May 5, 2000

Mr. Guy G. Campbell, Vice President - Nuclear
FirstEnergy Nuclear Operating Company
5501 North State Route 2
Oak Harbor, OH 43449-9760

SUBJECT: DAVIS-BESSE NUCLEAR POWER STATION - ISSUANCE OF EXEMPTION FROM THE REQUIREMENTS OF 10 CFR 50.46 AND 10 CFR PART 50, APPENDIX K (TAC NO. MA7831)

Dear Mr. Campbell:

By letter dated March 15, 2000, as supplemented by a letter dated April 3, 2000, FirstEnergy requested an exemption from the single-failure requirement of Appendix K, Item I.D.1 with respect to emergency core cooling system (ECCS) evaluation models for the Davis-Besse Nuclear Power Station (DBNPS) boric acid precipitation control (BPC) methodology. The staff has concluded that the information provided in the exemption request is sufficient to grant the requested exemption. As discussed in the enclosed exemption, DBNPS provided additional justification by crediting flow-through hot-leg nozzle gaps as an additional means of providing boron dilution. Although the Nuclear Regulatory Commission (NRC) does not accept credit for the hot-leg nozzle gaps, no correction to the DBNPS submittal was necessary since adequate justification had been provided to grant the requested exemption.

The Commission, pursuant to 10 CFR 50.12, has issued the enclosed exemption for Davis-Besse Nuclear Power Station. A copy of this exemption has been forwarded to the Office of the Federal Register for publication.

Sincerely,

/RA by Douglas V. Pickett
For/

Stephen P. Sands, Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-346

Enclosure: Exemption

cc w/encl: See next page

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7590-01

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
FIRSTENERGY NUCLEAR OPERATING COMPANY	)	Docket No. 50-346
	)	
(Davis-Besse Nuclear Power Station)	)	
	)	

EXEMPTION

I.

FirstEnergy (the licensee) is the holder of Facility Operating License No. NPF-3, which authorizes the operation of the Davis-Besse Nuclear Power Station (DBNPS). The license states that the licensee is subject to all rules, regulations, and orders of the Nuclear Regulatory Commission (NRC or the Commission) now or hereafter in effect.

The Commission is taking an action to approve this request prior to publication in the Federal Register of its Environmental Assessment and Finding of No Significant Impact. In accordance with 10 CFR 51.13, the Commission has determined that emergency circumstances are present to support the issuance of this exemption prior to publication in the Federal Register in that failure to act in a timely way would result in prevention of resumption of plant operation.

The facility consists of a pressurized-water reactor at the licensee's site located in Ottawa County, Ohio.

II.

The DBNPS is planning to implement a plant modification during the twelfth refueling outage, which is scheduled to end in May 2000. The modification will change the equipment used to prevent boric acid precipitation following certain loss-of-coolant accidents (LOCAs) to enhance the flow of water through the core, thus controlling the accumulation of boric acid in the core and preventing boric acid precipitation.

The Code of Federal Regulations at 10 CFR 50.46 provides acceptance criteria for the ECCS, including long-term cooling requirements in 50.46(b)(5) and an option to develop the ECCS evaluation model (EM) in conformance with Appendix K requirements (10 CFR 50.46(a)(1)(ii)). 10 CFR Part 50, Appendix K, Section 1.D.1, in turn, requires that accident evaluations use the combination of ECCS subsystems assumed to be operative "after the most damaging single failure of ECCS equipment has taken place." In addition, Appendix K Section I.A.4. specifies a requirement to assume decay heat generation rate is equal to 1.2 times the values for infinite operating time in a specified ANS standard.

The proposed action would exempt the Licensee from the single-failure requirement for very low probability scenarios under certain conditions. The exemption is limited to the systems required for preventing boron precipitation during the long-term cooling phase of a LOCA. In addition, the action would exempt the Licensee from the decay heat generation rate assumption specified in Appendix K, Section I.A.4.

