This letter forwards proprietary information in accordance with 10 CFR 2.390. The balance of this letter may be considered non-proprietary upon removal of Attachments (3).

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CENG[SM]
a joint venture of
Constellation Energy
eDF

NINE MILE POINT
NUCLEAR STATION

March 10, 2014

U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTENTION: Document Control Desk

SUBJECT: Nine Mile Point Nuclear Station, Unit 2
Renewed Facility Operating License No. NPF-69
Docket No. 50-410

License Amendment Request Pursuant to 10 CFR 50.90: Maximum Extended Load Line Limit Analysis Plus – Response to SRXB RAI 1 and RAI 2

REFERENCE:
(a) Letter from P. Swift (NMPNS) to Document Control Desk (NRC), dated November 1, 2013, License Amendment Request Pursuant to 10 CFR 50.90: Maximum Extended Load Line Limit Analysis Plus
(b) Letter from B. Vaidya (NRC) to C. Costanzo (NMPNS), dated February 20, 2014, Nine Mile Point Nuclear Station, Unit NO. 2 – First Round of Request for Additional Information Regarding License Amendment Request Pursuant to 10 CFR 50.90: Maximum Extended Load Line Limit Analysis Plus (MELLLA+) (TAC NO. MF3056)
(c) Letter from B. Hagemeier (GEH) to D. Goodney (NMPNS), dated March 4, 2014, GEH Response to NRC Request for Additional Information in Support of NMP2 MELLLA+ License Amendment Request

Nine Mile Point Nuclear Station, LLC (NMPNS) hereby transmits supplemental information requested by the NRC in support of a previously submitted request for amendment to the Nine Mile Point Unit 2 (NMP2) Renewed Facility Operating License NPF-69. The initial request, dated November 1, 2013 (Reference a), included a proposed expansion of the operating boundary to allow operation in the Maximum Extended Load Line Limit Analysis Plus (MELLLA Plus) domain and the use of the General Electric Hitachi Nuclear Energy (GEH) analysis code TRACG04.

The supplemental information, provided in Attachment (1) (non-proprietary), and Attachment (3) (proprietary) to this letter, responds to the request for additional information that was provided in a letter from the NRC to NMPNS on February 20, 2014 (Reference b). The supplemental information was prepared by GEH and transmitted to NMPNS as GEH letter GE-PPO-1GYEF-KG1-728 (Reference c).

Attachment (3) is considered to contain proprietary information exempt from disclosure pursuant to 10 CFR 2.390. Therefore, on behalf of GE-Hitachi Nuclear Energy Americas LLC (GEH), NMPNS hereby makes application to withhold this attachment from public disclosure in accordance with 10 CFR 2.390(b)(1). The affidavit from GEH detailing the reasons for the request to withhold the proprietary information is provided in Attachment (2).

This supplemental information does not affect the No Significant Hazards Determination analysis provided by NMPNS in Reference (a). Pursuant to 10 CFR 50.91(b)(1), NMPNS has provided a copy of this supplemental information, without the proprietary Attachment (3), to the appropriate state representative. This letter contains no new regulatory commitments.

Should you have any questions regarding the information in this submittal, please contact Everett (Chip) Perkins, Director Licensing, at (315) 349-5219.

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 10, 2014.

Sincerely,

Christopher R. Costanzo

CRC/KJK

Attachments
(1) Response to NRC Request for Additional Information, SRXB – RAI 1 and RAI-2 (Non-proprietary)
(2) Affidavit from GE-Hitachi Nuclear Energy Americas LLC (GEH) Justifying Withholding Proprietary Information Contained in Attachment (3)
(3) Response to NRC Request for Additional Information, SRXB – RAI 1 and RAI 2 (Proprietary)

cc: Regional Administrator, Region I, NRC
Project Manager, NRC
Resident Inspector, NRC
A. L. Peterson, NYSERDA (without Attachment (3))

ATTACHMENT (1)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION,

SRXB – RAI 1 and RAI 2

(NON-PROPRIETARY)

Nine Mile Point Nuclear Station, LLC
March 10, 2014

ENCLOSURE 2

GE-PPO-1GYEF-KG1-728

Response to NRC Request for Additional Information

Non-Proprietary Information - Class I (Public)

NON-PROPRIETARY NOTICE

This is a non-proprietary version of Enclosure 1 of GE-PPO-1GYEF-KG1-728 which has the proprietary information removed. Portions of the document that have been removed are indicated by an open and closed bracket as shown here [[ ]].

