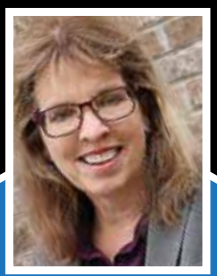
ISSUE 3—FALL 2018

PARTBUYERS AUTHORITY

AEROSPACE PARTS INNOVATION

This issue discusses the latest technologies in regards to metal part manufacturing for the aerospace industry. The authors in this issue detail the high level of quality required for their airplane, space, and military customers. Buyers of parts will appreciate how they describe specifically what happens on the production floor to make these high performing complex parts.

MARKETING OPTIONS



AEROSPACE MANUFACTURING CONTINUES TO EVOLVE

Advanced manufacturing technology options are exploding for the production of high performing metal and plastics parts. Understanding all of these options can be confusing which is why we encourage everyone involved in specifying and purchasing of parts to actually visit the production floor to see these technologies in action. As they say, seeing is believing.

Our foreward for this issue is by Chris Wentworth from the California Manufacturing Technology Consulting (CMTC). CMTC is affiliated with the National Institute of Standards and Technology (NIST) and is part of the Hollings Manufacturing Extension Partnership (MEP) Program. The MEP Program contains 51 centers across the U.S. to serve the manufacturing community. Chris helps to break down the applications and benefits of AM technologies.

The other authors for this issue discuss advances in aerospace manufacturing processes including 3D metal printing, metal stamping, metal casting, and machining. With each issue we strive to provide exposure to companies who are helping to advance the capability of American Manufacturing. This is a collaborative environment – which means you have a voice too. Do you have a technology or type of part that you would like us to discuss? **Complete our form at partbuyersauthority.com.** We would appreciate hearing from you and understanding the material and technology questions you have regarding part manufacturing.

Barb Castilano
Owner, Marketing Options
Founder/Publisher, Parts Buyers Authority

MARKETING OPTIONS

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FOREWARD

CHRIS WENTWORTH
Additive Manufacturing Practice Lead
CALIFORNIA MANUFACTURING TECHNOLOGY CONSULTING®

As the additive manufacturing technology lead for CMTC, the California MEP Center, I have used my over 20 years of experience in manufacturing to help companies throughout California experience the true value of Additive Manufacturing (AM). AM is a technology that has matured and evolved rapidly in recent years. Although it has commonly been referred to as 3D printing, it is industry referred to as "Additive Manufacturing" because of its real world impact on manufacturing. AM technologies are continuing to advance quickly as mainstream equipment producers have entered the market, leading to new additive processes being developed. These new processes have made a wide range of production grade materials available, such as titanium, tool steel and a wide range of plastics. Some of the benefits of adopting AM include:

- **Increased Innovation**
  AM allows manufacturers to print prototypes in hours, obtain feedback, refine designs & repeat the cycle until designs are perfect.
- **Improved Communication**
  Holding a full color, realistic 3D model in your hands imparts far more valuable information than a computer image.
- **Time to Market**
  Design cycles are compressed by using AM to create multiple on demand prototypes.
- **Reduced Development Costs**
  Cut traditional prototyping & tooling costs.
- **Win Business**
  Bring realistic 3D models to prospective accounts.
- **Mass Customization**
  Merchandise can be personalized for specific customer requirements.
- **Use New Structures & Shapes**
  AM allows more creative designs and the production of complex parts in one process–component rationaliation.
- **Produce Less Waste**
  Traditional (Subtractive) manufacturing typically creates a lot of chaff as parts are formed. AM uses little more than the material needed to form a part, resulting in a lot less material needing to be recycled."
- **Reduced Manufacturing Costs**
  AM results in savings up to 70% of manufacturing costs while making business more efficient, green & profitable.

To say that it is an exciting time to be in additive manufacturing is an understatement. As an example, GE Additive has been leading the way with additive adoption starting with their fuel nozzle project. This single use of AM technology has been saving the airline industry billions in fuel costs since its introduction. Additionally, with GE's purchase of Concept Laser and Arcam, they now have more than 9 AM centers around the world pumping out production additive metal parts for all their divisions including rail, medical, and aerospace.

