

**Aging Transport Systems Rulemaking Advisory  
Committee**

**Harmonization Working Group 10**

**Small Transport Category Aircraft**

**Final Report and Recommendations**

**February 7, 2003**

<b>BACKGROUND .....</b>	<b>5</b>
<b>EXECUTIVE SUMMARY.....</b>	<b>6</b>
<b>PURPOSE .....</b>	<b>7</b>
<b>ESTABLISHING A HARMONIZATION WORKING GROUP (HWG) .....</b>	<b>8</b>
<b>PART I - NON-INTRUSIVE INSPECTIONS .....</b>	<b>9</b>
<b>Airplane Evaluation Document Development .....</b>	<b>9</b>
<b>Sample Fleet .....</b>	<b>10</b>
<b>Survey Accomplishment Observations .....</b>	<b>11</b>
<b>Survey Results Evaluation Method .....</b>	<b>11</b>
<b>Evaluation Results Summary .....</b>	<b>12</b>
<b>Evaluation Results Summary Matrix.....</b>	<b>13</b>
<b>Non-intrusive Survey Conclusions .....</b>	<b>14</b>
<b>Non-Intrusive Evaluation Recommendations .....</b>	<b>14</b>
<b>PART II - SERVICE DATA REVIEW .....</b>	<b>15</b>
<b>Review Methods .....</b>	<b>15</b>
<b>Service Data Review Results Summary.....</b>	<b>16</b>
<b>Service Data Review Notes.....</b>	<b>16</b>
<b>Service Data Review Recommendations.....</b>	<b>17</b>
<b>PART III – REPETITIVE INSPECTION AIRWORTHINESS DIRECTIVE REVIEW.....</b>	<b>17</b>
<b>Task Statement .....</b>	<b>17</b>
<b>Review methods .....</b>	<b>17</b>
<b>Repetitive Action AD Review Conclusions .....</b>	<b>18</b>
<b>Repetitive Action AD Review Recommendations .....</b>	<b>18</b>

<b>PART IV – INTRUSIVE EVALUATIONS.....</b>	<b>19</b>
Introduction.....	19
Test Procedure .....	19
Samples.....	19
Summary of Findings:.....	20
Recommendations: .....	21
<b>PART V ATSRAC WORKING GROUPS 6 TO 9 - RECOMMENDATIONS RELEVANT TO SMALL TRANSPORT CATEGORY AIRCRAFT.....</b>	<b>22</b>
Methodology .....	22
Sub-Groups.....	22
<b>Harmonization Working Group 6 Work Product Review:.....</b>	<b>22</b>
Background.....	22
Summary of HWG-6 Tasking: .....	23
HWG-6 Tasking Products: .....	23
HWG-10 Conclusion, Recommendations and Rationale.....	23
<b>Harmonization Working Group 7 Work Product Review .....</b>	<b>24</b>
Background.....	24
Summary of HWG-7 Tasking: .....	24
HWG-7 Tasking Products: .....	25
HWG-10 Conclusion, Recommendations and Rationale.....	25
<b>Harmonization Working Group 8 Work Product Review .....</b>	<b>26</b>
Background.....	26
Summary of HWG-8 Tasking: .....	26
HWG-8 Tasking Products: .....	26
HWG-10 Conclusion, Recommendations and Rationale.....	26
<b>Harmonization Working Group 9 Work Product Review .....</b>	<b>27</b>
Background.....	27
Summary of HWG-9 Tasking: .....	27
HWG-9 Tasking Products: .....	27

HWG-10 Conclusion, Recommendations and Rationale.....	28
<b>CONCLUSION AND SUMMARY OF RECOMMENDATIONS FOR SMALL TRANSPORT CATEGORY AIRCRAFT .....</b>	<b>29</b>
<b>ADDITIONAL RECOMMENDATIONS FROM HWG-10.....</b>	<b>31</b>
<b>CLOSING REMARKS .....</b>	<b>32</b>
<b>APPENDIX 1 - ATSRAC HWG-10 MEMBERS AND PARTICIPANTS.....</b>	<b>33</b>
<b>APPENDIX 2 - AGING SMALL TRANSPORT WIRING EVALUATION PROTOCOL ..</b>	<b>35</b>
<b>APPENDIX 3 - SUPPLEMENTAL LABORATORY WIRING TESTS FOR SMALL TRANSPORT AIRPLANES.....</b>	<b>45</b>
<b>APPENDIX 4 – INTRUSIVE INSPECTION REPORT .....</b>	<b>54</b>
<b>APPENDIX 5 – REVISION TO HWG8 APPENDIX A.....</b>	<b>55</b>

## Background

Safety concerns about aging wiring systems in airplanes were brought to the forefront of public and governmental attention by a fatal accident involving a Boeing Model 747-131 airplane on July 17, 1996. The National Transportation Safety Board (NTSB) determined that “the probable cause of the accident was an explosion of the center wing fuel tank resulting from ignition of the flammable fuel/air mixture in the tank.” Although they were unable to determine the specific source of the ignition, the NTSB found several potentially unsafe conditions in and near the electrical wiring of the airplane, including cracked wire insulation, metal shavings adhered to a floor beam along which fuel quantity indication system wires were routed, other debris, and sulfide deposits.

The NTSB also found that deterioration, damage, contamination of aircraft wiring and related components, and unsatisfactory repairs were common in the airline transport airplanes that it inspected during the investigation. According to the NTSB’s report “the condition of the wiring system in the accident airplane was not atypical for an airplane of its age and one that had been maintained in accordance with prevailing industry practices.”

The NTSB found the deteriorated conditions of aircraft wiring systems of particular concern because the existence of these conditions revealed the general shortcomings of the current maintenance practices. As a result of its examinations the NTSB stated that a large portion of the aircraft wiring is difficult, if not impossible, to inspect because of its inaccessibility and that wire damage or other potentially unsafe conditions may not be detected, even on visible and accessible portions of aircraft wiring. The NTSB concluded “insufficient attention has been paid to the condition of aircraft electrical wiring, resulting in potential safety hazards.”

The accident investigation into the July 17, 1996, fatal accident resulted in a heightened awareness of the importance of maintaining the integrity of aircraft wiring. The FAA began to investigate fuel tank wiring, and to strengthen its focus on aging wiring in general. In 1997, the White House Commission on Aviation Safety and Security (WHCSS) issued the following recommendation to the FAA: “In cooperation with airlines and manufacturers, the FAA’s Aging Aircraft Program should be expanded to cover non-structural systems.”

ATSRAC was formed shortly after this mandate. Phase 1 of this program included performing a non-intrusive and intrusive inspection of aircraft wiring. The data collected during these inspections was used to develop recommendations for regulatory agencies and industry to review and make comment. Phase 1 was conducted from 1998 to 2001 through Harmonization Working Groups (HWG) 1 to 5. The recommendations from HWG 1 through 5 lead to the development of a Phase 2 tasking. HWG 6 to 9 were developed to review the data and make the next level of recommendations to ATSRAC and the FAA. The basis of all effort was for Transport Category Aircraft with =30 passengers and/or =7500 pound payloads.

As a result of the Bombardier Aerospace Learjet 35 accident on October 25, 1999, the NTSB recommended to FAA that all Transport Category Aircraft be included in the

Study even though NTSB found no electrical wiring safety related issues in the accident aircraft. In October 2001, Small Transport Working Group (STWG) was formed to assist FAA/JAA in the study. In January 2002, STWG was added to ATSRAC as Small Transport Aircraft Harmonization Working Group 10 (STAHWG10).

In April 2002, the Federal Register announced and established STAHWG10 tasking them to:

1. Investigate the applicability of previous ATSRAC recommendations to small transport airplane electrical wire systems; and
2. Identify issues unique to these (aircraft), systems and recommend appropriate actions based on results from—
  - Performing a sample inspection of in-service and retired small transport airplanes that correlate to the inspection previously performed under the original task 1 and task 2 of the ATSRAC;
  - Reviewing fleet-service history to identify trends or areas for actions; and
  - Coordinating with other ATSRAC Harmonization Working Groups to ensure that the ATSRAC reports to the FAA/JAA consider the needs of small transport airplanes. (i.e. review/modify collateral documents the working group determines to be appropriate and submit them to the ATSRAC for review and approval by January 2003.)
3. Make recommendations to ATSRAC and the FAA/JAA.

HWG-10 began its tasks in earnest starting in April of 2002 to investigate the applicability of previous ATSRAC recommendations to Small Transport Category Aircraft (6 to 30 type certificated passenger load and <7500 type certificated payload) and identify unique issues specific to these as operated in small transport category aircraft operations (e.g. FAR 91 and 135) and recommend appropriate action.

These tasks were to evaluate the airplane wiring installed on representative examples of aging airplanes, review service documents currently available to the fleet for possible additional action, and review existing airworthiness directives, which mandate periodic repetitive inspections for possible terminating action.

## **Executive Summary**

This report provides the results of tasks assigned to the ATSRAC Harmonization Working Group 10.

The document is arranged into five parts with additional information and data contained in the attached appendices. A summary of each activity follows:

**Part I** – The non-intrusive wiring inspections of 39 airplanes identified 2,281 individual discrepancies associated with the condition or installation of the electrical wiring, 73 of

which were deemed significant enough to require additional review for possible corrective action. None of the findings were immediate fleet wide safety of flight concerns. However, one significant item was identified during the aircraft evaluations, which the OEM felt that an engineering review was necessary.

**Part II** – Detailed review of 726 service documents related to airplane wiring did not warrant additional emphasis for incorporation since conditions noted during evaluations did not necessarily correlate with Service Bulletin incorporation or the lack of specific Service Bulletin compliance.

**Part III** – Identify and review repetitive inspection Airworthiness Directives. OEM searches of Airworthiness Directives revealed very few Airworthiness Directives, and all had terminating action. No repetitive Airworthiness Directives were identified, therefore no further action was recommended.

**Part IV** – Intrusively inspect samples of aging aircraft wiring in a laboratory environment to evaluate efficacy of visual inspections. The specimens were provided from in-service aircraft undergoing the evaluation process. With the exception of one, the wiring selected for Intrusive Inspection was wiring removed due to aircraft undergoing avionics modifications.

