INCH-POUND
MIL-PRF-32577
12 June 2017

PERFORMANCE SPECIFICATION

COATING SYSTEM, NONSKID, METALLIC THERMAL SPRAY APPLICATION

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

1. SCOPE

1.1 Scope. This specification covers thermal spray nonskid (TSN) inorganic coatings for electric arc wire spray application to flight decks. The TSN inorganic coating is applied to a steel substrate in accordance with the approved procedure. The thermal spray is then covered with one or more color toppings or coatings (sealers) as designated by the approved application procedure.

1.2 Classification.

1.2.1 Type. The TSN inorganic coatings covered by this specification are of the following types:

a. Type I: Coatings obtained from wire containing total chromium concentrations not exceeding 0.35 weight percent.

b. Type II: Coatings obtained from wire containing total chromium concentrations not exceeding 0.1 weight percent.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-5624	-	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-D-16791	-	Detergents, General Purpose (Liquid, Nonionic)
MIL-PRF-23699	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Numbers: O-152, O-154, O-156, and O-167
MIL-F-24385	-	Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water

Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line “Document Comment”. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

AMSC N/A FSC MFFP

DOD-G-24508 - Grease, High Performance, Multipurpose (Metric)

MIL-PRF-83282 - Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Code Number H-537

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC) PUBLICATIONS

TR-2298-SHR - Results of Various Pavement Materials Subjected to Simulated JSF VTOL Exhaust FY 2008 Progress Report

(Copies of this document are available from Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC), 1000 23rd Avenue, Port Hueneme, CA 93043-4301.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

T9070-AL-DPC-020/077-2 - NAVSEA Hazardous Material Avoidance Process

T9074-BD-GIB-010/0300 - Base Materials for Critical Applications: Requirements for Low Alloy Steel Plate, Forgings, Castings, Shapes, Bars, and Heads of HY-80/100/130 and HSLA-80/100

(Copies of these documents are available online via Technical Data Management Information System (TDMIS) at https://mercury.tdmis navy mil/ by searching for the document number without the suffix. Refer questions, inquiries, or problems to: DSN 296-0669, Commercial (805) 228-0669. These documents are available for ordering (hard copy) via the Naval Logistics Library at https://nll navsup navy.mil. For questions regarding the NLL, contact the NLL Customer Service at nllhelpdesk@navy.mil, (866) 817-3130, or (215) 697-2626/DSN 442-2626.)

CALIFORNIA CODE OF REGULATIONS

Title 22, Division 4.5, Chapter 11 Article 3, § 66261.24 - Characteristic of Toxicity

(Copies of this document are available online at http://ccr.oal.ca.gov/.)

CODE OF FEDERAL REGULATIONS (CFR)

27 CFR 21.35 - Formula No. 3-A

(Copies of this document are available online at www.ecfr.gov.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM A751 - Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

ASTM B487 - Standard Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section

ASTM C633 - Standard Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings

ASTM C838	-	Standard Test Method for Bulk Density of As-Manufactured Carbon and Graphite Shapes
ASTM D522/D522M	-	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM D660	-	Standard Test Method for Evaluating Degree of Checking of Exterior Paints
ASTM D661	-	Standard Test Method for Evaluating Degree of Cracking of Exterior Paints
ASTM D714	-	Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D1141	-	Standard Practice for the Preparation of Substitute Ocean Water
ASTM D4417	-	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D7127	-	Standard Test Method for Measurement of Surface Roughness of Abrasive Blast Cleaned Metal Surfaces Using a Portable Stylus Instrument
ASTM E34	-	Standard Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM E384	-	Standard Test Method for Microindentation Hardness of Materials
ASTM E415	-	Standard Test Method for Analysis of Carbon and Low-Alloy Steel by Spark Atomic Emission Spectrometry
ASTM E794	-	Standard Test Method for Melting and Crystallization Temperatures by Thermal Analysis
ASTM E855	-	Standard Test Methods for Bend Testing of Metallic Flat Materials for Spring Applications Involving Static Loading
ASTM E1226	-	Standard Test Method for Explosibility of Dust Clouds
ASTM E1251	-	Standard Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry
ASTM E1473	-	Standard Test Methods for Chemical Analysis of Nickel, Cobalt and High-Temperature Alloys
ASTM E2109	-	Standard Test Methods for Determining Area Percentage Porosity in Thermal Sprayed Coatings
ASTM E2594	-	Standard Test Method for Analysis of Nickel Alloys by Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based Method)
ASTM F21	-	Standard Test Method for Hydrophobic Surface Films by the Atomizer Test
ASTM F2931	-	Standard Guide for Analytical Testing of Substances of Very High Concern in Materials and Products
ASTM G14	-	Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
ASTM G59	-	Standard Test Method for Conducting Potentiodynamic Polarization Resistance Measurements
ASTM G76	-	Standard Test Method for Conducting Erosion Tests by Solid Particle Impingement Using Gas Jets
ASTM G85	-	Standard Practice for Modified Salt Spray (Fog) Testing

ASTM G102 - Standard Practice for Calculation of Corrosion Rates and Related Information from Electrochemical Measurements

(Copies of these documents are available online at www.astm.org.)

NACE INTERNATIONAL

NACE SP0508 - Methods of Validating Equivalence to ISO 8502-9 on Measurement of the Levels of Soluble Salts

(Copies of this document are available online at www.nace.org.)

SAE INTERNATIONAL

SAE AMS1424 - Fluid, Aircraft Deicing/Anti-Icing, SAE Type 1

(Copies of this document are available online at www.sae.org.)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-AB 1 - Mineral and Slag Abrasives

SSPC-SP 1 - Solvent Cleaning

SSPC-SP 5/NACE No. 1 - White Metal Blast Cleaning

(Copies of these documents are available online at www.sspc.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. TSN coating systems furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Description. The TSN coating systems covered by this specification shall consist of one or more inorganic thermal spray coating(s). The composition of each individual coating of the TSN is the manufacturer's responsibility subject only to the limitations herein.

3.3 Materials. Each individual layer and final coating system of the TSN qualified to this specification shall, when applied in accordance with the manufacturer's instructions, be in accordance with the applicable requirements. The composition of the coating system furnished to this specification shall be the responsibility of the manufacturer, except as limited by this specification.

3.4 Toxicity and prohibited materials.

3.4.1 Toxicity. When evaluated in accordance with 4.5, the as-applied TSN coating system shall pose no serious or high risk to the health of personnel or the environment when used for its intended purpose (see 4.5 and 6.7).

3.4.2 Prohibited materials. The as-applied TSN coating system shall not contain any chemicals categorized as "prohibited" in accordance with T9070-AL-DPC-020/077-2.

3.4.3 Heavy metals. When tested in accordance with 4.6.1, the total metal content of each wire prior to thermal spray application shall be not greater than the values listed in table I.

TABLE I. Maximum metals content.

Element	Maximum Metal Content, %WT 1/
Antimony	0.05
Arsenic	0.05
Barium (Excluding Barite)	1.00
Beryllium	0.0075
Cadmium	0.01
Chromium (VI) Compounds	0.05
Chromium or Chromium (III) Compounds	0.35 (Type I) 0.10 (Type II)
Cobalt	0.80
Copper	0.25
Lead	0.10
Mercury	0.002
Molybdenum	0.35
Nickel	0.20
Selenium	0.01
Silver	0.05
Thallium	0.07
Vanadium	0.24

NOTE:

1/ The metals content limits are based on those found in CA Title 22, Division 4.5, Chapter 11, Article 3, § 66261.24, Total Threshold Limit Concentration (TTLC) for hazardous waste.

3.5 Identification characteristics. The identification characteristics required in table II shall be established in accordance with the test method listed therein for each individual wire (as received, prior to spraying), and for the as-applied coating system. Identification characteristics listed in table II shall conform to the values established by the manufacturer during qualification testing and meet the requirements in table II.

