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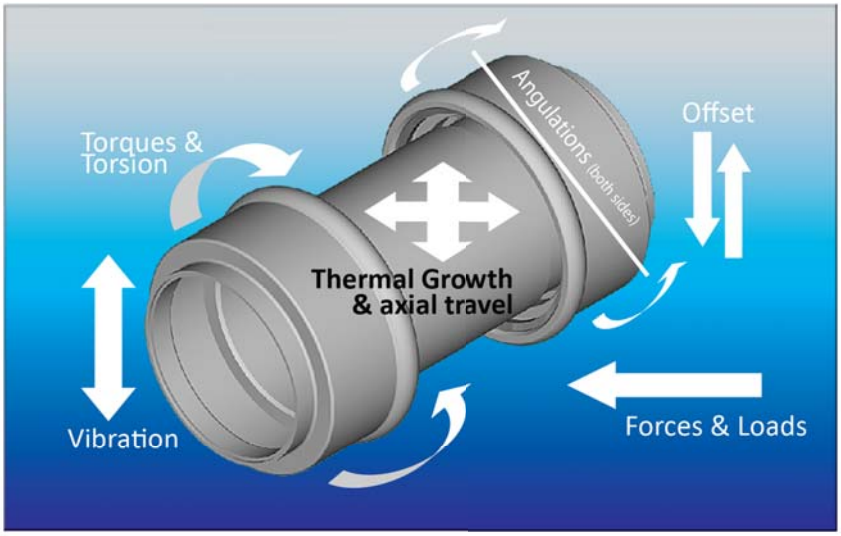

CASE STUDY:

Designing In Long Term Reliability and Fuel Efficiencies with Airtomic Ducting Solutions

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Sargent Aerospace & Defense: Designing In Long Term Reliabilty and Fuel Efficiencies with Airtomic Ducting Solutions

Sargent Aerospace & Defense is changing the model in the application of ducting technology by working with suppliers and manufacturers from the ground up. The company's goal is to multiply the benefits already being realized by its Airtomic alignment joints, angulation joints and energizing seals, through the replacement of existing bellows, joints and couplings that are based on technology that hasn't been significantly updated for 50 years.

Upgrading with Airtomic produces lower operating costs, higher efficiency and reduced time out of service for the maintenance and repair of engine, APU and airframe systems such as environmental controls, cooling systems, starter ducts, bleed air and other aircraft pneumatic ducting.

"You have parts that will consistently fail, and the customer has to respond with money or inventory," says Mike Callaway, business development manager. But operators don't have to settle for the cost of repeated downtime once they start using Airtomic products.

"When we go to our customers and explain our technology, they easily see the value," Callaway says. Once the initial coupling repair has been completed all that is needed going forward is to replace the sealing rings, in contrast with the old technology that is more labor-intensive and life-limited. "Our value proposition is different," Callaway says. "We are not in business to keep replacing couplings."

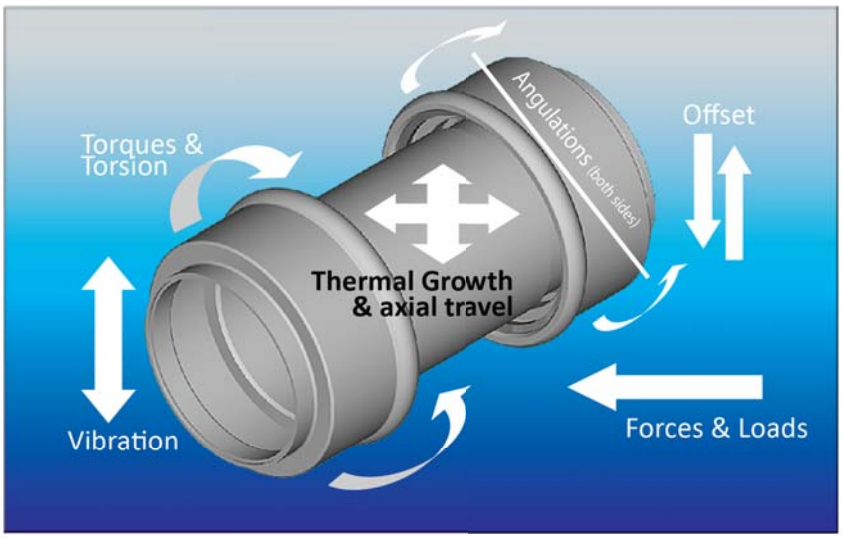
Industry Exploiting The Airtomic Advantage

Airtomic ducting technology is already used in a variety of commercial and military products. Customers include American Airlines, KLM, GE Engines, Rolls Royce and Hamilton Sundstrand. Specific applications include the CF6-80A low-temperature alignment joint in the low-pressure turbine; the CF6-50 high-temperature alignment joint in the high-pressure turbine (7th stage manifold); the low-temperature alignment joint in the Embraer EMB 145 transport's APU bleed air system, and the low-temperature alignment joint in the C-17's anti-ice system. Work is also under way on a U.S. military engine development program whose details are under wraps.

