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20-21 APRIL 2016

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GETTING SCHOOLED BY ROBINSON

Robinson Helicopter Maintenance School

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February / March 2016

BATTERY LIFE
TWO STORIES ABOUT
THE CURRENT STATE
OF BATTERIES AND
WHAT'S TO COME IN
THE FUTURE



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ON DRONES**
MARPA'S RYAN
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USE IN MAINTENANCE



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Getting Schooled by Robinson
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On the cover: Hands on experience is part of the curriculum at Robinson's maintenance school. Robinson image.



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The Wright Brothers

BY JOY FINNEGAN
EDITOR-IN-CHIEF



I read a lot and most books, while I enjoy them, don't capture my imagination or inspire awe about the subject. Every once in a while I read a book that just blows me away. I recently read such a book. It was "The Wright Brothers" by David McCullough.

I was riveted from the first page. I thought I knew a lot about these two men, Wilbur and Orville Wright, who changed our world. I mean I have been in the business all my professional life, I am an aviation history buff, have taken classes on aviation history and read numerous books about aviation history. I have visited Kitty Hawk multiple times and stood at the rails where the first flight of the Wrights took place. But I learned so much more about them, and their genius, that I had to write about this book and recommend it to anyone. Here are some of the interesting things I learned.

Wilbur became obsessed with the idea of conquering the challenge of manned, powered flight and began to read all the available documented research on the subject. The Smithsonian provided numerous books and research including the work of Louis Pierre Mouillard, who had studied the aerodynamics of birds, a method the brothers also used before building their first flyer. Wilbur also looked intently at the work done previously by Otto Lilienthal and Octave Chanute and other experts of the day. Chanute, a somewhat older, wiser contemporary, became an adviser of sorts. Initially the brothers took all the previous research as gospel.

The next remarkable thing was the idea of safety that permeated all the brothers did. As they determined that a place with steady strong wind was required for their experiments and found Kitty Hawk on the Outer Banks of North Carolina, they began building their first flying machine and transported it there in pieces.

Remember that many had died in hasty, poorly researched attempts to fly. But Wilbur wrote this while at Kitty Hawk preparing for their attempt, "The man who wishes to keep at the problem long enough to really learn anything positively must not take dangerous risks. Carelessness and overconfidence are usually more dangerous than deliberately accepted risks." He knew that to solve the problem would require a steep learning curve. To climb that curve, the brothers would need to live through their attempts. Therefore, they determined to stay low to the ground and found the soft sand of Kitty Hawk the perfect emergency landing surface.

The next point about these two brothers that hit home hard for me was that even among the rugged, hard working men and women of the remote and harsh North Carolina

coast, the Wrights were greatly admired for their work ethic. One of the locals who helped and observed them over many days said they were "'two of the workingest boys' ever seen 'and when they worked, they worked. They had their whole heart and soul in what they were doing,'" according to McCullough's book.

Of course I couldn't write about the Wright Brothers without mentioning their stroke of luck in hiring a gifted mechanic, Charlie Taylor, to run their bicycle shop while they were experimenting with flight. Little did they know when they hired him to work at their bike business, how important a role he would play in their success. When the brothers wrote to auto engine makers with specifications for their engine needs, no one could provide it. So, Charlie was tasked with making the engine to order. Without his skills, who knows what would have transpired.

Meanwhile, as their knowledge grew and experiments continued, others around the world were attempting to solve the same problem of manned flight. Notably, Samuel Langley, head of the Smithsonian Institute, had been given a grant of \$50,000 and had poured an additional \$20,000 into his attempt. In front of numerous reporters and other observers his device called "The Great Aerodrome" launched from a floating platform in the Potomac River south of D. C. It immediately crashed into the river and sank, a mere two months prior to December 1903.

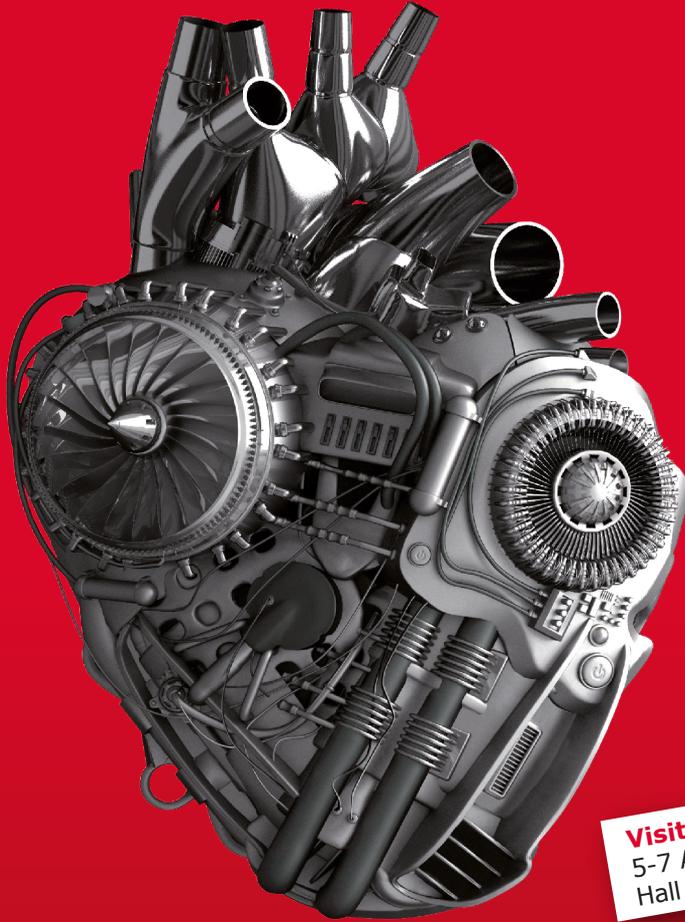
Langley was humiliated and the press were relentless in their taunts. The character of the Wright Brothers is made clear when they were asked about the flight and said the behavior of the press was "shameful" and that Langley's work "deserved neither abuse nor apology."

The most important thing the Wrights did, in my opinion, was to finally disregard the long-established research and calculations of those who came before them and were considered experts. They realized after doing their own tests, that the data of those pioneers was not correct and set out to create their own, including designing and building a wind tunnel to gather their own data.

As we all know, the Wrights made their first powered, manned flight on December 17, 1903. All in all, according to McCullough's book, they spent less than \$1000 to get there.

"The Wright Brothers" by David McCullough is full of interesting and awe-inspiring facts about these two men, who are often portrayed as hicks from Ohio who ran a bike shop. In fact, they were brilliant, focused and determined to solve the problem of manned flight. I highly recommend this book. **AM**

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Pratt & Whitney Opens First Manufacturing Facility in Singapore at Seletar Aerospace Park



L to R, Danny Di Perna, SVP Operations P&W; Bob Leduc, President, P&W; S. Iswaran, Minister for Trade and Industry; David Hess, EVP, Chief Customer Office, Aerospace, United Technologies Corp. PW images.

Pratt & Whitney opened its first manufacturing facility in Singapore, through its subsidiary P&W NGPF Manufacturing Company Singapore Pte Ltd, during the Singapore Air Show in February. The 180,000 square foot facility, located at Seletar Aerospace Park, will produce fan blades and other key components for Pratt & Whitney's new PurePower Geared Turbofan (GTF) engine family.

"Pratt & Whitney is proud of our presence in Singapore and our more than 30 years of engine overhaul and maintenance services on the island," said Danny Di Perna, senior vice president, Operations. "With the opening of this brand new state-of-the-art manufacturing facility to produce our innovative hybrid metallic fan blades and critical turbine rotating components, we are creating much needed manufacturing capacity and capability for our PurePower engine family. Over the past few years, we have invested more than \$1 billion globally to create and modernize our manufacturing infrastructure."

The company says it has about 7,000 orders/commitments, including options, from 70 customers in 30 countries, and that the facility will prove vital in supporting the GTF engine components to customers



in the Asia-pacific region. It is the second Pratt & Whitney production facility in existence to manufacture hybrid metallic blades, which are made with extremely lightweight materials.

The manufacturing facility borders the Pratt & Whitney Component Solutions (PWCS) facility, which opened in 2014 and is equipped with state-of-the-art repair capabilities. PWCS has increased its production while maintaining focus on quality and productivity. PWCS performs a comprehensive variety of engine component repairs.

Both facilities meet LEED Gold standards and Singapore's Green Mark building scheme.

"Pratt & Whitney's manufacturing investment in Singapore is a testament to our strengths in complex aerospace manufacturing," said Mr. Tan Kong Hwee, director for Transport Engineering, Singapore Economic Development Board.

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about people

Pentastar's Levangie Earns NAAA Cert



Levangie

Pentastar Aviation announced that Doug Levangie, director of Aviation Advisory Services, was recently credentialed as a Professional Certified Aircraft Appraiser by the National Aircraft Appraisers Association (NAAA). Levangie leads Pentastar Aviation's advisory services department, which provides insight on technical evaluations, aircraft pre-purchase inspections, valuation estimates and consulting for domestic and international transactions.

Levangie joins a NAAA membership made up of 250 professionals who have earned the certified aircraft appraiser designation. "Our entire team is proud of Doug for his recent accomplishment," said Greg Schmidt, president and CEO, Pentastar Aviation. "When our customers need information on aircraft transactions of any kind, Doug is always our go-to resource for advisory services. We have found that his experience – and the breadth of knowledge he brings to Pentastar Aviation – is unmatched in the industry."

The NAAA board has awarded the Certified Aircraft Appraiser designation to Levangie for demonstrating a level of competency reflected by his completion of a rigorous four-day hands-on training class. In addition to earning the NAAA Certified Aircraft Appraiser designation, Levangie is also pursuing the NAAA Senior Aircraft Appraiser certification. "We are pleased to welcome an aviation professional of Doug's caliber to NAAA," said Brian Jacobson, NAAA president. "Doug has the extensive experience we require to achieve the senior level certification and we look forward to offering him our continued support in that endeavor."

Constant Adds Witt as VP



Witt

Constant Aviation announced the addition of Paul Witt to their organization as vice president, AOG Operations. Witt joins the team with more than 20 years of experience in the aviation industry. Prior to Constant Aviation, he worked for Stevens Aviation serving as general manager and executive vice president of Operations. He has been involved with all facets of the industry, including responsibilities as lead maintenance technician, inspector, maintenance manager, customer service representative, general manager, and vice president of operations.

"We launched our dedicated AOG teams eighteen months ago. Since inception, the team has doubled in size, and we have expanded our network of hubs. The addition of Paul as vice president of AOG Operations provides >>>

ARC Completes Dual FMS Installations for tGNSS/WAAS & RNP



ARC Avionics Corporation (ARC) announced completion and delivery of a B737-400C as avionics-compliant for EASA-SESAR operations. ARC, as Universal Avionics integrator, has installed STC - ST03662AT for dual UNS-1Fw FMS and future UL-801 DataLink capability. Commercial Jet (KMIA) has installed an 11-pallet AEI cargo door and floor conversion as new NextGen DHL freighter conversion delivered to CarGOAir of Sofia, Bulgaria.

In accordance with NextGen and SESAR mandates, SN 24773 is the seventh B737 aircraft upgraded in a fleet of cargo freighters delivered to Bulgarian-based CarGOAir. Meanwhile, ARC has installed more Universal FMS in Boeing aircraft than any other EASA or FAA Engineering Repair Station. ARC's SN 24773 upgrades include new Universal Dual; full LPV approach-coupled autopilot capability, panel annunciation and EFIS symbology; TrueNorth Avionics; dual Enhanced Mode S transponders, upgradeable for 2020 planning to ADS-B; 18 to 31 parameter Digital Flight Data Recorder (DFDR) upgrade; Digital Cockpit Voice Recorder (DCVR) and Fixed 406 Mhz ELT upgrades.



CarGOAir's NextGen and SESAR compliant freighter is ARC's 29th Universal Avionics upgrade on Boeing 737s completed at locations in Florida and Canada with many customized for European and VIP global operators.

ARC Avionics is an EASA/FAA 145 Engineering Repair Station with PMA kit building capabilities to support 12 STCs for Boeing airliners with NextGen and SESAR compliance toward future mandates.

Boeing Wins Presidential Aircraft Contract

The Boeing Co. has been awarded a \$25,776,011 cost-plus-fixed-fee contract for Presidential Aircraft Recapitalization Program Phase 1 Pre-Milestone B activities. They will conduct activities aimed at improving affordability and reducing program execution risk. These activities will include the definition of detailed requirements and design trade-offs required to support informed decisions, leading to a lower-risk engineering and manufacturing development program and lower life-cycle costs.

Work will be performed at Seattle, Wash. and Everett, Wash., and is expected to be complete by April 21, 2017. This award is the result of a sole-source acquisition. Fiscal 2015 research and development funds in the amount of \$7,435,326 are being obligated at the time of award. Air Force Life Cycle Management Center, Wright Patterson Air Force Base, Ohio, is the contracting activity.

Last Bolt Ceremony for GE9X Held at MTU Aero Engines



Celebrating their team are (from left to right): Dr. Jörg Henne, Senior Vice President Engineering and Technology at MTU Aero Engines, and Theodor Pregler, Senior Vice President Commercial Programs, at the last bolt ceremony for the GE9X TCF in Munich.

MTU Aero Engines in Munich has completed the first development turbine center frame (TCF) to go into the GE9X engine. The company celebrated with a "Last Bolt Ceremony."

"In this engine program, we are not only responsible for the manufacture of the TCF, but also assumed responsibility for its development right from the outset," explained Dr. Jörg Henne, SVP Engineering and Technology, at the last bolt ceremony held in Munich in late January. "To make the deadline, we have completed the first GE9X TCF within record time," according to Theodor Pregler, SVP Commercial Programs at MTU in Munich.

The new GE engine has been selected to be the propulsion system for the Boeing 777X. Delivering more than 100,000 pounds of thrust, the GE9X will be the most fuel-efficient engine ever produced by GE Aviation on a per-pounds-of-thrust basis. MTU says the schedule is as follows: The first run of the engine is slated for this spring, and entry into service is expected for 2020. To date, there are firm orders for more than 300 of the aircraft.

Said Pregler: "We have a stake of four percent in the GE9X program. This secures MTU a significant market share in one of the most important next-generation engines in the upper thrust category." Long-haul commercial transports are considered a rapidly growing segment of the airliner market that is only moderately exposed to economic fluctuations. Taken over the entire life of the GE9X, MTU expects the program to generate revenues in the amount of some four billion euros. The TCF for the GE9X is the most highly sophisticated turbine center frame in MTU's portfolio from a technology point of view. "Starting from the basic architecture of the TCF for the GENx, we've made some comprehensive optimizations," reported Henne. These improvements include enhanced constructions and a new suspension concept for the first LPT vane."

about people

» Constant Aviation a unique opportunity to enhance our overall structure and bandwidth," said Stephen Maiden, president/CEO. "Paul's experience, knowledge and skill set will have an immediate impact on this division and his addition will enable our team to become the largest nationwide AOG provider."

