SIS Practices for Late Life Cycle Phases
Demonstrating Prior Use

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Abstract

Prior Use of a component within a Safety Instrumented System (SIS) can be claimed by the end user, provided certain requirements are fulfilled.

This paper will review a methodology to demonstrate prior use of a component for:
- inclusion into a new Safety Instrumented System based on prior use;
- the collection and analysis of reliability data from the field, in order to confirm the claimed reliability of a component within a SIS.

Although demonstrating prior use requires such information as Manufacturers Quality and Management, identification and specification of components, demonstration of performance and reliability, together with other general aspects for inclusion in a Safety Instrumented System such as Hardware Fault Tolerance (HFT). This paper will focus on the collection of reliability data from the field and apportioning the safe/dangerous split rather than the 'front end' design considerations. It will, however, provide an overview for selection of components.

Introduction

BS EN 61511:1 – Clause 3.2.60 Defines Prior Use as:

"When a documented assessment has shown that there is appropriate evidence, based on the previous use of the component, that the component is suitable for use in a Safety Instrumented System"

The above abstract presents us in many cases, with a "chicken and egg" situation. To be able to use a component utilising a Prior Use claim we must have reliability data, which is also an essential tool in the later stages of the BS EN 61511 lifecycle in justifying the claimed reliability of a component.

BS EN 61508 utilises the terminology Proven in Use, whereas BS EN 61511 Prior Use is as defined above. During this paper the term Prior Use is used to reflect inclusion of a non-certified component into a Safety Instrumented System and the term Proven in Use as a general term in gathering data for both certified and non-certified components to assess reliability.

Figure 1 demonstrates how the use of Prior Use (Proven in Use) assessments interact.

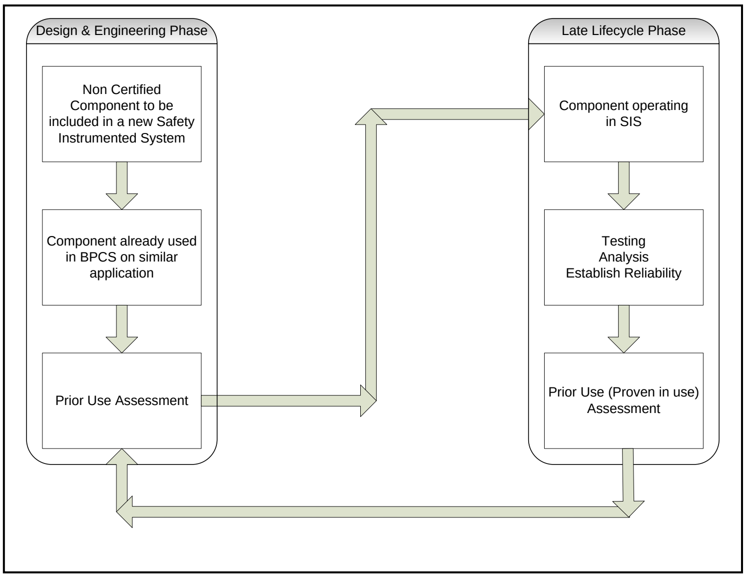


Figure 1 – Reliability Assessments for Prior Use – Lifecycle Phases

Following on from the BS EN 61511 lifecycle phases:

1 - Hazard Risk Assessment
2 - Allocation of Safety Functions
3 - Safety Requirement Specification leads to:

4 - Design & Engineering Phase

It is during this phase where the SIS components are selected.

Figure 2 shows the structure of a Safety Instrumented Function (SIF) comprising of components and elements (sub-systems).

