
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.: 151-8078
SRP Section: 03.09.02 – Dynamic Testing and Analysis of Systems, Components, and Equipment
Application Section: 3.9.2
Date of RAI Issue: 08/10/2015

Question No. 03.09.02-2

The staff reviewed DCD Tier 2, Sections 3.9.2 and 14.2.12.1, which state that the initial test program (ITP) of piping systems is applicable to the ASME BPV Code Section III, Class 1, 2, and 3 piping systems. The applicant did not, however, identify testing applicable to other piping systems not designed to the ASME BPV Code Section III. Based on SRP Section 3.9.2 Item I.1.D, the staff requests the applicant to provide a list seismic Category I portions of moderate energy piping systems located outside containment and confirm that it is included in the scope of the ITP similar to the ASME BPV Code Section III piping.

Response – Rev. 0

KHNP has reviewed the subject question and understands the staff's request. KHNP is in the process of upgrading the test plans presented in Section 14.2 of the DCD. 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 action to be taken as a result of this question is within the scope of the upgrade effort. Therefore, KHNP will address the noted items 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. 1

In performing the upgrade of the Initial Test Plans (ITPs) for DCD Section 14.2, it was determined that an alternate approach was more appropriate in responding to the above question. Therefore, a revision to the original response is being submitted. A complete list of seismic of Category I portions of moderate energy piping systems located outside containment will be provided at the detailed design phase by the COL applicant since not all of the applicable systems are within the scope of the DC design. For example, the non-ASME Section III seismic

Category I portions of the moderate energy piping systems in the reference plant (SKN 3 & 4) includes: Fuel Pool Cooling and Cleanup System (FC, Auxiliary Building), Fire Protection System (FP, Auxiliary Building), and Non-Radioactive Equipment Vents and Drains System (ED). The ED system is designed later by the COL applicant. The list of seismic Category I portions of moderate energy piping systems located outside containment will be included in the test procedure which is the responsibility of the COL applicant. Therefore, DCD Tier 2, Subsection 3.9.2.1 will be revised to state that the piping systems recommended in SRP 3.9.2, section I (1), A, B, C and D are to be included in the test procedure.

Impact on DCD

DCD Tier 2, Subsection 3.9.2.1 will be revised as shown 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.

APR1400 DCD TIER 2

Inelastic methods defined in the ASME Section III as plastic instability or limit analysis methods are not used.

3.9.1.4.1.1 Non-Code Items

The components not covered by the ASME Code but related to plant safety include:

- a. Reactor internal structures (Class IS)
- b. Fuel
- c. Control element drive mechanisms (CEDMs)
- d. Control element assemblies (CEAs)

Each component is designed in accordance with the relevant criteria to provide reasonable assurance of its operability as related to safety. The fuel assembly and CEA design is described in Section 4.2. The non-code components of the CEDMs are proven by testing as described in Subsection 3.9.4.4.

3.9.2 Dynamic Testing and Analysis of Systems, Components, and Equipment

3.9.2.1 Piping Vibration, Thermal Expansion, and Dynamic Effects

Piping vibration, thermal expansion, and dynamic effects are tested during the initial test program (ITP) as delineated in Section 14.2. ~~The ITP of piping systems is applicable to the following systems:~~

- a. ~~ASME Section III Class 1, 2, and 3 piping systems~~
- b. ~~High energy piping systems inside seismic Category I structures~~
- c. ~~High energy portions of piping systems whose failure could reduce the functioning of any seismic Category I plant feature to an unacceptable level~~

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The ITP is implemented to verify that the piping for all ASME Code, Section III Class 1, 2, and 3 piping systems, other high-energy piping systems inside seismic Category I structures, high energy portions of systems whose failure could reduce the functioning of any seismic Category I plant feature to an unacceptable safety level, and seismic Category I portions of moderate-energy piping systems located outside containment will remain within acceptable limits when subjected to piping vibrations and dynamic transients such as those caused by in-line component trips.

APR1400 DCD TIER 2

- ~~d. Seismic Category I portions of moderate-energy piping systems located outside the containment~~

The ITP is conducted in accordance with the ASME OM (Reference 34).

The ITP is implemented to demonstrate that these piping systems, restraints, components, and supports have been designed to withstand flow-induced dynamic loading under the steady-state and operational transient conditions anticipated during service, to confirm that proper allowance for thermal contraction and expansion is provided, and to demonstrate that piping vibrations are within the acceptable level. The supports and restraints necessary for operation during the life of the plant are considered to be parts of the piping system.

