Aviation Paint: More Than a Pretty Face

By Charlotte Adams

King Aerospace, an all-round maintenance, modifications, avionics and paint operation in Ardmore, Okla., specializes in VIP and corporate aircraft and uses Sherwin-Williams paints.

King Aerospace Photo
Aircraft paint is probably one of the most underappreciated technologies in aviation. Everyone oohs and aahs over today’s jet engines and the electronics that dominate modern flight decks. But paint? Passengers think of it as a pretty face, not realizing its implications for safety, fuel efficiency and aerodynamics.

Paint protects the exterior surfaces of an airplane from the elements. An aircraft hurtling through the air at 500 miles per hour or more is exposed to high levels of ultraviolet (UV) exposure, rapid and extreme temperature cycling, expansions and contractions of the outer skin, high wind velocities, and the effects of air, rain, and manmade chemicals. Aircraft paint has to stand up to this environment, be flexible, adhesive and durable, maintaining gloss and vibrancy for the five- to 10-year interval between refinishings. It must also be as eco-friendly as possible. And it has to look good.

Typical fuselage paint must be able to withstand temperature swings of well over 100 °F, says Mark Cancilla, PPG Industries global platform director, aerospace coatings. In a matter of minutes the temperature around the aircraft’s exterior falls from ground levels to perhaps minus 60 °F at altitude. Temperature requirements typically range from minus 60 °F to 160 °F, he says. There are also high air velocities and changes in humidity to deal with. “Of course, the effects of UV light are also much greater at 40,000 feet, and so the exterior topcoat must be able to survive this to maintain the integrity of the livery colors,” he says. They also must resist chemicals such as deicing fluids, hydraulic fluids and industrial-strength cleaners.

Coatings for structural elements inside an airplane face a different set of challenges. These coatings must protect the aircraft from corrosion—in some cases for the duration—as some areas are difficult to reach for maintenance after the aircraft is assembled. Coatings for areas such as the insides of fuel tanks may need to last 25 or even 50 years, says Andreas Ossenkopf, director of aviation for Mankiewicz, a paint manufacturer headquartered in Germany. Structural components paints must resist chemicals such as hydraulic fluids and prevent the corrosion of aluminum from contact with water electrolytes as well as aggressive media, he adds.

Interior cabin coatings also must meet strict standards for flammability, smoke and toxicity, Ossenkopf says. And cabin coatings must be functional, durable and pleasing to the eye. Mankiewicz has delivered exterior, cabin, and structural element coatings to the aviation industry for decades, the company says.

AkzoNobel, a paint manufacturer based in Amsterdam, points out that aerospace is a qualification-driven market. Coating systems must pass the stringent specification testing requirements set out by the aviation authorities and aircraft manufacturers before they can be used in the market. It often takes years for products to go from development through qualification to commercial application on aircraft, explains Maud Khelstovsky, the company’s segment manager for OEM and MRO. AkzoNobel’s Aerofine line...
of cabin coatings, introduced in 2013, comply with strict cabin flammability requirements per FAR 25.853/JAR 25.853, she says.

It takes a lot of paint to cover an airplane even though each layer is exceedingly thin. A typical wide-body generally can require 80 or more gallons of top-coat in a single-stage system, which can weigh almost 500 pounds, Cancilla says. Of course, the exterior primer, interior primer and interior topcoat systems will add significantly to this amount, he says. So, it would not be unreasonable to have more than 1,000 pounds of paint on a typical wide-body, he adds. The three layers of paint on a superjumbo A380-800’s exterior, by comparison, weigh about 1,102 pounds, according to the British Airways Web site.

**It’s Come a Long Way**

Paint has come a long way in the last decade. The biggest change so far has been the introduction of BaseCoat/ClearCoat (BCCC) formulations by Mankiewicz in 2007, asserts Ossenkopf. Nor has the company’s research stopped there. Mankiewicz is looking at futuristic concepts such as coatings with microstructures to reduce drag, also known as UV-Riblet technology, and on-demand functional coats, with ant-ice or easy-to-clean properties, that could replace clearcoat in areas where a specific function is needed.

The first PPG Electrocoat primer system in the U. S. is reducing application and process time at the U. S. Coast Guard Aviation Logistics Center in Elizabeth City, North Carolina. Robin Peffer, research associate (l) and Ed Mullins, sales and market development manager (r) worked with Coast Guard to design the system. PPG Photo.
BCCC involves the use of two types of coatings over the primer—the basecoat for colors and a protective clearcoat on top. In single-stage coating, on the other hand, everything necessary for the exterior is contained in a single formulation. But single-stage paints can take eight to 10 hours for the color to dry.

