Preparing Activity: USACE Superseding
UFGS-09 97 01.00 10 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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METALLIC COATINGS FOR HYDRAULIC STRUCTURES
08/21

NOTE: This guide specification covers the requirements for preparation of surfaces and application of metallized coatings for hydraulic structures. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTES: The protective metallic coating systems listed have limited applicability at this time. Some states and municipalities have stringent regulations governing the use of architectural coatings containing volatile organic compounds (VOC). Many of the coating systems found in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, do not meet VOC regulations in some regions of the country.

The coating systems contained herein are suitable substitutes for the paint systems in Section 09 97 02 and may be used should air pollution regulations so

dictate. It should be noted that some of the sealer and paint coats recommended in this guide may also not be VOC-compliant in some regions of the country.

The use of metallizing system 6-Z-A is advocated for use on steel immersed in very turbulent, ice- and debris-laden fresh waters. Exposures such as this may erode and cause total failure of the standard abrasion-resistant paint systems found in Section 09 97 02 in as little as 1 year. System 6-Z-A, with appropriate sealing and top coating, will provide superior protection for this type of severe service.

The use of metallizing system 8-A is endorsed for high temperature atmospheric exposures. Paint coatings do not generally perform as well as thermal spray coatings of aluminum for high temperature exposures such as stacks. The use of metallizing system 6-Z-A is recommended for use as a zebra mussel repellent coating where the use of such a coating is deemed necessary. System 6-Z-A is longer lived and has a lesser environmental impact than conventional copper-containing antifouling coatings. The use of this guide specification should be limited to work described in this note.

The metallizing systems described in this document are intended for corrosion protection of cold and hot rolled steel. Metallizing systems described herein are not intended for use on stainless steel, aluminum, bronze, copper, plastic, rubber, wood, masonry, and painted surfaces. Coating systems contained herein should not be specified for potable water tank interiors, moving parts or wear surfaces of machinery, or for surfaces subject to strong acids or bases.

For further technical assistance contact:

US Army Construction Engineering Research Laboratory
Attn: CECER-FL-M (Tel 217-373-7237)
P.O. Box 9005
Champaign, IL 61826-9005

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1.1 LUMP SUM PRICE

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (LUMP SUM PRICE) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

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1.1.1 Payment

Payment will constitute full compensation for furnishing all plant, labor,

materials and equipment and performing all operations necessary for metallizing hydraulic structures as specified.

1.1.2 Unit of Measure

Unit of measure: Lump Sum

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR QUALITY (ASQ)

ANSI/ASQ Z1.4	(2008; R 2013) Sampling Procedures and Tables for Inspection by Attributes

AMERICAN WELDING SOCIETY (AWS)

AWS A5.01M/A5.01	(2013) Procurement Guidelines for Consumables - Welding and Allied Processes - Flux and Gas Shielded Electrical Welding Processes
AWS C2.25/C2.25M	(2012; R 2018) Specification for Thermal Spray Feedstock -- Solid and Composite Wire and Rods
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM D3951	(2018) Commercial Packaging
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air

ASTM D4417	(2021) Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D7091	(2021) Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nondestructive Coatings Applied to Non-Ferrous Metals
ASTM E337	(2015; R 2023) Measuring Humidity with a Psychrometer (The Measurement of Wet- and Dry-Bulb Temperatures)

COMPRESSED GAS ASSOCIATION (CGA)

CGA P-1	(2022) Standard for Safe Handling of Compressed Gases in Containers; 13th Edition

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices
ANSI/ISEA Z89.1	(2014; R 2019) American National Standard for Industrial Head Protection

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 2003-154	(2003; 4th Ed; Supple 3) NIOSH Manual of Analytical Methods

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC AB 1	(2015; E 2017) Mineral and Slag Abrasives
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2003; E 2004) Ferrous Metallic Abrasive
SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety -- Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.20	Access to Employee Exposure and Medical Records
29 CFR 1926	Safety and Health Regulations for Construction
42 CFR 84	Approval of Respiratory Protective Devices

1.3 DEFINITIONS

1.3.1 Metallizing

Refers to any of several application methods for depositing sprayed-metal coatings.

1.3.2 Wire Flame-Spray

A metallizing process in which metallic wire is melted in an oxygen and fuel gas flame and is dispersed with an airstream.

1.3.3 Arc-Spray

A metallizing process in which metallic wire is melted by an electric arc and is dispersed with an airstream.

1.4 SYSTEM DESCRIPTION

Prepare a thermal spray Job Reference Standard (JRS) at the jobsite prior to the onset of production work. The JRS is used at the initiation of the contract to qualify the surface preparation, thermal spray application, and sealing processes and also serves as a standard of quality in case of dispute. To prepare the JRS, solvent and abrasive blast clean a steel plate measuring 600 x 600 x 10 mm 2 feet x 2 feet x 3/8 inch of the same alloy as the surfaces to be metallized in accordance with the requirements of the contract. Use the same abrasive blast media and equipment that will be used on the job. Mask one-fourth of the JRS plate with sheet metal and apply thermal spray coating to the unmasked portion of the plate. Apply the thermal spray coating using the same equipment, approved wire, and spray parameters to be used on the job. Operate the gun in a manner substantially the same as will be used on the job. Measure and record the approximate traverse speed and standoff distance during spraying. Once the JRS is qualified, the operating parameters must not be altered, except as necessitated by the requirements of the job. Seal two-thirds of the thermal spray coated portion of the JRS in accordance with the requirements of the contract. Paint one-half of the sealed area in accordance with the contract if applicable. Apply the sealer and paint using the same paint spray equipment that will be used for production. Preserve and protect the prepared JRS in such a manner that it remains dry and free of contaminants for the duration of the contract. The Coating Inspector will verify and record surface cleanliness, blast profile shape and depth, thermal spray appearance, thickness, and adhesion, and sealer and paint thicknesses in accordance with the contract requirements.

1.4.1 General Requirements

Perform the work in accordance with the requirements of 29 CFR 1910, 29 CFR 1926, EM 385-1-1, and other references as listed herein. Submit matters of interpretation of the standards to the Contracting Officer for resolution before starting work. Where the regulations conflict, the most stringent requirements apply. This paragraph, with its subparagraphs, supplements the requirements of EM 385-1-1. In any conflict between Section 01 of EM 385-1-1 and this paragraph, the provisions herein govern. Submit a Safety Indoctrination Plan as specified in the Submittals paragraph.

