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Original signed by

Sincerely,

A copy of the report is being filed with the Office of the Federal Register for publication.

The errors detected were of the nature of inputs to computer codes used in the analyses or were due to numerical errors in the calculations performed. The total impact of the errors and model changes requires that the maximum average planar linear heat generation rate (MW/LH) be reduced up to 6% for 1 x 7 fuel at burnups less than 10,500 megawatt days per ton, and up to 7 x 7 fuel at burnups greater than 10,500 megawatt days per ton. This order confirms the appropriateness of the reduction in MW/LH limits instituted by Tennessee Valley Authority on February 18, 1977, for Browns Ferry Units Nos. 1 and 2, when informed of these errors by DE. The order changes the technical specifications appended to Facility Operating Licenses Nos. DPE-53 and DPE-52 to reflect and implement the reductions that you have previously made on a voluntarily basis and requires that you submit a re-evaluation of your ECCS performance as soon as possible with the errors corrected, using a General Electric ECCS evaluation model approved by the staff.

The enclosed Order of Modification pertains to Facility Operating License No. DPE-53 and DPE-52 issued for Browns Ferry Nuclear Plant, Units Nos. 1 and 2. The order corrects errors and reflects changes in the methods of analysis in the ECCS performance evaluation submitted in accordance with 10 CFR 50.46.

RE: BROWNS FERRY NUCLEAR PLANT, UNITS NOS. 1 AND 2

Attention: Mr. Rodwin Williams, Jr., Manager of Power, 615 Power Building, Chattanooga, Tennessee 37201

Mr. Williams

ACRS (16)  
 Deisenhut  
 BSchart (10)  
 BJones  
 OIR (3)  
 OELD  
 TWambach  
 SShppard  
 KRogler/Tcarter  
 ECcase  
 BCRusche  
 PO'Connor  
 TBAbemathy  
 JRBuchan-a  
 CMiles, OPA  
 NRC PDR  
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MAR 11 1977

Dockets Nos. 50-259 and 50-260

UNITED STATES OF AMERICA  
 NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
Tennessee Valley Authority	)	Dockets Nos. 50-259
	)	and 50-260
Browns Ferry Nuclear Plant,	)	
Units 1 and 2	)	
	)	
	)	

ORDER FOR MODIFICATION OF LICENSE

I.

The Tennessee Valley Authority (the licensee), is the holder of Facility Operating Licenses Nos. DPR-33 and BPR-52 which authorize the operation of the nuclear power reactors known as Browns Ferry Nuclear Plant, Units Nos. 1 and 2 (the facility) at steady state reactor power levels not in excess of 3293 megawatts thermal (rated power). The facility consists of a boiling water reactor (BWR) located at the licensee's site in Limestone County, Alabama.

II.

In conformance with evaluations of the performance of the Emergency Core Cooling System (ECCS) of the facility submitted by the licensee on March 19, 1976, and supplements thereto dated May 7, May 11, May 21, and June 11, 1976, the Technical Specifications issued for the facility on October 23, 1976, limit the Average Planar Linear Heat Generation Rates to the values shown on Technical Specification Figures 3.5-1.A and 3.5-1.B. The ECCS performance evaluation submitted by the licensee was based upon an

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ECCS evaluation model developed by General Electric Company (General Electric), the designer of the facility. The General Electric ECCS Evaluation model had been previously found to conform to the requirements of the Commission's ECCS Acceptance Criteria, 10 CFR Part 50 § 50.46 and Appendix K. The evaluation indicated that with the average planar linear heat generation rate limited as set forth above, and with the other limits set forth in the facilities technical specifications, the ECCS cooling performance for the facilities would conform with the criteria contained in 10 CFR § 50.46(b) which govern calculated peak clad temperature, maximum cladding oxidation, maximum hydrogen generation, coolable geometry and long term cooling.

