Harmonization Working Group 13 (HWG-13)
Small Transport Category Aircraft

Final Report and Recommendations
To the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC)

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ACCRONYMS

AAIP	Approved Aircraft Inspection Program
AC	Advisory Circular
AD	Airworthiness Directive
AEA	Aircraft Electronics Association
AMM	Aircraft Maintenance Manual
ATSRAC	Aging Transport Systems Rulemaking Advisory Committee
CAMP	Continuous Airworthiness Maintenance Program
EWIS	Electrical Wiring Interconnect Systems
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FSDO	Flight Standards District Office
HWG	Harmonization Working Group
ICA	Instructions for Continuous Airworthiness
ISC	Industry Steering Committee
LTA	Large Transport Category Aircraft
MM	Maintenance Manual
MRB	Maintenance Review Board
MRBR	Maintenance Review Board Report
MRO	Maintenance Repair Organization
MSG	Maintenance Steering Group
MTBF	Mean Time Before Failure
MTBR	Mean Time Before Removal
NBAA	National Business Aviation Association
NTSB	National Transportation Safety Board
OEM	Original Equipment Manufacturer
PMA	Parts Manufacturer Approval
SPM	Standard Practice Manual
STA	Small Transport Category Aircraft
STC	Supplemental Type Certificate
STWG	Small Transport Working Group
TC	Type Certificate
WHCSS	White House Commission on Aviation Safety and Security

EXECUTIVE SUMMARY

This document will provide the results of Harmonization Working Group (HWG) 13 tasking to review existing small transport airplane manufacturers' wiring inspection procedures with an emphasis towards identifying and preparing, as necessary, criteria for upgrading and developing enhanced procedures for the inspection, maintenance and repair of the electrical wiring interconnection system (EWIS) on small transport airplanes.

HWG 13 does not support the application to small transport aircraft (STA) of the broad-based regulatory approach recommended by ATSRAC to address EWIS on large transport aircraft (LTA), but rather proposes a narrowly focused emphasis on training and education as a means to enhance compliance with existing guidance on inspection, maintenance and repair of EWIS.

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 current FAA’s Aging Aircraft Program should be expanded to cover non-structural systems.”

Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) was formed shortly after this mandate. The original applicability of all ATSRAC efforts 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 ATSRAC 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 the FAA/JAA in the study.

In January 2002, STWG was added to ATSRAC as the Small Transport Aircraft Harmonization Working Group 10 (HWG-10). HWG-10 investigated the applicability of previous ATSRAC recommendations to Small Transport Category Aircraft (6 to 30 type certificated passenger load and less than 7500 type certificated payload) and identified unique issues specific to these as operated in small transport category aircraft operations (e.g. FAR 91 and 135) and recommended appropriate action.

The Intrusive Inspections of the wiring indicated that overall the wiring is performing as designed. However, the inspections did find minor discrepancies that included the presence of lint, metal shavings, various forms of contamination, and physical damage was evident.

HWG-10 presented the group's final report to ATSRAC in January 2003 with the report submitted to the FAA in February 2003.

In May 2003, the Federal Register announced and established HWG-13 tasking.

HWG-13 was tasked to review existing small transport airplane manufacturers' wiring inspection procedures with an emphasis towards identifying and preparing, as necessary, criteria for upgrading and developing enhanced procedures for the inspection, maintenance and repair of the electrical wiring interconnection system (EWIS) on small transport airplanes. The working group was also tasked with developing and recommending compliance means to adopt the criteria and incorporate the enhanced wiring inspection procedures in operators' maintenance programs.

A total of ten (10) aircraft models from five (5) aircraft manufacturers were reviewed. The working group required the OEMs to review an "older" and a "newer" generation aircraft (earliest type certificate was January 1970 / latest type certificate December 2003). The basis of these selection criteria was to identify if there were differences in Instructions for Continued Airworthiness (ICA) development throughout the years.

The review included the model specific ICAs, Aircraft Maintenance Manuals (AMM), and Standard Practice Manuals (SPM). The OEMs also performed a review of the outcomes from HWG-10 aircraft evaluation findings to their respective SPMs to ensure adequate coverage for the technician. Furthermore, a review was performed on FAA Advisory Circular 43.13-1B, Chapter 11 comparing it to the findings of the HWG-10 aircraft evaluation.

The review of the OEMs ICA findings to the EWIS definition varied between the aircraft models. Several of the aircraft models had ICAs that were currently covering greater than 90% of the requirements of the proposed EWIS definition. The majority of the aircraft model ICAs addressed approximately 73% of the requirements of the proposed EWIS definition.

The working group requested the OEMs review their SPM for their respective aircraft model in comparison to the findings of WG-10 aircraft evaluations. The OEMs used the HWG-10 aircraft evaluation criteria and compared it to their SPM. This should indicate "How" technicians perform maintenance on the EWIS. The OEM review indicates that an average of approximately 68% of the aircraft evaluation findings were captured in the SPM.

The review indicated that if the technician had adequately addressed "Inadequate Clearance to Structure" and "Clamp Condition/Sizing/Spacing" criteria during routine inspections, a majority of the HWG-10 aircraft evaluation findings should not have been found. The majority of the OEM's SPMs specifically address these concerns.

The review of the SPMs indicates that the OEMs have adequately addressed their model specific wiring concerns and manufacturing techniques, and in some cases, have developed specific training material to care for EWIS components that require special handling.

The working group performed a review of AC43.13 - 1B Chapter 11 - "Aircraft Electrical Systems - Inspection and Care of Electrical Systems" addressing the proposed EWIS definition and the HWG-10 aircraft evaluation findings. This review was not directly tasked by the requirements of the Federal Register; however, HWG-13 felt that it was important to review the document's relevance to EWIS. The AC is FAA generated and is readily available to inspectors and technicians for additional guidance in regards to the inspection and maintenance of EWIS.

The AC, as it is currently written, incorporates 13 of the 14 (93%) items listed in HWG-6 EWIS definitions. The AC does not currently address "pressure seals associated with EWIS". The section on connectors had gaps in inspection criteria as compared to the requirements of the HWG-10 aircraft evaluation matrix, specifically, the AC does not adequately address "Contact Arcing / Fretting", "Missing Dummy Contacts / Seal Plug", and "Missing / Damaged Backshell".

In the STA operating arena, in the absence of OEM instructions, the AC is determined to be a very useful tool for the inspectors and technicians. Some STA OEMs have extracted verbiage and instructions for incorporating inspection techniques into the aircraft documentation as found in the AC. Currently, the preamble language in the AC has a limitation to “non-pressurized” areas of the aircraft, however, that should not keep the inspector / technician from using the document as an additional guidance when performing EWIS inspections, since EWIS in non-pressurized areas may be a worst case scenario.

When comparing the AC to HWG-10 aircraft evaluation matrix, the AC encompasses approximately 85% of the findings in the inspection of EWIS with the "OTHER" columns removed from the assumptions. (The working group did not have sufficient information to determine what "OTHER" meant during the HWG-10 aircraft evaluations).

Aviation trade associations, specifically, the Aircraft Electronics Association (AEA) and the National Business Aviation Association (NBAA) have been actively engaged in EWIS training of technicians for the past two years. From this awareness training effort it is evident that a certain level of complacency exists in the aircraft maintenance industry with respect to EWIS. HWG 13 finds that the STA OEMs, support organizations and operators currently have all the “tools” needed to address any deficiencies identified by HWG10 and HWG13 and their recommendations.

Going forward, there is a need to collaboratively communicate the knowledge gained from the ATSRAC activity to inform those responsible for determining airworthiness on the importance of EWIS. The initiating of training begins before the aircraft is in service, beginning at manufacturing; through the aircraft life cycle, including the personnel involved as maintainers and service providers.

HWG-13 recommends that the FAA incorporate "EWIS training" as part of the training requirements for Part 145 repair stations and FAA Safety Training Programs (I.A. renewal) maintenance seminars & conferences.

HWG-13 recommends to ATSRAC that the FAA incorporate "EWIS training" as part of the training requirements for Part 145 repair stations and FAA Safety Training Programs (I.A. renewal) maintenance seminars & conferences.

HWG 13 recommends that the FAA should write formally to the Small Transport Aircraft industry requesting that it continue its awareness and training programs in regards to EWIS. (ATSRAC generated recommendation)

HWG 13 applauds the STA OEMs for their efforts at proactively addressing EWIS issues and encourages them to continue their efforts to include "GAP" EWIS concepts and/or definitions found during their review of their Instructions of Continuous Airworthiness and Standard Practice Manuals and to continue to enhance the ICAs with EWIS information as needed.

HWG 13 recommends that the FAA should write formally to STA OEMs requesting they resolve "GAP" EWIS concepts and/or definitions found during their review of their Instructions of Continuous Airworthiness and Standard Practice Manuals and to continue to enhance the ICAs with EWIS information as needed. (ATSRAC generated recommendation)

STA OEMs should include EWIS training (i.e. ICA and SPM) into initial and recurrent factory approved training curriculums.

HWG 13 recommends that the FAA should write formally to STA OEMs requesting them to include EWIS training (i.e. ICA and SPM) into initial and recurrent factory approved training curriculums. (ATSRAC generated recommendation)

BACKGROUND INFORMATION

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 Federal Aviation Administration (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."

Aging Transport Systems Rulemaking Advisory Committee (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 (HWG-10).

In April 2002, the Federal Register announced and established HWG-10:

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 investigated the applicability of previous ATSRAC recommendations to Small Transport Category Aircraft (6 to 30 type certificated passenger load and less than 7500 type certificated payload) and identified unique issues specific to these as operated in small transport category aircraft operations (e.g. FAR 91 and 135) and recommended 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.

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 requiring an OEMs engineering department to perform additional engineering 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) inspection programs. Aircraft operators generally do not develop their own airworthiness inspection programs.
2. Small transport category aircraft are typically unique configurations. Each owner specifies a different interior or avionics options via amended TC or STC's.

These differences resulted in a broad application of proposed rules that are designated for large transport aircraft application while being difficult to implement for small transport

category aircraft. HWG-10 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 to the following issues:

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

The Intrusive Inspections of the wiring indicated 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. However, upon closer examination, the presence of lint, metal shavings, various forms of 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 wiring is slowly deteriorating, it continued to maintain its ability to perform electrically unless specific physical damage had occurred.
In principle, HWG-10 supported 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 presented the group's final report to ATSRAC in January 2003 with the report submitted to the FAA in February 2003.

