NAVAL FACILITIES ENGINEERING SERVICE CENTER
Port Hueneme, California 93043-4370

SITE SPECIFIC REPORT
SSR-2520-SHR

COATING SPECIFICATION FOR AIRCRAFT MAINTENANCE HANGAR: BARKSDALE AIR FORCE BASE

by

C. Dave Gaughen

October 1999

EXECUTIVE SUMMARY

A hangar floor condition assessment in accordance to the Naval Facilities Engineering Service Center's (NFESC) Users Guide titled "Condition Assessment and Coating Recommendations for Aircraft Maintenance Hangars (UG – 2036 – SHR)" is required prior to coating the hangar. A thin film coating system may be applied to floor surfaces if the hangar displays the following condition assessment results: 1) "Smooth" concrete surface texture, 2) Average moisture vapor emission rate ≤ 3.0 lbs/24 hours, 1000 ft^2, 3) Average concrete surface strength ≥ 200 psi, and 3) Average surface depth of hydrocarbon contamination ≤ 3/8". The "Thin Film Coating System" specification is enclosed in Appendix A.

Funding from NFESC's Demonstration/Validation (DEMVAL) program was used to perform all work associated with this effort.

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INTRODUCTION

A hangar floor condition assessment in accordance to the Naval Facilities Engineering Service Center's (NFESC) Users Guide titled "Condition Assessment and Coating Recommendations for Aircraft Maintenance Hangars (UG – 2036 – SHR)" is required prior to coating the hangar. A thin film coating system may be applied to floor surfaces if the hangar displays the following condition assessment results: 1) "Smooth" concrete surface texture, 2) Average moisture vapor emission rate ≤ 3.0 lbs/24 hours, 1000 ft^2, 3) Average concrete surface strength ≥ 200 psi, and 3) Average surface depth of hydrocarbon contamination ≤ 3/8". A thin film coating system may be applied to floors with a coarse surface texture, however the concrete's surface texture may mirror through the coating system to decrease aesthetics. Installation costs: *$3.00 - $4.25 ft^2*. Thickness: *≥ 16 mils.* Approximate service life: *Overcoating at 4 years.* Benefits: *Low cost, fast installation, and average applicator skill.* The "Thin Film Coating System" specification is enclosed in Appendix A.

CHEMICAL RESISTANCE OF TOPCOAT

During the first two-weeks of service and without full chemical resistance, several urethane topcoats continue to cure. During this period, chemical spills and drips should be immediately removed from floor surfaces.

New tires under warm conditions may produce dark-colored tire imprints in the specified topcoat. Without affecting the topcoat's performance, the resulting imprint permanently stains the topcoat. When performing maintenance on aircraft with new tires, place either cardboard or plastic sheets under each tire until new tires become slightly worn (approximately three or more take-offs and subsequent landings).

CLEANING COATING SYSTEM

Either mopping or light scrubbing using a pH neutral detergent followed by rinsing under low pressure (≤ 500 psi) may be used to clean the coating system. Scrub brushes are to be made from soft nylon fibers. Detergents containing bleach, acids (low pH), alkali (high pH), abrasive particles (cleansers), and organic solvents are not recommended. Do not wax or polish coated surfaces.

APPENDIX A

THIN FILM COATING SYSTEM

PART 1 GENERAL

1.1 Background (Place condition assessment results here).

1.2 References

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 307 1994 Test Method for Tensile Strength of Chemical Resistant Mortars, Grouts, and Monolithic Surfacings

ASTM C 579 1996 Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

ASTM D 412 1998 Test Method for Vulcanized Rubber and Thermoplastic Rubber and Thermoplastic Elastomers - Tension

ASTM D 638 1996 Test Method for Tensile Properties of Plastics

ASTM D 1308 1993 Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes

ASTM D 2240 1997 Test Method for Rubber Property-Durometer Hardness

ASTM D 4541 1995 Test Method for the Pull-off Strength of Coatings Using Portable Adhesion Testers

ASTM E 11 1995 Standard Specification for Wire Cloth and Sieves for Testing Purposes

ASTM E 831 1993 Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

FEDERAL STANDARDS

Federal Standard 595B: Colors

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926.59 Hazard Communication

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI Technical Guideline No. 03732: "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays".

1.3 Submittals

All submittals shall be submitted to the Government for approval and records.

a. Two Component Epoxy Polyamine Grout Primer
b. Three Component Sand Filled Epoxy Grout
c. Four Component Sand and Pea Gravel Filled Epoxy Grout
d. Two Component Polysulfide Sealant
e. Two Component Epoxy Polyamide Primer
f. Two Component Urethane Topcoat
g. White Aluminum Oxide Non-Skid Grit (#50, #60)
h. Degreaser(s)
i. Material Certificates (Section 1.3.2)
j. Contractor Qualifications (Section 1.3.3a)
k. Coating System Performance (Section 1.3.3b)
l. Sealant Performance (Section 1.3.3c)
m. Procedural Variation(s) (Section 1.3.4)
n. Scheduling (Section 1.3.5)
o. Warranty (Section 1.3.6)
p. Certified Coating and Sealant Applicator (1.3.2h)

1.3.1 Instruction

For materials a. – h., submit formulator's printed instructions to include brand name, catalog numbers, and name of manufacturer. Include in the instructions (if applicable) date material was manufactured, shelf-life, detailed mixing and application procedures, quantity of material to be used on job, minimum and maximum application temperatures, and curing procedures. Include copies of Material Safety Data Sheets (MSDS) for all materials to be used at the job site. All coatings shall be manufactured by one coating vendor. Each material shall contain less than 350 g/l of Volatile Organic Compounds (VOC).

