March 22, 2005

Mr. Joseph E. Venable
Vice President Operations
Entergy Operations, Inc.
17265 River Road
Killona, LA 70066-0751

SUBJECT: WATERFORD STEAM ELECTRIC STATION, UNIT 3 (WATERFORD 3) - RELAXATION REQUEST FROM U.S. NUCLEAR REGULATORY COMMISSION (NRC) FIRST REVISED ORDER EA-03-009 FOR CONTROL ELEMENT DRIVE MECHANISM (CEDM) NOZZLES (TAC NO. MC2643)

Dear Mr. Venable:

By letter dated April 15, 2004, and as supplemented by letter dated August 13, 2004, Entergy Operations Inc. (Entergy, the licensee) requested relaxation from Section IV.C.(5)(b) of the First Revised U. S. Nuclear Regulatory Commission (NRC) Order EA-03-009 (Order), dated February 20, 2004. Specifically, the relaxation is related to UT examination of the bottom portion (threaded area) of all 91 CEDM penetration nozzles. Your submittal requested authorization from NRC staff to perform ultrasonic testing (UT) of the reactor pressure vessel (RPV) head penetrations inside the tube from 2 inches above the J-groove weld to 1.544 inches above the bottom of the nozzle. The remaining 11 RPV head penetrations are 10 incore instrumentation penetrations and 1 RPV head vent line, for which relaxation is not requested.

The NRC staff has concluded that compliance with the requirements of Section IV, Paragraph C.(5)(b)(i), of the Order for all CEDM nozzles at Waterford 3, is acceptable using the proposed alternative method. The proposed alternative examination of the 91 CEDM RPV head penetration nozzles from 2 inches above the J-groove weld to a level of at least 0.40 inches below the J-groove weld on the downhill side provides reasonable assurance of the structural integrity of the RPV head. Further, inspection of the CEDM nozzles in accordance with Section IV.C.(1) of the Order would result in hardship without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV, Paragraph F of the Order, for good cause shown, the NRC staff authorizes the proposed relaxation request for all 91 CEDM head penetration nozzles at Waterford 3 for the remainder of the second 10-year inservice inspection interval, unless subsequent inspections reveal the presence of primary water stress corrosion cracking below the J-groove weld of the nozzles. In addition, the relaxation request is subject to the following condition agreed upon by Entergy.

> If the NRC staff finds that the crack-growth formula in MRP-55, "Materials Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material" is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack-growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during

the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an NRC-acceptable crack growth rate formula.

The NRC staff's related Safety Evaluation is enclosed.

If you have questions regarding this response please contact N. Kalyanam at (301) 415-1480.

Sincerely,

/RA/

Herbert N. Berkow, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-382

Enclosure: Safety Evaluation

cc w/encl: See next page

the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an NRC-acceptable crack growth rate formula.

The NRC staff's related Safety Evaluation is enclosed.

If you have questions regarding this response please contact N. Kalyanam at (301) 415-1480.

Sincerely,

/RA/

Herbert N. Berkow, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-382

Enclosure: Safety Evaluation

cc w/encl: See next page

DISTRIBUTION:

PUBLIC	RidsOgcRp
PDIV-1 Reading	RidsAcrsAcnwMailCenter
RidsNrrDlpmLpdiv (HBerkow)	GHill (2)
RidsNrrDlpmLpdiv1 (AHowe)	FBu
RidsNrrPMNKalyanam	JDixon-Herrity
RidsNrrLADBaxley	RidsRgn4MailCenter (AHowell)
RidsNrrDlpmDpr	

Accession No. ML050820683 *No major changes to SE input

OFFICE	PDIV-1/PE	PDIV-1/PM	PDIV-1/LA	EMCB/SC*	OGC	PDIV-1/SC	PDIV-1/D
NAME	MThorpe-Kavanaugh	NKalyanam	DBaxley	TChan	MLongo (NLO0	AHowe	HBerkow
DATE	3/3/05	3/3/05	3/7/05	12/29/05	3/11/05	3/21/05	3/21/05

OFFICIAL RECORD COPY

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELAXATION REQUEST FROM NRC FIRST REVISED ORDER (EA-03-009)

REGARDING CONTROL ELEMENT DRIVE MECHANISM EXAMINATION

FACILITY OPERATING LICENSE NO. NPF-38

ENTERGY OPERATIONS, INC.

