PSNH PUBLIC SERVICE
Company of New Hampshire

SEABROOK STATION
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January 5, 1984

SBN- 609
T.F. B7.1.2

United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. George W. Knighton, Chief
Licensing Branch No. 3
Division of Licensing

References:
(a) Construction Permits CPPR-135 and CPPR-136, Docket Nos. 50-443 and 50-444
(b) PSNH Letter, dated August 25, 1983, "New Hampshire and New Brunswick 1982 Seismic Events; Seismological and Geological Studies", J. DeVincentis to G. W. Knighton
(c) USNRC Letter, dated February 12, 1983, "Request for Additional Information", F. J. Miraglia to W. C. Tallman

Subject: Response to 230 Series RAIs; (Geosciences Branch)

Dear Sir:

In the referenced letter, we submitted a report prepared by Weston Geophysical Corporation entitled "Seismological and Geological Studies, Miramichi Area, New Brunswick, and Central New Hampshire". It was indicated that the report was responsive to the applicable Requests for Additional Information (230.6, 230.7, 230.8, and 230.10) which were forwarded to PSNH in Reference (c) and the Safety Evaluation Report (Outstanding Issue No. 3). In actuality, the report was only responsive to portions of RAIs 230.7 and 230.8.

To complete our response to the 230 Series RAIs and the Safety Evaluation Report Outstanding Issue, we have enclosed three copies of our responses to the following RAIs:

230.3, 230.6, 230.7, 230.8, and 230.10.

The responses to RAIs 230.3 and 230.6 make reference to an Appendix F in the Seabrook PRA Study. It is expected that the PRA, which is currently being printed, will be submitted for staff use not later than January 31, 1984.

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The enclosed responses will be incorporated in a future OL Application Amendment.

Please note that under separate cover, we are formally withdrawing the proprietary status which was afforded the Weston Geophysical Report discussed above.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

John DeVincentis

John DeVincentis
Project Manager

Enclosure

cc: Atomic Safety and Licensing Board Service List

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Question 230.3

The probability of exceeding the OBE during the operating life of the plant should be discussed.

Response 230.3

The probability of exceeding the OBE during the operating life of the plant is estimated from the fractile seismic hazard curves (Figure 20) determined in the report on "Seismic Hazard at Seabrook Nuclear Station", (Dames and Moore, 1983, Appendix F to Seabrook PRA Study). The median annual frequency of exceeding the OBE peak ground acceleration (0.125g) is 5.25 x 10^{-4}; this annual frequency is equivalent to a probability of .0259 for exceedance of the OBE acceleration during an assumed 50 year operating life span of the Seabrook plant. Uncertainty on this median estimate is illustrated by levels of the 84th and 16th percentile seismic hazard curves. The 84th percentile annual frequency of exceeding the OBE is 1.45 x 10^{-3} and the 16th percentile estimate is 2.00 x 10^{-4}. These plus and minus one standard error bounds on the median seismic hazard estimate correspond to probabilities of exceeding the OBE during the plant operating life of .07 and .01, respectively.

Question 230.6

Re: Your response to Question 230.3 on the probability of exceeding the OBE during the operating life of the plant. Provide the input parameters chosen for the McGuire (1976) seismic hazard program and discuss the sensitivity of the results upon the uncertainties in the parameters. Discuss the effect of the Franklin, New Hampshire event of Jan. 18, 1982 and other recent event supon the calculated probability of exceeding the OBE.

Response 230.6

The report entitled "Seismic Hazard at Seabrook Nuclear Station" is included as Appendix F to the Seabrook PRA Study. This hazard study describes all input seismicity and ground motion parameters. Various sensitivities are examined in this referenced study. The New Brunswick and New Hampshire earthquakes of January 1982 were included in the seismic hazard analysis, therefore, hazard curves accommodate the occurrence of these recent earthquakes.

Question 230.7

Update your historical record of regional earthquakes up to and including, at least, the time of occurrence of the Franklin, New Hampshire event of January 18, 1982. Discuss the correlation of this and other recent events with geologic structure or tectonic provinces and their significance with respect to the OBE and SSE. Discuss the effect of any strong motion data obtained from the New Hampshire event and other recent events upon empirical strong motion relationships used in determining the OBE and SSE.

Response 230.7

To answer this question, the Public Service Company of New Hampshire sponsored with other New England utilities a substantial program of studies related to the January 1982, New Hampshire seismic activity. The report entitled "Seismological and Geological Studies, Miramachi Area, New Brunswick and Central New Hampshire", prepared by Weston Geophysical Corporation, was filed with the NRC on August 25, 1983, as a proprietary document. Important data and conclusions are abstracted for this condensed response.

This question contains three specific requests: (1) an update of the earthquake catalog; (2) a discussion of the correlation of the January 1982 New Hampshire event with geologic structure or tectonic provinces; (3) a discussion of the strong motion data from the same event as affecting the OBE and SSE.

1. Updated and Expanded Earthquake Catalog

   Table 230.7-1 presents an updated and revised earthquake catalog intended to replace Table 2.5-5 of the SB FSAR. The corresponding Figure 230.7-1 updates and complements Figure 2.5-30 of the FSAR.

   The present catalog includes as many 1982 events as presently available (September 1, 1983), using preliminary solutions for the most recent years for which final catalogs have not yet been published by the national agencies of the United States and Canada. The update includes data from the last Bulletin, No. 24, of the Northeastern United States Seismic Network (NEUSSN) covering the third quarter of 1981; from the Monthly Listings of the Preliminary Determination of Epicenters (PDE) of the United States Department of the Interior for 1981 and 1982; and from the National Summary Bulletins of the Earth Physics Branch of Canada up to the end of 1982.

   The areal coverage of the present catalog and map has been expanded from that of the original FSAR in order to provide a basis for answering Question 230.8 on the New Brunswick

recent seismic activity. Magnitude and intensity thresholds are the same, i.e., magnitude greater than 3.0 and intensity (MM) greater than III. The catalog format has been improved as to include epicentral distance to the site for all events, and M_c (c for coda or duration) magnitude values.

Three symbols have been used in Figure 230.7-1 to plot all events of Table 230.7-1. All events have been plotted according to observed or inferred m_{blg}. This is done for sake of consistency with hazard studies for which b-value determination requires that all events be sorted and counted according to size, magnitude or intensity. Unrotated squares represent observed m_{blg}, M_c, and post-1967 M_L values. All 10° rotated squares represent pre-1968 M_L values converted to m_{blg} using

$$m_{blg} = -0.68 + 1.03\ M_L; \qquad (1)$$

45° rotated squares represent epicentral intensity (MM) converted to m_{blg} using

$$m_{blg} = 0.44 + 0.67\ I_o, \qquad (2)$$

following Klimkiewicz in both cases, as in a Weston Geophysical Corporation (1982) study.

2. Correlation With Geologic Structure or Tectonic Provinces

The January 19, 1982 (U.T.) event (m_b = 4.7) in the central New Hampshire area falls along a pre-existing north-northeast trending alignment of both instrumental and historical seismicity, as shown on Figure 230.7-2. Included within this alignment are the 1940 events (m_b = 5.5) which are spatially asssocited with the Mesozoic Ossipee intrusive complex. This association is fully discussed in the Boston Edison Co. Pilgrim Unit II Docket, (1976) and the Seabrook FSAR (1982). The Franklin event of January 1982 is approximately 41 km southwest of the relocated 1940 events and approximately 35 km southwest of the Ossipee complex.

The immediate area of the January 19, 1982 event is underlain by metamorphic rocks of the Devonian Littleton Formation. No large scale through-going structures nor plutons have been recognized in the immediate epicentral area, on the basis of the current available 15 minute mapping. However, some recent bedrock mapping on a localized scale, remote sensing analysis, and interpretation of existing geophysical data in conjunction with graduate studies in the area have added to the data base. The above data, including the epicentral pattern, reveals a spatial correlation to a north-northeast trending set of

remote sensing lineaments. Locally, this trend corresponds to post Jurassic faulting based on the mapped occurrence of faulted diabase. Also, the same trend is intersected by either northwest or east-northeast trending magnetic and remote sensing lineaments. This conjunction of structural elements, geophysical anomalies, and Mesozoic igneous activity, apparently combine to produce the present day seismic release. This seismic release seems to occur along the entire length of the lineament zone with the larger earthquakes most likely occurring at the locations of major asperities or fault barriers, e.g. the larger 1940 earthquakes (m_b = 5.5) were indeed in close proximity of the Ossipee Pluton. While geologic and geophysical data do not provide a one-to-one correlation of individual epicenters to bedrock structures, a reasonable correlation of the Franklin and other seismic events exists to a recognizable geologic setting.

Within this framework of a tectonic structure association, the occurrence of the smaller magnitude January 1982 event in central New Hampshire does not affect the earthquake potential at the Seabrook site, as assessed for design purposes. The Ossipee earthquakes of 1940, I_o = VII, m_b = 5.5, were used to evaluate the potential at the site from that structure.

3. Discussion of the strong motion data from the January 19, 1982 (U.T.) event; their effect on the OBE and SSE determination.

   The New Hampshire event of January 19, 1982, m_b = 4.7 triggered some SMA-1 acclerographs owned by the U.S. Army Corps of Engineers. Twelve accelerograms were collected for a total of 36 components. Chang (1983), Table 230.7-2 gives location information and lists the values of corrected acceleration, velocity and displacement.

