September 26, 2001

Mr. William R. McCollum, Jr.
Vice President, Oconee Site
Duke Energy Corporation
7800 Rochester Highway
Seneca, SC 29672

SUBJECT: OCONEE NUCLEAR STATION, UNITS 1, 2 AND 3 RE: ISSUANCE OF AMENDMENTS (TAC NOS. MA9596, MA9597, AND MA9598)

Dear Mr. McCollum:

The Nuclear Regulatory Commission has issued the enclosed Amendment Nos. 320 , 320 , and 320 to Renewed Facility Operating Licenses DPR-38, DPR-47, and DPR-55, respectively, for the Oconee Nuclear Station, Units 1, 2, and 3. The amendments consist of changes to the Technical Specifications (TS) in response to your application dated July 18, 2000, as supplemented August 22 and November 8, 2000, and June 7, July 26, and September 5, 2001.

The amendments evaluate the plant modification and revise the TS related to the Automatic Feedwater Isolation System (AFIS).

A copy of the related Safety Evaluation is also enclosed. A Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice. Notes to the AFIS TS provisions of these amendments state that the new provisions will become effective for an Oconee unit when the AFIS is operational on that unit. Accordingly, we request that you inform the staff in writing when the AFIS is operational on each Oconee Unit. In addition, implementation of appropriate Final Safety Analysis Report provisions and Selected Licensee Commitments will coincide with implementation of the enclosed amendment for each unit.

Sincerely,

/RA/

David E. LaBarge, Senior Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-269, 50-270, and 50-287

Enclosures:
1. Amendment No. to DPR-38
2. Amendment No. to DPR-47
3. Amendment No. to DPR-55
4. Safety Evaluation

cc w/encls: See next page

September 26, 2001

Mr. William R. McCollum, Jr.
Vice President, Oconee Site
Duke Energy Corporation
P. O. Box 1439
Seneca, SC 29679

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The amendments evaluate the plant modification and revise the TS related to the Automatic Feedwater Isolation System (AFIS).

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DUKE ENERGY CORPORATION

DOCKET NO. 50-269

OCONEE NUCLEAR STATION, UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 320
Renewed License No. DPR-38

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment to the Oconee Nuclear Station, Unit 1 (the facility) Renewed Facility Operating License No. DPR-38 filed by the Duke Energy Corporation (the licensee) dated July 18, 2000, as supplemented August 22 and November 8, 2000, and June 7, July 26, and September 5, 2001, comply with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations as set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is hereby amended by page changes to the Technical Specifications as indicated in the attachment to this license amendment, and Paragraph 3.B of Renewed Facility Operating License No. DPR-38 is hereby amended to read as follows:

B. Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 320 , are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance. It shall be implemented prior to reactor startup following installation of the system and training of appropriate personnel.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Richard J. Laufer, Acting Chief, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment:
Technical Specification
Changes

Date of Issuance: September 26, 2001

DUKE ENERGY CORPORATION

DOCKET NO. 50-270

OCONEE NUCLEAR STATION, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 320
Renewed License No. DPR-47

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment to the Oconee Nuclear Station, Unit 2 (the facility) Renewed Facility Operating License No. DPR-47 filed by the Duke Energy Corporation (the licensee) dated July 18, 2000, as supplemented August 22 and November 8, 2000, and June 7, July 26, and September 5, 2001, comply with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations as set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is hereby amended by page changes to the Technical Specifications as indicated in the attachment to this license amendment, and Paragraph 3.B of Renewed Facility Operating License No. DPR-47 is hereby amended to read as follows:

B. Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 320 , are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance. It shall be implemented prior to reactor startup following installation of the system and training of appropriate personnel.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Richard J. Laufer, Acting Chief, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment:
Technical Specification
Changes

Date of Issuance: September 26, 2001

DUKE ENERGY CORPORATION

DOCKET NO. 50-287

OCONEE NUCLEAR STATION, UNIT 3

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 320
Renewed License No. DPR-55

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment to the Oconee Nuclear Station, Unit 3 (the facility) Renewed Facility Operating License No. DPR-55 filed by the Duke Energy Corporation (the licensee) dated July 18, 2000, as supplemented August 22 and November 8, 2000, and June 7, July 26, and September 5, 2001, comply with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations as set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is hereby amended by page changes to the Technical Specifications as indicated in the attachment to this license amendment, and Paragraph 3.B of Renewed Facility Operating License No. DPR-55 is hereby amended to read as follows:

B. Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 320 , are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance. It shall be implemented prior to reactor startup following installation of the system and training of appropriate personnel.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Richard J. Laufer, Acting Chief, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment:
Technical Specification
Changes

Date of Issuance: September 26, 2001

ATTACHMENT TO LICENSE AMENDMENT NO. 320

RENEWED FACILITY OPERATING LICENSE NO. DPR-38

DOCKET NO. 50-269

AND

TO LICENSE AMENDMENT NO. 320

RENEWED FACILITY OPERATING LICENSE NO. DPR-47

DOCKET NO. 50-270

AND

TO LICENSE AMENDMENT NO. 320

RENEWED FACILITY OPERATING LICENSE NO. DPR-55

DOCKET NO. 50-287

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Technical Specification Pages

Remove	Insert
LOEP1	LOEP1
LOEP3	LOEP3
LOEP4	LOEP4
LOEP5	LOEP5
LOEP6	LOEP6
LOEP7	LOEP7
LOEP8	LOEP8
LOEP9	LOEP9
ii	ii
iii	iii
iv	iv
------	v
3.3.11-1	3.3.11-1
3.3.11-2	3.3.11-2
3.3.12-1	3.3.12-1
3.3.12-2	3.3.12-2

Technical Specification Pages (Continued)

Remove	Insert
3.3.13-1	3.3.13-1
3.3.13-2	3.3.13-2
------	3.3.24-1
------	3.3.25-1
------	3.3.25-2
------	3.3.26-1
------	3.3.26-2
------	3.3.27-1
------	3.3.27-2

Bases Pages

Remove	Insert
LOEP1	LOEP1
LOEP6	LEOP6
LEOP7	LEOP7
LEOP8	LEOP8
LEOP9	LEOP9
LEOP10	LEOP10
LEOP11	LEOP11
LEOP12	LEOP12
LEOP13	LEOP13
i	i
ii	ii
B 3.3.11-1	B 3.3.11-1
B 3.3.11-2	B 3.3.11-2
B 3.3.11-3	B 3.3.11-3
B 3.3.11-4	B 3.3.11-4
B 3.3.11-5	B 3.3.11-5
B 3.3.12-1	B 3.3.12-1
B 3.3.12-2	B 3.3.12-2
B 3.3.13-1	B 3.3.13-1
B 3.3.13-2	B 3.3.13-2
B 3.3.13-3	B 3.3.13-3
------	B 3.3.13-4
------	B 3.3.24-1
------	B 3.3.25-1
------	B 3.3.25-2
------	B 3.3.25-3
------	B 3.3.25-4
------	B 3.3.25-5
------	B 3.3.25-6
------	B 3.3.26-1
------	B 3.3.26-2
------	B 3.3.26-3

Bases Pages (Continued)

------	B 3.3.27-1
------	B 3.3.27-2
------	B 3.3.27-3
B 3.7.3-1	B 3.7.3-1
B 3.7.3-2	B 3.7.3-2

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO

AMENDMENT NO. 320 TO RENEWED FACILITY OPERATING LICENSE DPR-38

AMENDMENT NO. 320 TO RENEWED FACILITY OPERATING LICENSE DPR-47

AND AMENDMENT NO. 320 TO RENEWED FACILITY OPERATING LICENSE DPR-55

DUKE ENERGY CORPORATION

OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3

DOCKET NOS. 50-269, 50-270, AND 50-287

1.0 INTRODUCTION

By letter dated July 18, 2000, as supplemented by letters dated August 22 and November 8, 2000, and June 7, July 26, and September 5, 2001, Duke Energy Corporation (Duke or the licensee) submitted a request for staff review of a proposed modification to add a new Automatic Feedwater Isolation System (AFIS) and related changes to the Oconee Nuclear Station, Units 1, 2, and 3 (ONS) Technical Specifications (TS). The supplement dated August 22, 2000, revised the proposed no significant hazards consideration determination contained in the July 18, 2000, submittal and was published in the *Federal Register* on September 20, 2000. The submittals dated November 8, 2000; and June 7, July 26, and September 5, 2001, provided clarifying information that did not change the initial proposed no significant hazards consideration determination contained in the August 22, 2000, letter.

2.0 BACKGROUND

2.1 Design Criteria

In a nuclear power plant there are three barriers to the release of radioactivity from the fuel to the environment: the fuel rod cladding, the reactor coolant system (RCS) pressure boundary, and the containment building. In a pressurized water reactor (PWR) such as the Babcock and Wilcox (B&W) plant design at ONS, the RCS pressure boundary includes the reactor vessel; the pressurizer; the reactor coolant pumps and piping; piping connected to the RCS up to the safety related valves that isolate the RCS from systems connected to nonsafety related components; and the steam generator tubes, which transfer the energy from the reactor coolant system to the water in the steam generator (SG) secondary side.

General Design Criterion (GDC) 14 of 10 CFR Part 50, “Reactor coolant pressure boundary,” requires the reactor coolant pressure boundary to be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. GDC 15, “Reactor coolant system design,” requires the reactor coolant

system and associated auxiliary, control, and protection systems to be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences. Although the construction permits for the Oconee units were issued before the GDC were codified, the Oconee Updated Final Safety Analysis Report (UFSAR) contains plant-specific principal design criteria that embody design goals similar to those of the GDC.

Due to the design of the B&W once-through steam generator (OTSG), with the SG tubes anchored at both ends by the upper and lower tube sheets (which are welded to the SG shell), differences in thermal expansion coefficients between the SG tubes and the SG shell can produce high stresses in the SG tubes if the differential temperature between the SG tubes and the SG shell (the tube-to-shell temperature difference) becomes too large. For example, large tube-to-shell differential temperatures can occur if emergency feedwater (EFW) is injected into a SG that is connected to a ruptured main steam line. The relatively cold EFW, which is injected directly into the upper region of the SG tube bundle, would cool the SG tubes faster than the SG shell. This, in turn, would cause a rapid contraction of the SG tubes, resulting in large tensile stresses in the tubes because the SG shell would be contracting at a slower rate. If a SG tube had a sufficiently large flaw before the main steam line break (MSLB) event, the SG tube could fail as a result of the high tensile stresses.

When a licensee determines by inspection during a plant outage that a SG tube flaw exceeds an allowable flaw size limit, the licensee may isolate the flawed SG tube from the RCS pressure boundary by installing a plug in each end of the SG tube. The purpose of this SG tube plugging is to ensure that the RCS boundary will not have abnormal leakage or a gross rupture if the flawed tube fails as a result of a design basis event during the plant's operating cycle. The flaw size criteria for plugging a SG tube is determined by analyzing the expected stresses on a SG tube for various postulated design basis events, such as a MSLB.

