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MIL-STD-746A
31 JANUARY 1963
SUPERSEDING
MIL-STD-746(Wep)
20 FEBRUARY 1961

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

RADIOGRAPHIC TESTING
REQUIREMENTS FOR CAST EXPLOSIVES



AMSC N/A

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MIL-STD-746A

DEPARTMENT OF DEFENSE

Washington 25, D.C.

**Radiographic Testing Requirements
for Cast Explosives**

MIL-STD-746A

1. This standard has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy and the Air Force, effective 31 January 1963.
2. Recommended corrections, additions, or deletions should be addressed to Headquarters, DSA, Standardization Division, Washington 25, D. C.

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1. SCOPE

1.1 **Scope.** This standard covers the requirements for radiographic inspection used in

determining the presence of discontinuities in cast explosives.

2. REFERENCED DOCUMENTS

2.1 The issue of the following document in effect on the date of invitation for bids, forms a part of this standard:

STANDARDS

MILITARY

MIL-STD-23—Nondestructive Testing Symbols

(Copies of Specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be

obtained from the procuring agency or as directed by the contracting officer.)

2.2 **Other publications.** The following document forms a part of this standard. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

NATIONAL BUREAU OF STANDARDS

National Committee on Radiation Protection

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington 25, D. C.)

3. DEFINITIONS

3.1 The following definitions are applicable to this standard:

3.1.1 *Radiographic inspection.* The use of X-rays and nuclear radiation to detect discontinuities in material and present them on a recording medium.

3.1.2 *Recording medium.* Film or a detector which converts radiation into a visible image.

3.1.3 *Radiograph.* A visible image on film produced by penetrating radiation passing through the material being tested.

3.1.4 *Intensifying screens.* Sheets of metal or layers of fluorescent crystals between

which the film is sandwiched to decrease the exposure time and to improve image quality.

3.1.5 *Film holders or cassettes.* Lightproof containers for holding a radiographic film with or without intensifying screens. These film holders or cassettes may be rigid or flexible.

3.1.6 *Penetrameter.* A fiducial device whose image in the radiograph is used to determine satisfactory radiographic quality.

3.1.7 *Source.* A machine or radioactive material which emits penetrating radiation.

3.1.8 *Source—film distance.* The distance between the radiation producing area of the source and the film.

4. GENERAL REQUIREMENTS

4.1 **General.** The radiographic method of testing is used for determining the presence of discontinuities in cast explosives. Radiographic inspection specified herein is intended to apply to all items requiring radiographic

inspection in compliance with applicable specifications, drawings, contracts, purchase orders, and shall include the use of all X- and gamma-ray sources.

4.1.1 *Extent of radiographic inspection.*

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All procurement documents shall specify the extent of radiographic inspection, when it is required. This information shall include the number of areas and items to be radiographed, and the quality level of inspection to be applied (see paragraph 4.4). Radiographic location markings shall be incorporated on all applicable drawings, and shall be in accordance with MIL-STD-23.

4.2 Technique requirements for radiography.

4.2.1 Direction of radiation. Unless otherwise specified, the direction of the central beam of radiation shall be perpendicular to the surface of the film.

4.2.2 Radiographic sensitivity. Radiography shall be performed with a technique which will distinguish the applicable penetrameter. Sensitivity of radiographs shall be determined by using the penetrameters detailed in Figure 1. Unless otherwise specified by the bureau or agency concerned, the 2-2T (2 percent equivalent sensitivity) hole shall be distinctly visible on all radiographs. For repetitive operations, one penetrameter shall be included in each 50 radiographs.

4.2.3 Multiple film techniques. Film techniques with two or more films of equal or different speeds in the same film holder, will be permitted provided that the appropriate hole in the penetrameter(s) for a specific area is demonstrated.

4.2.4 Non-film techniques. The use of non-film techniques shall be subject to the approval of the bureau or agency concerned. When non-film techniques are permitted, the penetrameter hole shall be demonstrated in the resultant image.

