Docket File

MAR 1 9 1987

Mr. Donald R. Hunter, Assistant Director
for Research
Office of Legislative Services
Room 109 State House
Concord, New Hampshire 03301

Dear Mr. Hunter:

Your letter to Chairman Zech, dated March 2, 1987, regarding the seismic safety of the Seabrook Nuclear Power Plant, has been directed to this office for response. In the letter, you asked, "what proof is there that the earthquake-proof design of the Seabrook plant will actually protect the plant in the event of an earthquake, and could activity along the Portsmouth and/or Clinton-Newbury faults have any effect on the plant?".

The basic approach for addressing the effects of an earthquake on nuclear plants (including the Seabrook plant) is to define a safe shutdown earthquake (SSE) for each particular plant and to then ensure that structures, piping components and equipment required to maintain the safety of the plant are designed to withstand an earthquake of this magnitude.

The SSE is determined based on an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of the local subsurface material. For most Eastern U. S. plants (including Seabrook) the SSE is defined by assuming that the largest historic earthquake in the surrounding tectonic province recurs in the vicinity of the plant site. The staff conducts reviews of the geologic and seismologic studies performed by the utility to assure an acceptable SSE has been defined in accordance with NRC regulations.

Structures, piping components, and equipment required to maintain the safety of the plant are analyzed for the SSE using standard dynamic analysis techniques. Post-earthquake observation of structures and systems similar to those in nuclear power plants has confirmed that this type of seismic design results in a conservative seismic margin above the design earthquake levels. The design of structures, piping components, and equipment are reviewed by the staff for compliance with applicable NRC regulations and guidelines.

The NRC also conducts audits and inspections to assure both with respect to design and construction that the quality assurance regulations of Appendix B to 10 CFR 50 (Ref. 1) have been properly implemented.

The staff has completed its review of the Seabrook seismic design following the above approach and concluded in its Safety Evaluation Report (SER, Ref. 2) that the plant will maintain its integrity and safety in the event of a safe shutdown earthquake. A pertinent portion (Sections 3.7.1 to 3.7.3) of the SER is attached as Enclosure 1 for your information.

With respect to your second question concerning the Portsmouth and Clinton-Newbury faults, an extensive evaluation by the licensee and the NRC staff review of the geologic data indicates that these faults are not capable and pose no earthquake threat to the Seabrook Nuclear Power Plant. The bases for these conclusions are provided in Section 2.5 of the Safety Evaluation Report. The pertinent portion (Section 2.5.3) of the SER is attached as Enclosure 2.

For your information, an exhaustive compilation of all applicant submittals, staff reviews, and public hearing records is available at the public document rooms in the Exeter Public Library of Exeter, New Hampshire. These materials are readily available for perusal.

I trust that the above discussion has fully addressed your questions and will alleviate the concerns expressed by the New Hampshire State Representative.

Sincerely,

Original Signed by
H. R. Denton

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosures: As stated

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3/16/87	3/16/87	3/16 /87	3/17/87	3/17/87	3/18/87	3/18/87

With respect to your second question concerning the Portsmouth and Clinton-Newbury faults, an extensive evaluation by the licensee and the NRC staff review with consultation with the U. S. Geologic Survey concerning the seismicity data for the various fault systems indicate that there are no active faults in the vicinity of the site. Based on these findings, these faults are regarded as not being capable and no seismic activity is expected to originate from these faults. The bases for concluding that the faults are non-active are provided in Section 2.5 of the Safety Evaluation Report. The pertinent portion (Section 2.5.3) of the SER is attached as Enclosure 2.

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3/16/87	3/16/87	3/16 /87	3/17 /87	3/17/87	3/18/87	3/ /87

The staff has completed its review of the Seabrook seismic design following the above criteria and concluded in its Safety Evaluation Report (SER, Ref. 4) that the plant will maintain its integrity and safety in the event of a design basis earthquake. A pertinent portion (Sections 3.7.1 to 3.7.3) of the SER is attached as Enclosure 1 for your information.

With respect to your second question concerning the Portsmouth and Clinton-Newbury faults, an extensive evaluation by the Seabrook plant owners and NRC staff review of the seismicity data concerning the fault system indicate that there are no active faults in the vicinity of the site. Based on these findings, no safety significance can be attached to these faults since no seismic activity is expected to originate from them. The bases for concluding that the faults are non-active are provided in Section 2.5 of the Safety Evaluation Report. The pertinent portion (Section 2.5.3) of the SER is attached as Enclosure 2.

