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William J. Cahill, Jr.
Executive Vice President

August 16, 1989

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

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
DOCKET NOS. 50-445 and 50-446
ADVANCE FSAR SUBMITTAL
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION ON
FSAR SECTIONS 3.7 AND 3.8

Gentlemen:

On July 31, 1989, a public meeting was held in Bethesda, Maryland, to discuss the NRC's Request for Additional Information (RAI) on the amended FSAR Sections 3.7 and 3.8. This letter provides TU Electric's response to the RAI items discussed in the public meeting. Items 10A, 21, and 22B were resolved during the meeting and required no further action. As agreed to in the meeting, the enclosure to this letter provides responses to the RAI, advance FSAR changes (if applicable), and related supporting documentation. These changes will be included in a future FSAR amendment.

The enclosure to this letter also includes an FSAR advance submittal regarding the temperature ranges inside and outside the containment (Section 3.8.1.3.1).

In order to facilitate NRC staff review of these responses and changes, the enclosure is organized as follows:

1. List of the RAI items and the response (background information at the end of part 1 of the enclosure is provided if needed to clarify our response).

2. Draft revised FSAR pages, with changed portions indicated by a bar in the margin, as they are to appear in a future amendment (additional pages immediately preceeding and/or following the revised pages are provided if needed to understand the change).

3. Line-by-line description/justification of each item revised.

4. A copy of related SER/SSER Sections.

5. An index page containing the title of "bullets" which consolidate and categorize similar individual changes by subject and related SER Section.

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6. A discussion of each "bullet" which includes:

   - The line-by-line description/justification for each item related to the "bullet" which has been screened as a group 1 or 2 item or a group 3 or 4 item which impacts the existing SER/SSER's. (The discussion of these groups is contained in TU Electric letter TXX-88467 dated June 1, 1988)

   - The bold/overstrike version of the revised FSAR pages referenced by the description/justification for each item identified above. The bold/overstrike version facilitates review of the revisions by highlighting each addition of new text in bold type font and overstriking with a slash (/) the portion of the text that is deleted. In some cases, where the bold/overstrike version is unavailable, a hand marked-up version will be provided.

If you have any questions regarding this submittal please contact Carl Corbin at (214) 812-8859.

Sincerely,

William J. Cahill, Jr.

William J. Cahill, Jr.

CBC/cbc
Enclosure

c - Mr. R. D. Martin, Region IV
    Resident Inspectors, CPSES (3)

Enclosure to TXX-89569
August 16, 1989

Response to Request for Additional Information,
Advance FSAR Changes to FSAR Sections 3.7, 3.8, and Q130
and
Supporting Documentation

Part	1	List of RAI items and responses, and background information	pg. 2 thru 23
Part	2	Draft Revised FSAR Pages	pg. 24 thru 53
Part	3	Description/Justification	pg. 54 thru 64
Part	4	Related SER/SSER Pages	pg. 65 thru 72
Part	5	Index Page Containing the Title of "Bullets"	pg. 73
Part	6	Discussion of "Bullets"	pg. 74 thru 96

RESPONSE TO REVIEW OF AMENDED FSAR SECTIONS 3.7 & 3.8

FSAR Section 3.7

1. The correction to FSAR Section 3.7B.1.2 on page 3.7B-2, identified as evaluation 3.7-007-3.7.1-Q has not been implemented in the current version of the FSAR (Amendment 68). Revise the FSAR to incorporate your commitment for evaluation 3.7-007-3.7.1-Q.

   Resp: The original FSAR discussed the use of five (5) horizontal and five (5) vertical artificial time history records to envelope the design spectra for the various damping factors. Actual analyses were performed using only one (1) vertical and one (1) horizontal artificial time history input motion which enveloped all the design spectra for various damping factors. The FSAR Section 3.7B.1.2 (pages 3.7B-2 and 3) will be revised to clarify this issue.

2. Evaluation No. 3.7-009-3.7.1-N [page 3.7B-4, Section 3.7B.1.3] discusses the approval of Code Case N-411, which is endorsed by Regulatory Guide 1.84, Revision 24, and states that "conditions of approval require FSAR documentation of all stress problems using this code case." This information is not found in Amendment 68 to the FSAR.

   Resp: It has been the practice for CPSES to evaluate all piping systems for earthquake using Code Case N-411. Certain restrictions (i.e. independent support motion) and exceptions may exist which can best be detailed subsequent to completion of the final reconciliation process. In compliance with the established commitment, a complete list of stress problems utilizing Code Case N-411 will be provided as an advance FSAR submittal by September 15, 1989.

3. Figures 3.7B-41 through 50 have been intentionally deleted from the FSAR. Indicate the reasons for this deletion and discuss if it represents a change in the proposed analysis procedure and potential implication of the change, as applicable.

   Resp: Figures 3.7B-41 through 49 were Interpolation Instructure Response Spectra. The intent of these spectra was to provide a simplistic method for calculation of instructure response spectra at specific locations. These simplistic spectra calculation procedures were not used at CPSES and, therefore the figures were deleted from the FSAR. When specific location spectra were required they were calculated at specific equipment locations. This represents no change in the analyses methodology used for the CPSES structures.

   Figure 50 was Floor-by-Floor Instructure SSE Response Spectra for Safeguards Building el. 852'-6" for 2 percent damping. These 2 percent spectra were not used for any analyses at CPSES and were therefore removed.

4. Provide clarification of the following entries related to FSAR Section 3.7B.2.9 which addresses the effects of parameter variation on the floor response spectra:

A. The peaks should be widened by +/- 10% rather than only 10%.

Resp: The floor response spectra were in fact widened by +/-10 percent. FSAR Sections 3.7B.2.1.2(2) and 3.7B.2.9 will be revised to state +/- 10%.

B. Specify the parametric bounds that were used to obtain the referenced peaks used for widening (e.g. best estimate).

Resp: The parametric variation was per Section 3.7B.2.4 and is further clarified in Table 3.7B-3 and Table 3.7B-24 through 29.

C. Discuss the parametric study (e.g., the various parametric values used in the analyses and the resulting responses).

Resp: Refer to response to 4B. Only the peak broadened design floor spectra were plotted.

D. Specify the use of maximum vertical ground acceleration lower than the maximum horizontal acceleration for the entire frequency range as opposed to the requirements of Regulatory Guide 1.60.

Resp: The ground design response spectra are discussed in Section 3.7B-1.1 and conform to the procedures developed by Newmark, Blume and Kapur. These procedures were the forerunner to Regulatory Guide 1.60 and differ from regulatory Guide 1.60 as described in FSAR Section 3.7B.1.1.

Section 3.7B.2.9 should not present another discussion of ground response spectra. The last sentence of 3.7B.2.9 will be deleted since this subject is included in 3.7B.1.1. The statement "The ground design response spectra and design time history are discussed in FSAR Sections 3.7B.1.1 and 3.7B.1.2 respectively." will be added to the end of Section 3.7B.2.9. A similar discussion of ground response spectra will be deleted from Sections 3.7B.2.1.2(2) and 3.7B.2.1.5.

5. Evaluation 3.7-054-3.7.2 requires revision to the structural model for the Service Water Intake Structure. Discuss how the affects of the structural backfill for the Service Water Intake Structure was accounted for in the calculation of the soil spring stiffness values.

Resp: The effects of structural backfill on the Service Water Intake Structure (SWIS) foundation spring stiffness values were calculated on the basis of the average embedded depth. The SWIS is basically socketed into rock with soil backfill on three sides above the top of rock. The foundation springs were calculated for a surface founded structure and then increased because of embedment effects. The embedment effects were calculated for all rock, and then for all soil above the founding level and an average was calculated to be representative of the actual soil/rock profile.

FSAR Section 3.7B.2.4.2, "Effect of Embedment on Foundation Rigidities," will be changed to reflect the methodology used to determine the effect of embedment for the SWIS.

6. The FSAR should include a discussion on the seismic analysis of Category I tanks.

Resp: There are three outdoor Seismic Category I tanks, i.e., the Refueling Water Storage, Condensate Storage, and Reactor Makeup Water Storage Tanks. These are reinforced concrete structures with 2'-6" thick walls and 1'-9" thick roofs (see Section 3.8.4.1.6).

FSAR Section 3.8.4.1.6 will be amended to provide additional description of their geometry and the methods used to address hydrodynamic loads due to seismic excitations.

7. In your discussion for the development of floor response spectra (Section 3.7B.2.5 page 3.7B-40) you mention the term "typical refined response spectra". Provide an explanation of this statement.

Resp: Computer generated floor response spectra were labeled "Refined Response Spectra". Figure 3.7B-50A a typical example of such response spectra curves. The Refined Response Spectra are similar to the Floor-by-Floor response spectra, except that extra conservatism due to hand smoothing has been eliminated by use of computer and curves are plotted in terms of acceleration versus frequency. FSAR Section 3.7B.2.5 will be revised to clarify this item.

8. In Section 3.7B.2.8, you state that the internal bracing of the turbine building will prevent its failure during a seismic event. Provide information which will support his statement.

Resp: ORIGINALLY: "Structural failure in the direction of the adjacent Seismic Category I structure is prevented by anchoring the Turbine Building to the turbine generator pedestals."

PRESENTLY: "Structural failure in the direction of the adjacent Seismic Category I structure is prevented by internal bracing."

The bracing by itself will not prevent structural failure in the direction of the Seismic Category I building. The turbine building will bear against the turbine pedestal after the frame has translated horizontally sufficiently to close the surrounding one-inch gap (note: gap is filled with a compressible material). The combination of the horizontal bracing internal to the steel frame and the bearing of the mezzanine and operating floor slabs on the turbine generator pedestal will resist collapse of the frame.

FSAR Section 3.7B.2.8 will be changed to read as follows.

FUTURE: "Structural failure in the direction of the adjacent Seismic Category I structure is prevented by the combination of the horizontal bracing internal to the steel frame and the bearing of the mezzanine and operating floor slabs on the concrete turbine generator pedestal.

9. Evaluation No. 3.7-039-3.7.3 [p.3.7B-55, sect 3.7B.3.2] identifies a reduction of the number of the maximum amplitude loading cycles for OBE and SSE. Provide a correlation of, or the basis for, the proposed number of cycles with those of the time history used in the analyses.

Resp: The number of equivalent stress cycles for earthquake loading (10 cycles/earthquake), has been, and continues to be, standard practice for Stone & Webster engineering as a general criteria for seismic qualification of piping and equipment. This criteria is consistent with Standard Review Plan 3.7.3 (NUGEG-0800), Paragraph II.2.b, which states (NUREG-75-087 contains the same wording):

> During the plant life at least one Safe Shutdown Earthquake (SSE) and five Operating Basis Earthquakes (OBE) should be assumed. The number of cycles per earthquake should be obtained from the synthetic time history (with a minimum duration of ten seconds) used for the system analysis, or a minimum of 10 maximum stress cycles per earthquake may be assumed.

Supplement 14 (Section 4.1.2.2, pages 4-6 thru 4-9) to the Safety Evaluation Report (NUREG-0797) contains the evaluation of the above amendment 61 FSAR change. The amendment 74 change was editorial. The above referenced SSER pages, a mark-up of the amendment 61 change, and a mark-up of the amendment 74 change are included elsewhere in part 1 of this enclosure.

10. Address the following editorial staff concerns:

A. (This item was resolved during the meeting on July 31, 1989.)

B. Provide definitions for and in pages 3.7N-10 and 3.7N-18.

Resp: FSAR Sections 3.7N.2.1.1 and 3.7N.2.1.5 (pages 3.7N-10,11, and 18) will be revised as required.

11. Clarify whether "the envelope floor response spectra" identified in page 3.7N-29 envelopes the acceleration values for all pipe support locations at all applicable frequencies.

Resp: <u>RCL Piping</u>

The response spectrum used for the RCL piping analysis envelopes at all frequencies the respective response spectra at all of the RCL pipe and equipment support locations.

<u>Class 1 Auxiliary Piping and Non-Class 1 Extensions within Westinghouse Scope</u>

The individual piping analyses are performed using spectra which envelope, at all frequencies, the RCL Spectra described above and the applicable auxiliary line response spectra at the piping and non-RCL equipment support locations.

12. State whether you have used the power density function as stated in page 3.7B-14 in the seismic qualification of equipment. If it has been utilized, provide the applicable information in the FSAR.

Resp: The power density function has not been used at CPSES. FSAR Section 3.7B.2.1.3 will be revised to delete the reference to the power density function.

13. Clarify how the horizontal and vertical accelerations have been combined. The first paragraph of Section 3.7B.3.8.2 is not clear and specific enough to address this staff concern.

Resp: The combined effect of the three components of earthquake motion on the seismic design of piping is determined by the SRSS method (Section 3.7B.2.6). The maximum modal responses are combined by the methods of NRC Regulatory Guide 1.92, Revision 1. The methods presented in Regulatory Guide 1.99 paragraphs 1.1, 1.2.1, 1.2.2 or 1.2.3 are acceptable methods for vendor qualification.

FSAR Section 3.7B.3.8.2 will be revised to clarify how the horizontal and vertical accelerations have been combined.

FSAR Section 3.8

14. Provide the results of your determination of the ultimate capacity of the containment structure and discuss the analytical procedures as per the requirements of USNRC SRP NUREG-0800, Section 3.8. Also specify the extent of plastic deformation allowed in the structural evaluation of CPSES components.

    Resp. The ultimate capacity of the containment structure has not been evaluated. The previous issue of SRP 3.8.1 (NUGEG-75-087) did not address ultimate containment capacity. The ultimate capacity of the containment structure will be addressed as part of the analysis process, if required, by the Individual Plant Examination For Severe Accident Vulnerabilities (Generic Letter No. 88-20).

15. Identify and discuss the design codes utilized in the determination of thermal stresses for CPSES (evaluation 3.8-012-3.8.1-U).

    Resp: The ACI 349-76 code Appendix A, is identified in Section 3.8.1.2.2(3) as the applicable design code.

16. Specify the stud welding equipment that did not satisfy the requirements of CC-4543(a) and justify the basis of its acceptance.

    Resp: CC-4543.5(a) stipulates "Studs shall be welded to steel members with automatically timed stud welding equipment connected to a suitable power source." The licensing change was made to allow the use of manual welding equipment or other similar equipment that would provide a stud to steel member connection which develops the required strength of the anchor. Where the use of automatic welding equipment is not feasible due to space limitations during construction or repairs, it is necessary to use alternate equipment.

    At CPSES the manual arc welding equipment was used for the attachment of, and repair of, anchor studs. The manual arc welding method used at CPSES develops the full capacity of the anchor.

The weld procedure specifications (WPS) listed below were qualified for stud welding (i.e. the full capacity of the anchor is developed) in accordance with the rules and requirements of CPSES specification 2323-SS-14 "Containment Steel Liner."

1. WPS STUD WELDING (Automatically Timed Stud Weld Method)
2. WPS STUD WELDING-SMA (Shield Metal Arc Method)
3. WPS STUD WELDING (PWHT) (Automatically Timed Stud Weld Method)
4. WPS STUD WELDING (General Welding Procedure Specification for the Stud Welding Process)

17. Address the following staff concerns:

A. How do the [new] analysis results compare with the old analysis and, for the containment, compare them with the test results.

Resp: The new analysis and the old analysis were not compared. The following table was developed per your request, for the comparison of the new analysis and the containment's structural acceptance test case.

RADIAL DISPLACEMENTS

ELEVATION (FEET)	NEW ANALYSIS (INCHES)	TEST RESULTS * (INCHES)
1001.5	0.53	0.34
968.0	0.64	0.48
932.0	0.65	0.49
903.0	0.64	0.60
870.0	0.66	0.58
838.0	0.57	0.49

VERTICAL DISPLACEMENTS

ELEVATION (FEET)	NEW ANALYSIS (INCHES)	TEST RESULTS * (INCHES)
1068.0	0.72	0.34
1058.96	0.64	0.48
1034.25	0.48	0.39
1000.5	0.32	0.33 **

* The worst case measurement is listed
** At elevation 1000.5, four test measurements were taken: 0.33, 0.30, 0.30, and 0.25

B. For the containment analysis, state how do the strains from the [old] cylinder wall analysis compare with those from the new analysis at or near the boundary location.

Resp: Strains were not measured during the structural acceptance test as the containment is not considered a prototype. Results of the test demonstrate that the containment structure performed as expected. The displacements were bounded by the computed values and the degree of cracking was in the normal range. Therefore, the strains are also within acceptable limits.