Prior to licensing of Oconee Units 1, 2, and 3, the analysis submitted by Duke concerning SG tube stresses that result from a MSLB assumed that the Integrated Control System (ICS) would maintain post-trip SG level control, and that operator action would be taken to isolate main feedwater (MFW) flow to the affected SG in less than 50 seconds. By letter dated March 3, 1970, the Atomic Energy Commission (AEC) requested additional information and a reanalysis of the MSLB event. In response to the AEC request (Questions 14.3.3 and 14.3.5, and 14.3.8), the licensee indicated that: (1) the "worst case" MSLB was defined by continued operation of the ICS to automatically control SG level at the post-trip level setpoint without reliance on operator action for mitigating the event, and (2) the worst case MSLB will not result in concurrent SG tube rupture when considering the effects of blowdown loads, pressure and temperature induced stresses, and tube degradation caused by long-term erosion, vibration, corrosion, and leakage.

The plant designer (B&W) had concluded in the original ONS design basis analysis that no SG tube failures were expected to occur as a result of a design basis MSLB event if EFW is manually isolated from the affected SG within the first 10 minutes of the event. Manual isolation of EFW was assumed in the MSLB design basis analysis because the existing MSLB detection circuitry did not meet all of the protection system criteria set forth in IEEE Std 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations." The licensee determined later that little margin exists for the operator to secure EFW manually within the first 10 minutes of a MSLB event to ensure the tube-to-shell temperature change is maintained

within allowable limits. Additionally, MFW flow and EFW flow to an affected SG must be isolated within 10 minutes of a main steam line or main feedwater line break (MFLB) inside the containment to minimize the quantity of mass and energy released into the containment building because excessive containment pressures can affect the integrity of the containment radioactivity release barrier.

Upon detection of a MSLB or upon manual actuation, the existing MSLB detection circuitry prevents the turbine-driven emergency feedwater pump (TDEFWP) from auto-starting, or stops the TDEFWP if it has already started. A manual override for the TDEFWP inhibit is provided to allow the operator to subsequently start the TDEFWP if necessary for decay heat removal. The motor driven EFW pumps (MDEFWPs) are not stopped by the existing MSLB detection circuitry. The operators must stop the MDEFWPs manually.

Additionally, when a MSLB event is detected by the existing MSLB detection circuitry, a MFW isolation function in the MSLB detection circuitry trips both MFW pumps and automatically closes the MFW and startup feedwater control valves and block valves to isolate the MFW flow paths to both SGs. Although the MFW isolation function closes these valves, the ONS licensing analysis does not credit this MFW isolation function for limiting the mass and energy released into the containment and minimizing the resulting containment pressurization.

In the existing system, SG steam header pressure signals from three Rosemount pressure sensors on each SG steam header (six total) are used as input signals to the existing MSLB detection circuitry. Each of the six Rosemount pressure transmitter sensors provides a steam header pressure signal to an associated signal isolator and bistable. These bistables are calibrated to provide an ON/OFF signal at the desired setpoint for actuation of the MSLB detection circuitry. A pressure transmitter and its associated signal isolator(s) and bistable(s) constitute a MSLB detection circuit analog channel.

The six MSLB detection circuit analog channels provide signals to two redundant feedwater isolation digital channels consisting of two 2-out-of-3 logic circuits. A master relay coil is energized when the trip logic is satisfied, which results in closure of contacts in control circuits for systems and components used for responding to MSLB events. If either digital channel is actuated, a MFW isolation and TDEFWP trip will occur. The use of an energize-to-trip master relay ensures that a loss of power to the digital channels will not isolate feedwater from the SGs inadvertently, which would cause a partial or full loss of heat sink event.

Other features of the existing MSLB detection circuit digital channels include a test/manual actuation pushbutton, a circuit seal-in after the master relay is energized, a 2 second time delay to prevent spurious actuation, and an “enable" or “arming” switch. The two 2-out-of-3 logic circuits, and the associated enable switch, master relay, seal-in, time delay, and test/manual actuation pushbutton are considered a digital channel. The licensee’s operating procedures contain provisions to enable and disable the digital channels administratively rather than automatically.

To reduce operator burden and to provide more margin for isolating feedwater sources from a SG during a MSLB event, the licensee developed a replacement system (i.e., AFIS) for the existing MSLB detection circuitry and MFW isolation logic.

The AFIS modification is intended to upgrade and enhance the existing MSLB detection and MFW isolation circuitry by upgrading certain components to safety-grade classification, by eliminating certain single failure vulnerabilities, and by automatically isolating EFW to a faulted SG following a MSLB or MFLB event. Prompt isolation of feedwater sources to a faulted SG during a MSLB event reduces SG tube tensile stresses caused by cooling the SG tube bundle faster than the SG shell; reduces the release of mass and energy through the break into the containment; limits RCS overcooling; and provides protection against EFW pump runout. The AFIS eliminates the current requirement for manual operator actions to trip the motor driven EFW pumps within the first 10 minutes of a MSLB event. Additionally, the existing ONS MFW isolation function has been incorporated into the AFIS, and was modified to be SG steam header-specific.

2.2 Previous Evaluations

The licensee's analysis associated with Inspection and Enforcement (IE) Bulletin 80-04, "Analysis of a PWR [Pressurized Water Reactor] Main Steam Line Break with Continued Feedwater Addition," determined that containment design pressure would be exceeded without operator action to isolate MFW flow to the SGs. In order to minimize reliance on operator actions, Duke modified the Oconee units to include a MSLB isolation system to automatically isolate MFW to both SGs, trip both MFW pumps, and trip the turbine-driven EFW pump if running (or prevent it from starting if not running) following a MSLB event. The licensee indicated that the MFW equipment being controlled by the MSLB circuitry was non-safety related and not single failure proof. However, the associated transmitters, logic, and control circuitry that were installed by the modification were safety related. In order to fully resolve the IE Bulletin 80-04 containment overpressurization concern, the licensee proposed TS requirements for the MSLB isolation system in a letter dated July 15, 1997, as supplemented by letters dated October 26, and November 5, 1998.

The licensee's TS amendment request was approved by the NRC by issuance of License Amendments 234, 234, and 233 for Oconee Units 1, 2, and 3 (respectively) on December 7, 1998. In these amendments, the NRC evaluation noted that:

- The automatic MFW isolation function was not single failure proof with respect to containment overpressurization.

- The MFW block valve could not serve as a backup because it would not be able to close against the differential pressure that could exist across the valve due to continued condensate pump operation, and closure of the block valve was not fast enough to prevent exceeding containment design pressure during the worst-case scenario (thus, no TS requirements for the MFW block valves were proposed by the licensee).

- Potential failure of the turbine-driven EFW pump auto-start inhibit (or failure to trip if already running) would result in continued EFW flow to the faulted SG (though this was not expected to cause a threat to containment integrity).

In accepting the licensee's response to IE Bulletin 80-04 and approving the amendments, the NRC recognized that the Oconee main steam system was unique in that there are no main steam isolation valves and, therefore, the dose consequences from the design basis MSLB outside containment bound the dose consequences from a MSLB inside containment, even with

the containment leakage that could result from a failure to isolate MFW. The NRC concluded that the design of the MSLB isolation system, although not single failure proof, was acceptable because the design basis and most limiting MSLB for Oconee was a break outside containment, which does not rely on automatic MFW isolation.

2.3 Methodology for Determining SG Tube Loads Following a MSLB

By letter dated April 26, 1999, Duke submitted an amendment request to obtain NRC review and approval of (among other things) a revised methodology for determining SG tube loads following a MSLB. The revised methodology for analyzing SG tube stresses that was proposed in the amendment request included the following key assumptions:

- The plant is operating at full power with the ICS in Manual.
- The MSLB isolation system trips both MFW pumps, isolates the flow of MFW to both SGs, and inhibits auto-start of (or auto-stops) the turbine-driven EFW pump.
- The motor-driven EFW pumps start and provide feedwater to both SGs.
- The EFW flow control valve on the affected SG fails open, and operator action is taken to isolate flow in ten minutes.
- Operator action is taken to trip the reactor coolant pumps 2 minutes after a loss of subcooled margin.

In the submission, the licensee indicated that some of the equipment that is relied upon to function in the revised methodology is not fully Quality Assurance (QA)-1 or single failure proof. For example, the MFW control valve operators and associated power supplies, the startup MFW control valve operators and associated power supplies, and the turbine-driven EFW pump steam admission valve are not QA-1 qualified, have no backup air supply path, and are subject to a single failure. In addition, the MFW pump trip circuitry and the MFW pumps are not QA-1 qualified or single failure proof. However, in the submission, Duke noted that in the event of a failure associated with the MSLB isolation circuitry, the non-safety ICS would function as assumed for the worst case MSLB event and the resultant SG tube stresses would actually decrease relative to the proposed methodology. The licensee also indicated that reliance on this non-safety related, non-single failure proof equipment was approved previously by issuance of License Amendments 234, 234, and 233 for Oconee Units 1, 2, and 3 (respectively) on December 7, 1998 (see Section 2.2 of this evaluation).

By issuance of License Amendments 315, 315, and 315 for Oconee Units 1, 2, and 3 (respectively) on September 18, 2000, the NRC approved use of the proposed methodology for evaluating SG tube loads. In approving the proposed methodology with respect to MFW isolation and use of the non-safety, non-single failure proof MSLB isolation system, the NRC referred to the considerations that were discussed in the evaluation of the license amendments that were issued on December 7, 1998. The evaluation concluded that the design of the MSLB isolation system was acceptable because the design basis and most limiting MSLB for Oconee does not rely on automatic MFW isolation. This formed the basis of NRC approval for crediting the MSLB isolation system and for allowing the use of equipment that does not fully satisfy the criteria for safety-related applications.

3.0 DESCRIPTION AND EVALUATION OF AFIS DESIGN

3.1 Design Description

The AFIS modifications are intended to upgrade and enhance the existing MSLB isolation system by upgrading certain components to safety-grade classification, by eliminating certain single failure vulnerabilities, and by automatically isolating EFW to a faulted SG following a MSLB or MFLB event, thereby reducing the need for operator actions. TS changes associated with the MSLB Detection and MFW Isolation requirements were proposed to establish requirements that are applicable to AFIS and to facilitate implementation of the AFIS modifications. In addition, the Bases Section would be changed to indicate that closure of these valves is also credited for a feedwater line break. When fully implemented, AFIS will perform the functions that are currently performed by the MSLB isolation system, with the following notable enhancements:

- The AFIS modification will replace the existing MSLB detection and MFW isolation analog circuitry with two redundant digital systems. The AFIS design upgrades the current 2 out of 3 logic to a 2 out of 4 logic.

- On low SG pressure, AFIS will close the MFW main and startup control valves and the main and startup block valves for the affected SG, and trip both MFW pumps, thereby terminating MFW flow to the SGs. The MSLB isolation system currently closes the MFW isolation valves associated with both SGs. This particular enhancement provides additional flexibility for operators to use the MFW startup flow path for feeding the unaffected SG. Manual overrides for the TDEFWP and MDEFWPs allow the operator to subsequently start the EFW pumps if necessary. Although MFW is isolated from the affected SG, the isolation is not credited in the licensing basis for mitigation of a MSLB because the isolation function does not use safety grade components and is not single failure-proof.