**Part V** – Review ATSRAC working groups 6 to 9 reports and related work products for recommendation on relevance to Small Transport Category Aircraft. In addition, Part V includes additional recommendations resulting from the survey that are aimed at enhancing present maintenance guidelines and inspection practices.

## **Purpose**

The purpose of this document is to:

- Summarize the results of non-intrusive wiring inspection survey of affected airplane models,
- Provide the results of the service data review,
- Summarize the evaluation of repetitive inspection airworthiness directives applicable to the affected airplane models,
- Summarize the results of intrusive wiring inspection survey of affected airplane models,
- Recommend applicability of ATSRAC working groups 6 to 9 reports and work products to small transport category aircraft.

## **Establishing a Harmonization Working Group (HWG)**

To assist the FAA/JAA in formulating appropriate rulemaking and guidance pertaining to the enhancement of transport airplane systems, ATSRAC was tasked to identify and appoint a Small Transport Category Aircraft Harmonization Working Group (HWG). This HWG was tasked to assist the FAA/JAA in the applicability to Small Transport Category Aircraft of proposed draft advisory circular (AC) and possible rulemaking actions generated by Harmonized Working Groups 6, 7, 8 and 9.

Members of the group were selected for their experience and knowledge of electrical wiring design and installation, on-aircraft maintenance, maintenance program development and/or regulatory oversight of maintenance activities. A balance was achieved between OEMs, operators, regulators and wiring specialists. In accordance with ATSRAC Operating Procedures, an outline of each member's work history was assessed with representatives from ATSRAC in order to confirm the individual's suitability for inclusion in the group.

Task 10 Harmonization Working Group members and participants are listed in [Appendix 1](#).

## Part I - Non-Intrusive Inspections

Original Equipment Manufacturer (OEM) specific working groups, including regulatory agencies from throughout the world and HWG-10 representatives, were tasked with establishing, conducting and summarizing results of a non-intrusive evaluation of the wiring of a representative sample of selected airplane models. The intent of the evaluations were to survey a portion of the fleet using non-intrusive methods, to subjectively assess the overall condition of the fleet with regard to wiring, and to identify any airplane model-unique areas of concern. Each OEM working group was to determine, zone-by-zone, a list of potential or unforeseen problem areas, by paying particular attention to:

1. Wiring, connectors, grounds, circuit breakers, conduits, terminations, etc and its associated hardware in the following areas:
  - Flight critical areas.
  - Areas normally hidden from view.
  - Areas in close proximity to flammable liquids and gases (fuel vapors, oxygen, etc.).
  - High electric current draw areas.
2. Degradation / Damage caused by:
  - High vibration
  - Harsh environments
  - Corrosion
  - High maintenance traffic

*Note: Other than wiring effects, the effects on components for pneumatics, hydraulics, flight control systems, etc., as well as engines and fuel systems were excluded for reasons of priority or the fact that these systems were being addressed under other rulemaking advisory programs.*

When the final non-intrusive inspection areas were identified, an Aging Small Transport Wiring Evaluation Protocol ([Appendix 2](#)) was prepared by HWG-10 to assist in preparing aircraft model specific evaluation protocols. Specific reporting forms outlining the observations were to be used for ease of data compilation. Included in the inspection document for each airplane model were to be details regarding the aircraft undergoing inspection as well as instructions for actions to be taken if discrepancies were found during inspections This protocol was based on the one used by ASTRAC for task 1 and task 2.

### Airplane Evaluation Document Development

The following process outlines the typical working group procedures followed in developing the non-intrusive inspection documents:

- Working Group members performed an initial on-aircraft evaluation of wiring installation areas.
- The wiring evaluations were developed to address each zone containing high current system wiring. Fuel tank zones were excluded per Fuel Systems Safety Assessment agreement, i.e., another industry/FAA effort is already addressing these areas.
- Evaluation instructions for these non-intrusive evaluations were drawn from ATA Specification 117, Wiring Maintenance Practices / Guidelines and the FAA's recently developed "Aircraft Wiring Practices" training document.
- The evaluations were performed without specific inspection criteria and were based on the expert opinion of the individual performing the evaluation.

### Sample Fleet

Approximately 8,600 multi-engine, turbine-powered small transport category aircraft fitting HWG-10's scope are in operation. Five OEMs were represented in the HWG-10 committee: Bombardier, Cessna, Dassault Aviation, Gulfstream Aerospace, and Raytheon. The HWG-10 came to a conclusion that a sample of 40 aircraft from these five OEM's would be representative enough and practical for reaching a conclusion within the limited timeframe requested by the ATSRAC committee.

The HWG-10 further refined the requirement to target aircraft with approximately:

- 15 years or older,
- Approximately 7500 flight hours
- Approximately 5000 cycles/landings.

*Note: The Model Specific information has been purposely omitted because of the initial agreement with ATSRAC and the Owner/Operators of the aircraft used in the evaluation.*

A total of 39 aircraft were inspected. The following is a summary of the sampling size for each affected model:

<b>Aircraft Type</b>	<b>Number of AC inspected</b>	<b>% Of the Model Fleet</b>	<b>Age Range</b>	<b>Hour Range</b>	<b>Cycles Range</b>
<b>Model A</b>	5	5.90%	19 to 21	4,785 to 7,835	4,846 to 5,684
<b>Model B</b>	5	2.90%	11 to 24	4,130 to 12,001	3,473 to 8,558
<b>Model C</b>	5	0.61%	10 to 18	3,258 to 8,413	2,682 to 5,692
<b>Model D</b>	5	0.90%	18 to 25	7,223 to	5,709 to

				12,408	9,873
<b>Model E</b>	4	2.10%	11 to 12	4,130 to 8,083	2,746 to 7,498
<b>Model F</b>	5	1.14%	20 to 30	8,770 to 17,389	4,843 to 8,500
<b>Model G</b>	5	1.05%	12 to 15	4,271 to 5,904	2,638 to 3,389
<b>Model H</b>	5	0.80%	11 to 32	3,572 to 13,014	3,187 to 13,252

### Survey Accomplishment Observations

The number, location, and availability of targeted survey aircraft, and the configuration differences between those aircraft resulted in different inspection duration and man-hours between aircraft and between aircraft models. The number of airplane zones targeted and inspected, as well as the size of the airplane, has significant influence over the amount of time spent inspecting each airplane. Estimates are that between 8 and 35 man-hours were spent conducting the inspection on each airplane model.

The total number of items noted during each airplane inspection is highly dependent on the number of zones inspected, the total number of airplanes inspected, and at which maintenance inspection point during the aircraft visit the electrical evaluation was conducted.

### Survey Results Evaluation Method

The applicable model evaluation working groups individually evaluated every documented discrepancy from the inspected airplanes for significance. For evaluation purposes, each item was grouped using the following criteria:

- Immediate Fleet Wide Safety of Flight Concern: A discrepancy or safety of flight concern requiring immediate fleet action. Impending critical failure seen in the sample.
- Potential Hazard or Frequently Occurring (Significant) Item. A defect, which may require design changes or notification for enhanced inspection based on:
  - Potential hazard (e.g. fire, bundle damage, essential system damage), or
  - Frequency of occurrence at a specific location

*Note: Though no other signs of degradation may have been apparent, all fluid/chemical contamination findings were typically grouped under this heading due to the unknown long-term deterioration effects. An exception to this would be degradation that would obviously pose no hazard.*

- Defects Noted (Non-Significant Item). A minor discrepancy not requiring any fleet action. Isolated repair seen in the sample.

Even though the evaluators receive an official training session, by nature of the detailed visual examination, the models, and evaluator experience, these results varied somewhat from inspector to inspector; hence emphasis was placed on the consistent use of the evaluation format for each individual airplane model, and on the evaluation format. Since the same evaluation crew could not be used on all airplane models, variations may exist between models. All individual items noted during the evaluation were brought to the attention of the operator for corrective action consideration.

### **Evaluation Results Summary**

The non-intrusive wiring inspections of 39 airplanes identified 2,281 individual discrepancies associated with the condition or installation of the electrical wiring, 73 of which (or 3.20% of the total) were deemed significant enough to require additional review for possible corrective action. None of the findings resulted in immediate fleet wide safety of flight concerns

As detailed in the following matrix, the following highlights should be noted:

- Installation (general) findings represented 85% of the total findings and 69% of the significant ones.
- Wiring conditions represented 11% of the total findings and 31% of the significant ones.
- Connectors and terminations represented less than 5% of the total findings with no significant instance.

## Evaluation Results Summary Matrix

Note: The Model Specific information has been purposely omitted because of the initial agreement with ATSRAC and the Owner/Operators of the aircraft used in the evaluation.

