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U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Document Control Desk

Subject: Oconee Nuclear Station
Docket Numbers 50-269, 270, and 287
License Amendment Request for Automatic Feedwater Isolation System Modification affecting Technical Specifications 3.3.11, 3.3.12, 3.3.13 - Main Steam Line Break Detection and Main Feedwater Isolation Circuitry
Technical Specification Change (TSC) Number 99-10

Pursuant to Title 10, Code of Federal Regulations, Part 50, Section 90 (10 CFR 50.90), Duke Energy (Duke) proposes to amend Appendix A, Technical Specifications, for Facility Operating Licenses DPR-38, DPR-47 and DPR-55 for Oconee Nuclear Station, Units 1, 2, and 3. This license amendment request (LAR) provides a method for obtaining a Nuclear Regulatory Commission (NRC) review and approval of the proposed modification and Technical Specifications (TS) that will implement an Automatic Feedwater Isolation System (AFIS).

Duke has placed a high priority on initiatives and modifications that result in reducing Operator actions. AFIS will provide automatic termination of emergency feedwater (EFW) to a faulted Steam Generator (SG), thereby eliminating manual operator action for isolating EFW flow to a faulted SG. Prompt isolation of EFW flow to the faulted SG limits the Reactor Coolant System overcooling, provides protection against EFW pump runout, reduces the mass and energy release to containment, and reduces SG tube stresses.

AFIS will modify existing Main Steam Line Break (MSLB) circuitry. The MSLB functional requirements remain the same

A001

with AFIS. AFIS will actuate the same components that are currently actuated by the MSLB circuitry. This modification is considered an enhancement to the MSLB detection circuitry.

MSLB Detection and Main Feedwater (MFW) Isolation Circuitry TS were reviewed and approved by the NRC in Amendment No. 234, 234, 233 dated December 7, 1998.

The AFIS modification installs a digital control system using the Framatome Safety STAR Module, discussed in Topical Report BAW-10191P and previously approved for generic use in safety related systems in an NRC Safety Evaluation dated August 3, 1995. Installation prerequisites listed in Section 6.0 of the Topical Report and Section 5.0 of the NRC Safety Evaluation have been met except as noted. This information is documented in Attachment 3. The Safety STAR Module Procurement Specification is included in Attachment 7 as supporting documentation for the Framatome Safety STAR Module. This documentation does not reflect the final contractual agreement with Framatome, Inc.

A LAR entitled Proposed Amendment to the Facility Operating License Regarding Methodology for Determining SG Tube Loads Following a Main Steam Line Break and Runout Protection for the Turbine Driven Emergency Feedwater Pump - TSC 99-01 dated April 26, 1999 has been submitted to the NRC for review and approval. TSC 99-01 addresses crediting the MSLB detection and Feedwater isolation instrumentation as an additional means for providing runout protection of the Turbine-Driven EFW pump following a MSLB or MFW line break. TSC 99-01 also provides analytical details regarding the methodology for determining SG tube loads following a MSLB. AFIS will enhance the MSLB detection and Feedwater isolation instrumentation. Because the analysis presented in TSC 99-01 is bounding with respect to implementation of the AFIS modification, justification for SG tube loads will not be addressed in the AFIS LAR. TSC 99-01 is currently under review by the staff.

The design of the replacement SG, which are in fabrication, takes credit for AFIS in limiting SG tube stresses in the event of a MSLB. As previously communicated to the NRC, the first SG replacement outage is tentatively scheduled to occur in September of 2003 during 1EOC21 Refueling Outage (RFO). The implementation schedule for AFIS is being

developed and will support the SG replacements.

Reference drawings have been included in the LAR to aid in the review process.

The proposed revision to TS will revise the TS and TS Bases sections of 3.3.11, 3.3.12 and 3.3.13 MSLB Detection and MFW Isolation. The MSLB Detection and MFW Isolation TS and TS bases sections will be revised and renumbered to TS and TS bases sections 3.3.25, 3.3.26 and 3.3.27 until the AFIS modification is implemented on all three Oconee Units. Once implementation is complete, these sections will be obsolete and can be deleted. TS and TS Bases section 3.3.24 will be designated as not used. TS and TS Bases section 3.3.24 will be used for a future LAR related to Emergency Power instrumentation.

The revised TS pages are included in Attachment 1. Attachment 2 contains the markup of the current TS pages. Attachment 3 contains the Technical Justification for the LAR. Attachments 4 and 5 contain the No Significant Hazards Consideration Evaluation and the Environmental Impact Analysis, respectively. Attachment 6 contains reference drawings for the EFW System, MFW System, Main Steam System and AFIS. Attachment 7 contains the Procurement Specification for the AFIS STAR Module.

The Oconee Updated Final Safety Analysis Report has been reviewed. Various sections will require revision due to the AFIS modification. These revisions will be submitted per 10CFR50.71(e).

The design bases, functional requirements, potential impacts of spurious actuation for AFIS, and justification for conditions outside the bounds of current analyses are discussed in attachment 3 of the LAR.

This proposed change to the TS has been reviewed and approved by the Plant Operations Review Committee and Nuclear Safety Review Board.

Implementation of these changes will not result in an undue risk to the health and safety of the public.

Pursuant to 10 CFR 50.91, a copy of this proposed amendment is being sent to the South Carolina Department of Health and Environmental Control for review, and as deemed necessary and appropriate, subsequent consultation with the NRC staff.

If there are any questions regarding this submittal, please contact Eric Johnson at (864) 885-4716.

Very truly yours,

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W. R. McCollum, Jr., being duly sworn, states that he is Vice President, Oconee Nuclear Site, Duke Energy Corporation, that he is authorized on the part of said Company to sign and file with the U. S. Nuclear Regulatory Commission this revision to the Facility Operating License Nos. DPR-38, DPR-47, DPR-55; and that all the statements and matters set forth herein are true and correct to the best of his knowledge.

W. R. McCollum, Jr., Vice President
Oconee Nuclear Site

Subscribed and sworn to before me this 18th day of July, 2000

Canice M. Breazeale
Notary Public

My Commission Expires:

2/12/2003

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3.3.11 Automatic Feedwater Isolation System (AFIS) Instrumentation

LCO 3.3.11 Four AFIS analog instrumentation channels per steam generator (SG) shall be OPERABLE.

----------NOTE----------
Not applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig.

ACTIONS

----------NOTE----------
Separate Condition entry is allowed for each SG.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One analog channel inoperable or tripped.	A.1 Place channel in bypass.	4 hours
B. Two analog channels inoperable. OR Required Action and associated Completion Time of Condition A not met.	B.1 Restore channel(s) to operable status.	72 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Required Action and associated Completion Time of Condition B not met.	C.1 Be in MODE 3. AND C.2 Reduce main steam header pressure to <700 psig.	12 hours 18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.11.1	Perform CHANNEL CHECK.	12 hours
SR 3.3.11.2	Perform CHANNEL FUNCTIONAL TEST.	31 days
SR 3.3.11.3	Perform CHANNEL CALIBRATION.	18 months

3.3 INSTRUMENTATION

3.3.12 Automatic Feedwater Isolation System (AFIS) Manual Initiation

LCO 3.3.12 Two AFIS Manual Initiation switches per steam generator (SG) shall be OPERABLE.

--------------------------------------NOTE--------------------------------------
Not applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig.

ACTIONS

--------------------------------------NOTE--------------------------------------
Separate Condition entry is allowed for each SG.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One manual initiation switch per SG inoperable.	A.1 Restore manual initiation switch to OPERABLE status.	72 hours
B Two manual initiation switches per SG inoperable. OR Required Action and associated Completion Time of Condition A not met.	B.1 Be in MODE 3. AND B.2 Reduce main steam header pressure to < 700 psig.	12 hours 18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.12.1	Perform CHANNEL FUNCTIONAL TEST.	18 months

3.3 INSTRUMENTATION

3.3.13 Automatic Feedwater Isolation System (AFIS) Digital Channels

LCO 3.3.13 Two AFIS digital channels per steam generator (SG) shall be OPERABLE.

-----NOTE-----
Not applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure $\geq$ 700 psig.

ACTIONS

-----NOTE-----
Separate Condition entry is allowed for each SG.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One digital channel inoperable.	A.1 Restore digital channel to OPERABLE status.	72 hours

(continued)

Actions (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. Two digital channels inoperable. OR Required Action and associated Completion Time of Condition A not met.	B.1	Be in MODE 3.	12 hours
	AND		
	B.2	Reduce main steam header pressure to < 700 psig.	18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.13.1	Perform CHANNEL FUNCTIONAL TEST.	18 months

3.3 INSTRUMENTATION

3.3.24 Not Used

3.3 INSTRUMENTATION

3.3.25 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Instrumentation

LCO 3.3.25 Three MSLB Detection and MFW Isolation instrumentation channels per steam generator (SG) shall be OPERABLE.

---------------------------------------NOTE---------------------------------------
Applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.

ACTIONS

---------------------------------------NOTE---------------------------------------
Separate Condition entry is allowed for each SG (MFW Isolation Function).

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more MFW Isolation Functions with one channel inoperable.	A.1 Place channel(s) in trip.	4 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. One or more MFW Isolation Functions with two or more channels inoperable. OR Required Action and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2.1 Reduce main steam header pressure to < 700 psig. OR B.2.2 Close all MFCVs and SFCVs.	12 hours 18 hours 18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.25.1	Perform CHANNEL CHECK.	12 hours
SR 3.3.25.2	------------------------NOTE------------------------- Only applicable when modifications are implemented that allow online testing. --- Perform CHANNEL FUNCTIONAL TEST.	31 days
SR 3.3.25.3	Perform CHANNEL CALIBRATION.	18 months

3.3 INSTRUMENTATION

3.3.26 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation

LCO 3.3.26 Two MSLB Detection and MFW Isolation Manual Initiation switches shall be OPERABLE.

---------------------------------------NOTE---
Applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One manual initiation switch inoperable.	A.1 Restore manual initiation switch to OPERABLE status.	72 hours
B Two manual initiation switches inoperable. <u>OR</u> Required Action and associated Completion Time of Condition A not met.	B.1 Be in MODE 3. <u>AND</u> B.2.1 Reduce main steam header pressure to < 700 psig. <u>OR</u> B.2.2 Close all MFCVs and SFCVs.	12 hours 18 hours 18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.26.1	Perform CHANNEL FUNCTIONAL TEST.	18 months

3.3 INSTRUMENTATION

3.3.27 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels

LCO 3.3.27 Two MSLB Detection and MFW Isolation Logic channels shall be OPERABLE.

-----NOTE-----
Applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One logic channel inoperable.	A.1 Restore channel to OPERABLE status.	72 hours
B. Two logic channels inoperable. <u>OR</u> Required Action and associated Completion Time of Condition A not met.	B.1 Be in MODE 3. <u>AND</u> B.2.1 Reduce main steam header pressure to < 700 psig. <u>OR</u> B.2.2 Close all MFCVs and SFCVs.	12 hours 18 hours 18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.27.1	Perform CHANNEL FUNCTIONAL TEST.	18 months

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B 3.3 INSTRUMENTATION

B 3.3.11 Automatic Feedwater Isolation System (AFIS) Instrumentation

BASES

BACKGROUND

A Main Steam Line Break (MSLB) can lead to containment overpressure, unacceptable thermal stresses to the steam generator tubes, and significant core overcooling. Main and Emergency Feedwater must be promptly isolated to limit the effects of a MSLB. The AFIS instrumentation is designed to provide automatic termination of feedwater flow to the affected steam generator. The AFIS instrumentation automatically terminates Main Feedwater (MFW) by tripping both MFW pumps and closing the affected steam generator's main and startup feedwater control valves and block valves. Although the main and startup feedwater block valves are automatically closed, their closure is not credited for mitigation of a MSLB. The AFIS instrumentation automatically terminates emergency feedwater (EFW) by stopping the turbine-driven emergency feedwater pump (TDEFWP) and tripping the motor-driven emergency feedwater pump (MDEFWP) aligned to the affected steam generator. Manual overrides for the TDEFWP and MDEFWP's are provided to allow the operator to subsequently start the EFW pumps if necessary for decay heat removal.

In addition, AFIS instrumentation provides runout protection for the EFW pumps in the event of a MSLB and certain large break MFW line breaks with the pump in the automatic mode of operation.

Main Steam header pressure is used as input signals to the AFIS circuitry. There are four pressure transmitters per steam generator with each feeding a steam pressure signal to a signal isolator. The output of the signal isolator provides an analog signal to a processor module that actuates isolation functions at desired setpoints. One pressure transmitter per steam generator, associated signal isolator(s) and processor module inputs constitute an AFIS detection analog channel.

The four AFIS analog channels per steam generator feed two redundant digital channels. Each digital channel provides independent circuit functions to isolate each steam generator. If the logic is satisfied, a trip output is energized. The use of an energized to trip processor module ensures that a loss of power to the digital channel will not result in an inadvertent feedwater isolation. If either digital channel is actuated, feedwater is isolated to the affected steam generator. Energizing the trip outputs results in closure of contacts in various control circuits for systems and components used for the MSLB and feedwater line break mitigation. Therefore, when the trip outputs are actuated, the systems and

BASES

BACKGROUND (continued)

components perform their isolation functions. Other features of the digital channels include a test/manual initiation pushbutton and an "enable" or "arming" switch. The AFIS digital channel is defined as the analog isolation modules, the digital 2 out of 4 logic modules, the Enable/Disable pushbutton, the associated output relays, the trip relay outputs to the feedwater pumps, the redundant switchgear trips for the MDEFWP, the solenoid valves for the MFCV & SFCV, the trip solenoid valves for the feedwater pumps, and the TDEFWP trip function. While AFIS provides isolation of the feedwater block valves, this is not a credited function and is not a requirement for digital channel operability.

The AFIS digital channels are enabled and disabled administratively rather than automatically. Appropriate operating procedures contain provisions to enable/disable the digital channels.

APPLICABLE SAFETY ANALYSES

Based on the containment pressure response reanalysis, the containment design pressure would be exceeded for a MSLB inside containment without immediate operator or automatic action to isolate main feedwater to the affected steam generator.

In addition, prompt operator or automatic action would be required to isolate EFW to the affected steam generator to limit the resultant thermal stresses on the steam generator tubes following a MSLB.

Main Steam header pressure is used as input signals to the AFIS circuitry. When a MSLB is sensed, or upon manual actuation, main feedwater is terminated by tripping both MFW pumps and closing the affected steam generators main and startup feedwater control valves and block valves. Although the main and startup feedwater block valves are automatically closed, they are not credited for mitigation of a MSLB. In addition, EFW is terminated by stopping the TDEFWP and tripping the MDEFWP aligned to the affected steam generator. Manual overrides for the TDEFWP and MDEFWP are provided to allow the operator to subsequently start the EFW pumps if necessary for decay heat removal.

The AFIS Instrumentation satisfies Criterion 3 of 10 CFR 50.36 (Ref. 3).

LCO

This LCO requires that instrumentation necessary to initiate a MFW and EFW isolation shall be OPERABLE. Failure of any instrument renders the affected analog channel(s) inoperable and reduces the reliability of the Function.

BASES

LCO (continued)

Four analog channels per SG are required to be OPERABLE to ensure that no single failure prevents Feedwater isolation. Each AFIS analog channel includes the sensor, signal isolator and processor module.

This LCO is modified by a Note which indicated the requirements are applicable to a Unit after completion of the AFIS modification on the respective unit. This is necessary since the specification is based on the Unit's design after implementation of the modification.

APPLICABILITY

The AFIS Function shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because the SG inventory can be at a high energy level and contribute significantly to the peak pressure with a secondary side break. Feedwater must be able to be isolated on each SG to limit mass and energy releases to the reactor building. Once the SG pressures have decreased below 700 psig, the AFIS Function can be bypassed to avoid actuation during normal unit cooldowns. In MODES 4, 5, and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent. In MODES 4, 5, and 6, the primary system temperatures are too low to allow the SGs to effectively remove energy and AFIS instrumentation is not required to be OPERABLE.

ACTIONS

If a channel's trip setpoint is found nonconservative with respect to the Allowable Value, or any of the transmitter or signal processing electronics, are found inoperable, then the Function provided by that channel must be declared inoperable and the unit must enter the appropriate Conditions.

A Note has been added to the ACTIONS indicating that a separate Condition entry is allowed for analog channels associated with each SG.

A.1

Condition A applies to failures of a single AFIS analog channel. With one channel inoperable or tripped, the channel(s) must be placed in bypass within 4 hours. Bypassing the affected channel places the Function in a two-out-of-three configuration. Operation in this configuration may continue indefinitely since the AFIS Function is capable of performing its isolation function in the presence of any single random failure. The Completion Time of 4 hours is adequate to perform Required Action A.1.

B.1

With two channels inoperable or if the Required Action and associated

BASES

ACTIONS (continued)

Completion Time of Condition A can not be met, the channel(s) must be returned to service within 72 hours. An inoperable channel includes any channel bypassed by Condition A.

C.1 and C.2

With the Required Action and associated Completion Time of Condition B not met, the unit must be placed in MODE 3 within 12 hours and main steam header pressure must be reduced to less than 700 psig within 18 hours. The allowed Completion Time is reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.3.11.1

Performance of the CHANNEL CHECK once every 12 hours ensures that a gross failure of instrumentation has not occurred. A CHANNEL CHECK is normally a comparison of the parameter indicated on one channel to a similar parameter on other channels. It is based on the assumption that instrument channels monitoring the same parameter should read approximately the same value. Significant deviations between the two instrument channels could be an indication of excessive instrument drift in one of the channels or of something even more serious. CHANNEL CHECK will detect gross channel failure; therefore, it is key in verifying that the instrumentation continues to operate properly between each CHANNEL FUNCTIONAL TEST and CHANNEL CALIBRATION.

Agreement criteria are based on a combination of the channel instrument uncertainties, including isolation, indication, and readability. If a channel is outside the criteria, it may be an indication that the transmitter or the signal processing equipment has drifted outside its limit. If the channels are within the criteria, it is an indication that the channels are OPERABLE. If the channels are normally off scale during times when surveillance is required, the CHANNEL CHECK will only verify that they are off scale in the same direction. Off scale low current loop channels are verified, where practical, to be reading at the bottom of the range and not failed downscale.

A continuous, automatic CHANNEL CHECK function is provided by Software. If a channel is outside the criteria, then an alarm is provided to the control room. Manual performance of the CHANNEL CHECK is acceptable.

The frequency, about once every shift, is based on operating experience that demonstrates channel failure is rare. Since the probability of two random failures in redundant channels in any 12 hour period is extremely

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.11.1 (continued)

low, the CHANNEL CHECK minimizes the chance of loss of protective function due to failure of redundant channels. The CHANNEL CHECK supplements less formal, but potentially more frequent, checks of channel OPERABILITY during normal operational use of the displays associated with the LCO required channels.

SR 3.3.11.2

A CHANNEL FUNCTIONAL TEST is performed by comparing the test input signal to the value transmitted to the Calibration and Test Computer. This enables verification of the voltage references and the signal commons. This will ensure the channel will perform its intended function.

The Frequency of 31 days is based on operating experience, with regard to channel OPERABILITY and drift, which demonstrates that failure of more than one channel in any 31 day interval is a rare event.

SR 3.3.11.3

CHANNEL CALIBRATION is a complete check of the instrument channel including the sensor. The test verifies the channel responds to a measured parameter within the necessary range and accuracy. CHANNEL CALIBRATION leaves the channels adjusted to account for instrument drift to ensure that the instrument channel remains operational between successive tests. CHANNEL CALIBRATION shall find that measurement errors and setpoint errors are within the assumptions of the setpoint analysis. CHANNEL CALIBRATIONS must be performed consistent with the assumptions of the setpoint analysis.

The Frequency is based on the assumption of an 18 month calibration interval in the determination of the magnitude of equipment drift in the setpoint analysis.

REFERENCES

1. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.12 Automatic Feedwater Isolation System (AFIS) Manual Initiation

BASES

BACKGROUND

The AFIS manual initiation capability provides the operator with the capability to actuate the isolation function from the control room. This Function is provided in the event the operator determines that the Function is needed and does not automatically actuate. This is a backup Function to the automatic Feedwater isolation.

The AFIS manual initiation circuitry satisfies the manual initiation and single-failure criterion requirements of IEEE-279-1971 (Ref. 1).

APPLICABLE SAFETY ANALYSES

The Feedwater Isolation Function credited in the safety analysis is automatic. However, the manual initiation Function is required by design as backup to the automatic Function and allows operators to actuate Feedwater Isolation whenever the Function is needed. Furthermore, the manual initiation of Feedwater Isolation may be specified in unit operating procedures.

The AFIS manual initiation function satisfies Criterion 3 of 10 CFR 50.36 (Ref. 2).

LCO

Two manual initiation switches per steam generator are required to be OPERABLE. The Feedwater Isolation function has two actuation or "trip" digital channels, channels 1 and 2. Within each digital channel actuation logic there are two manual trip switches. When the manual switch is depressed, a full trip of actuation digital channel 1 or 2 occurs.

This LCO is modified by a Note which indicates the requirements are applicable to a Unit after completion of the AFIS modification on the respective Unit. This is necessary since the specification is based on the Unit's design after implementation of the modification.

APPLICABILITY

The AFIS manual initiation Function shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because SG inventory can be at a sufficiently high energy level to contribute significantly to the peak containment pressure with a secondary side break. In MODES 4, 5, and 6, the SG energy level is low and secondary side feedwater flow rate is low or nonexistent.

BASES (continued)

ACTIONS

A Note has been added to the ACTIONS indicating that a separate Condition entry is allowed for manual initiation switches associated with each SG.

A.1

With one manual initiation switch per steam generator inoperable, the manual initiation switch must be restored to OPERABLE status within 72 hours. The Completion Time of 72 hours is based on unit operating experience and administrative controls, which provide alternative means of AFIS initiation via individual component controls. The 72 hour Completion Time is consistent with the allowed outage time for the components actuated by the AFIS.

B.1

With both manual initiation switches per steam generator inoperable or the Required Action and associated Completion Time of Condition A not met, the Unit must be placed in MODE 3 within 12 hours and the main steam header pressure reduced to less than 700 psig within 18 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required MODES from full power conditions in an orderly manner and without challenging Unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.3.12.1

This SR requires the performance of a digital CHANNEL FUNCTIONAL TEST to ensure that the channels can perform their intended functions. The Frequency of 18 months is based on engineering judgment and operating experience that determined testing on an 18 month interval provides reasonable assurance that the circuitry is available to perform its safety function, while the risks of testing during unit operation is avoided.

REFERENCES

1. IEEE-279-1971, April 1972.
2. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.13 Automatic Feedwater Isolation System (AFIS) Logic Channels

BASES

BACKGROUND

The four AFIS analog channels per steam generator feed two redundant feedwater digital channels. Each digital channel provides independent circuit functions to isolate each steam generator. If the logic is satisfied, a trip output is energized. The use of an energized to trip processor module ensures that a loss of power to the digital channels will not result in an inadvertent feedwater isolation. If either digital channel is actuated, feedwater to the affected steam generator is isolated. Energizing the trip outputs results in actuation of contacts in various control circuits for systems and components used for the MSLB and feedwater line break mitigation. Therefore, when the trip outputs are actuated, the systems and components perform their isolation functions. The AFIS digital channel is defined as the analog isolation modules, the digital 2 out of 4 logic modules, the Enable/Disable pushbutton, the associated output relays, the trip relay outputs to the feedwater pumps, the redundant switchgear trips for the MDEFWP, the solenoid valves for the MFCV & SFCV, the trip solenoid valves for the feedwater pumps, and the TDEFWP trip function. While AFIS provides isolation of the feedwater block valves, this is not a credited function and is not a requirement for digital channel operability.

Trip Setpoints and Allowable Values

Trip setpoints are the nominal values that are user defined in AFIS software. AFIS software is considered to be properly adjusted when the "as left" value is within the band for CHANNEL CALIBRATION accuracy.

The trip setpoints used in the AFIS software are selected such that adequate protection is provided when all sensor and processing time delays are taken into account. To allow for calibration tolerances, instrumentation uncertainties, instrument drift, and severe environment induced errors for AFIS channels that must function in harsh environments as defined by 10 CFR 50.49, the Allowable Values specified are conservatively adjusted with respect to the analytical limits. The actual nominal trip setpoint entered into the software for low MS pressure is 550 psig and the rate of depressurization setpoint will be 3 psi/sec. A channel is inoperable if its actual trip setpoint is not within its required Allowable Value.

Setpoints, in accordance with the Allowable Values, ensure that the

(continued)

BASES (continued)

BACKGROUND

Trip Setpoints and Allowable Values (continued)

consequences of accidents will be acceptable, providing the unit is operated from within the LCOs at the onset of the accident and the equipment functions as designed.

Each channel can be tested online to verify that the setpoint accuracy is within the specified allowance requirements. The CHANNEL FUNCTIONAL TEST is performed by comparing the test input signal to the value transmitted to the Calibration and Test Computer. This enables verification of the voltage references and the signal commons to ensure the channel will perform its intended function. A continuous, automatic CHANNEL CHECK is provided by AFIS software. If the channel is outside acceptance criteria, an alarm is provided to the control room.

APPLICABLE SAFETY ANALYSES

AFIS circuitry is installed equipment necessary to automatically isolate main and emergency feedwater to the affected steam generator following a MSLB. The AFIS circuitry provides protection against exceeding containment design pressure for MSLB's inside containment and provides protection against exceeding allowable thermal stresses on the steam generator tubes following a MSLB.

Main Steam header pressure is used as input signals to the AFIS circuitry. When a MSLB is sensed, or upon manual actuation, MFW is terminated by tripping both MFW pumps and closing the affected steam generator's main and startup feedwater control valves and block valves. Although the main and startup feedwater block valves are automatically closed, they are not credited for mitigation of a MSLB. In addition, EFW is terminated by stopping the TDEFWP and tripping the MDEFWP aligned to the affected steam generator. Manual overrides for the TDEFWP and MDEFWP's are provided to allow the operator to subsequently start the emergency feedwater pumps if necessary for decay heat removal.

The AFIS logic channels satisfy Criterion 3 of 10 CFR 50.36 (Ref. 1).

LCO

Two digital channels of AFIS logic shall be OPERABLE. There are two redundant digital channels of automatic actuation logic.

This LCO is modified by a Note which indicates the requirements are applicable to a Unit after completion of the AFIS modification on the respective Unit. This is necessary since the specification is based on the Units design after implementation of the modification.

BASES (continued)

APPLICABILITY

The AFIS digital channels shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because SG inventory can be at a high energy level and can contribute significantly to the peak containment pressure during a secondary side line break. In MODES 4, 5, and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent.

ACTIONS

A Note has been added to the ACTIONS indicating that a separate Condition entry is allowed for logic channels associated with each SG.

A.1

With one digital channel inoperable, the inoperable digital channel must be restored to OPERABLE status within 72 hours. The Completion Time of 72 hours is based on unit operating experience and administrative controls, which provide alternative means of AFIS initiation via individual component controls. The 72 hour Completion Time is consistent with the allowed outage time for the components actuated by AFIS.

B.1 and B.2

With both digital channels inoperable or the Required Action and associated Completion Time not met, 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 allowed Completion Times are reasonable, based on operating experience, to reach the required MODES from full power conditions in an orderly manner and without challenging Unit systems.

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.3.13.1

This SR requires the performance of a CHANNEL FUNCTIONAL TEST to ensure that the digital channels can perform their intended functions. The Frequency of 18 months is based on engineering judgment and operating experience that determined testing on an 18 month interval provides reasonable assurance that the circuitry is available to perform its safety function, while the risks of testing during Unit operation is avoided.

REFERENCES

1. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.24 Not Used

B 3.3 INSTRUMENTATION

B 3.3.25 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Instrumentation

BASES

BACKGROUND

The MSLB Detection and MFW Isolation instrumentation is designed to address containment overpressurization concerns by isolating main feedwater (MFW) to both steam generators during an MSLB and to mitigate core overcooling concerns.

Steam generator header pressure is used as input signals to the MSLB circuitry for detection and feedwater isolation. When a MSLB is sensed, or upon manual actuation, the main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) will be closed to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The turbine-driven emergency feedwater (TDEFW) pump will be inhibited from auto-starting or will be auto-stopped if it has already started. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for decay heat removal. These functions are credited for mitigating an MSLB. The function of closing the main and startup feedwater block valves is not credited in the MSLB analysis for mitigation of containment overpressurization during a MSLB. However, the MSLB detection and MFW isolation circuitry performs this function.

There are three pressure transmitters per steam generator with each feeding a steam pressure signal to a signal isolator (when used) and bistable. These bistables are calibrated to provide an ON/OFF signal at the desired setpoint for actuation of the feedwater isolation circuitry. A pressure transmitter and its associated signal isolator(s) and bistable(s) constitute a MSLB detection analog channel.

The six MSLB detection analog channels feed two redundant feedwater isolation digital channels consisting of two single failure proof two-out-of-three logic circuits. If the logic is satisfied, a master relay coil is energized. The use of an energized master relay ensures that a loss of power to the digital channels will not result in an in advertent feedwater isolation. If either digital channel is actuated, an MFW isolation will occur. Energizing the master relay results in closure of contacts in various control circuits for systems and components used for the MSLB containment overpressurization protection. Therefore, when the master relay is

BASES

BACKGROUND (continued)

energized, the systems and components perform their isolation functions. Other features of the 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 two-out-of-three logic circuits, along with their associated enable switch, master relay, seal-in, time delay, and test/manual actuation pushbutton are considered a feedwater isolation digital channel.

The feedwater isolation digital channels are enabled and disabled administratively rather than automatically. Appropriate operating procedures contain provisions to enable/disable the digital channels.

APPLICABLE SAFETY ANALYSES

Based on the containment pressure response reanalysis, the containment design pressure would be exceeded for a MSLB inside containment without operator action to isolate main feedwater and installed equipment necessary to automatically isolate main feedwater to both steam generators during a MSLB.

Steam generator header pressure is used as input to the MSLB circuitry for detection and feedwater isolation. When a MSLB is sensed, or upon manual actuation, the MFCVs and SFCVs are closed to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The TDEFW pump will be inhibited from auto-starting or will be auto-stopped if it has already started. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for decay heat removal. All of these functions are credited for mitigating a MSLB inside containment.

The MSLB Detection and MFW Isolation Instrumentation satisfies Criterion 3 of 10 CFR 50.36 (Ref. 3).

LCO

This LCO requires that instrumentation necessary to initiate a MFW isolation shall be OPERABLE. Failure of any instrument renders the affected channel(s) inoperable and reduces the reliability of the Function.

Three channels per SG are required to be OPERABLE to ensure that no single failure prevents MFW isolation. Each MSLB Detection and MFW Isolation instrumentation channel includes the sensor and measurement channel.

This LCO is modified by a Note, which indicates the requirements are not applicable to a Unit after completion of the Automatic Feedwater Isolation System Modification on the respective Unit. This is necessary since the

BASES (continued)

LCO (continued)

specification is no longer based on the Unit's design after implementation of the modification.

APPLICABILITY

The MSLB Detection and MFW Isolation Function shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because the SG inventory can be at a high energy level and contribute significantly to the peak pressure with a secondary side break. The main feedwater must be able to be isolated on each SG to limit mass and energy releases to the reactor building. Once the SG pressures have decreased below 700 psig, the MFW Isolation Function can be bypassed to avoid actuation during normal unit cooldowns. Also during MODE 3 the MFW isolation Function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since the function of the instrumentation is already fulfilled. In MODES 4, 5, and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent. In MODES 4, 5, and 6, the primary system temperatures are too low to allow the SGs to effectively remove energy and MSLB Detection and MFW Isolation instrumentation is not required to be OPERABLE.

ACTIONS

If a channel's trip setpoint is found nonconservative with respect to the Allowable Value, or any of the transmitter or signal processing electronics, are found inoperable, then the Function provided by that channel must be declared inoperable and the unit must enter the appropriate Conditions.

A Note has been added to the ACTIONS indicating that a separate Condition entry is allowed for instrumentation channels associated with each SG (MFW isolation function).

A.1

Condition A applies to failures of a single MSLB Detection and MFW Isolation instrumentation channel in one or more MFW Isolation Functions.

With one channel inoperable in one or more MSLB Detection and MFW Isolation Function, the channel(s) must be placed in trip within 4 hours. Tripping the affected channel places the Function in a one-out-of-two configuration. Operation in this configuration may continue indefinitely since the MSLB Detection and MFW Isolation Function is capable of performing its isolation function in the presence of any single random failure. The Completion Time of 4 hours is adequate to perform Required Action A.1.

BASES

ACTIONS (continued)

B.1, B.2.1, and B.2.2

With two channels in one or more MSLB Detection and MFW Isolation Function inoperable or the Required Action and associated Completion Time of Condition A not met, the unit must be placed in MODE 3 within 12 hours and main steam header pressure must be reduced to less than 700 psig or all MFCVs and SFCVs must be closed within 18 hours. The allowed Completion Time is reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.3.25.1

Performance of the CHANNEL CHECK once every 12 hours ensures that a gross failure of instrumentation has not occurred. A CHANNEL CHECK is normally a comparison of the parameter indicated on one channel to a similar parameter on other channels. It is based on the assumption that instrument channels monitoring the same parameter should read approximately the same value. Significant deviations between the two instrument channels could be an indication of excessive instrument drift in one of the channels or of something even more serious. CHANNEL CHECK will detect gross channel failure; therefore, it is key in verifying that the instrumentation continues to operate properly between each CHANNEL FUNCTIONAL TEST and CHANNEL CALIBRATION.

Agreement criteria are based on a combination of the channel instrument uncertainties, including isolation, indication, and readability. If a channel is outside the criteria, it may be an indication that the transmitter or the signal processing equipment has drifted outside its limit. If the channels are within the criteria, it is an indication that the channels are OPERABLE. If the channels are normally off scale during times when surveillance is required, the CHANNEL CHECK will only verify that they are off scale in the same direction. Off scale low current loop channels are verified, where practical, to be reading at the bottom of the range and not failed downscale.

The Frequency, about once every shift, is based on operating experience that demonstrates channel failure is rare. Since the probability of two random failures in redundant channels in any 12 hour period is extremely low, the CHANNEL CHECK minimizes the chance of loss of protective function due to failure of redundant channels. The CHANNEL CHECK supplements less formal, but potentially more frequent, checks of channel OPERABILITY during normal operational use of the displays associated with the LCO required channels.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.25.2

A CHANNEL FUNCTIONAL TEST is performed on each required instrumentation channel to ensure the channel will perform its intended function.

The Frequency of 31 days is based on operating experience, with regard to channel OPERABILITY and drift, which demonstrates that failure of more than one channel in any 31 day interval is a rare event.

This SR is modified by a Note indicating that it is only applicable when modifications are implemented that allow online testing.

SR 3.3.25.3

CHANNEL CALIBRATION is a complete check of the instrument channel including the sensor. The test verifies the channel responds to a measured parameter within the necessary range and accuracy. CHANNEL CALIBRATION leaves the channels adjusted to account for instrument drift to ensure that the instrument channel remains operational between successive tests. CHANNEL CALIBRATION shall find that measurement errors and bistable setpoint errors are within the assumptions of the setpoint analysis. CHANNEL CALIBRATIONS must be performed consistent with the assumptions of the setpoint analysis.

The Frequency is based on the assumption of an 18 month calibration interval in the determination of the magnitude of equipment drift in the setpoint analysis.

REFERENCES

1. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.26 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation

BASES

BACKGROUND

The MSLB Detection and MFW Isolation manual initiation capability provides the operator with the capability to actuate the isolation function from the control room. This Function is provided in the event the operator determines that the Function is needed and does not automatically actuate. This is a backup Function to the automatic MFW isolation.

The MSLB Detection and MFW Isolation manual initiation circuitry satisfies the manual initiation and single-failure criterion requirements of IEEE-279-1971 (Ref. 1).

APPLICABLE SAFETY ANALYSES

The MFW Isolation Function credited in the safety analysis is automatic. However, the manual initiation Function is required by design as backup to the automatic Function and allows operators to actuate MFW Isolation whenever the Function is needed. Furthermore, the manual initiation of MFW Isolation may be specified in unit operating procedures.

The MSLB Detection and MFW Isolation manual initiation function satisfy Criterion 3 of 10 CFR 50.36 (Ref. 2).

LCO

One manual initiation switch per actuation channel (A and B) is required to be OPERABLE. The MFW Isolation function, has two actuation or "trip" channels, channels A and B. Within each channel actuation logic there is one manual trip switch. When the manual switch is depressed, a full trip of actuation channel A or B occurs.

This LCO is modified by a Note which indicates the requirements are not applicable to a Unit after completion of the Automatic Feedwater Isolation System Modification on the respective Unit. This is necessary since the specification is no longer based on the Unit's design after implementation of the modification.

APPLICABILITY

The MFW Isolation manual initiation Function shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because SG inventory can be at a sufficiently high energy level to contribute significantly to the peak containment pressure with a secondary

BASES (continued)

APPLICABILITY (continued)

side break. During MODE 3, the MFW Isolation manual initiation Function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since its function is already fulfilled. In MODES 4, 5, and 6, the SG energy level is low and secondary side feedwater flow rate is low or nonexistent.

ACTIONS

A.1

With one manual initiation switch inoperable, the manual initiation switch must be restored to OPERABLE status within 72 hours. The Completion Time of 72 hours is based on unit operating experience and administrative controls, which provide alternative means of MSLB Detection and MFW Isolation Function initiation via individual component controls. The 72 hour Completion Time is consistent with the allowed outage time for the components actuated by the MSLB Detection and MFW Isolation Function.

B.1

With both manual initiation switches inoperable or the Required Action and associated Completion Time of Condition A not met, the unit must be placed in MODE 3 within 12 hours and the main steam header pressure reduced to less than 700 psig or all MFCVs and SFCVs must be closed within 18 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required MODES from full power conditions in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.3.26.1

This SR requires the performance of a CHANNEL FUNCTIONAL TEST to ensure that the channels can perform their intended functions. The Frequency of 18 months is based on engineering judgment and operating experience that determined testing on an 18 month interval provides reasonable assurance that the circuitry is available to perform its safety function, while the risks of testing during unit operation is avoided.

REFERENCES

1. IEEE-279-1971, April 1972.

2. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.27 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels

BASES

BACKGROUND

The six MSLB detection analog channels feed two redundant feedwater isolation digital channels consisting of two single failure proof two-out-of-three logic circuits. If the logic is satisfied, a master relay coil is energized. The use of an energized master relay ensures that a loss of power to the digital channels will not result in an inadvertent feedwater isolation. If either digital channel is actuated, an MFW isolation will occur. Energizing the master relay results in closure of contacts in various control circuits for systems and components used for the MSLB containment overpressurization protection. Therefore, when the master relay is energized, the systems and components perform their isolation functions. Other features of the 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. Each of the two two-out-of-three logic circuits, along with their associated enable switch, master relay, seal-in, and time delay is considered a feedwater isolation digital channel.

APPLICABLE SAFETY ANALYSES

MSLB circuitry is installed equipment necessary to automatically isolate main feedwater to both steam generators during a MSLB.

Steam generator outlet pressure is used as input to the MSLB circuitry for detection and feedwater isolation. When a MSLB is sensed, or upon manual actuation, the MFCVs and SFCVs will be closed to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The TDEFW pump will be inhibited from auto-starting or will be auto-stopped if it has already started and the switch for MS-93 is in the AUTO position. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for heat removal. All of these functions are credited for mitigating a MSLB inside containment.

