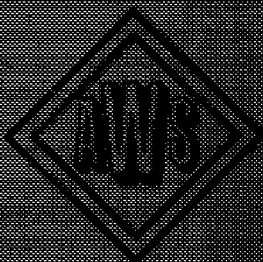


**Recommended
Practices
for
Metallizing
with
Aluminum and Zinc
for
Protection
of
Iron and Steel**



AMERICAN WELDING SOCIETY

AWS C2.2-67

**Recommended
Practices
for
Metallizing
with Aluminum and Zinc
for Protection of Iron and Steel**

Prepared by
AWS Committee on Metallizing

Under the direction of
AWS Technical Activities Committee

Edward A. Fenton
Technical Director

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Section I – General

101. Scope:

It is intended to present herein a description of the procedures employed in metallizing surfaces with zinc and aluminum where these metals are suitable to protect iron and steel against corrosion. The procedures represent various practices and methods currently used.

102. Definition of Terms:

A list of metallizing terms, together with their definitions, is available in AWS publication C2.9, "Metallizing Terms and Their Definitions." The terms employed herein are used in accordance with that publication.

103. Equipment Requirements:

A. Blasting Equipment

Any commercial type of blasting equipment, except wet blasting, can be used to clean and roughen the surfaces. Centrifugal or airless blasting equipment is the most economical and is used in many large production installations. Compressed air type equipment is most commonly used for general shop and field work. The pressure type equipment is faster, better, more economical and preferred over the siphon type. When compressed air is used, the compressor should have a capacity at least 25% greater than the total amount of air required at any one time. It should be equipped with an efficient oil and moisture separator to help prevent contamination of the surface to be metallized. Force feed masks with a protective hood plus suitable gloves should be provided to adequately protect operators from abrasive and dust. An AWS publication on "Safety Recommendations for Metallizing" is presently being prepared and will be made available as soon as possible.

B. Spraying Equipment

The four types of equipment commonly used for spraying zinc and aluminum are as follows:

- (1) Wire-gas metallizing equipment
- (2) Powder-gas metallizing equipment
- (3) Electric arc metallizing equipment
- (4) Plasma spraying equipment

Choice of the process depends on the requirements of the work to be done. Accessory equipment for each of the above processes will vary in accordance with the process being used and the subject being sprayed. For further information relative to blasting and spraying equipment reference should be made to the instructions and literature of the manufacturer of the equipment.

2 | Metallizing with Aluminum and Zinc**Section II – Surface Preparation****201. General:**

The surface to be metallized must be cleaned and then roughened by blasting, as sprayed metal will bond adequately only to cleaned and roughened surfaces. Cleaning prior to blasting can be done by several means. (See Section 202). Because methods of surface preparation other than blasting are so infrequently used for the application of aluminum and zinc, they are not covered in this Recommended Practice.

202. Cleaning Prior to Blasting:

Where heavy scale is encountered on steel or iron, it may be more economical to remove some of it by oxygen descaling, air hammer or other suitable means prior to final blasting. Blasting with a low grade of sand is often useful as a cleaning method prior to the final roughening blast with the proper grade of abrasive. This procedure could also apply to surfaces coated with paint or other materials. When oil or grease is present, the surface should first be cleaned with a suitable solvent. If the piece to be coated is cast iron that has been contaminated with oil or grease, it should be baked at 600 F for four hours to remove all traces of these contaminants. Occasionally, it is necessary to neutralize a surface prior to final blasting. Acid-contaminated surfaces may be neutralized by scrubbing with a sodium bicarbonate solution. Similarly, alkaline-contaminated surfaces may be neutralized by scrubbing with dilute (1%) hydrochloric (sometimes called muriatic) acid or acetic acid (10%) solutions. The surface is rinsed with fresh water and either allowed to air dry, or dry by contact with moving hot or cold air; or by use of heat alone.

203. Abrasives for Blasting:**A. Single Use Abrasive**

Sand, special crushed slag, flint or garnet abrasives are used where they cannot be reclaimed and reused. The abrasive must be hard, sharp and angular as might be produced by crushing. Round silica sand or similar materials should never be used. All abrasives should be clean, dry and free from oil or other contamination.

