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GASES AND VENTILATION SYSTEMS AT THERMAL SPRAYING

Mihaela Popescu[1], Ibolyka Bran[1], Radu Alexandru Roşu [1], Carmen Opriş[1]
[1]Politehnica University of Timişoara, hela.popescu@yahoo.com

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Abstract: Thermal spraying is proven to be a domain with high applicability, with technological elements intense studied. The issue of environmental protection is obligatory, however, are exemplified measures being taken to counteract of the unwanted effects, in terms of the gases and the applicability of ventilation systems. Are described information referring to quality assurance prescriptions in this domain and information according to „sustainable development" principle. Safety plans measures at thermal spraying are also detailed.

1. Introduction

Sustainable development is a term often used in the past ten years and for the industry has become a leitmotif in the produces presentation. Often, "ECO" produces presentation is sometimes only by comparison with similar products and includes only analysis of the product production phase without taking into account environmental damage during and at end of the life cycle (figure 1) [6].

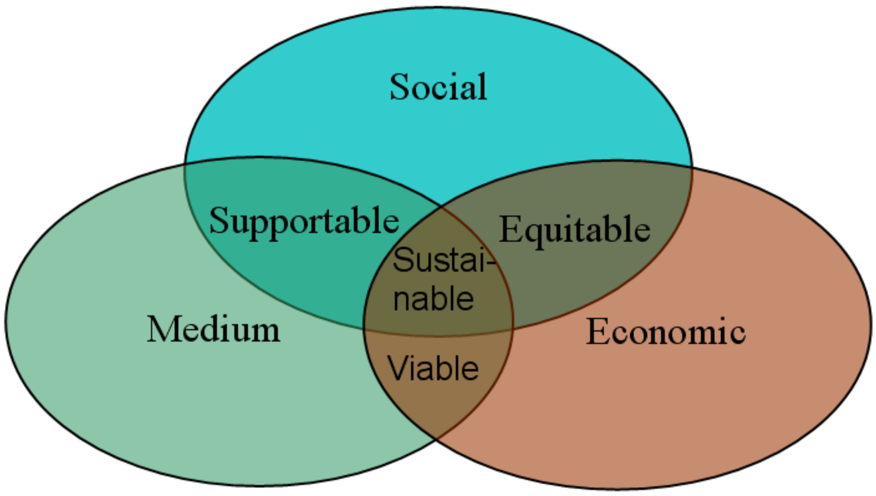

Figure 1. Synthesized data for "sustainable development" [6]

Currently, more than in the past the products/processes must be designed so as to preserve our existing resources and minimize environmental impact. Primary factor contributing to environmental degradation is the energy consumed in all stages of production and operation of products (processing, transport, use, including disposal).

Reduce and the environmental impact control represents the mission strategy called "sustainable development" and is one of the priority directions in the moment and in the future [2,4].

Sustainable development as a concept, change the conception of a practical product design process by embedding the environmental impact (Integrated design). Implementing the concept of "sustainable development" in Thermal Spraying can be achieved only through innovation at the conceptual level and technology. The process is obviously multi and interdisciplinary. It may address the domain based on conceptual models performance (functionality, reliability, neutral or low impact to the environment), using materials with superior physical and mechanical characteristics (recyclable and embedded low consumption of primary resources and energy), applying systems construction and related technologies (reliability, flexibility, low energy consumption, minimal impact to the environment).

Environmental impact assessment should not be done only for the initial version, but must integrate both the maintenance of equipment and the disposal of materials at the end of life cycle.

2. Factors in quality assurance approach to TS

Surface preparation, thermal spray, and sealing and painting operations expose workers to numerous potential health and safety hazards. The industrial protective coatings industry is considered a high-risk occupation. Common health and safety hazards associated with the industry include (a) electric shock, (b) flammable and explosive solvents, gases, and dusts, (c) confined space entry, (d) fall hazards, (e) exposure to high intensity noise and ultraviolet light and toxic materials, and (f) high-velocity particle impingement [2].

