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16.7 INSTRUMENTATION

16.7.14 Source Range High Flux at Shutdown (HF@SD) Alarm

COMMITMENT At least one channel of source range shall be FUNCTIONAL with:

a. HF@SD alarm set ≤ 2.12 times background,

b. Visual and audible alarm.

APPLICABILITY MODES 3, 4 and 5.

REMEDIAL ACTIONS CONDITION	REQUIRED ACTION	COMPLETION TIME
A. No functional source range HF@SD alarm	----------NOTE---------- Plant temperature changes are allowed provided that SDM is maintained and Keff remains < 0.99. ----------	
	A.1 Suspend operations involving positive reactivity additions.	Immediately
	AND	
	A.2 Close unborated water source isolation valves.	1 hour
	AND	
	A.3 Verify SDM is within the limit specified in the COLR	1 hour AND Once per 12 hours thereafter
	AND	
	A.4 Initiate action to restore one source range HF@SD alarm.	Immediately

TESTING REQUIREMENTS

	TEST	FREQUENCY
TR 16.7.14.1	Perform CHANNEL CHECK	12 hours
TR 16.7.14.2	----------NOTE---------- Neutron detectors are excluded from CHANNEL CALIBRATION. ---------- Perform CHANNEL CALIBRATION.	18 months

BASES

The source range neutron flux monitors are used during shutdown modes of operation to monitor the core reactivity condition. The installed source range neutron flux monitors are available from the Nuclear Instrumentation System (NIS) or from the Wide Range Neutron Flux Monitoring System (Gamma-Metrics). Source range indication is provided via the NIS source range channels and the Gamma-Metrics shutdown monitors using detectors located external to the reactor vessel. These detectors monitor neutrons leaking from the core. Neutron flux indication for these monitors are provided in counts per second (CPS). The NIS source range channels and the Gamma-Metrics shutdown monitors provide continuous visible count rate indication in the Control Room and a high flux control room alarm to alert operators to any unexpected positive reactivity additions.

The FUNCTIONALITY of the source range (SR) high flux at shutdown (HF@SD) alarm is for detection of an inadvertent boron dilution event. The source range monitor may consist of any channel of an NIS monitor or a wide range neutron flux (WRNF) monitor. The NIS SR HF@SD alarm provides a visual alarm indication on the respective NIS SR drawer, visual and audible alarm notification from AD2-D3, "S/R HI FLUX AT SHUTDOWN", visual and audible alarm notification from the Operator Aid Computer (OAC) and audible alarm from the containment evacuation alarm inside containment. The WRNF SR HF@SD alarm provides visual alarm indication on main control board MC2 and visual and audible alarm from AD2-D3, "S/R HI FLUX AT SHUTDOWN". NIS audible alarm requires the respective source range drawer high flux at shutdown switch in NORMAL. WRNF audible alarm requires the respective SHUTDOWN MONITOR ANNUNCIATOR BYPASS switch in NORMAL.

FUNCTIONALITY requires at least one channel with its detector monitoring neutron leakage from the core with visual and audible alarm notification from the HF@SD alarm configured at ≤ 2.12 times background. Audible alarm notification may consist of either the plant annunciator system or OAC. Alarm setpoint shall be ≤ 2.12 (alarm ratio of 2.0) times background. Background is the average CPS neutron level reading (the average CPS reading is the most consistent value between highest and lowest CPS neutron level reading). The source range shutdown margin monitor (SDMM) measures the source range count-rate and identifies any statistically significant increase in counts that could suggest a loss of reactor shutdown margin.

Selection of HF@SD alarm setpoint of 2.12 is based upon industry operating experience that determined source range (SR) Nuclear Instrumentation response lagged the reactivity change experienced by the core which occurred at substantially subcritical, rodded conditions. This is due to low-leakage core loading patterns with high-burnup fuel on the core periphery (and without secondary sources) that affect SR response in a manner that departs from traditional subcritical multiplication theory. The maximum setpoint calculated by the SDMM is 2.12 with an alarm ratio multiplier selection of 2.0. Analysis has shown that a HF@SD alarm setpoint of 2.12 is sufficient to compensate for the lagged detector response under these conditions and provide ample time for Operators to terminate a dilution event once the HF@SD alarm activates.

Condition A applies when the required number of FUNCTIONAL source range HF@SD alarms are not met in MODES 3, 4, or 5. With the unit in this condition, the source range HF@SD alarm performs a monitoring function. With less than the required number of source range HF@SD alarms FUNCTIONAL, operations involving positive reactivity additions shall be suspended immediately. In addition to suspension of positive reactivity additions, all valves that could add unborated water to the reactor coolant system (RCS) must be closed within 1 hour. The isolation of unborated water sources will preclude a boron dilution accident.

Also, the shutdown margin (SDM) must be verified within 1 hour and once every 12 hours thereafter as per TS SR 3.1.1.1, SDM verification. With no source range HF@SD alarm FUNCTIONAL, core monitoring is severely reduced. Verifying the SDM within 1 hour allows sufficient time to perform the calculations and determine that the SDM requirements are met. The SDM must also be verified once per 12 hours thereafter to ensure that the core reactivity has not changed. Required Action A.1 precludes any positive reactivity additions; therefore, core reactivity should not be increasing, and a 12 hour Frequency is adequate. The Completion Times of within 1 hour and once per 12 hours are based on operating experience in performing the Required Actions and the knowledge that unit conditions will change slowly. Required Action A.1 is modified by a note which permits plant temperature changes provided the temperature change is accounted for in the calculated SDM and that Keff remains < 0.99. Introduction of temperature changes, including temperature increases when a positive moderator temperature coefficient (MTC) exists, must be evaluated to ensure they do not result in a loss of required SDM or adequate margin to criticality.

REFERENCES

1. SER Supplement 1 Section 15.2.1
2. UFSAR Sections 7.7.1.3.1 and 15.4.6
3. Commitment Change 2010-M-002, PIP M-10-00463
4. Commitment Change 2014-M-001, PIP M-13-09052
5. Commitment Change 2015-M-002
6. NRC Generic Letter 85-05, "Inadvertent Boron Dilution Events" dated January 31, 1985
7. MCC-1552.08-00-0136 Rev. 08, "Generic FSAR Boron Dilution Accident Analysis"