In May 2003, the Federal Register announced and established HWG-13 tasking, HWG-13 to:

1. Review existing small transport airplane manufacturers' wiring inspection procedures.
2. Identify and prepare, as necessary, criteria for upgrading and developing enhanced procedures for inspection, cleaning, reduction of combustible material (*e.g.,* lint and chemical contamination), reduction of potential ignition sources (*e.g.,* cracked wiring), and maintenance of the electrical wiring interconnection system (EWIS) on small transport airplanes.
3. Develop and recommend compliance means to adopt the criteria referenced in bullet number 2 and incorporate the enhanced wiring inspection procedures in operators' maintenance programs.

PURPOSE

The purpose of this document is to:

- Summarize and provide the results of the Original Equipment Manufacturer (OEM) and AC 43.13-1B Chapter 11 review,
- Provide explanation of the Owner/Operator to OEM relationship in the Instructions for Continuous Airworthiness (ICA) development,
- Summarize the OEMs current ICA revision process,
- Provide recommendations to ATSRAC.

Harmonization Working Group (HWG) -13 Members / Participants

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 aviation associations, OEMs, operators, regulatory agencies, 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 13 Harmonization Working Group members and participants are listed in Appendix A.

TASK 1 - Review existing small transport airplane manufacturers' wiring inspection procedures

OEM ICA Review Methodology

The methodology for performing the ICA review used by each OEM was as follows

- Make and Model Selection
    - Two (2) different aircraft make and/or models
        - One (1) older generation
        - One (1) newer generation
- Review of current ICA requirements in regards to EWIS
- Perform a zone-by-zone review for ICAs that are specific to EWIS
- Perform a zone-by-zone review of current ICAs that include EWIS
- Develop a Chart or Matrix listing current ICAs by:
    - Aircraft Zone
    - ATA Chapter
    - Task Number
    - Task Description
    - Frequency of ICA (calendar, hours, landings)
    - Pass/Fail Criteria availability (Yes / No)
- Determine the type of analysis process used to determine the need for the ICA.
- Assess the effectiveness of the ICAs based on the findings during Working Group 10's aircraft evaluations
- Determine the percentage of total aircraft EWIS currently being inspected
- Develop a report for the members of Working Group 13.

The OEMs were required to perform their review using the definition of EWIS as defined in HWG-6 Final Report.

EWIS Definition

EWIS is defined as an electrical connection between two or more points including the associated termination devices and the necessary means for its installation and identification.

This includes:

- Wires and cables
- Bus bars
- Connection to electrical devices
- Circuit breakers or other circuit protection devices
- Connectors and accessories
- Electrical grounding and bonding devices
- Electrical splices
- Materials used to provide additional protection for wires
- Shield or braids

- Conduits that have electrical termination for the purpose of bonding
- Clamps and other devices used to route and support the wire bundle
- Cable tie devices
- Labels or other means of identification
- Pressure seals associated with EWIS

EWIS components inside shelves, panels, racks, junction boxes, distribution panels, back-planes of equipment racks including circuit board back-planes wire integration units, etc. answering to the upper definition, are included.

The mating connection at the termination point of the wire on those devices that are excluded from this definition are not included as part of the EWIS.

The following is excluded:

- Wiring inside avionics equipment
- Equipment including non-required miscellaneous equipment qualified to environmental conditions and testing procedures approved by the Administrator other than those specifically included in this definition
- Equipment qualified to a technical standard order
- Portable, carry on, or otherwise non-permanently mounted electrical equipment
- Fiber optics

Aircraft Model Selection and Documentation Review

A total of ten (10) aircraft models from five (5) aircraft manufacturers were reviewed. The working group required the OEMs to review an "older" and a "newer" generation aircraft (earliest type certificate was January 1970 / latest type certificate December 2003). The basis of these selection criteria was to identify if there were differences in ICA development throughout the years.

The review included the model specific ICAs, Aircraft Maintenance Manuals (AMM), and Standard Practice Manuals (SPM). The OEMs also performed a review of the outcomes from HWG-10 aircraft evaluation findings to their respective SPMs to ensure adequate coverage for the technician. Furthermore, a review was performed on FAA Advisory Circular 43.13-1B, Chapter 11 comparing it to the findings of the HWG-10 aircraft evaluation.

ICA Development

The OEMs have several methods of analysis for developing the ICAs for their aircraft. The reason for the different generations of aircraft was to see if there have been methodology changes and to see if this made a difference on how the EWIS is inspected.

There were 5 aircraft models reviewed in the "older" generation. The following is how these aircraft model ICAs were developed:

- Engineering Analysis
    - Corrosion

    - Fatigue
    - MTBR
    - MTBF
    - Structural
- Internal Maintenance Review Board determination
- Maintenance Steering Group -2 (MSG-2)
- Past product performance history
- System Safety Analysis

There were 5 aircraft models reviewed in the "newer" generation. The following lists processes under taken by some of the OEMs in how the aircraft model ICAs were developed:

- Engineering Analysis
- Internal Maintenance Review Board determination
- Maintenance Steering Group - 3 (MSG-3)
- Past product performance history
- Structure damage tolerance
- System Safety Analysis

The only significant change between the "older" and "newer" generation ICA development was an increase in the use of MSG-3 analysis (two (2) of the five (5) aircraft models used MSG-3).

Summary of OEM ICA Findings

The review of the OEMs ICA findings to the EWIS definition varied between the aircraft models. Several of the aircraft models had ICAs that were currently covering greater than 90% of the requirements of the proposed EWIS definition. The majority of the aircraft model ICAs addressed approximately 73% of the requirements of the purposed EWIS definition.

Task 1 research indicated evolutionary changes over the years in regards to the analytical process for developing ICAs, even though not specifically addressing the newly proposed EWIS definition. The OEMs did find that ICA revisions for "older" generation aircraft were brought forward and incorporated in the "newer" generation aircraft as lessons learned. In addition, through public awareness and information dissemination in regards to aging wiring issues, industry participation, and through production/manufacturing audits, specific emphasis has been placed on installation and maintenance practices. These enhancements were carried forward to in-service aircraft through Service Bulletins as a proactive response, mitigating potential concerns.

The OEMs were able to address their corresponding level of aircraft wire inspection programs by using their HWG-10 findings, and determine if their current inspection programs specifically addressed the findings. Several aircraft models had "Notes" in their respective Chapter 5, stating that if a panel was removed scheduled or unscheduled, a visual inspection (with inspection criteria) that included aircraft wiring was to be performed. Theoretically, the entire aircraft should at some point be inspected and the inspection should include aircraft wiring. However, the proposed EWIS definition criteria were not

completely present in all aircraft models ICAs. Four (4) aircraft models had inspection criteria very similar to the proposed EWIS definition. To the manufacturers credit, all of the different aircraft model ICAs had EWIS related inspection tasks that were to be performed up to an interval of no later than six (6) years.

Due to the newly defined “EWIS”, OEMs discovered gaps in their current ICAs. Voluntarily, OEMs recognized the benefit of including the proposed EWIS definition and internally submitted these changes into their maintenance manual revision process.

The working group continues to be concerned with the HWG-10 aircraft evaluation findings; HWG-13 recognized that approximately 69% of the current OEMs ICAs have met the proposed EWIS definition. The majority of the WG-10 aircraft evaluation findings were "Inadequate Clearance to Structure" (813 of 2064 findings or 39% of findings and 28 of 73 significant findings or 38% of significant findings); 70% of the aircraft model ICAs addressed this issue. Another area of concern was the "Clamp Condition/Sizing/Spacing" criteria, 419 of 2064 findings (20%) were captured specifically by 80% of the OEMs ICAs. If technicians had recognized these two (2) issues during routine inspections, the total number of findings should have been approximately 60% (or a total of 832 findings) lower during the aircraft evaluations. The above stated percentages are without the "OTHER" column totals included, HWG-13 did not have sufficient data to determine what types of issues were included in "OTHER" column. Nevertheless, the 85 - 90% of the findings fell into the 70% addressed in the current OEMs ICAs (reference Appendix B for details).

Summary of OEM Standard Practice Manual Review

The working group requested the OEMs review their SPM for their respective aircraft model in comparison to the findings of WG-10 aircraft evaluations. The OEMs used the HWG-10 aircraft evaluation criteria and compared it to their SPM. This should indicate "How" technicians perform maintenance on the EWIS. The OEM review indicates that an average of approximately 68% of the aircraft evaluation findings were captured in the SPM (reference Appendix B for details).

The review indicated that, again, if the technician had adequately addressed "Inadequate Clearance to Structure" and "Clamp Condition/Sizing/Spacing" criteria during routine inspections, a majority of the HWG-10 aircraft evaluation findings should not have been found. The majority of the OEM's SPMs specifically address these concerns.

The review of the SPMs indicates that the OEMs have adequately addressed their model specific wiring concerns and manufacturing techniques, and in some cases, have developed specific training material to care for EWIS components that require special handling.

Advisory Circular (AC) 43.13 - 1B Chapter 11 Review

The working group performed a review of AC43.13 - 1B Chapter 11 - "Aircraft Electrical Systems - Inspection and Care of Electrical Systems" addressing the proposed EWIS definition and the HWG-10 aircraft evaluation findings. This review was not directly tasked by the requirements of the Federal Registry; however, HWG-13 felt that it was important to review the document's relevance to EWIS. The AC is FAA generated and is readily

available to inspectors and technicians for additional guidance in regards to the inspection and maintenance of EWIS.

The AC, as it is currently written, incorporates 13 of the 14 (93%) items listed in HWG-6 EWIS definitions. The AC does not currently address "pressure seals associated with EWIS". The section on connectors had gaps in inspection criteria as compared to the requirements of the HWG-10 aircraft evaluation matrix. (reference Appendix C for details) The evaluation criteria "Contact Arcing / Fretting", "Missing Dummy Contacts / Seal Plug", and "Missing / Damaged Backshell" were not adequately addressed in the AC.

In the STA operating arena, in absence of OEM instructions, the AC is determined to be a very useful tool for the inspectors and technicians. Some STA OEMs have extracted verbiage and instruction for incorporating inspection techniques as found in the AC into the aircraft documentation. Currently, the preamble language in the AC has a limitation to “non-pressurized” areas of the aircraft, however, that should not keep the inspector / technician from using the document as an additional guidance when performing EWIS inspections, since EWIS in non-pressurized areas may be worst case scenario.

