

Safety Manual for Fisher™ 585C Actuators

Purpose

This safety manual provides information necessary to design, install, verify and maintain a Safety Instrumented Function (SIF) utilizing the Fisher 585C linear piston actuator.

WARNING

This instruction manual supplement is not intended to be used as a stand-alone document. It must be used in conjunction with the following manual:

Fisher 585C Actuator Instruction Manual ([D102087X012](#))

Failure to use this instruction manual supplement in conjunction with the above referenced manual could result in personal injury or property damage. If you have any questions regarding these instructions or need assistance in obtaining any of these documents, contact your [Emerson sales office](#).

Introduction

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

Figure 1. Fisher 585C Actuator



X0175-2

585C PISTON ACTUATOR WITH FIELDVUE™ DVC6200F
DIGITAL VALVE CONTROLLER

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 injury 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 the facts - of the safety achieved by safety-related systems.

Fail-Safe State:

- State where valve actuator is de-energized and spring is extended. (585C or 585CR sizes 25 and 50 constructions with bias spring).
- State where valve actuator is driven to or held in a predefined position by the control medium. (585C double-acting springless constructions).

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.

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.

PFD_{AVG}: 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).

Related Literature

Hardware Documents:

Bulletin:

61.2:585C, Fisher 585C Piston Actuators: [D102086X012](#)

Instruction Manual:

Fisher 585C Series Piston Actuators: [D102087X012](#)

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

Reference Standards

Functional Safety

- IEC 61508: 2010 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

Product Description

The 585C Series pneumatic actuators are double-acting springless or double-acting with bias spring construction piston actuators that provide accurate output for a wide range of thrust and travel requirements. The 585C Series actuators can be installed on sliding-stem valves for throttling control or on-off applications.

Sizes 25 and 50 actuators are available as a springless construction or with a bias spring. The bias spring construction forces the actuator piston rod to extend or retract upon the loss of supply pressure, thereby ensuring a fail-closed or fail-open mode of operation. Size 60 through 130 actuators are available as springless constructions only.

The 585C actuator is available with an optional top-mounted or side-mounted manual handwheel, depending on actuator size. The handwheel version can be used to open or close the valve manually, to position the valve at any point in the stroke or to act as a travel stop.

Designing an SIF Using a Fisher 585C Series Actuator

Safety Function

The double-acting springless 585C actuator constructions will maintain functionality so the actuator can be moved into the application dependent safe state by means of the control medium. When the spring-return 585C or 585CR actuator is de-energized, the actuator and valve shall move to its fail-safe position. Depending on which configuration is specified fail-closed or fail-open, the actuator will move the valve control element to close off the flow path through the valve body or open the flow path through the valve body.

The 585C or 585CR actuator is intended to be part of a final element subsystem as defined per IEC 61508 and the achieved SIL level of the designed function must be verified by the designer.

Environmental Limits

The designer of an SIF must check that the product is rated for use within the expected environmental limits. Refer to the Fisher 585C Actuator product bulletin (D102086X012) for environmental limits.

Application Limits

The 585C Series actuator materials of construction are specified in the product bulletin. A range of materials for certain parts are available for various applications. The serial card will indicate what the materials of construction are for a specific actuator. It is especially important that the designer check for material compatibility considering onsite chemical contaminants and air supply conditions. If the 585C Series actuator is used outside of the application limits or with incompatible materials, the reliability data provided becomes invalid.

Diagnostic Response Time

A 585C Series actuator does not perform any automatic diagnostic functions by itself and therefore it has no diagnostic response time of its own. However, automatic diagnostics of the final control subsystem may be performed such as Partial Valve Stroke Testing (PVST). This typically will exercise the actuator and valve over a small percentage of its normal travel without adversely affecting the flow through the valve. If any failures of this PVST are automatically detected and annunciated, the diagnostic response time will be the PVST interval time. The PVST must be performed 10 times more often than an expected demand in order for credit to be given for this test.

Design Verification

The achieved SIL of an entire SIF design must be verified by the designer via a calculation of PFD_{AVG} 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 HFT requirements.

When using a 585C Series actuator in a redundant configuration, a common cause factor of at least 10% should be included in the Safety Integrity calculations. This value is dependent on the level of common cause training and maintenance in use at the end user's facility.

The failure rate data listed in the SIL certificate and in Table 1 is only valid for the useful lifetime of a 585C Series actuator. The failure rates will increase after this time period. Reliability calculations based on the data listed in the SIL certificate and in Table 1 for mission times beyond the useful lifetime may yield results that are too optimistic, i.e. the calculated Safety Integrity Level will not be achieved.

Table 1. Failure Rates According to IEC 61508 in FIT⁽¹⁾

Safety Function	λ_s	λ_D
Single Acting - Perform full stroke via Spring Force (585CR)	15 FIT	26 FIT
Double Acting - Perform full stroke via Pressure Force (585C)	---	33 FIT
1. FIT = 1 failure / 10 ⁹ hours		

SIL Capability

Systematic Integrity

The product has met manufacturer design process requirements of SIL 3. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer. An SIF designed with this product must not be used at an SIL level higher than stated without "prior use" justification by the end user or diverse technology redundancy in the design.