1.4.2 Worker Hazard Communication Program

Submit the written program describing how the program is to be implemented, labels and other forms of warning, Safety Data Sheets(SDS), chemical inventory, employee information and training, methods the Contractor will use to inform employees of hazards associated with nonroutine tasks and unlabeled pipelines, and the methods the Contractor will use to inform Government employees and subcontractors of chemical hazards. The program must discuss the following items: 1) Treatment of airborne metal dusts, finely divided solids, or other particulate accumulations as explosive materials. 2) Maintaining proper ventilation, good housekeeping, and safe work practices to prevent the possibility of fire and explosion. 3) Danger of pointing thermal-spray equipment at a person or flammable material. 4) Avoiding thermal spraying in areas where paper, wood, oily rags, or cleaning solvents are present. 5) Use of conductive safety shoes in any work area where explosion is a concern. 6) Wearing of protective coveralls or aprons, hand protection, eye protection, hearing protection, and respiratory protection during metallizing operations, including the preparation and finishing processes. 7) Preparation and implementation of the Accident Prevention Plan as specified in the Submittals paragraph.

1.4.3 Surface Preparation Procedures

1.4.3.1 Abrasive Blasting

Ventilation and exhaust systems must comply with the requirements in Section 06.H of EM 385-1-1.

1.4.3.2 Hoses and Nozzles

In addition to the requirements in Section 20 of EM 385-1-1, use hoses and hose connections of a type to prevent shock from static electricity. Join hose lengths together by approved couplings of a material and type designed to prevent erosion and weakening of the couplings. The couplings and nozzle attachments must fit on the outside of the hose and be designed to prevent accidental disengagement.

1.4.3.3 Workers other than Blasters

Protect workers other than blasting operators, working in close proximity to abrasive blasting operations, by utilizing MSHA/NIOSH-approved half-face or full-face air purifying respirators equipped with high-efficiency particulate air (HEPA) filters, eye protection meeting or exceeding ANSI/ISEA Z87.1 and hearing protectors (ear plugs and/or ear muffs) providing at least 20 dBA reduction in noise level.

1.4.3.4 Personal Protective Equipment

Blasting operators must wear heavy canvas or leather gloves and apron or coveralls. Safety shoes must be worn to protect against foot injury. Hearing protection must be used during all blasting operations.

1.4.4 Metallizing Equipment

Submit for approval a tabulated list of equipment to be used on the job, including operating instructions.

1.4.4.1 Pressure Systems

Handle compressed gas cylinders in accordance with AWS Z49.1 and with CGA P-1. Use only special oxidation-resistant lubricants with oxygen equipment; do not use grease or oil. Install manifolding and pressure reducing regulators, flow meters, hoses, and hose connections in accordance with AWS Z49.1. Draw up tight, but do not over-tighten pressure connecting nuts. Replace any fitting if it cannot be sealed without excessive force. Use compressed air for thermal spraying or blasting operations only at pressures recommended by the equipment manufacturers. The air-line must be free of oil and moisture. Compressed air, oxygen, or fuel gas must not be used to clean clothing.

1.4.4.2 Flame-Spray Equipment

Maintain and operate flame-spray equipment according to the manufacturer's instructions. Metallizing operators must be fully trained in and familiar with specific equipment before starting an operation. Valves must be properly sealed and lubricated. Use friction lighters, pilot light, or arc ignition methods of lighting flame-spray guns. If a gun backfires, extinguish it as soon as possible. Do not attempt to reignite a gun that has backfired or blown out until the cause of the trouble has been determined. Do not hang flame-spray guns or hoses on regulators or cylinder valves. Release gas pressure from the hoses after equipment is shut down or when equipment will be left unattended. The pressure release sequence is as follows:

a. Close gun valves.

b. Close cylinder valve.

c. Open gun valves.

d. Turn regulator screw out until free.

e. Close gun valves.

f. Close tank valve or manifold valve ahead of regulator.

Do not allow oil to enter the gas mixing chambers when cleaning flame-spray guns. Use only special oxidation-resistant lubricants on valves or other parts of flame-spray guns that are in contact with oxygen or fuel gases.

1.4.4.3 Arc-Spray Equipment

Maintain and operate arc-spray equipment according to the manufacturer's instructions. Metallizing operators must be fully trained in and familiar

with specific equipment before starting an operation.

1.4.5 Cleaning

1.4.5.1 Compressed Air

Perform cleaning with compressed air in accordance with Section 20.B.5 of EM 385-1-1; protect personnel as specified in 29 CFR 1910, Part 139.

1.4.5.2 Solvents

Provide ventilation where required by 29 CFR 1910, Part 146 or where the concentration of solvent vapors exceeds 10 percent of the Lower Explosive Limit (LEL). Ventilation must be in accordance with 29 CFR 1910, Part 94, paragraph (c)(5). Sources of ignition are not permitted in the vicinity of solvent cleaning if there is any indication of combustible gas or vapor present. Take special precautions when metallizing materials that have been cleaned with hydrocarbon solvents. Make specific measurements to ensure that such solvent vapors are not present during metallizing operations, especially in confined spaces. Submit Confined Space Procedures as specified in the Submittals paragraph and including requirements for toxic materials and air sampling in confined spaces, as specified below. Collect representative air samples from the breathing zone of workers involved in the cleaning process to determine the specific solvent vapor concentrations. Provide personal protective equipment where required by 29 CFR 1910, Part 146 and in accordance with 29 CFR 1910, Subpart I.

1.4.6 Other Submittals Requirements

Submit the following:

a. SDS for all products required to have them as specified in 29 CFR 1910, Part 1200 plus documentation of the safety indoctrination plan as described in Section 01.B of EM 385-1-1.

b. An Accident Prevention Plan, in accordance with the requirements of Section 01 of EM 385-1-1, including, but not limited to, each of the topic areas listed in Appendix A therein and the specified requirements. Develop each topic in a concise manner to include management and operational aspects.

c. Detailed written standard operating procedures for confined spaces in accordance with 29 CFR 1910, Part 146 and Section 6.I. of EM 385-1-1. The procedures must include:

(1) Certificates of calibration for all testing and monitoring equipment including: type of equipment, model number, date of calibration, firm conducting calibration, and signature of individual certifying calibration.

(2) Methods of inspection of personal protective equipment prior to use.

(3) Work practices and other engineering controls designed to reduce airborne hazardous chemical exposures to a minimum.