At a recent lecture, Boeing engineers stated that, of the 6 million parts needed to construct one of their commercial aircraft, they are looking at every single part to see if it can be additively manufactured. The cost savings, they explained, are from savings in tooling, assembly, and time to market. The recent flood of new AM technologies is driving even more adoption by manufacturers:

- The Stargate 3D printer from Relativity can AM print a rocket from raw material to flight in 60 days.
- Titomic's cold spray printer can make very large titanium parts for aerospace projects in a very short period of time.

The combination of old technology and new AM printing methodology is proving to be a very powerful combination for the aerospace manufacturing sector. However, the biggest stumbling block to additive adoption in aerospace is part certification and more specifically material certification. Fortunately, these stumbling blocks are being dealt with as ASTM and SAE have released standards for additively manufactured parts for aerospace. The four SAE aerospace additive manufacturing technical standards are:

- AMS7000: Laser-Powder Bed Fusion (L-PBF) Produced Parts, Nickel Alloy, Corrosion & Heat-Resistant, 62Ni - 21.5Cr - 9.0Mo - 3.65Nb Stress Relieved, Hot Isostatic Pressed & Solution Annealed
- AMS7001: Nickel Alloy, Corrosion & Heat-Resistant, Powder for Additive Manufacturing, 62Ni - 21.5Cr - 9.0Mo - 3.65Nb
- AMS7002: Process Requirements for Production of Metal Powder Feedstock for Use in Additive Manufacturing of Aerospace Parts
- AMS7003: Laser Powder Bed Fusion Process
- These standards as well as new ERP software like Value Chain (valuechain.com) developed by Airbus, will drive further adoption of additive by aerospace.

In conclusion, it must be remembered that the power of Additive Manufacturing is not just the process, but starts with the design. Applying topology optimization and coalescing assemblies is where the real savings come into play. As an example, GE reduced a total of 855 parts in their new ATP engine through design optimization coupled with additive manufacturing for a new total of only about a dozen parts. This type of design optimization for additive is where the real savings and power of the technology come into play. Reducing the part count by removing uneeded nuts and bolts allows for better designs, not limited by manufacturability concerns and limitations.

ABOUT CMTC

CMTC is one of fifty-one Centers across the nation in the Manufacturing Extension Partnership (MEP) National Network which is part of the U.S. Government's effort to develop and deploy technology, management and technical expertise for SMMs focused on improving their productivity and global competitiveness. As a non-profit organization, CMTC's mission is to serve as a trusted advisor to manufacturers providing solutions which will grow both their businesses and the California economy. Since approximately 85% of all manufacturers in the United States employ less than 20 people it is vital that these small manufacturers have access to services related to innovation and growth, quality, marketing, exporting, cyber security and advanced manufacturing technologies (including additive manufacturing). In addition, CMTC collaborates with all the national labs and several Manufacturing USA institutes to promote technology transfer to small and medium-sized manufacturers.

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VALUE ANALYSIS LEADS TO COST SAVINGS FOR AEROSPACE INDUSTRIES

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Forecasts are predicting strong growth in the commercial and defense aerospace industries during the coming year, driven by increased demand for passenger travel and increased defense spending globally. In the commercial sector, there was a record high backlog of aircraft unit production at the end of 2017. However, the aerospace industry demands extremely stringent quality measures regardless of growth rate.

There are many suppliers capable of meeting these quality level demands, so how can one producer stand out? A successful supplier of aerospace parts must look for every opportunity to increase value and reduce lead time while maintaining the required high level of quality.

Value Analysis/Value Engineering (VA/VE) is one of the most important tools for hitting those seemingly contradictory goals of high quality, but also high value and low lead times. VA/VE is the process of conducting a systematic analysis to identify the best value possibilities for design, materials, and processes. VA/VE attempts to substitute materials and methods with less expensive alternatives, without sacrificing quality or functionality. VA/VE focuses entirely on the functional aspects of components and materials, and not their physical characteristics.

