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Our ref: LTR-NRC-09-11
February 12, 2009

Subject: Further Clarifications on RAIs for Topical Report (TR) WCAP-16766-P, "Westinghouse Next Generation Correlation (WNG-1) for Predicting Critical Heat Flux in Rod Bundles with Split Vane Mixing Grids," (TAC No. MD-7230) (Proprietary/Non-Proprietary)

Enclosed are copies of the Proprietary and Non-Proprietary response to NRC's Request for Additional Information By the Office Of Nuclear Reactor Regulation Topical Report WCAP-16766-P, "Westinghouse Next Generation Correlation (WNG-1) for Predicting Critical Heat Flux in Rod Bundles with Split Vane Mixing Grids".

Also enclosed is:

1. One (1) copy of the Application for Withholding, AW-09-2533 (Non-proprietary) with Proprietary Information Notice.
2. One (1) copy of Affidavit (Non-proprietary).

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 from Public Disclosure 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.

Correspondence with respect to the affidavit or Application for Withholding should reference AW-09-2533 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Enclosures
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G. Bucuta, NRR
H. Cruz, NRR
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Our ref: AW-09-2533
February 12, 2009

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: Further Clarifications on RAIs for Topical Report (TR) WCAP-16766-P, "Westinghouse Next Generation Correlation (WNG-1) for Predicting Critical Heat Flux in Rod Bundles with Split Vane Mixing Grids," (TAC No. MD-7230)(Proprietary)

Reference: Letter from J. A. Gresham to Document Control Desk, LTR-NRC-09-11, dated February 12, 2009.

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 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-09-2533 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-09-2533 and should be addressed to J. A. Gresham, Manager of Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P. O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Cc: A. Mendiola, NRR
G. Bucuta, NRR
H. Cruz, NRR
A. Attard, NRR
J. Keiser, NRR

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared J. A. Gresham, 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:

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Sworn to and subscribed
before me this 12th day
of February, 2009.

Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Sharon L. Markle, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Jan. 29, 2011
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory Compliance and Plant Licensing, in Nuclear Services, 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 rulemaking 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 which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

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

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

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

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

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

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

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked "Further Clarifications on RAIs for Topical Report (TR) WCAP-16766-P, "Westinghouse Next Generation Correlation (WNG-1) for Predicting Critical Heat Flux in Rod Bundles with Split Vane Mixing Grids," (TAC No. MD-7230)(Proprietary), for submittal to the Commission, being transmitted by Westinghouse letter (LTR-NRC-09-11) and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted by Westinghouse Electric Company is that associated with response to NRC's Request for Additional Information for WCAP-16766-P.

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

(a) Obtain generic NRC licensed approval for the WNG-1 Correlation.
(b) Assist customers in improving their fuel performance (zero defects).

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to continue to implement corrective actions to ensure the highest quality of fuel in order to meet the customer needs.

(b) Assist customers to obtain license changes.

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 for developing the enclosed improved core thermal performance methodology.

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).

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Further Clarifications on RAIs for Topical Report (TR) WCAP-16766-P, "Westinghouse Next Generation Correlation (WNG-1) for Predicting Critical Heat Flux in Rod Bundles with Split Vane Mixing Grids," (TAC No. MD-7230)(Non-Proprietary)

Westinghouse Electric Company
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355

Further Clarifications on RAIs for Topical Report (TR) WCAP-16766-P, "Westinghouse Next Generation Correlation (WNG-1) for Predicting Critical Heat Flux in Rod Bundles with Split Vane Mixing Grids," (TAC No. MD-7230)(Non-Proprietary)

On November 18, 2008, the NRC and Westinghouse held a meeting to discuss the supplemental requests for additional information (RAIs) related to statistical poolability and applicability range of the WNG-1 correlation in WCAP-16766-P. The Westinghouse presentation made at the meeting is attached as part of the RAI response. Several of the supplemental responses, provided below, address the applicability range questions raised by the NRC Staff. Additional points made during the November meeting also focused on the applicability range question. The following is a brief summary of those discussion points.

