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Docket Nos. 50-324  
50-325

APR 10 1975

Thomas Erwin, Esq.  
Post Office Box 923  
Raleigh, North Carolina 27602

Dear Mr. Erwin:

Reference is made to your petition pursuant to 10 CFR § 2.206, dated January 29, 1975, for an order to show cause why Carolina Power & Light Company's license to operate the Brunswick Steam Electric Plant should not be amended to require a comprehensive and independent re-evaluation of the seismic safety of the plant site as a continuing condition of the fueling, testing and operation of the Brunswick Plant. The petition was based on an accompanying paper entitled "Possible Earthquake Precursory Phenomena Centered Near Wilmington - Southport, N.C., with Recommendations for Appropriate Scientific Action".

Upon receipt of the request, the Nuclear Regulatory Commission undertook extensive study and analysis of the seismological data for the Brunswick facility. The Staff met with you, your clients and representatives of CP&L on March 19, 1975. As a result an Order to Show Cause has been issued to CP&L specifying certain activities which are to be undertaken to confirm or deny the alleged dilatancy. In so far as the show cause order requires seismometers to monitor for dilatancy and a reevaluation of seismic data gathered as a result, your request is granted. However, those portions of your petition which request actions which are not included in the show cause order should be considered denied for the reasons set forth in the enclosed copy of the technical staff's recommendation in this matter.

Sincerely,

*EC*  
Edson G. Case, Acting Director  
Office of Nuclear Reactor Regulation

Enclosures:  
(see attached page)

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ATTENTION →	WJO instead: jh	EGC/se				
DATE →	4/2/75	4/10/75				

Thomas Erwin, Esq.

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APR 10 1975

Enclosures:

1. Show Cause Order
2. Technical Staff's Recommendation

cc w/enclosures: Carolina Power & Light Company  
ATTN: Mr. J. A. Jones  
Senior Vice President  
336 Fayetteville Street  
Raleigh, North Carolina 27602

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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

In the Matter of

CAROLINA POWER & LIGHT COMPANY

(Brunswick Steam Electric Plant,  
Units 1 and 2)

}  
Docket Nos. 50-324  
50-325

ORDER TO SHOW CAUSE

I

Carolina Power and Light Co., 336 Fayetteville Street, Raleigh, North Carolina 27602, ("the licensee"), is the holder of operating license No. DPR-62 and Construction Permit No. CPPR-68, which authorize the operation of nuclear power reactor Unit 2 and construction of Unit 1 at the Brunswick Steam Electric Plant near Southport, North Carolina, under certain conditions specified therein.

II

On January 29, 1975 a request for issuance of show cause order was filed before the Nuclear Regulatory Commission (NRC) pursuant to 10 CFR § 2.206 on behalf of David M. Stewart, et. al. (petitioners). This request to amend the Brunswick licenses to require a reevaluation of the plant's seismic safety was based on a paper submitted to NRC entitled "Possible Earthquake Precursory Phenomena Centered Near Wilmington - Southport, N.C., with Recommendations for Appropriate Scientific Action." Notice of the request was mailed to the licensee and published in the Federal Register on February 19, 1975. <sup>1/</sup> NRC Staff requested a meeting with representatives of the licensee

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<sup>1/</sup> 40 F.R., p. 7142.

and the petitioners which was held on March 19, 1975 at Bethesda, Maryland. The licensee has not commented on the request or the supporting considerations cited by petitioners.

### III

The bases for the present action include the following:

1. Recently published absolute leveling data obtained by the National Geodetic Survey (Balazs, 1974) indicate possible anomalous elevation changes in land centered near Southport, North Carolina.
2. Groundwater anomalies, such as higher than normal piezometric pressure in deep wells coupled with warmer than normal water in such wells and water salinity, have been noted in the Wilmington - Southport areas. (Register and Peek 1975).
3. The safety reports (Final Safety Analysis Report dated June 1, 1972 and Staff Safety Evaluation Report dated November 1973) for the Brunswick facilities did not consider the dilatancy phenomena nor has any monitoring been done in the site area to determine the existence of conditions which might be a prelude to increased seismic activity, since information on this possibility has only recently been developed.

While the Staff does not consider the new information to be conclusive with respect to the existence of earthquake precursory phenomena in the Wilmington - Southport area, it does believe, based on presently available information, that additional and timely investigations are warranted to resolve the question that has been raised about possible dilatancy in the site

area. Notwithstanding our belief that such action is prudent and necessary, we do not consider the new information to be a sufficient or suitable basis for changing our previous conclusion regarding the adequacy of the seismic design basis for Brunswick Units 1 and 2.

