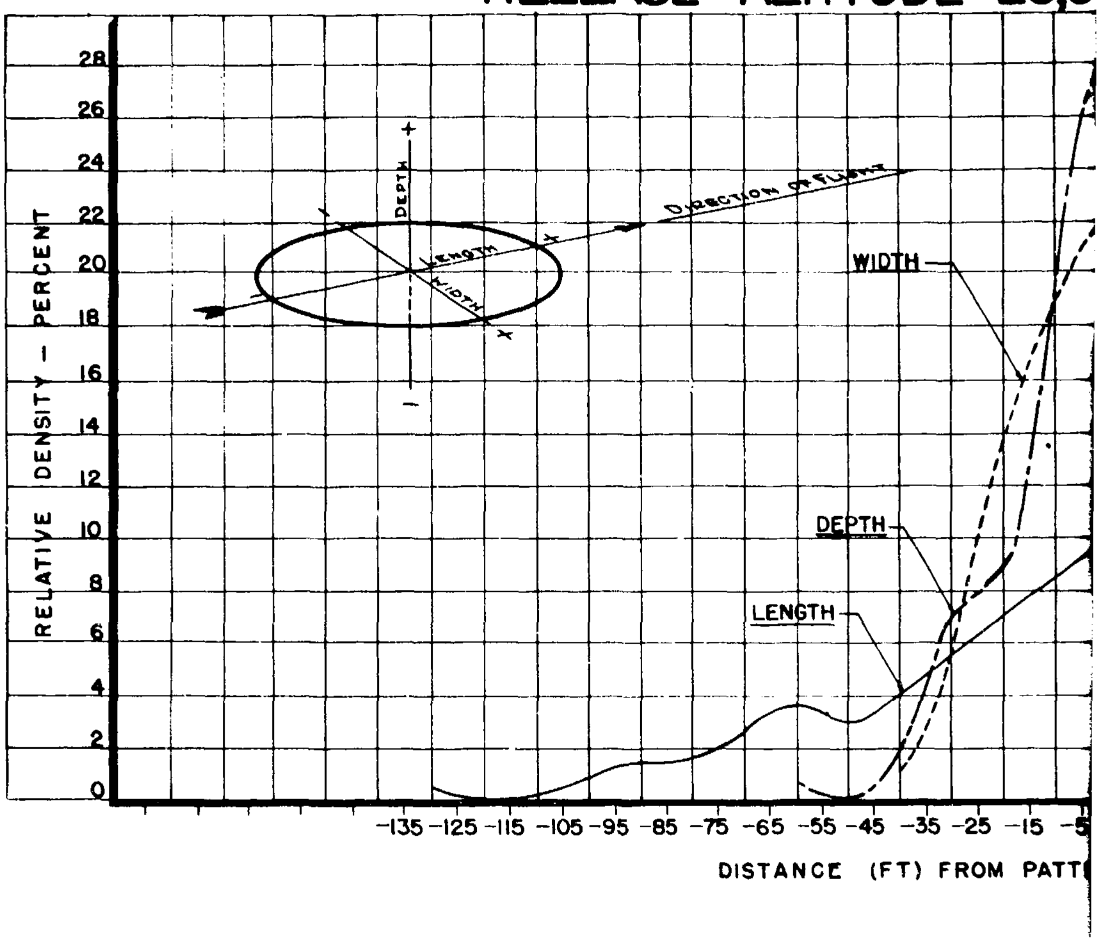


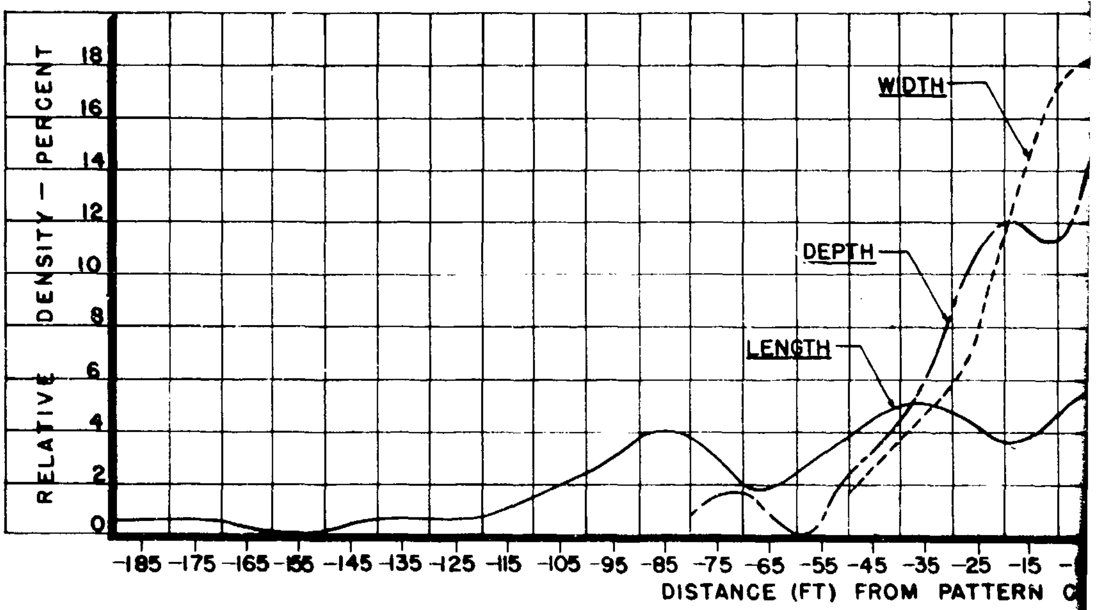
SITIES for DROP DISTANCES OF 1,000 & 2,000 FT
RELEASE ALTITUDE 10,000 FT



