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Report no.: TAI-FS-R-21-0173

SIL SUMMARY REPORT

IEC 61508-1/7:2010

Pneumatic / hydraulic compact scotchyoke spring return actuator **Series RC**

Rotork Sweden AB Kontrollvägen, 15 SE-791 22 Falun

Date: 2021-08-04

Corlo

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This document is only valid in its entirety, without any change.

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1 **INTRODUCTION**

This report is related to the assessment according to standards:

IEC 61508-1/7:2010

for the following products:

pneumatic / hydraulic compact scotch-yoke spring return actuator series RC

NOTES:

The results of this report can be used for the assessment of a complete Safety Instrumented System.

2 **ASSESSMENT AND RESULTS**

Product identification				
Device	Pneumatic / hydraulic compact scotch-yoke spring return actuator			
Series	RC			
Models / configurations	RC - No PST RC - With PST RC88 - No PST RC88 - With PST			
Safety function(s)				
1.	Delivery of a full stroke (90° ± tolerance) driven by the spring, with power fluid exhausted from the cylinder through the control system. NOTE: considering the functioning of the actuator to perform the safety function(s), the safety functions "close" and "open" can be considered equivalent. The safety function is in both cases driven by the spring.			
Mode of operation of the safety function(s)	Low demand mode			
Reference standards				
General functional safety standard	IEC 61508-1	/7:2010		
Product specific functional safety standard	None			
Assessment phases				
Management of functional safety / functional safety planning	Assessed	A functional safety audit of the management systems and of the functional safety planning is conducted to document and highlight that the development of the product under consideration is compliant with IEC 61508.		
Safety requirements specification	Assessed	The Safety requirements specification is assessed with respect to its consistency and completeness in a comparison with the applicable requirements of IEC 61508.		

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Design	Assessed	DC, SFF, PFI architectural of Non-quantifia safety function related softwar under consider the second secon	: aspects: random D _{AVG} , β factors, l constraints ble aspects: bet n under fault col are (not applicat eration), system der environment	n failure rates, MRT, PTC, naviour of the nditions, safety- ole to the product atic failures,		
Verification and Validation	Assessed					
Information for use	Assessed					
Modification	Assessed					
Results						
Selected assessment routes	 For Syste Furthermore, of IEC 61508 the producted designed the production (including suitability declared for the manufaciliures) 	 For Systematic Capability: Route 1s Furthermore, the requirements in paragraphs 7.4.10.1–7.4.10.7 of IEC 61508 Part 2 are assessed and considered fulfilled, as: the product has a restricted and specified functionality and is designed to perform specified safety functions the product has an adequate documentary evidence (including extensive operating experience and results of suitability analysis and testing), sufficient to claim the declared failure rates the manufacturer has an effective system for reporting 				
Element type (A or B)		Type A				
HFT Random failure rates	The determine FMEDA, integ	The product has a single channel configuration, HFT=0. The determination of random failure rates is performed with a FMEDA, integrated with field feedback, according to IEC 61508 Part 2 Par. 7.4.4.3.3, using the Bayesian approach.				
Configuration	Safety function	Safety 3 [4/b] 3 [4/b]				
RC - No PST	1	2,23E-08	0,00E+00	0,00E+00		
RC - With PST	1	2,01E-09	2,03E-08	0,00E+00		
RC88- No PST	1	3,40E-08	0,00E+00	0,00E+00		
RC88 - With PST	1	3,06E-09	3,09E-08	0,00E+00		
Spurious trip rate	 RC: 8,27E-08 [1/h] RC88: 1,23E-07 [1/h] NOTE: failures of components of the cylinder which can generate spurious trips shall be correctly classified as "No Part" and not "Safe", being related to components that "play no part in implementing the safety function" (see definition 3.6.16 of IEC 61508 Part 4). Anyway the spurious trip rate is estimated. 					

