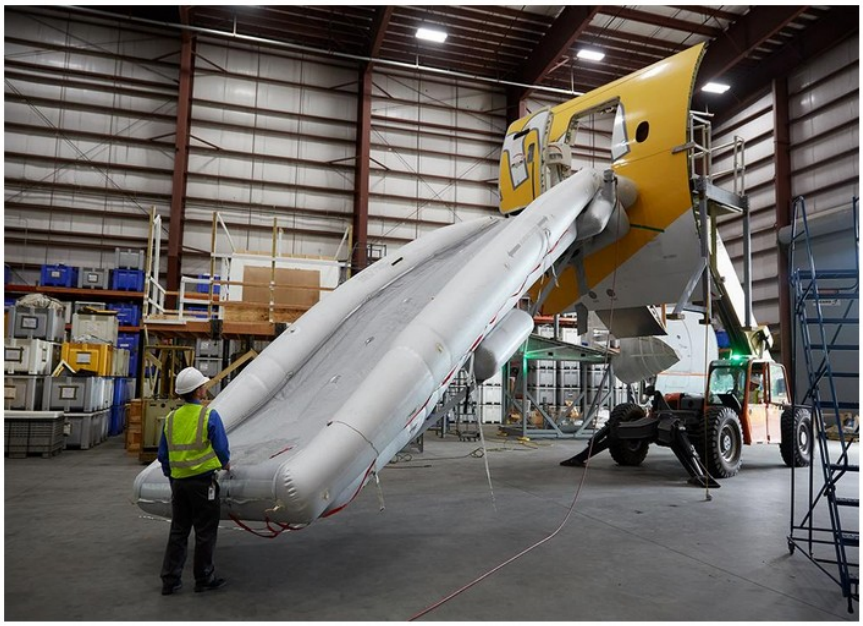

Aircraft Escape Slides Evolve Toward Lighter Weight, Better Maintainability

Paul Seidenman David Spanovich May 03, 2024



Credit: Matthew Bender/Capa Pictures/Safran

SAN FRANCISCO— Discretely contained within main cabin doors or inside a fuselage compartment adjacent to an over-wing exit, escape slides are incorporating new material technology, resulting in lighter weight, greater durability and longer inspection time intervals.

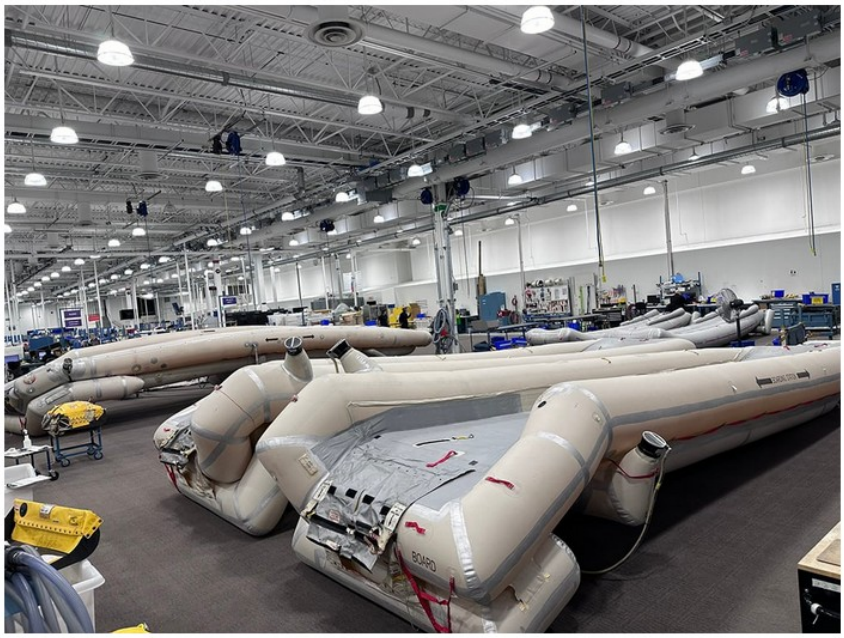
“We see the future engineering and design trends for slides focusing on lighter systems as a means to help reduce the carbon footprint of the aircraft,” says Mark Jeffers, president of Safran Aerosystems Evacuation. “At the same time, OEMs such as Airbus on the A321 family have been moving toward fuselage mounted systems for slides. This has been done historically for off-wing mounted systems such as the [Boeing] 757, 767 and A320 airplanes.” The A321 takes this a step further to provide more interior space, he adds.

Appreciating the engineering innovations in cabin evacuation slides requires some understanding of the system's design.

As Jeffers explains, the slides interface with the cabin door by means of a girt, a fabric component that attaches to the slide, and then to a girt bar, or metal or composite bar or tube. That is attached to the floor of the aircraft below the door when the door is “armed.” attachment of the girt bar to the floor is either done manually by a flight attendant or automatically by the door, depending on the aircraft model. The slide is enclosed in a packboard assembly that is consists of a rigid composite tray that is attached to the door. A lacing cover envelops the slide from the top of the tray to the lower portion that engages with the release mechanism, which releases the slide from the door when it is opened in the “armed” mode.