TABLE II. Identification characteristics.

Characteristic	Criteria	Test Paragraph
Chemical Composition	Each element or chemical compound constituting greater than or equal to 0.01 %wt of wire or wire jacket and wire core shall have its chemical composition established. Mercury and beryllium content greater than or equal to 0.001 %wt shall be established. Crystalline silica content shall not exceed 0.1 %wt of the wire.	4.6.1
Density	A value for the density of the wire in lb/ft^3 shall be established for all wire types.	4.6.2
Wire Diameter	The wire diameter tolerances shall be as specified in table III. Each coating system for all types shall be qualified for one specific wire diameter, which shall be specified in the Thermal Spray Data Sheet (see 6.4).	4.6.3
Porosity	A value for the as-applied porosity of each layer of the coating shall be established.	4.6.6.1
Microhardness	A value for the as-applied microhardness profile of the coating system shall be established.	4.6.6.2

TABLE III. Standard sizes for thermal spray bare electrode wires.

Diameter (Inch) (Fraction)	Tolerance (Inch)
0.062 (1/16)	±0.002
0.125 (1/8)	±0.005
0.188 (3/16)	±0.005
0.250 (1/4)	±0.005

3.6 Melting point. When tested in accordance with 4.6.4, the melting point of the coating system submitted for qualification, in the as-applied condition, shall be established for all types.

3.7 Finish and uniformity. When tested in accordance with 4.6.5, all thermal spray wires for all types shall have a smooth finish that is free from slivers, dents, scratches, scale, and foreign matter that would adversely affect wire feedability or the properties of the thermal spray wire. Welds or other joining techniques, when present, shall be made so as not to interfere with the uniform, uninterrupted feeding of the thermal spray wire in automatic or semiautomatic thermal spray equipment. Cored composite wires shall have the core ingredients evenly distributed throughout their length so as not to adversely affect the performance of the thermal spray wire, or the deposited thermal spray coating properties.

3.8 Metallurgical analysis. Porosity and microhardness testing shall be completed in accordance with 4.6.6 following thermal spray application.

3.8.1 Porosity. The average porosity of the as-applied coating system for all types shall be established by the individual manufacturer's identification characteristics in table II, when tested in accordance with 4.6.6.1.

3.8.2 Microhardness. The average microhardness profile shall be established by the individual manufacturer's identification characteristics in table II for all types when tested in accordance with 4.6.6.2.

3.9 Adhesion. When tested in accordance with 4.6.7, the average adhesion shall be a minimum of 2,000 psi.

3.10 Mandrel bend test. When tested in accordance with 4.6.8, any spalling, flaking, or delamination of the coating on any one of the five coupons shall constitute a mandrel bend test failure. Cracking without spalling, flaking, or delamination is acceptable (see figure 1 for reference). Flaking within 0.125 inch of the panel edges is acceptable.

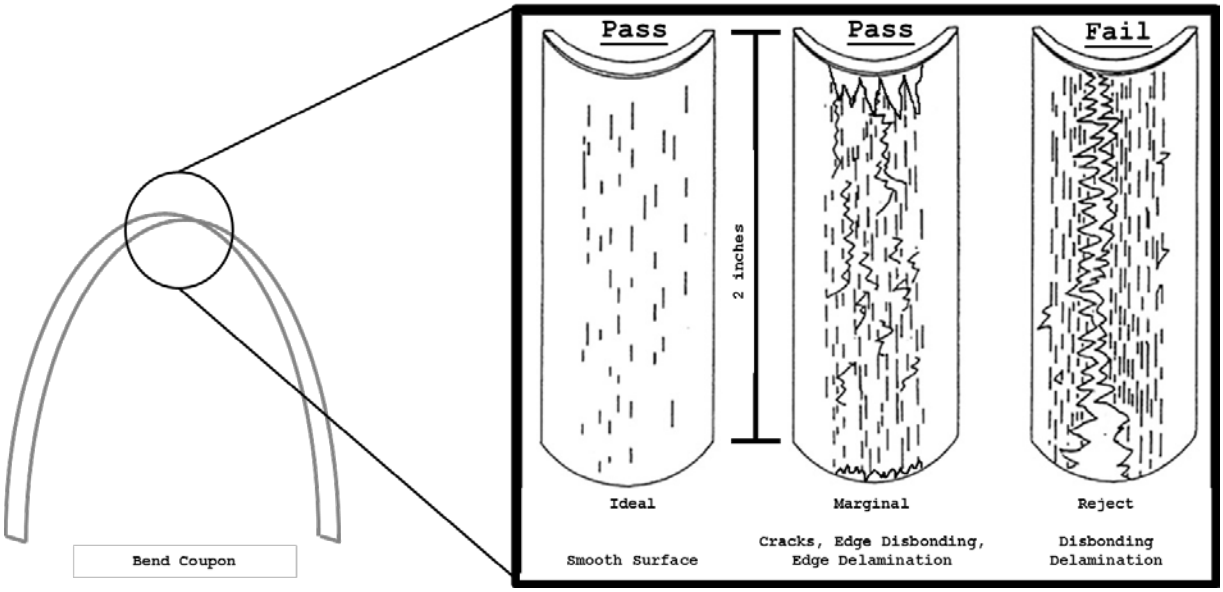


FIGURE 1. Mandrel bend test pass and fail samples.

3.11 Explosibility. When tested in accordance with 4.6.9, the dust in the thermal spray fume shall not be explosible in any of the conditions tested. The average particle size and dust concentration for each testing condition shall be recorded.

3.12 Erosion. When tested in accordance with 4.6.10, the maximum erosion weight loss shall be 200 milligram (mg).

3.13 Resistance to wear. When tested in accordance with 4.6.11, the percent weight loss after wear testing for all types shall not exceed 5 percent.

3.14 Coefficient of friction (COF). When tested in accordance with 4.6.12, the COF of the coating for all types shall be at or above the values specified in table IV.

TABLE IV. Coefficient of friction (COF) for TSN materials.

Testing Apparatus	Minimum COF Values
Static COF Meter	0.95 (dry) 0.90 (wet) 0.80 (oily)
Dynamic COF Meter	1.20 (dry) 1.10 (wet)

3.15 Resistance to chemical solutions. When tested in accordance with 4.6.13, the coating shall show no softening, delamination, or separation between coats of the system for all types.

3.16 Electrochemical test. When tested in accordance with 4.6.14, the coating for all types shall be anodic to the steel substrate throughout the extended current monitoring, as indicated by the current measurements. The average corrosion rate from the polarization resistance testing shall not exceed 5 mils/year.

3.17 Weight. When tested in accordance with 4.6.15, the mass of the TSN system shall not exceed 1 pound per square foot of application area.

3.18 Sequential testing. When tested in accordance with 4.6.16, the coating for all types shall comply with table V immediately following completion of each respective test.

TABLE V. Sequential testing requirements.

Test	Test Paragraph	Requirement
Sequential Four Point Bend	4.6.16.1	a. There shall be no surface cracking when evaluated in accordance with ASTM D661. b. There shall be no delamination or spalling of the TSN coating from the substrate.
Sequential Resistance to Accelerated Corrosion	4.6.16.2	When tested in accordance with 4.6.16.2, TSN materials shall have no loss of adhesion or separation between layers of the system, no blistering in accordance with ASTM D714, or corrosion of the steel substrate.
Sequential Impact Resistance	4.6.16.3	When tested in accordance with 4.6.16.3, TSN materials shall have no more than two breaches between the impact sites for each test panel.
Sequential Jet Impingement	4.6.16.4	When tested in accordance with 4.6.16.4, the TSN materials shall meet the following requirements: a. The TSN product shall show no melting or signs of erosion following jet plume exposure. b. Cracking shall have a rating between 6 and 10 when measured in accordance with ASTM D661. c. There shall be no separation between layers of the system or delamination from the substrate.
Post Exposure Adhesion	4.6.16.5.1	The average adhesion shall be a minimum of 1,300 psi.
Post Exposure Four Point Bend	4.6.16.5.2	There shall be no delamination or spalling. There shall be no surface cracking when evaluated in accordance with ASTM D661. Flaking along the edges is acceptable (see 3.10).
Post Exposure Electrochemical	4.6.16.5.3	When tested in accordance with 4.6.16.5.3, the TSN coating shall be anodic to the steel substrate throughout the extended current monitoring, as indicated by the current measurements. The average corrosion rate from the polarization resistance testing shall not exceed 5 mils/year.

