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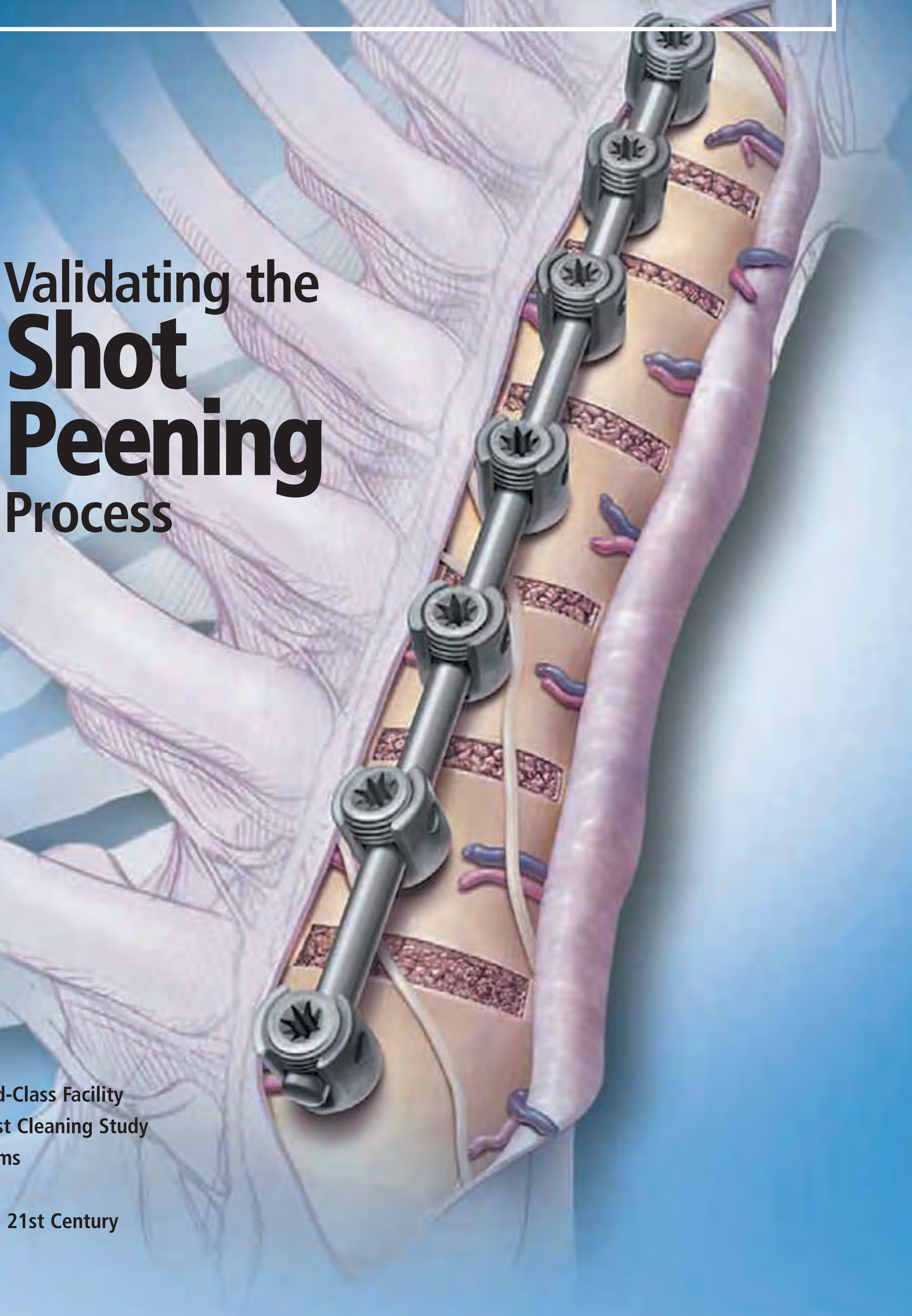
The Shot Peener

Dedicated to sharing information and expanding markets for shot peening and blast cleaning industries



Validating the Shot Peening Process

A global leader in the spinal treatment market brings shot peening in-house

Plus:

Aircraft MRO in a World-Class Facility
Australian Foundry Blast Cleaning Study
Automated Blast Systems
Internal Audits
Bringing Specs into the 21st Century

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4 Validating the Shot Peening Process

Medtronic shot peens the titanium bone screws that anchor their spinal fixation systems like the one illustrated on the right. When they decided to bring the shot peening process in-house, a Medtronic engineering team developed a validation strategy that every vendor, designer, engineer and operator must follow. If you are considering bringing shot peening in-house, read about the steps they took to achieve a successful manufacturing procedure.

8 Aircraft MRO in a World-Class Facility

KLM Royal Dutch Airlines has a history of being first. The world's first airline, the first MRO facility and first-class shot peening. Read how shot peening fits into the MRO workflow at KLM.

The Shot Peener
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Cover illustration: Medtronic CD HORIZON® ECLIPSE® Spinal System

Medtronic's Spinal and Biologics business, based in Memphis, Tennessee, is the global leader in the spinal treatment market and is committed to advancing the treatment of spinal conditions

Validating the Shot Peening Process

Over-peening, under-peening, and poor record keeping are just a few of the liabilities that keep many companies from shot peening in-house. However, due to equipment and testing advancements and the availability of professional training, validating the shot peening process in today's manufacturing environment has become a reality. Validate is defined as "to declare or make legally valid, to make with an indication of official sanction, and to establish the soundness of; corroborate." Validation is a tremendous responsibility in the context of shot peening but one that a world-class medical implant manufacturing is capable of assuming.

Medtronic's Spinal and Biologics business, based in Memphis, Tennessee, is the global leader in the spinal treatment market and is committed to advancing the treatment of spinal conditions. The Spinal business collaborates with world-renowned surgeons, researchers and innovative partners to offer state-of-the-art therapies for spinal, neurological, orthopaedic and oral maxillofacial conditions. Medtronic facilities in Warsaw, Indiana; Memphis, Tennessee; and Humacao, Puerto Rico share the responsibility for manufacturing titanium bone screws that anchor spinal fixation systems. These fixation systems are designed to assist with stability of the cervical, thoracic, and lumbar spine when performing modern spinal fusion surgery and help patients suffering from degenerative disc disease, trauma, tumors, severe curvatures and other degenerative diseases of the spine.

Not many companies have the resources of Medtronic but their strategy can be scaled to fit limited budgets and smaller facilities. If your company already has an in-house shot peening program, you can pick up some ideas on how to validate and thereby improve your processes. The following is an account of the Electronics Inc. staff's involvement with the project.

Homework

Medtronic had several reasons to bring the shot peening of the bone screws in-house: the need for validated process control, an ever-increasing number of bone screws to be shot peened and the likelihood of shot peening a larger portion of the part. Plus, given the scope of the company, Medtronic was more than capable of implementing a successful manufacturing process.

The Electronics Inc. staff first met Medtronic engineers at the 2006 EI Shot Peening Workshop in Indianapolis. The engineers read about the workshop in *The Shot Peener* magazine and attended the workshop to learn more about shot peening. The workshop proved to be a good learning opportunity. "The workshop gave us a thorough understanding of shot peening," said Scott Hatfield, Manufacturing Engineer at the Warsaw facility, "but it also met our higher expectations because our questions on our specific goals were addressed, too. The information was provided in an enjoyable format and the instructors were very engaged in the learning process. Because we were new to shot peening, it was very helpful to see all of these vendors in one place at the trade show and we were able to learn more about products like shot peening machines, separators and speed masking."

Collaboration

As the shot peening training company for Medtronic, Jack Champaigne and Tom Brickley of Electronics Inc. were invited to Medtronic's Shot Peening Titanium Symposium in June 2007. The Symposium was organized by Mark Pelo, Medtronic's Director of Advanced Manufacture Engineering. The Symposium was a gathering of outside vendors and Medtronic staff. The Outside Support Team included representatives from Cam-Met, Inc., Electronics

Inc., Industrial Metal Finishing, Lambda Research, Metallurgical Services, Inc., Progressive Technologies, and Technology for Energy Corp. Medtronic team members included manufacturing management, engineering, product development, prototype development and program/project analysts from Medtronic's three facilities. The symposium, held in Medtronic's auditorium in Warsaw, Indiana, was an open forum to review a standardized peening validation requirement for all of Medtronic's manufacturing facilities and outside suppliers.

The goal of the Symposium was to discuss a validation strategy that every vendor and each designer, engineer and operator, in all Medtronic manufacturing facilities, must follow. The final validation strategy will ensure that every bone screw is shot peened correctly according to company specification, no matter which facility shot peens it.

"Medtronic understood that they had limitations in their understanding of shot peening so they brought together everyone in their company that would be affiliated with shot peening and their outside resources," said Tom Brickley. "It was an incredibly professional event and I think it was a valuable experience for everyone." "They were very professional about attendance, asked many questions, and reviewed their present practices and research methods," said Jack Champaigne. "Medtronic understands the necessity of quality since they have to operate under FDA regulations," he added.

Equipment Selection

At the Electronics Inc. workshop trade show, the engineers reviewed products, met with several vendors and began a discussion that would result in the purchase of a Progressive Technologies robotic shot peening machine. The Progressive Technologies machine was chosen after a careful evaluation of machines from four manufacturers. "Progressive Technologies was our choice because they stepped up to our design challenge," said Mark Pelo. Medtronic's machine had to be flexible and specialized: flexible enough to accommodate several different products now and new products in the future (Medtronic brings products to the market continually); and specialized to provide crucial information. Because Medtronic will get validation information from their machine, they will meet the FDA's demands that the shot peening process be controllable and repeatable and they will save money in the long run due to fewer destructive tests of the implants. "Progressive didn't offer us a cookie-cutter solution. They are very creative. For example, when we asked for a particle sampler in real time, they gave it to us," said Pelo. Marty Hilbrands, the Progressive Technologies Sales Engineer for the Medtronic project commented, "The team at Medtronic should be commended for taking ownership of their shot peening processes. Their desire to understand and invest in the technology will no doubt pay off in the years ahead."

Training

EI's next involvement was during on-site training of Medtronic's shot peening operators and inspectors from Indiana and Puerto Rico in January 2008. Jack Champaigne and Dr. John Cammett of Cam-Met, Inc. trained 15 employees to the requirements of MIL-S-13165, AMS 2430 and the FAA approved course #AGL/1207/0006/8. "My impression of the group was that they were all very interested in learning the basics of shot peening, they were aware of the importance of the process, they wanted to do the process properly, they were relating to their current practices and realizing that some of these practices were not correct," said Champaigne. Every Medtronic employee passed the Level I Certification Exam. Level II and Level III shot peening training by Electronics Inc. will take place later this year. Their shot peening operators are also being trained by Progressive Technologies on the machine.