(4) Specification of the design and installation of ventilation systems which must provide adequate oxygen content and provide for

the dilution of paint solvent vapor, lead, and other toxic particulates within the confined space. Include plans to evaluate the adequacy of air flow patterns.

d. A comprehensive written respiratory protection program in accordance with 29 CFR 1910, Part 134, 29 CFR 1926, Part 62, and Section 05.G of EM 385-1-1. Include an Airborne Sampling Plan detailing the NIOSH 2003-154, Factory Mutual, or Underwriters Laboratories requirements.

e. A written plan for ventilation assessments to be performed by a qualified person for all confined-space work, solvent cleaning, abrasive blasting, and metallizing operations.

f. A written Hazard Communication Program as required by 29 CFR 1910, Part 1200.

g. A tabulated list of metallizing equipment to be used on the job and a listing of the type, brand name, size gradation, and supplier of each type of abrasive blast media to be used on the job.

h. A written record of physical examinations provided to all employees who may be required to wear a respirator, who may be exposed to excessive noise levels, or who may be exposed to toxic contaminants, including statements signed by the examining physician for each employee stating that the exam included the minimum requirements and that the employee is medically fit to perform the work.

i. Documentation of the Contractor's qualifications and experience. Prior to submission of other required safety and health submittal items, a statement of qualifications and experience for the Competent Person. Documentation of coating inspector qualifications and experience.

j. A working standard of the metallized coating. A 1 kg 2.2 lb unused sample of each blast media to be used on the job. And one liter quart samples of each type and batch of sealer and paint to be used on the job.

k. A 300 mm 12 inch sample of each lot and type of wire to be used on the job. Store batches or lots of metallizing wire at the project site or segregate them at the source of supply sufficiently in advance of need to allow 30 days for sampling and testing. Notify the Contracting Officer when and where the metallizing wire is available for sampling. Perform all sampling in accordance with ANSI/ASQ Z1.4. Sampling of each lot will be witnessed by a representative of the Contracting Officer unless otherwise specified or directed. Samples of metallizing wire must be clearly labeled to indicate type of coating material, lot number, date, name of manufacturer, total weight represented by lots, and contract number.

l. A test report showing the results of the required tests performed on the metallized coating test plates for each applicator and a statement that the specified requirements are met. A test report showing the results of the tests required for the metallizing wire and the arc spraying equipment qualification. A test report showing the results of the required tests performed on the Job Reference Standard (JRS) and a statement that all of the contract requirements of surface preparation, metallized coating, sealing, and painting are represented

by the JRS.

m. Certificates of qualifications for each Coating Inspector. And manufacturer's certificates of compliance.

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Safety Data Sheets

Accident Prevention Plan; G[, [_____]]

Confined Space Procedures; G[, [_____]]

Respiratory Protection Program; G[, [_____]]

Airborne Sampling Plan; G[, [_____]]

Ventilation Assessment Plan; G[, [_____]]

Worker Hazard Communication Program; G[, [_____]]

Metallizing Equipment; G[, [_____]]

Abrasive Media; G[, [_____]]

Contractor Qualifications and Experience

Competent Person Qualifications and Experience; G[, [_____]]

Safety Indoctrination Plan; G[, [_____]]

SD-04 Samples

Job Reference Standard (JRS)

Blast Media

Metallizing Wire

Sealer and Paint; G[, [_____]]

SD-06 Test Reports

Applicator Qualification Test

Metallizing Wire

Arc Spray Equipment Qualification

Job Reference Standard (JRS); G[, [_____]]

SD-07 Certificates

Coating Inspectors

Coating Thickness Gages

1.6 QUALITY ASSURANCE

1.6.1 Contractor Qualifications and Experience

The contractor must have a minimum of two years of documented experience in the field of thermal spray and have performed at least one similar project in the past.

1.6.2 Arc Spray Equipment Qualification

Each type and model of arc spray equipment to be used on the job must be qualified in accordance with the requirements of this subpart. Under conditions of continuous use, the equipment must be capable of keeping the actual current output, voltage, wire feed rate, atomization air pressure, and flow volume at set values and not deviate from them by more than 5

percent during a 15 minute period. The wire feed mechanism must be designed for automatic alignment. When operated continuously for 15 minutes the equipment and not sputter, pop, or stop operating. The equipment must be capable of continuous start and stop operation for a minimum of fifteen cycles consisting of 10 seconds on and 5 seconds off, without fusing, sputtering or deposition of nodules. The applied coating must be uniform and free of blisters, cracks, loosely adherent particles, nodules, or powdery deposits. The required measurements of operating performance must be conducted and documented by the qualified Coating Inspector.

1.6.3 Metallizing Applicator Qualification

Perform the Applicator Qualification Test in the presence of the Contracting Officer unless otherwise specified or directed. Qualify each worker to apply metallized coatings on the job in accordance with the requirements of this paragraph. Use test plates to qualify applicators at the start of a job that are 305 x 305 x 9.5 mm 12 x 12 x 0.375 inch flat steel and are of the same chemical composition as the work surfaces to be coated. The cleaning method and abrasives used to prepare the test plate are the same as that to be used on the work surfaces. Measure and record the blast profile in accordance with ASTM D4417, Method C. Apply the specified coating thickness in not less than two half lapped passes applied at right angles to each other. Test the adhesive strength in accordance with ASTM D4541 using a self-aligning Type IV adhesion tester. Measure and record the adhesion strength at five randomly selected locations. The average adhesion must not be less than [6.9 kPa 1000 psi for 85-15 zinc-aluminum alloy] [11 kPa 1600 psi for aluminum] [5.2 kPa 750 psi for zinc]. Any test plate with an average adhesion value below the requirements of this paragraph or any plate with a single adhesion measurement of less than 80-percent of the specified minimum average adhesion value will be rejected. If the test fails repeat the test using a new test plate. If the test fails on the second plate the applicator will be deemed unacceptable. The specified surface profile and adhesion tests must be conducted and documented by the qualified Coating Inspector.

1.6.4 Coating Inspector Qualifications and Experience

****

NOTE: Specify NACE Basic for most projects, NACE Certified for large or complex projects. The specifier may add a requirement for the qualified coating inspectors to be employed by an independent 3rd party inspection firm.

****

Submit documentation of certification for all coating inspectors. The minimum certification requirement is a [Basic] [Certified] Inspector under the National Association of Corrosion Engineers Coating Inspector Training and Certification Program. The documentation must include the NACE inspector identification numbers, date of qualification, and expiration date. In addition to certification all coating inspectors must as a minimum have performed coating inspection on at least one previous thermal spray job or have attended an SSPC tutorial on thermal spray coating application.

1.6.5 Metallized Coating Thickness Gage Qualification

Submit documentation of certification for all coating thickness gages.

Use magnetic flux-type thickness gages, as described in ASTM D7091, Method B, to make all metallized coating thickness measurements. Thickness gages used on the job must be certified by the gage manufacturer as having an accuracy of 3 percent or better.

