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NUCLEAR ENERGY BUSINESS OPERATIONS
GENERAL ELECTRIC COMPANY • 175 CURTNER AVENUE • SAN JOSE, CALIFORNIA 95125

December 20, 1985
MFN-149-85
JSC-081-85

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Boiling Water Reactor Licensing
Washington, D. C. 20555

Attention: M. W. Hodges, Section Leader
Reactor Systems Branch

L. Phillips, Section Leader
Reactor System Branch

Gentlemen:

SUBJECT: SUMMARY AND ACTION ITEMS FROM DECEMBER 3, 1985, GE/NRC MEETING ON AMENDMENT 13 TO GESTAR

Reference: Letter from J. S. Charnley (GE) to C. O. Thomas (NRC), "Proposed Administrative Amendment to GE Licensing Topical Report NEDE-24011-P-A", September 24, 1985.

The purpose of this letter is to summarize the conclusions and outline the action items from a GE/NRC meeting held on December 3, 1985 at the GE offices in Bethesda, Maryland. The meeting was held to discuss the recently submitted Amendment 13 to the General Electric Standard Application for Reactor Fuel (GESTAR II). A list of the meeting attendees is included as Attachment 1 to this letter.

At the meeting, GE outlined in detail each of the changes made to GESTAR in Amendment 13, and also provided a discussion as to why each change was made. Also, some background information was presented in order to bring the new BWR reviewers up-to-date.

GE also informed the NRC staff of our current plans to completely rewrite the GESTAR document to more closely follow the standard FSAR format. The time frame for submittal of this rewrite will be April 1986. The NRC staff supported this effort; however, GE was cautioned that Reg Guide 1.70 and the SRP (NUREG-0800) are fairly old documents and GE should assure themselves that any rewrite meets the technical requirements of today's FSAR's. GE agreed that the format and content would be compatible with current FSAR requirements.

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The major action items from the meeting for both GE and the NRC are listed in Attachment 2. Quick resolution of these items should expedite NRC approval of this amendment.

If you have any questions regarding the meeting, please call Dave Dennison on (408) 925-3302.

Very truly yours,

J S Charnley

J. S. Charnley, Manager
Fuel Licensing

JSC/dc

cc: L. S. Gifford

Attachment 1

MEETING ATTENDEES
December 3, 1985

NAME	ORGANIZATION
David Dennison	GE-Fuel Licensing
Larry Phillips	NRC-Reactor Systems Branch
Caroline Smith	GE-Fuel Licensing
Wayne Hodges	NRC-Reactor Systems Branch
T.M. Su	NRC-Reactor Systems Branch
Richard Lobel	NRC-Reactor Systems Branch (A)
Dimitri Cokinos	Brookhaven National Lab
Howard Richings	NRC-Reactor Systems Branch
George Thomas	NRC-Reactor Systems Branch
Frank Skopec	NRC-Reactor Systems Branch
J.S. Charnley	GE-Fuel Licensing
Gene Suh	NRC-Reactor Systems Branch
D.D. Yue	NRC-Reactor Systems Branch

Attachment 2

ACTION ITEMS FROM DECEMBER 3 GE/NRC MEETING ON AMENDMENT 13 TO GESTAR II

1. The NRC was concerned with GE's removal of the typical k_∞ vs. void fraction, local power peaking vs. exposure and Doppler coefficient vs. temperature curves (Figures 3-1 through 3-7 in GESTAR, Rev. 7). GE claimed that the curves are not necessary to meet NRC requirements and do not bound all GE fuel bundle types, therefore they do not need to be included in the document.

   NRC
   Action: The staff committed to get back to GE after they review, internally, whether the curves are necessary for a reload review and whether they should be left in their present form or updated to include all GE fuel designs.

2. Related to the changes made in Appendix A to the US Supplement (Format for Standard Supplemental Reload Submittal) the NRC requested the following:

   - R-factors should not be eliminated in Item 7. They are not completely redundant to the Peaking factors.

   - Heat flux values in Item 10 are necessary for proper review of a reload. Therefore the should not be eliminated.

