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March 11, 1980

Director of Nuclear Reactor Regulation
Attention: Mr. D. L. Ziemann, Chief
Operating Reactors Branch No. 2
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Subject: Docket No. 50-206
Systematic Evaluation Program
San Onofre Nuclear Generating Station
Unit 1

At a meeting in Rosemead on November 14, 1979, the NRC staff gave Southern California Edison (SCE) a copy of "Seismic Design Bases and Criteria for San Onofre Nuclear Generating Station, Unit 1, Systematic Evaluation Program, August, 1979," (EDAC-175-166.01 Draft) for SCE's review and comment. SCE has reviewed the report and comments are enclosed.

The EDAC report is simply a compilation of information from several previous SCE submittals to the NRC. It should be noted that the review of this document has not been conducted in the same manner as reviews of SCE submittals to the NRC. However, the review has been as complete as possible within the time available. In the event that the EDAC report is inconsistent with previous SCE submittals, the SCE submittals should be considered correct. Where such inconsistencies have been identified, this has been noted in the enclosed comments.

If you have any questions, please let me know.

Very truly yours,

J G Haynes

J. G. Haynes
Chief of Nuclear Engineering

Enclosure

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GENERAL COMMENTS

1. It is difficult for a reader not familiar with the seismic analyses of San Onofre Unit 1 to understand the design bases, criteria and analysis effort from the EDAC document. More care could have been taken to lead the reader through the original analysis and then the reanalysis, making clear what the original and reanalysis bases were. The majority of the report is just a reiteration of the April 29, 1977 SCE submittal in a different and more disjointed format (see General Comment 2). It might have been better if a report had been prepared discussing only the original seismic effort, and the scope of the reanalysis and then reference the April 29, 1977 SCE submittal document for reanalysis details since that report stands on its own.

2. The EDAC report is not in the Standard Format, as is the April 29, 1977 SCE submittal. The Standard Format was used by SCE at the NRC's request to facilitate review. It would have been better had the EDAC report also used the Standard Format.

3. The term "SSE" is used throughout the report instead of "DBE". Care had been taken in the April 29, 1977 SCE submittal document to maintain a consistency in terminology with the FSAR. This should have been followed in the EDAC report.

4. There are not enough references to documents used by EDAC. The specific sections and pages of docketed material should have been referenced throughout the EDAC report.

SPECIFIC COMMENTS

1. Page 1-1, Paragraph 2

   The stress components were not "combined by absolute addition". See Comment 50.

2. Page 1-2, Section 1.0

   The reference to Table 1-2 should have been Table 1-3. Table 1-2 was not referenced.

3. Page 1-2, Section 1.1

   The sphere enclosure building and diesel generator building were designed using more modern criteria, and were not part of the reevaluation. See Comment 19.C.

4. Page 1-3, Section 1.1

   A. Other safety related structures designed for 0.5g ground acceleration and Housner spectra included the fuel building and portions of the turbine building.

   B. "Main Building" should have been the Administration Control Building.

5. Page 1-3, Section 1.3

Only portions of the seismic analysis of the supports were repeated. (A list of supports evaluated is on Page 6-19 of the EDAC report and Page 3.9.1-18 of the April 29, 1977 SCE submittal document.) For example, the reactor component analysis was not repeated because it was determined that the reactor was subjected to similar seismic excitations with or without the RCS support modifications. (Reference 6, Page 3.9.1-20)

6. Page 1-4, Section 1.3

The statement is generally true, but there have been some modifications outside the scope of this reanalysis that have included a more modern criteria.

7. Page 1-5, Table 1-1.

A. The seismic input heading should have been classified as DBE so as not to be confused with OBE.

B. In the original analysis, the 0.25g Housner spectra was also used (FSAR Section 9). This is not apparent in Table 1-1.

C. Under "Re-evaluation","piping" should have been noted as reactor coolant loop (RCL) piping.

D. Under Codes Used, Comments, the list of codes should have been complete. Under the period 1961-65, the list should have contained ASA B31.1, ASME Section I and VIII, and ASME Section III, 1965. These Codes are given in Reference 6, Section 3.9.1.4.2.

