



Member of the FM Global Group

Approval Standard for Temperature Limit and Supervisory Switches

Class Number 3545

October 1998

Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet FM Approvals' stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and listing depends on compliance with the Approval Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1.0 INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states FM Approval criteria for temperature limit and supervisory switches. These switches use inputs from thermocouples or resistance temperature devices (RTDs). They may be stand-alone devices or incorporated into a temperature controller.
- 1.1.2 FM Approval criteria shall include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.

1.2 Scope

- 1.2.1 This standard sets performance requirements for temperature limit and supervisory switches used as safety devices in industrial heating control systems. They are intended to operate electrical switching devices in order to initiate a safety shutdown or initiate an alarm under abnormal conditions. Process temperature controllers and/or recorders can also be Approved if they are provided with limit and/or supervisory functions.
- 1.2.2 The requirements of this Standard shall be used to measure and describe the performance of thermal switches in response to exposure from heat, cold, abnormalities, etc., under controlled laboratory conditions. The results of these controlled exposures shall not be used to describe or appraise actual exposure conditions since such conditions vary widely. Dielectric strength and proper operation with variations in supply voltage are also assessed.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, and loss control specialists was also considered.
- 1.3.2 The requirements of this Standard reflect tests and practices used to examine characteristics of thermal switches for the purpose of obtaining FM Approval. Switches having characteristics not anticipated by this Standard may be Approved if performance equal, or superior, to that required by this Standard is demonstrated, or if the intent of the Standard is met. Alternatively, switches which meet all of the requirements identified in this Standard may not be Approved if other conditions which adversely affect performance exist or if the intent of this Standard is not met.

1.4 Basis for FM Approval

FM Approval is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

1.4.1 Product testing.

Examination and tests on production samples shall be performed to evaluate

- the suitability of the product
- the performance of the product as specified by the manufacturer and required by FM Approvals; and as far as practical,
- the durability and reliability of the product.

1.4.2 Facility and procedure evaluation.

An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to produce the product which was examined and tested, and the marking procedures used to identify the product. These examinations are repeated as part of FM Approvals' product follow-up program.

1.5 Basis for Continued Approval

Continued Approval is based upon:

- production or availability of the product as currently Approved;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the Approval Agreement;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM Approvals' product follow-up program.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products Approved under a previous edition shall comply with the new version by the effective date or forfeit Approval.

The effective date of this Standard is October 1, 1999 for full compliance with all requirements.

1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10-1997, “*Standard for Use of the International System of Units (SI)*.”

1.8 Applicable Documents

The switches shall be in compliance with FM Approval Standard 3810 for Electrical and Electronic Test, Measuring, and Process Control Equipment pertaining primarily to dielectric strength and supply voltage variation. Depending upon specific switch construction, other requirements of this standard may apply and shall be subject to special investigation.

1.9 Definitions

For purposes of this standard, the following terms apply:

Controller — The device that provides process temperature control by simple on-off or proportional, integral, and/or derivative (PID) functions.

Downscale burnout — Failure of the temperature input device, for a low limit switch, that results in a process shutdown; for a supervisory device, failure that results in an alarm and/or process shutdown.

Limit — The preset point beyond which the switching element will turn off and initiate process shutdown.

Supervisory — Used to describe a device with a switching element that turns “on” or “off” at preset limits and generates an alarm signal and/or initiates shutdown. May be used interchangeably with “limit” when a shutdown function is provided.

Upscale burnout — Failure of the temperature input device, for a high limit switch, that results in a process shutdown; for a supervisory device, failure that results in an alarm and/or process shutdown.

2.0 GENERAL INFORMATION

Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to the Electrical Group Manager at FM Approvals, 1151 Boston-Providence Turnpike, PO Box 9102, Norwood, MA 02062, U.S.A.

3.0 GENERAL REQUIREMENTS

3.1 Drawings/Plans/Specifications

The manufacturer shall provide drawings or specifications pertaining to the major components of these temperature devices, materials, labeling, schematics, and final assembly along with installation, maintenance, and operating instructions. If FM Approval is granted, all drawings listed in the Documentation Section of the Approval Report shall state that FM Approvals authorization is required prior to implementation of any revision(s).

