~~Proprietary Information – Withhold From Public Disclosure Under 10 CFR 2.390~~
~~The balance of this letter may be considered non-proprietary upon removal of Attachment 3.~~

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John C. Dinelli
Site Vice President
Waterford 3

10 CFR 50.90

W3F1-2019-0002

January 19, 2019

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

Subject: Response to U. S. Nuclear Regulatory Commission Request for Additional Information Regarding License Amendment Request Regarding Use of the TRANFLOW Code for Determining the Pressure Drops Across the Steam Generator Secondary Side Internal Components

Waterford Steam Electric Station, Unit 3 (Waterford 3)
NRC Docket No. 50-382
Renewed Facility Operating License No. NPF-38

By letter dated April 12, 2018 (Reference 1), Entergy requested an amendment to revise the Waterford 3 Updated Final Safety Analysis Report (UFSAR), Section 3.9, to incorporate the TRANFLOW computer code for determining the pressure drops across the steam generator secondary side internal components.

By letter dated June 1, 2018 (Reference 2), the NRC notified Entergy that the NRC staff reviewed the submittal and determined that additional information was necessary to enable the staff to make an independent assessment regarding the acceptability of the proposed amendment in terms of regulatory requirements and the protection of public health and safety and the environment. By letter dated June 13, 2018 (Reference 3), Entergy provided the supplemental information requested by the NRC.

By letter dated November 26, 2018 (Reference 4), the NRC staff informed Entergy that they have reviewed the license amendment request and the supplemental information and have determined that additional information is required to complete the review. A public teleconference was previously held on November 15, 2018.

The additional information requested by the NRC in Reference 4 is provided in the Enclosure to this letter.

Attached to the Enclosure are:

- Westinghouse Letter LTR-SGMP-18-45 NP-Attachment, "Responses to Request for Additional Information Regarding Waterford 3 Amendment Request for Revision of UFSAR Section 3.9 to Incorporate the TRANFLOW Computer Code," (Non-Proprietary) (Attachment 1).

- Westinghouse Letter LTR-SGMP-18-45 P-Attachment, "Responses to Request for Additional Information Regarding Waterford 3 Amendment Request for Revision of UFSAR Section 3.9 to Incorporate the TRANFLOW Computer Code," (Proprietary) (Attachment 3).

Also attached to the Enclosure is the following:

- Westinghouse Letter CAW-19-4851, "Application for Withholding Proprietary Information from Public Disclosure, accompanying Affidavit, Proprietary Information Notice, and Copyright Notice (Attachment 2).

As Attachment 3 contains information proprietary to Westinghouse Electric Company LLC ("Westinghouse"), it is supported by an Affidavit signed by Westinghouse, the owner of the information. The Affidavit sets forth the basis on which the information may be withheld from public disclosure by the Nuclear Regulatory Commission ("Commission") and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.390 of the Commission's regulations.

Accordingly, it is respectfully requested that the 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 the copyright or proprietary aspects of the items listed above or the supporting Westinghouse Affidavit should reference CAW-19-4851 and should be addressed to Camille T. Zozula, Manager, Infrastructure & Facilities Licensing, Westinghouse Electric Company, 1000 Westinghouse Drive, Building 2 Suite 259, Cranberry Township, Pennsylvania 16066.

This submittal contains no new regulatory commitments.

If you have any questions or require additional information, please contact the Acting Regulatory Assurance Manager, John V. Signorelli, at (504) 739-6032.

I declare under penalty of perjury that the foregoing is true and correct. Executed on January 19, 2019.

Respectfully,

John C. Dinelli

JCD/mmz

References:

1. Entergy Operations, Inc. (Entergy) letter W3F1-2018-0014 to U. S. Nuclear Regulatory Commission (NRC), "License Amendment Request for Use of the TRANFLOW Code for Determining the Pressure Drops Across the Steam Generator Secondary Side Internal Components," dated April 12, 2018 (ADAMS Accession Number ML18106A074)

2. NRC letter to Entergy, "Waterford Steam Electric Station, Unit 3 – Supplemental Information Needed for Acceptance of Requested Licensing Action Re: Use of the TRANFLOW Code for Determining Pressure Drops Across Steam Generator Secondary Side Internal Components (EPID L-2018-LLA-0112)," dated June 1, 2018 (ADAMS Accession Number ML18145A265)

3. Entergy letter W3F1-2018-0031 to NRC, "Supplemental Information Supporting the License Amendment Request Regarding Use of the TRANFLOW Code for Determining the Pressure Drops Across the Steam Generator Secondary Side Internal Components," dated June 13, 2018 (ADAMS Accession Number ML18169A275)

4. NRC letter to Entergy, " Waterford Steam Electric Station, Unit 3 – Request for Additional Information Regarding License Amendment Request for Use of the TRANFLOW Code for Determining Pressure Drops Across the Steam Generator Secondary Side Internal Components (EPID L-2018-LLA-0112)," dated November 26, 2018 (ADAMS Accession Number ML18320A090)

Enclosure: Response to NRC Request for Additional Information
Attachment 1: Westinghouse Letter LTR-SGMP-18-45 NP-Attachment, Rev. 0
Attachment 2: Westinghouse Letter CAW-19-4851
Attachment 3: Westinghouse Letter LTR-SGMP-18-45 P-Attachment, Rev. 0

cc: NRC Region IV Regional Administrator
NRC Senior Resident Inspector – Waterford Steam Electric Station, Unit 3
NRR Project Manager
Louisiana Department of Environmental Quality, Office of Environmental Compliance, Surveillance Division

ENCLOSURE

W3F1-2019-0002

Entergy Operations, Inc.

Response to NRC Request for Additional Information

Attachment 1: Westinghouse Letter LTR-SGMP-18-45 NP-Attachment, Rev. 0

Attachment 2: Westinghouse Letter CAW-19-4851

Attachment 3: Westinghouse Letter LTR-SGMP-18-45 P-Attachment, Rev. 0

Additional Information Requested by the NRC. *Entergy responses are in italics.*

1. To make its determination, the NRC staff requires additional information regarding drift-flux models. The supplement to the application dated June 13, 2018 (ADAMS Accession No. ML18169A275), indicated that TRANFLO received a major update in 1980 that implemented a drift-flux model (as compared to the homogeneous model employed in the original version). Provide additional information and documentation regarding the drift-flux model implemented in TRANFLOW. Documentation should specifically be provided on:

    a. The conservation equations (mass, momentum, and energy)
    b. Void-quality relations
    c. Heat transfer models (including boiling models)
    d. Pressure drop models (including skin friction, form losses, and expansion models)
    e. Any new models used in the Waterford 3 analysis added following NRC approval of TRANFLO.

