



## THERMAL SPRAYING SAFETY

### INTRODUCTION

Thermal spraying processes use electric arc, plasma, and combustion energy sources to produce a high temperature and high velocity gas stream. Powder or wire material is introduced to this gas stream. Particles of this material are heated and propelled at high velocity onto a surface to produce a coating. The noise, heat, dust, fumes, and mechanical operations of the spraying processes create a unique set of safety hazards for the operator and those nearby.

### DEFINITIONS/PROCESS DESCRIPTIONS

According to AWS A3.0M/A3.0, *Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*, Thermal Spraying 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 spraying device (combustion or electrical).

The spraying device is generally referred to as a thermal spray gun. At the gun the material is heated, blended into a hot gas stream, and sprayed at high velocity onto a prepared substrate. The heated particles strike the surface where they flatten and adhere to the surface. As this process continues a coating is formed by the spray material. The coating process is stopped when the desired thickness of coating is formed.

Thermal spray processes include:

- Combustion processes
  - LVOF: Low-Velocity Oxyfuel
  - HVOF: High Velocity Oxyfuel
- Electrical processes:
  - Arc (twin-wire)
  - Plasma Arc

Typical operating conditions for the various processes are shown in the table below.

	LVOF	HVOF	Arc	Plasma Arc
Temperature	To 5,000°F	To 6,000°F	4,000 – 15,000°F	4,000 – 15,000°F
Velocity	200 – 700 ft/sec (<Mach 1)	2,500 – 4,000 ft/sec (to Mach 5)	800 – 1,800 ft/sec (to Mach 2)	800 – 1,800 ft/sec (to Mach 2)
dBA (Sound Level)	110	150	115	132
Spray Distance	4 – 10"	6 – 18"	2-1/2 – 6"	2-1/2 – 6"

## POTENTIAL HAZARDS AND HAZARDOUS EFFECTS

- **Dust** – The finely divided airborne dust and fume should be treated as an explosion and inhalation hazard. Adequate ventilation, proper electrical system design, and appropriately designed dry collection systems should be provided.
- **Fumes, Vapors, And Gases** – Use ventilation and safe practices according to ANSI Z49.1, the material supplier's Safety Data Sheet (SDS), and AWS Safety and Health Fact Sheet No. 1. Most spray and abrasive blasting operations require the operator to use an approved respirator that complies with requirements of ANSI Z88.2. Also, precautions should be taken 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.
- **Noise** – Thermal spray processes generate noise levels that require hearing protection by the operator. Earmuffs 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** - Arc, Plasma Arc, and Plasma Induction Spraying utilize electrical voltages which can be in excess of 100 volts. Take precautionary measures according to ANSI Z49.1 and AWS Safety and Health Fact Sheet No. 5.
- **Fire** – The gas stream from a thermal spray gun is in excess of 3,000°F. Use care when handling thermal spray guns during operation to avoid personal injury or 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. Consult the equipment manufacturer's manuals and material supplier's SDS for their recommended safe practices.
- **Compressed Gases** – Use and handle compressed gases as specified in ANSI-Z49.1, *Safety in Welding, Cutting, and Allied Processes*.

## INFORMATION SOURCES

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes* (ANSI Z49.1), published by the American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

American National Standards Institute (ANSI). *Practice for Occupational and Educational Eye and Face Protection* (ANSI Z87.1), available from ANSI, 11 West 42nd Street, New York, NY 10036-8002; telephone: 212-642-4900; web site: [www.ansi.org](http://www.ansi.org).

American National Standards Institute (ANSI). *Safe Practices For Respiratory Protection* (ANSI Z88.2), available from ANSI, 11 West 42nd Street, New York, NY 10036-8002; telephone: 212-642-4900; web site: [www.ansi.org](http://www.ansi.org).

American National Standards Institute (ANSI). *Safety Requirements For Industrial Head Protection* (ANSI Z89.1), available from ANSI, 11 West 42nd Street, New York, NY 10036-8002; telephone: 212-642-4900; web site: [www.ansi.org](http://www.ansi.org).

Occupational Safety And Health Administration (OSHA). *Code Of Federal Regulations*, Title 29 Labor, Parts 1901.1 to 1910.1450, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 02402.

National Fire Protection Association (NFPA). *Standard for Fire Prevention During Welding, Cutting and Other Hot Work* (NFPA 51B), available from the National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-9101; telephone: 800-344-3555; Web site: [www.nfpa.org](http://www.nfpa.org).

National Fire Protection Association (NFPA). *National Electric Code* (NFPA 70), available from National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-9101; telephone: 800-344-3555; Web site: [www.nfpa.org](http://www.nfpa.org).

Compressed Gas Association (CGA). *Safe Handling of Compressed Gases in Cylinders*, CGA Pamphlet P-1 (and V-1), from Compressed Gas Association, 1735 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102 (telephone: 703-412-0900, web site: [www.cganet.com](http://www.cganet.com)).

Robotic Industries Association (RIA). *Safety Requirements for Industrial Robots and Robot Systems* (RIA R15.06), available from the Robotic Industries Association, P.O. Box 3724, 900 Victors Way, Ann Arbor, MI 48106; telephone: 734.994.6088; web site: [www.robotics.org](http://www.robotics.org).

American Welding Society (AWS). *Thermal Spraying: Practice, Theory, And Application*, published by the American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

National Fire Protection Association (NFPA). *Standard for the Design of Oxygen-Fuel Gas Systems for Welding and Cutting and Allied Process* (NFPA 51), available from National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-9101; telephone: 800-344-3555; Web site: [www.nfpa.org](http://www.nfpa.org).