

Electrical Wiring Interconnection Systems (EWIS)  
Research and Development (R&D)  
Technology Transfer HWG

**Status Presentation to ATSRAC**

**13 January 2005**

Kent V. Hollinger – US Co-chair  
David Tudor – European Co-chair

INSPECTION &  
MAINTENANCE  
TECHNOLOGIES

AGING &  
DEGRADATION KNOWLEDGE

**AGING  
ELECTRICAL SYSTEMS  
RISK MANAGEMENT**

○ **HAZARD PREVENTION**

○ **RESEARCH & ANALYSIS**

PROTECTIVE DEVICES

○ **HAZARD MITIGATION**

**DATE:** 12 January 2005

<b>WORKING GROUP / TASK #: 12</b>		<b>CO-CHAIRS:</b> Kent Hollinger Dave Tudor	
<b>MEMBERS:</b>			
<u>NAME</u>	<u>ORGANIZATION</u>	<u>NAME</u>	<u>ORGANIZATION</u>
Mike Walz	FAA	Luci Crittenden (secretary)	NASA
Galen Deeds	ABX Air	Bert Johan Vollmuller	NLR
Jean-Luc Ballenghien	Airbus	Larry Stevick	Northwest Airlines
Patrick Gombert	Airbus	Richard Jones	QinetiQ
Ken Elias	ALPA	Joe Kurek	Raytheon Tech Services
Giday Girmay	Boeing	Dave Allen / Phil LaCourt	SAE
Darrel Santala	Boeing	Jack Sutherland	Tensolite
Petar Glamoclija	Bombardier	Jean Cartier	Transport Canada
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<b>PAST MEETINGS:</b>	September 16-18, 2003	FAA AANC NDI Lab @ Albuquerque, NM	
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	June 20-22, 2004	Bombardier @ Montreal, QC	
	December 7-9, 2004	Boeing @ Seattle, WA	
<b>FUTURE MEETINGS:</b>	March 15-17, 2005	Tentatively Cancelled	
	June 21-23, 2005	Civil Aviation Authority @ Gatwick House, UK	
	September 20-22, 2005	FAA Tech Center @ Atlantic City, NJ	
	December 6-8, 2005	Tensolite @ St. Augustine, FL	
<b>OVERVIEW:</b> Identify, review, screen, transfer and implement technologies and knowledge that enhance the safety and continued airworthiness of aircraft EWIS. The scope of this HWG includes procedures, equipment and systems to design, monitor, inspect, test and maintain EWIS.			

<u>SUB-TASK#</u>	<u>DESCRIPTION</u>	<u>ESTIMATED COMPLETION DATE</u>	<u>STATUS (RED/GREEN/YELLOW)</u>
12.1 Develop effective strategies to transfer and implement products (including knowledge) resulting from mature R&D efforts.	<b><u>A. Aging Circuit Breaker Report</u></b>		
	1. Review report DOT/FAA/AR-01/118 and its recommendations.	October 2003	<b>COMPLETE</b>
	2. Develop strategy for each appropriate recommendation.	January 2004	<b>COMPLETE (5 Recommendations, plus letter to SAE)</b>
	<b><u>B. Single Phase Arc Fault Circuit Breaker</u></b>		
	1. Develop strategy for forward fit.	January 2004	<b>COMPLETE</b>
	2. Develop strategy for retrofit.	<del>July 2004</del> January 2005	<b>COMPLETE (Made Recommendation)</b>
	3. Identify operational and maintenance considerations.	<del>July 2004</del> October 2004	<b>COMPLETE (Made Recommendation)</b>
	4. Specify advisory materials requiring revision.	<del>July 2004</del> October 2005	<b>GREEN</b>
	5. Specify necessary operational and maintenance training areas.	<del>July 2004</del> October 2004	<b>COMPLETE (Made Recommendation)</b>
6. Recommend education of regulators. (NEW)	Pending AC	<b>GREEN</b>	

