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Industrie Service

ZERTIFIKAT
Certificate

EG-Baumusterprüfung (Modul B) nach Richtlinie 97/23/EG
EC Type-examination (Module B) according to Directive 97/23/EC

Zertifikat-Nr.: Z-IS-DDB-MAN-14-07-100327437-01
Certificate No.:

Gültigkeit / *Validity:* *bis 23. Mai 2023 / till 23th of May 2023*

Bevollmächtigter gemäß RL 97/23/EG:
Authorized Reprasentativ:
RegO GmbH
Industriestraße 9
D-35075 Gladenbach

Hiermit wird bescheinigt, dass das unten genannte EG-Baumuster die Anforderungen der Richtlinie 97/23/EG erfüllt.
We herewith certify that the type mentioned below meets the requirements of the Directive 97/23/EC.

Prüfbericht Nr.:
Test report No.:
P-IS-DDG-MUC-13-07-100327-437-005-005 Rev. 1

Geltungsbereich:
Scope of examination:
Direkt wirkende federbelastete Sicherheitsventile, Typen AR, PRV, SS, NR für LPG und tiefkalte Gase

Fertigungsstätte / Hersteller:
Manufacturing plant / manufacturer
Engineered Controls International, LLC, 100 Rego Drive Elon, NC 27244 United States of America

TÜV SÜD Industrie Service GmbH

Zertifizierungsstelle für Druckgeräte

Mannheim, 14. Juli 2014
(Ort, Datum)
(Place, date)

(Dipl.-Ing. Brinkmann)
Benannte Stelle, Kennnummer 0036
Notified Body, No. 0036

Bitte beachten Sie die Hinweise auf der zweiten Seite.
Please note the remarks on the second page.

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P-IS-DDG-MUC-13-07-100327-437-005-005 Rev.1

Type test of safety valves for LPG and cryogenic service

Reason for revision: Addition of type AR4104

Manufacturer: RegO GmbH
Industriestraße 9
D-35075 Gladenbach

Products: Safety Valves for LPG
Safety Valves for cryogenic service

Types: AR4104, AR4106, AR4108, AR4112, PRV9432, PRV9433, PRV9434, SS9432, SS9433, SS9434, NR9432, NR9434, PRV19432, PRV19433, PRV19434, PRV29432, PRV29433, PRV29434

Date: 2013-11-18

Our reference:
IS-DDG-MUC/fa

Report No. P-IS-DDG-MUC-13-07-100327-437-005-005 Rev.1

This document consists of 9 Pages.
Page 1 of 9

The test results refer exclusively to the units under test.

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Trade Register Munich HRB 96 869
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1. Task

The RegO GmbH is manufacturer of different types of valves and safety valves for LPG and cryogenic service. RegO aspires to get VD-TÜV Bauteilkennzeichen for following products:

Venil / Valve	Zeichnung / Drawing	P_S [bar]	T_S [°C]
AR4104	AR4104A SER, Rev.C, 11/19/2013	41,4	-196/74
AR4106	AR4106A SER, Rev.C, 6/11/2012	41,4	-196/74
AR4108	AR4108A SER, Rev.C, 6/11/2012	41,4	-196/74
AR4112	AR4112A SER, Rev.C, 6/11/2012	41,4	-196/74
PRV9432	PRV9432XX-XB, Rev.E, 10-15-09	41,4	-196/74
PRV9433	PRV9433XX-XB, Rev.E, 10-15-09	41,4	-196/74
PRV9434	PRV9434XX-XB, Rev.E, 10-15-09	41,4	-196/74
SS9432	SS9432XX-XB, Rev.C, 7-24-09	41,4	-196/74
SS9433	SS9433XX-XB, Rev.C, 7-24-09	41,4	-196/74
SS9434	SS9434XX-XB, Rev.C, 7-24-09	41,4	-196/74
NR9432	NR9432 SER, Rev./, 6-10-09	41,4	-196/74
NR9434	NR9434 SER, Rev./, 6-10-09	41,4	-196/74
PRV19432	PRV19430XXXXX, Rev.J, 2-23-09	41,4	-196/74
PRV19433	PRV19430XXXXX, Rev.J, 2-23-09	41,4	-196/74
PRV19434	PRV19430XXXXX, Rev.J, 2-23-09	41,4	-196/74
PRV29432	PRV29430XXXXX, Rev.J, 3-11-11	41,4	-196/74
PRV29433	PRV29430XXXXX, Rev.J, 3-11-11	41,4	-196/74
PRV29434	PRV29430XXXXX, Rev.J, 3-11-11	41,4	-196/74

Therefore, the company RegO GmbH, Industriestraße 9, 35075 Gladenbach applies by letter, dated 2013-02-05, for a module B certification in accordance to 97/23/EG. By letter, dated 2013-11-05, RegO applies for the addition of type AR4104 to the type approval.