By letter dated November 1, 2013 (Agencywide Document Access and Management System (ADAMS) Package Accession No. ML13316B090), Constellation Energy (the licensee) submitted a license amendment request for maximum extended load line limit analysis plus (MELLLA+). The proposed amendment request would allow operation in the expanded MELLLA+ domain.

Upon review of Attachment 10 (ADAMS) Accession No. ML13316B107) to the submittal titled "Safety Analysis Report for Nine Mile Point Unit 2 Maximum Extended Load Line Limit Analysis Plus" (ADAMS Accession No. ML13316B113), the staff has the following requests for additional information:

SRXB RAI 1

Section 9.3.3 of Attachment 10 states that zirconium credit will be used in the Shumway correlation. The staff is aware of the zirconium data described in letter dated September 9, 2013 (ADAMS Accession No. ML13253A105) from GE Hitachi Nuclear Energy to the NRC staff.

(a) Fresh fuel that has little or no oxide at the start of the transient and the fresh fuel is often in the more reactive part of the core; therefore, it is the data of interest. Figure 6 of the September 9, 2013 letter has many data sets provided together on it. Provide a plot showing clean zirconium separate from all the other data including SS, Inconel, zirconium oxide and any data that would be expected to have oxidized zirconium.

(b) In the September 9, 2013 letter, much of the Hoffman (FKZ) data that has a rapid cooling rate early in the experiment that may have been incorrectly interpreted as quench. A closer examination of the data shows this initial cooling was due to startup of the test and that quench occurred much later at significantly lower temperatures. In addition, because of high temperatures during the tests and pre-conditioning of the rods, the rods are likely have thick oxide layer thicknesses that are not representative of fuel in a commercial reactor undergoing an Anticipated Transient without Scram with Instability (ATWS-I) event. Provide a plot showing the data considered valid by the licensee for justifying Shumway as implemented in TRACG for the intended application (e.g. ATWS-I under MELLLA+). Textual justification to support the choice of the selected data and exclusion of the other data should be provided focusing on comparing the applicable test conditions to the plant application conditions to support a conclusion that the data is applicable.

Response to Parts (a) and (b)

Other materials were included in the original Figure 6 of Reference 1-1 to illustrate that the Shumway correlation matches very nicely the trend in both the data and the correlation from Henry over a wide range of material thermal properties and water pressures. Data for zirconium (Zr) with or without oxide is limited for the reasons cited in Reference 1-1 so consideration of collaborative evidence using other materials is essential and commonly practiced in designing experiments. Another key point being made in Reference 1-1 is that the presence of zirconium dioxide (ZrO_2) increases the value for T_{min} and this credit is conservatively not utilized by the Shumway correlation.

As requested in Part (a) of the RAI, data for stainless steel (SS) and Inconel have been removed from the original Figure 6 of Reference 1-1 together with the correlation curves pertaining to these materials and zirconium dioxide. The revised plot is provided in Figure 1-1. The solid red curve in Figure 1-1 is for the Shumway correlation using unoxidized zircaloy properties and no credit for the void term. The correlation as implemented in TRACG compares very well to the data shown by solid red circles that was characterized by Peterson and Bajorek (Reference 1-3) for clean zircaloy samples. There were no data points on the original figure that were specific to ZrO_2 although many of Hofmann's data points (Reference 1-2) were from zircaloy cladding that had some oxide layer on the surface as indicated by the figure legends. Fresh fuel does have less oxide at the start of the transient than fuel that has been exposed; however, the assertion that fresh boiling water reactor (BWR) fuel is "often in the more reactive part of the core; therefore, it is the data of interest" is not accurate. The hot rods in the hot fuel bundles in the core are of interest. The location in the core is not important. It is the highest power fuel bundles that are important. It is the highest reactivity fuel bundles that generally results in the highest power. Because of the presence of gadolinium, the peak reactivity for a typical BWR fuel bundle occurs at an exposure between 10 and 20 GWd/MTU which occurs roughly for fuel towards the end of its first cycle. Oxide accumulates slowly as a function of exposure during normal BWR operations. The exposure argument is not relevant because the amount of pre-transient oxide remains low because the normal BWR clad operating temperature is low and there is very limited oxygen available to form an oxide. Based on measured oxide data, the maximum pre-transient oxide is less than [[ ]] even for exposures as high as [[ ]].