1.6.6 Competent Person Qualifications and Experience

Utilize a qualified and competent person, as defined in Section 01 of EM 385-1-1, to develop the required safety and health submittal and to provide onsite safety and health services during the contract period. The person must be a Certified Industrial Hygienist (CIH), an Industrial Hygienist (IH), or a Certified Safety Professional (CSP) with a minimum of 3 years of demonstrated experience in similar related work. Certify that the Certified Industrial Hygienist (CIH) holds current and valid certification from the American Board of Industrial Hygiene (ABIH), that the IH is considered board eligible by written confirmation from the ABIH, or that the CSP holds current and valid certification from the American Board of Certified Safety Professionals. The CIH, IH, or CSP may utilize other qualified and competent persons, as defined in EM 385-1-1, to conduct onsite safety and health activities as long as these persons have a minimum of 3 years of demonstrated experience in similar related work and are under the direct supervision of the CIH, IH, or CSP.

1.6.7 Safety and Health Provisions

1.6.7.1 Electrical Shock Prevention

Control of electrical shock must include, but is not limited to, the following:

a. Properly maintain all cords and ground protection in good condition. Any damaged cords or grounding equipment must be immediately repaired or replaced. Cords must not be spliced.

b. Cords must be approved for wet or damp locations and be rated for hard usage or extra hard usage as specified in NFPA 70.

c. Use Ground Fault Circuit Interrupters (GFCI) in addition to appropriate overcurrent protection on all electrical outlets.

d. Switches and receptacles must have proper covers. Circuit breaker boxes must be closed.

e. Test all electrical circuit grounds and GFCI before beginning any actual work.

1.6.7.2 Respiratory Protection Program

Use appropriately certified respiratory equipment to protect the health of each employee who may be exposed to air contaminants. Select appropriate respirators from those currently approved and certified by NIOSH under the provisions of 42 CFR 84 and 29 CFR 1910, Part 134.

1.6.7.3 Eye Protection

Use helmets, handshields, faceshields, and goggles conforming to ANSI/ISEA Z87.1 and ANSI/ISEA Z89.1 to protect the eyes from infrared and ultraviolet radiation and flying particles during spraying or blasting operations. Provide helpers and adjacent operators with proper eye

protection. Supplement faceshields with safety goggles.

1.6.7.4 Hearing Protection

Provide protection against the effects of noise exposure in accordance with EM 385-1-1, Section 5, "Personal Protective and Safety Equipment," Subsection 05.C, "Hearing Protection and Noise Control," and 29 CFR 1910, Part 95.

1.6.7.5 Protective Clothing

Appropriate protective clothing is required for spray or blast operations.

1.6.7.6 Ventilation

Provide engineering controls, including local exhaust or general ventilation systems, to control toxic fumes and gases to the extent necessary. When toxic particulates are removed from a work area, use a dust collector to trap the dust and prevent contamination of the surrounding areas and the general environment. Submit a Ventilation Assessment Plan as specified in the Submittals paragraph.

1.6.7.7 Toxic Materials

Perform metallizing only with appropriate respiratory protection and adequate ventilation. When metallizing in a confined space provide either general or local ventilation. If ventilation cannot reduce exposures to safe levels, use respirators to reduce employee exposure to acceptable levels.

1.6.7.8 Air Sampling

Perform periodic air sampling as necessary to ensure that confined spaces are maintained within the limits of the acceptable entry conditions. Submit an Airborne Sampling Plan including a listing of approved equipment, equipment calibration procedures, sampling methods, sampling to be performed, and analytical procedures to be used based on the type of work to be performed and anticipated toxic contaminants to be generated. Include the name of the accredited laboratory, listed by the American Industrial Hygiene Association (AIHA), to be used to conduct the analysis of any collected air samples.

1.6.7.9 Medical Status

Prior to the start of work, and annually thereafter, submit a Medical Status Report. Medically evaluate all Contractor employees working with or around paint systems, thinners, blast media, flame- or arc-spray operations, those required to wear respiratory protective equipment, and those who will be exposed to high noise levels for the particular type of exposure they may encounter. The Report must include the employee's name, the tests performed, the name of the physician responsible for performing the tests, and a physician's statement that the employee's medical status would permit specific task performance. Maintain medical records as required by 29 CFR 1910.20. The evaluation must include:

a. Audiometric testing and evaluation of employees who will work in a noise environment with a time weighted average greater than or equal to 85 dBA.

b. Vision screening of employees who will require eye protection (employees who use full-facepiece respirators cannot wear contact lenses).

c. Medical evaluation of employees who will be required to wear respiratory protection must include, but is not limited to, the following:

(1) Medical history including, but not limited to, alcohol use, with emphasis on liver, kidney, and pulmonary systems, and sensitivity to chemicals to be used on the job.

(2) General physical examination with emphasis on liver, kidney, and pulmonary system.

(3) Determination of the employee's physical and psychological ability to wear respiratory protective equipment and to perform job-related tasks.

(4) Determination of baseline values of biological indices for later comparison to changes associated with exposure to paint systems and thinners or blast media, which include: liver function tests to include SGOT, SGPT, GGPT, alkaline phosphates, bilirubin, complete urinalysis, EKG (employees over age 40), blood urea nitrogen (bun), serum creatinine, pulmonary function test, FVC, and FEV, chest x-ray (if medically indicated), blood lead and ZPP (for individuals where it is known there will be an exposure to materials containing lead), other criteria that may be deemed necessary by the Contractor's physician.

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NOTE: 29 CFR 1926.62 Lead requires the development of a Worker Protection Plan for jobs involving removal of lead-containing coatings. It is the specifier's responsibility for determining when lead-containing paint will be removed and requiring the appropriate submittals including environmental compliance, worker protection, and waste management.

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1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Metallizing Wire

Package, ship, and store metallizing wire in conformance with ASTM D3951. Commercial packaging used for distribution directly to a using customer or subsequent redistribution is required to protect items against physical and environmental damage during shipment, handling, and storage. Clearly and durably label individual spool containers and shipping containers to indicate contract numbers, specification number, material type, lot number, net weight, date of manufacture (month and year), wire diameter, and manufacturer's and distributor's name. Deliver metallizing wire to the job in unbroken containers. Store all metallizing wire under cover from the elements.

1.7.2 Sealers and Paints

Process and package sealers and paints to ensure that within a period of

one year from date of manufacture, they will not gel, liver, or thicken deleteriously, or form gas in the closed container. Package sealers and paints, unless otherwise specified or permitted, in standard containers not larger than 20 L 5 gallons, with removable friction or lug-type covers. Label each container or separately packaged component thereof to indicate the purchaser's order number, date of manufacture, manufacturer's batch number, quantity, color, component identification and designated name, and formula or specification number of the paint together with special labeling instructions, when specified. Deliver materials to the job in unbroken containers. Store sealers and paints, that can be harmed by exposure to cold weather, in ventilated, heated shelters. Store all sealers and paints under cover from the elements and in locations free from sparks and flames.

