

September 27, 2004

Mr. David A. Lochbaum  
Nuclear Safety Engineer  
Union of Concerned Scientists  
1707 H Street, NW, Suite 600  
Washington, DC 20006-3919

Dear Mr. Lochbaum:

On behalf of the Nuclear Regulatory Commission (NRC), I am providing the final response to your letter dated December 18, 2003, regarding Davis-Besse Nuclear Power Station, Unit 1 (Davis-Besse). Your letter requested that the NRC reconsider the reactor pressure vessel (RPV) head degradation root cause analysis submitted by FirstEnergy Nuclear Operating Company, the licensee for Davis-Besse, because of the configuration of RPV head nozzle 14. In addition, you also questioned the reactor coolant temperature value used by the licensee in the root cause analysis. By letter dated February 18, 2004, we provided an initial response to your concerns, stating that while no immediate safety concerns were identified, the issues merited further evaluation.

We have completed our review of the concerns that you raised and we continue to find that the licensee's probable root cause remains a plausible scenario for the RPV head degradation. We also find that the inspection scope and frequency for the RPV head and associated penetration nozzles on the Davis-Besse replacement head are adequate to protect public health and safety. Our evaluation is enclosed.

The NRC staff continues to review data and methods that may enhance the ranking model for RPV head penetration susceptibility to primary water stress corrosion cracking. While these activities may, in the future, allow for refinement of the model, the current model appropriately prioritizes inspection activities and provides reasonable assurance of public health and safety.

My colleagues at the NRC and I continue to strive to ensure protection of public health and safety. If you have further requests or questions, please contact Mr. William H. Ruland of the Office of Nuclear Reactor Regulation at 301-415-1389.

Sincerely,

***/RA Martin J. Virgilio Acting For/***

Luis A. Reyes  
Executive Director  
for Operations

Enclosure: NRC Evaluation of Davis-Besse Nuclear Power Station  
Vessel Head Degradation Root Cause

September 27, 2004

Mr. David A. Lochbaum  
Nuclear Safety Engineer  
Union of Concerned Scientists  
1707 H Street, NW, Suite 600  
Washington, DC 20006-3919

Dear Mr. Lochbaum:

On behalf of the Nuclear Regulatory Commission (NRC), I am providing the final response to your letter dated December 18, 2003, regarding Davis-Besse Nuclear Power Station, Unit 1 (Davis-Besse). Your letter requested that the NRC reconsider the reactor pressure vessel (RPV) head degradation root cause analysis submitted by FirstEnergy Nuclear Operating Company, the licensee for Davis-Besse, because of the configuration of RPV head nozzle 14. In addition, you also questioned the reactor coolant temperature value used by the licensee in the root cause analysis. By letter dated February 18, 2004, we provided an initial response to your concerns, stating that while no immediate safety concerns were identified, the issues merited further evaluation.

We have completed our review of the concerns that you raised and we continue to find that the licensee's probable root cause remains a plausible scenario for the RPV head degradation. We also find that the inspection scope and frequency for the RPV head and associated penetration nozzles on the Davis-Besse replacement head are adequate to protect public health and safety. Our evaluation is enclosed.

The NRC staff continues to review data and methods that may enhance the ranking model for RPV head penetration susceptibility to primary water stress corrosion cracking. While these activities may, in the future, allow for refinement of the model, the current model appropriately prioritizes inspection activities and provides reasonable assurance of public health and safety.

My colleagues at the NRC and I continue to strive to ensure protection of public health and safety. If you have further requests or questions, please contact Mr. William H. Ruland of the Office of Nuclear Reactor Regulation at 301-415-1389.

Sincerely,

*/RA Martin J. Virgilio Acting For/*

Luis A. Reyes  
Executive Director  
for Operations

Enclosure: NRC Evaluation of Davis-Besse Nuclear Power Station  
Vessel Head Degradation Root Cause

**DISTRIBUTION:** See next page

**ADAMS Accession Number: ML042510281 (Package)**

**ADAMS Accession Number: ML033640613 (Incoming)**

**ADAMS Accession Number: ML042510212 (Response)**

\*via phone

OFFICE	PM:PD3-2	LA:PD3-2	Tech Editor	SC:LPD-3	D:LPD-3
NAME	JHopkins	PCoates	PKleene	AMendiola	WRuland
DATE	09/15/04	09/15/04	09/13/04	09/15/04	09/17/04

