



INTRODUCTION

Thermal spraying processes use modifications of arc, plasma, and oxyfuel energy sources to produce the resulting heat, atmosphere, and particle velocity needed to properly coat an object (a substrate) with the desired thickness and properties of a surfacing material. The high temperatures, velocity, and projectile distance of the spraying processes create a unique set of safety hazards for the operator and those nearby.

DEFINITIONS/PROCESS DESCRIPTIONS

According to ANSI/AWS A3.0, *Standard Welding Terms and Definitions*, Thermal Spraying (THSP) is a group of processes that deposit molten metallic or non-metallic surfacing materials onto a prepared substrate. All thermal spraying processes introduce a feedstock (usually a powder or wire) into a heating device (combustion or electrical). There the material is heated, blended into the heat plume, and sprayed onto a prepared substrate. The molten particles strike the surface, flatten, and form thin platelets that conform and adhere to the substrate and to one another. As they cool, they build up a lamellar structure to form the desired coating.

Combustion processes include Low-Velocity Oxyfuel (LVOF) and High-Velocity Oxyfuel (HVOF) systems. Electrical processes are Arc (two-wire), Plasma Arc (powder), and Plasma Induction (powder) systems. Typical operating conditions for the various processes are shown in the table below.

POTENTIAL HAZARDS AND HAZARDOUS EFFECTS

- Dust—Finely divided airborne solid particulate should be treated as an explosive and inhalation hazard. Adequate ventilation and wet collection of the overspray should be provided to minimize these hazards.
- Fumes, Vapors, and Gases—Ventilate and use safe practices according to ANSI Z49.1, the MSDSs, and AWS Safety and Health Fact Sheet No. 1. In addition, most spray and abrasive blasting operations require the use of an approved respirator that complies with requirements of ANSI Z88.2. Also, precautions should be exercised to avoid the presence of chlorinated hydrocarbon solvent vapor in the area of the arc or plasma spraying. Hazardous phosgene gas can be produced when hydrocarbon vapors are exposed to ultra-violet radiation from these processes.

	LVOF	HVOF	Arc	Plasma Arc	Plasma Induction (Atmosphere)
Temperature	to 5000°F	to 6000°F	4000–15,000°F	4000–15,000°F	to 30,000°F
Velocity	200–700 ft/sec (<Mach 1)	2500–4000 ft/sec (to Mach 5)	800–1100 ft/sec (<Mach 2)	800–1800 ft/sec (to Mach 2)	800–1800 ft/sec (to Mach 2)
dBA (Sound Level)	110	150	115	132	132
Spray Distance	4–10"	6–18"	2-1/2–6"	2-1/2–6"	3–8"

- Noise—The loud noise (high dBA ranges) of these processes must be addressed. Ear muffs and noise control procedures should be provided to conform to the standard limits of OSHA 29 CFR 1910.95.
- Radiation—Intense ultraviolet (UV) and infrared (IR) radiation occurs with these processes. They require total protection of the eyes and all exposed skin to avoid eye damage and burns. Eye shades of No. 3–6 for combustion and 9–12 for electrical processes are recommended (see AWS Safety and Health Fact Sheet No. 2).
- Electric Shock—The higher process voltages used in Arc, Plasma Arc, and Plasma Induction Spraying increase the risk of electric shock. Take precautionary measures according to ANSI Z49.1 and AWS Safety and Health Fact Sheet No. 5.
- Fire—Use care when handling spray guns during operation to avoid injury to personnel or causing fire (see AWS Safety and Health Fact Sheet No. 6).
- Mechanical Hazards—The substrate surface preparation, spraying, finishing, and post-treatment operations involved with thermal spraying processes present a variety of mechanical hazards specific to Thermal Spraying. Consult the equipment manufacturers' manuals and material suppliers' MSDSs for their recommended safe practices.
- Compressed Gases—Compressed gases require safe handling and use as specified in ANSI Z49.1.

INFORMATION SOURCES

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes*, Z49.1, available from American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

_____. *Safety Practices for Occupational and Educational Eye and Face Protection*, Z87.1, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

_____. *Safe Practices for Respiratory Protection*, Z88.2, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

_____. *Safety Requirements for Industrial Head Protection*, Z89.1, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations*, Title 29 Labor, Chapter XVII, Parts 1901.1 to 1910.1450, Order No. 869-019-00111-5, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 02402.

National Fire Protection Association (NFPA). *Standard for Fire Prevention in Use of Cutting and Welding Processes*, NFPA Standard 51B, available from National Fire Protection Association, One Batterymarch Park, Quincy, MA 02269.

_____. *National Electrical Code*, NFPA Standard 70, available from National Fire Protection Association. One Batterymarch Park, Quincy, MA 02269.

_____. *Standard for the Design of Oxygen-Fuel Gas Systems for Welding and Cutting and Allied Process*, NFPA Standard 51, available from National Fire Protection Association, One Batterymarch Park, Quincy, MA 02269.

Compressed Gas Association (CGA). *Safe Handling of Compressed Gas Cylinders*, CGA P-1, available from Compressed Gas Association, 1725 Jefferson David Highway, Suite 1004, Arlington, VA 22202.

Robotic Industries Association (RIA). *Safety Requirements for Industrial Robots and Robot Systems*. RIA R15.06, available from the Robotic Industries Association (RIA), P.O. Box 3724, 900 Victors Way, Ann Arbor, MI 48106.

American Welding Society (AWS). *Thermal Spraying: Practice, Theory, and Application*, available from American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.