When comparing the AC to HWG-10 aircraft evaluation matrix, the AC encompasses approximately 85% of the findings in the inspection of EWIS with the "OTHER" columns removed from the assumptions. The working group did not have sufficient information to determine what "OTHER" meant during the HWG-10 aircraft evaluations (reference Appendix C for details). The items not covered in the AC were as follows as compared to HWG-10 aircraft evaluations:

- "Contact Arcing / Fretting" - Total Findings = 0
- "Missing Dummy Contacts / Seal Plug" - Total Findings = 1
- "Missing / Damaged Backshell" - Total Findings = 10
- "Missing / Deteriorated Pressure Seals" - Total Findings = 3

The use of the AC as inspection guidance, as currently written, would have been effective in 99% of the HWG-10 aircraft evaluation findings.

A comparison of the AC to HWG-1 and -2 aircraft evaluation findings was performed to check the effectiveness to Large Transport Category aircraft. When comparing the AC to HWG-1 and -2 aircraft evaluation matrix, the AC encompasses approximately 85% of the findings in the inspection of EWIS with the "OTHER" columns removed from the assumptions. The working group did not have sufficient information to determine what "OTHER" meant during the HWG-1 and -2 aircraft evaluations (reference Appendix C for details). The items not covered in the AC were as follows as compared to HWG-1 and -2 aircraft evaluations:

- "Contact Arcing / Fretting" - Total Findings = 4
- "Missing Dummy Contacts / Seal Plug" - Total Findings = 23
- "Missing / Damaged Backshell" - HWG-1 and -2 Total Findings = 51
- "Missing / Deteriorated Pressure Seals" - Total Findings = 6

The use of the AC as inspection guidance, as currently written, would have been effective in 97% of the HWG-1 and -2 aircraft evaluation findings.

TASK 2 - Identify and prepare, *as necessary*, criteria for upgrading and developing enhanced procedures for inspection, cleaning, reduction of combustible material (*e.g.,* lint and chemical contamination), reduction of potential ignition sources (*e.g.,* cracked wiring), and maintenance of the electrical wiring interconnection system (EWIS) on small transport airplanes.

The review of Task 1 data produced several interesting facts:

1. OEMs that currently captured more than 90% of the proposed EWIS definition in their ICAs and SPMs did not realize a substantial drop in the number of HWG-10 aircraft evaluation findings.
    a. The average findings per aircraft model with the "OTHER" columns quantity removed were 258 findings.
        i. Sample C findings were 311 - "OTHER" columns quantity removed
        ii. Sample I and J (these two (2) aircraft models use the same ICAs and AMMs) findings were 214 - "OTHER" columns quantity removed
2. The HWG-10 aircraft evaluation finding "INADEQUATE CLEARANCE TO STRUCTURE" which had a total of 813 findings (39% of total findings) was captured by the majority of the OEMs ICA's and/or SPM's.
3. The HWG-10 aircraft evaluation finding " CLAMP CONDITION / SIZING / SPACING" which had a total of 419 findings (20% of total findings) was again captured by the majority of the OEMs ICA's and/or SPM's.
4. AC 43.13-1B Chapter 11 review showed the following:
    a. 93% of the proposed EWIS definition is currently captured
    b. 99% of the HWG-10 aircraft evaluation findings could have been captured
    c. 97% of the HWG-1 and -2 aircraft evaluation findings could have been captured
5. Gaps exist within the current OEMs ICA's and SPM's comparing them to the proposed EWIS definition

The Task 1 review validated the HWG-10 aircraft evaluation findings, which was not performed at the time of the evaluations. The initial aircraft evaluations performed by HWG-10 showed that there were similar findings to the Large Transport Aircraft (LTA) as discussed in HWG-1 and -2 final report. This validation also indicated that there is currently available a great deal of data available to Small Transport Aircraft (STA) inspectors and technicians for performing inspections and maintenance of EWIS. Unfortunately, even when the instruction was available EWIS findings were not always captured and repaired during routine aircraft inspections and/or maintenance.

The review of AC 43.13-1B Chapter 11 indicated that there were areas that need addressed such as:

1. "Contact Arcing / Fretting"
2. "Missing Dummy Contacts / Seal Plug"
3. "Missing / Damaged Backshell"
4. "Missing / Deteriorated Pressure Seals"

However, the document closely matched the proposed EWIS definitions and gave adequate explanations and instructions. The use of this document would have enhanced the

inspection and maintenance of EWIS for the inspector / technicians for both the STA and LTA.

HWG-13 determined that the need to enhance EWIS procedures could easily be incorporated into the OEMs current ICAs and SPMs. The STA OEMs acknowledge that the proposed EWIS definition "gaps" should be included in their normal documentation revision cycles. Voluntarily, several OEMs have proposed these changes to their organizations. However, this alone will not solve the EWIS inspection and maintenance issues. Inspector and technician awareness and training are paramount to the success of incorporation of the proposed EWIS definition into the OEMs documentation. One OEM has incorporated an extensive EWIS training curriculum at their completion center. The training began in 2000, since its inception the average number of EWIS related discrepancies has significantly declined. (reference Appendix D for details)

One major difference of aircraft operated in accordance with FAR 91 and to a large extent 135 as compared to the LTA is that the majority of owners/operators of STA do not develop their own inspection programs. As such, the OEMs play the ultimate role in the development of the STA inspection programs. Most operators of STA operate flight departments of only one (1) or two (2) aircraft. Even STA operated under FAR Part 135 normally adhere to OEM inspection requirements. The inspection programs are FAA approved by the local FSDO. The staffing requirements to develop a Continuous Airworthiness Maintenance Program are not a luxury that STA owners/operators have in-house. Therefore, as required by FAR 43.13, the owner/operator of STA must adhere to the inspection programs and maintenance manuals provided by the OEMs to maintain their aircraft in an airworthy condition. If the OEM does not give specific instruction on an inspection or maintenance task, the inspector and/or technician has the availability to refer to FAA AC 43.13-1B Chapter 11 for additional guidance. The review of this AC has validated its effectiveness in the inspection and maintenance of EWIS.

TASK 3 - Develop and recommend compliance means to adopt the criteria referenced in Task 2 and incorporate the enhanced wiring inspection procedures in operators' maintenance programs.

HWG13 reviewed the current processes for STA manufacturers for the models as identified in Tasks 1 and 2. This working group conducted a comprehensive analysis of ICAs, validating and identifying areas of requiring ICA enhancement and / or improvement

In order to develop and recommend compliance means to adopt criteria that enhances wiring inspection procedures in operators' maintenance programs we must first understand the existing regulatory requirements for Instruction for Continuous Airworthiness, their development and the ongoing revisions processes. In addition, an understanding of the role ICAs play in the STA operators' regulatory compliance.

Current ICA Regulation

FAR § 21.50(b) **Instructions for Continued Airworthiness and Manufacturer's Maintenance Manuals having Airworthiness Limitation Sections**

"The holder of a design approval, including either the type certificate or supplemental type certificate for an aircraft... shall furnish at least one set of complete Instructions for Continued Airworthiness, prepared in accordance with FAR §§ 23.1529, 25.1529...In addition, changes to the Instructions for Continued Airworthiness shall be made available to any person required by this chapter to comply with any of those instructions."

FAR § 25.1529 **Instructions for Continued Airworthiness**

"The applicant must prepare Instructions for Continued Airworthiness in accordance with appendix H to this part that are acceptable to the Administrator...."

FAR § 25 Appendix H **Instructions for Continued Airworthiness**

Appendix H contains a listing of the minimum elements that manufacturers need to provide for product certification. Key sections required by Appendix H are as follows:

- Airplane information
  - Introduction of airplane features
  - Description of systems
  - Control and operation instructions for airplane features
  - Servicing instructions
- Maintenance instructions
  - Scheduled maintenance
  - Troubleshooting instructions
  - Instructions for removal and replacement of components
  - Instructions for return to service tests/check-out
- Diagrams and instructions for access
- Special inspection instructions
- Instructions for application of protective treatments
- Structural fastener instructions

- Special tool list

Using the list above, HWG13 has determined that the maintenance instructions and its subsequent sub list are relevant to Task 3 workscope.

FAR § H25.1(c) **Instructions for Continued Airworthiness**

"The applicant must submit to the FAA a program to show how changes to the Instructions for Continued Airworthiness made by the applicant or by the manufacturers or products and appliances installed in the airplane will be distributed."

FAR § H25.2 **Format**

"The Instructions for Continued Airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided."

Currently, regulations are available to the TC and STC holders in regards to developing ICAs. Although the regulations do not specifically address EWIS at this time, there is a regulatory path for incorporating current and future EWIS requirements into current ICAs as necessary.

ICA Development Process

OEMs develop and produce designs necessary to build and certify a product. From design engineering, documents are created to satisfy each paragraph of § 25 Appendix H.

Even though several methodologies have been utilized in the past, MSG-3 methodology is the most commonly understood and utilized by the aircraft manufacturers including those building small transport aircraft.

When using MSG-3 process to support development of the ICA, the OEM, in close cooperation with the FAA, forms a Maintenance Review Board (MRB). First task of the MRB is to create a Policy and Procedures Handbook (PPH). This is followed by the formation of Working Groups and the Industry Steering Committee (ISC). Approving the Policy and Procedures handbook is the first task for the ISC.

The PPH contains procedural tasks and methods that should be utilized by working groups and ISCs to conduct technical analysis that will result in recommended scheduled maintenance tasks and intervals based upon expected airplane usage and other operational factors.
AC 121-22A, Maintenance Review Board Procedures, provides guidelines that may be used by industry during its development and revision of the initial minimum scheduled maintenance / inspection requirements. This document is used for developing the scheduled maintenance instructions using MSG-3. This AC is an internationally accepted guide for using MSG-3. It covers the following sources of inspection tasks:

- Working Groups reviewing and approving tasks.
- Fatigue evaluation for structural threshold inspections and safe life limits.

- System Safety Analysis are merged with MSG-3 (reliability and safety with MSG-3 analysis)

AC 25.19, Certification Maintenance Requirements, recommends assembling a committee to evaluate candidate Certification Maintenance Requirements (CMR).

Working groups

Working Groups perform the maintenance analysis per MSG-3 process within the boundaries identified by the PPH. Once the Working Group Chair approves the analysis, it is subsequently submitted to the ISC for concurrence.

Industry Steering Committee

This committee is responsible for keeping the analysis on track, approving Working Group recommendations and preparing the preliminary Maintenance Review Board Report (MRBR). The FAA reviews the preliminary MRBR and comments are shared with the OEM.

Maintenance Review Board Approval

The last step in scheduled inspection and maintenance development is the Maintenance Review Board (FAA AEG) accepting the Maintenance Review Board Report.

When all comments of the MRB are resolved, the draft MRBR is submitted to AFS-302 in Washington D.C. to assure it conforms to accepted standards for MSG-3. Upon acceptance by the AFS-302 office, the MRB Chairman approves the MRBR, and subsequently coordinates approval of the applicable documents with ACO and the aircraft manufacturers.

