ArevaEPRDCPEm Resource

From:	Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent:	Thursday, March 19, 2009 11:52 AM
To:	Getachew Tesfaye
Cc:	PORTER Thomas (EXT); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 122, Supplement 1
Attachments:	RAI 122 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. provided responses to 46 of 48 questions of RAI No. 122, via letter dated December 5, 2008. The attached file, "RAI 122 Supplement 1 Response US EPR DC.pdf" provides technically correct and complete responses to the two remaining questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 122 Questions 16-243 and 16-254.

The following table indicates the respective pages in the response document, "RAI 122 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 122 — 16-243	2	16
RAI 122 — 16-254	17	18

This concludes the formal AREVA NP response to RAI 122, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Ronda Pederson
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From: DUNCAN Leslie E (AREVA NP INC)
Sent: Monday, December 08, 2008 11:27 AM
To: Getachew Tesfaye
Cc: John Rycyna; Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 122, FSAR Ch. 16

Getachew,

The proprietary and non-proprietary versions of the response to RAI No. 122 are submitted via AREVA NP Inc. letter, "Response to U.S. EPR Design Certification Application RAI No. 122" NRC 08:097, dated December 5, 2008. An affidavit to support withholding of information from public disclosure, per 10CFR2.390(b), is provided as an enclosure to that letter.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI No. 122 Questions 16-244, 16-245, 16-246, 16-247, 16-248, 16-249, 16-250, 16-252, 16-253, 16-256, 16-257, 16-258, 16-259, 16-261, 16-262, 16-263, 16-264, 16-265, 16-266, 16-268, 16-270, 16-272, 16-273, 16-274, 16-275, 16-276, 16-277, 16-278, 16-279, 16-280, 16-281, 16-282, 16-284, 16-285, 16-286, 16-287, 16-288, 16-289, and 16-290.

The following table indicates the respective page(s) in the response document, “Response to U.S. EPR Design Certification Application RAI No. 122,” that contain AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 122—16-243	2	3
RAI 122—16-244	4	4
RAI 122—16-245	5	5
RAI 122—16-246	6	6
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RAI 122—16-287	48	48
RAI 122—16-288	49	49
RAI 122—16-289	50	51
RAI 122—16-290	52	52

A complete answer is not provided for 2 of the 45 questions. The schedule for a technically correct and complete response to each of these questions is provided below.

Question #	Response Date
RAI 122—16-243	March 19, 2009
RAI 122—16-254	March 19, 2009

Sincerely,

(Les Duncan on behalf of)

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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Wednesday, November 05, 2008 4:18 PM
To: ZZ-DL-A-USEPR-DL
Cc: Robert Prato; Michael Marshall; Peter Hearn; Joseph Colaccino; John Rycyna
Subject: U.S. EPR Design Certification Application RAI No. 122 (1332, 1334),FSAR Ch. 16

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on October 24, 2008, and discussed with your staff on November 5, 2008. Draft RAI Questions 16-251 and 16-283 were deleted and Draft RAI Questions 16-285, 16-288, 16-289, and 16-290 were modified as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
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Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 315

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Response to

Request for Additional Information No. 122, Supplement 1

11/05/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 16 - Technical Specifications
Application Section: FSAR Ch. 16

QUESTIONS for Technical Specification Branch (CTSB)

Question 16-243:

Provide additional explanation for each deviation from the reference STS definition for terms defined differently, for terms deleted, and for terms added into the proposed US EPR STS.

Provide justification regarding the changed content for the following terms:

AXIAL OFFSET (AO)
AZIMUTHAL POWER
CALIBRATION (vs STS defined CHANNEL CALIBRATION),
DIVISION OPERATIONAL TEST (vs STS defined CHANNEL OPERATIONAL TEST),
SENSOR OPERATIONAL TEST (vs STS defined CHANNEL OPERATIONAL TEST),
STAGGERED TEST BASIS (vs STS defined STAGGERED TEST BASIS),
ACTUATING DEVICE OPERATIONAL TEST (vs STS defined "TRIP ACTUATING DEVICE OPERATIONAL TEST" or new term without justification),
EXTENDED SELF TESTS (new term without justification),
ENGINEERED SAFETY FEATURE (ESF) RESPONSE TIME, and
REACTOR TRIP SYSTEM (RTS) RESPONSE TIME (STS terms deleted without justification)

The definition and use of these terms in the proposed Technical Specifications did not always appear consistent with terms defined and used in FSAR Chapter 7, as well as definitions used in IEEE Std 603-1998 and IEEE Std 338-1987 / RG 1.118, which were identified in FSAR 7.1, as part of the proposed licensing and design basis. Identify and justify any difference(s) between the definitions as used in the proposed Technical Specifications and the definitions established by IEEE Std 603-1998 and IEEE Std 338-1987 / RG 1.118.

See examples below:

Example #1 - It was not clear whether CALIBRATION would include the analog/digital (A/D) converter as well as the process analog sensor; both could be considered elements of an analog channel, but the TS typically refers to sensor output rather than channel. By contrast, FSAR 7.2.2.3.5, Compliance to Requirements on System Testing and Inoperable Surveillance Requirements (Clause 5.7 of IEEE 603-1998), describes testing of input channels.

Example #2 - It was not clear why the term "division" was almost always used in place of "channel." It appears to the staff that the proposed protection system architecture could be described as a sense-command-execute structure, whereby the channels could be defined in accordance with IEEE Std 603. The term "channel" would typically apply to the sense portion, and would be associated with a specific protective action. The term "division" would typically be used to establish boundaries for achieving physical, electrical, or functional independence from other divisions. Unless clearly described, the scope of a division can be substantially different than the scope of a single channel.

Example #3 - The scope and application of response time testing was not clear in the definitions. The proposed SENSOR OPERATIONAL TEST (SOT) definition includes, in part, the verification of the accuracy and time constants of the analog input modules. It was not clear if the SOT would include the sensor as well as the A/D converter. The methods to verify the response times associated with data processing and actuation devices was also not clear .

Example #4 - Provide a technical justification for the new EPR definition of AXIAL OFFSET (AO). This definition appears to be similar or equivalent to a previous AXIAL FLUX DIFFERENCE definition.

Example #5 - Provide a technical justification for the new EPR definition of AZIMUTHAL POWER. (Also, it appears this definition is really AZIMUTHAL POWER IMBALANCE (API)). This definition appears to be similar or equivalent to a previous QUADRANT POWER TILT RATIO definition.

This additional information is needed to ensure accuracy of terms used in GTS, STS, and PTS.

Response to Question 16-243:

AREVA recognizes the importance of maintaining a standard set of definitions for all facility Technical Specifications and has made a concerted effort to harmonize them, where possible. However, Technical Specifications are an operational document that must accurately reflect the subject plant's design.

