Duke Energy

W. R. McCollum, Jr.
Vice President

Duke Energy
Oconee Nuclear Station
7800 Rochester Highway
Seneca, SC 29672
(864) 885-3107 OFFICE
(864) 885-3564 FAX

July 26, 2001

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 - Supplement 2
Technical Specification Change (TSC) Number 99-10

On July 18, 2000, Duke Energy (Duke) submitted a proposed change to the Technical Specifications (TS) that will implement the Automatic Feedwater Isolation System (AFIS). On March 26, 2001 a Request for Additional Information was sent to us electronically with supplements on May 3, 2001 and June 5, 2001. Attachment 1 restates the questions and provides our response.

The installation of AFIS is an important modification in that it supports Duke's goal of reducing operator burden by eliminating prompt operator actions in the event of a Main Steam Line Break. It also provides header specific feedwater isolation which enhances the ability of operators to align the startup feedwater header if needed. The modification also upgrades the Turbine Driven Emergency Feedwater Pump trip to QA-1.

This supplement also contains two corrected pages of TS Bases. The Background section of the Bases for TS 3.3.13 describes how the Trip Setpoints and Allowable Values for AFIS are determined and verified and refers to CHANNEL CALIBRATION, CHANNEL CHECKS and a CHANNEL FUNCTIONAL TEST. These tests are applicable to the analog channels that feed the digital channels. Since TS 3.3.13 deals with the digital channels, minor editorial changes have been made to the Background section in the Bases of TS 3.3.13 to reflect

A001

that the calibration, checks and functional tests and on-line testing are applicable to the analog channels. Attachment 2 consists of the replacement Bases page and mark-ups to show the changes made.

At the time the original submittal was docketed on July 18, 2000, the modification development had begun final design. During final design, two minor changes were made to the modification as described in Attachment 3, Technical Justification, of the original submittal. The submittal stated that AFIS would use a custom designed 15 VDC power supply. During final design Duke identified an off-the-shelf power supply that meets the required specifications. Also during final design, an annunciator of contact status for the AFIS keyswitch was added in addition to status available on the plant computer. In addition, the total heat load calculation described on page 21 was revised and a minor change has been made to the description to remove unneeded detail. Revised pages to reflect these changes are included in Attachment 3 of this submittal.

During the review of the AFIS submittal, the staff had questions on the schedule for completing Steam Generator (SG) tube stress analyses. As discussed with the staff, the main steam line break (MSLB) and main feed line break (MFLB) analyses are currently in progress. The completion of the thermal- hydraulic analyses for these events is scheduled for mid-August. Based on the thermal-hydraulic analyses, Framatome will perform SG tube stress analyses for MFLB events in the fall. When their analyses are complete, currently scheduled for the end of the year, Duke can develop a schedule for implementing the results, if needed. At that time, Duke will inform the staff of the results and any actions needed to address the results. Following that, the tensile SG tube stress analyses for the MSLB cases can proceed. Until that work is complete and accepted by Duke, the more conservative SG tube tensile stress values developed in TSC 99-01 will be used as the basis for steam generator tube inspection and plugging criteria.

AFIS is scheduled to be implemented on unit 3 during U3EOC19 in late 2001. Unit 1 implementation is scheduled for U1EOC20 in the spring of 2002, and Unit 2 implementation during U2EOC20 in the fall of 2002. Duke understands that the license amendment for AFIS will be effective as of its date of issuance and shall be implemented on each unit prior to reactor startup following installation of the system and training of appropriate personnel.

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

Very truly yours,

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

cc: Mr. D. E. LaBarge, Project Manager
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Mail Stop O-14 H25
Washington, D. C. 20555

Mr. L. A. Reyes, Regional Administrator
U. S. Nuclear Regulatory Commission - Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

Mr. M. C. Shannon
Senior Resident Inspector
Oconee Nuclear Station

Mr. Virgil R. Autry, Director
Division of Radioactive Waste Management
Bureau of Land and Waste Management
Department of Health & Environmental Control
2600 Bull Street
Columbia, SC 29201

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 26th day of July, 2001

Conice M. Breazeale
Notary Public

My Commission Expires:

2-12-2003

Attachment 1

Response to Request for Additional Information
TSC 99-10 - Supplement 2

SPLB QUESTIONS PERTAINING TO AFIS

1. Those elements of AFIS that are relied upon to prevent SG tube stresses from exceeding the allowable limits following a MSLB, such as electrical components, and circuitry, actuated components, components that are relied upon to function (such as MS-95), and power supplies, should satisfy the criteria that has been established for safety system applications (including fire and EQ considerations). Provide a complete listing of the design criteria for safety system applications, identify any exceptions where the elements of AFIS (referred to above) do not satisfy the criteria, and explain why each identified exception should be allowed.

Response:

The following table summarizes the hazard criteria applied to AFIS and its support systems:

Function/Channel	**Other Design Criteria**					
	Seismic	EQ	Fire	HELB	Turbine Missile	Flood
AFIS Analog 1/2/3/4	Y	Y4	Y1	Y	N1	Y
AFIS Digital Channels 1&2	Y	Y	Y1	Y	Y	Y
Digital Ch. Output Devices for MDEFW Termination	Y	N/A	Y1	Y3	N1	N2
Digital Ch. Output Devices for TDEFW Termination	Y	N/A	Y1	Y3	N1	N2
Digital Ch. Output Devices for FDW Isolation	Y2	N/A	Y1	Y3	N1	N2

Y Complies.

Y1 All AFIS related equipment is located within the same fire zone. The SSF remains the fire mitigation strategy.

Y2 The AFIS solenoid valves on the control air to the FDW control valves are seismically qualified. The valve actuators, FDW pump trips, and FDW block valves are not seismically qualified.

Y3 There are no HELB scenarios that affect AFIS isolation equipment that also require AFIS mitigation. This equipment is not required to mitigate other non-Main Steam HELB events.

Y4 Analog Channels 1 & 2 are Environmentally Qualified for Harsh Environment. All other AFIS related equipment is located in mild environment. However, moisture protection is provided for all transmitters, and TDEFW trip devices.

N1 Turbine missile protection is not provided for 2 analog channels. The failure mode could result in AFIS actuation which trips Main Feedwater and EFW. However, since the total target area for MS piping outside containment is less than the target area criteria for consideration of turbine missile impacts as established in UFSAR 3.5.1.2.3, a turbine missile is not postulated to cause a MSLB. In accordance with the criteria stated in UFSAR 3.2.2, AFIS is not required to be designed to withstand the effects of a tornado missile. Therefore, AFIS is not required to mitigate postulated missile scenarios.