Specifically, DBNPS requested the following exemption by its letters dated March 15, and April 3, 2000:[1, 2]

> FirstEnergy, with respect to the Davis-Besse Nuclear Power Station, is exempt from the single failure criterion requirement of 10 CFR Part 50, Appendix K, Section I.D.1, with respect to (1) Simultaneous failure of both the primary auxiliary spray method and the backup decay heat removal drop line method of controlling boron concentration due to failure of an emergency core cooling component that

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[1]Campbell, Guy G., "Request for Exemption from 10 CFR 50, Appendix K, for Boric Acid Precipitation Control Methodology (TAC No. MA7831)," Letter to NRC from Vice President, Nuclear, FirstEnergy, Davis-Besse Nuclear Power Station, March 15, 2000.

[2]Campbell, Guy G., "Supplemental Information Regarding the Request for Exemption from 10 CFR 50, Appendix K, for Boric Acid Precipitation Control Methodology (TAC No. MA7831)," Letter to NRC from Vice President Nuclear, FirstEnergy, Davis-Besse Nuclear Power Station, April 3, 2000.

> results in inability to initiate, or continue to operate, an active means of controlling core boron concentration, and (2) Not establishing that the backup decay heat removal drop line method of controlling boron concentration is otherwise in compliance with Appendix K and 10 CFR 50.46(b)(5) requirements. Specifically, when establishing that boron precipitation will not occur in the decay heat removal system cooler, the Davis-Besse Nuclear Power Station credited flow through hot leg nozzle gaps and did not include all of the specific conservatisms required by Appendix K.

The staff considers that the modifications would also require an exemption from the decay heat generation rate requirement contained in 10 CFR Part 50, Appendix K, Section I.A.4.

III.

Certain LOCAs can result in a reactor coolant system (RCS) configuration in which the core is covered with boiling water and decay heat is transported from the core by steam while makeup water is provided to keep the core covered. This condition can result in accumulation of boric acid in the core since boric acid continues to be added via the makeup water, but little boric acid is removed by the steam. If too much boric acid accumulates, some might precipitate and prevent water from reaching the core to keep it cooled.

The DBNPS reactor vessel (RV) is equipped with reactor vessel vent valves (RVVVs). The RVVVs will cause water to flow through the core to control buildup of boric acid when needed for all LOCA conditions except for (1) some LOCAs between the reactor coolant pumps (RCPs) and the RV and (2) decay heat generation rate comparable to approximately a month following extended operation at full power for some LOCAs. Active means of controlling boric acid concentration are provided to address the case when the RVVVs are not effective.

In licensee event report (LER) 98-008 (October 1, 1998), DBNPS reported that for some small-break LOCAs, initiation of its active method of boron precipitation control (BPC) could cause steam binding in the suction piping of both decay heat removal (DHR) pumps. As part of the corrective action for LER 98-008, DBNPS committed to address all issues related to long-term LOCA BPC and to complete a related plant modification to improve the active methods by the end of the twelfth refueling outage. Improved active methods of BPC and the associated exemption request are in response to that commitment.

With the improved active methods, if the RVVVs are not effective, then (1) the primary active method of BPC is a new means of supplying water to the pressurizer via the auxiliary spray line and (2) a new backup method will take water from an RCS hot leg via the DHR system drop line and return water to the RV via the core flood nozzles. DBNPS has stated that either method will provide sufficient flow of water through the core to provide BPC.

The DBNPS identified the following single failure vulnerabilities for situations where the RVVVs cannot be established as being effective:

(1) The primary BPC method is only connected to one train of high-pressure safety injection (HPSI) and is subject to any single active component failure in the flow path. Thus, a backup method is needed.

(2) The backup BPC method is potentially vulnerable to boron precipitation in the DHR cooler and to certain failure modes that are common to both the primary and backup BPC methods.

In its March 15, and April 3, 2000, submittals, the DBNPS requested an exemption from certain requirements of the criteria. DBNPS justified its request on the basis of improvements over the existing methodology, conservatisms in calculations that result in over-prediction of the BPC problem, and a risk evaluation.

IV.

