Westinghouse

Westinghouse Electric Company
Nuclear Power Plants
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066
USA

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Direct tel: 412-374-6206
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e-mail: sisk1rb@westinghouse.com

Your ref: PROJ0797
Our ref: SMR_NRC_000010

June 17, 2013

Subject: SMR Response to Request for Additional Information (SBLOCA PIRT)

This letter replaces SMR_NRC_000009 in its entirety. No technical information has been changed but the letter is reformatted to meet NRC requirements.

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SBLOCA PIRT. This RAI response information is submitted in support of the Westinghouse Small Modular Reactor (SMR) (PROJ0797).

Responses are provided herein for each of the following:

RAI-TR-SBLOCA-PIRT-01 P & NP
RAI-TR-SBLOCA-PIRT-02 P & NP
RAI-TR-SBLOCA-PIRT-03 P & NP
RAI-TR-SBLOCA-PIRT-04 P & NP
RAI-TR-SBLOCA-PIRT-05 NP only
RAI-TR-SBLOCA-PIRT-06 NP only
RAI-TR-SBLOCA-PIRT-07 P & NP
RAI-TR-SBLOCA-PIRT-08 P & NP
RAI-TR-SBLOCA-PIRT-09 P & NP
RAI-TR-SBLOCA-PIRT-10 P & NP
RAI-TR-SBLOCA-PIRT-11 P & NP
RAI-TR-SBLOCA-PIRT-12 P & NP
RAI-TR-SBLOCA-PIRT-13 P & NP
RAI-TR-SBLOCA-PIRT-14 P & NP
RAI-TR-SBLOCA-PIRT-15 P & NP
RAI-TR-SBLOCA-PIRT-16 P & NP
RAI-TR-SBLOCA-PIRT-17 P & NP
RAI-TR-SBLOCA-PIRT-18 P & NP
RAI-TR-SBLOCA-PIRT-19 P & NP
RAI-TR-SBLOCA-PIRT-20 NP only
RAI-TR-SBLOCA-PIRT-21 P & NP
RAI-TR-SBLOCA-PIRT-22 P & NP
RAI-TR-SBLOCA-PIRT-23 P & NP
RAI-TR-SBLOCA-PIRT-24 P & NP
RAI-TR-SBLOCA-PIRT-25 P & NP
RAI-TR-SBLOCA-PIRT-26 NP only
RAI-TR-SBLOCA-PIRT-27 P & NP
RAI-TR-SBLOCA-PIRT-28 P & NP
RAI-TR-SBLOCA-PIRT-29 P & NP
RAI-TR-SBLOCA-PIRT-30 P & NP
RAI-TR-SBLOCA-PIRT-31 NP only
RAI-TR-SBLOCA-PIRT-32 P & NP
RAI-TR-SBLOCA-PIRT-33 P & NP
RAI-TR-SBLOCA-PIRT-34 P & NP
RAI-TR-SBLOCA-PIRT-35 P & NP
RAI-TR-SBLOCA-PIRT-36 P & NP
RAI-TR-SBLOCA-PIRT-37 P & NP
RAI-TR-SBLOCA-PIRT-38 P & NP
RAI-TR-SBLOCA-PIRT-39 NP only

D104
NRO

Per NRC request, the following RAI responses are on the enclosed proprietary CD:

RAI-TR-SBLOCA-PIRT-04 RAI-TR-SBLOCA-PIRT-25 RAI-TR-SBLOCA-PIRT-30

Pursuant to 10 CFR 50.30(b), proprietary and non-proprietary versions of the presentations are submitted as Enclosures 3 and Enclosure 4. Enclosure 1 is one copy of the Application for Withholding, AW-13-3699 (non-proprietary). Enclosure 2 is one copy of the associated Affidavit with Proprietary Information Notice and Copyright Notice (non-proprietary).

Enclosure 3 is the proprietary versions of the responses. Enclosure 4 is the non-proprietary versions of the responses.

This submittal contains proprietary information of Westinghouse Electric Company, LLC. In conformance with the requirements of 10 CFR Section 2.390, as amended, of the Commission's regulations, we are enclosing with this submittal an Application for Withholding and an Affidavit. The Affidavit sets forth the basis on which the information identified as proprietary may be withheld from public disclosure by the Commission. The information being redacted is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public.

Correspondence with respect to the Affidavit or Application for Withholding should reference AW - 13-3699 and should be addressed to James A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, 1000 Westinghouse Drive, Cranberry Township, Pennsylvania, 16066.

Very truly yours,

Jill SMonahan for RBS

Robert B. Sisk
Acting Director, Small Modular Reactor

/Enclosures

1. AW-13-3699 "Application for Withholding Proprietary Information from Disclosure," dated June 17, 2013
2. AW-13-3699, Affidavit, Proprietary Information Notice, Copyright Notice dated June 17, 2013
3. SMR Response to Request for Additional Information (SBLOCA PIRT) (Proprietary)
4. SMR Response to Request for Additional Information (SBLOCA PIRT) (Non-Proprietary)

cc: Arlon Costa U.S. NRC

ENCLOSURE 1

AW-13-3699

APPLICATION FOR WITHHOLDING
PROPRIETARY INFORMATION FROM DISCLOSURE

Westinghouse

Westinghouse Electric Company
Nuclear Power Plants
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066
USA

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Direct tel: 412-374-6206
Direct fax: 724-720-8505
e-mail: sisk1rb@westinghouse.com

Your ref: PROJ0797
Our ref: AW-13-3699

June 17, 2013

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: SMR Response to Request for Additional Information (SBLOCA PIRT)

The Application for Withholding is submitted by Westinghouse Electric Company LLC (Westinghouse), pursuant to the provisions of Paragraph (b) (1) of Section 2.390 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and is customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10 CFR Section 2.390, Affidavit AW-13-3699 accompanies this Application for Withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.390 of the Commission's regulations.

Correspondence with respect to this Application for Withholding or the accompanying affidavit should reference AW-13-3699 and should be addressed to James A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, 1000 Westinghouse Drive, Cranberry Township, Pennsylvania, 16066.

Very truly yours,

James W. Winters
Manager, Passive Plant Technology

ENCLOSURE 2

AFFIDAVIT

AW-13-3699
June 17, 2013

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF BUTLER:

Before me, the undersigned authority, personally appeared James W. Winters, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

James W. Winters
Manager, Passive Plant Technology

Sworn to and subscribed before me this 17th day of June 2013.

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Linda J. Bugle, Notary Public
City of Pittsburgh, Allegheny County
My Commission Expires June 18, 2017
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Linda J. Bugle, Notary Public
City of Pittsburgh, Allegheny County
My Commission Expires June 18, 2017
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

Notary Public

(1) I am Manager, Passive Plant Technology, Westinghouse Electric Company LLC (Westinghouse), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.390 of the Commission's regulations and in conjunction with the Westinghouse "Application for Withholding" accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of

Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in attachment to SMR_NRC_000010, "SMR Response to Request for Additional Information (SBLOCA PIRT)", to the Document Control Desk.

This information is part of that which will enable Westinghouse to:

(a) Manufacture and deliver products to utilities based on proprietary designs.

(b) Advance the SMR Design and reduce the licensing risk for the application of the SMR Design Certification

(c) Determine compliance with regulations and standards

(d) Establish design requirements and specifications for the system.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of plant construction and operation.

(b) Westinghouse can sell support and defense of safety systems based on the technology in the reports.

(c) The information requested to be withheld reveals the distinguishing aspects of an approach and schedule which was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar digital technology safety systems and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).