Testing, Verification and Implementation

A Medtronic team took the information gathered at the Symposium and wrote a validation strategy. Based on that strategy, they are developing operational qualifications that will be used consistently in every facility. The standardized validation elements are Almen Strips, Velocity, Recipe Control, Media Sampling, Fatigue Life and X-Ray Diffraction. To meet FDA requirements, Medtronic is fatigue life testing the screws and connectors in human movement simulations beyond the life expectancy of a typical implant. One of the exciting aspects of this project is that Medtronic engineers are also investigating the benefits of shot peening a larger portion of the implant, for even greater benefits to the patient. The studies are expected to be completed by July 2008 and the in-house shot peening program will start soon after. Approximately 250,000 screws will be shot peened yearly at the Indiana and Puerto Rico plants.

Reflection

In less than two years, a group of six Medtronic engineers in Warsaw, Indiana have created an in-house shot peening methodology for bone screws that will become the standard for additional product lines in this global company. The system will be applied to existing and future implant systems that can benefit from shot peening. "Shot peening allows us to design implants that are smaller, stronger, lighter and less invasive for patients," said Mark Pelo. "We are really pleased with what we've accomplished with shot peening," added Hatfield. The group is preparing an abstract of their shot peening protocol for the Science and Technology Conference this fall. The Medtronic conference explores many issues facing its scientists and engineers and the team is looking forward to sharing their shot peening knowledge base with others.


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Aircraft MRO in a World-Class Facility

KLM Royal Dutch Airlines has a history of being first. Founded in 1919 by a Dutch flyer named Albert Plesman, KLM launched the world's first scheduled airplane passenger service in 1920 by flying from London to Amsterdam. By World War II, it had a fleet of 51 planes and served 61 cities in 29 countries. During World War II, KLM's fleet was decimated and by war's end, KLM had only four planes in Europe. Plesman gathered KLM personnel from all over the world and led "the Flying Dutchman" in a remarkable comeback. Today KLM is part of Air France Industry and has 125 aircraft serving 145 cities in 67 countries. KLM ranks seventh among the International Air Transport Association's more than 200 member airlines in terms of international revenue to kilometers.

"Plesman had a very progressive view on how to do business," says Marcel van Wonderen, KLM's Master Engineer on Process, Equipment and Materials Development. "He founded an overhaul shop for aircraft and engines in 1921." Mr. van Wonderen works for KLM's Engineering and Maintenance division. With approximately 5,000 employees, KLM E&M is one of three divisions of KLM, the others are Passenger Transport and Cargo. KLM E&M is one of the larger MRO companies affiliated to an airliner. Located at Amsterdam Airport Schiphol, KLM E&M has a state-of-the-art engine shop facility with a capacity for 350 shop visits a year. Reliable engine support is the backbone of KLM's MRO offerings. The company provides these customized support programs:

- AOG service (Aircraft on Ground) to ensure continuous aircraft operation
- Spare engine programs with guaranteed availability
- Worldwide engine transportation through KLM Air Logistics
- On-wing support from worldwide specialized teams
- Customized engine maintenance programs
- Optimized EGT (exhaust gas temperature) margin with advanced maintenance programs
- Innovative cost-cutting repairs

Fifty to sixty percent of all engines serviced by KLM are for other airlines. KLM E&M is one of the largest GE overhaul shops in the world and it currently overhauls approximately 225 GE engines a year (CF6-50, CF6-80A, CF6-80C2, CF6-80E1). KLM E&M also overhauls Boeing 747, 737, 777, McDonnell Douglas MD11, and Airbus A330 aircraft. KLM performs two kinds of engine overhauls:

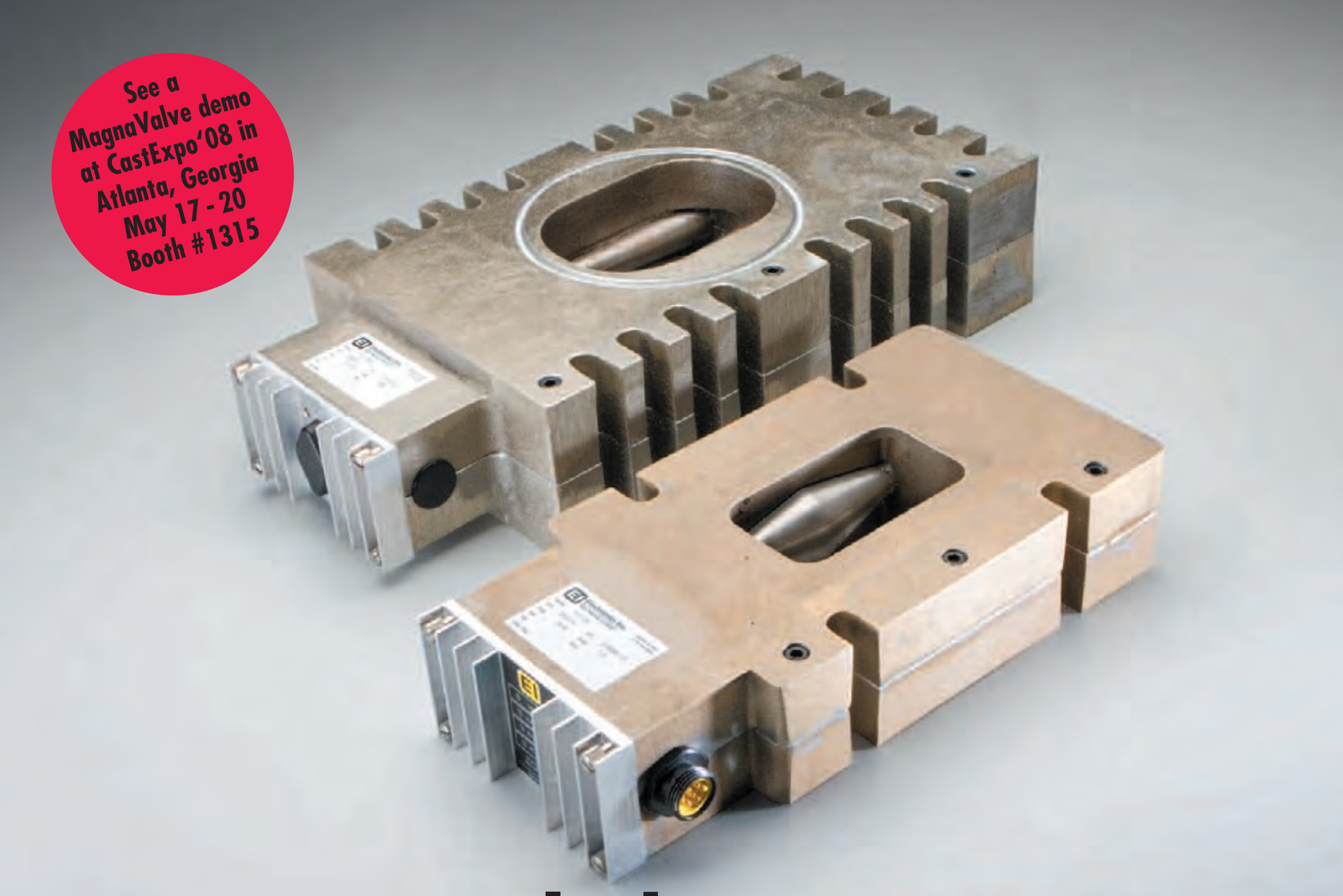
- Planned (after approximately three years or 5000 flight hours)
- Unplanned (due to reported vibrations, high fuel consumption, high engine gas temperature, loss of power, and bird strikes)

When an engine arrives in the shop, one or more of the five different modules will be overhauled - Low Pressure Compressor, High Pressure Compressor, Low Pressure Turbine, High Pressure Turbine, and Gearbox. The parts of the modules will go to the pre-route (cleaning, non-destructive testing, inspection, part-disposition) and after that, possibly into the repair route depending on the condition of the part and costs of the repair (the part will be repaired if the repair costs are less than 60% of the cost of a new part). A total engine overhaul (depending on how many modules must be repaired) takes 65 days with a repair-window of 17 days. As part of his responsibilities, the department of Mr. van Wonderen has engineering responsibilities for the following repairs/ treatments on engine parts:

Welding

- manual TIG-welding
- CNC Dabber-TIG-welding
- SWET welding (Superalloy Welding at Elevated Temperatures)

KLM's Engine Services building at Amsterdam Airport Schiphol



Control the Process

with the

MagnaValve®

The LowProfile MagnaValve is a magnetic valve that regulates the flow of steel shot in blast cleaning machines. With no moving parts, it's maintenance free. Plus it saves money in media and energy and provides reliable and consistant blasting.

Contact us and ask for:

- *An article on a blast cleaning machine installed with MagnaValves at Timet— the world's leader in titanium production*
- *A guide to installing MagnaValves on an abrasive blast machine*
- *Energy savings article from The Shot Peener magazine*

Electronics Inc.

Shot Peening Control

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Brazing
- nickel brazing
- silver brazing

Heat Treatments
- solution heat treatment
- homogenization
- precipitation hardening
- stress relieve heat treatment
- diffusion heat treatment
- hydrogen embrittlement to relieve heat treatment

Ultra-High Pressure Waterjet Cleaning

Shot Peening

Coatings
- galvanic: silver plating, nickel plating, chemical nickel, chromium plating, phosphating, anodizing, chromate conversion coating
- diffusion: Sermalloy J
- grit blasting prior to thermal spraying
- thermal spraying: plasma spraying, flame spraying, electric arc spraying

Machining
- turning
- milling
- drilling
- tapping
- grinding
- boring
- lapping, super finishing, honing

Measuring
- 3D-measuring
- LASER-measuring
- MK3-measuring
- manual measuring

Balancing
- static
- dynamic

As the world's first airline and MRO facility, KLM E&M has always been a leader in the MRO aircraft industry in innovations, state-of-the-art processes, experience, equipment and materials. For example: KLM E&M was the first MRO shop in the world with a full process approval from General Electric on the Ultra-High Pressure Waterjet process (KLM won the European LIFE award for clean technologies with this process), KLM E&M was also the first in the world with electric arc spraying on GE parts as an alternative for Plasma spraying, the first in superalloy welding at elevated temperatures (SWET) welding, and the laser-cladding of GE parts. (Laser-cladding is a metal surface enhancing process performed by applying a powdered metal material onto the base surface with a laser.)

Mr. van Wonderen oversees these innovative programs in the MRO facility, and shot peening is one of his passions. "Given all of the engine repair steps, shot peening is one of the most important steps," says van Wonderen. "During repair and overhaul there are many processes that introduce tensile stress in the metal parts. Only shot peening is capable of introducing compressive stress to eliminate or compensate for those tensile stresses."

KLM's Engine Services facility

A wide range of components for the world's finest aircraft are shot peened at KLM E&M. All GE engine parts that will be plated or thermal sprayed will be shot peened. Many engine parts with weld or blend repairs will be peened. All total, a minimum of 225 different parts are peened, from a 2-inch long cargo-door hook to a fan frame that is seven feet in diameter. Landing gear parts and flap-tracks are just two examples of aircraft parts shot peened for Boeing, McDonnell Douglas MD-11 and Airbus.