C. Also justify and discuss the following statement: "Properties of material are known with sufficient accuracy, and assumptions made are sufficiently conservative so that other variations need not be considered," (Top of page 3.8-40)

Resp: This quote comes from Section 3.8.1.4.3(3) Evaluation of Effect of Variations in Assumptions and Materials. This statement has never changed from the original issuance of the FSAR. A mark-up of the amendment 68 change is included elsewhere in part 1 of this enclosure.

The material properties used are based on standard ACI criteria as stated other Sections of the FSAR. Section 3.8.1.6.1(2) "Concrete Strength" specifies the minimum concrete strength as 4000 psi, in 28 days when tested in accordance with ASTM C 39-72. Section 3.8.1.6.2(1) and (2) "Reinforcing Steel" specifies the reinforcing steel conforms to the requirements of ASTM A 615-72 Grade 60' the specified minimum yield strength is 60,000 psi and the specified minimum ultimate strength is 90,000 psi. The structural acceptance criteria is given in Section 3.8.1.5 including that the concrete tensile strength is not relied upon to resist flexural and/or membrane tension. Section 3.8.1.4 discusses the design and analysis procedures used for the containment structure.

18. Provide a more descriptive detail of the electrical penetrations, e.g., o-ring, pressure monitoring, junction box, etc. identified in Figure 3.8-8.

Resp: The sketch of the electrical penetration in Figure 3.8-8 will be revised to provide detail (i.e. o-ring, pressure monitoring, and junction box).

19. Identify the controlling weights of the equipment supported by the overlay plates and structural shapes attached to the liner plate.

Resp: Overlay plates and/or structural shapes are provided in accordance with the requirements of ASME B&PV Code Section III, Division 2, Subsection CC; specifically CC-4543 "Welding of attachments," for the attachment of supports and/or equipment using other industry standards such as AWS. The overlay plates and/or structural shapes are designed in accordance with the requirements of the ASME B&PV Code Section III, Division 2, Subsection CC, specifically CC-3600 "Metalic Liner Design Analysis Procedures." The size of the overlay plate and/or structural shape is determined by the design parameters of CC-3600 based on the size, type, and loads of the attaching equipment.

20. The overlay plate welded to the liner plate is similar to a second liner plate. Discuss why the requirements for the second liner plate should not be applied to an overlay plate as well.

Resp: The overlay plates are attachments to the liner as described by subsubarticles CC-3600 and CC-3750 of the ASME B&PV Code Section III, Division 2, Subsection CC. The subsubarticles stipulate that the attachments shall be designed and analyzed using the accepted techniques applicable to beams, columns, and weldments, such as those illustrated in AISC-1969. The subsubarticles further stipulate the design allowables for the attachments shall be the same as those given AISC-1969.

21. (This item was resolved during the meeting on July 31, 1989)

22. Supply clarification regarding the use of the following requirements of AISC and ACI design codes:

A. State that this development length criteria satisfies ACI 318-83. If not, provide details and basis for the nonconformance.

Resp: TU Electric assumes the Section in question is 3.8.3.4.7 (3) "Bond and Anchorage requirements of Reinforcing Steel". The standard detail for development of reinforcement using a 90° hook is not in agreement with Chapter 12 of ACI 318-71. However, ACI 318-71 does allow the use of test data for anchorage requirements of reinforcing steel. Test Data is available which allows a reduction of development length. It should also be noted that, utilizing the same test data, the anchorage requirements for standard 90° hooks were revised in ACI 318-83 to allow a similar reduction of development length.

B. (This item was resolved during the meeting on July 31, 1989.)

23. The response to questions 130.25 and 130.28 do not provide the requested specific information. You stated compliance with SRP 3.8.3 and 3.8.4. However, Question 130.25 requests a listing and discussions of physical changes and Question 130.28 requests information pertaining to the controlling Sections of Category I structures resulting from the use of criteria identified in ACI 318, SRPs 3.8.1, 3.8.3, and 3.8.4. Address Question 130.25 and Question 130.28 for more pertinent information for staff issue and evaluation.

Resp: The response to FSAR Q130.25 and Q130.28 will be revised as follows:

<u>Question 130.25</u>

In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.

The Corrective Action Program for the civil/structural area was implemented to validate the design and hardware at CPSES. The various Seismic Category I structures were designed to conform to the loading combinations and their related acceptance criteria which are specified by U.S. NRC Standard Review Plans 3.8.1, 3.8.3, and 3.8.4 (NUREG-75-087).

Modifications to the design and hardware were implemented as required. The Civil Structural Project Status Report (PSR) describes the methods used to validate the safety-related hardware. Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

<u>Question 130.28</u>

In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.

The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The design of Seismic Category I structures conformed to the loading combinations which are specified by U.S. NRC Standard Review Plans 3.8.1, 3.8.3, and 3.8.4 (NUREG-75-087).

The methodology and results of this validation effort are described in the Civil Structural Project Status Report (PSR). Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

Also the response to Questions 130.15, 130.18, 130.25, and 130.28 will be changed to clarify which version of the Standard Review Plan was referenced (NUREG-75-087). The reference to Question 130.5 in Questions 130.25 and 130.28 appears to be incorrect and will be changed to Question 130.15.

24. The last paragraph on page 3.8-23 allows the reduction of a fillet weld by not more than 1/16". Provide justification for the acceptance criteria. Also justify why only indications greater than 1/16" are required to be examined by liquid penetrant or magnetic particle methods.

Resp: The justification for the reduction of a fillet weld by 1/16 inch for no more than 10 percent of the weld is the conservatism of design and codes (ASME-ACI 359, Section CC-4545.2(a), "Elimination of Surface Defects," and AWS D1.1 Section 8.15.1.6, "Quality of Welds").

The criteria that only indications with major dimensions greater than 1/16 inch shall be considered relevant is based on the following.

Magnetic Particle Examination-

Section CC-5533.2 of the proposed 1973 ASME B&PV Code Section III Division 2 states:

> All linear discontinuities are unacceptable and shall be removed and repaired in accordance with the applicable provisions of this Article.

Liquid Penetrant Examination-

Section CC-5534.2 of the proposed 1973 ASME B&PV Code Section III Division 2 states:

> All surfaces required to be examined shall be free of linear indication (cracks, laps, fissures, etc.) and of four or more rounded indications in a line separated by 1/16 inch or less (edge to edge), except where the specification for the material establishes different requirements for acceptance so far as indications are concerned.

The base material for the containment liner is SA-537 Class 2. The material specification references SA-20 which states "Plate furnished under this specification shall be free from injurious defects and shall have workmanlike finish." The material specification is vague and does not provide a definite acceptance criteria for defects.

The magnetic particle and liquid penetrant acceptance standards in FSAR Section 3.8.1.2.5.2.a states, "Only indications with major dimensions greater than 1/16 inch are considered relevant."

The 1/16 inch criteria was established based on the sensitivity of the nondestructive examination method for developing perceivable linear indications. The magnetic particle method uses metal particles that require a break in the magnetic flux and the retention of the metal particles to detect an indication. The approximate size of the minimum perceivable indication that would be detected is 1/32 inch. The liquid penetrant method uses liquid penetrant and developers for the detection of an indication. The approximate size of the minimum perceivable indication detected by the capillary action of the penetrant bleeding out into the developer is about the same as the magnetic particle examination method, i.e. 1/32 inch. As stated in Section CC-5534.1(a) of the proposed 1973 ASME B&PV Code Section III Division 2, linear indications are those indications in which the length is more than twice the width. Thus the linear indication would be 1/16 inch in length based on the minimum perceivable indication width of 1/32 inch.

Fundamentally there is no difference between existing code requirement that 1/16 inch indications are relevant and require rework and the CPSES effective code requirement for all linear indications to be reworked, as the method for detecting perceivable indications for the effective code was limited to 1/16 inch long defects. Thus the 1/16 inch criteria for relevant indications provides sufficient criteria for the construction of the reactor containment liner while providing adequate assurance of the structural and leak tight integrity of the reactor containment liner.

25. Discuss why you do not address the following Regulatory Guides; 1.69, 1.91, 1.94, 1.115, 1.136, 1.142, 1.143, in the FSAR. You recognize that various concrete codes were used for CPSES at different times and that certain exemptions have been taken to these codes as stated in the FSAR. However, you should clearly state as to the extent CPSES complies with current codes referenced in the SRP (e.g. ASME Section 3, Division 2 and ACI-349) and the applicable provisions of the above listed regulatory guides.

    Resp: Appendix 1A(B) discusses the CPSES position on the above Regulatory Guides.

26. In page 3.8-90 you state that "Local Section strength may be exceeded for CPSES Structural components." Specify the maximum strength the local strength capacity has been exceeded for the effective CPSES designs and basis for accepting the local section strength exceedances.

    Resp: The above criteria that, "local section strength capacities may be exceeded under these concentrated loads provided there will be no loss of function on any safety-related system," is assured by using the ductility acceptance criteria specified in Section 3.5.3.2 (note, this is identified on FSAR page 3.8-88).

    To provide additional clarification, Sections 3.8.3.5.7 and 3.8.4.5.3, on pages 3.8-103 and 3.8-123 respectively, will be amended to reference the ductility limits in Section 3.5.3.2 as the criteria for assuring that functional requirements are not impaired.

27. In evaluation 3.8-068-3.8.2 it is implied that the structural material list is not complete and that the engineer may approve the use of equivalent materials. State if this practice applies for any major and miscellaneous structure components or just minor non-safety related components. Discuss how this approach would guarantee adherence to the design requirements of the design codes, SRPs, Regulatory Guides, and other applicable standards.

    Resp: The material lists in the applicable specifications would provide complete identification. A complete listing was not provided in the FSAR due to the large number of unique materials involved. Engineering approval of equivalent material is obtained and documented in accordance with project procedures and specifications, which guarantees adherence to the applicable design requirements. In Section 3.8.3.6.4 the phrase, "...when specified by the engineers on design documentation," will be changed to, "...as specified by project specifications/design drawings."

28. In evaluation 3.8-078-3.8.3, you state that the PCI acceptance criteria can be used for brackets and corbels designed in place and the ACI 318-71 acceptance criteria. The FSAR requires adherence to the ACI requirements, therefore, provide a comparison of the applicable requirements and a discussion of the acceptability of the PCI criteria. Specific examples need to be discussed in you submittal.

    Resp: The FSAR was amended to allow the PCI 1978 criteria for the design of corbels, because the ACI 318-71 criteria does not provide specific guidance on choosing a minimum effective d distance. The ACI only provides the method to determine the maximum d distance. The corbel affected by this change supports the crane rail in the Fuel Building at elevation 831. The corbel also meets the ACI minimum reinforcement requirements when the d distance based on strength requirements is used. Based on strength this corbel design meets both the ACI 318-71 and PCI 1978 criteria. The corbel meets the PCI criteria (but not ACI) for minimum reinforcement based on gross cross-section dimensions.

    ACI 318-71 Section 11.14.1 requires that the maximum effective d distance (d_e) not exceed "twice the depth of the corbel or bracket at the outside edge of the bearing area." However, no limit is specified on the minimum effective d distance (d_e).

    The FSAR will be revised to state that the PCI criteria applies only for the fuel building crane corbel supports at elevation 831.

29. Identify the missing information between Section 3.8.5.3.3 and 3.8.5.4.3 or address why this information has been deleted.

    Resp: The missing information was deleted due to an administrative error. The missing text will be reinserted.

BACKGROUND INFORMATION FOR RAI # 9,
MARK-UP OF AMENDMENT 61 CHANGE

The seismic response loads obtained by either the modal response analysis or equivalent static load method are combined with all other external loads such as operating loads, hydrodynamic loads,
20 and piping interaction loads for design purposes. Non-linear responses of subsystems are considered on an individual basis where such phenomena are identified as existing, and are accounted for by analysis. Such an analysis was performed to account for the predetermined support clearance tolerances of the Service Water Intake Structure pumps.

For further details on seismic analysis methods, see Section 3.7B.2.1.

3.7B.3.2 <u>Determination of Number of Earthquake Cycles</u>

The product of maximum dominant natural frequency, which governs the maximum response, and the established duration of strong shaking yields the number of maximum amplitude loading cycles. These loading cycles include a portion of residual vibration of lightly damped structures, systems, and equipment that arises from continuous oscillations after the strong motion terminates.

The number of maximum amplitude loading cycles so determined is specified for seismic Category I structures, systems, and components as
20 a minimum of 600 loading cycles for the OBE, and 120 loading cycles for the SSE.

Insert 1

3.7B.3.3 <u>Procedure Used for Modeling</u>

The dynamic analysis of any complex system requires the discretization of its mass and elastic properties. This is accomplished by concentrating the mass of the system at distinct characteristic points
20 or nodes, and interconnecting them by a network of elastic springs representing the stiffness properties of the systems, which are

BACKGROUND INFORMATION FOR RAI #9,

MARK-UP OF AMENDMENT 61 CHANGE

Insert for Page 3.7B-5Bb

For ASME Code Class 2 and 3 piping systems including supports for ASME Code Class 1, 2, and 3 piping a minimum of 50 loading cycles for the OBE and 10 loading cycles for the SSE is specified.

Structurally simple equipment and systems, which can be represented 20
either by a single degree-of-freedom model or a simple mathematical
model, and equipment and subsystems which have been found to have no
natural frequencies below 33 Hz are generally analyzed by the
equivalent static load method as described in Section 3.7B.3.5.

The seismic response loads obtained by either the modal response 20
analysis or equivalent static load method are combined with all other
external loads such as operating loads, hydrodynamic loads, and piping
interaction loads for design purposes. Non-linear responses of
subsystems are considered on an individual basis where such phenomena
are identified as existing, and are accounted for by analysis. Such
an analysis was performed to account for the predetermined support
clearance tolerances of the Service Water Intake Structure pumps.

For further details on seismic analysis methods, see Section 20
3.7B.2.1.

3.7B.3.2 Determination of Number of Earthquake Cycles

61
The number of maximum amplitude loading cycles so determined is 20
specified for seismic Category I structures, systems, and components
as a minimum of 600 loading cycles for the OBE, and 120 loading cycles
for the SSE.

For ASME Code Class 2 and 3 piping systems including supports for ASME 61
Code Class 1, 2, and 3 piping a minimum of 50 loading cycles for the
OBE and 10 loading cycles for the SSE is specified.

3.7B.3.3 Procedure Used for Modeling

The dynamic analysis of any complex system requires the discretization of its mass and elastic properties. This is accomplished by concentrating the mass of the system at distinct characteristic points

BACKGROUND INFO FOR RAI #9

4.1.2.2 Design Criteria and Methodology

The CPSES pipe stress and pipe support design criteria in CPPP-7 (Reference 30) have been developed by SWEC for the design validation of ASME Code Class 1, 2, and 3 pipe supports and ASME Code Class 2 and 3 piping systems. The controlling documents for the SWEC design validation effort are contained in Comanche Peak Project Procedures CPPP-1 through CPPP-35 (Appendix E of this supplement). The piping stress analyses and pipe support calculations will become the CPSES analyses of record and provide assurance that the structural qualification of the piping and pipe supports within the CAP scope are in accordance with CPSES licensing commitments and the applicable requirements of the ASME Boiler and Pressure Vessel Code (References 27 and 28). The following sections discuss the staff review and evaluation of the CPSES design criteria and analytical methodologies used in the piping and pipe support design validation.

Review of Final Safety Analysis Report Amendment 61

In Amendment 61 (Reference 31) to the CPSES Final Safety Analysis Report (FSAR) (Reference 32), the applicant provided the changes made to the FSAR piping design criteria as a result of the CAP design validation effort. As a result of its review of the FSAR Amendment 61 changes, the staff concludes that the changes do not significantly alter the staff findings in the previous CPSES SER and supplements (Reference 11) except in the areas related to (1) the combination of loss-of-coolant accident (LOCA) and safe-shutdown earthquake (SSE) loads (Section 3.9.2.3 of the SER) and (2) the piping system damping values (Section 3.7.1 of the SER).

The staff evaluated the combination of LOCA and SSE loads for reactor coolant system heavy component supports in its safety evaluation provided in a letter from C. I. Grimes (NRC) to W. Counsil (TU Electric) dated June 8, 1987 (Reference 33), in conjunction with the implementation of the final rule on the modification of 10 CFR 50, Appendix A, General Design Criterion 4 requirements for protection against the dynamic effects of postulated pipe ruptures (51 Federal Register 12505, dated April 11, 1986). Similarly, the staff found that the use of revised damping values per ASME Code Case N-411 (Reference 34) was acceptable for CPSES as discussed in a letter from V. Noonan (NRC) to W. Counsil (TU Electric) dated March 13, 1986 (Reference 35).

