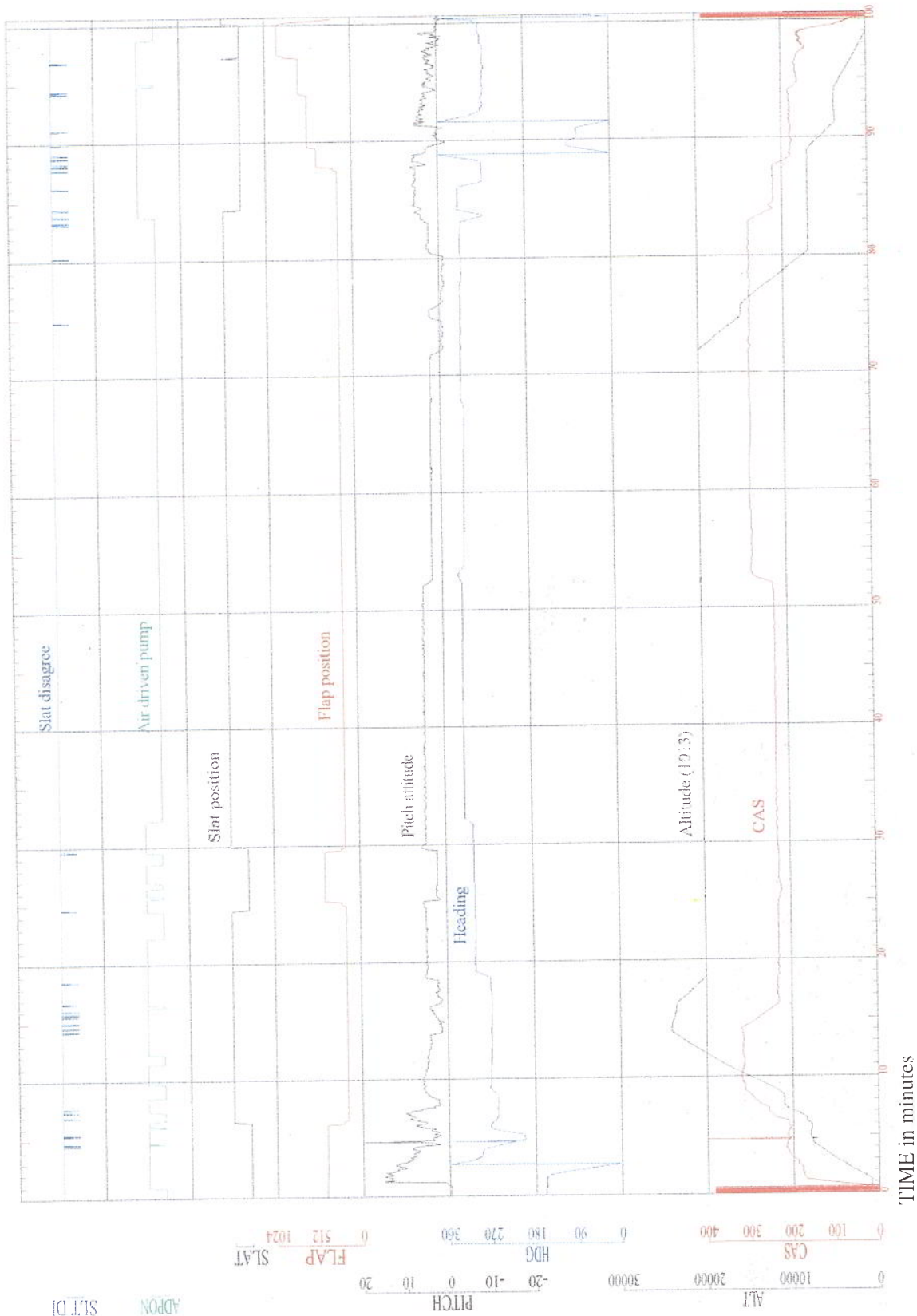
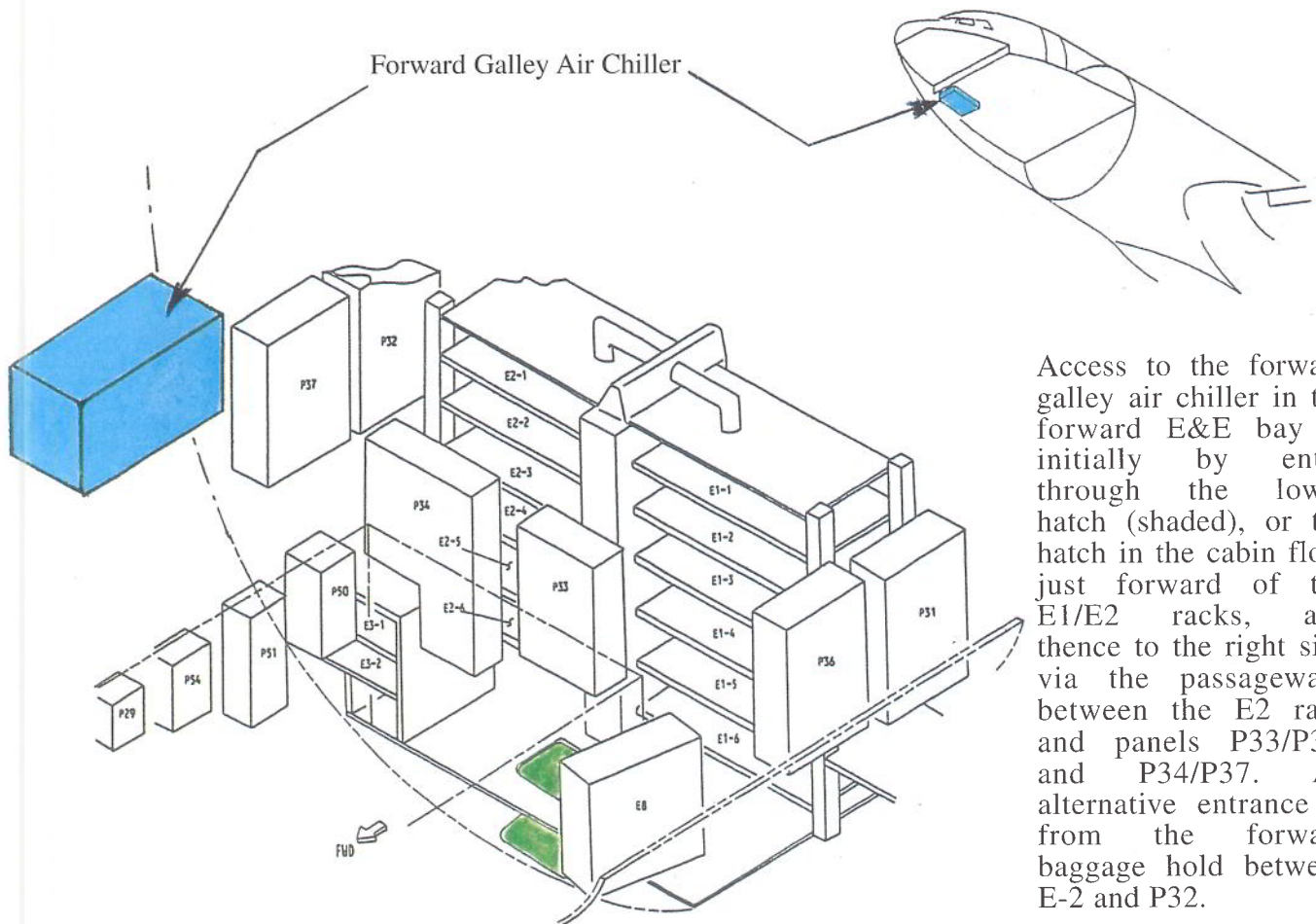


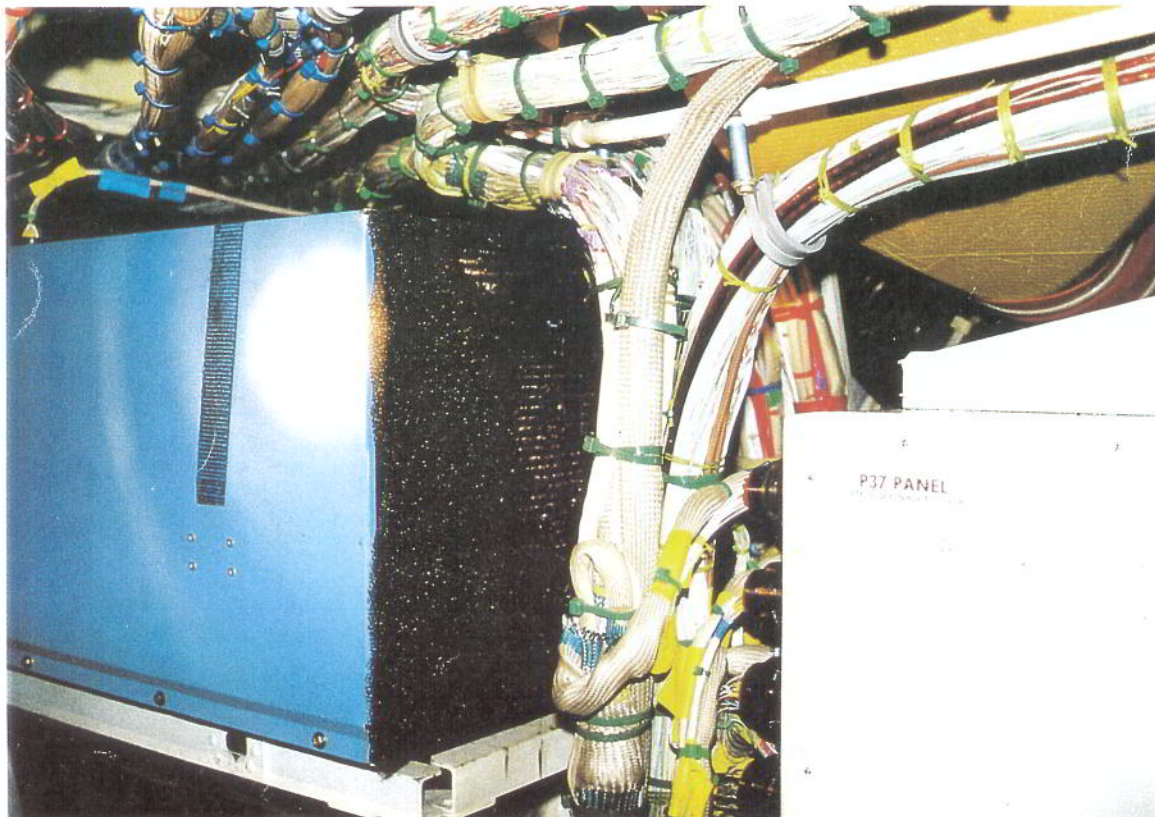
TIME HISTORY OF RELEVANT PARAMETERS





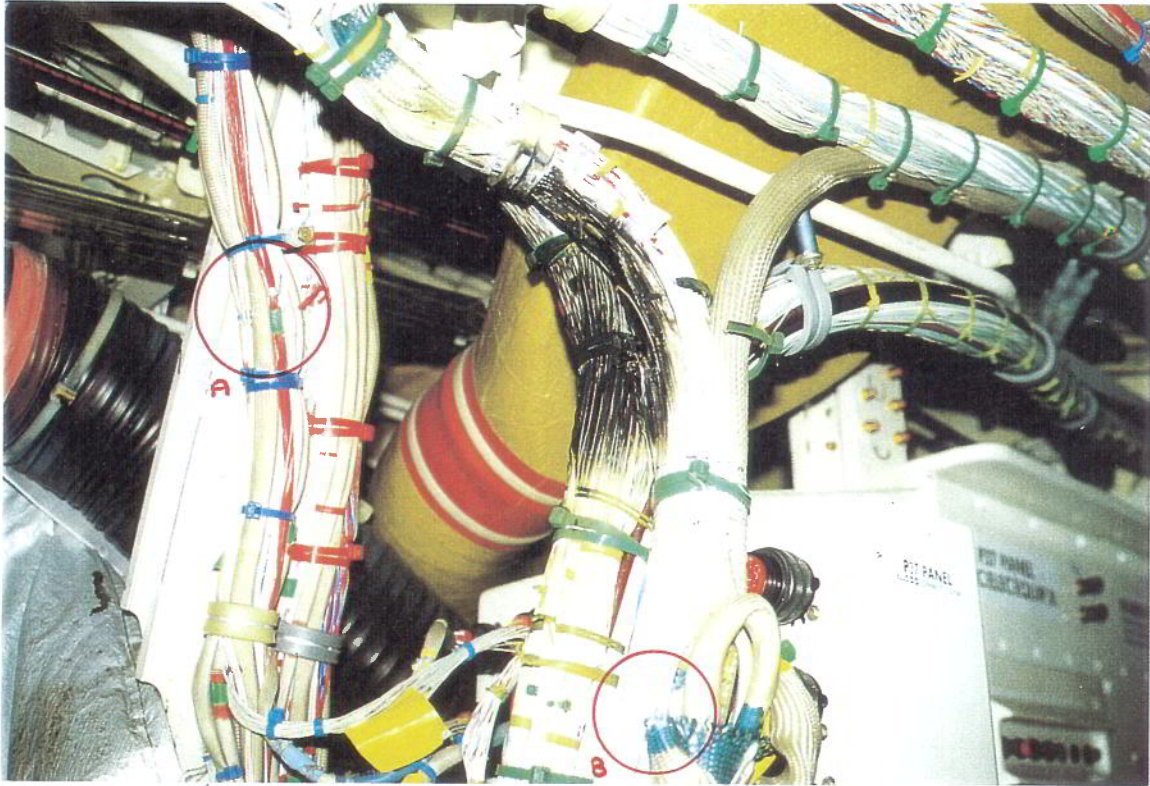


Access to the forward galley air chiller in the forward E&E bay is initially by entry through the lower hatch (shaded), or the hatch in the cabin floor just forward of the E1/E2 racks, and thence to the right side via the passageways between the E2 rack and panels P33/P34, and P34/P37. An alternative entrance is from the forward baggage hold between E-2 and P32.

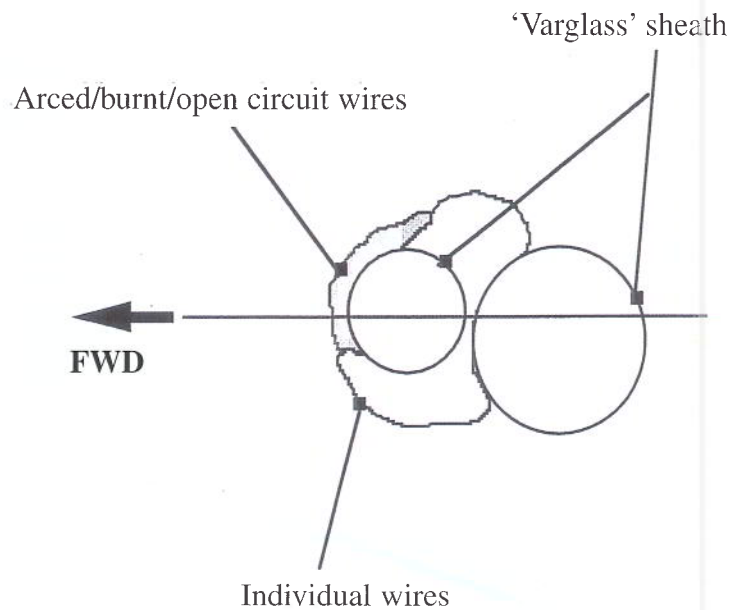
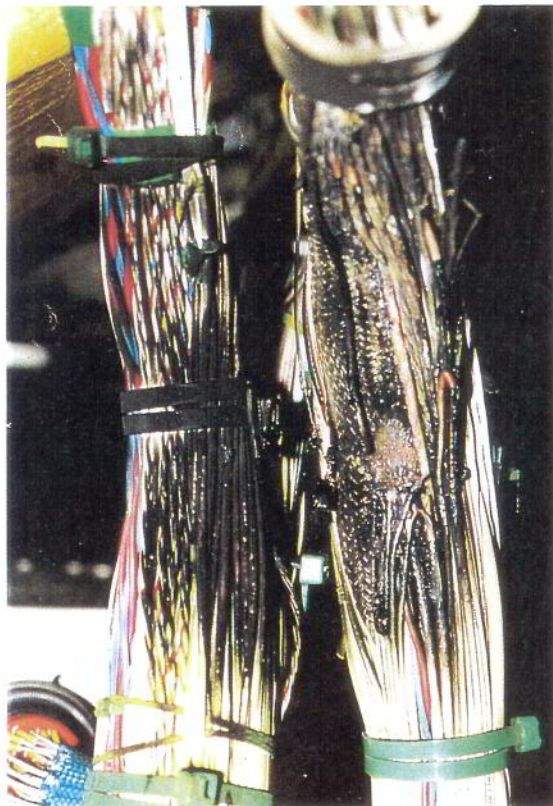


General view, looking forward and outboard, of the aft inboard corner of the galley chiller unit (blue) in relation to the wiring looms. Crew emergency oxygen bottle is located beneath chiller.