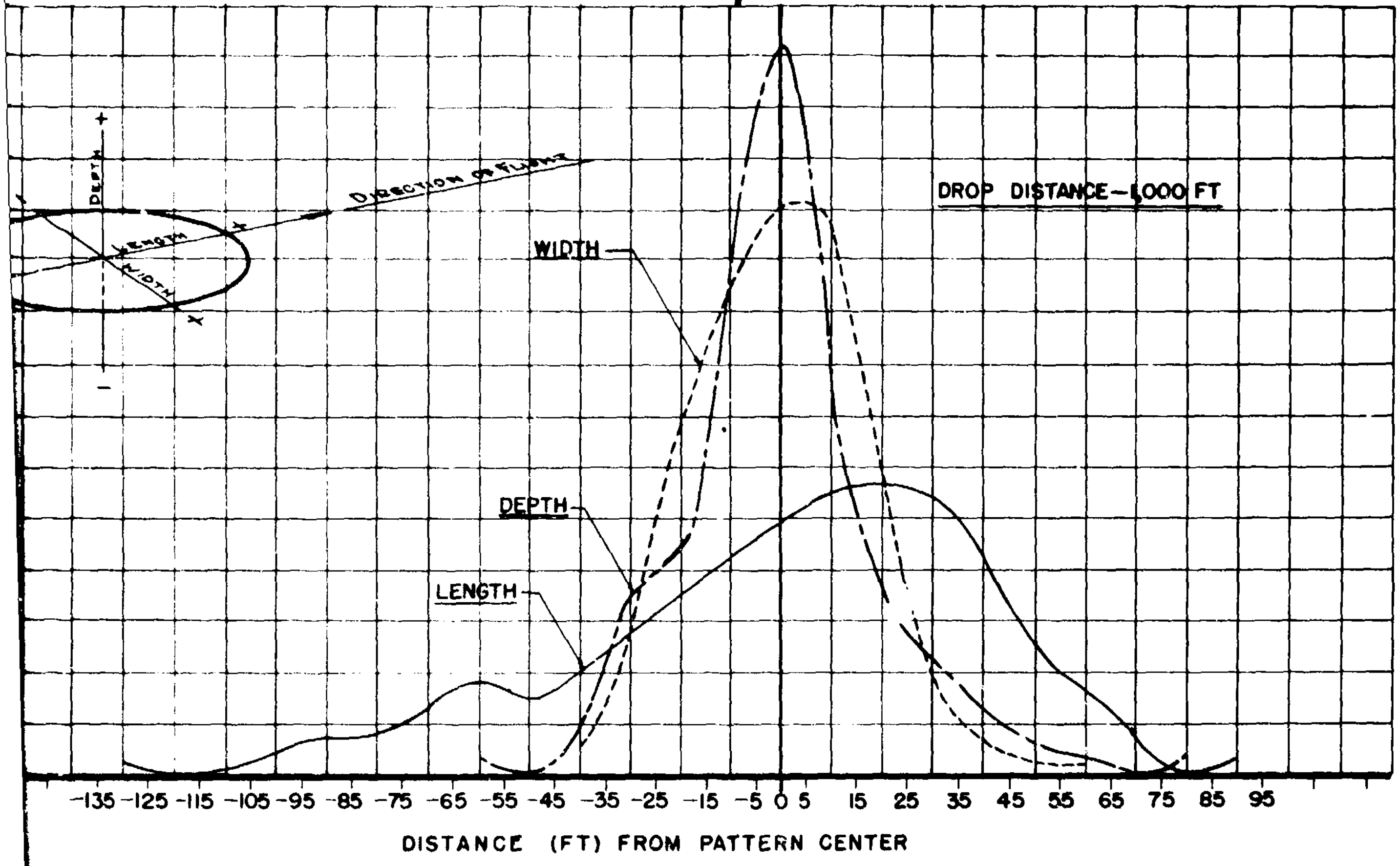
PATTERN DENSITIES for DROP DISTANCE

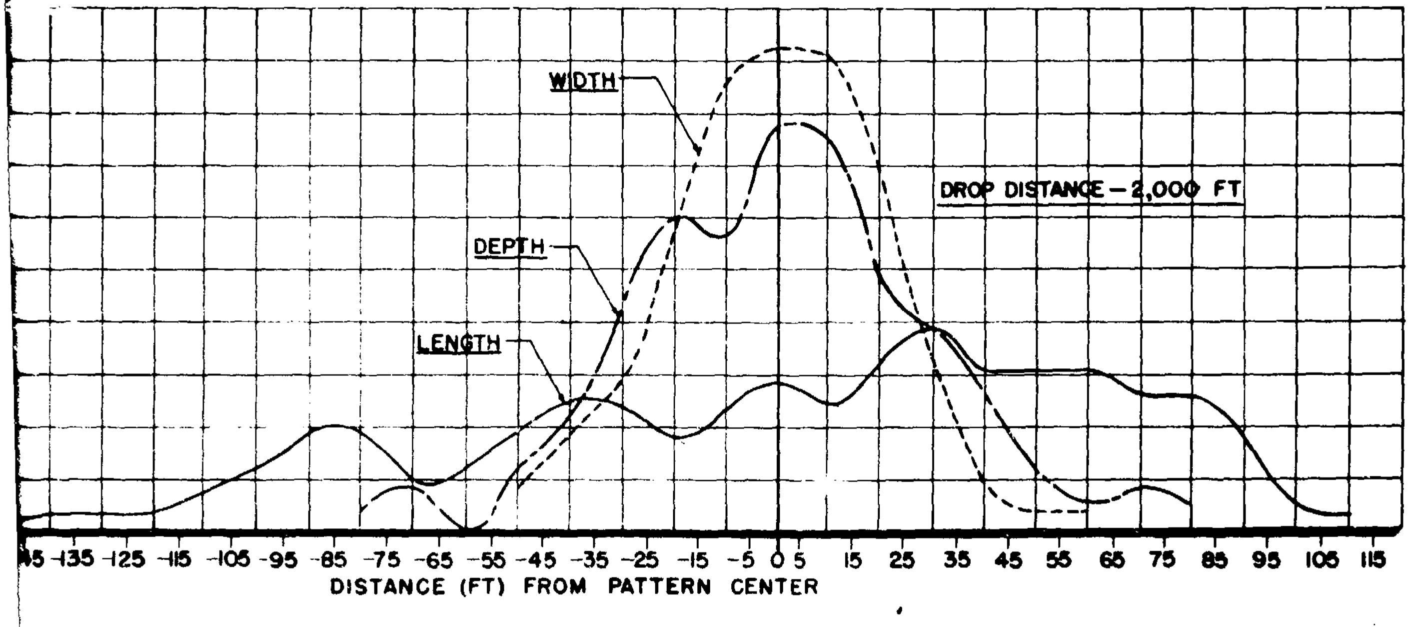
RELEASE ALTITUDE 25,0





DENSITIES for DROP DISTANCES OF 1,000 & 2,000 FT
RELEASE ALTITUDE 25,000 FT





AVERAGE VERTICAL PLANE BOMB PATTERN 1000 FEET BELOW THE BOMBER

The upper figure in each cell represents cell density (i.e., bombs per cell) based upon the frequency distribution of an average 20-bomb cluster. The lower figure in each cell represents the contribution of that cell toward producing hits on a B-29 airplane flying centrally through the given cell row.