COPYRIGHT NOTICE

ENCLOSURE 4

(Non-Proprietary Responses)

RAI-TR-SBLOCA-PIRT-01 NP
RAI-TR-SBLOCA-PIRT-02 NP
RAI-TR-SBLOCA-PIRT-03 NP
RAI-TR-SBLOCA-PIRT-04 NP
RAI-TR-SBLOCA-PIRT-05 NP
RAI-TR-SBLOCA-PIRT-06 NP
RAI-TR-SBLOCA-PIRT-07 NP
RAI-TR-SBLOCA-PIRT-08 NP
RAI-TR-SBLOCA-PIRT-09 NP
RAI-TR-SBLOCA-PIRT-10 NP
RAI-TR-SBLOCA-PIRT-11 NP
RAI-TR-SBLOCA-PIRT-12 NP
RAI-TR-SBLOCA-PIRT-13 NP
RAI-TR-SBLOCA-PIRT-14 NP
RAI-TR-SBLOCA-PIRT-15 NP
RAI-TR-SBLOCA-PIRT-16 NP
RAI-TR-SBLOCA-PIRT-17 NP
RAI-TR-SBLOCA-PIRT-18 NP
RAI-TR-SBLOCA-PIRT-19 NP
RAI-TR-SBLOCA-PIRT-20 NP
RAI-TR-SBLOCA-PIRT-21 NP
RAI-TR-SBLOCA-PIRT-22 NP
RAI-TR-SBLOCA-PIRT-23 NP
RAI-TR-SBLOCA-PIRT-24 NP
RAI-TR-SBLOCA-PIRT-25 NP
RAI-TR-SBLOCA-PIRT-26 NP
RAI-TR-SBLOCA-PIRT-27 NP
RAI-TR-SBLOCA-PIRT-28 NP
RAI-TR-SBLOCA-PIRT-29 NP
RAI-TR-SBLOCA-PIRT-30 NP
RAI-TR-SBLOCA-PIRT-31 NP
RAI-TR-SBLOCA-PIRT-32 NP
RAI-TR-SBLOCA-PIRT-33 NP
RAI-TR-SBLOCA-PIRT-34 NP
RAI-TR-SBLOCA-PIRT-35 NP
RAI-TR-SBLOCA-PIRT-36 NP
RAI-TR-SBLOCA-PIRT-37 NP
RAI-TR-SBLOCA-PIRT-38 NP
RAI-TR-SBLOCA-PIRT-39 NP

Westinghouse

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-01
Revision: 0

Question:

Please provide the latest detailed W-SMR design information supporting the Westinghouse Licensing Topical Report (LTR) for the W-SMR Small-break Loss of Coolant Accident (SBLOCA) PIRT.

Westinghouse Response:

Please see the attached plant parameter information.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

Table 1
SMR Plant Parameters

a,c,e

Input/Parameter[1]	Input/Parameter Value	Notes

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter[1]	Input/Parameter Value	Notes

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter[1]	Input/Parameter Value	Notes

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter(1)	Input/Parameter Value	Notes

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter[1]	Input/Parameter Value	Notes

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter(1)	Input/Parameter Value	Notes

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter[1]	Input/Parameter Value	Notes

Table 1
SMR Plant Parameters (cont.)

Input/Parameter[1]	Input/Parameter Value	Notes

a,c,e

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter[1]	Input/Parameter Value	Notes

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter[(1)]	Input/Parameter Value	Notes

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter[1]	Input/Parameter Value	Notes

Table 1
SMR Plant Parameters (cont.)

a,c,e

Input/Parameter[1]	Input/Parameter Value	Notes

Table 2
Containment Volume & ICP Surface Area as a Function of Containment Elevation

a,c,e

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-02
Revision: 0

Question:

Please provide the In-containment Pool (ICP) tank normal operating pressure and describe any inventory of non-condensable gases.

Westinghouse Response:

The In-Containment Pool (ICP) tanks are a set of 8 tanks that comprise two In-Containment Pools. Each ICP has a Sump Injection Tank (SIT) connected to it. The ICP tanks and SITs are all part of the same closed system, which is isolated from the Containment Atmosphere by rupture discs and Isolation Valves and from the Reactor Vessel (RV) by check and air-operated valves.

[ ]a,c,e

Any non-condensable gas can be vented from the high point of the SIT as well as from each ICP. [

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-03
Revision: 0

Question:

Please provide the rupture disk rupture pressure difference for the rupture disk at the top of the Sump Injection Tanks (SITs).

Westinghouse Response:

At the top of each of the Sump Injection Tanks (SITs), there are rupture disks. These rupture disks serve as a protection against both over-pressurization and under-pressurization of the SITs and the In-Containment Pool (ICP) Tanks. [

]^{a,c,e}

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-04
Revision: 0

Question:

Please provide detailed inputs (including assumptions, initial conditions, Emergency Core Cooling System [ECCS] setpoints, credited Engineered Safety Features [ESFs], operator actions, etc.) and analysis results (including event sequences, etc.) for the SBLOCA simulations.

Westinghouse Response:

The attachments provide both the Westinghouse proprietary and non-proprietary responses to this request for additional information.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

WESTINGHOUSE-SMR Direct Vessel Injection (DVI) LINE DOUBLE-ENDED GUILLOTINE BREAK LOCA ANALYSIS

1. INTRODUCTION

The Westinghouse Small Modular Reactor (SMR) is an 800 MWt (> 225 MWe) integral pressurized water reactor with all primary components, including the steam-generator and the pressurizer located inside the reactor vessel (Figure 1). The integration of pressurizer into the reactor vessel eliminates the need for a separate component. A single compact once-through straight tube steam generator produces saturated mixture from which steam is later separated in a steam drum outside the containment. Eight horizontally-mounted axial-flow pumps provide the driving head for the reactor coolant system while eliminating the need for pump seal injection.

The reactor core of Westinghouse SMR is made up of partial-length 17x17 Robust Fuel Assembly (RFA) design used in the **AP1000**®[1] reactor core. The fuel cycle is extended to 24 months. Within the reactor, internal control rod drive mechanisms provide a mix of reactor shutdown and control.

Containment is a compact steel vessel fabricated by a fully modular construction approach. It is designed to be able to sustain high pressures and is completely submerged in a pool of water, which acts as a heat sink during postulated accidents.

The Westinghouse SMR containment houses the integral reactor vessel and the passive safety system (PXS), which is illustrated in Figure 2. The SMR PXS, which is based largely on the passive safety systems used in the **AP1000** design, provides mitigation of all design basis accidents without the need for AC electrical power for at least seven days. The key components of the passive safety system are four core makeup tanks (CMTs) with an integrated passive residual heat removal (PRHR), heat exchanger two in-containment pool (ICP) tanks and associated Sump Injection Tanks (SITs), an automatic depressurization system (ADS), a boric acid storage tank (BAST), an outside-containment pool (OCP), and two ultimate heat sink (UHS) tanks [1].

The integral design of the reactor cooling system (RCS) contains no large bore piping and all penetrations in the reactor vessel are limited to 3-inch equivalent diameter, significantly reducing the flow area of postulated loss of coolant accidents. The vertical arrangement of the plant allows for a safe transition to natural circulation in the event of

1. AP1000 is a trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.

a disruption to the forced reactor coolant flow and inherently places the majority of the RCS water directly above the core for use in cooling of the reactor during an event. These design features enhance the passive safety features of the plant.

These features and the PXS components combined provide the protection required to mitigate various initiating faults. In Reference 2, preliminary studies were presented for a DVI line double-ended guillotine (DEG) type break. In Reference 3, the study is expanded to include different break sizes and types, 0.5 inch split break, 1.0 inch split break, 2.0 inch split break, 3.0 inch split break and 3.0 inch DEG break on the DVI line to demonstrate how the passive cooling system will perform in a postulated LOCA event. In this report, the input model and a double-ended guillotine break scenario on one of the DVI lines are described. Note that the following input model description and results are preliminary.

The LOCA analysis was performed using a new generation of realistic LOCA safety evaluation code, WCOBRA/TRAC-TF2, which is capable to address LOCA safety analysis from the smallest break size to the largest break size (i.e., FULL SPECTRUM™[2]) and post-LOCA Long Term Core Cooling (LTCC). The details of code and its assessment and validation are provided in References 4 and 5.

2. THE WCOBRA/TRAC-TF2 CODE

The previous generation of Westinghouse realistic safety analysis code, WCOBRA/TRAC, was the Westinghouse evolution of the original COBRA/TRAC code by combining the COBRA-TF code and the TRAC-PD2 code [6]. The COBRA-TF code, which has the capability to model three-dimensional flow behavior in a reactor vessel, was incorporated to replace the TRAC-PD2 vessel model. Westinghouse continued the development and validation of COBRA/TRAC and the code was renamed WCOBRA/TRAC. WCOBRA/TRAC code has been shown to adequately model large break LOCA phenomena and the **AP1000** post-LOCA LTCC [7].