The MSLB Detection and MFW Isolation logic channels satisfy Criterion 3 of 10 CFR 50.36 (Ref. 1).

BASES (continued)

LCO

Two channels of MSLB Detection and MFW Isolation automatic actuation logic shall be OPERABLE. There are only two channels of automatic actuation logic. Therefore, violation of this LCO could result in a complete loss of the automatic Function assuming a single failure of the other channel.

This LCO is modified by a Note which indicates the requirements are not applicable to a Unit after completion of the Automatic Feedwater Isolation System Modification on the respective Unit. This is necessary since the specification is no longer on the Unit's design after implementation of the modification.

APPLICABILITY

The MSLB Detection and MFW Isolation automatic actuation logic channels shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because SG inventory can be at a high energy level and can contribute significantly to the peak containment pressure during a secondary side line break. Also, during MODE 3, the MFW Isolation function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since its function is already fulfilled. In MODES 4, 5, and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent.

ACTIONS

A.1

With one automatic actuation logic channel inoperable, the channel must be restored to OPERABLE status within 72 hours. The Completion Time of 72 hours is based on unit operating experience and administrative controls, which provide alternative means of MSLB Detection and MFW Isolation Function initiation via individual component controls. The 72 hour Completion Time is consistent with the allowed outage time for the components actuated by the MSLB Detection and MFW Isolation Function.

B.1, B.2.1, and B.2.2

With both logic channels inoperable or the Required Action and associated Completion Time not met, 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 or all MFCVs and SFCVs must be closed within 18 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required MODES from full power conditions in an orderly manner and without challenging unit systems.

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.3.27.1

This SR requires the performance of a CHANNEL FUNCTIONAL TEST to ensure that the channels can perform their intended functions. This test verifies MFW Isolation automatic actuation logics are functional. This test simulates the required inputs to the logic circuit and verifies successful operation of the automatic actuation logic. The Frequency of 18 months is based on engineering judgment and operating experience that determined testing on an 18 month interval provides reasonable assurance that the circuitry is available to perform its safety function, while the risks of testing during unit operation is avoided.

REFERENCES

1. 10 CFR 50.36.

B 3.7 PLANT SYSTEMS

B 3.7.3 Main Feedwater Control Valves (MFCVs), and Startup Feedwater Control Valves (SFCVs)

BASES

BACKGROUND

The main feedwater isolation valves (MFIVs) for each steam generator consist of the MFCVs and the SFCVs. The MFIVs isolate main feedwater (MFW) flow to the secondary side of the steam generators following a high energy line break (HELB). The consequences of events occurring in the main steam lines will be mitigated by their closure. Closing the MFCVs and associated SFCVs valves effectively terminates the addition of feedwater to an affected steam generator, limiting the mass and energy release for steam line breaks (SLBs) inside containment and reducing the cooldown effects for SLBs. Closure of the MFCVs and associated SFCVs is also credited for a feedwater line break.

The MFIVs close on receipt of a MSLB detection signal generated by low steam header pressure. The MFIVs can also be closed manually.

APPLICABLE SAFETY ANALYSES

The design basis of the MFIVs is established by the containment analysis for the main steam line break (MSLB).

Failure of an MFIV to close following an MSLB, can result in additional mass and energy being delivered to the steam generators, contributing to cooldown. This failure also results in additional mass and energy releases following an MSLB.

The MFIVs satisfy Criterion 3 of 10 CFR 50.36 (Ref. 1).

LCO

This LCO ensures that the MFIVs will isolate MFW flow to the steam generators following a main steam line break.

Two MFCVs and two SFCVs are required to be OPERABLE. The MFIVs are considered OPERABLE when the isolation times are within limits and they close on a feedwater isolation actuation signal.

Automatic initiation instrumentation is not required to be OPERABLE in MODE 3 when main steam header pressure is < 700 psig in accordance with either LCO 3.3.11, " Automatic Feedwater Isolation System (AFIS) Instrumentation" or LCO 3.3.25, "Main Steam Line Break (MSLB) Detection

BASES

LCO (continued)

and Main Feedwater (MFW) Isolation Instrumentation." When automatic initiation circuitry is not required to be OPERABLE, the MFCVs and SFCVs are OPERABLE provided manual closure capability is OPERABLE. Automatic initiation is not required in this condition since additional time is available for the operator to manually close the valves if required.

Failure to meet the LCO requirements can result in excessive cooldown and additional mass and energy being released to containment following an MSLB inside containment.

APPLICABILITY

The MFCVs and SFCVs must be OPERABLE whenever there is significant mass and energy in the RCS and steam generators.

In MODES 1, 2, and 3, the MFCVs and SFCVs are required to be OPERABLE in order to limit the cooldown and the amount of available fluid that could be added to containment in the case of an MSLB inside containment. When the valves are closed, they are already performing their safety function.

In MODES 4, 5, and 6, feedwater and steam generator energy are low. Therefore, the MFCVs and SFCVs are not required for isolation of potential main steam pipe breaks in these MODES.

ACTIONS

The ACTIONS table is modified by a Note indicating that separate Condition entry is allowed for each valve.

A.1 and A.2

With one MFCV in one or more flow paths inoperable, action must be taken to restore the affected valves to OPERABLE status, or to close or isolate inoperable affected valves within 8 hours. When these valves are closed or isolated, they are performing their required safety function.

The 8 hour Completion Time provides a reasonable time to restore an inoperable MFIV to OPERABLE status and is acceptable due to the low probability of an event occurring during this time period that would require isolation of the MFW flow paths.

ATTACHMENT 2

TECHNICAL SPECIFICATION MARKUP

add

TABLE OF CONTENTS

3.3 INSTRUMENTATION

3.3.11 ~~Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW)~~ Automatic Feedwater Isolation System (AFIS) Instrumentation

LCO 3.3.11 ~~Three MSLB Detection and MFW Isolation~~ Four AFIS analog instrumentation channels per steam generator (SG) shall be OPERABLE.

ADD

---NOTE---
Not applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig. ~~except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.~~

ACTIONS

---NOTE---
Separate Condition entry is allowed for each SG ~~(MFW Feedwater Isolation Function).~~

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One ~~or more MFW Isolation Functions with one~~ analog channel inoperable or tripped.	A.1 Place channel~~(s)~~ in ~~trip~~ bypass.	4 hours
B. Two analog channels inoperable. OR Required Action and associated Completion Time of Condition A not met.	B.1 Restore channel(s) to operable status.	72 hours

ADD new condition

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C ~~B.~~ ~~One or more MFW Isolation Functions with two or more channels inoperable.~~ ~~OR~~ Required Action and associated Completion Time of Condition B not met.	C ~~B~~.1 Be in MODE 3. AND C ~~B~~.2.~~1~~ Reduce main steam header pressure to < 700 psig. ~~OR~~ ~~B.2.2 Close all MFCVs and SFCVs.~~	12 hours 18 hours ~~18 hours~~

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.11.1	Perform CHANNEL CHECK.	12 hours
SR 3.3.11.2	~~-------------------NOTE-------------------~~ ~~Only applicable when modifications are implemented that allow online testing.~~ ~~---~~ Perform CHANNEL FUNCTIONAL TEST.	31 days
SR 3.3.11.3	Perform CHANNEL CALIBRATION.	18 months

3.3 INSTRUMENTATION

3.3.12 Automatic Feedwater Isolation System (AFIS) ~~Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation~~ Manual Initiation

LCO 3.3.12 Two AFIS ~~MSLB Detection and MFW Isolation~~ Manual Initiation switches per steam generator (SG) shall be OPERABLE.

--------------------NOTE--------------------
Not applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig~~. except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.~~

ACTIONS

--------------------NOTE--------------------
Separate Condition entry is allowed for each SG ~~(Feedwater Isolation Function).~~

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One manual initiation switch per SG inoperable.	A.1 Restore manual initiation switch to OPERABLE status.	72 hours
B Two manual initiation switches per SG inoperable. OR Required Action and associated Completion Time of Condition A not met.	B.1 Be in MODE 3. AND B.2.1 Reduce main steam header pressure to < 700 psig. ~~OR~~ ~~B.2.2 Close all MFCVs and SFCVs.~~	12 hours 18 hours ~~18 hours~~

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.12.1	Perform CHANNEL FUNCTIONAL TEST.	18 months

3.3 INSTRUMENTATION

3.3.13 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Automatic Feedwater Isolation System (AFIS) Logic Digital Channels

LCO 3.3.13 Two MSLB Detection and MFW Isolation AFIS Logic digital channels per steam generator (SG) shall be OPERABLE.

-----NOTE-----
Not applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective unit.
----- ADD

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig. except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.

ACTIONS

-----NOTE-----
Separate Condition entry is allowed for each SG (MFW Feedwater Isolation Function).

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One logic digital channel inoperable.	A.1 Restore digital channel to OPERABLE status.	72 hours

(continued)

Actions (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. Two ~~logic~~ digital channels inoperable. OR Required Action and associated Completion Time of Condition A not met.	B.1	Be in MODE 3.	12 hours
	AND		
	B.2~~.1~~	Reduce main steam header pressure to < 700 psig.	18 hours
	~~OR~~		
	~~B.2.2~~	~~Close all MFCVs and SFCVs.~~	~~18 hours~~

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.13.1	Perform CHANNEL FUNCTIONAL TEST.	18 months

3.3 INSTRUMENTATION

3.3.24 Not Used

3.3 INSTRUMENTATION

25
3.3.~~11~~ Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Instrumentation

25
LCO 3.3.~~11~~ Three MSLB Detection and MFW Isolation instrumentation channels per steam generator (SG) shall be OPERABLE.

ADD

-----NOTE-----
Applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.

ACTIONS

-----NOTE-----
Separate Condition entry is allowed for each SG (MFW Isolation Function).

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more MFW Isolation Functions with one channel inoperable.	A.1 Place channel(s) in trip.	4 hours

(continued)

ADD

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. One or more MFW Isolation Functions with two or more channels inoperable. OR Required Action and associated Completion Time not met.	B.1	Be in MODE 3.	12 hours
	AND		
	B.2.1	Reduce main steam header pressure to < 700 psig.	18 hours
	OR		
	B.2.2	Close all MFCVs and SFCVs.	18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.~~11~~25.1	Perform CHANNEL CHECK.	12 hours
SR 3.3.~~11~~25.2	-----NOTE----- Only applicable when modifications are implemented that allow online testing. ---------- Perform CHANNEL FUNCTIONAL TEST.	31 days
SR 3.3.~~11~~25.3	Perform CHANNEL CALIBRATION.	18 months

3.3 INSTRUMENTATION

3.3.~~1~~26 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation

LCO 3.3.~~1~~26 Two MSLB Detection and MFW Isolation Manual Initiation switches shall be OPERABLE.

ADD

---NOTE---
Applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One manual initiation switch inoperable.	A.1 Restore manual initiation switch to OPERABLE status.	72 hours
B Two manual initiation switches inoperable. OR Required Action and associated Completion Time of Condition A not met.	B.1 Be in MODE 3. AND B.2.1 Reduce main steam header pressure to < 700 psig. OR B.2.2 Close all MFCVs and SFCVs.	12 hours 18 hours 18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.~~1~~26.1	Perform CHANNEL FUNCTIONAL TEST.	18 months

3.3 INSTRUMENTATION

3.3.~~13~~27 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels

LCO 3.3.~~13~~27 Two MSLB Detection and MFW Isolation Logic channels shall be OPERABLE.

ADD

---NOTE---
Applicable on each Unit until after completion of the Automatic Feedwater Isolation System modification on the respective Unit.

APPLICABILITY: MODES 1 and 2,
MODE 3 with main steam header pressure ≥ 700 psig except when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One logic channel inoperable.	A.1 Restore channel to OPERABLE status.	72 hours
B. Two logic channels inoperable. OR Required Action and associated Completion Time of Condition A not met.	B.1 Be in MODE 3. AND B.2.1 Reduce main steam header pressure to < 700 psig. OR B.2.2 Close all MFCVs and SFCVs.	12 hours 18 hours 18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.1327.1	Perform CHANNEL FUNCTIONAL TEST.	18 months

TABLE OF CONTENTS

B 3.3 INSTRUMENTATION

B 3.3.11 ~~Main Steam Line Break (MSLB) Detection and Main~~ Automatic Feedwater ~~(MFW)~~ Isolation Instrumentation System (AFIS)

BASES

BACKGROUND

A Main Steam Line Break ~~The~~ (MSLB) ~~Detection and MFW Isolation instrumentation is designed to address~~ can lead to containment overpressurization, unacceptable thermal stresses ~~concerns by isolating main feedwater (MFW)~~ to the ~~both~~ steam generators tubes, ~~during an MSLB and to~~ significant ~~mitigate~~ core overcooling ~~concerns.~~ (Add attached statement)

In addition, AFIS instrumentation provides runout protection for the EFW pumps in the event of a MSLB and certain large break MFW line breaks with the pump in the automatic mode of operation.

Main Steam ~~generator~~ header pressure is used as input signals to the ~~MSLB~~ AFIS circuitry. ~~for detection and feedwater isolation. When a MSLB is sensed, or upon manual actuation, the main feedwater control valves (MFCVs) and~~ MFW pumps and TDEFWP are ~~startup feedwater control valves (SFCVs) will be closed~~ tripped ~~to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The turbine-driven emergency feedwater (TDEFW) pump will be inhibited from auto-starting or will be auto-stopped if it has already started. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for decay heat removal. These functions are credited for mitigating an MSLB. The function of closing the main and startup feedwater block valves is not credited in the MSLB analysis. for mitigation of containment overpressurization during a MSLB. However, the MSLB detection and~~ AFIS ~~MFW isolation circuitry performs this function.~~

There are ~~three~~ four pressure transmitters per steam generator with each feeding a steam pressure signal to a signal isolator. ~~(when used) and bistable.~~ The output of the signal isolator provides an analog ~~These bistables are calibrated to provide an ON/OFF~~ signal ~~at the~~ to a processor module that actuates isolation functions at desired setpoint. ~~for actuation of the feedwater isolation circuitry.~~ ~~A~~ One pressure transmitter per steam generator, ~~and its~~ associated signal isolator(s) and ~~bistable(s)~~ processor module inputs constitute a ~~MSLB~~ AFIS detection analog channel.

The ~~six MSLB detection~~ four AFIS analog channels per steam generator feed two redundant ~~feedwater isolation~~ digital ~~channels~~ channels. ~~consisting of two single failure proof two-out-of-three logic circuits.~~ Each digital channel provides independent circuit functions to isolate each steam generator. If the logic is satisfied, a ~~master relay coil~~ trip output is energized. The use of an energized ~~master relay~~ to trip processor module ensures that a loss of power to the digital ~~channels~~ channels will not result in an inadvertent feedwater isolation. If either digital channel is actuated, an ~~MFW~~ feedwater is isolated to the affected steam generator ~~isolation will occur~~. Energizing the ~~master relay~~ trip outputs results in closure of contacts in various control circuits for systems and components used for the MSLB ~~containment overpressurization protection.~~ and feedwater line break mitigation. Therefore, when the ~~master relay is~~ trip outputs are

ADD to B 3.3.11 AFIS Instrumentation Background

Main and Emergency Feedwater must be promptly isolated to limit the effects of a MSLB. The AFIS instrumentation is designed to provide automatic termination of feedwater flow to the affected steam generator. The AFIS instrumentation automatically terminates main feedwater (MFW) by tripping both main feedwater pumps and closing the affected steam generator's main and startup feedwater control valves and block valves. Although the main and startup feedwater block valves are automatically closed, the~~y~~ir closure ~~are~~ is not credited for mitigation of a MSLB. The AFIS instrumentation automatically terminates emergency feedwater (EFW) by stopping the turbine-driven emergency feedwater pump (TDEFWP) and tripping the motor-driven emergency feedwater pump (MDEFWP) aligned to the affected steam generator. Manual overrides for the TDEFWP and MDEFWP's are provided to allow the operator to subsequently start the ~~emergency feedwater~~ EFW pumps if necessary for decay heat removal.

BASES

BACKGROUND (continued)

actuated ~~energized~~, the systems and components perform their isolation functions. Other features of the digital channels ~~channels~~ include a test/manual ~~actuation~~ initiation 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, two-out-of-three logic circuits, along with their associated enable switch, master relay, seal-in, time delay, and test/manual actuation~~ initiation ~~pushbutton are considered a feedwater isolation digital channel~~ channel.

Insert attached definition for AFIS Digital Channel

The AFIS ~~feedwater isolation~~ digital AFIS channels ~~channels~~ are enabled and disabled administratively rather than automatically. Appropriate operating procedures contain provisions to enable/disable the digital channels ~~channels~~.

APPLICABLE SAFETY ANALYSES

Based on the containment pressure response reanalysis, the containment design pressure would be exceeded for a MSLB inside containment without immediate operator or automatic action to isolate main feedwater ~~and installed equipment necessary to automatically isolate main feedwater~~ to ~~both~~ the affected steam generator~~s during a MSLB~~.

In addition, prompt operator or automatic action would be required to isolate EFW to the affected steam generator to limit the resultant thermal stresses on the steam generator tubes following a main MSLB.

Steam ~~generator~~ header pressure is used as input signals to the AFIS ~~MSLB~~ circuitry. ~~for detection and feedwater isolation.~~ When a MSLB is sensed, or upon manual actuation, ~~the MFCVs and SFCVs are closed to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The TDEFW pump will be inhibited from auto-starting or will be auto-stopped if it has already started. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for decay heat removal. All of these functions are credited for mitigating a MSLB inside containment.~~ ADD Attached statement

The AFIS ~~MSLB Detection and MFW Isolation~~ Instrumentation satisfies Criterion 3 of 10 CFR 50.36 (Ref. 3).

LCO

This LCO requires that instrumentation necessary to initiate a MFW and EFW isolation shall be OPERABLE. Failure of any instrument renders the affected channel(s) inoperable and reduces the reliability of the Function.

Four analog ~~Three~~ channels per SG ~~are~~ required to be OPERABLE to ensure that no single failure prevents feedwater and EFW ~~MFW~~ isolation. Each AFIS ~~MSLB Detection and MFW Isolation instrumentation~~ analog channel includes the sensor, ~~and measurement~~ signal isolator ~~channel.~~ and processor module.

This LCO is modified by a Note which indicates the requirements are applicable to a unit after completion of the AFIS modification on the respective unit. This is necessary since the specification is based on the unit's design after implementation of the modification.

Insert into TS bases 3.3.11 background and TS bases 3.3.13 background:

The AFIS digital channel is defined as the analog isolation modules, the digital 2 out of 4 logic modules, the Enable/Disable pushbutton, the associated output relays, the trip relay outputs to the feedwater pumps, the redundant switchgear trips for the MDEFWP, the solenoid valves for the MFCV & SFCV, the trip solenoid valves for the feedwater pumps, and the TDEFWP trip function. While AFIS provides isolation of the feedwater block valves, this is not a credited function and is not a requirement for digital channel operability.

ADD to B 3.3.11 AFIS Instrumentation Applicable Safety Analysis

main feedwater is terminated by tripping both MFW pumps and closing the affected steam generator's main and startup feedwater control valves and block valves. Although the main and startup feedwater block valves are automatically closed, they are not credited for mitigation of a MSLB. In addition, emergency feedwater is terminated by stopping the TDEFWP and tripping the MDEFWP aligned to the affected steam generator. Manual overrides for the TDEFWP and MDEFWP are provided to allow the operator to subsequently start the emergency feedwater pumps if necessary for decay heat removal.

BASES (continued)

APPLICABILITY

The AFIS ~~MSLB Detection and MFW Isolation~~ Function shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because the SG inventory can be at a high energy level and contribute significantly to the peak pressure with a secondary side break. ~~The main~~ Feedwater must be able to be isolated on each SG to limit mass and energy releases to the reactor building. Once the SG pressures have decreased below 700 psig, the AFIS ~~MFW Isolation~~ Function can be bypassed to avoid actuation during normal unit cooldowns. ~~Also during MODE 3 the MFW isolation Function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since the function of the instrumentation is already fulfilled.~~ In MODES 4, 5, and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent. In MODES 4, 5, and 6, the primary system temperatures are too low to allow the SGs to effectively remove energy and AFIS ~~MSLB Detection and MFW Isolation~~ instrumentation is not required to be OPERABLE.

ACTIONS

If a channel's trip setpoint is found nonconservative with respect to the Allowable Value, or any of the transmitter or signal processing electronics, are found inoperable, then the Function provided by that channel must be declared inoperable and the unit must enter the appropriate Conditions.

A Note has been added to the ACTIONS indicating that a separate Condition entry is allowed for instrumentation channels associated with each SG ~~(MFW isolation function).~~ ~~Feedwater~~

A.1

Condition A applies to failures of a single ~~MSLB Detection and MFW~~ AFIS ~~Isolation instrumentation~~ analog channel. ~~in one or more MFW Isolation Functions.~~

With one channel inoperable ~~in one~~ or tripped ~~more MSLB Detection and MFW Isolation Function~~, the channel(s) must be placed in bypass ~~trip~~ within 4 hours. Bypassing ~~Tripping~~ the affected channel places the Function in a two ~~one~~-out-of-three ~~two~~ configuration. Operation in this configuration may continue indefinitely since the AFIS ~~MSLB Detection and MFW Isolation~~ Function is capable of performing its isolation function in the presence of any single random failure. The Completion Time of 4 hours is adequate to perform Required Action A.1.

BASES

ACTIONS (continued)

B.1~~, B.2.1, and B.2.2~~

With two channels ~~in one~~ inoperable or if the Required Action and Completion Time of Condition A cannot be met, the channel(s) must be returned to service within 72 hours. An inoperable channel includes any channel bypassed by Condition A. or ~~more MSLB Detection and MFW Isolation Function inoperable or~~ the Required Actions and associated Completion Time of Condition ~~A~~ B not met, the unit must be placed in MODE 3 within 12 hours and main steam header pressure must be reduced to less than 700 psig ~~or all MFCVs and SFCVs must be closed~~ within 18 hours. The allowed Completion Time is reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

C.1 and C.2

SURVEILLANCE REQUIREMENTS

SR 3.3.11.1

Performance of the CHANNEL CHECK once every 12 hours ensures that a gross failure of instrumentation has not occurred. A CHANNEL CHECK is normally a comparison of the parameter indicated on one channel to a similar parameter on other channels. It is based on the assumption that instrument channels monitoring the same parameter should read approximately the same value. Significant deviations between the two instrument channels could be an indication of excessive instrument drift in one of the channels or of something even more serious. CHANNEL CHECK will detect gross channel failure; therefore, it is key in verifying that the instrumentation continues to operate properly between each CHANNEL FUNCTIONAL TEST and CHANNEL CALIBRATION.

Agreement criteria are based on a combination of the channel instrument uncertainties, including isolation, indication, and readability. If a channel is outside the criteria, it may be an indication that the transmitter or the signal processing equipment has drifted outside its limit. If the channels are within the criteria, it is an indication that the channels are OPERABLE. If the channels are normally off scale during times when surveillance is required, the CHANNEL CHECK will only verify that they are off scale in the same direction. Off scale low current loop channels are verified, where practical, to be reading at the bottom of the range and not failed downscale.

→ ADD: A continuous, automatic CHANNEL CHECK function is provided by software. If a channel is outside the criteria then an alarm is provided to the control room. Manual performance of the CHANNEL CHECK is acceptable.

The Frequency, about once every shift, is based on operating experience that demonstrates channel failure is rare. Since the probability of two random failures in redundant channels in any 12 hour period is extremely low, the CHANNEL CHECK minimizes the chance of loss of protective function due to failure of redundant channels. The CHANNEL CHECK supplements less formal, but potentially more frequent, checks of channel OPERABILITY during normal operational use of the displays associated with the LCO required channels.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.11.2

A CHANNEL FUNCTIONAL TEST is performed ~~on each required~~ by comparing the test input ~~instrumentation channel to ensure the channel will perform its intended function.~~ signal to the value transmitted to the Calibration via Test Computer. This enables verification of the voltage references and the signal commons. This will ensure the channel will perform its intended function.

The Frequency of 31 days is based on operating experience, with regard to channel OPERABILITY and drift, which demonstrates that failure of more than one channel in any 31 day interval is a rare event.

~~This SR is modified by a Note indicating that it is only applicable when modifications are implemented that allow online testing.~~

SR 3.3.11.3

CHANNEL CALIBRATION is a complete check of the instrument channel including the sensor. The test verifies the channel responds to a measured parameter within the necessary range and accuracy. CHANNEL CALIBRATION leaves the channels adjusted to account for instrument drift to ensure that the instrument channel remains operational between successive tests. CHANNEL CALIBRATION shall find that measurement errors and ~~bistable~~ setpoint errors are within the assumptions of the setpoint analysis. CHANNEL CALIBRATIONS must be performed consistent with the assumptions of the setpoint analysis.

The Frequency is based on the assumption of an 18 month calibration interval in the determination of the magnitude of equipment drift in the setpoint analysis.

REFERENCES

1. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.12 Automatic ~~Main Steam Line Break (MSLB) Detection and Main~~ Feedwater (MFW) Isolation System (AFIS) Manual Initiation

BASES

BACKGROUND

The AFIS ~~MSLB Detection and MFW Isolation~~ manual initiation capability provides the operator with the capability to actuate the isolation function from the control room. This Function is provided in the event the operator determines that the Function is needed and does not automatically actuate. This is a backup Function to the automatic Feedwater ~~MFW~~ isolation.

The AFIS ~~MSLB Detection and MFW Isolation~~ manual initiation circuitry satisfies the manual initiation and single-failure criterion requirements of IEEE-279-1971 (Ref. 1).

APPLICABLE SAFETY ANALYSES

The Feedwater ~~MFW~~ Isolation Function credited in the safety analysis is automatic. However, the manual initiation Function is required by design as backup to the automatic Function and allows operators to actuate ~~MFW~~ Feedwater Isolation whenever the Function is needed. Furthermore, the manual initiation of Feedwater ~~MFW~~ Isolation may be specified in unit operating procedures.

The AFIS ~~MSLB Detection and MFW Isolation~~ manual initiation function satisfy Criterion 3 of 10 CFR 50.36 (Ref. 2).

LCO

Two ~~One~~ manual initiation switches per steam generator ~~actuation channel (A and B) is~~ are required to be OPERABLE. The Feedwater ~~MFW~~ Isolation function has two actuation or "trip" digital channels, ~~channels~~, channels 1 and 2 ~~A and B~~. Within each digital channel ~~channel~~ actuation logic there are ~~is~~ two ~~one~~ manual trip switches. When the manual switch is depressed, a full trip of actuation digital channel 1 or 2 ~~channel A or B~~ occurs.

This LCO is modified by a Note which indicates the requirements are applicable to a Unit after completion of the Automatic Feedwater Isolation System modification on the respective unit. This is necessary since the specification is based on the Unit's design after implementation of the modification.

APPLICABILITY

The AFIS ~~MFW Isolation~~ manual initiation Function shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because SG inventory can be at a sufficiently high energy level to contribute significantly to the peak containment pressure with a secondary side break. ~~During MODE 3, the MFW Isolation manual initiation Function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since its function is already fulfilled.~~ In MODES 4, 5, and 6, the SG energy level is low and secondary side feedwater flow rate is low or nonexistent.

BASES (continued)

ACTIONS

A Note has been added to the ACTIONS indicating that a separate Condition entry is allowed for manual initiation switches associated with each SG. ~~(Feedwater isolation function).~~

A.1

With one manual initiation switch per Steam Generator inoperable, the manual initiation switch must be restored to OPERABLE status within 72 hours. The Completion Time of 72 hours is based on unit operating experience and administrative controls, which provide alternative means of ~~MSLB Detection and MFW Isolation Function~~ AFIS initiation via individual component controls. The 72 hour Completion Time is consistent with the allowed outage time for the components actuated by ~~the MSLB Detection and MFW Isolation Function~~ AFIS.

B.1

With both manual initiation switches per Steam Generator inoperable or the Required Action and associated Completion Time of Condition A not met, the unit must be placed in MODE 3 within 12 hours and the main steam header pressure reduced to less than 700 psig ~~, or all MFCVs and SFCVs must be closed within 18 hours.~~ within 18 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required MODES from full power conditions in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.3.12.1

This SR requires the performance of a CHANNEL FUNCTIONAL TEST to ensure that the channels can perform their intended functions. The Frequency of 18 months is based on engineering judgment and operating experience that determined testing on an 18 month interval provides reasonable assurance that the circuitry is available to perform its safety function, while the risks of testing during unit operation is avoided.

REFERENCES

1. IEEE-279-1971, April 1972.

2. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.13 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels

Automatic Feedwater Isolation System (AFIS)

BASES

BACKGROUND

The six MSLB detection analog channels feed two redundant feedwater isolation digital channels, consisting of two single failure proof two-out-of-three logic circuits. If the logic is satisfied, a master relay coil is energized. The use of an energized master relay ensures that a loss of power to the digital channels will not result in an inadvertent feedwater isolation. If either digital channel is actuated, an MFW isolation will occur. Energizing the master relay results in closure of contacts in various control circuits for systems and components used for the MSLB containment overpressurization protection. Therefore, when the master relay is energized, the systems and components perform their isolation functions. Other features of the 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. Each of the two two-out-of-three logic circuits, along with their associated enable switch, master relay, seal-in, and time delay is considered a feedwater isolation digital channel.

Each digital channel provides independent circuit functions to isolate each steam generator.

ADD attached Definition of Digital channel

ADD attached Trip Setpoints and Allowable Values

APPLICABLE SAFETY ANALYSES

MSLB circuitry is installed equipment necessary to automatically isolate main feedwater to both steam generators during a MSLB. The AFIS Circuitry provides protection against exceeding Containment design pressure for MSLB's inside containment and provides protection against exceeding allowable thermal stresses on the steam generator tubes following a MSLB. Steam generator outlet pressure is used as input to the MSLB circuitry for detection and feedwater isolation. When a MSLB is sensed, or upon manual actuation, the MFCVs and SFCVs will be closed to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The TDEFW pump will be inhibited from auto-starting or will be auto-stopped if it has already started and the switch for MS-93 is in the AUTO position. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for heat removal. All of these functions are credited for mitigating a MSLB inside containment.

MFW is terminated by tripping both MFW pumps and closing the affected steam generator's main and startup feedwater control valves and block valves.

EFW is terminated by stopping the TDEFWP and tripping the MDEFWP to the affected steam generator.

Although the main and startup feedwater block valves are automatically closed, they are not credited for mitigation of a MSLB.

The MSLB Detection and MFW Isolation logic channels satisfy Criterion 3 of 10 CFR 50.36 (Ref. 1).

Insert into TS bases 3.3.11 background and TS bases 3.3.13 background:

The AFIS digital channel is defined as the analog isolation modules, the digital 2 out of 4 logic modules, the Enable/Disable pushbutton, the associated output relays, the trip relay outputs to the feedwater pumps, the redundant switchgear trips for the MDEFWP, the solenoid valves for the MFCV & SFCV, the trip solenoid valves for the feedwater pumps, and the TDEFWP trip function. While AFIS provides isolation of the feedwater block valves, this is not a credited function and is not a requirement for digital channel operability.

Add to BASES B 3.3.13 Background:

Trip Setpoints and Allowable Values

Trip setpoints are the nominal values that are user defined in AFIS software. AFIS software is considered to be properly adjusted when the "as left" value is within the band for CHANNEL CALIBRATION accuracy.

The trip setpoints used in the AFIS software are selected such that adequate protection is provided when all sensor and processing time delays are taken into account. To allow for calibration tolerances, instrumentation uncertainties, instrument drift, and severe environment induced errors for AFIS channels that must function in harsh environments as defined by 10 CFR 50.49, the Allowable Values specified are conservatively adjusted with respect to the analytical limits. The actual nominal trip setpoint entered into the software for low MS pressure is 550 psig and the rate of depressurization setpoint will be 3 psi/sec. A channel is inoperable if its actual trip setpoint is not within its required Allowable Value.

Setpoints, in accordance with the Allowable Values, ensure that the consequences of accidents will be acceptable, providing the unit is operated from within the LCOs at the onset of the accident and the equipment functions as designed.

Each channel can be tested online to verify that the setpoint accuracy is within the specified allowance requirements. The CHANNEL FUNCTIONAL TEST is performed by comparing the test input signal to the value transmitted to the Calibration and Test Computer. This enables verification of the voltage references and the signal commons to ensure the channel will perform its intended function. A continuous, automatic CHANNEL CHECK is provided by AFIS software. If the channel is outside acceptance criteria, an alarm is provided to the control room.

BASES (continued)

LCO

Two digital channels ~~channels~~ of AFIS ~~MSLB Detection and MFW Isolation automatic actuation~~ logic shall be OPERABLE. There are ~~only~~ two redundant digital channels ~~channels~~ of automatic actuation logic. ~~Therefore, violation of this LCO could result in a complete loss of the automatic Function assuming a single failure of the other channel.~~ This LCO is modified by a Note which indicates the requirements are applicable to a Unit after completion of the Automatic Feedwater Isolation System modification on the respective unit. This is necessary since the specification is based on the Unit's design after implementation of the modification.

APPLICABILITY

The AFIS ~~MSLB Detection and MFW Isolation automatic actuation logic channels~~ digital channels shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because SG inventory can be at a high energy level and can contribute significantly to the peak containment pressure during a secondary side line break. ~~Also, during MODE 3, the MFW Isolation function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since its function is already fulfilled.~~ In MODES 4, 5, and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent.

ACTIONS

A.1

A Note has been added to the ACTIONS indicating that a separate Condition entry is allowed for Logic channels associated with each SG. ~~(feedwater isolation function)~~

With one ~~automatic actuation logic channel~~ digital channel inoperable, the ~~channel~~ inoperable digital channel must be restored to OPERABLE status within 72 hours. The Completion Time of 72 hours is based on unit operating experience and administrative controls, which provide alternative means of ~~MSLB Detection and MFW Isolation Function~~ AFIS initiation via individual component controls. The 72 hour Completion Time is consistent with the allowed outage time for the components actuated by the MSLB Detection and MFW Isolation Function.

B.1, ~~B.2.1,~~ and B.2 ~~.2~~

With both ~~logic channels~~ digital channels inoperable or the Required Action and associated Completion Time not met, 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 ~~or all MFCVs and SFCVs must be closed~~ within 18 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required MODES from full power conditions in an orderly manner and without challenging unit systems.

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.3.13.1

This SR requires the performance of a CHANNEL FUNCTIONAL TEST to ensure that the channels can perform their intended functions. This test verifies MFW Isolation automatic actuation logics are functional. This test simulates the required inputs to the logic circuit and verifies successful operation of the automatic actuation logic. The Frequency of 18 months is based on engineering judgment and operating experience that determined testing on an 18 month interval provides reasonable assurance that the circuitry is available to perform its safety function, while the risks of testing during unit operation is avoided.

REFERENCES

1. 10 CFR 50.36.

ADD

B 3.3 INSTRUMENTATION

B 3.3.24 Not Used

B 3.3 INSTRUMENTATION

B 3.3.~~11~~25 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Instrumentation

BASES

BACKGROUND

The MSLB Detection and MFW Isolation instrumentation is designed to address containment overpressurization concerns by isolating main feedwater (MFW) to both steam generators during an MSLB and to mitigate core overcooling concerns.

Steam generator header pressure is used as input signals to the MSLB circuitry for detection and feedwater isolation. When a MSLB is sensed, or upon manual actuation, the main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) will be closed to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The turbine-driven emergency feedwater (TDEFW) pump will be inhibited from auto-starting or will be auto-stopped if it has already started. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for decay heat removal. These functions are credited for mitigating an MSLB. The function of closing the main and startup feedwater block valves is not credited in the MSLB analysis for mitigation of containment overpressurization during a MSLB. However, the MSLB detection and MFW isolation circuitry performs this function.

There are three pressure transmitters per steam generator with each feeding a steam pressure signal to a signal isolator (when used) and bistable. These bistables are calibrated to provide an ON/OFF signal at the desired setpoint for actuation of the feedwater isolation circuitry. A pressure transmitter and its associated signal isolator(s) and bistable(s) constitute a MSLB detection analog channel.

The six MSLB detection analog channels feed two redundant feedwater isolation digital channels consisting of two single failure proof two-out-of-three logic circuits. If the logic is satisfied, a master relay coil is energized. The use of an energized master relay ensures that a loss of power to the digital channels will not result in an in advertent feedwater isolation. If either digital channel is actuated, an MFW isolation will occur. Energizing the master relay results in closure of contacts in various control circuits for systems and components used for the MSLB containment overpressurization protection. Therefore, when the master relay is

BASES

BACKGROUND (continued)

energized, the systems and components perform their isolation functions. Other features of the 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 two-out-of-three logic circuits, along with their associated enable switch, master relay, seal-in, time delay, and test/manual actuation pushbutton are considered a feedwater isolation digital channel.

The feedwater isolation digital channels are enabled and disabled administratively rather than automatically. Appropriate operating procedures contain provisions to enable/disable the digital channels.

APPLICABLE SAFETY ANALYSES

Based on the containment pressure response reanalysis, the containment design pressure would be exceeded for a MSLB inside containment without operator action to isolate main feedwater and installed equipment necessary to automatically isolate main feedwater to both steam generators during a MSLB.

Steam generator header pressure is used as input to the MSLB circuitry for detection and feedwater isolation. When a MSLB is sensed, or upon manual actuation, the MFCVs and SFCVs are closed to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The TDEFW pump will be inhibited from auto-starting or will be auto-stopped if it has already started. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for decay heat removal. All of these functions are credited for mitigating a MSLB inside containment.

The MSLB Detection and MFW Isolation Instrumentation satisfies Criterion 3 of 10 CFR 50.36 (Ref. 3).

LCO

This LCO requires that instrumentation necessary to initiate a MFW isolation shall be OPERABLE. Failure of any instrument renders the affected channel(s) inoperable and reduces the reliability of the Function.

Three channels per SG are required to be OPERABLE to ensure that no single failure prevents MFW isolation. Each MSLB Detection and MFW Isolation instrumentation channel includes the sensor and measurement channel.

This LCO is modified by a Note, which indicates the requirements are not applicable to a Unit after completion of the Automatic Feedwater Isolation System Modification on the respective Unit. This is necessary since the

BASES (continued)

LCO (continued)

specification is no longer based on the Unit's design after implementation of the modification.] add

APPLICABILITY

The MSLB Detection and MFW Isolation Function shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure $\geq$ 700 psig because the SG inventory can be at a high energy level and contribute significantly to the peak pressure with a secondary side break. The main feedwater must be able to be isolated on each SG to limit mass and energy releases to the reactor building. Once the SG pressures have decreased below 700 psig, the MFW Isolation Function can be bypassed to avoid actuation during normal unit cooldowns. Also during MODE 3 the MFW isolation Function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since the function of the instrumentation is already fulfilled. In MODES 4, 5, and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent. In MODES 4, 5, and 6, the primary system temperatures are too low to allow the SGs to effectively remove energy and MSLB Detection and MFW Isolation instrumentation is not required to be OPERABLE.

ACTIONS

If a channel's trip setpoint is found nonconservative with respect to the Allowable Value, or any of the transmitter or signal processing electronics, are found inoperable, then the Function provided by that channel must be declared inoperable and the unit must enter the appropriate Conditions.

