Nuclear

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May 21, 1990

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Dear Sir:

Subject: Oyster Creek Nuclear Generating Station
Docket No. 50-219
Response to NRC Bulletin 90-02
Loss of Thermal Margin Caused by
Channel Box Bow

On March 20, 1990, the USNRC issued Bulletin 90-02, "Loss of Thermal Margin Caused by Channel Box Bow." This bulletin addressed the effects of a reused fuel channel box on Critical Power Ratio calculations. Attachment I to this letter provides the requisite response to NRCB 90-02.

Additionally, on page 1 of NRCB 90-02, the NRC states:

> "...reuse of channel boxes in future core reloads will be addressed as an unreviewed safety question..."

Attachment II to this letter provides a brief history and discussion of the GPU Nuclear Channel Management Program. This program was initiated in 1974, with the first actual measurements taken in 1977. In all, forty six fuel channels have been measured to date. Attachment III to this letter provides a determination of No Significant Hazards as described in 10CFR50.92.(c). By this letter, GPU Nuclear requests the NRC to utilize the requisite attachments to resolve the unreviewed safety question noted above.

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To allow for inclusion into this letter of the No Significant Hazards determination, an extension of the the due date to May 25,1990 was requested on April 24,1990. If any further information is required, please contact Mr. John Rogers at 609-971-4893.

Very truly yours,

E.E. Fitzpatrick
Vice President and Director
Oyster Creek

Sworn to and Subscribed before me this 21st day of May, 1990.

A Notary Public of NJ

JUDITH M. CROWE
Notary Public of New Jersey
My Commission Expires 1-25-95

EEF/JJR
(90BU02)
Attachments

cc: Mr. Thomas Martin, Administrator
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NRC Resident Inspector
Oyster Creek Nuclear Generating Station

Mr. Alexander Dromerick
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ATTACHMENT I

Responses to NRC Bulletin 90-02

NRC Reporting Requirement:

"...advise the NRC of the number of such channel boxes (second bundle lifetime) and their disposition in the core."

GPUN Response:

The Oyster Creek Nuclear Generating Station is currently operating in its twelfth (12th) cycle. The current fuel bundles are channeled with 410 one bundle lifetime fuel channels and 150 channels in their second bundle lifetime (i.e. reused channels). GPUN has targeted the reuse of channels to approximately 25% of the core's total fuel channel population. The exposures of the current reused channels range from approximately 30,000 to 56,000 MWD/MTU. Second bundle lifetime channels have been installed in Oyster Creek in Cycle 10, 11 and 12. Their locations, marked with 10, 11 and 12 respectively are shown in Figure 1. Fifty one (51) reused channels were installed at the beginning of Cycle 10, 56 in Cycle 11, and 43 in Cycle 12. The first discharge of channels completing their second bundle lifetime will occur at the end of Cycle 12

NRC Reporting Requirement:

"...describe the methods, and associated data base, used to account for the effects of channel bow during the second bundle lifetime use of channel boxes to ensure conformance with the CPR technical specification operating and safety limits."

GPUN Response:

The methods used by GPU Nuclear to account for the effects of two bundle lifetime channel bow on CPR technical specification operating and safety limits are similar to the GE methodology. Whereas GE assumes that the limiting bundle does not have maximum bow, GPUN methods account for the reuse of channels and that a reused channel could be installed on a limiting bundle.

To account for the change in CPR resulting from channel bow during a cycle, the following GPUN methodology is used:

Calculate predicted bow:

A correlation has been developed which correlates channel bow versus channel exposure. The database used to develop this correlation is shown on Figure 2. This data represents all the Oyster Creek channel bow measurement data obtained since 1977. (Additional information on this data base is contained in Attachment 2). This correlation will be used to predict the EOC channel bow which will be used for modifying bundle R factors for the entire cycle.

The EOC core average bow will be used to modify all R-factors for all fuel designs.

Modify R-factors of limiting bundles to account for the largest bow.

For a fuel bundle(s) located in a control cell (four bundles around a control rod) which will be near CPR limits during the cycle and have a reused channel, the R-factor will be modified for the largest bow of either the limiting fuel bundle channel or the average of the four channels in the fuel cell containing the limiting bundle. This will be done for all the limiting locations projected during the cycle which have reused channels.