General view of damaged wires after chiller removal, with partially failed loom nearest the camera. Areas identified A and B exhibit wire damage not directly related to the loom failure (see Figure B-3). Of significance, damage at A is approximately at the same height as the failed section of loom.



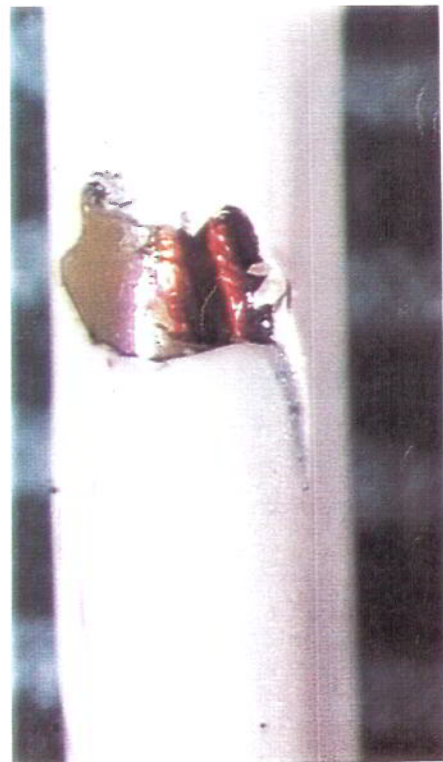
Detail view of failed areas of loom, and the adjacent heat affected loom. Above is a sketch of a cross section of the failed loom at the identified position.



Wire damage at location A in figure B-2. Three wires affected in addition to scuffing of braided sheath.

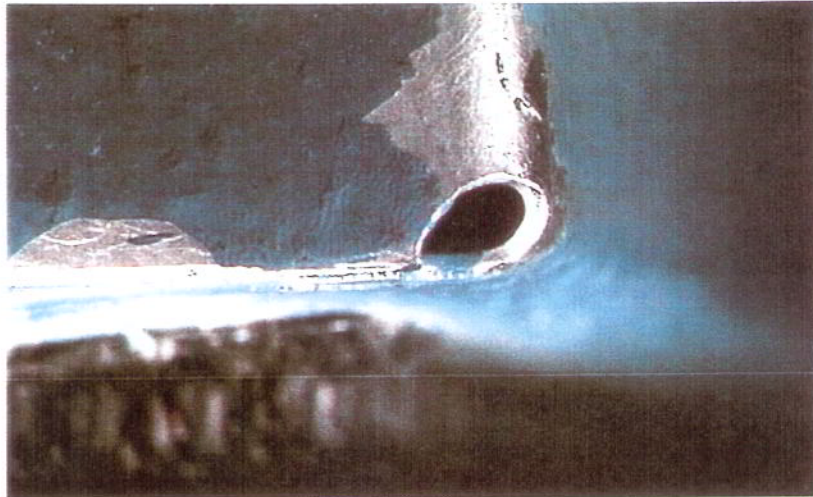


Abrasion of insulation topcoat at location B in figure B-2.



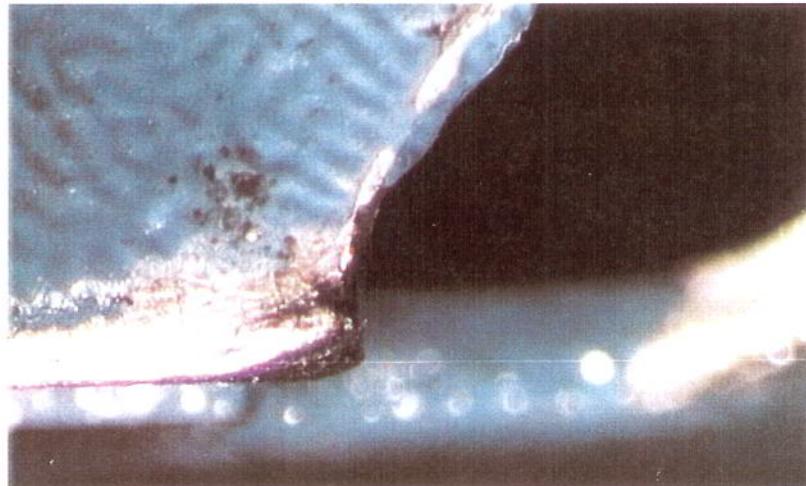
Details of 'cutting/slicing' damage to the outer insulation of two of the wires shown above left, leading to exposure of the polyimide insulation.





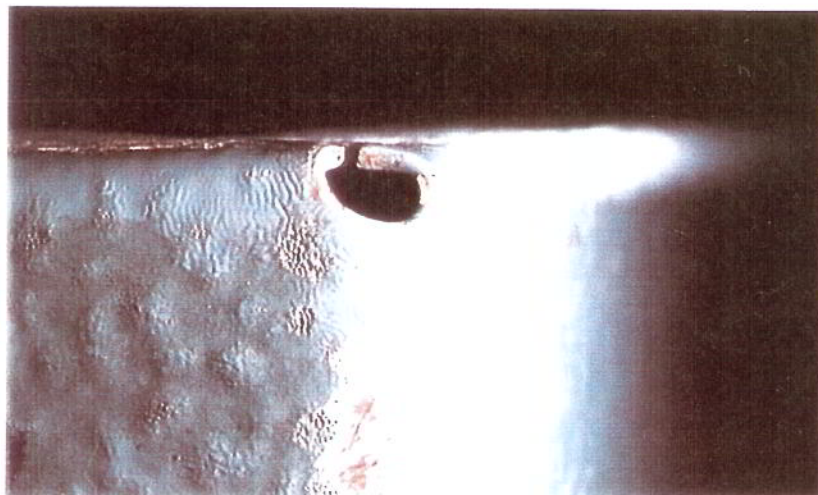
a

General view, above, of the top aft outboard corner of the chiller box showing the chipped paint, nature of construction and general bruising and, below, a detail of the burred 'sharp' edge.



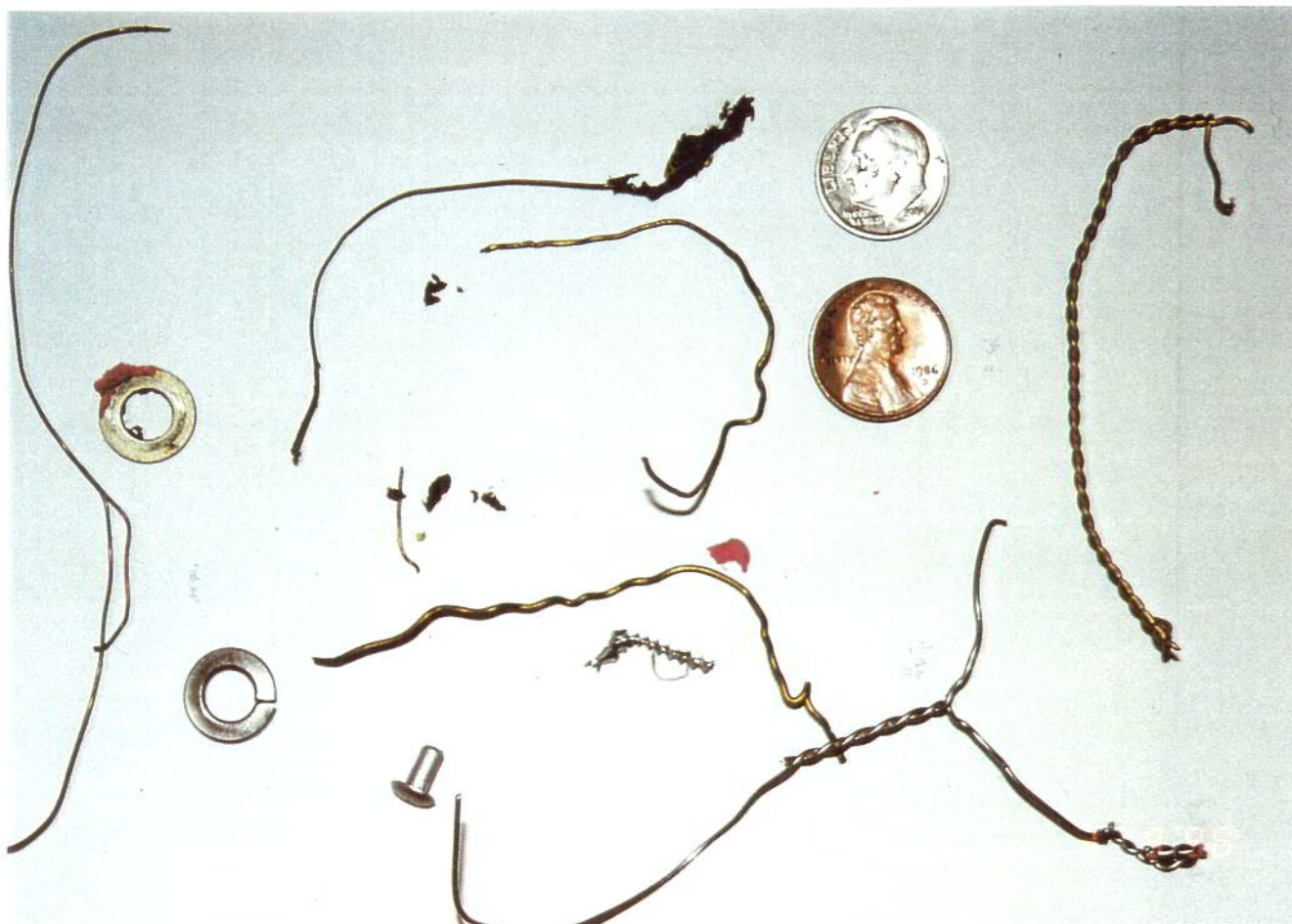
b

For comparison, below, a view of a top corner from the front of the chiller where three folds intersect. No exposed sharp edges were apparent.



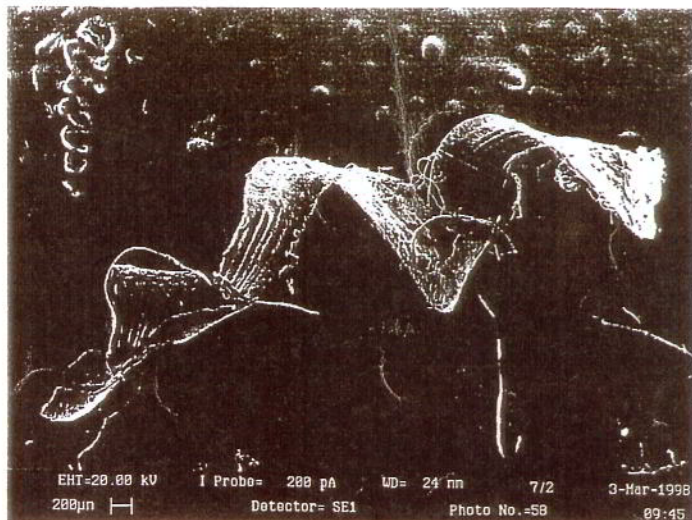
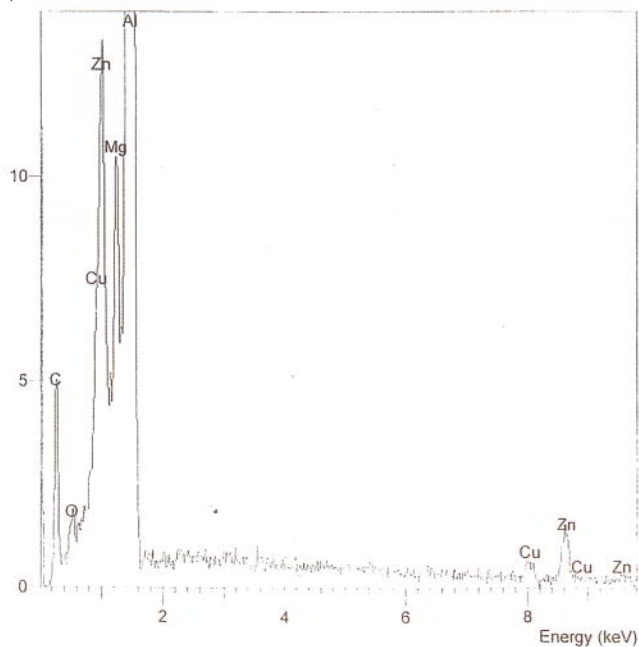
c

CONDUCTIVE DEBRIS SAMPLE



Above; Sample of conductive debris remove from immediate environment of chiller in the E&E bay of N653UA. Below: SEM analysis of typical swarf found in this region. (See also Figure D-1)

cps 7/2 curled swarf pic.58 (03/03/98 09:42)



Debris from floor below damaged harness - micrograph and EDX spectrum of aluminium swarf 7/2





FORWARD GALLEY AIR CHILLER - REMOVAL/INSTALLATION

1. General

- A. This procedure contains these tasks:  
 (1) Removal of the forward galley air chiller (EE bay).  
 (2) Installation of the forward galley air chiller (EE bay).

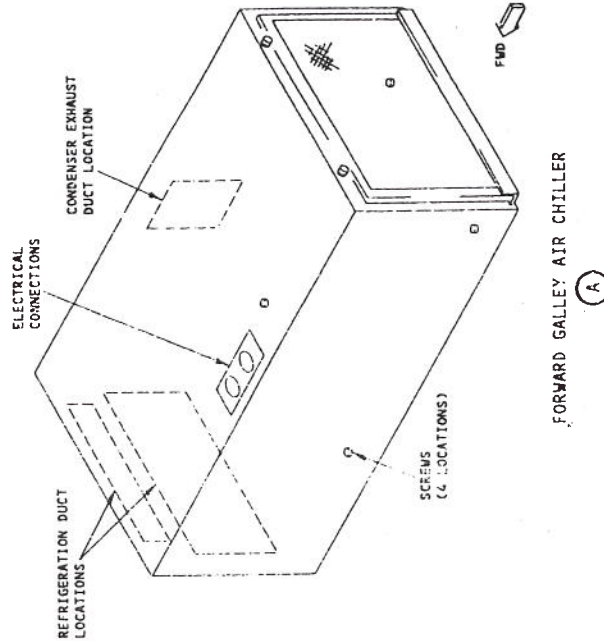
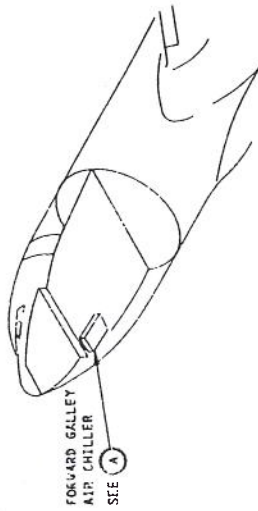
TASK 25-33-01-004-013

2. Remove the Forward Galley Air Chiller (EE bay).

- A. Equipment  
 (1) Forward Galley Air Chiller Replacement Equipment (ramp) - A25001-33  
 (2) Fishpole Hoist - Commercially available
- B. Access  
 (1) Location Zones  
 119/120 Main Equipment Center

C. Procedure

- S 864-061  
 (1) Open this circuit breaker on the main power distribution panel, P6, and attach DO-NOT-CLOSE tag:  
 (a) 6B7, CHILLER SHUTDOWN CONT
- S 864-014  
 (2) Put the air chiller ON-OFF switch to the OFF position on the forward galley.
- S 864-001  
 (3) Open the two CHILLER NO. 1 circuit breakers on the forward galley, and attach DO-NOT-CLOSE tags.
- S 014-016  
 (4) Open the electrical equipment access door.
- S 424-017  
 (5) To install the ramp (Fig. 402), do the steps that follow:  
 (a) Put the ramp into position.  
 (b) On the right side of the ramp, install the pin to the channel at the aft end of the chiller support structure.  
 (c) On the left side of the ramp, install the handle to the same channel.  
 (d) Connect the fishpole hoist to the attach point at the end of the ramp at BL 0.0.  
 (e) Use the fishpole hoist to lift the ramp to the horizontal position.
- S 034-018  
 (6) Disconnect the electrical connector from the air chiller (Fig. 401).