Two new active methods are planned for BPC: (1) a primary method using an improved auxiliary spray path into the pressurizer and (2) a backup method using flow into the DHR suction pipe from an RCS hot-leg pipe. A new pipe and new valves are being installed to accommodate the primary method. This path will supply about 250 gpm to the pressurizer, sufficient to fill the pressurizer in approximately an hour, after which BPC will be achieved by flow from the pressurizer into the reactor vessel via an RCS hot-leg. High-pressure injection (HPI) Pump 2 will be used with "piggyback" suction from DHR/low-pressure injection (LPI) Pump 2. A failure anywhere in the flow path could result in failure of this method to provide water to the pressurizer.

A backup method is provided in case the primary method fails. This method will use one of the two operating DHR/LPI pumps to take suction from the DHR drop line and to discharge a low flow rate into the reactor vessel via the core flood nozzles. The second DHR/LPI pump will be unthrottled and will continue to take suction from the emergency sump. The first pump will ensure a net flow of water through the core by withdrawing water from an RCS hot-leg while the second pump will ensure that makeup water is supplied to the RCS so that core cooling is ensured.

If only one ECCS train is available, the backup method is not available since the available ECCS train must be used to ensure the water makeup function. Thus, failure of ECCS Train 2 will disable both the primary and the backup method for BPC. DBNPS reported the results of a common-mode failure evaluation of this condition that identified several areas where a single-failure could disable both the primary and backup BPC methods. We briefly audited this evaluation.

The DBNPS assumed an initial RCS boric acid concentration of 1900 ppm for the small break LOCAs for analysis of DHR cooler performance on the basis that, after the first few days of operation, the actual RCS concentration prior to the LOCA would be 1700 to 1800 ppm. Injection water was included from the borated water storage tanks at about 2800 ppm and from the core flood tanks at about 4000 ppm. For the large and medium LOCAs, the 1900 ppm assumption was not used because much of the original water is lost from the RCS prior to injection, and the core flood tanks and borated water storage tank were assumed to inject into the RCS consistent with the LOCA RCS pressure calculations. This approach is acceptable because the amount of boron predicted to be in the core will be consistent with the sources of boron.

The DBNPS assumed 1.0 times the American Nuclear Society (ANS) standard infinite operation decay heat generation rate for calculation of the DHR cooler aspects of the backup method, whereas Appendix K specifies 1.2. Although using 1.0 is more realistic and is suitable for probabilistic risk calculations, the calculation does not include the conservatism required by Appendix K. The DBNPS exemption request therefore encompasses not complying with the Appendix K calculational requirement. Realistically, when considered in conjunction with a likely hot leg nozzle gap that provides a boron dilution path, DBNPS has shown that BPC will be maintained through the cooler. This, in conjunction with the low probability of encountering the condition (as discussed below), demonstrates that use of an assumed 1.0 decay heat generation rate does not constitute an undue risk and is therefore, acceptable.

Traditionally, core boric acid concentration evaluations use a solubility limit of the actual solubility reduced by four weight percent, an approach the staff has accepted in past Appendix K reviews to account for such items as solubility uncertainty and the non-uniform temperatures that may result in the RV. The DBNPS stated it used 4 percent for its core analyses, but that it used a 90 percent of the solubility limit for the DHR cooler analysis. This reduced margin approach is reasonable and is acceptable for the DHR cooler analysis because the complex flow patterns and potential temperature non-uniformities associated with the RV will not be present in the DHR cooler.

The DBNPS found that, when the backup method is first initiated, core boric acid concentration in water initially entering the DHR cooler could exceed solubility limits due to the low DHR cooler temperature. In its March 15, 2000, submittal, DBNPS addressed this for the break conditions of concern by assuming there would be water flow from above the core into the downcomer via the hot leg nozzle gaps. The licensee calculated that this flow would maintain the core boric acid concentration below a value where the DHR cooler problem would occur until the backup method was performing its core dilution function. In its April 3, 2000, submittal, DBNPS requested that the exemption cover the calculated initial DHR cooler response since there was insufficient evidence to substantiate the claimed gap flow under the requirements of 10 CFR 50.46 and Appendix K. The staff examined the licensee's evaluation using more realistic assumptions with respect to initial boron concentration, DHR cooler flow, decay heat rate, and DHR cooler temperatures. The staff concurs with the licensee that boric acid precipitation in the DHR cooler will not occur due to the conservative nature of their assumptions.