Let's consider a case where VA/VE was employed successfully to overhaul the production process of an aerospace part:

CASE STUDY

Application: Aerospace

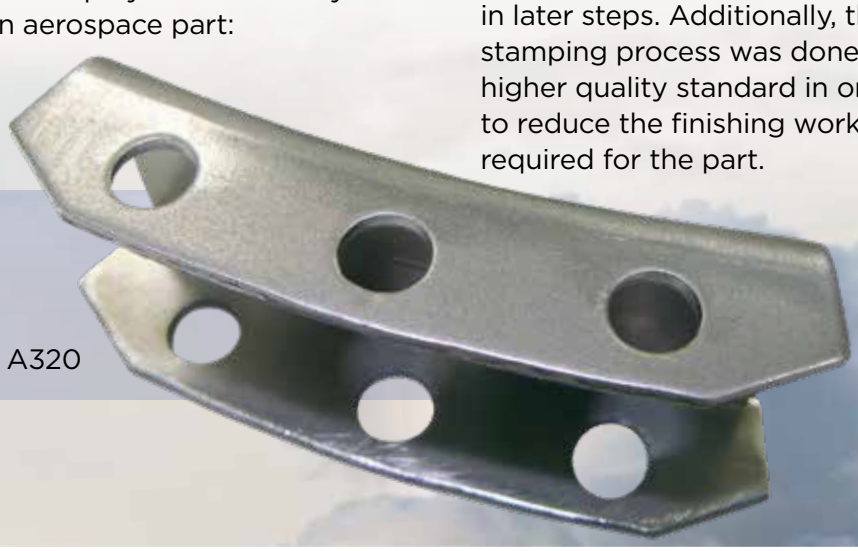
Part Description:
Rotor Clip for Carbon Brake, Airbus - A320

The original manufacturing process involved many incremental steps and processes. Some of these steps were relatively minor operations that nonetheless added significant amounts of time, while some processes were necessary to correct distortions or imperfections introduced by previous steps.

ORIGINAL Process

1. **Stamp Flat Blank**
2. **Form**
3. **Form Radius**
4. **Machine 6 holes**
5. **Machine ends of part**
6. **Remove burrs inside form**
7. **Re-Size inside form**
8. **Apply surface coating**

After a rigorous VA/VE process, several manufacturing steps were combined, and others eliminated. The initial stamping process was modified to account for the geometric distortions that are introduced in later steps. Additionally, the stamping process was done at a higher quality standard in order to reduce the finishing work required for the part.



How was it done?

- The 6 holes stamped in net size blank are not round. The shape is calculated to compensate for the forming process that will come later.
- Completed forming operation with radius stretches the 6 holes to shape; holes are round after forming.

Process after VA/VE

1 **Stamp Flat Blank (Net Size)**

2 **Form complete with radius**

3 **Apply surface coating**

VA/VE Improvement:

The end result of conducting VA/VE and refining the manufacturing process:

- Reduced lead time from 18 weeks to 8 weeks (10-week improvement)
- Reduced unit price (34% price reduction)
- Process was applied to similar parts for further savings

The huge reduction in production lead time is of special benefit in the aerospace realm, where reacting quickly is key. The post VA/VE part production also created significant cost savings. Given the large numbers of parts and assemblies in any particular aircraft, the cumulative savings in both time and money can be highly impressive.

Conclusion

Offering this kind of production expertise will ensure that a part supplier stands out from the crowd. The collaborative nature of the VA/VE process can also help a business move from a simple supplier role into being considered a trusted partner in the production process.

Quality cannot simply be inspected into a manufacturing process. While there is no substitute for rugged machines, precision tooling, and expert processing, the most important strategy for producing exceptional quality is identifying risks and proactive planning all aspects of the process. Fueled by the rapid expansion of technology, the need for partnering with both customers and suppliers has never been greater. By partnering, a supplier can become a valuable extension of their customer's business, offering innovative and cost-effective solutions to their manufacturing needs. The net result is enhanced product quality with reduced costs. This strategy of partnering with customers should be a valued priority and an integral part of the business culture.

