UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 30, 2017

Vice President, Operations
Entergy Operations, Inc.
Grand Gulf Nuclear Station
P.O. Box 756
Port Gibson, MS 39150

SUBJECT: GRAND GULF NUCLEAR STATION, UNIT 1 – RELIEF REQUEST GG-ISI-021 PROPOSING AN ALTERNATIVE FOR THE FOURTH 10-YEAR INSERVICE INSPECTION PROGRAM (CAC NO. MF9752; EPID L-2017-LLR-0031)

Dear Sir or Madam:

By letter dated May 25, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17145A321), as supplemented by letter dated September 22, 2017 (ADAMS Accession No. ML17269A078), Entergy Operations, Inc. (the licensee) requested changes to the inspection program for the fourth 10-year inservice inspection (ISI) interval for Grand Gulf Nuclear Station (GGNS), Unit 1.

The proposed relief request alternative GG-ISI-021 would revise the inspection requirements for certain reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii from those based on American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, to an alternative based on ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds Section XI, Division 1," without using the Code Case-specified visual examination.

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the licensee's submittals and concluded, as set forth in the enclosed safety evaluation, that the licensee has adequately addressed all of the regulatory requirements set forth in Title 10 of the *Code of Federal Regulations*, Section 50.55a(z)(1), and is in compliance with the ASME Codes' requirements. Therefore, the NRC authorizes the licensee's proposed alternative for inspection of the RPV nozzle-to-vessel shell welds and nozzle inner radii sections listed in Tables 1 and 2 and Attachment 1 of the licensee's May 25, 2017, submittal, with the exception of feedwater nozzles and control rod drive return nozzles, for GGNS through the end of the fourth ISI interval, which ends on November 1, 2024.

All other ASME Code, Section XI, requirements for which relief was not specifically requested and approved by the NRC staff remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the Project Manager, Siva P. Lingam, at 301-415-1564 or via e-mail at Siva.Lingam@nrc.gov.

Sincerely,

Robert J. Pascarelli, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-416

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST GG-ISI-021 PROPOSING AN ALTERNATIVE FOR THE

FOURTH 10-YEAR INSERVICE INSPECTION PROGRAM

ENTERGY OPERATIONS, INC.

GRAND GULF NUCLEAR STATION, UNIT 1

DOCKET NO. 50-416

1.0 INTRODUCTION

By letter dated May 25, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17145A321), as supplemented by letter dated September 22, 2017 (ADAMS Accession No. ML17269A078), Entergy Operations, Inc. (Entergy, the licensee) requested changes to the inspection program for the fourth 10-year inservice inspection (ISI) interval for Grand Gulf Nuclear Station (GGNS).

The proposed relief request alternative GG-ISI-021 would revise the inspection requirements for certain reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii from those based on American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, to an alternative based on ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds, Section XI, Division 1," without using the Code Case-specified visual (VT-1) examination.

2.0 REGULATORY EVALUATION

ASME Code Class 1, 2, and 3 components' ISI program is performed in accordance with Section XI of the ASME Code and applicable addenda as a way to detect anomaly and degradation indications so that structural integrity of these components can be maintained. This is required by Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g), "Preservice and inservice inspection requirements," except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i), "Impractical ISI requirements: Granting of relief." The regulations in 10 CFR 50.55a(z), "Alternatives to codes and standards requirements," state that alternatives to the requirements of paragraph (g) may be used, when authorized by the U.S. Nuclear Regulatory Commission (NRC), if: (1) the proposed alternatives would provide an acceptable level of quality and safety or (2) compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For all RPV nozzle-to-vessel shell welds and nozzle inner radii, ASME Code, Section XI, requires 100 percent inspection during each ISI interval. However, ASME Code Case N-702

proposes an alternative, which reduces the inspection of RPV nozzle-to-vessel shell welds and nozzle inner radius areas from 100 percent to 25 percent of the nozzles for each nozzle type during each 10-year interval. In its safety evaluation (SE) dated December 19, 2007 (ADAMS Accession No. ML073600374), the NRC approved the [BWR Vessel and Internals Project] BWRVIP-108 report, "BWRVIP-108: BWR Vessel and Internals Project, Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Inner Radii," which contains the technical basis supporting ASME Code Case N-702. The NRC staff's SE for the BWRVIP-108 report specified plant-specific requirements, which must be satisfied by the licensees in order to use ASME Code Case N-702.

