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16.7 INSTRUMENTATION

16.7.12 Leading Edge Flow Meter (LEFM) System

COMMITMENT: The LEFM system consisting of an ultrasonic flow measuring device in each feedwater loop shall be FUNCTIONAL.

APPLICABILITY: MODE 1.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LEFM system non-functional when thermal power is less than or equal to 98.32% RTP (≤ 3411 MWt)	A.1 Restrict thermal power to ≤ 98.32% RTP (≤ 3411 MWt)	Immediately
B. LEFM system non-functional when thermal power level is greater than 98.32% RTP (> 3411 MWt)	B.1 ---------NOTE---------- Normal variations in power, such as those associated with Tavg, caused by plant fluctuations and boron adjustment are permitted. ---------- Suspend operations involving increasing thermal power	Immediately
	AND	
	B.2 Restore LEFM system to FUNCTIONAL status	72 Hours
C. Required Action and associated Completion Time of Condition B not met	C.1 Reduce thermal power to ≤ 98.32% RTP (≤ 3411 MWt)	6 Hours
	AND	
	C.2 Suspend use of LEFM system data as input to thermal power calorimetric calculation	

TESTING REQUIREMENTS

TEST		FREQUENCY
TR 16.7.12.1	Verify LEFM system is FUNCTIONAL by verifying a. LEFM system mode is either Normal OR Alert - Maintenance. AND b. Verify use of LEFM system data as input to thermal power calorimetric calculation.	12 hours
TR 16.7.12.2	Perform a CHANNEL CALIBRATION on the LEFM system pressure transmitters in accordance with plant procedures.	18 months

BASES

Background:

The FUNCTIONALITY of the Leading Edge Flow Meter (LEFM) system ensures the system is able to measure and calculate the required feedwater parameters at the required uncertainty level to be used as input to the Thermal Power Best Estimate (TPBE) calorimetric calculation.

McGuire Nuclear Station Units 1 and 2 were initially licensed to operate at a maximum reactor Rated Thermal Power (RTP) level of 3411 megawatts thermal (MWt). A power uprate to a RTP level of 3469 MWt is based on a redistribution of analytical margin originally required of emergency core cooling system (ECCS) evaluation models performed per the requirements of 10 CFR 50, Appendix K, "ECCS Evaluation Models." Appendix K originally mandated 102% of licensed power level for light water reactor ECCS evaluation models. The NRC approved a change to the 10 CFR 50, Appendix K requirements on June 1, 2000. This change provided licensees the option of maintaining the 2% power margin between the licensed power level and the ECCS evaluation assumed power level, or applying a reduced ECCS evaluation margin based on an accounting of uncertainties due to instrumentation error.

Feedwater flow measurement uncertainty is the most significant contributor to uncertainty in the secondary calorimetric calculation used to determine core thermal power. The LEFM system provides a more accurate measurement of feedwater flow compared to the feedwater flow nozzles and thus reduces the uncertainty in the feedwater flow measurement. This reduced uncertainty, in combination with other uncertainties, results in an overall thermal power level measurement uncertainty of ≤ 0.3% RTP. The remaining margin to the previous 2% uncertainty of 1.7% RTP is the basis for the power uprate. This type of power uprate is referred to as a Measurement Uncertainty Recapture (MUR) Uprate.

The LEFM system for a Unit utilizes two ultrasonic flow measuring planes in each feedwater loop to measure feedwater parameters for use as input to the TPBE calorimetric calculation. The LEFM system main feedwater mass flow rate and temperature values are used directly in the TPBE calorimetric calculation. Concurrently, correction factors are continuously calculated based on the difference between the LEFM system mass flow rate and temperature values and the existing main feedwater flow nozzles flow and temperature values. Should the LEFM system become non-functional, the last good correction factors are used to normalize the existing main feedwater flow nozzles mass flow and temperature signals to the more accurate LEFM system signals. The normalized main feedwater mass flow and temperature signals are then used in the TPBE calorimetric calculation.

Functionality

The LEFM system is FUNCTIONAL if the system is in service with the ability to measure and calculate feedwater mass flow and feedwater temperature at the required uncertainty level to be used as input to the TPBE calorimetric calculation.

The LEFM system can be in Maintenance Mode or one of three different operational modes: 1) Normal, 2) Alert - Maintenance, and 3) Fail. Of these four modes, the LEFM system is capable of measuring and calculating the required feedwater parameters at the required uncertainty level in Normal and Alert - Maintenance modes only.

The below table describes the FUNCTIONAL status of the LEFM system corresponding to the maintenance Mode and the three different operational modes of the LEFM system.

LEFM System Mode	Discussion	FUNCTIONALITY
Operational Mode Normal	The LEFM system is capable of measuring and calculating the required feedwater parameters at the required uncertainty level. The Main Control Board (MCB) annunciator will not be triggered. The OAC and/or the local LEFM system CPU cabinet display screen will display NORMAL.	FUNCTIONAL*
Operational Mode Alert - Maintenance	The LEFM system has experienced a minor maintenance issue/minor alert. However, the system remains capable of measuring and calculating the required feedwater parameters at the required uncertainty level. The MCB annunciator will not be triggered. The OAC and/or the local LEFM system CPU cabinet display screen will display MINOR ALERT.	FUNCTIONAL*
Operational Mode Fail	The LEFM system has experienced a failure such that the system is no longer capable of measuring and calculating the required feedwater parameters at the required uncertainty level. The MCB annunciator will be triggered. The OAC and/or the local LEFM system CPU cabinet display screen will display MAJOR ALERT.	Non-Functional
Maintenance Mode	The system is not capable of measuring and calculating the required feedwater parameters at the required uncertainty level. The MCB annunciator will be triggered. The OAC and/or the local LEFM system CPU cabinet display screen will display FAILED.	Non-Functional

* FUNCTIONAL if the required feedwater parameters, as measured and calculated by the LEFM system, are being used as input to the TPBE calorimetric calculation. Otherwise, Non-Functional.