The primary difference between the NUREG-1431 definition of AXIAL FLUX DIFFERENCE (AFD) and the U.S. EPR Generic Technical Specifications definition of AO is that the U.S. EPR definition doesn't normalize the signal-to-reactor power. The U.S. EPR design calculates AO using the incore self-powered neutron detectors (SPND); therefore, the definition of AO is unique to the U.S. EPR. The expected response to exceeding the AO limit is addressed in U.S. EPR FSAR Tier 2, Chapter 16, Technical Specifications Section 3.2.4. The definition for AO will be revised to make the text portion of the definition agree with the formula provided in the definition.

The AZIMUTHAL POWER IMBALANCE (API) definition is unique to the U.S. EPR design and is not used as an input to the accident analyses. Exceeding the API limit is indicative of a core anomaly that must be resolved. The expected response to exceeding the API limit is addressed in U.S. EPR FSAR Tier 2, Chapter 16, Technical Specifications Section 3.2.5.

The digitally-based U.S. EPR protection system (PS) design uses a fundamentally different approach from the analog reactor trip and Engineered Safety Features (ESF) systems used in existing facilities. It is important to acknowledge and reflect these fundamental differences accurately in the definitions section to preclude both operational and compliance issues. It is also important to note that while the design approach is fundamentally different, it still complies with the requirements of IEEE Std 603-1998 and IEEE Std 338-1987. When reviewing the proposed changes to these definitions, also note that additional information regarding the associated surveillance testing is provided in the response to RAI 103, Question 16-193, which describes the overall approach and provides a figure summarizing the surveillance testing of the U.S. EPR PS.

In general, the primary difference between the definitions in NUREG-1431 and the U.S. EPR Technical Specifications is the use of the term "channel" in NUREG-1431 versus the use of the term "division" in the U.S. EPR Generic Technical Specifications *(NOTE: This addresses Example #2 in the Question).* Both IEEE Standard 338-1997 and IEEE Standard 603-1998 define the term "channel" as:

> "An arrangement of components and modules as required to generate a single protective action signal when required by a generating station condition. A channel loses its identity where single protective action signals are combined."

The design of the U.S. EPR PS combines signals between all four divisions and the term "channel" is not appropriate to describe how the system functions. For example, as discussed in U.S. EPR FSAR, Tier 2, Section 7.2, "Reactor Trip System," the SPND are used by the PS as inputs to calculate variables that cannot be directly measured, such as linear power density and departure from nucleate boiling ratio (DNBR). Redundant remote acquisition units (RAU) in each division are dedicated to the acquisition and distribution of the SPND measurements. The RAUs in each division acquire one-fourth of the total SPND measurements and distribute those measurements to acquisition and processing units (APU) in all four divisions, allowing for an accurate calculation over the whole reactor core in each division. This process is shown on U.S. EPR FSAR Tier 2, Figure 7.2-2, "Typical SPND-based RT Actuation".

Additionally, as also discussed in U.S. EPR FSAR Tier 2, Section 7.2, an APU in each division of the PS acquires one-fourth of the redundant sensor measurements that are inputs to a given reactor trip function. The APUs in each division perform any required processing or calculations using the input measurements, and compares the resulting variable to a relevant setpoint. If a setpoint is breached, a partial trigger signal is generated. The partial trigger signals generated in each division are sent to redundant actuation logic units (ALU) in all four divisions where two-out-of-four logic is performed. If partial triggers are present from two divisions, the ALU in all four divisions generate reactor trip signals. The reactor trip signals of the redundant ALU in each subsystem are combined in a hardwired “functional AND gate” logic. If a reactor trip signal is present from both redundant ALU, a reactor trip output is generated. The reactor outputs from both subsystems in a division are combined in a hardwired “functional OR gate” logic. If either subsystem produces a reactor trip output, a divisional reactor trip order is propagated to the reactor trip breakers, reactor trip contactors, and transistors of the control rod drive mechanism (CRDM) operating coils.

IEEE Standard 603-1998 defines the term "division" as:

> "The designation applied to a given system or set of components that enables the establishment and maintenance of physical, electrical, and functional independence from other redundant sets of components.
>
> NOTE - A division can have one or more channels."

In summary, since protective action signals are shared between all four divisions throughout the design of the PS, the use of the term "channel" is not technically correct. The use of the term "division" more accurately describes how the system architecture is designed and functions.

The primary use of the definitions discussed in this response is within U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications, Section 3.3.1, "Protection System". While the term "channel" may not be incorrect when applied to different systems addressed in other Technical Specifications sections, the use of the term "division" is also acceptable. Rather than have one set of definitions for the PS and another for the rest of the Generic Technical Specifications, the definitions were revised, as appropriate, to be accurate and apply throughout.

With regards to the other specific differences between the definitions in the Standard Technical Specifications for Westinghouse Plants (NUREG-1431) and the U.S. EPR Generic Technical Specifications, a comparison is provided in Table 16-243-1. Emphasis (bold and italicized) has been added to highlight the differences. Note that the cited definitions for the U.S. EPR Generic Technical Specifications reflect changes that will be made as part of the response to this question.

Table 16-243-1—Channel Calibration versus Calibration

DEFINITION IN STANDARD TECHNICAL SPECIFICATIONS FOR WESTINGHOUSE PLANTS	DEFINITION IN U.S. EPR GENERIC TECHNICAL SPECIFICATIONS
CHANNEL CALIBRATION	CALIBRATION
A ***CHANNEL*** CALIBRATION shall be the adjustment, as necessary, of the ***channel*** output such that it responds within the necessary range and accuracy to known values of the parameter that the ***channel*** monitors. The ***CHANNEL*** CALIBRATION shall encompass all devices in the ***channel*** required for ***channel*** OPERABILITY. Calibration of instrument ***channels*** with resistance temperature detector (RTD) or thermocouple sensors may consist of an inplace qualitative assessment of sensor behavior and normal ***calibration*** of the remaining adjustable devices in the ***channel***. The ***CHANNEL*** CALIBRATION may be performed by means of any series of sequential, overlapping, or total ***channel*** steps.	A CALIBRATION shall be the adjustment, as necessary, of the ***sensor*** output such that it responds within the necessary range and accuracy to known values of the parameter that the ***division*** monitors. The CALIBRATION shall encompass all devices in the ***division*** required for ***sensor*** OPERABILITY. CALIBRATION of instrument ***divisions*** with resistance temperature detector (RTD) or thermocouple sensors may consist of an inplace qualitative assessment of sensor behavior and normal ***CALIBRATION*** of the remaining adjustable devices in the ***division***. The CALIBRATION may be performed by means of any series of sequential, overlapping, or total steps.

As shown in comparison Table 16-243-1, the differences in the definitions are:

- Use of the term "CHANNEL CALIBRATION" versus "CALIBRATION,"
- Use of the term "channel output" versus "sensor output,"
- Use of the term "channel" versus "division," which was previously discussed, and
- Use of the term "channel OPERABILITY" versus "sensor OPERABILITY".

CHANNEL CALIBRATION VERSUS CALIBRATION

With regards to the use of the term "channel calibration," the general design and use of SPNDs in the PS is described previously. The SPND calibration can be performed by the adjustment of the amplifier module installed in the PS. Adjustments can be made by setting software parameters in the PS APUs for each of the SPNDs in the core. Since calibration of the SPNDs involves each of the four divisions for each SPND, the use of the term "channel" for the required calibration is not appropriate.

