INTRUSIVE
INSPECTION RECOMMENDATIONS ~

COMMENTS ON OWNER INCORPORATION PLANS *

* Also Includes owner remarks on comments

PRIORITY 1 ITEMS

OWNER

2.4	OEM	Review design and maintenance practices regarding the use heat shields. Establish on-condition criteria for the replacement of wire in heat-damaged bundles (external and internal heat). Develop and implement configuration management processes to prevent load creep that may result in circuits operating near the rated capacity and conductor heating

PRIORITY

P1 ~ WG issue

P2 ~ OEM issue related to WG

P3 ~ OEM only, not related to WG

Boeing - Expected and actual sources of heat impinging on electrical wiring is presently taken into consideration during the design of the electrical system. Allowable wire damage criteria is presently specified in the SPWM. Boeing presently provides electrical load documents with the delivery of new airplanes and conducts electrical load analysis on in-service airplanes upon request

Airbus - Expected and actual sources of heat affecting electrical wiring is presently taken into consideration during the design of the electrical system. Allowable wire damage criteria is presently specified in the ESPM. Airbus presently provides electrical load documents (ELA) with the delivery of new airplanes. Airbus supplies the ELA in an electronic format to allow the operator to update the actual electrical load of the aircraft following post delivery modification of the aircraft

Lockheed - LMCO design practices have taken into consideration wiring in proximity to heat sources. Allowable damage to wire is specified in the SWPM. LMCO provided operators with a load analysis at delivery. It is the responsibility of the operator to update the analysis as required

[COMMENT, also applies to 2.4/2.5 and 2c2] From the various comments, I do not see an effort to include in the Task 6 report Part 25 Design guidelines that govern where heat shields/drip shields are to be installed. While definition by each OEM as to where such items are to be installed on a type certified airframe are provided through the maintenance delivery documentation, there is nothing for operators/STC agencies to use for after delivery changes to the aircraft. Of concern are the various interior changes done by many carriers that move galley and lavatories throughout the cabin. With these interior changes, location of wiring, potable water, and waste water lines are changing. I presently see no guidance coming that instructs when to use heat shields/drip shields when an electrical disconnect panel is now too close to the rerouted plumbing components

OWNER REMARKS: WG6 P1

A new rule is drafted under sub-part 251705 to protect EWIS from heat damage. Corresponding Advisory Materials is included in the new wire AC/ACJ for EWIS

2a3	WG9	Investigate periodic, selective inspection and nondestructive testing of cockpit and EE bay wiring. Accelerate removal of flammable materials from the cockpit and electronics bay.

WG9 - EZAP requires full application of the logic in the cockpit and electronics bay regardless of whether combustible materials are

likely to be present. Due to the congestion and difficult access to these zones, it is expected that a Zonal Inspection will not be assessed as adequate. The logic will identify dedicated visual inspections, which could be Detailed Inspections in specific areas that warrant closer attention. While "periodic" and "selective" visual inspections will be identified, the use of non-destructive testing is insufficiently mature to apply on a scheduled basis at this time. Initially, new NDT methods would likely be used to support trouble-shooting activities that will provide the necessary experience to allow assessment of their use in scheduled maintenance. To further mitigate the concern for wiring in cockpit and electronics bay areas, EZAP requires consideration of the presence of combustible materials in a zone, and identification of tasks to remove significant accumulations of combustible contamination. In addition, enhancements to maintenance practices are proposed
That will minimize the risk of damage and contamination to wiring caused by maintenance activity.

[COMMENT 1] My personal belief about combustible material is that the EZAP logic should *allow* for their consideration without requiring a definitive list of combustibles. Operators would be able to implement the logic without any knowledge of the flammability properties of the material in the zone. Operators who do not confirm the absence of combustibles should assume the presence of combustibles and inspect accordingly. If, however, the operator could verify the absence of combustible materials in a zone, that operator could take credit for this by performing a less intensive inspection than would be required otherwise.
Furthermore, the classification of a zone as either containing combustibles or not can be simplified without serious detriment to safety. For example, the process could be as simple as this:

1) Consider all items in accessible zones (exclusive of the cockpit) to be non-combustible.

2) For solid materials, if the type certificate is post 1972 then the materials should pass the 60-degree burn test. Consider only AD'd materials as combustible (i.e. aluminized Mylar, not all of which will be removed from aircraft).

3) If the aircraft type certificate is pre 1972 then consider solid materials in an inaccessible zone to be non-combustible if:

a) they are metallic, or

b) they are not present in significant quantities, or

c) they are shown by subsequent analysis to pass the 60 degree burn test.

4) Fluids (hydraulic fluid, fuel, lubricants, corrosion control compounds) would be considered separately.

Item 3.c, verification of compliance with the current standards, will often be verifiable by citing continued use of the material on post-1972-type-certificated aircraft.

[COMMENT 2,also appears throughout report in 4.c.2, 4.f.1, 4.f.2, 5.a.2, 6.a.1, and 6.a.2]

Operators, Airframe Manufacturers, and FAA use an ATA developed Airworthiness Concerns Coordination process to implement corrective actions associated with unacceptable airworthiness risks to the operational fleets. As we have discussed in past ATSRAC meetings, it is going to be impossible for all parties to agree as to what exactly defines a material as an unacceptable flammable material. Any party may initiate an airworthiness concern item to be

handled via the ACC process. I would propose that all desired flammable material removal from any of the operational fleets use this process. As an example, the metallized mylar insulation used this process and resulted in an AD to remove the blankets in most areas of the aircraft over a 5 year period. Each flammable material of concern should use the same process

OWNER REMARKS: WG9 P1

While there is no specific restriction that prevents consideration of the presence of flammable material types when accomplishing the EZAP should an operator choose to do so, EZAP was not designed or intended to identify tasks to mitigate the risk posed by the presence of such materials. The FAA took ownership of this question at the January, 2002, ATSRAC meeting and in March, 2002, published it's position that ATSRAC tasking did not include consideration of the flammability characteristics of uncontaminated materials, nor was ATSRAC tasked to address the "gap" that is perceived to exist between current certification standards vs. those used to certify earlier designs. The FAA essentially concluded that the material flammability issue will be best addressed by the outcome of R&D and other efforts currently underway within FAA. T9WG maintains that use of EZAP to address flammability characteristics of uncontaminated materials will require the development of an industry agreed upon list of materials that do not meet current standards. In regard to pre-vs-post 1972 certification as a means to exclude certain designs or materials from consideration, this does not address the certainty of post-1972 modification via STC (or other means) where FAA surveillance and enforcement of standards may have been less stringent that on the original aircraft manufacturer.

2e2	WG6/7	Ensure that wiring separation and segregation guidelines that consider loss of multiple critical functions from a common mode failure are specified.

WG6 - Task Group 6 has reviewed and discussed this item in the last Seattle meeting. A FAR requirement similar to JAR 25.1353 (d) is being considered to be included in the wiring FAR section.

[COMMENT] Please state what this is.

OWNER REMARKS: WG6 P1

A new rule is drafted under sub-part 251705 so that under normal or failure conditions as defined by 25.1309, it will not adversely affect the simultaneous operation of any other system necessary for combined safe flight, landing and egress. Corresponding Advisory Materials is included in the new wire AC/ACJ for EWIS

2e2

WG7 - Wiring separation and segregation requirements will be required as SWPM/ESPM minimum content.

[COMMENT] And are generally inadequate. Need to prevent the SWR 111 (MD-11) wiring scenario from happening again.

OWNER REMARKS: WG7 P1

This comment refers to the HWG7 response to the recommendation that wire separation and segregation guidelines that consider the loss of multiple critical functions from a common failure be included as minimum content in the OEM standard wiring practices manual.

While this information is considered to be minimum content HWG7 suspects that the comment relates to the adequacy of these guidelines in light of recommendations emanating from the TSB.

Wire separation guidelines outlined within the OEM standard wiring practices manuals reflect those used during and certified for airplane manufacture.

2f1	WG6	Ensure that wiring separation and segregation guidelines that consider loss of multiple critical functions from a common mode failure are specified.

WG6 - Task Group 6 has reviewed and discussed this item in the last team meeting. A FAR requirement for general wiring separation is being considered for inclusion in the new Wiring FAR section. In addition, new Advisory Materials will also be developed.

[COMMENT] How general? See earlier comments also.
MJN - I'm assuming comments referred to are "..Need to prevent the SWR 111 (MD-11) wiring scenario from happening again.."

OWNER REMARKS: WG6 P1

A new rule is drafted under sub-part 251705 so that under normal or failure conditions as defined by 25.1309, it will not adversely affect the simultaneous operation of any other system necessary for combined safe flight, landing and egress.
Corresponding Advisory Materials is included in the new wire AC/ACJ for EWIS

3a	FAA	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. Wire or wire bundle chafing in the presence of flammable materials in the cockpit or electronics bay could result in wire-to-structure or wire-to-wire shorting arcing resulting in fire. Flammable contaminants increase the potential for ignition. More emphasis on cleaning and prevention of fluid contamination (e.g. drip shields) can mitigate the risks presented by contaminants and aid in the detection of chafing conditions. Nondestructive testing can detect wire chafing (after significant dielectric breakdown) and aid in repair.

[COMMENT] Original statement says flammable materials or contamination?
Clarification from commenter - The answer to the question only deals with contamination as I read it. That is the only action mentioned. Flammable materials, per our discussions in Committee appears to be ignored.

MJN – since this comment (a) appears to relate to all the items in 3a , and due to the fact that the FAA are developing a position on this subject, I have assigned it to the FAA for comment.

OWNER REMARKS: FAA P1

MJN - Subsequent to these comments being received the FAA has published their position on flammability and was distributed to all ATSRAC members by the ATSRAC Chair on March 25, 2002. The relevant section is quoted below:
"…In summary the FAA does not require that ATSRAC address the flammability of material adjacent to wire systems. The data collected by ATSRAC, and the subsequent recommendations addressed failures of wire systems and not the flammability of

		material adjacent to wire systems. Efforts are underway that will reduce the presence of material that does not meet current flammability standards. Establishing logic in the EZAP to address flammability is not straightforward and would not consider all possible sources of ignition. ATSRAC and EAPAS efforts will significantly reduce the probability of ignition sources. Given the above, and considering the current difficulties with meeting existing tasking schedules, the FAA recommends that ATSRAC focus their recommendations on minimization of ignition sources. If ATSRAC determines that the EZAP logic should address flammability of materials in a zone it is suggested that they make a request to the FAA for new tasking to consider using the EZAP to address flammable materials adjacent to wiring. As the flammability aspect is outside of the current tasking and the HWGs were not established with the appropriate specialists it would be unreasonable to address it at this point. The FAA will continue to address the usage of materials that exhibit unsafe flammability characteristics under current processes…"
3a1	WG6/7	(a) Develop situation-specific guidance to ensure the proper attention to protection and cleaning wire bundles. (b) Develop guidance on the separation of wire bundles from non-fire-retardant materials WG6 - New Regulatory as well as Advisory materials for Wiring separation are being developed by the group for inclusion in appropriate sections [COMMENT] Progress? Clarification - I was simply worried about the progress of the group. I think this item is now closed for me as I have heard of the progress they have made at their recent meeting. OWNER REMARKS: WG6 P1 A new rule is drafted under sub-part 251705 to ensure that appropriate separation of EWIS components exist from other susceptible materials. Corresponding Advisory Materials is included in the new wire AC/ACJ for EWIS WG7 - General and conditional wiring protection and cleaning procedures will be included in the SWPM/ESPM minimum content [COMMENT, also applies to 3a2] While we have struggled to get ATA/operator participation to the Task 7 working group, I am concerned cleaning practices may be developed independent of the end user. Cleaning specifications need to have a thorough review and trial application with both OEM maintainability engineers and operator engineering staff. We need to assess both the advantages of a clean wire and the risks associated with damage from cleaning methods. I would ask Task 7 WG advise how they would validate cleaning practices they intend to put into the SWPM and I could work on operator participation in this phase of Task 7's effort OWNER REMARKS: WG7 P1 HWG7 was tasked with defining the minimum content to be contained within a standard wiring practices manual. Although wiring cleaning and protection procedures were selected by HWG7

			as minimum content, developing, validating and presenting those procedures remains the responsibility of the OEM or operator. Supplemental OEM remarks-OEMs have not previously included in our standard wiring practices documents specific procedures for the cleaning and protection during maintenance of wiring for various reasons. One significant reason is that operators were expected to develop airline-specific procedures based upon their unique expertise. Because the OEMs are now incorporating recommended procedures for the cleaning and protection of wiring during maintenance it is prudent that these procedures not conflict with those developed by and in use at airlines. We are developing these procedures in conjunction with airlines to ensure that our procedures are clear, concise and do not compromise existing procedures. In addition, HWG7 recommendations will be evaluated and addressed accordingly. The Airbus ESPM currently provides guidelines for the cleaning of electrical components (Chapter 20-55-00) and protection (Chapter 20-54-00) during maintenance.
	3a2	WG7	(a) Specify situation-specific standards to ensure wire bundles are properly protected and cleaned based on OEM approved practice
			WG7 - (a) General and conditional wiring protection and cleaning procedures will be included in the SWPM/ESPM minimum content [COMMENT] The findings of the intrusive inspection team make it clear that compliance with existing airplane maintenance manuals for protection and cleaning of wires is neither preventive nor sufficient to insure wire integrity OWNER REMARKS: WG7 P1 HWG7 was tasked with defining the minimum content to be contained within a standard wiring practices manual. Although wiring cleaning and protection procedures were selected by HWG7 as minimum content, developing, validating and presenting those procedures remains the responsibility of the OEM or operator. Supplemental OEM Remarks- The OEMs disagree that the findings of the IIWG question the adequacy of protection and cleaning procedures provided in the airplane maintenance documentation. The stated conclusion from the IIWG report indicates that visual inspection is an effective tool for identifying some types of wire damage, but ineffective in detecting others. The IIWG did not review the procedures contained with the airline's maintenance documentation or whether those procedures had been in use on the airplane under inspection. The OEMs reviewed the results of the intrusive and non-intrusive inspections, reviewed our procedures, limitations and guidelines with those results in mind, and believe that proper use of the existing recommendations would have prevented or mitigated the effects of wiring damage. Please note that neither the OEM recommendations nor the ATA Specification 117 included procedures for the cleaning and protection of wiring during maintenance prior to either the intrusive or non-intrusive inspections.
	3b1	(a) WG7/8/9	(a) Develop situation specific guidance to ensure the proper attention

(b) WG6/OEM	to protection and cleaning wire bundles. (b) Develop guidance on the separation of wire bundles from non-fire-retardant materials.

WG9 - (a) MSG3, Rev 2001.1 EZAP logic includes a determination if accumulation of combustible material likely in a zone, and selection of task(s) to prevent significant accumulation of combustible material.

[COMMENT] Or installed combustibles

OWNER REMARKS: WG9 P1

EZAP was not designed or intended to identify tasks to mitigate the risk posed by the presence of properly certified, uncontaminated materials. The FAA took ownership of this question at the January, 2002, ATSRAC meeting and in March, 2002, published it's position that ATSRAC tasking did not include consideration of the flammability characteristics of uncontaminated materials, nor was ATSRAC tasked to address the "gap" that is perceived to exist between current certification standards vs. those used to certify earlier designs. The FAA concluded that the material flammability issue will be best addressed by the outcome of R&D and other efforts currently underway within FAA. T9WG maintains that use of EZAP to address flammability characteristics of uncontaminated materials will require the development of an industry agreed upon list of materials that do not meet current standards.

