MIL-STD-1166(MI)
3 May 1963

MILITARY STANDARD

RADIOGRAPHIC TESTING REQUIREMENTS FOR

SOLID PROPELLANTS

FSC /1375/

DEPARTMENT OF THE ARMY

1. This standard has been approved by the Army and is published to establish radiographic testing requirements for solid propellants.

2. Use of this standard by activities under cognizance of the Army shall be mandatory effective on actual effective date.

3. Recommended corrections, additions, or deletions should be addressed to: Commanding General, U. S. Army Missile Command, Redstone Arsenal, Alabama, ATTN: AMSMI-IES.

FOREWORD

This standard contains the requirements for radiographic testing of solid propellants. It has been developed as a separate entity for ease in future integration with other radiographic testing methods.

Radiographic testing is a major management area deserving separate standardization coverage. Such a standard should contain all radiographic testing methods identified under materials and process topics, e.g. metals, graphite, weldments, etc. Only in this manner can redundancy be prevented and the utility of radiographic methods facilitated.

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FIGURES

TABLES

1. SCOPE

1.1 This standard covers the requirements for quality level and testing sensitivity in radiographic inspection of solid propellants to determine the presence of unacceptable voids and other discontinuities.

2. REFERENCED DOCUMENTS

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

STANDARDS

MILITARY

MIL-STD-23 Nondestructive Testing Symbols

(Copies of specifications, standards, drawings, and publications required by suppliers 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 Handbook - 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 their images on a recording medium.

3.1.2 Recording medium. Film or a detector which converts radiation into visible images or onto any other recording media whereby the internal integrity of the object through which the radiation has passed may be deduced. The recording medium may be permanent, having a visible image retention characteristic of three years or more, or it may be an image examined visually without permanent recording, as required by the applicable detail specification.

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

3.1.4 Penetrameter. A device used as a standard of reference in determining satisfactory radiographic quality.

3.1.5 Source. A machine or radioactive material which emits penetrating radiation.

3.1.6 Source - film distance. The distance from the center of the radiation producing area of the source to the film.

3.1.7 Film density. A quantitative measure of photographic blackening obtained from inspection of the radiographic image with a suitable densitometer. It is defined by the equation: $D = \log_{10} \frac{Io}{I}$

D = Film Density
Io = Incident light intensity
I = Transmitted light intensity

4. GENERAL REQUIREMENTS

4.1 General. The radiographic method of testing is used for determining the presence of unacceptable voids and discontinuities in solid propellants. 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 X-ray, gamma-ray and neutron sources.

4.1.1 Quantity for inspection. The number of items and areas to be radiographed shall be in accordance with the applicable detail specification. Radiographic location markings shall be incorporated on all applicable drawings, and shall be in accordance with MIL-STD-23 or the detailed radiographic procedure approved by the procuring activity.

4.1.2 Quality levels of inspection. The quality level of inspection to be applied, based on the requirements of the propellant, shall be as specified in the detail specification and shall be in accordance with the normal and special quality levels of inspection established herein.

4.2 Radiographic technique.

4.2.1 Radiographic sensitivity. Radiography shall be performed with a technique which will distinguish the applicable penetrameter. The basis of judgement for radiographic sensitivity shall be the perceptibility of the penetrameter. Sensitivity of radiographs shall be determined by using the penetrameters detailed herein. The minimum dimension of the defect, required to be detected by the detail specification, shall be used as the basis for establishing the upper numerical sensitivity limit required of the radiograph.

4.2.2 Film placement. Unless otherwise specified, the film surface shall be perpendicular to the central beam of radiation.

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 on the film, or films, used to interpret that area.

4.2.4 Non-film techniques. The use of any non-film technique shall be approved by the procuring activity. When non-film techniques are permitted, the penetrameter hole shall be demonstrated in the resultant image or recording media.

4.2.5 Image quality. The exposed films shall be free of artifacts which interfere with their interpretation.

4.2.6 Source - film distance. Any source-film distance will be satisfactory provided that the required sensitivity and sharpness is attained without excessive image distortion.

4.3 Penetrameters. The quality of all levels of radiographic testing shall be determined by a penetrameter.

4.3.1 Fabrication. Penetrameters for examination of propellant materials shall be fabricated from propellant of the same type being examined or from inert material that is radiographically similar. Inert materials from which penetrameters may be fabricated shall be considered

radiographically similar provided the variation in the film densities, for corresponding thicknesses of the inert material and the propellant, is not more than plus or minus 0.2 density. In making this determination the blocks of propellant and inert material shall be simultaneously exposed on film utilizing the same technique proposed for subsequent testing.

4.3.1.1 Penetrameter designs other than those shown in Figure 1 may be permitted upon approval from the procuring activity concerned, provided that applicable sensitivity obtained is the same as that demonstrated by penetrameter designed in accordance with Figure 1.

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

4.3.1.3 The minimum penetrameter thickness shall be 0.010 inch despite the requirements of 4.3.1.2.

4.3.1.4 The minimum hole size shall be 0.020 inch at the 1T 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. For penetrameter thicknesses of less than 0.180-inch this number shall indicate in hundredths of an inch (0.01) the minimum thickness of material to which the level 2-1T, 2-2T and 2-4T penetrameter is applicable, as shown in Table I. For penetrameter thicknesses of 0.180 inch and greater this number shall indicate in inches the minimum thickness of material to which the level 2-1T, 2-2T and 2-4T penetrameter is applicable, as shown in Table I.

