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AUTH.NAME AUTHOR AFFILIATION
MECREDY,R.C. Rochester Gas & Electric Corp.
RECIP.NAME RECIPIENT AFFILIATION
VISSING,G.S.

SUBJECT: Forwards response to questions from NRC staff on proposed mod of spent fuel storage pool,dtd 970331.

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ROBERT C. MECREDY
Vice President
Nuclear Operations

October 10, 1997

U.S. Nuclear Regulatory Commission
Document Control Desk
Attn: Guy S. Vissing
Project Directorate I-1
Washington, D.C. 20555

Subject: Response to Questions from NRC Staff on Proposed Modification of the Ginna Spent Fuel Storage Pool (TAC No. M95759)
R.E. Ginna Nuclear Power Plant
Docket No. 50-244

Ref.(1): Letter from G. S. Vissing (NRC) to R. C. Mecredy (RG&E), Subject: Request for Additional Information - Spent Fuel Pool Modifications (TAC No. M95759), dated August 25, 1997.

Dear Mr. Vissing:

By Reference 1, the NRC staff requested additional information regarding the proposed Modification of the Ginna Spent Fuel Storage Pool dated March 31, 1997. Enclosed are responses to each of the questions submitted by the NRC staff.

Very truly yours,

Robert C. Mecredy

JPO

A001/,

010039

xc: Mr. Guy S. Vissing (Mail Stop 14B2)
Senior Project Manager
Project Directorate I-1
Washington, D.C. 20555

U.S. Nuclear Regulatory Commission
Region I
475 Allendale Road
King of Prussia, PA 19406

Ginna Senior Resident Inspector

Mr. Paul D. Eddy
State of New York
Department of Public Service
3 Empire State Plaza, Tenth Floor
Albany, NY 12223-1350

Question No. 1:

In the submittal you have indicated that some spent fuel racks with Boraflex, used presently in the spent fuel pool (SFP), will be retained. Although the analysis described in the submittal was based on a very conservative estimation of the degree of Boraflex degradation during its exposure in the SFP, experience has shown that this degradation depends on several factors which may be difficult to estimate. For example, maintaining low silica level in the SFP water may accelerate degradation of the polymer with consequential higher loss on boron carbide. Therefore, many plants instituted surveillance programs consisting of inspection of coupons and/or measurement of silica concentration in the SFP water. Are you intending to have a Boraflex surveillance program in the reracked SFP? If so, describe the program. If not, provide your basis.

Response:

RG&E has committed to monitor the reactive silica levels in the spent fuel pool on a monthly basis to detect and evaluate unusual trends of abnormal levels (Reference 1). RG&E is currently monitoring silica levels and will continue this surveillance after reracking of the spent fuel pool. Because the spent fuel racks with Boraflex do not have coupons which would allow periodic inspection, RG&E has outlined in Reference 1 several actions to monitor the potential for Boraflex degradation. Some of these activities, as described in Reference 1, will continue after the proposed reracking of the spent fuel pool. If there are any questions regarding this action plan, please provide a request for additional information.

Reference:

1. Letter from R. C. Mecredy (RG&E) to G. S. Vissing (NRC), dated October 24, 1996; SUBJECT: RESPONSE TO NRC GENERIC LETTER 96-04, DATED JUNE 26, 1996, ON BORAFLEX DEGRADATION IN SPENT FUEL RACKS.

Question No. 2:

In the new fuel racks, borated stainless steel panels will remain in contact with the components made from a regular stainless steel. Because of the slightly different chemical composition of these materials, galvanic cells may form in a boric acid solution and this may be a source of corrosion. Show that this phenomenon will not contribute to a significant degradation of the poison material.

Response:

Theoretically, the use of Borated Stainless Steel (BSS) panels as the absorber material in Spent Fuel Storage Racks is assessed as a much more benign condition than the use of porous aluminum-boron carbide panels. The latter, which are known to have a far greater potential for chemical reaction with the pool water under normal pool conditions, have been used in Spent Fuel Storage applications in the past. In order to verify the hypothesis that BSS will be essentially inert under pool conditions, a series of corrosion tests have been performed under very adverse conditions as discussed below.

