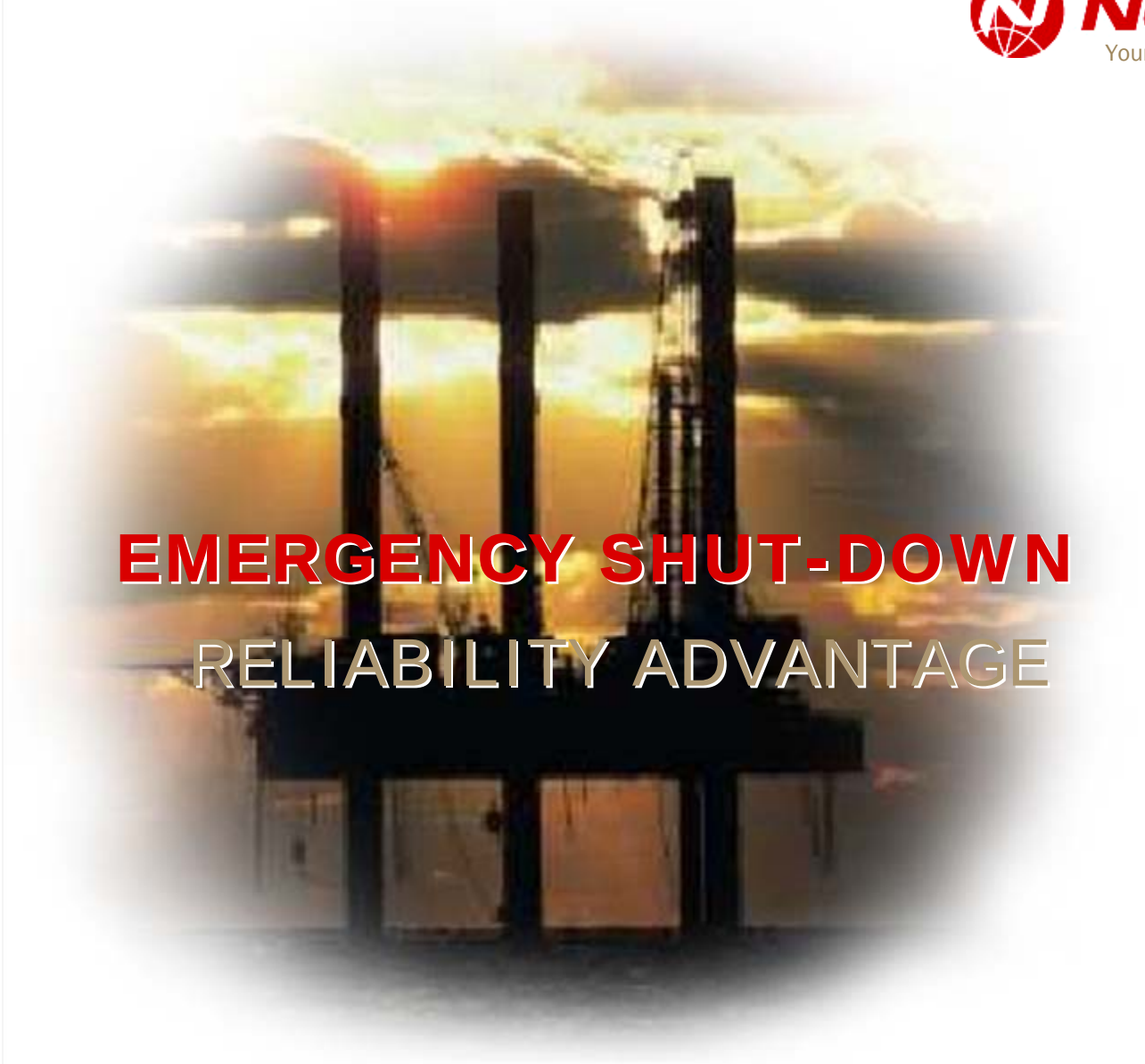
NORGREN
Your partner in Fluid Control Solutions

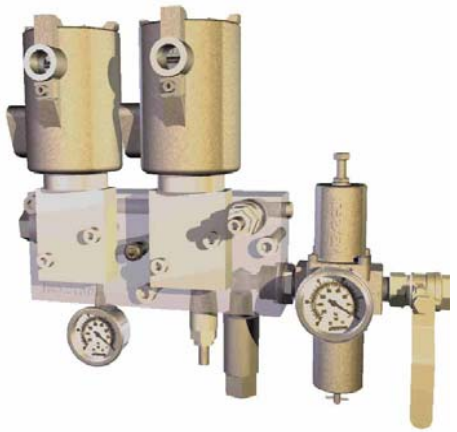


EMERGENCY SHUT-DOWN

RELIABILITY ADVANTAGE

George Cao
06 May, 2011

1. ESD Overview




Why Do You Need ESD Solution?
Safety!
Safety! !
Safety! ! !
Safety Is a Must !

The LPG depot before;.

The depot after the disaster

» On 19 November 1984, the LPG disaster in Mexico City, 500 fatalities, occurred; Two weeks later, 3 December 1984, the Bhopal tragedy (more than 3700 fatalities) occurred.

Safety Instrumented Function (SIF)

SIF/SIS

Field Sensor

Examples:

