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MILITARY SPECIFICATION

RADIOGRAPHIC INSPECTION;  
SOUNDNESS REQUIREMENTS FOR ALUMINUM  
AND MAGNESIUM CASTINGS  
(FOR SMALL ARMS PARTS)



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FSC-~~100~~

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DEPARTMENT OF DEFENSE

WASHINGTON, D. C.

Standardization Division

Radiographic Inspection; Soundness Requirements for Aluminum and Magnesium Castings (for Small Arms Parts).

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1. This Military Standard has been approved by the Department of Defense and is mandatory for use by all Departments and Agencies of the Department of Defense.
2. Recommended corrections, additions, or deletions should be addressed to the Commanding General, U. S. Army Weapons Command, ATTN: AMSWE-RDT, Rock Island, Illinois 61202.

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FOREWORD

The purpose of this standard is to provide established radiographic inspection standards and inspection procedures for aluminum and magnesium castings for small arms parts.

This revision introduces the use of industrial radiographic standards, ASTM E 155-60T, for discontinuities commonly occurring in thin wall aluminum and magnesium castings up to 2 inches in thickness and retains the industrial standards previously specified, ASTM E 98-53T, for use only on castings over 2 inches in thickness.

Prepared by the U. S. Army Weapons Command in conjunction with the Department of Defense Standardization Program, it is one of a series of standards which will encompass all FSC 1005 weapons, accessories, and related equipment.

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## 1. SCOPE

1.1 This standard covers the radiographic inspection of aluminum and magnesium sand, investment, permanent mold, and die castings. It establishes radiographic standards and standard inspection procedures for use in acceptance inspection of small arms parts for which radiographic inspection for soundness is specified.

1.2 Classification. The quality of castings shall be of the following classes:

- Class 1 - Very high stress.
- Class 2 - Medium to high stress.
- Class 3 - Low to medium stress.

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## 2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on date of invitation for bids form a part of this standard to the extent specified herein.

### SPECIFICATIONS

#### Governmental

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-453 - Inspection, Radiographic.

(Copies of standards required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

### PUBLICATIONS

Navy - NAVAER-00-15PC-504 - Reference Radiographs for Inspection of Aluminum and Magnesium Castings.

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

#### AMERICAN SOCIETY FOR TESTING AND MATERIALS

- ASTM Designation E 155-60T and ASTM Designation E 98-53T - Tentative Reference Radiographs for Inspection of Aluminum and Magnesium Castings.

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa.)

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### 3. DEFINITIONS OF CLASSIFICATIONS

- Class 1 - Very high stress. Stringent requirements of castings due to stress or fatigue consideration (factor of safety less than 2.0).
- Class 2 - Medium to high stress. These are the areas that are normally found in castings that must support moving parts or play an important role in stress distribution (factor of safety 2.0 to 4.0).
- Class 3 - Low to medium stress. Low stressed area when excess material is needed for rigidity, vibration damping, appearance, casting technique, or other similar reasons. This class may also apply to large, heavy, complicated castings when it is very difficult to obtain more sound castings with present foundry methods (factor of safety more than 4.0).

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#### 4. GENERAL REQUIREMENTS

4.1 Castings shall be radiographed and inspected in the position and locations specified on the applicable radiographic position chart drawing, component drawing, specification or as specified in the contract and in accordance with MIL-STD-453 except that non-film radiographic techniques are not permitted.

4.1.1 Penetrators shall be as specified in MIL-STD-453, or a step wedge type approved by the procuring activity may be used. The type of penetrators used shall be identified in the inspection records.

4.1.2 Unless otherwise specified, radiographs shall show the image of at least two holes (quality level 2-2T) and the outer edge of the penetrator.

4.2 Laboratories and personnel performing radiographic inspection shall meet the requirements of MIL-STD-453.

4.3 MARKINGS AND IDENTIFICATION. Unless otherwise specified, marking of parts and identification of penetrators shall be in accordance with MIL-STD-453. When the size of the casting is such that marking of individual castings is impractical, a procedure for identification shall be as agreed upon by the procuring agency and the contractor.

#### 4.4 DESIGNATION OF CLASSIFICATION.

4.4.1 The required quality of the casting or of specific areas thereof shall be designated as class 1, 2, or 3 on the applicable drawing or other contractual documents.

4.4.2 When radiographic inspection is required but the quality of the casting is not specified on the applicable drawings or other contractual documents, class 2 shall apply.