    The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 2 of 34.

2. Explain whether countercurrent flow limitation or condensation models are included in the version of TRANFLOW used at Waterford 3. Discuss whether it is conservative or not conservative to use such models in the evaluation of steam generator internals pressure drop.

    The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 11 of 34.

3. Describe the implementation of heat storage in and heat transfer to and from the steam generator metal mass, which is included in TRANFLOW as used at Waterford 3 (based on the supplement dated June 13, 2018) but does not appear to be in the NRC-approved version of TRANFLO.

    The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 13 of 34.

4. Table 1 of the original submittal dated April 12, 2018, showed that pressure drop caused by crossflow over the steam generator tube U-bend was included in the original steam generator design basis calculations but not in the TRANFLOW calculations. Explain why this pressure drop was not included in the replacement steam generator analysis.

    The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 14 of 34.

5. The NRC staff's original approval of TRANFLO indicated that data was passed back and forth between TRANFLO and MARVEL, a thermal-hydraulic systems analysis code, to determine both the primary and secondary system responses. However, the response to Sufficiency Item No. 2 in the supplement dated June 13, 2018, states that the primary side volumes were characterized in TRANFLOW as "constant pressure nodes with nodal temperature determined from the energy equation." Given that a full reactor simulation

of the main steam line break would indicate that the primary system cools and depressurizes over the course of the transient, justify this assumption.

The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 11 of 34.

6. The June 1, 2018, request for supplemental information included a request for information regarding the input biases applied in the TRANFLOW analysis and a discussion of how the input biases would produce conservative results. The response dated June 13, 2018, stated that hot standby conditions were considered to be conservative, as they would result in the highest initial steam generator pressure. The response also included a study that demonstrated that it was most conservative to assume the initial water level in the steam generators to be at the top tube support plate. The response, however, did not discuss the assumptions related to the characteristics of the steam line break, such as the break size or discharge coefficient. Describe the break conditions assumed in the analysis, and how are they known to be limiting.

   The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 16 of 34.

7. Explain whether main steam line flow restrictors were modeled in the TRANFLOW analysis.

   The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 18 of 34.

8. Discuss how the primary steam separators are modeled in the Waterford 3 steam line break analysis performed with TRANFLOW.

   The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 19 of 34.

9. Westinghouse letter LTR-SGMP-17-107 NP-Attachment, "Acceptability of the TRANFLOW Computer Code for Steam Line Break Internal Pressure Loads for the Waterford Unit 3 Replacement Steam Generators," Rev. 0, was included as attachment 4 to the licensee's supplemental information letter. (A publicly available version of this letter is included in the supplement dated June 13, 2018 (ADAMS Accession No. ML18169A275)). Section 3.3 of Appendix A of this document provides qualification of TRANFLOW versus test data, as requested by the NRC. However, the plots provided throughout this section to provide comparisons between measurement and prediction appear to be excerpted from the original TRANFLO topical report. Please explain if the validation in Section 3.3 was performed with the revised version of TRANFLOW. If not, justify why such validation against test data is not needed for the version of TRANFLOW used in the Waterford 3 analysis, which appears to have implemented completely different versions of the conservation equations and constitutive relations from that approved by the NRC.

   The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 20 of 34.

10. Section 3.1 of LTR-SGMP-17-107 NP-Attachment provides a benchmark of TRANFLOW to RELAP5. Table 3.1-1 demonstrates that pressure drops on the tube support plates calculated by TRANFLOW tend to differ from the pressure drops calculated by RELAP5. Please provide further discussion on why this difference exists and is acceptable, considering RELAP5 contains newer, higher fidelity models than TRANFLOW.

    The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 26 of 34.

11. Westinghouse Letter LTR-SGMP-18-20 NP-Attachment, "Responses to Waterford Unit 3 TRANFLOW License Amendment Request, Non-Accept Sufficiency Items," Rev. 1, was included as Attachment 1 to the licensee's supplemental information letter. (A publicly available version of this letter is included in the supplement dated June 13, 2018 (ADAMS Accession No. ML18169A275)). The Westinghouse Letter LTR-SGMP-18-20 states, in part, that

    > The TRANFLOW calculated values of thermal-hydraulic (TH) parameters: pressures, pressure loads (ΔPs), flow rates, flow loads (ρV2), bulk fluid temperatures, metal surface temperatures and film heat transfer coefficients are used in the downstream structural, fatigue and non-ductile failure analyses in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components.

Moreover, it is stated that,

> TRANFLOW is a one-dimensional, two-phase, thermal-hydraulic code used for calculating the thermodynamic and fluid (hydraulic) behavior of steam generators subject to prescribed transient conditions. The code calculates pressures, temperatures, flow rates, and heat transfer coefficients, which are used as inputs for structural analyses. TRANFLOW uses an elemental volume approach in which the spatial solution is achieved by dividing the system into a discrete number of control volumes having uniform thermal and hydraulic conditions.

One-dimensional TH analyses typically use significant course nodalization compared to three-dimensional (3D) finite element analysis (FEA) models used to analyze stresses for Section III. Describe how the TRANFLOW results are interpolated and what is assumed (i.e., asymmetry) when using them as inputs to 3D FEA models to assess fatigue and non-ductile failure analyses in accordance with Section III. Specifically, please provide information on how the nodal time history temperature and pressure information is applied to a finite element model to generate stresses and vibratory responses in the steam generator for the following components, where applicable:

a. Tube sheets
b. Tube to tube sheet welds
c. Lower shell, transition cone and upper shell
d. Primary separator assembly

The response can be found on Attachment 1(3), Westinghouse Letter LTR-SGMP-18-45 NP(P)-Attachment, Rev. 0, starting on page 28 of 34.

ENCLOSURE, ATTACHMENT 1

W3F1-2019-0002

Westinghouse Letter LTR-SGMP-18-45 NP-Attachment, Rev. 0

LTR-SGMP-18-45 NP-Attachment
Rev. 0

Westinghouse Electric Company

Responses to Request for Additional Information Regarding Waterford 3 Amendment Request for Revision of UFSAR Section 3.9 to Incorporate the TRANFLOW Computer Code

January 7, 2019

Authors:
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Reviewer:
Gary W. Whiteman* (Questions 1 through 11)
Plant Licensing and Engineering

Approved:
Michael E. Bradley*, Manager
Component Design & Management Programs

By letter dated April 12, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18106A074), Entergy Operations Incorporated (the licensee) submitted a License Amendment Request (LAR) to revise the Waterford Steam Electric Station, Unit 3 (Waterford 3) Updated Final Safety Analysis Report (UFSAR) Section 3.9 to incorporate the TRANFLOW computer code. By letter dated June 1, 2018 (ADAMS Accession No. ML18145A265), the NRC requested supplemental information to the application. A response to the request for supplemental information was provided by letter dated June 13, 2018 (ADAMS Accession No. ML18169A275),

The purpose of the license amendment is to approve TRANFLOW as the method of evaluation for calculation of internal loads in the Waterford 3 replacement steam generators during a postulated steam line break (SLB). Specifically, subsection 3.9.1.2.2.1.28 of the UFSAR, which describes that the computer code CEFLASH-4A is used to calculate internal loadings following a postulated main steam line break, will be deleted to document this change.