Leitschuck Joins Duncan Aviation Completions Team

Duncan Aviation has added Brian Leitschuck to its Paint and Interior Completions Sales Team. Leitschuck will work with Hawker and Citation operators at the company's Lincoln, Neb., location Leitschuck joined Duncan Aviation in 1999 as a weekend shift interior completions specialist renovating and refurbishing the inside of business aircraft.

Ten years later in 2009, he moved to Engineering as a liaison for the Dassault Falcon 7x Engineering program. In this role, he worked with both the Engineering and production teams facilitating communications, assisting with design elements and interior commodities before transitioning into a design engineering role. In 2013, Leitschuck became a design engineer for Gulfstream in Wisconsin, but returned to Duncan Aviation in 2015 to assume his current position on the Paint and Interior Sales team.

"Brian brings years of experience in aviation, engineering and customer service to the team," says Nate Klenke, Interior Completions Team leader. "His knowledge and years of understanding the complexities of aircraft interiors and design elements will serve both our team and our customers well as he takes on this new role."

ATR Appoints New SVP Engineering



Amendola

Alessandro Amendola has been appointed as new senior vice-president Engineering of ATR. He will be responsible for all the engineering activities related to the fields of certification and airworthiness, customization, systems and propulsion, structures, flight tests, flight technologies, support, and quality, processes and methods.

He will also closely work with the Programs directorate, providing engineering support and solutions in the definition of new aircraft developments. He will report to ATR's CEO, Patrick de Castelbajac, and will sit on the Executive Committee. He replaces Carmine Orsi.

He is a graduate of the Federico II University of Naples (Italy) with a degree in aeronautical engineering.



about people

Sun Air Jets Announces New Director of Maintenance

Sun Air Jets announced the addition of Rob Cox to their Senior Executive and Maintenance Management team. Rob will fill the role of vice president and director of maintenance.

Cox has more than 23 years of experience with virtually every type of business aircraft manufactured. He served as California Air National Guard Crew Chief on the C-130 Hercules aircraft and has served as a technician, supervisor, RII inspector, chief inspector, and director of maintenance for multiple operators in Southern California, including Part 135 and Part 91 operations. He has also acted in the same capacity for Part 145 repair stations.

"In our ongoing efforts to operate the finest and safest charter management company in the world, adding Rob to our maintenance department enables us to offer our aircraft owners and charter customers a level of experience, safety, and professionalism that is second to none," says Brian Council, Sun Air's president.

Volga-Dnepr Appoints New Global Director Aerospace

Volga-Dnepr Airlines has announced the appointment of the Aerospace global director to spearhead the continued growth of its transport and logistics solutions with customers in the Aerospace sector.

Axel Kaldschmidt has been appointed global director, Aerospace Industry. Aerospace customers account for 30 percent of Volga-Dnepr's annual business and since its launch, the airline has operated over 5,250 flights for customers in the industry, delivering nearly 175,000 tonnes of cargo such as satellites, helicopters, aircraft and parts. Kaldschmidt will be based in the company's U. S. headquarters in Houston, Texas.



Kaldschmidt

Dublin Aerospace Appoints Tyrrell as CEO

Dublin Aerospace has appointed Michael Tyrrell as the CEO. With more than 20 years' experience in airline MRO, Michael joins the company from Vector Aerospace where he has been the managing director of the UK division since 2011. In 1995 Tyrrell joined TEAM Aer Lingus as the commercial manager for their Aircraft Overhaul Division. At Team Aer Lingus he led areas including Outsourcing, APU, Component, and Landing Gear departments and was GM of the Aircraft Overhaul Division. Tyrrell holds a Bachelor of Commerce Degree from University College Cork, an MBA from Dublin City University and is a Fellow of both the Chartered Institute of Management Accountants and the Royal Aeronautical Society. >>>

Pentastar Awarded STC for Hawker 800XP/850XP Wi-Fi

Pentastar Aviation has been issued FAA STC ST04055CH for certification of compatibility of wireless data technologies on Hawker 800XP and 850XP series aircraft. This STC allows operators to approve the use of portable electronic devices onboard aircraft with wireless networks or Wi-Fi hot spots for their passengers.

The FAA certification of these two aircraft by Pentastar's avionics team, allows the use of transmitting portable devices for activities such as email, talk, text and video conferencing without interfering with flight-critical aircraft systems. It also compliments previous Pentastar STC's issued for Wi-Fi Compatibility on Gulfstream Aerospace G-IV and GV series aircraft.

"We continuously look for ways to ensure our customers' aircraft is updated with the most innovative technology available in the industry," said Greg Schmidt, Pentastar president and CEO. "For decades, we have contributed our technical expertise to the development of STC's. Our vast experience with aircraft avionics enables us to develop and obtain these STCs, which provide us the flexibility to install cabin connectivity systems from any manufacturer."

Gulfstream Airborne Support Completes 5000th Mission



Gulfstream recently completed its 5,000th airborne support flight, 13 years after Gulfstream launched business aviation's first airborne maintenance and support service in May 2002.

The Gulfstream Field and Airborne Support Teams, known as FAST, use two dedicated aircraft to deliver flight-essential parts and technicians to operators in North America, Central America and the Caribbean. The service, which has accumulated more than 16,600 flight hours and eight million nautical miles since its inception, operates 24 hours a day, seven days a week.

In the case of airborne mission No. 5,000, FAST pilots Ty Ung and Shanon Baker departed Savannah to deliver a section of an engine bleed air duct to a G450 at its home base at Illinois' Waukegan National Airport, which is approximately 45 miles north of Chicago. The G450 made its scheduled flight the next morning.

"Returning an aircraft to service with minimal downtime is what FAST is all about," said Derek Zimmerman, president, Gulfstream Product Support. "It takes a tremendous effort to pull off a swift, well-coordinated response to operators whose aircraft are unexpectedly grounded as a result of needed parts or technical assistance. FAST members have consistently met the challenge and continue to find ways to improve on what they do."

Zenith Signs Distributor Agreement with Hutchinson, Barry Controls

Zenith Aviation has been appointed a fully authorized distributor for Hutchinson Aerospace and Barry Controls Aerospace. The agreement allows Zenith to represent Hutchinson's full line of vibration isolators, engine mount systems, APU mounting systems, electrical harnesses, and other engine components for the full line of commercial, regional, and general aviation aircraft.

Zenith and Hutchinson can now offer customers new, exchange, overhauled and repaired parts to meet all customer requirements the two companies say. PMA mounting parts are also available for non-Hutchinson OEM mounts.



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All Metal Designs Platforms for Columbia Helicopters

All Metal MS delivered a customized line of Fall Protection Platforms to Portland, Ore.-based Columbia Helicopters. All Metal developed the concept of designing an adjustable Fall Protection Platform, for both the BV107/CH-46 and BV234/CH-47, which supports the aircraft with a platform crafted for specific functionality of fall protection. The mechanics and crews utilizing the platforms have touted the adjustability of the platforms to fit any configuration/angle of the aircraft is its most job friendly feature. The platforms were designed for use when performing both routine maintenance and complete overhauls.

In March, All Metal began working alongside Columbia Helicopter's team to design a Fall Protection Platform that was cost effective and more functional than other industry fall protection devices. Fall Protection Platforms differ from maintenance stands because they act more like a safety net when a mechanic is required to physically work on the aircraft, says All Metal.

"I continuously get thanked by our technicians, which is rare," says Oscar Acevedo, Hangar Operations manager, Columbia Helicopters. "With these new platforms the mechanics and leads are actually trying to justify why they need the platforms more on their project/aircraft."

Johnny Buscema, All Metal president and CEO, adds: "Designing platforms that are easily mobile, provide versatility for various aircraft, and can contour around aircraft accessories while overcoming the obstacles of hangar space, was a goal we are quite proud to have accomplished. We here at All Metal take pride in assuring that our Fall Protection Platforms provide the highest level of safety, efficiency, quality, and functionality for our clients."

Bombardier and PSA Extend Heavy Mx Agreement for CRJs

Bombardier announced that Bombardier Services Corporation and PSA Airlines have signed a heavy maintenance agreement that extends the current agreement between the parties by two years. Under this contract, all heavy maintenance tasks for the airline's fleet of CRJ200, CRJ700 and CRJ900 aircraft will be performed at Bombardier's West Virginia Air Center.

PSA recently added its 100th CRJ Series aircraft — a CRJ900 regional jet, delivered during a ceremony held at the Bombardier facility in Mirabel, Québec. The aircraft will be operated for American Airlines, under the American Eagle regional brand.

"Bombardier's CRJ Series aircraft are an essential part of PSA Airlines' growth, as we become one of the largest regional service providers for American Airlines," said Kevin Reinhalter, VP Maintenance and Engineering, PSA Airlines. "As the manufacturer of the aircraft, Bombardier's expertise in maintaining our all-CRJ regional jet fleet helps us deliver on our commitment to transport satisfied customers to their destinations safely and on time."

Titan Introduces New "LuxPro" Fiberoptic Light System

Buffalo, New York-based Titan Tool Supply has introduced a new fiberoptic illuminator that brings sustainability, performance, efficiency and convenience to users of illuminated borescopes and microscopes, according to the company.

Following in-use testing of its new LuxPro LED Fiberoptic Light System, Titan Tool President Frank Menza highlighted several key benefits such as the LuxPro offers a complete payback in less than two years compared to quartz halogen fiberoptic illuminators and a continued return on energy costs, bulb replacement and maintenance costs in replacing lamps. He emphasized the efficiency of the LuxPro as it exceeds the brightness of a 150-watt halogen bulb while reducing energy consumption by approximately 50 percent.

The new LuxPro illuminator features linear light intensity control with continuous dimming and accepts virtually any light guide with quick change adapters, the company states. It provides consistent color temperature (cool white 4500 K) and is equipped with a standard 0.625" light guide fitting (nosepiece). Since Titan Tool can supply an adapter for virtually any size diameter fiberoptic cable from 0.187" to 1.0" (including Fostec 0.718" and ACMI), customers can use their current fiberoptic guides and ring lights.



Atlanta, Georgia-Based The Bird Craft Grows

The Bird Craft, based at Fulton County Airport in the Atlanta, Georgia metroplex, is expanding. The mobile maintenance provider offers business jet and helicopter operators an option for dispatch maintenance, servicing aircraft and pre-accessed maintenance functions.

"We provide the personnel and tools needed, service scope depends on the customer's setting," says owner Joshua Jones. The Bird Craft provides maintenance inspections, additional manpower, post flight inspection and departure and arrival assistance.

The most recent addition to their portfolio of offerings will be a new computerized testing facility. They will offer all 18 FAA exams. "We have passed our inspection and are waiting on final approval," Jones says. He says they are ready to begin testing as soon as the FAA sends the approval. Jones can be reached at 678-517-0766.

SNAP-ON's ControlTech Steel Industrial Electronic Torque Wrench Reaches Minimal Clearance Areas



Snap-on Industrial's ControlTech (CTECH) Steel Industrial Electronic Torque Wrench now comes with interchangeable ISO/IZO wrench head models, giving the tool added flexibility to be used on a variety of applications in the industrial, power generation and aviation industries, the company says.

The two interchangeable wrench head models, insert ring and open ended, are ideal for use in minimal clearance areas. Technicians can select up to 23 open ended models in sizes between 7mm to 19mm 9 x 12, and select sizes between 13mm and 32mm 14 x 18. Insert ring sizes range between 10mm to 19mm 9 x 12, and select sizes between 13mm and 32mm 14 x 18.

Designed for repeated use, the CTECH is a lightweight, durable and reliable torque wrench for technicians. The weight is comparable to mechanical click-type torque wrenches, yet the CTECH provides instant data on the exact torque actually applied – something mechanical wrenches can't do.

The wrench is fully programmable with data download capabilities, has sequence programming and job mode functionality and built-in indicator alerts user when calibration is due.



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 - Software and Embedded Systems Workshop
- Certified Training Courses by leading experts on safety critical software/computer systems and certification.
 - Understanding, Designing, Simulating, and Testing: Complex ARINC 818 Systems
 - Understanding & Applying DO-178C and ARP-4754A
 - Understanding & Applying ADS-B
- Free to attend Exhibitor Workshops full of technology updates

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SCHEDULE OF EVENTS

REGISTRATION HOURS

Tuesday 19 th April 2016	2:00pm	-	5:00pm
Wednesday 20 th April 2016	8:00am	-	7:00pm
Thursday 21 st April 2016	8:00am	-	5:00pm

EXHIBITION OPENING HOURS

Wednesday 20 th April 2016	10:30am	-	7:30pm
Thursday 21 st April 2016	9:30am	-	5:30pm

MAIN CONFERENCE PROGRAMME

WEDNESDAY 20TH APRIL 2016

9:00am	-	10:30am	Opening Keynote
10:30am	-	11:00am	Networking Coffee Break
11:00am	-	12:30pm	SESAR & Next-Gen Update
12:30pm	-	2:00pm	Delegate Lunch
2:00pm	-	3:30pm	CNS Enabling Operational Efficiency
3:30pm	-	4:00pm	Networking Coffee Break
4:00pm	-	5:30pm	ADSB Updates - today and tomorrow!
5.30pm	-	7.30pm	Networking Reception on Exhibition Floor hosted by Ministry of Economic Affairs

THURSDAY 21ST APRIL 2016

9:00am	-	10:30am	Standardisation & Certification
10:30am	-	11:00am	Networking Coffee Break
11:00am	-	12:30pm	Cyber Security & the e-Enabled Aircraft
-	-	-	-
12:30pm	-	2:00pm	Delegate Lunch
2:00pm	-	3:30pm	Satellite Based Solutions for CNS
3:30pm	-	4:00pm	Networking Coffee Break
4:00pm	-	5:30pm	Innovations in Avionics

TECHNICAL WORKSHOPS PROGRAMME

WORKSHOP ONE

Wednesday 20th April - 11.00am- 3.30pm
Standardisation & Certification Workshop

WORKSHOP TWO

Thursday 21st April - 9.30am-12.30pm
Future Avionics, Cyber Security & eEnabling Workshop

WORKSHOP THREE

Thursday 21st April - 2pm-4.30pm
Software and Embedded Systems Workshop

CERTIFIED TRAINING COURSES

Wednesday 20th April 2016 - 9.00am-4.00pm
Understanding, Designing, Simulating, and Testing: Complex ARINC 818 Systems

Wednesday 20th April 2016 - 11.00am-5.30pm
Understanding & Applying DO-178C & ARP-4754A

Thursday 21st April 2016 - 10.00am-4.30pm
Understanding & Applying ADS-B

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3. Fax to +44 (0) 208 090 6211
4. Call +44 (0) 1704 621057
5. Mail to Aviation Electronics Europe, 1 Coyners Avenue, Southport, Merseyside, PR8 4SZ, UK

MAIN CONFERENCE PROGRAMME

WEDNESDAY 20TH APRIL 2016

9:00am - 10:30am

Opening Keynote

Gzim Ocakoglu, Policy Advisor, European Commission/DG MOVE
Friedhelm Runge, Chief Expert Avionics and Electrical Systems, European Aviation Safety Agency
Sven Kutschera, Lufthansa Airlines
Chair: Mark Holmes, Editor, Avionics Magazine

SESAR & Next-Gen Update

Europe's Single Sky (SES) and the US Next-Gen initiatives continue to be the fundamental drivers in the aerospace sector for enhanced safety and communication in an ever increasingly busy sky. The introduction of the SESAR Deployment Manager sees the programme begin to deliver and be deployed across platforms. This session provides an update on the SES and Next-Gen programmes including the main operational challenges and the technical enablers for SES deployment and integration with ATM, from the commercial airline and business jet perspectives.
Chair: Christian Schleifer, Secretary General, EUROCAE

Implementing the Future Air Transportation System

Rick Heinrich, Director, Strategic Initiatives, Rockwell Collins

SESAR Deployment: catalyst for European ATM modernisation

Nicolas Warinsko, Deputy Managing Director and Director Technical and Operations, SESAR Deployment Manager

Airbus Avionics Roadmap

Thomas Maier, Senior Manager CNS/ATM, Airbus

TBC

2:00pm - 3:30pm

CNS Enabling Operational Efficiency

Aeronautical communications, navigation, and surveillance (CNS) systems are key to the delivery of safe and efficient air traffic management. What are the latest concepts and developments in enhancing the CNS operations for more efficient and safer sky? Can 4D provide greater insight into optimising efficiencies?