4.2.5 Image quality. The radiographic image shall be free of blemishes which interfere with its interpretation.

4.2.6 Source—film distance. Any source-film distance will be satisfactory provided that the required radiographic sensitivity and sharpness is attained and distortion is not excessive.

4.3 Penetrameters. The quality of all levels

of radiographic testing shall be determined by a penetrameter.

4.3.1 Fabrication. Penetrameters for explosive materials of density not less than 1.3 and not more than 1.9 gm/cc shall be fabricated from commercial grade nylon. Penetrameters for use with explosive materials not included in this density range shall be fabricated from an inert material of approximately the same density as the explosive material being examined.

4.3.1.1 Penetrameter designs other than those shown in Figure 1 are permitted provided that the applicable thickness and hole sizes conform to Figure 1. Other penetrameter requirements specified herein shall be adhered to.

4.3.1.2 The penetrameter thickness for levels 2-1T, 2-2T and 2-4T (see 4.4) shall be no greater than 1/50 (2 percent) of the thickness of explosive being examined. For special levels 1-1T and 1-2T the penetrameter thickness shall be no greater than 1/100 (1 percent) of the thickness of the explosive being examined; for level 4-2T the penetrameter thickness shall be no greater than 1/25 (4 percent) of the thickness of explosive being examined.

4.3.1.3 The minimum penetrameter thickness shall be 0.005 inch despite the requirements of 4.3.1.2.

4.3.1.4 The minimum hole size shall be 0.010 inch at the 1T location, 0.020 inch at the 2T location and 0.040 inch at the 4T location, despite the requirements of 4.3.1.2.

4.3.2 Identification. The regular penetrameter shall be identified with an integral number made of lead which is attached to the penetrameter. This number shall represent the penetrameter thickness in thousandths of an inch, as shown in Table I.

4.3.2.1 Lead numbers shall be placed adjacent to the circular penetrameters to provide identification of the penetrameter on the film.

4.4 Quality levels of inspection. Three quality levels of inspection, levels 2-1T, 2-2T and

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TABLE I
Examples of Penetrameter Identification

Identification no. on penetrameter	Penetrameter thickness	Minimum specimen thickness		
		Levels 2-1T, 2-2T and 2-4T	Levels 1-1T and 1-2T	Level 4-2T
	Inches	Inches	Inches	Inches
20	0.020	1	2	$\frac{1}{2}$
60	0.060	3	6	$1\frac{1}{2}$
160	0.160	8	16	4
280	0.280	14	28	7
400	0.400	20	40	10

2-1T, which are available through the design and application of the penetrameter, are shown in Table II and specified in 4.4 through 4.4.1.2. Other levels of inspection available are shown in Table III, and specified in 4.4.2 through 4.4.2.2. Care should be exercised in specifying the radiographic quality levels 2-1T, 1-1T, and 1-2T, by first determining that these quality levels are necessary and can be maintained in production.

TABLE II
Normal Quality Levels of Inspection

Level of inspection	Penetrameter thickness	Minimum perceptible hole diameter	Equivalent penetrameter sensitivity ¹
2-1T	1/50 of specimen thickness.	1T	Percent 1.4
2-2T	1/50 of specimen thickness.	2T	2.0
2-4T	1/50 of specimen thickness.	4T ²	2.8

¹ Equivalent penetrameter sensitivity is that thickness of penetrameter expressed as a percentage of the total thickness in which a 2T hole would be visible under the same radiographic conditions.

² For the appropriate thicknesses, the outline of the circular penetrameter shall be shown when the 4T hole is specified.

4.4.1 *Level 2-1T radiography.* In level 2-1T radiography the 1T hole in a penetrameter 1/50 (2 percent) of the specimen thickness shall be visible.