A Note has been added to the ACTIONS indicating that a separate Condition entry is allowed for instrumentation channels associated with each SG (MFW isolation function).

A.1

Condition A applies to failures of a single MSLB Detection and MFW Isolation instrumentation channel in one or more MFW Isolation Functions.

With one channel inoperable in one or more MSLB Detection and MFW Isolation Function, the channel(s) must be placed in trip within 4 hours. Tripping the affected channel places the Function in a one-out-of-two configuration. Operation in this configuration may continue indefinitely since the MSLB Detection and MFW Isolation Function is capable of performing its isolation function in the presence of any single random failure. The Completion Time of 4 hours is adequate to perform Required Action A.1.

BASES

ACTIONS (continued)

B.1, B.2.1, and B.2.2

With two channels in one or more MSLB Detection and MFW Isolation Function inoperable or the Required Action and associated Completion Time of Condition A not met, the unit must be placed in MODE 3 within 12 hours and main steam header pressure must be reduced to less than 700 psig or all MFCVs and SFCVs must be closed within 18 hours. The allowed Completion Time is reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.3.~~11~~25.1

Performance of the CHANNEL CHECK once every 12 hours ensures that a gross failure of instrumentation has not occurred. A CHANNEL CHECK is normally a comparison of the parameter indicated on one channel to a similar parameter on other channels. It is based on the assumption that instrument channels monitoring the same parameter should read approximately the same value. Significant deviations between the two instrument channels could be an indication of excessive instrument drift in one of the channels or of something even more serious. CHANNEL CHECK will detect gross channel failure; therefore, it is key in verifying that the instrumentation continues to operate properly between each CHANNEL FUNCTIONAL TEST and CHANNEL CALIBRATION.

Agreement criteria are based on a combination of the channel instrument uncertainties, including isolation, indication, and readability. If a channel is outside the criteria, it may be an indication that the transmitter or the signal processing equipment has drifted outside its limit. If the channels are within the criteria, it is an indication that the channels are OPERABLE. If the channels are normally off scale during times when surveillance is required, the CHANNEL CHECK will only verify that they are off scale in the same direction. Off scale low current loop channels are verified, where practical, to be reading at the bottom of the range and not failed downscale.

The Frequency, about once every shift, is based on operating experience that demonstrates channel failure is rare. Since the probability of two random failures in redundant channels in any 12 hour period is extremely low, the CHANNEL CHECK minimizes the chance of loss of protective function due to failure of redundant channels. The CHANNEL CHECK supplements less formal, but potentially more frequent, checks of channel OPERABILITY during normal operational use of the displays associated with the LCO required channels.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.1125.2

A CHANNEL FUNCTIONAL TEST is performed on each required instrumentation channel to ensure the channel will perform its intended function.

The Frequency of 31 days is based on operating experience, with regard to channel OPERABILITY and drift, which demonstrates that failure of more than one channel in any 31 day interval is a rare event.

This SR is modified by a Note indicating that it is only applicable when modifications are implemented that allow online testing.

SR 3.3.1125.3

CHANNEL CALIBRATION is a complete check of the instrument channel including the sensor. The test verifies the channel responds to a measured parameter within the necessary range and accuracy. CHANNEL CALIBRATION leaves the channels adjusted to account for instrument drift to ensure that the instrument channel remains operational between successive tests. CHANNEL CALIBRATION shall find that measurement errors and bistable setpoint errors are within the assumptions of the setpoint analysis. CHANNEL CALIBRATIONS must be performed consistent with the assumptions of the setpoint analysis.

The Frequency is based on the assumption of an 18 month calibration interval in the determination of the magnitude of equipment drift in the setpoint analysis.

REFERENCES

1. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.~~1~~26 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation

BASES

BACKGROUND

The MSLB Detection and MFW Isolation manual initiation capability provides the operator with the capability to actuate the isolation function from the control room. This Function is provided in the event the operator determines that the Function is needed and does not automatically actuate. This is a backup Function to the automatic MFW isolation.

The MSLB Detection and MFW Isolation manual initiation circuitry satisfies the manual initiation and single-failure criterion requirements of IEEE-279-1971 (Ref. 1).

APPLICABLE SAFETY ANALYSES

The MFW Isolation Function credited in the safety analysis is automatic. However, the manual initiation Function is required by design as backup to the automatic Function and allows operators to actuate MFW Isolation whenever the Function is needed. Furthermore, the manual initiation of MFW Isolation may be specified in unit operating procedures.

The MSLB Detection and MFW Isolation manual initiation function satisfy Criterion 3 of 10 CFR 50.36 (Ref. 2).

LCO

One manual initiation switch per actuation channel (A and B) is required to be OPERABLE. The MFW Isolation function, has two actuation or "trip" channels, channels A and B. Within each channel actuation logic there is one manual trip switch. When the manual switch is depressed, a full trip of actuation channel A or B occurs.

This LCO is modified by a Note which indicates the requirements are not applicable to a Unit after completion of the Automatic Feedwater Isolation System Modification on the respective Unit. This is necessary since the specification is no longer based on the Unit's design after implementation of the modification.

APPLICABILITY

The MFW Isolation manual initiation Function shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ∃ 700 psig because SG inventory can be at a sufficiently high energy level to contribute significantly to the peak containment pressure with a secondary

BASES (continued)

APPLICABILITY (continued)

side break. During MODE 3, the MFW Isolation manual initiation Function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since its function is already fulfilled. In MODES 4, 5, and 6, the SG energy level is low and secondary side feedwater flow rate is low or nonexistent.

ACTIONS

A.1

With one manual initiation switch inoperable, the manual initiation switch must be restored to OPERABLE status within 72 hours. The Completion Time of 72 hours is based on unit operating experience and administrative controls, which provide alternative means of MSLB Detection and MFW Isolation Function initiation via individual component controls. The 72 hour Completion Time is consistent with the allowed outage time for the components actuated by the MSLB Detection and MFW Isolation Function.

B.1

With both manual initiation switches inoperable or the Required Action and associated Completion Time of Condition A not met, the unit must be placed in MODE 3 within 12 hours and the main steam header pressure reduced to less than 700 psig or all MFCVs and SFCVs must be closed within 18 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required MODES from full power conditions in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.3.~~1~~26.1

This SR requires the performance of a CHANNEL FUNCTIONAL TEST to ensure that the channels can perform their intended functions. The Frequency of 18 months is based on engineering judgment and operating experience that determined testing on an 18 month interval provides reasonable assurance that the circuitry is available to perform its safety function, while the risks of testing during unit operation is avoided.

REFERENCES

1. IEEE-279-1971, April 1972.
2. 10 CFR 50.36.

B 3.3 INSTRUMENTATION

B 3.3.~~13~~27 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels

BASES

BACKGROUND

The six MSLB detection analog channels feed two redundant feedwater isolation digital channels consisting of two single failure proof two-out-of-three logic circuits. If the logic is satisfied, a master relay coil is energized. The use of an energized master relay ensures that a loss of power to the digital channels will not result in an inadvertent feedwater isolation. If either digital channel is actuated, an MFW isolation will occur. Energizing the master relay results in closure of contacts in various control circuits for systems and components used for the MSLB containment overpressurization protection. Therefore, when the master relay is energized, the systems and components perform their isolation functions. Other features of the 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. Each of the two two-out-of-three logic circuits, along with their associated enable switch, master relay, seal-in, and time delay is considered a feedwater isolation digital channel.

APPLICABLE SAFETY ANALYSES

MSLB circuitry is installed equipment necessary to automatically isolate main feedwater to both steam generators during a MSLB.

Steam generator outlet pressure is used as input to the MSLB circuitry for detection and feedwater isolation. When a MSLB is sensed, or upon manual actuation, the MFCVs and SFCVs will be closed to isolate the MFW flow paths to both steam generators. In addition, the MFW pumps are tripped. The TDEFW pump will be inhibited from auto-starting or will be auto-stopped if it has already started and the switch for MS-93 is in the AUTO position. A manual override for the TDEFW pump inhibit is provided to allow the operator to subsequently start the TDEFW pump if necessary for heat removal. All of these functions are credited for mitigating a MSLB inside containment.

The MSLB Detection and MFW Isolation logic channels satisfy Criterion 3 of 10 CFR 50.36 (Ref. 1).

BASES (continued)

LCO

Two channels of MSLB Detection and MFW Isolation automatic actuation logic shall be OPERABLE. There are only two channels of automatic actuation logic. Therefore, violation of this LCO could result in a complete loss of the automatic Function assuming a single failure of the other channel.

This LCO is modified by a Note which indicates the requirements are not applicable to a Unit after completion of the Automatic Feedwater Isolation System Modification on the respective Unit. This is necessary since the specification is no longer on the Unit's design after implementation of the modification.

APPLICABILITY

The MSLB Detection and MFW Isolation automatic actuation logic channels shall be OPERABLE in MODES 1 and 2, and MODE 3 with main steam header pressure ≥ 700 psig because SG inventory can be at a high energy level and can contribute significantly to the peak containment pressure during a secondary side line break. Also, during MODE 3, the MFW Isolation function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed since its function is already fulfilled. In MODES 4, 5, and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent.

ACTIONS

A.1

With one automatic actuation logic channel inoperable, the channel must be restored to OPERABLE status within 72 hours. The Completion Time of 72 hours is based on unit operating experience and administrative controls, which provide alternative means of MSLB Detection and MFW Isolation Function initiation via individual component controls. The 72 hour Completion Time is consistent with the allowed outage time for the components actuated by the MSLB Detection and MFW Isolation Function.

B.1, B.2.1, and B.2.2

With both logic channels inoperable or the Required Action and associated Completion Time not met, 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 or all MFCVs and SFCVs must be closed within 18 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required MODES from full power conditions in an orderly manner and without challenging unit systems.

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.3.~~13~~27.1

This SR requires the performance of a CHANNEL FUNCTIONAL TEST to ensure that the channels can perform their intended functions. This test verifies MFW Isolation automatic actuation logics are functional. This test simulates the required inputs to the logic circuit and verifies successful operation of the automatic actuation logic. The Frequency of 18 months is based on engineering judgment and operating experience that determined testing on an 18 month interval provides reasonable assurance that the circuitry is available to perform its safety function, while the risks of testing during unit operation is avoided.

REFERENCES

1. 10 CFR 50.36.

B 3.7 PLANT SYSTEMS

B 3.7.3 Main Feedwater Control Valves (MFCVs), and Startup Feedwater Control Valves (SFCVs)

BASES

BACKGROUND

The main feedwater isolation valves (MFIVs) for each steam generator consist of the MFCVs and the SFCVs. The MFIVs isolate main feedwater (MFW) flow to the secondary side of the steam generators following a high energy line break (HELB). The consequences of events occurring in the main steam lines will be mitigated by their closure. Closing the MFCVs and associated SFCVs valves effectively terminates the addition of feedwater to an affected steam generator, limiting the mass and energy release for steam line breaks (SLBs) inside containment and reducing the cooldown effects for SLBs. Closure of the MFCVs and associated SFCVs is also credited for a feedwater line break.

The MFIVs close on receipt of a MSLB detection signal generated by low steam header pressure. The MFIVs can also be closed manually.

APPLICABLE SAFETY ANALYSES

The design basis of the MFIVs is established by the containment analysis for the main steam line break (MSLB).

Failure of an MFIV to close following an MSLB, can result in additional mass and energy being delivered to the steam generators, contributing to cooldown. This failure also results in additional mass and energy releases following an MSLB.

The MFIVs satisfy Criterion 3 of 10 CFR 50.36 (Ref. 1).

LCO

This LCO ensures that the MFIVs will isolate MFW flow to the steam generators following a main steam line break.

Two MFCVs and two SFCVs are required to be OPERABLE. The MFIVs are considered OPERABLE when the isolation times are within limits and they close on a feedwater isolation actuation signal.

Automatic initiation instrumentation is not required to be OPERABLE in MODE 3 when main steam header pressure is < 700 psig in accordance with either LCO 3.3.11, "Automatic Feedwater Isolation System (AFIS) Instrumentation" or LCO 3.3.~~11~~ 25, "Main Steam Line Break (MSLB) Detection and Main

ATTACHMENT 3

TECHNICAL JUSTIFICATION

Attachment 3

Technical Justification

Background

A Main Steam Line Break (MSLB) is one of the design basis accidents described in the Updated Final Safety Analysis Report (UFSAR). One of the requirements placed on this accident is that only "accident mitigation systems" are assumed to function within the first 10 minutes of the accident. Originally, B&W showed through analysis that continued feedwater addition during this accident did not cause unacceptable reactor core response and that no steam generator (SG) tube failures were expected to occur. Recent analysis shows that little margin exists for securing Emergency Feedwater (EFW) within 10 minutes to ensure SG tube stresses are maintained within allowable values. These allowable values are set to establish tube plugging criteria such that tube flaw sizes and surveillances are not overly restrictive for continued operation of a complete fuel cycle. The tube stress analysis assumes that main feedwater (MFW) has been isolated by the existing MSLB circuitry. The MFW isolation portion of the existing MSLB circuitry does not meet the "protection system" standards as set forth in IEEE-279.

Operator action is currently credited to recognize and manually isolate flow to a faulted SG. Prompt response is required to quickly recognize the depressurized SG and isolate EFW flow to the SG in order to avoid undue thermal stress on SG tubes and EFW pump runout. The timing of operator actions has the potential to affect tube plugging criteria.

Presently, the only EFW pump that is automatically stopped following a MSLB is the turbine-driven emergency feedwater pump (TDEFWP). This action relies on a single, non-safety component. EFW continues to be supplied to the faulted SG from the motor-driven emergency feedwater pump (MDEFWP) until operator actions are taken. The EFW control valve may be closed or the MDEFWP may be stopped to isolate EFW to the faulted SG. The accident analyses assume EFW to the affected SG is isolated at 10 minutes.

The Instrument Air (IA) or Auxiliary Instrument Air (AIA) System is relied upon for stopping the TDEFWP. The single non-safety component that initiates the automatic stop

function relies upon compressed air to function. Compressed air is provided from the IA or AIA system. Neither IA nor AIA is safety-related.

The current MSLB circuitry does not provide SG header specific isolation or detection to enable EFW isolation to the affected SG.

A License Amendment Request (LAR) entitled Proposed Amendment to the Facility Operating License Regarding Methodology for Determining SG Tube Loads Following a Main Steam Line Break and Runout Protection for the Turbine Driven Emergency Feedwater Pump - TSC 99-01 dated April 26, 1999 has been submitted to the NRC for review and approval. TSC 99-01 addresses crediting the MSLB detection and Feedwater isolation instrumentation as an additional means for providing runout protection of the TDEFWP following a MSLB or MFW line break and the analytical details regarding the methodology for determining SG tube loads following a MSLB. AFIS will enhance the MSLB detection and Feedwater isolation instrumentation. Since the analysis presented in TSC 99-01 is bounding with respect to implementation of the AFIS modification, justification for SG tube loads will not be addressed in the AFIS LAR. TSC 99-01 is currently under review by the staff.

A proposed modification is being designed to implement an Automatic Feedwater Isolation System (AFIS). AFIS will provide automatic termination of EFW to a faulted SG, thereby eliminating manual operator action for isolating EFW flow to a faulted SG. The new circuitry conforms to IEEE-279 except as noted under the Design Criteria section. The new circuitry will replace the existing MSLB circuitry. The new circuitry will employ a 2 out of 4 logic to sense a faulted SG. Two conditions are used to indicate a faulted SG. The first condition involves a low Main Steam pressure, which will trip MFW and the TDEFWP. The second condition involves concurrent low Main Steam pressure and a high rate of depressurization, which will trip the MDEFWP on the faulted SG. Output from the new logic will provide double isolation of EFW to the faulted SG. MFW isolation will continue to be provided by the MFW block valves (EMOs) and the MFW Control Valves (AOVs) via the AFIS header-specific circuitry. EFW flow from the affected MDEFWP will be terminated by redundant automatic trip signals to the pump motor. EFW flow from the TDEFWP will be terminated by automatically closing the steam admission valve (MS-93) and automatically closing the turbine governor valve (MS-95). This modification will provide

automatic EFW pump runout protection and minimize the mass and energy release into containment following a secondary side pipe break. This modification will reduce the stresses on the faulted SG following a MSLB by preventing excessive temperature differentials caused by continued EFW flow.

Duke has placed a high priority on initiatives and modifications that result in reducing Operator burden. The AFIS modification will reduce the need for manual operator action to isolate EFW flow to a faulted SG.

This LAR addresses proposed TS for the modification that will automatically isolate EFW. The actuation logic will continue to actuate the same MFW components addressed by the MSLB Detection and MFW Isolation Circuitry TS. The acceptability of the MFW isolation approach for containment overpressurization was approved in Amendment 234, 234, 233 dated December 7, 1998.

The proposed revision to Technical Specifications (TS) will revise the TS and Bases sections of 3.3.11, 3.3.12 and 3.3.13 to reflect the analog, manual, and digital functions required for AFIS operation. These TS and Bases sections will not be applicable until the modification is implemented on the applicable Unit. Current MSLB TS and bases will be renumbered as TS and Bases sections 3.3.25, 3.3.26 and 3.3.27. These TS will be in effect until the modifications are completed on the applicable unit. When the modifications are implemented, TS and Bases sections 3.3.25, 3.3.26 and 3.3.27 can be removed from TS. The Bases section of 3.7.3 will be revised to reflect AFIS TS and MSLB TS number revision. TS and Bases section 3.3.24 is being added and designated as not used. It has been reserved for a LAR related to emergency power. This LAR will occur at a later date.

NRC approval of the proposed modification and technical specifications is required.

Modification Description

The proposed AFIS modification will replace the existing MSLB detection and MFW Isolation analog circuitry with two new redundant digital systems. The AFIS design upgrades the current 2 out of 3 logic of the MSLB circuitry to a 2 out of 4 logic on redundant control systems. The addition of the fourth channel will require installation of a new QA-1 SG pressure transmitter (PT) on each steam header. The

detection algorithm based on low steam pressure from the existing MSLB detection analog circuitry will be duplicated on AFIS to identify a MSLB, to trip MFW pumps and to stop the TDEFWP. The PT inputs and FDW valve isolation outputs are modified to be header-specific. Upon actuation, only the MFW block valves and MFW control valves on the affected header are closed. A new algorithm, which is based on high rate of depressurization, is added to the digital channel to provide a MDEFWP trip on the affected SG. The rate of depressurization algorithm allows AFIS to differentiate between MSLB events and other events such as ATWS or SBLOCA.

Hardware will be added to meet single failure criteria and to automatically isolate EFW to the affected SG. MDEFWP flow to the affected SG will be terminated by providing automatic trip signals via redundant trip coils in the motor breaker. TDEFWP flow will be terminated by providing automatic closure of MS-95 (turbine governor valve) in addition to the existing automatic closure of MS-93 (steam admission valve). The assured closure of MS-95 will require the installation of a QA-1 solenoid valve in the oil supply line to MS-95. The new solenoid valve will be powered from an independent power source, separate from that which supplies the MS-93 solenoid valve. The closure signals will continue to be generated from either SG header isolation signal. The non-safety valve and operator for MS-93 will be replaced with a QA-1 valve and actuator. A bottled nitrogen backup will be installed for MS-93 to ensure that the valve will close without assistance from the plant instrument air system. Valve MS-93 will fail open upon a loss of station air or power to the normally energized solenoid valve.

Normal/Test/Bypass mode status and header isolation Normal/Initiated status will be added to the Control Room Statalarms. All protective functions of AFIS will be designed as energize to trip. The failure mode of the digital system will be a non-actuated state. All diagnosed failures including loss of power, loss of input, and hardware failure will not result in a spurious actuation. It is postulated that an unlikely software failure could result in spurious actuation. However, rigorous verification and validation will be performed on the software as prescribed in the STAR Topical Report, BAW-10191P. Since the software is installed on EPROM (firmware), there is little probability of adverse affects by abnormal conditions and events during normal operation. The design of the STAR modules for AFIS are consistent with the designs that were subjected to EMI/RFI, power surge, seismic, and environmental

qualification testing as documented in the STAR Topical Report. In the unlikely event of spurious actuation, manual manipulation of EFW pump controls will override the AFIS trip signals. This design will support optimum EFW and MFW availability for emergency secondary cooling.

Modification Design:

Seismic criteria are applied to all AFIS components to prevent unintended actuation during a seismic event.

The use of a digital system for AFIS incorporates a scan time element, which slightly effects system response time compared to the analog MSLB Detection and FDW Isolation System. The affects of the scan time have been analyzed as acceptable for total system response time.

Design basis events that apply to the MSLB and MFW control circuitry will be affected. Design Basis Events and other events considered in the design include:

Main Steam Line Break

Operator action is currently credited to manually isolate flow from the MDEFWP for the mitigation of a MSLB event. The new circuitry will reduce this required operator action. A single PT or its instrument lines may be damaged by the MSLB. The resulting failure mode of the PT will actuate 1 of the 4 input channels of AFIS. However, the PT design is protected from inadvertent MS header interaction and from other high energy line breaks. For all large break MSLB events, AFIS will isolate the depressurized SG upon reaching the low pressure and rate of depressurization setpoints for SG tube-to-shell differential temperature limit protection. For smaller breaks, the rate of depressurization setpoint may not be exceeded. For these smaller breaks, manual operator action is relied upon to terminate motor-driven emergency feedwater (MDEFW) to the depressurized SG prior to exceeding tube stress limits.

A single failure of EFW to the unaffected steam generator after AFIS has isolated EFW to the affected steam generator will require manual operator restoration of EFW.

For the bounding large MSLB inside containment, AFIS will automatically isolate all MFW and EFW to the depressurized SG to prevent exceeding containment pressure design limits. The AFIS modification will eliminate manual operator action for

the isolation of MDEFW flow to the faulted SG to prevent containment overpressurization. The current stroke time limits of the MFW control valves will be maintained. The MFW isolation components are not changed. MFW valves are designed for header-specific isolation.

Main Feedwater Line Break

For breaks downstream of the MFW isolation check valves (FDW-37, -46), manual operator action is currently credited for pump runout protection, primary system overcooling protection, and protection from flow induced vibration of the SG tubes. If the break occurs downstream of the MFW isolation check valves, AFIS logic will actuate to prevent FDW flow to the faulted header. Duke has determined that the results of large MFW line breaks downstream of the isolation check valves (FDW-37, -46) are similar to MSLB events. For breaks inside containment, SG tube-to-shell differential temperatures and containment pressure are bounded by the MSLB event. The AFIS logic will actuate, resulting in isolation of FDW and stopping of the TDEFWP, upon FDW line rupture downstream of the isolation check valves. The MFW isolation valve stroke times are bounded by the MSLB event. Breaks upstream of the isolation check valves will not result in a depressurized SG. Therefore, AFIS is not required to actuate.

A single failure of EFW to the unaffected SG after AFIS has isolated EFW to the affected SG will require manual operator restoration of EFW.

Loss of MFW With or Without Offsite Power Available

EFW Valves will remain open and EFW pumps will not be inhibited from starting. The AFIS circuitry will not actuate during this event.

Loss of All AC Power (Station Blackout). The Standby Shutdown Facility (SSF) is the mitigation method for Station Blackout. MFW is lost during this event. The TDEFWP is designed to operate without the need for AC power. The AFIS circuitry will not actuate in this event to cause a loss of the TDEFWP or the flowpath to the SG's.

Loss of Coolant Accident (LOCA). Some small break LOCA events require EFW to promote heat transfer and to provide for an orderly cooldown of the reactor coolant system. EFW injection to reach the required SG level setpoint can cause

SG depressurization. However, plant procedures contain guidance to throttle EFW while SG level is increasing in order to prevent excessive RCS overcooling which limits SG depressurization. The throttling of EFW should preclude exceeding the AFIS rate of depressurization setpoint. In the event that AFIS actuates and causes a MDEFWP trip during the small break LOCA event, manual restoration of EFW is required. Single failure criteria apply.

Justification for the LOCA event is provided in the No Significant Hazards Consideration located in attachment 4.

Anticipated Transient Without Scram (ATWS). This event (beyond design basis event) is mitigated by the Diverse Scram System (DSS) shutting down the reactor and by the ATWS Mitigation System Actuation Circuitry (AMSAC) tripping the main turbine and actuating the EFW System. SG depressurization below the AFIS low pressure setpoint should not occur, and thus AFIS will not actuate. Consideration of a single failure or seismic event is not required. Since AFIS trips the MFW pumps and AMSAC actuates EFW upon loss of MFW, an AFIS interlock is provided in the MDEFWP switchgear controls to inhibit EFW pump starts due to AMSAC actuation.

Loss of All Feedwater

The plant response to a total loss of MFW and EFW (beyond design basis event) can result in SG depressurization and approach the AFIS setpoint. It is unlikely that the decreasing pressure rate component of the setpoint will be exceeded. Regardless of AFIS actuation, manual operator restoration of EFW is required.

Turbine Bypass System Failure

For events which cause both SGs to depressurize (e.g. all turbine bypass valves open), AFIS may actuate on both SGs. This would require manual operator restoration of EFW.

Accident Analysis:

An accident analysis model was used in the development of the AFIS algorithm which detects a MSLB event. This algorithm was then evaluated for other events (SBLOCA, reactor trip, loss of FDW, and ATWS) to confirm the distinguishing characteristics of a MSLB. The proposed AFIS circuitry is designed to discriminate between severe overcooling events

(such as MSLB) and other events to minimize the possibility of isolating EFW for events where continued EFW flow is required. The SG tube stress analysis determines the maximum blowdown rate to prevent tube failures. The results indicate that small steam line breaks will not exceed tube stress limits or containment pressure limits within 10 minutes. Therefore, manual operator action is credited for mitigating small steam line break events. The rate of depressurization and low SG pressure setpoints will be based on large steam line breaks.

If a loss of subcooled margin occurs during a MSLB event, the reactor coolant pumps are tripped by manual operator action. Once the reactor coolant pumps are tripped, SG level is automatically raised to the natural circulation setpoint. The operators then manually raise SG level to the loss of subcooled margin setpoint. After AFIS actuation has isolated all MFW and EFW to the depressurized SG, the unaffected SG can continue to depressurize due to reverse heat transfer and delivery of EFW to raise SG level to the required setpoint. However, plant procedures contain guidance to throttle EFW while SG level is increasing in order to prevent excessive RCS overcooling which limits SG depressurization. The throttling of EFW should preclude exceeding the AFIS rate of depressurization setpoint in the unaffected SG. In the event that AFIS actuates and causes the isolation of MDEFW flow to the unaffected SG, manual restoration of EFW is required. The AFIS circuitry will be manually disabled when main steam pressure is below 700 psig. Manual operator action is credited for the mitigation of a MSLB when the AFIS circuitry is disabled. The plant is operated with main steam pressure less than 700 psig only during startup and shutdown evolutions. These evolutions are very short in duration. Therefore, the probability of a MSLB event occurring at these conditions is sufficiently small that an explicit analysis is not performed at these conditions.

Validation of the conceptual design of AFIS has been performed on the plant simulator. The simulation model included the MSLB detection algorithm and equipment actuations. The results demonstrate proper plant response to numerous events including large MSLB, small MSLB, and SBLOCA. Similar validation efforts will be performed on the Framatome prototype software design. Rigorous validation will be performed on the final system design using the plant simulator prior to plant implementation.

Modification Equipment:

The existing analog MSLB modules in Steam Generator Level Control (SGLC) cabinets will be replaced with a new QA-1 digital system with dual train redundancy. Framatome Safety Star Modules will be used. System actuation requires 2 out of 4 logic. Tripping MFW and isolating steam to the TDEFWP is triggered by a low SG pressure setpoint (550 psig) on either header. Header-specific closure of MFW valves is based on low pressure on the affected header. The header-specific MDEFWP trip is triggered by a low SG pressure setpoint (550 psig) concurrent with a high rate of depressurization. The setpoints for the MDEFWP trip will be indicative of a faulted SG or other severe overcooling event. The System will allow user definable low pressure setpoints and rate of depressurization setpoints. The System will provide analog signal isolation between each safety channel and between safety-to-non-safety interfaces. Each channel will be mounted in a seismically qualified card rack in the existing SGLC cabinets.

MSLB test panels will be removed and Analog Test Switches and test jacks will be installed on a new panel. The hardware in the SGLC cabinets will be grouped by safety channel. The current MSLB Detection and Mitigation control board switches will be modified to provide header specific enable, disable, and initiate switches. The same AFIS Enable/Disable switch will reset the low pressure and the rate of depressurization trips, as well as provide the manual bypass function. The control board overlay will be updated.

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

QA-1 power to a QA-1 solenoid valve in the oil supply to MS-95 will be provided. Upon a MSLB on either SG, the solenoid valve will energize to block the oil supply to MS-95. Power for the solenoid valve will be provided from a diverse source than the MS-93 power supply.

The EFW Low SG Level initiate circuit will not be capable of starting the affected MDEFWP while AFIS has actuated. Manual control of the MDEFWPs will override AFIS when the pump control switch is placed in RUN.

The isolation signals to MFW valves will be modified to actuate on header-specific signals.

Statalarms will be added to provide indication of header-specific isolation, channel bypass, or channel test.

The changes made to the control room will be duplicated on the Operations simulator.

The rate of depressurization function is armed when MS pressures are less than 800 psig. This is to prevent rate of depressurization trips during plant response to other scenarios such as LOCA and reactor trip.

Instrument Changes:

Two new QA-1 SG PT's will be added and powered from safety-related panelboard KVID for each MS line to become the fourth channel of inputs into the new circuitry. The PT's will be seismically mounted in the turbine building. QA instrument tubing for the SG PT's will be analyzed for seismic interaction. Seismic criteria are applied to prevent inadvertent AFIS actuation during a seismic event. The new and existing PT's in the turbine building will also be protected from other high energy line breaks besides MSLB events. Four new instrument root valves will be added. QA stainless steel instrument tubing for MS-93 pneumatics will be added. The PT's require new OAC analog inputs. QA/non-QA isolation is required.

Mechanical Changes:

MS-93 will be replaced with a QA-1 valve and operator. New backup nitrogen bottles with regulators and check valves will be installed near MS-93 to credit valve closure without the use of non-safety air systems. Each MS header in the turbine building will require new QA-1 instrument taps. A new QA-1 solenoid valve (fail-open) and associated piping will be added to MS-95.

Civil Changes:

The hydraulic oil solenoid valve on MS-95 will require support. Hangers will require revision for the solenoid valves on MS-93. Mounts will be required for the new MS PT's. A QA-1 nitrogen bottle rack is required. Instrument tube supports are required. New nitrogen tubing and supports and the upgrade of existing supports are required to support new stainless steel tubing.

Design Criteria:

The AFIS is to be designed as a new QA-1, protection system and will conform to IEEE-279 with the following exceptions and clarifications:

- 4.12 - Operating Bypasses: AFIS will not be provided with an automatic means of removing the bypass feature when bypass conditions are not met. A manual bypass feature is provided. Since Main Steam pressure signals are used for system actuation and system bypass, administrative control is preferred.
- 4.13 - Indication of Bypasses: Indication of the bypass condition (DISABLE) will be indicated on the OAC and the annunciators which are not QA-1 systems.
- 4.14 - Access to Bypass: Credit is used for procedural control, limited control room access, and/or key switches to limit access to the means of achieving bypass.
- 4.19 - Identification of Protective Actions: Indication of protective actions will be available on the OAC and the annunciators which are not QA-1 systems. Indication of protective actions are also available by monitoring EFW flow instrumentation and FDW flow instrumentation.

10 CFR Part 50 Appendix A General Design Criteria For Nuclear Power Plants provides design requirements for Systems. The principal design criteria for Oconee were developed in consideration of 10 CFR Part 50 Appendix A and were issued in 1967. As such, the general design criteria of 10 CFR Part 50 Appendix A do not apply. The general design criteria for Oconee are specified in Section 3 of the Oconee Updated Final Safety Analysis Report (UFSAR). The general design criteria that will be affected by the AFIS modification are described and discussed below.

UFSAR Criterion 19, Protection Systems Reliability (Category B) states that Protection Systems shall be designed for high functional reliability and in-service testability commensurate with the safety functions to be performed. The

protection systems design meets this criterion by specific instrument location, component redundancy, and in-service testing capability. The major design criteria stated below have been applied to the design of the instrumentation.

1. No single component failure shall prevent the protection system from fulfilling their protective function when action is required.
2. No single component failure shall initiate unnecessary protection system action, provided implementation does not conflict with the criterion above.

Test connections and capabilities are built into the protection system to provide for:

1. Pre-operational testing to give assurance that the protection systems can fulfil their required functions.
2. On-line testing to assure availability and operability.

The AFIS circuitry will meet this criterion by specific instrument location, component redundancy, and in-service testing capability. No single component failure will prevent the protection system from fulfilling its required function when action is required. No single component failure will initiate unnecessary protection system action, provided implementation does not conflict with the criterion above. Test connections and capabilities will be built into the protection system to provide for pre-operational testing to give assurance that the protection systems can fulfil their required functions and on-line testing to assure availability and operability.

UFSAR Criterion 20 - Protection Systems Redundancy and Independence - Redundancy and independence (separation) shall 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. All protection system functions are implemented by redundant sensors, instrument strings, logic, and action devices that combine to form the protection channels. Protection channels and their associated elements are electrically independent and packaged to provide physical separation and mutual redundancy.

All AFIS protection system functions will have redundant sensors, instrument strings, logic, and action devices that combine to form the protection channels. Redundant protection channels and their associated elements will be electrically independent and packaged to provide physical

separation. To achieve separation of AFIS actuation functions, the mutually redundant isolation functions will be separated between the two trains of actuation logic. The FTI Safety STAR employs diverse software to mitigate software common-mode failure concerns.

UFSAR Criterion 21 - Single Failure Definition - The instrumentation is designed so that a single event (i.e., seismic, turbine missiles, HELB, pipe whip) cannot result in multiple failures that would prevent the required protective action.

The instrument inputs will be protected from high energy line breaks other than MSLB events to prevent failures that result in AFIS actuation. A single PT may fail from MSLB pipe whip or jet impingement; however, the resulting failure mode will enable proper operation of the AFIS logic. All of the AFIS equipment will be designed for seismic events and protected from seismic interaction. Protection from turbine missiles will not be required. Turbine missiles could cause spurious actuation of AFIS. However, the portions of EFW and MFW that are affected by AFIS are not required to mitigate this event.

For the purpose of this submittal, it is assumed that a turbine missile can cause a MSLB. Two channels of AFIS transmitters are located inside containment, which is protected from missiles. Therefore, AFIS is capable of detecting a MSLB caused by turbine missiles. This assumes 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 AFIS are physically separated from MS lines, it is unlikely, that the turbine missiles which cause the MSLB, will disable the ability to terminate flow to the steam generators. Moreover, the failure modes of all pumps and switchgear are in the tripped state.

UFSAR Criterion 22 - Separation Of Protection And Control Instrumentation System - Protection Systems shall 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. The protection systems input channels are electrically and physically independent. Shared instrumentation for protection and control functions

satisfies the single failure criteria by the employment of isolation techniques to the multiple outputs of various instrument strings.

The AFIS protection systems input channels will be electrically and physically independent. Shared instrumentation for protection and control functions will satisfy the single failure criteria by the employment of isolation techniques to the multiple outputs of various instrument strings.

Qualified devices will be installed to provide electrical isolation between safety and non-safety related functions of AFIS.

UFSAR Criterion 23 - Protection Against Multiple Disability For Protection Systems - 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, shall not result in a loss of the protection function.

AFIS components must operate in the steam environment following a MSLB. The Protection Systems are designed to extreme ambient conditions. AFIS instrumentation will operate from 40 deg. F to 140 deg. F and sustain Reactor Building environmental conditions resulting from a LOCA, including 100 percent humidity, without loss of operability. The instrumentation will be subject to environmental testing as required by IEEE-279. Equipment outside of the Reactor Building is designed for continuous operation in an ambient temperature and relative humidity representative of LOCA conditions. The failure of a PT due to a MSLB results in a trip of a single analog channel.

UFSAR Criterion 24 - Emergency Power For Protection Systems - 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.

Each channel of AFIS will be powered by separate sources of the Vital AC and DC Instrument and Control Power System which is independent of off-site power.

UFSAR Criterion 25 - Demonstration of Functional Operability of Protection Systems - Means shall be included for testing Protection Systems while the reactor is in operation to demonstrate that no failure or loss of redundancy has

occurred.

Test circuits are supplied which utilize the redundant, independent, and coincidence features of the Protection System. This will enable manual control of on-line trip signals in any single protection channel for testing the trip capability in each analog channel without affecting the other channels.

UFSAR Criterion 26 - Protection Systems Fail-Safe Design - The Protection System shall be designed to fail into a safe state or into a state established as tolerable on a defined bases if conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air), or adverse environments (e.g., extreme heat or cold, fire, steam, or water), are experienced.

The design of AFIS can properly operate in the event of a loss of power. AFIS will not spuriously actuate upon loss of power. This single failure proof design of the AFIS channels will assure proper operation in the event of a failed power source and adverse environmental conditions.

There are no postulated failures related to the disconnection of the system, loss of energy, or adverse environmental conditions.

AFIS is designed to fail in a non-tripped state as a result of a single failure to maintain the licensing basis of EFW.

Functional Criteria

Train redundancy for AFIS is accomplished by Digital Channel 1 which involves MDEFWP switchgear trip channel 1 plus MS-95 oil trip isolation and by Digital Channel 2 which involves MDEFWP switchgear trip channel 2 plus MS-93 closure. Successful actuation of either digital channel satisfies the EFW isolation requirements. Each digital channel of AFIS shall provide control outputs to common MFW valves to isolate flow to the affected SG.

Time response - MDEFW will be isolated within the time response assumption of the analyses. The MFW and TDEFW isolation response time requirements for containment overpressure protection will remain unchanged.

Operations will be capable of manually initiating EFW flow to

any SG from the control room following actuation of AFIS. Manual control of the TDEFWP and of the MDEFWP will be diverse and independent of AFIS circuitry. Manual starting of the MDEFWP will override the AFIS signal.

The new PT's are designed to survive the MSLB steam environment. Potential failures of the sensing tubes due to MSLB result in acceptable low pressure failure modes. Manual control switches and associated cabling for the TDEFWP and MDEFWP are physically separated from the MS PT's. Therefore, manual control of EFW will provide defense-in-depth for a high energy line break which causes a potential loss of MS pressure sensing lines coupled with a single failure.

The AFIS actuates following a main steam line break or main feedwater line break that causes an uncontrolled blowdown of the SG.

The AMSAC EFW pump start shall be inhibited following an AFIS actuation. An ATWS event is mitigated by the DSS shutting down the reactor and by the AMSAC tripping the main turbine and actuating the EFW System. SG depressurization below the AFIS low pressure setpoint should not occur, and thus AFIS will not actuate during an ATWS event.

The rate of depressurization portion of the AFIS detection algorithm is designed to discriminate a small break LOCA from an overcooling event such as a MSLB. However, SG depressurization can occur during the filling of the SGs with EFW to reach the required SG level setpoint. Operator action to throttle EFW should preclude exceeding the AFIS rate of depressurization setpoint. In the event that AFIS actuates and causes a MDEFWP trip during the small break LOCA event, manual restoration of EFW is required. Seismic criteria are applied to all AFIS components (including the main steam PT and their impulse lines) to prevent unintended actuation during a seismic event.

