TECHNICAL REPORT

No.: 83-R110-33006454-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

Das Bauteil / The Specific Component

1	Make (trade name of manufacturer) Fabrikmarke	: Hy-Lok® Hy-Lok®
2.	Type Typ	: Compression Fittings with front and back ferrules Doppelklemmringverschraubung
3.	Article Art	: Tube Fittings, Class 0 Fttinge / Verbindungsteile Klasse 0
4.	Name and address of manufacturer Name und Anschrift des herstellers	: HY-LOK CORPORATION 1467-1, Songjeong-Dong, Gangseo-Gu, Busan, Korea 618-270

Meets the requirements of ECE Regulation 110 Uniform provisions concerning the approval of Part I specific components of motor vehicles using compressed natural gases in their propulsion system including all amendments until Supplement 1 to the original version of the Regulation - Date of entry into force : 2003-10-16 ;

And

International Standard ISO 15500
Road vehicles –Compressed natural gas (CNG) fuel system components
Part 2 including all Amendments until First edition (2001-2-15)
Performance and general test requirements;

Part 19 including all amendments until First edition (2001-2-15)
Fittings

5.	Detail information	
5.1.	List of tube fittings to be covered by the testing	: Appendix 0 (page 2 & 3)
5.2.	Test information	: Item 1 (page 4)
5.3.	Test minutes	: Item 2 (page 5, 6 & 7)
5.4.	Remark concerning tested object(s)	: Item 3 (page 8)
5.5.	Statement of conformity	: Item 4 (page 8)

Cologne, January 31, 2004

YBR

Prüflaboratorium · Typprüfstelle Fahrzeuge/Fahrzeugteile · TÜV Rheinland 0335

Dipl.-Ing. Carlos Lee

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

List of tube fittings to be covered by the testing

Appendix 0

No.	Description	Type(Series)	Connection Size		Remark
			In Size	Metric Size(mm)	
1	Cap for Tube End	CCA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
2	Male Connector	CMC	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	
3	Male Adapter	CAM	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	
4	Bulkhead Female Connector	CBFC	1/4"x1/4"NPT	6x1/4"PT	
			3/8"x3/8"NPT	10x3/8"PT	
			1/2"x1/2"NPT	12x1/2"PT	
5	SAE/MS Male Connector	CSC	1/4"xSAE9/16		
			3/8"xSAE9/16		
			1/2"xSAE9/16		
6	Bulkhead Union	CBU	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
7	Union	CUA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
8	Union Tee	CTA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
9	Union Cross	CXA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
10	Union Elbow	CLA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	

11	Port Connector	CPC	1/4"	6	
			3/8"	10	
			1/2"	12	
				16	
12	Male Elbow	CLMA	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	

Note : In above table Inch sizes and metric sizes are different size each other.
So to speak inch sizes are not corresponding sizes of the metric sizes
For example No 1 Cap for tube end have 5 inch sizes and 5 metric sizes, total 10 sizes.

0. General information

0.1 Make (trade name of manufacturer)	: Hy-Lok
0.2 Type	: Compression Fittings with front and back ferrules
0.3 Article	: Tube Fittings, Class 0
0.4 Name and address of manufacturer	: HY-LOK CORPORATION 1467-1, Songjeong-Dong, Gangseo-Gu, Busan, Korea 618-270
0.5 No. of information folder	: ---

1 Test Information

1.1 Test object(s) :

Sample Identification	Tube size	Wall thickness	Fitting Materials
C030349 and C030349/1	6 mm	1.0 mm & 1.5 mm	Barstock : ASTM A479 Type 316 Forging : ASTM A182 F316 X 5CrNiMo 17-12-2 (1.4401) / 316 (UNS S 31600) Tubing materials : ASTM A269 / A213 Type 316/L DIN 17458 (1.4401 /1.4404)
C030350 and C030350/1	3/8 inch	0.035 inch & 0.065 inch	
C030351 and C030351/1	12 mm	1.0 mm & 2.0 mm	
C030352 and C030352/1	1 inch	0.083 inch & 0.109 inch	

1.2 Test date	: September 2003 - December 2003
1.3 Test site	: GASTEC Certification BV, the Netherlands
1.4 Remark	: The results of the test refer exclusively to the object(s) mentioned under point 1.1 of this report.