- When two out of four SG steam header pressure signals indicate a steam header pressure below the setpoint and the rate of depressurization in a SG steam header is sufficiently high, this condition trips the MDEFWP on the affected SG via redundant trip coils in the pump motor breaker. The MSLB isolation system currently does not perform this function, and operator action is relied upon for isolating flow from the motor-driven EFW pump to the affected SG. The additional trip on high rate of depressurization concurrent with low SG steam header pressure is implemented in AFIS to differentiate between MSLB and MFLB events and other events, such as an anticipated transient without scram or a small break loss of coolant accident. This action will lessen RCS overcooling and provide runout protection for the MDEFWP during a MSLB or MFWLB event.

- Since the AFIS design uses 2-out-of-4 logic as opposed to the 2-out-of-3 logic in the existing MSLB circuitry, the number of trip channels is increased from three to four, by installing an additional safety grade pressure transmitter on each main steam line. Each pressure transmitter will provide a steam pressure signal to a signal isolator. The output of the signal isolator will provide an analog signal to a processor module that will actuate feedwater isolation functions at the specified setpoints. The four AFIS analog channels will provide signals to two redundant AFIS digital channels per SG. The pressure

transmitters will be seismically mounted in the turbine building. Seismic criteria will be applied to prevent inadvertent AFIS actuation during a seismic event. The new and existing pressure transmitters in the turbine building will be protected from vibration-induced interactions besides MSLB events, such as high energy line breaks.

- EFW flow from the turbine-driven EFW pump will be terminated by automatically closing the steam admission valve (MS-93) and the turbine governor valve (MS-95). Also, MS-93 will be upgraded to satisfy the criteria for safety-related applications, which will include a backup source of nitrogen. The MSLB isolation system currently only provides a closing signal to MS-93, which is not QA-1 and is, therefore, susceptible to single failure.

- A safety related solenoid valve (3TO-145) will be added to the hydraulic oil supply line to the TDEFWP governor valve (3MS-95). Power for the solenoid valve is provided by a source that is separate from the TDEFWP steam admission valve (3MS-93) power supply. This will provide a TDEFWP trip capability that is redundant to the power used to close 3MS-93. The TDEFWP control switch will be modified to add an AFIS override interlock feature to 3TO-145. Additionally, the non-safety 3MS-93 valve and operator will be replaced with a nuclear safety grade valve and actuator. A safety grade bottled nitrogen backup air supply will be installed for 3MS-93 to ensure that the valve will close without assistance upon failure of the non-safety plant instrument air systems. In addition, 3MS-93 will fail open upon a loss of plant air supply or power to the normally energized solenoid valve to prevent inadvertent isolation of the TDEFWP.

- The MDEFWP switchgear controls will be revised to provide redundant trip signals from the AFIS. An inhibit will be added on the automatic CLOSE circuits of each switchgear. The AFIS trip relays will separate the switchgear trip circuits on different contact decks as needed. The MDEFWP manual control switches are diverse and provide independent override of AFIS functions.

- The licensee defines an AFIS digital channel as the analog voltage isolation modules, the digital 2-out-of-4 logic modules, the Enable/Disable pushbutton, associated output relays, the redundant switchgear trips for the MDEFWPs, the TDEFWP trip function, the trip relay outputs for the feedwater pumps, and the trip relay outputs for closing the MFW control valves and block valves. The use of an energized-to-trip processor module ensures that a loss of power to the digital channel will not isolate feedwater to a SG inadvertently. Additionally, the ATWS Mitigation System Actuation Circuit EFW pump start is inhibited following an AFIS actuation by the AFIS detection algorithm.

- All protective functions of the AFIS are energize-to-trip. The failure mode of the digital system in a non-actuated state prevents inadvertent isolation of feedwater to a SG with a subsequent partial or complete loss of the heat sink. Failures, including loss of power, loss of input, and hardware failures, will not result in a spurious actuation. Manual manipulation of EFW pump controls, which also is provided in the existing system, will override the AFIS trip signals.

The AFIS digital channels will be enabled and disabled administratively rather than automatically. Plant operating procedures contain provisions to enable/disable the digital channels, and provide instructions for recovering from an inadvertent AFIS actuation.

The licensee stated that a software failure could result in spurious actuation of an AFIS trip; however, the licensee contract with B&W requires a rigorous verification and validation (V&V) of the software, as prescribed in Topical Report (TR) BAW-10191P. The staff found in its review of BAW-10191P that the Framatome V&V process addresses this potential failure mode. Additionally, the staff reviewed the AFIS development process and qualification of the AFIS modules and concluded that the design of the AFIS STAR Modules is consistent with the Framatome Safety STAR Module designs that were subjected to electromagnetic interference/radio frequency interference (EMI/RFI), power surge, seismic, and environmental qualification testing, as documented in BAW-10191P.

The existing analog MSLB detection circuit modules in the steam generator level control (SGLC) cabinets will be replaced with the safety-related AFIS digital system. Each channel will be mounted in a seismically qualified card rack in the existing SGLC cabinets. The system will provide analog signal isolation between each safety channel and between safety-to-nonsafety interfaces.

The setpoints for the MDEFWP trip indicate a faulted SG or other severe overcooling event. The system allows for user-definable low pressure setpoints and rate of depressurization setpoints. The licensee stated that the analysis for determining the appropriate initial trip setpoints has been completed and the results included in a proposed change to TS Bases 3.3.13. These setpoints will be verified before AFIS is implemented and, if necessary, a change will be processed in accordance with 10 CFR 50.59. The staff finds this process acceptable.

3.2 Design Criteria

The following sections address the acceptability of the proposed AFIS implementation and the criteria addressed by the staff for approval of the AFIS for use as a safety related system.

3.2.1 IEEE-279 Criteria

The licensee states that AFIS will be a safety-related protection system and will conform to IEEE-279, with the following exceptions and clarifications:

3.2.1.1 IEEE Std 279, Section 4.12 - Operating Bypasses

The licensee stated that the AFIS does not enable the bypass feature automatically when the AFIS bypass condition is achieved (SG header pressure greater than 700 psig). The licensee will manually enable and disable the AFIS bypass as part of the ONS operating procedures, and in accordance with the ONS TS. The licensee stated that main steam pressure signals are used for system actuation and system bypasses during normal plant evolutions. These evolutions occur on an infrequent basis, sufficient time is available during evolutions in which the steam pressure increases to above 700 psig, and manual operator actions are credited for the mitigation of a MSLB when the AFIS is disabled. The staff, therefore, finds that the use of administrative procedures to enable the AFIS when SG pressure exceeds 700 psig is acceptable.

3.2.1.2 IEEE Std 279, Section 4.13 - Indication of Bypasses

The licensee stated that the bypass condition (DISABLE) will be indicated on the operator aid computer (OAC) and the annunciators, which are not safety-related systems. Regulatory Guide 1.97, " Instrumentation for Light-Water-Cooled Nuclear Power Plants To Assess Plant and Environs Conditions During and Following an Accident," among other indications, specifies the appropriate indications for a failure of cooling water flow to the intact SG. EFW flow rates and the operating state of MFW and EFW pumps and valves is indicated on the main control room control boards. These indicators provide acceptable indications of MFW and EFW operating states. The staff, therefore, finds this exception to IEEE 279 to be acceptable.

3.2.1.3 IEEE Std 279, Section 4.14 - Access to Bypass

The licensee credits procedural controls, limited control room access, and key switches to limit access to the AFIS bypass capabilities. The licensee will incorporate these controls into the plant administrative procedures. The staff accepts the use of administrative procedures at ONS to ensure that access to bypassing the AFIS is maintained under administrative control, and, therefore, finds this exception to IEEE 279 to be acceptable.

3.2.1.4 IEEE Std 279, Section 4.19 - Identification of Protective Actions

Identification of protective actions will be given on the OAC and the annunciators, which are not safety-related systems. Indication of protective actions is also given by monitoring EFW flow indications. The staff, therefore, finds this exception to IEEE 279 to be acceptable.

3.2.2 10 CFR Part 50 Appendix A, "General Design Criteria For Nuclear Power Plants"

10 CFR Part 50, Appendix A provides design requirements for safety systems in nuclear power plants. The principal design criteria for ONS Unit 3 were developed in consideration of criteria that became part of 10 CFR Part 50, Appendix A. The principle design criteria that were found acceptable by the NRC for licensing ONS are specified in the ONS UFSAR. The staff evaluation of the AFIS implementation with regard to the applicable UFSAR principle design criteria is discussed in the following sections.

3.2.2.1 UFSAR Criterion 19, Protection System Reliability (Category B)

This criterion specifies that protection systems be designed for high functional reliability and in-service testability commensurate with the safety functions to be performed.

The AFIS is a 2-out-of-4 safety grade trip system; consequently, no single component failure will prevent the AFIS from performing its required function, and no single component failure will initiate unnecessary actions. Test connection and test capabilities in the AFIS provide for pre-operational testing to assure that the protection systems can perform their required functions, and provide on-line testing capabilities to assure availability and operability when required. The staff, therefore, finds that the AFIS design meets UFSAR Criterion 19.

3.2.2.2 UFSAR Criterion 20, Protection System Redundancy and Independence

This criterion specifies that redundancy and independence (separation) be sufficient to assure that no single failure or removal from service of any component or channel of a system will result in loss of the protection function.

The AFIS is designed with redundant sensors, instrument strings, logic, and actuation devices that combine to form the protection channels. Redundant protection channels and their associated elements are electrically independent and packaged to provide physical separation. To achieve separation of AFIS actuation functions, the mutually redundant isolation functions are separated between two trains of actuation logic. The Framatome Safety STAR Module employs diverse software to mitigate software common-mode failure concerns. The staff finds these design features are in accordance with UFSAR Criterion 19 and, therefore, are acceptable.

3.2.2.3 UFSAR Criterion 21, Single Failure Definition

This criterion specifies that the AFIS instrumentation be designed so that a single event cannot result in multiple failures that would prevent the AFIS from performing its required protective action.

The instrumentation inputs into AFIS will be protected from high energy line breaks other than MSLB events to prevent failures that could result in an AFIS actuation. The licensee stated that a single pressure transmitter may fail from a MSLB or other high energy line break pipe whip or jet impingement; however, the resulting failure mode would not adversely affect proper operation of the AFIS logic. For the same reason, the staff finds this acceptable.

All of the AFIS equipment is designed for seismic events and protected from seismic interaction. The licensee stated that protection from missiles generated by a turbine failure (turbine missiles) will not be required because, although a turbine missile could cause spurious actuation of the AFIS, the portions of EFW and MFW that are affected by the AFIS are not required to mitigate this event. For the same reason, the staff finds this conclusion acceptable.

The licensee performed an analysis in which it was assumed that a turbine missile can cause a MSLB. Two channels of AFIS transmitters will be located inside the containment building. These two channels will be protected from damage caused by missiles generated by a turbine failure because the turbine is located outside the containment. Therefore, the licensee concluded, the AFIS is capable of detecting a MSLB caused by turbine missiles because two of the four channels required for tripping AFIS on MSLB would remain operable following a MSLB caused by a turbine missile. An assumption of this conclusion is that the AFIS circuitry in the cable room and the manual defense-in-depth controls in the control room remain unaffected. Because the pumps, valves, and switchgear actuated by the AFIS are physically separated from the main steam lines, the staff concurs with the licensee that is it is unlikely that a turbine missile causing a MSLB would disable the ability to terminate feedwater flow to the SGs. Additionally, because the failure of a pressure transmitter sensing line would result in an indication of low steam header steam pressure for that AFIS channel, this failure mode would result in an AFIS channel trip. Also, the failure of an EFW pump or its switchgear as a result of a MSLB would result in the pump becoming inoperable, which has the same result as AFIS tripping the pump.