3.19 Appearance of as-applied coating. When tested in accordance with 4.6.17, the TSN coating system for all types shall present a uniformly rough appearance over the entire coated surface. There shall be no blisters, cracks, un-adhered or peeling coating, or exposed substrate as examined with × 10 magnification.

3.20 Film thickness (FT). When tested in accordance with 4.6.18, the FT of each layer of the TSN coating system for all types shall be as recommended by the manufacturer in the Thermal Spray Data Sheet (see 6.4). The total FT of the TSN coating system shall be within the tolerance specified by the manufacturer in the Thermal Spray Data Sheet.

3.21 Performance in service. When tested in accordance with 4.6.19, the nonskid system for all types shall show none of the following:

a. Wear-through (profile of the nonskid surface reduced to expose deck substrate material);

b. ASTM D660 checking (slight breaks in the coating system not penetrating to the underlying surface) rated 0 to 7;

c. ASTM D661 cracking (breaks which extend through the coating system to the substrate surface) rated 0 to 7;

d. Loss of adhesion (delamination or spalling);

e. Blistering;

f. COF values less than 80 percent of the initial value specified in 3.14; or

g. Other deficiency that would adversely affect its performance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification tests shall consist of the tests specified in table VI. The Government reserves the right to witness testing conducted at a non-Government laboratory. The service test shall be conducted on an in-service naval vessel as specified in 4.6.19 after successful completion of all laboratory tests. Testing of products on Government ships shall be conducted at the convenience of the Government.

TABLE VI. Qualification tests.

Characteristic	Performance Paragraph	Test Paragraph
Toxicity & Prohibited Materials	3.4	4.5
Heavy Metals	3.4.3	4.6.1
Chemical Composition	3.5	4.6.1
Density	3.5	4.6.2
Wire Diameter	3.5	4.6.3
Melting Point	3.6	4.6.4
Finish & Uniformity	3.7	4.6.5
Porosity	3.8.1	4.6.6.1
Microhardness	3.8.2	4.6.6.2
Adhesion	3.9	4.6.7
Mandrel Bend Test	3.10	4.6.8
Explosibility	3.11	4.6.9
Erosion	3.12	4.6.10
Resistance to Wear	3.13	4.6.11
Coefficient of Friction	3.14	4.6.12
Resistance to Chemical Solutions	3.15	4.6.13
Electrochemical Test	3.16	4.6.14
Weight	3.17	4.6.15
Sequential Testing	3.18	4.6.16
Appearance of Applied Coating	3.19	4.6.17
Film Thickness	3.20	4.6.18
Performance in Service	3.21	4.6.19

4.3 Conformance inspection. Conformance inspection shall consist of the conformance tests specified in table VII.

TABLE VII. Conformance tests.

Characteristic	Performance Paragraph	Test Paragraph
Chemical Composition	3.5	4.6.1
Density	3.5	4.6.2
Wire Diameter	3.5	4.6.3
Finish & Uniformity	3.7	4.6.5
Adhesion	3.9	4.6.7
Mandrel Bend Test	3.10	4.6.8
Erosion	3.12	4.6.10
Coefficient of Friction (COF) 1/	3.14	4.6.12
Appearance of Applied Coating	3.19	4.6.17

NOTE:

1/ Dynamic COF shall be measured in accordance with 4.6.12 using service test TSN application equipment on an LHA/LHD flight deck before any application of more than 1,000 square feet of coating.

4.4 Preparation for testing.

4.4.1 Standard conditions. In case of dispute, tests shall be performed at standard testing conditions, which are 75±5 °F and a relative humidity of 50±20 percent, unless otherwise instructed in the test specifications in 4.6.

4.4.2 Panel substrate material. Steel panels in accordance with 4.4.3 shall be used for all of the tests specified in 4.6, which require test panels, unless otherwise noted within the particular test requirement.

4.4.3 Steel test panel material specification and basic preparation for thermal spray application. TSN qualification testing shall be conducted on high strength HY-100 steel panels (or equivalent), in accordance with T9074-BD-GIB-010/0300 HY-100, at a plate thickness of ¼ inch, unless otherwise noted.

4.4.3.1 Substrate cleaning. Degreasing/cleaning shall be accomplished prior to surface preparation to ensure that the surface is free of contaminants in accordance with SSPC-SP 1. The clean panels shall be subject to a water break test in accordance with ASTM F21. Any panel exhibiting a water break shall be degreased/cleaned until the panel does not exhibit a water break. One conductivity reading shall be taken on each test panel and shall not exceed 30 micro-siemen per centimeter (µS/cm). Any panel with a conductivity exceeding 30 µS/cm shall be cleaned again until conductivity is at or below 30 µS/cm. Conductivity samples shall be collected using a product that meets the requirements of NACE SP0508.

4.4.3.2 Abrasive blasting. Panels shall be abrasive blasted to a uniform, white metal finish according to SSPC-SP 5/NACE No. 1 using a blend of 50 percent 16-mesh grit and 50 percent 24-mesh grit aluminum oxide aggregate in accordance with SSPC-AB 1.

4.4.3.3 Surface profile measurement. Following blasting operations, surface profile shall be determined. Surface peak-to-valley height shall be determined using Method B of ASTM D4417. The surface profile value shall be determined by taking the mean of 3 measurements, in which each measurement is the mean of 10 individual readings. The mean profile of the surface shall be between 4.0 and 10.0 mils. The surface profile shall also be determined in accordance with ASTM D7127 except that the average peak-to-valley height (Pq), maximum peak-to-valley height (Pz), and angularity (RΔq) of the surface shall be determined and recorded. The number of peak/valley pairs per unit of length and the distance between the highest peak and the lowest valley shall not be determined. The minimum values for Pq, Pz, and RΔq shall be 0.95 mils, 5 mils, and 0.45 respectively.

4.4.3.4 Surface blow off. The panels shall be cleaned with oil-free air or vacuum, and protected from moisture during storage.

4.4.4 Coating application on test panels. Panels prepared in accordance with 4.4.3 shall be coated with the TSN product submitted for qualification; see table VIII for test panel requirements. Each layer of the TSN coating system shall be applied in accordance with the Thermal Spray Data Sheet (see 6.4). TSN systems that include layers of intentionally differing chemical composition, density, or physical characteristics shall be applied to support the testing requirements of 4.6. After coating application, all panel surfaces shall be swiped with a stainless steel wire brush to remove any loose thermal spray particles, and then cleaned with oil-free air.

TABLE VIII. Sample requirements for specification testing.