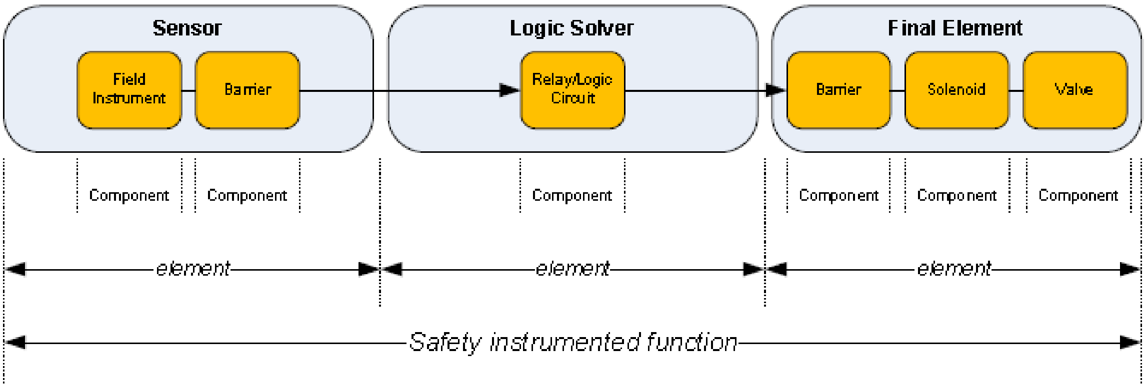


Figure 2 – Safety Instrument Function Structure

The selection process of the components within the SIF requires consideration to be given to the operating conditions and physical environment that the component will be subjected to, the Safety Integrity Level and any necessary redundancy to satisfy the fault tolerance requirements. For the purposes of this paper we will assume that a 1oo1 (one out of one) architecture, as shown in Figure 2, is to be utilised and is expected to achieve the required Safety Integrity Level (SIL).
The next step in the design process is to select and justify the components. Two alternative methods for safety integrity evaluation can be used:

1. BS EN 61508 Certification
2. Prior Use justification

1. BS EN 61508 Certification

The number of manufacturers subjecting their instrumentation to external certification has been increasing over the last few years. Organisations such as exida and TÜV perform reliability assessments and assign a Safety Integrity Level and Probability of Failure on Demand (PFD) figures. These assessments are conducted utilising reliability tools and are often based upon a technique know as Failure Modes, Effects and Diagnostics Analysis (FMEDA). From the FMEDA, failure rates are determined and consequently the Safe Failure Fraction (SFF) is calculated for the component.

The failure data from the analysis is normally presented as follows:

Units - Failures In Time (FIT) is the number of failures that can be expected in $1\text{x}10^{-9}$ (E-09) failures per hour.

Types of failure:

> Safe Failure, a failure that when occurs causes the system to perform the function which puts the system into the safe state, this is performed without a demand from the process and is often referred to as a nuisance trip. Safe failures can either be safe detected (SD) or safe undetected (SU).

Dangerous Failure, are classified as dangerous detected (DD) which is a failure that is dangerous but is detected by the component or system. Dangerous undetected (DU) is a failure when the component fails to operate when the process puts a demand onto it, thus being totally ineffective.

Dangerous undetected failures can only be detected on an actual process demand or by proof testing. Providing the proof testing is designed to detect it.

The above failure modes are presented in reliability data as shown below:

λ_{SU}, λ_{SD}, λ_{DU}, λ_{DD} together with a corresponding number for the failures in FIT's.

Utilising reliability data as above allows calculation of the Probability of Failing on Demand (PFD) and the Safe Fail Fraction (SFF).

1oo1 PFD_G – Average Probability of Failure on Demand

$$\text{PFD}_{\text{avg}} = [(\lambda_{DU}) + (\lambda_{DD})]\, t_{ce}$$

t_{ce} – Channel equivalent mean down time (hour)
(this is the combined down time for all the components in the channel of the sub-system).

$$t_{ce} = \frac{\lambda_{DU}}{\lambda_D} \text{ x } \left(\frac{T_1}{2} + \text{ MTTR}\right) + \left(\frac{\lambda_{DD}}{\lambda_D} \text{ x } \text{MTTR}\right)$$

T_1 = Proof test interval (hours)
MTTR = Mean Time to Restore (hours)

$$\text{Safe Fail Fraction} = \frac{\lambda_{SD} + \lambda_{SU} + \lambda_{DD}}{\lambda_{SD} + \lambda_{SU} + \lambda_{DD} + \lambda_{DU}}$$

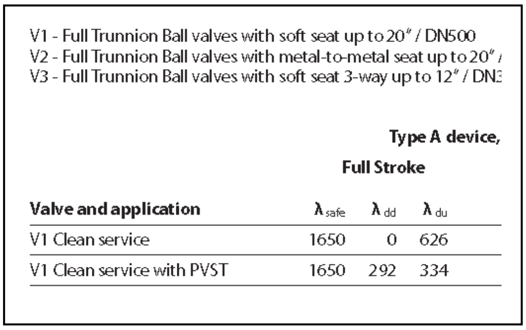
Example

The following failure data is available for a ball valve, certified by exida to BS EN 61508, with partial stroke testing, the valve is to be proof tested annually and has a mean time to restore of 16 hours:

T_1 = Proof Test Interval (8760 hours)
MTTR = Mean Time To Restore (16 hours)

λ_{SU} = 1650 FITS ($1.65 \text{ x} 10^{-6}$ per hour)
λ_{DD} = 292 FITS ($2.92 \text{ x} 10^{-7}$ per hour)
λ_{DU} = 334 FITS ($3.34 \text{ x} 10^{-7}$ per hour)

λ_D = 334 +292 FITS ($6.26 \text{ x} 10^{-7}$ per hour)



V1 - Full Trunnion Ball valves with soft seat up to 20″ / DN500
V2 - Full Trunnion Ball valves with metal-to-metal seat up to 20″
V3 - Full Trunnion Ball valves with soft seat 3-way up to 12″ / DN

