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OSHA's Occupational Exposure Standard For Hexavalent Chromium Challenges and An Opportunity

by Paul A. Kammer, Kammer Associates, Inc.

Introduction. OSHA's new standard (1) for occupational exposure to hexavalent chromium or hex Cr (also called hex chrome, Cr^{+6}, or chromium (VI)) presents the users of thermal spray processes with both challenges and an opportunity. The challenges include determining if your operations are in compliance and, if not, implementing and maintaining correctives actions and programs as required by the standard. The opportunity is to insure that you are maintaining a safe workplace and protecting your employees from overexposure to this hazardous substance (and preventing a citation and perhaps a fine as a result of an OSHA audit).

Hex Cr occurs in industrially used compounds such as chromates (such as are present in some chrome plating solutions and some anticorrosion paints and coatings) and is produced by some industrial processes, such as thermal spraying (plasma; electric arc; combustion, including HVOF) and welding (arc, laser, oxy-fuel) when chromium is present in the filler metal or feedstock. The presence of Cr in a form that may be converted to hex Cr is obvious for feedstocks that contain a specified amount of Cr, such as stainless steels and Ni-Cr alloys. However, it also has been noted that many iron-base alloys contain some Cr as an impurity that may result in airborne hex Cr during welding (2) and by implication during thermal spraying.

Overexposure to hex Cr may cause health effects such as lung cancer, irritation or damage to the nose, throat and lung, and irritation or damage to the eyes and skin. Exposure can occur by breathing high levels of hex Cr and by direct skin contact (3).

The new standard significantly lowers the PEL (Permissible Exposure Limit) for hex Cr from the prior level of 52 micrograms (µg) per cubic meter (m^3) of air to 5 $\mu g/m^3$ on an 8 hour time-weighted average (TWA). It also establishes an "Action Level" of 2.5 $\mu g/m^3$. Some organizations are pressuring OSHA for a further reduction of the PEL to 1.0 $\mu g/m^3$.

In addition to the standard, the OSHA web site (www.osha.gov) contains considerable information and references to many aspects of hex Cr.

Definitions. Some definitions that are important in understanding the standard are:

-Action Level: exposure level that, if exceeded, requires the employer to undertake specific actions

-PEL (TWA): maximum level of an airborne concentration that an employee may be exposed to calculated on an 8 hour time-weighted average

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Breaking News: ***Dear Friends of Thermal Spray,***

In collaboration with the American Welding Society (AWS), the Society of Manufacturing Engineers (SME), and the Fabricators and Manufacturers Association (FMA), The International Thermal Spray Association is proud to announce a **Thermal Spray Pavilion** at the ***Fabtech International & AWS Welding Show*** **in November of 2007** at the McCormick Place in Chicago with an estimated attendance of 17,000.

ITSA is planning many exciting and innovative industrial presentations for all show attendees. We encourage you to start planning now to be part of this special exposition highlighting the thermal spray industry to the AWS, SME, and FMA attendees. ***To reserve booth space*** in the Thermal Spray Pavilion for 2007, please contact Joe Krall, Director of Exposition Sales via email jkrall@aws.org or via phone 800.443.9353, extension 297.

Details to follow in the 4th quarter SPRAYTIME.

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-Emergency: any occurrence that results, or is likely to result, in an uncontrolled release of hex Cr; note that if an incidental release of hex Cr can be controlled at the time of release by employees in the immediate area, or by maintenance personnel, it is not an emergency.

-Regulated area: area in which an employee's exposure to airborne concentrations of hex Cr are, or can reasonably be expected to be, in excess of the PEL. A regulated area must be demarcated from the rest of the workplace and have limited access.

The standard contains additional definitions.

Timeline. The standard establishes a timeline for its required actions:

-The final standard took effect on May 30, 2006, which was 90 days after the date of publication in the Federal Register.

-Employers have until November 27, 2006, 180 days from the effective date, to comply. Employers with fewer than 20 employees have until May 31, 2007, one year after the effective date, to comply.

-The deadline for implementing any necessary engineering controls is 4 years after the effective date or May 31, 2010.

Primary Requirements. If an industrial activity (shop, on-site, etc.) might expose employees to hex Cr, the following actions are necessary to comply with the standard by insuring that no employee is exposed to an airborne concentration of hex Cr above the PEL on an 8-hr TWA basis (see the standard for the details):

1. Determine the exposure for each employee exposed to hex Cr by:

a. Following the scheduled monitoring option that requires taking sufficient breathing zone air samples; if representative sampling is done the employer shall sample the employees expected to have the highest exposure; or

a-1. Following the performance-oriented option that allows the 8-hr TWA to be determined on the basis of any combination of air monitoring data, historical monitoring data, or objective data.

2. Take action depending on the exposure that was found:

a. Below the Action Level of 2.5 µg/m^3, monitoring may be discontinued;

b. At or above the Action Level, but below the PEL of 5 µg/m^3, periodic monitoring shall be performed at least every 3 months and a medical surveillance program may be required depending on the number of days per year that such exposure occurs;

c. Above the PEL, periodic monitoring shall be performed at least every three months; and:

(1) Notify employees;

(2) Establish a regulated area;

(3) Implement engineering and work practice controls to reduce exposures below the PEL:

(4) If such controls are not feasible, controls must be used to reduce exposures to the lowest levels achievable and then may be supplemented by the use of respirators. Respirators may also be used in other instances (see standard), such as during the period before controls are implemented or when employees are exposed above the PEL for fewer than 30 days per year and such controls are not implemented.

Note that rotation of employees to different jobs to achieve compliance is not permitted.

Note that the levels of 2.5 or 5 µg/m^3 mean that very small amounts of hex Cr must be collected and analyzed. To insure accurate and reliable results are obtained, it is recommended that the sampling program be designed and conducted by an accredited industrial hygienist, and that the analyses be performed by an accredited laboratory. In addition, recognized standard procedures are recommended for sampling and analysis. Samples must be taken in the employees' breathing zones (4,5) and analyzed with methods (5,6) that will detect low levels of hex Cr. Even if you use an accredited hygienist and an accredited lab; it still is a good idea to review yourself the relevant OSHA documents and then review the hygienist's and lab's methods and procedures to insure that their activities conform to OSHA's standards and recommendations.

Other Requirements. In addition to the above requirements, the standard also deals with the following (see standard for details):

-Regulated area (if required) with limited access;

-Respiratory protection (Note that OSHA has detailed requirements (7) for a respirator program.);

-Protective work clothing and equipment-required where a hazard is present or is likely to be present from skin or eye

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INDUSTRY NEWS

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WHERE IS YOUR ARTICLE?