1. It was noted and agreed to by the NRC Staff that CHF is primarily a local phenomenon. The local aspects of CHF are not truly empirical but are modeled through a subchannel code and a DNB correlation based on first principle aspects and the relationship between CHF and local fluid parameters. Based on thirty plus years of fuel design experience (i.e., specifically grid design and optimization), Westinghouse has identified [ ] [a, c] that tend to affect CHF performance. While the SER for WCAP-8762-P (WRB-1) raised questions about the representative [ ] [a, c] and first principle understanding, over time the NRC SERs on correlations have also reflected increased understanding of the first principle aspects and impacts of [ ] [a, c] on CHF performance. Later, these parameters formed the basis of Section 6 in the Fuel Criteria Evaluation Process (FCEP) topical report approved by the NRC (WCAP-12488-A, Reference 1). In fact, the Technical Evaluation Report prepared by the Pacific Northwest Laboratory (PNL), concurred with the approach that Westinghouse uses based on first principle aspects. Based on this approach and evaluation of similarity in the [ ] [a, c], the fuel designs that comprise the DNB correlation database should yield essentially the same CHF performance relative to the correlation prediction. The statistical poolability evaluations then demonstrate that the designs are poolable and that there are no non-conservative trends in the CHF predictions over the applicable range.

2. Based on the above justification and similarity of fuel design parameters, all the fuel designs in a Westinghouse DNB correlation database yield essentially the same CHF performance relative to the correlation prediction. Thus, if 1) each design has a statistically significant number of data points, 2) the CHF measured-to-predicted ratios (M/P) of each design are demonstrated to be in the same population as the correlation database (i.e., poolable), and 3) correlation predictions show no non-conservative trends over the applicable range, then the need to test every single design over the entire range is unnecessary. This is not extrapolation, it is the use of extensive engineering experience backed by a first principle understanding of the phenomenological aspect of CHF and confirmatory testing results. This experience has been proven repeated times where new designs were developed and CHF tested and compared against existing CHF correlations to substantiate the expected CHF performance. The following summary captures the precedence where the NRC has accepted a CHF correlation and approved it for all the fuel designs specified, based on results of confirmatory tests that did not cover the entire applicable range.

WRB-1, WCAP-8762-P-A

- Test series A-1 through A-19 were "R-grid designs", Test series A-20 through A-24 were "L-grid designs". NRC approved the designs with two separate CHF limits since the grouped "L-grid" data did not pass the F-test: "R-grid" had a 1.17 DNBR and "L-grid" had a 1.37 DNBR. The NRC accepted that both designs were valid over the full range of the correlation even though the "R-grid" designs did not cover all the way down to the lower end of the Pressure and Quality range and the "L-grid" designs did not cover all the way up to the high end of the Pressure and Quality ranges.

- The test series for the 14x14 OFA was approved by the NRC later on as a supplement. Again this was a confirmatory test since the NRC questioned Westinghouse's scaling techniques. The scaling technique was not simply scaling, but was based on the first principle knowledge of which [ ] [a, c] were key to CHF performance. The 14x14 OFA test covered a reduced range relative to that which the correlation covered. The actual CHF testing confirmed that not only was the 1.17 correlation limit acceptable and applicable to the 14x14 OFA, but the actual testing could have supported a 1.122 limit. Since the full range of the correlation was approved for the 14x14 OFA, Westinghouse accepted the 1.17 correlation limit approved by the NRC.

WRB-1, WCAP-9401-P-A

- The test series for the 17x17 OFA was approved by the NRC in WCAP-9401-P-A. Again this was a confirmatory test since the NRC questioned Westinghouse's scaling techniques. The scaling technique was not simply scaling but was based on the first principle knowledge of which [ ] [a, c] were key to CHF performance. The 17x17 OFA test covered a reduced range relative to that which the correlation covered. The actual CHF testing confirmed that not only was the 1.17 correlation limit acceptable and applicable to the 17x17 OFA, but the actual testing could have supported a 1.165 limit. Since the full range of the correlation was approved for the 17x17 OFA, Westinghouse accepted the 1.17 correlation limit approved by the NRC.