   By examining the acceleration values listed, it is clear that the concern originally manifested about the New Hampshire data set was undoubtedly founded on the apparently high accelerations (0.15 to 0.5g) recorded at the three Franklin Falls Dam sites; at the nine other sites acceleration values were all less than .05g.

   The significance of the Franklin Falls Dam data was investigated carefully. First, it was found that Franklin Falls Dam should be regarded as located in the very near field. The current location of the main shock obtained from only permanent station data carries an uncertainty of ± 2 km. This means that the estimated epicentral distance (5 km) could be as small as 3 km. This becomes a very conservative case to estimate ground motion "at the site".

Assuming fault dimensions of about 2 Km by 2 Km, according to Nuttli's (1983) relationship, a shallow depth of 3 Km (Pulli, et al. 1983), and a fault plane orientation N20E (ibid), the Franklin Falls sites could be very close indeed to the rupture. This orientation and this proximity may well explain why the motion on all transverse components at the three sites is so much larger than the longitudinal components.

Refraction surveys and geological inspection were carried out at Franklin Falls. In particular, the right abutment site, where the highest value was recorded, has been carefully investigated by Weston Geophysical geologists; they concluded that the instrument shelter was not on solid rock, as reported by the U.S. Army Corps of Engineers, but on loose rock fill emplaced during the dam construction; this is confirmed by the results of a refraction survey immediately adjacent to the shelter. The instrument concrete pad is founded on a 10-foot boulder. The ground motion recorded on such foundation conditions is subject to spurious amplification, not characteristic of the true earthquake ground motion.

The second site at the crest of the earth-filled dam may serve a role for engineering study of dam behavior but it is not suitable for defining design ground motion on rock. Finally, seismic refraction surveys conducted at the third site, "downstream", have revealed dry alluvial material underlain by water saturated alluvium, down to the bedrock at a depth of 100 feet below ground surface. Again, this is not comparable to the Seabrook rock site.

The nine other strong motion sites were located at epicentral distances between 61 and 105 km, and thus not appropriate for consideration "at the Seabrook site". Four of these sites are at the crest of dams, and five others are on dam abutments or downstream. Regardless of foundation conditions, the observed values at these nine sites are in agreement with values predicted by three current attenuation models, as shown on Figures 230.7-3 for acceleration and 230.7-4 for velocity, particularly if one standard deviation is added.

Consequently, the New Hampshire strong motion data set is not applicable, and particularly the data from Franklin Falls, where the foundation conditions differ from those at the Seabrook plant.

The last part of Question 230.7 implicitly refers to the Trifunac and Brady (1975) relationship between intensity and acceleration. The relationship was established by "approximating the average trends of the data" available at the time at the Earthquake Engineering Research Laboratory

of the California Institute of Technology (C.I.T.). This data base contained 187 three-component records. The accelerograms were obtained on various soil conditions and at various epicentral distances; this information can be found in Chang (1978). Most of the data (175 records) is distributed between intensities V, VI and VII. A linear regression on the seven means, for intensities III, IV, V, VI, VII, VIII, X, predicts about .25g (horizontal) for an intensity VIII, while a regression on all the data set would predict .236g only.

If the New Hampshire data (6 horizontal accelerations at Franklin Falls Dam) is pooled with the C.I.T. data,and I_o (epicentral intensity) estimated at V (MM), the acceleration predicted for the SSE, i.e., VIII (MM) is only .221g. Table 230.7-3 gives regression coefficients of various sensitivity tests and the predicted acceleration values for SSE with I_o = VIII. These sensitivity tests consist of different conbinations of the New Hampshire data and New Brunswick data with the original CIT data. The applicant does not propose or support this pooling of the data, because of its heterogeneity.

In summary, the strong motion data from the New Hampshire event does not affect the SSE (and OBE) chosen for the Seabrook design.

REFERENCES

Boston Edison Company, 1976, Geological investigations: Prepared for the U.S. Nuclear Regulatory Commission, Pilgrim Unit 2, Plymouth, Massachusetts, N.R.C. Docket no. 50-471, BE-SG 7603.

Chang, F. K., 1978, State of the art for assessing earthquake hazards in the United States - Catalogue of strong motion earthquake records, western United States, 1933-1971: U.S. Army Engineers Waterways Experiment Station, Miscellaneous Paper S-73-1, Report 9, v. 1, 13 p.

Chang, F. K., 1983, Analysis of Strong Motion Data from the New Hampshire Earthquake of 18 January 1982; NUREG-CR-3327, prepared for U.S. N.R.C.

Hasegawa, H. S., Basham, P. W., and Berry, M. J., 1981, Attenuation relations for strong seismic ground motion in Canada: Bulletin of the Seismological Society of America, v. 71, no. 6, p. 1943-1962.

Nuttli, O. W., 1983, Average seismic source - parameter relations for mid-plate earthquakes: Bulletin of the Seismological Society of America, v. 73, no. 2, p. 519-535.

Nuttli, O. W., Herrmann, R. B., 1981, Consequences of earthquakes in the Mississippi Valley: American Society of Civil Engineers, Preprint 81-519.

Public Service Company of New Hampshire, 1982, Seabrook final safety analysis report: Prepared for the U.S. Nuclear Regulatory Commission, Docket no. 50-443.

Pulli, J. J., Nabelek, J. L., and Sauber, J. M., 1983, Source parameters of the January 19, 1982, Gaza, New Hampshire earthquake; abstract of the 55th meeting of the Eastern Section of the Seismological Society of America.

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Weston Geophysical Corporation, 1982, Estimation of seismicity parameters for New England: Prepared for Yankee Atomic Electric Company, 41 p.

Weston Geophysical Corporation, 1983, Seismological and geological studies, Miramichi area, New Brunswick and central New Hampshire: Prepared for Maine Yankee Atomic Power Company, Public Service Company of New Hampshire, Vermont Nuclear Power Corporation, and Yankee Atomic Electric Company, 233 p.

