

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: 724-940-8505 e-mail: sisk1rb@westinghouse.com

Your ref: PROJ0797 Our ref: SMR_NRC_000035

March 4, 2014

Subject: SMR Response to Request for Additional Information

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-W SMR Test Plan and Scaling-79 P & NP RAI-W SMR Test Plan and Scaling-80 P & NP RAI-W SMR Test Plan and Scaling-81 P & NP RAI-W SMR Test Plan and Scaling-82 P & NP RAI-W SMR Test Plan and Scaling-83 P & NP RAI-W SMR Test Plan and Scaling-84 P & NP RAI-W SMR Test Plan and Scaling-85 (NP Only) RAI-TR-SBLOCA-PIRT-103 R2 P & NP

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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-14-3901 (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 version of the responses. Enclosure 4 is the non-proprietary version 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-14-3901 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,

Rate B. Jule

Robert B. Sisk Acting Director, Small Modular Reactor

/Enclosures

- 1. AW-14-3901"Application for Withholding Proprietary Information from Disclosure," dated March 4, 2014
- 2. AW-14-3901, Affidavit, Proprietary Information Notice, Copyright Notice dated March 4, 2014
- 3. SMR Response to Request for Additional Information (Proprietary)
- 4. SMR Response to Request for Additional Information (Non-Proprietary)
- cc: Arlon Costa U.S. NRC Anna Bradford

ENCLOSURE 1

AW-14-3901

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM DISCLOSURE

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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-14-3901

March 4, 2014

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: SMR Response to Request for Additional Information

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-14-3901 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-14-3901 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,

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Robert B. Sisk Acting Director, Small Modular Reactor

ENCLOSURE 2

AFFIDAVIT

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF BUTLER:

Before me, the undersigned authority, personally appeared Robert B. Sisk, 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:

TB. het

Robert B. Sisk Acting Director, Small Modular Reactor

Sworn to and subscribed before me this AHAday of March 2014.

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

Sinda &

Jotary Public

- (1) I am Acting Director, Small Modular Reactor, 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.
- 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_000035, "SMR Response to Request for Additional Information", 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

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.390 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

ENCLOSURE 4

(Non-Proprietary Responses)

RAI-W SMR Test Plan and Scaling-79 NP RAI-W SMR Test Plan and Scaling-80 NP RAI-W SMR Test Plan and Scaling-81 NP RAI-W SMR Test Plan and Scaling-82 NP

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RAI-W SMR Test Plan and Scaling-83 NP RAI-W SMR Test Plan and Scaling-84 NP RAI-W SMR Test Plan and Scaling-85 (NP Only) RAI-TR-SBLOCA-PIRT-103 R2 NP

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

RAI Response Number: Revision: 0 RAI-W SMR Test Plan and Scaling-79

Question:

Follow-up to RAI-TR-SBLOCA-PIRT-91: The changes due to RAI-TR-SBLOCA-PIRT-91 as shown in response to RAI-TR-SBLOCA-PIRT-103 simply alter the importance ranking for [

]^{a,c}

Westinghouse Response:

SMR_NRC_000034, "SMR Response to Request for Addition Information (SBLOCA PIRT)," February 14, 2014 contains Revision 1 to RAI-TR-SBLOCA-PIRT-91 which addresses this question.

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: Revision: 0 RAI-W SMR Test Plan and Scaling-80

Question:

Follow-up to RAI-TR SBLOCA PIRT-75: According to the response to RAI-TR-SBLOCA-PIRT-74, Westinghouse has agreed that the [

1^{a,c}.

Similarly, the response to RAI-TR-SBLOCA-PIRT-74 also states that there is [

J^{a.c.} However, the updated version of Figure 3-2 shown in response to RAI-TR-SBLOCA-PIRT-103 does not appear to capture these changes. Figure 3-2 shown in response to RAI-TR-SBLOCA-PIRT-103 continues to states that the SDGVs [

 $J^{a,c}$." Please make appropriate changes to Figures 3-2 and 3-3.

Westinghouse Response:

Figure 3-2 and 3-3 of WCAP-17573 are modified as follows: [

]^{a,c}

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

WCAP-17573 will be revised as described in the response. The changes are provided in a revision to the response provided for RAI-TR-SBLOCA-PIRT-103.