Recently, the NRC staff was informed by General Electric that several errors had been discovered in the computer codes used to calculate peak clad temperature and the clad oxidation percentage in the General Electric ECCS evaluation model. These errors have been discovered by General Electric during a continuing internal Quality Assurance (QA) audit of their LOCA evaluation model codes. The additional effort expended by the vendor to enhance the assurance of the quality of its evaluation model, the staff believes, was prudent and desirable. This audit is still under way and the errors reported reflect those found to date. Identification of additional errors of a minor nature may still develop during the ongoing QA checks. Nonetheless, the staff believes it appropriate to order the correction of those uncovered thus far. While some of these errors discussed herein have either no significant

effect or a conservative effect on the evaluation results, one or more of					
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MAPLOR					
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(2) Bundle Vaporization

General Electric has used incorrect coefficients in the calculation of the amount of vaporization occurring during core spray. The vapor formation in the bundle is a prime determinant of the amount of spray water that can get through the upper tie plate and reflood the core. The vapor formation was under-calculated by approximately 4% resulting

(1) Pressure Rule

The LAMB code is used to calculate system pressure during the LOCA. This calculated pressure is then used as an input to the REFLOOD code which calculates the water level vs time relationship in the core. General Electric used an approximation of the pressure response of the LAMB code that was thought, at the time of approval, to be an acceptable representation of the physical phenomena involved. Later application of this approximation to certain cases showed it to be non-conservative. General Electric proposes to correct this nonconservatism by utilizing a conservative approximation to the pressure rule for input into REFLOOD. This correction increases reflood time by 0 to 50 seconds and decreases MAPLOR by 0 to 5%.

Units Nos. 1 and 2.

which would require a reduction in operating limits for Browns Ferry code errors, when corrected, could produce ECCS evaluation results the NRC staff has determined that the combined effect of the following including information and supportive calculations by General Electric, leads to non-conservative values. Based on a preliminary assessment,

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Current flooding calculations:

- (a) The use of actual plant specific break areas for the LOCA;
- (b) A reduced core plate weight;
- (c) An increase in the peripheral bypass area used in the counter

as being necessary to correct errors. They included:  
 Several small changes of inputs to the evaluation codes were identified

(6) Others

the Browns Ferry units 1 and 2 MAPLGR by 2%.  
 This could cause a delay in reflood time. Correction of this error reduces  
 fuel assembly during periods of CCFL may be higher than previously assumed.  
 Some experimental evidence exists that the differential pressure in a

(5) Increased Counter Current Flow Limiting (CCFL) Differential Pressure

2.  
 approximately a 4% decrease in the MAPLGR for Browns Ferry units 1 and  
 in non-fuel structural material. Correction of this error results in  
 General Electric has erroneously taken double credit for power generation

(4) Structural Absorption of Gamma Heat

limited plants by about 1.5%.  
 approximately 15 seconds. This increases the MAPLGR for discharge break  
 recirculation pump) that improves reflooding time for the discharge break by  
 line friction (from the vessel nozzle to the discharge side of the

General Electric proposes to take credit for an approved model for suction

(3) Discharge Break Modeling

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Limits the penetration of spray cooling water into the lower plenum and						
before increase the reflood time for the core.						
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of steam used to evaluate the counter current flow limiting phenomenon which only occurred for certain plant calculations and determined the fraction of the flow split between the core and the jet pumps. This logic error The REFLOOD code was modified to correct a logic error in the evaluation

(2) Reflood 05 Computer Code Revision

evaluation of view factors for calculation of rod to rod radiation of heat. The CHASTE code has been modified to incorporate an improved conduction solution for the calculation of fuel rod temperatures and more detailed

(1) CHASTE 04 Computer Code Change

effects offsetting such a reduction. These revisions included: General Electric's most recent ECCS model revisions some of which have of these errors. On the other hand, the NRC staff is currently reviewing should be reduced by approximately 5% to accommodate the cumulative effect corrected. The revised ECCS calculations indicated that the MAPLHGR temperature that would result from the worst break, if the errors were to submit an estimate of the impact of these errors on the peak clad for Browns Ferry Units 1 and 2, the staff requested the licensee Due to the above errors in the ECCS analysis currently approved by NRC

valve closure during blowdown.