Chair: John McHale, Editorial Director, Avionics Design / Military Embedded Systems

ILS Multipath Passivation

Nicolas Marconnet, Radio Navigation System Leader, Airbus Operations SAS

Airbus xLS Concept: from ILS to SLS

Frederic Belloir, Manager Navigation System – Systems sales and Marketing, Airbus SAS

Flights 4D trajectories routing over North Atlantic optimizing airlines costs and climate impact: the Reac4C modeling approach

Thierry Champougny, Expert Airspace Modeling, EUROCONTROL, TBC

Senior Representative, Boeing*

4:00pm - 5:30pm

ADSB Updates - today and tomorrow!

Allowing air traffic controllers to route traffic more efficiently, reducing congestion, noise, emission and fuel consumption, ADS-B promises to keep our skies safer by enhancing situational awareness. What is the latest blue sky thinking and architectural challenges in ADS-B In and ADS-B Out towards meeting the 2020 mandate?

Chair: Bob Darby, IET Aerospace Network

Friedhelm Runge, Chief Expert Avionics and Electrical Systems, European Aviation Safety Agency (EASA)

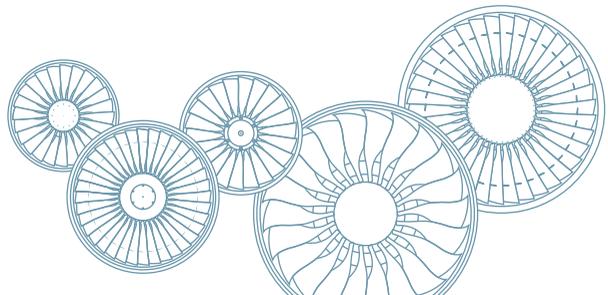


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Roland Mallwitz, Head of Surveillance, DFS

Johan Martensson, Surveillance Expert, EUROCONTROL

Retrofitting the industry for ADS-B

Arnold Oldach, Director Product Marketing ACSS, L-3 Aviation Products

THURSDAY 21ST APRIL 2016

8:30am - 10:30am

Standardisation & Certification

With the necessity for all systems and software design developed to be fit for purpose and support the deployment of SESAR and Next-Gen, we explore the latest approaches, analysis and implications in compliance and what the latest in standards and certification mean to developers, solutions providers and end users.

Chair: Peter Green, EUROCONTROL

Avionics Standards Update

Christian Schleifer, Secretary General, EUROCAE

Airbus A350XWB - RNP AR architecture

Frederic Belloir, Manager Navigation System – Systems Sales & Marketing, Airbus SAS

Technical Standard Orders (TSO) Certification Considerations in China for Integrated Modular Avionics (IMA) Hardware Elements

Frank Xiao, Certification Engineer, Aviage Systems

COTS & Safety Certifiability in the Military and Aerospace Industry

Gregory Sikkens, Senior Product Manager, Graphics, Safety Certifiable & ARM Single Board Computers, Curtiss Wright Defence Solutions

11:00am - 12:30pm

Cyber Security & the e-Enabled Aircraft

Cyber security is on the lips of every industry discussion and aerospace and avionics industry is no different. The alleged hacking of MH-370 causes major concern for the industry, and with high-profile cyber attacks on government agencies. With the aircrafts becoming more connected and wireless communications increasing in the cabin and cockpit, how can we ensure we make the aircraft secure and skies even safer from potential attack? Can we learn from other infrastructure sectors that have equally difficult challenges in cyber security?

Chair: Philippe Lievin, Rockwell Collins

Matt Shreeve, Technology Policy Expert, Helios

Aviation : the corner case for Digital Security

Ravi Nori, Sr Avionics Security Systems Subject Matter Expert (SME), Teledyne Technologies Incorporated

eEnablement? It's about data, not devices

Markus Gilges, VT Miltope

2:00pm - 3:30pm

Satellite Based Solutions for CNS

The eConnected aircraft and wireless communications require the increasing use of satellite technologies to fulfil services. What are the latest space based solutions and applications that can make ADS-B and the avionics systems more efficient in communication with ATM and enhance the increasing demand for passenger based communications.

Chair: Mark Holmes, Avionics Magazine & Via Satellite Magazine

Franca Pavlicevic, EUROCONTROL*

Communications for Passengers

Guy Christiansen, ViaSat

David Coiley, Vice President Aviation, Inmarsat*

Combined LTE-based ground network and satellite network

Stefan Wimmer, Deutsche Telekom

Senior Representative, Honeywell

4:00pm - 5:30pm

Innovations in Avionics

What innovations and concepts are around the corner that could soon become part of today's development in avionics. What are the future technologies and latest thinking in concepts for safer, more cost effective skies? How can the increasing demand for wireless be utilised in enhancing avionics?

Chair: Alex Wilson, Wind River

Towards Reliable, Secure, Wireless Avionics Networks

Luke Bolton, Advanced Technology Project Manager, GE Aviation Systems

Enhancing Avionics by Wireless

Patrik Moravek, R&D Scientist, Honeywell

Evolution of Integrated Modular Architectures: Cross-Industry Perspective

Mirko Jakovljevic, TTTech

Barriers to Increasingly Autonomous Systems in Civil Aviation

Nicholas Bloom, Technical Fellow, Rockwell Collins

For further details and updates on the Main Conference Programme and to register online visit www.ae-expo.eu/programme.



CERTIFIED TRAINING COURSES

Aviation Electronics Europe will deliver two Certified Training Course.

Three one-day courses, enabling you to gain enhanced levels of specialist knowledge, will take place during the two days of Aviation Electronics Europe and cover:

- **Understanding, Designing, Simulating, and Testing: Complex ARINC 818 Systems**
- **Understanding & Applying DO-178C & ARP-4754A**
- **Understanding & Applying ADS-B**

Wednesday 20th April 2016 - 9.00am-4.00pm

Understanding, Designing, Simulating, and Testing: Complex ARINC 818 Systems

ARINC 818, the Avionics Digital Video Bus, has been adopted worldwide as the video bus of choice in both commercial and military aircraft cockpits. It is used not only in mission computers, video processors, MFDs, PFDs, HUDs, HMDs, but also as a sensor interface. Updates in ARINC 818-2 accommodate operational speeds up to 28 Gb/s. It is also gaining as the standard for high-speed sensors, including both IR and visible-light sensors.

This hands-on workshop will provide a deep dive into the ARINC 818 protocol, and its applications. It is appropriate for system architects, avionics engineers and production test engineers.

Only 75 Places are available on these Certified Training Courses, so book your place today at www.ae-expo.eu. Further details can be found at www.ae-expo.eu/certified-training.

Wednesday 20th April 2016 - 11.00am-5.30pm

Understanding & Applying DO-178C and ARP-4754A

- Understanding ARP-4754A for Avionics Systems; now required for almost all aircraft and avionics
- Applying DO-178C to modern avionics software system development
- Understand the relationship between DO-178C and ARP-4754A, the new "Avionics Development Ecosystem"
- Understand the differences with DO-178B and DO-178C's best practices
- Understand and apply DO-331 Model Based Development, DO-332 Object Oriented Programming, and DO-330 Tool Qualification in a DO-178C environment
- Controlling engineering cost/risks with DO-178C & ARP-4754A
- Understanding and avoiding the top 15 mistakes with DO-178C & ARP-4754A
- Applying best practices within DO-178C & ARP-4754A

Attendees will put this all together in a fast paced training to "truly" understand how to understand and apply the new DO-178C & ARP-4754A standards for the real world: THEIR WORLD!

Thursday 21st April 2016 - 10.00am-4.30pm.

Understanding & Applying ADS-B

- Understanding ADS-B (Automatic Dependent Surveillance – Broadcast) for Avionics Systems; now required for almost all aircraft
- Background and technical context of ADS-B; what is really involved
- Ins and Outs of ADS-B: how to leverage ADS-B "In" and ADS-B "Out" in avionics solutions
- Why is ADS-B mandatory, and what are costs versus benefits?
- Today's versus Tomorrow's ADS-B solutions: how will avionics evolve for ADS-B?
- Top ADS-B development risks and how to certify ADS-B for EASA & FAA
- Applying ADS-B Best Practices

Attendees to "Understanding & Applying ADS-B" will gain the information they need to truly understand the "Ins" and "Outs" of the new mandatory ADS-B capability.



TECHNICAL WORKSHOPS PROGRAMME

WORKSHOP ONE

Wednesday 20th April - 11.00am- 3.30pm

Standardisation & Certification Workshop

- 11.00am How Hypervisor OS can cope with Multi-core Certification Challenges - Sven Nordhoff, SYSGO
- 11.30am Reducing administrative overhead for DO-178C code coverage - Andrew Coomes, Rapita Systems
- 12.00pm Reaping the benefits of Reusable Software Components - Mark Pitchford, Lynx Software
- 2.00pm Building Application and System Resilience in a Multi-Core Computing Environment Managing Avionics - Patrick Huyck, Green Hills Software
- 2.30pm Safety Certification for Unmanned Aircraft - David Barnett, Real Time Innovations
- 3.00pm Open System Architectures and COTS reduce risk and project schedule for safety critical avionics applications - Yves Mathys, CES – Creative Electronic Systems S.A.

WORKSHOP THREE

Thursday 21st April - 2.00pm-4.30pm

Software & Embedded Systems Workshop

- 2.00pm Managing Software Quality in an Aerospace Support Centre - Richard Borcz, Airbus Helicopter
- 2.30pm The Benefits of Data Driven Modeling in HMI Display Design - Raymond Niagaris, ENSCO Avionics
- 3.00pm The impact of design constructs on testing of high-integrity FPGAs - Matthew Noonan, Resource Group Embedded Systems & Solutions
- 3.30pm Which Bus Should I Get On? - Tim Keller, Great River Technology
- 4.00pm The challenges of developing embedded real-time aerospace applications on next generation multi-core processors - Paul Parkinson, Wind River

WORKSHOP TWO

Thursday 21st April - 9.30am-12.30pm

Future Avionics, Cyber Security & eEnabling Workshop

- 9.30am Aircraft Controllability & Primary Flight Displays - Knut Lande, LandAvia
- 10.00am Modular and Scalable Satellite Avionics based on COTS - Hans-Juergen Herpel, Airbus DS GmbH
- 10.30am Big Data Analytics for Improving Aircraft Navigation Algorithms - Matteo Dell'Amore, TXT Group
- 11.00am A New Platform to Study the Correlation between Aging and SEE Sensitivity for the Reliability of Deep Submicron Electronics Devices - Marc Gatti, Thales Avionics
- 11.30am Advanced backlights for LCD cockpit displays - Jaap Groeneweg, NLR and Stefan Carton, NDF Special Light Products
- 12.00pm Future Avionics Model-Based Design workflows that satisfy DAL-A requirements while minimizing engineering efforts - Albert Ramirez Perez, MathWorks

For further details on the Technical Workshops Programme and to register online visit www.ae-expo.eu/workshops-programme.



RAES/DGLR WORKSHOP

Wednesday 20th April - 11.00am-5.00pm

Chair: Dipl.-Ing. Gerhard Henselmann, FRAeS Chairman RAeS Munich Branch

German AirForce/ Bundeswehr: "Reflecting future scenarios for airborne support, based on UAV/RPAS relevant to satisfy the user requirements".

IET/ Airbus Defence&Space Dr. Alistair Munro, Senior Expert Studies and Innovative Concepts: "Standards and Regulation for RPAS – Update on Communications and Security".

DGLR/ University of Bundeswehr Munich, Faculty for Aerospace, Flight Systems Institute, Prof. Dr.-Ing. Axel Schulte: "Human-System Integration Issues in UAV Mission Management".

DGLR/ Techn. University of Munich, Aerospace Faculty, Institute of Helicopter Technology, Prof. Dr.-Ing. M. Hajek: "Design and Test of a High Altitude Rotary Wing UAV".

RAeS/Syrphus GmbH: "EASA's new Operation Authorization Process using examples of different mission types".

DGLR, RAeS/ R.STEMME UAS GmbH: "News from STEMME SK202 Geoexplorer – airborne system for surveillance tasks".

RAeS/ ELETTRONICA SpA: "The mini ISR solution for UAVs in swarm flying".

For further details and workshop programme visit www.ae-expo.eu.

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The event will also deliver a range of Exhibitor Presentations and Micro Workshops with many of the companies participating providing an enhanced level of activity to engage visitors and delegates.