Corrosion tests of BSS coupons of various configurations and boron contents were conducted several years ago by Carpenter Technology Corp., Reading, PA under contract to EPRI. The results of these tests have been published in EPRI Report TR-100784, June 1992[1]. The test conditions were 2000 PPM boric acid at 154°F for an exposure time of six months. The 154°F test temperature was based on the maximum allowable bulk pool water temperature for spent fuel storage pools. Specimen configurations included simple immersion, creviced, air-purged and galvanically-coupled specimens. The galvanically-coupled specimens consisted of BSS coupled with Type 304. None of the twenty-six (26) simple immersion, creviced or air-purged specimens exhibited any measurable weight change with the exception of one specimen which had been welded. Two of the three galvanically-coupled specimens exhibited a very small weight loss, and the third no measurable weight change. Minor rusting was noted on the galvanically-coupled specimens. The results of these tests indicated that BSS exhibits excellent corrosion resistance to spent fuel pool water at maximum pool operating temperatures.

In addition to the above tests at 154°F, elevated temperature corrosion tests of BSS have recently been conducted in 2450 PPM boric acid solution at 239°F using a recirculating autoclave[2]. The selection of the test temperature was based on the highest local pool water temperature which could occur in any cell in the Ginna SFP (saturation temperature based on minimum height of 23 feet of water over any cell). The BSS material used for these tests was ASTM A887-89, Grade B, Type B7 with 1.9% boron, which is slightly higher than the maximum boron content of 1.82% in the BSS material intended for use in the Ginna SFP, and therefore is conservatively representative of the Ginna material. Test specimens included

simple immersion (free corrosion), galvanically-coupled and artificially-creviced (ASTM G 78-89) configurations. The galvanically-coupled specimens included BSS coupled with Type 304L and with Zircaloy 4. Specimens were exposed for total times of 30 and 60 days (720 and 1440 hours). The results of these tests showed that all specimens exhibited stable, passive behavior in the boric acid environment with very low corrosion rates. The average corrosion rate for the simple immersion and creviced BSS specimens was .0167 Mils Per Year (MPY) and .0320 MPY, respectively. The average corrosion rate for the galvanically coupled BSS specimens was .033 MPY. These corrosion rates indicate that in the worst case condition (i.e. BSS galvanically coupled to 304L and Zircaloy 4 at a sustained water temperature of 239°F), the thickness loss over a 40 year exposure would be on the order of 1.3 mils (.0013"), or approximately 1% of the total thickness of a BSS sheet.

The minimum required thickness of the BSS sheet material for the Ginna SFP racks was 2.5 mm (.098") or 3.0 mm (.118"), depending on rack type. The actual thickness of the finished sheets, however, exceeded the minimum thickness by a considerable margin. For the 2.5 mm sheets, the actual thickness values measured during final dimensional checks on the sheets (each sheet was measured) were in the range 2.65 mm - 2.90 mm (.104" - .114") and for the 3.0 mm sheets, 3.15 mm - 3.50 mm (.124" - .138"). It can be seen that a loss of thickness due to corrosion on the order of .001"-.002" is much less than the extra margin in thickness in the plates and therefore does not result in a violation of the assumptions in the licensing report. The loss of neutron absorber thickness due to galvanic corrosion is therefore negligible and cannot lead to degradation of the absorber material below minimum design criteria.

It should be noted that exposure of the BSS material at such a high temperature (239°F) for prolonged periods of time is an extreme condition which does not represent normal pool operating conditions. The exit temperatures for local fuel bundle cooling, based on bounding conditions, are well below the temperature of 239°F.[3] As a result, the corrosion rates expected from exposure of the BSS panels to normal pool operating conditions would be significantly lower than those at the elevated temperatures. The corrosion rates measured in the elevated temperature tests, therefore, represent a bounding condition.

References:

1. Smith, R.J., Loomis, G.W., Deltete, C.P., Borated Stainless Steel Application in Spent-Fuel Storage Racks, EPRI TR-100784, Project 2813-21, Final Report, June 1992, p. 3-25.