1.3.2 Certificates

a. *Two Component Epoxy Polyamine Grout Primer*

Submit certified conformance to the requirements setforth in Section 2.1.1.

b. *Three Component Sand Filled Epoxy Grout*

Submit certified conformance to the requirements setforth in Section 2.2.1.

c. *Four Component Sand and Pea Gravel Filled Epoxy Grout*

Submit certified conformance to the requirements setforth in Section 2.3.1.

d. *Two Component Polysulfide Sealant*

Submit certified conformance to the requirements setforth in Section 2.4.1.

e. *Two Component Epoxy Polyamide Primer*

Submit Certified conformance to the requirements setforth in Section 2.5.1.

f. *Two Component Urethane Topcoat*

Submit certified conformance to the requirements setforth in Section 2.6.1.

g. *White Aluminum Oxide Non-Skid Material*

Submit certified conformance to the requirements setforth in Section 2.7.1.

h. *Certified Installation Contractor*

Installation contractor shall be certified by both the coating and sealant manufacturer in the correct handling, mixing and application of their materials. Submit copy of certificates.

1.3.3 Statements

a. Contractor Qualifications

Minimum requirements for installation contractor are as follows: Installation contractor shall have completed three or more jobs within the past two years applying the materials listed in Section 1.3.1 (a – h) exclusively to concrete surfaces in which the total area exceeds 200,000 square feet. Contractor shall submit documentation listing location of work, point of contact at job site, total square footage of applied materials, listing of both materials and equipment used, and validation from coating manufacturer documenting quantity of materials purchased per job for work totaling 200,000 ft^2 and within the past two-years. Customers referenced by contractor shall be contacted by Government to confirm contractor's work is acceptable.

b. Coating System Performance

The manufacturer of the coating system shall submit literature documenting the past performance of the coating system's use in aircraft maintenance hangars. Minimum requirements are two or more aircraft maintenance hangars totaling 34,000 ft^2 whereby the coating system has performed for two years with less than 1 % combined premature coating failures, material defects and surface discoloration (≤ 0.5 % discoloration due to aviation chemicals, tire plasticizers, and UV exposure). In addition, coating system shall exhibit greater than 85 % non-skid grit retention within the above time frame. Coating manufacturer shall list location of hangars, total coated area per hangar, hangar point of contact, date coating system was applied, and the names of the installed coating materials. Government shall contact each hangar to confirm performance of coating system.

c. Sealant Performance

The manufacturer of the sealant shall submit literature documenting the past performance of the sealant's use in aircraft maintenance hangars. Minimum requirements are two or more aircraft maintenance hangars with joint work totaling 10,000 linear feet whereby the sealant has performed for two years with less than 1 % combined sealant failures and defects. Sealant manufacturer shall list location of hangars, total linear feet of sealant applied per hangar, hangar point of contact, date sealant was applied, and the name of the installed sealant material. Government shall contact each hangar to confirm performance of sealant system.

1.3.4 Work Procedure

Contractor shall submit all procedural variations different than those outlined in Part 3 titled Execution.

1.3.5 Scheduling

Contractor shall submit procedural scheduling, for Government approval, to complete work within twelve (12) consecutive days (weekends and evenings may be included). Contractor shall assign one supervisor to the job who is to remain on site throughout all phases of work who, in addition, is to act as the primary point of contact between Government and contractor. This person shall be identified in the submitted schedule. All work shall be performed in a manner as to cause the least interference with the normal functions of the Government activity.

1.3.6 Warranty: Installation and Materials

Materials and workmanship used to perform spall repairs, crack repairs, coating work, and sealant work shall be warranted by the "Installation Contractor" for a minimum of one-year following material application. Materials and workmanship shall be subjected to the terms and conditions defined as follows. The entire floor coating system shall be removed and replaced at the expense of the installation contractor (cost includes materials plus application) if ≥ 1.0 % of the total coated surface becomes either blistered (chemical), checked, soft, or lifts within one-year following application. Within the warranty period, failures greater than 3/8" diameter (of the above type) totaling less than 1.0 % of coated surfaces (including spall repairs) shall be identified and repaired at contractor's expense. Cosmetic imperfections due to scratching and gouging are excluded from the warranty. If the coating system's adhesion is in question, one adhesion test (ASTM-D-4541) shall be performed per 100 ft^2. Each adhesion test shall produce cohesive failures within the concrete above 200 psi with concrete chunks attached to each pull-off coupon. All areas tested for adhesion that do not produce cohesive failures within the concrete and, in addition, exhibit adhesion values below 200 psi shall require removal and replacement at installation contractor's expense. There shall be 0 % sealant failures within one year. All sealant material within the warranty period displaying either chemically attacked surfaces or lifting from joint walls shall be removed and reinstalled at the expense of the installation contractor.

1.4 Materials: Condition, Storage, Disposal

Materials on site shall be inspected for damage prior to use. Packaged materials in dented, rusty, or leaking containers and, in addition, materials with an expired shelf life shall be returned to manufacturer. Packaged materials shall be unloaded and stored out of sun and weather, preferably in air-conditioned spaces. All unused material, whether in its' cured or uncured state, shall be removed from the job site by contractor.