- Discover new and latest technologies and solutions in Avionics and Aviation Electronics
- Network with the international avionics community in a great environment

List of Exhibitors (at 15th February 2016):

- AES Aerospace Embedded Solutions GmbH (AES)
- Aerospace Manufacturing
- Aitech Systems Ltd
- Aircraft Systems & Manufacturing (ASM)
- AVIAGE SYSTEMS
- Aviation Maintenance Magazine
- Avionics Magazine
- Avionics Today
- bavAIRia eV
- CES
- Core Avionics / Channel One
- COTSWORKS
- Curtiss Wright
- DAC International
- DGLR Munich
- dSPACE
- EBAS
- EUROCONTROL
- Great River
- Green Hills Software

- Honeywell
- The HR Smith Group of Companies
- Institution of Engineering & Technology (IET)
- Interface Concepts
- ICG / Rockwell Collins
- L-3 Aviation Products
- Liebherr Components
- Lynx Software Technologies
- Mathworks
- mbs
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- MICCAVIONICS
- Northrop Grumman LITEF GmbH
- Presagis
- Rapita Ssstems
- Rockwell Collins
- Rotor & Wing Magazine
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- Rapita Systems
- SYSGO
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- Teledyne
- TTTech
- (UN)MANNED
- Vector Informatik
- VEROCEL
- Wind River

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For further information on exhibiting and sponsorship contact:
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✉ pmpcherson@aerospace-media.com

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Exhibitor Workshops

A range of **FREE TO ATTEND** workshops by leading avionics technology and solutions companies exhibiting at Aviation Electronics Europe will deliver additional technical and technological presentations and discussions, for you to discover the latest advanced systems and ideas in the market.

A full Exhibitor Workshops schedule is available at www.ae-expo.eu but some of the leading avionics technology and solutions companies participating in these workshops include:

- Saving Weight & Space through HUMS Integration into Crash Recorder Designs - Curtiss Wright
- COTS GPU Selection Criteria for Avionics Display Systems - Core Avionics
- AviBlocks: Adapting to Modern Avionics Development - Curtiss Wright
- Security for the E-enabled aircraft - Wind River
- Speeding up the development cycles for C4ISR mission equipment using fully SW compatible laboratory development platforms - CES Swap

Keep up to date of the latest programme and workshop developments at www.ae-expo.eu.



New Approvals:

CFM #2R

CFM gear box positions (9541M89P01, 9972M33P07, 9972M34P09)

131-9 A, B & D

PT6 #2/3R, #5R, #7R

GP7200 main shaft positions (#2-B, #4-R, and #5-R)

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FAG Aerospace, Inc., Stratford, Ontario (EASA Repair Station No. 145.7221, TCCA Repair Station No AMO 41-99)

FAG Aerospace (Singapore) Pte (FAA Repair Station No. 3FEY480C. EASA & CAAS pending)

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- A 19% VAT/sales tax is included
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- GOVERNMENT ONLY.....(€495 + 19% Tax) – **€589**
- Full standard delegate.....(€795 + 19% Tax) – **€946**
- One Day standard delegate 20 or 21 Apr.....(€495 + 19% Tax) – **€589**
- Group booking 2 day – 3 for cost of ONLY 3..... (€1590 + 19% Tax) – **€1892**
- Group booking 2 day – 5 for cost of ONLY 3..... (€2385 + 19% Tax) – **€2838**

WORKSHOPS

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20 APRIL

- Standardisation & Certification.....(€250 + 19% Tax) – **€298**
- Understanding, Designing, Simulating & Testing
Complex ARINC 818 Sys.....(€99 + 19% Tax) – **€122**

21 APRIL

- Future Avionics, Cyber Security & eEnabling.....(€250 + 19% Tax) – **€298**
- Software and Embedded Systems.....(€250 + 19% Tax) – **€298**

CERTIFIED TRAINING

Includes access to Expo

20 APRIL

- Understanding & Applying DO-178C and ARP-4754A.....(€489 + 19% Tax) – **€589**

21 APRIL

- Understanding & Applying ADS-B.....(€489 + 19% Tax) – **€589**
- BOTH DAYS**.....(€795 + 19% Tax) – **€946**

EXHIBITION ONLY

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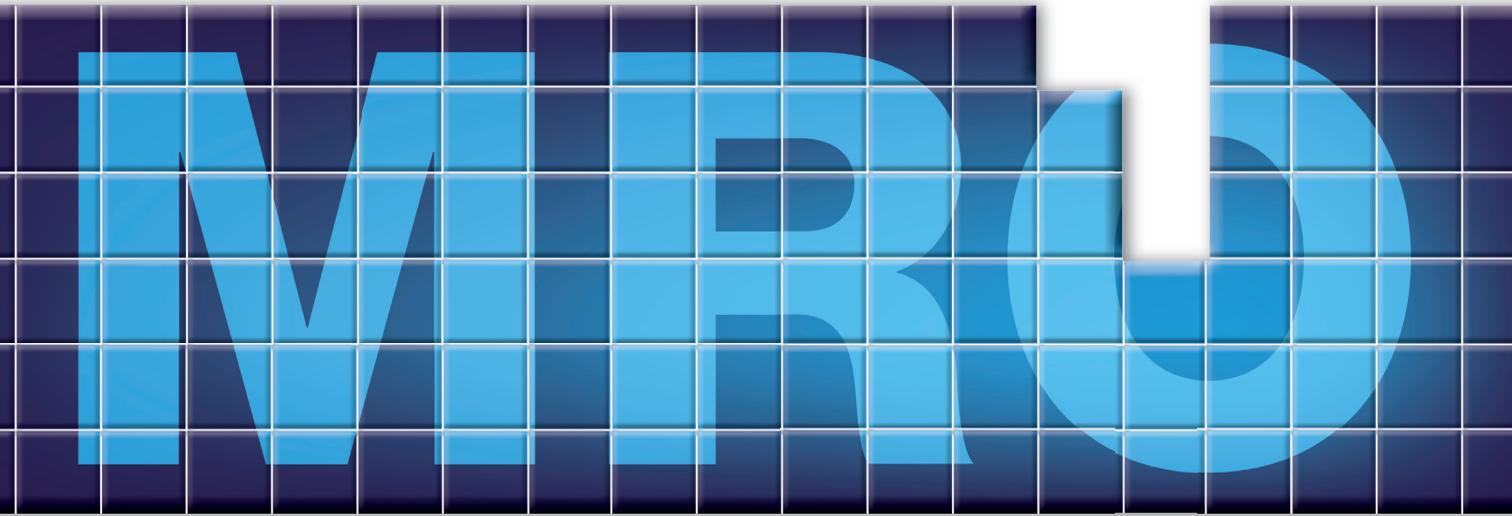
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Getting Schooled on Robinson Helicopter Maintenance

Robinson's factory maintenance school takes any mystery out of maintaining the world's most popular family of light helicopters.

by Dale Smith



“Helicopters are really a bunch of parts flying in relatively close formation; all rotating around a different axis. Things work well until one of the parts breaks formation.”

- Anon.

B

ack in the latter part of the 1950's, U.S.-built light aircraft were being turned out in great numbers and the theme of the day was: “An airplane in every garage.” And while that dream was never realized, it never really died.

Even today, like-minded entrepreneurs have their sights set on passenger toting UAVs to flying cars. Why sit in rush hour traffic when you can just fly right over it? The concept sounds even better today than it did 60-years ago.

In fact, while few of us remember it now, the idea of providing simple, affordable, personal airborne transportation was exactly what Frank Robinson had in mind when he founded the Robinson Helicopter Company in 1973.

“The two-place R22 was originally designed as a transport for busy executives,” explained Patrick Cox, manager, Technical Support, Robinson Helicopter Company. “The idea was that you could takeoff from your house and fly off to the office. Frank went so far as to use the two-blade rotor configuration to make it easy to fit an R22 in a suburban garage.”

“That obviously didn’t transpire as Frank had hoped,” he said. “But that was the idea of the original helicopter design – easy to fly and easy to maintain.”

The Little Helicopter That Did...

While busy executives may have overlooked the time saving opportunities that the early R22 presented, it’s capabilities and affordability quickly made it a hit with helicopter-hungry flight schools.

“Up until the R22’s introduction, options for helicopter flight training were limited to older Bell 47s, Schweizer 30s, some Hillers and an occasional Brantly,” Cox said. “While all fine basic trainers, each required a considerable amount of maintenance, which increased both the downtime and cost of operations.”

Current generation, piston-powered R22 and R44, and the new turbine R66s all have a 12-calendar year preventative maintenance schedule on the airframe components. Robinson Image.

As a point of reference, in 1976, when I did my basic rotor training in a Bell 47, the flight school pretty much counted on needing two-hours of maintenance for every hour in the air.

“In the case of the R22/R44 models, we figure it’s on the order of 10-hours of flight time to every one hour of maintenance,” he said. “That’s a good working estimate depending on where you are on the cycle of things on the aircraft. With the piston R22 and R44, the engine requires, by far the majority of the maintenance time.”

In fact, Cox said that the current generation, piston-powered R22 and R44, and the new turbine R66s all have a 12-calendar year preventative maintenance schedule on the airframe components.

“Operators today are really looking for value,” he said. “And this schedule saves a lot of inspection time. By minimizing maintenance requirements on our helicopters you actually increase the uptime and that, of course, has a direct positive impact on the aircraft’s operational value, which the flight schools want,” Cox said. “Easier maintenance also greatly reduces the hassle factor from a private owner/operator’s perspective.”

Robinson Rule #1: K.I.S.S. Complex Maintenance Goodbye

It’s not much of a stretch to think that Mr. Robinson had a pretty darn good idea about what were the high maintenance areas on piston helicopters of the day – and that he took great pains to design as many of those issues as possible out of his new generation R22.

“To that end, Frank got rid of all the grease nipples on the aircraft straight off,” Cox explained. “There were nipples on the ground handling wheels early on, but those are gone now. He also used sealed bearings and self-lubricating rod ends. They are either



There are more than 11,000 Robinson helicopters flying today. Robinson Image.

Teflon or, in cases like in the engine compartment, some are brass. But in any event, none of the rod ends require manual lubrication.”

“We also have a semi-rigid rotor systems, which goes back to Frank’s original concept of the busy executive as our target buyer,” he said. “The main and tail rotor drive systems use maintenance-free flexible couplings; all the hub bearings are self-lubricating; and the spindle bearings are lubricated with automatic transmission fluid (ATF) so you don’t have any periodic re-greasing requirements.”

Cox said that the ability to use ATF to lubricate the rotor bearings comes from the fact that Robinson used a fully evacuated pitch change bearing housing in his original design. And, by eliminating the use of standard grease, he was able to dramatically reduce the amount of routine maintenance on these critical systems.

“In a standard system you have bearings spinning in grease and that creates a path defined by the walls of the displaced grease and the liquid that separates from the grease to lubricate the balls,” he said. “Because there is space created in there you get air and moisture in the system. That increases the risk of wear and corrosion.”

“With those designs, you periodically have to go in there and purge the old grease out and replace it with new. That was a major maintenance requirement for older helicopters,” Cox said. “By using a sealed system with a low viscosity liquid like ATF, there is no displacement of the lubricant so there’s no room for air or moisture. Compared to the automatic transmission in your car, the spindle bearings are a piece-of-cake to lubricate with ATF.”

Other areas where the Robinson helicopter family maximizes design and manufacturing efficiency to reduce ongoing maintenance are in the powder coating of the tubular steel and aluminum frame and the use of one-piece components instead of multi-part units.

“We have a huge CNC (Computer Numerical Control) capability here so we can make parts that used to be assembled from multiple components out of a single block of whatever type material,” he said. “We have also have sophisticated CNC sheet metal bending capabilities. Instead of riveting or bolting panels together, the machine can fold it from a single sheet. Sort of like aluminum origami. That saves manufacturing and maintenance time.”

What all this adds up to is the fact that while they are sophisticated flying machines, the Robinson helicopter line are among the simplest aircraft to assemble, inspect and maintain in the sky.

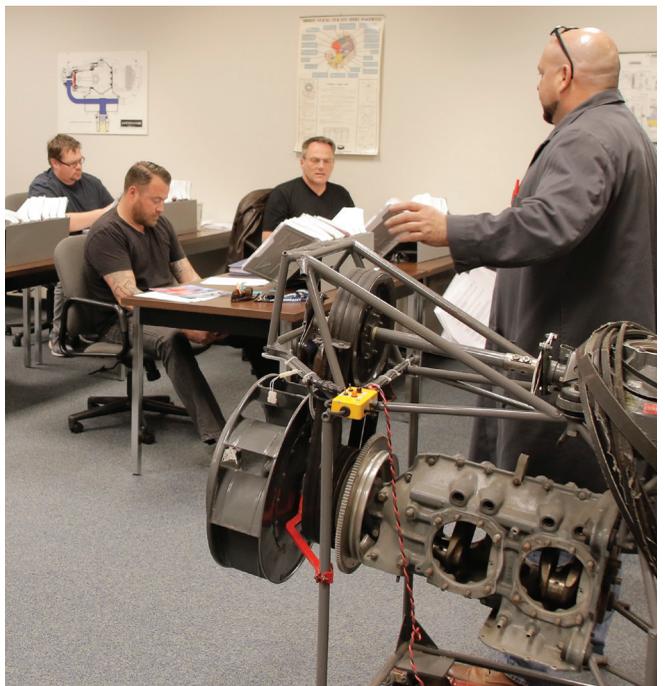
“From the beginning, Frank’s philosophy regarding the simplicity of the R-Series helicopters’ design was this: If it’s not in there it can’t break,” Cox said. “And if it is in there it needs to be easy to access and maintain.”

Robinson Rule #2: Proactive Maintenance is Key to Reliability

While Mr. Robinson’s original target “executive” market didn’t quite pan out, he was spot on with everything else about his plan. Today, there are more than 11,000 Robinson helicopters fulfilling a wide array of needs around the world.

And to help ensure that their helicopters will deliver the safe and reliable performance every customer expects Robinson runs its own maintenance school at its Torrance, Cali., headquarters.

The course’s primary instructor is Efrain Vargas. Vargas has been with Robinson since 1986 and story goes that he worked closely with Frank Robinson on the development of the four-place R44. Vargas is not only an employee and instructor for Robinson, he also owns a Robinson Helicopter dealership in Mexico.



Robinson runs its own maintenance training class at their Torrance Cali. location. Robinson Image.

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Minimizing maintenance requirements increases the uptime which has a direct impact on the aircraft's operational value. Robinson Image.

"Efrain has real world experience and insights into maintaining these helicopters on a daily basis," past attendee and director of maintenance for Helicopter Services, Inc., Mike Crossland said. "What he delivers is not just from a book. He shares the information that you can only get from maintaining helicopters in the field. That sets this school apart from others I've attended."

Crossland stressed that while Robinson helicopters may have been designed to be own and flown by "executives" they're not to be maintained by them. Robinson helicopters are very complex machines and a keen understanding and appreciation of that fact is paramount in safe operations.

While Robinson's in-house maintenance program is described as a "basic hands-on" course for the inspection and maintenance of R22, R44 and R66 airframes, Cox said the course is only available to technicians who already hold a valid A&P certificate or are active duty military with equivalent knowledge.

"We discourage owners from attending unless they have a valid technician's certificate," he said. "It's way too technical if you don't already possess the knowledge and skills. If they do have a certificate, then they're welcome to pay the tuition and attend."