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contact; includes removal, storage and cleaning;
-Hygiene practices such as change rooms, washing facilities and eating and drinking areas;
-Proper disposal of waste, scrap, debris, etc.;
-Medical surveillance (standard contains the detailed requirements) for all employees:
1. Who are or may be exposed at or above the Action Level for 30 days or more a year;
2. Experiencing signs or symptoms of adverse health effects associated with hex Cr exposures;
3. Exposed in an emergency;
-Employee information and training;
-Record keeping.

Conclusions and Comments. Any company that is using a thermal spray process and a feedstock that may produce airborne hex Cr must take action that starts with the proper sampling program and may continue to implementation of further actions based on the results. In addition, if changes are made in the future to these operations, a new sampling program may be required. In addition to proper controls during spraying, the employer must have the proper procedures in place for such activities such as clean-up, maintenance, and any filter changes and clean-out for dust collectors.

Since this new standard establishes a very low PEL for hex Cr, is complex, and contains many new requirements; every affected employer should study the standard, consult with an accredited industrial hygienist, and take all necessary actions. It is likely that the standard will be a focus of future OSHA compliance activities.

The best result for your facility would be to find that any exposures are below the Action Level; no further sampling is required, but proper procedures noted above must be maintained. If exposures are above the Action Level; it would be a good idea to install controls or procedures to reduce exposures to below it even if the exposures found by sampling are below the PEL. This should eliminate future sampling and analyses and a medical surveillance program once you have proven that you are below the Action Level. If you find any exposure above the PEL, you must take corrective action; again, try to introduce controls and procedures that will reduce all exposures below the Action Level. As noted previously, reducing the number of exposures above the Action Level to less than 30 days a year will also reduce the number of continuing actions that you are otherwise required to implement,

In addition to this standard for occupational exposure to hex Cr, do not overlook other regulations that deal with air pollution and hazardous waste disposal if you detect hex Cr.

References

1. "OSHA Standard 1910.1026 Chromium (VI)" for general industry; there are similar standards for shipyards (1915.1026) and construction (1926.1126), www.osha.gov.
2. Fiore, Susan R., "Reducing Exposure to Hexavalent Chromium in Welding Fumes", Welding Journal, vol 85, no. 8, August 2006.
3. "OSHA Fact Sheet -Health Effects of Hexavalent Chromium".
4. AWS F1.1, "Method for Sampling Airborne Particulates Generated by Welding and Allied Process", American Welding Society.
5. "Hexavalent Chromium in Workplace Atmospheres", OSHA Method ID-215.
6. "Hexavalent Chromium", NIOSH Method 7600.
7. "Respiratory Protection", OSHA Standard 1910.134.

Editor's Note: Read the additional article on this topic that is found on page 6.

For more information, contact Paul Kammer, phone 252.633.9825, email pakammer@cs.com

Many thanks to Daryl Crawmer, Thermal Spray Technologies, Inc., for his review and helpful comments on this article.

Harper Corporation of America Announces Employee Safety Efforts

HARPER

Harper Corporation of America is a global leader in supplying products to the Flexographic printing industry with its primary product being micron precision fluid transfer rollers called "Anilox" rollers. The manufacturing of high quality anilox rollers requires many thermal spray disciplines including electric arc, plasma, and HVOF.

Having pioneered ceramic coatings and thus thermal spray technology for this application in 1970, we have always been aware of the potential threats that thermal spray poses to the environment and the health of our employees. We have spent an extraordinary amount of time, money, and effort in our pursuit of making sure our facilities are compliant with all appropriate authorities. However, our first concern is not one of compliance, but one of protecting our employees, which has kept us a step ahead of compliance issues.

At a time when price competitiveness in our industry seems to be at a peak, the new OSHA occupational exposure standard 1910.1026 is scary. The system required to comply with the new maximum permissible airborne chromium (VI) or hex Cr limit of 5.0 µg/m^3 not only has a cost associated with physical dynamics, but the cost of lost production cycle times is considerable.

Although we have always been conscious of direct employee exposures to the hazards of thermal spray, the emphasis of past regulations have been focused more on "after stack" emissions. I am not in a position to argue the PEL/TWA (permissible exposure limit on a time weighted average) in the new regulation from a health standpoint but can only say it was quite a shock once we digested the numbers. And we now understand that the new limit is being challenged in the courts in a lawsuit asking for the PEL to be dropped down to 1.0 µg/m^3?!

To begin our compliance initiatives we completed the industrial hygiene air sampling requirements of the regulation which seem to set the stage for the majority of the regulation. If your initial sampling result is below the new PEL of 5.0 µg/m^3 you are released from the potentially cumbersome and costly measures required by the standard to bring exposures below 5.0 µg/m^3. In addition, if your initial sampling result is below the Action Level of 2.5 µg/m^3, you do not have to have a periodic sampling program unless significant changes occur in such factors as your feedstocks or processes, ventilation levels or of duration of spraying materials containing Cr, etc.

I was extremely pleased to see our numbers at both US facilities were not only under the 5.0 ug/m^3 OSHA limit, but were also under 1.0 µg/m^3 and also well below the Action Level of 2.5 µg/m^3. The highest readings ranged from 0.421 µg/m^3 to a low of <0.025. Monitoring was performed on employees wearing a state-of-the-art industrial hygiene monitoring system that was non-intrusive to performing their tasks. We monitored at several sites and systems which included multiple plasma, electric arc, and HVOF booths, and our customized Harcron Welding systems; and at each facility an "area sample" was also taken at a common point in the manufacturing facilities. The feedstocks sprayed included aluminum bronze, carbon steel powder and wire, chromium oxide, zinc, aluminum, and nickel alloy 625.

At one facility there were five plasma systems, two blasting systems, one modified HVOF system, one automated submerged arc welder, one modified GMAW welder, and three electric arc spray systems in operation--all in enclosed booths that are connected to dust collectors. Each collector uses a 30 hp motor and moves 10,500 cfm of air. We were able to get that number up to about 13,000 by addressing short comings in the blowers, but still using the same 30 hp motors. The duct velocity for each booth is 4,500 fpm and the velocities at the source exhaust hoods are about 1,100 fpm.

The hoods and duct work are of a special design that we contracted an air flow engineering firm to assist us with. It ultimately took the right combination of collector media, internal duct, after-stack duct, exhaust ports in the hoods, and intake air balancing to get where we needed to be. The balance of make up air is a critical factor. I cannot count how many thermal sprayers think that if the the door to the booth slams shut, they have a good exhaust system. Elementary falsities to most of us, but believe me, this type of thinking exists quite often.

