GPU Nuclear

GPU Nuclear Corporation
One Upper Pond Road
Parsippany, New Jersey 07054
201-316-7000
TELEX 136-482
Writer's Direct Dial Number:

September 23, 1994
5000-94-0039
C321-94-2152

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

Dear Sir:

Subject: Oyster Creek Nuclear Generating Station (OCNGS)
Operating License No. DPR-16
Docket No. 50-219

Technical Specification Change Request (TSCR) No. 216
Re: Limiting Safety System Settings - Technical Specification 2.3.D, "Reactor High Pressure, Relief Valve Initiation"
REQUEST FOR ADDITIONAL INFORMATION (RAI) - TAC No. M89684

Enclosed, please find our response to your letter dated August 22, 1994, which GPU Nuclear (GPUN) Corporation received by mail on August 26, 1994, which requested additional information on the subject TSCR No. 216.

Pursuant to 10 CFR 50.91 (b) (1), a copy of our response to your RAI has been sent to the State of New Jersey, Department of Environmental Protection.

Sincerely,

R. W. Keaten
Vice President and Director
Technical Functions Division

RWK\gmg

Enclosure: GPUN Response to RAI on TSCR No. 216

cc: OCNGS NRC Project Manager
Administrator, Region I
OCNGS NRC Sr. Resident Inspector

300065

9409300056 940923
PDR ADOCK 05000219
P PDR

A001 /1

ENCLOSURE

Technical Specification Change Request (TSCR) No. 216
Request for Additional Information, TAC No. M89684

QUESTION 1

The staff needs Reference 6.7 (Enclosure 1), MPR Report MPR-1434, to understand the factors considered by the consultant in arriving at torus stresses and their comparisons to corresponding stress allowables.

RESPONSE:

MPR Report MPR-1434 provides the following factors, which were considered by MPR Associates Inc. for GPU Nuclear, in evaluating the impact of increasing the EMRV high pressure actuation setpoint, on the results of the Mark I Containment Long-Term Program (LTP).

Introduction:

EMRV loads calculated during the Mark I Containment LTP can be increased by the following multipliers to conservatively represent the loads which would occur if the setpoint pressure for the EMRVs is increased from a nominal 1070 psig to a nominal 1105 psig:

LOAD DESCRIPTION	MULTIPLIER
EMRV Line Pressure	1.033
EMRV Line Temperature	1.033
Thrust Loads on Discharge Piping	1.033
Quencher Internal Pressure	Not used; bounded by Line Pressure
Water Jet Loads:	
- Magnitude of Load	1.033
- Jet Penetration Length	Negligible Impact
Torus Shell Pressure Distribution	1.033
Air Bubble Induced Drag Loads	1.033

As calculated below, the 1.033 multiplier results from conservatively assuming that the load is proportional to the setpoint pressure.

An approximate "first principles" evaluation was performed of the impact of increasing electromagnetic relief valve (EMRV) setpoint pressure on the EMRV discharge-induced loads. The evaluation concludes that the maximum pressure in the EMRV line, which typically occurs at the time of water slug clearing, is proportional to setpoint pressure raised to an exponent that is less than one. The pressure in the EMRV line provides the driving force for EMRV discharge-induced loads. Therefore, the assumption that loads vary linearly (exponent of 1.0) with setpoint pressure is conservative, as the pressure increases from 1070 psig to 1105 psig.

Approach:

The Mark I Containment LTP analyses for the Oyster Creek torus components considered the following design loads which result from EMRV discharge:

1. EMRV discharge line pressure and temperature
2. Thrust loads on the discharge line
3. Thrust loads on the Y-quencher
4. Y-quencher internal pressure
5. Water jet loads on torus submerged structures
6. Torus shell dynamic pressure loads
7. Air bubble drag loads on torus submerged structures

The load definitions for each of the above were determined as described in MPR-733. In general, the load definitions were in accordance with NEDO-21888, with the exception that the Oyster Creek quencher design - a "Y" configuration rather than the "Tee" or "Ramshead" - required unique approaches to calculate some of the loads.

The original LTP loads were calculated assuming that all five (5) EMRVs had a setpoint pressure of 1070 psig. In this evaluation, the effect of raising the nominal setpoint to 1105 psig was investigated for each load.

The approach for each load was as follows:

1. Determine how the load was defined for the original LTP analyses. This was performed by reviewing LTP analyses and supporting calculations.