Note: All existing Westinghouse split vane designs are representative of the original "R-grid" design. The same [ ] [a, c] are applicable today as they were twenty years ago. All confirmatory testing has substantiated that the specified correlation limit is not only applicable, but a lower limit may actually be justifiable (i.e., 17x17 OFA, 14x14 OFA, 15x15 VANTAGE 5H with IFMs, etc). If no trend is indicated in the data results and one of the designs covers the full range of data, then the other designs in the correlation database should also be covered.

All the fuel designs in the WNG-1 DNB correlation database yield essentially the same CHF performance relative to the correlation prediction. Each design has a statistically significant number of data points. The CHF measured-to-predicted ratios (M/P) of each design are demonstrated to be in the same population as the correlation database (poolable). However, during the Staff's review of the topical report, it was discovered that the WNG-1 predictions for the 15x15 fuel design showed a trend with respect to the local quality. If extended to the higher quality, the WNG-1 predictions may be non-conservative for the 15x15 design. Because of the M/P trend and lack of confirmatory test data at higher quality, Westinghouse would agree that the WNG-1 correlation applicability should not be applied to the 15x15 design until such time as additional data could be obtained to substantiate its acceptability. There

is no non-conservative trend in WNG-1 predictions for the other fuel designs. Therefore, based on similarity of the [ ] [a, c], demonstration of the data poolability and no trend in the correlation predictions, the WNG-1 correlation 95/95 DNBR limit of 1.14 is applicable to the 16x16 NGF, 17x17 RFA, and 17x17 NGF fuel designs within the applicable range as defined by the correlation database.

Further clarifications on RAI #5 (Reference 2):

d. *Provide technical justification for the use of the WNG-1 correlation for the 15x15 fuel for qualities above [ ] [a, b, c]. There is no data above that value and the trend is in the non-conservative direction. If a pool-ability argument is made provide sufficient technical justification why other fuel is similar to 15x15 fuel.*

Response:

Figure 11 of the RAI response in LTR-NRC-08-37 (Reference.2) [

] [a, b, c], Westinghouse would agree that the WNG-1 correlation would not include the 15x15 design until such time as additional data are available to substantiate its acceptability for [ ] [a, c].

e. *Provide technical justification for the use of the WNG-1 correlation for the 16x16 fuel for qualities above [ ] [a, b, c]. There is no data above that value. If a pool-ability argument is made provide sufficient technical justification why other fuel is similar to 16x16 fuel.*

Response:

The WNG-1 M/P predictions for the 16x16 fuel have been verified to be pool-able or to be in the same population as the WNG-1 database. Figure 8 of the RAI response in Reference 2 shows no significant trend in the WNG-1 M/P predictions with respect to local quality. Based on the WNG-1 M/P being in the same population and lack of any non-conservative trend or bias, the WNG-1 applicable range is applicable to the 16x16 fuel, as discussed in the introduction. The grid design of the 16x16 fuel is functionally the same as the 17x17 grid design so that the [

] [a, c] in the WNG-1 correlation database. The fact that the 16x16 data can be pooled with the 17x17 data with no significant trends confirms that the designs are functionally the same. As stated in the introduction, this is the same approach that has been reviewed and approved for the same grid design with different rod diameters for WRB-1 correlation in WCAP-9401-P-A, WCAP-8762-P-A, WRB-2 correlation in WCAP-10444-P-A, WSSV correlation in WCAP-16523-P-A, References 3 - 6. For the 16x16 fuel, it is noted [

] [a, c] fuel so that these data have been grouped in WCAP-9401, WCAP-10444 and Addendum 2 to WCAP-14565-P-A, Reference 7. This is also seen [

] [a, c], Figures 1 and 2. Although local quality at [

] [a, c], as shown in Figure 2. It is noted that [

] [a, c]. These data also support the fact that the grid designs are functionally the same as the 17x17 data. In summary, the similar grid designs and similar CHF performance through the data comparisons conclude that the proposed quality range in Table 5-1 of WCAP-16766-P is applicable to the 16x16 fuel.