The staff also reviewed the technical acceptability of the FSAR Amendment 61 changes and the use of later ASME Code provisions as permitted in paragraph NA-1140(f) of the ASME Code, Section III (Reference 27). The staff's review of the use of later ASME Code provisions focused primarily on the technical justifications provided in the applicant's report entitled, "Documentation of ASME III NA-1140 Review for Piping and Supports," Revision 2, dated September 30, 1987 (NA-1140 report). This report documented the applicant's review performed to ensure that the use of design criteria in CPPP-7 is in conformance with paragraph NA-1140(f) of the ASME Code and, in particular, that all related ASME Code requirements are met. The code of record for CPSES piping is ASME Code, Section III, 1974 Edition, including Summer 1974 Addenda Subsections NC/ND (Reference 27). The code of record for CPSES pipe supports is the 1974 Edition including Winter 1974 Addenda Subsection NF (Reference 28). On the basis of its review of the NA-1140 report, the staff finds that all related requirements associated with the use of specific provisions of a Code edition or addenda were met and thus, the use of later Code provisions as specified in the NA-1140 report is acceptable. The specific provisions from later Code editions and addenda reviewed and approved by the staff for CPSES are listed below:

(1) 1977 EDITION - WINTER 1978 ADDENDA

Appendix O - Rules for Design of Safety Valve Installations

(2) 1983 EDITION

NC-3658.2 - Standard Flange Joints at Moderate Pressures and Temperatures

NC-3658.3 - ANSI B16.5, Flanged Joints with High-Strength Bolting

ND-3658.2 - Standard Flange Joints at Moderate Pressures and Temperatures

ND-3658.3 - ANSI B16.5, Flanged Joints with High-Strength Bolting

(3) 1983 EDITION - WINTER 1984 ADDENDA

Figure NC-3673.2(b)-1 - Flexibility and Stress Intensification Factors (Do/tm less than or equal to 100) (Branch Connections, Buttwelds, and Fillet Welds)

Figure NC-3673.2(b)-2 - Branch Dimensions

Figure ND-3673.2(b)-1 - Flexibility and Stress Intensification Factors (Do/tm less than or equal to 100) (Branch Connections, Buttwelds, and Fillet Welds)

Figure ND-3673.2(b)-2 - Branch Dimensions

(4) 1977 EDITION - WINTER 1978 ADDENDA

XVII-2211 - Stress in Tension

Figure XVII-2111(c)-1 - Illustrations of Maximum Design Stress in Through Thickness Direction of Plates and Elements of Rolled Shapes (Figure Deleted)

NF-3226 - Through Plate Thickness Tensile Limit

Figure NF-3226.5-1 - Illustrations of Maximum Design Stress in Through Thickness Direction of Plates and Elements of Rolled Shapes (Figure Deleted)

NF-3321.1 - Design Conditions

BACKGROUND INFO FOR RAI # 9

(5) 1977 EDITION - WINTER 1979 ADDENDA

NF-3391.1 - Allowable Stress Limits (Class 2 and MC Plate/Shell)

NF-3392.1 - Allowable Stress Limits (Class 2 and MC Linear)

(6) 1980 EDITION

NF-1133 - Intervening Elements in Relation to Jurisdictional Boundaries

NF-1131.6 - Portion F

(7) 1980 EDITION

XVII-2462 - Minimum Edge Distance

(8) 1983 EDITION - SUMMER 1983 ADDENDA

NF-3225 - Design of Bolting

NF-3324.6 - Design Requirements for Bolted Joints

(9) 1983 EDITION - SUMMER 1985 ADDENDA

NF-4721 - Bolt Holes

(10) 1974 EDITION - WINTER 1975 ADDENDA

NC-6221 - Minimum Required Hydrostatic Test Pressure

(11) 1974 EDITION - WINTER 1975 ADDENDA

XVII-2410 - General Requirements (for the Design of Connections and Joints

(12) 1980 EDITION - WINTER 1982 ADDENDA

NF-3324.5 - Design Requirements for Welds

(13) 1974 EDITION - SUMMER 1975 ADDENDA

NB-3630(d) - Exemptions for Class 1 Piping

It should be noted that 10 CFR 50.55a "Codes and Standards," currently references the ASME Code, Section III, Division 1 up to the 1983 Edition including the Summer 1984 Addenda. Although the portion of 10 CFR 50.55a pertaining to ASME Code Class 2 and 3 piping is not directly applicable to CPSES, it does provide the staff position regarding the latest Code edition and addenda found suitable for use. Several provisions listed above from later Code addenda (i.e., Winter 1984 Addenda and Summer 1985 Addenda) are not referenced currently in 10 CFR 50.55a. A final rule has been developed to update 10 CFR 50.55a to incorporate by reference the Winter 1984 Addenda, Summer 1985 Addenda, Winter 1985 Addenda, and 1986 Edition of Section III, Division 1 and its issuance is awaiting final staff approval. Thus, contingent upon final acceptance of those Code editions and addenda for which final staff approval is pending, the staff finds the use of the above listed Code provision to be acceptable for CPSES.

The staff's findings as a result of its review of the FSAR changes in Amendment 61 related to the design of piping and pipe supports are given below.

In FSAR Section 3.7B.3.1, an analytical technique, developed in accordance with NUREG/CR-1161, "Recommended Revisions to Nuclear Regulatory Commission Seismic Design Criteria," May 1980 (Reference 36), is used by SWEC for piping systems to account for the modal contribution above the cutoff frequency. The NUREG/CR-1161 methodology ensures participation of high frequency seismic responses in the zero period acceleration region of the seismic response spectra and is thus acceptable.

In FSAR Section 3.7B.3.2, the maximum amplitude loading cycles for an operating basis earthquake have been revised from 600 cycles to 50 cycles and for a safe shutdown earthquake from 120 cycles to 10 cycles. The number of cycles specified by this change is applicable to ASME Code Class 2 and 3 piping systems. The revised number of earthquake cycles is in conformance with the acceptance criteria in Section 3.9.2 of the NRC Standard Review Plan (Reference 37) and is thus acceptable.

In FSAR Section 3.9B.1.1.1, the SSE has been removed from the emergency conditions (but remains in the faulted condition). This change is applicable to ASME Code Class 2 and 3 piping systems and Class 1, 2, and 3 pipe supports. The FSAR change as such is in conformance with the service conditions specified in Appendix A to Section 3.9.3 of the NRC Standard Review Plan (Reference 37) and is thus acceptable.

In FSAR Section 3.9B.3.1.1, Amendment 61 changed the combination of peak dynamic responses from the absolute-sum method to the square-root-of-the-sum-of-the-squares (SRSS) method. The SRSS method for combining dynamic responses is consistent with the guidelines of NUREG-0484, "Methodology for Combining Dynamic Responses," Revision 1 dated May 1980, (Reference 38) and is thus acceptable.

In FSAR Section 3.9B.3.1.2, the applicant has established stress limits in addition to those established by the ASME Boiler and Pressure Vessel Code (Reference 27) to ensure that during and after a design basis accident condition, essential piping systems will maintain their capability to deliver the rated flow and retain their dimensional stability. These stress limits used to ensure the piping functional capability are in accordance with the General Electric Company topical report, "Functional Capability Criteria for Essential Mark II Piping," NEDO-21985 dated September 1978 (Reference 39), which has been approved by the NRC staff for all nuclear facilities. As an alternative criteria for stainless steel elbows and bends, the applicant will continue to use the stress limits for functional capability that had been approved for CPSES in Sections 3.9.3.1 of Supplements 1 and 3 (Reference 11). The criteria used to ensure piping functional capability are thus acceptable.

BACKGROUND INFO FOR RAI # 17C

3. Evaluation of Effect of Variations in Assumptions and Materials

The fact that reinforced concrete is not a homogeneous material is accounted for in the design; stiffness properties are altered where the section is assumed to crack. ~~The analysis of the nonhomogeneous material considers the effects of varying degrees of cracking (maximum and minimum cracked state).~~ Properties of materials are known with sufficient accuracy, and assumptions made are sufficiently conservative so that other variations need not be considered.

4. Temperature Effects

The temperature gradient through the containment wall during operation is essentially linear and is a function of the internal operating temperature and the average external ambient temperature. The accident temperature primarily affects the liner, rather than the concrete and reinforcing steel, due to insulating properties of the concrete. By the time the temperature of the concrete within the interior of the concrete shell begins to rise significantly, the internal accident pressure within the Containment has fallen off to a point below the peak values. Therefore, it is not necessary to consider peak accident temperature in the concrete coincident with peak pressures in the Containment. (The thrust caused by the instantaneously hot liner against the reinforced concrete wall is considered simultaneously with the peak pressure.) Also, temperature stresses of the reinforcing steel in the Containment shell caused by the maximum thermal gradient do not significantly influence the capacity of the structure to resist membrane forces. Temperature gradients induce stresses in the structure which are internal in nature, causing tension on one face and compression on the other face; the resultant membrane force is and mode shapes where n equals the number of dynamic degrees of freedom of the system. The mode shapes are all orthogonal to each other and are sometimes referred to as normal mode vibrations. For a single degree of freedom system, the stiffness matrix and mass matrix are single terms and the determinant $\left|[K] - \omega^2 [M]\right|$ when set equal to zero yields simply:

$$k - \omega^2 m = 0$$

or:

$$\omega = \sqrt{\frac{k}{m}} \qquad (3.7N\text{-}9)$$

where ω is the natural angular frequency in radians per second.

The natural frequency in cycles per second is therefore:

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} \qquad (3.7N\text{-}10)$$

To find the mode shapes, the natural frequency corresponding to a particular mode, ω_n, can be substituted in Equation (3.7N-8).

Modal Equations

The response of a structure or component is always some combination of its normal modes. Good accuracy can usually be obtained by using only the first few modes of vibration. In the normal mode method, the mode shapes are used as principal coordinates to reduce the equations of motion to a set of uncoupled differential equations that describe the motion of each mode n. These equations may be written as (Reference [4], pages 116 through 125):

$$\ddot{A}_n + 2\omega_n p_n \dot{A}_n + \omega_n^2 A_n = - \Gamma_n \ddot{y}_s \qquad (3.7N\text{-}11)$$

where the modal displacement or rotation, A_n, is related to the displacement or rotation of mass point r in mode n, u_{rn}, by the equation:

$$u_{rn} = A_n \phi_{rn} \qquad (3.7N\text{-}12)$$

where

ϕ_{rn} = the modal displacement for mode n at mass point r | DRAFT

ω_n = natural frequency of mode n in radians per second

p_n = critical damping ratio of mode n

Γ_n = modal participation factor of mode n given by:

$$\Gamma_n = \frac{\sum^n m_r \phi'_{rn}}{\sum^n m_r \phi^2_{rn}} \qquad (3.7N\text{-}13)$$

where

ϕ'_{rn} = value of ϕ_{rn} in the direction of the earthquake

The essence of the modal analysis lies in the fact that Equation (3.7N-11) is analogous to the equation of motion for a single degree of freedom system that will be developed from Equation (3.7N-4). Dividing Equation (3.7N-4) by m gives:

$$\ddot{u} + \frac{c}{m}\dot{u} + \frac{k}{m}u = -\ddot{y}_s \qquad (3.7N\text{-}14)$$

The critical damping ratio of a single degree of freedom system, p, is defined by the equation:

$$p \equiv \frac{c}{cc} \qquad (3.7N\text{-}15)$$

The value of β is chosen equal to 1/3 in order to provide a margin of numerical stability for nonlinear problems. Since the numerical stability of Equation (3.7N-24) is mostly determined by the left hand side terms of that equation, the right hand side terms were replaced by F_{n+2}. Furthermore, since the time increment may vary between two successive time substeps, Equation (3.7N-24) may be modified as follows:

$$\frac{2}{(\Delta t + \Delta t_1)} [M] \left\{ \frac{x_{n+2} - x_{n+1}}{\Delta t} - \frac{x_{n+1} - x_n}{\Delta t_1} \right\} + \frac{1}{(\Delta t + \Delta t_1)} [C] \left\{ x_{n+2} - x_n \right\}$$

$$+ \frac{1}{3} [K] \{x_{n+2} + x_{n+1} + x_n\} = \{F_{n+2}\} \qquad (3.7N-25)$$

By factoring x_{n+2}, x_{n+1}, and x, and rearranging terms, Equation (3.7N-26) is obtained as follows:

$$\{C_5 [M] + C_3 [C] + (1/3) [K]\} \{x_{n+2}\} = \{F_{n+2}\}$$

$$+ \{C_7 [M] - (1/3) [K]\} \{x_{n+1}\}$$

$$+ \{-C_2 [M] + C_3 [C] - (1/3) K\} \{x_n\} \qquad (3.7N-26)$$

where

$$C_2 = \frac{2}{\Delta t_1 (\Delta t + \Delta t_1)}$$

$$C_3 = \frac{1}{\Delta t + \Delta t_1}$$

$$C_5 = \frac{2}{\Delta t (\Delta t + \Delta t_1)}$$

$$C_7 = C_2 + C_5$$

structural damping. Because the design response spectra have been developed from a large number of real records, following the procedures recommended by Newmark, the effect of strong motion duration and distance of focal depth are included [29].

There are, of course, general associations between duration of strong motion and the size of an event. Longer durations of strong motion are expected with greater-sized earthquakes. Higher frequency accelerations are attenuated with greater distance from the epicenter of the earthquake. These conditions are inherent in the strong motion records which are the source of Newmark's work. In no case are the amplification factors less than one.

3.7B.1.2 Design Time History

DRAFT One horizontal and one vertical SSE artificial time history have been developed for the design response spectra requirements presented in this section and Section 3.7B.1.1.

As an alternative to a site-dependent analysis, these artificial time history records are suitable for use as base excitations for the dynamic structural analysis.

The mathematical procedures used to generate these artificial time history records can be briefly summarized as follows:

1. The spectral characteristics of the selected site SSE design response spectra are extracted to construct a frequency response function with proper phase factor modification.

2. A fast Fourier transform of the frequency response function is performed to obtain a filter impulse response function.

3. The filter impulse response function is then integrated with a set of pseudorandom numbers to obtain an artificial time history record.

4. A comparison is made between the response spectrum derived from the artificial time history and the site SSE design response spectrum. Any unacceptable deviations are corrected by adding a series of sinusoidal impulses with proper amplitude and phase angles until the desirable fit is achieved.

Q130.6
Q130.7

5. The artificial time history records meet the minimum acceptance criteria given by Table 3.7.1-1 in Section 3.7.1 of the Standard Review Plan. 68

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The response spectra derived from the horizontal artificial time history record and the selected site SSE design response spectra are presented in Figures 3.7B-2 through 3.7B-6, for five structural damping values. The corresponding artificial time history is presented in Figure 3.7B-14. The response spectra from the vertical artificial time history record and the SSE design response spectra are presented on Figures 3.7B-8 through 3.7B-12, and the corresponding artificial time history is presented on Figure 3.7B-19. DRAFT 68

Time history durations of approximately 10 sec have been found necessary to allow the modifications of the time histories to match response spectra values at periods of three to four sec. A 10 sec record allows two to three cycles for modification by sinusoidal impulses. A record length of 10.24 sec is obtained because the fast Fourier transform used for this purpose operates on sets of numbers which are as powers to time; i.e., 1024 is equal to two raised to the tenth power.

The artificial time history records are generated at 0.01 sec equal time intervals with a time duration of 10.24 sec. They are in the digitized form of 1024 acceleration values.

and the idealization of structure with lumped masses and elastic properties in discrete parts, parametric studies are performed in order to take into account these effects for the construction of instructure response spectra. These effects result in the shifting of the resonance peaks of the instructure response spectra. The peaks are widened by at least ±10 percent of the resonance frequencies to account for these effects. The widening exceeds ±10 percent if the parametric studies indicate that such widening is necessary to achieve conservative results. The ground design response spectra and design time history are discussed in Section 3.7B.1.1 and 3.7B.1.2 respectively. Parametric studies and spectra widening are discussed in Subsection 3.7B.2.9. DRAFT 68

The preceding analyses are accomplished by using suitable computer programs as presented in Section 3.7B(A) and in accordance with References [30], [31], [36], and [38].

3.7B.2.1.3 Testing and Analysis for Equipment

Seismic Category I equipment, equipment supports, and components are designed to ensure functional operability during and after an earthquake of magnitude up to and including the SSE (refer to Section 3.2 for the list of seismic Category I mechanical and electrical equipment). The capability of all seismic Category I electrical and mechanical equipment and equipment supports to satisfy this requirement is verified by testing or analysis, or both.