The ITP includes a list of systems, flow modes, and selected locations for visual inspections and other measurements, the acceptance criteria, and possible corrective actions if excessive vibration or indications of thermal motion restraint occur.

The proper installation and operation of snubbers is verified through visual inspections, hot and cold position measurements, and observation of thermal movements during the ITP. The list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position is provided as part of the ITP to measure snubber travel. In addition, the ITP includes the procedure necessary to verify the snubber operability when snubber travel is not measured.

3.9.2.1.1 Steady-State Vibration

The above piping systems in Subsection 3.9.2.1 with the potential to exhibit significant vibration are monitored for steady-state vibration.

The details relating to this test are described in the test procedure prepared in accordance with ASME OM, Part 3. The piping is monitored for normal operating and test modes along with operating modes expected to result in the most severe vibration. The piping is visually inspected and vibration movements are measured using portable instrumentation at locations where the vibration is determined to be the most severe. The piping, if necessary, is instrumented and monitored remotely.

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Question No. 03.09.02-3

DCD Tier 2, Section 3.9.2.1 states that when applicable, the initial test program (ITP) includes a list of systems, flow modes, and selected locations for visual inspections and other measurements, as well as the acceptance criteria and possible corrective actions if excessive vibration or indications of thermal motion restraint occur. It further states that the list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position is provided as part of the ITP to measure snubber travel. The staff reviewed DCD Tier 2, Section 3.9.2.1 and Section 14.2.12.1, but did not find where the applicant identified which specific systems are included in the testing program, and whether, as stated in SRP Section 3.9.2, testing is conducted on all ASME Class 1, 2, and 3 piping systems. The staff requests the applicant to (a) provide a listing of the high- and moderate-energy piping systems inside containment that are covered by the vibration, thermal expansion, and dynamic effects testing program, (b) verify that the systems to be monitored include all ASME Class 1, 2, and 3 piping systems, and (c) provide the list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position. The DCD should be revised as needed to clarify the scope of the ITP.

Response – Rev. 0

KHNP has reviewed the subject question and understands the staff's request. KHNP is in the process of upgrading the test plans presented in Section 14.2 of the DCD. 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 action to be taken as a result of this question is within the scope of the upgrade effort. Therefore, KHNP will address the noted items 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. 1

In performing the upgrade of the Initial Test Plans (ITPs) for DCD Section 14.2, it was determined that an alternate approach was more appropriate in responding to the above question. Therefore, a revision to the original response is being submitted. The response to items (a) - (c) is as follows:

- (a) A listing of the high- and moderate-energy piping systems inside containment that are covered by the vibration, thermal expansion, and dynamic effects testing program will be provided at the detailed design phase after the piping physical layout is designed. A listing of these piping systems will be included in the test procedure, which is the responsibility of the COL applicant. Therefore, DCD Tier 2, Subsection 3.9.2.1, which defines the test scope and criteria, will be revised to state these piping systems recommended in SRP 3.9.2, section I (1), A, B, C and D will be in the test procedure.
- (b) DCD Tier 2, Section 3.9.2.1.a contains all ASME Class 1, 2, and 3 piping systems for the APR1400, as recommended by SRP 3.9.2, section I (1), A. To clarify the scope of ASME Class 1, 2, and 3 piping systems, DCD Tier 2, Section 3.9.2.1 will be revised as identified by SRP Section 3.9.2
- (c) The list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position will be provided by KHNP at the detailed design phase after the piping analyses and supports design are completed. The list of snubbers will be included in the test procedure, which is the responsibility of the COL applicant. Therefore, DCD Tier 2, Subsection 3.9.2.1 will be changed to indicate the list of snubbers on systems, which experience sufficient thermal movement to measure snubber travel from cold to hot position, will be provided as part of the test procedure.

Impact on DCD

DCD Tier 2, Subsection 3.9.2.1 will be revised as shown 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.

APR1400 DCD TIER 2

Inelastic methods defined in the ASME Section III as plastic instability or limit analysis methods are not used.

3.9.1.4.1.1 Non-Code Items

The components not covered by the ASME Code but related to plant safety include:

- a. Reactor internal structures (Class IS)
- b. Fuel
- c. Control element drive mechanisms (CEDMs)
- d. Control element assemblies (CEAs)

Each component is designed in accordance with the relevant criteria to provide reasonable assurance of its operability as related to safety. The fuel assembly and CEA design is described in Section 4.2. The non-code components of the CEDMs are proven by testing as described in Subsection 3.9.4.4.