E. Under the period 1975-77, "Backfit Stage", it is stated that the Code used was ASME Section IV. This should have been ASME Section III.

F. It is stated that ASME Section III, 1971 and Summer 1972 were used in the reevaluation of the reactor coolant loop and components. No date was given in the April 29, 1977 SCE submittal document. The following ASME Section III Code dates were employed for the following components in the reevaluation:

Reactor	1974
Pump	1972 (Winter)
Piping	1974
Supports	1974 (NF)
Steam Generator	1974
Pressurizer	1974

This comment also applies to Table 1-3 on Page 1-10.

8. Page 1-6, Note 4.

TERA Corporation is misspelled here and elsewhere in the EDAC report.

9. Page 1-10, Table 1-3.

A. In the original analysis, the 0.25g Housner spectra was also used (FSAR Section 9). This is not apparent from Table 1-3.

B. Under "Load Combination", deadweight should have been included and the seismic loads should have been classified as resulting from DBE.

C. Under "Results and Comments", the pump minimum surplus margin was 1.13 and not 1.7, as stated.

D. The minimum surplus margins given do not include the component nozzle stress surplus margins. In Table 1-3, it is implied that they do. Including the nozzle effects, the minimum surplus margins for the components become:

1.1 for RV - no change

1.13 for Pu - see Comment 9.C.

2.4 for Pr - no change

1.55 for SG

E. It is stated that the seismic stresses were calculated considering the combination of maximum seismic load components without time-phase relationships. This is also stated on Page 1-12, Page 5-3 (Section 5.1.3), and Page 6-12 (Section 6.1.7). This is not a true statement. The combination of maximum seismic load components with time-phase relationships was used in a large number of cases. For example, as given in the April 29, 1977 SCE submittal, Section 3.9.1.5, time-phase relationships were used for the reactor component analysis, reactor loop primary piping, pressurizer nozzles, steam generator nozzles, and reactor nozzles. As stated in Section 3.9.1.5.2.1 of the April 29, 1977 SCE submittal, as well as Pages 6-13, 6-14, 6-15 and 6-21 of the EDAC report, the pump casing and nozzle stresses were performed at every time-step during the twenty second run. Further, as given under Pump Component Analysis in Section 3.9.1.5.5 of the April 29, 1977 SCE submittal, the maximum resultant bending moment associated with the upper end of the motorstand was determined within the time segment 10 to 11.5 seconds.

10. Page 1-11, Table 1-3.

This page is missing from the EDAC report.

11. Page 1-12, Table 1-3.

For NSSS supports, the minimum surplus margin was 1.12, (Reference 6, Table 3.9.1.5-2) and 1.1 if support anchorage was considered (Reference 6, Table 3.9.1.5-3), and not 1.70 as listed in Table 1-3.

12. Page 1-13, Table 1-3.

A. The original damping values given for piping and equipment should have referenced Table 3-4 of the EDAC report. The welded steel 1% and bolted steel 2% damping values apply to reactor vessel internals (per Table 3-4). For other framed steel structures, the damping value is 2.5% (EDAC Table 3-4 and FSAR Table 9.1).

B. It is stated under the section for all other Category A piping and equipment that the 1964 B31.1 Code was used. In Section 9 of the FSAR, it just refers to the B31.1 Code. For RCL piping, ASA B31.1 1955 Code was used to establish cyclic loads with ASME Boiler and Pressure Vessel Code Section I. Further, in the equipment specification concerned with auxiliary piping systems pipe hangers and supports, ASA B31.1 1955 is referenced. Therefore, the reference to the 1964 Code is not consistent with existing design documents and the FSAR.

C. The table refers to ASME Section III - 1962. However, ASME Section III did not exist in 1962, but was published in 1963.

13. Page 3-2, Paragraph 3.4.2.

Subsurface conditions at the site were explored by means of borings to a depth of 987 feet after construction of Unit 1 and prior to construction of Units 2 and 3 (Appendix 2.5.C of the San Onofre Units 2 and 3 FSAR).