1. Seismic testing for equipment operability conforms to the following:

   a. A test required to confirm the functional operability of seismic Category I electrical and mechanical equipment and instrumentation during and after an earthquake of magnitude up to and including the SSE is performed. Analysis without testing may be performed only if structural integrity alone can ensure the design intended function. When a complete seismic testing is impracticable, a combination of test and analysis is performed.

   b. The characteristics of the required input motion are specified by one of the following:

      1) Response spectrum

DRAFT

      2) Time history

      Such characteristics, as derived from the structures or systems seismic analysis, are representative of the input motion at the equipment mounting locations.

   c. Where practicable, equipment which is required to function during and/or after an earthquake is tested in the operational condition. Operability is verified during and/or after the testing.

   d. The actual input motion is characterized in the same manner as the required input motion and the conservatism in amplitude and frequency content is demonstrated. The frequency spectrum covers the range from 1 through 33 Hz.

Subsection 3.7B.2.5. The analysis of these subsystems or components follows the same considerations as those described in Subsection 3.7B.2.1 for seismic Category I structures. The vertical analysis is combined with both horizontals, according to the statement in Subsection 3.7B.2.1.2, to produce basic dynamic loading conditions.

2. The same multimass lumped parameter model is subjected to a stress analysis due to differential displacements of the support points. The displacements used are consistent with the directions of structural excitation being considered in the spectrum analysis. This results in basic differential displacement loading conditions.

3. The results obtained from the spectrum analysis and differential displacement analysis are then combined directly. The effects of these loading conditions on the components and the supporting structures are determined.

3.7B.2.1.5 Stress and Deformation Criteria

The ground design response spectra and design time history are discussed in Section 3.7B.1.1 and 3.7B.1.2 respectively. DRAFT

Primary steady-state stresses including the effects of the normal operating loads plus the OBE loads are maintained well within the elastic limit of the material affected.

Incidentally, this value and the values obtained for the ratios of the depth to the length of embedment less than one are in close agreement with the values obtained on the basis of the approach to the problem for cohesive soils as presented in References [39] and [40]. These values also compare well for practical purposes with the ones obtained using formulation presented in Reference [7].

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For the dynamic analysis of seismic Category I structures which have relatively shallow depths of embedment (such as the Safeguards, Electrical and Auxiliary, and Fuel buildings), the effect of embedment on rotational foundation rigidities (torsion and rocking) is negligible. The Service Water Intake Structure (SWIS), which has a greater depth of embedment, is analyzed by including the effects of embedment according to procedures recommended in References 42, 43, 44 and 45. The Service Water Intake Structure is basically socketed into rock with soil backfill on three sides above the top of rock. The embedment effects were calculated for all rock and then for all soil above the founding levels and an average effect representative of the actual soil/rock profile was selected.

3.7B.2.5 Development of Floor Response Spectra

The methods of seismic analysis are covered in Subsection 3.7B.2.1. The response spectrum method for the development of instructure response spectra is not used.

Instructure response spectra at selected locations of interest are developed on the basis of computed responses to an artificial time history input of ground motion. The time history of the simulated earthquake ground motion is developed to be compatible to the given ground response spectra. Having established the time history of the ground motion, the lumped mass mathematical models of seismic Category I structures are analyzed and time histories at desired masses lumped at floor levels or any other location of interest are generated. Once the time history of the floor motion is obtained, the next step consists of subjecting a single degree-of-freedom system with the

DRAFT Typical response spectra for floor elevation 852.5 ft. of the
Safeguards Building and corresponding to 2-percent equipment damping
and SSE excitations are shown on Figure 3.7B-50A. Curves Ax, Ay, and
44 Az represent the spectra in the X, Y, and Z directions for the
combined effect of the three simultaneous earthquakes. The coupling
DRAFT effects of the nonsymmetric structure are included. These design
spectra were generated and peak broadened by computer and are
therefore labelled refined. Some other design spectra were generated
by computer but not peak broadened by computer and therefore have
extra conservatism due to the hand smoothing technique.

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For certain special subsystems such as the RCL subsystem, response spectra at the exact locations of the subsystems considered (e.g., at the steam generator support or the reactor nozzle) are developed as follows: Floor time histories for the three translational and three rotational degrees-of-freedom and for each earthquake excitation (SSE and OBE) are derived at the nodes corresponding to the floors which contain the selected locations. Response spectra are developed at these nodes by subjecting a single-degree-of-freedom system with the natural frequency range of interest and various damping ratios to the floor time history motions obtained. The response spectra at the selected points are then developed by rigid body transformations.

Figures 3.7B-51, 3.7B-52, and 3.7B-53 represent the response spectra of translational accelerations in three orthogonal directions at the location of the outermost support of the steam generator for two percent equipment damping and for SSE excitations in X, Y, and Z directions, respectively.

3.7B.2.6 <u>Three Components of Earthquake Motion</u>

The three orthogonal components of the design earthquake motion are assumed to act simultaneously. The combined responses (shears, 3.7B.2.8 Interaction of Non-Category I Structures with Seismic Category I Structures

A number of structures such as the Turbine Building, the Switchgear Buildings, the Circulating Water Intake and Discharge Structures, the Maintenance Building, and the Administration Building are designated as non-Category I.

The only non-Category I structures which are adjacent to any seismic Category I structure are the Turbine Building and the Switchgear Buildings. These structures do not share a common mat with the adjacent seismic Category I structure, and all structures are founded on firm rock. Therefore, there is no possible interaction of non-Category I structures with seismic Category I structures resulting from seismic motion. Sufficient space is provided between the Turbine and Switchgear Buildings and the adjacent seismic Category I structure so as to prevent contact because of deformations occurring in the structures during a seismic event.

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The possibility of structural failure during a seismic event is considered for the Turbine Building. Structural failure in the direction of the adjacent seismic Category I structure is prevented by the combination of the horizontal bracing internal to the steel frame and the bearing of the mezzanine and operating floor slabs on the concrete turbine generator pedestal. The Switchgear Buildings are design to withstand a seismic event equal to the SSE.

54 Non-Category I equipment and components located in seismic Category I buildings are investigated by analysis or testing, or both, to ensure that under the prescribed earthquake loading, structural integrity is maintained, or the non-Category I equipment and components do not adversely affect the integrity or operability, or both, of any

68 The enveloping technique used for the construction of instructure response spectra consists of enveloping the maximum peaks. Since the frequencies of the structures can only be computed approximately because of the linear and nonlinear deformability, the energy dissipation, variation in elastic properties of both structure and foundation, and the idealization of structure with lumped masses and elastic properties in discrete parts, parametric studies are performed in order to take into account these effects for the construction of instructure response spectra. These effects result in the shifting
DRAFT of the resonance peaks of the instructure response spectra. The peaks are widened by at least ±10 percent of the resonance frequencies to account for these effects. The widening exceeds ±10 percent if the parametric studies indicate that such widening is necessary to achieve conservative results. The ground design response spectra and design time history are discussed in Section 3.7B.1.1 and 3.7B.1.2 respectively.

68 The preceding analysis are accomplished by using suitable computer programs as presented in Section 3.7B(A) and in accordance with References [30], [31], [36], and [38].

3.7B.2.10 Use of Constant Vertical Static Factors

Constant static factors such as vertical response loads for the seismic design of seismic Category I structures, systems, and components are not used. Instead, multimass dynamic analysis for both horizontal and vertical directions of excitation is performed as described in Subsection 3.7B.2.1.

20 When all of the points of fixity are located on a single structure, the rigid body motions of the structure, translation and rotation, do not result in relative motion of the points of fixity. Since the third category of displacement, deformation of the structure, represents a small portion of the total displacement profile, the effects of this displacement on the points of fixity are neglected.

For piping passing between buildings or equipment mounted on individual structures or foundations (such as big tanks), the relative displacement of support points located in different structures is considered in piping stress analysis.

20 Maximum relative displacements in two horizontal and the vertical direction between piping supports and anchor points between buildings are used as equivalent static displacement boundary conditions in order to calculate the secondary stresses of the piping system. Relative seismic displacements used are obtained from a dynamic analysis of the structures, and are always considered to be out-of-phase between different buildings and the equipment if applicable to obtain the most conservative piping responses.

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3.7B.3.8.2 Basis for Computing Combined Responses

61 For the seismic design of piping, the horizontal and vertical loadings are obtained from the instructure response spectra that have been generated for the appropriate structures and elevations as outlined in Subsection 3.7B.2.1.2, and References [30], [31], and [36].

DRAFT The combined effect of the three components of earthquake motion on the seismic design of piping is determined by the SRSS method (section 3.7B.2.6). The maximum modal responses are combined by the methods of NRC Regulatory Guide 1.92, Revision 1. The methods presented in Regulatory Guide paragraphs 1.1, 1.2.1, 1.2.2 or 1.2.3 are acceptable methods for vendor qualification.

38. Stoykovich, M., Seismic Design and Analysis of Nuclear Plant Components, American Society of Civil Engineers Proceedings-Specialty Conference on Structural Design of Nuclear Plant Facilities, Chicago, Illinois, December 17-18, 1973, vol. I, pp. 1-28.

39. Pauw, A., 1953, A Dynamic Analogy for Foundation - Soil Systems, Symposium-Dynamic Testing of Soils, American Society for Testing and Materials Special Technical Publication no.156.

40. Leonards, G.A., ed., 1962, Foundation Engineering, McGraw-Hill Book Company, Inc., New York.

61 41. U.S. Nuclear Regulatory Commission, NUREG/CR-1161, Recommended Revision to Nuclear Regulatory Commission Seismic Design Criteria, December 1979.

DRAFT 42. Johnson, G. R., et al., "Stiffness Coefficients for Embedded Footings," ASCE Journal of the Geotechnical Engineering Division, 1975, GTS, pp. 789-800.

DRAFT 43. Analyses for Soil-Structure Interaction Effects for Nuclear Power Plants, ASCE Publication, 1979, p. 155.

DRAFT 44. Elsabee, F., et al., "Dynamic Stiffness of Embedded Foundations," in Advances in Civil Engineering Through Engineering Mechanics, ASCE Publication, 1977, pp. 40-43.

DRAFT 45. Kaldjian, M. J., "Torsional Stiffness of Embedded Footings," ASCE Journal of the Soil Mechanics and Fondations Division, 1971, SM7, pp. 969-980.

3.8.1.3 Loads and Load Combinations

3.8.1.3.1 Loads

The following loads are considered in the design of the steel-lined, reinforced concrete Containment structure (essentially in accordance with the ASME-ACI 359 document):

1. D - dead load of the Containment, and all superimposed permanent loads

2. L - live loads, comprising conventional floor and roof live loads, movable equipment loads, cables, and lateral soil pressure

3. Pa - Containment pressure load due to the DBA, at 50 psig

4. T - thermal effects

   a. To - thermal loads during normal operating conditions, including liner expansion and temperature gradients in the wall

      1) Normal operating temperature range inside the Containment is 50°F to 120°F. | DRAFT

      2) Ambient temperature range at the outside face of the Containment wall is 20°F to 110°F. | DRAFT

   b. Ta - added thermal loads (over and above operating thermal loads), exerted by the liner, which may occur during an accident and which correspond to the factored accident pressure (i.e., 1.0 Pa, 1.25 Pa, or 1.5 Pa); the accident temperature causes an almost instantaneous increase in the liner temperature, with little initial

3.8.3.5.7 Missile Load and Pipe Break Criteria at Local Areas

When subjected to impact loads by missiles and forces caused by a pipe rupture localized yielding is permitted when it is demonstrated that the deflections or deformations of the structures and supports are within the ductility limits (Section 3.5.3.2) necessary to ensure that functional requirements are not impaired. DRAFT

3.8.3.5.8 Criteria for Reactor Coolant System Supports

The stress criteria for the RCS supports are presented in Section 3 9N.1.4.8.

3.8.3.6 <u>Materials, Quality Control, and Special Construction Techniques</u>

3.8.3.6.1 Concrete

1. Materials

    a. Cement is in conformance with the requirements of ASTM C 150-74, Specification for Portland Cement, Type II.

    b. Aggregates are in conformance with the requirements of ASTM C 33-74, Specification for Concrete Aggregates.

    c. Mixing water is potable or nonpotable, but is clean and free from injurious amounts of oils, acids, alkalis, salts, and organic materials or other substances which are deleterious to concrete or steel. Tests are in accordance with the requirements of CC-2223 of the ASME-ACI 359 document.

3.8.3.6.3 Mechanical Butt Splices (Cadwelds)

Refer to Subsection 3.8.1.6.3 and to Appendix 1 A (B).

3.8.3.6.4 Structural and Miscellaneous Steel

1. Materials

   Listed below are specifications for structural and miscellaneous steel generally used. Other ASTM, conforming materials may be used as specified by project specifications/design drawings. | DRAFT

   ASTM A 36-74, Specification for Structural Steel

   ASTM A 537-74a, Specification for Pressure Vessel Plates, Heat Treated, Carbon-Manganese-Silicon

   ASTM A 307-74, Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners

   ASTM A 325-74, Specification for High-Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers

   ASTM A 540-70, Specification for Alloy Steel Bolting Materials for Special Applications

   ASTM A 240-74a, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Fusion Welded Unfired Pressure Vessels-Type 304 L

3.8.4.1.5 Drawings

For various details of o[illegible]r seismic Category I structures, see Figures 3.8-1 through 3.8[illegible] and Figure 3.8-16.

3.8.4.1.6 Outdoor Seismic Category I Tanks (Refueling Water Storage, Condensate Storage, and Reactor Makeup Water Storage)

The outdoor seismic Category I tanks are reinforced concrete structures, cylindrical in shape, with stainless steel liners to provide leaktightness and prevent absorption of radioactive material by the concrete (Refueling Water Storage Tank (RWST) only). The RWST is provided with a concrete trough external to the tank to collect incidental leakage. 68

<u>REFUELING WATER STORAGE AND CONDENSATE STORAGE TANKS:</u> DRAFT

Outside diameter of wall	50'-0"	DRAFT
Outside diameter of mat	53'-0"	DRAFT
Concrete wall thickness	2'-6"	DRAFT
Concrete mat thickness	5'-0"	DRAFT
Concrete roof thickness	1'-9"	DRAFT
Total height	54'-6"	DRAFT

<u>REACTOR MAKE UP WATER STORAGE TANK</u> DRAFT

Outside diameter of wall	30'-0"	DRAFT
Outside diameter of mat	33'-0"	DRAFT
Concrete wall thickness	2'-6"	DRAFT
Concrete mat thickness	4'-0"	DRAFT
Concrete roof thickness	1'-9"	DRAFT
Total height	39'-6"	DRAFT

DRAFT

The tanks are designed to withstand all credible loadings and to maintain their integrity during operation. These loadings include both normal operating loads such as structure weight, hydrostatic pressure of the contained fluid, live loads on the roof, thermal loads and environmental loads such as the 1/2 SSE, SSE, normal wind and tornados (wind, differential pressure and missiles), and hydrodynamic forces caused by seismic effects on the contained fluid in accordance with methods as shown in Reference 21.

The load combinations given in Subsection 3.8.4.3 are used for the design of the structures, using design methods and strength requirements in accordance with ACI 318-71. Flexural tensile cracking is permitted but is controlled by reinforcing steel. A minimum of 0.25 percent reinforcing steel is provided in the tank walls in both directions, vertical and hoop.

of safety is provided by ACI 318-71 in that the calculated ultimate capacity of the member is reduced by a capacity reduction factor, as indicated in Subsection 3.8.3.5.2.

The magnitude of the load factors applied to each type of load varies, depending on the factors discussed in Subsection 3.8.3.5.2.

3.8.4.5.3 Missile Load and Pipe Break Criteria at Local Areas

DRAFT | For local areas subjected to loads, such as missiles, and to forces caused by pipe rupture, localized yielding is permitted when the deflections or deformations of the structures and supports are within the (ductility) limits (Section 3.5.3.2) necessary to ensure that functional requirements are not impaired.

68 | 3.8.4.5.4 Bracket or Corbel Criteria at Local Areas

DRAFT | The fuel building crane corbel supports at elevation 831 are designed in accordance with the PCI Design Handbook Second Edition 1978. ~~For~~
68 | ~~local areas subjected to loads, such as brackets or corbels with shear friction, design of corbels based on PCI Design Handbook Second Edition 1978 is permitted when the loads on the supports or structures are within the limits necessary to ensure that functional requirements are not impaired.~~

3.8.4.6 Materials, Quality Control, and Special Construction Techniques

The materials and QC procedures used in the construction of other seismic Category I structures are as discussed in Subsection 3.8.3.6. No special construction techniques are required for these structures.

3.8.4.7 Testing and Inservice Inspection Requirements

With the exception of the stainless steel liners for the spent fuel pool and the outdoor seismic Category I tanks, no special testing of the completed structure or inservice inspection is required for

3. The base shear is transferred from the foundation to rock through bond and surface friction and is not a problem for structures founded on competent rock, such as that which exists at the Comanche Peak site.

