REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**198-8208**
Review Section:	**14.02 – Initial Plant Test Program – Design Certification and New License Applicants**
Application Section:	**14.2**
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Question No. 14.02-21

Demonstrate how the Plant Protection System (PPS) Test described in APR1400 FSAR Tier 2, Section 14.2.12.1.24 meets the requirements of Criterion XI of Appendix B to 10 CFR Part 50. Criterion XI, “Test Control,” of Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” to 10 CFR Part 50 states, in part, that a test program shall be established to assure that all testing required to demonstrate that SSCs will perform satisfactorily in service is identified and performed in accordance with written test procedures, which incorporate the requirements and acceptance limits contained in applicable design requirements. RG 1.68, “Initial Test Programs for Nuclear Power Plants” provides guidance on the initial test program.

APR1400 FSAR Tier 2, Section 14.2.12.1.24 provides the initial test for the PPS. The staff reviewed this test and finds that additional information is required regarding the objectives, prerequisites, test methods, and acceptance criteria to determine whether this test meets the requirements of Criterion XI of Appendix B to 10 CFR Part 50. The staff requests the applicant to address the following items described below.

1) Item 1.0 provides the test objectives of this test. Item 1.1 states, “to demonstrate the proper operation of the [PPS].” This test objective does not contain specific criteria that need to be met. In addition, the staff finds that portions of the test methods listed under Section 14.2.12.1.24, Item 3.0, “Test Method,” appear to be test objectives. For example, Item 3.11 under “Test Methods” states, “Verify proper operation of the core protection calculator system by input/output and internal function tests.” In this case, verifying the proper operation of the core protection calculator system should be a test objective. As such, the staff requests the applicant to provide specific objectives that should be met with this test.

2) Item 2.0, provides prerequisites for the PPS test. The staff finds that these prerequisites are not sufficiently specific to determine what systems need to be functional to perform this

test. For example, it states “Support systems required for operation of the trip circuit breakers, ESF-CCS and PPS are operational” It is not clear what these support systems are. It is also unclear what inputs to the PPS is required for the completion of this test. In addition, clarify whether the factory acceptance testing needs to be complete prior to conducting this test. As such, the staff requests the applicant to provide specific prerequisites that should be met with this test.

3) The staff needs the following clarification in order to evaluate Item 3.0, “Test Methods.”

a) Test Method Item 3.3, it states, “Using simulated reactor trip signals, trip each reactor trip circuit breaker with the breaker in the test position. Observe circuit breaker operation.” Clarify what is the objective of this test (e.g. verify RTSS functionality). In addition, it is unclear what is meant by “with the breaker in the test position.” Does this mean that the breaker is under test bypass? If so, are all the breakers under bypass or just one? The staff also requests the applicant to clarify these same issues for Item 3.4 with the circuit breakers in the operate position.

b) Test Method Item 3.5 states “Exercise the bistable comparators using internal and external test circuitry and observe the setpoints and operation of the appropriate ESFAS logic.” How do you observe the setpoints? Are the setpoints supposed to change when the bistable comparators are exercised? What is meant by exercised? Does this test intend to verify each Engineered Safety Feature Actuation System (ESFAS) function within the bistable? How do you observe the operation of the appropriate ESFAS logic (e.g. observe the output of the bistable)? Are reactor trip functions of the bistable comparators not verified? In addition, is the bistable comparator equivalent to the bistable processor specified in APR1400 FSAR Tier 2, Chapter 7?

c) Test Method Item 3.6 states “Check the operation of trip channel bypass features including, where applicable, observation of the setpoints at which the trip bypasses are cancelled automatically.” How do you observe this setpoint? What specifically is being checked with the operation of the trip channel bypass features (e.g. the capability to bypass, the modification of the voting logic when a channel is bypassed)? Does this test verify operating bypass or maintenance bypass?

d) Test Method Item 3.7 states “Test manual trips and observe relay operation.” However, the operation of the manual RT switches is not specified as a prerequisite. Is operation of manual RT switches required as a prerequisite? Is operation of manual RT switches required as a prerequisite?