Because it dries faster, BCCC technologies such as SKYscapes can reduce process times by as much as 30 percent, according to Sherwin-Williams Aerospace Coatings. BCCC formulations also can save customers up to 30 percent of the materials that would be used with standard single-stage topcoats, Mankiewicz’s Ossenkopf says. New pigments and resins, along with improved dispersing equipment and production methods, have allowed the “one-coat-to-hide” concept, he says.

BCCC basecoats use a higher level of pigmentation, PPG explains, so that a single coat of color typically does the job required by two coats of single-stage paint before. Some colors such as orange and yellow, however, can require more than one coat to achieve “desirable hiding properties,” Cancilla adds. Paint savings can translate to weight and fuel savings, as well as reduced application time and maintenance downtime, depending on...
completed the special livery for the Brussels Airlines A320 in March of this year. The project took just 10 days, including the stripping and sanding away of the previous paintwork, says Steve Pickering, Eirtech vice president of aircraft refinishing. The Tintin detail, executed in paint rather than decal, took just three days, he says.

Paint operations work closely with manufacturers to ensure just the right look. Global Jet Painting repainted the exterior of designer Peter Nygard’s 727, using custom-designed colors from Sherwin-Williams, Amico recalls. The company now is painting a 727 for ZERO-G, an operator that gives people the experience of weightlessness. Amico stresses the product support the paint manufacturer provides in advising on adjustments such as changes to the component mixtures needed to compensate for temperature and humidity during painting or repairs.

**Repairability**

No matter how beautiful the paint job, there are frequently repairs to be made before the next repainting. There may be damage related to an incident that requires a new panel to be installed. Or the owner may

---

**Real-World Applications**

But there are differences between the lab and the paint booth. King Aerospace, an all-round maintenance, modifications, avionics and paint operation in Ardmore, Okla., puts down at least two coats of basecoat and two coats of clearcoat when using BCCC paint products, says Randy Johnson, director of corporate aircraft services. That’s four coats plus the primer, or a total of five coats. When he’s using single-stage paint, he uses primer plus three coats of pigmented paint, which gives you better depth of luster than two coats, he says. King Aerospace specializes in VIP and corporate aircraft.

Single-stage and BCCC processes can be combined on the same airplane. The basic white fuselage can be painted in single-stage white, for example. Metallic stripes can be added in BCCC. A clearcoat also can be applied on top of a single-stage paint.

Some colors, on the other hand are available only in BCCC. If you have an all-pearl or all-metallic airplane, BCCC is the only way to go, Johnson says. Those colors aren’t designed to be a top coat, he says. “They have to be top-coated with clear to have the shine and luster.”

Painting also can involve complex designs on the aircraft fuselage. A recent project completed with Mankiewicz BCCC products involved the design of a new livery for Belgian flag carrier, Brussels Airlines, featuring the cartoon character, Tintin. Eirtech Aviation, an aircraft refinishing company headquartered in Ireland,
When you select Co-Operative Industries Aerospace & Defense for your electrical harness needs, you can depend on experienced technicians that deliver quality workmanship and responsive turn times. CIA&D offers interconnect manufacturing expertise to support OEMs, as well as certified harness repair services. Contact us to learn more about the advantages we can offer your organization.

It's What We Do

Wiring Harnesses

Manufacturing

Repair Services

Engineering Support

Interconnect Solutions for Today's Aerospace

CIA&D
CO-OPERATIVE INDUSTRIES AEROSPACE & DEFENSE

Voice: 817.740.4700 Fax: 817.624.4282
solutions@coopind.com www.coopind.aero
FAA No. OI0R891N EASA 145.5897 CAAC No. F00100406

need to change the registration number or want to add a stripe to the livery.

For white airplanes, for example, spot repairs can be a real challenge. That's why King Aerospace prefers to use single-stage paint for white color applications. Single-stage paint gives you reparability down the road, Johnson says. "Usually, if there's a clear coat on top, it's harder to match," he says. The clearcoat "has a tint to it." If the white has been clear-coated, you end up having to paint and clear a whole panel. On the other hand, deluxe products like pearl BCCC paints repair nicely, he says.

King Aerospace also looks for corrosion control performance and quality. The company uses Sherwin-Williams single-stage (Jet Glo Express) and BCCC (SkyScapes) formulations. King Aerospace handles everything from a Beechcraft King Air or Citation to a 757.

