F. APPENDIX B

AIRBUS

INSPECTION PROTOCOL

TO		
Mr. K.-P. Steen,	*BWED*	*HAM*
COPY		
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Mr. D.Schiller,	*ESWNG*	*BRE*
Mr. W. Pieles,	*ESWNG*	*BRE*
Mr. H. Hicken	*BIAS*	*BRE*

FROM
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04 März 2002
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REFERENCE
ESWNG-70032/02

Subject: Fin box and rudder inspection on aircraft A300-600, MSN 420 at NASA Langley Research Center in Hampton, Virginia / USA.

General: After the AA587 flight accident a meeting of structure specialists was arranged to debate about following actions and their goals.
Goals established by the NTSB (National Transportation Safety Board)

-1- To review all team member efforts to date in studying possible causes of the AA587 accident.
-2- To finalize the structure portion of a fault tree, including all possible scenarios that may have contributed to the accident (and idendify all interface issues with other working groups).
-3- To difine the report review, analysis, testing, and documentation tasks needed to "close" or retain as "likely" the branches of the fault tree that constributed to the AA587 accident
-4- To review field notes, team member hypotheses, photo maps and NDI data collected to date, and conduct additional detailed visual examinations and documentation in order to define the most likely sequences of structural failures occurring to the vertical fin and rudder.
-5- To identify the destructive lab experiments and inspections to perform with failed portions of the vertical fin and rudder structures, to get the most data of direct relevance to –2-, -3- and –4- from above in the shortes time. This would include detailes of the cuts, sequence of testing and test facilities needed.
-6- To assign team member action.

For special areas NDT-Inspections at the above mentioned aircraft components Airbus promised to support the US-authorities and airline during phase of investigation.
(Selected areas to be inspected by Airbus; ESWNG are given in following report)

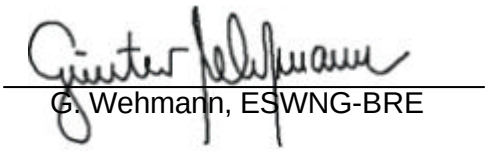
NDI-results: (ESWNG)

Fin box

- Debondings, Delaminations and Damages were found in the lower part of fin box in the structure of lugs region, in the rib no. 1area and in spar areas (front/center/rear).
- No findings in the hinge connection areas

Rudder -

Debondings, delaminations and damages were found in and at fiber glas hinge attachment blocks



G. Wehmann, ESWNG-BRE

General: After the AA587 flight accident a meeting of structure specialists was arranged to debate about actions.

Program:

With the agreement of all involved parties a recommended special NDE program was defined. Airbus; ESWNG-BRE was asked for take over the following tasks:

No.I Hand held ultrasonic inspection at fin box

a. Shells:

Inspection of lug regions from both sides of the lug and shell above the lugs from both the outside and inside of shell up to 340 mm from the hole of the lug.

b. Spars:

Inspection of front spar; center spar and rear spare to a distance up to 400 mm from missing region.

c. Composite Hinges Conection

Inspection of all composite hinges connection regions

d. Rib No. 1

Inspection of rib no. 1 as much as possible

No.II Hand held ultrasonic inspection at rudder

a. Ultrasonic inspection of the fiber glas hinge attachment blocks of rudder in accordance with NTM A300-600 SSI no. 55-40-04

No.III Application of the US-Phased Array Technic

a. US-phased array application for Stgr./ Skin debondings / delaminations in fin box structure.

Dates of inspection:

Location of NDI-inspection:	NASA Langley Research Center / Hampton / Virginia / USA
Date of inspection:	07.02.02 – 22.02.02
Used equipment:	Ultrasonic device Type USL25 and accessories , Ultrasonic device – Type USIP 12 and accessories ; Manual tap-test hammer, US-Phased Array –Type FOCUS from R/D Tech.
Inspection procedure:	For No.1 – acc. TN-ESWNG – 1155/01 (US-procedure /draft) For No.2 - acc. NTM SSI A300-600 No. 55-40-04 For No.3 - acc. Application Procedure for US-phased array technic

Names of NDI-Team members: Mr. Hicken; Mr. Pieles; Mr. Wehmann

Inspection areas:

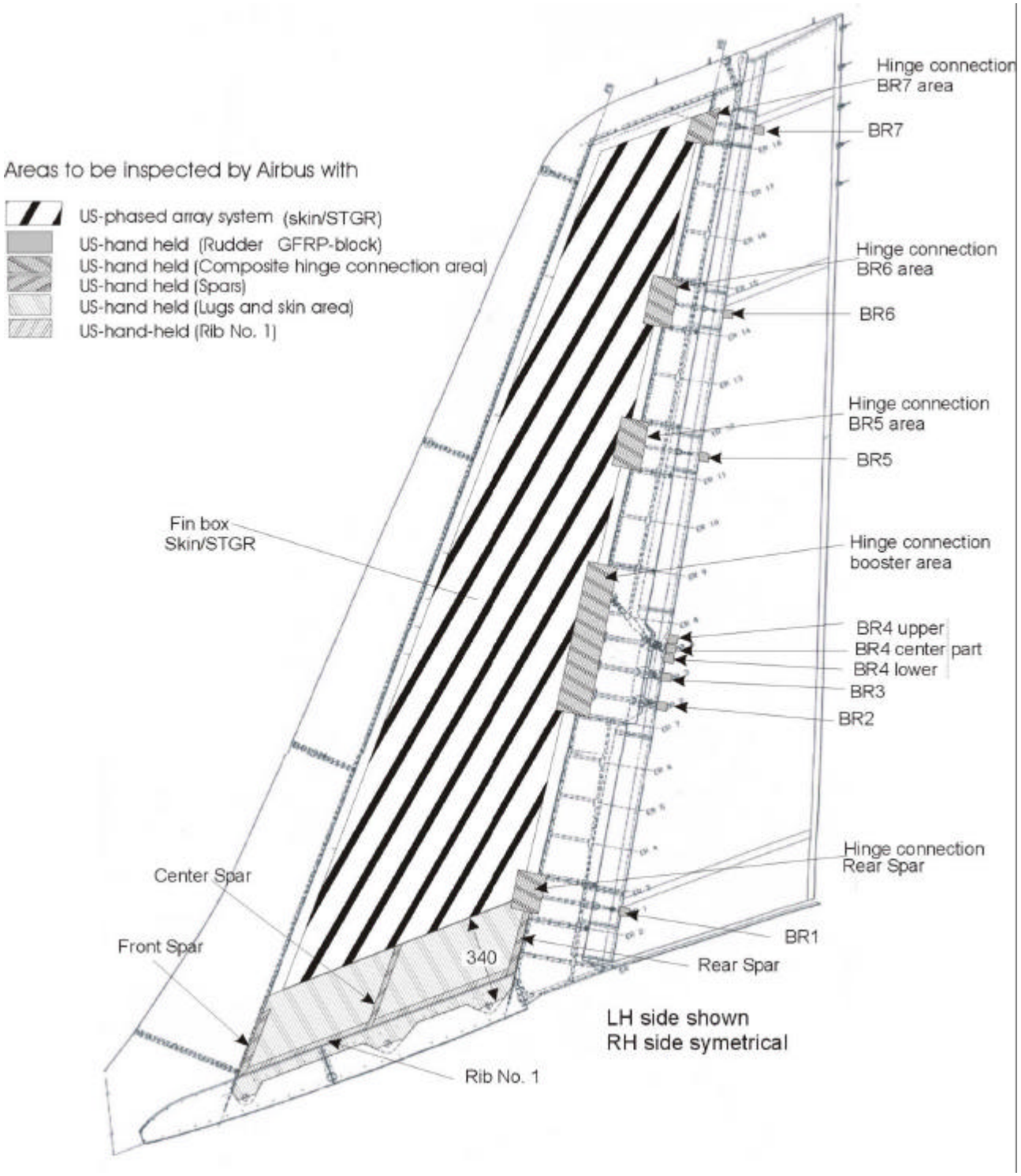


FIG. 01: Areas to be inspected by Airbus ESWNG at Vertical Stabilizer of MSN 420

Test Results:

No.I: HAND HELD ULTRASONIC INSPECTION AT FIN BOX

A. Condition during Inspection

The fin box was approx. 1 m jacked up in horizontal position on trestles so that the LH side was directed downward. From this it follows that the LH side inspection has to be done in an overhead work position which required a lot of human static muscularity. The RH side inspection could be done in a normal inspection position.

(1) Test results of shell (skin) and lug inspection with Ultrasonic.

(a1) LH side

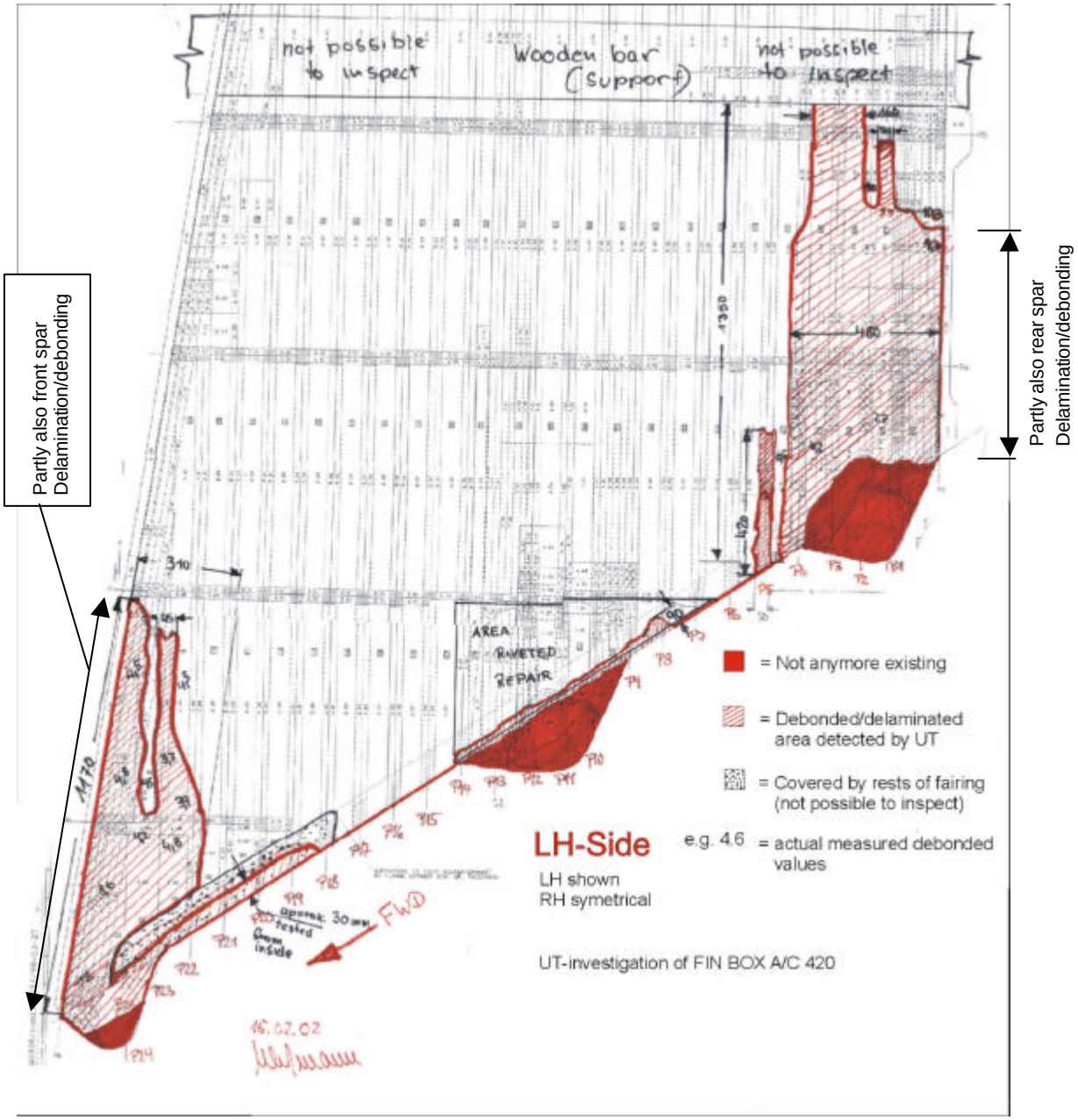


Fig.02: Test Results of Lug region from LH-side and shell above the lugs

(a2) RH side

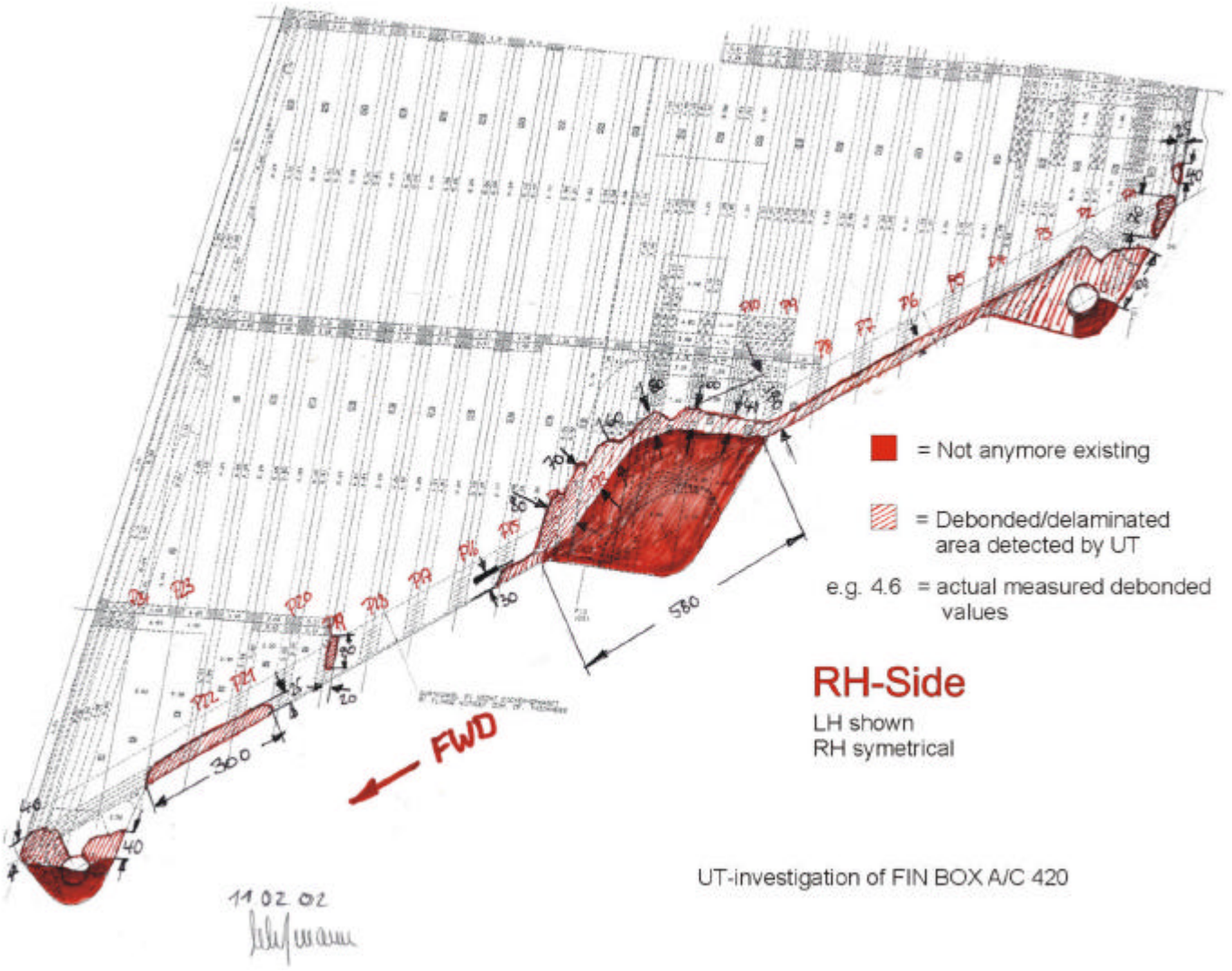


FIG. 03: Test Results of Lug region from RH-side and shell above the lugs

(b1) Front Spar /Stiffener No. 1 (see also photo no. 1)

! Length Dimension of debondings between Skin and Front Spar angle are illustrated in Fig. 02/03

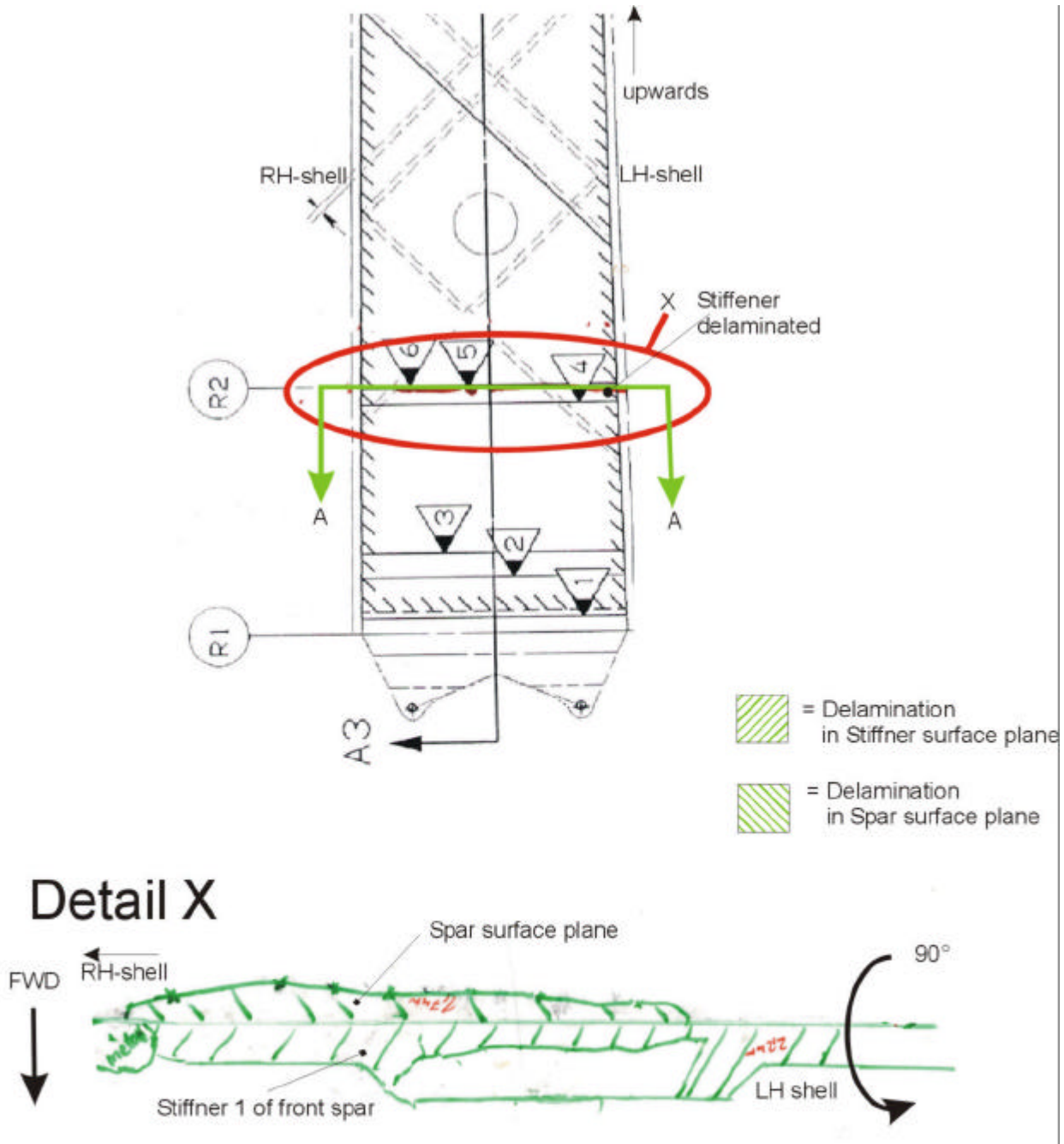
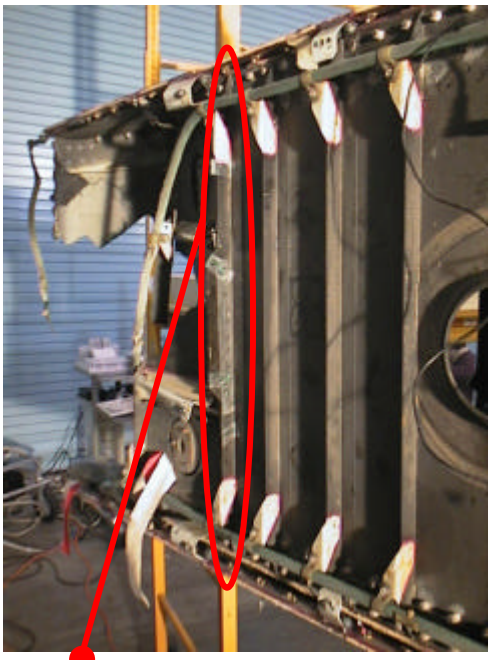
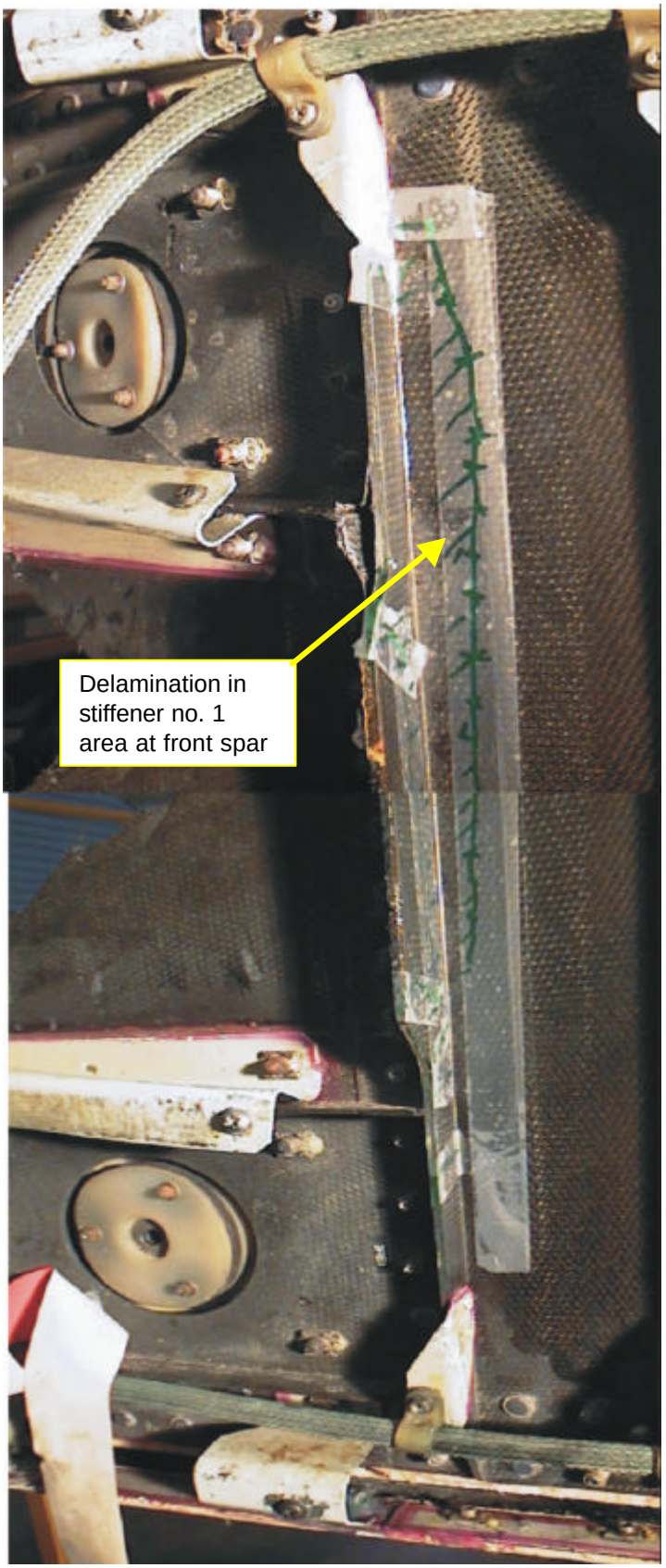