Cox explained that when a qualified owner does attend the course they are treated like any other attendee. Passing requires they do all the same tasks and pass the same tests everyone else.

"This is not a school for 'students' – everyone in the room is a qualified technician already," Cox said.

While Robinson helicopters are found in pretty much every corner of the world, Cox explained that the Torrance facility doesn't get many European-based technicians.

"It's mainly due to the EASA training requirements. They have



The maintenance course is available to technicians who already hold a valid A&P certificate or are active duty military with equivalent knowledge. Robinson Image.



To earn their factory authorization, each of the 450 Robinson Service Centers are required to have their technicians attend and pass the course.. Robinson Image.

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become quite onerous now," he said. "EASA requires much more practical experience than we can provide here. It's not just hands-on training. They require line-type training if you will. We're not set up to do that."

"If they require EASA certification, then we refer them to the EASA approved school held at Heli Air in the UK," Cox said. "They're an authorized Robinson dealer and service center."

Cox stressed another thing for international students to be aware of: All of the Robinson Helicopter classes are given in English. However, attendees who are not fluent in reading and writing English are welcome to bring an interpreter if they need to.

Robinson Rule #3: You Snooze, You Loose

As for how the program is run, Cox explained that the eight-day (Monday thru Friday then Monday thru Wednesday) course is structured more like a college program with lecture-type classes starting at 8:00 in the morning followed by a daily written test. Hands-on labs are held each day after lunch. There is also about an hour and a half's worth of homework each evening.



Robinson helicopters are complex machines. They were designed to be owned and flown by executives but not to be maintained by them. Robinson Image.



"It's not a difficult program by any stretch if you're at all familiar with helicopters," he said. "You just have to do your homework each evening and pay attention in class."

To earn their "factory authorization," each of the more than 450 (at last count) Robinson Service Centers are required to have their technicians attend and pass the course.

"We don't routinely fail any students. When that does happen it's usually a lack of preparation on their part or it has been an issue with language," he said. "Students are also failed if they do not pass each daily exam or in the opinion of the instructor, they cannot safely inspect and maintain a Robinson helicopter. That rarely happens. But just showing up does not ensure a pass."

Cox explained that the hands-on part of the program is based on the company's written task checklist. Students get to cover the typical inspection and maintenance items on the piston powered Robinson R22 and R44 and the turbine-powered R66. All the airframes are basically the same.

Since this is a Robinson course, the program doesn't get too deep into the Lycoming piston engine on the R22/R44 or the Rolls-Royce turbine on the R66. Both companies offer schools for their engines.

"Students are put in teams to do most of the tasks," he said. "But, each student has to demonstrate individual knowledge and skill to the instructor to pass that section."

"I know first hand that in many instances helicopter MROs will hire new A&Ps and put them on maintaining Robinson helicopters," Crossland said. "This course program gives everyone great insight into what to look for during routine inspections and maintenance. It's valuable training for anyone working on Robinson helicopters."

Robinson Rule #4: Change is Good

Cox said that, like the Robinson helicopters themselves, the maintenance, training course continues to improve from when it was first held in the early '80s.

"There's much more emphasis on the why behind the procedure now," he said. "If the technicians know and understand the 'why' it is done that way, the more likely they are to remember it and do it correctly."

One point that Cox said is stressed throughout the course is to always read the manual before beginning any task. And when in doubt, call the factory support team and ask.

He said that one related comment he hears a lot from attendees is, "This makes more sense now that I have read the instructions."

"When I attended the course it was one-week," Crossland said. "Now they've added three more days and I think that's a huge benefit to the attendees. There's so much to learn and Efrain has so much knowledge to share."

While the course has evolved, Cox doesn't see the need for a formal "recurrent" training program.

"One that's worked out pretty well with our R66 (turbine) model is we require all the maintenance shops to be Part 145 compliant," he said. "That regulation requires the operator to provide their own approved recurrent training program. That saves them from having to send technicians back. Travel is expensive."

"Our airframes have pretty much stayed the same since Frank designed them, so unless you are away from helicopters for a while, there's just not much to forget," Cox said. "We feel that our maintenance training course is right at where it needs to be to provide technicians with the product knowledge they need to keep our aircraft operating safely and efficiently." **AM**

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Power Sources Charge Ahead

by Charlotte Adams



Aircraft batteries are too often taken for granted. That is, until a plane loses electrical power far from home and has to switch to its emergency back-up system. Fortunately the prevailing nickel cadmium and lead acid battery technologies are well understood, while evolving lithium chemistries are becoming more acceptable as proper safeguards are applied.

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attery technology continues to improve and batteries last longer. Maintenance and test equipment likewise continues to develop as microprocessors and software make the gear more capable, flexible, and upgradeable.

It's hard to overemphasize the importance of batteries. As 14 CFR 23.1353 states, in the event of a complete loss of the primary electrical power generating system, the battery must be able to provide electrical power to loads that are essential to safe flight and landing. For aircraft certified to a maximum altitude of 25,000 feet, that means at least 30 minutes of battery power and for aircraft certified for higher altitudes, that means at least 60 minutes of battery power.

Yet batteries are almost an afterthought for some pilots. Battery-related accidents happen all too often, particularly in general aviation, where some pilots may fly their planes just a few hours a year. The rest of the time the battery may just be sitting there, losing charge and deteriorating without regular care and feeding. One day the pilot comes out, finds that the battery is dead, and then jump starts the aircraft from an external source. Up in the air after experiencing electrical failure, and with no backup battery power, the pilot is lucky to return unscathed. His airplane may be less lucky.

Never, ever jump start or hand-prop start an aircraft that is certified with a starting battery if the aircraft has a dead battery, warns Skip Koss, vice president of marketing with Concorde Battery, a leading manufacturer of sealed lead acid (SLA) batteries. He attributes "at least half a dozen" accidents to flying with dead batteries that were not properly recharged before flight. A dead battery's state is unknown. It needs to be removed, checked, and charged before takeoff.

Lead Acid Batteries

Lead acid batteries have been around for more than 100 years and are still being used in one form or another by general aviation,

Miami, Fla.-based battery test equipment manufacturer, JFM Engineering, provides calibration, repair, upgrades, consulting and training for their products. JFM Image.

military, and some smaller executive aircraft, not to mention conventionally powered automobiles. Unlike car batteries, however, aviation batteries are designed to be lightweight. They can't take the level of abuse dealt out to automotive equipment. And they need more regular test and maintenance.

Over the years wet cell, vented lead acid batteries have been giving way to sealed, recombinant-gas lead acid batteries. The latter type has the advantage of not requiring to be opened. Sealed lead acid batteries also have a higher energy density than the flooded lead acid devices, according to Concorde. The company supports more than 30 airframe manufacturers, including Piper, Cessna, Diamond, Dassault, and Gulfstream, Koss says. It has more than 100 battery models for use in more than 200 aircraft, according to the company.

Lead Acid Battery Test and Maintenance

Maintaining sealed lead acid batteries is pretty straightforward. You don't open them, but you do have to check them for airworthiness. "It's like a tire – you can have a fully charged tire that is worn out," Koss says. With a new sealed lead acid battery, "you have to check the capacity of the battery at least annually to verify the storage ability for essential power." Subsequent checks could be as frequent as every three months, depending on factors such as the battery, its percent of capacity, the aircraft, and the usage profile. After a capacity test is completed, the battery should be immediately recharged. A lead acid battery, however, should never be discharged to zero during testing because of the risk of damaging the unit, warns test equipment maker, JFM Engineering. JFM's test equipment can be used with NiCad or lead acid batteries.

VDC Electronics and COFKO Electronics are among the companies providing test equipment for lead acid batteries. VDC's BatteryMINDER line of products can be used with either SLA or wet cell batteries. These products can trickle-charge batteries to maintain capacity when the aircraft are not being used.

About six years ago Concorde and Gill – competing lead acid battery manufacturers – "realized that pilots were flying so many less hours every year" that the batteries were sulfating, recalls Bill



This COFKO BC-8000 unit can capacity-test, discharge-test and charge batteries. It comes with a power supply mode, used to charge aircraft emergency battery systems that have internal chargers. It monitors voltage, current, and time. Concorde Image.

Woods, founder of VDC Electronics, a supplier of battery support equipment. "They needed something that was safe and could be connected to the batteries indefinitely without ever overcharging them or using up the water or the electrolyte in the batteries." They came to VDC Electronics, he says, and the company has been building products to meet their specifications. Basically you can plug in a VDC BatteryMINDER and walk away, letting it run 24x7, 365 days a year, he says.

BatteryMINDers are billed as charger/maintainer/desulfator equipment. An additional feature is temperature compensation via a built-in sensor, which operates between freezing and 135 degrees F. This is helpful because, "when the batteries are warm, they can't accept the same voltage as [they can] at room temperature," Woods explains. And when the batteries are cold, they need to be charged at a relatively higher voltage. "This [feature] guarantees you won't use up any of the liquid in the battery" and you won't overcharge it or undercharge it.

The equipment also provides voltage control for charging to within 1/10th of a volt. This is important, particularly for sealed lead acid batteries, because an overcharge could use up the water in the electrolyte, and the water can't be replenished. This would starve the cells, which would not be able to hold the charge, dramatically reducing battery capacity.

LED lights on VDC equipment also help mechanics and owners weed out weak units. A forthcoming product will provide additional diagnostic information, Woods says. A circuit with high-frequency pulses also helps to dissolve the sulfate crystals that form in lead acid batteries.

Properly maintained, sealed lead acid batteries can last up to five years, Woods says. They are much less expensive than nickel cadmium batteries, which also have to be "constantly retested," he asserts. Lead acid battery technology has "dramatically improved" over the years, he says, with the move to sealed units and the use of better materials – "closer to pure lead" – and thinner plates. Internal resistance has been decreased, allowing the batteries to provide more energy.

COFKO Electronics

COFKO Electronics' equipment is used primarily for testing sealed lead acid batteries but can also be used for testing and charging nickel cadmium batteries. Its products, along with VDC Electronics', are described on the Concorde and Advanced Power Products Web sites. Both companies' products are endorsed by Concorde.

COFKO supplies both standalone and wall-powered units. Its portable BC-5000 and BC-6000 capacity testers use energy from the battery under test to run the test equipment. The capacity testers test 12-volt and 24-volt batteries with constant current loading from 10 to 55 amps, adjustable in 1-amp steps. The BC-6000, essentially an upgrade to the BC-5000, includes a USB interface for battery capacity test reports. A COFKO application downloads test information and prints out a sheet with data such as the battery serial number, tester serial number, time and date of test, a graph of battery voltage behavior during the test, and a column for notes.

The higher-end BC-7000 and BC-8000 products use wall power and work in most of the common power ranges worldwide. This "universal input" feature means "you can plug into most AC line voltages around the world," says Mike Coffman, COFKO marketing manager. The technology is also more immune to variations in voltages, he says.

The BC-7000 is a capacity tester with current ranges from 0.5 amp to 5.0 amps, adjustable, in 0.1-amp steps from 0.5 to 15.0 amps and in 1-amp steps from 16 to 55 amps. This is useful for batteries that have fractional amp hour ratings, he explains. The BC-5000, -6000, and -7000 do not have a built-in charger; they provide an option for customers that may already have a charger.

The top-of-the-line BC-8000 model can capacity-test, discharge-test, and charge batteries, Coffman says. Maximum charger output is 36 volts and amperage output ranges from 0.05 to 25.0 amps. Capability for constant potential charging is provided. The unit also comes with a power supply mode, which can be used to charge aircraft emergency battery systems that have internal chargers. It is "fully computerized" and monitors voltage, current, and time, he says. The C1 capacity test is a constant current load, adjustable in 0.1-amp increments from 0.5 amps to 55.0 amps. The BC-8000 has a USB port for C1 capacity and discharge test report generation.

The BC series of chargers is capable of constant current and constant voltage charging, Coffman adds. "The computers handle it automatically -- the operator only has to enter in the maximum voltage and the maximum current settings."

"Our chargers also will do trickle [charging], but they are more for heavy lifting," he says. COFKO's testers and battery chargers "are focused on the battery shops that perform required battery testing and maintenance." There is also a conditioning protocol that "basically applies a constant current charge to the battery for a period of time to break up the sulfation." It does not monitor temperature, as manufacturers want their batteries to be tested in a controlled environment, he says. But it does allow the battery technician to adjust the charge voltage to compensate for battery temperature.

In the future, Coffman expects COFKO to focus on things like ease of use – the operator interface – and higher charge rates. Lead acid batteries can be charged, in the case of Concorde specifications, at a maximum rate of up to eight times the C1 amp hour rating to reduce the charging time. Batteries are sometimes subjected to short duty cycles that don't allow proper recharging, he says. Higher initial rates can help offset reduced time.

Nickel Cadmium

Nickel cadmium batteries are more common than lead acid batteries in today's larger aircraft. The French company, Saft, the dominant provider of this type of battery in commercial aviation, estimates that nickel cadmium batteries hold about 60 percent of the overall aviation market, vs. 28 percent for lead acid and 12 percent for lithium chemistries. (The aviation "market" is understood here to include commercial, regional, and corporate aircraft as well as military fixed-wing and rotary-wing aircraft.)

Nickel cadmium provides a "much higher instantaneous current capability," says Joe Mibelli, vice president of engineering for JFM Engineering. "When you use it to start engines or APUs, that's where it shines." NiCad also has a longer life although the tests are "a lot more involved."

Although Saft designs for the aftermarket, it works closely with the OEMs. Saft batteries are on all Airbus planes and helicopters, as well as on most Boeing planes and on most Gulfstream and Dassault aircraft, says Jean-Marc Thevenoud, Saft's marketing manager for aviation.

Saft claims that nickel cadmium batteries provide a lower total cost of ownership than does lead acid technology. And nickel cadmium technology has improved over the years. Saft's ultra low maintenance (ULM) nickel cadmium battery line, launched five to 10 years ago, is able to double or triple the maintenance interval of earlier nickel cadmium batteries, depending on the model and its application and usage, Thevenoud says. He cites A330 operators who, when they switched from regular nickel cadmium batteries to ULMs, reported an increase from 1,000 to 3,000 operating hours between maintenance checks. A Saft case study on its Web site claims that an airline with 10 CRJ700s will save more than \$60,000 with ULMs vs. valve-regulated lead acid batteries over the life of the Saft batteries. The study assumes that the ULMs will last six years and the lead acid batteries, a year and a half.

The ULMs' plastic bonded electrode technology reduces overcharge current,

thereby reducing water consumption, according to the company. This slows down the aging process and increases safety, particularly at high temperatures.

Nickel Cadmium Battery Test and Maintenance

Nickel cadmium batteries require more extensive care and feeding than their lead acid counterparts. A level of automation in the test equipment can reduce the workload.