2 Test minutes

2.1 Test facilities : The test equipment used was in compliance with the requirements of the regulation and / or the standard.

2.2 Hydrostatic strength test according to ISO 15500 part 2 clause 5 and part 19 clause 6.2

2.2.1 Test results

Sample Identification	Tube size	Wall thickness	Test pressure	Test time	Rupture	Permanent distortion
C030349	6 mm	1.0 mm & 1.5 mm	100 Mpa	5 min.	No	No
C030350 and C030350/1	3/8 inch	0.035 inch & 0.065 inch	100 Mpa	5 min.	No	No
C030351	12 mm	1.0 mm & 2.0 mm	100 Mpa	5 min.	No	No
C030352/1	1 inch	0.083 inch & 0.109 inch	100 Mpa	5 min.	No	No
		Requirements	100 Mpa	> 3.0 min	No	No

2.2.2 Conclusion : The samples comply with the requirements.
The test results cover ECE R. 110 requirements as well.

2.3 External leakage test including high and low temperature according to : ECE R. 110 annex 5B

2.3.1 Test results

Sample Identification	Tube size	Wall thickness	Test temperature	Test pressure	External leakage
C030349 before & after vibration	6 mm	1.0 mm & 1.5 mm	all	39 Mpa	0
C030350 before & after vibration	3/8 inch	0.035 inch & 0.065 inch	all	39 Mpa	0
C030351 before & after corrosion	12 mm	1.0 mm & 2.0 mm	all	39 Mpa	0
C030352 before & after corrosion	1 inch	0.083 inch & 0.109 inch	all	39 Mpa	0
		Requirements	Room / 120 °C / -40 °C	Working pressure x 1.5	Lower than 15 cc/hour

2.3.2 Conclusion : The samples comply with the requirements.
The test results cover ISO 15500 requirements as well.

2.4 Corrosion resistance test (Salt spray test) according to : ECE R. 110 Annex 5E

2.4.1 Test results

Sample Identification	Tube size	Wall thickness	Salt spray testing time	Ambient temperature	Store time at room room temperature
C030351	12 mm	1.0 mm & 2.0 mm	144 hour	35 °C	1 hour
C030352	1 inch	0.083 inch & 0.109 inch	144 hour	35 °C	1 hour
		Requirements	144 hour	33 – 36 °C	0.5 –1 hour
Test to be performed after the endurance test			The external leakage test – see above 2.3.1		

2.4.2 Conclusion : The samples comply with the requirements.
The test results cover ISO 15500 requirements as well.

2.5 Vibration resistance test according to : ECE R. 110 Annex 5N

2.5.1 Test results

Sample Identification	Tube size	Wall thickness	Results
C030349	6 mm	1.0 mm & 1.5 mm	The components remain undamaged, continue to operate and comply with the leakage test after the vibration test of 6 hours was carried out.
C030350	3/8 inch	0.035 inch & 0.065 inch	

2.5.2 Conclusion : The samples comply with the requirements.
The test results cover ISO 15500 requirements as well.

2.6 Excess torque resistance test according to : ISO 15500 part 2 clause 7

2.6.1 Test results

Sample Identification	Tube size	Wall thickness	Position	Dimension	Declared torque	Test torque	Test time	Deformation or breakage after test
C030349/1	6 mm	1.0 mm & 1.5 mm	Male	1/4 inch	NA	35 Nm	900 sec	None
			Female	1/4 inch	NA	35 Nm	900 sec	None
C030351/1	12 mm	1.0 mm & 2.0 mm	Male	1/2 inch	NA	85 Nm	900 sec	None
			Female	1/2 inch	NA	85 Nm	900 sec	None
Requirements			-	-	-	150 % of declared value	900 sec or more	None

2.6.2 Conclusion : The samples comply with the requirements.

2.7 Non-metallic synthetic immersion test according to : ISO 15500 part 2 clause 13.1 & 13.2

2.7.1 Test results

Sample Identification	Before immersion		After immersion		Swelling	Weight change
	Above water (mass, g)	Under water (mass, g)	Above water (mass, g)	Under water (mass, g)		
O ring	0.20119	0.06580	0.20461	0.06211	5.2	1.7
	0.20450	0.06710	0.20766	0.06447	4.2	1.5
	0.15478	0.05039	0.15723	0.04879	3.9	1.6
Requirements	-	-	-	-	> - 1 & < 20 %	not more than 10 %

2.7.2 Conclusion : The samples comply with the requirements.

3 Remark concerning tested object(s)

: All components as listed in the appendix 0 are covered with the tested object(s).