Pattern Depth (50 feet)

← Pattern Width (40 feet) →					Expected Hits For Each Cell Row	Probability in Each Cell Row of	
						A Miss	One/More Hits
.1643 .0559	.4579 .2335	.6063 .4547	.5311 .2709	.1481 .0505	1.0655	.2732	.7268
.3456 .1175	9634 .4913	1.2756 .9567	1.1172 .5698	.3122 .1061	2.2414	.0074	.9926
.5022 .1707	1.3997 .7138	1.8533 1.3900	1.6232 .8278	.4536 .1542	3.2565	0	1.000
.3488 .1186	.9720 .4957	1.2870 .9653	1.1272 .5749	.3150 .1071	2.2616	.0058	.9942
.1891 .0643	.5270 .2688	.6978 .5234	.6112 .3117	.1708 .0581	1.2263	.2115	.7885
Total					10.0413	.4979	4.5021
Total x 20%					2.02	.0996	.9004

Note: Cell blocks are not drawn to scale.

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AVERAGE VERTICAL PLANE BOMB PATTERN 2000 FEET BELOW THE BOMBER

The upper figure in each cell represents cell density (i.e., bombs per cell) based upon the frequency distribution of an average 20-bomb cluster. The lower figure in each cell represents the contribution of that cell toward producing hits on a B-29 airplane flying centrally through the given cell row.

← Pattern Width (67 feet) →

↑ Pattern Depth (94 feet) ↓

.0046	.0119	.0188	.0200	.0171	.0123	.0052
.0510 .0219	.1307 .0392	.2072 .1057	.2199 .1649	.1881 .0959	.1354 .0406	.0573 .0246
.0788 .0339	.2020 .0606	.3202 .1633	.3398 .2549	.2907 .1483	.2093 .0628	.0886 .0381
.1085 .0467	.2780 .0834	.4407 .2248	.4678 .3509	.4001 .2041	.2881 .0864	.1219 .0524
.1502 .0646	.3849 .1155	.6103 .3113	.6477 .4858	.5540 .2825	.3988 .1196	.1688 .0726
.1520 .0654	.3897 .1169	.6178 .3151	.6557 .4918	.5609 .2861	.4038 .1211	.1709 .0735
.1326 .0570	.3398 .1019	.5387 .2747	.5717 .4288	.4891 .2494	.3521 .1056	.1490 .0641
.1242 .0534	.3184 .0955	.5048 .2574	.5357 .4018	.4583 .2337	.3299 .0990	.1396 .0600
.0769 .0331	.1972 .0592	.3127 .1595	.3318 .2488	.2839 .1448	.2043 .0613	.0865 .0372
.0417 .0179	.1069 .0321	.1695 .0865	.1799 .1349	.1539 .0785	.1108 .0332	.0469 .0202
.0046	.0119	.0188	.0200	.0171	.0123	.0052

Note: Cell blocks are not drawn to scale.