KLM E&M, a Six Sigma company, tests their shot peening processes according to the Six Sigma practices. Six Sigma was originally developed by Motorola to systematically improve processes by eliminating defects. Since shot peening cannot be tested on a part without destroying it, it is important to control, monitor and record the whole process. Intensity, saturation and coverage are calculated and measured indirectly through Almen tests and saturation curves. Highly-skilled operators are a must. The following are the components of the quality control system that KLM E&M incorporates into their shot peening process:
- Machine: calibration, maintenance, controlling, recording
- Manpower: training, qualification, proficiency checks
- Measurement: gauges, timers, monitoring devices
- Method: parameter, manuals, procedures
- Material: certification, standards, specifications, incoming goods inspections

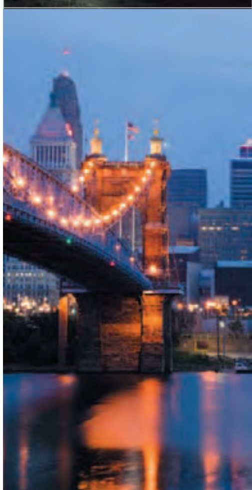
Put into actual practice, KLM utilizes these elements:
- Four state-of-the-art shot peening machines, three with a process integrated monitoring system in accordance with AMS 2432B
- Magnetic media valves
- Spherical conditioned cut wire shot in accordance with AMS 2431/4
- Simulation parts made from original aircraft parts embedded with Almen strip holders
- Highly-skilled and qualified operators that are checked every two years by means of a proficiency test, refreshment courses (theoretical and practical) and examinations
- Almen gages and calibration equipment
- Almen tests strips in accordance with SAE J442
- Following the procedures according to SAE J443, SAE HS-84, SMA 2430L, AMS-S-13165, etc.

Because he is an advocate for shot peening, van Wonderen developed a presentation titled "How can the shotpeen process really be controlled?" that outlines the steps his shot peening team takes to ensure a repeatable, controllable process. The presentation has been an educational tool for aircraft-related industries that aren't familiar with the metal treatment process or have misconceptions about the benefits of a tightly-controlled procedure.

Mr. van Wonderen feels so strongly about shot peening that he sees it as one of the keys to success in the current MRO marketplace. "One of the possible ways of increasing the chances of surviving is to be innovative and introduce new ideas in the MRO market. Innovative techniques include computerized and automated processes such as ultra high pressure waterjet stripping, shotpeening, TIG-welding, laser-cladding and thermal spraying," says van Wonderen.

Cincinnati, Ohio is the location for the 2008 US Shot Peening and Blast Cleaning workshop. The Cincinnati-Dayton is an aerospace corridor and a driving force in the worldwide aerospace industry.

Flying High in Cincinnati



A corridor running through the center of Ohio is an aerospace powerhouse with more than 300 industry-related businesses. From the earliest days of commercial aviation 100 years ago, this Cincinnati-Dayton region has been a center for aerospace firms including aircraft and parts, aircraft engines and engine parts, fabricated metal products, instruments and related products.

The proximity of Cincinnati to our many aerospace associates and its international airport (the Cincinnati/Northern Kentucky International Airport was voted the No. 1 U.S. Airport in 2004) made it a natural choice for a workshop. However, even though Ohio is our neighbor, the Electronics Inc. staff had more to learn about this community. Here are a few observations about Cincinnati that will make your workshop experience even more enjoyable.

Its Name

Cincinnati was not the first name for the community settled on the Ohio river at the Ohio-Kentucky border. The small outpost, originally named Losantiville, was renamed Cincinnati in 1790 by a group of Revolutionary War soldiers called the Society of Cincinnati. They had taken the Cincinnati name from the legendary Roman general Cincinnatus. The city has nicknames, too. During the first forty years after its founding, Cincinnati experienced spectacular growth. By 1820, citizens, extremely proud of their city, were referring to it as "The Queen City" or "The Queen of the West". Considerably less elegant is "Porkopolis", that came from the city's distinction as the meat packing capital of the world during the 19th century.

The Depth of its Aerospace Community

The Cincinnati-Dayton corridor ranks in the top 15 areas in the United States for the number of establishments directly involved with aerospace products and parts manufacturing. The number of aerospace-related facilities in the Cincinnati area provide work for 1.5 million people living within 50 miles of Cincinnati and more than 180,000 workers employed as engineers, mechanics and engine specialists, aircraft structure assemblers and specialists in precision production, craft and repair occupations. In 2003, the Cincinnati-Dayton corridor was awarded $2.5 billion in U.S. defense spending and $1.4 billion for U.S. Air Force Projects.[1]

The Wright-Patterson Air Force Base is located near Dayton, Ohio. The National Museum of the United States Air Force is located on the base—it's the world's largest military aviation museum and has more than 400 aerospace vehicles. Admission and parking are free and the museum is open seven days a week.

Cultural Offerings

Many workshop attendees bring their spouses and plan a couple of vacation days around class time. Cincinnati is a beautiful city, much deserving of its queenly nickname. A sampling of the local culture includes:

- Museum of Natural History and Science. This area is filled with caves so don't miss the life-sized Kentucky limestone cave and walk-through ice cave...in the museum!
- Cincinnati Art Museum is located in a scenic park and boosts a collection of over 60,000 pieces spanning 6,000 years.

- Cathedral Basilica of the Assumption is a touch of Paris just minutes from downtown Cincinnati. This small scale Notre Dame cathedral houses one of the world's largest stained glass windows (24 feet by 67 feet) and features a French Gothic design with gargoyles and flying buttresses, mural-sized oil paintings by renowned artist Frank Duveneck and 82 stained glass windows.
- Architecture. Cincinnati is known for having the largest collection of nineteenth-century Italian architecture in the U.S., primarily concentrated just north of Downtown, one of the largest historic districts listed on the National Register of Historic Places.

Shopping

Cincinnati has an abundance of shopping choices from upscale icons such as Saks Fifth Avenue to spacious malls. One-of-a-kind shopping experiences are the Newport on the Levee that features 12 restaurants, over 20 unique shopping venues, a comedy club, a live blues club, a live cabaret, 20 stadium-style AMC movie theaters, the Newport Aquarium, street performers, and live bands; Findley Market, one of the largest open-air marketplaces in the U.S., and Jungle Jim's - six acres of food under one roof!

Unique Foods

Last, but certainly not least, there are a couple of foods that you really must try that are unique to Cincinnati. The first is Cincinnati-Style Chili.

Cincinnati-Style Chili is a sauce usually poured over spaghetti or hot dogs, containing a unique blend of spices that gives it a very distinct taste. Recipes for Cincinnati-Style Chili are well-kept family secrets; however, many believe that its unique taste comes from chocolate and cinnamon. Several restaurants serve Cincinnati-Style Chili with Skyline Chili probably being the most famous.

After a meal of chili, what sounds better than ice cream? Graeter's Ice Cream is beloved by locals and tourists alike. According to Graeter's, their French pot ice cream method produces only two gallons of ice cream at a time, making it extremely dense and creamy. They offer many seasonal and signature flavors with Black Raspberry Chip touted as its all-time bestseller.

Workshop information, including the agenda, speaker biographies and a review of the Advanced Shot Peening classes is available at www.electronics-inc.com and we've included a registration form in this magazine. We hope you will make plans to join us. Don't forget that space is limited at the Hartzell Propeller tour so sign up as soon as possible (see inset). See you in Cincinnati this October.

[1]Resource: Cincinnati Chamber of Commerce

Photos courtesy of the Cincinnati USA Regional Chamber. From top to bottom on page 12: GE Aviation Center; the Cincinnati skyline at night; Findley Market; Paul Brown Stadium, home of the Cincinnati Bengals; and Cincinnati Skyline Chili.

Hartzell Propeller Tour

Monday, October 27, 2008, 1:30 p.m.

As a part of the Electronics Inc. Shot Peening and Blast Cleaning Workshop, October 28 - 29, 2008, in Cincinnati, Ohio, Hartzell Propeller Inc. has organized a tour of its facility located in Piqua, Ohio. The free tour and bus on Monday, October 27, 2008, are open to registered students of the EI Shot Peening and Blast Cleaning Workshop.

Tour participants will:

- see the actual shot peening/inspection of a new aircraft part
- see the propeller assembly cell where product is built
- learn about how Hartzell develops shot peen requirements
- see Hartzell's in-house fatigue testing
- see Hartzell's shot peen air system/controls
- visit our Media Resource Center
- look at our networked Shot Peen Database
- and have all your questions answered along the way!

The space on the bus and the tour is very limited. Register early for the Shot Peening and Blast Cleaning Workshop, then contact Joe Simmons to register for the free tour.

Joe Simmons
Hartzell Propeller Inc.
Piqua, OH 45356
jsimmons@hartzellprop.com

MagnaValve™ Reduces Maintenance for Australian Automotive Foundry

The grit valves in the foundry's shot blast machines broke down regularly, resulting in many labour hours spent on maintenance. Since the installation of the MagnaValves, the foundry has not had a single valve breakdown.
—Nathan Dalton Blastmaster

The maintenance staff at an automotive foundry in Fishermans Bend, Victoria, Australia was frustrated with the numerous breakdowns of the grit valves on their monorail eight wheel shot blast machine. The problems were linked to the mechanical shot control/shut off valves seizing due to metal dust ingress into the moving parts and shot leakage during shut down. Leaking valves can fill a wheel assembly with shot, making motor restart impossible until the wheel housing is cleaned out either by stripdown or contractor services. The valve seizures put the blast machines out of service, often two or three times per week. Each breakdown cost the foundry a high volume of labor to get the valve operational, plus lost production time while the machine was idle. The busy foundry needs to run several shifts a day so this was an expensive problem.

The foundry maintenance team contacted Blastmaster, a MagnaValve distributor in Adelaide, Australia, for a solution. After a successful in-house trial period with the MagnaValve, the team ordered eight of the magnetic valves. Blastmaster designed the first retrofit kit for the valves and the foundry built the remaining retrofit kits. "The customer found the installation easy and straight-forward," said Nathan Dalton with Blastmaster.

Seven months after the MagnaValve installation, Blastmaster reported the following outcomes at the foundry:
- Not one breakdown or stoppage
- Highly controllable shot flow rates to each wheel
- Consistent wheel motor loadings ensuring shot intensity is the same day after day
- Precision electronic flow rate adjustment when required
- No flooding of the wheel housing due to shot leakage
- No wear by shot flow is evident
- Electrical interference from the heavy foundry environment has not affected the controller or valve functions in any way

About the MagnaValve
MagnaValves use a strong permanent magnet and electro-magnet design to regulate the flow of steel shot in blast cleaning or shot peening machines. When no power is applied to the MagnaValve, the permanent magnet stops all flow. With power applied, the magnetic field is neutralized and shot is allowed to flow through the valve.