Framatome Safety Star Module:

The AFIS modification installs a digital protection system using the Framatome Safety STAR Module, discussed in Topical Report BAW-10191P and previously approved for generic use in safety related systems in an NRC Safety Evaluation dated August 3, 1995. Installation prerequisites listed in Section 6.0 of the Topical Report and section 5.0 of the NRC Safety Evaluation have been met with the exception that AFIS is designed to fail in the non-tripped state. AFIS is energized

to trip, which meets the non-fail safe requirements of the AFIS design. The redundancy and diversity of the STAR module architecture is consistent with the Framatome Topical Report. The AFIS STAR modules will maintain the self-diagnostic features. The design of the Framatome Safety STAR modules is being modified to fit the non-fail safe watchdog timer functions as described in the Framatome Topical Report.

Topical Report BAW-10191P

Section 6.0 Installation Prerequisites

Digital upgrades to protection systems using the STAR hardware described herein require review of several matters to ensure safe implementation. Therefore, the proposed digital upgrades shall meet the following criteria:

1. The use of the STAR System components shall be restricted to the protection function channels portion of the RPS as described in Section 2.1.2 or applications with similar interface requirements.

   AFIS is a logic protection system similar to RPS. The new circuitry will replace the existing Main Steam Line Break (MSLB) circuitry. The new circuitry will employ a 2 out of 4 logic to sense a faulted SG. Two conditions are used to indicate a faulted SG. The first condition involves a low Main Steam pressure, which will trip MFW and the TDEFWP. The second condition involves concurrent low Main Steam pressure and a high rate of depressurization, which will trip the MDEFWP on the faulted SG. Output from the new logic will provide double isolation of EFW to the faulted SG. MFW isolation will continue to be provided by the MFW block valves (EMO's) and the MFW Control Valves (AOV's), but the AFIS circuitry will make the isolation header specific. EFW flow from the affected MDEFWP will be terminated by redundant automatic trip signals to the motor. EFW flow from the TDEFWP will be terminated by automatically closing the steam admission valve (MS-93) and automatically closing the turbine governor valve (MS-95).

2. No changes to TS are required as a result of the upgrade. If TS changes are required, they must be reviewed by the NRC.

AFIS requires submittal of new TS. AFIS is considered an enhancement to the MSLB detection and feedwater isolation circuitry. Duke is submitting this LAR for NRC review and approval.

Section 6.1 System Design, Reviews and Analyses Prior to Installation

Section 6.1.1 System Requirements Specification

The design requirements 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.

Procurement specification OSS-0311.00-00-0011, Automatic Feedwater Isolation System - STAR Module Specification was written, reviewed, approved and submitted to Framatome. OSS-0311.00-00-0011 provides the design, material, software, quality assurance, documentation, testing and inspection requirements for the digital protection system. The specification has been included in the LAR as attachment 7. Duke is actively involved with Framatome in the development stages of the digital protection system. Duke will also be actively involved in system validation.

Section 6.1.2 Interface Requirements Review (NRC SER Section 5, #1)

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 which can be imposed on the circuit. Loads on analog and discrete outputs shall be verified to be within the specified STAR System components output load handling capacities.

Analog Input Interfaces:

All analog inputs AIN1, AIN2, AIN3 and AIN4 are derived from

Rosemount 1154 transmitters with a 4-20 mA output across a 250 ohm resistor to provide a valid 1-5 volts input signal to the Analog Voltage Isolation Modules (AVIM). The AVIM supplies the isolated analog inputs to the STAR modules. The valid range from the remaining spare analog inputs is 0 to 10 volts. Low pass filtering of the input signals may be performed by hardware or software.

Digital Input Interfaces:

The supplied input devices are safety grade relay and control switch contacts. The software will be interfaced with the pushbuttons on the STAR module front plate. The software will determine the state of the contacts by voltage presence. Front panel pushbuttons will be used to manually disable an inoperable channel. The corresponding LEDs will illuminate and flash and be used to indicate an input channel being tripped or bypassed, respectively. The same pushbutton shall be used to reset the manually tripped channel and extinguish the LED. A remote pushbutton will reset the rate of depressurization latch.

Analog Output Interfaces:

The AFIS control scheme does not require any analog outputs from the STAR modules. The unused analog outputs shall be set to zero volts with an available signal range from 0 to 10 Volts. Outputs shall remain at 0 VDC for calculated outputs of less than 0 VDC and at 10 VDC for calculated outputs of greater than 10 VDC.

Digital Output Interfaces:

Digital trip outputs from the STAR module shall interface with standard industrial relays to perform the required trip functions. Upon detection of a MSLB event, the trip output contacts shall close. The trip output contacts shall remain open for all other conditions including loss of power and detected failures. The trip output contact ratings have been upgraded to 125 VDC.

The auxiliary digital outputs shall open in the normal state and close in the logic true state to provide non-safety related status indication. The auxiliary output contacts shall remain open for all other conditions including loss of power and all detected failures.

The processor status digital outputs will close to provide

module operability monitoring upon detection of processor failure, loss of power, and module boot-up. The status outputs shall be open for normal operating conditions.

The keyswitch status contacts are to be provided for indication on the plant computer of testing and tuning conditions. Operation of the Keyswitch should disable the trip outputs and enable the test inputs of the module as required.

Section 6.1.3 Licensing Bases Impact Analysis
(NRC SER Section 5.0, #2)

The licensee shall verify that the intended upgrade meets the plant licensing bases 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.

The design of the STAR system satisfies the existing requirements of the MSLB Detection and Feedwater Isolation System The AFIS requirements are new to the SAR and require review and approval by the NRC. The functions of the STAR system comply with the conceptual design requirements for AFIS.

Section 6.1.4 Power Supply Loading Analysis
(NRC SER Section 5.0, #3)

The user shall review the loading of the 15 volt DC 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 maximum load of the STAR system components and any margins established by the licensee.

The 15 VDC power supply used by AFIS is custom designed and sized for the application including maximum temperature deratings.

Section 6.1.5 Cabinet Heat Rise Analysis
(NRC SER Section 5.0, #4)

Cabinet heat rise is proportional to power supply loading. If the 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.

Maximum worst case cabinet electrical loads and worst case control room ambient temperature shall be taken into account.

The total heat loads of the AFIS cabinet were calculated with the addition of the STAR hardware and additional electrical components. The total internal heat generated within the cabinet is estimated to be 425 W. Using natural convection formulas in calculation OSC-6869, the projected internal cabinet temperature was calculated to be less than 85°F. This is well below the maximum temperature limit for the STAR module and other components located in the AFIS cabinet.

Section 6.1.6 Quantification of EMI and RFI Environmental Levels
(NRC SER Section 5.0, #5)

The worst case levels of conducted and radiated emissions from equipment in the vicinity of AFIS 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 AFIS 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 they fall below the qualified levels for the STAR system components, or that measures are in place to prevent their effects from impacting the protection functions of AFIS.

The STAR components are qualified for operation in EMI/RFI field strengths of 10 V/m over a frequency range of 0.15 - 1000 Mhz. 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 study conducted for the NRC from November, 1994 to January, 1995. Therefore, the EMI/RFI fields associated with the AFIS installation environment are well within the design limits of the STAR system.

Section 6.1.7 Quantification of Gamma Radiation TID
(NRC SER Section 5.0, #6)

An analysis shall be performed to verify that the total integrated dose from background radiation will not exceed the

qualified level for the STAR Module and SBIM.

The analysis for the 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 SBIM. The TID for the location of the STAR Module and SBIM will be <1E3 Rads. Therefore, the TID will not exceed the qualified level for the STAR Module and SBIM.

Section 6.2 Installation Phase Actions

Section 6.2.1 Grounding Inspection (NRC Section 5.0, #7)

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.

The design of the grounding system in the AFIS cabinets is consistent with the design of the RPS cabinets. Post-modification testing includes verification of grounding system continuity including bond connections and signal cable shields.

Section 6.3 Actions Prior to Operation (NRC SER Section 5.0, #8)

After the modification is installed and with the cabinets powered up, the following verifying measurements shall be made.

Section 6.3.1 Measurement of Power Supply Loads

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 section 6.1.4.

Power supply loads will be measured and compared to performance specifications during post-modification testing.

Section 6.3.2 Measurement of Cabinet Heat Rise

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 per section 6.1.5.

Cabinet heat rise will be measured and compared to performance specifications during post-modification testing.

Section 6.3.3 Measurement of Power Supply DC Voltage

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 instruction manual.

The stability and ripple of the 15 VDC power supply will be measured and compared to performance specifications during post-modification testing.

Section 6.3.4 was deleted from the topical report.

Section 6.3.5 Controls on Use of Walkie-Talkies in Control Room (NRC SER Section 5.0, #9)

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.

AFIS circuitry will be located in Oconee's cable room. This area 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.

Section 6.3.6 Controls on Access to STAR Module Mode Selector Key (NRC SER Section 5.0, #10)

Controls shall be established over the access to STAR Module mode selector keylock switch keys to prevent unauthorized alteration of setpoints.

A keylock switch is provided on the module front panel for

administratively controlling 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.

Section 6.3.7 Maintenance Procedures for ESD (NRC SER Section 5.0, #11)

Procedures shall be established and personnel trained in the handling of STAR system components to protect them against electrostatically induced damage. These procedures shall meet the requirements specified in the STAR instruction manual.

Maintenance procedures for ESD are established and will be employed for maintenance handling of STAR modules.

Section 6.3.8 Calibration, Tuning and Testing Procedures (NRC SER Section 5.0, #12)

Existing procedures for the performance of surveillance interval maintenance activities, including calibration, tuning and trip accuracy testing of the AFIS channels shall be updated to incorporate the use of the Calibration and Test Computer for testing the upgraded channels containing STAR Modules.

Calibration, Tuning, and Testing procedures will be written to perform the required surveillance functions per the technical specifications.

NRC SER Section 5.0, #13 - The licensee shall provide adequate training for maintenance and operational personnel that will be utilizing the STAR System.

Plant personnel have been trained on STAR maintenance and operational procedures for the RPS and ICS systems. They will also be trained in this application. The Operations interface will be through the control board. There will be no burden in responding to an event. Operations may be required to take manual actions to return AFIS to service following a spurious event. Specific training will be provided to operations for manual recovery efforts from spurious events. This will be done as a part of implementation.

NRC SER Section 5.0, #14 - The licensee shall compare STAR System hardware qualifications to the actual plant requirements to ensure the qualification levels in BAW-10191P envelope the plant specific requirements for normal operation and worst case postulated accident conditions for temperature, humidity, and seismic conditions. Radiation, electro-magnetic compatibility, and radio frequency interference prerequisites are discussed above.

This information is provided in the procurement specification in attachment 7.

Probablistic Risk Assessment (PRA)

The addition of the AFIS is expected to have little impact on the Oconee PRA results. The design basis accidents whose response is expected to improve as a result of this system have not been evaluated as risk significant; further reduction in their frequency is not expected to lower the estimated core damage frequency for Oconee. Additionally, the expected high reliability of a digital control system with 2 out of 4 actuation logic, would not be expected to negatively influence the EFW reliability for other accident scenarios.

Updated Final Safety Analysis Report (UFSAR) Summary

Changes to the UFSAR will be required to support this modification. The following sections will be potentially affected and changes will be pursued under 10CFR 50.71(e):

3.1 Conformance with NRC General Design Criteria
3.9 Mechanical Systems and Components
Appendix 3 Chapter 3 Tables to Table 3-68 Page 7 of 7, Electrical Equipment Seismic Qualification.
5.2 Integrity of Reactor Coolant Pressure Boundary
6.2 Containment Systems
7.4 Systems Required for Safe Shutdown
7.5 Display Instrumentation
7.9 MSLB Circuitry
8.3 Onsite Power Systems
10.1 Summary Description
10.3 Main Steam System
10.4 Other Features of Steam and Power Conversion System
15.13 Steam Line Break Accident
16.10.5 MSLB Feedwater Isolation Features

Description of the Technical Specification Change

Attachment 1 provides the proposed TS pages. Attachment 2 provides a mark-up of the applicable TS pages. The proposed changes to the TS for Oconee Nuclear Station are described and justified below.

Copies of the following TS will be relocated to the end of TS section 3.3 and renumbered to 3.3.25, 3.3.26 and 3.3.27, respectively:

3.3.11 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Instrumentation.
3.3.12 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Instrumentation.
3.3.13 Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels.

This is a logistics change. The MSLB Detection and MFW Isolation Instrumentation Specifications will be removed from the TS when the Automatic Feedwater Isolation System (AFIS) is implemented on all three units.

TS and TS Bases 3.3.24 is being added to the TS. It is being designated as not used. It will be used for a future LAR related to Emergency Power.

<u>Revision Of TS 3.3.11, Automatic Feedwater Isolation System (AFIS) Instrumentation</u>

The title of TS 3.3.11 will be revised from Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Instrumentation to Automatic Feedwater Isolation System (AFIS) Instrumentation.

TS Limiting Condition of Operation (LCO) 3.3.11 currently requires that three MSLB Detection and MFW Isolation instrumentation channels per steam generator be OPERABLE. Duke proposes to revise the LCO to state that four AFIS instrumentation channels per steam generator shall be OPERABLE. The LCO is also modified by a NOTE that states that the TS is not applicable on each Unit until after completion of the AFIS modification on the respective unit.

The APPLICABILITY for MSLB detection and MFW isolation instrumentation are currently Modes 1 and 2, and Mode 3 with main steam header pressure ≥ 700 psig except when all main feedwater control valves (MFCVs) and startup feedwater

control valves (SFCVs) are closed. Duke proposes to delete the exception for Mode 3. The LCO will be required in Modes 1 and 2, and Mode 3 with main steam header pressure ≥ 700 psig.

The ACTIONS are modified by a Note that currently indicate that this is a MFW isolation function. Duke proposes to remove this reference.

CONDITION A currently requires that one or more MFW isolation functions with one channel inoperable be placed in trip within 4 hours. Duke proposes to revise CONDITION A to state one analog channel inoperable or tripped shall be placed in bypass within 4 hours.

CONDITION B currently states that one or more MFW isolation functions with two or more channels inoperable, or Required Action and associated Completion Time not met must be in mode 3 within 12 hours and reduce main steam header pressure to < 700 psig within 18 hours or close all MFCVs and SFCVs within 18 hours. Duke proposes to modify CONDITION B to state two analog channels inoperable, or the Required Action and Associated Completion Time of CONDITION A not met, restore channel(s) to operable status within 72 hours.

Duke proposes to add a separate condition entry C which requires that if the required action and completion time is not met for CONDITION B, then, be in Mode 3 within 12 hours and reduce main steam header pressure to < 700 psig within 18 hours.

TS Surveillance Requirement (SR) 3.3.11.2 currently contains a Note that allows for online testing. Duke proposes to delete the Note.

<u>Technical Justification for Revisions to TS 3.3.11, Automatic Feedwater Isolation System (AFIS) Instrumentation</u>

The title of TS 3.3.11 will be retitled Automatic Feedwater Isolation System (AFIS) Instrumentation. AFIS is the new system that replaces the MSLB detection and MFW Isolation Instrumentation.

The LCO requires that instrumentation necessary to initiate Feedwater (FDW) isolation be OPERABLE. Four channels are required to be OPERABLE to ensure that no single failure prevents FDW isolation and that the reliability of the function is not diminished.

The LCO is modified by a Note which allows the requirements of the specification to be applicable to a Unit after completion of the AFIS modifications on each respective Unit.

The APPLICABILITY states that the AFIS function shall be OPERABLE in Modes 1 and 2, and Mode 3 with main steam header pressure ≥ 700 PSIG because SG inventory can be at a high energy level and contribute significantly to the peak pressure with a secondary side break. Once the SG pressures have decreased below 700 PSIG, the AFIS function can be bypassed to avoid actuation during normal unit cooldowns. In Modes 4, 5 and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent. The primary system temperatures are also low to allow the SG to effectively remove energy and AFIS is not required to be operable. The AFIS circuitry will be manually disabled when main steam pressure is below 700 psig. Manual operator action is credited for the mitigation of a MSLB when the AFIS circuitry is disabled. The plant is operated with main steam pressure less than 700 psig only during startup and shutdown evolutions. These evolutions are very short in duration.

The ACTIONS are modified by a Note that currently indicate that this is a MFW isolation function. Duke proposes to remove this reference. This reference is provided for a multi-functional system. AFIS provides a feedwater isolation function only.

CONDITION A of TS 3.3.11 states that if one channel is inoperable or tripped then that channel can be bypassed within 4 hours. AFIS requires four channels be operable. Bypassing one channel will not prevent AFIS from performing its intended function. It will place the logic in a two-out-of-three configuration. Operation in this configuration may continue indefinitely since AFIS is still capable of performing its isolation function in the presence of any single random failure. Based on operating experience, the completion time of four hours is adequate to perform Required Action A.1. There is minimal risk for operating 4 hours with one channel tripped based on the low probability that another channel will trip within that time frame.

CONDITION B of TS 3.3.11 states that if two AFIS channels are inoperable, then the channel has to be returned to operable status within 72 hours. Four AFIS channels are required for operability. Two inoperable channels will decrease AFIS functionality. It will also place the logic in a two-out-of-

two configuration. Also, if the Required Action and Completion Time of Condition A cannot be met, then the channel must be returned to service within 72 hours. Based on operating experience, 72 hours is a reasonable time period for returning the channel to service.

CONDITION C requires that the Required Action and Associated Completion Time of Condition B be met or it places the Unit in Mode 3 in 12 hours and reduces the main steam header pressure to < 700 PSIG within 18 hours. The allowed completion time is reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems

The Note that states that SR 3.3.11.2 is applicable when modifications are implemented that allow online testing can be deleted because this modification will enhance the online testing capability that already exists on the Units.

Revision and Justification of the Bases for TS 3.3.11, Automatic Feedwater Isolation System (AFIS) Instrumentation

The title of the Bases for TS 3.3.11 will be revised from MSLB Detection and MFW Isolation Instrumentation to AFIS Instrumentation. AFIS is replacing the MSLB Detection and MFW Isolation Instrumentation.

The background and applicable safety analyses will be revised to reflect the AFIS description. This information is provided under the modification description in Attachment 3.

The LCO currently states that instrumentation necessary to initiate MFW isolation shall be OPERABLE. Duke proposes to revise that statement to state instrumentation necessary to initiate MFW and EFW isolation shall be OPERABLE. The LCO currently requires three channels per SG to be OPERABLE to ensure that no single failure prevents MFW isolation. Duke proposes to modify the LCO to require four channels per SG to be OPERABLE to ensure that no single failure prevents MFW and EFW isolation. The MSLB Detection and MFW isolation instrumentation channel is described. Duke proposes to replace that description with the AFIS instrumentation channel description. An AFIS instrumentation channel includes two pressure transmitters (one per SG), signal isolator(s), and the controller input.

The LCO bases include a Note that indicates that requirements

are applicable to a Unit after completion of AFIS modification on the respective Unit. AFIS will be installed on all three Units during each respective Units outage. MSLB Detection and MFW Isolation Instrumentation TS are applicable until AFIS is implemented on the respective Unit. The Note allows Duke to handle the TS logistically.

The APPLICABILITY has been revised to delete references to MSLB Detection and MFW Isolation. The statement 'Also during Mode 3 the MFW isolation Function is not required to be OPERABLE when all MFCV and SFCV are closed since the function of the instrumentation is already fulfilled' is deleted. AFIS will replace the MSLB Detection and MFW Isolation function. AFIS is not required in MODE 3 < 700 psig and is bypassed to avoid actuation during normal unit cooldowns.

The ACTIONS section has been modified by removing the feedwater isolation function from a Note that allow separate condition entries on each SG. AFIS will provide only a feedwater isolation function. References to MSLB Detection and MFW Isolation have been replaced with references to AFIS.

Under ACTION A.1, one channel can be inoperable or tripped. This will change the logic configuration from the stated one-out-of-two to a two-out-of-three with four required channels. Bypassing one channel is acceptable since AFIS is still able to perform its intended function. The channel may be placed in bypass within 4 hours. There is minimal risk for operating 4 hours with one channel tripped based on the low probability that another channel will trip within that time frame.

Under ACTION B.1, B.2.1 and B.2.2, B.2.1 and B.2.2 will be relocated to Action C.1 and C.2. Action B.1 will return the channels to service within 72 hours if two channels are inoperable or the Required Action and Completion Time of Condition A can not be met. An inoperable channel includes any channel that is bypassed per Condition A. Two inoperable channels will decrease AFIS functionality. It will also place the logic in a two-out-of-two configuration. Based on operating experience, 72 hours is a reasonable time period for returning the channel to service.

New ACTIONS C.1 and C.2 will state 'The Required Actions and associated Completion Time of Condition B not met, the unit must be placed in MODE 3 within 12 hours and main steam header pressure must be reduced to less than 700 psig within 18 hours. The allowed COMPLETION TIME is reasonable, based

on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

Under SR 3.3.11.2 - Duke proposes to delete 'This SR is modified by a Note indicating that it is only applicable when modifications are implemented that allow online testing.' This Note is applicable for MSLB Detection and MFW Isolation Instrumentation only. It is not valid once AFIS is installed on the respective Unit.

Under SR 3.3.11.2 - Four field inputs from transmitters are connected through a Voltage Isolation Module to the STAR Processor Module. A test signal is connected to a spare input of the Voltage Isolation Module then to the STAR Processor Module. The test input and field inputs will share the same voltage reference and signal commons. The data from the analog-to-digital process of the STAR module is transmitted to the Calibration and Test Computer via a serial bus. The Channel Functional Test is performed by comparing the test input signal to the value transmitted to the Calibration and Test Computer. This enables verification of the voltage references and signal commons.

Under SR 3.3.11.3 - Duke proposed to delete 'bistable' from setpoint errors. AFIS will remove bistables.

<u>Revision of TS 3.3.12, Automatic Feedwater Isolation System (AFIS) Manual Initiation</u>

The title of TS 3.3.12 will be revised from Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation to Automatic Feedwater Isolation System (AFIS) Manual Initiation.

TS LCO 3.3.12 currently requires that two MSLB Detection and MFW Isolation Manual Initiation switches be OPERABLE. Duke proposes to revise the LCO to state that two AFIS Manual Initiation switches per steam generator shall be OPERABLE. The LCO is also modified by a Note that states that the TS is not applicable on each Unit until after completion of the AFIS modification on the respective unit.

The Applicability for MSLB detection and MFW Isolation Manual initiation is currently Modes 1 and 2, and Mode 3 with main steam header pressure $\geq$ 700 psig except when all MFCVs and SFCVs are closed. Duke proposes to delete the exception for Mode 3. The LCO will be required in Modes 1 and 2, and Mode

3 with main steam header pressure ≥ 700 psig.

Duke proposes to modify The ACTIONS by a Note that states separate condition entry is allowed for each SG.

CONDITION A currently requires that one manual initiation switch inoperable be restored to operable status within 72 hours. Duke proposes to revise condition A to state one manual initiation switch per steam generator inoperable be restored to operable status within 72 hours.

CONDITION B currently states that two manual initiation switches inoperable, or Required Action and associated Completion Time of Condition A not met must be in mode 3 within 12 hours and reduce main steam header pressure to < 700 psig within 18 hours or close all MFCVs and SFCVs within 18 hours. Duke proposes to modify Condition B to state two manual initiation switches per SG inoperable or Required Action and associated Completion Time of Condition A not met, be in mode 3 within 12 hours and reduce main steam header pressure to < 700 psig within 18 hours.

<u>Technical Justification for TS 3.3.12, Automatic Feedwater Isolation System (AFIS) Manual Initiation</u>

TS 3.3.12 will be retitled AFIS Manual Initiation. AFIS is the new system that replaces the MSLB detection and MFW Isolation Manual Initiation circuitry.

Having all the manual isolation switches fully operable allows the Operators to fully trip the appropriate AFIS channel, thereby, manually initiating a feedwater isolation. The LCO contains a Note that makes the specification applicable on a unit once the modification has been implemented on that respective unit.

The AFIS function shall be OPERABLE in Modes 1 and 2, and Mode 3 with main steam header pressure ≥ 700 PSIG because SG inventory can be at a high energy level and contribute significantly to the peak pressure with a secondary side break. Once the SG pressures have decreased below 700 PSIG, the AFIS function can be bypassed to avoid actuation during normal unit cooldowns. In Modes 4, 5 and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent. The primary system temperatures are also low to allow the SG to effectively remove energy and AFIS is not required to be operable. The AFIS circuitry will be manually disabled when main steam pressure is below 700 psig. Manual

operator action is credited for the mitigation of a MSLB when the AFIS circuitry is disabled. The plant is operated with main steam pressure less than 700 psig only during startup and shutdown evolutions. These evolutions are very short in duration.

Duke proposes to modify The ACTIONS by a Note that states separate condition entry is allowed for each SG. This change allows for separate condition entry on each SG.

If one manual initiation switch per steam generator is inoperable then 72 hours is allowed for returning it to service. This time frame is based on unit operating experience and administrative controls, which provide alternative means of AFIS initiation via individual component controls. The 72 hour completion time is consistent with the allowed outage time for the components actuated by AFIS.

If two manual initiation switches per steam generator are inoperable or one manual initiation switch per steam generator is not returned to service within 72 hours, then the Unit must be in Mode 3 within 12 hours and main steam header pressure must be less than 700 PSIG in 18 hours. The allowed completion times are reasonable, based on operating experience, to reach the required Modes from full power conditions in an orderly manner and without challenging Unit systems.

<u>Revision and Justification of the Bases for TS 3.3.12, Automatic Feedwater Isolation System (AFIS) Manual Initiation</u>

The title of the Bases for TS 3.3.12 will be revised from Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation to Automatic Feedwater Isolation System (AFIS) Manual Initiation. AFIS will replace the MSLB Detection and MFW Isolation Circuitry on each Unit.

All Bases sections for TS 3.3.12 will be revised to replace references to MSLB Detection and MFW Isolation with references to AFIS. AFIS will replace the MSLB Detection and MFW Isolation Circuitry on each Unit.

The BACKGROUND and APPLICABLE SAFETY ANALYSES currently references the MFW Isolation Function. Duke proposes to revise that reference to include EFW as part of the isolation function. AFIS will actuate MFW and EFW.

The LCO is revised to require two manual initiation switches

per steam generator as a requirement for operability. The LCO currently states that the MFW Isolation Function has two actuation or 'trip' channels. Duke proposes to revise that to state the MFW and EFW Isolation Function has two actuation or 'trip' channels. The LCO is modified by a note that states the requirements are applicable when AFIS is implemented on the respective Unit. MSLB Detection and MFW Isolation Manual Initiation TS is applicable until AFIS is implemented on the respective Unit. The Note allows Duke to handle the TS logistically.

The APPLICABILITY has been revised to delete the following: During MODE 3, the MFW Isolation manual initiation Function is not required to be OPERABLE when all main feedwater control valves (MFCVs) and startup feedwater control valves (SFCVs) are closed. AFIS will replace the MSLB Detection and MFW Isolation function. AFIS is not required in MODE 3 < 700 psig and is bypassed to avoid actuation during normal unit cooldowns.

The ACTIONS section has been modified by a Note that allows separate condition entry for each SG. This change allows for separate condition entry on each SG.

ACTION A.1 has been revised to specify one manual initiation switch per steam generator. If one manual initiation switch per steam generator is inoperable then 72 hours is allowed for returning it to service. This time frame is based on unit operating experience and administrative controls, which provide alternative means of AFIS initiation via individual component controls. The 72 hour completion time is consistent with the allowed outage time for the components actuated by AFIS.

ACTION B.1 - Action B.2 was added to the title. Deleted 'or all MFCVs and SFCVs must be closed.' If two manual initiation switches per steam generator are inoperable or one manual initiation switch per steam generator is not returned to service within 72 hours, then the Unit must be in Mode 3 within 12 hours and main steam header pressure must be less than 700 PSIG in 18 hours. AFIS is not required at less than 700 PSIG and is bypassed. The allowed completion times are reasonable, based on operating experience, to reach the required Modes from full power conditions in an orderly manner and without challenging Unit systems.

Revision of TS 3.3.13, Automatic Feedwater Isolation System (AFIS) Digital Channels

The title of TS 3.3.13 will be revised from Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels to the Automatic Feedwater Isolation System (AFIS) Digital Channels.

TS LCO 3.3.13 currently requires that two MSLB Detection and MFW Isolation Logic Channels per steam generator be OPERABLE. Duke proposes to revise the LCO to state that two AFIS Digital channels per steam generator shall be OPERABLE. The LCO is also modified by a Note that states that the TS is not applicable on each Unit until after completion of the AFIS modification on the respective unit.

The APPLICABILITY for MSLB detection and MFW isolation logic channels are currently Modes 1 and 2, and Mode 3 with main steam header pressure ≥ 700 psig except when all MFCVs and SFCVs are closed. Duke proposes to delete the exception for Mode 3. The LCO will be required in Modes 1 and 2, and Mode 3 with main steam header pressure ≥ 700 psig.

Duke proposes to modify The ACTIONS by a Note that states separate condition entry is allowed for each SG.

CONDITION A currently requires that one logic channel inoperable be restored to operable status within 72 hours. Duke proposes to revise condition A to state one digital channel inoperable be restored to service within 72 hours.

CONDITION B currently states that two logic channels inoperable, or Required Action and associated Completion Time of Condition A not met must be in mode 3 within 12 hours and reduce main steam header pressure to < 700 psig within 18 hours or close all MFCVs and SFCVs within 18 hours. Duke proposes to modify condition B to state two digital channels inoperable be in Mode 3 within 12 hours and reduce main steam header pressure to < 700 psig within 18 hours.

Technical Justification for TS 3.3.13, Automatic Feedwater Isolation System (AFIS) Digital Channels

TS 3.3.13 will be retitled AFIS Digital Channels. AFIS is the new system that replaces MSLB Detection and MFW Isolation Logic Channels.

Two digital channels per SG are required to be operable.

There are two digital channels per SG. Therefore, a single failure would not cause a loss of automatic function if the other digital channel fails.

The AFIS function shall be OPERABLE in Modes 1 and 2, and Mode 3 with main steam header pressure ≥ 700 PSIG because SG inventory can be at a high energy level and contribute significantly to the peak pressure with a secondary side break. Once the SG pressures have decreased below 700 PSIG, the AFIS function can be bypassed to avoid actuation during normal unit cooldowns. In Modes 4, 5 and 6, the energy level is low and the secondary side feedwater flow rate is low or nonexistent. The primary system temperatures are also low to allow the SG to effectively remove energy and AFIS is not required to be operable. The AFIS circuitry will be manually disabled when main steam pressure is below 700 psig. Manual operator action is credited for the mitigation of a MSLB when the AFIS circuitry is disabled. The plant is operated with main steam pressure less than 700 psig only during startup and shutdown evolutions. These evolutions are very short in duration.

Duke proposes to modify The ACTIONS by a Note that states separate condition entry is allowed for each SG. This note allows for separate condition entry on each SG.

With one digital channel per SG inoperable, the channel must be restored to operable status within 72 hours. This completion time is based on the fact that there is a second logic train per SG that will provide the same function, operating experience, and administrative controls that provide an alternative means of AFIS via individual component controls. The 72 hour completion time is consistent with the allowed outage time for the AFIS actuated components.

With both digital channels per SG inoperable, the unit must be placed in Mode 3 within 12 hours and main steam header pressure must be reduced to less than 700 PSIG in 18 hours. Completion times are reasonable. Completion time is based on operating experience, to reach the required Modes from full power conditions in an orderly manner and without challenging Unit systems.

<u>Revision and Justification of the Bases for TS 3.3.13, Automatic Feedwater Isolation System (AFIS) Digital Channels</u>

The title of the Bases for TS 3.3.13 will be revised from Main Steam Line Break (MSLB) Detection and Main Feedwater

(MFW) Isolation Logic Channels to Automatic Feedwater Isolation System (AFIS) Digital Channels. AFIS will replace the MSLB Detection and MFW Isolation Logic circuitry.

All references to Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels will be revised to Automatic Feedwater Isolation System (AFIS) Digital Channels in all Bases sections. AFIS will replace the MSLB Detection and MFW Isolation Logic circuitry.

The BACKGROUND and APPLICABLE SAFETY ANALYSES will be revised to reflect the AFIS description. This information is provided under the modification description in Attachment 3.

The LCO Bases has been modified to specify two channels of AFIS actuation logic shall be operable per SG. The statement 'Therefore, violation of this LCO could result in a complete loss of the automatic Function assuming a single failure of the other channel' can be deleted from the LCO Bases. There are two channels of automatic actuation logic per SG.

The LCO bases has been modified by a note that indicates that requirements are applicable to a unit after completion of AFIS modification on the respective Unit. AFIS will be implemented on each Unit during the respective Units refueling outage. MSLB Detection and MFW Isolation Logic Channels TS are applicable until AFIS is implemented on the respective Unit. The Note allows Duke to handle the TS logistically.

The APPLICABILITY has been revised to delete the following statement: Also during Mode 3 the MFW isolation Function is not required to be OPERABLE when all MFCV and SFCV are closed. AFIS will replace the MSLB Detection and MFW Isolation function. AFIS is not required in MODE 3 $<$ 700 psig and is bypassed to avoid actuation during normal unit cooldowns.

The ACTIONS section has been modified by a Note that allows separate condition entry for each SG. Separate condition entry is allowed on each SG.

Under ACTION B.1 and B.2, the required action of closing MFCVs and SFCVs will be deleted. AFIS is not required at less than 700 psig and will be bypassed to avoid actuation during normal unit cooldowns.

<u>Revision of TS 3.3.25, Main Steam Line Break (MSLB) Detection</u>

<u>and Main Feedwater (MFW) Isolation Instrumentation</u>

All numbering has been revised from TS 3.3.11 to 3.3.25.

LCO 3.3.25 is modified by a Note that states that the TS is applicable on each Unit until after completion of the AFIS modification on the respective unit.

<u>Revision Of Bases for 3.3.25, Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Instrumentation</u>

All numbering has been revised from 3.3.11 to 3.3.25.

The LCO section will be modified to explain the Note, which makes the requirement of the TS not applicable following implementation of AFIS on the respective unit.

<u>Revision of TS 3.3.26, Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation</u>

All numbering has been revised from TS 3.3.12 to 3.3.26.

TS LCO 3.3.26 is modified by a Note that states the TS is applicable on each Unit until after completion of the AFIS modification on the respective unit.

<u>Revision of Bases for 3.3.26, Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Manual Initiation</u>

All numbering has been revised from 3.3.12 to 3.3.26.

The LCO section will be modified to explain the Note, which makes the requirement of the TS not applicable following implementation of AFIS on the respective unit.

<u>Revision of TS 3.3.27, Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels</u>

All numbering has been revised from TS 3.3.13 to 3.3.27.

TS LCO 3.3.26 is modified by a Note that states the TS is applicable on each Unit until after completion of the AFIS modification on the respective unit.

<u>Revision of Bases for TS 3.3.27, Main Steam Line Break (MSLB) Detection and Main Feedwater (MFW) Isolation Logic Channels</u>

All numbering will be revised from 3.3.13 to 3.3.27.

The LCO section will be modified to explain the Note, which makes the requirement of the TS not applicable following implementation of AFIS on the respective unit.

Technical Justification for TS and Bases Sections 3.3.25, 3.3.26 and 3.3.27

The Note is added because the TS will not be applicable on the Units AFIS has been implemented on. The MSLB Detection and MFW Isolation TS were moved to the end of section 3.3 so that when the AFIS modification is complete on all three units, the TS can be removed.

Revision of Bases for TS 3.7.3, Main Feedwater Control Valves (MFCVs) and Startup Feedwater Control Valves (SFCVs)

The LCO references LCO 3.3.11 as MSLB Detection and MFW Isolation Instrumentation. This reference will be revised to reflect that automatic initiation instrumentation is not required to be operable in Mode 3 when MS header pressure is < 700 PSIG in accordance with either LCO 3.3.11 Automatic Feedwater Isolation System Instrumentation or LCO 3.3.25 MSLB Detection and MFW Isolation Instrumentation. This statement will support AFIS implementation. A statement was added to credit closure of MFCVs and SFCVs for a feedwater line break. A Feedwater line break is similar to a MSLB. AFIS will actuate to isolate feedwater to the faulted SG.

ATTACHMENT 4

NO SIGNIFICANT HAZARDS CONSIDERATION

Attachment 4
No Significant Hazards Determination

Pursuant to 10 CFR 50.91, Duke Power Company (Duke) has made the determination that this amendment request involves a No Significant Hazards Consideration by applying the standards established by the NRC regulations in 10 CFR 50.92. This ensures that operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated:

No. The Automatic Feedwater Isolation System (AFIS) provides a means of automatic response to improve the ability to isolate Main Feedwater (MFW) and Emergency Feedwater (EFW) to mitigate containment overpressurization and steam generator tube stress limits resulting from Main Steam Line Break (MSLB) accidents. The manual operator actions currently required by emergency operating procedures remain as a defense-in-depth. There is no significant increase in the probability of a loss of FDW or EFW event due to spurious actuation of AFIS. The AFIS is designed with two independent trains of diverse digital control systems, each having four channels of inputs. AFIS uses the Framatome Technologies, Inc. Safety STAR digital controller which has an approved Safety Evaluation Report for its use in protection systems. There are no postulated failures which differ from those assumed for an analog control system that would prevent proper system actuation. There is minimal probability of a software induced failure which would cause a spurious actuation resulting in a temporary loss of secondary cooling. However, rigorous verification and validation will be performed on the software as prescribed in the STAR Topical Report. Since the software is installed on EPROM (firmware), there is little probability of adverse affects by abnormal conditions and events during normal operation. The design of the STAR modules for AFIS are consistent with the designs that were subjected to EMI/RFI, power surge, seismic, and environmental qualification testing as documented in the STAR Topical Report. In the unlikely event of spurious actuation, manual manipulation of existing EFW pump controls will override the AFIS trip signals.

Some small break LOCA events require EFW to promote heat transfer and to provide for an orderly cooldown of the reactor coolant system. EFW injection to reach the required SG level setpoint can cause SG depressurization. However, plant procedures contain guidance to throttle EFW while SG level is increasing in order to prevent excessive RCS overcooling which limits SG depressurization. The throttling of EFW should preclude exceeding the AFIS rate of depressurization setpoint. In the event that AFIS actuates and causes a MDEFWP trip during the small break LOCA event, manual restoration of EFW is required.

It is postulated that AFIS may actuate on both SG headers as a result of common mode Turbine Bypass Valve failures. The MS pressures following this event could actuate the low pressure and high rate of depressurization trips. The actuation of AFIS will mitigate the resulting overcooling event as desired by terminating secondary cooling. No operator action is required within the first 10 minutes.

The AFIS circuitry will be manually disabled when main steam pressure is below 700 psig. Manual operator action is credited for the mitigation of a MSLB when the AFIS circuitry is disabled. The plant is operated with main steam pressure less than 700 psig only during startup and shutdown evolutions. These evolutions are very short in duration. Therefore, the probability of a MSLB event occurring at these conditions is sufficiently small such that an explicit analysis is not performed at these conditions.