Figure 1
WNG-1 Critical Heat Flux versus Mass Velocity
for 16x16 and 17x17 Fuel Designs

a, b, c

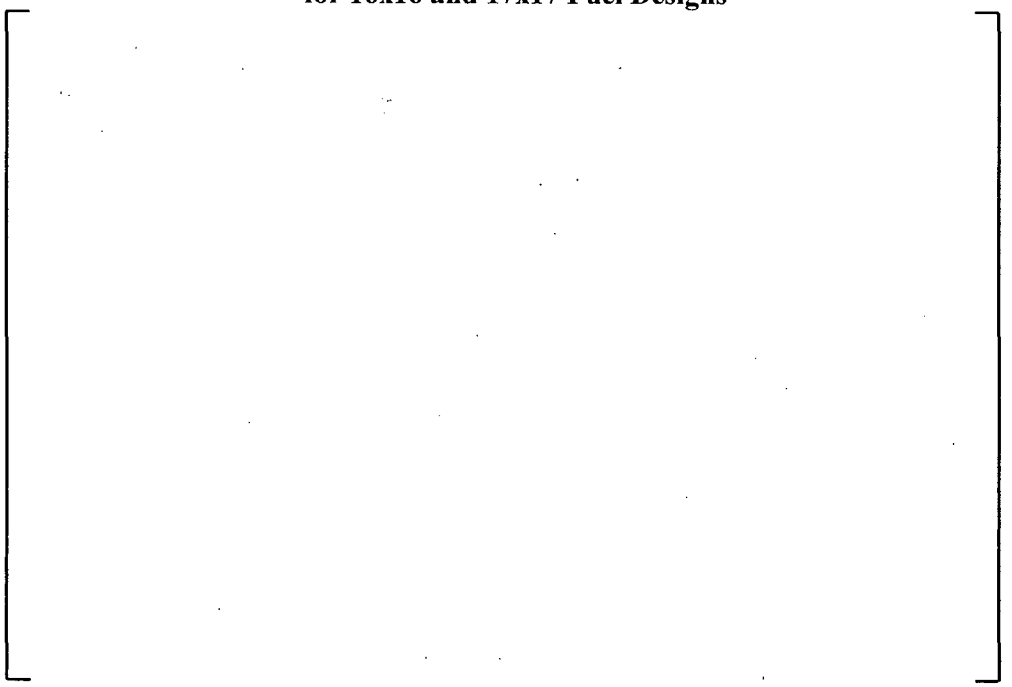
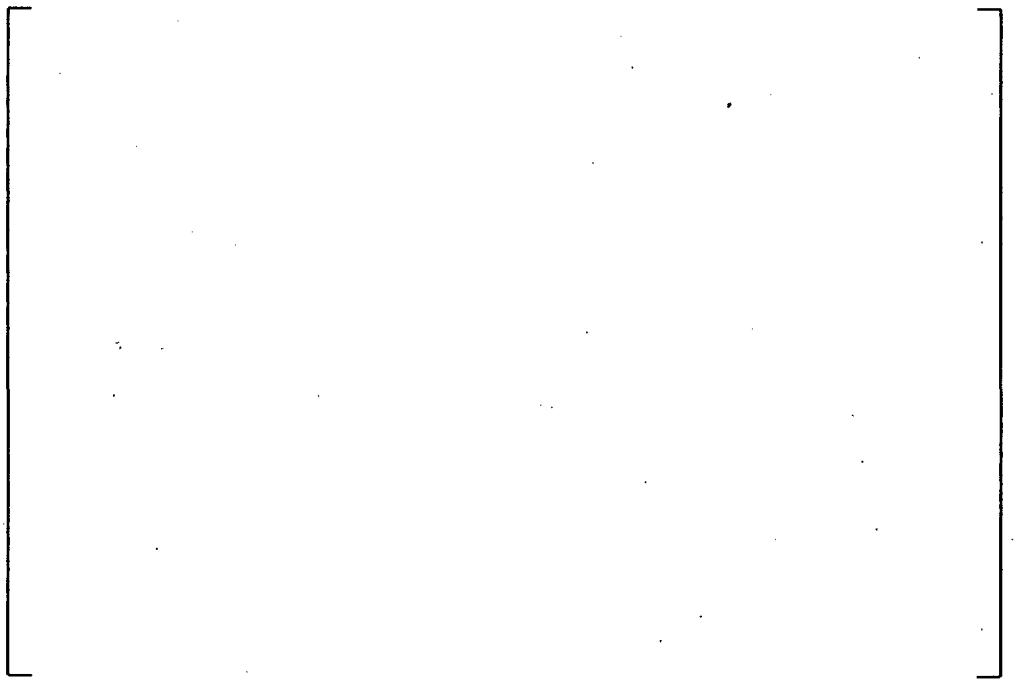


