

## Appendix 1.2: Transport Aircraft Intrusive Inspection Program Protocol

### Introduction

In June of 1998 the ATA formed the Aging Systems Task Force to review the effectiveness of maintenance on electrical interconnect systems of aircraft whose type certificates are older than 20 years. This action was in response to concerns that existing procedures, directives, and inspections may not be sufficient to prevent hazardous situations associated with the degradation of aircraft wire. As part of this effort 8 model-specific working groups were formed to perform detailed visual inspection (DVI) of DC 8, DC-9, DC-10, 727, 737, 747, A300, and L1011 aircraft.

The task of these model-specific working groups was to perform special visual inspections during scheduled maintenance visits in order to uncover any systematic electrical interconnect problems not currently addressed by existing maintenance programs. With over 70 aircraft inspections completed, these working groups are nearing the end of their tasking.

However, the results of these inspections can provide data only on physically observable faults. These inspection cannot provide data on certain latent defects and invisible degenerative conditions, nor can it provide data on the degraded performance of wire and insulation (as indicated by variation from some manufacturer established or observed baseline.) This data will only be available from a complementary effort involving enhanced *in situ* testing, and nondestructive and destructive analysis.

This document describes the protocols for this follow-on effort. The protocol is to be implemented by the recently formed Intrusive Inspection Working Group. This working group will report to the Aging Systems Task Force, which in turn will report to the Aging Transport Systems Rulemaking Advisory Committee.

Members of this working group include:

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### Description

While the inspections of the ATA model-specific working groups were *extensive* (covering 8 model types and including nearly 100 aircraft), the tasking for this working group is more *intensive* in nature (covering fewer aircraft, but with more sophisticated testing and inspection). Hence, instead of inspections focused on model-specific “hot spots”, this protocol will focus on generic applications representing a range of service environments from benign to severe.<sup>1</sup>

The protocol involves 3 distinct processes: 1) detailed visual inspection with or without invasive follow-up, 2) non-destructive testing (NDT) and nondestructive inspection (NDI), and 3) laboratory analysis. The coordination of these processes within this intrusive inspection program is shown conceptually on the diagram on the next page. Just prior to the detailed visual inspection the aircraft zones will receive a “close visual inspection” in accordance with the model-specific inspection protocols developed by the ATA. This close visual inspection will facilitate the comparison of results from this effort with results from the non-intrusive inspections.

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<sup>1</sup> The inclusion of (presumably) benign environments will allow us to establish a degradation benchmark for comparison with the accelerated degradation in more severe environments. When possible new or unused wire specimens will be used to establish a baseline from which to measure the degradation of the specimens taken from the aircraft.



## Applicability

The working group is looking for 8 candidate aircraft – 4 wide body and 4 narrow body aircraft. Candidate aircraft will include at least one L1011, but not more than two of any single type aircraft. The candidate aircraft must be available for destructive analysis, but should not have been retired for more than 6 months prior to the planned intrusive inspection. Candidate aircraft will be selected so as to ensure that all significant aging wire types are represented. These wire types are

- polyimide (Mil-W81381, the L1011 guarantees this),
- PVC/Glass/Nylon (Mil-W-5086, most aged narrow bodies),
- Extruded XL-Polyalkene/PVDF, (Mil-W-81044/6, DC-9 is the likely candidate here), and
- Poly-X (Mil-W-81044/16, DC-10 or 747 are the likely candidates here).
- XL-ETFE (Mil-W-22759/32-35, 41-46 type wire).

Other wire types taken purposely or coincidentally will be analyzed at the discretion of the working group on a non-interference basis (with respect to efforts focused on the primary wire types listed above).

## Procedure

This procedure is to be implemented by the intrusive inspection working group (henceforth, the “working group”). The working group will be supported by at least one nondestructive testing (NDT) contractor to be selected prior to the start of any inspections. The working group will also receive destructive testing support from the FAA’s Aging Aircraft Validation Center (AANC) at Sandia National Labs, Albuquerque, NM. The FAA will pay all costs associated with the support functions of the NDT contractors and AANC.

Because the procedure is aircraft dependent, the requirements and constraints of this process – but not the specific work items – are described in these protocols.

Formal decisions of the working group will be made by majority approval of a quorum of members. A quorum of members will consist of 6 members that shall include the chairman (or his designated representative), at least one representative of a large transport operator, and at least one representative of an airframe manufacturer. Majority approval shall be determined and recorded by the chairman.

1. The candidate aircraft will be assessed (directly or remotely) by a quorum of working group members prior to being subject to the inspection and testing. The working group will formally decide on the suitability of the aircraft. An aircraft will be deemed suitable if 1) it meets the applicability criteria described above, 2) has subject wire installations which are at least 80% original, and 3) is available for inclusion without conflict in the working group’s schedule. When multiple suitable candidates are available, the working group will select (by formal decision) an aircraft whose service experience is well known and distinct with respect to the service environment of other subject aircraft.
2. The working group will establish (by formal decision) a schedule for inspecting the aircraft. There will be a quorum of working group members present for the inspection. Prior to visiting any aircraft the working group will approve NDT protocols for the candidate aircraft. The NDT contractor will be informed of the working group’s intent to inspect the aircraft at least 15 working days prior to the scheduled inspection. The NDT contractor is to confirm his ability to support the inspection and submit protocols, comments, and requests to the chairman at least 5 working days prior to the scheduled inspection. The scheduling requirements may be waived with the mutual consent of the working group and NDT contractor.
3. Other individuals or organizations wishing to apply specific inspection or testing techniques to the selected locations may do so on a non-interference, no-cost-to-the-government basis. Individuals or organizations wishing to participate must submit test protocols at least 5 days prior to the start of the scheduled inspection, and these protocols must be approved by the working group prior to the scheduled inspection. No protocol which the working groups determines may result in damage to the aircraft or wire installations will be approved. Furthermore, the working group does not endorse any claims based on a comparison of its data to the data resulting from the application of these techniques.
4. If necessary, the aircraft will be prepared for inspection by AANC personnel. This preparation may include:
  - Grounding the aircraft
  - Ensuring that aircraft power systems (including battery back-ups) are taken off-line.
  - Establishing access to the identified inspection areas (including the provision of ladders where necessary)

Ensuring the availability of supplies and tools including digital camera, borescope, flashlights, handheld magnifying glass (10X power), mirror, cable cutters, wire cutters, drills, mallets and chisels, wrenches, screwdrivers, marking tape, shipping materials.

The extent of AANC's responsibility will be determined in conjunction with the scheduling of the aircraft.

5. The working group will select and precisely define several locations that will be the specific subjects of the intrusive inspections. These locations will be selected to ensure a proper distribution of service environments, wire bundle configurations. The locations will also be selected to ensure the availability of well defined wire specimens.

Whenever possible, the locations identified shall be contained within the locations specified by the in-service inspection protocols. Sub-Appendix 1.2.1 identifies the candidate locations for each model aircraft and cites, when possible, the appropriate protocol. With due consideration of all inspection tasks, the precise definition of all locations should not be such that the complete DVI requires more than 40 man-hours. As long as all other requirements are met, the locations need not be distinct from each other.

The locations and specific inspection tasks are to be specifically described on the form, *Intrusive Inspection Work Card*. See Sub-Appendix 1.2.2, *Generic Inspection Protocol*, and Sub-Appendix 1.2.4, *Forms*.