1.8 ENVIRONMENTAL REQUIREMENTS

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NOTE: Minimum and maximum application temperatures should be specified for metallized coating-sealer duplexes. The established limits for sealer and paint topcoats should be specified for the entire system. Vinyl sealers and paints are generally limited to a minimum application temperature of 2 degrees C 35 degrees F. All other sealers and topcoats have a minimum application temperature of 10 degrees C 50 degrees F. If no sealer or paint is to be applied then the minimum application temperature is unlimited, however, a practical limit of 2 degrees C 35 degrees F is recommended.

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Apply metallic coatings only to surfaces that are a minimum of 3 degrees C 5 degrees F above the dew point and that are completely free of moisture as determined by sight and touch. Do not apply metallic coatings to surfaces upon which there is detectable frost or ice. Metallized coatings must not be applied when ambient and surface temperatures are below or are expected to drop below the minimum application temperature prior to completion of metallizing and curing of the sealer and paint. The minimum application temperature is equal to that specified by the manufacturer of the sealer or paint but not below 0 degrees C 32 degrees F. During periods of inclement weather characterized by extremes of humidity and temperature, metallizing may be continued by enclosing the work area and providing conditioned air, provided the proscribed ambient, surface, and dew point temperatures are maintained.

PART 2 PRODUCTS

2.1 METALLIZING WIRE

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NOTE: For quick guidance to the first choice metallizing system, for steel surfaces in each of several exposure conditions frequently incurred on projects, the following will be helpful:

Normal atmospheric exposures - Systems No. 1-Z and 4-Z-A.

Severe industrial atmospheric exposures - Systems

No. 2-Z and 5-Z-A.

Prolonged condensation or immersion in relatively quiet, nonabrasive waters - System No. 5-Z-A.

Industrial atmosphere where longer service life is desired - Systems No. 3-Z and 6-Z-A.

Immersion in turbulent, ice- and debris-laden, abrasive waters - System No. 6-Z-A.

Zebra mussel control in fresh water immersion - System 6-Z-A.

Marine (salt) atmospheric exposures - System No. 7-A.

High temperature steel - System No. 8-A.

Immersion in sea water - System No. 8-A.

The following note paragraphs provide additional, useful information regarding the use of the different metallizing systems for specific applications.

For structural components that are only partially submerged, such as tainter gates, the designer should consider specifying a thicker system on the immersed surfaces and a thinner system on the atmospherically exposed surfaces. Systems using different metallizing materials should not be used for such applications. The use of multiple protective coating systems tailored to a specific structure may result in significant cost savings.

Systems No. 1-Z and 4-Z-A are considered equivalent and may be interchanged by the project specification writer. Systems No. 1-Z and 4-Z-A are intended for use on steel surfaces in normal atmospheric exposures.

Systems No. 2-Z and 5-Z-A are considered equivalent for atmospheric exposures only and may be interchanged by the project specification writer for this use. Systems No. 2-Z and 5-Z-A are intended for use on steel surfaces in normal and severe industrial atmospheres and for steel surfaces subject to prolonged periods of condensation. System 5-Z-A may also be used on steel surfaces in continuous or intermittent immersion in relatively quiet, nonabrasive fresh water.

For atmospheric exposures only, systems No. 3-Z and 6-Z-A are considered equivalent and may be interchanged by the project specification writer. Systems No. 3-Z and 6-Z-A may be used for steel surfaces exposed in normal and industrial atmospheres when a longer service life than would be provided by systems No. 2-Z or 5-Z-A is desired.

System No. 6-Z-A is intended primarily for use on steel surfaces immersed in fresh waters.

System 6-Z-A is recommended for applications where a coating that prevents zebra mussel fouling is required.

System No. 7-A is recommended for use on steel surfaces in marine (salt) atmospheric exposures.

Metallizing system No. 8-A is recommended for use on high-temperature steel at temperatures up to 900 degrees C 1650 degrees F and for steel immersed in seawater. System No. 8-A may also be used for extended service on marine (salt) atmospheric steel.

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Have the wire tested by a commercial laboratory or by the manufacturer of the wire. Acceptance of metallizing wire is based on the testing requirements described in AWS A5.01M/A5.01 Schedule H (chemical analysis). The tested wire must conform to the compositional requirements specified in AWS C2.25/C2.25M for [99.99 Zinc] [1100 Aluminum] [85/15 Zinc-Aluminum] wire. Submit a report of the test results.

2.2 SEALER AND PAINT

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NOTE: See paragraph SPECIAL PAINTING INSTRUCTIONS for instructions not found in Section 09 97 02.

Metallizing systems will provide excellent atmospheric corrosion protection for extended periods without sealing or painting. However, painting is recommended to extend the life of the metallic coating, and in some cases, to achieve a desired appearance. Painting systems found in Section 09 97 02 may be used to seal and paint the metallized surface. It is often convenient to paint metallized surfaces with identical paint systems employed on adjacent or contacting surfaces that have not been metallized. Paint systems No. 3, 4, and 5-D are suitable for sealing atmospherically exposed portions of partially immersed items such as tainter gates. Systems 13, 14, and a modified version of system 21 where it is topcoated with SSPC Paint 34, are recommended for items only exposed to the atmosphere. Paint systems No. 14 and SSPC Paint 34 are available in safety colors. Paint system 13 provides an aluminum finish. Other coating systems found in Section 09 97 02 are not recommended.

When used for high temperature atmospheric applications system 8-A should not be sealed.

Sealing and painting of the metallized surfaces intended for immersion is generally recommended to extend the life of the metallic coating except that aluminum coatings to be immersed in salt water should not be painted. Paint systems No. 3, 4, 5-D,

and 21 are recommended for immersion applications.

When used as a zebra mussel antifoulant, system 6-Z-A should not be sealed or painted.

