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Our ref: LTR-NRC-09-8

February 5, 2009

Reference:
1. Letter from W. H. Ruland (NRC) to J. A. Gresham (Westinghouse), November 24, 2008.

Subject: Response to NRC Request for Information Regarding Proposed Treatment of Double-Sided Cladding Oxidation in 10 CFR 50.46(b) (Non-Proprietary)

Attached is Westinghouse's response to the NRC's request for information regarding the proposed treatment of double-sided cladding oxidation in 10 CFR 50.46(b). Correspondence with respect to this letter should reference LTR-NRC-09-8 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

cc: G. Bacuta (NRC OWFN 12 E1)

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Response to NRC Request for Information Regarding Proposed Treatment of Double-Sided Cladding Oxidation in 10 CFR 50.46(b)

February 5, 2009

Westinghouse Electric Company, LLC
P.O. Box 355
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Response to NRC Request for Information Regarding Proposed Treatment of Double-Sided Cladding Oxidation in 10 CFR 50.46(b)

1.0 Purpose

Provide a response to a request from the Nuclear Regulatory Commission (NRC) for information regarding the proposed treatment of double-sided cladding oxidation in 10 CFR 50.46(b) (Reference 1).

2.0 Request for Information

The following text is from Reference 1 and summarizes the requested information:

It would be very helpful if you could provide relevant information for several cores in which your fuel is used. The information that is needed is identified in the following list and should come from existing licensing analyses that have been accepted by NRC in support of a plant license. No new analyses are needed. The plants do not need to be identified, but it would be helpful if the plant types were identified and the information provided in non-proprietary form.

Desired Information

Outside diameter of the as-fabricated cladding
Thickness of the as-fabricated cladding
Peak cladding temperature in the peak-cladding-temperature node
Maximum transient cladding oxidation in the peak-cladding-temperature node
Peak cladding temperature in the rupture node
Maximum transient cladding oxidation in the rupture node
Strain used to calculate wall thinning in the rupture node
Flow area reduction due to ballooning in the rupture node

The several cores selected should span the range found in your licensing analyses of the ratio of maximum cladding oxidation in the peak-cladding-temperature node to that in the rupture node.

3.0 Response

Results have been collected from 11 Large Break LOCA analyses using the Automated Statistical Treatment of Uncertainty Method (ASTRUM; Reference 2) that have been accepted by the NRC in support of a plant license. The results are based on the ASTRUM uncertainty cases that produced the highest peak cladding temperature (PCT) and maximum local oxidation (MLO) from the 124-run set, prior to any supplemental assessments. The results do not necessarily span the range of the ratio of the maximum cladding oxidation in the PCT and rupture nodes, as this information is not readily available for all NRC-accepted analyses using all NRC-accepted Evaluation Models. Table 1 provides selected plant and fuel design information for each analysis including the number of reactor coolant system loops (N_{LOOPS}); the fuel assembly array size; and the as-fabricated cladding outer diameter ($D_{O,CLAD}$) and thickness (t_{CLAD}).

Table 1: Selected Plant and Fuel Design Information

Analysis	N_{LOOPS}	Fuel Array	$D_{O,CLAD}$ (in)	t_{CLAD} (mils)
A	2	14×14	0.400	24.3
B				
C			0.422	
D	3	15×15	0.422	24.3
E		17×17	0.360	22.5
F	4	15×15	0.422	24.3
G				
H		17×17	0.360	22.5
I				
J				
K			0.374	

Table 2 provides the PCT and the transient equivalent cladding reacted (ECR_T) calculated by HOTSPOT for the axial nodes from the cases producing the highest PCT, the highest transient ECR among all non-burst nodes, and the highest transient ECR among all burst nodes; these cases are denoted as PCT_{MAX}, $(ECR_T)_{MAX,NB}$ and $(ECR_T)_{MAX,B}$, respectively. Also provided for the third case are the average burst strain calculated by HOTSPOT (if hot rod burst was predicted to occur) and the assembly blockage calculated by WCOBRA/TRAC (if hot assembly average rod burst was predicted to occur). PCT and ECR_T values in bold represent the overall maximum values for the analysis, with "N/A" used to denote values that are not available since the corresponding rod was not predicted to burst.

Table 2: Peak Cladding Temperature, Equivalent Cladding Reacted, Burst Strain and Assembly Blockage Results

Analysis	PCT_{MAX}		$(ECR_T)_{MAX,NB}$		$(ECR_T)_{MAX,B}$			
	PCT (°F)	ECR_T (%)	PCT (°F)	ECR_T (%)	PCT (°F)	ECR_T (%)	Strain (in/in)	Blockage (%)
A	**1593.1**	0.16	1487.8	**0.19**	1501.8	0.18	0.52	N/A
B	**1545.9**	0.12	1525.2	**0.49**	1511.7	0.45	0.28	N/A
C	**1869.9**	1.60	**1869.9**	1.60	1852.7	**3.43**	0.32	17.6
D	**2043.7**	3.69	**2043.7**	3.69	1905.0	**5.26**	0.30	17.5
E	**1835.5**	1.29	1784.4	1.56	1702.4	**2.86**	0.26	22.4
F	**2105.2**	**9.98**	<2105.2	<4.99	**2105.2**	**9.98**	0.63	17.8
G	**1962.2**	**2.39**	**1962.2**	**2.39**	1684.7	2.35	0.39	16.9
H	**1871.9**	1.55	**1871.9**	1.55	1673.6	**1.64**	0.48	N/A
I	**1491.5**	0.14	1424.0	**0.23**	N/A	N/A	N/A	N/A
J	**1631.9**	0.64	**1631.9**	0.64	1482.3	**0.71**	0.40	N/A
K	**1780.5**	**3.50**	1716.9	1.23	**1780.5**	**3.50**	0.33	N/A

Table 3 summarizes the MLO results from the existing analyses (denoted as $MLO_{CURRENT}$) and the results that would be obtained by doubling the highest transient ECR among all non-burst nodes regardless of burnup (denoted as $MLO_{ALTERNATE}$). Several cases show an increase in MLO from the current method to the alternate method, which is generally consistent with results reported in Reference 3 and underscores the need to avoid an excessively conservative treatment of double-sided oxidation. This is particularly important for analyses that may produce more limiting MLO results than some of the relatively benign ones shown in Table 3; for example, results calculated using methods developed according to the requirements of 10 CFR 50 Appendix K.

Table 3: Maximum Local Oxidation Results for Current and Alternate Methods

Plant	$MLO_{CURRENT}$ (% ECR_T)	$MLO_{ALTERNATE}$ (% ECR_T)	$\frac{MLO_{ALTERNATE}}{MLO_{CURRENT}}$
A	0.19	0.38	2.0
B	0.49	0.98	2.0
C	3.43	3.43	1.0
D	5.26	7.38	1.40
E	2.86	3.12	1.09
F	9.98	9.98	1.0
G	2.39	4.78	2.0
H	1.64	3.10	1.89
I	0.23	0.46	2.0
J	0.71	1.28	1.80
K	3.50	3.50	1.0

4.0 References

1. Letter from W. H. Ruland (NRC) to J. A. Gresham (Westinghouse), November 24, 2008.

2. WCAP-16009-P-A, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," M. E. Nissley et al., January 2005.

3. Letter from R. L. Gardner (AREVA) to W. H. Ruland (NRC), "Comments for Proposed Rulemaking 10 CFR 50.46(b)," December 31, 2008.