3.8.5.3.3 Loads Transferred from Supported Components to Foundations

The load combinations considered in the determination of the total loads transferred from supported components, such as the NSSS equipment, to the foundations are the same load combinations as those described in Subsection 3.8.5.3.1. For additional discussion, see Subsection 3.8.3.4.3.

3.8.5.4 Design and Analysis Procedures

3.8.5.4.1 Foundation and Supports for Containment and Internal Structure

The analysis of the foundation mat for the Containment and internal structure is described in Subsection 3.8.1.4.1, Item 1. The output of this analysis includes the displacements, rotations, forces, shears, moments, and stresses which are used for the design of the foundation mat.

1. Determination of Rock Contact Area Under the Foundation

   For load combinations which include the overturning effects of earthquake or tornado forces, some lift-off may occur, resulting in a condition where only a portion of the foundation is in contact with the rock. The area of contact between the bottom surface of the foundation and the rock is dependent on the resultant forces applied to the entire structure, based on the load combination being considered. The rock reaction is simulated by attaching appropriate springs to the nodes on the foundation mat that are within the area of contact. The predicted amount of foundation contact area affects the results of the analysis described in Subsection 3.8.1.4.1, Item 1.

The following procedures are used to determine the contact area. Before proceeding with the analysis of the structure under a combined loading, which includes earthquake loads or tornado loads, an area of rock contact is postulated. This postulated contact area is determined by first assuming that the structure is rigid with respect to the foundation springs. Then, by considering equilibrium of the applied force and the rock-spring reactions, the postulated contact area is determined by trial and error through a systematic search process. After the analysis based on the postulated contact area is performed, the resulting contact area is checked. If the postulated and resulting contact areas are significantly different, a new postulated contact area is determined based on analysis results, and the structure is reanalyzed. The checking cycle is terminated when the postulated contact area and the resulting contact area of the same analysis converge within a tolerable limit (approximately 5 percent difference).

2. NSSS Equipment Concrete Supports

The concrete supports for the NSSS equipment are designed for all the loading combinations (listed in Subsection 3.8.3.3) which include seismic and blowdown effects. A discussion of the blowdown effects as a result of a LOCA is contained in Sections 3.6 and 3.9. The dynamic analysis under seismic loading is described in Section 3.7.

DRAFT | 21. U. S. Atomic Energy Comm., "Nuclear Reactors and Earthquakes", TID-7021, Office of Technical Service, Wash. 25, D. C. 1963
DRAFT | p. 183-195 and 367-390.

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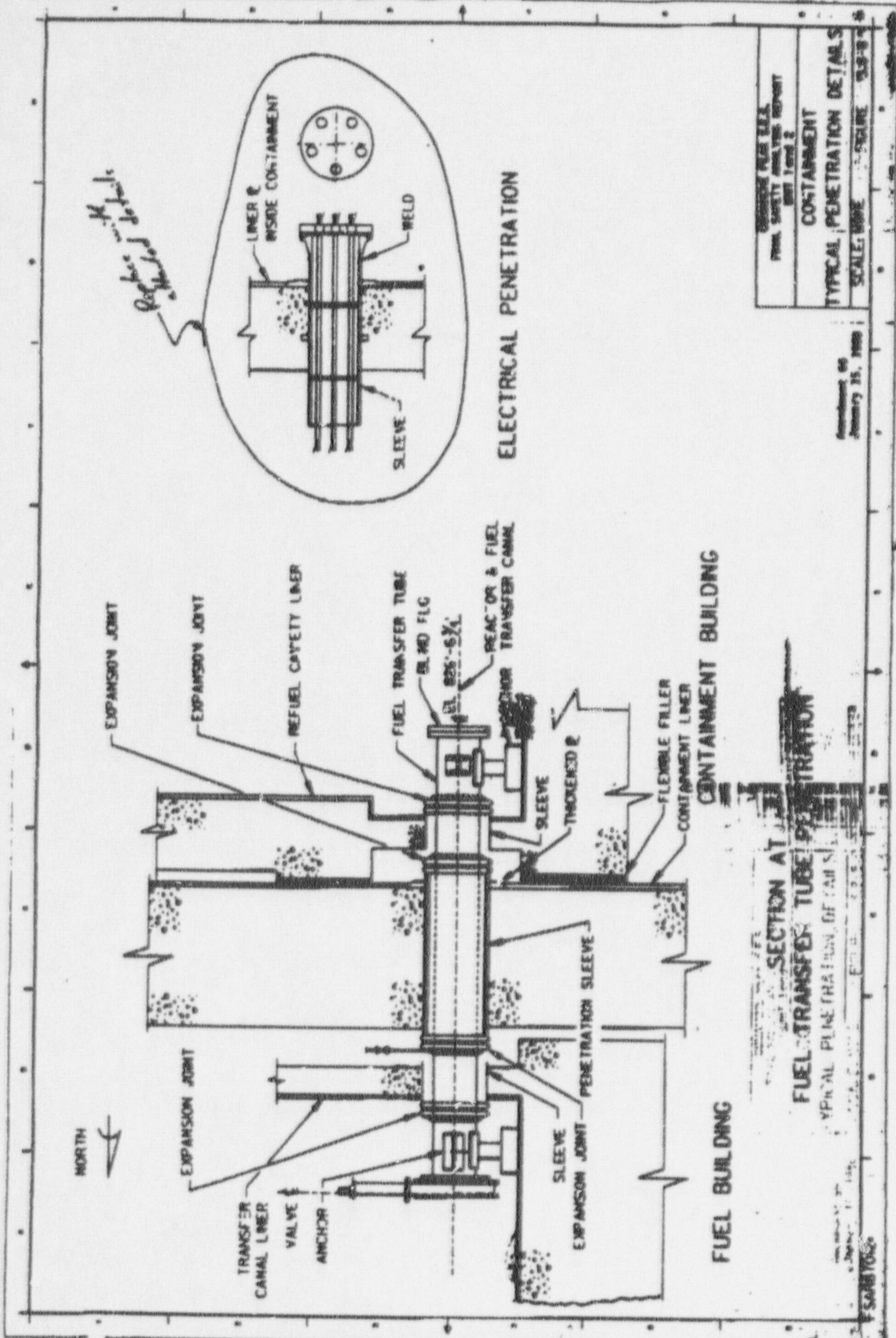

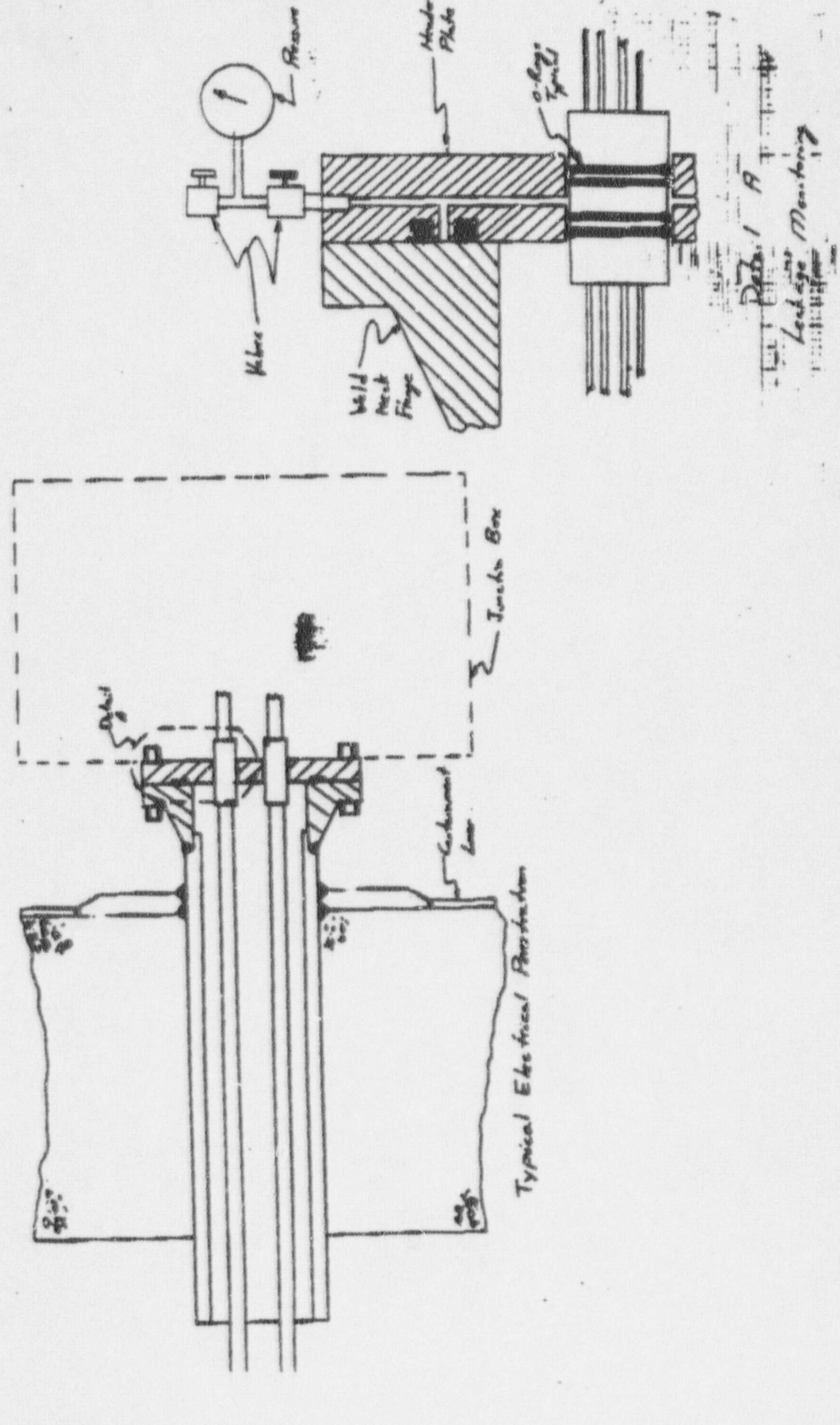
Pressure Gage
Header Plate
O-Rings Typical
Valves
Weld Neck Flange
Detail A
Leakage Monitoring
Junction Box
Containment Liner
Typical Electrical Penetration

Q130.15 Discuss in details any exception taken from the accepted requirements identified in the SRP. Note that the SRP accepts the ACI 359 code (1973) with certain exceptions as identified in the applicable section of SRP 3.8.1. Also, as applicable, expand on the deviation from the code identified in the FSAR.

R130.15 See revised Section 3.8.1.3 which indicates compliance with the requirements identified in the applicable section of SRP 3.8.1 (NUREG-75-087). DRAFT

Q130.18 The review of the load combination equations and their related acceptance criteria in this section of the FSAR shows deviations from those identified in the SRP 3.8.3. Provide detailed information and discussions related to the deviations to facilitate staff review of their technical bases for the deviations.

R130.18 We will comply with the SRP 3.8.3 (NUREG-75-087). See revised Sections 3.8.3.3 and 3.8.4.3. DRAFT

Q130.25 In your answers to Q130.15, Q130.16 and Q130.18, you changed the load combinations for the Containment Building to agree with the requirements of ACI 359 Code (1973) with certain exceptions as identified in the applicable sections of SRP 3.8.1. For the internal structures and for other Category I structures, you stated compliance with the respective requirements identified in SRP 3.8.3. and 3.8.4. In view of these changes, identify in detail how these changes in the design criteria have affected the final design of the Containment and other structures, if any. Specifically, state if they have resulted in any changes in the physical sizes of the structural components, rebar placement, properties, design stress levels, etc... DRAFT

R130.25 In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of Containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore, the identification of any changes that may have resulted prior to the CAP are not pertinent at this time. DRAFT

The Corrective Action Program for the civil/structural area was implemented to validate the design and hardware at CPSES. The various Seismic Category I structures were designed to conform to the loading combinations and their related acceptance criteria which are specified by U.S. NRC Standard Review Plans 3.8.3. and 3.8.4 (NUREG-75-087). DRAFT 68 DRAFT

DRAFT

Modifications to the design and hardware have been implemented as required. The Civil/Structural Project Status Report (PSR) describes the methods used to validate the safety-related hardware. Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

Q130.28 In your answers to Q130.15 16, 18, and 25, you stated how you considered the design and acceptance criteria identified in ACI-359 and SRP 3.8.1., 3.8.3. and 3.8.4. to validate the actual structural design of the Category I structures of the Comanche Peak NPP. In your conclusions, you stated that the actual design meets the requirements of ACI-359 and SRP 3.8.1., 3.8.3., and 3.8.4. Provide a detailed description of the specific controlling sections and components investigated in your reevaluation, including pertinent sketches and results. DRAFT

R130.28 In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of Containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore, the identification of any changes that may have resulted prior to the CAP are not pertinent at this time. DRAFT

The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The design of Seismic Category I structures conformed to the loading combinations which are specified by U.S. NRC Standard Review Plans 3.8.1., 3.8.3 and 3.8.4 (NUREG-75-087). DRAFT 68 DRAFT

The methodology and results of this validation effort are described in the Civil/Structural Project Status Report (PSR). Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

FSAR Page (as amended)	Group	Description
3.7N-10	4	Adds Greek symbol which was inadvertently omitted during the processing of Amendment 68. Editorial: Greek symbol was inadvertantly omitted during the processing of Amendment 68. FSAR Change Request Number: 89-567.1 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7N-11	4	Adds definition for Greek symbol. Editorial: Adds definition for Greek symbol. FSAR Change Request Number: 89-567.2 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7N-18	4	Adds Greek symbol which was inadvertently omitted during the processing of Amendment 68. Editorial: Greek symbol was inadvertantly omitted during the processing of Amendment 68. FSAR Change Request Number: 89-567.3 Related SER Section: 3.7.2 SER/SSER Impact: No

FSAR Page (as amended)	Group	Description
3.7B-2, 3	4	Clarifies that one earthquake was used to develop the design time history. Clarification: The original FSAR discussed the use of 5 horizontal and 5 vertical artificial time history records to envelope the design spectra for the various damping factors. Actual analyses were performed using only 1 vertical and 1 horizontal artificial time history input motion which enveloped all the design spectra for various damping factors. FSAR Change Request Number: 89-568.1 Related SER Section: 3.7.1 SER/SSER Impact: No
3.7B-11	4	Clarifies text by stating that the peaks of the floor response spectra were widened by "+/-" 10 percent. Clarification: Clarifies text by stating that the peaks of the floor response spectra were widened by "+/-" 10 percent. FSAR Change Request Number: 89-568.2 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7B-11	4	Removes discussion of ground design response spectra and design time history from Section 3.7B.2.1.2(2), as they are covered by Sections 3.7B.1.1 and 3.7B.1.2, respectively. Clarification: The ground design response spectra are discussed in Section 3.7B.1.1 and conform to the procedures developed by Newmark, Blume and Kapur. These procedures were the forerunner to Regulatory Guide 1.60 and differ from Regulatory Guide 1.60 as described in FSAR Section 3.7B.1.1. The discussion of ground design response spectra and design time history will be deleted from 3.7B.2.1.2(2) since this subject is included in 3.7B.1.1 and 3.7B.1.2 respectively. A statement will be added to section 3.7B.2.1.2(2) to reference the applicable sections. FSAR Change Request Number: 89-568.3 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7B-14	2	Deletes the power density function as a method which may be used to specify the input motion for seismic testing of equipment. Correction: The power density function has not been used at CPSES.