B. Multiple Use Abrasive

Angular chilled iron grit is most commonly used where the abrasive can be reclaimed. To a lesser degree aluminum oxide grit is also used. Round iron shot or rounded grit should not be used. Again, all abrasives should be clean, dry and free from oil or other contamination.

C. Operating Factors

Blasting speed and costs depend on several factors. With larger blast nozzles, more area will be prepared per hour. However, the size of the nozzle used may be limited by the amount of air available. Air requirements are given in Table 1. Smaller abrasive size will allow the preparation of more area per hour; however, too small a particle size may result in inadequate roughening and subsequently poor bonding.

D. Applications

1. Where zinc coatings 0.009 in. thick or less or aluminum coatings 0.007 in. thick or less are to be applied, the following unused abrasives are recommended for use with pressure-type blast machines:

(a) Washed, salt-free, angular, silica sand; flint; crushed garnet or special crushed slag free of feldspar or other mineral constituents that tend to break down and remain on the surface in visible quantities. Mesh size: through 20 and retained on 40, with a minimum of 40 percent retained on a 30-mesh screen.

(b) Angular chilled iron grit, clean and reasonably sharp. Old grit which is rusty, noticeably worn or dull when visually compared with new grit should not be used. Mesh size: SAE G-25 to and including SAE G-40. An individual size or a mixture may be used.

Table 1—Rate of Air and Abrasive Flow for Various Size Nozzles

Blast Nozzle Orifice Size, In.	Volume of Air Required, Cu Ft/Min					Blast Nozzle Orifice Size, In.
	60 psi	70 psi	80 psi	90 psi	100 psi	
3/16	37.5	43.0	47.5	52.5	57.8	3/16
1/4	67.0	76.0	85.0	94.0	103.0	1/4
5/16	105.0	119.0	133.0	146.0	161.0	5/16
3/8	151.0	171.0	191.0	211.0	232.0	3/8
7/16	206.0	233.0	260.0	286.0	315.0	7/16
1/2	268.0	304.0	340.0	376.0	413.0	1/2

Blast Nozzle Orifice Size, In.	Approximate Rate of Abrasive Flow, Lb/Hr						Blast Nozzle Orifice Size, In.
	Sharp Angular Sand	Crushed Chilled Iron Grit	Aluminum Oxide	Flint	Garnet	Crushed Slag	
3/16	500	1250	750	450	700	500	3/16
1/4	900	2250	1350	800	1250	950	1/4
5/16	1200	3250	1950	1150	1800	1400	5/16
3/8	1700	4250	2550	1500	2350	1800	3/8
7/16	2200	5500	3300	1950	3050	2350	7/16
1/2	3000	7500	4500	2650	4100	3200	1/2

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(c) Aluminum oxide, clean and free of fines. Mesh size: through 20 and retained on 50, with a minimum of 40 percent retained on a 40-mesh screen.

2. Where zinc coatings 0.010 in. or thicker, or aluminum coatings 0.008 in. or thicker are to be applied, the following abrasives are recommended for use with pressure-type blast machines:

(a) Washed, salt-free, angular, silica sand; flint; crushed garnet or special crushed slag free of feldspar or other mineral constituents that tend to break down and remain on the surface in visible quantities. Mesh size: through 12 and retained on 30, with a minimum of 40 percent retained on a 20-mesh screen.

(b) Angular chilled iron grit, clean and reasonably sharp. Old grit which is rusty, noticeably worn or dull when visually compared with new grit should not be used. Mesh size: SAE G-18 to and including G-25. An individual size or a mixture may be used.

(c) Aluminum oxide, clean and free of fines. Mesh size: through 12 and retained on 36, with a minimum of 40 percent retained on a 24-mesh screen.

3. Abrasive sizes may vary from the above recommendations depending on the requirements of the work to be done. When abrasive is reused it should be checked to see that at least 80 percent of it conforms to original size requirements. Contaminated abrasive should never be re-used.

204. Blasting Procedures:

A. The nozzle to workpiece distance may vary from 4 to 12 inches depending on the type of grit used, nozzle size, and capacity of the blast machine.

B. The abrasive stream should be directed against the work at an angle of approximately 15 degrees (not over 30 degrees) from the vertical.

