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

August 11, 1993

Docket Nos. 50-266
and 50-301

Mr. Lanny L. Smith, P.E.
Director-Technical Unit
Electric Division
Public Service Commission of Wisconsin
P.O. Box 7854
Madison, Wisconsin 53707-7854

Dear Mr. Smith:

SUBJECT: REACTOR PRESSURE VESSEL INTEGRITY - POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2

In your letter to the U.S. Nuclear Regulatory Commission dated April 14, 1993 (your File No. 6630-CE-197), you requested information on the integrity of the reactor vessels at the Point Beach Nuclear Plant. Specifically, you asked that the following be forwarded to you:

(1) A copy of the Commission report discussing staff concerns about reactor vessel integrity (SECY-93-048).

(2) Other relevant technical information on vessel integrity at Point Beach.

(3) The NRC's opinion as to the risk that vessel issues could materially shorten the remaining service life of the Point Beach units.

(4) A statement of whether the pressure vessel embrittlement problem or any other technical problem could result in the NRC's ordering permanent plant shutdown for either unit before the current license expiration date.

Item (1), the Commission report, is enclosed. Item (2) is discussed in the enclosed Summary of Reactor Vessel Issues. This summary includes the current status of ongoing issues. The NRC's review of the reactor vessel issues is scheduled to be completed later this year, and the results are scheduled to be published in early 1994.

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Item (3), the possible effect of vessel condition on the remaining service life of the Point Beach units, is also discussed in the enclosed summary. The preliminary NRC staff assessment is that the vessels will safely reach their scheduled retirement dates. The completion of the assessment of vessel condition at Point Beach and other operating reactors is a high priority for the Commission, and is scheduled to be completed later this year. The assessment will analyze identified potential vessel integrity problems.

Item (4) asks for a statement regarding the possible permanent shutdown of either unit before the license expiration date due to pressure vessel embrittlement or any other technical problem. As part of the Commission's mission to protect the health and safety of the public, all identified safety issues are thoroughly reviewed and appropriate actions are taken, up to and including issuing an order for permanent plant shutdown. To date, no safety issues have been identified for Point Beach which could result in the issuance of an order for permanent plant shutdown.

I hope that the enclosed information provides the data necessary to complete your evaluations. Please contact Allen Hansen, Project Manager for Point Beach, at any time regarding the status of these issues. He can be reached at (301) 504-1390.

Sincerely,
ORIGINAL SIGNED BY:
Jack W. Roe, Director
Division of Reactor Projects - III/IV/V
Office of Nuclear Reactor Regulation

Enclosures:
1. SECY-93-048
2. Summary of Reactor Vessel Issues

cc w/enclosures:
See next page

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Docket File	OGC
NRC & Local PDRs	ACRS(10)
PDIII-3 Reading	Region III, DRPW
JRoe	OSP
JZwolinski	DMcDonald
JHannon	RLickus, Region III
MRushbrook	
AHansen	
JStrosnider	

* See previous concurrence

LA:PDIII-3	PM:PDIII-3	BC:EMCB	D:PDIII-3
* MRushbrook	*AHansen/agh/bj	*JStrosnider	*JHannon
7/29/93	7/30/93	8/4/93	8/6/93

AD:DRPW	D:DRPW	OSP
*JZwolinski	JRoe	*CKammerer
8/6/93	8/11 /93	8/4/93

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DOCUMENT NAME: G:\PTBEACH\PSC.LTR

cc:

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ENCLOSURE 1

POLICY ISSUE

(Information)

February 25, 1993 SECY-93-048

For: The Commissioners

From: James M. Taylor
Executive Director for Operations

Subject: STATUS OF REACTOR PRESSURE VESSEL ISSUES INCLUDING COMPLIANCE WITH 10 CFR PART 50, APPENDICES G AND H (WITS 9100165)

Purpose: To respond to the Commission's request for a report on the status of licensee reactor vessel surveillance programs with regard to 10 CFR 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," as requested in the Staff Requirements Memorandum M910711A, July 19, 1991 (Samuel J. Chilk to James M. Taylor), and, based on the preliminary review of responses to Generic Letter 92-01, provide an update of the status of plants with regard to Appendix G, "Fracture Toughness Requirements."