Boeing - (b) Spatial separation of wiring from structure, systems components, or other wiring is accounted for in the design of the wiring system. The guidelines used to design the wiring system are contained within the Standard Wiring Practices Manual

Airbus - (b) The rules for the separation of wiring from structure, systems components, or other wiring is accounted for in the design of the wiring system. These separation guidelines are contained within the ESPM

Lockheed - (b) LMCO design specifications and the SWPM contain specific bundle category and segregation distances.

[COMMENT1] But not adequately, ref SWR111 and MD11

[COMMENT 2] Is the spatial separation of wiring in the wiring system design sufficient in the light of today's knowledge? What is the point of conducting inspections if we do not reevaluate designs using the information gleaned from those inspections? On what is the ATSRAC to base our acceptance of Boeing's claim that the wiring system design guidelines fully address what was discovered in the intrusive inspection report?

OWNER REMARKS: WG6/OEM P1

WG 6 - Boeing's wiring system separation design adequately covers most of the situations, however, it may be necessary to review certain specific situations for the separation distances from airplane structures and other components. These situations are covered by the new AC/ACJ for EWIS.

OEM - The OEMs do not understand the reference to SWR111 and MD-11, and how that relates to the spatial separation of OEM wiring systems. Additional clarification is desired.

With regard to comment 2, the OEM replies to the IIWG7 recommendation addressed whether guidance needed to be developed to address separation of wiring from non-fire retardant materials. Our replies indicated that this aspect of separation was accounted for during airplane design. The IIWG report did not indicate that changes to wire separation guidelines were needed to assure wire integrity.

Please note that the OEMs reviewed the results of the intrusive and non-intrusive inspections, reviewed our procedures, limitations and guidelines with those results in mind, and believe that proper use of the existing recommendations would have prevented or mitigated the effects of wiring damage found during the inspections. The results of this review was presented and accepted by the FAA members participating in the inspections.

In addition to the above, any new requirements which may arise from HWG6 Sub-tasks 6.7 (Wire Separation Requirements), 6.6 (Wire System Safety Assessment Requirements) and 6.8 (Wiring Identification Requirements) will be analyzed and applicable documentation updated accordingly.

3c1	WG7	(a) Specify guidelines to ensure the proper attention to protection and cleaning wire bundles

WG7 - (a) General and conditional wiring protection and cleaning procedures will be included in the SWPM/ESPM minimum content.

[COMMENT] Has there been a review of wire attachments that look specifically at the areas where the intrusive inspection discovered problems with loose or missing connections? Have these situations been incorporated into the SWPM?

OWNER REMARKS: WG7 P1

HWG7 did not conduct such a review of the OEM-specified wire attachment procedures. Wire attachment and interconnect information is considered to be minimum content for the electrical systems standard wiring practices manual.

3g1	WG9	Specify more detailed inspection and testing to ensure potential chafing problems are spotted and corrected.

WG9 - MSG3 Rev 2001.1 EZAP logic includes a detailed listing of "Details of Zone", where installed equipment, wire bundles, possible combustible materials present, L/HIRF protection features, etc., are determined as a prerequisite to conducting Zonal Analysis of a zone. Due to their high current potential and ease of identification (size), presence of feeder cables should be specifically noted in the list of details in a zone and considered for Detailed Inspection based on zone environment and frequency of maintenance access to the zone where potential damage could occur. Use of non-destructive testing is insufficiently mature to apply on a scheduled basis. Initially, new NDT methods would likely be used to support trouble-shooting activities which will provide the necessary experience to allow assessment of their use in scheduled maintenance

[COMMENT] From the various comments in this section, the quantity of Service Actions aimed at the power feeder cables reviewed as a part of Task 2's tasking, and NWA's experience with this system, I concur that this system warrants special review.

However, I don't know that I see a system review recommendation from the Task 9 WG comments. WG9 indicates power feeder cable elements should be specifically listed when doing EZAP analysis, however I wonder if a specific review of the entire system for maintenance actions would yield a better maintenance program for this area of concern. Specifically, items such as periodic torquing of terminal lugs, functional tests of cross tie lock out systems, power transfer tests may need review. EZAP focuses on wiring system components in the zone and will address some of the concerns with this system but many of the functional checks assigned and those intervals may remain as is. Should this important system have another assessment of overall maintenance tasks done from a systems approach knowing the criticality of defects in this system?

OWNER REMARKS: WG9 P1

T3WG and T9WG were not tasked to consider or identify particular systems that may benefit from an overall review of the entire system for maintenance actions. EZAP was developed as an enhancement to existing Zonal Analysis methods in response to the need to address wiring discrepancies which are not normally considered in the loss of function analysis performed at the system level. However, T9WG agrees that power feeder wiring should be specifically identified when listing the "Details of the Zone" when accomplishing the EZAP due to its potential for high energy release as a result of accidental or environmental damage. This ensures that the analyst will consider environment and potential for accidental damage to this wiring in the task selection portion of the EZAP. Normally, tasks such as re-torque-terminal-lugs on particular electrical components ~~and functional tests are derived from ATA specific systems analysis such as the MSG3 Systems/Power plant Analysis procedure.~~ are derived from service experience or inspection findings. EZAP should be effective in the selection of visual inspections (either GVI or DET as warranted by zone size, density, and potential impact of a localized fire) which should detect evidence of an overheat condition on high power terminals. Such a finding should cause an operator to consider additional tasking to prevent the overheat condition, such as periodic re-torque of the terminals.

4a1	WG7	Specify accelerated removal of flammable material

WG7 - General and conditional cleaning procedures will be included in the SWPM/ESPM minimum content

[COMMENT] Task Group 7 has not addressed the recommendation. Operators have several years to remove aluminized Mylar insulation materials. The recommendation was that operators prioritize, where possible, removal of this material in cockpits and electronics bays

OWNER REMARKS: WG7 P1

HWG7 was tasked with defining the minimum content and common format to be used for electrical systems standard wiring practices manuals. The recommendation that HWG7 consider the inclusion of accelerated removal of flammable materials prompted the response that cleaning procedures will be included as minimum content.

The removal of flammable, non-fire retardant or contaminated materials unrelated to wiring, such as metalized Mylar, is beyond the scope of the electrical systems standard wiring practices manuals.

4b3	WG6	Consider design modification to enhance wire separation requirements for this specific situation. Consider local design modification to replace non-fire-retardant materials

WG6 - Task Group 6 is considering development of new Advisory Materials for this item. The new AC material will be included in the revised AC for wiring

[COMMENT 1] Their idea is the present SWPM
Clarification from commenter - I can see some of the confusion here. I was referring to WG 6 and the progress so far in that group as of when I wrote the reply. It had appeared to me to be accepting that present practices were good enough and no changes
were needed. I disagreed, what was the point in doing the Intrusive Inspection if we did not make some changes based on the information we garnered. I understand there has been some movement on these issues lately. I hope they address the concerns I had earlier voiced on wire separation issues

[COMMENT 2] Although this Recommendation is aimed at aircraft manufacturers, the incorporation plan does not include an entry covering OEM responses. Also my comment against 4.a.2 applies (see below)
ATSRAC has spent a great deal of time debating the issues surrounding the treatment of flammable materials in zones, without reaching a firm conclusion on whether materials that meet the regulations extant at the time of original certification should automatically be considered adequately fire resistant. I do not want to restart that debate here, but I would like to put down a marker that ATSRAC's conclusion on that issue should determine how vigorously design modifications to replace non fire retardant materials should be pursued. That, in turn, will determine whether the responses to Recommendation 4.a.2 can be considered acceptable or not.

OWNER REMARKS: WG6 P1

WG 6 discussed the issue of non fire retardant material and separation from EWIS components. Separation of EWIS components from various airplane systems such as fuel systems, oxygen systems and others are adequately covered by the new FAR/JAR 25.1705 requirements and the new AC/ACJ for EWIS. As far as the replacing the non fire retardant material – it was determined that this item is beyond the scope of Task group 6.

6d2	WG8	Use additional precautions when performing maintenance in the vicinity of wire bundles supporting multiple flight-critical systems

WG8 - Because of the difficulty of identifying flight critical wire bundles, all wire bundles are to be treated identically. ESPM data will be used at all times as covered in Wiring Practices Documentation Module B and Wire Module E3, 4 & 6; Inspection Criteria and Standards of Wire and Wire Bundles, Wire Bundle Installation Practices, and Maintenance and Repair Procedures

[COMMENT] Task 8 WG comments that it must treat all wire bundles identically since there currently is difficulty in identifying flight critical wire bundles. I was expecting to find some mention here that in the future an identification standard would be phased in on new aircraft that will make this task easier for operators maintaining wiring systems of newer generation aircraft. Does WG 6 have this task and has it made a determination of whether it will

have requirements to specifically identify flight critical system wiring differently for future operators maintenance programs. If so, could comments be added to this section of the Intrusive Recommendations report? As it shows now, it leaves me with the impression that I will always have to inspect every bundle on the aircraft the same, when I believe the recommendation's intent is for more scrutiny to be applied against flight critical wiring. We need to move to help in identifying these wire systems on future aircraft.

OWNER REMARKS: WG8 P1

Identification of flight critical systems is assigned to WG 6. They are working to finalize this process. When this process is identified, it will be included in WG 8 Curriculum and Lesson

PRIORITY 2 ITEMS

1.1	WG 7/0EM	Update splicing practices as necessary. Consider procedure to tag locations of splices to aid in future visual inspection

PRIORITY

P1 ~ WG issue

P2 ~ OEM issue related to WG

P3 ~ OEM only, not related to WG

Boeing - Boeing has reviewed our present splicing practices in light of the results of the intrusive inspection and believe that no changes are necessary at this time

Airbus - All production splices are covered in the Airbus standard documentation. While the ESPM stipulates the maximum permitted number of splices per wire. Airbus will include in ESPM guidelines to inform operators of the need to tag locations of splices

Lockheed: Per the original design, production splices are addressed in the WDM's and are physically marked on the aircraft wire bundles

[COMMENT 1] This recommendation arose from the finding, albeit infrequently, of degraded splice repairs. The original recommendation anticipated the need for updated splicing practices and procedures as a means to reduce the instances of degraded splices in the fleet. The only OEM response received up to now has concluded that no changes to their splicing practices are necessary. That response raises the further question of what is now different? Have the splicing practices changed at some point in the past in a way that will decrease the occurrence of degraded splices in the future? Alternatively, if the written practices have not changed significantly, and the practices themselves are deemed to be adequate, is there something in the implementation that needs to be addressed in order to reduce the instances of degraded splices in the fleet? I think ATSRAC needs to be assured that measures are in place to control the potential for further degraded splices before it can close off this item permanently

[COMMENT 4] Supplemental Comment – "Boeing has reviewed our present splicing practices in light of the results of the intrusive inspection and believe that no changes are necessary at this time."

SWPM 20-30-12 states

A sealed splice is necessary if on these conditions are applicable:

The temperature grade is B or higher

The splice is in an un-pressurized area

The splice is in a circuit with an operating voltage that is greater than 115 volts."

A closed end splice is necessary if these two conditions are applicable:

The splice is in a pressurized area

The splice is in a circuit with low system voltage.

Though it is not stated explicitly in the manual, I assume that the necessity of the "closed end splice" is to preclude the use of an "unsealed butt splice. Presumably a sealed splice would be an acceptable, even preferable, alternative to the closed end splice.

One potential improvement to 20-13-12 consistent with the recommendations of the Intrusive Inspection Working Group would be to require sealed splices for all repairs and modifications to aircraft electrical wire systems. On page 44 of 20-30-12 a note indicates that "a sealed, closed end splice is recommended 1) to replace a damaged closed end splice and 2) when it is necessary to install a new closed end splice. Though adherence to this practice

would ensure that every new splice on an aircraft is sealed, it should be strengthened (required instead of recommended) and put on page 4 with other general information.

If this enhancement is impractical, sealed splices could be required for a broader variety of condition than those mentioned on page 4. Other conditions added to the list of conditions requiring sealed splice would include moisture-prone areas and locations under lavatories and galleys and cockpit and electronics compartment wiring.

Though 20-10-11 identifies the need to correctly mark replacement wire, there is no requirement or even recommendation to mark and record splices. The absence of this practice makes requirement that there be no more than three splices in any wire difficult to implement.

OWNER REMARKS: OEM P2

The supplemental comments provided by the OEMs indicated that, based on the information provided in the IIWG report coupled with the results of the non-intrusive inspection, review of the recommended splicing practices indicated that no changes to the present splicing have been identified. The OEMs firmly believe that the proper use of our standard wiring processes and procedures will result in a permanent installation that will not degrade over time.

Tagging or physical identification of the splice location is not presently a recommended practice. Due to the nature of the splice installation practices, a repair splice is usually placed on the outside of the wire bundle where it is visible for conditional inspection. The system in which the wire applies may be determined by verifying the wire number, and the system to which the wire applies can be verified by consulting the Wiring Diagram Manual. Some OEMs specify the system directly on the wiring.

However, Task 6 is expected to provide inputs to the FAA regarding the use of non-environmental splices. The OEMs will consider any future recommendation accordingly.

In addition to the above, Airbus will include in the ESPM guidelines to inform operators of the need to tag and record locations of repair splices. Boeing prefers to give operators the option of determining the best methods to assess the number of splices present within a wiring run.

1.5b	WG6/OEM	(b) Develop wiring configuration management software that will track the installation and location of splices. (c) Develop best practices regarding the maximum number of splices permitted for various types of circuits based upon frequency and severity of potential splice failures

Boeing - (b) Boeing has no plans to develop configuration software to track the location of splices on in-service airplanes

Airbus - (b) Airbus recommends that operators maintain a record of the location and installation of repair splices

Lockheed - (b) LMCO has no plans to develop wiring management software

[COMMENT 1] The “best practices” the Working Group had in mind would be developed with respect to the frequency and severity

of splice failures. These considerations are not the same as system reliability concerns.

[COMMENT 2] The only OEM response received up to now shows the item to be CLOSED and GREEN, yet the actual response itself was a direct refusal to adopt the recommendation. I cannot recall ATSRAC debating specifically the merits of developing wiring configuration management software to track the installation and location of splices. However, in the light of this rejection ATSRAC will need to decide how important we feel this recommendation was, and whether we are content that no action is to be taken.

[COMMENT 3] If Boeing has no plans to develop software to track the location of splices on airplanes, what method is used to track splices? Are there any location limitations for wire splices? Are there any limitations on splicing specific to the type, load or function of the wire? What is the maximum number of splices Boeing finds permissible? On what data is this figure based?

OWNER REMARKS: OEM P2

Development by the OEMs of software to record the location of repair splices on in-service airplanes was determined to be an inappropriate recommendation. Should a tracking procedure be deemed beneficial the method of identifying, recording, or tracking repair splices on in-service airplanes should be assessed by the individual operator based upon their knowledge and expertise.