TABLE 230.7-1

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		(KM.)	
1534	0	0	0	0		47.600N	70.100W		- X					SM	525.76	
1638	6	11	20	0		47.650N	70.170W		IX					EP	530.70	
1643	6	11	13	0		42.800N	70.800W		IV					EH	11.70	
1661	2	10	12	0		45.500N	73.000W		VII					EP	336.27	
1663	2	5	17	30		47.600N	70.100W		X					EP	525.76	
1663	2	5	23	0		47.600N	70.100W		V					EP	525.76	
1663	2	6	15	0		47.600N	70.100W		VI					EP	525.76	
1663	2	7	14	0		47.600N	70.100W		IV					EP	525.76	
1663	11	16	0	0		47.600N	70.100W		IV					EP	525.76	
1664	0	0	0	0		47.600N	70.100W		IV					EP	525.76	
1665	2	24	0	0		47.800N	70.000W		VIII					EP	548.75	
1665	10	15	21	50		46.820N	71.220W		IV					EP	436.74	
1668	4	13	13	0		47.100N	70.500W		VI					EP	467.69	
1677	12	13	0	0		41.050N	73.530W		IV					WG	302.56	
1685	2	19	0	0		42.700N	70.800W		IV					WG	22.47	
1705	6	27	0	0		42.350N	71.060W		IV					WG	63.40	
1727	11	9	22	40		42.800N	70.600W		VII					WG	23.14	FA = 296037 SC.KM.
1727	11	9	23	35		42.800N	70.600W		IV					WG	23.14	
1727	11	10	2	15		42.800N	70.600W		IV					WG	23.14	
1727	11	14	17	0		42.800N	70.600W		- V					WG	23.14	FA = 7096 SC.KM.
1727	11	19	11	20		42.800N	70.600W		IV					WG	23.14	
1727	12	1	0	0		42.800N	70.600W		IV					WG	23.14	
1727	12	16	0	0		42.800N	70.600W		IV					WG	23.14	
1727	12	19	10	0		42.800N	70.600W		IV					WG	23.14	
1727	12	28	22	30		42.800N	70.600W		IV					WG	23.14	
1728	1	4	23	0		42.800N	70.600W		- V					WG	23.14	
1728	2	4	21	30		42.800N	70.600W		IV					WG	23.14	
1728	2	8	6	30		42.800N	70.600W		IV					WG	23.14	
1728	2	10	15	30		42.800N	70.600W		V					WG	23.14	FA = 8495 SC.KM.
1728	5	16	0	0		42.800N	70.600W		IV					WG	23.14	
1728	7	30	10	0		42.800N	70.600W		IV					WG	23.14	
1728	8	2	3	15		42.800N	70.600W		IV					WG	23.14	
1729	3	30	14	0		42.800N	70.600W		IV					WG	23.14	
1729	8	6	0	0		41.400N	73.500W		IV					EP	275.19	
1729	11	25	8	0		42.800N	70.600W		IV					WG	23.14	
1729	12	8	20	0		42.800N	70.600W		IV					WG	23.14	
1730	3	9	1	45		42.800N	70.600W		IV					WG	23.14	
1730	4	23	20	0		42.800N	70.600W		IV					WG	23.14	
1731	1	12	19	0		42.800N	70.600W		IV					WG	23.14	
1731	1	22	24	0		42.800N	70.600W		IV					WG	23.14	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1731	10	12	23	0		42.800N	70.600W		IV					WG	23.14	
1732	9	16	16	0		45.500N	73.600W		VIII					EP	363.13	
1736	11	23	2	0		42.800N	70.600W		IV					WG	23.14	
1737	9	20	10	20		42.800N	70.600W		IV					WG	23.14	
1737	12	18	0	0		40.800N	74.000W		VII					EP	350.43	
1744	6	14	10	15		42.500N	70.900W		VI					WG	44.52	FA = 157213 SQ.KM.
1744	6	14	17	0		42.520N	70.920W		IV					WG	42.50	
1755	11	18	4	12		42.700N	70.300W		VIII					WG	50.06	FA = 1000000 SQ.KM.
1755	11	18	5	29		42.700N	70.300W		IV					WG	50.06	
1755	11	22	20	27		42.700N	70.300W		V					WG	50.06	
1755	12	19	20	15		42.700N	70.300W		IV					WG	50.06	
1757	7	8	14	30		42.350N	71.100W		IV					EP	54.37	
1761	11	1	20	0		43.100N	71.500W		IV					EP	57.59	
1764	9	30	0	0		45.300N	65.000W		V					EP	470.98	
1766	12	17	18	40		43.100N	70.300W		IV					EP	22.68	
1783	11	29	10	50		41.000N	74.500W		VI					EP	368.92	
1784	1	2	10	0		46.800N	71.200W		IV					EP	434.41	
1784	1	12	8	30		46.800N	71.200W		IV					EP	434.41	
1790	7	25	5	0		41.450N	72.460W		- IV					WG	208.86	
1791	5	16	8	0		41.500N	72.500W		- VII					WG	206.74	FA = 60010 SQ.KM.
1791	12	6	23	0		47.400N	70.500W		VIII					EP	500.93	
1800	12	20	0	0		43.700N	72.300W		IV					WG	147.59	
1801	3	1	15	30		43.070N	70.770W		IV					WG	20.06	
1805	4	25	19	20		42.500N	70.900W		IV					WG	44.52	
1807	1	13	23	0		43.000N	71.000W		IV					WG	16.67	
1807	5	5	13	0		43.480N	70.470W		IV					WG	71.52	
1810	11	9	21	15		43.000N	70.900W		V					WG	11.91	FA = 21497 SQ.KM.
1814	11	28	19	14		43.700N	70.300W		- V					WG	99.52	
1815	9	9	0	0		45.500N	73.600W		VII					EP	363.13	
1815	9	16	0	0		45.500N	73.600W		VI					EP	363.13	
1817	10	5	11	45		42.500N	71.200W		- VI					WG	52.84	FA = 55011 SQ.KM.
1818	10	11	0	0		46.900N	71.200W		IV					EP	445.51	
1821	5	5	7	30		44.800N	68.800W		V					WG	267.87	FA = 20694 SQ.KM.
1823	6	10	0	0		44.800N	68.800W		V					WG	267.87	
1823	7	23	6	55		42.900N	70.600W		- V					WG	20.34	FA = 29009 SQ.KM.
1824	7	9	0	0		46.500N	65.500W		V					EP	528.00	
1827	8	23	0	0		41.400N	72.700W		- V					EP	226.12	
1829	8	27	21	45		44.230N	69.770W		IV					WG	171.66	
1831	5	0	0	0		47.300N	70.500W		VII					EP	499.88	
1831	7	14	0	0		47.500N	70.100W		VII					EP	525.76	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1832	0	0	0	0		45.000N	64.000W		IV					EP	597.08	
1833	3	0	0	0		47.650N	70.170W		IV					EP	530.70	
1833	4	0	0	0		47.650N	70.200W		IV					EP	530.47	
1837	1	15	7	0		42.500N	70.950W		IV					EP	45.09	
1837	4	12	0	0		41.700N	72.700W		- V					WG	202.57	
1840	1	16	20	0		42.000N	75.050W		- VI					PM	338.92	
1840	8	9	15	30		41.500N	72.700W		V					WG	229.87	FA = 10593 SQ.KM.
1842	11	9	0	0		46.000N	73.200W		VI					EP	392.09	
1843	3	14	0	0		44.400N	72.500W		IV					EP	213.43	
1844	11	0	0	0		45.500N	73.600W		IV					EP	363.13	
1845	10	26	18	15		41.200N	73.300W		- VI					WG	277.09	FA = 13597 SQ.KM.
1845	11	0	0	0		43.600N	72.300W		IV					EP	141.25	
1846	5	30	13	30		42.700N	70.300W		IV					EP	50.06	
1846	8	25	4	45		42.500N	70.800W		V					WG	44.51	FA = 51800 SQ.KM.
1847	1	1	0	0		43.800N	66.100W		IV					EP	397.79	
1847	2	2	0	0		44.200N	69.100W		IV					EP	202.16	
1847	8	9	10	0		41.700N	70.100W		- VI					WG	146.81	
1847	9	29	0	0		40.500N	74.000W		V					EP	373.84	
1848	9	8	22	0		40.400N	74.300W		V					EP	381.97	
1851	1	3	23	30		44.550N	63.630W		IV					WG	208.08	
1852	1	10	11	40		41.200N	71.400W		IV					EP	134.15	FA = 9893 SQ.KM.
1852	11	27	23	45		43.000N	70.300W		V					WG	11.97	
1854	10	24	22	0		42.900N	72.700W		IV					EP	118.51	
1854	12	11	0	30		43.000N	70.800W		- V					WG	11.91	FA = 4092 SQ.KM.
1855	1	16	18	0		44.000N	71.000W		V					WG	122.94	FA = 32996 SQ.KM.
1855	1	15	19	20		44.000N	71.000W		IV					EP	122.94	
1855	2	6	23	30		42.000N	74.000W		V					MA	277.78	
1855	2	8	11	30		46.000N	64.500W		V					EP	611.33	
1855	2	19	0	0		44.550N	63.630W		IV					WG	208.08	
1855	6	0	0	0		44.700N	65.500W		IV					EP	474.59	
1855	12	17	14	0		43.300N	73.700W		IV					EP	236.33	
1855	3	12	22	0		41.400N	72.600W		IV					EP	220.61	
1857	6	30	22	45		41.500N	72.500W		IV					WG	206.74	
1857	12	8	20	0		46.690N	66.010W		IV					WG	476.40	
1857	12	23	13	30		44.100N	70.200W		VI					WG	143.33	FA = 9997 SQ.KM.
1857	12	28	0	0		44.100N	70.200W		IV					EP	143.39	
1858	5	17	20	0		45.500N	72.100W		IV					EP	305.82	
1858	6	27	0	0		41.400N	72.800W		IV					EP	231.73	
1859	6	30	22	45		41.300N	73.000W		- V					WG	251.40	FA = 2305 SQ.KM.
1860	10	17	11	15		47.500N	70.100W		- IX					EP	514.72	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		(KM.)	
1861	10	0	0	0		45.600N	73.700W		V					EP	376.69	
1862	2	2	20	0		41.500N	72.500W		IV					EP	206.74	
1863	6	9	21	30		44.500N	73.000W		IV					WG	248.40	
1864	4	20	18	15		46.900N	71.200W		VI					EP	445.51	
1864	10	21	9	10		45.500N	73.600W		IV					EP	363.13	
1866	11	9	16	10		46.300N	71.200W		IV					EP	434.41	
1869	10	22	11	0		45.000N	65.200W		VI					EP	440.10	
1969	12	0	0	0		47.500N	70.500W		V					EP	512.09	
1870	2	8	0	0		44.100N	69.800W		IV					EP	158.12	
1870	3	17	11	0		45.500N	66.500W		IV					EP	451.99	
1870	10	20	16	30		47.400N	70.500W		IX					EP	500.98	
1870	10	26	0	0		47.400N	70.500W		IV					EP	500.98	
1870	12	26	18	30		46.800N	71.200W		IV					EP	434.41	
1871	1	3	0	0		45.600N	74.500W		V					EP	423.99	
1971	1	9	0	0		47.500N	70.100W		V					EP	514.72	
1871	2	16	0	0		47.500N	70.400W		IV					EP	512.56	
1871	5	20	7	0		46.800N	71.200W		IV					EP	434.41	
1871	7	20	0	0		43.200N	71.530W		IV					WG	64.78	
1872	1	9	23	54		47.500N	70.500W		VII					EP	512.09	
1872	7	11	5	25		40.900N	73.800W		V					EH	330.52	FA = 259 SQ.KM.
1872	11	18	14	0		43.200N	71.600W		- V					WG	69.73	FA = 6008 SQ.KM.
1873	4	25	19	0		44.800N	74.200W		V					EP	347.33	
1873	4	30	0	0		45.000N	74.700W		IV					EP	387.32	
1873	9	30	11	50		45.500N	73.200W		IV					EP	344.72	
1874	1	6	0	0		43.600N	71.200W		IV					EP	82.93	
1874	1	25	12	0		42.600N	71.350W		IV					EP	52.79	
1874	2	27	23	35		45.130N	67.280W		- V					WG	382.14	FA = 15539 SQ.KM.
1874	11	24	0	0		42.700N	70.900W		IV					EP	22.50	
1874	12	10	22	25		40.900N	73.800W		VI					EP	330.52	FA = 12950 SQ.KM.
1875	7	28	4	10		41.900N	73.000W		V					WG	208.99	FA = 3600 SQ.KM.
1875	12	1	0	0		42.900N	72.300W		IV					EP	118.51	
1875	9	21	23	30		41.530N	71.280W		- V					WG	156.18	FA = 6604 SQ.KM.
1877	9	10	9	59		40.300N	74.900W		- V					EH	444.20	FA = 777 SQ.KM.
1877	11	4	1	55		45.200N	73.900W		VI					EP	353.73	FA = 233100 SQ.KM.
1878	2	5	11	20		40.000N	73.900W		V					EP	405.50	
1878	10	4	2	30		41.500N	74.000W		V					EP	303.09	FA = 1554 SQ.KM.
1879	6	11	0	0		45.600N	73.500W		IV					EP	371.92	
1879	10	25	22	30		42.920N	71.470W		IV					WG	51.48	
1880	5	12	7	45		42.700N	71.000W		- V					WG	25.32	FA = 4610 SQ.KM.
1980	7	20	19	0		42.930N	71.470W		IV					WG	51.48	