forward Galley Air Chiller  
Figure 401

EFFECTIVITY

ALL

01.1

25-33-01

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Nov 10/97

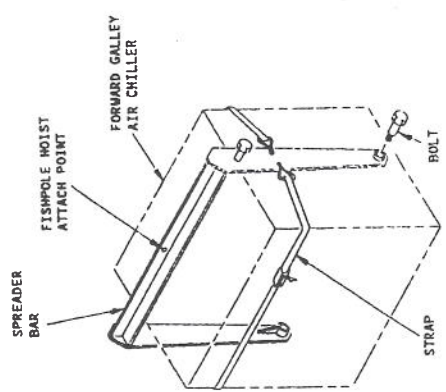
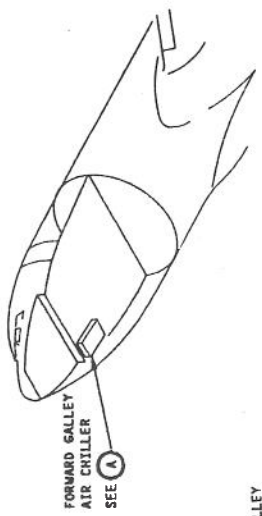
EFFECTIVITY

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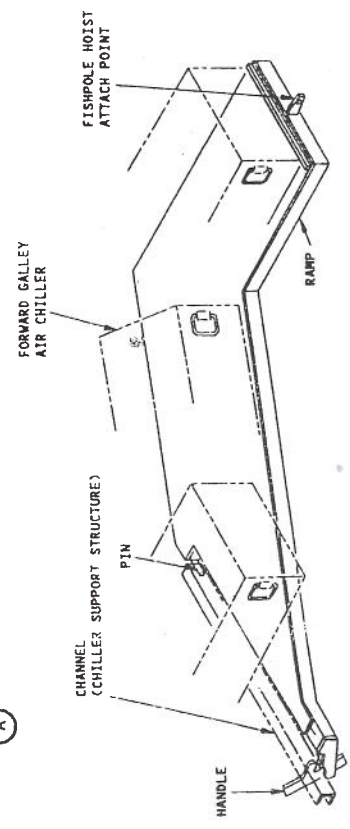
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May 10/90



FORWARD GALLEY AIR CHILLER (A)



Forward Galley Air Chiller Replacement Equipment (Ramp)  
Figure 402

- S 034-080 Disconnect the drain line, if necessary.
- S 034-022 Remove the screws (4 locations) on the bottom of the air chiller which attach the air chiller to the chiller support.
- S 824-074
- CAUTION:** AIR CHILLER WEIGHS 85 LBS (38 KGS).
- (9) Move the air chiller on the ramp.
- S 824-026
- (10) Move the air chiller down the ramp.
- S 824-027
- (11) Lower the air chiller to the top of the E/E rack.
- S 034-002
- (12) Remove the fishpole hoist.
- S 424-028
- (13) Attach the spreader bar to the air chiller (Fig. 402).
- S 424-029
- (14) Attach the fishpole hoist to the spreader bar.
- S 824-030
- (15) Lift the air chiller out of the ramp and let the air chiller hang.
- S 424-031
- (16) Make sure the air chiller is vertical and install the strap.
- S 824-032
- (17) Lower the air chiller to the ground through the electrical equipment access door.
- S 024-033
- (18) Remove the strap and the spreader bar.
- S 164-034
- WARNING:** MAKE SURE THE AREA AROUND THE AIR CHILLER IS CLEAN. THE AIR CHILLER IS NEAR THE CREW OXYGEN BOTTLES. OIL OR OTHER FLAMMABLE MATERIALS CAN CAUSE AN EXPLOSION IF THEY ARE NEAR THE CREW OXYGEN BOTTLES.
- (19) Clean the area around where the air chiller was installed.

BAB

EFFECTIVITY

ALL
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TASK 25-33-01-404-035

3. Install the Forward Galley Air Chiller (EE box)

- A. Equipment
- (1) Forward Galley Air Chiller Replacement Equipment (Ramp) - A25001-33
  - (2) Fishpole Hoist - Commercially available
- B. References
- (1) 24-22-00/201, Electrical Power - Control
- C. Access
- (1) Location Zones  
119/120 Main Equipment Center
- D. Procedure

S 164-060

**WARNING:** MAKE SURE THE AREA AROUND THE AIR CHILLER IS CLEAN. THE AIR CHILLER IS NEAR THE CREW OXYGEN BOTTLES. OIL OR OTHER FLAMMABLE MATERIALS CAN CAUSE AN EXPLOSION IF THEY ARE NEAR THE CREW OXYGEN BOTTLES.

- (1) Clean the area where you will install the forward galley air chiller.
  - (2) Attach the spreader bar and the strap to the air chiller (Fig. 402).
  - (3) Attach the fishpole hoist to the spreader bar.
  - (4) Lift the air chiller through the electrical equipment access door.
- S 824-075
- CAUTION:** AIR CHILLER WEIGHS 85 LBS (38 KGS).
- (5) Put the air chiller on the ramp. Make sure the air filter is in the correct position.
  - (6) Remove the strap and the spreader bar from the air chiller.
  - (7) Move the air chiller up the ramp.
  - (8) Move the air chiller from the ramp to the installed position.

EFFECTIVITY

ALL

25-33-01

- (9) S 214-046 Make sure the seal between the duct connections are satisfactory.
- (10) S 424-050 Install the screws (4 locations) on the bottom of the air chiller which attach the air chiller to the chiller support.
- (11) S 434-079 Connect the drain, if necessary.
- (12) S 434-051 Connect the electrical connector to the air chiller.
- (13) S 864-070 Supply the electrical power (Ref 24-22-00).
- (14) S 864-053 Remove the DO-NOT-CLOSE tags from the two CHILLER NO. 1 circuit breakers. Close the circuit breakers.

- (15) S 864-062 Remove the DO-NOT-CLOSE tag and close this circuit breaker on the P6 panel:  
(a) 687, CHILLER SHUTDOWN CONT
  - (16) S 864-071 Put the air chiller ON-OFF switch on the galley to the ON position.
  - (17) S 724-072 Make sure the air chiller supplies cold air to galley trolley bays.
- NOTE:** Air should be between 1°C and 5°C after 10 minutes operation of the chiller.

- (18) S 864-073 Put the air chiller ON-OFF switch on the galley to the OFF position.
- (19) S 024-057 Remove the fishpole hoist and the ramp.
- (20) S 414-058 Close the electrical equipment access door.
- (21) S 864-059 Remove the electrical power if it is not necessary.

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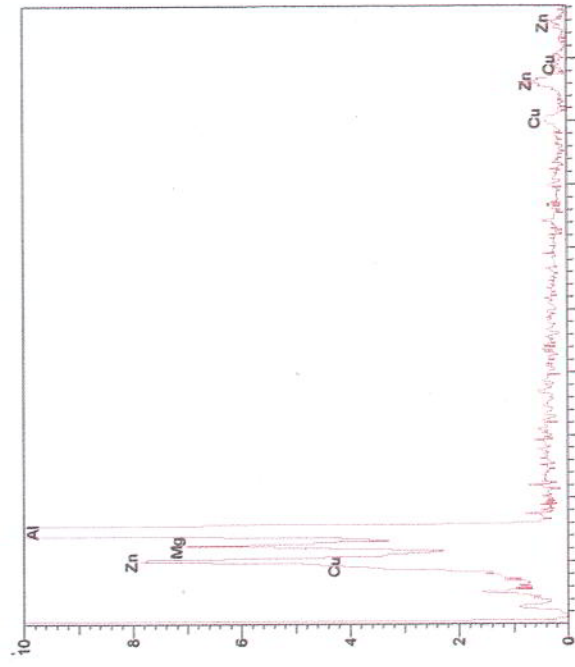
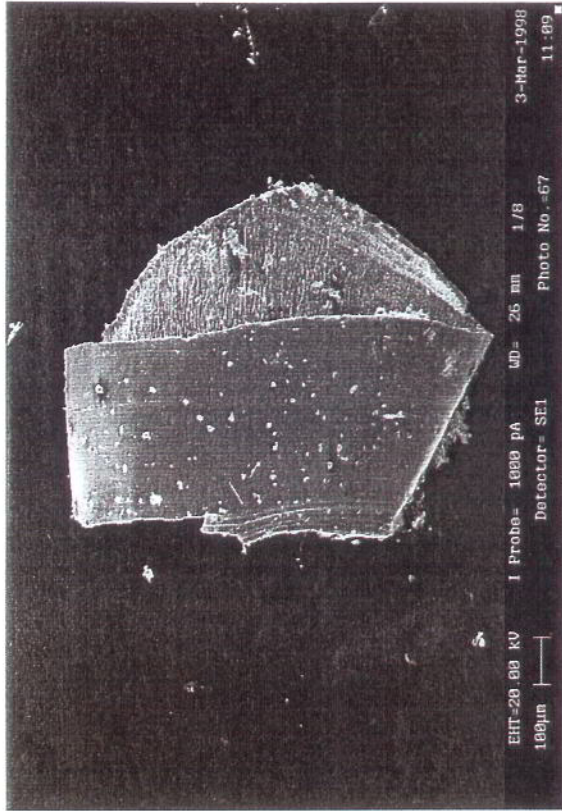
EFFECTIVITY

ALL

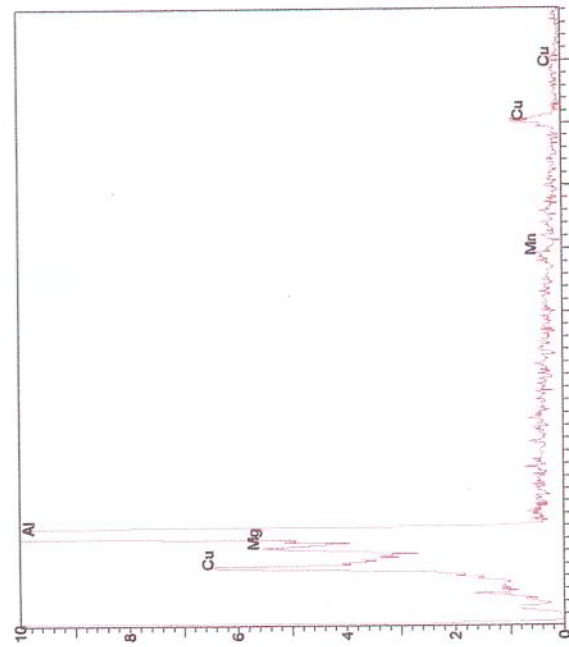
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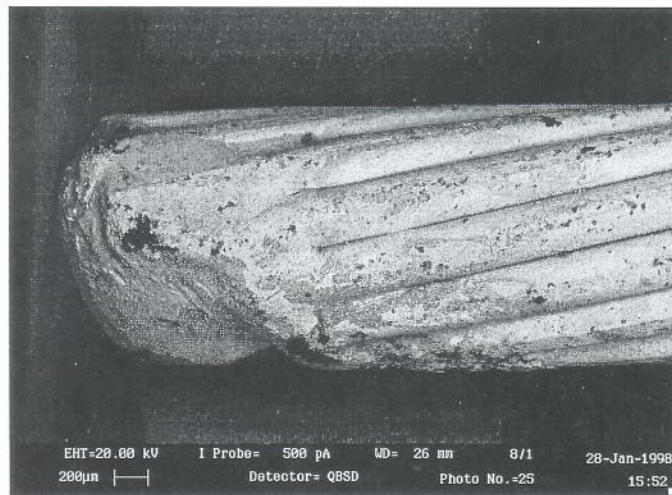
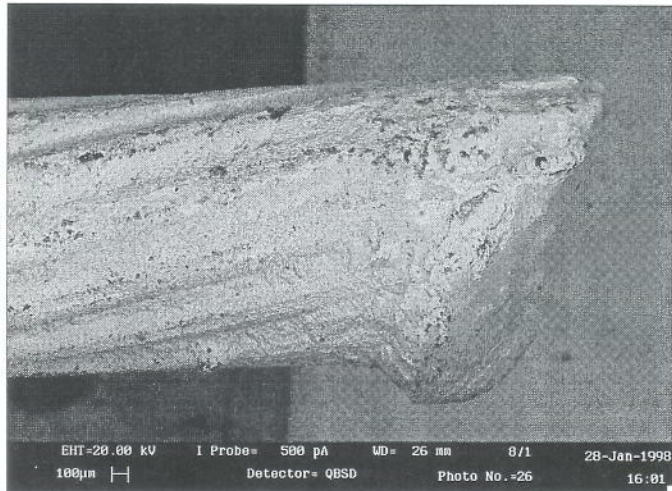
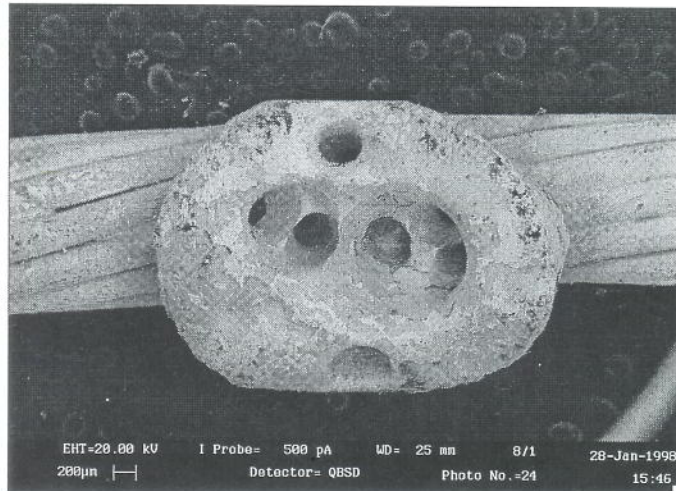




Debris from vacuum box - micrograph and EDX spectrum of aluminium swarf particle 1/8



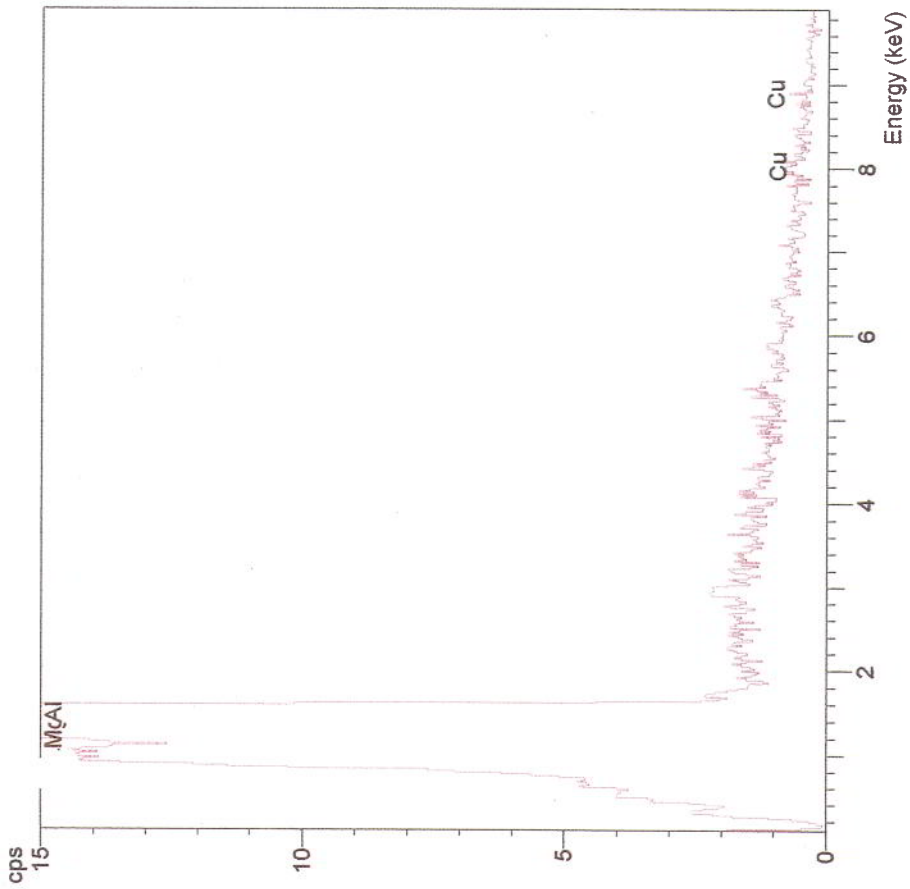
Debris from vacuum box - micrograph and EDX spectrum of aluminium swarf particle 1/10



