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

Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-53 and DPR-69
NRC Docket Nos. 50-317 and 50-318

Subject: Supplemental Response to Generic Letter 2004-02

References:
1. Letter from Mr. G. H. Gellrich (CCNPP) to Document Control Desk (NRC), dated July 23, 2010, Request for Additional Information Regarding Generic Letter 2004-02
2. Letter from Mr. D. V. Pickett (NRC) to Mr. G. H. Gellrich (CCNPP), dated, April 2, 2010, Request for Additional Information Re: Generic Letter 2004-02 Calvert Cliffs Nuclear Power Plant, Unit Nos. I and 2 - (TAC Nos. MC4672 and MC4673)

In Reference 1, Calvert Cliffs provided our response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) contained in Reference 2. In response to NRC RAI 1 Calvert Cliffs provided revised Zone of Influence (ZOI) information for use in the Debris Generation calculations. In response to NRC RAI 10 Calvert Cliffs provided revised debris size distribution information for Nukon insulation. Calvert Cliffs has discovered additional information on certain materials which we believe will enable us to revise the ZOI and debris size distribution information for these materials. A description of the revised ZOI and debris size distribution information is provided in Attachment (1). This information supersedes the applicable information originally provided in Reference 1.

This letter contains no regulatory commitments.

Should you have questions regarding this matter, please contact Mr. Larry D. Smith at (410) 495-5219.

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I declare under penalty of perjury that the foregoing is true and correct. Executed on June 8, 2016.

Respectfully,

Mark Flaherty
Plant Manager

MDF/KLG/bjm

Attachment: (1) Supplemental Response to Generic Letter 2004-02, Revised Zone of Influence and Debris Size Distribution Information

cc: NRC Project Manager, Calvert Cliffs
NRC Regional Administrator, Region I
NRC Resident Inspector, Calvert Cliffs
S. Gray, MD-DNR

# ATTACHMENT (1)

## SUPPLEMENTAL RESPONSE TO GENERIC LETTER 2004-02, REVISED ZONE OF INFLUENCE AND DEBRIS SIZE DISTRIBUTION INFORMATION

## ATTACHMENT (1)

## SUPPLEMENTAL RESPONSE TO GENERIC LETTER 2004-02, REVISED ZONE OF INFLUENCE AND DEBRIS SIZE DISTRIBUTION INFORMATION

In Reference (1) Calvert Cliffs provided Zone of Influence (ZOI) and debris characteristic data for Nukon, Thermal Wrap, mineral wool and generic fiberglass insulation and lead shielding blankets. We have discovered additional information on certain materials which we believe will enable us to revise the ZOI and/or debris size distributions information for these materials. A description of the revised ZOI and debris size distribution information is presented below.

### NUKON AND THERMAL WRAP INSULATION

In Reference (2) Calvert Cliffs informed the Nuclear Regulatory Commission (NRC) that we are pursuing a risk-informed resolution to GSI-191 and response to Generic Letter 2004-02. The debris generation calculation for the risk-informed approach uses the BADGER software to determine debris quantities generated. This software includes a calculation of the average distance (centroid) from the break to the insulation, which is used with four piecewise functions to calculate debris size fractions. The functions were derived in a calculation [Reference (3)] using an approach that is consistent with the methodology set forth in Appendix II of NEI 04-07 Volume 2 [Reference (2)]. The functions provide a size distribution for Nukon and Thermal Wrap Low Density Fiberglass insulation on piping and components based on Air Jet Impact Test (AJIT) data. The average centroid magnitude ($C$) of the break location relative to the target is an independent variable that is used to calculate a corresponding fraction of fines, small pieces, large pieces, and intact pieces generated for given break. Therefore, the size distribution varies based on the distance of the insulation from the break (i.e., insulation debris generated near the break location would consist of more small pieces than insulation debris generated near the edge of the ZOI). The piecewise functions are summarized in Table 1 below, and will be used as an alternative with the previously approved size distribution data.

**Table 1 – BADGER Nukon & Thermal Wrap Debris Size Distribution**

| Debris Size | Average (Centroid) Distance from Break Location to Target | | |
|---|---|---|---|
| | 0D – 4D ZOI | 4D – 15D ZOI | 15D – 17D ZOI |
| Fines Fraction ($F_{fines}$) | $F_{fines} = 0.2$ | $F_{fines} = -0.01364 \times C + 0.2546$ | $F_{fines} = -0.025 \times C + 0.425$ |
| Small Pieces Fraction ($F_{smalls}$) | $F_{smalls} = 0.8$ | $F_{smalls} = -0.0682 \times C + 1.0724$ | $F_{smalls} = -0.025 \times C + 0.425$ |
| Large Pieces Fraction ($F_{large}$) | $F_{large} = 0$ | $F_{large} = 0.0393 \times C - 0.157$ | $F_{large} = -0.215 \times C + 3.655$ |
| Intact Pieces Fraction ($F_{intact}$) | $F_{intact} = 0$ | $F_{intact} = 0.0425 \times C - 0.170$ | $F_{intact} = 0.265 \times C - 3.505$ |

### MINERAL WOOL INSULATION

The mineral wool at Calvert Cliffs was provided by Transco Products and is encapsulated in stainless steel cassettes. The mineral wool cassettes are virtually identical to that of the original Transco reflective metal insulation (RMI) installed at Calvert Cliffs but with a different filler material, i.e., mineral wool fibers instead of stainless steel foils. Based on the robust nature of these cassettes, the ZOI for the Transco mineral wool is closer to that of Transco RMI than that of low density fiberglass.