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ICT 3D Metal Printing
Additive Manufacturing for complex parts you can't get with traditional manufacturing and no tooling costs!

ICT Patterns & Machining
100% In-House Pattern Making & Machining for accurate and quick complex machining.

ICT Dualtech Foundry
Automated No-Bake Ferrous & Non-Ferrous Processes for faster delivery of complex parts 1–100 lb.

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ADDITIVE MANUFACTURING FOR AEROSPACE COMPONENTS

INNOVATIVE MANUFACTURING 3D

CHRIS BECK
Manager of Operations, Co-Owner
INNOVATIVE 3D MANUFACTURING

The hottest and trendiest topic in manufacturing today is Additive Manufacturing. Additive Manufacturing (AM) also known as 3D Printing can produce parts from plastic and metal. There are 3 common plastic processes and 5 common metal processes available today. Our article will focus on DMLS (Direct Metal Laser Sintering) also known as SLM (Selective Laser Melting) and sometimes referred to as Powder Bed Fusion. This process lays out layers of powdered metal from 20 to 100 micron then melts the area of the part to the prior layer. It's a truly amazing technology that creates parts that are 99.5% dense.

Parts for Aerospace

There is a fair amount of skepticism regarding the quality and density of parts that are built by the DMLS process. Frankly, I was one of those guys too. When we first started researching the process and looking for capital equipment to purchase it was a true eye opener. Not only can you make near net complex shapes with internal passages but the parts are denser (on average 99.5%) then a casting. We looked at this as a win-win.

A few years ago, the first parts we machined were amazing. There was no visual porosity – the parts looked like they were machined from solid bar stock. For the aerospace market, this is a huge advantage. Now, we are able to print the most common aerospace alloys including Inconel 625 and 718, Cobalt Chrome, Aluminum and Titanium.

You are truly only limited by your design imagination and your check book. Innovative 3D always includes 2 vertical and 2 horizontal tensile test bars, a material test plug and loose powder sample for every certified part build. We are able to check composition, tensile strength, hardness, and microstructure in our in-house materials lab.

Materials

One of our powder vendors has atomized over 1,000 different powders for the DMLS process. This sounds great to the customer but it does create a bit of an issue for the people running the equipment. For example if you are building a tall prototype part and want the part to be built from Haynes 282 material, it may cost around $20,000 to buy enough powder to fill the machine to make one part. Then a company has to develop a machine laser parameter set that work in order to achieve high density and good surface finish. Therefore, the one-off prototype may not make sense with that specific material type. If the customer is fine with using a similar material for the test like Inconel 718 then the prototype can be much more cost effective as Inconel 718 is a very popular AM powder. The takeaway on this, is that engineers need to be flexible with materials when developing working prototypes.

There are many considerations to determine which parts are best for the DMLS machines. First and foremost, remember that most DMLS machines are 10"x10"x12" LxWxH. After that, take into consideration the size, weight, part geometry, surface finish and tolerance.

Part Weight
Powder is very expensive, $30 to $130 per pound. The more the part weighs the longer it takes to print which drives the price up. Material price is never the limiting factor—it's always print time, which is how most service bureaus including Innovative 3D prices their parts.

Part Geometry & Part Design
The AM process does not like "overhangs" on parts. This refers to a specific feature on a part hanging out in space with nothing underneath it to support it. Examples are boss or v-flanges that would be traditionally welded onto a part or built into a casting. These features need to have gussets or angles designed below them. They can be designed to be permanent or designed to be removed after the part is made.

Surface Finish
Because the laser melts a straight line and the powder size varies; this can cause a rough surface finish. We like to tell our customers on average to expect a 250 Ra finish. With minimal work a Scotch Brite pad can ring this finish to 120 Ra. Most machined surfaces are 63 Ra or less. In the aerospace world this can be a problem because of air flow across turbine blades, veins, airfoils and swirlers. There are many post processing tricks to polishing to get those surfaces to the desired finish.

