UN/ECE Technical Service No. E8/C and E27/J

TECHNICAL REPORT
No. 120095 – 21 – TAC

Test according to Regulation ECE No. 110.04

I. Specific components of motor vehicles using compressed natural gas (CNG) in their propulsion system

ECE No. 110.00 – date of entry into force: 2000-12-28
including all amendments up to and including
ECE No. 110.04, supplement 1 – date of entry into force: 2020-09-25

Objectives: Document for issue of approval certificate

0.	**Specific component**	Pressure regulator with automatic valve

I.	**Technical data**	
0.1.	Make (trade name of manufacturer):	Rail
0.2.	Type:	TYRION
0.2.1.	Variants:	Outlet pressure from 2 to 8 bar
0.3.	Means of identification of type:	Manufacturer's label
0.3.1.	Location of that marking:	On the body of regulator
0.4.	Class of component:	2
0.4.1.	Additional symbol:	"C"
0.5.	Name and address of manufacturer:	RAIL S.r.l.. Via A. Grandi, 16 42030 Vezzano sul Crostolo, Reggio Emilia, Italy
0.8.	Address of assembly plant:	See item 0.5.
0.9.	Location of the approval mark:	On the body of the pressure regulator

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II. Test report

1. Test conditions

1.1.	Test sample:	Pressure regulator type TYRION
1.1.1.	Technical data from the manufacturer:	Working Pressure 26MPa Temperature range -40°C ÷ 120°C
1.2.	Test procedures used:	See the attachments
1.3.	Measuring and test equipment:	See the attachments
1.4.	Worst case evaluation:	The variants with max and low output pressure was tested
1.5.	Testing conditions:	See the attachments
1.6.	Test track or site:	See the attachments

2. Test results

The technical data and the test results are indicated in attachment to this Technical Report.

3.	Specimen submitted to test on:	2020-11-10
4.	Date of test:	2020-11-10 ÷ 2020-12-21

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III. Manufacturer's information folder Information document for the approval
15 pages total of 2020-12-21

IV. Other documentation

No other documentation

V. Attachments

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The results presented above relate to the tested items only and to the sample as provided by the customer.
Measuring and test equipment and test site meet the requirements of the applicable legislation.
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VI. Final assessment

The described vehicle sample

complies

with the requirements of ECE Regulation No. 110.04

for issue of approval certificate

This technical report consists of pages No. 1 to 3 and 12 pages of attachments.

Václav Baloun
Report author

Martin Hron
Officially recognized expert

Prague, 2021-01-08

End of the technical report

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Order:	EE00208	**ECE Regulation 110**	
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Test Report

PRESSURE REGULATOR

Tested and examined to: Annex 4D, Annex 4A - para. 2. and 4., Annex 4C, ECE Regulation 110

Mark:	RAIL
Type:	TYRION with: Automatic valve (class 0) Pressure relief valve (class 2/3) Filter (class 0)
Manufacturer:	RAIL S.r.l. Via A. Grandi, 16 42030 Vezzano sul Crostolo Reggio Emilia - Italy
Samples:	2 – MOD. 2 bar - No.: 1, 2 3 – MOD. 8 bar - No.: 3, 4, 5
Date of the tests:	20.11. 2020 - 21.12. 2020

Classification of component:	Class 0	Class 2	Class 3
Classification pressure:	26,000 kPa	200 kPa	800 kPa
Pressure relief valve:	370 kPa (class 2), 1,200 kPa (class 3)		
Design temperatures:	- 40°C to + 120°C		

General design rules:

		Results		
Annex 4A, para. 2.3.	It must have the electrical system isolated from the body. Isolation resistance shall be >10 MΩ.	**yes**	**~~NA~~**	**~~NT~~**
Annex 4A, para. 2.4.	The valve shall be in „closed" position when its power is switched off.	**yes**	**~~NA~~**	**~~NT~~**
Annex 4D, para. 2.2.	The materials constituting the regulator which are in contact with the heat exchange medium of the regulator when operating, shall be compatible with that fluid.	**yes**	**~~NA~~**	**~~NT~~**

Applicable test procedures according to Annex 5:

