



METALLIC MATERIALS MANUFACTURING CASTINGS

Casting is a process in which a liquid metal is delivered into a mold (usually by a crucible) that contains a negative impression (i.e., a three-dimensional negative image) of the intended shape. The metal is poured into the mold through a hollow channel called a sprue. The metal and mold are then cooled, and the metal part (the casting) is extracted. Casting is most often used for making complex shapes that would be difficult or uneconomical to make by other methods. Castings are very common in the aerospace industry, and the main processes used are sand casting and investment casting.

Failure to control the casting process can lead to reduced service life, premature and in-service part failure, increased costs and/or excessive lead time and program delays.

There are very few industry specifications controlling the manufacture of castings, with most original equipment manufacturers (OEMs) using their own or supplier

specifications to control casting and cast parts. General Quality System standards like AS9100 are not designed to provide the depth and breadth needed to address critical casting processes. At the request of Industry, the Nadcap® Management Council approved a Metallic Materials Manufacturing Task Group to address areas such as forgings, castings, and raw materials. The audit criteria for Sand Casting (AC7142) was published in 2022, and the audit criteria for Investment Casting (AC7141) was published in 2023, with audits starting in Q1 2023.

By working together through the Nadcap program, the aerospace industry benefits from the existing structure, policies, and systems to address the auditing of 2 casting processes efficiently and effectively. These audit criteria cover the casting of aluminum, magnesium, steel, titanium and nickel alloys, with audits covering 3-5 days depending on the number of alloy groups cast at the facility.

BUSINESS BENEFITS

- Reduced expenditure and lead time reduction.
- Reduced scrap, reduced rework and associated cost savings.
- Accredited Companies appear in the Aerospace Qualified Manufacturers List (QML) in eAuditNet. This is a publicly accessible database industry uses to find Nadcap accredited suppliers.
- Reduction in the number of Subscriber audits of suppliers.

INDUSTRY SUPPORT

The following Subscribers (OEMs) are active in the Nadcap Metallic Materials Manufacturing (MMM) Task Group supporting Castings:

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|------------------------|----------------|
| • Airbus Commercial | • MBDA |
| • BAE Systems | • MTU |
| • Collins Aerospace | • Rolls-Royce |
| • Honeywell Aerospace | • Safran Group |
| • Leonardo Helicopters | |

AUDIT CRITERIA

The castings audit criteria questions are grouped into sections based on the audit process. These include:

1. General requirements (preventative maintenance, training, documentation, tooling and dies manufacturing and storage)
2. Purchase order review
3. Purchasing and verification of product (raw material and consumables)
4. Manufacture of cores and patterns (sand casting)
5. Mold manufacture and assembly (sand casting)
6. Mold preparation
7. Casting process
8. Post cast processing (shell removal, gate witness removal, surface finishing and core removal)
9. Mechanical and Chemical testing
10. Hot Isostatic Pressing, heat treatment and nondestructive testing (NDT) inspection
11. One long job audit, covering the entire casting process, based on a historical job asking a wide array of compliance questions

Up to 36 shorter in process job audits for Investment Casting (Audit Criteria AC7141) based on specific parts of this casting process. Up to 25 shorter in process job audits for Sand Casting (Audit Criteria AC7142) based on specific parts of this casting process.

COMMON CASTING DEFECTS

- Metallurgical defects such as porosity, sinks, blisters, inclusions and dross
- Heat related defects such as cracks, hot tears, cold shuts and thermal fatigue
- Mechanically induced defects such as surface marks, bending and undercuts

An improved casting quality system reduces the number of defects, and attendant supplier costs. The Nadcap casting audit criteria have been developed with OEMs and suppliers, to bring 30 years of accreditation to special processes into the castings area.

BUSINESS IMPACTS OF POOR CASTING CONTROL

- Increased costs associated with casting malfunctions
- Reputational damage and impact
- Lack of credibility and trust in the industry
- Customer attrition due to inability to satisfy requirements

A Nadcap® casting audit can assist in improving a supplier's quality process. For example, minor nonconformances found in the Forgings commodity have been reduced by 50% over the last 5 years, and the number of Forging suppliers with extended accreditation status has doubled since 2020.

TECHNICAL BENEFITS OF THE CASTING PROGRAM

- Working with peers to develop audit criteria and approve auditors used for the Nadcap accreditation process
- Participating in global casting supply chain assessment activities
- Incorporation of OEMs specific requirements into the Nadcap casting audit criteria
- More robust, consistent approach to casting audits

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