1.5 Safety

Throughout all phases of work, contractor shall follow the requirements of the Occupational Safety and Health Administration (OSHA), 29 CFR 1926.59, and safety procedures as recommended by the material manufacturers. Safety procedures may include employing the use of respirators, impervious clothing, gloves, face shields, and ear plugs. Prior to use and per material, contractor shall understand the information contained in Material Safety Data Sheets (MSDS).

1.6 Demonstration of Coating System

Prior to the approval of the coating system, contractor shall apply the complete coating system to a ten-foot square section of concrete. Materials and procedures outlined in Parts 2 & 3, including full broadcasts of non-skid grit, shall be used in the application of the test patch. One week following the final topcoat application, three adhesion tests in accordance to ASTM D 4541 shall be performed. Each adhesion test shall produce cohesive failures within the concrete above 200 psi with concrete chunks attached to each pull-off coupon. If cohesive failures are not produced within the concrete, either coating system is unacceptable or concrete surface preparation was insufficient. If coating system is unacceptable, contractor shall submit a new coating system manufactured by a different coating vendor and re-perform the above testing. If concrete surface preparation was insufficient, contractor shall apply an additional coating system patch to properly prepared concrete followed by the

above testing. Immediately following adhesion testing, patch shall be sanded flush with surrounding concrete.

PART 2 PRODUCTS

2.1 Two Component Epoxy Polyamine Grout Primer

Two component, 100 % solids, epoxy polyamine primer for use in repairing spalled concrete prior to the application of epoxy grouts.

2.1.1 Epoxy Polyamine Primer

The epoxy polyamine primer shall be formulated to exhibit the following properties as listed in Table 1.

Table 1: Properties of Epoxy Polyamine Primer

Resin System	Epoxy Polyamine
Percent Volume Solids	100 %
Color	Clear to Amber
Application Thickness	5 to 30 mils Dry Film Thickness per coat
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi

[1]After immersion, the coating shall not contain blisters, checks, or lift from substrate.

2.2 Three Component Sand Filled Epoxy Grout

Three component, 100 % solids, sand filled epoxy grout for use in the repair of spalled/chipped concrete with an inner depth less than 1.0".

2.2.1 Sand Filled Epoxy Grout

The sand filled epoxy grout shall be formulated to exhibit the following properties as listed in Table 2.

Table 2: Properties of Sand Filled Epoxy Grout

Resin System	Epoxy Polyamine
Percent Volume Solids	100 %
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Compressive Strength (ASTM-C-579)	7,600 psi ± 1000 psi
Tensile Strength (ASTM-C-307)	1,800 psi ± 300 psi
Hardness (ASTM-D-2240: Shore D)	80 – 92

Mean Coefficient of Thermal Expansion (0°F – 120°F: ASTM-E-831)	3.0 – 11.5 x 10^{-6} in/in°F
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi

[1]After immersion, the grout shall not contain blisters, checks, or lift from substrate.

2.3 Four Component Sand and Pea Gravel Filled Epoxy Grout

Four component, 100 % solids, sand and pea gravel filled epoxy grout for use in the repair of spalled/chipped concrete with an inner depth greater than 1".

2.3.1 Sand and Pea Gravel Filled Epoxy Grout

The sand and pea gravel filled epoxy grout shall be formulated to exhibit the following properties as listed in Table 3.

Table 3: Properties of Sand and Pea Gravel Filled Epoxy Grout

Resin System	Epoxy Polyamine
Percent Volume Solids	100 %
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Compressive Strength (ASTM-C-579)	7,600 psi ± 1000 psi
Tensile Strength (ASTM-C-307)	1,400 psi ± 300 psi
Hardness (ASTM-D-2240: Shore D)	80 – 92
Mean Coefficient of Thermal Expansion (0°F – 120°F: ASTM-E-831)	3.0 – 11.5 x 10^{-6} in/in°F
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi

[1]After immersion, the grout shall not contain blisters, checks, or lift from substrate.

2.4 Two Component Self-leveling Polysulfide Sealant

Two component, 100 % solids, self-leveling polysulfide sealant formulated with high chemical resistance and capable of withstanding ± 25 % joint movement.

2.4.1 Sealant

The two component polysulfide sealant shall be formulated to exhibit the following properties as listed in Table 4.

Table 4: Properties of Sealant

Sealant System	Polysulfide: Manganese Cure (MnO_2)
Percent Volume Solids	100 %
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 5.0 % increase in volume
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 5.0 % increase in volume
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 5.0 % increase in volume

Hardness Shore A (ASTM-D-2240)	20 – 30
Tensile Strength (ASTM-D-412)	150 – 200 psi
Percent Elongation (ASTM-D-638)	≥ 500 %
Adhesion to Concrete	≥ 130 psi
Tack Free @ 65°F	12 hours maximum
Full Cure @ 65°F	24 hours: Full Chemical Resistance
Adhesion of Epoxy Polyamide (paintable sealant)	≥ 130 psi (chemically compatible)

[1]A 2" x 1/2" x 1/2" section of cured sealant shall be immersed and tested.

2.5 Two Component Epoxy Polyamide Coating System Primer

Two component, solvent based, epoxy polyamide penetrating primer for use on properly prepared concrete.

2.5.1 Primer Coat

The two component primer coat shall be formulated to exhibit the following properties as listed in Table 5.