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3/16/87	3/16/87	3/16 /87	3/17/87	3/ /87	3/ /87	3/ /87

The staff had completed its review of the Seabrook seismic design following the above criteria and concluded in its Safety Evaluation Report (SER, Ref. 5) that the plant would maintain its integrity and safety in the event of the design basis earthquake. A pertinent portion (Sections 3.7.1 to 3.7.3) of the SER is attached as Enclosure 1 for your information.

With respect to your second question concerning the Portsmouth and Clinton-Newbury faults, an extensive evaluation by the Seabrook plant owners and the NRC staff review of the seismicity data concerning the fault system indicate that there are no active faults in the vicinity of the site. Based on these findings, no safety significance can be attached to these faults since no seismic activity is expected to be originating from them. The bases for concluding that the faults are non-active are provided in Section 2.5 of the Safety Evaluation Report. The pertinent portion (Section 2.5.3) of the SER is attached as Enclosure 2.

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In accordance with the requirements of Reference 1, the safe shutdown earthquake for Seabrook is set at 0.25 g maximum ground acceleration. The plant is conservatively designed to be safely shutdown in the event of an SSE.

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REFERENCES:

1. Appendix B to 10 CFR Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

2. NUREG-0896, "Safety Evaluation Report Related to the Operation of Seabrook Station" and its Supplements 1 to 5.

The staff has reviewed the applicant's methodology for analysis of jet impingement forces and finds it consistent with the guidelines in SRP 3.6.2. Thus, it is acceptable.

Based on its review of FSAR Section 3.6.2, the staff concludes that the pipe rupture postulation and the associated effects are adequately considered in the plant design. Therefore, they are acceptable and meet the requirements of GDC 4. This conclusion is based on the following:

(1) The proposed pipe rupture locations have been adequately assumed and the design of piping restraints and measures to deal with the subsequent dynamic effects of pipe whip and jet impingement provide adequate protection to the structural integrity of safety-related structures, systems, and components.

(2) The provision for protection against dynamic effects associated with pipe ruptures of the reactor coolant pressure boundary inside containment and the resulting discharging fluid provide adequate assurance that design-basis LOCAs will not be aggravated by sequential failures of safety-related piping, and emergency core cooling system performance will not be degraded by these dynamic effects.

(3) The proposed piping and restraint arrangement and applicable design considerations for high- and moderate-energy fluid systems inside and outside of containment, including the reactor coolant pressure boundary, will provide adequate assurance that the structures, systems, and components important to safety that are in close proximity to the postulated pipe rupture will be protected. The design will be of a nature to mitigate the consequences of pipe ruptures so that the reactor can be safely shut down and maintained in a safe shutdown condition in the event of a postulated rupture of a high- or moderate-energy piping system inside or outside of containment.

3.7 Seismic Design

3.7.1 Seismic Input

The input seismic design response spectra for the operating basis earthquake (OBE) and the safe shutdown earthquake (SSE) are defined at the bedrock. These spectra comply with RG 1.60. All seismic Category I structures, with the exception of electrical manholes and ductbanks, are founded on the bedrock or conrete fill extending to the bedrock. The manholes and ductbanks are founded on soil with maximum depth of soil between the foundation and the bedrock being 18 ft. The soil amplification phenomenon has been accounted for in the seismic analysis for manholes and for ductbanks.

The damping ratios (expressed as a percentage of critical) used in the analysis of various seismic Category I structures, systems, and components are in compliance with those listed in RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants."

The staff concludes that the seismic design parameters used in the plant structure design are acceptable and meet the requirements of GDC 2 and Appendix A to

10 CFR 100 by appropriate consideration for the most severe earthquake recorded for the site with an appropriate margin and considerations for two levels of earthquakes, the SSE and OBE. The applicant has met these requirements by the use of the methods and procedures indicated below.

The seismic design response spectra (OBE and SSE) applied in the design of seismic Category I structures, systems, and components comply with the recommendations of RG 1.60. The specific percentage of critical damping values used in the seismic analysis of Category I structures, systems, and components are in conformance with RG 1.61. The artificial synthetic time history used for seismic design of Category I plant structures, systems, and components is adjusted in amplitude and frequency content to obtain response spectra that envelop the design response spectra specified for the site. Conformance with the recommendations of RGs 1.60 and 1.61 ensures that the seismic inputs to Category I structures, systems, and components are adquately defined to form a conservative basis for the design of such structures, systems, and components to withstand seismic loadings.