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TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1880	9	6	5	30		45.200N	73.900W		IV					EP	348.24	
1880	11	28	13	30		47.450N	70.500W		IV					EP	506.53	
1881	1	20	21	40		44.000N	70.000W		IV					EP	140.31	FA = 5180 SC.KM.
1881	10	1	6	40		47.600N	70.200W		IV					EP	524.94	
1881	10	6	5	3		43.200N	71.550W		IV					EP	66.19	
1882	4	17	0	0		43.200N	71.700W		IV					EP	76.93	
1882	12	19	17	24		43.200N	71.400W		V					WG	55.98	FA = 7692 SC.KM.
1882	12	31	21	55		45.000N	67.000W		V					EP	387.19	FA = 207200 SC.KM.
1883	1	1	7	53		44.600N	67.700W		IV					EP	316.27	
1883	2	4	20	5		43.600N	71.200W		IV					EP	82.93	
1883	2	27	23	30		41.500N	71.300W		V					WG	159.60	FA = 9194 SC.KM.
1883	3	12	0	0		45.100N	74.500W		IV					EP	381.47	
1884	1	18	7	0		43.200N	71.700W		IV					EP	76.93	
1884	8	10	19	7		40.600N	74.000W		VII					EP	365.87	FA = 181300 SC.KM.
1884	8	11	0	0		40.600N	74.000W		- V					WG	365.87	
1884	11	12	0	0		43.200N	71.550W		IV					EP	66.19	
1884	11	23	12	30		43.200N	71.700W		V					WG	76.93	FA = 11007 SC.KM.
1884	12	17	0	0		43.700N	71.500W		IV					EP	103.49	
1885	6	0	15	0		45.100N	65.100W		IV					EP	452.55	
1886	1	5	19	10		42.900N	71.500W		IV					WG	53.17	
1886	1	17	17	14		42.770N	71.450W		IV					WG	51.19	
1886	1	25	0	0		41.580N	73.800W		IV					WG	264.23	
1886	8	12	0	0		46.000N	74.000W		IV					EP	426.14	
1886	9	5	0	0		41.500N	72.500W		IV					EP	206.74	
1887	3	11	0	0		47.500N	70.500W		IV					EP	512.03	
1887	5	27	6	15		47.450N	70.500W		V					EP	506.53	
1887	6	30	21	0		43.200N	71.530W		IV					WG	64.78	
1888	2	1	11	20		44.650N	70.100W		IV					EP	203.69	
1888	4	13	5	30		47.450N	70.500W		IV					EP	506.53	
1888	8	14	20	15		44.300N	69.080W		IV					WG	170.74	
1889	3	8	0	0		43.450N	71.580W		IV					WG	85.33	
1889	8	10	0	0		43.430N	73.720W		IV					WG	240.81	
1891	5	1	19	10		43.200N	71.600W		V					WG	69.73	FA = 11007 SC.KM.
1891	5	29	19	0		43.100N	71.500W		IV					EP	57.59	
1892	12	11	11	30		44.300N	71.700W		IV					WG	170.15	
1893	3	9	0	30		40.600N	74.000W		V					EP	365.87	
1893	3	14	0	0		42.350N	72.650W		IV					WG	160.60	
1893	11	27	16	50		45.500N	73.300W		VII					EP	349.14	
1894	4	10	0	0		41.600N	72.500W		IV					EP	198.45	
1894	4	17	16	15		45.600N	73.300W		IV					EP	358.30	

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TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1894	12	17	0	0		42.470N	73.800W		IV					WG	246.50	
1895	9	1	6	3		40.700N	74.000W		VI					EP	409.18	FA = 90650 SQ.KM.
1896	3	22	20	0		45.200N	67.200W		V					EP	388.38	FA = 20720 SQ.KM.
1896	5	15	23	0		46.000N	65.500W		IV					EP	492.71	
1896	10	22	5	30		44.300N	71.770W		IV					WG	172.51	
1897	1	28	21	0		44.500N	65.800W		IV					EP	371.67	
1897	3	23	18	7		45.500N	73.600W		VII					EP	353.13	
1897	3	26	0	4		45.500N	73.500W		IV					EP	353.13	
1897	5	27	22	16		44.500N	73.500W		VI					EP	278.03	FA = 388500 SQ.KM.
1897	7	1	4	20		43.700N	71.600W		IV					EP	107.86	
1897	9	5	0	0		41.800N	72.500W		IV					EP	206.74	
1897	9	25	13	5		44.700N	69.700W		V					WG	254.47	FA = 47604 SQ.KM.
1898	1	7	6	0		45.160N	74.300W		IV					EP	369.31	
1898	1	11	9	0		44.700N	65.800W		IV					EP	382.33	
1898	6	11	1	45		42.830N	72.560W		IV					WG	140.04	
1899	5	16	20	15		41.600N	72.600W		V					WG	204.21	FA = 8909 SQ.KM.
1899	10	5	6	30		43.960N	69.500W		IV					WG	160.71	
1903	4	24	12	30		42.700N	71.000W		IV					EP	25.32	FA = 906 SC.KM.
1904	3	21	6	4		45.000N	67.200W		VI					EP	374.51	FA = 388500 SQ.KM.
1905	7	15	5	10		44.200N	70.000W		VI					WG	160.00	FA = 100310 SC.KM.
1905	8	30	10	40		43.100N	70.700W		V					WG	25.42	FA = 1036 SQ.KM.
1905	10	22	0	0		44.900N	72.200W		IV					BK	247.41	
1905	11	26	0	30		41.500N	71.300W		IV					WG	159.80	
1906	5	8	13	30		41.500N	72.500W		IV					EP	206.74	
1906	10	19	0	0		43.500N	70.500W		IV					WG	72.55	
1907	1	24	11	30		42.800N	74.000W		IV					EP	257.79	
1907	6	29	0	0		43.500N	70.500W		IV					WG	72.55	
1907	8	5	12	43		47.650N	70.160W		IV					EP	530.78	
1907	10	15	0	10		42.900N	71.000W		V					WG	16.53	FA = 5594 SC.KM.
1908	3	10	0	0		47.450N	70.500W		IV					EP	506.53	
1908	5	14	4	45		46.000N	65.300W		V					EP	420.54	
1908	6	16	20	41	52.	45.100N	74.300W		V					EP	400.22	
1908	8	8	12	0		46.300N	67.500W		VI					EP	457.50	
1908	11	23	13	0		43.450N	71.550W		IV					WG	89.38	
1909	2	1	8	20		45.510N	73.570W		IV					EP	362.56	
1909	5	3	21	20		46.050N	74.280W		IV					EP	443.91	
1909	6	9	8	25		46.050N	74.280W		IV					EP	443.91	
1910	1	23	1	30		43.800N	70.400W		IV					EP	106.52	FA = 389 SC.KM.
1910	2	0	0	0		48.000N	70.000W		VI					EP	570.81	
1910	8	21	18	45	30.	42.700N	71.100W		IV					EP	30.17	

