QUESTION 130.1

The use of a SRSS methodology to combine primary and secondary stresses is questioned. Provide background and engineering justification for SRSS usage for this application.

RESPONSE:

Please refer to the generic response to NRC Question SEB 1 provided by GE in a May 1, 1978 letter from L. J. Sobon (GE) to J. T. Knight (NRC).

QUESTION 130.2

The use of a low ($\pm$5%) peak broadening factor is contrary to related current practice. Provide detailed engineering justification for this deviation.

RESPONSE:

Please refer to the generic response to NRC Question SEB 2 provided by GE in a May 1, 1978 letter from L. J. Sobon (GE) to J. T. Knight (NRC).

QUESTION 130.3

The usage of SRSS for the combining of closely spaced mode response is not generally considered as good engineering practice.

Provide engineering justification for the adoption of this criteria.

RESPONSE:

Please refer to the generic response to NRC Question SEB 3 provided by GE in a May 1, 1978 letter from L. J. Sobon (GE) to J. T. Knight (NRC).

QUESTION 130.4

Explain the manner by which random bubble frequency samples will be obtained and enveloped.

RESPONSE:

Please refer to Subsection 4.1.3 of the Susquehanna Steam Electric Station, Design Assessment Report.

QUESTION 130.5

The horizontal and vertical design response spectra in the FSAR do not conform to the requirements of Regulatory Guide 1.60. Compare, via graphs, the horizontal and vertical design response spectra proposed in the Susquehanna FSAR and that required by R.G. 1.60. Note that in regards to the vertical design response spectra, the SEB Branch position is that the vertical design response spectra values may be taken as two-thirds the horizontal design response spectra only for sites located in the Western United States. The Susquehanna site does not meet this criteria. Justify the deviations that exist between the horizontal and vertical response spectra provided and those obtained by using R.G. 1.60.

RESPONSE:

Comparisons between the Susquehanna Project design response spectra (as last amended in February, 1972) and those in Regulatory Guide 1.60 (December, 1973) may be found in Figures 3.7b-102, 3.7b-103, 3.7b-104 and 3.7b-105, and described in FSAR Subsection 3.7b.1.1. These figures show that the Regulatory Guide Spectra are generally higher than the project design spectra.

In the report WASH-1255 (Ref. 1) N. M. Newmark has shown based upon 14 strong motion records that the ratio of vertical to the horizontal ground acceleration is 2/3 on an average. Although only 3 of 14 earthquake records considered were on rock, the ratio of the vertical to the horizontal accelerations is less in rocks than alluvium. From their additional research based on the analysis of 30 vertical recordings made on "hard" or rock sites, the authors P. C. Rizzo, D. E. Shaw, and M. D. Snyder report (Ref. 2) that the ratio of 2/3 between the vertical and horizontal accelerations is conservative. Their study which also includes the sites located in eastern United States, such as Blue Mountain Lake, New York, show that the provisions of the Regulatory Guide 1.60 are overly conservative for "hard" or rock sites. It is stated in their report that the requirement of the Regulatory Guide 1.60 envelopes both rock and soil sites.

All principal Category I structures of the Project are founded on competent rock and have been designed for a maximum SSE ground acceleration of 0.1g and 0.067g in the horizontal and vertical directions respectively. Engineered Safeguards and Service Water (ESSW) Pumphouse and Spray Pond which are founded on soil have the ground acceleration levels in both directions increased by 50%.

For discussions of additional conservatism in maximum earthquake potential and safe shutdown earthquake, please refer to Sections 2.5.2.4 and 2.5.2.6 of the FSAR.

References:

(1) "A Study of Vertical and Horizontal Earthquake Spectra." USAEC Contract No. AT(49-5)-2667, WASH-1255. N. M. Newmark Consulting Engineering Services, Urbana, Illinois, April 1973.

(2) "Vertical Seismic Response Spectra," P. C. Rizzo, D. E. Shaw, and M. D. Snyder, Journal of Power Division, ASCE, January 1976, pp. 121-141.

QUESTION 130.6

The damping value for welded steel structures is given as 5 percent of critical for the SSE condition in FSAR Table 3.7b-2. Regulatory Guide 1.61 states that this value should not exceed 4 percent of critical. Justify using the less conservative value.