FIG. 04: Test results of front spar ; stiffener no. 1



Stiffener no.1 / front spar



See also Fig. 04

Photo no. 01: Delamination at front spar; stiffener no. 1

(b2) Center spar & Rear Spar (radial force reinforcement lugs)

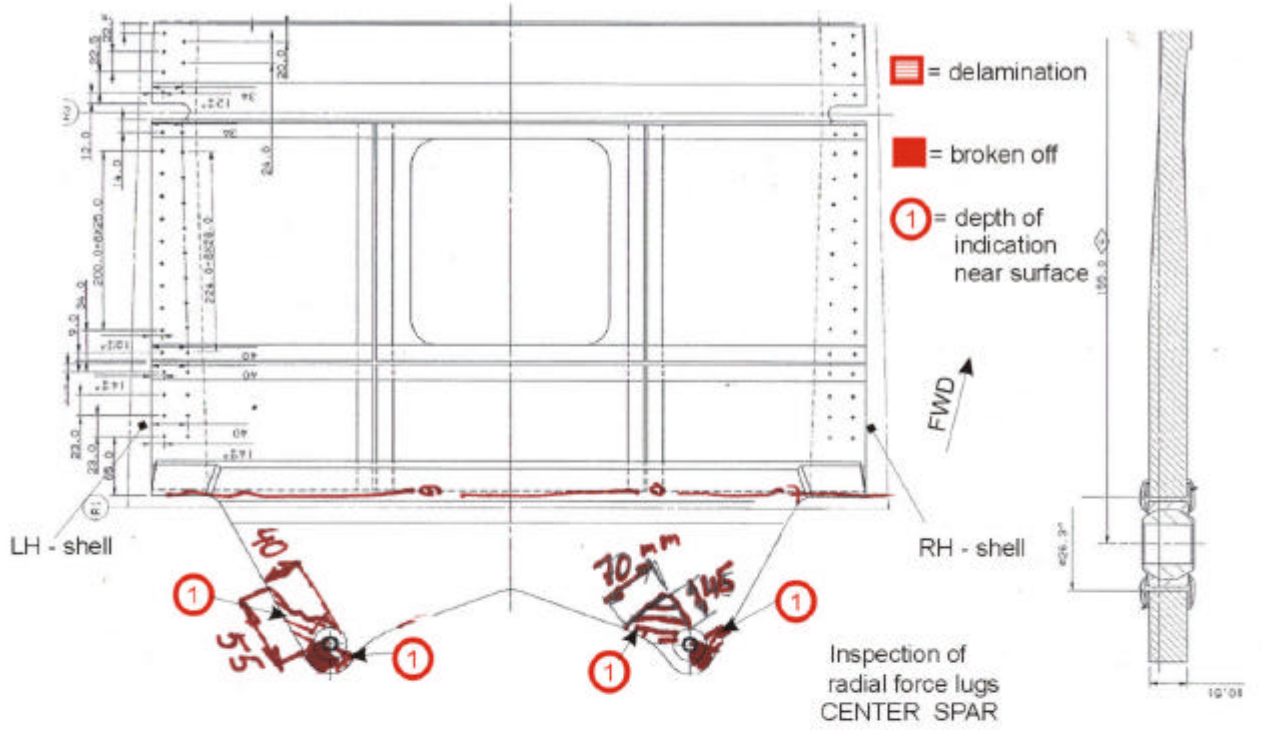


FIG. 05: Test results of center spar radial force lugs

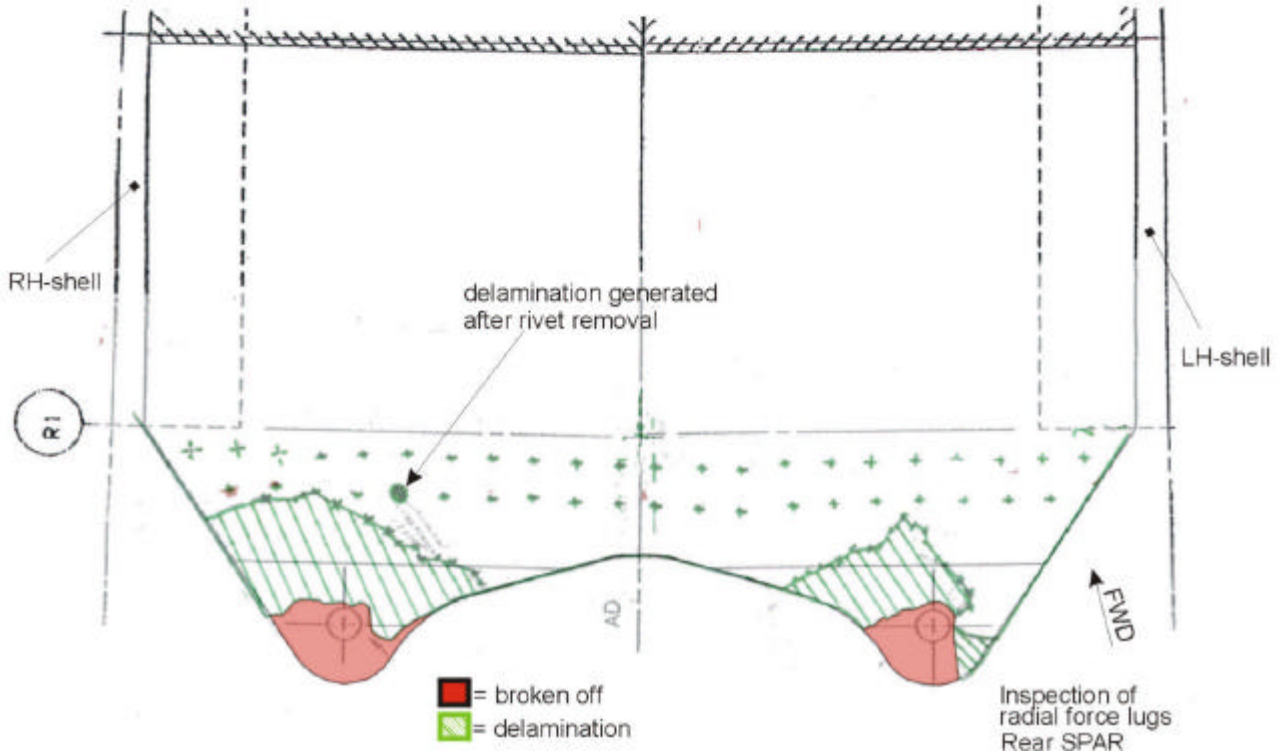


Fig.06: Test results of rear spar (radial force lugs)

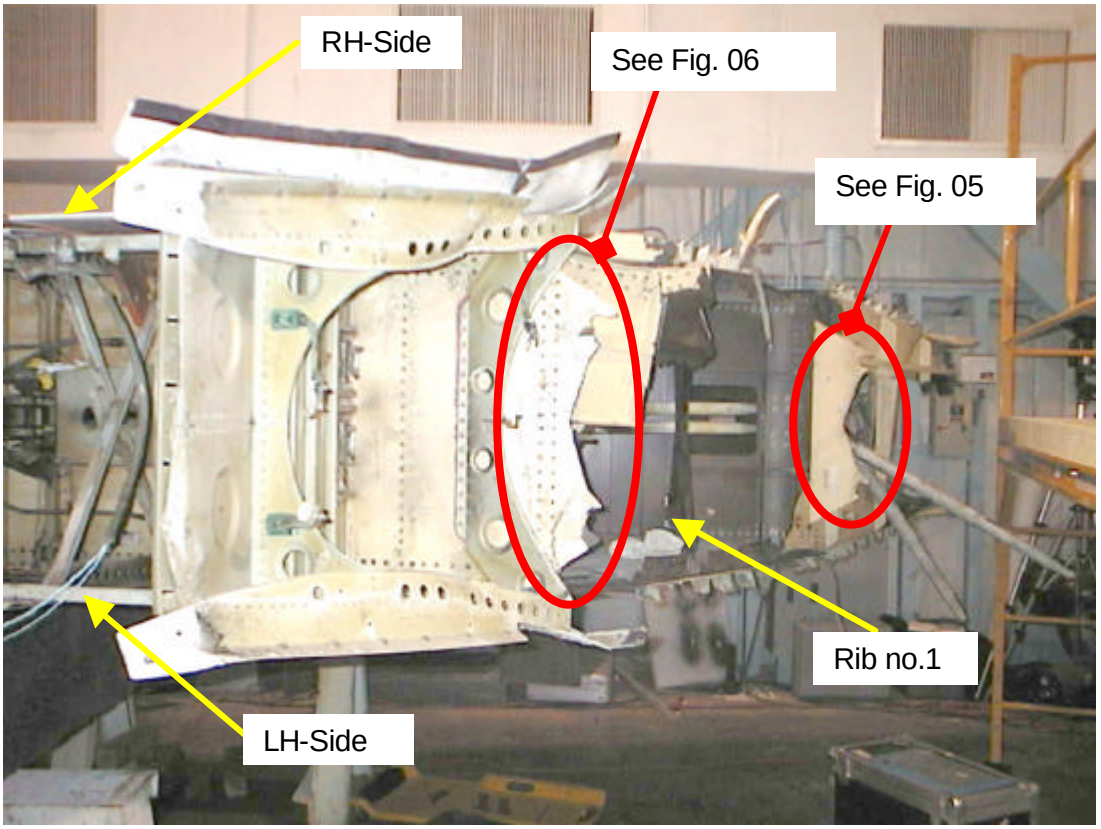


Photo No. 2: Inspection area Rib no. 1 and radial force lugs (see also Fig. No. 5 & 6)

(c) Composite Hinges Connection (see also Fig.no.7)

On RH-side and LH-side within the hinge connection the areas in shell have been inspected completely in a distance of ± 200mm from hinge center line.
Based on still partly attached rear fairing on left hand side the inspection of these covered areas could not be performed. All other rear fairing attachment areas were inspected .

Test result: **NO DELAMINATIONS** in the inspected areas.

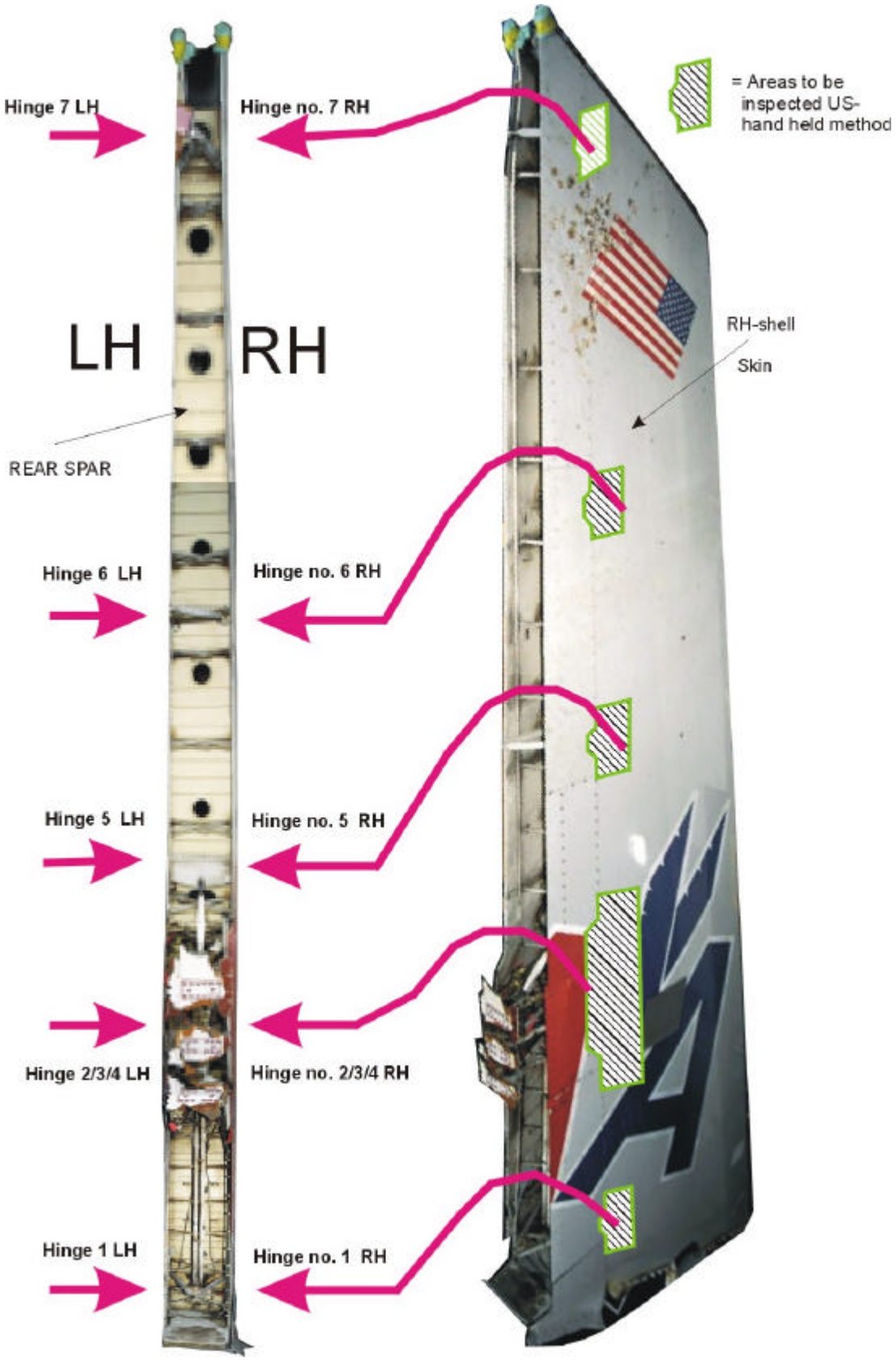


Fig no. 07 : Hinge connection areas to be inspected

(d) Rib no. 1

(d1) The rib no. 1 was nearly complete destroyed in area between Rear Spar position and Center Spar position therefor a UT-inspection made no sense in the still present parts.
(Refer to Photo no. 3)

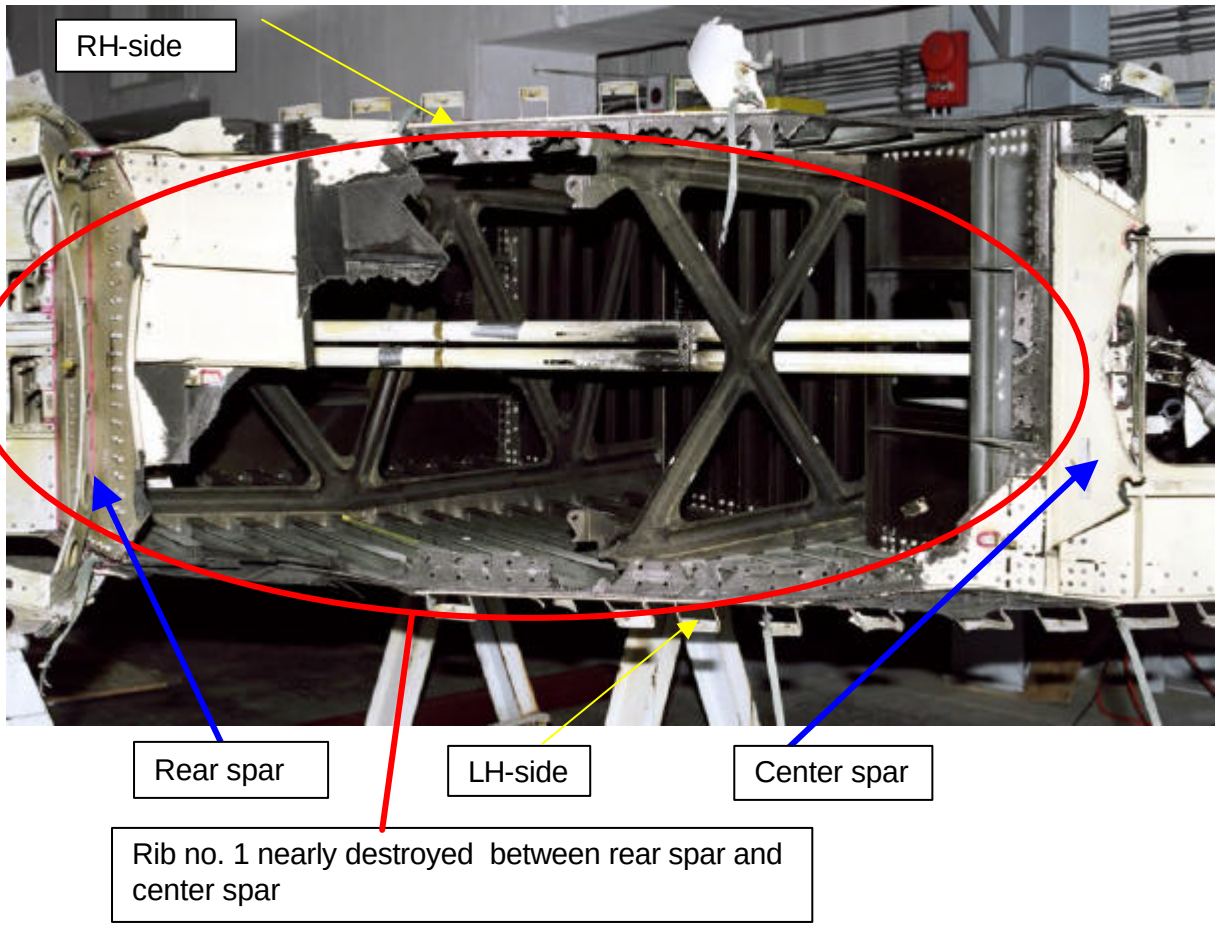


Photo no. 03: View of destroyed rib no.1 between rear spar position and center spar position

(d2) UT-results from rest of rib no. 1 between center spar and front spar (refer to Fig.08 and documentation photos).

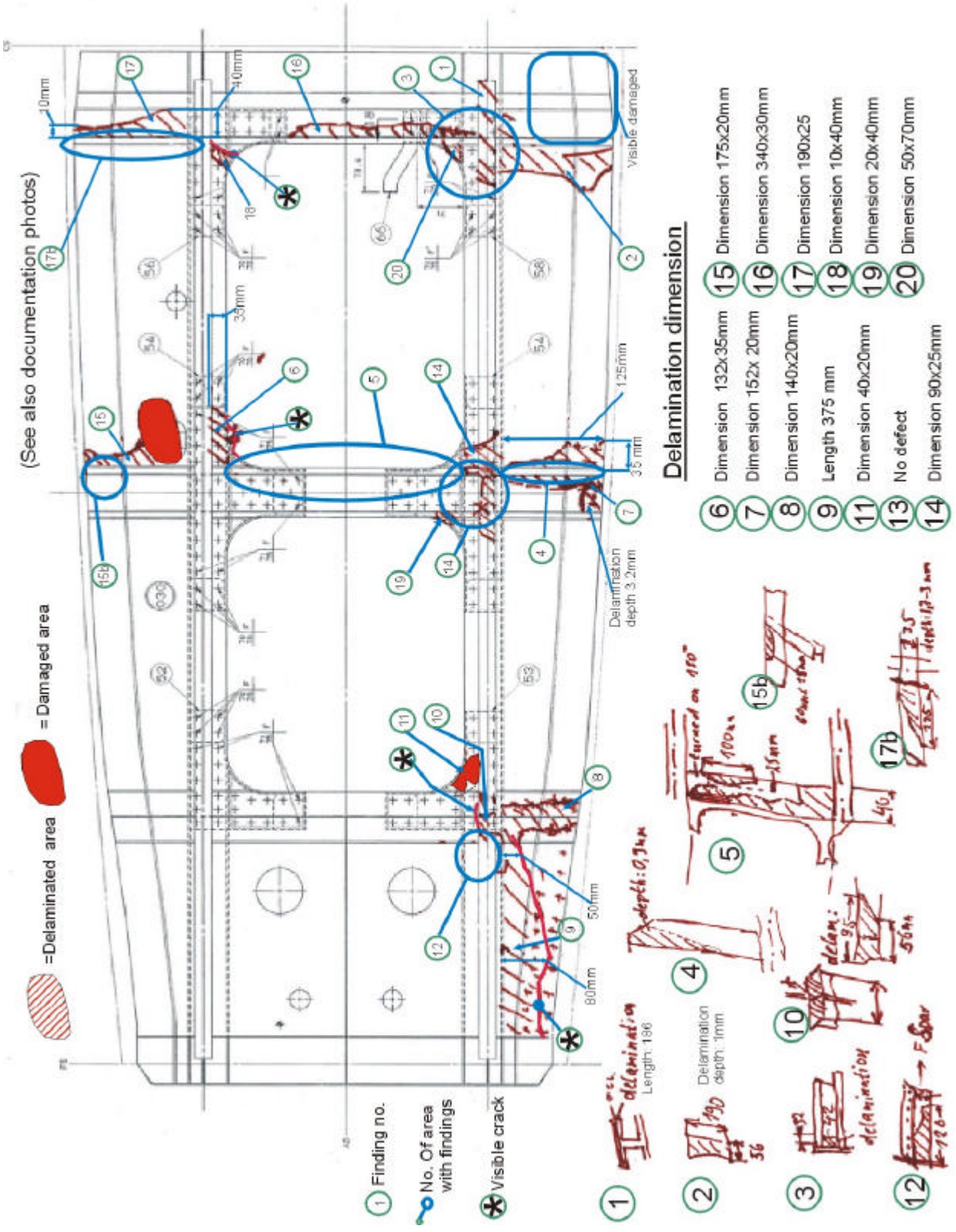
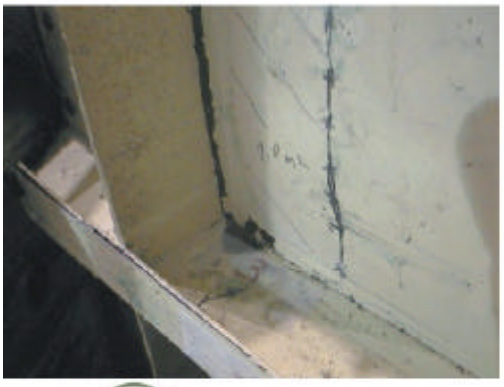


FIG.08: Delamination areas; damages in the area of rib no. 1 between center spar and front spar