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TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 49.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1910	8	30	14	30		43.400N	72.100W		IV					EP	115.99	
1910	10	29	21	50		44.300N	68.300W		IV					EP	227.15	
1910	10	25	9	30		47.600N	69.900W		V					EP	528.91	
1911	3	2	21	30		43.200N	71.530W		IV					WG	64.78	
1912	12	11	10	15		45.000N	64.000W		IV					EP	326.77	FA = 51800 SC.KM.
1913	6	8	6	30		45.580N	74.400W		IV					EP	419.24	
1913	8	10	5	15		44.000N	74.000W		IV					EP	282.85	
1913	11	3	14	30	00.	41.400N	71.400W		IV					WG	172.62	
1914	1	13	8	0		45.180N	67.280W		IV					WG	382.14	
1914	2	10	18	31		46.000N	75.000W		VII			5.5		EP	477.29	FA = 517999 SC.KM.
1914	2	14	9	34		46.400N	73.600W		V					EP	446.02	
1914	2	22	0	35		45.000N	70.500W		IV					WG	235.13	FA = 20720 SC.KM.
1915	2	21	2	3		42.800N	71.100W		IV					WG	23.28	
1915	2	21	23	41		44.700N	73.400W		IV					EP	286.67	
1915	7	27	16	30		44.000N	65.000W		V					EP	438.89	
1916	1	5	13	56		43.700N	73.700W		V					EP	247.86	FA = 777 SC.KM.
1916	2	3	4	25		43.000N	74.000W		V					EH	257.39	FA = 20720 SC.KM.
1916	2	23	5	15		46.800N	70.900W		IV					EP	433.55	
1916	6	8	21	15		41.000N	73.300W		IV					EP	323.02	
1916	11	2	2	37		43.300N	73.700W		V					EP	236.33	FA = 777 SC.KM.
1916	12	2	9	0	00.	41.500N	72.450W		- IV					EP	204.04	
1917	1	26	7	35	48.	46.800N	74.500W		V					EP	520.69	
1917	2	16	9	0	00.	41.500N	72.450W		IV					EP	204.04	
1918	7	23	12	0	00.	46.850N	71.350W		IV					EP	440.86	
1918	8	21	5	15		44.200N	70.500W		VI					WG	147.23	FA = 8906 SC.KM.
1919	7	11	1	40	00.	43.920N	69.970W		IV					EP	133.93	
1919	8	11	0	0		41.470N	72.450W		IV					EP	206.61	
1919	10	25	10	23		47.600N	70.000W		IV					EP	526.70	
1920	5	23	8	0		43.100N	71.500W		IV					EP	57.59	
1920	11	3	19	25		46.010N	73.430W		- V					EP	402.03	
1921	1	19	10	0		43.300N	73.700W		IV					EP	236.33	
1921	1	26	23	40		40.000N	75.000W		V					EP	473.17	
1921	1	27	0	0		43.300N	73.700W		IV					EP	236.33	
1921	10	10	13	0		44.800N	67.000W		IV					EP	374.65	
1922	5	7	22	40		43.400N	71.400W		IV					EP	71.46	
1922	7	2	22	25	35.	46.500N	66.600W		VI					EP	522.87	
1924	3	4	19	15		47.800N	70.200W		V					EP	547.07	
1924	9	30	8	52	30	47.620N	69.700W		-VIII		5.5			EP	530.13	
1925	1	7	13	7		42.600N	71.500W		V					WG	38.97	FA = 29009 SC.KM.
1925	3	1	2	19	20.	47.600N	70.100W		IX		6.6	7.0		EP	525.76	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		(KM.)	
1925	3	1	4	30	42.	47.600N	70.100W		VI					EP	525.76	
1925	3	1	5	25	21.	47.600N	70.100W		- V					EP	525.76	
1925	3	1	7	25	10.	47.600N	70.100W		- V					EP	525.76	
1925	3	1	13	21	30.	47.600N	70.100W		IV					EP	525.76	
1925	3	7	2	30	00.	47.600N	70.100W		V					EP	525.76	
1925	3	9	0	0		42.930N	71.470W		IV					EP	50.83	
1925	3	14	10	13	00.	47.600N	70.100W		IV					EP	525.76	
1925	3	17	14	45	20.	47.600N	70.100W		IV					EP	525.76	
1925	3	18	13	15	22.	47.600N	70.100W		IV					EP	525.76	
1925	3	21	15	22	04.	47.600N	70.100W		VI					EP	525.76	
1925	4	24	7	55		41.700N	70.500W		- V					WG	133.25	FA = 8598 SQ.KM.
1925	4	26	4	50	00.	47.600N	70.100W		IV					EP	525.76	
1925	7	6	9	33	04.	47.600N	70.100W		IV					EP	525.76	
1925	7	27	2	20	00.	47.600N	70.100W		IV					EP	525.76	
1925	10	9	5	0		46.820N	71.220W		IV					EP	436.74	
1925	10	9	13	55		43.700N	71.100W		VI					WG	91.29	FA = 17689 SQ.KM.
1925	10	19	12	5	17.	47.000N	73.000W		V					EP	486.30	
1925	10	29	0	0		41.500N	72.450W		IV					EP	204.04	
1925	11	14	13	4		41.700N	72.410W		V					WG	194.65	FA = 3211 SQ.KM.
1925	11	15	6	20	00	41.770N	72.700W		IV					EP	197.48	
1926	1	4	0	0		41.600N	71.900W		IV					EP	164.26	
1926	1	26	23	40		40.000N	75.000W		V					EP	473.17	
1926	1	27	0	0		44.330N	74.120W		IV					EP	308.20	
1926	2	19	20	20		47.700N	71.000W		IV					EP	533.72	
1926	2	21	21	55		47.600N	70.300W		IV					EP	522.49	
1926	3	18	21	9		42.800N	71.800W		V					WG	78.51	FA = 4791 SQ.KM.
1926	5	12	3	30		40.900N	73.900W		V					EP	336.71	FA = 388 SQ.KM.
1926	7	18	6	0		47.000N	71.500W		IV					EP	458.64	
1926	8	23	0	0		45.820N	71.110W		IV					EP	325.26	
1926	8	23	21	30		44.900N	70.400W		IV					EP	214.29	FA = 7769 SQ.KM.
1926	9	21	11	30		48.000N	70.500W		IV					EP	567.60	
1926	11	24	19	30		45.000N	67.500W		IV					EP	356.01	
1927	3	9	4	3		43.300N	71.400W		- V					WG	63.22	FA = 4791 SQ.KM.
1927	3	30	0	0		41.670N	72.780W		IV					EP	209.77	
1927	6	1	12	23		40.300N	74.000W		VII					EP	390.25	FA = 7769 SQ.KM.
1927	7	25	0	55		47.300N	71.000W		V					EP	489.25	
1927	8	20	0	0		42.700N	71.000W		IV					EP	67.69	
1927	10	24	11	0	00.	44.730N	73.750W		IV					EP	309.59	
1928	1	13	19	50		41.200N	71.500W		IV					EP	198.70	
1928	1	21	5	30		45.300N	67.000W		IV					EP	305.10	

