NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Aviation Engineering Division
Washington, DC 20594

January 16, 2004

ADDENDUM NUMBER 14 TO THE STRUCTURES GROUP CHAIRMAN'S FACTUAL REPORT

DCA02MA001

A. ACCIDENT

Location:	Belle Harbor, NY
Date:	November 12, 2001
Time:	09:16:14 EST
Aircraft:	American Airlines Flight 587, Airbus Model A300-605R, N14053 Manufactures Serial Number (MSN) 420

B. STRUCTURES GROUP

Chairman: Brian K Murphy
National Transportation Safety Board
Washington, DC

C. AIRBUS TEST REQUIREMENT

1. "MSN513 LHS and RHS Test Program for Rear Main Fittings Lug Test#2 and #3"

AIRBUS

Test Requirement

Department:	ESGE	Report No.:	32 X 029 K4 805 P34
Typ:	A300-600R		

Title:

MSN513 LHS and RHS test program for rear main fittings Lug Test#2 and #3

Summary:

The load level reaches during the 1997 event and the after RHS rear main lug damage detected in March 2002 indicate that in the reached configuration the fin was considered as unserviceable.
The LHS and RHS rear main lug, including the side skin panel, rib1 to 5 were removed from this VTP for test purposes.
The test of the two damaged main lug specimen shall demonstrate the residual strength of the lugs under load conditions to which the fin of AA flight 587 has been exposed during the accident. The load conditions are derived from DFDR-data and structural analysis by FEM.

Date:
06.01.2004

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Public Docket	1	06.01.2004	25		A300-600R

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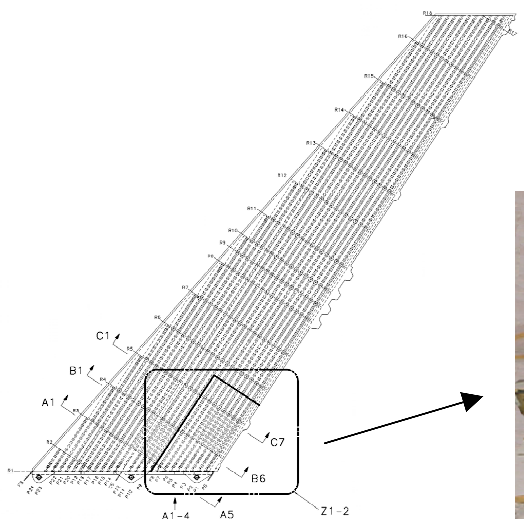
1. Introduction

The load level reaches during the 1997 event and the after RHS rear main lug damage detected in March 2002 indicate that in the reached configuration the fin was considered as unserviceable.

The LHS and RHS rear main lug, including the side skin panel, rib1 to 5 were removed from this VTP for test purposes (see figure 1.1). The cut out of the LHS and RHS test specimen was done by American Airlines in Tulsa. An Airbus specialist assists the cut out process. The specimen were shipped to Airbus Hamburg and an incoming inspection was done.



RHS LHS Rear main Lug

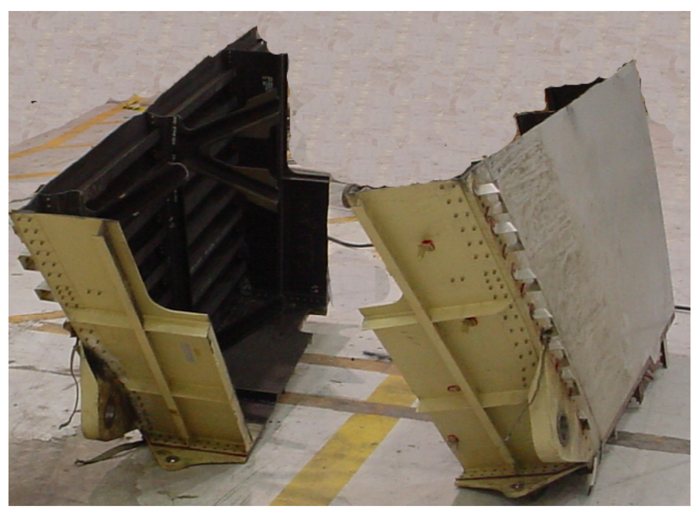
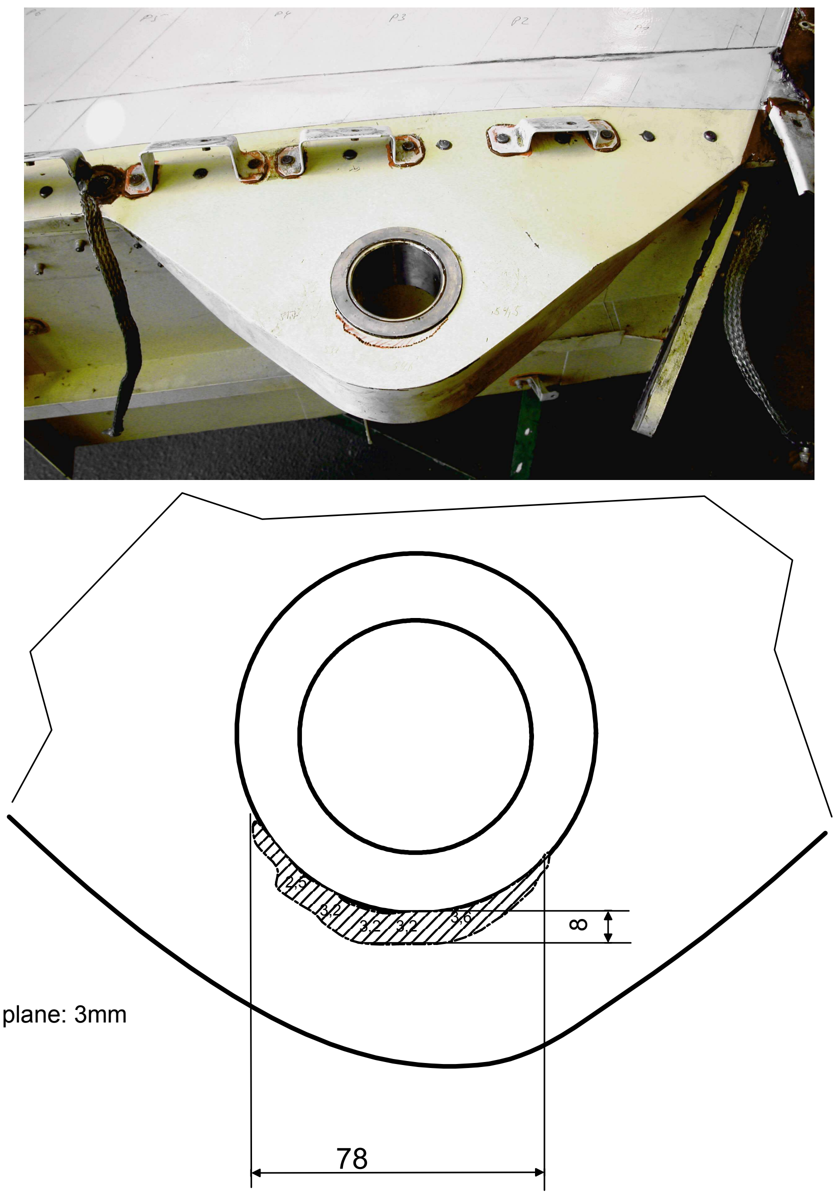