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DC	The product does not include internal diagnostics.
	Diagnostic is only be possible via external means, e.g. with a PST.
	The procedure for the PST is described in the Safety Manual.
SFF	 Considering that λs=0, according to definitions 3.6.15 of IEC 61508 Part 4: SFF=0 without external diagnostic tests SFF>0 with external diagnostic tests, carried out according to definition 3.8.7 of IEC 61508 Part 4, and according to what written in the Safety Manual
PFDavg	As the PFD _{AVG} value depends also on the test intervals and on the PTC and the coverage of external tests, which are not product-dependant quantities, the PFD _{AVG} values are not product relevant quantities, while λ values are. Anyway, PFD _{AVG} values are calculated for a certain number of combination of test intervals. See Annex A.
β factors	 β=β_D=0,05 The above value is the value for 1oo2 architecture. The values for other architectures shall be calculated according to IEC 61508 Part 6, Table D.5. The above value is calculated in the hypothesis of redundancy without diversity The β factors can be used when performing PFD_{AVG} calculations for redundant architectures.
MRT	24 h The MRT considered is the Technical Mean Repair Time, i.e., it takes in consideration availability of skilled personnel, adequate tools and spare parts.
PTC	The procedure for the Proof Test is described in the Safety Manual.
Architectural constraints	The product can be used in: • single channel configuration: • up to SIL 2 without external diagnostic tests • up to SIL 3 considering external diagnostic tests • double channel configuration: up to SIL 3
Expected lifetime	25 years
Behaviour of the safety function under fault conditions	The product does not include internal diagnostics.
Safety related SW	No SW is used to implement the safety function.
Systematic Capability	3
Behaviour under environmental conditions	The behaviour in environmental conditions is assessed evaluating the relevant environmental tests.
Limitations for use	Make reference to the Safety Manual.
Remarks	
The random failure rates in the product	e above table are valid for all the possible configurations of the

product.

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- According to the definition of IEC 61508 (in particular definitions 3.6.8 and 3.6.13 of IEC 61508 Part 4), no Safe Failures are possible in a single acting actuator: each failure mode of the actuator itself shall be classified as "Dangerous" or "No Effect" (failures which can generate the spurious operation of the safety function are only external to the actuator itself, or are related to components that "play no part in implementing the safety function"); hence, $\lambda_s=0$ for each type of single acting actuator.
- Failures of components of the cylinder which can generate spurious trips shall be correctly classified as "No Part" and not "Safe", being related to components that "play no part in implementing the safety function" (see definition 3.6.16 of IEC 61508 Part 4). Anyway the spurious trip rate is estimated.
- The λ_S values are not divided in λ_{SD} and λ_{SU} , as this subdivision has no relevance for any of the SIL parameters.
- For further details, make reference to the Safety Manual.

Reference documents	
SIL Assessment Report	TÜV AUSTRIA document no. TAI-FS-R-21-0172
Safety Manual	Rotork document no. SM-RC-A-00-E

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ANNEX A - EXAMPLES OF PFDAVG CALCULATIONS

Type: RC - No PST - Safety function: 1

Proof test interval (months)					
6 12 24 36 48					
4,94E-05	9,82E-05	1,96E-04	2,94E-04	3,91E-04	

Type: RC - With PST - Safety function: 1

		Proof test interval (months)					
		6	12	24	36	48	
	1	1,23E-05	1,67E-05	2,55E-05	3,43E-05	4,31E-05	
val s)	2	1,97E-05	2,41E-05	3,29E-05	4,17E-05	5,05E-05	
interva onths)	3	2,72E-05	3,16E-05	4,03E-05	4,91E-05	5,79E-05	
	6		5,38E-05	6,26E-05	7,14E-05	8,02E-05	
PST (m	9				9,36E-05		
	12			1,07E-04	1,16E-04	1,25E-04	

Type: RC88 - No PST - Safety function: 1

Proof test interval (months)						
6 12 24 36 48						
7,53E-05	1,50E-04	2,99E-04	4,48E-04	5,96E-04		

Type: RC88 - With PST - Safety function: 1

		Proof test interval (months)					
		6	12	24	36	48	
	1	1,88E-05	2,55E-05	3,89E-05	5,23E-05	6,57E-05	
val	2	3,01E-05	3,68E-05	5,02E-05	6,36E-05	7,70E-05	
inter	3	4,14E-05	4,81E-05	6,15E-05	7,49E-05	8,83E-05	
Ι. ≌	6		8,20E-05	9,54E-05	1,09E-04	1,22E-04	
PST (m	9				1,43E-04		
	12			1,63E-04	1,77E-04	1,90E-04	

NOTES:

- The above values of PFD_{AVG} are calculated for MRT=24 h and proof test coverage=100%. For other values of MRT, TI, TI_PS and/or non-perfect proof test, the $\mathsf{PFD}_\mathsf{AVG}$ values must be re-calculated.
- The PFD_{AVG} values including partial stroke test are calculated considering the use of a commercial automatic partial stroking test system: for further details, see the Safety Manual.

The values in the above tables are compatible with SIL 3.

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