PERFORMANCE TESTING BASICS

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NPPD/Cooper Nuclear Station

ANS-3.5-2009 Requirements

1.2 Background

The organization of the standard is such that simulator functional and physical requirements described in Sec. 3 correspond to testing and validation requirements described in Sec. 4.

The sub-numbering of Secs. 3 and 4 is consistent so that corresponding section paragraphs address the same subject matter from a requirements and testing standpoint.

Appendix A

Guideline for Documentation of Simulator Design and Test Performance

The purpose of this appendix is to provide an acceptable format for demonstration of a simulator's conformance to the requirements of this standard. It is intended that documentation be provided to the extent necessary to form a sufficient basis for verification of simulator performance, configuration control, and maintenance.

Appendix A

A.4 Simulator test documentation

The documentation of simulator performance criteria and simulator testing should include the following basic information:

- the initial condition;
- the perturbations made to induce the transient, such as malfunctions, remote functions, or operator actions;
- the responses of pertinent simulator parameters;
- an evaluation and validation of test results (acceptance criteria);
- the update of related documentation.

Performance Testing
ANS-3.5 Section 3.4.3 / 4.4.3

Performance testing shall be performed to ensure that no noticeable differences exist between the simulator control room or simulated systems when evaluated against the control room or systems of the reference unit.

Performance Testing
ANS-3.5 Section 3.4.3 / 4.4.3

- Operability Testing (Section 3.4.3.1/4.4.3.1)
  - Steady-state Performance Tests
  - Transient Performance Tests
- Scenario-based Testing (Section 3.4.3.2/4.4.3.2)
- Reactor Core Performance Testing (Section 3.4.3.3/4.4.3.3)
- Post-event Simulator Testing (Section 3.4.3.4/4.4.3.4)

Simulator Validation Testing
ANS-3.5 Section 3.4.2 / 4.4.2

Validation tests shall be conducted prior to the simulator's use in training and examination for the following situations:

- completion of simulator initial construction;
- whenever models are changed or modified in a way that potentially affects fidelity relative to the reference unit;
- whenever there are changes that have the potential to affect simulator capabilities or repeatability, including changes to computer platforms, operating systems and run-time utilities, interface systems, or instructor stations.

Simulator Validation Testing
ANS-3.5 Sections 5.3.1 / 5.3.2

- Modification-based changes
  - Reference unit modifications

- Performance-based changes
  - Simulator changes that are based upon items such as revised reference unit performance data, student feedback, simulator performance tests, a reference unit core reload, and LERs.

Simulator Capabilities Tests

ANS-3.5 Sections 3.1 / 4.1 & 3.3 / 4.3

- Real Time/Repeatability Test (Section 3.1.1/4.1.1)
- Normal Evolutions Tests (Section 3.1.3.2/4.1.3.2)
  - unit startup from cold shutdown to rated power conditions;
  - unit shutdown from rated power to cold shutdown conditions;
  - power operations and load changes;
  - operator-conducted surveillance testing on safety related equipment or systems.
- Malfunction Test (Section 3.1.4/4.1.4)
- Local Operator Action Test (Section 3.3.4/4.3.4)

Simulator Functional/Testing Requirements & Acceptance Criteria

- Steady-state Performance Test
- Transient Performance Test
- Scenario-based Test
- Reactor Core Performance Test
- Post-event Simulator Test
- Modification-based and Performance-based Tests
- Real Time/Repeatability Capability Test
- Normal Evolutions Capability Test
- Malfunction Capability Test
- Local Operator Action Capability Test

Steady-state Performance Test

Functional/Testing Requirements Section 3.1.3.1 / 4.1.3.1

A steady-state test shall be conducted once per reference unit fuel cycle. A record of the conduct of this test and its evaluation shall be maintained.

- Perform Simulator Steady-state performance testing at three distinct power levels spanning at least 50% of the operating range for which heat balance data is available.

- The simulator power levels at which the comparison is performed shall have been attained through continuous operation over the power range.

Steady-state Performance Test
Functional/Testing Requirements

- The recorded computed values of the parameters shall be compared with the reference unit data and shall be demonstrated to be within required tolerances (1%, 2%, 10%).

