AEROSPACE SHOT PEENING PRACTICES AND NADCAP AUDITS

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ABSTRACT
Shot peening practices are highly controlled by both proprietary and industry standard specifications. There are many cases where industry standards, such as SAE J442 and J443 or AMS 2430, are incorporated into proprietary practices. Audits to confirm compliance to an industry consensus standard are offered by Performance Review Institute (PRI) in the form of Nadcap audits.

KEY WORDS
Shot Peening audits, Nadcap shot peening audits,

INTRODUCTION
The control of the shot peening process can be traced back to a paper by Zimmerli (1) in 1941 where he mentions use of a standard test piece. The U.S. Army released a document titled “Shot Peening of Metal” (2) to control the process in 1944,. SAE then introduced its version of shot peening process control in 1948 with its release of AMS 2430. SAE then published two documents to control the process, “Test Strip, Holder and Gage” (3) and “Use of Test Strip for Shot Peening” (4) in 1952. The following year the U.S. Army released the first edition of MIL-S-13165 (commonly referred to as “The Mil Spec”).

The Mil Spec was self-contained, that is, it described the test strip, holder and gage as well as new and in-use media requirements. SAE didn’t describe media requirements until 1988 with its publication of AMS 2431 “Peening Media, General Requirements”.

One might surmise that the shot peening process would be properly controlled and maintained with all of the above documents and practices. Audits of the process should be simple and brief with expectations of compliance. Unfortunately, that has not been the case.

DISCUSSION
Many companies developed their own shot peening practices and standards separate from the Mil Spec and SAE standards, often to maintain confidentiality of intellectual property for competitive advantages. In spite of the various approaches to process control, many of these company standards would continue to refer back to SAE practices mainly J 442 and J 443 and often AMS 2430.

Companies wishing to maintain quality standards with their suppliers would then perform audits, a significant cost and time-exhaustive exercise for both parties. It wasn't unusual for a supplier to host a large number of audits each year for various aerospace prime contractors. A government/industry Equal Partners Conference in 1985 recommended a consensus solution to the duplication of supplier quality assurance systems. As a result, Nadcap (named originally for the National Aerospace and Defense Contractors Accreditation Program) was created in 1990 by the Performance Review Institute of the Society of Automotive Engineers. PRI, headquartered in Warrendale, Pennsylvania, defines Nadcap as "an industry-managed, consensus approach to OEM oversight of special process and product suppliers". Nadcap operations are guided by a Management Council, which is made up of high-level quality industry representatives. Nadcap's membership of prime contractors convene to coordinate industry-wide standards for special processes and products. Nadcap's subscribing prime contractors/governments numbers near 50 with 14 associate prime subscriptions. A qualified manufacturers list identifies Nadcap accredited suppliers is online. There are currently over 2,500 suppliers, including 89 in Japan.

Branch offices of Nadcap are located in London, Beijing, and Nagoya. Since its inception, over 20,000 Nadcap audits have been conducted, including nearly 4,000 in 2007. 168 of these took place in Japan. Significant effort has gone into working with the international community including the foundation of a PRI Asia office in Aichi, Japan to support local suppliers and the translation of Nadcap audit checklists into Japanese, completed with the support of the JAQG.

Nadcap Task Groups are made up of technical experts from industry. These individuals are collectively responsible for the development of audit criteria and ultimately determine supplier accreditation. The requirements are derived from industry norms and individual customer requirements. Nadcap determines accreditation for such special processes in aerospace and military industry as: Heat Treating, Chemical Processing, Coatings, Welding, NDT, Composites, Materials Testing, Electronics, Elastomer Seals, Fluid Distribution Systems, Sealants, Nonconventional Machining (including EDM, ECM, ECG, LBM) and Surface Enhancement (including shot peening, peen forming, glass bead peening).