Level sensors, Pressure Transmitter, etc

Logic Solver

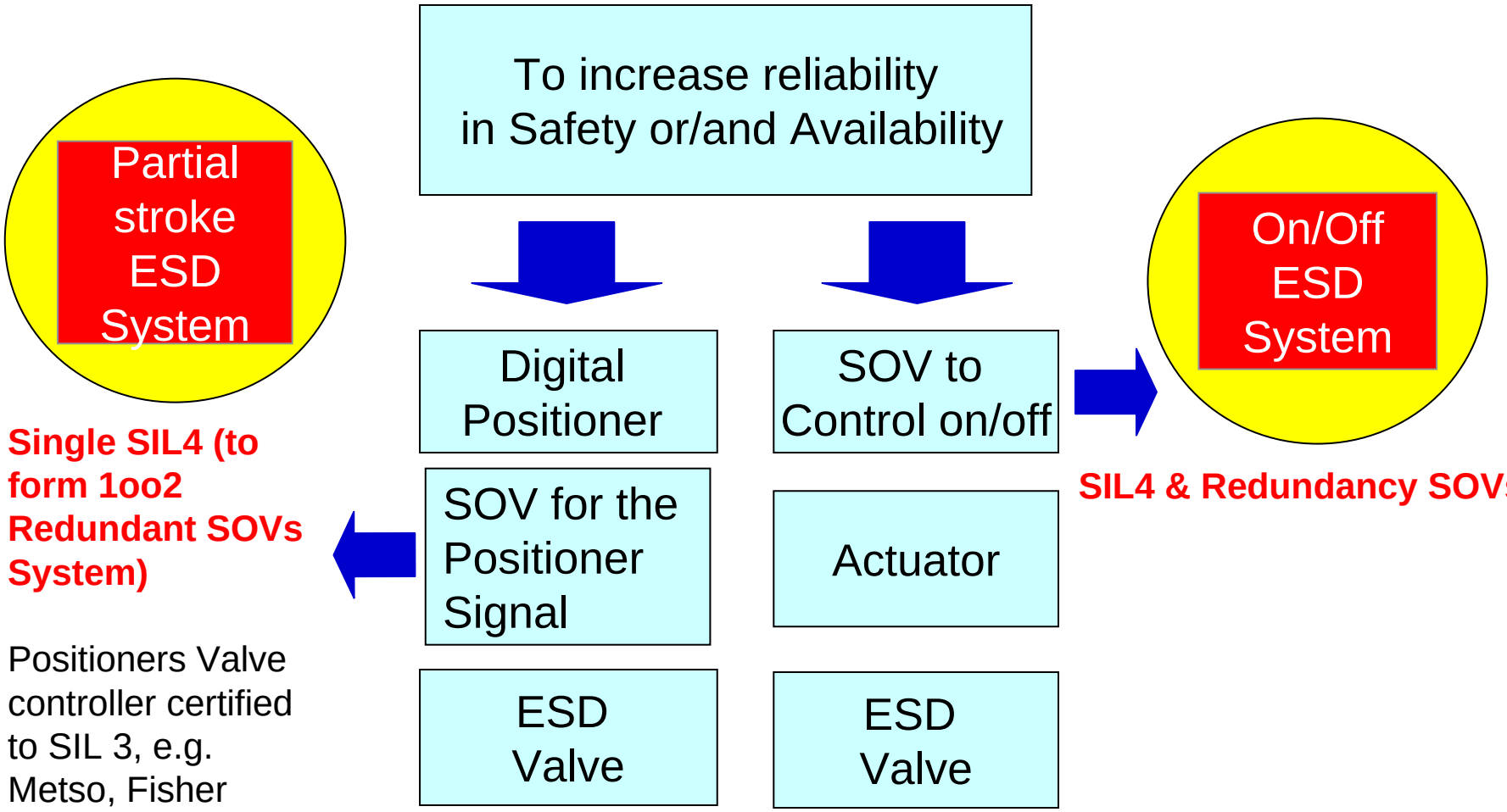
Triple Modular Redundancy (TMR) system

Actuation Elements

I) SOV + Actuator + Shutdown Valve (butterfly or globe vlv),
II) Fire Alarm

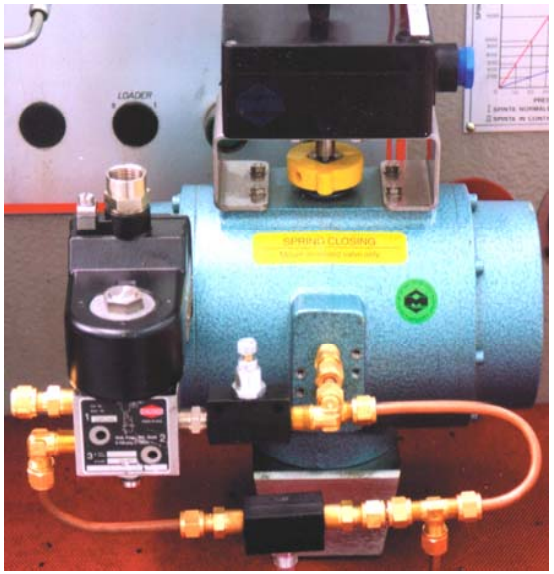
Where can Norgren help?

To reduce SOV Probability of Failure on Demand (PFD)