1

2



3

4

5

6

Fig.09: Photo documentaion of Findings 1-6 between center spar and front spar

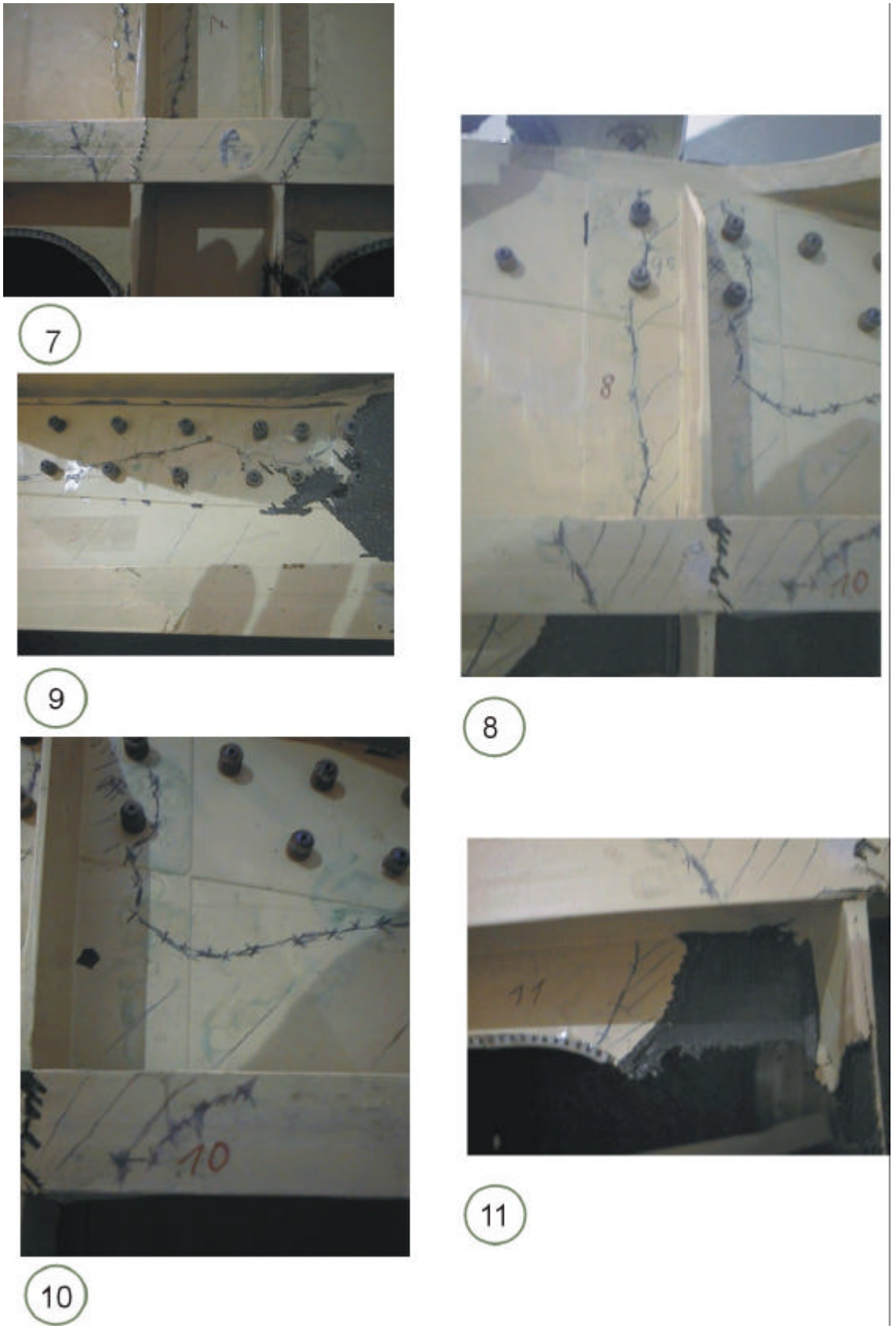


Fig.10: Photo documentaion of Findings 7-11 between center spar and front spar

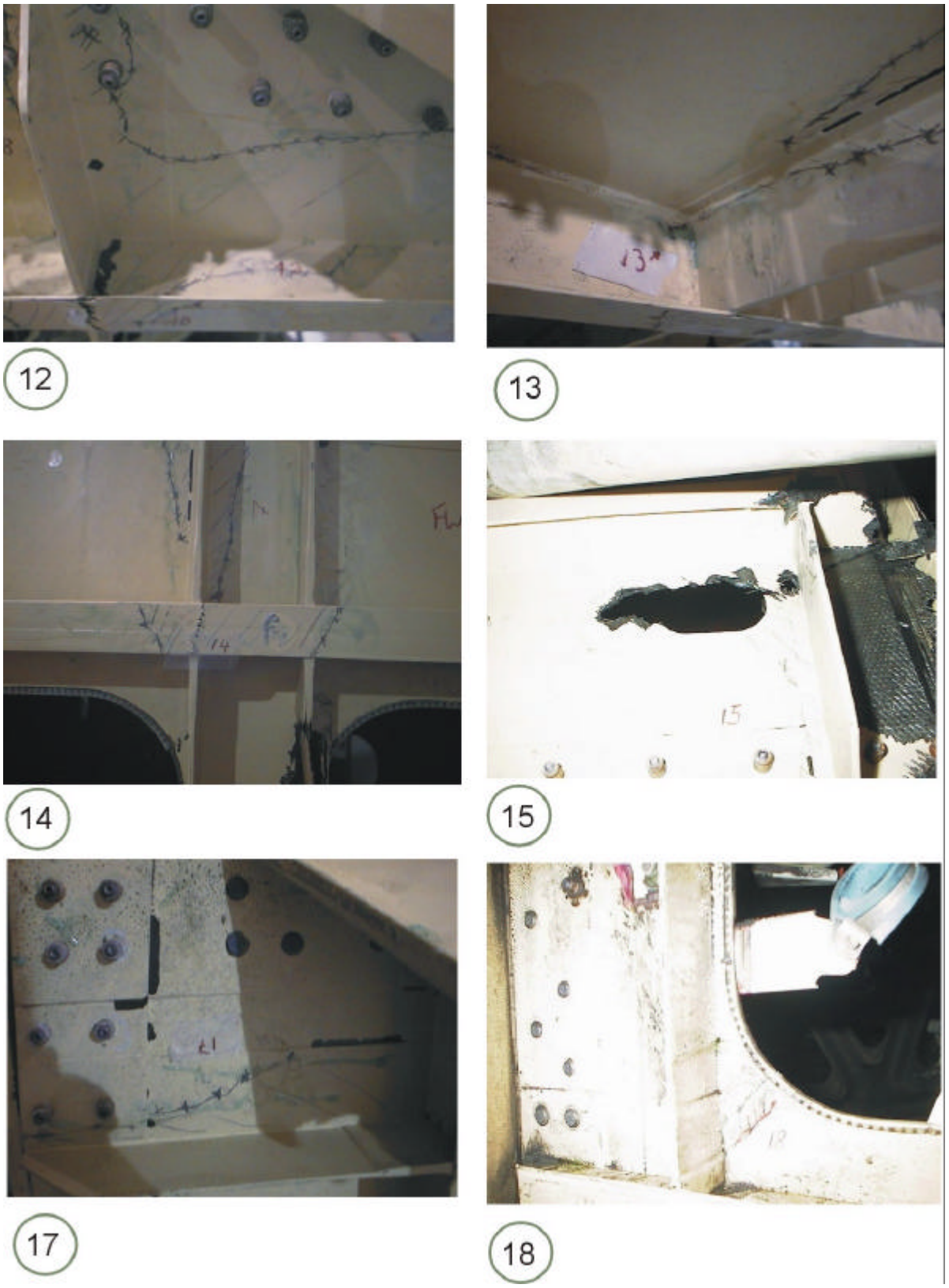


Fig.11: Photo documentaion of Findings 12-18 between center spar and front spar

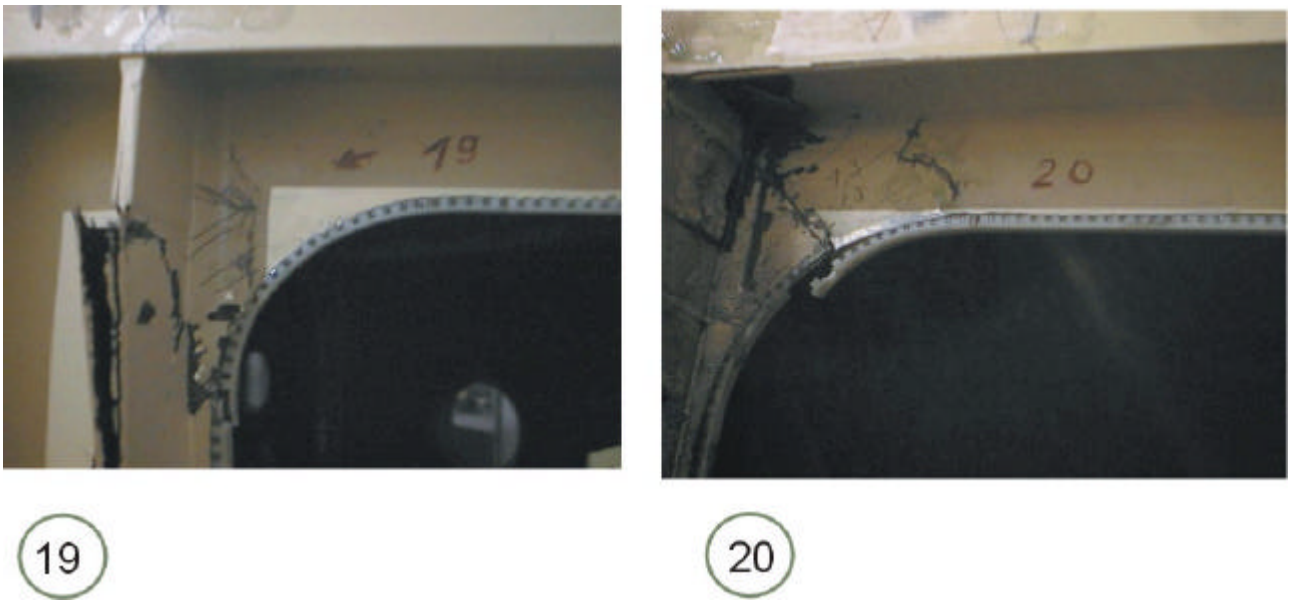


Fig.12: Photo documentaion of Findings 19-20 between center spar and front spar

(d3) Special investigation and test results on separated Center Lug /RH

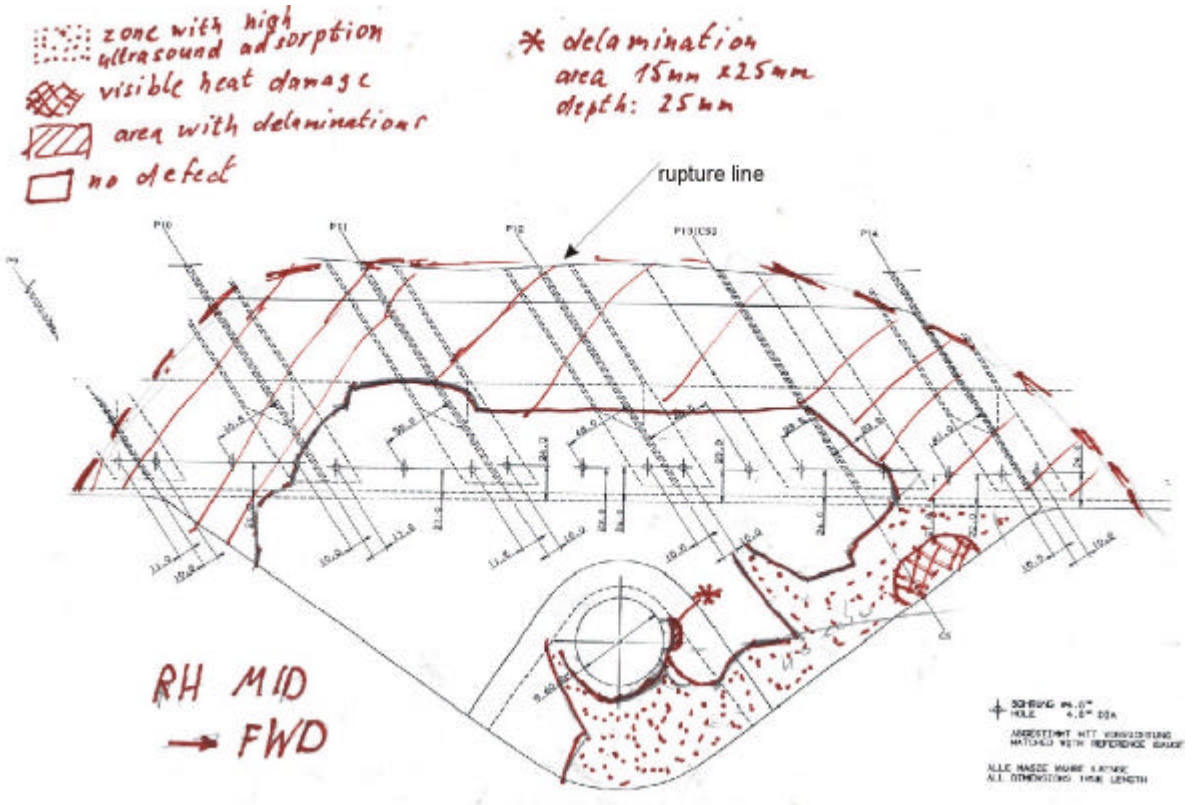
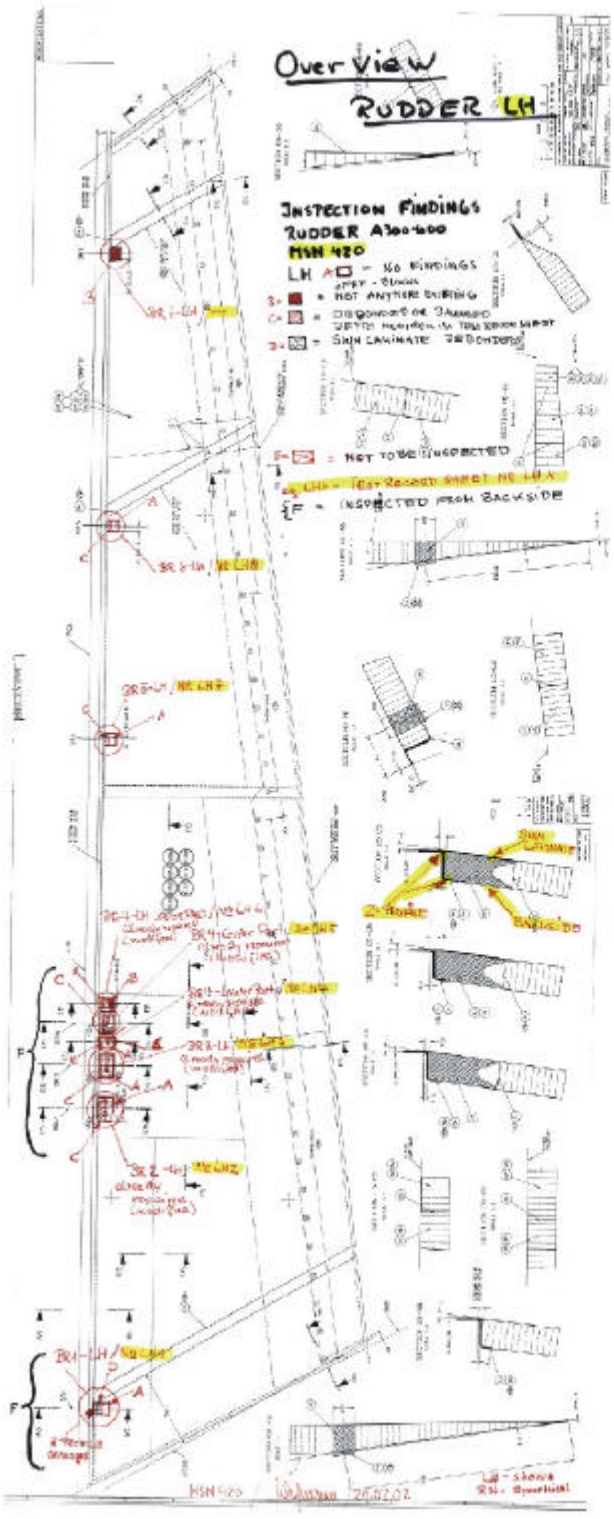


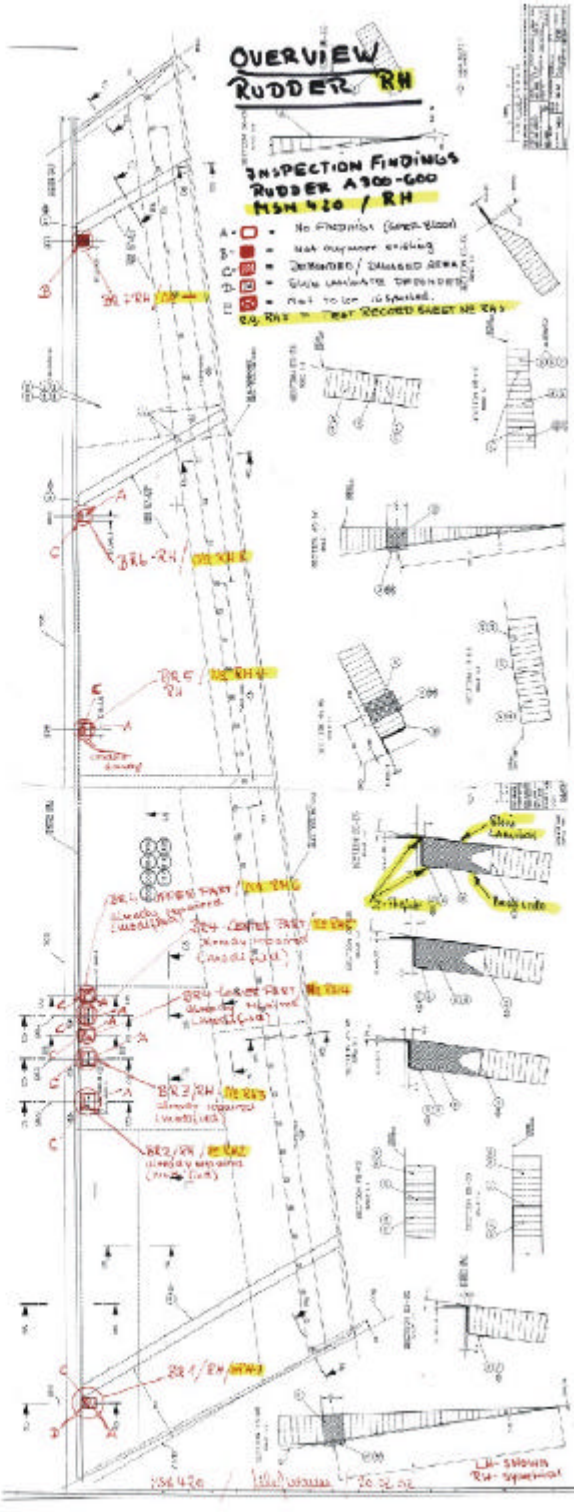
Fig. 13: Test results of UT-inspection at separated center lug / RH

APPENDIX A: TEST RESULTS OF CFRP-HINGE ATTACHMENT FITTINGS

II. Hand held UT-inspection on fiber glass hinge attachment blocks of rudder

(a) Ultrasonic inspection results of the glass fiber hinge attachment blocks of rudder in accordance with NTM A300-600 SSI no. 55-40-04 in not repaired or modified areas.
UT-inspection in glass fiber hinge attachment blocks already modified or repaired.

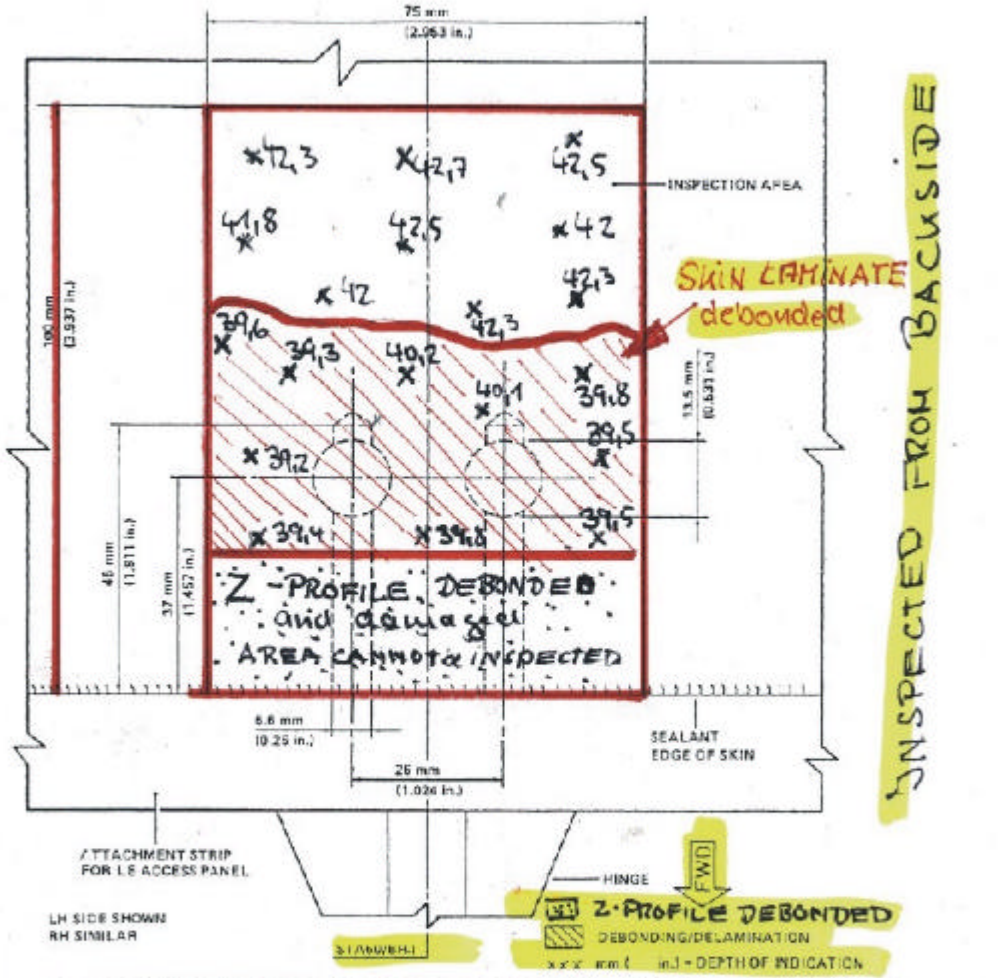




A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04

BR-1-LH



A/C MSN: MSN 420	DATE: 20.02.02	TEST UNIT: USIP 12	HINGE NO.: BR1
REG NO.:	INSPECTOR: Wehmann	SEARCH UNIT: U106	LH X RH
HOURS:	PLACE: LANGLEY VA USA	REMARKS: 2.25 MHz	PANEL THICKNESS: 42 mm (1.65 in.)
CYCLES:			