Aircraft Wiring Installation/Condition Report Summary																																		
NOTE: The enclosed data reflect raw numbers. Comparison between fleet types requires this data to be normalized to account for aircraft in each fleet type, zones inspected and bias induced by each individual work group.	CONNECTORS						TERMINATIONS				INSTALLATIONS (GENERAL)										WIRING CONDITION													
	INSERT DAMAGE/DETERIORATION	CONTACT ARCING/FRETTING	MISSING DUMMY CONTACTS/SEAL PLUGS	MISSING/DAMAGED BACKSHELLS	CONNECTOR BACKSHELL STRAIN RELIEF	LOOSE OR WORN B-NUTS	OTHER	GROUND POINTS - CONDITION/SECURITY	INADEQUATE DRIP LOOPS(S)	CORRECT HARDWARE BUILDUP/TORQUE	HEAT DAMAGE/CORROSION	OTHER	INADEQUATE CLEARANCE TO STRUCTURE	MISSING/DETERIORATED PRESSURE SEALS	SLEEVING/CONDUITS CONDITION	BEND RADIUS (10x WIRE/BUNDLE DIAMETER)	CLAMP CONDITION/SIZING/SPACING	MISSING/DETERIORATED GROMMETS	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	EXCESSIVE SLACK/SAG BETWEEN CLAMPS	T-STRIP CONDITION/HARDWARE BUILDUP	SIGNIFICANT DUST AN LINT BUILDUP	OTHER	PREVIOUS REPAIRS/CONDITION OF	HEAT/VIBRATION DAMAGE	INDIRECT DAMAGE (HYD, PNEU LEAKS)	CRACKED/ABRADED INSULATION	BROKEN SHIELD/CONDUCTORS	EXPOSED CONDUCTORS/SHIELD	FLUID/CHEMICAL CONTAMINATION	CORROSION	OTHER	TOTALS	
Model A	0	0	1	0	17	0	0	2	7	0	0	4	118	3	25	35	77	8	57	29	9	54	34	9	0	2	12	4	24	24	0	6	561	
Model B	0	0	0	1	0	1	4	0	0	0	0	2	99	0	11	25	42	9	7	23	0	12	24	3	3	0	15	16	5	11	0	4	317	
Model C	6	0	0	0	8	2	1	0	0	1	0	0	161	0	4	15	70	2	7	3	0	1	11	1	0	1	6	1	13	1	0	0	315	
Model D	0	0	0	4	0	0	4	0	2	3	0	11	56	0	4	15	109	7	6	0	3	1	7	0	0	0	3	0	0	3	0	1	239	
Model E	0	0	0	0	3	0	0	0	0	0	0	0	65	0	7	7	69	3	2	0	2	0	6	1	2	0	3	0	0	5	0	3	178	
Model F	1	0	0	1	3	0	0	0	1	0	0	0	98	0	0	36	12	10	4	4	0	6	65	0	0	0	19	1	1	8	0	2	272	
Model G	0	0	0	0	0	0	0	0	0	0	0	0	118	0	4	9	6	3	0	5	0	0	7	0	0	0	2	0	1	1	0	0	156	
Model H	0	0	4	1	0	0	0	0	0	0	0	13	103	0	14	15	34	4	4	4	0	2	13	0	0	2	6	16	1	3	1	3	243	
<b>Totals</b>	<b>7</b>	<b>0</b>	<b>5</b>	<b>7</b>	<b>31</b>	<b>3</b>	<b>9</b>	<b>2</b>	<b>10</b>	<b>4</b>	<b>0</b>	<b>30</b>	<b>818</b>	<b>3</b>	<b>69</b>	<b>157</b>	<b>419</b>	<b>46</b>	<b>87</b>	<b>68</b>	<b>14</b>	<b>76</b>	<b>167</b>	<b>14</b>	<b>5</b>	<b>5</b>	<b>66</b>	<b>38</b>	<b>45</b>	<b>56</b>	<b>1</b>	<b>19</b>	<b>2281</b>	
Safety of Flight Concerns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Significant Items	0	0	0	0	0	0	0	0	0	0	0	1	28	0	0	5	3	7	3	2	3	0	3	3	3	0	0	1	1	12	1	0	0	73

## **Non-intrusive Survey Conclusions**

Upon analyzing the sampling results it was observed that the majority of all reported items were listed as inadequate clearance to structure and improper clamp condition/sizing/spacing.

Furthermore, a number of findings were identified as either debris accumulation on wire bundles, dust and lint observed, but not to a level comparable to that reported in the Large Transport Aircraft, this includes fluid/chemical contamination.

## **Non-Intrusive Evaluation Recommendations**

Since these aging aircraft are currently in service, all having several changes and upgrades to the interior configurations, avionics and electrical systems, the HWG-10 believes that these condition and findings show the general shortcomings of the current maintenance practices.

These results indicate that the majority of the findings are related to improper practices for installation, maintenance, and housekeeping. These results could be prevented through:

- Awareness and Training
- Installation Guidance
- Enhanced Maintenance Procedures
- Inspection Criteria

One OEM reported the aircraft evaluations discovered a significant item that would require additional engineering analysis. In addition, all OEMs expressed intentions to review the collected data at their regularly scheduled continued improvement maintenance reviews.

## Part II - Service Data Review

### Review Methods

The airplane manufacturers conducted a keyword search of in-service data such as service bulletins, operator in-service reports, and other customer contact reports using the following keywords. Furthermore, a keyword search was also performed by the regulatory agencies (FAA, JAA and TC) to ensure that the airplane manufacturers had all pertinent data to perform the Service Data Review.

- arc, arced, arcing, arcs,
- black, blackened,
- burn, burned, burns, burnt,
- burndy,
- cannon,
- chafe, chafed, chafes, chafing,
- connector,
- electric,
- electrical,
- electronic,
- fire,
- flash, flashed,
- ground,
- intermittent, intermittently,
- open,
- resistance,
- shield, shielded, shielding, shields,
- short, shorted, shorting,
- smoke, smoked, smoking,
- spark, sparked, sparking, sparks,
- splice,
- strip,
- terminal,
- thermal,
- track,
- wire.

All systems, including engines and fuel systems, were included in this search. The resulted lists were then provided to the OEM working groups for categorization using the following criteria:

#### Category Criteria

- A) Potential origins for smoke from an uncontained heat source, fire, arcing, sparking, chafing in pressurized areas or, high current draw or, materials that may propagate a fire in areas of potential ignition sources
- B) Potential origins for smoke from an uncontained heat source, fire, arcing, sparking, chafing in non pressurized areas or, potential origins for smoke from contained heat source or chafing in pressurized areas or low current draw
- C) Events that could produce arcing/sparking during maintenance but not during normal operation.

*Note: Items associated with possible personnel shock, including flight crew or passenger, were also classified as category C.*

## Service Data Review Results Summary

The following is a summary of the categories for each affected model:

<b>Aircraft Model</b>	<b>A</b>	<b>B</b>	<b>C</b>
Model A (SB)	8	23	0
Model A (ISR)	65	123	0
Model B (SB)	10	2	0
Model B (ISR)	1	0	0
Model C (SB & ISR)	6	20	28
Model D (SB)	13	13	14
Model D (CCR)	38	47	3
Model E (SB)	15	9	1
Model E (CCR)	32	23	17
Model F (ISR)	1	0	0
Model F (ACB/CB)	5	4	3
Model G (ISR)	4	14	0
Model G (ACB/CB)	2	4	1
Model H (SB)	41	30	0
Model H (ISR)	62	44	0
<b>Total</b>	<b>303</b>	<b>356</b>	<b>67</b>

### Legend:

<i>SB:</i>	<i>Service Bulletin</i>
<i>ISR:</i>	<i>In Service Reports</i>
<i>CCR</i>	<i>Customer Contact Reports</i>
<i>ACB/CB</i>	<i>Alert Customer Bulletins/Customer Bulletins</i>

### Service Data Review Notes

- Evaluation Findings were identified primarily in the following areas
  - Wing Trailing Edge Bundles – Confined space with moving mechanisms
  - Equipment Bays – Many wires in a localized area
  - Cabin Doors – Have to route wiring around opening and door mechanisms

- Behind Instrument Panels – Confined space
- In Service Report Tracking was limited to the timeframe of computerized databases

### **Service Data Review Recommendations**

Due to the nature of the observations and the emphasis now being placed on wiring, the HWG-10 recommends:

- The OEMs will continue review of future in-service data items with close attention being focused on the Category A and B issues.
- FAA & Industry will improve training for both approval, design, installers, and maintenance personnel

Several OEMs further recommended enhancing their maintenance instructions for continued airworthiness to include and/or improve their wiring inspection program to prevent similar occurrences in the future.

One OEM suggests that additional analytical work on how to reduce the wire count and wire size in small transport category aircraft might be productive while investigating the use of alternative signal techniques (e.g. wireless.)

*Note: WG10 would like to emphasize that ISR are voluntary in the small transport category aircraft operating world. The results of evaluations, clearly illustrate interdependency between operators and manufacturers for aircraft operated with these established processes and best business practices.*

## **Part III – Repetitive Inspection Airworthiness Directive Review**

### **Task Statement**

Review any airworthiness directives that require repetitive inspections and determine if continued inspections are warranted, or if a terminating action is appropriate.

### **Review methods**

Each OEM developed a list of repetitive inspection airworthiness directives by selecting only those ADs applicable to airplanes systems, ATA Chapters 00 through 49.

Factors considered were:

- a) Frequency of inspection
- b) Possibility of damage or other adverse impact due to frequent inspections
- c) Cost (labor & material) of terminating action
- d) Downtime for terminating actions

- e) Parts availability for terminating action

This listing of systems ADs was to be evaluated using the following criteria:

- a) Description: Provide a brief description of the airworthiness concern and the required actions.
- b) Current Inspection Intervals: List the current inspections and intervals associated with each task
- c) Qualifying AD: Ensure that there is a condition on the world fleet of aircraft where the inspection activity required does result in a sufficient frequency (as determined by the working group) of negative findings. Further insure that the AD affects more than 5% of the world's population of aircraft for that fleet.
- d) Existing Terminating Action: Determine if there currently exists an effective terminating action. Further insure any terminating action called out in the AD is an effective answer to the airworthiness concern. Use operator, OEM, or FAA data as available to the group to make this determination.
- e) Effectiveness of Existing Repetitive Inspections: Determine if the current repetitive inspections are an effective method of satisfying the airworthiness concern. Explain why or why not.
- f) ADs Requiring Improvement: Ensure that the actions called out in the AD are satisfactory in addressing the airworthiness concern. If not, make a note on this item that the AD needs improvement and state why. Do not attempt to develop improvement actions at this point. Only evaluate the AD actions.

The applicable OEM was to determine whether or not the AD should be listed as a candidate for mandated terminating action using the information developed in the above questions.

### **Repetitive Action AD Review Conclusions**

There were no repetitive Airworthiness Directives related to wiring identified during the service data review.

### **Repetitive Action AD Review Recommendations**

HWG-10 has no recommendations, as there were no repetitive Airworthiness Directives related to wiring identified during the service data review.

## Part IV – Intrusive Evaluations

### Introduction

This is a summary of the ATSRAC working group 10 small transport wire testing conducted by Raytheon Technical Services Company (RTSC). The complete report can be found in [Appendix 4](#).

Samples of electrical wire were removed from three small transport aircraft that had been in service for a period of time. The wire was inspected and tested to determine the condition of the wire. Similarities of the aging of electrical wire in small transport aircraft and large transport aircraft are unknown.

### Test Procedure

The specimens were subjected to the test protocol provided by HWG 10. Following the visual inspection of the harness, the harnesses selected for further evaluation were broken down and random wires chosen from the outside and inside of the harness. These wires were intrusively inspected by observing all physical aspects of the wire and examining with a microscope any area that appeared unusual. Wires that contained some type of contamination from chemicals or corrosion were sent for analysis.