Calculation of modified R-factor:

$$R_{ij}^{+} = (1 + A_{ij}(E) * D(z)) * R_{ij}$$

Where: R_{ij}^{+} = Modified R-factor for channel bow

$A_{ij}(E)$ = Change in local R-factor due to change in bow

$D(z)$ = Max Bow * sin ($\pi Z/H$)

R_{ij} = Most limiting R-factor in the limiting bundle

Input modified R-factors in process computer for each fuel type and range of exposures.

Results of the Methodology for the Current Cycle:

Using the GPUN method, the impact of channel bow on thermal limits was investigated for the current cycle operation. A review of the actual fuel operating thermal limits for the current cycle identified at least a 9% margin to the Technical Specification limits. This margin is sufficient to prevent exceeding the CPR technical specification operating and safety limits during the entire cycle. The lowest adjusted CPR during the cycle's peak reactivity was only 93.8% of the CPR limit.

Table 1 summarized the results of the methodology described above.

Accounting for Change in CPR Resulting from Channel Bow for the Remainder of Cycle 12:

Because the change in CPR resulting from channel bow does not result in exceeding the Oyster Creek CPR Technical Specification and Safety Limit value, it is not necessary to change the operating Technical Specification limit. The modified R-factors have been loaded into the process computer. This adequately compensates for the loss of CPR margin caused by Channel Bow.

Accounting for a Change in CPR Resulting from Channel Bow Beyond Cycle 12:

GPU Nuclear will continue to reuse channels in the Oyster Creek NGS core. To account for the increased bundle power due to the core average channel bowing, the R-factors for all fuel types will be modified as described in the preceding methodology by using the core average channel bow in the calculation. For the projected limiting bundles having reused channels the R-factors will be modified as described in the preceding methods for the appropriate range of exposure using the largest bow of either the limiting bundle or the average channel bow in the fuel cell containing the limiting bundle. These modified R-factors will be installed in the plant process computer at the beginning of each cycle to account for the channel bow.

CPR Adjustment for Channel Bow for the Current Cycle

FUEL TYPE	FUEL CHANNEL	BOW FOR LIMIT. BUNDLE (MILS)	FUEL CELL AVG. BOW (MILS)	*** CPR BEFORE ADJUSTMENT	% OF LIMIT	CPR AFTER ADJUSTMENT	% OF LIMIT	LIMIT CHANGE
**GE3.21	CYCLE12	*74	62	1.69	89.3%	1.61	93.8%	4.5
GE3.21	NEW	32	*55	1.69	89.3%	1.63	92.6%	3.3
GE3.21	CYCLE12	73	*105	1.74	86.8%	1.62	93.2%	6.4
GE3.21	CYCLE12	*71	50	1.74	86.8%	1.66	91.0%	4.2
GE3.21	NEW	29	*40	1.74	86.8%	1.70	88.8%	2.0
GE3.21	CYCLE12	84	*105	1.75	86.3%	1.64	92.1%	5.8
GE3.21	CYCLE12	*70	50	1.76	85.8%	1.68	89.9%	4.1
GE3.21	CYCLE12	*71	50	1.77	85.3%	1.69	89.3%	4.0
GE3.21	NEW	32	*62	1.79	84.4%	1.72	87.8%	3.4
GE3.21	NEW	32	*55	1.80	83.9%	1.73	87.3%	3.4
GE2.99	CYCLE12	*69	57	1.82	83.0%	1.76	85.8%	2.8
GE3.21	NEW	30	*50	1.83	82.5%	1.77	85.3%	2.8
GE3.21	NEW	30	*40	1.84	82.1%	1.79	84.4%	2.3
GE2.99	CYCLE11	*116	62	1.85	81.6%	1.74	86.8%	5.2
GE2.99	NEW	*130	55	1.85	81.6%	1.74	86.8%	5.2
GE3.21	CYCLE12	*72	64	1.87	80.7%	1.79	84.4%	3.7
GE2.99	NEW	49	*50	1.88	80.3%	1.83	82.5%	2.2
GE2.99	NEW	*49	40	1.88	80.3%	1.83	82.5%	2.2
GE3.21	NEW	31	*51	1.88	80.3%	1.82	83.0%	2.7
GE2.99	NEW	*49	39	1.90	79.5%	1.85	81.6%	2.1

* - The most limiting value were used for CPR calculations
** - The most limiting case.
*** - CPR Limit is 1.51.