RESPONSE:

Table C.2.1 of the PSAR provides for a damping value of 5.0% of critical for the welded steel structures at a stress level at or just below the Yield Point. This was based on a technical paper by Dr. N. M. Newmark, cited as Reference 3.7b-2 in the FSAR. Since the stress levels for SSE conditions are allowed close to the yield point, the damping value of 5.0% for SSE has been considered appropriate and hence, has been provided in Table 3.7b-2. Therefore, the above criteria for the damping value is used for the design of the structures with appropriate design margins.

QUESTION 130.7

SRP Section 3.7.2.1 requires that a sufficient number of modes in the dynamic model of the structures must be considered, so that the inclusion of additional modes does not result in more than a 10 percent increase in the response. Show that this requirement has been taken into consideration in the design. If it has not been considered, justify your method in light of the 10 percent requirement.

RESPONSE:

As described in Subsection 3.7b.2.1 the Seismic analysis of the Seismic Category I Structures considers all modes whose frequencies are up to 33 cps. However, if a structure has only one or two modes with a natural frequency below 33 cps, then the three lowest modes are used. For example, see Table 3.7b-5 which lists the natural frequencies used for the Vertical Seismic analysis of the containment. If a structure has three or less degrees of freedom, then all modes are considered in the analysis. The design spectra for the project (Figures 3.7b-1 and 3.7b-2) show that the maximum spectral accelerations occur for frequencies between 2 cps and 6.67 cps, and reach an asymptotic value of ground acceleration of 0.05 g for OBE and 0.10g for SSE.

Analysis shows that the total effective mass of all the modes included is more than 90% of the total actual mass. From this discussion, it can be concluded that sufficient number of modes have been considered to satisfy the SRP requirements.

QUESTION 130.8

Describe the method employed for system/subsystem decoupling.

RESPONSE:

The procedure used for modeling considers Seismic Category 1 structures to be "Seismic Systems," whereas Seismic Category 1 piping systems, equipment and the components are considered "Seismic Sub-systems." As described in Subsection 3.7b.2.3, all equipment, components and piping systems are lumped into the supporting structure mass except for the reactor vessel, which is analyzed using a coupled model of the containment structure and the reactor vessel (See Figures 3.7b-7 and 3.7b-8). It is described in Section 3.2 of reference 3.7b-3 that any equipment, a component or a piping system is usually lumped into the Supporting Structure mass if its estimated mass is less than one-tenth (1/10) that of the supporting mass or, for supporting structures having continuous mass distributions, 0.03 of the fundamental mode effective mass. This equipment, component or piping system is later analyzed using response spectra generated at the supporting level.

Subsection 3.7b.2.3 has been revised accordingly.

QUESTION 130.9

The SRP defines closely spaced modes as modes with frequencies within 10 percent of each other, while the FSAR defines them as being within 0.5 cps of each other. Taking, for example, 15 cps the SRP would consider closely spaced modes to lie in the range of 13.5 cps to 16.5 cps. The FSAR, on the other hand, only admits those in the 14.5 cps to 15.5 cps range.

Justify, using the less conservative approach.

RESPONSE:

See revised Subsection 3.7b.2.7.

QUESTION 130.10

The loading combinations and allowable stress limits for the concrete containment must meet the provisions of SRP section 3.8.1 which reference the ASME Boiler and Pressure Vessel Code, Section III, Division 2, April 1973 issue entitled, "Proposed Standard Code for Concrete Reactor Vessels and Containment." There appear to be deviations between the ASME Code Table CC-3200-1, as modified on SRP page 3.8.1-6, and the load given in FSAR Table 3.8-2. Looking first at the loads themselves, Table 3.8-2 lacks "P_v," subatmospheric minimum pressure load. Also, it is not clear whether the FSAR expression "$T_o + T_a$" is equivalent to "$T_a + R_a$" as defined in the SRP. Also, is "T_o" from the FSAR equal to "$T_o + R_o$" as defined in the SRP? In comparing the load combinations the "construction" and "extreme environmental" loadings are absent in Table 3.8-2. Clarify these discrepancies.

Table CC-3200-1 of the ASME Code is based on working stress criteria as indicated in SRP Section 3.8.1.11.5, while FSAR Table 3.8-2 is based on ultimate strength design. Assess the extent to which the containment design satisfies the working stress criteria.