Tolerancing
Geometrical Dimensioning and Tolerancing (GD&T) seems to be a constant issue as this technology is only so accurate. Under normal conditions on a straight up and down feature the AM machine will hold .005" of diameter, length and true position. When the part is built at an angle the machine tolerance will open up to 2 or 3 times that it would be on a horizontal build and holes start to become oval shaped. Once the parts start getting placed on angles these numbers increase. In many instances we make parts without holes or make them undersized so that we can machine them later to hold tighter hole tolerancing and true positions. The design team can make or break an AM project with GD&T.

Design for Additive Manufacturing
We build many parts that are a traditional casting design. The problem with this is that the part has not been modified for the AM process. In other words, the part will have features like bosses and flanges hanging out in space with no support structure underneath them. To accommodate this design, we add a support structure or some type of gusset design to support the geometry to make it a self-supported geometry.

Cost and Delivery
On average parts built by the DMLS process cost 2 to 4 times the price of a traditional investment casting. They will be as low as 25% the cost of traditional machining from solid billet stock. Deliveries average from 2 to 6 weeks including all post processing and machining. Parts that require X-ray, pressure test, and FPI may add additional time to delivery.

Summary
Additive Manufacturing is here to stay. All of the large aerospace companies are adopting the technology. They are slow and cautious for flight approved hardware, but they are using it for R&D projects and other places that it makes sense for cost savings and deliveries. Machine work envelopes are getting larger and the development of multi-head lasering equipment is decreasing build time which makes it cost competitive. It's not a technology that will take over mass production anytime soon but it can definitely make sense for low volume super alloy parts, prototypes, support tooling and fixturing.

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UNDERSTANDING QUALITY
FOR AEROSPACE INDUSTRY MACHINED PARTS

DYSINGER INCORPORATED

GREG DYSINGER
Vice President of Sales & Marketing
DYSINGER INCORPORATED

With more than 42,000 flights, moving more than 2.5 million airline passengers across more than 29 million square miles of airspace each day – it's no wonder that the quality standards for the aerospace industry are like no other. When parts are trusted within the Aerospace Insustry - you know the quality has been well demonstrated before it goes into flight. And even while part weight is reduced and parts get more complex – safety and reliability increases.

This industry enjoys a well-deserved reputation for quality and reliability – resulting in a safety record that is the envy of all other industries. And, through continuous improvement – safety goes up each year, making it the safest form of transportation.

As a precision machining manufacturer of flight-critical parts, we understand quality and repeatability. At the heart of producing defect-free precision components which work together in concert with other components is a comprehensive deployment of quality, throughout the entire production process. This industry demands critical tolerances to ensure performance, as the slightest variation can lead to failure.

Some people associate quality management systems with the management of documentation and audits, and of course non-conformances and corrective actions. While others, reduce quality to using a "Coordinate Measuring Machine (CMM)," (a device used in the measurement of a part), quality in this industry, is so much more, and anchored by adherence to the most stringent of all certifications, AS9100. AS9100 helps ensure a part's quality, conformity, safety, airworthiness and reliability, and sets this industry's quality requirements apart from all other industries. The other demanding military and aerospace industry machining standards include: ITAR registration and ISO 9001:2008 certification.

High Strength Grade 5 Titanium Alloy NASA Mission Critical Component

This very thin wall component offers strength, precision, as well as light part weight in a dynamic assembly for our National Space Program. These thin wall sections offer many challenges when holding extreme close dimensional and flatness of less than .001 inch. With the necessity of many heat treat and stress relieving operations, the successful processing of these types of materials for these delicate features requires great planning.

In addition to understanding the quality standards, you will also want to observe how quality is moved throughout the production process, from the engineers, through the machinists and into post-processing. In this business, it's not about just having one person in charge of quality – its about building quality into the part.

The quality standards will vary depending on how the part is being produced from manual one-offs to higher volume work performed with automation.

You will also want an understanding of the equipment used for certified assurance processes (e.g., CNC machines, software and systems) and the guarantees regarding the quality assurance process (such as machining to exact specification, and on-time delivery).

PLANNING THRU EXPERIENCE

Building a quality product always starts with good planning. In today's machining market place appropriate machining processes and machining center selection can make a project a success, for the customer and the supplier. In like manner, poor planning and processing can lead to disasters, not only in part conformance, but also in delivering products on time.