Given the above, in terms of quality assurance through all stages of the work required, figure 2.

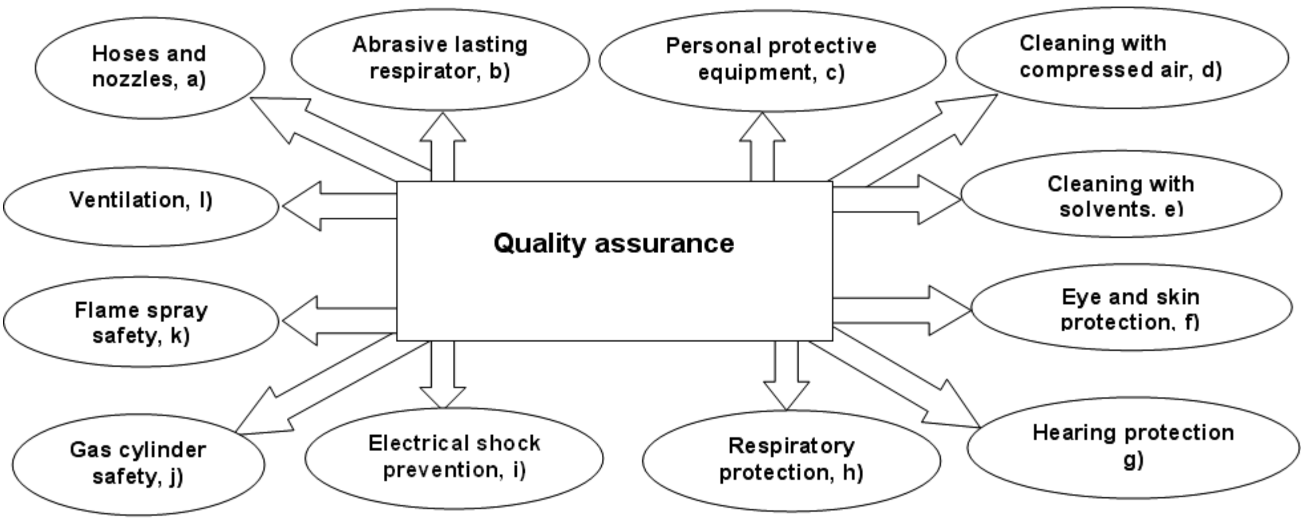

Figure 2. Factors in the quality assurance process

a. Hoses and nozzles. Hose and hose connections that do not allow electrostatic discharge should be used. Hose couplings and nozzles should be designed to prevent accidental disengagement. A deadman control device that automatically stops the flow of air and abrasive when the hose is dropped should be used. Hoses and fittings used for abrasive blasting should be inspected frequently to ensure the timely replacement of worn parts and equipment [1].
b. Abrasive blasting respirator. Abrasive blasting operators should wear an abrasive blasting respirator, which consists of a continuous-flow airline respirator constructed so that it covers the worker’s head, neck, and shoulders from rebounding abrasive. Respiratory equipment should be approved by OSHA [1].
c. Personal protective equipment. Blasting operators should wear heavy canvas or leather gloves and an apron or coveralls. Safety shoes should be worn to protect against foot injury. Hearing protection should be used during all blasting operations [1].