- Simulator functional/testing requirements:

  - ANSI/ANS-3.5-2009, Section 3.1
  - ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
  - ANSI/ANS-3.5-2009, Section 3.1.3/4.1.3
  - ANSI/ANS-3.5-2009, Section 3.1.3.1/4.1.3.1
  - ANSI/ANS-3.5-2009, Section 3.4.3.1(1)/4.4.3.1(1)
  - ANSI/ANS-3.5-2009, Appendix B, Section B.1.1/B.2.1
  - ANSI/ANS-3.5-2009, Appendix C

Steady-state Performance Test
Acceptance Criteria

References:

- ANS-3.5-2009, Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.3.1

- computed values of steady-state 1% parameters compared with reference unit data are within 1% of the reference unit instrument loop range (Section 4.1.3.1.3);

- computed values of steady-state 2% parameters compared with reference unit data are within 2% of the reference unit instrument loop range (Section 4.1.3.1.4);

- computed values of steady-state 10% parameters compared with reference unit data are within 10% of the reference unit instrument loop range (Section 4.1.3.1);

Steady-state Performance Test
Acceptance Criteria

(Cooper Specific)

- recorded and observed parameters did not violate the physical laws of nature (Section 3.1);
- the simulator operated in real time; an OVERRUN pop-up error message was not received during the conduct of this test (Section 4.1.1).

Transient Performance Test

Functional/Testing Requirements

Transient tests shall be conducted once per reference unit fuel cycle. A record of the conduct of this test and its evaluation shall be maintained.

Appendix B provides examples of acceptable transient tests.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.1
- ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
- ANSI/ANS-3.5-2009, Section 3.4.3.1(2)/4.4.3.1(2)
- ANSI/ANS-3.5-2009, Appendix B, Section B.1.2/B.2.2.1(9) *
- ANSI/ANS-3.5-2009, Appendix B, Section (B.2.2.4) * *

* where B.2.2.1(x) is the transient number

* * Section B.2.2.2, B.2.2.3, or B.2.2.4 as applicable

Transient Performance Test

Acceptance Criteria

References:

- ANS-3.5-2009, Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.4
- Appendix B Section B.1.2/B.2.2

- the simulator allows the use of applicable reference unit procedures (Section 4.1.4(1));

- any observable change in simulated parameters corresponds in direction to the change expected from actual or best estimate response of the reference unit to the malfunction/ transient (Section 4.1.4(2));

(COOPER) NOTE - Alarms and automatic actions verified shall be limited to those determined to be directly related to the transient tested.

- the simulator shall not fail to cause an alarm or automatic action if the reference unit would have caused an alarm or automatic action under identical circumstances (Section 4.1.4(3));

Transient Performance Test

Acceptance Criteria

References:

- ANS-3.5-2009, Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.4
- Appendix B Section B.1.2/B.2.2

(COOPER) NOTE - The following criteria shall be limited to certain select annunciators and automatic actions in specific test procedures, as specified by a subject matter expert.

- the simulator shall not cause an alarm or automatic action if the reference unit would not cause an alarm or automatic action under identical circumstances (Section 4.1.4(4));
- no follow-up operator action was taken during test performance (Appendix B Section B. 2.2);
- (COOPER) - recorded and observed parameters did not violate the physical laws of nature (Section 3.1);
- (COOPER) - the simulator operated in real time; an OVERRUN pop-up error message was not received during the conduct of this test (Section 4.1.1).

Scenario-based Test

Functional/Testing Requirements

Test data shall be acquired during scenario validation for subsequent evaluation of malfunctions, local operator actions, and other features exercised by the scenario.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.4.3.1/4.4.3.1

Scenario-based Test

Acceptance Criteria

References:

- ANS-3.5-2009, Section 4.4.3.2

- the simulator allows the use of applicable reference unit procedures;

- any observable change in simulated parameters corresponds in direction to the change expected from actual or best estimate response of the reference unit to the malfunction;

- the simulator shall not fail to cause an alarm or automatic action if the reference unit would have caused an alarm or automatic action under identical circumstances;

- the simulator shall not cause an alarm or automatic action if the reference unit would not cause an alarm or automatic action under identical circumstances.