N2 The design basis of FDW and EFW does not include flood protection. The SSF ASW system is the flood mitigation system.

The AFIS Analog Channels consist of the following:

- Pressure Transmitters and associated cabling/resistors
- Signal Isolators between the analog channel pressure transmitters and non-safety control system

The AFIS Digital Channels is defined as the following:

- Analog Voltage Isolation Modules (Framatome AVIM-D)
- Safety STAR Digital Logic Modules (Framatome)
- Header specific Enable/Disable(OFF) pushbuttons (Cutler Hammer E30AN) which have independent plungers and deck separation between Digital Channels
- Associated output relays
- Trip relay outputs to feedwater pumps, the redundant switchgear trips for the MDEFWP, the solenoid valves for the MFCV and SFCV, the trip solenoid valves for the feedwater pumps, and the TDEFWP trip function
- Header specific Manual Initiation pushbuttons (Cutler Hammer E30AD) which have deck separation between Digital Channels.

For convenience, the following table summarizes the trip outputs:

Isolation Function	Digital Channel 1	Digital Channel 2	Digital Channels 1 & 2
MDEFW Pump A	Switchgear Trip #2 Swgr close inhibit	Switchgear Trip #1 Swgr close inhibit	
MDEFW Pump B	Switchgear Trip #1 Swgr close inhibit	Switchgear Trip #2 Swgr close inhibit	
TDEFW Pump	TO-145 (MS-95)	SV-74 (MS-93)	
FDW-31 Main Block Valve Header A			Motor starter circuit
FDW-32 Main Control Valve Header A	SV-1089	SV-1090	
FDW-33 Startup Block Valve Header A			Motor starter circuit
FDW-35 Startup Control Valve Header A	SV-1091	SV-1092	
FDW-40 Main Block Valve Header B			Motor starter circuit
FDW-41 Main Control Valve Header B	SV-1085	SV-1086	
FDW-42 Startup Block Valve Header B			Motor starter circuit
FDW-44 Startup Control Valve Header B	SV-1087	SV-1088	
FDWP-A			Trip solenoid valve
FDWP-B			Trip solenoid valve

The only HELB scenarios that would credit AFIS for mitigation are the Main Steam Line Break event and Main Feedwater Break event downstream of the containment check valves (hereinafter referred to as MFLB). All FDW and EFW isolation equipment is immune from the consequences of MSLB events requiring AFIS actuation and of FDW line breaks downstream of the containment check valves. Therefore, AFIS is capable of detecting any scenario that credits AFIS mitigation and generating the required trip outputs. Since the MS pressure transmitters are protected from HELB and seismic events, AFIS will not spuriously actuate during these events. All EFW isolation functions are seismically qualified. The FDW isolation functions are not seismically qualified. When new QA-1 components are installed, a field walkdown is conducted that looks for seismic/non-seismic interactions. Non-seismic piping that is identified to present a potential hazard to QA-1 components during a seismic event is seismically supported (Seismic Category II) or the component is shielded or otherwise protected.

Non-safety related control systems cannot inhibit the AFIS trips of MFW pumps or the closure of MFW valves. Consistent with previous analysis, a failure of the MFW control valves is not assumed. Therefore, the worst-case feedwater addition occurs for the single failure of the EFW control valve to the affected SG. AFIS is relied upon to terminate MFW flow to the affected SG upon reaching the low pressure setpoint. The MFW boundary condition is described in detail in the response to Question 4a.

The MFW components that are actuated by AFIS are the same as those that are actuated by the MSLB circuitry. While the circuitry that actuates these components is QA-1 and single failure proof, the MFW components that are actuated by the circuitry are not. These components include the MFW startup and main control valves, the MFW block valves, the MFW pump trip circuitry, and the MFW pumps. In support of the AFIS project, a HELB review was performed. The results determined that for MSLB and MFLB events that require AFIS actuation, the effects of the MSLB or MFLB will not impair or inhibit the ability of AFIS devices to properly function.

The original licensing basis credited the closure of the MFW and startup feedwater control valves. The two channels of trip solenoid valves, which close the MFW and startup feedwater control valves, are powered from redundant QA-1 vital power buses. Therefore, the circuitry to generate a MFW and startup feedwater control valve closure signal remains assured for a loss of power to either channel. The MFW and startup feedwater control valves are included in the Duke QA-5 program and are periodically tested in accordance with TS-3.7.3.

A loss of power can adversely affect the MFW pump trips or block valve closure. The closure of the MFW block valves is not credited in the accident analyses. The single failure concerns of FDW components due to loss of power, control system interactions, etc., are not addressed by AFIS. The Main and Startup FDW control valves are air operated valves and would fail as-is on loss of air. However, there is redundant air supply to the valves. Loss of power can only affect one channel of the AFIS solenoid valves. The other channel of solenoid valves will close the valves. Power to the control valve solenoids is independent of power to the MFW pumps. The NRC approved the current mitigation strategy in response to TSC-99-01 which credited the use of non-single failure proof FDW equipment. The Oconee licensing basis remains unchanged.

2. The AFIS submittal indicates that TSC 99-01, dated April 26, 1999, is bounding with respect to steam generator (SG) tube loads. TSC 99-01 refers to the original SG tube stress analysis that was performed around the 1970 time period as justification for the amendment request. Many changes have been made to the Oconee units since 1970 to address HELB and TMI issues, and the validity of an analysis that was performed in 1970 is questionable. Explain why the 1970 SG tube stress analysis remains bounding for the current plant design, assuming worst-case conditions relative to SG tube stresses. [Letter, page2]

Response:

The TSC 99-01 submittal discusses the original SG tube stress analyses from a historical perspective. The original analyses performed in the 1970 time period credited the operation of the ICS to control SG level, which limited the SG tube stresses seen during a MSLB. Since the MFW System remained in operation, EFW actuation did not occur.

The TSC 99-01 submittal also presents the methodology and results of a revised SG tube stress analysis that forms the current licensing basis. In the revised analysis, no credit is taken for operation of the ICS to control SG level since the ICS is a non-safety related system. The MSLB Detection and Feedwater Isolation System actuates to isolate MFW and TDEFW flow. MDEFW flow continues to be delivered to the affected SG until operator action is taken at 10 minutes. The revised analysis is performed with conservative assumptions and reflects the current plant design.

