UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

February 21, 2014

NRC INFORMATION NOTICE 2014-01: FUEL SAFETY LIMIT CALCULATION INPUTS WERE INCONSISTENT WITH NRC-APPROVED CORRELATION LIMIT VALUES

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a power reactor early site permit, combined license, standard design approval, or manufacturing license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Reactors." All applicants for a standard design certification, including such applicants after initial issuance of a design certification rule.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of instances in which inputs into fuel safety limit calculations used critical heat flux (CHF) correlation limit values that were different from those previously approved by the NRC staff. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. Suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

BACKGROUND

General Design Criterion (GDC) 10, "Reactor Design," in Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR Part 50 states that the reactor core shall be designed with appropriate margin to assure that the specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences (AOOs). One of the specified acceptable fuel design limits for pressurized-water reactors (PWR) is the departure from nucleate boiling ratio (DNBR) safety limit. To ensure that the DNBR safety limit is not exceeded, a CHF correlation is developed which predicts the heat flux at which the departure from nucleate boiling (DNB) occurs. The NRC staff reviews and approves each CHF correlation for its application to a specific fuel type(s) to ensure conservatism. Additionally, the NRC staff reviews the associated CHF correlation limit, often

ML13325A966

referred to in safety evaluations as the DNBR limit, which captures the uncertainty of the correlation.

The CHF correlation limit is typically obtained by using measured CHF values at various locations in the correlation's application domain and dividing those values by the correlation's prediction of CHF at the same locations. The resulting ratios of measured-to-predicted data are then used to quantify the correlation's uncertainty. This quantification is usually performed by calculating the 95th percentile at the 95th confidence level of the measured-to-predicted distribution, generally referred to as the 95/95 statistic. Usually, the 95/95 statistic can be calculated from the mean (μ) and standard deviation (σ) of the measured-to-predicted data as well as Owen's k-value, which is solely a function of the degrees of freedom. The equation for the 95/95 statistic for a normal distribution is given as follows:

$$95/95\,statisic\ = \frac{1}{\mu - k \cdot \sigma}$$

The CHF correlation limit is often the 95/95 statistic; however, it may be necessary to bias the CHF correlation by choosing a correlation limit slightly higher than the 95/95 statistic. By using a CHF correlation limit slightly higher, the CHF correlation's predictions would be made more conservative. For example, the 95/95 statistic may be 1.113, whereas the NRC-approved CHF correlation limit may be 1.13.

The uncertainty of the CHF correlation can then be combined with system and operational uncertainties using an NRC-approved statistical methodology to calculate the DNBR safety limit. By demonstrating that this DNBR safety limit is not exceeded during any condition of normal operation, including the effects of AOOs, there is assurance that the DNB-based specified acceptable fuel design limit is not exceeded.

DESCRIPTION OF CIRCUMSTANCES

While performing a recent review of a statistical combination of uncertainties, the NRC staff became aware of a possible inconsistency in calculating the DNBR safety limit. When the CHF correlation uncertainty was combined with other uncertainties in order to generate the statistically-based DNBR safety limit, statistical parameter inputs based on the calculated 95/95 statistic from the CHF correlation were used as opposed to statistical parameter inputs based on the NRC-approved CHF correlation limit, as defined in the safety evaluation. In the observed example, the methodology used to calculate the DNBR safety limit used the mean, standard deviation, and Owen's k-value for the measured-to-predicted data. While these parameters were associated with the 95/95 statistic from the CHF correlation, they did not capture any upward bias that was factored into the NRC-approved CHF correlation limit. In the case of the observed example, additional conservatism associated with the upward bias was absent in the statistical methodology application that was used to generate the statistically-based DNBR safety limit.

DISCUSSION

Licensees rely on their safety analysis to demonstrate that the specified acceptable fuel design limits are not exceeded during any conditions of normal operation, including the effects of AOOs. The NRC staff has recently discovered that the DNBR safety limit generated from statistical methodologies may not properly account for a conservative bias that may be included in the NRC-approved CHF correlation limit as defined in the safety evaluation.

The correction of this inconsistency may increase the statistically-based DNBR safety limit. The magnitude of the increase is dependent on the difference between the CHF correlation's 95/95 statistic and the NRC-approved CHF correlation limit. While this difference in limits is typically small, and often zero, the NRC staff estimates that a "worst case" increase in a DNBR safety limit could be on the order of 1 to 2 percent. The NRC staff anticipates any increase in DNBR safety limit would be minimal and would not impact plant operation.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

/RA/

Michael C. Cheok, Director
Division of Construction Inspection
and Operational Program
Office of New Reactors (NRO)

/RA/

Lawrence E. Kokajko, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation (NRR)

Technical Contact: Joshua Kaizer, NRR
301-415-1532
E-mail: Joshua.Kaizer@nrc.gov

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under NRC Library.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

/RA/

Michael C. Cheok, Director
Division of Construction Inspection
and Operational Program
Office of New Reactors (NRO)

/RA/

Lawrence E. Kokajko, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation (NRR)

Technical Contact: Joshua Kaizer, NRR
301-415-1532
E-mail: Joshua.Kaizer@nrc.gov

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under NRC Library.

ADAMS Accession No.: ML13325A966 *email TAC MF3105

OFFICE	SNPB:DSS:NRR	Tech Editor	ABC:SNPB:DSS:NRR	BC:SRSB:DSRA:NRO
NAME	JKaizer*	CHsu*	JDean*	JDonoghue (JSchmidt for)*
DATE	01/07 /14	11/ 22 /13	01/13 /14	01/30/14
OFFICE	D:DSS:NRR	LA:PGCB:NRR	PM:PGCB:NRR	BC:PGCB:NRR
NAME	TMcGinty (DPelton for)	CHawes*	TMensah	SStuchell*
DATE	02/03 /14	02/04/14	02/04 /14	02/03/14
OFFICE	D: DCIP: NRO	DD:DPR:NRR	D:DPR:NRR	
NAME	MCheok	SBahadur	LKokajko	
OFFICE	02/11/14	02/18/14	02/21/14	

OFFICIAL RECORD COPY