ICA Revision Process

The STA OEMs have in their processes a means for revising their respective ICAs as required by current regulation. The OEMs receive feedback from owner/operators, internal maintenance review boards, factory service centers, and maintenance repair organizations (MRO). The data is collected, reviewed, and analyzed by the OEMs engineering staff and regulatory authorities. The results of this technical analysis are developed into action plans that are generated to mitigate these operational concerns and future potential issues. When necessary the information is incorporated into ICAs, AMMs, Service Bulletins, and Service Letters. These changes are incorporated into the ICAs that are reviewed by the applicable regulatory agencies responsible for the aircraft's certification and oversight activities.

Aircraft Maintenance Regulation

FAR § 43.13(a) **Performance Rules (General)**

"Each person performing maintenance...on an aircraft...shall use the methods, techniques, and practices prescribed in the current manufacturer's maintenance manual or Instructions of Continuous Airworthiness prepared by its manufacturer, or other methods, techniques, and practices acceptable to the Administrator..."

The above stated regulation is relative to STA operated under CFR 14 Parts 91 or 135. Maintenance is to be performed in accordance with the current manufacturer's maintenance manual or ICAs.

Operational Regulation

FAR §91.409(f) **Inspections**

"Selection of inspection program under paragraph (e) of this section. The registered owner or operator...must select, identify in the aircraft maintenance records, and use one of the following programs for the inspection of the aircraft:

> (1) A continuous airworthiness inspection program that is part of a continuous airworthiness maintenance program...
> (2) An approved aircraft inspection program...
> (3) A current inspection program recommended by the manufacturer.
> (4) Any other inspection program established by the registered owner or operator...and approved by the Administrator."

FAR § 91.501(a) **Applicability**

"This subpart prescribes operating rules, in addition to those prescribed in other subparts of this part, governing the operation of large airplanes of U.S. registry, turbojet-powered multiengine civil airplanes of U.S. registry, and fractional ownership program aircraft of U.S. registry that are operating under subpart K of this part in operation not involving common carriage. The operating rules in this subpart do not apply to those aircraft when they are required to operated under parts 121, 125, 129, 135, and 137 of this chapter (Section 91.409 prescribes an inspection program for large and for turbine-powered rotorcraft of U.S. registry when they are operated under this part or part 129 or 137)."

FAR § 135.411(a) **Applicability**

"This subpart prescribes rules in addition to those in other parts of this chapter for the maintenance, preventative maintenance, and alterations for each certificate holder as follows:

> (1) Aircraft that are type certificated for a passenger seating configuration...nine seats or less, shall be maintained under parts 91 and 43...An approved aircraft inspection program may be used...

(2) Aircraft that are type certificated for a passenger seating configuration of...ten seats or more shall be maintained under a maintenance program in FAR §§ 135.415, 135.416, 135.417, 135.422, and 135.424 through 135.443."

Operational Element

STA as found in FAR§§ 91.501 (subpart F), 91.1001 (subpart K), and Part 135 Operations use OEM Continuous Inspection Programs that meet the requirements of FAR §§ 91.409 (f)(3), 135.411 (a) (1) & (2). These ICAs are the model specific maintenance component of the entire ICA as required per FAR § 25.1529, Appendix H. In the case for Part 135 Operators, the ICAs are CMO/CHDO/FAA approved, where as ICAs for the Part 91 Operator are accepted. The ICA requirements are met during type certification (supplemental type certification) by FAA's ACO, with coordination with AEG, and AFS organizations during the aircraft certification or supplemental type certification process.

Operational Compliance

The owner/operator must indicate to their local regulatory inspector the planned method of operation and how the airplane will be maintained. Majority of corporate jets are operated under FAR §§ 91.501 and 91.409(f)(3) (using an inspection program recommended by the manufacturer).

FAR § 91.1001 Fractional Operators are required to comply with both 91 Subpart F and 91 Subpart K – Management Specifications.

Operations in Part 135 Charter and On-demand are required to establish an inspection and maintenance programs per FAR § 135.411(a) (1 or 2) depending on passenger seating. For operators flying Charter/On-demand, and when the Administrator finds the inspection program is inadequate, maintenance must be approved per the regulatory requirements of FAR § 135.419. Approved Airworthiness Inspection Program (AAIP) is developed to document the inspection/maintenance activities that will be used. Primarily, most AAIPs are created using the OEM's ICAs for inspection instructions and additionally contain a statement that the requirements of an AAIP must be reviewed each time the OEMs MM is revised.

Regardless of operations the continuous airworthiness requirements are met through joint program administration, involving the Type Design Holder, FAA and the operator. In addition to the program, operators and manufacturers alike must ensure they comply with FAA Airworthiness Directives as a result of safety concerns.

Regardless of which operating rules, manufacturers are required to design, build and document the airplane so the above requirements can be satisfied by the owner/operator. The airplane ICAs contains the instructions necessary for an owner/operator to maintain the airplane's airworthiness compliance to type design requirements.

Maintenance Tracking

OEMs of STA offer maintenance-tracking service for the life of the airplane. The service provides reports so a customer can plan operation in a way to assure the airplane is scheduled for maintenance when an inspection is due. Reports also identify when inspections are completed. This report is very valuable when demonstrating to either the FAA or a potential buyer that the airplane is being maintained per the latest OEM requirements.

Closed-loop System

FAR § 21.3(a) **Reporting of Failures, Malfunctions, and Defects**

"Except as provided in paragraph (d) of this section, the holder of a Type Certificate (including a Supplemental Type Certificate), a Parts Manufacturer Approval (PMA), or a TSO authorization, or the licensee of a Type Certificate shall report any failure, malfunction, or defect in any product, part, process, or article manufactured by it that it determines has resulted in any of the occurrences listed in paragraph (c) of this section."

AC 120-79, Developing and Implementing a Continuing Analysis and Surveillance System, describes a program required by FAR §§ 121.373 and 135.431 that monitors and analyzes the performance and effectiveness of the operator's inspection and maintenance programs, including FAA regulations and manufacturer instructions. In many cases, the STA operators adopted best industry practices for the purpose of analyzing the performance and effectiveness of inspection and maintenance programs. This is accomplished through voluntary operational feedback.

For example, OEM as does as well the NBAA, have model specific operator advisory boards, committees and panels that meet with the manufacturer customer support management on a semi-annually basis, to review maintenance /operational issues identified by operators using OEM In-Service Difficulty Report and maintenance tracking programs for in-service data. These programs are meant to identify operational issues as well as, aircraft reliability or inspection/maintenance difficulties and findings. These reports along with engineering projection and analyses, validate maintenance programs and inspection intervals, in essence, the driving force for making revisions to the ICAs content and maintenance intervals.

These model specific operator groups are comprised of voluntary operating members with the purpose of improving the product and processes that OEMs use to support the operator. Much of their efforts are realized as enhancements to aircraft reliability, seen as Service Bulletins, Service Letter or ICA revisions.

The inspection and maintenance practices are very closely tied to the OEMs' ICA. Most 91 operators use the OEMs' ICA as the method of compliance. Every time the OEM revises their programs, operators automatically adopt to the latest program revision. This is also true for 135 operators with AAIPs or CAMP, as they normally accept revision of the OEM's ICAs.

STA aircraft in private and on-demand operations do not have their own engineering staff and systematically are interdependent on the existing structure and working relationship established with manufacturers, as well as, the FAA.

Many STA operators do not have a dedicated maintenance staff. Because of this, each OEM has developed a network of approved Service Centers to be used, with some OEMs owning their own Service Centers. All OEM Service Centers are FAA approved 145 Repair stations. Service Centers and their technicians' work with the latest revision of ICA (MM) and / or the operators approved program, to ensure each airplane is inspected to the requirements found in Part 43 and requirements of Part 145 - Repair Stations Requirements.

Inspection and maintenance programs are approved by FAA at various levels, from aircraft certification to operational specifications.

Customer Feed Back - Airplane Operation

OEMs, as with NBAA's model specific technical committees, track fleet issues. These issues have a broad range of variation from maintenance / technical to operational concerns. In addition to the committee work, each OEM has a method for customers to report operational difficulties. Some imploring their company owned maintenance reliability advisory boards.

The OEM Customer feedback program begins at the introduction of a new model and continues beyond the delivery of the last aircraft from the production line. A majority of Service Bulletins, Service Letters and revised Maintenance Manuals are derived from feedback initiated by structured Customer feedback programs.

Each OEM periodically revises and updates existing Maintenance Manuals (typically one year revision cycle.) The frequency is usually higher when a new model is first introduced and trails off as the product matures.

Since the majority of Part 91 operators agree to maintain their airplane per FAR § 91.409 (f)(3), each time an airplane ICA (Maintenance Manual) is revised and issued, it becomes the requirement on the airplane. No additional coordination is required with the local FAA inspector. Even the Part 135 operators are tied to the latest Maintenance Manual revision; therefore practically 100% of the STA fleet is always using the latest OEMs Instructions for Continued Airworthiness.

Conclusions

When HWG10 conducted their evaluations, findings were discovered during maintenance intervals, which are currently in existing inspection and maintenance programs. There is no data to support or argue that the findings were not going to be identified and corrected during this specific shop visit and maintenance interval. The evaluation team conducted their evaluation independently of the inspection maintenance organization and did not collaborate with the Service Provider their findings; however, the information was presented to the owner/operator for their disposition. During the evaluation process, it was noted that some of the finding apparently existed for a period and that the conditions should have been addressed in previous inspection intervals, leaving the evaluator to conclude that the inspector/maintainer's knowledge base, or personal judgment and decision-making process weighed-in on the airworthiness decision.

From the yearlong awareness training effort conducted by AEA and NBAA, it is evident that a certain level of complacency exists for some personnel. More specifically, EWIS training is lacking to the extent recommended in ATSRAC reports. Going forward, there is a need to collaboratively communicate the knowledge gained from the ATSRAC activity informing those responsible for determining airworthiness on the importance of EWIS. The initiating of training begins before the aircraft is in service, at manufacturing, through the aircraft life cycle, and includes the personnel involved as maintainers and service providers.

STA OEMs, support organizations and operators have all the “tools” needed to address any deficiencies identified and recommendations reported by HWG10 and HWG13.

Through the life cycle of the aircraft maintenance, the owner / operator will outsource a variety of large maintenance tasks and completion projects to a FAA 145 Repair Stations, and Maintenance Repair Organization (MRO). These visits, varying between 4 – 6 year intervals, offer an opportunity to have the inspection and maintenance program task conducted by a appropriately certificated and authorized facility with training as part of the service center approval process.

