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THERMAL OVERLOAD PROTECTION FOR ELECTRIC MOTORS ON MOTOR-OPERATED VALVES

A. INTRODUCTION

Criterion 1, "Quality Standards and Records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires, in part, that components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

Criterion 4, "Environmental and Missile Design Bases," of Appendix A to 10 CFR Part 50 requires, in part, that components important to safety be designed to accommodate the effects of and be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

Criterion 13, "Instrumentation and Control," of Appendix A to 10 CFR Part 50 requires that instrumentation be provided to monitor variables and systems over their anticipated ranges for normal operation and for postulated accident conditions and that controls be provided to maintain these variables and systems within prescribed operating ranges.

Criterion XI, "Test Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 requires, in part, that a test program be established to ensure that systems and components perform satisfactorily and that the test program include operational tests during nuclear power plant operation.

This regulatory guide describes a method acceptable to the NRC staff for complying with the above criteria with regard to the application of thermal overload protection devices that are integral with the motor starter for electric motors on motor-operated valves. This method would ensure that the thermal overload protection devices will not needlessly prevent the motor from performing its safety-related function. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

Motor-operated valves with thermal overload protection devices for the valve motors are used in safety systems and in their auxiliary supporting systems. Operating experience has shown that indiscriminate application of thermal overload protection devices to these valve motors could result in needless hindrance to successful completion of safety functions.

Thermal overload relays are designed primarily to protect continuous-duty motors while they are running rather than during starting. Use of these overload devices to protect intermittent-duty motors may therefore result in undesired actuation of the devices if the cumulative effect of heating caused by successive starts at short intervals is not taken into account in determining the overload trip setting.

It is generally very difficult for any thermally sensitive device to approximate adequately the varying thermal characteristics of an intermittent-duty motor over its full range of starting and loading conditions. This is mainly caused by the wide variations in motor heating curves for various sizes and designs and also by the difficulty in obtaining motor heating data to an acceptable accuracy.

* Lines indicate substantive changes from previous issue.

Since the trip function in a thermal overload device is dependent on temperature, the degree of overload protection provided is affected by change in ambient temperature at the motor or starter location. This aspect becomes more complex in nuclear power plant applications where, in some cases, the motor to be protected is inside the containment and the overload protection devices are outside the containment. In such a situation, the temperature difference between the motor and the overload device could be as high as 200°F under design basis conditions. Thus, the selection of an appropriate trip setpoint for such a valve motor should take into consideration operation of the valve under various temperatures for both normal and postulated accident conditions, including loss-of-coolant accidents.

The accuracy obtainable with the thermal overload relay trip generally varies from -5% to 0% of trip setpoint. Since the primary concern in the application of overload devices is to protect the motor windings against excessive heating, the above negative tolerance in trip characteristics of the protection device is considered in the safe direction for motor protection. However, this conservative design feature built into these overload devices for motor protection could interfere in the successful functioning of a safety-related system; i.e., the thermal overload device could open to remove power from a motor before the safety function has been completed or even initiated. In nuclear power plant application, the criterion for establishing an overload trip setpoint should be to complete the safety function (e.g., drive the valve to its proper position to mitigate the effects of an accident) rather than merely to protect the motor from destructive heating. In some plants, the thermal overload devices are bypassed during normal plant operation, except that they are temporarily placed in force when the valve motors are undergoing periodic testing.

Where the thermal overload protection devices are bypassed, it is important to ensure that the bypassing does not result in jeopardizing the completion of the safety function or in degrading other safety systems because of any sustained abnormal motor circuit currents that may be present. As an example, for small motors (1/2 horsepower or less), the magnetic trip devices provided in the motor combination starter-breaker may not adequately protect the circuit at all times against sustained locked-rotor currents.

C. REGULATORY POSITION

In order to ensure that safety-related motor-operated valves whose motors are equipped with thermal overload protection devices integral with the motor starter will perform their function, one of the two alternatives described in regulatory position 1 or the one described in regulatory position 2 should be implemented:

1. Provided that the completion of the safety function is not jeopardized or that other safety systems are not degraded, (a) the thermal overload protection devices should be continuously bypassed and temporarily placed in force only when the valve motors are undergoing periodic or maintenance testing or (b) those thermal overload protection devices that are normally in force during plant operation should be bypassed under accident conditions.

The bypass initiation system circuitry should conform to the criteria of Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.10, and 4.13 of IEEE Std 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations," and should be periodically tested.

2. The trip setpoint of the thermal overload protection devices should be established with all uncertainties resolved in favor of completing the safety-related action. With respect to those uncertainties, consideration should be given to (a) variations in the ambient temperature at the installed location of the overload protection devices and the valve motors, (b) inaccuracies in motor heating data and the overload protection device trip characteristics and the matching of these two items, and (c) setpoint drift. In order to ensure continued functional reliability and the accuracy of the trip point, the thermal overload protection device should be periodically tested.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this regulatory guide.

This guide reflects current NRC staff practice. Therefore, except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein is being and will continue to be used in the evaluation of submittals for construction permit applications until this guide is revised as a result of suggestions from the public or additional staff review.