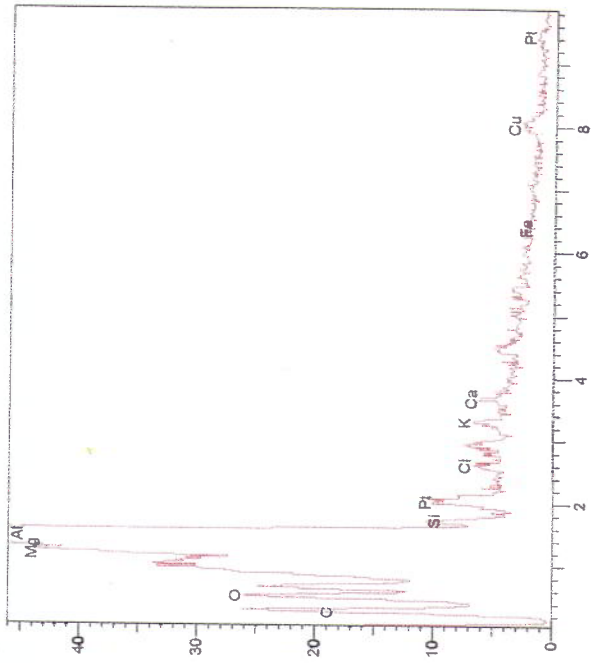
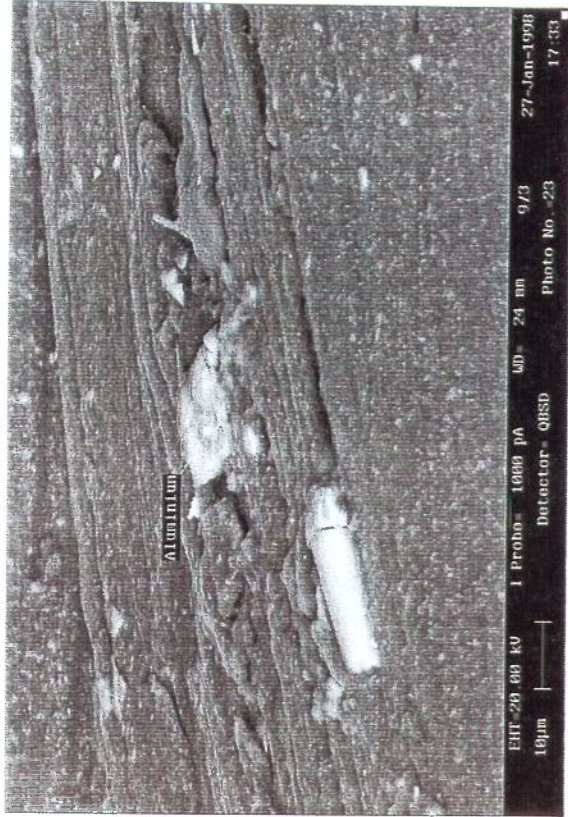
Debris from shelf below damaged harness - copper conductor

Upper micrograph - central globular attachment to conductor  
 Central micrograph - one end; Lower micrograph - other end

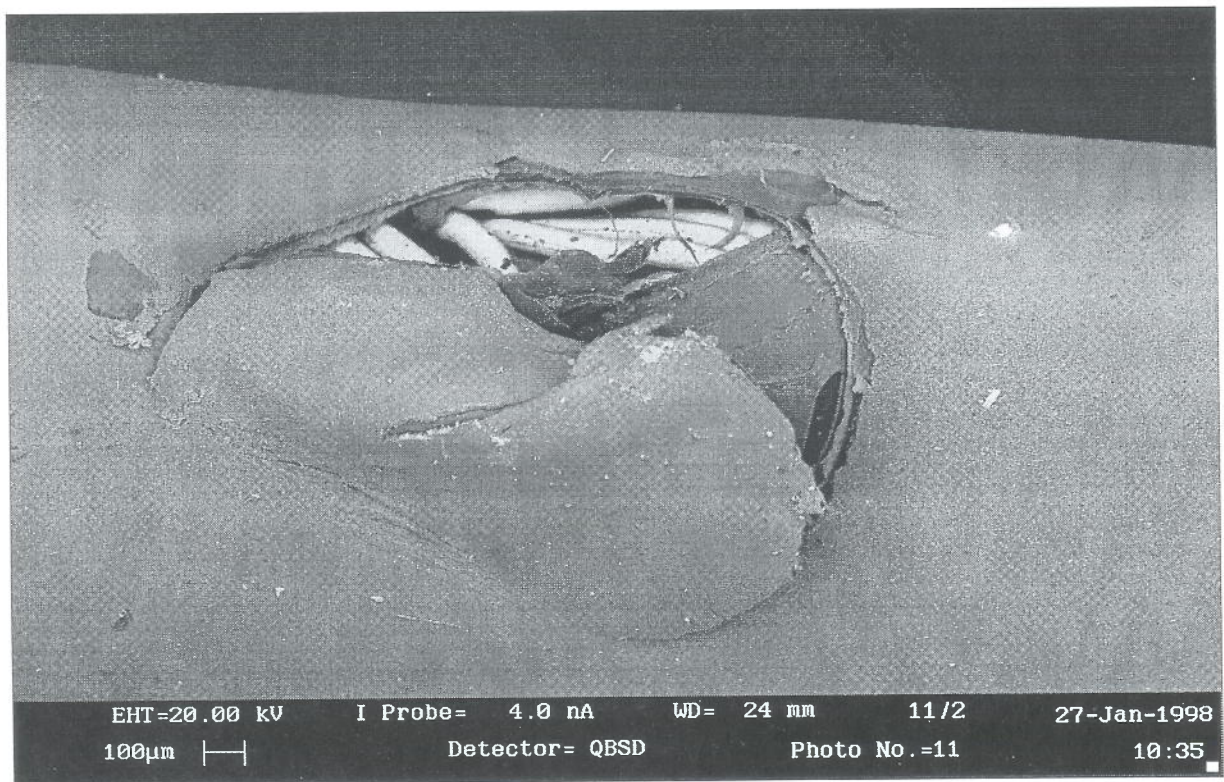
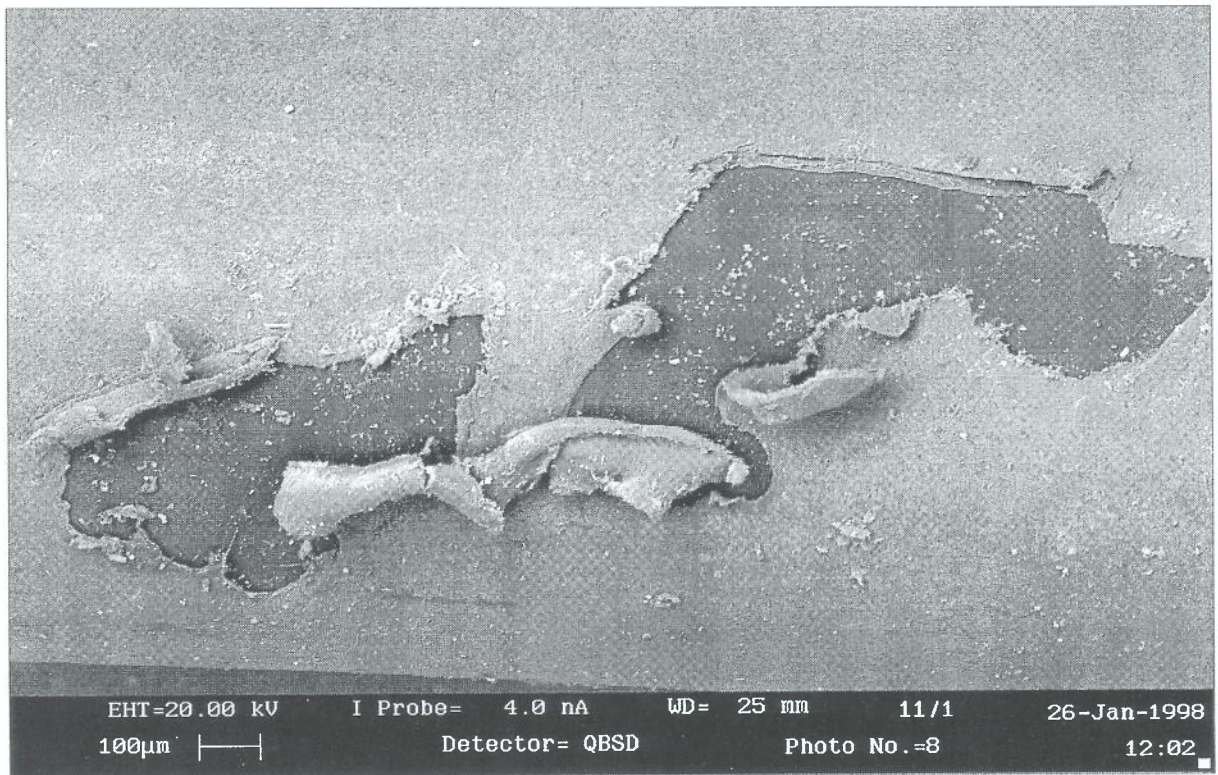




Box covering refrigeration unit  
 Typical EDX spectrum of aluminium alloy  
 from which box is made



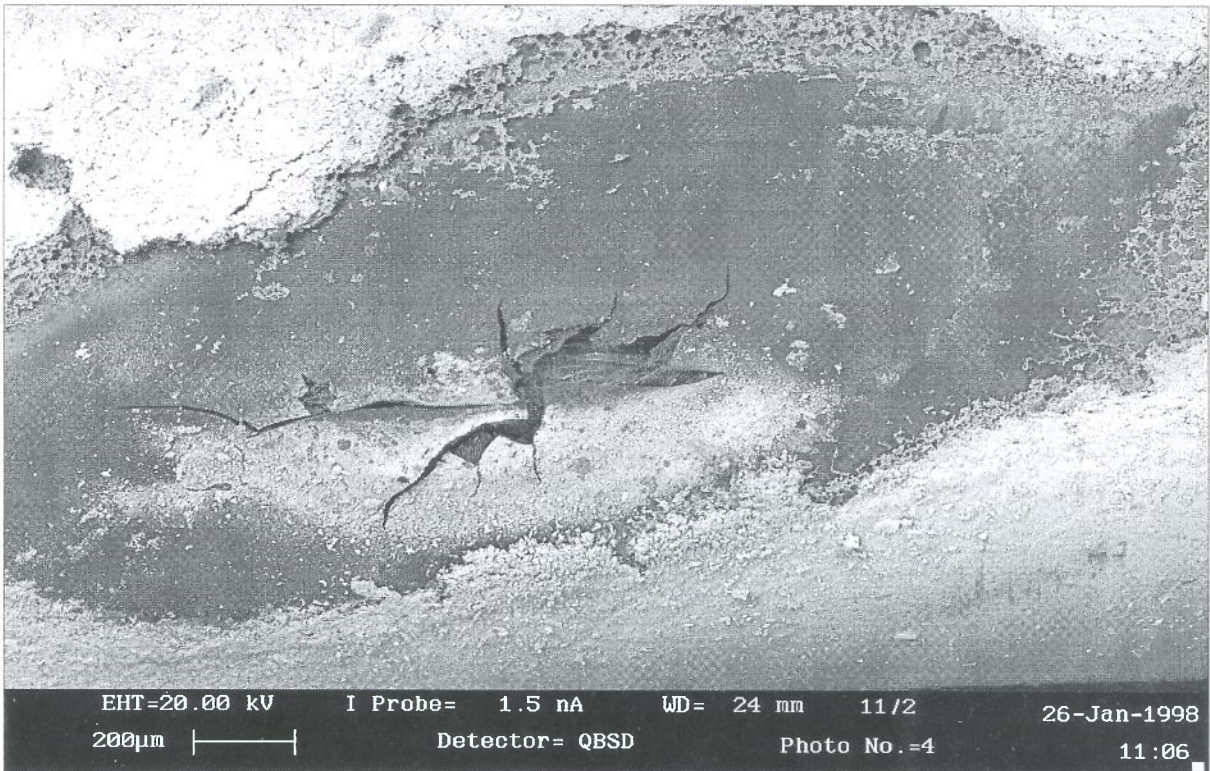
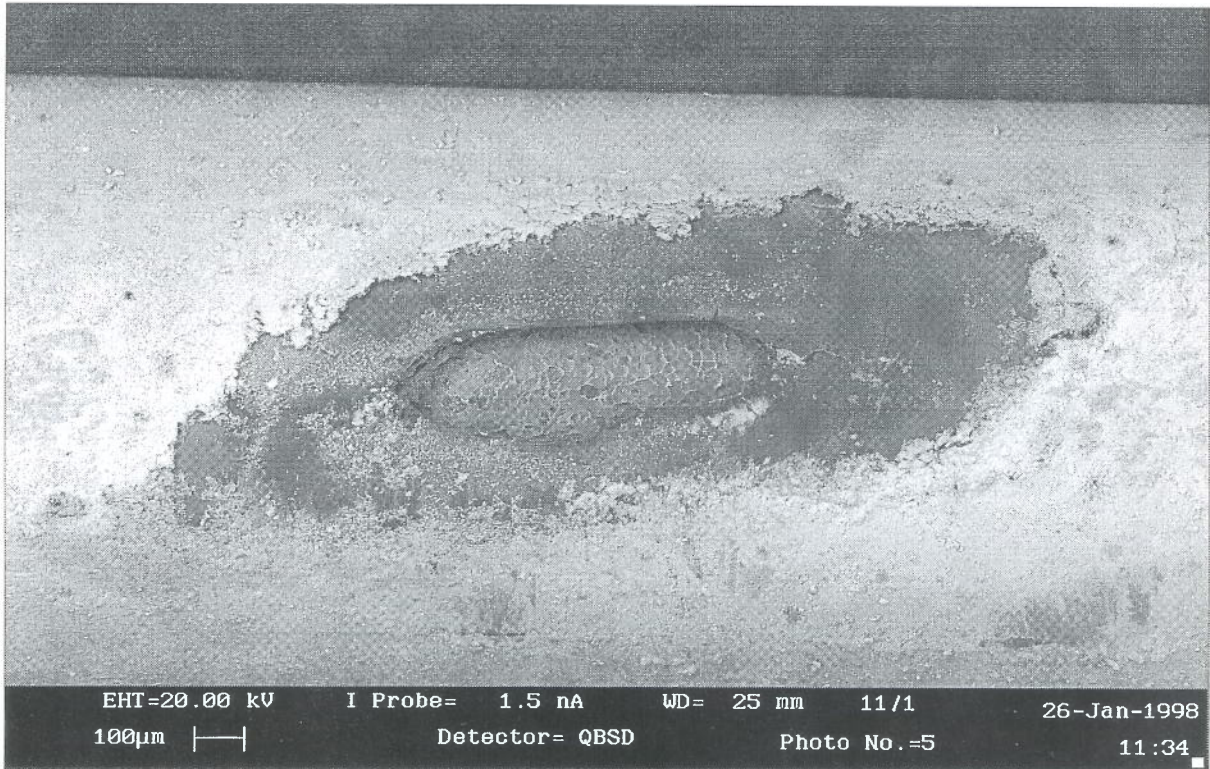
Wire from outboard harness - micrograph and EDX spectrum  
 of embedded aluminium in insulation of wire, 9/3



Wire from harness which suffered electrical failure  
Mechanical damage at a distance of ~ 10 mm from blackened area

Upper micrograph - wire 11/1; Lower micrograph - wire 11/2

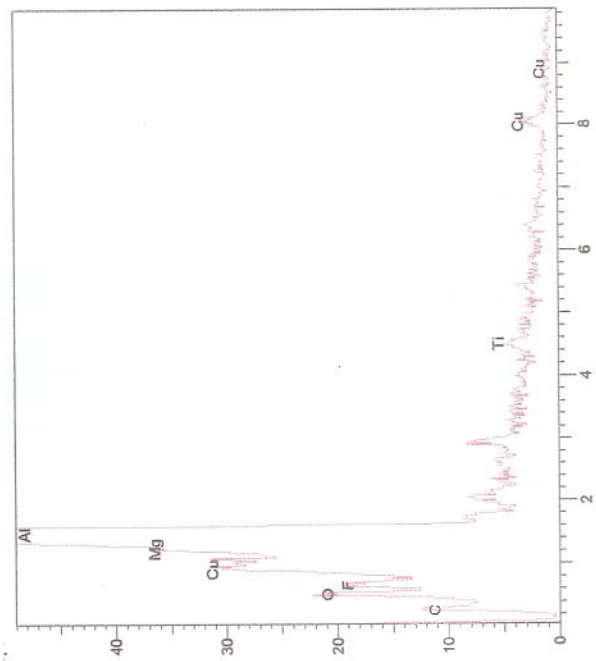
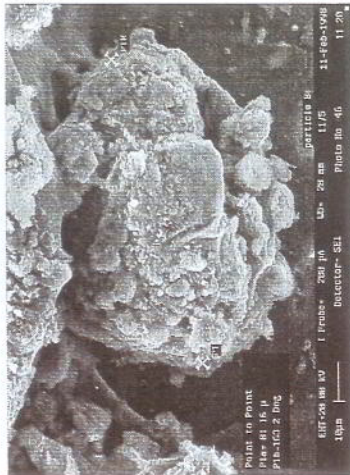
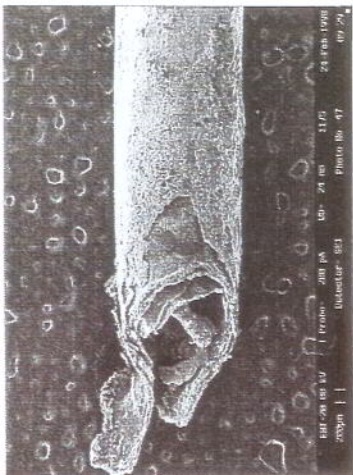