   - The statement "Includes Power Spiking Penalty" in Items 11 and 14 should not be removed but should be modified to indicate that the limiting values in the GESTAR tables have been reduced to account for power spiking.

   - Item 16 on stability should be included even for those plants which are no longer required to report decay ratio. For those plants this item should consist of a note stating that the SIL-380 recommendations have been included in the plant Tech. Specs.

   GE
   Action: These requests will be considered by GE and will either be agreed to or additional information will be supplied supporting the existing change. However, the ODYN options listed in Item 8 are in error and GE will submit an addendum to the amendment later with the proper information.

3. The NRC requested that GE add a status sheet, outlining all the various amendments and revisions to GESTAR, to the front section of the GESTAR document. They also requested copies of all amendments 7 through 12.

   GE
   Action: GE agreed to do these tasks. GE also agreed to add both Wayne Hodges and Larry Phillips to the standard GESTAR II distribution list so that they will obtain their own copies of all current and future revisions to the GESTAR document. This will be in addition to the 22 copies which are required to be formally submitted to the NRC.

4. The NRC staff requested that GE send additional copies of the July 1983 letter on the generic LFWH analysis directly to Hodges and Phillips.

   GE
   Action: The requested letter is attached.

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NUCLEAR POWER SYSTEMS DIVISION

GENERAL ELECTRIC COMPANY • 175 CURTNER AVENUE • SAN JOSE, CALIFORNIA 95125

MC 682, (408) 925-3697

MFN-125-83

July 5, 1983

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555

Attention: Mr. F. J. Miraglia, Assistant Director
Safety Assessment

Dear Mr. Miraglia:

SUBJECT: LOSS OF FEEDWATER HEATING ANALYSIS

This letter submits for your review a copy of a report describing General Electric's proposed generic bounding analysis of the Loss of Feedwater Heating (LFWH) transient.

The attached report shows that based on calculations performed using the 3-D BWR Simulator, a bounding ΔCPR of 0.085 may be conservatively applied for all LFWH events up to a maximum heating loss of 100°F. General Electric plans to apply this bounding analysis to all CP, OL and reload analyses initiated after receipt of your approval; in the interim period it is expected that some licensees may reference this submittal and request approval on a plant/cycle unique basis.

Please contact J. L. Rash (408-925-3181) of the Fuel & Services Licensing staff if you have any questions.

Very truly yours,

J. S. Charnley

J. S. Charnley
Fuel Licensing Manager
Nuclear Safety and Licensing Operation

JSC:cal/K062814*

cc: L. S. Gifford
M. W. Hodges
R. W. Houston

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LOSS OF FEEDWATER HEATING ANALYSIS

INTRODUCTION

The Loss of Feedwater Heating (LFWH) event is an anticipated operational occurrence that results from a reduction in feedwater heating due to the loss of one or more feedwater heaters. It is analyzed in accordance with the NRC-approved methods and codes described in Reference 1.

Repetitive NRC review is required since the LFWH event is evaluated for each General Electric initial core and reload. Standardization promises to significantly reduce this expenditure of resources.

A large number of LFWH analyses have been performed which provide an adequate statistical base to support a revised procedure which will justify the elimination of most plant specific analyses and thus increase the application of standardization.

SUMMARY

A generic General Electric Loss of Feedwater Heating (LFWH) analysis has been developed to promote standardization and more effectively utilize General Electric engineering and NRC review resources. This analysis is applicable to loss of 100°F or less in feedwater temperature for BWR/2, 3, 4, 5 and 6 plants and both initial and reload cores. Results for the event were obtained from a number of design cases which used the General Electric three-dimensional BWR Core Simulator (Reference 2) to simulate the event. The results used from these cases were the change in minimum critical power ratio (ΔMCPR) divided by the initial minimum critical power ratio (IMCPR) and the change in core power (ΔP) divided by the initial core power (IP). These results were fitted to a normal distribution and the upper 95% probability at the 95% confidence level (95/95) values were used as bounding results.

EVENT DESCRIPTION

The normal amount of feedwater heating can be reduced in two ways:

1) a steam extraction line to a feedwater heater is closed, or

2) feedwater is bypassed around a feedwater heater.