The OEMs account for production splices and indicate the location of these splices within the Wiring Diagram Manual. Manufacturing repair splices are accounted for in the disposition of production rejection or repair tags which are provided to the operator prior to airplane delivery. Repair splices made by the operator or mod center could be annotated on the wiring diagram I the same manner.

The answers to questions regarding location, type, load, or limitations on the frequency of use are unique to the OEM. This information can be obtained by referring to the individual standard wiring practices manual for that OEM.

Please note that the guidelines provided to operators regarding the number, location, type or frequency of splices do not comprise limitations, nor does exceeding these guidelines pose a safety concern. Due to the need for additional slack within a wire bundle when installing a splice, rarely are multiple splices installed on the same wire between connectors. The vast number of multiple repairs are addressed by replacing the damaged wire or adding a supplemental wire to the bundle rather than using multiple splices. Due to this practice documenting the location of repair splices within a software program would be more onerous than beneficial.

1a1	OEM	Consider updating splicing practice to reflect special considerations associated with 1) the proximity of the splice to non-fire-retardant materials and 2) the expected wire current.

Boeing - Boeing has no plans to specify different splicing practices to accommodate adjacent materials or circuit loads

Airbus - Task Group 6 reviewed the item in November task group meeting and agreed to consider updating the splicing section of the

current advisory materials. Revised material is expected to be provided to ATSRAC by July 2002

Lockheed - LMCO has no plans to deviate from its current splicing practices outlined in the SWPM in order to address adjacent materials or current loads

[COMMENT 1] As stated in the preamble to the specific recommendations, each recommendation represented an option, but not the only option, for remedying a condition. If Boeing feels that this remedy is impractical, then that is an argument for requiring environmental splices for all applications and areas

[COMMENT 2] I wanted to be sure I understood the comments listed here as they also appear at various other locations in the document. Boeing has commented they have no plans to specify such special considerations, yet Task 6 agreed to do it and include in their July report. I have assumed these comments reflect historical comments and that the Task 6 agreement to include in their report postdates the Boeing comment. If there were a disagreement here, I would be interested in hearing this at future Task 6 report.

[COMMENT 3] The only OEM response received up to now shows the item to be CLOSED and GREEN, yet the actual response itself confirms there are no plans to specify different splicing practices to accommodate adjacent materials or circuit loads. I note that Task Group 6 have agreed to consider updating the splicing section of the current advisory materials, with the revised material expected to be provided to ATSRAC by July 2002. I propose that once this material is available ATSRAC should reconsider the response(s) to Recommendations 1.a.1 & 1.b.1, to determine whether we are content that no action is to be taken.

OWNER REMARKS: OEM P2

As indicated in the Boeing reply, splices are specified in the wiring design based upon the wire size, a direct result of the load on the circuit. As the fire-retardancy properties of adjacent materials is not normally known during the design or repair of the electrical system, this recommendation is impractical. Typically the most restrictive condition, such as the presence of fuel vapor, is used to assess the splice type and installation technique, rather than assess the type and proximity of all adjacent materials within a wiring run.

To address special conditions the use of only environmental splices is one option, the replacement of non-fire retardant or flammable materials another, and the proper use and installation of appropriate splices to reduce the potential of high-resistance heating of the splice a third. The OEMs will consider any forthcoming recommendations regarding improvements in splicing practices to prevent the potential for high resistance heating in the presence of flammable materials.

In addition, Airbus uses only environmental splices in production and only environmental splices are allowed for repair.

1b1	WG/6OEM	Consider updating splicing practice to reflect special consideration associated with high-current carrying splices in bundles with wire supporting multiple flight-critical systems

Boeing - Boeing has no plans to specify different splicing practices to accommodate adjacent materials or circuit loads

Airbus - Airbus will await any forthcoming revision to the splicing section of the current AC as recommended by HWG6. Airbus includes in the ESPM splicing practices. These rules take into consideration the function ant use pertaining to that wire

Lockheed - LMCO has no plans to update splicing practices with special consideration for high current splices. The SWPM provides the correct method for making high current splices. Flight critical systems are segregated from high current systems

[COMMENT] The only OEM response received up to now shows the item to be CLOSED and GREEN, yet the actual response itself confirms there are no plans to specify different splicing practices to accommodate adjacent materials or circuit loads. I note that Task Group 6 have agreed to consider updating the splicing section of the current advisory materials, with the revised material expected to be provided to ATSRAC by July 2002. I propose that once this material is available ATSRAC should reconsider the response(s) to Recommendations 1.a.1 & 1.b.1, to determine whether we are content that no action is to be taken.

OWNER REMARKS: OEM P2

As indicated in the Boeing reply, splices are specified in production based upon the wire size, a direct result of the load on the circuit. The OEM ESWPM typically provides special procedures for routing and splicing of power feeder cables. However, noting the expected actions of HWG6, the OEMs will consider any forthcoming recommendations regarding improvements in splicing practices related to high-current applications adjacent to or within wire bundles containing flight-critical systems.

In addition, Airbus uses only environmental splices in production and only environmental splices are allowed for repair.

2c1	WG9/OEM	Insure that drip guard installation and maintenance are appropriately specified

WG9 - Installation of drip shields are an OEM design issue, and existing Zonal Inspection requirements should be adequate to detect malfunction, degradation, or failure of a drip shield. However, it is possible that a drip shield could inadvertently be left off after performing maintenance in a zone and the missing shield would not necessarily be clearly evident. While this situation could exist on any aircraft, HWG9 concludes that older aircraft that have undergone repetitive heavy maintenance events are more likely to have experienced such an event. HWG9 recommends that aircraft manufacturers provide guidance to Operators for all such drip shields required on each aircraft model. If inspection for the shields reveals inadvertent removal has occurred, consideration should be given to enhancement of maintenance documents (task cards, manuals, etc.) with additional information to ensure compliance with drip shield installation requirements

[COMMENT] Under the Incorporation Plan, HWG9 has recommended that aircraft manufacturers provide guidance to Operators for all such drip shields required on each aircraft model. For completeness, this transfers an action to the OEMs that needs to be covered by a supplemental OEM comment, as it is in 2.d.2.

OWNER REMARKS: OEM P2

As with any component installed on the airplane, except as cited within the Configuration Deviation List contained within the Dispatch Deviations Procedures Guide, wiring protection shielding and guards are required to be installed on the airplane during revenue service. Replacement of removed shields and guards is both a standard practice and a regulatory requirement. It is the responsibility of each operator to ensure that the design integrity of the airframe is properly maintained and to incorporate maintenance and inspection programs that follow industry best maintenance practices.

The OEM's believe that, although there exists the possibility that some protection may have been inadvertently omitted on airlines undergoing extensive modification, we believe that the existing maintenance procedures in place at the airlines would dictate that such omissions would be rare. We also believe that the effects of such an omission would be minor in scope but still recognizable through normal or enhanced maintenance activities.

Operators should use the guidance provided in the forthcoming wiring inspection programs, coupled with the guidance contained within the OEM standard wiring practices documents to either identify damage caused from missing drip or heat shields, or identify the conditions that would necessitate protection. The OEMs believe that any wiring systems training program should emphasize the purpose and necessity of wiring protection systems.

FOLLOW UP OWNER REMARKS: WG9

WG9 concurs that there is insufficient evidence of problems related to missing drip or heat shields to warrant a fleet wide campaign to check for drip shield installation. Determination of type and number of drip shields per individual aircraft configuration and post delivery modification would be complex and considered unjustified.

2d2	OEM/WG9	Ensure that drip guard installation and maintenance are appropriately specified

WG9 - Installation of drip shields are an OEM design issue, and existing Zonal Inspection requirements should be adequate to detect malfunction, degradation, or failure of a drip shield. However, it is possible that a drip shield could inadvertently be left off after performing maintenance in a zone and the missing shield would not necessarily be clearly evident. While this situation could exist on any aircraft, HWG9 concludes that older aircraft that have undergone repetitive heavy maintenance events are more likely to have experienced such an event. T9HWG recommends that aircraft manufacturers provide guidance to Operators for all such drip shields required on each aircraft model. If inspection for the shields reveals inadvertent removal has occurred, consideration should be given to enhancement of maintenance documents (task cards, manuals, etc.) with additional information to ensure compliance with drip shield installation requirements.

Airbus - Potential source of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in from of drip or heat shields are included to minimize the effects of contamination. If in-service experience shows that additional protection against contamination is required,

then a design modification will be developed to provide additional protection. This will be made available to operators through a service bulletin. In the case of general protection of wiring during unrelated maintenance, Airbus will be providing protection guidelines in an upcoming revision to the ESPM

[COMMENT 1] Are visual inspections sufficient to give a complete picture of whether moisture is or has been present in wiring? The intrusive inspections showed that visual inspections do not work to discern the majority of wiring flaws.

With this is mind it seems negligent and wrong to take the position that visual inspection is the "preferred NDT inspection method" knowing that it does not work to discern the majority of wiring flaws including and especially detecting flaws, nicks and cuts within a wire bundle or under clamps, loss of continuity problems, and sometimes does not reveal heat or arcing damage in wire insulation.

Though detailed visual inspections are an improvement, there are many testing procedures and devices available today that go beyond that. There should be no further delay in evaluating and incorporating proven NDTs in wire inspection and maintenance programs

Furthermore, ALPA raises the issue that not all aircraft in need have drip shields. Is this a manufacturer issue or an operator issue? Does the OEM agree with this assessment?

[COMMENT 2] From the various comments, I do not see an effort to include in the Task 6 report Part 25 Design guidelines that govern where heat shields/drip shields are to be installed. While definition by each OEM as to where such items are to be installed on a type certified airframe are provided through the maintenance delivery documentation, there is nothing for operators/STC agencies to use for after delivery changes to the aircraft. Of concern are the various interior changes done by many carriers that move galley and lavatories throughout the cabin. With these interior changes, location of wiring, potable water, and waste water lines are changing. I presently see no guidance coming that instructs when to use heat shields/drip shields when an electrical disconnect panel is now too close to the rerouted plumbing components.

OWNER REMARKS: OEM P2

The use of general and detailed visual inspections of wiring installed in airplanes remains the preferred method of detecting actual or the potential for damage to wiring. This preference accounts for the present level of diagnostic equipment available to the industry, and the needs of the industry. The OEMs vehemently disagree that this preference is either negligent or wrong given the present options.

With regard to the comment regarding wiring protection, as with any component installed on the airplane, except as cited within the Configuration Deviation List contained within the Dispatch Deviations Procedures Guide, protective shields and guards are required to be installed on the airplane during revenue service. The OEMs provide wiring protection in specific cases and expect that that protection will remain on the airplane indefinitely. The reinstallation of removed equipment is a standard practices and a regulatory requirement. It is the responsibility of each operator to ensure that the design integrity of the airframe is properly maintained and to incorporate maintenance and inspection programs that follow industry best maintenance practices. The OEM's believe that,

although there exists the possibility that some protection may have been inadvertently omitted on airlines undergoing extensive modification, we believe that the existing maintenance procedures in place at the airlines would dictate that such omissions would be rare. We also believe that the effects of such an omission would be minor in scope but still recognizable through normal or enhanced maintenance activities.

Operators should use the guidance provided in the forthcoming enhanced wiring inspection programs, coupled with the guidance contained within the OEM standard wiring practices documents to either identify damage caused from missing drip or heat shields, or identify the conditions that would necessitate protection. The OEMs believe that any wiring systems training program should emphasize the purpose and necessity of wiring protection systems

Finally, with regard to the comment concerning the installation of post-delivery modifications, OEM design practices, and the resulting guidance used to maintain those designs, are proprietary to the OEM. The requirement to use these practices and procedures for designs created by entities other than the OEM is inappropriate. Although the ESWPM is not considered to be a wiring standards document for designs of new installations, operators and STC applicants may refer to these guidelines in development of their installations.

As far as post-delivery modifications are concerned, Airbus is currently reviewing the ESPM content related to wire routing and segregation and will include in the ESPM guidance and recommendations in case of new wiring installation after delivery to the aircraft. Boeing will conduct a similar review based upon the forthcoming HWG6 recommendations.

[COMMENT] Not all aircraft that need such shields have them: Ref SWR 111 and resulting TSB inspections of MD-11 fleet.

OWNER REMARKS: OEM P2

The OEMs do not understand the use of the references cited with regard to wiring protection. Previous statements concerning the installation and maintenance of wiring protection, as well as the use of OEM design standards on non-OEM designs, hold considering our confusion regarding the references. Perhaps clarification is needed.

If the comment refers to the condition whereby moisture or heat protection was not specified at the time of initial design, operators should use the guidance provided in the forthcoming enhanced wiring inspection programs, coupled with the guidance contained within the OEM standard wiring practices documents to either identify damage caused from missing drip or heat shields, or identify the conditions that would necessitate protection.

FOLLOW UP OWNER REMARKS: WG9

WG9 concurs that there is insufficient evidence of problems related to missing drip or heat shields to warrant a fleet wide campaign to check for drip shield installation. Determination of type and number of drip shields per individual aircraft configuration and post delivery modification would be complex and considered unjustified

3.2	OEM/WG8	Develop a catalog of unacceptable wire bundle configurations

Boeing - We have no plans to create and maintain a catalog of unacceptable wire bundle configurations but will ensure that the criteria for acceptable wire bundles is clear

Airbus - Airbus includes in the ESPM some examples of unacceptable wire bundle installations. In addition this subject (photo library) will be included in the training program.

Lockheed - LMCO has no plans to create and maintain a catalog of unacceptable bundle configurations. Review of the current information in the SWPM finds that examples of unacceptable practices are presented along with the acceptable config's and practices. SIL 24-10 contains a list of applicable SB's related to specific wiring problems discovered by LMCO and the L-1011 operators. SIL 24-10 is currently in revision status for the incorporation of the intrusive and non-intrusive recommendations.

[COMMENT 1] The only OEM response received up to now shows the item to be CLOSED and GREEN, yet the actual response itself confirms there are no plans to create and maintain a catalogue of unacceptable wire bundle configurations. I cannot recall ATSRAC debating specifically the merits of creating and maintaining a catalogue of unacceptable wire bundle configurations. However, in the light of this rejection ATSRAC will need to decide how important we feel this recommendation was, and whether we are content that no action is to be taken. For my own part, I believe that this is not necessary provided that the criteria for acceptable wire bundles is made sufficiently clear. In addition, TG8 recommends that the OEM's construct a graphical database of model and zone specific wire system faults for instructor and technician training and knowledge. For completeness, this transfers an action to the OEMs that needs to be covered by a supplemental OEM comment.

[COMMENT 2] Developing a catalog of unacceptable wire bundle configurations is a good way to learn from the mistakes of others. It is self-evident that real problems are more illustrative and instructive than theoretical ones.

OWNER REMARKS: OEM P2

The OEM responses indicated that we had no plans to create a readily accessible electronic library of unacceptable wire bundle configurations. As much of this data already exists with documentation readily available to the operator or repair station, the OEMs agreed to provide upon request representative photographs or line drawings of unacceptable wire bundle configurations for training purposes.

As far as Airbus Wiring System Training Course is concerned, representative photos of unacceptable wiring systems and/or connective devices installation/contamination will be part of the Airbus training documentation to illustrate typical problems found on the airplane.