Table 5: Properties of Primer Coat

Resin System	Epoxy Polyamide
Percent Volume Solids	≥ 62 %
Color: Light Gray (Fed. Std. 595B)	Either 15622, or 15550, or 16495
Application Thickness	2 to 20 mils Dry Film Thickness per coat
Specular Gloss at 60°	≥ 75
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Adhesion @ 6 hrs cure, 75°F (ASTM-D-4541)	≥ 200 psi
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi
Softening Point (ASTM-E-831)	≥ 175 °F
Mean Coefficient of Thermal Expansion (0°F – 120°F: ASTM-E-831)	3.0 – 60.0 x 10^{-6} in/in°F

[1]After immersion, the coating shall not contain blisters, checks, or lift from substrate.

2.6 Two Component Urethane Topcoat

Two component, urethane topcoat formulated to increase chemical and abrasion resistance.

2.6.1 Urethane Topcoat

The two component urethane topcoat shall be formulated to exhibit the following properties as listed in Table 6.

Table 6: Properties of Topcoat

Resin System	Urethane
Percent Volume Solids	≥ 60 %

First Topcoat Color: White, Semi-gloss or Matte Finish (Fed. Std. 595B)	27925, 37925
Hiding Power: White	Complete hiding of light gray coatings at 2.5 - 3.0 mils DFT (one coat).
Second Topcoat Color: Clear	0 % pigments
Walkway Strip Color: Red/Orange, Semi-gloss (Fed. Std. 595B)	22197
Hiding Power: Red/Orange	Complete hiding of white coatings at 2.5 -3.0 mils DFT (one coat).
Application Thickness	Up to 4 mils Dry Film Thickness
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion[1]: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Service @ 48 hours cure, 65°F	Heavy Traffic, Full Chemical Resistance
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi
Adhesion to Epoxy Polyamide @ 48 hrs cure, 75°F	≥ 350 psi
Softening Point (ASTM-E-831)	≥ 175 °F

[1]After immersion, the coating shall not contain blisters, checks, or lift from substrate. Slight staining is unacceptable.

2.7 White Aluminum Oxide Non-Skid Material

Dust free (washed and dry), white aluminum oxide non-skid material.

2.7.1 Aluminum Oxide

a. Size #50

Size #50 white aluminum oxide shall exhibit the following size gradations and formulation as listed in Table 7.

Table 7: Properties of White #50 Aluminum Oxide

Percent White Al_2O_3	≥ 99 %
Sieve No. 30 (ASTM-E-11)	100 % Passing
Sieve No. 40 (ASTM-E-11)	10 – 25 % Retained
Sieve No. 50 (ASTM-E-11)	75 – 90 % Retained
Sieve No. 60 (ASTM-E-11)	0 – 15 % Retained

b. Size #60

Size #60 white aluminum oxide shall exhibit the following size gradations and formulation as listed in Table 8.

Table 8: Properties of White #60 Aluminum Oxide

Percent White Al_2O_3	≥ 99 %
Sieve No. 40 (ASTM-E-11)	100 % Passing
Sieve No. 50 (ASTM-E-11)	15 – 30 % Retained
Sieve No. 60 (ASTM-E-11)	70 – 85 % Retained
Sieve No. 70 (ASTM-E-11)	0 – 15 % Retained

PART 3 EXECUTION

Notes A – E shall be treated as part of the specification.

NOTES A - E

Note A: Protection shall be provided by contractor to prevent damage to adjacent areas, equipment, fixtures, finishes, electrical utilities, mechanical services, "Grounding Rods", and existing work. Damage to the above items while performing work shall be either repaired or replaced with new items at no additional cost to Government.

Note B: Care shall be taken to reduce the spread of dust and debris to office spaces within the hangar. Dust, waste, and debris resulting from work shall be cleaned and removed "daily" from the Activity.

Note C: Minor materials and work not specifically mentioned herein but necessary for the proper completion of the specified work shall be furnished without additional cost to Government.

Note D: Should deteriorated materials of a major nature be uncovered during the course of work, it shall be brought to the attention of the Contracting Officer. Repairs as directed by Government (in writing) shall be made with an adjustment, reflecting the terms of the modification(s), to contract price.

Note E: All work that is not performed in accordance to either the specification or manufacturer's recommended procedures shall be replaced and reworked at contractor's expense. If a dispute exists between specification and manufacturer's procedures, the procedure which offers the greatest degree of prudence shall supercede.

"The following procedures are sequential and have been presented in the order in which the work shall proceed starting with Section 3.1."

3.1 Removal of Material in Joints and Re-saw Cutting

Remove 100 % of the existing material in all expansion and contraction joints including material bonded to joint walls and base. Rigid material may require the use of saw cutting equipment to remove. Saw Cutting equipment shall be capable of producing straight lines with sporadic joint spalls less than 1/16". All joints that were not originally saw cut to a minimum depth of 1" or were previously filled with coating material shall be re-saw cut open to a depth of 1". Joints may be widened by up to 1/8" when re-saw cutting.

3.2 Material Application

A minimum period of 36 hours following degreasing and 48 hours following heavy rain shall be used to allow concrete surfaces a chance to dry prior to the application of concrete repair materials, coatings, and sealant.

