

RESILIENT SEATED BUTTERFLY VALVES

FUNCTIONAL SAFETY MANUAL

Per IEC 61508 and IEC 61511 Standards

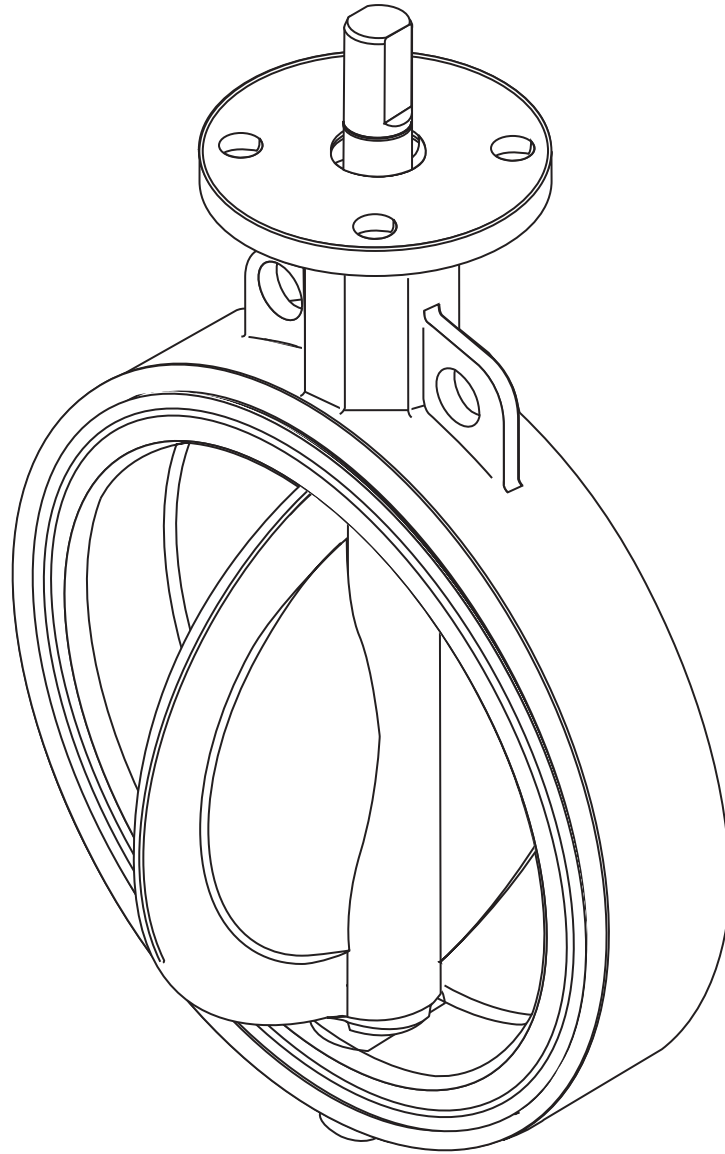


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1.0 INTRODUCTION

This Safety Manual provides information necessary to design, install, verify and maintain a Safety Instrumented Function (SIF) utilizing the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36.

This manual provides necessary requirements for meeting the IEC 61508 or IEC 61511 functional safety standards.

1.1 TERMS AND ABBREVIATIONS

Safety - Freedom from unacceptable risk of harm.

Functional Safety - The ability of a system to carry out the actions necessary to achieve or to maintain a defined safe state for the equipment / machinery / plant / apparatus under control of the system.

Basic Safety - The equipment must be designed and manufactured such that it protects against risk of damage to persons by electrical shock and other hazards and against resulting fire and explosion. The protection must be effective under all conditions of the nominal operation and under single fault condition.

Safety Assessment - The investigation to arrive at a judgment - based on evidence - of the safety achieved by safety-related systems.

Fail-Safe State - State where the valve actuator is de-energized and (if applicable with a spring-returned actuator) the springs are extended..

Fail Safe - Failure that causes the valve to go to the defined fail-safe state without a demand from the process.

Fail Dangerous - Failure that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state).

Fail Dangerous Undetected - Failure that is dangerous and that is not being diagnosed by automatic stroke testing.

Fail Dangerous Detected - Failure that is dangerous but is detected by automatic stroke testing.

Fail Annunciation Undetected - Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic and is not detected by another diagnostic.