TÜV SÜD Industrie Service GmbH was assigned to perform type tests for the mentioned products.

2. Regulations

The examination of the valves was based on following regulations:

- VdTÜV-Merkblatt „Sicherheitsventil 100"
- VdTÜV-Merkblatt „Allgemeines 002"
- Pressure Equipment Directive 97/23/EC

The tests were performed based on following standards:

- EN ISO 4126-1:2004
  Safety devices for protection against excessive pressure – Part 1: Safety valves
- EN 13648-1:2008
  Cryogenic vessels – Safety devices for protection against excessive pressure – Part 1: Safety valves for cryogenic service

The following report will give a summary of the performed tests and show the results.

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3. Design

The design of the safety valves have been checked in accordance to EN ISO 4126-1:2004, chapter 5.1 and 5.2. A. All applicable requirements have been fulfilled.

The main drawings of all types of safety valves are attached to this report.

4. Springs

Spings have to be in accordance to EN ISO 4126-7:2004.
The spring types and the corresponding pressure range are given in the following table:

Spring	P_{min} [psi]	P_{max} [psi]	P_{min} [bar]	P_{max} [bar]
BX250-025	10	39	0,7	2,7
BX250-065	40	89	2,8	6,1
BX250-115	90	139	6,2	9,6
BX250-180	140	199	9,7	13,7
BX250-260	200	299	13,8	20,6
BX250-340	300	379	20,7	26,1
BX250-420	380	459	26,2	31,6
BX250-500	460	600	31,7	41,4
AR004106A-61SS	301	400	20,7	27,6
AR004106A-62SS	80	129	5,5	8,9
AR004106A-63SS	130	199	9,0	13,7
AR004106A-6SS	200	300	13,8	20,7
AR004112A-6SS	200	300	13,8	20,7

All applicable requirements of EN ISO 4126-7:2004 are fulfilled. The drawings of the springs are attached to this test report.

5. Materials

	AR Series	PRV Series	NR Series	SS Series
Body	Bronze ASTM B61	Brass ASTM B16	Brass ASTM B16	1.4404
Seat &Stem	Brass ASTM B16	Brass ASTM B16	Brass ASTM B16	1.4404
Bushing	Teflon	-	-	-
Gasket	PTFE ASTM D4894	PTFE ASTM D4894	PTFE ASTM D4894	PTFE ASTM D4894
Spring	ASTM A313 – 17-7	ASTM A313 – 17-7	ASTM A313 – 17-7	ASTM A313 – 17-7

For the used materials, particular material appraisals (PMA), have been provided and are attached to this report.

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6. Tests of Safety Valves acc. to EN ISO 4126 + EN 13648

The safety valves for the cryogenic service have been tested in accordance to EN ISO 4126-1:2004 and EN 13648-1:2008:

The tests have been performed in Gladenbach from 2012-09-03 to 2012-09-05 and in Elon, North Carolina, from 2012-11-12 to 2012-11-16. In Gladenbach, the test for the functional parameters and the hydraulic pressure tests have been performed. In Elon, North Carolina, the test regarding the spring requirements, the flow characteristics, the seat leakage, the influence of rain water and the cryogenic tests have been performed.

Remark: The only deviation between type AR4104 and AR4106 is a modification of the lower thread (inlet). Therefore, the flow characteristics and the functional parameters of AR4104 are similar to type AR4106.

6.1. EN ISO 4126-1:2004, 6.3, Hydraulic pressure tests:

The portion of the valve from the inlet to the seat shall be tested to a pressure 1.5 times the manufacturer's stated maximum pressure for which the safety valve is designed.

The shell on the discharge side of the seat shall be tested to 1.5 times the manufacturer's stated maximum back pressure for which the valve is designed.