For the purpose of this submittal, it is assumed that a turbine missile can cause a MSLB. Two channels of AFIS transmitters are located inside containment, which is protected from missiles. Therefore, AFIS is capable of detecting a MSLB caused by turbine missiles. This assumes 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 AFIS are physically separated from MS lines, it is unlikely, that the turbine missiles which cause the MSLB, will disable the ability to terminate flow to the steam generators. Moreover, the failure modes of all pumps and switchgear are in the tripped state.

(2) Create the possibility of a new or different kind of accident from any kind of accident previously evaluated:

No. AFIS replaces the MSLB Detection and FDW Isolation Circuitry as described in the SAR. There are increased adverse affects of a spurious actuation of AFIS compared to a spurious actuation of the MSLB Detection and FDW Isolation Circuitry. A spurious actuation of AFIS may trip an additional source of secondary cooling, a motor-driven EFW pump, which was previously unaffected by the MSLB Detection Circuitry. Safety features have been designed into AFIS to prevent spurious actuation. The System is required to energize to trip which makes AFIS non-fail safe. Therefore, AFIS does not introduce hardware failures that inhibit proper operation of MFW or EFW when required by the Oconee licensing basis. The design of the two out of four input logic inhibits the adverse affects of single failures which could cause spurious actuation. The detection algorithm is triggered by symptoms of a MSLB or other significant overcooling event. There are no postulated single failures which produce the MSLB symptoms, except those which would require system actuation. There are two digital channels of AFIS logic which produce the trip outputs. The digital channels employ diverse, redundant hardware and software to prevent system level common-mode failures. The redundant processors monitor the health of the input signals and the performance of the algorithm to assure proper operation during a MSLB event. There is minimal probability of a software induced failure which would cause a spurious actuation resulting in a temporary loss of secondary cooling. However, as described in 1 above, credit is taken for verification and validation.

The use of a digital system for AFIS incorporates a scan time element, which slightly effects system response time compared to the analog MSLB Detection and FDW Isolation System. The effects of the scan time are within the delay time assumed for the MSLB circuitry.

With actuation of AFIS during a MSLB event, a single failure of emergency FDW equipment on the unaffected steam generator header would result in the temporary loss of all secondary cooling. The consequences of the EFW single failure are consistent with the existing

license and UFSAR Chapter 10. The possibility of the temporary loss of all secondary cooling during an MSLB event exists with the existing procedures involving manual termination of EFW. However, credit is afforded for defense in depth using non-safety related secondary systems and manual restoration. These lines of defense in depth remain available by manual operator actions. In addition, the turbine-driven EFW pump can be manually started and aligned to the intact steam generator from the control room. Alignment of the motor-driven EFW pump is also possible, but requires actions outside the control room.

(3) Involve a significant reduction in a margin of safety.

No. The proposed change does not adversely affect any plant safety limits, set points, or design parameters. The change also does not adversely affect the fuel, fuel cladding, Reactor Coolant System, or containment integrity. For a postulated feedwater line break (FLB)/ MSLB inside containment, AFIS will improve the margin of safety by reducing the mass and energy release to containment. AFIS will also improve the margin of safety for departure from nucleate boiling by minimizing the overcooling transient from a FLB/MSLB. Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Duke has concluded, based on the above, that there are no significant hazards considerations involved in this amendment request.

ATTACHMENT 5

ENVIRONMENTAL IMPACT ANALYSIS

ATTACHMENT 5

Environmental Assessment

Pursuant to 10 CFR 51.22(b), an evaluation of the license amendment request (LAR) has been performed to determine whether or not it meets the criteria for categorical exclusion set forth in 10 CFR 51.22(c)9 of the regulations. The LAR does not involve:

1) A significant hazards consideration.

   This conclusion is supported by the determination of no significant hazards contained in Attachment 4.

2) A significant change in the types or significant increase in the amounts of any effluents that may be released offsite.

   This LAR will not change the types or amounts of any effluents that may be released offsite.

3) A significant increase in the individual or cumulative occupational radiation exposure.

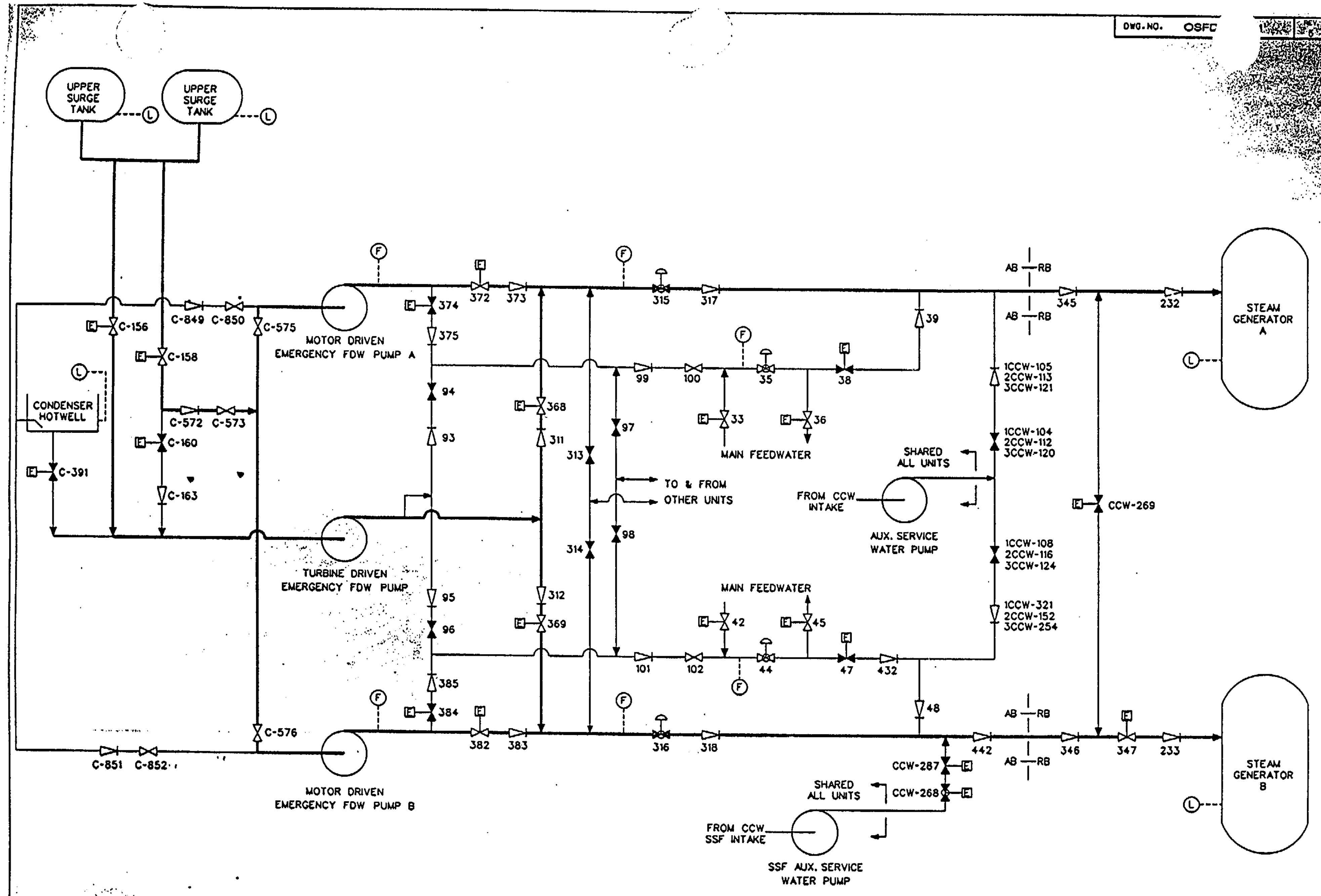
   This LAR will not increase the individual or cumulative occupational radiation exposure.

In summary, this LAR meets the criteria set forth in 10 CFR 51.22 (c)9 of the regulations for categorical exclusion from an environmental impact statement.

ATTACHMENT 6

Reference Drawings

OSFD-121D-1	EFW System
OSFD-122A-1	Main Steam System
OSFD-121B-1	Feedwater System
Proposed	AFIS Digital Channel 1
Proposed	AFIS Digital Channel 2



TYPICAL FOR UNITS 1, 2, & 3

ALL VALVES "FDW" EXCEPT AS NOTED

ERN: 0X001181

LEGEND

- SHUTOFF VALVE
- FLOW CONTROL VALVE
- CHECK VALVE (ALL TYPES)
- RELIEF VALVE
- NORMALLY OPEN
- NORMALLY CLOSED
- NORMALLY THROTTLED
- (X) F-FLOW, L-LEVEL, P-PRESSURE, T-TEMPERATURE, R-RADIATION MONITOR
- E-ELECTRIC, H-HYDRAULIC, P-PISTON (PNEUMATIC), S-SOLENOID
- DIAPHRAGM (PNEUMATIC)
- (ES)-RECEIVES ENGINEERED SAFEGUARD SIGNAL

THIS DRAWING IS A SUMMARY FLOW DIAGRAM. FOR COMPLETE SYSTEM DESIGN INFORMATION REFER TO FLOW DIAGRAMS LISTED BELOW:

OFD-121A -1.7, 2.7, 3.7	UPPER SURGE TANKS
OFD-121A -1.8, 2.8, 3.8	CONDENSER HOTWELL
OFD-121B -1.3, 2.3, 3.3	FINAL FEEDWATER
OFD-121D -1.1, 2.1, 3.1	EMERG. FEEDWATER
OFD-121D -1.2 (SHARED)	AUX. SERVICE WATER
OFD-133A -2.5 (SHARED)	SSF AUX. SERVIC

NO.	REVISIONS	DRN	DATE	CHKD	DATE	APPR	DATE	CIVIL	ELEC.	MECH.
5	REV. PER ED. EX. M.10	MSL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	RP	[illegible]	[illegible]
4	REV. PER ED. EX. M.10	[illegible]	[illegible]	DGM	[illegible]	RLS	[illegible]	RCF	JAK	HBH
3	REDRAWN ON ACAD & MISC. CORRECTIONS	RBS	[illegible]	NAS	[illegible]	WAH	[illegible]	RLO	HM	HAH
2	MINOR DRAWING CORRECTIONS	BKS	[illegible]	NAS	[illegible]	RAH	[illegible]	RLO	BGF	HBH
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ORIG.	RELEASED FOR INFORMATION	RAH	[illegible]	HAH	[illegible]	RPW	[illegible]	MBS	EGF	BMW

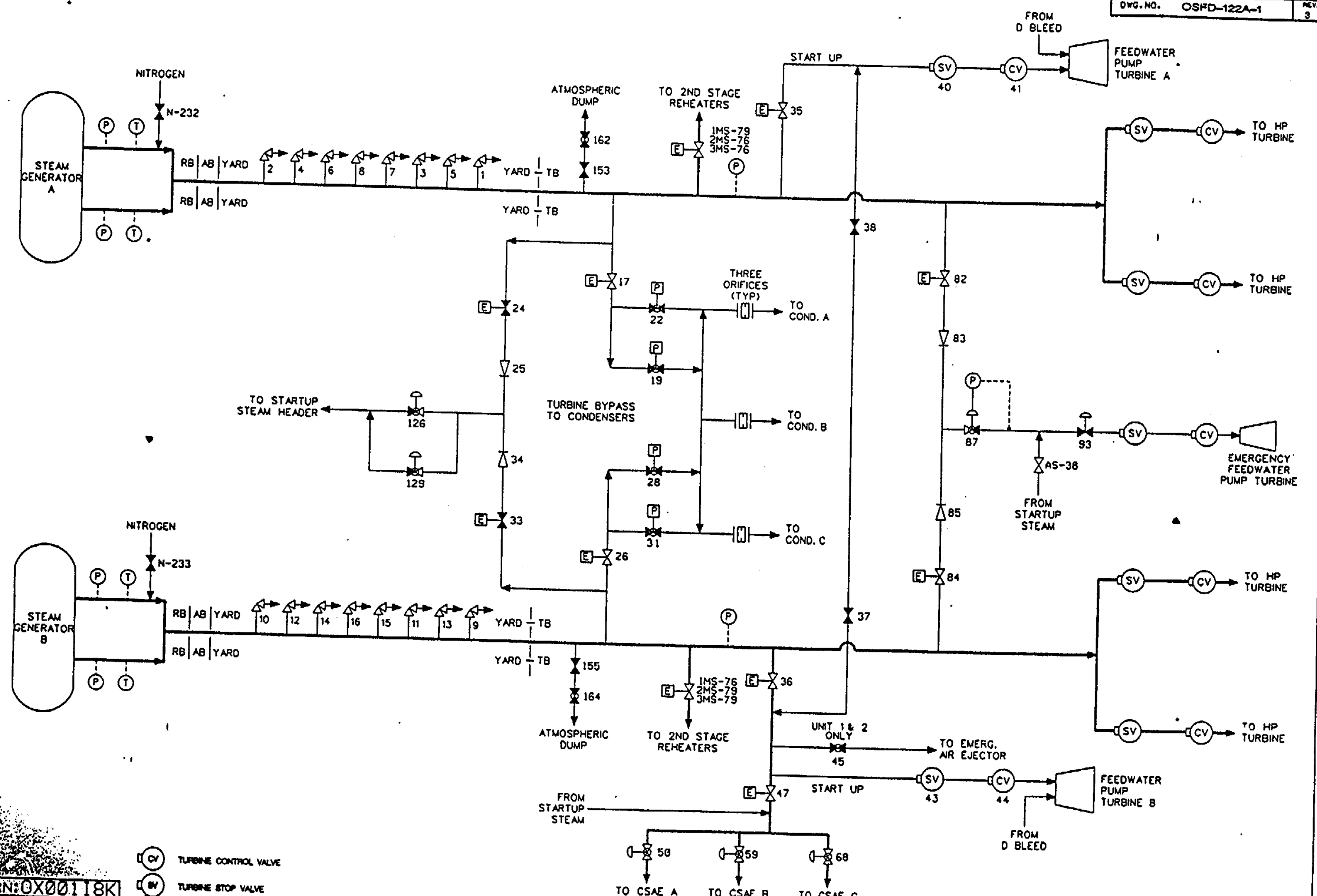
INSPECTED

DUKE POWER COMPANY
OCONEE NUCLEAR STATION

SUMMARY FLOW DIAGRAM OF EMERGENCY FEEDWATER SYSTEM

DWG. NO. OS HD-1 REV. 5

11/03/98 10:52AM



ERN:0X0118K

CV TURBINE CONTROL VALVE

SV TURBINE STOP VALVE

LEGEND

SHUTOFF VALVE
FLOW CONTROL VALVE
CHECK VALVE (ALL TYPES)
RELIEF VALVE

NORMALLY OPEN
NORMALLY CLOSED
NORMALLY THROTTLED

F-FLOW
L-LEVEL
P-PRESSURE
T-TEMPERATURE
R-RADIATION MONITOR

E-ELECTRIC
H-HYDRAULIC
P-PISTON (PNEUMATIC)
S-SOLENOID
DIAPHRAGM (PNEUMATIC)
(ES)-RECEIVES ENGINEERED SAFEGUARD SIGNAL

THIS DRAWING IS A SUMMARY FLOW DIAGRAM. FOR COMPLETE SYSTEM DESIGN INFORMATION REFER TO FLOW DIAGRAMS LISTED BELOW:

OFD-122A-1.1, 2.1, 3.1	MAIN STEAM TO HP TURBINE
-1.2, 2.2, 3.2	TURBINE BYPASS TO CONDENSER
-1.3, 2.3, 3.3	MAIN STEAM TO FDWP TURBINES
-1.4, 2.4, 3.4	MAIN STEAM TO EMER FDWP TURB
OFD-122B-1.1, 2.1, 3.1	HP TURBINE STOP VALVES AND CONTROL VALVES
OFD-122B-1.7, 2.7, 3.7	D BLEED TO FDW PUMP TURBINES
OFD-128A-1.1, 2.1, 3.1	STARTUP STEAM

TYPICAL FOR UNITS 1, 2, & 3
ALL VALVES "MS" EXCEPT AS NOTED

NO.	REVISIONS
3	REV. PER ED. EX. M.16
2	REDRAWN ON ACAD & MISC. CORRECTIONS
1	REV. PER NSM-2463
ORIG	RELEASED FOR INFORMATION

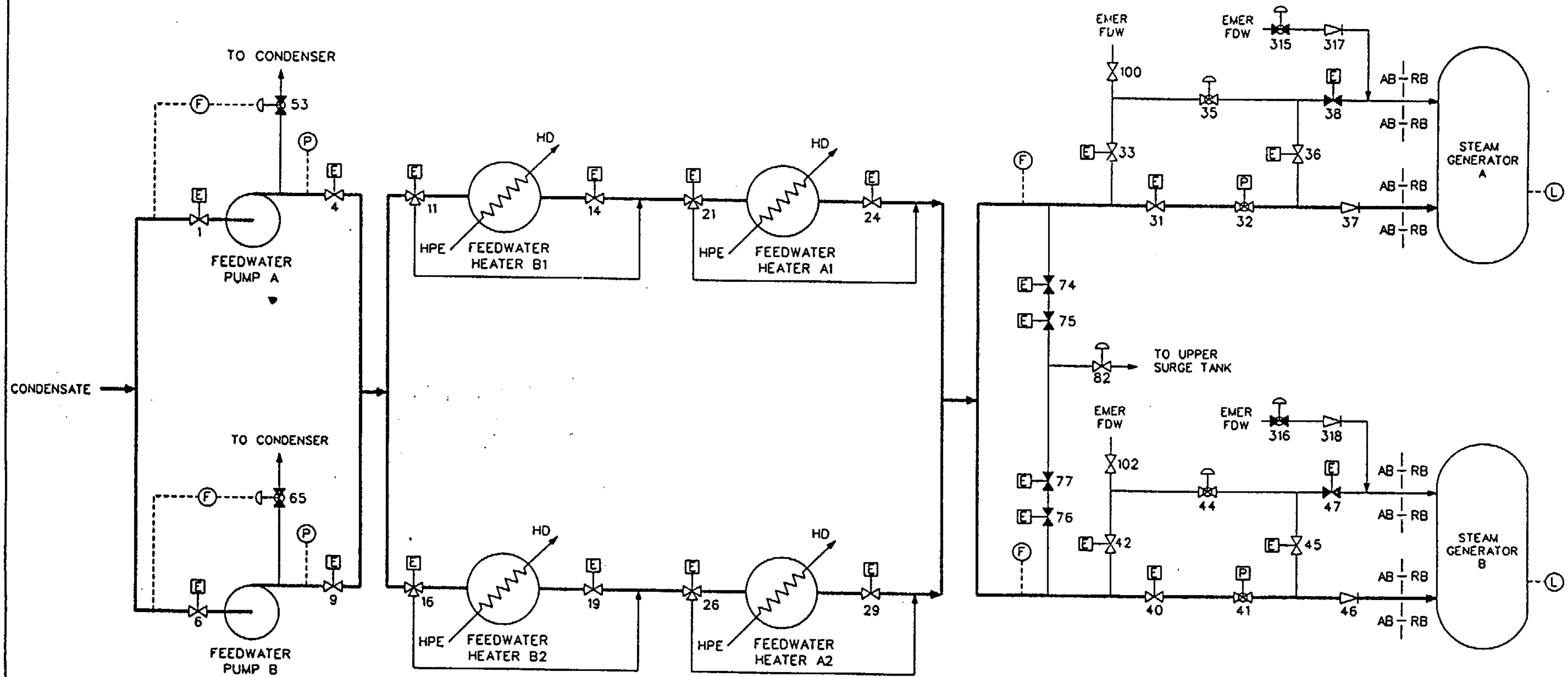
DRN | DATE | CHKD | DATE | APPR | DATE | CIVIL | ELEC. | MECH. — INSPECTED

DUKE POWER COMPANY
OCONEE NUCLEAR STATION

SUMMARY FLOW DIAGRAM OF MAIN STEAM SYSTEM

DWG. NO. OSFD-[illegible]-1 REV. 3

DWG. NO. OSFD-121B-1 REV. 4



ERN: 0X00118G

LEGEND

- SHUTOFF VALVE
- FLOW CONTROL VALVE
- CHECK VALVE (ALL TYPES)
- RELIEF VALVE
- THREE WAY VALVE
- NORMALLY OPEN
- NORMALLY CLOSED
- NORMALLY THROTTLED
- F-FLOW
- L-LEVEL
- P-PRESSURE
- T-TEMPERATURE
- R-RADIATION MONITOR
- E-ELECTRIC
- H-HYDRAULIC
- P-PISTON (PNEUMATIC)
- S-SOLENOID
- DIAPHRAGM (PNEUMATIC)
- (ES)-RECEIVES ENGINEERED SAFEGUARD SIGNAL

THIS DRAWING IS A SUMMARY FLOW DIAGRAM. FOR COMPLETE SYSTEM DESIGN INFORMATION REFER TO FLOW DIAGRAMS LISTED BELOW:

OFD-121B-1.2, 2.2, 3.2	FEEDWATER PUMPS
OFD-121B-1.2, 2.2, 3.2	FEEDWATER HEATERS A & B
OFD-121B-1.3, 2.3, 3.3	FINAL FEEDWATER
OFD-121D-1.1, 2.1, 3.1	FINAL FEEDWATER

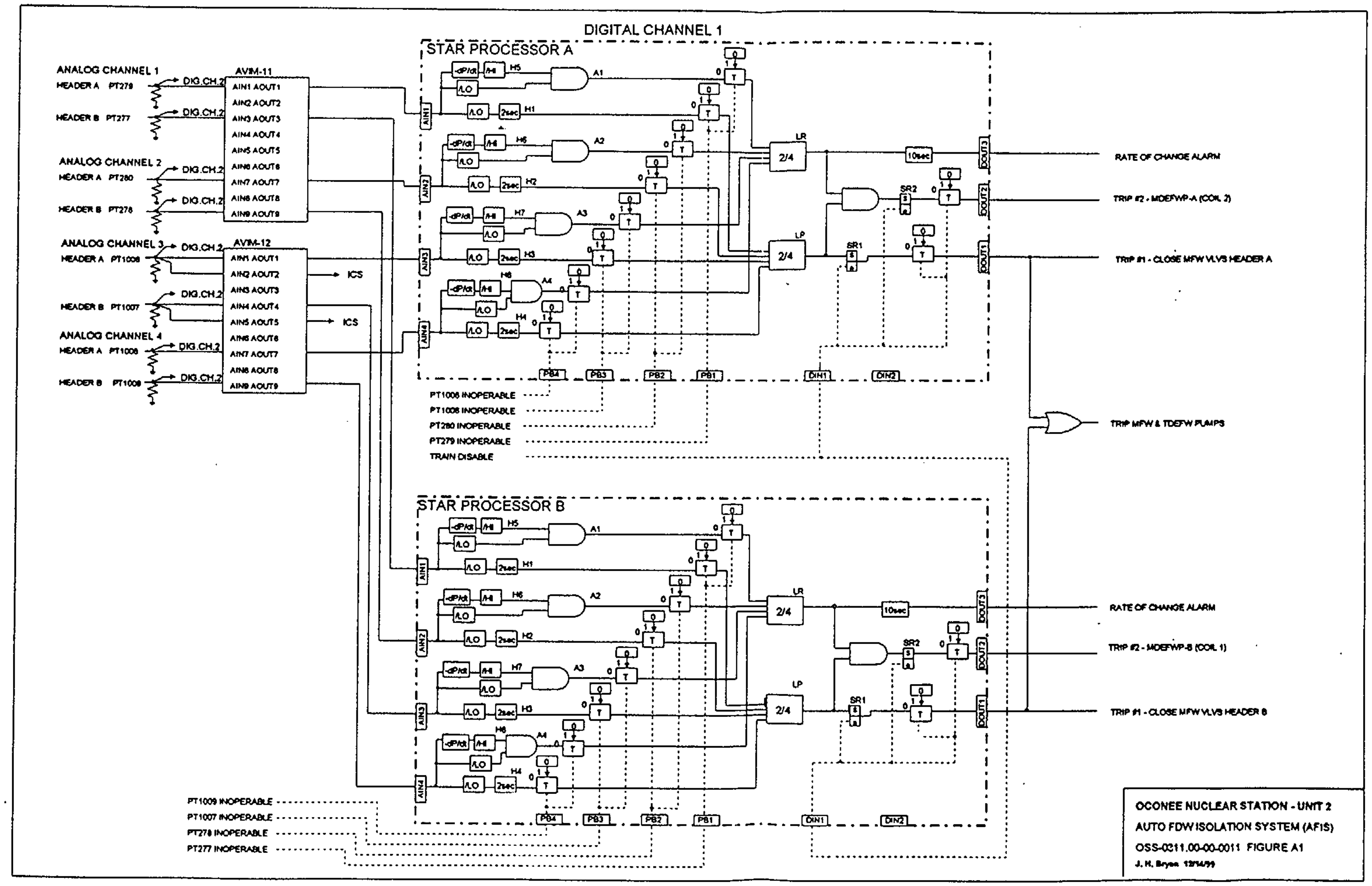
TYPICAL FOR UNITS 1, 2, & 3
ALL VALVES "FDW" EXCEPT AS NOTED

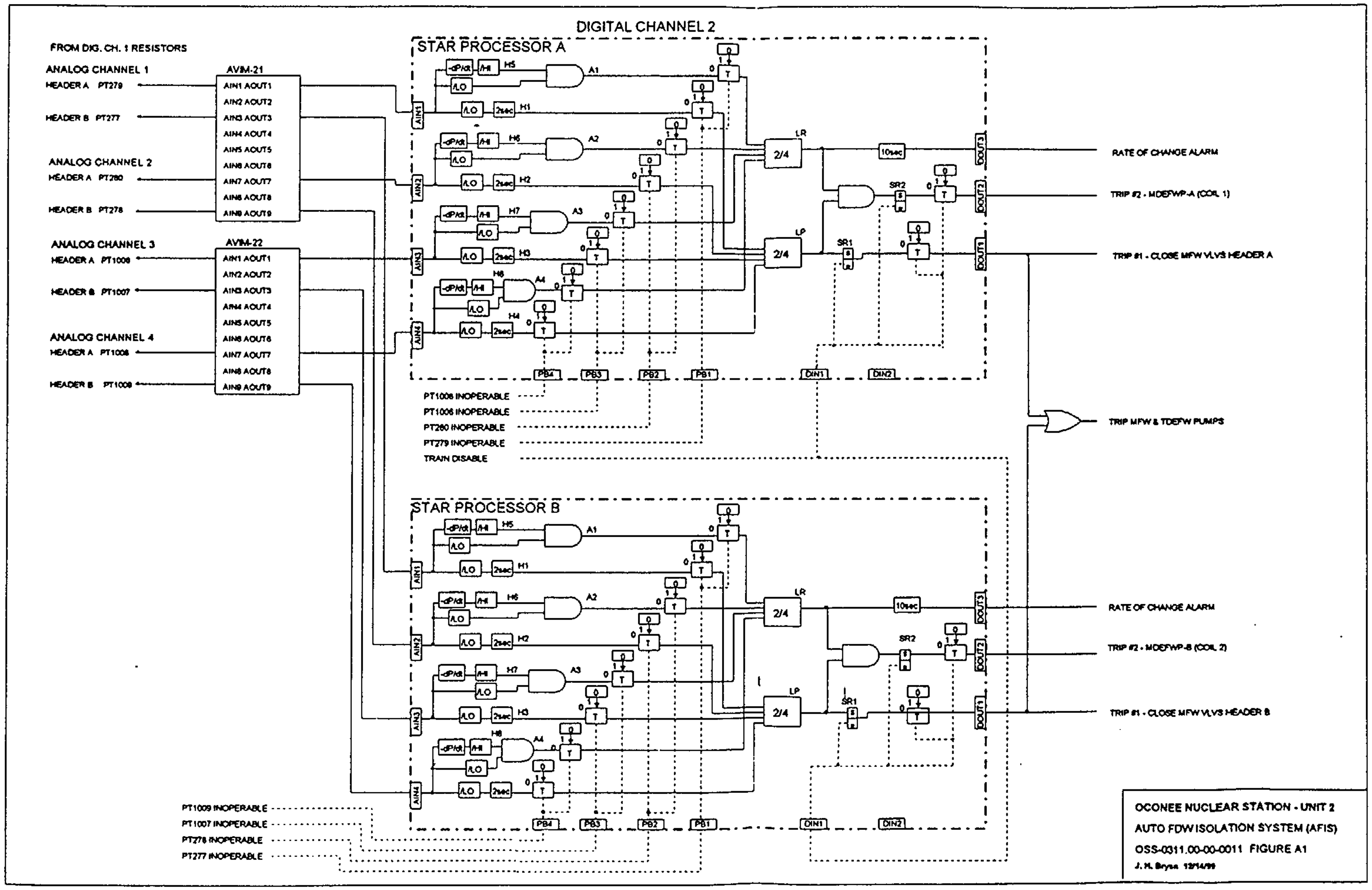
NO.	REVISIONS	DRN	DATE	CHKD	DATE	APPR	DATE	CIVIL (INSPECTED)	ELEC. (INSPECTED)	MECH. (INSPECTED)
4	REV. PER ED. EX. M.10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	REV. PER ED. EX. M.10	[illegible]	[illegible]	LBR	[illegible]	RLB	[illegible]	RCF	JAK	DKH
2	REDRAWN ON ACAD	RBS	[illegible]	NAS	[illegible]	WAH	[illegible]	RLC	HM	JRW
1	MINOR DRAWING CORRECTIONS	LBR	[illegible]	NAS	[illegible]	EMW	[illegible]	RLC	EGF	RAH
ORIG.	RELEASED FOR INFORMATION	RAH	[illegible]	ELH	[illegible]	RPW	[illegible]	MSS	EGF	EMW

DUKE POWER COMPANY
OCONEE NUCLEAR STATION

SUMMARY FLOW DIAGRAM OF FEEDWATER SYSTEM

DWG. NO. OSFD-121B-1 REV. 4


DIGITAL CHANNEL 1
STAR PROCESSOR A
STAR PROCESSOR B
ANALOG CHANNEL 1
ANALOG CHANNEL 2
ANALOG CHANNEL 3
ANALOG CHANNEL 4
AVIM-11
AVIM-12
ICS
RATE OF CHANGE ALARM
TRIP #2 - MOEFWP-A (COIL 2)
TRIP #1 - CLOSE MFW VLVS HEADER A
TRIP MFW & TDEFW PUMPS
RATE OF CHANGE ALARM
TRIP #2 - MOEFWP-B (COIL 1)
TRIP #1 - CLOSE MFW VLVS HEADER B
PT1006 INOPERABLE
PT1008 INOPERABLE
PT280 INOPERABLE
PT279 INOPERABLE
TRAIN DISABLE
PT1009 INOPERABLE
PT1007 INOPERABLE
PT278 INOPERABLE
PT277 INOPERABLE
OCONEE NUCLEAR STATION - UNIT 2
AUTO FDW ISOLATION SYSTEM (AFIS)
OSS-0311.00-00-0011 FIGURE A1


DIGITAL CHANNEL 2
FROM DIG. CH. 1 RESISTORS
ANALOG CHANNEL 1
HEADER A PT279
HEADER B PT277
ANALOG CHANNEL 2
HEADER A PT280
HEADER B PT278
ANALOG CHANNEL 3
HEADER A PT1006
HEADER B PT1007
ANALOG CHANNEL 4
AVIM-21
AVIM-22
STAR PROCESSOR A
STAR PROCESSOR B
RATE OF CHANGE ALARM
TRIP #2 - MDEFWP-A (COIL 1)
TRIP #1 - CLOSE MFW VLVS HEADER A
TRIP MFW & TDEFW PUMPS
TRIP #2 - MDEFWP-B (COIL 2)
TRIP #1 - CLOSE MFW VLVS HEADER B
PT1006 INOPERABLE
PT280 INOPERABLE
PT279 INOPERABLE
TRAIN DISABLE
PT1007 INOPERABLE
PT278 INOPERABLE
PT277 INOPERABLE
OCONEE NUCLEAR STATION - UNIT 2
AUTO FDW ISOLATION SYSTEM (AFIS)
OSS-0311.00-00-0011 FIGURE A1

ATTACHMENT 7

Automatic Feedwater Isolation System Procurement Specifications

SPECIFICATION NO. OSS-0311.00-00-0011
DATE December 14,1999

VERIFICATION OF SPECIFICATION

Station and Unit Number: Oconee Nuclear Station – Units 1, 2 & 3

Title of Specification: Automatic Feedwater Isolation System – STAR Module Procurement Specification

Specification Number: OSS-0311.00-00-0011 Revision: 0

This document specifies items related to QA CONDITION 1 . In accordance with established procedures, its quality has been assured. Signatures certify that the above specification was originated, checked, approved and inspected (or waived) as noted.

Signature also certifies that a review for determining potential impact to work performed per previous revisions was conducted for this revision.

Previous Work Impacted by this revision: [X] No, [] Yes, (see Attachment)

Sponsor Location/Team: Oconee/ Modification Engineering

Prepared By: [signature] Date: 12/14/99

Checked By: [signature] / Aaron J Pugh Date: 2/17/00

Approved By: [signature] Date: 3-21-00

QUALITY ASSURANCE: [signature] Date: 3/23/00

(FOR ASME CODE ITEMS)

This is to certify that the above specification has been reviewed by me, the undersigned, and is correct, complete, and in compliance with ____________ Edition including the ________. Addendum of ASME Code, Section III, Paragraph ____________.

(SEAL)

Signature: ____________

Name: ____________
Professional Engineer

No. & State: ____________

SPECIFICATION NO. OSS-0311.00-00-0011
DATE December 14, 1999

INSPECTION OF SPECIFICATION

Inspection Waived By: [signature] Date: 3-21-00
(Sponsor)

GENERAL OFFICE

	Inspection Waived		
Procurement Engineering	☐	Inspected By/Date:	[signature] 2/18/00
Civil Engineering	☐	Inspected By/Date:	[signature] 2/18/00
Electrical Engineering	☐	Inspected By/Date:	[signature] 2/28/00
Mechanical Engineering	☒	Inspected By/Date:	
Others (NED)		Inspected By/Date:	[signature] 3/17/00

CATAWBA

	Inspection Waived		
Procurement Engineering	☒	Inspected By/Date:	
Civil Engineering	☒	Inspected By/Date:	
Electrical Engineering	☒	Inspected By/Date:	
Mechanical Engineering	☒	Inspected By/Date:	
Others ( )		Inspected By/Date:	

OCONEE

	Inspection Waived		
Procurement Engineering	☐	Inspected By/Date:	[signature] 3-21-00
Civil Engineering	☐	Inspected By/Date:	[signature] 3-20-2000
Electrical Engineering	☐	Inspected By/Date:	* checked by CEN/E
Mechanical Engineering	☐	Inspected By/Date:	[signature] 1/6/2000
Others ( )		Inspected By/Date:	

MCGUIRE

	Inspection Waived		
Procurement Engineering	☒	Inspected By/Date:	
Civil Engineering	☒	Inspected By/Date:	
Electrical Engineering	☒	Inspected By/Date:	
Mechanical Engineering	☒	Inspected By/Date:	
Others ( )		Inspected By/Date:	

NOTE: An X in the Inspected Waived box and the Sponsor Manager or designee signature in the "Inspection Waived By:" space at the top of this sheet indicates the inspection has been waived in accordance with the requirements of NPP-207, paragraph 4.4.1c.1.

Form NPP-207D
Revision 1

SPECIFICATION NO. OSS-0311.00-00-0011

DATE December 14, 1999

REVISION NUMBER	PAGES OR SECTIONS REVISED AND DESCRIPTION
0	Original Issue

SPECIFICATION NO: OSS-0311.00-00-0011
DATE: December 14, 1999
REVISION: 0
PAGE: 1 OF 18

DUKE POWER COMPANY

OCONEE NUCLEAR STATION, UNITS 1, 2 & 3

TITLE: AUTOMATIC FEEDWATER ISOLATION SYSTEM STAR MODULE PROCUREMENT SPECIFICATION

REVISION LOG

1 __________	6 __________
2 __________	7 __________
3 __________	8 __________
4 __________	9 __________
5 __________	10 __________

TABLE OF CONTENTS

DUKE POWER COMPANY
OCONEE NUCLEAR STATION, UNITS 1, 2 and 3
AUTOMATIC FEEDWATER ISOLATION SYSTEM (AFIS)
STAR MODULE PROCUREMENT SPECIFICATION

1.0 GENERAL

1.1 Scope:

The scope of the specification includes a Nuclear Class1E digital protection system to provide automatic isolation of feedwater systems upon recognition of a Main Steam Line Break event. The system consists of four analog inputs from owner supplied Main Steam pressure transmitters. There are two levels of system trips. (Trip #1) The first trip condition, which involves isolating Main FDW and tripping the TDEFW pump, occurs when two out of four Main Steam Pressure analog channels fall below setpoint. (Trip #2) A MDEFW trip occurs when two out of four Main Steam Pressure channels on the affected header fall below setpoint concurrent with a high rate of depressurization. Upon a system trip actuation, the digital control system provides relay outputs (closed contacts) that the owner will configure to interface with field components. The owner shall provide the functional requirements of the software algorithm. The owner shall provide the input/output wiring interfaces, 19"mounting cabinet, and installation. In summary, the vendor shall provide the single failure-proof, digital protection system with software, analog input isolation, digital inputs/output modules, on-line testing software, seismic qualification, mounting rack and hardware, and system commissioning support. The general design of the system is based on the Framatome Safety STAR Module architecture as specified in BWNT Document Numbers 08-1213637-01 and 08-1224843-00 unless otherwise stated in this specification.

1.2 Definitions/Abbreviations:

Owner	- Duke Power Company.
Purchaser	- Oconee Purchasing
Vendor	- Framatome Technologies (FTI)
AFIS	- Automatic Feedwater Isolation System
MSLB	- Main Steam Line Break Event
TDEFW	- Turbine Driven Emergency Feedwater
MDEFW	- Motor Driven Emergency Feedwater
MFW	- Main Feedwater
Trip	- Actuation of the digital outputs to the logic "1" state.
Analog Channel	- Input segment of the system designed for separation and independence.
Digital Channel	- Segment of detection algorithm, actuation logic, and trip outputs designed for separation and independence

1.3 Installation Site:
Oconee Nuclear Station, Units 1, 2, and 3.
Seneca, South Carolina

1.4 References:

1.4.1. ANSI/IEEE 279-1971 Criteria for Protection Systems for Nuclear Power Generating Stations

1.4.2. ANSI/IEEE 323-1984 Qualifying Class 1E Equipment for Nuclear Power Generating Stations

1.4.3. ANSI/IEEE 344-1987 Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations

1.4.4. ANSI/IEEE 384-1981 Criteria for Independence of Class 1E Equipment and Circuits

1.4.5. BWNT Document Number 08-1213637-01, "Design Specification for STAR Module."

1.4.6. BWNT Document Number 08-1224843-00, "Design Specification for Calibration and Test Computer."

1.4.7. IEEE – 7.4.3.2, "Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations."

1.4.8. IEEE Standard 1016-1987, "Recommended Practice for Software Design Descriptions."

1.4.9. IEEE Standard 1016.1-1993, "Guide to Software Design Descriptions."

1.4.10. MIL STD 461C Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference

1.4.11. MIL STD 462 Measurement of Electromagnetic Interference Characteristics

1.4.12. NRC Generic Letter 95-02, "Use of NUMARC/EPRI Report TR-102348: Guideline on Licensing Digital Upgrades."

1.4.13. NRC Regulatory Guide 1.152, Revision 1, "Criteria for Programmable Digital

Computer System Software in Safety Systems of Nuclear Power Plants"

1.4.14. NRC Regulatory Guide 1.168, "Verification, Validation, Reviews, and Audits For Digital Computer Software in Safety Systems of Nuclear Power Plants"

1.4.15. NRC Regulatory Guide 1.169, "Configuration Management Plans for Digital Computer Software in Safety Systems of Nuclear Power Plants"

1.4.16. NRC Regulatory Guide 1.170, "Software Test Documentation for Digital Computer Software in Safety Systems of Nuclear Power Plants"

1.4.17. NRC Regulatory Guide 1.173, "Developing Software Life Cycle Processes for Digital Computer Software in Safety Systems of Nuclear Power Plants"

1.4.18. SAMA PMC 33.1-1978 Electro-Magnetic Susceptibility of Process Control Instrumentation

1.4.19. IEEE 472-1974 Guide for Surge Withstand Capability Tests

1.4.20. ANSI N45.2.2 Packaging and Shipping Requirements

2.0 OPERATING AND INSTALLATION CONDITIONS

The equipment shall be designed to remain functional over a projected plant life of 40 years under the normal service conditions listed below:

	Continuous	Accident
Temperature Range	60-110°F	40- 140 °F
Relative Humidity Range	30 – 80%	30 – 80%
Radiation (Rads)	1.0E3 R	9.0E3 R *
Duty Cycle	100%	100%
EMI/RFI	See Section 10.3	

* The system shall remain in a non-tripped state in a 9.0E3 R radiation environment. The Total Integrated Dose maximum is the sum of the continuous dose plus the accident dose (1E3 + 9E3 = 1E4 R).