1. To make its determination, the NRC Staff requires additional information regarding drift-flux models. The supplement to the application dated June 13, 2018 (ADAMS Accession No. ML18169A275), indicated that TRANFLO received a major update in 1980 that implemented a drift-flux model (as compared to the homogeneous model employed in the original version). Provide additional information and documentation regarding the drift-flux model implemented in TRANFLOW. Documentation should specifically be provided on:

    a. The conservation equations (mass, momentum, and energy)
    b. Void-quality relations
    c. Heat transfer models (including boiling models)
    d. Pressure drop models (including skin friction, form losses, and expansion models)
    e. Any new models used in the Waterford 3 analysis added following NRC approval of TRANFLO.

    <u>Response</u>:

    The fluid flow equations currently used in TRANFLOW are based on the one-dimensional drift flux formulation of the conservation equations for mass, energy and momentum of the two-phase mixture. The form of the conservation equations, integrated over a control volume, are given below, and a comparison is made to the original homogenous void fraction versions of the conservation equations. The following sketch identifies the subscripts used in the equations.

a,c

TRANFLOW requires that data is input in specific units. The time unit is seconds; the length unit is feet. The temperature unit is °F; the mass unit is lbm. All other properties and quantities are derived from these units; however, the derived pressure is also converted to psi.

The following equations are from Reference 2, unless otherwise noted.

Mass Conservation

a,c

where,

a,c

The conservation of mass is calculated as the change in nodal mass plus the sum of the mass "in" minus the mass "out" equals zero. For the conservation of mass there is no difference between the drift flux and homogeneous void fraction models.

Energy Conservation

a,c

where,

a,c

a,c

The conservation of energy is the change in internal energy plus the sum of the enthalpy "in" minus the enthalpy "out" plus the interfacial energy exchange is equal to the opposite of the sum of the heat "in" minus the heat "out." The interfacial energy exchange term was previously based upon a phase slip correlation and a homogeneous void fraction based upon the Armand two-phase flow correlation. This has been replaced with the drift flux

formulation which relates the counterflow between phases to their relative velocity and the quality.

Momentum Equation

[ ]a,c

where,

[ ]a,c

The conservation of momentum is the change in thermodynamic pressure minus the expansion and form losses and minus the skin friction losses and plus the change in elevation pressure head. In the drift flux formulation, the skin friction losses are calculated considering a [ ]a,c.

Void Fraction and Quality

The original TRANFLO code (Reference 1) used an experimental phase slip correlation, where the homogenous void fraction of the node was used to calculate a flowing quality, x_f, that accounted for slip between the phases:

[ ]a,c

where,

[ ] a,c

In the drift flux formulation (Reference 2), the counterflow between phases is dependent on [ ]a,c. In the drift flux formulation the [ ]a,c. In the drift flux formulation, the total mass flux is a combination of cocurrent (or traditional homogenous flow) and countercurrent flows of the steam and liquid phases. The density of the mixed fluid is a function of the quality, while the relative velocity between the phases is a function of both the quality and the mass flux. The mass flux is determined by simultaneously solving equations to identify a transition point between positive cocurrent and negative countercurrent flows such that the separate steam and liquid mass flows are conserved, and the energy transfer and total mass flow equations are also conserved.

In the drift flux formulation, the mass flow rates are:

[ ] a,c

where,

[ ]a,c

In calculating [ ]a,c is selected by the TRANFLOW code.

Heat Transfer Models

Heat can be transferred from heat nodes to fluid nodes or from heat nodes to other heat nodes. The heat transfer mechanisms considered in TRANFLOW include heat transfer by [ ]a,c. A summary of the heat transfer coefficients commonly applied to steam generator transient analyses follows.

For heat transfer by forced convection to subcooled water, the heat transfer coefficient is obtained by [ ]a,c correlation:

[ ]a,c

where,

[.]a,c

For forced convection heat transfer to superheated steam, the heat transfer coefficient is obtained by [ ]a,c correlation:

[ ]a,c

where,

[ ]a,c.

The heat flux for local boiling is given by the [ ]a,c correlation:

[ ]a,c

where,

[ ]a,c

The heat transfer coefficient for forced convection vaporization to saturated water and steam mixtures when the void fraction is [ ]a,c, is given by the correlation of [ ]a,c:

[ ]a,c

where,

[ ]a,c

The upper limit of nucleate boiling is marked by the critical heat flux where a restriction of liquid supply to the metal wall results in significantly reduced heat transfer. [ ]a,c:

[ ]a,c

where,

[ ]a,c

[ ]a,c.

The TRANFLOW code also includes heat transfer correlations for transition and stable film boiling; however, these are not active heat transfer mechanisms for most steam generator transients. [ ]a,c:

[ ]a,c

where,

[ ] a,c

where,

[ ] a,c

[ ] a,c

TRANFLOW also calculates conduction and free convection film coefficients using classical wall and film temperature equations.

Pressure Drop Correlations

The [ ][a,c], in the momentum equation is the form loss due to expansion, which is defined as:

[ ][a,c]

The [ ][a,c], in the momentum equation is the loss due to differences in the relative velocity of the phases, which is defined as:

[ ][a,c]

The [ ][a.c]:

[ ][a,c]

The [ ][a,c], is defined as:

[ ][a,c]

where β is calculated as:

[ ]a,c

And the [ ]a,c, is defined as:

[.]a,c

For cross-flow over a tube bundle, the friction term is modified as:

[ ]a,c

Other New Models Added Following the NRC Approval of TRANFLO

No additional thermal-hydraulic models besides the drift flux model have been incorporated into the TRANFLOW code following the NRC approval of TRANFLO.

2. Explain whether countercurrent flow limitation or condensation models are included in the version of TRANFLOW used at Waterford 3. Discuss whether it is conservative or not conservative to use such models in the evaluation of steam generator internals pressure drop.