The DBNPS did not attempt to address the change in core damage frequency (CDF) due to the planned modifications since BPC was not previously addressed in its plant risk assessment. Instead, it addressed the total risk associated with BPC. This assessment was based on several conservative assumptions. The DBNPS assumed that, for certain break size and location combinations, active BPC failure would cause core damage. This is consistent with the past regulatory approach to prevent conditions where boric acid precipitation could occur and the assumed failure to do so would be a failure to prevent core damage. Realistically, a significant quantity of boric acid would have to precipitate to lead to a loss of heat transfer that could cause core damage. This is an unquantified conservatism.

The CDF is directly affected by the initiation rate of accidents of concern to BPC failure. For the bounding calculations, the DBNPS stated that it used generic LOCA rates of $5X10^{-6}$ and $4X10^{-5}$ events/reactor-year for large and medium LOCAs, respectively, from NUREG/CR-5750. DBNPS then assumed that an active control method was needed for breaks lower than the 573-foot elevation in the cold-leg RCP discharge piping for medium and large-break LOCAs, and that the break rate of concern was 25 percent of the large and medium LOCA frequency, leading to an initiation rate of $1.1X10^{-5}$/reactor-year for active BPC. DBNPS then calculated the CDF due to boron precipitation to be approximately $1.1X10^{-7}$/reactor-year[3] (i.e., the frequency of an accident occurring in combination with a failure that renders both active BPC methods inoperable). DBNPS also reported the large early release frequency (LERF) associated with boron precipitation to be $1.1X10^{-11}$/reactor-year. DBNPS concluded that the proposed plant modification would not be a significant contributor to the total CDF or LERF of the plant (approximately $1.63X10^{-5}$ and $7.3X10^{-8}$/reactor-year, respectively). Regulatory Guide 1.174, "An approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," July 1998, considers an increase in risk to be very small if CDF and LERF are less than 10^{-6} and 10^{-7}, respectively. It further considers decreases in CDF and LERF to be satisfactory. The DBNPS predictions meet the guidance and are acceptable.

The LOCAs where the RVVVs are initially ineffective are those involving roughly the lower half of the cold-leg piping between the RCPs and the RV. Considering symmetry and working with one side of the RCS that consists of one hot leg, a SG, and two cold legs, the actual fraction of concern was evaluated. Each cold leg has a segment between the RCP and the RV and between the SG and the RCP. Assuming each segment has about the same likelihood of breaking, and a hot leg section is about 3 times as long as a cold leg segment, and since the breaks of concern are in the cold leg between an RCP and the RV, and only a break in the lower half of a cold leg at that location is of concern, then the fraction of big pipe breaks of concern is (½)(2) / (2+2+3) = 0.14. DBNPS assumed 0.25, a conservatism of a factor of 1.8 with respect to this example.

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[3]This calculation assumes the hot-leg nozzle gaps pass water with respect to calculating DHR cooler response. The effect of excluding hot-leg nozzle gap flow is addressed below. The values discussed here are only changed by a small amount.

The DBNPS identified several other conservatisms in its risk assessment calculations. For example, with the exception of the backup method DHR cooler calculation where DBNPS used 1.0 times the decay heat, it used 1.2 times the decay heat for an infinitely irradiated core, thus predicting a faster boric acid concentration increase rate than would be expected, it took no credit for operator recovery actions, and, with the exception of the original DHR cooler analysis, it took no credit for hot-leg nozzle gaps. We agree that the above mentioned assumptions introduced conservatisms in the BPC related risk estimates assessed by DBNPS.