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

RAI Response Number: Revision: 0

RAI-W SMR Test Plan and Scaling-81

Question:

Follow-up to RAI-TR SBLOCA PIRT-78: The response cites [

1^{a,c}

Westinghouse Response:

[

]^{a,c}

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: Revision: 0 RAI-W SMR Test Plan and Scaling-82

Question:

Follow-up to RAI-TR SBLOCA PIRT-89: The response to the original RAI provided justification for the importance ranking which is acceptable. However, the rationale for the corresponding importance ranking still states that a [

]^{a,c}." It is not clear how the [

J^{a,c}. The rationale is expected to incorporate the justification provided in response to the RAI. Please clarify the rationale and/or make appropriate changes.

Westinghouse Response:

L

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

WCAP-17573 will be revised as described in the response. The changes are provided in a revision to the response provided for RAI-TR-SBLOCA-PIRT-103.

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

RAI Response Number: Revision: 0 RAI-W SMR Test Plan and Scaling-83

Question:

Follow-up to RAI-TR SBLOCA PIRT-99: Even though the response to the original RAI is acceptable, the definition for the [J^{a,c} phenomenon (D37 in Table 3-2 of the LTR) is unclear and does not contain the clarification provided in response to part (a) of the RAI. It is recommended that the definition be updated to clarify the phenomenon T.1.e to improve the LTR and facilitate review.

Westinghouse Response:

[

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

WCAP-17573 will be revised as described in the response. The changes are provided in a revision to the response provided for RAI-TR-SBLOCA-PIRT-103.

]^{a,c}

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

RAI Response Number: Revision: 0 RAI-W SMR Test Plan and Scaling-84

Question:

Follow-up to RAI-TR-SBLOCA-PIRT-88: The original RAI only questioned the knowledge ranking form phenomenon E.1 in Table 3-3. The response to the original RAI agreed to change the knowledge ranking to [J^{a,c}. However, the response to the original RAI also changed, without justification, the importance ranking for the phenomena to [J^{a,c} as seen in the response to RAI-TR-SBLOCA-PIRT-103. The importance ranking was never questioned in the original RAI. Furthermore, detailed justification for decreasing the importance ranking is necessary. Please explain the reason for changing the

importance ranking for phenomenon E.1.

Westinghouse Response:

]

l^{a,c}

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

WCAP-17573-P Table 3-3 will be updated to change the importance for E.1 from "L" to "M".

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

RAI Response Number: Revision: 0 RAI-W SMR Test Plan and Scaling-85

Question:

Follow-up to RAI-TR SBLOCA PIRT-164: The response did not provide sufficient information for staff evaluation. Please supply more information on how the process is modeled in the code, not just the code name and its version.

Westinghouse Response:

SMR_NRC_000034, "SMR Response to Request for Addition Information (SBLOCA PIRT)," February 14, 2014 contains Revision 1 to RAI-TR-SBLOCA-PIRT-164 which addresses this question.

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: Revision: 2 RAI-TR-SBLOCA-PIRT-103

Question:

Please provide a table summarizing the changes to the WCAP-17573-P due to the responses to RAI-TR-SBLOCA-PIRT-69 through -102.

Westinghouse Response:

Table 103-1 provides a summary of the changes to WCAP-17573-P that were discussed in response to RAI-TR-SBLOCA-PIRT-69 through -102. Note that in addition to the changes identified in the responses to these RAIs, related pages were updated and included in Table 103-1 for consistency.

Revision 1:

Based on the revised response provided in RAI-TR-SBLOCA-PIRT-91, Revision 1, an additional change to WCAP-17573-P is required beyond those provided in Revision 0 of RAI-TR-SBLOCA-PIRT-103. Table 103-1 is updated for this change.

Revision 2:

Table 103-2 provides a summary of the changes to WCAP-17573-P that were discussed in response to RAI-W SMR Test Plan and Scaling-80 through -84.

Reference:

None.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

Technical Report (TR) Revision:

The changes described in Tables 103-1 and 103-2 are attached in the form of markups to WCAP-17573-P.