3a2	WG7/OEM	(b) Specify nondestructive testing procedures for validating wire integrity in response to undiagnosed malfunctions of cockpit electrical equipment

Boeing: (b) Troubleshooting guidance for system anomalies are contained within the specific Airplane Maintenance Manual chapter applicable to that system

Airbus - (b) The ESPM includes current technology electrical NDT testing methods. Any new testing methods that arise (e.g. HWG 9 recommendations) will be analyzed and included if appropriate

Lockheed - (b) Troubleshooting practice are contained in the specific MM chapter for each system

[COMMENT] The recommendation that there be nondestructive testing to validate the integrity of wire is quite different from recommending nondestructive testing for troubleshooting. Many electrical components are returned to the aircraft after a diagnosis of no-fault-found. Troubleshooting requires the *existence of a condition*. The recommendation was to help ensure the *absence of a condition.*

OWNER REMARKS: OEM P2

If the comment concerns the periodic testing of wiring to ensure the absence of a condition, the OEMs believe that is an inadequate method of preventing the condition from occurring. As present on-wing wiring evaluation techniques are inadequate to determine the health of the wiring on a continuous basis, the OEMs have undertaken use of continuous monitoring of the systems to determine the health of the wiring. Non-destructive testing of the wiring is reserved for determining the location of the wiring fault. These techniques account for the condition where a wiring fault occurs immediately after, or as a result of, a recommended periodic check of wiring health and the absence of a condition.

If the comment concerns the specification of techniques to identify an intermittent fault within the wiring of a anomalous system, the OEMs specify that the wiring should be inspected, both physically and through continuity, time-domain reflectometry, impedance, etc. to ensure the health of the wiring before returning the airplane to service. These procedures may be contained within the system troubleshooting sections of the airplane maintenance manual or the ESWPM. Additional troubleshooting techniques and procedures will be added to the AMM or ESWPM as they become available.

3b2	WG6/OEM	(b) Specify updated wiring separation and segregation guidelines that consider loss of multiple critical functions from a common mode failure. (c) Specify nondestructive testing procedures for validating wire integrity in response to undiagnosed malfunctions of flight critical equipment.

Boeing - (b)(c) Wire separation and segregation guidelines are presently contained within the SWPM and reflect current production design standard that account for loss of multiple or redundant systems. Any changes to the standards will be reflected in future revisions to the SWPM. Troubleshooting procedures to determine the cause of any system malfunction or anomaly, including non-destructive troubleshooting of the system wiring, is contained within the specific Airplane Maintenance Manual section applicable to the system under review
Airbus - (b)(c) Production design standards specify wire separation and segregation rules to provide system redundancy. These standards are described within the ESPM. Any changes to the standards will be reflected in future revisions to the ESPM. Troubleshooting procedures to determine the cause of any system malfunction or anomaly is contained within the specific Airplane Maintenance

		Manual section applicable to the system under review. Non-destructive testing of the system wiring is included in the ESPM Lockheed - (b)LMCO's design standards, currently, take into consideration the possible loss of multiple critical systems. Lessons learned and recommendations are to be incorporated into the SWPM revision. (c) Troubleshooting procedures are contained in the specific MM chapter. [COMMENT directed at Boeing] And outdated OWNER REMARKS: WG6/OEM P2 This comment concerns the response to the recommendation that the OEMs update wire separation and segregation guidelines to account for loss of multiple critical functions as a result of a common failure, and specify NDT procedures for undiagnosed malfunctions in the flight critical equipment. The OEM response indicated that these guidelines and procedures were presently available. The OEMs suspect that the comment relates to the adequacy of these procedures. At present there is no indication that the wire separation and segregation guidelines and NDT procedures provided by the OEMs are inadequate. However, the OEMs will review and act accordingly should ATSRAC accept recommendations that necessitate a change to the guidelines. If the comment refers to the techniques to identify an intermittent fault within the wiring of a anomalous system, the OEMs already specify that the wiring should be inspected, both physically and through continuity, time-domain reflectometry, impedance, etc. to ensure the health of the wiring before returning the airplane to service. These procedures may be contained within the system troubleshooting sections of the airplane maintenance manual or the ESWPM. Additional troubleshooting techniques and procedures will be added to the AMM or ESWPM as they become available.
5.4	OEM	(a) Specify use of in-situ indicators to identify exposure to precipitating agents or conditions – a “canary”. (In particular, use in-situ litmus testing to identify exposure of wrapped construction wire to high or low pH solutions or contaminants)
		Boeing- Guidelines for the cleaning and conditional inspection of contaminated wiring will soon be included in the SWPM and Maintenance Planning Document applicable to the specific model airplane. A review of the wiring separation guidelines is anticipated as a result of the changes noted in the TG6 comment below Airbus - The ESPM currently gives guidelines for the cleaning, protection and inspection of wiring. Airbus will review the wire testing requirements following any recommendations that result from HWG 9 and also HWG6. (b) Production design standards specify wire separation and segregation rules to provide system redundancy. These standards are described within the ESPM Lockheed - LMCO will include additional guidelines, in the SWPM, that are specific to contamination identification, replacement criteria of, and cleaning of bundles. Additionally, LMCO will re-issue a SIL that addresses the cleaning of contaminants from wiring [COMMENT 1 directed at Boeing] Not responsive to the recommendation

[COMMENT 2 directed at Boeing] Boeing's comment that "a review of the wiring separation guidelines is anticipated as a result of the changes noted in the TG6 comment below" is welcome

OWNER REMARKS: OEM P2 on comment (1) only

The OEM response stating that a review of the wiring separation guidelines is anticipated as a result of the changes expected from HWG6 indicates that the OEMs are being responsive. As indicated in the response to Item 5.1, the response to the IIWG recommendation that the OEMs specify guidelines that would result in the evaluation of wiring thought to be contaminated by acidic or alkaline materials, and the recommendation that decontamination procedures be provided, indicated that these guidelines have already or will soon be incorporated into the maintenance documentation. Although they do not assess the acidity or alkalinity of contaminants, present guidelines regarding the cleaning and/or repair of wiring account for the wide pH range of possible contaminants.

OEMs account for the environment in which wiring is expected to operate and specify wiring and components suitable for that environment. The OEMs believe that the process of a detailed visual examination, determining whether contamination exists or existed previously, whether wiring damage resulted from that contamination, procedures for the removal of contamination regardless of the pH, and repair of wiring damage, precludes the need to install Litmus paper at various locations throughout the airframe.

Wiring separation guidelines will be reviewed following any recommendations that result from HWG 6 Sub-tasks 6.7 (Wire Separation Requirements, and prospective FAR/JAR 25.1705) and 6.8 (Wiring Identification Requirements, and prospective FAR/JAR 25.1706)

PRIORITY 3 ITEMS

PRIORITY

P1 ~ WG issue

P2 ~ OEM issue related to WG

P3 ~ OEM only, not related to WG

1.1/1.3 OEM — Update splicing practices as necessary. Consider procedure to tag locations of splices to aid in future visual inspections

Boeing - Boeing has reviewed our present splicing practices in light of the results of the intrusive inspection and believe that no changes are necessary at this time

Airbus - All production splices are covered in the Airbus standard documentation. While the ESPM stipulates the maximum permitted number of splices per wire. Airbus will include in ESPM guidelines to inform operators of the need to tag locations of splices

Lockheed: Per the original design, production splices are addressed in the WDM's and are physically marked on the aircraft wire bundles

[COMMENT] What is the current OEM practice for splice v. replacement of wire? Do guidelines exist?

OWNER REMARKS: OEM P3

Recommendations regarding the use of splices, including the maximum number of splices to be used within a single wire run are provided in the standard wiring practices manuals. The Boeing SWPM manual recommends replacement of the wire as preferred to splice repair, and cites a maximum of three repair splices per wire run. The Airbus ESPM manual recommends replacement of the wire as preferred to splice repair, and cites a maximum of three repair splices per wire run. For EFCS and sensitive cables, splice repair is not approved as permanent repair, when feeder splice repair is not allowed above certain gauges.

Tagging or physical identification of the splice location is not presently a recommended practice. Due to the nature of the splice installation practices, a repair splice is usually placed on the outside of the wire bundle where it is visible for conditional inspection. The system in which the wire applies may be determined by verifying the wire number, and the system to which the wire applies can be verified by consulting the Wiring Diagram Manual. Some OEMs specify the system directly on the wiring.

As splices are added to the wiring during repair, and the entire length of the wiring run may not be readily accessible to determine the total number of splices within that run, the OEMs recommend that documenting the splice location within the WDM is preferable to physically tagging the splice on the airplane. In addition, because the WDM would include information on the location of the splices, and the splices would be visible on the airplane, tagging a splice for future inspection would not be necessary.

1.3 OEM — Where appropriate utilize design practices which facilitate the repair of electrical interconnect systems without the need for splices. Develop splice vs. replacement of wire guidelines

Boeing – Boeing review of our present splicing practices, as a result of both the IIWG results and previous operator input indicates that no changes to our current practices is warranted

Airbus - Airbus review of our present splicing practices, as a result of both the IIWG results and previous operator input indicates that no changes to our current practices is warranted

Lockheed - Review of LMCO's splicing practices indicates that no changes are required

[COMMENT 1 directed at Boeing] Boeing's SWPM prohibits the use of a permanent splice in a few specific instances (see Table V in section 20-10-13). The list of instances could be increased to include much more than engine harness wire, FQIS wire, primary flight control systems, and special purpose wire or special wire types. Other prohibitions could involve the presence of proximate splices in the same harness, moisture prone areas, wire segments shorter than a specific length, etc. In these instances a replacement wire or wire segment could be specified.

[COMMENT 2 directed at Boeing] As witnessed in our tour of the Boeing wiring fabrication shop in July 2001, splices are used as well in type design applications. We saw where a Boeing harness integrated with a PSU lighting supplier via splices to each individual PSU light fixture. It is not clear to me at this point in the process, when splices are acceptable and when they should be discouraged. It would seem that for in service aircraft, we want to only allow environmental splices when the cost/downtime associated with replacing the wire is prohibitive. If we take such a stance with the aircraft operators, should we not also have standards that discourage their use in new design build applications? And to the contrary, if splices such as we saw at Boeing are safe and maintainable, should we not sanction their use for in service fleet modifications

OWNER REMARKS: OEM P3

The prohibition of splices within these systems is due to the nature of the system operation rather than the physical location of the wire harness. Guidelines regarding the placing of splices within a wire bundle and the use of splices within a SWAMP area are already specified. Although Boeing recommends the replacement of a wire over use of a repair splice, a properly installed repair splice is an effective and permanent repair of wiring.

Airbus design practices are to use interconnect elements and production splices are minimized to specific zones where installation of connective devices is impracticable. Although Airbus recommends replacement of the wire as preferred to splice repair, a properly installed repair splice is an effective and permanent repair of wiring.

The use of splices is a necessary and effective method of branching systems during airplane manufacture. The specification of which type of manufacturing splice is used in each situation is reflected within the OEM standard wiring practices documents, i.e. what is accomplished during production is permitted on in-service airplanes.

As far as post-delivery modifications are concerned, Airbus is currently reviewing the ESPM content related to wire routing and segregation and will include in the ESPM guidance and recommendations in case of new wiring installation after delivery to the aircraft

2.4	OEM	Review design and maintenance practices regarding the use heat shields. Establish on-condition criteria for the replacement of wire in heat-damaged bundles (external and internal heat). Develop and implement configuration management processes to prevent load creep that may result in circuits operating near the rated capacity and conductor heating

Boeing - Expected and actual sources of heat impinging on electrical wiring is presently taken into consideration during the design of the electrical system. Allowable wire damage criteria is presently specified in the SWPM. Boeing presently provides electrical load documents with the delivery of new airplanes and conducts electrical load analysis on in-service airplanes upon request

Airbus - Expected and actual sources of heat affecting electrical wiring is presently taken into consideration during the design of the electrical system. Allowable wire damage criteria is presently specified in the ESPM. Airbus presently provides electrical load documents (ELA) with the delivery of new airplanes. Airbus supplies the ELA in an electronic format to allow the operator to update the actual electrical load of the aircraft following post delivery modification of the aircraft

Lockheed - LMCO design practices have taken into consideration wiring in proximity to heat sources. Allowable damage to wire is specified in the SWPM. LMCO provided operators with a load analysis at delivery. It is the responsibility of the operator to update the analysis as require

[COMMENT 1 directed at Boeing] How do we reconcile the inspection report finding that heat damaged wiring is relatively common, with Boeing's response that the manufacturer presently takes into account the expected and actual sources of heat impinging on wiring? Is it part of the design that wiring should be damaged by heat? What is the long-term consequence of such a design philosophy?

[COMMENT 2, also applies to 2.4/2.5 and 2c2] From the various comments, I do not see an effort to include in the Task 6 report Part 25 Design guidelines that govern where heat shields/drip shields are to be installed. While definition by each OEM as to where such items are to be installed on a type certified airframe are provided through the maintenance delivery documentation, there is nothing for operators/STC agencies to use for after delivery changes to the aircraft. Of concern are the various interior changes done by many carriers that move galley and lavatories throughout the cabin. With these interior changes, location of wiring, potable water, and waste water lines are changing. I presently see no guidance coming that instructs when to use heat shields/drip shields when an electrical disconnect panel is now too close to the rerouted plumbing components.

[COMMENT 3 directed at Boeing]

The recommendation was made because the Working Group observed apparently heat damaged wire in areas near heat-emitting surfaces and equipment. I have no doubt that Boeing did consider heat sources when designing the electrical interconnect system. The question is whether those considerations were sufficient and whether their assumptions have stood the test of time.

[COMMENT] Section 20-10-11 correctly sites vibration, heat, cold, fuel, dirt, moisture, and hydraulic fluid as potential sources of damage to wire. Section 20-10-13, however, discusses damage assessment only in terms of traumatic damage. There is no discussion on how to identify and correct thermal or chemical degradation – the intent of this recommendation

OWNER REMARKS: OEM P3

In the case of heat impinging on wiring, protection is provided during the initial design for known or locations where heat is expected. Additional protection is provided in locations where in-service experience dictates that protection is needed. For example, Lockheed Martin requires the use of Bentley Harris type sleeving and segregation from heat producing equipment to address known heat sources. Operators are expected to identify areas of heat-damaged wiring during normal maintenance activities and take appropriate action. One appropriate action is to request that the OEM develop and provide fleetwide protection if the damage is expected to occur on other airplanes, or if the nature of the damage is considered to impugn safety.

As far as post-delivery modifications are concerned, Airbus is currently reviewing the ESPM content related to wire routing and segregation and will include in the ESPM guidance and recommendations in case of new wiring installation after delivery to the aircraft.

OEM design practices, and the resulting guidance used to maintain those designs, are proprietary to the OEM. The requirement to use these practices and procedures for designs created by entities other than the OEM is inappropriate. Operators, repair houses and STC applicants could consult the OEM guidelines in developing their after-delivery modifications, or develop their own.