“While the overall slide architecture has not fundamentally changed over the years, we have seen the use of improved and lighter materials, which has enabled extended maintenance intervals in addition to reduced weight,” says Louis Mallette, senior vice president of operations at Montreal-based AJW Technique, which repairs slides.

Mallette points out that for slides produced during the last five years, the greater reliability of the new materials, coupled with the use of modern LED escape slide lighting systems—in place of incandescent bulbs—has contributed to an overall reduction of maintenance costs over the life of the aircraft. “Unless disturbed or mishandled, the slides normally stay on-wing until their scheduled maintenance is due,” he says.



Escape slides typically stay on-wing until scheduled maintenance is due. Credit: AJW Technique

Mallette also reports that newer materials are replacing the heavy, rubber-coated fabrics which have been the long-time standard ingredient of escape slide fabrication. While thinner, the modern materials are both lighter and equally durable. “Compared to the older materials, they appear to be at least as resistant to damage and wear over time,” he says.

As Mallette explains, newer slides are generally constructed of lightweight, high-strength fabrics with reflective polyether urethane or elastomer coatings which offer a heat-reflective surface and increased resistance to punctures, tears and abrasions. This provides the necessary strength and reliability, making the slides easier to deploy and handle during emergency evacuations while offering operators substantial financial benefits, he says.

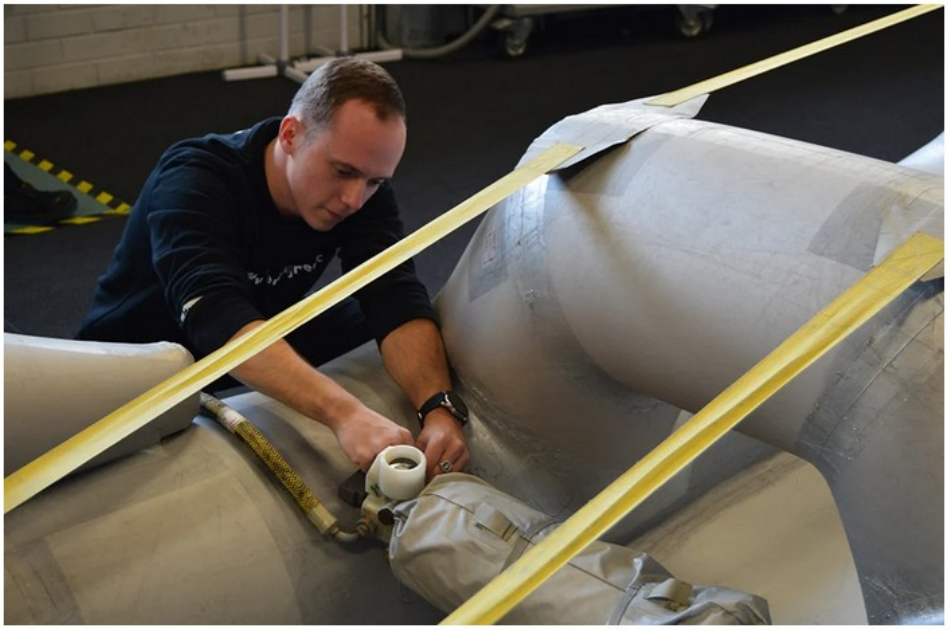
Slide-containing packboards are now typically fabricated with composites, which also contribute to reduced weight and higher strength, says Mallette.

MAINTENANCE CONSIDERATIONS

Asked if the new fabric technology has also addressed slide maintenance issues, Mallette says that technicians still tend to see small tears around the folds and seams caused by the age of the materials. “These are vulnerable areas and the porosity in these areas can lead to leakages which affect the slide’s ability to maintain pressure over time,” he says. “The newer materials, which are more malleable, tend to reduce stresses around the folds and seams. As such, we do expect this to be beneficial over time.”

In fact, punctures and worn places on the inflatable components of a slide and the girt assembly usually occur in the event of deployment and/or evacuation, according to Margus Graf, workshop manager at Magnetic MRO. The Tallinn, Estonia-based MRO repairs door-mounted and off-wing slides on the Airbus narrowbody family, as well as the door slides and girt assembly replacement on Boeing 737NGs and 737 Classics.

“Incorrect handling and work methods may also cause premature aging of an escape slide and its components,” Graf explains. “As the slide ages, the material may start to show signs of porosity or lifted seams, which will require repairs. This is also why older slides—those over 15 years of age from date of manufacture—must be inspected annually. Those less than 15 years old are typically inspected every three years.