	Type A device,		
	Full Stroke		
Valve and application	**λ_{safe}**	**λ_{dd}**	**λ_{du}**
V1 Clean service	1650	0	626
V1 Clean service with PVST	1650	292	334

Figure 3 – Valve Reliability Data

$$\mathbf{t_{ce}} = \frac{\lambda_{DU}}{\lambda_D} \textbf{ x } \left(\frac{T_1}{2} + \textbf{ MTTR}\right) + \left(\frac{\lambda_{DD}}{\lambda_D} \textbf{ x } \textbf{MTTR}\right)$$

$$t_{ce} = \frac{3.34 \text{ x } 10^{-7} \text{ per hour}}{6.26 \text{ x } 10^{-7} \text{ per hour}} \text{ x } \left(\frac{8760 \text{ hours}}{2} + \text{ 16 hours}\right) + \left(\frac{2.92 \text{ x } 10^{-7} \text{ per hour}}{6.26 \text{ x } 10^{-7} \text{ per hour}} \text{ x } \text{16 hours}\right)$$

$$t_{ce} = (0.5335 \text{ x } 4396) + (\, 0.4665 \text{ x } 16 \text{ hours})$$

$$t_{ce} = (2345) + (\, 7.5 \text{ hours})$$

$$t_{ce} = 2352 \text{ hours}$$

$$\mathbf{PFD_{avg}} = [(\boldsymbol{\lambda}_{\mathbf{DU}}) + (\boldsymbol{\lambda}_{\mathbf{DD}})]\, \mathbf{t_{ce}}$$

$$\mathrm{PFD_{avg}} = [2.92 \text{ x } 10^{-7}\text{per hour} + 3.34 \text{ x } 10^{-7}\text{per hour}\,] \text{ x } 2352 \text{ hours}$$

$$\mathrm{PFD_{avg}} = 1.47 \text{ x } 10^{-3}$$

$$\textbf{Safe Fail Fraction} = \frac{\boldsymbol{\lambda}_{\mathbf{SD}} + \boldsymbol{\lambda}_{\mathbf{SU}} + \boldsymbol{\lambda}_{\mathbf{DD}}}{\boldsymbol{\lambda}_{\mathbf{SD}} + \boldsymbol{\lambda}_{\mathbf{SU}} + \boldsymbol{\lambda}_{\mathbf{DD}} + \boldsymbol{\lambda}_{\mathbf{DU}}}$$

$$\text{Safe Fail Fraction} = \frac{0 + 1650 + 292}{0 + 1650 + 292 + 334}$$

$$\text{Safe Fail Fraction} = \frac{1942}{2276}$$

$$\text{Safe Fail Fraction} = 0.85$$

As stated previously certification to BS EN 61508 utilises failure data reliability tools. What it does not consider is the operating environment, so it essential to gather data in the field for the component once it is in service performing its specified duty.
Hence, even components that have BS EN 61508 should still be monitored in the field and failure data collected and analysed to establish proven in use.

2. Prior Use Justification

It is quite common that components successfully and reliably used for process control will be required to be utilised in Safety Instrumented Systems. The advantage of utilising these components is that they may have shown, in a similar process application and field environment, there suitability.

BS EN 61511 Clause 11.5.3 states that “Appropriate evidence shall be available that the components and subsystems are suitable for use in the safety instrumented system.” It further explains that - “The evidence of suitability shall include the following

- consideration of the manufacturer’s quality, management and configuration management systems;
- adequate identification and specification of the components and subsystems;
- demonstration of the performance of the components or subsystems in similar operating profiles and physical environments;
- the volume of the operating experience.”

What the standard does not provide us with is the extent and detail of the evidence, other than to state that it “.....should be in accordance with the complexity of the considered component or subsystem and with the probability of failure necessary to achieve the required safety integrity level......”

Demonstrating Prior Use

As stated previously, this paper will not attempt to deal with a detailed methodology for assessing manufacturer’s quality and competence. If performing a Prior Use justification as part of the design process of the SIS, it is anticipated that a design dossier would be set up to provide, in essence, a safety manual for the component to be utilised in line with that supplied for a certified component, with specific emphasis on:

- adequate identification and specification of the components and subsystems;
- demonstration of the performance of the components or subsystems in similar operating profiles and physical environments:

Reliability

There are many formulae available for the calculations of reliability data, but all require good data sources in order to provide realistic results. Probably the simplest are calculations using Mean Time between Failure (MTBF). BS EN ISO 14224 Annex C details these and other calculations. The calculations utilised in this paper are those referenced in BS EN 61508-6:2010 Annex B3.2 Average probability of failure on demand (for low demand mode of operation.)

In order to concentrate on late cycles of the SIS and to try and provide reliability data for critical instrumentation the methodology discussed here will utilise data collection based upon Figure 4.