Table - 1

Location of Cycle 12

Reused Channels

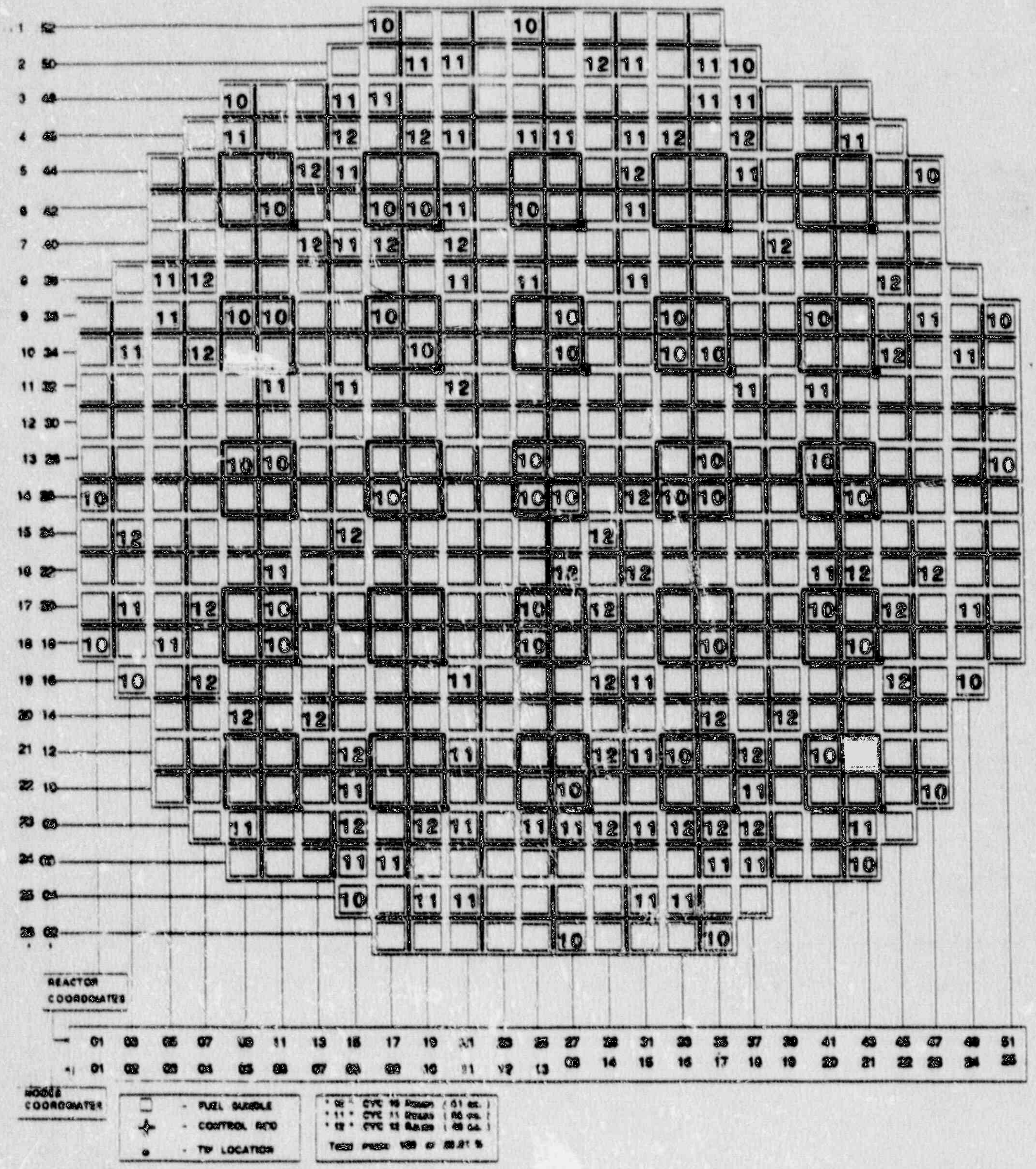

FIGURE 1

OYSTER CREEK CHANNEL BOW MEASUREMENTS DATA BASE