4 Statement of conformity

The test laboratory is accredited for the above mentioned tests by the accreditation body of the RDW, Netherlands.

The technical report comprises the pages 1 to 8 (including appendix 0) and shall not be reproduced except in full without the written approval of the test laboratory.

TÜV Kraftfahrt GmbH
TÜV Rheinland Group

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

Das Bauteil / The Specific Component

1	Make (trade name of manufacturer) Fabrikmarke	: Hy-Lok® Hy-Lok®
2.	Type Typ	: Compression Fittings with front and back ferrules Doppelklemmringverschraubung
3.	Article Art	: Tube Fittings, Class 0 Fttinge / Verbindungsteile Klasse 0
4.	Name and address of manufacturer Name und Anschrift des herstellers	: HY-LOK CORPORATION 1467-1, Songjeong-Dong, Gangseo-Gu, Busan, Korea 618-270

Meets EIHP draft, UNIFORM PROVISIONS CONCERNING THE APPROVAL OF SPECIFIC COMPONENTS OF MOTOR VEHICLES USING COMPRESSED GASEOUS HYDROGEN Rev. 12b dated 12.10..2003, annex 08 and Trans/WP. 29/GRPE/2003/14 7-03-2003, The following program is applicable.

- Pressure test;
- External leakage test at different temperatures;
- Resistance to corrosion + leakage test at different temperatures;
- Resistance to dry heat test with respect to O ring;
- Connection test + leakage test at different temperatures.
- Hydrogen compatibility test

5. Detail information

5.1. List of tube fittings to be covered by the testing	: Appendix 0 (page 2 & 3)
5.2. Test information	: Item 1 (page 4)
5.3. Test minutes	: Item 2 (page 5, 6, 7, 8, 9 & 10)
5.4. Remark concerning tested object(s)	: Item 3 (page 10)
5.5. Statement of conformity	: Item 4 (page 10)

Cologne, June 30, 2005

YBR

Dipl.-Ing. Carlos Lee

Prüflaboratorium TÜV Rheinland 0035 Typprüfstelle Fahrzeuge/Fahrzeugteile

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.7 **Hydrogen compatibility**	: Trans/WP. 29/GRPE/2004/3 Annex 8B
2.7.1 Test results	The material of the tube fittings, type 316 is confirmed to be compatible for hydrogen service by US NASA reports without performing actual test The tube fitting materials compliy with the hydrogen compatibility requirements.
3 **Remark concerning tested object(s)**	: All components as listed in the appendix 0 are covered with the tested object(s).

4 Statement of conformity

The test laboratory is accredited for the above mentioned tests by the accreditation body of the RDW, Netherlands.

The technical report comprises the pages 1 to 10 (including appendix 0) and shall not be reproduced except in full without the written approval of the test laboratory.

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

List of tube fittings to be covered by the testing **Appendix 0**

No.	Description	Type(Series)	Connection Size		Remark
			In Size	Metric Size(mm)	
1	Cap for Tube End	CCA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
2	Male Connector	CMC	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	
3	Male Adapter	CAM	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	
4	Bulkhead Female Connector	CBFC	1/4"x1/4"NPT	6x1/4"PT	
			3/8"x3/8"NPT	10x3/8"PT	
			1/2"x1/2"NPT	12x1/2"PT	
5	SAE/MS Male Connector	CSC	1/4"xSAE9/16		
			3/8"xSAE9/16		
			1/2"xSAE9/16		
6	Bulkhead Union	CBU	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
7	Union	CUA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
8	Union Tee	CTA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
9	Union Cross	CXA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
10	Union Elbow	CLA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

11	Port Connector	CPC	1/4"	6	
			3/8"	10	
			1/2"	12	
				16	
12	Male Elbow	CLMA	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	

Note : In above table Inch sizes and metric sizes are different size each other.
So to speak inch sizes are not corresponding sizes of the metric sizes
For example No 1 Cap for tube end have 5 inch sizes and 5 metric sizes, total 10 sizes.