Benefits of the MagnaValve
- Maintenance-free—no moving parts
- Cost savings from the efficient use of media and lower media disposal fees
- Optimizes the load of large horsepower motors thereby reducing energy consumption
- Many control options available
- No risk of machine malfunction due to running out of shot during procedure
- Confidence that your product was blast cleaned or peened properly
- Compliance to specifications is readily attainable
- Requires less operator time
- Available in 24 Vdc and 110 Vac models
- Works with most steel media sizes
- Environmentally-responsible—conserves energy and media (less media in landfills)
- Over 26 years of proven performance in the field
- Trusted by OEMs and end-users worldwide
- Available for wheel and air blast machines

About Electronics Inc.
The MagnaValve is manufactured by Electronics Inc. For more information on our complete line of MagnaValves for wheel and air blast machines, contact us by phone or email: 1-574-256-5001 or 1-800-832-5653 Email: info@electronics-inc.com

About Blastmaster
Since 1975, Blastmaster has been a specialist supplier to the protective coating and corrosion control industry. The company provides maintenance programs and distributes industry products including blast media, Wheelabrator machines and parts, and Electronics Inc. MagnaValves. Blastmaster is located in Adelaide, South Australia. For more information, contact Nathan Dalton via telephone or email: (08) 8292 2000 or +61 8 8292 2000 (International) sales@blastmaster.com.au

User-friendly touch-screen operator interface is convenient for on/off and component control.

Automated Blast Systems... Infinite Possibilities

With the uptick in economic activity in North America over the past several years, many customers have sizeable production backlogs. That is certainly nothing any CEO wants to complain about, but speeding production without suffering quality reduction can be challenging.

If you outsource some or all of your blast work, can your job shop keep up with your higher volumes? There no doubt are several viable solutions to meet the demand of higher volume. You could pressure your job shop to increase their capability or you could bring some or all of the work in-house, where you can better control lead times. There are many benefits of in-house processing, including being able to more easily adjust production for part changes or adapt to changes in peening specifications. Perhaps more importantly, you may more easily respond to production emergencies.

Usually, for high production applications, we are talking automation. But since no two customers or their applications are exactly alike, there are numerous technology variables that are combined to suit a particular customer or job.

Before you can allocate the necessary funding to pay for your new equipment, it's important to assess what your present needs are and what you think your future requirements for the equipment will be. This assessment process is often difficult and calls for careful planning and some sound expert advice. Help is only a phone call away.

We know where you are coming from, as we recently went through the process ourselves when we designed and built a new lab machine (yippeee...a new toy for Herb!). It is our business to help customers solve cleaning, peening, and finishing problems. So, our machine has to have a multitude of features that can simulate many different air-blast nozzle combinations, blast nozzle manipulation, and part handling processes in a precisely controlled way.

Like all of our equipment, our new machine is a workhorse, built-to-last, and with heavy-duty construction for the industrial manufacturing environment. It can accommodate almost any material finishing requirement needed by our customers. The system accepts every blasting media from non-aggressive media such as starch or plastic, to finishing/deburring media such as glass or ceramic media, to aggressive media such as aluminum oxide, silicon carbide, or steel grit, as well as steel shot, glass beads, or ceramic shot for shot peening applications.

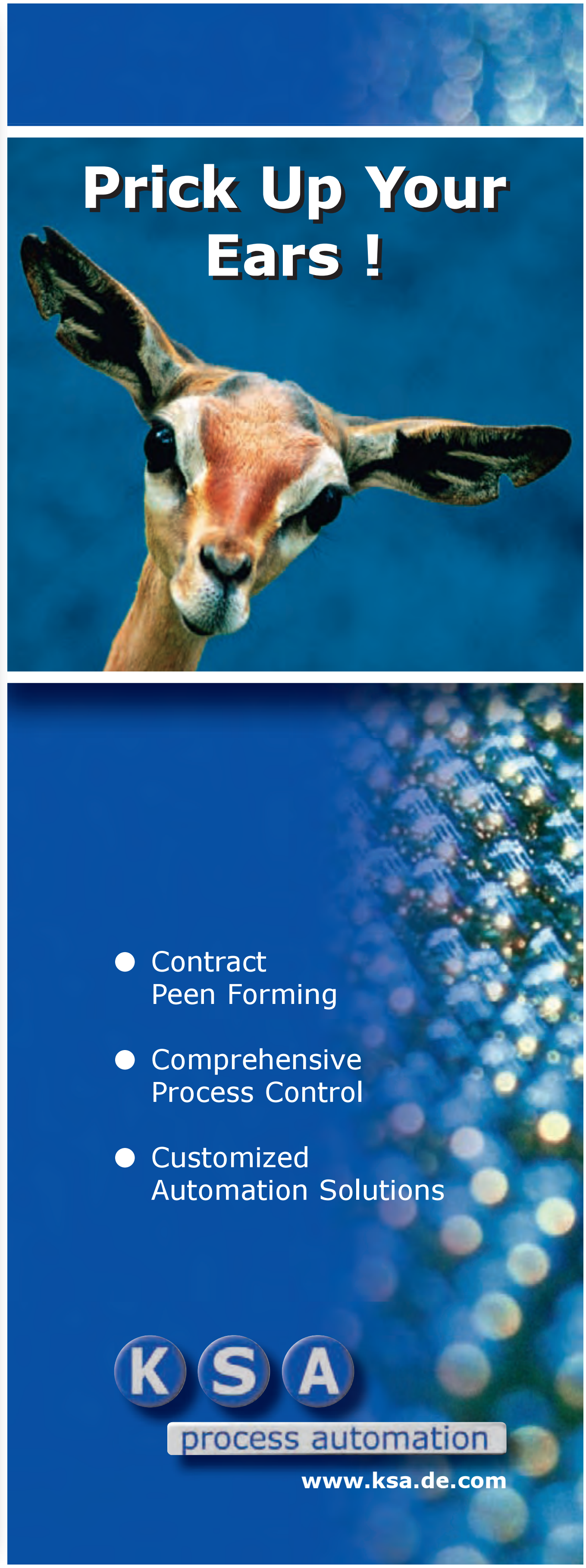
The machine is versatile, allowing suction or pressure blasting with multiple nozzles and horizontal, vertical, or rotary nozzle manipulation. It can also be set up for continuous or indexing turntable applications as well as other methods of part manipulation. It has a removable belt conveyor system to allow simulation of various conveyor systems. The conveyor mechanisms vary but all are for high production and through-feeding. The different conveyor technologies include a magnetic-belt that keeps lightweight metallic parts in place, or an inclined-belt for small round parts that roll into the cabinet, or a straight-line belt conveyor for parts that are large and stable enough to stay in place at the blast station.

We incorporated state-of-the-art electronic controls and drive systems for the nozzle manipulation and material handling devices that provide high-precision repeatability of the process. PLC controls with "touch-screen" operator interface provide visual confirmation of nozzle manipulation and part manipulation speeds, and all-important process parameters for the system. Physical alarms make it possible to signal and shut down the system for any out-of-tolerance condition that affects the process.

Automation is a key component of a successful labor-saving, repeatable, finishing operation that is much in demand in today's manufacturing environment. For optimum efficiency, it is important to eliminate repetitive manual blast operations for labor and material savings.

Call the 'guy in the white coat', send in your finishing challenge and let us apply our sample processing capability and demonstrate the benefits and savings you can obtain by incorporating a quality piece of automation into your production line. Direct any questions to Herb Tobben at 636 239-8172 or send email to htobben@clemcoindustries.com.

Herb is Sample Processing Manager for the ZERO Automation product line at Clemco Industries Corp. He is a regular speaker at the Electronics Inc. Shot Peening Workshop.



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Industry News

Electronics Inc. Introduces Computer Interface Device for Almen Gage TSP-3

Mishawaka, Indiana. The TSP-3 Computer Interface Device (CID) system makes entering multiple measurements quick and accurate. The CID plugs into your computer's USB port and inputs the value displayed on your Almen gage directly into the Almen Saturation Curve Solver Program*, Excel, Word or similar program used to store collected data. Pick the entry method that is most convenient for you: push-button or footpad control. Either entry method will eliminate typing errors and speed up the measurement process. There are no power requirements as the CID is powered from a USB port. There are no drivers to load. The CID will automatically communicate with the application as if the data (and a carriage return) has been entered on the keyboard. For more information, call Electronics Inc. at (574)256-5001 or 1-800-832-5653 or send email to info@electronics-inc.com.

* The Almen Saturation Curve Solver Program, developed by Dr. David Kirk, is available free at www.shotpeener.com/learning/solver.htm

ICSP-10 Hotel Accommations

Tokyo, Japan. The ICSP10 Local Organzing Committee has offered hotel suggestions. The event will be September 15-18, 2008 in Tokyo, Japan at Meiji University.

Hotel Tokyo Garden Palace

Standard Single / ¨¥11,000 (w/Breakfast; tax and service charge included) Deluxe Single / ¥12,050 (w/Breakfast; tax and service charge included)

Ochanomizu Hotel Juraku

Single occupancy / ¥9,500 (w/breakfast; tax and service charge included.) Double occupancy / ¥15,800 (w/breakfast for 2 people; tax and service charge included.) included.)

Tokyo Green Hotel Ochanomizu

Single occupancy / ¥9,800 (w/breakfast; tax and service charge included.) Double occupancy / ¥16,400 (w/breakfast for 2 people; tax and service charge included)

ICSP10 conference and exhibition forms, schedules, maps, and conference topics are available at www.icsp10.jp.

Kennametal Honors Excellence in Environmental, Health and Safety

Latrobe, Pennsyvlania. Kennametal Inc. announced today that it has presented its sixth annual Environmental, Health and Safety (EHS) Excellence Awards to six Kennametal projects worldwide. The awards recognize excellence in promoting progressive environmental, health and safety initiatives. This year Kennametal received a record 49 nominations spanning a wide array of projects and ideas.

"Environment, Health and Safety are an integral part of Kennametal's core business strategy," commented Kennametal President and CEO Carlos Cardoso. "We are dedicated to helping safeguard the health and safety of our employees and the environments in which they operate and are excited to recognize the projects that showcase excellence and commitment to our EHS initiatives."

Winners of the 2007 EHS Excellence Awards were chosen by a set of six external judges representing various environmental, health and safety institutions. Nominees were judged according to their demonstration of leadership, innovation, facility collaboration, employee benefit, measurable cost and risk reduction and improvement in business operations and quality. This year's winners are: Presidential Award for Health and Safety: ASHEBORO, NORTH CAROLINA Kennametal's Asheboro, North Carolina, facility was recognized for their indoor air quality modifications resulting in improved air quality on the manufacturing floor.

Presidential Award for Environmental: ASHEBORO, NORTH CAROLINA; AUGUSTA, GEORGIA; CLEMSON, SOUTH CAROLINA; GREENFIELD, MASSACHUSETTS Through a scrap material recycling program, these Kennametal facilities will be able to recycle over 1,300 tons of material annually, as well as benefit from the elimination of potential disposal fees.

Health and Safety Excellence Award: KENNAMETAL DISTRIBUTION CENTER, CLEVELAND, OHIO Through the development of a reusable container, the Kennametal Distribution Center in Cleveland, Ohio, reduced potential ergonomic concerns and increased productivity by over 35 percent.

Health and Safety Excellence Award: BEDFORD, PENNSYLVANIA Through the installation of furnace loading improvements, Kennametal's Bedford, Pennsylvania, facility has reduced manual efforts associated with production further ensuring employee safety. Environmental Excellence Award: ENGINEERED PRODUCTS GROUP Through employee awareness and involvement in Kennametal's Lean process, the company's Engineered Products Group, has significantly reduced energy usage resulting in savings across the entire business unit worldwide. (Irwin, Pennsylvania; TCM Detroit, Michigan; Traverse City, Michigan; Victoria, British Columbia ; Kelowna, British Columbia; Arnheim & Hardenberg, Netherlands)

Environmental Excellence Award: CORPORATE CAMPUS LATROBE, PENNSYLVANIA Through Kennametal's Lean process, this facility was able to identify ways to reduce the consumption of electricity and natural gas significantly reducing costs and generating savings.