The wire specimens were then subjected to a series of electrical, physical, and environmental tests to determine the condition of the wire relative to the original performance specifications. Portions of the specimens were sent to Underwriter's Laboratories (UL) for verification testing.

The specimens were subjected to the following tests as defined by the WG10 test Protocol:

- Insulation Resistance (IR) and Dielectric Withstand Voltage (DWV)
- Conductor Resistance
- Dynamic Cut-Through
- Wrap or Mandrel Bend and DWV, Wrap and DWV after thermal exposure
- Insulation Tensile and Elongation

Results were recorded and are presented in table format. ([Appendix 4](#))

### Samples

Sixty-Four (64) harnesses were received from three different aircraft models. The samples were received pre-marked, with a few exceptions, and submitted to the test protocol. The age of Aircraft A is 32 years, Aircraft B is 20 years and Aircraft C was 19 years.

## Summary of Findings:

A series of samples were submitted to RTSC for evaluation. A total of 64 harnesses from three aircraft were received. These samples were examined for their condition. The initial examinations found that the wire was in generally good condition. Upon closer examination, a large number of specimens were found to contain discoloration, corrosion, and cracking and chafing, along with other signs of wear. Specimens were removed from four samples from Aircraft A, Five samples from Aircraft B, and five samples from Aircraft C for further analysis.

- Aircraft A: Intrusive visual examination of removed specimens indicated that the wire from Aircraft A was cracked in many places, although further microscopic evaluation revealed that the cracking was limited to the outer jacket, and the DWV for the specimens continued to pass, indicating that the cracks did not pass through to the conductors. The diameters were compared to a similar specification, and the intended size could not be determined. These specimens were subjected to a number of electrical, physical and environmental tests to determine their integrity as electrical wires. Test results indicate that the wires, except for one specimen, continue to maintain their electrical integrity, although their insulation resistances were somewhat low compared to similar specifications. Results based on the low elongation values, indicate that the PVC insulation in certain samples has decreased dramatically, and may be determining that the insulation itself is becoming brittle. This may cause concern if the wire were to be subjected to much flexing or maintenance that may move the wires substantially.
- Aircraft B: The specimens from Aircraft B were highly discolored, but continued to maintain their electrical integrity. These wires also continued to meet all requirements expected of new wire, although their insulation resistances were somewhat low compared to similar specifications. All test results indicate that the wire appears to remain in very good condition.
- Aircraft C: The MIL-W-22759/16 wire type, which was prevalent in the aircraft, had many IR and DWV failures (18%, 5 of 21 specimens). These appeared to be mainly due to physical damage to the insulation. The two wire types present in this aircraft appeared to meet the original specification requirements otherwise, even after the thermal exposures on a different location of the same specimens.

There were difficulties identifying some of the wire types (no markings). The closest specification requirements that could be found were used to determine test parameters and new wire requirements. As noted by the differences in the diameters of the wire from aircraft A, and since these wires were not actually marked with the military specification part number as required for that specifications, these were not the exact specifications.

Comparisons of these test results to the test results of the ATSRAC Intrusive Inspection of Large Transport Aircraft indicate a few differences. For the most part, visually these wires tended to be in better condition than the wire of the large transports, with fewer incidences of damage and better appearance. The test results however, indicate that

electrical failures that cannot be visually identified continue to arise. The closer the visual examination, the more problems found. Contaminated areas of the wire specimens did not show increased cracking in B or C specimens, but the A specimen did exhibit cracking at exactly the same location as the contamination. It is unknown whether the contamination induced the cracking or whether the cracking allowed for the discoloration to occur.

The visual examination of these wire specimens on a very general scale indicated that the wires appeared to be fairly clean with little contamination, however, upon closer examination the presence of lint, shavings, contamination, and physical damage was evident. Most of the damage appears to have been incurred by mechanical means, such as chafing, nicks, etc. The performance tests suggest that although the wire is degenerating, it continues to maintain its ability to perform electrically unless specific physical damage has occurred.

### **Recommendations:**

Upon reviewing the findings HWG 10 concludes that for the most part, visually the wires tended to be in better condition than the wire of the large transports, with fewer incidences of damage and better appearance and that most of the damage appears to have been incurred by mechanical means, such as chafing, nicks, etc. HWG 10 recommends the following:

- Enhanced scheduled maintenance program with emphasis on wiring be created by OEM and approved by the FAA
- Wiring awareness program to be accomplished by the FAA and Industry
- Introduction of a training program to be accomplished by the FAA and Industry

## Part V ATSRAC Working Groups 6 to 9 - Recommendations Relevant to Small Transport Category Aircraft

### Methodology

Harmonization Working Group 10 (HWG-10) was established to investigate, based upon the findings identified in the foregoing, the applicability of previous ATSRAC recommendations (HWG 6, 7, 8 and 9) and to identify unique issues specific to Small Transport Category Aircraft.

To facilitate this task, the HWG-10 created 4 sub-groups with the appropriate level of representation from industry to review the final reports and proposed rulemaking and guidance submitted by HWGs 6, 7, 8 and 9.

Each sub-group was tasked with providing its recommendations to HWG-10. This section summarizes the background work from each sub-group, and provides conclusions and recommendations from HWG-10.

### Sub-Groups

The attached table lists participants for each sub-group:

<b>WG – 6 Design</b>	<b>WG – 7 ESPWM</b>	<b>WG –8 Training</b>	<b>WG-9 EMP</b>
* Jerome Bruel	* Karl Eisenmenger	* Mike Richardson	* Mike Sevigny
* Pete Philips	Barry Ballenger	Mike Bruno	Bertrand d'Yvoire
Dominique Bellon	Eli Cotti	Guy Debien	Jon Haag
Ken Elias	Ron Grose	Bob Marinace	Tony Heather
Frank Keefer	Ric Peri	Steve O'Neal	Michel Larhantec
Norm Hunt		Mike Sevigny	Ric Peri
Bill Miller		Jack West	Rich Wagner

\* = Subcommittee Chairs

### Harmonization Working Group 6 Work Product Review:

#### Background

HWG-10 was tasked to evaluate the report of ATSRAC Harmonization Working Group Task 6 (HWG-6), Wire Systems Certification Requirements, and its relevance to the Small Transport Category Aircraft.

### Summary of HWG-6 Tasking:

- 6.1 through 6.3 Administrative in nature
- 6.4 Combine Current Wire Systems Regulations into One Section
- 6.5 Identify Design Requirements to Mitigate Problems of Aging in Wire Systems
- 6.6 Identify Requirements for Wire System Safety Assessments
- 6.7 Identify Requirements for Wire Separation
- 6.8 Identify Requirements for Wire Identification
- 6.9 Recommend Advisory Material for the New Wire Systems Rules

### HWG-6 Tasking Products:

- 6.1 through 6.3 N/A
- 6.4 Proposed a New FAR/JAR Part 25 subpart (H) and revisions to some existing regulations
- 6.5 Resulted in the creation of proposed new and revised regulations. Advisory material was developed to support the new/revised regulations.
- 6.6, 6.7, and 6.8 Resulted in the creation of proposed new/revised regulations and advisory material
- 6.9 Advisory Material was developed to support new/revised regulations.

### HWG-10 Conclusion, Recommendations and Rationale

HWG-10 performed a review of the HWG-6 work product and the relevance to small transport category aircraft. The review was based on the aircraft evaluations performed, service history review performed, and the HWG-6 final report.

HWG-10 concludes the following:

HWG-10 agrees that HWG-6 fulfilled the task placed upon it by FAA. HWG-10 agrees in principle with HWG-6 proposals and that the concepts contained in those proposals are applicable to small transport category aircraft.

Notwithstanding the HWG-10 Conclusion stated above, the evaluation results do not support the proposed rulemaking change contained in Subpart H to FAR 25 for the small transport category airplanes. HWG-10 believes, with the exception of proposed paragraphs 25.1705, 25.1709 and 25.1711 that the current FAR 25 regulations adequately address the findings of HWG-6, and that proposed Subpart H is not necessary to achieve the desired level of safety for small transport category aircraft.

#### Rationale

- a. The small transport category aircraft evaluations findings do not support the need for the proposed certification regulations with the exception of

the above stated proposed rulemaking changes that are discussed below under items 2 and 3. Aircraft evaluations clearly indicated that improvements could be made in the following areas:

- i. Awareness and Training
  - ii. Installation Guidance
  - iii. Maintenance Procedures
  - iv. Inspection Criteria
  - v. Enforcement of current regulations
- b. Duplicate rules create complexity and confusion and also tend to drift apart with use resulting in conflicting interpretations, diverging requirements, and gaps in coverage.

HWG-10 recommends that the concepts of 25.1705 be incorporated into the AC/ACJ 25.1309 in order to adequately address the Electrical Wiring Interconnection Systems (EWIS).

HWG-10 recommends that the concepts of 25.1709 and .1711 be incorporated into 25.1351 or stand alone .1300 series rules (e.g. 25.1352 and 25.1354).

**NOTE:** ATSRAC DOES NOT AGREE WITH THE ABOVE CONCLUSION BECAUSE OF THE SIMILARITY OF INSPECTION RESULTS BETWEEN LTA AND STA FLEETS.

HWG-10 Recommendation:

1. Definition of EWIS 25.1701 needs to be incorporated into FAR Part 1.

**Harmonization Working Group 7 Work Product Review**

Background

HWG-10 was tasked to evaluate the report of ATSRAC Harmonization Working Group Task 7(HWG-7), Electrical Standard Wire Practices Manual (ESWPM) and its relevance to the Small Transport Category Aircraft.