e) Test Method Item 3.8 states, “Check that low pressurizer pressure and low steam generator pressure trip setpoints track the process variable at the prescribed rate…” Where is this prescribed rate specified?

f) Test Method Item 3.9 states, “using the installed testing devices, observe test functions and verify proper [local coincidence logic] LCL operation.” What are the installed testing devices? Where is it described? What specific LCL function is being verified here (e.g. voting logic function, voting modifications when channels are bypassed or signal faults are detected)?

g) Test Method Item 3.10 states, “Using manually initiated semi-automatic test functions to trip reactor trip breakers and ESF-CCS interfaces, observe interlock, alarm, and interface operation.” Which specific interfaces does this test refer to (e.g. with non-safety systems, with the ESFAS components)?

h) Test Method Item 3.11 states “verify proper operation of the core protection calculator input/output and internal function test.” Specify the specific internal function tests that are verified.

i) Test Method Item 3.12 states, “Inject signals into appropriate sensor or sensor terminals and measure the elapsed time to achieve tripping of the reactor trip circuit breaker or actuation of the ESFAS actuation relays. Trip or actuation paths may be tested in several segments.” It appears that this test intends to verify the response time for the performance of the RT and ESFAS functions from sensor to final actuation device. Does this test verify the response time for every RT and ESFAS function?

j) Is there a specific integrated test that verifies the functionality of the entire RT and ESFAS train? If not, provide an integrated test to verify the functionality of the entire RT and ESFAS train.

k) RG 1.68, Section A-1.j, “Instrumentation and Control Systems” specify that “tests should be conducted, as appropriate, to verify redundancy and electrical independence.” What tests are performed to verify redundancy and electrical independence within the PPS?

4) Item 5.1, under “Acceptance Criteria” states that “The PPS performs as described in Sections 7.2 and 7.3.” The staff finds the information provided in this reference includes a significant amount of design information. However it is unclear what specific design criteria is being referenced as acceptance criteria for this test. Clarify what specific design criteria within FSAR Tier 2 Sections 7.2 and 7.3 provide the acceptance criteria for the PPS test.

Response

The test plans presented in Section 14.2 of the DCD Tier 2 are being upgraded. This effort is focused on adding additional SSCs that are important to safety and risk significant as well as increasing the level of detail described in the DCD for test prerequisites, test methods and acceptance criteria for the various tests. It has been determined that the actions to be taken as a result of this question are within the scope of the upgrade effort. Therefore, the noted items will be addressed in the upgrade effort, which is scheduled to be completed by February 1, 2016. A revised response to this question that incorporates the results of the upgrade effort will be submitted to the NRC after completion.

Response – (Rev. 3)

A document upgrade has been completed to the test plans in Section 14.2.12.1 which included various changes to 14.2.12.1.24 as well (ref. submittal MKD/NW-16-0156L dated February 24, 2016; ML16056A003). The following responses to the items requested in this

RAI will refer to changes that were made in that submittal and in some instances result in additional changes to 14.2.12.1.24 which will also be discussed.

1) The Objectives in DCD Tier 2 Section 14.2.12.1.24 will be updated to add eleven items pertaining to specific test objectives to demonstrate the proper operation of the plant protection system (PPS). The objective for verification of the PPS interlock function will be added from Revision 1 as Objective 1.9 with associated additions to the test methods and acceptance criteria. A paragraph will be added to the test method section to provide descriptions of the verification of redundancy and electrical independence within the PPS. Verification that the outputs of the PPS will go to a predefined state on restoration of power will be restored as Objective 1.13 with related test method and acceptance criterion added to the test plan. Objective 1.1 will be further clarified to demonstrate proper operation of the bistable logic and coincidence logic of the PPS since the other added objectives in their entirety demonstrate proper operation of the system. Item 3.11 which appeared to be an objective rather than a test method will be removed entirely from Section 14.2.12.1.24 since it is related to the core protection calculator system (CPCS) and is not appropriate to be included in the PPS test. The test plan for the CPCS is to be provided in DCD Tier 2 Section 14.2.12.1.138, “Core Protection Calculator System Test.”