4.4.1.1 *Level 2-2T radiography.* In level

TABLE III
Special Quality Levels of Inspection

Level of inspection	Penetrameter thickness	Minimum perceptible hole diameter	Equivalent penetrameter sensitivity
1-1T	1/100 of specimen thickness.	1T	Percent 0.7
1-2T	1/100 of specimen thickness.	2T	1
4-2T	1/25 of specimen thickness.	2T	4

2-2T radiography the 2T hole in a penetrameter 1/50 (2 percent) of the specimen thickness shall be visible.

4.4.1.2 *Level 2-4T radiography.* In level 2-4T radiography the 4T hole in a penetrameter 1/50 (2 percent) of the specimen thickness shall be visible.

4.4.2 *Level 1-1T radiography.* In level 1-1T radiography the 1T hole in a penetrameter 1/100 (1 percent) of the specimen thickness shall be visible.

4.4.2.1 *Level 1-2T radiography.* In level 1-2T radiography the 2T hole in a penetrameter 1/100 (1 percent) of the specimen thickness shall be visible.

4.4.2.2 *Level 4-2T radiography.* In level 4-2T radiography the 2T hole in a penetrameter 1/25 (4 percent) of the specimen thickness shall be visible.

4.4.3 *Containing vessels.* In the radiography of explosive material contained within a vessel, such as a shell, bomb or warhead, the thickness of the explosive load shall be the criterion for determining the appropriate penetrameter. The wall thickness of the containing vessel shall not be added to the thickness of explosive nor equated to equivalent thicknesses of explosive, but may be considered in determining the level of radiographic quality to be obtained.¹

¹ The level of radiographic quality to be obtained should be specified such that the degree of inspection necessary is obtained within the limits of radiography.

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4.5 Placement of penetrameters. The penetrameters shall be placed on the source side of the section being examined and the plane of the penetrameter shall be normal to the radiation beam. In no case shall the penetrameter be placed closer to the film than the source side of the section being examined unless specifically permitted by the contracting agency or bureau.

4.5.1 In the inspection of irregular objects the penetrameter shall be placed on the part of the object farthest from the film.

4.6 Number of penetrameters. One penetrameter shall represent an area within which radiographic densities do not vary more than plus 30 percent or minus 15 percent of the film density at the penetrameter. At least one penetrameter per radiograph shall be used except as specified in 4.6.1, 4.6.1.1 and 4.6.1.2.

4.6.1 Film density. When film density varies more than plus 30 percent or minus 15 percent from that film density at the penetrameter, two penetrameters used in the following manner will be satisfactory: If one penetrameter shows an acceptable sensitivity at the most dense portion of the radiograph and the second penetrameter, placed in accordance with 4.5, shows an acceptable sensitivity at the least dense portion of the radiograph, then these two penetrameters will serve to qualify the radiograph within these density limits.

4.6.1.1 When film is exposed in a 360 degree radiation beam, a minimum of one penetrameter shall be required in each quadrant.

4.6.1.2 When a large number of relatively small identical items are being radiographed in a continuous process, at least one penetrameter shall be included in each 50 radiographs.

4.7 Location markers. The image of the location markers for the coordination of the part with the film shall appear on the film without interfering with the interpretation. The arrangement used shall be such that it is evident that complete coverage was obtained. These marker positions shall be

marked on the part and the position of the markers shall be maintained on the part during radiography.

4.7.1 Identification of the radiograph. A system of positive identification of the film shall be provided. Any or all of the following may appear:

- a. Name of inspecting activity.
- b. Date
- c. Part number
- d. View
- e. Whether original or subsequent exposure

4.8 Retention of radiographs and records. Radiographs shall be retained for three years, or as agreed upon by the bureau or agency concerned and the inspection activity. Complete records of the technique details, including radiographic inspection location sketches, shall be retained for the same period as the radiographs to which they apply.