Initial oxide amounts for the Hofmann (FKZ) tests were carefully created using controlled pre-transient conditioning at high temperatures with cooling supplied mainly by argon to limit the oxygen available for oxidation. Nominal pre-transient oxide layers from 0 to 350 μm were studied and the amount of oxide predicted by calculations was confirmed by measurements. For the pre-oxidized specimens, steam was mixed with the argon to provide an oxygen source and the time and temperature were controlled to achieve the desired amount of oxidation. Any additional oxide formation during the transient tests has been estimated for each test by integrating the Cathcart reaction rate equation from the beginning of the transient to the quench time using an average of the reaction rates at the initial and final conditions. The oxide production rate increases exponentially with temperature but also decreases inversely proportional to the accumulated oxide thickness. The time at the high temperature where oxygen from water is also available to form oxide was relatively short so the incremental amounts of oxide formed during the Hofmann transients are relatively small once some oxide has formed.

The original Figure 6 from Reference 1-1 was constructed by reviewing more than 85 data traces from Hofmann and rejecting all but those where the quench was obvious. The original usable set included seven for zero oxide, 16 for 100 μm oxide and 24 at 300 μm oxide.

Part (b) of the RAI asserts that "initial cooling was due to startup of the test and that quench occurred much later at significantly lower temperatures." It is true that early temperature decreases recorded for the thermo-couples at the upper and middle elevations can easily be misinterpreted as a quench when in fact the rapid temperature reduction may be due to a sudden increase in steam cooling as quenching occurred at a lower elevation. All data traces were critically reviewed again with attention on whether the temperature reduction rate was maintained at a high or increasing value after the time the quench temperature was recorded.

Also the time of the quench has been recorded. Quench times less than 5.0 seconds are not expected for the thermo-couples at the center and upper elevations. Temperature traces that did not meet this additional scrutiny were rejected. Most notably, six of the seven original temperature traces with zero oxide were eliminated so that only one trace remained (and it is questionable as suggested by the red highlighting in Table 1-1). The more objective criteria were also applied to the traces that had 100 μm and 300 μm pre-transient oxides which resulted in the removal of a few traces and the addition of a few others. The revised statistics are presented in Table 1-1. In view of the standard deviations, there is no statistically significant difference in the quench temperatures as the initial oxide increases from 100 to 300 μm. The key points are that the Hofmann data supports the material property dependence in the Shumway correlation and assuming clean zircaloy in the application of the correlation results in a T_{min} value that is conservatively below the data.

Table 1-1 Statistics for Usable Liquid Quench Data from Hofmann

Oxide (μm)	Usable Traces	[TQ – Tsat] (K) Statistics				
		Minimum	Maximum	Median	Average	Stdev
0	0				1269	
100	16	469	839	554	574	97
300	24	389	809	539	562	124
All	40	389	839	539	567	113

Details for forty-two (42) temperature traces from Hofmann are presented in Table 1-2 to facilitate independent critical review of how the data traces in Reference 1-2 were processed. The two data points shaded in red in Table 1-2 are unbelievably high and significantly different from all the other values in the table. These values are from two thermo-couples (T/Cs) at the lowest elevation so an early quench time is expected. The temperature traces from which these points were obtained appear to indicate a liquid quench; however, it is also possible that the traces are indicating that these T/Cs detached from the rod or failed in some other way. These two red data points are not shown in Figure 1-1 and they are not considered in the statistics in Table 1-1.