2) The prerequisites in 14.2.12.1.24 will be revised to clarify more specifically the support systems that are needed for the test. Item 2.2 will be added to describe that the software of the PPS and engineered safety features – component control system (ESF-CCS) needs to be installed. Item 2.5 will be clarified to describe the specific interface systems required for completion of the test; namely, CPCS, reactor trip switchgear system (RTSS), and ESF-CCS. Factory acceptance testing does not need to be added as a prerequisite since it is a requirement of the vendor in accordance with the procurement specification and verified by the Quality Assurance program.

3) Clarifications to Test Methods:

   a) The objective of the test regarding Items 3.3 and 3.4 is to confirm the functionality of the trip circuit breaker (TCB) in each division of the RTSS. This test is performed for each TCB. The TCB can be switched from the CONNECT position to the TEST position or vice versa. When in the TEST position, the TCB is operational for test purposes only. When in the CONNECT position, the TCB becomes fully operational either for testing or for normal operation. Item 3.3 will be revised to specify the TCBs in the RTSS and the operate position in Item 3.4 will be corrected to the CONNECT position.

      Item 3.2 will be deleted since it is an unnecessary test item for verifying the PPS functionality. As a result, Items 3.3 and 3.4 will be re-numbered as Items 3.2 and 3.3.

   b) The bistable comparison logic is part of the bistable application program loaded in the bistable processor. The bistable logic test is performed based on the manual test procedures using the maintenance and test panel (MTP). While the bistable comparison logic test is performed, the setpoints of each trip parameter can be observed in the operator module (OM) in the main control room (MCR). The engineered safety features actuation system (ESFAS) function is not verified by performing the bistable comparison logic test. Therefore, the wording of Item 3.5 will

be changed accordingly. Note that Item 3.5 will be re-numbered as Item 3.4 as a result of the deletion of 3.2 discussed previously.

The main purpose of the bistable logic test is to verify that a partial pre-trip and trip signals are properly initiated by simulating the pre-trip and trip conditions for each trip parameter. Therefore, an additional item (Item 3.5) will be added to the test methods to perform a coincidence logic test using the MTP and observing the operation of the appropriate coincidence logic.

c) Item 3.6 is to verify the operating bypass function. The trip parameters associated with the operating bypass function are high logarithmic power level, departure from nucleate boiling ratio (DNBR), local power density (LPD), and low pressurizer pressure as described in DCD Tier 2 Section 7.2.1.6, “Bypasses”.

In order for these trip parameters to be in the operating bypass state, the permissive conditions as provided in Table 7.2-1 of DCD Tier 2 must be received prior to operating bypass. Once the permissive signal is detected, manual operation by the operator is accomplished. After the operating bypass for each of the above trip parameters is enabled, the operating bypass is automatically removed whenever the permissive condition is lost or not satisfied.

Table 7.2-1 of DCD Tier 2 provides the operating bypass permissive and removal conditions for the stated trip parameters. While DNBR/LPD, high log power level, and CPC CWP operating bypass permissive signals are received as a contact input via the digital input module within a bistable processor rack, the low pressurizer pressure operating bypass permissive condition is set by the pressurizer pressure input via an analog input module based on the operating bypass setpoint.

When the low pressurizer pressure input goes below the operating bypass setpoint (a preset value), then the operating bypass can be manually enabled by the operator. If the pressurizer pressure input goes above the operating bypass removal setpoint (the other preset value), then the operating bypass is automatically removed. DCD Tier 2 Section 7.2.1.4, “Reactor Trip Initiation Signals” provides the related description in Item (f) “Low pressurizer pressure”: *The trip can be manually bypassed by the operator if the pressure decreases below a preset value. The bypass is automatically removed as pressure is increased above the preset value.*

Item 3.6 will be modified to clarify the test method to simply check the operation of the operating bypass logic and switches to align more closely with the intent of the test as discussed above.

