

7 INSTRUMENTATION AND CONTROLS

Nuclear power plant instrumentation senses various plant parameters and transmits appropriate signals to the control systems during normal operation and to the reactor trip and engineered safety feature systems during abnormal and accident conditions. The information provided in this chapter emphasizes those instruments and associated equipment that constitute the protection and safety systems.

7.1 Introduction

7.1.1 Introduction

The Westinghouse AP1000 Design Control Document (DCD), Revision 19, contains Combined License (COL) Information Item 7.1-1 that requires the COL applicant to address setpoint calculations for protective functions

7.1.2 Summary of Application

Section 7.1 of the William States Lee III Nuclear Station (WLS) COL Final Safety Analysis Report (FSAR), Revision 11, incorporates by reference AP1000 DCD, Revision 19, Section 7.1, with the departures and/or supplements with respect to AP1000 DCD, Section 7.1.6.1, pertaining to "Setpoint Calculations for Protective Functions." This change to AP1000 DCD, Section 7.1.6.1 addressed the new COL Information Item (COL 7.1-1), which was incorporated in AP1000 DCD, Revision 18.

To address the above COL Information Item 7.1-1, the applicant provided the following additional information in the COL application:

AP1000 COL Information Item

- STD COL 7.1-1

Standard (STD) COL 7.1-1 addresses setpoint calculations for protective functions.

7.1.3 Regulatory Basis

The regulatory basis of the information incorporated by reference in the WLS COL application is addressed in NUREG-1793, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," and its supplements.

In addition, the acceptance criteria associated with the relevant requirements of NRC regulations for Instrumentation and Controls are included in NUREG-0800, Section 7.1, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants."

The applicable regulatory requirements for the information being reviewed in this section are as follows:

- Title 10 of the *Code of Federal Regulations* (10 CFR) 50.36, "Technical specifications"

- 10 CFR 52.79(a)(30), "Contents of applications; technical information"

7.1.4 Technical Evaluation

The staff reviewed WLS COL FSAR Section 7.1 and checked the referenced DCD to ensure that the combination of the DCD information incorporated by reference and the information in the COL application represents the complete scope of information relating to this review topic.¹ The NRC staff's review confirmed that the information in the WLS COL application and the information incorporated by reference from the AP1000 DCD application addressed the required information relating to setpoint calculations for protective functions. The results of the staff's evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this safety evaluation report (SER) provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the design certification (DC) and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (Vogtle Electric Generating Plant (VEGP), Units 3 and 4) were equally applicable to the WLS Units 1 and 2 COL application, the staff undertook the following reviews.

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In performing this comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the COL application, as applicable) resulting from requests for additional information (RAIs).
- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed.
- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the WLS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) may include evaluation material from the SER for the Bellefonte Nuclear Plant (BLN), Units 3 and 4 COL application.

The following portion of this technical evaluation section is reproduced from VEGP SER Section 7.1.4:

The applicant, in its letter dated May 21, 2010, proposed to incorporate the Setpoint Program (SP) that will be added to the AP1000 DCD into the VEGP Technical Specifications (TS). This proposal was made to address Open Item 6.1-1. In Chapter 16 of this safety evaluation report (SER), the staff concludes that the response to Open Item 16.1-1 is acceptable. The incorporation of this program into the VEGP TS in a later revision was being

¹ See Section 1.2.2 for a discussion of the staff's review related to verification of the scope of information to be included in a COL application that references a design certification (DC).

tracked as **Confirmatory Item 16.1-1**. The closure of this Confirmatory Item is addressed in SER Section 16.1.

In addition, in a letter dated June 4, 2010, the applicant proposed adding STD COL 7.1-1 as a new COL information item addressed in the VEGP COL FSAR.

