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MILITARY SPECIFICATION

COATING, METALLIC-CERAMIC

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope - This specification covers the requirements of metallic-ceramic coatings to provide corrosion and oxidation protection of metallic substrates.

1.2 Classification - Metallic-ceramic coatings shall be furnished in the following Types and Classes, as specified (see 6.2):

Type I - Class 1 - Coating cured at 650 ± 25°F

Class 2 - Coating cured at 650 ± 25°F and post treated at elevated temperature

Class 3 - Initial coat(s) cured at 650 ± 25°F, and burnished prior to applying top coat that is cured at 650 ± 25°F

Class 4 - Coating cured at 650 ± 25°F and post treated by burnishing

Type II - Class 1 - Coating fused at 1485 ± 35°F

Class 2 - Coating fused at 1485 ± 35°F and post treated by burnishing

Type III - Class 1 - Coating deposited by thermal spraying

Class 2 - Coating deposited by thermal spraying and post treated by burnishing

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2. APPLICABLE DOCUMENTS

* 2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification herein.

SPECIFICATIONS

Federal

O-E-760	Ethyl Alcohol (Ethanol) Denatured Alcohol, and Proprietary Solvent
O-T-236	Tetrachloroethylene (Perchloroethylene), Technical Grade
O-T-634	Trichloroethylene, Technical
QQ-S-691	Steel, Plate, Carbon, Marine Boiler
QQ-S-766	Steel Plate, Sheet, and Strip - Corrosion Resisting
TT-C-490	Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings
TT-I-735	Isopropyl Alcohol

Military

MIL-S-5002	Surface Treatments and Metallic Coatings for Metal Surfaces of Weapons Systems
MIL-R-5632	Rods and Wire, Steel, Welding (For Aircraft Applications)
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-E-22200/1	Electrodes, Welding, Mineral Covered, Iron Powder, Low Hydrogen Medium and High Tensile Steel, As Welded or Stress-relieved Weld Application
MIL-T-81533	Trichloroethane, 1, 1, 1, (Methyl Chloroform) Inhibited, Vapor Degreasing

STANDARDS

Federal

Fed. Test Method Std. No. 141	Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling and Testing
Fed. Test Method Std. No. 151	Metals, Test Methods

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards

B 117	Method of Salt Spray (Fog) Testing
B 487	Method for Measuring Metal and Oxide Coating Thickness by Microscopic Examination of a Cross Section
B 499	Method for Measurement of Coating Thickness by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metal
B 529	Method for the Measurement of Coating Thickness by the Eddy Current Test Method: Nonconductive Coatings on Nonmagnetic Basis Metals
C 313	Method of Test for Adherence of Porcelain Enamel and Ceramic Coatings to Sheet Metal

(Applications for copies of ASTM standards should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3. REQUIREMENTS

3.1 First article samples - First article samples of the metallic-ceramic coatings shall be processed using the materials, methods and processes proposed for production. The samples are for the purpose of determining that the processor's materials and processes will produce coatings on basis metals that will meet the requirements of this specification. These samples shall be inspected as specified in Section 4 and shall be submitted as directed by the procuring activity for examination and written approval.

3.2 Materials - The materials shall be such as to produce metallic-ceramic coatings which meet the requirements of this specification. All ingredients used in the formulation shall be inorganic with the binder solids being either inorganic compounds, ceramic oxides or glass frits.

3.2.1 Ingredients - The ingredients for Type I coating shall be compounded to form an acidic aqueous slurry containing aluminum powder and a homogeneous solution of binder solids. The ingredients for Type II coating shall be compounded to form an aqueous slurry of metal or metal powders and ceramic binder solids. The ingredients for Type III coating shall be a dry blend of sprayable metal and ceramic powder.

3.2.2 Composition - The composition of the materials shall be as formulated in Table I to form a metallic-ceramic coating when applied to the basis metal or to a metallic substrate.

* TABLE I

COMPOSITION - PERCENT BY WEIGHT

Material	Type I	Type II	Type III
Solvent Contents (water)	38 to 44	30 to 40	--
Nonvolatile Contents (solids)	56 to 62	60 to 70	100
Nonvolatile Contents			
Metal or Pigment Contents	60 to 64	30 to 60	40 to 60
Binder Contents	36 to 40	40 to 70	40 to 60

* 3.2.3 Pigment (Type I) - The pigment for Type I coating shall consist of commercially pure (99% minimum aluminum)spherical aluminum powder or atomized powder and shall contain no other filler or adulterant. The particle size distribution shall be as follows:

Less than 15 microns - 90 percent by weight, minimum
Less than 10 microns - 50 percent by weight, minimum

3.3 Equipment and processes - The equipment and processes employed to accomplish metallic-ceramic coatings shall be approved by the procuring activity.

3.3.1 Material and property control - Prior to production, controls shall be established to assure that the coatings conform to the requirements of this specification. When processing practices have been so established, the procedures shall not be changed without approval of the procuring activity.

3.3.2 Application processing -

3.3.2.1 Preparation - Surfaces to be coated shall be free from all contamination (see 3.4.3) prior to roughening by dry grit blasting or wet vapor blasting with 100 to 250 mesh silica, silicon carbide, or alumina grit in accordance with Method I of TT-C-490 for Type I coatings. For Types II and III coatings, a dry 40 to 80 mesh grit shall be used for roughening heavy sections and others where applicable (see 6.6). The grit used for blasting shall be new. Residual grit shall be removed from parts by blasting with clean oil-free dry air. The surfaces after blasting shall conform to the surface roughness requirements specified in the contract, order or applicable drawing.

3.3.2.2 Application -

3.3.2.2.1 Type I coating - The coating material shall be applied to the parts by spraying without any thinning of the material. After each spray application, parts shall be dried at 175 $\pm$ 25°F (80 $\pm$ 14°C) for a minimum of 15 minutes. Unless otherwise specified or required by the metallurgical nature of the basis material, parts shall then be cured at 650 $\pm$ 25°F (343 $\pm$ 14°C) for a minimum of 15 minutes after the parts have reached the specified temperatures. When otherwise specified or required, parts shall be given a curing heat treatment at 375 $\pm$ 25°F (191 $\pm$ 14°C) for a minimum of 24 hours as a substitution for the curing at the more elevated temperature. Parts shall be at room temperature prior to applying subsequent coats.

3.3.2.2.2 Type II coating - The coating material shall be applied to the parts by spraying, dipping, slushing or draining. After application, parts shall be dried at 230 $\pm$ 20°F (110 $\pm$ 11°C) for a minimum of 15 minutes to produce a dry or bisque coating. Parts shall then be fired in an air atmosphere furnace, either of the muffle or electric type, at 1485 $\pm$ 35°F (807 $\pm$ 21°C) for the length of time established by the supplier for the particular coating formulation.

3.3.2.2.3 Type III coating - The coating material shall be applied to the parts by thermal spraying either by flame spraying techniques using oxygen together with acetylene or stabilized methylacetylene propadiene or plasma-arc flame spraying either by the vortex stabilized jet or gas

sheath stabilized jet torch. Application shall be in accordance with the process established by the supplier for the particular coating formulation.

3.3.3 Coating characteristics -

3.3.3.1 Type I, class 1 - Type I, class 1 coatings shall be nonconductive and shall require no further treatment after final curing at 650 ± 25°F.