The staff, therefore, finds that the AFIS design is in accordance with UFSAR Criterion 21.

3.2.2.4 UFSAR Criterion 22, Separation Of Protection And Control Instrumentation Systems

This criterion specifies that protection systems be separated from control instrumentation systems to the extent that failure or removal from service of any control instrumentation system component or channel, or of those common to control instrumentation and protection circuitry, leaves intact a system satisfying all requirements for the protection channels. Additionally, the protection system input channels shall be electrically and physically independent. Shared instrumentation for protection and control functions must satisfy the single failure criterion by the employment of isolation techniques to the multiple outputs of various instrument strings.

The licensee stated that AFIS input channels are electrically and physically independent. Additionally, shared instrumentation for protection and control functions satisfy the single failure criterion by the employment of isolation techniques to the multiple outputs of the instrument strings. Qualified devices will be installed to provide electrical isolation between the safety and non-safety related functions of the AFIS. The staff confirmed that the planned AFIS input channels will be electrically and physically independent. Additionally, the staff confirmed that the safety-related functions of the AFIS will be isolated from non-safety systems using qualified isolation devices. The staff, therefore, finds that the AFIS design is in accordance with UFSAR Criterion 22.

3.2.2.5 UFSAR Criterion 23, Protection Against Multiple Disability for Protection Systems

This criterion specifies that the effects of adverse conditions to which redundant channels or protection systems might be exposed in common, either under normal conditions or those of an accident, will not result in a loss of the protection function.

The licensee stated that the AFIS components required to operate inside the containment will operate in a steam environment following a MSLB. These components have been designed and tested to assure continuing operability in environmental conditions resulting from a loss-of-coolant accident (LOCA), including 100 percent humidity.

Additionally, the AFIS components located outside the containment have been designed for continuous operations in an ambient temperature and relative humidity representative of LOCA conditions outside the containment building. These environmental qualification conditions are listed in Table 1.

Table 1. Environmental Qualification Conditions for AFIS Equipment Located Outside the ONS Containment Building

Environmental Condition	Normal Operations	Accident Conditions
Temperature	15.6°C - 43.3°C (60°F - 110°F)	4.4°C - 60.0°C (40°F - 140°F)
Relative Humidity	30% - 80%	30% - 80%
Radiation	10 Gy (1000 R)	90 Gy (9000 R)

The environmental qualification conditions listed in Table 1 are enveloped by the design basis accident conditions at ONS. The staff, therefore, finds the licensee's application of the qualification provisions of UFSAR Criterion 23 acceptable.

The staff reviewed the licensee's specification for seismic qualification of equipment as follows. AFIS seismic testing addresses the response spectra of an operating basis earthquake and a safe shutdown earthquake at the ONS site. The staff finds these seismic test acceptance criteria specifications are in accordance with UFSAR Criterion 23 and, therefore, are acceptable.

The licensee stated that the STAR components are qualified for operation in EMI/RFI radiated field strengths of 10 volts per meter (V/m) over a frequency range of 0.15 mega-hertz to 1 giga-hertz. The maximum radiated field strength in the proximity of the applicable electrical cabinets was measured to be less than 0.2 V/m. This data was collected during an Oak Ridge National Laboratory (ORNL) study conducted for the NRC from November 1994 to January 1995. Additionally, as described in Section 4.2 of the BAW-10191P, Rev. 1 "Topical Report for STAR System Components for RPS Digital Upgrades" (September 1994), Framatome/B&W performed EMI/RFI testing during qualification of the STAR system. The standards referenced for the EMI/RFI testing include IEEE 472-1974, SAMA PMC 33.1-1978, and MIL STD 461C Part 4, RS03. This testing was reviewed by the NRC and described in the NRC Safety Evaluation for TR BAW-10191P, dated August 3, 1995.

The testing for radiated susceptibility was consistent with the high frequency radiated susceptibility standards of Electric Power Research Institute (EPRI) TR-102323, Rev. 1. As set forth below, the radiated emissions test results demonstrated that the STAR components are qualified for operation in EMI/RFI field strengths of 10 V/m over a frequency range of 0.15 to 1000 Mhz. This corresponds to 140 decibel microvolts per meter (dBµV/m). The licensee reported that the maximum radiated field strength in the proximity of the applicable electrical cabinets was measured to be less than 0.2 V/m. This data was collected during an ORNL study conducted from November 1994 to January 1995. The 0.2 V/m measurement corresponds to 106.2 dBµV/m, or a margin of 34 dBµV/m. EPRI TR-102323, Rev.1 recommended a margin of 8 dBµV/m. Therefore, the radiated emissions and susceptibility testing performed during STAR qualification acceptably demonstrates the EMI immunity of the STAR system for application in the AFIS environment.

The low frequency radiated emissions tests referenced in EPRI TR-102323, Rev. 1 report are not required for the AFIS installation because the STAR system modules will be located in a metallic electrical enclosure and all external interfacing cables will be grounded interlocked armored cables. The major contributors to low frequency radiated emissions are welding and power equipment within one meter of the digital system. The licensee's administrative policies restrict welding in the cable rooms during power operation, and there is no power equipment within one meter of the AFIS SGLC cabinets. The metallic enclosure and the armored cables effectively prevent transmission of low frequency EMI into the AFIS module assemblies.

The STAR EMI qualification testing for conducted EMI susceptibility utilized a pulse transient procedure test methodology that is different from any of the methodologies described in the EPRI TR-102323, Rev. 1. The conducted noise qualification tests for STAR consisted of voltage surge withstand tests without higher magnitudes than the continuous conducted noise tests specified by EPRI TR-102323. The pulse component of the STAR surge test differs from the continuous conducted EMI tests described in the EPRI report, but each test offers a valid demonstration of conducted EMI susceptibility for the AFIS application.

The maximum radiated field strength in the proximity of the applicable electrical cabinets was measured to be less than 0.2 V/m during an ORNL study conducted from November 1994 to January 1995. Other tests performed by ORNL in October to November 1995, to collect conducted emissions data on the worst case, most heavily loaded vital 120 VAC inverter at Oconee. The licensee stated that switching power supplies are the main source of continuously-conducted EMI on the Oconee vital inverters. All power supplies interfacing with the AFIS circuits are low output noise Lambda LN and LD series, which are qualified for conducted and radiated EMI per MIL STD 1-6181D. The Lambda power supplies are qualified for 5 mV peak-to-peak noise on the output loads. The power susceptibility specifications for STAR indicate that 5 mV p-p power noise is within the 15 V ±10 percent power requirements. The STAR modules were subjected to conducted emissions testing to determine a 5 milli-volt (mV) peak-to-peak noise output generated by the STAR internal power circuits. The Lambda LN power supplies are designed to regulate constant output voltage in the presence of load noise emissions. Therefore, the continuous conducted EMI noise is attenuated by the Lambda power supplies without requiring additional testing of the AFIS STAR system. In the staff evaluation of EPRI TR-102323, Rev. 1, the staff concluded that test CE101 can be omitted if it can be demonstrated that the power quality requirements of the new equipment are consistent with the existing power supply. Since the power quality requirements of the Lambda power supplies are consistent with the existing ONS power supplies, CE101 testing of the AFIS STAR system is not necessary.

EPRI TR-102323 states that the primary EMI concerns involve conducted transients (surges) and high frequency radiated electromagnetic fields. The EMI qualification testing performed for STAR adequately demonstrates STAR system immunity from these concerns. The ORNL emissions testing at Oconee provides reasonable assurance that the STAR system is suitable for the AFIS installation environment. The EMI/RFI qualification levels of the STAR system module components were verified to envelop the EPRI TR-102323 recommended levels for radiated and conducted EMI levels. Therefore, the EMI/RFI fields associated with the AFIS installation environment are within the design limits of the STAR system. The staff concurs with the licensee's conclusion that the AFIS, which consists of Framatome Safety STAR Module components, is qualified for the EMI/RFI fields in the SGLC cabinet in which the AFIS will be installed.

The staff finds the EMC qualification limits are in accordance with UFSAR Criterion 23 and the recommended EMI/RFI levels in EPRI TR-102323, and, therefore, are acceptable.

The licensee stated that the analysis for total integrated dose (TID) is documented in Oconee Calculation OSC-1521 for equipment located in the cable room. This analysis bounds the AFIS Star Module and serial bus isolation module (SBIM). The calculated TID for the location of the STAR Module and SBIM is <1E3 rads; therefore, the expected TID does not exceed the qualified level for the STAR Module and SBIM. The staff concurs with the licensee's conclusion that the AFIS is qualified for the TID in the cabinet in which the AFIS is to be installed. The staff, therefore, finds the TID qualification limits are in accordance with UFSAR Criterion 23 and, therefore, are acceptable.

3.2.2.6 UFSAR Criterion 24, Emergency Power For Protection Systems

This criterion specifies that, in the event of loss of all off-site power, sufficient alternate sources of power shall be provided to permit the required functioning of the protection systems.

The licensee stated that each channel of the AFIS will be powered by separate sources of the vital AC and DC instrument and control power system, which are independent of off-site power. The use of vital AC and DC power sources is acceptable for providing alternate sources of power for the AFIS. Additionally, tripping the TDEFWP by isolating hydraulic fluid to valve 3MS-93 using safety related components and bottled nitrogen gas is diverse from the safety related trip solenoid for closing valve 3MS-95. The staff, therefore, concludes that the AFIS power sources are in accordance with UFSAR Criterion 24.

3.2.2.7 UFSAR Criterion 25, Demonstration of Functional Operability of Protection Systems

This criterion specifies that a capability be provided for testing protection systems while the reactor is in operation to demonstrate that no failure or loss of redundancy has occurred.

The licensee stated that test circuits in AFIS use the redundant, independent, and coincidence features of the protection system. These circuits enable manual control of on-line trip signals in any single protection channel for testing the trip capability of each analog channel without affecting the operability of the other channels. The staff finds this testing capability is in accordance with UFSAR Criterion 25, and, therefore, is acceptable.

3.2.2.8 UFSAR Criterion 26, Protection Systems Fail-Safe Design

This criterion specifies that protection systems be designed to fail into a safe state or into a state established as tolerable by a design basis if conditions such as disconnection of the system, loss of energy, or adverse environments are experienced.

The licensee stated that the AFIS will operate properly in the event of a loss of power. To maintain the licensing basis of EFW, the AFIS is designed to fail in a non-tripped state as a result of a single failure. The licensee stated that the single-failure-proof design of the AFIS channels will assure proper operation in the event of a failed power source and adverse environmental conditions, and that there will be no postulated failures related to the disconnection of the system, loss of energy, or adverse environmental conditions. The AFIS failure state will not result in a loss of feedwater sources to the SGs. Additionally, the operator

will be provided with a manual means of isolating feedwater sources if the AFIS is inoperable. The staff concludes that the AFIS design is in accordance with UFSAR Criterion 26.