d) A prerequisite Item 2.6 will be added to ensure that the manual reactor trip and ESFAS switches in the MCR and RSR are operational. In addition, Item 3.7 will be modified to clarify that the manual RPS trips and ESFAS actuation are being tested and observation of relay operation will be deleted.

e) Since low pressurizer pressure and low steam generator pressure trip parameters are not rate limited variables, the reference to a “prescribed rate” in Item 3.8 will be

replaced to state “a fixed value” as described in DCD Tier 2, Table 7.2-4, “Reactor Protection System Design Input,” Note 4.

f) Section 4.2.1.10, “MTP Function” of the Safety I&C System technical report states that the MTP is the local human system interface (HSI) for maintenance and testing of the PPS. Therefore, the PPS testing functions are initiated from the MTP located in the I&C equipment room. Items 3.9 and 3.10 were to verify the final output of the PPS; namely, the reactor trip output and ESFAS initiation generation output. These items (Items 3.9 and 3.10) will be merged into a single item, Item 3.9, and the previous reference to installed testing devices, observation of test functions and verification of proper local coincidence logic operation will be deleted.

g) For tripping the reactor TCB from the MTP, the specific interface system is the RTSS. Once the trip occurs in one division, then the TCB of the corresponding division will be opened; its alarm and status indication will be provided via the MTP and OM. For initiating ESFAS, the interface system is ESF-CCS. Once one of the ESFAS signals is initiated, then the related alarm and status indication of the corresponding ESF-CCS division will be provided via the MTP and OM. As stated previously in f) above, Items 3.9 and 3.10 will be merged into Item 3.9 and the test method description clarified.

h) As stated in response to sub-question 1), the CPCS test item 3.11 will be deleted from Section 14.2.12.1.24. The test plan for the CPCS is to be provided in DCD Tier 2 Section 14.2.12.1.138, “Core Protection Calculator System Test.”

i) The response time test stated will be performed for every RT and ESFAS trip parameter. The response time test results should be within the response time requirements specified in DCD Tier 2 Table 7.2-5 for each trip parameter.

j) The functionality of the entire division of the reactor trip path is verified through the divided, but overlapped portions of the tests as shown in Figure 4-6, “Overlap in Functional Testing for the PPS” of the Safety I&C System technical report and Figure 7.2-11, “PPS Testing Overlap” of DCD Tier 2. To be more specific, the overlap between the following tests verifies the entire division of the reactor trip path as shown in Figure 7.2-11 of DCD Tier 2: *transmitter test, analog input test, bistable logic test, reactor trip local coincidence logic test, reactor trip initiation test, and engineered safety features local coincidence logic test*.

   Section 3.4.10, “Regulatory Guide 1.118, “Periodic Testing of Electric Power and Protection Systems”, Rev. 3 - endorses IEEE Std. 338-1987” states, “Overlap in the RPS and ESFAS division tests is provided to assure that the entire division is functional.”

   Also, Section 7.3.3.5, “Periodic Testing Method” states, “Testing is overlapped to provide reasonable assurance that the entire division is tested.”

   Test objective 1.2 of DCD Tier 2 Section 14.2.12.1.24 describes the verification of response times of the RPS and ESFAS. Accordingly, acceptance criteria 5.2 of DCD Tier 2 Section 14.2.12.1.24 describes that the response times for RPS and

ESFAS path are verified. The response time test is performed to verify that the response times for RPS and ESFAS path meet the response time requirements.

k) PPS is demonstrated through the testing specified in Tier 1 Section 2.5.1.1 and Table 2.5.1-5 ITAAC Item 3.b. To verify redundancy and electrical independence within the PPS for the as installed system, the tests in DCD Tier 2 Section 14.2.12.1.24 Item 3.0, “Test Method” are conducted separately for each safety division. Observations are performed both within the division under test and concurrently of the other divisions. This will be described in DCD Tier 2 Section 14.2.12.1.24 Item 3.0, “Test Method.” DCD Tier 2 Section 14.2.12.1.138 "Core Protection Calculator System Test" will be revised to provide details relating specifically to the testing of the CPCS system design attributes, including redundancy and independence.