2. Determine how the load will change (if at all) if the nominal EMRV setpoint pressure is increased from the original LTP value of 1070 psig to the proposed 1105 psig value.

The resource available to perform step 2 was the Emergency Operating Procedure (EOP) Guideline calculations performed in 1983. In particular, three EMRV-discharge cases occurring at different reactor vessel pressures [1147.7, 426.7, and 220.7 psia] were compared to "base case" EMRV loads [1116.8 psia] used in the LTP. The pressure that was used as input was determined as follows: 1.03 x nominal EMRV setpoint pressure (psig) + 14.7 psia.

The only major difference between the cases reviewed was the input pressures (dependent parameters, such as steam flow rate and density also were impacted by pressure); therefore, relationships between loads calculated for these three cases could be evaluated to develop correlations between loads and setpoint pressure.

Other differences in the input to the EMRV-discharge cases reviewed were considered to have a minor or negligible impact on the suitability of using EOP Guidelines for the purpose of developing this correlation. Specifically, the differing initial pressures assumed for the torus vapor space are not significant because flow through the valve, and out of the sparger, is choked; and, downstream pressures are not relevant in such cases. Initial EMRV discharge header temperatures are judged to have a second-order impact on the results.

The remainder of the discussion below presents the impact of increasing EMRV pressure setpoint on the loads calculated for the LTP.

1. EFFECT OF EMRV SETPOINT PRESSURE ON EMRV DISCHARGE HEADER PRESSURE AND TEMPERATURE

LTP Analysis Method

In the original LTP analyses, EMRV discharge header pressure was calculated using a GE computer program called RVFOR, which calculated the flow, pressure, and thrust resulting in each portion of the EMRV discharge header as a function of time during the transient. MPR-733 and GE Document NEDE-24555-P Application Guide 3, describe the RVFOR program inputs and outputs.

EMRV line temperature was to be calculated per Section 5.2.7.3 of the GE Load Definition report (NEDO-21888 Revision 2) by first determining the steady state steam flow pressure in the discharge line, and then assuming the pipe temperature equaled the corresponding saturation temperature. Based on review of MPR calculations performed in 1982 for the EMRV pipe LTP analysis, the piping was assumed to be 400°F throughout.

Effect of EMRV Setpoint Pressure Increase

The RVFOR runs for the three EMRV-discharge cases at different "starting" pressures were reviewed to determine the maximum EMRV line pressures calculated for each case.

The results showed that the maximum discharge line pressure and temperature vary with respect to "setpoint" pressure. Based on the above, it is conservative to say that the variance is directly linearly proportional to pressure; this would result in over-estimating the line pressure and temperature for higher setpoints.

Note that the setpoint increase from 1070 psig to 1105 psig results in an increase in assumed EMRV steam line pressure from 1116.8 psia to 1152.85 psia (when including the LTP 1.033 multiplier on setpoint pressure). The ratio of these numbers is:

$$\frac{1152.85}{1116.8} = 1.0323 \approx 1.033$$

Based on the results of the EMRV-discharge cases reviewed, it is conservative to assume that the pressure and temperature loads will increase by a factor of 1.033.

2. THRUST LOADS ON EMRV DISCHARGE LINE PIPING

The GE computer program RVFOR was used, during the original Mark I evaluation, to determine transient thrust loads due to steam flow through the EMRV piping. These loads were printed out as segment forces for each time step. MPR used the GE methodology for computing segment forces. Differences between the GE model assumptions and the Oyster Creek configuration were as follows:

- Oyster Creek has 2 or 3 EMRVs which could discharge into an EMRV header; GE assumed a single EMRV.

- Oyster Creek uses a Y-quencher; GE assumed a rams-head or tee-quencher.

It has been shown that using RVFOR was conservative for the Oyster Creek case. The EMRV discharge header stress analyses were performed by translating these line forces into piping point loads.

Therefore, it can be assumed that the controlling EMRV steam thrust loads will increase by the following factor as setpoint pressure increases from 1116.8 psia to 1152.85 psia:

$$\frac{1152.85}{1116.8} = 1.033$$

3. THRUST LOADS ON QUENCHER ARMS

The LTP analysis methods proposed by GE for thrust loads on quencher arms were developed for T-quenchers and Ramshead EMRV discharge header devices; these methods did not directly apply to the Oyster Creek Y-quencher design. Hence, MPR developed an alternate method to define this load. The method developed by MPR involved calculating the water velocity and acceleration - and corresponding thrust forces - as water moved through the quencher, using backward difference mathematical modeling methods. The driving force for the water flow is the pressure immediately upstream of the slug. A pressure-time history was obtained from RVFOR output. Forces at various points in the quencher are then determined from this pressure-time history. MPR developed a computer code called "BDIF" to solve for these forces.