AFIS will enhance the MSLB Detection and Feedwater Isolation System by providing automatic isolation of MDEFW to the affected SG. Thus, the SG tube stresses with the AFIS circuitry are bounded by those presented in the TSC 99-01 submittal.

Overview of SG Tube Loading Analyses

The original SG tube loading analyses relied upon the non-safety ICS to control MFW following a MSLB. These tube loading analyses were revised by TSC 99-01, which was submitted to the staff April 26, 1999, and approved in a safety evaluation dated September 18, 2000. Technical Specifications to support the AFIS design (TSC 99-10) were submitted to the staff on July 18, 2000. This response summarizes key differences in the original licensing basis, TSC 99-01, and TSC 99-10 with respect to the feedwater boundary conditions and the function of the non-safety main feedwater and startup feedwater control valves.

Overview of ICS Feedwater Control

Secondary side heat removal is normally provided by the main feedwater (MFW) system. The once through steam generators operate based on level control at low loads (less than about 15% power) and flow control at loads between about 15% power and full power. Oconee relies on the Integrated Control System (ICS) to control secondary side heat removal during normal operation. The following table describes valve positions during startup, power operation, and post-trip conditions. Note that MFW continues to provide secondary side heat removal post-trip.

Plant Condition	Startup Feedwater Control Valve	Startup Feedwater Block Valve	Main Feedwater Control Valve	Main Feedwater Block Valve
No Load to about 15 % power (ICS on level control)	Modulates to control SG level at 25"	Fully opened	Closed	Closed
Approximately 15% power to full power (ICS on flow control)	Fully opened	Fully opened	Modulates to control flow	Fully opened
Immediate post-trip response	Fully closed	Fully opened	Fully closed	Fully closed
Post-trip response after SG levels decrease to 25" (RCPs running)	Modulates to control SG level at 25"	Fully opened	Fully closed	Fully closed
Post-trip response with no RCPs running	Modulates to control SG level at 50% operating level to promote natural circulation	Fully opened	Fully closed	Fully closed

Overview of MSLB Modification (TSC 99-01)

Safety-related, single failure proof circuitry (2 of 3) performs the following functions on low SG pressure in either steam generator:

- Trips both MFW pumps
- Closes both main feedwater control valves
- Closes both startup feedwater control valves
- Closes both main feedwater block valves**
- Closes both startup feedwater block valves**
- Trips or prevents a start of the TDEFW pump

** Closure of the block valves is not credited

Overview of AFIS Modification (TSC 99-10)

Safety-related, single failure proof circuitry (2 of 4) performs the following functions on low pressure in a steam generator:

- Trips both MFW pumps
- Closes the main feedwater control valve to the affected SG
- Closes the startup feedwater control valve to the affected SG
- Closes the main feedwater block valve to the affected SG**
- Closes the startup feedwater block valve to the affected SG**
- Trips or prevents a start of the TDEFW pump

In addition, the following function is performed based on concurrent low SG pressure and rate of depressurization:

- Trips the MDEFW pump to the affected steam generator

** Closure of the block valves is not credited

Comparison of SG Tube Loading Analyses

The following table compares key differences between the different tube loading analyses:

System or Component	Original Tube Loading Analysis	TSC 99-01 (MSLB Modification)	TSC 99-10 (AFIS Modification
ICS	Automatically controls MFW flow to the post-trip setpoint of 25 inches	Assumed to be in manual	Assumed to be in manual
EFW	Does not actuate since MFW continues to provide secondary side heat removal	• Actuates when MFW pumps trip • TDEFWP prevented from starting or tripped by MSLB circuitry • One MDEFW pump feeds affected SG for 10 minutes • One MDEFW pump feeds unaffected SG with SG level controlled by the EFW control valve	• Actuates when MFW pumps trip • TDEFWP prevented from starting or tripped by AFIS circuitry • The MDEFW pump feeding affected SG is tripped by AFIS circuitry • One MDEFW pump feeds unaffected SG with SG level controlled by the EFW control valve
MFW pumps	MFW pumps continue to provide secondary side heat removal	Both pumps tripped on low SG pressure by MSLB circuitry	Both pumps tripped on low SG pressure by AFIS circuitry
MFW main control valve to affected SG	• Valve is initially controlling full power MFW flow • ICS closes valve on reactor trip • Valve remains closed	• Valve is initially controlling full power MFW flow • MSLB circuitry closes valve on low SG pressure • Valve remains closed	• Valve is initially controlling full power MFW flow • AFIS circuitry closes valve on low SG pressure • Valve remains closed
MFW startup control valve to affected SG	• Valve is initially fully open • ICS closes valve on reactor trip • ICS reopens valve when SG level decreases to 25" and modulates to control level at this setpoint	• Valve is initially fully open • MSLB circuitry closes valve on low SG pressure • Valve remains closed	• Valve is initially fully open • AFIS circuitry closes valve on low SG pressure • Valve remains closed

Overview of Resultant SG Tube Loads

The SG tube loads are strongly influenced by the amount of MFW and EFW delivered to the affected SG. Thus, for the MFW and EFW boundary conditions outlined in the previous table and applying the same analytical methods to each case, the following SG tube load results are obtained:

Original Tube Loading Analysis Boundary Conditions	TSC 99-01 (MSLB Modification)	TSC 99-10 (AFIS Modification)
Tube loads are less limiting than TSC 99-01 results due to low level control of MFW and the absence of EFW. Tube loads are slightly worse than TSC 99-10 due to the continuation of MFW flow.	Most limiting tube loads due to continued addition of MDEFW to the affected SG for 10 minutes. MFW boundary condition for the affected SG is identical to TSC 99-10.	Lowest tube loads due to the isolation of all MFW and EFW to the affected SG by AFIS.

Conclusion

Two facts are readily apparent from the above.

First, under the conditions of the original licensing basis, the MFW control valves close and the Startup feedwater control valves initially closed and then modulated open to maintain level. With the AFIS modification, both main and startup feedwater control valves will close and remain so. AFIS reduces the demand placed on the startup feedwater control valves.

Second, under the original licensing basis, the control signal for the main and startup feedwater control valves came from the non-safety ICS system. Under the AFIS modification, the control signal is generated by the protection-grade, safety-related AFIS system.

