

## ArevaEPRDCDocsPEm Resource

---

**From:** Wunder, George  
**Sent:** Tuesday, April 29, 2014 10:36 AM  
**To:** ArevaEPRDCDocsPEm Resource  
**Subject:** FW: Draft Audit Plan for Review of Vortexing and NPSH Analyses at Mid-loop Operation

---

**From:** RYAN Tom (AREVA) [mailto:Tom.Ryan@areva.com]  
**Sent:** Tuesday, April 29, 2014 9:46 AM  
**To:** Hearn, Peter  
**Cc:** SEALS Jeff (AREVA); HOTTLE Nathan (AREVA); GUCWA Len (EXTERNAL AREVA); DANNAKER Brian (AREVA); JONES Stuart (AREVA); Eudy, Michael; Wunder, George  
**Subject:** RE: Draft Audit Plan for Review of Vortexing and NPSH Analyses at Mid-loop Operation

Pete – based on yesterday's Public Call on RAI 579 and Mid-loop Operation, we need to have a follow-up call to discuss this audit plan (this does not need to be a Public Call based on yesterday's discussion).

AREVA would like to hold the call this week if possible to ensure we are prepared for the Audit that is set to begin next month.

We propose either this Thursday 5/1 from 2-3 PM, or Friday 5/2 from 10-11 AM.

If neither of these times work for you, please propose an alternative.

Thanks for your support,

***Tom Ryan***

Manager, US EPR DCD  
Regulatory Affairs

**AREVA**

7207 IBM Drive - CLT2B

Charlotte, NC 28262

Phone: 704-805-2643, Cell : 704-292-5627

Fax: 434-382-6657

---

**From:** HOTTLE Nathan (EP/PE)  
**Sent:** Thursday, April 24, 2014 10:16 AM  
**To:** RYAN Tom (RS/NB); GUCWA Len (External AREVA INC); DANNAKER Brian (EP/PE); JONES Stuart (EP/PE)  
**Cc:** RANSOM Jim (RS/NB); LEIGHLITER John (RS/NB); SEALS Jeff (EP/PE)  
**Subject:** FW: Draft Audit Plan for Review of Vortexing and NPSH Analyses at Mid-loop Operation

The draft audit plan for the vortexing calculation is attached.

Brian and Tom – Please review and determine if it is acceptable to us.

*Nathan Hottle*

AREVA Inc.  
3315 Old Forest Road  
Lynchburg, VA 24501  
Phone 434-832-3864  
Mobile 434-485-4239  
[nathan.hottle@areva.com](mailto:nathan.hottle@areva.com)

---

**From:** Hearn, Peter [<mailto:Peter.Hearn@nrc.gov>]  
**Sent:** Tuesday, April 22, 2014 8:14 AM  
**To:** HOTTLE Nathan (EP/PE)  
**Cc:** Wunder, George  
**Subject:** Draft Audit Plan for Review of Vortexing and NPSH Analyses at Mid-loop Operation

Nathan,

Below is a copy of the draft audit plan for tomorrow's meeting.

Pete

## **Draft Audit Plan for Review of Vortexing and NPSH Analyses at Mid-loop Operation**

### **APPLICATION INFORMATION**

APPLICANT: AREVA NP, INC.  
PROJECT: EPR DESIGN CERTIFICATION  
Docket No.: 52-020

### **PURPOSE**

The purpose of this regulatory audit is to review documents containing data and analysis related to vortexing and NPSH during reduced inventory operations (mid-loop operations) of the U.S. EPR Design Certification Application Section 5.4.7. Based on the review of the applicant's interim response to RAI 579, Question 19-366, Supplement 1 and AREVA's latest proposal, the staff will review the applicant's evaluation to make a safety determination regarding the adequacy of the residual heat removal (RHR) system to perform its safety function at reduced inventory conditions (mid-loop conditions) due to the possibility of vortex formation and subsequent pump air entrainment with sufficient NPSH.

### **BACKGROUND**

To facilitate the safety evaluation of AREVA's analyses related to mid-loop operations as described in FSAR Section 5.4.7 revision 5, the documents related to the vortex and NPSH analyses are requested for audit to ensure that air entrainment, potential vortexing, NPSH concerns do not challenge the RHR pump safety functions for the most limiting RHR flow rate at mid-loop water level.

### **REGULATORY AUDIT BASES**

Review of DCD Chapter 5.4.7 is being conducted in accordance with Section 5.4.7, “Residual Heat Removal System,” of NUREG-0800, “Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants.” SRP 5.4.7 directs the U.S. Nuclear Regulatory Commission (NRC) staff to review the RHR system during shutdown operations, including reduced inventory and mid-loop operations.