Metrology of Almen Arc Height Measurement

INTRODUCTION

Almen arc height measurement is very important to the shot peening industry. The primary application is for determining acceptable shot peening intensity which uses ferromagnetic steel (SAE 107) strips. A secondary application, using paramagnetic aluminum alloy (2024-T3) strips, is for ensuring that excessive intensity is not applied during aircraft paint stripping procedures. The mechanics of Almen arc height measurement are very well documented. Almen strips, holders and measurement gage requirements are rigorously specified.

This article deals with the metrological principles of arc height measurement. The basic measurement components are the dial gage, strip holder and strip. Attention is focused on the significance of hold-down forces and ball wear.

DIAL GAGE

Arc height measurements are normally made using some type of dial gage. Dial gages have a long and honorable history within the engineering industry. Gages for measuring distance changes are generally either analog or digital. An example of a digital gage, sensitive to 0·001mm, is shown in fig.1. The facility for interface connection to a computer - so that readings can be fed directly to, for example, spreadsheets – has been incorporated. In this instance the gage is part of a basic facility for measuring peening parameters other than arc height – such as strip thickness variation, shot diameter, etc.

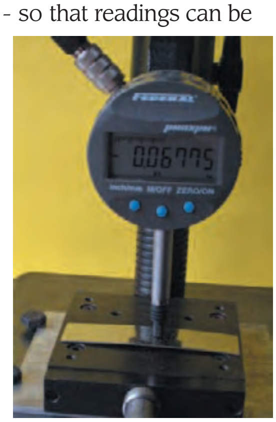

Fig.1. Digital gage with interface connection.

Interface connection reduces the chance of an operator introducing recording errors. Both types of dial gage have a spring-loaded shaft that exerts a constant force against the sample. The shaft travel is converted, using an internal rack and pinion system, into a rotary movement. This rotary movement is displayed directly on a dial for analog gages. Rotary movement for digital gages is converted into digital steps by a rotary encoder. Digital indicators can also be switched between imperial and metric units with the press of a button and may retain a 'memory' of a zero position. It is of fundamental importance that indicated shaft movements are very, very, close to actual shaft movements. Fig.2 shows the results of calibration tests on a TSP-3 Almen gage made by placing pairs of gage blocks on either side of the gage point. The gage block thickness range, of necessity, started just above the clearance between the support balls and the Almen gage body. A least-squares straight line fitted to the data is shown. The slope of the line, 1·005, reflects the required accurate relationship between shaft travel and shaft reading. The intersection of the line with the 'y-axis', -1·496mm, is the actual clearance between the check block surface and the gage body.

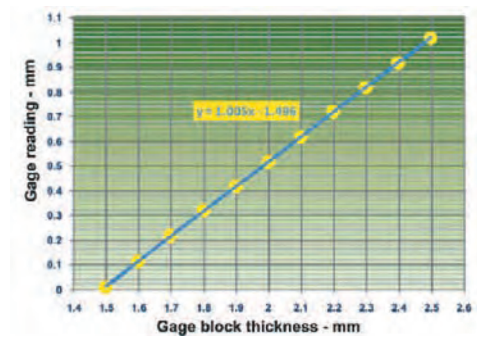

Fig.2 Calibration results on Almen gage made using gage block pairs.

Range, sensitivity, and shaft force are significant gage parameters for arc height measurements. A gage range of about 2.5mm/0.1" and a sensitivity of about 0.001mm/0.00015" would be appropriate. Much greater sensitivity would lead to annoying 'hunting' of the readout. The gage indicator point may be flat, rounded or sharp. A specified roundness of point is appropriate for location against the concave side of a curved Almen strip.

Shaft force is a significant parameter for Almen arc height measurements. Digital gages have shaft forces normally within a range of 0·3 to 3N with the largest force being required to drive gages measuring the longest distances.

Dr. David Kirk is a regular contributor to The Shot Peener. Since his retirement, Dr. Kirk has been an Honorary Research Fellow at Coventry University, U.K. and is now a member of their Faculty of Engineering and Computing. We greatly appreciate his contribution to our publication.

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A shaft force of about 0.5N is typical for commercial Almen gages. **0.5N** is the gravitational force that would be exerted by an object having a mass of **50g**. **N**, **A** and **C** Almen strips have masses of **9**, **14.5** and **27**g respectively. It follows that Almen strips must be held down if the gage shaft is pushing the strip upwards.

The dial gage acts in a comparator mode when in use for arc height measurements. Fig.3 represents this type of operation. A curved Almen strip induces a gage shaft travel to point **B** with a corresponding gage reading. We must have a second point **A**, in order to measure the distance between them – which in this case is our required arc height. The flat side of a 'calibration block' is generally used to provide this reference point – the gage being 'zeroed' when the block is in position. We would then have gage readings of **0** and **h** as shown in fig.3. The accuracy of arc height readings depends upon the accuracy with which both points, **A** and **B**, can be determined. It is good practise to have a second 'reference' flat block for periodically confirming the gage's zero indication.

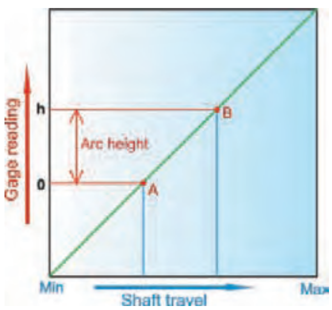

Fig.3. Dial gage comparator mode for arc height measurements.

HOLDER GEOMETRY

Gage specifications require that Almen strips are supported on four precision balls lying in a plane and at defined locations. These balls are crucial for maintaining precision of measurement. Ball material is normally either ferromagnetic steel or a ceramic. Fig.4 indicates the significance of the relative positions of strip, balls and peening block. An Almen strip is shown positioned on its four support balls. The contact points at A, B, C and D define the measurement plane, ABCD, which is on the unpeened underside of the strip. This plane is crucial because it determines both the gage zero and the arc height. It is worth noting how close the contact points are to the prior positions of the hold-down screws and to the strip edges – a matter of only 1-2mm! The heads of the screws will have shielded the strip from exposure to the shot stream. Strip edges will have received inhomogeneous peening. It follows that the strip must be positioned accurately relative to the support balls. Specifications require that two 'side stops' are provided and also indicate the positions of two optional 'end stops'.

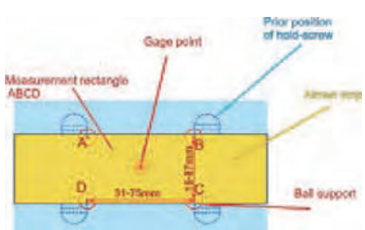

Fig.4. Representation of holder support geometry – to scale.

Fig.5 is a schematic representation of the holder stop locations with consequent tolerances. The side tolerance of 0·20mm is derived from the J442 Specification requiring the distance between the tangent to the side stops to be between 1·49 and 1·69mm from the edge of the strip. The required distance between the optional end stops is 76·9 to 77·4mm. If we combine that with the allowable length range of Almen strips of 75·6 to 76·6mm we get that the end tolerance range is between 0·3 and 1·8mm.

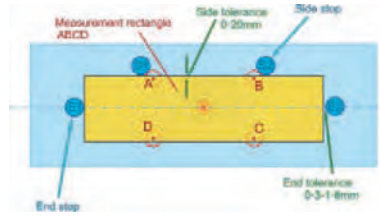

Fig.5 Side and end stop locations together with consequent tolerances.

HOLD-DOWN FORCES

Hold-down forces are required to hold strips and calibration blocks firmly in position relative to the four ball supports. The guiding principles are that (a) the thrust force of the dial gage must be overcome, (b) any bending moments applied during measurement must be negligible and (c) force location must be precise. Once positioned, movement has to be constrained so that dial gage measurements can be made at a fixed point – the centre of the measurement rectangle. Hold-down forces can be applied either mechanically or magnetically to ferromagnetic strips. The Almen strips used for shot peening intensity determination are ferromagnetic.

Fig.6 illustrates, schematically, the balance of forces that would be achieved IF the hold-down forces were only large enough to allow an Almen N strip to just touch the four support balls. Forces are shown to one decimal place. It is assumed that the dial gage exerts an upward thrust of 0·5N and forces are drawn as vectors (length indicating force magnitude). An Almen N strip, because of its mass of 10g, exerts a downward force of 0·1N directly over the gage point. The required balance of equal and opposite forces is achieved therefore by four 0·1N hold-down forces directly over the four support balls. With this situation the strip is not actually being held down in a practical sense – there are no upward forces at the four ball contact points to secure the strip in position.

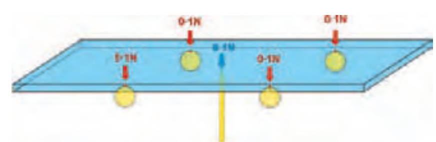

Fig.6 Balance of forces for Almen N strip just touching each support ball.

Fig.7 (page 28) illustrates, again schematically, the balance of forces achieved when useful levels of hold-down force are applied.

FORCE, BENDING MOMENTS and DEFLECTION

The bending moment, **M** that a force, **F**, generates is the product of force and distance through which it acts, **D**. Hence we have that **M** is given by:

$$M = F.D \qquad (1)$$

An Almen strip has a rectangular section of width **W** and thickness **T**. Bending moments applied to a strip cause deflections that depend upon its rigidity. Rigidity, **I**, is given by:

$$I = W.T^3/12 \qquad (2)$$

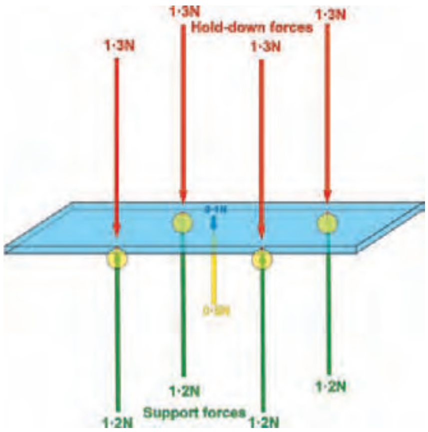

Fig.7 Typical actual hold-down forces and balancing forces.

Almen strips have thicknesses of about 0·8, 1·3 and 2·4mm for N, A and C respectively. Width is the same for all three at about 19mm. Corresponding I values are 0·8, 3·5 and 21·9mm^4. The ratios of rigidities are therefore 1:4:27. Any bending moments applied to an N strip will induce bending that is four times that which would suffered by an A strip and 27 times that for a C strip.