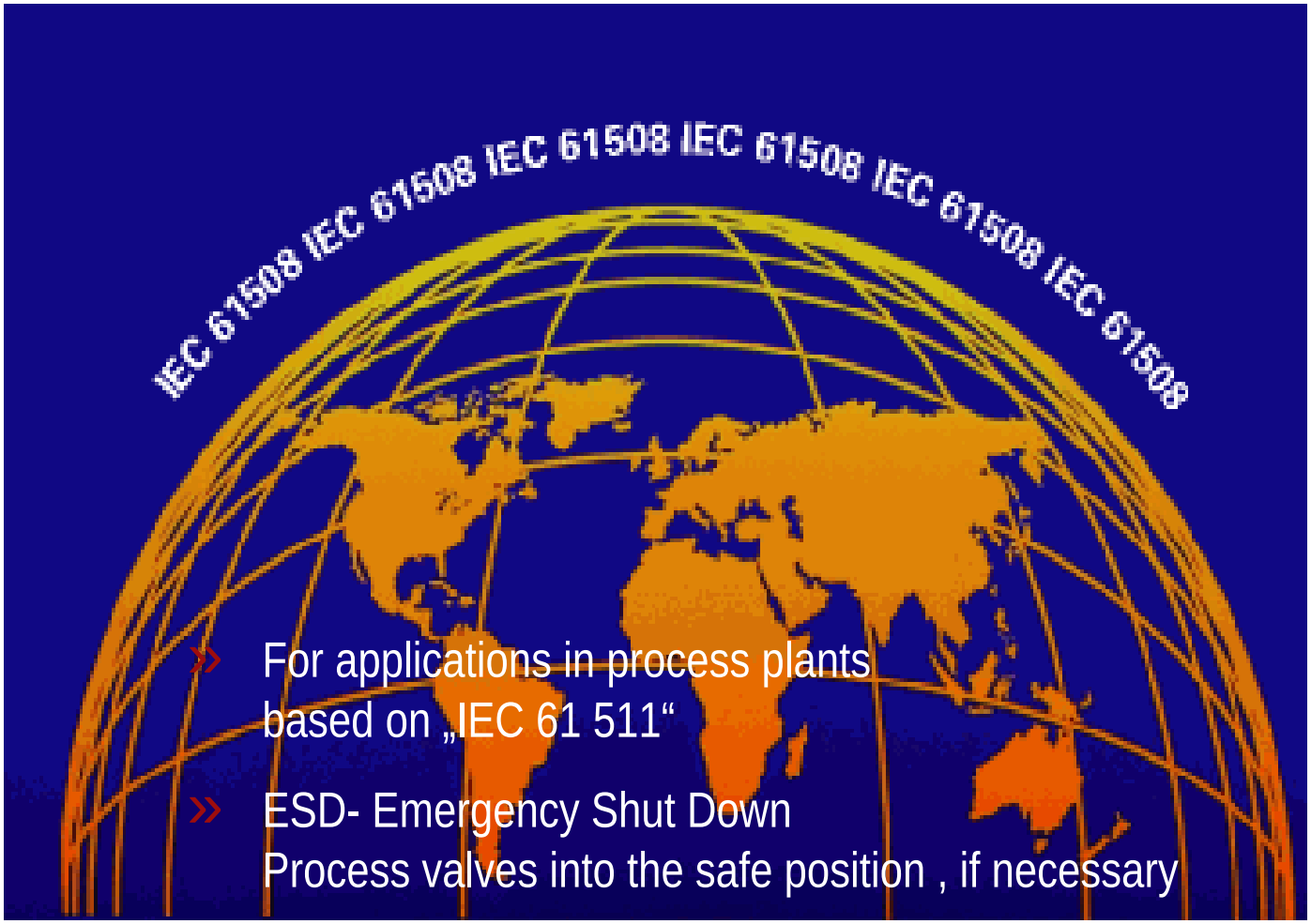
Actuated Shutdown Valve

- The actuated shutdown valve are expected to remain static in one position for a long period of time, during the operation, and reliably operate only when an emergency situation arises.
- Failure and/or spurious trips could result in expensive procedural and downtime consequences.
- The challenges is: ESD valve to operate & return to safe mode, when emergency occurs.
- Thus, the reliability on safety and availability, need to tested frequently before the next maintenance, but not interrupting the operation.
- The heart of the actuated shutdown valve system is the solenoid valve that requires high level of reliability, availability and safety too.



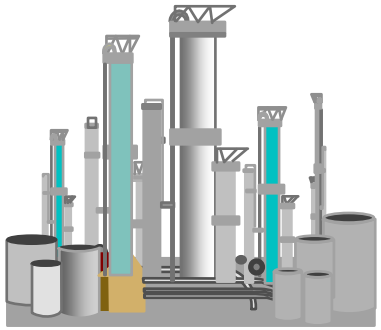
2. IEC 61508 Standard

Safety and availability based on „IEC 61 508“



- For applications in process plants based on „IEC 61 511“
- ESD- Emergency Shut Down
  Process valves into the safe position , if necessary

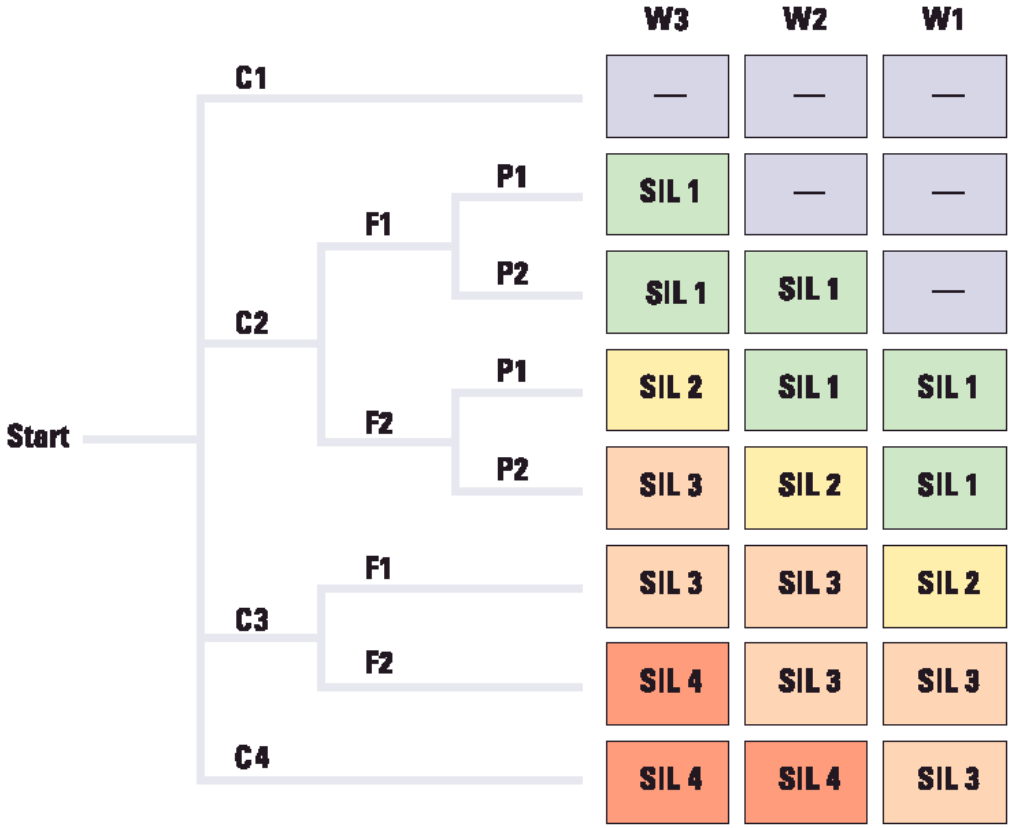
- The international standard "IEC 61 508/61 511" replaces the local standard "DIN V 19 251/19 250" .



Safety and availability based on „IEC 61 508“

Risk-graph and requirement classes according to:

IEC 61 508/ 61 511



C = Extend of damage
- C1: slight injury of a person
- C2: severe, irreversible injury of one or several persons
- C3: death of several persons
- C4: catastrophic implication with many death persons

F = Duration of stay
- F1: rarely or more often
- F2: frequently up to permanent

P = Hazard prevention
- P1: possible under certain conditions
- P2: rarely possible

W = Probability with which undesirabal incidents happen
- W1: very low
- W2: low
- W3: relatively high

— = No safety requirement

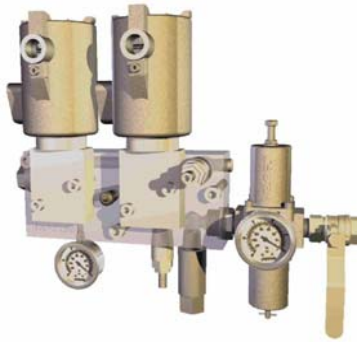
Product Range according IEC 61508 - SIL4