6. The aircraft will be placed at the disposal of a subgroup of inspectors – at least two of whom are familiar with the model-specific non-intrusive inspections. Using the model-specific non-intrusive inspection protocol<sup>2</sup>, the subgroup will perform inspections in zones identified in item 5 that corresponding with the model-specific non-intrusive inspection zones. The findings of these inspections are to be submitted to the chairman of the non-intrusive working group, but should not be marked or tagged on the aircraft.
7. Within the locations in item 5, the working group will mark (using color coded tape to segregate and demarcate the ends of specimens) 14 distinct specimens to be removed for laboratory testing:

9 cabin interior specimens:

LCL	2 lower cabin, thick bundle <sup>3</sup> , 4 feet, straight, no conduit or sheath, multiple wire gauges if possible
LCS	2 lower cabin, thin bundle, 4 feet, straight, no conduit or sheath, multiple wire gauges if possible
UCL	2 upper cabin, thick bundle, 4 feet, straight, no conduit or sheath, multiple wire gauges if possible
ICH	2 harness segments with multiple branches and turns <sup>4</sup> , at least 4 connectors, to be removed with all connectors, clamps, brackets, conduit, sheathing, etc. in place
IPF	4 power feeder cables or bundles, 4 feet or maximum available length, no conduit
PSU	6 PSU cables, max available length.
CPT	6 cockpit instrument cables, maximum available length.
CTM	2 contaminated bundles from below lavatories or galleys (if available)
CDT	2 bundles in sheathing or flexible or rigid conduit maximum available length.

5 unpressurized area specimens from wheel wells, hydraulic service center, wing spars, or tail cone. Whenever possible, the full set of inspection locations should include more than one distinct unpressurized area of the aircraft.

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<sup>2</sup> The protocols should be applied as written with the following exceptions: 1) when the protocol calls for repair, 2) when the protocol calls for re-assembly after gaining access, 3) when the protocol calls for an aircraft function (e.g. power).

<sup>3</sup> Thick bundles have 25 or more wires bound tightly. Thin bundles will have 4 to 24 wires bound tightly

<sup>4</sup> The complex harness may be cut at one or more ends, but should whenever possible be separated from the aircraft at the connectors with connectors intact.

ENL	2 thick bundles, infrequent-maintenance <sup>5</sup> , no conduit or sheathing, 4 feet or max available length
ENS	2 thin bundles, infrequent-maintenance, no conduit or sheathing, 4 feet or max available length
EPF	2 power feeder cables, no conduit
ECH	2 harness segments with multiple branches and turns, at least 4 connectors, to be removed with all connectors, clamps, brackets, conduit, sheathing, etc. in place
ECD	2 bundles in sheathing or flexible or rigid conduit, max available length

The specimens are to be specifically described on the form, *Intrusive Inspection Work Card*. See Sub-Appendix 1.2.2, *Generic Inspection Protocol*, and Sub-Appendix 1.2.4, *Forms*.

8. The aircraft locations identified in Item 5 will be reviewed by the NDT contractor. This review will only be to determine which specific interconnect systems are to be evaluated with the selected NDT techniques according to the approved protocols. The interconnect systems to be tested by the NDT techniques should include – but need not be limited to – those selected for removal and destructive testing. The NDT techniques may include:

Lectromech’s DelTest: This testing is to be done *in situ*, but need not be non-destructive. If connectors are not available, wire may be cut or conductors exposed to apply the test. Repair of disturbed systems will not be necessary.

Eclipse Corp’s Automatic Test Equipment: This test will be used to establish configuration and to verify that the state of removed wire has not significantly changed in the removal process. Even in the absence of configuration specifications for the aircraft, some flaws may be identifiable with this technique.

Hand-held microscope or borescope: Clamps, grommets, and ties will be removed and wires carefully inspected. Objectives of this inspection will be the same as those of the detailed visual inspection (see attached protocol).

The NDT contractor should clearly tag and delineate all specimens subject to NDT. This will ensure that these specimens are not disturbed during the detailed visual inspection.

9. The aircraft will be inspected in accordance with the *Generic Inspection Protocol* and the *Intrusive Inspection Work Cards*. (The *Generic Inspection Protocol* can be found in Sub-Appendix 1.2.2. The *Intrusive Inspection Work Cards* will be available at the time of inspection – see Sub-Appendix 1.2.2, *Generic Inspection Protocol*, and Sub-Appendix 1.2.4, *Forms*) The inspections will also adhere to the guidance in ATA spec 117, Wiring Maintenance/Practices Guidelines. Inspectors should pay special attention to harnesses subject to subsequent nondestructive or destructive testing. The inspection team should consist of:
- inspectors who took part in the model specific inspections
  - assigned members of the work group

Subgroups will be assigned by the chairman to perform the inspections in the several distinct locations. In addition to specific assignments, all accessible locations are subject to inspection by any working group member.

All locations to be inspected on-aircraft non-destructively will be photographed prior to testing. All specimens scheduled to under-go destructive testing will be photographed prior to removal. All anomalous conditions reported during the DVI will be photographed. All photographs will be annotated with aircraft identification (serial number), time and date of photograph, location of photograph, and name of wire installation and/or function (if known).

The results of this inspection should be recorded on the form, *Aircraft Wiring Installation/Condition Report Form* (See Sub-Appendix 1.2.2, *Generic Inspection Protocol*, and Sub-Appendix 1.2.4, *Forms*). Upon completion of the inspection all *Aircraft Wiring Installation/Condition Report Forms* as well as the *Intrusive Inspection Work Cards* and any supplemental data should be delivered to the chairman of the working group.

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<sup>5</sup> Infrequent-maintenance implies that the wires are disposed in a way that does not allow for routine servicing (e.g. no connectors).

10. The working group should remove all tags indicating flaw findings from all wires or wire bundles to be inspected nondestructively. For specimens to be removed from the aircraft these tags will be replaced after the NDT contractor has finished his inspection.
11. The FAA's NDT contractor will perform the testing specified in Item 8 using the NDT protocols identified in Item 2. Because of the possibility that the NDT disturbs the wire, for each zonal inspection this testing is prohibited until after the completion of the detailed visual inspection identified in Item 9.
12. The working group will ensure that pre-selected wire specimens identified in Item 7 are appropriately delimited, identified, and tagged with annotated markers indicating the presence of any flaw indications identified by the DVI or NDT inspections.
13. The pre-selected wire specimens will be removed with as little disturbance to the wire as possible. The wire topology should be maintained as it was on the aircraft. Under no circumstances should the wire specimens be tightly coiled. Clamps, ties, and brackets should, whenever possible, remain with the specimens. Any damage to wire specimens inflicted during removal should be documented.
14. Other wires with fault indications identified by the DVI or NDT inspection may – at the discretion of the inspector – be removed for follow-on analysis. Wire and wire bundles with identified configuration faults (e.g. inadequate bend radius, inadequate separation) need not be removed.
15. The pre-selected wire specimens and flawed wire specimens are to be transported to the Aging Aircraft Nondestructive Evaluation Center at Sandia National Labs in Albuquerque, NM.

FAA/AANC Validation Center  
 3260 University SE  
 Albuquerque, NM 87106  
 Attn: Gerald Langwell

Shipping arrangements will be made as appropriate with costs to be paid by the FAA.

