



Practitioner Case History

Field Experience



Why am I here?

- To share NWA's experiences and learn from the experiences of others
- To ensure NWA is using “best practices” to accomplish safe and economical repairs
- To help OEM's understand what they can do to facilitate/improve their customers understanding and accomplishment of maintenance



CACRC Charter

- “To develop and improve maintenance, inspection and repair of commercial aircraft composite structure and components”
 - Ultimate goal
 - Lower maintenance cost of existing composite structures, via standardization among OEMs and airlines.
 - Minimize life cycle cost of future designs.



Not a success story

- Not a single event but specific component issue
 - Significant financial impact
 - Material procurement issues
 - OEM approval difficulties
 - High component life cycle cost



The Problem

- Moisture ingress
– Slat wedges
– Spoilers
– Elevators
– Fan cowls
– Body fairings
– etc
- How is it identified
 - Obvious damage
 - Disbond
 - Directed inspection
 - Tap test
 - Thermography
 - X-ray



Background

- Originally discovered on NWA aircraft in 1993
- Escalated to AD for mandatory SB accomplishment in 2002
- 99 of 95 units had indications
- 82 units repaired at NWA
- 13 units beyond economical repair
- No units exhibited signs of disbond as determined by tap test



Financial Impact

- NDI equipment
 - Specific thermographic equipment required
 - Training and certification required for use
- Material acquisition
 - Required materials not commonly stocked at NWA
 - OEM unable to approve requests for alternate materials
 - Replacement cost of components found beyond repair



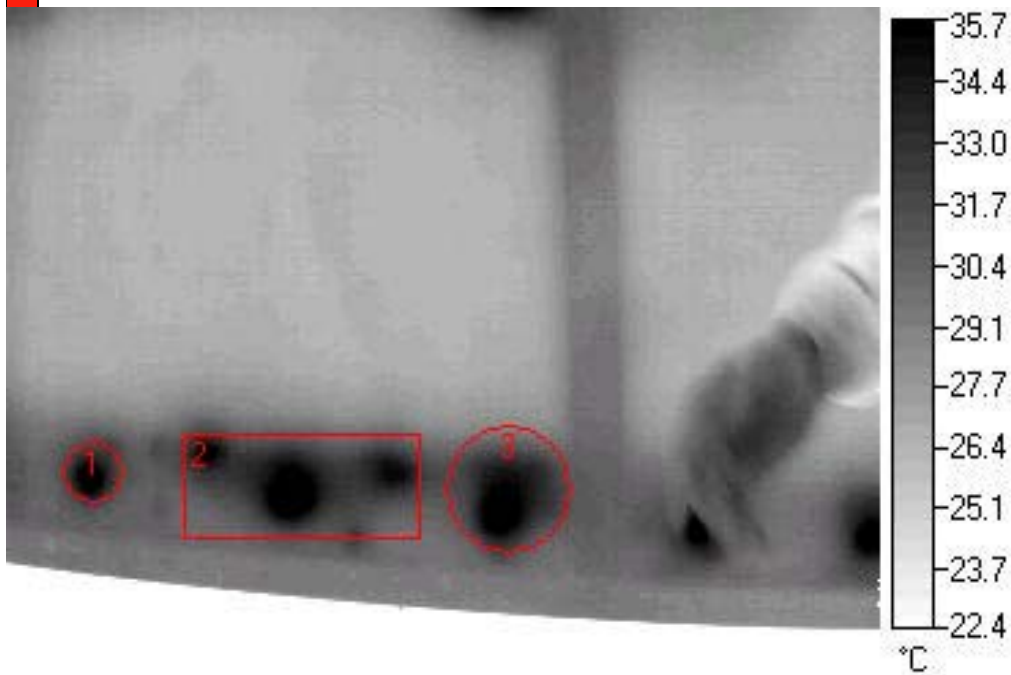
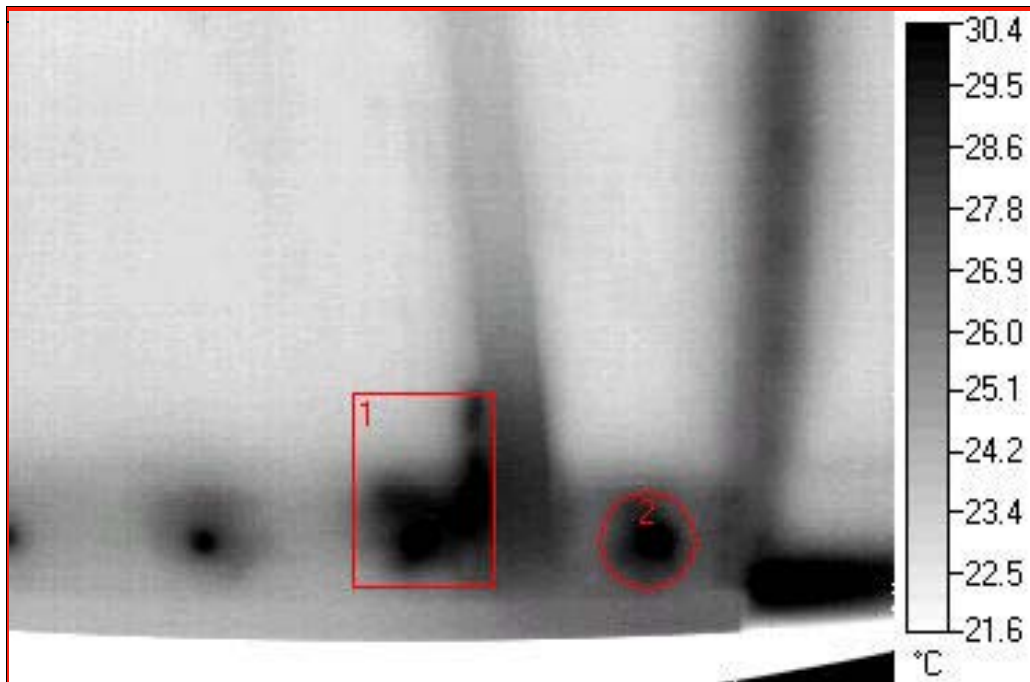
Financial Impact