Series 24011 & 24010

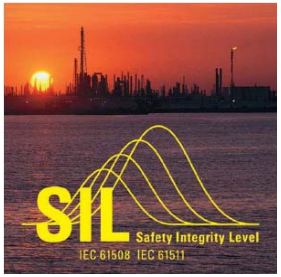
Series 98015 & 98025

Series 97105 Inline

Series 97105 Namur



double channel / increased safety or availability 1oo2 & 2oo2



Triple channel / increased safety & availability 2oo3

NORGREN
Incorporating Maxseal

Maxseal

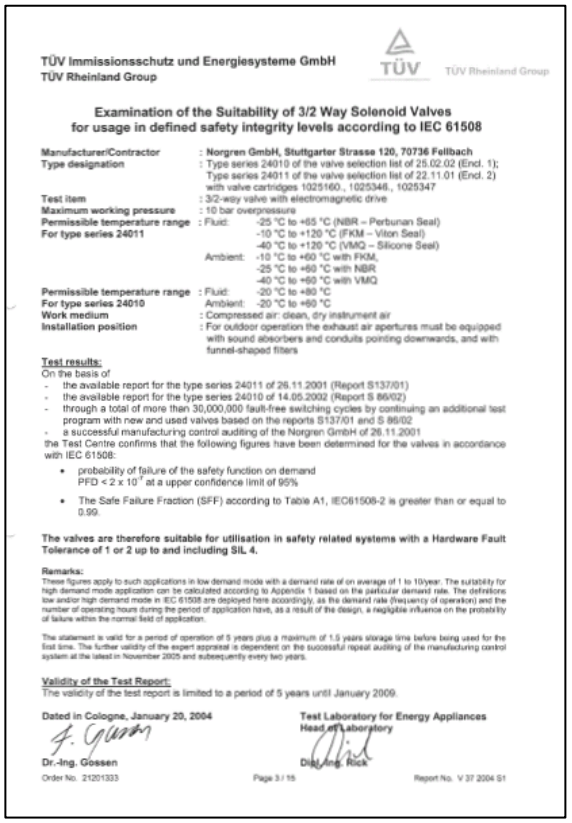
Maxseal SIL Product Overview
ICO series
Solenoid Valves

- Rugged Stainless steel construction
- ¼” to 4” threaded, flanged and Namur connections
- Exd Exia Exmbe Exn – ATEX, CSA, IECEX
- Sil 3 / 4
- Low power coils
- Fit & forget 30 year life

Safety and availability

» Approval for the Product testing of the HERION Solenoid valves

Product safety



TÜV Immissionsschutz und Energiesysteme GmbH
TÜV Rheinland Group

TÜV Rheinland Group

Examination of the Suitability of 3/2 Way Solenoid Valves for usage in defined safety integrity levels according to IEC 61508

Manufacturer/Contractor	: **Norgren GmbH, Stuttgarter Strasse 120, 70736 Fellbach**	
Type designation	: Type series 24010 of the valve selection list of 25.02.02 (Encl. 1); Type series 24011 of the valve selection list of 22.11.01 (Encl. 2) with valve cartridges 1025160., 1025346., 1025347	
Test item	: 3/2-way valve with electromagnetic drive	
Maximum working pressure	: 10 bar overpressure	
Permissible temperature range	: Fluid:	-25 °C to +65 °C (NBR – Perbunan Seal)
For type series 24011		-10 °C to +120 °C (FKM – Viton Seal)
		-40 °C to +120 °C (VMQ – Silicone Seal)
	Ambient:	-10 °C to +60 °C with FKM,
		-25 °C to +60 °C with NBR
		-40 °C to +60 °C with VMQ
Permissible temperature range	: Fluid:	-20 °C to +80 °C
For type series 24010	Ambient:	-20 °C to +60 °C
Work medium	: Compressed air: clean, dry instrument air	
Installation position	: For outdoor operation the exhaust air apertures must be equipped with sound absorbers and conduits pointing downwards, and with funnel-shaped filters	

Test results:
On the basis of
- the available report for the type series 24011 of 26.11.2001 (Report S137/01)
- the available report for the type series 24010 of 14.05.2002 (Report S 86/02)
- through a total of more than 30,000,000 fault-free switching cycles by continuing an additional test program with new and used valves based on the reports S137/01 and S 86/02
- a successful manufacturing control auditing of the Norgren GmbH of 26.11.2001

the Test Centre confirms that the following figures have been determined for the valves in accordance with IEC 61508:

- probability of failure of the safety function on demand PFD < 2 x 10^{-4} at a upper confidence limit of 95%
- The Safe Failure Fraction (SFF) according to Table A1, IEC61508-2 is greater than or equal to 0.99.

The valves are therefore suitable for utilisation in safety related systems with a Hardware Fault Tolerance of 1 or 2 up to and including SIL 4.

Remarks:
These figures apply to such applications in low demand mode with a demand rate of on average of 1 to 10/year. The suitability for high demand mode application can be calculated according to Appendix 1 based on the particular demand rate. The definitions low and/or high demand mode in IEC 61508 are deployed here accordingly, as the demand rate (frequency of operation) and the number of operating hours during the period of application have, as a result of the design, a negligible influence on the probability of failure within the normal field of application.

The statement is valid for a period of operation of 5 years plus a maximum of 1.5 years storage time before being used for the first time. The further validity of the expert appraisal is dependent on the successful repeat auditing of the manufacturing control system at the latest in November 2005 and subsequently every two years.

Validity of the Test Report:
The validity of the test report is limited to a period of 5 years until January 2009.

Dated in Cologne, January 20, 2004

Dr.-Ing. Gossen

Test Laboratory for Energy Appliances
Head of Laboratory

Dipl.-Ing. Rick

Order No. 21201333 Page 3 / 15 Report No. V 37 2004 S1

The excellent test results are recorded on pages 1 through 22 of the TÜV test protocol and its relating annex.

Safety and availability based on „IEC 61 508“

» Approved HERION Solenoid valves, series 24011

Report No. V 37/ 2004 S1

Expert Appraisal
based of: IEC 61 508
3/2 directional solenoid valve, series 24011

Test results:
As a result of the tests and examinations carried out, it is the opinion of the Test Centre that the probability of the failure of the safety functions at an operational requirement (PFD) is determined for the valves as follows:

- **probability of failure of the safety function on demand PFD > 2 x 10^{-7} at a upper confidence limit of 95%**
- **The Safe Failure Fraction (SFF) according to Table A1, IEC61508-2 is greater than or equal to 0.99**

