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Users Guide
UG-2036-SHR

CONDITION ASSESSMENT AND COATING RECOMMENDATIONS FOR AIRCRAFT MAINTENANCE HANGARS

by

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EXECUTIVE SUMMARY

The Users Guide presents a systematic approach to assessing the condition of aircraft maintenance hangar floors prior to specifying one of three, non-conductive, coating systems: A) Thin film coating system (≥ 16 mils: 1 mil = 0.001"), B) Thick film coating system (≥ 250 mils), and C) Overcoating sound coating systems. Coating specifications based upon the above coating systems are presented in the Naval Facilities Engineering Service Center's (NFESC) Special Publication titled "Hangar Floor Coating Specifications: Thin Film, Thick Film, and Overcoating Sound Coating Systems (SP-2057-SHR)." By assessing the condition of hangar floor surfaces, coating failures resulting from the following practices should decrease: 1) Overcoating unsound coating systems, 2) Coating concrete with low surface strength, 3) Coating concrete with high levels of hydrocarbon contamination (oils, fuels, skydrol), and 4) Coating concrete with a high rate of moisture vapor emission.

Presented within the Users Guide are the following sections: 1) Condition assessment, 2) Coating system requirements, and 3) Application of coating systems. Enclosed in Appendix A is an example of a "Repair and Resurfacing Map." The following tools and test kits are required to perform a complete hangar floor condition assessment: A) Measuring wheel, B) Portable adhesion tester, C) Concrete coring unit, and D) Three Moisture Vapor Emission Test Kits (MVETK).

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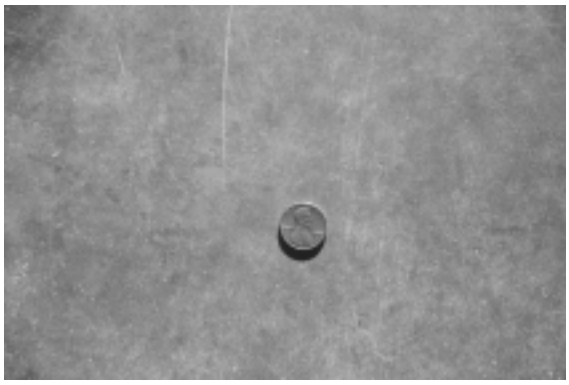
INTRODUCTION

The Users Guide presents a systematic approach to assessing the condition of aircraft maintenance hangar floors prior to specifying one of three, non-conductive, coating systems: 1) Thin film coating system (≥ 16 mils: 1 mil = 0.001"), 2) Thick film coating system (≥ 250 mils), and 3) Overcoating sound coating systems. Coating specifications based upon the above coating systems are presented in the Naval Facilities Engineering Service Center's (NFESC) Special Publication titled "Hangar Floor Coating Specifications: Thin Film, Thick Film, and Overcoating Sound Coating Systems (SP-2057-SHR)." By assessing the condition of hangar floor surfaces, coating failures resulting from the following practices should decrease: 1) Overcoating unsound coating systems, 2) Coating concrete with low surface strength, 3) Coating concrete with high levels of hydrocarbon contamination (oils, fuels, skydrol), and 4) Coating concrete with a high rate of moisture vapor emission. Enclosed in Appendix A is an example of a hangar floor repair and resurfacing map. It is recommended that a map of the hangar floor be drawn and used to document cracks, spalls, coarse concrete, and popouts requiring either repair or resurfacing. A numbered legend corresponding to each area identified on the map is required to record the dimensions per repair and resurfacing area. Presented below are the following sections: 1) Condition assessment, 2) Coating system requirements, and 3) Application of coating systems.

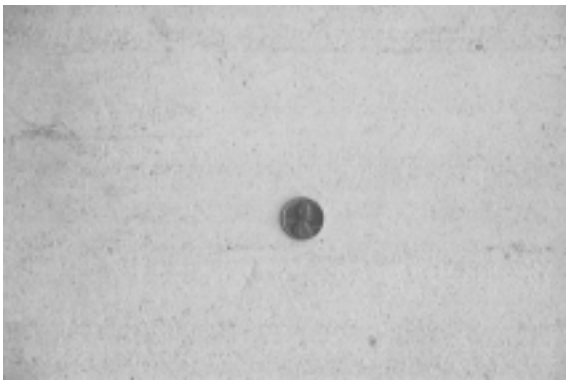
CONDITION ASSESSMENT

The following tools and test kits are required to perform a complete condition assessment: A) Measuring wheel, B) Portable adhesion tester, C) Concrete coring unit, and D) Three Moisture Vapor Emission Test Kits (MVETK).