Table 1-2 Details for Hofmann TQ Values

Page	Figure(s)	Elevation	Curve	TQ (C)	Quench Time (s)	TQ-Tsat (C)	Initial Oxide (µm)	Transient Oxide (µm)
103	3.9, 3.10	lower	L31085 1	1380	1.6	1269	0	12.3
106	3.15, 3.16	lower	L31056 1	1450	1.5	1339	100	0.8
106	3.15, 3.16	lower	L1007 1	800	5.1	689	100	1.9
107	3.17, 3.18	center	C1007 1	720	9.0	609	100	3.4
108	3.19, 3.20	upper	U1007 1	680	17.1	569	100	6.3
108	3.19, 3.20	upper	U31056 1	600	14.0	489	100	5.2
115	3.33, 3.34	lower	L0507 1	950	1.8	839	100	0.2
115	3.33, 3.34	lower	L29056 1	750	2.6	639	100	0.3
116	3.35, 3.36	center	C0507 1	750	6.6	639	100	0.7
116	3.35, 3.36	center	C29056 1	650	9.0	539	100	0.9
117	3.37, 3.38	upper	U0507 1	650	9.6	539	100	1.0
117	3.37, 3.38	upper	U29056 1	730	10.0	619	100	1.0
124	3.51. 3.52	lower	L04066 1	680	2.2	569	100	0.0
124	3.51. 3.52	lower	L0607 1	580	4.0	469	100	0.1
125	3.53, 3.54	center	C04066 1	590	7.6	479	100	0.2
125	3.53, 3.54	center	C0607 1	630	7.0	519	100	0.1
126	3.55, 3.56	upper	U04066 1	630	7.8	519	100	0.2
126	3.55, 3.56	upper	U0607 1	580	8.7	469	100	0.2
109	3.21, 3.22	lower	L1107 1	870	6.2	759	300	0.8
109	3.21, 3.22	lower	L19066 1	920	4.0	809	300	0.5
109	3.21, 3.22	lower	L27095 1	820	7.4	709	300	0.9
110	3.23, 3.24	center	C1107 1	650	12.4	539	300	1.6
110	3.23, 3.24	center	C19066 1	790	8.8	679	300	1.1
110	3.23, 3.24	center	C27095 1	530	16.8	419	300	2.1
111	3.25, 3.26	upper	U1107 1	720	18.0	609	300	2.3
111	3.25, 3.26	upper	U19066 1	500	13.0	389	300	1.6
111	3.25, 3.26	upper	U27095 1	820	7.3	709	300	0.9
118	3.39, 3.40	lower	L05066 1	840	3.9	729	300	0.1
118	3.39, 3.40	lower	L1207 1	550	7.5	439	300	0.3
119	3.41, 3.42	center	C05066 1	600	10.5	489	300	0.4
119	3.41, 3.42	center	C1207 1	700	9.7	589	300	0.3
120	3.43, 3.44	upper	U05066 1	580	14.2	469	300	0.5
120	3.43, 3.44	upper	U1207 1	750	11.5	639	300	0.4
127	3.57, 3.58	lower	L25095 1	730	4.2	619	300	0.0
127	3.57, 3.58	lower	L29085 1	600	3.2	489	300	0.0
127	3.57, 3.58	lower	L30056 1	650	2.4	539	300	0.0
128	3.59, 3.60	center	C25095 1	550	10.1	439	300	0.1
128	3.59, 3.60	center	C29085 1	650	6.4	539	300	0.0
128	3.59, 3.60	center	C30056 1	650	6.6	539	300	0.0
129	3.61, 3.62	center	U25095 1	510	12.8	399	300	0.1
129	3.61, 3.62	upper	U29085 1	670	7.5	559	300	0.1
129	3.61, 3.62	upper	U30056 1	500	8.8	389	300	0.1

Table 1-2 includes the details for 24 experiments that had 300 µm of pre-transient oxide (shaded rows). As requested, these points have not been included in Figure 1-1 since the amount by which the quench temperature would be reduced, to determine an equivalent clean zirconium temperature from the data, for significant amounts of ZrO_2 has not been well established. There is no consensus in the literature regarding how thick the oxide must be before the impact on the minimum stable film temperature becomes significant. The statistics in Table 1-1 suggest there is no statistically significant difference in the quench temperatures as the initial oxide increases from 100 to 300 µm. Dhir (Reference 1-7) acknowledges that the "effect of oxidation on quenching behavior is most difficult to quantify." In several places Dhir states that the quenching temperature on oxidized zircaloy surfaces were 50 to 80 K higher than on fresh surfaces but does not indicate the amount of oxide required to cause this difference. Even if all the Hofmann 100 µm data points in Figure 1-1 were shifted downward by 80 K all data points would still be above the curve for clean zircaloy from the Shumway correlation. This observation supports the conclusion that the Shumway correlation (as applied) is conservatively low for the intended applications.