16. At AANC and other designated performing organizations the wire specimens may be subject to the following destructive testing:
  - **Qualitative Tests:** optical microscopy (10x or greater), x-ray
  - **Mechanical Behavior Tests:** microhardness (Sandia), abrasion and cut-through testing (SAE AS 4373/701&703), insulation tensile strength and elongation (SAE AS 4373/705), modulus profiling (Sandia), density measurements (Sandia)
  - **Assessment of Degradation-Indicative Parameters:** infrared spectroscopy (Sandia), viscosity test (polyimide only, DuPont proprietary?), oxygen induction time measurements (Sandia), solvent swelling (Sandia), chemiluminescence (Sandia), thermo-oxidative wear-out assessment (Sandia)
  - **Electrical Tests:** WIDAS testing, mandrel and wrap back test (SAE AS 4373/708), wet dielectric - voltage withstand (SAE AS 4373/510), conductor resistance. (SAE AS 4373/401), insulation resistance (SAE AS 4373/504), wet/dry arc tracking (SAE AS 4373/301/509)
  - **Environmental Tests:** Fluid Immersion (SAE AS 4373/601)
  - **Thermal Tests:** flammability (FAA Technical Center – SAE AS 4373/801), lamination sealing (SAE AS 4373/808), cross link proof test (SAE AS 4373/811)

Test suites for both flawed and no-flaw-found specimens will be developed. These test suites will be wire-type specific and may be subject to change depending on the nature of the data collected.

Prior to bundle disassembly and testing, individual wire specimens will be labeled with the source aircraft, the installation (location and function), and the disposition of the wire (e.g. whether the wire was in a large or small bundle, whether the wire was on the surface or interior of the bundle).

Sub-Appendix 1.2.5 Table 1.2.5-1 summarizes the objectives, merits, and limitations of these tests. Table 1.2.3-2 summarizes the Working Group's implementation plan for this testing.

## Conclusion and Reporting

AANC will be responsible for drafting a report detailing and comparing the results of the detailed visual inspection, the nondestructive testing, and the destructive testing. The report will be submitted to the working group for review and concurrence.

## Sub-Appendix 1.2.1: Candidate Inspection Locations

Location Codes (based on wire specimens):

- LCL: Lower Cabin area with Large wire bundle
- LCS: Lower Cabin area with Small wire bundle
- UCL: Upper Cabin area with Large wire bundle
- ICH: area Inside pressure vessel with a Complex Harnesses,
- IPF: area Inside pressure vessel with Power Feeder cable
- PSU: area with Passenger Service Unit cabling
- CPT: CockPiT,
- CTM: area inside pressure vessel with ConTaMinated wire bundles
- CDT: area Inside pressure vessel with wire bundles in sheathing or conduit
- ENL: area Exterior to pressure vessel with LarGe bundle,
- ENS: area Exterior to pressure vessel with SMall bundle,
- EPF: Exterior Power Feeder,
- ECH: Exterior Complex Harness
- ECD: Exterior ConDuit

Location	737 <sup>6</sup>
<b>LCL</b>	3.B.2.b (Zone 2, Area 5 – E/E bay) or 3.B.5a/6a (Zone 2, Areas 13/18 – forward/aft cargo compartment) Bundles in forward compartment bundles may be in metal trough.
<b>LCS</b>	3.B.5a/6a (Zone 2, Area 13/18 – forward/aft cargo compartment)
<b>UCL</b>	3.A.2.a (Zone 1, Area 7/8 – forward/aft half of passenger cabin)
<b>ICH</b>	3.B.2.c (Zone 2, Area 5 – E/E bay)
<b>IPF</b>	3.A.2.b (Zone 1, Area 7/8 – forward/aft half of passenger cabin) or 3.B.5.b (Zone 2, Area 13 – forward cargo)
<b>PSU</b>	3.A.2.d (Zone 1, Area 7/8 – forward/aft half of passenger cabin)
<b>CPT</b>	3.A.1.a (Zone 1, Areas 1 and 2 – cockpit)
<b>CTM</b>	3.B.2.a (Zone 2, Area 5 – E/E bay)
<b>CDT</b>	3.B.2 (Zone 2, Area 5 – E/E bay) or 3.B.6 (Zone, Area 18 – aft cargo compartment)
<b>ENL</b>	3.C.1.a (Zone 3/4, Areas 2 and 3, Areas 6 through 9 – left/right wing, outboard and inboard leading edges, wing training edge) or 3.D.1 (Zone 7, Area 1 – tail compartment)
<b>ENS</b>	3.C.1.a (Zone 3/4, Areas 2 and 3, Areas 6 through 9 – left/right wing, outboard and inboard leading edges, wing training edge) or 3.D.1 (Zone 7, Area 1 – tail compartment) or 3.B.4.a/b (Zone 2, Areas 16/17 – left/right main wheel wells)
<b>EPF</b>	3.C.1.a (Zone 3/4, Areas 2 and 3, Areas 6 through 9 – left/right wing, outboard and inboard leading edges, wing training edge)
<b>ECH</b>	3.C.1.a (Zone 3/4, Areas 2 and 3, Areas 6 through 9 – left/right wing, outboard and inboard leading edges, wing training edge) or 3.D.1 (Zone 7, Area 1 – tail compartment) or 3.B.4.a/b (Zone 2, Areas 16/17 – left/right main wheel wells)
<b>ECD</b>	3.B.4.a (Zone 2, Areas 16/17 – left/right main wheel wells)

<sup>6</sup> See the 737 non-intrusive inspection protocol for additional inspection details.

Location	727 <sup>7</sup>
LCL	4.A (Zone 12 – E/E bay)
LCS	4.A (Zone 12 – E/E bay) or 4.E (Zone 15 – aft cargo compartment)
UCL	4.G (Zone 24 – main cabin)
ICH	4.A (Zone 1 – E/E bay)
IPF	4.A (Zone 1 – E/E bay) or 4.B (Zone 13 – forward cargo compartment)
PSU	4.G (Zone 24 – main cabin)
CPT	4.F (Zone 21, 22, 23 – flight compartment)
CTM	
CDT	
ENL	4.C/D, 4.I/J, 4./L ?
ENS	4.C/D, 4.I/J, 4./L ?
EPF	4.C/D (Zone 14 – air conditioning bay, left/right side)
ECH	4.C/D, 4.I/J, 4./L ?
ECD	

Location	DC9
LCL	main cabin, directly above aisle
LCS	main cabin, directly above aisle
UCL	cockpit overhead switch panel, or behind the left side circuit breaker panel (accessible from main cabin)
ICH	3.E.2/6/10 (E/E bay, station 148 – generator feeder cable terminal strips) Take harness with terminal strips in tact
IPF	3.C.2 (flight compartment, overhead switch panel) or 3.D.2 (E/E bay, station 160, near battery charger and transfer relay)
PSU	main cabin
CPT	3.C.2 (flight compartment, overhead switch panel)
CTM	rear cargo compartment
CDT	front cargo compartment
ENL	tail compartment
ENS	tail compartment
EPF	tail compartment
ECH	tail compartment
ECD	tail compartment

<sup>7</sup> See the 737 non-intrusive inspection protocol for additional inspection details.