14. Page 3-2, Paragraph 3.4.3.

Section 2.5.2.4 of the San Onofre Units 2 and 3 FSAR lists faults significant to establishing the earthquake potential at the San Onofre site. This paragraph in the EDAC report should have been consistent with the San Onofre Units 2 and 3 FSAR.

15. Page 3-4, First paragraph

A. Contrary to statements made in the EDAC report, the seismic design basis for San Onofre Unit 1 has not been changed. The plant is being reevaluated, however, to a seismic design criteria higher than the original design.

B. Reference 5, Del Mar Technical Associates, "Simulation of Earthquake Ground Motions for San Onofre Nuclear Generating Station Unit 1," final report to SCE, California, May, 1978, should have included Supplement 1, July, 1979. Supplement 1 included, among other things, random effects and generated a mean value of velocity versus

period. However, the ZPA for the mean was not calculated; therefore, the value of 0.37g in paragraph 2 of page 3-4 is no longer appropriate.

16. Page 3-4, Section 3.5.2

Reference is made to Figure 3-11 (page 3-30 of the EDAC report). That figure is not the appropriate figure. Supplement 1 of Reference 5 (see Comment 15.B) contains a more up-to-date figure. The appropriate figure from Reference 5, Supplement 1 should have been used and Section 3.5.2 should have been worded for the proper comparison.

17. Page 3-5, Section 3.5.3

There is a typographical error in the third line. The ZPA for the vertical direction is 0.33g for the DBE.

18. Page 3-5, Section 3.5.4

The three components were not statistically independent, but had sufficiently low correlation factors to justify simultaneous input of the three traces.

19. Page 3-7, Paragraph 3.7.2.

A. As stated in Comment 15, the seismic design criteria for San Onofre Unit 1 has not been changed.

B. It is not clear in this section that the 0.67g ground acceleration is for the horizontal component of the DBE.

C. The sphere enclosure and diesel/generator building were designed in accordance with the 0.67g Newmark criteria and were not part of the reevaluation.

D. The criteria for reevaluation and modifications of the NSSS and for design of the sphere enclosure were not the same in all respects. For example, Regulatory Guide 1.92, Combining Modal Responses, was not followed for reanalysis of the sphere and reactor building.

E. This section should have been written as follows:

"Reevaluation and modification of the NSSS, its support systems, equipment and components used 2/3g Housner criteria.

The vertical component was taken to be 2/3 of the horizontal and a time history which produced a response spectrum compatible with the 2% damped Housner spectrum was used in the reevaluation.

The sphere enclosure and diesel generator buildings were originally designed and constructed using 2/3g Newmark criteria and were not part of the reevaluation."

20. Page 3-12, Table 3-3

Table 3-3 lists the categorization of reactor equipment as listed in FSAR Table 9-2. However, it is noted that for the purposes of reevaluation, some items on this list may change.

21. Page 3-19, Table 3-5.

A. The reactor coolant pump and steam generator damping of 4% should have been included in the table. (Reference 6, Page 3.7.2-65)

B. The footnote should have read:

> "Energy loss resulting from impact was represented in the RCS system model by dash pots acting as viscous dampers during impact. The viscous damper was adjusted to produce an energy loss equivalent to experimentally determined values. These values were expressed as coefficients of restitution, which were then converted to damping percentages; 8% for the main coolant loop (based on the coefficient of restitution of steel on steel) and 25% for the fuel assembly impact. (Reference: Gesinski, L. and Chang, P., "Safety Analysis of the 17 x 17 Fuel Assembly for Combined Seismic and Loss of Coolant Accident", WCAP 8288.)

22. Page 4-1, Section 4.0

A. Item 4 does not identify which foundations are intended.

B. The fuel handling building should have been included in Item 7.

23. Page 4-3, Section 4.1.3

The +100% and -50% variation in the soil modulus applied only to the sand transition zone where the steel sphere meets the concrete foundation. The seismic response of the sphere was analyzed using a single modulus value of 4100 ksf which was chosen based on parametric studies of confining pressure, strain level, building frequency and probability.