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

1 Test Information

1.1 Test object(s) :

Sample Identification	Tube size	Wall thickness	Fitting Materials
C040512	6 mm	1.0 mm & 1.5 mm	Barstock : ASTM A479 Type 316 Forging : ASTM A182 F316 X 5CrNiMo 17-12-2 (1.4401) / 316 (UNS S 31600) Tubing materials : ASTM A269 / A213 Type 316/L DIN 17458 (1.4401 /1.4404)
C040494, C040495, C040496, C040497, C040498 and C040513	3/8 inch	0.035 inch & 0.065 inch	
C040514	12 mm	1.0 mm & 2.0 mm	
C040515	1 inch	0.083 inch & 0.109 inch	
O ring	Rubber O-rings with code V75 dimension approximately 12.0 mm x 2.0 mm		

1.2 Test date : August to September 2004 & June 2005

1.3 Test site : GASTEC Certification BV, the Netherlands

1.4 Remark : The results of the test refer exclusively to the object(s) mentioned under point 1.1 of this report.

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2 Test minutes

2.1 Test facilities : The test equipment used was in compliance with the requirements of the regulation and / or the standard.

2.2 **External leakage test** including high & low temperature in accordance with : Trans/WP. 29/GRPE/2003/14 Annex 8B

2.2.1 Test results

Test results	Requirement	Sample no. C040512, C040513, C040514 & C040515					
Test temperature	---	Room temperature		~~85/105~~/120°C		- 40°C	
Moment of test	Corrosion	Before	After	Before	After	Before	After
Test pressure (Bar)	0.02 x NWp	4.2	4.2	4.2	4.2	4.2	4.2
External leakage	≤ 15 cc/hr	0	0	0	0	0	0
Test pressure (Bar)	NWP	210	210	---	---	210	210
Test pressure (Bar)	NWP x 1.37	---	---	287	287	---	---
External leakage	≤ 15 cc/hr	0	0	0	0	0	0
Test date	To be monitored	Aug. 4, 2004	Sept. 4 2004	Aug. 4, 2004	Sept. 4 2004	Aug. 4, 2004	Sept. 4 2004

* NWP=Normal working pressure (210 bar)

2.2.2 Conclusion : The samples comply with the requirements.

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.3 **Corrosion test (Salt sparay)** in accordance with : Trans/WP. 29/GRPE/2003/14 Annex 8B

2.3.1 Test results

Test results	Requirement	Sample no. C040512, C040513, C040514 & C040515
Date & time starting the test	To be monitored	August 2004
Date & time stopping the test	To be monitored	September 2004
Salt spray testing time	144 hours	144
Ambient temperature during the test	35 ± 2°C	35
Store time at room temperature	0.5 – 1.0 hour	1
Tests to be performed after the endurance test are :		
External leakage test	---	See above 2.2
Internal leakage test	---	---

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.4 **Overpressure test** in accordance with : Trans/WP. 29/GRPE/2003/14 Annex 8B

2.4.1 Test results

Test results	Requirement	Sample no. C040512, C040513, C040514 & C040515					
Moment of test	---	Before	After	Before	After	Before	After
Test pressure (Bar)	1.5 x MAWP	315	N/A	315	N/A	315	N/A
Test time	≥ 3 min	5	N/A	5	N/A	5	N/A
Rupture	No	No	N/A	No	N/A	No	N/A
Permanent distortion	No	No	N/A	No	N/A	No	N/A
Test pressure (Bar)	3.0 x MAWP	630	N/A	630	N/A	630	N/A
Test time	≥ 3 min	5	N/A	5	N/A	5	N/A
Rupture	No	No	N/A	No	N/A	No	N/A
Permanent distortion	No	No	N/A	No	N/A	No	N/A
Test date	To be monitored	Sep. 4, 2004	N/A	Sep. 4, 2004	N/A	Sep. 4, 2004	N/A

* N/A : Not applicable

* MAWP : maximum allowable working pressure

2.4.2 Conclusion : The samples comply with the requirements.

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.5 **Endurance test** including high & low temperature in accordance with : Trans/WP. 29/GRPE/2003/14 Annex 8B (Leak tightness)

Draft ECE regulation revision 12b dated 12-10-2003 (Endurance test)

