



DIE CASTING QUALITY STANDARD



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AMERICAN MANUFACTURING COMPLIANCE AUTHORITY (AMCA) QUALITY STANDARDS FOR DIE CASTINGS (United States)

AMCA Standard 402-DC (2025 Edition)

1. Scope

This standard defines the minimum quality, inspection, process, and performance requirements for metallic die-cast components manufactured using high-pressure, low-pressure, or gravity die-casting processes. It applies to castings used in industrial, commercial, automotive, aerospace, consumer, and structural applications unless otherwise superseded by contract-specific requirements.

2. Normative References

The following documents are referenced within this standard and shall be considered integral to its application:

- AMCA 100-QMS: General Requirements for Manufacturing Quality Systems
- AMCA 210-MAT: Metallic Materials and Mechanical Integrity Guidelines
- AMCA 305-INS: Dimensional Inspection and Measurement Protocol

Unless otherwise specified, the latest editions apply.

3. Definitions

3.1 Die Casting: A manufacturing process in which molten metal is injected or poured into a reusable steel mold to form a solidified component.

3.2 Surface Discontinuity: Any visible or sub-surface irregularity including porosity, cracks, laps, cold shuts, or inclusions.

3.3 Critical Feature: A dimension, surface requirement, or characteristic essential to fit, form, function, or safety performance.

3.4 Lot: A production quantity manufactured under essentially identical conditions, traceable to a single melt batch or machine cycle window.

4. Material Requirements

4.1 Material Certification

All materials shall conform to the applicable alloy specifications stated in

procurement documents. Suppliers must provide traceable material certifications identifying alloy composition, melt source, heat number, and any modifier additions.

4.2 Chemical Composition

Chemical composition must remain within the specified tolerance limits for the alloy grade in use. Any deviation exceeding $\pm 0.15\%$ of a listed element requires written authorization from the client or quality authority.

4.3 Mechanical Properties

Mechanical performance shall meet the minimum tensile, yield, and elongation requirements for the alloy. If heat treatment is applied, results must be recorded and validated for each treated lot.

5. Manufacturing Requirements

5.1 Process Control

Die-casting operations shall use controlled parameters including melt temperature, die temperature, injection pressure, fill time, lubrication cycles, venting, and cooling time. All critical parameters must be logged automatically and retained for a minimum of five years.

5.2 Tooling and Die Maintenance

Dies shall be maintained to prevent dimensional drift and surface degradation. Preventive maintenance frequency must be established based on cycle counts and documented in a tooling history record. Any die repair must undergo first-article validation.

5.3 Gating and Runner Design

Gates, runners, and overflow systems must be designed to minimize turbulence, ensure complete fill, and reduce porosity. Changes to gating design after initial qualification require re-approval under AMCA 402-DC Section 10.

5.4 Metal Handling

Melting furnaces shall be equipped with temperature and oxidation monitoring. Slag removal must occur at defined intervals. Recycled metal content shall not exceed 30% of total melt per batch unless explicitly approved.

6. Dimensional Requirements

6.1 General Tolerances

Dimensional tolerances shall comply with drawing specifications. If no tolerances are listed, AMCA standard tolerance class CT-4 applies to all linear dimensions

unless specifically exempted.

6.2 Critical Features

Critical dimensions and features shall be identified on the drawing and verified 100% for each lot. Automated inspection is recommended for features requiring precision beyond ± 0.05 mm.

6.3 Shrinkage and Distortion Control

Manufacturers must apply appropriate compensation for expected shrinkage based on alloy characteristics and tooling geometry. Distortion beyond 80% of the allowable tolerance band requires process correction or tooling repair.

7. Surface Quality Requirements

7.1 Visual Surface Standards

Castings shall be free of cracks, cold shuts, excessive flash, blisters, visible porosity, inclusions, or surface delamination.

- **Class A Surfaces:** No visible defects at 50 cm under normal lighting.
- **Class B Surfaces:** Minor cosmetic defects permitted; no material performance impact.
- **Class C Surfaces:** Functional surfaces only; visual irregularities allowed if not detrimental.

7.2 Porosity Limits

Porosity shall not exceed:

- Level 1 for Class A surfaces
- Level 2 for Class B surfaces
- Level 3 for Class C surfaces
(Per AMCA 305-INS visual comparator standards.)
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8. Non-Destructive Testing (NDT)

8.1 Radiographic Inspection

Mandatory for safety-critical or pressure-retaining components. Acceptance criteria follow AMCA 608-NDT Class R1 unless otherwise stated.

8.2 Dye Penetrant Inspection

Used for surface crack detection on machined surfaces or areas subject to high stress.

8.3 Ultrasonic Testing

Required when wall thickness exceeds 6 mm or when internal voids may compromise integrity.

9. Mechanical Testing

9.1 Tensile Testing

Performed per lot on separately cast or integrally cast specimens as specified by the design authority.

9.2 Hardness Testing

Brinell or Rockwell hardness tests must be performed at defined control points on heat-treated castings.

9.3 Pressure Testing

Applicable to fluid-handling castings. Test pressure shall be $1.5\times$ the rated operating pressure.

10. Qualification, Validation, and Change Control

10.1 First Article Inspection (FAI)

A complete FAI must be conducted for all new or modified castings. FAI reports shall be archived for the life of the part plus five years.

10.2 Process Change Notification

Any change to tooling, alloy, heat treatment, casting machine, or gating design requires written submission to the customer and AMCA compliance auditor at least 14 days prior to implementation.

10.3 Re-qualification

Re-qualification is required if more than 12 months pass without production, or if cumulative dimensional drift exceeds 75% of tolerance limits.

11. Packaging and Identification

Each casting shall be labeled with lot number, part number, alloy designation, and manufacturer ID. Packaging must prevent corrosion, abrasion, and mechanical damage during transportation.

12. Documentation and Records

All production, inspection, testing, and certification records must be retained for a minimum of ten years and made available for audit upon request.

13. Non-Conformance and Corrective Action

Non-conforming castings shall be segregated and documented under AMCA 100-QMS requirements. Root-cause analysis and corrective action plans must be completed within 30 days of detection.

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