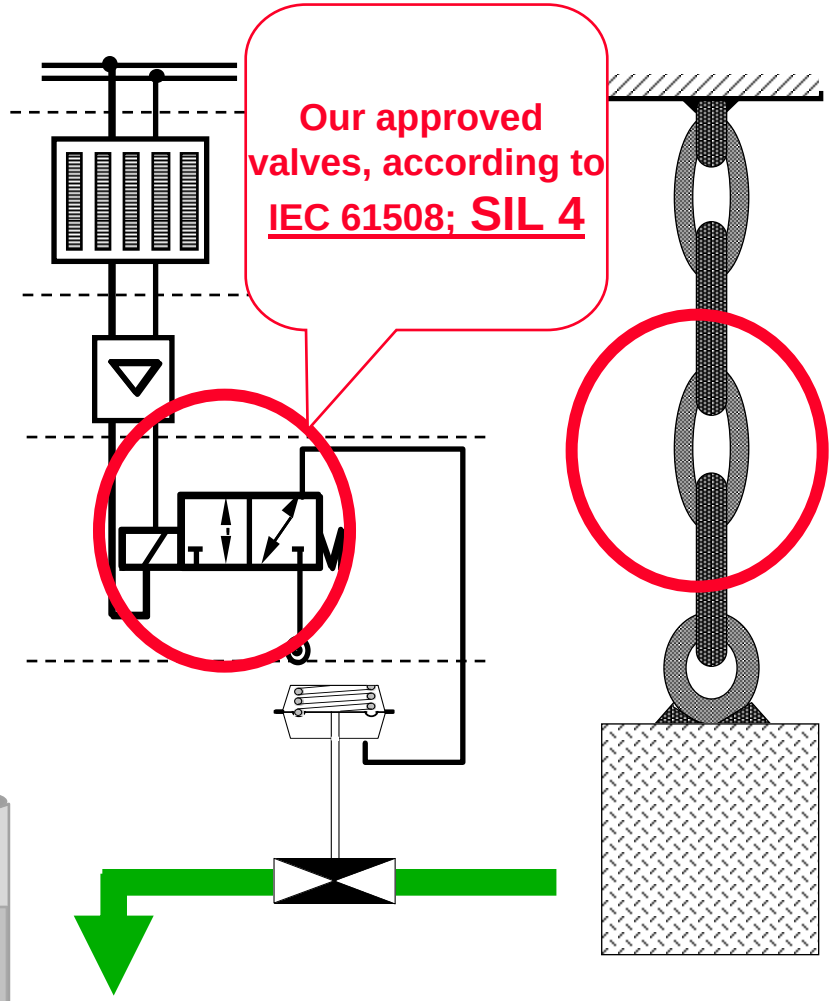
The valves are therefore suitable for utilisation in safety related systems with a Hardware Fault Tolerance of 1 or 2 up to and including SIL 4.

3. ESD Concept & Applications

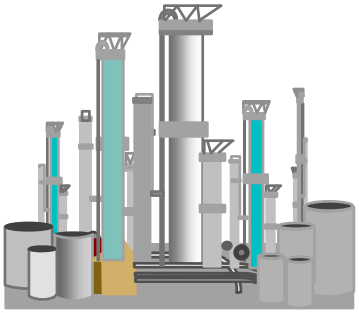
Reliability, safety and availability in process plants

» Application:
Solenoid valves control process valves

- "ESD" Emergency- Shut - Down



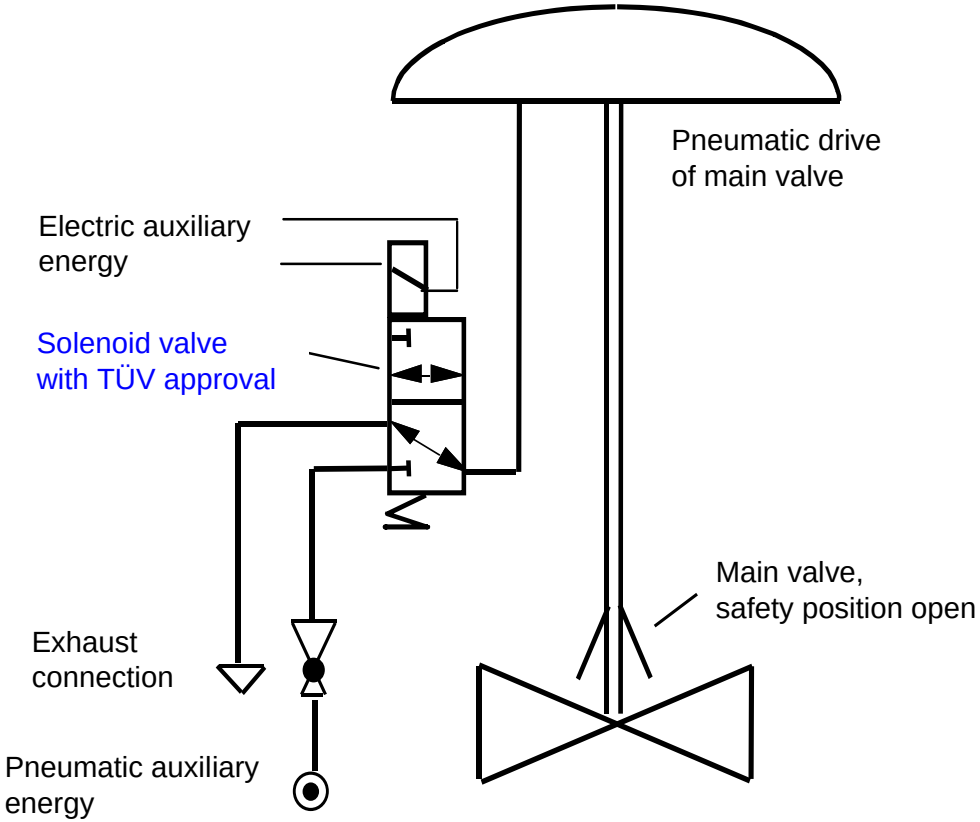
Safety and availability



Plant engineering

- Application
- Main valve in the safety position in case of power failure.

