

## APPLICATION OF SOLID PAINT COATING ON AIRCRAFT

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### **Abstract**

*Applying solid paint is a procedure used in practice to cover an aircraft skin with a coat of chromatic lacquer which possesses anti-corrosion properties. Additionally, this coat improves aerodynamic characteristics of a/c skin. Solid paint is applied as a preventive maintenance of the material the skin is made of to protect it against atmospheric exposure factors and it is conducted before an a/c is certified airworthy or when a given assembly requires separate maintenance or repair, and even in case of faults removal of skin coating fragment during scheduled maintenance. Painting process is conducted in a specially designated room which needs to meet a number of requirements and occupational safety regulations. The most important factor which the painting shop must meet is an appropriate room temperature, air-conditioning system and fire extinguishing equipment. The process of applying solid paint is time-consuming and requires precision. The author presents chosen methods of applying solid paint on aircraft construction elements as well as painting process preparatory maintenance. The article presents specificity of the preparatory process starting with appropriately prepared room, protective clothing and equipment suitable for solid paint application and ending with appropriate humidity parameters. The contents of the article depicts conditions which have to be met so that the process is accomplished in a safe manner and according to technological procedures. Subsequent stages of the paint application process show complex technology and influence of many factors which guarantee correct and safe task execution. Correct and technologically appropriate removal of the old lacquer layer, aircraft washing and finally outer layers application guarantee high quality, durability and safety of air crews and passengers.*

**Keywords:** *aircraft, paint, material, application*

### **1. Pre-treatment procedures**

Before each application it is necessary to prepare a sample called a 'witness'. Anodized, grease free, sheet metal plate made of aluminum alloy needs to be cut to 100x100 mm size and covered with lacquer which is to be applied on the airframe. If the lacquer does not chip, peel or creep then the painting process can be carried out safely.

The paint shop should be equipped with an air flow system. To carry out a successful painting process, an ambient temperature recommended by a lacquer manufacturer should be maintained in the shop. It most commonly is the room temperature, but one should bear in mind it cannot be higher than 25 and not lower than 18. The standard is the value of 21, as this temperature is most conducive both to the application process regardless of the chosen application method and to the drying process, viscosity coefficient should not be ignored as well.

Technological process of solid paint application should start with painting materials to be applied. It is necessary to secure the painted object against fire, which can be caused by spark electrical discharges in the environment of flammable substances vapours as these substances are contained in the painting emulsions. For this reason the painted object should be grounded. The earthing is connected to the shock absorber or airframe grounding rod. As the aircraft to be subjected to painting contains complete equipment, therefore surfaces or elements that can be damaged, dusted or sprayed during the application process should be secured with paper and tape. In order to secure the parts, they should be cleaned from any residue with a cloth and the contour of the part to be secured during the painting cycle should be outlined. While cutting out

the outline of the part an allowance should be made to secure the cover with a tape. The next step is sticking the paper to the surface which is to be protected. The temperature of the skin of aircraft should be adjusted to the ambient air temperature. To achieve this condition surfaces prepared for the painting process should be held at the temperature of the shop. In case the surface becomes contaminated due to precipitation, the time of holding is 2 hrs. in other cases it is 1 hr. Painting materials and protective equipment inventory should be carried out before the application process.

Protective tools inventory involves inspection of compressed air installation, cleanliness of utensils, painting material strainers and condition of painting templates, spray guns, spray gun Fine coat and surface cleaning fabric.

The range of the coating bond strength is very small. In the distance of a few millionth of the millimetre from the metal surface it disappears almost completely. It explains why the presence of organic and non-organic contaminants such as grease, oil, water or fluid reduce adhesive properties of the coating.

During pre-treatment procedure, corrosion contaminated surfaces are marked with chalk, after that preliminary abrasion with 320-400 grit sand paper should be carried out. Attention should be paid to the anodized surface in the proximity of the surface which is being abraded. Then the surface designated for painting undergoes cleaning and quality control respectively.



*Fig. 1. F-16 vertical stabilizer cleaning process. Source: mjr pil. Adam Wójcik*

The solution of the cleaning agent and water in proportion 1:10 is spread on the prepared surface and then washed down under pressure and dried with grease-free wiping cloth. The surface is first degreased with extraction naphtha and then held at the temperature of 15 for 40-45 minutes.