4) The Acceptance Criteria Item 5.1 is to ensure that the safety functions of the PPS specified in Sections 7.2 and 7.3 are met; that is, to successfully generate reactor trip and ESFAS initiation signals.

Item 5.1 will be modified as follows:
The PPS performs the safety functions as described in Sections 7.2 and 7.3.

The safety functions described in Sections 7.2 and 7.3 are to successfully generate reactor trip initiation signal and ESFAS initiation signals.

An additional eight Acceptance Criteria items (Items 5.3 to 5.10) have been added to the test to ensure that the pertinent objectives have been met and include, adequate operation of the power supplies, fiber optic interconnections, PPS/APC-S interconnection, alarm operation, manual trip operation from the MCR/RSR, bistable trip function, operating bypass function, and trip channel bypass function.

The term “should be” will be revised to “is” or “are” to provide a more definitive requirement for the as-installed system to meet the acceptance criteria listed for all items in 5.0.

Impact on DCD

Section 14.2.12.1.24 and 14.2.12.1.138 of DCD Tier 2 will be revised as indicated in the attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Report.

5.0 ACCEPTANCE CRITERIA

5.1 The ESF-CCS performs as described in Subsection 7.3.1.

5.2 ESF-CCS should operate as specified in the related design specification.

5.3 Manual control of ESF-CCS should operate as specified in related design specifications.

5.4 Interface operation to GC and LC should be as specified in the related design specification.

5.5 MTP/ITP should operate as specified in the related design specification.

5.6 Interface operation to IPS, QIAS-N and OM Display should be as specified in the related design specification.

5.7 Alarms should be provided as specified in the related design specification.

5.8 Transfer switches for remote control room should operate as specified in the related design specification.

5.9 ESF - CCS power supplies should operate as specified in the related design specification.

5.10 ESF-CCS should meet the requirement of redundancy, electrical independence, coincidence, and safe failure on loss of power as specified in the related design specification.

14.2.12.1.24 Plant Protection System Test

1.0 ~~OBJECTIVE~~OBJECTIVES

1.1 To demonstrate the proper operation of the ~~plant protection system (~~PPS~~)~~ bistable logic and coincidence logic of the

1.2 To ~~determine~~verify the ~~reactor protection system (~~RPS~~)~~ and the ~~engineering safety features actuation system (~~ESFAS~~)~~ response times

1.3 To verify the operation of the manual reactor trip

1.4 To verify the PPS related alarm functions

1.5 To verify the process input/output inter-connection and the input accuracy of PPS

1.6 To verify the operation of the PPS interface to the MTP and Interface and Test Processor (ITP)

1.7 To verify the integrity of signal path using manual testing functions and verify the operation of the manual testing functions on the MTP

Void

1.8 To verify the operation of watchdog timer of PPS

1.9 To verify the operation of the interlock functions of PPS.

delete

~~1.9~~ ~~To verify the operation of the interlock functions of PPS~~

1.9

~~1.10~~ To verify the operation of the operating bypasses functions of PPS

1.10

~~1.11~~ To verify the operation of the PPS power supplies

1.11

~~1.12~~ To verify the operation of the reactor trip circuit breaker in the reactor trip switchgear system (RTSS)

delete

~~1.13 To demonstrate redundancy, electrical independence, coincidence, and safe failure on loss of power.~~

1.13 To verify the safe failure of the system on loss of power.

2.0 PREREQUISITES

2.1 Construction activities on the trip circuit breaker and plant protection system and ESF-CCS have been completed.

2.2 PPS and ESF-CCS ~~system~~ software is installed.

delete

2.3 PPS instrumentation has been calibrated.

2.~~3~~4 External test instrumentation is available and calibrated.

2.~~4 Support~~5 The interface systems ~~required~~ for ~~operation of the trip circuit breakers, ESF-CCS, and PPS~~PPS such as CPCS, RTSS and ESF-CCS are operational.