2.6 OEM Develop diagnostic technologies and techniques to identify and prevent the development of high resistance interconnects

Boeing - Boeing has no plans to develop additional technologies or techniques to prevent or identify high resistance interconnects

Airbus - Airbus has no plans to develop additional technologies or techniques to prevent or identify high resistance interconnects. Airbus feels that the current visual inspections guidelines presently provided in the ESPM plus any additional inspection requirements recommended by HWG 9 will be sufficient to detect this type of event

Lockheed - Common wiring practices in the SWPM will prevent the development of high resistance interconnects. LMCO has no plans for the development of new technologies or techniques for the prevention of high resistance interconnects

[COMMENT directed at Boeing] The only OEM response received up to now shows the item to be CLOSED and GREEN, yet the actual response itself confirms there are no plans to develop additional technologies or techniques to prevent or identify high resistance interconnects. I cannot recall ATSRAC debating specifically the merits of this particular course of action. However, in the light of this rejection ATSRAC will need to decide how important we feel this recommendation was, and whether we are content that no action is to be taken. For my own part, I believe that proper installation and

environmental protection of connections and terminal blocks will prevent development of high resistance interconnects. In addition, visual indicators, such as discoloration and surface corrosion can be used as pointers towards the development of high resistance interconnect.

OWNER REMARKS: OEM P3

The OEMs agree with the commenter that the proper installation of connections, terminal blocks, splices, etc. will prevent development of high resistance interconnects. The development of diagnostic technologies and techniques to either identify the potential for or development of high-resistance interconnects is not necessary given that visual indicators, such as discoloration, apparent during detailed visual inspections will identify high resistance interconnects. System monitoring will identify system effects as a result of high resistance interconnects.

However, the OEMs are actively either developing or evaluating wiring test equipment intended to determine the condition of wiring. The need to assess the development of high-resistance interconnects will be accounted for in this evaluation.

2a2 OEM

Investigate periodic, selective inspection and nondestructive testing of cockpit and electronics bay wiring

Boeing - Boeing presently conducts periodic inspections of airplanes, including the E/E bay and flight deck. Selective inspections, as a result of in-service experience, are evaluated on a case-by-case basis

Airbus - Airbus currently conducts periodic inspections of airplane wiring, including the avionics bay and flight deck. The information collected as a result of these inspections is used to improve and update, as required, the current electrical design, technology of electrical components and technical design directives

Lockheed - LMCO addresses wiring concerns utilizing Service Information Letter (SIL) 24-10. This SIL is updated periodically to include new information and concerns received. Recurring wiring related problems are addressed via Service Bulletins. Inspections and lab testing of in service wiring is not presently done due to the reduction of resources allocated for the L-1011. On aircraft wiring issues are addressed via SILs, Customer Technical Support and the Engineering Support staff

[COMMENT directed at Boeing] The response indicates an appropriate course of action whose adequacy will depend on the frequency and intensity of the inspections. If these inspections are no more frequent and no more intensive than those performed prior to our awareness of wiring issues, then the response is not adequate.

OWNER REMARKS: OEM P3

The initial recommendation was interpreted as, and the OEM response applied to, the concept of periodic sampling of the E/E bay and flight deck condition of wiring as a method of determining what additional actions were necessary to prevent the accumulation of combustible materials in these areas. The acknowledgement of ongoing assessments, in addition to the enhanced zonal inspections emanating from the EZAP, should result in a frequency and intensity of inspections to address the concern.

2b.3	OEM	Review design practices regarding the use of drip shields for this specific situation, investigate periodic selective inspection and non-destructive testing of wiring. Develop updated wiring separation guidelines that consider loss of multiple critical functions from a common mode failure

Boeing - Expected and actual sources of moisture impinging on electrical wiring is presently taken into consideration during the design of the electrical system. Boeing presently conducts periodic inspections of airplanes, including the E/E bay and flight deck. Selective inspections, as a result of in-service experience, are evaluated on a case by case basis. Wire separation and segregation guidelines are presently contained within the SWPM and reflect current production design standard that account for loss of multiple or redundant systems. Any changes to the standards will be reflected in future revisions to the SWPM

Airbus - Potential source of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in from of drip or heat shields are included to minimize the effects of contamination. Airbus currently conducts periodic inspection of the aircraft wiring including the avionics bay and flight deck. The information collected as a result of these inspections is used to improve and update, as required, the current electrical design, technology of electrical components and technical design directives and ESPM guidelines.

Routing, separation and attachment guidelines, as well as prevention of contamination and cleaning of noted contamination on the wiring and/or electrical components are currently included in the ESP

Lockheed - The Lockheed SWPM manual provides practices specific to SWAMP locations. Detailed Visual Inspection is the suggested inspection method for detecting wiring faults that may be related to moisture ingression. Drip shields are used throughout the SWAMP areas exclusively for the protection of wiring. It is the responsibility of each operator to ensure that the design integrity of the airframe is properly maintained and to incorporate maintenance and inspection programs that follow industry best maintenance practices

[COMMENT 1] Boeing states that “wire separation and segregation guidelines are presently contained within the SWPM and reflect current production design standard that account for loss of multiple or redundant systems.” The SWPM is referenced, but not quoted, and the reference to the production design standard is non-specific. Section 20-10-19 of the SWPM states the following:

The airplane wiring is designed and installed:

- To prevent the propagation of the effects of electrical faults to other independent power sources
- To prevent possibility that the failure of a component in a redundant system can disable another related, redundant system
- To avoid electromagnetic interference (EMI) between electromagnetic compatibility (EMC) circuits that are not compatible.

These functional concerns do not take into account the potential fire or the potential for multiple critical systems failure. In other words it’s OK to lose all primary flight control circuits simultaneously (possibly as the result of a localized fire or arc-tracking event) as long as the back-up are still functional.

Under the assumption that the critical failure mode is a simple bolted (non-intermittent) short circuit, Boeing allows the separation requirements to be relaxed if a fusible link circuit breaker is placed between the source and the co-located wires.

[COMMENT 2] Boeing represents that present wire separation and segregation guidelines already account for loss of multiple or redundant systems. The ATSRAC needs details to better determine if these guidelines provide adequate separation.

[COMMENT 3] This does not update anything. It only says we already have it covered. Also does not address wire separation.

OWNER REMARKS: OEM P3

Wire separation guidelines outlined within the OEM standard wiring practices manuals reflect those used during and certified for airplane manufacture. These guidelines reflect only a portion of the methods used to meet the requirements outlined in FAR 25-1309 which states, in part, that the equipment, systems and installations must be designed so that the occurrence of any failure condition which would prevent the continued safe flight and landing is improbable, and that the analysis must take into account the probability of multiple and undetected failures.

Although the OEM ESWPM provide guidelines on proper wire separation and segregation, it does not provide the reasons for these guidelines, nor does it provide the design standards for post-manufacture modifications. STC applicants can and should refer to the OEM guidelines when developing their modifications, but they are cautioned that the ESWPM is not intended as a design standard but, rather, for use in maintenance and repair of the OEM wiring installations.

In addition to the above, any new requirements which may arise from HWG 6 Sub-tasks 6.7 (Wire Separation Requirements), 6.6 (Wire System Safety Assessment Requirements) and 6.8 (Wiring Identification Requirements) will be analyzed and documentation will be updated if appropriate.

2b4	FAA	(b) Investigate segregation and separation of wire installed after manufacture of the aircraft

[COMMENT, also applies to 2d4] The aircraft operators would not be best suited to accomplish this recommendation. While there may be some talent at the carriers to tap, this is by and far, not one of our core competencies. I would put forth that the FAA Technical Center talent that we have been fortunate to see be assigned to this issue. This group is a better talent base to investigate this recommendation. Operators would be able to assist with access to aircraft, carrying out testing/evaluations that technical experts deem helpful to the investigation.

OWNERS REMARKS: FAA P3

MJN – subsequent to these comments were received, the FAA have taken ownership of this item

2c2	OEM	Review design practices regarding the use of drip guards for this specific situation. Investigate the use of nondestructive testing to troubleshoot suspect wire installations

Boeing - Moisture ingression prevention guidelines are specified in the SWPM and are commonly used during the production of new airplanes. Detailed visual inspection is the preferred NDT inspection method to identify the presence of or indications of moisture ingression.

Airbus - Moisture ingression prevention is presently taken into consideration during the design of the electrical system. Airbus will include in the ESPM guidance and practices to maintain the design provisions for the prevention of moisture contamination to wiring

Lockheed - The Lockheed SWPM manual provides practices specific to SWAMP locations. Detailed Visual Inspection is the suggested inspection method for detecting moisture ingression. Drip shields are used throughout the SWAMP areas exclusively for the protection of wiring. It is the responsibility of the operator to ensure the design integrity of the airframe and to incorporate maintenance and inspection programs that follow industry best maintenance practices

[COMMENT 1 directed at Boeing response] Are visual inspections sufficient to give a complete picture of whether moisture is or has been present in wiring? The intrusive inspections showed that visual inspections do not work to discern the majority of wiring flaws.

With this is mind it seems negligent and wrong to take the position that visual inspection is the “preferred NDT inspection method” knowing that it does not work to discern the majority of wiring flaws including and especially detecting flaws, nicks and cuts within a wire bundle or under clamps, loss of continuity problems, and sometimes does not reveal heat or arcing damage in wire insulation.

Though detailed visual inspections are an improvement, there are many testing procedures and devices available today that go beyond that. There should be no further delay in evaluating and incorporating proven NDTs in wire inspection and maintenance programs

Furthermore, ALPA raises the issue that not all aircraft in need have drip shields. Is this a manufacturer issue or an operator issue? Does the OEM agree with this assessment?

[COMMENT 2] From the various comments, I do not see an effort to include in the Task 6 report Part 25 Design guidelines that govern where heat shields/drip shields are to be installed. While definition by each OEM as to where such items are to be installed on a type certified airframe are provided through the maintenance delivery documentation, there is nothing for operators/STC agencies to use for after delivery changes to the aircraft. Of concern are the various interior changes done by many carriers that move galley and lavatories throughout the cabin. With these interior changes, location of wiring, potable water, and waste water lines are changing. I presently see no guidance coming that instructs when to use heat shields/drip shields when an electrical disconnect panel is now too close to the rerouted plumbing components.

OWNER REMARKS: OEM P3

The use of general and detailed visual inspections of wiring installed in airplanes remains the preferred method of detecting actual or the

potential for damage to wiring. This preference accounts for the present level of diagnostic equipment available to the industry, the needs of the industry, and the potential for undetected damage to result in failure. The OEMs vehemently disagree that this preference is either negligent or wrong given the present options. However, as stated previously, the OEMs continue to consider NDT methods other than visual inspections as a method of identifying actual or potential wiring faults.

In addition, the OEMs expect that the enhanced zonal analysis process (EZAP) will likely both determine whether general or detailed visual inspections are sufficient, and will likely result in identification of post-delivery wiring installations and specify any resultant wiring inspections.

With regard to the comment regarding wiring protection, as with any component installed on the airplane, except as cited within the Configuration Deviation List contained within the Dispatch Deviations Procedures Guide, protective shields are required to be installed on the airplane during revenue service. It is the responsibility of each operator to ensure that the design integrity of the airframe is properly maintained and to incorporate maintenance and inspection programs that follow industry best maintenance practices. Operators should use the guidance provided in the forthcoming wiring inspection programs, coupled with the guidance contained within the OEM standard wiring practices documents to either identify damage caused from missing drip or heat shields, or identify the conditions that would necessitate protection.

The OEM's believe that, although there exists the possibility that some protection may have been inadvertently omitted on airlines undergoing extensive modification, we believe that the existing maintenance procedures in place at the airlines would dictate that such omissions would be rare. We also believe that the effects of such an omission would be minor in scope but still recognizable through normal or enhanced maintenance activities.

Finally, with regard to the comment concerning the installation of post-delivery modifications, OEM design practices, and the resulting guidance used to maintain those designs, are proprietary to the OEM. The requirement to use these practices and procedures for designs created by entities other than the OEM is inappropriate. Operators, repair houses and STC applicants could consult the OEM guidelines in developing their after-delivery modifications, or develop their own, but they are cautioned that the ESWPM is not intended as a design standard but, rather, for use in maintenance and repair of the OEM wiring installations.

As far as post-delivery modifications are concerned, Airbus is currently reviewing the ESPM content related to wire routing and segregation and will include in the ESPM guidance and recommendations in case of new wiring installation after delivery to the aircraft.

2d3	OEM	Review design practices regarding the use of drip guards. Investigate use of nondestructive testing to trouble-shoot suspect wire installations

Boeing - Moisture ingression prevention guidelines are specified in the SWPM and are commonly used during the production of new airplanes. Detailed visual inspection is the preferred NDT inspection

method to identify the presence of or indications of moisture ingression

Airbus - Moisture ingression prevention is presently taken into consideration during the design of the electrical system. Airbus will include in the ESPM guidance and practices to maintain the design provisions for the prevention of moisture contamination to wiring

Lockheed - The Lockheed SWPM manual provides practices specific to SWAMP locations. Detailed Visual Inspection is the suggested inspection method for detecting moisture ingression. Drip shields are used throughout the SWAMP areas exclusively for the protection of wiring. It is the responsibility of the operator to ensure the design integrity of the airframe is maintained and to incorporate maintenance and inspection programs that follow industry best practices and are FAA approved

[COMMENT 1 directed at Boeing] What about poor initial design? Also, visual inspection was shown to inadequate to detect the type of flaws that water may cause. Such as insulation cracking

[COMMENT 2 directed at Boeing] Are visual inspections sufficient to give a complete picture of whether moisture is or has been present in wiring? The intrusive inspections showed that visual inspections do not work to discern the majority of wiring flaws.

With this is mind it seems negligent and wrong to take the position that visual inspection is the "preferred NDT inspection method" knowing that it does not work to discern the majority of wiring flaws including and especially detecting flaws, nicks and cuts within a wire bundle or under clamps, loss of continuity problems, and sometimes does not reveal heat or arcing damage in wire insulation.

Though detailed visual inspections are an improvement, there are many testing procedures and devices available today that go beyond that. There should be no further delay in evaluating and incorporating proven NDTs in wire inspection and maintenance programs

Furthermore, ALPA raises the issue that not all aircraft in need have drip shields. Is this a manufacturer issue or an operator issue? Does the OEM agree with this assessment?

OWNER REMARKS: OEM P3

The use of general and detailed visual inspections of wiring installed in airplanes remains the preferred method of detecting actual or the potential for damage to wiring. This preference accounts for the present level of diagnostic equipment available to the industry, the needs of the industry, and the potential for undetected damage to result in failure. The OEMs vehemently disagree that this preference is either negligent or wrong given the present options. However, as stated previously, the OEMs continue to consider NDT methods other than visual inspections as a method of identifying actual or potential wiring faults.

In addition, the OEMs expect that the enhanced zonal analysis process (EZAP) will likely both determine whether general or detailed visual inspections are sufficient, and will likely result in identification of post-delivery wiring installations and specify any resultant wiring inspections.

With regard to the comment regarding wiring protection, as with any component installed on the airplane, except as cited within the Configuration Deviation List contained within the Dispatch Deviations Procedures Guide, they are required to be installed on the airplane during revenue service. It is the responsibility of each operator to ensure that the design integrity of the airframe is properly maintained and to incorporate maintenance and inspection programs that follow industry best maintenance practices. The OEM's believe that, although there exists the possibility that some protection may have been inadvertently omitted on airlines undergoing extensive modification, we believe that the existing maintenance procedures in place at the airlines would dictate that such omissions would be rare. We also believe that the effects of such an omission would be minor in scope but still recognizable through normal or enhanced maintenance activities.