4.5 ACCEPTANCE STANDARDS. The acceptance standards for the designated class of castings are as specified in tables I and II. The numbers in the columns of these tables are the identification numbers of the applicable reference radiograph standard film to be used as acceptance standards;

4.6 DEFECTS. The defects which are apt to cause casting failure may be recognized on the radiographic negative by the following descriptions:

4.6.1 Gas holes. Appear as round or elongated, smooth-edged dark spots, occurring individually, in clusters, or distributed throughout the casting.



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4.6.2 Gas porosity. Represented by round or elongated dark spots corresponding to minute voids usually distributed throughout the entire casting.

4.6.3 Shrinkage cavity. Appears as a dendritic, filamentary, or jagged darkened area.

4.6.4 Shrinkage sponge. Shrinkage sponge or porosity is a localized lacy or honeycombed darkened area.

4.6.5 Microshrinkage (Magnesium only). Appears as dark feathery streaks or dark irregular patches, indicative of cavities occurring in the grain boundaries.

4.6.6 Foreign materials. Appear as isolated, irregular, or elongated variation of film density, not corresponding to variations in thickness of material nor to cavities.

4.6.7 Segregations. Appear as variations in film density which can be explained by segregation of elements of atomic numbers different from that of the matrix.

4.6.8 Hot cracks. Appear as ragged dark lines of variable width and numerous branches. They have no definite line of continuity and may exist in groups. They originate internally or at the surface.

4.6.9 Cold cracks. Appear as a straight line usually continuous throughout its length and generally exist singly. These cracks start at the surface.

4.6.10 Cold shuts. Appear as a distinct darkened line or band of variable length and definite smooth outline - separations where two streams of molten metal do not form a bond.

4.6.11 Misruns. Appear as prominent darkened areas of variable dimensions with a definite smooth outline - where metal did not fill the mold.

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Table I  
 Acceptance Standards for Aluminum and Magnesium Castings up to 2 Inches  
 (ASTM E 155-60T Reference Radiographs)

Defect	ASTM E 155-60T Radiograph Reference		Aluminum			Magnesium		
	Reference		Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
	Aluminum	Magnesium	1/4	3/4	1/4 3/4	1/4 3/4	1/4 3/4	1/4 3/4
Gas Holes	1.1	1.1	1	2	5	1	2	4
Gas Porosity (round)	1.21	1.1	1	3	7	NA	*	*
Gas Porosity (elongated)	1.22	None	1	2	4	--	--	--
(Aluminum only)								
Shrinkage (cavity)	2.1	2.32	NA	1 @	2 @	NA	*	*
Shrinkage (sponge)	2.2	2.31	1	2	3	1	3	5
Microshrinkage	None		--	--	--	1	3	5
(Magnesium only)								
Foreign Material	3.11	3.11	1	2	4	2	3	5
(less dense)								
Foreign Material	3.12	3.12	1	4	6	1	3	4
(more dense)								
Segregations			NA	NA	NA	NA	NA	NA
Hot Cracks			NA	NA	NA	NA	NA	NA
Cold Cracks			NA	NA	NA	NA	NA	NA
Cold Shuts			NA	NA	NA	NA	NA	NA
Misruns			NA	NA	NA	NA	NA	NA

NA - Not allowed.  
 \* - Reference radiographs under development and not presently available in ASTM E 155-60T. Use Table II.  
 1/4 - Reference radiograph thickness up to and including 1/2 inch.  
 3/4 - Applicable casting thickness over 1/2 inch to and including 2 inches.  
 @ - Use reference standard for 1/4 inch.

**Table II**  
**Acceptance Standards for Aluminum and Magnesium Castings Over 2 Inches**  
**(ASTM E 98-53T or NAVAER-00-15PC-504)**

Defect	ASTM E 98-53T or NAVAER-00-15PC-504 Radiograph Reference		Aluminum			Magnesium		
	Aluminum	Magnesium	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
Gas Holes	1.1	1.1	2	4	6	1	2	3
Gas Porosity (round)	1.21	1.2	2	3	7	1	2	3
Gas Porosity (elongated) (Aluminum only)	1.22	None	1	3	5	--	--	--
Shrinkage (cavity)	2.1	2.1	NA	2	3	NA	1	2
Shrinkage (sponge)	2.2	None	1	3	5	--	--	--
Microshrinkage (Magnesium only)	None	2.3	--	--	--	1	3	5
Foreign Material (less dense)	3.11	3.11	1	3	5	2	3	5
Foreign Material (more dense)	3.12	3.12	1	3	4	1	2	3
Segregations	NA	NA	NA	NA	NA	NA	NA	NA
Hot Cracks	NA	NA	NA	NA	NA	NA	NA	NA
Cold Cracks	NA	NA	NA	NA	NA	NA	NA	NA
Cold Shuts	NA	NA	NA	NA	NA	NA	NA	NA
Misruns	NA	NA	NA	NA	NA	NA	NA	NA

NA - Not allowed.