Inconel Stainless Steel (High Heat) Precision Machined Jet Engine Component Fuel/Oil Delivery

This high performance alloy has many complex features on many different planes that must be machined to very close tolerances of less than .001 inch. All intersecting bores must blend without steps and finishes must be of high quality to avoid scratches and blemishes. Extreme hardness and high tool wear are just a few of the many challenges when machining this material and this component.

The planning starts at the estimation stage by making and documenting a basic manufacturing plan and selecting the best processes and machinery that will meet the drawing requirements. This thorough drawing review also considers the many material specifications, heat treat, plating and other outside services that are so common in today's aerospace markets.

After orders are placed, and these preliminary plans are reviewed, detailed manufacturing plans are developed by the engineering group, who designates the materials, processes, work centers and services that will ultimately make this project a success. This plan details the exact features and tolerances that are to be machined, including allowances for finish machining and plating. With a thorough knowledge of materials, heat treat, plating specifications – many processing and dimensional errors are eliminated as the project is completed.

Methodically going through each step, also ensures that you can be informed throughout the entire process.

MANUFACTURING

The aerospace industry requires expertise working with high performance alloys including: Inconel, Nickel, Titanium, and Aluminum alloys. In order to machine complex parts from these high performance materials, continuous improvement regarding the latest tools and education should be standard in any machining organization.

Constant upgrading and calibration of equipment guarantees that machine inconsistencies are avoided. With these factors eliminated, work centers are manned to assist in meeting customer deadlines and providing the required time to set up parts for consistency, perform adequate in-process checks with documentation, and machine them to the highest quality standards in today's marketplace.

QUALITY

Inspection protocol is serious business for aerospace parts. We recommend accurate final checks that are verifiable and documented to AS9102 format for finished parts.

Ensuring that any machining operation is aggressive in the early detection of inconsistencies using in-process checking at all stages along the way is the most valuable way to avoid non-conforming parts. Every process requires first piece approval prior to further machining to isolate and correct any inconsistencies before production release. To verify these checks, we utilize Digital Equipment, Programmable CMM, and state-of-the-art Programmable Visual Inspection equipment all calibrated semiannually to provide accurate checks and verification of all features required.

Co-Authored by: Bud Martin

Maraging 250 Ultra High Strength Steel Mars 2020 Rover Drill Component

Special processing was required to machine this mission critical component, from a 3D model through heat treat.

This part has an extremely tight tolerance spherical internal bore and thread milled holes.

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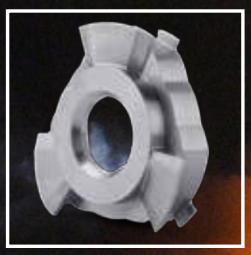
Housing-Bit Holder
A critical titaniam component for the Mars rover drilling assembly.

AEROSPACE MACHINING

We have the capabilities to effectively machine short- to mid-volume production runs of high quality components, particularly those requiring precision tolerances. We take pride in our ability to meet our commitments with on-time deliveries and have been satisfying customers' critical deadlines for over 40 years.

We have the right blend of aircraft, military/defense experience, equipment, processes and highly trained personel to exceed the quality machining services required by the aerospace industry.



Dysinger has been **ISO CERTIFIED** since 2000 and currently carry the **AS9100D** with **ISO9001:2015**. The **AS CERTIFICATION** adheres to all quality standards accepted and required by the aerospace industry for manufacturing. Dysinger is a registered **ITAR** supplier.

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PART BUYERS AUTHORITY

Are you a manufacturer of metal, plastic, or composite parts?

If so, we encourage you to contribute as an author in our next issue of ***The Part Buyers Authority***, an industry online publication. Featured authors are positioned as the topic expert in your 2-page article. Your company will also receive a full page advertisement (for a total of 3 pages). As an additional benefit, competitors to you cannot contribute in the same publication to provide you with dedicated space to your expertise.

