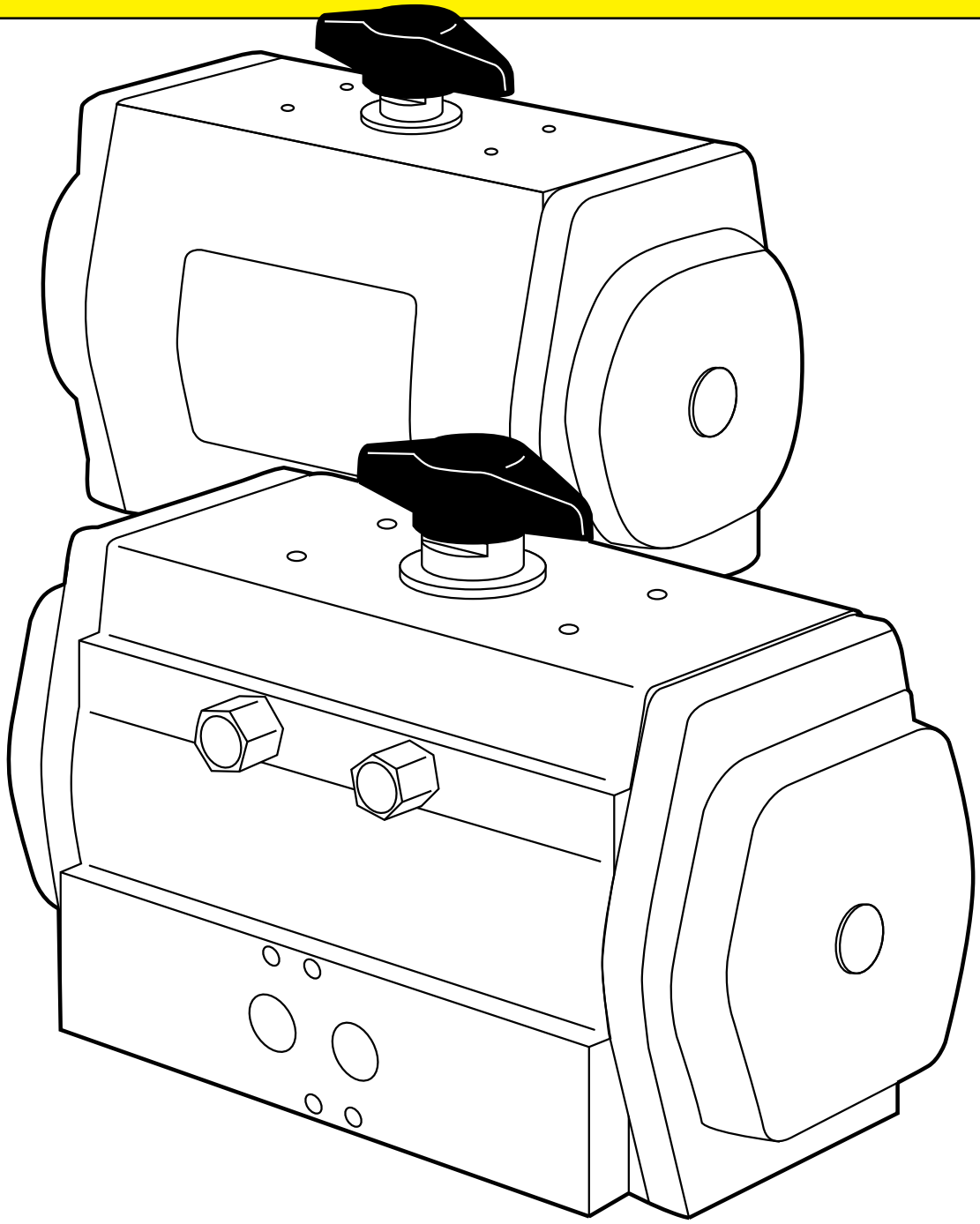
Bray

SERIES 92/93

PNEUMATIC ACTUATOR

SAFETY MANUAL



The High Performance Company

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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 series 92 and 93 Pneumatic Actuator. 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 normal air delivery to the actuator is discontinued, and spring is extended (S93).

> **Note:** In S92, auxiliary air supply is activated to move the actuator into fail-safe position upon decay of normal air supply pressure.

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 - 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 Blvd. East
Houston, TX, 77041, USA.
Phone: 281 894 5454
www.braycontrols.com

1.4 Related Literature

Hardware Documents:

- Pneumatic Actuator & Accessories Product Brochure
- Series 92/93 Pneumatic Actuator Installation, Operation and Maintenance Manual

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 electronic 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 Bray S92 and S93 Pneumatic Actuator is available in torque output ranging from 150 pound-inches to 29,000 pound-inches at 80 psi supply pressure. S92/93 is designed to meet ISO 5211 mounting requirements and is provided with NAMUR interface for installation of solenoid-operated directional controls.