- Labor Requirements (per component)
 - Inspection 18 hrs
 - Thermographic examination and RII and completion of work
 - Engineering 8 hrs
 - Assessment and documentation of damage
 - Correspondance with OEM
 - Technicians 122 hrs
 - Component removal/installation
 - SB/AD accomplishment
 - Non routine Items



Findings

- Majority of moisture ingressions indications located around skin discontinuities
 - Trailing edge inserts
 - Holes in skin provide possible moisture ingression path
 - Electrical conductivity straps
 - Embedded in OML surface possibly distorting fiber alignment





Repair Issues

- Complicated damage assessment guidelines
 - Technicians request engineering to assist in determining damage order and grouping
 - Large number of damage sites and irregular shapes require detailed and careful mapping
 - Misinterpretation can result in damage cut-outs which exceed allowable repair limits

ORIGINAL IN RED

Distribution: Engineer: <u>DLH</u> Engr. Ingr.: <u>JAB</u>		Northwest Airlines ENGINEERING AUTHORIZATION National Airlines, Inc. Engineering Dept.		E.A. Number 32-197865	Rev B
Name of Component/Title Left Hand Elevator, Upper Skin		Orig. Issue Date 02 Feb 04	Last Rev. Date 02 Mar 04		
NWA Ship & Serial No. - 58486 -		Type A320	Hours 34,678	Cycles 15,143	Mfg. ATA Code 55-20-01
Mfg. PIN D552 80001 004 51		Classification <input checked="" type="checkbox"/> Major <input type="checkbox"/> Recurrence <input type="checkbox"/> Vice		Prepared By / Date Dan Hitchcock / 02 Feb 04	
Approval No. 0121 (CG 1421)		Approval Date 02 Feb 04		Approved By / Date Brian Holasek / 02 Feb 04	
NWA Stock No. 32-5520-4-0001		NWA DSR SFAR 36		Aircraft Zone 33C	
Weight & Balance Change Weight: <u>NA</u> <u>NA</u> <u>NA</u>		Approval of AIRCRAFT DEPT <u>NA</u>		Rev Info See Sheet 3	

Category of Repair: 1. IN-SERVICE DAMAGE 2. DAMAGE ON THE GROUND 3. MODIFICATION 4. REPAIR 5. N/A 6. OTHER

DTA Required: MA NO YES

REPAIR/MSRP Accomplished for the primary government. Additional E1 requirements in this field will be addressed. Ref: SRM 55-21-11

Description of Problem:
 During accomplishment of Airbus Service Bulletin A320-55-1024 [Ref (A)] through inspection at MUP and per Refs (C), (D), & (F) multiple locations with evidence of water ingestion were found on the upper surface of the LH Elevator. The elevator skin panels are made from CFRP with FRP fiberglass fabric honeycomb core. See Figure 1 for details.