The DBNPS addressed a potential increase in scope to include both HPI trains in the primary BPC method as opposed to only having HPI Train 2, thus eliminating part of the failure concern. It reported a CDF of $1.3X10^{-8}$/reactor-year for two trains, which it compared to the CDF of $1.1X10^{-7}$/reactor-year for only having HPI Train 2. DBNPS concluded that an increase in scope would not achieve a significant benefit in terms of risk reduction. NUREG-1.174 considers an increase in CDF to be very small if it is less than 10^{-6}. In effect, the risk in moving from two trains to one would increase by 10^{-7}, well within the 10^{-6} criterion. We therefore agree with the DBNPS conclusion and we find the decision to remain with one HPI train to be acceptable because a significant benefit would not be achieved by the increased scope.

As discussed above, the backup BPC method was not shown to be functional using assumptions consistent with Appendix K, nor was it shown to be functional using more realistic assumptions unless hot-leg nozzle gap flow was credited. Consequently, the DBNPS assumed a nozzle gap failure probability of 0.1, and predicted a CDF of $1.3X10^{-7}$/reactor-year. We believe that a 0.1 failure probability is a reasonable bound and the actual failure probability would most likely be smaller. This, in conjunction with other potential bypass paths, such as associated with the core former-downcomer-thermal shield region and other applicable conservatisms is sufficient for us to accept the 0.1 probability used in this risk assessment. The increase from the previously calculated $1.1X10^{-7}$/reactor-year is small enough that risk-associated conclusions from the original analysis remain unchanged.

The new connection between the Train 2 HPI and LPI systems introduces a potential for overpressurization of the Train 2 LPI system if valves are misaligned. The DBNPS evaluated this potential and the measures it will put in place to prevent valve misalignment, and reported an increase in CDF of less than 10^{-8}/reactor-year due to valve misalignment. This is a negligible impact on the overall CDF of $1.63X10^{-5}$/reactor-year.

The equipment modification addresses recognized weaknesses in the previous response to BPC and improves the defense-in-depth and safety margins should such conditions be encountered. DBNPS did not provide the calculated CDF and LERF that existed prior to the modification, but we judge the modification would reduce CDF and LERF because it addresses recognized weaknesses. DBNPS calculated that the CDF and LERF due to boron precipitation with the modification would be approximately $1.1X10^{-7}$/reactor-year and $1.1X10^{-11}$/reactor-year, respectively. These are small when compared to the total CDF and LERF from all causes of $1.63X10^{-5}$/reactor-year and $7.3X10^{-8}$/reactor-year, respectively. Further, Regulatory Guide 1.174 indicates that increases in CDF and LERF are very small if less than 10^{-6}/reactor-year and 10^{-7}/reactor-year, respectively, and that decreases satisfy the relevant principles of risk-informed regulation. Here, the total contribution is smaller than what RG 1.174 considers to be small as an increase. These comparisons establish that the proposed exemption does not present an undue risk to public health and safety.

IV.

Pursuant to 10 CFR 50.12, "... The Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements ... which are ... authorized by law, will not present an undue risk to the public health and safety, ... are consistent with the common defense and security (and) ... special circumstances are present...." Special circumstances are present whenever, according to 10 CFR 50.12(a)(2)(ii), "Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule...."

The requested exemption is authorized by law and does not affect the systems and processes associated with common defense and security.

As identified above, the requirements of 10 CFR Part 50 apply to BPC and the DBNPS exemption request. With respect to the single-failure aspect of this evaluation, the underlying purpose of the single-failure criterion requirement is to assure long-term cooling performance of the ECCS in the event of the most damaging single-failure of ECCS equipment.

As a licensing review tool, the single-failure criterion helps assure reliable systems as an element of defense in depth. As a design and analysis tool, it promotes reliability through enforced redundancy. Since historically, only those systems or components that were judged to have a credible chance of failure were assumed to fail, the criterion has been applied to such responses as valve movement on demand, emergency diesel generator start, short circuit in an electrical bus, and fluid leakage caused by gross failure of a pump or valve seal during long-term cooling. Reactor vessels or certain types of structural elements within systems, when combined with other unlikely events, were not assumed to fail because the probabilities of the resulting scenarios were deemed sufficiently small that they need not be considered. Certain passive failures 24 hours or more after initiation of a LOCA, such as pipe breaks, were not addressed as single failures because the compounded probabilities were judged sufficiently small that they could be discounted without affecting overall systems reliability.