With regards to other systems besides the PS, deletion of the term "channel" is acceptable and does not alter the required calibration.

CHANNEL OUTPUT VERSUS SENSOR OUTPUT

Normally, as previously described, the term "channel" was replaced with the term "division". In this instance, the term "channel output" was replaced with the term "sensor output" to more clearly describe the scope of equipment used in the calibration activity. The term "division output" might be interpreted to include equipment downstream of the APUs, which is not included in the scope of the calibration activity.

CHANNEL OPERABILITY VERSUS SENSOR OPERABILITY

With regards to the use of the term "channel OPERABILITY" versus "sensor OPERABILITY," Topical Report EMF-2110(NP), Revision 1, "TELEPERM XS: A Digital Reactor Protection System," was submitted by Siemens Power Corporation (SPC) on September 1, 1999. Revision 0 of the topical report was submitted on September 23, 1998, and Revision 1 incorporated the resolution of all comments received from the NRC on the review of Revision 0. Included in the supplemental information was Siemens letter NRC:99:056, dated December 28, 1999, which submitted report EMF-2341 (P), "Generic Strategy for Periodic Surveillance Testing of TELEPERM XS Systems in U.S. Nuclear Generating Stations," for staff review. As discussed in Section 5 and shown in Figure 1.1 of that report, calibration can involve the protection system sensor, transmitter, signal conditioning, input module, and input buffer / driver *(NOTE: This addresses Example #1 in the Question).* Since it would be impractical and unnecessary to have each individual subcomponent specified in the PS Technical Specifications, the U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications Section 3.3.1 is arranged into a set of four functional components (See U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications Bases Page B 3.3.1-4):

1. Sensors (which include the associated signal conditioning),
2. Manual Actuation Switches,
3. Signal Processors, and
4. Actuation Devices.

If a calibration fails, the impact to the PS is governed in the Technical Specifications by declaring the "sensor" inoperable and taking the required actions specified in U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications, Table 3.3.1-1.

As discussed in the Standard Technical Specifications for Westinghouse Plants (NUREG-1431) for Surveillance Requirement 3.3.1.10:

> "CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to a measured parameter within the necessary range and accuracy."

The corresponding discussion is provided in U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications Bases for Surveillance Requirement 3.3.1.6, and shown in Table 16-243-2, which states:

> "A CALIBRATION shall be the adjustment, as necessary, of the sensor output such that it responds within the necessary range and accuracy to known values of the parameter that the sensor monitors. The CALIBRATION shall encompass all devices in the division required for sensor OPERABILITY."

As discussed above, in the digital systems utilized in the U.S. EPR a calibration may include the sensor, transmitter, signal conditioning, input module, and input buffer/driver. Declaring the "sensor" inoperable in these other systems would result in the associated divisional input being declared inoperable and the appropriate actions being taken.

Table 16-243-2—Channel Operational Test (COT) versus Sensor Operational Test (SOT)

DEFINITION IN STANDARD TECHNICAL SPECIFICATIONS FOR WESTINGHOUSE PLANTS	DEFINITION IN U.S. EPR GENERIC TECHNICAL SPECIFICATIONS
CHANNEL OPERATIONAL TEST (COT) A ***COT*** shall be the injection of a simulated or actual signal into the ***channel*** as close to the sensor as practicable to verify OPERABILITY of all devices in the ***channel*** required for ***channel*** OPERABILITY. ***The COT shall include adjustments, as necessary, of the required alarm, interlock, and trip setpoints required for channel OPERABILITY such that the setpoints are within the necessary range and accuracy.*** The COT may be performed by means of any series of sequential, overlapping, or total channel steps.	***SENSOR*** OPERATIONAL TEST (SOT) A ***SOT*** shall be the injection of a simulated or actual signal into the ***division*** as close to the sensor as practicable to verify OPERABILITY of all devices in the ***division*** required for ***sensor*** OPERABILITY. ***The SOT shall include the verification of the accuracy and time constants of the analog input modules.*** The SOT may be performed by means of any series of sequential, overlapping, or total steps.

As shown in comparison Table 16-243-2, the differences in the definitions are:

- Use of the term "channel" versus "division," which was previously shown in Table 16-243-1,
- Use of the term "channel OPERABILITY" versus "sensor OPERABILITY," which was also previously discussed,

- The deletion of the sentence: "The COT shall include adjustments, as necessary, of the required alarm, interlock, and trip setpoints required for channel OPERABILITY such that the setpoints are within the necessary range and accuracy," and
- The addition of the sentence: "The SOT shall include the verification of the accuracy and time constants of the analog input modules".

DELETION OF SENTENCE

Regarding the deletion of the sentence that states the channel operational test (COT) shall include adjustments, as necessary, of the required alarm, interlock, and trip setpoints required for channel OPERABILITY such that the setpoints are within the necessary range and accuracy. Setpoints are software-specified values in the digitally based U.S. EPR PS. Actions necessary to provide assurance of the accuracy of the sensor input are performed as part of the CALIBRATION. In the U.S. EPR Technical Specifications, a separate Surveillance Requirement (SR 3.3.1.9) is used to verify that the setpoints are properly loaded into the APUs.

ADDITION OF SENTENCE

Regarding the addition of the sensor operational test (SOT) sentence: "The SOT shall include the verification of the accuracy and time constants of the analog input modules," the specific details regarding the SOT are discussed in Section 5.2 of EMF-2341(P) *(NOTE: This addresses Example #3 in the Question).* This was discussed in Subsection 4.2 of the NRC Safety Evaluation for EMF-2341(P):

By letter NRC:99:056, dated December 28, 1999, Siemens submitted report EMF-2341 (P), "Generic Strategy for Periodic Surveillance Testing of TELEPERM XS Systems in U.S. Nuclear Generating Stations," for staff review. By letter NRC:00:017 dated March 3, 2000, Siemens provided additional clarification on recommended periodic surveillance test requirements for TXS applications. The report describes measures to be implemented in safety instrumentation and controls (I&C) systems configured with a TXS architecture. The measures include:

- Periodic verification (during refueling outages) of accuracy and time constants of the analog input modules.

This sentence was added to capture the surveillance testing requirement contained in the NRC Safety Evaluation Report for EMF-2341(P).

STAGGERED TEST BASIS

Table 16-243-3—Staggered Test Basis Comparison

DEFINITION IN STANDARD TECHNICAL SPECIFICATIONS FOR WESTINGHOUSE PLANTS	DEFINITION IN U.S. EPR GENERIC TECHNICAL SPECIFICATIONS
STAGGERED TEST BASIS A STAGGERED TEST BASIS shall consist of the testing of one of the systems, subsystems, ***channels***, or other designated components during the interval specified by the Surveillance Frequency, so that all systems, subsystems, ***channels***, or other designated components are tested during *n* Surveillance Frequency intervals, where *n* is the total number of systems, subsystems, ***channels,*** or other designated components in the associated function.	STAGGERED TEST BASIS A STAGGERED TEST BASIS shall consist of the testing of one of the systems, subsystems, ***divisions***, or other designated components during the interval specified by the Surveillance Frequency, so that all systems, subsystems, ***divisions***, or other designated components are tested during *n* Surveillance Frequency intervals, where *n* is the total number of systems, subsystems, ***divisions***, or other designated components in the associated function.