<b>Location</b>	<b>747<sup>8</sup></b>
<b>LCL</b>	8.A - forward cargo compartment or 7.A - E/E bay
<b>LCS</b>	8.A - forward cargo compartment (Take bundles from under luggage container tracks )
<b>UCL</b>	1.B - upper deck or above aft lavatories (relatively easy access to crown)
<b>ICH</b>	6.A - E/E bay (access to harnesses may be easier from cargo compartment)
<b>IPF</b>	7.C - forward cargo compartment 3.B/4.B – Main deck galley power feeders
<b>PSU</b>	main cabin or upper deck
<b>CPT</b>	17.A - cockpit
<b>CTM</b>	near main cabin galleys or forward cargo compartment under lavatories
<b>CDT</b>	E/E bay or forward cargo compartment
<b>ENL</b>	18A/B - front spar
<b>ENS</b>	18A/B - front spar, or tail cone
<b>EPF</b>	18.D - front spar
<b>ECH</b>	12.H - body wheel well
<b>ECD</b>	body wheel well

<b>Location</b>	<b>L1011</b>
<b>LCL</b>	4.E – zone 150 center cargo compartment
<b>LCS</b>	4.E – zone 150 center cargo compartment
<b>UCL</b>	4.G – zone 223, 224, 230, 240, 260, 270, 280 passenger compartment
<b>ICH</b>	4.A – zone 112, 113 forward electronics service center
<b>IPF</b>	4.E – center cargo compartment
<b>PSU</b>	4.G – zone 223, 224, 230, 240, 260, 270, 280 passenger compartment
<b>CPT</b>	cockpit
<b>CTM</b>	4.A – zone 112, 113 forward electronics service center
<b>CDT</b>	
<b>ENL</b>	4.O – zone 147 hydraulics service center
<b>ENS</b>	4.O – zone 147 hydraulics service center
<b>EPF</b>	4.L (4.M) – zone 510, 520 (610, 620) LH (RH) wing inboard and outboard LE
<b>ECH</b>	4.O – zone 147 hydraulics service center

<sup>8</sup> Location references refer to Boeing Service Letter, 747 SL-20-048 Attachment 2, 1995.

<b>ECD</b>	
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<b>Location</b>	<b>DC-10</b>
<b>LCL</b>	3.a – Zone 110 Avionics Compartment (access from nose wheel well.) 3.b – Zone 130 Center Accessory Compartment (just forward of main landing gear.)
<b>LCS</b>	3.a – Zone 110 Avionics Compartment 3.b – Zone 130 Center Accessory Compartment
<b>UCL</b>	3.d – Zone 210 Flight Compartment C (third) zone (drop a ceiling panel on the port side)
<b>ICH</b>	3.b – Zone 130 Center Accessory Compartment 3.d – Zone 210 Flight Compartment 3.a – Zone 110 Avionics Compartment
<b>IPF</b>	3.b.1 – Zone 130 Center Accessory Compartment (preferred) 3.a.2 – Zone 110 Avionics Compartment
<b>PSU</b>	Main Cabin (floor tracks under seats contain multiplexer entertainment system wire. Overhead light and call button wiring an acceptable option.)
<b>CPT</b>	3.d – Zone 210 Flight Compartment (Behind flight engineer instrument panel; enter via the hatch behind the pilot's seat, pass through avionics compartment to area behind FE's panel.)
<b>CTM</b>	3.a – Zone 110 Avionics Compartment. Under lavatory decking
<b>CDT</b>	3.a – Zone 110 Avionics Compartment 3.b – Zone 130 Center Accessory Compartment 3.d – Zone 210 Flight Compartment
<b>ENL</b>	3.g – Zone 500/600 Wing Leading and Trailing Edges 3.c – Zone 140 Landing Gear Wheel Wells 3.e – Zone 310 Aft Fuselage
<b>ENS</b>	3.c – Zone 140 Landing Gear Wheel Wells 3.e – Zone 310 Aft Fuselage 3.g – Zone 500/600 Wing Leading and Trailing Edges Stabilizer compartment (enter via hatch forward of APU.)
<b>EPF</b>	3.e – Zone 310 Aft Fuselage 3.g – Zone 500/600 Wing Leading and Trailing Edges
<b>ECH</b>	3.c – Zone 140 Landing Gear Wheel Wells (overhead, wires include boost pump, FQIS) 3.e – Zone 310 Aft Fuselage
<b>ECD</b>	3.c – Zone 140 Landing Gear Wheel Wells (6 conduits off top of landing gear.) 3.e – Zone 310 Aft Fuselage 3.g – Zone 500/600 Wing Leading and Trailing Edges

<b>Location</b>	<b>A300</b>	
<b>LCL</b>	Zone 130 Zone 120	- Forward cargo compartment - E/E bay
<b>LCS</b>	Zone 130 cargo floor ) Zone 170	- Forward cargo cmpt (Take bundles from under - Recorder bay, aft of bulk cargo cmpt
<b>UCL</b>	Zone 200 Zone 260 crown)	- main cabin - above Aft lavatories (relatively easy access to
<b>ICH</b>	Zone 120	- E/E bay
<b>IPF</b>	Zone 130	- Forward cargo compartment
<b>PSU</b>	Zone 200	- Main cabin
<b>CPT</b>	Zone 210	- Cockpit
<b>CTM</b>	Zone 220/240/260 Zone 120/130	- near Fwd/Mid/Aft cabin galleys or - E/E or forward cargo compartment under lavatories
<b>CDT</b>	Zone 120 Zone 130	- E/E bay or - Forward cargo compartment
<b>ENL</b>	Zone 570/580/590 Zone 670/680/690 Zone 510/520 Zone 610/620	- Left wing rear spar or - Right wing rear spar - Left wing front spar or - Right wing front spar
<b>ENS</b>	Zone 570/580/590 Zone 670/680/690 Zone 510/520 Zone 610/620 Zone 310 Zone 325 Zone 334/344	- Left wing rear spar or - Right wing rear spar or - Left wing front spar or - Right wing front spar or - tail cone - Vertical stabilizer rear spar - Left/right rear spar horizontal stabilizer
<b>EPF</b>	Zone 310 Zone 510/520 Zone 610/620	- tail cone or - Left wing front spar or - Right wing front spar
<b>ECH</b>	Zone 147/148	- body wheel well
<b>ECD</b>	Zone 147/2148	- body wheel well

## Sub-Appendix 1.2.2: Generic Inspection Protocol

### References:

- Boeing Document D6-54446, Chapter 20, Standard Wiring Practices Manual
- Airbus AXXX Standard Practices Manual
- McDonnell Douglas Standard Practices
- Air Transport Association (ATA) Specification 117
- Federal Aviation Administration (FAA) Advisory Circular (AC) 43.13-1B, Acceptable Methods, Techniques, and Practices-Aircraft Inspection and Repair, Chapter 11, Aircraft Electrical Systems.
- Applicable airplane operator's maintenance procedures

### Constraints

All Inspections should be carried out in a way that does not cause unnecessary damage to the individual wires. If wire installations are not subject to subsequent nondestructive or laboratory testing, installation hardware (ties, clamps, grommets, etc) may be *selectively* removed to facilitate access to otherwise un-inspectable locations or to assess the extent of partially visible indications. Wire hardware should not be disturbed on wire bundle subject to nondestructive or laboratory testing.

### Definitions

**Detailed Visual Inspection (DVI):** An intensive visual examination of a specified detail, assembly, or installation. It searches for evidence of irregularity using adequate lighting and, where necessary, inspection aids such as mirrors, hand lens, etc. Surface cleaning and elaborate access procedures may be required.

**Special Detailed Inspection:** An intensive examination of a specific location similar to the detailed inspection except for the following differences: The examination requires some special techniques such as non-destructive inspection test techniques, dye penetrant, high powered magnification, etc. and may require disassembly procedures.

All on-board inspections in the intrusive inspection protocol are DVI or SDI. The preliminary model specific non-intrusive inspection is a "close visual inspection" defined uniquely in each model-specific protocol.

### General Inspection Requirements:

All wires in the indicated inspection area should be checked according to the protocol below. Feeder cables and wires in areas subject to contamination should receive special attention.