3. Explain how the design of the replacement SGs take credit for AFIS in limiting SG tube stresses in the event of a MSLB, and why this is not necessary for the current SGs. [Letter, page 2]

Response:

See response to question 2 above.

4. Relative to the criteria listed below, describe the worst-case scenarios and mitigation strategies (considering loss of offsite power and single failure, as appropriate).

a. Maximum SG tube stress that results from a valid or spurious AFIS actuation. [Attachment 3, pages 5, 6, 7]

Response:

The transients that may result in a valid AFIS actuation are steam line break (including main steam safety valve or turbine bypass valve failures), feedwater line break, and small break

LOCA (SBLOCA). Although the analyses for the steam line break transient have not yet been finalized, the tube stresses are expected to be slightly lower than the SBLOCA tube stresses. The SBLOCA event is expected to be the most limiting event for tensile tube stresses once the MSLB reanalysis with AFIS is completed. Without AFIS, the MSLB tube stresses bound those for SBLOCA. As stated on page 2 of the cover letter for the AFIS submittal dated July 18, 2000, the existing TSC 99-01 MSLB analysis is bounding with respect to the implementation of the AFIS modification. Therefore, the TSC 99-01 MSLB tube loads will continue to form the basis for the SG tube plugging inspection criteria until the MSLB reanalysis with AFIS is completed.

Steam Line Break

During a MSLB, pressure in the affected SG rapidly decreases to the AFIS low pressure setpoint. Upon reaching this setpoint, AFIS will automatically isolate MFW and TDEFW flow to the affected SG. For breaks that exceed the rate of depressurization setpoint, AFIS will also automatically isolate MDEFW flow to the affected SG, and no manual operator action is required to limit the tube stresses seen by the affected SG. For breaks that are too small to reach the rate of depressurization setpoint, manual operator action is required within 10 minutes to isolate MDEFW flow to the affected SG. The worst-case MSLB tube stresses occur in the scenario with AFIS isolation of MDEFW flow to the affected SG. The rate of depressurization setpoint is chosen to ensure that the break sizes with manual isolation of MDEFW flow produce less limiting tube stresses. These break sizes are sufficiently small that the rate of shell cooling is closer to that of the tubes, which reduces tube stresses (as described in the response to Question 7).

The worst single failure that is modeled in the MSLB SG tube loads analysis is the failure of the EFW control valve to the affected SG in the full open position. If the EFW control valve were to function normally, the EFW control valve would modulate to control SG level to 25″ with the reactor coolant pumps running or 240″ with the reactor coolant pumps tripped. For smaller break sizes, the SG rapidly fills with liquid due to the addition of feedwater outpacing the release of steam through the break. In these instances, the throttling of EFW would reduce the cooling of the tubes, thus reducing stresses. Therefore, the single failure of the EFW control valve conservatively maximizes the EFW addition to the affected SG. Unthrottled EFW flow is delivered to the affected SG until AFIS trips the TDEFW pump and the MDEFW pump aligned to the affected SG is tripped either by AFIS or by manual operator action at 10 minutes. A loss of offsite power does not impact the ability of AFIS to function. A loss of offsite power results in lower SG tube stresses due to the lack of feedwater addition by the MFW pumps.

As described in Question 2, the MSLB tube stresses are analyzed with the ICS in manual and the MFW main and startup control valves fully open. MFW flow to the affected SG initially increases above the full power value due to decreasing SG pressure. Upon reaching the AFIS low pressure setpoint, the MFW pumps are tripped and complete their coastdown within 30 seconds. In addition, the MFW main and startup control valves are closed by the AFIS circuitry within 25 seconds. EFW actuation occurs when the MFW pumps are tripped. The EFW control valve to the affected SG is assumed to fail in the full open position. Thus, maximum EFW flow is delivered to the affected SG until isolation by AFIS and/or manual operator action. Upon reaching the AFIS low pressure setpoint, the steam admission valve to the TDEFW pump is closed within 30 seconds. Following the isolation of the steam supply to the TDEFW pump, a 14 second pump coastdown time is assumed. For break sizes that exceed the AFIS rate of depressurization setpoint, the MSLB tube stresses are analyzed with termination of MDEFW flow to the affected SG upon reaching the rate setpoint coincident with low pressure. A MDEFW pump coastdown time of 14 seconds is assumed. No valve closure is associated with AFIS termination of MDEFW flow. For break sizes that do not exceed the rate setpoint, the MSLB tube stresses are analyzed with manual isolation of MDEFW flow to the affected SG at 10 minutes by the closure of the EFW control valve (stroke time of 60 seconds). The above times assumed in the analyses bound the current plant design. These times may be revised in the future as long as they continue to remain bounding.

After the affected SG has reached the AFIS setpoints, the unaffected SG can continue to depressurize due to reverse heat transfer and the raising of SG level by EFW. The EOP guidance allows the operators to throttle EFW while level is increasing, which should preclude reaching the rate of depressurization setpoint. Without operator action it is possible that the rate of depressurization setpoint may be reached in the unaffected SG. In this situation, manual operator action is required to restore EFW flow to the unaffected SG. This scenario is bounded by the single failure of the EFW supply to the unaffected SG described below.

In the event of a single failure of the EFW supply to the unaffected SG, AFIS isolation of all feedwater to the affected SG results in a loss of all feedwater. This results in a heatup of the RCS following the end of blowdown of the affected SG. The operator must mitigate this event by restoring a source of feedwater supply to the intact SG. So long as this action occurs within 20 minutes of the steam line break, this scenario remains bounded by the loss of feedwater analysis. The EOPs will also direct the operator to align HPI forced cooling (primary feed and bleed cooling) as a backup method of decay heat removal if the restoration of feedwater to the intact SG is delayed. This sequence of events and operator actions is unchanged from the current plant design without AFIS, with the exception that the current manual isolation of EFW to the affected SG will be replaced by the automatic AFIS response. Therefore, AFIS does not introduce a new possibility of loss of all FDW to the intact SG.

Feedwater Line Break
The tensile tube stresses that result from a feedwater line break are bounded by steam line break. Analyses of the compressive SG tube stresses that result from a feedwater line break are currently in progress. Duke will update the staff on compressive tube loads during a feedwater line break when these analyses are completed.

Small Break LOCA
See response to Question 4c.