3.0 EQUIPMENT TO BE FURNISHED

The project includes three digital control systems, one for each Oconee Unit. Each system shall have two independent, diverse digital channels of hardware/software.

Each digital channel shall be an assembly containing items 1 through 6, at a minimum, as revised from Framatome Budgetary Estimate FTI-99-1564:

1. Two (2) STAR Processor Modules

2. Two (2) Analog Voltage Isolation Modules (AVIM) including 500 ohm precision input resistors.

3. Pre-wired rack assemblies as required for mounting STAR Hardware in a Westinghouse cabinet.

4. Application software/firmware for the AFIS algorithm described in Appendix A for operation and testing of the system.

5. One Serial Bus Isolation Module (SBIM), or more as required, for remote monitoring to existing System Monitor Computer and interfacing with the plant computer.

6. Optional: Auxiliary Relay Modules (Class 1E) compatible with the rack assemblies.

7. One prototypical STAR Processor to test the algorithm. The prototype is a single shipment that is not associated with a digital channel delivery.

4.0 GENERAL DESIGN AND MATERIAL REQUIREMENTS

4.1. The general design of the system shall be consistent with the provisions of BWNT Document Numbers 08-1213637-01 and 08-1224843-00, unless required otherwise per this specification.

4.2. The design of the two diverse digital channels of AFIS digital controllers shall be single failure-proof, including protection from software induced system level failure.

4.3. The system shall be designed for electrical separation and independence of digital channels.

4.4. The analog input channels shall be designed for electrical separation and independence.

4.5. The system shall provide analog signal isolation between safety and non-safety related functions.

4.6. The pin assignments of the jacks for the STAR module should employ separation of safety and non-safety related functions as practical.

4.7. The mounting rack shall be capable of installation into an existing 19" standard Westinghouse cabinet. Specific measurements will be provided with award of order.

4.8. The Function Nameplate shall be marked as "AFIS". The ID label should be used to identify any unique configurations required for each digital channel, if needed.

5.0 COATINGS

5.1 The module front panel shall be primed and painted using ANSI 61 finish coat using procedures governed by the vendor's Quality Assurance Program.

6.0 SPECIAL REQUIREMENTS

6.1 Seismic Qualification

All hardware shall be seismically qualified to the requirements of Attachment 1.

6.2 STAR Processor Module Hardware Functional Requirements. (Refer to Appendix A for Software Requirements Specifications)

6.2.1 The module shall be plug-in compatible with Bailey 880 module racks used in the original Reactor Protection System. Power connection pin numbering and backplane connector type shall be the same as employed in Bailey 880 modules.

6.2.2 The physical design of the module shall permit operation without forced-air cooling. The modules shall permit operation with unassisted convection cooling from bottom to top compatible with the existing Westinghouse cabinet.

6.2.3 The two digital channels of digital control modules shall contain two diversely designed processors, each of which shall read the module inputs, process the protection function, and be capable of tripping the applicable trip output relay regardless of the operation of the other processor. See Appendix A for additional requirements.

6.2.4 The module shall contain the following input and output channels at a minimum:

a) Five 0 - 10 Vdc analog input channels, each read by both safety function processors. The design range accuracy of each channel from the point of input to the module to the conversion to digital value shall be equal to or better than 0.1% of full range, including resolution errors, plus 0.02% of full range for drift and temperature/humidity effects.

b) Four 0 - 10 Vdc analog output channels, controlled from one safety function processor. The design range accuracy of each analog output channel from the point of conversion from digital value to the point of output from the module shall be equal to or better than 0.1% of full range, including resolution errors, and drift and temperature/humidity effects.

c) Eight discrete input channels rated for 15 Vdc. The module shall contain an isolated voltage source for interrogating the inputs. The module shall also be capable of interfacing with external voltage sources for interrogation of the inputs.

d) Four optically isolated trip output contacts rated for up to 120 VAC / 125VDC at 1 ampere load. The trip output relays shall each be of a **non-fail-safe type.** The trip output shall be controlled from the safety function processor(s) through logic that shall cause the output contact to remain open upon a detected failure of a safety function processor. The trip outputs shall be open on a loss of power to the module and during module boot-up. If the safety processor(s) calculates a trip condition, then the output contact shall close. To support automated surveillance testing, the capability shall be provided to measure the voltage across each of these trip output contacts through a test connector on the module front panel. These contacts are intended for use in the trip relay string to the existing field components.

e) Six optically isolated auxiliary contacts rated for up to 120 VAC / 125VDC at 1 ampere load. The auxiliary relays shall be of a non-fail-safe type, controlled from the safety function processor(s) through logic that shall cause the contact to close upon a calculated trip condition. The outputs shall open on a loss of power to the module and during module boot-up. These contacts are typically used to control indicators and annunciators.

f) Two optically isolated status contacts rated for up to 120 VAC / 125VDC at 1 ampere load. The status relays shall be of a fail-safe type, controlled from the safety function processor(s). The output contacts shall close upon detection of a processor failure, loss of power, and module boot-up. These contacts are intended to provide outputs to indicate the operability status of the module.

g) Two optically isolated contacts rated for up to 120 VAC / 125VDC at 1 ampere load which are controlled from a keylock switch on the module front panel. The relays shall be energized when the switch is in the TEST, TUNE or CALIBRATE positions.

6.2.5 All analog outputs shall be driven to 0 Vdc and all discrete output relays under processor control shall be de-energized during power up and power down.

6.2.6 The module shall be configured to perform the protection function by installing a pre-programmed PROM into the module. The PROM shall contain the system and application-specific firmware for the safety function processors. Hardware shall prevent changes to this code (except for tuning and setpoint constants) while the module is in operation.

6.2.7 The tuning, scaling, and setpoint constants shall be contained in EEPROM. This EEPROM memory shall be capable of at least 100,000 write cycles.

6.2.8 The module shall contain a serial data bus for communication with a Calibration and Test Computer (CTC) directly or via the Serial Bus Isolation Module (SBIM). Communications interrupts from the serial data bus shall be handled in the module by a communications processor which is separate from the two safety function processors. When in the OPERATE mode it shall not be possible for communications on the serial data bus to prevent the module from performing its protection functions.

6.2.9 The module shall be capable of being separately addressed as a slave on the serial data bus (supplied by owner). The communications protocol shall permit separate addressing of up to 32 devices in each of four safety divisions. The serial data bus shall be compatible with RS 485 requirements. The serial data bus address of the module shall correspond to a unique physical location of the module in the system. The serial data string shall match a standard to be provided by the Owner.

6.2.10 The module shall have a means to support automated calibration of the analog inputs and outputs during surveillance testing. The analog circuits shall be of a low drift design to permit operation for a minimum of eighteen months between surveillance intervals without requiring recalibration.

6.2.11 To facilitate periodic surveillance testing, the module shall interface to test hardware as described in 6.3. The interfaces shall be a serial data bus and a front panel mounted test connector. The serial data bus shall be used for receiving commands and reference values from the test hardware and sending internal test results to the test hardware. The test connector shall provide connection points to all analog and discrete field inputs to the module and shall also provide connection points to the analog outputs and discrete trip outputs from the module.

6.2.12 LED indications and controls shall be visible and accessible at the module front panel. More than one indication may be provided by the same LED by means of continuous illumination versus flashing.

6.2.13 A system reset pushbutton shall be provided on the front plate to reinitialize the processors.

6.2.14 The module shall have four INPUT CHANNEL INOPERABLE pushbuttons on the frontplate of the module for each analog input channel.

6.2.15 The module shall be capable of being removed under power without damage to the module and without actuating the system.

6.2.16 Two PROMs, each one containing the program for one safety function processor, shall be contained in one installable part.

6.2.17 A keylock switch shall be provided on the module front panel for administratively controlling hardware interlocks for maintenance operations including testing, calibration and tuning of the module. The switch shall have four positions, OPERATE, TEST, TUNE AND CALIBRATE. The OPERATE position shall place the module in its normal mode of operation for performing the protection function. When the switch is in the CALIBRATE or TEST positions, the contacts should disconnect the selected field input from the modules and connect test points to the input. The vendor may elect to use the INOPERABLE INPUT pushbuttons as a means of inhibiting the affects of test inputs on the actuation logic. Refer to Appendix A Sections A3.2 and A7 for software requirements related to keyswitch positions.

6.2.18 Test jacks for input and output analog channels shall be provided for making voltage measurements of the signals on these channels. The jacks shall be selected to the individual channels by selector switches. The jacks shall be buffered to prevent shorted test leads, grounded test leads or EM/RF disturbances from affecting the field signal or the module operation.

6.2.19 The module shall permit adjustment of tuning and setpoint constants. This operation shall be possible only by placing the module into the TUNE mode using the keylock switch. A hardwired interlock shall be provided to prevent the tuning and setpoint constants from being altered when the keylock switch is not placed into the TUNE position.

6.2.20 To the extent practical, the module components shall be mounted on removable printed circuit boards.

6.2.21 The communication processor of the STAR module shall be configured to support RS-485 interface to the plant computer via the SBIM and an owner provided gateway, if needed.

6.2.22 A prototype STAR controller shall be provided to test the features described in Section 6.2 and Appendix A with the exception of the redundant processor functions.

6.3 Calibration and Test Computer (CTC) [Refer to FTI Contract No. 4150190]

6.3.1 The AFIS STAR modules shall be designed to interface with the existing CTC per BWNT Document Number 08-1224843-00 unless otherwise stated.

6.3.2 The CTC shall communicate on the STAR System RS 485 serial data bus.

6.3.3 The CTC operator interface shall consist of a special function and numeric keypad and a menu-driven screen display. The software requirements for these functions are listed in Appendix A.

6.4 Serial Data Bus Isolation Module (SBIM)

6.4.1 The SBIM shall support a serial interface with the plant computer via an owner supplied gateway as needed.

6.4.2 An SBIM module shall be pre-wired in the mounting rack provided with each digital channel.

6.5 Analog Voltage Isolation Module (AVIM)

6.5.1 The Analog Voltage Isolation Module shall convert 4-20 mA inputs from Rosemount transmitters using 500 ohm precision resistors to generate isolated 2 - 10 Vdc inputs to the STAR Processor Module. The AVIM input voltage signals shall be wired in parallel to additional inputs to provide isolated 2 - 10 Vdc outputs capable of driving loads up to 2000 ohms. This isolation is required for sending analog signals generated in a safety division to non-safety systems. Each module shall contain provisions for up to 6 separate channels.

6.5.2 The AVIM shall contain test jacks on the front panel for reading the outputs from each channel.

6.5.3 The signal common shall be isolated from chassis ground and from power ground reference.

6.5.4 The input-to-output and input-to-input galvanic isolation capability shall be a minimum of 500 Vac ± 700 Vdc.

6.5.5 Front accessible calibration adjustments for zero and gain shall be provided for each analog channel. Total long term drift shall not exceed 3.5×10^{-3} mV/Hr. Total temperature drift shall not exceed 2.5 mV/°C.

7.0 QUALITY ASSURANCE REQUIREMENTS AND DOCUMENTATION

7.1 The design, manufacture, inspection and verification and validation of materials, components or services required by this specification shall be provided in accordance with the Vendor's quality assurance program which has been specifically evaluated by the Duke Power Supplier Verification Department. Subsequent to this approval, the Vendor shall notify the Duke Power Supplier Verification Department of any changes in the approved program.

7.2 The Duke Power Supplier Verification Department bases its approval of the Vendor's quality assurance program on the requirements of American National Standards Institute N45.2-1977, Quality Assurance Program Requirements of 10CFR50 Appendix B, Quality Assurance Criteria.

7.3 This specification covers equipment, systems structures, and/or materials important to Nuclear Safety, CLASS 1E. It is essential that they meet the quality standards of this specification and referenced codes, standards, and guides.

7.4 The vendor shall provide documentation to certify compliance with the regulatory documents listed in Section 1.4 of this specification. A schedule for the delivery of such certification documentation shall be provided for Owner approval within four weeks after award of order. Delivery of all documentation shall be completed upon delivery of the initial system.

7.5 Quality Assurance documentation shall be delivered to Oconee QA Receiving / ON02PE, 7800 Rochester Highway, Seneca, SC 29672.

7.6 Site activities will be performed in accordance with Owner's Quality Assurance Plan.

7.7 Certification of the AFIS design in conformance to Safety Evaluation Report (SER) for Topical Report BAW-10191P, "STAR System Upgrades for Reactor Protection System Digital Upgrades", September 1994, or technical justification for exceptions, shall be provided ten (10) weeks after receipt of order.

7.8 Seven (7) copies of Quality Assurance documentation to be provided shall include a certificate of conformance. Seven (7) copies of Test Summary Reports which include tests as required in Section 10 of this specification and seismic test results for all the appropriate STAR System hardware (STAR Module, AVIM, SBIM, CTC, etc.) shall also be provided ten (10) weeks after receipt of order.

7.9 All software used in the STAR System components shall be verified and validated by the Vendor in accordance with RG 1.152 and IEEE-ANS-7-4.3.2-1993.

8.0 DELIVERY

8.1 Delivery of the system and prototype shall be in accordance with the schedule provided on the Owner's purchase order.

8.2 The Vendor shall provide a written progress report each month (minimum) to J.H. Bryan, Oconee Nuclear, 7800 Rochester Highway, Seneca, SC 29672, to communicate status of deliverables and any pertinent information required to support the project. The progress report may be transmitted electronically to jhbryan1@duke-energy.com, if preferred.

8.3 Shipping and packing requirements are listed on Attachment 2.

8.4 Before final shipment of the material the Vendor must first obtain approval from the Owner. Approval will be based on the satisfactory completion of all requirements of the equipment specification including all phases of quality assurance documentation required by the Owner.

9.0 VENDOR DRAWINGS

9.1 The Vendor shall prepare and submit seven (7) prints each of all drawings to J.H. Bryan/ON02MO, Duke Power Company, Oconee Nuclear Station, 7800 Rochester Hwy, Seneca, SC 29672. Also submit 1 copy each of the files for all CAD drawings. The preferred vector image file type format is MicroStation DGN, but AutoCAD DWG formats will be accepted. Any drawings revised by the contractor as stated below will require re-submittal of the CAD file along with new prints. The prints and CAD files are to be submitted within eight weeks of award of order and are to be full-size and legible with uniform background density suitable for microfilming and subsequent reproduction from microfilm. These prints will be reviewed by the Owner and, if satisfactory, will be approved. If requested, one copy of each print so marked, will be returned to the Vendor. If not satisfactory, the prints will be appropriately marked and one copy of each print returned to Vendor for correction after which seven (7) prints of the drawings as corrected shall again be submitted to the Owner for approval. The Vendor shall make any corrections required by the Owner and appropriately note any changes by dated revisions on the drawings.

9.2 The following Drafting Lettering Standards should apply, as all drawings are to be microfilmed by the Owner.

- 9.2.1 Minimum character height (A, B and C size dwg) - 0.125 in. (1/8)
- 9.2.2 Minimum character height (D and E size dwgs) - 0.156 in. (5/32)
- 9.2.3 Minimum spacing between lines of characters - height of characters
- 9.2.4 Guide generated characters - 12 point size minimum
- 9.2.5 Density of Characters and line - Dense, Sharp, and Uniform

9.3 All drawings and correspondence shall show the Owner's Purchase Order Number.

9.4 The Vendor shall clearly identify the applicable drawings as QA CONDITION 1. The drawings should clearly differentiate between QA Condition and non-QA Condition parts and components.

9.5 A Field Change Package (FCP) shall be provided which illustrates the details for installing the STAR Hardware in the Owner's existing Westinghouse SGLC Cabinets. This FCP shall be sent to Owner ten (10) weeks after receipt of order.

9.6 Seven (7) copies of instruction manuals shall be provided to the Owner for review which describe the operation of the STAR System components, installation, operating, calibration, testing and troubleshooting instructions, equipment specifications, and spare parts list. These manuals shall be sent to Owner ten (10) weeks after receipt of order.

9.7 Schematic diagrams (SAMA logic) and connection diagrams of each system shipped which describes the input and output relationship to the control algorithm shall be provided for Owner review within ten (10) weeks after receipt of order.

9.8 The Vendor shall make any corrections required by the Owner and appropriately note any changes by dated revisions and brief description of change on the documents; after which, seven (7) copies of the documents as corrected shall again be submitted to the Owner.

9.9 If the drawings are not acceptable to the Owner for microfilming, the Vendor shall furnish full-size copies (number to be determined later) of all drawings for the Owner's records within 15 days of receipt of drawing approval.

9.10 Seven (7) copies of Topical Report (BAW-10191P, Revision 1), or equivalent, shall be provided four (4) weeks after receipt of order.

9.11 The Vendor shall submit six (6) months after receipt of order a Software Design Description in conformance with IEEE-1016-1987 and IEEE-1016.1-1993 for owner approval.

9.12 Documentation previously supplied by the vendor that does not require revision may be used with owner approval to meet the requirements of Sections 9 and 10 of this specification.

10.0 TEST AND INSPECTIONS

10.1 The STAR System components shall be tested to demonstrate operability under the environmental conditions stated in Section 2.0. The applicability of each test to a particular component shall be as described in the test requirement. Testing shall be performed in accordance with IEEE 323 - 1984.

10.2 The STAR System components shall be qualified for operability under the seismic conditions stated in Appendix A. The qualification shall be performed in accordance with IEEE 344 - 1987. The STAR Processor Module shall remain functional during and after the Safe Shutdown Earthquake (SSE). The SBIM and AVIM shall not fail during the SSE in a manner that could prevent the STAR Processor Module or other components in the electrical cabinet from performing their safety function.

10.3 The STAR System components shall be tested to meet the electro-magnetic compatibility (EMC) requirements given below.

10.3.1 The STAR Processor Module, SBIM and AVIM shall be tested for susceptibility to noise on the power and signal leads in accordance with MIL-N-19900B.

10.3.2 The STAR Processor Module and SBIM shall be tested to demonstrate their capability to withstand voltage surges at the power and signal inputs using the procedure of IEEE 472-1974. The same tests shall be performed on the AVIM power and output signal leads.

10.3.3 The STAR Processor Module and SBIM shall meet their performance requirements when exposed to electromagnetic fields of 10 volts/meter throughout a frequency range of 0.014 MHz to 1000 MHz using both a continuous and keyed test field in accordance with SAMA PMC 33.1-1978, MIL STD 461C, and MIL STD 462.

10.3.4 The STAR System components shall be tested to demonstrate that they are electromagnetically compatible with each other, with representative components in the existing cabinet, and with interfacing systems components. Such components include Cutler Hammer Type D26 relays with transzorbs, Bailey auxiliary Relay modules, and Rosemount 1154 pressure transmitters with 500 ohm shunt resistors.

10.4 The STAR System components shall be tested for operability at power input voltage variations of +/- 10% of the component nominal rated voltage.

10.5 The SBIM and AVIM shall be tested to demonstrate their ability to isolate against fault voltages and grounds which are applied to the isolated conductors of the devices in either of the following manners: (1) between the signal and return conductors (transverse fault mode) and (2) between either the signal or return and ground (common mode fault). The applied fault voltage shall be 120 Vac and 125 Vdc. The non-isolated conductors of the SBIM and AVIM shall be connected to a STAR Processor Module during the test. The applied faults shall not affect the SBIM or AVIM in a manner that could prevent the STAR Processor Module from performing its safety function.

10.6 The STAR System components excluding the CTC shall be tested or analyzed to demonstrate operability after exposure to the radiation levels stated in Section 2.0.

11.0 SPARE PARTS

The Vendor shall furnish, with proposal or at some later date, a list of recommended spare parts with itemized prices. Spare parts specified in accordance with this specification shall be equal to or better in fit, form and function than the original item purchased under this specification.

12.0 DISCREPANCIES AND INTERPRETATION

Should a Vendor find discrepancies in, or omissions from, the specifications, or be in doubt as to their meaning, he shall notify the Owner who will issue a written interpretation.

13.0 CONFORMANCE WITH SPECIFICATIONS

The Vendor shall notify the Owner of any and all exceptions to specifications. No variations without written approval of Owner will be permitted. A statement indicating conformance should be included if no exceptions are taken.

14.0 CONSTRUCTION SERVICES

The Owner shall furnish construction personnel for the implementation of the hardware and interface wiring.

15.0 ERECTION ENGINEER

The Vendor shall provide an erection engineer to support system commissioning following implementation.

16.0 ATTACHMENTS

Appendix A "Software Requirements Specification "

Attachment 1 "Specification for Seismic Qualification of Equipment"

Attachment 2 "Packing and Shipping Requirements"

Attachment 3 OSS-0278.00-00-0001 "Year 2000 Criteria"

APPENDIX A

Automatic Feedwater Isolation System (AFIS) Software Requirements Specification

A.1 INTRODUCTION

A.1.1 PURPOSE

This appendix is intended to define the software requirements in compliance with NRC Regulatory Guide 1.172, which endorses IEEE 803-1993. This document defines the requirements of the software application to the vendor software development team.

A.1.2 SCOPE

This appendix contains the software functional requirements for the AFIS protection function for the STAR Processor Module, Calibration and Test Computer, and System Monitor Computer. The software is required to control normal operation, perform on-line testing, and perform self-diagnostics of hardware/software failures. The requirements for STAR Module testing and diagnostics, for the CTC, and for the System Monitor Computer are consistent with BWNT Document No.s 08-1213637-01 and 08-1224843-00, unless otherwise specified in this appendix.

A.1.3 DEFINITIONS

AFIS	Automatic Feedwater Isolation System
EFW	Emergency Feedwater System
MDEFWP	Motor Driven EFW Pump
TDEFWP	Turbine Driven EFW Pump
MFW	Main Feedwater
MSLB	Main Steam Line Break
Trip	Digital output contact used for protection system actuation
Analog Channel	Input of the system designed for separation and independence
Digital Channel	Detection algorithm, actuation logic, and trip outputs designed for separation and independence

A.1.4 REFERENCES

ANSI/IEEE-ANS-7-4.3.2-1982, Application Criteria for Programmable Digital Computer Systems in Safety Systems of Nuclear Power Generating Stations

NRC Regulatory Guide 1.152, Revision 1, " Criteria for Programmable Digital Computer System Software in Safety Systems of Nuclear Power Plants"

NRC Regulatory Guide 1.169, " Configuration Management Plans for Digital Computer

Software in Safety Systems of Nuclear Power Plants"

NRC Regulatory Guide 1.170, " Software Test Documentation for Digital Computer Software in Safety Systems of Nuclear Power Plants"

NRC Regulatory Guide 1.173, " Developing Software Life Cycle Processes for Digital Computer Software in Safety Systems of Nuclear Power Plants"

BWNT Document Number 08-1213637-01, " Design Requirements for STAR Module"

BWNT Document Number 08-1224843-00, " Design Requirements for Calibration and Test Computer"

A.2 GENERAL DESCRIPTION

AFIS is a Class 1E, nuclear safety related protection system which terminates all feedwater to the affected steam generator following a Main Steam Line Break (MSLB) event. The software requirements for AFIS are modeled for integration into the Framatome STAR platform as depicted in the body of this specification. Detection of the MSLB event is accomplished by monitoring four pressure transmitters on each of the two main steam headers. Single failure and on-line testing criteria require that the system employ two out of four channel logic for system actuation. There are two levels of system trips. (Trip #1) A Main FDW trip and TDEFWP isolation occurs when two out of four Main Steam Pressure analog channels below setpoint. (Trip #2) A MDEFW trip occurs when two out of four Main Steam Pressure channels on the affected header fall below setpoint concurrent with a high rate of depressurization. The rate of depressurization trip is enabled when Main Steam Pressure is less than 800 psig. Upon a system trip actuation, the digital control system provides relay outputs (closed contacts) that the owner will configure to interface with field components. Trip #1 will isolate steam to the TD EFW pump and isolate FDW by tripping both FDW pumps and by closing FDW valves on the depressurized header. Trip #2 will trip the MD EFW pump on the depressurized header. These trip contacts shall remain open for all diagnosed failure modes. A serial communication interface transmits the system status to the plant computer. An acceptable graphical representation of the AFIS function is illustrated in Figure A1. Refer to Section 6.0 of the specification for STAR hardware functional requirements.

Testing and monitoring software functions on the Calibration and Test Computer (CTC) shall be permitted by operation of the STAR module keyswitch.

The following describes the software relationship to the hardware and interfaces.

APPENDIX A

A.2.1 Analog Input Interfaces

All analog inputs AIN1, AIN2, AIN3 and AIN4 are derived from owner supplied Rosemount 1153 and 1154 transmitters with a 4-20mA output across a 500Ω resistor to provide a valid 2-10 volts input signal to the AVIM. The AVIM supplies the isolated analog inputs to the STAR modules. The valid range for the remaining spare analog inputs is 0 to 10 volts.

A.2.2 Digital Input Interfaces

The owner supplied input devices are nuclear grade relay and control switch contacts. The vendor shall interface the software with the pushbuttons on the STAR module front plate. The software shall determine the state of the contacts by voltage presence. Front panel pushbuttons shall be used to manually disable an inoperable analog channel. The corresponding LEDs shall illuminate and flash be used to indicate an analog channel being tripped or bypassed, respectively. The same pushbutton shall be used to reset the manually bypassed (INOPERABLE) analog channel and extinguish the LED. A remote pushbutton supplied by the owner shall reset the rate of depressurization latch.

A.2.3 Analog Output Interfaces

The AFIS control scheme does not require any analog outputs from the STAR modules. There are no specific software requirements for analog outputs.

A.2.4 Digital Output Interfaces

Digital trip outputs from the STAR module shall interface with Bailey 880/881 Auxiliary Relay modules or standard industrial relays to perform the required trip functions. Upon detection of a MSLB event, the trip output contacts shall close. The trip output contacts shall remain open for all other conditions including loss of power and all detected failures. The status alarm digital output contact shall close on errors per Section 6.2.4-f and upon activation of the Inoperable Input Channel pushbuttons on the module frontplate.

The auxiliary digital outputs shall open in the normal state and close in the logic true state to provide non-safety related status indication. The auxiliary output contacts shall remain open for all other conditions including loss of power and all detected failures.

The processor status digital outputs shall close to provide module operability monitoring upon detection of processor failure, loss of power, and module boot-up. The status outputs shall be open for normal operating conditions.

APPENDIX A

The keyswitch status contacts are to be provided for indication on the plant computer of testing and tuning conditions. Operation of the keyswitch should disable the trip outputs and enable the test inputs of the module as required.

A.2.5 Serial Communication Interfaces

The RS485 communication processor of the STAR module shall transmit the status of the following parameters at a minimum to the plant computer via the SBIM and a serial gateway (provided by the owner): (Refer to Table A1 for parameter descriptions.)

- Input Channel Inoperable pushbuttons
- H1 through H4 low pressure logic outputs
- H5 through H8 high rate of depressurization logic outputs
- Digital outputs.

The format of the serial data string shall be in the following format:

TAB <Data> TAB <Data> TAB <Data> TAB <Data> TAB <Data>TAB <Data> TAB <Data> TAB <Data> TAB <Data> TAB <Data> TAB <Data> TAB <Data> TAB <Data> TAB <Data> TAB <Data> EOT,

The TAB represents an ASCII 009 and the End Of Transmission is an ASCII 004.
The vendor may elect to offer an alternate proposal to the owner to support this function.

A.2.6 Calibration and Test Interfaces

Communication between the system software and the CTC is accomplished using a separate processor that provides serial data exchange. The operation of the safety processors shall be independent of the communication processor. The CTC shall be used to modify the applicable Tuning Parameters listed in Table A1. Online testing of analog input channels is accomplished by isolating each input with Owner supplied test switches and test points. The frontplate pushbuttons (PB1-4) must inhibit the logic for the channel in test.

APPENDIX A

Table A1: Signal, Parameter and Variable Descriptions				
Symbol	**Description**	**Units**	**Valid Range**	**Notes**
T_1	First time scan	Seconds	N/A	From system clock or timer
T_2	Second time scan	Seconds	N/A	From system clock or timer
DT	$T_2 - T_1$ time period	Seconds	1 – 10 seconds	User defined parameter via CTC
$P1_1$	MS Pressure Ch. 1 at T_1	0-1200 psig	2 – 10V	From analog input AIN1
$P1_2$	MS Pressure Ch. 1 at T_2	0-1200 psig	2 – 10V	From analog input AIN1
DP1	Ch. 1 Delta Pressure $P1_2 - P1_1$	-1200 to +1200 psig	(-10) to +10V	From analog input AIN1. This value is negative for falling pressure.
R1	Ch. 1 rate of depressurization	Psig/sec	(-10) to +10V/sec	From analog input AIN1
H1	Ch.1 low pressure trip	Digital	0 or 1	Logic 1 is low pressure trip = True.
H5	Ch. 1 high rate of depressurization condition	Digital	0 or 1	Logic 1 is high rate = True.
A1	Ch. 1 rate of depressurization trip	Digital	0 or 1	Logic 1 is high rate trip = True
$P2_1$	MS Pressure Ch. 2 at T_1	0-1200 psig	2 – 10V	From analog input AIN2
$P2_2$	MS Pressure Ch. 2 at T_2	0-1200 psig	2 – 10V	From analog input AIN2
DP2	Ch. 2 Delta Pressure $(P2_2 - P2_1)$	-1200 to +1200 psig	(-10) to +10V	From analog input AIN2. This value is negative for falling pressure.
R2	Ch. 2 rate of depressurization	Psig/sec	(-10) to +10V/sec	From analog input AIN2
H2	Ch.2 low pressure trip	Digital	0 or 1	Logic 1 is low pressure trip = True.
H6	Ch. 2 high rate of depressurization condition	Digital	0 or 1	Logic 1 is high rate = True.
A2	Ch. 2 rate of depressurization trip	Digital	0 or 1	Logic 1 is high rate trip = True
$P3_1$	MS Pressure Ch. 3 at T_1	0-1200 psig	2 – 10V	From analog input AIN3
$P3_2$	MS Pressure Ch. 3 at T_2	0-1200 psig	2 – 10V	From analog input AIN3
DP3	Ch. 3 Delta Pressure $(P3_2 P3_1)$	-1200 to +1200 psig	(-10) to +10V	From analog input AIN3. This value is negative for falling pressure.
R3	Ch. 3 rate of depressurization	Psig/sec	(-10) to +10V/sec	From analog input AIN3

APPENDIX A

Table A1: Signal, Parameter and Variable Descriptions				
Symbol	**Description**	**Units**	**Valid Range**	**Notes**
H3	Ch.3 low pressure trip	Digital	0 or 1	Logic 1 is low pressure trip = True.
H7	Ch. 3 high rate of depressurization condition	Digital	0 or 1	Logic 1 is high rate = True.
A3	Ch. 3 rate of depressurization trip	Digital	0 or 1	Logic 1 is high rate trip = True
$P4_1$	MS Pressure Ch. 4 at T_1	0-1200 psig	2 – 10V	From analog input AIN4
$P4_2$	MS Pressure Ch. 4 at T_2	0-1200 psig	2 – 10V	From analog input AIN4
DP4	Ch. 4 Delta Pressure ($P4_2 - P4_1$)	-1200 to +1200 psig	(-10) to +10V	From analog input AIN4. This value is negative for falling pressure.
R4	Ch. 4 rate of depressurization	Psig/sec	(-10) to +10V/sec	From analog input AIN4
H4	Ch.4 low pressure trip	Digital	0 or 1	Logic 1 is low pressure trip = True.
H8	Ch. 4 high rate of depressurization condition	Digital	0 or 1	Logic 1 is high rate = True.
A4	Ch. 4 rate of depressurization trip	Digital	0 or 1	Logic 1 is high rate trip = True
LP	2 out of 4 logic low pressure trips	Digital	0 or 1	Logic 1 = Trip Condition #1
LR	2 out of 4 logic rate of depressurization trips	Digital	0 or 1	Logic 1 = Trip Condition #2
SP_1	Low Pressure setpoint	0-1000 psig	0 – 10V	User defined parameter.
SP_2	Rate of depressurization setpoint	0-20 psig/sec	(-10) to +10V/sec	User defined parameter
SP_3	Rate of depressurization permissive	500-1000 psig	0 – 10V	User defined parameter
SR1	Master reset trip flip flop	Digital	0 or 1	Logic = Set Trip Condition #1
SR2	Master reset trip flip flop	Digital	0 or 1	Logic = Set Trip Condition #2

A.3 MODULE FUNCTIONAL REQUIREMENTS

The functional requirements of the STAR processors are depicted on Figure A1. The requirements apply to all safety processors on all digital channels. Refer to Table A1 for clarification of signal function tags.

A.3.1 Software Requirements For Keyswitch In OPERATE Position

A.3.1.1 During module power-up and initialization, the program shall perform the following:

a) Verify module identification, configuration of internal boards, and position.
b) Verify safety and communication processors.
c) Check RAM memory locations including read/write errors and coupling faults.
d) Check data and address lines for hang ups and coupling faults.
e) Test EEPROM memory by checksums.
f) Validate setpoints and scaling parameters by checksums.
g) Test peripherals and inputs/outputs.
h) Perform the program algorithm that exercises the instruction set, except those that may affect the program outputs.
i) Check of analog to digital converter and multiplexer.
j) Provide a signal to the MAINT LED to indicate performance of startup tests.
k) Failure of any of the above functions shall result in stopping the processors.
l) Provide a signal to reset the MAINT LED and illuminate the μP LEDs upon successful completion of the power up tests.

A.3.1.2 The protection software functions shall perform of the following:

a) Read and store values of the analog and digital inputs and outputs.

b) Provide a high (1) input (H1–H4) to the Low Pressure two out of four logic (LP) if the value of an analog input descends below the low pressure setpoint SP1 for two seconds. {Basis – The 2 second timer allows validation of steam line breaks.}

c) Provide a high output from the Low Pressure two out of four logic (LP) if any two of the Low Pressure inputs (H1-H4) are high (1).

APPENDIX A

d) Enable the inputs (H5-H8) to the rate of depressurization logic when pressure descends below the permissive setpoint (SP3).

e) Provide a high (1) input (H5-H8) to the Rate of Depressurization two out of four logic (LR) if the value of an analog input exceeds the rate of depressurization setpoint SP2. The symbols used in the following equations are described in Table A1. Rate of depressurization is calculated as a positive value by the following equations:

$R1 = -(P1_2 - P1_1) / (T_2 - T_1) = dP1/dT$ Analog Channel 1
$R2 = -(P2_2 - P2_1) / (T_2 - T_1) = dP2/dT$ Analog Channel 2
$R3 = -(P3_2 - P3_1) / (T_2 - T_1) = dP3/dT$ Analog Channel 3
$R4 = -(P4_2 - P4_1) / (T_2 - T_1) = dP4/dT$ Analog Channel 4

f) Provide a high output from the Rate of Depressurization two out of four logic (LR) if any two of the Rate of Depressurization inputs (A1-A4) are high (1). The LR output is not latched. A valid MSLB event will cause continuous depressurization below the low pressure setpoint.

g) The output of the Low Pressure two out of four logic (LP) sets Master Reset Flip-Flop (SR1) to high (1) to trip a digital trip output contact (Trip #1 DOUT1, FDW isolation).

h) The output of the Rate of Depressurization two out of four logic (LR) shall drive a user-definable timer (0-30 secs) which triggers a non-safety, digital alarm output DOUT3.

i) If the output of the Rate of Depressurization two out of four logic (LR) AND the output of the Low Pressure two out of four logic (LP) are high (1), then Master Reset Flip-Flop (SR2) is set high (1) to trip an output contact (Trip #2 DOUT2; MDEFW Trip).

j) The Trip #1 and Trip #2 output contacts DOUT1 and DOUT2 shall be forced to the low (0) state when an external DIGITAL CHANNEL DISABLE switch contact (DIN1) is closed (logic 1).

k) The Master Set Flip-Flops (SR1 and SR2) are reset by an external DIGITAL CHANNEL DISABLE switch on digital input DIN1.

l) The Analog Channel 1 logic outputs of H1 and A1 shall be forced to a low (0) state when " Analog Channel 1 Inoperable" frontplate pushbutton PB1 is pressed. PB1 is also used for on-line testing.

m) The Analog Channel 2 logic outputs of H2 and A2 shall be forced to a low (0) state when "Analog Channel 2 Inoperable" frontplate pushbutton PB2 is pressed. PB2 is also used for on-line testing.

n) The Analog Channel 3 logic outputs of H3 and A3 shall be forced to a low (0) state when "Analog Channel 3 Inoperable" frontplate pushbutton PB3 is pressed. PB3 is also used for on-line testing.

o) The Analog Channel 4 logic outputs of H4 and A4 shall be forced to a low (0) state when "Analog Channel 4 Inoperable" frontplate pushbutton PB4 is pressed. PB4 is also used for on-line testing.

A.3.1.3 The program shall perform the following On-line Diagnostics and make the results available on the data bus:

a) Test critical RAM locations used by the safety program including checking for read/write errors and coupling faults.

b) Check data and address lines, except those that may affect the program outputs, for hang ups and coupling faults.

c) Test EEPROM memory by checksums.

d) Validate setpoints and scaling parameters by checksums.

e) Test peripherals and inputs/outputs.

f) Perform the program algorithm that exercises the instruction set, except those that may affect the program outputs.

g) Check of analog to digital converter and multiplexer.

h) Check watchdog timer to verify proper operation of program cycle.

A.3.2 Software Requirements For Keyswitch In TEST Position (Refer to Section A4 for testing program requirements of CTC.)

A.3.2.1 In the TEST mode, the safety function processors shall perform the same software routines as in the OPERATE mode.

APPENDIX A

A.3.2.2 Test programs shall be enabled only when the keyswitch is in the TEST position.

A.3.2.3 Software, or a hardware interlock such as the front plate pushbuttons, shall inhibit the affects of a test input of an Analog Channel on the actuation logic.

