



DRAFT REGULATORY GUIDE

Contact: M. Benson
(301) 251-7492

DRAFT REGULATORY GUIDE DG-1279

(Proposed Revision 4 of Regulatory Guide 1.31, dated April 1978)

CONTROL OF FERRITE CONTENT IN STAINLESS STEEL WELD METAL

A. INTRODUCTION

This guide describes a method that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for controlling ferrite content in stainless steel weld metal. The staff has consulted with the Advisory Committee on Reactor Safeguards on this guide, and the Committee concurs with the regulatory position.

Title 10, of the *Code of Federal Regulations*, Part 50, “Domestic Licensing of Production and Utilization Facilities” (10 CFR Part 50) (Ref. 1), Appendix A, “General Design Criteria for Nuclear Power Plants,” General Design Criterion (GDC) 1, “Quality Standards and Records,” requires that components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. GDC 14, “Reactor Coolant Pressure Boundary,” requires that the reactor coolant pressure boundary be designed, fabricated, erected, and tested so that it has an extremely low probability of abnormal leakage, rapidly propagating failure, and gross rupture. Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” to 10 CFR Part 50 requires that a quality assurance program be applied to the design, construction, and operation of structures, systems, and components. Appendix B also requires that measures be established to ensure that special processes, including welding, are controlled and accomplished by qualified personnel using qualified procedures and that proper process monitoring is performed.

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 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 Rules, Announcements, and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; 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 December 2, 2012.

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 Library 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. ML12024A004. The regulatory analysis may be found in ADAMS under Accession No. ML12024A014.

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. This regulatory guide is a rule as designated in the Congressional Review Act (5 U.S.C. 801-808). However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

B. DISCUSSION

Inspection of some welds in austenitic stainless steel components of nuclear reactors has revealed the presence of microfissures. Further investigations related the presence of the microfissures to the low delta ferrite content of the deposited weld metal. Since microfissures in austenitic welds may have an adverse effect on the integrity of components, the control of weld deposits to ensure the presence of delta ferrite in these welds is advisable.

To achieve this control, the original version of this guide, Safety Guide 31, "Control of Stainless Steel Welding," issued August 1972 (Ref. 2), provided guidance to test production welds. This guidance was retained in Revision 1 of the Safety Guide, which was issued June 1973 as Regulatory Guide 1.31, "Control of Ferrite Content in Stainless Steel Weld Metal (Ref. 3). Because licensees and other representatives of the nuclear industry believed that adequate control of filler metal ferrite content would consistently provide sound weld deposits with an absence of microfissures, the American Society of Mechanical Engineers (ASME), the American National Standards Institute (ANSI), and the NRC formed a cooperative study group to investigate the problem and the alternatives that would ensure adequate control of ferrite content. The study group analyzed data from welds prepared by eight different procedures. The group analyzed about 1,500 test results and made recommendations to both ASME and the NRC on how testing of production welds could be reduced without sacrificing control of the ferrite content.

Revision 2 (issued May 1977) and Revision 3 (issued April 1978) to this guide were based on those recommendations. Revision 2 of this guide replaced the guidance for testing production welds in Revision 1 with guidance for process control through testing weld test pads. These changes considerably reduced the testing effort needed to control delta ferrite in welds. Revision 4 updates several outdated standards and removes an appendix that has been incorporated into relevant specifications.

The provisions of the ASME Boiler and Pressure Vessel Code (ASME Code) (Ref. 4) incorporated by reference into the NRC regulations require compliance with one of two alternative methods (i.e., either a chemical analysis method or a magnetic measurement method) to control delta ferrite in weld metal filler materials. The NRC staff does not consider the use of the chemical analysis method for every welding process adequate by itself to ensure controlled delta ferrite in production welds. The staff positions in this guide are intended to supplement the ASME Code requirements to ensure control of delta ferrite in welds in austenitic stainless steel core support structures; reactor internals; and Class 1, 2, and 3 components.

The staff concludes that ferrite content in the weld filler metal, as depicted by a ferrite number, should be between 5 and 20. This lower limit provides sufficient ferrite to avoid microfissuring in welds, whereas the upper limit provides a ferrite content adequate to offset dilution and reduce thermal aging effects.

This regulatory guide endorses the use of one or more voluntary consensus codes or standards developed by external organizations. These codes or standards may contain references to other codes or

standards. These references should be considered individually. If a referenced standard has been incorporated separately into NRC regulations, licensees and applicants must comply with that standard as set forth in the regulation. If the referenced standard has been endorsed in a regulatory guide, the standard constitutes a method acceptable to the NRC staff for meeting a regulatory requirement as described in the specific regulatory guide. If a referenced standard has been neither incorporated into NRC regulations nor endorsed in a regulatory guide, licensees and applicants may consider and use the information in the referenced standard, if appropriately justified and consistent with current regulatory practice.

The NRC has an interest in facilitating the harmonization of standards used domestically and internationally. This regulatory guide endorses standards from the American Welding Society (AWS) and the American Society of Mechanical Engineers (ASME), which are international standards organizations that develop and publish voluntary consensus technical standards for a wide range of materials, products, systems, and services.