3.2 Physical or Structural Features

- 3.2.1 A temperature switch, controller, or recorder shall be available as a complete and identifiable assembly. It shall perform to the manufacturer's specifications in all respects.
- 3.2.2 Electrical components, operating members, and setting adjustments shall be suitably protected against any detrimental effects from normally expected atmospheric conditions.
- 3.2.3 The devices shall be capable of proper operation within an ambient temperature range of at least 40° to 130°F (4° to 55°C).
- 3.2.4 Limit switches with an adjustable setpoint shall be configured so that the possibility of casual adjustment is minimized. This may be accomplished by requiring: removal of a cover, the use of a tool, mounting inside a control panel, or a password for electronic devices.
- 3.2.5 Reset of a limit switch shall not be possible until the process temperature is below the limit setpoint and shall require a manual action.
- 3.2.6 Sensor failure shall result in process shutdown for a limit switch; an alarm or process shutdown for a supervisory switch. Upscale burnout is required for a high limit switch, downscale burnout for a low limit switch.

3.3 Markings

- 3.3.1 An Approved thermal switch shall be permanently marked on the exterior, or upon removal of a cover or housing, to include the name and address of the manufacturer, and distinctive type or model number.
- 3.3.2 The switch shall also bear the FM Approval mark. Reproduction art formats are shown in Appendix B. The location, material, and application method will be by mutual agreement between FM Approvals and the manufacturer.
- 3.3.3 The device shall be marked to indicate electrical ratings and wiring information.
- 3.3.4 The device shall bear a marking that indicates, in some fashion, the date of manufacture; the date shall be clearly visible on the exterior or upon removal of a cover or housing.
- 3.3.5 All markings shall be legible and sufficiently durable to withstand, or be protected from, normally expected atmospheric conditions.

3.4 Manufacturer's Installation and Operation Instructions

The manufacturer shall provide, with each device, instructions and/or illustrations for proper installation, maintenance, and operation.

3.5 Calibration

All examinations and tests performed in evaluation to this Standard shall use calibrated measuring instruments traceable and certified to acceptable national standards.

4.0 PERFORMANCE REQUIREMENTS

4.1 Operating Characteristics

4.1.1 Requirement

Temperature switches shall operate in accordance with the manufacturer's specifications and FM Approvals requirements.

4.1.2 Test/Verification

The switches shall be tested to verify that they operate as described by the manufacturer, that limit switches must be reset manually, that the process temperature must be within limits before reset can be accomplished, that an adjustable setpoint is adequately protected against casual adjustment, and that sensor failure results in an alarm or process shutdown.

4.2 Actuation Point Accuracy and Repeatability

4.2.1 Requirement

A. Accuracy: The actuation point shall be within the manufacturer's specification for accuracy or within ± 5 percent of full scale value for adjustable types (± 5 percent of set value for factory pre-set types), whichever is less.

Note: The scale markings for some adjustable switches may only be approximate, serving only as a starting point for adjustment upon installation. Therefore, the accuracy requirement does not apply.

B. Repeatability: The actuation point shall repeat within the manufacturer's specification or within ± 1 percent of the set value, whichever is less.

C. Reset, automatic for supervisory or manual for limit devices, shall not occur until the input is above (low limit) or below (high limit) the actuation value.

4.2.2 Test/Verification

An input signal shall be applied, slowly, until the switch actuates. The input shall be applied as an increasing signal for a high limit switch, decreasing signal for a low limit. This test shall be repeated for a minimum of five times. Adjustable types shall be tested, as a minimum, at 25, 50, and 75 percent of range.

A. Accuracy is the deviation from the set value expressed as a percent of full scale value.

B. Repeatability (non-repeatability) is the difference between the highest and the lowest input value needed to cause actuation, expressed as a percentage of the set value.

C. As part of this test, it shall be verified that reset does not occur until the input is inside the limit.

4.3 Ambient Temperature Effects

4.3.1 Requirement

Switches must be capable of operating properly at ambient temperatures between 40° and 130°F (4° and 55°C). Actuation point shall not change more than ± 1 percent of full scale from that at room temperature. Repeatability shall be within the requirement stated in 4.2 above.

4.3.2 Tests/Verification

The sample(s) shall be conditioned at temperatures of 40° and 130°F (4° and 55°C), or at the manufacturer's specified limits, whichever are greater, for a minimum of 4 hours at each temperature. The sample shall operate properly at these temperatures and upon return to room temperature. Actuation characteristics shall be as noted in 4.3.1 above.

4.4 Endurance

4.4.1 Requirement

Limit switches shall be capable of withstanding 1000 operational cycles, at rated electrical load, without failure or significant deterioration in performance. Supervisory switches (alarm type) or on-off controls shall withstand 100,000 operations.

Exception: This requirement does not apply to devices that use solid state relays.

4.4.2 Test/Verification

Temperature devices equipped with electro-mechanical relays shall be subjected to an electrical load, equal to maximum contact rating, for the duration of the endurance test noted above. There shall be no evidence of relay failure or contact fusion.

