

Castings, Classification and Inspection of

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NOTICE

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1. SCOPE:

1.1 Purpose:

The purpose of this military standard is to prescribe the non-destructive testing acceptance criteria for the inspection of metal castings that are classified (see 1.3) in accordance with this standard.

1.2 Applicability:

1.2.1 Casting methods: This standard is intended to apply to all casting methods except high pressure die castings (such as the ones covered by ASTM B 85, "Aluminum Alloy Die Castings").

1.2.2 Casting Alloys: This standard applies to casting alloys that fall under one of the alloy families covered in tables 6 through 14 of this standard. Alloys that do not belong to any of the alloy families covered in tables 6 through 14 may be inspected to this standard in accordance with 5.3.3.2.

1.3 Classification:

Castings that are inspected in accordance with this standard are classified by classes and applicable grades. This class governs the frequency of inspection (see 6.4), while the grade controls the quality of the casting.

1.3.1 Classes: For design information only, castings are classified as follows:

- a. Class 1. A casting, the single failure of which would endanger the lives of operating personnel, or cause the loss of a missile, aircraft, or other vehicle.
- b. Class 2. A casting, the single failure of which would result in a significant operational penalty. In the case of missiles, aircraft, and other vehicles, this includes loss of major components, unintentional release or inability to release armament stores, or failure of weapon installation components.
- c. Class 3. Castings not included in Class 1 or Class 2 and having a margin of safety of 200 percent or less.
- d. Class 4. Castings not included in Class 1 or Class 2 and having a margin of safety greater than 200 percent.

1.3.2 Grades: Castings, or sections of a casting, shall be of grades A, B, C or D as shown in Tables 6 through 14 for radiographic requirements, and table 4 for magnetic particle and liquid penetrant requirements. For design information only, definitions for the grades are shown below:

- a. Grade A - The highest quality grade of casting, or area of a casting, with minimum allowable discontinuities and very difficult to produce except in local areas.
- b. Grade B - The second highest quality grade of casting, or area of a casting, which allows slightly more discontinuities than grade A, and difficult to produce, except in local areas.
- c. Grade C - A high quality grade of casting, or area of a casting, that can be consistently produced.
- d. Grade D - The lowest quality grade of a casting, or area of a casting, that is easily produced and is used primarily for low stress or noncritical areas adjacent to the higher graded areas.

2. APPLICABLE DOCUMENTS:

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

2.1 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-I-25135 Inspection Materials, Penetrants

MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification

MIL-STD-453 Inspection, Radiographic

MIL-STD-6866 Inspection, Liquid Penetrant

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings

ASTM E 186 Reference Radiographs for Heavy-walled (2 to 4.5 in. (51 to 114 mm)) Steel Castings

ASTM E 192 Reference Radiographs of Investment Steel Castings for Aerospace Applications

ASTM E 272 Reference Radiographs of High-Strength Copper-Base and Nickel-Copper Alloy Castings

ASTM E 280 Reference Radiographs for Heavy-walled (4.5 to 12 in. (114 to 305 mm)) Steel Castings

ASTM E 310 Reference Radiographs for Tin Bronze Castings

ASTM E 446 Reference Radiographs for Steel Castings up to 2 in. (51 mm) in Thickness

ASTM E 1255 Radioscopic Real-Time Examination

ASTM E 1444 Magnetic Particle Examination

3. DEFINITIONS:

3.1 Alloy:

A metallic substance composed of two or more elements which possesses properties different from those of its constituents.

3.2 Casting:

An object at or near finished shape obtained by filling a mold with molten metal and allowing it to solidify.

3.3 Chaplet:

Metal core support which is used in the mold cavity and which fuses into the casting.

3.4 Cold shut:

An imperfect junction between two flows of metal in a mold caused by the surface of the streams of metal chilling too rapidly, or in effect, being chilled to the extent that fusion does not occur. This discontinuity may have the appearance of a crack or seam with smooth or rounded edges.