Type	Valve	Test pressure	time	result
SV	AR4112A	62 bar	180 s	No leak, no deformation
	AR4106A	62 bar	180 s	No leak, no deformation
	AR4104A	62 bar	180 s	No leak, no deformation
	PRV9434	80 bar	180 s	No leak, no deformation
	PRV9432	80 bar	180 s	No leak, no deformation
	SS9432	80 bar	180 s	No leak, no deformation
	SS9434	80 bar	180 s	No leak, no deformation

The requirements according to EN ISO 4126-1:2004 have been fulfilled.

In addition, the pressure bearing parts of the safety valves have been tested to a pressure 5.0 times the manufacturer's stated maximum pressure for which the safety valve is designed.

The reason for the hydraulic pressure test with an elevated test pressure was the verification of design of the safety valves, as substitute for a design examination. The time for the pressure test has been 300 s. The results are shown in the following table:

Type	Valve	Test pressure	time	result
SV	AR4112A	210 bar	300 s	No leak, no deformation
	AR4106A	210 bar	300 s	No leak, no deformation
	AR4104A	210 bar	300 s	No leak, no deformation
	PRV9434	210 bar	300 s	No leak, no deformation
	SS9434	210 bar	300 s	No leak, no deformation

The requirements according to EN ISO 4126-1:2004 have been fulfilled.

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6.2. EN ISO 4126-1:2004, 7.2, Functional parameters:

The set pressures at which the operating characteristics are determined shall be the minimum and maximum set pressures for which the spring is designed.

The allowable tolerances or limits as applicable on the operating characteristics are as follows:

a) set pressure : ± 3 % of set pressure or ± 0,15 bar whichever is the greater;
b) lift : not lower than the value specified by the manufacturer;
c) overpressure: the value stated by the manufacturer but not exceeding 10 % of set pressure or 0,1 bar whichever is greater;
d) blowdown: not greater than the value stated by the manufacturer, but within the following limits
   compressible fluids : minimum : 2,0 % (not applicable to safety valves with proportional opening characteristics according to 7.2.1 f); maximum : 15 % or 0,3 bar, whichever is greater;
   incompressible fluids : minimum : 2,5 % (not applicable to valves with proportional opening characteristics according to 7.2.1 f); maximum : 20 % or 0,6 bar, whichever is greater ;
e) overpressure and blowdown of restricted lift valves shall have the same tolerances or limits as the unrestricted lift valves;
f) overpressure and blowdown of valves with proportional opening characteristic shall be verified and be stable for various lifts between the minimum and maximum stated by the manufacturer. A curve shall be established for valve lift versus overpressure.

Every safety valve was activated at least three times, in accordance to the requirement given in EN ISO 4126-1:2004, chapter 7.2.4.

P_E: *set pressure* [bar] $P_Ö$: *pressure valve completely open* [bar]
P_A: *opening pressure* [bar] P_S: *reseating pressure* [bar]
1,2,3: 1.Measurement / 2.Measurement / 3.Measurement

Valve	P_E	P_{A1}	$P_{Ö1}$	P_{S1}	P_{A2}	$P_{Ö2}$	P_{S2}	P_{A3}	$P_{Ö3}$	P_{S3}
AR 4112A	17,2	16,5	18,2	-	15,7	17,7	12,5	14,7	17,5	12,2
	13,8	13,8	14,5	12,0	14,1	14,5	11,8	14,0	14,5	11,9
	20,7	21,1	21,5	18,2	21,2	21,7	18,4	20,8	21,7	18,4
AR 4106A	17,2	17,4	17,9	16,3	17,4	18,0	16,2	17,5	18,1	16,2
	13,8	13,9	14,5	12,5	13,7	14,5	12,4	13,7	14,4	12,3
	20,7	20,8	21,6	19,6	20,8	21,8	19,6	20,9	21,7	19,6
PRV9432 FAB	0,7	0,7	0,75	0,5	0,65	0,75	0,5	0,65	0,7	0,55
	2,5	2,55	2,7	2,3	2,45	2,65	2,3	2,5	2,65	2,3
PRV9434 FAB	0,7	0,7	0,8	0,65	0,7	0,8	0,65	0,7	0,75	0,65
	2,5	2,5	2,65	2,4	2,5	2,6	2,4	2,5	2,6	2,4
SS9432 FAB	0,7	0,7	0,8	0,7	0,7	0,75	0,7	0,7	0,8	0,7
	2,5	2,5	2,65	2,45	2,5	2,6	2,45	2,5	2,65	2,45
SS9434 FAB	0,7	0,7	0,8	0,65	0,7	0,8	0,65	0,7	0,75	0,65
	2,5	2,5	2,6	2,4	2,5	2,65	2,4	2,5	2,6	2,4
PRV9432 THB	32,0	32,0	32,6	30,5	32,1	32,6	30,0	31,9	32,5	30,3
	38,5	38,5	39,3	36,0	38,7	39,4	36,0	38,7	39,5	35,8
PRV9434 THB	32,0	32,1	33,5	28,5	31,9	33,2	28,2	32,0	33,5	28,3
	38,5	38,6	40,0	34,5	38,7	40,0	34,5	38,9	40,0	34,5