RESPONSE:

The containment was analyzed for the external pressure load, "P_v," acting alone. The magnitude of this load is defined in Subsection 3.8.1.3.2.7. Since this load is small, it may be combined with other loads without affecting the design. Table 3.8-2 has been revised accordingly to include "P_v."

"T_o" and "T_a" as used include piping loads during operating and accident conditions respectively. Therefore, "$T_o + T_a$" as defined in the FSAR is equivalent to "$T_a + R_a$" as defined in the SRP. Also, "T_o" as defined is equivalent to "$T_o + R_o$" as defined in the SRP.

See Subsection 3.8.1.5.1.1 for the discussion regarding the extent to which the containment design satisfies the working stress criteria.

QUESTION 130.11

Explain the apparent contradiction in the statements concerning tangential shears on FSAR pages 3.8-11 and 3.8-13.

Page 3.8-11 states that "Tangential shears caused by seismic loads are totally resisted by helical reinforcing bars and concrete in compression." Page 3.8-13 indicates, however, that tangential shear is not permitted. Note that tangential shear stress is governed by subsection CC-3400 of the ASME-ACI 359 Code with exceptions listed in SRP Section 3.8.1. II.5. In those exceptions, Vc is increased from 40 psi to 60 psi for the 7th combination of Table CC-3200-1.

RESPONSE:

Seismic tangential shears are totally resisted by helical reinforcing bars and concrete acting together as a truss. The reinforcing bars resist diagonal tension and the concrete resists diagonal compression. Although SRP Section 3.8.1. II.5 allows concrete to resist tangential shear, the helical reinforcing bars were designed assuming no tangential shear was taken by the concrete (as stated in Subsection 3.8.1.5.1.2 a) 4)).

Subsection 3.8.1.4.2 has been revised to clarify the design procedure.

QUESTION 130.12

Provide, in tabular form, the concrete compressive strengths used for the containment including its interior structures, "other Category I structures" of Section 3.8.4, and their associated foundation mats.

RESPONSE:

Table 3.8-11 is added, and Subsections 3.8.1.6.1, 3.8.3.6.1, 3.8.4.6.1 and 3.8.5.6 are revised accordingly.

QUESTION 130.13

The loading combinations of FSAR Table 3.8-3 for the drywell head assembly, equipment hatches, personnel lock, suppression chamber access hatches, and CRD removal hatch are not in agreement with those of SRP Section 3.8.2.II.3.b.

For example, Table 3.8-3 does not contain the contributions from "T_e," "R_e," or "P_e" as defined in the SRP. Also, the allowable stresses are as given in SRP Table 3.8.2-1 based on subsection NE of the ASME Code, Section III, Division 2. FSAR Table 3.8-3, however, bases allowable stresses on subsection NB of the Code. Address the load combinations and stress limits of the SRP and discuss the degree of conservatism that exists between the SRP guidelines and FSAR Table 3.8-3.

RESPONSE:

Table 3.8-3a provides a comparison of FSAR and SRP load combinations and allowable stresses for ASME Class MC components. Subsection 3.8.2.3.1 has been revised accordingly.

QUESTION 130.14

The drywell floor, like the concrete containment, must meet the provisions of the ASME "Proposed Standard Code for Concrete Reactor Vessels and Containment," April 1973 issue. This includes the load combinations of Table CC-3200-1, with exceptions given in SRP Section 3.8.3.3, pg. 3.8.3-16, and the allowable stress limits of Subsection CC-3400 with exceptions on SRP page 3.8.3-22. In a similar manner to Question 130.10 assess the degree to which the drywell floor satisfies the loading conditions and stress allowables of the SRP.

RESPONSE:

For a complete response to this question, see the response to Question 130.10.

The allowable stress criteria for the drywell floor, as given in Subsection 3.8.1.5.1.2, meets the provisions of ASME Subsection CC-3400 with exceptions on SRP page 3.8.3-22.

QUESTION 130.15

There appear to be three deviations in the load combinations for the reactor pedestal between those in SRP Section 3.8.3.3, page 3.8.3-14 and those provided in FSAR Table 3.8-2: The "Normal" and "Normal/Severe" loadings provided in the FSAR does not meet our requirements. The following two loadings should be addressed instead:

a) $1.4D + 1.7L + 1.9E = U$

b) $(0.75)\ (1.4D + 1.7L + 1.9E + 1.7T_o + 1.7R_o) = U$

Address the two load cases by showing that they will not cause overstress in the existing design.