<u>Response</u>:

The drift flux formulation accounts for countercurrent flows in the TRANFLOW code through the use of a [ ]^{a,c} , but does not inherently provide limitations to countercurrent flow. Countercurrent flow limitations would be provisions in the thermal-hydraulic model that prevent the separation of phases based upon relative velocity, such that steam and liquid flows are either forced to remain entrained or forced to separate. There currently are no such limitations inherent in the code. However, limitations may be added during the input of geometrical parameters. In the current drift flux formulation of TRANFLOW, for low velocity transients (non-break transients) [

]^{a,c}. However, for break transients, [

]^{a,c}. Unlike the original version of TRANFLO, this allows for both the secondary separator volumes and the elliptical head volumes to have two-phase quality. For break transients using the drift flux model, the secondary separators do not have to reach a flooded state of quality equal to zero before they will pass liquid phase mass into the steam dome and steam nozzle. **The drift flux formulation allows two-phase fluid to reach the break earlier and is conservative with respect to the calculation of the break mass flow.**

The drift flux formulation does not include a film condensation model. Film condensation models are developed to calculate the overall heat transfer from a flowing two-phase mixture through a flowing liquid film subject to gravitational force and into a volume of metal. Neither the homogeneous void fraction model nor the drift flux formulation of TRANFLOW includes heat transfer correlations specifically for film condensation. Westinghouse has previously evaluated the application of the Nusselt condensation correlation over a vertical plate assuming laminar condensate flow without momentum change or film drag to calculate heat transfer film coefficients. A Nusselt condensation correlation (Reference 12) is:

$$Nu = 0.943 \left[\frac{\rho_w \cdot (\rho_w - \rho_s) g \sin\theta i_{ws}' \cdot {k_w}^3}{\mu_w \cdot L \cdot (T_f - T_w)} \right]^{\frac{1}{4}}$$

where,

ρ_s is the density of the steam,
ρ_w is the density of the liquid,
g is the gravitational constant,

θ is the incline angle of the surface,
k_w is the thermal conductivity of the condensate,
μ_w is the viscosity of the liquid,
L is the characteristic length of the surface,
T_f is the film temperature, defined as the average of the wall and bulk fluid temperatures,
T_w is the wall temperature,
i_{ws}' is the Rohsenow latent heat of vaporization correction, given as:

$$i_{ws}' = i_{ws}\left[1 + 0.68\left(\frac{C_p(T_f - T_w)}{i_{ws}}\right)\right]$$

where,
i_{ws} is the latent heat of vaporization,
C_p is the constant pressure specific heat.

During the application of the Nusselt condensation correlation, it is assumed that the condensate flow is laminar and gravity driven, subcooling of the condensate is neglected, momentum changes through the condensate film are negligible, the vapor present at the film surface exerts no drag on the film, and that heat transfer is by conduction.

[

]^{c}. **Because the heat transfer film coefficients calculated using condensation correlations are typically much less than heat transfer film coefficients from the forced or free convection of steam, it is conservative to apply the larger heat transfer film coefficients from steam forced convection to structural calculations to maximize calculated thermal stresses**.

3. Describe the implementation of heat storage in and heat transfer to and from the steam generator metal mass, which is included in TRANFLOW as used at Waterford 3 (based on the supplement dated June 13, 2018) but does not appear to be in the NRC-approved version of TRANFLO.

   Response:

   The homogeneous void fraction model of TRANFLO included heat connectors to model the transfer of energy from the primary fluid to the secondary fluid. The drift flux model of TRANFLOW adds metal volumes between the heat connectors to model heat storage as temperature change. Metal volumes are able to transfer heat to other metal volumes by conduction as well as to the fluid using previously mentioned fluid and flow conditional heat transfer correlations. Heat transferred into metal volumes satisfies the conservation of energy and thus affects the properties of the fluid volumes such as temperature, pressure, and quality.

   The inherent assumption in the initial TRANFLO code is that the fluid and metal were essentially isothermal and remained isothermal throughout the transient. For fast transients, such as break transients, the transient time scale does not allow for significant thermal gradients between the fluid and metal to develop, and heat transfer between the metal and fluid is typically neglected. For slower transients or transients that do not initiate from an isothermal steady-state condition, differences between the metal temperature and fluid temperature are critical to the heat transfer calculations and energy balance. [

   ]^{c}.

4. Table 1 of the original submittal dated April 12, 2018, showed that pressure drop caused by cross flow over the steam generator tube U-bend was included in the original steam generator design basis calculations but not in the TRANFLOW calculations. Explain why this pressure drop was not included in the replacement steam generator analysis.

   Response:

   The form loss coefficient representing the pressure drop across the tube U-bend is included in the TRANFLOW model. [

   ]^{a,c}.

5. The NRC Staff's original approval of TRANFLO indicated that data was passed back and forth between TRANFLO and MARVEL, a thermal-hydraulic systems analysis code, to determine both the primary and secondary system responses. However, the response to Sufficiency Item No. 2 in the supplement dated June 13, 2018, states that the primary side volumes were characterized in TRANFLOW as "constant pressure nodes with nodal temperature determined from the energy equation." Given that a full reactor simulation of the main steam line break would indicate that the primary system cools and depressurizes over the course of the transient, justify this assumption.

   Response:

   For the Waterford 3 Replacement Steam Generators (W3RSG), the full reactor simulation of the main steam line break was performed using the CENTS code. The results of this simulation defined the Main Steam Line Break (MSLB) design transient. The full reactor simulation calculated primary side parameters include the following: primary side flow, primary side pressure, hot leg temperature and cold leg temperature.

   The W3RSG TRANFLOW analysis used the MSLB design transient primary side flow, hot leg temperature and pressure as input. The cold leg temperature was calculated by TRANFLOW based on the primary to secondary side heat transfer calculation during the MSLB transient.

   The W3RSG TRANFLOW model contains [ ][a,c] primary side fluid nodes. The W3RSG TRANFLOW analysis used the MSLB design transient primary side pressure as a function of time as input to the primary side nodes. The primary side system depressurization during the MSLB event is therefore accounted for in the TRANFLOW analysis.

   [

   ][a].

6. The June 1, 2018, request for supplemental information included a request for information regarding the input biases applied in the TRANFLOW analysis and a discussion of how the input biases would produce conservative results. The response dated June 13, 2018, stated that hot standby conditions were considered to be conservative, as they would result in the highest initial steam generator pressure. The response also included a study that demonstrated that it was most conservative to assume the initial water level in the steam generators to be at the top tube support plate. The response, however, did not discuss the assumptions related to the characteristics of the steam line break, such as the break size or discharge coefficient. Describe the break conditions assumed in the analysis, and how are they known to be limiting.