Background: During the staff presentation to the Commission on Yankee Rowe Embrittlement Issues on July 11, 1991, Commissioner Curtiss requested additional information related to Appendices G and H. Commissioner Curtiss requested:

(1) the staff to provide information on whether there are facilities other than Yankee Rowe where Upper Shelf Energy (USE) requirements of 10 CFR 50, Appendix G, Section IV.A.1 are not met, and whether, if such cases exist, not only has the analysis authorized under IV.1 been done by the Director of NRR but the licensee has also been required to meet V.C.1 as well;

(2) the staff to provide for the record their position on whether the requirements of V.C. in Appendix G to 10 CFR 50 apply if the Upper Shelf Energy values specified in IV.A.1 are not met; and

NOTE: TO BE MADE PUBLICLY AVAILABLE IN 10 WORKING DAYS FROM THE DATE OF THIS PAPER

CONTACT: Jack R. Strosnider, NRR/DE:EMCB
11pp. 504-2796

(3) the staff to provide to the Commission a list of any other plants which have not but should have requested exemptions from the requirements of 10 CFR 50, Appendix H.

The staff provided complete responses to items (1) and (2) and a partial response to item 3 in SECY-91-220, "Yankee Rowe Pressure Vessel Embrittlement Issues," dated July 24, 1991. The information provided in this paper on Appendix H (Question 1 in Generic Letter 92-01, Revision 1, "Reactor Vessel Structural Integrity, 10 CFR 50.54(f),") completes the staff response to item 3.

The integrity of the reactor pressure vessel is essential in ensuring reactor safety. The fracture resistance of reactor vessel materials decreases with increasing fluence. This is manifested by an increase in the brittle-to-ductile transition temperature and a reduction in the upper shelf energy. These changes in fracture resistance must be carefully monitored and periodically assessed through reactor vessel surveillance programs to ensure that specified margins of safety are satisfied for reactor vessels. On March 6, 1992, the staff issued Generic Letter 92-01, Revision 1, to compile information necessary to confirm that licensees and permittees satisfy requirements for ensuring reactor vessel integrity. In the generic letter, the staff requested responses to three questions. The staff received responses to each question from all licensees and permittees except those for Bellefonte 1 and 2, Perry 2, San Onofre 1, WNP-1, WNP-3 and Yankee Rowe. The licensee for Yankee Rowe was not required to respond and the other facilities have deferred licensing activities or are being shut down. Results of the staff's preliminary review of the responses are summarized below.

Discussion: Question 1: Reactor Vessel Material Surveillance Programs

The staff requested information on the reactor vessel material surveillance requirements specified in 10 CFR Part 50, Appendix H. All licensees and permittees stated that their reactor vessel surveillance programs satisfy the requirements of 10 CFR Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements." The staff performed a preliminary review, and agrees with the licensees' responses.

Question 2: Reactor Vessel Material Upper Shelf Energy

The staff requested information on the 50 ft-lb minimum upper shelf energy criterion specified in 10 CFR Part 50, Appendix G. All licensees responded that, based on plant-specific data and evaluations, their reactor vessels satisfy the 50 ft-lb minimum upper shelf energy criterion. However, if the NRC staff's generic criteria are used, fifteen (15) plants would currently have calculated reactor vessel material upper shelf energies less than 50 ft-lbs. Three (3) other plants would have reactor vessel upper shelf energies less than 50 ft-lbs before the end of their operating licenses. These plants are listed in the Enclosure.

During the staff's review, it found that it would need additional information to determine if plant-specific analyses used acceptable methods to derive reactor vessel upper shelf energies. Typical information required would include the bases for correlation factors used to convert test results from longitudinal to transverse specimen orientations and the bases for establishing initial upper shelf energies in the absence of unirradiated test data. The licensees for many boiling water reactor (BWR) plants lack the initial unirradiated upper shelf energy and materials data necessary to perform plant-specific analyses. The staff also found differences between the data in some of the responses and previously reported data. These differences need to be reconciled. The staff anticipates that as

the reviews proceed, some licensees may not be able to adequately demonstrate that their reactor vessel upper shelf energies are above 50 ft-lbs or will remain above 50 ft-lbs until the end of their licenses.