d. Cleaning with compressed air. Cleaning with compressed air should be restricted to systems where the air pressure has been reduced to 204 kPa or less. Cleaning operators should wear safety goggles or face shield, hearing protection, and appropriate body covering. Compressed air or pressurized gas should never be pointed at anyone.
e. Cleaning with solvents. The material safety data sheet (MSDS) should be consulted for specific solvent information and procedures in addition to those listed here. Flammable liquids with a closed-cup test flash point below 38 °C should not be used for cleaning purposes. Sources of ignition should not be permitted in the vicinity of solvent cleaning if there is any indication of combustible gas or vapor present. Measurements should be made to ensure that solvent vapors are not present during thermal spray operations, especially in confined spaces. Representative air samples should be collected from the breathing zone of workers involved in the cleaning process to determine the specific solvent vapor concentrations. Worker exposures should be controlled to levels below the Occupational Safety and Health Standards (OSHA) Permissible Exposure Limit. Airborne metal dusts, finely divided solids, or other particulate accumulations should be treated as explosive materials. Proper ventilation, good housekeeping, and safe work practices should be maintained to prevent the possibility of fire and explosion. Thermal spray equipment should never be pointed at a person or flammable material. Thermal spraying should not be performed in areas where paper, wood, oily rags, or cleaning solvents are present. Conductive safety shoes should be worn in any work area where explosion is a concern. During thermal spray operations including the preparation and finishing processes, employees should wear protective coveralls or aprons, hand protection, eye protection, ear protection, and respiratory protection.
f. Eye and skin protection. All thermal spray processes introduce particulates into the air that may damage the eyes or skin. Eye and face protection must be worn to protect against particulate impingement. High intensity visible, infrared and ultraviolet light may also cause eye and skin damage. Flame resistant clothing should be worn to protect the skin. Hoods or face shields conforming to OSHA with filter lenses should be worn to protect the face and eyes. Various shades of lens filters are recommended based on the type of thermal spray process being used. For wire flame spray, lens shades 2-4 should be used. For powder flame spray, lens shades 3-6 should be used. For wire arc and powder plasma spray, lens shades 9-12 should be used. Shades 3-6 can be used for wire arc spray if the gun is equipped with an arc shield. The shield encloses the arc and reduces the operator's exposure to high intensity light. Other workers in the vicinity of the thermal spray applicator should also use proper eye protection. Table 1 summarizes the recommended lens shades for thermal spraying [1].

Table 1. Recommended Lens Shades for Thermal Spraying [1]

Thermal-Spray Process	Shade
Wire flame spraying	2-4
Powder flame spraying	3-6
Wire arc and powder plasma spraying	9-12
Wire arc if gun is equipped with arc shield	3-6

g. Hearing protection. Thermal spray produces very high intensity noise that will cause permanent hearing loss. Thermal spray operators and other workers in the vicinity of the thermal spray operation should wear hearing protection at all times. Protection against the effects of noise exposure should be provided in accordance with the requirements of OSHA. Insert earplugs should be used in conjunction with wire or powder flame spray.

Insert earplugs should be worn as a minimum for wire arc spray. Insert earplugs and earmuffs are recommended for use with wire arc and plasma spray. Table 2 lists the minimum recommended hearing protection devices for various thermal spray application methods.

h. Respiratory protection. Thermal spray produces toxic dusts and fumes. Thermal spray operators and those in the general vicinity of the operation should wear appropriate respirators. Overexposure to zinc fume is known to produce flu-like symptoms, often called metal fume fever.

Table 2. Typical Noise Levels and Recommended Hearing Protection for Thermal Spray Process [1]

Thermal Spray Process	Noise Level dBA	Minimum Recommended Protection
Wire flame spraying	114	Earplugs
Powder flame spraying	90-100	Earplugs
Wire arc	111-116	Earplugs and earmuffs
Plasma spraying	128-131	Earplugs and earmuffs

i. Electrical shock prevention. Wire arc spray presents an electrical shock hazard. The manufacturer's safe operating procedures should always be followed. Ground protection for equipment and cords should be present and in good condition Switches and receptacles should have proper covers. Damaged cords and equipment should be repaired or replaced. Circuit breaker boxes should be kept closed [1,5].

