



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 7, 1985

Docket No.: 50-206
LS05-85-11-013

Mr. Kenneth P. Baskin, Vice President
Nuclear Engineering
Safety and Licensing Department
Southern California Edison Company
2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770

Dear Mr. Baskin:

SUBJECT: SAN ONOFRE UNIT 1-SEP TOPIC III-6 SEISMIC DESIGN
CONSIDERATIONS (MASONRY WALLS AND FUEL STORAGE
BUILDING) AND IE BULLETIN 80-11, MASONRY WALL DESIGN

The enclosed safety evaluation provides the results of the staff's review of your submittals on seismic reevaluation of reinforced concrete masonry walls at San Onofre Unit 1. These submittals were provided in response to IE Bulletin 80-11 and as part of the SEP seismic review. The staff's evaluation is based on the results of reviews performed by Franklin Research Center, which are discussed in the enclosed Technical Evaluation Reports (TER).

Southern California Edison Company (SCE) developed a nonlinear analysis technique to evaluate the masonry walls at San Onofre Unit 1. A test program was also conducted to validate the analysis technique. Your letter of April 12, 1984 requested withholding from public disclosure, pursuant to 10 CFR 2.790, of the details of the test program and the results. By letter dated May 15, 1984, the staff approved your request for withholding.

By letter dated July 26, 1985 the staff issued to SCE a copy of the draft TER prepared by Franklin for your review to identify which specific sections you considered to be proprietary. Your letter of September 20, 1985 provided your response along with an application for withholding of specified pages. It should be noted that the page numbering of the final TER is slightly different from the draft that you reviewed, however, the pages that are now being treated as proprietary information contain the same information as those identified in your letter.

Enclosures 2 and 3 to this letter are the non-proprietary and proprietary versions of the TER respectively. The proprietary version is being withheld from public disclosure in accordance with 10 CFR 2.790 and our previous approval of your withholding application.

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P PDR

Mr. Kenneth P. Baskin
Southern California Edison Company

San Onofre Nuclear Generating Station
Unit No. 1

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Regional Administrator, Region V
U.S. Nuclear Regulatory Commission
1450 Maria Lane
Walnut Creek, California 94596

November 7, 1985

- 2 -

As discussed in the staff safety evaluation, Enclosure 1, the staff concludes the following: 1) there is reasonable assurance that the masonry walls at San Onofre 1 will withstand the 0.67g modified Housner earthquake without loss of wall integrity or of required safety function 2) The requirements of items 2(b) and 3 of IE Bulletin 80-11 are considered to be implemented and 3) there is reasonable assurance that the fuel storage building and its components will withstand the 0.67g modified Housner spectrum earthquake without loss of integrity or of required safety functions.

Sincerely,

Original signed by: J. A. Zwolinski

John A. Zwolinski, Chief
Operating Reactors Branch No. 5
Division of Licensing

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As discussed in the staff safety evaluation report, Enclosure 1, the staff concludes the following: 1) there is reasonable assurance that the masonry walls at San Onofre 1 will withstand the 0.67g modified Housner earthquake without loss of wall integrity or of required safety function 2) The requirements of items 2(b) and 3 of IE Bulletin 80-11 are considered to be implemented and 3) there is reasonable assurance that the fuel storage building and its components will withstand the 0.67g modified Housner spectrum earthquake without loss of integrity or of required safety functions.

John A. Zwolinski, Chief
Operating Reactors Branch No. 5
Division of Licensing

Enclosures:
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SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SEP TOPIC III-6, MASONRY WALLS (INCLUDING IE BULLETIN 80-11 RESPONSES)

AND FUEL STORAGE BUILDING

SAN ONOFRE NUCLEAR GENERATING STATION (SONGS) - UNIT 1

DOCKET NO.: 50-206

I. INTRODUCTION

On May 8, 1980, the NRC issued Inspection and Enforcement (IE) Bulletin 80-11, Masonry Wall Design, which required licensees to reevaluate the design adequacy of safety-related masonry walls under postulated loads, including seismic load. SCE responded to the bulletin by letters dated July 17, 1980 and November 10, 1980. Under SEP Topic III-6, a seismic reevaluation of structures, systems and components was being performed. The Bulletin review of masonry walls for seismic events was therefore incorporated into the overall SEP seismic review.

II. DISCUSSION

The findings reported in this Safety Evaluation (SE) are based on the attached Technical Evaluation Report (TER) prepared by Franklin Research Center (FRC) as a contractor to NRC. The TER contains the details of construction techniques used, technical information reviewed, acceptance criteria, and technical findings with respect to adequacy of masonry walls at SONGS-1 to withstand design loading conditions and the effects of the earthquake specified in the Systematic Evaluation Program (SEP) (modified Housner spectrum anchored at 0.67g). The discussions on the masonry walls include the detailed descriptions of the licensee's nonlinear analysis technique. In addition, the TER contains technical findings with respect to the seismic analysis of the fuel storage building and adequacy of its various structural components to withstand imposed loadings. The staff has reviewed the TER and concurs with its technical findings. The following is our summary of major technical findings.