Test Paragraph	Test Sample	Sample Size	Quantity
4.6.2	Wire	4-inch length	Every 1,000 linear feet
4.6.3	Wire	6-inch length	Every 1,000 linear feet
4.6.5	Wire	12-inch length	Every 1,000 linear feet
4.6.6	Panel	6 by 12 by ¼ inches	1
4.6.7	Panel	6 by 12 by ¼ inches	1
4.6.8	Panel	2 by 8 by 0.0625 inches	5
4.6.9	Dust	As required by ASTM E1226	1
4.6.10	Panel	2 by 2 by ¼ inches	7
4.6.11	Panel	6 by 12 by ¼ inches	3
4.6.12.1	Panel	18 by 18 by ¼ inches	2
4.6.13	Panel	6 by 2 by ¼ inches	16
4.6.14	Panel	3 by 3 by ¼ inches	1
4.6.15	Panel	6 by 12 by ¼ inches	3
4.6.16	Panel	6 by 12 by ¼ inches	3
4.6.17	Panel	6 by 6 by ¼ inches	1
4.6.18	Panel	6 by 6 by ¼ inches	1

4.5 Toxicity and prohibited materials. A Health Hazard Assessment (HHA) will be conducted to ensure conformance to 3.4.1 and 3.4.2, as required by the qualifying activity. The Navy and Marine Corps Public Health Center (NMCPHC) will evaluate the as-applied TSN coating system using data provided by the manufacturer/distributor to the NMCPHC (see 3.4.1 and 6.7).

4.6 Tests.

4.6.1 Chemical composition. The chemical composition of each TSN wire material (as received) shall be determined.

4.6.1.1 Solid wires. The suggested ASTM methods that can be used for chemical analysis of solid wires are E415, E1251, or E2594, depending upon the expected wire composition. ASTM A751, E34, E1473, and F2931 should be consulted for a more complete list of methods. The chemical composition for each element shall not exceed the values listed in table I (see 3.5).

4.6.1.2 Powder core wires. Powder core wires shall have the chemical composition of the outer jacket and inner powder analyzed separately in accordance with 4.6.1.1. In addition, the crystalline oxide phases in the powder shall be identified using X-ray Powder Diffraction (XRD) in accordance with the diffractometer manufacturer's instructions. The percent by weight of each oxide shall be estimated using results from the applicable chemical analysis in 4.6.1.1. The chemical composition resolution limits shall conform to those in table II (see 3.5).

4.6.2 Density. A 4-inch sample of wire shall be cut from every 1,000 linear feet of wire and shall have density determined in accordance with ASTM C838.

4.6.3 Wire diameter. A 6-inch sample of wire shall be cut from every 1,000 linear feet of wire and shall have diameter determined at three random locations along the sample to within 0.001 inch. Each diameter measurement shall conform to the tolerance requirements of table III (see 3.5).

4.6.4 Melting point. The melting point of each TSN thermal spray wire material, in the as-applied condition, shall be determined in accordance with ASTM E794.

4.6.5 Visual inspection. For every 1,000 linear feet of wire, a randomly selected 12-inch length of wire shall be visually examined prior to thermal spray application. The 12-inch section of wire shall conform to the finish and uniformity requirements of 3.7.

4.6.6 Metallurgical analysis. One panel, 6 by 12 by ¼ inches (nominal) shall be prepared in accordance with 4.4.3. The thermal spray coating submitted for qualification shall be applied in accordance with 4.4.4. Five samples, 1 by 1 by ¼ inch shall be cut from the panel using water-jet cutting or a fine diamond saw, or any other technique that does not cause the coating to spall at the kerf. The following tests shall be conducted on each sample.

4.6.6.1 Porosity. The porosity of each thermal spray coating layer shall be determined in accordance with ASTM E2109 for each sample. The average of the five measured porosity values, one value from each sample, shall be recorded to fulfill the requirement of 3.8.1.

4.6.6.2 Microhardness. Five microhardness profiles across all layers of the coating shall be determined on each sample, with each measurement taken in accordance with ASTM E384. The average of all 25 profiles, with five from each panel, shall be recorded to fulfill the requirement of 3.8.2.

4.6.7 Adhesion. One panel, 6 by 12 by ¼ inches (nominal), shall be prepared in accordance with 4.4.3. The thermal spray coating submitted for qualification shall be applied in accordance with 4.4.4. The adhesion shall be determined in accordance with ASTM C633 on three 1.5-inch diameter by ¼-inch thick circular samples cut from the panel using water-jet cutting or a fine diamond saw, or similar process that does not cause the coating to spall at the kerf. The average of the three adhesion values shall be used to determine conformance with the requirement of 3.9.

4.6.8 Mandrel bend test. Five bend coupons shall be constructed out of UNS G10100 cold rolled steel. The dimensions shall be 2 by 8 by 1/16 inches (nominal). The coupons shall be prepared in accordance with 4.4.3 with the addition that both sides of the coupon shall be blasted. One coating layer, specifically the bottom most layer adjacent to the substrate, of the TSN material submitted for qualification shall be applied in accordance with 4.4.4. Coupons shall be tested in accordance with ASTM D522/D522M Test Method B, the cylindrical mandrel test, except that an alternative test apparatus with a mandrel diameter of 2.25 inches shall be used. Coupons shall be tested along the short axis. Test coupon conditions specified in ASTM D522/D522M shall not be followed. The elongation does not need to be determined. Following the bend test, the TSN coating shall be in accordance with the requirements of 3.10.

4.6.9 Explosibility. Dust shall be collected via an inhalable dust sampler located in the application area during spray application of the TSN coating system submitted for qualification. The dust collected shall be of sufficient quantity to be tested in accordance with ASTM E1226 and shall be in accordance with 3.11. The inhalable dust sampler shall be able to collect dust 100 microns or smaller and allow for retrieval of the collected dust for testing.

4.6.10 Erosion. Seven panels, 2 by 2 by ¼ inches (nominal), as specified in 4.4.3, shall be coated with the TSN coating system submitted for qualification in accordance with 4.4.4. The erosion weight loss shall be measured in accordance with ASTM G76 except that an alternative test setup shall be used. The alternative test setup shall be as described in ASTM G76 except that the nozzle angle shall be 22 degrees, the distance between the nozzle tip and the specimen shall be 4 inches, and the erosion weight loss shall be determined after one exposure lasting 90 seconds. The erosion weight loss shall be in accordance with 3.12.

4.6.11 Resistance to wear. Three steel panels, 12 by 6 by ¼ inches (nominal), as specified in 4.4.3, shall be coated with the TSN coating system submitted for qualification in accordance with 4.4.4. The mass of each panel shall be measured to the nearest 0.001 pound before application of the coating system. Each panel shall be abraded by the cable abrasion test apparatus in 4.6.11.1 for 50 cycles and then its mass shall be determined. The panel shall then be worn for an additional 750 cycles in the cable abrasion test apparatus. After completion of the wear, the final coating mass shall be taken. The percent of determined mass loss is calculated as follows:

Percent mass loss = $100 \times (M2 - M3) / (M2 - M1)$

M1 = Mass of panel before coating

M2 = Mass at 50 cycles

M3 = Mass at end of test

The average percent of determined mass loss of the three panels shall be computed. Loss of mass shall conform to the requirements of 3.13.

4.6.11.1 Wear by cable abrasion test apparatus. The test apparatus shall be constructed so that there will be relative motion between the steel rod and the test panel, and shall have the following features:

a. A carriage or jig on which either the test panel or the steel rod is mounted. The test panel and the rod shall be securely fastened to preclude movement within the carriage or jig during the test, and shall be moved in a reciprocating motion 9 inches along the long axis of the sample panel.

b. The steel rod shall be in contact with the test panel, with the axis of the rod horizontal and at a right angle to the direction of the reciprocating motion. The clamps holding the rod shall not come into contact with the test panel, and shall not permit the rod to bend, twist, or rotate during the test. The test apparatus shall be constructed so as the contact force between the rod and the sample is 30±¼ pounds during the test.

4.6.12 Coefficient of friction (COF). The static and dynamic COF shall be determined as follows and shall be in accordance with the requirements of 3.14.

4.6.12.1 Test panel preparation. Two steel panels, 18 by 18 by ¼ inches (nominal), prepared in accordance with 4.4.3, shall be coated with the TSN materials comprising the TSN product submitted for qualification in accordance with 4.4.4.