Wendelstorf and others in Reference 1-8 applied a *thin sheet approximation* that shows how the presence of an oxide layer impacts the effective heat transfer coefficient (HTC_{eff}) near the surface of the oxidized metal. The work was motivated by the need to understand how oxide impacts the spray cooling of steel but the theory is applicable also to Zr and ZrO_2. For stainless steel Wendelstorf concludes that "the theoretical effect of thin homogeneous and adhesive oxide layers on heat transfer is significant only for layers of 100 µm thickness and above." His conclusion is based on how much HTC_{eff} is reduced as oxide increases. A similar statement can be made for Zr and ZrO_2 by adapting the approach used in Reference 1-8 to the fuel cladding geometry and the properties of Zr and ZrO_2. It should be noted that for a low convective heat transfer coefficient such as that for film boiling that the resistance of the ZrO_2 layer is not a major contributor to the overall thermal resistance from the fuel pellet surface to the coolant. For a high convective heat transfer coefficient such as that for nucleate boiling the presence of a ZrO_2 layer has a higher percentage impact on the overall thermal resistance but still produces relatively small absolute changes in the temperature difference from the fuel pellet surface to the coolant.

Figure 6 of Reference 1-1 included 61 data points from Peterson and Bajorek (Reference 1-3). Of the total 61 data points, 24 were characterized as *clean* or *unoxidized* and 37 were labeled as *oxidized.* Reference 1-3 focused on how oxidization changes the surface roughness and characterized the test samples in this way. No oxide thickness values were documented. For the 37 points that were labeled as *oxidized* samples, there were 13 points where the roughness values were more than a factor of three higher than the unoxidized values indicating the presence of substantial amounts of oxide. These 13 points have been removed and are not present in Figure 1-1. All 24 of the original points for *unoxidized* samples have been retained. Another 24 points for the so-called *oxidized* samples had average roughness values (1.6 µm) that were less than the *unoxidized* samples (1.7 µm). These samples were retained because they could not have had any significant amounts of oxide and still had such a low roughness. The two different data sets from Peterson and Bajorek independently support the suggestion from Wendelstorf that thin oxide layers do not significantly affect the overall heat transfer. It is expected that the lightly oxidized data from Reference 1-3 should have a slightly higher quench temperature (see Figure 1-1).

Figure 6 of Reference 1-1 included ten data points from GEAP-13112 (Reference 1-4). The maximum stated oxide in the GEAP-13112 report was estimated as 1.8 mil (45.7 μm). All GEAP-13112 points have been removed from Figure 1-1 but not because of the amount of oxide. Although the quench temperatures do indicate the ability to rewet the dry cladding surface from an elevated temperature following a LOCA, quenching by spray from high-void conditions as used in the GEAP-13112 tests is not representative of the quenching that occurs in an ATWSI scenario. It is for this reason that the ten data points from GEAP-13112 previously shown in Figure 6 of Reference 1-1 have been omitted from Figure 1-1.

For purposes of evaluating the modeling of T_{min} for applicability to ATWSI originating from MELLLA+ conditions, the most representative zircaloy data is that from the Halden experiments (References 1-5 and 1-6). Because the GEH implementation of the Shumway correlation does not credit void fraction or oxidation, the two most important parameters for T_{min} applicability are the pressure and wall material property. Most data shown in Figure 1-1 are at low pressures relative to a MELLLA+ ATWSI analysis. Because no depressurization is expected in an ATWSI event, the pressure range is approximately 7 to 8 MPa. The Halden data were recorded for fluid pressures ranging from 6.5 to 6.9 MPa using a zircaloy BWR fuel rod segment. Also, the average heat fluxes in the Halden tests correspond well to those expected in an ATWSI scenario after the power is reduced by reducing core flow. Boiling transitions experienced in the Halden tests were a result of the low flow, which is the same causal mechanism for boiling transition during an ATWSI. The cooling as liquid flow was suddenly restored in the tests also emulates the cooling that occurs when flow upsurges during an ATWSI flow oscillation. These conditions in a BWR fuel channel are generic for ATWSI power/flow conditions where large oscillations can occur. The only distinction being that the more reactive control rod line for MELLLA+ used in the plant calculations is more likely to result in higher channel power and earlier onset of instability as the core flow is reduced. All of the Halden data described and presented in Reference 1-1 has been retained here in Figure 1-1 because it is judged, based on the discussion above, that the Halden test conditions are the most representative of the conditions expected in an ATWSI scenario for MELLLA+ conditions once the power and flow oscillations grow to the point that boiling transitions occur and could result in cladding temperatures that approach or exceed T_{min}.