2. ATEA Technical Specification 2226.031.000, Borated Stainless Steel Application in Fuel Racks.

3. Letter from R. C. Mecredy (RG&E) to G. S. Vissing (NRC), dated March 31, 1997; SUBJECT: APPLICATION FOR AMENDMENT TO FACILITY OPERATING LICENSE, REVISED SPENT FUEL POOL STORAGE REQUIREMENTS. ATTACHMENT: R. E. GINNA NUCLEAR POWER PLANT, SPENT FUEL POOL RERACKING, LICENSING REPORT, SECTION 5.0, THERMAL-HYDRAULIC EVALUATION.

Question No. 3:

Describe the inspection program of borated stainless steel panels before their incorporation into the spent fuel racks.

Response:

Background

The borated stainless steel for the Ginna SFP racks was specified as ASTM A887-89, Grade B, Type B6/B7 with a minimum boron content of 1.70%.

Borated stainless steel (BSS) heats were electric-furnace melted and bottom-poured into ingots at the BOHLER/UDDEHOLM melt facility in Kapfenberg, Austria. The steel chemistry is based on Type 304 stainless steel. The carbon content is restricted to .04% max., and phosphorus, sulfur, and nitrogen are controlled at very low levels. Heat analyses are checked by extracting a chill cast sample from each melt and analyzing spectrographically prior to pouring the ingots. The heat analyses for the four heats of material melted for the Ginna SFP racks are listed in Table 1.

Ingots were hot-reduced to slabs, and then further reduced by hot-rolling to sheets at BOHLER Bleche in Honigsberg, Austria. The rolling process consisted of reductions in the principal (longitudinal) rolling direction to approximately 10 mm thickness, then further reduction by cross-rolling in the transverse direction, and final rolling in the principal direction to final thickness.

After hot rolling, finishing operations were performed at BOHLER Bleche, Murzzuschlag, Austria. These operations included roller leveling, solution annealing, surface grinding, laser cutting to specified sheet dimensions, and pickling. Sheet product was divided into lots during the finishing operations. A lot was defined as product from one heat, one heat-treatment batch, and one thickness. The BSS material for the Ginna SFP consisted of eleven (11) lots.

Inspections and Tests Performed at BOHLER Bleche

The following inspections of the BSS sheets were performed at BOHLER Bleche prior to final acceptance of the material:

- Visual Inspection

  Both sides of each sheet were visually inspected after grinding for the presence of

burrs, scratches, or other surface blemishes which might interfere with or cause damage to fuel assemblies during insertion into, or removal from, the racks. Such surface conditions were dressed by buffing or light sanding.

- Dimensional Inspections

The length and width of each sheet was measured. The thickness of each sheet was measured at six different locations using calibrated micrometers.

- Mechanical Properties

Ultimate tensile strength, yield strength, elongation, and hardness were measured by destructive tensile testing on a sample cut from one sheet from each lot. The results of these tests all meet the mechanical properties requirements of ASTM A887-89 (see Table 2). The excellent ductility values (10% - 16%, substantially above the minimum specification requirement of 6%) are indicative of homogeneous distribution of fine borides in the material. It should be noted that although the product fully meets the ASTM acceptance criteria, there are no design requirements for mechanical properties of BSS in the Ginna SFP application.

- Chemical Analyses (Product analyses by wet chemical analysis)

Product chemical analyses were obtained from a sample cut from one sheet from each heat. In addition, samples were cut from one sheet from each lot and analyzed for carbon and boron. Boron analyses were performed by digestion of the sample into aqueous solution and analyzing by ICP (Inductively Coupled Plasma). The results of these analyses are presented in Table 3. All values meet the chemical requirements of ASTM A887-89 Type B6/B7. All boron values exceed the minimum requirement of 1.70%. It should be noted that the product analyses in Table 3 are in excellent agreement with the heat analyses (Table 1).

- Chemical Analyses (Boron content by wet chemical analysis)

Fifty (50) locations within one sheet from Heat C70780 were sampled and analyzed for boron to establish the homogeneity of boron distribution within one sheet. These values all fell within the range 1.78% to 1.82% boron (mean value 1.80%, standard deviation .0117% boron).