We contracted the services of ECCI (Environmental Compliance Consultants, Inc.) who are located in Green Bay, WI; but work all over the country. I have been dealing with ECCI since 1996 when I stumbled on them while we were constructing our Green Bay facility. These people are top notch! They have over 20 employees in the state of Wisconsin and many more located throughout the country. They have multiple service offerings and connections with many authorities which keeps them on the leading edge of regulation. Although they did not design the exhaust system, their resource of compliance issues is second to none. If anyone is interested in contacting them, please contact them at: ECCI P.O.BOX 11417, Green Bay, WI 54307-1417; phone 888-322-4669 or 920-434-5380, or see their website at www.eccinow.com

I want to add that just because we passed the PEL number requirement of the new regulation this does not mean that the initiative is over.

We have to properly control exposures such as booth clean ups, filter changes in our dust collectors, etc.; and keep our employees up to date and educated as how to properly protect themselves from the hazards of thermal spray. In regard to booth cleaning, our booths are cleaned at least every two months with special dual-filter HEPA vacuum systems. No compressed air is allowed to be used to blow down any part of the booth or equipment. Trained and approved operators are required to wear fully enclosed disposable clothing with air-supplied hoods. Only certain operators are approved for booth cleaning. Dust collector cartridges are removed by trained employees utilizing the same protective gear as for booth cleaning. Filters are immediately enclosed in approved plastic bags and contained in special, triple-wall corrugated containers for shipment as hazardous waste.

For more information, contact author ***Art Ehrenberg***, Vice President Global Manufacturing Operations, Harper Corporation of America, P.O.Box 410369, 11625 Steel Creek Rd., Charlottes, N.C. 28241-0369, phone 800.438.3111, email arte@harperimage.com

Editor's Note: Read the additional article on this topic that is found on page 1.

Hexavalent Chromium Information

Visit www.osha.gov/SLTC/hexavalentchromium to view the safety/health topics and the final rule of February 2006.

OSHA has recently released an excellent publication, "*Small Entity Compliance Guide for the Hexavalent Chromium Standards*"; it is found at: www.osha.gov/Publications/OSHA_small_entity_comp.pdf

We would appreciate you sharing any information on this subject so that we can provide to the SPRAYTIME readers.

Send resource data to SPRAYTIME@thermalspray.org

Metallisation Protecting Playground Equipment

A Metallisation Arcspray system has been used to protect playground equipment from corrosion and to create an excellent base for the powder coated finish. SMP (Playgrounds) Ltd has selected Metallisation's Arcspray system and electric arc zinc coating process, to protect its wide range of outdoor playground equipment. SMP has been designing, manufacturing and building playgrounds throughout the world for 40 years.

Grit blasting.

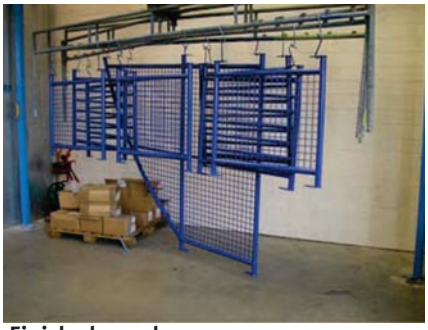
The safety of the finished surface is critical to SMP, as is the long-term protection against corrosion provided by the zinc metal spraying process. Since 1999, updated safety standards for play equipment design have been introduced in Europe. It is a priority for SMP to be compliant with these new standards.

Zinc spraying.

The European Standard for children's playground equipment EN1176 states that the equipment must be protected from corrosion and no toxic paints are to be used. SMP uses a multi-stage process to offer optimum protection and a safe, compliant coating in their playground equipment. To start with, the equipment is grit blasted to a cleanliness of SA2.5. The Metallisation Arc140/S250 system is then used to manually apply 100 microns (0.004 in.) of zinc. The 250-amp power source allows the operator to apply the coating in a controlled method to small profiles. A 10 m (33 ft) supplies package enables good access for the operator to spray larger structures.

The zinc coating itself is all that is required to protect the steelwork from corrosion, but to ensure added protection, a zinc rich primer is also applied to a thickness of 60-80 microns (0.0024 - 0.0003 in.). As there is no curing time for the metal sprayed coating, the play equipment can move immediately on to color powder coating so the process is very efficient. The complete process is also within the control of SMP so they are assured that their high standards of quality and safety are met on all of their equipment.

The appearance of the zinc coating and primer does not lend itself to children's playgrounds so the play equipment is finished with a 60-80 micron (0.0024 - 0.0003 in.) thick, high gloss powder coating. A common issue when powder coating over metal sprayed coatings is the appearance of bubbles in the surface. This is due to the porosity that is always present in arc and flame sprayed coatings expanding during the powder coat curing time in the oven and the bubbles rising to the surface. There are three main solutions to this issue. Firstly, you can use special powders with anti-gassing additives. These stop the surface of the powder coat hardening too quickly and hence allow the bubbles to escape before the powder coat cures. The second option is to degas the coating before powder coating, which basically involves preheating the items to be coated to expand the gases before powder coating. This is not a popular choice, as it requires additional ovens and/or time. The third option practiced by SMP is to ensure that the coating is as smooth as possible with minimal porosity. SMP has honed the Metallisation equipment and spraying process so well that they are able to spray very smooth coatings with 2 mm (0.079 in) wire and do not have problems with bubbles.



Finished panels.

A number of factors allow SMP to achieve the smooth coatings. The Metallisation equipment is designed solely for metal spraying and the power source produces a very even power supply. When combined with an accurately controlled Arc140 spray gun, the result is a very stable arc and hence a high quality coating. The quality equipment, combined with using the optimum parameters, excellent housekeeping and maintenance procedures, including a twice yearly Metserve preventative maintenance contract, ensure that the systems are always in optimum condition.

The complete coating process enables SMP to offer a 5-year corrosion guarantee on its range of coated equipment but it would actually expect a time span of around 15 years before corrosion is an issue.

In March 2006, SMP Playgrounds purchased its second Arc140/S250 system. Both systems will be used instead of flame spray systems and SMP reports noticeable cost savings over flame spray now that they are using the two Arc140 systems. This is because the electric arc systems do not use gas and oxygen and only need electricity and compressed air to run. Fewer consumable spares are also needed with these systems. Metallisation supplies the zinc spray material as 2 mm (0.079 in.) wire in two 250 kg (550 lb) drums, which allows them to spray for long periods of time without the need to change the wire supply.

SMP designs and manufactures a diverse range of playground equipment suitable for public parks, leisure areas, holiday centers, hotels, and schools. The equipment ranges include everything from swings, roundabouts and slides, through to specially-designed structures for very young children and stylish futuristic equipment for older kids. The equipment ranges are designed to encourage interactive play, stimulate imagination and physical activity, and allow accessibility for children of all abilities.