There is no indication in the Halden reports how much oxide accumulated during the tests. The accumulated amount has been calculated by considering the number of boiling transition (BT) events, the maximum temperature for each event, and the duration of each event for each rod segment. The amount of oxide produced during a BT event averaged 2.4 μm with a minimum to maximum range of 0.2 to 6.9 μm. The highest value was calculated for a segment conservatively assumed to have zero initial oxide. The maximum accumulated oxide for the series of tests was less than 50 μm for the rod segment that experienced the most BT events. These calculated numbers should be considered as rough estimates to support the conclusion that the accumulated oxide amounts were not excessive and thus the Halden data points support the conclusion that the Shumway correlation as applied is conservative. Note that even the minimum Halden data point is 166 K above what is predicted by the Shumway correlation for unoxidized zircaloy.

In Figure 1-1, the solid red curve obtained from the Shumway correlation using zircaloy material properties is below essentially all of the zircaloy T_Q values extracted from References 1-2 through 1-6. The data supports the conclusion that the Shumway correlation is conservative for the intended applications in the TRACG code. There are several plausible explanations (not related to oxide) for why the Shumway correlation is conservatively lower than the bulk of the data. For the correlated curve, the Reynolds number was assumed to be zero because the experiments did not provide sufficient information to determine the experimental flow; however, the Reynolds number dependence is small in the Shumway correlation and accounting for it would not affect the conclusion that the Shumway correlation is conservative for the intended applications. The Shumway correlation (solid red curve) was also evaluated assuming that $\alpha = 1$ so no credit would be realized from the term $\left[1+(1-\alpha)^2\right]$ in the correlation. This term has been judged to have inadequate experimental support because in Shumway's words it is based on "a small amount of unpublished Semiscale void data" and the "accuracy of the void effect is untested". Especially for the cases of the Hofmann and Halden data the quench occurs for a much lower void fraction than 1.0 just based on how the liquid water was forced into the test section. It is also likely that a credit for liquid subcooling is observed in the data that is not represented in the Shumway correlation. As an upper bound on the temperature prediction from the Shumway correlation, a value of $\alpha = 0$ was assumed to obtain the dashed red curve in Figure 1-1. The dashed curve is in reasonable agreement with the Hofmann and Halden quench temperature data; however, in applications of the Shumway correlation in TRACG analyses the term $\left[1+(1-\alpha)^2\right]$ is conservatively replaced by 1.0 because of the inadequate experimental support for this term.

Summary

The Shumway correlation for T_{min} properly accounts for a wide range of material properties and water pressures as evidenced by the comparisons to data in Figure 6 of Reference 1-1. As requested, the collaborating data for other materials has been removed from this document leaving only zircaloy. All the zircaloy data points from Figure 6 of Reference 1-1 were reviewed to evaluate if they were applicable for the intended purpose of supporting the use of the Shumway correlation for unoxidized zircaloy to calculate T_{min} used in ATWSI calculations. The zircaloy data from GEAP-13112 (Reference 1-4) was excluded because quenching occurred by spray cooling into a steam environment from above whereas quenching in an ATWSI occurs by liquid water. The thickness of the zirconium dioxide (ZrO_2) that was initially present in the specimens or that accumulated during the tests was also considered. The data points that were retained contained a total accumulated ZrO_2 layer of less than 120 μm. All the Hofmann data (Reference 1-2) traces were carefully scrutinized to ensure proper recording of the quench temperatures. Hofmann data obtained from specimens with an initial 300 μm ZrO_2 layer was removed even though this data does not indicate an increase in quench temperatures relative to the data obtained from the samples where the initial ZrO_2 layer was 100 μm. The Peterson and Bajorek (Reference 1-3) data with roughness values above the clean zircaloy roughness values were also removed because high roughness values imply a thick ZrO_2 layer that was not quantified by the researchers. The remaining zircaloy data was plotted in Figure 1-1 along with two examples of the Shumway correlation for zircaloy properties. Shumway at 0% voids corresponding to liquid water quench provides reasonable agreement with the Hofmann and

Halden (References 1-5 and 1-6) data; nevertheless, the more conservative form of the Shumway correlation without crediting the void term is what is used in TRACG to estimate T_{min} for zircaloy. This implementation is justified because it provides a value of T_{min} that is lower than most of the zircaloy data as shown in Figure 1-1. Lower values of T_{min} are more conservative because they delay the return to nucleate boiling and thus result in higher and more conservative calculated values for the wall temperature (T_w).