Fail Annunciation Detected - Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic or false diagnostic indication.

Fail No Effect - Failure of a component that is part of the safety function but that has no effect on the safety function.

Low Demand Mode - Mode, where the frequency of demands for operation made on a safety-related system is no greater than twice the proof test frequency.

1.2 ACRONYMS

FMEDA - Failure Modes, Effects and Diagnostic Analysis.

HFT - Hardware Fault Tolerance.

MOC - Management of Change. These are specific procedures often done when performing any work activities in compliance with government regulatory authorities.

PFDavg - Average Probability of Failure on Demand.

SFF - Safe Failure Fraction, the fraction of the overall failure rate of a device that results in either a safe fault or a diagnosed unsafe fault.

SIF - Safety Instrumented Function, a set of equipment intended to reduce the risk due to a specific hazard (a safety loop).

SIL - Safety Integrity Level, discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems where Safety Integrity Level 4 has the highest level of safety integrity and Safety Integrity Level 1 has the lowest.

SIS - Safety Instrumented System – Implementation of one or more Safety Instrumented Functions. An SIS is composed of any combination of sensor(s), logic solver(s), and final element(s).

1.3 PRODUCT SUPPORT

Product support can be obtained from:

Bray Controls Inc.
13333 Westland East Blvd.
Houston, TX 77041 - USA.
Phone: 281-894-5454
bray.com

1.4 RELATED LITERATURE

Hardware Documents:

- Product Brochure
- Installation, Operation and Maintenance Instructions for Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36.
- Bray Technical Manual TM-1050

Guidelines/References:

- Safety Integrity Level Selection – Systematic Methods Including Layer of Protection Analysis, ISBN 1-55617-777-1, ISA
- Control System Safety Evaluation and Reliability, 2nd Edition, ISBN 1-55617-638-8, ISA
- Safety Instrumented Systems Verification, Practical Probabilistic Calculations, ISBN 1-55617-909-9, ISA

1.5 REFERENCE STANDARDS

Functional Safety:

- IEC 61508: 2000 Functional safety of electrical/electronic/programmable electronics safety-related systems
- ANSI/ISA 84.00.01-2004 (IEC 61511 Mod.) Functional Safety – Safety Instrumented Systems for the Process Industry Sector

2.0 DEVICE DESCRIPTION

The S20/21 resilient seated butterfly valve is used to control process fluids. It comprises a two-piece body and a single piece disc stem, and an elastomer seat. It is offered in wafer and lug version in sizes from 1" through 20", with rating of up to 150 psi (10 bar), depending on the materials of construction.

The S22/23 resilient seated butterfly valve is used to control process fluids. It comprises a two-piece body and a separate disc and stem in sizes 2" through 4", single piece disc stem in sizes 6" through 24", and a polymer seat. It is offered in wafer and lug version in sizes from 2" through 24", with rating of 150 psi (10 bar).

The S30/31 resilient seated butterfly valve is used to control process fluids. It comprises a one-piece body, a disc, a stem, and an elastomer seat. It is offered in wafer and lug version in sizes from 2" through 20",

with rating of 175 psi (12 bar).

The S32/33 resilient seated butterfly valve is used to control process fluids. It comprises a one-piece body, a disc, a stem, and an elastomer seat. It is offered in wafer version in sizes from 24" through 36". S32 is rated at 75 psi (5 bar), and S33 is rated at 150 psi (10 bar).

The S35/36 resilient seated butterfly valve is used to control process fluids. It comprises a one-piece body, a disc, a stem, and an elastomer seat. It is offered in flanged version in sizes from 24" through 72". S35 is rated 75 psi (5 bar), and S36 is rated 150 psi (10 bar).

Installation details conform to the international flange standards ASME B16.1, B16.5, B16.47, ISO 7005, JIS B2238, and others. All Bray resilient seated butterfly valves are provided with actuator/operator mounting details which conform to ISO 5211 standard.

3.0 DESIGNING A SIF USING A MANUFACTURED PRODUCT

3.1 SAFETY FUNCTION

When de-energized, the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 move to their fail-safe position. Depending on the version specified: Fail – Closed or Fail - Open, the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 will rotate the valve disc to close off the flow path through the valve body or open the flow path through the valve body.

The Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 are intended to be part of final element subsystem as defined per IEC 61508 and the achieved SIL level of the designed function must be verified by the designer.