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

Table 103-1Summary of Changes Made in Response toRAI-TR-SBLOCA-PIRT-69 through -102

RAI Number	Summary of Change	Impacted Page Number(s) from WCAP-17573-P, Revision 1
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RAI Number	Summary of Change	Impacted Page Number(s) from WCAP-17573-P, Revision 1

RAI Number	Summary of Change	Impacted Page Number(s) from WCAP-17573-P, Revision 1
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RAI Number	Summary of Change	Impacted Page Number(s) from WCAP-17573-P, Revision 1	а

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

Table 103-2Summary of Changes Made in Response toRAI-W SMR Test Plan and Scaling-80 through -84

RAI Number	Summary of Change	Impacted Page Number(s) from WCAP-17573-P, Revision 1
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LIST OF ACRONYMS

ADS	Automatic Depressurization System
ADS-1	ADS Stage One
ADS-2	ADS Stage Two
CCFL	Counter Current Flow Limitation
CHF	Critical Heat Flux
CMT	Core Makeup Tank
CRDM	Control Rod Drive Mechanism
CSAU	Code Scaling, Applicability, and Uncertainty
CV	Containment Vessel
DVI	Direct Vessel Injection
FoM	Figure of Merit
ICP	In-containment Pool
IET	Integral Effects Test
iPWR	Integral PWR
IRWST	In-containment Refueling Water Storage Tank
IVR	In-vessel Retention
LBLOCA	Large Break LOCA
LOCA	Loss-of-Coolant Accident
LTCC	Long-term Core Cooling
MFIV	Main Feed Isolation Valve
MSIV	Main Steam Isolation Valve
OCP	Outside Containment Pool
PCCWST	Passive Containment Cooling Water Storage Tank
PIRT	Phenomena Identification and Ranking Table
PLS	Plant Control System
PMS	Protection Monitoring System
PORV	Power Operated Relief Valve
PRHR	Passive Residual Heat Removal
RCCA	Rod Cluster Control Assembly
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RFA	Robust Fuel Assembly
RV	Reactor Vessel
SBLOCA	Small Break LOCA
SCV	Sump Coupling Valve
SDIV	Steam Drum Isolation Valve
SET	Separate Effects Test
SG	Steam Generator
SGDV	Steam Generator Depressurization Valve
SIT	Sump Injection Tank
SMR	Small Modular Reactor
SoK	State of Knowledge
UHS	Ultimate Heat Sink

Figure ES-1 Scenario Selection Process

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The second means of removing heat is through the passive residual heat removal (PRHR) heat exchanger which is connected to the RCS, and is situated in the IRWST at an elevation above the reactor core. The PRHR heat exchanger is maintained at RCS pressure, and isolation valves at the outlet prevent flow during normal operation. In the event of an S-Signal, the isolation valves are opened, hot reactor coolant enters the PRHR heat exchanger from the RCS hot leg, and transfers heat to the IRWST. Cold water is returned to the RCS cold leg. The water in the IRWST is heated, reaches saturation, and generates steam. The steam is condensed on the containment. Then, heat is conducted through the wall and is removed by the PCS.

The **AP1000** plant uses nitrogen-charged accumulators to provide post-LOCA makeup water to the reactor. After the accumulators empty, the nitrogen expands into the RCS and accumulates in the high points including the reactor vessel head, steam generator tubes, and the PRHR tubes. After becoming filled with nitrogen, the PRHR heat exchanger becomes less effective and nearly all decay heat removal is through the ADS valves into containment. Accumulators are the primary defense for large break LOCAs. (There are no large break LOCAs in the Westinghouse SMR.)

1.2.4 Long-Term Core Makeup Water Supply

Westinghouse SMR



AP1000 Plant

For the **AP1000** plant, the CMTs also provide makeup flow at all RCS pressures. After the ADS valves are actuated, the RCS pressure falls and the nitrogen-charged accumulators begin to inject. As the RCS pressure is equalized with the containment, gravity injection of the IRWST water starts when the pressure difference is less than the hydrostatic head in the IRWST.

Condensed steam from the containment fills the containment sump. As the sump level increases, valves are opened between the sump and the IRWST creating one source of water. The CMTs, accumulators, IRWST and sump all inject into the reactor vessel downcomer through two direct vessel injection (DVI) lines.