Figure 2
WNG-1 Critical Heat Flux versus Local Quality
for 16x16 and 17x17 Fuel Designs

a, b, c



f. Provide technical justification for the use of the WNG-1 correlation for the 17x17 fuel for qualities above [ ] [a, b, c]. There is limited data above that value. Provide justification why [ ] [a, b, c].

Response:

The WNG-1 M/P predictions show a conservative trend at high quality conditions. As stated in section 6.2.4 of WCAP-16523-P-A, a [

] [a, c]. Based upon the [

] [a, c]. As noted in the response to question 5 in LTR-NRC-08-37 (Reference 2), there are [ ] [a, c] where the local quality range at the measured DNB elevation ranged from [ ] [a, c] and additional test points where the local quality [ ] [a, c].
The data came from both uniform and non-uniform axial power tests, tests bundles with and without Intermediate Flow Mixers (IFMs), and test bundles with and without guide thimbles. The data covered a range in pressure from 1400 to 2400 psi and a range in flow from 0.9 to 3 Mlbm/hr-ft^2. The data at the [

] [a, c] demonstrated the correlation conservatism for three different operating conditions from three separate tests. Additional [

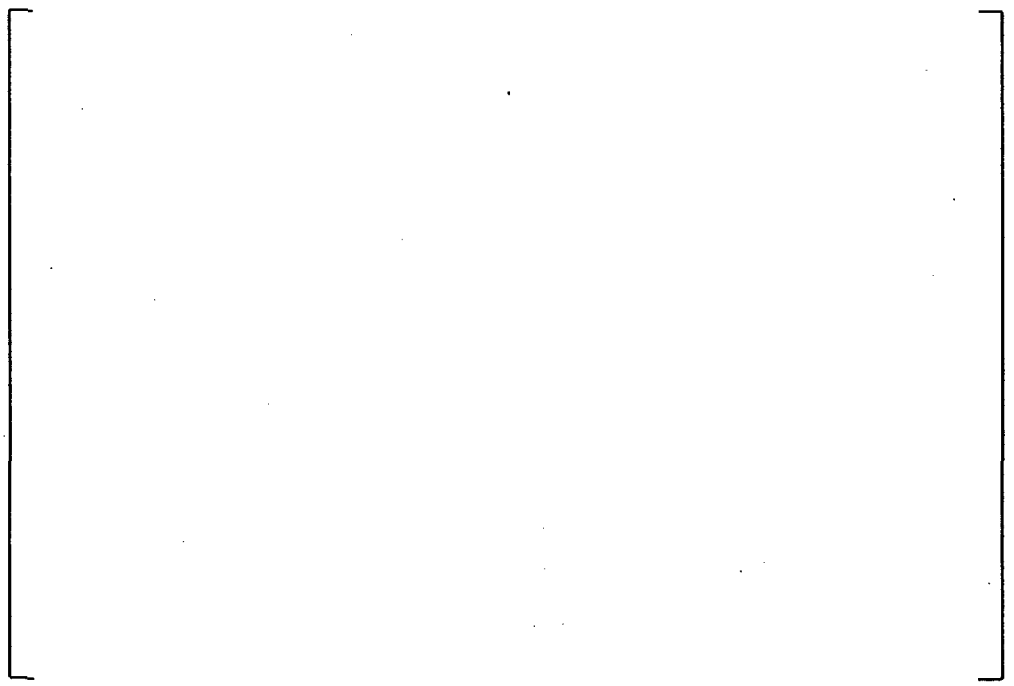
] [a, c], providing further evidence at multiple conditions that the correlation is conservative at qualities from [ ] [a, c].
The data that demonstrate the conservatism of the correlation over the quality range of [ ] [a, b, c] include:

[a, b, c]