3.2 ENVIRONMENTAL LIMITS

The designer of a SIF must check that the product is rated for use within the expected environmental limits. Refer to the Service data and Material sections of Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 product catalogues for environmental limits.

3.3 APPLICATION LIMITS

The materials of construction of Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 are specified in the respective valve product brochures. It is important that the designer check for material suitability considering on-site conditions and air supply conditions. If any of the Bray resilient seated butterfly

valves S20/21, S22/23, S30/31, S32/33, and S35/36 are used outside of the application limits or with incompatible materials, the reliability data provided becomes invalid.

3.4 DESIGN VERIFICATION

A detailed Failure Mode, Effects, and Diagnostics Analysis (FMEDA) report is available from Bray Controls. This report details all failure rates and failure modes as well as the expected lifetime.

The achieved Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) design must be verified by the designer via a calculation of PFDavg considering architecture, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of all products included in the SIF. Each subsystem must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements.

When using the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 in a redundant configuration, a common cause factor of at least 10% should be included in safety integrity calculations.

The failure rate data listed in the FMEDA report is only valid for the useful life time of Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36.

The failure rates will increase sometime after this time period. Reliability calculations based on the data listed in the FMEDA report for mission times beyond the lifetime may yield results that are too optimistic, i.e. the calculated Safety Integrity Level will not be achieved.

3.5 SIL CAPABILITY

3.5.1 SYSTEMATIC INTEGRITY

The product has met manufacturer design process requirements of Safety Integrity Level (SIL) 3. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer. A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than the statement without "prior use" justification by end user or diverse technology redundancy in the design.

3.5.2 RANDOM INTEGRITY

Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 are Type A Devices and are just some of the many components that can be used in a final element assembly.

The final element assembly consists of many components, i.e. a Bray resilient seated butterfly valve such as S20/21, S22/23, S30/31, S32/33, and S35/36, an actuator or operator, solenoid, quick exhaust valve, etc. and the SIL must be verified for the entire assembly using failure rates from all components. This analysis must account for any hardware fault tolerance and architecture constraints.

3.5.3 SAFETY PARAMETERS

For detailed failure rate information refer to the Failure Modes, Effects and Diagnostic Analysis Report for the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36.

3.6 CONNECTION OF THE BRAY RESILIENT SEATED BUTTERFLY VALVES S20/21, S22/23, S30/31, S32/33, AND S35/36 TO THE SIS LOGIC-SOLVER

The Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 are connected to the safety rated logic solver which is actively performing the safety function as well as automatic diagnostics designed to diagnose potentially dangerous failures within the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36, (i.e. partial stroke test).

3.7 GENERAL REQUIREMENTS

The system's response time shall be less than process safety time. The Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 are only part of the final element of a SIS. All elements of the SIF must be chosen to meet the safety response time.

All SIS components, including the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 must be operational before process start-up.

User shall verify that each Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 is suitable for use in safety applications by confirming the each valve's nameplate is properly marked.

Personnel performing maintenance and testing on Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 shall be competent to do so.

Results from the proof tests shall be recorded and reviewed periodically.

The useful life of the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 is discussed in Section 5.4.

4.0 INSTALLATION AND COMMISSIONING

4.1 INSTALLATION

The Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 must be installed per standard practices outlined in the Installation, Operation and Maintenance Instructions.

The environment must be checked to verify that environmental conditions do not exceed the ratings.

The Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 must be accessible for physical inspection.

4.2 PHYSICAL LOCATION AND PLACEMENT

The Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 shall be accessible with sufficient room for pneumatic connections and shall allow manual proof testing.

Pneumatic piping to the valve actuator shall be kept as short and straight as possible to minimize the airflow restrictions and potential clogging. Long or kinked pneumatic tubes may also increase the valve closure time.

The Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 shall be mounted in a low vibration environment. If excessive vibration can be expected special precautions shall be taken to ensure the integrity of pneumatic connectors to the valve actuator, or the vibration should be reduced using appropriate damping mounts.

4.3 PNEUMATIC CONNECTIONS

Recommended piping for the inlet and outlet pneumatic connections to the actuator of the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 is a minimum 1/4" metal or PVC tubing. The length of tubing between the actuator and the control device, such as a solenoid valve, shall be kept as short as possible and free of kinks.