3.0 TECHNICAL EVALUATION

The following plant-specific requirements are specified in the NRC staff's SE for the BWRVIP-108 report supporting use of the ASME Code Case N-702:

> [E]ach licensee should demonstrate the plant-specific applicability of the BWRVIP-108 report to their units in the relief request by showing that all the following general and nozzle-specific criteria are satisfied:
>
> (1) the maximum RPV heatup/cooldown rate is limited to less than [<] 115 °F/hour [degrees Fahrenheit per hour];
>
> For recirculation inlet nozzles
>
> (2) $(pr/t)/C_{RPV} < 1.15$
>
> p = RPV normal operating pressure,
> r = RPV inner radius,
> t = RPV wall thickness, and
> C_{RPV} = 19332 (i.e., 1000 psi [pounds per square inch] x 110 inch/5.69 inch, based on the BWRVIP-108 recirculation inlet nozzle/RPV FEM [finite element method] model);
>
> (3) $[p(r_o^2 + r_i^2)/ (r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$
>
> p = RPV normal operating pressure,
> r_o = nozzle outer radius,
> r_i = nozzle inner radius, and
> C_{NOZZLE} = 1637 [i.e., 1000 psi x($13.988^2 + 6.875^2$)/ ($13.988^2 - 6.875^2$)], based on the BWRVIP-108 recirculation inlet nozzle/RPV FEM model];
>
> For recirculation outlet nozzles
>
> (4) $(pr/t)/C_{RPV} < 1.15$
>
> p = RPV normal operating pressure,
> r = RPV inner radius,
> t = RPV wall thickness, and
> C_{RPV} = 16171 (i.e., 1000 psi x 113.2 inch/7.0 inch, based on the BWRVIP-108 recirculation outlet nozzle/RPV FEM model); and

(5) $[p(r_o^2 + r_i^2)/ (r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$

p = RPV normal operating pressure,
r_o = nozzle outer radius,
r_i = nozzle inner radius, and
C_{NOZZLE} = 1977 [i.e., 1000 psi x($22.31^2 + 12.78^2$)/ ($22.31^2 - 12.78^2$)], based on the BWRVIP-108 recirculation outlet nozzle/RPV FEM model].

This plant-specific information was required by the NRC staff to ensure that the probabilistic fracture mechanics (PFM) analysis documented in the BWRVIP-108 report applies to the RPV of the applicant's plant.

3.1 Licensee Evaluation

Component(s) for which Alternative is Requested (ASME Code Class 1)

Reactor Recirculation Inlet Nozzles - N2A, N2B, N2C, N2D, N2E, N2F, N2G, N2H, N2J, N2K, N2M, and N2N

Main Steam Nozzles - N3A, N3B, N3C, and N3D

Core Spray Nozzles - N5A and N5B

RPV Head Nozzles - N6A, N6B, N6C, N7 and N8

Jet Pump Instrumentation Nozzles – N9A and N9B

Vibration Instrumentation Nozzle to Vessel - N16

Note that the feedwater nozzles and control rod drive return nozzles were not included in the licensee's request.