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## 5. DETAILED REQUIREMENTS

5.1 INSPECTION. Radiographic inspection shall be performed by the contractor in accordance with the provisions of this standard. Contractors not having suitable radiographic facilities may obtain the services of a commercial testing laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth herein where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

5.2 LOT SIZE. A lot shall consist of all castings of same design which are submitted for approval at the same time and from the same melt.

5.3 SAMPLING. Unless otherwise specified in procurement documents, sampling inspection shall be as specified herein.

5.3.1 Class 1 castings. Sampling inspection shall be performed only after satisfactory results have been obtained with 100 consecutive castings. After this requirement has been met, sampling shall be performed in accordance with inspection level S4 of MIL-STD-105 using an AQL of 0.65 percent.

5.3.2 Class 2 and class 3 castings. Sampling inspection shall be performed only after satisfactory results have been obtained with 50 consecutive castings. After this requirement has been met, sampling shall be performed in accordance with inspection level S4 of MIL-STD-105 using an AQL of 1.5 percent.

5.3.3 Inspection shall revert to the number of consecutive castings specified in 5.3.1 or 5.3.2, as applicable, in the event that any of the following conditions occur:

- (a) Failure of samples from a lot to meet the sampling inspection acceptance criteria.
- (b) Any pattern, permanent mold or die change or modification.
- (c) Any major change of foundry technique, such as risering, gating, chilling, sand mix, or pouring temperatures.
- (d) Start of a new foundry. (Includes lapse of production of 3 months or more.)

### 5.4 DETERMINATION OF ACCEPTABILITY.

5.4.1 Acceptability of the casting shall be determined by comparing the actual radiograph with the designated reference radiographic standard film using the same illuminator.

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5.4.1.1 The frequency and distribution of the defects in the casting or specified casting area shall not exceed that illustrated in the designated reference radiographic standard film for that type of defect.

5.4.1.2 Despite the fact that the designated acceptance standard requirements are met for internal shrinkage, gas holes, or foreign materials, castings shall be rejected when such defects occur closer than twice their maximum dimension to any edge or surface of the casting.

5.4.2 Single-type defect. When the radiograph shows but one type of defect which is equal to or better than the designated acceptance standard specified for that type of defect, the casting shall be acceptable. If the radiograph shows the casting to be lower quality than the designated acceptance standard, the casting shall be rejected.

5.4.3 Multiple defects.

5.4.3.1 When the radiograph shows two or more types of defects to an extent equal to or not significantly better than the acceptance standards for respective defects, the casting shall be rejected.

5.4.3.2 When the radiograph shows two or more types of defects significantly better than the acceptance standard for respective defects, the casting shall be considered acceptable provided no defects occur closer to each other than a distance equal to twice the maximum dimension of the largest defect.

5.4.3.3 When the radiograph shows one predominant type of defect to an extent equal to or not significantly better than the acceptance standard and all other types of defects to an extent significantly better than the acceptance standard for respective defects, the casting shall be considered acceptable provided the other defects do not occur closer to the predominant defect than a distance equal to twice the maximum dimension of the predominant defect.

5.4.4 Special attention shall be given to application of the proper acceptance standards to probable defective areas that are specified by special symbol or area outline on the applicable drawing.

5.4.5 False indications of defects. At times, radiographic films may indicate defective castings when actually the film is defective. If doubt exists as to whether the film or the casting itself is defective, the casting shall be radiographed again.

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5.5 REPORTS OF INSPECTION. The contractor shall furnish inspection reports in accordance with MIL-STD-453. Delivery of reports and radiographs shall be made to the procuring agency at time of delivery of production castings.

5.5.1 Packing. When radiographs are to be mailed or shipped, they shall be packed in flat envelopes, cartons, or boxes so as to prevent injury to the negatives. Single paper sheets shall be used to separate individual negatives from each other. Radiographs packed in flat envelopes shall be suitably stiffened by cardboard, fiberboard, or other material to prevent bending or rolling of the package.

(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.)

(Copies of this standard for military use may be obtained as indicated in the foreword to the Index of Military Specifications and Standards.)

(Copies of this standard may be obtained for other than official use by individuals, firms, and contractors from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.)

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