AN INSIDER'S PERSPECTIVE

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Extending the Reach of Conformance

BASICS OF CONFORMANCE

Industries that manufacture and process mission-critical components are generally better tuned to conformance. Aerospace, Medical, and to an extent, Automotive, are a few examples. The purpose of conformance is to ensure standardization of a process. Conformance also moderates suppliers of parts and services to such industries so that the end-user can rest assured that the inputs have been designed and manufactured to help them achieve standardized and expected results.

The shot peening Industry refers to multiple specifications/documents, including SAE Recommended Practices for Surface Vehicles, AMS for Aerospace Material Specifications, and a healthy cross-referencing between them. SAE and AMS documents cover both process and product specifications. In addition to these primary specifications, most Aerospace primes and Automotive OEMs have their localized specifications that are generally based on the source SAE and AMS documents.

For most that work with these specifications, the compliance process also involves an audit. Aerospace primes and MROs rely on audits such as Nadcap (formerly North American Defence Contractors Accreditation Program) administered by PRI (Performance Review Institute) to validate whether the end user has interpreted and geared their equipment and processes to peen correctly.

WHAT IS INVOLVED?

Though the scope of our discussion will not permit a line-line review of a specification, I have used AMS2430 (Shot Peening) to identify and illustrate some of the key tenets of a process document. This document is one of the successors to AMS13165 and MIL-S-13165C after their cancellation. It validates both manual and automated peening if the former technique is permitted by the part owner.

Foremost among inputs that define any peening (or blast cleaning) process is the blast media. AMS2430 lists criteria to deem whether new and in-process media meets the requirements of screening (size), and shape. If the product fails to meet the requirements, it may be due to bad chemistry, microstructure and a variety of factors that are covered in the product specification (AMS 2431/x), whose conformance is the responsibility of the media supplier with subsequent verification by the end-user. The specification also describes the process to inspect media size and shape. A well-drafted specification describes what needs to be done and how to do it without specifying the exact make of tool that should be used. AMS 2430 is no exception to this rule.

The specification extends its reach to list machine features that will result in a repeatable process. Examples include description of automation (moving part to media stream and vice versa), part presentation, ventilation and alarms. A brief description of shot peening deliverables such as intensity and coverage, their respective measurements/inspections, including masking, is part of this document.

A detailed process parameter sheet requirement list is part of this specification to characterize the process being adopted. This sheet identifies practically every aspect of the process and is a very useful tool to follow during an audit. The process parameter sheet or the technique sheet will be approved by the part owner prior to peening production parts and is also reviewed as part of the audit documentation. The specification also contains information pertaining to verifying intensity at requisite intervals.

It is relevant to note that though the specification (and audit criteria) describes inspection techniques for media size, it does not stipulate that the machine be equipped with a classifier. It does stipulate the frequency of inspection if a classifier (identified as "separator" in the document) is not part of your machine. However, with experience, we do know that conformance is a lot more straightforward with such process control components installed in the machine. The same goes for media flow rate, shape control, velocity, etc.

Distinct appendices are part of this document that describe Manual and Batch Peening. A quick note on batch peening will be relevant here, especially for our Aerospace customers that may be unfamiliar with the process. Batch peening involves peening parts in a barrel or tumblast in multiples without individual fixtures. Parts are exposed at random to the media stream generated commonly by a blast

wheel, and sometimes with nozzles. One of the first applications that discovered shot peening and used it to peen parts was in automotive, and automotive valve springs continue to be peened in batch-type tumblast machines.

When it pertains to audits, most Primes such as Airbus, Boeing, and GE Aviation are subscribers to Nadcap. This means that the Nadcap auditor will validate the specific prime's requirements in the Nadcap checklist (ex. AC7117/x) whenever a question requires such verification. Other than that, an audit such as Nadcap is a thorough evaluation of the entire process with questions that follow the framework of the general specifications.

For those shot peeners outside of the industries identified above, or those simply interested in blast cleaning in a better controlled fashion, the need for specification conformance might seem unnecessary, and even daunting. I have a proposition for such users in the paragraphs that follow.

CONFORMANCE LITE

I was corresponding recently with an Aerospace MRO who kept referring to a potential shot peening machine acquisition as a "sandblasting machine". Though tempted, I took refuge in my recently discovered "maturity with age" trait and refrained more than once from correcting him! But this led me to wonder if he truly believed that the process was simply glorified sandblasting! Those of us that are diligent about peening correctly, and conforming to specifications are justified to be shocked! However, there may be some belief of such a notion, especially outside of mainstream industry adopters.

I do not wish to diminish any industry's propensity and interest to enforce the rigors of specification conformance, but partial conformers do exist. Some continue to seek compliance with cancelled documents such as MIL-S-13165C while others are slowly realizing the need to enforce a structure around what might be passed on as a shot-peened component from their service-provider or in-house peening operation. These are industries that are neither bound by the requirement of an Aerospace grade audit nor conformance to AMS 2430. For example, Audit or specification intimidation could lead to dissuasion and ultimately the lack of adoption altogether of the peening technique. I would like to attempt a leap of faith and propose a "conformance lite" solution to such customers.

Before my inbox gets flooded with admonitions on this approach, let me clarify. I am neither proposing an alternative to commonly used specifications nor a shortcut. My proposal is to draw the common elements of conformance and identify techniques that will help you reap the benefits of a process in conformance without the formality. As a start, let us first identify the key aspects of control that all specifications trace their origin to:

- How hard are you impacting (reference: media, velocity and intensity)?
- Where are you impacting (reference: flow rate, coverage, and masking)?