C. The blast nozzle should be replaced when the diameter of the orifice has been increased 25 percent by wear.

D. All areas that can be injured by the blast or are not to be coated should be protected by suitable masking.

E. Where a pressure-type blast machine is used, the minimum pressure at the nozzle should be:

(a) With aluminum oxide, flint or slag: 50 psi (maximum pressure 60 psi)

(b) With sand, garnet or chilled iron grit: 75 psi

F. When a syphon-type blast machine is used, the minimum pressure at the nozzle should be:

- (a) With aluminum oxide, flint or slag: 75 psi
- (b) With sand, garnet or chilled iron grit: 90 psi (maximum pressure 100 psi)

G. The surface should be uniformly blasted until a dull matte finish is produced.

Section III – Zinc and Aluminum Coatings

301. Material:

A. Material used for spraying should be made especially for that purpose. Zinc should have a minimum purity of 99.9 percent. Aluminum should have a minimum purity of 99.0 percent.

B. Zinc coatings 0.005 in. thick provide approximately 2.64 ounces of zinc per square foot of surface. Galvanized coatings on sheet are usually described in terms of weight of zinc in ounces for two sides. A galvanized coating of 0.005 in. thickness would be double the weight of a single square foot of zinc coating, or 5.28 ounces. An aluminum coating 0.005 in. thick provides a coating of approximately 1.0 ounces per square foot of surface.

C. To apply a zinc coating 0.005 in. thick requires the spraying of approximately 0.25 pounds (4.0 ounces) per square foot. To apply an aluminum coating 0.005 in. thick requires the spraying of approximately 0.07 pounds (1.12 ounces) per square foot. This takes into consideration the average deposition efficiency of metallizing equipment, but does not allow for edge or other losses.

302. Spraying Procedure:

A. Clean, dry air should be used with not less than 50 psi air pressure at the air regulator. Not more than 50 ft. of $\frac{3}{8}$ in. ID hose should be used between the air regulator and metallizing gun.

B. The metallizing gun should be lighted and adjusted with the spray directed away from the work. During the spraying operation and depending upon the equipment being used, the gun should be held from 3 to 10 inches from the surface of the work.

C. Any surface that exhibits visible moisture, rust, scale or other contamination should be reblasted before spraying. At least one layer

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of the coating must be applied within four hours of blasting and the surface must be completely coated to the specified thickness within eight hours of blasting. It is preferable, however, to apply the full thickness of metal within two hours after blasting.

D. Where the coating is being applied manually, multiple passes should be used, preferably 0.001 in. to 0.003 in. thick, and in no case should less than two passes be made over the surface. The sprayed metal should overlap on each pass of the gun to assure uniform coverage.

Section IV – Additional Protective Measures

401. Purpose:

Sealing treatments are generally recommended to improve corrosion resistance, to enhance appearance, or both. The minimum treatment fills the sub-surface pores and confines corrosion to the surface of the coating. More elaborate treatments fill the surface irregularities so as to provide a smooth, attractive surface that will not tend to absorb and retain atmospheric contaminants. In industrial atmospheres, unsealed coatings soon become dark and unsightly and usually develop voluminous corrosion products. In seacoast and industrial areas, unsealed coatings may develop blisters because of corrosion beneath the surface.

402. Seal Materials:

Materials used for sealing should be selected on the basis of proven compatibility with the metal to be sealed. A zinc chromate primer is generally recommended for severe conditions. The primer should be thinned sufficiently to penetrate thoroughly. If a wash primer is used, the PVB (Polyvinyl Butyral) type containing not over four percent phosphoric acid is recommended. Sealers used include vinyls, epoxies, phenolics, and silicone-base formulations. The manufacturers of flame-spray equipment can usually recommend suitable sealers.

Sealing materials and their compositions that have given excellent results (except chlorinated rubber) are listed in AWS C2.11-67 "Corrosion Tests of Metallized Coated Steel – 12 Year Report."

403. Application:

Seal and finishing coats must be applied to clean, dry surfaces. These coatings can be applied by brush or spray. Pressure-type spray guns should be used, but any oil, grease or other contamination should be removed by thorough washing with a suitable thinner until no visible traces remain. The rinsed surfaces should be allowed to dry thoroughly

before applying the sealers. Seal coats must be applied heavily enough to produce a thoroughly wet appearance. First coats must be properly thinned to provide complete wetting of the metallized coating.

Section V – Inspection

501. Abrasives:

Abrasive should be checked periodically to determine that it conforms to the requirements of Section 203.