3.3.3.2 Type I, class 2 - Type I, class 2 coatings shall be conductive. They shall be developed by heating the parts at elevated temperature after final curing at 650 ± 25°F. After reaching the required temperature, the coated parts should be held at this temperature for a sufficient time to develop specified properties. Temperature and times for post heat treatment are given in Table II.

TABLE II

TIME FOR POST HEAT TREATMENT
FOR CLASS 2 COATINGS

Temperature Range - °F	Heating Time - Minutes
1090 to 1110	10
990 to 1010	90
940 to 960	240

3.3.3.3 Type I, class 3 - Type I, class 3 coatings shall be nonconductive. These coatings shall be developed by burnishing the first coating prior to application and curing of the top coat. The coating shall remain nonconductive unless heated in service to elevated temperatures or burnished, thus changing the electrical properties. Parts shall be burnished by rolling, peening, light blasting, wire brushing, etc. Materials for burnishing should be chemically inert. They shall not leave a smudge deposit on the coating, shall not cause damage to delicate parts, shall not abrade the coating or shall not introduce impurities into the coating.

3.3.3.4 Type I, class 4 - Type I, class 4 coatings shall be conductive. They shall be developed by burnishing the parts after final curing at 650 ± 25°F. The parts shall be burnished as detailed in 3.3.3.3. The aesthetic qualities of the coating will also be increased without affecting the corrosion properties. The matte gray surface finish when burnished, will achieve either a satin luster or produce a bright polished mirror-like surface.

3.3.3.5 Type II, class 1 - Type II, class 1 coatings shall be conductive and shall require no further treatment after fusing. The coating shall be applicable to basis metals capable of withstanding the 1485 ± 35°F firing schedule without loss of the required physical and mechanical properties as detailed in the applicable basis metal material specification.

3.3.3.6 Type II, class 2 - Type II, class 2 shall be developed by buffing, polishing or burnishing the Type II, class 1 coating by procedures detailed in 3.3.3.3. This operation is not required to attain the specified oxidation and corrosion resistance properties as only the aesthetic qualities of the coating are achieved to produce a metallic luster.

3.3.3.7 Type III, class 1 - Type III, class 1 coatings shall be conductive and shall require no further treatment after thermal spraying. The coating, as sprayed shall be essentially pore-free and ductile. The coating is applicable for basis metals where temperature of other types of coating applications can effect changes in required physical and mechanical properties as detailed in the applicable basis metal specifications as well as the effects of shot peening and other residual compressive stress inducing treatments. Generally, the temperature of the basis metal will not exceed 350°F (177°C) during application.

3.3.3.8 Type III, class 2 - Type III, class 2 coatings are developed by buffing, polishing, or burnishing, as detailed in 3.3.3.3, the Type III, class 1 coatings. This operation is not required to attain the specified oxidation and corrosion resistance properties as only the aesthetic qualities of the coating will be increased.

3.4 General requirements -

3.4.1 Basis metal - The basis metal shall be free from visible defects which will be detrimental to the appearance or protective value of the coating. Unless otherwise specified, the coating shall be applied after all basis metal heat treatments and mechanical operations such as machining, brazing, welding, forming and perforating of the article have been completed. The basis metal shall be subjected to such cleaning and coating procedures as necessary to yield coatings as herein specified.

3.4.2 Stress relief treatment - All steel parts shall be given a stress relief heat treatment at a minimum of 375 ± 25°F (191 ± 14°C) for 3 hours or more prior to cleaning and coating if they contain or are suspected of having residual tensile stresses caused by machining, grinding or cold forming operations. Parts which are cold straightened and cold formed are considered to contain damaging tensile stresses (see 6.4). The temperature and time at temperature shall be such that maximum stress relief is obtained without reduction in hardness to less than the specified minimum.

3.4.3 Cleaning - All steel parts having a hardness Rockwell C33 and higher shall be cleaned using materials which will have no damaging effects on the metal, including freedom from pits, intergranular attack, etching and hydrogen embrittlement. Steel parts having a hardness of less than Rockwell C33 which have been exposed to hydrogen contamination processes such as cathodic cleaning, pickling, and etching shall be heat treated at a minimum of 375 ± 25°F (191 ± 14°C) for 3 hours or more prior to surface preparation and blasting. Other basis metals shall be cleaned in accordance with MIL-S-5002. Prior to coating, cleaned steel parts shall be degreased in accordance with Method II of TT-C-490 with a suitable solvent such as trichloroethylene, O-T-634; perchloroethylene, O-T-236; or 1, 1, 1 trichloroethane, MIL-T-81533. Titanium alloys shall be cleaned in accordance with MIL-S-5002. To prevent stress corrosion cracking of titanium alloys, they shall not be degreased in chlorinated hydrocarbon solvents.

3.4.4 Undercoating (applicable to Type I only) - The metallic-ceramic coating shall be deposited directly on the basis metal without a preliminary coating of other metals or materials.

3.4.5 Coverage - The coating shall completely cover all visible surfaces where the coating is functionally required.

3.5 Detail requirements -

* 3.5.1 Thickness - Unless otherwise specified, the thickness of the coating shall be as specified in Table III. Unless otherwise specified, surfaces on which the specified thickness cannot be readily controlled such as holes, deep recesses, bases of angles, and internal threads from which the external environment is completely excluded and where a controlled deposit cannot be normally obtained, shall not be subject to a thickness requirement. However, the coating on such surfaces shall be of sufficient thickness to ensure coating continuity and uniform appearance (see 4.6.1).

TABLE III

THICKNESS OF COATINGS

Type	Thickness			
	Inch		Equivalent thickness in micrometers (approx) 1/	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
I	0.0015	0.0040	38	102
II, III	0.0030	0.0060	76	152

1/ 0.001 inch = 1 mil - 25.4 micrometers (microns)

3.5.2 Curing (applicable to Type I only) - No part or any portion of area with the coating shall be undercured when tested as specified (see 4.6.2).

3.5.3 Adhesion - The adhesion of the coating shall be such that when examined at a magnification of approximately 4 diameters, the coating shall not show separation from the basis metal at the interface, nor shall any of the separately applied coats show separation from each other, when tested as specified (see 4.6.3). For Type I coatings, the interface between the coating and the basis metal is the surface of the basis metal before coating. For Type II coatings, the substrate-coating interface is the tough ductile corrosion resistant alloy formed as a product of the fusion reaction. The interface of the Type III coating is also a diffusion type bond applied mechanically or sometimes quasimetallurgically prior to coating depending upon the thermal spraying procedures employed. The formation of cracks in the coating caused by rupture of the basis metal which does not result in flaking, peeling, or blistering of the coating shall not be considered as nonconformance to this requirement (see 4.6.3).

* 3.5.4 Lubricating oil resistance (applicable to Type I only) - The coating shall withstand immersion in oil at a temperature of 250°F (121°C) for 24 hours without showing any wrinkling, blistering, pitting or other surface defects. The adhesion of the coating shall be satisfactory. Upon cooling to room temperature, the coating shall not exhibit flaking when bent over a mandrel (see 4.6.4).

* 3.5.5 Abrasion resistance - The abrasion resistance of the coating shall be such that when tested with falling sand, the abrasion coefficient (liters of sand per mil of thickness) for Type I coatings cured at 650 ± 25°F (343 ± 14°C) shall not be less than 100, whereas those Type I coatings post treated in accordance with Table II as well as Types II and III coatings shall not be less than 200 (see 4.6.5).