The U.S. EPR definition of a STAGGERED TEST BASIS will be revised such that the only difference is the use of the term "divisions" instead of the NUREG-1431 use of the term "channels". The issue of the use of the term "channel" versus "division" was previously discussed.

TRIP ACTUATING DEVICE VERSUS ACTUATING DEVICE

With regards to the deletion of the word "trip" from the phrase "trip actuation device," the U.S. EPR Tier 2, Chapter 16 Technical Specifications included a requirement to periodically verify the operability of the reactor coolant pump bus and trip breakers. These breakers are associated with the ESF function Reactor Coolant Pump Trip on Low Delta P across Reactor Coolant Pump with Safety Injection Signal. Since the associated surveillance is utilized in more that reactor trip device testing, it is appropriate to delete the word "trip". For a comparison of TADOT with ADOT, refer to Table 16-243-4.

DELETION OF SENTENCE

With regards to the deletion of the sentence: "The TADOT shall include adjustment, as necessary, of the trip actuating device so that it actuates at the required setpoint within the necessary accuracy," the digitally-based PS does not require adjustments of the trip actuating device so that it actuates at the required setpoint within the necessary accuracy. Necessary calibrations are performed only on the sensors (which include the associated signal conditioning). Since the sentence does not reflect any physical activity performed during surveillance testing of the PS it was deleted.

Table 16-243-4—Trip Actuating Device Operational Test (TADOT) versus Actuating Device Operational Test (ADOT)"

DEFINITION IN STANDARD TECHNICAL SPECIFICATIONS FOR WESTINGHOUSE PLANTS	DEFINITION IN U.S. EPR GENERIC TECHNICAL SPECIFICATIONS
TRIP ACTUATING DEVICE OPERATIONAL TEST ***(TADOT)*** A ***TADOT*** shall consist of operating the ***trip*** actuating device and verifying the OPERABILITY of all devices in the ***channel*** required for ***trip*** actuating device OPERABILITY. ***The TADOT shall include adjustment, as necessary, of the trip actuating device so that it actuates at the required setpoint within the necessary accuracy.*** The ***TADOT*** may be performed by means of any series of sequential, overlapping, or total ***channel*** steps.	ACTUATING DEVICE OPERATIONAL TEST ***(ADOT)*** An ***ADOT*** shall consist of operating the actuating device and verifying the OPERABILITY of all devices in the ***division*** required for actuating device OPERABILITY. The ***ADOT*** may be performed by means of any series of sequential, overlapping, or total ***division*** steps.

As shown in comparison Table 16-243-4, the differences in the definitions are:

- "Trip actuating device" versus "actuating device,"
- "Channel" versus "division," which has been discussed previously, and
- Deletion of the sentence: "The TADOT shall include adjustment, as necessary, of the trip actuating device so that it actuates at the required setpoint within the necessary accuracy."

ENGINEEREED SAFETY FEATURE (ESF) RESPONSE TIME AND REACTOR TRIP SYSTEM (RTS) RESPONSE TIME

In existing facilities, separate systems are used to perform the reactor trip and engineered safety features (ESF) functions. The U.S. EPR protection system (PS) performs both the reactor trip and ESF functions. The definitions were combined since there is only one system which shares sensors and signal processors and it is not possible to differentiate the surveillances into reactor trip portions and ESF portions. Thus, the terms "RTS" and "ESF" were replaced with "PS". The term "trip setpoint" was replaced with the term "actuation setpoint," which more accurately describes both the reactor trip and ESF function.

The remaining difference is only in the use of the term "channel" versus "division," which has been discussed previously. Refer to Tables 16-243-5 and 16-243-6 for a comparison of terms.

Table 16-243-5—Engineered Safety Feature (ESF) Response Time versus Protection System (PS) Response Time

DEFINITION IN STANDARD TECHNICAL SPECIFICATIONS FOR WESTINGHOUSE PLANTS	DEFINITION IN U.S. EPR GENERIC TECHNICAL SPECIFICATIONS
ENGINEERED SAFETY FEATURE (ESF) RESPONSE TIME The ***ESF*** RESPONSE TIME shall be that time interval from when the monitored parameter exceeds ***its*** actuation setpoint at the ***channel*** sensor until the ***ESF*** equipment is capable of performing its safety function ***(i.e., the valves travel to their required positions, pump discharge pressures reach their required values, etc.).*** Times shall include diesel generator starting and sequence loading delays, where applicable. The response time may be measured by means of any series of sequential, overlapping, or total steps so that the entire response time is measured. In lieu of measurement, response time may be verified for selected components provided that the components and methodology for verification have been previously reviewed and approved by the NRC.	PROTECTION SYSTEM (PS) RESPONSE TIME The ***PS*** RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its ***PS*** actuation setpoint at the ***division*** sensor until the ***PS*** equipment is capable of performing its safety function ***(i.e., loss of stationary gripper coil voltage, the valves travel to their required positions, pump discharge pressures reach their required values, etc.).*** Times shall include diesel generator starting and sequence loading delays, where applicable. The response time may be measured by means of any series of sequential, overlapping, or total steps so that the entire response time is measured. In lieu of measurement, response time may be verified for selected components provided that the components and methodology for verification have been previously reviewed and approved by the NRC.

Table 16-243-6—Reactor Trip System (RTS) Response Time versus Protection System (PS) Response Time

DEFINITION IN STANDARD TECHNICAL SPECIFICATIONS FOR WESTINGHOUSE PLANTS	DEFINITION IN U.S. EPR GENERIC TECHNICAL SPECIFICATIONS
REACTOR TRIP SYSTEM (RTS) RESPONSE TIME The ***RTS*** RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its ***RTS trip*** setpoint at the ***channel*** sensor until ***loss of stationary gripper coil voltage***. The response time may be measured by means of any series of sequential, overlapping, or total steps so that the entire response time is measured. In lieu of measurement, response time may be verified for selected components provided that the components and methodology for verification have been previously reviewed and approved by the NRC.	PROTECTION SYSTEM (PS) RESPONSE TIME The ***PS*** RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its ***PS actuation*** setpoint at the ***division*** sensor until ***the PS equipment is capable of performing its safety function (i.e., loss of stationary gripper coil voltage, the valves travel to their required positions, pump discharge pressures reach their required values, etc.). Times shall include diesel generator starting and sequence loading delays, where applicable.*** The response time may be measured by means of any series of sequential, overlapping, or total steps so that the entire response time is measured. In lieu of measurement, response time may be verified for selected components provided that the components and methodology for verification have been previously reviewed and approved by the NRC.

