Stepping Up Your Game to Compete in the Aerospace Arena

By William W. Corcoran

Anodizers are accustomed to processing to MIL-A-8625 and certifying to that specification as well. In my experience, few anodizers doing commercial work and certifying to that specification are in fact complying with all of the requirements of the spec. If you want to "Step Up' to aerospace work and certify to MIL-A-8625F or to the anodizing specification of any of the prime aerospace manufacturers, it will be like going from high school to the NFL. I will explore some of the challenges of this leap.

As John Fullen pointed out in his paper presented to AAC in Montreal in 2010, ("*Becoming an Approved Aerospace Anodize Supplier"*) the procurement groups in Aerospace OEM's don't purchase anodizing services but rather they purchase finished parts that have been made, coated and/or assembled to strict design requirements which have been established by their design engineers. Thus, in order to "play in the game" the anodizer needs to establish credibility in the market place.

Credibility starts with an acceptable quality system; i.e. AS9100C or AC7004 from the Performance Review Institute. ISO 9001:2008 is a good start but it isn't enough to qualify. That is because after achieving "quality" status with the appropriate quality system approval, the anodizer must achieve NADCAP accreditation. The rigors of this process have been discussed by this author in the past (see "*A Step by Step Approach to NADCAP Accreditation*" AAC Conference Proceedings, 2012). Virtually all aerospace Prime and their major suppliers require that their sub-tier suppliers be Nadcap accredited. And, Nadcap requires the above primary quality system approval before the Nadcap process can be approved.

Making the leap to aerospace anodizing is akin to the leap suggested above; going from high school to the NFL. The added complexity, the attention to detail, the need for excellence and perfection are unparalleled in special processing. In the aerospace arena, processes such as anodizing (and plating, painting, coating, etc.) are called "special processes" for a reason. That is because they require "special" attention to detail. Attention to detail in the process specifications and attention to detail in the process itself.

Michael Porter, author of *Competitive Strategy* (1980), defined two principals for strategic advantage: 1. Overall cost leadership or 2. Differentiation by providing complexity that adds value (and also cost). Stepping up to compete in the aerospace sector is going to require added complexity in the anodizing operation. That complexity, and your ability to handle it, will make your enterprise more valuable.

Let's look at MIL-A-8625F, the latest revision of the Military Specification covering anodizing. How many of those who process to this specification have truly examined the level of detail that is called for in that specification? In section 3.2 of the specification it states, "process operation conditions shall be at the option of the supplier." What does this mean? Is it sufficient to run your operation as you wish without accounting in detail for what you have done? The answer is "no". The level of documentation is rarely met by commercial suppliers and is a challenge to seasoned aerospace suppliers.

In a further examination of the specification, section 4.3.1 instructs that the "anodizer shall develop, maintain, and adhere to a PCD (Process Control Document) describing the anodizing process and procedures used to meet the requirements of this specification. As a minimum, the PCD shall describe the following:

-All steps in the processing sequence.

-Ranges for immersion time and temperature for each step in the process.
-Chemical constituents used and allowable solution control ranges to be used for solution analysis (see 4.3.2) for each step in the process.
-Ranges for temperature, current density and anodizing time (or voltage ramps and hold times) as applied to individual alloys or alloy series."

The specification goes on to require solution analysis on all processing solutions in the anodizing line to confirm solutions are within control limits and that a record of this analysis must be maintained for at least one year. The specification also requires Process Control Tests to assure process validation.

Additional requirements covered are "testing specimens", "test failure", "lot testing", "sampling", and "test methods" (including test method specifications). These requirements are the "complexity" of complying with the specification but there is more. Most, if not all Military and Aerospace specifications are subject to the definitions in ARP1917A and the Solution Analysis requirements of ARP4992B. When a specification is silent on some of the requirements discussed above, the ARP requirements may well apply.

Furthermore, changes in chemistry or solution constituents or concentrations will likely subject the anodizer to a new First Article Inspection. This statement presumes that you, as the anodizer, have conducted an original First Article Inspection (FAI) and have issued a First Article Inspection Report in compliance with the requirements of AS9102. AS9102 is the Aerospace Standard for First Article Inspection Requirements. The First Article Inspection Report can be documented on (1) Forms 1 Accountability Report, (2) Product Accountability Report, (3) Characteristic Accountability, Verification and Compatibility Evaluation. The purpose of the First Article Inspection is to give the objective evidence that all engineering, design and specification requirements are understood, accounted for,

verified and recorded. This is a requirement that is missed by many suppliers.