Weston Geophysical

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		(KM.)	
1928	1	27	0	0		48.000N	70.200W		IV					EP	569.21	
1928	2	8	0	0		45.300N	69.000W		VI					WG	305.10	FA = 1605 SQ.KM.
1928	3	18	15	25		44.500N	74.300W		- VI			4.1		EP	330.16	FA = 31079 SQ.KM.
1928	3	22	13	30		45.300N	69.000W		IV					EP	305.10	
1928	3	23	0	0		45.300N	69.000W		IV					EP	305.10	
1928	4	25	23	33		44.500N	71.200W		V					WG	180.12	FA = 15410 SQ.KM.
1928	4	29	22	7		43.200N	71.500W		IV					EP	52.70	
1928	11	20	2	30		45.000N	67.200W		IV					EP	374.51	
1929	2	5	19	9		44.000N	70.300W		IV					EP	130.15	
1929	5	11	9	30		45.400N	71.900W		IV					EP	290.34	
1930	1	4	14	30	38.	46.730N	65.830W					4.5		EP	581.90	
1930	2	14	6	15		43.400N	71.700W		IV					EP	88.83	
1930	3	19	0	15		43.300N	71.600W		IV					EP	75.65	
1930	6	13	12	0	56.	45.730N	71.220W					3.6		EP	315.97	
1930	7	13	4	52	39.3	47.500N	69.830W					3.1		EP	517.57	
1930	12	13	23	13	23.7	47.650N	70.170W					3.5		EP	530.70	
1930	12	25	22	7	34.	47.630N	70.170W					4.5		EP	528.49	
1931	1	8	0	13	36.5	47.630N	70.170W					5.4		EP	528.49	
1931	1	24	12	23	11.9	47.450N	70.500W					3.4		EP	506.53	
1931	4	20	19	54		43.400N	73.700W		VII		4.7	5.0		EP	238.49	FA = 155400 SQ.KM.
1931	7	1	2	45		41.600N	73.400W		IV					EP	255.22	
1931	8	7	0	0		44.620N	65.770W		IV					EP	451.41	
1931	11	14	14	2	29.5	47.330N	70.170W					3.4		EP	495.34	
1932	3	9	5	23	38.8	46.470N	74.570W					3.8		EP	499.12	
1932	12	7	3	15		44.400N	74.100W		IV					EP	310.79	
1933	1	17	5	30		41.630N	70.930W		IV					WG	141.12	
1933	1	21	16	4	39.5	45.300N	74.650W					3.3		EP	404.66	
1933	1	25	2	0		40.200N	74.700W		V					EP	439.35	FA = 1554 SQ.KM.
1933	2	25	9	43	02.7	47.430N	69.930W					3.4		EP	508.72	
1933	10	29	0	0		43.000N	74.700W		IV					EP	314.45	
1934	1	30	10	30		41.800N	72.500W		IV					EP	188.99	
1934	3	17	0	0		43.500N	65.500W		- IV					EP	439.79	
1934	4	15	2	59	13.	44.670N	73.800W		- VI			4.5		EP	308.43	FA = 20720 SQ.KM.
1934	8	2	14	59		42.600N	70.700W		IV					EP	35.39	
1934	8	2	14	59		42.700N	70.300W		IV					EP	99.52	
1934	8	3	2	30		43.700N	70.300W		IV					EP	99.52	
1935	1	28	6	0		44.800N	74.300W		IV					EP	348.69	
1935	1	23	9	1	32.	44.800N	74.300W		III			3.2		EP	348.69	
1935	4	24	1	24		42.170N	70.220W		IV					EP	96.07	
1936	3	29	0	49	23.4	47.330N	70.250W					4.0		EP	494.70	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1936	11	10	2	45		43.550N	71.430W		V					WG	86.37	FA = 1502 SQ.KM.
1936	11	10	4	2		44.650N	71.670W		IV					EP	205.46	
1937	7	19	3	51		40.720N	73.710W		IV					EP	339.23	
1937	7	27	9	10		41.630N	72.430W		IV					EP	176.26	
1937	9	5	11	3	15.	41.500N	66.000W					3.5		EP	429.51	
1937	9	30	7	53	10.	45.470N	65.830W					5.0		EP	492.47	
1937	11	12	14	43	44.3	45.920N	74.330W					3.6		EP	435.32	
1937	11	12	16	57	32.5	45.920N	74.330W					3.7		EP	435.32	
1938	6	15	5	7	43.	46.500N	65.800W		- IV					EP	512.82	
1938	6	23	3	57	56.	42.620N	71.420W		IV					EP	56.09	
1938	8	2	9	2	30.	41.040N	73.700W		- IV					EP	310.84	
1938	8	22	7	43		44.700N	65.300W		- V			4.1		WG	259.28	FA = 9065 SQ.KM.
1938	8	23	3	35	34.	40.100N	74.500W		V		3.9	4.6		EH	435.33	FA = 12950 SQ.KM. MO = 2.4E21 DY-CM.
1938	8	23	5	4	55.	40.250N	74.250W				4.0	4.9		EP	408.62	MO = 2.6E21 DY-CM.
1938	8	23	7	3	29.	40.250N	74.250W				3.7	4.6		EP	408.62	MO = 2.8E21 DY-CM.
1938	9	7	23	18	18.9	45.870N	74.900W					3.4		EP	461.63	
1939	6	24	17	20	21.	47.830N	70.330W				4.4			EP	548.05	
1939	10	19	11	53	58.	47.800N	70.000W		VI		5.6			EP	548.75	
1939	10	19	14	12	16.	47.800N	70.000W					3.4		EP	548.75	
1939	10	19	18	37	22.	47.500N	70.900W					3.5		EP	511.37	
1939	10	21	8	7	13.8	47.500N	70.920W					4.0		EP	511.39	
1939	10	27	1	35	36.2	47.800N	70.000W				4.5			EP	548.75	
1939	11	7	2	40	32.	47.800N	70.500W				4.1			EP	545.39	
1939	12	8	1	17	47.	47.970N	71.400W					3.5		EP	555.25	
1939	12	25	10	29	13.4	48.000N	70.500W					4.1		EP	567.60	
1940	1	28	23	11	51	41.630N	70.800W		V		2.6	4.3		WG	141.02	FA = 6190 SQ.KM. MO = 1.3E20 DY-CM.
1940	3	2	4	15	36.	41.500N	72.500W		IV					EP	206.74	
1940	3	13	1	27		41.500N	72.500W		IV					EP	206.74	
1940	3	28	11	42	34.5	44.700N	69.900W					3.8		NF	214.19	
1940	4	13	8	13	34.	47.730N	70.730W					3.9		EP	537.01	
1940	5	16	14	0	17.1	45.900N	73.200W					2.6		EP	372.87	
1940	8	4	16	20	52.	46.250N	74.780W					3.1		EP	495.84	
1940	9	11	1	6	55.4	47.000N	71.130W					3.5		EP	456.30	
1940	12	20	7	27	26	43.872N	71.370W		VII		5.5			DW	116.05	FA = 786000 SQ.KM. MO = 9.0E23 DY-CM.
1940	12	24	13	43	44.	43.908N	71.283W		VII		5.5			DW	117.49	
1940	12	25	5	3	43.	43.908N	71.283W				3.7	4.0		DW	117.49	MO = 1.4E21 DY-CM.
1940	12	27	19	55	09.	43.908N	71.283W				3.8	3.9		DW	117.49	MO = 1.6E21 DY-CM.
1941	4	4	8	10	43.7	44.730N	73.920W					3.3		EP	320.03	
1941	8	30	10	21	25.	46.190N	67.700W					3.7		EP	426.01	
1941	9	5	17	4	56.5	47.430N	70.520W					3.9		EP	504.23	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1941	10	6	16	34	27.6	47.630N	70.730W					4.0		EP	525.89	
1941	10	21	5	10	41.	44.770N	74.800W					3.3		EP	379.69	
1941	10	24	14	13	59.3	45.700N	74.300W					3.6		EP	415.52	
1942	2	18	7	55	12.	46.830N	74.770W					3.1		EP	535.46	
1942	3	8	23	37	58.	44.130N	73.350W		IV					EP	147.93	
1942	5	20	12	13	22.8	45.770N	74.670W					4.4		EP	441.10	
1942	5	24	11	33	57.	44.730N	73.330W					3.9		EP	314.47	
1942	9	5	14	30	24.1	46.970N	71.500W					3.1		EP	455.33	
1943	1	14	21	32	38	45.300N	69.600W		V		4.3			WG	284.91	FA = 131002 SQ.KM. MO = 9.4E21 DY-CM.
1943	3	14	14	2	27.5	43.700N	71.570W					3.9		EP	106.50	
1943	5	9	11	3	12.5	44.770N	73.830W					3.2		EP	317.31	
1943	7	6	22	10	14.8	44.920N	73.130W					4.1		EP	289.81	
1943	9	25	5	[illegible]	36.1	47.550N	70.650W					3.3		EP	517.15	
1943	9	28	16	30	25.2	47.270N	70.400W					3.8		EP	487.06	
1943	11	6	0	5	40.5	47.330N	70.060W					3.9		EP	501.66	
1943	12	6	7	13	40.	47.630N	74.270W					3.2		EP	617.74	
1943	12	19	9	0	44.	44.600N	69.500W		- IV					EP	214.10	
1944	2	5	17	37	52.5	47.400N	70.500W					4.0		EP	500.98	
1944	6	3	15	13	08.7	47.300N	70.280W					3.7		EP	491.16	
1944	6	24	23	49	36.5	46.000N	74.250W					3.7		EP	438.13	
1944	9	5	4	33	45.	44.970N	74.900W		VIII		5.9	5.9		EP	396.37	FA = 453250 SQ.KM. MO = 2.3E24 DY-CM.
1944	9	5	8	30	49.	44.930N	74.900W					3.4		EP	398.99	
1944	9	5	8	51	06.	44.980N	74.900W					4.6		EP	398.99	
1944	9	5	10	56	51.	44.980N	74.900W					3.3		EP	398.99	
1944	9	9	23	24	48.	44.930N	74.900W					4.1		EP	398.99	
1944	10	31	8	42	25.	44.930N	74.900W					4.0		EP	398.99	
1944	12	14	3	15		41.600N	72.800W		IV					EP	216.20	
1945	6	13	15	20	06.9	47.130N	71.120W					4.7		EP	476.25	
1945	7	15	10	44	59.	44.900N	67.000W		IV					EP	380.81	
1946	4	21	5	5	55.5	45.730N	73.430W					3.5		EP	375.94	
1946	9	1	4	33	41.	47.330N	71.470W					3.3		EP	434.85	
1946	9	13	0	53	28.6	47.720N	75.000W					3.2		EP	626.73	
1946	9	26	21	13	08.2	46.430N	72.150W					3.4		EP	405.72	
1946	11	24	10	23	47.2	45.170N	74.580W					3.1		EP	397.40	
1946	12	25	4	47	02.7	44.900N	74.900W					3.3		EP	394.09	
1947	1	4	18	51	04.	41.030N	73.530W		IV					EP	307.14	
1947	2	2	16	53	32.3	47.570N	70.330W					4.2		EP	530.84	
1947	3	29	12	21	52.4	47.370N	70.230W					4.0		EP	499.27	
1947	10	22	9	[illegible]	28.3	47.550N	70.720W					3.3		EP	517.01	
1947	12	28	13	54	20	45.200N	69.200W		V		4.1			WG	287.80	FA = [illegible] SQ.KM.

