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Division 1

DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-1222

(Proposed Revision 1 of Regulatory Guide 1.50, dated May 1973)

CONTROL OF PREHEAT TEMPERATURE FOR WELDING OF LOW-ALLOY STEEL

A. INTRODUCTION

General Design Criterion 1, "Quality Standards and Records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50) requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 requires that measures be established to ensure control of materials and of special processes such as welding and that proper process monitoring be performed. This guide describes an acceptable method of implementing these requirements with regard to the control of welding for low-alloy steel components during initial fabrication. This guide applies to light-water-cooled reactors. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has not objected to publishing the draft Regulatory Guides for public comment.

The U.S. Nuclear Regulatory Commission (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

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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 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 Rulemaking, Directives, and Editing Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; e-mailed to nrcrep.resource@nrc.gov; submitted through the 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 the NRC's Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by August 31, 2009.

Electronic copies of this draft regulatory guide are available through the NRC's interactive rulemaking Web page (see above); the NRC's public Web site under Draft Regulatory Guides in the Regulatory Guides document collection of the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/doc-collections/; and the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML090750343.

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. The 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.

B. DISCUSSION

The American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME B&PV Code), Section III, "Nuclear Power Plant Components,"[1] specifies certain requirements associated with manufacturing Code Class 1, 2, and 3 components.

Procedure Qualification

Section III requires adherence to Section IX, "Welding Qualifications," of the ASME B&PV Code, including the requirements governing procedure qualifications for welds. Review of the requirements of Section IX for procedure qualifications and the fabrication requirements of Section III indicates the desirability of supplementary requirements to ensure adequate control of welding variables in the production welding of low-alloy steels. The assurance of satisfactory welds in low-alloy steels can be increased significantly and, in particular, the propensity for cracks (cold cracks) or reheat cracks forming in underbead areas and heat-affected zones (HAZs) can be minimized, by maintaining proper preheat temperatures on the base metals concurrent with controls on other welding variables.

Cold cracking can occur when the steel is hardened (i.e., it undergoes a phase transformation to martensite in the HAZ and/or weld metal). The martensite exhibits brittle fracture tendencies, and it may not be able to withstand rapid cooling and the volume change associated with the phase transformation without the occurrence of local cracking. This susceptibility to cracking increases with higher stresses, such as those experienced with increased thickness of the part being welded, and also increases with a decrease in welding energy input. To avoid or minimize the effects of hardening associated with phase transformation, a longer cooling time is needed for the weld; in other words, the preheat temperature should be maintained high enough to achieve an acceptable condition of the phase transformation.

It is generally recognized that atomic hydrogen absorption and diffusion into and through the region being welded have an important influence on the tendency to form cracks. The level of hydrogen in weld filler metal is low enough to preclude adverse effects in the welds, but greater quantities of hydrogen can be present in the weld region from the dissociation of moisture in hygroscopic welding fluxes or from adsorption on metal surfaces if the welding fluxes and surfaces have not been properly dried before weld deposition. Embrittlement of metal in the weld area as the result of the presence of hydrogen generally occurs at lower temperatures and may be prevented by prolonging the time the weldment is maintained at preheating temperature or by performing a postweld heat treatment. Prolonged time at the preheating temperature can prevent or interrupt local hardening and assist in reducing the adverse effects of a potential hydrogen gradient. This gradient would disappear by means of diffusion of the hydrogen before the weldment is returned to room temperature. Therefore, the minimum preheat temperature should be established to ensure a desirable cooling rate for the weld, and this temperature should be maintained until a postweld heat treatment has been achieved.

In addition to the minimum preheat temperature, a maximum interpass temperature should be specified. If the weld metal transforms at too high a temperature, the required mechanical properties for the metal may not be met. The maximum interpass temperature varies for different steels, as does the minimum preheat temperature, and should be selected on the basis of such influencing factors as the chemical composition of the steel.

