

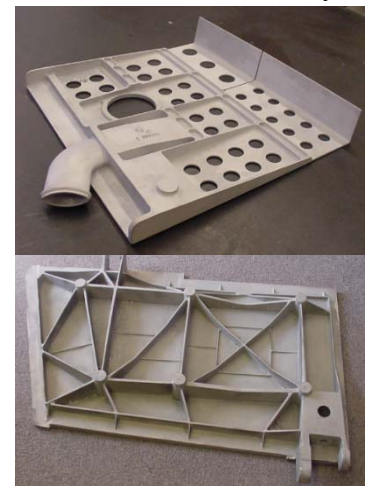
Impact of Requiring NADCAP-Approved Heat Treatment Facilities for Castings

The Defense Logistics Agency (DLA) Aviation Casting and Forging Summit held in September of 2019 and resulting working groups sought to uncover the reasons for sourcing issues, long lead times, and delayed procurements and deliveries of cast and forged components. The Technical and Quality working group discovered a recurring issue caused by technical data package/purchase order requirements for using National Aerospace and Defense Accreditation Program (NADCAP) heat treatment facilities.

Example of the Problem: Tinker Air Force Base incorporated a clause that required all B-52 components to be produced using NADCAP-approved sources for heat treatment and non-destructive testing. An unexpected consequence of this decision was aluminum metalcasters choosing to no-bid requests for quotes containing this clause, thereby reducing the supply chain by 50% and increasing the cost of light metal alloy castings by 40% to 70%. The cause of no-bids were unrecoverable costs of NADCAP source logistics and probable scrap castings resulting from inaccurate dimensional adjustments during the complex and time-dependent transition of aluminum castings from the soft solution heat treatment to the stiffening, natural aging of the aluminum prior to final aging heat treatment. In simple terms, NADCAP heat treatment facilities are typically not located conveniently to the aluminum metalcasters and don't have the time-dependent experience with straightening aluminum... or magnesium... castings accurately and quickly before they stiffen and can't be further adjusted dimensionally.

NADCAP's heat treating certifications for equipment, personnel, and best practices are designed to ensure that the specified, heat-treated mechanical properties of a casting alloy are achieved. These properties are demonstrated and certified from tensile test coupons that are created based on the requirements of the technical data package and purchase order. NADCAP reduces risk by ensuring equipment and personnel meet minimum certification requirements. Those certifications can assure that tensile test coupons are heat treated accurately to represent the specified mechanical properties of the aluminum casting, but those certifications cannot assure that the castings emerge from the complex heat treatment process dimensionally correct.

Why is this an issue? Many defense customers do not require NADCAP for heat treating as it lengthens lead times and increases costs. This is due to the limited number of suitable NADCAP heat treatment facilities and their relative distances from foundries which affects shipping costs and lead times. The number of suitable NADCAP heat treatment facilities is further narrowed by the fact that it is typical for a NADCAP facility to specialize by type of component (not just castings) and metal alloys they will work with. Additionally, parts created with non-casting methods are more stable and distortion-free during the heat-treating process. The hollow interiors, ranginess, and complexity of casting geometry in general, and aluminum castings specifically, are fundamental to their high strength and low mass. However, that geometric complexity also makes aluminum (or magnesium) castings susceptible to movement during heat treatment.

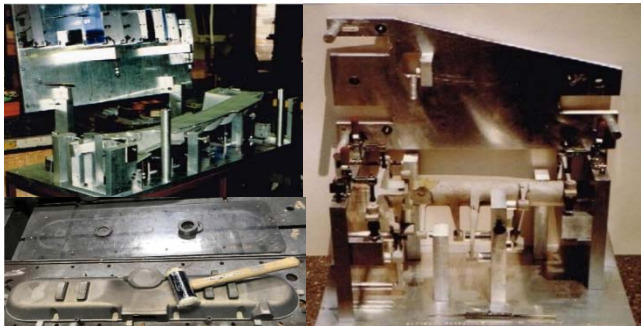


The complex shapes, lofted contours, and ranginess that are common in castings make them more susceptible to distortion during the heat treatment process.

Distortion is caused by residual stresses from the casting process and/or relaxing of the aluminum during the solution phase of the heat-treating process. This distortion then requires a straightening process between the softening solution annealing step and the stiffening aging process. The straightening process is an art and requires great expertise to meet the dimensional requirements of the drawing. The straightening of aluminum or magnesium castings is critical and time sensitive. Straightening needs to be performed within minutes of the casting coming out of the solution treatment (called the T4 condition) because the casting will start to self-age immediately. (Note: this time can be lengthened by freezing the casting immediately after quenching.)

An aluminum casting quickly becomes more difficult to straighten as time passes. Eventually, it is impossible to achieve the required results. To solve this problem, when use of a NADCAP heat treatment facility is not required, most foundries have either heat treatment capabilities on site or work closely with a local heat treatment facility so difficult castings can be straightened by qualified foundry personnel immediately after the solution process. When a NADCAP-approved heat treatment facility is required and that facility is hundreds or thousands of miles away, the straightening process becomes a major lead-time and dimensional non-conformance risk to overcome.

Typically, it is not justifiable for a foundry to get NADCAP certified due to the high cost and low business opportunity. This leaves external facilities as the only option when NADCAP certification



Complex castings can require straightening using check fixtures with go/no-go gauges, complicating the straightening process.

is required. NADCAP heat treatment facilities typically have little to no straightening experience, let alone proficiency with complex cast shapes that typically require straightening fixtures, and checking fixtures with go/no-go gauges to correct and verify dimensional compliance.

Most NADCAP heat treatment facilities do not have the expertise or the dedicated facility space to accurately straighten aluminum or magnesium castings in the very short time window of solution and aging heat treatment. Instead, this type of complex straightening is almost always done by experienced aluminum

metalcasting personnel who travel to the NADCAP heat treatment facility. This means the foundry must factor in costs of sending personnel (potentially multiple times for large casting orders) and straightening fixtures to the NADCAP facility causing excessive cost in dollars and lead time.

Solution: A time and cost-saving solution is to remove the requirement to use only NADCAP-approved heat treatment facilities for castings procured by DLA, any of the Services, and any light metal alloy casting designed or procured by an OEM. Simply allow the aluminum metalcasters to use their own heat treatment capability, or the local heat treater of their usual choice, but send tensile test coupons associated with the heat-treated casting to a NADCAP-approved nondestructive testing (NDT) laboratory. This is the same validation process used to test a NADCAP heat treated casting; that is, the tensile test coupons are evaluated by the NADCAP NDT lab to verify that the aluminum casting was heat treated properly. Making this change would have no effect on the end product's quality requirements or performance and would open up additional sources making the procurement more competitive, ultimately reducing both lead time and cost.