The NRC staff and industry met on September 2-3, 1992 to coordinate their efforts on reactor pressure vessel integrity issues. During the meeting, the NRC staff suggested that the industry perform generic bounding analyses to demonstrate that vessels with upper shelf energies below 50 ft-lbs have safety margins equivalent to those required by Appendix G of the American Society of Mechanical Engineers (ASME) Code. Analyses of this type are required by 10 CFR Part 50, Appendix G, to assure reactor vessel integrity if the upper shelf energy falls below 50 ft-lbs. The Babcock and Wilcox (B&W) reactor vessel Owners Group and some individual licensees (Zion 1 and 2, Turkey Point 3 and 4, Oyster Creek and Nine Mile Point 1) had previously begun to perform such analyses. After the September meeting, the Nuclear Management and Resources Council (NUMARC) began coordinating the industry's efforts in this area. The owners groups representing the licensees of General Electric, Westinghouse and Combustion Engineering reactors also began conducting bounding equivalent margins analyses.

The owners groups have scheduled to submit their final bounding analyses as follows:

Owners Group	Date
Babcock & Wilcox (B&W) Reactor Vessel Owners Group	1/93
Westinghouse Owners Group	3/93
Combustion Engineering (CE) Owners Group	3/93
Boiling Water Reactors (BWR) Owners Group	4/93

The B&W, BWR, and CE owners groups have already submitted or presented preliminary analyses to the staff. In addition, the NRC Office of Nuclear Regulatory Research has performed independent

analyses to bound the results for the different plant and material types. The results of these industry and staff analyses indicate that the margins of safety required by Appendix G of the ASME Code can be satisfied using conservative estimates of upper shelf energy based on the staff's generic criteria.

The NRC staff is conducting detailed reviews to resolve differences in the methodologies used to calculate upper shelf energies, discrepancies in the available data, and other issues. Licensees or permittees for which these concerns exist have the option of requesting that the equivalent margins analyses be reviewed and approved for their facilities.

Question 3: Temperature Effects and Surveillance Data

The staff requested information on the consideration of temperature effects and surveillance data in evaluating irradiation embrittlement. The staff will thoroughly review licensees' responses on the effects of irradiation temperature and the implications of surveillance data on the assessment of reactor pressure vessel fracture toughness and will consider them in evaluating the methods used to calculate upper shelf energies.

FUTURE ACTIONS AND SCHEDULE

The staff will confirm the adequacy of the equivalent margin analyses and expects to complete this effort by the middle of 1993. The staff is performing detailed reviews of the responses to Generic Letter 92-01. These reviews will include requests for additional information, as indicated in the discussion of Question 2, and detailed evaluations of the upper shelf energies reported for each plant, or the review and approval of equivalent margin analysis as requested by licensees. The staff will also review the current values of reactor vessel material brittle-to-ductile transition temperatures using the

information submitted in response to the generic letter. The staff is scheduled to complete detailed reviews of the responses to Generic Letter 92-01 by the end of 1993.

James M. Taylor
Executive Director
for Operations

Enclosure:
As Stated

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ENCLOSURE I

Plants with reactor vessel upper shelf energies currently below 50 ft-lbs based on the NRC staff generic guidance:

Nine Mile Point 1
Oyster Creek 1
Arkansas Nuclear One-1
Crystal River 3
Ginna
Oconee 1
Oconee 2
Point Beach 1
Point Beach 2
Robinson 2
Three Mile Island 1
Turkey Point 3
Turkey Point 4
Zion 1
Zion 2

Plants with reactor vessel upper shelf energies less than 50 ft-lbs before the end of their operating license based on the NRC staff generic guidance:

Oconee 3
Millstone 2
Watts Bar 1

ENCLOSURE 2

SUMMARY OF POINT BEACH, UNITS 1 AND 2 REACTOR VESSEL ISSUES

I. POINT BEACH REACTOR VESSELS

The Point Beach Unit 1 and Unit 2 plants are pressurized water reactors. The reactor pressure vessels for Units 1 and 2 are fabricated from low alloy carbon steel and the internal surfaces, in contact with the primary reactor coolant, are clad with weld deposited austenitic stainless steel at a nominal thickness of 0.156" for corrosion resistance.