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MS	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1948	1	1	18	33	45.3	47.330N	70.430W				4.9			EP	493.55	
1948	1	1	18	44	40.	47.330N	70.430W					3.2		EP	493.55	
1948	1	6	20	46	51.	45.400N	69.280W		IV			4.0		EP	304.93	
1948	5	4	2	23	25.	41.390N	71.830W		IV					EP	187.21	
1948	5	7	12	2	26.	45.750N	74.530W					4.0		EP	386.70	
1948	6	9	3	4	12.2	45.230N	73.370W					3.7		EP	354.46	
1948	7	7	7	39	01.4	45.130N	73.900W					3.5		EP	352.15	
1948	11	13	16	49	56.6	46.700N	70.300W					3.5		EP	424.64	
1948	11	29	4	55	47.	45.200N	69.200W		IV					EP	297.80	
1949	4	17	0	15		41.600N	71.500W		IV					EP	153.97	
1949	10	5	2	33	47	44.800N	70.500W		V		4.5	4.0		WG	213.09	FA = 45195 SQ.KM. MO = 2.2523 DY-CM.
1949	10	16	23	33	42.3	45.300N	74.930W		V			4.2		EP	415.60	
1949	10	30	20	51	13.7	46.470N	72.120W					3.4		EP	409.42	
1950	3	6	16	14	11.8	46.000N	74.500W					4.0		EP	450.68	
1950	3	29	14	43	02.	41.050N	73.500W		IV					EP	306.85	
1950	8	4	6	45	21.	47.330N	70.250W					3.2		EP	434.70	
1950	8	4	14	29	28.7	45.200N	74.720W					4.0		EP	401.93	
1950	8	5	23	59	07.0	45.070N	74.750W					3.5		EP	395.08	
1951	1	26	3	27		41.500N	72.500W		IV					EP	206.74	
1951	3	31	3	50	37.	42.200N	72.200W		IV					EP	135.44	
1951	6	10	17	20	37.9	41.500N	71.500W		IV					EP	164.44	
1951	7	25	0	22	51.5	47.200N	71.370W					3.3		EP	479.75	
1951	8	8	9	36	24.1	45.930N	74.670W					3.3		EP	453.84	
1951	9	3	21	26	24.5	41.250N	74.250W		V		3.9	4.4		EP	335.77	FA = 14245 SQ.KM. MO = 1.4521 DY-CM.
1951	10	25	7	7	52.8	45.270N	74.730W					3.9		EP	407.39	
1951	11	5	17	54	41.5	45.000N	73.600W		IV			3.7		US	321.32	FA = 20720 SQ.KM.
1952	1	30	4	0		44.500N	73.200W		VI					WG	259.91	FA = 129 SQ.KM.
1952	2	13	20	55	07.	46.330N	69.380W					3.3		EP	398.69	
1952	2	26	0	55	58.	46.800N	70.200W					3.7		EP	436.55	
1952	3	30	13	31	07.	47.830N	69.380W				4.1			EP	553.25	
1952	4	19	2	50	52.6	47.470N	70.580W					3.8		EP	508.46	
1952	4	20	19	5	01.3	47.500N	70.680W					3.5		EP	511.52	
1952	8	25	0	7		43.000N	74.500W		V					EP	298.15	
1952	10	9	21	40		41.700N	74.030W		V					EP	291.96	
1953	3	27	8	59		41.100N	73.500W		V					WG	296.92	FA = 1191 SQ.KM.
1953	3	31	12	53	34.3	42.700N	73.[illegible]00W		V			4.0		WG	195.92	FA = 7200 SQ.KM.
1953	4	26	1	20		44.720N	73.450W		IV			3.7		EP	291.03	
1953	5	11	6	13	17.	43.380N	71.130W		IV					EP	122.24	
1953	6	17	4	27	50.	41.000N	74.000W		IV					EP	335.75	
1954	2	7	20	24	16.	47.600N	70.250W					3.8		EP	524.58	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 43.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MS	MN	ML	MC		(KM.)	
1954	2	21	9	0	37.	47.670N	70.520W					3.5		EP	530.56	
1954	3	31	21	25		40.250N	74.000W		IV					EP	394.44	
1954	4	21	15	45		44.720N	73.470W		IV					EP	292.23	
1954	5	20	22	1	18.	44.970N	74.200W		IV			[illegible]		EP	354.00	
1954	6	30	7	41	07.	47.000N	70.120W					3.7		EP	459.37	
1954	7	29	19	57	06	42.700N	70.700W		V			4.0		WG	25.25	FA = 4092 SC.KM.
1954	12	13	3	53	52.	44.600N	74.600W		IV			3.6		EP	356.32	
1955	1	21	8	40		42.970N	73.780W		V					EP	239.39	
1955	2	1	12	40	27.	47.670N	70.500W					4.0		EP	530.96	
1955	2	1	20	49	46.	47.670N	70.500W					3.2		EP	530.96	
1955	2	3	2	30		44.500N	73.200W		V					WG	259.91	
1955	10	7	18	9	52.	45.220N	73.900W					3.5		EP	355.31	
1956	1	30	9	43	13.	47.050N	71.170W					3.7		EP	462.01	
1956	2	2	19	24	16.	45.450N	74.820W					3.1		EP	425.59	
1956	7	27	1	34	44.	44.700N	73.780W					3.4		EP	309.30	
1957	2	20	15	45		44.930N	74.880W		IV					EP	394.60	
1957	3	23	19	2		40.630N	74.330W		VI					EP	415.99	
1957	4	24	0	41	59	44.400N	72.000W		V					WG	190.88	FA = 802 SQ.KM.
1957	4	26	11	40	06	43.600N	69.300W		VI		4.7			WG	115.43	FA = 82491 SC.KM. MO = 4.1E22 DY-CM.
1957	8	4	12	41	58.	46.530N	67.080W					3.7		EP	506.28	
1957	8	6	23	50	38.	47.430N	70.620W					4.0		EP	510.24	
1957	8	17	1	30	07.	46.730N	70.120W					3.3		EP	429.63	
1957	11	30	8	27	51.	45.020N	74.770W		IV			2.5		EP	333.10	
1958	1	11	16	35		44.930N	74.880W		IV					EP	394.60	
1958	3	23	22	4	17.	45.550N	67.120W					3.4		EP	418.91	
1958	5	6	19	0		42.650N	73.820W		IV					EP	244.71	
1958	7	18	23	56	27.	46.700N	71.400W					3.2		EP	424.65	
1958	8	8	22	15	03.	47.930N	70.380W				3.6			EP	550.36	
1958	9	13	17	45		43.600N	70.200W		V					WG	94.04	
1958	9	30	0	13	58.	45.180N	73.730W					3.7		EP	342.84	
1958	11	21	23	30		43.970N	71.680W		IV					EP	136.70	
1958	12	23	23	14	16.	46.930N	69.920W					[illegible]		EP	460.74	
1959	4	13	21	20	19.	41.920N	73.270W					[illegible]		EP	227.03	
1959	4	15	16	35	25.	47.120N	70.330W					3.5		EP	470.83	
1959	8	22	3	52	30.	46.950N	70.780W					3.2		EP	450.24	
1960	2	5	0	44	02.	47.800N	70.380W					3.3		EP	545.94	
1960	4	23	11	47	52.	47.530N	70.300W					4.0		EP	516.49	
1961	1	29	9	49	39.	46.330N	65.930W					3.8		EP	496.13	
1961	4	20	13	13	00.	45.000N	74.780W		V			2.0		PM	332.45	
1961	8	22	13	55	51.	47.330N	70.500W					3.4		EP	493.21	

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TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		(KM.)	
1961	9	29	1	30		44.930N	74.390W		IV					US	334.60	
1961	12	14	1	43	35.	43.830N	67.920W					3.9		EP	266.41	
1961	12	27	17	6		40.500N	74.750W		V			4.3		EP	419.98	
1962	1	27	12	11	17.	45.920N	74.850W				3.8			EP	462.77	
1962	1	31	14	32	38.	47.500N	67.130W					3.5		EP	538.79	
1962	3	23	2	2	21.	47.130N	69.470W					3.3		EP	498.00	
1962	3	25	5	15	05.	47.570N	65.020W					4.0		EP	642.60	
1962	4	10	14	30	48.1	44.100N	73.400W		V		4.3			WG	245.70	FA = 52395 SQ.KM.
1962	5	21	2	6	48.	45.370N	72.700W		V			3.9		EP	311.96	
1962	7	27	17	56	57.	47.250N	70.570W				3.9			EP	483.76	
1962	8	11	3	5	16.	47.530N	70.050W				3.6			EP	518.49	
1962	10	2	18	45	52.	44.300N	74.300W		IV					PM	348.69	
1962	12	29	6	13	10	42.900N	71.700W		V			4.3		WG	70.43	
1963	7	1	19	59	12.	42.570N	73.750W					3.3		EP	240.36	
1963	8	26	16	29	35.	45.180N	73.950W					3.5		EP	354.95	
1963	10	16	15	28	01.8	42.500N	70.800W		V		3.9	4.2		WG	44.51	FA = 17793 SQ.KM. MO = 1.5E21 DY-CM.
1963	10	30	17	35	57.9	42.700N	70.300W		- V		2.4	5.0		WG	22.47	FA = 5905 SQ.KM. MO = 8.9E19 DY-CM.
1963	12	4	21	32	34.9	43.600N	71.600W		- V			3.7		WG	98.92	FA = 2305 SQ.KM.
1964	1	20	18	57	55.	46.830N	71.330W					4.0		EP	438.51	
1964	3	29	4	15		44.900N	74.900W		V			4.3		EP	394.09	
1964	4	1	11	21	34	43.600N	71.500W		IV	1.8				US	94.13	
1964	6	16	13	0	44.	45.000N	74.230W		IV			2.7		EP	357.95	
1964	6	26	11	4	46	43.300N	71.900W		V	2.6		3.6		WG	96.47	FA = 14996 SQ.KM.
1964	7	12	0	9	41.	46.720N	71.410W					3.4		EP	426.94	
1964	10	17	14	13	07.	47.670N	67.250W					3.9		EP	600.59	
1964	11	17	17	3		41.200N	73.700W		V			4.3		EP	302.17	
1965	3	1	2	22	08.	47.500N	71.250W					3.1		EP	512.32	
1965	8	31	8	33	44.	46.000N	65.280W					3.2		EP	561.25	
1965	9	29	15	57	39.5	41.400N	74.400W		IV					PM	337.42	
1965	10	24	17	45		41.300N	70.100W		V			4.3		WG	198.11	
1965	12	3	3	3		41.700N	71.400W		- V			4.3		WG	140.72	FA = 1010 SQ.KM.
1965	12	16	13	53	19.	47.830N	70.500W					4.1		EP	548.39	
1966	5	20	0	5	42.	44.250N	66.500W					3.3		EP	331.98	
1966	6	25	0	5	51.	45.160N	73.830W					3.4		EP	346.70	
1966	7	20	20	8	29.	47.750N	70.000W					3.2		EP	543.23	
1966	7	24	1	53	58.	44.500N	67.600W		V			2.5		US	316.57	
1966	9	23	20	11	35.	46.920N	65.250W					3.2		EP	628.34	
1966	10	23	23	5	34	43.000N	71.300W		- V			3.1		WG	78.42	FA = 1605 SQ.KM.
1967	2	2	13	40	39	41.400N	71.400W		V			2.4		WG	172.62	FA = 1702 SQ.KM.
1967	4	28	12	23	32.	46.200N	67.300W	14	IV			2.5		US	444.52	