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- (A) Airbus Service Bulletin A320-55-1024
- (B) Airbus Service Bulletin A320-55-1021
- (C) OM812 #584002, Item #5, Dated 12 Jan 04.
- (D) OM812 #234912, Items #1, #2, #3, #4, & #5, Dated 12 Jan 04.
- (E) OM812 #234913, Items #1, #2, #3, #4, & #5, Dated 12 Jan 04.
- (F) Airbus R15, Reference R15/CAS/02-04/Rev. 1 Dated 01 Dec 04

Sec.	Recommended Scheduling	Labor Required			Material Advice
		Mech	Elapsed	Total	
I.	During shop visit, 02 Feb 04	-	-	-	Draw Stock
II.					
III.					
IV.					

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SECTION I - REPAIR (MAJOR)

1. Gain access as required.
2. Repair each damage in group of damage as follows:
 - a) Damage #1 & #2: Perform a combined cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2) and Figure 205 (sheet 4).
 - b) Damage #3: Perform a cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2).
 - c) Damage #4: Perform a cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2).
 - d) Damage #5: Perform a cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2).
 - e) Damage #6: Perform a cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2).
 - f) Damage #7 - #14, plus damage from removing the metallic strip at this location: Perform a structural repair according to A320 SRM 55-21-11 Figure 214 with the following deviations: (See Figure 2 for similar repair)
 - i) Only remove core where water indications exist. Do not remove core in adjacent areas in affected areas within the same envelope.
 - ii) Install 3 carbon fiber ply, extended to cover the adjacent areas within the envelope, where the outer original ply has been removed.
 - iii) The repair plies have to extend to the front spar and trailing edge ends.
 NOTE: The fasteners in the front spar area need to be removed as can be seen in Figure 2.
 - g) Damage #15 & #17: Perform a combined cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2) and Figure 205 (sheet 4).
 - h) Damage #17: Perform a cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2).
 - i) Damage #18 - #24, plus damage from removing the metallic strip at this location: Perform a structural repair according to A320 SRM 55-21-11 Figure 214 with the following deviations: (See Figure 2)
 - i) Only remove core where water indications exist. Do not remove core in adjacent areas in affected areas within the same envelope.
 - ii) Install 3 carbon fiber ply, extended to cover the adjacent areas within the envelope, where the outer original ply has been removed.
 - iii) The repair plies have to extend to the front spar and trailing edge ends.
 NOTE: The fasteners in the front spar area need to be removed as can be seen in Figure 2.
 - j) Damage #25: Perform a cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2).
 - k) Damage #26 & #27: Perform a combined cosmetic repair according to A320 SRM 55-21-11 (C1) Figure 204 (sheet 2) and Figure 205 (sheet 4).
3. RII required.
4. Restore access.

A. SUBSTANTIATION

1. This is an Airbus Company approved per Reference (F) in (B).
2. The subject deviation is a repair structure per A320 SRM 55-21-11, Figure 2. The Section I repair is a cosmetic repair with strength restored per standard SRM guidelines with minor deviations and is therefore considered major per NWA CR-35.

B. AIRBUS CO. REP. (02 Feb 04)

1. NWA requests Airbus clarification on what order (different vs. same order) these damaged areas are, along with what the total damaged area to be considered is. NWA would like to know which areas are required to be enveloped together as one damage and which are flight as separate damages. NWA is having some difficulty interpreting A320 SRM 55-21-00 [Ref (B)] for the damaged areas as are detailed in this EA. Please refer to Figure 1, Table I, and Details I, II, III, IV, & V.
2. Please note, water ingestion indications were such that two (2) of the metallic strips had to be removed. During

removal, further damage occurred. One ply of CFRP was pulled up along the entire length of both the strap identified in Figure 1.

3. NWA would like Airbus instructions/approval for how to repair the damaged areas detailed in this EA.
4. A quick response would be appreciated in order to maintain the schedule of overhaul for this and other areas in the NWA shop. NWA would like a response by close of business on Wednesday, 04 Feb 04.
5. A response was received from Airbus on 04 Feb 04 and included in the Section I repair.

