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Aviation and the Supply Chain

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Aircraft manufacturing engineers know the value of environmental monitoring throughout the supply chain. Despite the extreme temperatures and vibrations experienced by aircraft and spacecraft during liftoffs, flights, and landings, individual components can be surprisingly sensitive during shipping and storage. These components need controlled environments to ensure they meet the tight mechanical tolerances necessary for secure flight.

For example, certain rivets used for aircraft assembly are routinely shipped at the deep frozen temperature of -40°C. The reason tracks back to a basic law of thermodynamics – metals expand when heated and contract when chilled. At -40°C, they can be installed into extremely small holes. Then, as the rivet warms, it expands, making the space ever tighter so that the riveted space is almost as strong as the surrounding area. When the rivet and the surrounding structure are of similar alloys, their coefficient of thermal expansion is virtually the same throughout a flight.

Some composite materials also may be shipped and stored at frozen temperatures. In these cases, they may have been impregnated with adhesives that begin to cure at temperatures above freezing. So, until the component is assembled, they may need to maintain sub-zero temperatures to prevent premature curing. Some sealants also must be chilled.

Impacts also are a concern. Although sensitive electronics are designed to withstand the force of landings and the vibrations that are inherent in flight, their individual components may be less rugged. They depend upon the overall device for protections. During transit, however, they may not be mounted in their final assemblies. And therefore are at risk to damage from shocks and vibrations. At this point, they are protected by packaging materials and are susceptible to damage. As aerospace engineers point out, any component can be damaged or ruined because of a drop. After a drop, a component will be evaluated, repaired and reevaluated to determine whether it is usable or is scrap, using valuable expertise and resources that otherwise could be allocated to the core mission.

These concerns increase as avionics components become lighter and smaller. Newly improved electronics, such as flight management systems and GPS devices, are designed to increase functionality and ease of use, also often feature more compact designs. Consequently, internal components are closer together and often, thinner, which makes them more susceptible to the vibrations and jolts they may experience before being mounted into the aircraft.

Drones are susceptible, too. Here, flight depends upon the GPS, receiver and responder antennae, WiFi ports, and electronic speed controllers all working together. If one system is a downed by a faulty circuit, the drone doesn't fly… at least, not for long.

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Aviation and the Supply Chain

Ground-based systems are susceptible to damage, too. The Federal Aviation Administration is installing several new systems at airports throughout the U.S., including data communications that use typed messages to augment radio communications, performance-based navigation systems that use satellites for more precise navigation, and an a new air traffic control system (called the En Route Automation Modernization project) that lets air traffic controllers track up to 1,900 aircraft at once – up from the previous limit of 1,100. Each of these systems depends upon electronic components that may be damaged in transit.

Russian Soyuz Capsule

Standards

The aviation industry flourishes through strict adherence to a plethora of federal regulations, including guidelines for procurement, environmental considerations, space transport, air worthiness, and parts certification.

While federal guidelines tend to focus on performance criteria, suppliers understand that meeting those guidelines depends upon components that meet exacting requirements during design and manufacturing and, importantly, during shipping. Consequently, the Aviation Suppliers Association developed the Quality System Standard ASA-100 to help aviation suppliers meet stringent quality requirements and become accredited suppliers. Two of the points in ASA-100 address the use of environmental controls and thorough documentation. Under this standard, suppliers are expected to monitor and document the environmental conditions experienced by their components between their facilities and their customers' plants.

Handwritten documentation, it says, is not acceptable. Instead, suppliers meeting the ASA-100 standard are expected to use systems that automatically log data, thus providing one additional assurance that the data is accurate and objective.

Spotting the Damage

In the aerospace industry, federal and industry standards have become the foundation of companies' own standard operating procedures. For manufacturing engineers, the challenge is knowing whether those standards have been maintained for each shipment, throughout the supply chain. Sometimes the damage is obvious. In 2010, for example, one of three fasteners suspending a 7 metric ton Russian Soyuz spacecraft failed as the vehicle was shipped from its Moscow manufacturing site to its launch site in Kazakhstan. The Soyuz dropped several centimeters and rolled slightly on the floor for much of the trip, damaging the heat shield attachments and displacing the capsule's axis by two millimeters.

Although monitoring may not have prevented the event causing the damage, impact or vibration monitors could have alerted carriers of the handling requirements of the shipments. With real-time alerts, those transporting the spacecraft could have known that something had happened, allowing them to take actions to prevent further damage. This Russian example exhibited obvious damage, but sometimes the damage isn't so obvious. Adhesives, for example, may pose a risk if they begin curing too early, before components are properly joined. Other chemicals may begin to separate when too cold or too warm, sometimes altering their functional properties.