In order to address the small break LOCA analysis, the WCOBRA/TRAC code was subjected to a significant number of changes which led to the creation of the advanced WCOBRA/TRAC-TF2 (WCT-TF2) safety analysis code. The WCOBRA/TRAC-TF2 code is the combination of the 3D module of the current WCOBRA/TRAC and the TRAC-PF1. Thus, the original TRAC-PD2 five-equation drift-flux formulation was replaced with the more mechanistic six-equation, two-fluid formulation of TRAC-PF1. As part of the development of WCT-TF2, the 3D module (two-fluid, three-field model) was upgraded by including one additional mass conservation equation for the non-condensable species [5].

2. FULL SPECTRUM is a trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.

A significant number of fluid dynamics and heat transfer models were developed or improved in WCT-TF2. Major developments and improvements are listed below:

- Break (critical) flow model
- Core void distribution (mixture level)
- Core heat transfer model
- Fuel rod deformation model
- Horizontal flow regime in the loops
- Cold-leg/downcomer condensation
- Loop seal clearance

The code assessment approach for the WCT-TF2 code includes the large set of experiments used for the original WCOBRA/TRAC assessment, and a new set of Separate Effects Tests (SETs) and Integral Effects Tests (IETs) for scenarios/phenomena identified in the FULL SPECTRUM™ LOCA PIRT [8]. The assessment also includes modeling of standard numerical problems and analytical benchmarks which are available in the literature. The results of the various test simulations demonstrated that WCOBRA-TRAC-TF2 is capable of simulating with sufficient accuracy, the key thermal-hydraulic phenomena that might occur during both large break and small break LOCA events in a PWR.

In summary, the WCOBRA/TRAC-TF2 code is a state-of -the-art LOCA safety evaluation code based on proven code and methodologies with two decades of continuous development and extensive experience for real applications in the industry.

3. WESTINGHOUSE SMR WCT-TF2 MODEL DESCRIPTION

[

]a,c,e

3.1. Primary Reactor Coolant System

3.1.1. 3D Vessel Model

[

]a,c,e

3.1.2. Westinghouse SMR Core Model

[

]a,c,e

[

]a,c,e

3.1.3. Central Primary Riser and SG Primary Side

[

]a,c,e

3.1.4. Pressurizer Surge Plate

[

]a,c,e

3.1.5. Pressurizer

[

]a,c,e

3.1.6. Reactor Coolant Pumps (RCP)

[

]a,c,e

3.2. Steam Generator Secondary System

[

]a,c,e

3.3. Passive Safety Systems

[

]a,c,e

3.3.1. CMT Balance Lines

[

]a,c,e

3.3.2. ADS1 Valves

[

]a,c,e

3.3.3. ADS2 Valves

[

]a,c,e

3.3.4. Core Make-Up Tanks and PRHR

[

]a,c,e

3.3.5. Ultimate Heat Sink (UHS) Loop

[

]a,c,e

[

]a,c,e

3.3.6. Lower ICP/SIT, ICP Injection Lines

[

]a,c,e

[

]a,c,e

3.3.7. CMT Actuation Valves and Check-Valves

[

]a,c,e

3.3.8. Boric Acid Storage Tank

[

]a,c,e

3.3.9. DVI Lines

[

]a,c,e

3.4. Containment Vessel and the Outside Containment Pool

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[

]a,c,e

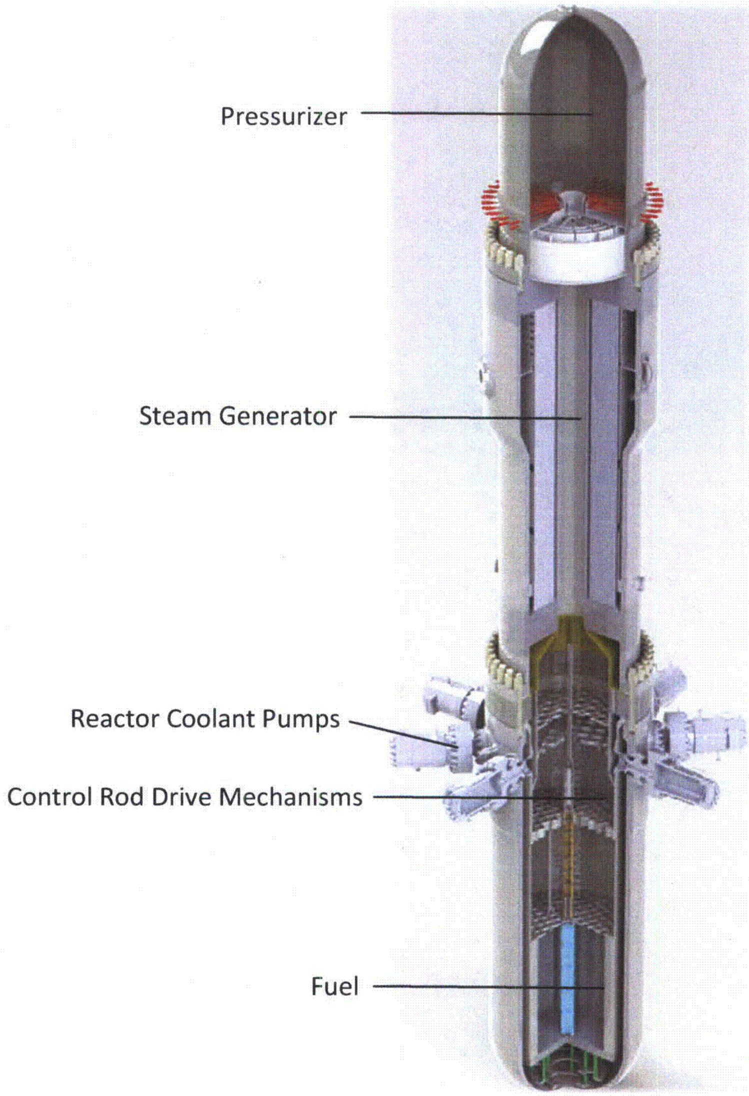

Figure 1: Westinghouse SMR Integral Reactor Vessel

a,c,e

Figure 2: Sketch of the Westinghouse SMR Passive Safety System

a,c,e

Figure 3: Westinghouse SMR WCT-TF2 Model VESSEL Input Noding

a,c,e

Figure 4: Gaps in Sections 6 through 10

a,c,e

Figure 5: Westinghouse SMR Core Configuration

a,c,e

Figure 6: Westinghouse SMR WCT-TF2 Model Input Noding

a,c,e

Figure 7: SMR Noding on the Central Primary Riser and SG Primary Side Region

a,c,e

Figure 8: Westinghouse SMR Secondary Side Noding Diagram

a,c,e

Figure 9: Lower ICP Noding Diagram

a,c,e

[ ]

Figure 10: Illustration of ICP, Sump Injection Tank, Sump Line, ICP Injection Line Arrangement

a,c,e

Figure 11: Containment Vessel and the Outside Containment Pool Components

4. DVI LINE BREAK LOCA ANALYSIS

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]a,c,e

[

]a,c,e

[

]a,c,e

[

]a,c,e

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

Table 1: Westinghouse SMR Signals and Actuations

a,c,e

Table 2: Sequence of Events for Westinghouse SMR DVI Line DEG Break

a,c,e

a,c,e

Figure 12: RCS and Containment Pressures

a,c,e

Figure 13: RCS and Containment Pressures

a,c,e

Figure 14: Break Flow, Vessel Side

a,c,e

Figure 15: Break Flow –CMT Side

a,c,e

Figure 16: DVI Injection Flow

a,c,e

Figure 17: DVI Injection Flow, First 2000 Seconds

a,c,e

Figure 18: ADS1 Flows

a,c,e

Figure 19: ADS2 Flows

a,c,e

Figure 20: SIT Injection Flow

a,c,e

Figure 21: Boric Acid Tank Injection Flows

a,c,e

Figure 22: Sump Circulation Flow

a,c,e

Figure 23: ADS2 Exit Quality

a,c,e

Figure 24: Heat Removal Rates

a,c,e

Figure 25: Heat Removal Rates

a,c,e

[ ]

Figure 26: Vessel Inventory

a,c,e

[ ]

Figure 27: Upper Plenum Collapsed Liquid Level

REFERENCES

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4. C. Frepoli and K. Ohkawa, "The Development of a Realistic LOCA Evaluation Model Applicable to the Full Range of Breaks Sizes: Westinghouse Full Spectrum LOCA (FSLOCA™) Methodology," *Proc. of the 14th International Topical Meeting on Nuclear Reactor Thermal-Hydraulics*, Toronto, Canada (2011).