<u>SUB-TASK#</u>	<u>DESCRIPTION</u>	<u>ESTIMATED COMPLETION DATE</u>	<u>STATUS (RED/GREEN/YELLOW)</u>
<b>12.2</b>			
Review and screen on-going R&D efforts and devise strategies to further develop these products into commercially viable solutions, as appropriate.	<b>A. <u>Material Characterization Report</u></b>		
	1. Review report.	<del>October 2003</del> January 2004	<b>COMPLETE</b>
	2. Make recommendation for dissemination of information, if appropriate.	<del>January 2004</del> April 2004	<b>COMPLETE (No Dissemination)</b>
	3. Make recommendation for dissemination of revised report (due to HWG#12 inputs), if appropriate. Suggested editorial clarifications.	July 2004	<b>COMPLETE (Make Report Public)</b>
	<b>B. <u>Excited Dielectric Test</u></b>		
	1. Review status and the schedule that will be determined after Navy Critical Design Review (contract ends June 2004).	January 2004	<b>COMPLETE</b>
	2. Monitor progress.	July 2004	<b>COMPLETE</b>
	3. Possible field test with ABX.	January 2005	<b>Solely in the Navy's hands. Will not be pursued by FAA.</b>

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<b>12.2</b> Review and screen on-going R&D efforts and devise strategies to further develop these products into commercially viable solutions, as appropriate.	<b><u>C. Fiber Optical Chafe Detection</u></b>		
	1. Review preliminary data.	April 2004	<b>COMPLETE</b>
	2. Make recommendation for dissemination of information, if appropriate.	July 2004	<b>COMPLETE</b> <b>(FAA Tech Note has been issued. Report is not appropriate for dissemination.)</b>
	<u>NOTE:</u> The Navy is now in charge of program.		
	<b><u>D. Wire Indenter</u></b>		
	1. Review report.	October 2003	<b>COMPLETE</b>
	2. Develop recommendations for enhancements to improve utility for wire inspection. Include in Phase II research.	April 2004	<b>COMPLETE</b>
	3. Review Phase II results.	<del>April 2005</del> June 2005	<b>GREEN</b>
	<b><u>E. Wire Performance Specification</u></b>		
	1. Review report.	January 2004	<b>COMPLETE</b>
2. Develop recommendations for consideration in the FAA wire performance project. Draft AC is in progress. Review AC when supplied.	July 2004 TBD	<b>COMPLETE</b> <b>(Made Recommendation)</b>	

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<b>12.2</b> Review and screen on-going R&D efforts and devise strategies to further develop these products into commercially viable solutions, as appropriate.	<b><u>F. Maintenance Effects on EWIS</u></b>		
	1. Review report.	April 2004	<b>COMPLETE</b>
	2. Develop recommendations for enhancements to improve EWIS maintenance practices and non-EWIS practices that impinge upon the EWIS.	January 2005	<b>COMPLETE (Made Recommendation)</b>
	<b><u>G. Effects of Mixed Wire Types in Aircraft EWIS</u></b>		
	0. Review preliminary data.	October 2003	<b>COMPLETE</b>
	1. Review report.	April 2004	<b>COMPLETE</b>
	2. Develop recommendations regarding mixing of wire types in aircraft EWIS.	January 2005	<b>COMPLETE (Made Recommendation)</b>
	<b><u>H. Separation and Segregation in Aircraft EWIS</u></b>		
	1. Review preliminary data and status.	January 2004	<b>COMPLETE</b>
	2. Review report.	October 2004	<b>Original program terminated by FAA. Final report not available for review.</b>
3. Develop recommendations regarding separation and segregation of wire and cables in aircraft EWIS.	July 2005		

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<b>12.2</b> Review and screen on-going R&D efforts and devise strategies to further develop these products into commercially viable solutions, as appropriate.	<b><u>I. Broadband Impedance Measurement</u></b>		
	1. Review report.	October 2004	<b>Final report not adequate for dissemination.</b>
	2. Make recommendation for dissemination of information, if appropriate.	January 2005	
	<b><u>J. Pseudo Random Binary Reflectometry</u></b>		
	1. Review preliminary data and status.	April 2004	<b>COMPLETE</b>
	2. Review report.	<del>April 2005</del> June 2005	<b>GREEN</b>
	3. Make recommendation for dissemination of information, if appropriate.	<del>July 2005</del> October 2005	<b>GREEN</b>
	<b><u>K. Pulse Arrested Spark Discharge</u></b>		
	1. Review preliminary data and status.	April 2004	<b>COMPLETE</b>
	2. Review report.	<del>July 2005</del> October 2005	<b>GREEN</b>
	3. Make recommendation for dissemination of information, if appropriate.	<del>October 2005</del> January 2006	<b>GREEN</b>