3.9.2 Dynamic Testing and Analysis of Systems, Components, and Equipment

3.9.2.1 Piping Vibration, Thermal Expansion, and Dynamic Effects

Piping vibration, thermal expansion, and dynamic effects are tested during the initial test program (ITP) as delineated in Section 14.2. ~~The ITP of piping systems is applicable to the following systems:~~

- a. ~~ASME Section III Class 1, 2, and 3 piping systems~~
- b. ~~High energy piping systems inside seismic Category I structures~~
- c. ~~High energy portions of piping systems whose failure could reduce the functioning of any seismic Category I plant feature to an unacceptable level~~

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The ITP is implemented to verify that the piping for all ASME Code, Section III Class 1, 2, and 3 piping systems, other high-energy piping systems inside seismic Category I structures, high energy portions of systems whose failure could reduce the functioning of any seismic Category I plant feature to an unacceptable safety level, and seismic Category I portions of moderate-energy piping systems located outside containment will remain within acceptable limits when subjected to piping vibrations and dynamic transients such as those caused by in-line component trips.

APR1400 DCD TIER 2

- d. ~~Seismic Category I portions of moderate energy piping systems located outside the containment~~

The ITP is conducted in accordance with the ASME OM (Reference 34).

The ITP is implemented to demonstrate that these piping systems, restraints, components, and supports have been designed to withstand flow-induced dynamic loading under the steady-state and operational transient conditions anticipated during service, to confirm that proper allowance for thermal contraction and expansion is provided, and to demonstrate that piping vibrations are within the acceptable level. The supports and restraints necessary for operation during the life of the plant are considered to be parts of the piping system.

test procedure

The ITP includes a list of systems, flow modes, and selected locations for visual inspections and other measurements, the acceptance criteria, and possible corrective actions if excessive vibration or indications of thermal motion restraint occur.

The proper installation and operation of snubbers is verified through visual inspections, hot and cold position measurements, and observation of thermal movements during the ITP. ~~The list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position is provided as part of the ITP to measure snubber travel.~~ In addition, the ITP includes the procedure necessary to verify the snubber operability when snubber travel is not measured.

test procedure

3.9.2.1.1 Steady-State Vibration

A check of snubber operability is made by recording hot and cold positions and comparing these positions to calculated hot and cold positions. The list of snubbers on systems, which experience sufficient thermal movement to measure snubber travel from cold to hot position, will be provided as part of the test procedure.

The above piping systems in Subsection 3.9.2.1 with the potential to exhibit significant vibration are monitored for steady-state vibration.

The details relating to this test are described in the test procedure prepared in accordance with ASME OM, Part 3. The piping is monitored for normal operating and test modes along with operating modes expected to result in the most severe vibration. The piping is visually inspected and vibration movements are measured using portable instrumentation at locations where the vibration is determined to be the most severe. The piping, if necessary, is instrumented and monitored remotely.

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SRP Section: 03.09.02 – Dynamic Testing and Analysis of Systems, Components, and Equipment
Application Section: 3.9.2
Date of RAI Issue: 08/10/2015

Question No. 03.09.02-4

In review of the DCD Sections 3.9.2 and 14.2, it is not clear whether the vibration, thermal expansion, and dynamic effects testing program simulates actual operating modes. Section 3.9.2 of the SRP states that an acceptable test program to confirm the adequacy of the design should include a list of the flow modes of operation and transients such as pump trips, valve closures, etc., to which the components will be subjected during the test. In consideration of the transients of the reactor coolant system heat-up tests may include start and trip of the reactor coolant pump (RCP), operation of pressure relieving valves, and closure of turbine stop valve. Therefore, the staff requests the applicant to provide a listing of the different flow modes to which the systems will be subjected during the vibration, thermal expansion, and dynamic effects testing program to confirm that the piping systems, restraints, components, and supports have been adequately designed to withstand flow-induced dynamic loadings under the steady-state and operational transient conditions anticipated during service.