- Examine all wire bundles, connectors, and associated equipment and installations for signs of contamination and debris accumulation. Examples include but are not limited to:
  - Metal shavings and fragments on and imbedded in wire bundles as the result of drilling, grinding, and other metal rework,
  - Accumulation of excessive amounts of lint or other ignitable materials,
  - Caustic chemicals (i.e. corrosion inhibitors, paint, oil, grease, soft drink, coffee, lavatory fluids, etc.).
- Check for broken, nicked, cut, cracked, chafed, heat damaged, unraveling, or decayed wire insulation.
- Check for damaged, missing, loose, or unsecured cable brackets, clamps, ties, grommets, and pressure seals.
- Check for wires contacting structure or components, wire bundles with inadequate separation, excessive sagging or looseness, excessive tension, missing drip loops, and/or improperly routed wire bundles.

- Check for wire with excessive bending (usually 10 times diameter of wire bundle).
- Check the integrity of wire sleeving and conduit – proper establishment and operation of drain holes, correct wire support at entry and exit to sleeving and conduit
- Check for properly installed wire splices – waterproof and in fluid free areas.
- Check ground points and terminal strips for loose connections and corrosion.
- Check connectors for missing or inadequate strain relief hardware, signs of moisture or debris accumulation, corrosion or heat damage.
- If the connector shows signs of damage, corrosion, or miss-installation, detach the connector and check the connector pins for signs of corrosion, damage, arcing, bent pins, etc.
- Check relays, relay sockets, connectors, terminations, and switches, including switch linkages, for fluid damage, corrosion, wear, etc.

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

### **Special Inspection Requirements:**

All inspections are to be performed in accordance with the model- and zone-specific work cards, which will include sufficiently detailed zonal diagrams. These work cards will be generated at the time of the actual inspection.

### **Reporting Requirements:**

Aircraft and inspection team information is to be recorded on the *Intrusive Inspection Data Sheet*. The information required on this sheet is largely self-explanatory. The inspection should be given a unique Report ID: Model-X where model is the aircraft model and X represents the visit number for this model (1 or 2).

The model- and zone-specific *Intrusive Inspection Work Cards* are to be completed using information in the tables of Sub-Appendix 1.2.1. *Intrusive Inspection Work Cards* should be given a Zone ID which can be any unique code. Prior to initiating the inspection, detailed zonal diagrams for the target areas should be acquired.

All flaw indications should be recorded on the form, *Intrusive Inspection Wiring Installation/Condition Report Form*. Flaw indications should also be recorded on the form, *Intrusive Inspection Wiring Installation/Condition Summary*.

Each finding should be given a special *item code*: YYY-No, where YYY is Zone ID identified on the relevant *Intrusive Inspection Work Card* and No. is the sequence number of the flaw find.

Findings should be marked as significant or not. A significant item is any condition, which – if the aircraft were still in service – would be squawked for follow-up action or repair. A non-significant finding is an observation, which – on initial inspection or follow-up – validates the integrity of the wire or wire installation. Examples of non-significant findings include:

- the determination that the flaking of an FEP outer coat is superficial only,
- the determination that contamination or UV exposure has not embrittled a wire insulation.

Each significant finding should be tagged with the appropriate *item code* and photographed with its tag legible in the image. If the image does not show the tag with the full *report ID* and *item code* visible and legible, the photograph itself should be annotated with this information.

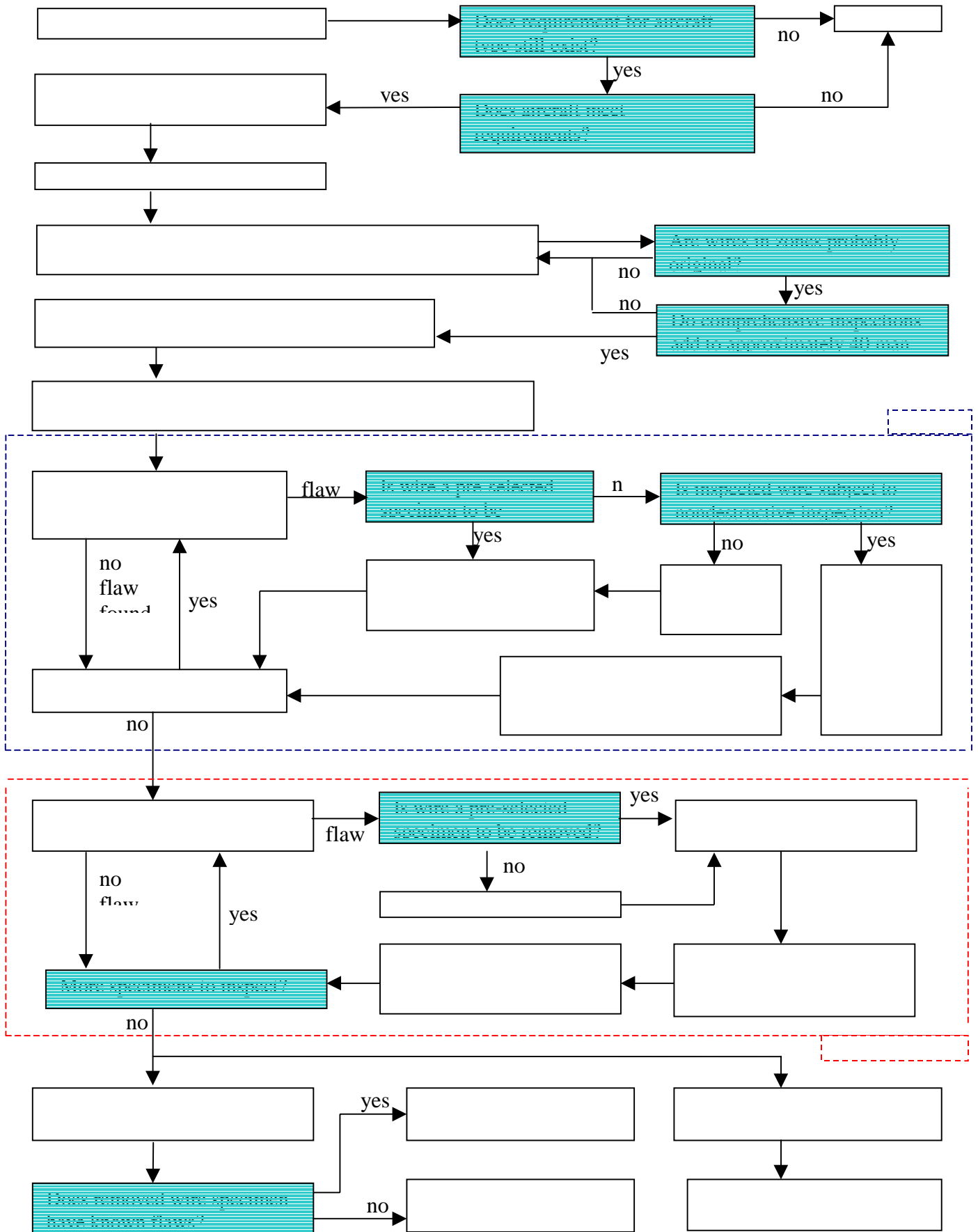
The last column of the *Intrusive Inspection Wiring Installation/Condition Report* contains check boxes for *Invasive*, *NDT* and *Lab Analysis*. The appropriate box should be checked if there is an invasive follow-up inspection (e.g. hardware is removed), the item is scheduled to undergo nondestructive testing on the aircraft, or the item is scheduled to undergo laboratory analysis. The following rules for this column hold:

- *NDT* is checked if
  - The bundle was pre-selected for NDT analysis
  - The inspector – using his discretion – selects the bundle or wire for follow-up NDT inspection.
- *Lab Analysis* is checked if
  - The bundle was pre-selected for laboratory analysis
  - The inspector – using his discretion – selects the bundle or wire for follow-up laboratory inspection.
- If *Lab Analysis* or *NDT* is checked, invasive must not be checked.