Only dry air filtered to 50 micron or better is recommended.

The process air pressure shall meet the requirements set forth in the Installation, Operation and Maintenance Instructions.

The process air capacity shall be sufficient to move the valve actuator within the required time.

5.0 OPERATION AND MAINTENANCE

5.1 PROOF TEST WITHOUT AUTOMATIC TESTING

The objective of proof testing is to detect failures within the valve that are not detected by any automatic diagnostics of the system. Of main concern are undetected failures that prevent the safety instrumented function from performing its intended function.

The frequency of proof testing, or the proof test interval, is to be determined in reliability calculations for the safety instrumented functions for which a valve is applied. The proof tests must be performed more frequently than or as frequently as specified in the calculation in order to maintain the required safety integrity of the safety instrumented function.

The following proof test is recommended. The results of the proof test should be recorded and any failures that are detected and that compromise functional safety should be reported to Bray Controls.

The suggested proof test consists of a full stroke of the Bray resilient seated butterfly valves' S20/21, S22/23, S30/31, S32/33, and S35/36 valve actuator.

TABLE 1: RECOMMENDED PROOF TEST

Step	Action
1	Bypass the safety function and take appropriate action to avoid a false trip
2	Send a signal to the final element configuration to perform a full stroke and verify that this is achieved
3	Inspect the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 for any visible damage or contamination
4	Record any failures in your company's SIF inspection database
5	Remove the bypass and otherwise restore normal operation

This proof test coverage for Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 are listed in the FMEDA report which is available from Bray Controls.

The person(s) performing the proof test of Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 should be trained in SIS operations, including bypass procedures, valve maintenance and company Management of Change procedures.

5.2 PROOF TEST WITH AUTOMATIC PARTIAL OPERATIONAL STROKE TESTING

An automatic testing scheme that performs a full stroke of the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 and measures valve movement timing will detect most potentially dangerous failure modes. It is recommended that a physical inspection (Step 2 from Table 1) be performed on a periodic basis with the time interval determined by plant conditions. A maximum inspection interval of five years is recommended.

5.3 REPAIR AND REPLACEMENT

Repair procedures in the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 Installation, Operation and Maintenance manuals must be followed.

5.4 USEFUL LIFE

The normal useful life of the Bray resilient seated butterfly valves in **Functional Safety Applications** (IEC 61508-2) is 10 to 15 years; however, valve cycle life and valve useful life can be greater or less depending on temperature, flow media (acids, abrasives, total dissolved solids, compatibility of valve trim materials with media), pressure, fluctuation between extreme temperatures, cycle frequency, flow velocity, valve orientation and placement in pipeline with respect to elbows, pumps, etc., and other application conditions.

5.5 MANUFACTURER NOTIFICATION

Any failures that are detected and that compromise functional safety should be reported to Bray Controls. Please contact Bray Controls customer service.

5.6 PRODUCT REGISTRATION

If the product is being used in a safety application and there is a desire to receive notices regarding the product, register the product with Bray Controls Customer Service.

START-UP CHECKLIST

The following checklist may be used as a guide to employ the Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33 and S35/36 in a safety critical SIF compliant to IEC 61508.

Activity	Result	Verified	
		By	Date
Design			
Target Safety Integrity Level and PFD avg determined			
Correct valve mode chosen (Fail-closed, Fail-open)			
Design decision documented			
Pneumatic compatibility and suitability verified			
SIS logic solver requirements for Bray resilient seated butterfly valves S20/21, S22/23, S30/31, S32/33, and S35/36 tests defined and documented			
Routing of pneumatic connections determined			
SIS logic solver requirements for partial stroke tests defined and documented			
Design formally reviewed and suitability formally assessed			
Implementation			
Physical location appropriate			
Pneumatic connections appropriate and according to applicable codes			
SIS logic solver valve actuation test implemented			
Maintenance instructions for proof test released			
Verification and test plan released			
Implementation formally reviewed and suitability formally assessed			
Verification and Testing			
Electrical connections verified and tested			
Pneumatic connection verified and tested			
SIS logic solver valve actuation test verified			
Safety loop function verified			
Safety loop timing measured			
Bypass function tested			
Verification and test results formally reviewed and suitability formally assessed			
Maintenance			
Tube blockage / partial blockage tested			
Safety loop function tested			

HEADQUARTERS

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