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3.3 INSTRUMENTATION

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.

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 analog channel inoperable or tripped.	A.1 Place channel in bypass.	4 hours
B. Two analog channels inoperable. <u>OR</u> Required Action and associated Completion Time of Condition A not met.	B.1 Restore channel(s) to operable status.	72 hours

(continued)

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.

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 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. <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 Reduce main steam header pressure to < 700 psig.	12 hours 18 hours

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.

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
B. Two digital 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 Reduce main steam header pressure to 700 psig	12 hours 18 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.3.13.1 Perform CHANNEL FUNCTIONAL TEST.	18 months

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Not Used |
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3.3.25 Not Used |

Not Used |
3.3.26

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3.3.26 Not Used |

Not Used |
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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 an analog isolation module. The output of the analog isolation module provides an analog signal to a processor module that actuates isolation functions at desired setpoints. One pressure transmitter per steam generator, associated Integrated Control System (ICS) signal isolator(s) and analog isolation module inputs constitute an AFIS detection analog isolation 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

BASES

BACKGROUND
(continued)

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. Other features of the digital channels include a test/manual initiation pushbutton and an "enable" or "arming" switch. An AFIS digital channel is defined as an analog isolation module, two digital 2 out of 4 logic modules (a Trip Module and a Trip Confirm Module), 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. There are two digital channels per steam generator. The two logic modules of each digital channel are configured in a two out of two logic arrangement. In this configuration a random failure of one of the logic modules will not result in a spurious actuation or preclude a valid AFIS actuation. In addition, a random failure of one of the logic modules will not preclude a valid AFIS actuation due to the redundant digital channel. 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).

BASES (continued)

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.

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, ICS signal isolator and an analog isolation module.

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.

BASES

ACTIONS
(continued)

B.1

With two channels inoperable or if the Required Action and associated 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.

BASES

**SURVEILLANCE
REQUIREMENTS**

SR 3.3.11.1 (continued)

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.

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.

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) 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 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. An AFIS digital channel is defined as an analog isolation module, two digital 2 out of 4 logic modules (a Trip Module and a Trip Confirm Module), 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. There are two digital channels per steam generator. The two logic modules of each digital channel are configured in a two out of two logic arrangement. In this configuration a random failure of one of the logic modules will not result in a spurious actuation or preclude a valid AFIS actuation. In addition, a random failure of one of the logic modules will not preclude a valid AFIS actuation due to the redundant digital channel. 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

BASES

BACKGROUND Trip Setpoints and Allowable Values (continued)

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 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).

BASES (continued)

LCO Two AFIS digital channels per steam generator shall be OPERABLE. Both logic modules of a digital channel shall be in the untripped condition for the digital channel to be considered OPERABLE.

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.
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-

Not Used |
B 3.3.25 |

B 3.3 INSTRUMENTATION

B 3.3.25 Not Used

Not Used
B 3.3.26

B 3.3 INSTRUMENTATION

B 3.3.26 Not Used

Not Used
B 3.3.27

B 3.3 INSTRUMENTATION

B 3.3.27 Not Used