	Results		
5A. Overpressure test	**yes**	**~~NA~~**	**~~NT~~**
5B. External leakage test	**yes**	**~~NA~~**	**~~NT~~**
5C. Internal leakage test	**yes**	**~~NA~~**	**~~NT~~**
5D. CNG compatibility test	**yes**	**~~NA~~**	**~~NT~~**
5E. Corrosion resistance test	**yes**	**~~NA~~**	**~~NT~~**
5F. Resistance to dry-heat	**yes**	**~~NA~~**	**~~NT~~**
5G. Ozone ageing	**yes**	**~~NA~~**	**~~NT~~**
5H. Temperature cycle test	**~~yes~~**	**NA**	**~~NT~~**
5L. Durability test (Annex 4D, para. 2.4.; Annex 4A, para.: 2.2.3.)	**yes**	**~~NA~~**	**~~NT~~**
5N. Vibration resistance test	**yes**	**~~NA~~**	**~~NT~~**
5O. Operating temperatures	**yes**	**~~NA~~**	**~~NT~~**
5Q. Compatibility with heat exchange fluid	**yes**	**~~NA~~**	**~~NT~~**

Note: **NA** = not applicable, **NT** = not tested

Date: 21.12.2020	**Worked up by:** Žďánský	**Signature:**

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Testing and measuring equipment

Testing equipment Reg. no. 7 – Freezer NZ 350/75
Testing equipment Reg. no. 13 – The source of hydraulic pressure with armoured housing
Testing equipment Reg. no. 24 – Furnace HS 122/1
Testing equipment Reg. no. 30 – Climatic chamber CSR – 70/500 CTS
Testing equipment Reg. no. 33 – High pressure compressor Astra 160/E
Testing equipment Reg. no. 34 – Hydro-pneumatic multiplier
Testing equipment Reg. no. 36 – High pressure test pump PI 1300
LDS vibration systém V850-440HBT 600
Corrosion chamber Erichsen-Corrotherm 610
Analytical balance KERN 770, Inv. No. 8946
Semi-laboratory balance Meopta, Inv. No. 321008
Universal oven drying Memmert, type ULP 600, Serial No.: g600.0150
Climatic chamber WK 111 with the ozone generator ANSEROS

Pressure gauge 0 - 60 MPa, accuracy 1.0, (serial no. 197705)
Pressure gauge 0 - 40 MPa, accuracy 1.6, (serial no. 237902MC)
Pressure gauge 0 - 40 MPa, accuracy 2.5, (serial no. 205312)
Pressure gauge 0 - 10 MPa, accuracy 1.0, (serial no. SM 419173)
Pressure gauge 0 - 4 MPa, accuracy 2.5, (serial no. RJ 734355)
Pressure gauge 0 - 1 MPa, accuracy 2.5, (serial no. OJ 156384)
Pressure gauge 0 - 600 kPa, accuracy 2.5, (serial no. LL 864736)
Pressure gauge 0 - 250 kPa, accuracy 2.5, (serial no. MB 190304)

Annex 4A, para. 2.3.: Isolation resistance

		Samples			
	Requirement	1	2	3	4
Isolation resistance	> 10 MΩ	> 500 MΩ	> 500 MΩ	> 500 MΩ	> 500 MΩ

Annex 5A: Overpressure test

Test pressure 39,000 kPa (class 0) during 3 minutes

		Samples			
	Requirement	1	2	3	4
Rupture	no	no	no	no	no
Permanent distortion	no	no	no	no	no

		Samples			
	Requirement	5			
Rupture	no	no			
Permanent distortion	no	no			

Test pressure 820 kPa (class 2) – No. 2 and 2,400 kPa (class 3) – No. 5 during 3 minutes

		Samples			
	Requirement	2	5		
Rupture	no	no	no		
Permanent distortion	no	no	no		

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Annex 5B: External leakage test

Test pressure 0 to 39,000 kPa (class 0) during 3 minutes

			Samples			
	Temperature	Requirement	1	2	3	4
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h
	– 40°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h
	+ 120°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h

			Samples			
	Temperature	Requirement	5			
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h			
	– 40°C	< 15 cm^3/h	0 cm^3/h			
	+ 120°C	< 15 cm^3/h	0 cm^3/h			

Test pressure 0 to 820 kPa (class 2) – No. 2 and 0 to 2,400 kPa (class 3) – No. 5 during 3 minutes

			Samples			
	Temperature	Requirement	2	5		
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h		
	– 40°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h		
	+ 120°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h		

Annex 5B, para. 5: High temperature test
Test pressure 26,000 kPa (class 0), 200 kPa (class 2) – No.: 1, 2 and 800 kPa (class 3) – No.: 3, 4, 5 during 3 minutes by + 120°C (8 hours of tempering)

		Samples			
	Requirement	1	2	3	4
Leakage	≤ 15 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h