Response – Rev. 0

KHNP has reviewed the subject question and understands the staff's request. KHNP is in the process of upgrading the test plans presented in Section 14.2 of the DCD. 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 action to be taken as a result of this question is within the scope of the upgrade effort. Therefore, KHNP will address the noted items 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. 1

In performing the upgrade of the Initial Test Plans (ITPs) for DCD Section 14.2, it was determined that an alternate approach was more appropriate in responding to the above question. Therefore, a revision to the original response is being submitted. A listing of the different flow modes will be provided at the detailed design phase since the flow modes and their result on the piping systems are determined after the piping analyses are completed. However, to ensure the elements of an acceptable startup test-program are incorporated, as identified by SRP 3.9.2, the different flow modes of operation and transients to which the systems will be subjected during startup function testing of the specified piping systems will be added in DCD Tier 2, Subsection 3.9.2.1.

Impact on DCD

DCD Tier 2, Subsection 3.9.2.1 will be revised as shown 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.

APR1400 DCD TIER 2

- d. Seismic Category I portions of moderate-energy piping systems located outside the containment

The ITP is conducted in accordance with the ASME OM (Reference 34).

The ITP is implemented to demonstrate that these piping systems, restraints, components, and supports have been designed to withstand flow-induced dynamic loading under the steady-state and operational transient conditions anticipated during service, to confirm that proper allowance for thermal contraction and expansion is provided, and to demonstrate that piping vibrations are within the acceptable level. The supports and restraints necessary for operation during the life of the plant are considered to be parts of the piping system.

The ITP includes a list of systems, flow modes, and selected locations for visual inspections and other measurements, the acceptance criteria, and possible corrective actions if excessive vibration or indications of thermal motion restraint occur.

The proper installation and operation of snubbers is verified through visual inspections, hot and cold position measurements, and observation of thermal movements during the ITP. The list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position is provided as part of the ITP to measure snubber travel. In addition, the ITP includes the procedure necessary to verify the snubber operability when snubber travel is not measured.

3.9.2.1.1 Steady-State Vibration



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The above piping systems in Subsection 3.9.2.1 with the potential to exhibit significant vibration are monitored for steady-state vibration.

The details relating to this test are described in the test procedure prepared in accordance with ASME OM, Part 3. The piping is monitored for normal operating and test modes along with operating modes expected to result in the most severe vibration. The piping is visually inspected and vibration movements are measured using portable instrumentation at locations where the vibration is determined to be the most severe. The piping, if necessary, is instrumented and monitored remotely.

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During the startup testing, the piping systems which are specified as part of the ITP are operated to check the performance characteristics of critical pumps, valve, controls, and auxiliary equipment. The flow modes of operation and transients that are performed during the test include pump trips and valve closures. In the case of the RCS heatup tests, transients that are applied to the system include the RCP start, RCP trip, the operation of pressure-relieving valves, and closure of a turbine stop valve. Additional requirements of startup testing are outlined in Subsection 14.2.1.

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SRP Section: 03.09.02 – Dynamic Testing and Analysis of Systems, Components, and Equipment

Application Section: 3.9.2

Date of RAI Issue: 08/10/2015

Question No. 03.09.02-6

The staff reviewed DCD Tier 2, Section 14.2 did not find any initial test program (ITP) element that tested the dynamic transient conditions stated above. SRP Section 3.9.2, Item I.1 states that the ITP tests are to confirm that the piping systems, restraints, components, and supports have been adequately designed to withstand flow induced dynamic loadings under the steady state and operational transient conditions anticipated during service. Therefore, the applicant is requested to provide appropriate ITP test programs for each of the transient vibration conditions in accordance with provisions of RG 1.68 and ASME OM-3 such that APR1400 would meet 10 CFR 50, Appendix A, GDC 14 and GDC 15.

Response – Rev. 0

KHNP has reviewed the subject question and understands the staff's request. KHNP is in the process of upgrading the test plans presented in Section 14.2 of the DCD. 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 action to be taken as a result of this question is within the scope of the upgrade effort. Therefore, KHNP will address the noted items 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. 1

In performing the upgrade of the Initial Test Plans (ITPs) for DCD Section 14.2, it was determined that an alternate approach was more appropriate in responding to the above question. Therefore, a revision to the original response is being submitted. Each piping transient test will be performed in connection with the system test during the Power Ascension Test. ITP 14.2.12.1.118, "Balance-of-Plant Piping Vibration Measurement Test" includes testing of the

systems to withstand flow induced dynamic loadings under the steady state and operational transient conditions and references DCD Section 3.9. The associated test procedures will include the detailed test specifications in accordance with the general requirements of RG 1.68 and the specific vibration testing requirements of ASME OM Part 3. To ensure that the requirements of RG 1.68 and ASME OM are included, DCD Tier 2, Subsection 3.9.2.1 will be updated to specify that these specific provisions are addressed as part of the test program.