WATERFORD STEAM ELECTRIC STATION, UNIT 3

DOCKET NO. 50-382

1.0 INTRODUCTION

By letter dated April 15, 2004, and as supplemented by letter dated August 13, 2004, Entergy Operations Inc. (Entergy, the licensee) requested relaxation from Section IV.C.(5)(b) of the First Revised U. S. Nuclear Regulatory Commission (NRC) Order EA-03-009 (Order), dated February 20, 2004. Specifically, the relaxation is related to UT examination of the bottom portion (threaded area) of all 91 CEDM penetration nozzles. Specifically, the relaxation is related to UT examination of the bottom portion (threaded area) of all 91 CEDM penetration nozzles. The application requested authorization from NRC staff to perform ultrasonic testing (UT) of the reactor pressure vessel (RPV) head penetrations inside the tube from 2 inches above the J-groove weld to 1.544 inches above the bottom of the nozzle. The remaining 11 RPV head penetrations are 10 incore instrumentation penetrations and 1 RPV head vent line, for which relaxation is not requested.

2.0 BACKGROUND

The NRC First Revised Order EA-03-009 (Order), issued on February 20, 2004, requires specific examinations of the RPV head and vessel head penetration (VHP) nozzles of all pressurized water reactor (PWR) plants. Section IV, Paragraph F, of the Order states that a Project Director or higher management positions in the Division of Licensing Project Management of the Office of Nuclear Reactor Regulation, may, in writing, relax or rescind any of the requirements of the Order upon demonstration by the licensee of good cause shown and that such requests for relaxation of the Order associated with specific penetration nozzles will be evaluated by the NRC staff using the procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code in accordance with 50.55a(a)(3) of Title 10 of the *Code of Federal Regulations* (10 CFR). Section IV, Paragraph F, of the Order states that a request for relaxation regarding inspection of specific nozzles shall address the following criteria: (1) the proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or (2) compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For Waterford Steam Electric Station, Unit 3 (Waterford 3), and similar plants determined to have a high susceptibility to primary water stress corrosion cracking (PWSCC) in accordance with Sections IV.A. and IV.B. of the Order, the following inspections are required to be performed every refueling outage in accordance with Sections IV.C.(5)(a) and IV.C.(5)(b) of the Order:

(a) Bare metal visual (BMV) examination of 100% of the RPV head surface (including 360E around each RPV head penetration nozzle). For RPV heads with the surface obscured by support structure interferences which are located at RPV head elevations downslope from the outermost RPV head penetration, a bare metal visual inspection of no less than 95 percent of the RPV head surface may be performed provided that the examination shall include those areas of the RPV head upslope and downslope from the support structure interference to identify any evidence of boron or corrosive product. Should any evidence of boron or corrosive product be identified, the licensee shall examine the RPV head surface under the support structure to ensure that the RPV head is not degraded.

(b) For each penetration, perform a nonvisual NDE [nondestructive examination] in accordance with either (i), (ii), or (iii):

(i) Ultrasonic testing of the RPV head penetration nozzle volume (i.e., nozzle base material) from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches [see Figure IV-1]); OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater (see Figure IV-2). In addition, an assessment shall be made to determine if leakage has occurred into the annulus between the RPV head penetration nozzle and the RPV head low-alloy steel.

(ii) Eddy current testing [(ECT)] or dye penetrant testing [(PT)] of the entire wetted surface of the J-groove weld and the wetted surface of the RPV head penetration nozzle base material from at least 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches [see Figure IV-3]); OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration

nozzle surfaces below the J-groove weld have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater (see Figure IV-4).