4.9 Safety. Radiographic procedures shall be performed under protected conditions so that the radiographer will not receive a maximum whole body radiation dosage exceeding that permitted by city, state or national codes. The recommendations of the National Committee on Radiation Protection should be the guide to radiological safety.

Notice. When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

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Both the title and identifying symbol number should be stipulated when requesting copies of Military Standards.

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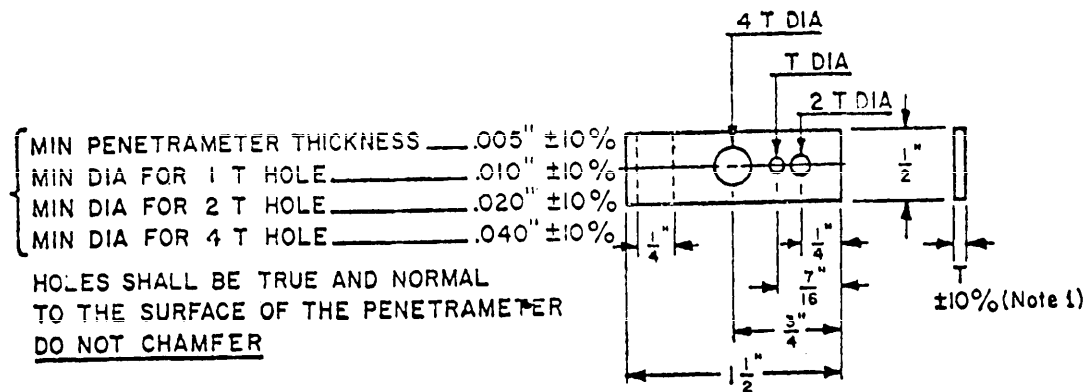
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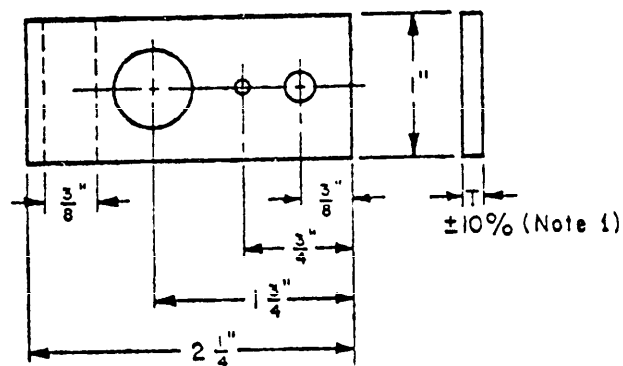
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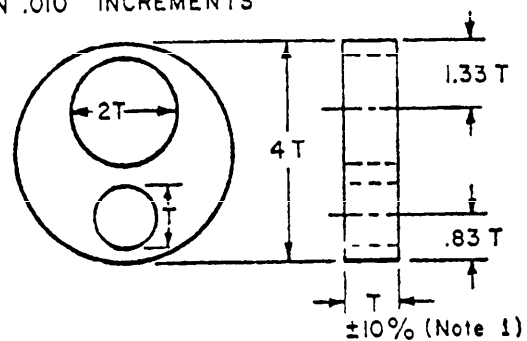
DESIGN FOR PENETRATOR THICKNESS FROM .005" TO AND INCLUDING .050"

NOTE: FROM .005" TO .020" MADE IN .0025" INCREMENTS
 FROM .025" TO .050" MADE IN .005" INCREMENTS



DESIGN FOR PENETRATOR THICKNESS FROM .060" TO AND INCLUDING .160"

NOTE: FROM .060" TO .160" MADE IN .010" INCREMENTS



DESIGN FOR PENETRATOR THICKNESS OF .180" AND OVER

NOTE: MADE IN .020" INCREMENTS

Note 1: Tolerances on penetrator thickness and hole diameter shall be plus or minus 10 percent or 1/2 of the thickness increment between penetrator sizes, whichever is smaller.

FIGURE 1. Penetrator

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