Random Integrity

The Fisher 585C Series actuator is classified as a Type A device according to IEC 61508, having a hardware fault tolerance of 0. The complete final element subsystem, with a 585C Series actuator and sliding stem valve as the final control element, will need to be evaluated to determine the Safe Failure Fraction of the subsystem. If the SFF for the entire final element subsystem is between 60% and 90%, a design can meet SIL 2 @ HFT=0.

Safety Parameters

For detailed failure rate information, refer to the SIL certificate for the Fisher 585C Series linear piston actuators.

Connection of the Fisher 585C Actuator to the SIS Logic-solver

The final element subsystem (consisting of a positioner, 585C Series actuator and a sliding-stem valve) is connected to the safety rated logic-solver which is actively performing the Safety Function as well as any automatic diagnostics designed to diagnose potentially dangerous failures within the 585C Series actuator, valve and any other final element components (i.e., Partial Valve Stroke Test).

General Requirements

The system's response time shall be less than process safety time. The final control element subsystem needs to be sized properly to assure that the response time is less than the required process safety time. The 585C Series actuator will move the valve to its safe state in less than the required SIF's safety time under the specified conditions.

All SIS components including the 585C Series actuator must be operational before process startup. The user shall verify that the 585C Series actuator is suitable for use in safety applications.

Personnel performing maintenance and testing on the 585C Series actuator and valve shall be competent to do so.

Results from the proof tests shall be recorded and reviewed periodically. The results of the periodic proof test must be evaluated and maintenance must be performed when necessary. Especially in case of changes (e.g., aging of the elastomers, increased response time, leakage, etc.), maintenance or repair must be completed.

For 585C actuators under operating conditions with low requirements (low demand mode), a service life of approximately 15 years plus a storage period of 1-1/2 years from the date of production is confirmed, considering the compliance with the requirements for operating the devices described in the safety manual and the installation and operating instructions.

When ordered, each valve or actuator product intended for an SIS application must be designated with a Product Service Code (PSCD) by your Emerson sales office or Local Business Partner. The PSCD code is used by Emerson to track SIS valves and actuators in the event that a notification to users is necessary to address a product issue affecting functional safety. PSCD-256 must be designated for applicable valve products and PSCD-257 for actuator products and will be noted on the product serial card.

Installation and Commissioning

Installation

WARNING

To ensure safe and proper functioning of equipment, users of this document must carefully read all instructions, warnings and cautions in each applicable instruction manual.

To ensure actuator travel is not restricted on Sizes 25 and 50 constructions with a manual handwheel, the neutral indicator must be in the neutral position. Sizes 60 to 130 actuator constructions with a handwheel must also have the neutral indicator in the neutral position and the locking pin removed to prevent travel restriction.

The Fisher 585C Series actuator must be installed per standard practices outlined in the instruction manual. The environment must be checked to verify that environmental conditions do not exceed the ratings. The 585C actuator must be accessible for physical inspection.

Physical Location and Placement

The 585C Series actuator shall be accessible with sufficient room for the valve, actuator, pneumatic connections and any other components of the final control element. Provisions shall be made to allow for manual proof testing.

Pneumatic piping to the 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 585C Series 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.

Pneumatic Connections

Recommended piping for the inlet and outlet pneumatic connections to the 585C Series actuator is stainless steel tubing. The length of tubing between the 585C Series actuator and the control device, such as a solenoid valve, shall be kept as short as possible and free of kinks.

The supply pressure medium should be clean, dry filtered air. The process air pressure shall meet the requirements set forth in the instruction manual.

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

Operation and Maintenance

Suggested Proof Test

The objective of proof testing is to detect failures within a 585C Series 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 585C Series 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 proof test shown in Table 2 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 Emerson. The suggested proof test consists of a full stroke of the 585C Series actuator.

The person(s) performing the proof test of a 585C Series actuator should be trained in SIS operations, including bypass procedures, valve maintenance and company Management of Change procedures. No special tools are required.

Table 2. Recommended Full Stroke Proof Test

Step	Action
1	Bypass the safety function and take appropriate action to avoid a false trip.
2	Interrupt or change the signal/supply to the 585C Series actuator to force the actuator and valve to perform a full stroke to the Fail-Safe state and confirm that the Safe State was achieved and within the correct time.
3	Restore the supply/signal to the 585C Series actuator and confirm that the normal operating state was achieved.
4	Inspect the 585C Series actuator and the other final control element components for any leaks, visible damage or contamination.
5	Record the test results and any failures in your company's SIF inspection database.
6	Remove the bypass and restore normal operation.

Repair and Replacement

Repair and replacement procedures in the instruction manuals must be followed.

Manufacturer Notification

Any failures that are detected and that compromise functional safety should be reported to Emerson. Please contact your [Emerson sales office](#).

Appendix

Sample Start-Up Checklist

This appendix provides a sample Start-up Checklist for a 585C Series actuator. A Start-up Checklist will provide guidance during the final control elements employment.

Start-Up Checklist

The following checklist may be used as a guide to employ the 585C Series actuator in a safety critical SIF compliant to IEC61508.

#	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 valve 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			
	Tubing blockage/partial blockage tested			
	Safety loop function tested			

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