ACTUATION LOGIC TEST

An "ACTUATION LOGIC TEST" is defined in the Standard Technical Specifications for Westinghouse Plants (NUREG-1431) as:

> "An ACTUATION LOGIC TEST shall be the application of various simulated or actual input combinations in conjunction with each possible interlock logic state required for OPERABILITY of a logic circuit and the verification of the required logic output. The ACTUATION LOGIC TEST, as a minimum, shall include a continuity check of output devices."

Table 16-243-7—Actuation Logic Test Comparison

DEFINITION IN STANDARD TECHNICAL SPECIFICATIONS FOR WESTINGHOUSE PLANTS	DEFINITION IN U.S. EPR GENERIC TECHNICAL SPECIFICATIONS
ACTUATION LOGIC TEST An ACTUATION LOGIC TEST shall be the application of various simulated or actual input combinations in conjunction with each possible interlock logic state required for OPERABILITY of a logic circuit and the verification of the required logic output. The ACTUATION LOGIC TEST, as a minimum, shall include a continuity check of output devices.	No corresponding definition in the U.S. EPR Generic Technical Specifications.

Justification for deletion of ACTUATION LOGIC TEST

As described in U.S. EPR FSAR Tier 2, Section 7.2.1.2.1, "Reactor Trip on Low Departure from Nucleate Boiling Ratio," the DNBR calculation performed by the protection system (PS) is based on:

- Power density distribution of the hot channel: This parameter is directly derived from the SPND measurements.
- Inlet temperature: This parameter is derived from the cold leg temperature sensors.
- Pressure: This parameter is given by the pressurizer pressure sensors.
- Core Flow Rate: This parameter is derived from the reactor coolant pump (RCP) speed sensors.

The outputs of the DNBR calculation consist of twelve DNBR values (one per SPND finger), and twelve outlet quality values (one per SPND finger). The output values are used in various combinations to generate a reactor trip:

- Second lowest DNBR value compared to a variable low setpoint.
- Lowest DNBR value compared to a variable low setpoint that is only valid when either a rod drop (1/4) signal or SPND imbalance signal is present.
- Lowest DNBR value compared to a variable low setpoint that is only valid when a rod drop (2/4) signal is present.
- Second highest quality value compared to a fixed high setpoint.

- Highest quality value compared to a fixed high setpoint that is only valid when either a rod drop (1/4) signal or SPND imbalance signal is present.

The values of the variable low DNBR setpoints depend on the number of invalidated SPND fingers. Each SPND input signal is monitored by the Protection System, using both inherent and engineered monitoring mechanisms, to determine the validity of the signal. If an SPND input signal is determined to be invalid, it is automatically assigned a faulty status. Since the DNBR calculation produces its outputs on a per-finger basis (six SPND per finger), if one SPND carries a faulty status, then the entire finger is considered invalid. One of six pre-determined setpoint values is automatically selected for use based on the number of invalidated fingers. This is done for each of the three variable setpoints used in the DNBR function.

There are 89 Rod Control Cluster Assemblies (RCCA) located within the U.S. EPR reactor vessel. The rod drop (1/4) and rod drop (2/4) signals are based on the rate of change of the rod position measurements acquired by the Protection System. If a dropped rod is detected in one quadrant of the core, the rod drop (1/4) signal is generated, and the corresponding setpoints are activated. If a dropped rod is detected in two or more quadrants of the core, the rod drop (2/4) signal is generated and the corresponding DNBR setpoint is activated.

The SPND imbalance signal is generated based on an indication of asymmetrical power distribution in the core. All 72 SPND measurements are used in each Protection System division to detect this condition.

In summary, the Low DNBR trip function is based on inputs from:

a) 72 SPNDs, which are shared with all four PS divisions and either provided a measure flux value or a faulted signal that results in an adjusted setpoint,

b) 89 RCCA position indicators, that provide a rate of change value that can result in a rod drop signal in one quadrant or two or more quadrants,

c) 4 Cold Leg temperature sensors,

d) 4 Pressurizer pressure sensors, and

e) 4 Reactor coolant pump speed sensors.

It is not practical to perform a surveillance test for "each possible" combination of sensor inputs and function responses that could result in a low DNBR reactor trip. The surveillance would meet Criterion 1 of NUREG-1366, "Improvements to Technical Specifications Surveillance Requirements," which states:

> "The surveillance places an unnecessary burden on plant personnel because the time required is not justified by the safety significance of the surveillance".

A surveillance test for "each possible" combination of sensor inputs and function responses that could result in a reactor trip or Engineered Safety Features (ESF) actuation is not necessary. The purpose of this surveillance test would be to detect long-term physical degradation that could result in a function being inoperable, especially while equipment is in a standby mode. In the U.S. EPR PS, reactor trip and ESF actuation decisions are performed by software that does not physically degrade. The adequacy of the Protection System software is based on the software development methodology, verification and validation (V&V) of the software, type testing, the ability of the Protection System to continuously verify that the software has not been corrupted, and the Extended Self Tests that also verifies the software integrity. Therefore, it is not required to perform an ACTUATION LOGIC TEST for the U.S. EPR protection system.

DIVISION OPERATIONAL TEST

The term "DIVISION OPERATIONAL TEST" was not referenced in any U.S. EPR Technical Specification Surveillance Requirement. Therefore, it will be deleted from the Definitions section.

EXTENDED SELF TESTS

The extended self test of the PS (U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications Surveillance Requirement 3.3.1.7) is a startup self-test of the TELEPERM XS system. It includes a basic hardware test and a cyclic redundancy check to verify the software has not been degraded. A comparison chart is provided in Table 16-243-8. Details are provided in Section 3.0 of Reference 1. The extended self test has been reviewed and accepted by the NRC as described in Reference 2.

Table 16-243-8—Extended Self Test Comparison

DEFINITION IN STANDARD TECHNICAL SPECIFICATIONS FOR WESTINGHOUSE PLANTS	DEFINITION IN U.S. EPR GENERIC TECHNICAL SPECIFICATIONS
No corresponding definition in the Standard Technical Specifications for Westinghouse Plants.	***EXTENDED SELF TESTS*** ***Testing of the Protection System signal processors that cannot be performed during power operation are performed during the start-up of a computer. These tests can also be initiated by pushing a reset button on the computer. These tests include a basic hardware test using the internal diagnostics monitor, a self-test of the operating system, and basic hardware tests.***

CONCLUSION

The proposed differences in definitions between NUREG-1431 and the U.S. EPR Technical Specifications are both necessary and sufficient to reflect the U.S. EPR digital protection system design, the components involved in the associated surveillance test, and establish the required controls on operability.

Question 16-243 References:

1. EMF-2341(P), Revision 1, “Generic Strategy for Periodic Surveillance Testing of TELEPERM XS Systems in U.S. Nuclear Generating Stations,” March 2000.

2. Letter dated Mar 5, 2000, from Stuart A. Richards, NRC, to Jim Mallay, Siemens Power Corporation, "Acceptance for Referencing of Licensing Topical Report EMF-2110(NP), Revision 1, "TELEPERM XS: A Digital Reactor Protection System" (TAC No. MA1983)".