Reactor Core Performance Test

Functional/Testing Requirements

Simulator reactor core performance testing shall be conducted each reference unit fuel cycle. Testing shall be performed in accordance with the reference unit procedures and shall be compared and demonstrated to replicate the response of the reference unit.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.1
- ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
- ANSI/ANS-3.5-2009, Section 3.4.3.3/4.4.3.3
- ANSI/ANS-3.5-2009, Section 5.3.1.2
- ANSI/ANS-3.5-2009, Section 5.3.2
- 10CFR55.31(a)(5), Operator's License Applications
- 10CFR55.46(c)(2)(i), Simulation Facilities
- Reg. Guide 1.149 Revision 4 (in part)

Reactor Core Performance Test

Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS 3.5 Section 4.4.3.3

- be the same as the reference unit procedures' acceptance criteria (Section 4.4.3.3);

- (COOPER) - recorded and/or observed parameters did not violate the physical laws of nature (Section 3.1);

- (COOPER) - the simulator operated in real time; an OVERRUN pop-up error message was not received during the conduct of this test (Section 4.1.1).

Post-event Simulator Test

Functional/Testing Requirements

Perform post-event simulator testing to confirm that the simulator is capable of reproducing the response of relevant reference unit parameters within the scope of simulation.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.1
- ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
- ANSI/ANS-3.5-2009, Section 3.4.3.4/4.4.3.4

Post-event Simulator Test

Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.4.3.4

- simulator response confirms that the simulator is capable of reproducing the response of relevant reference unit parameters within the scope of simulation (Section 4.4.3.4);
- the simulator allows the use of applicable reference unit procedures (Section 4.4.3.4);
- the simulator shall not fail to cause an alarm or automatic action if the reference unit caused an alarm or automatic action under identical circumstances (Section 4.1.4(3));
- the simulator shall not cause an alarm or automatic action if the reference unit did not cause an alarm or automatic action under identical circumstances (Section 4.1.4(4));

Post-event Simulator Test

Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.4.3.4

(Cooper Specific)

- recorded and observed parameters did not violate the physical laws of nature (Section 3.1);

- the simulator operated in real time; an OVERRUN pop-up error message was not received during the conduct of this test (Section 4.1.1).

Modification-based / Performance-based Tests
Functional/Testing Requirements

Perform simulator testing by comparison of simulator model results to actual or predicted reference unit data.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.1
- ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
- ANSI/ANS-3.5-2009, Section 5.3.1/5.3.2

Modification-based / Performance-based Tests
Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.4
- ANS-3.5 Section 5.3.1/5.3.2

(COOPER) NOTE - Although not required per ANS-3.5, Malfunction Test acceptance criteria is applied to modification-based and performance-based tests.

(COOPER) NOTE - Acceptance criteria shall address Steady-state, Transient, Malfunction, and Normal Evolution acceptance criteria as they apply to the specific modification-based and performance-based test.

- the simulator allows the use of applicable reference unit procedures (Section 4.1.4(1));
- any observable change in simulated parameters corresponds in direction to the change expected from actual or best estimate response of the reference unit (Section 4.1.4(2));

Modification-based / Performance-based Tests
Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.4
- ANS-3.5 Section 5.3.1/5.3.2

- the simulator shall not fail to cause an alarm or automatic action if the reference unit would have caused an alarm or automatic action under identical circumstances (Section 4.1.4(3));
- the simulator shall not cause an alarm or automatic action if the reference unit would not cause an alarm or automatic action under identical circumstances (Section 4.1.4(4));
- (COOPER) - recorded and/or observed parameters did not violate the physical laws of nature (Section 3.1);
- (COOPER) - the simulator operated in real time; an OVERRUN pop-up error message was not received during the conduct of this test (Section 4.1.1).

Real Time/Repeatability Capability Test
Functional/Testing Requirements

Demonstrate that the simulator completes execution within the designed time interval, and is repeatable.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
- ANSI/ANS-3.5-2009, Section 4.4.2 (2) (3) (in part)

Real Time/Repeatability Capability Test
Acceptance Criteria

Reference: ANS-3.5 Section 4.1.1

- (COOPER) - overrun message displayed on the Simulator Computer;
- (COOPER) - overrun Status popup displayed on the Instructor Station;

- between successive simulator tests no noticeable differences exist with respect to time base relationships, sequences, durations, rates, and accelerations (Section 4.1.1).

