



AN INSIDER'S PERSPECTIVE

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Specifications beyond Aerospace

AS I START MY 36TH YEAR of gainful employment, 95% of which has been in this industry, like most of you, I too have accumulated many interesting stories. However, this one stands apart and worthy of repetition, with apologies, if you have already heard it from me. As an impressionable engineer in my 20s, I was tasked to sell air pollution control equipment for any dust emitting source from a blast machine to an electric arc furnace.

During one such meeting in a part of the world where electricity was then scarce and moderated, I was pitching a fume extraction system that required a 75HP exhaust fan downstream to it all. When calculating the operating cost of this system with the end-user, I was informed that this fan would only be operated selectively, maybe a few hours every month. This left me baffled (pun intended) since as we all know, no ventilation system can function without its exhaust fan on, first.

My technical knowledge was less than appeased with the end-user's explanation that the purpose of this fume extraction system was not to control air pollution, rather to satisfy pollution control authorities! Therefore, the fan's operation was timed to operate solely during inspection visits by said authorities! This experience helped me decide the type of industry I wanted to spend my career in. I wanted to work with end-users that would sometimes by choice but every time by requirement work in compliance with a specification. Aerospace was the perfect candidate for that and here I am!

As the benefits of peening get recognized by industries outside of aerospace and automotive, I have often questioned the significance and usefulness of AMS process documents among non-aerospace shot peeners. Are 2430, 2431 and 2432 mere numbers to them? What do they consider specifications and how do they go about achieving conformance? I suspect such questions keep you up at night as well. Therefore, this discussion! My research involved speaking to users in automotive (spring, transmission), oil and gas (torsion bars) and railway (wheels).

SAE J2441 Shot Peening is a Surface Vehicle Standard intended to provide direction to shot peeners outside of aerospace. During the last SAE meeting (May 2025), I learnt that the SAE had not sold many (or possibly none) copies of

this document in a while. Given that I had offered to sponsor this document and revise it to current relevance, I figured it needed to be re-written to aim for status between the historic MIL-S-13165C and contemporary AMS 2430. The task of marketing such a product will be herculean, given that the wild west of specifications outside aerospace is a vast unknown! But I need to start somewhere. In our discussion, I'd like to bring some of the key aspects of a "relevant" document with the expectation of receiving constructive feedback from our community on other content you would like to see in a future document.

Background

1. MIL-S-13165 was first published in 1953 and updated four times until June 1989. Since a vast majority of users are familiar with this document, I would like to highlight key aspects of MIL-S-13165C before its cancellation:

- Process control such as shut down limits was part of the last version. Though the specific tolerances were not published until future versions of AMS 2432, this MIL document in sections 6.8 and 6.9 identified all key variables such as shot flow rate, air pressure/wheel speed (velocity), and nozzle and work stand-off that needed to be monitored and shutdown the process when it strayed outside tolerance.
- Peening intensity tolerance was established by this document (3.3.6). For drawings that listed a single (minimum) value for intensity, a variation of -0, +30% and in no case less than three intensity units was specified.
- Better definition of coverage, boundary variation, minimum shot size based on smallest (fillet) radius on the part were part of this document.

MIL-S-13165C was cancelled in February 1998 when the military transferred its ownership and responsibility for future updates to AMS, which then replaced it with AMS-13165. For more details on this, read *The Shot Peener*, Summer 2020 edition.

2. AMS-S-13165A has since been cancelled (December 2007). This was the prevailing document for almost a decade before being made redundant by AMS 2430 and AMS 2432

(which, though in existence were not commonly in use as a replacement).

3. AMS 2430 and 2432 are process specifications, supported by a host of material specifications such as AMS 2431/x for peening media, and SAE recommended practices for additional details.

4. SAE J2441 is a surface vehicle standard, which I am proposing should be re-written to better accomplish the goals of a non-aerospace spec document. Highlights of this document in its current version (June 2015):

- J2441 is a process specification with no reference to AMS documents (as expected) for new media requirements. All references are to J documents.
- In-process media requirements for size (screening) are as per AMS 2430. There is no reference to shape maintenance except for a brief mention that tolerates 10% maximum of a representative sample as broken. In contrast, AMS 2430 (and 2432, which refers to 2430) has detailed instructions on in-process media inspection for shape along with the sample window size for visual assessment for different media sizes, magnification for assessment and tolerance. This is true for metallic and non-metallic media.
- While on the topic of media, this specification does not list AMS 2431 as a reference document. Note that users of this document will be in conformance if they choose to use industrial grade media (SAE J827 and J444) for shot peening without needing to use AMS grade (formerly and still colloquially known as MILSPEC) media bearing higher shape and size tolerance (accompanied by a greater investment requirement for media purchase).

Comment: If you are wondering whether this aspect makes it a less-precise shot peening process, let me explain. Neither AMS 2430 nor J2441 will pin you down to use a vibratory classifier or spiralator for size and shape control. These are recommendations/suggestions in both documents, perhaps a bit sterner in 2430 ('Equipment may include a media separator to mechanically control size and shape such as vibrating screens, spiral device or inclined belt') as compared to 'at least one determination of shot size and uniformity shall be made when the size or type of media in the machine is changed, every 8h of continuous machine operation with metallic shot.....and 'Uniformity shall be determined using the sampling and sieving procedures defined in SAE J444'.

Therefore, a conscientious shot peener that recognizes the value such control offers to a stable process and repeatable

results, without creating surface damage to the parts being peened, will install features to ensure that the process always operates with consistent size and shape of shot in the machine.