Task 3 - Compliance Means

Existing Process - Regulatory, manufacturer, and operational requirements as a system utilized today is viewed as mandatory per the existing rules. These rules form the basis for STA OEM ICAs Inspection and Maintenance Programs development and revision process. The process allows for new and developing requirements to enter from any source. A myriad of activity is continually initiated continuing throughout the aircraft's service life.

Compliance, from a regulatory standpoint is mandatory, not voluntary. However, from an industry's perspective, best practices, process improvements, and product enhancements are in continuous motion. STA operations demand the highest degree of quality for products and programs, and will proactively pursue OEM participation in development and compliance for EWIS. Communicating EWIS maintenance issues is a must, as meetings with industry and regulatory personnel have resulted in positive future commitments to improve aircraft safety through implementation of enhanced EWIS concepts

STA Industry Proactive Efforts

- Continued periodic publication information
- NBAA / AEA sponsored EWIS presentation and roundtable discussion - NBAA Convention 2004 with
    - Aircraft Manufacturer Representatives
    - Maintenance Repair Organization Representatives
- OEM EWIS presentations to Owner/Operators during Maintenance and Operation conferences
- Ongoing EWIS Training and Awareness
    - AEA seminars around the world to:
        - Authorized OEM Service Centers
        - Inspection Authorization Renewal Seminars
        - Inspectors / Technicians
        - Maintenance Repair Organizations
        - Regulatory Agencies
    - OEM internal production and completion EWIS training
    - NBAA Regional forums, conferences, and dedicated I.A. renewal workshops
- EWIS training materials provided to CASSD-Mitre for posting on the ATSRAC web page.
- HWG10 report and articles posted to NBAA Technical Committee web page
- EWIS discussed during NBAA model specific Tech Committee meetings

HWG-13 Recommendations to ATSRAC that:

1. FAA recommends:
    a. "EWIS training" as part of the training requirements for Part 145 repair stations.
    b. Incorporating EWIS training as part of FAA Safety Training Programs (I.A. renewal) maintenance seminars & conferences.
2. STA OEMs should voluntarily:
    a. Resolve "GAP" EWIS concepts and/or definitions found during their review of their Instructions of Continuous Airworthiness and Standard Practice Manuals
    b. Enhance the ICAs with EWIS information as needed.
    c. Include EWIS training (i.e. ICA and SPM) into initial and recurrent factory approved training curriculums.
3. Industry continues its awareness and training programs in regards to EWIS.

ATSRAC Developed Recommendations:

NOTE: ATSRAC rejected HWG-13 voluntary approach and voted to accept the following recommendations. These recommendations were accepted during the January 12, 2005 HWG-13 presentation to ATSRAC.

1. Recommendation to FAA to include "EWIS training" as part of the training requirements for Part 145 repair stations.

2. Recommendation to FAA to incorporate EWIS training as part of FAA Safety Training Programs (I.A. renewal) maintenance seminars & conferences.
3. The FAA should write formally to STA OEMs requesting they resolve "GAP" EWIS concepts and/or definitions in their Instructions for Continuing Airworthiness and Standard Practice Manuals.
4. The FAA should write formally to STA OEMs requesting them to enhance the ICAs with EWIS information.
   NOTE: This recommendation was specifically voted on by ATSRAC - no consensus - 8 "For" votes, 7 "Against" votes, and 1 Abstention.
5. The FAA should write formally to the STA industry requesting that it continues its EWIS awareness and training programs.
   NOTE: Editorial Comment - HWG-13 would like to know to whom the FAA should send this letter.
6. The FAA should write formally to STA OEMs requesting them to include EWIS training (i.e. ICA and SPM) into initial and recurrent factory approved training curriculums.

HWG-13 Additional Recommendation to ATSRAC that:

- FAA to revise AC 43.13-1B Chapter 11 to include the "gap" items from the proposed EWIS definition:
  - Currently there is a working group developed to review this AC and incorporate revisions as necessarily.
  - This group is based on Part 23 aircraft however, as the review process has shown it should be expanded to Part 25 aircraft.
- FAA to remove or clarify when the "non-pressurized" statement is appropriate for in the use of the document. i.e. structural repairs, etc…

Appendix A

Harmonization Working Group - 13
Members / Participants

Name	Organization	Member/Participant
Jon Haag	Altria Corporate Services, Inc.	Co-chair
Gunnar Jancke	Jet Aviation Basle	Co-chair
Jerome Bruel	JAA / DGAC	M
Wilfrid Cote	Transport Canada	M
Bryan Easterwood	FAA	M
Glen White	FAA	M
Dan Withers	FAA	M
Ric Peri	Aircraft Electronics Association	M
Ken Elias	ALPA	M
Mike Sevigny	Bombardier Aerospace	M
Mike Richardson	Cessna Aircraft	M
Dominique Bellon	Dassault Aviation (Retired)	M
Michel Larhantec	DFS Service Center	M
Jean-Claude Laugeois	Dassault Aviation	M
Jeff Derf	Gulfstream Aerospace	M
Rosita Green	Gulfstream Aerospace	P
Keith Clevenger	Health South	M
Norm Hunt	Midcoast Aviation	M
Eli Cotti	NBAA	M
Frank Keefer	Raytheon Aircraft	M
Jeff Kouba	Southern Company	M
Harry van Soestbergen	Garrett Aviation	M

Appendix B

HWG-10 Aircraft Evaluation Comparison Report

Explanations:

Column "HWG-10 Findings"

- N/A = Aircraft was not evaluated during HWG-10 Aircraft Evaluations
- Subtotal Row = subtotal of total findings (without "OTHER" included)
- % of Total = percentage of subtotal to total findings
- Sample I and J = the OEM has combine Chapter 5 and SPM for the two (2) different aircraft models

Aircraft Wiring Installation/Condition Report Summary from ATSRAC HWG-10					OEM ICA Chapter 5 (Scheduled Maintenance) Review										OEM Chapter 20 (Standard Practices) Review										
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.		**Sample Totals**	Safety of Flight Concerns	Significant Items	Model A	Model B	Model C	Model D	Model E	Model F	Model G	Model H	Model I	Model J	Model A	Model B	Model C	Model D	Model E	Model F	Model G	Model H	Model I	Model J	***AC43.13-1B Review***
CONNECTORS	INSERT DAMAGE/DETERIORATION	7	0	0		X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X
	CONTACT ARCING/FRETTING	0	0	0	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X			
	MISSING DUMMY CONTACTS/SEAL PLUGS	1	0	0			X	X	X	X	X	X	X	X		X	X	X	X	X			X	X	
	MISSING/DAMAGED BACKSHELLS	10	0	0	X		X	X	X	X	X	X	X	X		X	X	X	X	X			X	X	
	CONNECTOR BACKSHELL STRAIN RELIEF	32	0	0		X	X	X	X		X	X	X	X	X		X	X	X	X			X	X	X
	LOOSE OR WORN B-NUTS	3	0	0			X	X			X	X	X	X		X	X	X							X
	OTHER	9	0	0																					
TERMINATIONS	GROUND POINTS - CONDITION/SECURITY	2	0	0		X	X	X	X	X			X	X			X	X	X	X	X	X	X	X	X
	INADEQUATE DRIP LOOP(S)	10	0	0			X	X			X	X	X	X	X		X	X			X	X	X	X	X
	CORRECT HARDWARE BUILDUP/TORQUE	4	0	0		X	X	X			X	X	X	X	X		X	X		X	X	X	X	X	X
	HEAT DAMAGE/CORROSION	0	0	0			X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
	OTHER	30	0	1																					
INSTALLATIONS (GENERAL)	INADEQUATE CLEARANCE TO STRUCTURE	813	0	28	X		X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X
	MISSING/DETERIORATED PRESSURE SEALS	3	0	0			X	X	X	X		X	X	X		X	X	X	X	X				
	SLEEVING/CONDUITS CONDITION	69	0	0	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X			X	X	X
	BEND RADIUS (10x WIRE/BUNDLE DIAMETER)	157	0	5			X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X
	CLAMP CONDITION/SIZING/SPACING	419	0	3	X		X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X
	MISSING/DETERIORATED GROMMETS	58	0	7			X	X			X	X	X	X	X	X	X	X					X	X	X
	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	87	0	3						X	X	X	X	X		X				X	X	X	X	X	X
	EXCESSIVE SLACK/SAG BETWEEN CLAMPS	68	0	2			X	X			X	X	X	X	X	X	X	X					X	X	X
	T-STRIP CONDITION/HARDWARE BUILDUP	14	0	3		X	X	X			X	X	X	X			X	X			X	X	X	X	X
	SIGNIFICANT DUST AN LINT BUILDUP	76	0	0							X	X	X	X		X							X	X	X
	OTHER	167	0	3																					
WIRING CONDITION	PREVIOUS REPAIRS/CONDITION OF	14	0	3			X	X			X	X				X	X	X							X
	HEAT/VIBRATION DAMAGE	5	0	0		X	X	X		X	X	X	X	X	X	X	X	X			X	X	X	X	X
	INDIRECT DAMAGE (HYD, PNEU LEAKS)	5	0	0		X	X	X		X	X	X	X	X		X	X	X					X	X	X
	CRACKED/ABRADED INSULATION	66	0	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BROKEN SHIELD/CONDUCTORS	38	0	1	X	X	X	X		X	X	X	X	X	X	X	X	X		X			X	X	X
	EXPOSED CONDUCTORS/SHIELD	46	0	12	X	X	X	X		X	X	X	X	X	X	X	X	X		X			X	X	X
	FLUID/CHEMICAL CONTAMINATION	56	0	1		X	X	X			X	X	X	X	X	X	X	X			X	X	X	X	X
	CORROSION	1	0	0		X	X	X			X	X	X	X	X	X	X	X			X	X	X	X	X
	OTHER	19	0	0																					
	TOTALS	2289	0	73	8	13	26	26	13	17	23	27	27	27	14	19	26	26	13	17	14	15	24	24	24
	PERCENTAGE OF WIRING INSPECTION ISSUES COVERED				25.0%	40.6%	81.3%	81.3%	40.6%	53.1%	71.8%	84.4%	84.4%	84.4%	43.8%	59.4%	81.3%	81.3%	40.6%	53.1%	43.8%	46.9%	75.0%	75.0%	75.0%
	PERCENTAGE OF WIRING INSPECTION ISSUES COVERED *(EXCLUDES THE "OTHER" ISSUE UNDER EACH DEFINED CATEGORY)*				28.6%	46.4%	92.9%	92.9%	46.4%	60.7%	82.1%	96.4%	96.4%	96.4%	50.0%	67.9%	92.9%	92.9%	46.4%	60.7%	50.0%	53.6%	85.7%	85.7%	85.7%