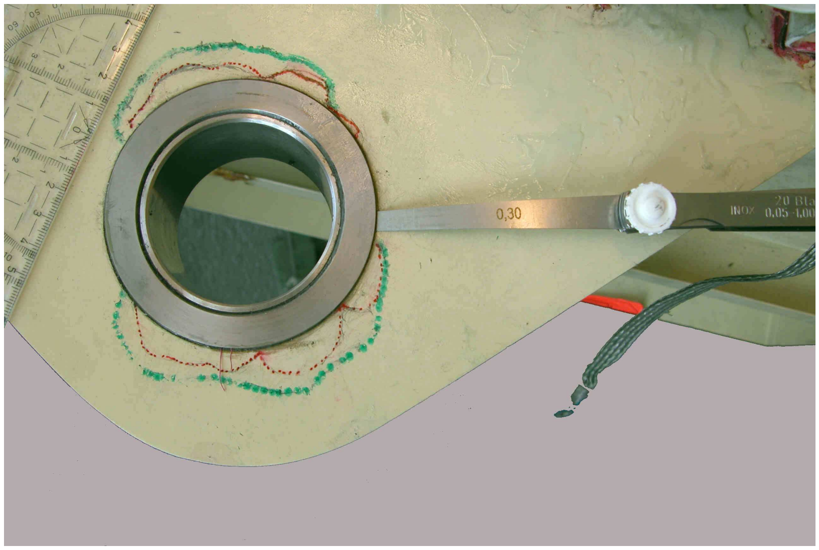
Figure 1.1

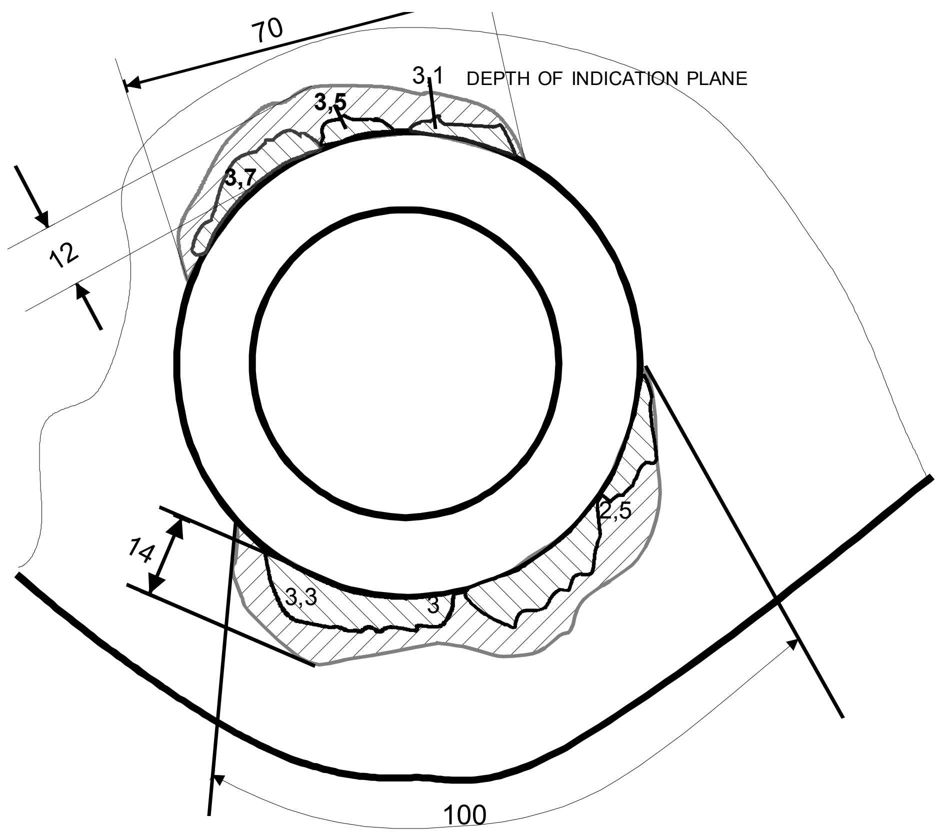
The incoming inspection reports show, that the parts to be tested have new or increased defects as compared to the inspection made in March 2002 (see figure 1.2 and 1.3).



Depth of indication plane: 3mm

Figure 1.2 LHS rear main lug outboard view with the delamination and cracks around the bushing. (findings not existing in the inspection at Tulsa in 2002)





Area of the Delamination at the inspection of the MSN 513 at AA in Tulsa

Area of the Delaminations and cracks at the incoming inspection of the cut out in the structure test departmen

Figure 1.3 RHS rear main lug outboard view with the delamination around the bushing

The origin of these differences are as yet not explained and therefore the test should not be considered reflecting the standard behavior of the lugs.

The complete results of the NDI inspection are documented.

2. Test objective

The test of the two damaged main lug specimen shall demonstrate the residual strength of the lugs under load conditions to which the fin of AAL flight 587 has been exposed during the accident. The load conditions are derived from DFDR-data and structural analysis by FEM.

3. Test component

The test components are built according to the specific drawing. The precured inboard and outboard lug parts, which are assembled to the rear main fuselage attachment lugs for the MSN513 (AAL903) have the same design and stacking sequence as the MSN420 (AAL587) broken lug.

The final dimensions of the test specimen and the reinforcements are shown on the drawings.
The test component is shown in figure 3.1 to 3.5 with the assembled parts.