Nadcap meetings are held regularly at locations around the world. In 2008, meetings will take place in Pittsburgh, Pennsylvania, Rome, Italy and Yokohama, Japan. The meeting in Japan will take place from 6-10, October 2008. Nadcap meetings allow attendees to participate in consensus-based decisions regarding specific audit criteria, Auditor recruitment and training and are also a great networking opportunity, with in excess of 800 delegates in regular attendance. In addition to the benefit of supplier participation, PRI has developed Partners in Education, an alliance with shot peening training organizations. These training companies provide training to Nadcap auditors and suppliers. As a Partner in

Education, Electronics Inc. conducts workshops and on-site programs on Nadcap audit preparation worldwide and has trained many PRI staff members.

The benefits of Nadcap to the aerospace community are numerous: one participating prime subscriber reports a saving of over $1 million annually while achieving technically superior audits. An accredited Nadcap supplier has tracked a 97% reduction in rework resulting from improvements implemented to satisfy Nadcap requirements. Since suppliers typically prepare for a Nadcap audit by conducting internal audits and providing additional staff training, they also achieve improved conformance of practices, improved practices and procedures, improved employee moral, and reduced costs of processes.

Occasionally, subgroups from the Nadcap Task Group will consult a Standards Committee and work toward aligning checklist interpretation to Industry Standards and Customer Specifications that may be referenced in the Checklist question. This is where the Surface Enhancement Division of the Fatigue Design and Evaluation Committee would review the “J Specifications” or the Aerospace Materials Engineering Committee (AMEC) would review the AMS Specifications and participate in the sub-group inquiry.

For example: one incident involved the media size analysis using sieves with the requirement that no media reside on the “all pass” screen. This might imply that the presence of only one media particle could result in a finding (discrepancy). The definition of “trace amount” of material “any measurement less that 0.5%”, as mentioned in many other industry standards, would have precluded this finding. As a result, the AMEC committee is reviewing all of its sieve requirements relative to this practice.

Other issues have arisen that cause concern in the aerospace community. A good example is the cancellation of AMS-S-13165 in 2008 (the Mil Spec was adopted by SAE in 1998) with re-direction to AMS 2430. Many administrative issues were created with this cancellation and many discussions of “technical equivalency” were also debated. The Mil Spec, under the jurisdiction of the U.S. Army, had not been maintained with emerging technologies and practices. As a result, other industry practices, notably AMS 2430, continued to evolve and accommodate “Best Practices”. Two examples of inherent deficiencies of AMS-S-13165 are worth mentioning.

The determination of shot stream exposure time to achieve proper “coverage” seems to follow practices established in AMS 2430 and as well as J 2277 but a contradictory paragraph in 13165 states that the parts are to be processed in a manner identical to the saturation curve. Some aerospace companies were concerned that they would have to write new technical plans to adhere to AMS 2430 while others felt that AMS 2430 was compatible with the 13165 requirements.

Another example of conflict within 13165 was the directive to perform peening intensity tests. It stated "At least two test strip specimens conforming in dimensions and mechanical properties to figures 1, 2 or 3 shall be used for each intensity determination at each location." Noticeably absent from this directive is what exposure times should be used, either both test strips at one exposure time or one at double the exposure time of the other, and also, there is no mention of acceptance or rejection criteria. AMS 2430 requires exposure of one test strip at the saturation time with acceptance when the arc height is within the peening tolerance requested for the particular application.

CONCLUSION AND IMPLICATIONS

While Nadcap audits are intended to minimize the time and costs of quality assurance, it should be recognized that the documents and standards used for shot peening must be created, maintained accurately, and harmonized with other supporting documents and practices. As the chairman of the SAE Aerospace Materials Engineering Committee Surface Enhancement sub-committee and also Chairman of the SAE Surface Enhancement Division of the Fatigue Design and Evaluation Committee, I encourage suppliers to participate in document maintenance activities such as AMEC (for Aerospace or "AMS" documents) and Surface Enhancement Division (for Land and Sea or "J" documents).

REFERENCES

SAE documents may be obtained at the web site www.SAE.org.
(1) Shot Blasting and its Effect on Fatigue Life, F. P. Zimmerli, Associated Spring, Detroit, MI.
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(4) Procedures for Using Standard Shot-Peening Test Strip, SAE Recommended Practice, first published January, 1952