Appendix B
HWG-10 Aircraft Evaluation Comparison Report

		HWG-10 FINDINGS SAMPLE A	HWG-13 ICA RESULTS SAMPLE A	HWG-13 SPM RESULTS SAMPLE A	HWG-10 FINDINGS SAMPLE B	HWG-13 ICA RESULTS SAMPLE B	HWG-13 SPM RESULTS SAMPLE B	
CONNECTORS	INSERT DAMAGE OR DETERIORATION	0	N	N	N/A	Y	N	INSERT DAMAGE OR DETERIORATION
	CONTACT ARCHING / FRETTING	0	Y	N	N/A	N	Y	CONTACT ARCHING / FRETTING
	MISSING DUMMY CONTACTS / SEAL PLUGS	1	N	N	N/A	N	Y	MISSING DUMMY CONTACTS / SEAL PLUGS
	MISSING / DAMAGED BACKSHELLS	0	Y	N	N/A	N	Y	MISSING / DAMAGED BACKSHELLS
	CONNECTOR BACKSHELL STRAIN RELIEF	17	N	Y	N/A	Y	N	CONNECTOR BACKSHELL STRAIN RELIEF
	LOOSE OR WORN B-NUTS	0	N	N	N/A	N	Y	LOOSE OR WORN B-NUTS
	SUBTOTAL	18						**SUBTOTAL**
	% OF TOTAL	3.5%						**% OF TOTAL**
TERMINATIONS	GROUND POINTS - CONDITION / SECURITY	2	N	N	N/A	Y	N	GROUND POINTS - CONDITION / SECURITY
	INADEQUATE DRIP LOOP (S)	7	N	Y	N/A	N	N	INADEQUATE DRIP LOOP (S)
	CORRECT HARDWARE BUILD UP TORQUE	0	N	Y	N/A	Y	N	CORRECT HARDWARE BUILD UP TORQUE
	HEAT DAMAGE / CORROSION	0	N	N	N/A	N	Y	HEAT DAMAGE / CORROSION
	SUBTOTAL	9						**SUBTOTAL**
	% OF TOTAL	1.7%						**% OF TOTAL**
INSTALLATIONS (GENERAL)	INADEQUATE CLEARANCE TO STRUCTURE	118	Y	Y	N/A	N	N	INADEQUATE CLEARANCE TO STRUCTURE
	MISSING / DETERIORATED PRESSURE SEALS	3	N	N	N/A	N	Y	MISSING / DETERIORATED PRESSURE SEALS
	SLEEVING / CONDUITS CONDITION	25	Y	Y	N/A	Y	Y	SLEEVING / CONDUITS CONDITION
	BEND RADIUS	35	N	Y	N/A	N	N	BEND RADIUS
	CLAMP CONDITION / SIZING / SPACING	77	Y	Y	N/A	N	N	CLAMP CONDITION / SIZING / SPACING
	MISSING / DETERIORATED GROMMETS	8	N	Y	N/A	N	Y	MISSING / DETERIORATED GROMMETS
	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	57	N	N	N/A	N	Y	DEBRIS ACCUMULATIONS ON WIRE BUNDLE
	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	29	N	Y	N/A	N	Y	EXCESSIVE SLACK / SAG BETWEEN CLAMPS
	T-STRIP CONDITION / HARDWARE / BUILD-UP	9	N	N	N/A	Y	N	T-STRIP CONDITION / HARDWARE / BUILD-UP
	SIGNIFICANT DUST AND LINT BUILD-UP	54	N	N	N/A	N	Y	SIGNIFICANT DUST AND LINT BUILD-UP
	SUBTOTAL	415						**SUBTOTAL**
	% OF TOTAL	80.3%						**% OF TOTAL**
WIRING CONDITION	PREVIOUS REPAIRS / CONDITION OF	9	N	N	N/A	N	Y	PREVIOUS REPAIRS / CONDITION OF
	HEAT / VIBRATION DAMAGE	0	N	Y	N/A	Y	Y	HEAT / VIBRATION DAMAGE
	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	2	N	N	N/A	N	Y	INDIRECT DAMAGE (HYD., PNEU. LEAKS)
	CRACKED / ABRAIDED INSULATION	12	Y	Y	N/A	Y	Y	CRACKED / ABRAIDED INSULATION
	BROKEN SHIELD / CONDUCTORS	4	Y	Y	N/A	N	Y	BROKEN SHIELD / CONDUCTORS
	EXPOSED CONDUCTORS / SHIELD	24	Y	Y	N/A	N	Y	EXPOSED CONDUCTORS / SHIELD
	FLUID / CHEMICAL CONTAMINATION	24	N	Y	N/A	N	Y	FLUID / CHEMICAL CONTAMINATION
	CORROSION	0	N	N	N/A	N	Y	CORROSION
	SUBTOTAL	75						**SUBTOTAL**
	% OF TOTAL	14.5%						**% OF TOTAL**
	SAMPLE TOTAL	517						**SAMPLE TOTAL**

Appendix B
HWG-10 Aircraft Evaluation Comparison Report

		HWG-10 FINDINGS SAMPLE C	HWG-13 ICA RESULTS SAMPLE C	HWG-13 SPM RESULTS SAMPLE C	HWG-10 FINDINGS SAMPLE D	HWG-13 ICA RESULTS SAMPLE D	HWG-13 SPM RESULTS SAMPLE D		
CONNECTORS	INSERT DAMAGE OR DETERIORATION	6	Y	Y	N/A	Y	Y	INSERT DAMAGE OR DETERIORATION	CONNECTORS
	CONTACT ARCHING / FRETTING	0	Y	Y	N/A	Y	Y	CONTACT ARCHING / FRETTING	
	MISSING DUMMY CONTACTS / SEAL PLUGS	0	Y	Y	N/A	Y	Y	MISSING DUMMY CONTACTS / SEAL PLUGS	
	MISSING / DAMAGED BACKSHELLS	0	Y	Y	N/A	Y	Y	MISSING / DAMAGED BACKSHELLS	
	CONNECTOR BACKSHELL STRAIN RELIEF	8	Y	Y	N/A	Y	Y	CONNECTOR BACKSHELL STRAIN RELIEF	
	LOOSE OR WORN B-NUTS	2	Y	Y	N/A	Y	Y	LOOSE OR WORN B-NUTS	
	SUBTOTAL	16						**SUBTOTAL**	
	% OF TOTAL	5.1%						**% OF TOTAL**	
TERNINATIONS	GROUND POINTS - CONDITION / SECURITY	0	Y	Y	N/A	Y	Y	GROUND POINTS - CONDITION / SECURITY	TERNINATIONS
	INADEQUATE DRIP LOOP (S)	0	Y	Y	N/A	Y	Y	INADEQUATE DRIP LOOP (S)	
	CORRECT HARDWARE BUILD UP TORQUE	1	Y	Y	N/A	Y	Y	CORRECT HARDWARE BUILD UP TORQUE	
	HEAT DAMAGE / CORROSION	0	Y	Y	N/A	Y	Y	HEAT DAMAGE / CORROSION	
	SUBTOTAL	1						**SUBTOTAL**	
	% OF TOTAL	0.3%						**% OF TOTAL**	
INSTALLATIONS (GENERAL)	INADEQUATE CLEARANCE TO STRUCTURE	156	Y	Y	N/A	Y	Y	INADEQUATE CLEARANCE TO STRUCTURE	INSTALLATIONS (GENERAL)
	MISSING / DETERIORATED PRESSURE SEALS	0	Y	Y	N/A	Y	Y	MISSING / DETERIORATED PRESSURE SEALS	
	SLEEVING / CONDUITS CONDITION	4	Y	Y	N/A	Y	Y	SLEEVING / CONDUITS CONDITION	
	BEND RADIUS	15	Y	Y	N/A	Y	Y	BEND RADIUS	
	CLAMP CONDITION / SIZING / SPACING	70	Y	Y	N/A	Y	Y	CLAMP CONDITION / SIZING / SPACING	
	MISSING / DETERIORATED GROMMETS	14	Y	Y	N/A	Y	Y	MISSING / DETERIORATED GROMMETS	
	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	7	N	N	N/A	N	N	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	
	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	3	Y	Y	N/A	Y	Y	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	
	T-STRIP CONDITION / HARDWARE / BUILD-UP	0	Y	Y	N/A	Y	Y	T-STRIP CONDITION / HARDWARE / BUILD-UP	
	SIGNIFICANT DUST AND LINT BUILD-UP	1	N	N	N/A	N	N	SIGNIFICANT DUST AND LINT BUILD-UP	
	SUBTOTAL	270						**SUBTOTAL**	
	% OF TOTAL	86.8%						**% OF TOTAL**	
WIRING CONDITION	PREVIOUS REPAIRS / CONDITION OF	1	Y	Y	N/A	Y	Y	PREVIOUS REPAIRS / CONDITION OF	WIRING CONDITION
	HEAT / VIBRATION DAMAGE	0	Y	Y	N/A	Y	Y	HEAT / VIBRATION DAMAGE	
	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	1	Y	Y	N/A	Y	Y	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	
	CRACKED / ABRAIDED INSULATION	6	Y	Y	N/A	Y	Y	CRACKED / ABRAIDED INSULATION	
	BROKEN SHIELD / CONDUCTORS	1	Y	Y	N/A	Y	Y	BROKEN SHIELD / CONDUCTORS	
	EXPOSED CONDUCTORS / SHIELD	14	Y	Y	N/A	Y	Y	EXPOSED CONDUCTORS / SHIELD	
	FLUID / CHEMICAL CONTAMINATION	1	Y	Y	N/A	Y	Y	FLUID / CHEMICAL CONTAMINATION	
	CORROSION	0	Y	Y	N/A	Y	Y	CORROSION	
	SUBTOTAL	24						**SUBTOTAL**	
	% OF TOTAL	7.7%						**% OF TOTAL**	
	SAMPLE TOTAL	311						**SAMPLE TOTAL**	