Failures				
Random hardware failures				Systematic failures
Dangerous		Safe		
Detected (DD)	Undetected (DU)	Detected (SD)	Undetected (SU)	

Figure 4 – Required Data to be Analysed

BS EN 61511 requires that in addition to reliability considerations the systematic failures of the component be evaluated.

“A major distinguishing feature between random hardware failures and systematic failures, is that system failure rates (or other appropriate measures), arising from random hardware failures, can be predicted with reasonable accuracy but systematic failures, by their very nature, cannot be accurately predicted.”

“That is, system failure rates arising from random hardware failures can be quantified with reasonable accuracy but those arising from systematic failures cannot be accurately statistically quantified because the events leading to them cannot easily be predicted.”

Some examples of causes of systematic failures include human error in

- the safety requirements specification;
- the design, manufacture, installation, operation of the hardware;
- the design, implementation of the software.

It is also important not to confuse component usable life with the components reliability. Component reliability figures become more accurate the greater the volume of components and data within the analysis, whereas usable life is referred to the actual component. Failures of the component are often more prominent at the early and late stages of the components life. This is often referred to as the bath tub curve. See Figure 5.

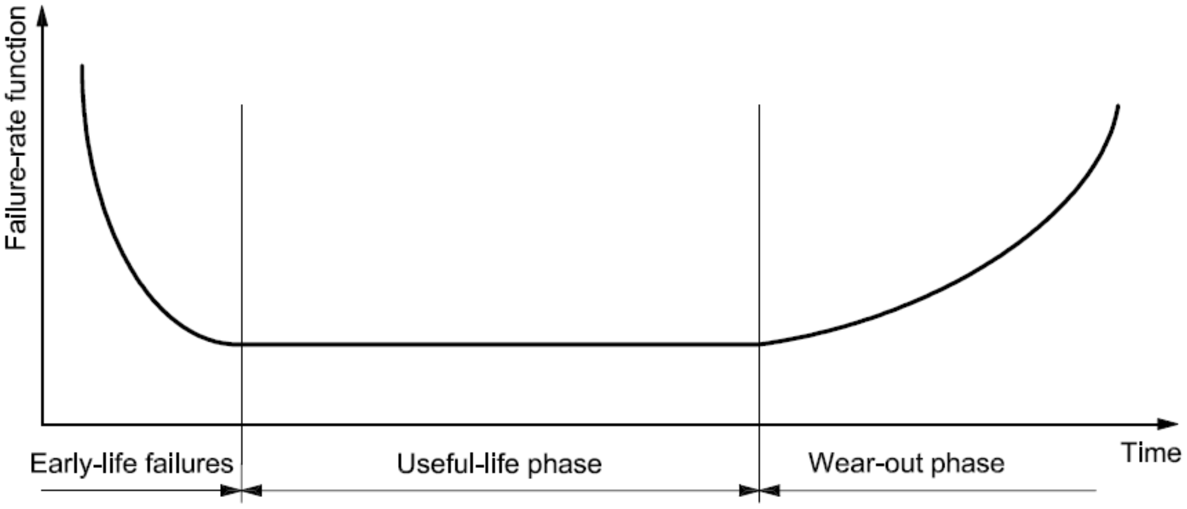


Figure 5 – Bath Tub Curve

Data Collection

The companies and processes which utilise Safety Instrumented Systems vary both in size and complexity. Some locations will be small and data gathering will be manual and probably paper based, larger and multi-national establishments are almost certainly going to employ Computerised Maintenance Systems (CMS) with the facility to share data between many establishments.

What is essential in providing successful data collection is that all events relevant to the SIS are recorded and analysed. This not only includes failure data, but also proof testing, activations (both genuine and spurious), maintenance activities, anything which occurs with the system and component.

In order to perform reliability calculations it is necessary to build up a history of how long each component has been in service, its operating hours, how often it has been activated, tested, maintained together with a description and record of any failures.

BS EN ISO 14224 details a taxonomy[1] for data collection, large organisations will probably have their own structures. Various organisations are trying to bring together companies to provide failure data in order to provide a larger body of data. The Center for Chemical Process Safety (CCPS) have developed a system which end users can subscribe to by providing their date to be included in an international database:

"The CCPS Process Equipment Reliability Database (PERD) is a source of industry-reported equipment reliability data. The purpose of the PERD database is to provide high quality, valid, and useful data pertaining to the hydrocarbon and chemical process industries. This data can support equipment availability analysis, reliability and design improvements, maintenance strategies, quantitative risk analysis, and life cycle cost determinations."