*j. Gas cylinder safety. S*pecial oxidation-resistant lubricants should be used with oxygen equipment; grease or oil should not be used. Manifolding and pressure reducing regulators, flow meters, hoses, and hose connections should be installed. A protective shield should be used to shield glass tube flow meters from the spray gun. Pressure connecting nuts should be tight, but not overtight. Fittings that cannot be sealed without excessive force, should be replaced. Compressed air for thermal spraying or blasting operations should be used only at pressures recommended by the equipment manufacturers. The airline should be free of oil and moisture. Compressed air, oxygen, or fuel gas should never be used to clean clothing [1,3].

k. Flame spray safety. Flame spray equipment should always be maintained and operated according to the manufacturer's instructions. Thermal spray operators should be trained and familiar with their equipment before starting an operation. Valves should be properly sealed and lubricated. Friction lighters, pilot light, or arc ignition methods of lighting flame spray guns should be used. If the flame spray gun backfires, it should be extinguished immediately. Re-ignition of a gun that has backfired or blown out should not be attempted until the cause of the trouble has been determined. Flame spray guns or hoses should not be hung on regulators or cylinder valves. Gas pressure should be released from the hoses after equipment is shut down or when equipment will be left unattended. Lubricating oil should not be allowed to enter the gas mixing chambers when cleaning flame spray guns. Only special oxidation-resistant lubricants should be used on valves or other parts of flame spray guns that are in contact with oxygen or fuel gases.

l. Ventilation. Local exhaust or general ventilation systems should be used to control toxic fumes, gases, or dusts in any operations not performed in the open. Thermal spray should be performed with appropriate respiratory protection and adequate ventilation. Thermal spraying in an enclosed space should be performed with general mechanical ventilation, airline respirators, or local exhaust ventilation sufficient to reduce the fumes to safe limits specified by OSHA. Employee exposures should be controlled to the safe levels recommended by OSHA, whichever is more stringent. Air sampling should be performed before entry to a confined space, during confined-space entry that involves contaminant-generating operations such as flame spray operations, and in areas where ventilation is inadequate to ensure that air contaminants will not accumulate. Engineering controls (enclosures and/or hoods with ducted, mechanical ventilation of sufficient volume to remove contaminants from the work space) are the most-desired methods of preventing job-related illness resulting from breathing air contaminated with harmful dusts, mists, fumes, vapors, or gases [1].

3. Safety Plans

Thermal spray contracts require the development and submittal of various procedures and plans, including an accident prevention plan, confined space procedures, medical surveillance documentation, a respiratory protection program, an air sampling plan, a worker hazard communication program, a ventilation assessment plan, a qualifications and experience statement, and a safety indoctrination plan [1].

a. Accident prevention plan. The contractor should prepare a written accident prevention plan:

- Identification of contractor personnel responsible for accident prevention.
- Methods contractor proposes to coordinate the work of subcontractors.
- Layout plans for temporary buildings, construction of buildings, use of heavy equipment, and other facilities.
- Plans for initial and continued safety training for each of the contractor's and subcontractor's employees.
- Plans for traffic control and the marking of hazards to cover waterways, highways and roads, railroads, utilities, and other restricted areas.
- Plans for maintaining good housekeeping and safe access and egress at the jobsite.
- Plans for fire protection and other emergencies.
- Plans for onsite inspections by qualified safety and health personnel. Plans shall include safety inspections, industrial hygiene monitoring if required, records to be kept, and corrective actions to be taken.
- Plans for performing Activity Hazard Analysis for each major phase of work. The Activity Hazard Analysis shall include the sequence of work, specific hazards that may be encountered, and control measures to eliminate each hazard.

b. Confined space procedures. The contractor should prepare a written confined-space procedure. The written procedure should include, but not be limited to, the following requirements:

- A description of the methods, equipment, and procedures to test for oxygen content and combustible and toxic atmospheres in confined spaces prior to entry and during work.
- Emergency procedures for each type of confined space work, including methods of communication, escape, and rescue.
- Air monitoring plans by qualified individuals and a certificate of calibration for all air monitoring equipment.
- A plan for training workers in confined-space procedures that should include confined-space hazards, evaluation of confined-space atmospheres, combustible-gas indicator operation, entry procedures, attendant requirements, isolation and lockout, preparation of confined areas, respiratory protection, communication, safety equipment, no smoking policy, use of entry permits, and appropriate escape and rescue procedures.