Spurious Actuation
See the response to Question 15.

b. Maximum SG tube stress that results from a lower pressure MSLB (less than 700 psig). Also, explain why this situation remains bounded by the existing accident analyses. [Attachment 3, page 5; Attachment 4, page 2]

Response:

As described in the AFIS submittal, Attachment 3, page 8, the AFIS circuitry will be manually disabled when main steam pressure is below 700 psig. At these lower pressures, only one MFW pump is delivering flow through the startup flow path and the TDEFW pump is out of service. In this operating regime, the initial SG shell temperature is much lower than during power operations. When the AFIS circuitry is disabled, manual operator action is required to isolate MFW and MDEFW flow to the affected SG for a MSLB event. 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.

During shutdown, the TDEFW pump is locked in the OFF position prior to reducing SG pressure below 885 psig. During startup, the TDEFW pump is locked in the OFF position below Mode 3 (< 250 psig RCS pressure, SG pressure typically <100 psig). When going from Mode 3 to Mode 2, the Pre-criticality Checklist increases SG pressure to 885 psig and then returns the TDEFW pump to AUTO.

Less than 700 psig there is no automatic signal that will cause MFW to terminate. Therefore the MDEFWP will only start if SG low level is reached. Operators must manually terminate any MDEFW pump that is in service with SG pressure less than 700 psig. No actions are required for the TDEFW pump when SG pressure is less than 700 psig.

Below 700 psig when the AFIS circuitry is disabled, the required manual operator actions are no different than those with the superseded MSLB circuitry disabled. As noted above, the time the plant is in this regime is very short and the probability of a MSLB is remote. Therefore, an analysis of this event has not been performed.

c. Maximum SG tube stress that results during a SBLOCA. Also, explain why this situation remains bounded by the existing accident analyses. [Attachment 3, page 16]

Response:

A pressurizer surge line break is analyzed to determine the SG tensile tube loads for SBLOCA. During this event, RCS inventory is blown out of the cold leg J bends and the SG tube regions. Since the break location is above the reactor coolant pump spill-over elevation, ECCS injection is capable of spilling over the reactor coolant pumps and refilling the pump suction region, and eventually the primary SG tube region, with cold low pressure injection fluid. Without a cooling mechanism for the SG shell region, the SG shell remains hot while the tube temperature drops rapidly.
The SBLOCA tube stresses are bounded by the TSC 99-01 MSLB tube stresses. However, with implementation of the AFIS modification, the MSLB tube stresses will be reduced such that the SBLOCA tensile tube stresses become limiting.

The current EOPs reflect the plant design without AFIS. Following a SBLOCA, the EFW System will actuate if the MFW pumps trip. Depending on the SBLOCA break size and the resulting RCS response, EFW flow will be automatically controlled to either the minimum level setpoint or the natural circulation level setpoint. If subcooled margin is lost, the operator will use EFW flow to raise SG levels to the loss of subcooled margin setpoint. The EOP directs the operator to initially supply 200 gpm of EFW flow to each SG, or 400 gpm to one SG if only one is being supplied with EFW. The operator is then allowed to throttle EFW if overcooling symptoms develop, as long as steady progress to the target SG level setpoint is maintained. The operator is also required to prevent exceeding the maximum EFW flowrate limits, but the above guidance serves that purpose also. With AFIS installed, the EOPs will accomplish the same control of EFW flow following a SBLOCA.

As described in the AFIS submittal, Attachment 3, pages 6 and 7, during a SBLOCA, EFW injection to reach the required SG level setpoint can contribute to 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. Thus, the existing SBLOCA SG tube stress analysis remains bounding. The analysis assumes a minimum EFW flow rate from one MDEFW pump. This assumption conservatively minimizes the cooling of the SG shell, which maximizes the tube-to-shell temperature differential. If AFIS actuates and causes a MDEFW pump trip during the small break LOCA event, manual restoration of EFW is required.

d. Maximum SG tube stress that results during ATWS. Also, explain why this situation remains bounded by the existing accident analyses. Alternatively, confirm that AFIS actuation will not occur as a result of ATWS.

Response:

As described in the AFIS submittal, Attachment 3, page 7, 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. The tripping of the main turbine prevents any significant depressurization of the SG, and SG pressure is subsequently controlled to 1010 psig by the Turbine Bypass system. SG depressurization below the AFIS low pressure setpoint of 550 psig should not occur, and thus AFIS will not actuate during an ATWS event.

e. Most severe impact on EFW and the decay heat removal function resulting from a valid or spurious AFIS actuation. Also, explain why this situation remains bounded by the existing accident analyses. [Attachment 3, pages 5, 6, 7]

Response:

As described in response #15, a spurious actuation of AFIS is not credible. The worst case scenario involves a failure of the EFW flow path to the intact steam generator as described in response #14.

f. Most severe impact on EFW and the decay heat removal function resulting from a fire event. Also, explain why this situation remains bounded by existing accident analyses.

Response:

AFIS does not adversely impact the mitigation strategy for the Appendix R Fire Events. The SSF Auxiliary Service Water remains physically separated from the plant locations affected by AFIS.

5. Identify the size of MSLB that was used as the basis for establishing the low pressure and the pressure rate of change setpoints for AFIS actuation, and explain why the consequences of other break sizes (those that rely on AFIS actuation) are bounded by this event.

Response:

The low pressure setpoint for AFIS actuation is unchanged from the low pressure setpoint of 550 psig used by the MSLB detection and feedwater isolation circuitry. The AFIS pressure rate of change setpoint is determined by the MSLB break spectrum analysis. These analyses have not been finalized, but the expected size of MSLB that is expected to set the rate of change setpoint is roughly 0.4 ft^2. The break spectrum is analyzed with the chosen rate of depressurization setpoint to ensure that acceptable SG tube loads are obtained for all break sizes, including those that rely on manual operator action rather than AFIS isolation of MDEFW flow to the affected SG.

6. Identify what the allowable tolerances are for the low pressure and pressure rate of change trip setpoints, how they were established, and how they will be maintained over time. [Attachment 3, page9]

Response:

Instrument setpoints including uncertainty are calculated in accordance with EDM-102, "Instrument Setpoint/Uncertainty Calculations." This engineering directive outlines the requirements for performing instrument uncertainty and setpoint calculations. The primary purpose of this directive is to provide a consistent methodology based on standard industry practices for performing instrument uncertainty and setpoint calculations. The calculation methodology is consistent with the intent of ISA-67.04, Part II, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation."