FSAR Page (as amended)	Group	Description
		FSAR section 3.7B.2.1.3 will be revised to delete the reference to the power density function. FSAR Change Request Number: 89-568.4 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7B-21	4	Removes the discussion of ground design response spectra and design time history from section 3.7B.2.1.5, as they are covered by sections 3.7B.1.1 and 3.7B.1.2, respectively. Clarification: The ground design response spectra are discussed in Section 3.7B.1.1 and conform to the procedures developed by Newmark, Blume and Kapur. These procedures were the forerunner to Regulatory Guide 1.60 and differ from Regulatory Guide 1.60 as described in FSAR section 3.7B.1.1. The discussion of ground design response spectra and design time history will be deleted from 3.7B.2.1.5 since this subject is included in 3.7B.1.1 and 3.7B.1.2 respectively. A statment will be added to section 3.7B.2.1.5 to reference the applicable sections. FSAR Change Request Number: 89-568.5 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7B-38	4	Revises the text to discuss how the effects of the structural backfill for the Service Water Intake Structure were accounted for in the calculation of the soil spring stiffness values. Clarification: The effects of structural backfill on the Service Water Intake Structure foundation spring stiffness values were calculated on the basis of the average embedded depth. The SWIS is basically socketed into rock with soil backfill on three sides above the top of rock. The foundation springs were calculated for a surface founded structure and then increased because of embedment effects. The embedment effects were calculated for all rock, and then for all soil, above the founding level and an average was calculated to be representative of the actual soil/rock profile. FSAR Change Request Number: 89-568.6 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7B-40	4	Provides an explanation of "refined response spectra". Clarification: Computer generated floor response spectra were labeled

FSAR Page (as amended)	Group	Description
		"Refined Response Spectra". Figure 3.7B-50A is such an example of these typical spectra curves. The Refined Response Spectra are similar to the Floor-by-Floor response spectra, except that extra conservatism due to hand smoothing has been eliminated by use of computer and curves are plotted in terms of acceleration versus frequency. FSAR Change Request Number: 89-568.7 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7B-42	2	Corrects statement describing structural failure of the Turbine Building in the direction of the adjacent Seismic Category I building. Correction: The bracing by itself will not prevent structural failure in the direction of the Seismic Category I building. The Turbine Building will bear against the turbine pedestal after the frame has translated horizontally sufficiently to close the surrounding one-inch gap (note: gap is filled with a compressible material). The combination of the horizontal bracing internal to the steel frame and the bearing of the mezzanine and operating floor slabs on the turbine generator pedestal will resist collapse of the frame. FSAR Change Request Number: 89-568.8 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7B-44	4	Removes the discussion of ground design response spectra and design time history from 3.7B.2.9, as they are covered by sections 3.7B.1.1 and 3.7B.1.2, respectively. Clarification: The ground design response spectra are discussed in section 3.7B.1.1 and conform to the procedures developed by Newmark, Blume and Kapur. These procedures were the forerunner to Regulatory Guide 1.60 and differ from Regulatory Guide 1.60 as described in FSAR section 3.7B.1.1. The discussion of ground design response spectra and design time history will be deleted from section 3.7B.2.9 since this subject is included in sections 3.7B.1.1 and 3.7B.1.2 respectively. A statement will be added to section 3.7B.2.9 to reference the applicable sections. FSAR Change Request Number: 89-568.10 Related SER Section: 3.7.2 SER/SSER Impact: No

FSAR Page (as amended)	Group	Description
3.7B-44	4	Clarifies text by stating that the peaks of the floor responce spectra were widened by "+/-" 10 percent. Clarification: See justification for page 3.7B-11 (#89-568.2). FSAR Change Request Number: 89-568.9 Related SER Section: 3.7.2 SER/SSER Impact: No
3.7B-60	2	Revises text to clarify how the horizontal and vertical accelerations have been combined. Correction: The discussion in this section did not adequately address the subject of the section heading. This change contains no new technical information. The added text is similar to the discussions presented in sections 3.7B.3.6 and 3.7B.3.7. FSAR Change Request Number: 89-568.11 Related SER Section: 3.7.3.3 SER/SSER Impact: No
3.7B-79	4	Adds references to support the change on page 3.7B-38 regarding soil spring stiffness values. Clarification: Adds references to support the change on page 3.7B-38 regarding soil spring stiffness values. FSAR Change Request Number: 89-568.12 Related SER Section: 3.7.2 SER/SSER Impact: No

FSAR Page (as amended)	Group	Description
3.8-29	2	Section 3.8.1.3.1 changes the lower limits of normal operating temperatures inside and outside of containment from (inside) "60F" to "50F" and from (outside) "0F" to "20F". Revision: As a result of design validation activities the temperature limits were revised. FSAR Change Request Number: 88-935 Related SER Section: 3.8.1 SER/SSER Impact: No

FSAR Page (as amended)	Group	Description
3.8-103	4	Clarifies tne design criteria used to evaluate the localized yielding of structures and supports (provided functional requirements are not impaired). Clarification: The criteria "local section strength capacities may be exceeded under these concentrated loads provided there will be no loss of function on any safety-related system." is assured by using the ductility acceptance criteria specified in Section 3.5.3.2 (note, this is identified on FSAR page 3.8-88). To provide additional clarification, Sections 3.8.3.5.7 and 3.8.4.5.3, on pages 3.8-103 and 3.8-123, respectively, will be amended to reference the ductility limits in Section 3.5.3.2 as the criteria for assuring that functional requirements are not impaired. FSAR Change Request Number: 89-569.1 Related SER Section: 3.8.2 SER/SSER Impact: No
3.8-105	4	Provides clarification as to which types of design documentation are used to specify the approved structural and miscellaneous steel. Clarification: The material lists in the applicable specifications/design drawings would provide complete identification. A complete listing was not provided in the FSAR due to the large number of unique materials involved. Engineering approval of equivalent material is obtained and documented in accordance with project procedures and specifications, which guarantees adherence to the applicable design requirements. In Section 3.8.3.6.4 the phrase, "...when specified by the engineers on design documentation," will be changed to, "...as specified by project specifications/design drawings." FSAR Change Request Number: 89-569.2 Related SER Section: 3.8.2 SER/SSER Impact: No
3.8-111, 112	2	Clarifies the discussion on the seismic analysis of the Category I tanks. Correction: Provides additional description of the Category I tanks' geometry and the method used to address hydrodynamic loads due to seismic excitations. FSAR Change Request Number: 89-569.3 Related SER Section: 3.8.3 SER/SSER Impact: No

FSAR Page (as amended)	Group	Description
3.8-124	4	Clarifies the design criteria used to evaluate the localized yielding of structures and supports (provided functional requirements are not impaired). Clarification: See justification for page 3.8-103 (#89-569.1). FSAR Change Request Number: 89-569.4 Related SER Section: 3.8.3 SER/SSER Impact: No
3.8-124	2	Clarifies that PCI criteria applies only for the Fuel Building crane corbel supports at elevation 831. Correction: The FSAR was amended to allow the PCI 1978 criteria for the design of corbels, because the ACI 318-71 criteria does not provide specific guidance on choosing a minimum effective d distance. The ACI only provides the method to determine the maximum d distance. The corbel affected by this change supports the crane rail in the Fuel Building at elevation 831. The corbel also meets the ACI minimum reinforcement requirements when the d distance based on strength requirements is used. Based on strength this corbel design meets both the ACI 318-71 and PCI 1978 criteria. The corbel meets the PCI criteria (but not ACI) for minimum reinforcement based on gross cross-section dimensions. ACI 318-71 Section 11.14.1 requires that the maximum effective d distance not exceed "twice the depth of the corbel or bracket at the outside edge of the bearing area." However, no limit is specified on the minimum effective d distance. FSAR Change Request Number: 89-569.5 Related SER Section: 3.8.3 SER/SSER Impact: Yes The SER makes the statement that ACI 318-71 is the major design code. The PCI could be referenced as the code for the subject case. However, the SER would not be incorrect if left as is, since the word "major" implies there may be exceptions to the ACI Code.
3.8-128	4	Provides missing text which was inadvertently deleted during Amendment 68 due to an administrative error. Editorial: Provides missing text which was inadvertently deleted during Amendment 68 due to an administrative error. FSAR Change Request Number: 89-569.6 Related SER Section: 3.8.4 SER/SSER Impact: No
3.8-138	4	Adds reference used to address hydrodynamic loads due to seismic excitations.

FSAR Page (as amended)	Group	Description
		Editorial: See justification for page 3.8-11 (#89-569.3). FSAR Change Request Number: 89-569.7 Related SER Section: 3.8.3 SER/SSER Impact: No
Figure 3.8-8	4	Revises sketch of the electrical penetration to provide additional detail. Clarification: Revises sketch of the electrical penetration to provide additional detail. FSAR Change Request Number: 89-569.8 Related SER Section: 3.8.1 SER/SSER Impact: No

FSAR Page (as amended)	Group	Description
Q&R 130-15, 18	4	Clarifies which version of the Standard Review Plan was referenced. (Questions 130.15 & 130.18) Clarification: Clarifies which version of the Standard Review Plan was referenced (NUREG-75-087). FSAR Change Request Number: 89-570.1 Related SER Section: 3.8.1 SER/SSER Impact: No
Q&R 130-25	4	Changes the reference to the previous Question from "130.5" to "130.15" (Question 130.25). Clarification: Corrects what appears to be an incorrect reference to an earlier question. Question 130.15 and 130.25 discuss the applicability of the SRP section 3.8.1. Question 130.5 addressed subject matter contained within FSAR section 3.5.3.2. FSAR Change Request Number: 89-570.2 Related SER Section: 3.8.1 SER/SSER Impact: No
Q&R 130-25, 26	2	Corrects response (Question 130.25) to address the issue of physical changes which may have resulted from the change in design criteria. Correction: In response to previous questions, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore the identification of any changes that may have resulted prior to the CAP are not pertinent at this time. The CAP was implemented to validate the design and hardware at CPSES. Modifications to the design and hardware were implemented as required. The methodology and results of this validation effort are described in the Civil Structural Project Status Report (PSR). Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline. FSAR Change Request Number: 89-570.3 Related SER Section: 3.8.2 SER/SSER Impact: No
Q&R 130-30	4	Changes the reference to previous Question from "130.5" to "130.15" (Question 130.28). Clarification:

FSAR Page (as amended)	Group	Description
		See justification for page 130-25 (#89-570.2). FSAR Change Request Number: 89-570.4 Related SER Section: 3.8.1 SER/SSER Impact: No
Q&R 130-30	2	Corrects response (Question 130.28) to address how the design at CPSES was validated. Correction: In response to previous questions, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore the identification of any changes that may have resulted prior to the CAP are not pertinent at this time. The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The methodology and results of this validation effort are described in the Civil Structural Project Status Report (PSR). Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline. FSAR Change Request Number: 89-570.5 Related SER Section: 3.8.1 SER/SSER Impact: No

Based on the review described above, the staff concludes that the applicant has not met the requirements of GDC 4 regarding pipe breaks. The staff will provide the resolution to the open items described above in a supplement to this report.

3.7 Seismic Design

3.7.1 Seismic Input

The input seismic design response spectra (operating-basis earthquake (OBE) and safe-shutdown earthquake (SSE)) applied in the design of seismic Category I structures and components were developed from numerous real records, following the procedures recommended by Newmark, Blume, and Kapur* and conform to the requirements of Regulatory Guide 1.60, Revision 1, with the exception of those in the 33-Hz to 50-Hz frequency range. In this range, the vertical response spectrum of Regulatory Guide 1.60, Revision 1, differs from the vertical response spectrum used by the applicant. Because this deviation only affects the modes that have low amplification, the effect of this deviation on the results of the analyses of structures and systems is negligible. Similarly, the method recommended by Newmark and his colleagues for the construction of vertical response spectra leads to a slight deviation from the Regulatory Guide 1.60, Revision 1, recommendations for accelerations corresponding to 3.5 Hz. The magnitude of these differences is negligible.

The horizontal and vertical design response spectra are scaled to the maximum ground acceleration of 0.12g and 0.08g selected for the SSE. For the OBE, a scaling factor of 0.5 is applied to the SSE design spectra. The site design response spectra are applied at the various foundations of seismic Category I structures.

The specific percentage of critical damping values used in the seismic analysis of Category I structures, systems, and components is based on material, stress levels, and type of connections of the particular structure or component. These values are determined in accordance with the recommendations of Regulatory Guide 1.61 and those in Newmark's work. The synthetic time history used for the seismic design of Category I structures, systems and components is adjusted in amplitude and frequency content to obtain response spectra that enveloped the response spectra specified for the site.

3.7.2 Seismic Structural System and Subsystem Analyses

The review of the seismic system and subsystem analysis for the plant included the seismic analysis methods for all Category I structures, systems, and components, in addition to procedures for modeling, seismic soil-structure interaction, development of floor response spectra, inclusion of torsional effects, evaluation of Category I structure overturning, and determination of composite damping. The review included design criteria and procedures for evaluation of interaction of non-Category I structures and piping with Category I

*"Design Report Spectra for Nuclear Power Plants" presented by N. B. Newmark, J. A. Blume, and K. K. Kapur, at the ASCE Structural Engineering Meeting, San Francisco, April 1973.

structures and piping and the effects of parameter variations on floor response spectra. The review also included criteria and seismic analysis procedures for reactor internal and Category I buried piping outside the containment.

The system and subsystem analyses were performed by the applicant on an elastic basis. Modal response spectrum multidegree of freedom and time-history methods form the basis for the analyses of all major Category I structures, systems and components. When the modal response spectrum method is used, governing response parameters will be combined by a method that is generally more conservative than the square-root-of-the-sum-of-the-squares rule adopted as the staff position. However, the absolute sum of the modal response was used for modes with closely spaced frequencies. The square root of the sum of the squares of the maximum codirectional responses was used in accounting for three components of the earthquake motion for both the time history and response spectrum methods. Floor spectra input for design and test verification of structures, systems, and components was generated from the time-history method, taking into account variation of parameters by peak widening. Peaks were broadened ± 10% and connected without leaving valleys. When the peak broadening is less than ± 15%, the smoothing method is conservative and acceptable. A vertical seismic system dynamic analysis was employed for all structures, systems, and components where analysis showed significant structural amplification in the vertical direction. Torsional effects and stability against overturning were considered. The applicant has demonstrated to the staff that the eccentricities used in the analysis of Category I structures for the evaluation of torsional effects exceed the minimum value of ± 5% recommended by the staff. The staff finds the eccentricity values considered in the design acceptable.

The lumped-mass-spring approach is used to evaluate soil-structure interaction and structure-to-structure interaction effects and seismic responses.

For the analysis of Category I dams, a finite element approach that takes into consideration the time history of forces, the behavior and deformation of the dam caused by the earthquake, and applicable stress-strain relations is used.

The staff concludes that the seismic system and subsystem analysis procedures and criteria proposed by the applicant provide an acceptable basis for the seismic design.

3.7.3 Seismic Mechanical Subsystem Analyses

The review under SRP Section 3.7.3 included the applicant's seismic analysis of the reactor coolant system; reactor internals, core, and control rod drive mechanisms; and seismic Category I piping systems (excluding the reactor coolant system). Each of these areas is discussed below.

3.7.3.1 Reactor Coolant System

The reactor vessel, pumps, steam generators and their supports, and the interconnecting piping system were evaluated as a coupled system. The mathematical model provides a three-dimensional representation of the dynamic response of the coupled components to seismic excitations in both the horizontal and vertical directions. The analysis was conducted using methods of dynamic analyses employing time-history and modal response spectra techniques.

For both types of analyses, the applicant has appropriately considered the combination of modal responses by the rule of the square root of the sum of the squares. The absolute sum of the modal responses is used for modes with closely spaced frequencies. The applicant has also considered combination of the three spatial components of earthquake motion by the square root of the sum of squares, and has provided an evaluation of multiple-supported components with distinct inputs applied at each support.

The staff concludes that the seismic analysis procedures described by the applicant for reactor coolant systems are acceptable.

3.7.3.2 Reactor Internals, Core, and Control Rod Drive Mechanism

The applicant described mathematical models and analysis techniques for reactor internals, core, and control rod drive mechanism that are analogous to those described for the reactor coolant systems. The input response spectra used are based on the acceleration of the reactor vessel supports. Also, the adequacy of the control rod drive mechanism when subjected to seismic loadings is verified by a combination of test and analysis. The seismic analysis of the reactor internals is in accordance with Regulatory Guide 1.92, and system structural damping values are in accordance with Regulatory Guide 1.61.

The staff concludes that the seismic evaluation techniques and procedures described by the applicant for reactor internals, core, and control rod drive mechanism are acceptable.

3.7.3.3 Seismic Category I Piping Systems (Excluding the Reactor Coolant System)

All seismic Category I piping systems are seismically analyzed. Code Class 1 piping systems are analyzed by the modal response spectra method. In the analysis of complex systems where closely spaced modal frequencies (the difference is less than 10% of the lower frequency) are encountered, the responses of the closely spaced modes are combined by the summation of the absolute values and are then combined with the responses of the remaining significant modes by the square root of the sum of the squares method. The approach used by the applicant for modal combination provides an equivalent level of safety to that provided in Regulatory Guide 1.92. The analysis method used for Class 1 Seismic Category I equipment depends on its dynamic characteristics. Flexible equipment, characterized by several modes in the frequency range that could produce amplification of the base input motion, was analyzed by the modal analysis techniques. Rigid equipment and equipment of limited flexibility, which are characterized by only one predominant mode in the frequency range subject to possible amplification in the input motion, are generally analyzed using the static analysis method. Class 2 and 3 piping systems are analyzed by one of three methods:

(1) the same modal response spectra method as used for Class 1 piping systems

(2) an equivalent static load method

(3) the simplified design method .