Airtomic's thermal expansion alignment joints replace standard couplings such as carbon couplings, carbon bellows, slip-flex and peri-seal housings. Its self-restraining spherical angulation joint takes the place of bellows, gimbal joints, carbon sphericals and ball joints.

The Airtomic upgrades are much more capable of handling vibration, offset, torsion and thermal growth than the outdated versions they replace—and without the risk of catastrophic failure or extended downtime for servicing. Their robust qualities result from designs that take advantage of patented PTFE (Teflon®) and metal sealing rings in place of traditional fabrications using carbon.

"Ducting wants to turn," Callaway says. "If a coupling does not allow for movement, it may stress a different part of the system, say a bracket." Airtomic's couplings, joints and seals adapt to the operational environment in a way competitors' products cannot.



Airtomic coupling materials and design permit movement and expansion in dynamic environments

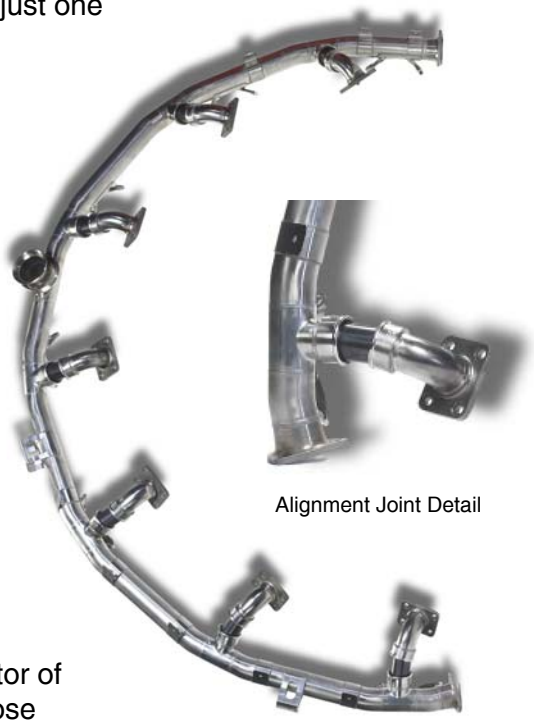
Carbon bellows are a prime example. "The materials used in our couplings won't fail between maintenance intervals," Callaway notes. "Bellows are an old design, with three to five thin layers of metal. It works great for a short period of time, but secondary devices must be added over the years as the bellows materials ultimately crack and fail. The only way to fix that is to cut the coupling off.

The repair procedures for spherical carbon joints are familiar to mechanics but require painstaking, time-consuming attention. "Carbon has to be tightly sealed to work," Callaway says. "The design uses shims to get things in place. There may be multiple iterations to get it right—you might have to leakage test and assemble two or three times, and it's labor-intensive. With our technology, you basically remove a simple retaining ring, replace the sealing rings and install a new retainer, and you're ready to go. You can do that on-wing or remove the whole assembly to do it."

The FAA acknowledged the advantage of Sargent's approach while it was addressing what eventually led to eight service bulletins over ten years on the CF6-50 seven-stage manifold. The agency issued an airworthiness directive ("AD") saying the engine had to be inspected every 250 hours to check for damage on ducting. Sargent, partnering with Pratt & Whitney's International Aerospace Tubes, presented this ducting solution to the FAA, prompting them to lift the AD, provided that the Airtomic system was used. The main part of the solution was to add three different alignment joints.

KLM is one customer who realized the value of Airtomic technology. Their engineers report a savings of $200,000 per engine in just one application due to the durability of the new couplings and eliminating the need for an OEM service bulletin that was issued to fix a design issue. Over a one-year period, KLM had replaced 71% of the couplings with the OEM carbon couplings. But after installing Airtomic alignment joints in 2006, there have been no reports of on-wing discrepancies, with units accumulating over 15,000 hours in service.

CF6-80C2 7th Stage Manifold



Alignment Joint Detail

Dynamic Response In A Stressed Environment

The company's products handle the stresses of functioning in a dynamic environment in a variety of ways. On its alignment joint, for example, a canted spring is used to reduce vibration in the joint and adjoining ducting. And unlike bellows, it can accommodate shear and offset. This affects its ability in real-world applications. Even in a brand-new design, the joints must line up exactly right. "So what will mechanics do?" asks Mike Mislan, director of operations for the Airtomic repair station. "They'll clamp those on—and as soon as you do that, you add force that shouldn't be there. Our part takes up that load and as the engine moves, the joint will adjust."