Robert Wilson, Production Director at SMP, says: "We understand the responsibilities and challenges facing playground providers and operators today. Our aim is to help them create a successful playground area that is fun, challenging, safe, durable and as vandal resistant as possible. The finished surface of our equipment is critical and the corrosion protection offered by the Metallisation process helps us to achieve the required results. The Metallisation equipment is very reliable and is also covered by a Metserve preventative maintenance contract. This ensures that our high quality coatings and production is maintained with the minimum of unplanned downtime, which is critical to customer service."

For more information on products in the Arc 140 range, contact Stuart Milton at Metallisation, email: sales@metallisation.com, tel: +44 (0)1384 252 464, web: www.metallisation.com.

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Ask The Experts

Powders *by Mitch Dorfman*

Question: Why should method of manufacture (i.e. HOSP, sintered, blend, fused and crushed, etc.) be taken into consideration when choosing a powder/parameter combination for a given application?

Answer: Understanding the manufacturing process of thermal spray powders is critical. Powders with similar chemistries and size may have different temperature and velocity profiles when feed into similar thermal spray guns for the same spray parameters. This could be due to the apparent density of the powder, particle morphology and surface area. The result of these differences is that parameters will need to be readjusted to optimize heat into the powder for the same velocity. In some cases however the applicator will never achieve similar microstructures and performance. For example, two tungsten carbide-cobalt materials with the same chemistry and size may have different carbide grain sizes. This will significantly affect coating microstructure and wear properties. In the case of ceramics for thermal barrier coatings, purity and phase stability is also critical. Small levels of impurities affect sintering resistance at high temperatures (1200-1400°C [2190-2550°F]) and overall coating microstructure consistency. Manufacturing process also effects application cost by influencing the deposition rates.

Question: Why are there so many powder products to choose from for one given material composition (i.e., size cuts, morphology differences, purity, etc.)? How do I choose the right one for my application?

Answer: The decision of what powder to use depends on many items: (1)application (2)cost, (3)performance requirements, (4)equipment availability or cost and (5) existing customer coating specification requirements. There is no one simple answer; however the customer needs to understand the application requirements and recognize that powder chemistry is not the only criteria for powder selection. In the case of carbides powders for wear applications, recognize that wear can take many forms: erosion, abrasion, adhesive wear, fretting, and corrosive wear. What is optimized for one coating application may not necessary be optimum for another. Carbide grain size and volume percent retained within a coating are critical for performance. The ability to achieve these microstructures is based on the powder and the parameter selection process.

Safety *by Daryl Crawmer*

Question: My company does on-site spraying for several customers using a hand-held HVOF system. We protect our operators by using earplugs and ear muffs, air-supplied respirators, eye protection, and protective clothing. We also rotate operators using a 1 hour on, 2 hour off schedule over a 10-hour work day. One of my customers now refuses to contract for any more work because his safety department says that we cannot comply with the current OSHA requirements for noise. We have measured noise levels of 120 dBA when spraying.

How can we comply with OSHA's requirements and resolve this customer's concerns?

Answer: The short answer is "You can't." Here is the long answer, the "why".

Conventional HVOF guns produce 125 dBA noise levels at the operator's ear position during hand spraying. Kerosene-fueled guns produce noise levels of 133 dBA at the operator's ear position. By way of definition, the point of measurement for operator's ear position is ½ m (1.66 ft) to the rear of the nozzle exit and ½ m (1.66 ft) upward toward the ear. Another point of reference is the TWA or time-weighted average for the noise measurement. You have measured 120 dBA, so let's take that at face value, assume it is TWA, and deal with that number.

Ear plugs and muffs are rated by the manufacturers with an NRR number or Noise Reduction Rating, which is based on laboratory data. OSHA, MSHA, and NIOSH (as well as foreign governing bodies) require that the NRR for ear plugs and ear muffs be derated to what they consider an effective NRR. They all disagree on the approach to derating. In that OSHA is the organization with authority to impose fines and restriction, we will use their approach. On many packages of plugs and muffs sold in the United States we are seeing "SLC80." New Zealand is using sound level conversion (SLC80) rating, defined as the difference between the C-weighted sound level of the environment in which the plugs or muffs are actually worn and the A-weighted sound level reaching the wearer's ear. "The SLC value includes a mean minus one standard deviation correction to ensure that the stated degree of noise reduction is obtained on 80% of occasions." It appears to be a better than the NRR rating, but would still have to have correction made to meet OSHA regulatons.

The "best" hearing protection on the market, typically has an NRR of 33 dB. OSHA requires that the following formula be used for de-rating. (NRR-7)/2. Applying this formula to the "best" NRR we have

(33-7)/2 = 13 dB effective noise reduction

The combined use of plugs and muffs does not provide an arithmetic reduction in noise, but a logarithmic reduction. The decibel scale is logarithmic where there is a doubling or halving noise every 3 dB. However, OSHA uses a more lax 5 dB for doubling and halving the noise level. So the formula for using muffs and plugs with NRR's of 29 dB and 33 dB respectively would look like this. (NRR-7)/2+5 or

(33-7)/2 = 13 dB for muffs

(29-7)/2 = 11 dB for plugs

13 dB + 5 dB = 18 dB combined effectiveness.

The 5 dB number is added to the adjusted number for the better of the two hearing protectors, in this case the plugs.

That takes us back to the question. The noise level you have measured is 120 dBA, assumed to be TWA.

120 dBA TWA - 18 dBA = 112 dBA.

According to the exposure tables in 1910.95 Appendix A, the operator can be exposed for 0.38 hours or 22.8 minutes per day. That being the case you would have to have a large team of operators to fill a 10-hr-day.

Refer to OSHA 1910.95 with its many appendixes.

NEW FEATURE SPRAYTIME® *Ask the Experts*

SPRAYTIME now has a panel of "experts" (see below) to answer your thermal spray questions.

Daryl Crawmer, Thermal Spray Technology, Inc. - **Safety - Plasma Spraying - Applications**

Mitch Dorfman, Sulzer Metco (US) Inc. **Powders**

Frank Hermanek, Retired - **Turbine Applications and Materials**

Paul Kammer, Kammer Associates **Combustion Spraying and Atomized Powders**

Sanjay Sampath, State University of New York - **Coatings' Properties and Characterization**

Mark Smith, Sandia National Laboratories **Cold Spray**

Richard Thorpe, Praxair TAFA - **Equipment and HVOF Spraying**

Bob Unger, Polymet Corporation **Electric Arc Spraying**

These individuals are ready to answer your questions in an educational manner to share with the entire SPRAYTIME readership. Questions are not limited to the subject areas listed above. If your question is outside the expertise of these panel members, we will find the right person to answer your question. ***Guidelines are as follows:***

- Questions should be 25 words or less and submitted only by e-mail to SPRAYTIME@thermalspray.org
- Upon reveiw and acceptance, questions will be distributed to appropriate panel member(s)
- Due to the publication time schedule, should not be a question for which the individual needs an immediate answer.
- The question must be accompanied by the name and affiliation of the submitter; however, the name will not be published.
- SPRAYTIME reserves the right to edit any question (and the answers) and due to space and time limitations only questions selected for publication will be answered.