Summary of HWG-7 Tasking:

- |     |   |
|-----|---|
| 7.1 | Develop recommendations for ESWPM to be used to create an FAA AC, which lists the topical areas for a Standard Wiring Manual. |
| 7.2 | Administrative in nature.   |
| 7.3 | Define a Standard Format for a Standard Wiring Practice Manual.   |
| 7.4 | Define a Minimum Standard Content for the ESWPM.  |
| 7.5 | Recommend Updates of Existing ESWPMs.   |

## HWG-7 Tasking Products:

- |     |  |
|-----|--|
| 7.1 | Guidance for a Draft Advisory Circular for a Standard Wiring manual. |
| 7.2 | N/A.   |
| 7.3 | Proposal for a Master Breakdown Index (MBI).                         |
| 7.4 | Minimum Standard Content for the ESWPM.                              |
| 7.5 | Timeframe for Updates of Existing ESWPMs.                            |

## HWG-10 Conclusion, Recommendations and Rationale

HWG-10 performed a review of the HWG-7 work product and the relevance to small transport category aircraft. The review was based on the aircraft evaluations performed, service history review performed, and the HWG-7 final report. HWG-10 agrees with the form and content, generally, as described in HWG-7 final report and work product. However, HWG-10 does recommend the following:

1. ATSRAC in the section “Inspection Methods” – expand the statement: “as determined by the enhanced zonal analysis procedure”. The statement should read “ as determined by the enhanced zonal analysis procedure or equivalent process”.

### Rationale

Part 25 Small Transport category aircraft operating under (Part 91 and Part 135) have equivalent inspection programs that may not be linked to Zonal Inspection concepts.

2. ATSRAC’s use of the terminology “Component Manufacturer” and “EWIS Component Manufacturer” should be carefully chosen.

### Rationale

To distinguish between Line Replaceable Units and Wire System Components so that there is no confusion as to the intent of ATSRAC.

*Note: Although the MBI may be of some value especially in the larger transport aircraft, mixed fleet, and service center environment, we do not see added value in the concept of regulating the form that this information is placed in for the small transport category aircraft environment.*

3. Recommend to the FAA that better defined structure, content, and standards for how the MBI will follow ATA or FAA JASSC standards are needed.

We recognize that accomplishing this may be beyond the tasking of ATSRAC, but it is an industry recommendation and is needed.

### Rationale

Current ATA standards are inadequate to address wiring as a system. Appropriate guidance is needed to properly define the MBI and to be used in general application. The advisory circular and other ATSRAC

recommendations appear to use the FAA coding system JASCC. This may not be acceptable for application worldwide where ATA is considered the standard. HWG-10 recommends ATA expand the ATA coding system to better define wiring as a system.

4. Replace the word “airline” in the appendix tables with the words “airline and/or owner operator”.

Rationale

To make the document more universal in application.

## **Harmonization Working Group 8 Work Product Review**

### Background

HWG-10 was tasked to evaluate the report of ATSRAC Harmonization Working Group Task 8 (HWG-8), Enhanced Training Program (ETP) and its relevance to the Small Transport Category Aircraft.

### Summary of HWG-8 Tasking:

- |     |   |
|-----|---|
| 8.1 | Administrative in Nature                          |
| 8.2 | Administrative in Nature                          |
| 8.3 | Develop Guidance for Wire System Training Program |
| 8.4 | Identify SWPM Recurrent Training                  |

### HWG-8 Tasking Products:

- |     |                          |
|-----|--------------------------|
| 8.1 | N/A.                     |
| 8.2 | N/A.                     |
| 8.3 | Draft Advisory Circular. |
| 8.4 | Draft Advisory Circular. |

### HWG-10 Conclusion, Recommendations and Rationale

HWG-10 performed a review of the HWG-8 work product and the relevance to small transport category aircraft. The review was based on the aircraft evaluations performed, service history review performed, and the HWG-8 final report.

Based on the aircraft evaluations, HWG-10 recognizes the definite need for enhanced training for TC and STC holders, approvers, designers, installers, and technicians in the small transport category aircraft industry. However, there are differences between how small transport category aircraft and large transport aircraft are structured in operation. The Advisory Circular is tailored to the “Airline” industry with the various target groups that may not match the operations of Part 91.

HWG-10 recommends the following:

1. FAR Part 147 Appendix E is revised to include the concepts of AC 120-yy (EWIS, Detailed Inspection (DET), General Visual Inspection (GVI), and Special Detailed Inspection (SDI)).

Rationale

- a. A culture change is needed in the small transport category aircraft industry that should be a “ground up” approach. (e.g. future technicians are trained from day one on EWIS concepts)
2. Training is emphasized for both applicants and approvers to achieve compliance with existing regulations and current industry recurrent training requirements (i.e. Inspection Authorization renewal, Designated Engineering Representative recurrent training, and various small transport category aircraft industry seminars held throughout the year).

Rationale

The small transport category aircraft industry currently has training opportunities available in which the concepts described in AC 120-yy could be communicated to a large portion of the community on an annual or biannual basis.

3. In the advisory circular related to HWG-8 add an additional column in the table for a 9th and 10th categories related to “General Aviation” (see Appendix 5).

## **Harmonization Working Group 9 Work Product Review**

### Background

HWG-10 was tasked to evaluate the report of ATSRAC Harmonization Working Group Task 9 (HWG-9), Enhanced Maintenance Practices (EMP), and its relevance to the Small Transport Category Aircraft.

### Summary of HWG-9 Tasking:

- |                 |   |
|-----------------|---|
| 9.1 through 9.2 | Administrative in nature  |
| 9.3             | Develop Guidance for Enhance Maintenance Criteria   |
| 9.4             | Assist in development of SFAR for performance of Enhanced Zonal Analysis Procedure (EZAP) |
| 9.5             | Recommend wire system instructions for continued airworthiness                            |

### HWG-9 Tasking Products:

- |                 |  |
|-----------------|--|
| 9.1 through 9.2 | N/A  |
| 9.3             | Proposal of guidance Advisory Circular AC120-XX                  |
| 9.4             | Resulted in the creation of proposed SFAR and NPRM               |
| 9.5             | Resulted in the proposed revision of FAR Appendix H to Part 25.3 |

## HWG-10 Conclusion, Recommendations and Rationale

HWG-10 performed a review of the HWG-9 work product and the relevance to small transport category aircraft. The review was based on the aircraft evaluations performed, service history review performed, and the HWG-9 final report.

HWG-10 recommends the following:

1. HWG-10 concurs with HWG-9 final report and tasking products. HWG-10 also recommends revision to the 25.1529 requirements from “EZAP” to “EZAP or equivalent analytical logic procedure”.

### Rationale

The small transport category aircraft maintenance programs are developed by the OEMs whose philosophy may differ from a zonal approach. HWG-10 agrees that some type of analytical logic be used. However, the determination of the approach should be consistent with the current philosophy of each OEM.

2. HWG-10 recommends the OEMs of small transport category aircraft perform a review of current maintenance programs to ensure that the EWIS concepts are incorporated. The OEMs should enhance their maintenance programs with additional requirements based on their aircraft design, HWG-10 aircraft evaluations, and their service histories. These OEM enhanced maintenance programs will be reviewed and approved by regulatory authorities for compliance with EWIS enhanced maintenance.

### Rationale

Based on the findings of the aircraft evaluations it has been shown the need to enhance the current maintenance programs to ensure that EWIS concepts are incorporated.

3. HWG-10 recommends an exemption from HWG-9 tasking products on previously installed Supplemental Type Certificated installations in regards to small transport category aircraft provided the enhanced maintenance programs are approved by regulatory authorities. (See item 2. above)

### Rationale

- a. Currently, there are approximately 15,000 STC's registered with the FAA.
  - i. Each STC would require a revisit and review for potential impact on wiring.

*Example of man hours involved in the review:*

*Approximate average of 8 man hours per STC review would entail 120,000 man hours of work or 57.60 man years of work.*

- b. There are approximately 8,600 small transport category aircraft currently registered with the FAA. A large majority of these aircraft are unique in nature (i.e. corporate interiors, avionic packages...). The ratio of owner/operator to these aircraft is 1 to 1.4.

- i. Orphan STC's would be very costly to the owner/operators because of lack of expertise and lack of STC certification documentation.

## **Conclusion and Summary of Recommendations for Small Transport Category Aircraft**

HWG-10 performed a representative non-intrusive wiring evaluations of 39 small transport category aircraft and found conditions somewhat similar in nature to those found on large transport aircraft. Only a fraction of the findings were deemed important enough to require additional review for possible corrective action. None of the items were immediate fleet wide safety of flight concerns. One significant item was found that required the OEM to take the finding back their engineering department for additional analysis.

Nevertheless, there are notable and unique differences in operation and maintenance of the small transport category aircraft that merit attention:

1. Small transport category aircraft tend to conform to OEM (OEM has ownership) maintenance programs. Aircraft operators do not develop their own maintenance programs.
2. Small transport category aircraft are typically unique configurations. Each owner specifies a different interior or avionics options.

These differences have the end-result to render a broad application of certain aspect of the proposed rules designed for large transport aircraft rather difficult to implement for small transport category aircraft. In this report, the HWG-10 has attempted to put forward a recommendation to the ATSRAC committee that maximizes safety enhancement with practical implementation in mind.

The aircraft evaluations results seemed to indicate that the majority of the findings were related the following issues:

1. Awareness and Training
2. Installation Guidance
3. Maintenance Procedures
4. Inspection Criteria
5. Enforcement of Current Regulations

The Intrusive Inspections of the wiring indicate that overall the wiring is performing as designed. The visual examination of these wire specimens on a very general scale indicated that the wires appeared to be fairly clean with little contamination, however, upon closer examination the presence of lint, shavings, contamination, and physical damage was evident. Most of the damage appears to have been incurred by mechanical means, such as chafing, nicks, etc. The performance tests suggest that although the wire is degenerating, it continues to maintain its ability to perform electrically unless specific physical damage has occurred.

In principle, HWG-10 supports the direction of the HWG 6, 7, 8, and 9 recommendations for:

- Industry wide standard wiring practices,
- Enhancement of current maintenance programs for wiring,
- Wiring awareness program, and
- Enhancement of training programs for wiring.

HWG-10 has several specific recommendations with regards to applicability to small transport category aircraft:

#### HWG-6

HWG-10 agrees that HWG-6 fulfilled the task placed upon it by FAA. HWG-10 agrees in principle with HWG-6 proposals and that the concepts contained in those proposals are applicable to small transport category aircraft.