Examination Category

B-D, Full Penetration Welds of Nozzles in Vessels

Examination Item Numbers

B3.90, "Nozzle-to-Vessel Welds" and B3.100, "Nozzle Inside Radius Section"

ASME Code Requirement for which Alternative is Requested (as stated by the licensee in its letter dated May 25, 2017)

The 2007 Edition through 2008 Addenda is the applicable ISI Code of Record for the fourth ISI interval for GGNS of ASME Code, Section XI, Table IWB-2500-1, "Examination Category B-D, Full Penetration Welds of Nozzles in Vessels – Inspection Program B":

- Item B3.90 - Requires a volumetric examination of Reactor Vessel Nozzle-to-Vessel Welds.
- Item B3.100 - Requires a volumetric examination of Reactor Vessel Nozzle Inside Radius Sections.

Proposed Alternative to the ASME Code (as stated by the licensee, in part, in its letter dated May 25, 2017)

> Pursuant to 10 CFR 50.55a(a)(z)(1), Entergy requests an alternative from performing the ASME Code required examinations on 100% of the nozzle-to-vessel welds and nozzle inner radius sections identified in Tables 1 and 2,[1] respectively. Specifically, Entergy proposes to adopt ASME Code Case N-702, which allows examination of a minimum of 25% of the nozzle-to-vessel welds and nozzle inside radius sections, including at least one nozzle from each system and nominal pipe size.... For each of the identified nozzle assemblies..., both the nozzle-to-vessel weld and the inner radius section for that scheduled nozzle assembly will be examined.
>
> ...
>
> "ASME Code Case N-702 also includes a provision that stipulates that a VT-1 visual examination method may be used in lieu of the volumetric examination method for the inside radius sections of (Item No. B3.100) listed in Table 2 [of the May 25, 2017 submittal], but as of now all inside radius section examinations within the scope of this alternative request have been performed previously at GGNS using an [ultrasonic testing (UT)] examination method. With this option available in ASME Code Case N-702, GGNS may perform examinations on the inside radius sections listed in Table 2 [of the May 25, 2017 submittal] under Code Case N-702 with either the VT-1 or the volumetric examination method for the 4th Interval.

Bases for Alternative

The licensee stated that currently ASME Code Case N-702 is listed in NRC Regulatory Guide (RG) 1.147, Revision 17, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1" (ADAMS Accession No. ML13339A689) as conditionally acceptable for use. The condition reads as follows in the May 25, 2017, submittal:

> The technical basis supporting the implementation of this Code Case is addressed by BWRVIP-108: BWR Vessel and Internals Project, "Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii," EPRI [Electric Power Research Institute] Technical Report 1003557, October 2002 ([ADAMS Accession No.] ML023330203) and BWRVIP-241: BWR Vessel and Internals Project, "Probabilistic Fracture Mechanics Evaluation for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii," EPRI Technical Report 1021005, October 2010 ([ADAMS Accession No.] ML11119A041). The applicability of Code Case N-702 must be shown by demonstrating that the criteria in Section 5.0 of NRC Safety Evaluation regarding BWRVIP-108 dated December 18, 2007 ([ADAMS Accession No.] ML073600374) or Section 5.0 of NRC Safety Evaluation regarding BWRVIP-241 dated April 19, 2013 ([ADAMS Accession No.] ML13071A240) are met. The evaluation demonstrating the

[1]Refers to Tables 1 and 2 of the licensee's May 25, 2017, submittal. Tables 1 and 2 are not included in this SE.

> applicabilitv of the Code Case shall be reviewed and approved bv the NRC prior to the application of the Code Case.

In Section 5.0, "Plant-Specific Applicability," of the NRC staff's SE for the BWRVIP-108 report, the NRC stated, in part, that

> Licensees who plan to request relief from the ASME Code, Section XI requirements for RPV nozzle-to-vessel shell welds and nozzle inner radius sections may reference the BWRVIP-108 report as the technical basis for the use of ASME Code Case N-702 as an alternative. However, each licensee should demonstrate the plant-specific applicability of the BWRVIP-108 report to their units [by complying with the following general and nozzle-specific criteria. Criteria listed in Section 3.0 above].