AIRBUS CO. REP. (04 Feb 04)

1. NWA has three things to report/question:
 - a) In regards to Airbus' repair direction for damages 7, 8, 9, 10, 11, 12, 13, & 14 (and a reply to 16, 17, 21, 22, 23, & 24), Airbus' assumption that the outer ply of CFRP under the metallic strip is the damage is correct. Additionally, NWA has already removed core of ALL of the damage locations reported in the The Service Bulletin (A320-55-1024) requires that "water ingress damage systematically requires core replacement." Therefore, NWA would like Airbus to clarify the required "work" direction for those to repair areas to allow for core removal, since this is a requirement in the SR.
 - b) In regards to damage 17, recued overlapping is not necessary. In fact, NWA incorrectly reported damage 17 and 18 too close together. Damage 17 is 9.75" away from the metallic strip rather than 6.0" as was incorrectly reported in the original FA. The new revision of this FA will include this correction.
 - c) Detail I also has a mistake. Damage 6 of this area is being 7.1" westward from the metallic strip (vs. 4.25"). It is still 4.25" forward of the trailing edge. This information will also be corrected in the new revision of this EA.
2. Your response to the above request would be appreciated as soon as possible, please.
3. A response was received from Airbus on 04 Feb 04 and included in the Section I repair and added as high.

AIRBUS CO. REP. (28 Feb 04)

1. All of the work has been accomplished. Please note the final damage sizes are unchanged as shown in Fig 1 (a-e).
2. NWA would like Airbus approval for the repair to the damaged areas detailed in this EA. Please issue an RA this month.
3. A response is requested by close of business on Monday, 01 Mar 04.
4. A response was received from Airbus on 01 Mar 04 and included as Reference (F).

REVISIONS:

- (A) Revised Classification, Description of Problems, TOC, Section I, A (supplementation), B (Airbus Co. Rep., Figure 1 - Details I & IV), Added (C) (Airbus Co. Rep.), (D) (Airbus Co. Rep.), and (Figure 1)
- Dan Hitchcock / 28 Feb 04 / Brian Palasek
- (B) Revised (C) (Airbus Co. Rep.); Added Reference (F).
- Dan Hitchcock / 02 Mar 04 / Brian Palasek