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
	Inch	Inches	Inches	Inches
100	0.020	1	2	1/2

Table I (Con't)

300	0.060	3	6	1-1/2
800	0.160	8	16	4
14	0.280	14	28	7
20	0.400	20	40	10

4.3.2.1 For the special levels 1-1T and 1-2T, this lead identification number for penetrameter thickness less than 0.180-inch shall indicate in hundredths of an inch (0.01), one-half the minimum thickness to which the penetrameter is applicable. For penetrameter thickness of 0.180-inch and greater the identification number shall indicate in inches one half the minimum thickness to which the penetrameter is applicable. (See Table I).

4.3.2.2 For the special level 4-2T, this lead identification number for penetrameter thicknesses less than 0.180-inch shall indicate in hundredths of an inch (0.01), twice the minimum thickness to which the penetrameter is applicable. For penetrameter thickness of 0.180-inch and greater the identification number shall indicate in inches twice the thickness to which the penetrameter is applicable. (See Table I).

4.3.2.3 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 2-4T, 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, 1-2T, 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/
			Percent
2-1T	1/50 of specimen thickness	1T	1.4

Table II (Con't)
Normal Quality Levels of Inspection

2-2T	1/50 of specimen thickness	2T	2.0
2-4T	1/50 of specimen thickness	4T 2/	2.0

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.

Table III
Special Quality Levels of Inspection

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

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 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. 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 propellant material contained within a vessel, the thickness of the propellant shall be the criterion for determining the appropriate penetrameter. The wall thickness of the containing vessel shall not be added to the thickness of propellant nor equated to equivalent thicknesses of propellant, but may be considered in determining the level of radiographic quality to be obtained. 1/

4.5 Placement of penetrameters. The penetrameter shall be placed on the source side of the section being examined. 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 procuring activity. In the inspection of propellants the penetrameter shall be placed on the part of the object farthest from the film and to the outer edge of the radiation cone.

4.6 Number of penetrameters. One penetrameter shall represent an area within which radiographic densities do not vary more than 1.0 density. The minimum film density through the areas of concern shall not be less than 1.80 density, except when multiple film techniques are employed. At least one penetrameter per exposure shall be used.

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. Identification shall include at least the following information:

(a) Name of inspecting activity

(b) Date

(c) Part Number

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.

(d) View

(e) Original or subsequent exposure of the same item

4.8 Retention of radiographs and records. Radiographs shall be retained for three years, or for a longer period when specified by the procuring 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 recommendation of the National Committee on Radiation Protection, as contained in the National Bureau of Standards Handbooks, 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.

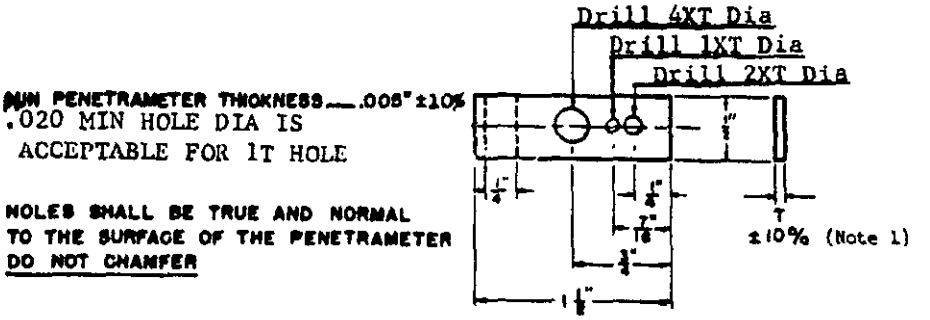
Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.

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

"Copies of this standard for military use may be obtained as indicated in the general provisions of the Department of Defense Index of Specifications and Standards".

Custodian:
Army - (MI)

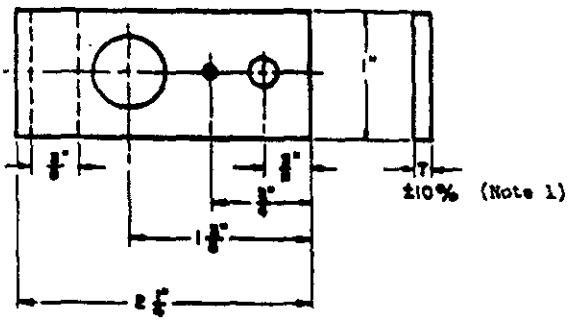
Preparing Activity
Army - (MI)
Project No. 1375-A484



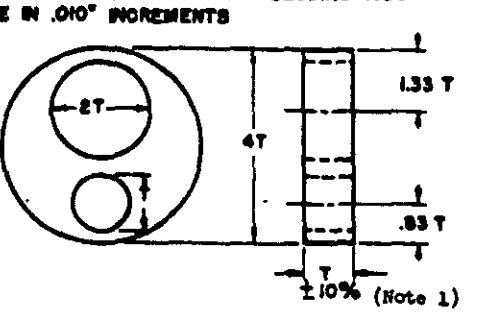
RUN PENETRAMETER THICKNESS ___ .005" ±10%
.020 MIN HOLE DIA IS
ACCEPTABLE FOR 1T HOLE

HOLES SHALL BE TRUE AND NORMAL
TO THE SURFACE OF THE PENETRAMETER
DO NOT CHAMFER

DESIGN FOR PENETRAMETER 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 PENETRAMETER THICKNESS FROM .060" TO AND INCLUDING .180"
NOTE: FROM .060" TO .180" MADE IN .010" INCREMENTS



DESIGN FOR PENETRAMETER THICKNESS OF .180" AND OVER
NOTE: MADE IN .020" INCREMENTS

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

Figure 1 - Penetrameters

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