SS9432	32,0	32,0	33,3	28,8	31,9	33,4	29,0	32,2	33,4	29,1
THB	38,5	38,4	39,3	36,0	38,8	40,0	36,4	39,2	40,0	36,5
SS9434	32,0	31,9	32,5	30,2	31,9	33,4	30,2	31,9	32,4	30,4
THB	38,5	38,4	39,2	35,3	38,3	39,1	35,6	38,4	39,0	35,6

All tests have been carried out successfully. The requirements according to EN ISO 4126-1:2004, chapter 7.2, have been fulfilled.

6.3. EN ISO 4126-1:2004, 7.3, Flow Characteristics

After the operating characteristics (see above) have been satisfactorily established, nitrogen has been used as the fluid for flow characteristic tests.

The tests have been carried out with the springs fitted. Tests have been conducted at various pressures to establish that no variations of the coefficient of discharge with the relevant positions of the adjusting rings, occurs. Flow tests with the springs installed have been carried out at a set pressure plus overpressure as used to determine operating characteristics with atmospheric back pressure.

No adjustment to the valve shall be made during the tests. Following any changes or deviation in the test conditions, a sufficient period of time shall be allowed to permit the rate of flow, temperature and pressure to reach stable conditions before readings are taken.

In all the methods described for flow characteristics testing, all final results shall be within ± 5 % of the arithmetic average.The test equipment is designed and operated such that the actual test flowing capacity measurements is accurate to within ± 2 %.

The test records include all observations, measurements, instrument readings for the objective of the tests. Original test records remain in the custody of the test establishment in Elon. Copies of all test records have been supplied to the notified body and are attached to this test report.

Valve	D (inlet)		D (outlet)		D (min)		α
AR4104	.415 inch	10,5 mm	1.120 inch	28,5 mm	.415 inch	10,5 mm	0.56
AR4106	.51 inch	13 mm	1.120 inch	28,5 mm	.415 inch	10,5 mm	0.71
AR4108	.51 inch	13 mm	1.461 inch	37 mm	.415 inch	10,5 mm	0.62
AR4112	1.18 inch	30 mm	2.163 inch	55 mm	.91 inch	23 mm	0.63
PRV9432	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
PRV9433	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
PRV9434	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
SS9432	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
SS9433	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
SS9434	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
NR9432	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.17
NR9434	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.17
PRV19432	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70

PRV19433	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
PRV19434	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
PRV29432	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
PRV29433	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70
PRV29434	.281 inch	7 mm	.696 inch	17,5 mm	.281 inch	7 mm	0.70

D (inlet): Diameter at inlet of valve
D (outlet): Diameter at outlet of valve
D (min): Minimum flow diameter
α: Coefficient of discharge

The selection of the samples and the number of tests were based on the requirements according to EN ISO 4126-1:2004.The flow characteristics have been determined in accordance to EN ISO 4126-1:2004, chapter 7.

The requirements according to EN ISO 4126-1:2004 are fulfilled.

6.4. DIN EN 13648-1:2009-02, 5.2.2, Seat leakage test:

These tests have been executed in order to have a particular valve design specified in accordance with DIN EN 13648-1:2009-02. Any modification of the design that could have an effect on the results of these tests (for example a different design of the valve disc) will necessitate a new series of tests.