AP1000 COL Information Item

- STD COL 7.1-1

The applicant proposed adding a new line item to VEGP COL FSAR Table 1.8-202 to address COL Information Item 7.1-1. The applicant also proposed the following addition to VEGP COL FSAR Section 7.1:

7.1.6.1 Setpoint Calculations for Protective Functions

The Setpoint Program described in Technical Specifications Section 5.5 provides the appropriate controls for update of the instrumentation setpoints following completion of the calculation of setpoints for protective functions and the reconciliation of the setpoints against the final design.

The applicant states that the TS program identified in the proposed Section 7.1.6.1 was that addressed in the VEGP revised response to Bellefonte Nuclear Plant (BLN) Open Item 16.1-1, dated May 21, 2010, and that the calculation and reconciliation of the setpoints discussed is required by the AP1000 Inspections, Tests, Analyses and Acceptance Criteria (ITAAC) included in AP1000 DCD Tier 1, Table 2.5.2-8, Item 10. In Chapter 16 of this SER, the staff concludes that the May 21, 2010, response to BLN Open Item 16.1-1 is acceptable.

Based on the ITAAC in Table 2.5.2-8, Item 10 and the TS controls in Section 5.5, the staff finds there are adequate controls for updating the instrumentation and controls (I&C) setpoints. Therefore, the staff finds STD COL 7.1-1 acceptable.

*The incorporation of the changes associated with proposed STD COL 7.1-1 into a future revision of the VEGP COL FSAR is **Confirmatory Item 7.1-1**.*

Resolution of Standard Content Confirmatory Item 7.1-1

Confirmatory Item 7.1-1 is an applicant commitment to revise its WLS COL FSAR Table 1.8-202 and Section 7.1 to address COL Information Item STD COL 7.1-1. The staff verified that the WLS COL FSAR was appropriately revised to address STD COL 7.1-1. As a result, Confirmatory Item 7.1-1 is now closed.

7.1.5 Post Combined License Activities

There are no post COL activities related to this section.

7.1.6 Conclusion

The staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant addressed the required information relating to setpoint calculations for protective functions, and there is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff compared the application to relevant NRC regulations and other NRC regulatory guides and concludes that, pending closure of the identified confirmatory items, the applicant is in compliance with NRC regulations. The staff based its conclusion on the following:

- To address AP1000 COL Information Item STD COL 7.1-1, the applicant provided a program for setpoint calculations for protective functions in accordance with the requirements of 10 CFR 50.36 and 10 CFR 52.79(a)(30).

7.2 Reactor Trip

WLS COL FSAR, Revision 11, Section 7.2, incorporates by reference, AP1000 DCD, Revision 19, Section 7.2, "Reactor Trip." In addition, in WLS COL FSAR, the applicant provided the following:

Departures

- WLS DEP 6.4-2

The applicant provided additional information in Figure 7.2-202 of the WLS COL FSAR about WLS DEP 6.4-2 related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance. This information, as well as related WLS DEP 6.4-2 information appearing in other chapters of the FSAR, is reviewed in Section 21.3 of this SER.

- WLS DEP 7.3-1

The applicant provided additional information in Figure 7.2-201 of the WLS COL FSAR about WLS DEP 7.3-1 related to required design changes for the protection and safety monitoring system (PMS) source range neutron flux doubling logic to comply with the requirements of IEEE Std. 603-1991, Clause 6.6. This information, as well as related WLS DEP 7.3-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.5 of this SER.

The NRC staff reviewed Section 7.2 of the WLS COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of the information relating to this section.¹ The NRC staff's review confirmed that the applicant addressed the required information to satisfy the evaluation criteria. There is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

7.3 Engineered Safety Features

WLS COL FSAR, Revision 11, Section 7.3, incorporates by reference, AP1000 DCD, Revision 19, Section 7.3, "Engineered Safety Features." In addition, in WLS COL FSAR, the applicant provided the following:

Departures

- WLS DEP 6.4-1

The applicant provided additional information in Section 7.3.1.2.17 of the WLS COL FSAR about WLS DEP 6.4-1 related to design changes affecting habitability of the main control room and changes to the calculated doses to control room operators. This information, as well as related WLS DEP 6.4-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.2 of this SER.