FSAR Impact:

U.S. EPR FSAR Tier 2, Chapter 16, Technical Specifications Section 1.1 "Definitions" will be revised as described in the response and indicated on the enclosed markup.

Question 16-254:

Provide additional information for the following statement included in the EPR GTS, Section 5.5.10, Ventilation Filter Testing Program:

The design versus operational flowrate of AVS and SBVS appear inconsistent with the flowrate used in the EPR GTS. Also, the test tolerance appears to exceed the +10% tolerance. For each group of filter systems tested, identify the FSAR Table which lists the nominal flowrate upon which this test should be based. The tolerances listed for the heater capacities in the EPR GTS, Section 5.5.10.e appear to exceed the +/- 10%.

In the EPR GTS, Section 5.5.10.e lists two filter banks for CREF, outside air and emergency filter banks, but does not identify the two filter banks in EPR GTS, Section 5.5.10.a thru d. The names used in the EPR GTS, Section 5.5.10.e do not match the names provided in the EPR GTS, Section 3.7.10 which are identified as iodine filtration train and fresh air intake train. Provide a technical justification for these differences and incorporate changes to make them consistent.

This additional information is needed to ensure the accuracy and completeness of the EPR GTS.

Response to Question 16-254:

The nominal flow rates for each ventilation system listed in U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications, Section 5.5.10, the -10 percent and +10 percent flow value and the FSAR cross-reference is provided in the following tabulation:

	TS 5.5.10 – Flow Rates			**FSAR**	
	Nominal	-10%	+10%	Reference	Value
AVS	1177	1060	1295	Table 6.2.3-1	1177
SBCAVS	2400	2160	2640	Sec 6.5.1.3	2400
CREF	4000	3600	4400	Sec 6.5.1.3	4000
CLFPS	3000	2700	3300	Sec 6.5.1.3	3000

As this tabulation demonstrates, the flow values currently in U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications, Section 5.5.10 are correct.

The following provides a tabulation of ventilation system nominal heater values, -10 percent, +10 percent, and U.S.EPR FSAR cross-references:

	TS 5.5.10 – Heater Capacities			**FSAR**	
	Nominal	-10%	+10%	Reference	Value
AVS	6	5.4	6.6	Table 6.2.3-1	6
SBCAVS	11	9.9	12.1	Sec 6.5.1.2.2	11
CREF	15	13.5	16.5	Sec 6.5.1.2.2	15
CLFPS	14	12.6	15.4	Sec 6.5.1.2.2	14

U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications Section 5.5.10 will be revised to reflect the correct ± 10 percent heater values. A change will also be made to delete the outside air heater. This heater is only used for conditioning the entering air. This will remove the inconsistency with U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications Section 3.7.10. Also, U.S. EPR FSAR Tier 2, Section 6.5.1.2.2, will be revised to add additional ventilation system parameters.

FSAR Impact:

U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications Sections 5.5.10 and 3.7.10 and U.S. EPR FSAR Tier 2 Section 6.5.1.2.2 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

1.0 USE AND APPLICATION

1.1 Definitions

---NOTE---
The defined terms of this section appear in capitalized type and are applicable throughout these Technical Specifications and Bases.

Term	Definition
ACTIONS	ACTIONS shall be that part of a Specification that prescribes Required Actions to be taken under designated Conditions within specified Completion Times.
ACTUATING DEVICE OPERATIONAL TEST (ADOT)	An ADOT shall consist of operating the ~~trip~~ actuating device and verifying the OPERABILITY of all devices in the division required for ~~trip~~ actuating device OPERABILITY. The ADOT may be performed by means of any series of sequential, overlapping, or total division steps.
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AXIAL OFFSET (AO)	AO (%) shall be the power generated in the ~~lower~~ upper half of the core less the power generated in the ~~upper~~ lower half of the core, divided by the sum of the power generated in the lower and upper halves of the core. $$AO = ((Upper - Lower)\ /\ (Lower + Upper)) * 100$$
AZIMUTHAL POWER IMBALANCE (API)	AZIMUTHAL POWER IMBALANCE shall be the maximum of the difference between the maximum power generated in any core quadrant (QN_{max}) and the minimum power generated in any core quadrant (QN_{min}), as measured by the power range excore detectors. $$API = QN_{\max} - QN_{\min}$$
CALIBRATION 16-243	A CALIBRATION shall be the adjustment, as necessary, of the sensor output such that it responds within the necessary range and accuracy to known values of the parameter that the ~~sensor~~division monitors. The CALIBRATION shall encompass all devices in the division required for sensor OPERABILITY. CALIBRATION of instrument divisions with resistance temperature detector (RTD) or thermocouple sensors may consist of an inplace qualitative assessment of sensor behavior and normal CALIBRATION of the remaining adjustable devices in the division. The CALIBRATION may be performed by means of any series of sequential, overlapping, or total steps.

1.1 Definitions

PHYSICS TESTS	PHYSICS TESTS shall be those tests performed to measure the fundamental nuclear characteristics of the reactor core and related instrumentation. These tests are: a. Described in FSAR Chapter 14, "Verification Programs"; b. Authorized under the provisions of 10 CFR 50.59; or c. Otherwise approved by the Nuclear Regulatory Commission.
PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)	The PTLR is the unit specific document that provides the reactor vessel pressure and temperature limits, including heatup and cooldown rates and the low temperature overpressure protection setpoints, for the current reactor vessel fluence period. These pressure and temperature limits shall be determined for each fluence period in accordance with Specification 5.6.4, "Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)."
PROTECTION SYSTEM (PS) RESPONSE TIME	The PS RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its PS actuation setpoint at the division sensor until the PS equipment is capable of performing its safety function (i.e., loss of stationary gripper coil voltage, the valves travel to their required positions, pump discharge pressures reach their required values, etc.). Times shall include diesel generator starting and sequence loading delays, where applicable. The response time may be measured by means of any series of sequential, overlapping, or total steps so that the entire response time is measured. In lieu of measurement, response time may be verified for selected components provided that the components and methodology for verification have been previously reviewed and approved by the NRC.
RATED THERMAL POWER (RTP)	RTP shall be a total reactor core heat transfer rate to the reactor coolant of 4590 MWt.
SENSOR OPERATIONAL TEST (SOT)	A SOT shall be the injection of a simulated or actual signal into the division as close to the sensor as practicable to verify OPERABILITY of all devices in the ~~input circuit~~division required for sensor OPERABILITY. The SOT shall include the verification of the accuracy and time constants of the analog input modules. The SOT may be performed by

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1.1 Definitions

means of any series of sequential, overlapping, or total steps.

SHUTDOWN MARGIN (SDM) — SDM shall be the instantaneous amount of reactivity by which the reactor is subcritical or would be subcritical from its present condition assuming:

a. All rod cluster control assemblies (RCCAs) are fully inserted except for the single RCCA of highest reactivity worth, which is assumed to be fully withdrawn. However, with all RCCAs verified fully inserted by two independent means, it is not necessary to account for a stuck RCCA in the SDM calculation. With any RCCA not capable of being fully inserted, the reactivity worth of the RCCA must be accounted for in the determination of SDM; and

b. In MODES 1 and 2, the fuel and moderator temperatures are changed to the nominal zero power design level.