Duff Held 07-MAR-04 / *[Signature]* 3/2/04

Figure 1

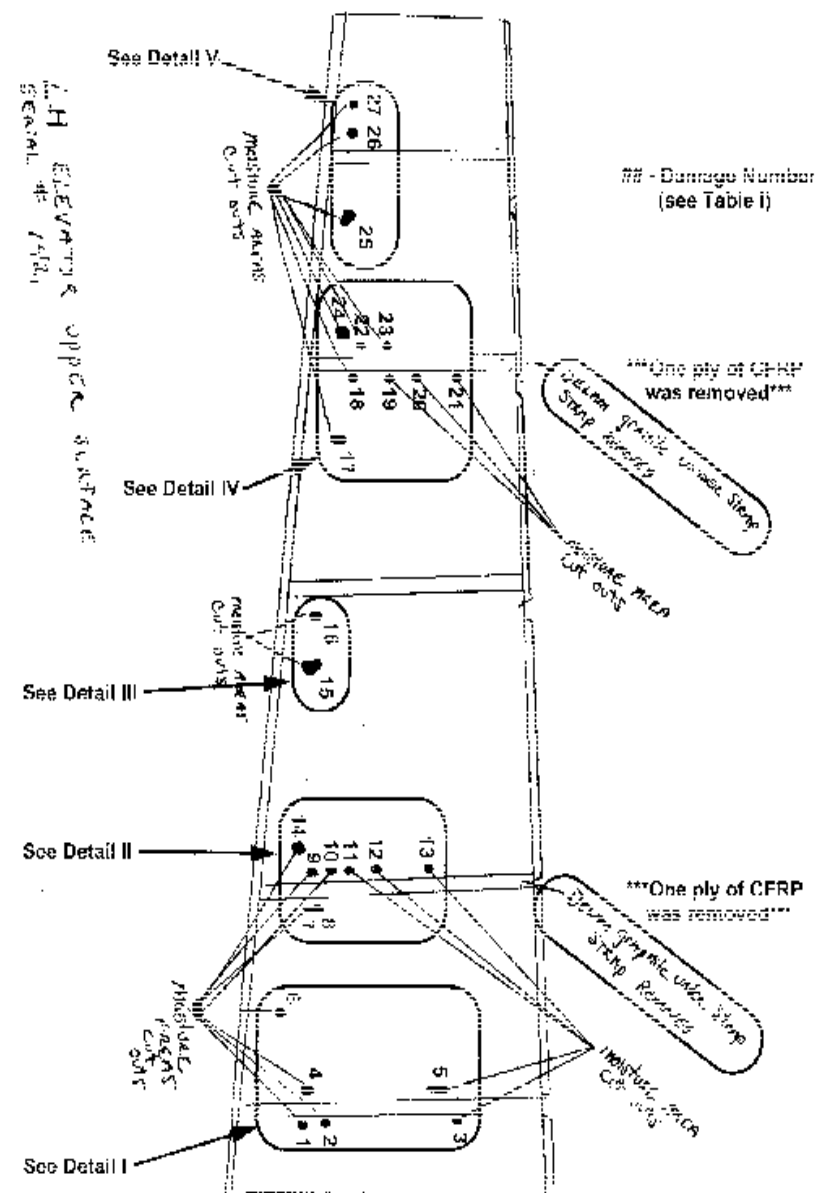


Figure 1
Table I

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B

Damage Number	Damage Size
1	0.5" x 0.5"
2	0.5" x 0.5"
3	0.5" x 0.5"
4	0.5" x 0.5"
5	0.5" x 1.625"
6	1.0" x 1.0"
7/8	0.5" x 2.0"
9	0.5" x 0.5"
10	0.5" x 0.5"
11	0.5" x 0.5"
12	0.5" x 0.5"
13	0.5" x 0.5"
14	1.0" x 1.0"
15	2.5" x 3.5"
16	1.0" x 1.0"
17	1.0" x 1.625"
18	0.5" x 0.5"
19	0.5" x 0.5"
20	0.5" x 0.5"
21	0.5" x 0.5"
22	0.5" x 0.5"
23	0.5" x 0.5"
24	1.0" x 1.0"
25	3" x 2.5"
26	1.0" x 1.0"
27	0.5" x 0.5"

Figure 1
Detail I

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Sheet 6 of 15

B

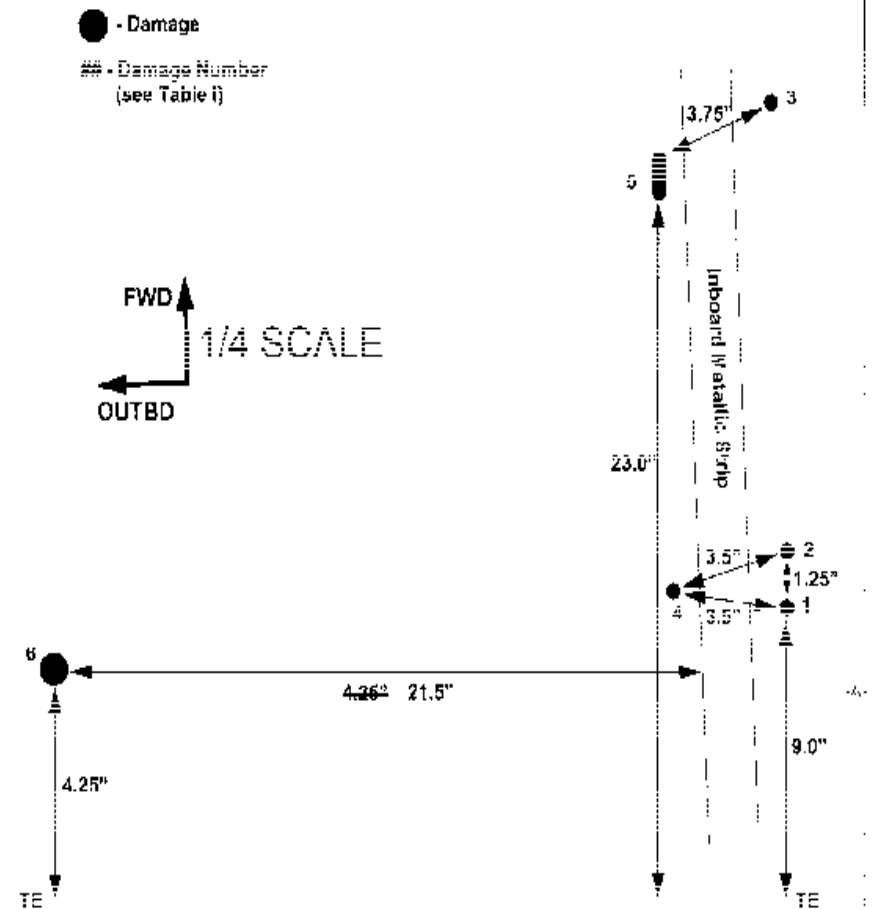


Figure 1
Detail II

1. A Number
32-197865
Steel 7/8"

Rev
B

● - Damage
- Damage Number
(see Table I)