Operators should use the guidance provided in the forthcoming wiring inspection programs, coupled with the guidance contained within the OEM standard wiring practices documents to either identify damage caused from missing drip or heat shields, or identify the conditions that would necessitate protection.

Finally, with regard to the comment concerning the installation of post-delivery modifications, OEM design practices, and the resulting guidance used to maintain those designs, are proprietary to the OEM. The requirement to use these practices and procedures for designs created by entities other than the OEM is inappropriate. However, operators and STC applicants can consult the ESWPM for guidelines in developing post-delivery modifications.

As far as post-delivery modifications are concerned, Airbus is currently reviewing the ESPM content related to wire routing and segregation and will include in the ESPM guidance and recommendations in case of new wiring installation after delivery to the aircraft.

2e3	OEM	Investigate use of nondestructive testing to trouble-shoot suspect wire installations. Review sources of potential contamination

Boeing - Presently available NDT/troubleshooting methods are provided within the specific airplane maintenance manual chapter appropriate for the system undergoing test. Prevention of contamination, and cleaning of noted contamination on the exterior of wiring will be included in the Boeing SWPM

Airbus - Airbus will review "EWIS" testing requirements following any recommendations that result from HWG 9. Prevention of contamination, and cleaning of noted contamination on the exterior of wiring and/or electrical components is currently included in the ESPM

Lockheed - Specific methods for NDT & troubleshooting are outlined in the maintenance manuals. It is the intent of LMCO to incorporate ATA Spec. 117 practices into the MM & SWPM

[COMMENT 1 directed at Boeing] All old and not near what can be done.

[COMMENT 2 directed at Boeing] The statement that Boeing will include new cleaning and contamination prevention material in the SWPM may be their only response indicating definitive action in response to IIWG recommendations. Unfortunately this response

		(satisfying other recommendations of other working groups) falls short of fully satisfactory. Though the general guidance in the SWPM is welcome, the recommendation had intended that manufacturers make it a practice to examine more closely model-specific sources of contamination and release service literature indicating how those systems could be adjusted or modified to minimize the potential for contamination [COMMENT 3, also applies to 2f4] Boeing comments indicate that existing NDT methods are called out within existing maintenance manuals. I believe this recommendation is aimed at developing NDT methods to detect wiring flaws and locate within a wiring run. This also looks as if this recommendation should be assigned to FAA Tech Center such that the work being done with some of the NDT agencies can be tied to this recommendation. OWNER REMARKS: OEM P3 The OEMs disagree that the inclusion of recommended procedures for the prevention and removal of contamination is the only action to be undertaken as a result of the IIWG recommendations. We also disagree that this action is unsatisfactory given the fact that we presently examine model-specific sources of contamination and release service literature indicating how those systems could be adjusted or modified to minimize the potential for contamination. This service literature was reviewed by industry teams responsible for accomplishing ATSRAC Tasks 1 and 2. In addition, the OEMs expect that the EZAP, which contains specific evaluation of the actual and potential sources of contamination within a zone, would address the need for changes in maintenance or the need for a design change to preclude the possibility of subsequent contamination. The Airbus ESPM currently provides guidelines for the cleaning of EWIS components (Chapter 20-55-00) and protection (Chapter 20-54-00) during maintenance. Any HWG7 and HWG9 recommendations will be analyzed and included if appropriate. With regard to the recommendation concerning non-destructive testing, the OEM response considered the use of NDT for troubleshooting purposes. OEMs are presently evaluating the use of diagnostic equipment utilizing various technologies to identify actual or the potential for wiring faults.
2f4	OEM	Review design practices regarding the clamping and tying of wire bundles. Investigate use of nondestructive testing to trouble-shoot suspect wire installations Boeing - Review of Boeing wire clamping and bundle assembly techniques is complete with no changes expected to those currently specified. Presently available NDT/troubleshooting methods are provided within the specific airplane maintenance manual chapter appropriate for the system undergoing test Airbus - Review of Airbus wire clamping and bundle assembly techniques is complete with no changes expected to those currently specified. The ESPM currently provides electrical nondestructive testing, guidelines for the bundle correct attachment and bundle attachment repair. Airbus will review "EWIS" testing requirements following any recommendations that result from HWG 9

Lockheed - Current design practices for clamping and bundle assembly techniques are acceptable. No changes are planned at this time. Specific methods for NDT & troubleshooting are outlined in the maintenance manuals. It is the intent of LMCO to incorporate ATA Spec. 117 practices into the MM & SWPM

[COMMENT 1 directed at Boeing] No changes

[COMMENT 2 directed at Boeing] This recommendation arose from the finding of wire degradation caused by vibration. The original recommendation anticipated the need for updated design practices as a means to reduce the instances of vibration induced damage to wire bundles. The only OEM response received up to now shows the item to be CLOSED and GREEN, yet the actual response itself confirms there are no changes expected to be made in design practices regarding the clamping and tying of wire bundles. That response raises the further question of what is now different? Have the design practices changed at some point in the past in a way that will decrease the occurrence of vibration damage in the future? Alternatively, if the written practices have not changed significantly, and the practices themselves are deemed to be adequate, is there something in the way clamps and ties are installed during manufacture, or reinstalled during service, that needs to be addressed in order to reduce the instances of damaged wires in the fleet? I think ATSRAC needs to be assured that measures are in place to control the potential for excessive vibration damage before it can close off this item permanently.

[COMMENT 3 directed at Boeing] If the intrusive inspection team found evidence of vibration initiated damage then the response from Boeing does not address the problem by stating that no changes in wire clamping of bundle assembly techniques are necessary

OWNER REMARKS: OEM P3

OEM review of the results of the intrusive inspections indicate that proper use of present wire retention practices as outlines within the ESWPM would have prevented much of the observed vibration damage. The OEM response to the recommendation for a review of these practices indicated that no change to the present techniques was deemed appropriate.

The expectation that release of an SFAR requiring that the ESWPM be included as part of the Instructions for Continued Airworthiness (FAR 25-1529, Appendix H) will ensure that operators will be using the guidelines outlined within that document, or using equivalent procedures developed using their own expertise.

2f5	FAA/OEM	(a) Investigate use of nondestructive testing to trouble-shoot suspect wire installations. (b) Investigate separation and segregation of wire installed after manufacture of the aircraft

FAA - (b) - The FAA has completed the research plan for this project and acquisition process is underway. The bidding process will be full and open to all vendors

[COMMENT] There is clearly at present no effective definition of criteria for where a degradation of insulation becomes unacceptable. It seems that various items in the FAA R&T programme will provide further information but until that is available it would be premature to press this action with operators

OWNER REMARKS: FAA P3

MJN – subsequent to comments being received the FAA have taken ownership of this item. Their action plan is identified above

OEM

Boeing - (a) Presently available NDT/troubleshooting methods are provided within the specific airplane maintenance manual chapter appropriate for the system-undergoing test

Airbus - (a) The ESPM currently provides electrical nondestructive testing to trouble-shoot electrical wiring. Airbus will review "EWIS" testing requirements following any recommendations that result from HWG 9

Lockheed - (a) Specific methods for NDT & troubleshooting are outlined in the maintenance manuals. It is the intent of LMCO to incorporate ATA Spec. 117 practices into the MM & SWPM.

[COMMENT directed at Boeing] All old tech, is this all we can do?

OWNER REMARKS: OEM P3

This comment is in response to the OEM statement that presently available methods are specified for use in the non-destructive testing of installed wiring. In addition to the techniques presently available, OEMs are currently evaluating the use of additional diagnostic equipment utilizing various technologies to identify actual or the potential for wiring faults.

3b4 FAA Develop and understanding of how vibration and contamination (solid and liquid) interact

The FAA is currently conducting a three-year program to address wire degradation, which includes vibration and contamination along with a variety of other degradation factors. Phase I of the project will be complete at the end of April 2002, followed by 20 months of testing, and an additional 8 months of data reduction, analysis, and modeling efforts

[COMMENT 1] As yet, this recommendation has no owner. Owing to the nature of the task I believe that it would best be achieved through an FAA R&D program. However, before any work is started I would welcome an ATSRAC debate on the issue in order to decide whether a study of the interaction between vibration and contamination would be valuable.

[COMMENT 2] Is this covered in the FAA planned work on wiring?

[COMMENT 3, also applies to 3e3] This is shown as unassigned and RED status for each area. I suspect that this is very much an unknown area to us. Our efforts in Task Group 9 to provide a maintenance program to keep the wiring free from contamination would be the preventative measure from any concerns that may arise in this area. If the working groups are having trouble assigning this task, I would defer to the FAA EAPAS effort to see if this warrants research in their view. If FAA does not pick this up, my thoughts would be to show the preventative actions from Task Group 9 as closing action on this issue.

OWNER REMARKS: FAA P3

MJN – Since receiving the above comments, FAA has taken ownership of this item. Their action plans above are identified above

3e2	OEM	Consider design modification to minimize potential for contamination

Boeing - Potential sources of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in the form of drip or heat shields are included to minimize the effects of contamination. When unanticipated sources of contamination are identified during service operation, additional protection is specified and available to operators through a service letter or service bulletin. In the case of general protection of wiring during unrelated maintenance, Boeing will be providing protection guidelines in an upcoming revision to the SWPM

Airbus - Potential sources of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in the form of drip or heat shields are included to minimize the effects of contamination. If in-service experience shows that additional protection against contamination is required, then a design modification will be developed to provide additional protection. This will be made available to operators thru a service bulletin. In the case of general protection of wiring during unrelated maintenance, Airbus will be providing protection guidelines in an upcoming revision to the ESPM

Lockheed - Sources of contamination are taken into account during design and are addressed via SB's or SIL's when unforeseen discrepancies are discovered. LMCO's design standards, currently, take into consideration the possible loss of multiple critical systems. Lessons learned and recommendations are to be incorporated into the SWPM revision.

[COMMENT directed at Boeing] Provide details of the unrelated maintenance wire protection guidelines and timetable for its inclusion in the SWPM.

OWNER REMARKS: OEM P3

As unanticipated causes of wiring contamination are addressed on a case basis, the OEMs believe that this comment relates to the forthcoming recommendations regarding protection of wiring from damage and contamination during maintenance. Boeing is presently evaluating several methods of maintenance protection in various areas of an airplane. These recommendations must be validated with operators and repair stations before they are implemented into the SWPM. At this time a definitive schedule is not available.

The Airbus ESPM currently provides guidelines for the cleaning of EWIS components (Chapter 20-55-00) and protection (Chapter 20-54-00) during maintenance. Any HWG7 and HWG9 recommendations will be analyzed and included if appropriate.

In addition, based upon the ATSRAC and FAA recommendations that we do so, the OEMs are presently implementing notes into all service bulletins cautioning operators about the importance of protecting wiring during maintenance. Boeing anticipates release of service bulletins incorporating this note in mid-2002.

		Airbus has launched corresponding actions to implement the EAPAS recommendation to include information in service data on minimizing wiring contamination during maintenance. A dedicated procedure is presently under preparation for introduction in the next available revision of the ESPM. This task will cover the recommendations and information included in ATA117. We are investigating also the possibility to introduce this Task in the AMM. As soon as this specific Task will be available, a cross-reference to the ESPM or AMM will be made in all relevant Service Bulletins. LMCO has been adding notes to its SB's recommending the utilization ATA Specification 117 guidelines when performing maintenance in, on or around wiring. All L-1011 operators have been supplied a copy of the specification and are urged to implement it into their maintenance programs. The revision of the LMCO SWPM will provide reference to ATA 117. Additionally, review of our Maintenance Manuals shows that more notes should be added, regarding proper techniques and the use of suggested references.
4.2	OEM	Boeing - Implementation of any new technology will be evaluated as it is being developed and with the input of the operators Boeing - Implementation of any new technology will be evaluated as it is being developed and with the input of the operators. Airbus - Implementation for in-service aircraft will be dependant on the result of the test program Lockheed - As AFCB technology is developed LMCO will continue to evaluate, with operators, the applicability for individual systems. [COMMENT directed at Boeing] I appreciate Boeing's commitment to examining the potential of Arc-Fault Circuit Breakers. Boeing's efforts in this area have encouraged other OEMs, circuit breaker manufacturers, and operators to take seriously this technology.
4.3	OEM	Research and develop nondestructive testing techniques capable of identifying and locating insulation cracks. Consider using these techniques for both inspection and troubleshooting of suspect wires. Consider utilization of such techniques to establish on-condition criteria for replacement of endemic cracking wire Boeing - We are presently conducting testing of wiring removed from service airplanes with the intent of identifying techniques to replace suspect wiring. This testing is ongoing and may result in the identification of and limits to insulation cracking Airbus -Airbus is currently investigating possible non-destructive testing methods that will detect wire insulation damage Lockheed - Currently, visual inspection techniques are the method utilized in determining wiring discrepancies. As new technology is developed LMCO will evaluate and recommend the use of proven, viable techniques in an effort to improve the detection of suspect wiring. [COMMENT directed at Boeing] Wire cracking was identified as one of the most critical issues to address. Boeing's efforts in this area are appropriate and welcome
4a2	OEM	Consider local design modification to replace non-fire-retardant materials

Boeing - Specification and use of materials in the manufacture of an airplane, especially the ability of the material to self-extinguish, comply with federal regulations at the time of certification. Service experience or a change in the use of the airplane would be used to determine whether an original material should be replaced by a material meeting a different flammability standard
Airbus - Specification and use of materials in the manufacture of an airplane, comply with federal regulations at the time of the certification. The results of the ongoing studies aimed at identifying acceptable materials will be used to determine the use of these materials in present and future airplanes

Lockheed - Materials met the current FAA flammability requirements at the time of design

[COMMENT 1 directed at Boeing] This does not address the question about current design mods.

[COMMENT 2 directed at Boeing] ATSRAC has spent a great deal of time debating the issues surrounding the treatment of flammable materials in zones, without reaching a firm conclusion on whether materials that meet the regulations extant at the time of original certification should automatically be considered adequately fire resistant. I do not want to restart that debate here, but I would like to put down a marker that ATSRAC's conclusion on that issue should determine how vigorously design modifications to replace non fire retardant materials should be pursued. That, in turn, will determine whether the responses to Recommendation 4.a.2 can be considered acceptable or not.

[COMMENT 3 directed at Boeing] The ATSRAC is well aware that materials used in airplane manufacturing comply with federal regulations at the time of certification. However, service experience, as illustrated by the intrusive inspections, show that some original material should be replaced with materials meeting a more current flammability standard. This is the basis for this series of recommendations that design modifications be considered to eliminate non-fire retardant materials. Boeing's comments are non responsive to the recommendations.

[COMMENT 4 directed at Boeing] The point of ATSRAC is to identify systemic safety issues with aging systems, not to write model-specific airworthiness directives. The airworthiness directive process is quite adequate for addressing unique problems with unique fixes, and it does not require the participation of unaffected parties (we don't need Boeing to help write Airbus AD's). Therefore, to insist that the certification basis is adequate unless modified by an AD is to deny the legitimacy of ATSRAC.