3.7.2 Seismic System Analysis

This topic is addressed in Section 3.7.3.

3.7.3 Seismic Subsystem Analysis

The scope of review of the seismic system and subsystem analysis for the plant included the seismic analysis methods for all seismic Category I structures, systems, and components. It included review of procedures for modeling, seismic soil-structures interaction, development of floor response spectra, inclusion of torsional effects, evaluation of Category I structure overturning, and determination of composite damping. The review has included design criteria and procedures for evaluation of interaction of non-Category I structures with Category I structures and effects of parameter variations on floor response spectra. The review has also included criteria and seismic analysis procedures for Category I buried piping outside the containment.

The system and subsystem analyses were performed by the applicant on an elastic basis. Modal response spectrum 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 was used, all modes except the closely spaced modes are combined by the square root of the sum of the squares (SRSS) method. The method used to combine the closely space modes was in compliance with the intent of RG 1.92. The applicant has used a fixed-base lump mass model for all major seismic Category I structures. The square root of the sum of the squares of the maximum co-directional responses was used in accounting for three components of earthquake motion. Floor spectra inputs used for design and test verifications of structures, systems, and components were generated from the time history methods, taking into account variation of parameters by peak widening. A vertical seismic system dynamic analysis is employed for all structures, systems, and components. Torsional effects and stability against overturning are considered. However, the accidental torsion was not accounted for in the analysis.

The present staff position requires that the accidental torsion, based on the eccentricity of 5% of the base dimension, be included in the design of structures. This is an addition to that which results from the actual geometry and mass distribution of the building. The applicant believed that the added accidental torsion would not result in a need to modify its structures, and this was verified by subsequent confirmatory analyses.

The staff concludes that the plant design is acceptable and meets the requirements of GDC 2 and Appendix A to 10 CFR 100 with respect to the capability of the structures to withstand the effects of the earthquakes so that the design reflects

(1) appropriate consideration for the most severe earthquake recorded for the site with an appropriate margin (GDC 2); consideration of two levels of earthquakes (Appendix A, 10 CFR 100)

(2) appropriate combination of the effects of normal and accident conditions with the effect of the natural phenomena

(3) the importance of the safety functions to be performed (GDC 2); the use of a suitable dynamic analysis or a suitable qualification test to demonstrate that structures, systems, and components can withstand the seismic and other concurrent loads, except where it can be demonstrated that the use of an equivalent static load method provides adequate consideration (Appendix A, 10 CFR 100)

The applicant has met the requirements of item (1) above by use of the acceptable seismic design parameters, according to SRP 3.7.1. The combination of earthquake-resultant loads with those resulting from normal and accident conditions in the design of Category I structures as specified in SRP 3.8.1 through 3.8.5 will be in conformance with item (2) above.

The staff concludes that the use of the seismic structural analysis procedures and criteria delineated above by the applicant provides an acceptable basis for the seismic design, which is in conformance with the requirements of item (3) above.

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 RG 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 staff concludes that the seismic instrumentation system provided for the plant is acceptable and meets the requirements of GDC 2 and 10-CFR 50.55a by providing the instrumentation that is capable of measuring the effects of an earthquake and by providing the inservice inspection program that will verify operability by performing channel checks, calibrations, and functional test at acceptable intervals. In addition, the installation of the specified seismic instrumentation in the reactor containment structure and other Category I assumptions regarding ground motion that underlie the SSE design response spectra, particularly for frequencies greater than about 9 Hz. The staff's review of vibratory ground motion will be completed after receipt and evaluation of this information.

2.5.2.6.5 Duration

The applicant has assumed a duration of strong ground shaking (acceleration greater than 0.05 g) of 10 to 15 seconds for the SSE. This is a conservative estimate for Intensity VIII (MM) shaking at rock sites near the causative earthquake (e.g., see Chang and Krinitzsky, 1977). The adequacy of the time history used for seismic analysis is reviewed in Section 3.7.1.

2.5.2.7 Operating Basis Earthquake

The applicant has characterized the OBE by a 0.125 g-RG 1.60 response spectrum. A peak horizontal acceleration of 0.125 g corresponds approximately to Intensity VII (MM) ground motion (Trifunac and Brady, 1975). The OBE acceleration level is one-half that of the SSE, in accordance with Appendix A to 10 CFR 100, and is acceptable to the staff.