In brief, the methodology conservatively accounts for the typical uncertainty terms such as reference accuracy, drift, temperature effect, calibration effects (which include measurement and test equipment uncertainty, calibration tolerance and resolution), etc. The random-independent uncertainty terms are combined via the "square-root-sum-of-the-square" (SRSS) technique, whereas the random-dependent and bias uncertainty terms are combined via a combination of SRSS and/or algebraic techniques.

The safety analyses determine the low pressure and rate of depressurization setpoints that result in acceptable tube stress results. The trip setpoints for AFIS are determined by adjusting the values assumed in the safety analyses by the uncertainties calculated by the methodology described above. The setpoint calculations are still in progress.

The trip setpoints reside in EEPROM on the STAR modules. Maintenance procedures are used to document, test and control the setpoints. Access to the setpoints requires a key which is administratively controlled by Operations. The Calibration and Test Computer (CTC) is used by the craft to manipulate the value of the setpoints as required by procedure.

7. Explain why the largest MSLB that relies on operator action rather than AFIS actuation for event mitigation is bounded by existing accident analyses.

Response:

For break sizes that produce a rate of SG depressurization that is less than the AFIS rate setpoint, manual operation action is required to isolate MDEFW flow to the affected SG within 10 minutes. AFIS will still automatically isolate MFW and TDEFW flow to the affected SG upon reaching the low pressure setpoint. The break sizes that rely upon operator action are analyzed with continued EFW flow for 10 minutes with the EFW control valve fully open. These break sizes are expected to produce slightly lower SG tube loads than the larger break sizes that have isolation of MDEFW by AFIS. For the smaller break sizes, the SG tubes cool more slowly due to the lower SG blowdown rate. The more gradual cooling of the tubes allows more time for the SG shell to cool, which helps reduce the SG tube loads. Since a complete spectrum of break sizes is analyzed that includes those with operator action as well as with AFIS isolation of MDEFW, a bounding SG tube load is ensured.

8. During the SBLOCA event, assuming the TDEFW pump trips due to AFIS and one MDEFW pump fails to start, only one MDEFW pump remains to mitigate the event. Explain how this scenario is bounded by the existing accident analyses.

Response:

The SBLOCA analyses do not credit the operation of the TDEFW pump. Only one MDEFW pump is credited in the analyses to provide the necessary heat removal. The second MDEFW pump fails to start consistent with the assumed single failure in the analyses. As discussed in the response to Question 4c, operator action to throttle EFW should preclude exceeding the AFIS rate of depressurization setpoint. Therefore, this scenario is within the bounds of the existing accident analyses so long as the AFIS rate of depressurization setpoint is not exceeded. If AFIS actuates and causes a MDEFW pump trip during the SBLOCA event, manual restoration of EFW is required. However, this is an event that compounds an operator error with an equipment failure and is therefore beyond design basis.

9. Explain why the response time requirements for the TDEFW pump are more limiting for containment overpressurization than for SG tube stress considerations. [Attachment 3, page 15]

Response:

The TDEFW pump isolation response time requirements for SG tube stress considerations are identical to those for containment overpressurization.

10. When relying on MS-93 to close, what assurance is there that EFW flow from the TDEFW pump will stop since MS-93 is designed to allow some amount of bypass steam flow?

Response:

If the TDEFW Pump is rotating less than 400 rpm, it can not develop enough head to overcome the elevation change necessary to feed the steam generators. There is currently steam leakage through the existing valves and the turbine does not rotate. The controlled leakage associated with the new valve will have a magnitude of the same order as the existing leakage. Thus, no rotation is expected.

Observations of the TD EFW pump suggest that the turbine will coast down very quickly once the pump is tripped. To provide verification of this, a one-time speed response test will be performed. This test will confirm that the TDEFW pump coastdown occurs within the time required by the accident analyses.

11. Describe the design basis function and mission time of the nitrogen supply for MS-93, what constitutes operability, and how this capability will be assured. [Attachment3, page4]

Response:

The function of the nitrogen supply is to close MS-93 and keep it closed for 2 hours in the event of a loss of instrument air and auxiliary instrument air. The 2-hour closure is based on a nitrogen bottle that has decayed to an assumed reduced pressure with an assumed leakage rate. The system design does not consume nitrogen once the valve has stroked closed. Therefore, if the system is leak-free, the valve would remain closed indefinitely. Since small leaks are expected, an allowable leakage rate has been determined, along with corresponding alarm setpoints to alert operators that a bottle swap is required. A periodic test will be conducted to verify that the leakage rate is less than that used in calculations. If the leakage rate is acceptable and the bottle pressure is above the Lo-Lo alarm setpoint, the nitrogen supply will deliver the required 2 hour closure time.

Following a MSLB, the TDEFW Pump will be automatically stopped by the closure of MS-93 and MS-95. Should MS-95 fail to close, then MS-93 must remain closed long enough to allow operators to complete isolation of the affected Steam Generator from the EFW system. The Emergency Operating Procedure directs the operator to close FDW-315 or FDW-316, depending on the affected SG, following a symptom of excessive heat transfer. This action is performed inside the control room and is considered to be a simple operator action. The EOP then directs operators to further isolate feedwater to the faulted steam generator by closing a list of additional valves. Numerous options are available to the operators to accomplish this isolation. Assuring MS-93 remains closed for 2 hours provides adequate time for operator action if required for TDEFW pump isolation.

Even though the controls for MS-95 and FDW-316 share the same power panelboard, the operation of MS-93 and of the supporting nitrogen supply assures termination of the TDEFW pump. Therefore, the EFW isolation functions required by AFIS do not rely upon the operation of FDW-315 and FDW-316.

12. Explain the purpose of the AFIS/ATWS interlock function, and explain how this function is accomplished.

Response:

The ATWS circuitry is designed to start the EFW pumps for loss of FDW events. An AFIS actuation causes a FDW pump trip, which is sensed as a loss of FDW by ATWS. Therefore, normally closed contacts from each digital channel of AFIS inhibit the ATWS start contacts within the MDEFW pump control circuits to avoid cyclical trip (AFIS) and close (ATWS) operations of the switchgear. Similar contact logic prevents cyclical open and close operations of the steam isolation valve on the TDEFW pump.