IV

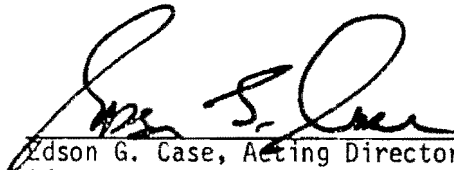
In view of the foregoing and pursuant to the Atomic Energy Act of 1954, as amended, and the regulations in 10 CFR Parts 2, 50 and 100, IT IS HEREBY ORDERED THAT:

The licensee show cause, in the manner hereinafter provided, why its license Nos. DPR-62 and CPPR-68 should not be amended to require initiation within six months of the following: 1) Installation of a micro-earthquake seismograph network to remain in place for two years or until it can be determined with reasonable certainty that no significant seismic hazard bearing on the public health and safety exists. This network shall have the capability to detect dilatancy within a 100 mile radius of the site and would include changes in P-wave velocity, S-wave velocity, ratio of P-wave velocity to S-wave velocity, and differences in the velocities of horizontally and vertically polarized shear waves. 2) Conduct of an appropriate releveling program to determine the rate at which the area is being uplifted to corroborate the monitoring results.

The licensee may, within thirty days of the date of this order, file a written answer to this order under oath or affirmation. Within the same time, the licensee or any person whose interest may be affected by this order may request a hearing. If a hearing is requested, the Commission will issue an

order designating the time and place for hearing. Upon failure of the licensee to file an answer within the time specified, the Director of Nuclear Reactor Regulation will, without further notice, issue an order modifying license Nos. DPR-62 and CPPR-68 to require the monitoring program specified above to be initiated within six months of the date of such order.

In the event that a hearing is requested, the issue to be considered at such hearing shall be: Whether the licensee should be required to establish the above specified releveing program and the microearthquake seismograph network to monitor seismicity and changes in seismic wave velocities in the vicinity of the Brunswick site as a condition of licenses DPR-62 and CPPR-68.

  
Edson G. Case, Acting Director  
Office of Nuclear Reactor Regulation

Dated at Bethesda, Maryland  
this 10th day of April, 1975.

cc: See attached list

April 10, 1975

LIST

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Atomic Safety and Licensing  
Board Panel  
U. S. Nuclear Regulatory Commission  
Washington, D. C. 20555

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Atomic Safety and Licensing  
Board Panel  
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700. 0

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

APR 1 1975

R. C. DeYoung, Assistant Director  
for LWR's, Group 1, RL

SEISMIC POTENTIAL AT BRUNSWICK SITE

PLANT NAME: Brunswick Steam Plant  
LICENSING STAGE: OL  
DOCKET NUMBER: 050-324  
RESPONSIBLE BRANCH: LWR, Group 1  
REQUESTED COMPLETION DATE: Open  
APPLICANTS RESPONSE DATE NECESSARY FOR  
NEXT ACTION PLANNED ON PROJECT: N/A  
DESCRIPTION OF RESPONSE: N/A  
REVIEW STATUS: N/A

We have reviewed the report submitted by Professor Stewart and others entitled: "Possible Earthquake Precursory Phenomena Centered Near Wilmington - Southport, N.C., with Recommendations for Appropriate Scientific Action." This report contends that the seismic risk analysis for the Brunswick plant should be reevaluated based on three general concerns: 1) anomalous elevation changes; 2) groundwater anomalies, and 3) earthquake history. The question raised by the petitioners is whether several different sets of observations in the area imply the buildup of strain in the area and, therefore, a pending large earthquake.

Our review of the petition raised several questions about the quality and significance of the data cited therein. We, further, could not agree, based on the cited data, with all the conclusions reached by the petitioners. We did, however, consider the data to warrant further discussion and clarification.

A meeting was held on March 19, 1975, to discuss the petition. Participating in this meeting were members of the NRC staff, S. Holdahl and E. Balazs of NOAA, and the petitioners represented by Drs. Stewart, Dunn, and Heron. Representatives of Carolina Power and Light Co. were also present but did not choose to participate in discussions. New information, beyond that cited in the petition, from tide gauge records, history of earthquake activity in North Carolina, and recent progress in earthquake prediction were discussed in the meeting. As a result of the meeting, we have concluded that additional data are



needed to determine whether the seismic design of the Brunswick plant should be reevaluated. We recommend that the licensee be directed to obtain the necessary data.