OWNER REMARKS: OEM P3

The OEMs agree that this issue concerns whether materials meeting flammability requirements in place at the time of initial certification should be considered to be flammable under present certification standards. However, we do not agree with the comment that the results from the IIWG review indicate that some materials should be replaced. Identification of safety issues remains the responsibility of the FAA. Removal of materials thought to degrade the operational safety of an airplane is an appropriate response whereas removal of materials meeting a different standard from that currently in place for new airplane designs is not.

4a3	ARAC/FAA	Accelerate removal of flammable materials from the cockpit and electronics bay ARAC/FAA - Airworthiness Directives have been issued for the metalized mylar insulation [COMMENT 1] What about other flammable materials ? [COMMENT 2] Given the extensive period for compliance, prioritizing the removal of aluminized Mylar from the cockpit and electronics bay is not an inappropriate or inconsequential recommendation OWNER REMARKS: FAA P3
4b1	OEM	Specify accelerated removal of flammable materials. Specify guidelines to minimize moisture intrusion into wire bundles (e.g. specify drip shields over bundles running under lavatories). Specify guidelines to minimize moisture accumulation on or near bundles Boeing - Prevention of contamination, and cleaning of noted contamination on the exterior of wiring will be included in the Boeing SWPM. Procedures for the use of drip loops as a method of prevention for moisture ingression into connectors is presently outlined in the SWPM. Additional guidelines for the removal of moisture accumulations within the airplane as a whole are contained within the specific AMM chapter applicable to the system or zone under review Airbus - The results of the ongoing studies aimed at identifying and eliminating the use of flammable materials in the flight deck and E/E bay areas, will determine the Airbus required action. Moisture ingression prevention is presently taken into consideration during the design of the electrical system. Airbus will include in the ESPM guidance and practices to maintain the design provisions for the prevention of moisture contamination to wiring Lockheed - Expanded requirements for the cleaning of and prevention of contamination will be included in the revision to the SWPM. Current SWPM guidelines address moisture ingression prevention. [COMMENT directed at Boeing] Why not the materials? Instead of just contaminant OWNER REMARKS: OEM P3 This comment is in regard to the response to the recommendation that the OEMs specify accelerated removal of flammable materials. The OEMs defined flammable materials as the accumulation of contaminants over time rather than an assessment of the flammability of the materials used in the construction of the airplane. The OEMs support the prompt removal of flammable contaminants and recommend both that operators do so and provide effective procedures for doing so. However, we do not support the identification and removal of materials that meet flammability requirements and do not degrade the operational safety of the airplane.

4b2	OEM	Specify situation-specific wiring separation and segregation guidelines that consider loss of multiple critical functions from a common mode failure

Boeing - Wire separation and segregation guidelines are presently contained within the SWPM and reflect current production design standard that account for loss of multiple or redundant systems. Any changes to the standards will be reflected in future revisions to the SWPM

Airbus - Production design standards specify wire separation and segregation rules to provide system redundancy. These standards are described within the ESPM. Any changes to the standards will be reflected in future revisions to the ESPM

Lockheed - Current guidelines and design practices contain the requirements for bundle separation and segregation by category. Certification and design considerations have taken into account the possibility of loss of multiple functions from a common mode failure

[COMMENT directed at Boeing] No change once again

OWNER REMARKS: OEM P3

An assessment of the current wiring separation and segregation guidelines provided by the OEMs indicate that they already account for loss of multiple critical functions as a result of a common mode failure, so no changes were necessary to the guidelines to comply with the recommendation

Any new requirements which may arise from HWG 6 Sub-tasks 6.7 (Wire Separation Requirements), 6.6 (Wire System Safety Assessment Requirements) and 6.8 (Wiring Identification Requirements) will be analyzed and documentation will be updated if appropriate.

4b5	FAA	Research and develop fire retarding and suppressing materials and systems suitable for this situation

Currently, no incorporation plan from the FAA (MJN)

[COMMENT 1] As yet, this recommendation has no owner. Owing to the nature of the task I believe that it would best be achieved through an FAA R&D program

[COMMENT 2] I think I understood this is being pursued by the FAA Fire research centre but is it expected that work will be stimulated in industry to develop better materials? If current materials meet the standards there is no incentive to do so

[COMMENT 3] This is another area where it is not clear to me what the recommendation actually targets. My best guess would be that we are recommending development of better wire insulation material that is both resistant to cracking and more fire resistant? If so, this looks like a tasking for the wire industry. It may be better to refer the recommendation back to the Intrusive Inspection WG for clarification. By the coding of Red and the????? shown, it appears our working group chairs are not sure on this.

OWNER REMARKS: FAA P3

MJN – Since receiving these comments, the FAA have taken ownership of this item.

4c2	OEM	Accelerate removal of flammable materials

Boeing - Prevention of contamination, and cleaning of noted contamination on the exterior of wiring will be included in the Boeing SWPM. Additional guidelines for the removal of accumulations of flammable materials are contained within the specific AMM chapter applicable to the system or zone under review

Airbus - Prevention of contamination, and cleaning of noted contamination on the exterior of wiring is included in the ESPM. The results of the ongoing studies aimed at identifying and eliminating the use of flammable materials, will determine the Airbus required action

Lockheed - Materials met the current FAA flammability requirements at the time of design. It is LMCO's intent to provide additional guidelines for cleaning and prevention of flammable contamination in the revision of the SWPM

[COMMENT directed at Boeing] Once again contamination only

OWNER REMARKS: OEM P3

Once again, the OEMs support the prompt removal of flammable contaminants provide effective procedures for doing so. However, we do not support the identification and removal of materials which meet flammability requirements and do not degrade the operational safety of the airplane.

4e2	OEM	Consider design modification to minimize potential for contamination.

Boeing - Potential sources of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in the form of drip or heat shields are included to minimize the effects of contamination. When unanticipated sources of contamination are identified during service operation, additional protection is specified and available to operators through a service letter or service bulletin. In the case of general protection of wiring during unrelated maintenance, Boeing will be providing protection guidelines in an upcoming revision to the SWPM

Airbus - Potential sources of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in the form of drip or heat shields are included to minimize the effects of contamination. If in-service experience shows that additional protection against contamination is required, then a design modification will be developed to provide additional protection. This will be made available to operators thru a service bulletin. In the case of general protection of wiring during unrelated maintenance, Airbus will be providing protection guidelines in an upcoming revision to the ESPM

Lockheed - Expanded requirements for the cleaning of and prevention of contamination will be included in the revision to the SWPM

		[COMMENT 1 directed at Boeing] Status quo [COMMENT 2 directed at Boeing] Not responsive to the recommendation OWNER REMARKS: OEM P3 The OEMs disagree that we are not responsive to the recommendation that we consider design modifications to minimize the potential for contamination. The presence of contamination may affect the operation of the system, definitely affects the ability to assess the condition of airplane wiring, and increases both unscheduled and schedule maintenance costs. The OEMs presently evaluate the possibility and effects of sources of contamination and consider methods of preventing contamination to minimize the effects on the operation and maintenance of our airplanes. This policy is eveident in the release of service bulletins recommending the incorporation of drip shields, heat shields, drains, etc.
4f1	OEM	Specify accelerated removal of flammable materials. Establish guidelines to ensure, and enhance where necessary, the secure installation of wire bundles Boeing - Prevention of contamination, and cleaning of noted contamination on the exterior of wiring will be included in the Boeing SWPM. In addition, specific unique procedures for the attachment and prevention of damage to wiring in high vibration areas is presently provided in the SWPM Airbus - Prevention of contamination, and cleaning of noted contamination e.g. lint etc. will be included in the ESPM. Airbus has specific design rules governing the attachment of wire bundles to counter the affects of vibration Lockheed - Requirements for the cleaning of and prevention of contamination will be included in the revision to the SWPM. The SWPM contains specific requirements for bundle attachment in high vibration areas [COMMENT 1 directed at Boeing] Once again contamination only [COMMENT 2 directed at Boeing] Not responsive to the recommendation OWNER REMARKS: OEM P3 Once again, the OEMs are being responsive to the recommendation in our support for the prompt removal of flammable contaminants and provide effective procedures for doing so. However, we do not support the identification and removal of materials which meet flammability requirements and do not degrade the operational safety of the airplane.
5.1	OEM	Specify guidelines that precipitate an invasive inspection or nondestructive testing of wire bundles exposed to suspected high or low pH contaminants. Specify guidelines for decontamination procedures for wire to neutralize the effects of chemically aggressive contaminants Boeing- Guidelines for the cleaning and conditional inspection of contaminated wiring will soon be included in the SWPM and

Maintenance Planning Document applicable to the specific model airplane

Airbus - The ESPM currently gives guidelines for the cleaning, protection and inspection of wiring. Airbus will review the wire testing requirements following any recommendations that result from HWG 9 and also HWG6

Lockheed - LMCO will include additional guidelines, in the SWPM, that are specific to contamination identification, replacement criteria of, and cleaning of bundles. Additionally, LMCO will re-issue a SIL that addresses the cleaning of contaminants from wiring

[COMMENT 1 directed at Boeing] Once again contamination only

[COMMENT 2 directed at Boeing] The only OEM response received up to now shows the item to be CLOSED and GREEN. However, the response does not address the first part of the recommendation to "specify guidelines that precipitate an invasive inspection or nondestructive testing of wire bundles exposed to suspected high or low pH contaminants". Until a response is received on this point, the item should remain OPEN and YELLOW

[COMMENT 3] Guidelines for cleaning and inspecting contaminated wiring must be reflective of the intrusive inspection findings. Use of the qualifier "when unanticipated sources of contamination are identified during service operation." Leads one to conclude there have not already been unanticipated sources. The intrusive inspection report assures us there have been and there will continue to be unanticipated contamination. We can anticipate that.

[COMMENT 4 directed at Boeing] While Boeing specifically rejects the notion of assessing the caustic nature of contaminants, the recommendation that "the procedures should specify the replacement of the wiring if the contamination is suspected of entering the wiring insulation and cannot be removed through conventional cleaning procedures" is welcome.

OWNER REMARKS: OEM P3

The response to the IIWG recommendation that the OEMs specify guidelines that would result in the evaluation of wiring thought to be contaminated by acidic or alkaline materials, and the recommendation that decontamination procedures be provided, indicated that these guidelines have already or will soon be incorporated into the maintenance documentation. Although they do not assess the acidity or alkalinity of contaminants, present guidelines regarding the cleaning and/or repair of wiring account for the wide pH range of possible contaminants.

5a1	OEM	Consider design modification to eliminate non-fire-retardant materials

Boeing - Specification and use of materials in the manufacture of an airplane, especially the ability of the material to self-extinguish, comply with federal regulations at the time of certification. Service experience or a change in the use of the airplane would be used to determine whether an original material should be replaced by a material meeting a different flammability standard

Airbus -- The results of the ongoing studies aimed at identifying and eliminating the use of flammable materials in the flight deck and E/E bay areas, will determine the Airbus required action.

Lockheed - Materials met the FAA flammability requirements at the time of design

[COMMENT 1 directed at Boeing] ATSRAC has spent a great deal of time debating the issues surrounding the treatment of flammable materials in zones, without reaching a firm conclusion on whether materials that meet the regulations extant at the time of original certification should automatically be considered adequately fire resistant. I do not want to restart that debate here, but I would like to put down a marker that ATSRAC's conclusion on that issue should determine how vigorously design modifications to replace non fire retardant materials should be pursued. That, in turn, will determine whether the responses to Recommendation 4.a.2 can be considered acceptable or not.

[COMMENT 2 directed at Boeing] The ATSRAC is well aware that materials used in airplane manufacturing comply with federal regulations at the time of certification. However, service experience, as illustrated by the intrusive inspections, show that some original material should be replaced with materials meeting a more current flammability standard. This is the basis for this series of recommendations that design modifications be considered to eliminate non-fire retardant materials. Boeing's comments are non responsive to the recommendations.

OWNER REMARKS: OEM P3

Once again, the OEMs support the prompt removal of flammable contaminants and provide effective procedures for doing so. However, we do not support the identification and removal of materials that meet flammability requirements and do not degrade the operational safety of the airplane.

5a2	OEM	Accelerate removal of flammable materials.

Boeing - Prevention of contamination, and cleaning of noted contamination on the exterior of wiring will be included in the Boeing SWPM

Airbus -The results of the ongoing studies aimed at identifying and eliminating the use of flammable materials in the flight deck and E/E bay areas, will determine the Airbus required action. Contamination prevention is presently taken into consideration during the design of the electrical system. Airbus will include in the ESPM guidance and practices to maintain the design provisions for the prevention of contamination to wiring

Lockheed - Expanded requirements for the cleaning of and prevention of contamination will be included in the revision to the SWPM.

[COMMENT directed at Boeing] Once again contamination only

OWNERS REMARKS: OEM P3

Once again, the OEMs support the prompt removal of flammable contaminants and provide effective procedures for doing so. However, we do not support the identification and removal of

materials that meet flammability requirements and do not degrade the operational safety of the airplane

6a1	OEM	Accelerate removal of flammable materials from the cockpit and electronics bay

Boeing - Prevention of contamination, and cleaning of noted contamination on the exterior of wiring will be included in the Boeing SWPM. Additional guidelines for the removal of accumulations of contamination are contained within the specific AMM chapter applicable to the system or zone under review

Airbus - the results of the ongoing studies aimed at identifying and eliminating the use of flammable materials in the flight deck and E/E bay areas, will determine the Airbus required action. Moisture contamination prevention is presently taken into consideration during the design of the electrical system. Airbus will include in the ESPM guidance and practices to maintain the design provisions for the prevention of moisture contamination to wiring

Lockheed - Expanded requirements for the cleaning of and prevention of contamination will be included in the revision to the SWPM

[COMMENT 1 directed at Boeing] Once again contamination only

[COMMENT 2 directed at Boeing] The ATSRAC is well aware that materials used in airplane manufacturing comply with federal regulations at the time of certification. However, service experience, as illustrated by the intrusive inspections, show that some original material should be replaced with materials meeting a more current flammability standard. This is the basis for this series of recommendations that design modifications be considered to eliminate non-fire retardant materials. Boeing's comments are non responsive to the recommendations.

OWNER REMARKS: OEM P3

As stated previously, the OEMs are responsive to the recommendation in our support of the prompt removal of flammable contaminants. We recommend that operators do so and provide effective procedures for doing so. However, we do not support the identification and removal of materials which meet flammability requirements and do not degrade the operational safety of the airplane. We do not support the statement that the intrusive inspections indicated that some original materials should be replaced with materials meeting later flammability standards. The OEMs could not locate this conclusion or the recommendation within the IIWG report.