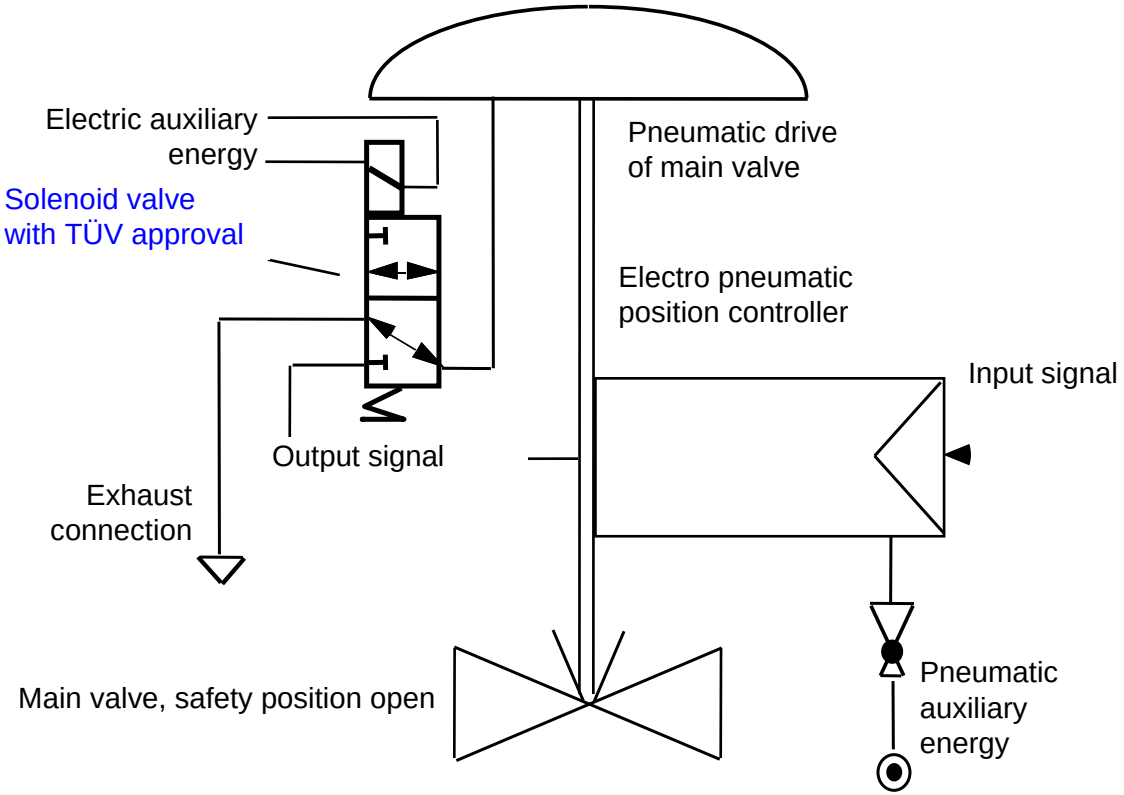
“ESD” Emergency- Shut - Down, closing / opening by spring



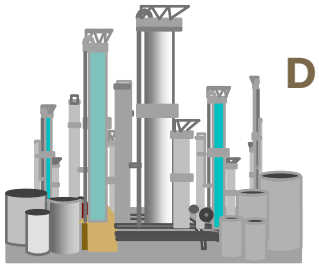
Safety and availability

- Application:
- Main valve in the safety position in case of power failure.

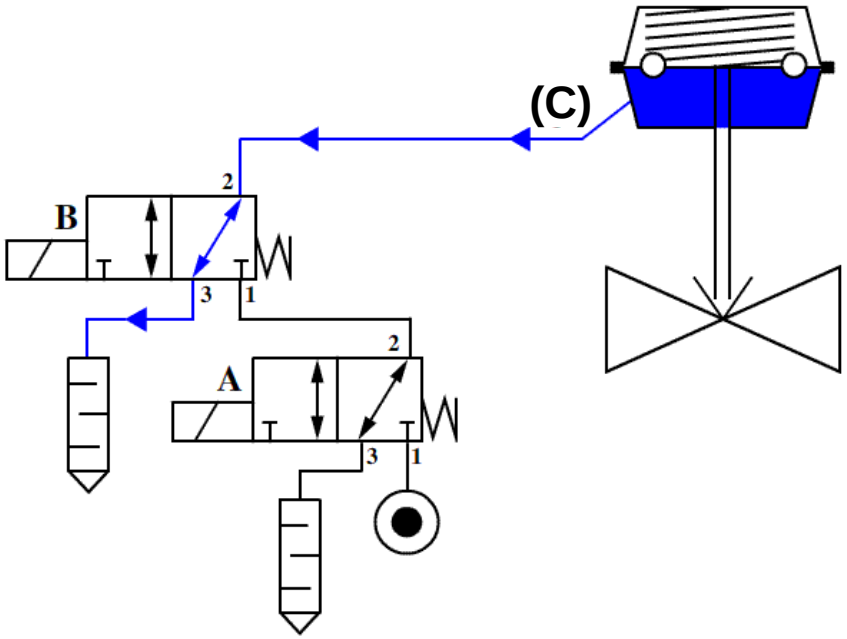
“ESD” Emergency- Shut - Down, closing / opening by spring



Output signal of the positioner travels via the solenoid valve.



Redundant systems „Safety“
Double channel: switching on: series / switching of : parallel



“1oo2“ Safety Logic Analysis

Condition	R1	R2	(C)
	A	B	
All functioning	0	0	0
ONE channel fail its function	1	0	0
	0	1	0

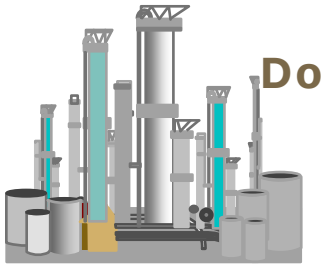
“1oo2“ Availability Logic Analysis

Condition	R1	R2	(C)
	A	B	
All functioning	1	1	1
ONE channel fail its function	1	0	0
	0	1	0

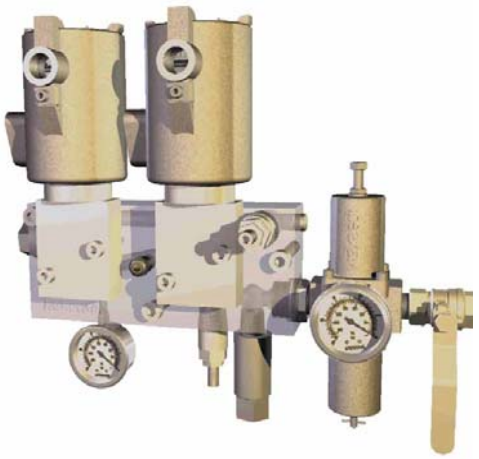
Activated Without Error

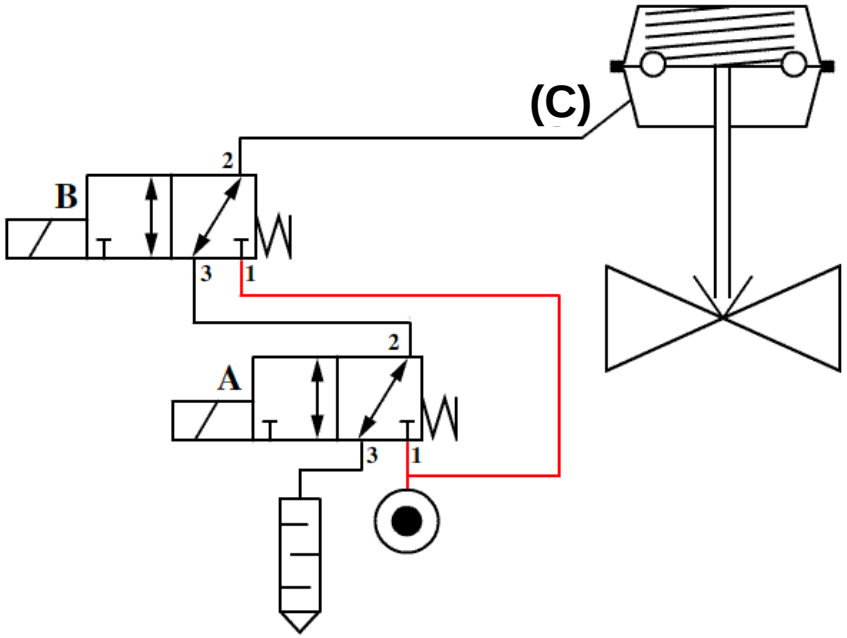
Error Valve A

Error Valve B



Redundant systems „Availability“
Double channel: switching on: parallel / switching of : series