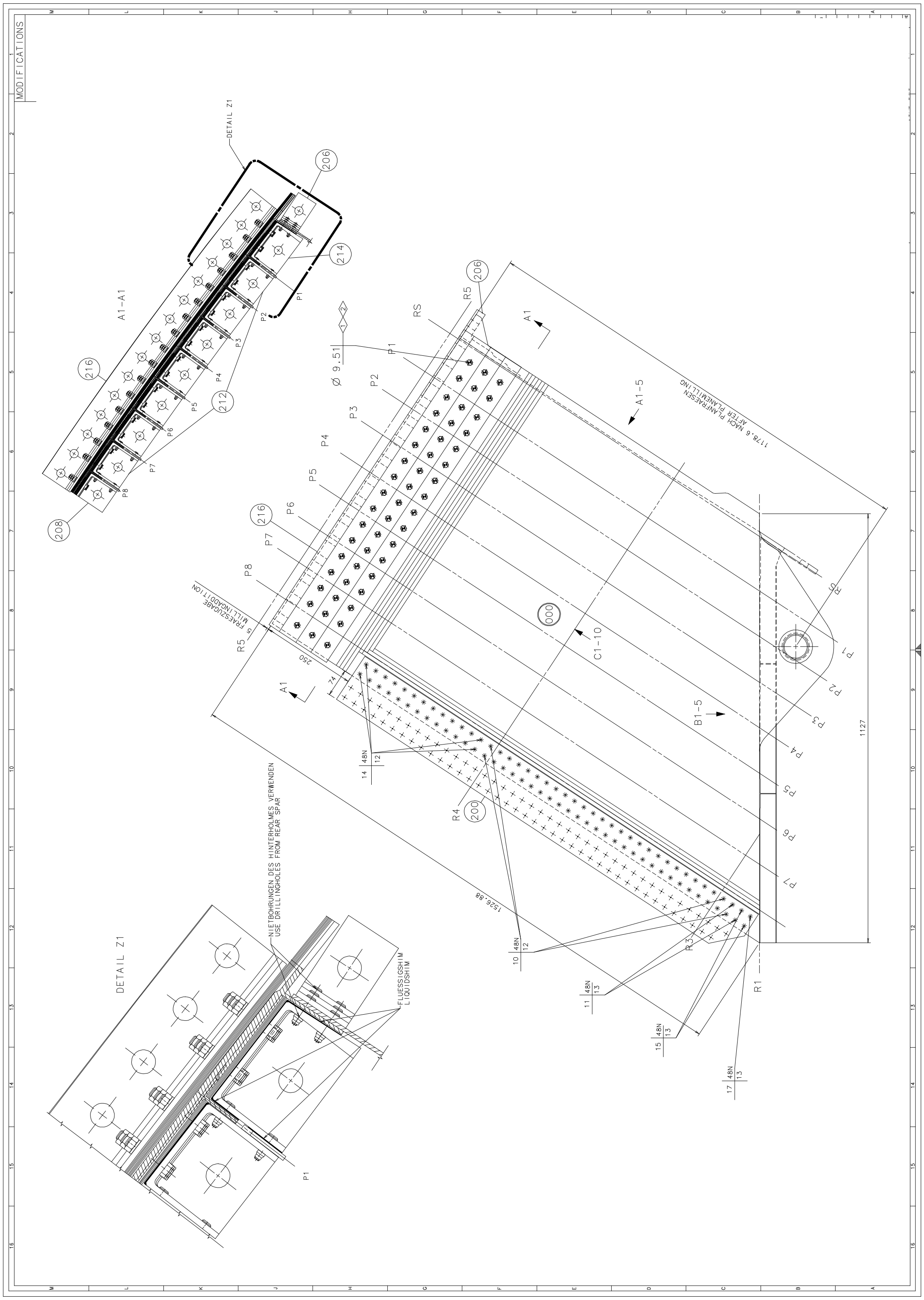


Figure 3.1 LHS Lug Test#2 specimen drawing [outside view]

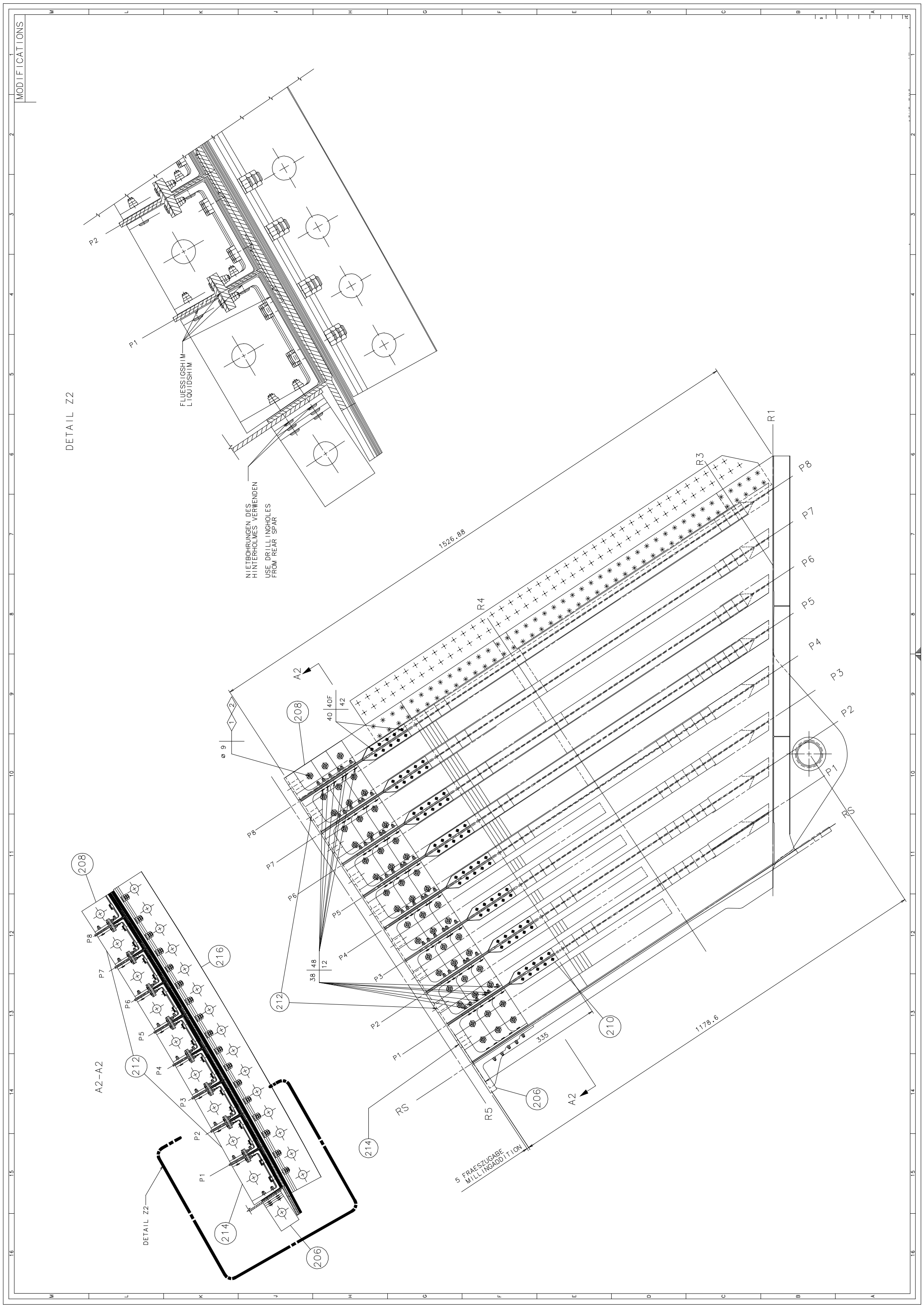


Figure 3.2 LHS Lug Test#2 specimen drawing [inside view]

Figure 3.3 LHS Lug Test#2 [inside]

Figure 3.4 LHS Lug Test#2 [outside]