Impact on DCD

DCD Tier 2, Subsection 3.9.2.1 will be revised as shown 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.

APR1400 DCD TIER 2

- d. Seismic Category I portions of moderate-energy piping systems located outside the containment

The ITP is conducted in accordance with the ASME OM (Reference 34).

The ITP is implemented to demonstrate that these piping systems, restraints, components, and supports have been designed to withstand flow-induced dynamic loading under the steady-state and operational transient conditions anticipated during service, to confirm that proper allowance for thermal contraction and expansion is provided, and to demonstrate that piping vibrations are within the acceptable level. The supports and restraints necessary for operation during the life of the plant are considered to be parts of the piping system.

The ITP includes a list of systems, flow modes, and selected locations for visual inspections and other measurements, the acceptance criteria, and possible corrective actions if excessive vibration or indications of thermal motion restraint occur.

The proper installation and operation of snubbers is verified through visual inspections, hot and cold position measurements, and observation of thermal movements during the ITP. The list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position is provided as part of the ITP to measure snubber travel. In addition, the ITP includes the procedure necessary to verify the snubber operability when snubber travel is not measured.

3.9.2.1.1 Steady-State Vibration



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The above piping systems in Subsection 3.9.2.1 with the potential to exhibit significant vibration are monitored for steady-state vibration.

The details relating to this test are described in the test procedure prepared in accordance with ASME OM, Part 3. The piping is monitored for normal operating and test modes along with operating modes expected to result in the most severe vibration. The piping is visually inspected and vibration movements are measured using portable instrumentation at locations where the vibration is determined to be the most severe. The piping, if necessary, is instrumented and monitored remotely.

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The general requirements for vibration and dynamic effects testing of piping systems are specified in RG 1.68 (Reference 71). Test specifications are in accordance with ASME OM-S/G-1990, Part 3 (Reference 34). If vibration is noted beyond the acceptance levels, corrective measures to the restraints are designed, incorporated in the piping systems analysis, and installed. If the test results determines that the piping system restraints are inadequate or are damaged, corrective measures to the restraints are installed and another test is performed to determine whether the vibrations have been reduced to an acceptable level.

APR1400 DCD TIER 2

- 63. Joint Owners Group Air Operated Valve Program, Rev. 1, December 13, 2000.
- 64. Regulatory Guide 1.124, "Service Limits and Loading Combinations for Class 1 Linear-Type Supports," Rev. 3, U.S. Nuclear Regulatory Commission, July 2013.
- 65. Regulatory Guide 1.130, "Service Limits and Loading Combinations for Class 1 Plate-and-Shell-Type Supports," Rev. 3, U.S. Nuclear Regulatory Commission, July 2013.

71. Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plant," Rev. 4, U.S. Nuclear Regulatory Commission, June 2013.

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Question No. 03.09.02-7

In DCD Tier 2, Section 3.9.2.1.2 the applicant stated that the thermal expansion tests are developed in accordance with the guidance of ASME OM, Part 7. However, the applicant did not provide a description of the test in the DCD. In addition, SRP Section 3.9.2 states that an acceptable thermal expansion program to confirm the adequacy of the design should include a description of the thermal-motion monitoring program. Therefore, the staff requested the applicant to provide a description of the thermal motion monitoring program for verification of snubber movement, adequate clearances and gaps, the acceptance criteria, and the method regarding how motion will be measured.

Response – Rev. 0

KHNP has reviewed the subject question and understands the staff's request. KHNP is in the process of upgrading the test plans presented in Section 14.2 of the DCD. 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 action to be taken as a result of this question is within the scope of the upgrade effort. Therefore, KHNP will address the noted items 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. 1

In performing the upgrade of the Initial Test Plans (ITPs) for DCD Section 14.2, it was determined that an alternate approach was more appropriate in responding to the above question. Therefore, a revision to the original response is being submitted. DCD Tier 2, Subsection 3.9.2.1.3 will be changed to clarify that the detailed description of the thermal motion

monitoring program will be included as part of the test procedure completed by the COL applicant.