The single-failure criterion was developed without the benefit of numerical failure assessments. Regulatory requirements and guidance consequently were based upon categories of equipment and examples that must be covered or that are exempt, and do not allow a probabilistic consideration during routine implementation. Hence, a single failure that was not judged to be incredible (exempt) during development of the regulations, whether or not there is a substantial impact upon overall system reliability, will not meet the regulatory requirements. A non-beneficial result is inconsistent with the objective of the single-failure criterion, which was not intended to force changes if essentially no benefit would accrue. This is the case with potential failure of the active means of BPC.

No US plants have encountered LOCA conditions where BPC was of concern. BPC measures are not needed for hot-leg breaks because water will flow through the core, thus preventing significant boric acid buildup, they are not needed if excore thermocouples indicate an adequate subcooling margin because there is no boiling to cause concentration of boric acid, and they are not needed for many of the remaining breaks until decay heat is low because water will flow from the core to the upper downcomer via the RVVVs, thus providing a mechanism to control accumulation of boric acid in the core. Active means for BPC are needed in case one of the above conditions is not satisfied.

The DBNPS will provide two active methods of BPC. The first does not meet the single-failure criterion. The second does not meet regulatory requirements for analyses applicable to an acceptable system and is susceptible to some of the same failures that cause failure of the first. Further, the second has a small likelihood of failing to function when first initiated because core bypass flow is necessary for a short time to prevent conditions where boron precipitation may occur. However, DBNPS has predicted via a conservative assessment that the <u>total</u> BPC-related CDF and LERF are about 10^{-7}/reactor-year and 10^{-11}/reactor-year, respectively. The DBNPS has further described in-depth, proceduralized actions that will be applied to restore an active BPC method should it fail to initiate when called upon. These actions, in combination with the predicted failure rate without the actions, establish that a satisfactory defense-in-depth is provided such that long term cooling performance of the ECCS will continue to be met.

Therefore, the requested exemption meets the special circumstances requirement of 10 CFR 50.12(a)(2)(ii) with respect to the single failure criterion requirements.

With respect to the decay heat generation rate specified in Appendix K, Section I.A.4, the underlying purpose of the heat generation rate is to provide an appropriate value for the ECCS evaluation model. The DBNPS assumed 1.0 times the American Nuclear Society standard infinite operation decay heat generation rate for calculation of the DHR cooler aspects of the backup method whereas Appendix K specifies 1.2. The staff considers the use of 1.0 to be more realistic and suitable for probabilistic risk calculations. Therefore, the requested exemption meets the special circumstances requirement of 10 CFR 50.12(a)(2)(ii) with respect to the decay heat generation rate in that use of the 1.2 value is not necessary to achieve the underlying purpose of the rule.

VI.

For the foregoing reasons, the NRC staff has concluded that an exemption is acceptable to the requirements of Appendix K, Section I.D.1, 10 CFR 50.46(b)(5), and 10 CFR 50.46(a)(1)(ii) with respect to the DBNPS active methods for BPC. The NRC staff has determined that there are special circumstances present, as specified in 10 CFR 50.12.(a)(2)(ii), in that application of the specific regulations is not necessary in order to achieve the underlying purpose of these regulations, which is to assure long term cooling performance of the ECCS in the event of the most damaging single failure of ECCS equipment. In addition, the staff has determined that an exemption to Appendix K, Section I.A.4 is acceptable with respect to the decay heat generation rate. Special circumstances exist in that use of the 1.2 value specified in Appendix K, Section I.A.4, is not necessary in order to achieve the underlying purpose of the rule.

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), the requested exemption is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. Therefore, the Commission hereby grants the requested exemption. This exemption is effective upon issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Suzanne C. Black, Acting Director
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Dated at Rockville, Maryland,
this fifth day of May 2000.