5. C. Frepoli, K. Ohkawa and M. E. Nissley, "Development of WCOBRA/TRAC-TF2 Computer Code: Coupling of the 3D Module (COBRA-TF) with the 1D Module of TRAC-PF1/MOD2", *Proceedings of the 17th International Conference on Nuclear Engineering ICONE17*, Brussels, Belgium (2009).

6. C. Frepoli, "Review Article - An Overview of Westinghouse Realistic Large Break LOCA Evaluation Model," *Science and Technology of Nuclear Installations*, Vol. 2008, Hindawi Publishing Corporation, Article ID 498737 (2008).

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8. C. Frepoli, K. Ohkawa, et al., *Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FULL SPECTRUM™ LOCA Methodology)*, WCAP-16996-NP, Revision 0, Westinghouse Electric Company (2010).

Westinghouse

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-05
Revision: 0

Question:

Please provide the analysis results for the SBLOCA simulations presented in pages A4-1 through A4-30 during the audit on May 2, 2013 in electronic format. The event progression and description is essential for understanding the scenario and for the review of the Westinghouse LTR on the SBLOCA PIRT.

Westinghouse Response:

The response to RAI-TR-SBLOCA-PIRT-4 has been provided electronically on a CD. Please note the CD contains proprietary information and has been marked as such.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

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WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-06
Revision: 0

Question:

Please provide the setpoints for the activation of all ECCS components. This includes the activation setpoints for various valves that are involved in the SBLOCA progression and the time delays between various Automatic Depressurization System Stage One (ADS-1) and ADS-2 openings. This information is also requested in electronic format for easy reference during PIRT Panel deliberations.

Westinghouse Response:

Table 1 provided in the response to RAI-TR-SBLOCA-PIRT-4 contains the ECCS component activation setpoints and delays. The response to RAI-TR-SBLOCA-PIRT-4 has been provided electronically on a CD. Please note the CD contains proprietary information and has been marked as such.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-07
Revision: 0

Question:

Please provide description, accompanied by a schematic diagram, of the connections (e.g., rupture disk, valves, etc.) at the top of the two SITs (also called "upper ICP tanks"). Also explain the purpose, function, and operational characteristics of each connection. Clarify whether the SITs are "water-solid" during normal operation, if this is the case; please explain how the rupture disk can function if it discharges into a water solid tank. If SITs are not water solid, provide the volume of the gas space at the top of the SITs.

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

a,c,e

Westinghouse

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-08
Revision: 0

Question:

Please clarify the operation of the SIT/ICP during injection. It would seem from the SBLOCA PIRT LTR that SIT/ICP flow begins when RPV pressure is low enough and the upper SIT rupture disc opens due to Containment Vessel (CV) over-pressure. But, the audit indicates that an S signal opens the SIT upper vent valve (maybe an Air Operated Valve (AOV)) and another AOV on the ICP injection line. Please provide more information on the operation and design of this system. In particular,

a) What is the arrangement of valves in the SIT/ICP system?

b) What types of valves are used? If the valves are AOV, is air required to open the valves?

c) How often is the system vented to remove non-condensable gases (NCGs)?

d) If the SIT/ICP is water solid, it is likely to have a cooling requirement. What is this requirement? How is it achieved? Could a single failure remove cooling to both SITs?

Westinghouse Response:

a) and b):

[

]a,c,e

a,c,e

[

]a,c,e

c) [ ]a,c,e

[

]a,c,e

d) [

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-09
Revision: 0

Question:

Please clarify the modeling of the AOV in the ICP injection line. It does not appear that the AOV in the ICP injection line is simulated in the WEC analysis.

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-10
Revision: 0

Question:

Since the SIT vents, or appears to vent to CV, please specify the expected inventory of NCG in the CV.

Westinghouse Response:

[

]^{a,c,e}

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

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WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-11
Revision: 0

Question:

The diagrams of the Core Makeup Tank (CMT) piping indicate a pressure balance line local high point. Please clarify how the accumulation of NCG in the high point of the piping is managed.

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-12
Revision: 0

Question:

Please specify the maximum and (if non zero) normal flow rate in the Spray Line from the Reactor Coolant Pump (RCP) discharge to Pressurizer spray.

Westinghouse Response:

The spray flow rate can range from [ ]a,c,e depending on the spray demand flow based on the PZR level/pressure program. The [ ] a,c,e flow corresponds to the spray control valve completely closed and the only flow through the spray line nozzle into the PZR is that associated with flow through the [

] a,c,e

a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

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WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-13
Revision: 0

Question:

Please confirm that the only path for injection of water from the sump to the downcomer is via the lower ICP tanks, i.e., water from the sump enters the lower ICP tanks through the Sump Coupling Valves (SCVs), and subsequently enters the reactor vessel via the sump injection valves

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

a,c,e

Westinghouse

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-14
Revision: 0

Question:

Various schematic diagrams presented during the audit on May 2, 2013 show the SCVs to be located at an elevation below the sump injection valves. Please confirm that this is an accurate description of the actual layout and provide the elevations for these valves from a specified datum.

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

a,c,e

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-15
Revision: 0

Question:

Has Westinghouse performed any sensitivity analyses using the computational models for W-SMR to determine/alter the importance ranking of phenomena in the W-SMR SBLOCA PIRT? If yes, please provide a description of the sensitivities and their impact on the importance rankings. If sensitivity calculations have not been performed, please provide the rationale for arriving at the various importance rankings, and the reasons for not supporting the rankings with sensitivity analyses.

Westinghouse Response:

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]a,c,e

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

[

]a,c,e

[

]a,c,e

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-16
Revision: 0

Question:

Please describe the type of debris anticipated in the W-SMR containment during an SBLOCA event? If possible, please compare and contrast with the debris profile that was the subject of GSI-191. Please explain the planned approach for demonstrating the effect of debris on blockage in the core, carryover of solids via ADS-2 and long term cooling performance. Please provide the bases for the type and quantity of debris being considered for any relevant testing.

Westinghouse Response:

[

]a,c,e

[

]a,c,e

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

[

]a,c,e

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-17
Revision: 0

Question:

Please describe how the presence of debris and its retention was considered during the simulation of the SBLOCA that was used to inform Westinghouse's W-SMR SBLOCA PIRT. Please provide the values and the bases for the loss coefficients used for the sump screen and "trash rack."

Westinghouse Response:

[

]a,c,e

RAI-TR-SBLOCA-PIRT-16 describes the planned approach for GSI-191.

Reference:

None.

[

]a,c,e

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-18
Revision: 0

Question:

Please describe the process that will be followed by Westinghouse to change the importance rankings in the W-SMR SBLOCA PIRT based on the results of the planned integral and separate effects tests.

Westinghouse Response:

[

]a,c,e

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

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WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-19
Revision: 0

Question:

Please provide length and spring force of the plenum spring. Does the plenum spring have the same length and spring force as for the full-length assembly? If yes, what is its impact on the fuel pellets in a shorter stack?

Westinghouse Response:

The SMR plenum spring will be designed to have design margins equivalent to those of the **AP1000**®[1] PWR plenum spring. No excessive spring forces will be applied to the shorter pellet stack. The SMR fuel rod is constructed similar to the **AP1000** PWR fuel rod – except for the active fuel stack length. However, the plenum spring design is currently not completed. [

][a,c,e] This design optimization will be completed to support submission of the SMR DCD, Revision 0.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

[1] AP1000 is a trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.

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WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-20
Revision: 0

Question:

Please provide design pressure of the containment.