- WLS DEP 6.4-2

The applicant provided additional information in Section 7.3.1.2.17 of the WLS COL FSAR about WLS DEP 6.4-2 related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance. This information, as well as related WLS DEP 6.4-2 information appearing in other chapters of the FSAR, is reviewed in Section 21.3 of this SER.

- WLS DEP 7.3-1

The applicant provided additional information in Section 7.3.1.2.14 of the WLS COL FSAR about WLS DEP 7.3-1 related to required design changes for the PMS source range neutron flux doubling logic to comply with the requirements of IEEE Std. 603-1991, Clause 6.6. This information, as well as related WLS DEP 7.3-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.5 of this SER.

The NRC staff reviewed Section 7.3.1.2 of the WLS COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this section.¹ The NRC staff's review confirmed that the applicant addressed the required information to satisfy the evaluation criteria. There is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

In RAI 01-04, issued to the applicant for the BLN Units 3 and 4, the staff questioned how the applicant would verify that the as-built Instrument & Control (I&C) system configuration conformed to schematics. In its response to RAI 01-04, the BLN applicant indicated that it or a designee would verify I&C cabinets as-built against the design drawings during manufacturing and would functionally test each system. In addition, the BLN applicant's response indicated that the I&C cabinets would be tested during preoperational testing and in accordance with several ITAAC related to the I&C system. The BLN response to RAI 01-04 was endorsed as standard for WLS by Duke Energy Carolinas, Inc., in its February 5, 2009, letter.

The staff notes that vendor qualification testing, which may be done offsite, and preoperational testing fall under the applicant's quality assurance program. Any anomalies found during the testing or any problems identified from the time the testing is complete until the components are installed at the site would be corrected in accordance with the applicant's quality assurance program.

The staff finds the verification of the as-built I&C system configuration against schematics using a combination of vendor and onsite testing that falls under the applicant's quality assurance program acceptable. In addition, the staff finds that adequate program controls exist to ensure that once the testing was complete, the I&C system configuration would be maintained as valid throughout the life of the plant. Based on the above, the staff finds the response to BLN RAI 01-04 and the WLS endorsement of that response acceptable.

7.4 Systems Required for Safe Shutdown

WLS COL FSAR, Revision 11, Section 7.4 incorporates by reference AP1000 DCD, Revision 19, Section 7.4, "Systems Required for Safe Shutdown," with the following departures:

Departures

- WLS DEP 6.3-1 and WLS DEP 3.2-1

The applicant provided additional information for WLS DEP 6.3-1 and WLS DEP 3.2-1 in WLS COL FSAR Section 7.4.1.1 related to extended operation of the PRHR-HX, the ability to maintain safe shutdown conditions, changing the indefinite duration to at least 72 hours, and operator directed actions to preserve battery capability. This information, as well as related WLS DEP 6.3-1 information appearing in other chapters of the WLS COL FSAR, is reviewed in Section 21.1 of this SER.

The staff reviewed WLS COL FSAR Section 7.4.1.1 and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this section. The staff's review confirmed that the applicant adequately addressed the required information to satisfy the evaluation criteria. There is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. Section 21.1 of this report evaluates the departures from the AP1000 DCD provided in WLS DEP 6.3-1 and WLS DEP 3.2-1.

7.5 Safety-Related Display Information (Related to RG 1.206, Section C.III.1, Chapter 7, C.I.7.5, "Information Systems Important to Safety")

7.5.1 Introduction

Safety-related display information includes equipment that processes safety-related information and displays it for use by the operator to monitor and maintain the safety of the AP1000 throughout operating conditions that include anticipated operational occurrences and accident and post-accident conditions.

The AP1000 DCD contains COL Information Item 7.5-1 that requires the COL applicant to address post accident monitoring variables listed as site-specific in DCD Tables 7.5-1 and 7.5-8.