4.5 Voltage Variation

4.5.1 Requirement

The temperature devices shall operate properly over a range of 85 to 110 percent of rated input voltage.

4.5.2 Test/Verification

Input voltage shall be varied from 85 to 110 percent of rated voltage. There shall be no change in operating characteristics or any significant change in setpoint.

4.6 Dielectric Strength

4.6.1 Requirement

Electrical components shall be capable of withstanding a dielectric strength test without arcing or breakdown.

4.6.2 Test/Verification

A test voltage of 1000 V ac, plus twice the rated operating voltage, shall be applied between power input terminals and circuit ground (or conductive housing if applicable) for a period of one minute. There shall be no evidence of arcing or breakdown.

Exceptions:

1. For operating voltages of 60 V or less, the test voltage shall be 500 V ac.
2. This test is not required if input power terminals are not accessible to an operator *and* the device housing is non-conductive.

5.0 OPERATIONS REQUIREMENTS

A quality assurance program is required to assure that subsequent temperature devices produced by the manufacturer shall present the same quality and reliability as the specific devices examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and is documented in the Approval Report.
- Continued conformance to this Standard is verified by the Facilities and Procedures Audits (F&PA).
- Quality of performance is determined by field performance and as necessary by periodic re-examination and testing.

5.1 Demonstrated Quality Control Program

5.1.1 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines
- incoming quality assurance, including testing
- in-process quality assurance, including testing
- final inspection and tests
- equipment calibration
- drawing and change control
- packaging and shipping
- handling and disposition of discrepant materials.

5.1.2 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.3 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, and shall maintain this record for a minimum period of two years from the date of manufacture.

5.1.4 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents identified in the Approval Report must be reported to, and authorized by, FM Approvals prior to implementation for production.
- The manufacturer shall assign an appropriate person or group to be responsible for, and require that, proposed changes to Approved or Listed products be reported to FM Approvals before implementation. The manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of FM Approvals Form 797, Approved Product Revision Report or Address/ Contact Change Notice.
- Records of all revisions to all Approved products shall be maintained.

5.2 Facilities and Procedures Audit (F&PA)

5.2.1 An audit of the manufacturing facility is part of the Approval investigation to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to insure a uniform product consistent with that which was tested and Approved.

5.2.2 These audits shall be conducted periodically but at least annually by FM Approvals or its representatives or more frequently dependent on jurisdictional requirements. At the time of issue of this standard, the Occupational and Safety Health Administration (OSHA) of the United States Department of Labor requires audits of manufacturing sites producing products for use in hazardous locations during each calendar quarter the product is manufactured.

5.2.3 FM Approved products or services shall be produced or provided at or from the location(s) audited by FM Approvals and as specified in the Approval Report. Manufacture of products bearing the FM Approval Mark is not permitted at any other location without prior written authorization by FM Approvals.

APPENDIX A

UNITS OF MEASUREMENT

Pressure:	psi - "pounds per square inch"; (kPa — "kilopascals") kPa = psi x 6.895
	bar — "bar"; (kPa — "kilopascals") bar = kPa x 0.01 bar = psi x 0.06895
	in H ₂ O — "inches of water"; (Pa — "Pascals") Pa = in H ₂ O x 248.86
TEMPERATURE:	°F - "degrees Fahrenheit" (°C - "degrees Celsius") °C = (°F - 32) × 0.556

APPENDIX B

APPROVAL MARKS

REPRODUCTION ART: FM Approval Marks

**For use on nameplates, in literature, advertisements,
packaging and other graphics.**



- 1) The FM Approvals diamond mark is acceptable to FM Approvals as an Approval mark when used with the word "Approved."
- 2) The FM Approval logomark has no minimum size requirement, but should always be large enough to be readily identifiable.
- 3) Color should be black on a light background or a reverse may be used on a dark background.

For Cast-On Marks



- 4) Where reproduction of the mark described above is impossible because of production restrictions, a modified version of the diamond is suggested. Minimum size specifications are the same as for printed marks. Use of the word "Approved" with this mark is optional.

NOTE: These Approval marks are to be used only in conjunction with products or services that have been FM Approved. The FM Approval marks should never be used in any manner (including advertising, sales or promotional purposes) that could suggest or imply FM Approval or endorsement of a specific manufacturer or distributor. Nor should it be implied that Approval extends to a product or service not covered by written agreement with FM Approvals. The Approval marks signify that products or services have met certain requirements as reported by FM Approvals.

Additional reproduction art is available through

FM Approvals
P.O. Box 9102,
Norwood, Massachusetts 02062
U.S.A.