Inspection of the pre-treated surface is performed in three stages. The first stage involves covering the pre-treated surface with distilled water with the use of a spraying nozzle. Appearance of drops and clearance/cavities/ translucent spaces proves that the surface has been pre-treated appropriately. Additionally, during the first stage of cleanliness inspection, the surface is treated with a drop of extraction naphtha and after 30 seconds a circle of clean, absorbent paper is pressed against the surface to determine the degree of the solvent absorption. Parallely, the inspection of extraction naphtha purity is carried out by soaking absorbent paper with the same amount of naphtha. After its evaporation the circle is inspected in the day light. The presence of grease stains means that degreasing is not sufficient.

The second stage involves removing acid and alkalic/basic agents with the use of litmus paper. The paper showing pH 6-7 after the contact with water-wet surface, signals that electrolytes have been removed from the surface.

The third stage is the inspection of the surface with lignin. The skin surface of 50 cm<sup>2</sup> is wiped with lignin. By this method presence of dirt, dust or grease is easily detected. Covering of the pre-treated surface is the most essential part of the whole process. The a/c performance will greatly depend on the personnel professional knowledge and the quality of the applied coating. The process of coating application must be carried out in complete compliance with the steps described in the work card. As the compliance is essential here, therefore it should be reminded of and highlighted before involving in any activity connected with aircraft maintenance or inspection.

Modern paint shops are equipped with state-of-the art guns designed for spray painting.



*Fig. 2. Spray gun. Source [www.dvidshub.net](http://www.dvidshub.net)*

Creating a good quality coating involves meeting several requirements. Firstly, clean and dry compressed air should be provided. It needs to be compressed under certain pressure values in case pneumatic gun is to be used. The next condition is maintaining cleanliness of the gun and taking care of appropriate calibration of the tool. The painting material must be prepared in compliance with the manufacturer's recommendations and selected in accordance with the parameters of the surface on which it will be applied as well as, the gun technical parameters. It is also essential to hold the gun properly while applying the coating.

While using low-pressure gun, the compressed air in the gun during the standard operating range should not exceed 0.1 MPa. The allowable range for low pressure guns is 0.1-0.14 MPa. The best coating application results are achieved if the pre-defined parameters are maintained, that is the temperature of the shop is 15, humidity does not exceed 75% and pneumatic installation maintains the pressure value within 0.294-0.392 range. The distance between the spraying nozzle and the surface is important too, and it should be between 30 and 35 centimetres.

## **2. Coating application process**

All the painting procedures to be carried on the a/c are described in the work cards. They should be carried out in compliance with such technical instructions as paint shop coating application technology, painting instruction for a given aircraft type and aircraft final assembly technology.

Pre-treated surface is covered with the etching primer. It is a chemical mixture which consists of a primer and hardener in proportion 1:2. The Ford Viscosity Cup measuring method is used to check viscosity of the primer.



Fig. 3. Ford Viscosity Cup Source wikipedia.org

The method involves the measurement of rate of liquid flow through a calibrated orifice of 4mm diameter at the bottom of the cup. The tolerance is 2 mm. The observed liquid should have the temperature of 20°C. Viscosity examination with the use of the Ford Cup can be carried out for anhydrous lacquers and pigmented substances which do not exhibit thixotropy. Viscosity measured with Ford Cup is expressed in conventional units - seconds.



Fig. 4. Aircraft covered with etching primer Source: <http://www.desapi.com>

One of the characteristics of the substance is its yellow colour. Applying the primer is executed with the use of a painting device and at the minimum temperature of 16 and relative humidity up to 75%. Then the first coating is dried for 1 hr. at the temperature of 16-30 degrees Celsius. The maximum drying time should not exceed 7 hrs.

After drying the etching primer coat, the purpose of which is anti-corrosive protection, the surface is covered with the coat of polyurethanes paint. It is a mixture of a primer, hardener and thinner. To achieve the desired composition of this coating the substances are blended in the proportion 1:0.5:1. Viscosity measured with the Ford Cup at temperature of is 11-13 seconds. This coating is white in colour. Application is performed with the use of a painting device at the minimum temperature of 16...and relative humidity of air not exceeding 75. Drying is conducted at the ambient temperature of 16-30 within minimum 4 hrs. and maximum 72 hrs.



