SUPERIOR PRODUCTS PEELABLE COATING FOR DAVIS-MONTHAN AFB

Final Report

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ABSTRACT

The 309th Aerospace Maintenance and Regeneration Group (309th AMARG), located at Davis-Monthan Air Force Base (DMAFB), Arizona, is the sole site for short-term and long-term preservation of all military aircraft. These aircraft can be new and awaiting delivery, active but waiting for a system upgrade, used and waiting for new mission, or preserved for parts support of other active aircraft. These weapon systems need protection from environmental exposure; all aircraft are parked outside on the dirt surface of the Arizona desert. Environmental protection is paramount, so the equipment is ready and accessible should it be needed.

The primary method of protection is to apply a peelable coating that can be easily removed after an extended period of exposure. Material designed for this application cures to a tough film that provides heat reflection, good temporary adhesion, and can be removed with a simple pull. The coating currently being used for aircraft preservation is provided by PPG (previously supplied by Spraylat). The 309th AMARG wanted to validate an additional alternate source for the peelable coating, and requested the AFRL Coatings Technology Integration Office (CTIO) and the University of Dayton Research Institute (UDRI) to perform the testing.

Superior Products International (SPI) has developed a peelable coating system for use on aircraft in preservation storage at 309th AMARG. The objective of the alternate coating was to reduce the labor time required for application of the coating, reduce the cost of the material, and improve the heat load resistance (thermal resistance) capability for the aircraft cockpits to better protect the electronics. The SPI alternate coating is designed to be applied with similar techniques as described in Air Force Technical Order TO-1-1-686, *Desert Storage, Preservation And Process Manual For Aircraft, Aircraft Engines, And Aircraft Auxiliary Power Unit Engines*, Chapter 11.2.

Initial testing of SPI peelable coating did not allow the coating to be pulled off of the substrates with ease. This could have been due to the application method, as the material for the first test was applied with a roller. This project applied the material with an airless sprayer as recommended in Air Force TO 1-1-686, Chapter 11.4.1. This project evaluated the critical properties of the peelable coating using variations of tests found in MIL-PRF-6799L, *Performance Specification: Coatings, Sprayable, Strippable, Protective, Water Emulsion.*

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1.0 SUMMARY

The SPI peelable coating was tested by itself as a peelable coating candidate. Initial testing of the SPI coating did not provide representative results of the material as designed, because it was applied incorrectly. The coating is designed for application using an airless or conventional sprayer; this testing used an airless sprayer.

Testing included adhesion of the peelable coatings on:

- unaged, uncoated acrylic sheets (MIL-P-5425);
- uncoated acrylic sheets (MIL-P-5425) exposed to 1,000 hours of xenon-arc;
- unaged, freshly painted aluminum (2024-T3);
- painted aluminum (2024-T3) that had been artificially-aged in a xenon-arc chamber for 1,000 hours.

Prior to coating application on the acrylic sheets and F-16 canopy (**Figure 1**), a fine layer of plastic polish was applied to assist as a release agent to allow the peelable coating to be removed more easily. The SPI material performed better than expected. The amount of force required to remove the material from the different substrates was not enough to register on the pull strength tester. There was no crazing of the acrylic materials. The heat resistance ability of the SPI material was much better than the current PPG coating.

Figure 1: F16 Canopy with SPI coating applied

2.0 METHODS, ASSUMPTIONS, AND PROCEDURES

The system matrix is presented in **Table 1.** Aluminum panels were pretreated with Alodine 1600, primed with MIL-PRF-23377 (Deft 02-Y-40), and topcoated with MIL-PRF-85285 (Deft 99-GY-001). Acrylic sheets were uncoated. Peelable coatings were applied to unaged painted panels, aged painted panels, and unpainted acrylic sheets, both aged and unaged.

After the topcoated panels were aged for 1,000 hours in xenon-arc, the SPI peelable coating was applied. After cure, the panels were aged again in xenon-arc for 1,000 hours. All testing was performed after the 1,000 hours of exposure was completed.