The IRWST injection in the **AP1000** plant is functionally similar to the ICP tank-SIT gravity injection in the Westinghouse SMR. The sump injections for the two designs are also functionally similar.

Additional information regarding the PIRT panel and the qualifications of the panel members are provided in Appendix A.

Although not considered panel members, the project was supported by Westinghouse SMR experts. These individuals were Westinghouse engineers responsible for various areas of the Westinghouse SMR design. To insure transparency in the process, the role of the Westinghouse SMR experts was to address requests for information from the PIRT panel.

1.5 REPORT STRUCTURE

The PIRT methodology used for this SBLOCA application is described in Section 2. Section 2.1 focuses on the generalized PIRT process. Section 2.2 then expands the generalized process to those features common to the SBLOCA scenario addressed. Section 3 presents the results of the PIRT in several tables. The significant conclusions drawn from the results are given in Section 4.

Table 1-1	Westinghouse SMR Co	omponent Descriptions	a
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Table 1-1 (cont.)	Westinghouse SMR Cor	nponent Descriptions	
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WCAP-17573-NP

Table 1-2	Westinghouse SMR Important Dimensions	
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Table 1-3	Westinghouse SMR Normal Operating Conditions		a
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Figure 1-1 Schematic of Safety Systems Design





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WESTINGHOUSE NON-PROPRIETARY CLASS 3

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2.2.4 System, Component and Scenario Specifications

A hierarchical system break down in subsystems and components was performed in order to complete the PIRT. For example, a reactor design can be partitioned into systems and components within those systems. As noted in the previous section, a sufficiently mature design database existed to partition the plant into systems and components that provided a logical framework for the subsequent plausible phenomena identification (see subsection 2.2.6). The systems and components are described in Table 1-1.

For reasons already given, this PIRT effort was directed to SBLOCAs. Postulated breaks that were considered by the PIRT panel include:

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Table 2-1	Westinghous	e SMR SBLOCA Scenario Description	<u>a,c,e</u>
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Table 2-1 Westinghouse SMR SBLOCA Scenario Description (cont.) (cont.)		a
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2.2.5 Figures of Merit

Figures of Merit are those criteria against which the relative importance of each "phenomenon" is judged. Successful figures of merit have distinct characteristics, and in particular they are (1) directly related to the issue(s) being addressed by a PIRT, (2) directly related to the phenomena being assessed for relative importance, (3) easily comprehended, (4) explicit, and (5) measurable. In this context, the design goals of the Westinghouse SMR design provide the basis for selection of suitable Figures of Merit. The design goals are to:

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Accordingly, the Figures of Merit appropriate to the SBLOCA PIRT are consistent throughout all four phases of the scenarios and are: the core coolant inventory as associated with successful removal of the initial stored energy and core decay heat, the containment pressure and successful heat removal to the environment, and the demonstration of long-term core coolability accounting for debris and chemical precipitation as indicated by a core exit quality less than one. Figure 2-3 shows the SBLOCA Figures of Merit from above as predicted from models as a function of time.

a,c,e

Figure 2-3 SBLOCA Figures of Merit

2.2.6 Phenomena Identification

In the PIRT process, phenomena are broadly defined. Plausible phenomena are those physical behaviors and/or processes that may have some influence in reactor plant's response. It is important to clearly characterize the plausible phenomena before a PIRT panel considers what safety importance (ranking) a phenomenon may have in influencing the plant response. That is, the panel first considers all possible physical behaviors and/or processes that may occur before evaluating if each phenomenon has real

3 **SBLOCA SCENARIO PIRT RESULTS**

3.1 **INTRODUCTION**

The general scenario including system and component descriptions and phase details were described in Sections 1 and 2, respectively. A list of plausible phenomena is provided in Table 3-1. As might be expected, the plausible phenomena are cast in terms of the component partitioning already described. Descriptions of the phenomena are also provided in Table 3-2. Additional information relative to the expected scenario progression is given in the following section.