It is important to ensure a structured data collection database is defined, and should provide for the following[2]:

a) Equipment Unit Data

   i. Classification data, e.g. Industry, plant, location, system;
   ii. equipment attributes, e.g. manufacturer's data, design characteristics;
   iii. operation data, e.g. operating mode, operating power, environment.

b) Failure Data

   i. Identification data, e.g. failure record number and related equipment that has failed;
   ii. failure data for characterising a failure, e.g. failure data, items failed, failure impact, failure mode, failure cause, failure detection method.

c) Maintenance Data

   i. Identification data, e.g. maintenance record number, related failure and/or equipment record;
   ii. maintenance data, parameters characterising a maintenance action, e.g. date of maintenance, maintenance category, maintenance activity, impact of maintenance, items maintained;
   iii. maintenance resources ....
   iv. maintenance times, ... down time etc.

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[1] A systematic classification of items into generic groups based on factors possibly common to several of the items.

[2] Taken from Clause 9 of BS EN ISO 14224

Failure Data Example

The following example could be a typical failure data analysis for a component utilised in either or both Basic Process Control System (BPCS) and a Safety Instrumented System. It is obviously essential that the taxonomy of the system provides the correct boundary and sub-units. See Figures 6 & 7.

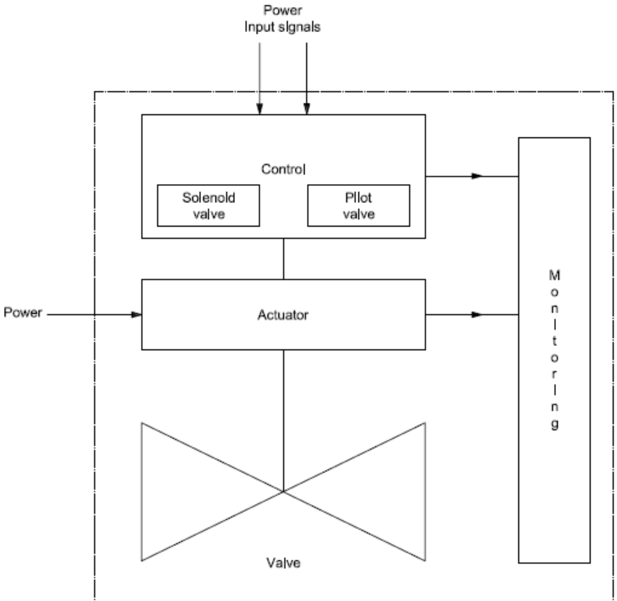


Figure 6 – Boundary Definition – Valves (BS EN ISO 14224)