- Plans to conduct an emergency drill prior to confined-space work to ensure the adequacy of the procedures. A rescue test should be performed to ensure that rescue equipment will fit through the confined-space entrance and to test and practice other confined-space procedures such as communication.
- Plans for a stand-by person to be present outside the confined space while workers are inside. The attendant should be trained in the duties of a stand-by person, including appropriate rescue procedures. The stand-by person should have no other duties except to attend the entrance of the confined space, to be in constant communication with the confined-space workers, and to perform a rescue, if needed, with a self-contained breathing apparatus (minimum air supply of 30 min).
- Plans to inspect personal protective equipment prior to entry.
- Plans for ventilation of the confined space.
- Procedures for real-time monitoring of the concentrations of combustible gases or solvent vapors during occupancy [1].

c. Medical surveillance documentation. Employees required to work with or around solvents, blasting, flame- or arc-spray operations, respiratory equipment, or those exposed to noise above 85 dBA continuous or 140 dBA impact, or those who are required to use respiratory protective devices should be evaluated medically. The contractor should provide a written record of the physical examinations of all employees who may be required to wear a respirator, those who may be exposed to high noise, or those who may be exposed to toxic contaminants. The documentation should include a statement signed by the examining physician confirming that the employees' exams included the following as a minimum:

- Audiometric testing and evaluation.
- Medical history with emphasis on the liver, kidney, and pulmonary system.
- Testing for an unusual sensitivity to chemicals.
- Alcohol and drug use history.
- General physical exam with emphasis on liver, kidney, and pulmonary system.
- Determination of the employee's physical and psychological ability to wear protective equipment, including respirators, and to perform job-related tasks.

d. Respiratory protection program. The contractor should establish and implement a written respiratory protection program that includes instruction and training about respiratory hazards, hazard assessment, selection of proper respiratory equipment, instruction and training in proper use of equipment, inspection and maintenance of equipment, and medical surveillance. The written respiratory program should take into account current and anticipated work conditions for each work area and should be specific for each work area.

e. Air sampling plan. The contractor should prepare and submit plans for conducting air sampling by qualified individuals for toxic contaminants regulated by the Occupational Safety and Health Act (OSHA).

f. Hazard communication program. The contractor should develop and operate a worker hazard communication program for employees. There should be a written program that describes how the employer will comply with the standard, how chemicals will be labeled or provided with other forms of warning, how MSDS's will be obtained and made available to employees and OSHA representatives, and how information and training will be provided to employees. The program should include the development of an inventory of toxic chemicals present in the workplace, cross-referenced to the MSDS file. The written program should also describe how any subcontractor employees and the Contracting Officer will be informed of identified hazards. Specific elements of the program should include:

(1) A file of MSDS's for each hazardous chemical on the chemical inventory, kept in a location readily accessible during each work shift to employees when they are in their work area.
(2) Containers of hazardous chemicals in the workplace should have appropriate labels that identify the hazardous material in the product, have appropriate health and safety warnings, and include the name and address of the manufacturer or responsible party.
(3) Training on:
(a) Provisions of the hazard communication standard.
(b) The types of operations in the work areas where hazardous chemicals are present.
(c) The location and availability of the written program and MSDS's.
(d) Detecting the presence or release of toxic chemicals in the workplace.
(e) The visual appearance, odor, or other warning or alarm systems.
(f) The physical and health hazards associated with chemicals in the workplace.
(g) Specific measures to protect from the hazards in the work areas, such as engineering controls, safe work practices, emergency procedures, and protective equipment.
g. Ventilation assessment plan. The contractor should prepare a written plan for ventilation assessments to be performed by a qualified person for all confined-space work, solvent cleaning, abrasive blasting, and thermal spray operations.
h. Qualifications and experience statement. The contractor should submit a written qualification and experience statement for the person(s) responsible for developing the required safety and health submittals and serving as the contractor's onsite safety and health representative [1].

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4. Conclusions

There are presented information referring to „sustainable development” in thermal spraying process, factors for quality assurance and the plans and the procedures for properly thermal spraying.

Thermal spraying domain has proven to be actually by its applicability results and particular advantages.

5. References

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