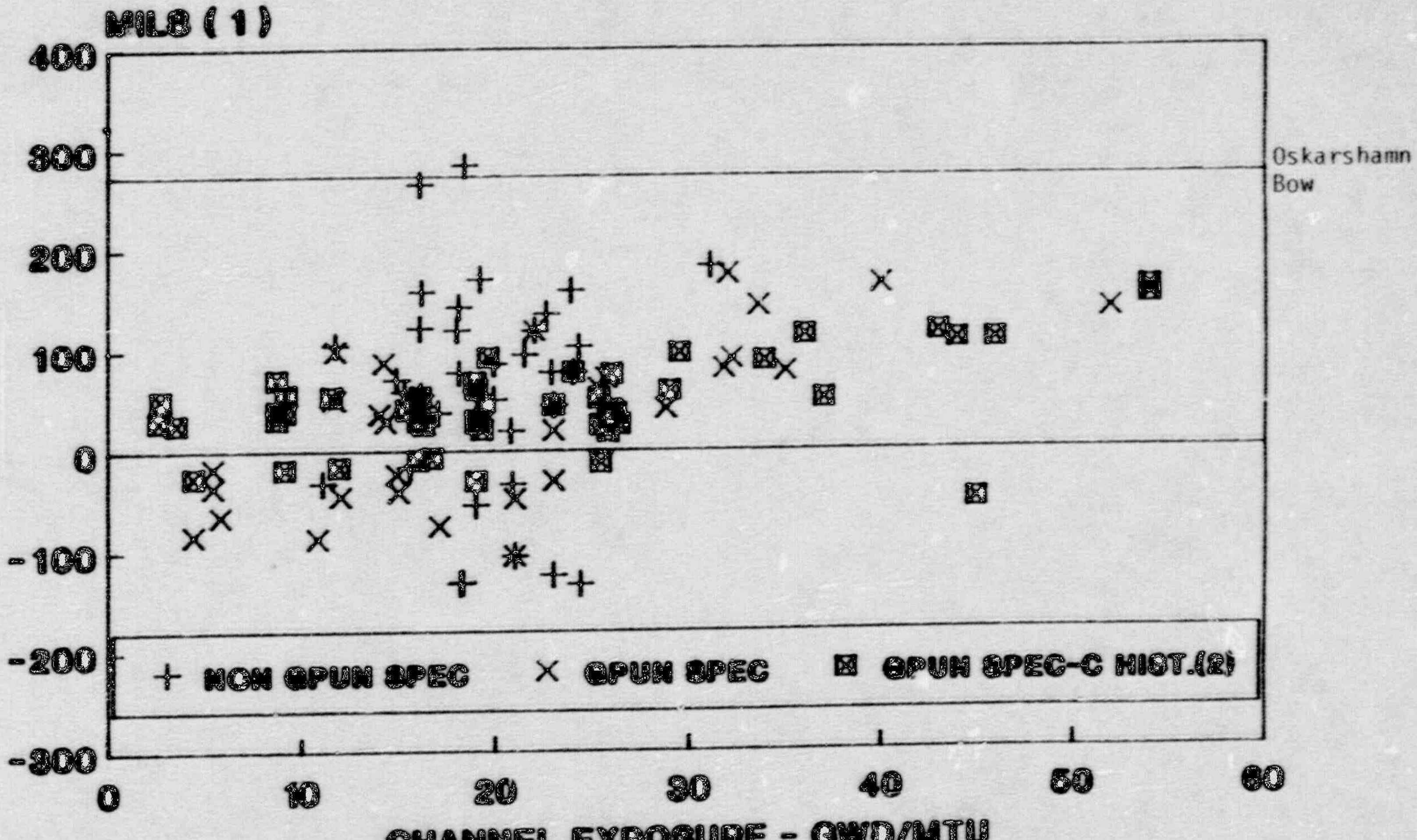

Figure - 2

NOTES: 1) Positive bow away from the control rod, negative bow towards the control rod.