Figure 3
Critical Heat Flux versus Quality
[ ] [a, c]

a, b, c

Figure 4
Critical Heat Flux versus Quality
[ ] [a, c]



a, b, c

Figure 5
Critical Heat Flux versus Quality

[ ] a, c

a, b, c

Figure 6
Critical Heat Flux versus Quality

[ ] a, c

a, b, c

Figure 7
Critical Heat Flux versus Quality
[ ] [a, c]

[a, b, c]

Figure 8
Critical Heat Flux versus Quality
[ ] [a, c]

[a, b, c]

Figure 9
Critical Heat Flux versus Quality

[ ] a, c

a, b, c

Figure 10
Critical Heat Flux versus Quality

[ ] a, c

a, b, c

Figure 11
Critical Heat Flux versus Quality

[ ] [a, c]

[a, b, c

]

Further clarifications on RAI #7: (Reference 2)

a. Provide technical justification for the statistical pooling of data from the 17x17 tests with emphasis on the following difference:
i. The difference between the mixing vanes of NGF and RFA/RFA-2 type fuel.

Response:

Although there is a [

] [a, c], Figures 12 and 13, show that the NGF and RFA/RFA-2 vane designs had the same or similar CHF performance, independent of any correlation predictions. Therefore, both the 17x17 NGF and the RFA fuel designs are included in the WNG-1 database. Since the vane designs are [

] [a, c] are applied. As described in LTR-NRC-08-37 (Reference 2), there were no trends in the 17x17 data when plotted by design and as shown in Table 1, the [

] [a, b, c]. Based on the raw data

comparisons, the results of the M/P t-test, the trend plots presented in Reference 2, and the fact that the sample variances are within the typical range for CHF testing of the same design, it is concluded that statistical pooling of the 17x17 test data is justified.

Figure 12

[ ] a, c

a, b, c

Figure 13

[ ] a, c

a, b, c

ii. The difference between the spacer grids and spacer grid arrangement. For example, some tests like 82, 85, 94, and 107 contain only Mixing Vane Grids (MV). Tests 89 and 90 contain one Intermediate Mixing Grid (IFM) between the MVs. Tests 108, 109, and 110 contain two IFMs between the MVs. Provide sufficient technical justification for the use of these 3 different types of mixing vane arrangements to be pooled into one data base.

Response:

The WNG-1 correlation contains a grid spacing term to explicitly account for effect of grid spacing on CHF (DNB) performance, similar to other DNB correlations (WRB-1, WRB-2, WRB-2M, and etc.) that are applicable to fuel designs with or without IFM grids. All the fuel designs with IFM grids are manufactured with different grid spacings: the bottom half of the fuel region without IFM grids, and the top half of the fuel containing IFM grids. As a result, CHF (DNB) tests were performed with and without IFM grids, in order to account for CHF changes with different grid spacings of the actual fuel designs. For WNG-1, the correlation calibration database included tests with the grid spacing term, GST, ranging from [ ] [a, b, c]. The grid spacing [ ] [a, c], the correlation GST limit was specified to be: GST $\geq$ 26.5. To confirm the correlation accounted for the range of GST properly, [ ] [a, c] in WCAP-16766-P.

The results of the normality test and analysis of variance F-test are given in Table 1. The fact that [ ] [a, c]. Based upon these tests, [ ] [a, c], so the limit of 1.14 remained valid. Scatter plots for the four groups did not show any significant trend. [ ] [a, c]. Therefore, the [ ] [a, c]. Based upon these comparisons, it is concluded that the 17NGF and 17RFA data can be pooled and treated as one design for the WNG-1 correlation.

Figure 14
Grid Spacing Multiplier, F_{GS}, versus Grid Spacing Term

[ ] a, b, c

Table 1
Comparison Tests for WNG-1 Data
[ ] [a, c]

a, b, c

b. Provide technical justification for the use of the WNG-1 correlation for the 15x15 fuel for Local Mass Velocity [ ]$^{a, b, c}$. There is no data beyond that range. If a pool-ability argument is made provide sufficient technical justification why other fuel is similar to 15x15 fuel.