Those dynamic stresses are too often not well recognized, until parts are installed throughout an operator's fleet. The old technology that ends up being replaced by Airtomic ducting tests well for individual environmental conditions, but can't handle the dynamic operational forces for extended periods and, in some cases, such as the inability of bellows to handle torsion, isn't capable of withstanding them at all.

Another vulnerability is the loss of fuel efficiency from slowly degrading systems. A carbon sealing device might work up to 7,000 - 8,000 hours even though a crack may have developed. "The cracks in that kind of system have to be pretty bad before they do something about it," Mislan says, partly because there is no real test for it—other indicators are used, such as whether the engine is running too hot. And the result can be worse than poor fuel efficiency. With ducting supplying air to an engine-cooling case, undetected cracking has even led to fan-blade damage.

CF6-80C2 HPT/LPT Cooling Manifold

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Another example of stealthy system decay involves anti-ice ducting on wings. Some original designs allow relatively high amounts of leakage throughout the entire system using standard components. "When it comes down to it, the mechanics may just hold their hands six inches away from the part, and as long as they don't feel hot air, they're okay with it," says Smail Vila, Sargent's lead sealing system design engineer. But Airtomic ducting can provide consistently low leakage from the start, and a longer lifespan.

Airtomic energizing duct seals for peri-seal housings provide another step up from silicone seals currently in use. Its patented design, which applies force over the seal through a unique cross-section, performs its task over the life of the component. Its sealing occurs in the dynamic operating environment thanks to the design of the cross-section and canted spring, producing better sealing between overhauls and therefore improved fuel efficiency. Operators using the energizing duct seals thus enjoy a significant edge over competitors using silicone materials, which cannot handle high temperatures, have a short lifecycle and have no guarantee on how long the seal will last. Airtomic energizing seals come with a 15,000-hr Mean Time Between Overhaul ("MTBO") warranty.

CF6-50 Starter Duct

A sample of Airtomic problem-solving includes:

The General Electric – Rolls Royce F136 engine, an alternate powerplant for the F-35 – In 2010, an engineer approached Sargent with the news that eight couplings were leaking on the heat exchanger, at a rate 80% higher than what was allowable. So Sargent brought its dedicated prototype manufacturing and testing facilities into play. In six weeks, Sargent provided a new Airtomic design, produced it in another six weeks, and tested it successfully in the lab. Those couplings are now working with a leak rate 40% below specs. The system has many offsets, which the original heat seals couldn't handle as well as the Airtomic seal.

APUs on American Airlines 737s – The Allied-Signal 131-9B was having issues with a bleed and surge duct. Sargent repaired and replaced about 30 assemblies with Airtomic components. "We knew American had more," Callaway says, "but they told us they sold their additional inventory." The airline no longer needed as many backup units to keep the fleet flying. "One of their engineers told us they pressure-test these systems, and if an Airtomic coupling leaks, 'we take it out, replace the seal rings, and we never have to worry about it.'"

C-17 anti-ice system – Sargent used its facility to test a five-inch low-temperature alignment joint to MILSTD 810C, including factors such as axial movement (considering its placement through the wing) and vibration testing over 10,000,000 million cycles. In its pressure-drop test, the Airtomic coupling acted like pure ducting, with no pressure drop due to the coupling. In another part of the system, tests found the Airtomic five-inch-diameter seals—"a huge sealing surface," says Callaway—leaked less than a flange-to-flange coupling normally expected to have virtually no leakage. "Overall, I think it is a great design that will solve leakage problems of pneumatic systems, and our customer will benefit from it," said Boeing, Long Beach design engineer Scott Bui, when asked about the Airtomic solution.

131-9B Bleed Duct

Later, once the coupling was installed on the aircraft, a production mechanic at Boeing said, "Excellent, great design, but what happened to the small slip joint? Why don't you change that too?" He was referring to another small slip joint on the anti-ice system which wasn't a part of this project.

Designing Out The Risk

Sargent Aerospace & Defense now eyes getting itself in front of engine, nacelle, and airframe manufacturers, outlining the ducting solutions it can provide from the outset. "We're good firefighters," Callaway says, referring to the multiple problems it has solved for operators. But now, "we let them know we can provide the entire ducting assembly," in addition to fixing and upgrading what operators have already deployed.

The company's on-site ducting system condition simulator aids that process. The system can test to Airbus and Boeing ducting system requirements, simulating seals and coupling assemblies in maximum operating conditions of temperature, pressure, vibration and motion.

"Now, we've been talking with folks right at the beginning of the design phase, providing the solution at that point instead of responding to problems that were designed-in with the old technology," Callaway says. "Your system will be improved, you're going to get better fuel efficiency, you will have less maintenance time because it will be reliable. We offer warranties to that effect. You're not going to need to keep expensive assemblies in stock.

"You don't drive around with four tires in the trunk," he says. "What we provide is confidence."

CF6-80C2 HPT/LPT Cooling Manifold