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MIL-STD-1166A
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DEPARTMENT OF DEFENSE
TEST METHOD STANDARD

RADIOGRAPHIC TESTING REQUIREMENTS
FOR SOLID PROPELLANTS



AMSC N/A

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FOREWORD

1. This military standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Missile Command, ATTN: AMSMI-RD-SE-TD-ST, Redstone Arsenal, AL 35898-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. 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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1. SCOPE

1.1 Scope. 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.

1.2 Application. The criteria for the radiographic testing of solid propellants in this standard are applicable to normal and special quality levels of inspection of radiography penetrameter sensitivity.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

STANDARDS

MILITARY

MIL-STD-369 - Glossary of Terms and Definitions for Radiographic Testing

(Unless otherwise indicated, copies of the federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Ave., Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLICATIONS

National Institute of Standards and Technology - National Council On Radiation Protection and Measurements (NCRP) (Users of this document are encouraged to select only those NCRP document reports appropriate for their individualized applications.)

(Application for complete listing of NCRP numbered reports should be addressed to NCRP Publications, 7910 Woodmont Avenue, Suite 800, Bethesda, MD 20814.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

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American Welding Society

AWS A2.4

Standard Symbols for Welding, Brazing and
Nondestructive Examination

(Application for copies should be addressed to the American Welding Society, Inc., 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

(For definition of terms relative to this document, refer to MIL-STD-369.)

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4. GENERAL REQUIREMENTS

4.1 General. The radiographic method of testing is used for determining the presence of 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 AWS A2.4 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 penetrometer. The basis of judgment for radiographic sensitivity shall be the penetrometer. Sensitivity of radiographs shall be determined by using the penetrometers 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 penetrometer(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 penetrometer 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.

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

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

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 ± 0.2 density. In making this determination the blocks of propellant and inert material shall be simultaneously exposed on film using the same technique proposed for subsequent testing.

4.3.1.1 Penetrometer designs. Designs other than those 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 penetrameters designed in accordance with figure 1.

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5. DETAILED REQUIREMENTS

5.1 Penetrameter thickness. The penetrameter thickness, for levels 2-1T, 2-2T and 2-4T (see 5.2 and figure 1), shall be no greater than .02 (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 .01 (1 percent) of the thickness of the propellant being examined; for level 4-2T the penetrameter thickness shall be no greater than .04 (4 percent) of the thickness of propellant being examined.

5.1.1 Penetrameter thickness. Penetrameter thickness shall be not less than 0.010 inch despite the requirements of 5.1.

5.1.1.1 Hole size. Hole size shall be not less than 0.020 inch at the 1T location, despite the requirements of 5.1.

5.1.2 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.

| Identifi- cation no. on penetra- meter | Penetra- meter 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 | 1.0 4.0 | 2.0 | .5 |
| 300 | 0.060 | 3.0 | 6.0 | 1.5 |
| 800 | 0.160 | 8.0 | 16.0 | 4.0 |
| 14 | 0.280 | 14.0 | 28.0 | 7.0 |
| 20 | 0.400 | 20.0 | 40.0 | 10.0 |

5.1.2.1 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

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identification number shall indicate in inches one half the minimum thickness to which the penetrameter is applicable (see table I).

5.1.2.2 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).

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

5.2 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 5.2 through 5.2.1.2. Other levels of inspection available are shown in table III, and specified in 5.2.2 through 5.2.2.2. Care should be exercised in specifying the radiographic quality levels 2-1T or 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 <u>1/</u> |
|---------------------|---------------------------|-----------------------------------|---|
| 2-1T | .02 of specimen thickness | 1T | Percent 1.4 |
| 2-2T | .02 of specimen thickness | 2T | 2.0 |
| 2-4T | .02 of specimen thickness | 4T <u>2/</u> | 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.

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TABLE III. Special quality levels of inspection.

| Level of inspection | Penetrameter thickness | Minimum perceptible hole diameter | Equivalent penetrameter sensitivity |
|---------------------|---------------------------|-----------------------------------|-------------------------------------|
| 1-1T | .01 of specimen thickness | 1T | 0.7 |
| 1-2T | .01 of specimen thickness | 2T | 1 |
| 4-2T | .04 of specimen thickness | 2T | 4 |

5.2.1 Level 2-1T radiography. In level 2-1T radiography the 1T hole in a penetrameter .02 (2 percent) of the specimen thickness shall be visible.

5.2.1.1 Level 2-2T radiography. In level 2-2T radiography the 2T hole in a penetrameter .02 (2 percent) of the specimen thickness shall be visible.

5.2.1.2 Level 2-4T radiography. In level 2-4T radiography the 4T hole in a penetrameter .02 (2 percent) of the specimen thickness shall be visible.

5.2.2 Level 1-1T radiography. In level 1-1T radiography the 1T hole in a penetrameter .01 (1 percent) of the specimen thickness shall be visible.

5.2.2.1 Level of 1-2T radiography. In level 1-2T radiography the 2T hole in a penetrameter .01 (1 percent) of the specimen thickness shall be visible.

5.2.2.2 Level 4-2T radiography. In level 4-2T radiography the 2T hole in a penetrameter .04 (4 percent) of the specimen thickness shall be visible.

5.2.3 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/}

5.3 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

^{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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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.

5.4 Number of penetrameters. One penetrameter shall represent an area within which radiographic densities do not vary more than 1.0 density. The 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.

5.5 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.

5.5.1 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
- (d) View
- (e) Original or subsequent exposure of the same item.

5.6 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.

5.7 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 Council on Radiation Protection and Measurements should be the guide to radiological safety.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This document is intended for use in establishing quality level and testing sensitivity in radiographic inspection of solid propellants.

6.2 Issue of DODISS. When this standard is used in acquisition, the issue of the DODISS to be applicable to this solicitation must be cited in this solicitation (see 2.1.1 and 2.2).

6.3 Metrication. Metric equivalents in accordance with FED-STD-376 are acceptable for use in this standard.

6.4 Subject term (keyword) listing.

Gamma-ray
Nuclear radiation
Penetrameter, sensitivity
Radiation
Testing sensitivities
X-ray

6.5 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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Review Activities:
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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

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| RECOMMEND A CHANGE | | 1. DOCUMENT NUMBER MIL-STD-1166A | 2. DOCUMENT DATE (YYMMDD) 19 September 1991 |
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| 6. PREPARING ACTIVITY | | | |
| a. NAME COMMANDER U. S. ARMY MISSILE COMMAND | | b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (205) 876-6980 746-6980 | |
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