BDIF runs for the three EMRV-discharge cases were generated using the pressure-time histories obtained from RVFOR runs. The maximum forces in each segment for the three cases were reviewed. This review indicated that an assumption that the maximum force in a segment will increase proportionately with setpoint pressure would be conservative for all significantly loaded segments (i.e. will over-predict loads for higher pressures). Consequently, water clearing thrust loads on the quencher can be conservatively represented for an input pressure of 1105 psig by ratioing the loads calculated for an input pressure of 1070 psig by the following factor:

$$\frac{1152.85}{1116.8} = 1.033$$

4. QUENCHER INTERNAL PRESSURE

Quencher internal pressure loads were not used in the original LTP analysis. Instead, the EMRV discharge headers were assumed to be at the maximum discharge pressure along the entire length.

The effect of EMRV setpoint pressure increase on quencher internal pressure is not applicable, since this internal pressure was not considered in the original LTP analysis.

5. WATER JET LOADS ON INTERNAL STRUCTURES

For Oyster Creek, the LTP analysis method for water jet loads had to be modified to account for the Y-quencher configuration. The methodology of NEDE-24555-P, Application Guide 6 was followed, except that the final equations were developed using the Oyster Creek hole pattern. Water velocities through the quencher holes - which were needed to calculate jet loads - were obtained from the output of BDIF. The torus configuration was reviewed to determine whether any components were in the water jet path. For Oyster Creek, only the vent header support columns and catwalk braces were in that path. Using the worst case jet load, it was determined that only the support columns would experience water jet loading; the catwalk braces were beyond the penetration of the jet. Support column loads due to the water jet were than calculated based on the drag coefficient and calculated velocity.

A review of the BDIF runs associated with the three EMRV-discharge cases reviewed indicated that water jet penetration distance is fairly insensitive to setpoint pressure. Consequently, the assumption may be made that increasing setpoint pressure from 1070 psig to 1105 psig will have a negligible impact on jet penetration length. This assumption results in the conclusion that the catwalk braces will not be loaded by water-jet pressures at the proposed 1105 psig setpoint.

6. TORUS SHELL PRESSURE DISTRIBUTION

The EMRV actuation-induced torus shell pressure distribution was originally determined based on test results performed after installation of the Y-quencher at Oyster Creek. Tests were performed for a variety of initial conditions (number of valves actuated, initial or subsequent actuation) and shell response was recorded via instruments attached to the vessel. MPR-550 and MPR-733 respectively (submitted and referenced in NRC's SER of the LTP) summarize test results and show how test results were used to calculate factors to be applied to the torus water deadweight loads case to model torus reactions for the range of conditions to be considered for the original LTP analysis. Torus shell pressure distribution due to EMRV actuation was then treated as a multiplier on torus water deadweight for analysis of components.

The EMRV-discharge cases reviewed can be used to show how the torus shell response will vary with setpoint pressure. In particular, the program QBUBS (written by G.E. to predict torus shell pressure due to air and steam bubble loads) was run with input from RVFOR and EOP Guideline bases; the bubble pressures for each EMRV-discharge case were excerpted from the QBUBS output.

Review of the case results show that in the range of 1100 psi, bubble pressure varies linearly and directly with setpoint pressure. Therefore, if setpoint pressure increases from nominally 1070 psig to 1105 psig, the torus shell response will be increased by the following ratio:

$$\left[\frac{1152.85}{1116.8}\right] = 1.033$$

The ratio above does not provide for dynamic amplification due to frequency shifts which might occur with setpoint changes. Neglecting this effect is reasonable since the forcing frequency is highly insensitive to setpoint pressure.

7. AIR BUBBLE-INDUCED DRAG ON SUBMERGED STRUCTURES

Underwater drag loads were calculated in accordance with NEDE-24555-P, Application Guide 5, with the exception that the GE factor "BFAC" (empirical bubble charging factor) was recalculated to represent more accurately the Oyster Creek Y-quencher design. These peak drag loads were applied to stress models after accounting for dynamic amplification effects (required if the natural frequency of a component was near the forcing frequency). For air bubble drag, the forcing frequencies were the same as the frequency of the torus shell bubble load.