* 3.5.6 Oxidation resistance - Coatings shall show no blistering, softening or other coating failure at the end of 250 hours for Type I or 500 hours for Types II and III continuous exposure. Type I coating shall be tested at a temperature which the parts will be exposed to in service as indicated in the applicable drawing, contract or purchase order (see 6.2). Where the service temperature is not indicated for Type I, the coating shall be subjected to a temperature of 1600 ± 25°F (871 ± 14°C). The Types II and III coatings shall be tested at 1400 ± 25°F (760 ± 14°C). There shall be no weight loss and the weight gain of coated articles or specimens shall not exceed 5 percent or 12.5 grams per 100 square inches of exposed surface (see 4.6.6).

3.5.7 Cyclic oxidation-corrosion resistance - The coating shall show no blistering, softening, separation from the basis metal, corrosion products or other coating failure after 6 cycles of testing. Each cycle shall consist of 16 hours continuous exposure at a temperature which the parts will be exposed to in service as indicated in the applicable drawing, contract or purchase order (see 6.2) and 32 hours continuous exposure to 5 percent salt spray. Where the service temperature is not indicated, the coating shall be subjected to a temperature of 1000 ± 25°F (538 ± 14°C) (see 4.6.7).

* 3.5.8 Thermal shock resistance - The coating shall show no blistering, softening, separation from the basis metal or other coating failure when tested. Type I coating shall be heated at a temperature which the parts will be exposed to in service as indicated in the applicable drawing, contract or purchase order (see 6.2). Where the service temperature is not indicated for Type I, the coating shall be subjected to a temperature of 1175 ± 25°F (635 ± 14°C). Types II and III coatings shall be tested at 1400 ± 25°F (760 ± 14°C). Coatings shall be exposed to the stated temperature for 4 hours and then thermal shocked by quenching in water (see 4.6.8).

* 3.5.9 Thermal shock resistance (T-joint) - The coating shall show no blistering, softening, cracks, thin chips greater than 3/8 inch in diameter, separation from the basis metal or substrates, or other coating failures after thermal shocking by quenching in water. Type I coatings shall be acceptable after 5 cycles when tested to the temperatures specified in 4.6.9.1 or 4.6.9.2 for 1-1/2 hours, while Type II and III coatings shall be acceptable after 8 cycles when tested in accordance with 4.6.9.3.

* 3.5.10 Sacrificial corrosion protection resistance - All coatings except those of Type I, class 1 shall provide sacrificial corrosion protection of uncoated areas. At the end of 1000 hours, when tested by continuous exposure to 5 percent salt spray, no galvanic attack of the basis metal shall be observed with freedom from blistering, basis metal corrosion products or other coating failure (see 4.6.10).

* 3.5.11 Electric resistance properties - Type I classes 2 and 4 coatings shall have a maximum electrical resistance of 15 ohms per inch, whereas Types II and III coatings shall have a maximum electrical resistance of 15 ohms per 5 inches when tested as specified herein (see 4.6.11).

3.5.12 Impact resistance - The coating shall show no flaking, cracking and spalling from the basis metal or other substrates as well as no exposure of bare metal in any impacted area when tested as specified (see 4.6.12). Impacted areas, except those of Type I, class 1 coatings, shall also provide sacrificial corrosion protection as described in 3.5.10 at the end of 1000 hours when tested as specified (see 4.6.10).

3.5.13 Flexibility (applicable to Types II and III only) - The flexibility of the coating shall be such that when examined at a magnification of approximately 7 diameters, the tension side of the coating shall show no evidence of brittle flaking or spalling in the deformed area when tested as specified herein (see 4.6.13). The formation of microscopic or macroscopic cracks in the coating shall not be cause for rejection. Flaking of a superficial topcoat on the compression side which does not result in exposure of the basis metal shall not be considered as nonconformance to this requirement. Deformed areas shall also provide sacrificial corrosion protection as described in 3.5.10 at the end of 1000 hours when tested as specified (see 4.6.10).

3.5.14 Deformation (applicable to Types II and III only) - The coating shall show no brittle flaking and spalling from the basis metal as well as any exposure of the basis metal on either side of the deformed areas when tested as specified (see 4.6.14). The formation of microscopic or macroscopic cracks in the coating shall not be cause for rejection. Deformed areas shall also provide sacrificial corrosion protection as described in 3.5.10 at the end of 1000 hours when tested as specified (see 4.6.10).

3.6 Workmanship - The cured Type I coating shall be smooth, adherent, uniform in appearance, non-glazed, free from blisters, pits, nodules, beads, drips, edge build-up and other irregularities of surface. The Type II and III coatings shall be adherent, uniform in appearance, free from blisters, hair line cracks, discontinuities, edge build-up and other irregularities of surface. All details of workmanship shall conform to the best practices for high quality coating.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests - The inspection and testing of metallic-ceramic coatings shall be classified as follows:

(a) First article tests (see 4.3 and 4.4)

(b) Quality conformance tests (see 4.5)

4.3 First article tests -

4.3.1 Sampling for first article inspection - Except as specified in 4.3.4 as soon as possible after the award of contract, the contractor shall submit to a testing activity designated by the procuring activity the first articles or samples of metallic-ceramic coating. Whether or not first articles or samples are required, the contractor shall supply a certified statement of prior tests which show the coating complies with the requirements of this specification. The statement shall also include the basis metal material, the material used to produce the coating and a general description of the processes and post treatments for the fabrication of the submitted samples. Processes and nonproprietary control data information pertinent to the fabrication of articles with metallic-ceramic coatings shall also be furnished.

4.3.2 Test sample preparation - When the coated articles are of such form, shape, size and value as to prohibit use thereof, or are not readily adaptable to the test specified herein, or when destructive tests of small lot sizes are required, the test shall be made by the use of separate specimens coated concurrently with the articles represented. The separate specimens shall be of the same basis metal as that of the articles represented. The same basis metal includes chemical composition, grade, heat treated condition and finish of surface prior to coating. For example, a cold-rolled surface should not be used to represent a hot-rolled surface. Due to the impracticality of forging or casting separate test specimens, hot-rolled specimens may be used to represent forged and cast articles. The separate specimens may also be cut from scrap castings when alloy castings are being coated. These specimens shall be introduced into a lot at regular intervals prior to the cleaning operations preliminary to coating and shall not be separated therefrom until after completion of coating. Conditions affecting the coating of specimens including the spacing, positioning, feed rate, particle velocity and orifice opening in respect to treatments and to other objects being coated shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented. Separate specimens shall not be used for thickness measurements, however, unless the necessity for their use has been demonstrated.

* 4.3.2.1 Specimens for thickness, curing, adhesion, lubricating oil resistance, abrasion resistance, impact resistance, flexibility and deformation - If separate specimens for thickness, curing, adhesion, lubricating oil resistance, abrasion resistance, impact resistance, flexibility and deformation are required, they shall be strips of mild steel approximately 6 inches long, 3 inches wide and 0.04 inch thick. The test panels for thickness, curing, adhesion, and abrasion resistance may be coated on one side only. The test panels for impact resistance, flexibility and deformation shall have all surfaces protected with the metallic-ceramic coating.