<u>Response</u>:

The W3RSG TRANFLOW main steam line break (MSLB) analysis assumes an open ended guillotine break at the steam nozzle to steam pipe weld. The break size is set equal to [ ][a] which corresponds to the replacement steam generator steam outlet nozzle integral flow limiter cross-sectional flow area. This break size corresponds to the largest possible (limiting) break size based on the steam outlet nozzle design configuration and results in the highest pressure loads for steam generator internal component analysis. The integral flow limiter is composed of [ ][a] venturi nozzles each with a throat diameter of [ ][a] inches. The loss coefficient for the flow limiters is [ ][a] and is calculated based on the geometry of the flow limiters. A nozzle discharge coefficient of [ ][b] was used in the analysis; [ ][b].

Steam generator conditions at the start of the MSLB event are assumed to be at [ ][b] conditions with saturated liquid and vapor at equilibrium conditions equal to 970 psia and 541°F. Of all defined operating conditions, the [ ][b] condition results in the highest secondary pressure and highest secondary fluid mass.

Containment conditions throughout the duration of the MSLB event are assumed to be saturated steam conditions at [ ][b].

By assuming containment pressure remains constant at [ ][b], the pressure differential between the steam generator and the containment is maximized. The resulting secondary blowdown flow rates are thus limiting.

[ ][c] Steam Generator water levels were evaluated in the W3RSG TRANFLOW MSLB analysis: [

][c]. Thus, the [ ][c] water

level assumed in the MSLB analysis is bounded and conservative. The highest pressure load for a given internal component was then used in subsequent structural analyses.

7. Explain whether main steam line flow restrictors were modeled in the TRANFLOW analysis.

   Response:

   The main steam line flow restrictors were not included in the W3RSG TRANFLOW model.

   The W3RSG TRANFLOW steam line break analysis assumed an open ended guillotine break at the steam nozzle to steam pipe weld. Flow restrictors integral to the steam outlet nozzle were modeled in the replacement steam generator TRANFLOW model. The TRANFLOW analysis only evaluated the steam generator component. The hydraulic loads resulting from a break at the steam outlet nozzle location are conservative, as compared with a break downstream of the steam line flow restrictors, due to one fewer restriction to the flow during the MSLB event.

8. Discuss how the primary steam separators are modeled in the Waterford 3 steam line break analysis performed with TRANFLOW.

Response:

The Primary Separators are modeled using a series of flow connectors between fluid nodes. Flow connectors contain geometric data necessary to determine pressure drops in both the forward and reverse directions.

In order to model the steam-water separation that takes place during power operations in the primary and secondary separator regions, the drift flux flow area (AFALL) is adjusted. The value of AFALL affects the relative velocity between steam and water in the appropriate flow connector. A large AFALL value encourages water to separate from the steam / water flow, as the differential velocity between the two phases becomes larger. [

]b.

[

]b.

9. Westinghouse letter LTR-SGMP-17-107 NP-Attachment, "Acceptability of the TRANFLOW Computer Code for Steam Line Break Internal Pressure Loads for the Waterford Unit 3 Replacement Steam Generators," Rev. 0, was included as Attachment 4 to the licensee's supplemental information letter. (A publicly available version of this letter is included in the supplement dated June 13, 2018 (ADAMS Accession No. ML18169A275)). Section 3.3 of Appendix A of this document provides qualification of TRANFLOW versus test data, as requested by the NRC. However, the plots provided throughout this section to provide comparisons between measurement and prediction appear to be excerpted from the original TRANFLO topical report. Please explain if the validation in Section 3.3 was performed with the revised version of TRANFLOW. If not, justify why such validation against test data is not needed for the version of TRANFLOW used in the Waterford 3 analysis, which appears to have implemented completely different versions of the conservation equations and constitutive relations from that approved by the NRC.

Response:

The plots provided in Section 3.3 of Appendix A of LTR-SGMP-17-107 P-Attachment (Reference 10) were excerpted from the original TRANFLO topical report (Reference 1).

Subsequent to the implementation of the Drift-Flux Version of TRANFLO as documented in MPR-663 (Reference 2), the qualification versus test data was re-performed in MPR-755 Volume 2 (Reference 3). TRANFLO was compared with four experimental blowdown tests. Specifically, these tests are: Frankfurt/Main (7, 12, and 14) and Battelle Northwest B53B.

The Frankfurt 7 test comparison is provided in revised Figures 3.3-2, 3.3-3 and 3.3-4. The Battelle B53B test comparison is provided in revised Figure 3.3-7. These figures were extracted from MPR-755 Volume 2 (Reference 3) where they were updated to include the points marked as "Calculated 3/81" which represent code calculated values using the Drift-Flux Version of TRANFLO (1980). These figures correspond to the same figure numbers in LTR-SGMP-18-20 P-Attachment (Reference 10).

For both the Frankfurt 7 test and the Battelle B53B test, the updated Drift-Flux version of TRANFLO calculated values closely match those of the original calculated values from TRANFLO (1976) and the test data. The Drift-Flux version of TRANFLO is, therefore, benchmarked to test data and changes related to the Drift-Flux model do not significantly alter the break model results.

As stated within LTR-SGMP-18-20 P-Attachment, (Reference 11) TRANFLOW Versions 3.0 and 3.2 were used in the analysis of the Waterford Unit 3 RSGs. In addition to some code maintenance items (e.g., a capability was provided to monitor calculated variables for convenient examination of results, transient data of parameters can be provided as direct inputs), the major changes from the original version of TRANFLO which was reviewed by the NRC staff are:

1. TRANFLO Drift Flux Version (1980) - implemented a drift flux model to better simulate relative flow velocity between water and steam. Benchmarking to test data was performed again in MPR-755 Volume 2 (Reference 3) – excerpts are included in this document.
2. TRANFLO Version 1.0 (1991) - [ ][b]. Verification and validation testing included test cases run on both Version 1.0 and the Drift Flux Version and the thermal/hydraulic output results are identical per WNEP-9124 (Reference 4); therefore, the Frankfurt and Battelle test comparison plots shown in this document also apply to Version 1.0.
3. TRANFLOW Version 1.1 (1994) – [ ][b]. Verification and validation testing was completed successfully – therefore, the Frankfurt and Battelle test comparison plots shown in this document also apply to Version 1.1.
4. TRANFLOW Version 2.0 (1999) – [ ][b]. Verification and validation testing per CN-NEE-99-092 (Reference 6) indicated equivalent results by graphical comparison to the prior version – therefore, the Frankfurt and Battelle test comparison plots shown in this document also apply to Version 2.0.
5. TRANFLOW Version 3.0 (1999) – [ ][b]. Verification and validation testing per CN-NEE-99-158 (Reference 7) indicated equivalent results from the prior code version – therefore, the Frankfurt and Battelle test comparison plots shown in this document also apply to Version 3.0.
6. TRANFLOW Version 3.1 (2009) – [ ][b]. Verification and validation testing per CN-SST-08-19 (Reference 8) indicated acceptable results within defined tolerances from the prior code version and correction of known errors – therefore, the Frankfurt and Battelle test comparison plots shown in this document also apply to Version 3.1.
7. TRANFLOW Version 3.2 (2011) – [ ][b]. Verification and validation testing per LMD-SST-10-014 (Reference 9) indicated acceptable results within defined tolerances from the prior code version (last digit round off) – therefore, the Frankfurt and Battelle test comparison plots shown in this document also apply to Version 3.2.