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<b>12.2</b>			
Review and screen on-going R&D efforts and devise strategies to further develop these products into commercially viable solutions, as appropriate.	<b>L. <u>Terahertz Reflectometry</u></b>		
	1. Review report.	October 2004	<b>FAA terminated program due to unsatisfactory results.</b>
	2. Make recommendation for dissemination of information, if appropriate.	January 2005	
	<b>M. <u>Wire Degradation Research</u></b>		
	1. Review preliminary data and status.	April 2004	<b>COMPLETE</b>
	2. Review final report.	<del>April 2005</del> June 2005	<b>GREEN</b>
	3. Develop recommendations.	October 2005	<b>GREEN</b>

<u>SUB-TASK#</u>	<u>DESCRIPTION</u>	<u>ESTIMATED COMPLETION DATE</u>	<u>STATUS (RED/GREEN/YELLOW)</u>
12.3 Explore additional opportunities to promote cooperative efforts and partnerships valuable to achieving EWIS R&D objectives.	<b><u>A. Micro Energy High Voltage Wire Tester</u></b>		
	1. Identify maintenance personnel to participate in a blind test of the system.	September 2003	<b>COMPLETE</b>
	<b><u>B. Advanced Risk Assessment Techniques for Aircraft EWIS</u></b>		
	1. Review preliminary data and status.	January 2004	<b>COMPLETE</b>
	2. Identify organizations to participate in reviewing/testing potential techniques. (Cessna and ACO).	April 2004	<b>COMPLETE</b>
	3. Provide preliminary tester feedback to FAA. Project delayed 6 months. Beta testing starts in October 2004.	<del>July 2004</del> <del>April 2005</del> June 2005	<b>GREEN</b>
	<b><u>C. NOVA Test System</u></b>	<b>CANCELLED</b>	<b>COMPLETE (Made Recommendation)</b>

<u>SUB-TASK#</u>	<u>DESCRIPTION</u>	<u>ESTIMATED COMPLETION DATE</u>	<u>STATUS (RED/GREEN/YELLOW)</u>
<b>12.3</b> Explore additional opportunities to promote cooperative efforts and partnerships valuable to achieving EWIS R&D objectives.	<b><u>D. 3-Phase and 28VDC AFCB</u></b>		
	1. Review preliminary data and status.	December 2003	<b>COMPLETE</b>
	2. Review status and make plans.	October 2004	<b>COMPLETE (Made Recommendation)</b>
	3. Continue to monitor progress.	On-going	<b>GREEN</b>
	<b><u>E. Identify other opportunities</u></b>		
	1. Fiber Optical Chafe Detection (Navy and others)	On-going	<b>GREEN</b>
	2. NASA proof of concept wire repair	On-going	<b>GREEN</b>
3. Discussion of /16 wire suitability.	July 2004	<b>COMPLETE (Made Recommendation)</b>	

# Recommendations

# Arc Fault Circuit Breakers

## (Single and 3-phase)

- **Strategies for Retrofit**

- **Installation**

- Grounding is required. Devices can use existing grounding practices
    - Some panel modification may be necessary depending upon AFCB design and should not affect the surrounding installation
    - Some AFCB designs are non-reversible and may include an indicator of proper grounding installation

- **Identification**

- Not necessary from the front since flight crew should not reset
    - Back side differentiation required for recognition by installation and maintenance personnel
    - The software version must be identified either through the overall part number or a software date code.

- **Coordination**

- Current SAE specification AS5692 does not address coordination, therefore tiered AFCB installations are not recommended until requirements are established

# Arc Fault Circuit Breakers

## (Single and 3-phase)

- **Operational and Maintenance Considerations**

- Amendments to maintenance documents regarding installation and testing may be required
- Periodic cycling should be performed at the same intervals as for thermal breakers
- MSG-3 with EZAP should guide the inspection intervals and level of detail
- MSG-3 should guide any required periodic maintenance tasks
- If separate arc fault trip indication is available, then troubleshooting procedures should be revised to focus on wiring first. If no separate indication is available, then existing troubleshooting procedures should be used

# Arc Fault Circuit Breakers

## (Single and 3-phase)

- **Operational and Maintenance Training Areas**
  - Inform flight crew of the operational description of AFCBs
  - Need to maintain good grounding and bonding contacts throughout aircraft life.
- **Advisory Materials Requiring Revision**
  - Will research these documents and provide a listing at the next ATSRAC meeting