* 4.3.2.2 Specimens for oxidation resistance, cyclic oxidation-corrosion resistance, thermal shock, and sacrificial corrosion protection - If separate specimens for oxidation resistance (Type I coatings), cyclic oxidation-corrosion resistance, thermal shock, and sacrificial corrosion protection resistance are required, they shall be strips approximately 6 inches long, 3 inches wide and 0.04 inch thick. However, for oxidation resistance of Types II and III the strips shall be approximately 0.09 inch thick. Test panels shall have all surfaces protected with the metallic-ceramic coating. Unless the basis metal is equivalent or better than corrosion resisting steel, class 410, conforming to QQ-S-766, that alloy shall be used for the specimens required for the cyclic oxidation-corrosion resistance test.

4.3.2.3 Specimens for electrical resistance - If separate specimens for electrical resistance are required, they shall be strips approximately 8 inches long, 3 inches wide and 0.04 inch thick. These specimens may be coated on one side only.

4.3.2.4 Specimens for thermal shock resistance (T-joint) - The Tee joint specimens for thermal shock resistance tests shall be fabricated from steel conforming to QQ-S-691 according to the dimensions shown in Figure 2. The plates shall be welded with electrodes conforming to MIL-R-5632, class 1, or MIL-E-22200/1, classes MIL-7018 or MIL-8018-C3. While being thermal sprayed or coated with a slurry material by spraying, dipping or slushing, the T-sections shall be suspended by a wire hook through the 1/2-inch hole nearest the corner of the 3/16-inch plate and allowed to remain thereon throughout the drying and firing cycles.

4.3.2.5 The first article samples shall consist of at least the number of specimens coated in accordance with Table IV.

4.3.3 Further production - Further production of the metallic-ceramic coating of parts, items or articles by the contractor prior to approval of the procuring activity or completion of the first article sample shall be at the contractor's risk.

4.3.4 First article sample and inspection for a subsequent contract - If a contractor has previously delivered metallic-ceramic coated parts, items or articles in accordance with the requirements of this specification and his product has been found satisfactory, the requirements for a first article sample and its submittal in accordance with 4.3.1 for any subsequent contract or order may be waived at the discretion of the procuring activity (see 6.2).

4.4 Preproduction testing - Preproduction testing of metallic-ceramic coating shall consist of all tests specified in 4.5 and all tests described under Test Methods (see 4.6) except that testing for the Type I Tee joint thermal shock resistance shall not be performed unless specified (see 6.2). The responsibility for the performance of the first article testing shall be as specified in the contract or order (see 3.1 and 6.2). Failure of any specimen to conform to any of the requirements of this specification shall be cause for rejection of the lot represented.

4.5 Quality conformance tests -

4.5.1 Lot - A lot shall consist of coated articles, of the same basis material and approximately the same size and shape, coated under the same conditions and submitted for inspection at one time.

4.5.2 Sampling -

* 4.5.2.1 For visual examination and nondestructive tests - Sampling for visual examination and nondestructive tests shall be conducted as specified by the procuring activity in accordance with MIL-STD-105 or using Table V. Samples shall be selected at random from each lot the number of articles in accordance with MIL-STD-105, Acceptable Quality Level (AQL) 1.5 percent defective, or as indicated in Table V. The lot

TABLE IV

* SAMPLING PREPARATION FOR FIRST ARTICLE TESTING

Test	Minimum Number of Specimens Required	Applicable to Coating Types	Specimen Reference Paragraph	Test Reference Paragraph	Conforming to Paragraph
Thickness	3 1/	All	4.3.2 and 4.3.2.1	4.6.1	3.5.1
Curing	3 1/	I	4.3.2 and 4.3.2.1	4.6.2	3.5.2
Adhesion	3	All	4.3.2 and 4.3.2.1	4.6.3	3.5.3
Lubricating oil resistance	4 2/	I	4.3.2 and 4.3.2.1	4.6.4	3.5.4
Abrasion resistance	6 3/	All	4.3.2 and 4.3.2.1	4.6.5	3.5.5
Oxidation resistance	3	All	4.3.2 and 4.3.2.2	4.6.6	3.5.6
Cyclic oxidation-corrosion resistance	3	All	4.3.2 and 4.3.2.2	4.6.7	3.5.7
Thermal shock resistance	3	All	4.3.2 and 4.3.2.2	4.6.8	3.5.8
Thermal shock resistance (T joint)	5 4/	I	4.3.2.4	4.6.9.1	3.5.9
	3	II and III	4.3.2.4	4.6.9.3	3.5.9
Sacrificial corrosion protection resistance	3	All except Type I, class 1	4.3.2 and 4.3.2.2	4.6.10	3.5.10
Electrical resistance	3	All except Type I, classes 1 and 3	4.3.2 and 4.3.2.3	4.6.11	3.5.11
Impact resistance	3	All	4.3.2 and 4.3.2.1	4.6.12	3.5.12
Flexibility	3	II and III	4.3.2 and 4.3.2.1	4.6.13	3.5.13
Deformation	3	II and III	4.3.2 and 4.3.2.1	4.6.14	3.5.14

1/ These panels shall be prepared if destructive thickness measurements are conducted. The same specimens may be used for thickness and curing as well as visual examination.
2/ Retain one specimen for unexposed comparison.
3/ Post treat three of the Type I specimens.
4/ When specified (see 4.4 and 6.2).

shall be accepted or rejected according to the procedures in 4.5.2.1.1 for visual examination, in 4.5.2.1.2 for coating thickness (nondestructive tests) and in 4.5.2.1.3 for curing of Type I coating.

TABLE V

SAMPLES FOR VISUAL INSPECTION AND NONDESTRUCTIVE TESTS

Number of Items in Lot Inspection	Number of Items in Samples (Randomly Selected)	Acceptance Number (Maximum Number of Sample Items Nonconforming to any Test)
15 or less	7 1/	0
16 to 40	10	0
41 to 110	15	0
111 to 300	25	1
301 to 500	35	1
501 and over	50	2

1/ If the number of items in the inspection lot is less than 7, the number of items in the sample shall be equal to the number of items in the inspection lot.

4.5.2.1.1 Visual examination - Samples selected in accordance with 4.5.2.1 shall be examined for compliance with the requirements of 3.4.1 before coating, unless otherwise specified, of 3.6 after coating, and of 3.4.5 for coverage. If the number of nonconforming articles exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

4.5.2.1.2 Thickness of plating (nondestructive tests) - Samples selected in accordance with 4.5.2.1 shall be inspected and the coating thickness measured by the applicable tests detailed in 4.6.1 at locations on each article as defined in 3.5.1 for compliance with the requirements. The article shall be considered nonconforming if one or more measurements fail to meet the specified thickness. If the number of defective items in any sample exceeds the acceptance number for the specified sample, the lot represented by the sample shall be rejected. Separate specimens (see 4.3.2) shall not be used for thickness measurements unless a need has been demonstrated.

4.5.2.1.3 Curing - Samples selected in accordance with 4.5.2.1 shall be examined for compliance with the requirements of 3.5.2 by the applicable test detailed in 4.6.2. The article shall be considered nonconforming if there is any indication of green coloration and the lot represented by the sample shall be rejected. This test is not applicable to Types II and III coatings.