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STAGGERED TEST BASIS — A STAGGERED TEST BASIS shall consist of the testing of one of the systems, subsystems, ~~trains,~~ divisions, or other designated components during the interval specified by the Surveillance Frequency, so that all systems, subsystems, ~~trains,~~ divisions, or other designated components are tested during *n* Surveillance Frequency intervals, where *n* is the total number of systems, subsystems, divisions, or other designated components in the associated function.

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THERMAL POWER — THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.

3.7 PLANT SYSTEMS

3.7.10 Control Room Emergency Filtration (CREF)

LCO 3.7.10 Two CREF trains shall be OPERABLE.

---NOTE---
The control room envelope (CRE) may be opened intermittently under administrative control.

APPLICABILITY: MODES 1, 2, 3, 4, 5, and 6,
During movement of irradiated fuel assemblies.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One CREF train inoperable for reasons other than Condition B.	A.1 Restore CREF train to OPERABLE status.	7 days
B. ~~Two~~ One or more CREF trains inoperable due to inoperable CRE boundary in MODE 1, 2, 3, or 4	B.1 Initiate action to implement mitigating actions.	Immediately
	AND	
	B.2 Verify mitigating actions ensure CRE occupant exposures to radiological, ~~[[~~chemical,~~]]~~ and smoke hazards will not exceed limits.	24 hours
	AND	
	B.3 Restore CRE boundary to OPERABLE status.	~~90~~ 60 days

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5.5 Programs and Manuals

5.5.10 Ventilation Filter Testing Program (VFTP) (continued)

ESF Ventilation System	Penetration	RH	Face Velocity (fpm)
AVS	0.5%	≤ 70%	300
SBCAVS	0.5%	≤ 70%	375
CREF	0.5%	≤ 70%	250
CLFPS	0.5%	≤ 70%	375

d. Demonstrate for each of the ESF systems that the pressure drop across the combined HEPA filters, the prefilters, and the charcoal adsorbers is less than the value specified below when tested in accordance with Regulatory Guide 1.52, Revision 3, and ASME N510-1989 at the system flowrate specified below.

ESF Ventilation System	Delta P (in wg)	Flowrate (cfm)
AVS	7.5	≥ 1060 and ≤ 1295
SBCAVS	7.5	≥ 2160 and ≤ 2640
CREF	7.5	≥ 3600 and ≤ 4400
CLFPS	7.5	≥ 2700 and ≤ 3300

e. Demonstrate that the heaters for each of the ESF systems dissipate the value specified below when tested in accordance with ASME N510-1989.

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ESF Ventilation System	Wattage (kw)
AVS	≥ ~~4~~ 5.4 and ≤ ~~8~~6.6
SBCAVS	≥ ~~9~~9.9 and ≤ ~~13~~12.1
CREF	≥ 13.5 and ≤ 16.5
~~Outside Air~~	~~≥ 30 and ≤ 38~~
~~Emergency Filter Bank~~	~~≥ 13 and ≤ 17~~
CLFPS	≥ 12.6 and ≤ ~~16~~15.4

The provisions of SR 3.0.2 and SR 3.0.3 are applicable to the VFTP Test Frequencies.

uncontrolled release of radioactivity to the environment. The design description and performance criteria of the RSB are presented in Section 3.8.4.

The annulus ventilation system collects and filters airborne radioactive material that may leak from the primary containment by maintaining a subatmospheric pressure in the annulus.

6.2.3.2.2 Annulus Ventilation System

The AVS is designed to contain leakage from the primary containment by maintaining a subatmospheric pressure in the annulus. The AVS consists of three trains: one train is used during normal plant operation; two trains are used to mitigate potential accidents. AVS design and performance parameters are presented in Table 6.2.3-1.

Refer to Section 3.2 for the seismic and system quality group classification of the AVS.

6.2.3.2.2.1 AVS Normal Operation Train

The normal operation filtration train is shown in Figure 6.2.3-1. The full capacity normal operation filtration train is designed to maintain a subatmospheric pressure in the annulus, to maintain the annulus temperature above 45°F to prevent boron precipitation in the extra borating system piping, and to provide conditioned air in the annulus for personnel accessibility.

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During normal operation, the conditioned air is drawn from the Nuclear Auxiliary Building ventilation supply shaft (See Section 9.4.3) through a fire damper, a motor-operated control damper, and two motor-operated isolation dampers. The supply air is distributed in the bottom of the annulus to four different locations. A subatmospheric pressure of less than or equal to ~~-0.03 psig~~ -0.8 inches water gauge is maintained in the annulus during normal operation by regulating the control damper with two redundant pressure sensors located in the annulus.

The exhaust air is drawn from the top of annulus by the Nuclear Auxiliary Building ventilation system exhaust fans through two motor-operated isolation dampers and a fire damper. The exhaust air is filtered by the Nuclear Auxiliary Building filtration trains and discharged through the vent stack.

The normal operation filtration train is in service during normal plant operation and plant shutdown conditions. The two accident trains are available as backup if the normal operation train is not able to maintain the subatmospheric pressure in the annulus.

The motor-operated air-tight dampers—located on the normal operation filtration train supply and exhaust ducts—isolate the secondary containment in case of a postulated accident. The redundant dampers in the supply and exhaust trains are powered by different electrical divisions backed by separate emergency diesel generators. The dampers can be operated automatically or manually from the main control room (MCR). In the event of a station blackout (SBO), these dampers are automatically closed by batteries.

The fire dampers on both supply and exhaust trains are located at the wall penetration between the Fuel Building and the annulus. These dampers are equipped with thermal sensors for automatic closing, and can be closed or re-opened remotely if not released by the thermal sensor.

6.2.3.2.2.2 AVS Accident Trains

The AVS accident filtration trains are shown on Figure 6.2.3-2. The filtration trains are engineered safety feature (ESF) filters and are used during postulated accidents to contain leakage from the primary containment by maintaining a subatmospheric pressure in the annulus. The exhaust air from the annulus is filtered before release to the environment via the vent stack.

There are two full capacity ESF trains, each consists of an air-tight motor-controlled damper, an electrical heater, a pre-filter, an upstream HEPA filter, an iodine absorber, a downstream HEPA filter, an air-tight motor controlled damper, a fan, and a back-draft damper. The filter system components are designed in accordance with Regulatory Guide 1.52, and are described in Section 6.5.1.

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During a postulated accident, the ESF filtration trains collect the containment leakage from the annulus, remove airborne radioactivity through the filtration train, and release the filtered air to the vent stack. The AVS accident trains reduce the pressure in the annulus to at least ~~-0.09 psig~~ -0.25 inches water gauge or less and maintain the lower subatmospheric pressure. The system is capable of maintaining a uniform negative pressure throughout the secondary containment structure following the design basis loss of coolant accident (LOCA).

The exhaust air is monitored for radiation levels before release to the vent stack, as described in Section 12.3.4.