For more information, contact Kathy Dusa at SPRAYTIME via email spraytime@thermalspray.org

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CALENDAR OF EVENTS

31 OCT - 2 NOV Atlanta, GA USA *FABTECH Int'l & AWS Welding Show* - organized by American Welding Society, web: www.aws.org,Fabricators & Mfgrs Assoc, web: www.fmafabtech.com, Society of Manufacturing Engineers, web: sme.org/fabtech

NOVEMBER 2006

5-10 Chicago, IL USA *ASME Int'l Mechanical Engineering Congress & Expo* - contact American Society of Mechanical Engineers, tel 973-882-1170, email: infocentral@asme.org, web: www.asme.org

9-10 Erding Germany *7th Colloquium High Velocity Oxy-Fuel Flame Spraying* - contact Linde AG, Mr. Peter Heinrich, tel: 49(0)89.3.1001.564, email: hvof@gts-ev.de, web: hvof.gts-ev.de

12-16 Austin, TX USA *32nd Int'l Symposium for Testing & Failure Analysis (ISTFA2006)* - ASM Intl, tel: 800.336.5152 or 440.338.5151, web: www.asminternational.org/events, fax: 440.338.4634; email: cust-srv@asminternational.org

12-17 San Francisco, CA USA *53rd AVS Science & Technology of Materials, Interfaces, and Processing Int'l Symposim & Exposition* - contact AVS, tel: 212.248.0200, email: avs-nyc@avs.org, web: www.avs.org

14-16 Anaheim, CA USA *Aerospace Testing Expo 2006* - contact Christine Ellis, Facet Co., tel: 734.453.3500, email: facet@facetcompany.com, web: www.aerospacetesting.com

27 NOV-1 DEC Boston, MA USA *MRS 2006 Fall Meeting* - contact MRS tel: 724.779.3003, email: info@mrs.org, web: www.mrs.org/fall2006

28-30 Orlando, FL USA *Power-Gen Int'l* - visit www.power-gen.com

DECEMBER 2007

1-3 Fatehgagh Sahib, India *Advances in Mechanical Engineering (AME-2006)* - contact Dr. Harpreet Singh, tel: 91.1763.232113, email: ame2006conf@yahoo.co.in, web: www.ame.mech.bbsbec.org

JANUARY 2007

14-18 Sharm El Shiekh, Egypt *Int'l round Table on Thermal Plasma Fundamentals and Applications* - contact Prof. Maher Boulos, tel: 819.821.7168, email: maher.boulos@usherbrooke.ca

FEBRUARY 2007

11-14 Dallas, TX USA *Paint & Coatings Expo (PACE 2007)* visit www.pace2007.com

MARCH 2007

11-15 Nashville, TN USA *NACE Int'l. Corrosion 2007* - contact Cindy Euton, tel: 281.228.6274, fax: 281.228.63.74, email: cindy.euton@nace.org, web: www.nace.org/c2007

26-28 Cambridge United Kingdom *Fatigue 2007: Fatigue & Durability Assessment of Materials, Components & Structures* - contact Engrg Integrity Soc UK tel: +44(0)114.262.1155, email: fatigue@e-i-s.org.uk, web: www.e-i-s.org.uk

APRIL 2007

Phoenix, AZ USA *International Thermal Spray Association Membership Meeting and Technical Program* - contact Kathy Dusa tel: 440.357.5400, emai: kathydusa@thermalspray.org

2-4 Shanghai, China *2nd Pan-Asian Conf on Advancing PM Tech (PMAsia2007)* email: pmasia2007@inovar-events.com, web: www.pmasia2007.com

16-20 Detroit, MI USA *SAE World Congress* - Contact tel: 877.606.7323 or 724.776.4970, fax: 724.776.0790, email: customerservice@sae.org, web: www.sae.org

MAY 2007

7-10 Indianapolis, IN USA *AISTech 2007*, Iron & Steel Technology - Association for Iron & Steel Technology tel: 724.776.6040, fax: 724.776.1880, web: www.aistech.org

14-17 Beijing, China *Intl Thermal Spray Conference & Expo ITSC 2007* - contact ASM Int'l, tel: 800.336.5152 (ext. 6) or 440/338-5151, web: www.asminternational.org, email: customerservice@asminternational.org

14-17 Montreal, Canada *ASME Turbo Expo 2007* presented by the Int'l Gas Turbine Institute - visit www.turboexpo.org

JUNE 2007

4-7 San Diego, CA USA *MegaRust 2007 Marine Coatings & Corrosion Conference* - contact Karen Chitwood, kchitwood@nstcenter.com, web: www.nstcenter.com

CALENDAR OF EVENTS

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5-7 Baltimore, MD USA *SAMPE 2007* - contact Doris Weaver, tel: 626.331.0616, email: doris@sampe.org, web: www.sampe.org

25-28 Baltimore, MD USA *18th Advanced Aerospace Materials & Processes Conf & Expo (AeroMat2007)* - contact ASM Int'l, tel: 440/338-5151, web: www.asminternational.org, email: customerservice@asminternational.org

AUGUST 2007

6-9 Fort Lauderdale, FL USA *40th Intl Metallographic Society IMS Convention* - contact ASM International, tel: 800.336.5152 or 440.338.5151 x5900, fax: 440.338.4634; em: cust-srv@asminternational.org, web: www.asminternational.org

SEPTEMBER 2007

17-19 Detroit, MI USA *Materials Science & Tech. Conf & Expo (MS&T'07)* - organized by ASM, ACerS, AIST, AWS, and TMS, and held in conjunction with ASM Heat Treating Society Conf./Expo, contact ASM Int'l, tel: 440.338.5151 x5900, em: cust-srv@asminternational.org, web: www.asminternational.org

17-20 Detroit, MI USA *24th ASM Heat Treating Society Conf & Expo* - held in conjunction with MS&T'07 - contact ASM Int'l, tel: 800.336.5152 or 440/338-5151 ext. 6, fax: 440.338.4634, web: www.asminternational.org, email: customerservice@asminternational.org