Users will want to test a battery's ability to receive a charge and to deliver required current for the minimum required time while remaining above the minimum required voltage, according to JFM Engineering.

Both lead acid and nickel cadmium batteries require capacity testing to check current delivery, Mibelli says. JFM's charger/analyzer equipment features very precise regulation of current and voltage, as well as temperature measurement, since



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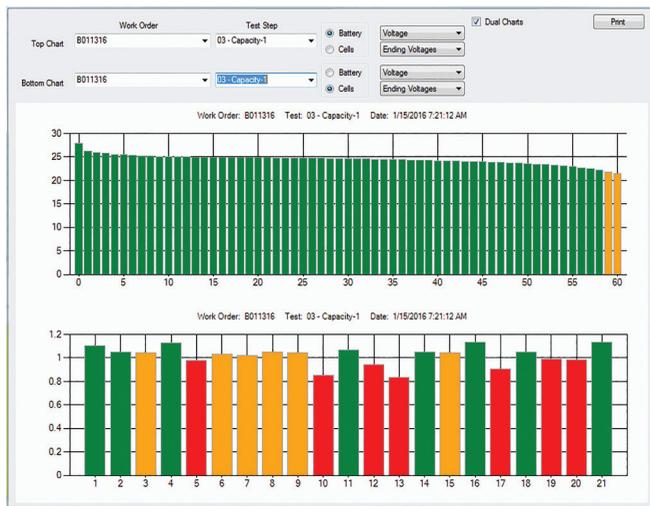
   

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elevated temperature during charge would signal a problem.

The difficulty with NiCad is that you may have 20 cells to keep track of. During discharge each cell needs to be measured individually, Mibelli explains. The discharge cycle is short – only one hour – and in one minute there can be a significant change, with the potential to “make some big errors.”

JFM Engineering produces a suite of equipment that can be used together to automate the process. Among the elements of this suite, as described in a company presentation, are the SuperMasterCharger charger/analyzer, the battery test and analysis system (BTAS 16) software, and the MasterFiller product for adding distilled water to NiCad cells. The BTAS 16 is designed to monitor up to 16 batteries and to monitor and control up to 16 charger/analyzers. It coordinates the measurement, recording, analysis, display, and archiving of test data.



Nickel cadmium test procedures include topping off, capacity tests, and deep cycling, according to JFM. Topping off also should include monitoring for temperature rises and voltage drops. Capacity checks test a battery's ability to deliver the required current over a 1-hour period. After a capacity check, the battery would be recharged. But if the cells are “heavily unbalanced,” the battery should be fully discharged (deep cycle), JFM information says.



Saft lithium ion battery. Saft Image.

Lithium Batteries

Sensational problems with lithium ion batteries rocked the introduction of the Boeing 787. Carriage of lithium batteries as cargo or passenger luggage has been linked with onboard fires, and shipments of lithium batteries are suspected as the source of fire in three major accidents. In February 2016 the FAA reiterated its lithium cargo concerns, issuing a “safety alert” to U.S. and foreign commercial passenger and cargo airlines urging safety risk assessments, according to the agency.

Nevertheless some form of lithium chemistry is likely to become widely used in aviation because of its high energy density, relative weight savings, large power output in a short time, and rapid recharge characteristics. The aviation world wants to save weight and lithium ion is a good way to do that, Thevenoud says. Developments such as “more electric” aircraft need more and more power and hence increased battery performance, he says.

The Airbus A350 is approved for nickel cadmium and lithium ion batteries. A TAM Airlines A350 is flying commercial flights equipped with Saft's lithium ion batteries, according to Thevenoud. Airbus saves 176 pounds (80 kilograms) on the A350 by using lithium ion vs. nickel cadmium, he says. “That’s the weight of one passenger.” Saft also supplies lithium ion batteries to the U.S. F-35 Joint Strike Fighter.

Saft's new lithium ion battery for the A350 is designed to DAL-A (design assurance level-A), the only battery to achieve this assurance level, Thevenoud says. “Safety was the first concern.” In addition to the weight savings, the battery only needs a scheduled maintenance check every two years, he says.

Lithium ion batteries, however, require careful monitoring. Each Saft A350 battery incorporates a battery management system (BMS), built into the cover, that monitors battery behavior. The BMS, for example, manages charge/discharge and monitors temperatures and individual cell voltages. Packaged in a metal case, the battery weighs 66 pounds (30 kilograms).

Saft also manufactures the ground service equipment (GSE) for the units. Known as battCARE, the GSE is available from distributors such as Aviall, Satair, and D+C-Airparts. This equipment allows for charge and discharge of the batteries, and capacity and impedance checks, monitoring the batteries without necessarily removing them from the aircraft. The battCARE allows the battery to be powered from 20 percent to 90 percent charge in less than 45 minutes, according to the company. It can store 16 records and allows the transfer of data to a Saft Web portal for storing battery test history. **AVI**



JFM Engineering produces a suite of equipment that can be used together to automate the battery testing process. JFM Image.



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Can Batteries Be Maintenance Free?

by David Jensen

Well, perhaps not totally so. However, one manufacturer is applying a chemistry and design that takes battery operation a step closer to a maintenance-free goal.



Todd Winter, president and CEO of Mid-Continent Instrument Co. and president and CEO of a six-year-old Mid-Continent subsidiary, True Blue Power, which produces Li-ion battery packs says not all lithium-ion batteries are alike. Shown above, a True Blue Power lab technician welds a TB17 subassembly. True Blue Power Image.

Lithium-ion (Li-ion) batteries have become ubiquitous, powering everything from smart phones to electric-powered automobiles. They can be found in aircraft, too, in portable radios, electronic flight bags and the laptop computers pilots bring on board for flight planning and check lists. Li-ion batteries have been used in military aircraft for years—for engine starts, emergency power and other functions—and they have become widely employed in unmanned air vehicles. They serve as main-ship batteries in the Boeing F-18, Lockheed Martin F-35, Sikorsky CH-53K and Northrop Grumman Global Hawk, among other aircraft.

However, Li-ion batteries have yet to reach their full potential in the civil aviation arena. This is primarily because new-technology batteries require extensive effort and money to prove they meet certification requirements.

But the use of Li-ion batteries in aircraft may soon become widespread after more light is shed on their benefits. These rechargeable power units—in which lithium ions move from the negative electrode to the positive electrode during discharge and move the opposite direction during charging—represent the latest generation in the evolution of aircraft batteries. They succeed those utilizing lead-acid and nickel-cadmium (NiCad) chemistries, both more than a century old.

Improved battery technology has become more and more vital, not only to perform conventional functions such as engine starts, power stabilization and running onboard electrical systems, but also to supply an ever-growing number of systems in what many commonly call “the more electric airplane.” To give just one example of this trend, Honeywell and Safran have partnered to develop electrically controlled taxiing for commercial aircraft, to allow engine startups away from the gate thus reducing fuel consumption.

A relatively new (introduced as a product in the 1970s) and therefore emerging technology, Li-ion offers advantages over lead-acid and NiCad technologies. Newer aspects of Li-ion technology can provide greater energy density, more consistent power delivery, environmental benefits and reduced weight, among other gains. They also can reduce battery maintenance significantly, in part by simplifying and reducing the required number of battery checks. Indeed, new versions of Li-ion chemistry may some day reduce the need for dedicated battery shops at fixed-base operations (FBOs).

Bit of Controversy

A relatively new technology invariably draws controversy, however. In the field of consumer goods, a spate of incidents occurred late last year in which the Li-ion batteries on hoverboards—essentially self-balancing, powered scooters—burst into flames during recharge mode. It prompted airlines to bar stowing hoverboards on board their aircraft.

In the aviation field, two operators of the Boeing 787 Dreamliner, All Nippon Airways and Japan Airlines, made

emergency landings in January 2013 because the lithium metal oxide batteries in the new-design aircraft overheated, released electrolyte vapors and created oxygen within their cases. The incidents resulted in internal thermal runaway, or accelerated heat buildup, that created fire outside the batteries’ steel cases. The National Transportation Safety Board (NTSB) cited “deficiencies in the [battery’s] design and certification processes” as the overall reason why the incidents occurred.

The 787 has two lithium metal oxide batteries onboard that provide backup power. Their malfunction invoked a three-month, fleet-wide grounding. Boeing had the battery installation redesigned, and in April 2013 the FAA gave the 787 fleet the green light to fly.

So, are Li-ion batteries volatile and unsafe? They don’t have to be, according to Todd Winter, president and CEO of Mid-Continent Instrument Co. “It all depends on the chemistry and design,” he states. Winter is also president and CEO of a six-year-old Mid-Continent subsidiary, True Blue Power, which produces Li-ion battery packs, as well as inverters, emergency power supplies, testers, chargers and USB charging ports for aircraft.

Winter emphasizes that “not all lithium-ion batteries are alike.” Some apply a lithium metal-oxide compound, such as cobalt-oxide, nickel-cobalt-aluminum or cobalt aluminum. These may offer substantial power but can generate more heat and create oxygen when shorted or overheated. The batteries in the 787 contain a cobalt-oxide cathode, applying chemistry similar to that used in many mobile devices and computer-laptop batteries, only on a larger scale. One alternative to lithium metal-oxide is lithium iron-phosphate, a chemistry that may supply less power than metal-oxide but is less reactive, i.e., emits less heat at a slower rate in case of damage or abuse.

Nanophosphate Chemistry

True Blue Power applies a subtype of the iron phosphate compound. Called Nanophosphate lithium-iron phosphate (LFP), it provides the best of both worlds: high energy density and long life along with improved safety and cycle time and more power than other Li compounds. It well may be called the latest generation of the aforementioned battery evolution. The relatively new Nanophosphate LFP chemistry was developed in 2001 at Massachusetts Institute of Technology and is proprietary to A123 Systems LLC, Livonia, Mich., which has applied the technology to battery cell production. True Blue Power is a worldwide aerospace distributor for A123 Systems, offering battery packs, custom cell modules and traceable factory cells.

An A123 Systems white paper claims that Nanophosphate LFP is “much more stable chemically,” than other compounds used in Li-ion batteries. Cells made of Nanophosphate technology are more resistant to abuse such as a short circuit with over-voltage charging or damage to the battery pack. However, the paper adds, should they suffer abuse, they tend to release significantly smaller



Shown above are the different sizes of True Blue Power's batteries.
True Blue Power Image.

amounts of heat and oxygen under similar conditions compared to other battery types. This makes the batteries "easier to manage in a thermal situation," says Winter.

When compared to lead-acid and NiCad technologies, Nanophosphate LFP provides benefits in addition to safety, including:

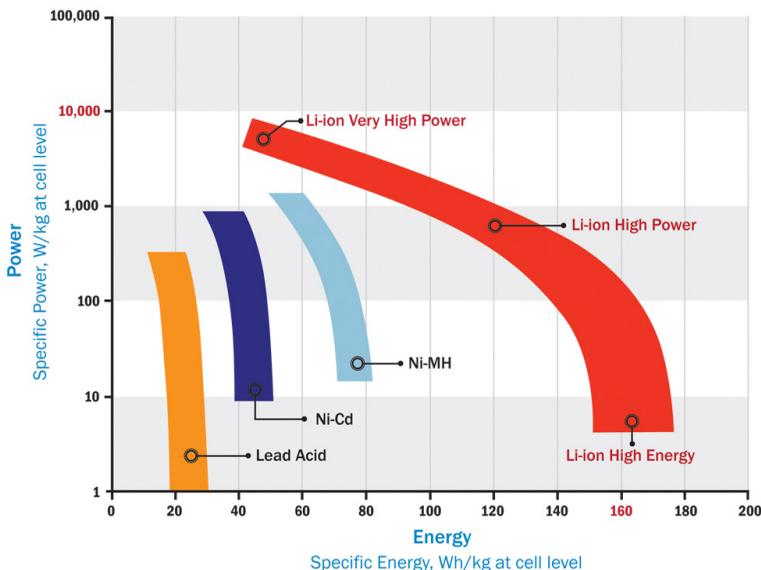
- ➔ Three times more energy density (energy per kilogram);
- ➔ Longer life/cycle time, up to 10,000 cycles (10 times more than with NiCad batteries) and 10 years;
- ➔ Performance within a wide temperature range, typically from -40 C to +70 C;
- ➔ A significantly flatter voltage discharge curve, providing smoother, consistent power delivery;
- ➔ Higher power for engine starts and other high-current operations;
- ➔ Virtually full power until the battery is discharged;
- ➔ Greater thermal and chemical stability;
- ➔ Low loss of charge during proper storage;
- ➔ Environmental benefits, for example, zero gas emissions and no use of toxic heavy metals, and
- ➔ Because of the high energy density, reduction in weight by up to 40 to 75 percent.

According to the A123 Systems white paper, Nanophosphate LFP technology provides "consistent power capability over a wide range of states-of-charge [SOC]." Able to accept and deliver capacity quickly, Nanophosphate LFP batteries can achieve "rapid recharge and rapid starting, up to seven [engine] starts in seven minutes," says David Copeland account manager at True Blue Power.

"With our batteries, even if they're significantly discharged, they likely will start the aircraft, and then they will recharge in 15 minutes," says Winter. "In fact, they likely can be recharged by the time the aircraft reaches the runway for takeoff."

Improvements by Design

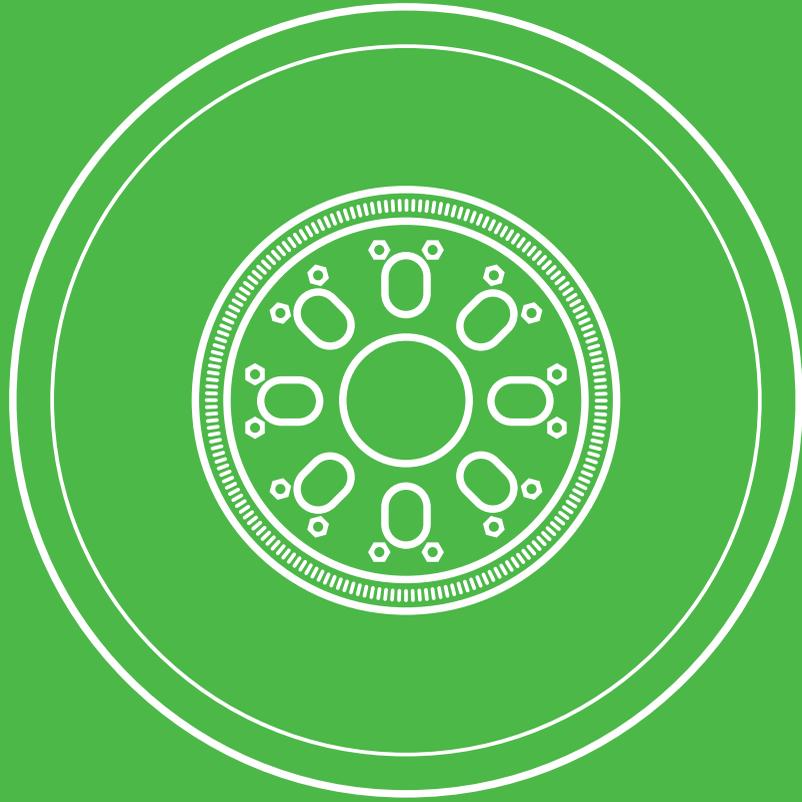
An optimum chemical compound is essential in aviation batteries but so, too, is battery design. The make-up of True Blue Power's batteries can be observed in a modest-size assembly room, where the company receives and tests the cells from A123 Systems prior to their integration into modules, or battery packs. The relatively small cells, about the size and shape of a roll of quarters, are sealed and non-toxic. Each provides a 3.3-volt (nominal) output. The battery packs can vary in size, depending on the desired capacity, typically measured in amp-hours (Ah).