#### HWG-7

1. Inspection Methods – expand the statement: “as determined by the enhanced zonal analysis procedure”. The statement should read “ as determined by the enhanced zonal analysis procedure or equivalent process”.
2. Use of the terminology “Component Manufacturer” and “EWIS Component Manufacturer” should be carefully chosen.
3. Recommend to the FAA that better defined structure, content, and standards for how the MBI will follow ATA or FAA JASCC standards are needed.
4. Replace the word “airline” in the appendix tables with the words “airline and/or owner/operator”.

#### HWG-8

1. FAR Part 147 Appendix E is revised to include the concepts of AC 120-YY (EWIS, Detailed Inspection (DET), General Visual Inspection (GVI), and Special Detailed Inspection (SDI)).
2. Training is emphasized for both applicants and approvers to achieve compliance with existing regulations and current industry recurrent training requirements (i.e. Inspection Authorization renewal, Designated Engineering Representative recurrent training, and various small transport category aircraft industry seminars held throughout the year).

#### HWG-9

1. HWG-10 concurs with HWG-9 final report and tasking products. HWG-10 also recommends revision to the 25.1529 requirements from “EZAP” to “EZAP or equivalent analytical logic procedure”.
2. HWG-10 recommends an exemption from HWG-9 tasking products on previously installed Supplemental Type Certificated installations in regards to small transport category aircraft.

3. HWG-10 recommends the OEMs of small transport category aircraft perform a review of current maintenance programs to ensure that the EWIS concepts are incorporated. The OEMs should enhance their maintenance programs with additional requirements based on their aircraft design, HWG-10 aircraft evaluations, and their service histories.

Additionally, members from HWG-10 are taking a proactive stance in making the small transport category aircraft industry more aware of the results of our working group's findings.

1. Presentations are scheduled through industry organizations to make its membership more aware of the concepts and needs of the Electrical Wiring Interconnect System.
2. An article will be published in the near future through industry/technical publication on the subject of EWIS.
3. A member has developed an Inspection Authorization renewal seminar that will include concepts of EWIS.
4. A member, during an installation of an avionics package, performing a quality assurance inspection found several issues of deficiency and affected installation improvements as a result of the increased awareness learned as a direct result our aircraft evaluations.

### **Additional Recommendations from HWG-10**

1. HWG-10 further recommends that the FAA and industry implement an "EWIS Awareness" program.

#### Rationale

- a. The aircraft evaluations support the need for TC and STC holders, approvers, designers, installers, and technicians to become more aware of the concepts of EWIS during design, certification, installation and maintenance. HWG-10 feels that the current regulations with slight modifications are adequate if properly communicated and enforced.
- b. Communication avenues are available through industry organizations (i.e. AEA, GAMA, PAMA, NBAA...) and regulatory agencies (i.e. D.E.R renewals, IA Renewal...).
2. HWG-10 also recommends that the FAA revise FAR Part 147 Appendix E to include the concepts of AC 120-YY (EWIS, Detailed Inspection (DET), General Visual Inspection (GVI), and Special Detailed Inspection (SDI)).

#### Rationale

- a. A "ground up" approach is required to fully effect a culture change in the aviation industry, this should include future technicians trained from day one on EWIS concepts.
3. The following Advisory Circulars be revised to include EWIS concepts:

- a. 43.13 (-1B and -2A)
- b. 43.204
- c. 65-9A
- d. 65-11B
- e. 65-12A
- f. 65-15A

Rationale

These Advisory Circulars are the basis to certification, maintenance, and training of industry personnel. Their revision and incorporation of the concepts of EWIS would generate awareness to a large group of existing and future approvers, designers, installers, and technicians.

- 4. The development of AC/ACJ 65.XX on the concepts and language with standardized criteria for EWIS.

Rationale

HWG-10 recognises through the aircraft evaluations that there is a lack of guidance material for alteration, inspection, installation, and maintenance of the EWIS. Development of AC/ACJ 65.XX would increase awareness to the industry.

## **Closing Remarks**

The HWG 10 would like to thank all its active members, participants and their supporting organizations for a great deal of hospitality and support. The impressive achievements performed in such a very short period of time would not have been possible without their dedication.

## Appendix 1 - ATSRAC HWG-10 Members and Participants

HWG –10 Status Member (M) / Participant (P)	Name	Organization
<b>M</b>	Ballenger, Barry	FAA
<b>M</b>	Bellon, Dominique	Dassault Aviation
<b>P</b>	Bruel, Jerome	JAA / DGAC (F)
<b>P</b>	Byer, Eric	NATA
<b>P</b>	Card, Vic	JAA / CAA (UK)
<b>M</b>	Cotti, Eli	NBAA
<b>P</b>	Crowley, Jerry	FAA
<b>P</b>	Debien, Guy	Dassault Aviation
<b>M</b>	Duncan, Aaron	Garrett Aviation
<b>M</b>	D'Yvore, Bertrand	Regourd Aviation / Occitania
<b>M</b>	Eisenmenger, Karl	Dassault Aviation
<b>M</b>	Elias, Ken	ALPA
<b>M</b>	Gau, Francois	Honeywell Aviation
<b>M</b>	Gdalevitch, Manny	Bombardier Aerospace
<b>M</b>	Grose, Ron	Duncan Aviation
<b>M</b>	Haag, Jon	Altria Corporate Service, Inc.
<b>P</b>	Heather, Tony	JAA / CAA (UK)
<b>M</b>	Hunt, Norm	Midcoast Aviation
<b>M</b>	Keefer, Frank	Raytheon Aircraft
<b>P</b>	Kurek, Joe	Raytheon Technical Services Company
<b>M</b>	Larhantec, Michel	Dassault Falcon Services
<b>M</b>	Marinace, Bob	New World Jet
<b>P</b>	McGuire, Bob	FAA
<b>M</b>	Miller, Bill	Transport Canada
<b>M</b>	Miller, George	Pizza Hut
<b>M</b>	O'Neal, Steve	Gulfstream
<b>P</b>	Pappas, Robert	FAA
<b>M</b>	Peri, Ric	AEA
<b>M</b>	Phillips, Peter	Duncan Aviation
<b>M</b>	Richardson, Mike	Cessna Aircraft

<b>M</b>	Sadeghi, Massoud	FAA
<b>M</b>	Schultz, Bill	GAMA
<b>M</b>	Sevigny, Mike	Bombardier Aerospace
<b>P</b>	Ward, Phil	Gulfstream
<b>M</b>	Wagner, Richard	Underwriters Laboratories
<b>P</b>	West, Jack	FAA

## **Appendix 2 - Aging Small Transport Wiring Evaluation Protocol**

### **General**

This protocol is prepared in a general form. Its format should be used as a guide to prepare model/aircraft-specific evaluation protocols based on applicability and appropriateness to aircraft models. This document does not imply specificity or requirements. Teams will use model specific evaluation during all samplings.

### **Aircraft Zones/Area to be Considered for Evaluation**

Model/aircraft-specific protocols should include a combination of the zones listed below and/or any other zones not listed below found appropriate for the specific aircraft by the manufacture:

- Landing gear wheel wells
- Fuel Tanks – only if aircraft maintenance requirement avail this opportunity
- Wings – internal and external to fuel tanks as applicable
- Passenger: Galley, Lighting, lavatories
- Tail Cone
- Seats/Passenger Entertainment Systems
- Engine pylons
- Center structure (overhead, under floor) /Side walls (feeder wires, bundles, etc.)
- Avionics Bay/Compartments (nose, tail or other as applicable)
- Circuit breakers and panels as available for evaluation
- Cockpit/overhead/pedestal – if opened or exposed

### **Wiring to Be Inspected**

Model/aircraft-specific protocols should include a combination of the wiring listed below and any other wiring found appropriate for the specific aircraft by the manufacturers:

- Large/Complex wire bundles
- Heavy Current wires (generator, galleys, batteries, etc.)
- Essential System wiring

### **Wiring components to be evaluated**

Model/aircraft-specific protocols should include a combination of the wiring components listed below and any other components found appropriate for the specific aircraft by the manufacturer (and the operators due to post production modifications).

- Connectors, back shell, strain relief

- Clamps
- Splices
- Conduits/trays
- Markings/identifications
- Grounding terminations
- Terminal Strips and blocks
- Sleeves
- Shields
- Feed through/Pass through grommets
- Stand-offs
- Tie straps
- Heat shields/pressure shields

### Wiring Discrepancies

Deteriorated Repair	A currently dysfunctional wire splice assumed to have met requirements when established (e.g. a splice originally established to be environmentally sealed but no longer so). Does not include inappropriate or unacceptable repair practice.
Heat Damage or burnt wire	Thermal damage to insulation resulting from the presence of elevated temperature over some extended period of time.
Vibration Damage/Chafing	Insulation wear (material loss) resulting from the repeated application of a force which if applied only once would not result in noticeable damage.
Cracked Insulation	A breach in the wire insulation resulting from internal stresses in excess of the local strength of the polymer. Does not include tearing resulting from the direct physical contact with other material (e.g. knife cut).
Arcing	Localized burnt spot on one or more wires indicating one or more instantaneous discharges of electrical energy.
Delamination	The unraveling of a tape-wrapped insulation. The separation of layers of insulation in a multilayered construction.
Component Damage/Failure	Obvious damage of failure of components (connector, claps, tie wraps, etc.)
Improper Installation	Slack, bend radius, strain, wire spares/unused, routing, drip loops, drip holes,
Contamination	Dust, fluids, FOD, etc.
Corrosion	

### Related Data To Be Reviewed

Related data to be reviewed by manufacturers in preparation of model specific evaluation protocol:

- Services Bulletins
- Problem Reports
- Airworthiness Directive
- Repetitive Inspections

#### **Definition**

- **Significant Item:**  
Potential Hazard or Frequently Occurring (Significant) Item. A defect, which may require design changes or notification for enhanced inspection based on:
  - Potential hazard (e.g. fire, bundle damage, essential system damage), or
  - Frequency of occurrence at a specific location
  - Defects Noted (Non-Significant Item). A minor discrepancy not requiring any fleet action. Isolated repair seen in the sample.
- **Immediate Fleet Wide Safety of Flight Concern:**  
A discrepancy or safety of flight concern requiring immediate fleet action. Impending critical failure seen in the sample.