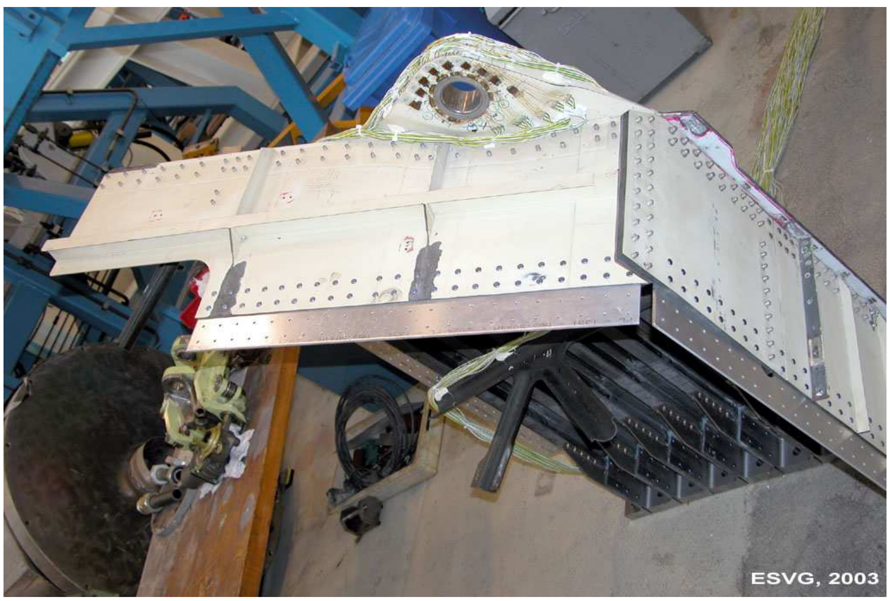


Figure 3.5 LHS Lug Test#2 [view on rib1]

4. Environmental conditions

The tests will be carried out at ambient temperature (RT). The component will be tested in an 'as received ' condition.

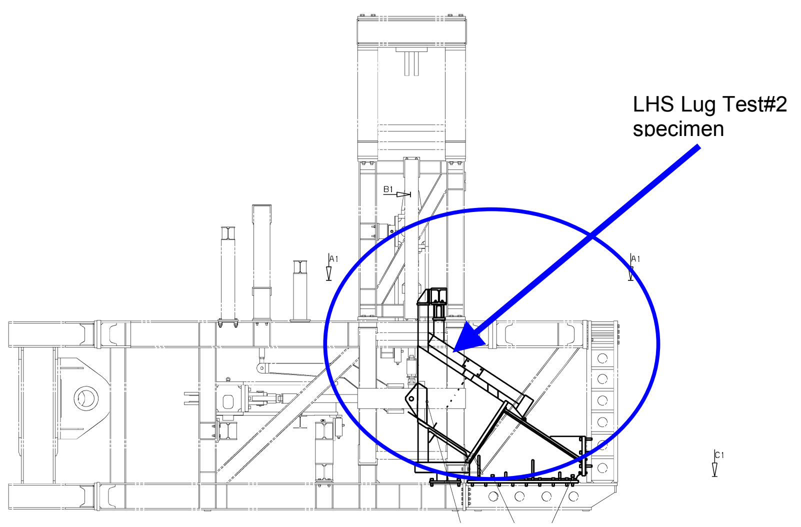
5. Test setup

The test specimen is fixed to the test rig at the upper end (parallel to rib 5), at the rear spar, parallel to stringer 8, the rib 1 and rib 4 (see figure 5.1 to 5.4). The loads are introduced in the global coordinate system by 3 servo-hydraulic-jacks (For the final rupture test the X/Z load introduction is force controlled and Y load introduction is displacement controlled). The lateral load in Y-direction is introduced in line with the axis of the connecting pin.

The loads in X- and Z-direction are applied by two rods each which are adjustable in their length by turnbuckles. The turnbuckles can be used to pre-adjust an initial lug rotation Rx and Rz, which corresponds to a local lug moment Mx and Mz, before applying the load vector.

The original fin/fuselage connecting pin has to be used. The fitting is attached to a fork-end lug (representing the fuselage attachment fitting) made from high strength aluminum alloy with similar dimensions as the original fuselage fitting for stiffness reason.