A preliminary seismic hazard analysis by the applicant indicates a probability of exceeding the OBE of 1.97×10^{-3} per year, or 7.6×10^{-2} over the expected 40-year operating life of the plant; the staff finds this to be conservative for an event that "could reasonably be expected to affect the plant site during the operating life of the plant" (10 CFR 100, Appendix A, Section III(d)). The applicant is repeating the hazard analysis to incorporate new information resulting from the New Hampshire and New Brunswick earthquakes, but the staff is confident that the applicant's characterization of the OBE is conservative.

2.5.3 Surface Faulting

There are many faults in the site vicinity, some in the rock beneath the site. The faults that have been discussed in the literature, and those that were discovered during the applicant's investigations have been investigated and shown to be noncapable according to Appendix A to 10 CFR 100. The following paragraphs present the bases for that conclusion.

The most significant regional faults to the site are major thrust faults of the Clinton-Newbury fault system and the Bloody Bluff fault system located within an arcuate, generally east-west trending zone between the area 7 to 30 miles south of the site. The zone is characterized by many closely spaced east-northeast striking, north dipping thrust faults, which also have a component of dextral strike-slip movements (NUREG/CR-0881). This zone of faulting is interpreted to represent a collision boundary between a plate containing the southeastern New England Platform to the south and a plate containing the New England Fold Belt to the north. The zone of deformation curves to the southwest and extends into eastern Connecticut. It is of Late Paleozoic age (at least 240 mybp) and contains Early Paleozoic volcanoclastic rocks similar to those in the Merrimack Group, Early Paleozoic instrusive rocks and slices of Precambrian rocks, and rocks like those found in the southeastern New England Platform (Cameron and Naylor, 1976; Nelson, 1976; and Schutts et al., 1976).

The thrust-fault complex has been extensively investigated and mapped during the NRC-sponsored New England Seismotectonic Study (Dennen, 1979 and 1980), and no evidence has been found that indicates recent movement. The northernmost fault of this system, the Scotland Road fault, has been investigated by the applicant using borings, trenching and geologic mapping.

The NRC staff evaluated the applicant's work on the Scotland Road fault during the CP review and concluded that it was not capable, as follows:

> The Scotland Road fault, as defined by A.F. Schride (1971), is interpreted to be the Northeastern projection of the regional Clinton-Newbury fault, an apparent thrust fault on which the hanging wall plate moved from north to south over the footwall block. Various workers related this fault to the Acadian orogeny or post-orogenic adjustments prior to the end of the Paleozoic era. Shride's extension of this fault projects it to Plum Island on the New Hamsphire coast some 7 miles to the south of the site. Results of more recent investigations of J. R. Rand substantiate Shride's interpretation. Subsurface investigations located the fault within 150 feet of the location inferred by Shride in his regional field studies. Deformed rock within the fault zone has been annealed and radiometric age dating of several samples indicate the fault to be of early to middle Permian age.

A large fault had been postulated north of the site by Novotny (1963). Novotny interpreted it as a normal fault of unknown displacement that formed the contact between the Kittery and Rye Formations. He projected the fault trend for a distance of about 9 miles from New Castle, near Portsmouth, to North Hampton, where it is shown to die out against the Newburyport Pluton about 1.5 miles from the site. The postulate was based, in part, on an apparent unconformable stratigraphic relationship between the Kittery and Rye Formations. Time of faulting was interpreted by Novotny to be during the Acadian Orogeny, about 330 to 360 million years ago. J. R. Rand, a consultant for the applicant, conducted an extensive investigation in the area of the inferred structure, including borings, trenching, and geologic mapping. This investigation failed to encounter any evidence of the fault. The NRC staff evaluated this fault during the CP review. The staff concludes that the fault, if it exists, is at least 330 million years old and not capable because it apparently does not cut the Newburyport Pluton.

During construction activities for the Seabrook plant and excavation of the circulating water tunnels, numerous faults were encountered. It had been expected that faults would be found based on geologic investigations of the site and the region around the site. The faults were investigated in considerable detail by the applicant. The staff has completed its review of the data and the applicant's analysis and concludes that these faults are not capable.

Faults exposed in the plant excavation were examined by NRC geologists on June 8, 1978 and July 17, 1978. Some of the faults and other features exposed in the circulating water tunnels were examined by an NRC geologist on October 19, 1981.