(iii) A combination of (i) and (ii) to cover equivalent volumes, surfaces, and leak paths of the RPV head penetration nozzle base material and J-groove weld as described in (i) and (ii). Substitution of a portion of a volumetric exam on a nozzle with a surface examination may be performed with the following requirements:

1. On nozzle material below the J-groove weld, both the outside diameter [(OD)] and inside diameter [(ID)] surfaces of the nozzle must be examined.

2. On nozzle material above the J-groove weld, surface examination of the inside diameter surface of the nozzle is permitted provided a surface examination of the J-groove weld is also performed.

Specifically, the licensee requested the relaxation to implement an alternative to the requirements of Section IV, Paragraph C.(5)(b)(i), of the Order for all CEDM nozzles at Waterford 3.

3.0 EVALUATION OF RELAXATION REQUEST

First Revised NRC Order EA-03-009 Relaxation Request for examination coverage of reactor VHP nozzles.

3.1 Order Requirements for which Relaxation Is Requested

Section IV.C.(1) of the Order requires, in part, that the following inspections be performed every refueling outage for high susceptibility plants similar to Waterford 3 using techniques specified in Paragraph IV.C.(5)(a) and Paragraph IV.C.(5)(b) of the Order.

The licensee has requested relaxation from Section IV.C.(5)(b)(i) of the Order to perform UT of the RPV head penetrations inside the tube from 2 inches above the J-groove weld to 1.544 inches above the bottom of the nozzle. Specifically, the relaxation is related to UT examination of the bottom portion (threaded area) of all 91 CEDM penetration nozzles. The remaining 11 RPV head penetrations are 10 ICI penetrations and 1 RPV head vent line, for which relaxation is not requested.

The licensee requested the relaxation for one 18-month operating cycle commencing from the startup in the spring of 2005.

3.2 Licensee's Proposed Alternative Method

The licensee proposed to perform UT examination from 2 inches above the weld to the extent possible below the weld but not less than 0.40 inches below the toe of the J-groove weld. The actual distances of UT coverage from the bottom of the weld to the uninspected area (characterized by the licensee as "blind zone") based on the previous inspection were provided

in a letter dated August 13, 2004. Among the 91 CEDM penetration nozzles, Nozzle No. 87 is the bounding nozzle with a distance of 0.40 inches.

3.3 Licensee's Basis for Relaxation

The licensee stated that guide cones are attached to the bottom of the Waterford 3 CEDM nozzles via threaded connections. The guide cones screw into the end of the CEDM nozzles with a welded set screw and two tack welds at the cone-nozzle interface to secure the guide cone to the nozzle. There is a chamfer at the top of the threaded region that is 0.094 inch in length and the threaded region is 1.25 inches.

According to the licensee, this design condition will prevent UT examination of CEDM nozzles from collecting data to the end of the nozzles. The licensee stated that inspecting the non-pressure boundary area of the threaded portion of the CEDM nozzles would result in a hardship or unusual difficulty without a compensating increase in the level of quality and safety. In particular, the guide cones would have to be removed and special equipment would have to be developed to inspect the threaded nozzle surface in order to implement an inspection in accordance with Section IV, Paragraph C.(5)(b)(i) of the Order.

As an alternative to the UT examination of Order Section IV.C.(5)(b)(i), compliance with the Order can be achieved by ECT or PT of the wetted surfaces of each J-groove weld and RPV head penetration nozzle base material as described in Order Section IV.C.(2)(b)(ii). However, the licensee stated that performing either ECT and PT on the outside surfaces would increase personnel radiation exposure significantly, estimated to be between 27 to 45 man-Rem for the 91 nozzles. The licensee stated that implementation of surface examinations in accordance with Section IV.C.(1)(b)(ii) of the Order, by removing the CEDM nozzle guide cones and reinstalling new nozzle guide cones in order to remove the threaded area, or removing and reinstalling the existing nozzle guide cones, would create a hardship.