3.3 Framatome Safety Star Module (TR BAW-10191P) Acceptance Criteria

As discussed in BAW-10191P, digital upgrades to protection systems using Framatome Safety STAR modules require review of the criteria shown in the following sections. Some of the following sections also address NRC open items that are contained in Section 5.0 of the staff's Safety Evaluation that approved implementation of BAW-10191P.

3.3.1 BAW-10191P Section 6.0, Installation Prerequisites

Each of the installation prerequisites is stated below, followed by the staff's conclusions regarding the acceptability of the AFIS design features that address the requirement.

3.3.1.1 The use of the STAR system components shall be restricted to the protection function channels portion of the Reactor Protection System (RPS), as described in Section 2.1.2 of BAW-10191P or applications with similar interface requirements.

The licensee stated that AFIS is a logic protection system similar to the RPS. The new circuitry replaces the existing MSLB circuitry and employs a 2-out-of-4 logic to sense a faulted SG. Two conditions are monitored by AFIS instrumentation to detect a faulted SG. The first condition is low main steam pressure, which will initiate MFW and TDEFWP trips. The second condition is low main steam pressure concurrent with a high rate of depressurization, which trips the MDEFWP on the faulted SG. Output from the AFIS logic provides double isolation of EFW to the faulted SG. MFW isolation will continue to be provided by the MFW block valves and the MFW control valves, but the AFIS circuitry will make the isolation header-specific. EFW flow from the affected MDEFWP is terminated by redundant automatic trip signals to the MDEFWP motor switchgear. The AFIS isolates EFW flow from the TDEFWP by automatically closing the steam admission valve (MS-93) and the turbine governor valve (MS-95) using safety related components.

The AFIS design uses two diverse software algorithms, implemented in diverse microprocessors, to actuate safety related, redundant components to isolate the EFW feedwater sources during a MSLB event. The AFIS design is consistent with the design provisions of the Framatome Safety STAR system, and are controlled using the processes that control other Framatome Safety STAR system products. The staff finds, therefore, that the AFIS design is restricted to the protection function channels portion of the RPS, as described in Section 2.1.2 of BAW-10191P or applications with similar interface requirements.

3.3.1.2 BAW-10191P stated that no changes to TS are required as a result of the upgrade. If TS changes are required, they must be reviewed by the NRC.

The AFIS is a new system that upgrades and changes the existing MSLB detection circuitry and MFW isolation function. As such, TS requirements will be changed. This SER addresses the AFIS design, TS changes associated with removal of the existing circuitry, and implementation of the AFIS at ONS. The acceptability of the TS changes is addressed later in this Safety Evaluation.

3.3.2 BAW-10191P Section 6.1.1, System Requirements Specification

BAW-10191P stated that the design requirements for the system shall be developed and documented in accordance with the licensee's design control program. The required functions of the system upgrade shall be included as part of the procurement specification. Active involvement of cognizant licensee personnel with the vendor during the development of the system and software requirements and system validation is a necessary element to ensure quality.

The staff reviewed the licensee's procurement specification, OSS-0311.00-00-0011, "Automatic Feedwater Isolation System - STAR Module Specification." The procurement specification addresses the operating and installation environmental qualification requirements; the design and fabrication of the equipment; seismic testing requirements; specific requirements concerning the development of the AFIS STAR processor module, the calibration and test computer, the serial data bus isolation module, and the analog voltage isolation module; software development processes; quality assurance requirements and documentation; testing and inspection requirements; spare parts requirements; packing and shipping requirements; and Year 2000 criteria. Additionally, the licensee stated that there was active participation with the vendor in the development process and in the system validation. The staff reviewed the results of the licensee's participation in the development of the AFIS and determined that the licensee's procurement specification and active participation in the development process to be acceptable.

3.3.3 BAW-10191P, Section 6.1.2, Interface Requirements Review (NRC Open Item #1)

BAW-10191P stated that the system interface requirements shall be reviewed to verify that inputs and outputs of the STAR hardware are applied within their specified ratings (e.g., signal type, voltage range, loading, etc.). STAR Module analog and discrete output signals to circuits outside of the originating safety division shall be electrically isolated by use of isolation amplifiers or auxiliary relays qualified to withstand the maximum credible voltages that can be imposed on the circuit. Loads on analog and discrete outputs shall be verified to be within the specified STAR System components load handling capabilities.

In the submittals, the licensee described the analog and digital input and output interface voltage requirements, and the processes by which the voltages in the interfaces will be maintained within their specified ranges in the AFIS. The staff finds the interface design features to be acceptable.

3.3.4 BAW-10191P, Section 6.1.3, Licensing Basis Impact Analysis (NRC Open Item #2)

BAW-10191P stated that the licensee shall verify that the intended upgrade meets the plant licensing basis requirements. A verification shall be made that all protection functions, parameters, interlocks, indications and alarms in the present system have been accounted for in the digital upgrade.

In the submittals, the licensee stated that the design of the STAR system satisfies the existing requirements of the MSLB Detection and Feedwater Isolation System. The AFIS specifications are new to the SAR [Safety Analysis Report] and require review and approval by the NRC. The functions of the STAR system comply with the conceptual design specifications for AFIS.

The staff reviewed the completed AFIS system documentation and test results to confirm that the proposed design has been implemented in the AFIS. On the basis of its review of the AFIS design, the staff finds that the AFIS design satisfies the plant licensing bases for MSLB detection and MFW isolation.

3.3.5 BAW 10191P Section 6.1.4, Power Supply Loading Analysis (NRC Open Item #3)

BAW-10191P stated that the user shall review the loading of the 15 VDC power supply powering the STAR system components. The worst case load shall not exceed the rated capacity of the power supply. Worst case load determinations shall include the maximum load of the STAR system components and any margins established by the licensee. In the submittals, the licensee stated that the 15 VDC power supply used by the AFIS is sized for the application, including maximum temperature deratings. The staff reviewed the power supply specifications and finds that the power supply for the AFIS satisfies the BAW-10191P criteria and, therefore, is acceptable.

3.3.6 BAW-10191P Section 6.1.5, Cabinet Heat Rise Analysis (NRC Open Item #4)

BAW-10191P stated that, since cabinet heat rise is proportional to power supply loading, if a modification results in additional loading of the power supplies, a verification shall be performed to ensure that the worst case internal cabinet temperature is below the specified ratings of all components located in the cabinet. In this verification, maximum worst case cabinet electrical loads and worst case control room ambient temperature shall be taken into account.

In the submittals, the licensee described that the calculation for the total heat loads of the AFIS cabinet with the STAR hardware and additional electrical components had been performed. Using natural convection formulas in Oconee calculation OSC-6869, the licensee calculated the projected internal cabinet temperature to be less than the maximum temperature limit for STAR modules and other components located in the AFIS cabinet. The staff verified that the AFIS equipment is designed for the environmental conditions stated in the licensee's submittal. The staff also verified that the maximum temperature calculated in the licensee's heat rise calculation is less than the maximum temperature rating of the equipment during normal operations. The staff, therefore, finds the licensee's verification that the worst case internal cabinet temperature is below the specified ratings of all components located in the cabinet acceptable.

3.3.7 BAW-10191P Section 6.1.6, Quantification of EMI and RFI Environmental Levels (NRC Open Item #5)

BAW-10191P stated that the worst case levels of conducted and radiated emissions from equipment in the vicinity of the RPS shall be quantified. The method used to quantify these levels shall be by tests designed to map radiated levels at the front and back of the RPS cabinets and measure the conducted levels on the system power supply leads. Analytical methods using comparisons to data obtained from tests of other installations may be used in lieu of testing provided that adequate similarity can be established between the proposed installation and the tested installations.

An analysis of the worst case EMI and RFI levels shall be performed to verify that the EMI and RFI levels are enveloped by the qualified levels for the STAR System components, and that measures are in place to prevent EMI and RFI effects from affecting the protection functions of the RPS. Additionally, the STAR module components were tested for EMI and RFI susceptibility. The results of the tests were compared to the measured electromagnetic environment at ONS and to the electromagnetic envelopes recommended in EPRI TR-102323. The EMI/RFI qualification levels of the STAR system module components were verified to envelop the EPRI TR-102323 recommended levels for conducted and radiated EMI levels.

The AFIS electromagnetic compatibility within the SGLC cabinet was addressed in Section 3.2.2.5 of this Safety Evaluation. As stated in Section 3.2.2.5, the staff finds the EMI qualification limits are in accordance with UFSAR Criterion 23 and EPRI TR-102323, and consequently, BAW-10191P and, therefore, are acceptable.

3.3.8 BAW-10191P Section 6.1.7, Quantification of Gamma Radiation TID (NRC Open Item #6)

BAW-10191P stated that an analysis shall be performed to verify that the TID from background radiation will not exceed the qualified level for the STAR Module and SBIM.

Analysis of the AFIS TID within the SGLC cabinet was addressed in section 3.2.2.5 of this Safety Evaluation. As stated in section 3.2.2.5, the staff finds the TID qualification limits are in accordance with UFSAR Criterion 23 and, therefore, are acceptable.

3.3.9 BAW-10191P Section 6.2.1, Grounding Inspection (NRC Open Item #7)

BAW-10191P stated that the STAR System components are designed to operate using the grounding scheme provided in the B&W RPS. No modifications to the grounding scheme are required. The licensee shall verify by inspection that ground connections internal and external to the system cabinets are in accordance with the as-supplied system. Continuity measurements shall be made to verify the condition of the ground bonding connections. Checks of signal cables shall be made to verify that cable shields are properly grounded and are free of inadvertent ground connections.

In the submittal, the licensee stated that the grounding system in the AFIS cabinets is consistent with the design of the RPS cabinets. Post-modification testing will verify grounding system continuity including bond connections and signal cable shields.

The staff finds the licensee's plans for performance of post-modification testing of the AFIS grounding connections to confirm that the AFIS cable shields and connections internal and external to the AFIS cabinets are properly grounded and are free of inadvertent ground connections acceptable. The staff, therefore, finds the licensee's plans for verification that cable shields are properly grounded and are free of inadvertent ground connections to be acceptable.

3.3.10 BAW-10191P Section 6.3.1, Measurement of Power Supply Loads (NRC Open Item #8)

BAW-10191P stated that, after the AFIS modification is installed with the cabinets powered up, the power supply loading under maximum load conditions shall be measured to verify that these

values are within acceptable limits as determined in the analysis performed per TR BAW-10191P, Section 6.1.4.

The staff finds the testing of the AFIS power supply loads acceptable. As stated in Section 3.3.5 of this Safety Evaluation, the staff reviewed the licensee's power supply loading test results to confirm that the AFIS power supply loads are within the power supply load specifications.

3.3.11 BAW-10191P Section 6.3.2, Measurement of Cabinet Heat Rise (NRC Open Item #8)

BAW-10191P stated that heat rise in the system cabinets with doors closed and cabinet fans on shall be measured to verify that the heat rise is within acceptable limits as determined in the analysis performed in TR BAW-10191P, Section 6.1.5.

The staff finds that the licensee used the methods identified in BAW-10191P for measurement of the cabinet heat rise and verification that the heat rise is within the AFIS performance specifications. Therefore, the staff finds the licensee's procedure acceptable.