		Samples			
	Requirement	5			
Leakage	≤ 15 cm^3/h	0 cm^3/h			

Annex 5B, para. 6: Low temperature test
Test pressure 26,000 kPa (class 0), 200 kPa (class 2) – No.: 1, 2 and 800 kPa (class 3) – No.: 3, 4, 5 during 3 minutes by – 40°C (8 hours of tempering)

		Samples			
	Requirement	1	2	3	4
Leakage	≤ 15 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h

		Samples			
	Requirement	5			
Leakage	≤ 15 cm^3/h	0 cm^3/h			

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Annex 5C: Internal leakage test

Seat leakage test of pressure relief valve (Annex 5C, para. 2.)
Test pressure 0 to 350 kPa (class 2) during 3 minutes

		Samples			
	Requirement	1			
Leakage	0 cm^3/h	0 cm^3/h			

Seat leakage test of pressure relief valve (Annex 5C, para. 2.)
Test pressure 0 to 1,200 kPa (class 3) during 3 minutes

		Samples			
	Requirement	3	4		
Leakage	0 cm^3/h	0 cm^3/h	0 cm^3/h		

Seat leakage test of automatic valve (Annex 5C, para. 2.)
Test pressure 0 to 39,000 kPa (class 0) during 3 minutes

		Samples			
	Requirement	1	2	3	4
Leakage	0 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h	0 cm^3/h

		Samples			
	Requirement	5			
Leakage	0 cm^3/h	0 cm^3/h			

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Annex 5D: CNG compatibility test

Samples:

1 - O-ring 5.0 x 2.0 FPM ED 90 Sh - position 2
2 - Diaphragm - position 10
3 - O-ring 12.42 x 1.78 HNBR 70 Sh - position 12
4 - O-ring 41.0 x 1.78 V2N - position 15
5 - O-ring 15.0 x 1.8 FPM ED 90 Sh - position 16
6 - O-ring 7.5 x 1.5 VITON 80 Sh - position 21
7 - Seat sealing of pressure relief valve 5.2 x 2.7- position 25
8 - O-ring 10.82 x 1.78 FPM ED 90 Sh - position 29
9 - Seat sealing of automatic valve 5.5 x 2.2 - position 32
10 - O-ring 3.5 x 1.0 FKM GLT 85 Sh - position 34

		Samples			
	Requirement	1	2	3	4
Maximum change in volume	< 20 %	+ 2.67 %	+ 8.63 %	+ 7.53 %	+ 1.28 %
Change of mass after air tempering	≥ – 5 %	+ 0.05 %	– 4.83 %	– 2.25 %	+ 0.03 %

		Samples			
	Requirement	5	6	7	8
Maximum change in volume	< 20 %	+ 2.06 %	– 0.39 %	+ 1.71 %	+ 1.89 %
Change of mass after air tempering	≥ – 5 %	+ 0.03 %	– 0.04 %	– 0.03 %	+ 0.03 %

		Samples			
	Requirement	9	10		
Maximum change in volume	< 20 %	+ 4.42 %	+ 6.51 %		
Change of mass after air tempering	≥ – 5 %	– 0.07 %	– 0.05 %		

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Annex 5E: Corrosion resistance test

Salt spray (144 hours) according to ISO 15500-2 - Sample No.: 5
Immersion in Ammonia (24 hours) according to ISO 15500-2 - Sample No.: 2

		Samples	
	Requirement	2	
Cracking	no	no	

Overpressure test (Annex 5A) after Corrosion resistance test
Test pressure 39,000 kPa (class 0) during 3 minutes

		Samples			
	Requirement	2	5		
Rupture	no	no	no		
Permanent distortion	no	no	no		

Test pressure 820 kPa (class 2) – No. 2 and 2,400 kPa (class 3) – No. 5 during 3 minutes

		Samples			
	Requirement	2	5		
Rupture	no	no	no		
Permanent distortion	no	no	no		

External leakage test (Annex 5B) after Corrosion resistance test
Test pressure 0 to 39,000 kPa (class 0) during 3 minutes

			Samples			
	Temperature	Requirement	5			
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h			
	– 40°C	< 15 cm^3/h	0 cm^3/h			
	+ 120°C	< 15 cm^3/h	0 cm^3/h			

Test pressure 0 to 820 kPa (class 2) – No. 2 and 0 to 2,400 kPa (class 3) – No. 5 during 3 minutes

			Samples			
	Temperature	Requirement	2	5		
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h		
	– 40°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h		
	+ 120°C	< 15 cm^3/h	0 cm^3/h	0 cm^3/h		