Activated Without Error

Error Valve A

Error Valve B

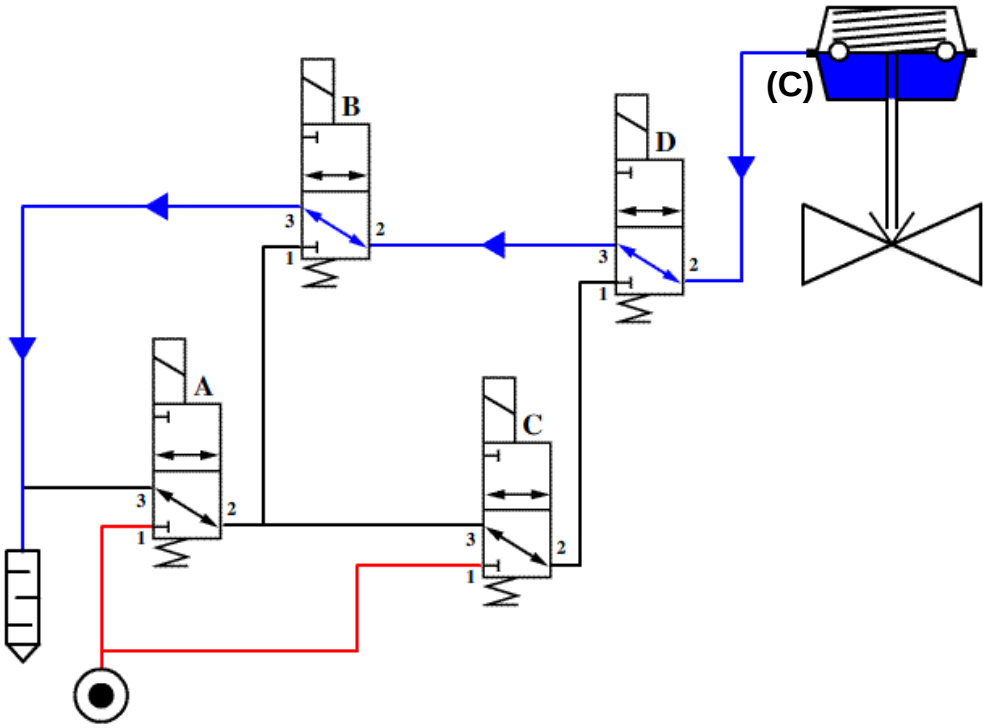
“2oo2“ Safety Logic Analysis

Condition	R1	R2	(C)
	A	B	
All functioning	0	0	0
ONE channel fail its function	1	0	1
	0	1	1

“2oo2“ Availability Logic Analysis

Condition	R1	R2	(C)
	A	B	
All functioning	1	1	1
ONE channel fail its function	1	0	1
	0	1	1

Redundant systems „Safety and Availability“ design 2 out of 3



Safety Logic Analysis

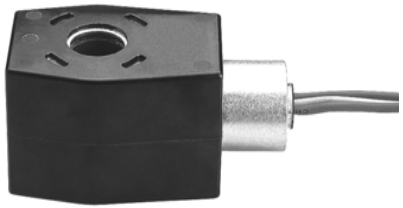
Condition	R1	R2		R3	C
	V_1	V_3	V_2	V_4	
All functioning	0	0	0	0	0
ONE channel fail its function	1	0	0	0	0
	0	1	1	0	0
	0	0	0	1	0
TWO channels fail its function	1	0	0	1	1
	1	1	1	0	1
	0	1	1	1	1

Availability Logic Analysis

Condition	R1	R2		R3	C
	V_1	V_3	V_2	V_4	
All functioning	1	1	1	1	1
ONE channel fail its function	0	1	1	1	1
	1	0	0	1	1
	1	1	1	0	1
TWO channels fail its function	0	1	1	0	0
	0	0	0	1	0
	1	0	0	0	0

Acti-vated Without Error					
	Availability	Error A	Error B	Error C	Error D
	Safety	Error A	Error B	Error C	Error D

Product Range for ESD Application



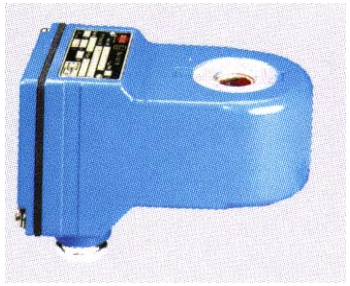
NEMA
4,4X,7,9

NAMUR Interface

EEx me

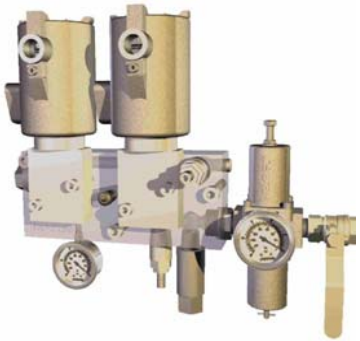
IP 67

Inline ported body



EEx ia

IP 65



SS ported body

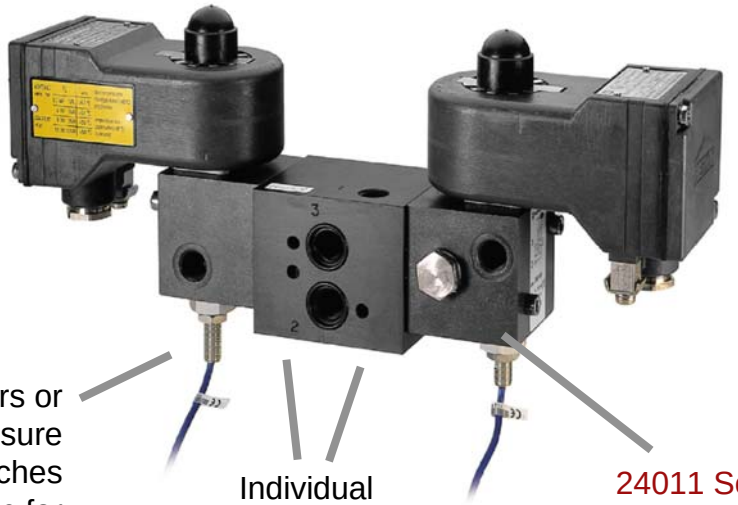
EEx me/md

Product Range for ESD Application

Namur SOV Redundancy Solutions

Double Redundancy
(i) 1oo2 increased Safety, or
(ii) 2oo2 increased Availability

Triple Redundancy
(iii) 2oo3 increased Safety
and increased Availability



Sensors or pressure switches option for **diagnostics coverage**

Individual Isolation Valve option for **online maintenance**

24011 Series NAMUR Interface Solenoid Valve **(SIL 4 option)**

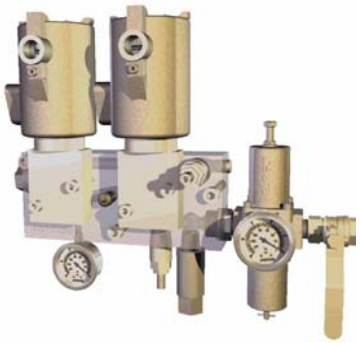
Individual Isolation or Bypass Valve option for **online maintenance**