C. STAFF REGULATORY GUIDANCE

1. Verification of Delta Ferrite Content of Filler Materials

Prior to production usage, the delta ferrite content of test weld deposits from each lot and each heat of weld filler metal procured for the welding of austenitic stainless steel core support structures, reactor internals, and Class 1, 2, and 3 components should be verified for each process to be used in production.

Delta ferrite determinations are not necessary for type 16-8-2 filler metal in filler metal specifications SFA-5.4, "Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding," and SFA-5.9, "Bare Stainless Steel Welding Electrodes and Rods" of Section II of the ASME Code, or for filler metal used for weld metal cladding.

Delta ferrite determinations for consumable inserts, electrodes, rod, or wire filler metal used with the gas tungsten arc welding process, and deposits made with the plasma arc welding process, may be predicted from their chemical composition by using an applicable constitutional diagram in the applicable filler metal specification (e.g., WRC-1992 diagram for stainless steel weld metal in SFA-5.9 of Section II of the ASME Code).

For all other processes, delta ferrite verification should be performed through tests using magnetic measuring devices on undiluted weld deposits. For submerged arc welding processes, the verification tests for each wire and flux combination may be made on a production weld or simulated production weld. All other delta ferrite weld filler verification tests should be made on weld pads that contain undiluted layers of weld metal.

2. Ferrite Measurement

The NRC staff considers the procedures for pad preparation and ferrite measurement in American Welding Society (AWS) A5.4/A5.4M, "Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding," (Ref. 5) and SFA-5.4 of Section II of the ASME Code acceptable.

3. Instrumentation

The weld pad should be examined for ferrite content by using a magnetic measuring instrument that has been calibrated against a Magnegage in accordance with AWS A4.2M, "Standard Procedures for

Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Ferritic-Austenitic Stainless Steel Weld Metal” (Ref. 6). The Magnegage should have been previously calibrated in accordance with AWS A4.2M using primary standards as defined therein.

4. Acceptability of Test Results

Weld pad test results showing an average ferrite number from 5 to 20 indicate that the filler metal is acceptable for the production welding of Class 1, 2, and 3 austenitic stainless steel components, reactor internals, and core support structures.

5. Quality Assurance

The applicable provisions of Appendix B to 10 CFR Part 50 should be used to verify compliance with requirements for delta ferrite of each lot and each heat of weld filler metal as described herein.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees¹ may use this guide and information regarding the NRC’s plans for using this regulatory guide. In addition, it describes how the NRC staff complies with the Backfit Rule (10 CFR 50.109) and any applicable finality provisions in 10 CFR Part 52.

Use by Applicants and Licensees

Applicants and licensees may voluntarily² use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this regulatory guide may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged.

Licensees may use the information in this regulatory guide for actions which do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59. Licensees may use the information in this regulatory guide or applicable parts to resolve regulatory or inspection issues.

Use by NRC Staff

During regulatory discussions on plant specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this regulatory guide as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting even if prior versions of this regulatory guide are part of the licensing basis of the facility. However, unless this regulatory guide is part of the licensing basis for a facility, the staff may

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.

² In this section, “voluntary” and “voluntarily” mean that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

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 voluntarily seeks a license amendment or change and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this new or revised regulatory guide and (2) the specific subject matter of this regulatory guide is an essential consideration in the staff's determination of the acceptability of the licensee's request, then the staff may request that the licensee either follow the guidance in this regulatory guide or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. 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.

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this regulatory guide. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this regulatory guide, unless the licensee makes a 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. Examples of such unplanned NRC regulatory actions include 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 backfit consideration.

Additionally, an existing applicant may be required to adhere to new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

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 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.

If a licensee believes that the NRC is either using this regulatory guide or requesting or requiring the licensee to implement the methods or processes in this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG 1409 and NRC Management Directive 8.4.

REFERENCES

1. 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” U.S. Nuclear Regulatory Commission, Washington, DC.³
2. Safety Guide 31, “Control of Stainless Steel Welding,” U.S. Nuclear Regulatory Commission, Washington, DC.³
3. Regulatory Guide 1.31, “Control of Ferrite Content in Stainless Steel Weld Metal,” U.S. Nuclear Regulatory Commission, Washington, DC.³
4. ASME Boiler and Pressure Vessel Code, Section II, Part C, “Specifications for Welding Rods, Electrodes, and Filler Metals,” American Society of Mechanical Engineers.⁴
5. AWS A5.4/A5.4M, “Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding,” American Welding Society, (January 2006, or equivalent).⁵
6. AWS A4.2M, “Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Ferritic-Austenitic Stainless Steel Weld Metal,” American Welding Society, (January 2006, or equivalent).⁵

³ Publicly available NRC published documents are available electronically through the NRC Library on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/doc-collections/>. The documents can also be viewed online 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.

⁴ Copies of American Society of Mechanical Engineers (ASME) standards may be purchased from ASME, Three Park Avenue, New York, NY 10016-5990; telephone (800) 843-2763. Purchase information is available through the ASME Web-based store at <http://www.asme.org/Codes/Publications/>.

⁵ Copies may be obtained from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126. Publications may also be obtained through the AWS online store at <http://www.aws.org/w/a>.