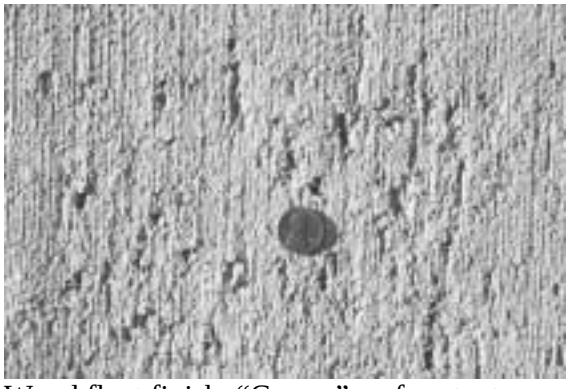
IDENTIFY CONCRETE SURFACE TEXTURE



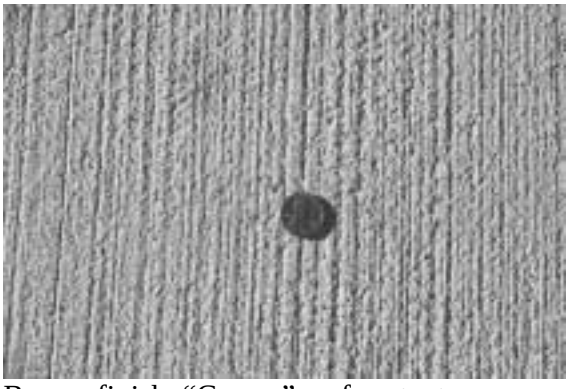
Steel trowel finish: "Smooth" surface texture.



Wood float finish: "Smooth" surface texture.



Wood float finish: "Coarse" surface texture.



Broom finish: "Coarse" surface texture.

Identify and record the concrete's surface texture as either "Smooth" or "Coarse". Surface textures greater than "Smooth" but less than "Coarse" shall be reported as "Coarse". If coated, record surface as "Coated".

MEASURE FLOOR DIMENSIONS

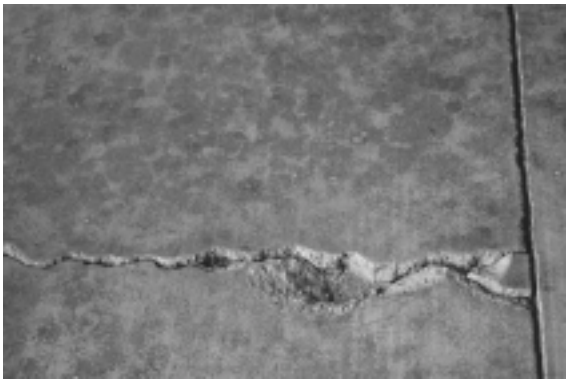
Hangar drain grate.

Measuring wheel.

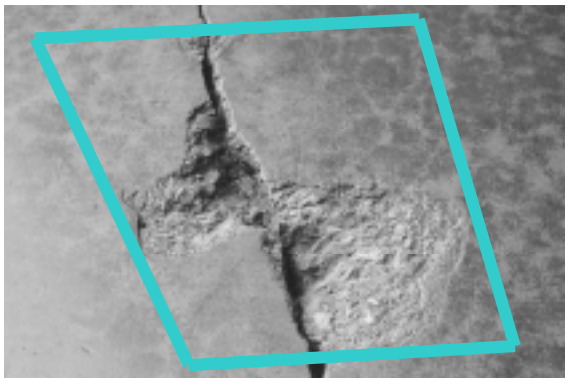
Measure and record the interior area of the hangar's floor surfaces. Hangar floors generally receive coatings from the interior edge of the drain grate to the base of interior perimeter walls. A measuring wheel is ideal for measuring the interior area of large hangars.

MEASURE JOINTS, CRACKS AND SPALLS

Joint.



Crack.



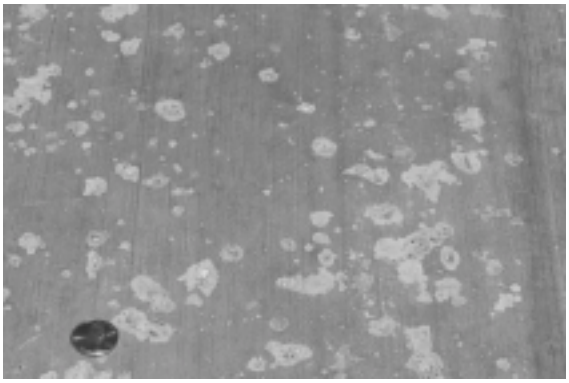
Crack spall with repair geometry.

Corner spall with repair geometry.

Measure and record the total linear feet of joints and cracks classified by width. Cracks displaying widths less than 1/8" are not to be recorded. Measure the area of each spall in rectangular geometries as illustrated above. Record the total area of spalls.

MEASURE COARSE CONCRETE, POPOUTS AND FAILED COATINGS

Coarse concrete: Poor surface finishing.