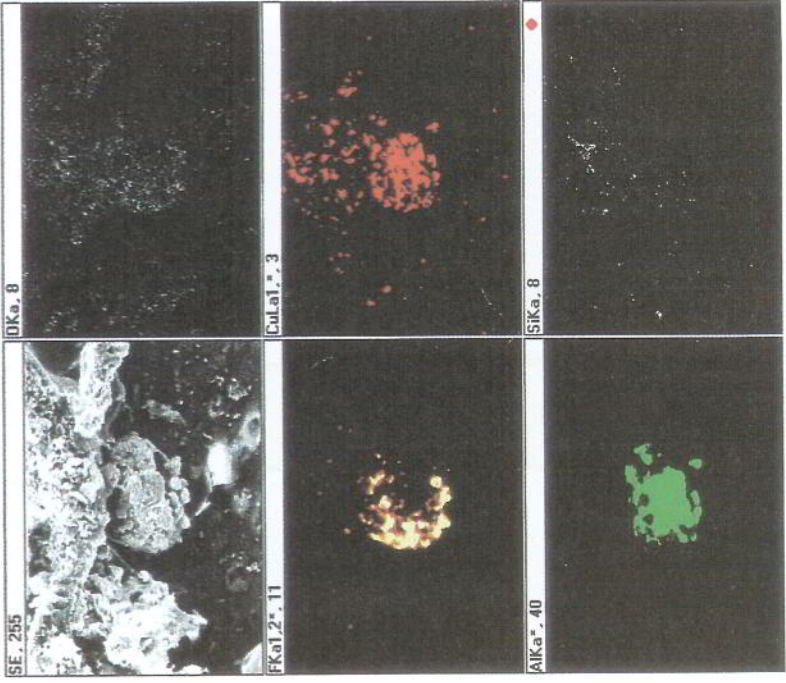
Wire from harness which suffered electrical failure  
Heat damage at a distance of ~ 10 mm from blackened area

Upper micrograph - wire 11/1; Lower micrograph - wire 11/2





Label: 11/5 @ melted wire end, detail B (11 Feb 98 11:11:00)



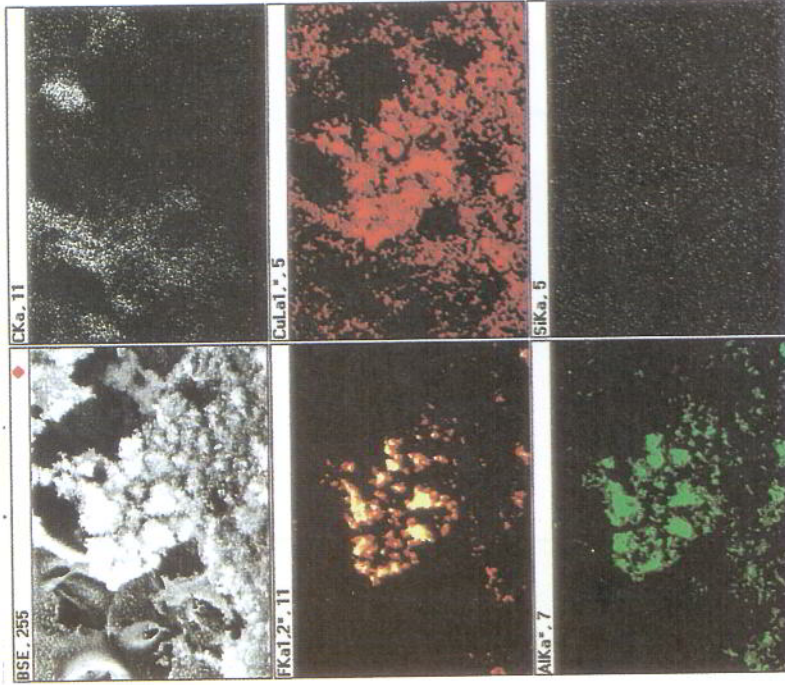
Wires from harness which suffered electrical failure

LHS: micrographs and EDX spectrum of aluminium sphere on insulation of wire 11/5

Upper micrograph - location; Lower micrograph - detail

RHS: Element maps of aluminium sphere on wire 11/5

Label: 11/8b pic. 75 (13 Mar 98 15:58:49)

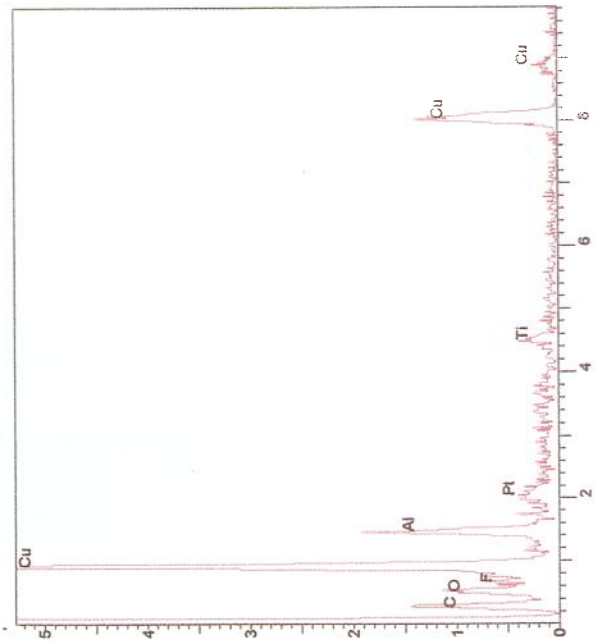


Wires from harness which suffered electrical failure

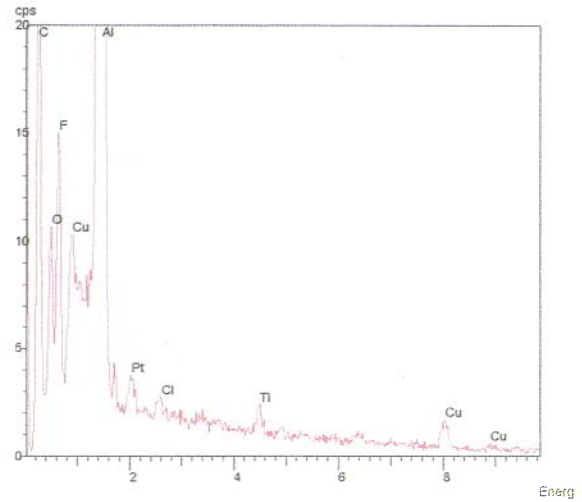
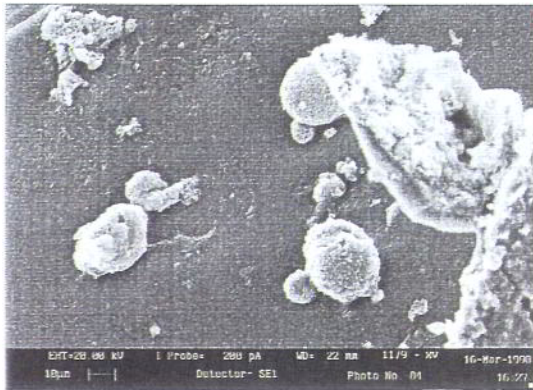
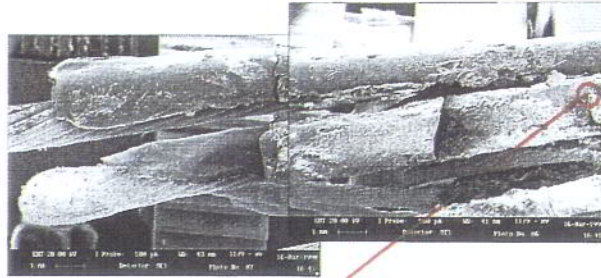
LHS: micrographs and EDX spectrum of aluminum and copper 'dust' on insulation of wire 11/7

Upper micrograph - location; Lower micrograph - detail

RHS: Element maps of aluminum nodules on wire 11/8



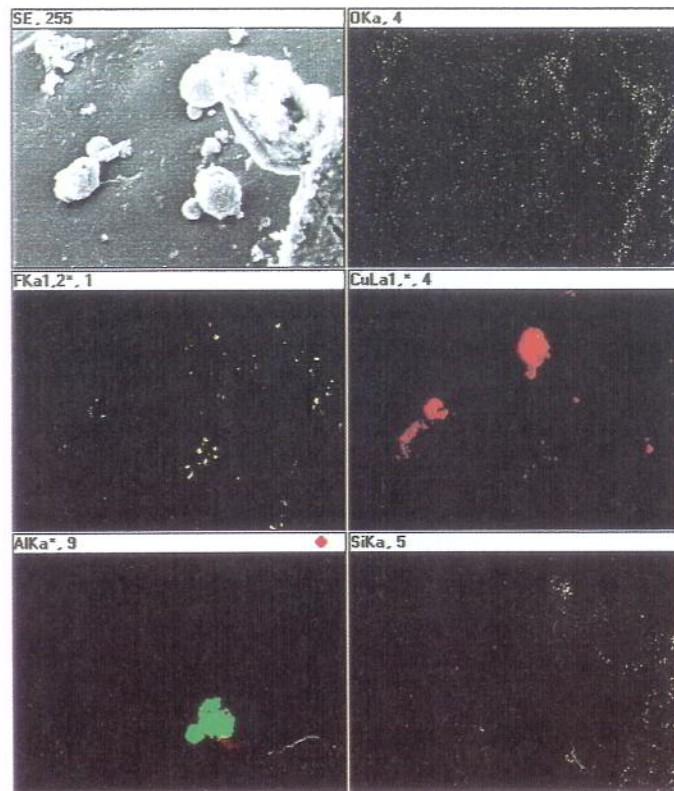




Wire from harness which suffered electrical failure

Micrographs and EDX spectrum of aluminium spheres on insulation of wire 11/9  
Upper micrograph - location @ O; lower micrograph - detail

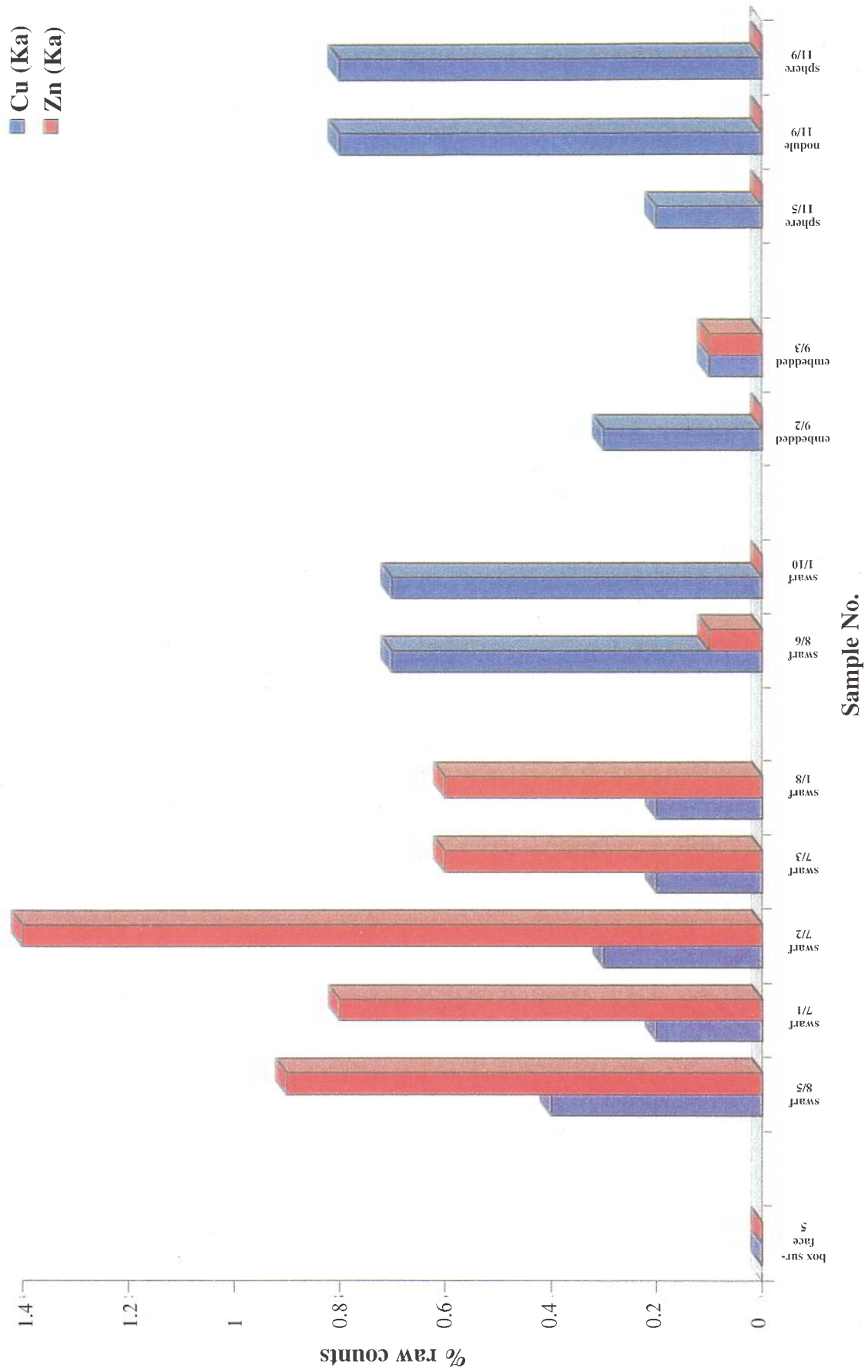
Label: 11/9 - xv, detail, pic. 84 (16 Mar 98 16:24:37)



Element maps of aluminium and copper spheres on wire 11/9



# COMPARISON OF MINORITY METALS IN ALUMINIUM ALLOYS





**APPENDIX E**

Wire Ident No.	Type	System Description	Comments
W 254-001-14	51F	TRU's - Main	Discontinuous, burnt insulation, arced wire ends. Molten/re-solidified aluminium particle found embedded in burnt insulation at wire failure location.
W 254-002-14	51F	TRU's - Main	Discontinuous, burnt insulation, arced wire ends
W 254-003-14	51F	TRU's - Main	Discontinuous, burnt insulation, arced wire ends
W 254-201R-18	48D	DC meters	Discontinuous, burnt insulation, arced wire ends
W 254-201B-18	48D	DC meters	Discontinuous, burnt insulation, arced wire ends
W 264-086-18	51F	Thrust Rev. Control L engine	Insulation mechanically damaged, removed from bundle adjacent to chiller outboard aft corner
W 264-087-18	51F	Thrust Rev. Control L engine	Insulation mechanically damaged, removed from bundle adjacent to chiller outboard aft corner
W 264-0177-18		Thrust Rev. Control R engine	Insulation mechanically damaged, removed from bundle adjacent to chiller outboard aft corner
W 272-001-14	51F	Altn T/E flap drive	Continuous, burnt insulation,
W 272-002-14	51F	Altn T/E flap drive	Discontinuous, burnt insulation, arced ends
W 272-003-14	51F	Altn T/E flap drive	Discontinuous, burnt insulation, arced ends
W 272-004-18	51F	Altn L/E o/b slat drive	Continuous, heat damaged insulation over 3 in length, conductor not exposed

**WIRES REMOVED FROM N653UA FOR EXAMINATION**



W 272-005-18	51F	Altn L/E o/b slat drive	Discontinuous, burnt insulation, ends melted- not arced, exposed conductor
W 272-006-18	51F	Altn L/E o/b slat drive	Discontinuous, burnt insulation, ends melted- not arced, exposed conductor
W 272-007-20	51F	Altn L/E i/b slat drive	Discontinuous, burnt insulation, arced ends
W 272-008-20	51F	Altn L/E i/b slat drive	Discontinuous, burnt insulation, copper strands fused into solid wire over a length of some 1.25 inches.
W 272-009-20	51F	Altn L/E i/b slat drive	Discontinuous, burnt insulation, arced ends.
W 272-010-12	51F	115V ac gnd serv bus	Continous, insulation burnt away, conductor exposed, copper strands fused into solid rod over a length of approx 1.5 inches
W 272-011-12	51F	115V ac gnd serv bus	Continous, burnt insulation, conductor exposed
W 272-012-12	51F	115V ac gnd serv bus	Continous, heat damage to insulation, conductor not exposed
W 272-013-12	51F	115V ac gnd serv bus	Continous, burnt insulation, conductor exposed with signs of arcing damage.
W 272-014-18	51F	Service outlets	Discontinuous, burnt insulation, ends melted- not arced, exposed conductor
W 272-015-18	51F	Service outlets	Discontinuous, burnt insulation, ends melted- not arced, exposed conductor
W 272-025-22	51F	First officer pitot/static probe heat	Discontinuous, burnt insulation, ends melted- not arced, exposed conductor