The selection of size and number of valves for type testing has been in accordance with the requirements of EN ISO 4126-1:2004.

Safety valves of category A shall be lifted to their manufacturer's specified maximum overpressure and re-seated a minimum of 1 000 times. The valves shall then be leak tested at 90 % of the set pressure using air or nitrogen at ambient temperature and the leak rate shall not exceed 3 mm^3/s DN.

Safety valves of category B shall be lifted at their specified set pressure and re-seated a minimum of 20 times. The valves shall then be leak-tested at 90 % of the set pressure using air or nitrogen at ambient temperature and the leak rate shall not exceed 3 mm^3/s DN.

The testes safety valves are safety valves of category B:
"safety valve which would not be expected to relieve during normal operation due to the provision of an alternative relieving or control device"

Valve	Cycles	Temp. [F]	Press. [PSIG]	Leakage rate	Result
AR 4108	20	66	225	No leak	Ok
		66	225	No leak	Ok
PRV9432	20	60	225	No leak	Ok
		64	225	No leak	Ok
NR9432	20	61	270	No leak	Ok
		64	270	No leak	Ok

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SS9434	20	61	270	No leak	Ok
		64	270	No leak	Ok

The requirements have been fulfilled.

6.5. DIN EN 13648-1:2009-02, 5.2.3, Cryogenic Tests:

Each safety valve tested in accordance to 5.2.2 has been subjected to a cryogenic test.
The sample safety valves have been connected to a reservoir of liquid nitrogen and opened and closed repeatedly.

The orientation of the valve during the test has been in accordance with the installation instructions on the manufacturer's data sheet.

All tests have been completed sequentially and there was no delay between tests. The sample valve opened without restriction and re-seated audibly leak tight within its specified pressure tolerances.

Valve	Temp.	P_E	P_{A1}	P_{O1}	P_{C1}	P_{A2}	P_{O2}	P_{C2}	P_{A3}	P_{O3}	P_{C3}
AR 4108A	-196	250	254	270	230	255	270	230	258	270	230
PRV9432	-196	250	252	265	240	261	270	220	230	270	220
SS9434	-196	300	309	320	280	300	320	270	310	315	280
NR9434	-196	300	304	315	280	300	320	280	310	330	270

The requirements have been fulfilled.

6.6. DIN EN 13648-1:2009-02, 5.2.3.4, Influence of Rainwater:

If agreed between the parties, an assessment that the operational characteristics of the valve will not be affected by rain can be done by reviewing drawings and any other suitable information about the valve to eliminate the water spraying during this test.

Valve	Comment / Result
AR 4112A	- All equipped with drain holes and caps, no influence of water ➔ No rainwater influence due to construction ➔ No spraying during cryogenic test
AR 4108A	
AR 4106A	
AR 4104X	
PRV9432	
PRV9434	
SS9432	
SS9434	

The main drawings of the valves are attached to this report.

The requirements have been fulfilled.

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7. Summary

The RegO GmbH is manufacturer of different types of valves and safety valves for LPG and cryogenic service. RegO aspires to get a VdTÜV Bauteilkennzeichen for Safety Valves for cryogenic service.

Therefore, TÜV SÜD Industrie Service GmbH was assigned to perform type tests for the mentioned products.

The examination of the valves was based on following regulations:
- VdTÜV-Merkblatt „Sicherheitsventil 100"
- VdTÜV-Merkblatt „Allgemeines 002"
- Pressure Equipment Directive 97/23/EC

The tests were performed based on following standards:
- EN ISO 4126-1:2004
  Safety devices for protection against excessive pressure – Part 1: Safety valves
- EN 13648-1:2008
  Cryogenic vessels – Safety devices for protection against excessive pressure – Part 1: Safety valves for cryogenic service

All technical tests have been performed successfully.
The requirements in accordance to the applied regulations are fulfilled.

The marking of the safety valves has to be in accordance to 97/23/EC and shall contain the set pressure, the minimum flow diameter and the coefficient of discharge.

Inspector of the Notified Body

TÜV SÜD Industrie Service GmbH 00 36 Notified Body

Tim Faber

Annexes:
1. Drawings of safety valves (14 pages)
2. Drawings of springs (12 pages)
3. Test protocols of flow characteristics (38 pages)
4. PMAs for used materials (9 pages)