3.2.1 Temperature and Humidity Requirements

Coatings and sealant shall be applied when the relative humidity is below 80 % with temperatures between 55°F to 90°F (concrete and air). Temperatures shall also be a minimum of 5°F above the dew point temperature. If temperatures and relative humidity exceed the above ranges, work shall stop until either acceptable temperatures and relative humidity or material manufacturers approve application under existing conditions.

3.2.2 Mixing and Application of Materials

Mix and apply all materials in accordance to manufacturer's requirements. The use of spray equipment to apply materials is prohibited. Epoxy and urethane coatings, once mixed and prior to application, may require time to initiate their chemical reaction (induction period). The epoxy primer and sealant shall be applied in the late afternoon after the heat of the day when both the air and concrete temperatures are decreasing and prior to the dew point temperature. It is recommended that representatives from the material manufacturers be on site to view both the mixing and application of their materials.

3.3 Treatment of Cracks and Spall Repair

3.3.1 Treatment of Cracks

Cracks with widths greater than 1/8" may be treated and repaired as moving joints. Cracks containing a crack width between 1/8" to 1.25" may be chased by either saw cutting or power grinding to a minimum depth of 5/8". Where crack spalling exceeds a width of 1.25", crack spalls shall be repaired according to the procedures outlined in Section 3.3.2. Resulting crack surfaces shall contain smooth vertical walls of uniform depth.

3.3.2 Spall Repair

Saw cut, in square to rectangular geometries, 0.5 – 2 inches away from the perimeter of each spall using a depth of 0.5 – 2.0 inches (depth is spall dependant). Concrete within the repair area shall be broken out using a chipping hammer and contain a minimum depth of 0.5 inch or until sound concrete is exposed. The repair cavity shall be inspected for unsound concrete by tapping with a hammer or steel rod. In areas where tapping indicates unsound concrete, additional concrete shall be removed. Resulting surfaces shall contain sound concrete, smooth vertical walls, and a repair base of uniform depth. Sweep and vacuum all dust from repair area.

3.3.2.1 Prime Repair Areas

Prime all concrete surfaces that are to receive either of the two types of epoxy grout using the "Two Component Epoxy Polyamine Grout Primer" specified in Section 2.1. Primer shall be applied at 10 mils wet. Prime saw cuts outside the repair geometry.

3.3.2.2 Epoxy Grout Application

Immediately following primer application, apply the appropriate epoxy grout directly into the wet primer per repair area (see Sections 2.2 & 2.3 to determine which grout is appropriate per specific area). Fill and trowel in the epoxy grout into both the concrete repair and the adjacent saw cuts. Epoxy grout shall be worked towards the perimeter of the patch to establish contact and enhance bonding to the existing slab. Make at least two passes with the trowel to ensure a smooth repair surface that is level with the surface of the floor slab. Resulting repair shall be dense, homogenous and finished to the same surface slope as the existing concrete slab. When cured, remove trowel marks and blend grout into adjacent concrete by sanding.

3.3.2.3 Grout Coat Application

Approximately 8 – 24 hours following application of epoxy grout, seal the surface of the grout repair by applying a grout coat at 10 mils wet to the epoxy grout's surface. Either the

"Two Component Epoxy Polyamine Grout Primer" or the "Two Component Epoxy Polyamide Coating System Primer" shall be used (see Sections 2.1 & 2.5).

3.3.2.4 Saw Cutting Repaired Joint Spalls and Spalled Cracks

Less than 8 hours following application of grout coat, saw cut through the repair and directly above either the existing joint or crack (if applicable). Saw cuts shall be 1/4" wide and at a depth 1/4" greater than the base of the repair. The placement of the saw cut is to enable the repaired area to expand/contract in relation to and in the same pattern as either the underlying joint or crack. The resulting saw cut shall be treated as a joint and filled using backer rod and sealant.

3.4 Surface Preparation

3.4.1 Coated Hangar Floors

3.4.1.1 Degrease Coating System

Degrease entire floor by scrubbing (manual and power) using a solution of hot potable water (120°F – 170°F) and a concentrated aqueous-based caustic degreaser (water-based alkaline degreaser). Solution shall be allowed to soak into surfaces prior to scrubbing and removed using hot potable water under a minimum of 4,000 psi pressure. Rinsing shall be complete when rinse water appears clear. Two complete degreasing cycles shall be performed on entire floor surface and, in addition, one additional cycle of spot degreasing shall be performed on all areas where either the existing coating system or existing joint sealant has failed. If the industrial detergent is not biodegradable, all rinse water shall be collected and disposed of as hazardous waste. Use of industrial degreasers containing either phosphates or organic solvents is prohibited. Squeegees and shop vacuums may be used to collect pooling rinse water. Fans may be used to aid drying of floor surfaces.

3.4.1.2 Coating System Removal

Remove 100 % of the existing coating system employing a combination of one or more of the following techniques: shot blasting, chipping, scraping, sanding, scarification, high pressure water blasting, and various hand tools. The use of impact tools (such as scabblers) shall not be used to remove the existing coating system. Shot blasting equipment shall produce a 20" minimum blast path width. Prior to blasting, old shot shall be removed and replaced with new shot. Shot blasting to remove existing coatings shall stop when the concrete's surface resembles an ICRI CSP 5 profile. If contractor produces concrete surfaces with a level of coarseness greater than an ICRI CSP 5 profile, contractor shall resurface these areas using the materials and procedures outlined in Section 3.6 at contractor's expense.