OFFICE	RIII	D:DLPM	D:NRR	EDO
NAME	CLipa*	LMarsh (JLyons for)	JDyer (RBarrett for)	LReyes
DATE	09/13/04	09/17/04	9/23/04	9/27/04

OFFICIAL RECORD COPY

DISTRIBUTION FOR EDO #G20030763 RESPONSE TO D. LOCHBAUM ON REACTOR PRESSURE VESSEL HEAD DEGRADATION ROOT CAUSE ANALYSIS RE: DAVIS-BESSE NUCLEAR POWER PLANT

DATED: September 27, 2004

DISTRIBUTION: G20030763

PUBLIC

PDIII-2 R/F

LReyes

(RidsEdoMailCenter)

EMerschhoff

MVirgilio

WKane

PNorry

WDean

SBurns/K. Cyr

DRathbun

LCox

JGoldberg, OGC

JCaldwell, RIII

(RidsRgn3MailCenter)

JDyer

(RidsNrrOd)

BSheron/KJohnson

(RidsNrrAdpt)

OGC

(RidsOgcRp)

OPA

(RidsOpaMailCenter)

OCA

(RidsOcaMailCenter)

NRR Mailroom

(RidsNrrWpc)

WRuland

(RidsNrrDlpmLpdiii)

AMendiola

(RidsNrrDlpmLpdiii2)

JHopkins

(RidsNrrPMJHopkins)

PCoates

(RidsNrrLAPCoates)

EDO

(RidsEdoMailCenter)

CLipa, RIII

GMulley, OIG

## NUCLEAR REGULATORY COMMISSION EVALUATION

### DAVIS-BESSE NUCLEAR POWER STATION

### VESSEL HEAD DEGRADATION ROOT CAUSE

#### 1.0 INTRODUCTION

A letter dated December 18, 2003 (ADAMS ML033640613), from the Union of Concerned Scientists (UCS) to the Nuclear Regulatory Commission (NRC), raised concerns regarding Davis-Besse Nuclear Power Station, Unit 1 (Davis-Besse). Specifically, the letter requested that the NRC reconsider the reactor pressure vessel (RPV) head degradation root cause analysis submitted by FirstEnergy Nuclear Operating Company (FENOC or the licensee), because of the configuration of RPV head nozzle 14. UCS also questioned the reactor coolant temperature value used by the licensee in the root cause analysis. By letter dated February 18, 2004 (ADAMS ML040060824), the NRC staff provided an initial response to UCS, stating that while no immediate safety concerns were identified, the issues merited further evaluation.

By letter dated March 4, 2004 (ADAMS ML040640499), as supplemented March 11, 2004 (ADAMS ML040700301), the NRC staff requested information from FENOC regarding the UCS concerns. The licensee responded to the staff request by letters dated May 25 (ADAMS ML041480352) and August 18, 2004 (ADAMS ML042360716).

#### 2.0 EVALUATION

The licensee submitted the Root Cause Analysis Report, "*Significant Degradation of the Reactor Pressure Vessel Head*," by letter dated April 18, 2002 (ADAMS ML021130029). Revision 1 to the report was submitted by letter dated September 23, 2002 (ADAMS ML022750125).

Section 3.2.1, "*CRDM Nozzle Cracks and Propagation to Leakage*," of the report states, in part, the following:

##### RPV Head to Hot Leg Vent Line at CRDM Nozzle 14

Davis-Besse has a vent line that runs from nozzle 14 to the steam generator 2 upper primary hand hole. This line is unique to Davis-Besse. The purpose of the line is to vent noncondensable gases from the head during a loss of coolant accident. This vent line could have a minor effect on head temperature. However, since this nozzle is displaced from the cracked nozzles, its effect on other nozzles is considered to be very small. There is no evidence of thermal fatigue on this penetration.