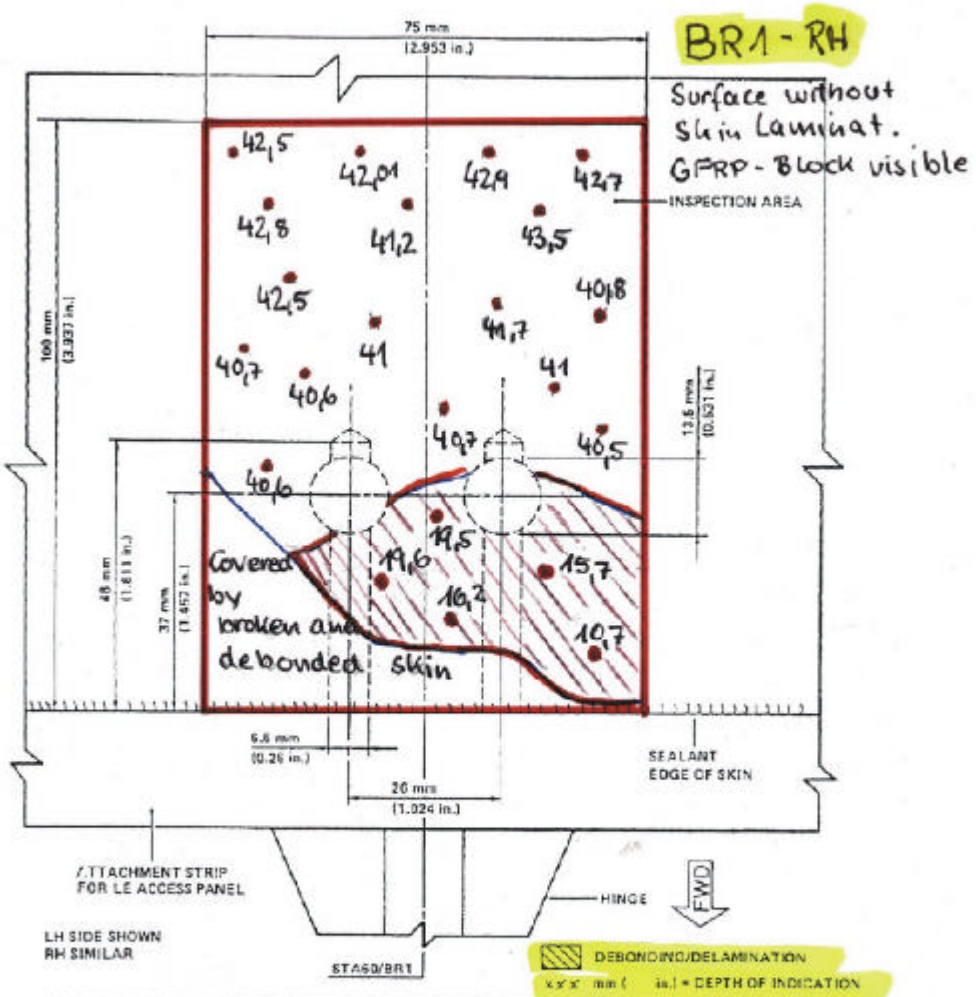
D N 6 55 40 04 4 AO NO - 37

PART 4

Record Sheet - Hinge Attachment Area BR1 LH 55-40-04
Figure 408

A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04



A/C MSN: 420	DATE: 15.02.02	TEST UNIT: USIP 12	HINGE NO.: BR1
REG NO.:	INSPECTOR: WEHMANN	SEARCH UNIT: V106 2.25 MHz	LH / RH X
HOURS:	PLACE: LANGLEY	REMARKS:	PANEL THICKNESS: 42 mm (1.65 in.)
CYCLES:			

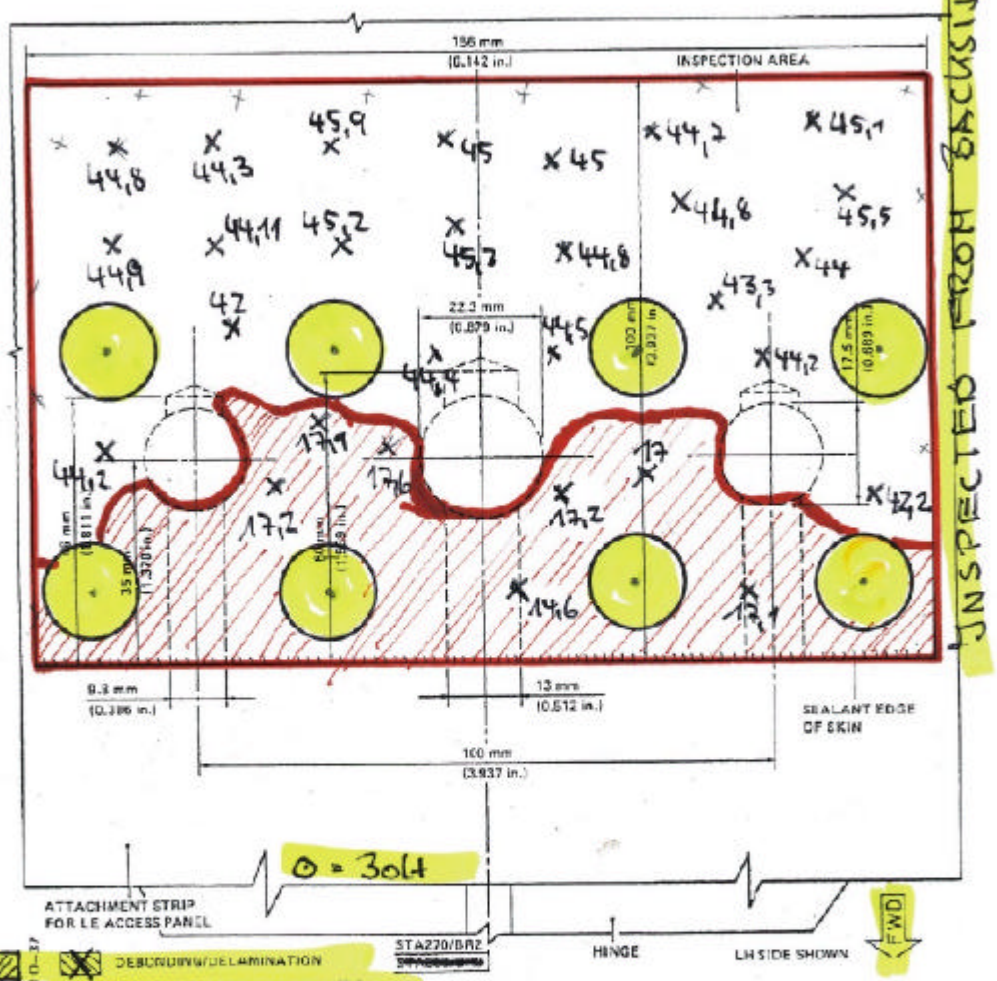
D N S 55 40 04 1 A0 M 0-37

PART 4

Record Sheet - Hinge Attachment Area BR1 55-40-04
Figure 408

PART 4 - ULTRASONIC
SSI NO. 55-40-04

BR2-LH



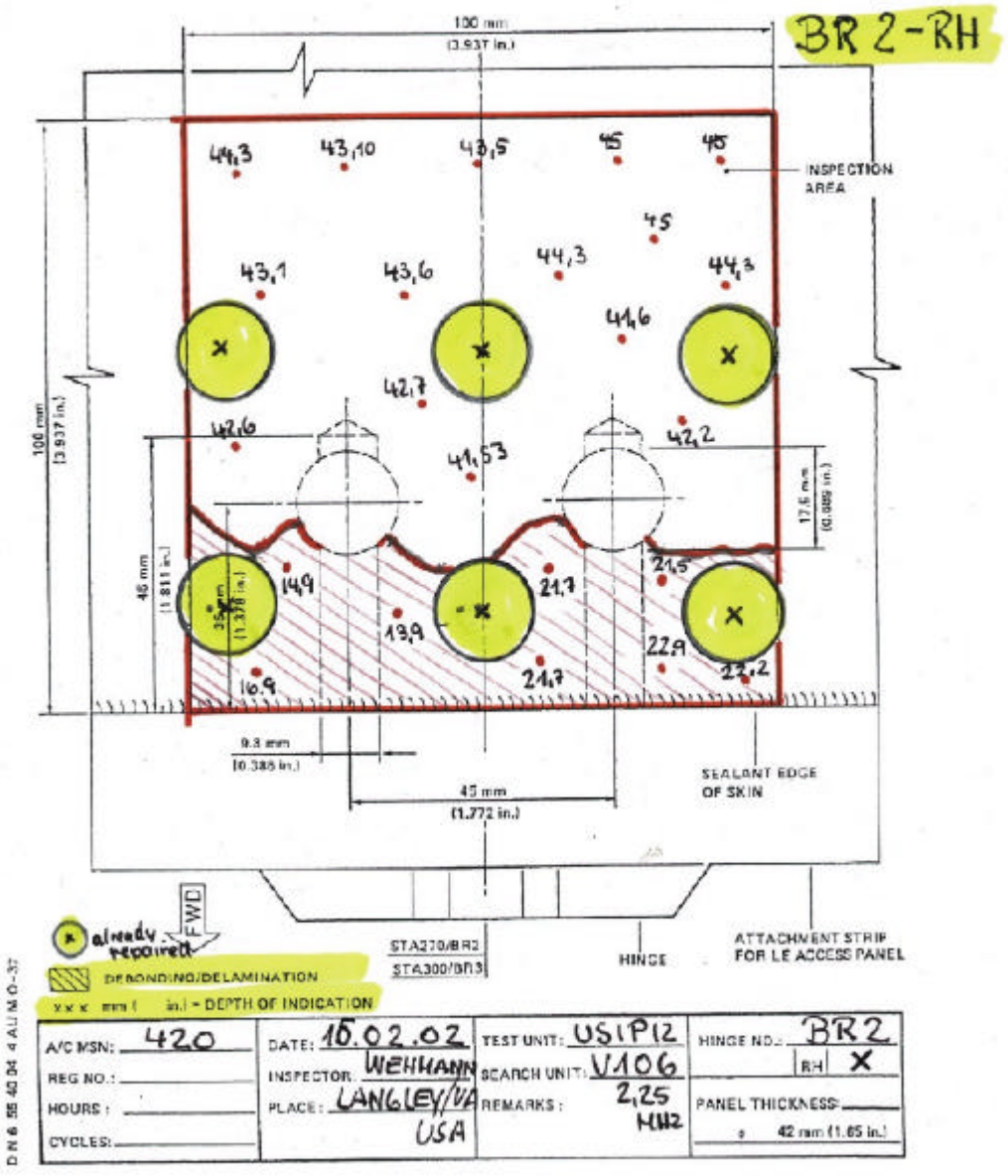
PART 4

Record Sheet - Hinge Attachment Area BR2/[illegible] LH 55-40-04

Figure 409

A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04



PART 4

Record Sheet - Hinge Attachment Area BR2 RH 55-40-04
Figure 410

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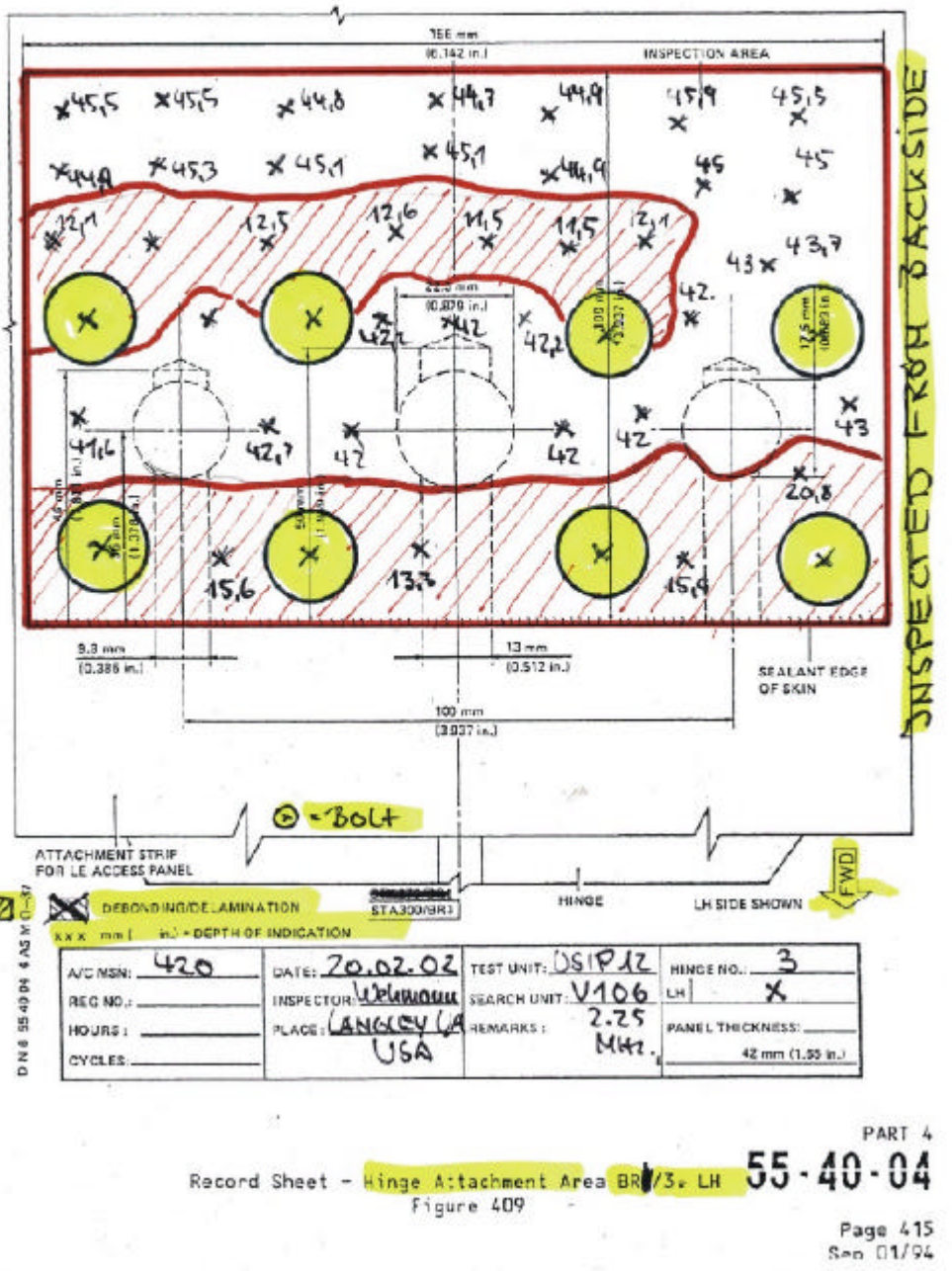
A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04

BR 3 - LH



PART 4
Record Sheet - Hinge Attachment Area BR 3, LH 55-40-04
Figure 409

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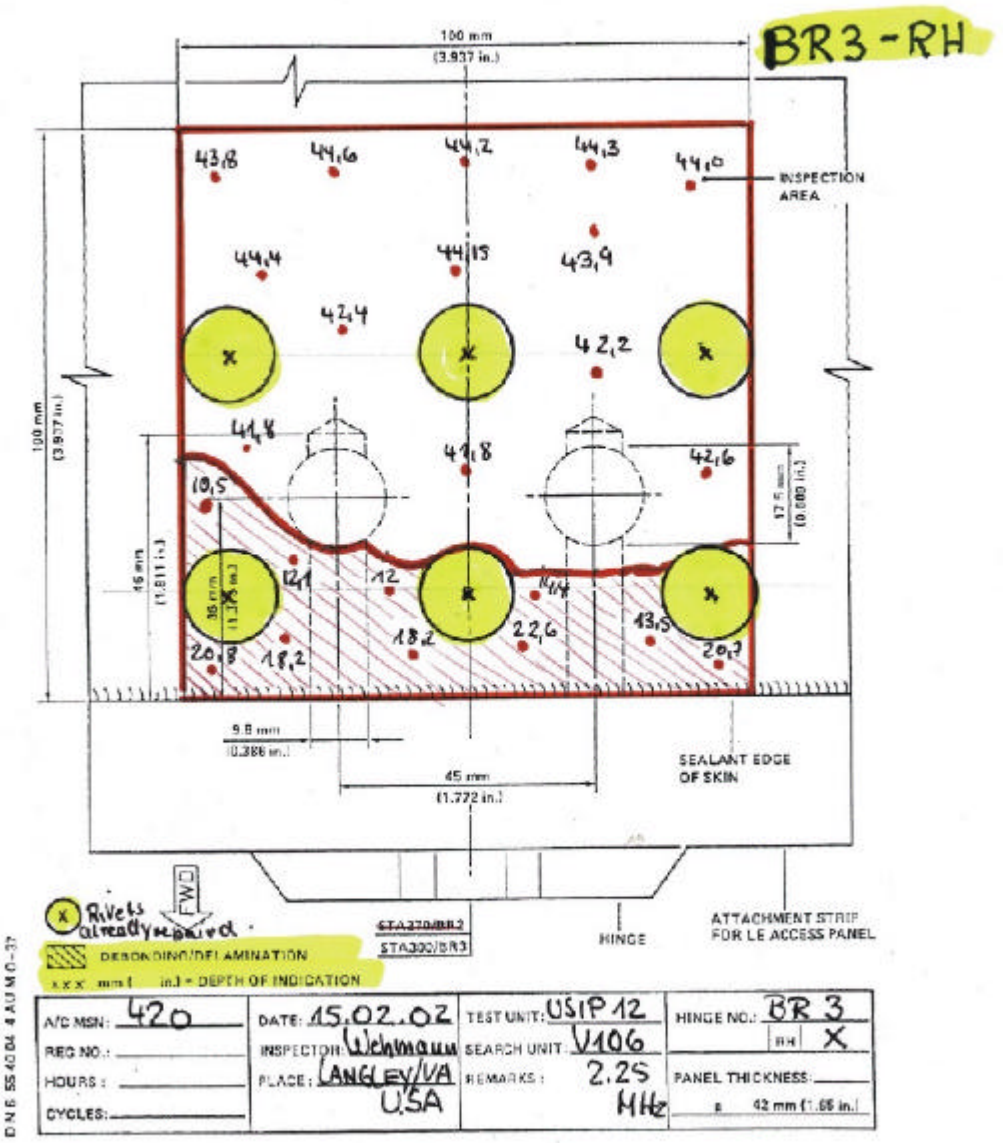
A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04



A/C MSN: 420	DATE: 15.02.02	TEST UNIT: USIP 12	HINGE NO.: BR 3
REG NO.:	INSPECTOR: Wehmann	SEARCH UNIT: V106	RH X
HOURS:	PLACE: LANGLEY/VA U.S.A	REMARKS: 2.25 MHz	PANEL THICKNESS:
CYCLES:			± 42 mm (1.65 in.)

D N 6 55404 4 AU M0-37

PART 4
Record Sheet - Hinge Attachment Area BR2/3. RH 55-40-04
Figure 410

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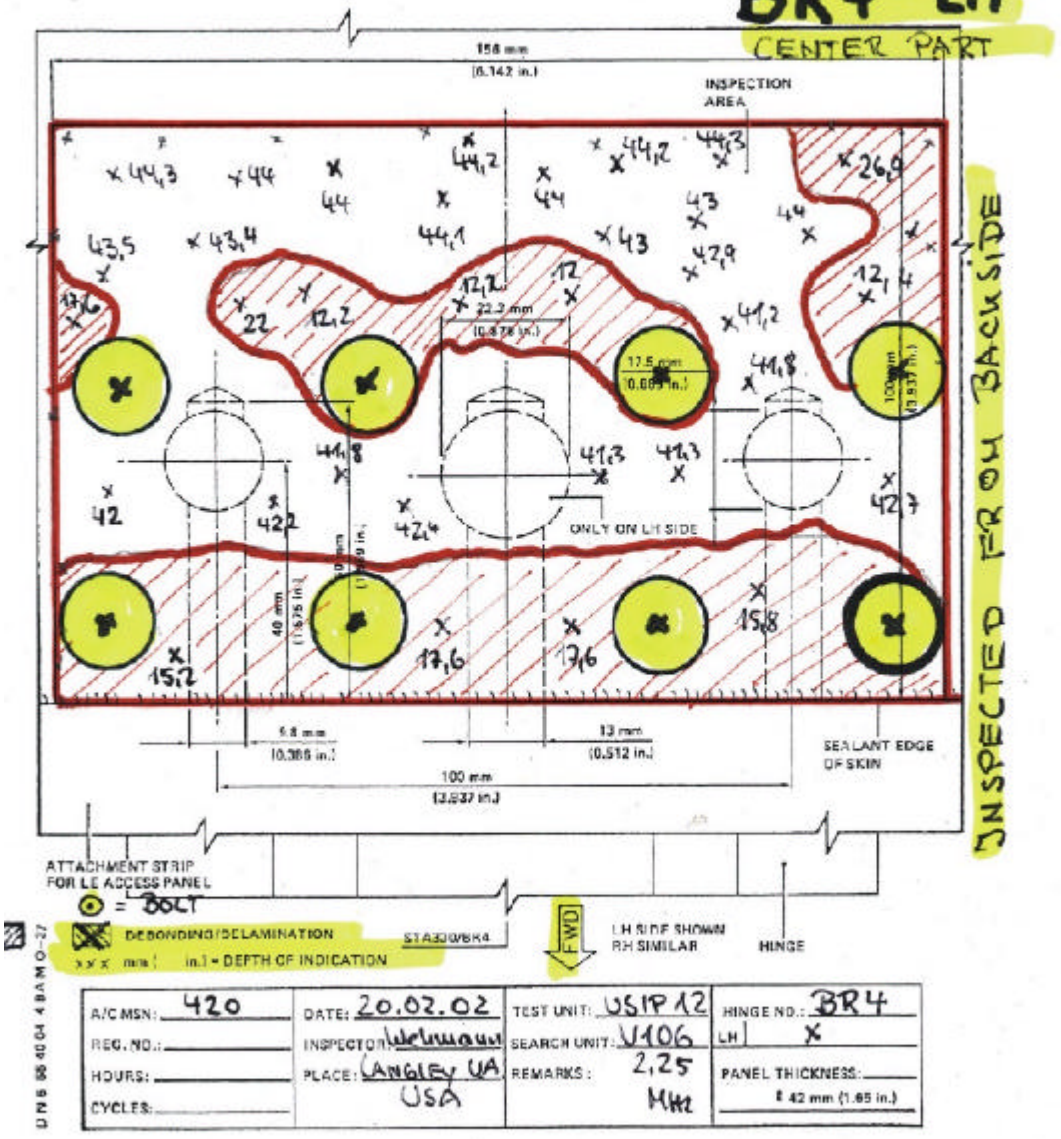
A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04

BR4 - LH
CENTER PART



INSPECTED FROM BACKSIDE

A/C MSN: 420	DATE: 20.02.02	TEST UNIT: USIP 12	HINGE NO.: BR4
REG. NO.:	INSPECTOR: Wehmann	SEARCH UNIT: V106	LH X
HOURS:	PLACE: LANGLEY VA USA	REMARKS: 2,25 MHz	PANEL THICKNESS: ≈ 42 mm (1.65 in.)
CYCLES:			