W 272-026-22	51F	Left aux pitot/static probe heat	Discontinuous, burnt insulation, ends melted- not arced, copper globules adhering to exposed conductor
W 656-801-22	51F	Thrust rev position ind system - R engine	Discontinuous, burnt insulation, strands fused into solid wire over a length of some 1.25 inches
W 656-802-22	51F	Thrust rev position ind system - R engine	Discontinuous, burnt insulation, strands fused into solid wire over some 0.5 inches
W 656-803-22	51F	Thrust rev position ind system - R engine	Discontinuous, burnt insulation, arced ends
W 656-804-22	51F	Thrust rev position ind system - R engine	Discontinuous, burnt insulation, arced ends
W 656-805-22	51F	Thrust rev position ind system - R engine	Discontinuous, burnt insulation, arced ends
W 656-807-22	51F	Thrust rev position ind system - R engine	Discontinuous, burnt insulation, arced ends
W 782-009-24	51F	EEC Data busses	Continuous, minor sooting damage
W 782-013-16	48D		Continuous, no damage
W 783-014-24	51F	EEC & indications discretes	Continuous, minor heat damage to outer insulation
W 782-018-24	51F	EEC & indications discretes	Continuous, slight heat damage to insulation, conductor not exposed
W 782-027-22	51F	Thrust Rev. position - indicating system R engine	Continuous, minor heat/sooting damage to outer insulation
W 782-201 B&R-24	48D	EC data busses	Continuous. Shielded twisted pair. Minor sooting damage to outer insulation
W 782-202 B&R-24	48D	EC data busses	Continuous. Shielded twisted pair. Minor sooting damage to outer insulation

W 782-210 B&R-24	48D	EC data busses	Continous. Shielded twisted pair. Minor sooting damage to outer insulation
W 782-211 B&R-24	48D	EC data/indication discretes & TT2 EEC discrete	Continous. Shielded twisted pair. Minor sooting damage to outer insulation
W 782-213 B&R-24	48D	Engine tachometer system	Continous. Shielded twisted pair. Minor sooting damage to outer insulation

*N.B. All discontinuous wire ends had burnt insulation and varying lengths of exposed conductor.*



## N653UA - REPAIRED WIRE LIST

WRN	SMC	Wire Ident	WTC	Wiring Diag. No.	System Description	From	To	Damage/Repair	SC	FC
78	137	W0506-171-24	W51F	21-26-11 PG1 SH2	Equip. Lav/Galley Ventilation Fans Aft	D04646P-51	D05644P-18	INS discolour	R2	1
77	136	W0506-174-24	W51F	21-26-11 PG1 SH2	Equip. Lav/Galley Ventilation Fans Aft	D04646P-11	D05644P-21	INS discolour	R2	1
76	135	W0506-700-24	W51F	21-26-11 PG1 SH2	Equip. Lav/Galley Ventilation Fans Aft	D04646P-49	D05644P-33	Pin/splice	R2	4
79	138	W0506-778-24	W51F	21-26-11 PG1 SH2	Equip. Lav/Galley Ventilation Fans Aft	D05644P-27	D05768P-61	INS discolour	R2	1
82	141	W1204-045-24	W51F	21-44-21 PG1 SH1	Heating - Cargo Compartment Aft/Bulk	D05348P-30	D04870P-27	Splice	R2	3
94	159	W0738-214B-24	W48D	21-52-41 PG1	Right & Left Pack Flow Indication	D08050J-41	D05136J-02	Splice	R2	3
94	160	W0738-214R-24	W48D	21-52-41 PG1	Right & Left Pack Flow Indication	D08050J-40	D05136J-03	Splice	R2	3
93	157	W0738-223B-24	W48D	21-52-41 PG1	Right & Left Pack Flow Indication	D08050J-45	D06236P-A10	Splice	R2	3
93	158	W0738-223R-24	W48D	21-52-41 PG1	Right & Left Pack Flow Indication	D08050J-46	D06236P-A11	Splice	R2	3
59	175	W0506-139-24	W51F	21-58-15 PG1	Equipment Cooling Exhaust Fan	D04766P-40	LC5612F-2C	Splice	R2	3
73	132	W0506-140-22	W51F	21-58-15 PG1	Equipment Cooling Exhaust Fan	D06076P-02	EC5644F-7	Pin/splice	R2	4
36	92	W0506-597-12	W51F	21-58-15 PG1	Equipment Cooling - Exhaust Fan	D05928P-03	D06288P-06	Pin/splice	R2	4
74	133	W0506-710-24	W51F	21-58-15 PG1	Equipment Cooling Exhaust Fan	D06076P-06	D05644P-8	Pin/splice	R2	4
40	96	W0506-715-24	W51F	21-61-11 PG2 SH1	Temperature Control - Flight Deck Zone	D05724P-05	D04504J-04	Splice	R2	3
50	173	W0506-716-24	W51F	21-61-21 PG1 SH1	Temperature Control Forward Zone	D05724P-18	D04504J-40	INS discolour	R2	1
37	93	W0506-713-24	W51F	21-61-31 PG1 SH2	Temperature Control - Aft Zone	D04646P-56	D04504J-55	INS discolour	R2	1
9	64	W0254-001-14	W51F	24-32-11 PG 1	Transformer Rectifier Units - Main	D00360-08	D04120P-1	Splice	R1	3
12	67	W0254-002-14	W51F	24-32-11 PG 1	Transformer Rectifier Units - Main	D00360-07	D04120P-02	Splice	R1	3
10	65	W0254-003-14	W51F	24-32-11 PG 1	Transformer Rectifier Units - Main	D00360-06	D04120P-03	Splice	R1	3
21	76	W0254-201B-18	W48D	24-34-11 PG1 SH1	DC Meters	D04122P-03	D00360-03	Splice	R1	3
21	77	W0254-201R-18	W48D	24-34-11 PG1 SH1	DC Meters	D04122P-04	D00360-04	Splice	R1	3
8	63	W0272-010-12	W51F	24-51-52 PG 1 SH1	115 VAC Ground Service Bus	D05860P-04	D05858P-04	Splice	R1	3
2	57	W0272-011-12	W51F	24-51-52 PG 1 SH1	115 VAC Ground Service Bus	D05860P-05	D05858P-05	Splice	R1	3
1	56	W0272-012-12	W51F	24-51-52 PG 1 SH1	115 VAC Ground Service Bus	D05860P-06	D05858P-06	Splice	R1	3
3	58	W0272-013-12	W51F	24-51-52 PG 1 SH1	115 VAC Ground Service Bus	D05860P-07	D05858P-07	Splice	R1	3
6	61	W0272-014-18	W51F	25-29-11 PG 1	Service Outlets	D05860P-08	D05868P-07	Splice	R1	3
19	74	W0272-015-18	W51F	25-29-11 PG 1	Service Outlets	D05860P-09	D05868P-08	Splice	R1	3
38	94	W0506-719R-22	W51F	26-18-22 PG1	Duct Leak Detection - Right Strut	D05602P-07	D04650P-48	Pin/splice	R2	4
69	128	W0506-720R-22	W51F	26-18-22 PG1	Duct Leak Detection - Right Strut	D05602P-08	D04650P-49	Pin/splice	R2	4
14	69	W0272-001-14	W51F	27-51-11 PG 1A SH1	Alternate Trailing Edge Flap Drive	D05860P-01	D05858P-01	Splice	R1	3
13	68	W0272-002-14	W51F	27-51-11 PG 1A SH1	Alternate Trailing Edge Flap Drive	D05860P-02	D05858P-02	Splice	R1	3
11	66	W0272-003-14	W51F	27-51-11 PG 1A SH1	Alternate Trailing Edge Flap Drive	D05860P-03	D05858P-03	Splice	R1	3
4	59	W0272-007-20	W51F	27-81-11 PG 1A SH1	Alternate Leading Edge Inboard Slat Drive	D05862P-04	D05868P-04	Pin/splice	R1	4
15	70	W0272-008-20	W51F	27-81-11 PG 1A SH1	Alternate Leading Edge Inboard Slat Drive	D05862P-05	D05868P-05	Pin/splice	R1	4
5	60	W0272-009-20	W51F	27-81-11 PG 1A SH1	Alternate Leading Edge Inboard Slat Drive	D05862P-06	D05868P-06	Pin/splice	R1	4
7	62	W0272-004-18	W51F	27-81-21 PG 1A SH1	Alternate Leading Edge Outboard Slat Drive	D05862P-01	D05868P-01	Pin/splice	R1	4
20	75	W0272-005-18	W51F	27-81-21 PG 1A SH1	Alternate Leading Edge Outboard Slat Drive	D05862P-02	D05868P-02	Pin/splice	R1	4
16	71	W0272-006-18	W51F	27-81-21 PG1A SH1	Alt. Leading Edge Outboard Slat Drive	D05622J-12	D05316P-14	pin/splice	R2	4
83	142	W0768-303B-24	W48D	27-81-21 PG1A SH1	Alt. Leading Edge Outboard Slat Drive	D05622J-13	D05316P-15	pin/splice	R2	4
84	143	W0768-303R-24	W48D	27-81-21 PG1A SH1	Alt. Leading Edge Outboard Slat Drive	D05622J-14	D05316P-16	pin/splice	R2	4
85	144	W0768-303Y-24	W48D	27-81-21 PG1A SH1	Alt. Leading Edge Outboard Slat Drive	D05928P-07	D05602P-01	Pin/splice	R2	4
35	91	W0506-682-16	W51P	28-22-11 PG2 SH1	Fuel Boost Pumps - Main Tanks	D05928P-08	D05602P-02	Pin/splice	R2	4
33	89	W0506-683-16	W48D	28-22-11 PG2 SH1	Fuel Boost Pumps - Main Tanks	D05928P-09	D05602P-03	Pin/splice	R2	4
39	95	W0506-684-16	W51P	28-22-11 PG2 SH1	Fuel Boost Pumps - Main Tanks	D05384P-20	D04870P-27	INS discolour	R2	1
81	140	W1204-021-18	W51F	30-11-11 PG1 SH1	Wing Thermal Anti-ice	D05648P-19	D05656P-08	ok	R2	1
65	124	W0902-034-22	W51F	30-11-11 PG1 SH1	Wing Thermal Anti-ice	D05648P-23	D05656P-11	Splice	R2	3
66	125	W0902-036-22	W51F	30-11-11 PG1 SH1	Wing Thermal Anti-ice	D05648P-24	D05656P-12	ok	R2	1
63	122	W0902-037-22	W51F	30-11-11 PG1 SH1	Wing Thermal Anti-ice					



WRN	SMC Wire Ident	WTC	Wiring Diag. No.	System Description	From	To	Damage/Repair	SC	FC
45	W0766-013-24	W51F	30-21-11 PG1 SH2	Engine Inlet Thermal Anti-ice	D05326P-20	D04616J-29	Splice	R2	3
46	W0766-033-24	W51F	30-21-11 PG1 SH2	Engine Inlet Thermal Anti-ice	D05326P-22	D04616J-45	Splice	R2	3
64	W0902-110-22	W51F	30-31-11 PG1	Probe Heat - Captains Pitot Static	D05906P-20	D05908P-19	INS Discolour	R2	1
60	W0902-111-22	W51F	30-31-13 PG1	Probe Heat - Right Auxiliary Pitot Static	D05656P-34	D05648P-48	INS Discolour	R2	1
17	W0272-025-22	W51F	30-31-21 PG 1	Probe Heat - First Officer - Pitot Static	D05960P-09	D05868P-09	Splice	R1	3
58	W0902-113-24	W51F	30-31-21 PG1	Probe Heat - First Officer - Pitot Static	D05906P-21	D05908P-21	INS Discolour	R2	1
18	W0272-026-22	W51F	30-31-23 PG 1	Probe Heat - Left Auxiliary Pitot Static	D05960P-10	D05868-10	Splice	R1	3
61	W0272-078-22	W51F	30-32-11 PG1	Probe Heat - Angle of Attack - Left	D05908P-22	D05906P-05	Splice	R2	3
62	W0902-064-22	W51F	30-34-21 PG1	Probe Heat - Engine TT2 - Right	D05648P-44	D05656P-31	ok	R2	1
53	W1258-021-22	W51F	30-71-21 PG1	Forward Water Supply & Drain - Line Heaters	D05690P-07	SP430	Splice	R1	3
54	W1258-170-22	W51F	30-71-21 PG1	Forward Water Supply & Drain - Line Heaters	D05690P-37	SP3254	Splice	R1	3
34	W0506-047-24	W51F	32-42-12 PG1 SH2	Autobrake System	D04646P-08	D04656J-03	Pin/splice	R2	4
52	W0902-005-16	W51F	33-31-41 PG1	Electrical Equipment Center Lights	S354-1	S355-3	Splice	R2	3
55	W0902-007-16	W51F	33-31-41 PG1	Electrical Equipment Center Lights	S356-1	S355-2	Splice	R2	3
57	W0902-008-16	W51F	33-31-41 PG1	Electrical Equipment Center Lights	S356-3	S355-5	Splice	R2	3
56	W0902-010-16	W51F	33-31-41 PG1	Electrical Equipment Center Lights	S354-3	S355-6	INS Discolour	R2	1
67	W0902-096-18	W51F	33-31-41 PG1	Electrical Equipment Center Lights	SM1	SP1664	Splice	R2	3
68	W0902-116-18	W51F	33-31-41 PG1	Electrical Equipment Center Lights	SP1668	D05290P-14	Splice	R2	3
71	W0506-539-22	W51F	36-11-52 PG2 SH1	Air Supply - R Press Reg & Shutoff	D05768P-42	D05644P-34	Pin/splice	R2	4
72	W0506-689-22	W51F	36-11-52 PG2 SH1	Air Supply - R Press Reg & Shutoff	D05644P-14	D05768P-38	INS discolour	R2	1
70	W0506-558-22	W51F	36-11-62 PG2 SH1	Air Supply Bleed Aur - R Engine HPC	D06076P-20	D05766P-08	INS discolour	R2	1
75	W0506-721-22	W51F	36-11-62 PG2 SH1	Air Supply Bleed Aur - R Engine HPC	D06076P-24	D05766P-24	Pin/splice	R2	4
86	W0738-212B-24	W48D	36-21-11 PG1	Air Supply Duct Pressure - Indication	D04004J-17	D05136J-09	pin/splice	R2	4
87	W0738-212R-24	W48D	36-21-11 PG1	Air Supply Duct Pressure - Indication	D04004J-16	D05136J-08	pin/splice	R2	4
51	W0506-578-24	W51F	36-22-11 PG2	Air Supply Overheat Indication	D05644P-38	D05768P-34	Pin/splice	R2	4
80	W0506-685-24	W51F	73-21-11 PG1 SH2	EEC & Indication Discretes	D06076P-10	D05766P-25	Splice	R2	3
80	W0506-685-24SH	W51F	73-21-11 PG1 SH2	EEC & Indication Discretes	D06076P-16	D05766P-26	Splice	R2	3
23	W0782-014-24	W51F	73-21-11 PG1 SH2	EEC & Indications Discretes	D06580J-08	D06584P-09	Splice	R2	3
95	W0768-002-24	W51F	73-21-11 PG1 SH4	EEC & Indications Discretes	D04624J-08	D05316P-29	INS Repair	R2	2
95	W0768-002-24SH	W51F	73-21-11 PG1 SH4	EEC & Indications Discretes	D04624J-DED	D05316P-34	INS Repair	R2	2
22	W0782-018-24	W51F	73-21-11 PG1 SH4	EEC & Indications Discretes	D06580J-09	D06584P-10	Splice	R2	3
89	W0782-211R-24	W48D	73-21-12 PG1	TT2 EEC Discrete	D06580J-01	D06584P-14	Pin/splice	R2	4
89	W0782-211Z-24	W48D	73-21-12 PG1	TT2 EEC Discrete	D06580J-DED	D06584P-15	Pin/splice	R2	4
91	W0782-201B-22	W48D	73-21-14 PG1 SH1	EEC Data Busses	D06580J-21	D06584P-25	Pin/splice	R2	4
91	W0782-201R-22	W48D	73-21-14 PG1 SH1	EEC Data Busses	D06580J-22	D06584P-26	Pin/splice	R2	4
92	W0782-202B-24	W48D	73-21-14 PG1 SH1	EEC Data Busses	D06580J-17	D06584P-27	Pin/splice	R2	4
92	W0782-202R-24	W48D	73-21-14 PG1 SH1	EEC Data Busses	D06580J-18	D06584P-28	Pin/splice	R2	4
47	W0766-202B-24	W48D	73-21-14 PG1 SH2	EEC Data Busses	D05326P-42	D06180J-26	INS discolour	R2	1
47	W0766-202R-24	W48D	73-21-14 PG1 SH2	EEC Data Busses	D05326P-43	D06180J-27	INS discolour	R2	1
47	W0766-202Z-24	W48D	73-21-14 PG1 SH2	EEC Data Busses	D05326P-41	D06180J-31	INS Repair	R2	2
24	W0782-009-24	W51F	73-21-14 PG1 SH4	EEC Data Busses	D06580J-02	D06584P-02	Splice	R2	3
88	W0782-210B-24	W48D	73-21-14 PG1 SH4	EEC Data Busses	D06580J-12	D06584P-04	Pin/splice	R2	4
88	W0782-210R-24	W48D	73-21-14 PG1 SH4	EEC Data Busses	D06580J-11	D06584P-03	Pin/splice	R2	4
89	W0782-211B-24	W48D	73-21-17 PG1 SH2	EEC Data & Indication Discretes	D06580J-10	D06584P-13	Pin/splice	R2	4
32	W0782-013-16	W48D	73-21-20 PG1	Performance Selinoid Power	D06580J-13	D06584P-07	Splice	R2	3
42	W0766-302B-24	W48D	73-31-11 PG1	Fuel Flow Indication	D05326P-24	D04616J-24	INS Repair	R2	2
42	W0766-302R-24	W48D	73-31-11 PG1	Fuel Flow Indication	D05326P-25	D04616J-23	INS Repair	R2	2
42	W0766-302Y-24	W48D	73-31-11 PG1	Fuel Flow Indication	D05326P-26	D04616J-25	INS Repair	R2	2