A. Masonry Walls

A total of 33 masonry walls at SONGS-1 are within the scope of this evaluation. These walls are located in the following buildings: Turbine Building (12 walls); Ventilation Equipment Building (4 walls); Reactor Auxiliary Building (7 walls); and Fuel Storage Building (10 walls). All of the masonry walls at SONGS-1 are reinforced vertically and have horizontal bond beams at 48 inches.

The licensee has qualified only one wall in the reactor auxiliary building based on working stress criteria utilizing linear analysis. The licensee's working stress criteria, as applied in the evaluation of this wall, are in compliance with the staff acceptance criteria. Therefore, the staff concludes that this wall has been shown to be adequate to withstand the seismic load.

The licensee developed a rigorous non-linear analyses technique, taking into account the ductile behavior of reinforced walls into post-yield conditions when subject to out-of-plane seismic loading (see section 5 of the TER for complete discussion of this technique). The licensee used this technique to evaluate the remaining masonry walls.

Based on the review of this technique by the staff, FRC and FRC's consultants, the staff requested the licensee to develop a test program to validate the non-linear analysis technique. After several discussions with the staff, the licensee's final test program consisted of testing of six full size wall panels, built to simulate actual conditions in the plant, by subjecting them to the required seismic loading. Sections 7 and 9 of the TER contains detailed discussions of the test program, results and observations from the test program, and correlation between test results and the analysis technique predictions. Based on these discussions, the staff finds the following:

- ° Test results demonstrated that the walls were able to withstand the SEP earthquake levels specified for SONGS-1.
- ° Test results demonstrated that a well-anchored reinforced concrete masonry wall could sustain inelastic deformations. The test walls exhibited a ductile mode of behavior.
- ° Test results demonstrated that although the wall's mid-span displacements were noticeably high in a few cases, the overall wall conditions were reasonably good. Except for the bottom joint, no extensive crushing of face shell or spalling was reported. The anchors were well behaved; wall stability was maintained. It was also noted that the test input motions for the critical walls representing the fuel storage building were significantly higher (i.e., on the average at least 25% higher) than the calculated SEP motions. This is an indication of available margin associated with the SEP seismic loadings.
- ° In general, the analytical procedures were able to capture the behavior of the test walls. However, due to differences in the input values of the test and the analysis, several parameters in the correlation study did not exhibit good correlation. It is judged that the model was tested and

examined extensively during the model formulation phase and the fact that it captured the general response of the walls indicated that the methodology is very promising. However, it is judged that additional study should be conducted before using it in future applications. As a minimum, the following parameters should be examined: (1) Adjust the steel strength of the rebar in the model to reflect the actual results; (b) Adjust the input loadings applied to the model so that they are comparable to those of the test inputs; (c) Adjust the off-center location of the rebar in wall in the model as required; (d) Adjust the length of the plastic hinge in the model and (e) Refine the model so that it could predict the permanent set of the wall.

- ° Despite the assessment given above regarding the correlation between the analysis technique and the test program, the fact that the test walls did exhibit their capacity and that a ductile behavior was realized in the tests serves as evidence that the San Onofre walls will perform their intended functions in the postulated SEP seismic environment.

B. Fuel Storage Building

In addition to the masonry walls of the fuel storage building, the staff also evaluated the seismic analysis of the building and its various components (i.e., structural steel framing, reinforced concrete fuel pool and basement, reinforced concrete slab at elevation 42 feet, and roof deck) to determine their adequacy to withstand the SEP seismic loading. As discussed in Section 5.2 of the TER, the licensee used both linear and nonlinear models to perform the seismic analysis of the fuel storage building. The review of the licensee's seismic analysis and subsequent structural evaluations indicates that the various structural components of the fuel building are adequate to resist the SEP seismic loading and that they comply with the acceptance criteria. The acceptance criteria are in accordance with the "Specification for Steel Design," AISC, 1978 edition and "Building Code Requirements for Reinforced Concrete," ACI 318, 1977 edition.

III. CONCLUSION

Based on the findings discussed above, the staff concludes the following:

- ° Based on the test results of the most critical walls, there is a reasonable assurance that masonry walls at SONGS-1 will withstand the specified SEP seismic reevaluation loading without loss of wall integrity or of the required safety functions.

- ° The test program results also satisfy the requirements of IE Bulletin 80-11, Masonry Wall Design. Therefore, items 2(b) and 3 of the bulletin are considered fully implemented at SONGS-1.
- ° The seismic analysis of the fuel storage building is found to be acceptable and there is reasonable assurance that the building and its components will withstand the specified SEP seismic reevaluation loading without loss of integrity or of required safety functions.

IV. Acknowledgment

Principal contributor: N. Chokshi