2.6 Manual reactor trip switches and ESFAS switches in the MCR and RSR are operational.

3.0 TEST METHOD

3.1 Energize power supplies and verify output voltage.

~~3.2 Simulate ground faults and observe operation of the ground fault~~

To verify redundancy and electrical independence within the PPS, these tests are conducted separately for each safety division with observations within the division under test and concurrent observations of the other divisions.

~~3.3~~3.2 Using simulated reactor trip signals, trip each reactor trip circuit breaker located in the RTSS with the breaker in the ~~test~~ position. Observe the reactor trip circuit breaker operation.

TEST

3.~~4~~3 Repeat Step 3.~~3~~2 with the reactor trip circuit breakers in the ~~operate~~ position.

CONNECT

3.~~5 Exercise~~4 Perform the bistable ~~comparators~~ logic test using ~~internal and external test circuitry~~the MTP and observe the setpoints used in the bistable logic and operation of the appropriate ~~ESFAS~~bistable logic.

3.5 Perform the coincidence logic test using the MTP and observe the operation of the coincidence logic.

logic and switches

3.6 Check the operation of ~~trip channel~~operating bypass ~~features including, where applicable, observation of the~~ observe the ~~setpoints at which the trip~~operating ~~bypasses are canceled~~ automatically removed.

delete

Delete

3.7 Test manual RPS trips and ~~observe relay operation~~ESFAS actuation.

the

with a fixed value

3.8 Check that low pressurizer pressure and low steam generator pressure trip setpoints track the process variable ~~at the prescribed rate~~ and can be manually reset to the proper margin below the process variable.

3.9 Using the ~~installed~~MTP initiation testing ~~devices, observe test functions and verify proper local coincidence logic (LCL) operation.~~

~~3.10 Using manually initiated semi-automatic test functions to~~function, trip the reactor trip circuit breakers and ~~ESF-CCS interfaces~~initiate ESFAS, observe ~~interlock,~~ alarm, and interface operation.

and then

for each division at a time

~~3.11 Verify proper operation of the core protection calculator system by input/output and internal function tests.~~

~~3.12~~3.10 Inject signals into appropriate sensors or sensor terminals and measure the elapsed time to achieve tripping of the reactor trip circuit breakers or ~~actuation~~initiation of the ESFAS ~~actuation relays.~~. Trip or actuation paths ~~may~~can be tested ~~in several segments~~by overlapped testing method.

3.11 Check each bistable trip parameter's trip channel bypass feature, which blocks the trip condition at the LCL logic so that the channel trip does not occur as long as the trip channel bypass is enabled.

4.0 DATA REQUIRED

4.1 Power supply voltages

4.2 ~~Resistance for ground fault detector operation~~

~~4.3 Circuit~~Reactor trip circuit breaker and indicator operation

~~4.4 Point of actuation of bistable comparators~~

3.12 Simulate the loss of power by disconnecting the power connected to the PPS cabinets in the division under test. Observe the alarms and status of that division and check if a proper safe failure occurs in that division.

4.3 Bistable logic trip/pre-trip setpoints

4.4~~.5~~ Reset margin and rate of setpoint change of variable setpoints

4.~~6~~5 Maximum and minimum values of variable setpoints

4.~~7~~6 RPS and ESF trip and actuation path response times

4.~~8~~ 7 LCL operation

5.0 ACCEPTANCE CRITERIA

5.1 The PPS performs the safety functions as described in Sections 7.2 and 7.3.

5.2 The total response time of each RPS and ESFAS trip or actuation path is verified to be conservative with respect to the times used in the safety analysis.

5.3 Power Supplies ~~should operate as specified in the related design specification.~~ ~~be~~ properly operated as specified in Subsection 7.2.2.3.

are

5.4 Fiber optic interconnections ~~Tests should provide the indications as specified in the related design specification.~~ ~~be~~ provided as specified in Subsection 7.2.1.2.