WRN	SVC	Wire Ident	WTC	Wiring Diag. No.	System Description	From	To	Damage/Repair	SC	RC
42		W0766-302Z-24	W48D	73-31-11 PG1	Fuel Flow Indication	D05326P-44	D04616J-22	INS Repair	R2	2
44		W0766-085-24	W51F	75-23-11 PG1	Engine External Accessories Cooling	D05326P-17	D04616J-40	INS discolour	R2	1
90		W0782-213B-24	W48D	77-12-11 PG1	Engine Tachometer System	D06580J-03	D06584P-23	Pin/splice	R2	4
90		W0782-213R-24	W48D	77-12-11 PG1	Engine Tachometer System	D06580J-04	D06584P-22	Pin/splice	R2	4
97		W0264-086-18	W51F	78-34-11 PG2.1 SH1	Thrust Reverser Control Left Engine	D04774P-25	D04042P-21	INS-SPL-AAIB	S2	3
98		W0264-087-18	W51F	78-34-11 PG2.1 SH1	Thrust Reverser Control Left Engine	D06310P-08	D05854P-19	INS-SPL-AAIB	S2	3
96		W0264-0177-18	W51F	78-34-21 PG2.1 SH4	Thrust Reverser Control Right Engine	D04774P-36	D04042P-22	INS-SPL-AAIB	S2	3
48		W0768-610-18	W51F	78-34-21 PG2.1 SH4	Thrust Reverser Control	D06260P-19	D20162-05	INS Repair	R2	2
48		W0768-610-18SH	W51F	78-34-21 PG2.1 SH4	Thrust Reverser Control	D06260P-20	D20162-DED	INS Repair	R2	2
41		W0766-514-18	W48D	78-34-21 PG2.1SH1	Thrust Reverser Control - Right Indication	D05326P-23	D04616J-55	INS discolour	R2	1
41		W0766-514-18SH	W48D	78-34-21 PG2.1SH1	Thrust Reverser Control - Right Indication	D05326P-54	D04616J-DED	INS discolour	R2	1
49		W0768-611-18	W51F	78-34-21 PG2.1SH4	Thrust Reverser Control	D05668P-33	D20162-08	INS Repair	R2	2
25		W0782-027-22	W51F	78-36-21 PG2 SH2	Thrust Reverser Pos - Indicating Sys R Eng.	D11832-08	D06584P-06	Splice	R2	3
26		W0656-801-22	W51F	78-36-21 PG2.1 SH5	T/R Position Indicating System - R Eng	D05068P-54	D07162J-01	Pin/splice	R2	4
29		W0656-802-22	W51F	78-36-21 PG2.1 SH5	T/R Position Indicating System - R Eng	D05068P-55	D07162J-02	Pin/splice	R2	4
30		W0656-803-22	W51F	78-36-21 PG2.1 SH5	T/R Position Indicating System - R Eng	D05068P-58	D07162J-03	Pin/splice	R2	4
28		W0656-804-22	W51F	78-36-21 PG2.1 SH5	T/R Position Indicating System - R Eng	D05068P-57	D07162J-04	Pin/splice	R2	4
27		W0656-805-22	W51F	78-36-21 PG2.1 SH5	T/R Position Indicating System - R Eng	D05068P-56	D07162J-05	Pin/splice	R2	4
31		W0656-807-22	W51F	78-36-21 PG2.1 SH5	T/R Position Indicating System - R Eng	D05068P-60	D07162J-07	Pin/splice	R2	4
43		W0766-032-24	W51F	SPARE	EEEEEEEEEE spare ffffffff	D04760P-25	D04616J-44	Splice	R2	3

**WRN** Wire reference Number

**WTC** Wire type code

**SC** Separation code

**RC** Repair code. Wires were either allowed to continue in service, or required repair, in accordance with criteria and procedures contained in the wiring repair manual (BSWPM Chapter 20-10-13, -15 and 20-30-12) and the maintenance manual (GN/MM-2-0-15-1)

**R-1** Wire discoloured, insulation not damaged. Continued in service.

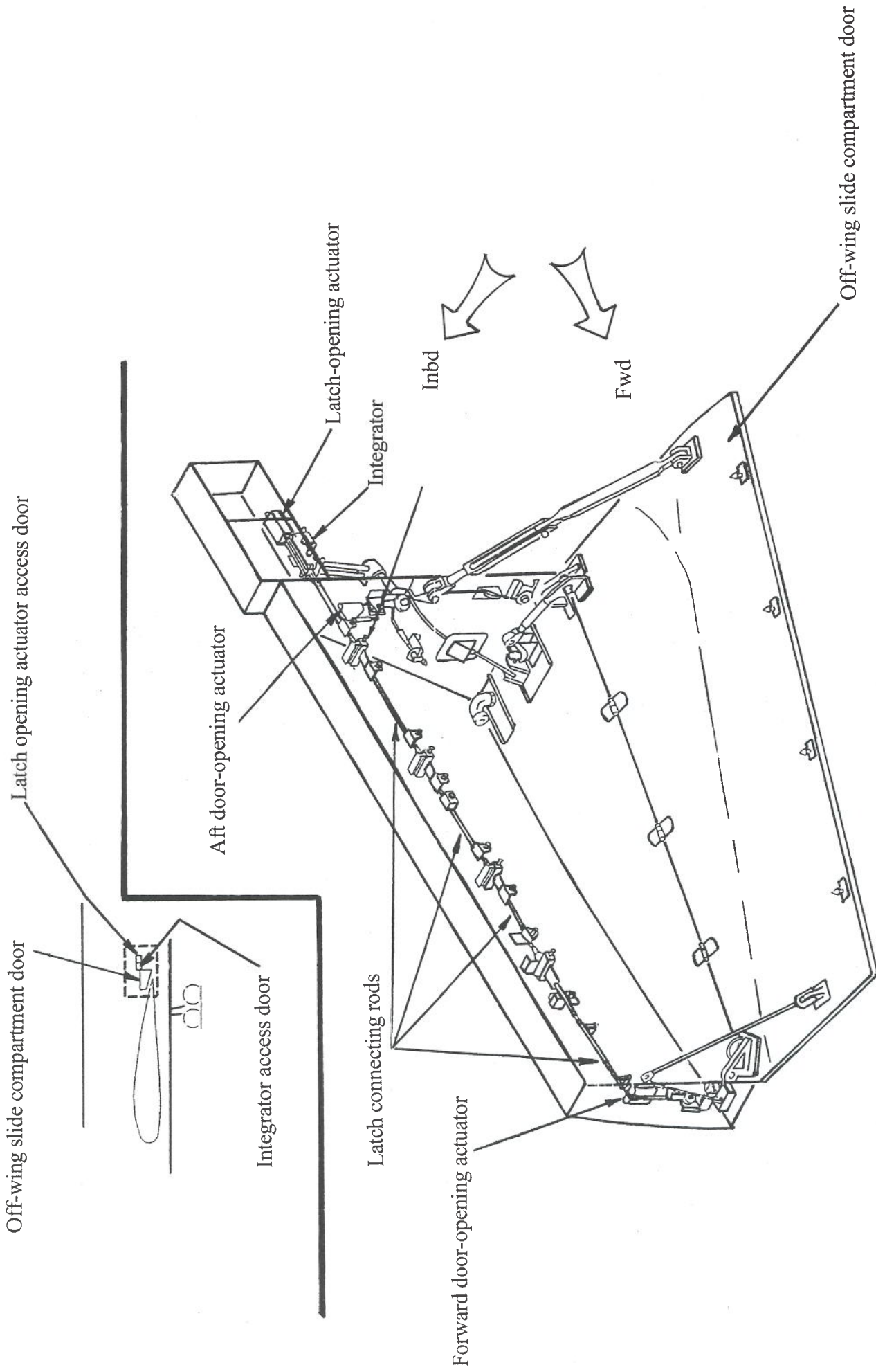
**R-2** Wire discoloured, insulation damaged. Insulation repaired.

**R-3** Wire damaged. Splice repaired.

**R-4** Wire damaged. Wire spliced at one end and terminated at the corresponding connector at the other.

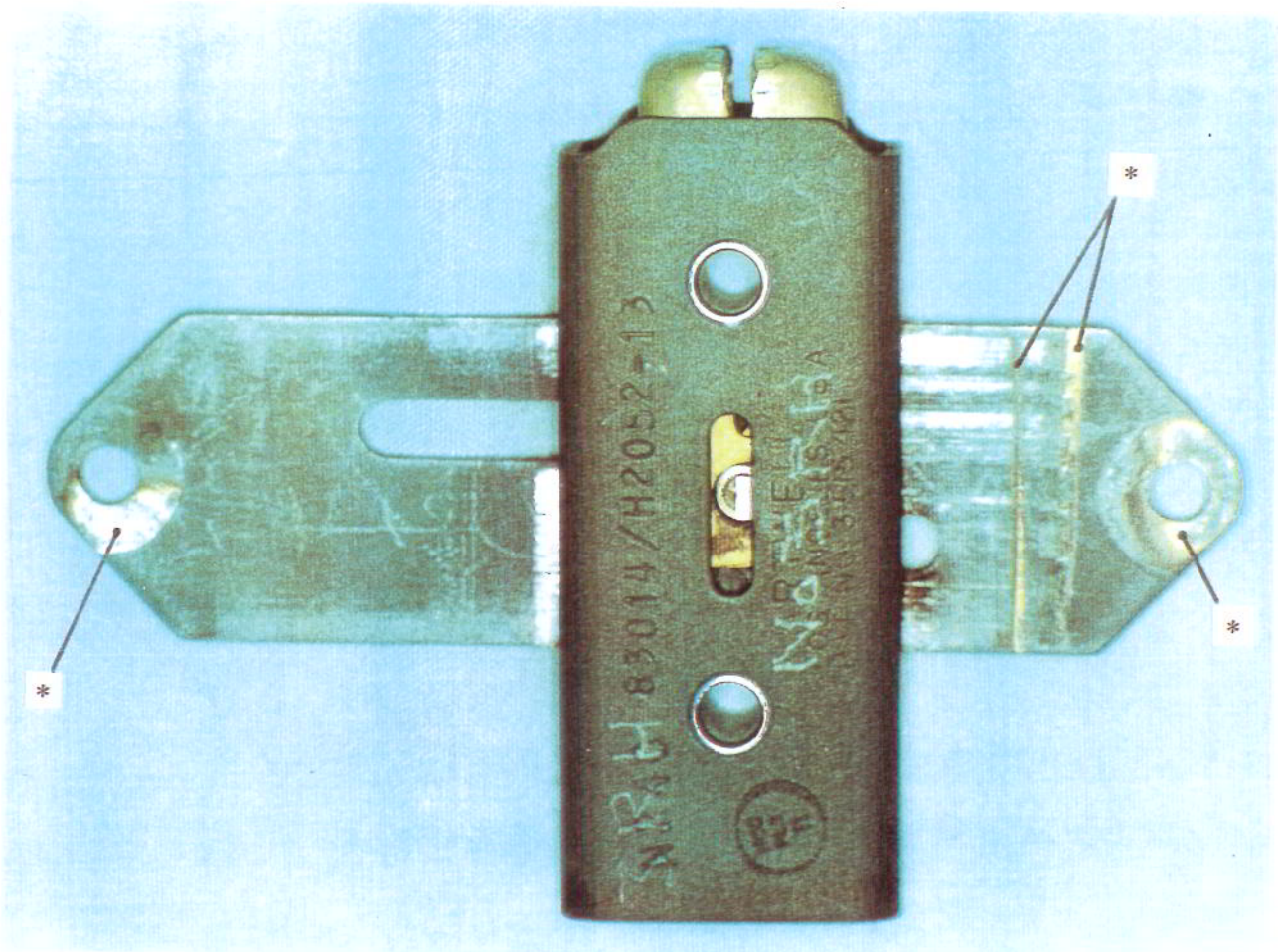
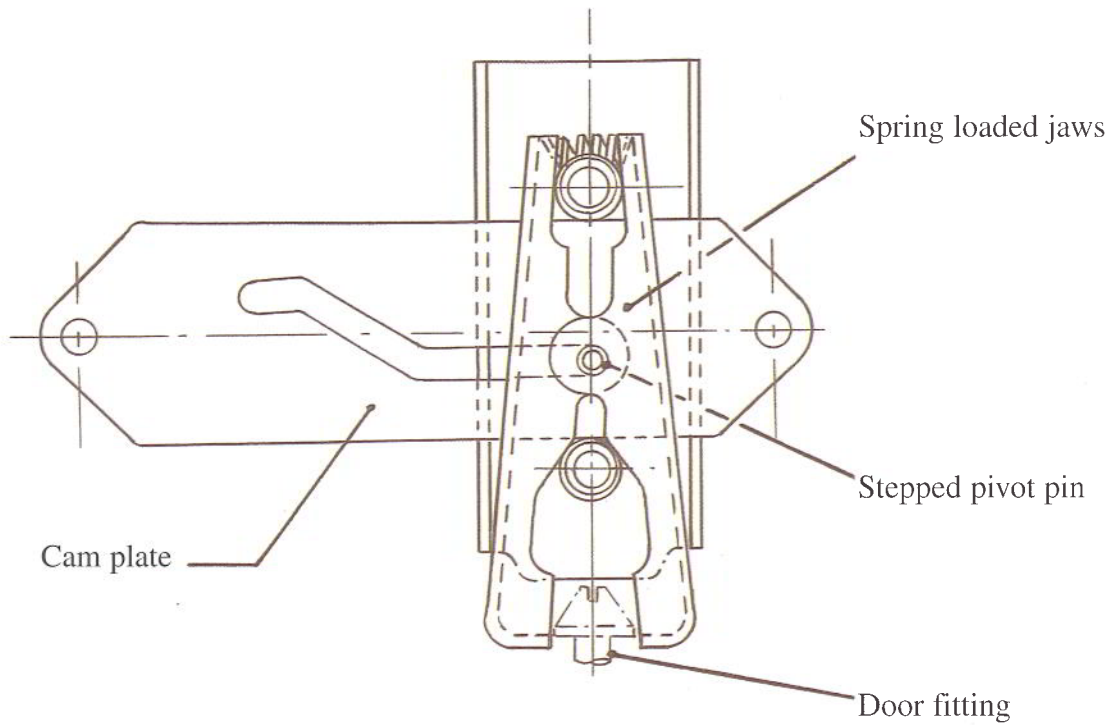