Record Sheet - Hinge Attachment Area BR4 (center LH)
Figure 412

PART 4
55-40-04

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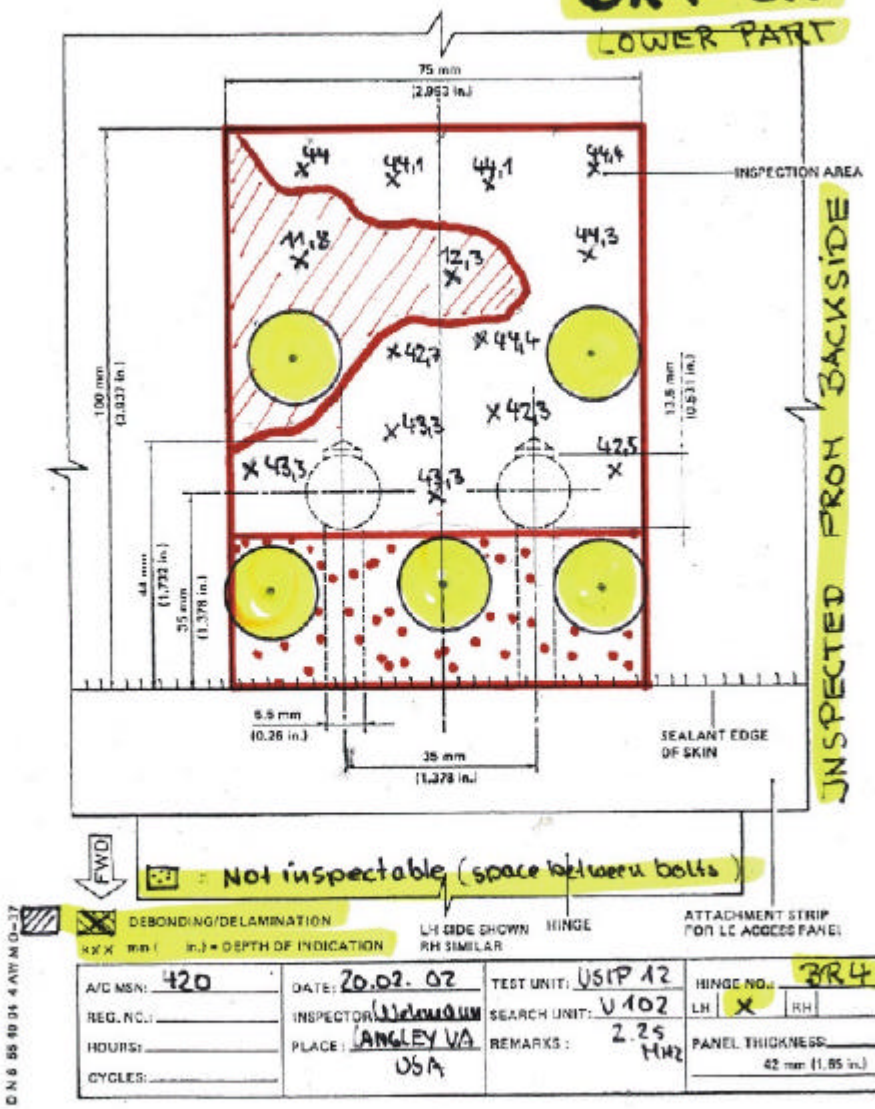
A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04

BR4 - LH
LOWER PART



A/C MSN: 420	DATE: 20.02.02	TEST UNIT: USIP 12	HINGE NO.: BR4
REG. NO.:	INSPECTOR: [illegible]	SEARCH UNIT: U 102	LH X RH
HOURS:	PLACE: LANGLEY VA USA	REMARKS: 2.25 MHz	PANEL THICKNESS: 42 mm (1.65 in.)
CYCLES:			

D N 6 88 90 91 4 AW N 0-37

PART 4
Record Sheet - Hinge Attachment Area BR4 (~~Upper~~/Lower) 55-40-04
Figure 411

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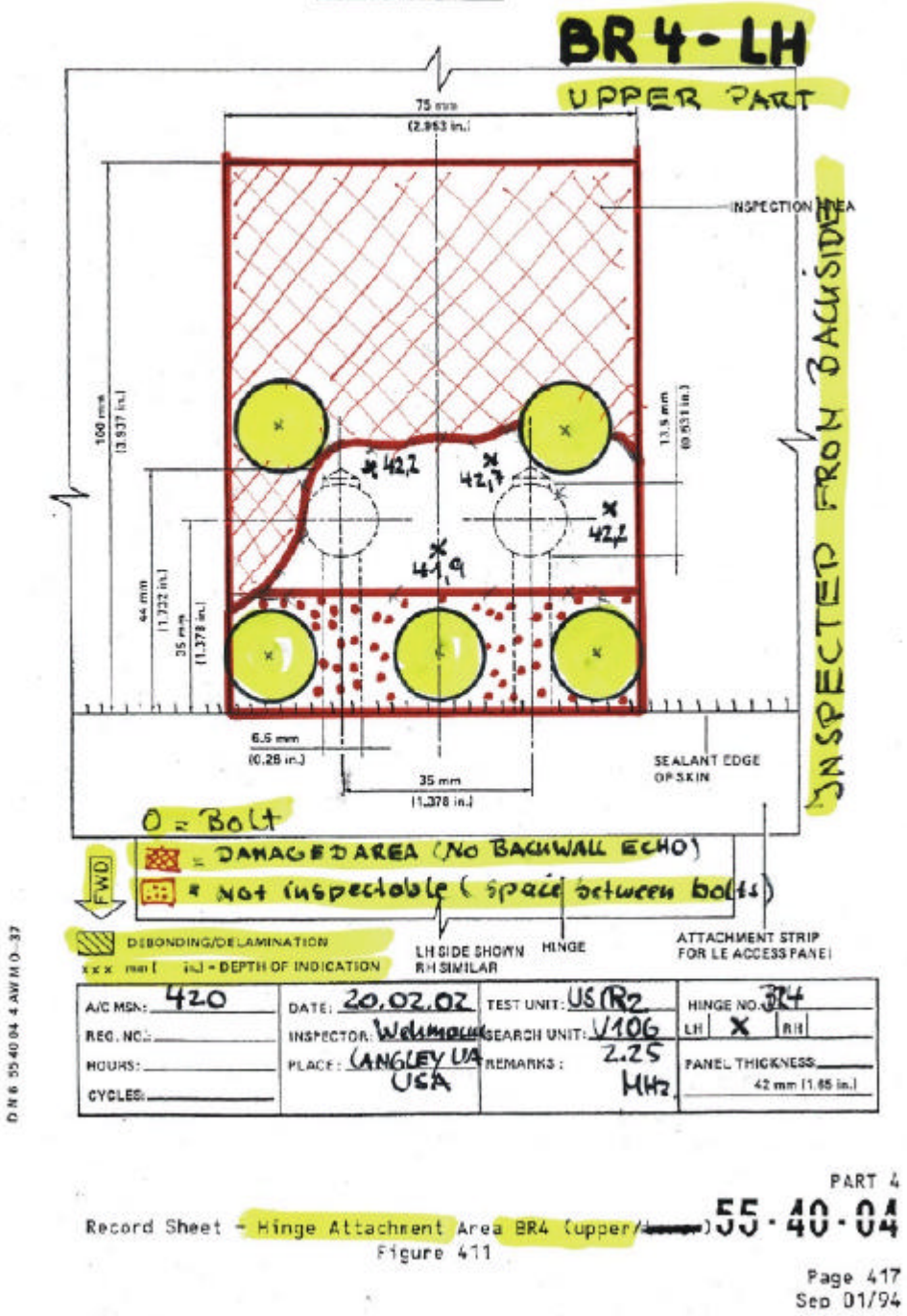
A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04

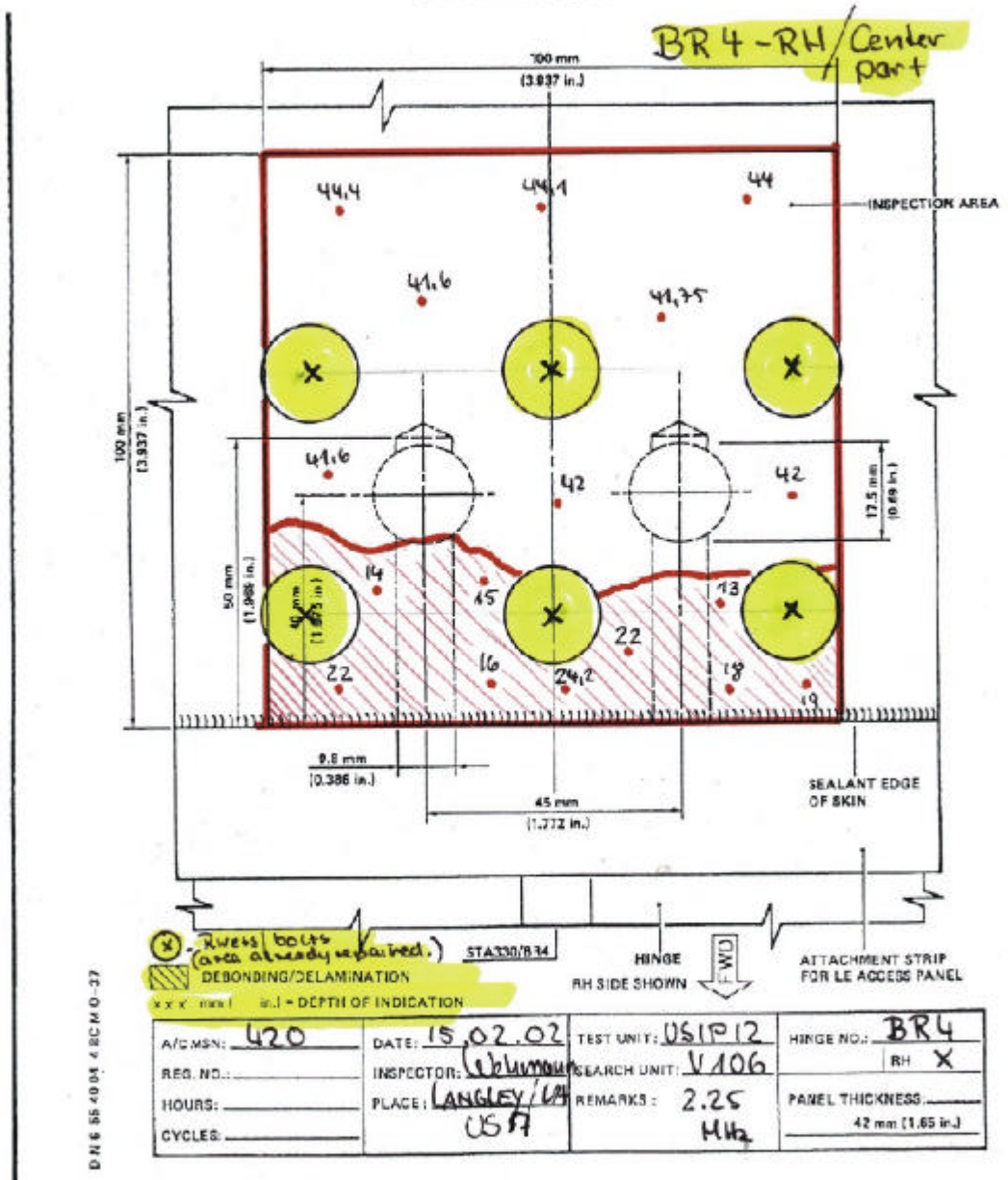


Record Sheet - Hinge Attachment Area BR4 (upper/~~lower~~)

Figure 411

A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04

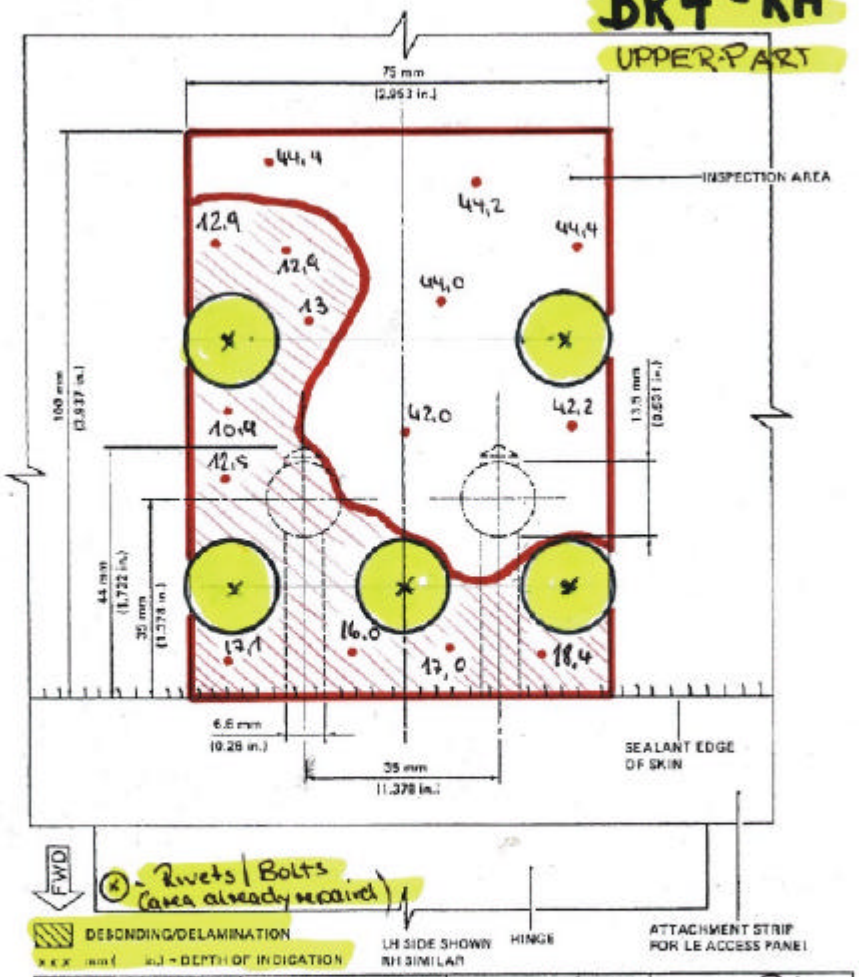


Record Sheet - Hinge Attachment
Area BR4 (Center RH)
Figure 413

A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04

BR4 - RH
UPPER PART



⊗ - Rivets / Bolts (area already repaired)

A/C MSN: 420	DATE: 15.02.02	TEST UNIT: USIP 12	HINGE NO.: B4
REG. NO.:	INSPECTOR: WEHMANN	SEARCH UNIT: V106	LH / RH X
HOURS:	PLACE: LANGLEY/VA USA	REMARKS: 2.25 MHz	PANEL THICKNESS: 42 mm (1.65 in.)
CYCLES:			

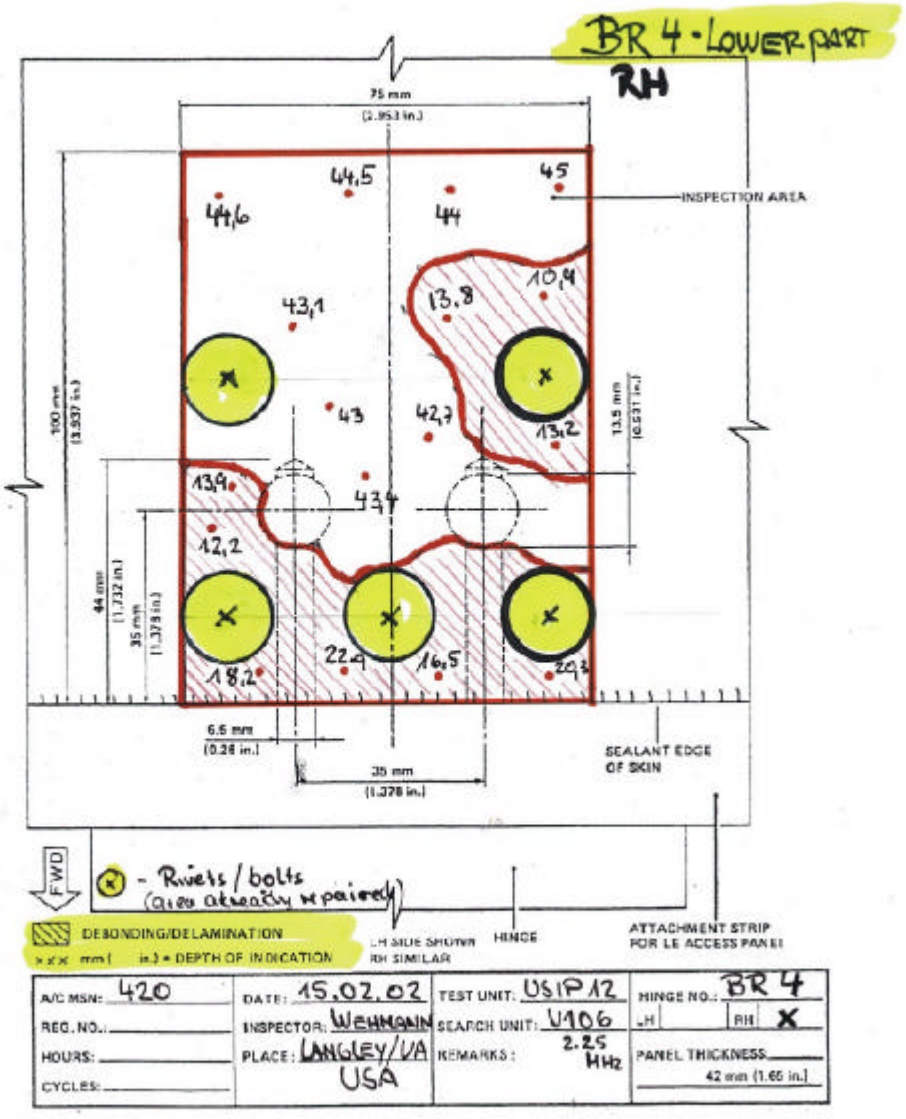
DNG 55 40 04 AAWMO-37

PART 4

Record Sheet - Hinge Attachment Area BR4 (upper [redacted]) 55-40-04
Figure 411

A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04



PART 4
Record Sheet - Hinge Attachment Area BR4 (Upper) 55·40·04
Figure 411

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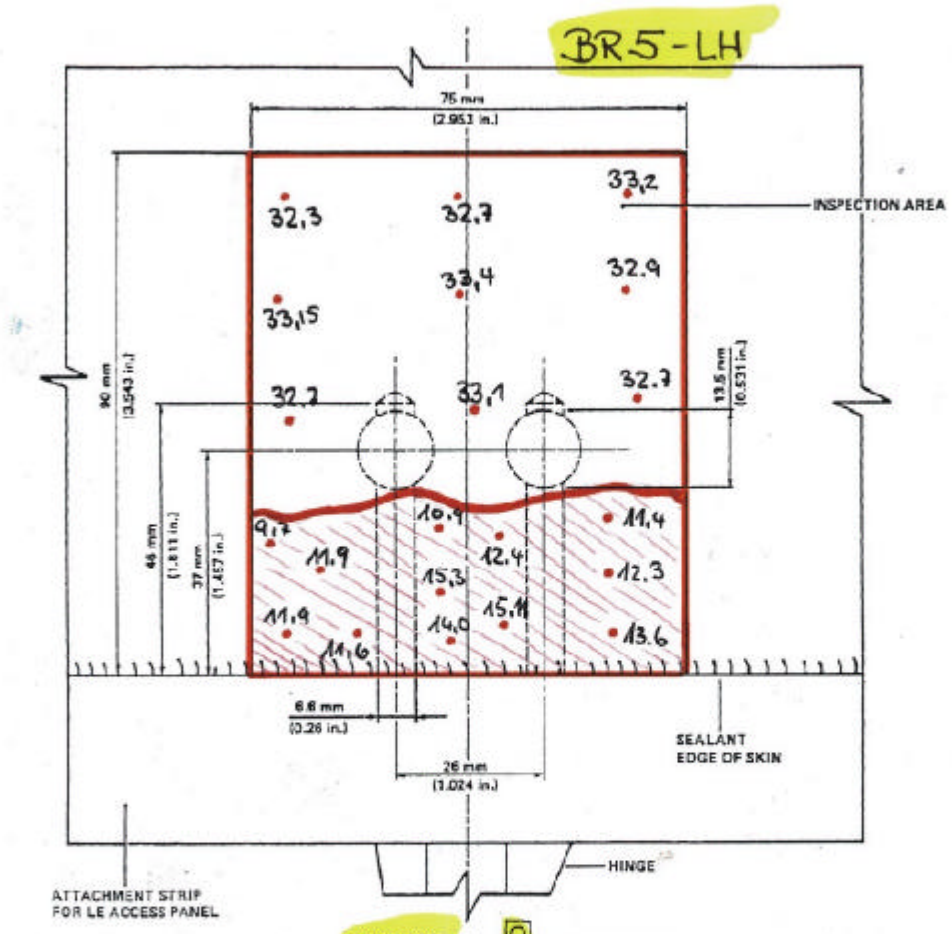
PART 4 - ULTRASONIC
SSI NO. 55-40-04



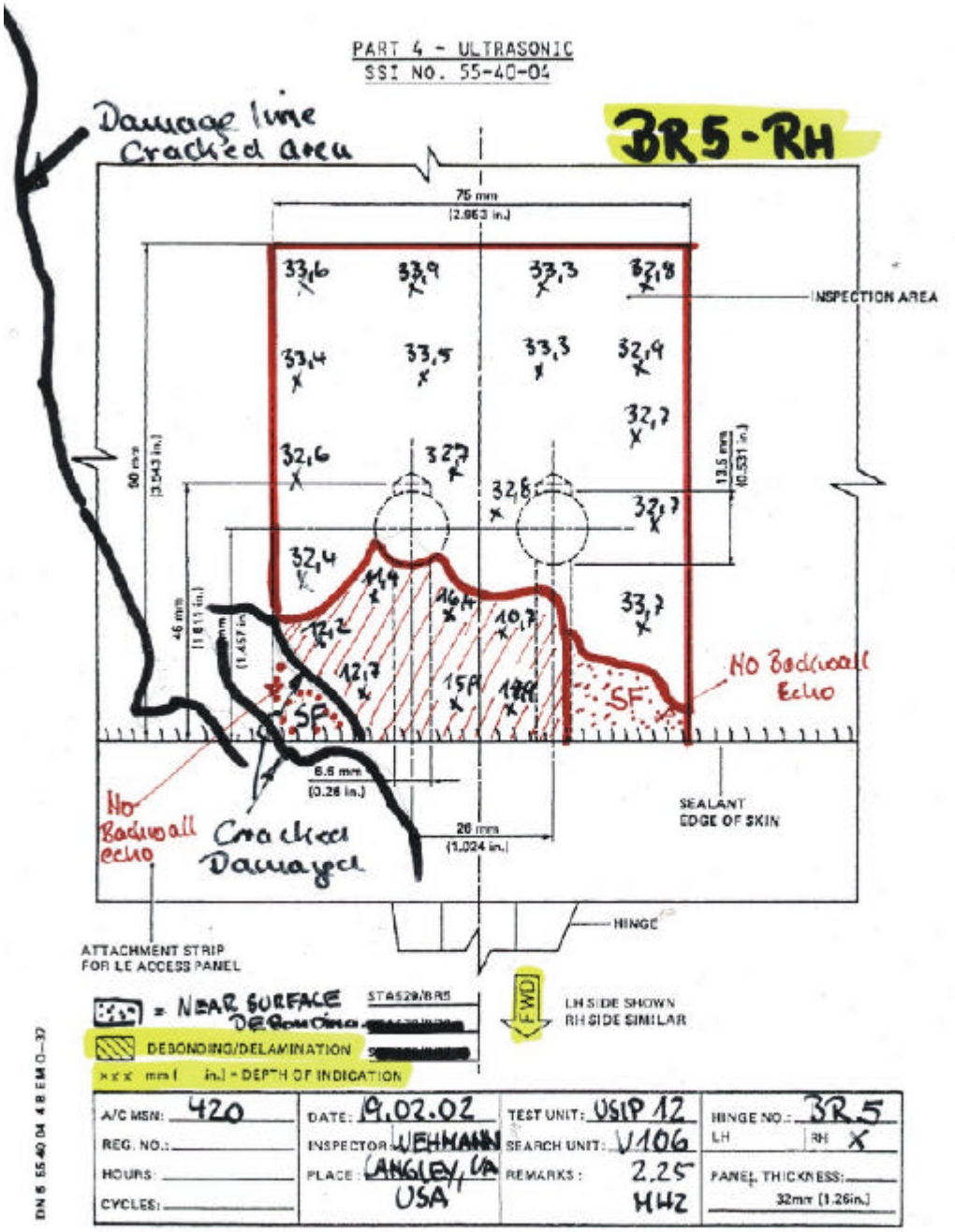
DNS 55 40 04 4 8 E M O - 3 2

A/C MSN: 420	DATE: 15.02.02	TEST UNIT: USIP12	HINGE NO.: BR5
REG. NO.:	INSPECTOR: Wehmann	SEARCH UNIT: V106	LH X RH
HOURS:	PLACE: LANGLEY/VA USA	REMARKS: 2.25 MHz	PANEL THICKNESS: 32mm (1.26in.)
CYCLES:			