Westinghouse Response:

The Westinghouse SMR containment design pressure is 250 psig.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

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WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-21
Revision: 0

Question:

Please describe and clarify the reactor trip after the SBLOCA initiation. Does the SBLOCA WEC analysis presume coincident Loss of Offsite Power (LOOP)? If so, does the reactor trip on LOOP? What is the assumed transient power?

Westinghouse Response:

In the SBLOCA scenario, the reactor is assumed to be at 100% power at the beginning of the transient. When the LOCA occurs, the reactor coolant system (RCS) inventory decreases; and consequently, the RCS pressure and pressurizer water level decrease. [

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-22
Revision: 0

Question:

The ADS-2 wet steam quality seems high for the SBLOCA simulation with the Direct Vessel Injection (DVI) line break. Please also describe how the steam quality was determined for the RSG outlet.

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-23
Revision: 0

Question:

Please list and describe the automatic trips of the RCPs.

Westinghouse Response:

The following lists the automatic reactor coolant pumps (RCPs) trips credited in the safety analyses.

RCP Trips
[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-24
Revision: 0

Question:

Please discuss the extent of RCP vibration and countermeasures, including monitoring, trips, etc.

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-25
Revision: 0

Question:

Please clarify and provide detailed information on how the specific separate and integral effects tests planned for the W-SMR, i.e., the test plan or test matrix, correlate with the "gaps" in knowledge identified with the W-SMR SBLOCA PIRT.

Westinghouse Response:

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]a,c,e

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]a,c,e

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]a,c,e

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]a,c,e

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]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

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Westinghouse

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-26
Revision: 0

Question:

Please provide the information presented in pages B1-1 through B1-8 during the audit on May 2, 2013 in electronic format. The "gaps" in knowledge identified with the W-SMR SBLOCA PIRT are required to understand important SBLOCA phenomena.

Westinghouse Response:

The response to RAI-TR-SBLOCA-PIRT-25 – which provides the requested information – has been provided electronically on a CD. Please note the CD contains proprietary information and has been marked as such.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-27
Revision: 0

Question:

Please clarify what, if any, separate effects experiments are planned for the prototypic sump screen and "trash rack" to determine the fouling, pressure drop and debris non-retention in those components due to W-SMR specific debris (see Question #16 on type of debris). If no tests are planned, please provide the basis for the design of these components.

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

[

]a,c,e

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

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WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-28
Revision: 0

Question:

Please provide clarification on whether the sump screen and "trash rack" will be included in the integral effects testing. If yes, please provide information on the scaling methodology for these components (note that information on the prototypic design is sought above). If not, please provide the rationale for the exclusion of these components.

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-29
Revision: 0

Question:

Please explain the approach for determining the prototypic pressure drops or loss coefficients in the core and the primary circuit. Please provide information on how these parameters will be scaled in the test facility during integral testing.

Westinghouse Response:

[

]a,c,e

a,c,e

[ ]a,c,e

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

[

]a,c,e

Westinghouse

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-30
Revision: 0

Question:

Please provide detailed inputs (including assumptions, initial conditions, ECCS setpoints, credited ESFs, operator actions, etc.) and analysis results (including event sequence, etc.) for the following potential limiting events for consideration:

a) Loss of forced reactor coolant flow (e.g., limiting trip of multiple RCPs)

b) Limiting decrease in Reactor Coolant Pressure Boundary (RCPB) temperature event (e.g., inadvertent Steam Generator Dump Valve (SGDV) opening or recirculation pump overspeed)

c) Limiting increase in RCPB temperature event (e.g., Main Steam Isolation Valve (MSIV) closure)

d) Steam Generator Tube Rupture (SGTR)

e) Inadvertent ADS Actuation

f) Inadvertent pressurizer Safety or Relief Valve (RV) opening

g) Malfunction of the Chemical and Volume Control System (CVCS)

h) Main steam line break inside CV

i) Control Rod (CR) ejection accident

j) Inadvertent/Uncontrolled Rod Withdrawal

k) Station Blackout

l) Anticipated Transient Without Scram (ATWS)

Westinghouse Response:

The responses to the questions above are attached. Please note however for consistency, the order of the events discussed has been modified from that requested with the "Main steam line break inside CV" discussed last due to the differences in the computer model used. The revised order that the response is presented in is:

a) Loss of forced reactor coolant flow (e.g., limiting trip of multiple RCPs)

b) Limiting decrease in Reactor Coolant Pressure Boundary (RCPB) temperature event (e.g., inadvertent Steam Generator Dump Valve (SGDV) opening or recirculation pump overspeed)

c) Limiting increase in RCPB temperature event (e.g., Main Steam Isolation Valve (MSIV) closure)

d) Steam Generator Tube Rupture (SGTR)

e) Inadvertent ADS Actuation

f) Inadvertent pressurizer Safety or Relief Valve (RV) opening

g) Malfunction of the Chemical and Volume Control System (CVCS)

h) Control Rod (CR) ejection accident

i) Inadvertent/Uncontrolled Rod Withdrawal

j) Station Blackout

k) Anticipated Transient Without Scram (ATWS)

l) Main steam line break inside CV

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

WESTINGHOUSE-SMR NON-LOCA ANALYSES

1. INTRODUCTION

The Westinghouse Small Modular Reactor (SMR) is an 800 MWt (> 225 MWe) integral pressurized water reactor with all primary components, including the steam-generator and the pressurizer located inside the reactor vessel (Figure 1). The integration of pressurizer into the reactor vessel eliminates the need for a separate component. A single compact straight tube steam generator produces saturated mixture from which steam is later separated in a steam drum outside the containment.
Eight horizontally-mounted axial-flow pumps provide the driving head for the reactor coolant system while eliminating the need for pump seal injection.

The reactor core of Westinghouse SMR is made up of partial-length 17x17 Robust Fuel Assembly (RFA) design used in the **AP1000**®[1] reactor core. The fuel cycle is extended to 24 months. Within the reactor, internal control rod drive mechanisms provide a mix of reactor shutdown and control.

The containment vessel is compact and fabricated by a fully modular construction approach. It is designed to be able to sustain high pressures and is completely submerged in a pool of water, which acts as a heat sink during postulated accidents.

The Westinghouse SMR containment houses the integral reactor vessel and the passive core cooling system (PXS), which is illustrated in Figure 2. The SMR PXS, which is based largely on the passive safety systems used in the **AP1000** plant design, provides mitigation of all design basis accidents without the need for AC electrical power. The key components of the passive safety system are four core makeup tanks (CMTs) with integrated passive residual heat removal heat exchanger (PRHR HX), two in-containment pools (ICPs) and associated sump injection tanks, an automatic depressurization system (ADS), a boric acid storage tank (BAST), an outside containment pool (OCP), and two ultimate heat sink (UHS) pools (Reference 1).

The integral design of the reactor cooling system (RCS) contains no large bore piping. The vertical arrangement of the plant allows for a safe transition to natural circulation in the event of a disruption to the forced reactor coolant flow and inherently places the majority of the RCS water directly above the core for use in cooling of the reactor during an event. These design features enhance the passive safety features of the plant. These features and the PXS components combined provide the protection required to mitigate various initiating faults.

[1] AP1000 is a trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.

The Non-LOCA analyses were performed using the RETRAN-3D thermal-hydraulic analysis code (Reference 2), which is capable of addressing the various Non-LOCA safety analyses addressed in Chapter 15 of the Design Control Document. The details of code and its assessment and validation are provided in Volumes 1 through 4 of Reference 2.

2. THE RETRAN-3D CODE

RETRAN-3D is a best-estimate transient thermal-hydraulic code designed to analyze operational transients, anticipated transients without scram, natural circulation, long-term transients, and events involving limited nonequilibrium conditions in light water reactors. It can also be used to analyze the steady-state and transient response of any thermal-hydraulic system using water as the cooling fluid.