13. Typically, operator actions following an accident are not credited before 20 minutes for actions inside the control room, and before 30 minutes for actions outside the control room, unless approved by the NRC for certain specific applications.

a. Identify where and for what purposes the 10 minute operator action criterion was approved for mitigation of MSLB events. [Attachment 3, pages 1 and 8]

Response:

The 10 minute operator action to isolate MDEFW to the affected SG was approved for MSLB containment response in the SER for Technical Specification Change Request 95-03 (dated December 7, 1998) and for MSLB SG tube stresses in the SER for Technical Specification Change Request 99-01 (dated September 18, 2000).

b. Identify where the 10 minute operator action criterion was approved for common mode turbine bypass valve failure. Attachment 4, page 2.

Response:

In the original AFIS submittal, Attachment 4 (No Significant Hazards Consideration) contained a statement that common mode failure of all turbine bypass valves would cause both steam generators to depressurize. This in turn might cause the AFIS setpoint to be reached for both, and that no operator action would be required within the first 10 minutes.

The No Significant Hazards Consideration was revised in Duke letter dated August 22, 2000 and the above information was deleted.

Page 7 of Attachment 3 contains the following regarding turbine bypass valve failures:

"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."

In point of fact, the common mode failure of all turbine bypass valves to open is not a credible event. The turbine bypass valves are pneumatically controlled and loss of air will cause the valves to shut. The changes made in the modified Integrated Control System corrected earlier issues that could cause common mode failures.

With respect to AFIS, the worst case failure mode is two turbine bypass valves on one header failing to the 50% open position. This failure mode results in the depressurization of only one SG. The resultant tube stresses are therefore bounded by the MSLB break spectrum analysis.

The main steam lines are normally connected at the steam chest upstream of the turbine, unless the turbine stop valves have closed such as following a turbine trip. Prior to turbine trip, an event that causes depressurization of either SG will cause the other SG to also depressurize. Following turbine trip, the two main steam lines are separated and one will be restored to an intact condition. The only exception to this is a break in the piping that supplies main steam from either steam line to the EFW pump turbine. For this break location, both SGs will depressurize, and in the absence of operator action to isolate the break, the AFIS setpoint will be approached. In the event that AFIS actuates and terminates MFW and/or EFW to both SGs, the resultant heatup is less limiting than the scenario described in the response to Question 4a. Therefore, so long as the operator mitigates this event by restoring feedwater within 20 minutes of the break, a break in this location remains bounded by the loss of feedwater analysis.

In the above scenario, the break causes indications of excessive heat transfer and the operator enters the Excessive Heat Transfer section of the EOP. As part of the first set of actions in this EOP section, the operator will close the steam supply valves to the EFW pump turbine. This will stop the blowdown and give indication that there is an intact steam generator. In fact, both steam generators will be intact. Within a few steps, the EOP directs reestablishing feed flow with the motor-driven EFW pump to all intact SG(s). These are simple actions that are conducted in the control room and experience with excessive heat transfer scenarios on the simulator suggests that they can be done well within the 20 minute time frame. As noted in response to Question 4a, the EOP will direct decay heat removal by HPI feed and bleed if the restoration of feed flow is delayed.

Both SGs can also depressurize due to excessive feedwater flow. Actuation of AFIS for these scenarios is desired to mitigate the event. Subsequently the operator will be required to restore some source of feedwater for decay heat removal. This situation may occur for some SBLOCA events. Both SGs can also depressurize due to reverse heat transfer for larger LOCAs. However, EFW is not required for these larger LOCAs, and therefore AFIS actuation is not of concern.

Events that result in depressurization of both steam generators are not limiting but do require operator action to provide for decay heat removal. Alignment of forced HPI cooling (feed and bleed) is also included in the EOP as a backup method for decay heat removal.

14. Describe any time-critical operator actions that may be necessary following an AFIS actuation (including appropriate justification) to either isolate feedwater flow to the faulted SG, or to initiate feedwater flow to the intact SG. For example, these actions may be required in response to single failure problems, or because the event is outside the AFIS design criteria. Justify any reliance that is placed on equipment (including annunciation and indication) that does not fully satisfy the criteria for safety-related applications. Explain why each situation remains bounded by the existing accident analyses.

Response:

Single failures of the EFW control valve or motor-driven pump on the intact steam generator require operator action to establish secondary cooling. Manual actions would involve placing any desired MDEFW pump control switch in the RUN position and using control room switches to align valves as required. Other strategies are available using the TDEFW pump and the FDW startup header as described in UFSAR Section 10.4.7. The ability to establish secondary cooling via the startup feedwater header is improved by AFIS due to the header specific FDW isolation enhancement. Actions required to establish secondary cooling are consistent with the licensing basis of the EFW single failures described in Section 10.4.7 of the UFSAR and the consequences are bounded by existing analyses. Indications of the failure are provided by safety related flow instrumentation and by status indicating lights on the EFW pumps and valves.

There are no potential failures of ICS that would inhibit an AFIS isolation function.

Operator actions that are credited in safety analyses are translated into required actions in EOPs or other procedures.

15. To what extent must the manual operator actions in the emergency operating procedures continue to be credited for accident mitigation in order to compensate for design weaknesses? [Attachment 4, page 1]

Response:

For MSLB events that exceed the AFIS rate of depressurization setpoint, manual operator action is no longer required to isolate MDEFW flow to the affected SG. For MSLB events that do not exceed the AFIS rate of depressurization setpoint, manual operator action continues to be credited at 10 minutes for isolation of MDEFW flow to the affected SG.

Spurious actuation of a STAR digital channel is a non-credible event for the following reasons:

- The STAR Processor Module trip outputs are non-fail-safe, resulting in a non-tripped condition on a loss of power.
- A failure of either or both safety function processors due to detected failure such as power-on self test, on-line diagnostic test or low voltage, or a lock-up of the processor will not cause a spurious trip. In order for a trip output to energize, a watchdog timer must be activated and periodically refreshed in order to hold the output energized. The activation and refresh functions cannot be performed by a processor that is not operating.
- Power-on Self test and on-line diagnostics prevent a processor from operating in a reduced state of operability.
- Transmitter voltages below 1.8 volts (3.6 ma) result in the affected channel being disabled. No trip will result from a transmitter catastrophically failing to zero. This is an improvement in reliability that digital technology provides over the analog circuitry.
- A spurious trip could occur due to a fault in the software of either safety function processor. However, this software is verified and validated by an independent V&V group in accordance with a process that was audited and accepted by the NRC during their review of the STAR Topical Report. This process complies with IEEE 7-4.3.2-1993 and NQA-1-1994, Subpart 2.7. The AFIS software programs have a limited quantity of inputs, i.e., four transmitter signals, a trip reset/disable switch and a channel disable input for each of the four transmitters. The processors process each transmitter in the same way as the next, i.e., the same function is repeated four times. Therefore, the possible combinations of these inputs can be rigorously tested such that a spurious trip resulting from an untested input configuration is not considered credible.