Small popouts.

Failed coating system: “A”.

Spot failing of coating system. “B”.

Measure and record the total area of concrete surfaces with surface textures greater than ± 1/4” (coarse concrete). Measure and record the total area of concrete with greater than 1/4” diameter popouts (small cone-shaped surface voids). Coating systems resembling “A” (above) shall be reported as a failed coating system whereas coating systems with spot failing resembling “B” (above) shall be measured and recorded. For coating systems with spot failing, use the measuring wheel to determine the total area of failed coatings. Individual coating failures less than 3” in diameter are not to be reported unless grouped together in visually significant densities.

DETERMINE ADHESION OF EXISTING COATINGS

Elcometer™ portable adhesion tester with 3/4” pull-off coupon.

Resulting pull-off coupons. A-C, Cohesive failures (attached concrete): D, Adhesive failure (attached coating).

If less than 7 % of the floor surface contains coating failures, perform adhesion testing to determine the coating system's suitability for overcoating. Determine the adhesive strength of the existing coating system using a portable adhesion tester (ASTM-D-4541: American Society for Testing and Materials; West Conshohocken, PA). Perform nine adhesion tests per floor (3 left side, 3 center, 3 right side). Record adhesion values per test and document failure type (cohesive or adhesive: see above photograph).

DETERMINE CONCRETE SURFACE STRENGTH

Portable adhesion testers with pull-off coupons: Dyna tester (L) and Elcometer™ (R).

Portable core drill with air cooled core bits and pull-off coupons.

Determine the cohesive strength of the concrete's surface on uncoated floors and previously coated floors with a failed coating system (ASTM-D-4541 or equivalent). Perform six cohesive strength tests per floor (2 left side, 2 center, 2 right side) and record results. For concrete with aggregate larger than 3/8" diameter, adhesion testers employing 2" diameter pull-off coupons are preferred. The accuracy of cohesive strength testing may be improved by coring a distance of 1/8" to 3/8" into concrete surfaces prior to adhering pull-off coupons. If concrete cohesive values are low (≤ 200 psi), concrete surfaces may contain a weak layer of surface cement paste (laitance). Once the laitance is removed through a surface preparation technique such as shot blasting, cohesive strength values should increase. If cohesive failures are not produced within the concrete's surface (adhesive failures), concrete surfaces may contain surface contamination (fuels, oils, skydrol) requiring degreasing prior to re-testing.

DETERMINE DEPTH OF HYDROCARBON CONTAMINATION

Oil saturated concrete.

Depth of surface contamination.

Determine the depth of hydrocarbon contamination (oils, fuels, skydrol) by extracting concrete cores from uncoated and visually dirty surfaces (1 to 3 cores: 2"D x 3"L). On concrete cores contaminated with hydrocarbons a line can be seen which separates the dark-colored hydrocarbon contamination from the uncontaminated concrete. Oils and fuels tend to be dark-colored whereas skydrol appears reddish. Measure and report the distance from the surface of each core to the end of the discoloration. Repair resulting core holes using a cementitious repair material.

DETERMINE RATE OF MOISTURE VAPOR EMISSION

Moisture Vapor Emission Test Kit (MVETK) with scale.

MVETK in use.

Determine the concrete's rate of moisture vapor emission by applying three Moisture Vapor Emission Test Kits (MVETK) per floor (right side, center, left side: ASTM-F-1869). Report the concrete's rate of moisture vapor emission as the average of the above three rates. When floor coatings are applied to concrete with a high rate of moisture vapor emission, vapor pressure sufficient to lift a coating system may be generated. MVETK contain calcium chloride (a common deicer) which absorbs water vapor at a linear rate. Each kit is applied directly to uncoated concrete for a continuous period of 60 to 72 hours.

COATING SYSTEM REQUIREMENTS

If condition assessment results exceed the below coating system requirements, a Naval Facilities Coating Specialist is to be contacted prior to specifying a coating system.

THIN FILM COATING SYSTEM

A thin film coating system is for use on hangar floors with 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 4) Average surface depth of hydrocarbon contamination ≤ 1/4". 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 and average applicator skill.*

THICK FILM COATING SYSTEM

A thick film coating system is for use on hangar floors with the following condition assessment results: 1) Either "Smooth" or "Coarse" concrete surface textures, 2) Average moisture vapor emission rate ≤ 5.0 lbs/24 hours, 1000 ft^2, 3) Average concrete surface strength ≥ 200 psi, and 4) Average surface depth of hydrocarbon contamination ≤ 1/4".