The two ESF trains are physically separated by being installed in separate rooms of the Fuel Building, which are also in separate fire areas. The two ESF trains are powered by different electrical divisions backed by separate emergency diesel generators.

6.2.3.2.2.3 System Operation

The normal operation filtration train is in service during normal plant operation, including cold shutdown and outages. During normal operation, the isolation dampers are in the open position and the annulus is continuously vented. The subatmospheric pressure inside the annulus is maintained by regulating the control damper located on

Table 6.2.3-1—Design and Performance of Annulus Ventilation System

Design Feature	Value
Maximum annulus pressure during normal operation [2]	≤ -0.8 inches water gauge~~0.03 psig~~ [2]
Maximum annulus pressure during postulated accidents [2]	≤ -2.5 inches water gauge~~0.09 psig~~ [2]
Minimum annulus temperature (all modes)	45°F
Maximum relative humidity at iodine filters (postulated accident)	70%
Design pressure	2.77 inches water gauge~~0.1 psig~~
Design temperature	212°F
Electrical heater power (each train)	6 kW
Minimum rated efficiency – Pre-filter	55-65%
Minimum rated efficiency – HEPA filters	99.95%
Minimum rated efficiency – Iodine adsorbers [1]	99% ~~[1]~~
Fan design air flow	60 – 1177 cfm

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Note:

1. Laboratory test results for both elemental iodine and organic iodine, based on four (4) inch deep bed of carbon.
2. The subatmospheric pressure in the annulus will be equal to or lower than the value listed.

Table 6.2.3-2—Secondary Containment Response Analysis

Design Feature [3]	Value	
Annulus temperature	Initial After 24 hours	86.6°F < 92°F
Annulus pressure	Start of drawdown	~~14.712 psia~~ 0.44 inches water gauge
	At 305 seconds	~~14.686 psia~~ -0.25 inches water gauge
	After 565 seconds	~~14.609 psia~~ ≥ -2.5 inches water gauge
Annulus volume	Initial	706,299 ft^3
	After compression and at start of drawdown analysis	704,737 ft^3
Heat transfer coefficients [1, 2]	N/A [4]	
Conductive heat transfer [1]	N/A [4]	
Radiant heat transfer [1]	N/A [4]	
Compressive effect of primary containment [1]	Volume reduction of 1556 ft^3	
Secondary containment in-leakage assumed [1]	0.25% of containment free volume per day	
Secondary containment out-leakage assumed [1]	Zero leakage out of the secondary containment	
Heat loads generated within annulus [1]	Negligible	

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Notes:

1. During postulated accident in primary containment.
2. Heat transfer calculated by methods provided in BTP 6-2.
3. Secondary containment response analysis based on worst single failure.
4. An infinite heat transfer coefficient was assumed such that the surface temperature in contact with primary containment is at the design maximum value from time zero.

Next File

released to the environment (GDC 41). The ESF filter systems are designed to permit periodic inspection and periodic pressure and functional testing (GDC 42, GDC 43).

The ESF filter systems remove radioactive material from the atmosphere to maintain the MCR in a safe condition under accident conditions, including loss of coolant accidents (LOCA), in accordance with GDC 19. These systems, although not credited in the radiological analyses, also provide protection during fuel handling in accordance with GDC 61.

Design bases for radiation monitoring are presented in Section 12.3.4.

The ESF filter systems are designed to meet the design and performance requirements of RG 1.52, Revision 3, ASME N509 (Reference 1), and ASME N510 (Reference 2).

6.5.1.2 System Design

6.5.1.2.1 General System Design

The ESF filter systems described in this section are designed to limit the release of fission products to the environment and to limit radiation dose to the personnel in the MCR. Regardless of the application, each ESF filter system consists of two independent trains. Each train has an activated charcoal carbon adsorber with motorized dampers, an electric heater, a prefilter, and inlet and outlet high efficiency particulate air (HEPA) filters. A booster fan and isolation dampers are included to provide the flow to the ventilation stack for the discharge of filtered air.

Refer to Section 3.2 for the seismic and system quality group classification of the ESF filters.

6.5.1.2.2 Component Design

Filter Air Heaters

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The iodine adsorption efficiency of the filters decreases at high humidity. Therefore, the radiological filter air heaters limit the relative humidity to a maximum of 70 percent so that the carbon adsorber can remove iodine from the exhaust air. The filter air heaters are located upstream of the iodine filtration units to prevent excessive moisture accumulation in the charcoal filter beds. The heaters meet the requirements of ASME AG-1 (Reference 3). The heater sizes are as follows:

- AVS: 6 kW nominal heater rating.
- SBVS: 11 kW nominal heater rating.
- CRACS: 15 kW nominal heater rating.
- CBVS: 14 kW nominal heater rating.

The ESF filter systems capacities are as follows:

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- AVS: ≥ 1060 cfm and ≤ 1295 cfm (nominal ~~1200~~1177 cfm), face velocity 300 fpm, configuration 1 High x 1 Wide.
- SBVS: ≥ 2160 cfm and ≤ 2640 cfm (nominal 2400 cfm), face velocity 375 fpm, configuration 2 High x 1 Wide.
- CRACS: ≥ 3600 cfm and ≤ 4400 cfm (nominal 4000 cfm), face velocity 250 fpm, configuration 2 High x 2 Wide.
- CBVS: ≥ 2700 cfm and ≤ 3300 cfm (nominal 3000 cfm), face velocity 375 fpm, configuration 2 High x 1 Wide.

The ESF filter systems in the CRACS, AVS, and SBVS are aligned automatically with their associated ventilation systems upon receipt of an ESF actuation signal, including safety injection, or detection of high radiation levels. The ESF filter systems may also be manually aligned. The ESF filter systems can also be aligned to the FB and the containment area during fuel handling of irradiated fuel assemblies. The systems are placed in line with the FBVS and CBVS in case of a fuel handling accident. With this ESF filter system alignment, the offsite release of radioactive material from a fuel handling accident does not exceed regulatory limits. During containment purging, the ESF filters in the low-flow purge exhaust subsystem of the CBVS are aligned to reduce radioactive releases in case of a rod ejection accident occurring during purging operations.

Each ESF filter system is sized to accommodate the required ventilation flow and to remove greater than 99 percent of the fission products that could be entrained in the air. The ESF filter systems conform to the requirements of RG 1.52.

Performance evaluations of the ventilation systems that operate in conjunction with the ESF filter systems to limit fission product release to the environment or the MCR are presented in the sections corresponding to the ventilation systems.

6.5.1.4 Tests and Inspections

Refer to Section 14.2 (test abstracts #076, #077, #082, and #083) for initial plant testing of the ESF filter systems. Routine testing and inspection of ESF filter systems are conducted under the ventilation filter testing program in the Technical Specifications Section 5.5.10. Laboratory testing of samples of activated carbon adsorber material is performed in accordance with ASTM D3803 (Reference 5) and RG 1.52.

6.5.1.5 Instrumentation Requirements

Instrumentation and controls provide automatic operation and remote control of the ESF filter systems and continuous indication of system parameters. Instrumentation