---

[1] [ ] [b].

b

Figure 3.3-2
Comparison of Calculated and Measured Pressure for Frankfurt Test 7 - Updated

b

Figure 3.3-3
Comparison of Calculated and Measured Pressure vs. Mass Flow for Frankfurt Test 7 - Updated

b

Figure 3.3-4
Comparison of Calculated and Measured Energy vs. Mass Flow for Frankfurt Test 7 - Updated

[ ]b

Figure 3.3-7
Comparison of Calculated and Measured Pressure, Battelle Test B53B - Updated

10. Section 3.1 of LTR-SGMP-17-107 NP-Attachment provides a benchmark of TRANFLOW to RELAP5. Table 3.1-1 demonstrates that pressure drops on the tube support plates calculated by TRANFLOW tend to differ from the pressure drops calculated by RELAP5. Please provide further discussion on why this difference exists and is acceptable, considering RELAP5 contains newer, higher fidelity models than TRANFLOW.

    Response:

    As noted in LTR-SGMP-17-107 NP-Attachment, the pressure drop on the support plates as calculated between TRANFLOW and RELAP5 generally compare well. The maximum calculated value of pressure drop for a given support plate alternates between RELAP5 and TRANFLOW codes. For example, TRANFLOW predicts a higher pressure drop for the lowest and highest support plates while RELAP5 predicts a higher pressure drop for some of the mid-elevation support plates. For W3RSG MSLB, Service Level D the [ ]^{c} tube support plate is the limiting stress location for all tube support plates and has [ ]^{c} % margin to the ASME code allowable. For W3RSG MSLB, Service Level D the limiting location for stayrod stress is between the [ ]^{c} tube support plate locations and has [ ]^{c} % margin to the ASME code allowable. The total vertical pressure loading on all support plates is used as input to the lower internals structural analysis, specifically the wrapper support lugs. The difference between RELAP5 ([ ]^{b} psi) and TRANFLOW ([ ]^{b} psi) calculated total vertical pressure loading is [ ]^{b} psi ([ ]^{b} %). For the W3RSG Service Level D evaluation of the wrapper support lugs, the [ ]^{c} load combination bounds the [ ]^{c} load combination. The limiting stress location is the wrapper support lug-to-shell weld which has a [ ]^{b} % margin to the ASME Code allowable.

    Differences between TRANFLOW and RELAP5 models that may contribute to the noted differences in results include:

    - For RELAP5, the tube support plate pressure differences are based on static pressure differences between adjacent fluid nodes resulting in an addition of 0.06 psi of fluid head.
    - RELAP5 tube support plate pressure drop results include tube bundle friction and fluid momentum flux terms. These terms are difficult to quantify because they vary continuously with local fluid behavior and plate location during the transient.
    - These three terms mentioned above (additional static head, tube bundle friction and fluid momentum flux) should be subtracted from RELAP5 results to obtain true loads on tube support plates and a more accurate comparison with TRANFLOW.

Given that the maximum pressure drop for a given support plate alternates between RELAP5 and TRANFLOW codes, TRANFLOW reports higher pressure loads at the limiting [ ]b support plate location, and the difference between RELAP5 and TRANFLOW total vertical pressure loading on all support plates is [ ]b psi ([ ]b %), Westinghouse concludes that these two codes are technically equivalent.

11. Westinghouse Letter LTR-SGMP-18-20 NP-Attachment, "Responses to Waterford Unit 3 TRANFLOW License Amendment Request, Non-Accept Sufficiency Items," Rev. 1, was included as Attachment 1 to the licensee's supplemental information letter. (A publicly available version of this letter is included in the supplement dated June 13, 2018, (ADAMS Accession No. ML18169A275)). The Westinghouse Letter LTR-SGMP-18-20 states, in part, that

> The TRANFLOW calculated values of thermal-hydraulic (TH) parameters: pressures, pressure loads (ΔPs), flow rates, flow loads (ρV^2), bulk fluid temperatures, metal surface temperatures and film heat transfer coefficients are used in the downstream structural, fatigue and non- ductile failure analyses in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components.

Moreover, it is stated that,

> TRANFLOW is a one-dimensional, two-phase, thermal-hydraulic code used for calculating the thermodynamic and fluid (hydraulic) behavior of steam generators subject to prescribed transient conditions. The code calculates pressures, temperatures, flow rates, and heat transfer coefficients, which are used as inputs for structural analyses. TRANFLOW uses an elemental volume approach in which the spatial solution is achieved by dividing the system into a discrete number of control volumes having uniform thermal and hydraulic conditions.

One-dimensional TH analyses typically use significant course nodalization compared to three-dimensional (3D) finite element analysis (FEA) models used to analyze stresses for Section III. Describe how the TRANFLOW results are interpolated and what is assumed (i.e., asymmetry) when using them as inputs to 3D FEA models to assess fatigue and non-ductile failure analyses in accordance with Section III. Specifically, please provide information on how the nodal time-history temperature and pressure information is applied to a finite element model to generate stresses and vibratory responses in the steam generator for the following components, where applicable:

1. Tube sheets
2. Tube to tube sheet welds
3. Lower shell, transition cone and upper shell
4. Primary separator assembly

Response:

The TRANFLOW model of a steam generator is composed of a network of nodes and connectors that represent the primary coolant, secondary side fluid and the thermal mass of steam generator components such as the steam generator tubes, shell and tubesheet. Components such as the wrapper, tube support plates, deck plates, and primary and secondary

separators are included in the TRANFLOW model as hydraulic boundaries, but not as metal nodes since the thermal mass effects from these components is negligible compared to the shell, tubes and tubesheet.