Our sole focus of ***The Part Buyers Authority*** is to provide technical information to assist anyone that designs, specifies or purchases metal, plastic or composite parts. Specifically we will address the changing technologies that affect the many ways that parts can be manufactured.

The Part Buyers Authority will be issued several times a year on topics of interest to buyers of parts. Our planned editorial line-up includes:

Fall 2018	Aerospace Part Manufacturing
Spring 2019	Oil/Gas Mining Part Manufacturing
Summer 2019	Additive Manufacturing Technologies

SPACE IS LIMITED IN EACH ISSUE...

To contribute, please contact Barb Castilano by calling 937-436-2648 or email barb@moptions.com

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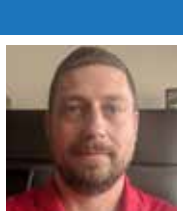
CASTING CERTIFICATIONS FOR THE AEROSPACE INDUSTRY



YANKEE CASTING

KEVIN VECCHIARELLI
Vice President of Engineering, Co-Owner
YANKEE CASTING

Yankee Casting has been producing quality sand castings since 1961, with a focus on aerospace, defense, and marine applications, as well as some medical and commercial castings. Multiple generations of foundry engineers work with their customers from conceptual prototypes through full lifetime support of production parts.

Like all foundries that produce parts for the aerospace industry, they must maintain their AS9100 certification. In addition, they are committed to Total Quality Management, Continuous Quality Improvement, and Just-In-Time Delivery. Their quality system is also ISO 9000:2000 certified and their heat treating facility is NADCAP certified to AS7102. Welding and Material testing are NADCAP approved as well.

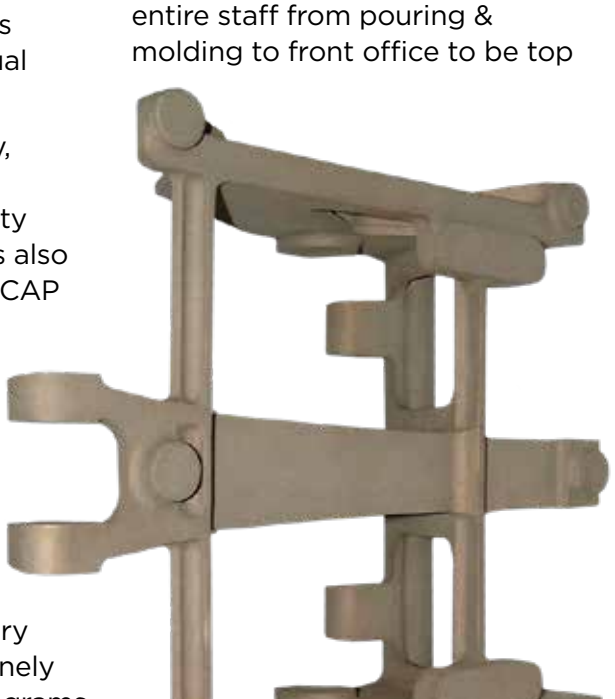
What are AS9100 and NADCAP?

The AS9100 Certification is required for any foundry making parts for the Aerospace and Defense (AS&D) industry, but those not familiar with that industry may wonder what the certification requires, and what the end customer gets for it. At the top level, the AS9100 is the ISO 9001 program – on steroids. As such it includes the ISO designation in the AS9100 certificate. The program is managed by the International Aerospace Quality Group (IAQG). The certification governs the quality management processes of the manufacturer in a manner intended to guarantee the output is of exceptional workmanship, and ensures that all steps of the manufacturing process are traceable and repeatable. This is the level of quality control that is required by the FAA, DoD, and NASA.

An AS9100 certified foundry has documented and routinely audited quality control programs for everything under the roof. Incoming sand and metal inspections, pouring times and temperatures, physical, chemical and NDT testing of castings are all documented. Also, subcontractors (if any) should also be AS9100 approved – so machinists, heat treat, and other operations that are farmed out by the foundry must be performed by companies that also follow the same stringent quality control and management processes.

Why Make Commercial Castings at an AS9100 Certified Foundry?