## Environments to be considered for Evaluation of Wiring

Benign Environment	Low humidity, nonflammable environment. Few or no critical system wires in bundle. Uncontaminated and secured well.
Explosive Environment	An environment where there is a reasonable expectation of the presence of an explosive combination of gases during some phase of operation.
Flammable Materials	Surrounding materials that can sustain combustion under normal operating conditions. Includes the wire insulation itself.
Other Critical Systems	The wire in question is bundled with other wires, at least one of which supplies current to a systems required for safe flight.
Moisture	Normal relative humidity in excess of 90% during some phase of flight (landing, takeoff, climb, cruise, decent, approach, landing), resulting in enhanced likelihood of shorting.
Vibration	Sufficient relative motion between wires or between wires and structure to cause or accentuate intermittent shorting.
Contamination	Contamination as the result of normal operation or maintenance resulting in either enhanced flammability or likelihood of shorting.
Cockpit or Electronics Compartment	High consequence failure locations within the aircraft.
Arc Tracking Potential	The presence of arc tracking materials in the bundle.
High Temperature Areas	Thermal damage to insulation resulting from the presence of elevated temperature over some extended period of time.
Potential for Excessive Resistance Heating	Wires with high current loads may fail as the result of excessive resistive heating at repair or splice locations or loose connections. This failure can evolve into severely burnt, cracked, or melted insulation on the offending wire and its neighbors. With excessive heat and bare wire at these locations, the potential for fire is high.

## Evaluation Procedure

The following actions should be taken, plus those found appropriate by the manufacturer, during wiring evaluations.

- Examine all wire bundles, connectors, and associated equipment and installations for signs of contamination and debris accumulation. Examples include but are not limited to:
- Metal shavings and fragments on and imbedded in wire bundles as the result of drilling, grinding, and other metal rework,
- Accumulation of excessive amounts of lint or other ignitable materials,

- Caustic chemicals (i.e. corrosion inhibitors, paint, oil, grease, soft drink, coffee, lavatory fluids, etc.).
- Check for broken, nicked, cut, cracked, chafed, heat damaged, unraveling, or decayed wire insulation.
- Check for damaged, missing, loose, or unsecured cable brackets, clamps, ties, grommets, and pressure seals.
- Check for wires contacting structure or components, wire bundles with inadequate separation, excessive sagging or looseness, excessive tension, missing drip loops, and/or improperly routed wire bundles.
- Check for wire with excessive bending (10 times the diameter of wire bundle supported at one end and 3 times the diameter for wire bundle supported at both ends).
- Check the integrity of wire sleeving and conduit – proper establishment and operation of drain holes, correct wire support at entry and exit to sleeving and conduit
- Check for properly installed wire splices – waterproof and in fluid free areas.
- Check ground points and terminal strips for loose connections and corrosion.
- Check connectors for missing or inadequate strain relief hardware, signs of moisture or debris accumulation, corrosion or heat damage.
- If the connector shows signs of damage, corrosion, or miss-installation, detach the connector and check the connector pins for signs of corrosion, damage, arcing, bent pins, etc.
- Check connection to relays, relay sockets, connectors, terminations, and switches, including switch linkages, for fluid damage, corrosion, wear, etc.
- Check wiring connection behind circuit breaker panels, if accessible.

*Note: Do not correct or otherwise disturb wiring systems with anomalous conditions. Photograph and make sufficient notes of the anomalous condition and its location so that it can be found and identified on a subsequent visit, if necessary.*



## **Evaluation Check list**

The evaluation team leader (or his/her designee) shall ensure that the following information is properly documented for each aircraft evaluation.

### **Evaluation Preparation**

- Aircraft Prepared For Evaluation
- Zonal Access Gained
- Evaluation Tool available (mirror, flashlight, tags, camera, etc.)
- Model/Aircraft-Specific Protocol Prepared

### **Evaluation**

- Discrepancies are tagged with permission of the operator/service facility
- Discrepancies Are Documented (see forms)
- Discrepancies Are Photographed

### **Specimen Removal (if available)**

- Specimens Removed From Aircraft
- Specimen Removal Damage Documented (no form)
- Shipping Arranged

### **Post Evaluation**

- All Data Sheets Collected
- All Photographs Collected
- Evaluation Debriefed
- All Deviation From The Protocol Documented (no form)

### **Evaluation Team Information**

All the evaluation team members should follow the ground rules listed below:

- 1) Only one master record should be used during the evaluation.
- 2) Changes to the protocol and/or the plan must be coordinated with the team leader.
- 3) Team leader will act as the focal for any coordination and arrangements with the organization hosting the evaluation.
- 4) The team leader must coordinate decisions affecting the team progress.
- 5) Significant findings must be evaluated by the whole evaluation team and reviewed with the manufacturer, operator, and host organization before conclusions are made on their severity (i.e., unsafe condition).
- 6) Evaluation team information should be recorded in the using Table 1.

Evaluation Team Information			
Team Member	Affiliation	Phone	e-mail

Table 1

**Evaluation Documentation Format**

The evaluation team leader (or designee) shall ensure that the following information is properly documented for each aircraft evaluation.

- ❑ List of team members and their organizations.
- ❑ List significant dates for team meetings, aircraft surveys, and evaluation report creation, etc.
- ❑ How did you develop your evaluation checklist?
- ❑ Who did the evaluation? (e.g. line maintenance staff, working group. members, inspectors)
- ❑ Duration (person-hours).
- ❑ What paperwork did they use as a guide?
- ❑ How many aircraft were inspected?
- ❑ Aircraft time, cycles, and year of manufacture.
- ❑ How many significant items did you find?
- ❑ Categories of aircraft inspected – passenger, cargo, stored in desert, unusual high/low time/cycles, age range, other unique characteristics, maintained by how many programs, etc?
- ❑ Status of aircraft when evaluated – heavy check, desert storage, line, other?
- ❑ Were any immediate wide safety concerns identified during the evaluation? How many? Describe each.
- ❑ Special Comments.

## List of Equipment

The manufacturer shall provide the equipment listed in Table 2 (and others as needed) for each evaluation.

<b>Equipment</b>	<b>Quantify</b>
Digital Camera (including films/diskettes)	One
Flash lights	One per evaluation team member
Viewing mirrors	One per evaluation team member
Tags	As required
Laptop	Optional
Magnifying glasses	One per evaluation team member
Safety glasses	One per evaluation team member
Safety shoes	One pair per evaluation team member, as required by local facility regulations <sup>1</sup>
Ruler/gages	As required

*Note: (1) Safety shoes are the responsibility of individual evaluation team members. Evaluators should be aware they might be denied access to certain facilities without proper safety shoes. The evaluation team leader shall be responsible for determining safety shoe requirements and notifying all team members of these requirements in advance of the evaluation.*

Working paper only: aircraft unique information will not part of the final report.

**Confidential**

**ATSRAC WG#10 Evaluation**

**Significant Item Report**

(Complete one form for each significant item)

**Aircraft Data**

Model: \_\_\_\_\_

Serial Number: \_\_\_\_\_

Line Number: \_\_\_\_\_

Cumulative Flight Hours: \_\_\_\_\_

Aircraft Age: \_\_\_\_\_

Cumulative Flight Cycles: \_\_\_\_\_

Date of Evaluation: \_\_\_\_\_

What kind of activity (e.g., modification, repair, storage, periodic maintenance, etc.):

\_\_\_\_\_

Submitted by: \_\_\_\_\_

**Description of Discrepancy**

(Write description here. Include details regarding aircraft system or location in which discrepancy was found)

Type of wires currently installed in discrepant location (e.g. pvc/nylon, Specification xxxxx), if available:

Hypothesis on possible/probable cause for discrepancy:

Could this discrepancy be detected by the normal aircraft procedures?

# Appendix 3 - Supplemental Laboratory Wiring Tests For Small Transport Airplanes

## 1. Objectives

The objective of this task is to perform necessary tests on wiring components (wires, connectors, clamps, grommets, terminal lugs, etc.) removed from small transport airplanes to:

- Assess the condition of the electrical wiring in the small transport airplane category.
- Provide supporting data for completeness of final wiring evaluation report.
- Develop appropriate conclusions and recommendations for electrical wiring in small transport airplanes.

## 2. Removing

The following steps should be used for removing electrical wiring components from small transport airplanes.

### 2.1 Labeling

Attach harness or cable identification tag to the wiring components selected for laboratory testing. This will be provided for later identification and correlation. Note the approximate installations date of wiring. (*Getting a wire number from test specimen and researching wiring diagrams may gather this data.*)

Identification Tag No.: (X-XX) \_\_\_\_\_

Aircraft: \_\_\_\_\_

Aircraft Age: \_\_\_\_\_

Compartment: \_\_\_\_\_

Interconnecting System(s): \_\_\_\_\_

Equipment in the vicinity: \_\_\_\_\_

Age of wire/component: \_\_\_\_\_

Date (Removal): \_\_\_\_\_

Removed by (Org./team lead): \_\_\_\_\_

Purpose of Removal: \_\_\_\_\_  
(Mod, repair, etc.)

Note: the identification designator X-XX is composed of the following

X – a letter (A - Z) unique for the aircraft. Begin at A, then B, etc.

XX – a number to designate each harness from the aircraft. Begin at 01 and continue in order for each harness from the aircraft.

Note: Original fabrication takes place prior to original delivery of the aircraft from the aircraft manufacturer. Post-delivery is anytime after that point in time.

### 2.2 Recording

Record the wiring component conditions prior to removal in the table below. Photographs should be taken to support the noted conditions.

Tag No.	Photo No.	Remarks

**2.3 Packaging**

Wiring components should be removed from airplane and packaged without any damage. The wiring components should not be cleaned during removal or packaging. Record any damage encountered during the removal or packaging process. Damages may be photographed, if necessary.

Tag No.	Photo No.	Damage Description

**2.4 Shipping**

The removed wiring components should be shipped to the address below for laboratory testing after packaged and placed properly in shipping containers. Include any harness documentation along with the samples. This could include all background information, any general visual observations, etc.