High temperature test (Annex 5B, para. 5) after Corrosion resistance test
Test pressure 26,000 kPa (class 0), 200 kPa (class 2) – No.: 2 and 800 kPa (class 3) – No.: 5 during 3 minutes by + 120°C (8 hours of tempering)

		Samples			
	Requirement	2	5		
Leakage	≤ 15 cm^3/h	0 cm^3/h	0 cm^3/h		

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Low temperature test (Annex 5B, para. 6) after Corrosion resistance test
Test pressure 26,000 kPa (class 0), 200 kPa (class 2) – No.: 2 and 800 kPa (class 3) – No.: 5
during 3 minutes by – 40°C (8 hours of tempering)

		Samples			
	Requirement	2	5		
Leakage	≤ 15 cm^3/h	0 cm^3/h	0 cm^3/h		

Seat leakage test of automatic valve (Annex 5C, para. 2.) after Corrosion resistance test
Test pressure 0 to 39,000 kPa (class 0) during 3 minutes

		Samples			
	Requirement	2	5		
Leakage	0 cm^3/h	0 cm^3/h	0 cm^3/h		

Annex 5F: Resistance to dry-heat
Samples:
1 - O-ring 5.0 x 2.0 FPM ED 90 Sh - position 2
2 - O-ring 12.42 x 1.78 HNBR 70 Sh - position 12
3 - O-ring 41.0 x 1.78 V2N - position 15
4 - O-ring 15.0 x 1.8 FPM ED 90 Sh - position 16
5 - O-ring 7.5 x 1.5 VITON 80 Sh - position 21
6 - O-ring 10.82 x 1.78 FPM ED 90 Sh - position 29
7 - O-ring 3.5 x 1.0 FKM GLT 85 Sh - position 34

		Samples			
	Requirement	1	2	3	4
Allowable change in tensile strength	≤ + 25 %	+ 1.19 %	– 1.96 %	– 8.33 %	– 2.04 %
Allowable change in ultimate elongation	≤ + 10 % ≥ – 30 %	– 2.33 %	– 16.42 %	+ 2.12 %	+ 2.22 %

		Samples			
	Requirement	5	6	7	
Allowable change in tensile strength	≤ + 25 %	– 1.47 %	+ 2.86 %	– 4.17 %	
Allowable change in ultimate elongation	≤ + 10 % ≥ – 30 %	+ 2.04 %	– 1.79 %	+ 4.76 %	

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Annex 5G: Ozone ageing

Samples:
1 - O-ring 5.0 x 2.0 FPM ED 90 Sh - position 2
2 - Diaphragm - position 10
3 - O-ring 12.42 x 1.78 HNBR 70 Sh - position 12
4 - O-ring 41.0 x 1.78 V2N - position 15
5 - O-ring 15.0 x 1.8 FPM ED 90 Sh - position 16
6 - O-ring 7.5 x 1.5 VITON 80 Sh - position 21
7 - O-ring 10.82 x 1.78 FPM ED 90 Sh - position 29
8 - O-ring 3.5 x 1.0 FKM GLT 85 Sh - position 34

		Samples			
	Requirement	1	2	3	4
Cracking of test piece	no	no	no	no	no

		Samples			
	Requirement	5	6	7	8
Cracking of test piece	no	no	no	no	no

Annex 5Q: Compatibility with heat exchange fluids of non-metallic parts

Samples:
1 - O-ring 41.0 x 1.78 V2N - position 15
2 - O-ring 7.5 x 1.5 VITON 80 Sh - position 21

		Samples			
	Requirement	1	2		
Maximum change in volume	< 20 %	+ 2.06 %	+ 2.99 %		
Change of mass after air tempering	≥ – 5 %	+ 1.21 %	+ 0.67 %		
Allowable change in tensile strength	≥ – 25 %	– 2.17 %	– 1.52 %		
Allowable change in ultimate elongation	≤ + 10 % ≥ – 30 %	+ 4.24 %	+ 2.08 %		

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Annex 5L: Durability test (Annex 4D, para. 2.4.)

