METAL DEPOSITION PROCESSES

Date Initiated:

December 28, 1992

Dates Modified / Updated:

October 25, 1993

October 26, 1998

PROCESS DESCRIPTION:

Metal deposition processes are versatile fabrication techniques used by many aerospace, military, and industrial operations. Deposition processes are used to modify metallic parts for a variety of reasons that include restoring desired dimensions, improving abrasion resistance, improving temperature resistance, increasing corrosion protection, providing electrical shielding, and increasing conduction. While many different types of deposition processes and equipment exist, most operations currently found in San Diego County can be broadly categorized into two groups; Flame Spray and Plasma Arc.

Flame Spray processes include powder flame spray, wire flame spray, rod flame spray, and detonation spray. Powder and wire flame spray operations are most common locally. Plasma Arc processes include plasma arc spray, electric arc spray, and transferred arc deposition with plasma and electric arc being most prevalent. The principle differences between these metal deposition methods are the type of energy used to melt the coating material, operating temperatures, and spray velocities. A more detailed discussion of each spray process is provided in the "Thermal Spray Handbook" prepared by Flame Spray Incorporated.

Flame spray processes typically use the combustion of acetylene and oxygen to heat metallic coating materials to working temperatures of 4600 F to 6000+ F. The molten atomized particles are then sprayed at a velocity of 80 to 800 ft/sec onto the desired part. Plasma and electric arc processes use electrical resistance and compressed inert gas to achieve the same purpose. Operating temperatures (10,000 F to 20,000+ F) and spray velocities (800 to 1600 ft/sec) are substantially higher. Both permit and AB2588 testing has been locally conducted at NAS North Island, Chemtronics, Ketema, and Flame Spray. Emission factors have been developed for each type of spray operation and control equipment (water curtain, scrubber, & baghouse) in units of lbs of listed substance released per lb of substance sprayed.

Approximately 200 coating materials are used in the various deposition processes. Coatings usually contain combinations of aluminum, cadmium, ceramics, chromium, cobalt, copper, iron, molybdenum, nickel, plastics, silver, stainless steel, titanium, tungsten, or zirconium. Trace metal emissions, which may include hexavalent chromium, are released into the atmosphere. The following standard estimation techniques are used by the District for Emissions Inventory purposes are based upon material usage, material composition, transfer efficiencies, and control efficiencies:

Ea = Ua x Ci x EF

Eh = Uh x Ci x EF

Where:

Ea = Annual emissions of each listed substance, (lbs/year)

Eh = Maximum hourly emissions of each listed substance, (lbs/hour)

Ua = Annual usage of each coating material containing a listed substance, (lbs/year)

Uh = Maximum hourly usage of each coating material containing a listed substance, (lbs/hr)

Ci = Concentration of each listed substance in each material used, (lbs/lb)

EF = Emission factor for listed substance after controls, (lb emitted /lb sprayed)

EMISSIONS INFORMATION:

Material information can be obtained from MSDS documentation. Powder compositions can be confirmed by METCO sales representatives ((800) 645-3182) if necessary.

Several difficulties were encountered in attempting to source test metal deposition processes. While the typical process time for powder spray operations is a few minutes, sampling methodologies required longer run times to obtain detectable stack samples. For test purposes, large scrap metal parts were continuously sprayed. Many operating parameters that may affect the emission rate were not evaluated including part size, part configuration, operating temperature, operating velocity, distance between the spray gun and the part, coating spray rate, exhaust air flow rate, part temperature, water curtain design, water flow rate, and water additives. Testing costs prevent a more thorough, site specific, evaluation.

Significant questions remain regarding the reproducibility of these test results. In most cases, testing was performed under maximum spray rates with newly installed control devices producing 'best case' emission factors. Emissions of previously captured substances from the release of water curtain mist, scrubber mist, or HEPA filter breakthrough were not evaluated and are not accounted for in the above procedures. If the magnitude of these secondary emissions is significant, the estimation procedure must be modified to include hours of control device operation as well as spray rates. It is also possible that emissions are not a linear function of the spray rate (i.e.; control devices buffer the emission rates). If this is true, testing at the maximum spray rate further minimizes the emission factor and underestimates actual releases. Future testing at different spray rates must be conducted to verify the release profile.

ASSUMPTIONS / LIMITATIONS:

- Site specific test data should be used in place of default factors when available. It should be noted that only very limited test data currently exists and that it s reproducibility is questionable.

- The conversion rate of chromium to hexavalent chromium requires additional study. Test results involving both hexavalent chromium and total chromium sampling trains have produced Cr+6 fractions of 2% to 100%. Test methods need to be confirmed, reproducible values need to be developed, and critical operating variables need to be identified.

- All sprayed material not deposited on the part or captured by the control device is assumed to be PM10. A 80% transfer + fallout efficiency appears typical for large parts. Control device removal efficiencies seem to vary by site and equipment (99.9% - 99.96% for HEPA systems), (98% - 99.5% for scrubbers), and (70% - 99%) for water curtains.

- Material usage information should account for waste that may be generated at the site. While very little sprayed material is expected to be disposed of as waste due to the high cost of the coatings, some fallout does occur. Unsprayed coating material is typically returned to inventory for future use.

- Emissions from the combustion of acetylene are assumed negligible at this time based on the relatively small quantity of gases typically consumed during flame spray operations.

FORMS:

Complete a separate reporting form for EACH material sprayed in each metal deposition booth. Clearly identify the type of spray operation and control device.