502. Surface:

A. The blasted surfaces should be inspected visually and approved as suitable for metallizing before moving and dismantling the blast equipment. A sample steel plate should be blasted until the surface cannot be further cleaned or roughened. This should be used for visual comparison. Any areas that do not compare favorably with this plate, as to roughness or cleanliness, should be reblasted.

B. "Photographic Standards for Surface Preparation" are available from the Steel Structures Painting Council for comparison. In addition their publication "White Metal Blast" could be helpful.

503. Zinc or Aluminum Coatings:

A. The metal coating should be inspected for thickness by means of a magnetic thickness gage. Inspection should follow as closely as possible after completion of the spraying. Unless a minimum thickness is specified, the coating thickness at any point should not be less than seventy-five percent of the nominal thickness.

B. The inspector may cut through the coating with a knife or chisel. If upon doing so, any part of the coating lifts away from the base metal $\frac{1}{4}$ in. or more ahead of the cutting blade without cutting the metal, then the bond is not effective.

C. Defective areas should be blasted clean prior to respraying, except where the rejection has been caused solely by inadequate coating thickness. Additional sprayed metal can be added if the surface is dry and free of visible contamination or surface damage.

504. Seal Coats:

The inspector should verify that seal coats have been applied in accordance with Section IV, and that the coating completely and uniformly covers the sprayed metal.

Section VI—

Typical Coatings for Various Exposures

601. General:

A. In using this section it is important to recognize that each application must be evaluated on the basis of the actual conditions to be encountered in service. The examples given herein are intended only as a guide but will be helpful in arriving at final coatings for a given job.

B. All thicknesses given in this section are nominal thicknesses.

C. The code used in the following sections is as follows:

CODE: Al — Aluminum

Zn — Zinc

PR — Wash primer, low in phosphoric acid

AV — Aluminum Vinyl (Aluminum Pigmented Vinyl)

CV — Clear Vinyl

SA — Silicone Aluminum (Aluminum
Pigmented Silicone)

Note: A suitable vinyl color code may be substituted for AV where required.

602. Salt, Highly Humid, and Industrial Atmospheres:

A. Light 0.004 in. Al, 1 coat PR, 1 coat AV

B. Heavy 0.006 in. Al, 1 coat PR, 2 coats AV

C. For use on work having areas which are not fully accessible. 0.004 in. Zn, 1 coat PR, 2 coats AV

603. Rural Atmospheres:

A. 0.004 in. Al, 1 coat PR, 1 coat AV

B. 0.003 in. Zn, 1 coat PR, 1 coat AV

C. For areas which are not fully accessible, use 0.003 in. Zn without subsequent treatment.

604. Tank Interiors:

A. Salt water under 120°F,
and cold (under 60°F) fresh
water of pH less than 6.5

0.006 in. Al, 1 coat PR, 2 coats CV

B. Fresh water under 125°F
and over 6.5 pH.

0.010 in. Zn, No subsequent
treatment

605. Ship, Boat and Barge Hulls:

A. For super structures where
there would normally be no
direct spray and where
painting is maintained for
appearance.

0.004 in. Al, 1 coat PR, 1 coat AV

B. Above water line

0.006 in. Al, 1 coat PR, 2 coats AV

C. For steel decks with light
traffic

0.006 in. Al, 1 coat PR, 2 coats AV

D. As a base for an effective
vinyl anti-fouling system

0.006 in. Al, 1 coat PR

E. Below water line where
fouling is not a problem

0.006 in. Al, 1 coat PR, 2 coats CV

F. Fish holds and tanks

0.006 in. Al, 1 coat PR, 2 coats CV

G. Bottom interior exposed
to bilge water

0.006 in. Al, 1 coat PR, 2 coats CV

H. Chain lockers

0.006 in. Al, 1 coat PR, 2 coats CV

606. Steel Pilings:

A. From just below mud line
to 3 ft. above high water line

0.006 in. Al, 1 coat PR, 2 coats CV

B. Balance of piling
above water

0.006 in. Al, 1 coat PR, 2 coats AV

607. General:

For use instead of galvanizing,
plating or baked phenolics

0.003 in. Zn, No subsequent
treatment.

608. High Temperature Protection:

For exposures to atmosphere
where temperatures up to
900°F are continuous or
intermittent

0.006 in. Al, 2 coats SA

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