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1 Copies of ASME standards discussed herein may be obtained from the American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990; telephone (800) 843-2763; http://www.asme.org/Codes/Publications//.

Production Welds

The procedure qualification by itself does not ensure that the production welds will be made within the specified preheat temperature range. To ensure that the welds will be acceptable, the metal temperature should be monitored during the welding process and through postweld heat treatment.

C. REGULATORY POSITION

Weld fabrication[2] for low-alloy steel components should comply with the fabrication requirements specified in Section III and Section IX of the ASME B&PV Code supplemented by the following:

1. The procedure qualification should require the following:
a. A minimum preheat and a maximum interpass temperature should be specified.
b. The welding procedure should be qualified at the minimum preheat temperature.

2. For production welds, the preheat temperature should be maintained until final postweld heat treatment or a hydrogen bakeout is performed between 200 and 400 °C (400 and 750 °F) for a minimum of four hours after which the component may be slowly cooled to ambient temperature prior to the performance of the final post weld heat treatment. The post weld hydrogen bakeout temperature and soak time should be based on the materials being welded, geometry and the welding process used.

3. Production welding should be monitored to verify that the limits on preheat and interpass temperatures are maintained.

4. If Regulatory Positions 1, 2, and 3 above are not met, the weld is subject to rejection. However, the soundness of the weld may be verified by an acceptable examination procedure.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC's plans for using this draft regulatory guide. The NRC does not intend or approve any imposition or backfit in connection with its issuance.

The NRC has issued this draft guide to encourage public participation in its development. The NRC will consider all public comments received in development of the final guidance document. In some cases, applicants or licensees may propose an alternative or use a previously established acceptable alternative method for complying with specified portions of the NRC's regulations. Otherwise, the methods described in this guide will be used in evaluating compliance with the applicable regulations for license applications, license amendment applications, and amendment requests.

[2] This position does not apply to weld repairs after initial fabrication.

REGULATORY ANALYSIS

Statement of the Problem

The NRC initially issued Regulatory Guide 1.50, "Control of Preheat Temperature for Welding of Low-Alloy Steel," in May 1973. The guidance does not reflect changes in the ASME B&PV Code since 1973. Therefore, revision of this regulatory guidance is necessary to reflect updates in the ASME Code.

Objective

The objective of this regulatory action is to update the NRC's guidance for the control of preheat temperature for welding of low-alloy steel, consistent with changes in the ASME Code since May 1973.

Alternative Approaches

The NRC staff considered the following alternative approaches:

Do not revise Regulatory Guide 1.50.
Revise Regulatory Guide 1.50.

Alternative 1: Do Not Revise Regulatory Guide 1.50

Under this alternative, the NRC would not revise the guidance, and the current guidance would be retained. If the NRC does not take action, there would not be any changes in costs or benefit to the public, the licensees, or the NRC. However, the "no-action" alternative would not address identified concerns with the current version of the regulatory guide. The NRC would continue to review each application on a case-by-case basis. This alternative provides a baseline condition from which any other alternatives will be assessed.

Alternative 2: Revise Regulatory Guide 1.50

Under this alternative, the NRC would revise Regulatory Guide 1.50, taking into consideration the changes in the ASME Code.

One benefit of this action is that it would clarify the guidance and references to the ASME Code for applicants building new nuclear power plants, as well as for licensees.

The impact to the NRC would be the costs associated with preparing and issuing the regulatory guide revision. The impact to the public would be the voluntary costs associated with reviewing and providing comments to the NRC during the public comment period. The value to the NRC staff and its applicants would be the benefits associated with enhanced efficiency and effectiveness in using a common guidance document as the technical basis for license applications and other interactions between the NRC and its regulated entities.

Conclusion

Based on this regulatory analysis, the NRC staff recommends revision of Regulatory Guide 1.50. The staff concludes that the proposed action will reduce unnecessary confusion when referencing the ASME Code. It could also lead to cost savings for the industry, especially with regard to applications for standard plant design certifications and combined licenses.