6b1	OEM	Accelerate removal of flammable materials. Ensure separation of wire bundles from flammable materials

Boeing - Prevention of contamination, and cleaning of noted contamination on the exterior of wiring will be included in the Boeing SWPM. Additional guidelines for the removal of accumulations of contamination are contained within the specific AMM chapter applicable to the system or zone under review

Airbus - The results of the ongoing studies aimed at identifying and eliminating the use of flammable materials in the flight deck and E/E

bay areas, will determine the Airbus required action. Moisture contamination prevention is presently taken into consideration during the design of the electrical system. Airbus will include in the ESPM guidance and practices to maintain the design provisions for the prevention of moisture contamination to wiring

Lockheed - Expanded requirements for the cleaning of and prevention of contamination will be included in the revision to the SWPM

[COMMENT 1directed at Boeing] Once again contamination only

[COMMENT 2 directed at Boeing] The ATSRAC is well aware that materials used in airplane manufacturing comply with federal regulations at the time of certification. However, service experience, as illustrated by the intrusive inspections, show that some original material should be replaced with materials meeting a more current flammability standard. This is the basis for this series of recommendations that design modifications be considered to eliminate non-fire retardant materials. Boeing's comments are non responsive to the recommendations.

OWNER REMARKS: OEM P3

As stated previously, the OEMs are responsive to the recommendation in our support of the prompt removal of flammable contaminants and provide effective procedures for doing so. However, we do not support the identification and removal of materials that meet flammability requirements and do not degrade the operational safety of the airplane. We do not support the statement that the intrusive inspections indicated that some original materials should be replaced with materials meeting later flammability standards. The OEMs could not locate this conclusion or the recommendation within the IIWG report.

6c1	OEM	Consider design modification to minimize potential for contamination.

Boeing - Potential sources of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in the form of drip or heat shields are included to minimize the effects of contamination. When unanticipated sources of contamination are identified during service operation, additional protection is specified and available to operators through a service letter or service bulletin. In the case of general protection of wiring during unrelated maintenance, Boeing will be providing protection guidelines in an upcoming revision to the SWPM

Airbus - Potential sources of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in the form of drip or heat shields are included to minimize the effects of contamination. If in-service experience shows that additional protection against contamination is required, then a design modification will be developed to provide additional protection. This will be made available to operators thru a service bulletin. In the case of general protection of wiring during unrelated maintenance, Airbus will be providing protection guidelines in an upcoming revision to the ESPM

Lockheed - Expanded requirements for the cleaning of and prevention of contamination will be included in the revision to the SWPM.

[COMMENT directed at Boeing] But what have you learned?

OWNER REMARKS: OEM P3

The OEMs were aware of the continued potential for contamination throughout the life of the airplane, a fact that was reinforced by the results of the IIWG. The OEMs learned that the prevention and prompt removal of contamination on wiring were not being emphasized by the operators as routine maintenance of the wiring.

6d1	OEM	Consider design modification to minimize potential for contamination

Boeing - Potential sources of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in the form of drip or heat shields are included to minimize the effects of contamination. When unanticipated sources of contamination are identified during service operation, additional protection is specified and available to operators through a service letter or service bulletin. In the case of general protection of wiring during unrelated maintenance, Boeing will be providing protection guidelines in an upcoming revision to the SWPM

Airbus -Potential sources of contamination of airplane wiring are identified during the design and development of the airplane, and appropriate protection in the form of drip or heat shields are included to minimize the effects of contamination. If in-service experience shows that additional protection against contamination is required, then a design modification will be developed to provide additional protection. This will be made available to operators thru a service bulletin. In the case of general protection of wiring during unrelated maintenance, Airbus will be providing protection guidelines in an upcoming revision to the ESPM

Lockheed - Sources of contamination are taken into account during design and are addressed via SB's or SIL's when unforeseen discrepancies are discovered. LMCO's design standards, currently, take into consideration the possible loss of multiple critical systems Lessons learned and recommendations are to be incorporated into the SWPM revision

[COMMENT directed at Boeing] Guidelines for cleaning and inspecting contaminated wiring must be reflective of the intrusive inspection findings. Use of the qualifier “when unanticipated sources of contamination are identified during service operation.” Leads one to conclude there have not already been unanticipated sources. The intrusive inspection report assures us there have been and there will continue to be unanticipated contamination. We can anticipate that.

OWNER REMARKS: OEM P3

The response stated that “…when unanticipated sources of contamination are identified during service operation, additional protection is specified and available to operators through a service letter or service bulletin…” The fact that the OEMs have already released such documents to provide protection from sources of contamination on in-service airplanes not anticipated during the

		design of the airplane, would contradict the conclusion that there have not already been unanticipated sources.
GR5	FAA	Excessive wire heating presents the risk of electrical fire or ignition of surrounding combustible materials. High resistance inter-connections where electrical heating is sufficient to damage the wire insulation are typically detected by visual inspection for embrittled, charred or missing insulation. However, the relationship of observable thermal damage to wire hot enough to hazard the aircraft is still unknown. It is recommended that the FAA conduct research to determine how best to manage this issue AAR-433 - This is not currently part of the FAA Electrical Systems Research Program [COMMENT] I do not recall any of the activities in the extensive FAA R&T program which address this. Did I miss it? OWNER REMARKS: FAA P3

GENERAL COMMENTS

[COMMENT 1]

a. The determination was made that all wires are considered critical, but yet the Intrusive Inspection Group realized there was a definite need to categorize/separate power wires from signal wires. "Stray currents which effect the functionality of those systems". Kapton wires (not mentioned) were advised not to be used in high current carrying cables due to arc-tracking and flashover concerns by the current Advisory Circular 25.16 . No mention of the flammability of PVC wires (Table 7.1) in flammable materials removal discussions either.

FAA Remarks

- AC 25-16 recommends that aromatic polyimide insulated wire should be avoided in installations where wires or wire bundles are expected to flex, such as landing gear harnesses.
- The AC also states that installation of this wire type in areas where it may be exposed to condensation, rain, snow, hail, ice, or slush should be carefully evaluated.
- The statement in the AC that aromatic polyimide insulated wire should not be used in high current carrying cables is used in the context that this type of wire should not be used in where flammable fluids or vapors may be present, such as fuel tanks.
- The title of Table 7-1 is “Age Related Wire Conditions.” The table identifies conditions that affect the aging of wires regardless of wire type.

b. Advisory Circular 25.16 also states that different wire types should not be routed in the same bundles due to differences in hardness. Boeing has stated they have no in-house prohibition against mixing different wire types. Clearly if ATSRAC hopes to have voluntary compliance with only Advisory Circulars being issued, something has to change. How can we choose to support some advisory material and ignore others?

FAA Remarks

- As addressed by AC 25-16, abrasion becomes a concern when wire installation allows relative movement between wires in the same bundle. Additionally, this can also be a concern when wires of different bundles cross each other and there is relative movement between the bundles. However, the AC states that testing and service history may be used to demonstrate that the mixing of wire types will not result in abrasion.
- Service history does not indicate abrasion problems for the type of wire used in aircraft applications.
- As part of the EAPAS program, the FAA is conducting a research program to evaluate concerns over mixing of wire types and how this applies to wire installed on the aircraft over its expected lifetime.

c. The summation of nearly all of the green-lighted (closed) issues could be; already considered, already being done, only needs improved housekeeping, reference to insufficiently mature technology (arc-fault circuit breakers and non-destructive test equipment), need better maintenance awareness through increased training, or will be covered by future Advisory Circulars. It has already been shown that Advisory Circulars are being ignored. Boeing thinks existing industry practices in design and maintenance are sufficient. The NTSB and the FAA have declared that current best practices are inadequate.

FAA Remarks

- In terms of tracking the status of ATSRAC recommendation, the color green indicates that the task is closed, closed with comment, or on plan (i.e., the item is expected to be completed on schedule).
- Advisory circulars are effectively used by the global aviation community as a means to show compliance to the applicable requirements.

- The FAA along with other international regulatory authorities and the aviation industry has taken a proactive approach to improve wire related requirements, advisory material, and policy. Examples include current ATSRAC Task Nos. 6-9, recently released FAA wire policy, and a best wiring practices training course that has been well received on a global scale.

d. The intent of the Intrusive Inspection Group Report was to be as politically correct as possible. This was done by softening the verbiage for example; hypothetical, plausible scenarios, no mention of arcing of aromatic polyimides, etc. The result being that without any concrete conclusions that visual inspections can't find the most common wire flaws, and that the condition of the fleet is dangerous, these type of responses are to be expected. What problem with wiring? If there is no problem then nothing needs to be done about the fleet of wiring with; 1,100 cracks per aircraft, burned conductors, arced conductors, embrittled wires, delaminated wires, etc. The whole context of the Intrusive Inspection recommendations could be summed up by saying, we have a problem. We don't have test equipment (NDT) or futuristic arc-fault circuit breakers but we sure need them. Boeing has said everything is as designed and all is well, in this report. Boeing has agreed to the drafting of Advisory Circulars that they will ignore as the ones they ignore now.

FAA Remarks

The commenter has stated an opinion.

e. The lack of wire performance testing is what allowed the dangerous condition of the fleet's wiring, along with a fit and forget maintenance attitude. We need wire performance now, as called for by the TSB in Aug 2001 and Advisory Circular 25.16 "Demonstrations of arcing on wire insulation should be allowed to progress to the point of "insulation flashover". The tests may be supported by any relevant analysis. If laboratory tests are conducted instead of airplane tests, compliance should be with FAR 25.1363".

FAA Remarks

The title of 25.1363 is “Electrical System Tests.” The purpose of this requirement is to simulate the aircraft electrical generating and distribution system by using the same equipment used in the airplane. The reason for this is to monitor the functional characteristics of the electrical system including system components and wiring under foreseeable operating conditions.

f. This report highlights what is wrong with the Intrusive Inspection Group Report. "The conclusions are not sufficiently specific to serve as mandatory design or maintenance requirements". The conclusions should have been specific in order to disallow the report received from Boeing on the recommendations.

FAA Remarks

The commenter has stated an opinion

g. Visual inspections don't work and yet we continue to call for them in enhanced zonal (visual) inspections.

FAA Remarks

Visual inspections are an important part of inspection/maintenance programs that also include wire integrity tests. To further enhance the effectiveness of inspection programs better and improved detection devices such as arc-fault circuit and enhanced fault isolation tools are being developed for future use.

[COMMENT 2]

The responses from the working groups are, in general, detailed and well researched. There was clearly much effort put into developing proactive responses to the recommendations. Most of the manufacturer-specific comments refer to Boeing because Boeing's comments are the most complete. The absence of comments referring to other organizations should not be construed as a specific endorsement of their current practice.

In general, the responses by Boeing are too generic and dismissive. Boeing is justifiably proud of its products and processes, and, if fed the appropriate data, existing Boeing processes may be sufficient to safely manage the fleet of aging Boeing aircraft. There is, however, reluctance on the part of Boeing to accept the recommendations of the IIWG as data to drive those processes. The IIWG recommendations were not the random musings of working group members, but the considered analysis of data from real aircraft – albeit few aircraft. If the IIWG observed a phenomenon and recommended a course of action, it is incumbent on the responsible parties – using their existing fleet management processes where applicable – to determine the prevalence of that phenomenon, assess the specific consequences, make specific changes to the service literature (or directly implement changes to aircraft), and alert other affected parties. Instead the majority of Boeing responses simply state that generic or specific Boeing processes and standards are currently adequate.

A proper response to recommendations would, of course, require concerted, long-term effort on the part of all parties affected. It is not likely, for instance, that any aircraft manufacturer could specify non-destructive testing for specific at-risk circuits by the conclusion of ATSRAC's current mandate. Identification of the specific circuits alone would take more time than is available. Development of the testing systems and processes would take even longer. ATSRAC is not, however, mandated to define and fully implement comprehensive solutions to aging wiring problems: It need only define and commit to an approach – full implementation (compliance new rules) may take years.

I find it hard to believe that Boeing saw fit to close all of its actions (approximately 50) with only a few generic changes to the SWPM (mainly concerning good housekeeping practice). I would like to have seen:

1) Some commitment to intensify the frequency, intensity, or focus of their in-service evaluations,
2) Specific field assessments of issues identified by the IIWG,
3) More commitment to R&D (in addition to their degradation study).

While a fully adequate response to the IIWG recommendations would be a lot of work, it is not impossible or even impractical. The IIWG recommendations are focused specifically. The conditions associated with each recommendation should allow the OEMs and operators to restrict their efforts to specific areas of the aircraft, to specific applications, or in response to specific conditions. Nondestructive testing is not, for example, recommended for indiscriminant application – its recommended application is restricted to ensure both practicality and utility. Furthermore the recommendations are identified as options, not all of which must be implemented simultaneously to ensure safety.

Boeing Remarks.

As the commenter states, Boeing is justifiably proud of its products and processes. It is also committed to making air travel, the safest mode of transportation, even safer. That is why Boeing has aggressively supported, and will continue to support the efforts of the aging systems non-structural plan. It is the right thing to do.

With respect to the comments the process used by to formulate responses to recommendations, Boeing carefully considered each and every recommendation, not just those assigned to OEMs, and formulated an appropriate reply given the information presented in both the intrusive and non-intrusive inspection reports. In many cases Boeing felt that reassignment of recommendations aimed toward the airlines were more appropriately addressed by the OEMs. In each case the Boeing responses accounted for the results emanating from the working groups, from years fleet experience, and from inputs directly from our operators. We diligently evaluated our processes when such a recommendation was made and carefully considered the need for additional research and development. The merits of each recommendation were assessed before formulating our response.

Our responses and the actions we have committed to undertake were not taken lightly. The Boeing commitment to enhance the safety of the fleet, both older airplanes and those just entering service drove our responses. We believe we are adjusting our processes, modifying our recommended actions, and

undertaking additional tasks as a result of the IIWG recommendations that will further enhance the safety of wiring within the in-service fleet. Although not a complete list, Boeing is:

- Implementing changes to our wiring designs
- Developing and providing new procedures for the maintenance and repair of wiring
- Making changes to our certification standards
- Developing and implementing a wiring training course
- Updating our scheduled wiring maintenance programs, and voluntarily implementing this change on out-of-production airplanes
- Conducting research on wire testing and wiring protection devices
- Actively advocating the removal of flammable contaminants
- Promoting all the recommendations to our operators
- Providing fleet experiences and specific examples to the industry
- Preempting the industry by collecting wiring information separate from systems effects

[COMMENT 3]

(1) I don't know how to interpret the lack of comments under the Airbus and Lockheed Titles where OEMs are tasked as the owner of the particular recommendation. Is the Boeing position agreed upon by all three OEM participants or are we waiting for Airbus and Lockheed positions? I would be interested in seeing any position differences between the major aircraft suppliers surfaced for ATSRAC review.

(2) The work done in the development of Arc Fault Circuit Breakers thus far is very encouraging. Should this technology continue to the point of successfully detecting arcing in aircraft wiring systems and NOT cause excessive troubleshooting problems from nuisance tripping, future aircraft designs will operate with an added level of protection from on board electrical fire events? As an operator, selective installation on certain critical or problematic circuits may prove valuable in the future after case by case assessment of an airworthiness concern through the ATA's Airworthiness Concern Coordination Process.

FAA Remarks

(1) All three OEMs have now supplied comments for the majority of the recommendations. The separate OEMs positions will be consolidated into one position/plan for action and reviewed and accepted by the FAA.

(2) AFCBs appear to have the potential to be a valuable tool in the detection of arcs and prevention of damage typically associated with arching events. Currently AFCBs are being considered for non-essential systems only in order to gain service experience, collect data, and monitor their operation. When the design, installation, and operation of AFCBs reach maturity they will be considered for installation to protect wiring on all airplane systems.