Normal Evolutions Capability Test
Functional/Testing Requirements

Perform simulator testing of selected normal plant evolutions.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.1
- ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
- ANSI/ANS-3.5-2009, Section 3.1.3.2/4.1.3.2

Normal Evolutions Capability Test

Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.3.2

- be the same as the reference unit startup test procedure acceptance criteria (Section 4.1.3.2(1));
- be the same as the reference unit surveillance procedure acceptance criteria (Section 4.1.3.2(2));
- be the same as the reference unit normal operating procedure acceptance criteria (Section 4.1.3.2(3));
- require that any observable change in simulated parameters corresponds in direction to the change expected from actual or best estimate response of the reference unit (Section 4.1.3.2(4));

Normal Evolutions Capability Test

Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.3.2

- require that the simulator shall not fail to cause an alarm or automatic action if the reference unit would have caused an alarm or automatic action under identical circumstances (Section 4.1.3.2(5));

- require that the simulator shall not cause an alarm or automatic action if the reference unit would not cause an alarm or automatic action under identical circumstances (Section 4.1.3.2(6));

- (COOPER) - observed parameters did not violate the physical laws of nature (Section 3.1);

- (COOPER) - the simulator operated in real time; an OVERRUN pop-up error message was not received during the conduct of this test (Section 4.1.1).

Malfunction Capability Test
Functional/Testing Requirements

Perform simulator malfunction testing.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.1
- ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
- ANSI/ANS-3.5-2009, Section 3.1.4/4.1.4
- ANSI/ANS-3.5-2009, Section 3.3.2/4.3.2

Malfunction Capability Test
Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.4

- the simulator allows the use of applicable reference unit procedures (Section 4.1.4(1));

- any observable change in simulated parameters corresponds in direction to the change expected from actual or best estimate response of the reference unit to the malfunction (Section 4.1.4(2));

(COOPER) NOTE - Alarms and automatic actions verified shall be limited to those determined to be directly related to the malfunction tested.

- the simulator shall not fail to cause an alarm or automatic action if the reference unit would have caused an alarm or automatic action under identical circumstances (Section 4.1.4(3));

Malfunction Capability Test

Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.1.4

(COOPER) NOTE - The following criteria shall be limited to certain select annunciators and automatic actions in specific test procedures, as specified by a subject matter expert.

- the simulator shall not cause an alarm or automatic action if the reference unit would not cause an alarm or automatic action under identical circumstances (Section 4.1.4(4));
- (COOPER) - recorded and/or observed parameters did not violate the physical laws of nature (Section 3.1);
- (COOPER) - the simulator operated in real time; an OVERRUN pop-up error message was not received during the conduct of this test (Section 4.1.1).

Local Operator Action Capability Test
Functional/Testing Requirements

Perform simulator remote function testing.

Simulator functional/testing requirements:

- ANSI/ANS-3.5-2009, Section 3.1
- ANSI/ANS-3.5-2009, Section 3.1.1/4.1.1
- ANS-3.5 Section 3.2.2.2/4.2.2.2
- ANSI/ANS-3.5-2009, Section 3.3.4/4.3.4