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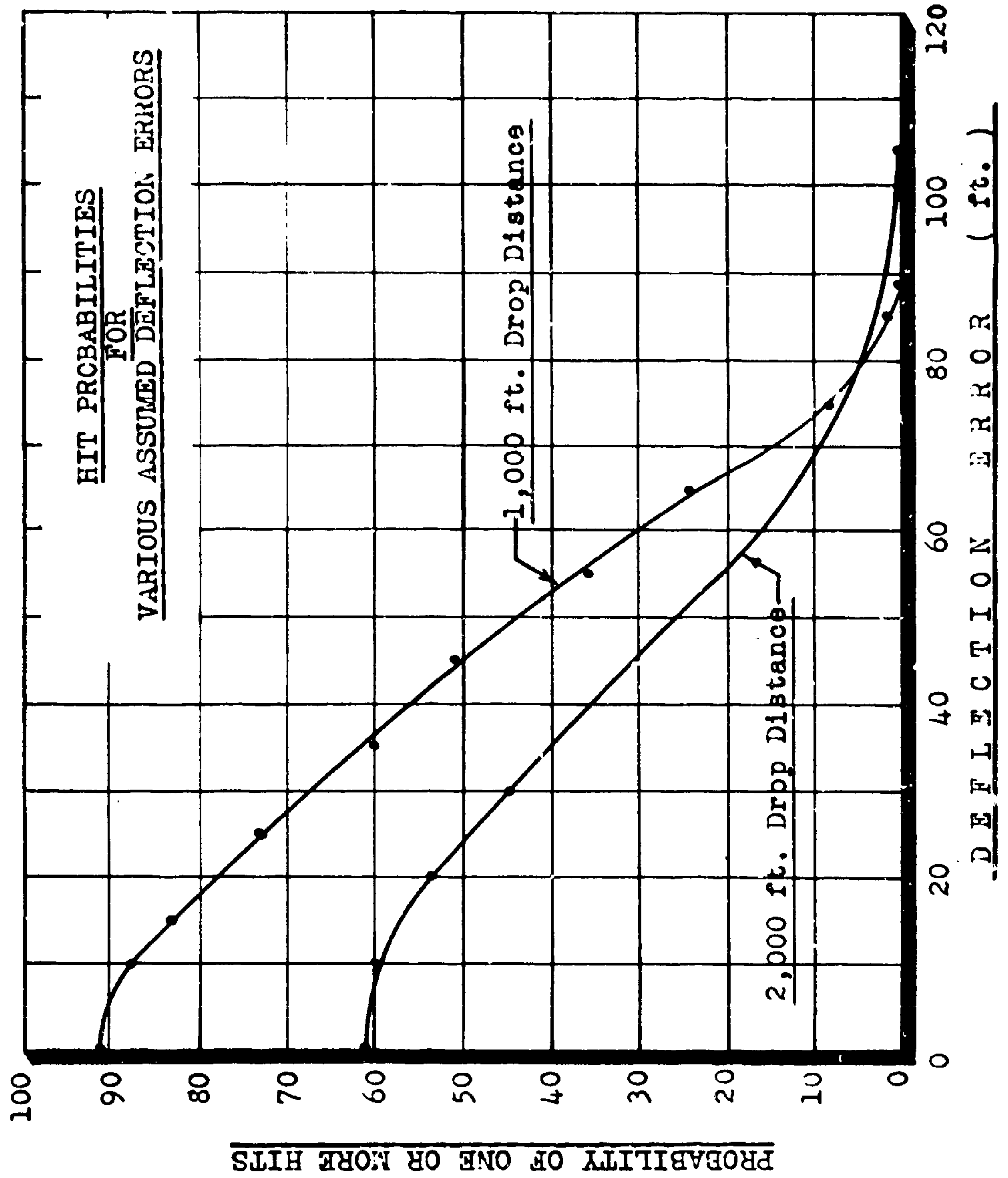
[redacted]

UNCLASSIFIED



HIT PROBABILITIES
FOR
VARIOUS ASSUMED DEFLECTION ERRORS

UNCLASSIFIED

INCLOSURE 5

[redacted]