Entergy performed this demonstration in Attachment 1 of the May 25, 2017, submittal:

> Criterion 1: the maximum RPV heat[up]/cooldown rate is limited to less than 115 °F/hour,
>
> (1) Maximum heat[up] and cooldown rates are limited to ≤ [less than or equal to] 100 °F in any one-hour period, in accordance with GGNS Technical Specification Surveillance Requirement 3.4.11.1.
>
> Criteria 2 and 3: for recirculation inlet nozzles,
>
> (2) $(pr/t)/C_{RPV} < 1.15$; the calculation for GGNS recirculation inlet nozzles results in 0.9296, which is less than 1.15 and satisfies Criterion 2.
>
> (3) $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$, the calculation for GGNS nozzles results in 0.9598, which is less than 1.15 and satisfies Criterion 3.
>
> Criteria 4 and 5: for the recirculation outlet nozzles,
>
> (4) $(pr/t)/C_{RPV} < 1.15$, the calculation for GGNS recirculation outlet nozzles results in 1.104, which is less than 1.15 and satisfies Criterion 4.
>
> (5) $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$, the calculation for the GGNS nozzles results in 0.977, which is less than 1.15 and satisfies Criterion 5.

Based upon the above information, the licensee concluded that it has established applicability of BWRVIP-108 to GGNS and the proposed use of ASME Code Case N-702 provides an acceptable level of quality and safety in accordance with 10 CFR 50.55a(z)(1) for all applicable RPV nozzle-to-vessel weld and nozzle inside radius, excluding the six N04 nozzles (feedwater) and one N10 nozzle (control rod drive return nozzles). The licensee further stated that only twenty eight total nozzle assemblies are included in the scope of the request and to date, no reportable indications were found during the second and third ISI intervals. In addition, the licensee stated that its "evaluation found that the failure probability due to a Low Temperature Overpressure event at the nozzle blend radius region and nozzle-to-vessel shell weld is very low with or without ISI and this evaluation is only applicable to the initial 40 years of operation for GGNS. The report concludes that inspection of 25 % of each nozzle type is technically justified."

Period of Application

Fourth 10-year inspection interval (December 1, 2017 to November 1, 2024).

3.2 NRC Staff Evaluation

The NRC staff's SE for the BWRVIP-108 report specified five plant-specific criteria that licensees must meet to demonstrate that the BWRVIP-108 report results apply to their plants. The five criteria are related to the driving force of the PFM analyses for the recirculation inlet and outlet nozzles. It was stated in the NRC staff's SE for the BWRVIP-108 report that the nozzle material fracture toughness-related reference nil ductility temperature [RT_{NDT}] used in the PFM analyses were based on data from the entire fleet of BWR RPVs. Therefore, the BWRVIP-108 report PFM analyses are bounding with respect to fracture resistance, and only the driving force of the underlying PFM analyses needs to be evaluated. It was also stated in the NRC staff's evaluation that except for the RPV heatup/cooldown rate, the plant-specific criteria are for the recirculation inlet and outlet nozzles only because the probabilities of failure for other nozzles are an order of magnitude lower. The plant-specific heatup/cooldown rate that the NRC staff established in Criterion 1 regards the rate under the plant's normal operating condition, which is limiting. Events with excursions of heatup/cooldown rates exceeding 115 °F/hour are considered as transients. According to the NRC staff's SE for the BWRVIP-108 report, the PFM results with a very severe low temperature overpressure transient is not limiting, largely because the event frequency for that transient is $1x10^{-3}$ as opposed to 1.0 for the normal operating condition.

In its submittal dated May 25, 2017, the licensee provided Entergy's plant-specific data for the GGNS RPV and its evaluation of the five driving-force factors, or ratios, against the criteria established in the NRC staff's SE for the BWRVIP-108 report. The staff verified the licensee's evaluation, which indicated that all criteria are satisfied. As a result, the reduced inspection requirements in accordance with ASME Code Case N-702, apply to all proposed GGNS RPV nozzles, and the NRC staff concluded that the licensee's proposed alternative for all GGNS RPV nozzles included in this application (see Section 3.1 of this SE) provides an acceptable level of quality and safety.