Fig. 5. Aircraft partially covered with polyurethane paint. Source vimeo.com

Polyurethane topcoat enamel is prepared by mixing an appropriate to painting technology colour, hardener and thinner in proportion 1:1:0.75. Viscosity of polyurethane paint in the Ford cup test at temperature is before applying the enamel, surfaces should be wiped with antistatic cloth. Paint application is executed at a minimum temperature of 16 c with the relative air humidity not higher than 75... The coat is applied fully not in crossform. Drying at the same temperature should take 20-30 minutes. After this time another full coat is applied in a criss-cross manner. Allow 12 hrs. for drying of this coat. After the two coats have been applied, the craft is left for three consequent days. Within this time after 12 hrs., a decorative patterns and motives are applied.



Fig. 6. Aircraft covered with colour enamel. Source: <http://www.desapi.com>

First, they are marked with a use of a pencil and template. Before securing the template with tape and packing paper, the cover surface marked by contours is wiped with a special cloth. Additionally dust is removed with a clean cloth.

To paint an inscription, checquerboard, tactical numbers and alignment designations phthalate enamel is used. Attention should be paid to the expiry date. The applied phthalate enamel elements should be dried for 6 hrs.

After the template surfaces are dried, the quality of the applied paint cover is inspected as well as the correctness of inscriptions and designations and consistence of tactical numbers. Consequently, securing covers of the surfaces and elements which were not intended for painting, tape and packing paper are stripped off. Any possible tape remains are removed with a cotton cloth soaked in extraction naphtha III.



Fig. 7. Removing glue remains. Source: [www.advancedaircraftrefinishers.com](http://www.advancedaircraftrefinishers.com)

The last activity before the earthing is removed and quality control performed, is reassembly of elements included in the final reassembly technological card. During the quality control attention should be paid to the presence of any damp patches. A well-applied enamel exhibits no damp patches and has uniform gloss. After the prior drying, paint coat adhesion is tested. The test starts with making cuts in the sample and then feeling the surface with a finger without applying pressure.

### 3. Other methods of coat application in aviation industry

*Electrostatic coating.* This method involves directing atomized and electrically charged paint droplets on the part to be painted. The paint particles are charged negatively, while the workpiece is a positive electrode. The electrostatic field between the gun and the grounded workpiece causes that the charged particles fly along the lines of the field coating the part which is being painted. Thanks to the wraparound effect the paint mist is intercepted by the electromagnetic field and guided on the surfaces of the part which are not directly accessible.

*Electrophoretic coating.* This method is similar to dip coating method but the application process is aided with the use of direct current. There are two types of electrophoretic coating. If the part being painted is connected to the positive electricity source then the method is called anaphoretic, and if it is connected to the negative source the method is called cataphoretic. Cataphoretic painting allows for better results, yet it is more expensive. In this method aqueous paints with good conductivity properties are used. Among the advantages of this method are: material savings, fire safety, good anti-corrosion properties, lower labour intensity and higher process precision. Yet as all other processes, it has its drawbacks too. These include high cost of equipment, limited coating thickness, uneven coating if applied on parts made of different metals.

*Flow coating.* In a flow coat system, multiple streams of paint are applied on the part to be painted, then the element undergoes dripping and drying in the solvent environment. This method produces uniform coat and gives material savings in comparison with the dip coating. In flow

coating method aqueous paints with polyester paint vehicle are used. This method is well suited for large yet not oddly shaped objects, with no difficultly accessible areas.

*Dip coating.* With his process, parts are dipped into a tank of paint, then dripped and dried in the solvent environment. Dipping is well suited for automation and cost-effective in case of mass-production. The drawbacks of this method are:

- uneven coating thickness,
- it is suitable for some asphalt and aqueous paints only,
- during the process of paint application constant mixing and filtering of paint in the tank is required as well as proper concentration of solvent in the drippage tunnel.

#### 4. Summary

The article discusses the coat application techniques used in aviation industry. The article presents such aspects of the process as preliminary work on the aircraft like removing of damaged coat, applying specific coat types and techniques of application. Aviation industry branch dealing with painting technologies works on many documents and technologies which constitute vast data base. This article is aimed at familiarizing the reader with the essence of respective technological processes. Development of technologies aiding the process of paint removal and application is a critical factor to efficiency and environment protection. Neatness and quality of coat application have an impact on aerodynamic properties and anti-corrosion protection of an aircraft and what follows flight safety.

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