Table 1: Matrix

Substrate	Pre Clean	Clean / Wash	De-Ox	Conversion Coat	Primer	Topcoat	Cure	Wipe
Unaged 2024-T3 Bare 0.032"	CTIO STANDARD			Alodine 1600	Deft 02-Y-40	Deft 99-GY-001	14 day cure	Solvent Wipe or equivalent after environmental exposure
Aged 2024-T3 Bare 0.032"	CTIO STANDARD			Alodine 1600	Deft 02-Y-40	Deft 99-GY-001	14 day cure, then 1,000 hours of xenon-arc	Solvent Wipe or equivalent after environmental exposure
MIL-P-5425 Acrylic sheet 0.125"	UNCOATED							Clean with water or aliphatic naptha type II

2.1 Primer and Topcoat Application

Aluminum test panels were pretreated with Alodine 1600 and then sprayed with one coat of an epoxy-polyamide primer conforming to MIL-PRF-23377 (Deft 02-Y-40) to a dry film thickness (DFT) between 0.6 and 0.9 mils. The primed panels were allowed to cure overnight under ambient conditions before being sprayed with two cross coats of polyurethane coating conforming to MIL-PRF-85285 (Deft 99-GY-001 color number 36173 of FED-STD-595) yielding a DFT of 1.2 ± 0.3 mils. After application of the polyurethane coating, test panels were allowed to cure under ambient conditions for 14 days. After cure, the panels were exposed to 1,000 hours of xenon-arc (exposure cycle is in **Table 2**). The average DFT of the primer was 0.68 mils and the average DFT of the topcoat was 1.94 mils.

Table 2: Xenon-Arc Cycle

Lamp	Irradiance	Control Wavelength	Exposure Cycle
Xenon	0.35 $W/m^2/nm$	340 nm	• 102 minutes at 63 (±3)°C Black Panel Temperature • 18 minutes spray

2.2 Acrylic Test Panel Preparation

Acrylic test panels were made from acrylic plastic sheet conforming to MIL-P-5425, Finish A. Test panels were given a preliminary cleaning with a cloth saturated with aliphatic naphtha, rinsed with warm water, and dried with a lint-free cloth. Polish conforming to P-P-560 (**Figure 2**) was evenly applied per AFTO 1-1-686, Chap 11.9.1., allowed to dry, and wiped clean with a lint-free cloth. The polish acted as a release agent allowing the peelable coating to be cleanly removed from the acrylic.

Figure 2: Polish / Release Agent

2.3 Peelable Coating Application

All materials were applied per manufacturer's specifications with the two components of the peelable coatings being applied with spray equipment (**Figure 3**) recommended by SPI representatives. Representatives from SPI were present for the application of the coatings. The undercoat, a blue peelable coating, was applied until a wet film thickness of 20 mils was achieved. The white reflective material, or topcoat, was applied until a wet film thickness of 16 mils was achieved.

Figure 3: Graco 7900 Airless Sprayer

2.4 Weathering

Test panels were exposed to in a xenon-arc chamber (**Figure 4**) for 1,000 hours to simulate approximately 1 year of outdoor exposure. UDRI/CTIO Laboratory Procedure CLG-LP-036, *Xenon-arc Accelerated Weathering Testing*, was followed, including the industrial maintenance coating cycle recommended in ASTM D 6695, *Standard Practice for Xenon-Arc Exposure of Paint and Related Coatings.*

Figure 4: Xenon-Arc Weathering Chamber

2.5 Testing and Test Results

The tests performed (**Table 3**) for project are not included in the CTIO/UDRI's ISO 17025 accreditation.

Table 3: Tests Performed

Test	Requirement	Substrate
Peelable Coating Performance after Artificial Weathering*	• Coating does not check, crack, or embrittle • Does not penetrate to the substrate • Peelable in one continuous sheet. • No crazing of acrylic surfaces or corrosion of aluminum surface • After peeling, finished surfaces will not lift, mar, or show other irregularities • Heat resistance	Acrylic MIL-P-5425 Aluminum 2024-T3
**** 1,000 hours of xenon-arc exposure was used in place of the 1-year of aging in the sun required by MIL-PRF-6799L.*** **** Testing over aged paint is not required by MIL-PRF-6799L.***		

2.5.1 Peelable Coatings Performance Testing

A Salter Electrosamson Pull Tester (**Figure 5**) was used to determine the amount of force necessary to peel the coating off of the substrates. Previous testing was performed at the University of Dayton Research Institute (UDRI) campus using an Instron Pull Tester using a 20# load cell. The 20# load cell is no longer available; the smallest load cell available for use was a 100# load cell. The amount of force necessary to register on the 100# load cell could not be reached with the SPI peelable coating; therefore, testing was performed using the handheld Salter unit. Pull test results are in **Table 4.**