3.3.12 BAW-10191P Section 6.3.3, Measurement of Power Supply DC Voltage (NRC Open Item #8)

BAW-10191P stated that the voltage stability and ripple of the 15 volt DC power in the system cabinets shall be measured with the STAR System components installed to verify that these values are within the specified values as contained in the STAR user instructional manual.

In the submittal, the licensee stated that the stability and ripple of the 15 volt DC power supply was measured and compared to performance specifications during post-modification testing. The staff reviewed the AFIS power supply stability and ripple test results report to confirm that the power supply operates within its performance specifications. The staff finds that the measurement of the AFIS 15VDC power supply stability and ripple, and verification that the power supply performance is within the power supply performance specifications is acceptable.

3.3.13 BAW-10191P Section 6.3.5, Controls on Use of Walkie (NRC Open Item #9)

BAW-10191P stated that administrative controls shall be established to restrict the use of radio transmitters in the vicinity of the AFIS to reduce the potential for spurious operation of AFIS from RFI induced noise.

In the submittal, the licensee stated that AFIS circuitry is located in the ONS cable spreading room, which is administratively controlled such that radio transmitters are not allowed in the area due to the sensitive nature of the various electronics located in the room. The staff, therefore, finds the licensee's administrative control of radio transmitters in the vicinity of the AFIS acceptable.

3.3.14 BAW-10191P Section 6.3.6, Controls on Access to STAR Module Mode Selector Key (NRC Open Item #10)

BAW-10191P stated that controls shall be established over the access to STAR Module selector keylock switch keys to prevent unauthorized alteration of setpoints.

In the submittal, the licensee stated that a keylock switch is provided on the module front panel for controlling access to hardware interlocks for maintenance operations including testing, calibration and tuning of the module. The switch has four positions: OPERATE, TEST, TUNE, and CALIBRATE. The keylock switch will be locked in the OPERATE position and the key will be controlled by a licensed operator per an Operations Management Procedure. The staff finds these measures for controlling access to the AFIS module setpoints to be acceptable.

3.3.15 BAW-10191P Section 6.3.7, Maintenance Procedures for electrostatic discharge (ESD) (NRC Open Item #11)

BAW-10191P stated that procedures shall be established and personnel trained in the handling of STAR System components to protect them against electromagnetically induced damage. These procedures shall meet the requirements specified in the STAR instruction manual.

In the submittal, the licensee stated that maintenance procedures for ESD are established and will be employed for maintenance handling of STAR modules. The licensee received approval for implementation of an RPS based on the STAR System in 1995. The requirement for establishing maintenance procedures for ESD were developed as part of the STAR System RPS implementation at ONS. These procedures will be used with the AFIS modules. The staff, therefore, finds the licensee's response acceptable.

3.3.16 BAW-10191P Section 6.3.8, Calibration, Tuning, and Testing Procedures (NRC Open Item #12)

BAW-10191P stated that existing procedures for the performance of surveillance interval maintenance activities, including calibration, tuning and trip accuracy testing of the RPS channels shall be updated to incorporate the use of the Calibration and Test Computer for testing the upgraded channels containing STAR Modules. In the submittal, the licensee stated that calibration, tuning, and testing procedures shall be written to perform the required TS surveillance functions. Accordingly, the staff finds this response acceptable.

3.3.17 NRC Open Item #13, Training

NRC Open Item #13 requires that the licensee provide adequate training for maintenance and operational personnel who will be using the STAR System.

In the submittal, the licensee stated that plant personnel have been trained on STAR maintenance and operational procedures for the RPS and ICS systems and that these personnel will be trained on the AFIS. The licensee stated that the operations interface is through the control board and there will be no operator burden in responding to an event. Operation personnel may be required to take manual actions to return the AFIS to service following a spurious event. Specific training will be provided to Operations personnel for manual recovery efforts from spurious events. This training will be performed as a part of the AFIS implementation.

The staff finds acceptable the licensee's plans to conduct appropriate training for maintenance and operational personnel who will be using the AFIS.

3.3.18 NRC Open Item #14, SER Section 5.0, Equipment Qualification

The licensee shall compare STAR system hardware qualifications to the actual plant requirements to ensure the qualification levels in BAW-10191P envelop the plant-specific requirements for normal operation and worst case postulated accident conditions for temperature, humidity, and seismicity.

Based on this SE as set forth above, the staff has determined that the AFIS equipment qualification is acceptable.

3.4 Overall Evaluation of the Modification

In general, the AFIS modification is an upgrade of the existing MSLB detection and MFW isolation circuitry, and does not relax operational requirements or design features that currently exist. However, AFIS is credited for performing additional functions beyond those that are performed by the MSLB detection and MFW isolation circuitry as previously approved by the NRC, and the licensee plans to credit these added functions to some extent in analyzing SG tube stresses that result from a MSLB or MFLB event.

3.4.1 Added Functions

The additional functions that are credited by AFIS include tripping the motor-driven EFW pump associated with a faulted SG, thereby terminating EFW flow to that SG (previously, operator action was credited for performing this function); and isolating the MFW control valves associated with the faulted SG (previously, the MFW control valves associated with both SGs were automatically isolated). The AFIS modification also upgrades the turbine-driven EFW pump trip function to fully safety-related and single-failure proof. As described by the licensee in the amendment request and supplementary information that was provided, the AFIS modifications satisfy the requirements for safety-related applications and reduce reliance on operator actions, and improve the reliability of the turbine-driven EFW pump trip function. Therefore, the staff finds that these added functions are acceptable. Except for the turbine driven pump trip that have been upgraded to single failure criteria, AFIS does not change any of the actuation components or MFW actuating devises that were credited in previous amendments related to SG tube stress analyses.

3.4.2 Potential Vulnerabilities

The amendment request and supplementary information that was provided discussed various event scenarios and potential vulnerabilities that need to be considered. In general, the vulnerabilities of concern include single active failures and inadvertent AFIS actuation.

Single Failure:

- A failure of EFW supply to the unaffected SG results in a total loss of feedwater. The existing analysis for this event scenario is essentially unchanged, and AFIS does not introduce a more limiting failure scenario in this respect.

- The worst case single failure that has been identified by the licensee with respect to SG tube loads is the failure of the EFW control valve for the affected SG in the full open

position. EFW flow to the affected SG is terminated when AFIS trips the turbine-driven EFW pump, and either when AFIS trips the motor-driven EFW pump that is feeding the affected SG, or when manual operator action is taken within 10 minutes to isolate EFW flow to the affected SG (depending on the event scenario). This worst-case scenario is an improvement over the existing analysis which only credits operator action for terminating EFW flow to the affected SG.

Inadvertent AFIS Actuation:

- Following an AFIS actuation, the unaffected SG can continue to depressurize due to reverse heat transfer to the reactor coolant system and due to EFW addition. Guidance provided in the Emergency Operating Procedures (EOPs) and operator action is credited for throttling EFW flow as necessary to prevent exceeding the rate of SG depressurization setpoint, which would terminate EFW flow to the unaffected SG. If EFW flow to the unaffected SG is inadvertently terminated by AFIS, operator action is credited for restoring flow. The licensee has determined that this scenario is bounded by a failure of EFW flow to the unaffected SG.

- During a small-break loss-of-coolant accident (SBLOCA), the addition of EFW to the SGs to raise level to the required setpoint could result in exceeding the AFIS rate of depressurization setpoint and inadvertent termination of EFW flow. However, existing EOPs provide guidance for throttling EFW flow so that EFW flow limitations and RCS cooldown rates are not exceeded, thereby preventing SG depressurization.

- As explained by the licensee in the July 26, 2001, submission certain event scenarios can cause depressurization of both SGs and result in AFIS actuation and termination of all feedwater flow. Such events would be rare, and if necessary EFW flow could easily be restored to one or both SGs from the control room by placing the control switch for the appropriate motor-driven EFW pump into the “run” position. This is a straight-forward action, and one that is easily performed by the control room operators. While these event scenarios may require operator action to provide for decay heat removal, the licensee has determined that such events are not limiting and are bounded by other event scenarios.

Based on our review of the information that was provided and our understanding of the various vulnerabilities that exist, some of which are discussed above, the staff finds that the licensee’s evaluation is thorough and that potential vulnerabilities have been adequately addressed.

3.4.3 Design Considerations

As described by the licensee, the proposed AFIS modification satisfies the requirements that have been established for safety-related applications, including seismic and single failure considerations. Consistent with the operability requirements that were established for the MSLB detection and MFW isolation circuitry, AFIS will be manually disabled whenever steam pressure is less than 700 psig. The licensee qualitatively concluded that the probability of a MSLB occurring while steam pressure is less than 700 psig is remote, and operator actions that would be required to mitigate such an event are unchanged from what is currently required. Because the likelihood of a MSLB event is small when steam pressure is less than 700 psig and

the consequences are considered to be less severe, the licensee has determined that additional SG tube load analyses for this condition were warranted.

The criteria for selecting the low steam pressure and high rate of depressurization setpoints for AFIS initiation are based on achieving acceptable SG tube stress results, and are determined by the safety analyses. The AFIS low steam pressure actuation setpoint is unchanged from the low steam pressure setpoint of 550 psig that is currently used by the MSLB detection and MFW isolation circuitry. The AFIS rate of depressurization setpoint that is relied upon for terminating EFW flow to the affected SG will be selected to ensure that acceptable SG tube loads are obtained for all break sizes, including those that rely on manual operator action rather than AFIS actuation for terminating EFW flow to the affected SG.

The following additional design details and considerations are especially noteworthy:

- The proposed AFIS modifications do not change the existing design of the MFW components that will be actuated by AFIS (i.e., MFW startup and main control valves, MFW block valves, MFW pump trip circuitry, and MFW pumps). This equipment is non-safety related, and does not satisfy seismic and single failure criteria for safety-related applications. Reliance on this equipment remains unchanged from what is currently assumed.

- The information submitted by the licensee indicates that the AFIS design with respect to fire, missile, and flood protection is consistent with the existing plant design bases for these events. The staff considers this approach to be acceptable, but notes that the EFW system design and licensing basis is currently being reviewed by the NRC (License Amendment Request dated June 21, 2000). The outcome of this review may have some impact on the licensee's characterization of the plant design bases and on the criteria that must ultimately be applied to the AFIS modifications, but does not affect the provisions of the proposed TS changes reviewed herein.

- The licensee has indicated that AFIS devices will not be impaired or inhibited in their ability to properly function by any high-energy line break (HELB) event that AFIS is relied upon to mitigate. Also, AFIS is designed so that spurious actuation will not occur during HELB and seismic events.

- The individual component response times that are assumed for terminating feedwater flow to a faulted SG will be selected so they are bounding with respect to the actual component response times.

- The proposed AFIS design provides the capability for reactor operators to manually restart any EFW pump that is tripped by AFIS by placing the manual control switch in the RUN position without having to reset AFIS. This affords the operators the ability to quickly restore EFW flow to a SG following inadvertent AFIS actuation, and provides flexibility for responding to evolving accident scenarios and changing plant conditions and indications.

- The steam admission valve for the turbine-driven EFW pump (MS-93) is designed to allow a certain amount of bypass steam flow. This valve is being replaced with a safety-related valve that is designed to allow an amount of bypass steam flow that is

similar to the existing valve. After the valve has been replaced, a speed response test will be performed to confirm that when the valve closes, the pump coastdown time satisfies accident analyses assumptions with the amount of bypass steam flow that exists.

