MIL-B-81006B
23 February 1968
Superseding
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15 September 1965

MILITARY SPECIFICATION

BOMBS, FREE-FALL, DEMONSTRATION OF DISPERSION REQUIREMENTS FOR

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope - This specification establishes sampling plans and procedures for use in the demonstration of compliance with dispersion requirements for free-fall bombs.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

PUBLICATIONS

NWL Report No. 1905	Theory and Application of Qualification Testing Plans for Munition Dispersion

(Application for copies should be addressed to Commander, U.S. Naval Weapons Laboratory, Dahlgren, Virginia 22448).

3. DISPERSION REQUIREMENTS

3.1 Conduct of demonstration test -

3.1.1 Selection of test items - The bombs to be used in the demonstration test shall be as nearly representative of end-item procurement units as possible. These bombs shall be classified as having (a) canted fins or (b) uncanted fins in accordance with design specifications. Test units shall be selected from among the available production model units without regard for any special characteristics of the units selected.

3.1.2 Initial number of test drops - The initial set of drops for the demonstration test shall consist of an equal number of bombs dropped under each type of maneuver at which the bomb will be used. The types of release conditions considered shall be subject to approval by the procuring activity. These conditions shall include minimum and maximum airspeeds and altitudes when there are significant variations in a particular maneuver. Decisions in accordance with the provisions of 3.1.4 shall not be made prior to the completion of this initial set of drops.

3.1.3 Order of test drops after completion of initial set of drops - The initial set of drops specified in 3.1.2 shall be accomplished without regard to the order of the release conditions employed. The release conditions of drops (if any) made subsequent to the initial set of drops shall be in the order specified by a series of random numbers selected from a table of random numbers. Each release condition shall be assigned a number prior to the selection of the sequence of random numbers. The random numbers shall be chosen in groups in such a way that within any group no number is repeated. The size of each group of random numbers shall be equal to the number of release conditions employed.

3.1.4 Decision procedure - The decision procedure shall be based upon the acceptance numbers (a_n) and rejection numbers (r_n) given in Tables I and II (see 3.2) and the test statistic calculated as in 3.1.4.1. The numbers a_n and r_n shall be selected from Table I if the bombs used in the demonstration test are classified as having canted fins, or from Table II if the bombs are classified as having uncanted fins. No decision shall be made prior to the completion of the initial set of drops, as specified in 3.1.2. Subsequent decisions shall be made in accordance with 3.1.4.2, 3.1.4.3 and 3.1.4.4, after each succeeding drop or set of drops is accomplished.

3.1.4.1 Calculation of test statistic - The test statistic for n drops, d_n, shall be calculated from the sample data according to 4.4.4.

3.1.4.2 Acceptance criterion - The demonstration test shall be considered to lead to an acceptance of the bomb as meeting its specified dispersion requirements when, after the completion of the initial set of drops or after any single drop subsequent to the initial set of drops, the test statistic, d_n, becomes less than or equal to the acceptance number a_n, and no decision has been previously made to reject.

3.1.4.3 Rejection criterion - The demonstration test shall be considered to lead to a rejection of the bomb as not meeting its dispersion requirements when, after the completion of the initial set of drops, or after any single drop subsequent to the initial set of drops, the test statistic d_n, becomes greater than or equal to the rejection number, r_n, and no decision has been previously made to accept.

3.1.4.4 Continue testing criterion - The demonstration test shall be considered to require at least one additional drop when, after the completion of the initial set of drops or after any single drop subsequent to the initial set of drops, the test statistic, d_n, is greater than the acceptance number, a_n; less than the rejection number, r_n, and no decision has been made previously either to accept or to reject.

3.2 Acceptance and rejection numbers - The acceptance and rejection numbers to be employed in connection with 3.1.4.2, 3.1.4.3 and 3.1.4.4 are given in the following tables:

Table I

Acceptance and Rejection Numbers for Bombs with Canted Fins

Number of Drops (n)	Acceptance Number (a_n)*	Rejection Number (r_n)
1	--	1.56
2	--	1.82
3	--	2.08
4	--	2.34
5	--	2.60
6	--	2.86
7	--	3.12
8	0.25	3.37
9	0.51	3.63
10	0.77	3.89
11	1.03	4.15
12	1.29	4.41
13	1.55	4.67
14	1.81	4.93
15	2.06	5.19

$$a_n = -1.821 + 0.259n$$

$$r_n = 1.302 + 0.259n$$

*A dash (-) in the a_n column indicates that no acceptance decision is possible for the corresponding value of n (i.e. $a_n \leq 0$).