The Transco stainless steel cassette system includes inner and outer sheaths, slotted end panels, and latch & strike closure buckles similar to one of the RMI cassette configurations tested in the air jet impact testing [Reference (6)]. The approved ZOI for Transco RMI of 2.0D

[Reference (4)] was developed from this air jet impact testing. The tested cassettes contained metal foil and produced none or very little transportable debris. The contained material contributes no strength to the cassettes. Therefore, the destruction pressure for the Transco mineral wool cassettes and RMI cassettes are considered equal. However, to account for the difference in filler material, the ZOI for the mineral wool cassettes will be conservatively increase by a factor of 2 from 2.0D to 4.0D. The debris size for the mineral wool will be conservatively assumed to be 100% fine fibers.

## GENERIC FIBERGLASS INSULATION

The generic fiberglass insulation at Calvert Cliffs does not have a cloth jacket that the Nukon and Thermal Wrap insulation have, and is instead exposed insulation molded of heavy density resin bonded inorganic glass fibers inside the jacketing. Therefore, there are no undamaged pillows of insulation for this material, and all insulation that would have been characterized as "intact pieces" will be assumed to be "large" pieces. The outer jacket is 0.010" stainless steel sheet metal held together with rivets. This fiberglass and has a bulk density generally greater and no lower than Nukon and Thermal Wrap. Calvert Cliffs assumes that the ZOI and debris size distribution for generic fiberglass are the same as that used for Nukon and Thermal Wrap based on the insulation density. The comparison of debris damage for three insulation types with differing densities shown in Figure II-8 of Reference (4), Volume 2, supports the assumption of less damage for a higher density material.

This assumption was also accepted in Reference (5) by the NRC. Also note that since there is substantially less generic fiberglass than Nukon and Thermal wrap at Calvert Cliffs, the accurate prediction of the size distribution for generic fiberglass is not nearly as important as it is for Nukon and Thermal Wrap. The mass percentage of generic fiberglass relative to total fibrous debris load is 20% for the bounding break at Calvert Cliffs.

## LEAD SHIELDING BLANKETS

The lead shielding blankets potentially exposed to high energy line break jet are both free-hanging blankets hung adjacent to piping and wrapped around piping or components. Typically, there are two lead blankets between the piping and the surrounding area. Blast testing of lead blankets similar to those used at Calvert Cliffs has been performed with both air jets and steam jets. The air jet testing conducted as part of the AJITs is included in the BWR URG for ECCS Suction Strainer Blockage [Reference (6)]. The steam jet testing was performed by Wyle and is documented in WCAP-16727-P [Reference (7)].

The Wyle testing is not used to quantify ZOI information. This testing is used to show that open back (freely hanging) blankets will be torn from their grommets and not generate fine debris when near a break jet and that open back blankets are less likely to generate debris than those installed in a strong back configuration. Furthermore, the inner and outer cover and lead wool on the break side of a lead blanket are sacrificial and provide protection to the inner and outer cover on the opposite side of the blanket.

The AJITs subjected rubberized cloth coated lead shielding blankets to a range of surface pressures, the maximum pressure being 40 psig. The lead blankets were wrapped around a 12 inch pipe in these tests, not a free hanging, open-back configuration. This configuration is similar to the strong back configuration discussed in the Wyle testing, even though the backing in this test was a pipe, not a flat plate.

No debris was generated in any of these tests. Since these tests were performed with an air jet, the damage pressures is reduced by 40% to account for potentially enhanced debris generation in a two phase jet, consistent with Reference (2). Therefore, a ZOI corresponding to a damage pressure of 24 psig [= (1-0.4)*40] is applicable to the lead blankets wrapped around piping and components and it is conservative for the free-hanging lead blankets since the blankets at Calvert Cliffs have an open-back configuration. This damage pressure corresponds to a PWR ZOI of 5.4 D.

**Lead Wool**

Although lead wool debris may be generated, it will not transport to the strainer due to the high density of lead.

**Lead Blanket Covers**

In the AJITs, no lead blanket debris was generated for surface pressures corresponding to a ZOI of 5.4 D. In order to determine the size distribution for the lead blanket cover debris which could potentially be generated inside of 5.4 D, other tests performed as part of the AJITs were used.

The cloth cover used on NUKON blankets is similar to the lead blanket Alpha Maritex cover materials, except that the NUKON cover uses a plain weave while the Alpha Maritex 3259-2-SS and 8459-2-SS covers use a 4-harness and 8-harness satin weave, respectively. The NUKON cover cloth is made of 18 oz/yd$^2$ E-glass. Both Alpha Maritex 3259-2-SS and 8459-2-SS are made with G37 fiberglass yarn, which is also E-glass. The density of Alpha Maritex 3259-2-SS (the inner cover) is 17.5 oz/yd$^2$ while the density of Alpha Maritex 8459-2-SS (the outer cover) is 34 oz/yd$^2$.