5.5 PPS/APC-S Interconnection ~~should provide as specified in the related design specification.~~ ~~be~~ provided as specified in Subsection 7.2.1.

is

5.6 Alarm operations ~~should be provided as specified in the related design specification~~. ~~be~~ provided as specified in Subsections 7.2.1.3 and 7.2.1.4.

are

5.7 Manual trip operation from MCR and RSR ~~should be as specified in the related design specification.~~ ~~be provided~~ as specified in Subsection 7.2.1.3.

is operated

Void

delete

5.8 Bistable trip function operations ~~should be as specified in the related design specification.~~ ~~provided~~ as specified in Subsection 7.2.1. are provided

~~5.9 Interlock functions should operate as specified in the related design specification.~~

5.9 5.9 Interlock functions are provided as specified in Subsection 7.2.1.7.

~~5.10~~ Operating bypass operation ~~should be as specified in the related design specification.~~ provided as specified in Subsection 7.2.1.6. is

5.10 ~~5.11~~ Trip channel bypass operation ~~should be as specified in the related design specification.~~ provided as specified in Subsection 7.2.1.6. is

14.2.12.1.25 Ex-Core Neutron Flux Monitoring System

1.0 ~~OBJECTIVE~~OBJECTIVES

1.1 To verify the proper functional performance of the ex-core neutron flux monitoring system

1.2 To verify the proper performance of audio and visual indicators

2.0 PREREQUISITES

2.1 Construction activities on the ex-core neutron flux monitoring system have been completed and system software is intalled.

2.2 Ex-core neutron flux monitoring system instrumentation has been calibrated.

2.3 External test equipment has been calibrated and is operational.

2.4 Support systems required for operation of the ex-core neutron flux monitoring system are operational.

5.12 The proper safe failure is provided upon the loss of power to the PPS cabinets in the division under test. The alarms and status of that division is provided as specified in Table 7.2-7 and Subsections 7.2.1.3 and 7.2.1.4.

1.2 To verify existing, or establish new alarm setpoints as required for the NSSS Integrity Monitoring System.

2.0 PREREQUISITES

2.1 Plant is stable at the required temperature and pressure plateau.

2.2 The NIMS is operational as applicable.

3.0 TEST METHOD

3.1 Collect baseline data during pre-core HFT.

3.2 Adjust setpoints, if required, based on the data collected.

4.0 DATA REQUIRED

4.1 Baseline data for ALMS, LPMS and RCPVMS

4.2 Alarm setpoints for ALMS, LPMS and RCPVMS

4.3 RCS temperature and pressure

5.0 ACCEPTANCE CRITERIA

5.1 Baseline data of ALMS, LPMS and RCPVMS are collected during pre-core HFT.

5.2 The alarm setpoints of each subsystem are adjusted as necessary.

14.2.12.1.138 Core Protection Calculator System Test

1.0 OBJECTIVES

1.1 To demonstrate the proper operation of the CPCS

Replaced with following pages

1.2 To verify use of software loading laptop computer

1.3 To verify the CPCS related alarm functions

1.4 To verify operation of CPCS components from the input side of I/O Chassis to the interfacing equipment

1.5 To verify the CPCS Operator Module and Maintenance and Test Panel (MTP) Function

1.6 To verify the interface integrity for the Periodic Test between the CPCS I/O Simulator and CPCS

1.7 To verify the operation of watchdog timer of CPCS

1.8 To verify display hierarchy, page and screen status displayed on CPCS

1.9 To verify the operation of the CPCS power supplies

2.0 PREREQUISITES

2.1 CPCS instrumentation has been calibrated.

2.2 External test instrumentation is available and calibrated.

3.0 TEST METHOD

3.1 Energize power supplies and verify output voltage.

3.2 Verify proper loading of the CPCS software.

3.3 Verify that the appropriate alarms are activated.

3.4 Verify proper operation of the CPCS by input/output and internal function tests.

4.0 DATA REQUIRED

4.1 Power supply voltages

4.2 Indicator operation

4.3 Point of actuation and reset for DNBR and LPD trips

4.4 Point of actuation and reset for Penalty Factors

5.0 ACCEPTANCE CRITERIA

5.1 Power Supplies should operate as specified in the related design specification.

5.2 Inputs shall be applied for calculation to be outputted as specified in the related design specification.

5.3 Outputs to the following systems or equipment shall be provided with specific acceptance criteria listed in the related test guideline.