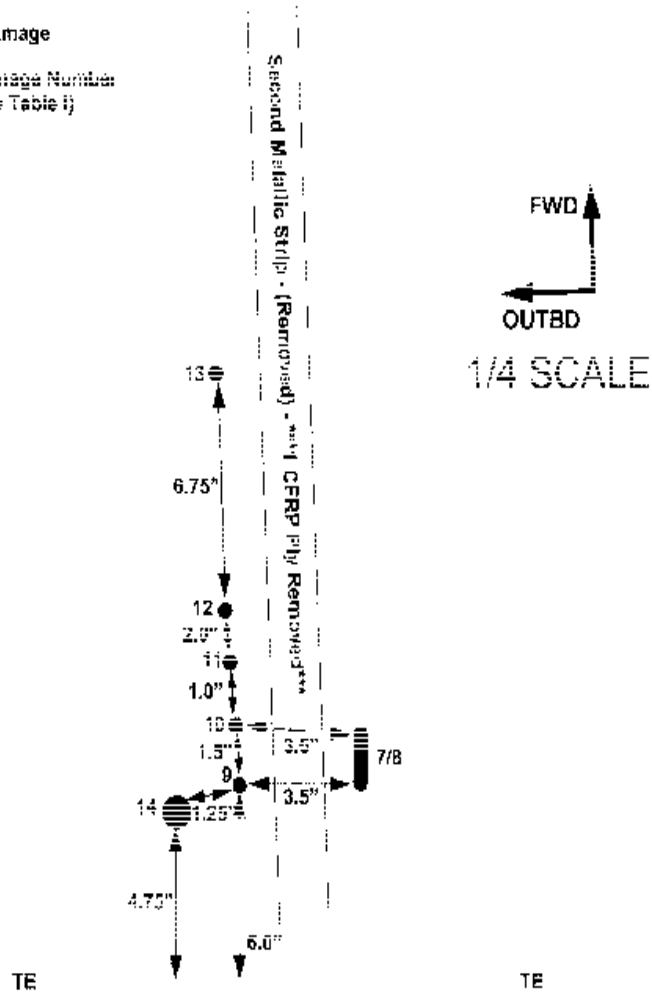


Figure 1
Detail III

1. A Number
32-197865
Steel 7/8"

Rev
B

● - Damage
- Damage Number
(see Table I)

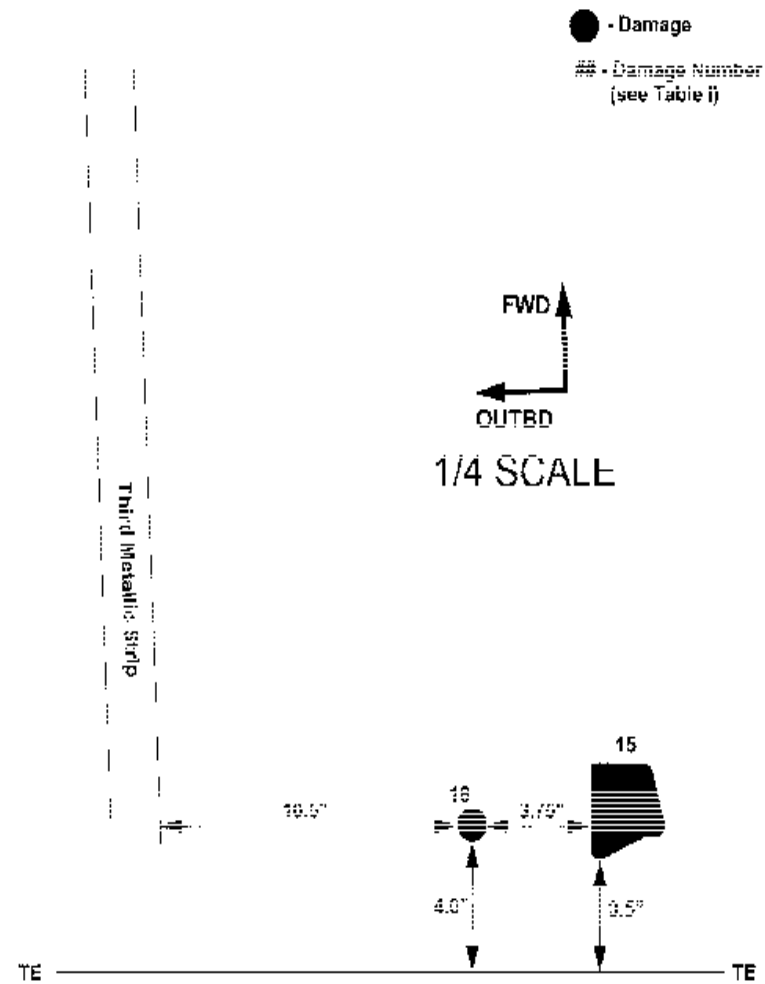


Figure 2
(sheet 1 of 2)