The field equations solved include the integral form of the one-dimensional, homogeneous equilibrium mixture equations for the conservation of continuity, momentum and energy, with options to also use (1) a slip equation based on either dynamic or algebraic models, and (2) a slip equation and a vapor mass equation. The addition of a slip equation in the second and third options allows each phase in a two-phase mixture to move with a separate velocity. This is important in the analysis of many two-phase flow transients. The fluid in the homogeneous mixture and slip equation option is treated using an assumption of equilibrium thermodynamic conditions. In the third field equation option (referred to as the "five-equation" option), non-equilibrium conditions are allowed for a two-phase mixture, with the vapor phase in the mixture constrained to saturation conditions.

To all of the above options is added an additional mass conservation equation for non-condensables (when present). Non-condensables and/or water-vapor are lumped together to create what is referred to as the "gas" or "gas-phase." The components of this gas phase are always well mixed and at a single temperature. Slip equations, when used, treat this gas phase as a second fluid that "slips" relative to the liquid phase. When homogeneous equilibrium assumptions are used, all of the phases (regardless of composition) exist at a single temperature. When non-equilibrium conditions are permitted, the gas temperature is mass weighted between the liquid temperature and the saturation temperature. That is when the gas contains solely non-condensables, its temperature is the liquid temperature; when the gas contains solely water vapor, its temperature is the saturation temperature. Between these endpoints the gas temperature is mass weighted, linearly, as a function of vapor mass to total gas mass. Input models for the code are developed by assembling the basic building blocks consisting of fluid control volumes, flow paths or junctions, and components (e.g., heat conductors, pumps, energy sources, valves, and control systems) into a representative model of the system to be analyzed. Node and component number assignments for the building blocks may be assigned in random order which allows the addition or deletion of components to be done with relative ease.

Overview of RETRAN-3D

RETRAN-3D has options to use the following features:

- iterative solution of the steady-state field equations and the control system and other component equations;
- an implicit, two-surface heat conduction model that allows internal power generation;
- models for one-dimensional and point reactor kinetics;
- trip logic;
- control system models;
- two sets of heat transfer correlations;
- flow and pressure boundary conditions;
- component models for pressurizers, steam separators, centrifugal pumps, valves, and accumulators; and
- special purpose models for modeling the movement of a temperature front or impurities.

Implicit solution methods are used for the steady-state and transient form of the field equations. Both linear and iterative nonlinear solutions of the transient field equations are available. The iterative transient solution method includes a number of algorithms used to provide automated time-step size control.

The equation-of-state properties are generally valid between 100 and 6000 psi, allowing for the analysis over a wide range of operating conditions. Separate numerical algorithms (algebraic and finite difference in form) are also used for the solution of other equations (e.g., equation of state, heat conduction, neutron kinetics, control system, and pump behavior) as required. The running times required to analyze a particular transient with RETRAN are dependent on the detail of the geometric model, the type of event to be analyzed, and the computer performing the calculation. The solution of the steady-state field equations typically requires between four and ten iterations for a PWR and between fifteen and thirty iterations for a BWR. An iteration in the solution of the steady-state equations is approximately equivalent to a time step for the transient equations. The time required for the solution of the transient field equations is dependent on the equations being solved (three-, four-, or five-equation and/or noncondensable options), the conditions for the problem (e.g., slowly varying or rapidly varying conditions), and the duration of the transient to be analyzed.

In summary, the RETRAN-3D code is an NRC approved (Reference 2) Non-LOCA transient thermal-hydraulic analysis code based on proven code and methodologies with two decades of continuous development and extensive experience for real applications in the industry.

3. WESTINGHOUSE SMR RETRAN-3D INPUT MODEL

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4. NON-LOCA ANALYSES

The RETRAN-3D based Non-LOCA safety analyses are listed below:

- Loss of Flow
- Limiting decrease in RCPB temperature
- Limiting increase in RCPB temperature
- Steam Generator Tube Rupture (SGTR)
- Inadvertent ADS Actuation
- Inadvertent Opening of Pressurizer Relief valve
- Malfunction of CVS
- Rod Ejection Event (Not applicable to design as discussed in attached.)
- Inadvertent/Uncontrolled Rod Withdrawal
- Station Blackout
- Anticipated Transient Without SCRAM (ATWS)

Each analysis is detailed in a separate section and provides a brief description of the event as modeled as well as figures depicting the transient response of the key system parameters. Tables 1 and 2 presented below provide a listing of the various actuation signals and signal delays utilized in the Non-LOCA analyses presented herein.

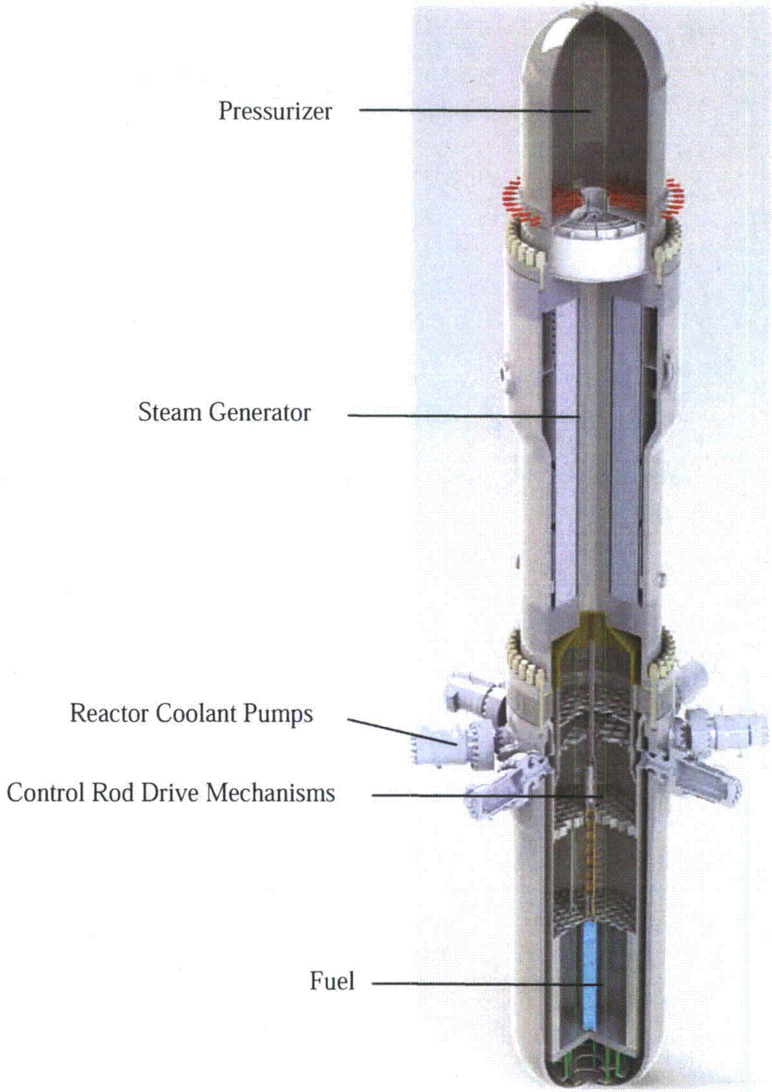

Figure 1: Westinghouse SMR Integral Reactor Vessel

a,c,e

Figure 2: Sketch of the Westinghouse SMR Passive Safety System

a,c,e

Figure 3: Westinghouse SMR RETRAN Primary Side Input Noding

a,c,e

Figure 4: Westinghouse SMR RETRAN Secondary Side Input Noding

a,c,e

Figure 5: Westinghouse SMR Core Makeup Tank Noding

Table 1: Reactor Trip Signals and Actuations

a,c,e

Table 2: Engineering Safeguards Control System Setpoints

a,c,e

a,c,e

A. Loss of Forced Reactor Coolant Flow

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]a,c,e

Table A-1: Sequence of Events for CLOF

a,c,e

a,c,e

Figure A-1: Normalized Core Power vs. Time

a,c,e

Figure A-2: RCP Flow vs. Time

a,c,e

Figure A-3: RCP Speed vs. Time

a,c,e

Figure A-4: RCS Pressure vs. Time

a,c,e

Figure A-5: RCS Temperature vs. Time

a,c,e

Figure A-6: Pressurizer Level vs. Time

a,c,e

Figure A-7: Secondary Side Pressure vs. Time

a,c,e

Figure A-8: Secondary Side Level vs. Time

B.1 Limiting Decrease in RCPB Temperature Event

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]a,c,e

a,c,e

Figure B-1: MSL Limiting Break Location

Table B-1: Sequence of Events for the MSL Break Event

a,c,e

a,c,e

Figure B-2: Normalized Core Power vs. Time

a,c,e

Figure B-3: Pressurizer Pressure vs. Time

a,c,e

Figure B-4: RCS Temperature vs. Time

a,c,e

[ ]