Note that, as stated in Question 130.10, it is assumed that "T_o" from the FSAR equals "$T_o + R_o$" from the SRP, and "$T_o + T_a$" from the FSAR equals "$T_a + R_a$" from the SRP.

RESPONSE:

The reactor pedestal has been analyzed for the two (2) additional load combinations listed above without any overstress occurring. Refer to revised Subsections 3.8.3.3.1 and 3.8.3.3.2, revised Table 3.8-2, and new Table 3.8-2a.

Refer to the response to Question 130.10 for a clarification of loads "T_o", "T_a", and "R_a".

QUESTION 130.16

Indicate whether the reactor shield wall is designed using composite steel-concrete design. If so, describe the provisions made to allow for adequate shear transfer.

RESPONSE:

The concrete in the reactor shield wall is used for radiation shielding only and is not relied upon as a structural element. The inner and outer steel plates resist all structural loadings without any assistance from the concrete; i.e., composite action between steel and concrete is not assumed.

Subsection 3.8.3.1.3 has been revised to include this information.

QUESTION 130.17

The qualitative statement that the abnormal loadings govern the design of the suppression chamber columns because they include the design basis accident pressure load does not demonstrate that our requirements for load combinations are met by FSAR Table 3.8-5. State whether the loading combinations (along with allowable stresses) given below (SRP page 3.8.3-15) are satisfied.

Allowable Stress	Load Combination
Y	$1.7D + 1.7L + 1.7E$
Y	$1.3 (D + L + E + T_o + R_o)$
.9Y	$D + L + T_o + R_o + E'$

RESPONSE:

The suppression chamber columns have been analyzed for the three (3) additional loading combinations listed above without any overstress occurring.

Table 3.8-5 has been revised to include these additional load combinations.

QUESTION 130.18

The seismic loads due to the dead weight of the drywell platforms has been ignored, although seismic reaction loads of piping and equipment supported by the box girders of the platforms is included.

Justify the omission of seismic loads due to dead weight by comparing the masses (or weights) of the piping and equipment with that of the drywell platforms themselves. Also, clarify whether the seismic input for the piping and equipment is the SSE.

RESPONSE:

The drywell platforms are not designed for seismic loads due to their own dead weight for the following reasons:

1. For the box beams, seismic loads due to the dead weight of the beams are insignificant relative to the pipe rupture loads. Seismic loads on the box beams due to their own dead weight are less than 10 kips. Equivalent static pipe rupture loads on the box beams range from approximately 350 to 850 kips depending on the pipe diameter.

2. For the framing beams, seismic loads due to dead weight of the beams are small since these beams are laterally braced by other framing beams and by the grating.

The omission of seismic loads on the drywell platforms due to their own weight is based upon the above reasons and not on the relative weights of the platforms and the piping and equipment supported by the platforms.

The seismic input for the piping and equipment is the SSE.

Subsection 3.8.3.3.5 has been revised accordingly.

QUESTION 130.19

Explain the basis of the load combination for reinforced concrete in Table 3.8-8 for the reactor building, which applies to "Structural Elements Carrying Mainly Seismic Forces." It implies that if seismic loads exceed a certain proportion of the total then that load combination is used in lieu of the others.

RESPONSE:

Table 3.8-8 has been revised to clarify the design procedure. For response see revised Table 3.8-8.

QUESTION 130.20

The Susquehanna FSAR Section 3.7b.2.1 indicates that both a flexible base model and fixed base model were utilized for the seismic analysis of the containment building. Discuss and explain the rationale for using two different models for the seismic analysis. Demonstrate the equivalency of the two models by comparing their dynamic characteristics on the results from the two analyses.

RESPONSE:

For response see Subsection 3.7b.2.1.1.

QUESTION 130.21

In Torsional Analysis of Diesel Generator Building and ESSW pumphouse: Justify the use of static analysis for a dynamic phenomenon.

RESPONSE:

See Subsections 3.7b.2.11.1 and 3.7b.2.11.2 for response.

TABLE 130.21-2
TABLE 130.21-3

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TABLE 130.21-2
TABLE 130.21-3

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QUESTION 130.22

Explain why the analysis for the torsional effect was not done for the Reactor Building.