Table II

Acceptance and Rejection Numbers for Bombs with Uncanted Fins

Number of Drops (n)	Acceptance Number (a_n)*	Rejection Number (r_n)
1	--	1.69
2	--	1.95
3	--	2.21
4	--	2.47
5	--	2.73
6	--	2.99
7	0.12	3.25
8	0.38	3.50
9	0.64	3.76
10	0.90	4.02
11	1.16	4.28
12	1.42	4.54
13	1.68	4.80
14	1.93	5.06
15	2.19	5.32

$$a_n = -1.691 + 0.259n$$

$$r_n = 1.432 + 0.259n$$

*A dash (-) in the a_n column indicates that no acceptance decision is possible for the corresponding value of n (i.e. $a_n \leq 0$).

4. NOTES

4.1 Intended Use - The sampling plans and procedures described herein are for use in the demonstration of compliance with dispersion requirements for conventional and nuclear free-fall bombs. Demonstration of acceptability in this analysis is based on bomb impact position and does not include other effects. The specific dispersion requirement will be assigned a classification dictated by the weapon for which the dispersion is specified and will be supplied by the procuring activity.

4.2 Information for contracting officer - Contracts or orders should specify the following:

(a) Title, number and date of this specification.

(b) Items of data required (see 4.3).

(c) Dispersion parameter, B, in MILS (see 4.4.3).

4.3 Data - For the information of Contractors and Contracting Officers, any of the data specified in (a) subparagraphs below, (b) applicable documents listed in Section 2 of this specification, or (c) referenced lower-tier documents need not be prepared for the Government and shall not be furnished to the Government unless specified in the contract or order. The data to be furnished shall be listed on DD Form 1423 (Contractor Data Requirements List), which shall be attached to and made a part of the contract or order.

4.3.1 Demonstration test data - The demonstration test data generated in the application of this specification shall be reported to that official of the procuring activity designated in the development or procurement specifications or contract. Specific data reporting procedures shall be proposed by the contractor and shall be subject to approval by the procuring activity.

4.4 Definitions -

4.4.1 Dispersion - As used herein, the term dispersion indicates the difference between the computed center of impact and the actual impact of each round which can be achieved with free-fall bombs exclusive of the effects due to bombing system and, in the case of a bomb designed with canted fins, the effect of spin. Also, the bomb dispersion referred to does not include the effects of variation in weather, bomb weight, and launching disturbances.

4.4.2 Units of measurement - The dispersion shall be measured in mils in the plane normal to the bomb trajectory at impact. A mil is defined as the ratio of a unit distance in the plane normal to the bomb trajectory at impact to a thousand units of trajectory arc length. (Mils = 1000 x distance in normal plane ÷ trajectory arc length).

4.4.3 Dispersion parameter - The dispersion specifications for free-fall bombs are given in terms of the dispersion parameter B. The parameter B, in MILS, is the radius of a circle, located in the plane normal to the bomb's theoretical trajectory with its center at the theoretical mean impact point and encompassing 99% of the total population for a given bomb type. For a given bomb, the value of B to be employed in the demonstration test will be specified in the development or procurement specifications or contract (see 4.2.c).

4.4.4 Test Statistic - The test statistic is defined by

$$d_n = \frac{1}{B^2} \sum_{i=1}^{n} r_i^2$$

where n is the number of drops, B is as defined in 4.4.3 and

$$*r_i^2 = (x_i - \bar{x}_n)^2 + (y_i - \bar{y}_n)^2 \text{ ; for bombs designed with canted fins}$$

$$*r_i^2 = (x_i - \bar{x}_n)^2 + (y_i)^2 \text{; for bombs designed with uncanted fins.}$$

The values x_i and y_i are defined in mils in the plane normal to the theoretical trajectory of the i^{th} drop at impact and are related to the observed errors in the ground plane in the following way:

$$x_i = \Delta R_i \sin \omega_i$$

$$y_i = \Delta D_i$$

where ΔR_i and ΔD_i are the range and deflection errors in mils, respectively, observed in the ground plane and ω_i is the angle of impact of the theoretical trajectory. The values $\bar{x}_n$ and $\bar{y}_n$ are the sample means of x_i and y_i in mils, respectively, for all drops. The range and deflection errors are the differences between the computed point of impact and the observed range and deflection (see Figure 1). The computed impact point for any drop in a sample is the impact point of the trajectory computed for the observed conditions of that drop. The computed trajectory is based on the best estimate of the drag coefficient available for the weapon under consideration.