2.5.1 Test results

Test results	Requirement	Sample no. C040512, C040513, C040514 & C040515					
Test temperature	---	Room temperature		~~85/105~~/120°C		- 40°C	
Moment of test	25 connections/ disconnections	Before	After	Before	After	Before	After
Test pressure (Bar)	0.02 x NWp	4.2	4.2	4.2	4.2	4.2	4.2
External leakage	≤ 15 cc/hr	0	0	0	0	0	0
Test pressure (Bar)	NWp	210	210	---	---	210	210
Test pressure (Bar)	NWp x 1.37	---	---	287	287	---	---
External leakage	≤ 15 cc/hr	0	0	0	0	0	0
Test date	To be monitored	Aug. 4, 2004	Sept. 4 2004	Aug. 4, 2004	Sept. 4 2004	Aug. 4, 2004	Sept. 4 2004

2.5.2 Conclusion : The samples comply with the requirements.

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.6 **Resistance to dry heat test with respect to O-ring** in accordance with : Trans/WP. 29/GRPE/2004/3 Annex 8 part B2

2.6.1 Test results

Property	Status	Method	Sample : Rubber O ring code V75	Specification of manufacturer
Hardness [IRHD]	- As received - After 96 hours at 120℃, 100% oxygen, 2.0 Mpa - Change [IRHD]	ISO 48-M ASTM D572	79 80 +1	75 ± 5 not specified
Tensile strength [Mpa]	- As received - After 96 hours at 120℃, 100% oxygen, 2.0 Mpa - Change [%]	ISO 37 ASTM D572	11.9 10.7 -10	Min 9.65 not specified
Elongation at break [%]	- As received - After 96 hours at 120℃, 100% oxygen, 2.0 Mpa - Change [%]	ISO 37 ASTM D572	185 190 +3	Min. 125 not specified

2.6.2 Conclusion : The test samples show no cracks or visual detoriation after exposure.

The samples as received meet the specification of the manufacturer for the measured properties. The properties after ageing in oxygen as carried out in this evaluation are not specified by the manufacturer. The changes in hardness, tensile strength and elongation after these ageing are small.

Prüflaboratorium · Typprüfstelle Fahrzeuge/Fahrzeugteile · TÜV Rheinland 0395

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.7 **Hydrogen compatibility**	: Trans/WP. 29/GRPE/2004/3 Annex 8B
2.7.1 Test results	The material of the tube fittings, type 316 is confirmed to be compatible for hydrogen service by US NASA reports without performing actual test The tube fitting materials compliy with the hydrogen compatibility requirements.
3 **Remark concerning tested object(s)**	: All components as listed in the appendix 0 are covered with the tested object(s).

4 Statement of conformity

The test laboratory is accredited for the above mentioned tests by the accreditation body of the RDW, Netherlands.

The technical report comprises the pages 1 to 10 (including appendix 0) and shall not be reproduced except in full without the written approval of the test laboratory.

TÜV Kraftfahrt GmbH
TÜV Rheinland Group

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

Das Bauteil / The Specific Component

1.	Make (trade name of manufacturer) Fabrikmarke	: Hy-Lok® Hy-Lok®
2.	Type Typ	: Compression Fittings with front and back ferrules Doppelklemmringverschraubung
3.	Article Art	: Tube Fittings, Class 0 Fttinge / Verbindungsteile Klasse 0
4.	Name and address of manufacturer Name und Anschrift des herstellers	: HY-LOK CORPORATION 1467-1, Songjeong-Dong, Gangseo-Gu, Busan, Korea 618-270

Meets EIHP draft, UNIFORM PROVISIONS CONCERNING THE APPROVAL OF SPECIFIC COMPONENTS OF MOTOR VEHICLES USING COMPRESSED GASEOUS HYDROGEN Rev. 12b dated 12.10..2003, annex 08 and Trans/WP. 29/GRPE/2003/14 7-03-2003, The following program is applicable.