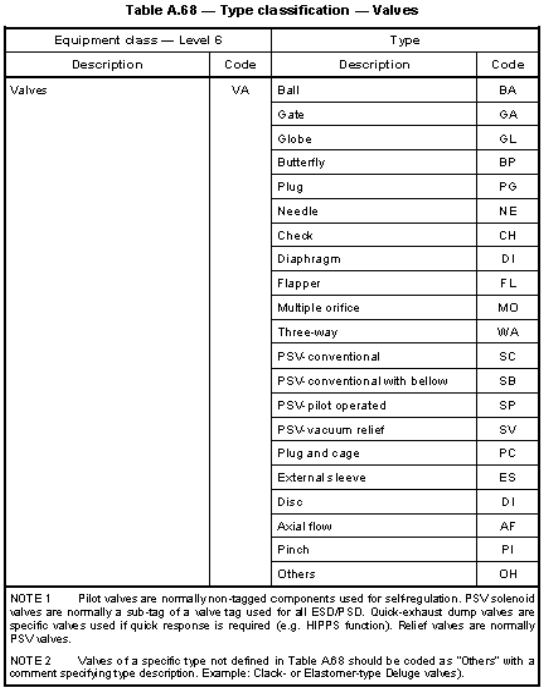


Table A.68 — Type classification — Valves

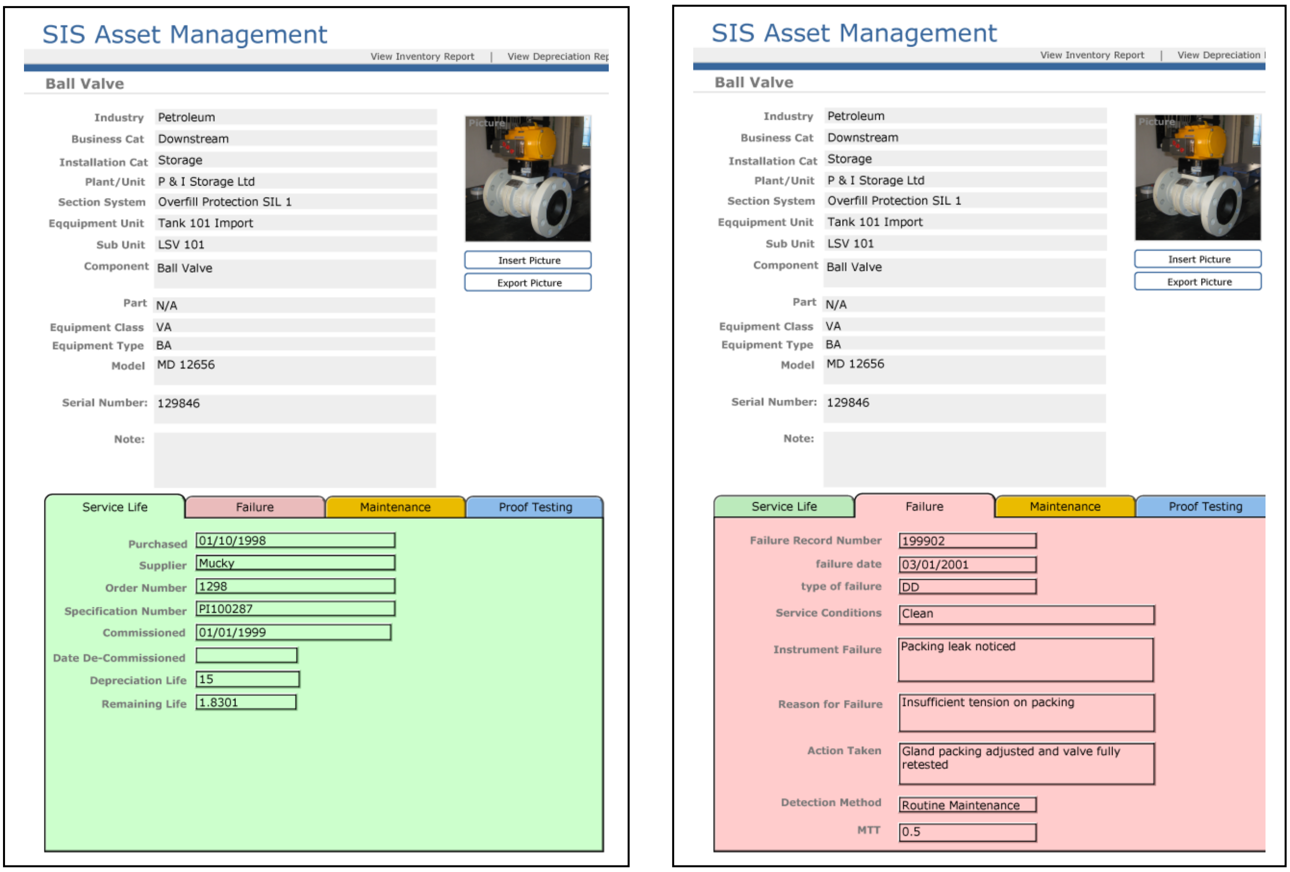
Equipment class — Level 6		Type	
Description	Code	Description	Code
Valves	VA	Ball	BA
		Gate	GA
		Globe	GL
		Butterfly	BP
		Plug	PG
		Needle	NE
		Check	CH
		Diaphragm	DI
		Flapper	FL
		Multiple orifice	MO
		Three-way	WA
		PSV-conventional	SC
		PSV-conventional with bellow	SB
		PSV-pilot operated	SP
		PSV-vacuum relief	SV
		Plug and cage	PC
		External sleeve	ES
		Disc	DI
		Axial flow	AF
		Pinch	PI
		Others	OH

NOTE 1 Pilot valves are normally non-tagged components used for self-regulation. PSV solenoid valves are normally a sub-tag of a valve tag used for all ESD/PSD. Quick-exhaust dump valves are specific valves used if quick response is required (e.g. HIPPS function). Relief valves are normally PSV valves.

NOTE 2 Valves of a specific type not defined in Table A.68 should be coded as "Others" with a comment specifying type description. Example: Clack- or Elastomer-type Deluge valves).

Figure 7 – Type Classification – Valves (BS EN ISO 14224)

Each component should have a record containing details of its history; this should include all aspects of failures, maintenance and proof testing throughout the components life.



Ball Valve

Industry	Petroleum
Business Cat	Downstream
Installation Cat	Storage
Plant/Unit	P & I Storage Ltd
Section System	Overfill Protection SIL 1
Eqquipment Unit	Tank 101 Import
Sub Unit	LSV 101
Component	Ball Valve
Part	N/A
Equipment Class	VA
Equipment Type	BA
Model	MD 12656
Serial Number:	129846
Note:	

Purchased	01/10/1998
Supplier	Mucky
Order Number	1298
Specification Number	PI100287
Commissioned	01/01/1999
Date De-Commissioned	
Depreciation Life	15
Remaining Life	1.8301