Appendix B
HWG-10 Aircraft Evaluation Comparison Report

		HWG-10 FINDINGS SAMPLE E	HWG-13 ICA RESULTS SAMPLE E	HWG-13 SPM RESULTS SAMPLE E	HWG-10 FINDINGS SAMPLE F	HWG-13 ICA RESULTS SAMPLE F	HWG-13 SPM RESULTS SAMPLE F		
CONNECTORS	INSERT DAMAGE OR DETERIORATION	0	Y	Y	0	Y	Y	INSERT DAMAGE OR DETERIORATION	CONNECTORS
	CONTACT ARCHING / FRETTING	0	Y	Y	0	Y	Y	CONTACT ARCHING / FRETTING	
	MISSING DUMMY CONTACTS / SEAL PLUGS	0	Y	Y	0	Y	Y	MISSING DUMMY CONTACTS / SEAL PLUGS	
	MISSING / DAMAGED BACKSHELLS	4	Y	Y	3	Y	Y	MISSING / DAMAGED BACKSHELLS	
	CONNECTOR BACKSHELL STRAIN RELIEF	0	Y	Y	0	N	N	CONNECTOR BACKSHELL STRAIN RELIEF	
	LOOSE OR WORN B-NUTS	0	N	N	0	N	N	LOOSE OR WORN B-NUTS	
	SUBTOTAL	4			3			**SUBTOTAL**	
	% OF TOTAL	1.8%			1.8%			**% OF TOTAL**	
TERNINATIONS	GROUND POINTS - CONDITION / SECURITY	0	Y	Y	0	Y	Y	GROUND POINTS - CONDITION / SECURITY	TERNINATIONS
	INADEQUATE DRIP LOOP (S)	2	N	N	0	N	N	INADEQUATE DRIP LOOP (S)	
	CORRECT HARDWARE BUILD UP TORQUE	3	N	N	0	N	Y	CORRECT HARDWARE BUILD UP TORQUE	
	HEAT DAMAGE / CORROSION	0	Y	Y	0	Y	Y	HEAT DAMAGE / CORROSION	
	SUBTOTAL	5			0			**SUBTOTAL**	
	% OF TOTAL	2.3%			0.0%			**% OF TOTAL**	
INSTALLATIONS (GENERAL)	INADEQUATE CLEARANCE TO STRUCTURE	56	Y	Y	65	Y	Y	INADEQUATE CLEARANCE TO STRUCTURE	INSTALLATIONS (GENERAL)
	MISSING / DETERIORATED PRESSURE SEALS	0	Y	Y	0	Y	Y	MISSING / DETERIORATED PRESSURE SEALS	
	SLEEVING / CONDUITS CONDITION	4	Y	Y	7	Y	Y	SLEEVING / CONDUITS CONDITION	
	BEND RADIUS	15	Y	Y	7	Y	Y	BEND RADIUS	
	CLAMP CONDITION / SIZING / SPACING	109	Y	Y	69	Y	Y	CLAMP CONDITION / SIZING / SPACING	
	MISSING / DETERIORATED GROMMETS	7	N	N	3	N	N	MISSING / DETERIORATED GROMMETS	
	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	6	N	N	2	Y	Y	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	
	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	0	N	N	0	N	N	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	
	T-STRIP CONDITION / HARDWARE / BUILD-UP	3	N	N	2	N	N	T-STRIP CONDITION / HARDWARE / BUILD-UP	
	SIGNIFICANT DUST AND LINT BUILD-UP	1	N	N	0	N	N	SIGNIFICANT DUST AND LINT BUILD-UP	
	SUBTOTAL	201			155			**SUBTOTAL**	
	% OF TOTAL	92.2%			91.7%			**% OF TOTAL**	
WIRING CONDITION	PREVIOUS REPAIRS / CONDITION OF	0	N	N	1	N	N	PREVIOUS REPAIRS / CONDITION OF	WIRING CONDITION
	HEAT / VIBRATION DAMAGE	0	N	N	2	Y	N	HEAT / VIBRATION DAMAGE	
	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	0	N	N	0	Y	N	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	
	CRACKED / ABRAIDED INSULATION	3	Y	Y	3	Y	Y	CRACKED / ABRAIDED INSULATION	
	BROKEN SHIELD / CONDUCTORS	0	N	N	0	Y	Y	BROKEN SHIELD / CONDUCTORS	
	EXPOSED CONDUCTORS / SHIELD	0	N	N	0	Y	Y	EXPOSED CONDUCTORS / SHIELD	
	FLUID / CHEMICAL CONTAMINATION	5	N	N	5	Y	N	FLUID / CHEMICAL CONTAMINATION	
	CORROSION	0	N	N	0	Y	N	CORROSION	
	SUBTOTAL	8			11			**SUBTOTAL**	
	% OF TOTAL	3.7%			6.5%			**% OF TOTAL**	
	SAMPLE TOTAL	218			169			**SAMPLE TOTAL**	

Appendix B
HWG-10 Aircraft Evaluation Comparison Report

		HWG-10 FINDINGS SAMPLE G	HWG-13 ICA RESULTS SAMPLE G	HWG-13 SPM RESULTS SAMPLE G	HWG-10 FINDINGS SAMPLE H	HWG-13 ICA RESULTS SAMPLE H	HWG-13 SPM RESULTS SAMPLE H		
CONNECTORS	INSERT DAMAGE OR DETERIORATION	1	Y	Y	0	Y	Y	INSERT DAMAGE OR DETERIORATION	CONNECTORS
	CONTACT ARCHING / FRETTING	0	Y	Y	0	Y	Y	CONTACT ARCHING / FRETTING	
	MISSING DUMMY CONTACTS / SEAL PLUGS	0	Y	N	0	Y	N	MISSING DUMMY CONTACTS / SEAL PLUGS	
	MISSING / DAMAGED BACKSHELLS	1	Y	N	0	Y	N	MISSING / DAMAGED BACKSHELLS	
	CONNECTOR BACKSHELL STRAIN RELIEF	3	Y	N	0	Y	N	CONNECTOR BACKSHELL STRAIN RELIEF	
	LOOSE OR WORN B-NUTS	0	Y	N	0	Y	N	LOOSE OR WORN B-NUTS	
	SUBTOTAL	5			0			**SUBTOTAL**	
	% OF TOTAL	2.4%			0.0%			**% OF TOTAL**	
TERNINATIONS	GROUND POINTS - CONDITION / SECURITY	0	N	Y	0	N	Y	GROUND POINTS - CONDITION / SECURITY	TERNINATIONS
	INADEQUATE DRIP LOOP (S)	1	Y	Y	0	Y	Y	INADEQUATE DRIP LOOP (S)	
	CORRECT HARDWARE BUILD UP TORQUE	0	Y	Y	0	Y	Y	CORRECT HARDWARE BUILD UP TORQUE	
	HEAT DAMAGE / CORROSION	0	Y	Y	0	Y	Y	HEAT DAMAGE / CORROSION	
	SUBTOTAL	1			0			**SUBTOTAL**	
	% OF TOTAL	0.5%			0.0%			**% OF TOTAL**	
INSTALLATIONS (GENERAL)	INADEQUATE CLEARANCE TO STRUCTURE	98	N	Y	118	Y	Y	INADEQUATE CLEARANCE TO STRUCTURE	INSTALLATIONS (GENERAL)
	MISSING / DETERIORATED PRESSURE SEALS	0	N	N	0	Y	N	MISSING / DETERIORATED PRESSURE SEALS	
	SLEEVING / CONDUITS CONDITION	0	N	N	14	Y	N	SLEEVING / CONDUITS CONDITION	
	BEND RADIUS	36	N	Y	15	Y	Y	BEND RADIUS	
	CLAMP CONDITION / SIZING / SPACING	12	Y	N	34	Y	Y	CLAMP CONDITION / SIZING / SPACING	
	MISSING / DETERIORATED GROMMETS	10	Y	N	4	Y	N	MISSING / DETERIORATED GROMMETS	
	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	4	Y	Y	4	Y	Y	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	
	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	4	Y	N	4	Y	N	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	
	T-STRIP CONDITION / HARDWARE / BUILD-UP	0	Y	Y	0	Y	Y	T-STRIP CONDITION / HARDWARE / BUILD-UP	
	SIGNIFICANT DUST AND LINT BUILD-UP	6	Y	N	2	Y	N	SIGNIFICANT DUST AND LINT BUILD-UP	
	SUBTOTAL	170			195			**SUBTOTAL**	
	% OF TOTAL	82.9%			87.1%			**% OF TOTAL**	
WIRING CONDITION	PREVIOUS REPAIRS / CONDITION OF	0	Y	N	0	Y	N	PREVIOUS REPAIRS / CONDITION OF	WIRING CONDITION
	HEAT / VIBRATION DAMAGE	0	Y	Y	0	Y	Y	HEAT / VIBRATION DAMAGE	
	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	2	Y	N	2	Y	N	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	
	CRACKED / ABRAIDED INSULATION	6	Y	Y	6	Y	Y	CRACKED / ABRAIDED INSULATION	
	BROKEN SHIELD / CONDUCTORS	16	Y	N	16	Y	N	BROKEN SHIELD / CONDUCTORS	
	EXPOSED CONDUCTORS / SHIELD	1	Y	N	1	Y	N	EXPOSED CONDUCTORS / SHIELD	
	FLUID / CHEMICAL CONTAMINATION	3	Y	Y	3	Y	Y	FLUID / CHEMICAL CONTAMINATION	
	CORROSION	1	Y	Y	1	Y	Y	CORROSION	
	SUBTOTAL	29			29			**SUBTOTAL**	
	% OF TOTAL	14.1%			12.9%			**% OF TOTAL**	
	SAMPLE TOTAL	205			224			**SAMPLE TOTAL**	

Appendix B
HWG-10 Aircraft Evaluation Comparison Report

		HWG-10 FINDINGS SAMPLE I&J	HWG-13 ICA RESULTS SAMPLE I&J	HWG-13 SPM RESULTS SAMPLE I&J
CONNECTORS	INSERT DAMAGE OR DETERIORATION	0	Y	Y
	CONTACT ARCHING / FRETTING	0	Y	N
	MISSING DUMMY CONTACTS / SEAL PLUGS	0	Y	Y
	MISSING / DAMAGED BACKSHELLS	4	Y	Y
	CONNECTOR BACKSHELL STRAIN RELIEF	1	Y	Y
	LOOSE OR WORN B-NUTS	0	Y	N
	SUBTOTAL	5		
	% OF TOTAL	2.3%		
TERNINATIONS	GROUND POINTS - CONDITION / SECURITY	0	Y	Y
	INADEQUATE DRIP LOOP (S)	0	Y	Y
	CORRECT HARDWARE BUILD UP TORQUE	0	Y	Y
	HEAT DAMAGE / CORROSION	0	Y	Y
	SUBTOTAL	0		
	% OF TOTAL	0.0%		
INSTALLATIONS (GENERAL)	INADEQUATE CLEARANCE TO STRUCTURE	103	Y	Y
	MISSING / DETERIORATED PRESSURE SEALS	0	Y	N
	SLEEVING / CONDUITS CONDITION	14	Y	Y
	BEND RADIUS	15	Y	Y
	CLAMP CONDITION / SIZING / SPACING	34	Y	Y
	MISSING / DETERIORATED GROMMETS	4	Y	Y
	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	4	Y	Y
	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	4	Y	Y
	T-STRIP CONDITION / HARDWARE / BUILD-UP	0	Y	Y
	SIGNIFICANT DUST AND LINT BUILD-UP	2	Y	Y
	SUBTOTAL	180		
	% OF TOTAL	84.1%		
WIRING CONDITION	PREVIOUS REPAIRS / CONDITION OF	0	N	N
	HEAT / VIBRATION DAMAGE	0	Y	Y
	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	2	Y	Y
	CRACKED / ABRAIDED INSULATION	6	Y	Y
	BROKEN SHIELD / CONDUCTORS	16	Y	Y
	EXPOSED CONDUCTORS / SHIELD	1	Y	Y
	FLUID / CHEMICAL CONTAMINATION	3	Y	Y
	CORROSION	1	Y	Y
	SUBTOTAL	29		
	% OF TOTAL	13.6%		
	SAMPLE TOTAL	214		