- In the event that the governor valve for the turbine-driven EFW pump (MS-95) fails to close following AFIS actuation, MS-93 is credited for terminating flow from the turbine-driven EFW pump. A safety-related, seismic, backup nitrogen supply system to keep MS-93 closed for at least 2 hours following an AFIS actuation will be installed as part of the AFIS modification to address the potential failure of the non-safety instrument air and auxiliary instrument air supplies. The assured 2 hour backup supply of nitrogen provides sufficient time for plant operators to take action to isolate flow from the turbine-driven EFW pump on a more permanent basis if it is necessary.

- The SG tube load analyses based on AFIS actuation are still in progress and are not expected to be completed until around the end of December 2001. Until these analyses are completed, the licensee will continue to rely on the current analyses, which is more limiting, as the basis for SG tube inspection and plugging criteria. AFIS will be used in this analysis and credited by the licensee when performing the SG tube load analysis for MSLB events. The staff requests that the licensee inform the staff of the results of the analyses when they are completed, as well as any additional actions that are deemed necessary based on the results of this analysis.

4.0 PROPOSED TS CHANGES

4.1 Description and Evaluation

The proposed amendment for MSLB detection and MFW isolation revises TS and TS Bases Sections 3.3.11, 3.3.12, and 3.3.13, and incorporates the new proposed AFIS requirements. The current MSLB detection and MFW isolation TS and TS Bases sections would be moved and renumbered to become TS and TS Bases Sections 3.3.25, 3.3.26, and 3.3.27, respectively. Upon completion of the AFIS implementation, TS sections 3.3.25, 3.3.26, and 3.3.27 will be obsolete.

Because the AFIS modifications for each of the Oconee units will be implemented during outages that will be separated by many months, the TS provisions concerning AFIS will not be implemented until the respective unit starts up with the modification in place. Therefore, there will be a period of time when the current TS requirements are in effect for some unit(s) while the AFIS TS provisions are in place for other unit(s). To reflect this in the TS, the licensee has proposed that a Note be added to the AFIS TS 3.3.11, TS 3.3.12, and TS 3.3.13 that states the TS is not applicable on a unit until the modification has been completed on the respective unit. Correspondingly, the licensee proposed that a Note be added to the current MSLB (which will become TS 3.3.25, TS 3.3.26, and TS 3.3.27) that states the TS is applicable on each unit until the AFIS modification is completed on the respective unit. These statements clarify the applicability of the TS requirements and are acceptable. The renumbering TS changes would be implemented on all three units at the same time without waiting for implementation of the AFIS modification for the unit.

4.1.1 Technical Specification 3.3.11

The licensee proposed revising the title from “Main Steam Line Break Detection and Main Feedwater Isolation Instrumentation” to “Automatic Feedwater Isolation System (AFIS) Instrumentation.” The staff finds the proposed revision of the title is consistent with the AFIS implementation and is, therefore, acceptable.

The Limiting Condition of Operation (LCO) currently requires that three MSLB detection and MFW isolation instrumentation channels per SG be operable. The licensee proposed revising the LCO to state that four AFIS instrumentation channels per SG shall be operable to ensure that no single failure prevents feedwater isolation. Increasing the number of channels required to be operable from three MSLB detection and MFW isolation instrumentation channels to four AFIS instrumentation channels is consistent with the AFIS design and implementation. The AFIS is a four-channel-per-SG safety grade system and the requirement that four channels be operable for each SG to ensure that a single failure does not affect system operability is conservative because three AFIS channels per SG would satisfy single failure criteria. The requirement for four OPERABLE channels per SG, therefore, is acceptable.

The APPLICABILITY for MSLB detection and MFW isolation instrumentation is currently Modes 1 and 2, and Mode 3 with main steam header pressure greater than or equal to 700 psig except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed. The licensee proposed deleting the exception for Mode 3. The LCO would be required in Modes 1 and 2 and in Mode 3 with main steam header pressure greater than or equal to 700 psig. The licensee stated that AFIS operability is required in Mode 3 when the SG pressure is greater than or equal to 700 psig because the SG inventory at pressures greater than or equal to 700 psig can contribute significantly to the peak containment pressure in the event of a SG secondary side break. Additionally, after the SG pressure decreases to less than 700 psig, the AFIS function can be bypassed to avoid an AFIS actuation during normal unit cooldowns. Consequently, the AFIS will be bypassed by the operator when main steam pressure is less than 700 psig. The licensee stated that manual operator action is credited for the mitigation of a MSLB when the AFIS is not enabled. Additionally, the plant is operated with main steam pressure less than 700 psig only during startup and shutdown evolutions, and these evolutions are very short in duration. Additionally, the licensee stated that, in Modes 4, 5 and 6, the energy in the SG is low and the feedwater flow into the SGs is low or nonexistent. The primary coolant system temperatures are also low to allow the SG to effectively remove energy. The licensee concluded that the AFIS, therefore, is not required during these conditions. The staff finds acceptable the licensee’s justification for AFIS operability in Modes 1 and 2, and in Mode 3 when the main steam pressure is greater than or equal to 700 psig.

The existing TS 3.3.11 Actions are modified by a Note that currently indicates that this LCO is a MFW isolation function. The licensee proposed removing this note, which pertains to multi-functional systems, because AFIS provides a feedwater isolation function only. The licensee’s justification for modifying the Note is consistent with the AFIS design and, therefore, is acceptable.

CONDITION A currently requires that one or more MFW isolation functions with one channel inoperable be placed in trip within 4 hours. The licensee proposed revising CONDITION A to state that one inoperable or tripped analog channel shall be placed in bypass within 4 hours. The licensee stated that bypassing one AFIS analog channel will not prevent the AFIS from

performing its intended function because a bypassed channel will place the AFIS logic in a 2-out-of-3 configuration. Operation in this configuration may continue indefinitely since the AFIS will remain capable of performing its isolation function in the presence of any single random failure. The licensee stated that the completion time of 4 hours is adequate to perform Required Action A.1 because operating experience and the licensee's analysis show there is minimal risk in operating 4 hours with one channel tripped because of the low probability that another channel will trip within that time. The licensee's justification for bypassing one analog channel for 4 hours is consistent with the AFIS design and plant operating experience and, therefore, is acceptable.

Condition B currently states that if one or more MFW Isolation Functions with two or more analog channels are inoperable, the unit must be placed in Mode 3 within 12 hours and the main steam pressure must be reduced to less than 700 psig within 18 hours, or, if these two Required Actions cannot be met, all MFCVs and SFCVs must be closed within 18 hours. The licensee proposed modifying Condition B to require that if two AFIS analog channels are inoperable or if the Required Action and associated Completion Time of Condition A is not met, then the AFIS channel(s) must be returned to operable status within 72 hours. Additionally, the licensee proposed to remove the associated alternative requirement to close all MFCVs and SFCVs within 18 hours. The licensee stated that four AFIS analog channels are required for operability, and two inoperable channels will decrease AFIS functionality. This condition will also place the logic in a 2-out-of-2 configuration, which does not satisfy single failure criteria. The licensee stated that, based on operating experience and its analysis, 72 hours is a reasonable time period for returning a channel to service. On the basis of the availability of alternative means of initiating individual component controls if an AFIS channel becomes inoperable, and the low probability of a MSLB event occurring during the period the AFIS channel is inoperable, the staff finds that the allowable outage time of 72 hours to restore channel operability is acceptable.

The AFIS is designed to isolate MFW from a faulted SG header without closing the MFCV and SFCV on the intact SG. The TS requirement to close all MFCVs and SFCVs, therefore, is not consistent with the AFIS design. Additionally, during controlled plant evolutions to Mode 3 conditions, the Integrated Control System (ICS) in the B&W plant design will close the MFCVs on both SGs before the plant achieves Mode 2 operating conditions (0 percent power) or when the reactor is tripped. Main feedwater flow rate will be on SG low level limits control with a SG level setpoint at approximately 25 SG startup range (approximately 25" above the SG lower tube sheet surface). In ICS SG low level limits control mode conditions, the MFCVs and MFW block valves are closed, and feedwater flow is controlled by the SFCVs. The TS requirement to close all MFCVs, therefore, is not necessary. With SG levels maintained at 25-inch in the startup range during Mode 3 conditions, the SFCVs will not provide sufficient feedwater to the SGs to overcool the reactor coolant system or overpressurize the containment building in a MSLB event. The TS requirement to close all SFCVs, therefore, is not necessary. The licensee's proposal to remove TS 3.3.11 Required Action B.2.2 (Close all MFCVs and SFCVs) and the associated 18 hour Completion Time, therefore, is acceptable.

The licensee proposed adding a separate entry condition, Condition C, which requires that, if the Required Action and Completion Time is not met for Condition B, then the unit must be placed in Mode 3 within 12 hours and the main steam header pressure must be reduced to less than 700 psig within 18 hours. The licensee stated that, based on operating experience, the allowed completion time is reasonable to reach the required unit conditions from full power

conditions in an orderly manner and without challenging unit systems. The licensee's justification for placing the unit in Mode 3 with main steam pressure less than 700 psig within 18 hours is consistent with plant operating experience and, therefore, is acceptable.

The existing Surveillance Requirement 3.3.11.2 contains a Note that allows online testing. The licensee proposed deleting the Note because the AFIS modifications will enhance the existing on-line testing capability of the units. The staff concurs that the online testing features in the AFIS obviate the need for this Note and, therefore, removal of the Note is acceptable.

4.1.2 Technical Specification 3.3.12

The licensee proposed changing the title from "Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation" to "Automatic Feedwater Isolation System (AFIS) Manual Initiation." The staff finds the revised title is acceptable because the AFIS will replace the MSLB detection circuit and MFW isolation function.

The LCO currently requires that two MSLB detection and MFW isolation Manual Initiation switches be operable. The licensee proposed revising the LCO to state that two AFIS manual initiation switches per steam generator shall be operable. The licensee stated that having all the manual isolation switches operable allows the operators to fully trip the appropriate AFIS channel, thereby manually initiating a feedwater isolation. The staff finds the requirement for having all manual isolation switches operable is consistent with the AFIS design, and, therefore, is acceptable.

The Applicability for MSLB detection and MFW isolation manual initiation is currently Modes 1 and 2, and Mode 3 with main steam header pressure greater than or equal to 700 psig except when all MFCVs and SFCVs are closed. The licensee proposed deletion of the exception for Mode 3 for the AFIS such that the LCO applicability will be required in Modes 1 and 2, and in Mode 3 with main steam header pressure greater than 700 psig. On the basis of the justifications discussed in Section 4.1.1 of this Safety Evaluation, the staff finds the licensee's justification for AFIS manual initiation operability in Modes 1 and 2, and in Mode 3 when the main steam pressure is greater than or equal to 700 psig to be acceptable.

The licensee proposed modifying the Actions statement by adding a Note allowing separate condition entry for each SG. This change is consistent with the design of the AFIS and, therefore, is acceptable.