Response:

As stated in the introductory section and in response to Part b for Further Clarification of RAI #5 (Reference 9), the [ ]$^{a, c}$.
Therefore, the [ ]$^{a, c}$ are applied.
The fact that the CHF M/P data pass the pool-ability tests [

]$^{a, c}$. As shown in Figures 9 and 10 of LTR-NRC-08-37 (Reference 2), there was no trend in the 15x15 data with mass velocity [ ]$^{a, c}$. Based on the fact that the [ ]$^{a, c}$, the CHF M/P data are pool-able and no trends are observed as a function of mass velocity, the WNG-1 flow parameter range in Table 5-1 of WCAP-16766-P is applicable to the 15x15 fuel, as discussed in the introductory section. However, as stated above, due to the [ ]$^{a, c}$, Westinghouse would agree that the WNG-1 correlation applicability would not include the 15x15 design until such time as additional data are available to substantiate its acceptability for [ ]$^{a, c}$.

c. Provide technical justification for the use of the WNG-1 correlation for the 16x16 fuel for Local Mass Velocity [ ]$^{a, b, c}$. There is no data beyond that range. If a pool-ability argument is made provide sufficient technical justification why other fuel is similar to 16x16 fuel.

Response:

As stated in the introductory section and in the response to part b for further clarification of RAI #5, the [ ]$^{a, c}$, similar to the approved topical reports listed in the response. Therefore, the [ ]$^{a, c}$ is applied. The fact that the CHF M/P data pass the pool-ability tests [

]$^{a, c}$. As shown in Figures 7 and 8 of LTR-NRC-08-37 (Reference 2), there was no trend in the 16x16 data with mass velocity [ ]$^{a, c}$. Based on the fact that the [ ]$^{a, c}$, the CHF M/P data are pool-able and no trends are observed as a function of mass velocity, the WNG-1 parameter range in Table 5-1 of WCAP-16766-P is applicable to the 16x16 fuel, similar to the approved topical reports listed in response to part b for further clarification to RAI #5.

d. Provide technical justification for the use of the 95/95 from the pooled data when the 95/95 from the specific fuel type may be more appropriate due to dissimilarities between the fuel types tested.

Response:

As stated previously, the fuel designs included in the WNG-1 correlation are [

]^{a,c}.

Based upon raw data comparisons for the same test geometries, it was shown that the RFA and NGF 17x17 designs [ ]^{a,c}. As stated in response to RAI #19 for the WRB-2 correlation in WCAP-10444-P-A, the approach to calculate the DNBR 95/95 limit may be justified by either 1) demonstrating there are no test geometry effects on the M/P values or distribution, or 2) demonstrating that explicitly accounting for any test section to test section variation does not affect the DNBR calculation. The fact that the data are pool-able when [

]^{a,c}, demonstrates that geometry effects have been properly accounted for in the WNG-1 correlation, and the WNG-1 database can be treated as samples from the total population of DNB data that could be obtained for the tested designs. To examine item 2, the DNBR limit was [

]^{a,c}. Following the Total Variance approach in WCAP-10444-P-A, [

]^{a,c}. Following the most conservative approach described in NS-NRC-85-3033, attached to WCAP-10444-P-A, the variance within tests, [

]^{a,b,c}. It is noted that the DNBR limit computed with the Total Variance approach remains at 1.140 when the 15x15 data are deleted. As stated in WCAP-16776-P, there are only 3.5% of the points with M/P values below the DNBR limit of 1.14 compared to slightly over 4% using the binomial distribution or the distribution free limit. A third approach examined [

]^{a,c}. This further provides support that there are no test geometry effects on the M/P values for the WNG-1 correlation. The DNBR limit for the limiting test sections is 1.15; however, only 3% of the data have M/P values below the DNBR limit of 1.15, [

]^{a,c}. Therefore, the proposed 95/95 DNBR limit of 1.14 based on the whole WNG-1 data base is appropriate. The 95/95 DNBR limit determination in the future will continue to follow the existing method, which has been NRC-approved, and is based on evaluation of the fuel DNB performance, supplemented with statistical evaluation of data poolability.

e. Provide reference for statistical methods for pooling data.