CHEMISTRY COMPARISON: POWER AND ENERGY

- Lead Acid
- Ni-Cd
Nickel Cadmium (NiCad)
- Ni-MN
Nickel Metal Hydride
- Li-ion
Lithium-ion

In this chart, the power differential between lead acid, ni-cad, nickel metal hydride and lithium-ion batteries can be seen. True Blue Power Chart.



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Because Nanophosphate LFP batteries provide three times more energy than legacy power units, RTCA DO-311 requires that they be monitored. This is commonly achieved by installing data-acquisition hardware and/or sensor nodes in the aircraft. True Blue Power's answer to the mandate is to incorporate a comprehensive battery management system (BMS) within the battery box. A "smart board" (electronic monitoring device) is installed in each battery module, comprising eight cells. It checks such parameters as temperature, voltage and current, essentially the pack's health, then transmits that data to the BMS, a computer module about the size of a Hershey candy bar.

The real-time data allows the BMS to manage the battery, i.e., optimize its performance. For example, it can automatically achieve cell balancing within a module or assure it doesn't "crater" (go down to zero charge) or adjust temperatures in a pack. The BMS also can mitigate situations in which limits are exceeded, for example, by automatically shutting down a module or cell.

Using ARINC digital protocol that interfaces with panel displays, the BMS can transmit battery-related data to the cockpit; it also can store the data for review by the maintenance technician during a capacity check. Winter foresees the day when data from the BMS will be transmitted automatically from the aircraft to the ground, reporting the battery's health to maintenance technicians in real time. He says the BMS also will report potential damage, such as adding too much current or voltage, in the event that an FBO's ground power unit malfunctions or is misused.

At True Blue Power, the BMS, smart boards and modules are housed in ruggedized sealed containers, the final layer in a battery's multiple layers of protection. The company uses a steel

case for its large 44-Ah TB44 battery and an aluminum box for the smaller 17-Ah TB17 and TS835 emergency power supply. With the sealed casings, these batteries need gas venting only in case of extreme overheat scenarios.

The company's TB44 model battery weighs 51.7 pounds (23.5 kg), about half the weight of a comparable NiCad or lead-acid battery. The TB17 weighs less than 15.6 pounds (7 kg).

Shipment of Li-ion and Nanophosphate LFP batteries is comparable to that of lead-acid and NiCad modules. Because they cause no spillage, the batteries need not be placed in isolated storage. And, regarding their disposal, Li-ion batteries are accepted at most land fills because they don't contain toxic heavy metals.

World's First TSO

True Blue Power is "the world's first company to attain a FAA TSO [technical standard order] and EASA ETSO for Li-ion battery packs," says Winter. The effort required "exhaustive testing and engineering work," applying RTCA standards, a process that took two and half years to complete from design to certification, he adds.

True Blue Power is working with OEMs to integrate its main-ship batteries in 11 models of business jet and rotorcraft. The company is pursuing aftermarket, supplemental type certificates (STCs), as well, including the Cessna Caravan, Pilatus PC-12, Beech King Air and Bonanza. Winter reports that "three or more" FAA STCs for his company's batteries are forthcoming and that, currently, reaching the minimum performance standard in RTCA DO-311 (for Li-ion batteries), DO-160 (environmental conditions and testing) and other requirements entails a quite manageable 10 to 12 months.

Incidentally, True Blue Power's line-up of Nanophosphate LFP batteries was not available when Boeing was developing the 787, according to Copeland. But he adds that all the fixes to the Dreamliner's batteries already happened to be incorporated in True Blue Power products.

Maintenance Free?

To profile the Nanophosphate LFP technology's benefits, Winter refers to a Canadian operator of the de Havilland DHC-8, in which the TB44 battery has been STC'd by Transport Canada and applied for FAA bilateral STC acceptance. A comparison with the NiCad batteries formerly used reveals the one drawback to Nanophosphate LFP batteries: cost. The price of two TB44 batteries plus panel assemblies and STC installation kit adds up to \$30,000, about 20 to 40 percent more than for a comparable NiCad battery installation. However, under normal aircraft use (2,250 hours/year), the TB44 was found to reduce the cost of maintenance and fuel by \$56,700 per aircraft a year. Also, the battery's weight savings allowed additional cargo weight, fetching an additional \$25,200 in revenue annually per aircraft. The DHC uses two batteries and thus, after replacing the NiCad batteries, it shed 100 pounds (45.3 kg).

Regarding maintenance, the Canadian operator estimates the TB44 will be able to "save 90 percent of its battery maintenance cost," says Winter, adding that Nanophosphate LFP batteries are "nearly maintenance free." The battery is sealed; there is no need to add water or acid. True Blue Power recommends a battery capacity check every two years. The battery need not be removed from the aircraft for the biennial check; with accompanying custom software, a technician can hook his or her laptop to the battery for diagnostics, to reset capacity and develop a log. In addition, the battery can be recharged by whatever ground unit an FBO has available, though it must be done according to manufacturer specifications, as Li-ion batteries may require different charging points than lead-acid and NiCad products. **AM**

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Drones in Maintenance: The New Frontier

After a flurry of activity at the end of 2015 and the beginning of 2016, the United States finds itself in the midst of an emerging (if slowly) regulatory regime governing the use of Unmanned Aircraft Systems, also known as UAS or, more commonly, "drones." Although the FAA is still working through the process of integrating UAS into the National Airspace System (NAS), a regime is beginning to emerge that gives UAS operators a better idea of what is expected of them in order to operate UAS safely and remain compliant.

For those in the maintenance world, there are a few now-established rules and guidance that one should be aware of if seeking to work with or on drones in the future. Note that these requirements apply to small UAS (those under 55 pounds) where the FAA seems to be currently focusing most of its attention.

Use in Maintenance

There have been a number of stories recently of drones being used to perform inspections of aircraft as part of the maintenance process. The appeal of this method is quickly apparent, as it allows an individual to rapidly inspect an aircraft from the ground without the need for mechanical lift equipment or stands that must be moved along the length of the aircraft in order for an individual to see all angles of the aircraft. However, before grabbing a drone and a GoPro and going to work, it is necessary to consider a number of practical and legal issues presented by this technology.

From a practical perspective it is necessary that only individuals with the proper training be permitted to operate a UAS used for inspection. There are at least two reasons for this: first, it is important to avoid a scenario in which a mis-controlled drone strikes the aircraft being inspected, causing or exacerbating damage, or strikes equipment or persons at the maintenance facility causing damage or injury. (A quick YouTube search will reveal the shocking number of ways people can find to crash a drone.) Second, it is vital that the person operating the drone for purposes of inspection is able to satisfy the inspection requirements established by the applicable manuals.

At this point it is necessary to establish an important line of demarcation between practical and legal concerns. If you are seeking to use a drone for inspection purposes in your maintenance facility, and your operations occur exclusively indoors, the FAA's jurisdiction over your use of drones is practically nothing. This is because the FAA's authority—and the NAS—do not extend inside of buildings and

hangars. It is only when you operate a drone outside that the FAA's statutory authority kicks in and you become subject to its regulations. Therefore, if you wish to use a drone indoors for the purposes of inspection, you are free to do so, provide you take the necessary precautions to guard against injury and other liability.

Once you step (or fly) outside—and into the FAA's jurisdiction—a significant set of regulations attach, or will soon attach. This is because the FAA regulates the use of UAS when they are operated for business purposes. The same practical considerations apply.

As of this writing, the FAA's Small UAS Notice of Proposed Rulemaking is still being dispositioned. That means that in order to operate a UAS for business purposes, you must still obtain from the FAA a Section 333 exemption. This exemption allows a business to legally operate a UAS for business purposes. The exemption includes a blanket Certificate of Waiver or Authorization that permits operation with certain restrictions. However, because most maintenance operations are based on or near airports, a specific COA addressing your particular airspace will also likely be necessary. This COA will spell out the specific operational parameters for your use of drones in the performance of inspection and maintenance.

In addition to the Section 333 exemption and COA, you will need to make sure that your UAS is registered with the FAA. As of December 21, 2015, all UAS between 0.55 pounds and 55 pounds are required to be registered. Registration costs \$5 and can be done online. Each registration is valid for three years, and a single registration number can be used on all of your drones. Although there is pending litigation over the validity of the registration rule, a cost benefit analysis suggests that it would be in an operator's best interest to make sure its UAS is registered to avoid a possible penalty, which could reach as high as \$27,500 for civil penalties and \$250,000 for criminal penalties.

Finally, because the United States Code requires an aircraft operating in the NAS to have a certificated pilot in command, the operator of a drone must hold an airline transport, commercial, private, recreational, or sport pilot certificate.

Once the Small UAS NPRM becomes a Final Rule, several other requirements are expected to go into effect. These will include limitations on operations around people, use of spotters, and line of sight requirements. We can also expect UAS-specific pilot testing requirements to emerge as the rule calls for a specific UAS operator certificate. This may be beneficial if it results in reduced restrictions on who may operate UAS.



Want to learn more? Then please register for the 2016 MARPA Conference, which will take place October 26-27, 2016 at the B Resort and Spa in Orlando, Fla.

Although use of drones in the inspection process is an exciting prospect, it is necessary to ensure your business remains compliant with all existing FAA requirements. Though simple in its undertaking, using a drone for inspection purposes (unless performed exclusively indoors) carries with it a number of obligations in order to remain FAA-compliant. And these requirements are subject to change pending the Small UAS Final Rule.

Drone Maintenance Requirements

In addition to their value as a tool for performing maintenance, drones will also themselves require maintenance. Unfortunately, the direction the FAA is heading with respect to maintenance requirements is not yet clear.

Under the proposed Small UAS rule an FAA airworthiness certificate would not be required. But the operator will be required to maintain the UAS in a condition for safe operation and must perform preflight inspections to ensure the UAS is in a condition for safe operation.

Current FAA guidance suggests that in cases where an airworthiness certification is sought (although it does not appear to be required under the Small UAS rule), and applicant would be required to certify that they have established an inspection and maintenance program for their UAS.

While it does not appear that the FAA has yet made a final determination with respect to airworthiness certification and maintenance requirements of UAS, it does appear that for the foreseeable future, maintenance and inspection of drones themselves will be left to the operator.

Permitting the operator to make its own determinations regarding maintenance requirements and airworthiness of UAS does, in the short term, mean that drones are not likely to be a source of maintenance revenue. However there have been some discussions about whether UAS should be subject to part 43 maintenance requirements and if so how those would be enforced. Such a rule is likely to be far off in the future, but seems reasonably possible, particularly as drones grow larger and more expensive to own and operate. In the short-term, drones that cost in the mere hundreds of dollars are more cost effective to simply replace if they become damaged or inoperable.

UAS laws and regulations continue to rapidly evolve. For operators, it is important to know where the limits of FAA jurisdiction begin and end. For those seeking to use drones to assist in maintenance (or to operate for other business purposes such as taking aerial footage of a facility for promotional purposes) it is necessary to ensure compliance with the FAA's current Section 333 exemption process and associated requirements. This is particularly true given that drones used for maintenance purposes will almost always be operated on or around airports, where high profile near-misses with commercial aircraft have drawn the attention of politicians and the media. If in doubt, limit such operations to inside the hangar, where FAA jurisdiction does not extend.

Those seeking to take advantage of a robust market for UAS repair may have to wait a while longer. In the short term, value of UAS will determine whether they are repaired or simply replaced. In the long term, the FAA may determine that UAS must be maintained in accordance with part 43, thus creating a new opportunity for part 145 repair stations. **AVM**



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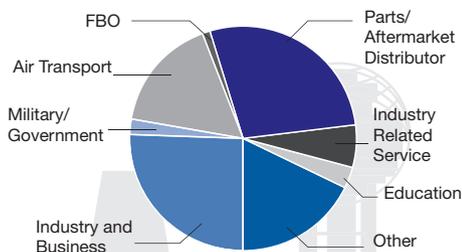
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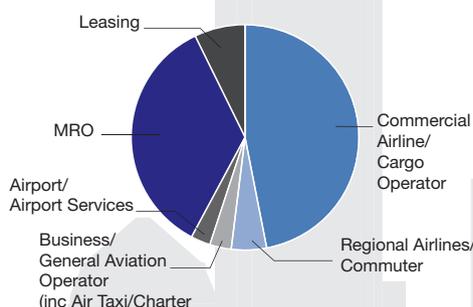
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Lockheed Martin Aircraft, Av Fuerza A Argentina 5500, C Rdoba Capital X5010JMN, Argentina (2, 3)

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Australia

Aerolec (NAS Services Pty Ltd), Hangar 8, Kittyhawk Lane Parafield Airport SA 5106, Australia, 61 8 8258 2013, Fax: 61 8 8285 6788, stefano@erolec.com.au, www.nasservices.com.au (2)

Aircraft Claims Australia, PO Box CP 70, Condell Park 2200, Australia (1, 2, 3, 4)

Aircraft Support Industries, Ste.. 201, 39 E. Esplanade, Manly 2095, Australia, 61-2-9976-0188, Fax: 61-2-99760199, enquiries@asiGLOBAL.net, www.asiGLOBAL.net

Australian Aerospace Engineering Pty Ltd., P.O. Box 459, Jindera, NSW 26403045, Australia, 61-260262614, Fax: 61-260262615, aaepi@austaerospace.com, www.austaerospace.com L-AF, L-PP, SC-1, SC-2, SC-3, SC-4, SC-5 (1, 2)

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Hawker Pacific Pty Ltd., P.O. Box 172, Yagoona, NSW 2199, Australia, 61-297088555, Fax: 61-297910780, hawkercpac@hawkerpacific.com.au, www.hawkerpacific.com.au L-AF, L-INS, L-PP, L-RAD

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Jet Care Pty Ltd, Wooloowin, P.O. Box 1526, Eagle Farm, QLD 4009, Australia, 61 7 3860 4477, Fax: 61 7 3860 8394, g.roud@patrick.com.au, www.patrick.com.au