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Sheet 1 of 3

Rev.
B

*IN THIS AREA, THE EXISTING FASTENERS HAVE TO BE REMOVED
IN ACCOMPISH THE REPAIR. WHEN THE REPAIR HAS BEEN
PERFORMED, INSTALL FASTENERS SAME TYPE AS ORIGINAL
(GRIP TO BE DEFINED IN ASSEMBLY)*

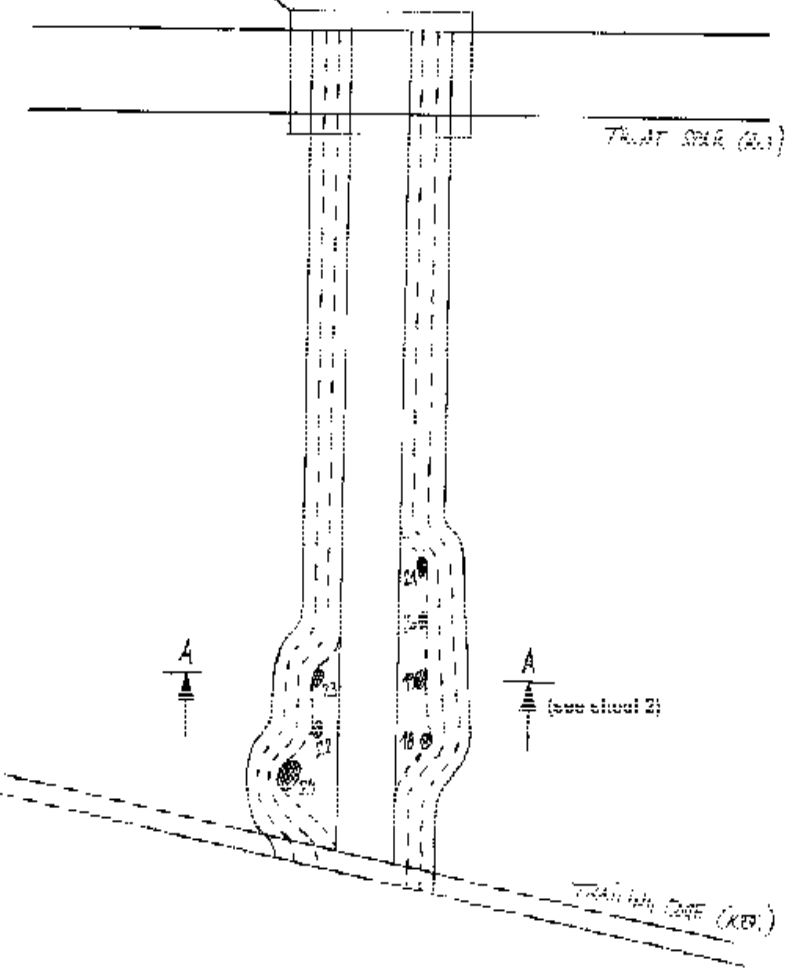
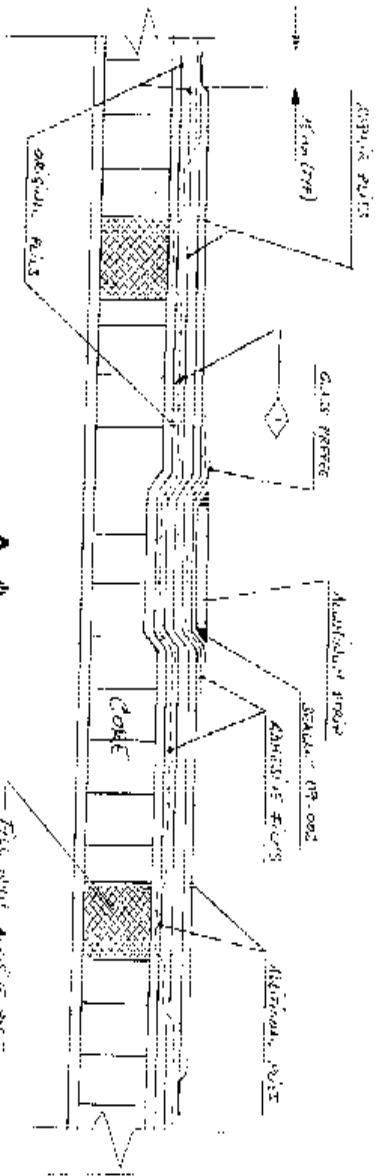


