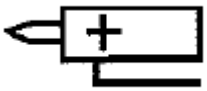
American Welding Society
Safety and Health
Fact Sheet No. 20 November 2024



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”

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POTENTIAL HAZARDS AND HAZARDOUS EFFECTS

- **Dust** – The finely divided airborne dust and fume can an explosion and inhalation hazard. Adequate ventilation, proper electrical system design, and appropriately designed dust collection systems shall 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 shall 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. Hearing protection and noise control procedures shall be provided to conform to the standard limits of OSHA 29 CFR 1910.95.

- **Radiation** - Intense ultraviolet (UV), visible (light), 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.

- Lens 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 can be an electrical hazard. 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

ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes,* American Welding Society, <www.aws.org>.

ANSI Z87.1, *Practice for Occupational and Educational Eye and Face Protection* American National Standards Institute, <www.ansi.org>.

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ANSI Z88.2, *Safe Practices For Respiratory Protection,* American National Standards Institute, <www.ansi.org>.

ANSI Z89.1, *Safety Requirements For Industrial Head Protection,* American National Standards Institute, <www.ansi.org>.

AWS, *Thermal Spraying: Practice, Theory, And Application*, American Welding Society, <www.aws.org>.

CGA Pamphlet P-1 and V-1, *Safe Handling of Compressed Gases in Cylinders*, CGA Pamphlet P-1, Compressed Gas Association, <www.cganet. com>.

NFPA, 51 *Standard for the Design of Oxygen-Fuel Gas Systems for Welding and Cutting and Allied Process,* National Fire Protection Association, <www.nfpa.org>.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting and Other Hot Work,* National Fire Protection Association, <www.nfpa.org>.

NFPA 70, *National Electric Code,* National Fire Protection Association, <www.nfpa.org>.

OSHA, *Title 29 Labor, Parts 1901.1 to 1910.1450*, Occupational Safety And Health Administration, Code Of Federal Regulations (CFR), <www.osha.org>.

RIA R15.06, *Safety Requirements for Industrial Robots and Robot Systems,* Robotic Industries Association, <www.robotics.org>.