Non-Functional LEFM system while Unit is greater than the pre-uprate level of 98.32% RTP (> 3411MWt):

As described in Condition B, when the LEFM system becomes non-functional, operations involving increasing thermal power must be suspended immediately and the LEFM shall be restored to a FUNCTIONAL status within 72 hours. Normal variations in power, such as those associated with Tavg caused by plant fluctuations and boron adjustment are permitted. Correction factors locked-in and used in the TPBE calorimetric calculation are specific to the Unit thermal power at the time the LEFM system became non-functional. If thermal power were increased, the use of the locked-in correction factors at higher thermal power levels may introduce an additional error that could result in the Unit exceeding the licensed RTP limit of 3469 MWt. When an LEFM system becomes non-functional, the last good correction factors are locked in and applied to the feedwater flow nozzles measurement. While the system is non-functional, analysis has demonstrated the drift associated with the flow nozzles instrumentation providing variables to the TPBE calorimetric calculation will be minimal over a 72 hour period and the Unit can continue to operate over this time period with a non-functional LEFM system without exceeding the licensed RTP limit of 3469 MWt.

If the Required Action and Completion Time of Condition B cannot be met, Condition C will be entered. Within 6 hours Unit thermal power shall be reduced to ≤ 98.32% RTP (≤ 3411 MWt) and the use of LEFM data as input to the TPBE calorimetric calculation shall be suspended. The reduction in thermal power ensures the drift associated with the flow nozzles instrumentation providing variables to the TPBE calorimetric calculation will not be sufficient to result in the Unit exceeding the licensed RTP limit of 3469 MWt. Suspending the LEFM data input to the TPBE calculation is warranted since, at these reduced thermal power levels, the reduced uncertainty provided by the LEFM system is not needed.

Unit thermal power could be decreased during the Condition B required Completion Time of 72 hours since any error introduced by decreasing thermal power would be considered conservative and would not contribute to the possibility of the Unit exceeding the licensed RTP limit of 3469 MWt. If Unit thermal power is decreased to a point less than or equal to 98.32% RTP (≤ 3411 MWt), Condition B will be exited and the Required Action and Completion Time of Condition A would apply.

Non-Functional LEFM system while Unit is less than or equal to 98.32% RTP (≤ 3411 MWt):

As described in Condition A, when the LEFM system becomes non-functional, Unit thermal power shall be immediately restricted to ≤ 98.32% RTP (≤ 3411 MWt) since, above 3411 MWt, the reduced uncertainty provided by the LEFM system is needed to ensure Unit operation at ≤ 3469 MWt does not exceed the uncertainty-adjusted licensed RTP limit of 3479 MWt. The Unit can remain at ≤ 3411 MWt indefinitely with a non-functional LEFM system since any reduced uncertainty provided by the system is not needed to preclude the Unit from exceeding the uncertainty-adjusted RTP limit of 3479 MWt.

Testing Requirements

The LEFM system Testing Requirements (TR) provide assurance that the minimum FUNCTIONALITY requirements of the LEFM system are met.

TR 16.7.12.1 ensures the LEFM system is in Normal or Alert - Maintenance operational modes which are the only modes where the system has the capability to measure and calculate feedwater mass flow and feedwater temperature at the required uncertainty level to be used as input to the TPBE calorimetric calculation. This TR also verifies the LEFM system data is being used as input to thermal power calorimetric calculation.

TR 16.7.12.2 requires the LEFM system to be calibrated on a periodic basis and applies to all eight feedwater pressure transmitters (2 per loop) providing input to the LEFM. This calibration ensures the measurement uncertainty of the outputs from these pressure transmitters remain bounded by the analysis and assumptions set forth in Cameron Engineering Uncertainty Analysis Reports ER-822 (Unit 1) and ER-819 (Unit 2) - Reference 4 and 5.

REFERENCES:

1. Duke letter to NRC dated March 5, 2012, License Amendment Request for Measurement Uncertainty Recapture Power Uprate.

2. NRC letter to Duke dated May 16, 2013, Safety Evaluation Report for McGuire Measurement Uncertainty Recapture Uprate, License Amendment Numbers 269/249 for McGuire Unit 1 and Unit 2, respectively.

3. AD-OP-ALL-0105, Operability Determinations and Functionality Assessments.

4. Cameron Engineering Report ER-822, "Bounding Uncertainty Analysis for Thermal Power Determination for McGuire Unit 1 Using the LEFM + System (Unit 1)".

5. Cameron Engineering Report ER-819, "Bounding Uncertainty Analysis for Thermal Power Determination for McGuire Unit 2 Using the LEFM + System (Unit 2)".