Because of the design limitation in meeting the Order required inspections, the licensee performed an analysis to determine if sufficient freespan length (characterized by the licensee as the distance between the bottom of the weld to the uninspected areas) exists between the uninspected area and the weld that would allow one operating cycle of crack growth without the postulated crack reaching the J-groove weld. The licensee's analysis is detailed in Entergy Engineering Report M-EP-2003-004, Rev. 00 (Engineering Report) "Fracture Mechanics Analysis for the Assessment of the Potential for Primary Water Stress Corrosion Crack (PWSCC) Growth in the Uninspected Regions of the Control Element Mechanism (CEDM) Nozzles at Waterford Steam Electric Station Unit 3."

The licensee stated that for the bounding nozzle location, a postulated axial through-wall flaw in the uninspected area will propagate 0.16 inches within an 18-month operating cycle whereas the minimum distance is 0.40 inches between the uninspected area and the bottom of the weld. There is sufficient safety margin to support an 18-month operating cycle.

The licensee stated that additional efforts to achieve 100 percent of the Order requirements would result in a hardship or unusual difficulty without a compensating increase in the level of quality and safety.

3.4 Evaluation

The NRC staff's review of this request was based on criterion (2) of Section IV.F of the Order, which states:

> Compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Within the context of the licensee's proposed alternative examination of the RPV penetration nozzles, the licensee has demonstrated the hardship that would result from implementing examinations to the bottom-end of these nozzles. The hardship identified by the licensee includes the nozzle configuration and the limitation of the UT probe used for nozzle examination. In its submittal, the licensee stated that, in order to meet 100 percent of the Order requirements, the guide cones would have to be removed and special equipment would have to be developed to inspect the threaded nozzle surface. This process is estimated to cost 2.5 man-Rem for each nozzle. The licensee has considered other options, including supplementing the UT coverage with a PT or ECT examination below the weld on the OD surface of the nozzles. In a letter dated August 13, 2004, the licensee stated that performing PT on the OD of the 91 nozzles could result in a radiation dose of 45 man-Rem. It also stated that it has the capability to perform ECT on the OD of the 91 nozzles. Since the process would require removal of the guide cones, the estimated radiation exposure is 27 man-Rem. The staff agrees that the nozzle's threaded area that mates with the guide cones makes inspection of these nozzles in accordance with the Order very difficult and would create a hardship. This evaluation focuses on the issue of whether there is a compensating increase in the level of quality and safety such that these nozzles should be inspected in accordance with the Order despite the hardship.

To assess the likelihood of a postulated flaw in the uninspected portion of the nozzle propagating to the pressure boundary, the licensee referenced a crack growth analysis performed during the previous refueling outage (RF-12). The objective of the analysis is to determine whether a postulated flaw will grow to the J-groove weld in an 18-month operating cycle. The staff had evaluated the licensee's crack growth analysis as part of the safety evaluation (ML033140264) of the licensee's relaxation request regarding the Order inspection requirements during the previous outage, and found it acceptable. Previous inspection performed during RF-12 did not find any indications in any of the nozzles

The NRC staff approved an equivalent relaxation request for Waterford 3 for the refueling outage RF-12. Since the licensee's analysis was performed for this request for inspection in RF-12, the NRC staff raised a question if the licensee's previous analysis would still be valid for the current relaxation request. In its response to the request for additional information in a letter dated August 13, 2004 (ML04230558), the licensee stated that inspections performed during RF-12 confirmed that the as-built nozzle configurations are bounded by the analysis, and therefore, the analysis are still valid for the current relaxation request.

The licensee's analysis indicates that Nozzle No. 87 is the bounding nozzle with a freespan length of 0.40 inches. A postulated crack, as shown in its analysis, could propagate only 0.16 inches within a cycle. Therefore, there is sufficient safety margin to support an 18-month operating cycle.