4.6.12.2 Static coefficient of friction (COF).

4.6.12.2.1 Test apparatus. The static COF testing device shall be a block and sled apparatus, referred to as a sliding block COF meter hereafter. The sliding block COF meter shall be constructed of the following components:

a. The drag sled shall be constructed of a steel block having dimensions of 5.75 by 4 by 0.85 inches with one 4-inch edge having a 0.75-inch radius. The 4- by 0.85-inch face with the radius edge will also receive a screw eye in the center of the face. The block will be covered with a vulcanized neoprene rubber pad covering the two faces joined by the radius edge and the radius edge itself. The rubber pad shall have a Type “A” durometer hardness of 57±2 and a nominal thickness of ⅛ inch. The total weight of the drag sled including the rubber pad and screw eye shall be 6.0±0.5 pounds.

b. A force gage shall be used which can measure at least 10 pounds with a minimum resolution of 0.02 pound. The gage shall also be able to output information to a computer for analysis. Chatillon force gage model DFS-0050 (Standard model), or equal, has been found acceptable for this application.

c. A computer program that can collect and save data from the force gage, as well as analyze the data to determine the COF at the moment at which motion begins (static friction), shall be used.

d. A platform shall be moved across a 1-inch minimum distance at a constant speed of 12 inches per minute (nominal) of the test apparatus.

e. The COF tester and the panels shall be securely fastened to a stable platform to ensure no extraneous slippage of the panels or the tester occurs, and that there will be no interference with the securing attachment and the motion of the sled.

4.6.12.2.2 Test procedure. The sliding block COF meter shall be used on one of the two panels specified in 4.6.12.1 to test the static COF. The panel tested shall not be the same panel used in 4.6.12.3.2.

a. The sled shall be placed rubber side down on the panel and connected to the force gage using a rigid rod such that no tension is experienced while minimizing slack between the force gage and the sled.

b. The sled shall be moved across the panel at a rate of approximately 12 inches per minute. The sled should move for approximately 5 seconds to give a travel distance of 1 inch. The computer program will determine COF data by dividing the force required to initiate movement of the sled by the weight of the sled and record the results.

c. COF test shall first be run with the panel dry.

d. After completion of the dry condition test, the panel shall be wetted with substitute ocean water in accordance with ASTM D1141, and the tests shall be repeated.

e. After completion of the wet condition test, the panel shall be rinsed in tap water to remove the substitute ocean water, dried at 248 °F for 1 hour, and cooled to standard conditions. The panel shall then be wetted with aircraft engine turboshaft lubricating oil in accordance with MIL-PRF-23699, and the test shall be repeated.

f. Five replicate static COF measurements shall be made; the panel shall then be turned 90 degrees and five additional measurements shall be made. The average of the ten readings shall be recorded for each testing condition (dry, wet, and oily). The average static COF shall be in accordance with the requirements of 3.14.

4.6.12.2.3 Sled calibration. Since friction readings are a function of the surface condition of the steel sled rubber surface, a steel sled with a new vulcanized neoprene rubber pad shall be used for each product tested. Sleds shall be calibrated against a flat steel block having machined cross hatched v-shaped grooves having a nominal depth of 0.05 inch and a nominal groove peak-to-peak distance of 0.01 inch. Sleds may continue to be used in testing the same product until repeat measurements on the calibration surface changes by more than five percent (plus or minus). All calibrations shall be performed on the same calibration block since the intent of the calibration blocks are only to determine reproducibility of readings by the rubber pad and thus rubber pad replacement criteria. Calibration of sleds on different calibration blocks during the determination of friction values on a test specimen is not permitted. Calibration shall be performed before and after test specimen friction determinations and the values obtained recorded with the test value.

4.6.12.3 Dynamic coefficient of friction (COF).

4.6.12.3.1 Test apparatus. The dynamic COF testing device shall be Vision Point Systems Inc., μ-Deck Rotating Arm COF Meter, or equal.

4.6.12.3.2 Test procedure. The rotating arm COF meter shall be used on one of the two panels prepared in 4.6.12.1 to test the dynamic COF. The panel used shall not be the same panel used in 4.6.12.2.2. The dynamic COF shall be measured, in accordance with the rotating-arm meter manufacturer's instructions, three times dry, and then three wet using substitute ocean water in accordance with ASTM D1141. The average of the three measurements, dry and wet, shall be recorded. The average dynamic COF shall be in accordance with the requirements of 3.14.

4.6.13 Resistance to chemical solutions. Sixteen steel panels, 6 by 2 by ¼ inches (nominal), as specified in 4.4.3 shall be coated with the TSN coating system submitted for qualification in accordance with 4.4.4. Eight panels shall be subjected to two impacts from the impact test apparatus (see 4.6.16.3.1); the impacts shall be 4±¼ inches apart and equidistant from the edges and sides of the panels. Each of eight wide mouth jars with a minimum diameter of 3 inches and with tightly fitting caps that are larger than 2 inches in diameter shall be filled to a depth of 3 inches (nominal) with one of the following materials:

a. Grease in accordance with DOD-G-24508.

b. JP-5 jet fuel in accordance with MIL-DTL-5624.

c. Hydraulic fluid in accordance with MIL-PRF-83282.

d. Ethyl alcohol in accordance with 27 CFR 21.35.

e. Aircraft engine turboshaft lubricating oil in accordance with MIL-PRF-23699.

f. Detergent in accordance with MIL-D-16791, 0.5 percent solution in substitute ocean water in accordance with ASTM D1141.

g. Aqueous firefighting foam in accordance with MIL-F-24385, 10 percent solution in substitute ocean water in accordance with ASTM D1141.

h. Deicing/Anti-icing fluids in accordance with SAE AMS1424.

Two panels, one impacted and one unimpacted, shall be placed in each jar in a vertical orientation with each panel resting on its 2-inch side, with one half of the panel immersed in the test fluid and one half above the test material and in such a manner as to not touch each other. The jars shall be sealed tightly and kept in a climate controlled laboratory at standard conditions in accordance with 4.4.1 for 4 weeks for all fluids except JP-5, ethyl alcohol, and deicing/defrosting fluid, which shall be tested for 24 hours only. Upon removal from the immersion medium, the panels shall be probed with a sharp, 1-inch wide blade, wood chisel and compared with the identical untested control panel to detect signs of softening, loss of adhesion, or separation between layers of coating, and otherwise examined for conformance to 3.15. The panels immersed in JP-5, ethyl alcohol, and deicing/anti-icing fluids shall be allowed to dry under a ventilated fume hood for a minimum of 6 hours before testing. All other panels shall be examined for conformance immediately after removal from the immersion medium. Results of the evaluation shall be in accordance with the requirements of 3.15.

4.6.14 Electrochemical test. One steel panel, 3 by 3 by ¼ inches (nominal), as specified in 4.4.3 shall be coated with the TSN coating system submitted for qualification in accordance with 4.4.4. Corrosion cells shall be created on the surface of the panels as specified herein and subjected to extended current monitoring and potential resistance testing as specified herein.

4.6.14.1 Electrochemical test corrosion cell apparatus. A 1.5-inch inner diameter cylinder made of PVC pipe shall be attached to the surface of the panel via 100 percent pure silicone sealant/caulk such that 1.8 square inches of TSN surface area inside the cylinder is exposed to the electrolyte. There shall be enough silicone sealant/caulk applied to ensure a water tight seal. Once the silicone sealant/caulk has cured, the cell shall be filled with an ASTM D1141 substitute ocean water solution. The top of the cylinder shall be capped with standard PVC cap fitting with a ⅝-inch diameter hole in the center of the cap. A ½-inch diameter carbon steel rod of the same composition as the test panel shall be masked such that the amount of steel surface area immersed in the solution is equivalent to the TSN surface area inside the corrosion cell. The masked steel rod shall have an electrical connection point for attaching test leads. The steel rod shall be placed through the hole in the PVC cap and immersed in the test solution. A test lead shall be attached to the steel rod and to the positive terminal of a zero-resistance ammeter. A test lead shall be connected to the TSN coated panel and the negative terminal of the ammeter to complete an electrochemical circuit between the test panel and the steel rod.