24. Page 4-3, Section 4.1.4

The first sentence should have read:

> "An axisymmetric, finite element model ..."

25. Page 4-4, Section 4.1.7

Item C should have included "under dead weight, internal pressure and seismic loads".

26. Page 4-5, Section 4.1.10

A. In the first sentence, "latches" should have been "hatches".

B. The finite element model described in Section 4.1.4 was not used to generate in-structure floor response spectra. The model used is described in Section 3.7.2.1.2 of Reference 6.

27. Page 4-6, Section 4.2.1.

As stated in Section 3.1.1.1 of Amendment 52 of the Unit 1 FSAR (Reference 7 of the EDAC report), the elevation of the ring girder which supports the roof is 105', not 111'-1".

28. Page 4-10, Section 4.2.7.

A. For completeness, the definition of tornado load should have included "and a repressurization" (Page 3.1-8, Amendment 52 of the Unit 1 FSAR.)

B. In the table showing missiles and assumed velocities, the wood missile should have been a 4"x4"x12' long beam.

29. Page 4-13, Section 4.3.3

Multi-directional components of the earthquake and the modal response were combined using the SRSS method. No special provision for closely spaced modes in accordance with Regulatory Guide 1.92 was included.

30. Page 4-14, Section 4.3.5

Table 3-5 does not include soil damping values as stated.

31. Page 4-17, Last paragraph

According to Section 11.1.1 of ACI-318-71, shear reinforcement through the wall thickness (i.e., stirrups) is not required if:

$v_v < 1/2\ v_c$

where $v_c = 2\sqrt{f_c'}$

v_c equals 110 psi for f_c' equal to 300 psi. Since no ties were provided between the reinforcing on the inside and outside faces of the wall, it was necessary to maintain v_u less than 55 psi for f_c equal to 3000 psi.

32. Page 4-19, Section 4.3.11

Table 4-7 does not give a frequency comparison as stated.

33. Page 4-20, Section 4.4.8

Under Item 1), the word "heating" is a typographical error from Reference 6. The word should have been "seating".

34. Page 4-23, Section 4.6.1

A. The Main Building (Administration/Control) is not located between the turbine and containment. See Figure 4-1 of the EDAC report.

B. The Administration Office is now located in the Administration/ Warehouse/Shop (AWS) Building, located southeast of the main building.

C. The Control Room and Watch Engineer Office are located on the same floor, elevation 42'-6".

35. Page 4-23, Section 4.6.2.

The original design, as stated on page 9-8 of the Unit 1 FSAR (Reference 1), was one horizontal and one vertical component, as opposed to two horizontal components and one vertical component.

36. Page 4-24, Section 4.6.3

A pseudo-response spectrum analysis method was used, not a true response spectrum analysis. The analysis method used is described in the second paragraph of Section 4.6.4, Model Description.

37. Page 4-24, Section 4.6.4

A. A dynamic model was not used. Seismic loads were based on the zero-period acceleration from the design spectra.

B. The second paragraph should have been included in Section 4.6.3, Analysis Method.

38. Page 4-26, Section 4.7.1

The Fuel Building should have been included in the list of Category A structures.

39. Page 4-26, Section 4.7.3

Natural periods of vibration were not determined for obviously rigid type structures (e.g., auxiliary building and turbine pedestal). For these structures, the zero-period acceleration from the design spectra or other equivalent static criteria was used.

40. Page 4-31, Table 4-2

Loads for the Design + OBE condition were based on a 1/3 DBE earthquake load (0.22g OBE at zero period) and not a 1/3g load.

41. Page 4-43, Figure 4-1

The site plot plan illustrates the location of all structures listed on page 4-1 except the diesel generator building.

42. Page 4-58, Figure 4-15

This is a repeat of Figure 4-3.

43. Page 5-2.

A. The material used in construction for pipe should have read:

"Pipe-SA-376, Type 316, seamless, 27.5" I.D. and larger".

B. The material used in construction for fittings should have read:

"Fittings-SA-351, Grade CF8M, all 27.5" and larger".

