Commentary

An Environmental Guideline for the Thermal Spray Industry

ASM International® and the Thermal Spray Industry Collaborating to Solve Problems

Air pollution and hazardous materials are increasingly becoming a consideration of business and the thermal spray industry is no exception. Laws such as the Clean Air Act (CAA) and the Resources Conservation and Recovery Act (RCRA) have recently been clarified and given enforcement "teeth" by Congress. National Ambient Air Quality Standards (NAAQS) and Hazardous Waste Disposal regulations are being implemented and enforced. Their implementation is changing the way in which manufacturing businesses are being operated and are permitted to operate. How should the thermal spray industry respond? Being a responsible "citizen" and protecting the health and safety of the environment should be second nature to us, but what are the issues and how should one control emissions and meet the law? ASM International® will issue in early 1994 an "Environmental Guideline" for the thermal spray industry, as the culmination of its past 30 months of work in collaboration with industry sponsors. It is hoped that its issuance will be useful in guiding you through the regulatory processes which are now becoming key parts of your business. The guideline also demonstrates how ASM can collaborate with its industry members to face tough, industry wide issues. This editorial previews the reasoning behind and the major results of the guideline.

It has been found that the typical questions which are asked and continue to permeate the industry are:

- What are hazardous materials? Which apply to thermal spraying?
- What are air pollutants? Which apply to thermal spraying?
- What are the limits for air emissions? What are typical thermal spray values?
- What must a thermal spray shop do to comply with air emission regulations?
- How does a thermal shop comply with air emission regulations?
- How do I measure and calculate my plant air emissions?
- Does thermal spray pose a serious health or pollutant risk?
- What is hexavalent [Cr(VI) or Cr^{6+}]? How is hexavalent Cr generated in thermal spray?
- How are emissions controlled? What is accepted by regulators?
- What is considered hazardous waste in thermal spray shops?
- How do shops generate hazardous waste materials?
- What are thermal spray shop responsibilities for hazardous wastes?
- What are the procedures for handling hazardous wastes?
- How can hazardous wastes be controlled?

After a preliminary review was completed, it was clear that the largest challenge facing the thermal spray industry is EDUCATION—education in the relevant laws and regulations as well in the processes and their potential to generate emissions and/or waste materials which fall under control by State and U.S. regulatory oversight. It was determined by the Industry Sponsor Group that the project should result in a guideline. The project has been conducted over the past two (2) years and has been a painstaking review of literature, regulations, reviews with agencies, and a collection task from "corporate" files of the sponsors or other responsible thermal spray industry members.

This guideline, the result of their endeavors, is a comprehensive compilation of information which will be useful in tackling many of the laws and regulations with respect to air emissions and hazardous solid wastes emanating from thermal spraying operations. The guideline will be a general information and education source, compiling processing characteristics, pertinent laws and regulation, reviewing the industry as a whole, and making conclusions and recommendations regarding future relationships with the US EPA and other regulatory agencies responsible for air and hazardous waste emissions.

A synopsis of the guideline shows that, despite some perceptions, the thermal spray industry does not have a hazardous air or solid emissions problem. What it does have, however, is an education and understanding problem regarding what the industry produces as emissions, what are the relevant regulations and responsibilities, and what are the relevant control technologies and procedures. It can be stated that the perceived problem comes from implementation of regulations guided by federal laws, mostly stemming from the Clean Air Act (CAA) (revised from 1970 to 1990) and the Resource Conservation and Recovery Act (RCRA) of 1976 and

amended in 1984. California, Texas, New York, Connecticut, and Pennsylvania, as well as many other states now draw many of their regulations from these laws, which hold the states ultimately responsible for regulation. Many states set specific limits on pollutants and hazardous materials defined by federal guidelines.

The laws and state agencies are regulating the emissions from spray booths, the installation or modification of equipment in the handling of many coating and cleaning materials, and in the disposal of waste materials. The new guideline educates and reports significant information and concludes that the thermal industry, as a whole or even individual shops/facilities, are not significant pollution sources, however, they have the responsibility to meet all laws and regulations. For example, the thermal spray industry handles and potentially emits pollutants and hazardous materials. Pollutants include particulate materials less than 10μm (PM_{10}), ozone, NO_x, CO, hydrocarbons; while hazardous materials include such materials as chromium, nickel, copper, cobalt, aluminum, and zinc. It was found, generally, that the thermal spray industry uses and emits pollutants and hazardous materials, when using filtration, at such low levels that except in high pollution areas, such as the Los Angeles Basin (an EPA Non-attainment Area) that permitting of facilities should be no problem. Generally, the problems encountered to date have come from the user and/or the regulatory agency not having sufficient knowledge, understanding or information.