- Pressure test;
- External leakage test at different temperatures;
- Resistance to corrosion + leakage test at different temperatures;
- Resistance to dry heat test with respect to O ring;
- Connection test + leakage test at different temperatures.
- Hydrogen compatibility test

5. Detail information

5.1. List of tube fittings to be covered by the testing	: Appendix 0 (page 2 & 3)
5.2. Test information	: Item 1 (page 4)
5.3. Test minutes	: Item 2 (page 5, 6, 7, 8, 9 & 10)
5.4. Remark concerning tested object(s)	: Item 3 (page 10)
5.5. Statement of conformity	: Item 4 (page 10)

Cologne, June 30, 2005

YBR

Dipl.-Ing. Carlos Lee

Prüflaboratorium TÜV Rheinland 0035 Typprüfstelle Fahrzeuge/Fahrzeugteile

TECHNICAL REPORT

No.: 83-EIHP-33009246-100

Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

List of tube fittings to be covered by the testing **Appendix 0**

No.	Description	Type(Series)	Connection Size		Remark
			In Size	Metric Size(mm)	
1	Cap for Tube End	CCA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
2	Male Connector	CMC	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	
3	Male Adapter	CAM	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	
4	Bulkhead Female Connector	CBFC	1/4"x1/4"NPT	6x1/4"PT	
			3/8"x3/8"NPT	10x3/8"PT	
			1/2"x1/2"NPT	12x1/2"PT	
5	SAE/MS Male Connector	CSC	1/4"xSAE9/16		
			3/8"xSAE9/16		
			1/2"xSAE9/16		
6	Bulkhead Union	CBU	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
7	Union	CUA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
8	Union Tee	CTA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
9	Union Cross	CXA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	
10	Union Elbow	CLA	1/4"	6	
			3/8"	10	
			1/2"	12	
			3/4"	16	
			1"	25	

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Type : Compression Fittings with front and back ferrules

11	Port Connector	CPC	1/4"	6	
			3/8"	10	
			1/2"	12	
				16	
12	Male Elbow	CLMA	1/4"x1/4"NPT	6X1/4"PT	
			3/8"x3/8"NPT	10X3/8"PT	
			1/2"x1/2"NPT	12X1/2"PT	
			3/4"x3/4"NPT	16X3/4"PT	

Note : In above table Inch sizes and metric sizes are different size each other.
So to speak inch sizes are not corresponding sizes of the metric sizes
For example No 1 Cap for tube end have 5 inch sizes and 5 metric sizes, total 10 sizes.

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Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

1 Test Information

1.1 Test object(s) :

Sample Identification	Tube size	Wall thickness	Fitting Materials
C040512	6 mm	1.0 mm & 1.5 mm	Barstock : ASTM A479 Type 316 Forging : ASTM A182 F316 X 5CrNiMo 17-12-2 (1.4401) / 316 (UNS S 31600) Tubing materials : ASTM A269 / A213 Type 316/L DIN 17458 (1.4401 /1.4404)
C040494, C040495, C040496, C040497, C040498 and C040513	3/8 inch	0.035 inch & 0.065 inch	
C040514	12 mm	1.0 mm & 2.0 mm	
C040515	1 inch	0.083 inch & 0.109 inch	
O ring	Rubber O-rings with code V75 dimension approximately 12.0 mm x 2.0 mm		

1.2 Test date : August to September 2004 & June 2005

1.3 Test site : GASTEC Certification BV, the Netherlands

1.4 Remark : The results of the test refer exclusively to the object(s) mentioned under point 1.1 of this report.

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2 Test minutes

2.1 Test facilities : The test equipment used was in compliance with the requirements of the regulation and / or the standard.

2.2 **External leakage test** including high & low temperature in accordance with : Trans/WP. 29/GRPE/2003/14 Annex 8B

2.2.1 Test results

Test results	Requirement	Sample no. C040512, C040513, C040514 & C040515					
Test temperature	---	Room temperature		~~85/105~~/120°C		- 40°C	
Moment of test	Corrosion	Before	After	Before	After	Before	After
Test pressure (Bar)	0.02 x NWp	4.2	4.2	4.2	4.2	4.2	4.2
External leakage	≤ 15 cc/hr	0	0	0	0	0	0
Test pressure (Bar)	NWP	210	210	---	---	210	210
Test pressure (Bar)	NWP x 1.37	---	---	287	287	---	---
External leakage	≤ 15 cc/hr	0	0	0	0	0	0
Test date	To be monitored	Aug. 4, 2004	Sept. 4 2004	Aug. 4, 2004	Sept. 4 2004	Aug. 4, 2004	Sept. 4 2004

* NWP=Normal working pressure (210 bar)