RESPONSE:

See Subsection 3.7b.2.11.2 for response.

QUESTION 130.23

In Figure 7-6, which shows downcomer bracing system details, it appears that the bracing is welded to the liner plate through the use of an embedded plate without any anchorage to the containment concrete wall. Since the steel liner plate is not a structural component, indicate how the pulling forces from the bracing can be resisted and how the leaktight integrity of the liner can be maintained.

RESPONSE:

Downcomer bracing forces are resisted by embedded anchorages in the containment concrete wall. This design assures the leaktight integrity of the liner plate is maintained.

Question 130.24

In your response to Question 2, you indicated that Sm is the allowable stress as specified in UBC. For extreme and/or abnormal loading combinations, you increase the allowable stress by a factor of 1.67, which is in conformance with the practice of SRP Sections 3.8.3 and 3.8.4, for reinforced concrete structures. However, concrete masonry walls are quite different from reinforced concrete walls, particularly the unreinforced ones, the use of such a practice may not result in an adequate design. Depending on the types of stress, that is, tensile, shearing or axial compressive, the factor may vary from 0 to 2.5 (see enclosure 2). Specify the masonry design strength f'_m used in Susquehanna masonry walls and the allowable values for all types of stresses.

Response:

Masonry walls are described in Section 3.8.

In accordance with the meeting with NRC's Structural Branch of May 29, 1981, and subsequent phone call of June 2, 1981, PLA-831 (Curtis to Schwencer dated June 3, 1981) transmitted the requested information.

TABLE 130.24-1
Page 1 and 2

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Question 130.25

In the note to you response to Question 2, you stated that the allowable shear or tension between masonry block and concrete or grout infill is considered to be equal to three percent of the compressive strength of the block. The allowable shear or tension as specified by you is in the staff's opinion too high. To specify the allowable shear or tension of the vertical joint between why these in terms of the compression strength of the block is in the first place unconservative and the use of seemingly low percentage of 3% may actually result in an allowable shearing stress greater than its corresponding strength. Therefore, revision of the stress criterion is required.

Response:

Masonry walls are described in Section 3.8.4.

In accordance with the meeting with NRC's Structural Branch of May 29, 1981, and subsequent phone call of June 2, 1981, PLA-831 (Curtis to Schwencer dated June 3, 1981) transmitted the requested information.

Question 130.26

In your response to Question 4: (1) It is indicated that response spectrum method is used for the dynamic analysis of the concrete masonry walls. However, there is no mention as to which of the response spectra is used, upper floor or lower floor response spectrum or the average of the two. It is required that an upper bound envelope of the individual floor is used. (2) Through the use of ACI-318 formula the cracking of concrete masonry wall is considered. The use of such a formula is questionable in view of the fact that in a concrete masonry wall the weakest section is the bed joint and the modulus of rupture is equal to that of neither the concrete block nor the mortar.

Indicate how the modulus of rupture is established in your computation.

Response:

Masonry walls are described in Section 3.8.

In accordance with the meeting with NRC's Structural Branch of May 29, 1981, and subsequent phone call of June 2, 1981, PLA-831 (Curtis to Schwencer dated June 3, 1981) transmitted the requested information.

Question 130.27

In response to Question 5, it is stated that when the design stresses of masonry walls exceed the allowable stresses, fixes are designed such that the criteria is satisfied.

Indicate the number of walls where such fixes are needed and provide examples.

Response:

Masonry walls are described in Section 3.8.

In accordance with the meeting with NRC's Structural Branch of May 29, 1981, and subsequent phone call of June 2, 1981, PLA-831 (Curtis to Schwencer dated June 3, 1981) transmitted the requested information.

TABLE 130.27-1

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Question 130.28

Provide justification for any deviation from the attached staff's interim criteria in you design and analysis of the masonry walls.

RESPONSE:

Masonry walls are described in Section 3.8.

In accordance with the meeting with NRC's Structural Branch of May 29, 1981, and subsequent phone call of June 2, 1981, PLA-831 (Curtis to Schwencer dated June 3, 1981) transmits the requested information.

TABLE 130.28-1
TABLE 130.28-2

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TABLE 130.28-1
TABLE 130.28-2

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