Air pollution/emissions from thermal spray processes which utilize inert, combustible, and oxidizing gases and heat metals, ceramics, and polymers (initially powder or rod/wire form) are either in a particulate or gaseous forms. These processes produce exhaust gas jets of combusted and/or heated gases, generally ranging from 50 to 1500 slm [100 to 3,000 scfh] in which solid or molten particulate travel and in which some fumes and/or vapors (particle sizes are typically less than 1μm) are generated. These process pollutant exhausts and the hazardous materials, particularly containing chromium and/or nickel compounds, are what concern any environmental regulation and are what bring this industry under agency scrutiny. The guideline reports the typical types of air and solid waste emissions from thermal spray coating processes and demonstrates that when controlled, emissions are well within all regulations.

The guideline reports that the most potent hazardous material which the thermal spray industry generally uses is chromium, which, when in its hexavalent (Cr^{6+}) state, becomes a potent carcinogen. However, when in its neutral state (metallic) or other ionic states, (except the trivalent (Cr^{3+})), the effect of chromium is benign. Thermal spray uses many chromium-containing alloys or compounds (NiCr, stainless steels, chromium carbides, and chromium oxides) which are heated, sometimes to their vapor states, where it is believed that some small fraction of the chromium oxides in the presence of moisture or the atmospheric contaminants form some chromates. It is in this form that some concentrations of the trivalent and the hexavalent states occur.

The major reason for such EPA scrutiny is the use in the industry of materials considered as hazardous, in particular, chromium appears to be singled out. Chromium compounds, with the possible conversion to Cr^{3+} or Cr^{6+}, are severely restricted to the lowest concentration levels of any common material outside the plant, these levels (GCL's) range from .00002 to 1μgm/m^3, depending on the acceptable risk assigned. Concentrations are at ground level at the perimeter of plant where the general public is exposed and are determined by the quantity of the emissions, the concentrations emitted at the stack and the dispersion conditions relate to prevailing atmospheric conditions, models for calculating the areas prevailing dispersion conditions are available through local environmental agencies.

Many corrosion-resistant and high-temperature wear coatings contain chromium or chromium compounds, hence its use by the thermal spray industry. Based on measurements taken in the industry in the past few years, Cr^{6+} emissions levels, without controls, can typically be about 1 lb/ per day for a large shop (one with more than $10 million / year in spraying revenues). However, with controls such as dry cartridge filtration systems with HEPA filters, whose reported efficiencies exceed 99.99%, these emissions can be kept well below 0.00001 lbs/day. Typical atmospheric dispersion will then reduce this to below acceptable levels. PM_{10} (particulate below 10μm size), nickel, copper, cobalt, aluminum, and zinc are also to be controlled but have GLC limits 10 to 10,000 times that of Cr^{6+}, which means that, given the efficiencies of today's air emission controls, 10 to 10,000 lbs of these materials could be sprayed without exceeding the emissions levels. Gaseous emissions are not controlled by filtration, but with concentration limits of NO_x (GCL<100μgm/m3), ozone (GCL<235μgm/m3), related to plasma and wire arc spray operations, and CO(GLC<30,000μg/m) or hydrocarbons (volatile organic compounds known as V.O.C.'s) related to combustion spraying are expected to be below these limits in normal operation with ventilation. Despite the assumption, however, industry measurements of these gaseous emissions still need to be documented.

A review of the available air emissions control technologies indicates that dry filtration, incorporating cartridge type systems, in combination with high-efficiency particle absorption (HEPA) filters meet the Maximum Achievable Control Technology (MACT) standard. It has been concluded, based on the limited and documented data that do exist, that with the incorporation of such filtration, air emissions in the thermal spray industry can be controlled to meet all air district air quality standards, including the strictest found in the South Coast Air Quality District of California (which includes the Los Angeles basin). Best Available Control Technology (BACT) may, however, be allowed with smaller sources or in certain attainment areas, permitting the use of less expensive air filtration equipment such as bag houses, wet scrubber filters, or other technology. Each thermal spray shop must work with its local environmental control agency. The major problem in the industry which still persists is the permitting and the reporting procedures in the various "air districts" around the country. Each new permit raises questions, both by the shops and the regulatory agencies, regarding what is required, what has been measured, what are the emissions, and what are acceptable controls.

Solid hazardous waste is also generated by the industry. The levels which are generated depend on the size of the shop, its practices, and the types of coatings it produces. As in air emissions, chromium, nickel, copper, cobalt, aluminum, and zinc as well as certain organic compounds, typically used in maskants and cleaning, are the most potent of the hazardous materials which thermal spray shops generate from their coating processes. The Resources Conservation and Recovery Act (RCRA) of 1976 (amended in 1984), which ties together regulations originating back to the Solid Waste Disposal Act of 1964 and many subsequent Clean Water Acts, is the major act regulating the handling of hazardous wastes which are typically generated by the thermal spray industry. The major impact of this law is the assignment of "cradle to grave" responsibility of the wastes generated by sources. A thermal spray shop typically has overspray, air/vacuum filters, spilled powders, powder containers, sludge from wet filters, filtered powders, maskants, masks, and spent cleaning agents. If these items contain any of the elements or compounds listed by the EPA, the source company must document the quantity of waste, register it with the EPA/local environmental regulatory agency, and dispose of it in an approved manner. Generally, disposal consist of containment marked 55-gallon drums, documented lists of its contents, manifests which describe the contents, and disposal by approved, specialized hazardous materials haulers.

