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DRAFT REGULATORY GUIDE

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THERMAL OVERLOAD PROTECTION FOR ELECTRIC MOTORS ON MOTOR-OPERATED VALVES

A. INTRODUCTION

This regulatory guide describes a method acceptable to the U.S. Nuclear Regulatory Commission (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.

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,” (Ref 1) 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 dynamic effects 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 structures, systems and components will perform satisfactorily and that the test program includes operational tests during nuclear power plant operation.

This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received final staff review or approval and does not represent an official U.S. Nuclear Regulatory Commission (NRC) final staff position. Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rules, Announcements, and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; submitted through NRC’s interactive rulemaking Web page at http:/www.nrc.gov; or faxed to (301) 492-3446. Copies of comments received may be examined at NRC’s Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by June 28, 2011.

Electronic copies of this draft regulatory guide are available through NRC’s interactive rulemaking Web page (see above); NRC’s public Web site under Draft Regulatory Guides in the Regulatory Guides document collection of NRC’s Electronic Reading Room at http://www.nrc.gov/reading-rm/doc-collections/; and NRC’s Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html under Accession No. ML110130176. The regulatory analysis may be found in ADAMS under Accession No. ML110130180.

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required.

This regulatory guide contains information collection requirements covered by 10 CFR Part 50 that the Office of Management and Budget (OMB) approved under OMB control number 3150-0011. NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. The NRC has determined that this Regulatory Guide is not a major rule as designated by the Congressional Review Act and has verified this determination with the OMB.

B. DISCUSSION

Typical valve actuator motors are intermittent-duty, high-torque motors. When an actuator motor receives a signal to operate, the motor must attain operating speed quickly with sufficient force to deliver the equivalent of a hammer blow to the valves stem to initiate movement. If a valve is tightly sealed or must operate under a high differential pressure or flow condition, the initial period of operation when opening the valve calls for a high torque at low speed demand on the motor. During the period of time when the valve is unseating or initially opening, the motor may draw high current. Starting current (which is usually assumed to be equivalent to locked-rotor current) drawn by a motor may be 4 to 10 times higher than the motor's continuous current rating. A similar condition may exist when a valve begins its closing stroke because of interaction with the backseat. During closing stroke, the motor experiences a relatively high-speed/low-torque condition until the disc begins to interact with fluid flow. Thereafter, a low-speed/high-torque motor operating condition can occur during the last half of the valve stroke and as the valve disc is being seated.

Both high-torque/low speed and low-torque/high speed conditions generate heat that, if excessive, can cause deterioration of the insulation in the motor winding. If the heat buildup is severe, it can cause burnout of the winding insulation in a matter of seconds. Damage to the rotor also may occur. Moreover, degradation of the winding insulation and the rotor may occur in small increments and then fail under some particular demand depending on the degree and recurrence of the heat buildup. Thermal overload protection devices can be used to protect against such deficiencies by cutting off power to the motor to avoid degradation of the winding insulation and the rotor.

Following a motor shutoff by the thermal overload protection device, the motor could be restarted for a later attempt to open or close the valve. Appendix A, "LERs Pertinent to Thermal Overload Protection Issue" of NUREG 1296, "Thermal Overload Protection for Electric Motors on Safety Related Motor-Operated Valves – Generic Issue II.E.6.1" (Ref 2), lists a number of Licensee Event Reports related to thermal overload protection. Moreover, Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard 279-1971 referenced in the regulatory position of Regulatory Guide 1.106, Revision 1, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves," has been superseded by IEEE Standard 603-2009, "Criteria for Safety Systems for Nuclear Power Generating Stations" (Ref 3).

A lesson learned from operating experience and testing programs for motor-operated valves used in nuclear power plants is that significant valve operating requirements can occur as a result of high differential pressure and fluid flow conditions. For example, tilting of a valve disc in a gate valve because of high differential pressure and flow can cause metal grinding or binding that results in operating requirements much greater than those associated with sliding friction. Subsequent to initial accident conditions, the high differential pressure and fluid flow conditions might be significantly reduced during later stages of an accident. Therefore, a motor that is shut off by a thermal overload protection device might be capable of operating the valve later when the fluid conditions are less severe (such as lower differential pressure and flow). The need for a motor-operated valve to operate immediately at the outset of an accident or whether the safety function can be performed later during an accident should be considered in sizing and setting thermal overload protection devices.

Thermal overload protection devices for valve operator motors can be categorized as either thermal overload relays, usually housed in the motor starter, or temperature-sensing elements that are embedded in the motor windings. Thermal overload relays are available in a variety of designs and sizes with variations in features and accessories available for each. The basic components of a thermal overload relay are the heater element, which reacts to the current drawn by the motor, and the trip mechanism. Because the trip function in thermal overload relays 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 located 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 200º F under design basis conditions. Thus, the selection of an appropriate trip set point 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 percent to 0 percent of trip set point. Because 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 set point 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.

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. Acceptable criteria on selecting an appropriate trip set point that will protect the motor windings against excessive heating without jeopardizing the motor-operated valve's ability to complete its safety function are provided in Section 5.5, "Valve actuator motors," and Annex B, "Guidelines for Selection of Overload Protection for VAM Circuits" of IEEE Standard 741- 2007, "Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations" (Ref 4).

