AMCA

AMERICAN MANUFACTURING COMPLIANCE AUTHORITY

INVESTMENT CASTING QUALITY STANDARD

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AMERICAN MANUFACTURING COMPLIANCE AUTHORITY (AMCA)
QUALITY STANDARDS FOR INJECTION-MOLDING

(AMCA-QS-IC/2025)

1. Purpose and Scope

The AMCA Quality Standards for Investment Castings establish minimum manufacturing, inspection, testing, and documentation requirements to ensure consistent dimensional accuracy, material integrity, surface finish, and performance of investment-cast components. These standards apply to all ferrous and non-ferrous castings produced using the investment casting (lost-wax) process for industrial, commercial, and aerospace applications.

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2. Definitions

2.1 Investment Casting: A casting process in which a wax pattern is coated with refractory material to form a mold shell. After wax removal and metal pouring, the shell is broken to retrieve the casting.
2.2 Critical Feature: Any dimension, surface, or mechanical property essential to functional performance or fit.
2.3 Lot: A group of castings manufactured under the same process conditions and heat.
2.4 Supplier: The manufacturer or foundry responsible for producing the castings.

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3. General Requirements

3.1 Compliance

All suppliers shall maintain documented process controls demonstrating compliance with AMCA-QS-IC/2025. Castings must meet all applicable engineering drawings, customer specifications, and contractual requirements.

3.2 Process Control

Suppliers shall establish a controlled process covering:

- Wax pattern production
- Shell building and drying

- Wax removal
- Metal melting and pouring
- Shell removal
- Heat treatment
- Final finishing
- Inspection and testing

Process deviations must be recorded and approved through a formal corrective action procedure.

3.3 Personnel Qualification

Personnel performing melt operations, nondestructive testing, and dimensional inspections shall be qualified and trained. NDT technicians shall meet ASNT Level II or equivalent competency.

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4. Material Requirements

4.1 Raw Materials

Wax, ceramic shell materials, alloys, and gating components shall conform to approved supplier lists and meet chemical composition specifications.

4.2 Alloy Verification

Each melt lot shall undergo chemical analysis to confirm conformance to alloy standards. Certification must be retained as part of the permanent quality record.

4.3 Traceability

Castings must be traceable to:

- Melt lot
- Heat treatment batch
- Pattern batch
- Inspection documentation

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5. Pattern and Mold Requirements

5.1 Pattern Accuracy
Wax patterns shall be produced using controlled shrinkage allowances documented for each alloy and geometry.

5.2 Cluster Assembly
Assemblies shall be visually inspected for cleanliness, structural integrity, material compatibility, and proper gating design.

5.3 Shell Quality
Shell molds must meet minimum strength requirements:

- Green strength
- Fired strength
- Permeability
- Thermal shock resistance

Shell defects such as delamination, insufficient drying, cracking, or foreign inclusions shall be cause for rejection.

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6. Casting Requirements

6.1 Melting and Pouring
Melting operations shall follow standardized procedures ensuring:

- Temperature control within ±10°C of specification
- Clean melt practices
- Slag and gas control
- Documented pouring times

6.2 Heat Treatment
Heat treatment must follow controlled furnace cycles with continuous temperature monitoring and calibration at defined intervals. Lot-specific heat treatment charts must be retained.

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7. Dimensional and Visual Inspection

7.1 Dimensional Tolerances

Unless otherwise specified, castings shall conform to the following general tolerances:

- Linear dimensions: ±0.005 in/in (minimum ±0.010 in)
- Hole diameters: ±0.005 in
- Flatness and straightness: 0.010 in per inch

Critical dimensions shall be 100% inspected using calibrated equipment.

7.2 Visual Criteria

Castings shall be free from:

- Surface cracks
- Misruns or cold shuts
- Shrinkage cavities
- Porosity clusters visible to the naked eye
- Inclusions of ceramic shell
- Excess metal or flash violating drawing specifications

Surface finish shall not exceed 125 microinches Ra unless otherwise specified.

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8. Nondestructive Testing (NDT)

8.1 Radiographic Inspection

When required, radiography shall follow ASTM E1742 or equivalent. Acceptance criteria shall meet Level 2 severity unless customer specifications indicate otherwise.

8.2 Dye Penetrant Inspection

Penetrant testing shall meet ASTM E1417 standards. Linear indications, clustered porosity, or any crack-like indications are not permitted.

8.3 Ultrasonic Inspection

For thicker sections (>0.50 in), ultrasonic testing shall be performed to evaluate potential subsurface defects. Acceptance criteria must align with ASTM A609 or customer requirements.

9. Mechanical Testing

9.1 Tensile and Hardness Tests

Mechanical properties must be confirmed per lot. Test bars shall be cast integrally or separately if approved by the customer. Results must meet drawing or alloy specifications.

9.2 Impact Testing

When specified, Charpy impact tests must meet minimum energy requirements for the designated material grade.

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10. Finishing Requirements

10.1 Surface Finishing

Grinding, machining, shot blasting, or polishing shall not compromise dimensional or metallurgical integrity. All finished surfaces must meet contamination-free requirements.

10.2 Coatings

Any protective coatings, plating, or passivation treatments must be documented and inspected for uniformity and adhesion.

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11. Documentation and Records

11.1 Required Documents

Suppliers shall provide:

- Material certifications
- Process control records
- Heat treatment charts
- NDT reports
- Dimensional inspection reports
- Final acceptance documentation

11.2 Record Retention
Records must be retained for a minimum of **10 years**, or longer if required by contract.

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12. Nonconformance and Corrective Action

12.1 Nonconforming Product
Any casting failing to meet requirements shall be segregated, documented, and dispositioned via:

- Rework (per approved procedures)
- Repair (with customer approval)
- Scrap

12.2 Corrective Action
Suppliers must conduct root-cause analysis for recurring issues and submit corrective action responses in accordance with AMCA CA-102 standards.

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13. Packaging and Delivery

13.1 Protection
Castings must be individually protected from impact, abrasion, moisture, and corrosion. No bare metal shall contact wood or corrosive materials.

13.2 Identification
Each shipment shall include:

- Lot number
- Part number
- Quantity
- Revision level
- Certificate of conformance

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14. Compliance and Audits

AMCA reserves the right to audit suppliers' facilities, processes, and records. Noncompliance may result in probation, suspension, or revocation of approved supplier status.

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Printed in the United States of America