Figure 5.1



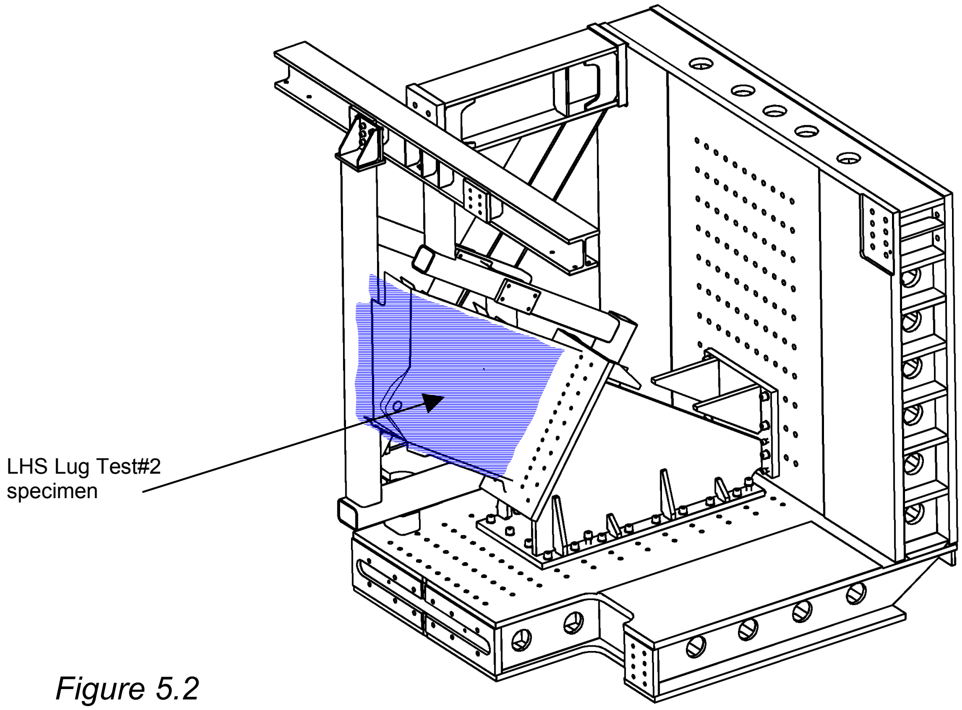


Figure 5.2

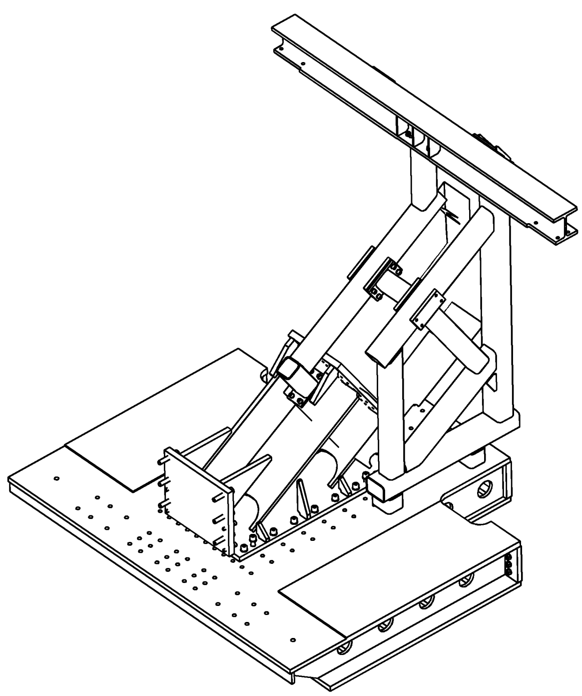


Figure 5.3

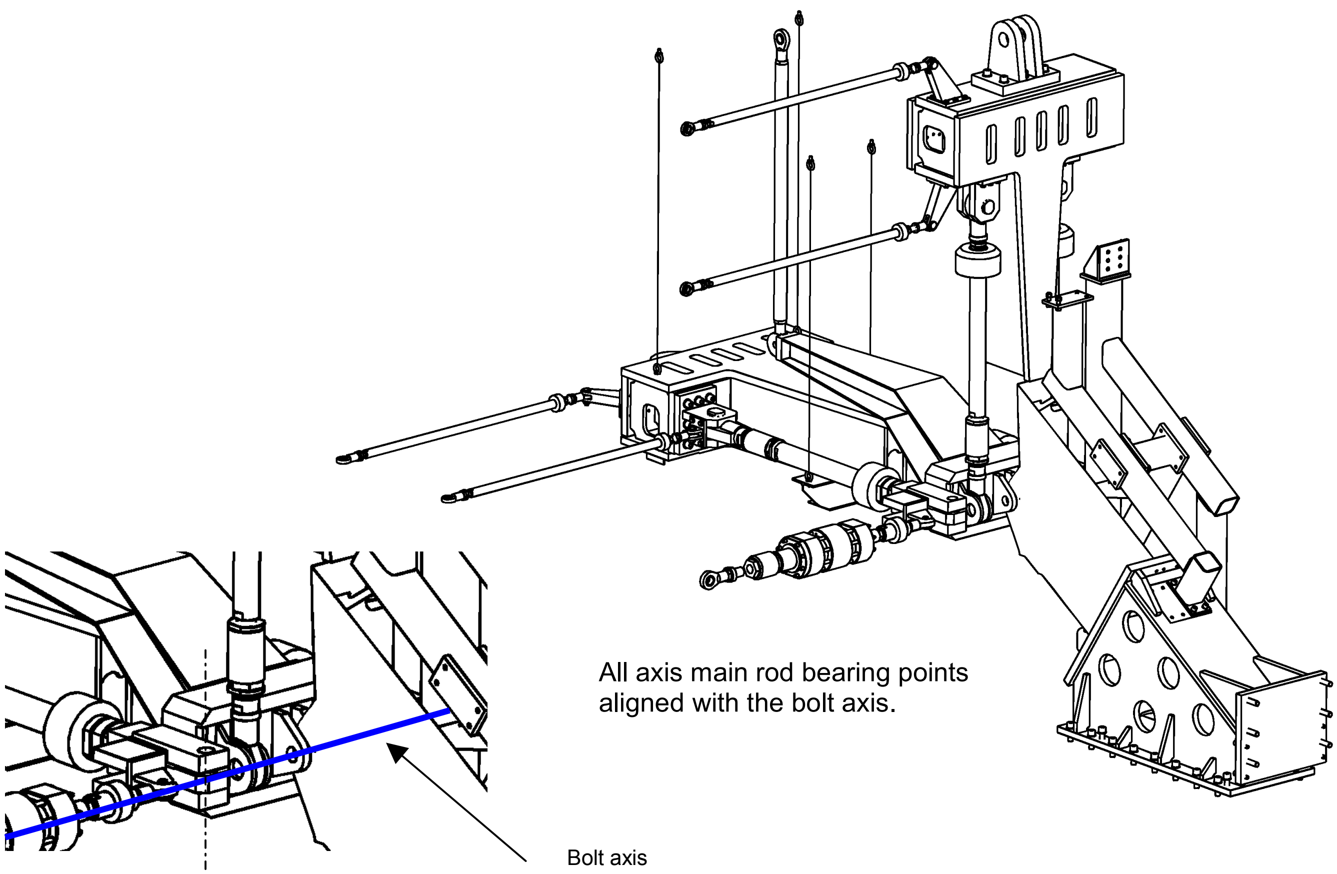


Figure 5.4 Modified load introduction

6. Measurement plan

Figure 6.1 to 6.3 shows the strain gauge positions and the orientation. The position of the strain gauges around the lug and on the fuselage clevis are identically to the Lug Test#1 specimen in test requirement 32 X 029 K4 804 P34. Additional strain gauges are defined in the skin panel area between rib1 and 4 and on the inner stringer girder.

Displacement measurement positions are shown in the fig. 6.4.

The strain gauge locations and numbering around the lug are identically to the Lug Test#1 specimen described in test requirement 32 X 029 K4 804 P34.

Strain Gauge numbering system

All strain gauges are on both sides (inboard and outboard) of the test specimen installed. The table show the numbering system with the gauge type, orientation and the location.

Example: **16iB** (No. **16** rosette round the lug, **inboard** and **45°** gate)

No.	Inboard/ Outboard	Strain Gauge Type	Orientation [°]			Location
			0	45	90	
E1-9	i/o	Unidirectional	A			Round the lug
R10-18	i/o	Rosette	C	B	A	Round the lug
E20-27		Unidirectional	A			Outer border of the lug
R30-38	i/o	Rosette	C	B	A	Skin panel
E40-41	i/o	Unidirectional	A			Stringer area (inner girder and outside on the skin panel)