A.3.2.4 The analog input channels not being tested shall be fully functional in a two out of three logic configuration to perform the safety trip function.

A.3.3 Software Requirements For Keyswitch In CALIBRATE Position

A.3.3.1 The software shall allow calibration of the analog inputs via the CTC.

A.3.3.2 The software, or hardware interlocks such as the front plate pushbuttons, shall inhibit the affects of the analog input being calibrated on the actuation logic.

A.3.3.3 The analog input channels not being calibrated shall be fully functional in a two out of three logic configuration to perform the safety trip functions.

A.3.4 Software Requirements For Keyswitch In TUNE Position

A.3.4.1 The software shall allow the ability to change the setpoints and tuning parameters via the CTC.

A.3.5 Software Requirements for Human Interfaces

A.3.5.1 The availability of suitable power to the module components shall be indicated by the continuous illumination of a POWER LED.

A.3.5.2 Operability status of the safety function processor(s) shall be indicated by separate LEDs for each processor. The LEDs shall also, by their steady on or flashing operation, differentiate between the OPERATE mode and the CALIBRATE or TUNE modes of the processor. A lockup of a processor shall not place the respective LED in a continuously energized state.

A.3.5.3 Indication that the module is in a mode other than OPERATE shall be indicated by an LED and the status alarm digital output.

A.3.5.4 The module configuration mismatch condition shall be indicated by an LED.

APPENDIX A

A.3.5.5 The tripped status of the two trip conditions shall be indicated by the continuous illumination of trip LEDs. Only those LEDs controlled by protection functions shall be able to be illuminated.

A.3.5.6 All logic latch functions shall be able to be manually reset using a remote digital input after the plant parameters have returned to normal.

A.4 CALIBRATION AND TEST COMPUTER REQUIREMENTS

A.4.1 The Vendor shall provide revised software for the existing Oconee CTC to enable testing of the AFIS system when permitted by keyswitch hardware interlocks. Menu options shall allow the user to select AFIS test programs.

A.4.2 General requirements of the CTC software shall include menu-driven screens that support the following operations:

A.4.2.1 Permit viewing, storing, and recording module status, internally stored data and system variable data from STAR Processor Modules in the system.

A.4.2.2 Monitoring up to four isolated divisions in the system.

A.4.2.3 Display of operator-selected plant process parameters and internal calculated parameters and setpoint constants.

A.4.2.4 Display of the status (OPERATE, TEST, TUNE, TRIPPED or FAULT) of each STAR Processor Module in the system.

A.4.2.5 Display module diagnostics test data, including counters to show the number of times each diagnostic test is performed, the test result (OK or FAILED) and communication status.

A.4.2.6 Read values of each field Analog Input Channels and digital inputs from each safety function processor.

A.4.2.7 View STAR Processor Module trip report screen which displays the tripped/untripped status of both safety function processors for a selected module, and the values of pertinent parameters at the time of the most recent trip. The screen shall also provide a means of generating report files and retrieving report files from previous trips and displaying this data.

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A.4.2.8 Setting the clock and calendar in the CTC.

A.4.2.9 Calibration of CTC inputs using five point method.

A.4.2.10 A file screen for creating data files specific to each of the screens identified above. The file screen shall provide for automatic file naming that relates the file to a specific functional screen, the applicable safety division, module, and safety function, and a file sequence number. Files created from this screen shall be in ASCII format to support use of the data with commercially available software. This screen shall provide the capability to save data to a new or existing file, retrieve data from a file to the respective screen for that file type, and to print from a display or from a file.

A.4.3 With the STAR module keyswitch in the TUNE position, the CTC software shall permit or perform the following functions:

A.4.3.1 The CTC shall verify and display that the keyswitch is in the TUNE position.

A.4.3.2 STAR Processor Module tuning, including the ability to display existing setpoint and tuning constants for each safety function processor in the module and to enter to the screen and download new constants to the module.

A.4.3.3 The operator shall only need to enter one set of constants, which shall be sent to both safety function processors.

A.4.3.4 During uploads from the module, the CTC shall compare the constants from each safety function processor and indicate any mismatching data.

A.4.3.5 Constants shall be capable of entry manually or by data retrieved from a file.

A.4.4 With the STAR module keyswitch in the CALIBRATE position, the CTC software shall permit or perform the following functions:

A.4.4.1 The CTC shall verify and display that the keyswitch is in the CALIBRATE position.

A.4.4.2 Generating analog output signals to the STAR Processor Module and reading analog input signals from the module with an accuracy of +/- 0.025% of full range for automatic testing of the rate of depressurization and low pressure setpoints.

A.4.4.3 Automatic calibration and accuracy checking of the STAR Processor Module analog input channels including analog to digital converters.

A.4.4.4 Provide a report that calculates the percent of full range error and the acceptable limits.

A.4.4.5 The CTC shall prompt the user of any required external functions, such as use of the INOPERABLE INPUT pushbutton, required for calibration.

A.4.5 With the STAR module keyswitch in the TEST position, the CTC software shall permit the following functions:

A.4.5.1 The CTC shall verify and display that the keyswitch is in the TEST position.

A.4.5.2 Automatic or manual testing of the STAR Processor Module trip outputs and time response of each protection function.

A.4.5.3 On command from the operator, test cases shall be performed automatically by the CTC or manually to test sample trip scenarios where the test channel input parameter exceed setpoints. Each analog input channel shall be tested individually with the results displayed on-screen with the appropriate tags per Table A2. The initial test case identified as Test Case 001 shall be provided that is intended for use during surveillance testing of the Processor Module. The test case number shall increment as the program varies the pressure input and rate of depressurization from 0 volts to the required low pressure and rate of depressurization setpoints.

A.4.5.4 The test case is designed to test the time response for trips caused by a change in pressure. Hardware filter time lag shall not be considered in the test.

A.4.5.5 The trip time for a successful response time test should be less than 250 milliseconds from detection of the event. The basis of this requirement is to minimize the AFIS time delay contribution to the total isolation time.

A.4.5.6 Measuring the elapsed time from the initiation of a test trip condition to the receipt of a trip response from the STAR Processor Module trip output. The accuracy of the elapsed time measurement shall be +/- 0.005 seconds or better when measuring the response to a step input to the module.

A.4.5.7 The CTC shall prompt the user of any required external functions, such as use of the INOPERABLE INPUT pushbutton, as required for testing.

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A.4.6 The Tag Numbers (instrumentation numbers) that shall be used for CTC display screens are listed in Table A2.

Table A2: Tag Numbers (Unit 1)				
Input	Tag Number			
	Digital Channel 1A	Digital Channel 1B	Digital Channel 2A	Digital Channel 2B
AIN1	1MS PT0279	1MS PT0277	1MS PT0279	1MS PT0277
AIN2	1MS PT0280	1MS PT0278	1MS PT0280	1MS PT0278
AIN3	1MS PT1006	1MS PT1007	1MS PT1006	1MS PT1007
AIN4	1MS PT1008	1MS PT1009	1MS PT1008	1MS PT1009

Table A2: Tag Numbers (Unit 2)				
Input	Tag Number			
	Digital Channel 1A	Digital Channel 1B	Digital Channel 2A	Digital Channel 2B
AIN1	2MS PT0279	2MS PT0277	2MS PT0279	2MS PT0277
AIN2	2MS PT0280	2MS PT0278	2MS PT0280	2MS PT0278
AIN3	2MS PT1006	2MS PT1007	2MS PT1006	2MS PT1007
AIN4	2MS PT1008	2MS PT1009	2MS PT1008	2MS PT1009

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Table A2: Tag Numbers (Unit 3)				
Input	Tag Number			
	Digital Channel 1A	Digital Channel 1B	Digital Channel 2A	Digital Channel 2B
AIN1	3MS PT0279	3MS PT0277	3MS PT0279	3MS PT0277
AIN2	3MS PT0280	3MS PT0278	3MS PT0280	3MS PT0278
AIN3	3MS PT1006	3MS PT1007	3MS PT1006	3MS PT1007
AIN4	3MS PT1008	3MS PT1009	3MS PT1008	3MS PT1009

A.5 PERFORMANCE REQUIREMENTS

A.5.1 The STAR processor should be capable of generating a trip output within 250 milliseconds of the inputs descending below the low pressure setpoint and exceeding the rate of depressurization setpoint. This requirement is intended to minimize the AFIS system delay time contribution to the total isolation time. The 250 millisecond target is not a safety limit.

A.5.2 The software shall take multiple readings of inputs for validation of an input value.

A.5.3 The EEPROM used for tuning and setpoint constants shall be capable of at least 100,000 write cycles.

A.6 SOFTWARE SYSTEM ATTRIBUTES

A.6.1 Software design shall provide adequate confidence that none of the following Abnormal Conditions and Events were introduced: (Refer to IEEE 7-4.3.2-1993 Annex F)

A.6.1.1 Equations, algorithms, and control logic should be evaluated for logic errors, forgotten cases or steps, duplicate logic, extreme conditions neglected, unnecessary functions, misinterpretation, missing condition test, checking wrong variable, and iterating loop incorrectly.

APPENDIX A

A.6.1.2 Potential computational problems, including equation insufficient or incorrect, precision loss, and sign convention faults, should be evaluated.

A.6.1.3 Evaluation of data structure and intended use should be performed for data dependencies that circumvent isolation, partitioning, data aliasing, and fault containment issues affecting safety and the control or mitigation of abnormal conditions and events.

A.6.1.4 Potential data handling problems, including incorrect initialized data, accessed or stored data, scaling or units of data, should be evaluated.

A.6.1.5 Interface design considerations, including interfaces between modules and external components should be reviewed. Interface protocols, and control and data linkages should be properly defined. Redundancy management, partitioning, and abnormal conditions and events containment should be evaluated. Potential interface and timing problems including interrupts handled incorrectly, incorrect input and output timing, and subroutine/module mismatches should be evaluated.

A.6.1.6 Non-safety related modules should be evaluated for electrical isolation and seismic integrity to provide adequate confidence of no adverse affects on safety software.

A.6.1.7 Potential problems with interface and communication data, word format compatibility or structure, synchronization with other modules should be evaluated.

A.6.2 Software code shall provide adequate confidence that none of the following Abnormal Conditions and Events were introduced: (Refer to IEEE 7-4.3.2-1993 Annex F)

A.6.2.1 Equations, algorithms, and control logic should be evaluated for logic errors, forgotten cases or steps, duplicate logic, extreme conditions neglected, unnecessary functions, misinterpretation, missing condition test, checking wrong variable, and iterating loop incorrectly.

A.6.2.2 Confirm the correctness of algorithms, accuracy, precision, and equation discontinuities, out of range conditions.

A.6.2.3 Evaluation of data structure and intended use should be performed.

APPENDIX A

A.6.2.4 Provide adequate interface compatibility of software modules with each other and with external hardware and software.

A.6.2.5 Examine non-critical code to provide adequate confidence that critical software functions are not adversely affected and that adequate isolation exists.

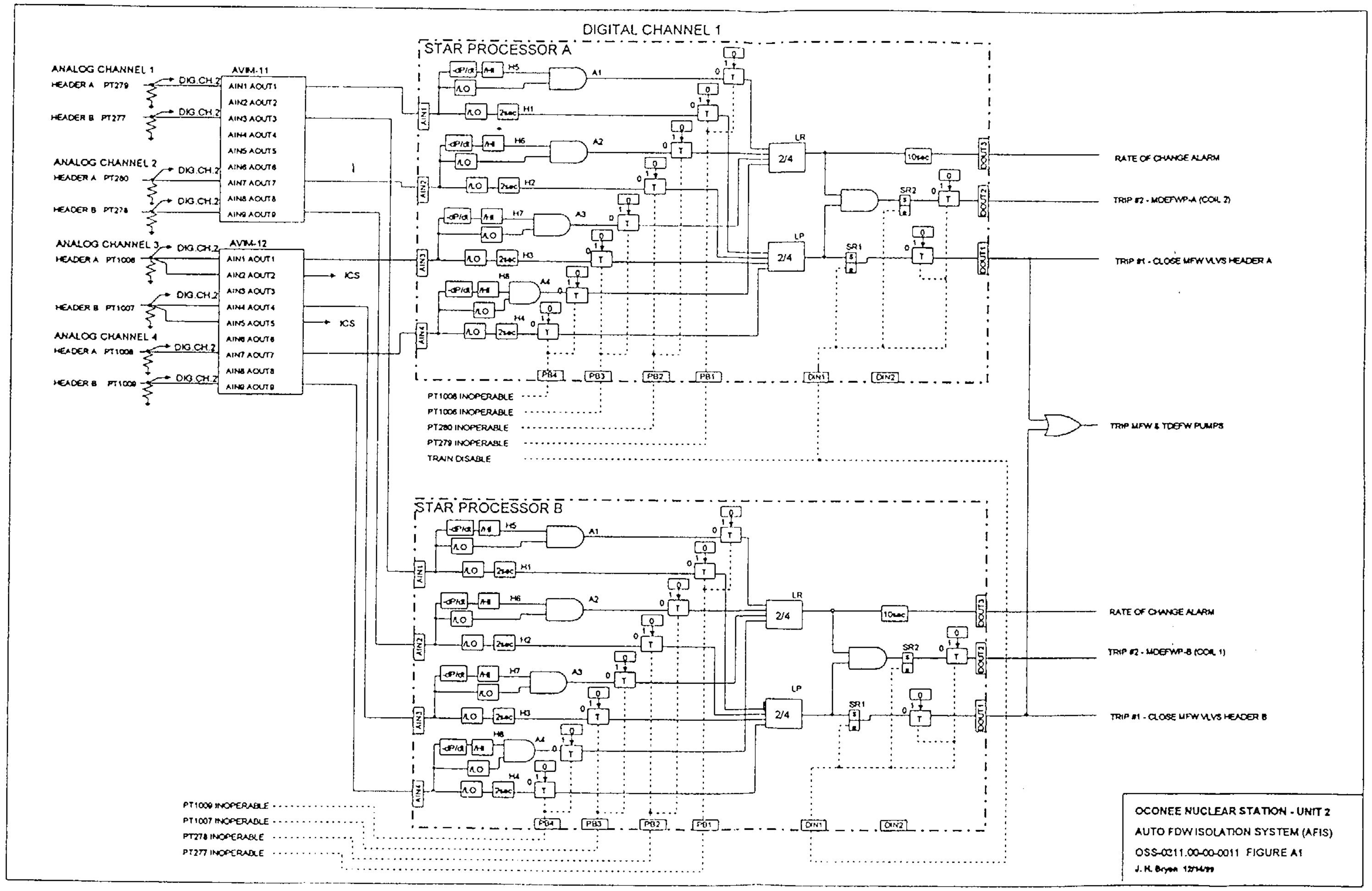
A.6.2.6 Provide adequate confidence that results of coding activities are within the timing and sizing constrains imposed by the specification.

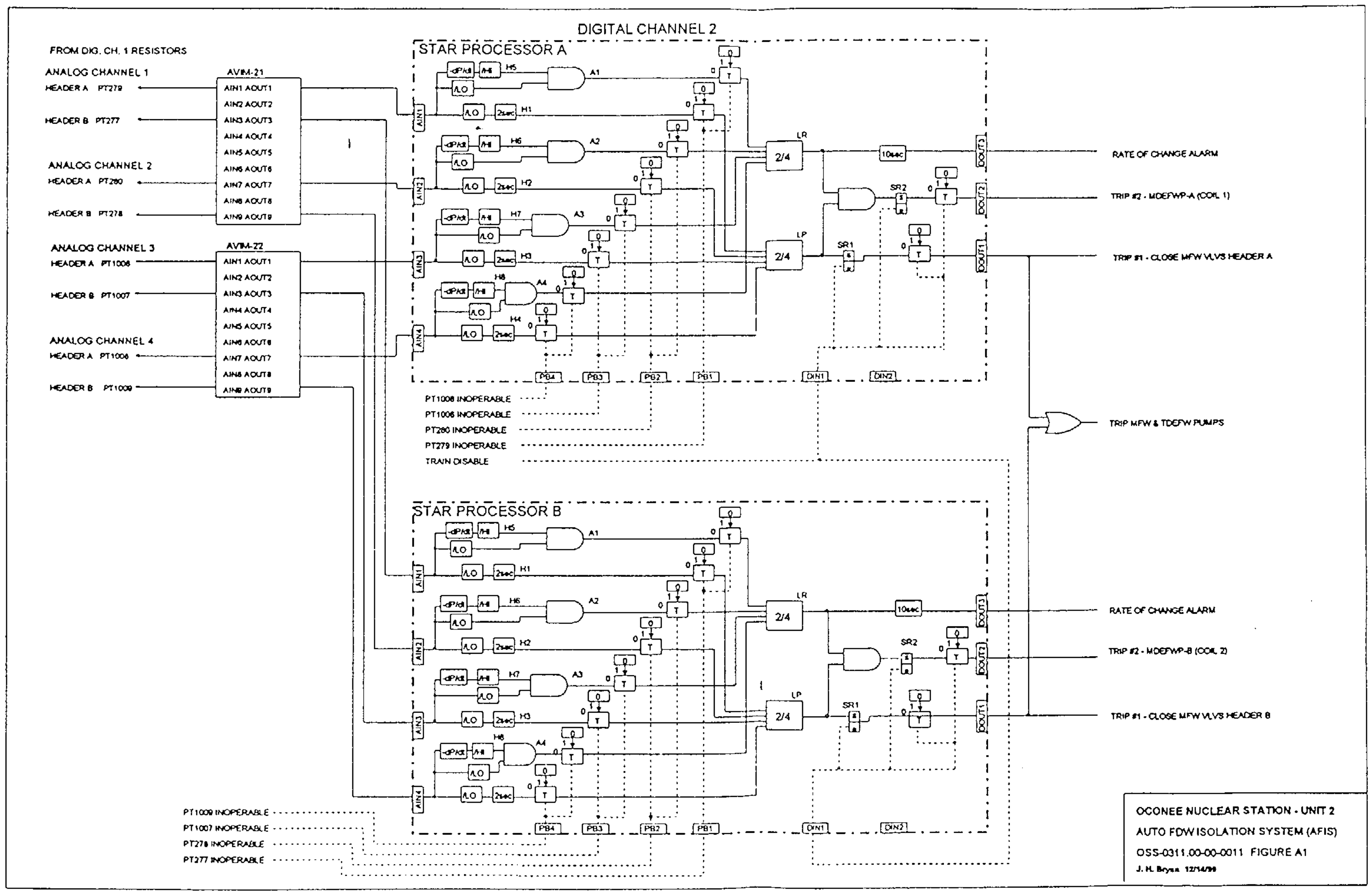
A.6.3 Failure Management

A.6.3.1 The software shall alarm the status alarm output upon recognition of an over-/under-ranged analog input.

A.6.3.2 Upon loss of power, the software shall render all digital outputs in a non-tripped state. The software shall re-initialize the safety processors upon return of power without tripping the outputs unless valid trip conditions exist.

A.6.3.3 The software shall conform to Year 2000 criteria per OSS-0278.00-00-0001.


DIGITAL CHANNEL 1
STAR PROCESSOR A
STAR PROCESSOR B
ANALOG CHANNEL 1
HEADER A PT279
HEADER B PT277
ANALOG CHANNEL 2
HEADER A PT280
HEADER B PT278
ANALOG CHANNEL 3
HEADER A PT1006
HEADER B PT1007
ANALOG CHANNEL 4
HEADER A PT1008
HEADER B PT1009
DIG.CH.2
AVIM-11
AVIM-12
ICS
RATE OF CHANGE ALARM
TRIP #2 - MDEFWP-A (COIL 2)
TRIP #1 - CLOSE MFW VLVS HEADER A
TRIP MFW & TDEFW PUMPS
RATE OF CHANGE ALARM
TRIP #2 - MDEFWP-B (COIL 1)
TRIP #1 - CLOSE MFW VLVS HEADER B
PT1008 INOPERABLE
PT1006 INOPERABLE
PT280 INOPERABLE
PT279 INOPERABLE
TRAIN DISABLE
PT1009 INOPERABLE
PT1007 INOPERABLE
PT278 INOPERABLE
PT277 INOPERABLE
OCONEE NUCLEAR STATION - UNIT 2
AUTO FDW ISOLATION SYSTEM (AFIS)
OSS-0311.00-00-0011 FIGURE A1
J. H. Bryan 12/14/99


DIGITAL CHANNEL 2
STAR PROCESSOR A
STAR PROCESSOR B
FROM DIG. CH. 1 RESISTORS
ANALOG CHANNEL 1
HEADER A PT279
HEADER B PT277
ANALOG CHANNEL 2
HEADER A PT280
HEADER B PT278
ANALOG CHANNEL 3
HEADER A PT1006
HEADER B PT1007
ANALOG CHANNEL 4
HEADER A PT1008
HEADER B PT1009
AVIM-21
AVIM-22
PT1008 INOPERABLE
PT1006 INOPERABLE
PT280 INOPERABLE
PT279 INOPERABLE
TRAIN DISABLE
PT1009 INOPERABLE
PT1007 INOPERABLE
PT278 INOPERABLE
PT277 INOPERABLE
RATE OF CHANGE ALARM
TRIP #2 - MDEFWP-A (COIL 1)
TRIP #1 - CLOSE MFW VLVS HEADER A
TRIP MFW & TDEFW PUMPS
RATE OF CHANGE ALARM
TRIP #2 - MDEFWP-B (COIL 2)
TRIP #1 - CLOSE MFW VLVS HEADER B
OCONEE NUCLEAR STATION - UNIT 2
AUTO FDW ISOLATION SYSTEM (AFIS)
OSS-0311.00-00-0011 FIGURE A1
J. H. Bryan 12/14/99

SPECIFICATION NO.: ECV-0601.00-00-0005

DATE: February 29, 1984

20,650
6-18-85
Orig. Rec'd

DUKE POWER COMPANY

DESIGN ENGINEERING DEPARTMENT

Specification For Seismic
Qualification of Equipment

REVISION LOG

1 June 4, 1985 (Entire Document Revised)	6
2	7
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ATTACHMENT NO. 1 pg 1 of 22
SPECIFICATION NO. OSS-0311.00-00-0011
REV. NO.: 0 REV. DATE 11-22-99

26165 (R1-84)
Form 170.2 Rev. 1

Att. 1 pg 2 of 22
OSS-0311.00-00-0011

VERIFICATION OF DESIGN SPECIFICATION

Station and Unit Number: All Nuclear Stations and Keowee Hydro Station

Title of Specification: Specification for Seismic Qualification of Equipment

Specification Number: ECV-0601.00-00-0005

Revision: 1

This document specifies items related to QA CONDITION 1 and 4. In accordance with established procedures, its quality has been assured. Signatures certify that the above specification was originated, checked, approved and inspected (or waived) as noted below:

Signature also certifies that a review for determining potential impact to work performed per previous revisions was conducted for this revision.
Previous Work Impacted By This Revision ☐ Yes, See Attachment ☒ No

Prepared By: Kenneth S. [signature], III Date: June 11, 1985

Checked By: John M McCalagh Jr. Date: June 11, 1985

Approved By: DED [signature] Date: 6-11-85

Inspection Waived By: ________ Date: ________

Inspection Waived For: ☐ ELECTRICAL ☐ M/N ☐ C/E ☐ PMD ☐ SRAL (GDCS only)

Inspected By: [signature] Miller Date: 6-11-85

Inspected By: [initials] RL Dobson Date: 6/12/85

Inspected By: ________ Date: ________

Inspected By: ________ Date: ________

QUALITY ASSURANCE Henry I Underwood, Jr. Date: 6-12-85

****

(FOR ASME CODE ITEMS)

Division: ________ Date: ________
Design Engineering Department

This is to certify that the above specification has been reviewed by me, the undersigned, and is correct, complete, and in compliance with ______ Edition including the ______. Addendum of ASME Code, Section III, Paragraph ______.

(SEAL)

Signature: ________

Name: ________
Professional Engineer

No. & State: ________

Form 170.1 Rev. 0
26161 (9-82)

DESIGN SPECIFICATION NO. ECV-0601.00-00-0005
DATE February 29, 1984
Revision 1, June 4, 1985

REVISION DESCRIPTION SHEET

REVISION NUMBER	PAGES REVISED AND DESCRIPTION
0	Original Issue
1	The specification has been revised to incorporate details of specific requirements for qualification of Class 1E electrical equipment. A new section 7.7 has been added to address development of component response spectra. The entire specification has been retyped for clarity. With the incorporation of this revision, this specification supersedes specification ECV-0601.00-00-0002, Revision 0, Specification for Seismic Qualification of Electrical Equipment.
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TABLE OF CONTENTS

TABLE OF CONTENTS

DUKE POWER COMPANY

SPECIFICATION FOR SEISMIC QUALIFICATION OF EQUIPMENT

1.0 INTRODUCTION

This specification describes acceptable methods for seismic qualification of equipment for use at Duke Power Company's Nuclear Stations and Keowee Hydro Station. It is to be used as an attachment to procurement specifications for new or replacement equipment for these stations when the vendor is to perform the qualification. It may also be used as a guide for qualification by Duke Power Company.

2.0 SCOPE

The requirements presented herein are applicable only for equipment for which this specification is invoked at the time of purchase. The use of this qualification specification is mandatory for purchase of vendor qualified equipment by the Civil-Environmental Division, Design Engineering Department after the issue date of this specification. Its use by other divisions is optional. The requirements of this specification are to have precedence over reference documents cited herein. Any conflict between this specification and its references shall be brought to the attention of the Owner. 1

3.0 DEFINITIONS AND ABBREVIATIONS

Owner - Duke Power Company, Charlotte, N.C., or its authorized representative.

Bidder - A potential Contractor who offers to furnish materials and to perform work required.

Contractor - Person or Corporation to whom work is awarded.

Operating Basis Earthquake (OBE) - A seismic event during which all equipment necessary for continued plant operation without undue risk to the health and safety of the public is required to remain functional.

Safe Shutdown Earthquake (SSE) - A seismic event which all equipment necessary (1) to safely shut down the reactor and to maintain it in a safe shutdown condition, (2) to maintain the integrity of the reactor coolant pressure boundary, and (3) to prevent or mitigate the release of radioactive material which could result in potential offsite releases comparable to the guideline exposures of the Code of Federal Regulations, Title 10, Part 100, is required to endure without failure or damage sufficient to disrupt its safety function.

Loss of Coolant Accident (LOCA) - A design basis event resulting from loss of reactor coolant which produces a pressure transient load on the Steel Containment Vessel (SCV). All equipment mounted on the SCV and needed to perform the safety functions described in SSE above (except maintain reactor coolant

pressure boundary) is required to endure this load without failure or damage sufficient to disrupt its safety function.

Zero Period Acceleration (ZPA) - For a given equipment location, the maximum acceleration at high frequencies. This is taken to be the value at 33 Hz. Frequencies other than 33 Hz may be specified and will be noted in a format similar to Table 1. 1

Required Response Spectrum (RRS) - The response spectrum required to be met during the qualification process.

Test Response Spectrum (TRS) - The response spectrum constructed by analysis or derived using spectral analysis equipment based on actual shake table motion. This response spectrum shall be compared to the RRS when qualifying equipment per this specification by test.

Active Equipment - That equipment which must perform a mechanical motion during the course of accomplishing a function during or after the seismic event.

Margin - Difference between design conditions and conditions used for equipment qualification. In this specification, margin refers to peak broadening and amplitude increase requirements for a given dynamic response spectrum. 1

SCV --- Steel Containment Vessel
IEEE -- Institute of Electrical and Electronics Engineers
ASTM -- American Society for Testing and Materials
ASME -- American Society of Mechanical Engineers
ANSI -- American National Standards Institute
AISC -- American Institute of Steel Construction
AISI -- American Iron and Steel Institute
USNRC - United States Nuclear Regulatory Commission
NEMA -- National Electrical Manufacturer's Association
SAE --- Society of Automotive Engineers
USAEC - United States Atomic Energy Commission
AWS --- American Welding Society

4.0 RESPONSIBILITIES

The Contractor is responsible for compliance with all the detailed requirements presented in this specification. Approval of any drawings, specifications, analyses, or tests by the Owner shall in no way relieve the Contractor from these responsibilities. There shall be no deviations from this specification or its references without prior written approval of the Owner.

Nothing in this specification shall relieve the Contractor of the responsibility for performing, in addition to the requirements of this specification, such tests, inspections, design checks, analyses, and other activities which the Contractor considers necessary to insure that the equipment is qualified for the service intended, or as may be required by common usage or good practice.

The Owner reserves the right to review seismic analyses and/or test results prior to authorizing shipment.

5.0 GOVERNING DESIGN CRITERIA DOCUMENTS AND REFERENCES

5.1 FSAR CRITERIA

The following FSAR sections are the bases for the requirements presented in this specification:

a. Section 3.2, "Classification of Structures, Systems and Components", of the applicable station FSAR.

b. Section 3.7, "Seismic Design," of the applicable station FSAR.

c. Section 3.8, "Design of Category 1 Structures", of the applicable station FSAR.

d. Section 3.9, "Mechanical Systems and Components," of the applicable station FSAR.

e. Section 3.10, "Seismic Qualification of Category I Instrumentation and Electrical Equipment," of the applicable station FSAR. 1

5.2 CODES AND STANDARDS

The Bidder/Contractor shall identify all codes and standards used in the structural design, fabrication, and qualification process for the equipment. Some acceptable codes and standards are issued by the following organizations: NEMA, AWS, ASME, AISC, AISI, and IEEE. Certain equipment may have specific codes or standards to which they must be qualified other than those noted above and these should be listed by the Bidder/Contractor. Class 1E electrical equipment shall meet the requirements of IEEE Std 344-1975 Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations unless otherwise specified in the procurement document. 1 Additionally, parts of certain equipment may be designed and fabricated to different codes and standards which also must be identified by the Bidder/Contractor.

This section is written to be general in nature and other codes and standards pertaining to the fabrication and qualification process may not be listed above. The Bidder/Contractor shall use these additional information sources after receiving approval from the Owner.

5.3 LICENSING SUBMITTALS

This section does not apply to this specification.

5.4 SPECIFICATIONS

The following Duke Power Company Specifications are considered in the requirements presented in this specification:

a. Specification OSDC-0193.01-00-0001, Duke Power Company, Oconee Nuclear Station Seismic Design Criteria.

b. Specification MCS-1108.02-00-0001, Duke Power Company, McGuire Structural Design Specification.

c. Specification CNS-1108.02-00-0001, Duke Power Company, Catawba Structural Design Specification.

5.5 REGULATORY DOCUMENTS

The following regulatory documents are considered in the requirements presented in this specification:

a. USAEC Regulatory Guide 1.60, Design Response Spectra for Seismic Design of Nuclear Power Plants, December 1973.

b. USAEC Regulatory Guide 1.61, Damping Values for Seismic Design of Nuclear Power Plants, October 1973.

c. USNRC Regulatory Guide 1.89, Qualification of Class 1E Equipment for Nuclear Power Plants, November 1974. 1

d. USNRC Regulatory Guide 1.92, Combining Modal Responses and Spatial Components in Seismic Response Analysis, November 1974.

e. USNRC Regulatory Guide 1.100, Seismic Qualification of Electrical Equipment for Nuclear Power Plants, March 1976.

f. USNRC Regulatory Guide 1.122, Development of Floor Design Response Spectra for Seismic Design of Floor Supported Equipment or Components, February 1978. 1

5.6 WORKPLACE PROCEDURES

This section does not apply to this specification.

6.0 QUALITY ASSURANCE REQUIREMENTS

This specification covers the seismic qualification of equipment which is important to nuclear safety (QA Condition 1), or which might interact with such equipment during a seismic event (QA Condition 4). It is essential that the equipment meet the standards of this specification and its references. This quality must be documented.

7.0 GENERAL DESIGN REQUIREMENTS AND METHODS

7.1 QUALIFICATION METHODS

There are three acceptable methods of equipment seismic qualification. These methods can be described as qualification by testing, qualification by analysis, and qualification by a combination of testing and analysis. Analyses shall be performed in accordance with code requirements and accepted engineering practice.

Section 8.1 provides requirements for the Bidder/Contractor who has previously qualified his equipment. Section 8.2 proves requirements for the Bidder/Contractor who has not previously qualified his equipment.

7.2 DESIGN ACCELERATION

The dynamic conditions for which the equipment must be qualified shall be identified in the procurement documents in a format similar to Table 1. The equipment shall be qualified for seismic response spectra corresponding to both OBE and SSE. When spectra are not provided for both conditions, the relationship between the two conditions shall be explicitly stated in the procurement documents. Additional spectrum margin requirements shall be identified in Table 1 format when applicable. 1

For McGuire and Catawba Nuclear Stations only, equipment mounted on the SCV shall be identified as requiring qualification for LOCA response spectra. Significant SCV motions occur due to dynamic pressures immediately following a LOCA in an ice condenser containment. For the purposes of design and qualification of equipment mounted on the SCV, these motions have been translated into shock spectra. The terms "Radial" and "Tangential" refer to the motion of the SCV in the horizontal plane. Because of the source of the loading, all three spatial components must be assumed to act simultaneously. For qualification purposes, the LOCA is considered the same as a SSE and a LOCA-SSE enveloped spectrum may be used as SSE input.

7.3 CONCURRENT LOADING CONDITIONS

The equipment procurement specification shall identify applicable loads and loading combinations. As a minimum, the loadings described below shall be taken to occur concurrently with the Design Acceleration. Variations in allowable stresses for different loading combinations are permitted when identified in the procurement specification.

7.3.1 GRAVITY

The dead weight of the equipment, mounting hardware and all significant appurtenances shall be considered. The mass of these items shall also be considered in dynamic qualification of the equipment.

7.3.2 DESIGN TEMPERATURE

Thermal loads are to be derived from design temperatures specified in the equipment procurement specification.

7.3.3 DESIGN PRESSURE

Pressure loads must be considered when all or part of the equipment is subjected to internal or external pressures. The design pressure shall be specified in the equipment procurement specification. Pressure stresses shall be calculated in accordance with code requirements and accepted engineering practice.

7.3.4 NOZZLE LOADS

Nozzle loads shall be considered if the equipment has externally attached piping, and the magnitude of such nozzle loads shall be identified in the equipment procurement specification. Nozzle loads are to be applied to the equipment as external, static loads at the intersection of the equipment outside wall and the theoretical centerline of the attached piping. At an individual nozzle location, the equipment shall be capable of withstanding all loads, both forces and moments, for the nozzle applied simultaneously. Forces and moments are to be taken as positive or negative as conservative for design. At points other than nozzle-to-shell junctures, such as supports or equipment housing, minimum values of forces and moments due to loads from all nozzles shall be calculated by a square root of the sum of the squares combination of the effects of each nozzle at the point of interest.

7.3.5 OPERATING LOADS

Loads resulting from the operation of the equipment under design conditions shall be considered for all active equipment.

7.4 ORIENTATION

The equipment shall be considered in the worst possible orientation (greatest stress/deformation level in each component) with respect to the total combined loading conditions.

7.5 ANCHORAGE

Unless anchorage is specified by the Owner, the Bidder/Contractor shall submit his recommended anchorage criteria for the equipment. Furthermore, the Bidder/ Contractor shall submit verification that this criteria corresponds to the anchorage used in the test/analysis programs. The Bidder/Contractor shall address and reconcile any differences between Owner specified anchorage and qualification anchorage. 1

7.6 OPERABILITY

Operability requirements shall be specified in a format similar to Table 1. All active equipment and electrical equipment whose continued function is required shall be functionally tested to insure its ability to accomplish its function under design conditions. For equipment qualified by dynamic testing, this requirement may be satisfied by operating the equipment under the specified conditions during and after the SSE test. Alternate methods must be approved by the Owner. Test results shall be documented in the report required by Section 9.0. 1 1

7.7 DEVELOPMENT OF COMPONENT RESPONSE SPECTRA

The development of component response spectra shall meet the requirements of USNRC Regulatory Guide 1.122. In addition, the response spectra acceleration values shall be calculated at the natural frequencies of the equipment and component locations and at frequencies sufficiently close to ensure adequate representation of the generated response spectra. 1

8.0 SPECIAL DESIGN REQUIREMENTS AND METHODS

8.1 EQUIPMENT WITH EXISTING QUALIFICATION

8.1.1 SUBMISSION FOR REVIEW AND APPROVAL

For equipment with an existing qualification, the Bidder shall submit the qualification documents or sufficient detailed technical evidence for the Owner's review and approval. The Bidder shall also include as part of this documentation the additional information described in Section 8.1.2.

8.1.2 CONFORMANCE TO OWNER'S REQUIREMENTS

8.1.2.1 Equipment Qualified By Testing

For equipment whose existing qualification is by testing, the Bidder shall provide documentation showing:

a. That the TRS envelops the SSE-RRS
b. That the operability requirements have been met
c. That test report anomalies (if any) have been resolved
d. All other information necessary to verify that the qualification meets the requirements shown in Section 7.0.

8.1.2.2 Equipment Qualified By Analysis

For equipment whose existing qualification is by analysis, the Bidder shall provide documentation showing:

a. Type of analysis used
b. Percent damping used
c. Acceleration values used in relation to those specified
d. All other information necessary to verify that the qualification meets the requirements shown in Section 7.0.

8.1.2.3 Equipment Qualified By Combined Testing and Analysis

For equipment whose existing qualification is by combined testing and analysis, the Bidder shall provide the following documentation:

a. The Test method and results along with applicable information required in Section 8.1.2.1 1
b. The information required in Section 8.1.2.2
c. All other information necessary to verify that the qualification meets the requirements shown in Section 7.0. 1

8.1.3 TECHNICAL ACCEPTABILITY

Proposals will be considered technically acceptable after the Owner has reviewed and approved the information required by Sections 8.1.1 and 8.1.2. Proposals failing to meet this criteria will not be considered for the award of order.

8.2 EQUIPMENT WITH NO EXISTING QUALIFICATION

8.2.1 SUBMISSION OF PROPOSED QUALIFICATION PLAN

The Bidder shall submit his proposed qualification plan for review. The proposed plan shall state the method of qualification to be used, include any documentation required by Section 8.2.2, 8.2.3, and 8.2.4, and state any exception to the requirements of this specification. Failure to submit a proposed qualification plan will result in rejection of the bid.

8.2.2 TESTING

This section provides requirements for seismically qualifying equipment by testing. Other test methods may be acceptable. However, they must meet all other requirements of this specification and must be approved by the Owner.

8.2.2.1 Qualification Range

The equipment shall be qualified over the seismic range of 1 to 40 hertz unless otherwise noted.

8.2.2.2 Test Input

The aim of the test input is to reproduce as faithfully as possible the actual seismic environment. Where this is not practical, it is required to simulate the environment in a conservative manner. Therefore, random multifrequency vibration input shall be used to reproduce the seismic excitation. However,

single frequency input, such as sine beats may be applicable provided one of the following conditions is met and justified in the qualification report:

a. The anticipated response of the equipment is adequately represented by one mode.
b. The input has sufficient intensity and duration to excite all individual modes to the required magnitude such that the TRS adequately envelops the RRS.

The random motion test input shall be amplitude-controlled in 1/3 octave (or lower) bandwidths and spaced 1/3 octaves (or lower) apart over the qualification range. The actual input motion must be characterized in the same manner as the required input motion and the conservativeness in amplitude and frequency content must be demonstrated.