Eco-Friendly

Paint manufacturers also stress their effort to reduce or eliminate the use of hazardous, toxic, and otherwise undesirable chemicals. They have made "great strides," for example, in removing hexavalent chromium compounds such as chromate as the primary corrosion inhibitors, as these materials are being regulated out of the industry, Cancilla says. PPG has "an extensive line of chromate-free primers" for commercial, military and general aviation applications. And Sherwin-Williams Aerospace Coatings features a "complete line of chrome-free primers" for both aluminum and composite substrates, says Julie Voisin, global product manager for the unit.

AkzoNobel Aerospace Coatings recently celebrated the certification of new, 100 percent chrome-free paint systems under AMS 3095A, an SAE standard, the company says. Chrome-free systems help customers to reduce waste, save energy, cut maintenance costs, and enhance workplace safety, Khelstovsky says.

The new AkzoNobel systems include multiple topcoat options (both basecoat/clearcoat and single-stage topcoat) and the possibility to choose between water-based surface pretreatment or a unique direct-to-metal (DTM) system, she says.

The use of chemicals that release volatile organic compounds (VOCs) and other undesirable substances into the air is also on the decline in the industry. AkzoNobel, for example, has introduced a chrome-free, water-based pretreatment for paint systems that need a metal pretreatment. The Metaflex SP 1050 brand reduces emissions of VOCs by as much as 75 percent and simplifies the aircraft repainting process, Khelstovsky says.

Electrocoating also promises to reduce environmental impact and decrease waste. PPG has developed Aerocron, a corrosion-inhibiting electrocoat primer that is chromate-free and water-based, the company says. The process involves immersing metal aircraft parts in the primer bath and then applying an electrical charge. The primer is attracted to the charged part, resulting in uniform film thickness even in recessed and hidden areas, Cancilla says. The sequence involves the pretreatment of parts, primer dipping, rinsing, and thermal curing. The primer can be applied to any structural component of the aircraft, he says. "The determining factor is the size of the primer bath."

Weight savings could range from 30 to 70 percent, depending on the complexity of the part, Cancilla says. This results from the "nearly perfect film thickness across each coated component," when compared with spray-applied systems, he says. Moreover, the primer can achieve application efficiencies over 95 percent while spray-applied systems often achieve only 30 to 40 percent application rates, Cancilla asserts.

Manufacturers also are always trying to give paint a new look while making it easier to use. A new Sherwin-Williams Aerospace Coatings interior product, Jet-Flex Elite, for example, will impart "subtle glows" and vibrant effects from aircraft LED lighting, giving a special look to first class and business areas, Voisin says.
Aftermarket Insights

Some coatings can be hard to get off, Amico says. His company is painting former American Airlines MD80s for a South American airline. Even the polish on the bare aluminum surface of the upper fuselage can be a challenge to remove, he says.

Finding a match to the existing color also can be a challenge, Amico says. He tries to find out who manufactured the paint and what batch was used on the original job. Sometimes paint can be matched via a panel from the existing aircraft. If the plane has been flying for a while, colors may have faded or been discolored. White, the most popular color, is also very hard to match, he says. It also discolors over time. “I think white is so popular because it is like a canvas,” he says. “It makes colors and logos pop.”

Cabin temperature could also be a factor, he says, as white reflects rather than absorbs the light.

You also have to be careful to put on just the right amount of paint—not too little, but not too much. “You have to be really careful on the layer thickness,” Amico says. The one time that thickness wasn’t a challenge was when Global Jet Painting repainted the first 747 for the Museum of Flight at Boeing Field in Seattle, Amico says. “We sanded all areas, did some spot priming on all the exposed areas, and then painted it over with a couple of coats, he says. With an airplane that was going back on the flight line, Global Jet would have paid closer attention to paint thickness, he says.

Composite Challenge

Composites are another challenge, Amico says. Coating composite surfaces is more labor-intensive because these substrates have little pinholes, he says. You have to “heavy sand” and use a high-build primer to fill any cracks and pinholes and then sand most of that off.

The processes required to coat composites on corporate jets, for example, are somewhat different from those used to cover aluminum, Johnson says. Typically, additional priming and sanding steps are involved in order to work out all the composite texture flaws before you paint.

Removing the paint from a composite airplane is all manual labor, he says. Painters can’t use chemical strippers because these would break down the polymers. So it’s a matter of labor-intensive sanding with 180-grit and 240-grit sandpaper until they get down to the composite surface. Manufacturers are designing a composite stripper that’s supposed to be available in a year or so, Johnson says, but it’s not out yet.

Repainting an entire composite aircraft like the 787 will be an interesting challenge, Amico says. Composites are made up of resins and fibers. Global Jet Painting has handled interior composites, and “we would never consider [chemically] stripping paint off a composite in an interior,” Amico says. Global Jet Painting just sands and repaints these components, maybe using a primer filler when needed.