Sixty-one minor faults were mapped in the excavation for the plant. None are considered to be throughgoing in that all but one of them terminate with at least one end in the excavation, and many are of limited vertical extent. They appear to be controlled by pre-existing joints or foliation planes. Displacements range from a few inches to several feet, and sense of movement is generally normal.

The applicant has categorized all faults in the excavation into seven sets based on orientations, attitudes, sense of displacement, physical characteristics of the fault, and lithologic relationships. The applicant demonstrated by crosscutting relationships with other faults and/or diabase dikes that the youngest faults last moved about the same time as dike emplacement (more than 200 mybp). By crosscutting relationships and radiometric age dating, the applicant showed that all of the faults were related to two periods of deformation, one in early Paleozoic, about the time of intrusion of the Newburyport Pluton (400 mybp), and the other during the early Mesozoic at the time of intrusion of the diabase dikes, more than 200 mybp. Additional evidence of antiquity was documented by mapping unfaulted Pleistocene sediments overlying the faults.

More than 100 faults were mapped in the circulating water tunnels. According to the applicant all of these faults have similar orientations, attitudes, and relationships to diabase dikes as the seven sets of faults mapped in the plant excavations and, therefore, are interpreted to have been formed by the same tectonic mechanisms in the Paleozoic and Mesozoic Eras. Staff geologists visited the site on several occasions to examine geologic features exposed in excavations, including the circulating water tunnels. Based on its review of the applicant's data, the scientific literature, including the results of the New England seismotectonic study and observations during the site reconnaissances, the staff concludes that there are no capable faults in the site vicinity.

2.5.4 Stability of Subsurface Materials and Foundations

2.5.4.1 Geologic Features

2.5.4.1.1 General Plant Description

As noted above in this report, the Seabrook site is 2 miles inland from the open Atlantic Ocean coast of New Hampshire, about 13 miles south of the Maine state line and 1.5 miles north of the Massachusetts state line. The site is within the Seabrook Lowland section of the New England Physiographic Province. The topography of the Seabrook Lowland section is gently undulating, rising gradually from the seacoast to an elevation of 500 ft approximately 30 miles inland. The topography of the general Seabrook site area is flat, consisting of broad open areas of level tidal marshes. The plant site itself is located on an outcrop of bedrock, which was overlain by a thin veneer of glacial till prior to construction. The outcrop rises out of the tidal marsh at this location to form a peninsula composed of quartz diorite and included quartzitic bedrock. All of the main seismic Category I structures were founded on sound bedrock or on 3000-psi concrete backfill extending to sound bedrock. Table 2.3 below lists the major seismic Category I structures, the approximate foundation dimensions, and the approximate bearing elevation of each foundation.

Electrical ductbanks, five electrical manholes, and service water piping at the site were founded on compacted granular backfill extending to sound bedrock. The finished plant grade has been established at 20 ft above mean sea level (msl).

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

ACTION

EDO PRINCIPAL CORRESPONDENCE CONTROL

FROM: DUE: 03/23/87 EDO CONTROL: 002599
DOC DT: 03/02/87
DONALD R. HUNTER FINAL REPLY:
STATE OF NEW HAMPSHIRE

TO:

CHAIRMAN ZECH

FOR SIGNATURE OF: ** GREEN ** SECY NO: 87-221

DENTON

DESC: ROUTING:

Q'S RE SEABROOK TAYLOR
MURLEY

DATE: 03/09/87
ASSIGNED TO: NRR CONTACT: DENTON

SPECIAL INSTRUCTIONS OR REMARKS:

NRR RECEIVED: MARCH 9, 1987
ACTION: DPLA:NOVAK

NRR ROUTING: DENTON/VOLLMER
PPAS
MOSSBURG

ACTION
DUE TO NRR DIRECTOR'S OFFICE
BY 3/18/87

OFFICE OF THE SECRETARY
CORRESPONDENCE CONTROL TICKET

PAPER NUMBER: CRC-87-0221 LOGGING DATE: Mar 5 87

ACTION OFFICE: EDO

AUTHOR: D.R. HUNTER
AFFILIATION: NH (NEW HAMPSHIRE)

LETTER DATE: Mar 2 87 FILE CODE:

SUBJECT: QUALITY OF EARTHQUAKE DESIGN USED AT SEABROOK

ACTION: Direct Reply

DISTRIBUTION:

SPECIAL HANDLING: None

NOTES:

DATE DUE: Mar 20 87

SIGNATURE: DATE SIGNED:
AFFILIATION:

Rec'd Off. EDO
Date 3-9-87
Time 9A

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