- (e) Credit is no longer assumed for recirculation loop discharge tube thickness; and
- (d) The correction of a decimal point error in the assumed guide

OFFICE	§ 50.46 in the specific computer runs for the particular facility.					
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The partial drilling correction gives credit for additional flow paths provided by drilling holes in the bottom nozzle of the fuel assemblies. This additional flow area enhances the refill of the lower plenum by spray cooling water following the postulated loss-of-coolant Accident and results in a faster core reflood which reduces peak clad temperatures.

Although the entire group of model changes is still under review, the staff has completed its review of the CHASTE and REFLOOD changes and has concluded that they may be used in GE's ECCS performance evaluation model. While revised computer runs incorporating these changes in the model as a whole have not yet been run for a spectrum of break for all plants, the parametric studies performed by GE to determine the effect of these changes demonstrate that they will in turn result in changes of at least a 2% MAPLNGP increase for 7 x 7 fuel assemblies up to 10,500 MWd/ft, a 4% increase for 7 x 7 fuel assemblies at fuel burnups greater than 10,500 MWd/ft. These values may be used to offset the reductions discussed above.

These parametric studies and calculational runs for typical boiling reactor models demonstrate that the reduction of the Browns Ferry Units 1 and 2 MAPLNGP, as set forth in Appendix A will conservatively assure that calculated peak clad temperatures in the event of postulated loss-of-coolant accidents would not exceed 2200°F and that the other criteria of 10 CFR § 50.46(b) will be satisfied. Operation of the facilities would nevertheless be technically in non-conformance with the requirements

(3) Partially Drilled Core Credit

employing the revised model as a complete entity will not be complete for some time. However, the limitations on MAPLNCR set forth herein will assure that the ECCS system will conform to the performance criteria of § 50.46. Accordingly, while the actual computer runs for the specific facility are carried out to achieve full compliance with 10 CFR s 50.46, operation of the facilities will not endanger life or property or the common defense and security.

Upon notification by the NRC staff on January 19, 1977, the licensee promptly modified the plant setpoints to reduce its Maximum Average Planar Linear Heat Generator Rate by to accommodate the effect of the errors and changes in the General Electric evaluations. The licensee again reduced the Browns Ferry Units 1 and 2 MAPLNCRs by an additional 2% to accommodate the effect of the CCFL error on February 18, 1977. The staff believes that the licensee's action under the circumstances is appropriate and that this action should be confirmed by NRC order.

III.

Copies of the following documents are available for inspection at the Commission's Public Document Room at 1717 H Street, Washington, D. C. 20555 and are being placed in the Commission's local public document room at the Athens Public Library, South and Forrest, Athens, Alabama, 35611:

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- (1) Letters from General Electric to NRC dated February 14, 1977, and January 26, 1977;
- (2) Letters from Tennessee Valley Authority to the Director of Nuclear Reactor Regulation dated January 19, 1977, and February 13, 1977;
- (3) Letters dated March 19, May 7, May 11, May 21, and June 11, 1976, from Tennessee Valley Authority; and
- (4) This Order for Modification of License in the matter of Tennessee Valley Authority (Browns Ferry Nuclear Plant, Units Nos. 1 and 2).

Accordingly, pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's Rules and Regulations in 10 CFR Parts 2 and 50, IT IS ORDERED THAT Facility Operating Licenses Nos. DPR-33 and DPR-52 are hereby amended by adding the following new provisions:

- (1) As soon as possible, the licensee shall submit a re-evaluation of ECCS cooling performance calculated in accordance with General Electric Company's Evaluation Model approved by the NRC staff and corrected for the errors described herein and any other corrections in the Model of which the licensee is aware at the time the calculations are performed;

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(2) Until further authorization by the Commission, the reactor shall be operated with the limiting Maximum Average Planar Linear Heat Generation Rates specified in Appendix A to this Order.

FOR THE NUCLEAR REGULATORY COMMISSION

**Original signed by**

Ben C. Rusche, Director  
Office of Nuclear Reactor Regulation

Appendix A -  
Corrected MAPLHGR Values

Dated in Bethesda, Maryland  
this **MAR 11 1977**

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