Table 4: Pull Test Results

Substrate	**Unexposed Aluminum**	**Exposed Aluminum**	**Unexposed Acrylic**	**Exposed Acrylic**
Force	Did not register	Did not register	Did not register	Did not register

The Salter pull tester was used to pull polyester tape off of an aluminum substrate to verify that it was working properly. The force required to remove the tape was approximately 2 pounds. The documentation for the Salter Electrosamson does not give a minimum force required to register so the only conclusion that can be made is that the force required to remove the peelable coating was less than 2 pounds.

Figure 5: Salter Electrosamson Pull Tester

2.5.2 Thermal Resistance

The test panels were placed in a Styrofoam cooler (**Figure 6**) that was cut to fit the panels and eliminate air flow under the panels to duplicate the inside of the aircraft. An ultraviolet (UV) lamp (**Figures 7-8**) was placed over the panel at a 6-inch standoff distance. Temperatures were recorded using a calibrated thermocouple attached to the bottom of the panel; the top surface was measured using a calibrated infrared (IR) thermometer. Temperatures were recorded after 5 minutes and after 10 minutes (**Table 5**). One sample of Spraylat material was supplied by SPI for comparison purposes. The coatings for the Spraylat sample were applied according to manufacturer's specifications.

Table 5: Thermal Resistance

	Spraylat 5 minutes	**Spraylat 10 minutes**	**SPI 5 5 minutes**	**SPI 10 10 minutes**
Underside Temp °F	131	155	127	147
Top side Temp °F	146	167	135	149

After 10 minutes of exposure, the surface of the SPI peelable coating was 18°F cooler than the Spraylat panel. The underside, representing the interior of the aircraft, was 8°F cooler than Spraylat.

Figure 6: Styrofoam Panel Holder

Figure 7: UV Lamp

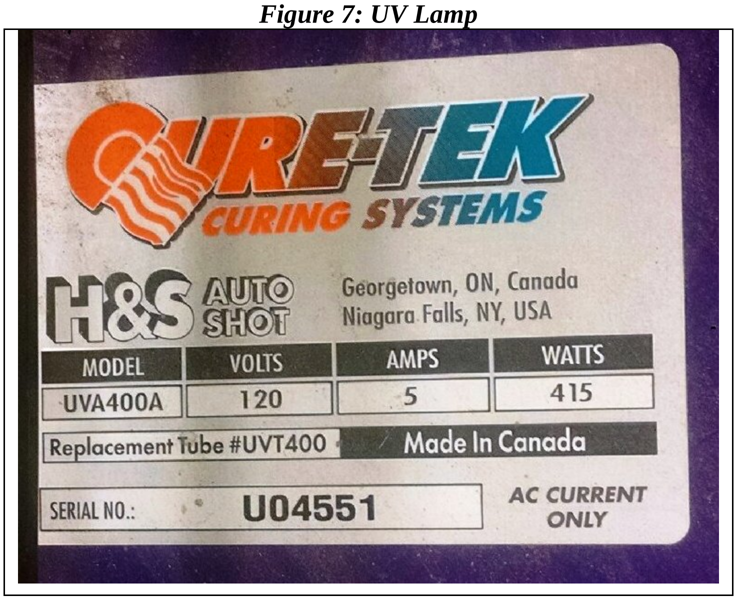

Figure 8: UV Lamp Specifications

2.5.3 Crazing

There was no visible crazing of the acrylic substrate before, during, or after testing.

3.0 RESULTS AND DISCUSSION

The SPI peelable coating applies easily with an airless sprayer, has excellent weatherability characteristics, and was easily removed after exposure to artificial weathering. The SPI peelable coating provides significantly better thermal protection than the material currently being used. The acrylic substrates did not have any adverse effects, such as crazing, from the peelable coating. The SPI peelable coating should be considered as an effective peelable coating system to be used for aircraft preservation at the 309^{th} Aerospace Maintenance and Regeneration Group, Davis-Month AFB. The F-16 canopy, with the SPI peelable coating intact, will be returned to the 309^{th} AMARG for continued environmental weathering and evaluation.

END OF REPORT