(1) OM and MTP

(2) QIAS-N

(3) IPS

5.4 Alarm operations should be provided as specified in the related design specification.

5.5 The Addressable Constants and RDB shall be operated in the related test guideline.

1.0 OBJECTIVES

The internal functions of the CPCS are confirmed through factory acceptance testing. The basis of this in-plant test is to confirm the correct installation of the CPCS, including inter-cabinet cable interfaces, and interfaces to other I&C systems.

1.1 To demonstrate the proper operation of DNBR and LPD trip functions of the CPCS

1.2 To verify the CPCS response times

1.3 To verify the CPCS related alarm functions

1.4 To verify the process input/output inter-connection and the input accuracy of the CPCS

1.5 To verify the operation of the CPCS interface to the MTP and ITP

1.6 To verify the operation of watchdog timer of CPCS

1.7 To verify the operation of redundant CPCS power supplies and the safe failure of the system on loss of power

1.8 To verify the redundancy and independence of the CPCS

2.0 PREREQUISITES

2.1 Factory acceptance tests have been completed for the CPCS.

2.2 Construction activities for the CPCS have been completed. This includes:

- Installation of CPCS software

- Power-up of CPCS electronic components, including digital controllers, and I/O modules

- Connection of digital data communication interfaces, both wired and fiber-optic, between CPCS internal components (e.g., operator modules) and to/from other plant systems such as PPS, QIAS-N, IPS
- Connection of wired interfaces between CPCS internal components (e.g., conventional switches and indicators), to/from other plant systems

2.3 CPCS instrumentation has been calibrated.

2.4 External test instrumentation is available and calibrated.

2.5 There are no unexpected CPCS self-diagnostic alarms. Self-diagnostic alarms may exist for temporary test conditions; any self-diagnostic alarms are justified.

3.0 TEST METHOD

The CPCS tests are conducted to confirm the correct CPCS operation. To verify redundancy and electrical independence within the CPCS, these tests are conducted separately for each safety channel with observations within the channel under test and concurrent observations of the other channels.

3.1 Energize power supplies and verify output voltage.

3.2 Stimulate the sensor inputs to the CPCS using the I/O simulator. Observe the DNBR and LPD trip occurrences.

3.3 Verify proper operation of the CPCS by input/output and internal function tests. This includes:

- The data communications between CPPs and CEACs of the other channels

- The transmission of the trip and pre-trip signals to PPS

- Interface functions with QIAS-N and IPS

- OM and MTP functions including the modification of Addressable Constants and RDB

- Watchdog timer operation

3.4 Simulate the loss of power by disconnecting the power connected to the CPCS cabinets in the channel under test. Observe the alarms and status of that channel and check if a proper safe failure occurs in that channel.

4.0 DATA REQUIRED

4.1 Power supply voltages

4.2 Indicator operation

4.3 Points of actuation and reset for DNBR and LPD trips

4.4 Points of actuation and reset for Penalty Factors

5.0 ACCEPTANCE CRITERIA

Test acceptance is confirmed for each separate safety channel under test, with confirmation of no unexpected interactions with other safety channels.

5.1 The CPCS performs the safety function as described in Sections 7.2.1.1.e, including the calculation of the DNBR, LPD and the transmission of trip and pre-trip output signals.

5.2 The total response time of the CPCS is verified with respect to the times used in the safety analysis.

5.3 Power Supplies are properly operated as specified in Subsection 7.2.2.3.

5.4 The data communications between CPPs and CEACs of the other channels properly isolated and separated using one-way SDL communication for the redundancy.

5.5 Outputs to the following systems are provided as specified in Subsection 7.2.1.1.e.

(1) PPS

(2) QIAS-N

(3) IPS

5.6 The Addressable Constants and RDB can be manually changed according to administrative procedures.

5.7 The proper safe failure is provided upon the loss of power to the CPCS cabinets in the channel under test. The alarms and status of that channel is provided as specified in Table 7.2-7.