TRANFLOW is typically used to calculate heat transfer coefficients for metal nodes and secondary side fluid temperatures during various design transients and are applied in the heat transfer problem (thermal) phase of the structural analysis as boundary conditions. Metal nodes are used in the code to allow energy storage in fluid boundaries such as steam generator tubes, shell, and tubesheets. The heat transfer problem provides the temperature distributions which give rise to the thermal stresses that are used in the stress and fatigue evaluation. In addition, TRANFLOW is used to predict pressure drops across tube support plates and other internal components under steam line break conditions in support of the internals design effort.

For each transient analyzed, thermal-hydraulic time-history data is written to various output files which can be accessed by structural analysts. Time-history data include heat transfer film coefficients for all metal nodes exposed to secondary side fluid, temperatures and pressures for all secondary side fluid nodes and total mass flow rates of all secondary side flow connectors. For a steam line break analysis, hydraulic pressure drop data is provided for use in the structural qualification of various support structures including tube support plates (TSPs), various deck plates, primary separators, secondary separators and the wrapper barrel.

[

]^{a,c}.

[

]^{a,c} (**ANSYS®**[2]). [

]^{a,c}.

[2] *ANSYS is a trademark or registered trademark of ANSYS, Inc. Other names may be trademarks of their respective owners.*

The process to reduce the number of time-history data points from TRANFLOW to a manageable data set involves three phases, consisting of:

Phase 1 - Preconditioning phase [

]^{a,c}.

Phase 2 - Main Data Reduction where two main data reduction algorithms are applied:

1. [ ]^{a,c}, and
2. [ ]^{a,c}.

[

]^{a,c}.

Phase 3 - Merging and Checking [

]^{a,c}.

Current practice is to document the data reduction for each project in a report separate from the TRANFLOW calculation reports. A structural analyst performs the data reduction so that they may assess the acceptability of the reduced data set for ANSYS input. A thermal-hydraulic analyst then verifies the data reduction calculation report.

<u>Tubesheet Analysis</u>

In the TRANFLOW model, the tubesheet is represented by [ ]^{a,c} metal nodes. Corresponding to each node, a heat transfer coefficient is provided between the tubesheet secondary surface and the secondary side fluid adjacent to the top of the tubesheet. The secondary side fluid adjacent to the tubesheet is represented by [ ]^{a,c} fluid nodes. Corresponding to each node, a fluid temperature is provided. The primary and secondary fluid temperatures and film coefficients are applied to the thermal finite element model as boundary conditions.

Temperatures and Heat Transfer Coefficients:

For the tubesheet structural analysis, the primary side fluid temperatures were obtained from the [ ]^{a,c} and the associated primary side film coefficients were obtained from [ ]^{a,c}. The primary side thermal boundary conditions are applied to FEA model nodes in the [ ]^{a,c} of the tubesheet [ ]^{a,c}. The temperature boundary condition is applied as a function of time and follows the temperature of the hot or cold leg primary fluid. [ ]^{a,c}. The thermal gradient [ ]^{a,c} is calculated by the ANSYS thermal model using the TRANFLOW calculated secondary fluid temperatures and the TRANFLOW calculated heat transfer coefficients across the secondary face of the tubesheet as boundary conditions.

Secondary side fluid temperatures and the associated film coefficients were obtained directly from the TRANFLOW analysis results. [ ]^{a,c}. The secondary side temperatures are also obtained directly from the TRANFLOW analysis. These data (heat transfer coefficient and temperature time histories) were reduced from the TRANFLOW results and verified separately, [ ]^{a,c}.

Pressures:

For the tubesheet structural analysis, the primary and secondary pressure loads used in the analysis are from the Design Specification and not from TRANFLOW results. The stress results are influenced by the pressure differential across the tubesheet. Therefore, minimum secondary side pressure is used in order to maximize this pressure differential. The bounding pressures for each of the Design, Normal/Upset, Emergency, Faulted, and Test loading conditions were used in evaluating the analytical model. The pressures are bounding in terms of primary pressure, secondary pressure, and positive and negative tubesheet pressure differentials.

Application of TRANFLOW Results to the FEA Model:

The thermal parameters (temperatures and heat transfer coefficients) from the TRANFLOW analysis are mapped based on location and applied to the FEA model as appropriate. For example, a temperature from the TRANFLOW fluid node that models the fluid region adjacent to the outer portion of the hot side of the tubesheet would apply to all elements of

the outer portion of the hot side of the tubesheet in the FEA model where a temperature boundary condition is needed.

A transient thermal finite element analysis was performed to obtain the temperature distribution in the primary chamber, tubesheet, lower shell and pedestal support complex. [

]a,c.

Tube-to-Tubesheet Weld

Temperatures [

]a,c are assumed to follow the primary fluid temperatures during all transients. It is reasonable to assume that the temperatures [ ]a,c follow the primary fluid temperatures [

]a,c.

Pressure boundary conditions applied to the FEA model consist of the primary side pressure load on the primary faces of the tube and weld and a secondary side pressure on the secondary face of the tube and the adjacent tubesheet surface. The pressure loads are taken from the Design Specification. TRANFLOW data were not used for this analysis.

Lower Shell, Transition Cone and Upper Shell

In the TRANFLOW model [ ]a,c metal nodes represent the steam generator shell (lower, transition cone and upper) metal and [ ]a,c fluid nodes model the fluid in the upper shell between the lower and mid-deck plates, downcomer, and upper shell above the mid-deck plate. The metal and fluid nodes provide for the temperature and heat transfer coefficient time-histories used as input to the heat transfer analysis. Pressures are taken from the Design Specification.

[

]a,c. Thermal loads are temperature gradients (temperature distributions) due to the thermal transients. The results of the thermal analysis were used as input during stress analysis for thermal load consideration.

The thermal transients analyzed in this analysis all have governing conditions that are evaluated with TRANFLOW calculations. The fluid temperature and heat transfer coefficient time-histories are obtained from the fluid and metal nodes described above. [

]a,c.

In order to properly capture the effects of a transient analysis, the FEA code (ANSYS) automatically selects smaller time steps (AUTOTS) within each defined load step to accurately solve the problem. The fluid temperatures and heat transfer coefficients are

determined automatically for each time step by the ANSYS program. The ramp option is used to force ANSYS to linearly interpolate the fluid temperatures and heat transfer coefficients for the current time step from the bounding defined load steps. [

]^{a,c}.

Primary Separator Assembly

The primary separator is composed of the lower deck subassembly, the primary separator column subassemblies (also called risers) and the middle deck subassembly.

The loads on the upper internals include: dead weight, seismic loads, loss-of-coolant accident (LOCA) loads, flow loads, pressure loads and thermal loads. The flow loads on the primary separator assembly come from pressure drops in the TRANFLOW model. All other loads considered in the analysis are applied as prescribed in the Design Specification.

