Wouter Witzel EuroValve B.V.
Industrieterrein De Pol 12
7581 CZ Losser
The Netherlands

P.O. Box 54
7580 AB Losser
The Netherlands

Tel. +31 (0) 53 53 69 536
Fax +31 (0) 53 53 69 500
E-mail info@wweurovalve.nl
www.wweurovalve.nl

MTBF and SIL classification

MTBF: Mean Time Between Failure
SIL: Safety Integrity Level

Wouter Witzel Eurovalve Butterfly valves

PRODUCTS:
Rubber lined butterfly valves: type EVS, EVBS, EVBLS, EVCS, EVMS, EVML, EVTLS, EVFS, EVFL, EVUS

WWE TYPE	TYPE DESCRIPTION	TYPE	AVAILABLE DN RANGE
EVS	EuroValve Short	WAFER TYPE; series 20	DN50 - DN1200
EVBLS	EuroValve Bolt Longneck Short	SEMI LUG TYPE; series 20	DN50-DN200
EVBS	EuroValve Bolt Short	SEMI LUG TYPE; series 20	DN50 - DN300
EVTLS	EuroValve Tap Lug Short	FULL LUG TYPE; series 20	DN50 - DN1200
EVMS	EuroValve Mono Short	MONO FLANGE; series 20	DN350 - DN1000
EVML	EuroValve Mono Long	MONO FLANGE; series 16	DN80 - DN600
EVUS	EuroValve U-section Short	FLANGED TYPE; series 20	DN600 - DN2200
EVFS	EuroValve Flanged Short	FLANGED TYPE; series 13	DN50 - DN2000
EVFL	EuroValve Flanged Long	FLANGED TYPE; series 14	DN50 - DN1500

OBJECTIVE:
The objective is to determine the MTBF (Mean Time Between Failure).
To establish SIL classification for the Butterfly Valve Range as listed above, based on sales and customer complaints which occurred in 2011 and 2012.

DEFINITION OF THE PRODUCT SCOPE:
The Butterfly Valve range as listed above are 90° (quarter) turn butterfly valves with a vulcanized elastomer seat. The valves are considered as bare shaft and identified as mechanical units that don't include any electronic components. The valve function is determined as fully watertight in both directions of flow.

Wouter Witzel EuroValve B.V.
Industrieterrein De Pol 12
7581 CZ Losser
The Netherlands

P.O. Box 54
7580 AB Losser
The Netherlands

Tel. +31 (0) 53 53 69 536
Fax +31 (0) 53 53 69 500
E-mail info@wweurovalve.nl
www.wweurovalve.nl

THE MTBF:

The MTBF (Mean Time Between Failure) is a statistic parameter which is used to calculate the reliability of a piece of equipment, showing the average time between two failures. This indicator helps to plan preventive maintenance by anticipating breakdowns statistically.

Principle:

The MTBF is the relationship between the cumulative operating time and the number of failures.

$$\text{MTBF} = \frac{\text{Cumulative operating time}}{\text{Number of failures}}$$

In our anticipated case, the cumulative operating time is equal to the number of valves sold multiplied by the average number of hours that the valve is used.

$$\Rightarrow \text{MTBF} = \frac{\text{Number of valves sold x Hours of use}}{\text{Number of failures}}$$

The MTBF is defined in years.
Failure rate: $\lambda = 1/\text{MTBF}$

MTBF DETERMINATION:

Hypothesis:

The primary function of an industrial valve is to allow and prevent, on demand, fluid passing through a pipe. This function is carried out by fully opening or closing the valve.

The two main failures which could prevent this function in the best conditions are;

- A failure of water tightness of the valve. This is characterized by an internal or external leak of the valve. This water tightness (internal or external) is a valve function that must be continually satisfied.
- An operating failure of the valve, preventing its complete opening or closing during operation. This function is satisfied when the valve is operated.

The calculation of the number of failures recorded in 2008 and 2007 is based on the particular complaints made by our customers. This record of complaints is constantly monitored as a part of our commitment to quality, in accordance with ISO 9001: 2000.

Note: No distinctions were made in valve material trims or applications where the valve was functioning.

Wouter Witzel EuroValve B.V.
Industrieterrein De Pol 12
7581 CZ Losser
The Netherlands

P.O. Box 54
7580 AB Losser
The Netherlands

Tel. +31 (0) 53 53 69 536
Fax +31 (0) 53 53 69 500
E-mail info@wweurovalve.nl
www.wweurovalve.nl

<u>MTBF calculation for a failure water tightness of the valve</u>
To make this calculation, we assume that a valve works continually for its water tightness function, which represents 8760 hours in one year and consequently 17520 for the corresponding period.

Furthermore, we anticipated that 85% of the valves sold are actually installed.

$$MTBF_{\text{Water tightness}} = \frac{\text{Number of valves sold x 0.85 x Hours of use}}{\text{Number of failures}}$$

➔ $MTBF_{\text{Water tightness}}$ = 32121828 hours = 3667 years

➔ Hourly failure rate λ = 1/MTBF = 3.1^{E} -08 this makes it **<u>compatible with SIL level 3</u>**

<u>MTBF calculation for an operating failure of the valve</u>
To make this calculation, we assume that a valve executes 20.000 cycles per year, the average time of a cycle (open & close) takes 5 seconds. This results in a constantly duration of use (moving) of 27.7 hours per year, and consequently 55.5 hours for the corresponding period.

Furthermore, we anticipated that 85% of the valves sold are actually installed.

$$MTBF_{\text{Operation}} = \frac{\text{Number of valves sold x 0.85 x Hours of use}}{\text{Number of failures}}$$

➔ $MTBF_{\text{Operation}}$ = 82684 hours = 9.4 years

➔ Hourly failure rate λ = 1/MTBF = 1.2^{E} -05

In this situation, the PDF "Probability of Failure on Demand" is calculated as follows;
The hourly failure rate "valve operation" is 1.2^{E} -05

➔ PFD = 1.2^{E} -05 x ½ x 55.5 = 3.4^{E} -04 this makes it **compatible with SIL level 3**

Safety Integrity Level	**Security Level Function failure annual probability**	
	Continual operation	**Operation on demand**
	Hourly failure rate	**Failure probability at moment of use**
SIL 4	$10^{-9} < \lambda < 10^{-8}$	$10^{-5} < PFD_{avg} < 10^{-4}$
SIL 3	$10^{-8} < \lambda < 10^{-7}$	$10^{-4} < PFD_{avg} < 10^{-3}$
SIL 2	$10^{-7} < \lambda < 10^{-6}$	$10^{-3} < PFD_{avg} < 10^{-2}$
SIL 1	$10^{-6} < \lambda < 10^{-5}$	$10^{-2} < PFD_{avg} < 10^{-1}$