Record Sheet - Hinge Attachment Area BR5/[redacted]
Figure 414

A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04

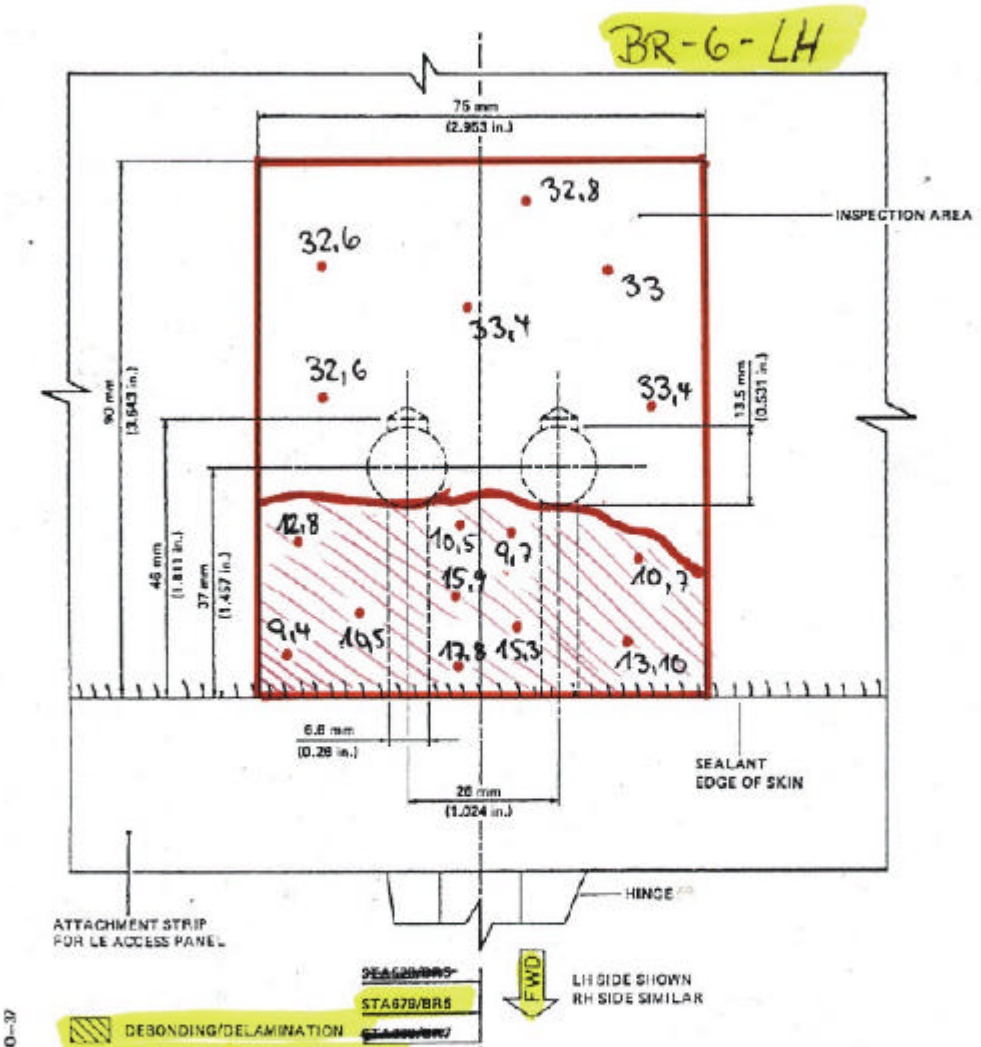


PART 4
Record Sheet - Hinge Attachment Area BR5/[redacted] 55-40-04
Figure 414

Page 420

A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04



A/C MSN: 420	DATE: 25.02.02	TEST UNIT: USIP 12	HINGE NO.: BR6
REG. NO.:	INSPECTOR: WEHMANN	SEARCH UNIT: V106	LH X RH
HOURS:	PLACE: LANGLEY/VA USA	REMARKS: MHz 2,25	PANEL THICKNESS: 32mm (1.26in.)
CYCLES:			

DN 6 55 40 04 4 B E M O - 37

PART 4
Record Sheet - Hinge Attachment Area BR6/8 55-40-04
Figure 414

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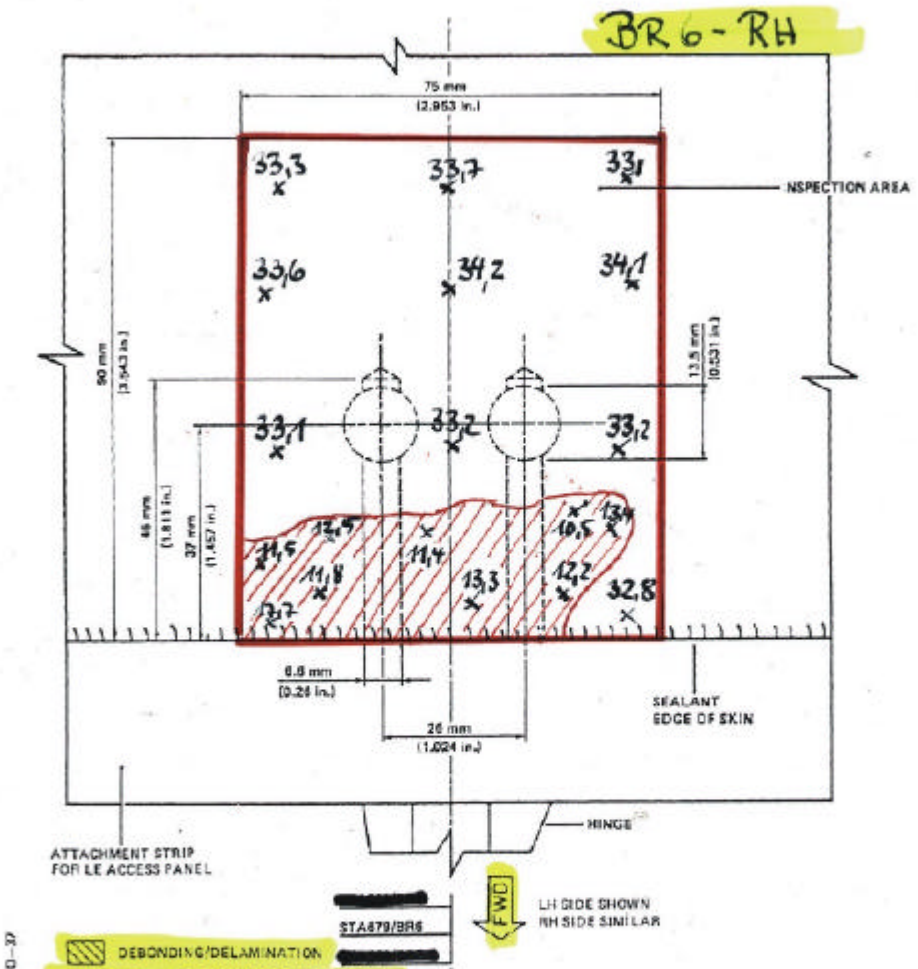
A300-600
NONDESTRUCTIVE TESTING MANUAL

PART 4 - ULTRASONIC
SSI NO. 55-40-04



A/C MSN: 420	DATE: 19.02.02	TEST UNIT: USIP 12	HINGE NO.: BR.6
REG. NO.:	INSPECTOR WEHMANN	SEARCH UNIT: V106	LH / RH X
HOURS:	PLACE: LANGLEY, VA USA	REMARKS: 2.25 MHz	PANEL THICKNESS: 32mm (1.26in.)
CYCLES:			

DNE 554004 ESWD-20

PART 4

Record Sheet - Hinge Attachment Area BR 6/7 55-40-04
Figure 414

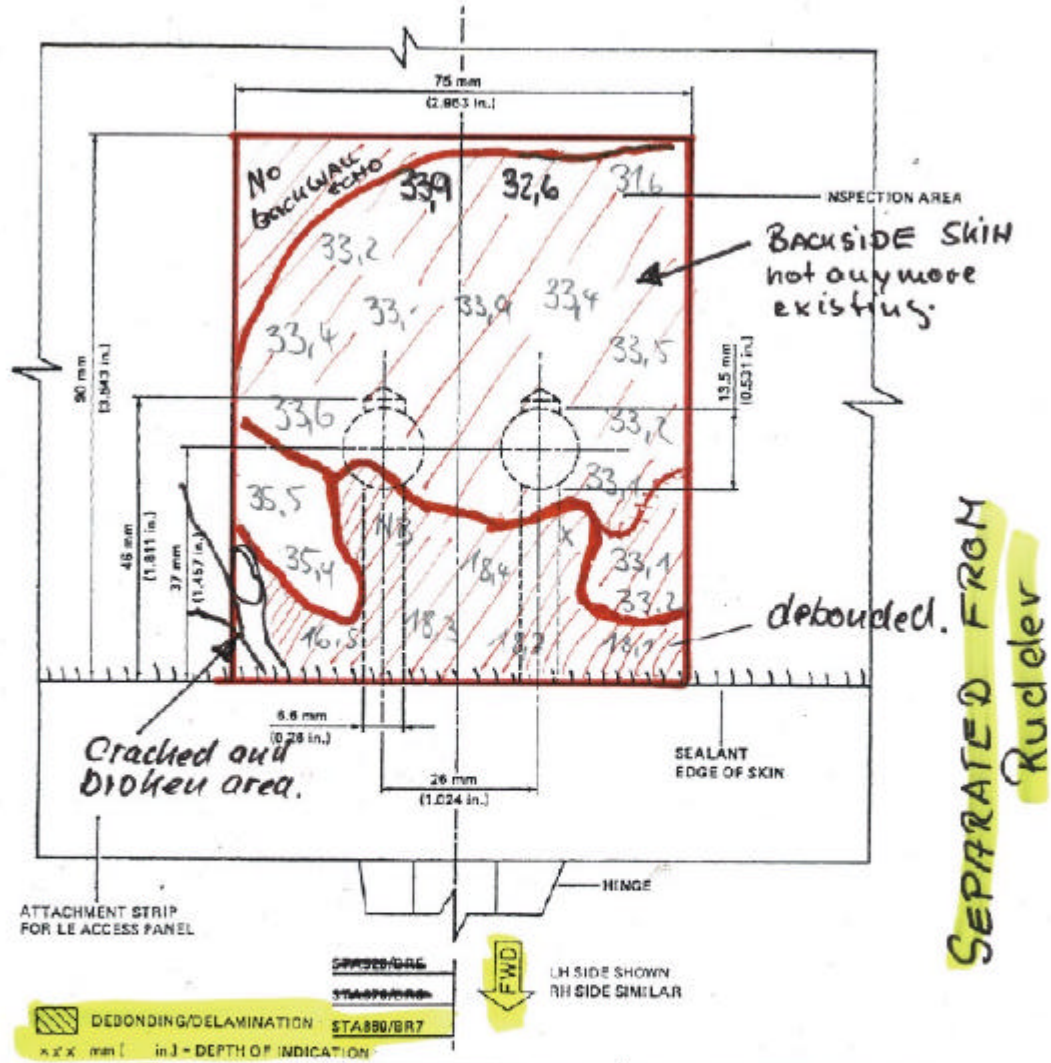
Page 420

A300-600
NONDESTRUCTIVE TESTING MANUAL

№ LH9

PART 4 - ULTRASONIC
SSI NO. 55-40-04

BR7 - LH



SEPARATED FROM Ruddelev

A/C MSN: 420	DATE: 21.02.02	TEST UNIT: USIP 12	HINGE NO.: BR7
REG. NO.:	INSPECTOR: Wehmann	SEARCH UNIT: V106	LH X RH
HOURS:	PLACE: LANGLEY VA USA	REMARKS: 2,25 MHz.	PANEL THICKNESS: 32mm (1.26in.)
CYCLES:			

DNS 55 40 04 4 01 EMO-37

PART 4

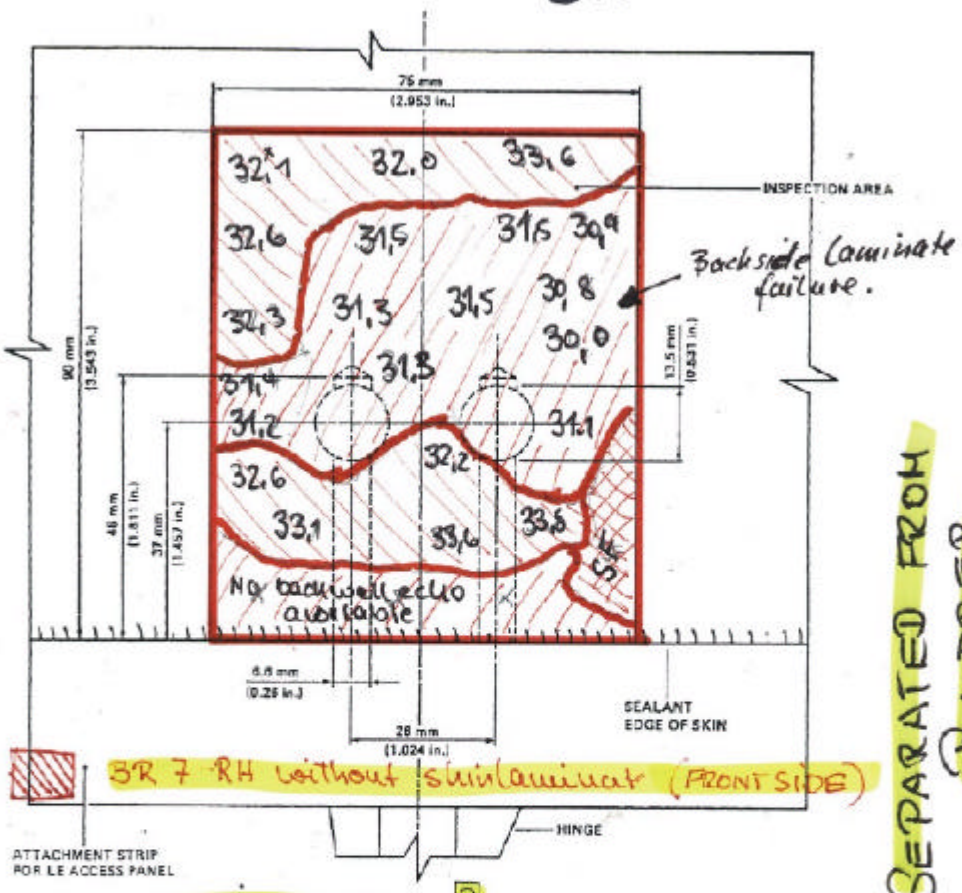
Record Sheet - Hinge Attachment Area BR7/7 55-40-04
Figure 414

A300-600
NONDESTRUCTIVE TESTING MANUAL

No RH9

PART 4 - ULTRASONIC
SSI NO. 55-40-04

BR7 - RH



SEPARATED FROM RUDDER.

A/C MSN: 420	DATE: 21.02.02	TEST UNIT: USIR 12	HINGE NO.: BR 7
REG. NO.:	INSPECTOR: Wehmann	SEARCH UNIT: V106	LH / RH X
HOURS:	PLACE: LANGLEY VA USA	REMARKS: 2.25 MHz	PANEL THICKNESS: 32mm (1.26in.)
CYCLES:			

PART 4

Record Sheet - Hinge Attachment Area BR7 55-40-04
Figure 414

Photo documentation of glass fiber blocks BR1 – 7 LH/R

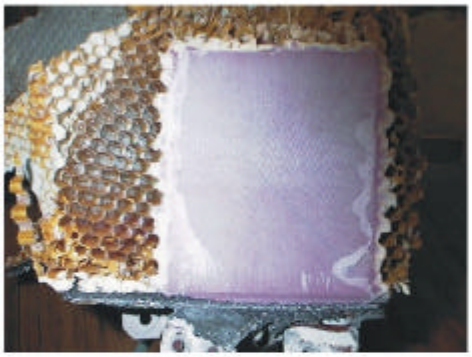
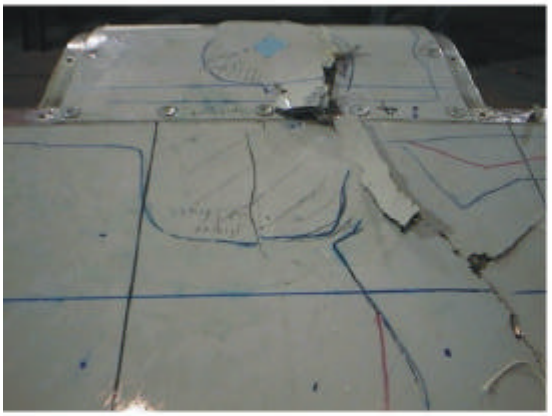


Photo documentation of glass fiber blocks BR1 – 7 LH/R



AIRBUS

APPENDIX B: PROTOCOL OF ULTRASONIC PHASED ARRAY INSPECTION

Protocol

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BIAS, Bremen
Tel.: 0421 – 538 5378
E-mail: helge.hicken@airbus.dasa.de

Location: NASA Langley Research Center, 21.Feb.2002

Title: Ultrasonic PHASED ARRAY inspection of vertical stabilizer A300-600 MSN 420, concerning delamination in the area of CFRP-stringers and CFRP-ribs.

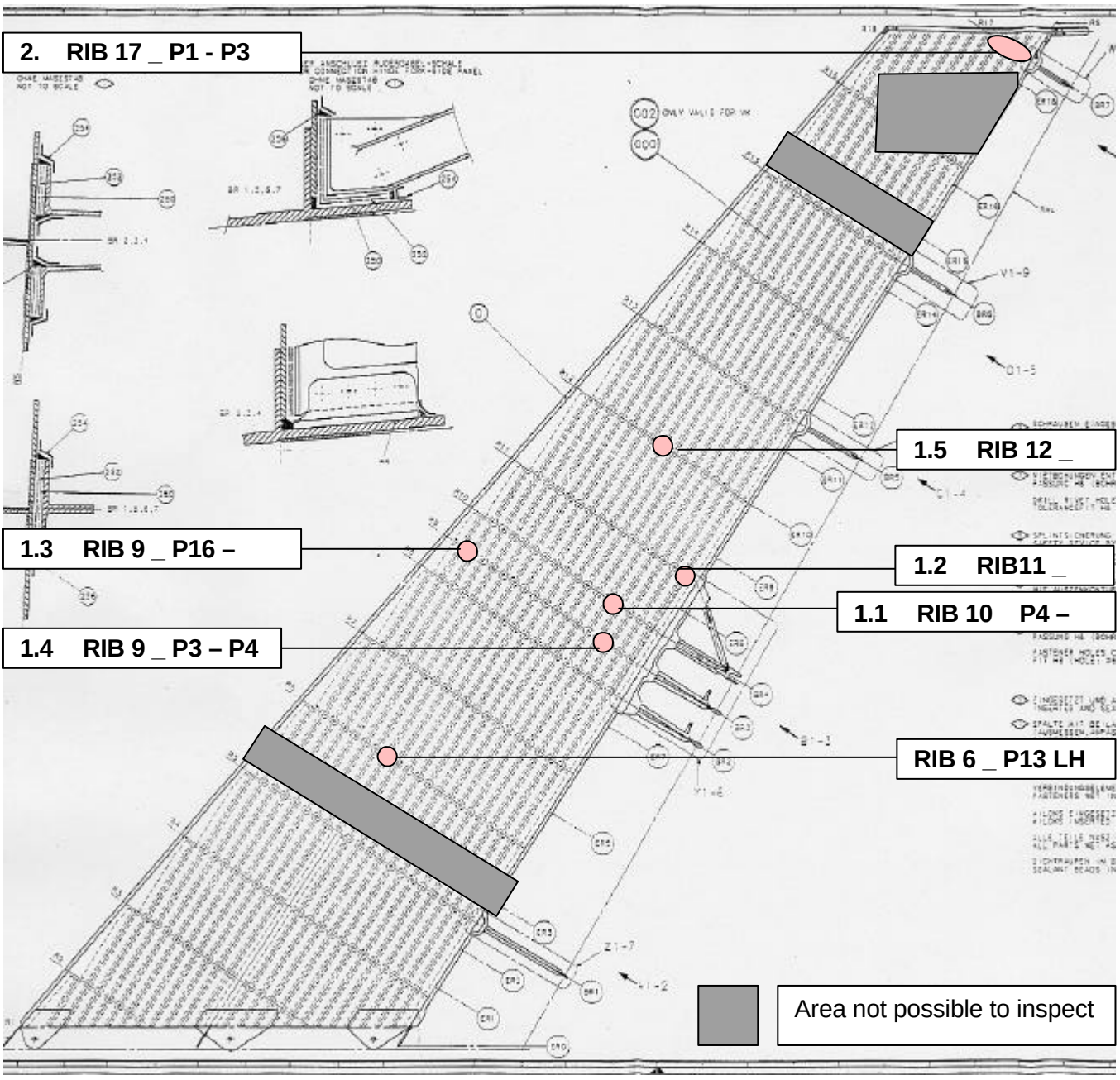
Summary: An inspection of the vertical stabilizer A300-600 MSN 420, concerning delamination in the area of CFRP-stringers and CFRP-ribs were performed from Feb. 13 to Feb. 21 at the NASA Langley Research Center, with phased array equipment from R/D Tech (Focus 16/128).

Indication: The indication which were found are spots with small extensions (Ø ~ 4mm – 6 mm). The delamination which were found in the area of **rib 1(ref to main protocol –Fig. 01 /Fig. 02)**, correspond to the inspection with handheld ultrasonic performed by AIRBUS.

Note: In view of a very sensible inspection performance there was the attempt to record all indications.
All documented indications in this appendix are therefore below the size which have to be recorded in accordance with the quality requirements and should not interpret in general as de-lamination. Especially the very shall indication do have the character of permissible pores or allowable free resin inclusions.