Installation costs: *$5.50 - $8.00 ft^2*. Thickness*: ≥ 250 mils.* Approximate service life: *Overcoating at 4 years.* Benefits: *Tolerates high moisture vapor emission rates, produces a level surface over coarse concrete, high impact resistance, and may provide a suitable topcoat base for ≥ 10 years service.*

OVERCOATING SOUND COATING SYSTEMS

Overcoating sound coating systems is to be used over either epoxy or urethane coating systems with the following condition assessment results: 1) Average moisture vapor emission rate ≤ 3.0 lbs/24 hours, 1000 ft^2, 2) Average coating system adhesive strength ≥ 250 psi or ≥ 200 psi with coating system producing cohesive failures within the concrete, and 3) Coating system failures total ≤ 7 % of floor surface. Installation costs: *$1.25 - $2.50 ft^2*. Thickness: *≥ 5 mils.* Approximate service life: *At 4 years, either overcoating or complete coating system removal.* Benefits: *Increases service life of existing coating systems.*

SUMMARIZE CONDITION ASSESSMENT RESULTS

Results from each condition assessment are to be summarized in the below format and placed within Section 1.1 titled "Background" of the appropriate coating specification. The completed "Repair and Resurfacing Map" with legend may be attached as an appendix for use with the coating specification. *"Building A contains 26,000 ft^2 of a failing hangar floor coating system over concrete with a "Smooth" surface texture. The floor slab has 1930 ft of 1/4" - 3/8" joints, 325 ft of 1/2" joints, 1210 ft of 1" joints, 127 ft of cracks up to 3/4" (width), 105 ft of cracks greater than 3/4" (width), and 50 ft^2 of spalled concrete. Greater than 15 % of the coating system has spot failed. The coating system has an average adhesive strength of 275 psi whereas the concrete's surface has an average cohesive strength of 300 psi. Hydrocarbon contamination has penetrated the concrete's surface to an average depth of 1/16" (average of three cores). Results from moisture vapor emission testing indicate an average moisture vapor emission rate of 2.0 pounds moisture/24 hours, 1000 ft^2 (average of 3 tests). Appendix A contains a "Repair and Resurfacing Map" with legend documenting the location and size of areas identified for either repair or resurfacing."*

APPLICATION OF COATING SYSTEMS

The below photographs show the sequential execution of the above coating systems and represent key specification procedures.

SEALANT REMOVAL

Hand-held power saw.

Air-cooled concrete saw.

Failing joint sealants are to be 100 % removed and replaced with new sealant. Joint sealants may be removed using hand and power tools.

DEGREASING

Walk behind degreasing unit.

Pressure rinsing.

In order to promote sound adhesion between coatings and the floor surface, surface contamination (oils, fuels, skydrol) is removed by degreasing. Floor surfaces are to receive a minimum of two degreasing cycles and, depending upon the level of surface contamination may require additional degreasing.

COATING REMOVAL

Hand tool scraping of failed coatings.

Diamond disk grinding.

Failing coating systems may be removed using hand tools, power tools, high pressure water, light scarification, and shot blasting. Overcoating weakly bonded coating systems may result in premature coating failures.

CONCRETE SURFACE PREPARATION

Shot blasting unit.

Disk ground surface (ICRI CSP 2).

Ideal concrete surface profile for coating systems (ICRI CSP 3).

Maximum acceptable surface profile (ICRI CSP 5).

Exposed coarse aggregate from over shot blasting.

In hangar entrances, a keyed groove is required for thick film coating systems.

Concrete surfaces are prepared using a combination of shot blasting and power tool grinding. In areas inaccessible to shot blasting, power tool grinding is employed. Shot blasting and power tool grinding remove weak surface cement (laittance), surface contamination, and open up micro-pores within the concrete's surface to increase penetration and the subsequent adhesion of coatings to concrete. Resulting concrete surface profiles are to be equivalent to the following International Concrete Repair Institute's (ICRI) Concrete Surface Profiles (CSP): ICRI CSP 2, 3, 5.

ADDITIONAL DEGREASING

Concrete contaminated with skydrol.

Concrete contaminated with oils.

If following shot blasting and power tool grinding, concrete surfaces appear either discolored or wet-looking when the concrete is dry, concrete requires additional

degreasing. In an attempt to produce a clean layer of concrete above the surface contamination, several additional degreasing cycles are performed. Either poor adhesion or premature coating failures result when coatings are applied to concrete with surface contamination.

JOINT SEALANT APPLICATION

Round closed cell polyethylene backed rod.

Bulk chalking gun.

The joint sealant is applied over round closed cell polyethylene backer rod. Although the specified sealant is self-leveling, it is best applied using a bulk chalking gun. Painter's tape may be used to protect adjacent surfaces from sealant drips.

COATING APPLICATION

Squeegee application.

Roller application.

Screed application of thick film coatings.

Home made non-skid application device.

Hangar coatings are applied using squeegees, rollers, and by screed (thick films). Non-skid grit is broadcast into the wet topcoat and backrolled.