NOVEMBER 2007

4-8 San Jose, CA USA *33rd Int'l Symposium for Testing & Failure Analysis (ISTFA2007)* contact ASM Int'l, tel: 440/338-5151 ext. 6, web: www.asminternational.org, em: customerservice@asminternational.org

11-14 Chicago, IL USA *FABTECH Int'l & AWS Welding Show* - ***with a Thermal Spray Pavilion*** - organized by American Welding Society, web: www.aws.org,Fabricators & Mfgrs Assoc, web: www.fmafabtech.com, Society of Manufacturing Engineers, web: sme.org/fabtech

SPRAYTIME® Continues Industry News

The International Thermal Spray Association is pleased to announce that it will continue to provide *SPRAYTIME* free-of-charge to the thermal spray community. If you have been receiving *SPRAYTIME*, you will continue receiving *SPRAYTIME*. If you or your colleagues wish to sign up for a free subscription, visit www.spraytime.org. *SPRAYTIME* will continue to grow by reaching across other industries (AWS, SAE, NACE, ASME, etc.) for pertinent information-sharing and additional readership.

As a result of this collaboration with other professional industries, open enrollment and expanded readership, we expect our circulation to increase significantly to 10,000 in this decade.

ITSA is proud of what we started with *SPRAYTIME* in 1992 and what we have planned for future expansion of news and circulation.

Is Your Event Listed? Send your event notice to spraytime@thermalspray.org

Thermal Spray In China

(reprinted with permission from The Thermal Spraying Committee of the China Surface Engineering Association)

Current Thermal Spraying Industry in China

In China, thermal spraying technology has been broadly applied to many industries, with a total output of approximately RMB 3 billion (USD 375 million) per year.

As the China Surface Engineering Association knows, the total national thermal spraying employees accounts for about 5000 people (construction coating teams and casual labor are not calculated) working in 400 organizations, including equipment, materials and other suppliers; job shop coatings ; as well as R&D teams, institutes, and trading companies.

The thermal spraying organizations are mainly medium and small sized, with an average output of RMB 600,000 (USD 75,000) per person each year, ranking in the upper standard in Chinese machinery industry.

Thermal spraying has been widely used in the steel, aircraft, aerospace, automobile, textile, power, printing, oil and chemical, anti-corrosion, etc., industries.

However, China's thermal spraying market is far from maturity and saturation. Therefore, this market offers many opportunities in the coming 10 years due to the high growth rate of the GDP for China and continual adjustment and upgrade of end products' construction.

Structure of China Thermal Spray Industry (2005)

Equipment	4.54%	Coating Service	72.26%
Materials	23.2%		

Total: 3 billion RMB (USD 375 million)

The estimated breakdown by techniques according to the sales of equipment, materials and coating is:

Detonation	2%	Plasma	10%
PTA	2%	Electric arc	20%
HVOF	6%	Spray and fuse	30%
Flame spray	30%		

Coating materials market by materials categories are:

Ceramic	2.2%	Anticorrosion (Zn, Al wire)	11%
Mo	5%	Others	18%
Carbides	11.7%	Ni-base	41%
Co-base	11%		

The estimated breakdown of organizations according to numbers of staff (600,000 RMB/person, 5000 people total) is:

Trading companies	2%	Equipment makers	10%
R&D institute	3%	Materials production	12%
Universities	3%	Coating job shops	70%

Breakdownof 2.1 billion RMB (USD 262.5 million) coating activities and service across end use sectors is:

Oil and gas	4%	Corrosion protection	11.2%
Printing and paper	5%	Other process industries	16.8%
Glass	5%	Aircraft	13%
Power	5%	Auto and engines	10%
Textile	10%	Steel	20%

The size of organizations by staff member (total: around 400 units) is:

>100	1%	20-50	5%		
50-100	2%	<10	22%	10-20	70%

The Current Applications and Development

Within the last five years, for coating applications the types, levels, quantity of spray coatings all have increased.

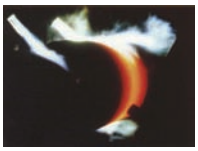
Coating applications have increased in maintenance, and new applications have risen sharply. Examples are hearth rolls, pot rolls in CAL, CGL, etc., mill and conveyor rolls for continuous casting, large diameter plungers for chain of locks at hydroelectric power station high dam, automobile engine piston ring, synchronization rings, diesel engine piston rings, injection molding screws, power station boiler tubes, corrosion protection of large steel structures (magnetic suspension train frame) and long-span bridges. Ingot molds for continuous casting production lines and anilox rolls/central impression drums for printing machines are being developed and being readied for mass production.

The following applications are described with: 1 = technology; 2 = spraying material; 3 = life; 4 =anticipating market.

Nozzles for the blasting furnace:
1. spray and fuse, HVOF, APS
2. alloy, ceramic
3. improved 1 time
4. >50 million RMB (USD 6.3 mllion)

Fan blades:
1. electric arc, HVOF
2. anti-abrasive alloy
3. improved 1 time
4. above 20 million RMB (USD 2.5 million)

Mould narrow plate:
1. HVOF
2. alloy
3. improved 1 time
4. >100 million RMB (USD 12.5 million)



Conveyor roll:
1. spray and fuse
2. Ni-base alloy
3. improved 1 time
4. >100 million RMB (USD 12.5 million)

Sink roll and stabilizing roll:
1. HVOF
2. Cermet
3. improved 1 time
4. >400 million RMB (USD 50 million)

Thermal Spraying R&D in China

The main R&D efforts still come from institutes and universities. Over a hundred papers are issued in overseas and domestic academic magazines a year. R&D on equipment concentrates on the research and manufacture of vacuum plasma, HVOF, high velocity arc spray, the development of a dentonation spray system, plasma spray, flame plastic spray, and cold spray. R&D on processes mainly emphasize compound processes, such as spraying plus laser/induction/vacuum deposition, and self-combustion processes. Regarding materials, research is mainly made on the ceramic powders, such as pure Cr_2O_3, MCrAlY, WC-Co, and nano powders. For the coating design, performance, inspection, evaluation, and quality control, the research emphasizes TBC coatings, high temperature and oxidation resistant cermet coatings, and generic engineering coatings -- composition, stress distribution, micro-structure and interface reactions.

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The ***International Thermal Spray Association*** is closely interwoven with the history of thermal spray development in this hemisphere. Founded in 1948, and once known as Metallizing Service Contractors, the association has been closely tied to most major advances in thermal spray technology, equipment and materials, industry events, education, standards and market development.