High RHR system availability and reliability during shutdown conditions are important to mitigating risk and maintaining an appropriate level of safety. Specifically, the Technical Rational section of SRP 5.4.7 states as it relates to GDC 4 and GDC 34,

“GDC 4 requires that SSCs important to safety be designed to accommodate the effects of and be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accident conditions, including such effects as pipe whip and jet impingement. The safety function of the RHR system is to transfer heat from the reactor to the environment during and after plant shutdown. To ensure the availability of the decay heat removal function, the RHR system must be capable of performing heat transfer under the expected operational and postulated accident conditions for the plant. These conditions include consideration of the dynamic effects of flow instabilities and the loadings caused by water hammer events. Compliance with GDC 4 enhances plant safety by providing assurance that the dynamic effects of events such as flow instabilities and water hammer will not affect the capability of the RHR system to remove decay heat.”

“GDC 34 requires the capability to transfer decay heat and other residual heat from the reactor such that fuel and pressure boundary design limits are not exceeded. In addition, the system must be designed with sufficient redundancy and isolation capability to ensure that the safety functions can be accomplished assuming a single failure of an active component with or without a coincident loss of offsite power. The RHR system transfers the fission product decay and other residual heat from the reactor core. Removal of decay and residual heat is necessary to prevent core damage under both normal and accident shutdown conditions. BTP 5-4 provides an acceptable approach to ensure compliance with GDC 34 with regard to accomplishing the RHR system safety functions assuming a single failure. Compliance with GDC 34 enhances plant safety by providing assurance that decay and RHR will be accomplished and the RCS pressure boundary and fuel cladding integrity will be maintained, thereby minimizing the potential for the release of fission products to the environment.”

In addition, Branch Technical Position (BTP) 5-4 states that:

“The design and operating procedures of any RHR system shall have provisions to prevent damage to the RHR system from overheating, cavitation, or loss of adequate pump suction fluid.”

Vortexing, and the resulting air entrainment, is a dynamic flow instability which could negatively affect the RHR pump from performing its heat removal function. In addition, air entrained by vortexing could lead to air entrapment in the RHR system leading to a loss of safety function e.g., water hammer, NPSH availability for heat removal.  $NPSH_A$  available and  $NPSH_R$  required must be determined to ensure adequate heat removal while minimizing the effects of vortexing.

## **REGULATORY AUDIT SCOPE**

The audit will consist of the review of the applicant’s data and analyses which demonstrates that vortexing, and the associated air entrainment, at the minimum mid-loop water level does not impact the safety function of the US-EPR RHR system. This includes RHR NPSH pump performance and evaluation of possible air entrapment in the system leading to the potential loss of the RHR safety function.

## **AUDIT LOCATION**

The audit will be held at the NRC headquarters through the secured AREVA electronic reading room. The staff will have access to the AREVA electronic reading room during the course of the audit, as necessary.

## **AUDIT TIMES**

**To Be Determined (TBD)**

## **INFORMATION TO BE AUDITED**

Specifically, the staff will audit documents related to the vortex and NPSH analysis at the lowest reduced inventory level anticipated (normally mid-loop operations). Information should include all data and calculation sheets used in the analysis.

## **PARTICIPANTS**

John Budzynski, NRO/DSRA/SRSB, Lead/Technical Reviewer for reactor systems (Chapter 5)  
Marie Pohida, NRO/DSRA/SPRA, Technical Reviewer for risk assessment (Chapter 19)  
Hien Le, NRO/DSRA/BPTS, Technical Reviewer for technical specifications (Chapter 16)  
Peter Hearn, NRO/DNRL/LB1, Project Manager (Chapter 5)  
Michael Eudy, NRO/DNRL/LB1, Project Manager (Chapter 19)

## **LOGISTICS**

Staff proposes that the audit take place through the AREVA electronic reading room. The staff will access the AREVA electronic reading room during the course of the audit, as necessary.

## **DELIVERABLE**

A regulatory audit summary will be placed on the docket and in ADAMS within 90 days of the completion of the audit.

## **REFERENCES:**

U.S. EPR FSAR, Revision 5  
SRP 5.4.7  
BTP 5-4  
GL 88-17  
RAI 579, Question 19-366, Supplement 1, Interim Response  
Latest AREVA mid-loop operations proposal (April 7, 2014 meeting and any additional proposals that impact the audit)

**Hearing Identifier:** AREVA\_EPR\_DC\_Docs\_Public  
**Email Number:** 156

**Mail Envelope Properties** (DAC719623E968245BD52D03696111100021986E415DC)

**Subject:** FW: Draft Audit Plan for Review of Vortexing and NPSH Analyses at Mid-loop  
Operation  
**Sent Date:** 4/29/2014 10:35:34 AM  
**Received Date:** 4/29/2014 10:35:45 AM  
**From:** Wunder, George

**Created By:** George.Wunder@nrc.gov

**Recipients:**  
"ArevaEPRDCDocsPEm Resource" <ArevaEPRDCDocsPEm.Resource@nrc.gov>  
Tracking Status: None

**Post Office:** HQCLSTR02.nrc.gov

<b>Files</b>	<b>Size</b>	<b>Date &amp; Time</b>
MESSAGE	9091	4/29/2014 10:35:45 AM

**Options**  
**Priority:** Standard  
**Return Notification:** No  
**Reply Requested:** No  
**Sensitivity:** Normal  
**Expiration Date:**  
**Recipients Received:**