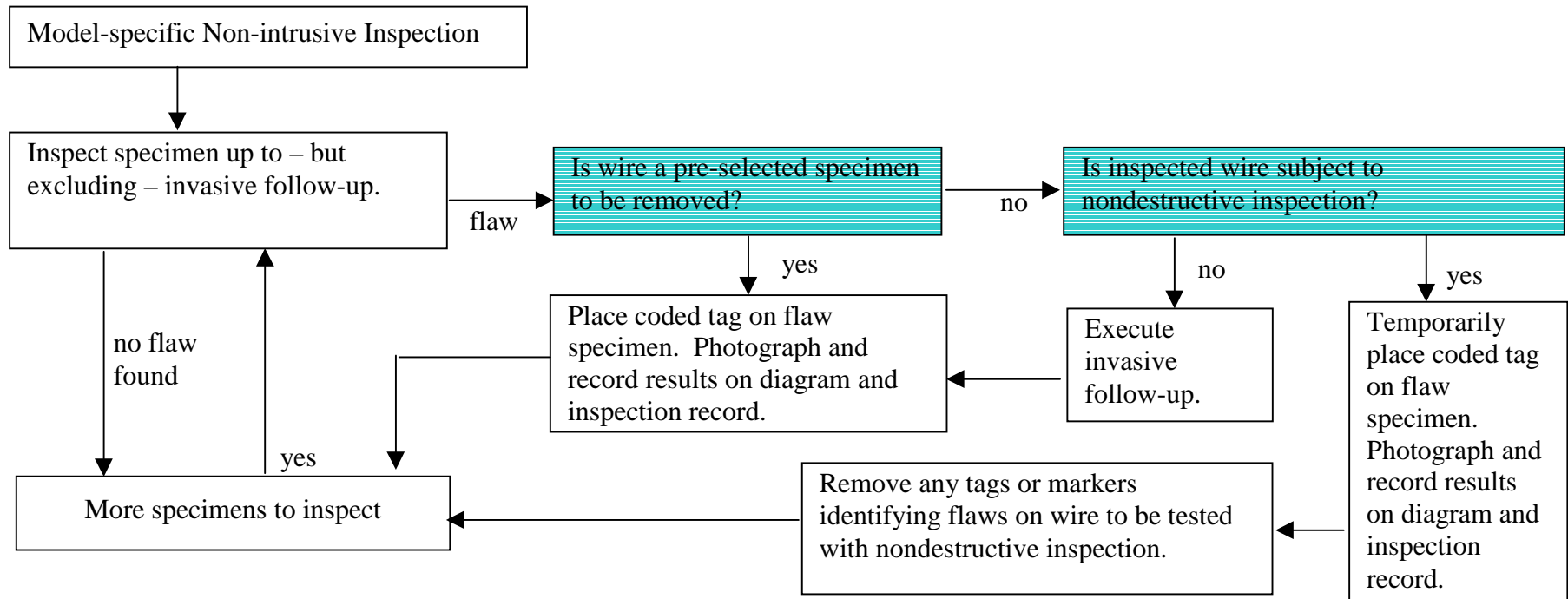
Transcribe this information into the corresponding three columns of the *Intrusive Inspection Wiring Installation/Condition Summary*.

Use of additional sheets for any form is acceptable.

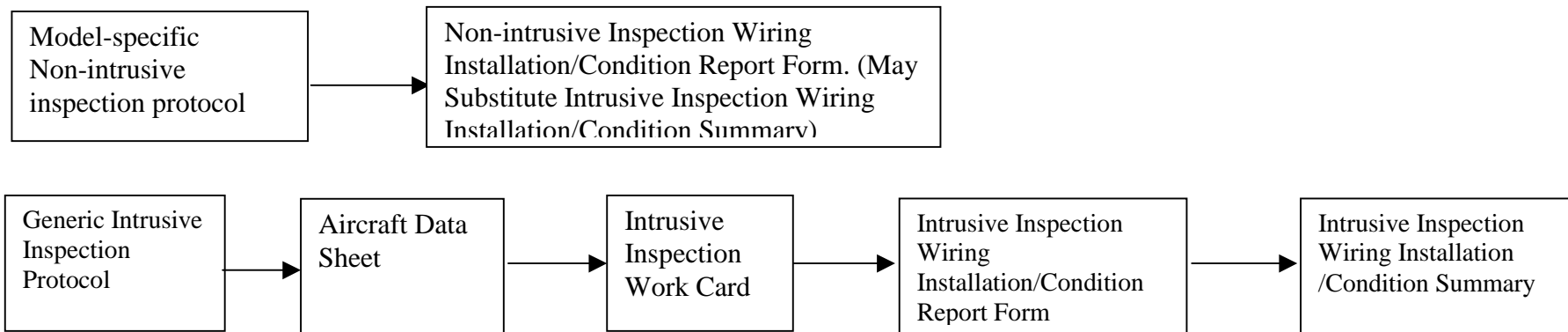
### Sub-Appendix 1.2.3: Intrusive Inspection Flow Chart



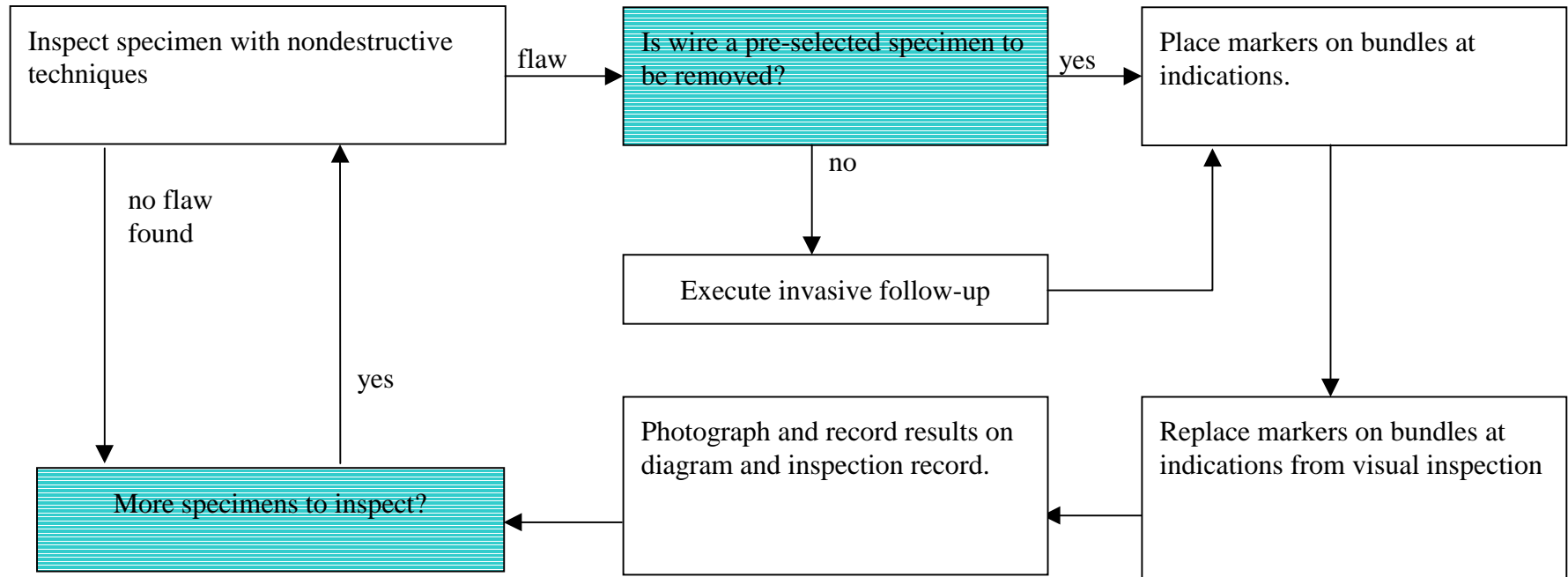
### Sub-Appendix 1.3.4: Visual Inspection Protocol