Response:

In addition to the references provided in WCAP-16776-P on statistical methods previously applied for pooling data, described in Section 4.1, the following references describing the statistical methods for pooling data are listed below:

d.) WCAP-12488-A (Reference 1) describes statistical method for pooling data.

e.) WCAP-9401-P-A (Reference 3) describes statistical method for pooling the CHF data of the 17x17 Optimized Fuel Assembly (OFA) having a rod OD of 0.360 inch with the WRB-1 database.

f.) WCAP-8168-P-A (Reference 8) describes repeatability of DNB tests.

Additional References that provide background on statistical tests that have been or could be applied on correlation Measured/Predicted data from DNB tests.

d.) A. Hald, "Statistical Theory with Engineering Applications". J. Wiley, N.Y, N.Y., 1952, describes Bartlett Test, Sec. 11.6, including a method for investigating whether the distribution of individual subgroup variances are distributed in accordance with χ^2. Also, two sample t-test, Sec. 15.4, and F-test for the equality of multiple means, Sec. 16.4.

e.) J. V. Bradley, "Distribution-Free Statistical Tests", Prentice-Hall, Inc. Englewood Cliffs, N.J. 1968, describes Wilcoxon (Mann-Whitney) & Kruskal Wallis tests.

f.) W. J. Conover, "Practical Nonparametric Statistics, 2nd edition", J. Wiley, N.Y., N.Y., 1980, describes Wilcoxon (Mann-Whitney) & Kruskal Wallis tests, a test like Wilcoxon for variances of two populations and a test like Kruskal Wallis for multiple variances.

g.) H. M. Wadsworth, "Handbook of Statistical Methods for Engineers and Scientists", McGraw-Hill, Inc., N.Y., N.Y., 1990 (Chapter 16, "Robust Estimation & Identifying Outliers", P. J. Rousseeuw) describes the "M.A.D." method for detecting outliers (median of all absolute deviations from the sample median)

h.) R. M. Bethea, B. S. Duran, T. L. Boullion, "Statistical Methods for Engineers & Scientists", Marcel Dekker, Inc., N.Y., N.Y., 1975, discusses the "robust" nature of the F-test for multiple means with respect to deviations from normality and variances which fail the Bartlett test (Sec. 8.6).

i.) N. R. Draper and H. Smith, "Applied Regression Analysis", J. Wiley & Sons, N.Y., N.Y., 1966, discusses the fact that regression analyses will have a zero mean error when there is a constant term in the regression or correlation (p.13).

References:

1. WCAP-12488-A, "Westinghouse Fuel Criteria Evaluation Process," April 1994.

2. LTR-NRC-08-37, "Response to NRC's Request for Additional Information by the Office of Nuclear Reactor Regulation for Topical Report (TR) WCAP-16766-P, "Westinghouse Next Generation Correlation (WNG-1) for Predicting Critical Heat Flux in Rod Bundles with Split Van Mixing Grids" (TAC No. MD7230) (Proprietary/Non-Proprietary)," July 29, 2008.

3. WCAP-9401-P-A, "Verification Testing and Analysis of the 17x17 Optimized Fuel Assembly," August 1981.

4. WCAP-8762-P-A, "New Westinghouse Correlation WRB-1 for Predicting Critical Heat Flux in Rod Bundles with Mixing Vane Grids," March 1978.

5. WCAP-10444-P-A, "Reference Core Report – VANTAGE 5 Fuel Assembly," September 1985.

6. WCAP-16523-P-A, "Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes," August 2007.

7. WCAP-14565-P-A Addendum 2-P-A, "Addendum 2 to WCAP-14565-P-A, Extended Application of ABB-NV Correlation and Modified ABB-NV Correlation WLOP for PWR Low Pressure Applications," April 2008.

8. WCAP-8168-P-A, "Evaluation of DNB Test Repeatability," April 1975.

9. NRC-RCPL-08-083, "Request for Additional Information RE: Westinghouse Electric Company (Westinghouse) Topical Report (TR) WCAP-16766-P, "Westinghouse Next Generation Correlation (WNG-1) for Predicting Critical Heat Flux in Rod Bundles with Split Vane Mixing Grids" (TAC NO. MD7230)," November 25, 2008.