S92 is a double-acting (air-to-air) actuator. Fail-safe mode can be realized by providing an auxiliary pneumatic circuit equipped with a compressed air reservoir.

S93 is a single-acting, spring return actuator. Fail-safe more is automatically provided by the integral compressed-spring system.

3.0 Designing a SIF Using A Manufactured Product

3.1 Safety Function

When de-energized, the S92/93 Pneumatic Actuator moves to its fail-safe position. Depending on the version specified Fail – Closed or Fail - Open, the S92/93 Pneumatic Actuator 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 S92/93 Pneumatic Actuator is 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 S92/93 Pneumatic Actuator product brochure for environmental limits.

3.3 Application limits

The materials of construction of the S92/93 Pneumatic Actuator are specified in the Bray S92/93 Pneumatic Actuator product brochure. It is important that the designer check for material suitability considering on-site conditions and air supply conditions. If the S92/93 Pneumatic Actuator is 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 S92/93 Pneumatic Actuator in a redundant configuration, a common cause factor of at least 10% should be included in safety integrity calculations.

The failure rate data listed the FMEDA report is only valid for the useful life time of the S92/93 Pneumatic Actuator. 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

The S92/93 Pneumatic Actuator is a Type A Device and is one of many components that can be used in a final element assembly. The final element assembly consists of many components, i.e. S92/93 Pneumatic Actuator, 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 S92/93 Pneumatic Actuator.

3.6 Connection of the S92/93 Pneumatic Actuator to the SIS Logic-solver

The S92/93 Pneumatic Actuator is 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 S92/93 Pneumatic Actuator, (i.e. partial stroke test).

3.7 General Requirements

The systems response time shall be less than process safety time. The S92/93 Pneumatic Actuator is only one 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 S92/93 Pneumatic Actuator must be operational before process start-up.

User shall verify that the S92/93 Pneumatic Actuator is suitable for use in safety applications by confirming the S92/93 Pneumatic Actuator's nameplate is properly marked.

Personnel performing maintenance and testing on the S92/93 Pneumatic Actuator shall be competent to do so.

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

The useful life of the S92/93 Pneumatic Actuator is discussed in the Failure Modes, Effects and Diagnostic Analysis Report for the S92/93 Pneumatic Actuator.

4.0 Installation And Commissioning

4.1 Installation

The S92/93 Pneumatic Actuator must be installed per standard practices outlined in the Installation Manual.

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

The S92/93 Pneumatic Actuator must be accessible for physical inspection.

4.2 Physical Location and Placement

The S92/93 Pneumatic Actuator shall be accessible with sufficient room for pneumatic connections and shall allow manual proof testing.

Pneumatic piping to the valve 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 S92/93 Pneumatic Actuator 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 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 S92/93 Pneumatic Actuator is a minimum 1/4” metal or PVC tubing. The length of tubing between the S92/93 Pneumatic Actuator and the control device, such as a solenoid valve, shall be kept as short as possible and free of kinks. Direct NAMUR mount of control device is recommended.

Dry air filtered to 50 micron or better is recommended, but not necessary.

The process air pressure shall meet the requirements set forth in the installation manual.

The process air capacity shall be sufficient to move the S92/93 Pneumatic 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 S92/93 Pneumatic Actuator 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 S92/93 Pneumatic Actuator 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 S92/93 Pneumatic Actuator.

Table1: 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 S92/93 Pneumatic Actuator for any visible damage or contamination.
4	Record any failures in your company's SIF inspection database.
5	Restore normal operation.

The proof test coverage for S92/93 Pneumatic Actuators are listed in the FMEDA report which is available from Bray Controls.

The person(s) performing the proof test of S92/93 Pneumatic Actuator 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 partial valve stroke testing scheme that also performs a periodic full stroke of the S92/93 Pneumatic Actuator 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 S92/93 Pneumatic Actuator Installation, Operation and Maintenance manual must be followed.

5.4 Useful Life

The useful life of the S92/93 Pneumatic Actuator is 10 to 15 years.

Cycle life varies by actuator size and ranges from 1,000,000 cycles for small units to 200,000 cycles for the largest unit.

Cycle life of spring systems in S93 single acting actuators is 100,000 cycles.

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 S92 / 93 Pneumatic Actuator in a safety critical SIF compliant to IEC 61508.

Activity	Result	Verified	
		By	Date
Design			
Target Safety Integrity Level and PFDavg determined			
Correct operating mode chosen (Fail-closed, Fail-open)			
Design decision documented			
Pneumatic compatibility and suitability verified			
SIS logic solver requirements for S92/93 Pneumatic Actuator 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 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 actuation test verified			
Safety loop function verified			
Safety loop timing measured			
Bypass function tested (manual override)			
Verification and test results formally reviewed and suitability formally assessed			
Maintenance			
Tubing blockage / partial blockage tested			
Safety loop function tested			

Bray® CONTROLS

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