The applicant has indicated the analysis method used for each piping system and has provided technical justification for use of the equivalent static load and simplified design methods. Both of these methods are based on static seismic analysis. The applied seismic loads correspond to accelerations equal to at least the zero-period accelerations of the appropriate floor response spectra. The staff has reviewed the applicant's procedures and concludes that the seismic evaluation methods and procedures described by the applicant for nuclear steam supply system and nonnuclear steam supply system Seismic Category I piping systems and equipment are acceptable.

3.7.4 Seismic Instrumentation Program

The type, number, location, and utilization of strong-motion accelerographs to record seismic events and to provide data on the frequency, amplitude, and phase relationship of the seismic response of the containment structure comply with Regulatory Guide 1.12. Supporting instrumentation is being installed on Category I structures, systems, and components to provide data for the verification of the seismic responses determined analytically for such Category I items.

The installation of the specified seismic instrumentation in the reactor containment structure and at other Category I structures, systems, and components constitutes an acceptable program to record data on seismic ground motion as well as data on the frequency and amplitude relationship of the response of major structures and systems. A prompt readout of pertinent data at the control room can be expected to yield sufficient information to guide the operator on a timely basis for the purpose of evaluating the seismic response in the event of an earthquake. Data obtained from such installed seismic instrumentation will be sufficient to determine that the seismic analysis assumptions and the analytical model used for the design of the plant are adequate and that allowable stresses are not exceeded under conditions where continuity of operation is intended. Provision of such seismic instrumentation complies with Regulatory Guide 1.12.

3.8 Design of Seismic Category I Structures

3.8.1 Concrete Containment

The reactor coolant system is enclosed in a steel-lined, reinforced concrete containment structure. This structure consists of a vertical cylinder and a hemispherical dome, and is supported on an essentially flat foundation mat with a reactor cavity pit projection. The containment structure was designed in accordance with American Concrete Institute (ACI)/ASME Code (ACI-359) and Regulatory Guides 1.10, 1.15, 1.18, 1.19, and 1.55. Various combinations of dead loads, live loads, environmental loads (including those caused by wind, tornadoes, OBE, and SSE), and loads generated by the design-basis accident (including pressure, temperature, and associated pipe rupture effects) were considered. The load combinations used and presented in the FSAR are more conservative than those specified in SRP Section 3.8.1.

Static analysis of the containment shell and base is founded on methods previously applied. Likewise, the liner design for the containment employs methods similar to those previously accepted by the staff.

The choice of materials, the arrangement of anchors, the design criteria, and the design methods are similar to those evaluated for previously licensed nuclear plants. Materials, construction methods, and quality assurance and quality control measures are covered in the FSAR. In general, they are similar to those used for previously licensed facilities.

Before the plant begins operation, the containment will be subjected to an acceptance test in accordance with Regulatory Guide 1.18. During this test, the internal pressure will be 1.15 times the containment design pressure.

The criteria used in the analysis, design, and construction of the concrete containment structure to account for anticipated loadings and postulated conditions that may be imposed on the structure during its service lifetime are in conformance with established criteria, codes, standards, guides, and specifications acceptable to the staff.

The use of these criteria (as defined by applicable codes, standards, guides, and specifications); the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials, quality control programs, and special construction techniques; and the testing and inservice surveillance requirements provide reasonable assurance that, in the event of winds, tornadoes, earthquakes, and various postulated accidents occuring within and outside the containment, the structure will withstand the specified design conditions without impairment of structural integrity or safety functions Conformance with these criteria constitutes an acceptable basis for satisfying, in part, the requirements of GDC 2, 4, 16, and 50.

3.8.2 Concrete and Structural Steel Internal Structures

The containment internal structures are constructed primarily of reinforced concrete and consist of the following major elements: primary shield wall; operating floor; refueling cavity; interior base slab; missile shields; intermediate floors; removable slabs and walls; polar crane supporting elements; and supports for reactor pressure vessel, steam generators, reactor coolant pumps, pressurizers, and loop piping. These concrete and steel internal structures are designed to resist various combinations of dead and live loads, and accident-induced loads, including pressure, jet loads, and seismic loads. The applicant has verified that the internal structures meet the design requirements stated in SRP Section 3.8.3.

The criteria used in the design, analysis, and construction of the containment internal structures to account for anticipated loading and postulated conditions that may be imposed upon the structures during their service lifetime, are in full conformance with established criteria, and with codes, standards, and specifications acceptable to the staff.

The use of these criteria (as defined by applicable codes, standards, and specifications); the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials, quality control programs, and special construction techniques; and the testing and inservice surveillance requirements provide reasonable assurance that, in the event of an earthquake and various postulated accidents occurring within the containment, the interior structures will withstand the specified design conditions without impairment of structural integrity or the performance of required safety functions. Conformance with these criteria constitutes an acceptable basis for satisfying, in part, the requirements of GDC 2 and 4.

3.8.3 Other Seismic Category I Structures

The structural systems for all Category I structures except the outdoor seismic Category I tanks consist of reinforced concrete floor slabs, beams, girders, walls, columns, and raft-type foundation mats. The outdoor seismic Category I tanks are circular reinforced concrete structures, with stainless steel liners to provide leak tightness. Floor systems and walls are designed for vertical and lateral loads. Seismic, tornado, and other lateral loads applied to the total structure are resisted by the diaphragm action of the floors and shear walls and are transmitted to the foundation mats. Because the columns have relatively low lateral stiffness, they are not assumed to participate in resisting these lateral loads. The tanks are designed to withstand all credible loadings and to maintain their integrity during operation.

These Category I structures were designed to resist various combinations of dead loads, live loads, environmental loads including those caused by winds, tornadoes, OBE, and SSE; thermal loads; loads generated by postulated ruptures of high-energy pipes such as reaction and jet impingment forces, compartment pressure, and impact effects of whipping pipes; and hydrodynamic loads caused by seismic effects of the containment fluid.

The major code used in the design of concrete Category I structures is ACI 318-71, "Building Code Requirements for Reinforced Concrete." For steel Category I structures, the AISC "Specification for the Design, Fabrication and Erection of Structural Steel of Buildings" is used.

The applicant has verified that all of the other Category I structures meet the design requirements stated in SRP 3.8.4. The construction materials and their fabrication, construction, and installation are in accordance with ACI 318-71, and the AISC "Specification for Concrete and Steel Structures," respectively.

The applicant was requested to submit information on the use of masonry walls in Category I structures, including their location, design and analysis methods, piping, and equipment supports. In an earlier reply to NRC, the applicant stated that some masonry walls are located within Category I structures but do not support safety components. During the Structural Engineering Branch (SEB) audit, however, the applicant identified specific walls that may affect safety components. The applicant identified in some detail the major safety-related masonry walls within the service water intake structure and the auxiliary building, and stated that safety-related masonry blocks are used as access blockouts, as required. The applicant has committed that the major masonry walls will either be designed in conformance with "SEB Interim Criteria for Safety-Related Masonry Wall Evaluation," or seismically designed walls of other materials will be constructed in their places. In addition, all masonry access blockouts will be supported by seismically designed steel supports to prevent the collapse of the blocks. The staff agrees with the proposed design considerations. The details of the final designs will be submitted for staff review and acceptance before operation of the plant. With the understanding the applicant will not change the current commitments, the staff considers this item resolved.

The use of these criteria as defined by applicable codes, standards, and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the material, quality control, and special construction techniques; and the testing and inservice surveillance requirements provide reasonable assurance that, in the event of winds, tornadoes, earthquakes, and various postulated accidents occurring within the structures, the structures will withstand the specified design conditions without impairment of structural integrity or the performance of required safety functions. Conformance with these criteria, codes, specifications, and standards constitutes an acceptable basis for satisfying, in part, the requirements of GDC 2 and 4.

3.8.4 Foundations

Foundations of Category I structures are described in Section 3.8.5 of the FSAR. The foundation mat for the containment and internal structure is essentially a flat mat approximately 12 ft thick, with a reactor cavity pit projection. The foundation mat is covered with a steel liner that is an integral part of the containment liner system, which is covered with a 30-in.-thick interior base slab. The foundations for other seismic Category I structures are generally flat slabs that vary in thickness from approximately 3 to 6 ft, depending on the requirement for shear and bending moment. Reinforcing steel is provided in two mutually perpendicular directions, at both the top and bottom faces. Shear reinforcement is provided where required by the provisions of ACI 318-71, the principal code used in the design of these concrete foundations. These concrete foundations are designed to resist various loads and load combinations stated for each pertinent structure in Sections 3.8.1, 3.8.3, and 3.8.4 of the FSAR. In addition, the applicant has considered in the design of the foundations the effects of overturning, sliding and floatation, and has adopted the minimum safety factors stated in SRP 3.8.5.

The design and analysis procedures used for Category I foundations are the same as those approved on previously licensed facilities and, in general, are in accordance with procedures delineated in the ACI 318-71 code. The materials of construction, their fabrication, construction, and installation are in accordance with ACI 318-71.

The criteria used in the analysis, design, and construction of all Category I foundations to account for anticipated loadings and postulated conditions that may be imposed upon each foundation during its service lifetime are in conformance with established criteria, codes, standards, and specifications acceptable to the staff.

The use of these criteria as defined by applicable codes, standards, and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials, quality control, and special construction techniques; and the testing and inservice surveillance requirements provide reasonable assurance that, in the event of winds, tornadoes, earthquakes, and various postulated events, Category I foundations will withstand the specified design conditions without impairment of structural integrity and stability or the performance of required safety functions. Conformance with these criteria, codes, specifications, and standards constitutes an acceptable basis for satisfying, in part, the requirements of GDC 2 and 4.

3.9 Mechanical Systems and Components

The review performed under SRP Sections 3.9.1 through 3.9.6 pertains to the structural integrity and operability of various safety-related mechanical components in the plant. The staff review is not limited to ASME Code components and supports, but extends to other components such as control rod drive mechanisms, certain reactor internals, ventilation ducting, cable trays, and any safety-related piping designed to industry standards other than the ASME Code.

3.9.1 Special Topics for Mechanical Components

The review performed under SRP Section 3.9.1 pertains to the design transients, computer programs, experimental stress analysis, and elastic-plastic analysis methods that were used in the analysis of seismic Category 1 ASME Code and non-Code items. The applicant has provided a complete list of transients to be used in the design and fatigue analysis of all Code Class 1 and CS components and of component supports and reactor internals within the reactor coolant pressure boundary. The number of events postulated for each transient has been included and is acceptable.

The applicant has listed the computer program used in the dynamic and static analysis to determine the structural and functional integrity of seismic Category 1 Code and non-Code items. Verification of one of these programs, WECAN, is described in topical report WCAP-8929, "Benchmark Problem Solutions Employed for Verification of WECAN Computer Program." The staff is currently reviewing this topical report and will present the results of its evaluation in a supplement to this SER.

The methods of analysis that the applicant has employed in the design of all seismic Category I ASME Code Class 1, 2, and 3 components, component supports, reactor internals, and other non-Code items are in conformance with SRP Section 3.9.1 and satisfy the applicable portions of GDC 2, 4, 14, and 15. The use of these criteria in defining the applicable transients, computer codes used in analyses, and analytical methods provides reasonable assurance that the stresses, strains, and displacements calculated for the above items are as accurate as the current state of the art permits and are adequate for the design of these items.

3.9.2 Dynamic Testing and Analysis

The review performed under SRP Section 3.9.2 pertains to the criteria, testing procedures, and dynamic analyses employed by the applicant to ensure the structural integrity and operability of piping systems, mechanical equipment,

3.7 Seismic Design

3.7.2 Seismic Structural System and Subsystem Analyses

6. Deletes the power density function as a method which may be used to specify the input motion for seismic testing of equipment.

7. Corrects statement describing structural failure of the Turbine Building in the direction of the adjacent Seismic Category I building.

3.7.3 Seismic Mechanical Subsystem Analyses

11. Revises text to clarify how the horizontal and vertical accelerations have been combined.

3.8 Design of Seismic Category I Structures

3.8.1 Concrete Containment

19. Section 3.8.1.3.1 changes the lower limits of normal operating temperatures inside and outside of containment from (inside) "60F" to "50F" and from (outside) "0F" to "20F".

20. Corrects response (Question 130.28) to address design changes prior to the Corrective Action Program.

3.8.2 Concrete and Structural Steel Internal Structures

9. Corrects response (Questions 130.25 and 130.28) to address design changes prior to the Corrective Action Program.

3.8.3 Other Seismic Category I Structures

7. Clarifies the discussion on the seismic analysis of the Category I tanks.

8. Clarifies that PCI criteria applies only for the Fuel Building crane corbel supports at elevation 831.

9. Corrects response (Questions 130.25 and 130.28) to address design changes prior to the Corrective Action Program.

3.7 Seismic Design

3.7.2 Seismic Structural System and Subsystem Analyses

6. Deletes the power density function as a method which may be used to specify the input motion for seismic testing of equipment.

3.7B-14 2 Deletes the power density function as a method which may be used to specify the input motion for seismic testing of equipment.

Correction:

The power density function has not been used at CPSES. FSAR section 3.7B.2.1.3 will be revised to delete the reference to the power density function.

FSAR Change Request Number: 89-568.4

Related SER Section: 3.7.2

SER/SSER Impact: No

1. Seismic testing for equipment operability conforms to the following:

   a. A test required to confirm the functional operability of seismic Category I electrical and mechanical equipment and instrumentation during and after an earthquake of magnitude up to and including the SSE is performed. Analysis without testing may be performed only if structural integrity alone can ensure the design intended function. When a complete seismic testing is impracticable, a combination of test and analysis is performed.

   b. The characteristics of the required input motion are specified by one of the following:

      1) Response spectrum

      ~~2) Power spectral density function~~

      2 ~~3~~) Time history

      Such characteristics, as derived from the structures or systems seismic analysis, are representative of the input motion at the equipment mounting locations.

   c. Where practicable, equipment which is required to function during and/or after an earthquake is tested in the operational condition. Operability is verified during and/or after the testing.

   d. The actual input motion is characterized in the same manner as the required input motion and the conservatism in amplitude and frequency content is demonstrated. The frequency spectrum covers the range from 1 through 33 Hz.

3.7 <u>Seismic Design</u>

3.7.2 <u>Seismic Structural System and Subsystem Analyses</u>

7. Corrects statement describing structural failure of the Turbine Building in the direction of the adjacent Seismic Category I building.

3.7B-42 2 Corrects statement describing structural failure of the Turbine Building in the direction of the adjacent Seismic Category I building.

Correction:

The bracing by itself will not prevent structural failure in the direction of the Seismic Category I building. The Turbine Building will bear against the turbine pedestal after the frame has translated horizontally sufficiently to close the surrounding one-inch gap (note: gap is filled with a compressible material). The combination of the horizontal bracing internal to the steel frame and the bearing of the mezzanine and operating floor slabs on the turbine generator pedestal will resist collapse of the frame.

FSAR Change Request Number: 89-568.8

Related SER Section: 3.7.2

SER/SSER Impact: No

3.7B.2.8 Interaction of Non-Category I Structures with Seismic Category I Structures

A number of structures such as the Turbine Building, the Switchgear Buildings, the Circulating Water Intake and Discharge Structures, the Maintenance Building, and the Administration Building are designated as non-Category I.

The only non-Category I structures which are adjacent to any seismic Category I structure are the Turbine Building and the Switchgear Buildings. These structures do not share a common mat with the adjacent seismic Category I structure, and all structures are founded on firm rock. Therefore, there is no possible interaction of non-Category I structures with seismic Category I structures resulting from seismic motion. Sufficient space is provided between the Turbine and Switchgear Buildings and the adjacent seismic Category I structure so as to prevent contact because of deformations occurring in the structures during a seismic event.

The possibility of structural failure during a seismic event is considered for the Turbine Building. Structural failure in the direction of the adjacent seismic Category I structure is prevented by **the combination of the horizontal bracing internal to the steel frame and the bearing of the mezzanine and operating floor slabs on the concrete turbine generator pedestal** ~~internal bracing~~. The Switchgear Buildings are design to withstand a seismic event equal to the SSE. 69

Non-Category I equipment and components located in seismic Category I buildings are investigated by analysis or testing, or both, to ensure that under the prescribed earthquake loading, structural integrity is maintained, or the non-Category I equipment and components do not adversely affect the integrity or operability, or both, of any 54

3.7 Seismic Design

3.7.3 Seismic Mechanical Subsystem Analyses

11. Revises text to clarify how the horizontal and vertical accelerations have been combined.

3.7B-60	2	Revises text to clarify how the horizontal and vertical accelerations have been combined. Correction: The discussion in this section did not adequately address the subject of the section heading. This change contains no new technical information. The added text is similar to the discussions presented in sections 3.7B.3.6 and 3.7B.3.7. FSAR Change Request Number: 89-568.11 Related SER Section: 3.7.3.3 SER/SSER Impact: No

When all of the points of fixity are located on a single structure, 20
the rigid body motions of the structure, translation and rotation, do not result in relative motion of the points of fixity. Since the third category of displacement, deformation of the structure, represents a small portion of the total displacement profile, the effects of this displacement on the points of fixity are neglected.