AIRBUS

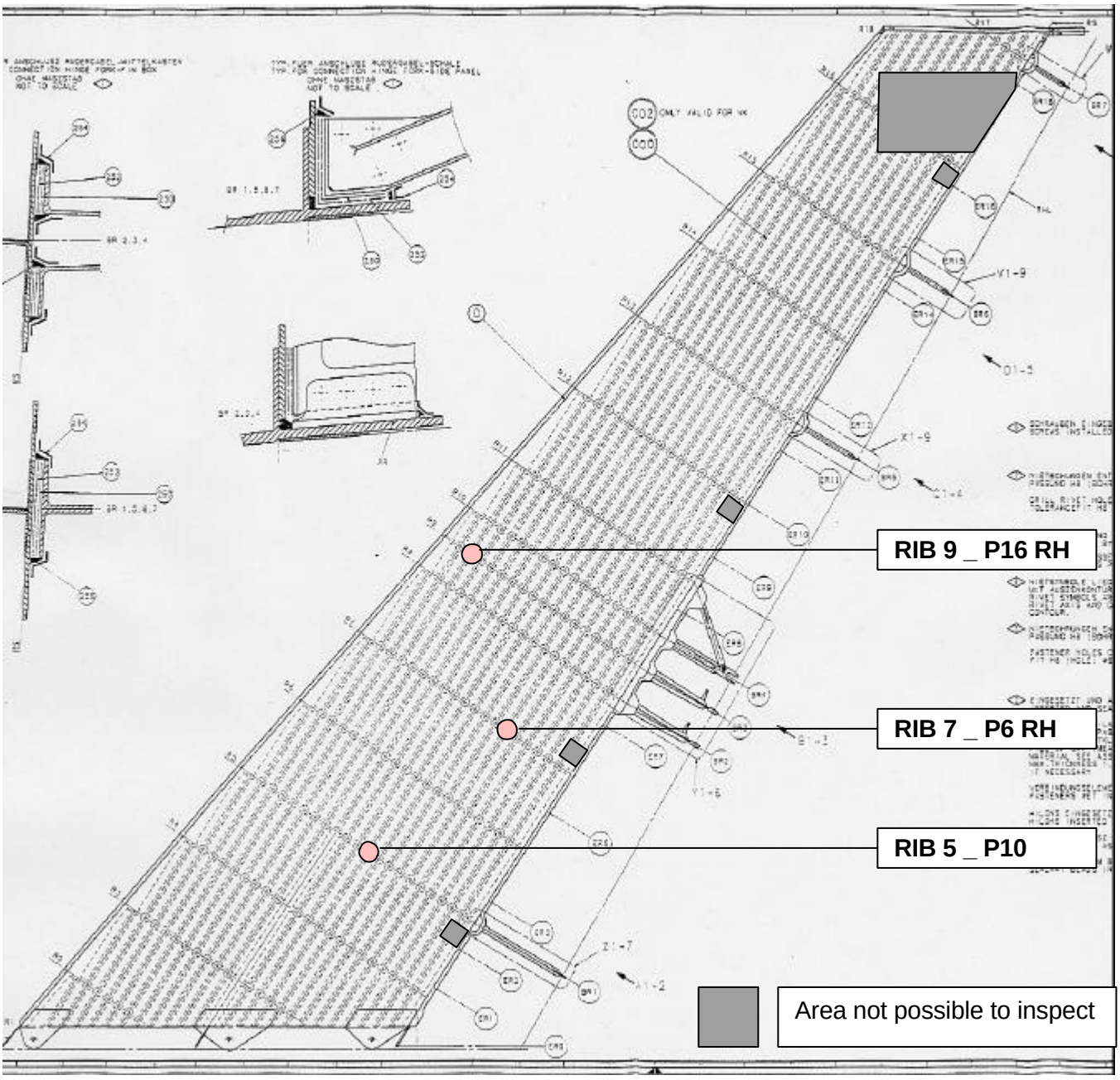
Indication vertical stabilizer A300-600 MSN420 LH



NOTE: The above illustrated drawing does not confirm in all details exactly with the construction level of Airbus MSN 420 (e.g. different rudder bearing forks).
The rudder shell illustration itself confirms with construction level of Airbus A300-600; MSN 420
The relevant NDT-result locations are given in the correct structure positions and are named by the correct STGR/RIB co-ordinates numbering.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements (see also the following detail sketches).

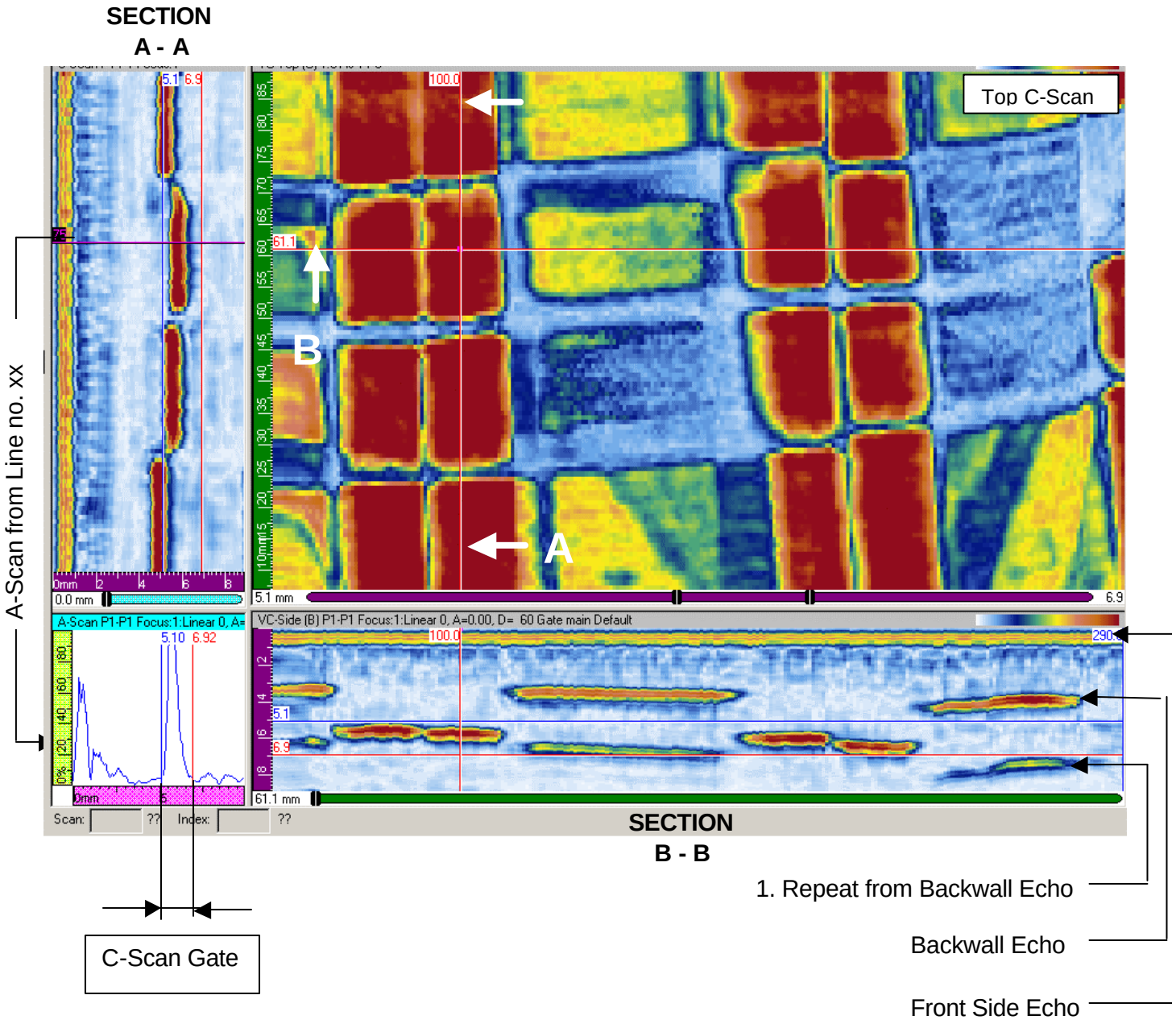
Indication vertical stabilizer A300-600 MSN420 RH



NOTE: The above illustrated drawing does not confirm in all details exactly with the construction level of Airbus MSN 420 (e.g. different rudder bearing forks).
The rudder shell illustration itself confirms with construction level of Airbus A300-600; MSN 420
The relevant NDT-result locations are given in the correct structure positions and are named by the correct STGR/RIB co-ordinates numbering.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements (see also the following detail sketches).

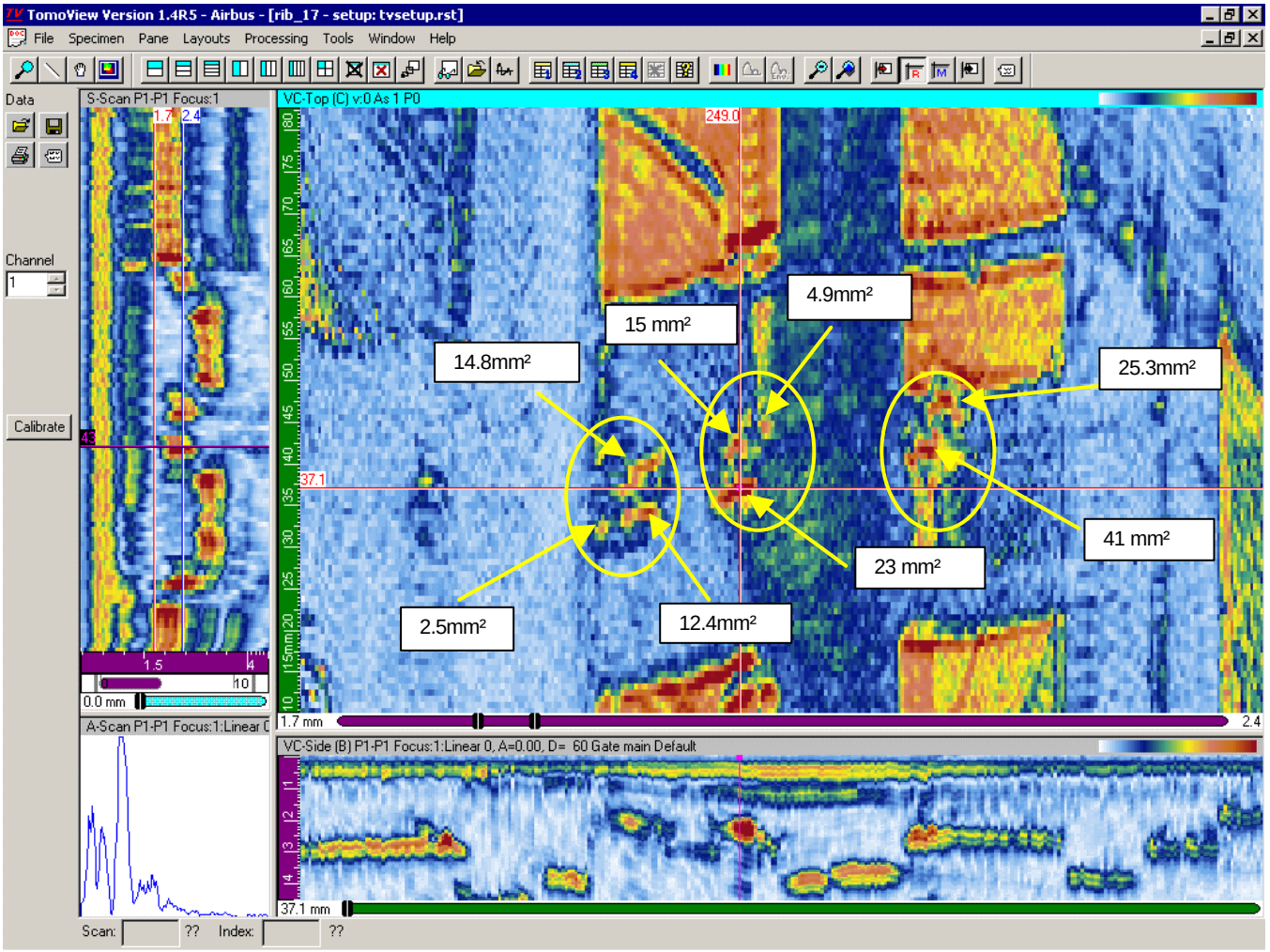
Example for an area without indication



EXAMPLE

* S-Scan: Sectorial Scan (The ability to scan a complete sector of the volume without any probe movement

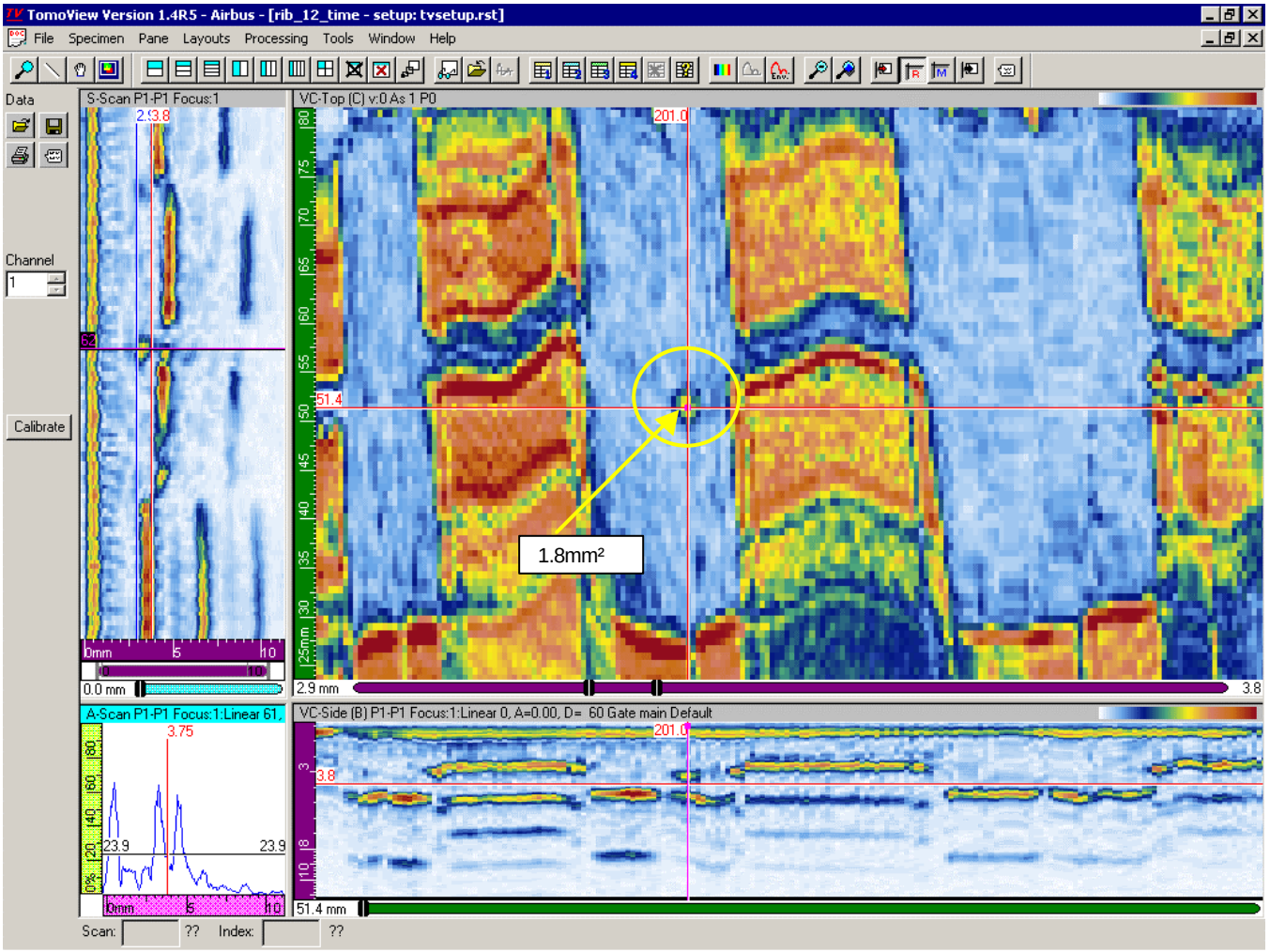
RIB 17 _ P1 - P3 LH



NOTE: The above illustrated area belongs to the quality requirement zone D, which means that a max. extension of de-lamination of 250mm² is permissible.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements.

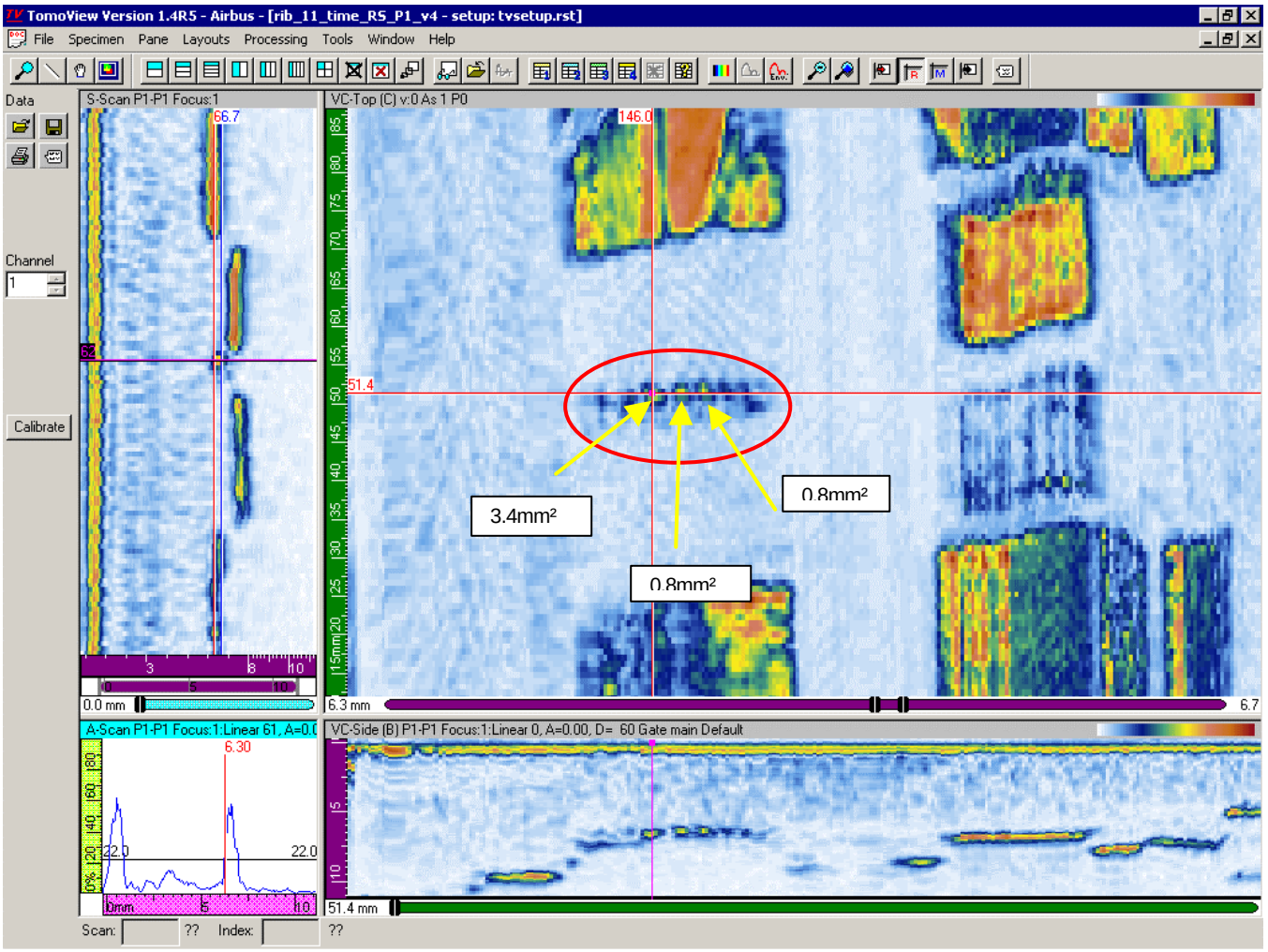
RIB 12 _ P8 LH



NOTE: The above illustrated area belongs to the quality requirement zone D, which means that a max. extension of de-lamination of 250mm² is permissible.

NOTE: Above documented indication is below the size to be registered in accordance with the quality requirements.

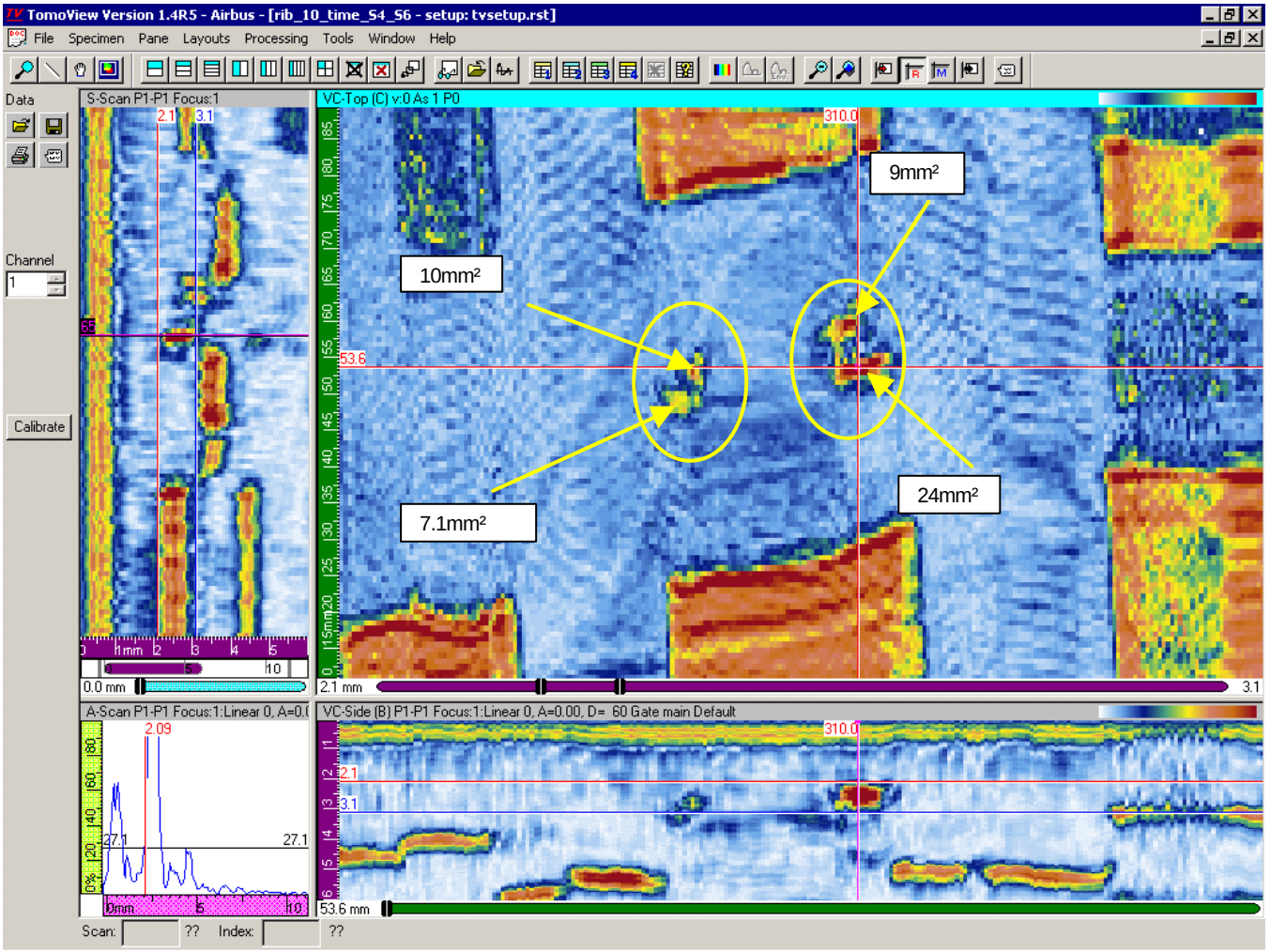
RIB11 _ P1 LH



NOTE: The above illustrated area belongs to the quality requirement zone B, which means that a max. extension of de-lamination of 150mm² is permissible.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements.