Figure B-5: Pressurizer Level vs. Time

a,c,e

Figure B-6: Secondary Side Pressure vs. Time

a,c,e

Figure B-7: Secondary Side Level vs. Time

a,c,e

Figure B-8: Steam Flow vs. Time

[ ]a,c,e

C.1 Limiting Increase in RCPB Temperature Event (AOO)

[

]a,c,e

Table C.1-1: Sequence of Events for MSIV Closure

a,c,e

a,c,e

Figure C.1-1: Core Power vs. Time

a,c,e

Figure C.1-2: RCS Pressure vs. Time

a,c,e

Figure C.1-3: RCS Temperature vs. Time

a,c,e

Figure C.1-4: Pressurizer Level vs. Time

a,c,e

Figure C.1-5: Steam Drum Pressure vs. Time

a,c,e

Figure C.1-6: Steam Drum Level vs. Time

C.2 Limiting Feedline Break Event (PA)

[

]a,c,e

Table C.2-1: Sequence of Events for the FLB Event

a,c,e

a,c,e

Figure C.2-1: Core Power vs. Time

a,c,e

Figure C.2-2: RCS Pressure vs. Time

a,c,e

Figure C.2-3: RCS Temperature vs. Time

a,c,e

Figure C.2-4: Pressurizer Level vs. Time

a,c,e

Figure C.2-5: Steam Drum Pressure vs. Time

a,c,e

Figure C.2-6: Steam Drum Level vs. Time

a,c,e

Figure C.2-7: RFW Line Break Flow vs. Time

D. Steam Generator Tube Rupture

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]a,c,e

Table D-1: Sequence of Events for the Steam Generator Tube Rupture Event

a,c,e

a,c,e

Figure D-1: Core Power vs. Time

a,c,e

Figure D-2: RCS Pressure vs. Time

a,c,e

Figure D-3: RCS Temperature vs. Time

a,c,e

Figure D-4: Secondary Side Pressure vs. Time

a,c,e

Figure D-5: Secondary Side Temperature vs. Time

a,c,e

Figure D-6: Steam and Feed Flows vs. Time

a,c,e

[ ]

Figure D-7: Recirculation Feedwater (RFW) Flow vs. Time

a,c,e

Figure D-8: Break and Makeup Flow vs. Time

a,c,e

Figure D-9: Pressurizer Level vs. Time

a,c,e

Figure D-10: Steam Drum Level vs. Time

a,c,e

Figure D-11: Secondary Level vs. Time

a,c,e

Figure D-12: CMT Flow vs. Time

E. Inadvertent ADS Actuation

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]a,c,e

F.1 Inadvertent Opening of a PSV

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]a,c,e

F.2 Pressurizer Spray Malfunction

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]a,c,e

[

]a,c,e

Table F.2-1: Sequence of Events

a,c,e

a,c,e

Figure F.2-1: Core Power vs. Time

a,c,e

Figure F.2-2: RCS Pressure vs. Time

a,c,e

Figure F.2-3: RCS Temperature vs. Time

a,c,e

Figure F.2-4: Pressurizer Level vs. Time

a,c,e

Figure F.2-5: Steam Drum Pressure vs. Time

a,c,e

Figure F.2-6: Steam Drum Level vs. Time

a,c,e

Figure F.2-7: PZR Spray Flow vs. Time

G. CVS Malfunction (Borated Water)

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]a,c,e

H. Rod Ejection Event

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]a,c,e

I. Inadvertent/Uncontrolled Rod Withdrawal

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[

]a,c,e

Table I-1: Sequence of Events for the Rod Withdrawal Event

a,c,e

a,c,e

Figure I-1: Core Power vs. Time

a,c,e

Figure I-2: RCS Pressure vs. Time

a,c,e

Figure I-3: RCS Temperature vs. Time

a,c,e

Figure I-4: Pressurizer Level vs. Time

a,c,e

Figure I-5: Steam Drum Pressure vs. Time

a,c,e

Figure I-6: Steam Drum Level vs. Time

J. Station Blackout– Long Term Loss of Normal Feedwater with Loss of AC

[

]a,c,e

Table J-1: Sequence of Events

a,c,e

a,c,e

Figure J-1: Core Power vs. Time

a,c,e

Figure J-2: RCS Pressure vs. Time

a,c,e

Figure J-3: RCS Temperatures vs. Time

a,c,e

Figure J-4: Pressurizer Level vs. Time

a,c,e

Figure J-5: Steam Drum Pressure vs. Time

a,c,e

Figure J-6: Steam Drum Level vs. Time

a,c,e

Figure J-7: CMT #1 Flow vs. Time

a,c,e

Figure J-8: CMT #1 Temperature vs. Time

K. Anticipated Transient Without Scram (ATWS)

K.1 General Background

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]a,c,e

K.2 Anticipated Transients Without Scram in the Westinghouse SMR

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]a,c,e

K.3 Sample ATWS Transient Response

[

]a,c,e

a,c,e

Figure K.3-1: RCS Pressure vs. Time

a,c,e

Figure K.3-2: RCS Temperature vs. Time

References

1. M.C. Smith and R.F. Wright, "Westinghouse Small Modular Reactor Passive Safety System Response to Postulated Events," *Proc. of ICAPP'12,* Chicago, U.S.A. (2012).

2. **EPRI Report NP-7450(A)**, "RETRAN-3D --- Program for transient Thermal-Hydraulic Analysis of Complex Fluid Flow Systems," Volumes 1 through 4.

3. [ ]a,c,e

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

WESTINGHOUSE SMR WET STEAMLINE DOUBLE-ENDED GUILLOTINE BREAK INSIDE CONTAINMENT VESSEL ANALYSIS

1. INTRODUCTION

The break of wet steamline inside the containment vessel is considered as a challenge to the design pressure of the containment vessel due to the large size of the wet steam line and the compact size of containment vessel. The accident is mitigated by the core trip, the passive containment cooling provided by the containment vessel wall, outside containment pool (OCP) and passive heat sinks inside the containment, and the passive core cooling provided by the natural circulation through PRHR heat exchangers.

2. WESTINGHOUSE SMR WCOBRA/TRAC-TF2 MODEL DESCRIPTION

The wet steamline break accident analysis is performed using the WCOBRA/TRAC-TF2 safety evaluation code, which is employed for the SMR LOCA analysis (detailed description in the LOCA analysis report).The wet steamline break accident analysis shares the same nodalization used in the SMR LOCA analysis. Thus, a consistency on the containment response between the LOCA and wet steamline accident is maintained. The detailed input nodalization has been provided in the LOCA analysis document, and is not repeated in the document. However, the nodalization related to the steam generator is shown in Figure 1 to illustrate the SGs secondary side design and the location of the wet steamline break. [

]a,c,e .

Initial conditions used in the wet steamline break analysis are shown in Table 1.

Table 2: Initial Condition of Wet Steamline Break inside Containment Vessel

a,c,e

a,c,e

Figure 1: The Break Location of the Steamline DEG Accident; The Break Is Inside the Containment Vessel

3. WET STEAMLINE DEG BREAK ACCIDENT ANALYSIS

In this report, double ended guillotine (DEG) break at the wet steamline inside the containment is selected as the reference case to demonstrate the SMR containment pressure response and core cooling during this postulated accident. The nominal design values of the initial and operating conditions of the Westinghouse SMR are used for the simulation as seen in Table 1. The single failure assumed in this analysis is the [ ]^{a,c,e} which covers the mitigation of containment peak pressure and a part of the long term core cooling stage.

[

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The simulation results of DEG break wet steamline inside the containment using WCOBRA/TRAC-TF2 are shown in Figures 2 through 10. Figure 2 shows that the steam generator secondary side pressure drops rapidly when the postulated accident occurs.