4.6.14.2 Extended current monitoring. The current flow between the steel rod and TSN coated test panel as measured using the 4.6.14.1 apparatus shall be recorded for 1,000 hours. Throughout the testing, the current shall be in conformance with 3.16.

4.6.14.3 Polarization resistance testing. The same corrosion cells used in 4.6.14.2 shall be used for the polarization resistance testing after the completion of the extended current monitoring. Remove the PVC cap and ½-inch rod from the cell. Immerse a standard reference electrode and a carbon or platinum counter electrode into the solution for one hour. Measure and record the potential (E_{Corr}). Conduct the polarization resistance (R_P) measurement in accordance with ASTM G59 except that the electrochemical cell described in 4.6.13 shall be used instead of the standard test apparatus described in ASTM G59. Record the determined R_P and calculate the corrosion rate in accordance with ASTM G102. The measured values for E_{Corr} and R_P as well as the type of reference electrode used during testing shall be recorded. The corrosion rate shall be in conformance with 3.16.

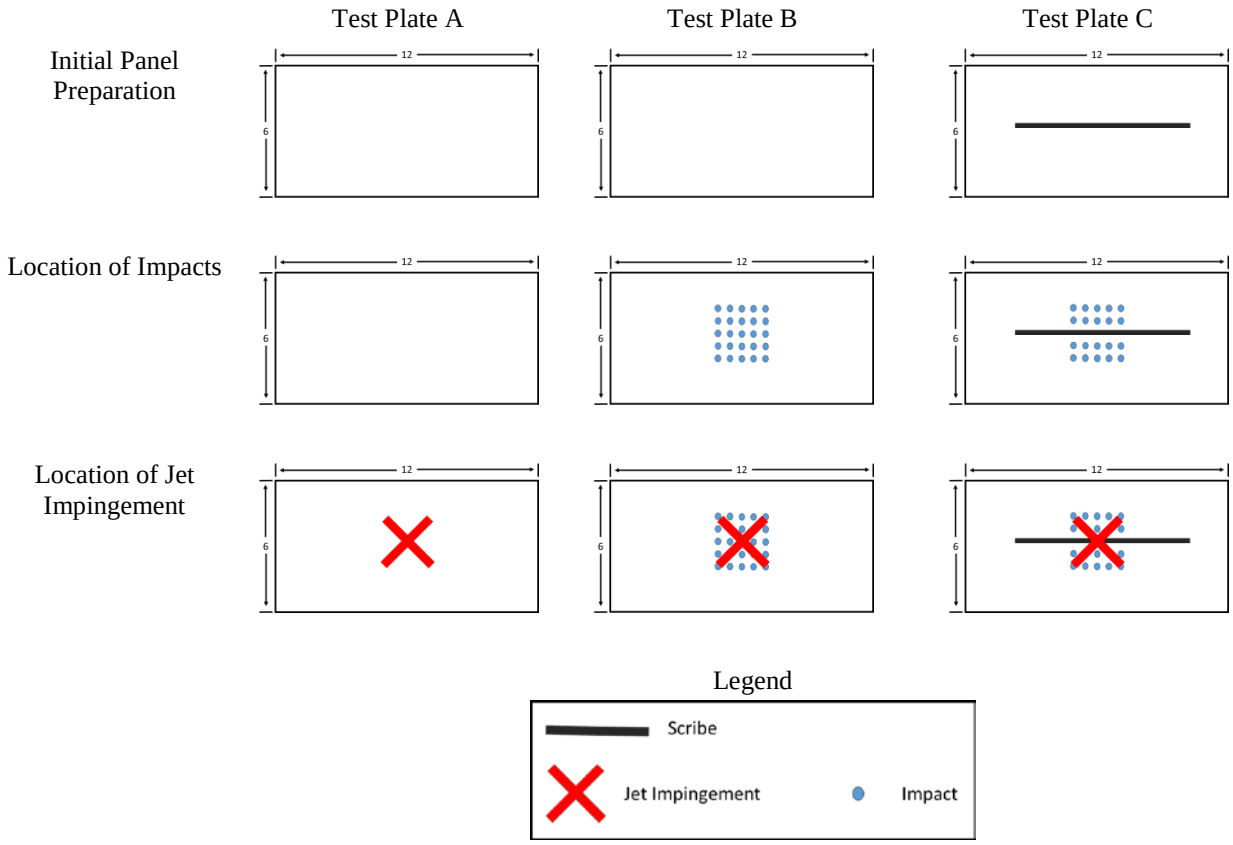
4.6.15 Weight. Three panels, 6 by 12 by ¼ inches (nominal), shall be prepared as specified in 4.4.3. The tare weight of each panel shall be determined to the nearest 0.0001 pound. The areas of the test plates shall be determined to the nearest 0.01 in^2. The TSN coating system shall be applied to each panel in accordance with 4.4.4 and the coating system shall be allowed to cool. After cooling, any excess coating shall be cleaned from the edge of the panels. The weight of each panel shall be determined to the nearest 0.0001 pound, and the tare weight shall be subtracted to give the net weight of the TSN coating. The areas of the three test plates shall be averaged. The three net weights shall be averaged and divided by the average test plate area to determine the weight of the coating per square foot of application area. The weight of the coating shall be in accordance with the requirements of 3.17.

4.6.16 Sequential testing. Three steel panels, 6 by 12 by ¼ inches (nominal), as specified in 4.4.3 shall be coated with the TSN coating system submitted for qualification in accordance with 4.4.4. One test plate shall be scribed down the center of the panel lengthwise (12-inch dimension). The scribe shall penetrate the TSN to expose the panel substrate material and shall be 0.125 inch wide (nominal) and shall be 8 inches long. Testing shall be accomplished in the order in which the tests are presented below. Panels shall have an epoxy anticorrosive coating applied to the edges and back side of the panels following the testing in 4.6.16.1.

4.6.16.1 Sequential four point bend. The three steel panels, 6 by 12 by ¼ inches (nominal), specified in 4.6.16 shall be subject to four point fatigue testing. Each test panel shall be placed in a four point bend testing apparatus in accordance with ASTM E855, Method C except that steel rollers, ½ inch in diameter and 4 inches in length, shall be used instead of knife edges for loading and supporting the test panel. The loading rollers shall be placed 1.5 inches apart and the support rollers shall be 11 inches apart. The TSN coating shall be fatigued for 650 cycles at 0.2 hertz. One cycle consists of increasing strain to, and then from, 1,600 µin/in at the specimen center along the longitudinal direction. The coating shall be in tension during cycling. After testing, the TSN shall be in accordance with the requirements of table V (see 3.18).

4.6.16.2 Sequential resistance to accelerated corrosion. The three steel panels, 6 by 12 by ¼ inches (nominal), specified in 4.6.16.1 shall be tested for 1,000 hours in a salt fog cabinet in accordance with ASTM G85, Annex A5. The coating system shall be examined for loss of adhesion, corrosion, blistering (in accordance with ASTM D714), and separation between coats. After testing, all three test plates shall be in accordance with the requirements of table V (see 3.18).

4.6.16.3 Sequential impact resistance. Of the three steel panels, 6 by 12 by ¼ inches (nominal), specified in 4.6.16.2, one scribed and one unscribed sample shall be impacted as specified herein. The impacts shall be placed in the center of the test panel as shown on figure 2. Impact damage extending into the scribe shall be disregarded. Impact resistance for test plate shall be in accordance with the requirements of table V (see 3.18).



NOTE:

1. Dimensions are in inches.

FIGURE 2. Test locations for sequential testing for the unscribed/unimpacted test plate (test plate A), the unscribed/impacted test plate (test plate B), and the scribed/impacted test plate (test plate C).