The NRC staff notes that the RPV feedwater nozzles and control rod drive return line nozzles are outside the scope of ASME Code Case N-702 and, accordingly, are outside the scope of this application.

Regarding the examination of the inner nozzle radius, ASME Code Case N-702 permits a VT-1 examination of the nozzle inner radius in lieu of UT. The requirements for VT-1 examinations on the nozzle inner radius are addressed in ASME Code, Section XI, Code Case N-648-1, "Alternative Requirements for Inner Radius Examinations of Class 1 Reactor Vessel Nozzles, Section XI, Division 1." The NRC staff's conditional approval of this Code Case is addressed in Revision 17, of RG 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1." Tha staff's condition in RG 1.147 states, "In lieu of a UT examination, licensees may perform a VT-1 examination in accordance with the code of record for the Inservice Inspection Program utilizing the allowable flaw length criteria of Table IWB-3512-1 with limiting assumptions on the flaw aspect ratio."

In the letter dated May 25, 2017, however, the licensee did not invoke Code Case N-648-1 for the fourth ISI interval at GGNS. In this context, by e-mail dated August 23, 2017 (ADAMS

Accession No. ML17235B175), the NRC staff requested that the licensee respond to the following request for additional information (RAI):

RAI-1

If the licensee chooses to implement VT-1 in lieu of UT, please confirm that all the requirements addressed in ASME Code Case N-648-1 and the NRC staff's condition associated with this Code Case is met for the fourth ISI interval at GGNS.

By letter dated September 22, 2017, the licensee stated that if it elects to perform VT-1 in lieu of UT, Code Case N-648-1 will be used. Furthermore, the licensee stated that it incorporated Code Case N-648-1 for the third and fourth ISI intervals at GGNS. Based on the licensee's response, the NRC staff concluded that the licensee would comply with the requirements of Code Case N-648-1 and the staff's condition addressed in Table 2 of RG 1.147, and therefore, the staff considers that this issue is closed.

4.0 CONCLUSION

The NRC staff has reviewed the submittal regarding the licensee's evaluation of the five plant-specific criteria specified in the December 19, 2007, SE for the BWRVIP-108 report, which provides technical bases for use of ASME Code Case N-702, to examine RPV nozzle-to-vessel welds and nozzle inner radii at GGNS, Unit 1. Based on the evaluation in Section 3.2 of this SE, the NRC staff concluded that the licensee's proposed alternative provides an acceptable level of quality and safety and applies to all requested GGNS, Unit 1 RPV nozzles, with the exception of feedwater nozzles and control rod drive return nozzles. The NRC staff also concludes that with respect to the VT-1 examination of nozzles' inner radii, the licensee's confirmation to invoke ASME Code Case N-648-1 consistent with the NRC position stipulated in RG.1.147 provides reasonable assurance that any aging degradation in the subject nozzles' inner radii would be identified in a timely manner during the fourth ISI interval.

Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1) and is in compliance with the ASME Codes' requirements. Therefore, the NRC authorizes the licensee's proposed alternative for inspection of the RPV nozzle-to-vessel shell welds and nozzle inner radii sections listed in Tables 1 and 2 and Attachment 1 of the licensee's letter dated May 25, 2017, with the exception of feedwater nozzles and control rod drive return nozzles, for GGNS through the end of the fourth ISI interval, which ends on November 1, 2024.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved by the NRC staff remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Ganesh Cheruvenki

Date: October 30, 2017

SUBJECT: GRAND GULF NUCLEAR STATION, UNIT 1 – RELIEF REQUEST GG-ISI-021 PROPOSING AN ALTERNATIVE FOR THE FOURTH 10-YEAR INSERVICE INSPECTION PROGRAM (CAC NO. MF9752; EPID L-2017-LLR-0031) DATED: OCTOBER 30, 2017

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