The overall pressure drop for the primary separator assembly is composed of the pressure drops for the upper wrapper cone, lower deck plate and mid-deck plate. The individual pressure drops correspond to the pressure differences in the fluid nodes outside those regions in the TRANFLOW model. [

]^{a,c}.

For the Normal and Upset Conditions, the most limiting flow loads from any Normal or Upset Condition transient were used. Emergency condition flow loads are bounded by the Faulted condition flow loads, therefore, only TRANFLOW Faulted flow load conditions are considered.

For the Main Steam Line Break (MSLB)/Safe Shutdown Earthquake (SSE) plus MSLB Flow Loads Condition, the flow loads from the TRANFLOW MSLB were used.

For the Feedwater Line Break (FWLB)/SSE accelerations plus FWLB Flow Loads Condition, the TRANFLOW FWLB flow loads are used.

REFERENCES:

1. WCAP-8821-P-A, Rev. 0, "TRANFLO Steam Generator Code Description," Westinghouse Electric Company LLC, September 1976, edited by J. C. Reck, June 2001.

2. MPR Associates Report MPR-663, Rev. 0, "TRANFLO: A Computer Program for Transient Thermal Hydraulic Analysis with Drift Flux," November 1980.

3. MPR Associates Report MPR-755, Vol. 2, Rev. 0, "Model D-3 Steam Generator Thermal Hydraulic Transients," January 1983.

4. WNEP-9124, Rev. 0, "PROGRAM TRANFLO VERSION 1.0, A Computer Code Update with Improved Input/Output," Westinghouse Electric Company, November 1991.

5. Not used.

6. CN-NEE-99-092, Rev. 0, "Upgrades to TRANFLOW for Y2K Compliance Validation package for TRANFLOW 2.0," Westinghouse Electric Company, August 1999.

7. CN-NEE-99-158, Rev. 0, "Software Change Specification (SCS) and Validation Package for TRANFLOW Version 3.0," Westinghouse Electric Company, November 1999.

8. CN-SST-08-19, Rev. 0, "Software Change Specification and Verification for TRANFLOW Version 3.1," Westinghouse Electric Company, May 2009.

9. LMD-SST-10-014, Rev. 0, "Software Change Specification and Validation for TRANFLOW Version 3.2," Westinghouse Electric Company, August 2011.

10. LTR-SGMP-17-107 P-Attachment, Rev. 0, "Acceptability of the TRANFLOW Computer Code for Steam Line Break Internal Pressure Loads for the Waterford Unit 3 Replacement Steam Generators," Westinghouse Electric Company LLC, February 2018.

11. LTR-SGMP-18-20 P-Attachment, Rev. 1, "Responses to Waterford Unit 3 TRANFLOW License Amendment Request Non-Accept Sufficiency Items," Westinghouse Electric Company LLC, June 2018.

12. Collier, J. G., and Thome, J. R., <u>Convective Boiling and Condensation</u>. McGraw-Hill Book Company, England, 1972.

ENCLOSURE, ATTACHMENT 2

W3F1-2019-0002

Westinghouse Letter CAW-19-4851

As Attachment 3 contains information proprietary to Westinghouse Electric Company LLC, it is supported by an Affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the commission and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.390 of the Commission's regulations.

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CAW-19-4851

January 8, 2019

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: LTR-SGMP-18-45 P-Attachment, Revision 0, "Responses to Request for Additional Information Regarding Waterford 3 Amendment Request for Revision of UFSAR Section 3.9 to Incorporate the TRANFLOW Computer Code (Proprietary)"

The Application for Withholding Proprietary Information from Public Disclosure is submitted by Westinghouse Electric Company LLC ("Westinghouse"), pursuant to the provisions of paragraph (b)(1) of Section 2.390 of the Nuclear Regulatory Commission's ("Commission's") regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary information for which withholding is being requested in the above-referenced report is further identified in Affidavit CAW-19-4851 signed by the owner of the proprietary information, Westinghouse. The Affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.390 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Entergy Operations, Inc.

Correspondence with respect to the proprietary aspects of the Application for Withholding or the Westinghouse Affidavit should reference CAW-19-4851, and should be addressed to Camille T. Zozula, Manager, Infrastructure & Facilities Licensing, Westinghouse Electric Company, 1000 Westinghouse Drive, Building 2, Suite 259, Cranberry Township, Pennsylvania 16066.

Korey L. Hosack
Product Line Regulatory Support

Enclosures:
1. Affidavit CAW-19-4851
2. Proprietary Information Notice and Copyright Notice
3. "Responses to Request for Additional Information Regarding Waterford 3 Amendment Request for Revision of UFSAR Section 3.9 to Incorporate the TRANFLOW Computer Code (Proprietary)"

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF BUTLER:

I, Korey L. Hosack, am authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC ("Westinghouse") and declare that the averments of fact set forth in this Affidavit are true and correct to the best of my knowledge, information, and belief.

Executed on: 2019 01 05

Korey L. Hosack, Manager
Product Line Regulatory Support

(1) I am Manager, Product Line Regulatory Support, 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 Nuclear Regulatory Commission's ("Commission's") regulations and in conjunction with the Westinghouse Application for Withholding Proprietary Information from Public Disclosure 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 constitute Westinghouse policy and provide 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.

(iii) 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.

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

(v) 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.

(vi) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in LTR-SGMP-18-45 P-Attachment, Revision 0,"Responses to Request for Additional Information Regarding Waterford 3 Amendment Request for Revision of UFSAR Section 3.9 to Incorporate the TRANFLOW Computer Code" (Proprietary), for submittal to the Commission, being transmitted by Entergy Operations letter. The proprietary information as submitted by Westinghouse for use by Entergy Operations, Inc., for Waterford 3 is provided in response to a request for additional information from the Nuclear Regulatory Commission staff concerning the acceptability of using the computer code, TRANFLOW, to calculate replacement steam generator secondary side internal loads during a postulated steam line break event.

(a) This information is part of that which will enable Westinghouse to describe the computer code, TRANFLOW, and to benchmark calculated pressure drops using TRANFLOW with other NRC approved computer code results.

(b) Further, this information has substantial commercial value as follows:

(i) Westinghouse plans to sell the use of similar information to its customers for the purpose of meeting NRC requirements for licensing documentation supporting the use of the computer code, TRANFLOW, during replacement steam generator design.

(ii) Westinghouse can sell support and defense of industry guidelines and acceptance criteria for plant-specific applications.

(iii) The information requested to be withheld reveals the distinguishing aspects of a methodology 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 technical evaluation justifications 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 non-proprietary versions of a document, 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).