- Chemical Analyses (Boron content by wet chemical analysis)

One sample was cut from each of 51 sheets selected from the total population of 380 sheets and analyzed for boron content. The number of samples selected from each of

the four heats and the range of boron values for each sample set is as follows:

Heat #	Total Sheets	Sample Size	% Boron
Heat B00021	13	13 samples	1.75-1.77%
Heat B04901	8	8 samples	1.75-1.77%
Heat C70780	279	20 samples	1.79-1.81%
Heat C70796	80	10 samples	1.75-1.79%

- JEN-3 Neutron Attenuation Measurements

Description of JEN-3 Device and Test Method

The JEN-3 device is a solid state detector which contains a Cf-252 source. The device is shaped like a teapot with a handle. The front half of the device is the detector, and the back half contains the source. The handle is approximately 2 feet in length. The dose at the top of the device is 30 mrem/hour. The efficiency for neutrons is approximately 0.1%. A table which is used to reflect neutrons is made of polyethylene which is approximately 3" thick. The borated stainless steel (BSS) sheet to be analyzed is placed between the detector and the table. The neutrons which are emitted by the source pass through the stainless steel and are then reflected back by the plastic table. The energy of the neutrons is also reduced. Those thermalized neutrons are attenuated by the borated stainless steel. The fewer the counts recorded by the detector, the greater the boron loading in the BSS sheets.

The boron loading calculations are influenced by the following factors:

a) The actual percent boron;

b) The thickness of the BSS sheet material; and

c) The power supply for the detector.

Initially, the power supply for the detector was a source of systematic error. After investigating the operating principles of the instrument, the source of error was eliminated and erroneous test results from the initial measurements were eliminated from consideration.

The ability of the JEN-3 instrument to function properly is influenced by both the thickness of the BSS material and the boron loading. The relationship between the counts recorded by the JEN-3 detector and boron loading is a negative exponential relationship. All calibration curves were developed using log-log plots.

Inspection Program

1) Calibration Curve - A calibration curve for the statistical analysis of BSS was developed using destructive chemical testing and neutron albedo analysis with the JEN-3.

The response of the JEN-3 device as a function of boron loading in BSS sheets of varying boron content and thickness was established using destructive chemical analysis. Boron content ranged from 1.2% to 1.9%, and sheet thickness from 2.0 mm to 3.5 mm.

Boron analyses were performed by BOHLER at the corporate chemistry laboratory in Kapfenburg, Austria. Thickness was measured using a calibrated ultrasonic thickness meter (calibration records for the meter and technician training records were reviewed and found to be satisfactory).

The JEN-3 device was response checked on a daily basis to verify instrument operability. These records were maintained for review and approval during all QA surveillance activities performed by FTI, ATEA, or RG&E.

The resulting calibration curve was a negative exponential line (log-log plot) with a correlation confidence of approximately 99.9%.

2) Verification of Boron Content - The neutron attenuation characteristics of all BSS sheets was measured at one randomly selected location using the JEN-3 device. Sheet thickness was also measured at the exact location where the JEN-3 measurement was taken.

The boron loading in each sheet was calculated from the JEN-3 measurement using the equation developed from the calibration curve.

In order to account for all of the statistical errors in the JEN-3 measurement process, the minimum acceptable level of boron for any sheet was established as 1.74%. This minimum limit provides an additional margin of safety in boron loading. With 1.74% as the minimum acceptable calculated boron loading, there is greater than 95% confidence that no BSS sheets contained less than 1.70% boron. This level of confidence provides a margin of safety in the criticality calculations.

Neutron attenuation data of all BSS sheets, as measured by JEN-3 at one randomly selected location in each sheet, was reviewed by an independent statistical consultant retained by RG&E; Joseph O. Voelkel, PhD., Assistant

Professor of Statistics at the College of Engineering, Rochester Institute of Technology. His conclusions, based on both parametric and non-parametric tolerance intervals, confirmed the acceptance criteria described above.