Ball Valve

Industry	Petroleum
Business Cat	Downstream
Installation Cat	Storage
Plant/Unit	P & I Storage Ltd
Section System	Overfill Protection SIL 1
Eqquipment Unit	Tank 101 Import
Sub Unit	LSV 101
Component	Ball Valve
Part	N/A
Equipment Class	VA
Equipment Type	BA
Model	MD 12656
Serial Number:	129846
Note:	

Failure Record Number	199902
failure date	03/01/2001
type of failure	DD
Service Conditions	Clean
Instrument Failure	Packing leak noticed
Reason for Failure	Insufficient tension on packing
Action Taken	Gland packing adjusted and valve fully retested
Detection Method	Routine Maintenance
MTT	0.5

Figure 8 – Typical Component Recording System

Basis of Analysis - Example[3]

A ball valve manufactured by the Mucky Valve Company, Model Number MD 12656 has been utilised throughout the Tank Farm area in both process and safety critical applications since 1998 up to and including 2011. Throughout that period there have been no manufacturer design changes and no systematic failures have been uncounted.

Total number of valves in service = 163
Combined operational service: Number of valves times years of operation per valve = 960 component years

The following table details all failures involving all the 163 valves from 1998 to 2011.

Failure data for ball valves (BA) of the same manufacture a

Tag Number	Failure Record	Date	Duty	Service	Classification	Failure	Reason for Failure	Event	SD	SU	DD	DU	Remarks	Maintenance/ Repair	MTTR
XV10098	1998/034	13/04/1998	Tank 98 Import Valve	Diesel	Clean	Packing Leaks Noticed	Insufficient tension on packing	Fail Safe	1				Failure noted at visual inspection. No safety related issues, valve operation unaffected.	Routine Maintenance	<30mins
XV10101	1999/02	16/02/1999	Tank 101 Import Valve	Diesel	Clean	Packing Leaks Noticed	Insufficient tension on packing	Fail Safe	1				Failure noted at visual inspection. No safety related issues, valve operation unaffected.	Routine Maintenance	<30mins
XV10014	1999/09	21/06/1999	Tank 14 Import Valve	Gas Oil	Clean	Long Valve closure time noticed. High friction on shaft	High tension on Packing	Possible Dangerous Failure			1		Failure noted at visual inspection. Safety related issues, valve operation affected.	Routine Maintenance	<1 hour
XV10031	2000/56	18/12/2000	Tank 31 Import Valve	Gasoline	Clean	Valve Shaft Sheared	Torque too high. Valve Siezed.	Fail to Danger. However detected on proof test				1	Mechanical Failure noted at proof test under flowing process conditions - Safety Related	Valve Replacement	<8 hours
XV10097	2001/01	03/01/2001	Tank 97 Export Valve	Diesel	Clean	Valve not closed 100%	Build up of material on shaft bearing	Possible Dangerous Failure			1		Failure noted at proof test. Safety related issues, valve operation marginally affected. Consideration given to reorientation of valve from vertical	Valve Replacement and maintenance prior to re-use.	<8hours
XV10001b	2001/07	12/05/2001	Tank 1 Export Pump Discharge Isolation valve	Additive	Clean	Tight Shut-off not achieved	Solids in the additive causing erosion of the valve and seat	Possible Dangerous Failure			1		Failure noted during operation. Safety related issues, valve operation affected. Valve specification modified for all additive valves.	Valve Replacement	24 hours

Figure 9 – Typical Failure Report

From the failure data records the following can be quantified:

T_1 = Proof Test Interval (8760 hours)

MTTR = Mean Time To Restore $\Sigma\frac{0.5 + 0.5 + 1 + 8 + 8 + 24}{6} = 7$ hours

Failure Rate

Dangerous Undetected 1 in 960 years

$$\lambda_{DU} = \frac{1}{960} = 1.04 \text{ x } 10^{-3} \text{ per year } = \frac{1.04 \text{ x} 10^{-3}}{8760} = 1.2 \text{ x } 10^{-7} \text{per hour} \quad (118 \text{ FITS})$$

Dangerous Detected 3 in 960 years

$$\lambda_{DD} = \frac{3}{960} = 3.1 \text{ x} 10^{-3} \text{per year } = \frac{3.1 \text{ x} 10^{-3}}{8760} = 3.6 \text{ x } 10^{-7} \text{per hour} \quad (356 \text{ FITS})$$

Safe Detected 2 in 960 years

$$\lambda_{SU} = \frac{2}{960} = 2.08 \text{ x} 10^{-3} \text{per year } = \frac{2.08 \text{ x} 10^{-3}}{8760} = 2.4 \text{ x} 10^{-7} \text{per hour} \quad (237 \text{ FITS})$$

λ_D = 118 +356 FITS (4.74 x10^{-7} per hour)

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[3] Please note this example is fictitious and the data used is to illustrate one methodology for compiling and analysing field reliability data. There are alternate methods that can be employed and this paper in no way implies this is the best or only technique.