John Holland Aviation Services, Gate 24 Operations Rd., Melbourne Airport, Victoria 3045, Australia, 61 39 373 8401, Fax: 61 39 373 8444, www.jhas.com.au (1)

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Virgin Tech, P.O. Box 76, Gladstone Park VIC 3043, Australia, andrew.lillyman@virginblue.com.au, www.virginblue.com.au (3)

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Austrian Technik, Austrian Airlines Technical Base, Building 992, 1300 Vienna Airport, Austria, 43 517 666 3838, technical.sales@austrian.com, www.austriantechnik.at INS-1, INS-2, INS-3, INS-4, L-AF, L-EE, L-NDT, L-PP, L-SS, RAD-1, RAD-2, RAD-3

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Minas Avionics Rev Eq Aeron Ltda, Rua Prof. Nelson de Sena, 122, Belo Horizonte, MG CEP 31270-660, Brazil, 55-31-3441-3479, comercial@minasavionics.com.br, www.minasavionics.com.br AAC-1, AAC-2, AAC-3, INS-1, INS-2, INS-3, INS-4, RAD-1, RAD-2, RAD-3 (2)

- **Pratt & Whitney Canada do Brasil**, See ad p. 13, Rua Dullio Bonani, 100, Sorocaba SP 18065-460, Brazil, 55-152-102-1000, Fax: 55-152-102-1008, paschoal.silva@pwc.ca, www.pwc.ca

Rockwell Collins do Brazil, Ltda., Brazil Service Center, Rua Ambrosio Molina, 1090 Quadra 11-F1, Eugenio de Melo, Sao Jose dos Campos, Sao Paulo 12247-000, Brazil, 55-12-3908-6205, Fax: 55-12-3908-6204, brazil@rockwellcollins.com, www.rockwellcollins.com/customer INS-1, INS-3, INS-4, L-AAC, L-INS, L-RAD, RAD-1, RAD-2, RAD-3 (2)

TAP Maintenance & Engineering Brazil, Estrada das Canarias 1862 - Block 2, Rio de Janeiro - RJ 21941-480, Brazil, 55-213-383-2782, Fax: 55-213-383-2067, anderson.fenocchio@tapme.com.br, www.tap-mro.com AAC-1, AAC-2, AAC-3, INS-1, INS-2, INS-3, INS-4, L-EE, L-LG, L-NDT, L-PP, L-SS, PP-3, RAD-1, RAD-2, RAD-3, SC-1, SC-2, SC-3, SC-4, SC-7, SC-8 (1, 2, 3, 4, 5, 6)

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William Industria Aeronautica Ltda., R Igino Bonifoli, 9, Bairro Jaragua, Belo Horizonte 31270460, Brazil, 55-31-3441-0351, Fax: 55-31-3441-1683, william@williamaeronautica.com.br, www.williamaeronautica.com.br AAC-1, AAC-2, AAC-3, INS-1, INS-2, INS-3, INS-4, RAD-1, RAD-2, RAD-3, SC-4 (2)

- Dusseldorf Citation Service Center, See ad p. 7**, Dusseldorf Intl. Airport, Hangar 2, Dusseldorf 40474, Germany, 49-211-454970, Fax: 49-211-4543423, cscdusseldorf@cessna.textron.com, www.citationservice.com AAC-1, AAC-2, AAC-3, AF-3, AF-4, L-LG, L-NDT, L-PP, PP-1, PP-2, PP-3, SC-1, SC-2, SC-3, SC-4, SC-7, SC-8 (1, 2, 3, 4, 5, 6)

EADS Elbe Flugzeugwerke GmbH, P.O. Box 80 01 37, Dresden 1101, Germany, efw.sales@efw.eads.net, www.efw.eads.net L-AAC, L-AF, L-NDT, L-PP

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HAM - Hamburg, airberlin technik GmbH, Flughafenstr. 1-3 Geb: 175, Hamburg 22335, Germany, 49-40-50751927, abt-ham@airberlin.com, www.airberlin-technik.com

Hoffmann Propeller GmbH & Co., KG, Kuepferlingstrasse 9, Rosenheim, Bavaria 83022, Germany, 49-8031-1878-0, Fax: 49-8031-1878-78, info@hoffmann-prop.com, www.hoffmann-prop.com PRP-1, PRP-2

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Leitner EDV, EDV-Beratungs GmbH, Schmiedweg 3, Zorneding D-85604, Germany, 49-8016-38801, Fax: 49-8106-38840, w@edv-leitner.de, www.ltb400.eu

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- MTU Maintenance Berlin-Brandenburg GmbH, See ad p. 17**, Dr. Ernst-Zimmermann Str. 2, Ludwigfelde D-14974, Germany, 49-3378-82400, Fax: 49-3378-824300, ludwigsfelde@mtu.de, www.mtu-berlin.com L-AAC, L-NDT, PP-3, SC-7, SC-8

- MTU Maintenance Hannover GmbH, See ad p. 17**, Muenchner Str. 31, Langenhagen D-30855, Germany, 49-511-7806-0, Fax: 49-511-7806-2111, hannover@mtu.de, www.mtu-hannover.de L-AAC, L-NDT, PP-3

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N3 Engine Overhaul Services, Gerhard-Höljke Str. 1, Arnstadt 99310, Germany, 49-3628-5811-0, Fax: 49-3626-5811-8210, sales@n3eos.com, www.n3eos.com

Nayak Aircraft Service GmbH & Co. KG, Component Service Center, Langbaughstr. 8, Troisdorf D-53842, Germany, 49-2203-6995-0, Fax: 49-2203-6995-129, info@nayak.aero, www.nayak.aero

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Nord-Micro AG & Co. OHG, Victor-Slotsch-Street 20, Frankfurt am Main 60388, Germany, 49 6 109 3030, Fax: 49 6 109 3036 15, mail@nord-micro.de, www.nord-micro.de L-AAC, L-INS, L-RAD

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Monarch Aircraft Engineering Ltd., London Luton Airport, Luton, Bedfordshire LU2 9LX, UK, 44-01582-398644, engineering@monarch.co.uk, www.monarchaircraftengineering.com AAC-2, AF-2, AF-3, AF-4, L-AAC, L-EE, L-INS, L-NDT, L-OT, L-RAD, PP-3, SC-1, SC-2, SC-4, SC-7 (1, 2, 3, 5, 6)

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Muirhead Aerospace Ltd., Mallory House, Navigator Park, Southall Lane, Middlesex UB2 5NH, UK, 44-208-5713422, Fax: 44-208-5712336 L-AAC, L-INS, RAD-1, RAD-2, RAD-3 (2)

Muirhead Avionics, 2 Square One Heathrow, Southall Ln., Southall UB2 5NH, UK, 44-208-571-3422, Fax: 44-208-843-6902, david.hendy@ametek.co.uk, www.muirheadavionics.com

Multiflight Ltd., South Side Aviation Centre, Leeds Bradford International Airport, West Yorkshire LS19 7UG, UK, 44 113 238 7100, Fax: 44 113 239 1326, david.layton@multiflight.com, www.multiflight.com

Newbow Aerospace Ltd., Park Farm North, Redditch B98 7SY, UK, 44-1527-518-100, Fax: 44-1527-518-300, sales@newbowaerospace.com, www.newbowaerospace.com

NORDAM Europe Ltd., Hawtin Park, Blackwood, Gwent, South Wales NP12 2EU, UK, 44 144 386 5400, Fax: 44 144 386 5411, contact-nel@nordam.com, www.nordam.com L-SS

NORDAM Transparency Europe Ltd. Division, Unit G3, 2 Tudor Rd., Altrincham Business Park, Altrincham, Cheshire WA14 5RZ, UK, 44 161 941 2068, Fax: 44 161 926 9897, bcollins@nordam.com, www.nordam.com L-SS

Northrop Grumman Corp., Clareville House, Oxendon Street, London SW1Y 4EL, UK, 44-207-9304173, Fax: 44-207-747-1949, www.northropgrumman.com L-INS, L-RAD

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Oxford Aviation Academy, Fleming Way, Crawley, W. Sussex RH10 9UH, UK, 44-1293-543541, Fax: 44-1293-547063, info@oaa.com, www.oaa.com

Pacific Scientific, Aviation Services Company, Howarth Rd., Maidenhead, Berkshire SL6 1AP, UK, 44 162 868 2200, Fax: 44 162 868 2250, custadmin@pascieurope.com, www.pascieurope.com AAC-1, L-EE, L-SS

PCE Instruments UK Ltd, Units 12/13 Southpoint Business Park, Ensign Way, Hamble, Southampton SO31 4RF, UK, 44-2380-987030, Fax: 44-2380-987039, info@industrial-needs.com, www.industrial-needs.com

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Prime Air Europe, HEICO Component Repair Group, 3 Hall Rd. Portland Business Ctr., Maylands Wood Estate, Hemel Hempstead, Herts HP2 7BH, UK, 44-1442-262698, Fax: 44-1442-261506, cherrera@heico.com, www.heico.com

Qualitair, Francis Ct., Fen Ditton, Cambridge CB5 8TE, UK, 44-1223-295-111, Fax: 44-1223-295-112, al@qualitair.com, www.qualitair.co.uk SC-1, SC-2 (1, 2, 3)

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Reheat International Ltd., Riverside, Omega Park, Alton, Hampshire GU34 2UF, UK, 44 142 059 4000, Fax: 44 142 059 4001, sales@reheat.aero, www.reheat.co.uk L-AAC, SC-2

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Rolls-Royce Aero Repair & Overhaul, P.O. Box 31, Derby DE24 8BJ, UK, 44-1332242424, www.rolls-royce.com L-PP

Rotable Repairs Ltd., Units 1-5, Britania Business Park, Comet Way, Southend-on-Sea, Essex SS2 6GE, UK, 44-1702-529888, Fax: 44-1702-523580, info@rotablerepairs.com, www.rotablerepairs.com L-AAC, L-NDT

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Triumph Logistics - UK, Unit 57 Tempus Business centre, Kingsclere Rd., Basingtoke, Hampshire RG21 6XG, UK, 44 125 633 7640, Fax: 44 125 633 7649, smullen@triumphgroup.com, www.triumphgroup.com

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Vector Aerospace, Old Ivelly Rd., Farnborough, Hants GU14 0LZ, UK, 44 1252 359810, Fax: 44 1252 522725, sales.esuk@vectoraerospace.com, www.vectoraerospace.com PP-3, PRP-2 (4)

Vector Aerospace, Fareham Rd., Gosport, Hants PO13 0AA, UK, 44 -2392 946692, Fax: 44 2392 946474, sales.esuk@vectoraerospace.com, www.vectoraerospace.com SC-1, SC-2, SC-4, SC-5, SC-7, SC-8 (2, 3, 4, 6)

Virgin Atlantic Engineering Services, Aeronautics House, Manor Royal, Crawley, West Sussex RH10 9QH, UK, Fax: 44 129 374 4527, engineeringervices@fly.virgin.com, www.virgin-atlantic.com/en/gb/engineering

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Wood Group Accessories and Components Ltd., Unit 22, Wellheads Industrial Centre, Dyce, Aberdeen, Ballyboughal, Co. Dublin AB21 7G, UK, 44 122 477 1133, Fax: 44 122 472 5285, www.woodgroup.com L-AAC

Woodward Aircraft Engines Systems Prestwick, 5 Shawfarm Rd., Prestwick, Ayrshire KA9 2TR, UK, 44 129 267 7600, Fax: 44 129 247 4231, jhouston@woodward.com, www.woodward.com

ZOK, Airworthy House, Elsted Marsh, Midhurst GU29 0HD, UK, 44-1730-811920, Fax: 44-1730-811930, zok@zok.com, www.zok.com

Uzbekistan

Uzbekistan Airways Technics, Aviagorodok, Tashkent 100167, Uzbekistan, 998 71 254 1850, Fax: 998 71 255 6822, common@airtech.uz, www.uzairways.com/uat.aspx

Venezuela

AEROPOSTAL, Av. Aeropuerto Simón Bolívar, Hangar Aeopostal, Maiquetía, Vargas 1070, Venezuela, 58-212-3037221, sante-brucoli@aeopostal.com, www.aeropostal.com AF-4, L-EE, L-INS, L-NDT, L-PP, L-RAD, SC-1 (1, 4, 6)

Vietnam

Vietnam Airlines Engineering Company (VAECO), Noi Bai International Airport, Hanoi, Vietnam, 84 43 886 5532, Fax: 84 43 886 5532, www.vaeco.com.vn

VNA, Noi Bai Airport, Hanoi 884, Vietnam (1)

Zimbabwe

Air Zimbabwe Pvt Ltd, Engineering Division, Box AP1 Harare Airport, Zimbabwe, 263 4 575111, Fax: 263 4 575098, hdube@airzim.co.zw, www.airzim.co.zw

Zimbabwe Aircraft Maintenance Centre (ZAMC), P.O. Box AP1, Harare International Airport, Harare, Zimbabwe, 263 457 5111 ext. 2, Fax: 263 457 5098, technicalmarketing@airzimbabwe.aero, www.airzim.co.zw



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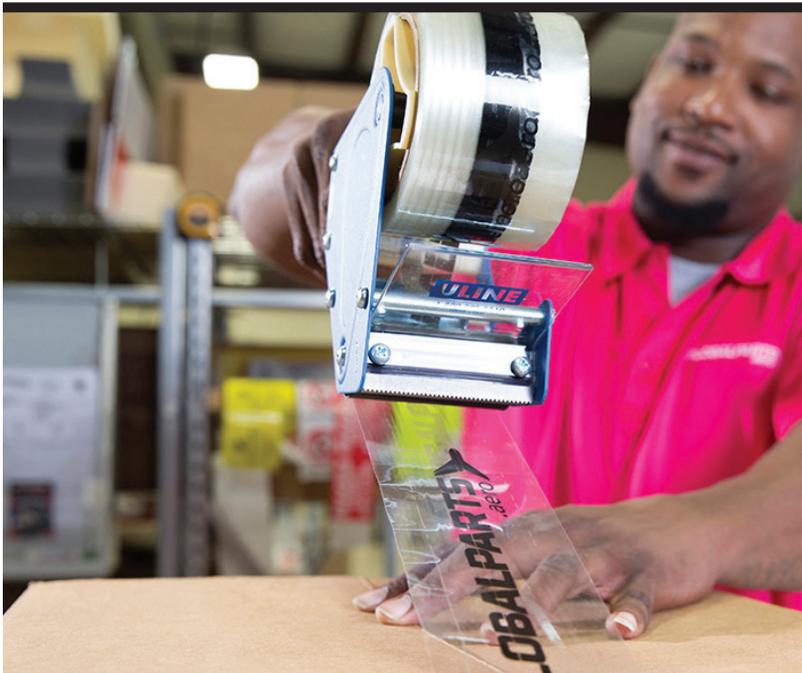
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