4.5.2.2 For destructive tests - A random sample of four coated Type I parts or articles shall be taken from each lot or four separately coated Type I specimen shall be prepared in accordance with 4.3.2 and 4.3.2.1 to represent each lot for thickness, curing and adhesion. For Types II and III coated parts, the number of random samples shall be eight instead of four for thickness, adhesion and flexibility. When specified in the contract or order (see 6.2), the supplier shall fabricate the number of welded T-joint specimens (see 4.3.2.4) in accordance with Table VI for each inspection lot to determine thermal shock resistance of the coated specimens. If the number of articles in the lot is four or less, the number of articles in the sample shall be specified by the contracting agency (see 6.2).

TABLE VI

TEE-JOINT SAMPLES FOR THERMAL SHOCK TEST

Number of Items in Inspection Lot	Number of Items in Samples (Welded T-joint Test Specimens)	Acceptance Number (Maximum Number of Sample Items Nonconforming
65 or less	2	0
66 to 180	3	0
181 to 500	5	0
501 and over	8	1

4.5.2.2.1 Thickness of coating (destructive tests) - If samples and testing for thickness of plating by nondestructive testing is not applicable, samples selected in accordance with 4.5.2.2 shall be measured for coating thickness by the applicable tests detailed in 4.6.1 at several locations on each article as defined in 3.5.1 for compliance with the specified requirements. Measurements on threaded articles such as screws, nuts, bolts and other fasteners shall be made on the shank, or other smooth surfaces as close to the threads as possible. If the coating thickness at any place on any article or specimen fails to comply with the specified thickness, the lot shall be rejected. Separate specimens (see 4.3.2 and 4.3.2.1) shall not be used for thickness measurements unless a need has been demonstrated.

4.5.2.2.2 Curing (destructive tests) - The articles or specimens used for the destructive thickness test (see 4.5.2.2.1) may be used as the specimens for the curing test (see 4.6.2) to determine compliance with the requirements of 3.5.2. Failure of one or more of the test specimens shall constitute failure of the lot. This test is not applicable to Types II and III coatings.

4.5.2.2.3 Adhesion (destructive tests) - Four of the articles or specimens used for the destructive thickness test (see 4.5.2.2.1), if of suitable size and form, may be used as the specimens for the flexibility adhesion test (see 4.6.3) to determine compliance with the requirements of 3.5.3. Failure of one or more of the test specimens shall constitute failure of the lot.

4.5.2.2.4 Flexibility (destructive tests) - The remaining four articles or specimens used for the destructive thickness test (see 4.5.2.2.1), if of suitable size and form, may be used as specimens for the conical mandrel flexibility test (see 4.6.12) to determine conformance with the requirements of 3.5.12. Failure of one or more of the test specimens shall constitute failure of the lot.

* 4.5.2.2.5 Thermal shock resistance (T-joint) - The samples fabricated in accordance with 4.5.2.2 and Table VI shall be used as the specimens for the destructive T-joint thermal shock resistance test (see 4.6.8.2 and 4.6.8.3) to determine compliance with the requirements of 3.5.8. Those specimens with Type I coatings shall be subjected to 5 heating and quenching cycles at 800 ± 25°F (427 ± 14°C), whereas those with Types II and III coating shall be subjected to 8 heating and quenching cycles at 1400 ± 25°F (760 ± 14°C). If the number of nonconforming articles exceeds the acceptance number for that sample as stated in Table VI, the lot represented by the sample shall be rejected.

4.6 Test methods -

4.6.1 Thickness - The magnetic method ASTM B499 and the eddy current test method, Fed. Test Method Std. No. 151, Method 520, or ASTM B529, shall be used for nondestructive measuring of coating thickness, provided a calibration is established for those coatings resulting in diffusion and alloy layers. The microscopic test method, ASTM B487, shall be used for destructive measuring of coating thickness. (see 3.5.1).

4.6.2 Curing - A cotton swab soaked in water or alcohol, conforming to either O-E-760 or TT-I-735 shall be applied to all surfaces of the coated part or to a portion of the coating area. An uncured surface can be detected by the appearance of green coloration on the coated surface or on the moistened swab (see 3.5.2). This is only applicable to Type I coatings.

4.6.3 Adhesion - Adhesion shall be determined in accordance with Fed. Test Method Std. No. 141, Method 6223 using a mandrel whose diameter is 14 times the basis metal thickness. The time of test shall be 2 seconds. If the edge of the ruptured coating can be peeled back or

if separation of the coating from the basis metal can be seen at the point of rupture when examined at four diameters magnification adhesion is not satisfactory (see 3.5.3).

4.6.4 Lubricating oil resistance - Lubricating oil resistance shall be determined by immersing specimens or parts in diester lubricating oil conforming to MIL-L-7808 at a temperature of 250°F (121°C) for 24 hours. After removal specimens or parts shall be cooled to room temperature, examined and compared with unexposed specimens or panels. Discoloration shall not be a cause for rejection. Specimens or parts shall then be subject to the test as detailed in 4.6.3 (see 3.5.3 and 3.5.4).

4.6.5 Abrasion resistance - The abrasion resistance of specimens or parts shall be determined by means of falling sand in accordance with Fed. Test Method Std. No. 141, Method 6191 (see 3.5.5).

* 4.6.6 Oxidation resistance - Specimens or parts shall be weighed to the nearest 0.01 gram. Specimens or parts shall then be supported horizontally upon pins on a rack and placed in a precision controlled circulating oven or furnace. Type I coated pieces shall be held at the temperature specified for service (see 6.2). If the service temperature is not indicated, the test temperature shall be 1600 ± 25°F (871 ± 14°C) for Type I. Types II and III pieces shall be at a temperature of 1400 ± 25°F (760 ± 14°C). No part of the test pieces shall be in direct contact with the bottom or sides of the heating unit. Type I test pieces shall be left in the oven for a period of 250 hours at the test temperature, whereas Types II and III test pieces shall be held for a period of 500 hours. After removal and subsequent cooling in a natural air atmosphere, the heat aged test pieces shall be visually examined for defects and reweighed (see 3.5.6). The gain in weight shall be calculated as follows:

$$G = \frac{(Wa - W)}{W} 100$$

Where G = Percent gain in weight due to oxidation

Wa = Weight of test piece in grams after heating

W = Weight of test piece in grams before heating

4.6.7 Cyclic oxidation-corrosion resistance - Specimens or parts shall be placed in a precision controlled circulating oven or furnace at the temperature specified for service (see 6.2), as detailed in 4.6.6 and left in for a period of 16 hours. If the service temperature is not indicated, the test temperature shall be 1000 ± 25°F (538 ± 14°C). After removal and subsequent cooling, the test pieces shall then be subjected to a 5 percent salt spray for 32 hours in accordance with Fed. Test Method Std. No. 141, Method 6061, or ASTM B117. Test pieces shall be supported or suspended 15 degrees from the vertical. Upon removal, the combination heat treatment - salt spray tests shall be repeated an additional 5 times to obtain a total of 6 cycles. Upon removal after the 6th cycle, all traces of salt residue shall be removed from the test pieces by washing in clear running water. Pieces shall be examined visually after each heat exposure and salt spray test for defects (see 3.5.7).