7.5.2 Summary of Application

WLS COL FSAR, Revision 11, Section 7.5, incorporates by reference AP1000 DCD, Revision 19, Section 7.5 with departures and/or supplements.

To address the departures and/or supplements, the applicant provided the following additional information:

Departure

- WLS DEP 6.4-2

The applicant provided additional information in Section 7.5 of the WLS COL FSAR about WLS DEP 6.4-2 related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance. This information, as well as related WLS DEP 6.4-2 information appearing in other chapters of the FSAR, is reviewed in Section 21.3 of this SER.

AP1000 Information Items

- WLS COL 7.5-1 and STD COL 7.5-1

The applicant provided additional information in WLS COL FSAR Section 7.5, "Safety-Related Display Information," describing the WLS COL FSAR Table 7.5-201 supplement (SUP) to AP1000 DCD Table 7.5-1 and AP1000 DCD Table 7.5-8 providing variable data shown in the DCD tables as "site specific."

7.5.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the information systems important to safety are given in NUREG-0800, Section 7.5.

The applicable regulatory requirements, guidelines, and related acceptance criteria for the supplemental information item are as follows:

- General Design Criterion (GDC) 13, "Instrumentation and Control"
- GDC 64, "Monitoring Radioactivity Releases"

The regulatory bases require, in part, that instrumentation be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to ensure adequate safety. Monitoring should include checking the plant environs for radioactivity that may be released from postulated accidents.

7.5.4 Technical Evaluation

The staff reviewed WLS COL FSAR Section 7.5 and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.¹ The staff's review confirmed that the information in the COL application and the DCD information incorporated by reference addressed the required information relating to safety-related display information. The results of the staff's evaluation of the DCD information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the WLS COL FSAR:

AP1000 Information Items

- WLS COL 7.5-1 and STD COL 7.5-1

The AP1000 DCD references and commits to Regulatory Guide (RG) 1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident," Revision 3, as the method of complying with GDC 13 and GDC 64.

WLS COL FSAR, Appendix 1AA, Revision 3, takes exception to RG 1.97, Revision 4. Instead, the applicant stated conformance to RG 1.97, Revision 3. The applicant stated, "Portable equipment outside the DCD scope conforms to Revision 3 of this Regulatory Guide for consistency with DCD scope since Revision 4 indicates that partial implementation is not advised." The acceptability of RG 1.97, Revision 3, is discussed by the staff in Section 12.1 of this report.

RG 1.97, Revision 3, states that the variable and range information should be provided for environs radiation and radioactivity, and meteorological instrumentation.

The staff issued RAI 4, Question 07.05-1, to the applicant requesting information on boundary environs radiation and meteorological instrumentation. The staff finds that the range of the boundary environs radiation instruments is necessary to ensure that the instruments are adequate for monitoring radioactivity that may be released from a postulated accident. The meteorological range and accuracy information conforms to the guidance of RG 1.97, Revision 3 with the exception of the differential temperature range. In its October 1, 2009, response to RAI 4, Question 07.05-1, the applicant proposed a range of -4°C to 8°C instead of - 5°C to 10°C and provided the following justification:

Stability class is estimated from the vertical temperature gradient between the 60m and 10m levels on the meteorological tower. As noted in footnote (f) of revised FSAR Table 2.3-281 transmitted as an enclosure to Reference 1, Delta-T is calculated by the datalogger. The datalogger Delta-T reading is verified to be within +0.05 degrees when the temperature sensors are placed in a drywell isothermal environment during calibration. A stated range of -4°C to +8°C is referenced based on procedural tolerances and ranges used at Duke Energy's operating nuclear stations. This range is adequate for Delta-T in determining the stability class per Table 1 of Regulatory Guide 1.23, Revision 1, with Delta-T criteria covering an overall range of (dT < -1.9°C) to (dT > +4.0°C) per a 100m separation. For the Lee 60m meteorological tower, with a 50m separation between the upper and lower temperature measurement levels, this equates to

Delta-T criteria for estimating stability class within the overall range of (dT < -0.95°C) to (Dt > +2.0°C).