The first case produces a gradual drop in the temperature of the feedwater. In the second case, the feedwater bypasses the heater and no heating occurs. Both cases cause a decrease in the temperature of the feedwater entering the reactor vessel. This results in an increase in core inlet subcooling which collapses voids and thus increases core average power and shifts the axial power distribution towards the bottom of the core. Because of this axial shift, voids begin to build up at the bottom again which acts as a negative feedback to the void collapsing process. This feedback moderates the core power increase. This event also tends to flatten the radial power distribution.

The maximum number of feedwater heaters which can be tripped or bypassed by a single equipment failure event defines the most severe transient for licensing analysis considerations. For most BWRs, this event has been conservatively specified as a loss of up to 100°F in feedwater inlet temperature.

The 100°F LFWH transient is a relatively slow event. The reactor core is essentially in steady state at the end of the transient. The transient parameters behave smoothly with no sudden increase or decrease throughout the transient. This trend has been verified by both startup test results and calculations using the GE One-Dimensional Transient Model (ODYN). Results show that parameters at the initial and final stages of a LFWH event bound those throughout the transient. Due to this quasi-steady state nature, the event can be represented by its initial and final state, i.e., the GE three-dimensional BWR Core Simulator is an appropriate model for this analysis.

EVALUATION PROCEDURE

The generic LFWH analysis is based on a statistical evaluation of the resultant changes in core power and Minimum Critical Power Ratio (MCPR).

LFWH event data points were generated from a variety of operating and pre-operating BWR analyses to determine worst case conditions and parameters necessary to provide bounding results.

The approach used the ratio of delta to initial CPR (ΔCPR/ICPR) to represent the MCPR response to this event since ΔCPR/ICPR is proven to be essentially constant over the range of ICPR's encountered. A total of 128 LFWH cases from 33 operating and pre-operating BWR analyses were used for the statistical data base. The analysis was performed for the most recent cycle (for operating plants) with exposure accounting cases based on actual plant data at 3 different points in the cycle (BOC, MOC, EOC). The BWR/6 plants were analyzed at the end of an equilibrium cycle. The ΔCPR/ICPR results were examined to assure that there were no plant or product line dependencies imposed on the results. The same type of analysis was also performed using the delta to initial core power (ΔP/IP) from the same data base.

A normal distribution was fitted to the Delta/Initial (Δ/I) of the core power, and minimum critical power ratio (MCPR). The mean, standard deviation, and the bounding values were determined for these parameters. The bounding value was defined as the upper 95% probability/95% confidence limit level.

Table 1 shows the resulting expected (50% probability/50% confidence), the bounding (95% probability/95% confidence), and the standard deviation for the Δ/I parameters (core power and MCPR).

The bounding results show that if the 100°F LFWH event is initiated at 100% power (bounding case) there is a 95% probability with 95% confidence that the core thermal power level will not exceed 114.8%. At an operating

MCPR Limit of 1.20, the ΔMCPR observed will be smaller than 0.085 (1.20 times 0.071).

CONCLUSIONS

The results of the generic LFWH analysis were generated by a statistical analysis using a variety of plant conditions based on BWR/2's through BWR/6's. The data points used included various power conditions, exposure points, and observed power shapes. The data covers the expected range of nuclear characteristics and power densities, as well as initial, reload, and equilibrium cycles.

The resultant operating limit MCPR for initial/reload cores will provide sufficient protection against violation of the safety limit during a LFWH event for all BWR/2 through BWR/6 plants which require a 100°F drop in feedwater temperature analysis.

References:

1. "General Electric Standard Application for Reactor Fuel," NEDE-24011-P-A-US.

2. J. A. Wooley, "Three-Dimensional BWR Core Simulator," NEDO-20953-A, January 1977.

TABLE 1

STATISTICAL ANALYSIS RESULTS

PARAMETER	MEAN (50/50)	BOUNDING (95/95)	STANDARD DEVIATION
$\frac{\Delta P}{IP}$ 100	12.2	14.8	1.3
$\frac{\Delta MCPR}{IMCPR}$	0.058	0.071	0.007