2.2.2 Conclusion : The samples comply with the requirements.

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Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.3 **Corrosion test (Salt sparay)** in accordance with : Trans/WP. 29/GRPE/2003/14 Annex 8B

2.3.1 Test results

Test results	Requirement	Sample no. C040512, C040513, C040514 & C040515
Date & time starting the test	To be monitored	August 2004
Date & time stopping the test	To be monitored	September 2004
Salt spray testing time	144 hours	144
Ambient temperature during the test	35 ± 2°C	35
Store time at room temperature	0.5 – 1.0 hour	1
Tests to be performed after the endurance test are :		
External leakage test	---	See above 2.2
Internal leakage test	---	---

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Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.4 **Overpressure test** in accordance with : Trans/WP. 29/GRPE/2003/14 Annex 8B

2.4.1 Test results

Test results	Requirement	Sample no. C040512, C040513, C040514 & C040515					
Moment of test	---	Before	After	Before	After	Before	After
Test pressure (Bar)	1.5 x MAWP	315	N/A	315	N/A	315	N/A
Test time	≥ 3 min	5	N/A	5	N/A	5	N/A
Rupture	No	No	N/A	No	N/A	No	N/A
Permanent distortion	No	No	N/A	No	N/A	No	N/A
Test pressure (Bar)	3.0 x MAWP	630	N/A	630	N/A	630	N/A
Test time	≥ 3 min	5	N/A	5	N/A	5	N/A
Rupture	No	No	N/A	No	N/A	No	N/A
Permanent distortion	No	No	N/A	No	N/A	No	N/A
Test date	To be monitored	Sep. 4, 2004	N/A	Sep. 4, 2004	N/A	Sep. 4, 2004	N/A

* N/A : Not applicable

* MAWP : maximum allowable working pressure

2.4.2 Conclusion : The samples comply with the requirements.

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Manufacturer : HY-LOK CORPORATION
Type : Compression Fittings with front and back ferrules

2.5 **Endurance test** including high & low temperature in accordance with : Trans/WP. 29/GRPE/2003/14 Annex 8B (Leak tightness)

Draft ECE regulation revision 12b dated 12-10-2003 (Endurance test)

2.5.1 Test results

Test results	Requirement	Sample no. C040512, C040513, C040514 & C040515					
Test temperature	---	Room temperature		~~85/105~~/120°C		- 40°C	
Moment of test	25 connections/ disconnections	Before	After	Before	After	Before	After
Test pressure (Bar)	0.02 x NWp	4.2	4.2	4.2	4.2	4.2	4.2
External leakage	≤ 15 cc/hr	0	0	0	0	0	0
Test pressure (Bar)	NWp	210	210	---	---	210	210
Test pressure (Bar)	NWp x 1.37	---	---	287	287	---	---
External leakage	≤ 15 cc/hr	0	0	0	0	0	0
Test date	To be monitored	Aug. 4, 2004	Sept. 4 2004	Aug. 4, 2004	Sept. 4 2004	Aug. 4, 2004	Sept. 4 2004

2.5.2 Conclusion : The samples comply with the requirements.

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Type : Compression Fittings with front and back ferrules

2.6 **Resistance to dry heat test with respect to O-ring** in accordance with : Trans/WP. 29/GRPE/2004/3 Annex 8 part B2

2.6.1 Test results

Property	Status	Method	Sample : Rubber O ring code V75	Specification of manufacturer
Hardness [IRHD]	- As received - After 96 hours at 120℃, 100% oxygen, 2.0 Mpa - Change [IRHD]	ISO 48-M ASTM D572	79 80 +1	75±5 not specified
Tensile strength [Mpa]	- As received - After 96 hours at 120℃, 100% oxygen, 2.0 Mpa - Change [%]	ISO 37 ASTM D572	11.9 10.7 -10	Min 9.65 not specified
Elongation at break [%]	- As received - After 96 hours at 120℃, 100% oxygen, 2.0 Mpa - Change [%]	ISO 37 ASTM D572	185 190 +3	Min. 125 not specified

2.6.2 Conclusion : The test samples show no cracks or visual detoriation after exposure.

The samples as received meet the specification of the manufacturer for the measured properties. The properties after ageing in oxygen as carried out in this evaluation are not specified by the manufacturer. The changes in hardness, tensile strength and elongation after these ageing are small.

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