- Intensity verification is specified to be within the tolerance specification on the drawing (as in AMS 2430). However, the original tolerance from minimum peening intensity is allowed to be -0, +40%, as compared to +30% in 2430.
- Overall, the information contained in J2441 mimics 2430 with a truncated level of detail.

Industry feedback

The adoption of J2441 is minimal at best, with its barely acknowledged existence! To learn more, I spoke to end-users and other stakeholders including OEMs that build shot peening equipment. As expected, there was lack of awareness of anything starting with the letters AMS among non-aerospace shot peeners. The word aerospace triggered intimidation in terms of specification conformance. The fear was two-fold: The process being too cumbersome and difficult to adopt/conform and their equipment not being capable of meeting the requirements to conform. However, their interest to learn more and potentially adopt a usable and practical specification was evident.

Don Paul, Manufacturing Engineer at Matthew Warren Spring in Logansport, Indiana, provides insight into the company's approach to quality and process control in spring manufacturing. The facility specializes in producing cold coil springs, retainer rings and carbon composite springs. "Our peening specifications are an extension of our work technique or instruction," Don explained. "Through process control, primarily managing velocity, media flow rate and media size tolerance—we ensure that we meet the requisite intensity within the specified range and establish part coverage. Along with our customers, we are aware of the criticality of shot peening in the fatigue life of springs we manufacture."

Don anticipates the increasing demands for process repeatability and precision will shape the future of the industry. However, he expresses some skepticism about the widespread adoption of any new overreaching specification. "Though I am not familiar with the AMS documents you have referenced, our internal quality plan closely aligns with customer-mandated specifications," he noted. Due to confidentiality agreements, access to specific internal or customer-driven specifications was not possible at the time of this discussion.

Blast Cleaning Technologies (BCT), West Allis, Wisconsin, is a manufacturer that specializes in centrifugal wheelblast equipment. Benjamin Roche is a fellow Applications Engineer who also has attended the EI Shot Peening training. He works on shot peening applications for

BCT's customers that shot peen cast and forged components in different industry sectors with BCT manufactured equipment. "Commonly, we are provided with customer written specifications to follow, which will occasionally reference SAE, AMS, or MIL specifications. Often, the SAE specifications that are referenced in customer specification documents are J441, J442, J443, and J444," explained Ben. "Our design philosophy for peening, and most cleaning applications, is to offer full control of the intensity of blast (and peen) by installing inverters on blast wheel motors. All peening applications that I've been involved with are wheel machines where wheel ammeters were expected to provide a loose indication of media flow rate. This combined with MagnaValves closed the loop for media flow control. The least common equipment that customers have on hand is a classifier for size control," said Ben. Not a surprise, given that classifiers are not manufactured with the capacity to handle 100% of the media flow in a multi-wheel machine and can only be expected to continuously sample a percentage of the total flow. This is an acceptable practice that users need to be made aware of.

Ben was optimistic about the value of a new specification. "I think this would be well received, especially by the automotive industry users. In some of the automotive peening applications, OEMs use their own specifications which can be confusing and contradictory in some cases. I think it would help those operations to reference common specifications when developing their shot peening process."

What is important in a specification?

On a macro, yet fundamental level, we are dealing with impact energy ($1/2 \times \text{mass} \times \text{square of velocity}$) and our ability to deliver this value consistently. When using this concept to construct a specification, the document will need to deliver instructions on the following to initiate simple relevance, interest and eventual adoption:

1. A constant mass of peening media particles within a specified tolerance. This is ensured by maintaining at least 80% of media particles within a specified size (sieving standards for new and in-process media). Inspection intervals such as listed in 2430 for machines with and without separator (classifier) are useful to incorporate in the document, especially given earlier feedback that this is the most often missed tool among users.

2. In addition to misshapes and sharp-edged media particles not having the same uniform mass, there exists the added possibility of sharp edges impacting and damaging the part surface. Clear notes on eliminating such particles when their numbers increase beyond tolerance to prevent inconsistent energy transfer and damage to fatigue-critical parts. Possibly optical and electronic means of reviewing media samples as an option for those operations that can afford it.

3. Measurement – the need for accuracy and repeatability must be reflected in this document with reasonable allowance for anticipated and practical process-centric deviation. In other words, I would like to submit that the specification for non-aerospace be relaxed to allow the verification strip Arc height to be outside the main intensity range of the drawing so long as it is within the ± 0.0015 " tolerance.

4. Clarity between arc height and intensity. Though all specifications refer to SAE J443, a more practical explanation that ties to energy transfer will help with the end user's understanding of the difference.

5. Coverage – the reference here is to SAE J2277. Though this is a comprehensive document in its current version, inspection and agreement on coverage percentage continue to be subjective. A new specification document must incorporate suggestions of practical techniques for coverage inspection on the part.

6. Other practical notes in this document could be discussions on:

(a) presence of rust in media and techniques (storage and de-rusting) to render it useful, (b) effect of angle of impingement on intensity, (c) wear patterns of common parts such as blast wheels and nozzles and methods of identification. Though these might seem like pages out of a manual and not a specification, I feel that their usefulness, even if included in the 'Notes' section, cannot be underestimated. Wear is a subjective topic, but extreme wear that affects the outcome is well within the scope of being incorporated in a specification.

7. Training – like rotary flapper peening training, there needs to be some detail in the specification that identifies the minimum training required to carry out shot peening on any component—mission critical and otherwise.

Summary

I hope to incorporate most or all the above in my attempt at reviewing SAE J2441. As indicated earlier, I welcome any feedback on making this document efficient and useful to the new and seasoned user. ●

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