

Appendix 3.3: Raytheon Validation of NDT Findings

Specimens of wiring that had insulation resistance anomalies discovered by the Insulation Resistance testing by Eclipse and the Lectromec Del Test, were selected and sent to Raytheon Indianapolis's test laboratory. The purpose was to validate the in situ insulation breaches or low insulation resistance readings with the well established laboratory insulation resistance and wet dielectric voltage withstand tests.

Specimens with low insulation resistance from the B-747 and DC-9(2) aircraft were selected. Raytheon examined these specimens in the laboratory, then performed the 500 volt dc insulation resistance test and the 2500 volt ac wet dielectric voltage withstand test in accordance with the test methods documented in chapter 4. Raytheon test results are summarized in Table 3.3.2.

Three specimens from the B-747 ECD-1 specimen were examined. Raytheon determined that specimens W1 and W3 had fairly high resistance measurements, 380,000 to 500,000 megohms, but these were low compared to other B-747 specimens tested by Raytheon when compared on a unit basis, 200-400 megohms/1000 feet compared to 1000-10,000 megohms/1000 ft. These were not actually the same size specimens as tested by Eclipse, and the insulation resistance measurement is dramatically affected by the length of the specimen under test. On a relative basis to other B-747 specimens, these specimens exhibited low insulation resistance for both Eclipse and Raytheon. The ECD-1 W12 specimen included an environmental splice, and results were similar, roughly 3600 megohms/1000 ft regardless of whether or not the splice was present. All three specimens passed the wet dielectric voltage withstand test, indicating that the wires would hold the 2500 volt potential.

The DC-9 (2) specimens from the ENL and ISTA zones were visually examined, and it was determined that a number of the "wires" (W1, W4, W7, W10, W13, and W16) were actually shields for the twisted pairs of conductors. The jackets of the cable appeared to be a glass braid over a wrapped mylar tape, and was found to not be water-tight. The shields would have failed to ground (electrolyte solution) in the wet dielectric or insulation resistance tests; therefore, these tests were not performed on the shields. The low values for insulation resistance were verified for the specimens W6, W26, W27, W33, and W37 of ENL and W5 and W9 of ISTA when compared on a unit basis. Many of these specimens also failed the wet dielectric voltage withstand test as well. W6 was arcing in the termination cap, W33 contained a non-environmentally sealed splice, and the others had badly damaged wire with exposed conductor. In addition, when wet, the glass braid had a tendency to wick the electrolyte solution up to the conductor at the ends of the wires. This created artificial shorts, not valid measurements of the insulation resistance.

The Raytheon laboratory testing largely validated the faults found by the NDT electrical tests.

Table 3.3.1: Raytheon Indianapolis Validation Testing of wire bundles tagged by Lectromec and Eclipse.

Aircraft	Wire bundle notation	Eclipse Wire ID	Wire Specimen Length	Insulation Resistance		Wet Dielectric Withstand Leakage Current	Lectromec Marker #	Description	
				measured Megohms	60 s @500V Mohm/1000 ft				
B-747	ECD 1	W1	0.66	500000	328	0.123		Extremely short red wire with contamination with sm	
		W3	0.66	380000	245	0.183		Extremely short blue wire with contamination with sm	
		W12 w/splice	10.5	350000	3675	1.12		Environmental splice assembly with or without splice.	
		W12 w/o splice	10.17	360000	3660	not tested			
DC-9 (2)	ENL	W1			shield*	not tested			
		W2	7.58	65000	493	1.21		Twisted shielded pair.	
		W3		97000	736	1.07			
		W2-W3		150000	1140	0.57			
		W4			shield*	not tested			
		W5	7.58	10000	75.8	1.14		Twisted shielded pair. Arcing occurred in the water, but w	
		W6		150	1.1	1.04			
		W5-W6		10000	75.8	0.55			
		W7			shield*	not tested			
		W8	5.67	660000	3740	0.58		Twisted shielded pair.	
		W9		130000	740	0.59			
		W8-W9		660000	3740	0.29			
		W10			shield*	not tested			
		W11	7.58	26000	197	1.1		Twisted shielded pair.	
		W12		3700	28	1.39			
		W11-W12		30000	228	0.61			
		W13			shield*	not tested			
		W14	5.58	150000	837	0.58		Twisted shielded pair.	
		W15		120000	670	0.61			
		W14-W15		300000	1670	0.29			
W16			shield*	not tested					
W17	7.58	120000	910	1.01		Twisted shielded pair.			
W18		36000	273	1.38					
W17-W18		130000	985	0.61					
		W26	2.79	0	0	Fail (>10 mA)		M22759/16 type wire. insulation with expose	
		W27	3.41	0	0	Fail (>10 mA)	LM 1047	M22759/16 type wire. insulation with expose	
		W33 w/o splice	7.4	1	4.74	1.1		Non-Environmental splice would have failed)	

Aircraft	Wire bundle notation	Eclipse Wire ID	Wire Specimen Length ft.	Insulation Resistance		Wet Dielectric Withstand Leakage Current 5 min @2500 V mAmps	Lectromec Marker #	Description
				measured Megohms	60 s @500V Mohm/1000 ft			
		W37	6.125	0	0	Fail (>10 mA)	LM 1028	No glass braid present hold voltage. Badly de
		W38		5000	30.63	1.13		No glass braid present extrusion cracking.
		W37-W38		0	33.08	1.16		
	ISTA	W5	1.7	0	0	Fail (>10 mA)		Could not hold voltage
		W9	1.5	0	0	Fail (>10 mA)		Could not hold voltage

* NOTE: The DC-9 wire specimens were all PVC/glass braid/nylon extrusion, unless otherwise noted. Outer jackets, when present, were mylar film wrapped with glass braid. None of the shields were tested for Insulation Resistance or Wet Dielectric Withstand, since the outer jacket was not water-tight, and all were exposed to the electrolyte solution. Instead, inner primaries were tested to each other (noted by W#-W#).

Electrolyte solution wicked up the glass braid almost immediately to the wire ends. To eliminate failures due to the braid, the nylon extrusion was removed and the glass braid pulled back away from the PVC insulation layer.