While complying with MIL-A-8625F may seem daunting and overly burdensome, it is necessary to understand who the recipients of your work are. The aerospace supply chain is demanding and unbending in the need for suppliers to meet specification requirements because of where the parts are used. There is no room for "pretty good" or "ok". A warranty on a flight-critical part is worthless if the part fails.

The demands placed on the anodizer actually increase when one moves to "Prime" specifications. Below is a list of processing requirements from a process specification of a Prime aircraft manufacturer.

The specification begins with the Scope of the specification and is very detailed on this subject:

- The "processing source" (read anodizer) shall be qualified and controlled in accordance with Prime specific requirements (quality requirements stated elsewhere in the Prime documentation).
- The process is classified by Class and Type.
- The list of ancillary specifications covering everything from cleaning to pH determination is almost two pages long.
- Facilities shall be equipped as specified.
- Engineering requirements for all process tanks are specified.
- Equipment such as racking materials and rectifier capability are included.
- The facility of the supplier is subject to inspection and prior approval before any processing can be done.
- Materials such as chemicals and maskants are specified.
- Processing shall be qualified and no deviations from procedures or material specifications are permitted without prior deviation approval

- Preparation and maintenance of solutions is specified and shall be controlled and documented.
- Cleaning as a processing step is controlled by separate specification.
- The anodizing process is to be done per the exact current density or voltage (as necessary and specified).
- Rinsing shall be for a specific time in double cascading rinses.
- Parts shall not be allowed to dry during processing.
- Seal, if specified shall be for and exact time (=/- 2 minutes)
- Stripping requires following a strict “rework/repair” procedure and documentation as well as MRB authority where required
- New Solutions shall not be used for production purposes until the solution samples have been analyzed by an approved laboratory and shown to be within acceptance requirements as spelled out earlier.
- Qualification testing shall be according to a “Qualification Test” table and testing shall be according to test specifications identified in the processing specification.
- Sampling plans must be approved prior to being used; until such time as sampling plans are approved, 100% inspection is required.
- Process Control testing shall be as required in the specification and performed, at the frequency required in the specification.
- Solution control analysis shall be to specification as identified and at the frequency required.
- Only accredited laboratories approved by the prime shall be used.
- Personnel shall be certified and/or qualified per prime specification.

As you can see, the complexity increases when working to prime specifications but the opportunity increases as well. Top suppliers in the aerospace supply chain are in demand and have an excellent marketing position for the work they provide.

So how do you Step Up your Game to Compete in the Aerospace Industry?

The first thing you must do is develop a systematic approach to your anodizing processes. Determine what you can control and what you have to measure and contain. Chemical processing has inherent variation. Every time parts are placed in a bath, the chemical reaction causes changes in the chemistry. You probably dragged some constituents into the bath, caused changes in the bath chemistry, and then dragged constituents out of the chemical bath. This is the inherent variation that is a constant in your processing. You need to measure the bath constituents at a frequency which permits you to adjust your chemistry in a narrow enough range that the results are reasonably controllable. The best way to do this is with statistical process control techniques. Run charts of each processing tank can permit you to keep the range of variation narrow enough to give you a predictable level of control.

Predictable chemistry should lead to consistent results in lot testing and periodic testing. In most anodizing, visual inspection is an essential requirement in lot testing. Establish specific criteria and teach inspectors what to look for. If you have parts or coupons that fail the visual standards of your specification, keep them as teaching aids. People need to know what a failure looks like. Develop data records for other lot testing; i.e. thickness testing for Type III Hardcoat.

That same predictable chemistry should lead to consistent results in your periodic testing. Develop control charts or data records of corrosion test results. Don't be satisfied if you pass all the time. Track whether the number of pits is increasing and determine why. The cause can be your chemistry but it could also be how you store your test coupons or what condition they were in when you received them.

Other periodic testing such as Taber Abrasion tests should produce results that can be tracked. Correlate chemistry changes with test result changes.

Once your processes are under control and your can validate results with confidence, you can convey to customers your improved process control and predictable results. This hopefully will lead to more complex business and more demanding processing.

At this point it becomes necessary to be sure your contract review process and specification review process are up to the task. Contract review is an essential part of assuring yourself and your customer that the work meets expectations. Even in aerospace work, the customers don't always understand what they need to convey to the "special processor". Constant, accurate communication will win customers. The flow of customer requirements via PO and specification must reach the "traveler" that you operators work to. This transmission of critical information is what will assure that the work will meet expectations.

If you are doing these things well and you are meeting customer expectations, it is time to consider preparing for Nadcap.