3.5 Contracting agency:

A prime contractor, subcontractor, or government agency procuring castings.

3.6 Defect:

A discontinuity or condition in a casting which exceeds allowable limits. Defects are, by definition, unacceptable.

3.7 Diffraction:

A pattern of light or dark areas in a casting radiograph, due to grain structure, which is not detrimental to the casting.

3.8 Discontinuity:

An interruption in the normal physical structure or configuration of a part such as cracks, inclusions, and porosity, which may or may not affect the usefulness of a part.

3.9 Foreign materials:

Appear as isolated, irregular, or elongated variations of radiographic film density, corresponding to variations in thickness of material, or to cavities. They may be due to the presence of sand, slag, oxide, dross, or metal of different density. External foreign material would, of course, be detected by visual inspection. In radiographic inspection, the distinguishing factor between inclusions and foreign material is that the foreign material indications occur over a larger area while the inclusion indications are singular indications of one inclusion.

3.10 Gas holes:

Round or elongated, smooth-edged voids occurring individually, in clusters, or distributed throughout the casting. They are generally caused by trapped air or gases rejected from the metal during solidification.

3.11 Gas porosity:

Minute voids usually distributed throughout the entire casting. They are generally caused by trapped air or gases rejected from the metal during solidification.

3.12 Hot tear:

Hot tears appear as ragged dark lines of variable width and with no definite line of continuity. Hot tears may exit in groups starting at a surface. They usually result from uneven cooling associated with abrupt changes in wall thickness, and they are formed upon solidification of the molten metal.

3.13 Inclusions:

Inclusions are particles of foreign material such as sand or slag that are embedded in the cast metal.

3.14 Insert:

A piece of steel used to locally increase the rate of heat removal during solidification. It is also called an internal chill.

3.15 Misruns:

A misrun is caused by a failure of the molten metal to completely fill the mold. It appears on the radiograph as prominent darkened areas of variable dimensions with a definite and smooth outline.

3.16 Penetrameter or Image Quality Indicator (IQI):

A strip of metal that is radiographically similar to the metal being tested, representing a percentage of object thickness and provided with a combination of steps, holes or wires. When placed in the path of X-rays or gamma rays, its image provides a check on the radiographic technique employed.

3.17 Radiographic quality level:

The ability of the radiographic procedure to demonstrate a certain IQI sensitivity based on the perception of the IQI holes or wires.

3.18 Segregation:

A concentration of alloying elements in specific regions of the casting, usually the result of the primary crystallization of one phase with the subsequent concentration of other elements in the remaining liquid.

3.19 Shrinkage:

The term shrinkage, as used in this standard, refers to a network of small voids due to grain boundary solidification phenomena. It is different than the larger and singular voids caused by solidification shrinkage on a large scale, as defined in 3.20 (shrinkage cavity). Shrinkage is usually categorized as either dendritic, filamentary, feathery, or sponge. It is usually below the surface but may extend to the surface. In radiographic inspection, depending on the category, shrinkage may appear as dark irregular patches, as dark feathery streaks, or as a lacy or honeycombed darkened area with a diffuse outline. In penetrant inspection, dendritic shrinkage (sometimes called "microshrinkage"), and sponge shrinkage, are often indistinguishable from each other and appear as a sponge-like cluster of tiny pin holes or spotty irregular areas with feathery outlines. In magnetic particle inspection shrinkage may appear as a jagged area or irregular patch of magnetic particles.

3.20 Shrinkage cavity:

Shrinkage cavities occur when insufficient feeding of a section results in a continuous cavity within the section. Shrinkage cavities appear on the radiograph as dark areas that are indistinctly outlined and have irregular dimensions.

3.21 Surface irregularities:

In radiographic inspection, they are any images corresponding to an irregularity visible on the surface. In visual inspection they are any interruptions, either positive (raised) or negative (depressed) from the normal cast surface.

3.22 Visual inspection:

Inspection of casting surfaces to determine conformance to the requirements for surface roughness, surface irregularities, dimensions, or any visible surface discontinuities.