3) Boron Homogeneity - Thirty-four (34) BSS sheets were randomly chosen from the total population. A neutron attenuation measurement was taken at five (5) randomly selected locations on each sheet using the JEN-3 device. This sampling plan was in accordance with the instructions of ASTM-E826, "Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials." Thickness measurements were taken at the exact locations where the JEN-3 measurements were taken. The data were then evaluated by statistical tests as follows:

   Ranges (maximum minus minimum measured value) were calculated for each of the 34 sets of 5 JEN-3 values. These were plotted against the calculated mean range and 2-sigma values. If no values fell outside the 2-sigma limits, this would be one indication of homogeneity within the population. This was indeed the case; i.e., all values were within 2-sigma limits.

   Analysis Of Variance under the random effects model was performed on the data. Residual model diagnostics demonstrated a random distribution of residuals, indicating homogeneity of boron distribution throughout the BSS population.

   These results strongly indicate homogeneity of boron distribution throughout the BSS product.

<u>Inspections and Tests Performed by Rochester Gas & Electric Corp.</u>

- Chemical Analysis Overchecks (Boron content by wet chemical analysis)

  Chemical analysis overchecks on samples of BSS obtained from BOHLER were performed by two independent commercial testing laboratories in the US. These analyses were obtained to provide additional confidence in the boron analyses reported by BOHLER. Results of these tests are presented in Table 4.

  The results of the these overchecks indicate that the boron analyses reported by BOHLER are reliable.

- Metallographic Examinations

Samples cut from one sheet from each lot of material in both the principal and transverse rolling directions were examined metallographically. All specimens were polished and etched with Kallings reagent. The microstructures in both longitudinal and transverse cross-sections exhibit a fine, uniform dispersion of borides in an austenitic matrix. No evidence of banding or segregation are present. The boride homogeneity in the BOHLER material compares very favorably with published microstructures of Grade A material produced by powdered metallurgy methods[1].

Quality Assurance Oversight

Additional inspections were provided as part of Quality Assurance oversight. Bohler activities were subject to quality surveillance by personnel from the Bohler, ATEA, Framatome Technologies, and Rochester Gas & Electric Quality Assurance organizations. This oversight provided independent monitoring of the BSS manufacturing process and results of inspection activities at Bohler.

References:

1. Smith, R.J., Loomis, G.W., Deltete, C.P., Borated Stainless Steel Application in Spent-Fuel Storage Racks, EPRI TR-100784, Project 2813-21, Final Report, June 1992, p. 3-13.

TABLE 1

Heat Analyses

Heat #	C	Si	Mn	P	S	Cr	Ni	B	N
	Composition (Wt %)								
C70780	.021	.33	1.13	.013	.001	19.89	12.50	1.81	.018
C70796	.029	.34	1.06	.012	.001	19.96	12.64	1.76	.021
B00021	.020	.55	1.18	.009	.002	19.69	13.18	1.76	.027
B04901	.013	.42	1.21	.008	.001	19.50	13.21	1.75	.015
ASTM A887	.08[1]	.75[1]	2.0[1]	.045[1]	.03[1]	18.0	12.0	1.5	.10[1]
Type B6						20.0	15.0	1.74	
ASTM A887	.08[1]	.75[1]	2.0[1]	.045[1]	.03[1]	18.0	12.0	1.75	.10[1]
Type B7						20.0	15.0	2.25	

Note 1: Maximum value

TABLE 2

Mechanical Properties

Heat #	Lot #	UTS (KSI)	YS (KSI)	Elongation (% in 2")	Hardness (Brinell)
C70796	290	94.7	66.4	12.3	195
C70796	314	96.0	62.1	11.7	219
C70780	287	99.1	65.3	12.2	209
C70780	282	93.1	61.2	14.1	239
C70780	313	94.7	55.3	10.6	229
C70780	288	97.5	63.8	11.2	199
C70780	289	95.9	56.7	16.8	239
B00021	221	94.4	62.8	10.9	224
B00021	223	97.2	61.8	12.2	229
B04901	224	93.0	58.3	13.8	234
B04901	222	95.3	66.1	12.3	229
ASTM A887-89		75 Min	30 Min	6.0 Min	241 Max