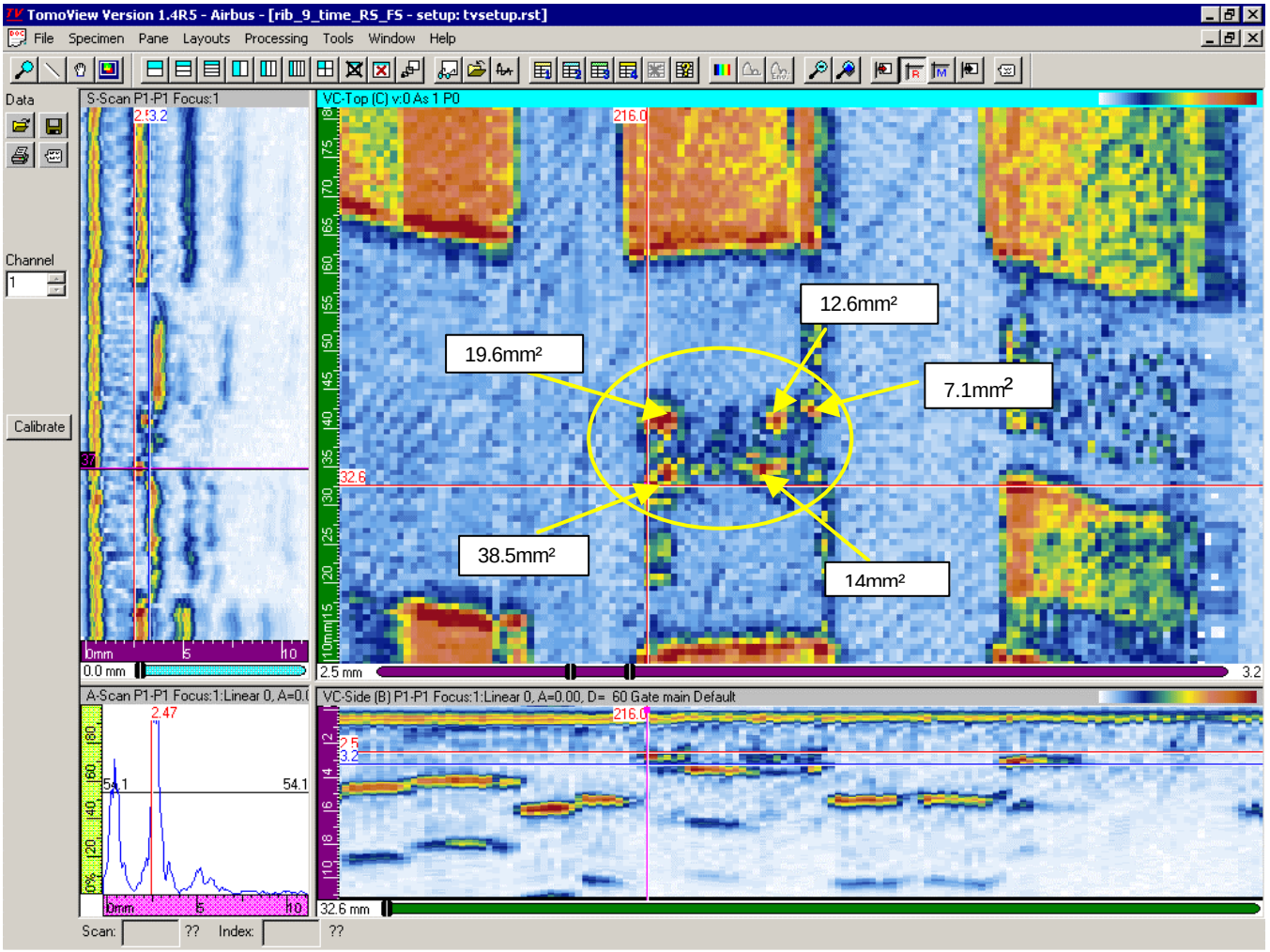
RIB 10 _ P4 – P5 LH



NOTE: The above illustrated area belongs to the quality requirement zone D, which means that a max. extension of de-lamination of 250mm² is permissible.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements.

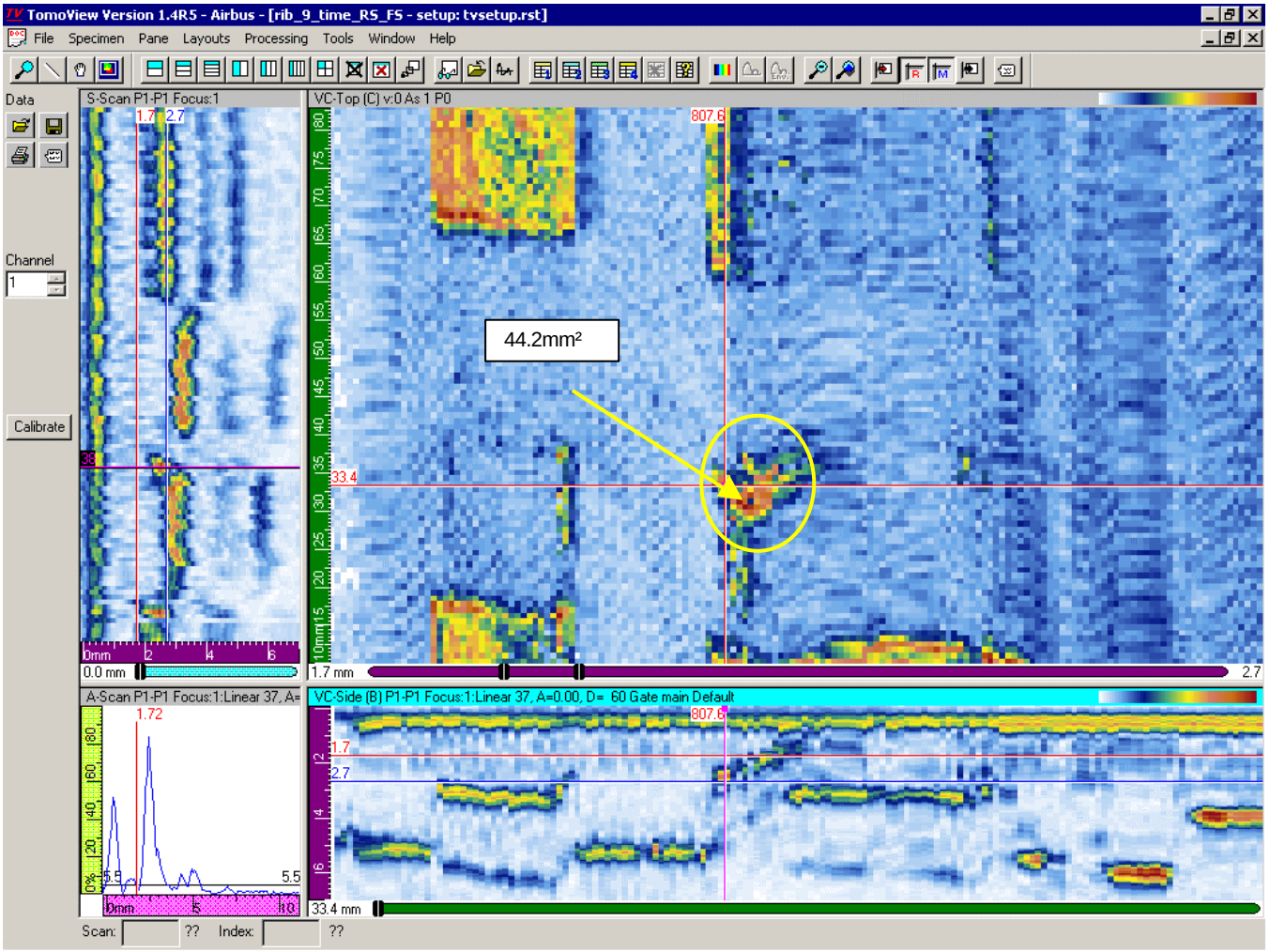
RIB 9 _ P3 – P4 LH



NOTE: The above illustrated area belongs to the quality requirement zone B, which means that a max. extension of de-lamination of 150mm² is permissible.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements.

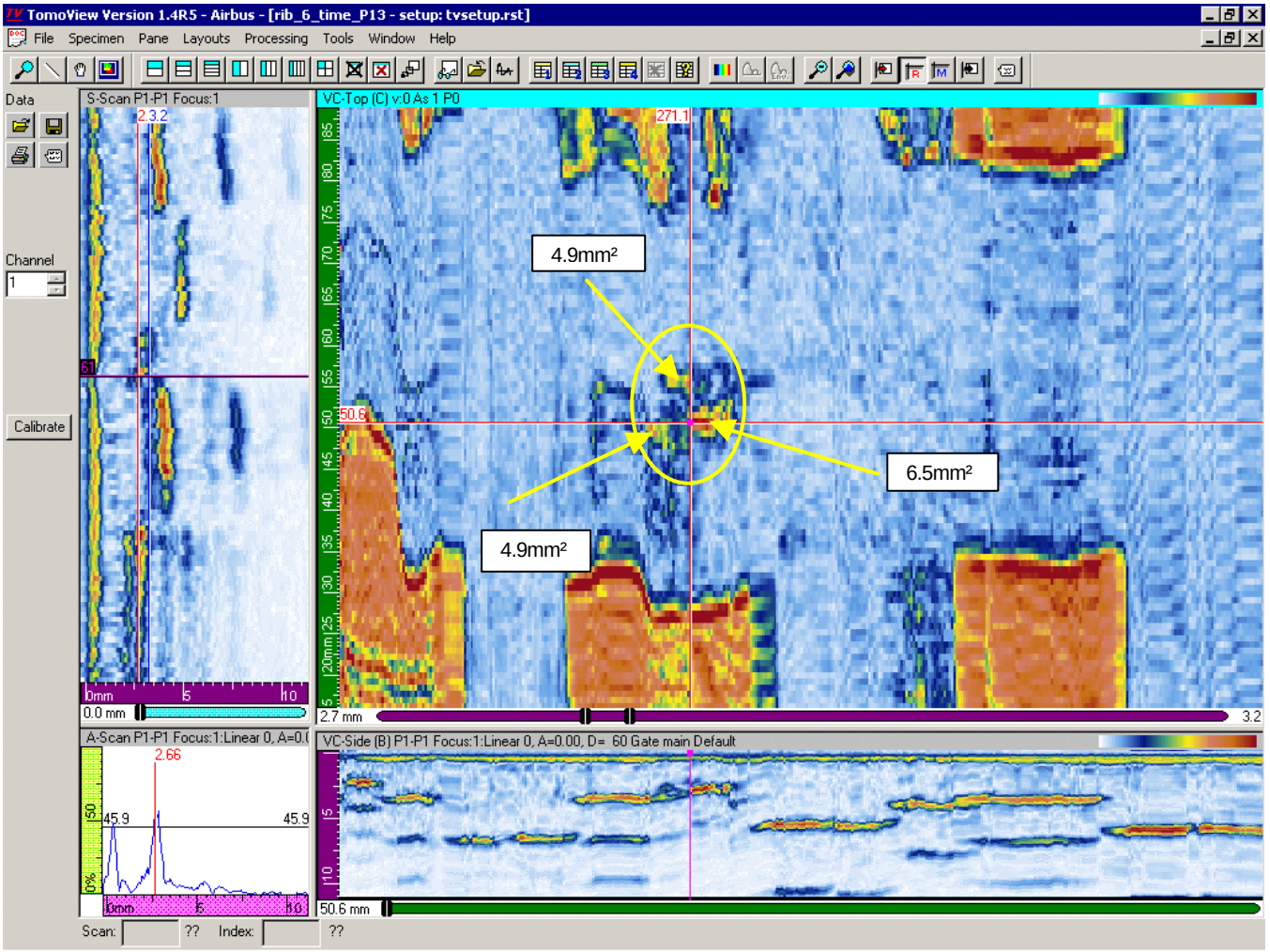
RIB 9 _ P16 – P17 LH



NOTE: The above illustrated area belongs to the quality requirement zone B, which means that a max. extension of de-lamination of 150mm² is permissible.

NOTE: Above documented indication is below the size to be registered in accordance with the quality requirements.

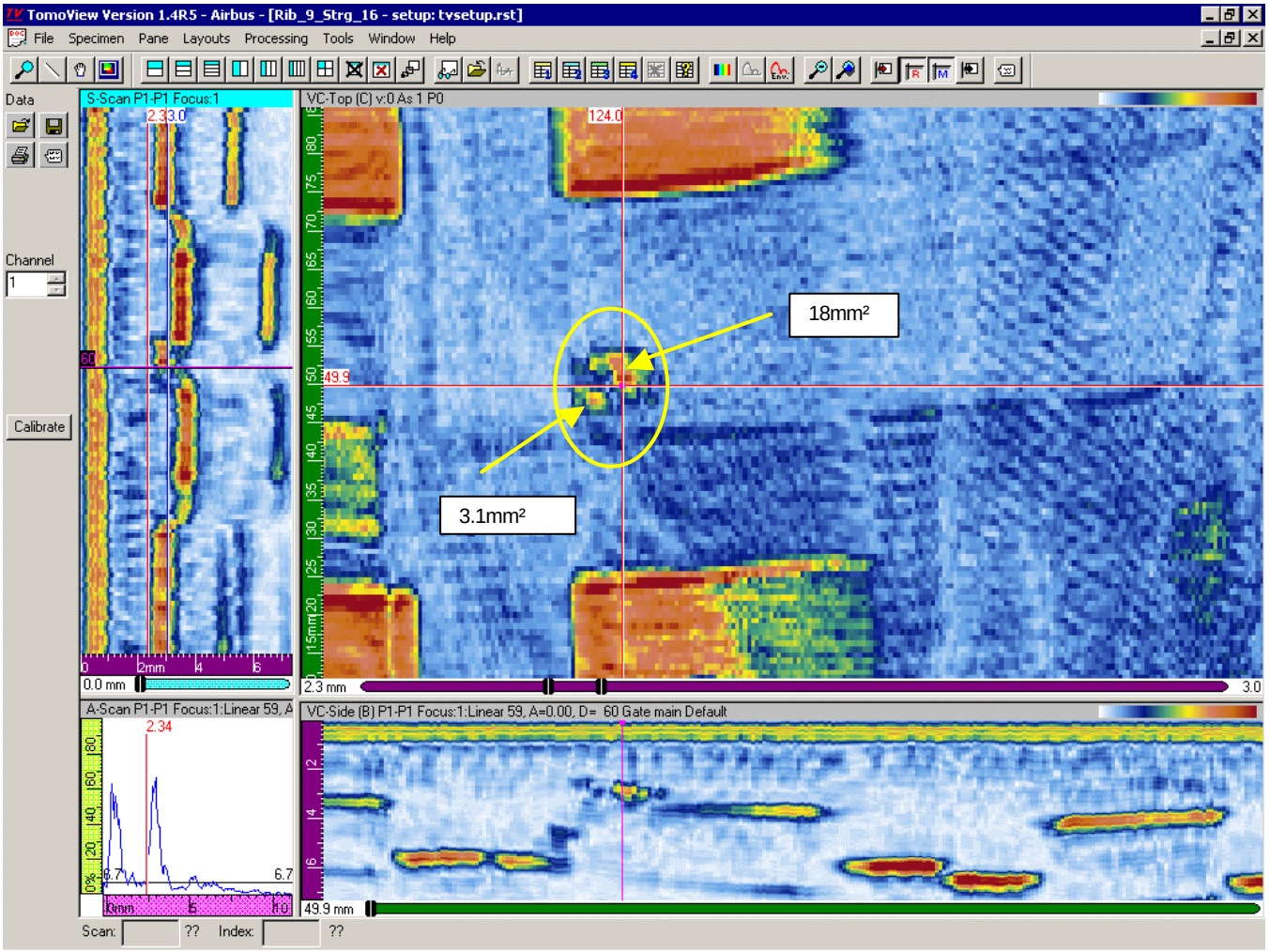
RIB 6 _ P13 LH



NOTE: The above illustrated area belongs to the quality requirement zone B, which means that a max. extension of de-lamination of 150mm² is permissible.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements.

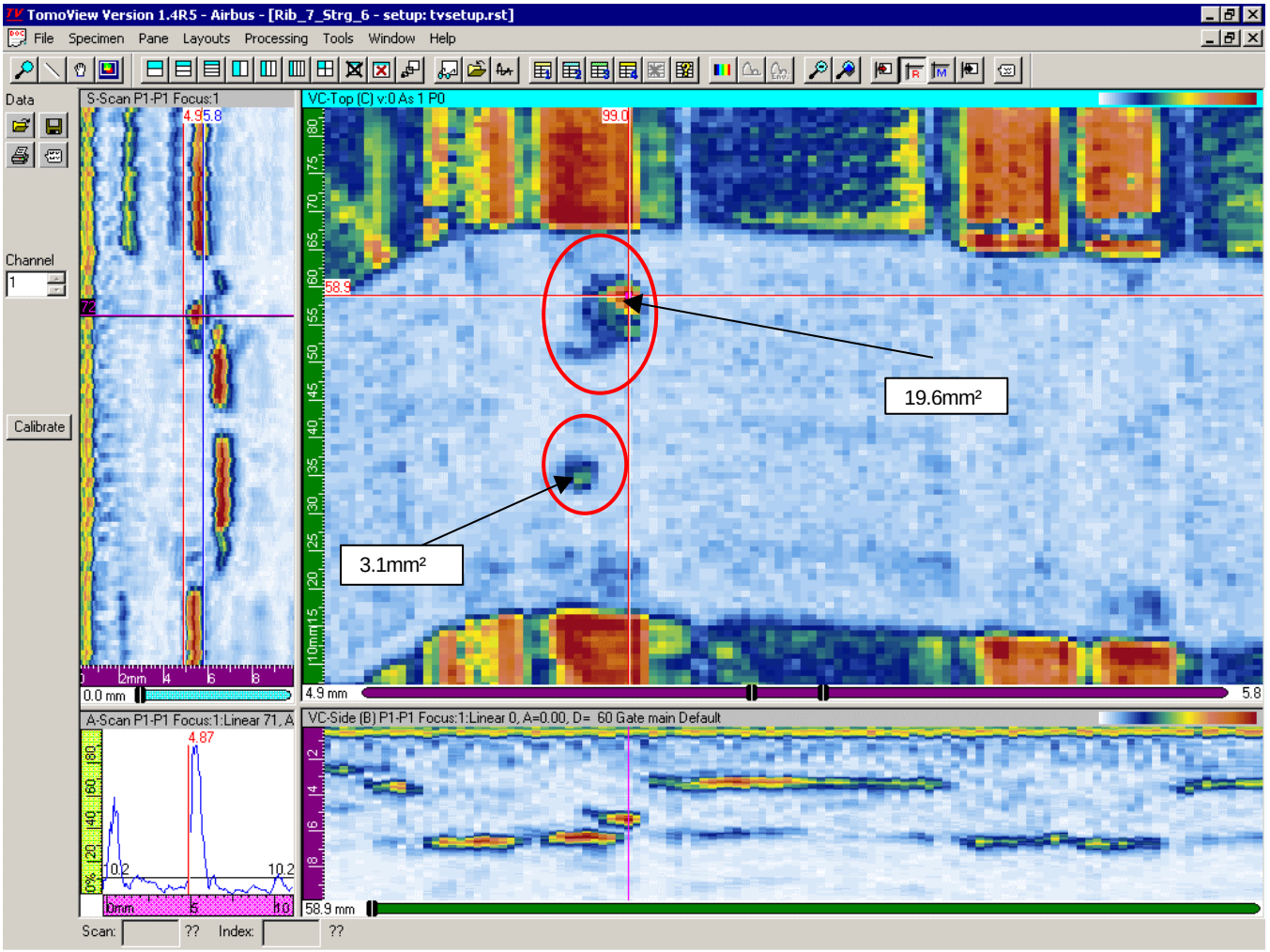
RIB 9 _ P16 RH



NOTE: The above illustrated area belongs to the quality requirement zone B, which means that a max. extension of de-lamination of 150mm² is permissible.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements.

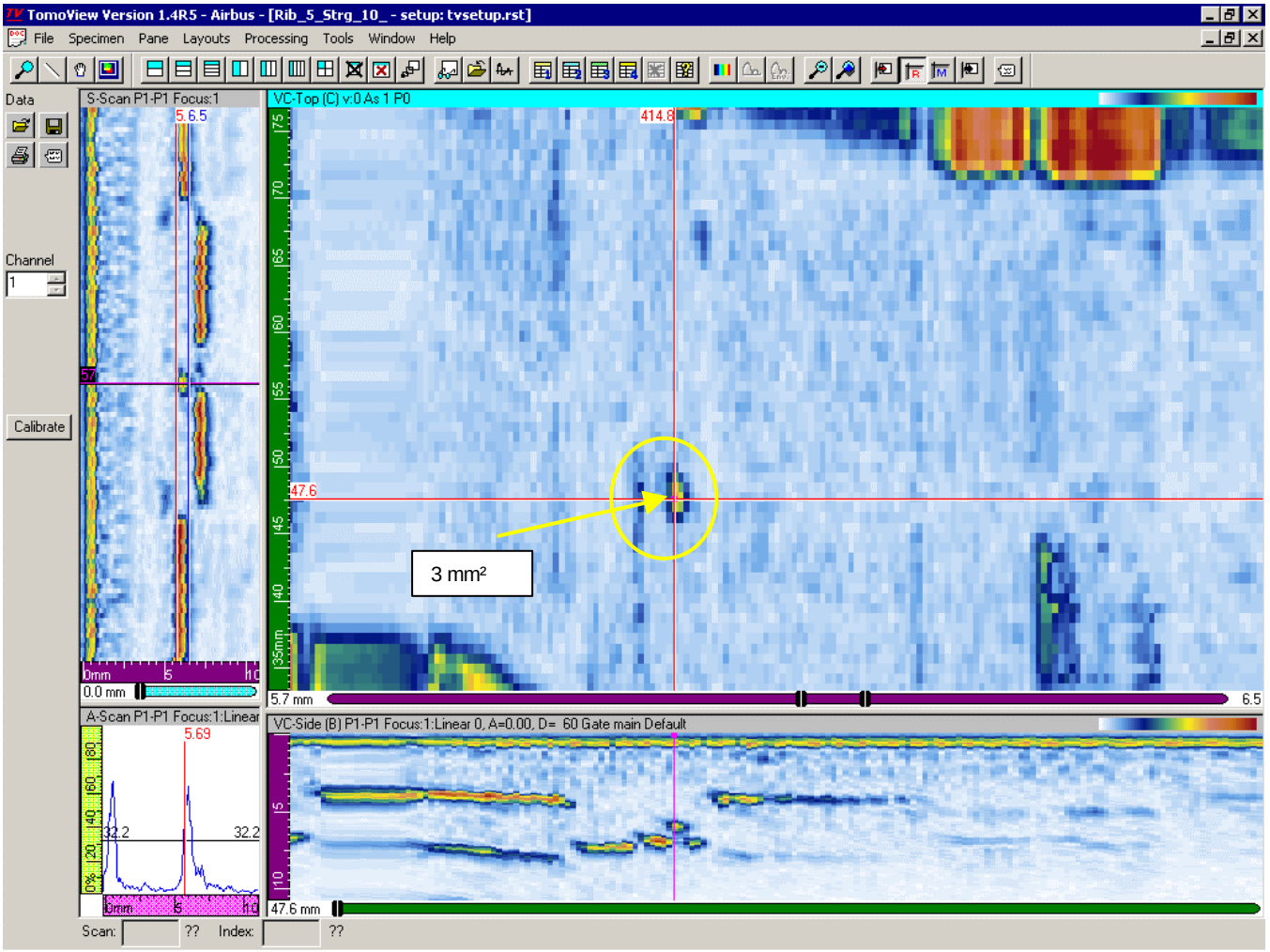
RIB 7 _ P6 RH



NOTE: The above illustrated area belongs to the quality requirement zone D, which means that a max. extension of de-lamination of 250mm² is permissible.

NOTE: All above documented indications are below the size to be registered in accordance with the quality requirements.

RIB 5 _ P10



NOTE: The above illustrated area belongs to the quality requirement zone B, which means that a max. extension of de-lamination of 150mm² is permissible.

NOTE: Above documented indication is below the size to be registered in accordance with the quality requirements.