3.4.1.3 Concrete Surface Preparation

Surface preparation techniques employing acid, organic solvents, extreme heat (flame), impact tools (scabblers) and scarification is prohibited. After degreasing and when concrete is dry, shot blast entire floor to produce a surface profile between ICRI CSP 3 and ICRI CSP 5 (excluding ICRI CSP 4). Shot blasting equipment shall produce a 20" minimum blast path width and, in addition, each pass shall be slightly overlapped (1/4" – 1/2" overlap). New shot shall be added to shot blasting equipment prior to blasting. Shot blasting shall stop when the concrete's surface resembles an ICRI CSP 5 profile. If contractor produces concrete surfaces with a level of coarseness greater than an ICRI CSP 5 profile, contractor shall resurface these areas using the materials and procedures outlined in Section 3.6 at contractor's expense.

Concrete surfaces inaccessible to shot blasting (base of perimeter walls and under secured equipment) shall be prepared using diamond disk grinding to produce an ICRI CSP 2 profile. Resulting surfaces shall appear visually clean and contain the appropriate level of surface profile. If the resulting level of cleanliness can not be determined, adhesion testing in accordance to ASTM D 4541 shall be conducting on the dirtiest areas of concrete. Each adhesion test shall produce cohesive failures within the concrete above 200 psi with concrete chunks attached to each pull-off coupon. If the above adhesion results are not produced, then up to two additional degreasing cycles shall be performed using the materials and procedures outlined in Section 3.4.1.1. Sweep, vacuum, and run a high powered magnet over the above areas.

3.4.2 Uncoated Hangar Floors

3.4.2.1 Degrease Concrete

Two complete degreasing cycles shall be performed on entire floor surface and one additional cycle of spot degreasing shall be performed on all areas that appear visually oily/greasy. The materials and techniques outlined in Section 3.4.1.1 shall be used.

3.4.2.2 Concrete Surface Preparation

The procedures and resulting profiles outlined in Section 3.4.1.3 shall be used.

3.5 Treatment of Joints Greater Than 2" in Width

Wide joints shall be examined for the presence of hydrocarbons (fuels, oils) and, if detected, spot cleaned in accordance to Section 3.4.1.1. Sweep and vacuum up residual dust from within joints.

3.5.1 Install Bondbreaker

Apply solvent resistant bond breaker tape with an adhesive backing to the base of each joint. Resulting tape application shall cover each joint's horizontal base and span its' total length. Application of tape facilitates movement of repair material and prevents repair material from rigidly fusing joint. Bond breaker tape shall contain a thickness less than or equal to 6 mils.

3.5.2 Repair Joints Greater Than 2" in Width

Repair joints greater than 2" in width using the procedures outlined in Sections 3.3.2.1 – 3.3.2.4, respectively. Less than 8 hours following application of grout coat, saw cut directly in the middle of the joint the entire joint length. Saw cuts shall be 1/4" wide and at a depth 1/4" greater than the base of the joint. The resulting saw cut shall be treated as a joint and filled using backer rod and sealant.

3.6 Resurfacing Coarse Concrete and Repair of Surface Voids

3.6.1 Resurfacing Coarse Concrete

Coarse concrete may be resurfaced using the following materials and procedures.

3.6.1.1 Key Perimeter of Each Area Identified for Resurfacing

Key the entire perimeter surrounding each area identified for resurfacing. Resulting key shall contain one vertical wall at a depth between 3/8" to 5/8" with a 1.5" to 2" sloped surface

leading down to the resulting vertical depth. A hand held concrete saw may be used to cut the correct vertical depth followed by power tool grinding to attain the above sloped surface.

3.6.1.2 Prime Coarse Concrete

Sweep and vacuum resulting repair areas. Prime each area using the epoxy grout primer specified in Section 2.1 at 10 mils wet.

3.6.1.3 Resurfacing Grout Application

Immediately following primer application, apply the epoxy grout specified in Section 2.2 directly into the wet primer at 3/16" thickness or until concrete surface appears smooth (minimum thickness shall be 1/8"). Resulting surface shall be finished flush with perimeter key using either a steel trowel or steel power trowel.

3.6.1.4 Sand Resurfacing Grout

When grout has sufficiently cured, all trowel marks shall be removed by sanding. Resulting surface shall appear smooth and flush with adjacent surfaces.

3.6.1.5 Grout Coat Application

Following grout sanding, seal the surface of each resurfaced area using either the "Two Component Epoxy Polyamine Grout Primer" or the "Two Component Epoxy Polyamide Coating System Primer" (Sections 2.1 & 2.5). Apply the grout coat at 10 mils wet. When sufficiently cured, grout coat shall be sanded to a dull appearance with visible scratches.

3.6.2 Repair of Surface Voids

Surface voids (bugholes and popouts) with an inner diameter between 1/4" to 1" may be repaired using the following materials and procedures.

3.6.2.1 Prime Surface Voids

Prime each surface void using the epoxy grout primer specified in Section 2.1 to produce a surface that appears wet.

3.6.2.2 Repair Surface Voids

Fill each surface void with the repair material specified in Section 2.2 directly into the wet primer. A steel trowel may be used to pack repair material into each surface void. Resulting surface shall appear smooth and flush with adjacent concrete. Surface void repairs shall be allowed to cure to a semi-rigid state prior to the full application of the coating system primer.