The reactor vessels, though similar in type, differ in the method in which they where fabricated. The Unit 1 vessel was fabricated from carbon steel plate segments which were roll formed to dimension and welded together (both radially and axially). The Unit 2 vessel was fabricated from forged carbon steel components with no axial welds.

II. REACTOR VESSEL STRUCTURAL INTEGRITY

The importance of the reactor pressure vessel and the safety implications of its failure mean that a high degree of reliability is paramount. This is guaranteed only through careful attention to design, material selection, fabrication, quality assurance, testing, and inspection. Accordingly, the manufacturing of reactor pressure vessels, within the United States, is performed under conservative regulations and codes specified by the United States Nuclear Regulatory Commission (NRC) and the American Society of Mechanical Engineers (ASME). The ASME Code forms the basis for the engineering requirements for the design and manufacturing process. These requirements are expressed in Federal Regulations set forth by the NRC. Two important requirements are the vessel's fracture toughness (Appendix G of 10 CFR Part 50) and the material surveillance program (Appendix H of 10 CFR Part 50).

Various physical and chemical processes during operation could affect the properties of the vessel material. Material embrittlement is one of the more critical issues facing vessel materials. Neutron irradiation must not cause undue deterioration of the vessel's toughness over time. The beltline of the reactor vessel, the region adjacent to the core, is particularly sensitive to property deterioration, because this is the region which receives the greatest amount of neutron irradiation.

III. 10 CFR 50.61

An important safety issue, raised in the past few years, is pressurized thermal shock which results from rapid lowering of the coolant temperature while the reactor is still at high pressure. This issue warrants increased concern when the vessel material has lost fracture toughness (fracture toughness is the resistance of a material to fracture) due to prolonged

neutron irradiation (neutron embrittlement). This safety issue is known as pressurized thermal shock. To prevent failure from pressurized thermal shock, the NRC requires that licensees for all light water nuclear power reactors adhere to Section 50.61 of Title 10 of the Code of Federal Regulations (10 CFR 50.61). Part 50.61 stipulates that the pressurized thermal shock screening criterion (RT_{PTS}) is 270 °F for plates, forgings and axial welds, and 300 °F for circumferential weld materials.

To determine the effect of neutron irradiation on the Charpy transition temperature and Charpy upper-shelf energy, the NRC has issued Regulatory Guide 1.99 Revision 2, "Radiation Embrittlement of Reactor Vessel Materials." The NRC recommends that all licensees and permittees follow this guide in determining the effect of neutron irradiation on reactor vessel beltline materials.

IV. 10 CFR 50.60

The NRC also requires licensees to adhere to 10 CFR 50.60. Part 50.60 of the Code of Federal Regulations stipulates that licensees must meet fracture toughness requirements and have a material surveillance program for the reactor coolant pressure boundary. These requirements are set forth in Appendices G and H to 10 CFR Part 50.

Appendix G stipulates that reactor vessel beltline materials must have an initial Charpy upper-shelf energy of no less than 75 ft-lbs, and maintain an upper shelf energy of no less than 50 ft-lbs throughout the life of the vessel, unless it is demonstrated in a manner approved by the Director, Office of Nuclear Reactor Regulation, that lower values of upper-shelf energy will provide margins of safety against fracture equivalent to those required by Appendix G of the ASME Code.

Appendix H gives the requirements of the reactor vessel material surveillance program. The material surveillance program will monitor changes in the fracture toughness properties of ferritic materials in the reactor vessel beltline region. The fracture toughness changes result from the material's exposure to neutron irradiation and operating temperatures. Under the program, fracture toughness test data are obtained from material specimens exposed in surveillance capsules, which are withdrawn periodically from the reactor vessel.