**Raytheon Technical Services**  
**6125 East 21<sup>st</sup> Street**

**Indianapolis, IN 46219**

**Attn: Joe Kurek, M/S 37**

### **3. Test Approach**

Focus will be on non-destructive testing of the wiring components removed for small transport airplanes. Some destructive testing will also be performed. The tests may include:

- General visual inspection (5.1)
- Detail and intrusive visual inspection (5.2)
- Microscopic insulation inspection (5.3)
- Chemical contamination analysis (5.4)
- Insulation Resistance and Dielectric Withstand Voltage (DWV) measurement (5.5)
- Conductor Resistance (5.6)
- Cut Through (5.7)
- Mandrel Bend/DWV, Bend after Thermal Exposure/DWV (5.8)

### **4. Preparation**

All test specimens should be photographed in their original conditions prior to any test. All abnormalities such as damage encountered during removal and/or shipment should be noted and documented.

### **5. Test Processes**

The non-destructive tests should be performed before the destructive tests. After properly recording the condition of the wiring removed from airplane, perform the following tests on the wiring components. Record all test data appropriately.

#### **5.1 General Visual Inspection**

Without disturbing the wiring condition, perform a visual inspection. Record the following information:

Identification Tag No.: \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_

\_\_\_\_\_

#### **5.2 Detail Visual Inspection**

Very gently remove dust and lint, if any, (do not remove contamination) from the wiring components used in step 5.1 and perform a detail visual inspection. Record the findings:

Findings/Remarks: \_\_\_\_\_

\_\_\_\_\_

### 5.3 Intrusive Visual Inspection

Select 3 to 5 segments of wire bundles (wires and components). Remove ties and clamps. Identify damage, contamination, etc. Choose several components from the outer edge of the bundle and several from the interior of the bundle. Record the following information for each segment. Note, the segment number is added to the harness number as a suffix.

#### Segment 1:

Identification Tag No.: (X-XX-1) \_\_\_\_\_

Location of component in harness: \_\_\_\_\_

Location in aircraft (if more specific than whole harness) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### Segment 2:

Identification Tag No.: (X-XX-2) \_\_\_\_\_

Location of component in harness: \_\_\_\_\_

Location in aircraft (if more specific than whole harness) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### Segment 3:

Identification Tag No.: (X-XX-3) \_\_\_\_\_

Location of component in harness: \_\_\_\_\_

Location in aircraft (if more specific than whole harness) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### Segment 4:

Identification Tag No.: (X-XX-4) \_\_\_\_\_

Location of component in harness: \_\_\_\_\_

Location in aircraft (if more specific than whole harness) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### Segment 5:

Identification Tag No.: (X-XX-5) \_\_\_\_\_

Location of component in harness: \_\_\_\_\_

Location in aircraft (if more specific than whole harness) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

#### 5.4 Wire Insulation Microscopic Inspection

Select 3 to 5 segments of wiring (wires and components that were previously evaluated in 5.3) and perform a microscopic inspection. Wires should be selected from both inner and outer parts of the bundles removed from the airplanes. Identify breaches in insulation, crack in conductor, exposed conductors, etc. Record the following information for each segment. Document with photographs when appropriate.

##### Segment 1:

Identification Tag No.: (X-XX-1) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

##### Segment 2:

Identification Tag No.: (X-XX-2) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

##### Segment 3:

Identification Tag No.: (X-XX-3) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

##### Segment 4:

Identification Tag No.: (X-XX-4) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

##### Segment 5:

Identification Tag No.: (X-XX-5) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_

### 5.5 Chemical Contamination Testing

Select 3 to 5 segments of wiring (wires and components that were previously evaluated) and perform a chemical contamination analysis/test. Wires should be selected from both inner and outer parts of the bundles removed from the airplanes. Record the following information for each segment.

Identification Tag No.: (X-XX-#) \_\_\_\_\_

Discrepancies/Remarks: \_\_\_\_\_

### 5.6 Wire Insulation Resistance and Dielectric Withstand Voltage (DWV) Test

Select 3 to 5 segments of wiring (wires and components that were previously evaluated) and perform an IR and dielectric test using specification for the wire (under the test). Wires should be selected from both inner and outer parts of the bundles removed from the airplanes. Record the following information for each segment.

#### Segment 1:

Identification Tag No.: (X-XX-1) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Discrepancies/Remarks: \_\_\_\_\_

#### Segment 2:

Identification Tag No.: (X-XX-2) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Discrepancies/Remarks: \_\_\_\_\_

#### Segment 3:

Identification Tag No.: (X-XX-3) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Discrepancies/Remarks: \_\_\_\_\_

#### Segment 4:

Identification Tag No.: (X-XX-4) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Discrepancies/Remarks: \_\_\_\_\_

**Segment 5:**

Identification Tag No.: (X-XX-5) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Discrepancies/Remarks: \_\_\_\_\_

**5.7 Cut Through**

Select 3 to 5 segments of wiring (wires and components that were previously tested) and perform cut-through tests. Wires should be selected from both inner and outer parts of the bundles removed from the airplanes. Record the following information for each segment.

**Segment 1:**

Identification Tag No.: (X-XX-1) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_

**Segment 2:**

Identification Tag No.: (X-XX-2) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_

**Segment 3:**

Identification Tag No.: (X-XX-3) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_

**Segment 4:**

Identification Tag No.: (X-XX-4) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

**Segment 5:**

Identification Tag No.: (X-XX-5) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

**5.8 Mandrel Bend and Mandrel Bend after Thermal Exposure**

Select 3 to 5 segments of wiring (wires and components that were previously tested) and perform mandrel bend and mandrel bend following thermal exposure. Wires should be selected from both inner and outer parts of the bundles removed from the airplanes. Record the following information for each segment.

**Segment 1:**

Identification Tag No.: (X-XX-1) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

**Segment 2:**

Identification Tag No.: (X-XX-2) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

**Segment 3:**

Identification Tag No.: (X-XX-3) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

**Segment 4:**

Identification Tag No.: (X-XX-4) \_\_\_\_\_

Original fabrication       Post-delivery installed component

Findings/Remarks: \_\_\_\_\_  
\_\_\_\_\_

**Segment 5:**

Identification Tag No.: (X-XX-5) \_\_\_\_\_

    ÿ Original fabrication      ÿ Post-delivery installed component

Findings/Remarks: \_\_\_\_\_

\_\_\_\_\_

## **Appendix 4 – Intrusive Inspection Report**

Refer to the following files to access the Report:

- Final Intrusive Test Report.doc
- Final Intrusive Test Report Appendix C.pdf
- Final Intrusive Test Report Table II.xls

## Appendix 5 – Revision to HWG8 Appendix A

Appendix A to AC120-YY (HWG-10 Revision)

Target group 9: 91/135 Qualified maintenance technicians

Target group 10: 91/135 Flight Crew (to include Flight Deck and/or Cabin Crew)

<b>TARGET GROUP</b>	<b>9</b>	<b>10</b>
<b><u>A - INTRODUCTION:</u></b>		
<b>Demonstrate the safe handling of airplane electrical systems, Line Replacement Units (LRU's), tooling, troubleshooting procedures, and electrical measurements.</b>		
1. Safety Practices	<b>X</b>	<b>X</b>
2. Electrostatic Discharge Sensitive (ESDS) Device handling and protection	<b>X</b>	
3. Tools, special tools and equipment	<b>X</b>	
4. Verify calibration/certification of instruments, tools, and equipment	<b>X</b>	
5. Required wiring checks using the Troubleshooting Procedures and Charts	<b>X</b>	
6. Measurement and troubleshooting using meters	<b>X</b>	
7. LRU replacement general practices	<b>X</b>	
<b><u>B - WIRING PRACTICES DOCUMENTATION:</u></b>		
<b>Know the construction and navigation of the applicable airplane wiring system overhaul or wiring practices manual</b>		
8. Chapter 20 structure/overview	<b>X</b>	
9. Chapter cross-reference index	<b>X</b>	
10. Important Data and Tables	<b>X</b>	
11. Wiring Diagram Manual	<b>X</b>	
12. Other Documentation as applicable	<b>X</b>	
<b><u>C-INSPECTION:</u></b>		
<b>Know the different types of inspections, human factors in inspections, zonal areas, and typical damages</b>		
13. General Visual Inspection (GVI), Detailed Inspection (DET), Special Detailed Inspection (SDI), Zonal Inspection and Enhanced Zonal Inspection Analysis Procedure (EZAP)	<b>X</b>	
14. Human factors in inspection	<b>X</b>	
15. Zonal areas in inspection	<b>X</b>	
16. Wiring system damage	<b>X</b>	<b>low level</b>
<b><u>D- HOUSEKEEPING:</u></b>		
<b>Know the contamination sources, materials, cleaning and protection procedures</b>		
17. Airplane external contamination sources	<b>X</b>	<b>X</b>
18. Airplane internal contamination sources	<b>X</b>	<b>X</b>
19. Other contamination sources	<b>X</b>	<b>X</b>
20. Contamination protection planning	<b>X</b>	
21. Protection during airplane maintenance and repair	<b>X</b>	
22. Cleaning processes	<b>X</b>	

<b><u>E - WIRE:</u></b>		
<b>Demonstrate the correct identification of different wire types, their inspection criteria, and damage tolerance, repair and preventative maintenance procedures</b>		
23. Identification, type and construction	X	
24. Insulation damage limits	X	
25. Inspection criteria and standards of wire and wire bundles	X	
26. Wire bundle installation practices	X	
27. Typical damage and areas found (airplane specific)	X	low level
28. Maintenance and repair procedures	X	
29. Sleeving	X	
30. Unused wires-termination and storage	X	
31. Electrical bonding and grounds	X	
<b><u>F-CONNECTIVE DEVICES:</u></b>		
<b>Know the procedures to identify, inspect and find the correct repair for typical types of connectors found on the technician's airplane</b>		
32. General types and identification	X	
33. Cautions and protections	X	
34. Visual inspection procedures	X	
35. Typical damage found	X	
36. Repair procedures	X	
<b><u>G - CONNECTIVE DEVICE REPAIR:</u></b>		
<b>Demonstrate the procedures to replacement of all parts for typical types of connectors found on the technician's airplane</b>		
37. Circular Connectors	X	
38. Rectangular Connectors	X	
39. Terminal Blocks - Modular	X	
40. Terminal Blocks - Non-modular	X	
41. Grounding Modules	X	
42. Pressure Seats	X	