* 4.6.8 Thermal shock resistance - Specimens or parts shall be placed in a precision controlled circulating oven or furnace as detailed in 4.6.5 and left in for a period of 4 hours. For Type I, if the service temperature is not indicated (see 6.2), the test temperature shall be 1175 ± 25°F (635 ± 14°C). Types II and III shall be tested at a temperature of 1400 ± 25°F (760 ± 14°C). The test pieces shall be removed from the oven and quenched immediately in a tank of cold running water so that the maximum quench delay time, when the oven door is opened and the last corner of the test piece is immersed in the water tank, does not exceed 5 seconds. Upon removal from the water tank the test specimens or parts shall be visually examined for defects (see 3.5.8).

4.6.9 Thermal shock resistance (T-joint) -

* 4.6.9.1 First article test of Type I coatings - Three of the coated T-joint Type I specimens shall be placed in a precision controlled circulating furnace or oven at a temperature of 650 ± 25°F (343 ± 14°F) and left in for a period of 1-1/2 hours. The test piece shall be removed from the furnace and quenched immediately in a tank of cold running water so that the maximum quench delay time when the furnace door is open and the last corner of the specimen is immersed in the water tank does not exceed 5 seconds. After the specimen has cooled to allow comfortable handling with the bare hands, the test piece shall be removed and visually examined for defects (see 3.5.9). The heating and quenching shall be repeated an additional 4 times to obtain a total of 5 cycles at 650 ± 25°F (343 ± 14°C) and 5 cycles at 800 ± 25°F (427 ± 14°C). The remaining two T-joint sections shall be similarly subjected to 5 heating and quenching cycles at 900 ± 25°F (482 ± 14°C). Occurrence of defects as stated in 3.5.9 shall be cause for rejection of the coating.

* 4.6.9.2 Quality conformance testing of Type I coating - The coated Type I T-joint specimens shall be tested by the procedure specified in 4.6.9.1. However, each T-joint sections shall receive 5 heating and quenching cycles at 800 ± 25°F (427 ± 14°C). Upon removal from the water tank, after each quench, the specimens shall be visually examined for defects (see 3.5.9).

* 4.6.9.3 Types II and III coating - For first article testing three of the coated T-joint specimens shall be tested by the procedure specified in 4.6.9.1. However, each T-joint section shall receive 8 heating and quenching cycles at 1400 ± 25°F (760 ± 14°C). Upon removal from the water tank, after each quench, the specimens shall be visually examined for defects (see 3.5.9).

4.6.10 Sacrificial corrosion protective resistance - Coated specimens or parts shall have a 3/8 inch diameter hole drilled through the test piece, leaving the hole uncoated. At the option of the supplier, specimens or parts may be selected prior to coating. These test pieces shall have a 3/8 inch diameter area marked off where no coating shall be

applied during processing. Test pieces shall be subjected to a 5 percent salt spray for 1000 continuous hours in accordance with Fed. Test Method Std. No. 141, Method 6061, or ASTM B117. Test pieces shall be supported or suspended 15 degrees from the vertical. Upon removal after completion of the test period, all traces of salt residue shall be removed from the test piece by washing in clear running water. Pieces shall be examined visually for any evidence of defects (see 3.5.10).

4.6.11 Electrical resistance - The coating on the specimen or parts shall be tested for electrical resistance by means of a Wheatstone bridge or a suitable direct reading ohm-meter operated on direct current, using the apparatus shown in Figure 1. The brass electrodes shall be 1/2 inch square, spaced with their inner edges parallel and 5 inches apart. The specimen under test shall be supported on an insulated surface such as a glass plate, with coated surface uppermost and the test fixture placed on it, with the additional 5-pound weight added. Three readings, at various positions on the specimen, shall be made. No reading shall be more than the specified maximum (see 3.5.11).

4.6.12 Impact resistance - The coating on the specimen or parts shall be tested for impact resistance by means of a tester. The apparatus shall consist of a falling weight of 4 pounds (1.8 kilograms), a guide tube through which the weight falls, a bracket to hold the guide tube in a vertical position and an anvil base. The tool of the instrument terminates in a 5/8-inch ball. The die upon which the uncoated side of the specimen rests is 0.640 inch in diameter. The weight is lifted in the guide tube to impart a drop on the coating equal to 72 inch-pounds energy of impact. Three areas of the test piece shall be impacted. The deformed areas shall be examined visually for any detrimental defects resulting from impact (see 3.5.12). Substantiation that the coating will offer sacrificial corrosion protection after impact may be established by subjecting the deformed test piece to the salt spray test in accordance with 4.6.10.

4.6.13 Flexibility - Flexibility shall be determined in accordance with Fed. Test Method Std. No. 141, Method 6222, using a conical mandrel. The test piece shall be bent 180 degrees in about 15 seconds. When examined visually at approximately 7 diameters magnification, flexibility is not satisfactory if the edges of the coating can be peeled back, if the coating shows evidence of spalling or flaking, or if separation between the coating and the basis metal can be seen at the point of rupture (see 3.5.12). Substantiation that the coating will offer sacrificial corrosion protection resistance after flexure may be established by subjecting the deformed test piece to the salt spray test in accordance with 4.6.10.

4.6.14 Deformation - Deformation shall be determined in accordance with ASTM C313 using the deforming press. The coating shall be deformed with a die having a depth of 0.190 inch (Research X) at a pressure

of 2000 pounds. The deformed area of the test piece shall be cleaned of any loosely held coating fragments by dropping the test piece face down, two times from a height of about 6 inches onto a hard surface. The deformation is not satisfactory if the edges of the coating can be peeled back, if the coating shows evidence of spalling or flaking, or if separation between coating and the basis metal can be seen on either side of the deformed area when visually examined (see 3.5.14). Substantiation that the coating will offer sacrificial corrosion protection after deformation may be established by subjecting the deformed test piece to the salt spray test in accordance with 4.6.10.

5. PREPARATION FOR DELIVERY

5.1 Packaging and packing - The preservation, packaging and packing methods for metallic-ceramic coated parts or articles employed by a supplier shall be such as to preclude any physical damage during shipment and handling.

6. NOTES

6.1 Intended use - The Type I multi-sprayed metallic-ceramic coating (from two or more spraying applications and curing) is intended to be used for the prevention of heat sealing, oxidation, salt water corrosion and for protection from corrosion due to other corrosive environments. The coating material may be applied to jet engine parts. There may be an unfavorable effect upon the fatigue strength of basis materials beginning about 1000°F (538°C) due to diffusion of the Type I coating into the basis metals. Types II and III coatings are intended for general oxidation and corrosion prevention of basis metals in marine, above ground and underground applications. The Type II coating may be used with any basis metal capable of withstanding the elevated fusion temperature (1450 to 1520°F). As with Type I coating, there may be an unfavorable effect upon the physical properties of the basis metals due to diffusion of the coating materials. The Type III coating should be used primarily on basis metals not capable of withstanding processing temperatures above 350°F (177°C), with metal parts that may be prone to distortion at temperatures above 350°F, or if parts are too large for a furnace capacity for Type II application. The Type III coating is compatible corrosion-wise with the Type II coating and may be used to protect weldments of parts, welded after having been previously coated with Type II material.

6.1.1 Type I, class 1 - The Type I, class 1 coating is intended to provide oxidation corrosion protection of parts up to temperatures of 1600°F (871°C) and to marine atmosphere corrosion protection where coated parts are exposed to elevated operating temperatures for time periods as stated in Table II which would render the coating conductive. This class coating is also intended to be used where the nature of the basis material of the part limits curing and post treatment temperatures to 650°F (343°C).