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]a,c,e

Table 2: Westinghouse SMR Signals and Actuations

a,c,e

Table 3: Sequence of Events for Westinghouse SMR Wet Steamline DEG Break

a,c,e

a,c,e

Figure 2: Steam Generator 2ndary Side Pressure

a,c,e

Figure 3: Containment Pressure

a,c,e

Figure 4: Break Flow - Steam Generator Side

a,c,e

Figure 5: Break Flow - Steam Drum Side

a,c,e

Figure 6: Flow Rate of SG Recirculation Line

a,c,e

Figure 7: SG Secondary Side Collapsed Liquid Level

a,c,e

Figure 8: Primary Side RCS Pressure (extended time scale)

a,c,e

Figure 9: DVI Injection Flow Rates of 4 Trains

a,c,e

Figure 10: Comparison between Core Decay Heat and Heat Removals through SG and through PRHR

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-31
Revision: 0

Question:

Please provide the information presented in pages C-1 through C-90 and C.h-1 through C.h-10 during the audit on May 2, 2013 including all tables, such as Table 1 for Trip Signals and Actuations and Table 2 for Control System Setpoints, etc., in electronic format. The event progressions and descriptions are essential for identifying limiting events for the PIRT reviews and for confirming the scope of the SBLOCA PIRT LTR.

Westinghouse Response:

The response to RAI-TR-SBLOCA-PIRT-30 – which provides the requested information – has been provided electronically on a CD. Please note the CD contains proprietary information and has been marked as such.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Westinghouse

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WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-32
Revision: 0

Question:

The uncontrolled rod withdrawal accident analysis is presented in pages C-71 through C-77 of a document made available during the audit on May 2, 2013. The event analyzed therein was an uncontrolled rod withdrawal from hot full power. Please provide the rationale for simulating the event from full power. In addition, provide similar uncontrolled rod withdrawal accident analyses from other power levels including hot zero power and subcritical conditions. Specifically, the staff is interested in the uncontrolled rod withdrawal scenario that provides the limiting 'high startup rate' and the conditions under which this rate occurs. Please also provide the power (or count rate) at which the detector threshold condition is met for detection of this event.

Westinghouse Response:

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Table 32-1 lists the sequence of events. Figure 32-1 illustrates the DNBR versus Time trace; and Figure 32-2 illustrates the Maximum RCS Pressure vs. Time trace for the Uncontrolled Rod Withdrawal event.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

Table 32-1
Uncontrolled Rod Withdrawal Sequence of Events

a,c,e

a,c,e

Figure 32-1: Uncontrolled Rod Withdrawal DNBR vs. Time

a,c,e

Figure 32-2: Uncontrolled Rod Withdrawal RCS Pressure vs. Time

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WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-33
Revision: 0

Question:

Please describe how the maximum reactivity insertion rate is determined for inadvertent CR withdrawal. Is there an associated design or Technical Specification (TS) that determines this rate? What feedback parameters are considered in the analysis? Were the analyses done with point or multi-dimensional kinetics? Are the consequences worse at Cold Zero Power (CZP)?

Westinghouse Response:

Maximum reactivity insertion rate was determined for two inadvertent control rod withdrawal transient categories:

1. Rod withdrawal at power (RWAP)
2. Rod withdrawal from subcritical (RWFS)

The maximum reactivity insertion rate was determined through [

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RWAP:

[

]a,c,e

The SAC limit is set to bound all potential future fuel cycle designs. The reload safety analysis checklist process confirms that the SAC limit for a specific reload core design is met.

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RWFS:

[

]^{a,c,e}

The SAC limit is set to bound all potential future fuel cycle designs. The reload safety analysis checklist process will confirm that the SAC limit for a specific reload core design is met.

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Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

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WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-34
Revision: 0

Question:

Please provide a description of each of the 'reactor modes' for the W-SMR.

Westinghouse Response:

MODES

MODES	TITLE	REACTIVITY CONDITION (k_{eff})	% RATED THERMAL POWER[a]	AVERAGE REACTOR COOLANT TEMPERATURE (°F)
1	Power Operation	≥ 0.99	> 5	Function of power level[d]
2	Startup	≥ 0.99	≤ 5	Function of power level[d]
3	Hot Standby	< 0.99	N/A	> 420
4	Safe Shutdown[b]	< 0.99	N/A	$420 \geq T_{avg} > 200$
5	Cold Shutdown[b]	< 0.99	N/A	≤ 200
6	Refueling[c]	N/A	N/A	N/A

Notes:
(a) Excluding decay heat.
(b) All reactor vessel closure bolts fully tensioned.
(c) One or more reactor vessel closure bolts less than fully tensioned.
(d) [
]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

PRA Revision:

None.

Technical Report (TR) Revision:

None.

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WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-35
Revision: 0

Question:

Please provide Departure from Nucleate Boiling Ratio (DNBR) plots that demonstrate the conclusion that DNBR criteria are met for the transients with Min DNBR acceptance criteria.

Westinghouse Response:

The following pages contain the DNBR plots for the following bounding transients:

- Figure 35-1 – Feedwater Malfunction event
- Figure 35-2 – Pressurizer Spray Malfunction event
- Figure 35-3 – Main Steamline Break event
- Figure 35-4 – Recirculation Steamline Break event
- Figure 35-5 – Complete Loss of Flow event

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

a,c,e

[ ]

Figure 35-1: Feedwater Malfunction DNBR vs. Time

a,c,e

Figure 35-2: PZR Spray Malfunction DNBR vs. Time

a,c,e

Figure 35-3: Main Steamline Break DNBR vs. Time

a,c,e

Figure 35-4: Recirculation Steamline Break DNBR vs. Time

a,c,e

Figure 35-5: Complete Loss of Flow DNBR vs. Time

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WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-36
Revision: 0

Question:

Please provide sequence of events for the Pressurizer Spray Malfunction and Uncontrolled Rod Withdrawal events.

Westinghouse Response:

Table 36-1 lists the Uncontrolled Rod Withdrawal at Power sequence of events.

Table 36-2 lists the Uncontrolled Rod Withdrawal at Subcritical sequence of events.

Table 36-3 lists the Pressurizer Spray Malfunction event sequence of events.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

Table 36-1
Uncontrolled Rod Withdrawal at Power Sequence of Events

Time (sec)	Description

a,c,e

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

Table 36-2
Uncontrolled Rod Withdrawal at Subcritical Sequence of Events

a,c,e

Time (sec)	Description

WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

Table 36-3
PZR Spray Malfunction Sequence of Events

a,c,e

Time (sec)	Description

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WESTINGHOUSE SMR REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-37
Revision: 0

Question:

Please clarify why the Loss of Recirculation Feedwater event is the bounding Station Blackout (SBO).

Westinghouse Response:

[

]a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.

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Westinghouse Non-Proprietary Class 3

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-38
Revision: 0

Question:

Please provide the point kinetics data used to support the transient analyses (reactivity coefficients, delayed neutron fractions, decay constants, etc.).

Westinghouse Response:

The following point kinetics data appears in the Safety Analysis Checklist (SAC) interface document to support the transient analyses:

a,c,e

Reference:

None.

Design Control Document (DCD) Revision:

None.

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

PRA Revision:

None.

Technical Report (TR) Revision:

None.

a,c,e

Figure 1: SMR Trip Reactivity Shape SAC Limit

Westinghouse

WESTINGHOUSE SMR REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR-SBLOCA-PIRT-39
Revision: 0

Question:

Please describe normal alignment of the CVCS. Is there a possible normal alignment of the CVCS that could result in unborated water injection?

Westinghouse Response:

The normal CVS alignment includes charging pumps that can draw water from both the demineralized water system and the boric acid storage tank. Two control valves blend these two streams to achieve the desired boron concentration to a common charging pump header. The charging pump output controls flowrate from the CVS to the primary system. Because the charging pumps are connected to the demineralized water system, it is possible to inject unborated water. This risk is being mitigated by mechanically limiting charging pump flow rate below a value that could cause a boron dilution event during plant modes other than refueling. Potential dilution sources will be isolated (closed valves) during refueling operations.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

None.