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All sealer and paint materials must conform to the requirements of Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

2.3 ABRASIVE MEDIA

Provide angular abrasive blast media capable of producing the specified surface profile listed in paragraph Abrasive Blasting. The blast media must be steel grit, garnet, iron oxide, coal slag, silicon carbide, or aluminum oxide. New steel grit must have a Rockwell C hardness of 51 or greater and conform to the requirements of SSPC AB 3 including paragraph 4.3.3.2 Steel Grit. Steel grit hardness must be Rockwell C of 51 or greater. Recycled steel grit must conform to the requirements of SSPC AB 2 and at no time contain greater than 15 per cent round or half-round particles when viewed under a 10X microscope or magnifying glass. Garnet abrasive must conform to the requirements of SSPC AB 1, Type 1, Class A. Iron oxide abrasive must be a commercial specular hematite material. Coal slag abrasive must conform to the requirements of SSPC AB 1, Type 2, Class A. Silicon carbide and aluminum oxide abrasives must be commercially pure.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Pit, Edge, and Weld Preparation

Grind visibly rough flame-cut steel and weld metal with a disk wheel grinder or other tool to produce a smooth contour prior to abrasive blasting. Perform grinding of flame-cut edges and welds to the extent necessary to etch heat-hardened metal. Grind pits with an aspect ratio of greater than unity (as deep as they are wide) with an abrasive disk or other tool prior to blasting. Pits with sharp edges, undercut pits, and pits with an irregular horizontal or vertical orientation must also be ground smoothto the extent necessary to allow the entire surface of the pit to be blasted and coated. Grind sharp edges prior to abrasive blasting to a uniform minimum diameter of 3 mm 1/8 inch.

3.1.2 Abrasive Blasting

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Note: Consideration should be given to high-pressure water washing when the substrate to be metallized has previously been exposed to a chloride environment. Chloride environments are marine exposures or bridges to which de-icing salts are applied. High-pressure washing should be performed before abrasive blasting.

A profile range is specified and is dependent on the type and thickness of metallizing to be applied. Specify a 0.05 to 0.07 mm 2.0 to 3.0 mil profile for systems 1-Z, 4-Z-A, and 7-A; 0.06 to 0.09 mm 2.5 to 3.5 mils for systems 2-Z, 5-Z-A, and 8-A; and 0.07 to 0.10 mm 3.0 to 4.0 mils for systems 3-Z and 6-Z-A.

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Solvent clean and blast all ferrous surfaces to be metallized to a white metal grade in accordance with SSPC SP 5/NACE No. 1. The surface profile, as measured in accordance with subparagraph Blast Profile, must be between [0.05 and 0.07] [0.06 and 0.09] [0.07 and 0.10] mm [2.0 and 3.0] [2.5 and 3.5] [3.0 and 4.0] mils. Take special care to achieve the specified blast profile on welds and flame-cut edges. In some cases, it may be necessary to either grind these surfaces with a disk wheel grinder or other tool prior to blasting or to use a harder abrasive blast media. If recycled abrasives are used, the particle size distribution of the working mix must be maintained such that a consistent blast profile is obtained. Remove weld spatter not dislodged by blasting with impact or grinding tools and reblast the area to bring the surface to the required profile. Acceptable surfaces must be free of all visible contaminants including moisture, grease, oil, soot, and dust prior to receiving the first or any succeeding coat of metallizing.

3.1.3 Protection

Program cleaning, metallizing, and painting so that dust, dry spray, or other contaminants from the cleaning and painting operations do not contaminate surfaces ready for metallization or painting. Protect surfaces not intended to be metallized from the effects of cleaning and metallizing operations. Protect machinery against entry of blast abrasive and dust into working parts.

3.2 METALLIZING APPLICATION

Set up and operate metallizing equipment in the same manner as used to prepare the JRS. Validate equipment set up and operation using a bend test. The bend test is acceptable if the coating shows no cracks or exhibits only minor cracking with no lifting of the coating from the substrate. If the coating cracks and lifts from the substrate, the results of the bend test are unacceptable. Provide clean and dry compressed air to atomize the metallized coating.

3.2.1 Metallizing Application Technique

Preheat surfaces to be flame sprayed to prevent condensation of the flame on the surface to be coated. Arc spray application does not require preheating of the substrate. Surfaces to be metallized must be free of all visible contaminants including grease, oil, soot, and dust prior to receiving the first and subsequent coats of metallizing. Apply all metallizing coats in such a manner as to produce an even, continuous film of uniform thickness. Give special attention to edges, corners, crevices, seams, joints, welds, rivets, and other surface irregularities to ensure that they receive an adequate thickness of metallic coating. Operate metallizing equipment using qualified applicators in accordance with the manufacturer's recommendations. Overlap each spray pass of the sprayed metal a minimum of 40 percent on each spray pass to ensure uniform coverage. Perform manual spraying in a block pattern not exceeding 600 by 600 mm 2 by 2 feet square. Build up the specified thickness of coating in multiple layers of no fewer than 2 spray coats (overlapping at right angles). Hold the application gun at such a distance from the work surface that the metal remains plastic until impact with the surface. Do not metallize closer than 19 mm 3/4 inch to surfaces that are to be welded.

3.2.2 Metallizing Appearance

The thermal-sprayed coating prior to sealing must have a uniform appearance and not contain any of the following: blisters, cracks, chips or loosely adhering particles, oils or other internal contaminants, pits exposing the substrate, or nodules.

3.2.3 Metallizing Thickness

Coat surfaces with the systems indicated in the metallizing schedule and/or as noted on the drawings in accordance with the following:

3.2.3.1 System No. 1-Z

Apply to a minimum average thickness of 0.15 mm 6.0 mils for the completed system and a thickness at any one spot of not less than 0.12 mm 5.0 mils.

3.2.3.2 System No. 2-Z

Apply to a minimum average thickness of 0.3 mm 12.0 mils for the completed system and a thickness at any one spot of notless than 0.25 mm 10.0 mils.

3.2.3.3 System No. 3-Z

Apply to a minimum average thickness of 0.4 mm 16.0 mils for the completed system and a thickness at any one spot of not less than 0.32 mm 13.0 mils.

3.2.3.4 System No. 4-Z-A

Apply to a minimum average thickness of 0.15 mm 6.0 mils for the completed system and a thickness at any one spot of not less than 0.12 mm 5.0 mils.

3.2.3.5 System No. 5-Z-A

Apply to a minimum average thickness of 0.3 mm 12.0 mils for the completed system and a thickness at any one spot of not less than 0.25 mm 10.0 mils.

3.2.3.6 System No. 6-Z-A

Apply to a minimum average thickness of 0.4 mm 16.0 mils for the completed system and a thickness at any one spot of not less than 0.32 mm 13.0 mils.

3.2.3.7 System No. 7-A

Apply to a minimum average thickness of 0.12 mm 5.0 mils for the completed system and a thickness at any one spot of not less than 0.10 mm 4.0 mils.

3.2.3.8 System No. 8-A

Apply to a minimum average thickness of 0.25 mm 10.0 mils and a thickness at any one spot of not less than 0.20 mm 8.0 mils.

3.2.4 Metallizing Adhesion

The minimum average adhesion of the metallized coating is [6.9 kPa 1000 psi for 85-15 zinc-aluminum alloy] [11.0 kPa 1600 psi for aluminum] [5.2 kPa 750 psi for zinc]. Any coating having an average adhesion value below the requirements of this paragraph or having any single adhesion measurement of less than 80-percent of the specified minimum average adhesion will be

rejected.