Maintaining and following all of the process and quality control documentation from order to final shipment adds cost to the process, every step of the way. Why would someone consider making a commercial casting at such a foundry? Customers who understand, know they have 100% confidence in the operations of the whole company. Running an AS9100 certified foundry requires the entire staff from pouring & molding to front office to be top



Helicopter Rudder Pedal

caliber, consistent, professional individuals. The level of skill, training, and attention to detail is higher all the way through such a shop. Even customer communications and response times are governed by the standard, so these foundries have a higher onus to make castings right, and deliver them on time, than a standard commercial foundry.

It is important to have an in-house internal process to track delivery ratings. In one case, they were producing a clock tower casting. While their cost per casting was higher, the higher quality castings delivered allowed the customer to substantially reduce any rework, and eliminated most of the customer's in-house inspection costs. The net result was a total reduction in the project cost for the customer.

New technology makes it easier and more cost effective to meet the AS9100 requirements. Aerospace customers typically purchase castings in lots less than 50 pieces per year, but sometimes higher volume as well. An in-house pattern shop allows them make and change tooling as needed, while maintaining control of confidential customer data. Investments in flexible robotic work cells allow repeatability and tolerance control beyond the typical human worker's abilities. Welding operations and heat treating are also certified, reducing the number of shops that their customers need to work with on any given casting.

Helicopter Gearbox

In-house Quality Control:

- Metrology grade 3D Scanners, scan to CAD reporting
- Chemical and physical metal testing
- Digital x-Ray for NDT testing
- Fluorescent Penetrant Inspection (FPI)
- Simulation programs for metal solidification and flow

While the AS9100 standard defines what must be documented, how to document it, and how often the company gets reviewed – this is still just a standard. Your goal of course is to receive customer communications and response time that exceeds their standards.

Top Values of the AS9100 Certification

- Documentation requirements demand process consistency & repeatability over a period several years
- Sophisticated work tracking & routing system used for every part poured
- Includes & exceeds all ISO requirement
- Higher confidence in quality & consistency for medical device, instrumentation, as well as AS&D

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Below is a resource listing that would be of benefit for those involved in purchasing, specifying, and designing parts. Have a resource you would like to see added to this list, or a topic, material, or process discussed? **Complete our form at partbuyersauthority.com**

Metal Part Manufacturers

Banner Metals Group, Inc. ..... www.bannermetalsgroup.com
Dysinger Incorporated ..... www.dysinger.com
Epcor Foundry ..... www.epcorfdy.com
Innovative Casting Technologies ..... www.innovative-castings.com
..... www.innovative3dm.com
Kentucky Chrome Works ..... www.kentuckychromeworks.com
Southern Cast Products ..... www.southerncast.com
Tech Cast ..... www.techcastllc.com
Trident Alloys ..... www.tridentalloysinc.com
Yankee Casting Co. ..... www.yankeecasting.com

Suppliers of Technology for Part Buyers

Foundry Solutions ..... www.solutionsfonderie.com

Contract Packaging

Crown Packaging ..... www.crownpkg.com

Additive Mfg Consulting/Part Design Consulting/Engineering

Carl Berube, Celero Partners ..... www.celero-partners.com
Chris Wentworth, CMTC ..... www.CMTC.com
Will Shambley, New England Foundry Technologies ..... www.nefoundrytech.com
John Kuhn, Rimrock Corporation ..... www.rimrockcorp.com

Industry Associations

3D Printing Industry News www.3dprintingindustry.com
Additive Manufacturing ..... www.additivemanufacturing.media
Additive Manufacturing Users Group (AMUG) ..... www.am-ug.com
America Makes ..... www.americamakes.us
American Foundry Society ..... www.afsinc.org
ASM International ..... www.asminternational.org
Ductile Iron Society ..... www.ductile.org
Investment Casting Institute ..... www.investmentcasting.org
National Tooling & Machining Association ..... www.ntma.org
North American Die Casting Association ..... www.diecasting.org
Precision Machined Products Association ..... www.pma.org
Precision Metal Forming Association ..... www.ntma.org
SME ..... www.sme.org
Steel Founders' Society of America ..... www.sfsa.org

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