The primary difference between the NUKON cover and the Alpha Maritex products is the weave type. Typically, a plain weave is the least tear resistant since it has a very tight construction which has the least amount of internal slippage/yarn mobility. In addition, only one yarn bears the load in a plain weave when the fabric is torn. However, satin weaves have fewer yarn interlacings per area (less tight weave) and therefore allow more internal slippage. Furthermore, multiple yarns bear the load in a satin weave when the fabric is torn. This results in satin weaves, used in the Alpha Maritex covers, being much more tear resistant than plain weaves, used in NUKON cloth covers.

Although the materials of construction are similar for the NUKON cloth cover and the Alpha Maritex products, the plain weave utilized in the NUKON cloth cover is less tear resistant than the satin weave utilized in the Alpha Maritex covers. Therefore, the fiberglass cover used for NUKON is less robust than the lead blanket inner and outer covers. Thus, the debris generation properties for the NUKON cover are conservative for Alpha Maritex 3259-2-SS and Alpha Maritex 8459-2-SS.

The AJITs subjected unjacketed NUKON blankets installed on a 12 inch pipe to a range of pressures with the maximum pressure being 190 psig. In all of these tests, the cloth cover and scrim failed in large intact sections and was determined to be non-transportable. Since these tests were performed with an air jet, the damage pressure is reduced by 40% to account for potentially enhanced debris generation in a two-phase jet. An air jet damage pressure of 190 psig corresponds to a two-phase damage pressure of 114 psig [= (1-0.4)*190], which corresponds to a ZOI of 2.1 D. Therefore, lead blanket cover debris generated beyond 2.1 D is considered to be large or intact pieces.

Within a ZOI of 2.1 D, the lead blanket covers on the break side of the lead wool in the blankets closest to the break are considered to become 20% fines and 80% small pieces. As the lead blanket covers are more robust than NUKON blanket covers, this approach is conservative.

The lead blanket covers on the opposite side of the lead wool in the blankets closest to the break are considered to form large pieces or remain intact, as are the lead blanket covers on the 2nd outboard set of lead blankets where two blankets are essentially "stacked" next to each other. These covers are shielded from the break by the innermost lead wool and inner and outer covers. This approach is reasonable since the lead blankets are freely hanging, and therefore would be torn from their grommets and projected away from the pipe in the event that a break occurs.

The size distributions and sub-zone ZOIs for lead shielding blankets are shown in Table 2.

**Table 2 – Lead Shielding Blanket Debris Size Distribution**

| Debris Type | Size | Size Distribution | |
|---|---|---|---|
| | | 2.1D ZOI | 2.1D – 5.4D ZOI |
| Lead Blanket Cover Layers Closest to Pipe Break (Open Back Configuration) | Fines | 20% | 0% |
| | Small Pieces | 80% | 0% |
| | Large/Intact Pieces | 0% | 100% |
| Remaining Lead Blanket Cover Layers (Open Back Configuration) | Fines | 0% | 0% |
| | Small Pieces | 0% | 0% |
| | Large/Intact Pieces | 100% | 100% |
| Wrapped Lead Blanket Cover Layers (Strong Back Configuration) | Fines | 0% | 0% |
| | Small Pieces | 0% | 0% |
| | Large/Intact Pieces | 100% | 100% |

This size distribution for lead blanket cover material was also accepted by the NRC in Reference (8).

## REFERENCES:

(1) Letter from Mr. G. H. Gellrich (CCNPP) to Document Control Desk (NRC), dated July 23, 2010, Request for Additional Information Regarding Generic Letter 2004-02

(2) Letter from Mr. G. H. Gellrich (Exelon) to Document Control Desk (NRC), dated November 17, 2015, Calvert Cliffs GSI-191 Resolution Plan

(3) CA10007, Attachment A, ENERCON Calculation No, GSI191-CALC-001, Revision 1, "Insulation ZOI Size Distribution Report"

(4) NEI 04-07, Revision 0, December 2004, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Volume 1 and Volume 2

(5) NRC Audit Report, "Indian Point Energy Center Corrective Actions for Generic Letter 2004-02", ADAMS Accession Number ML082050433

(6) C.D.I. Report No. 96-06, Revision A, "Air Jet Impact Testing of Fibrous and Reflective Metallic Insulation," included in Volume 3 of GE Nuclear Energy Document No. NEDO-32686-A, DRF A74-00004, "Utility Resolution Guide for ECCS Suction Strainer Blockage," dated October 1998

(7) WCAP-16727-P, Revision 0, "Evaluation of Jet Impingement and High Temperature Soak Tests of Lead Blankets for Use Inside Containment of Westinghouse Pressurized Water Reactors"

(8) Letter from Mr. Carl J. Fricker (PSEG) to Document Control Desk (NRC), dated April 27, 2012, Final Supplemental Response to Generic Letter 2004-02, Attachment 1