IF the hold-down forces applied to strips act **exactly in line** with the points of contact then they cannot exert a bending moment – the distance through which the forces are acting, **D**, is zero. Hence they cannot generate bending of the Almen strips. There is, however, one unavoidable bending moment. That is generated by the net force being applied by the dial gage point. Exact calculation of the deflection for five-point bending is complicated. Fortunately the problem can be simplified enormously by assuming that each pair of support balls acts at a single point. We then have three-point loading and the induced deflection **x** is given by:

$$\mathbf{x = P.L^3/(48E.I)} \qquad (3)$$

Substituting P=0·4N for load, L=32mm as distance between end support points, E=210,000Nmm^{-2} and I =0·8mm^4 predicts that, for an N strip:

x = 0·0016mm or 0·00006"

This dial-gage-induced deflection of an N strip is so small that it can only be detected using a sensitive Almen gage. Experimental confirmation of the predicted deflection was obtained by centrally placing an additional mass of 40g on a positioned Almen N strip. This mass generates a downward force of 0·4N counteracting the net upward 0·4N exerted by the dial gage. Twenty repeat measurements showed that the dial gage reading was reduced by 0·0017mm – confirming the accuracy of the preceding calculation. A and C Almen strips have rigidities four and twenty-seven times that of an N strip so that for them dial-gage-induced strip deflection is too small to be measurable.

The forces indicated in figs.6 and 7 were measured directly using an Electronics Incorporated TSP-3 Almen gage. 76mm by 19mm non-magnetic strips of various masses were piled up until the dial gage was just able to read zero. The pile of strips was then weighed as being 51g – indicating a dial gage force of **0.5N**. Sets of 10 Almen strips were weighed using 'letter scales' (accurate to 1g) to obtain average masses of **9**, **14.5** and **27**g for **N**, **A** and **C** Almen strips respectively. An accurate spring balance (scale 0 to 1000g) was connected using a string harness attached to positioned Almen strips. Raising the spring balance progressively counteracts the hold-down force until a given strip is pulled off the magnetically-energized support balls. The 'pull-off force' was about **4·8N** (490g times 0·98 for gravity) regardless of strip thickness.

The magnitude of mechanically-applied hold-down forces depends upon individual manufacturer's design. Magnetically-induced hold-down forces of necessity act precisely at the strip/ball contact points. Accuracy of load location is crucial for mechanical gages.

AERO STRIPS

Paramagnetic aluminum alloy (2024-T3) strips are used for aircraft paint-stripping control. These have the same dimensions as Almen N strips but the elastic modulus is much lower, at 73GPa, than the 210GPa of steel shot peening Almen strips. Applying equation (3) predicts that a dial gage force of 0·5N (the lighter mass of aluminum alloy strips having been neglected) would induce a strip bending deflection of 0·005mm (0·0002"). Such a small deflection can be ignored since paint stripping specifications typically require abraded strips to show less than 0·127mm (0·005") deflection.

Hold-down forces must be applied to paramagnetic strips mechanically – either directly or indirectly. The EI TSP-3AA Aero gage employs an ingenious hold-down device. Four spring-loaded pins press against the aero strip at points directly opposite each support ball. This device is located precisely by sliding down four parallel posts – which also act as the end and side strip stops. The springs display an increase in force that is a linear function of displacement – as with a spring balance. Dead weight loading of the pins indicated that the total force exerted when the device 'bottomed-out' was 3·9N – rather less than the total of 5·2N magnetic force exerted by the standard Almen gage.

HOLD-DOWN FORCE OFFSET AND ITS SIGNIFICANCE

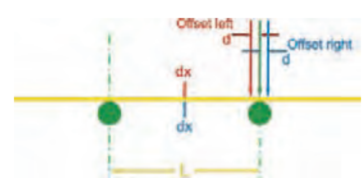

Fig.8. Offset hold-down forces generating strip displacements, dx.

For all types of Almen gage that apply hold-down forces mechanically there is the question of force application accuracy and its significance. Each hold-down force is offset a tiny distance (however small) away from the contact point between strip and support ball. An exaggerated situation is illustrated in fig.8 with two strip ball supports a distance **L** apart. The offset is **d** which will generate a negative displacement **dx** if it is to the left of the ball centerline (positive if it is to the right).

The induced deflection, dx, is given by:

$$\mathbf{dx = P.d(L^2 - d^2)/[9.\sqrt{3}.L.E.I]} \qquad (4)$$

Equation (4) can be used to predict the value of d that

will give a stated value of dx. For example, we can choose the lowest measurable value for dx of 0·001mm, and substitute values of 2N for P, 32mm for L, 73,000Nmm-2 for E (hard aluminum alloy value) and I = 0·8mm4. That yields the prediction that d would have to be 0·44mm. For standard steel strips (E = 210,000Nmm^{-2}) the offset would need to be 1·28mm to give a measurable deflection. An identical offset to either right or left on BOTH support ball pairs would cancel induced deflections. If, on the other hand, one offset was to the left and the other to the right then the deflection would be doubled.

Fig.9 Photograph showing pin hold-down mechanism used for Almen Aero gage TSP-3AA.

The preceding calculations reinforce the need for mechanical hold-down to be precise – as with the Aero gage shown in fig.9.

SAMPLE SHAPES AND CONTACT POINTS

There are three shapes of sample surface used for arc height measurements. These are:

1. **Flat** – zero side of 'check block' and unpeened Almen strips,
2. **Single curvature** – curved side of 'check block' used to confirm dial gage readings and
3. **Double curvature** – peened Almen strips.

Flat samples will rest on the highest points of the four support balls. Samples with single curvature, on the other hand, will rest at some point **C** on a support ball, see fig.10.

The offset, **x**, can be estimated using equation (5). This equation was derived using a combination of 'Intersecting Chord' and 'Similar Triangle' theorems. The triangle **ABC** is 'similar' to one formed by the sample radius and L/2 so that:

$$\mathbf{x = 2.D.h_o/L} \qquad (5)$$

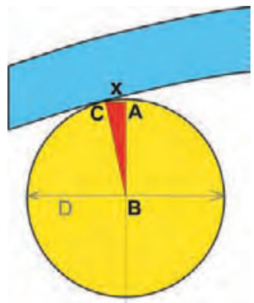

Fig.10. Effect of sample curvature on contact point.

where **D** is the support ball diameter, $\mathbf{h_o}$ is the arc height measured at the center of the strip and **L** is the distance between ball supports.

As an example: **D** and **L** are specified as 4·76mm and 31·75mm respectively and the standard EI 'Check Block' has a nominal arc height of 0·61mm. Substituting these values into equation (5) yields a value of 0·183mm for x.

The double curvature of peened Almen strips will induce two-dimensional off-sets for contact with the support balls. Fig.11 is an attempt to illustrate the difference between the contact points for the three sample surface shapes. Flat and single-curved samples will make contact at fixed points as shown for the plan view of a single ball (see position A in fig.5). Only the top part of the ball is included – because of the tiny off-sets involved. Peened Almen strips will make contact somewhere along the indicated track - depending on the arc height.

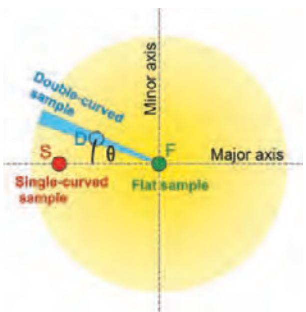

Fig.11. Schematic plan view of the top 0·5mm of one support ball showing different samples' contact positions.

BALL WEAR DETECTION

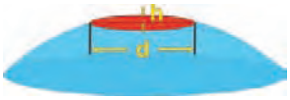

Fig.12. Ball wear flat (exaggerated) on top of support ball.

Some ball wear is inevitable and increases with use. The major regions of wear will be the contact point areas **F** and **S** shown in fig.11. That is because the same points are contacted every time the 'check block' is used. The flat side of the block is normally used at least an order of magnitude more often than the curved side - being used for gage zeroing and pre-peening check of each strip. Most wear will therefore occur at point **F** on the top of each of the four support balls. This wear generates a 'flat' having a diameter, **d**, which reduces the ball diameter locally by an amount **h**, see fig.12. The relationship between **d** and **h** is given by the equation:

$$\mathbf{d = 2.\sqrt{(D.h)}} \qquad (6)$$

where **D** is the support ball diameter.

Equation (6) can be written in the form h = D^2/4D. **D** is nominally a fixed quantity – 4·76mm so that:

$$\mathbf{h = d^2/19.04} \qquad (7)$$

Equation (6) shows that when h = 0·001mm (smallest detectable value) and d = 4·76mm then d = 0·14mm. Hence, for wear to be gage-detectable the flat would have to be at least 0·14mm in diameter. When h = 0·002mm then d = 0·19mm, when h = 0·003mm then d = 0·24mm and so on. J442 requires that d has a maximum value of 1mm. When d does equal 1mm then equation (7) shows that h = 0·053mm (0·002").

The curved side of a standard Check Block can used as an accurate indicator of ball wear - up to a d-value of 0·37mm (being twice the radius value predicted by equation (5) for the Check Block). An alternative approach is to support the flat side of the check block on a pair of 1·500mm thick gage blocks, one on either side of the dial gage pointer, see fig.13 (b). The gage reading is compared with that without the gage blocks being in position, see fig.13 (a). For the author's TSP-3 Almen gage the **difference** is currently 0·006mm. Any further ball wear will increase the difference.

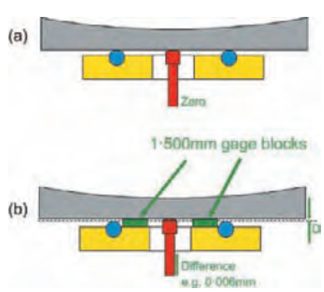

Fig.13. Ball wear test using 1·500mm gage blocks, 'difference' exaggerated for clarity.

PEENED ALMEN STRIP GEOMETRY

Peened Almen strips develop a fairly complex geometrical shape. Fig.14 is a schematic representation of the effect of this geometry on the measured Almen arc height, **h**. There are two components such that: $\mathbf{h = h_1 + h_2}$. The Almen strip contacts the support balls at four points defining the measurement plane **ABCD** (as in fig.4). Only the part of the strip shown in fig.14 contributes to the measured arc height – the rest is redundant.

Fig.14. Schematic representation of the part of an Almen strip delineated by contact with the four support balls.

Two curves, longwise and crosswise, define the shape of a peened Almen strip. These curves for a complete peened Almen strip are illustrated by fig.15.

Fig.15. Complete peened Almen strip showing defining curves L1-L2-L3 and C1-L2-C3.

Measured arc heights are only a minor part of the maximum strip deflection, H, shown in fig.14. Fig.16 shows complete profilometer traces of the two curves L1-L2-L3 and C1-L2-C3 produced for a severely-peened N strip. The maximum deflection, H, is 2·97mm whereas a measured standard Almen arc height, h, is only 0·775mm. The latter is made up of h1 and h2 contributions of 0·506 and 0·269mm respectively. These contributions are in almost exactly the same ratio as that of AB/BC.