4.6.16.3.1 Impact test apparatus. The impact test shall be conducted with a device similar to that depicted in ASTM G14, except that the v-block securing device shall be replaced with a steel base that is at least 1.5 inches thick, is capable of securing the sample plate without allowing movement when impacted, and allows alignment of the plate with the designated impact locations. A machinist's magnetic vice has been demonstrated to have this capability. The tup nose shall have a ⅝-inch hemispherical head and the weight of the tup shall be modified so that it is 4.0 pounds.

4.6.16.3.2 Impacting the sample. Immediately upon removal from accelerated corrosion testing, each panel shall be subjected to either 20 or 25 impacts by the tup dropped from a distance of 4.0 feet. The impacts on the panel shall be made in the sequence specified on figure 3. Successive points of impact shall form a 5 by 5 pattern, enclosed within an area of about 9 square inches (58 square centimeters), in which the impacts are equally spaced ¾±1/16 inch center-to-center.

2	13			7	3
6	17			18	14
9	19			20	10
12	16			15	8
1	5			11	4

2	15	11	7	3
6	19	23	20	16
10	22	25	24	12
14	18	21	17	8
1	5	9	13	4

FIGURE 3. Impact sequence for impact resistance test of scribed (left) and unscribed (right) panels.

4.6.16.3.3 Removal of loosened nonskid coating. Upon completion of each impact test, the panel shall be probed by hand with a hand held, sharpened, 1-inch (nominal) wood chisel in an area that received no impacts in order to judge the force needed to remove the coating. The panel shall then be probed in the impact area with the chisel, using a force less than that used in the nonimpact area, and coating which has been loosened by the impact of the steel ball shall be removed from the panel.

4.6.16.3.4 Evaluation. The percentage of coating system remaining intact and tightly adhering to the panel shall be evaluated. The total number of breaches shall be totaled for each test panel. Impact resistance for each panel shall be in accordance with the requirements of table V (see 3.18).

4.6.16.4 Sequential jet impingement test. The three steel panels, 6 by 12 by ¼ inches (nominal), specified in 4.6.16.3 shall be exposed to 50 jet plume cycles in the location shown on figure 2. The burner nozzle temperature and exhaust gas velocity shall be set in accordance with TR-2298-SHR. The exposure cycle shall be as follows:

a. Position the specimen so that its horizontal plane is 12 inches from the exit of the nozzle.

b. Roll the specimen under the nozzle, in accordance with table IX, until the plate's center is aligned with the center of the nozzle.

TABLE IX. Jet impingement test timing table.

Time (Seconds)	Distance From Center (Inches)
0	6
2	4
4	2
6	0
7	1
8	2
9	Remove

c. Remove specimen from burner and allow it to cool for 45 seconds.

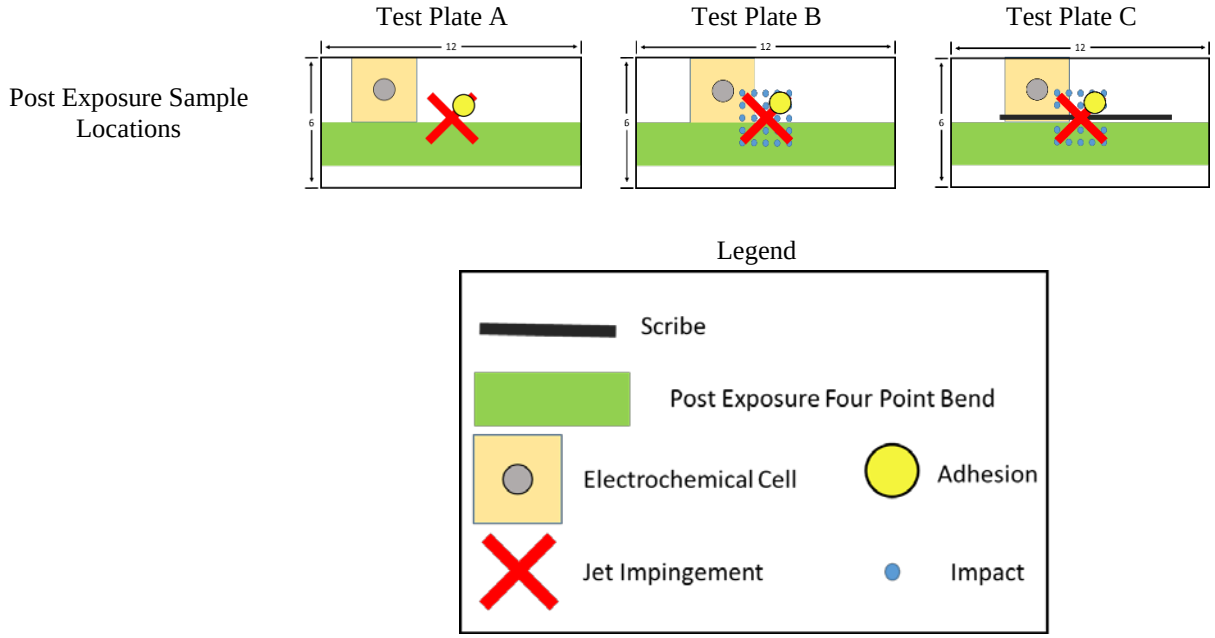
d. Repeat steps a. through c. for 10 consecutive cycles.

e. Allow panel to cool for 30 to 45 minutes in ambient conditions.

f. Steps a. through e. shall be repeated until a total of 50 exposures are reached for each specimen.

After testing, the panels shall be in accordance with the requirements of table V (see 3.18).

4.6.16.5 Post exposure testing. The three steel panels, 6 by 12 by ¼ inches (nominal), specified in 4.6.16.4 shall be cut into three smaller specimens as specified in 4.6.16.5.1, 4.6.16.5.2, and 4.6.16.5.3 (see figure 4). Specimens shall be cut with a water-jet or fine diamond saw, or any other technique that does not cause the coating to spall or delaminate at the kerf. Once specimens are cut, the following tests shall be conducted on the smaller samples.



NOTE:

1. Dimensions are in inches.

FIGURE 4. Sample extraction locations for post exposure tests.

4.6.16.5.1 Post exposure adhesion testing. A single 1.5-inch diameter by ¼-inch thick circular sample shall be extracted from each of the three steel panels, 6 by 12 by ¼ inches (nominal), specified in 4.6.16.5, as shown on figure 4, and tested in accordance with 4.6.7. The measured value for adhesion shall be in accordance with table V (see 3.18).

4.6.16.5.2 Post exposure four point bend test. A single steel panel, 1 by 12 by ¼ inches (nominal), shall be extracted by water-jet or fine diamond saw cutting from each of the three 6- by 12- by ¼-inch steel panels specified in 4.6.16.5 as shown on figure 4. Each test panel shall be placed in a four point bend test apparatus in accordance with ASTM E855, Method C except that steel rollers, ½ inch in diameter and 4 inches in length, shall be used instead of knife edges for loading and supporting the test panel. The loading rollers shall be placed 4 inches apart and the support rollers shall be placed 10 inches apart. Each test panel shall be placed so that the TSN coating is in tension. Each panel shall be loaded until a maximum surface strain of 2,400 µin/in is achieved at the specimen center along the longitudinal direction. After testing, the TSN coating shall be in accordance with the requirements of table V (see 3.18).

4.6.16.5.3 Post exposure electrochemical test. A single steel panel, 3 by 3 by ¼ inches (nominal), shall be cut from each of the three 6- by 12- by ¼-inch (nominal) steel panels specified in 4.6.16.5, as shown on figure 4. Corrosion cells shall be created on the surface of the panels as specified in 4.6.14.1. Conduct the extended corrosion current monitoring test in accordance with 4.6.14.2. Conduct the polarization resistance test in accordance with 4.6.14.3. Throughout the extended current monitoring test duration, the cell current shall conform to table V (see 3.18). The calculated corrosion rate shall be in conformance with table V (see 3.18).