2) Those channels residing only in the central region of the core.

ATTACHMENT II

History of the GPUN Channel Management Program

The objective of the GPU Nuclear Channel Management Program is to develop fuel channels that will meet the operating requirements for two fuel bundle lifetimes. The program includes: a historical database containing core locations and accumulated exposure for each channel; the development of a channel fabrication specification; the measurement of fuel channels; and the development of correlations which predict channel bow and displacement (i.e. creep). The program has been active since 1977 in order to measure channel bow and displacement over the period of two bundle lifetimes.

The GPUN Channel Management Program was developed following the discovery of excessive distortion and corrosion of some of Oyster Creek's initial channels. In 1974 an Oyster Creek specific fuel channel fabrication specification was developed. This specification was the first of its type. It required the channel vendors to: anneal channels; perform a 14 day, not 3 day, corrosion test; use matched channel halves; characterize the channels; and adhere to tighter as-built bow tolerances.

Following the development of the channel fabrication specification, GPU and MPR (consulting company) designed a channel measurement system. This system is capable of accurately measuring channel deflections including bow. The measurement device utilizes 12 LVDT transducers which move axially up the channel.

In order to develop a plant-specific and controlled database for channel bow and other key channel performance parameters, a systematic program of measurements was established. The data from these measurements is used to confirm the satisfactory operation of channels fabricated to the GPUN specification as well as provide a basis for evaluating channels made by alternate suppliers and/or advanced fabrication processes.

The channels in the program include channels with atypical as well as typical exposure histories. Also representation channels are selected and followed as "lead" channels throughout their exposure history. Some of these channels are operated to exposures beyond the expected 2-bundle exposure to obtain performance data beyond the expected exposure for reuse channels.

The first measurements at Oyster Creek were recorded in 1977 (EOC 6). Additional measurements were made at EOC 7 (1978), EOC 8 (1980), EOC 9 (1983) and EOC 11 (1988). In all, a total of forty six channels have been measured. Many of these are starting or are well into their second fuel bundle lifetime. Most of the channels have been measured more than once and more than half were measured 3 or 4 times. All channel data has been documented and the results used to establish the operating data base.

Figure 2 in Attachment 1 is a plot of all maximum bows measured at Oyster Creek, and their corresponding exposures. This data base was used to develop the correlations which predict channel bow. Note the data is divided into three categories: channel bows resulting from channels not fabricated to the GPUN channel fabrication specification; those channels fabricated in accordance to the GPUN channel specification; and those channels fabricated to GPUN specifications which resides only in the central region of the core. The data base clearly illustrates the reduction in channel bow resulting from the GPUN fabrication specification and the channel core residence history from only the central region of the core (i.e. non peripheral locations).

A few of the original Oyster Creek channels manufactured prior to the development of the GPUN Specification had bows greater than that seen at Oskarshamn at exposures less than 17 GWD/MTU (Gigawatt Days/Metric Ton Uranium). These channels were removed from service and not reused. The Oskarshamn channels had exposures approaching 60 GWD/MTU.

The core average of the maximum channel bows at the end of the cycle has been fairly consistent from cycle to cycle. Using a GPUN correlation developed from only Oyster Creek channel measurement data, the core average maximum channel bow at the end of a cycle can be predicted. The following core average maximum channel bows were predicted:

EOC	Average Maximum Bow (Mils)	Number of Reused Channels
9	53	0
10	50	51
11	51	107
12	57	150

The good channel performances at Oyster Creek can be attributed to a systematic channel management program which considers bow as a channel fabrication specification backed by a plant specific, in reactor data base. Among other things, the specification includes the following requirements:

1. Matched channel halves
2. Annealing
3. Preferred bowing away from the control rod
4. Tight fabrication bow tolerances
5. Channel characterization

The Oyster Creek channel measurements have provided the following results:

1. Confidence that fuel channels fabricated to the GPU Nuclear channel fabrication specification can operate with acceptable bow for two bundle lifetimes, provided the reused channels have an acceptable exposure and location history.

2. Revision to the GPU Nuclear channel fabrication specification to further tighten the bow fabrication tolerance. Some channel vendors could not meet this tolerance as late as 1989.