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Aviation and the Supply Chain

Aerospace electronics pose another concern. Printed circuit boards, for example, may be damaged by impacts or vibrations that fracture solder joints and thin wires or damage substrates or mounting brackets.

To prioritize testing, aerospace manufacturing engineers need to know exactly what environmental conditions these components, chemicals, and adhesives have experienced, immediately when they are received. With this information, incoming shipments that may be damaged can be flagged for special attention, examined, and either accepted or rejected. This alert helps minimize the risk that hidden damage will remain hidden until the component is in use.

Monitoring

Monitoring aviation components throughout transportation and storage is an important step in ensuring their integrity. While temperature or drop-shock impact monitors provide instant, visual indications that components need additional inspection to ensure safety, more sophisticated data loggers can provide the detailed, accurate electronic records that meet regulatory requirements. Data loggers also allow procurement specialists to peer more deeply into their supply chains to identify patterns of damage and attribute that damage to specific causes, carriers, or locations. With heightened reporting requirements, data loggers offer asimple way to provide detailed, accurate information that meets regulatory requirements.

The ShockLog 298 is a highly durable impact recorder that can be custom configured to monitor critical parameters providing an unmistakable alert that an impact to a shipment or equipment may have compromised its integrity, performance, or safe operation. The ShockLog 298 monitors and records shock, vibration, and internal temperature. Additional sensors can be added to record external temperature, humidity, pressure, tilt and roll conditions. The ShockLog 298 can also be paired with either the ShockLog Cellular or ShockLog Satellite to provide real time notifications when out of tolerance conditions occur. For chemical shippers and others that are only concerned specifically with temperature, the MaxiLog Alert Temperature Data Recorders offer a cost-effective way to record temperature excursions via single-use or multi-use models. MaxiLog Alert offers simple data retrieval via built-in USV interface with direct download to software, and customization options for start time delay, sampling intervals, alarm values, and measurement data. Simple indicators, like the ColdChain Complete, WarmMark, and FreezeSafe are available with pre-defined temperature limits as well.

The aerospace supply chain is a complicated network made of suppliers throughout the world. The Boeing Dreamliner – the 787 – is a good example. Its manufacturing connects more than 450 pairs of cities. Components were shipped to Seattle and assembled at Boeing Field. The 787 may have a more complicated supply chain than many aircraft, but every plane Boeing builds relies upon multiple suppliers and multiple locations. With such a far-flung supply chain coupled with the degree of precision and accuracy to ensure safe flights, monitoring aeronautical components during shipping is good business.

Aviation and the Supply Chain

ShockLog® Cellular

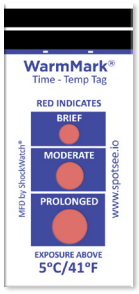
ShockLog Cellular shock recorder, adding cellular connectivity to the ShockLog 298 impact recorder, sends you a text or email whenever an impact exceeds your pre-set thresholds, anywhere there is cell service. The ShockLog® Cellular combines the powerful monitoring capabilities of the ShockLog 298 impact recorder with a cellular communication module to deliver real-time notifications of unacceptable handling in the supply chain.

ShockLog® 298

ShockLog® 298 monitors and records shock, vibration, and environmental conditions experienced by any type of structure or equipment, whether in use, in transit, or in storage. With the capacity to record data for 870 events and 262,000-time slots, the device alerts you whenever damage may have occurred so you can respond promptly. Optional sensors extend the value of your ShockLog by providing more intelligence about your environmental journey by adding temperature/humidity sensor into unit, or adding a temperature/ pressure/humidity accessory sensor.

MaxiLog Alert

SpotSee's temperature data logging solutions provide accurate recording of temperature situations for when every degree matters. With product lines that measure temperatures from-80°C to +72°C it is important to deploy the right solution for sensitive shipments like biologics, vaccines, chemicals, pharmaceuticals, food and ultra-frozen products that require temperature validation to ensure their safety and quality.



WarmMark®

WarmMark, a time-temperature indicator sticker, provides insights into your cold chain logistics so you will know which packages may have experienced thermal damage and which were handled properly. This single-use temperature recorder for shipping turns red when it reaches the temperature threshold you selected. Then, unlike many temperature indicator stickers, WarmMark starts a countdown, with its three individual indicator dots changing color for brief, moderate, and prolonged exposure.

Contact Spotsee about your supply chain and explore our best-in-class logistics devices.

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