Remote Function Capability Test

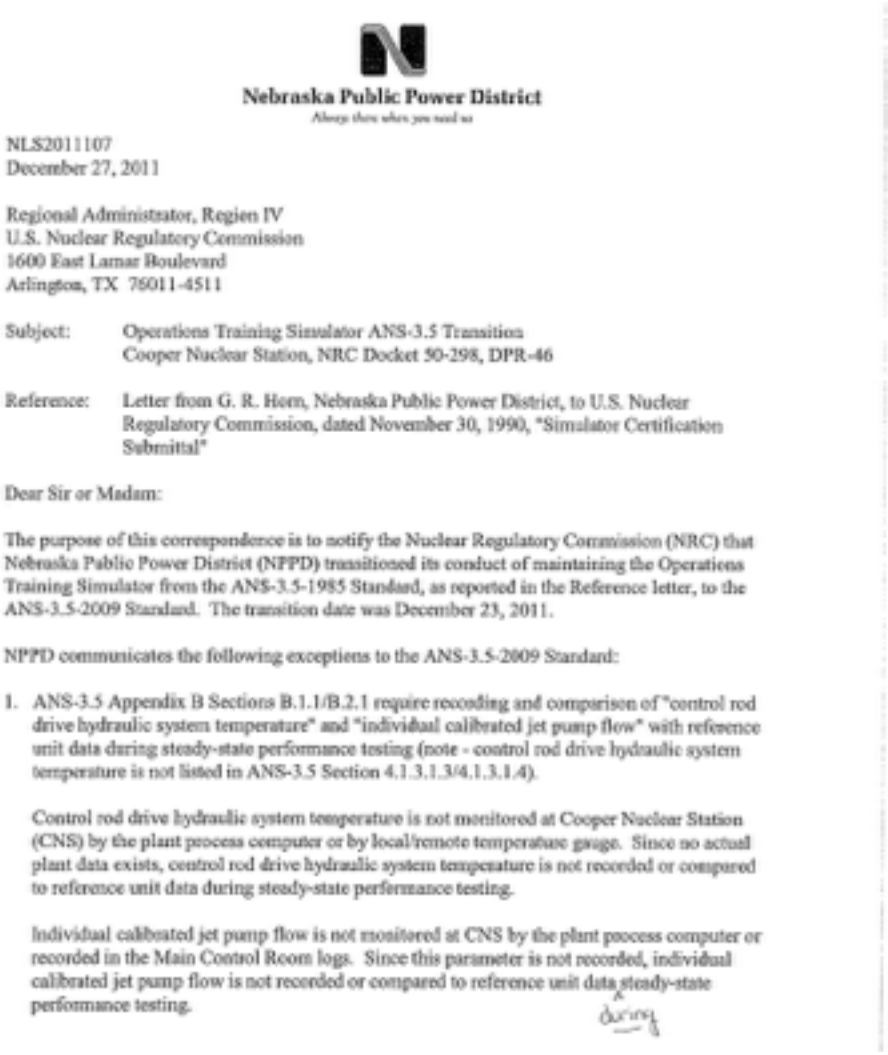
Acceptance Criteria

References:

- ANS-3.5 Section 3.1
- ANS-3.5 Section 4.1.1
- ANS-3.5 Section 4.2.2.2
- ANS-3.5 Section 4.3.4

- the operator is able to interface with the remote activity in a similar manner as in the reference unit (Section 4.2.2.2);
- the introduction of the remote function does not alert an operator to pending events other than by indications that would occur in the reference unit (Section 4.3.4);
- observed parameters did not violate the physical laws of nature (Section 3.1);
- the simulator operated in real time; an OVERRUN pop-up error message was not received during the conduct of this test (Section 4.1.1).

Exceptions to ANS-3.5 Standard?



Nebraska Public Power District

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NLS2011107
December 27, 2011

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
1600 East Lamar Boulevard
Arlington, TX 76011-4511

Subject: Operations Training Simulator ANS-3.5 Transition
Cooper Nuclear Station, NRC Docket 50-298, DPR-46

Reference: Letter from G. R. Horn, Nebraska Public Power District, to U.S. Nuclear Regulatory Commission, dated November 30, 1990, "Simulator Certification Submittal"

Dear Sir or Madam:

The purpose of this correspondence is to notify the Nuclear Regulatory Commission (NRC) that Nebraska Public Power District (NPPD) transitioned its conduct of maintaining the Operations Training Simulator from the ANS-3.5-1985 Standard, as reported in the Reference letter, to the ANS-3.5-2009 Standard. The transition date was December 23, 2011.

NPPD communicates the following exceptions to the ANS-3.5-2009 Standard:

1. ANS-3.5 Appendix B Sections B.1.1/B.2.1 require recording and comparison of "control rod drive hydraulic system temperature" and "individual calibrated jet pump flow" with reference unit data during steady-state performance testing (note - control rod drive hydraulic system temperature is not listed in ANS-3.5 Section 4.1.3.1.3/4.1.3.1.4).

   Control rod drive hydraulic system temperature is not monitored at Cooper Nuclear Station (CNS) by the plant process computer or by local/remote temperature gauge. Since no actual plant data exists, control rod drive hydraulic system temperature is not recorded or compared to reference unit data during steady-state performance testing.

   Individual calibrated jet pump flow is not monitored at CNS by the plant process computer or recorded in the Main Control Room logs. Since this parameter is not recorded, individual calibrated jet pump flow is not recorded or compared to reference unit data steady-state performance testing.

USS Nebraska SSBN 739

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QUESTIONS?