Specification conformance and equipment design

A discussion of how equipment and process design of shot peening machinery could facilitate compliance to specifications and audit criteria such as Nadcap.

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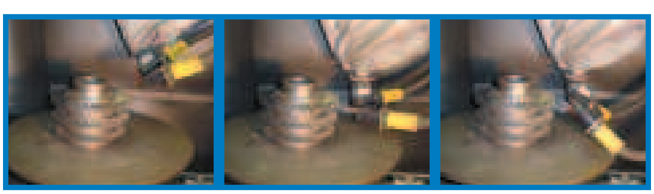
In the recent past, the shot peening group at Wheelabrator has been approached by several aerospace MRO facilities with request for peening equipment that conforms to Nadcap (National Aerospace and Defense Accreditation Program) audit requirements. To address the importance of this audit to our aerospace customers, this discussion will attempt to explain and highlight how equipment design can satisfy such a critical requirement. If appropriate steps are taken in the design of peening equipment and associated processes, conformance to specifications and audits including Nadcap will be simplified to a routine and effortless task.

The need for a unified specification was felt almost 15 years ago resulting in the genesis of Nadcap under SAE and PRI. The current audit criteria are the result of elaborate discussions over the years among various primes such as Boeing, GE Aircraft, Rolls-Royce, etc.

PRI AC7117 is the prescribed audit criteria for Nadcap. Section 4 of this document audits equipment features and surveys conformance to its various elements. Depending on the nature of the end user's existing equipment, some of the audit requirements may not be met. PRI AC7117 understands this aspect and requires the user/applicant to explain such discrepancies.

Listed below are critical aspects of the audit, each followed by the manner in which that aspect can be addressed in equipment and process design. Response to each line item is based on the machine being equipped with a PLC controller and Windows-based Operator Interface.

4.1.1: Does the equipment have the capability of mechanically moving the shot stream and/or the workpiece?



The shot stream can be moved in several ways. In an automated airblast peening machine, nozzle(s) could be mounted on a carriage/manipulator that follows defined travel paths based on inputs provided. Industrial robots could also be employed for this purpose. In a wheel blast machine, though not very common, the control cage setting could be altered on the fly to provide sweeping blast patterns.

Workpiece movements are application specific. While peening round parts such as fan disks, compressor disks and blades, the parts are independently mounted on a rotary table and spun while being peened. When processing long parts such as wing spars and other structural members, the parts are conveyed on a roller conveyor. In either case, the requirements of this audit element are well met.

4.1.2: Does the supplier check the physical characteristics of (a) nozzle and air-jet wear, (b) Almen fixture wear, (c) masking fixtures, (d) test sieves, (e) part fixtures, (f) hoses, (g) wheel condition?

These are elements from the supplier's operations and maintenance manual. In addition to mere compliance, it is to the user's benefit to adhere to the instructions.

4.1.3: Is the equipment equipped such that the air and media will not turn on unless the part and nozzle/wheel motions are also turned on?

Most automated machines are equipped with zero speed switch circuits that prevent air and media to be turned on if zero speed is detected in the drive arrangements for the nozzle and wheel motions. In addition to just satisfying this criteria, a separate circuit could ensure that the nozzle manipulator always reports 'home' before starting a new or re-starting an interrupted cycle. This could be verified by a photoeye. Given the cost of scrapping an improperly peened part, it is critical that such checks be built into the design.

4.1.4: Are all process monitoring equipment and/or gages identified as to their calibration status and current?

Automated peening systems are usually equipped with electronic or analog gages for displaying process parameters such as blast pressure, flow rate, etc. These gages are factory calibrated and typically do not require additional calibration. In addition to such gages, Operator Interfaces such as a TouchScreen or a PC monitor display nozzle position coordinates, table or conveyor speed, media flow rates, etc. Such gages only require a one-time calibration.

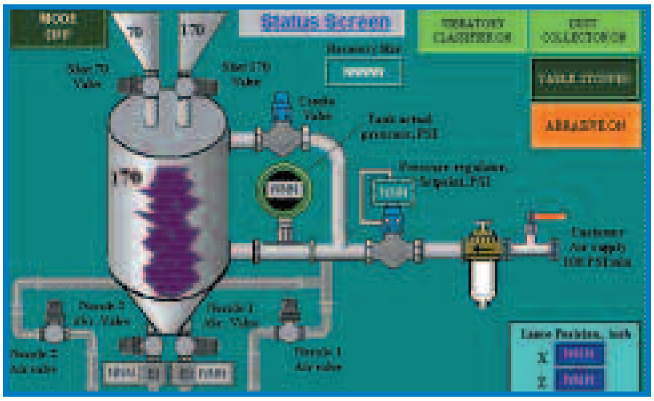
Individual user groups may have other calibration policies. For example, calibrating the flow control valves every 6 or 12 months, calibrating the test sieves every 12 months, etc.