Sample No.: 3
Rate: 6 cycles/minute
Total number of cycles: 50,000 cycles
Testing medium: air

		Samples	
	Requirement	3	
Damage	no	no	
Malfunction	no	no	

a) Room temperature cycling
47,500 cycles at temperature + 20°C and at the pressure 20,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

			Samples	
	Temperature	Requirement	3	
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h	

b) Room temperature cycling
500 cycles at temperature + 20°C and at the pressure from 20,000 kPa to 10,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

			Samples	
	Temperature	Requirement	3	
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h	

c) High temperature cycling
500 cycles at temperature + 120°C and at the pressure 20,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

			Samples	
	Temperature	Requirement	3	
External leakage	+ 120°C	< 15 cm^3/h	0 cm^3/h	

d) High temperature cycling
500 cycles at temperature + 120°C and at the pressure from 20,000 kPa to 10,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

			Samples	
	Temperature	Requirement	3	
External leakage	+ 120°C	< 15 cm^3/h	0 cm^3/h	

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e) Low temperature cycling
500 cycles at temperature – 40°C and at the pressure 10,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

			Samples	
	Temperature	Requirement	3	
External leakage	– 40°C	< 15 cm^3/h	0 cm^3/h	

f) Low temperature cycling
500 cycles at temperature – 40°C and at the pressure from 10,000 kPa to 5,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

			Samples	
	Temperature	Requirement	3	
External leakage	– 40°C	< 15 cm^3/h	0 cm^3/h	

Seat leakage test of pressure relief valve (Annex 5C, para. 2.) after Durability test
Test pressure 0 to 1,200 kPa (class 3) during 3 minutes

		Samples	
	Requirement	3	
Leakage	0 cm^3/h	0 cm^3/h	

Seat leakage test of automatic valve (Annex 5C, para. 2.) after Durability test
Test pressure 0 to 39,000 kPa (class 0) during 3 minutes

		Samples	
	Requirement	3	
Leakage	0 cm^3/h	0 cm^3/h	

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 800 kPa (class 3) during 3 minutes

			Samples	
	Temperature	Requirement	3	
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h	
	– 20°C	< 15 cm^3/h	0 cm^3/h	
	+ 120°C	< 15 cm^3/h	0 cm^3/h	

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Annex 5L: Durability test (Annex 4A, para.: 2.2.3.)

Sample No.: 1
Rate: 6 cycles/minute
Total number of cycles: 50,000 cycles
Testing medium: dry air

	Requirement	Samples	
		1	
Damage	no	no	
Malfunction	no	no	

a) Room temperature cycling
48,000 cycles at temperature + 20°C and at the pressure from 20,000 kPa to 10,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

	Temperature	Requirement	Samples	
			1	
External leakage	+ 20°C	< 15 cm^3/h	0 cm^3/h	

b) High temperature cycling
1,000 cycles at temperature + 120°C and at the pressure from 20,000 kPa to 10,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

	Temperature	Requirement	Samples	
			1	
External leakage	+ 120°C	< 15 cm^3/h	0 cm^3/h	

c) Low temperature cycling
1,000 cycles at temperature – 40°C and at the pressure from 20,000 kPa to 10,000 kPa

External leakage test (Annex 5B) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

	Temperature	Requirement	Samples	
			1	
External leakage	– 40°C	< 15 cm^3/h	0 cm^3/h	

Seat leakage test of automatic valve (Annex 5C, para. 2.) after Durability test
Test pressure 0 to 39,000 kPa during 3 minutes

	Requirement	Samples	
		1	
Leakage	0 cm^3/h	0 cm^3/h	

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Annex 5N: Vibration resistance test

Sample No.: 4
Amplitude: 1,5 mm

Frequency: 17 Hz
Total test time: 6 hours

		Samples	
	Requirement	4	
Damage	no	no	
Malfunction	no	no	

Seat leakage test of pressure relief valve (Annex 5C, para. 2.) after Vibration resistance test
Test pressure 0 to 1,200 kPa (class 3) during 3 minutes

		Samples	
	Requirement	4	
Leakage	0 cm^3/h	0 cm^3/h	

Seat leakage test of automatic valve (Annex 5C, para. 2.) after Vibration resistance test
Test pressure 0 to 39,000 kPa (class 0) during 3 minutes

		Samples	
	Requirement	4	
Leakage	0 cm^3/h	0 cm^3/h	

Presented results are only applicable to samples, which have been tested.
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The test results and examinations according to ECE Regulation No. 110 were handed over to the TÜV SÜD Czech s.r.o., Novodvorská 994/138, 142 21 Praha 4. This Institute has authorised the VZLU TEST to carry out approval tests under the Contract of Agreement.

TESTING LABORATORY APPROVED BY CTA – TEST VZLU – 631

Jindřich Žďánský
Head of Hydraulics Testing Laboratory

Prague, 21 December 2020

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Ministry of Transport UN/ECE Approval Authority E 8 Type approvals of wheeled vehicles equipment and parts C Czech Republic

***END OF TEST REPORT ***

Date: 21.12.2020	**Worked up by:** Žďánský	**Signature:**