For piping passing between buildings or equipment mounted on individual structures or foundations (such as big tanks), the relative displacement of support points located in different structures is considered in piping stress analysis.

Maximum relative displacements in two horizontal and the vertical 20
direction between piping supports and anchor points between buildings are used as equivalent static displacement boundary conditions in order to calculate the secondary stresses of the piping system. Relative seismic displacements used are obtained from a dynamic analysis of the structures, and are always considered to be out-of-phase between different buildings and the equipment if applicable to obtain the most conservative piping responses.

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3.7B.3.8.2 Basis for Computing Combined Responses

For the seismic design of piping, the horizontal and vertical loadings 61
are obtained from the instructure response spectra that have been generated for the appropriate structures and elevations as outlined in Subsection 3.7B.2.1.2, and References [30], [31], and [36].

The combined effect of the three components of earthquake motion on the seismic design of piping is determined by the SRSS method (section 3.7B.2.6). The maximum modal responses are combined by the methods of NRC Regulatory Guide 1.92, Revision 1. The methods presented in Regulatory Guide paragraphs 1.1, 1.2.1, 1.2.2 or 1.2.3 are acceptable methods for vendor qualification.

3.8 Design of Seismic Category I Structures

3.8.1 Concrete Containment

19. Section 3.8.1.3.1 changes the lower limits of normal operating temperatures inside and outside of containment from (inside) "60F" to "50F" and from (outside) "0F" to "20F".

3.8-29 2 Section 3.8.1.3.1 changes the lower limits of normal operating temperatures inside and outside of containment from (inside) "60F" to "50F" and from (outside) "0F" to "20F".

Revision:

As a result of design validation activities the temperature limits were revised.

FSAR Change Request Number: 88-935

Related SER Section: 3.8.1

SER/SSER Impact: No

3.8.1.3 Loads and Load Combinations

3.8.1.3.1 Loads

The following loads are considered in the design of the steel-lined, reinforced concrete Containment structure (essentially in accordance with the ASME-ACI 359 document):

1. D - dead load of the Containment, and all superimposed permanent loads

2. L - live loads, comprising conventional floor and roof live loads, movable equipment loads, cables, and lateral soil pressure

3. Pa - Containment pressure load due to the DBA, at 50 psig

4. T - thermal effects

   a. To - thermal loads during normal operating conditions, including liner expansion and temperature gradients in the wall

      1) Normal operating temperature range inside the Containment is 50 ~~60~~°F to 120°F.

      2) Ambient temperature range at the outside face of the Containment wall is 20 ~~0~~°F to 110°F.

   b. Ta - added thermal loads (over and above operating thermal loads), exerted by the liner, which may occur during an accident and which correspond to the factored accident pressure (i.e., 1.0 Pa, 1.25 Pa, or 1.5 Pa); the accident temperature causes an almost instantaneous increase in the liner temperature, with little initial

3.8 <u>Design of Seismic Category I Structures</u>

3.8.1 <u>Concrete Containment</u>

20. Corrects response (Question 130.28) to address design changes prior to the Corrective Action Program.

Q&R 130-30	2	Corrects response (Question 130.28) to address how the design at CPSES was validated. Correction: In response to previous questions, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore the identification of any changes that may have resulted prior to the CAP are not pertinent at this time. The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The methodology and results of this validation effort are described in the Civil Structural Project Status Report (PSR). Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline. FSAR Change Request Number: 89-570.5 Related SER Section: 3.8.1 SER/SSER Impact: No

Q130.28 In your answers to Q130.15 $/ 16, 18, and 25, you stated how you considered the design and acceptance criteria identified in ACI-359 and SRP 3.8.1., 3.8.3. and 3.8.4. to validate the actual structural design of the Category I structures of the Comanche Peak NPP. In your conclusions, you stated that the actual design meets the requirements of ACI-359 and SRP 3.8.1., 3.8.3., and 3.8.4. Provide a detailed description of the specific controlling sections and components investigated in your reevaluation, including pertinent sketches and results.

R130.28 **In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of Containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore, the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.**

The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The design of Seismic Category I structures conformed to the loading combinations which are specified by U.S. NRC Standard Review Plans 3.8.1., 3.8.3 and 3.8.4 (**NUREG-75-087**). 68

NOTE: THIS PARAGRAPH SHOULD BE BOLD TYPE

The methodology and results of this validation effort are described in the Civil/Structural Project Status Report (PSR). Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

3.8 Design of Seismic Category I Structures

3.8.2 Concrete and Structural Steel Internal Structures

9. Corrects response (Questions 130.25 and 130.28) to address design changes prior to the Corrective Action Program.

Q&R 130-25, 26 2 Corrects response (Question 130.25) to address the issue of physical changes which may have resulted from the change in design criteria.

Correction:

In response to previous questions, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore the identification of any changes that may have resulted prior to the CAP are not pertinent at this time. The CAP was implemented to validate the design and hardware at CPSES. Modifications to the design and hardware were implemented as required. The methodology and results of this validation effort are described in the Civil Structural Project Status Report (PSR).

Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

FSAR Change Request Number: 89-570.3
Related SER Section: 3.8.2
SER/SSER Impact: No

Q&R 130-30 2 Corrects response (Question 130.28) to address how the design at CPSES was validated.

Correction:

In response to previous questions, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.

The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The methodology and results of this validation effort are described in the Civil Structural Project Status Report (PSR).

Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

FSAR Change Request Number: 89-570.5
Related SER Section: 3.8.1
SER/SSER Impact: No

Q130.25 In your answers to Q130.15 5, Q130.16 and Q130.18, you changed the load combinations for the Containment Building to agree with the requirements of ACI 359 Code (1973) with certain exceptions as identified in the applicable sections of SRP 3.8.1. For the internal structures and for other Category I structures, you stated compliance with the respective requirements identified in SRP 3.8.3. and 3.8.4. In view of these changes, identify in detail how these changes in the design criteria have affected the final design of the Containment and other structures, if any. Specifically, state if they have resulted in any changes in the physical sizes of the structural components, rebar placement, properties, design stress levels, etc...

R130.25 **In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of Containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore, the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.**

The Corrective Action Program for the civil/structural area was implemented to validate the design and hardware at CPSES. The various Seismic Category I structures were designed to conform to the loading combinations and their related acceptance criteria which are specified by U.S. NRC Standard Review Plans 3.8.3. and 3.8.4 (**NUREG-75-087**). 68

68

Modifications to the design and hardware have been implemented as required. The Civil/Structural Project Status Report (PSR) describes the methods used to validate the safety-related hardware. Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

Q130.28 In your answers to Q130.15 &/ 16, 18, and 25, you stated how you considered the design and acceptance criteria identified in ACI-359 and SRP 3.8.1., 3.8.3. and 3.8.4. to validate the actual structural design of the Category I structures of the Comanche Peak NPP. In your conclusions, you stated that the actual design meets the requirements of ACI-359 and SRP 3.8.1., 3.8.3., and 3.8.4. Provide a detailed description of the specific controlling sections and components investigated in your reevaluation, including pertinent sketches and results.

R130.28 **In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of Containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore, the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.**

The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The design of Seismic Category I structures conformed to the loading combinations which are specified by U.S. NRC Standard Review Plans 3.8.1., 3.8.3 and 3.8.4 (**NUREG-75-087**). 68

NOTE: THIS PARAGRAPH SHOULD BE BOLD TYPE

The methodology and results of this validation effort are described in the Civil/Structural Project Status Report (PSR). Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

3.8 Design of Seismic Category I Structures

3.8.3 Other Seismic Category I Structures

7. Clarifies the discussion on the seismic analysis of the Category I tanks.

3.8-111, 112 2 Clarifies the discussion on the seismic analysis of the Category I tanks.
Correction:
Provides additional description of the Category I tanks' geometry and the method used to address hydrodynamic loads due to seismic excitations.
FSAR Change Request Number: 89-569.3
Related SER Section: 3.8.3
SER/SSER Impact: No

3.8.4.1.5 Drawings

For various details of other seismic Category I structures, see Figures 3.8-1 through 3.8-4 and Figure 3.8-16.

3.8.4.1.6 Outdoor Seismic Category I Tanks (Refueling Water Storage, Condensate Storage, and Reactor Makeup Water Storage)

68 The outdoor seismic Category I tanks are reinforced concrete structures, cylindrical in shape, with stainless steel liners to provide leaktightness and prevent absorption of radioactive material by the concrete (Refueling Water Storage Tank (RWST) only). The RWST is provided with a concrete trough external to the tank to collect incidental leakage.

REFUELING WATER STORAGE AND CONDENSATE STORAGE TANKS:

Outside diameter of wall	**50'-0"**
Outside diameter of mat	**53'-0"**
Concrete wall thickness	**2'-6"**
Concrete mat thickness	**5'-0"**
Concrete roof thickness	**1'-9"**
Total height	**54'-6"**

REACTOR MAKE UP WATER STORAGE TANK

Outside diameter of wall	**30'-0"**
Outside diameter of mat	**33'-0"**
Concrete wall thickness	**2'-6"**
Concrete mat thickness	**4'-0"**
Concrete roof thickness	**1'-9"**
Total height	**39'-6"**

The tanks are designed to withstand all credible loadings and to maintain their integrity during operation. These loadings include both normal operating loads such as structure weight, hydrostatic pressure of the contained fluid, live loads on the roof, thermal loads and environmental loads such as the 1/2 SSE, SSE, normal wind and tornados (wind, differential pressure and missiles), and hydrodynamic forces caused by seismic effects on the contained fluid **in accordance with methods as shown in Reference 21.** 68

The load combinations given in Subsection 3.8.4.3 are used for the design of the structures, using design methods and strength requirements in accordance with ACI 318-71. Flexural tensile cracking is permitted but is controlled by reinforcing steel. A minimum of 0.25 percent reinforcing steel is provided in the tank walls in both directions, vertical and hoop.

3.8 <u>Design of Seismic Category I Structures</u>

3.8.3 <u>Other Seismic Category I Structures</u>

8. Clarifies that PCI criteria applies only for the Fuel Building crane corbel supports at elevation 831.

3.8-124 2 Clarifies that PCI criteria applies only for the Fuel Building crane corbel supports at elevation 831.

Correction:

The FSAR was amended to allow the PCI 1978 criteria for the design of corbels, because the ACI 318-71 criteria does not provide specific guidance on choosing a minimum effective d distance. The ACI only provides the method to determine the maximum d distance. The corbel affected by this change supports the crane rail in the Fuel Building at elevation 831. The corbel also meets the ACI minimum reinforcement requirements when the d distance based on strength requirements is used. Based on strength this corbel design meets both the ACI 318-71 and PCI 1978 criteria. The corbel meets the PCI criteria (but not ACI) for minimum reinforcement based on gross cross-section dimensions.

ACI 318-71 Section 11.14.1 requires that the maximum effective d distance not exceed "twice the depth of the corbel or bracket at the outside edge of the bearing area." However, no limit is specified on the minimum effective d distance.

FSAR Change Request Number: 89-569.5

Related SER Section: 3.8.3

SER/SSER Impact: Yes

The SER makes the statement that ACI 318-71 is the major design code. The PCI could be referenced as the code for the subject case. However, the SER would not be incorrect if left as is, since the word "major" implies there may be exceptions to the ACI Code.

of safety is provided by ACI 318-71 in that the calculated ultimate capacity of the member is reduced by a capacity reduction factor, as indicated in Subsection 3.8.3.5.2.

The magnitude of the load factors applied to each type of load varies, depending on the factors discussed in Subsection 3.8.3.5.2.

3.8.4.5.3 Missile Load and Pipe Break Criteria at Local Areas

For local areas subjected to loads, such as missiles, and to forces caused by pipe rupture, localized yielding is permitted when the deflections or deformations of the structures and supports are within the (**ductility**) limits (**Section 3.5.3.2**) necessary to ensure that functional requirements are not impaired.

3.8.4.5.4 Bracket or Corbel Criteria at Local Areas | 68

The fuel building crane corbel supports at elevation 831 are designed in accordance with the PCI Design Handbook Second Edition 1978. ~~For local areas subjected to loads, such as brackets or corbels with shear friction, design of corbels based on PCI Design Handbook Second Edition 1978 is permitted when the loads on the supports or structures are within the limits necessary to ensure that functional requirements are not impaired.~~ | 68

3.8.4.6 Materials, Quality Control, and Special Construction Techniques

The materials and QC procedures used in the construction of other seismic Category I structures are as discussed in Subsection 3.8.3.6. No special construction techniques are required for these structures.

3.8.4.7 Testing and Inservice Inspection Requirements

With the exception of the stainless steel liners for the spent fuel pool and the outdoor seismic Category I tanks, no special testing of the completed structure or inservice inspection is required for

3.8 <u>Design of Seismic Category I Structures</u>

3.8.3 <u>Other Seismic Category I Structures</u>

9. Corrects response (Questions 130.25 and 130.28) to address design changes prior to the Corrective Action Program.

Q&R 130-25, 26 — 2 — Corrects response (Question 130.25) to address the issue of physical changes which may have resulted from the change in design criteria.

Correction:

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Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

FSAR Change Request Number: 89-570.3
Related SER Section: 3.8.2
SER/SSER Impact: No

Q&R 130-30 — 2 — Corrects response (Question 130.28) to address how the design at CPSES was validated.

Correction:

In response to previous questions, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.

The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The methodology and results of this validation effort are described in the Civil Structural Project Status Report (PSR).

Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

FSAR Change Request Number: 89-570.5
Related SER Section: 3.8.1
SER/SSER Impact: No

Q130.25 In your answers to Q130.15 5, Q130.16 and Q130.18, you changed the load combinations for the Containment Building to agree with the requirements of ACI 359 Code (1973) with certain exceptions as identified in the applicable sections of SRP 3.8.1. For the internal structures and for other Category I structures, you stated compliance with the respective requirements identified in SRP 3.8.3. and 3.8.4. In view of these changes, identify in detail how these changes in the design criteria have affected the final design of the Containment and other structures, if any. Specifically, state if they have resulted in any changes in the physical sizes of the structural components, rebar placement, properties, design stress levels, etc...

R130.25 In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of Containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore, the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.

The Corrective Action Program for the civil/structural area was implemented to validate the design and hardware at CPSES. The various Seismic Category I structures were designed to conform to the loading combinations and their related acceptance criteria which are specified by U.S. NRC Standard Review Plans 3.8.3. and 3.8.4 (NUREG-75-087). 68

68

Modifications to the design and hardware have been implemented as required. The Civil/Structural Project Status Report (PSR) describes the methods used to validate the safety-related hardware. Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.

Q130.28 In your answers to Q130.15 ~~5~~, 16, 18, and 25, you stated how you considered the design and acceptance criteria identified in ACI-359 and SRP 3.8.1., 3.8.3. and 3.8.4. to validate the actual structural design of the Category I structures of the Comanche Peak NPP. In your conclusions, you stated that the actual design meets the requirements of ACI-359 and SRP 3.8.1., 3.8.3., and 3.8.4. Provide a detailed description of the specific controlling sections and components investigated in your reevaluation, including pertinent sketches and results.

R130.28 **In response to question AEC 3.6 of the PSAR (which was originally based on the ASME-ACI-359) and questions 130.15, 130.16, and 130.18 of the FSAR, some design requirements were changed to agree with the additional requirements in the SRP (NUREG-75-087). The above question requested the identification of how these additional requirements affected the final design of Containment and other structures. Changes that may have resulted from this change in criteria would have been implemented prior to the Corrective Action Program (CAP). Therefore, the identification of any changes that may have resulted prior to the CAP are not pertinent at this time.**

The Corrective Action Program for the civil/structural area was implemented to validate the structural design of the Category I structures at CPSES. The design of Seismic Category I structures conformed to the loading combinations which are specified by U.S. NRC Standard Review Plans 3.8.1., 3.8.3 and 3.8.4 **(NUREG-75-087).** 68

NOTE: THIS PARAGRAPH SHOULD BE BOLD TYPE

The methodology and results of this validation effort are described in the Civil/Structural Project Status Report (PSR). Supplement 17 to the Safety Evaluation Report (NUREG-0797) contains the NRC's evaluation of the CAP related to the civil/structural discipline.