The interpretation offered by the petitioners is that the existing data indicate dilatancy precursory to the occurrence of an earthquake. Discussions at the meeting indicated that alternate interpretations of the existing data, which would have no impact on earthquake hazard, were equally possible. Members of the NRC staff and the petitioners were in general agreement, however, that the existing data are insufficient to determine conclusively whether or not dilatancy (or other earthquake precursory phenomena) is occurring in the Southport area. The petitioners have suggested a general program of data gathering by which they believe this issue could be conclusively resolved.

As a result of discussions in the March 19 meeting and our independent review of the data cited in the petition, we have concluded that a number of data acquisition and evaluation techniques (tiltmeters, releveing, well monitoring, etc.) could be used to help clarify this problem. However, the most conclusive indicators of earthquake precursory phenomena to date have been obtained using seismic velocity information. This technique is dependent on the use of a micro-earthquake seismograph network to monitor changes in seismic wave velocities in the dilatant zone as the dilatancy progresses. If no anomalous seismic wave velocities are found in the Southport area, it can be concluded with a high degree of certainty that the apparent anomalous uplift there does not imply an unusual risk for earthquake occurrence.

The microearthquake network should be designed to detect and locate local earthquakes with magnitudes on the order of zero and larger. The monitoring program should have the capability to detect any indications of dilatancy occurring within a 100 mile radius of the Brunswick site. The observations are to include changes in P-wave velocity, S-wave velocity, ratio of P-wave velocity to S-wave velocity, and differences in the velocities of horizontally and vertically polarized shear waves. Details of the program will be the subject of future review by the NRC staff. However, we believe that the minimum program which could be effective would require monitoring for a period of at least two years using a network of at least ten high-sensitivity seismograph stations. In order to monitor shear-wave birefringence in the dilatant zone (a technique for determining dilatancy advocated by the petitioners), it will be necessary to equip each station with two horizontal component instruments in addition to the vertical instruments typically used in microearthquake networks.

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We foresee two possible consequences of the monitoring program:

- . No microearthquakes, or very few, observed with no indications of velocity changes. The lack of earthquake activity and velocity changes implies dilatancy is not occurring or is progressing at a very slow rate. The data do not indicate unusual earthquake risk near the Brunswick site.
- . Many microearthquakes observed along with indications of velocity changes. Dilatancy (or other earthquake precursory phenomena) may be progressing; the monitoring program should be continued; and an assessment should be made of the implications of the dilatant zone for earthquake occurrence, size, and the adequacy of the plant's seismic design.

To corroborate the results of the seismic monitoring, we recommend that a minimal releveling program be undertaken in the area. This program could be completed at little expense and would clarify the rate at which the area is being uplifted.

The dilatancy/fluid-diffusion model as a physical basis for earthquake prediction is barely three years old and has been used in only a few documented cases to predict earthquakes, e.g. Matsushiro, Japan, Blue Mountain Lake, N.Y., although an intensive effort is now on-going in this field. The U. S. Geological Survey has indicated (letter to Mr. Conrad, Director, North Carolina Department of Natural and Economic Resources from Dr. McKelvey) that, "the existence of uplift in North Carolina does not necessarily imply a high earthquake hazard," but clarification of the existence of uplift was needed and further consideration should be given to establishing a state-wide seismograph network. The USGS did not act as our consultant in reviewing this petition and their comments to Mr. Conrad did not assess the risk to a nuclear plant in Southport, N.C. Although this area might not be a candidate area for conducting research in dilatancy and its associated earthquake precursory phenomenon, the existence of the Brunswick nuclear plant here requires special consideration. A number of lines of evidence indicate that dilatancy could be occurring and, therefore, it is necessary that we require that CP&L provide data needed to determine whether the seismic design of this plant should be reevaluated.



Harold R. Denton, Assistant Director  
for Site Safety  
Division of Technical Review  
Office of Nuclear Reactor Regulation

cc: See attached list

APR 1 1975

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H. Denton  
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B. Rusche  
W. Butler  
R. Powell  
J. Murray  
W. Olmstead  
C. Stepp  
R. Jackson  
J. Bennett  
R. Klecker  
D. Eisenhut  
S. Varga