3.2.5 Time Between Surface Preparation and Metallizing

Following surface preparation all surfaces approved for metallizing must receive the first coat of metallizing within 4 hours or prior to the appearance of flash rust, whichever is sooner.

3.2.6 Time Between Metallizing and Painting

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NOTE: Dry time prior to immersion, if applicable, should be in accordance with the painting schedule. There is no dry time associated with thermal-spray coatings. A brief cool-down period prior to painting is necessary and may be addressed in the painting schedule by specifying a maximum temperature for surfaces to be sealed.

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Within 8 hours or prior to the appearance of condensation on the receiving surfaces, whichever is sooner, seal approved sections of metallizing as metallized coatings must not be allowed to become contaminated prior to application of sealers. Apply subsequent paint coats in a timely manner consistent with the painting schedule.

3.2.7 Approved Methods of Metallizing

Metallizing methods, which employ metal wire feed stock with oxygen-fuel gas flame spray or electric-arc spray that produce coatings in conformance with requirements of this specification, are acceptable.

3.3 FIELD INSPECTION

3.3.1 Quality Control Inspection and Testing

The qualified Coating Inspector must be present during all work phases to perform and document all of the tests and inspections in paragraphs Ambient Conditions Inspection, Presurface Preparation Inspection, Surface Preparation Inspection, and Metallized Coating Inspection.

3.3.1.1 Ambient Conditions Inspection

Ambient air and surface conditions including humidity, dew point, and surface and ambient air temperature before and during all work phases. Determine humidity in accordance with ASTM E337. Conditions specified in paragraph Environmental Requirements must be met before work is initiated.

3.3.1.2 Presurface Preparation Inspection

Identify and mark all areas requiring preparation prior to abrasive blasting as specified in paragraph Pit, Edge, and Weld Preparation as well as areas requiring solvent-type cleaning. The entire work surface does not need to be inspected at one time, but rather the Coating Inspector may choose to mark up work areas with an indelible marker as the job progresses. Measure pit depth with any suitable pit depth gage. Identify irregular shaped pits visually.

3.3.1.3 Surface Preparation Inspection

Inspect all prepared surface for compliance with the specification. Blasted surfaces must meet the requirements of SSPC SP 5/NACE No. 1. Surfaces not meeting this requirement must be reblasted and reinspected.

3.3.1.3.1 Abrasive Blast Air Cleanliness

Evaluate the compressed air cleanliness on a daily basis at the beginning of the work shift in accordance with ASTM D4285. Allow the air compressor to warm up and discharge air under normal operating conditions to allow accumulated moisture to be purged. Hold an absorbent clean white cloth in the stream of compressed air not more than 600 mm 24 inch from the point of discharge for a minimum of one minute. Check the air as near as possible to the point of use and always after the position of the in-line oil and water separators. Inspect the cloth for moisture or staining. Do not use the compressed air source if there is any oil or water contamination present.

3.3.1.3.2 Recycled Blast Media Cleanliness and Shape

Evaluate the cleanliness of blast media on a daily basis at the beginning of the work shift. A clear glass container is half filled with new or recycled abrasive and distilled or deionized water is added to fill the container. The resulting slurry mixture is stirred or shaken and allowed to settle. The water is then examined for the presence of an oil sheen. If a sheen is present, the media must not be used and the source of contamination must be identified and corrected. Inspect recycled steel grit blast media at minimum once for every four hours of blasting for compliance with paragraph Abrasive Media requirements for number of round and half-round particles. Recycled steel grit working mixtures with greater than 15 percent round or half-round particles must be disposed or reconstituted by the addition of a suitable quantity of new steel grit abrasive to the working mixture. Retest the particle shape of the reconstituted steel grit prior to the commencement of blasting.

3.3.1.3.3 Blast Profile

Measure the surface profile depth in accordance with ASTM D4417, Method C. The mean value of three profile measurements taken within a 103 cm^2 16 in^2 area constitutes a spot measurement. Conduct a minimum number of 3 spot measurements at random per unit area per 45 m^2 500 ft^2. The average surface profile for each 45 m^2 500 ft^2 area must conform to the requirements of paragraph Abrasive Blasting. Perform spot measurements on weldments and flame-cut edges. Perform at least one spot measurement for each 15 m^2 50 ft^2 of weld and at least one spot measurement for each 3 m^2 10 ft^2 of flame-cut edge. Each spot measurement on welds or flame-cut edges must conform to the requirements of paragraph Abrasive Blasting. Surfaces not meeting the profile requirement must be reblasted and reinspected.

3.3.1.3.4 Contaminants on Prepared Surface

Visually inspect abrasive blasted surfaces that have been swept, blown down, or vacuum cleaned to remove residual debris and dust for grease, oil, and dust. Use any suitable test to enhance the visual inspection for grease and oil including water break, solvent evaporation, and heat tests. Inspect for grease and oil at least once per workday or every four

hours of blasting. Inspect the cleaned surfaces for residual dust using the tape test. The tape test is performed by adhering a clear piece of tape to the surface. The removed tape is inspected for adherent particles. Perform the tape test once per 45 m^2 500 ft^2 of prepared surface.

3.3.1.4 Metallized Coating Inspection

3.3.1.4.1 Equipment Setup Validation Bend Test

Record and confirm that the operating parameters are the same as were used to prepare the JRS each day or every time the thermal spray equipment is to be used. The thermal spray applicator must then apply the coating to prepared test panels and conduct the bend test. The bend test is a qualitative test used to confirm that the equipment is in proper working condition. The test consists of bending coated steel panels around a cylindrical mandrel and examining the coating for cracking. Record the results of the bend test and label and save the test panels. The test panels consist of five cold rolled steel panels measuring 50 x 150 x 1.25 mm 2 x 6 x 0.050 inch. The panels are cleaned, blasted, and coated using the identical surface preparation procedures and spray parameters as used to prepare the working surface. The coating is applied in a cross-hatch pattern using the same number of overlapping spray passes as used to prepare the JRS. The coating thickness is measured to confirm that the coating thickness is within the specified range. Test panels are bent 180 degrees around a steel mandrel of a specified diameter. Thermal spray coating systems 1-Z, 2-Z, 4-Z-A, 5-Z-A, 7-A, and 8-A are tested using a 12.5 mm 0.5 inch diameter mandrel. Systems 3-Z and 6-Z-A are tested using a 15.6 mm 0.625 inch diameter mandrel. Use a pneumatic or manual mechanical bend test apparatus to bend the test panels. Visually examine the test panels without magnification. If the bend test fails, corrective action must be taken and the bend test repeated until acceptable results are achieved. Successful completion of the bend test is required before any metallizing is applied to the working surface.