The test input shall equal or exceed the minimum acceleration specified over the qualification range. Exceptions shall be addressed individually and justified in detail. 1

8.2.2.3 Single or Multiaxis Test

The degree of coupling in the equipment will, in general, determine if single or multiaxis testing is required to conservatively produce the same response for a particular test method compared to the seismic event. The test shall reproduce the effects of three spatial components occurring simultaneously (two horizontal orthogonal components plus one vertical component). The effects of coupling with respect to single or multiaxis tests are discussed below.

8.2.2.3.1 Single Axis Test

If the degree of coupling can be determined to be insignificant, single axis testing is allowable.

If the degree of coupling can be determined and is significant, single axis testing is allowable provided it can be justified. The input must be increased sufficiently to include the effect of coupling on the response of the equipment.

The Bidder shall submit verification that the single axis test will adequately qualify the equipment for the effect of three spatial components occurring simultaneously.

8.2.2.3.2 Multiaxis Test

If the degree of coupling cannot be determined, multiaxis testing is required. For biaxial testing, the input will be applied to the vertical and one horizontal axis simultaneously. The input must be sufficient to reproduce the effects of three spatial components acting simultaneously. For triaxial testing, the input motion will be applied to the vertical axis and two horizontal axes simultaneously. The time phasing of inputs in the vertical and horizontal directions must be such that a purely rectilinear resultant input is avoided

and to insure that an accurate representation of the equipment response to simultaneous excitations is determined. The equipment shall be tested as described above, and where necessary, rotated ninety degrees in the horizontal plane (physically for biaxial test; with respect to load input for triaxial test), and the test shall be repeated.

8.2.2.4 Aging

In order to simulate seismic aging in equipment relating to the lifetime subjection of seismic disturbances, five (5) OBE seismic tests plus one (1) full SSE test shall be conducted in each direction. The duration of each test shall be at least 30 seconds. 1

8.2.2.5 Support-Amplified Loads

The possibility of amplification from the equipment's support(s) shall be considered. This may be accomplished either by testing the device on its supports or by analyzing the supports to determine the level of amplification.

8.2.2.5.1 Testing

The equipment, mounted on its supports, shall be tested in accordance with Sections 8.2.2.1 through 8.2.2.4. During the test, some components may be 1 inoperative or replaced by dummy weights at the appropriate location. In this instance, the response (time history, response spectrum, etc.) at the component 1 mounting location shall be monitored and recorded. The component that was inoperative or replaced by dummy weights must then be tested separately using the mounting location response spectra. Where test input includes margin requirements, the mounting location response spectra require no additional margin. Where test input does not include margin requirements, the actual input 1 shall be more conservative in acceleration by 10% and include a ±10% envelope in frequency than the monitored response.

8.2.2.5.2 Analysis

The supports may be analyzed using the procedures outlined in Section 8.2.3.4. If the supports have no resonant frequencies below the high frequency asymptote (ZPA frequency) specified, they are considered "rigid" and do not amplify the design loads. If the supports have resonant frequencies below the ZPA fre- 1 quency specified, amplification of design loads may occur. New time histories or response spectra shall be developed at the equipment mounting location for the amplified load and used for testing the equipment (See Sections 8.2.2.1 through 8.2.4). The Owner will supply design input time histories upon request from the Bidder/Contractor. Results of the analysis shall be submitted for the Owner's review and approval prior to testing.

8.2.2.6 Test Fixture Design

Interposing fixtures separating the equipment and the testing apparatus may be required. These fixtures shall be designed such that no dynamic coupling or

load amplification occurs during testing. Verification shall be submitted for the Owner's review and approval prior to testing.

8.2.2.7 Resonant Frequency Search and Transmissibility Plots

A low level (approximately .1g - .2g) sine sweep from 1 to 100 Hz shall be conducted on the equipment in each test orientation to determine resonant frequencies. The sweep rate shall be 1-2 octaves per minute. The test report shall include plots of transmissibility, defined as the ratio of response to excitation, for the frequency range of the resonance search.

8.2.2.8 Response Spectra Plot

The response spectra plots of accelerometers mounted on the equipment shall be plotted over the frequency range of 1 to 1000 Hz. Alternately, the response spectra plots may be plotted over the frequency range of 1 to 200 HZ if an independent measurement of the ZPA is performed and provided in the test report. 1

8.2.3 ANALYSIS

8.2.3.1 Determination of Analysis Procedure

The Contractor shall assess the dynamic characteristics of the equipment to determine the adequacy of analytical techniques to properly predict the equipment's response under seismic conditions. If the equipment is too complex to model, testing procedures (Section 8.2.2) should be considered.

The equipment (including supports) should be modeled to best represent its mass 1
distribution and stiffness characteristics by either a series of discrete mass points connected by mass-free members, or by a more detailed finite element approach. The model shall have sufficient independent degrees of freedom to ensure adequate modal representation. All significant masses and mass moments of inertia of the equipment, especially those associated with appurtenances, shall be included in the analysis.

The natural frequencies (periods of vibration) and mode shapes of the equipment and its support system in both major horizontal and the vertical directions should be determined. If the model has no frequencies that are below the high frequency asymptote (ZPA frequency) specified, it is considered rigid and may be analyzed statically as described in Section 8.2.3.2.

An easier but more conservative method of analysis is the static coefficient method described in Section 8.2.3.3.

If the equipment cannot be analyzed statically, and the static coefficient method is not used, a dynamic analysis as described in Section 8.2.3.4 must be performed. Some equipment does not lend itself to qualification by testing or analysis alone. See Section 8.2.4 for a discussion of this qualification technique.

8.2.3.2 <u>Static Seismic Analysis</u>

This method may be used when it has been shown that the equipment (including supports) and its components are rigid. In the static analysis, the seismic forces on each component (including supports) are obtained by concentrating the 1
component's mass at its center of gravity and multiplying by the applicable ZPA value specified.

Deflections, forces, and/or stresses due to the seismic loads are required for each of the three component directions (longitudinal, transverse, and vertical). Individual results for each of the three directions of excitation should then be combined by the square root of the sum of the squares method.

The adequacy of the equipment, components, and supports shall be checked as described in Section 8.2.3.5.

8.2.3.3 <u>Static Coefficient Seismic Analysis</u>

This is an alternate analysis method which is independent of natural frequencies. In the static coefficient analysis, the seismic forces on each component (including supports) are obtained by concentrating the component's mass at its 1
center of gravity location, multiplying by the peak of the applicable response spectrum curve, and multiplying again by a static coefficient of 1.5. For 1
Class 1E electrical equipment, this static coefficient must be justified as noted in USNRC Regulatory Guide 1.100.

From this point, the qualification proceeds the same as described in Section 8.2.3.2 for the Static Seismic Analysis.

8.2.3.4 <u>Dynamic Seismic Analysis</u>

In a dynamic analysis, the equipment, including supports, may be modeled as previously described in Section 8.2.3.1. This model may be analyzed using a time history or a response spectrum modal analysis technique. The response spectrum technique is the preferred approach. The corresponding spectral accelerations are obtained from the specified response spectra. The Owner will supply time history input upon request.

Natural frequencies and mode shapes are required from the modal analysis for each of the three component directions (longitudinal, transverse, and vertical). Modal results (deflections, forces, and/or stresses) for frequencies less than the ZPA frequency specified must be combined by the square root of the sum of the squares for each of the three component directions. The modal responses for significant closely spaced modes (modes whose frequencies are within 10% of 1
each other) shall be combined by absolute sum (Reference USNRC Regulatory Guide 1.92). The individual results for each of the three directions of excitation (forces, stresses, etc.) are then combined using the square root of the sum of the squares method. Structural mass not participating below the ZPA 1
frequency specified shall be appropriately considered in the analysis.

The adequacy of the equipment, components, and supports shall be checked as described in Section 8.2.3.5.

8.2.3.5 <u>Adequacy of Equipment</u>

The seismic stresses as determined from the procedures of Section 8.2.3.2, 8.2.3.3, 8.2.3.4 or 8.2.4 shall be added to the equipment's operating and/or dead load stresses to determine the adequacy of the equipment. This adequacy determination shall address (but is not limited to) the parameters described in Section 8.2.3.5.1 and 8.2.3.5.2.

8.2.3.5.1 Mechanical/Electrical Operability | 1

An evaluation of the effects of the calculated seismic stresses on the mechanical strength, alignment (if critical to operation), electrical performance (contact bounce, etc.) and noninterruption of function as related to the specified operability requirements shall be performed. Also, all interference effects caused by seismic displacements shall be evaluated.

All design codes used to verify mechanical/electrical adequacy shall be identified.

8.2.3.5.2 Structural Adequacy

The structural integrity of the equipment, components, and supports shall be verified for all loading conditions (Normal Operating, Normal Operating ± OBE, Normal Operating ± SSE). The stress levels determined in the structural analysis shall be compared against allowable levels as defined in the design codes and standards.

8.2.4 COMBINED TESTING AND ANALYSIS

Some types of equipment cannot practically be qualified by testing or by analysis alone. This may be due to the size or complexity of the equipment, or to the large number of similar configurations.

A testing program may be selected to satisfy any portion of the seismic requirements. The remainder of the equipment components not tested shall be qualified by analysis. A useful method combining both test and analysis involves low impedance testing to determine equipment response.

Low impedance testing is performed by placing a number of portable exciters at various locations on the equipment that will best excite the various vibrational modes. Vibration sensors (accelerometers, etc.) are placed at numerous locations on the equipment to obtain data on vibrational characteristics such as frequency and mode shape.

The data obtained from the low level test (frequencies, mode shapes, damping) may be used in a dynamic analysis. This information can be used to refine, as necessary, an analytical model of the equipment. The analytical model is then

used to determine the adequacy of the equipment for the specified seismic loads.

The adequacy of the equipment should then be checked as described in Section 8.2.3.5. Also, some components of the equipment may be tested (see Section 8.2.2), as applicable, to new seismic response spectra generated from the refined analytical model.

9.0 DOCUMENTATION REQUIREMENTS

Documentation for the qualification program shall be in accordance with the governing codes and standards. Qualification documentation shall include all drawings, bills of material, instruction manuals, etc., necessary to adequately review and approve the method and results of the qualification program. Pertinent structural information, to include material specifications and thicknesses, as well as equipment weights and centers of gravity shall be included. Fastener details are of particular interest and shall include bolt hole sizes and locations, bolt sizes and types, and any applicable torque requirements. When welded construction is used, weld locations and sizes shall be clearly documented. The documentation shall also include all verifications, calculations, test reports, etc., as described in this specification. 1

For equipment qualified by Section 8.2.3 or 8.2.4, documentation shall include all anchoring details (anchor bolts, welds, etc.) and loads for use by the Owner. In addition, all computer programs used in the qualification process shall be identified.

For equipment qualified by Sections 8.2.2 or 8.2.4, documentation shall include the following:

a. Full Level Testing: The base mounting (control) accelerometer and response accelerometer data, stored on tape, along with sufficient information to facilitate data access. Also, response spectra plots at all control accelerometer locations showing the TRS/RRS comparisons (SSE and one representative OBE).

b. Low Level In-Situ Testing: The reduced data giving the eigenvalues and eigenvectors for each test specimen, stored on tape, along with sufficient information to facilitate data access. Additional information such as coherence and transfer functions at selected data points may be required and will be addressed in a separate specification.

In all cases, the documentation shall clearly demonstrate that all requirements of this specification have been satisfied and that the equipment meets its performance requirements when subjected to the seismic accelerations for which it is to be qualified. Submission of this documentation shall be in accordance with the equipment procurement specification. 1

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TABLE 1 - OPERABILITY, ANCHORAGE AND SEISMIC REQUIREMENTS FOR EQUIPMENT QUALIFICATION

EQUIPMENT IDENTIFICATION: Automatic Feedwater Isolation System STAR Module

EQUIPMENT LOCATION: BLDG Auxiliary Building ELEVATION 809+3
ROOM Unit 1,2,3 Cable Rooms COORDINATES

Response Spectra for Equipment Qualification

Attached Spectrum Fig. No.	Spectrum Elev.	Type Spectrum	Spectrum Direction	Spectrum Damping (%)	Spectrum ZPA	ZPA Cutoff Freq.
1	809+3	SSE	Horizontal	5%	1.7g	20 Hz
1	All	SSE	Vertical	5%	0.1g	20 Hz

1

Notes: 1) OPERABILITY: Equipment operability to be confirmed as follows:

☒ before SSE ☒ during SSE ☒ after SSE

2) ANCHORAGE: Equipment anchorage requirements to be:

☒ per manufacturer's recommendation per Duke Drawing No: ______

3) ADDITIONAL SPECTRUM MARGIN REQUIREMENTS: The following additional margins shall be incorporated into spectra used for equipment qualification.

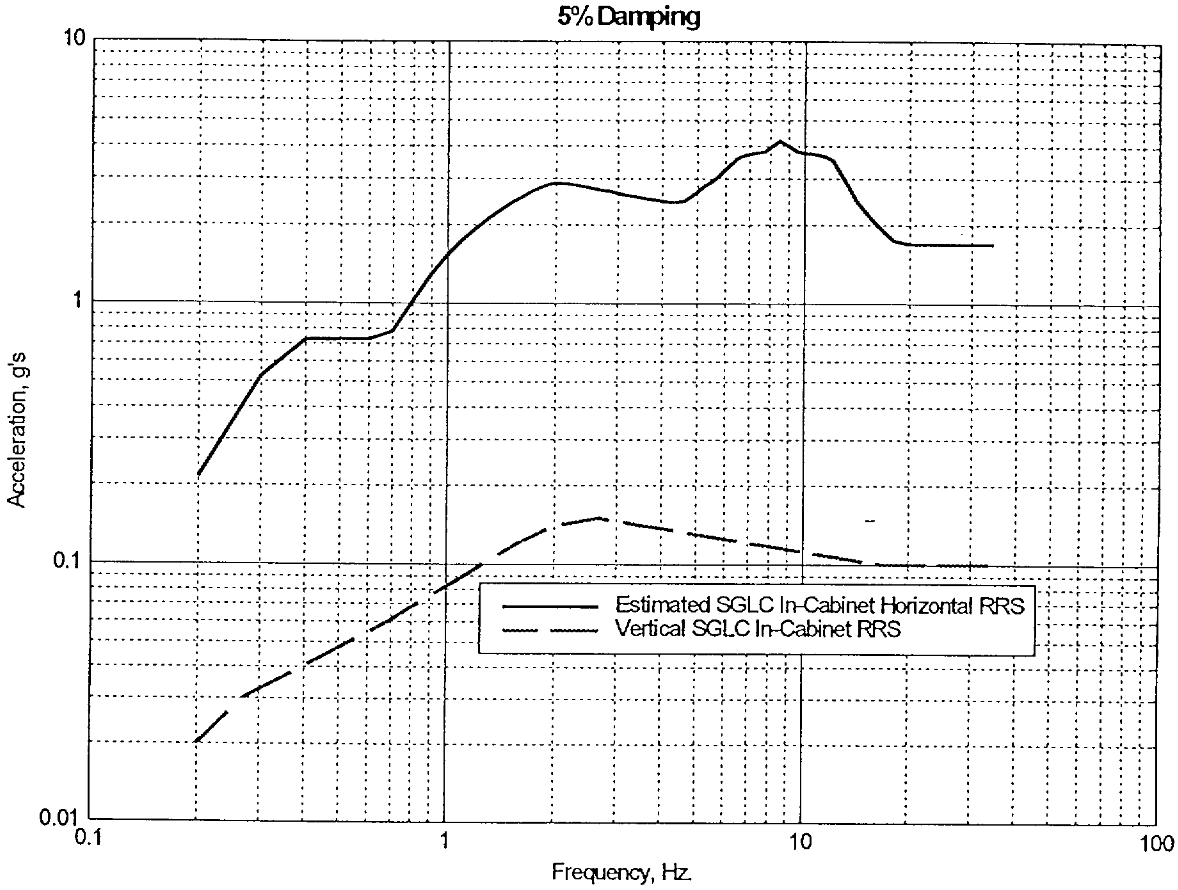
☐ ± ____ % Frequency Broadening ☒ + 10% % Amplitude increase

4) OBE - SSE RELATIONSHIP: 1

OBE = ½ X SSE SSE = 2 X OBE

Figure 1, RRS for SGLC Star Module

5% Damping



Attachment 2 pg 1 of 1
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PACKAGING AND SHIPPING REQUIREMENTS

Specification No. OSS-Ø311.ØØ-ØØ-ØØ11 Date 11/22/99

1. ITEM CLASSIFICATION (ANSI N45.2.2 -1972)
   Level A (B) C D Special
   Special ______

2. PACKAGING (ANSI N45.2.2 -1972, Section 3 and Appendix A3)
   Level A (B) C D Special
   Special Instructions ______

3. SHIPPING (ANSI N45.2.2 -1972, Section 4.2)
   Carrier: [] Open [] Closed [] Special
   Special Instructions ______

   Shipment Via: [] Train [] Truck [] Plane [] Barge [] Ship [] Other
   Description of Other Means ______

4. LOADING & TRANSIT (ANSI N45.2.2 -1972, Section 4.3)

   Special Instructions for loading, rigging, handling, preservative coatings, seals, stacking and vandalism precautions: ______

5. IDENTIFICATIONS AND MARKING (ANSI N45.2.2 -1972, Appendix A3.9)
   Item Markings Per section 4.8 of specification.

   Container Markings Per purchase order.

COVER SHEET

Specification No.:
DPS 1605.00-00-0001
CNS 1605.00-00-0001
MCS 1605.00-00-0001
OSS 0278.00-00-0001

DUKE ENERGY
All_STATION
UNIT _All

QA Condition 1

TITLE: **Technical Criteria For Year 2000 Compliance**

REVISION LOG

1__________ 6__________
2__________ 7__________
3__________ 8__________
4__________ 9__________
5__________ 10__________

DUKE ENERGY YEAR 2000 PROGRAM

VERIFICATION OF SPECIFICATION

Station and Unit Number: N/A

Title of Specification: Technical Criteria For Year 2000 Compliance

Specification Number: DPS 1605.00-00-0001, Revision: 0.

This document specifies items related to QA CONDITION 1. In accordance with established procedures, its quality has been assured. Signatures certify that the above specification was originated, checked, approved and inspected (or waived) as noted.

Signature also certifies that a review for determining potential impact to work performed per previous revisions was conducted for this revision.

Previous Work Impacted by this revision: [x] No, [] Yes, (see Attachment)

Sponsor Location/Team: Duke Energy Year 2000 Team/WC11A John H Lanier 1-8-98

Prepared By: Sharon S. Lorhaly Date: 12/19/97

Checked By: [signature] 1/8/98 Date: 12/19/97

Approved By: Sally S. White [signature] 1/8/98 Date: 12/19/97

QUALITY ASSURANCE: TC Roberts Date: 1/12/98

(FOR ASME CODE ITEMS)

This is to certify that the above specification has been reviewed by me, the undersigned, and is correct, complete, and in compliance with N/A edition including the N/A.
Addendum of ASME Code, Section III, Paragraph N/A.

(SEAL)

Signature: N/A

Name: N/A

Professional Engineer

No. & State: N/A

NPP-207 Format 11/97)

INSPECTION OF SPECIFICATION

Inspection Waived By: John H Lanier (Sponsor) Date: 1-8-98

GENERAL OFFICE

	Inspection Waived		
Procurement Engineering	☐	Inspected By/Date:	John H Lanier 1-8-98
Civil Engineering	☒	Inspected By/Date:	
Electrical Engineering	☒	Inspected By/Date:	
Mechanical Engineering	☒	Inspected By/Date:	
Others (LIT)		Inspected By/Date:	[signature] 1/8/98

CATAWBA

	Inspection Waived		
Procurement Engineering	☒	Inspected By/Date:	N/A
Civil Engineering	☒	Inspected By/Date:	
Electrical Engineering	☒	Inspected By/Date:	
Mechanical Engineering	☒	Inspected By/Date:	
Others (LIT)	X	Inspected By/Date:	

OCONEE

	Inspection Waived		
Procurement Engineering	☐	Inspected By/Date:	N/A
Civil Engineering	☒	Inspected By/Date:	
Electrical Engineering	☒	Inspected By/Date:	
Mechanical Engineering	☒	Inspected By/Date:	
Others (LIT)	X	Inspected By/Date:	

MCGUIRE

	Inspection Waived		
Procurement Engineering	☐	Inspected By/Date:	N/A
Civil Engineering	☒	Inspected By/Date:	
Electrical Engineering	☒	Inspected By/Date:	
Mechanical Engineering	☒	Inspected By/Date:	
Others (LIT)	X	Inspected By/Date:	

NOTE: An X in the Inspected Waived box and the Sponsor Manager or designee signature in the "Inspection Waived By:" space at the top of this sheet indicates the inspection has been waived in accordance with the requirements of NPP-207, paragraph 4.4.1c.1.

NPP-207Format11/97

REVISION LOG

REVISION NUMBER	PAGES OR SECTIONS REVISED AND DESCRIPTION
0	Original Issue

* When more than one Revision Log page is used, number as follows: 4a, 4b, 4c, etc.

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TECHNICAL CRITERIA

FOR

YEAR 2000 COMPLIANCE

TECHNICAL CRITERIA FOR YEAR 2000 COMPLIANCE

1.0 GENERAL

1.1 BACKGROUND

The Year 2000 situation arises from the use of only two digits for the year, ignoring the two digits which denote the century. When computational resources, both hardware and software, begin mixing dates from 19xx and 20xx, various and uncertain results can be produced. At one extreme, the computation may fail immediately at the point of an error, thus alerting users of the problem. At the other extreme, a particular computation may use dates and times in such a way as to not experience any problem whatsoever. The most dangerous results fall in the middle ground. In that case a date usage problem occurs, but the process continues using the incorrect data, without being noticed.

Addressing the Year 2000 problem at Duke Energy is an urgent matter. However, addressing the problem without some up-front analysis could impact the overall goal of achieving timely and cost-effective Year 2000 compliance. The organization should begin its Year 2000 compliance program by clearly defining criteria for compliance and establishing baseline standards for going forward.

The purpose of this document is to provide a standard enterprise-level definition of "Year 2000 compliance" and how compliance will be implemented. It is intended to be used by all Duke Energy entities as a framework for achieving enterprise-wide compliance. The enterprise-level definition of compliance will identify the technical elements of the Year 2000 challenge for criteria for Year 2000 compliance, and a standard interpretation of the criteria.

Official notification and communication of the compliance definition and standards will be made with the publication of this document to the entire enterprise. This document will undergo revisions as Duke Energy moves forward with their Year 2000 program. Any changes or revisions to this document will be reviewed and approved by the Year 2000 program management team, and formally communicated to the organization as part of the Year 2000 communication strategy.

1.2 DEFINITIONS

For the purposes of this document, the following definitions apply:

1.2.1. Computational Resources

All applications of programming, primarily software but also including firmware, microcode or any other embedded programming in hardware. All criteria apply to computational resources in combination.

a. Software

Includes operating systems and other system software, end-user application programming, third party vendor software, networking software, real-time and batch programming software, telecommunications programming, process control and monitoring software, etc.

b. Firmware and Microcode

Includes PLCs, EPROMs, EEPROMs or any other programmable hardware changeable by persons other than the OEM.

c. Hardware

Primarily BIOS chipsets, but also includes embedded programming in automobiles, elevators, clocks, HVAC systems, telecommunications, etc. Also applies to the entire combination of electronic equipment used for calculational processes.

d. Embedded Devices and Systems

Includes devices such as sensors, actuators, transducers etc. that are ordinarily considered hardware, yet contain software in the form of firmware, microcode, Application Specific Integrated Circuits, system software etc. Also includes complete, integrated systems of such devices. In this category, the entire device or the entire system should conform to the compliance criteria laid out in this document.

1.2.2. DBMS

Data Base Management System, such as DB2, Oracle, Sybase, ADABAS, etc.

1.2.3. Julian (Ordinal)

Refers to a method of displaying date in which the 2-digit year and the sequential day within that year are shown as "YY.DDD". For example, September 20, 1996 is the 264th day of that year, so the Julian representation of that date would be "96.264".

1.3. TECHNICAL ELEMENTS

The technical elements of the Year 2000 remediation involve the computational processes of accepting, creating, manipulating, and outputting time- and calendar-related information. The primary study effort has been on whether computational resources can properly process the change to the year 2000 (this is *not* a change of century!). This is of course a high-risk concern, and should be of primary importance to remediation efforts. However, several other date-related problems exist in association with the Year 2000 date rollover. These are summarized in Table 1. Any references to "applications" include any software or firmware components of this product.

Table 1. Technical Elements of the Year 2000 Challenge

Element	Description	Example Event	Probable Timing
Century Ambiguity	This is the most common element. Computer represents dates with a 1- or 2-digit year. When computer does not recognize that dates are not all in the 19xx range, the results are unpredictable.	Examples of century ambiguity can appear in the following events:	Examples of events can occur with timing as early as:
	a. Data edits reject years in early 20xx as invalid	a. Bank ATM rejects an otherwise valid bank or credit card with an expiration date of "00".	a. First use of cards issued in 1995.
	b. User interface does not allow 4-digit year to clarify century.	b. Lotus 1-2-3 accepts only 2-digit years which it assumes to be in 19xx only.	b. First need to enter values later than 1999. Has already occurred.
	c. Sorting leaves dates in 20xx and 19xx in jumbled order.	c. Itemized monthly bill lists transaction for Jan 1, 2000 through Jan 15, 2000 followed by Dec. 19, 1999 through Dec. 31, 1999.	c. First monthly data processing in 2000.
	d. Durations such as invoice aging are calculated incorrectly.	d. Invoice age calculated as a ridiculously large number or as a negative number, erroneously triggering overdue notices and staggering interest penalties.	d. January, 2000
	e. The century is truncated or changed between entering and retrieving a date.	e. Software stores dates in the 20xx range using DBMS but only passes 2-digit years to the product. DBMS defaults to 19xx and stores.	e. Could happen in 1996 for systems with 5-year time horizon.

Element	Description	Example Event	Probable Timing
	f. Comparing a date in 19xx with a date in 20xx assumes both are in 19xx.	f. Payroll-deduction calculations for years in 20xx incorrectly mistake the year as 19xx and fail to apply recent changes in tax laws.	f. First quarter of 2000.
Extended Semantics	In general, specific values for a date field are reserved for special interpretation. The most common example is interpreting "99" in a 2-digit year files as an indefinite end date, i.e. "does not expire". Another is embedding a date value in a *non-date* data element.	Some software may erroneously process a transaction with a valid end date in 1999 - such as not terminating an expired software license or failing to age back-up tapes for recycling as scratch tapes.	Will occur on various days after Dec. 31, 1998.
Calendar Errors	Errors typically include failing to treat 2000 as a leap year and converting incorrectly between date representations. Day-of-week may also be incorrect, since the year 2000 begins on a Saturday, while 1900 begins on a Monday.	Logic sensitive to day-of-week will be two days off at the beginning of the year, and an additional day off after February 28, 2000. Calculating day of week for all dates following this will be incorrect.	Day of week error will occur Jan 1, 2000. Leap year error will occur the first time input data contains Feb. 29, 2000.
Date Overflow	Many computer products represent dates internally as a base date/time plus an offset in days, seconds, or microseconds since that base date/time. Integers holding the offset value can overflow past the maximum corresponding date - an event which may lead to undefined behaviors.	Value for date can revert to a date near the base date/time, to a negative value, or crash the computer because of an illegal operation.	Happened in the 1980s on certain Tandem hosts. Could happen again at any time to any product depending on how product stores dates.
Inconsistent Semantics	At interfaces between systems, each side assumes semantics of data passed; systems must make same century assumptions about 2-digit years.	Software on one side assumes all dates in 19xx. Software on other side assumes years 51-99 are 19xx, and 00-50 are 20xx.	Could happen in 1996 for software that stores date values 5 or more years into the future.

1.4. CRITERIA FOR YEAR 2000 COMPLIANCE

This document requires that computational resources satisfy the General integrity and Date integrity criteria, and either the Explicit or Implicit century criteria. It is preferred and recommended that both the Explicit and Implicit criteria be met if possible, although meeting one or the other of these criteria is acceptable. Resources (hardware, software, or "firmware") that meet these conditions will be considered "Year 2000 Compliant". These criteria are listed in Table 2.

Table 2. Four Criteria for "Year 2000 Compliance"

Criterion	Description
General integrity	No value for *current date* and/or current time will cause interruptions in desired operation.
Date integrity	All manipulations of time- and calendar-related data (dates, durations, days of week, etc.) will produce desired results for all valid time and date values within the operational domain.
Explicit century	Date elements in interfaces and data storage permit specifying century to eliminate ambiguity.
Implicit century	For any date element represented without century, the correct century is unambiguous for all manipulations involving that element.

Each criterion as described in this table is intended to be a general requirement. The following sections describe the criteria in more detail.

1.4.1. General Integrity

As a system date advances normally on a computer resource, each date roll-over must not lead the computer resource (including, but not limited to, the host processor and any software executing there) to erroneous processing. This must also be true if the system date is regressed to a prior date. All date roll-overs must be transparent to the user.

The best-recognized, high-risk date change is roll-over to 2000, although all other roll-overs such as Feb. 29 also apply. The term "desired operation" in Table 2 is intentionally broad and must be interpreted for specific technologies and applications.

1.4.2. Date Integrity

This criterion primarily covers the correctness of manipulations of time and date data as described in Table 3. These manipulations need to be reliable only over the range of times and dates that a computer resource is expected to handle.

For example, sales-order processing may handle dates from 5 years in the past to one year in the future. In contrast, an employee database may store dates of birth from early in the 20th century to planned retirement dates well into the 21st century.

Table 3. Variety of Manipulation of Date Data

Category	Examples of Manipulation
Arithmetic	• Calculate the duration between two times and/or dates • Calculate date based on starting date and duration • Calculate day of week, day within year, and week within year • Hashing calculation using year as divisor
Branching	• Compare two times and/or dates
Format	• Convert between date representations (YMD, Julian, etc.) • Reference same data address with different variables
Data Storage	• Storing and retrieving • Sorting and merging • Searching • Indexing on disk file or database table • Moving data within primary memory
Extended Semantics	• "99" as special value for year • "99.365" as special value for Julian year • "00" as special value for year

1.4.3. Explicit Century

This criterion essentially requires the *capability* to store explicit values for century.

For example, third-party products that can use a 4-digit year in all date data elements stored and passed across each interface (including the user interface) would satisfy this criterion. A base-and-offset representation of dates that covers all centuries of interest would also satisfy this criterion. Whether this capability *should* be used to eliminate century ambiguity is part of the last criterion.

1.4.4. Implicit Century

This last criterion requires that, if the century is not explicitly provided, its value can be correctly inferred with 100% accuracy from the value of date provided.

For example, the range of values for an "invoice date" would very rarely span more than 10 years. Because the century can always be guessed correctly from an invoice date with a 2-digit year, this date data element would satisfy this criterion.

Note that this criterion permits cost-risk trade-offs that minimize changes to existing date formats.

1.5. INTERPRETATION OF THE CRITERIA

1.5.1. STANDARD INTERPRETATION

Table 4 contains the standard interpretation of these criteria. Any deviation from this interpretation in a Duke Energy organization must be documented and approved by both the organization and by the provider of the computational resource.

Note the importance of clearly identifying the specific date ranges for compliance, reasonable latitude in date format, and situations under which implicit century values will be tolerated. Also note that certain exceptions are included to support important options for cost/risk trade-off.

Table 4. Interpretation of Year 2000 Compliance Criteria

Criterion	Description of Criterion	Interpretation of Criterion
General Integrity	No value for current date will cause interruptions in desired operation.	• All computational resources will function correctly, without human intervention, and transparent to the user, for all values of system time and/or date between 1900-01-01 and 2050-12-31 • Of special interest are the following dates and the ability to roll over forwards and backwards to the correct next date: 1998-12-31, 1999-09-09, 1999-12-31, 2000-01-01, 2000-02-28, 2000-02-29, 2000-03-01, 2000-12-31, 2001-01-01, 2027-12-31.
Date Integrity	All manipulations of calendar-related data (dates, durations, days of week, etc.) will produce desired results for all valid date values within the operational domain.	• Computing resources must correctly handle all representation and manipulation of times and/or dates with values between 1900-01-01 and 2050-12-31. Especially important is that all years divisible by 4 in this 150-year range are leap years except 1900. • All computational resources developed for Duke Energy must initialize all date elements with either all zeros (0000-00-00) or null values. Null values are defined for each application by the development facilities, such as the language compiler. A null-value feature is strongly recommended in third-party product selection. • All developed software must not contain literals or constants for dates unless required to capture specific business rules such as calculations of payroll deductions. • All developed software must not use special time and/or date values as logical flags, such as "99" as year to mean "no end date" or "00" to mean "does not apply". **Exceptions:** • Valid date ranges in existing developed or existing third-party software may start with the oldest date value in the application's archived data rather than 1900-01-01 when there is no business need to support earlier dates.

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Table 4. Interpretation of Year 2000 Compliance Criteria (continued)

Criterion	Description of Criterion	Interpretation of Criterion
Explicit Century	Date elements in interfaces and data storage permit specifying century to eliminate date ambiguity.	• All developed and third-party software must permit the use of date formats which explicitly specify century in all date data stored or transmitted. The format of these date elements must be YYYYMMDD or YYYYJJJ as specified by ANSI X3.30-1985(R1991) unless superseded by another application-specific standard or convention. • In storing or transmitting date data, some applications must conform to domain-specific standards, contractual agreements, or APIs to necessary third-party products whose date formats must supersede ANSI X3.30 as appropriate within the application. Examples of these standards are listed in Table 5. • Third-party products must permit formatting data with explicit century in the user interface. • All developed applications using third-party products must always explicitly supply century and never rely on those products' default value for century. **Exceptions:** • For date data formatted for a user interface, it is acceptable to use punctuation (slash, hyphen, period, comma) within a formatted date, to spell out or abbreviate the name of the month, or to reorder year-month-day to serve customs among the end users. • DBMSs which cannot store date in conformance with SQL standards but do store century explicitly (such as DD-MM-YYYY) are acceptable. • Default values for century are permitted only when supplied by data-entry aids and the end-user can verify the defaulted value before committing the data.
Implicit Century	For any date element represented without century, the correct century is unambiguous for all manipulations involving that element.	• Century must be explicit in all date data stored or transmitted unless the correct century can be inferred with 100% accuracy based on the value for date. Explicit century is preferred where practical. • Developed and third-party software may imply century in the user interface in the format YYMMDD or YYJJJ (as specified by ANSI X3.30). • In storing or transmitting date data, some applications must conform to domain-specific standards whose requirements for dates may supersede ANSI X3.30 as appropriate within the application. Examples of these standards are listed in Table 5. **Exceptions:** • For date data formatted for a user interface, it is acceptable to use punctuation such as slash within a formatted date, to spell out or abbreviate the name of the month, or to reorder year-month-day to serve customs among the end users.

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Table 5. Additional Year 2000 Compliance Criteria Interpretations

Criterion	Description of Criterion	Interpretation of Criterion
Leap Year Calculation	For any year that is either evenly divisible by 400 or evenly divisible by 4 and not evenly by 100, there are potential exposures.	• Day-in-year calculations must address 366 days not 365. • Day-of-the-week calculations must address the fact that 28 February 2000 is a Monday and 1 March 2000 is a Wednesday, not a Tuesday which is February 29, 2000. • Week-of-the-year calculations. The 11th week of the year 2000 is 5 through 11 March, not 6 through 12 March.
Special Values	Fixed dates cannot be used as a global indicator.	• Certain years cannot be used as an "end of input" flag, e.g. 99 and 00. • Certain dates cannot be used to indicate "no-expiration", e.g. 12/31/99.
Century Calculations	All manipulations of century data will produce desired results for all valid date values within the operational domain.	• Rollover to 1/1/2000 - The calculation of 12/31/1999 23:59:59 plus 1 second must produce 1/1/2000 00:00:00. • Pre-2000 Calculations - The calculation of 12/31/1999 plus 1 day must produce 1/1/2000. • Post-2000 Calculations - The calculation of 1/1/2000 less 1 day must product 12/31/1999.

1.5.2. STANDARD DATE FORMAT

Standardizing the format for date data is an important part of Year 2000 compliance. However, although several standards for date data format are available, the criteria in this document take precedence over other date standards. These other date standards may be used, as long as the criteria in this document are met.

Furthermore, two considerations must be made when evaluating computing resources for compliance.

1.5.2.1. Limitations in Standards

None of the 3 standards for date representation (ANSI, ISO, FIPS) mandates a 4-digit year for ALL calendar data. For example, conformance to ANSI X3.30 does not eliminate century ambiguity from all date variables and interfaces. Instead, conformance simply reduces the variety of formats occurring in the computing resource.

1.5.2.2. Accommodating Conflicts

While trying to conform to ANSI X3.30, some applications may need to satisfy other standards or conventions for date representation. Table 6 lists examples of standards with date representations that may supersede ANSI X3.30 in specific applications. In addition, the criteria and performance expectations set forth in this document take precedence over all other standards or conventions.

Table 6. Examples of Standards which may Supersede ANSI X3.30

Domain	Standard
Interoperability with international concerns	ISO 8601 (1988)
SQL	ANSI X3.135-1992, ISO-IEC 9075:1992, or FIPS 127-2
Electronic commerce (EDI)	ASC X12 EDI draft std for trial use, ISO 9735, UN/EDIFACT

2.0 OPERATION AND INSTALLATION CONDITIONS

N/A

3.0 EQUIPMENT/SERVICE TO BE FURNISHED

Approved vendor is to supply personnel, equipment and/or services identified on purchase order meeting the requirements of the purchase order and this specification.

4.0 GENERAL DESIGN AND MATERIAL REQUIREMENTS

This document requires that computational resources satisfy the General Integrity and Date Integrity criteria, and either the Explicit or Implicit century criteria. It is preferred and recommended that both the Explicit and Implicit criteria be met if possible, although meeting one or the other of these criteria is acceptable. Resources (hardware, software, or "firmware") that meet these conditions will be considered "Year 2000 Compliant" These criteria are listed in Table 2.

5.0 COATINGS

N/A

6.0 SPECIAL REQUIREMENTS

Refer to Section 1.0.

7.0 QUALITY ASSURANCE REQUIREMENTS AND DOCUMENTATION

All applications and/or devices will be tested and certified as Year 2000 compliant prior to return as identified on the purchase order and/or contract.

8.0 DELIVERY

All applications and/or devices will be delivered within the time period specified on the purchase order and/or contract.

9.0 VENDOR DRAWINGS

N/A

10.0 INSTRUCTION MANUALS

N/A

11.0 TEST AND INSPECTIONS

All tests and inspections will be performed as specified on the purchase order and/or contract.

12.0 SPARE PARTS

N/A

13.0 INFORMATION TO BE FURNISHED BY SUPPLIER

All information will be furnished as specified on the purchase order and/or contract.

14.0 DISCREPANCIES AND INTERPRETATION

Should vendor find discrepancies in, or omission from, attachments or specifications or be in doubt as to their meaning, Duke Year 2000 representative shall be contacted for a written interpretation.

15.0 CONFORMANCE WITH SPECIFICATIONS

Any unapproved non-conformity with specifications must be changed to complete conformity at the vendor's expense, including cost of all labor, materials and other related expenses or approved by a Duke Year 2000 representative.

16.0 CONSTRUCTION SERVICES

N/A

17.0 ERECTION ENGINEER

N/A