3.7 Application of Sealant

Prior to sealant work, joints shall be examined for the presence of hydrocarbons (fuels, oils) and, if detected, spot cleaned in accordance to Section 3.4.1.1. Sweep and vacuum up residual dust from floor surface and within joints.

3.7.1 Install Bondbreaker

Install, using a backer rod tool, round closed cell polyethylene backer rod into joints and cracks designated for repair. Backer rod shall be a minimum of 1/8" larger diameter than the width of the joint. Backer rod shall fit tight between joint walls (30 % compression) with a

minimum depth of 3/8" below surface of joint. For 1/2", 3/8", and 1/4" wide joints use a joint depth of 3/8" above backer rod (3/8" below joint surface to highest point on backer rod). For joint widths greater than 3/4" but less than 2", use a joint depth of 5/8" above backer rod (joints greater than 2" in width require special treatment). All backer rod that is installed using either the incorrect size (loose fit) or at the incorrect depth shall be removed and reinstalled. After backer rod is installed, apply painter's tape to both sides of joint to protect adjacent surfaces from sealant.

3.7.2 Sealant Application

Mix and apply the sealant material specified in Section 2.4 to joints and cracks designated for repair. Although the joint sealant is self-leveling, it is best applied using a bulk caulking gun. Resulting sealant finish shall exhibit a recess of 1/8" – 1/32" below the surface of each joint. All sealant which remains either flush or greater shall be removed and reapply by contractor at contractor's expense. Immediately following sealant application, remove painter's tape and sealant drips from concrete. Sealant shall be allowed to cure a minimum of 24 hours following application and prior to coating. If temperatures remain below 60°F, sealant shall cure a minimum of 36 hours prior to the application of coatings.

3.8 Application of Coatings

Sweep, vacuum, and run a high powered magnet over all areas that are to receive the coating system. To ensure coating materials are applied at the specified thickness, contractor may wish to grid the floor into 600 ft^2 areas. Coating batches may be mixed for complete use per area at the specified thickness. Sealant surfaces may be lightly coated.

3.8.1 Primer Application

A minimum of 24 hours following sealant application (temperature dependant), primer shall be applied late in the afternoon following the heat of the day when both the air and concrete temperatures are cooling (this practice minimizes the off-gassing of water-vapor from concrete). *When it appears that the concrete temperature may be decreasing, apply the mixed primer at 10 mils Dry Film Thickness (DFT) to a 9 ft^2 section of extremely coarse and porous concrete.* For a minimum of 20 minutes, monitor patch for fisheyes, paint separations, and the new formation of bubbles. If either fisheyes or paint separations occur and the concrete is cooling, concrete contains hydrocarbon contamination (fuels, oils, skydrol) and requires additional degreasing in accordance to Section 3.4.2.1. If none of the aforementioned occurs within 20 minutes, concrete is cooling and a full coat of the primer may be applied. *Apply a full coat of the epoxy primer specified in Section 2.5 at a spreading rate of 10.0 mils DFT.* Stripe coat perimeter edges and around equipment footings using the specified primer. Contractor shall monitor and report a minimum of one Wet Film Thickness (WFT) reading to Government every 600 ft^2 of floor surface. Care shall be taken to not allow primer to pool over sealant. Wet primer in excess of 3 mils shall be removed from the surfaces of all joint sealant. In areas where primer has cured and completely filled recess above sealant flush with joint surfaces, sealant shall be removed and reapplied at contractor's expense. *The adhesion of the primer shall be tested in accordance to Section 4.1.1.*

3.8.2 Application of Topcoats

Two coats of the urethane topcoat (Section 2.6) shall be applied with non-skid grit (Section 2.7). The first topcoat of urethane shall be white followed by a second topcoat of clear

urethane. White aluminum oxide non-skid grit shall be broadcast into the topcoat(s) at the *Customer's desired rate and size* specified in Section 3.8.2.1.

3.8.2.1 Non-skid Grit

a. Light Broadcast of Non-skid Grit

Number 60 white aluminum oxide shall be broadcast at a rate of 1.0 lbs per 100 ft^2 into the second topcoat of clear urethane and backrolled. The hangar floor shall be broken down into 600 ft^2 sections where 6 lbs of #60 non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 ft^2 section.

b. Medium Broadcast of Non-skid Grit

Number 50 white aluminum oxide grit shall be broadcast at a rate of 1.0 lbs per 100 ft^2 into the first topcoat of white urethane and backrolled. The hangar floor shall be broken down into 600 ft^2 sections where 6.0 lbs of #50 non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 ft^2 section. Number 60 white aluminum oxide shall be broadcast at a rate of 1.0 lbs per 100 ft^2 into the second topcoat of clear urethane and backrolled. The hangar floor shall be broken down into 600 ft^2 sections where 6 lbs of #60 non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 ft^2 section.

c. Heavy Broadcast of Non-skid Grit

Number 50 white aluminum oxide grit shall be broadcast at a rate of 1.0 lbs per 100 ft^2 into the first topcoat of white urethane and backrolled. The hangar floor shall be broken down into 600 ft^2 sections where 6.0 lbs of #50 non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 ft^2 section. Number 60 white aluminum oxide shall be broadcast at a rate of 3.0 lbs per 100 ft^2 into the second topcoat of clear urethane and backrolled. The hangar floor shall be broken down into 600 ft^2 sections where 18 lbs of #60 non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 ft^2 section.