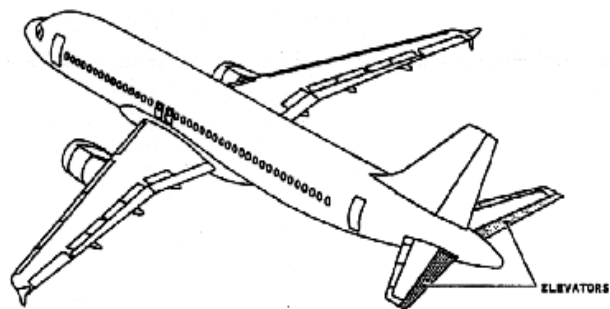
Figure 2
(sheet 2 of 2)

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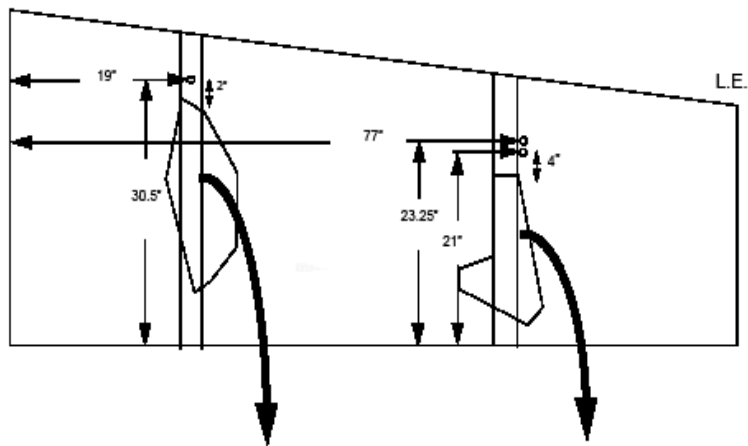
Rev.
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① IT IS VERY ESSENTIAL TO REMOVE THE CORROSION AND COKE IN THE AFFECTED AREA BY
WATER JACKETS,
THE ORIGINAL AND CURRENT USE OF THE SPAR AND UNDERLIES MUST BE REVIEWED
ASOR NOT NOT BE LISTED





INBD

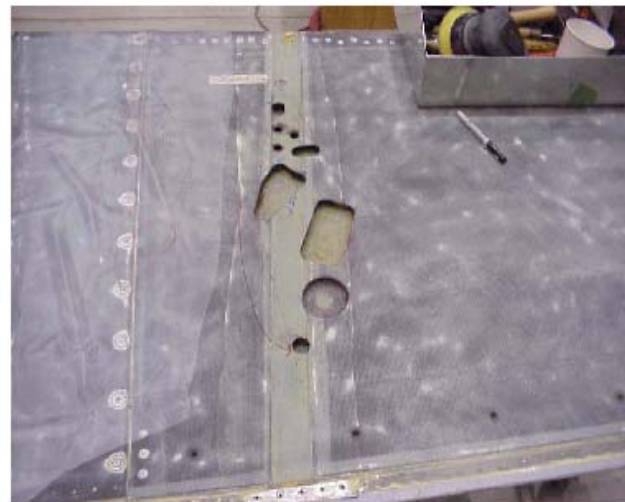


SEE DETAIL A

SEE DETAIL B

AREA OF DETAIL A 63 sqin

AREA OF DETAIL B 40 sqin



DETAIL A



DETAIL B



Repair Issues

-
- Allowable composite repairs constricted by tight size limits
 - Unable to convince OEM to allow larger repairs through the use of analytical methods
 - Repair material specified is not the original construction material
 - Test data unavailable to substantiate larger repair
 - Large scale repairs forbidden
 - Skin panel replacement not allowed



Repair Issues

-
- Majority of repairs accomplished via SRM procedures
 - Approval from OEM still required due to contact OEM requirements in SRM



Summary

-
- Moisture Ingression is a known composite phenomena and must be accounted for in design
 - Several years passed between initial findings and SB release, yet repairs not developed to allow for findings
 - Components are Airworthiness Limitation Items (ALI) and will require continued inspections with additional findings expected



Suggestions

-
- Develop increased composite repair limits
 - Allow for large scale repairs to be accomplished, for example skin panel replacement
 - Re-evaluate use of similar design in future aircraft



Closing Remarks

-
- Comments and Questions?