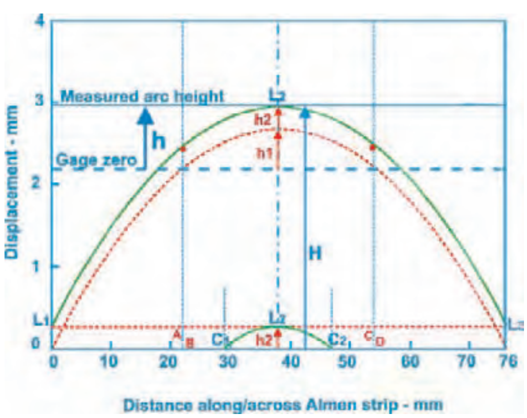

Fig.16. Profilometer analysis of Almen strip complete curvatures.

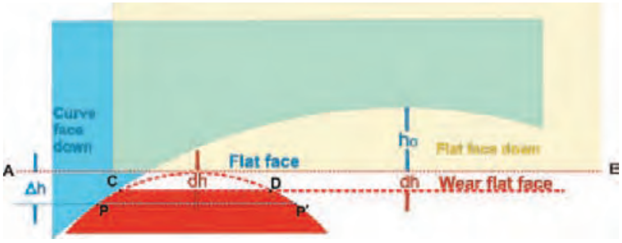

Fig.17. Effect of ball wear on arc height reading using Check Block, not to scale

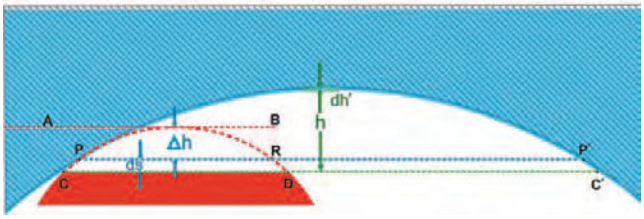

*Fig.18. Schematic representation of ball wear effect beyond normal contact point, **P**.*

EFFECT OF BALL WEAR ON ARC HEIGHT READINGS

(a) Check Block

The standard Check Block has a fixed, large, single curvature of one face. In the absence of any ball wear the flat face of the Check Block will make contact at the top of the balls along **A-B**, see schematic diagram fig.17. The curved face will make contact at some point, P, The corresponding gage reading will indicate that the arc height is $\mathbf{h_o}$. For single curvature $\mathbf{PP' = 0{\cdot}6{*}h_o}$.

With wear, the flat face of the Check Block will now make contact along the flat **C-D** (rather than along **A-B**). The indicated arc height reading will now be $\mathbf{(h_o + dh)}$. As wear increases, **C-D** increases, so that **dh** increases. The curved face continues to make contact at the point **P** - it is only the flat side of the Check Block that changes its position. $\mathbf{dh = CD^2/(4D)}$, where **D** is the support ball diameter. For 4·76mm diameter balls we therefore have that:

$$\mathbf{dh = CD^2/19.04} \tag{8}$$

Equation (8) is valid up to **CD** reaching **PP'**. Then **dh** has a maximum value, **Δh**, as shown in fig.17. **PP'** for the standard Check Block is **0·37mm** (0·6*0·6096mm) so that **Δh = 0·007mm**.

If wear extends below the level PP' a different regime then operates. The curved face no longer makes contact at the fixed point, **P**, but at some lower point, C – see fig.18 – with a corresponding lowering of the Check Block. The Check Block position is shown 'hatched' for contact at **P** and 'plain blue' for contact at **C**. Again it is emphasized that the drawing is schematic.

For a wear flat diameter increase of from **PR** to **CD** the flat face of the Check Block has lowered by amount **ds**. The curved face has also lowered - by amount **dh'**. Net increase in **h**, **dh**, is given, for balls separated by 31.75mm, by: **dh = (CD – PR)/15·875**. Combining this with equation (8) gives a 'working equation', in mm, that:

$$\mathbf{dh = 0{\cdot}36{*}h_o^2/19{\cdot}04 + (FD - 0{\cdot}6{*}h_o)h_o/15{\cdot}875} \tag{9}$$

where **FD** is the wear flat diameter and $\mathbf{h_o}$ is the arc height in the absence of wear.

Equation (8) applies if FD≤$0{\cdot}6{*}h_o$. Equation (9) applies if FD≥$0{\cdot}6{*}h_o$.

Fig.19 (page 32) shows a plot for a standard Check Block (ho = 0·6096mm). Between **A** and **B** equation (8) operates and between **B** and **C** equation (9) operates.

The minimum detectable change (using a standard Almen gage) is 1 micron (0·001mm), when the wear flat has a diameter of 0·138mm. One manufacturer's recommendation is to limit allowed wear to 0·366mm – beyond this, the gage should be re-furbished – when the corresponding height change is 0·007(03)mm.

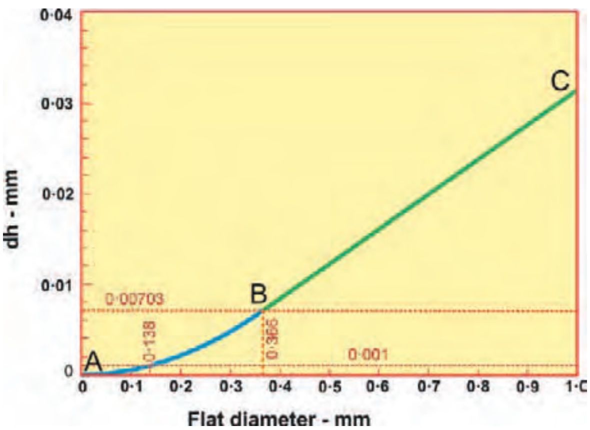

Fig.19. Effect of wear flat diameter on Check Block height reading.

(b) Peened Almen Strips

Peened Almen strips have a double curvature. The combined curvature varies considerably from strip to strip e.g. within a saturation curve set. The effect of wear flat diameter then depends upon the curvature. Strips with a very small curvature will make contact at the edge of the wear flat. Strips with a large curvature will make contact below the wear flat – as with the Check Block situation previously described.

The effect of wear flat diameter on a given set of peened Almen strips is illustrated in fig.20. A set of six strips have measured arc heights of 200, 240, 260, 275, 290 and 300 microns when the gage support balls have suffered zero wear. IF the gage balls had suffered wear then the effects on measured arc heights for each strip would be as shown. The larger the curvature the greater is the increase in corresponding measured arc height. Saturation intensity in the absence of wear is 258µ (based on peening 'times' of 1,2, 3, 4, 8 and 16 passes for the six strips). The increases of measured arc height, caused by ball wear, result in apparent saturation intensity values of 261, 265 and 273µ for wear flat diameters of 0·25, 0·5 and 1·0mm respectively (for the same set of peened strips).

DISCUSSION

Accurate Almen arc height measurement is a fundamental requirement for properly-controlled shot peening. The several factors that influence such accuracy have been analyzed. It has been shown that modern Almen gages accommodate all of these factors. It must be realized, however, that precision equipment demands careful, trained, usage if

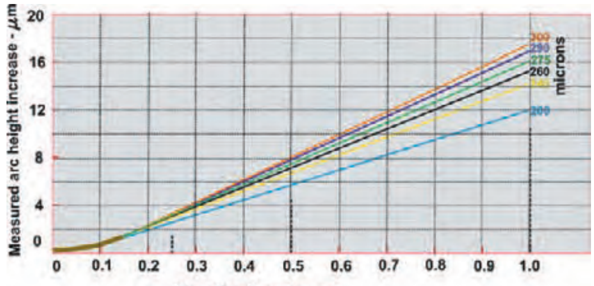

Fig.20. Effect of wear flat diameter on indicated arc heights for a set of peened Almen strips

required accuracy levels are to be maintained. Gage calibration and veracity of zero measurements are very important. It is proposed that a separate flat calibration block should be specified for monthly cross-checking of the 'everyday' zero setting block.

Hold-down forces and specimen misalignment have been shown to have a measurable effect on measurements carried out on N strips. This effect is, however, very small and is normally only just detectable. The rigidity of thicker Almen strips means that the influences of hold-down forces and small misalignments are so small that they cannot be detected.

Magnetic hold-down of Almen strips has at least two significant advantages over mechanical hold-down. Hold-down force is applied at the top of each support ball and specimen manipulation is simpler. One disadvantage is that paramagnetic strips, such as those used for paint-stripping test requirements, cannot be held directly. Substantial involvement with paint-stripping justifies the purchase of a dedicated gage - such as the Aero gage TSP-3AA. Occasional involvement can be accommodated by using a simple modification. This is illustrated in fig.21. A simple 'raft' is shown - made from two 5mm diameter mild steel rods glued to a (ferromagnetic) C strip. The rod centers were separated by a distance of some 32mm (the separation of the support balls) during setting of the epoxy resin employed for gluing. Magnetic forces pull the raft onto paramagnetic specimens with sufficient force to hold them in position for arc height measurement.

Fig.21. Raft device for holding paramagnetic specimens on a magnetic hold-down Almen gage.

Almen arc height measurements are valuable, both immediately and for subsequent reference. They should all be stored in an appropriate computer database. The tedium of entering data manually is virtually eliminated if a computer interface device is employed to connect gage to computer.

Data-analysis programs can then be used to highlight any significant changes in, for example, zero calibration. Saturation curve analysis can be carried out directly on intensity data entered into a solver program.


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Internal Audits—One of the Keys to Your Company's Success

In many ways external/customer audits are conducted as a "game": the customer tries to find out what the audited company is doing wrong, and the audited company tries to conceal it from them.

The aerospace industry has long accepted the need for an internal audit program as part of a company's quality system. At times these internal audit programs were not always well constructed or properly implemented and, as a result, were of limited value to the company.

Recently there has been a greater appreciation for the value of an effective internal audit program. This article addresses two aspects of an effective internal audit program: Basic Philosophy and Management support.

Philosophy of Internal Audits

Unless a company has a positive and proactive philosophy towards internal audits, it is unlikely that the necessary effort will be put forth to make it effective. A philosophy like the following one will help drive the company to give the internal audit program a focus and purpose. We firmly believe that a company with a strong Internal audit system is serious about quality, and is more likely to produce high quality product.

The purpose and goal of the internal audit program also needs to be established and reinforced. Many have come to believe that an internal audit program serves two purposes: to asses the degree of compliance of your personnel and practices against your published policies and processes; and to provide opportunities for continual improvement.

Internal Audits Need to be Different From External Customer Audits

Internal audits need to be designed to uncover the "real world" of how your company operates. In many ways external/customer audits are conducted as a "game": the customer tries to find out what the audited company is doing wrong, and the audited company tries to conceal it from them. An effective internal audit program must take the opposite approach.

The goal of an internal audit program should be to uncover as many compliance problems and new ideas for changing practices and procedures as possible. After all, the best way to improve your operations is to do it yourself - rather than have your customer force you to respond to problems that you have caused them. Management, auditors, and those being audited need to believe in this approach - and act accordingly. Employees must not be criticized or chastised for internal audit findings.

Management Support

Internal audit programs will not succeed without top management support. Management shows support by requiring personnel to be at work the day of the audit - no vacations, large company meetings, or other distractions which will hurt the effectiveness of the audit. Auditors must be given the time necessary to perform the audit correctly - and management must pay attention to the follow-up on the findings and insist on good corrective actions, their implementation and effectiveness.