The bubble factor used in TQFOR (BFAC = 0.6) conservatively over-predicted bubble pressures (and hence bubble induced drag loads) by at least 23% for positive bubble pressures and 27% for negative bubble pressures. This over-prediction was determined by comparing test results to calculated bubble pressures.

Drag loads are proportional to bubble pressure adjusted to account for bubble charging rates. The LTP program analyses showed that the relationship is:

$$\text{Drag Load} \propto [\text{Bubble Pressure}]^{BFAC}$$

Since the exponent on bubble pressure listed above is less than one, it is conservative to assume the drag load varies directly and linearly with setpoint pressure as the setpoint pressure increases from 1116.8 psia to 1152.85 psia.

Therefore the factor is:

$$\left[\frac{1152.85}{1116.8}\right] = 1.033$$

And, the effects of bubble frequency shifts from a nominal setpoint pressure of 1070 psig to 1105 psig are negligible.

QUESTION 2

A. Provide a summary of the calculations of torus stresses with EMRV actuation (increased setpoint pressures corresponding to ASME Levels A to D load combinations (see Standard Review Plan 3.8.2).

RESPONSE TO PART A.

The summary of the result of the evaluation of the impact of the proposed EMRV setpoint increase was provided in our Technical Specification Change Request No. 216 submittal.

Raising the nominal EMRV setpoint pressure at Oyster Creek from 1070 to 1105 psig will increase EMRV discharge-induced loads by less than 3.3 percent. The structures covered by the Mark I Long-Term Program are adequate for the increased EMRV discharge loads. The adequacy of these structures was confirmed by the following three step process.

1. Components which were originally reported to the below allowable stress and/or load in the LTP were ratioed up 3.3 percent irrespective of EMRV contribution to the load. If these components were still below allowable with the 3.3 percent increase in load, they were considered acceptable. The majority of components fall into this category.
2. Components which did not pass Test 1 above were then examined in greater detail. The contribution of EMRV discharge to the stress and/or load was determined and only that portion associated with EMRV discharge was ratioed up 3.3 percent.
3. Only the EMRV discharge piping itself, and the vent line/vent header intersections did not pass Test 2. For these two components, the stresses reported in the LTP analyses slightly exceeded allowable values for several load combinations, but were considered acceptable due to conservatism in the original analysis methods. To determine the acceptability of increasing the EMRV discharge-induced loads on these components, the stress analyses performed were reviewed to determine whether more realistic (less conservative) analysis methods could be used to more accurately determine the stresses for these components. In these cases, using the square root sum of the squares (SRSS) summation method for independent dynamic loads (such as earthquake, EMRV discharge and loss of coolant accidents), results in stresses that are within allowables for the increased EMRV discharge loads as well as for the original Mark I Containment Long-Term program loads.

SRSS summation of independent dynamic loads was used previously in MPR-772, "Oyster Creek Nuclear Generating Station Mark I Containment Long-Term Program, Plant-Unique Analysis, Supplemental Report." This report was submitted by GPUN to the NRC in August, 1983.

QUESTION 2

B. Provide a copy of MPR Report 658 (Ref. 40, Enc. 3) related to the spectral analysis and safety/relief valve.

RESPONSE TO PART B.

As noted above, the Oyster Creek specific in-plant test results had been used to conduct the LTP. As such, a procedure was required to extrapolate test results to bubble frequencies that were not tested. MPR Report No. MPR-658 provided the outline of such an extrapolating procedure. However, the change in the dynamic response of the torus to EMRV actuations was described in MPR-733, as part of the LTP results, and not by MPR-658.

The change in the dynamic response of the structure in the design cases compared to the tested base case was accounted for by performing a dynamic analysis of the torus for each condition. The dynamic load factor (the ratio of the peak dynamic response amplitude to the static response amplitude) was calculated for each case using the coupled load-structure analytical model of the Oyster Creek torus and the bubble time history measured in the Oyster Creek in-plant test as required by NUREG-0661. The bubble time history was shifted in frequency as required for each design case. The frequency used for the analysis of each design load case was selected to coincide with the upper limit of the dominant frequency range predicted for each design load case. The range of frequencies considered were in accordance with the requirements of NUREG-0661. The upper limit of the frequency range was used for the analysis because this results in the highest torus response, since the torus fundamental natural frequency (19 Hz) is above the highest EMRV bubble frequency (11.4 Hz). In addition, to reduce the extent of analysis, the frequencies for subsequent actuations were used for the frequencies applicable to first actuations under normal, small and intermediate break accident conditions. This approach introduces further conservatism, since the EMRV bubble frequencies are higher (and thus closer to the torus fundamental natural frequency) for subsequent actuations than for first actuations.