3.3.1.4.2 Atomization Air Cleanliness

Test compressed air used for atomizing metallized coatings using the method described in paragraph Abrasive Blast Air Cleanliness.

3.3.1.4.3 Metallized Coating Appearance

Visually inspect the appearance of the applied metallized coating prior to sealing for compliance with the requirements of paragraph Metallized Coating Appearance. Report areas of defective coating to the Contracting Officer and document, and mark them for repair.

3.3.1.4.4 Metallized Coating Thickness

Evaluate the thickness of the thermal spray coating for compliance with paragraph Metallizing Thickness. Make measurements using an approved and calibrated magnetic film thickness gage. Calibrate the gage on metal substantially the same in composition and surface preparation to that being coated and having a similar thickness or a minimum thickness of 6 mm 1/4 inch. Use calibration thickness standards (shims) of a metallic composition and a thickness to that of the material being sprayed. Follow calibration instructions and obtain thickness standards from the manufacturer or supplier of the gage. Make thickness readings either in a straight line with individual readings taken at 25 mm 1 inch intervals or

spaced randomly within a 25 cm^2 4 in^2 area as appropriate for the configuration of the surface being inspected.. The average of five readings comprises one spot measurement. Make a minimum of 5 randomly spaced spot measurements per 9 m^2 100 ft^2. For each 9 m^2 100 ft^2 area evaluated the minimum average and minimum spot thickness requirements must be met. Make areas of deficient coating thickness for correction before sealing begins. Document the results of the thickness measurements.

3.3.1.4.5 Metallized Coating Adhesion

Evaluate the adhesion of the thermal spray coating for compliance with paragraph Metallizing Adhesion in accordance with ASTM D4541 using a self-aligning type IV tester described in Annex A4 of the specification. Perform a total of three randomly spaced adhesion tests for each 45 m^2 500 ft^2 of work area. Where deficiencies are noted, additional testing may be performed to help delineate the extent of area with poor adhesion. Repair areas of deficient adhesion by removing and reapplying the metallized coating. Repair areas damaged by adhesion testing by abrasive blasting and reapplication of the metallic coating. As an alternative to testing to the failure point, the tests can be interrupted when the minimum specified adhesion value is achieved. This method precludes the need to repair coatings damaged by the test. The adherent pull stubs can then be removed by heating to soften the glue or by firmly striking the side of the stub. Use a strong (minimum 20.7 MPa 3000 psi) adhesive with a rapid cure (maximum 1-hour at 21 degrees C 70 degrees F) to adhere the pull stubs to the metallized coating. Some methyl methacrylate adhesives are known to achieve a 27.6 MPa 4000 psi bond strength in 1-hour.

3.3.2 Quality Assurance Hold Point Evaluations

The Coating Inspector must perform and document the Quality Assurance Hold Point evaluations and report the results to the Contracting Officer. The Contracting Officer will have sole authority to approve progression from one work phase to the next. Work phases are delineated by the Inspection Hold Points.

3.3.2.1 Surface Preparation Quality Assurance Hold Point Evaluation

At the completion of surface preparation on a given work area and prior to metallization, submit to the Contracting Officer the completed documentation resulting from the inspections performed in paragraphs Ambient Conditions Inspection, Presurface Preparation Inspection, Surface Preparation Inspection, Abrasive Blast Air Cleanliness Inspection, Blast Media Cleanliness and Shape, Blast Profile, and Contaminants on Prepared Surface.

3.3.2.2 Metallized Coating Quality Assurance Hold Point Evaluation

At the completion of metallized coating application on a given work area and prior to sealing, submit to the Contracting Officer the completed documentation resulting from the inspections performed in paragraphs Ambient Conditions Inspection, Atomization Air Cleanliness, Metallized Coating Appearance, Metallized Coating Thickness, and Metallized Coating Adhesion.

3.3.2.3 Sealed System Quality Assurance Hold Point Evaluation

At the completion of sealer and paint coat application on a given work

area and prior to the placement of the coated item in service, submit to the Contracting Officer the completed documentation resulting from all inspections and tests including those specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.4 METALLIZING SYSTEMS TO BE APPLIED

Apply the required metallizing systems as shown on the drawings.

3.5 SPECIAL PAINTING INSTRUCTIONS

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NOTE: Thinning instructions in the painting specification should be modified as follows: the first coat of systems No. 3, 4, 5-D, and 21 must be thinned with 25 percent by volume of the recommended thinner. Subsequent paint coats must be thinned in accordance with the standard instructions found in Section 09 97 02. The first coat of paint systems No. 13 and 14 should not receive extra thinning. It is not required.

In geographic regions where air pollution regulations prohibit the use of impacted immersion paint systems No. 3, 4, and 5-D, for architectural painting, paint system No. 21 should be substituted for immersion applications. If system 21 does not comply with air pollution regulation then no sealer should be used. Where systems 13 and 14 do not comply with VOC regulations then do not specify a sealer system for atmospheric service.

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Perform sealing and painting in accordance with the painting schedule and with the requirements of Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES. The clean, dry metallized surface is the receiving surface for the specified paint systems.

3.6 METALLIZING SYSTEMS AND METALLIZING SCHEDULE

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NOTE: By inserting specific item component names or surface description in the blank spaces provided in the tabulation, the metallizing to be done on a project can be shown in schedule form. Alternately, the metallizing system number can be shown on the applicable drawings.

The number assigned to each metallizing system in the listing should not be changed locally, even though on specific projects some systems are omitted. If other systems are added locally, they should be assigned numbers other than those used in this guide.

****

SYSTEM NO. 1-Z			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.05 - 0.072.0 - 3.0	Zinc	0.125	0.156

SYSTEM NO. 2-Z			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.06 - 0.092.5 - 3.5	Zinc	0.2510	0.3012

SYSTEM NO. 3-Z			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.08 - 0.103.0 - 4.0	Zinc	0.3514	0.4016

SYSTEM NO. 4-Z-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.05 - 0.072.0 - 3.0	85-15 Zinc-Aluminum	0.125	0.156

SYSTEM NO. 5-Z-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.06 - 0.092.5 - 3.5	85-15 Zinc-Aluminum	0.2510	0.3012

SYSTEM NO. 6-Z-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.08 - 0.103.0 - 4.0	85-15 Zinc-Aluminum	0.3514	0.4016

SYSTEM NO. 7-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.05 - 0.082.0 - 3.0	Aluminum	0.104	0.125

SYSTEM NO. 8-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.06 - 0.092.5 - 3.5	Aluminum	0.208	0.2510

-- End of Section --