Chairman Simonds

A company-member trade association, ITSA invites all interested companies to talk with our officers, committee chairs, and company representatives to better understand member benefits. A complete list of ITSA member companies and their representatives are at www.thermalspray.org

ITSA Mission Statement

The International Thermal Spray Association is a professional trade organization dedicated to expanding the use of thermal spray technologies for the benefit of industry and society.

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ITSA Scholarship Opportunities

The International Thermal Spray Association offers annual Graduate and Undergraduate Scholarships. Since 1992, the ITSA scholarship program has contributed to the growth of the thermal spray community, especially in the development of new technologists and engineers. ITSA is very proud of this education partnership and encourages all eligible participants to apply. Please visit www.thermalspray.org for criteria information and a printable application form.

ITSA Materials Camp Student Sponsor

Commencing in 2001, the International Thermal Spray Association provides an annual $1,500 student scholarship to the ASM International Foundation Materials Camp.

ITSA Thermal Spray Historical Collection

In April 2000, the International Thermal Spray Association announced the establishment of a Thermal Spray Historical Collection which is now on display at their headquarters office in Fairport Harbor, Ohio USA.

Growing in size and value, there are now over 30 different spray guns and miscellaneous equipment, a variety of spray gun manuals, hundreds of photographs, and several thermal spray publications and reference books.

Future plans include a virtual tour of the collection on the ITSA website for the entire global community to visit.

This is a worldwide industry collection and we welcome donations from the entire thermal spray community.

ITSA *SPRAYTIME* Newsletter

Since 1992, the International Thermal Spray Association has been publishing the ***SPRAYTIME*** newsletter for the thermal spray industry. The mission is to be the flagship thermal spray industry newsletter providing company, event, people, product, research, and membership news of interest to industrial leaders, engineers, researchers, scholars, policy-makers, and the public thermal spray community.

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NEW

SPRAYTIME®--*Letters To The Editor*

WRITE US!

SPRAYTIME solicits letters to the Editor for publication in our new column. Letters are solicited that comment on a recent SPRAYTIME article, on a topic of general interest to the thermal spray industry, on a recent event in the industry, or on a recently published letter to the editor.

Send your letter to SPRAYTIME by e-mail to spraytime@thermalspray.org or via fax to 440.357.5430; electronic submissions as a Word document are preferred. Letters must be signed and must give the author's name, affiliation, and phone or e-mail address. The author's name will be published. Letters of fewer than 300 words will be given preference. Longer letters may be abridged by the editor. Please give the headline and issue number if referring to a specific article previously published.

The editor reserves the right to select letters for publication, and due to space and time limitations not all letters will be published nor acknowledged. If you have any questions please contact SPRAYTIME via email spraytime@thermalspray.org, or via phone 440.357.5400.

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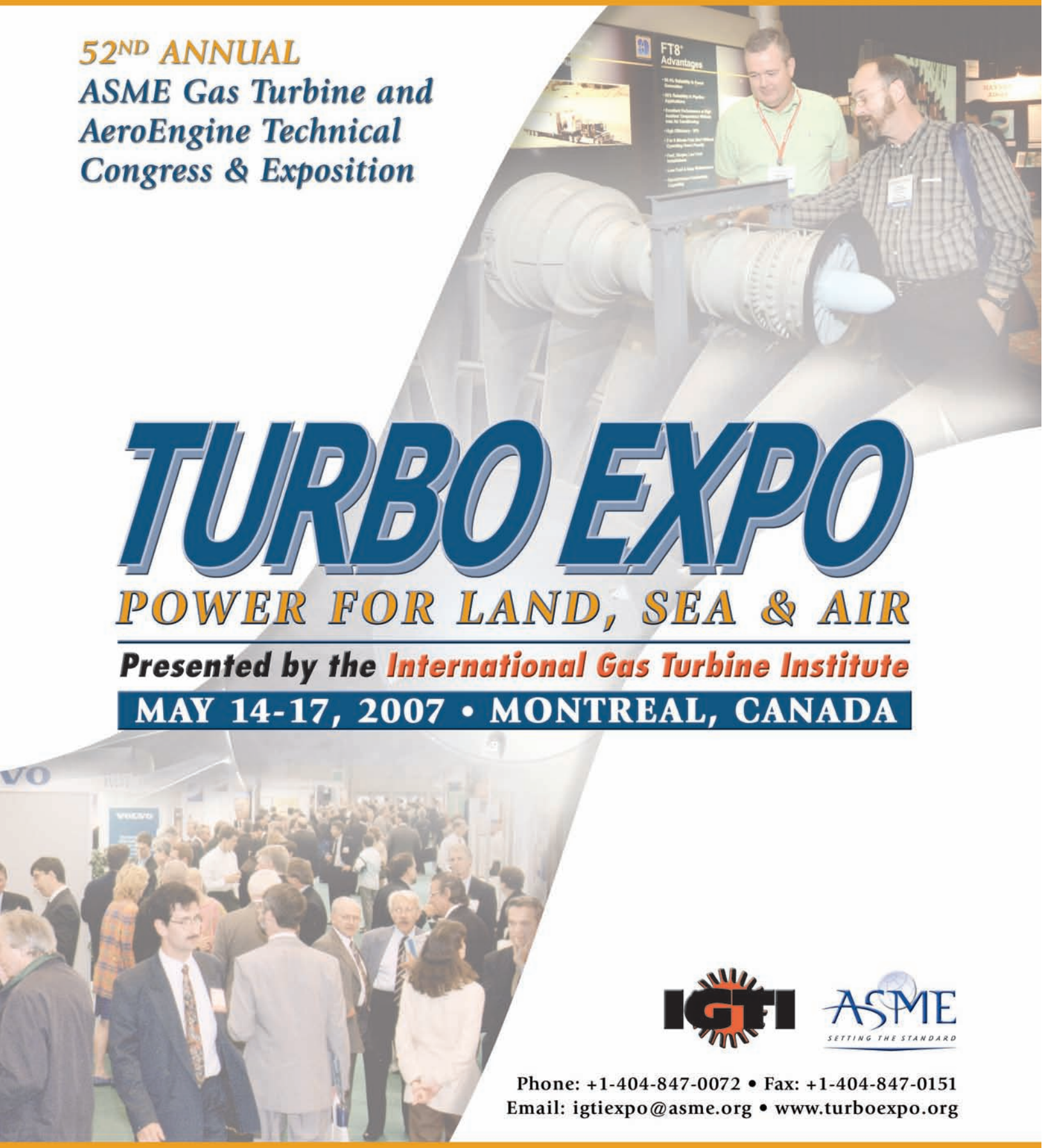

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continued from page 17

Future of Thermal Spray in China

Following along with the rapid economic development in China, the thermal spray industry has a good future:

Industry	Output /Year	Growth Rate	TS Market in Million RMB*	Typical Parts	Note
Iron and Steel	0.3 billion ton	--	500	Sink roll, hearth roll, table roll, mold for continuous casting lines, furnace nozzle, fan blade, etc.	No. 1 in the world
Power	1654 billion kwh	>15%	300	Boiler tubes, hydraulic cylinders, blades, fans, shafts, etc.	No. 2 in the world
Paper and Printing	--	12%	100	Calendar rolls, dry rolls, robbin winder rolls, anilox rolls, corrugating rolls, etc.	No. 3 in the world
Textile	--	15%	100	Godet rolls, grooved rolls, thread guides, etc.	No. 1 in the world
Automobile	5 million sets	38.8%	100	Pistons, piston rings, brake disks, synchronizing rings, multi-void tubes, etc.	No. 4 in the world
Anti-corrosion	highways - 20,000km; coal - 1.38 billion tons	(coal) 18.9%	300	Bridges, tanks, highways, tubes, towers, etc.	highways: No. 2 in the world
Oil, Gas, and Chemical	--	--	400	Metal-to-metal seals for galling, gate valves, etc.	No. 2 consumer in the world

*100 million RMB = 12.5 million USD

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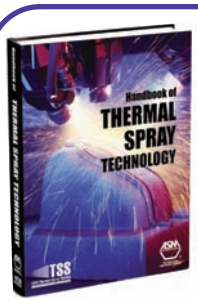
For more information, contact, Mr. Huang Xiaoou, email xiaoou@chinathermalspray.org

ITSC 2007 - Global Coating Solutions

This 2007 event will be held May 14-16, 2007 at the Beijing International Convention Center in **Beijing, China**.

For more information, visit www.asminternational.org/itsc07



Handbook of Thermal Spray Technology Highlight

"***When to Start Spraying***: It is always good practice to begin thermal spraying of a component as soon as possible after completion of surface preparation. Freshly exposed clean metal is metallurgically active and readily susceptible to contamination. Fingerprints or contact with foreign materials may severely affect coating adhesion. If a freshly prepared surface must be stored before spraying, it should be . . "

From "Coating Processing" in the *Handbook of Thermal Spray Technology*

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Journal of Thermal Spray Technology®

A publication of the **ASM Thermal Spray Society**

(An abstract from September 2006 VOL. 15: NO. 3)

Process-Based Quality for Thermal Spray Via Feedback Control

R.C. Dykhuizen and R.A. Neiser

Quality control of a thermal spray system manufacturing process is difficult due to the many input variables that need to be controlled. Great care must be taken to ensure that the process remains constant to obtain a consistent quality of the parts. Control is greatly complicated by the fact that measurement of particle velocities and temperatures is a noisy stochastic process. This article illustrates the application of quality control concepts to a wire flame spray process. A central feature of the real-time control system is an automatic feedback control scheme that provides fine adjustments to ensure that uncontrolled variations are accommodated. It is shown how the control vectors can be constructed from simple process maps to independently control particle velocity and temperature. This control scheme is shown to perform well in a real production environment. We also demonstrate that slight variations in the feed wire curvature can greatly influence the process. Finally, the geometry of the spray system and sensor must remain constant for the best reproducibility. .

Read the entire article in the September 2006 *Journal of Thermal Spray Technology*. For more information visit www.asminternational.org/tss or contact ASM Customer Service Center, ext. 5900 tel: 800.336.5152 (toll free in United States) or 440.338.5151; fax 440.338.4634; email: customerservice@asminternational.org

Editor: Christian Moreau

Associate Editors: Jan Ilavsky, Seiji Kuroda, Lech Pawlowski, and Armelle Vardelle

Economical Mobile Filtration Unit Cleans Up Fumes

A new mobile "Farr Cart™" fume and dust collector from Farr Air Pollution Control provides economical yet powerful filtration in welding workshops and industrial settings. The unit will extract moderate concentrations of smoke and light dust generated by intermittent processes such as welding and grinding, delivering 99+ percent efficiency on welding fume.

With its sturdy injection-molded plastic construction, large rubber wheels, and slim design, the Farr Cart offers high mobility and ease of use at a low cost, even where space constraints are tight – ensuring a safe environment for the operator and nearby workers. Additional environmental benefits include low noise level and low power consumption. The unit comes ready to use with no installation required, and the long-life pleated filter can be easily changed in minutes.

The Farr Cart comes with a 10-ft (3 m) flexible fume extraction arm and built-in halogen spotlight in the hood. Accessories include a HEPA safety filter and spark protection device.

For further information, contact Farr Air Pollution Control at 800.479.6801; fax 800.222.6891, web www.farrapc.com, e-mail filterman@farrapc.com **(See advertisment page 2.)**

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INDUSTRY NEWS

ASB Industries Receives Newest Cold Spray Equipment

ASB Industries, Inc. has received the newest cold spray equipment available. The equipment has been developed and build by Cold Gas Technology GmbH of Ampfling Germany.

The Kinetiks 4000/34 was installed in September 2006 at ASB Industries, the North American distributor.

The Kinetiks 4000/34 is capable of running nitrogen at 800°C (1470°F) and 600 psi and running helium at 600°C (1470°F) and 600 psi. This will allow the use of nitrogen for most material to be sprayed.

For a demonstration of the Kinetiks 4000/34 and the 3000, contact Al Kay at ASB Industries, tel: 330.753.8458, email: alkay2@ix.netcom.com

New Headquarters for NanoSteel Company

The NanoSteel Company has relocated its corporate headquarters to Providence, Rhode Island effective August 1, 2006.

For more information, contact The NanoSteel Company, Corporate Headquarters, 67 Cedar Street, Suite 101, Providence, RI 02903, tel: 401.270.3549, fax: 401.270.9306, email: info@nanosteelco.com, web: www.nanosteelco.com

New Offices for Nooter Construction

Nooter construction is pleased to announce the relocation of their Mid-Atlantic Regional office to 6 Neshaminy Interplex, Suite 300, Trevose, PA 19053.

For more information, contact Mike Murphy, phone 215.638.7474, email mjmurphy@nooter.com, web www.nooterconstruction.com

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ASM TSS Email Discussion Group

Over 600 subscribers from 40 countries use this lively discussion forum. Sharing information and networking with colleagues is a key goal of the ASM Thermal Spray Society. All thermal spray related communication is welcome. The forum has seen ideas on applications for thermal spray, coating properties, equipment for sale, positions wanted and job openings, calls for papers, and other news of interest to the thermal spray community. ***Join the group now!*** Visit www.asminternational.org/tss and choose "*Technical Resources*" for subscribing information.

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