Sensors or pressure switches option for **diagnostics coverage**

New Product Range according IEC 61508 - SIL4

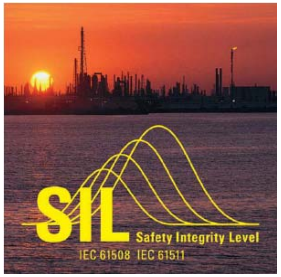
Low Flow Rate
Version Series 24011

High Flow Rate
Version Series 98015



double channel / increased safety or availability 1oo2 & 2oo2

Triple channel / increased safety & availability 2oo3

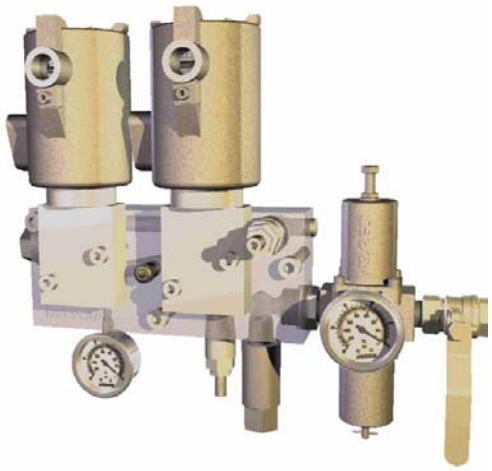


V81 Advantage --- Aluminum version

Mainly for Chemical & petrochemical process

- Aluminium, brass or stainless steel construction
- IEC 61508 SIL 3 & 4 based on field reliability data
- DIN EN 161/3394 DVGW Type examination; Automatic shut off / control Valves
- Compact modular manifold design
- Reduced potential leak paths
- Modular construction enabling standard and customisable circuits
- Bypass function for online valve replacement
- 1oo2, 2oo2 and 2oo3 options providing "safety", "availability" or "safety & availability" functionality
- Standard and high flow options
- Inductive proximity sensing of valve spool position
- 24011xx -40 to +80°C
- 98000xx -25 to +60°C

V81 Advantage --- Stainless Steel Version



Mainly for Oil & Gas

- 316 Stainless steel construction
- IEC 61508 SIL 3 & 4 based on field reliability data
- 3 point mounting system
- Integrated downstream filter to protect against particle ingress
- Reduced potential leak paths
- Modular construction enabling standard and customisable circuits
- Bypass function for online valve replacement
- 1oo1, 1oo2, 2oo2 and 2oo3 options providing "safety", "availability" or "safety & availability" functionality
- 5kg return spring ensures safe, reliable closing of valve
- -50 to +90ºC
- Flow controls to individually meter in and out

V81 Advantage --- Flexibility

2oo2

2oo2

2oo3

By Pass Advantage：

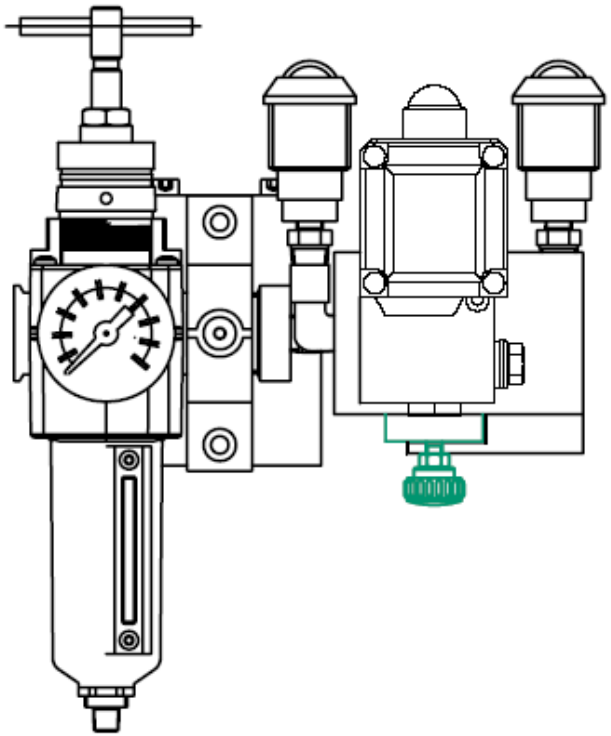
>> 97105 Namur interface: flow >1000 L/m; SIL 4;

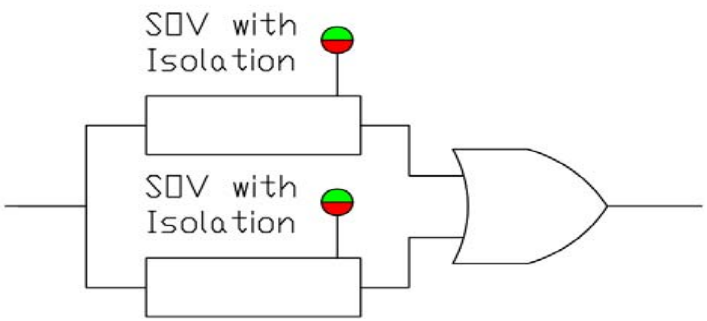
>> Easy to operate;

>> POKA-YOKE

Add-on Bypass Kit

Solutions





Customized Dual Redundancy 2oo2 with:

- **Individual isolation valve**
- **Visual SOV pressure indicators**
- **Automatic drain Filter Regulator**

Other Optional:

- **Diagnostic SOV sensors / pressure switches**
- **Bypass valve**
- **SIL 4 SOVs**

NORGREN
Your partner in Fluid Control Solutions

Real Advantage . . .

RELIABILITY ADVANTAGE

AVAILABILITY ADVANTAGE

MAINTAINABILITY ADVANTAGE

+

SAFETY ADVANTAGE


The End
Thank you for your attention