Cabin evacuation slides must undergo annual inspections starting at 15 years after manufacturing. Credit: Magnetic Group

Graf adds that annual inspections for older escape slides include testing and inspection of the inflatable assemblies and necessary repairs, which he says are typically for punctures or cuts on air-holding tubes, along with refilling of the inflation cylinder assembly and reassembly of the whole unit. “An overhaul adds cylinder maintenance, which consists of disassembly, cleaning and visual inspections of regulator valve components and the reservoir, and hydrostatic testing of the reservoir, as well as assembly and leakage test of the unit,” he says.

Trelleborg AB, a polymer technology-focused engineering company based in Sweden, supplies polyurethane coated and laminated woven fabrics to slide manufacturers. The fabrics, which use industry-known materials, are enhanced through Trelleborg's proprietary processes, says Kevin Maine, commercial director for aerospace and North America. He says this allows the company to optimize the slides’ performance, according to specific customer needs and industry standards.

“The advantages for the slide manufacturers include enhanced durability and reliability, improved safety features due to superior material properties and the ability to meet stringent aerospace regulations,” he explains. “For end-users, these materials ensure reliable performance in emergencies, contributing to overall flight safety.”

Maine says some of the material's key performance characteristics include air retention, flame resistance, fungus resistance, high strength-to-weight ratio and weldability. They have been achieved, he says, through the careful selection of polymers and fabric construction, as well as the application of Trelleborg’s specialized coating and laminating techniques. “Each characteristic is targeted through specific chemical formulations and process controls to ensure optimum performance,” says Maine. “We conduct extensive laboratory testing and have gathered substantial field data that demonstrate superior performance in terms of durability, safety and reliability compared to standard materials used in the market.”

Maine reports that the fabrics have shown increased resistance to environmental stress and mechanical damage, as corroborated by both laboratory testing and operational feedback—translating into fewer maintenance needs and greater reliability under diverse conditions.

While this points to the potential of longer on-wing time and wider inspection intervals, Maine cautions that such variables are generally determined by the slide OEMs and the regulatory authorities. “Materials provided by Trelleborg are designed to support extended durability and longer inspection intervals, subject to the manufacturers’ designs and maintenance schedules,” he says. “We are working on new formulations that promise even greater performance in terms of environmental resistance, durability and safety, and further benefits such as improved sustainability and cost efficiency.”

Alexander Huebinger, senior engineer for rescue and safety components at Lufthansa Technik, says the slide’s inflatable material and introduction of welding for joining the inflatable sections have contributed to weight reduction. Minor changes, such as the introduction of LED lighting instead of bulbs, have also been made, he confirms.

In addition to neoprene, nylon, polyether urethane coated, single ply or polyurethane materials for the slides, Huebinger says that weight-saving changes have also been made to the packboards themselves. “That includes molded and ribbed composites, and honeycomb Kevlar composites,” he explains. “For the reservoir (a component of the inert gas inflatable system) we are seeing carbon fiber/resin composites over aluminum liners.”

Weight savings varies by slide size, Huebinger says. “For big slides—those which are installed on widebodied jets—the savings is about 5-7 kg (11-15 lb.) per slide, but only 1-2 kg (2.2-4.4 lb.) per slide on smaller ones,” he says.

Huebinger says a more significant breakthrough has been the increase in the inspection time frame—from 3-5 years starting with the entry into service of the Boeing 787. That time frame remains until the slides reach 15 years, when yearly maintenance is required.

Despite the innovations in slide materials, there is still the obvious question of damage resistance compared to older systems. As Huebinger explains, time will tell.

“At Lufthansa Technik, we are not able to make a statement on that, as we do not have enough longtime service experience concerning aging effects,” he stresses. “However, according to our experience and records, the systems have generally demonstrated long-term reliability over decades. They are reliable and mature products.”

A DIFFERENT KIND OF SLIDE

At first glance, the slide for airline cabin crew evacuation training looks like it just came off an airplane. But they are different, explains Patrick Phillips, vice president of business development at Tulmar Safety Systems. The company designs and builds escape slides specifically for the training market.

Phillips says the training slides Tulmar designs and builds provide as realistic an experience as possible. But the punishment they must take means their construction differs somewhat from those found on an actual aircraft.

“Slides installed on aircraft are not made to [withstand] the frequent deployment and repacking—sometimes over two shifts per day—required to train new cabin crew recruits or cabin crew returning for scheduled training,” he says. “The use of materials that can stretch under pressure without deforming, and other materials that can weather long-term exposure to chlorinated water without degradation, are preferred [for] training equipment that must last years.”

As an example, Phillips notes that most of Tulmar’s customers permanently connect their training slides to an air compressor located in the training area to ensure that the slide is always inflated. He says some customers will integrate an air pressure system that will inflate the slide when the door of the trainer they use opens.

“Because training slides are usually kept pressurized for extended periods of time, this can eventually, over months, create weaknesses and leaks from the skin of the fabric itself or from seams,” he says.

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