V. NRC GENERIC LETTER 92-01

The NRC issued Generic Letter 92-01, "Reactor Vessel Structural Integrity," (GL 92-01) on February 28, 1992 (Revision 1, March 6, 1992) to all holders of operating licenses or construction permits for nuclear plants. GL 92-01 was issued to obtain information necessary to assess compliance with requirements and commitments regarding reactor vessel integrity in view of certain concerns raised in the staff's review of the Yankee Nuclear Power Station reactor vessel, particularly compliance with Appendices G and H, 10 CFR 50, and the effect of neutron irradiation on reactor vessel beltline materials.

VI. LICENSEES' RESPONSES TO GENERIC LETTER 92-01

In Commission Letter SECY-93-048, the NRC staff provided a preliminary assessment of the licensees' responses to GL 92-01. All licensees stated that their reactor vessel surveillance programs satisfy the requirements of 10 CFR Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements." The NRC staff performed a preliminary review, and agreed with the licensees' responses.

In GL 92-01, the NRC staff requested information on the 50 ft.-lbs. minimum upper-shelf energy criterion specified in 10 CFR Part 50, Appendix G. The licensees responded that, based on plant-specific data and evaluations, their reactor vessels satisfy the 50 ft.-lbs. minimum upper-shelf energy criterion. However, the NRC staff performed similar analyses on all of the reactors, within the United States, using a generic criteria. According to the staff's analyses, fifteen plants currently have calculated reactor vessel material upper-shelf energies less than 50 ft.-lbs. and three others would be below 50 ft.-lbs prior to the end of their operating licenses. Point Beach, Units 1 and 2, are two of the fifteen plants.

The NRC staff and industry met on September 2 and 3, 1992, to coordinate their efforts on reactor pressure vessel integrity issues. During the meeting, the NRC staff suggested that industry owners' groups perform generic bounding analyses to demonstrate that their vessels have safety margins equivalent to those required by the ASME code.

The Owners Group representing Point Beach submitted a bounding analysis for the plant. The NRC Office of Nuclear Regulatory Research also performed an independent analysis to bound the result for Point Beach. The results of these industry and staff analyses indicate that the margin of safety required by the ASME Code can be satisfied using conservative estimates of upper-shelf energy based on the staff's generic criteria.

The NRC staff is currently conducting detailed reviews to resolve differences in the methodologies used to calculate upper-shelf energies, discrepancies in the available data, and other issues.

In GL 92-01, the staff also requested that licensees provide information on the effect of temperature and surveillance data in their evaluation of irradiation embrittlement. The licensees responded that they had correctly analyzed the temperature and surveillance data in evaluating irradiation embrittlement. The NRC staff will thoroughly review the licensees' responses on the effects of irradiation temperature and the implications of surveillance data on the assessment of reactor pressure vessel fracture toughness. The NRC staff will also consider the licensees' responses in evaluating the methods used to calculate upper-shelf energies.

VII. LICENSEE'S RESPONSE TO 10 CFR 50.61, PTS RULE

The licensee has also taken additional measures to assure the safety of the reactor vessels. Wisconsin Electric Power Company has implemented a number of

Point Beach reactor vessel neutron flux reduction initiatives which include a super low leakage core pattern (L4P) and the introduction of partial length hafnium inserts (absorbers) in the core periphery. The licensee believes that these additional measures will lessen the effect of neutron irradiation on the beltline materials and the reactor vessels will be below the PTS screening criteria in 10 CFR 50.61. In addition, the licensee has installed excore neutron dosimetry to provide additional information on vessel irradiation.

VIII. GENERAL STATUS OF THE POINT BEACH REACTORS

The Point Beach licensee is a member of the Babcock & Wilcox Reactor Vessel Owners Group. This group has responded as earlier stated. Their assessment indicates that the Point Beach vessels will safely reach their scheduled retirement dates. This assessment is being reviewed along with the assessment provided by the other owners groups. The NRC's preliminary evaluation tends to agree with this assessment. The NRC is currently conducting a more thorough investigation, scheduled to be completed later this year, into the owners group evaluation.