$$\mathbf{t_{ce}} = \frac{\boldsymbol{\lambda}_{\mathbf{DU}}}{\boldsymbol{\lambda}_{\mathbf{D}}} \mathbf{\ x\ } \left(\frac{\mathbf{T_1}}{\mathbf{2}} + \mathbf{MTTR}\right) + \left(\frac{\boldsymbol{\lambda}_{\mathbf{DD}}}{\boldsymbol{\lambda}_{\mathbf{D}}} \mathbf{\ x\ MTTR}\right)$$

$$t_{ce} = \frac{1.2 \text{ x } 10^{-7} \text{ per hour}}{4.74 \text{ x } 10^{-7} \text{ per hour}} \text{ x } \left(\frac{8760 \text{ hours}}{2} + 7 \text{ hours}\right) + \left(\frac{3.6 \text{ x } 10^{-7} \text{ per hour}}{4.74 \text{ x } 10^{-7} \text{ per hour}} \text{ x } 7 \text{ hours}\right)$$

$$t_{ce} = (0.253 \text{ x } 4387) + (\ 0.76 \text{ x } 7 \text{ hours})$$

$$t_{ce} = (1110) + (\ 5.3 \text{ hours})$$

$$t_{ce} = 1115 \text{ hours}$$

$$\mathbf{PFD_{avg}} = [(\boldsymbol{\lambda}_{\mathbf{DU}}) + (\boldsymbol{\lambda}_{\mathbf{DD}})]\ \mathbf{t_{ce}}$$

$$\text{PFD}_{\text{avg}} = [1.2 \text{ x } 10^{-7} \text{per hour} + 3.6 \text{ x } 10^{-7} \text{per hour}\ ] \text{ x } 1115 \text{hours}$$

$$\text{PFD}_{\text{avg}} = 5.3 \text{ x } 10^{-4}$$

$$\textbf{Safe Fail Fraction} = \frac{\boldsymbol{\lambda}_{\mathbf{SD}} + \boldsymbol{\lambda}_{\mathbf{SU}} + \boldsymbol{\lambda}_{\mathbf{DD}}}{\boldsymbol{\lambda}_{\mathbf{SD}} + \boldsymbol{\lambda}_{\mathbf{SU}} + \boldsymbol{\lambda}_{\mathbf{DD}} + \boldsymbol{\lambda}_{\mathbf{DU}}}$$

$$\text{Safe Fail Fraction} = \frac{0 + 237 + 356}{0 + 237 + 356 + 118}$$

$$\text{Safe Fail Fraction} = \frac{593}{711}$$

$$\text{Safe Fail Fraction} = 0.83$$

As with the result of any calculation, a sanity and sensitivity check should be conducted to ensure that the results are realistic. It is often a practise to provide a statistical analysis of uncertainties.

Final Thoughts

To ensure that failure data is truly representative of the component, it is essential that end users provide a culture for proof testing and failure data recording that is detailed and thorough. Proof test procedures must be designed to detect for potentially dangerous failures and all proof tests must be recorded and retained. Any failures detected during proof testing must be thoroughly investigated to find the root cause of the failure.

It is only by recording all activities (including failures, maintenance events, proof test, diagnostic events, process demands and spurious activations) and analysing these results that failure data will be of any use.

For data collection systems to provide Prior Use; for inclusion in a new Safety Instrumented System or for Proven in Use; of components employed in an existing BPCS or SIS the following should always be considered:

- Identification of the components
- Consideration of the operating environment and process conditions
- The volume of the operating experience
- The quality of the historical data
- The ability of Proof Testing to illustrate potential dangerous failures

References:

BS EN 61508: 2010

Functional safety of electrical/electronic/programmable electronic safety-related Systems.

BS EN 61511:2004

Functional safety —Safety instrumented systems for the process industry sector.

BS EN ISO 14224:2006

Petroleum, petrochemical and natural gas industries – Collection and exchange of reliability and maintenance data for equipment.

Chemical and Downstream Oil Industry Forum (CDOIF) - Guideline Demonstrating Prior use.

Acronyms and Abbreviations:

The 21st Century seems to have seen an explosion in the use of acronyms. Confusion can be caused in not understanding what the acronym means. Many technical documents now include them and often they have dual meanings. For instance, chemical and instrumentation engineers associate PFD with a Process Flow Diagram, whereas when used in Safety Instrumented Systems; means Probability of Failure on Demand. There are more on the way, I believe a new one will be ISF, not to be taken as a miss-spelt SIF, ISF stands for Instrumented Safety Function and will apply to all instrumented systems which are utilised as part of instrumented protection layers.

A full description of acronyms and abbreviations utilised in this paper can be referenced in BS EN 61508-4:2010 and BS EN 61511-1:2004 Section 3.