### Documentation:



**Sub-Appendix 1.2.5: Nondestructive Inspection Protocol – Generic**



## Sub-Appendix 1.2.6: Forms

# Intrusive Inspection Check List

### Preliminary Work Items

- Quorum verified
- Wire Presumed Original
- Candidate Aircraft Formally Accepted
- Aircraft Data Sheet Completed (see forms)
- Copies Of Zonal Diagrams Available
- Copies Of Inspection Forms Available

### Inspection Preparation

- Aircraft Prepared For Inspection
- Zonal Access Gained
- Inspection Tools Available

### Work Card Development and Non-intrusive Inspection

- 14 Specimens Identified
- Corresponding Zones Identified And Delimited
- Model-Specific Visual Inspection Performed
- 14 Specimens Clearly Delimited And Tagged
- Specimens Photographed
- Zones Photographed
- Work Cards For All Zones Created (see forms)
- Work Card Instructions And Nomenclature Are Clear And Precise

### NDT Preliminary Assessment

- NDT Contractor Shown Aircraft
- NDT Specimens Clearly Delimited And Tagged
- NDT Specimens Photographed

### Visual Inspection

- Inspectors Are Aware Of Specimens To Be Preserved
- Flaw Indications Are Tagged
- Invasive Follow-Up On Indeterminate Indications Performed (except specimens to be removed)
- Flaw Indications Are Documented (see forms)
- Appropriate Follow-On Action Is Specified (see forms)
- Flaw Indications Are Photographed
- Finding Tags Are Removed From Specimens Subject To NDT.

### NDT Inspection

- NDT Contractor Is Authorized To Inspect (see contractors protocol)

### Specimen Removal

- Tags And Tag Replacement Verified
- Specimens Removed From Aircraft
- Specimen Removal Damage Documented (no form)
- Shipping Arranged

### Post Inspection

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



See Sub-Appendix 1.2.2 of Intrusive Inspection Protocol (Generic Inspection Protocol) for instructions



**Intrusive Inspection Wiring Installation/Condition Report Form**  
**Report ID: 300-1**

Sheet of

	Specific Description of Location	Specific Description of Item	Specific Description of Flaw	Possible Cause	Action
Item Code:  Inspector:  <input type="checkbox"/> Significant? <input type="checkbox"/> Picture?					Invasive Follow-up? <input type="checkbox"/> Preselected Specimen NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/> Inspector Requested NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/>
Item Code:  Inspector:  <input type="checkbox"/> Significant? <input type="checkbox"/> Picture?					Invasive Follow-up? <input type="checkbox"/> Preselected Specimen NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/> Inspector Requested NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/>
Item Code:  Inspector:  <input type="checkbox"/> Significant? <input type="checkbox"/> Picture?					Invasive Follow-up? <input type="checkbox"/> Preselected Specimen NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/> Inspector Requested NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/>
Item Code:  Inspector:  <input type="checkbox"/> Significant? <input type="checkbox"/> Picture?					Invasive Follow-up? <input type="checkbox"/> Preselected Specimen NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/> Inspector Requested NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/>
Item Code:  Inspector:  <input type="checkbox"/> Significant? <input type="checkbox"/> Picture?					Invasive Follow-up? <input type="checkbox"/> Preselected Specimen NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/> Inspector Requested NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/>
Item Code:  Inspector:  <input type="checkbox"/> Significant? <input type="checkbox"/> Picture?					Invasive Follow-up? <input type="checkbox"/> Preselected Specimen NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/> Inspector Requested NDT <input type="checkbox"/> Lab Analysis <input type="checkbox"/>

See Appendix 1.2.2 of Intrusive Inspection Protocol (Generic Inspection Protocol) for instructions

### Intrusive Inspection Wiring Installation/Condition Summary

Transcribe the required data from the primary inspection form	REPORT ID													PAGE		OF																						
	CONNECTORS				TERMINATIONS			INSTALLATION (GENERAL)						WIRING CONDITION				ACTION																				
	INSERT DAMAGE/DETERIORATION	CONTACT ARCING/FRETTING	MISSING DUMMY CONTACTS/SEAL PLUGS	MISSING/DAMAGED BACKSHELLS	CONNECTOR BACKSHELL STRAIN RELIEF	LOOSE OR WORN B-NUTS	OTHER	GROUND POINTS - CONDITION/SECURITY	INADEQUATE DRIP LOOPS(S)	CORRECT HARDWARE BUILDUP/TORQUE	HEAT DAMAGE/CORROSION	OTHER	INADEQUATE CLEARANCE TO STRUCTURE	MISSING/DETERIORATED PRESSURE SEALS	SLEEVING/DONUTS CONDITION	BEND RADIUS (10X WIRE/BUNDLE DIA.)	CLAMP CONDITION/SIZING/SPACING	MISSING/DETERIORATED GROMMETS	DEBRIS ACCUMULATIONS ON WIRE BUNDLES	EXCESSIVE SLACK/SAG BETWEEN CLAMPS	T-STRIP CONDITION/HARDWARE BUILDUP	SIGNIFICANT DUST AND LINT BUILDUP	OTHER	PREVIOUS REPAIRS/CONDITION OF	HEAT/VIBRATION DAMAGE	INDIRECT DAMAGE (HYD. PNEU LEAKS)	CRACKED/ABRADED INSULATION	BROKEN SHIELD/CONDUCTORS	EXPOSED CONDUCTORS/SHIELD	FLUID/CHEMICAL CONTAMINATION	CORROSION	OTHER	Invasive Inspection	Nondestructive Inspection	Laboratory Analysis			
ITEM CODE																																						
1.																																						
2.																																						
3.																																						
4.																																						
5.																																						
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See Sub-Appendix 1.2.2 of Intrusive Inspection Protocol (Generic Inspection Protocol) for instructions

## Sub-Appendix 1.2.7: Wire Tests Summary

<b>Table 1.2.7-1 Candidate Laboratory Tests</b>				
<b>Technique</b>	<b>Description</b>	<b>Objective</b>	<b>Protocols</b>	<b>Limitations</b>
Optical Microscopy	10 power	Gives qualitative insight into the degradation characteristics of wire and pathology of insulation flaws.	-	Qualitative measure only
X-Ray	X-ray of wire conductors near connectors.	Assesses wire conductor whose resistance is not within expected parameters. Specimens the physical integrity of conductors sheathed in insulation.	-	Qualitative measure only
Microhardness, Indentation	Indenter's indentation depth, force, and spring back are the recorded outputs.	Assesses the modulus of the insulation near the surface.	Sandia	Questionable repeatability and correlation with material properties. Local measurement does not capture modulus variation spatially.
Abrasion	Various protocols, none currently approved under ASTM D 3032.	Assesses a wire's ability to resist abrasion.	SAE AS 4373/701 (non-existent), Navy, Lectromec.	Correlation to actual service performance is speculative.
Dynamic Cut-Through	Needle or other cutting edge is forced through insulation until breach. Force at breach is the recorded output.	Evaluates the resistance of insulation to penetration of a cutting surface.	SAE AS 4373/703	Difficulty in controlling all variables limit use to pass-fail testing. Best used for comparison testing only.
Insulation Tensile Strength And Elongation	Insulation (removed from conductor) is stretched to break. Force and elongation at break are the recorded outputs.	Assesses tensile strength of the insulation.	SAE AS 4373/705	Test must be tailored to insulation type. Does not work on tape wraps. Difficult to remove insulation from conductor for used wire with insulation degradation.
Modulus Profiling	Resolves spatially (radially) the modulus of an insulating material. Resolution to within 50 microns.	Reveals the degradation characteristics of wire insulation as a function of radial position.	Sandia	Point measurements may show significant variation with linear position. Multiple measurements can get expensive.
Density Measurements	Assesses minute changes in material density using "density gradient columns".	Observe material density, which is correlated with changes or incipient changes in macroscopic mechanical properties.	Sandia	Difficult to apply to multiplayer insulation systems.