Consistent with the requirements of Generic Letter 95-02 and the guidance of EPRI TR-102348, a diverse means of manually initiating AFIS and defeating AFIS is provided with control room switches. The unlikely failure of the STAR is alarmed on control room annunciators via a fail-safe relay. Therefore, immediate recognition of the failure is available to the operators.

Operators are required to initiate manual actions to establish secondary cooling for failures of the EFW equipment to the intact steam generator.

16. Explain how manual reset of AFIS is accomplished, what happens when manual reset is performed, and when manual reset is required. Justify any reliance that is placed on equipment (including annunciation and indication) that does not fully satisfy the criteria for safety-related applications.

<u>Response</u>:

The manual reset of AFIS is accomplished via the header specific Enable/OFF pushbuttons, which meet the applicable safety-related design criteria, for each AFIS digital channel. The OFF position effectively resets AFIS by opening contacts in the trip relay logic. The AFIS related inhibits and trips are removed. The control of the isolation devices (valves and pumps) is restored to normal controls and automatic systems. Operating procedures will administratively control the desired condition of each pump and valve prior to resetting AFIS. For valid AFIS actuations, there is no requirement for resetting the AFIS logic unless single failures are experienced with the EFW cooling path of the intact steam generator. The Regulatory Guide 1.97 steam generator level and pressure indications provide safety-related indication of a failure of cooling water flow to the intact steam generator. Operations is able to manually restart any EFW pump tripped by AFIS by placing the manual control switch in the RUN position without having to reset AFIS.

17. If not explained elsewhere, describe what actions are required to mitigate an ATWS scenario that results in AFIS actuation. Justify any reliance that is placed on equipment (including annunciation and indication) that does not fully satisfy the criteria for safety-related applications. Alternatively, confirm that ATWS will not result in AFIS actuation.

Response:

See response to Question 4d.

18. Explain why a Technical Specification requirement should not be established for when SG pressure is greater than 700 psig and the MDEFW pumps are in run. Explain why this situation is bounded by the existing accident analyses.

Response:

The only evolutions allowed by normal operating procedures that would place an EFW pump in the manual RUN mode requires closure of the valves to the SG. The MDEFW pumps are placed in manual run during operation only during short periods of time when performing pump testing. In this case, the discharge path is isolated from the steam generator. Therefore, AFIS would not be required to trip the MDEFW pump. A new TS for AFIS is not required.

19. Explain why Technical Specification surveillance requirements should not be established for periodically initiating AFIS actuation, and for periodically testing related pumps, valves, and other components.

Response:

AFIS will perform no new functions over those already performed by the MSLB circuitry except to provide automatic termination of motor-driven EFW flow to the faulted steam generator and to provide header specific isolation of MFW. Under the current TS 3.3.13, we are required to perform a channel functional test of the MSLB Detection and MFW Isolation Logic Channels each 18 months. As noted in the bases for this TS, when these logic channels are tripped, all the isolation functions (or auto-start inhibit of TDEFW) occur. The specification of the actions that must occur during this functional check are contained in Test Acceptance Criteria (TAC) sheets. TAC sheets contain required response times where needed.

The TS proposed for AFIS are identical in function to those already approved for the MSLB Detection and MFW Isolation System. Proposed TS 3.3.13 will require an AFIS digital channel functional check every 18 months.

As with the current TS surveillance requirement, the acceptable performance of this proposed TS will be documented on Test Acceptance Criteria which will contain the required acceptance criteria, including response times where appropriate.

Currently, Selected Licensee Commitment (SLC) 16.10.5 contains a requirement to verify that the components actuated by the MSLB circuitry will function as required. With the implementation of AFIS, this SLC will no longer be needed since the actuation of end components (valves closing, pumps tripping, auto-start inhibit) will be verified by the station test procedures that will implement SR 3.3.13.1.

The Post Modification Testing required for this modification will be conducted in accordance with the Modification Test Plan that was developed as part of the Modification Package. The Test Plan describes the testing (including procedure references) that is required. The test plan provides a description of how testing will meet the following objectives: that testing will verify that all modified systems, structures and components are properly installed and operational; that existing, new or changed design bases are met; that the modification has solved the problem; that the modification does not adversely affect other systems, structures or components; and that Technical Specification requirements are met.

The execution of the Modification Test Plan will verify that all AFIS inputs, outputs, and logic functions satisfy design requirements. One time tests will be performed for the TDEFW coast-down time assumption and electrical power assumption. The final phase of the Modification Test Plan is the performance of the TS surveillance procedures. When these have been successfully completed, AFIS will be declared operable for that unit.

ATTACHMENT 2
REVISED TECHNICAL SPECIFICATION BASES PAGES
AND MARKUPS

Remove Bases Page	Insert Bases Page
B3.3.13-1	B3.3.13-1
B3.3.13-2	B3.3.13-2

B 3.3 INSTRUMENTATION

B 3.3.13 Automatic Feedwater Isolation System (AFIS) Digital 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 analog 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

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 analog channel can be tested online to verify that the setpoint accuracy is within the specified allowance requirements. The analog 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 analog channel will perform its intended function. A continuous, automatic analog 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

B 3.3 INSTRUMENTATION

B 3.3.13 Automatic Feedwater Isolation System (AFIS) Digital 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 analog 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.

analog analog

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.

analog analog

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.

ATTACHMENT 3
REVISED LAR SUBMITTAL ATTACHMENT 3 PAGES

Remove the below listed pages from the July 18, 2000 submittal and insert the pages listed below

Remove Page	Insert Page
20	20
21	21

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 and for annunciation when testing and tuning conditions are in progress. 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 Lambda power supply is a commercial grade unit designed to MIL-STD-810C 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 has been determined using natural convection formulas in calculation OSC-6869, the projected internal cabinet temperature was calculated 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