3. The development of models which predict channel bow (central and peripheral locations) and channel creep.

4. The ability to monitor channels fabricated with advanced channel fabrication processes suggested by channel vendors, and to monitor the lead channels performance using the GPUN channel measurement system and sharing this information with the vendor.

The latest enhancement to the GPUN Channel Management Program is the addition of the Channel Oxide Measurement System. GPUN procured the oxide measurement system in 1988 and measured the oxide thickness of twenty eight (28) channels that same year. The purpose of these measurements was to determine oxide thickness of one and two bundle lifetime channels and determine whether oxide thickness is life limiting.

The initial measurements were successful and it was concluded that the oxide thickness on Oyster Creek channels fabricated to the GPUN channel fabrication specification in their second bundle lifetime is not life limiting. It was also concluded that it was not necessary to require corrosion resistant channels (i.e. Alpha plus Beta heat treatment) in the Oyster Creek core. The channels supplied to the GPUN specification (i.e. Alpha heat treatment) were performing satisfactorily.

The oxide measurements from 1988 were also used to develop a correlation to predict oxide thickness as a function of reactor residence time, fast flux and temperature. The oxide thickness measurements is another example of the GPUN commitment to the development of excellent channel performance.

The GPU Nuclear Channel Management Program has encompassed over sixteen (16) years of effort to produce improved fuel channels and gather confirmatory performance data on selected chan[illegible] goal of demonstrating channels which will achieve two bundle l[illegible]eptable channel bow. This technical base forms the basis [illegible] program and provides high confidence that reused channels [illegible] perform satisfactorily at Oyster Creek.

Channel Reuse

The results of the channel measurement program have demonstrated that channel bowing for two bundle lifetime channels is not life limiting. The initial measurements recorded on 10 reused channels indicated a peak bow of 165 mils. GPUN data shows increasing bow with exposure, as expected. However, the data to date does not show accelerated or excessive bow. The magnitude of the bows measured at Oyster Creek do not approach the values of the bows measured in Oskarshamn (i.e. 270 mils), except for some non GPU specification channels measured in 1977 (EOC-6).

The reuse of fuel channels results in the reduction of fuel channel procurement cost and a significant reduction in radwaste and its associated disposal cost. These savings make the GPUN Channel Reuse Program beneficial.

The GPU Nuclear Fuel Channel Reuse Program has been successful in maintaining acceptable fuel channel bows on second bundle lifetime (i.e. reused) channels, thereby minimizing the increase in fuel bundle powers resulting from excessive channel bowing. GPUN will continue its practice of reusing channels for a second bundle lifetime by continuing to implement the current practices of:

1) Selecting reuse channels having a core exposure history from only the central region of the core.

2) Updating the channel bow correlation as more data becomes available.

3) Continuing to improve the channel fabrication process by improving the GPUN nuclear fuel channel fabrication specification.

In addition, the R-factors have been and will be modified to compensate for the power peaking increase resulting from channel bow as described in Attachment 1.

ATTACHMENT III

Pursuant to 10CFR50.92.(c), the reuse of fuel channels in the Oyster Creek Nuclear Generating Station reactor has been determined to contain No Significant Hazards in that:

1. It does not involve a significant increase in the probability or consequences of an accident previously evaluated.

   Channel Box Bow does not cause a violation of Critical Power Ratio (CPR) safety limits. Measurements have shown that the maximum bow on channels at the end the present fuel cycle (cycle 12), will average 57 mils, including the reused channels. This would decrease CPR by 4 per cent. This decrease has been included in the CPR calculation, and is consistent with values projected for D-Lattice plants. The R-factor has adequately compensated for the loss of CPR caused by Channel Bow.

2. It does not create the possibility of a new or different kind of accident from any accident previously evaluated.

   Channel Box Bow affects the core by affecting localized power generation. The effects of localized power anomalies have been analyzed and submitted with each core reload for the Oyster Creek Plant.

3. It does not involve a significant reduction in a margin of safety.

   Although Channel Box Bow caused by a reused fuel channel does decrease the margin of safety (CPR), the amount of decrease is small (.04), and has been compensated in the core calculations (R-factor) as described in Attachment I to this letter.