1i= for the inboard strain gauge

1o= for the outboard strain gauge

A,B,C= notation of the strain gauge gate

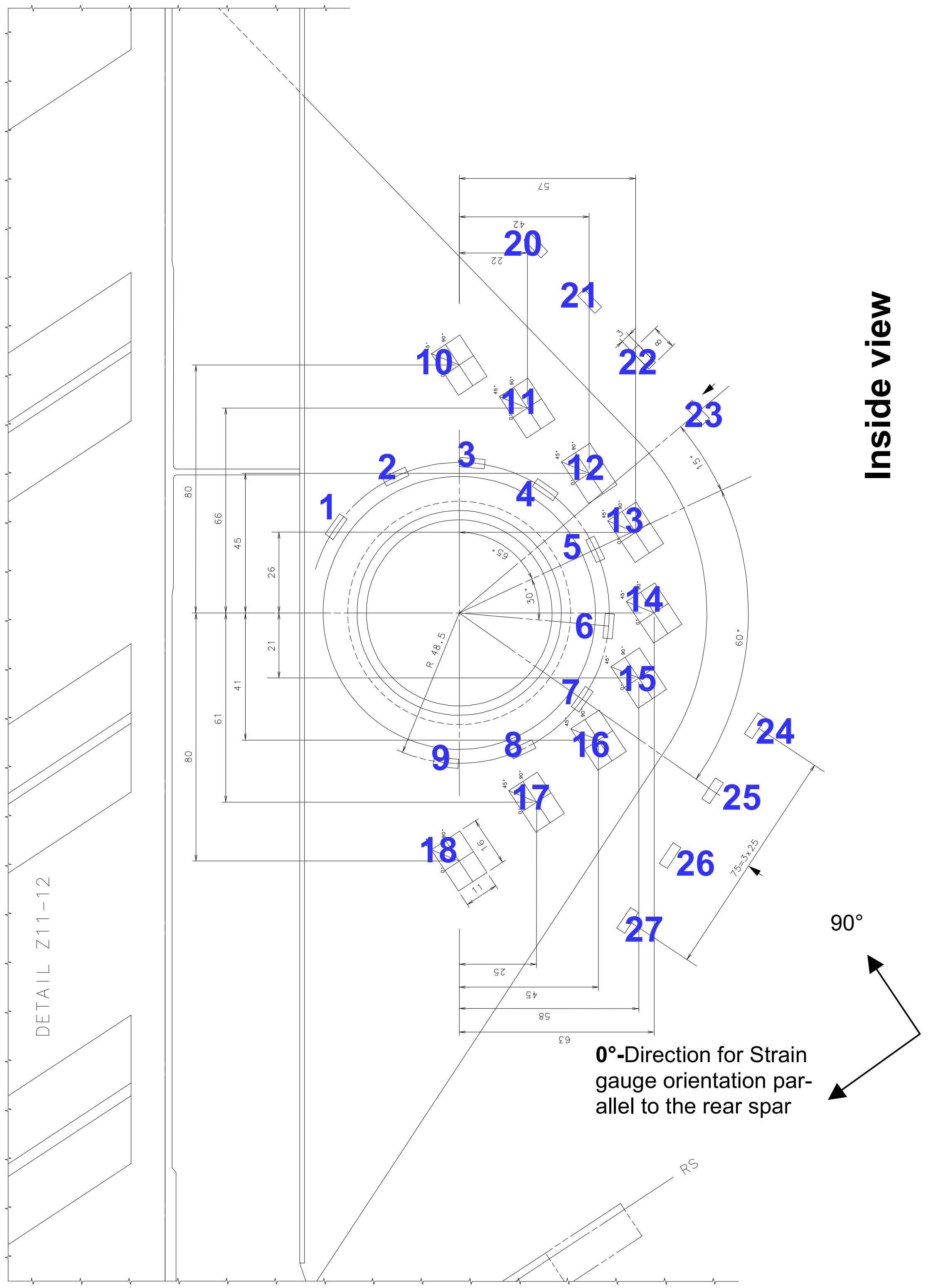


Figure 6.1 Strain Gauge position around the lug

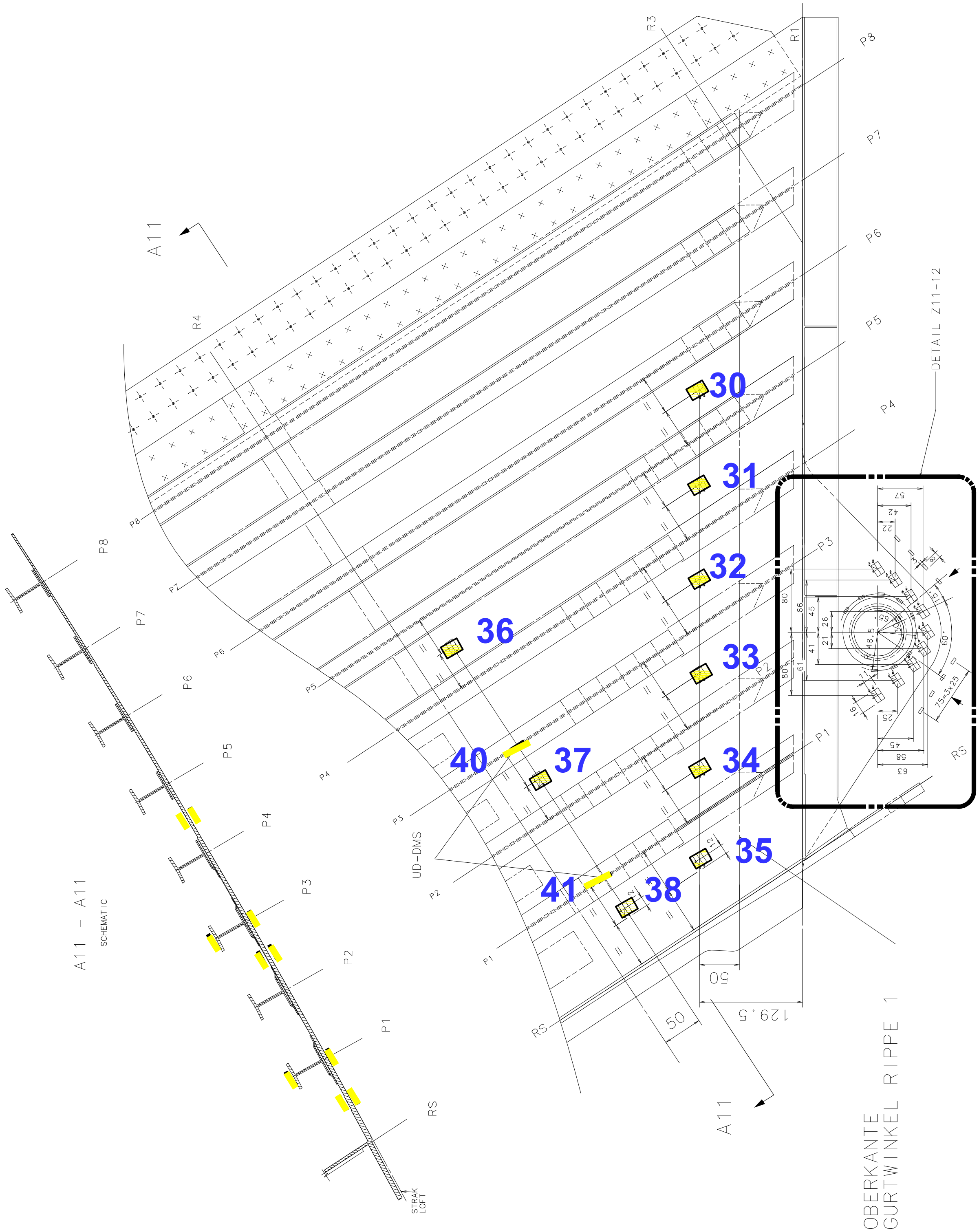


Figure 6.2 Strain Gauge position in the skin panel area

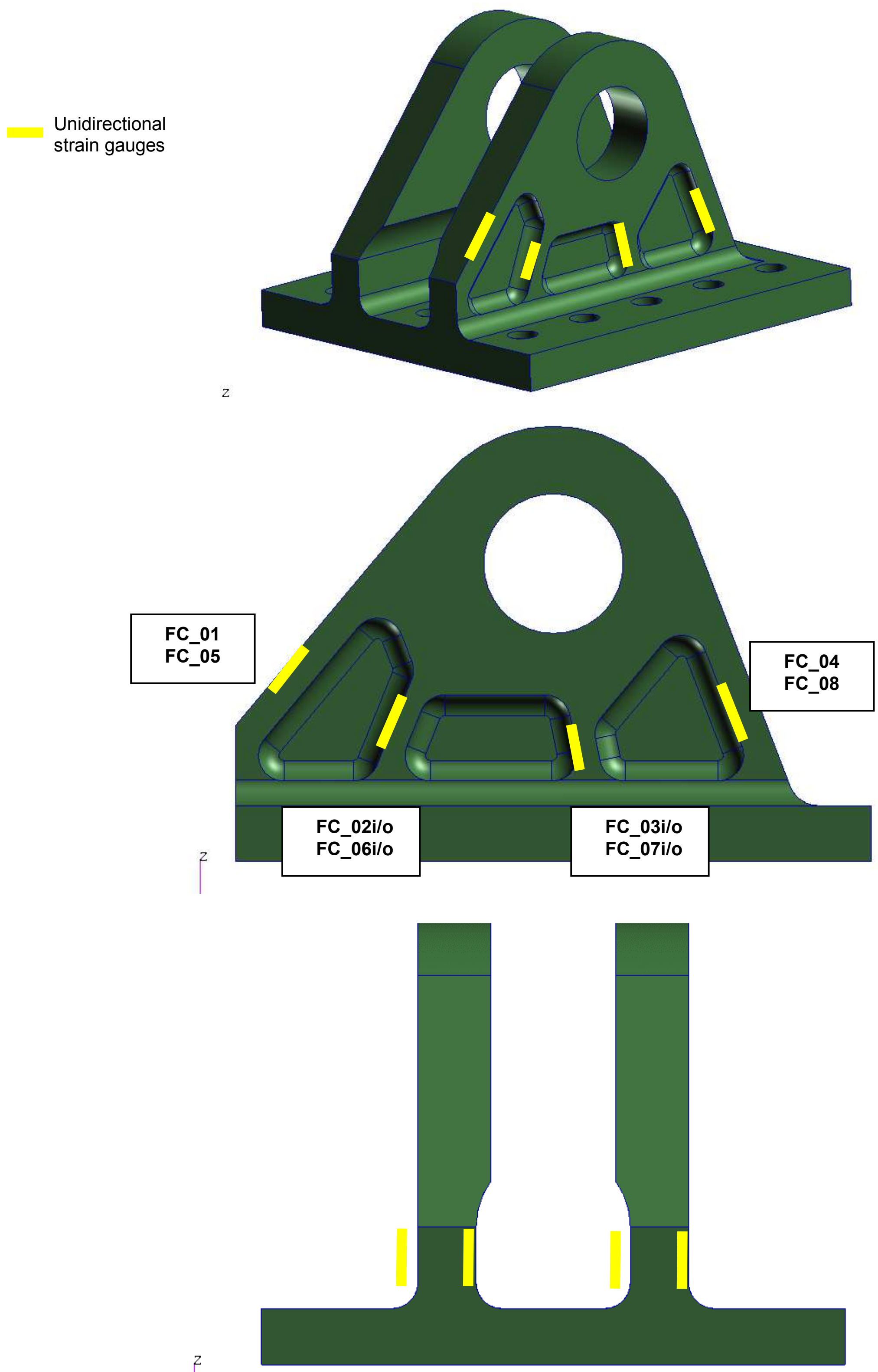


Figure 6.3 Strain Gauge position on the fuselage clevis

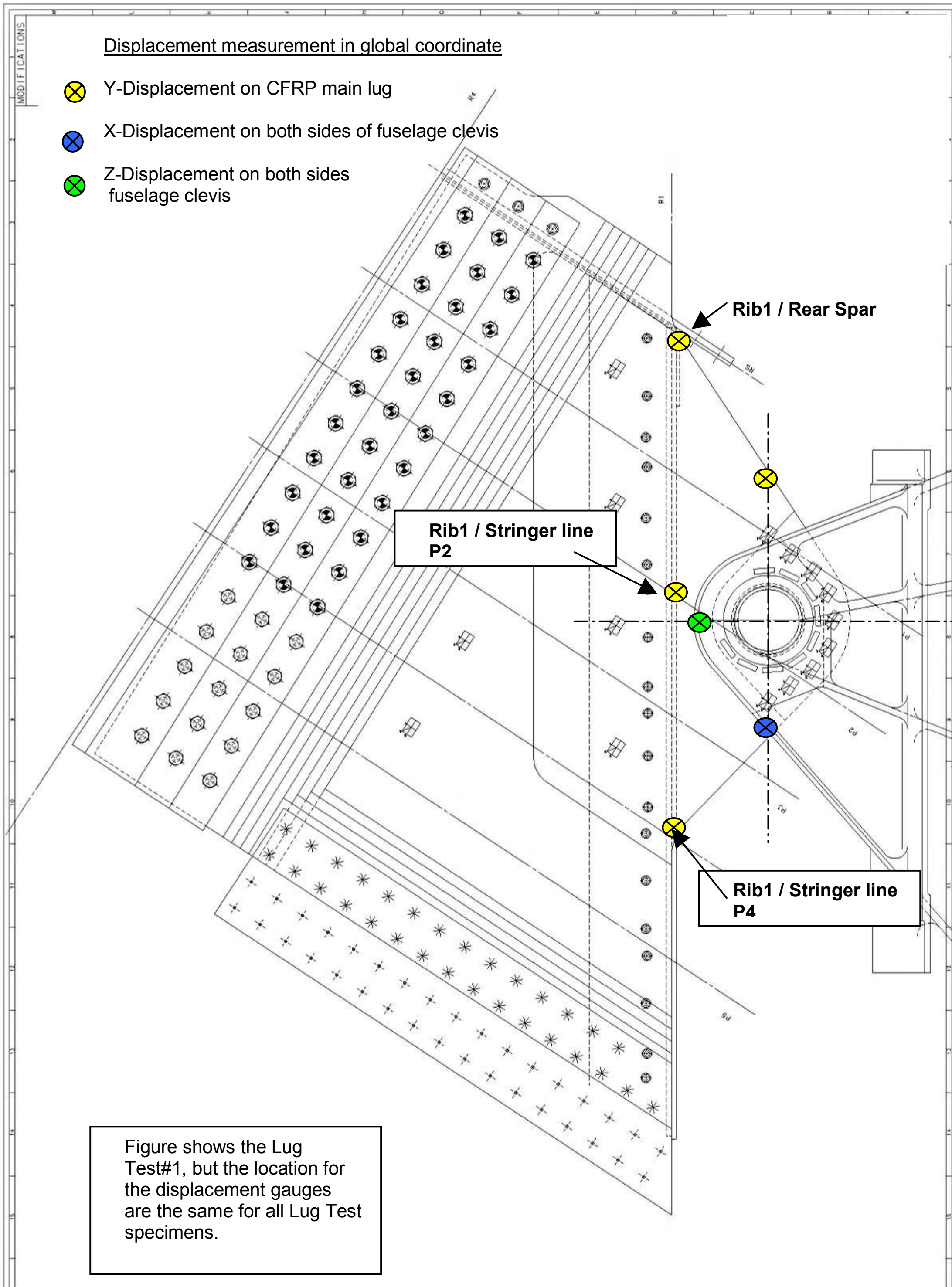


Figure 6.4 Displacement Transducer location

7. Basic inspections

After delivery of the MSN513 LHS and RHS rear main test specimen to Airbus a visual and ultrasonic inspection has to done to document the quality and condition.
Also after reinforcement of the test specimen a visual and ultrasonic inspection has to be done.

8. Measurements

For all load cases strain, displacements and forces have to be recorded for each load step.

9. LHS rear main lug calibration load cases

Each load case will be repeated 3 times to check the linearity and the hysteresis behavior of test rig. The increase of the load level depends on the measured strain level and the displacements at the main lug. The calibration load cases will be stopped if a defined strain level is reached to prevent a structural damage of the test specimen.