The staff finds the applicant's reduced differential temperature range acceptable because the data logger reading is verified to be within 0.05 degrees, which meets the 0.1 degrees resolution requirements of RG 1.23 (Revision 1), and the Delta-T calibration range (-4°C to +8°C) bounds RG 1.23 (Revision 1) Ambient Temperature Change with Height criteria as identified in RG 1.23, Revision 1, Table 1(AS1), "Classification of Atmospheric Stability." RG 1.23 provides guidance on meteorological instrumentation, which is referenced by RG 1.97.

The staff notes that the supplemental information conforms to the guidance of RG 1.97, Revision 3. The staff confirmed the incorporation of the instrumentation supplemental information in the WLS COL FSAR. The staff finds the supplemental response acceptable and considers RAI 4, Question 07.05-1 resolved.

In a May 26, 2010, letter, Westinghouse proposed a change to the AP1000 DCD to add COL Information Item 7.5-1 requiring that COL applicants provide information for variables listed as "site specific" in DCD Tables 7.5-1 and 7.5-8. Although this information was provided for WLS as part of WLS SUP 7.5-1 and incorporated in the WLS COL FSAR, the identification of COL Information Item 7.5-1 in the AP1000 DCD required that the applicant address this information with a COL identifier rather than as supplemental information. Accordingly, the applicant's November 4, 2010, letter proposes to replace WLS SUP 7.5-1 with STD COL 7.5-1 (for standard information) and WLS COL 7.5-1 (for WLS specific information). This change of identifiers does not impact the staff's conclusion regarding the instrumentation information added to the WLS COL FSAR. The incorporation of the changed identifiers into the WLS COL FSAR was treated as **Confirmatory Item 7.5-1**.

Resolution of Standard Content Confirmatory Item 7.5-1

Confirmatory Item 7.5-1 is an applicant commitment to revise its WLS COL FSAR Table 1.8-202, and Sections 7.5.2, 7.5.3.5, and 7.5.5 to address COL Information Item STD COL 7.5-1. The staff verified that the WLS COL FSAR was appropriately revised. Accordingly, the staff considers Confirmatory Item 7.5-1 closed.

7.5.5 Post Combined License Activities

There are no post COL activities related to this section.

7.5.6 Conclusion

The staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant adequately addressed the required information relating to safety-related display information, and there is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the staff's technical evaluation of the DCD information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff compared the application to the relevant NRC regulations and other NRC regulatory guides and concludes that, the applicant is in compliance with NRC regulations. The

applicant has satisfactorily addressed the guidance of Revision 3 of RG 1.97 through the response to RAI 4, Question 07.05-1. The staff based its conclusion on the following:

- WLS DEP 6.4-2, related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance, is reviewed and found acceptable by the staff in Section 21.3 of this SER.
- To address WLS COL 7.5-1 and STD COL 7.5-1, the applicant provided sufficient information regarding the safety-related display information, which is acceptable in accordance with the requirements of 10 CFR Part 50, Appendix A, GDC 13 and GDC 64.

7.6 Interlock Systems Important to Safety

WLS COL FSAR Section 7.6, Revision 11, incorporates by reference, with no departures or supplements, AP1000 DCD, Section 7.6, "Interlock Systems Important to Safety," Revision 19. The staff reviewed the WLS COL application and checked the referenced DCD to ensure that no issue relating to this section remained for review.¹ The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the DCD information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

7.7 Control and Instrumentation Systems (Related to RG 1.206, Section C.III.1, Chapter 7, C.I.7.7, "Control Systems Not Required for Safety")

WLS COL FSAR, Revision 11, Section 7.7, incorporates by reference, with no departures or supplements, AP1000 DCD, Revision 19, Section 7.7, "Control and Instrumentation Systems," The staff reviewed the WLS COL application and checked the referenced DCD to ensure that no issue relating to this section remained for review.¹ The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the DCD information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.