Table 3-1 Plausible Phenomena		

Table 3-1 Plausible Phenomena (cont.)		
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Table 3-1 Plausible Phenomena (cont.) (cont.)		
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Table 3-1 (cont.)	Plausible Phenomena	a
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(cont.)	Plausible Phenom	ena Descriptions
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Table 3-2 (cont.)	Plausible Pho	nomena Descriptions	
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3.2 EXPECTED SCENARIO PROGRESSION

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3.3 RANKING RESULTS

The complete body of ranking results for the DVI break is provided in Tables 3-3, 3-4, and 3-5. Table 3-3 shows the phenomena safety rank for each phase and the state of knowledge rank. Also, listed in this table are rationale codes for each safety rank (denoted as PX) and state of knowledge rank (denoted as SX). These codes correspond to the descriptions given for every safety rank rationale and state of knowledge rank rationale in Tables 3-4 and 3-5, respectively.

3-15

Figure 3-1 Westinghouse SMR During Normal Operation

Figure 3-2 Westinghouse SMR During a SBLOCA Blowdown Phase (Phase 1)

Figure 3-3 Westinghouse SMR during a SBLOCA CMT Natural Circulation and Draining Phase (Phase 2)

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Figure 3-4 Westinghouse SMR during a SBLOCA ADS Phase (Phase 3)

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Figure 3-5 Westinghouse SMR During a SBLOCA Long-term Core Cooling Phase (Phase 4)

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Table 3-3 Phe (cont.)	nomena Importance	 			-		
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Table 3-4 (cont.)	Safety Ranking Rationales	
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Table 3-5 (cont.)	State of Knowledge Ranking Rationales	
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Table 4-1High Safety and Low State of Knowledge Ranking Phenomena Recommendations(cont.)							
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4.3.2 Recommendations to Support Phenomena with High Safety and Moderate State of Knowledge Ranking

Table 4-2 lists all phenomena that received a high safety ranking in at least one phase of a SBLOCA scenario and also a moderate SoK rank. The table describes the recommendations that may be considered to increase the SoK. In some cases, the information can be developed using tests while in other cases, a bounding approach in the computer simulation can be used.

APPENDIX B AP600 PLANT PROGRAM TEST SUMMARIES

The following provides a summary of each **AP600** plant test including their purpose, a description of the facility, and a discussion of the test matrix/results.

B.1 PASSIVE CORE COOLING SYSTEM (PXS) TEST SUMMARIES

The following tests were performed for the PXS:

- Departure from Nucleate Boiling (DNB) test (subsection B.1.1)
- Passive Residual Heat Removal Heat Exchanger (PRHR HX) test (subsection B.1.2)
- Automatic Depressurization System (ADS) test, phase A (subsection B.1.3)
- ADS test, phase B (subsection B.1.4)
- Core Makeup Test (CMT) test (subsection B.1.5)
- Low-pressure, integral systems test, OSU (subsection B.1.6)
- Low-pressure, integral systems test, OSU-NRC (subsection B1.7)
- High-pressure, integral systems test, SPES-2 (subsection B.1.8)
- High-pressure, integral systems test, ROSA-**AP600** (subsection B.1.9)

B.1.1 DNB Tests

General Purpose/Description

While low-flow DNB tests have been performed successfully on other fuel assembly geometries, data accumulated over several years of testing on the current Westinghouse fuel designs have concentrated on the higher flow range associated with operating conditions of conventional, higher-power density cores. The purpose of these tests was to determine the critical heat flux (CFICHF) performance of the AP600 plant fuel assembly design, particularly at low-flow conditions. In addition, the effect on CHF of the intermediate flow mixer (IFM) grids at low-flow conditions was measured.

The test objective was to gather CHF data on typical and thimble cell **AP600** plant bundle geometry covering the range of fluid conditions anticipated during **AP600** plant DNB-related ANS Condition I and II transients. The conditions cover the following ranges:

Pressure:	1500 to 2400 psia
Mass velocity:	$0.5 \text{ to } 3.5 \text{ x } 10^6 \text{ lbm/hr-ft}^2$
Inlet temperature:	380° to 620°F

Also, a typical cell test where the **AP600** plant bundle has the IFM grids replaced by simple support grids (SSGs) was run to assess the effect of the IFMs at low-flow conditions.

To perform a series of low-flow tests, two test bundles were constructed. The test bundles consisted of a small 5 by 5 array of rods, which are electrically heated and well-instrumented with thermocouples. The components for the test bundles were shipped to the test site, Columbia University, and assembled just prior to testing.