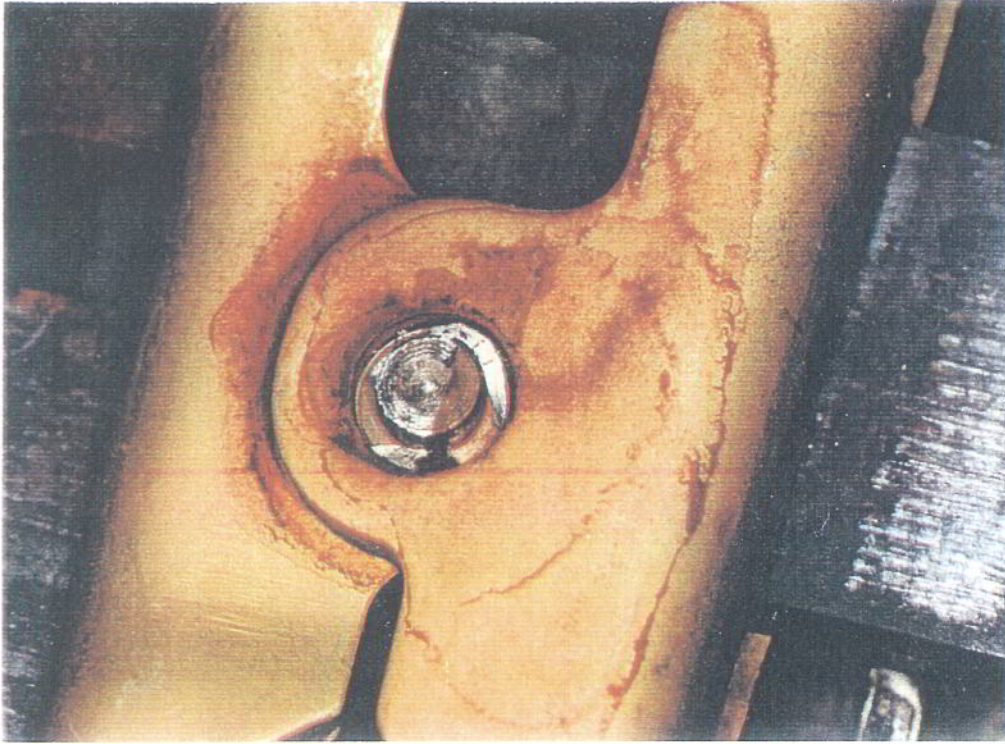
OFF-WING SLIDE COMPARTMENT LAYOUT (Left side shown)

OFF-WING SLIDE COMPARTMENT DOOR LATCH DETAILS

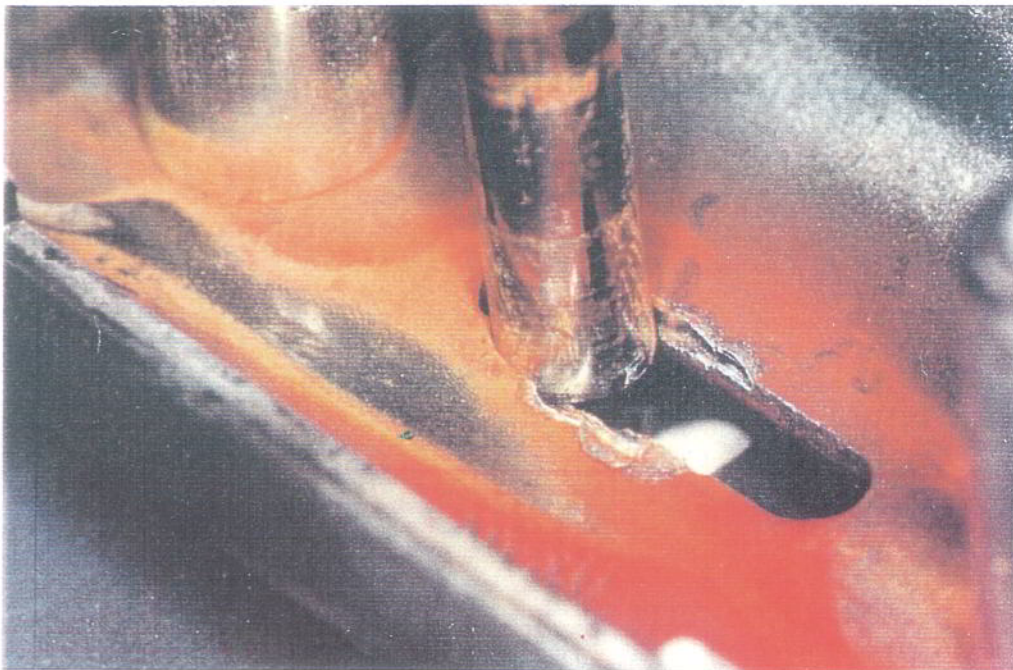


Latch No 3 from left side of aircraft, as found, and jammed mid-travel. Note evidence of fretting around operating rod attachment holes and on cam plate (\*), and displaced pivot pin.





Detail of damage to top of stepped pivot pin, No 3 right side latch.



Detail of lower part of stepped pivot pin, located in area of fretting/wear on the inside face of the lower latch housing. The damage to the right of the pin along the slot edge was caused during the attempted operation and forced opening of the door. Orange deposits resulted from wear between jaws and housing.



AAIB Bulletin No: 10/97

Ref: EW/C97/4/3

Category: 1.1

**INCIDENT**

**Aircraft Type and Registration:** Boeing 747-243B, G-VGIN

**No & Type of Engines:** 4 Pratt & Whitney JT9D-7J turbofan engines

**Year of Manufacture:** 1971

**Date & Time (UTC):** 28 April 1997 at 0018 hrs

**Location:** En-route Washington DC - London Heathrow

**Type of Flight:** Public Transport

**Persons on Board:** Crew - 20                      Passengers - 140

**Injuries:** Crew - None                      Passengers - None

**Nature of Damage:** Overheating damage to wiring loom and furnishing behind overhead panels in forward cabin

**Commander's Licence:** Airline Transport Pilot's Licence

**Commander's Age:** 57 years

**Commander's Flying Experience:** 16,800 hours (of which 11,800 were on type)  
Last 90 days - 155  
Last 28 days - 51

**Information Source:** AAIB Field Investigation

The aircraft had taken off from Washington Dulles Airport en-route for Heathrow. As it approached Halifax, Nova Scotia, the cabin crew in the first class section saw smoke and sparks coming from an overhead panel above the beautician's table, which was fitted as part of this operator's interior layout. No passengers were in the area at the time, which was curtained-off, and they remained unaware of the occurrence. The Flight Crew were informed and the appropriate drills were executed.

The Flight Engineer investigated by dropping the two Passenger Service Unit panels nearest to where the cabin crew had seen the smoke and sparks. Initially he could not see any problem, however, upon removing a lamp fitting and shining a torch into the aperture, he could see evidence of blackened wires and paint discoloration. There were by now no further signs of smoke or fire but he left the opening available for the introduction of extinguishant if required. He also examined the circuit-breaker panels and found that two had tripped - P14 'Ceiling control' and P15 'Light window right'. The flight was continued and completed without further problems.



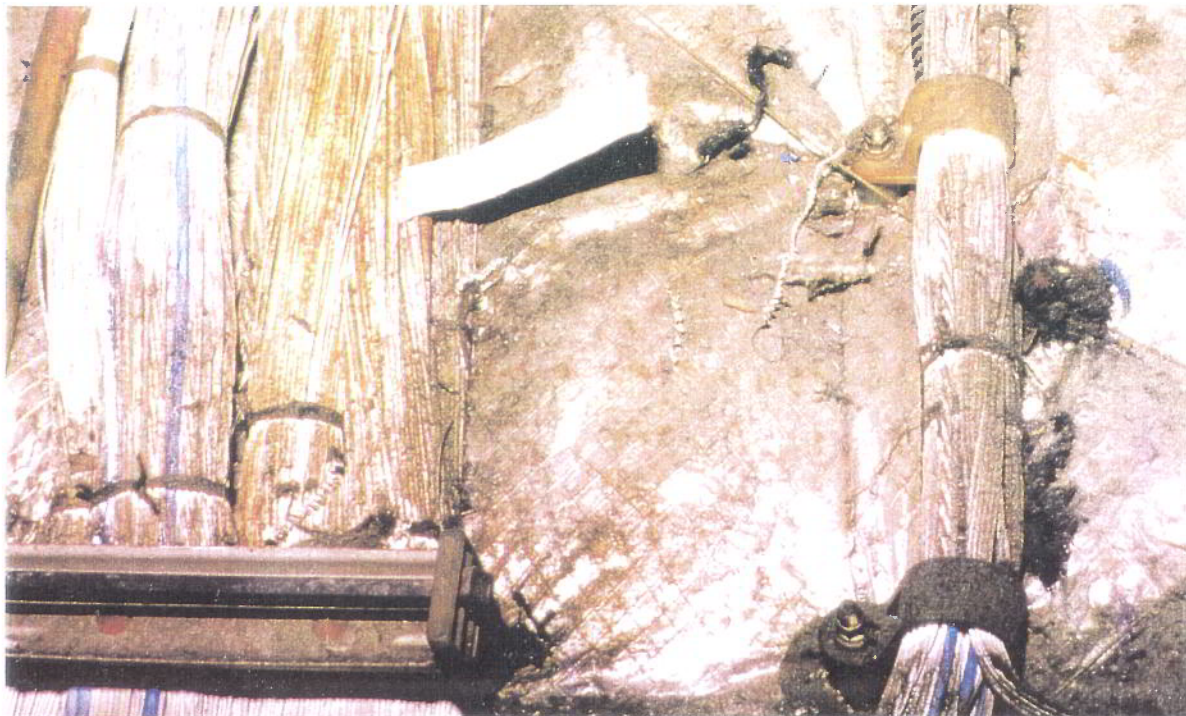
After landing, the aircraft was removed from service and inspected by the operator and the AAIB. Severe overheat damage was found to wiring loom W1144 which was located in the central ceiling panel in Zone B (Station 655) and contained wires for the ceiling and sidewall lights in this zone, both 115V ac and 28V dc. The loom comprised about 50 wires, the majority of which had melted at the same location, associated with a 'P' clip which had also partially melted. Secondary damage to a gasper air pipe and sooting/heat damage to adjacent structure and trim panels was also noted. It was evident that the fire had self-extinguished but the loom in the area of the overheat was too badly burned to identify which individual wire had initiated the sequence.

The airline uses third-party maintenance for major checks and modification and G-VGIN had just undergone such a check at the maintenance facility of another UK operator. Whilst undergoing this work a modification had been embodied to the lighting in the affected section which involved introducing new wires into loom W1144, which consequently ran through the 'P' clip mentioned above. Examination of some of the new wires in an area away from the overheating showed damage to the insulation typical of it having been pulled through a clip, possibly in the presence of sharp metallic debris such as swarf, causing tearing of the insulation. A considerable amount of 'fresh' debris such as swarf, a solid fastener, a stiffnut and a drill bit was found in the area which had been subject to modification. The operator's Quality Assurance is of the opinion that the overheat was due to the new wires being pulled through the 'P' clip with a piece of swarf trapped within the clip, causing damage to the insulation. Unfortunately, the overheat damage in the immediate area had destroyed any direct evidence of this.

The airline has drawn the attention of their maintenance contractor to these findings who had stated that they will in future ensure that such a situation should not arise again, both with respect to 'pulling' wires through clips and the amount of debris not cleaned-up after modification work. The operator also inspected another aircraft which had undergone the same modification work by the same contractor and, as a precaution, changed all four circuit breakers associated with the wiring loom. It is understood that, although some quantity of debris was recovered from the other aircraft, there was no evidence of a potential short-circuit in the loom as had been postulated for the incident to G-VGIN.



Contamination of wiring looms by drilling swarf, found in a retired B747, above, and an A300, below.



TYPICAL EXAMPLES OF CONDUCTIVE DEBRIS

## APPENDIX H

The table below illustrates trip time requirements for thermal type Circuit Breakers, taken from MS 22073.

<b>Trip Times at 25°C</b>
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Rated Current, %	Trip Time
115	Must hold: 60 mins minimum
150	Must trip: 60 mins maximum
200	2.0 - 20 secs
500	0.16 - 2.0 secs
1000	0.046 - 0.8 secs

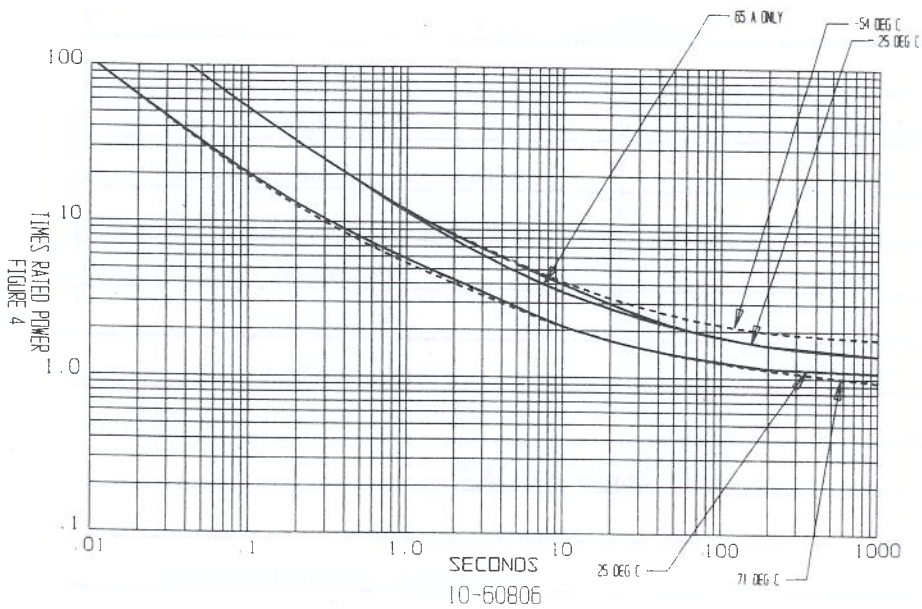
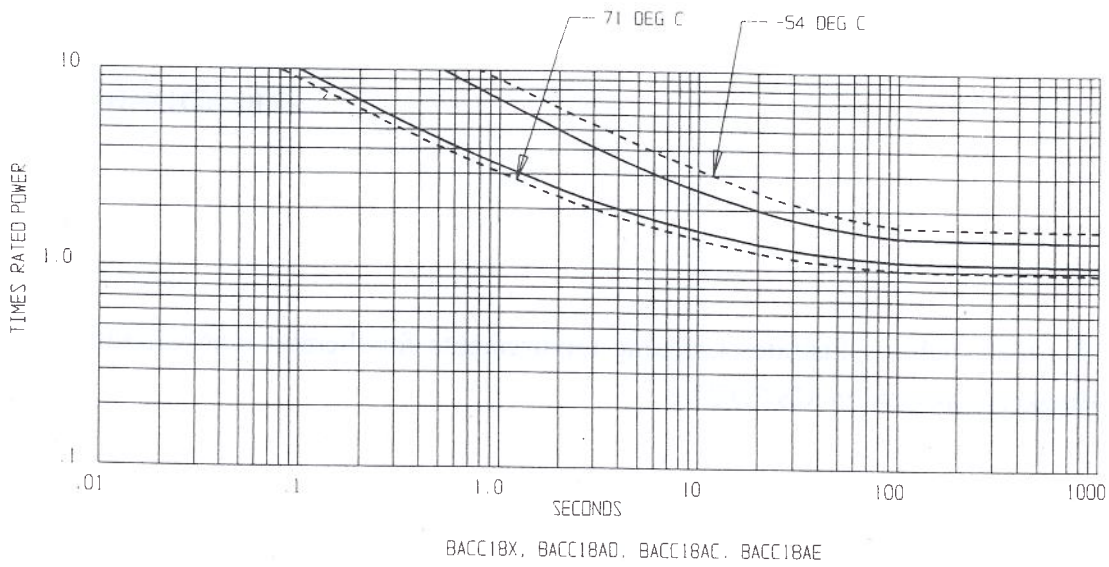
<b>Trip Limits at -55°C</b>
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135	Must Hold: 60 mins minimum
180	Must Trip: 60 mins maximum

<b>Trip Limits at 71°C</b>
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90	Must Hold: 60 mins minimum
130	Must Trip: 60 mins maximum





Location	Circuit Breaker/Pt No	Rating
Fwd Equipment Ctr P33 panel	Bus Sect 2 Gnd Service BACC18X20	10A
Flt Deck Overhead panel P11	T/R Ind BACC18Z1R	1A
	R Eng T/R Ind Altn BACC18Z1R	1A
Flt Deck P6-4 Panel	Pitot Heat - L Aux Phase C BACC18Z5R	5A
	Pitot Heat - F/O Phase B BACC18Z5R	5A
	Passenger Service Outlet BACC18AC10	10A
	Altn Slat Outbd Pwr BACC18AC10	10A
	Altn Flap Pwr BACC18AE15	15A
	Altn Slat I/B Pwr BACC18AC3	3A
	R TRU 10-60806-1020	20A

*Stated Response Characteristics of  
Circuit Breakers Found Tripped on  
N653UA*