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UNCLASSIFIED

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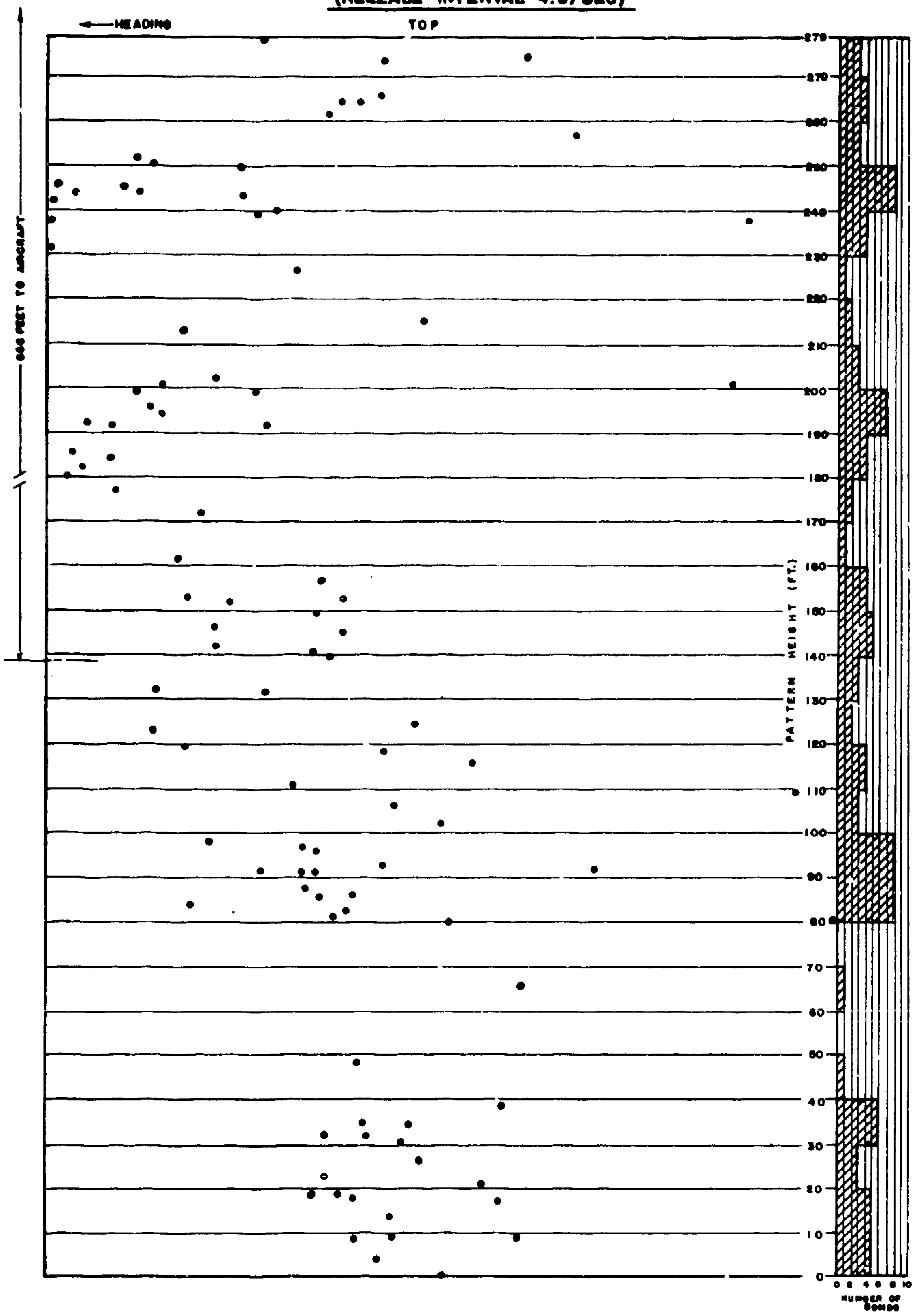
SIDE VIEW OF SPATIAL PATTERN OF 5 M26 CLUSTERS RELEASED IN TRAIN (RELEASE INTERVAL 4.5/SEC)