The licensee's analysis has also shown that the stresses in the uninspected areas are very low. The bounding nozzle has a stress value of 19 ksi on the ID while the OD has a compressive stress. It is commonly believed that 20 ksi is the stress value below which PWSCC is unlikely to initiate. Based on a review of the information provided, the staff agrees with the licensee that the uninspected areas have very low stress level. Significant crack initiation in the uninspected portion of the nozzles is, therefore, not expected.

The licensee's crack growth analysis applied a methodology consistent with that described in Footnote 1 of the Order, as provided in the Electric Power Research Institute Report, "Material Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material (MRP-55), Revision 1." The NRC staff has completed a preliminary review of the crack growth formula but has not yet made a final assessment regarding the acceptability of the report. If the NRC staff finds that the crack growth formula in industry report MRP-55 is unacceptable, the licensee will take the actions as described in the condition provided in Section 4.0 of this safety evaluation. The licensee accepted this condition in its submittal dated April 15, 2004.

Based on the above evaluation, the staff concludes that there is sufficient safety margin to support an 18-month operating cycle, and that performance of inspection below the J-groove weld according to the Order requirements would result in hardship without a compensating increase in the level of quality and safety.

The staff notes that although the licensee requested relaxation from the Order requirements for one 18-month operating cycle, the physical conditions and radiological issues which result in the hardship and the technical bases which form the justification for the acceptability of the request are not expected to significantly change during the remainder of the current 10-year ISI interval. Therefore, unless PWSCC occurs in the nozzles below the J-groove weld, the acceptability of this request should remain valid for operating cycle 14.

4.0 CONCLUSION

The NRC staff concludes that compliance with the requirements of Section IV, Paragraph C.(5)(b)(i), of the Order for all CEDM nozzles at Waterford 3, to be acceptable using the proposed alternative method. The licensee's proposed alternative examination of its 91 CEDM RPV head penetration nozzles from 2 inches above the J-groove weld to a level of at least 0.40 inches below the J-groove weld on the downhill side provides reasonable assurance of the structural integrity of the VHP nozzles. Further inspection of the VHP nozzles in accordance with Section IV.C.(1) of the Order would result in hardship without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV, Paragraph F, of the Order, for good cause shown, the staff authorizes the proposed relaxation request for all 91 CEDM head penetration nozzles at Waterford 3 for the remainder of the second 10-year ISI interval, unless subsequent inspections reveal the presence of PWSCC below the J-groove weld of the nozzles. In addition, the relaxation request is subject to the following condition agreed upon by the licensee.

> If the NRC staff finds that the crack-growth formula in MRP-55, "Materials Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material" is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack-growth formula. If the licensee's

revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

Principal Contributor: Z. Fu

Date: March 22, 2005

Waterford Steam Electric Station, Unit 3

cc:

Mr. Michael E. Henry, State Liaison Officer
Department of Environmental Quality
Permits Division
P.O. Box 4313
Baton Rouge, Louisiana 70821-4313

Vice President Operations Support
Entergy Operations, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

Director
Nuclear Safety Assurance
Entergy Operations, Inc.
17265 River Road
Killona, LA 70066-0751

Wise, Carter, Child & Caraway
P. O. Box 651
Jackson, MS 39205

General Manager Plant Operations
Waterford 3 SES
Entergy Operations, Inc.
17265 River Road
Killona, LA 70066-0751

Licensing Manager
Entergy Operations, Inc.
17265 River Road
Killona, LA 70066-0751

Winston & Strawn
1400 L Street, N.W.
Washington, DC 20005-3502

Resident Inspector/Waterford NPS
P. O. Box 822
Killona, LA 70066-0751

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

Parish President Council
St. Charles Parish
P. O. Box 302
Hahnville, LA 70057

Executive Vice President
& Chief Operating Officer
Entergy Operations, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

Chairman
Louisiana Public Services Commission
P. O. Box 91154
Baton Rouge, LA 70825-1697