*It is noted that the ri^2 values must be recomputed after each new drop using the new values of $\bar{x}_i$ and $\bar{y}_i$.

4.4.5 Producer and consumer risks - The basic sampling plans have been formulated so that the probability of accepting a bomb whose true dispersion parameter is B or less is not less than 90% and the probability of accepting a bomb whose true dispersion parameter is twenty percent or more larger than B is not more than 10%.

4.5 Example of calculations - Suppose that the compliance of the MARK XX bomb to its dispersion specification is to be demonstrated. Imagine that for this type bomb, the dispersion specification of the contract indicates the dispersion parameter B = 10 mils. The MARK XX is designed with uncanted fins and is intended for use under three different nominal release conditions:

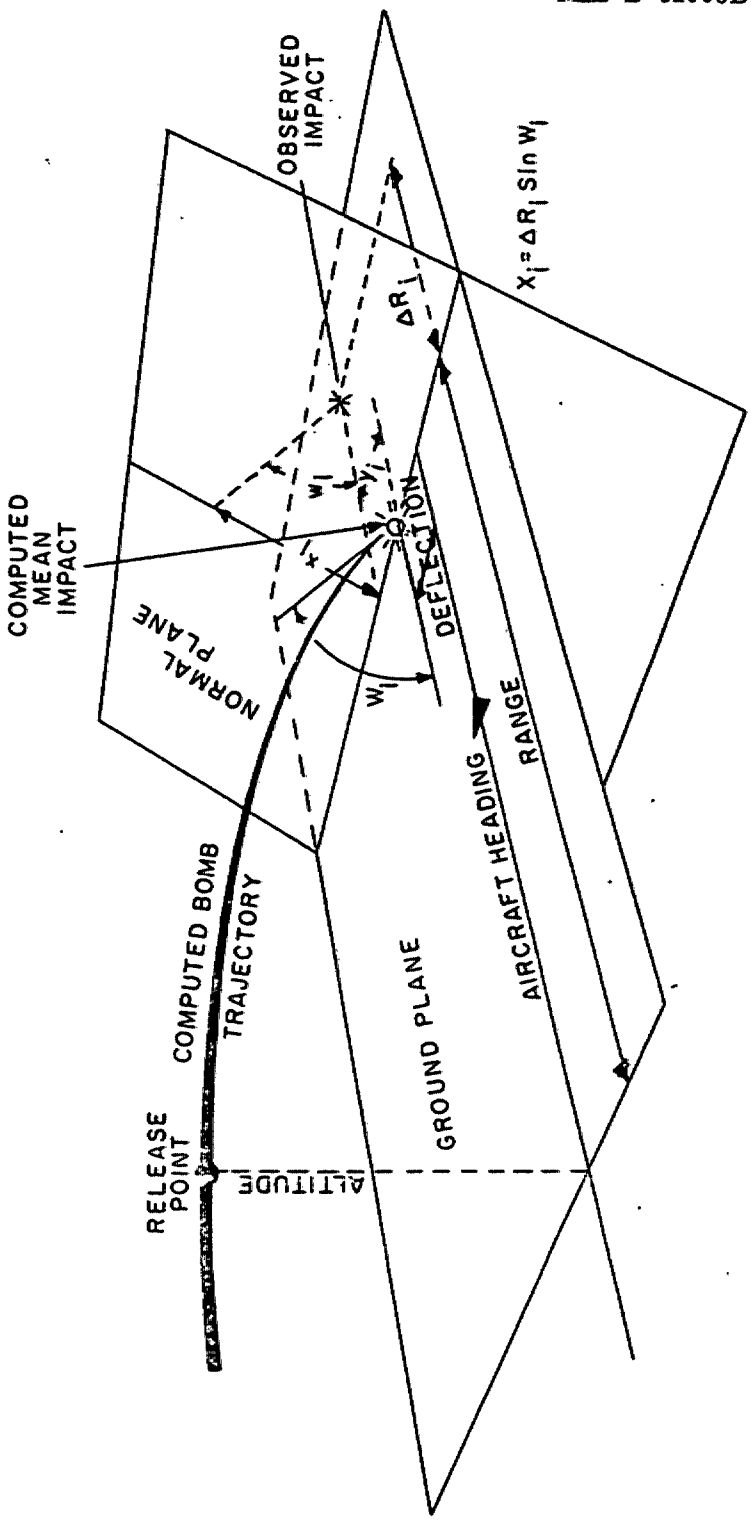

Figure 1

(a) Horizontal; 35000 feet altitude, 480 knots true airspeed.