4.1.5: Do gages used to monitor/control the process have a measurement range to cover the operating range of the equipment, and is the gage resolution sufficient?

Peening intensity is directly proportional to the blast pressure. Blast pressure requirement for most peening applications is within 90 PSI (6.2 Bars). It is therefore important to ensure that pressure gages at the minimum have an operating range of up to 100 PSI. Graduation in most analog gages is 1 PSI.

The MagnaValve, widely-used for flow control and monitoring, can display maximum media flow rates for all commercially-available blast nozzle sizes and wheel designs.

4.1.6: Is the equipment equipped with instrumentation or visual indicators that allow the operator to monitor: (a) Air pressure or wheel speed, (b) Part movement, (c) Nozzle/wheel movement?



As mentioned earlier, instrumentation in the form of proximity sensors and zero speed switches detect part and nozzle movement (or absence of it).

Visual indicators could be provided either in the form or gages or graphic displays on the operator interface screen.

4.1.7: Is the equipment equipped with media quality equipment to maintain size and shape as per the specification requirements?

Mechanical vibratory classifiers provide media size classification (100% for most airblast peening applications and a steady sampling for wheelblast applications). Media shape can be maintained, if required, by a Spiralator.

4.2.5: Is shot screening equipment integral to the shot peening media reclaim system so that the media is classified continuously?

Classification in an airblast application is usually continuous, given the lower flow rates from nozzles (when compared to wheels). In a multiple wheelblast peening system, it is usually only a sample.

Spiralator capacities are quite limited in capacity and therefore only a sample percentage (usually 10 to 25 Lbs/min) is passed through the unit.

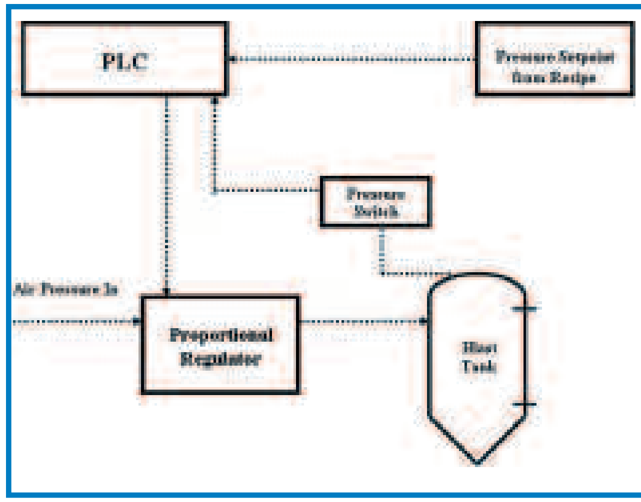
4.1.8: Does the peening equipment include a dust collector for continuous removal of dust and other fine particles during operation?

It is a requirement that all blast machines (cleaning and peening) be supplied with a ventilation and dust collection system.

4.1.10: Does the air system include low-air pressure alarms or does supplier have an air capacity management plan?

Well-designed peening systems incorporate a closed loop feedback for pressure control. This system, while satisfying the above audit criteria, operates as follows: (Please refer to line diagram)

The operator inputs the desired blast pressure as part of the technique/recipe. A pressure transducer senses the air pressure in the blast tank and compares it with the desired



setting. Any variation between the two values is automatically corrected by an Analog Proportional Regulator provided in the main airline to the blast tank.

In addition to this corrective feedback loop, sophisticated controls systems could also incorporate a setting for bandwidth values. This essentially permits the operator to set bandwidths (time delays) before triggering a fault alarm. The system could be set to shut down the process if the required pressure is not maintained within a specified time period of say 30 seconds.

4.2.3: Is the equipment equipped with the capability to shut down the process when required parameter limits are exceeded?

As explained above, bandwidth settings will permit shutting down the system in the event where the required parameter limits are exceeded.

4.2.4: Is a record of the shut down details generated for each occurrence of automatic shut down?

In addition to just shutting down the system, a record of the shut down can also be generated in the form of an 'Alarm' screen.

Summary:

The above audit criteria do not necessitate compliance to various elements but questions whether such features are available in the equipment used for peening. If not present, the audit requires the user/applicant to explain the discrepancy.

Though most specifications are open to interpretation, uncertainties can be eliminated by ensuring that the equipment supplier understands and meets requirements.

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