* 6.1.2 Type I, class 2 - The Type I, class 2 coating is intended to provide oxidation corrosion protection, galvanic corrosion protection and marine atmosphere corrosion protection of ferrous alloys, titanium and titanium alloys and other metallic substrates. The coating also has current carrying capacity for static charges. The post curing treatment at 950° to 1100°F (510 to 593°C) as recommended in Table II provides for the sacrificial corrosion protection at the lowest processing cost. This class coating, because of these coating characteristics, is recommended to be used for parts wherever possible.

* 6.1.3 Type I, class 3 - The Type I, class 3 coating is also intended to provide oxidation corrosion protection, galvanic corrosion protection and marine atmosphere corrosion protection. Essentially, this class is similar to Type I class 1 except that the surface is mechanically burnished prior to the last coating application to obtain sacrificial corrosion protection. This class will provide the minimum corrosion products. Coatings will protect parts with faying surfaces, joints and seams of similar and dissimilar basis metal. Such parts with faying surfaces of dissimilar metals would not require tape or sealing compounds for precluding the galvanic corrosion effects of dissimilar basis materials.

6.1.4 Type I, class 4 - The Type I, class 4 coating is intended to provide the same protection against corrosion as Type I, class 2. The coating is used to match the matte finish, polished or buffed surfaces of surrounding corrosion resistance steels or other materials. This coating can be polished to a mirror finish if desired. For compressor blades and vanes, this class coating may be used, as certain types of burnishing operations will improve the surface finish of the final part when polished.

* 6.1.5 Type II - The Type II coating is intended to provide oxidation and corrosion protection of ferrous and ferrous base alloys, corrosion resistance steels and nickel base alloys. It is highly effective in salt and acid vapor atmospheres. Parts with this coating must be capable of withstanding the 1450 to 1520°F (786 to 828°C) fusion temperature without deleterious effects. It affords a high degree of sacrificial corrosion protection and can be used on faying surfaces of dissimilar metals. Essentially, there is no difference in properties between the two classes of this type coating except that the surface is mechanically burnished or buffed to improve finish of the part.

* 6.1.6 Type III - The Type III coating is intended to provide oxidation and corrosion protection of the same basis metals as with Type II, with titanium and its alloys added and for the same applications. It affords a high degree of sacrificial corrosion protection as does Type II. Faying surfaces are covered and protected as well as weldments. Essentially, there is no difference in properties between the two classes of this type coating except the mechanical post treatment improves surface finish.

6.2 Ordering data - Purchasers should exercise any desired options offered herein, and the procurement documents should specify the following:

(a) Title, number and date of this specification.

(b) Type and class of coating (see 1.2).

(c) Curing temperature, if other than specified (see 3.3.2.2.1).

(d) Specified precoating operations, if applicable (see 3.4.1).

(e) Thickness of plating, if other than specified (see 3.5.1).

(f) Service temperature (see 3.5.7, 3.5.8, 3.5.9, 4.6.7, 4.6.8 and 4.6.9 for Type I).

(g) First article sampling (see 3.1, 4.3.1, 4.3.2 and 4.3.4 and Table IV).

(h) Responsibility for first article testing (see 4.4).

(i) Preproduction testing for Type I T-joint thermal shock resistance, if required (see 4.4 and Table IV).

(j) Fabrication and testing of T-joint thermal shock specimens, if required (see 4.5.2.2 and 4.5.2.2.5).

6.3 Humidity effects - The color characteristics of the Type I coating may be affected by weather conditions during application. Humidity and temperature fluctuations during operation may change the matte gray cured coating to a darker shade with tints of brown or green coloration without effecting the properties of the metallic-ceramic coating.

6.4 Stress relief - There is a hazard that cold-worked or cold-straightened steel parts of hardness Rockwell C40 or below may crack during cleaning and plating. Such parts should have a suitable heat treatment for stress relief prior to cleaning and coating (see 3.4.2).

* 6.5 Handling precautions - Dried aluminized metallic-ceramic residues, especially those of Type I, are extremely flammable and with air mixtures are explosive. Residues of Type I coating material in contact with alkaline solutions can generate explosive, flammable hydrogen gas. Care must be taken to prevent the starting of an exothermic reaction.

6.6 Blast cleaning - To prepare surfaces of heavy sections prior to application of Types II and III coatings, 46 to 80 mesh sand is often used for dry abrasive blast cleaning. This will remove rust, scale, soils from the metal surface, roughen the metal surface and also act as a compressive stress-inducing treatment to obtain improved fatigue behavior and decrease stress corrosion cracking of the basis metal. Cleaning with coarse grit, in addition to cold working, will increase the required surface roughness height values of the part or article. For parts to be coated with Type II or III coatings, surface characteristics (roughness and texture) should not be controlled on a drawing or specification unless such control is essential to the appearance or mechanical performance of the product. Imposition of such restrictions when unnecessary may increase production costs and in any event lessen the emphasis on the control specified for important surfaces.

6.7 Coating material packaging and packing - For information only, the following packaging and packing details relate to the delivery preparation of the metallic-ceramic coating material. The coating material should be packaged in one-gallon or five-gallon containers.

6.7.1 Type I - The coating materials should be packaged in one-gallon or five-gallon containers.

6.7.1.1 One-gallon containers - The one-gallon packaged unit should consist of a molded heavy duty plastic container conforming to Class B of PPP-C-00569 and a box for overpacking conforming to Type B of PPP-C-00569. The plastic container should be of a cubical or rectangular design with the spout integrally molded into the plastic container and should have a plastic screw cap for reclosing. The one-gallon containers should be packed in accordance with TT-P-143 for 1-gallon round containers.

6.7.1.2 Five-gallon containers - The five-gallon container should be a single trip metal pail with a polyethylene liner conforming to PPP-P-123. The design and dimensions should conform to Type II, Class 3 of PPP-P-704 with a flexible spout. The five-gallon container should be packed in accordance with TT-P-143 for pails and drums.

6.7.2 Type II - The coating materials should be packaged as two dry-weight components, one being the pigment or metal powder and the other the binder solids. The correct proportions of each dry material should be packaged in predetermined amounts in containers. Containers should conform to Type V, Class 2 round of PPP-C-96 and should be of one-gallon capacity or less. Polyethylene bags may be used for interior packaging. The materials should be blended to form an aqueous slurry in accordance to the supplier's instructions.

6.7.3 Type III - The coating material should be blended and packaged in a 5-pound or less round container conforming to Type V, Class 2 of PPP-C-96. The blended materials should be of a -120 + 325 mesh U.S. standard sieve size. Polyethylene bags may be used for interior packaging. As a slight separation of the ingredients may take place in shipping, the containers should be rolled prior to use to assure a homogeneous mix before thermal spraying.