(b) Loft; 65°, 5100 feet altitude, 470 knots true airspeed.

(c) Dive; 30°, 18000 feet altitude, 590 knots true airspeed.

4.5.1 Acceptance and rejection numbers - The acceptance (a_n) and rejection (r_n) numbers are as shown in Table II.

4.5.2 Initial number of test drops - Since the Mark xx is intended for use under three different release conditions, the initial number of test drops is, according to 3.1.2, a multiple of three. It will be assumed that one drop will be made under each release condition. No decision for the Mark xx shall be made until at lease three initial drops are made.

4.5.3 Order of test drops - If test drops in addition to the initial three are required, the order of the release conditions employed shall be selected by choosing random numbers between 0 and 2 from a table of random numbers. In order to accomplish this, the release conditions are first identified as:

Release Condition:	A B C
Number Designation:	0 1 2

Selecting only numbers between 0 and 2 and omitting duplicates in each group assume that the following groups of three random numbers each are obtained,

Random Number:	(1, 0, 2) (0, 2, 1) (2, 0, 1) --
Release Condition:	(B, A, C) (A, C, B) (C, A, B) --

which specify the order of the release conditions employed in test drops subsequent to the initial set of drops.

4.5.4 Test results - Assume that the initial three test drops yield the following results:

Drop Number	1	2	3
Nominal Release Condition	B	A	C
Observed:			
Altitude (feet)	5175	35300	18200
True Airspeed (knots)	467	483	592
Range (feet)	15695	36269	18170
Deflection (feet)	-64	-16	174

Computed:		1	2	3
Range (feet)		15644	36549	18099
Deflection (feet)		13	140	37
Trajectory Length (feet)		27100	53450	25990
Impact Angle (degrees)		71.6	64.9	56.3
ΔR_i	(feet)	51	-280	71
x_i	(feet)	48	-254	59
	(mils)	1.77	-4.75	2.27
y_i	(feet)	-77	-156	137
	(mils)	-2.84	-2.92	5.27
$\bar{x}_3$	(mils)	-0.24		

These data result in a test statistic value of

$$d_3 = \frac{1}{100} \sum_{i=1}^{3} (x_i - \bar{x}_n)^2 + y_i^2 = (2.01)^2 + (-2.84)^2 + (-4.51)^2 + (-2.92)^2 + (2.51)^2 + (5.27)^2 = 0.750$$

which indicates that at least one additional drop should be made (since $0 < d_3 < 2.2$). The fourth drop, from the list of random numbers, is under release condition A. Assuming that the errors in the fourth drop are $x_4 = 0.69$ mils and $y_4 = 1.01$ mils, then the sample mean of the range errors for the four drops is $\bar{x}_n = -0.01$. The test statistic becomes:

$$d_4 = \frac{1}{100} \sum_{i=1}^{4} (x_i - \bar{x}_n)^2 + y_i^2 = (1.78)^2 + (-2.84)^2 + (-4.74)^2 + (-2.92)^2 + (2.28)^2 + (5.27)^2 + (0.70)^2 + (1.01)^2 = 0.767$$

Again, an additional drop is required (since $0 < d_4 < 2.47$). The fifth drop is made under release condition C. Assuming that the following data are obtained for the fifth and successive drops:

n	Random Number	Release Condition	d_n
5	2	C	.79
6	1	B	.84
7	2	C	.90
8	0	A	.92
9	1	B	.94
10	0	A	.96
11	2	C	1.00

The decision to accept the Mark xx bomb as meeting its dispersion specification is made after the eleventh drop ($d_{11} < a_{11}$, i.e., 1.00 < 1.16).

4.6 Mathematical development of sampling plans - Details concerning the mathematical development of the Sampling plans contained in this specification are in the NWL document, "Theory and Application of Qualification Test Plans for Munition Dispersion." This document also contains information on Average Sample Numbers and Operating Characteristic Curves for the sampling plans used in this specification.

Custodians:

Navy - AS
Air Force - 15

Preparing Activity:

Navy - AS

(Project No. 1105-0008)

Review Activities:

Air Force - 15

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(as indicated on reverse hereof)*.

SPECIFICATION

MIL-B-81006B, Bombs, Free-Fall, Demonstration of Dispersion Requirements For

ORGANIZATION *(Of submitter)*	CITY AND STATE

CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT
		$

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)*	DATE

DD FORM 1426 1 APR 63

REPLACES NAVSHIPS FORM 4863, WHICH IS OBSOLETE

C-8279