4.6.17 Appearance of applied coating. Each coating layer comprising the TSN coating system submitted for qualification shall be applied in accordance with 4.4.4 to one steel panel, 6 by 6 by ¼ inches (nominal), prepared as specified in 4.4.3. The appearance of each coat shall be in accordance with the requirements of 3.19.

4.6.18 Film thickness (FT). Separate samples of each layer of the TSN coating system submitted for qualification shall be applied in accordance with 4.4.4 to one steel panel, 6 by 6 by ¼ inches (nominal), prepared as specified in 4.4.3. The thickness of each TSN coating shall be determined in accordance with ASTM B487. The total TSN system FT and the FT of each TSN layer shall be in accordance with the requirements of 3.20.

4.6.19 Performance in service. A service test shall be conducted on an LHA or LHD class ship in the landing area. The TSN coating system shall be applied in accordance with 4.4.4. The coating shall be color topped and marked in accordance with applicable NAVSEA/Naval Air Systems Command (NAVAIR) requirements. The coating system shall be subject to a minimum of one deployment or underway period. The condition of the coating shall be examined after 12 months and evaluated for conformance (see table VII) to 3.21.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The coating systems described by this specification are intended to provide a heat resistant, corrosion resistant nonskid coating for use on naval shipboard flight decks.

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

b. Packaging and labeling requirements (see 5.1, 6.5, and 6.6).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 32577 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.4 Thermal spray data sheet. Manufacturers of TSN will be required to provide the Thermal Spray Data Sheet as seen on figure 5 (front) and figure 6 (back) for the product being qualified to the qualifying activity as part of the final qualification package.

THERMAL SPRAY DATA SHEET

Material Information

Date:

Product Trade Name: Recommended Substrate (steel, aluminum, etc.):

Specification:

Manufacturer: Wire Diameter:

Chemical Composition (nominal):

Available Packaging

Storage

Storage Temperature Recommended Storage Conditions (dry, dark, etc.):

Minimum: Maximum:

Special Surface Preparation Instructions

Coating Parameters

Number of Coats: Thickness of Each Coat[1] (minimum and maximum):

Finishing Methods:

Spray Equipment Parameters

(The below information is required for each coat, or layer, within the thermal spray nonskid system.)

	1st Coat	2nd Coat	3rd Coat
Atomizing Gas (type and pressure):			
Method of cooling (air, gas, etc.):			
Volts:			
Amps:			
Wire Feed Rate:			
Spray Distance:			
Spray Angle:			
Gun Raster Speed:			
Coating Thickness per Pass:			
Number of Passes:			
Method of Application (Are the above parameters for application by hand or robot? Include make/model of spray equipment):			

FIGURE 5. Thermal spray data sheet (front).

Environmental Parameters	
Substrate Temperature Minimum: Maximum:	Maximum Relative Humidity:
Ambient Temperature Minimum: Maximum:	Minimum Temperature Difference between Dew Point and Substrate Temperature:
Special Instructions	
Provide repair procedures if coated areas are above or below the recommended dry film thickness.	
Safety Precautions	
List safety concerns for the application process and the required Personal Protection.	

[1] The requested information must be supplied for each coat in the thermal spray system.

FIGURE 6. Thermal spray data sheet (back).

6.5 Packaging recommendations. Packaging recommendations are contained herein (see 6.2).

6.5.1 Standard package sizes. Thermal spray products should be suitably packaged to ensure against damage during shipment and storage under normal conditions. Standard packaging dimensions are given in table X. Packaging size, weight, and the respective tolerances of coils without support should be as agreed upon between the purchaser and supplier. Sizes and net weights other than those listed in table X may be supplied as agreed upon between the supplier and purchaser.

TABLE X. Standard packaging dimension and weights for thermal spray wires.

Type of Package	Package Size		Net Weight
	Inches	Dimension (Diameter)	Pounds
Coils with Support	12	inside	25, 30, 50, and 60
	12±⅛	inside	25 and 30
	12±⅛	inside	50, 60, and 65
Drums	15.5	outside	300 and 600
	20	outside	300 and 600
	23	outside	300 and 600
Spools	12	outside	15 to 45
	14	outside	50 and 60
	22	outside	250
	24	outside	300
	30	outside	600, 750, and 1,000

6.5.2 Coil weight. The net weight of the coil should be available in a variety of sizes to support various jobs. The net weight of the coil should be within 10 percent of the net weight agreed upon by the purchaser and supplier, unless otherwise agreed upon by the purchaser and supplier.

6.5.3 Coil inside diameter. The inside diameter of the wire coil should be within 1 percent of the diameter agreed upon by the purchaser and supplier, unless otherwise agreed upon by the purchaser and supplier.

6.5.4 Winding. Thermal spray wire on spools and in coils (including reels and drums) should be wound so that kinks, waves, sharp bends, overlapping, or wedging are not encountered, leaving the thermal spray wire free to unwind without restriction. The outside end of the thermal spray wire (the end with which thermal spraying is to begin) should be identified so that it can be located readily and should be fastened to avoid unwinding. The outermost layer on spools should be at least ⅛ inch (3.2 millimeter) from the rim of the flanges of the spool. Coils without support should be wound with a left-hand configuration so that when the coil is laid horizontal with the beginning end tag up, the coil will unwind in a counterclockwise direction with end of the wire on the right side of the spool.

6.5.5 Cast and helix. The cast and helix of thermal spray wires in coils, spools, and drums should be such that the thermal spray wire will feed in an uninterrupted manner in automatic and semiautomatic equipment.

6.5.5.1 Test procedure. The cast and helix of thermal spray wire on 12-inch outside diameter spools should be such that a specimen long enough to produce a single loop, when cut from the spool and unrestrained on a flat surface will:

a. Form a circle not less than 15 inches nor more than 50 inches in diameter, and

b. Rise above the flat surface no more than 1 inch at any location.

6.6 Labeling recommendations. Labeling recommendations are contained herein (see 6.2).

6.6.1 Product and precautionary information. The product information and the precautionary information should be placed on each coil, spool, or drum of wire.

a. Coils without support should have a tag containing this information securely attached to the thermal spray wire at the inside of the coil.

b. Coils with support should have the information securely affixed in a prominent location on the support.

c. Spools should have this information securely affixed in a prominent location on the outside of at least one flange of the spool.

d. Drums should have the information securely affixed in a prominent location on the side of the drum.

6.6.1.1 Product information. The following product information, as a minimum, should be legible and visible from the outside of each unit package:

a. Alloy type/designation.

b. Supplier's name and trade designation.

c. Size and net weight.

d. Wire diameter.

e. Lot, control, or heat number.

6.6.2 Precautionary information. The appropriate precautionary information given in ANSI Z49.1 (as a minimum) should be prominently displayed in legible print on all packages, including individual unit packages within a larger package.

6.7 Toxicity evaluation. The NMCPHC requires sufficient information to permit an HHA of the product. Upon completion of the HHA, a copy will be provided by the NMCPHC to the Government for evaluation. The HHA process is described on the NMCPHC's website, http://www.med navy mil/sites/nmcphc/industrial-hygiene/Pages/health-hazard-assessment.aspx.

6.8 Subject term (key word) listing.

Arc spray

Flight deck

Flight deck nonskid

Thermal spray nonskid

Weather deck

CONCLUDING MATERIAL

Custodians:
- Army – MR
- Navy – SH
- Air Force – 11
- DLA – DH

Review activities:
- Army – AV, MI, PT
- Navy – AS, MC
- Air Force – 19, 20, 70
- DLA – GS8, IS
- DISA – DC5

Civil agency:
- GSA – FAS

Preparing activity:
- Navy – SH
- (Project MFFP-2016-014)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.