C. The material used in construction for the surge line should have read:

"Surge Line-SA-376, Type 316, Schedule 160, ASA 36.10".

44. Page 5-3, Paragraph 5.1.2.

The time-histories used in the seismic reevaluation were 20 seconds in duration (Reference 6, Page 3.7.1-1), not 22 seconds.

45. Page 5-3, Paragraph 5.1.4.

A. In the time-history analysis performed, six soil springs were not used. Three soil springs were used for rocking and vertical motion. Horizontal translation soil springs were not used since the soil is stiff for this type of motion.

B. Reference should have been made to Figure 5-3 rather than Figure 5-2.

46. Page 5-13, Section 5.1.8.

A. The first line should have read "The RCL model was connected to a three-dimensional model of the RB".

B. The second line should have read "...that simulated the significant frequency".

47. Page 5-13, Paragraph 5.1.9.

The date, 1971, is not correct. See Comment 7.F.

48. Page 5-13, Paragraph 5.1.10.

The date, 1971, is not correct. See Comment 7.F.

49. Page 5-15, Last Paragraph.

This paragraph should have addressed the system model and not the reduced model since the system model was verified by comparison to test results and by comparison to seismic response deflections calculated using the detailed building-simplified NSSS model. The simplified NSSS model and the reduced model, as described in the EDAC report, are the same.

50. Page 5-17, Section 5.2.3, paragraph a.

It is stated that the vertical and horizontal seismic stresses are combined by "absolute addition". In the FSAR, Paragraph 9.2.4, Item 5a, it is stated that the horizontal and vertical components are considered "acting simultaneously". The results obtained will be similar to, or equal to that obtained by the "absolute sum method". However, the procedure employed is not the same as an absolute sum method, which would have required separate analyses for the horizontal and vertical seismic components. Therefore, the statements made in the EDAC report concerning absolute addition of seismic stresses are not correct.

51. Page 5-18, Section 5.2.7

See Comment 50.

52. Page 5-19, Table 5-1

A. For RB rocking, a damping ratio of 15% is given. This is not correct. The damping value should have been 10%, which reflects soil rocking,(Reference 6 Page 3.7.6-66). Further, the component "RB, rocking" should have read "RB, soil rocking".

B. The component "RB, translation" should be "RB, vertical soil translation", so it would not be confused with horizontal translation.

53. Page 5-20, Table 5-2

Footnote "f" was not in SCE's April 29, 1977 submittal but was added in the EDAC report. This footnote should not have been included. Section 3.9.1.4 in the April 29, 1977 SCE submittal document should have been reproduced in the report and referenced Table 5-2. It should be noted that the EDAC report does not give the design stress limit for steam generator internals on the secondary side, which is contained in Paragraph 3.9.1.4.4 or the grid crush strength which is contained in Paragraph 3.9.1.4.7.

54. Page 5-26, Figure 5-6

This figure is not the latest since it does not reflect the upper lateral support (elevation 43'-6") which was added (and referred to on page 5-6). Figure B-2 on Page B-5 of Reference 6 illustrates the upper support.

55. Page 6-1, Section 6.0

It is noted that while the discussions in Section 6 are confined to Category A (Class I or Category 1E) equipment and their supports, not all Category A equipment is included.

56. Page 6-1, Section 6.1.1

In order to avoid possible confusion, reference should have been made to San Onofre, Unit 1.

57. Page 6-4, Section 6.1.1, last paragraph.

There were several reasons for reevaluating the RCL, including changes in seismic qualification requirements. Seismic analysis has also become increasingly sophisticated since the time of the original design of San Onofre, Unit 1. The primary objectives of the reevaluation program were:

A. To ensure the integrity, during a 2/3g Housner DBE, of structures and systems that prevent a Hypothetical Accident (reactor building and reactor coolant system) and

B. To ensure the integrity, during a 2/3g Housner DBE, of the major structural feature that mitigates the consequences of a Hypothetical Accident (containment sphere).

58. Page 6-10, Paragraph 2

The correlation of test and analytical results is discussed in Appendix B of the EDAC report, not Appendix C.