# Arc Fault Circuit Breakers

## (Single and 3-phase)

- **Additional Recommendations**
  - Further study is needed on acceptable wire and collateral damage limits when protected by AFCB
  - Continued research into portable test equipment is needed to assist in troubleshooting arc faults
  - Further study is needed to quantify the costs and benefits of AFCB implementation

# Wire Performance TSO?

- **Pros**

- Internalizes the industry specifications to the FAA
- Places a visible FAA approval to the minimum performance of the wire
- Allows non-Part 25 users to select a wire with known properties

- **Cons**

- Might allow for misuse because of perceived approval to install
- TSO approved wire is not appropriate for all applications
- OEMs will still have to set their own specifications
- The tests in the TSO may not be repeatable or appropriate
- ACOs will still need additional guidance in order to grant a TSO ?
- The AC for 25.17xx is adequate guidance
- A TSO does not cover installation aspects

# Wire Performance TSO?

- HWG12 does not believe that a TSO would enhance aviation safety given the guidance in the proposed AC 25.17xx that is extremely valuable, but similar guidance does not exist for Part 23 aircraft. Therefore, HWG12 recommends continued consideration of the information in AC 25.17xx for use in the creation of a similar AC for Part 23 aircraft.
- HWG12 recommends that SAE consider the requirements listed in the proposed FAA document *Minimum Performance Standard for Aircraft Electrical Wires* (supplied to SAE by FAA in October 2004) for inclusion in the SAE specifications that are listed in Table A-1 of AS50881 and Table 11-11 of AC 43.13-1B. (see handout letter to SAE).

# Maintenance Effects & Mixed Wire Types

Harmonization Working Group #12 (HWG12) of the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) has reviewed and discussed the FAA report titled *Effects of Related and Unrelated Maintenance on the Integrity of Aircraft Electrical Interconnect Systems (EWIS)* dated 28 November 2003, compared this information with data from previous ATSRAC research, such as the *Intrusive Inspection Final Report* dated December 29, 2000, and decided to make the following recommendations in line with previous ATSRAC recommendations:

# Maintenance Effects & Mixed Wire Types

- **Training:**

All personnel performing maintenance to EWIS should have received recurrent training as recommended in draft Advisory Circular 120-YY. Training should also be given to personnel who perform maintenance in the vicinity of the EWIS. (It is recognized that this is in conflict with the HWG#11 Final Report, but HWG#12 firmly believes that this training is essential). Training records should be kept current to ensure that repairs are performed by trained personnel.

# Maintenance Effects & Mixed Wire Types

- **Inspection:**

Enhanced Zonal Analysis Procedure (EZAP) draft Advisory Circular 120-XX should place emphasis on the periodic inspection of clamping and routing of wires, along with the incorporation of EWIS cleaning procedures. This recommendation is further supported by the findings of the FAA report titled *The Effects of Mixed Wire Types in Aircraft Electrical Wiring Interconnect Systems (EWIS)*.

# Maintenance Effects & Mixed Wire Types

- **Testing:**

Support the development of portable electrical test equipment that could facilitate the identification and location of areas of compromised electrical wiring on the aircraft.

- **Components:**

Support development of an improved shield terminator to better seal the shield/pigtail interface. ATSRAC should write a letter to SAE stating that: prior to such development, provide limitations on the application of environmental sealing capabilities of existing shield terminating devices in industry standards documentation (see handout letter to SAE).

# Maintenance Effects & Mixed Wire Types

- **Proposal:**

Suggest that operators take digital pictures of unusual damage to the EWIS and that these pictures be kept with the maintenance records. Pictures of the repaired area could be included when appropriate. These pictures could be used to further enhance EWIS training curriculums.

# **Future of HWG #12**

- HWG #12 has nearly completed its original work plan
- Only 1 task will remain after October 2005

DATE: 12 January 2005

**CONDENSED WORK PLAN**

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	4. Specify advisory materials requiring revision.	July 2004 October 2005	<b>GREEN</b>
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	3. Review Phase II results.	<del>April 2005</del> June 2005	<b>GREEN</b>
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**What is ATSRAC's desire for the  
future of HWG #12?**

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# Questions

- **Should HWG #12 identify technologies and knowledge to bring them to ATSRAC's attention?**
- **Does HWG #12 need to wait for tasking from ATSRAC to initiate new study areas?**
- **What role does ATSRAC want HWG #12 to play?**

Thank You