3.8.2.2 First Coat

When the primer is well within the coating manufacturer's recoat window, apply a full coat of the white urethane topcoat specified in Section 2.6 at a spreading rate of 3.0 mils Dry Film Thickness (DFT). Contractor shall monitor and report a minimum of one WFT reading to Government per 600 ft^2 section of floor surface prior to broadcasting #50 grit. Stripe coat perimeter edges and around equipment footings. When the correct WFT has been applied per 600 ft^2 area, immediately and evenly broadcast the desired quantity of #50 white aluminum oxide grit into the urethane topcoat and backroll in two directions (medium and heavy broadcast only). Wet urethane in excess of 3 mils on sealant surfaces shall be removed by light brushing. The white urethane topcoat shall provide sufficient hiding to completely hide the light gray primer coat. If insufficient hiding occurs, contractor shall apply one additional white topcoat containing non-skid (if applicable) at no additional charge to Government. If bubbles appear in the topcoat (solvent popping) and create fisheyes (small paint separations) that cannot be rolled out, topcoat application is too thick and work shall stop until contractor demonstrates application at the correct thickness. If fisheyes appear without the presence of bubbles, primer coat has been contaminated and topcoat application shall stop. To remove

contamination, contractor shall degrease entire floor using a pH neutral degreaser (water-based) followed by potable water rinsing and light sanding.

3.8.2.3 Second Coat

When the first coat of urethane is well within the coating manufacturer's recommended recoat window, apply a second topcoat of the "clear" urethane specified in Section 2.6 at a spreading rate of 3.0 mils DFT. Contractor shall monitor and report a minimum of one WFT reading to Government per 600 ft^2 section of floor surface prior to broadcasting #60 grit. Stripe coat perimeter edges and around equipment footings. When the correct WFT has been applied per 600 ft^2 area, immediately and evenly broadcast the desired quantity of #60 white aluminum oxide grit into the second topcoat of urethane and backroll in two directions. Wet urethane in excess of 3 mils on sealant surfaces shall be removed by light brushing. In areas where topcoat has cured and completely filled recess above sealant flush with joint surfaces, sealant shall be removed and reapplied at contractor's expense. *The adhesion of the topcoats shall be tested in accordance to Section 4.1.2.*

3.8.2.4 Walkway Stripe

Less than 24 hours following the clear topcoat application, apply a stripe of the red/orange topcoat specified in Section 2.6 at 3.0 mils DFT with #60 white aluminum oxide broadcast into the stripe. The walkway stripe shall be placed 10 feet from the base of the three interior perimeter walls and form one continuous line with two connecting right angles. The stripe shall start and end on the interior side of the drain gate. Tape shall be used to protect the floor coating against stripe coat bleed. Government shall provide a map detailing the exact size and location of the walkway stripes. The red/orange topcoat shall completely hide, in one coat, the white topcoat color. If insufficient hiding occurs, contractor shall apply one additional coat of walkway stripe coating at no charge to Government

3.9 Curing

All materials shall cure in accordance to manufacturer's requirements. Improperly cured material shall be removed and reapplied by contractor at contractor's expense. It is recommended that a material representative(s) sign off on the contractor's finished product.

3.10 Final Cleanup

Following completion of work, remove debris, equipment, and materials from the site. Remove temporary connections to Government furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

PART 4 QUALITY CONTROL

It is recommended that either a Navy Coating Specialist or a National Association of Corrosion Engineers (NACE) Certified Coating Inspector be on site prior to and during all coating operations. The Coating Inspector's role will be to enforce the specification by documenting and reporting on the quality of workmanship. Differences between coating specification and contractor's work shall be immediately reported to either Public Works or the Resident Officer In Charge of Construction. *Mixed material samples shall be taken during the application of each material and stored in labeled plastic containers.* Clean plastic bottle caps may be used for sampling materials. Fill one bottle cap per mixed material

sample (liquid) to an approximate thickness of 1/8". If the coating system prematurely fails, the above samples will be used in the failure analysis.

4.1 Adhesion of Coating System

Either the Government or a third party coating inspector shall perform the below adhesion testing.

4.1.1 Primer Adhesion

A minimum of six hours following primer application and prior to topcoat applications, three adhesion tests (ATSM-D-4541) shall be performed on the primer (left side, center, right side). Each adhesion value shall be greater than or equal to 200 psi (this value is time/temperature dependent and may vary). Contractor shall feather sand the tested areas back into the adjacent coating and spot prime prior to topcoat applications. If adhesion values are below 200 psi, contractor shall remove 100 % of the primer to bare concrete and correctly re-apply the primer (Section 3.8.1) at contractor's expense.

4.1.2 Topcoat Adhesion

Forty-eight hours following topcoat application, three adhesion tests (ASTM-D-4541) shall be performed on the topcoat (left side, center, right side). If each adhesion value is greater than or equal to 200 psi, coating system is acceptable and ready for service. If adhesion values are below 200 psi and do not produce cohesive failures within the concrete (removal of concrete chunks), contractor shall remove topcoats, sand primer to a dull appearance with visible scratches, degrease entire floor (use a pH neutral degreaser with warm water followed by potable water rinsing), and re-apply the topcoats (Section 3.8.2) at contractor's expense. Contractor shall repaint the tested areas using the specified white topcoat (Section 2.6) and #60 grit (Section 2.7). Resulting repair shall be flush with adjacent coatings.