The dynamic load factor for each design case was compared to the dynamic load factor for the tested base case for various parts of the torus and its supports and bounding values of this ratio were selected for use in the structural analyses. This bounding method of adjusting for frequency effects was possible because dynamic amplifications are not large, since the torus structural resonant frequencies at Oyster Creek are well above EMRV discharge bubble frequencies.

Additional detail can be found in GPUN's response (P. B. Fiedler to D. G. Eisenhut, dated 9/14/83) to Brookhaven National Laboratory's requests for information (letter LS05-83-05-067 dated 5/27/83 and Item 12 of letter LS05-83-04-030 dated 4/14/83).

QUESTION 3.

Section 11.0 of Enclosure 3 discusses the effects of torus corrosion and EMRV setpoint increases on the code allowable. The staff has not accepted the use of the actual material properties (compared to the minimum properties established by the ASME code) for design basis loadings. It should be recognized that the code permitted under tolerance is for accepting the plate material for use in the fabrication of vessels. Therefore, it should not be used to allow for additional corrosion depth. Provide a summary of the torus stresses considering the reduced thickness due to corrosion. Also, provide a copy of MPR Report 953 which formed the basis for your safety assessment of the torus.

RESPONSE

In this question the Staff points out the following with regard to Section 11.0 of Enclosure 3 to the TSCR (GPUN Topical Report 101) to note the following:

1. The Staff has not accepted the use of the higher material allowables that are documented in Certificates of Material Test Reports (CMTRs).

2. The ASME code permitted under-tolerance for accepting plate material for fabrication should not be used to allow for additional corrosion depth.

The MPR reports cited in Section 11.0 of Enclosure 3 do not use CMTRs or the ASME code under-tolerance provision to compute torus shell thickness margins. These computed margins are based solely on the differences between the as-found shell thicknesses and the minimum thicknesses required to satisfy Mark I Long-Term Program stress requirements.

Additionally, the staff requests a summary of the torus stresses considering the reduced shell thicknesses due to corrosion.

GPUN conducted a torus corrosion inspection and repair program during Outage 10R in 1983. During this program, corrosion pitted areas were inspected and mapped to identify areas of weld overlay, localized areas of the torus shell were repaired, and as-found shell thicknesses were documented. (See NRC Inspection Report No. 50-219/84-07, dated May 17, 1984.)

MPR confirmed the acceptability of these as-found shell thicknesses by computing the minimum shell thicknesses required to satisfy Mark I Program stress requirements and by confirming that the differences between nominal and minimum shell thicknesses exceeded shell corrosion depths.

GPUN's Topical Report 101 submitted with TSCR 216 summarizes the MPR evaluation of the Mark I Containment Long-Term Program for the proposed increase in EMRV discharge-induced loads. MPR concluded that stress levels for all Mark I components were acceptable for the increased EMRV loads. However, the MPR report did not compute new thickness margins for the torus shell.

To consider the effect of the increased EMRV loads on the torus shell thickness margins, GPUN calculated new thickness margins based on the following conservative screening criteria:

1. Computed stresses were increased by a factor of 1.04 without regard for the specific EMRV contribution to the stress.

2. Stresses were assumed to be membrane rather than bending stresses.

These bounding assumptions result in new minimum thicknesses for the torus shell that are four (4) percent greater than MPR's original minimum thicknesses that MPR documented in Report No. 953. As documented in the GPUN calculation and the MPR report, the revised shell thickness margins remain greater than corrosion depths at all locations on the torus shell. Of note, the minimum shell thicknesses of MPR-953 are based on MPR's original torus shell calculations performed for the Mark I LTP. Further, Brookhaven National Laboratory evaluated the MPR reports for the Staff in Technical Evaluation Report No. BNL 04243, which BNL issued in September, 1983. Therefore, MPR-953 does not form the basis of the safety assessment of the torus for this TSCR.

QUESTION 4

MPR-953 is based on 1983 torus inspections. Provide a summary of the subsequent updated torus corrosion inspection data that would form the basis for safety assessment of the torus.

RESPONSE:

Underwater Engineering Services took additional pit depth and ultrasonic thickness readings in portions of the torus shell during Outage 13R in 1990 and Outage 14R in 1992. Pit depths observed and recorded during these inspections were less than the thickness margins which GPUN and MPR documented previously for all these shell locations.