If a thermal spray shop exceeds the threshold limits of any waste (<1,000 kgs/month, typically greater than five 55-gallon drums/month) they are a "large quantity generator" and must register with the EPA or state agency. Large quantity generators must have reduction programs in place for EPA to approve their applications. Small quantity generators (<1, 000 kgs/month), on the other hand, don't have to register, but they do have to document and dispose of all hazardous waste according to the procedures. Disposal is not the end of the thermal spray shop's responsibility. The shop will forever be responsible for the waste and any future liabilities which it may incur. For example, if a hazardous waste dump is found to be leaching its contents to the environment and your waste is registered in that dump, then your company will be liable for its share of the damages, if any, and will share in the costs of any remedial actions. This long-term liability for waste drives many companies to reduce wastes through more efficient processes, better methods, recycling, on-site volume reduction, and material/coating substitutions. Most thermal spray shops, with good waste management practices, will be small quantity generators, thus the industry is not a high priority for many regulatory agencies, but that does not absolve any shop from meeting the laws. The message is: know the law, know your waste stream, document all your hazardous materials, register properly, and minimize the generation of waste.

The thermal spray industry is required by law to report and seek permits and to meet all regulation pertaining to the materials it uses. Ignorance is no excuse and each shop must meet the local and federal regulations. It is recommended that each shop take a proactive and open approach to its emissions and hazardous materials. Know the law, know your local agencies responsible for air quality and hazardous materials, and work with them to conform. Meeting the regulations will be a cost of conducting business—this includes control equipment and its maintenance, paperwork, liability insurances, and waste disposal. However, many costs can be minimized through planning; besides the costs of noncompliance there can be high fines, lawsuits and restrictions on new spray facilities! Education of the users and the regulatory agencies is the start of the process of compliance. This encompasses education about the regulations and regulatory procedures about the types and levels of emissions and hazardous materials generated by the thermal spray industry, and about the available control technologies and remedial procedures. Several strong points and recommendations stem from this review and are supported in the guideline.

Important Points and Recommendations

- The thermal spray industry is not a major source of pollutants or hazardous materials, but since it uses and generates materials, classified as "pollutants or hazardous materials" it must take all steps necessary to meet the pertinent Clean Air Act and Conservation and Recovery Act regulations. Self-policing is the most effective way to prevent industry problems and should be promoted.
- Education about the regulations, procedures, of thermal spray process characteristics, and of control equipment performance is of foremost importance. Ignorance is not an excuse for non-compliance. This guideline initiates the education process but each thermal spray company must know more about its own sources and the pertinent regulatory agencies.
- Thermal spray does not have its own "industry source" category so it ends up with "industrial coatings," lumping it with painters and platers, which are more potent sources. The thermal spray industry should petition to define its own category with the EPA. This will minimize many permitting problems that are now encountered.
- There are inconsistent regulation requirements in the industry, much of it stemming from lack of documented information and knowledge.
- An authoritative source of information and data on emissions from the range of thermal spray processes is lacking. Some data does exist, however, much of it has been collected with inadequately documented procedures or by unacceptable testing procedures.
- Chromium compounds, more specifically hexavelent Cr^{6+}, are the most potent hazardous materials which the industry handles or generates. Controls must be built around this material.
- Air emissions can, in most cases, be controlled to acceptable levels using dry filtration incorporating cartridges with HEPA filters. Some users may meet local limits with less efficient control technology.
- Air emissions from thermal spray processes need to be better documented by an industry-led, EPA-supervised test protocol. Many of the more potent conditions and materials should be evaluated to understand the level of the various emissions and the effectiveness of control technologies.
- Hazardous wastes are generated. These wastes must be documented, registered and disposed of with licensed haulers. These wastes, however, can be minimized through proper procedures.

- The laws and knowledge are evolutionary, hence, and updates to educate users should be produced on a regular basis under industry supervision.

More work remains for the guideline to be the complete source of knowledge on the topic, however, it is timely that the past 30 months of work be documented for your use. It was hoped that the guideline would contain more authoritative and quantitative information on the emissions from a wide range of thermal spray processes using a range of filtration systems. However, the cost of this data was prohibitive and that information is in place. ASM International and the sponsoring Thermal Spray Industry Group hopes to be able to complete some of these tests as funding is made available, either through the sale of this guideline or by EPA/Industry funding.

The Environmental Guideline for the Thermal Spray Industry will be issue in early 1994. It represents the collective efforts of many of your colleagues. We hope you purchase it and find it useful in your work to meet your local requirements. It also contains a compilation for sources of assistance. Please use these sources or ASM International as your continuing source of information. We look forward to your support by purchasing this Guideline and we invite your comments. The forthcoming Guideline is an excellent example of how industry and ASM worked together to address one industry issue. We expect it is an example of things to come as the industry faces other issues such as Training & Certification, Practices & Standards, and Information/Data. Please look for further announcements in these areas.

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