[[

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Figure 1-1 Shumway Correlation Compared to Zircaloy Data versus Pressure

References

1-1 *Use of the Shumway T_{min} correlation with Zircaloy for TRACG Analyses*, Letter J.F. Harrison (GEH) to NRC Document Control Desk, MFN 13-073 (ADAMS Accession No. ML13253A105), September 9, 2013.

1-2 Hofmann, P. et al., Quench Behavior of Zircaloy Fuel Rod Cladding Tubes: Small-Scale Experiments and Modeling of the Quench Phenomena, FZKA 6208, Forschungszentrum Karlsruhe, March 1999.

1-3 Peterson, L.J. and S.M. Bajorek; *Experimental Investigation of Minimum Film Boiling Temperature for Vertical Cylinders at Elevated Pressure*; Proceedings of ICONE10 10th; Arlington, VA; April 14-18, 2002.

1-4 Duncan, J.D. and J.E. Leonard, *Thermal Response and Cladding Performance of an Internally Pressurized Zircaloy-Clad Simulated BWR Fuel Bundle Cooled by Spray Under Loss-of-Coolant Conditions,* GEAP-13112, April 1971.

1-5 McGrath, M., *Minutes of the Fourth Workshop on Dry-out Fuel Behaviour Tests (IFA-613),* HWR-499, OECD Halden Reactor Project, April 1997.

1-6 Ianiri, R., *The Third Dryout Fuel Behaviour Test Series in IFA-613*, HWR-552, OECD Halden Reactor Project, February 1998.

1-7 Dhir, V.K. et al., *Quenching Studies on a Zircaloy Rod Bundle*, Journal of Heat Transfer, Vol. 103, pp. 293-299, May 1981.

1-8 Wendelstorf, R. et al., *Effect of Oxide Layers on Spray water Cooling Heat Transfer at High Surface Temperatures*, Journal of Heat and Mass Transfer, Vol. 51, pp. 4892-4901, 2008.

SRXB RAI 2

Section 9.3.3 of Attachment 10 states:

> *The plant-specific ATWS stability calculation was performed using the NRC-approved neutronic and thermal-hydraulic codes ... TRACG04.*

An error in the code was corrected by letter from GE Hitachi Nuclear Energy to the staff dated October 15, 2013 titled "Updated TRACG Quench Front Model Description and Qualification", which is currently under staff review. In the October 15, 2013 letter, GE noted:

> *The quench front model has been updated to correct an error in the quench front heat transfer coefficient for bottom reflooding, and to better capture the heat transfer ahead of and behind the quench front.*

Please clarify which quench model is being used in the application.

Response

The ATWSI cases documented in Section 9.3.3 of the M+SAR were performed with the corrected quench model described in the letter from James F. Harrison (GEH) to the NRC Document Control Desk, "Updated TRACG Quench Front Model Description and Qualification," MFN-13-085, October 15, 2013.

ATTACHMENT (2)

AFFIDAVIT FROM GE-HITACHI NUCLEAR ENERGY AMERICAS LLC (GEH) JUSTIFYING WITHHOLDING PROPRIETARY INFORMATION CONTAINED IN ATTACHMENT (3)

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Peter M. Yandow, state as follows:

(1) I am the Vice President, NPP/Services Licensing, Regulatory Affairs, of GE-Hitachi Nuclear Energy Americas LLC ("GEH"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 1 of GEH letter, GE-PPO-1GYEF-KG1-728, "GEH Response to NRC Request for Additional Information in Support of NMP2 MELLLA+ License Amendment Request," dated March 4, 2014. The GEH proprietary information in Enclosure 1, which is entitled "Response to NRC Request for Additional Information," is identified by a dotted underline inside double square brackets. [[This sentence is an example.{3}]] Figures and large objects are identified with double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the *Freedom of Information Act* ("FOIA"), 5 U.S.C. Sec. 552(b)(4), and the *Trade Secrets Act*, 18 U.S.C. Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F.2d 871 (D.C. Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F.2d 1280 (D.C. Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. Some examples of categories of information that fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information that reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information that discloses trade secret or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GEH.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary or confidentiality agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains the detailed GEH methodology for maximum extended load line limit analysis and for the GEH Boiling Water Reactor (BWR). These methods, techniques, and data along with their application to the design, modification, and analyses associated with stability were achieved at a significant cost to GEH.

The development of the evaluation processes along with the interpretation and application of the analytical results is derived from the extensive experience databases that constitute a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 4th day of March 2014.

Peter M. Yandow

Peter M. Yandow
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