Strain direction	Strain level bandwidth [micro strain]
X-strain 0°-degree	**± 2000**
Y-strain 90°-degree	**± 2000**
XY shear strain	**± 2500**

9.1 Tension Fz / X+Y-force=0

Fz [kN]
-20
-40
-60
-80
-100
-200
-220
-240
-260
-280
-300

9.2 Tension Fx / Z+Y-force= 0

Fx [kN]
-10
-20
-30
-40
-60
-80
-100

9.3 Tension Fy / Z+X-force=0

Fy [kN]
-2
-4
-6
-8
-10

9.4 Tension Fres (NASA W375-MOD load vector Rx=0°)

Load case has to be done up to load step 85%.

Fx [kN]	Fy [kN]	Fz [kN]	Fres [kN]	Load step [%]
-30	-3	-65	71	15
-40	-4	-86	95	20
-50	-5	-108	119	25
-60	-6	-130	143	30
-68	-7	-147	162	35
-78	-8	-168	186	40
-88	-9	-190	210	45
-98	-10	-212	233	50
-108	-11	-233	257	55
-118	-12	-255	281	60
-128	-13	-276	305	65
-138	-14	-298	329	70
-148	-16	-320	353	75
-158	-17	-341	376	80
-168	**-18**	**-363**	**400**	**85**
-178	-19	-384	424	90
-188	-20	-406	448	95
-196	**-21**	**-423**	**467**	**100**
-400	**-42**	**-864**	**953**	**203**

Limit Load level (← 100)

NASA W375-MOD load vector (← 203)

9.5 Mx Variation with adjusted bolt rotation Rx (Fy=0 force)

Rx [°]
0.1
0.2
0.3
0.4
0.5

10. Test load cases

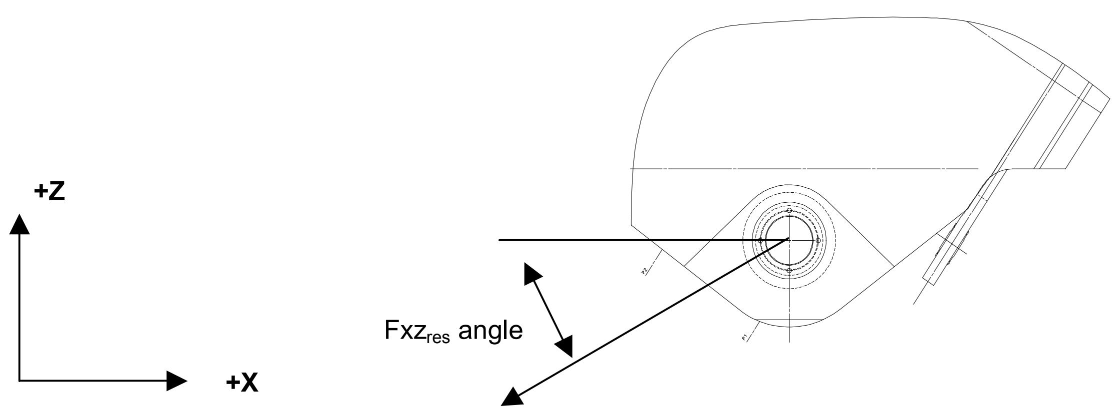
The following load sets (preliminary) are the target condition for 100% applied forces Fx, Fy and Fz in combination with the pre-adjusted bolt rotation Rx.

Load cases:

- ***BI17_UL*** is the design lateral gust case (Ultimate load conditions) for the A300-600R
- AAL587 load case ***NASA W375-MOD ls18***

MSN 420							
Load case		Fx	Fy	Fz	Fres	Rx bolt rotation*)	Angle xz plane
No.		[N]	[N]	[N]	[N]	[°]	[°]
1	BI17_UL	-255794	-28990	-636556	686640	0.3	68
2	W375-MOD	-400000	-42000 1)	-864000	953000	0.45	65

*) pre-adjusted bolt rotation Rx



1) The value Fy=-42000N is equivalent to a lateral displacement of Wy=-1,55mm derived from W375-MOD pretest (Y-application force controlled) by linear extrapolation.

10.1 Load case 1: BI17 (Lateral Gust / Ultimate Load)

Fx	Fy	Fz	Fres	Load step
[N]	[N]	[N]	[N]	%
Pre-adjusted bolt rotation Rx=0.3				0
-25579	-2899	-63656	68664	10
-51159	-5798	-127311	137328	20
-76738	-8697	-190967	205992	30
-102318	-11596	-254622	274656	40
-127897	-14495	-318278	343320	50
-153476	-17394	-381934	411984	60
-179056	-20293	-445589	480648	70
-204635	-23192	-509245	549312	80
-230215	-26091	-572900	617976	90
-232773	-26381	-579266	624842	91
-235330	-26671	-585632	631709	92
-237888	-26961	-591997	638575	93
-240446	-27251	-598363	645442	94
-243004	-27541	-604728	652308	95
-245562	-27830	-611094	659174	96
-248120	-28120	-617459	666041	97
-250678	-28410	-623825	672907	98
-253236	-28700	-630190	679774	99
-255794	**-28990**	**-636556**	**686640**	**100**

10.2 Load case 2: NASA W375-MOD ls18

The forces and displacements are then applied in the following steps:

Fx	Wy	Fz	Fres	Load step	
[kN]	[mm]	[kN]	[kN]	[-]	
0	0,40	0	0	0	
-10	0,37	-21	23	5	
-19	0,33	-41	46	10	
-29	0,30	-62	69	15	
-38	0,27	-83	91	20	
-48	0,23	-104	114	25	
-58	0,20	-124	137	30	
-67	0,16	-145	160	35	
-77	0,11	-166	183	40	
-86	0,05	-187	206	45	
-96	0,00	-207	229	50	
-106	-0,08	-228	251	55	
-115	-0,13	-249	274	60	
-125	-0,18	-270	297	65	
-134	-0,23	-290	320	70	
-144	-0,27	-311	343	75	
-154	-0,32	-332	366	80	
-163	-0,36	-353	388	85	
-173	-0,41	-373	411	90	
-182	-0,46	-394	434	95	
-192	**-0,51**	**-415**	**457**	**100**	Limit Load level
-202	-0,56	-435	480	105	
-211	-0,61	-456	503	110	
-221	-0,65	-477	526	115	
-230	-0,70	-498	548	120	
-240	-0,75	-518	571	125	
-250	-0,80	-539	594	130	
-259	-0,85	-560	617	135	
-269	-0,89	-581	640	140	
-278	-0,94	-601	663	145	
-288	**-0,99**	**-622**	**686**	**150**	Ultimate Load level
-400	**-1,55**	**-864**	**952**	**208**	NASA W375 MOD load vector
[kN]	[mm]	[kN]	[kN]	[-]	
Fx	Wy	Fz	Fres	Load step	

All force values are kN

Definition of load step:

Load step 100 is defined as 100% of Limit Load of the design gust case (BI17) with Fres=469kN.

From load step 150 (150% of Limit Load) the test is pursued by continuous proportional load increase up to the failure.

At each load step strain gauges, displacements and load cell values (see 7.) have to be recorded. After measuring the load step 150 all measurements are recorded continuously up to failure.