The NRC staff review has found that it is likely that localized temperatures around nozzle 14 are greater than the average reactor coolant hot leg temperature, which was used by the licensee as its RPV head temperature estimate in the Davis-Besse Root Cause Report. However, as

Enclosure

explained below, these temperature differences are not significant enough to change the conclusions of the Davis-Besse Root Cause Report. Additionally, in the response dated August 18, 2004, FENOC stated that a more conservative estimate than the one utilized in the Davis-Besse Root Cause Report would now be used for temperature. The licensee stated that they will use the average temperature, as read by the narrow range instrumentation on the hot leg with the highest temperature during full power operation, to determine the Davis-Besse RPV head's susceptibility ranking in accordance with the requirements of the First Revised NRC Order EA-03-009 (the Order) dated February 20, 2004 (ADAMS ML040220181).

For primary water stress corrosion cracking (PWSCC) to occur, three factors need to be present: environment (high temperature primary system water), stress, and a susceptible material. To effectively address the root cause for PWSCC at Davis-Besse, the licensee evaluated each of these three factors. The Davis-Besse Root Cause Report identifies that the estimated RPV head temperature was sufficient to allow PWSCC to occur. An increased temperature value would increase the susceptibility of the material to PWSCC, but the Davis-Besse Root Cause Report recognizes that PWSCC had already occurred. As the report does not question that PWSCC occurred, an increase in the incremental susceptibility value does not affect the overall root cause analysis performed by FENOC.

The NRC staff reviewed other uses of the licensee-estimated RPV head temperature in related equations to establish an effective root cause report conclusion. RPV head temperature was used in crack growth rate calculations to determine when the cracking might have first initiated. However, the general conclusion of the Davis-Besse Root Cause Report was that the cracking began in 1990, plus or minus 3 years, with the crack growing throughwall sometime between 1994 to 1996. The NRC staff estimated that applying an RPV head temperature due to the effects of nozzle 14 to the crack growth rate equation would generate crack growth time values which fall within the large ranges of these estimates. The staff concluded that the estimated change in the assumed RPV head temperature value caused by the nozzle 14 vent line would not change Section 5.0, "Root Cause Determination," of the Root Cause Report. Therefore, the licensee's probable root cause remains a plausible scenario for the reactor pressure vessel head degradation, and the only change to the Root Cause Report resulting from the nozzle 14 vent line would be a small increase in the assumed RPV head temperature above the quoted value of 605 degrees Fahrenheit.

The staff does not expect that using an adjusted temperature due to flow through the vent path in nozzle 14 would change the inspection regime for Davis-Besse committed to by the licensee in a letter dated March 11, 2004 (ADAMS ML041610291). FENOC's calculations project that Davis-Besse will be performing inspections required by the moderate susceptibility category of the Order in Refueling Outage 15 (estimated to occur in 2008) and will meet the requirements of the high-susceptibility category of the Order by Refueling Outage 18 (estimated to occur in 2014). From those calculations, there would be no earlier Order-required inspections unless the best-estimate 100 percent power RPV head temperature reached 611.2 degrees Fahrenheit, which is unlikely.

In its letter, UCS indicated that data showed that the full-power hot leg temperature at Davis-Besse reaches approximately 607.5 degrees Fahrenheit. If that value was used as a best-estimate 100 percent power RPV head temperature, the NRC staff estimates that there would be no change to the projected RPV head and associated penetration inspections. Therefore, the staff concludes that the inspection scope and frequency for the Davis-Besse replacement RPV head and associated penetration nozzles remain appropriate.

While the NRC staff accepts the new Davis-Besse best estimate 100 percent power RPV head temperature, the staff recognizes that the value remains an estimate. Considering the fleet of pressurized water reactor plants, the staff designed the Order susceptibility ranking to be based on best estimate RPV head temperature values. The ranking system utilizes an effective degradation years (EDY) calculation which is based on time and head temperature. The staff established upper RPV head penetration inspection program requirements by applying previous inspection results to the susceptibility ranking results. As a result, the determination of the values of 12 and 8 EDY to mark the boundaries of high and moderate PWSCC susceptibility categories is based on inspection experience applied to a susceptibility ranking. Through this technique, the Order uses a susceptibility ranking model that has worked using best estimate RPV head temperatures.

### 3.0 CONCLUSION

The NRC staff has reviewed the concerns raised in the UCS letter of December 18, 2003, and concludes that the licensee's probable root cause remains a plausible scenario for the Davis-Besse RPV head degradation. The staff also concludes that the inspection scope and frequency for the replacement RPV head and associated penetration nozzles are adequate to protect the public health and safety.