59. Page 6-12, Section 6.16

A. In the third line, the word "model" should have been "modal" and the word "an" should have been "and".

B. The frequency range and damping ratio in Table 5-1 refer to the system model and not the component models. Table 3-5 should have been referenced instead of Table 5-1.

60. Page 6-14, first paragraph

The surplus margins are stated to be greater than unity. It should have been stated that the surplus margins are equal to or greater than 1.1, since this was an NRC requirement.

61. Page 6-16

A. Table 5-2 does not provide all the information concerning allowable limits, namely, grid crush strength and deflection limits. Grid crush strength is addressed in Section 3.9.1.4.7, page 3.9.1-13 of the April 29, 1977 SCE submittal document. Deflection limits are addressed in Section 3.9.1.4.5, page 3.9.1-9 of the same document.

B. In the second paragraph, "OBE" should have been "DBE".

62. Page 6-20, Section 6.2.3

A. The first sentence should have read "The direct integration time-history approach was used to compute the dynamic response of the reactor coolant loop and components".

B. The computer program STRUDL was not used for time-history analysis. See Comment 64.

63. Page 6-21, Section 6.2.4

Modal damping was not employed in the time-history analysis; Rayleigh's damping or viscous damping was employed as discussed in Section 3.7.2.15 of Reference 6.

64. Page 6-21, Section 6.2.6

A time-history analysis was performed using the combined RCL-building-soil model. Loads which the supports must carry were generated from this analysis. These loads were applied statically, and not by time-history, to models of the supports using the computer program STRUDL.

65. Page 6-21, Section 6.2.7.

It is not stated in the April 29, 1977 SCE submittal document that the supports were evaluated using maximum earthquake component loads "applied without consideration of time-phase relationship." In general, this is true. However, the calculation of embedment loads for pump frame B did not include the time-phase relationship.

66. Page 6-22, Section 6.2.8 and Section 6.2.9

Sub-section NC of ASME B and PV Code, Section III was not used for supports. Sub-section NF was used.

67. Page 6-26, Section 6.4.8 and 6.4.9

The EDAC report points to "Reference 31". There is no Reference 31 listed in the References section.

68. Page 6-26, Section 6.5.1

A. The equipment hatch is approximately 22' above grade, not 25'.

B. The last sentence should have read:

> "The escape hatch is approximately 7' in diameter and is supported by both the steel sphere and the sphere enclosure building."

69. Page 6-27, Section 6.5.5

The damping valves are the same as the containment (4%).

70. Page 6-28, Table 6-1

A. The footnote indicated by a * is not referenced in the table.

B. In the footnote, it should have been clarified that the 0.67g acceleration level does not refer to the seismic acceleration for the vertical direction.

C. The surplus margin for the steam generator should have been 3.33, not 3.30. (Reference 6, Page B-12)

71. Page 6-30, Table 6-3

The minimum surplus margin for Pr Support Structure should have been 1.45 and not 1.43.

72. Page C-1, Appendix C.

A. In the first paragraph, tenth line, there is a missing word "lateral". The sentence should have read, "Primary coolant loop piping provides lateral support in the ....".

B. In the second paragraph, seventh line, there are missing words. The sentence should have read, "Lateral support for the frame is provided by beams that attach to the refueling canal, ...".

73. Page C-2, Appendix C.

In the first paragraph, the end of the last sentence should have read, "...is shown in Figures C-1, C-2 and C-3".

74. Page C-3, Appendix C

Under d. Pressurizer, reference should have been made to Figure B-2, Page B-5 of Reference 6 and that figure should have been incorporated into the EDAC report. See Comment 54.

75. Page C-5, Section C.2.

A. This section is not complete. It should have included, from Paragraph 3.8.3.2 of Reference 6:

> "Stress criteria for structural steel not covered by Subsection NF, Section III, ASME Boiler and Pressure Vessel Code are in accordance with AISC Specification for Design, Fabrication, and Erection of Structural Steel for Buildings, 1971 Edition".

B. It is not clear why Section C.2 was included in Appendix C.