1. The quality of media used in your peening process will determine the consistency and quality of the layer of compressive residual stress it is expected to create. Uniformity of media size equates to transfer of equal and uniform energy on all part surfaces.

2. Propelling this media at a uniform velocity is the next step, whether it be through a blast nozzle, blast wheel or a flap mounted on a rotary tool (rotary flapper peening).

3. It is important to point out that broken media particles in the above will not only impact the component with lower energy, but also potentially damage (nick) the part surface. All broken particles should be discarded from the process.

So, we are now left to deal with (a) removal of undersized media particles, (b) maintenance of uniform velocity and (c) removal of broken particles (misshapes).

4. Maintenance of constant media flow rate is particularly important in airblast machines since the compressed air that is assisting with the generation of impact energy has to do reduced or increased amount of work based on the quantity of media it has to propel. This is not as critical in a wheelblast machine where the wheel's reliance on the electric motor that is driving it mitigates capacity concerns and is only limited by full load amperage of the motor.

5. Increased media flow leads to faster coverage in both types of media propulsion techniques with only reservations related to part geometry (flooding of tight areas with excessive shot flow).

6. In a shot peening process that leans heavily into conformance, the above is addressed with sub-systems such as vibratory classifiers (size classification), spiralators (removal of sharp particles), flow control valves (MagnaValves, etc.). Process limits installed in control systems associated with these machines monitor, record and report such data, including anomalies when they occur.

7. However, this may not be the case in a cleaning machine though it has been well-intentionally repurposed for shot peening. If this is your situation, consider the following to get closer to your dream process/machine for shot peening:

    a. Decide which of the two processes you are going to dedicate the machine to and be consistent.

    b. If your peening projects involve multiple media sizes, (a) try to dedicate the machine to a single media size. Though switching media sizes is possible, it is time-

consuming, and possibilities of cross-contamination are rife.

c. If your plan involves operating multiple peening machines, and installing classifiers is not an option, establish a practice of offline classification with a universal screening rig consisting of a bucket elevator, airwash separator or drop box, and a classifier of adequate capacity. The screens in this classifier can be replaced to suit the size of media being classified. Keep in mind that classifier capacities are limited, especially with smaller diameter units. Refrain from overloading the system.

d. Establish a similar practice with an offline spiral separator— a unit that also has restricted capacity.

e. If your machines do not have a means for monitoring flow, a portable catch test arrangement can be utilized to carry out this activity shared between multiple machines.

f. Maintaining constant media velocity is unfortunately not easily achieved without proper equipment. There are no reliable alternatives to inverters for blast wheel motors and pressure transducers/sensors in airblast machines to monitor and control media velocity.

To summarize, conformance lite can help you establish the discipline of a well-designed peening operation and lead you along the path to eventual specification adoption. The world outside of shot peening is heavily populated with blast cleaning machines. Can that world benefit from Conformance Lite?

BENEFITS TO BLAST CLEANING

Our belief is that if material is being removed from the component being peened, then something is not being done right. Though blast cleaning does not intend to remove the base material, its purpose is to remove contaminants such as scale, rust, sand, etc. However, the fundamental mechanisms remain unchanged between cleaning and peening, such as the reliance on velocity, size and shape of media, and media flow rate. The differences in process details allow us to use the term "abrasive" in blast cleaning instead of "media" in peening. The advantages of process control, in other words, conformance (lite or otherwise) in blast cleaning can be seen in the following:

- The magic descaling velocity over 30 years ago when I first started in this industry was 240 feet per second. This may have been limited then by wheel and drive arrangements, and a variety of other constraints existing then. Steel used to be cleaned to satisfaction at that abrasive velocity, which should make us question the necessity of some current wheel configurations that generate velocities upwards of 320 feet per second! The relevance of this discussion is in process control. Perhaps some processes suffer from high velocity and overblasting parts with resulting wear of machine components and breakdown/consumption of abrasive. Velocity control, as in shot peening, will definitely keep this in check.
- We can also utilize lessons learnt in relating shot velocity to intensity and transfer it to blast cleaning—use an Almen strip deflection check (likely A strip) every eight hours to determine if your cleaning process (velocity) is repeatable. If you are concerned that your cleaning application uses steel grit (or AlOx grit), rest assured that both the strip and the process are ambivalent to that fact and will unfailingly leave you with a deflected surface and arc height to measure after continued impacts. Our intention is to measure impact energy, and damage to the part due to angular abrasive particles is not an issue as would be in shot peening when non-spherical media is used.
- Blast cleaning thrives on a "work mix" of abrasive sizes, unlike shot peening which relies on uniformity of media size which is commonly monitored and maintained by a vibratory classifier. If this unit is installed in a blast cleaning machine, its purpose will be limited to eliminating large contaminants from the work mix.

SUMMARY

Conformance comes with a cost, but there is value in it even for processes that are not bound by the need to achieve conformance. The world is populated by more blast cleaning than shot peening machines. Majority of those are wheelblast cleaning machines that propel a significant volume of shot per minute. A defined structure to monitor usage by monitoring process parameters will certainly help with justifying the operation and making it profitable.

About Kumar Balan

Kumar Balan is a shot peening and blast cleaning technical specialist. He is currently assisting Ervin Industries achieve business growth in North American and overseas markets.

Mr. Balan has published several technical papers on blast cleaning and shot peening and is a regular contributor to *The Shot Peener* magazine. His expertise is in centrifugal wheel-type and air-type blast cleaning and shot peening equipment. He is a regular speaker at industry conferences and training seminars worldwide. He is also an EI Shot Peening Training Lead Instructor at their international seminars and workshops. Mr. Balan's contributions to the industry were recognized when he was named the 2006 Shot Peener of the Year.