UNCLASSIFIED

INCLOSURE 6

[redacted]

PROJ. NO. 5471-1--5

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

MAY 23 2000

MEMORANDUM FOR DTIC/OCQ (ZENA ROGERS)
8725 JOHN J. KINGMAN ROAD, SUITE 0944
FORT BELVOIR VA 22060-6218

FROM: HQ AFMC/SCDP
4225 Logistics Avenue, Room A112
Wright-Patterson AFB OH 45433-5744

SUBJECT: Change in Distribution Statement for AFMC Documents

1. Distribution statements on several documents were officially changed to Distribution Statement A in accordance with AFI 61-204, 27 Jul 94, *Disseminating Scientific and Technical Information*. The documents (excluding those marked out in Atch 3) are owned by AFMC and were reviewed by the HQ AFMC History Office and HQ AFMC Public Affairs Office. The documents cleared for public release are listed on three attachments.

2. Please direct further questions to Ms. Lezora Nobles, AFMC STINFO Assistant, HQ AFMC/SCDP, DSN 787-8583.

Patricia T. McWilliams

PATRICIA T. McWILLIAMS
AFMC STINFO Program Manager
Directorate of Communications and Information

Attachments:
1. AFDTC/PA Memo, 11 Jan 95
2. HQ AFMC/PAX 1st Ind, 4 May 00
3. HQ AFMC/PAX Memo, 5 May 00

2. Attachments a through c are part of an internal AFMC/HO review; attachments d and e are requested by Mr. Morris Betry, a private researcher; attachments f through h are requested by Ms. Pat McWilliams (AFMC/SCDP); and attachment i is requested by Mr. Gregory Hughes (ASC/ENFD).

3. The AFMC/HO point of contact for these reviews is Dr. William Elliott, who may be reached at extension 77476.

JOHN D. WEBER
Command Historian

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~~8~~ Attachments:
a. ~~AFSC No. 150.174~~
b. ~~AFSC No. 400.490~~
c. DTIC No. AD-098 048
d. DTIC No. AD-376 934
e. DTIC No. AD-895 879
f. DTIC No. AD-094 838
g. DTIC No. AD-068 388
h. DTIC No. AD-046 931
~~i. AFLC No. R1-120-2~~

1st Ind, HQ AFMC/PAX 4 May 2000

This material has been reviewed for security and policy IAW AFI 35-101. It is cleared for public release.

JAMES A. MORROW
Security and Policy Review
Office of Public Affairs

atch 2