Impact on DCD

DCD Tier 2, Subsection 3.9.2.1.3 and 14.2.12.1.117 will be revised as shown 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.

APR1400 DCD TIER 2

The piping is instrumented to measure the system response during the dynamic transient events. The measured responses are compared with analytically predicted values from the piping stress reports.

If excessive system vibration is apparent during the dynamic transient events, an evaluation is performed to determine the cause and to identify the corrective action.

Alternatively, an analysis may be performed to demonstrate that the measured dynamic transient vibration does not cause the piping system in question to exceed stress or fatigue acceptance criteria.

3.9.2.1.3 Thermal Expansion

The detailed description of the thermal motion monitoring program will be included as part of the test procedure. The thermal motion monitoring program will include verification of snubber movement, adequate clearances and gaps, the acceptance criteria, and how the motion is to be measured.

For piping systems expected to be subjected to significant thermal movements, the thermal expansion test is performed to verify that the piping system expands and contracts within the acceptable limits based on analytically predicted movements from the piping stress analyses during the ITP and is performed in accordance with the requirements of ASME OM, Part 7. ←

Prior to heatup, the locations of potential thermal interferences are identified and appropriate corrective restraints are installed through a pre-heatup walkdown. One complete thermal cycle (i.e., cold to hot position and back to cold position) is monitored.

The piping and components are visually inspected and piping displacements are monitored at predetermined locations. The measurement locations are based on those of snubbers, hangers, and expected large displacements.

3.9.2.2 Seismic Analysis and Qualification of Seismic Category I Mechanical Equipment

3.9.2.2.1 Seismic Qualification Testing

The recommended guidance and requirements in NRC RG 1.100 (Reference 35) and IEEE Std. 344-2004 (Reference 36) are used for the development and implementation of methods and procedures for seismic qualification of mechanical and electrical equipment. The

APR1400 DCD TIER 2

recorded. Visual inspection of snubbers is performed to provide reasonable assurance they have not contacted either stop and are within expected travel range. Snubber piston scales are read to provide reasonable assurance acceptance criteria for piston to stop gap are met. Also, system walkthroughs are performed during HFT to visually verify that piping and components are unrestricted from moving within their ranges. Hot displacement measurements of all snubbers are obtained and motion is compared with predicted values.

- 3.2 For systems that do not attain design operating temperature, verify by observation and/or calculation that the snubbers accommodate the predicted thermal movement.
- 3.3 Inspect small pipe in the vicinity of connections to large pipe to provide reasonable assurance that sufficient clearance and flexibility exists to accommodate thermal movements of the large pipe.
- 3.4 The feedwater system and auxiliary feedwater system hot displacement measurements are obtained during the initial startup and power escalation phase.
- 3.5 All snubbers and spring supports that required adjustments during the test are reinspected in their hot condition to provide reasonable assurance that proper adjustments are made.

4.0 DATA REQUIRED

- 4.1 Position measurements versus temperature for cold, heatup, steady-state, cooldown, and return to ambient conditions for designated piping, spring supports, and snubbers

5.0 ACCEPTANCE CRITERIA

- 5.1 The pipe moves freely, except at locations where supports/restraints are designed to restrain pipe thermal movement as described in ~~Section 3.12.~~

Subsection 3.9.2.



APR1400 DCD TIER 2

- 5.2 Thermal movement of pipe at the locations of spring hangers and snubbers are within the allowable travel range as described in ~~Section 3.12.~~

Subsection 3.9.2.



- 5.3 The thermal movement of the pipe at restricted measurement locations are within the acceptable limits or the discrepant response is reconciled using acceptable reconciliation methods as described in ~~Section 3.12.~~

Subsection 3.9.2.



14.2.12.1.118 Balance-of-Plant Piping Vibration Measurement Test

1.0 OBJECTIVE

- 1.1 To verify that piping layout and support/restraints are adequate to withstand normal transients without damage in the designated piping systems
- 1.2 To demonstrate that flow-induced vibration is sufficiently small to cause no fatigue or stress failures in the designated piping systems

2.0 PREREQUISITES

- 2.1 System components and piping supports have been installed in accordance with design drawings for the system to be tested.
- 2.2 System piping has been installed in accordance with design drawings for the system to be tested.
- 2.3 Hot functional testing and/or pre-critical heatup for power escalation is underway.
- 2.4 System piping has been filled for normal operation.

3.0 TEST METHOD

- 3.1 Perform an assessment of piping system vibration.