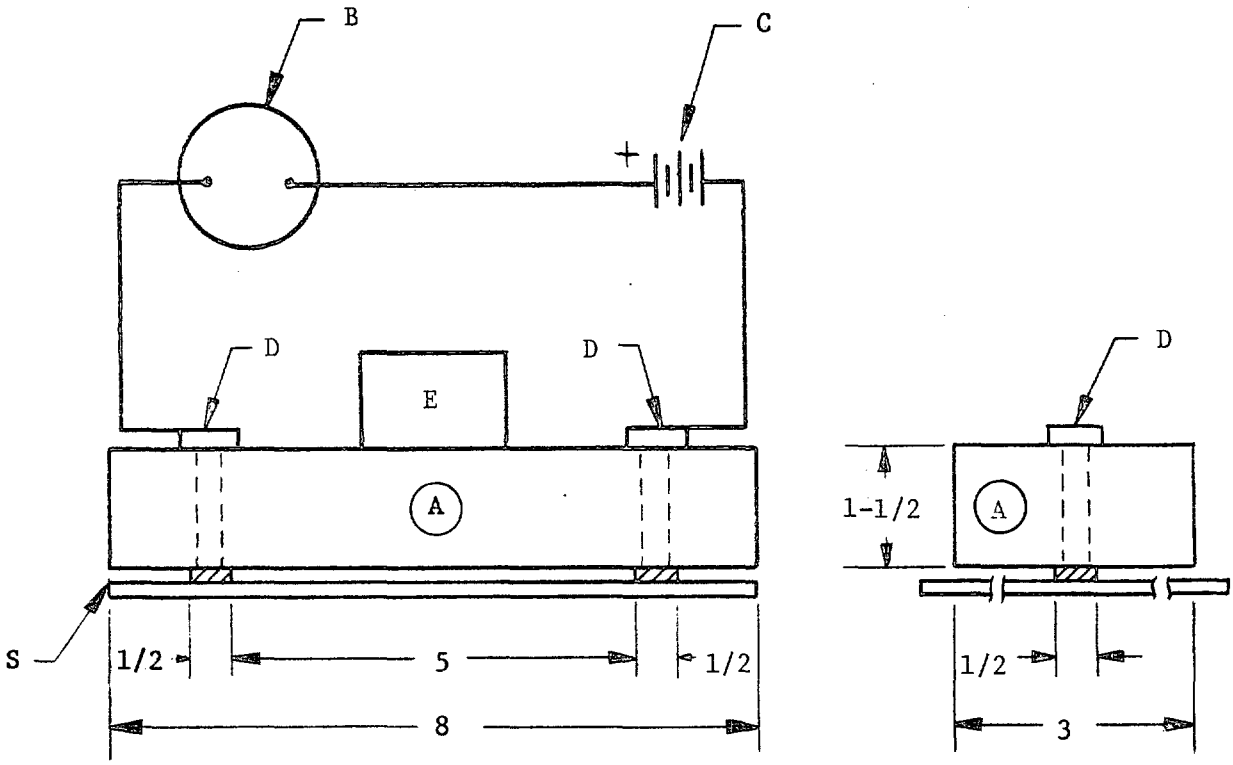
6.8 Changes from previous issue - The outside margins of this document have been marked "*" to indicate where changes (deletions, additions, etc.) from the previous issue have been made. This has been done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - MR
Navy - AS
Air Force - 11

Preparing activity:
Navy - AS
(Project No. MFFP-0054)

Review activities:
Army - MR, MI, EL, WC, ME, AV, MU, GL, EL
Navy - SH
Air Force - 84, 70, 71

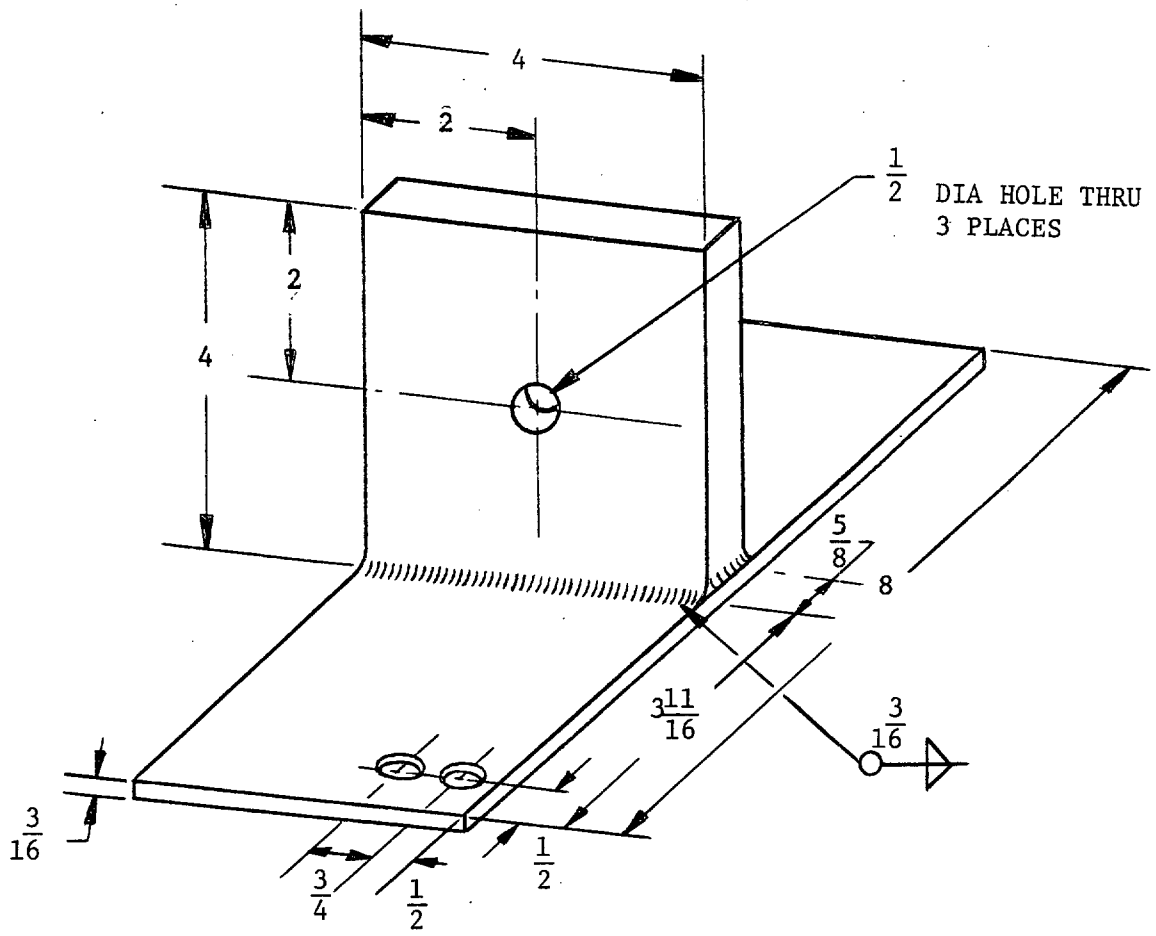
User activities:
Army - AT
Navy - YD, OS
Air Force - None



S - COATED SPECIMEN
A - DRY WOOD BLOCK
B - OHM-METER
C - POWER SUPPLY
D - BRASS ELECTRODES
E - WEIGHT (5 POUNDS)

ALL DIMENSIONS IN INCHES.

FIGURE 1. TEST FIXTURE FOR ELECTRICAL RESISTANCE.



DIMENSIONS IN INCHES.
BREAK SHARP EDGES.

FIGURE 2 - TEE JOINT SPECIMEN

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