TABLE 3

Product Analyses

Heat#	Lot#	C	Si	Mn	P	S	Cr	Ni	B	N
				Composition (Wt %)						
B00021	221	.021	.55	1.18	.008	.003	19.7	13.1	1.75	.032
B00021	223	.020							1.74	
B04901	222	.009	.43	1.21	.007	.002	19.4	13.1	1.73	.016
B04901	224	.01							1.76	
C70780	282	.024	.32	1.10	.012	.001	19.8	12.4	1.76	.022
C70780	287	.023							1.81	
C70780	288	.023							1.80	
C70780	289	.023							1.80	
C70780	313	.023							1.80	
C70796	290	.025	.33	1.06	.012	.001	19.9	12.5	1.78	.028
C70796	314	.025							1.78	

TABLE 4

Boron Analysis Overchecks

Heat #	Sheet #	Laboratory	% Boron
C70780	105	Bohler	1.83%
C70780	105	Ledoux	1.86%
C70780	105	M&P Labs	1.82%
B00021	91A	Ledoux	1.82%
B00021	371A	M&P Labs	1.84%
B04901	11A	Ledoux	1.82%
B04901	171A	M&P Labs	1.85%

Question #4:

Although tests with borated stainless steel have indicated that in the SFP environment no measurable corrosion degradation takes place, the importance of its role in reactivity control in the SFP makes it advisable to have a surveillance program which would provide additional assurance that at all times there will be enough poison material in the SFP. Are you planning to institute such a program in your plant? If so, describe the program. If not, provide your basis.

Response:

RG&E plans to institute a surveillance program for borated stainless steel (BSS) in the SFP at the R.E. Ginna Nuclear Power Station. A coupon tree has been designed which consists of a 304L stainless steel rack to which 36 BSS coupons (8" long X 6" wide) will be bolted. Each face and the edges of the coupons are exposed to the SFP boric acid environment. Crevices and 304L/BSS galvanic couples are created on the tree at each bolt location. The coupons were selected so that material from each heat and lot of BSS sheet material to be used as poison panels in the pool are represented on the tree. In comparison with surveillance programs for other neutron absorber materials, the design and construction of the coupon tree for the Ginna SFP provides a more accurate representation of the actual exposure conditions of BSS in the SFP.

The tree will be removed and inspected after the first 18-month operating cycle, and every three operating cycles (approximately 4 1/2 years) thereafter. The coupons will be removed from the tree, inspected visually for any evidence of corrosion, and thickness measurements taken on the exposed surfaces and in the creviced/galvanically coupled areas. These measurements will be compared with the original thickness measurements recorded for each coupon to determine if any measurable material loss has occurred. In addition, each coupon will be weighed and the weights compared with original weights to determine weight change. Any unusual surface condition suggestive of significant corrosion will be evaluated using appropriate analytical methods.

Question #5:

With a larger number of fuel assemblies stored in the SFP it is expected that more corrosion products and other impurities will be generated in the SFP. Is the presently existing purification system adequate to handle this increased amount of impurities? Provide your basis.

Response:

The current purification system consists of: (a) a string-wound skimmer filter for surface cleanliness, and (b) a spent fuel pool mixed bed resin for liquid purification. The resin bed pulls from the bottom of the pool for its cleaning process. It is a 15 cubic foot mixed bed resin filtration system.

The frequency of change-out of the surface filtration system is currently approximately once every two years. This is a surface clarity maintenance system. The additional fuel will not affect its operating characteristics.

The frequency of change-out for the resin system is currently once per year. Historical records following the 1985 rerack project at Ginna Station showed no measurable increase in the change-out frequency. The 1985 change was larger in its work scope than the proposed modification. At that time, approximately 420 cells were added. By comparison, the proposed modification will increase the storage capacity by 305 cells in 1998 (an additional 48 storage cells may be added in the future if needed). It is postulated that the upcoming rerack will not increase the cleaning system change-out. However, the system will be monitored to determine any changes to historical patterns.

Therefore it can be concluded that the capacity of the purification system is adequate and can absorb the additional storage requirements without substantially affecting current plant maintenance capability to handle any increased amount of corrosion products and other impurities.