**Table 1.2.7-1 Candidate Laboratory Tests**

<b>Technique</b>	<b>Description</b>	<b>Objective</b>	<b>Protocols</b>	<b>Limitations</b>
Infrared Spectroscopy	Observed IR spectra provide information on chemical content and structure.	Identifies chemical conditions or changes, which are correlated to the degradation of mechanical properties.	Sandia	IR spectra are complex and often difficult to interpret.
Viscosity Test	Measurement the viscosity of a polymer dissolved in an acid.	Determines the length of polymer chains, which correlates with material integrity.	DuPont proprietary?	Polyimide only
Oxygen Induction Time Measurements	Observation of oxidation with increasing temperature. Temperature at which oxidation increases rapidly is the recorded output	Observation of a reduced temperature threshold for rapid oxidative degradation, which often indicates that a polymer has undergone age degradation.	Sandia,	This test is material specific.
Solvent Swelling	Material is soaked in a solvent chosen to match the solubility parameter of the polymer. Equilibrium weight gain observed.	Observation of equilibrium weight gain, which is associated with the degree of polymer cross-linking.	Sandia	Applies only to specific polymers.
Chemiluminescence	Photon emissions from metastable compounds in the insulation are observed as temperature is raised.	Observation and quantification of metastable compounds, which are intermediate products in the degradation process of polymers.	Sandia	Not as quantitatively accurate as other techniques.
Thermo-Oxidative Wear-Out Assessment	Wire is artificially aged to failure or wear-out. Failure or wear-out is assessed with other techniques described here.	Assesses the remaining life of specimens.	Sandia	The validity of artificial aging process has been questioned.
WIDAS Testing,	Wire is artificially aged to failure or wear-out. Failure or wear-out is assessed with other techniques described here.	Assesses the remaining life of specimens.	Lectromec	Limited to polyimide only. Requires large number of wire specimens.
Mandrel And Wrap Back Test	The wire is wrapped tightly around a mandrel or itself and subject to extreme temperatures. Used in conjunction with Voltage Withstand	Assess an insulations ability to withstand cracking under harsh conditions.	SAE AS 4373/708	
Wet Dielectric - Voltage Withstand	Wet wire (insulation) previously subject to other endurance tests is subject to at least 2.5kV (for 600V+ wire).	Assess a wire's isolation and insulation integrity following other performance tests.	SAE AS 4373/510	

**Table 1.2.7-1 Candidate Laboratory Tests**

<b>Technique</b>	<b>Description</b>	<b>Objective</b>	<b>Protocols</b>	<b>Limitations</b>
Conductor Resistance	Determines the DC resistance per unit length at 20 degrees C	Assesses conductor resistance, which may increase in the presence of corrosion.	SAE AS 4373/403	
Insulation Resistance	Measures the resistance from wire to ground of a specified length of wire immersed in grounded conducting solution.	Assesses a wire's isolation and deviation in expected insulation resistance, which may indicate impending wear out.	SAE AS 4373/504	Requires lengths of 26 feet minimum for accuracy.
Dry Arc Tracking	Mill Std 2223: Mechanically damaged wires are forced to arc. Damage to entire bundle is recorded.	Assesses the arc resistance of a bundle of damaged (e.g. chaffed) wires.	SAE AS 4373/509	Many test variables need to be controlled. Needs significant quantity of wire for testing. Should be repeated several times.
Wet Arc Tracking	Wire with non-located insulation breaches are subject to contamination with conducting solution until arcing.	Assesses the arc resistance of a bundle of damaged wires subject to contamination.	SAE AS 4373/301	Many test variables need to be controlled. Needs significant quantity of wire for testing. Should be repeated several times.
Fluid Immersion	Coiled wire specimens are immersed in various fluids at elevated temperatures for some specified time, the subject to Mandrel Bend and Wet Dielectric Tests.	Determines the effects of various fluids on wire insulation.	SAE AS 4373/601	Difficulty in storing and handling various fluids.
Flammability	The 60-degree burn test. Flame applied to wire. Measures length of burn and propensity to drip and ignite.	Assesses various burning characteristics of wire and its ability to ignite surrounding materials.	FAA Technical Center, SAE AS 4373/801	Results can vary based on test variables.
Lamination Sealing	Specimens of tape wrapped wire are subject to elevated temperatures. Upon return to room temperature they are examined for delamination.	Evaluates a tape wrapped insulation's ability to resist delamination of its wrap layers.	SAE AS 4373/808	Only applies to tape-wrapped insulations.
Cross Link Proof Test	Coiled wire is baked, straightened, and then subject to the Mandrel Bend and Wet Dielectric Tests.	Assesses the adequacy of crosslinking.	SAE AS 4373/811	Only applies to cross-linked insulations.

### Wire Test Matrix

OC: On Observed Condition. The test will be performed only when an observed condition indicates the need for such a test

GS: General Sampling. Tests on specimens from all bundles and general locations within bundles.

LS: Limited Sampling. Tests on select bundles and select locations within bundles.

CD: Tests initiated on most significant specimens with results dictating expansion or reduction of scope.

NA: Not applicable

Black Text: Sandia; *Red Italics Text*: Subcontractor to Sandia or other performing organization

Table 1.2.7-2 Laboratory Test Application Plan						
Technique	Polyimide	PVC/Glass/ Nylon	Extruded XL Polyalkene	Poly X	XL ETFE	Other <sup>9</sup>
Density Measurements	GS	GS	GS	GS	GS	GS
Mandrel bend screening	GS	GS	GS	GS	GS	GS
Modulus Profiling/ (Microhardness)	GS or LS	GS or LS	GS or LS	GS or LS	GS or LS	GS or LS
Insulation Tensile Strength And Elongation	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC
Solvent Swelling	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC
Infrared Spectroscopy	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC
Chemiluminescence	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC
Oxygen Induction Time Measurements	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC	LS/OC
Optical Microscopy	OC	OC	OC	OC	OC	OC
Thermo-Oxidative Wear-Out	CD	CD	CD	CD	CD	CD
Inherent Viscosity Test	?	NA	NA	NA	NA	NA
Dynamic Cut-Through	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>LS</i>
WIDAS Testing,	<i>LS</i>					
Mandrel And Wrap Back Test	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>CD</i>
Wet Dielectric - Voltage Withstand	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>CD</i>
Conductor Resistance	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>GS</i>	<i>CD</i>
Insulation Resistance	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>CD</i>
Dry Arc Tracking	<i>CD</i>	<i>CD</i>	<i>CD</i>	<i>CD</i>	<i>CD</i>	<i>CD</i>
Wet Arc Tracking	<i>CD</i>	<i>CD</i>	<i>CD</i>	<i>CD</i>	<i>CD</i>	<i>CD</i>
Flammability	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>LS</i>	<i>CD</i>
Lamination Sealing	<i>LS</i>					
Cross Link Proof Test						

<sup>9</sup> Other wire types may be represented incidentally.