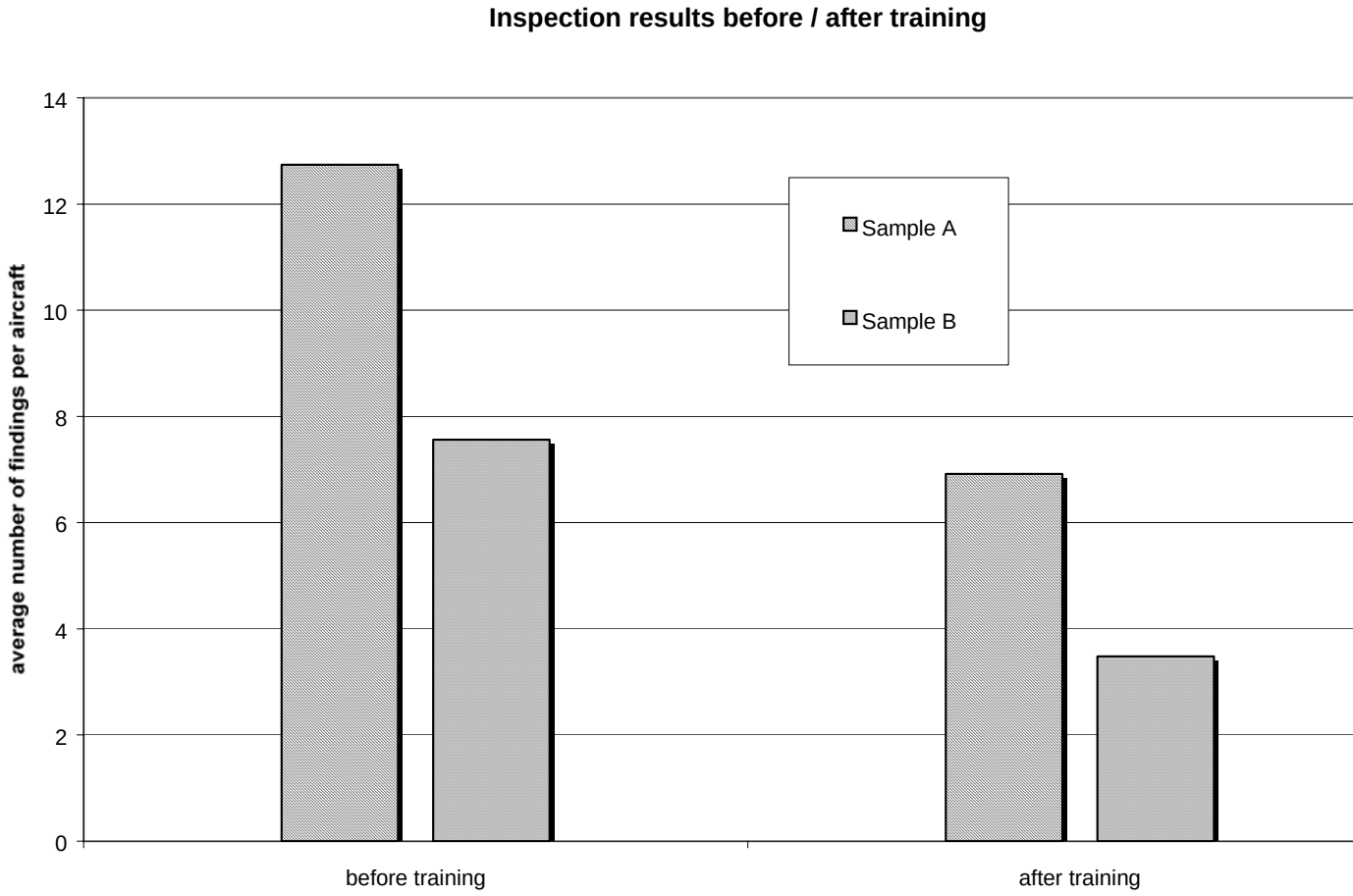
Appendix C

HWG-10 and HWG-1 / -2 Aircraft Evaluation Comparison to AC43.13-1B, Chapter 11

		HWG-10 TOTAL FINDINGS	AC 43.13-1B CHAPT. 11 REVIEW	HWG-1 & -2 TOTAL FINDINGS	AC 43.13-1B CHAPT. 11 REVIEW		
CONNECTORS	INSERT DAMAGE OR DETERIORATION	7	Y	50	Y	INSERT DAMAGE OR DETERIORATION	CONNECTORS
	CONTACT ARCHING / FRETTING	0	N	4	N	CONTACT ARCHING / FRETTING	
	MISSING DUMMY CONTACTS / SEAL PLUGS	1	N	23	N	MISSING DUMMY CONTACTS / SEAL PLUGS	
	MISSING / DAMAGED BACKSHELLS	10	N	51	N	MISSING / DAMAGED BACKSHELLS	
	CONNECTOR BACKSHELL STRAIN RELIEF	32	Y	98	Y	CONNECTOR BACKSHELL STRAIN RELIEF	
	LOOSE OR WORN B-NUTS	3	Y	16	Y	LOOSE OR WORN B-NUTS	
	SUBTOTAL	53		242		**SUBTOTAL**	
	% OF TOTAL	2.6%		8.0%		**% OF TOTAL**	
TERMINATIONS	GROUND POINTS - CONDITION / SECURITY	2	Y	98	Y	GROUND POINTS - CONDITION / SECURITY	TERMINATIONS
	INADEQUATE DRIP LOOP (S)	10	Y	9	Y	INADEQUATE DRIP LOOP (S)	
	CORRECT HARDWARE BUILD UP TORQUE	4	Y	15	Y	CORRECT HARDWARE BUILD UP TORQUE	
	HEAT DAMAGE / CORROSION	0	Y	48	Y	HEAT DAMAGE / CORROSION	
	SUBTOTAL	16		170		**SUBTOTAL**	
	% OF TOTAL	0.8%		5.6%		**% OF TOTAL**	
INSTALLATIONS (GENERAL)	INADEQUATE CLEARANCE TO STRUCTURE	813	Y	380	Y	INADEQUATE CLEARANCE TO STRUCTURE	INSTALLATIONS (GENERAL)
	MISSING / DETERIORATED PRESSURE SEALS	3	N	6	N	MISSING / DETERIORATED PRESSURE SEALS	
	SLEEVING / CONDUITS CONDITION	69	Y	210	Y	SLEEVING / CONDUITS CONDITION	
	BEND RADIUS	157	Y	38	Y	BEND RADIUS	
	CLAMP CONDITION / SIZING / SPACING	419	Y	495	Y	CLAMP CONDITION / SIZING / SPACING	
	MISSING / DETERIORATED GROMMETS	58	Y	50	Y	MISSING / DETERIORATED GROMMETS	
	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	87	Y	188	Y	DEBRIS ACCUMULATIONS ON WIRE BUNDLE	
	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	68	Y	238	Y	EXCESSIVE SLACK / SAG BETWEEN CLAMPS	
	T-STRIP CONDITION / HARDWARE / BUILD-UP	14	Y	48	Y	T-STRIP CONDITION / HARDWARE / BUILD-UP	
	SIGNIFICANT DUST AND LINT BUILD-UP	76	Y	233	Y	SIGNIFICANT DUST AND LINT BUILD-UP	
	SUBTOTAL	1764		1886		**SUBTOTAL**	
	% OF TOTAL	85.5%		62.2%		**% OF TOTAL**	
WIRING CONDITION	PREVIOUS REPAIRS / CONDITION OF	14	Y	245	Y	PREVIOUS REPAIRS / CONDITION OF	WIRING CONDITION
	HEAT / VIBRATION DAMAGE	5	Y	22	Y	HEAT / VIBRATION DAMAGE	
	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	5	Y	41	Y	INDIRECT DAMAGE (HYD., PNEU. LEAKS)	
	CRACKED / ABRAIDED INSULATION	66	Y	172	Y	CRACKED / ABRAIDED INSULATION	
	BROKEN SHIELD / CONDUCTORS	38	Y	59	Y	BROKEN SHIELD / CONDUCTORS	
	EXPOSED CONDUCTORS / SHIELD	46	Y	58	Y	EXPOSED CONDUCTORS / SHIELD	
	FLUID / CHEMICAL CONTAMINATION	56	Y	104	Y	FLUID / CHEMICAL CONTAMINATION	
	CORROSION	1	Y	34	Y	CORROSION	
	SUBTOTAL	231		735		**SUBTOTAL**	
	% OF TOTAL	11.2%		24.2%		**% OF TOTAL**	
	SAMPLE TOTAL	2064		3033		**SAMPLE TOTAL**	

Appendix D

Major OEM Completion Center Training Matrix



Back to Text

Appendix E

Dissenting Opinion:

Email received January 7, 2005 from (Member HWG-13) Wilfrid Cote (Transport Canada)

"I have reviewed the final report (attached). Generally, I concur with the final report in promoting EWIS AWARENESS AND TRAINING. However, the 2nd para on Page 5 (Executive Summary) (which I had not seen) I do not support for the simple reason that discrepancies found on Small Transport Aircraft (STA) were essentially the same as those found on Large Transport Aircraft (LTA). The recommendation should be directed to both STA and LTA.

A cultural shift must occur all over the aviation industry towards wiring in general and I think most aviation people are aware of that. Awareness in the handling of wires must be strongly promoted at initial training and repeated at regular interval.

STA may be used in the same manner as LTA and are not only used in business aircraft operation environment."