Condition A currently requires that one inoperable manual initiation switch be restored to operable status within 72 hours. The licensee proposed revising Condition A to state one inoperable manual initiation switch per steam generator be restored to operable status within 72 hours. There are four AFIS channels per SG in the AFIS design. The proposed revision of Condition A to state one inoperable manual initiation switch per steam generator is consistent with the design of the AFIS and, therefore, is acceptable.

The licensee stated that the proposed 72-hour completion time is based on unit operating experience and administrative controls, which provide alternative means of AFIS initiation via individual component controls. On the basis of the availability of alternative means of initiating individual component controls if an AFIS channel becomes inoperable, and the low probability

of a MSLB event occurring during the period the AFIS channel is inoperable, the staff finds that the allowable outage time of 72 hours to restore channel operability is acceptable.

Condition B currently states that with two manual initiation switches inoperable, or the required action and associate completion time of Condition A not met, the unit must be in Mode 3 within 12 hours and main steam header pressure must be reduced to less than 700 psig within 18 hours, or all MFCVs and SFCVs must be closed within 18 hours. The licensee proposed modifying Condition B to state that with two manual initiation switches per SG inoperable or the required action and associated completion time of Condition A not met, the unit must be in Mode 3 within 12 hours and main steam header pressure must be reduced to less than 700 psig within 18 hours. On the basis of the discussion in Section 4.1.1 of this Safety Evaluation, the staff finds the proposed change acceptable.

4.1.3 Technical Specification 3.3.13

The licensee poposed revising the title from “Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels” to “Automatic Feedwater Isolation System (AFIS) Digital Channels.” The revised title is acceptable because the AFIS will replace the MSLB detection circuit and MFW isolation function.

The current TS require that two MSLB detection and MFW isolation logic channels per steam generator be operable. The licensee proposed revising the LCO to state that two AFIS digital channels per steam generator shall be operable. The licensee stated that having all the AFIS logic channels operable allows the operators to fully trip the appropriate AFIS channel because a single failure would not cause a loss of automatic function. The staff finds the requirement for all AFIS logic channels to be operable is consistent with the AFIS design, and, therefore, is acceptable.

The Applicability statement for MSLB detection and MFW isolation logic channels is currently Modes 1 and 2, and Mode 3 with main steam header pressure greater than or equal to 700 psig except when all MFCVs and SFCVs are closed. The licensee proposed deletion of the exception for Mode 3 for the AFIS such that the LCO applicability will be required in Modes 1 and 2, and in Mode 3 with main steam header pressure greater than or equal to 700 psig. On the basis of the justifications discussed in Section 3.1.1 of this Safety Evaluation, the staff finds acceptable the licensee’s justification for AFIS digital channel operability in Modes 1 and 2, and in Mode 3 when the main steam pressure is greater than or equal to 700 psig.

The licensee proposed modifying the Actions statement by adding a Note that states separate condition entry is allowed for each SG. This change is consistent with the design of the AFIS and, therefore, is acceptable.

Condition A currently requires that one channel inoperable be restored to operable status within 72 hours. The licensee proposed revising Condition A to state that one inoperable digital channel be restored to service within 72 hours. The licensee stated that the basis for the 72-hour completion time is operating experience, administrative controls that provide an alternative means of AFIS actuation via individual component controls, and that there is a second logic train on each SG to provide the same function. Additionally, the 72-hour completion time is consistent with the allowed outage time for the components actuated by AFIS. On the basis of the availability of alternative means of initiating individual component

controls if an AFIS channel becomes inoperable, and the low probability of a MSLB event occurring during the period the AFIS channel is inoperable, the staff finds that the allowable outage time of 72 hours to restore operability to an AFIS digital channel is acceptable.

Condition B currently states that with two logic channels inoperable, or the Required Action and associated Completion Time of Condition A not met, the unit must be in Mode 3 within 12 hours, and the main steam header pressure must be reduced to less than 700 psig within 18 hours or all MFCVs and SFCVs must be closed within 18 hours if the main steam header pressure is not reduced to less than 700 psig. The licensee proposed modifying Condition B to state that with two digital channels inoperable, the unit must be in Mode 3 within 12 hours and the main steam header pressure must be reduced to less than 700 psig within 18 hours. On the basis of the discussion in Section 4.1.1 of this Safety Evaluation, the staff finds the proposed revision of TS 3.3.13 Condition B acceptable.

4.1.4 Miscellaneous

Other non-technical, administrative and Bases changes have been reviewed by the staff and are acceptable.

The licensee indicated that post modification testing would be completed in accordance with their Modification Test Plan and the specific procedures that are referenced by the plan. As an integral part of the modification process, Duke will verify that the AFIS modifications have been properly installed and are fully operational, that the applicable design bases are met, that the modifications do not adversely affect other structures, systems or components, that the TS requirements are satisfied, and revised procedures are in effect. In addition, normal administrative controls will have been implemented to ensure that only personnel that have received the appropriate training regarding AFIS will operate, test, or maintain the system on the unit with the operable AFIS.

Based on our review of the information that was provided, the staff considers the proposed changes to the TS requirements to be acceptable for implementing the proposed AFIS modifications.

5.0 OPERATOR ACTIONS EVALUATION

5.1 Scope

This evaluation is limited to the changes in operator actions resulting from implementation of AFIS in place of the currently installed and NRC-approved Main Steam Line Break Detection and Feedwater Isolation System (MSLBFIS).

The staff's guidance for this review includes Information Notice 97-78, "Crediting of Operator Actions In Place of Automatic Actions and Modifications of Operator Actions, Including Response Times," which references Generic Letter 91-18, Revision 1, "Resolution of Degraded and Nonconforming Conditions and on Operability," and ANSI/ANS-58.8, "Time Response Design Criteria for Safety Related Operator Actions."

5.2 Background

Oconee currently uses a combination of operator action and MSLB feedwater isolation to mitigate the consequences of certain steam and feed line breaks. The currently installed MSLBFIS was approved by the NRC via a license amendment dated December 7, 1998 (license amendment nos 234, 234, and 233 for Units 1, 2, and 3, respectively). The line breaks of interest are those breaks that result in a blowdown of SG secondary-side inventory (i.e., a faulted SG).

In order to terminate all feed sources to a faulted SG, Oconee currently relies on operator action to stop the MDEFW pump or close the emergency feedwater flow control valve to terminate emergency feedwater flow to the affected SG within ten minutes.

5.3 Evaluation

In its submittal of July 18, 2000, the licensee proposed to replace the currently-installed MSLB feedwater isolation system with AFIS.

Comparing AFIS to the currently installed MSLBFIS, the operational differences are:

- AFIS closes *header-specific* main and startup feedwater valves for the *affected* SG. MSLBFIS closes *both* headers' main and startup feedwater valves if *either* SG is faulted.

- AFIS trips the MDEFWP to the affected SG (low SG pressure concurrent with high depressurization rate). MSLBFIS does not trip MDEFWPs.

Since AFIS also trips the MDEFWP to the faulted SG during large steam/feed line breaks (i.e., breaks that result in both low SG pressure and a high depressurization rate), no operator action is required to terminate emergency feedwater for these events. During large breaks, AFIS will, therefore, eliminate the currently required time-constrained operator action for terminating emergency feedwater to a faulted SG.

There are some events or situations where AFIS does not appreciably change operator actions when compared to MSLBFIS. These events and situations include:

- For smaller steam/feed breaks, the rate of SG depressurization may be insufficient to cause AFIS to trip the MDEFWP to the affected SG. For this situation, operator action would be required, just as it is now, to isolate emergency feedwater to the faulted SG.

- If it is desired to re-start the TDEFWP following an AFIS trip, the TDEFWP control room switch must be taken to "run" to override the AFIS trip. This is the same action to restart the TDEFWP following a MSLBFIS trip.

- For situations where it is desired to operate MFW or startup feedwater valves closed by an AFIS trip (e.g., feeding the SGs with the condensate booster pumps), AFIS must be disabled by depressing two pushbuttons in the main control room. This is the same action to allow feedwater valve operation following a MSLBFIS trip (although the pushbuttons are re-labeled as "AFIS enable/disable").

- To manually initiate AFIS to an affected *SG*, two pushbuttons for the affected *SG* must be depressed in the main control room. This action is essentially unchanged when compared to initiating MSLBFIS, which also requires depressing two pushbuttons to initiate the non-header-specific MSLBFIS. (Note: AFIS *is* header-specific; there are two AFIS initiation pushbuttons *per* SG. MSLBFIS is *not* header-specific; there are two initiation pushbuttons for the whole system).

There are situations where SG pressure may decrease due to causes other than a feed or steam break. Such situations include a SBLOCA and raising SG level to promote natural circulation (following a trip of reactor coolant pumps). In addition, there is the remote possibility that AFIS or MSLBFIS will spuriously actuate. In these "non-faulted SG" cases, it is desirable to maintain both SGs available for reactor heat removal. For the currently installed MSLBFIS, these situations will not automatically result in a complete loss of feedwater, since MSLBFIS does not trip MDEFWPs.

However, when AFIS actuates (assuming a high SG depressurization rate), one or both MDEFWPs will trip (both MDEFWPs will trip if both SGs are at low pressure and rapidly depressurizing). If it is desired following AFIS actuation to restore one or both MDEFWPs, operator action is required to take the selected control room MDEFWP control switch to "run," which overrides the AFIS trip signal, and starts the selected pump.

These non-faulted SG situations and the required additional action to manually start a MDEFWP are, however, of minor concern since:

a) The situations where AFIS actuates without a faulted SG are expected to occur only rarely. Operators are procedurally directed and trained to throttle feedwater flow to control SG pressure, thus avoiding an undesired AFIS actuation and MDEFWP trip. Also, a spurious actuation of AFIS is expected to be a remote occurrence.

b) If an undesired AFIS actuation and MDEFWP trip were to occur, operators are procedurally directed and trained to recognize and respond to a loss of SG heat sink.

c) If an undesired AFIS actuation and MDEFWP trip were to occur, the only action required to restore a MDEFWP is to take its control room switch to "run." This is a straightforward and easy to perform action.

d) According to the licensee, all licensed operators will receive training and evaluation on AFIS before they can assume the licensed duties on the unit with the new components. This training will focus on the AFIS circuitry, actuation of AFIS, the controls and components affected, and bypassing the circuitry.

5.4 Operator Actions Conclusion

The staff has concluded that AFIS is generally an improvement over the currently installed MSLBFIS. When compared to MSLBFIS, AFIS should eliminate the operator action (currently assumed to occur within ten minutes) to isolate emergency feedwater to a faulted SG, by the additional trip of the MDEFWP to the affected SG. In the unlikely case that AFIS trips one or both MDEFWPs when it is not necessary, the MDEFWPs are easily restarted using the controls in the main control room. Also, recognizing an undesired loss of heat removal and restarting

one or both MDEFWPs is well within the capabilities of a trained operator. Therefore, from a human performance standpoint, the staff finds the implementation of AFIS acceptable.

6.0 STATE CONSULTATION

In accordance with the Commission's regulations, the South Carolina State official was notified of the proposed issuance of the amendments. The State official had no comments.

7.0 ENVIRONMENTAL CONSIDERATION

The amendments change requirements with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and change surveillance requirements. The NRC staff has determined that the amendments involve no significant increase in the amounts and no significant change in the types of any effluents that may be released offsite and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (65 FR 56949). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

8.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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