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

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 three alternatives described in regulatory position 1 and regulatory positions 2 or 3 should be implemented:

1. Provided that the completion of the safety function is not jeopardized or that other safety systems are not degraded:

   a) For valves that are required to function immediately to open or close to perform a single safety-related action and that do not change position thereafter, the thermal overload protection devices should be placed in service only when the valve motors are undergoing periodic or maintenance testing.

   b) For valves that operate during normal plant conditions and are automatically actuated to perform a safety-related function (whether to perform a single safety-related action or to modulate during an accident condition), the thermal overload protection devices should normally be in service during plant operation, testing, and maintenance and automatically bypassed under accident or station blackout (SBO) conditions.

   c) For motor-operated valves that do not have an immediate safety function to perform in response to an accident condition, the thermal overload protection device should be in service at all times (during normal operation, accident or SBO conditions, and maintenance).

   The bypass initiation system circuitry should generally conform to the criteria of Sections 4(g), 4(h), 4(i), 4(j), 4(k), 4(l), 5, 5.1, 5.2, 5.3, 5.4, 5.5, and 5.7 of IEEE Std 603-2009, "Criteria for Safety Systems for Nuclear Power Generating Stations," and should be periodically tested.

2. The trip setting 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 and (b) inaccuracies in motor heating data and the overload protection device trip characteristics and the matching of these two items. To ensure continued functional reliability and the accuracy of the trip point, the thermal overload protection device should be periodically tested.

   The trip setting of the thermal overload protection device should conform to the guidance provided in Annex B of IEEE Standard 741-2007, "Critera for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations."

3. An alarm indication should be provided in the control room that should generally conform to criteria 5.8 provided in IEEE 603-2009, "Criteria for Safety Systems for Nuclear Power Generating Stations," when a safety-related valve motor generates overcurrent (and thus heat) and trips the thermal overload protection device.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[1] may use this guide and information regarding the NRC's plans for using this Regulatory Guide. In addition, it describes how the NRC staff has complied with the Backfit Rule, 10 CFR 50.109 and any applicable finality provisions in 10 CFR Part 52.

Applicant and Licensees' Use

Applicants and licensees may (i.e., voluntarily) use the information in this regulatory guide to develop applications for initial licenses, amendments to licenses, or other requests for NRC regulatory approval (e.g., exemptions). Licensees may use the information in this regulatory guide for actions which do not require prior NRC review and approval (e.g., changes to a facility design under 10 CFR 50.59 which do not require prior NRC review and approval). Licensees may use the information in this Regulatory Guide or applicable parts to resolve regulatory or inspection issues (e.g., by committing to comply with provisions in the regulatory guide).

Current licensees may continue to use the guidance that was found acceptable for complying with specific portions of the regulations as part of their license approval process, which may be a previous version of this Regulatory Guide.

A licensee who believes that the NRC staff is inappropriately imposing this Regulatory Guide as part of a request for a license amendment or request for a change to a previously issued NRC regulatory approval may file a backfitting appeal with the NRC in accordance with applicable procedures.

NRC Staff Use

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this Regulatory Guide. The staff does not expect any existing licensee to use or commit to using the guidance in this Regulatory Guide in the absence of a licensee-initiated change to its licensing basis. The NRC staff does not expect or plan to request licensees to voluntarily adopt this Regulatory Guide to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action which would require the use of this regulatory guide (e.g. issuance of an order requiring the use of the Regulatory Guide, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this regulatory guide, generic communication, or promulgation of a rule requiring the use of this Regulatory Guide) without further back-fitting consideration.

During inspections of specific facilities, the staff may suggest or recommend that licensees consider various actions consistent with staff positions in this regulatory guide. Such suggestions and recommendations would not ordinarily be considered backfitting even if prior versions of this Regulatory Guide are part of the licensing basis of the facility with respect to the subject matter of the inspection. However, unless this Regulatory Guide is part of the licensing basis for a plant, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this Regulatory Guide constitutes a violation.

If an existing licensee seeks a license amendment or change to an existing regulatory approval, and the staff's consideration of the request involves a regulatory issue which is directly relevant to this

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[1] In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52; and the term "applicants" refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

Regulatory Guide and the specific subject matter of the new or revised guidance is an essential consideration in the NRC staff's determination of the acceptability of the licensee's request, the staff may require the licensee to use this Regulatory Guide or its equivalent as a prerequisite for NRC approval. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

Conclusion

This regulatory guide is not being imposed upon current licensees and may be voluntarily used by existing licensees. In addition, this Regulatory Guide is issued in conformance with all applicable internal NRC policies and procedures governing backfitting. Accordingly, the NRC's staff issuance of this regulatory guide is not considered backfitting, as defined in 10 CFR 50.109(a)(1), nor is it deemed to be in conflict with any of the issue finality provisions in 10 CFR Part 52.

REFERENCES[2]

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington, DC.

2. NUREG-1296, "Thermal Overload Protection for Electric Motors on Safety Related Motor-Operated Valves – Generic Issue II.E.6.1," U.S. Nuclear Regulatory Commission, Washington, DC, June 1988.

3. IEEE Std. 603-2009, "Criteria for Safety Systems for Nuclear Power Generating Stations" (Revision of IEEE Std. 603-1998), Institute of Electrical and Electronics Engineers, New York, NY.[3]

4. IEEE Std. 741-2007, "Criteria for Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations" (Revision of IEEE Std. 741-1997), Institute of Electric and Electronics Engineers, New York, NY.

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[2] Publicly available NRC published documents are available electronically through the Electronic Reading Room on the NRC's public Web site at: http://www.nrc.gov/reading-rm/doc-collections/. The documents can also be viewed on-line or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone 301-415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail pdr.resource@nrc.gov.

[3] Copies of Institute of Electrical and Electronics Engineers (IEEE) standards may be purchased from the IEEE Standards Association, 445 Hoes Lane, Piscataway, NJ 08855-1331; telephone (800) 678 4333. Purchase information is available through the IEEE Standards Association Web site at http://www.ieee.org.