An Effective Internal Audit Program is Key to Consistently Good Audit Performance

Management also shows the importance of the internal audit program by evaluating the results of the audits and making corresponding changes to policies and processes based upon the results.

In return, management has the right to expect the following as a result of the internal audit program:

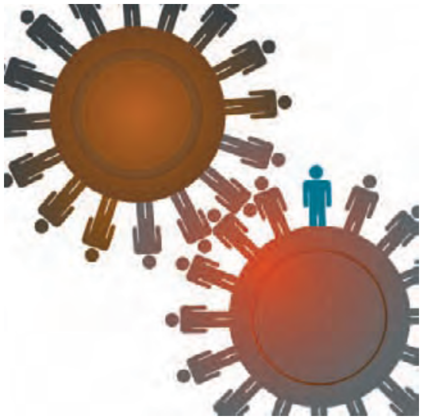
- Improved conformance of practices
- Improved practices and procedures (as changes to the processes which are discovered or suggested by the internal auditors are incorporated)
- Improved employee morale as employees bond together to help improve their company's process - which should result in less waste - and more profit from operations
- Reduced costs of processes as they are improved
- Improved performance on external audits (thereby gaining greater customer good will)

A strong internal audit program will provide your company with key information to continually improve your operations. Take time to review your audit plan and management and employee commitment to the internal audit program, and take action now to ensure your internal audits provide true and actionable results.

Preparing Your Operators for an Audit

Thorough preparation for your Nadcap commodity audit is an essential key to your successful accreditation process. But preparation does not mean a quality manager and a few trained auditors scouring over procedures and specifications. Nor does it mean for that same group to go around and verify compliance to a checklist. It does mean getting everyone involved in understanding the scope of the audit. There are two methods of preparation for the audit. The first is the utilization of the Supplier Mentoring program. A statement by Dan LeMasurier of West Coast Aerospace in the October 2007 Communiqué Flyer sums it up: "It is very important that the company that is being mentored enter into the process with a team spirit attitude: it is not an activity undertaken by an individual but by a collective effort of the whole company."

That brings us to the second method of preparation – job audits. The one group of personnel that tend to be ignored is the key operators/participants of the commodity being audited. Performing job audits throughout the year provides personnel time to learn the content of the potential questions to be asked and the company time to review compliance to specifications and process flows.



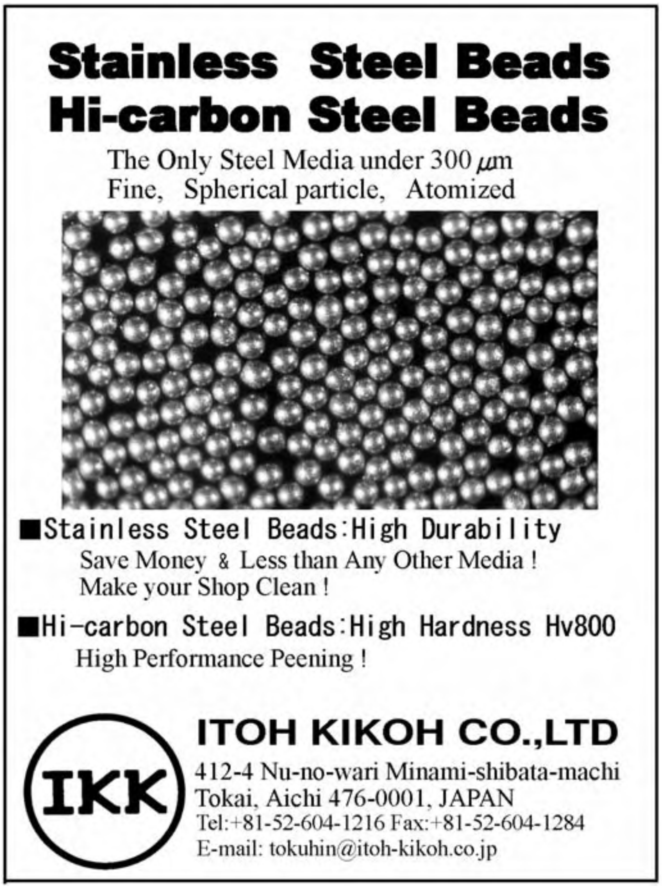
"It is very important that the company that is being mentored enter into the process with a team spirit attitude: it is not an activity undertaken by an individual but by a collective effort of the whole company."

Dan LeMasurier
West Coast Aerospace

Keep in mind that your personnel, as adults, will decide for themselves what is important and whether they think there is value in understanding the questions involved in the checklist. Therefore, it is critical that you emphasize, one-on-one, the value and importance of the checklist. Stressing to them that their responses and actions to the questions can help solve existing problems and avoid future product compliance issues and audit findings will help secure their commitment to perform to the maximum capability. Also, performing one-on-one job/process audits on a frequent basis will help the employee to become comfortable with their knowledge of the process, with the audit process as a whole, the checklist requirements, and being approached by auditor. It will help alleviate, but not eliminate, the nervousness an employee experiences during the audit process.

How your employee responds to auditors is a reflection of your company's performance capability. Is it not important to involve them in the preparation?

Resources:
Nadcap Communiqué Flyers (October 2007, February 2008)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Bringing Specs into the 21st Century

Shot Peening specs written in the 1940s by OEMs just don't make sense for today's MROs, job shops, product and media manufacturers. As a member of AMEC (Aerospace Metals Engineering Committee of the Aerospace Materials Division of the Society of Automotive Engineers), I have the opportunity to contribute to the evolution of shot peening specifications. AMEC is composed of technical specialists in aerospace metallic materials and related processes. AMEC was founded in January 1972 under the name of Aerospace Heat Treat Committee to consider specifications and common problems related to heat treatment. In July of 1974, the scope was expanded to include all aerospace metallic materials and related problems, and the name was changed to AMEC. In October 1977, AMEC became a committee of the Aerospace Materials Division of the Society of Automotive Engineers. AMEC's aim is to provide the aerospace industry and government agencies, in the public interest, with the technical benefits which accrue from cooperative activities and through the synergistic interchange of ideas and experience of members.

Photographed are participants of the first AMEC shot peening sub-committee meeting in Pacific Grove, California.

Al Patterson, a good friend and the AMEC Chairman, upon my request sanctioned a new shot peening sub-committee. As Chairman of this sub-committee and with my Co-Chairman, Hali Diep with Boeing, we called a meeting in January and invited industry leaders. Boeing, Cam-Met, Electronics Inc., Ervin Industries, General Electric, Honeywell Aerospace, Lawrence Ripak, Metal Improvement Company, Mitsubishi Heavy Industry, MTU, Nex Tech Processing, Peening Technologies, Pratt & Whitney, Premier Shot, Potters, PRI, Raytheon, Saint-Gobain Zirpo, Superior Shot Peening, Shockform, Tri Process, and U.S. Army sent representatives; 27 people attended in all.

During the two-day meeting, we worked as a group to discuss the following shot peening specification issues:

AMS-S-13165 discussion about impact of its cancellation in various industries. This document, created by the U.S. Army in August 1944, is cancelled. Issues such as MIL-Spec media as opposed to AMS-2431 media, intensity verification procedures, etc., were out-of-date and AMS-2430 seemed to be an attractive alternative. There will be some issues with proprietary drawings and shop practices that will need to be addressed. Some companies may wish to continue use of AMS-S-13165, others may be willing to transfer over to AMS-2430.

AMS-2430 discussion about changes that would be desirable to former users of AMS-13165. Issues related to transition from users of AMS-S-13165 were discussed and suggested changes from Peening Technologies, Shockform and Aeronamic BV were reviewed.

AMS-2431 /2, /3 and /6 discussion on media sizing using sieve analysis. Several AMS-2431 specifications refer to sieve analysis with requirements of rotation speed and tapping frequency of the sieves. Some difficulties have been reported in Europe when 50 Hertz is used instead of 60 Hertz and therefore the speed/frequency isn't within specification. SAE J-444 has different requirements precluding dual qualification to both specifications. Also, there are newer technologies for sieve shaking that do not rely upon a motor but use a proprietary magnetic field to effect the shaking. The manufacturer confirms (near) identical results compared to conventional sieve testing but lack of rotation and tapping presently precludes using this machine for sieve testing.

AMS-2431.7 Ceramic Bead for Peening Saint Gobain is introducing a new small size (Z100) and asked to have it included in the specification.

Flapper Peening: Discussion regarding creation of new AMS for Flapper Peening MIL-P-81841 was adopted by SAE without proper cancellation by U.S. Navy and SAE had to subsequently issue a cancellation notice. This MIL-spec document is rife with errors but the Navy has no interest (time, money, enthusiasm) for revision. We propose a new AMS specification that is up-to-date.

Needle Peening: New AMS required A novel device used for peening which uses ultra-sonically activated needles has been demonstrated and accepted by several aerospace companies. There is no current specification available to qualify for the construction and use of this device. We propose a new AMS specification should be created for this technique. Almen intensity tests are appropriate for process control but standard media requirements, new and in-use, are not required. Sylvain Forgues of Shockform Inc. provided a short video clip on the Sonats device to illustrate this process.

Ultrasonic Peening: New AMS required A cavity with ultrasonic resonator plate capable of inducing high speed motion to peening balls can be used to peen complex small parts. Almen intensity tests are appropriate for process control but standard media requirements, new and in-use, are not required. An example of this technology is a product from Sonats in France.

Eddy Current Non-Destructive Testing for Peening Intensity Dr. John Cammett reports that ASTM E07 NDT committee has developed a standard for coating thickness determination. It's possible that the eddy current techniques could lead to peening intensity verification. Dr. Cammett has volunteered to review this technology and, if appropriate, offer a new AMS document for its practice.

Low Sodium Glass Bead for Peening A draft specification was offered by Potters Industries and will be posted on the AMEC web site for comments. The AMEC requirement for one producer and two users was discussed and since Mitsubishi Heavy Industries and Boeing are potential but not current users of this material it was deemed that additional review and comment should be sought.

Update: SAE J-442 industry standard for Test Strip, Holder and Gage for shot peening Jack Champaigne has prepared a draft revision to relax the flatness requirement of the zero block from the current ±0.001mm to ±0.005mm.

Update: SAE J-2597 (not released yet) industry standard for use of computer-generated curves for shot peening intensity tests

The new shot peening sub-committee meeting was very productive and progress was made. I submitted 14 concepts to the main committee for consideration. The efforts of the contributing members (many of them are competitors) to take time from their busy work schedules, and in some cases, to travel from overseas, to make specs relevant for us all should be commended.

Do these topics affect you? Then consider requesting membership into AMEC. Our next meeting is in August. Please contact me for more information at (574)256-5001 or 1-800-832-5653 or jack.champaigne@electronics-inc.com.

A work session at the AMEC shot peening sub-committee meeting.

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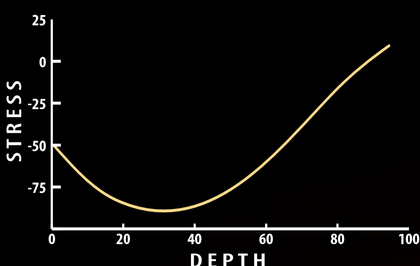

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