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TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		(KM.)	
1967	5	15	22	47	12.	42.300N	69.900W					3.2		EP	102.44	
1967	7	1	14	9	07	44.400N	69.900W		IV		2.9	3.2		WE	183.51	MO = [illegible].3E20 DY-CM.
1967	7	1	15	33	32	44.400N	69.900W					3.2		WE	183.51	
1967	7	1	15	55	58.2	44.330N	69.860W					3.3		WE	182.88	
1967	7	1	16	5	40.	44.330N	69.970W		V		3.4	3.3		EP	182.53	MO = 1.0E21 DY-CM.
1967	7	1	16	11	18.9	44.330N	69.960W					3.5		WE	182.88	
1967	9	23	16	27	55.	46.930N	70.700W					3.4		EP	448.13	
1967	11	22	22	10		41.230N	73.900W		V					OM	308.69	FA = 1036 SC.KM.
1968	3	30	15	29	59.	47.940N	70.490W	18			3.1			EP	560.99	
1968	4	11	9	19	33.	47.600N	70.440W	18			3.5			EP	523.45	
1968	5	27	19	21	56.	46.980N	65.660W	18				3.3		EP	554.07	
1968	7	24	23	16	37.	47.010N	71.300W	18				3.1		EP	458.26	
1968	9	23	15	33	50.	45.170N	69.450W	18			3.3			EP	276.13	
1968	10	19	10	37	18.	45.300N	74.120W	18	V		3.2			EP	373.81	
1968	10	20	2	36	58.	47.470N	70.570W	18			3.6			EP	508.49	
1968	11	3	8	33	52.5	41.400N	72.500W		V					WG	215.28	FA = 1800 SC.KM.
1969	5	10	18	43	29.	47.470N	70.650W	18			3.6			EP	508.26	
1969	5	10	20	1	55.	47.470N	70.650W	18			3.6			EP	508.26	
1969	7	14	3	6	59.	47.830N	70.090W	18			3.8			EP	553.25	
1969	8	6	16	3		43.900N	71.400W		V					WG	109.62	
1969	8	31	7	20	27.	47.490N	70.070W	18				3.2		EP	513.89	
1969	10	6	0	0		41.000N	74.600W		IV					NJ	375.75	
1970	8	3	0	19	30.	45.800N	66.120W	18			3.3			EP	495.94	
1970	9	7	21	39	27.	47.920N	70.300W	18			3.2			EP	559.70	
1970	9	19	13	35	09.4	42.950N	71.870W		IV					US	83.55	
1971	5	14	6	20	09.	45.100N	73.370W	18			3.2			EP	317.30	
1971	5	23	6	24	27.	43.820N	74.540W	1			3.7			EP	316.20	
1971	5	23	9	29	59.	43.940N	74.550W				3.6			EP	321.24	
1971	6	21	2	43	34.	43.930N	74.520W	1				3.3		EP	321.67	
1971	7	19	9	15	02.	43.920N	74.530W	1			3.4			EP	319.35	
1971	9	12	8	31	43.	47.560N	70.240W	18			3.2			EP	520.22	
1971	10	21	0	54	46.2	42.700N	71.150W		V					WG	33.09	FA = 1191 SC.KM.
1971	12	18	15	35	24.	46.180N	74.620W	18			3.9			EP	471.86	
1973	1	23	13	7	50.	47.930N	70.000W	10			3.1			EP	568.61	
1973	6	15	1	9	05.	45.330N	71.030W	10			4.9			EP	277.17	FA = 248639 SC.KM.
1973	7	15	8	20	31.	43.970N	74.490W	13			3.4			EP	317.88	
1973	7	15	10	32	38.	43.950N	74.430W	13			3.2			EP	312.93	
1973	7	16	2	41	58.	43.760N	74.470W	1			3.3			EP	308.85	
1973	11	16	1	36	34.	47.550N	70.790W	10			3.1			EP	518.77	
1974	6	7	19	43	37.	41.570N	73.340W	5			3.3			LD	294.76	MO = 2.3E20 DY-CM.

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		(KM.)	
1974	6	30	16	55	10.	47.940N	70.080W	15			3.1			EP	552.44	
1975	1	17	0	17	39.	44.910N	65.710W	10			3.1			EP	387.32	
1975	4	2	19	3	17.	45.730N	74.240W	5			3.1			EP	414.84	
1975	6	9	18	33	22.	44.940N	73.650W	10			3.5			EP	319.40	FA = 13001 SQ.KM. MO = 1.0E21 DY-CM.
1975	8	21	4	23	37.	47.440N	70.180W	5				3.1		EP	507.41	
1975	10	10	4	54	27.3	44.030N	70.170W		- IV					WE	142.25	
1975	10	15	3	25	17.	45.110N	65.390W	18			3.1			EP	467.36	
1975	11	3	20	54	55.9	43.830N	74.640W				3.9			LD	326.25	MO = 4.0E21 DY-CM.
1975	11	3	21	6	40.8	43.890N	74.650W				4.0			LD	327.01	
1976	3	11	8	23	32.2	41.560N	71.210W				3.5			PD	151.69	MO = 1.5E19 DY-CM.
1976	4	13	15	39	12.9	40.930N	74.030W				3.1			PD	352.30	
1976	4	24	10	22	22.1	41.460N	72.490W		IV		2.2			PD	209.59	
1976	5	10	1	34	20.5	41.540N	71.010W		V		2.7			PD	151.56	
1976	7	13	3	51	14.0	45.175N	74.096W		- IV		2.9			PD	362.85	
1976	10	23	20	53	18.0	47.820N	69.790W	18	V		4.2			PD	553.17	
1976	10	23	21	23	06.1	47.830N	69.780W				3.1			CE	559.88	
1976	10	24	10	43	45.	47.820N	69.860W				3.6			LD	552.63	
1977	2	14	0	35	04.1	47.540N	70.420W				3.1			CE	516.90	
1977	6	20	5	5	53.	47.840N	70.160W				3.[illegible]	3.1		LD	551.80	
1977	7	14	7	39	30.0	46.030N	74.400W	10			3.8			PD	448.14	
1977	10	16	21	29	19.	46.510N	73.730W				3.4			LD	461.62	
1977	12	20	17	44	24.9	41.822N	70.759W	5	IV		3.1			WG	119.87	
1977	12	25	15	35	53.4	43.200N	71.641W	2	IV		3.2			WG	72.68	
1978	1	4	19	23	10.8	44.070N	70.500W				3.2			LC	133.13	
1978	1	4	19	23	10.7	44.066N	70.552W	9	- IV		3.0			WG	131.87	
1978	2	13	14	43	25.0	46.350N	74.110W				4.1			CE	462.56	
1978	2	23	5	24	33.0	46.360N	74.130W				3.4			CE	464.36	
1978	5	26	2	31	40.0	47.720N	69.990W				3.2			CE	540.02	
1978	7	30	10	54	46.0	45.550N	74.430W				3.8			LD	410.59	
1978	8	10	21	12	11.6	40.460N	71.130W				3.5			WE	271.91	
1978	8	21	8	47	10.9	44.520N	74.510W				3.1	1.9		LD	345.65	
1979	1	30	16	30	52.1	40.320N	74.260W	5	FELT		3.5			NS	403.54	
1979	3	10	4	43	39.4	40.716N	74.495W	1			3.1			PC	388.26	
1979	3	23	22	53	05.0	47.660N	70.150W		FELT		3.1		3.6	NS	531.97	
1979	4	13	2	34	14.4	43.950N	69.750W		V		4.1			US	146.82	
1979	4	20	10	37	49.2	45.240N	65.030W		FELT				3.2	NS	455.40	
1979	4	23	0	5	45.7	43.040N	71.240W		- IV		3.1			NS	35.54	
1979	6	7	13	45	53.3	44.430N	73.960W				3.1			NS	296.49	
1979	7	28	23	27	12.3	43.230N	70.440W	11	FELT		3.5		3.7	NS	54.73	
1979	8	19	22	43	31.0	47.570N	69.300W	10	FELT		5.0		4.3	NS	535.44	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	DISTANCE (KM.)	REMARKS
1980	2	29	5	53	56.1	42.530N	74.200W	12			3.1		2.2	NS	276.67	
1980	3	11	4	15	55.0	46.790N	71.270W	19	V		3.7			EP	439.87	
1980	7	1	3	5	38.0	47.560N	70.750W	10	- IV		3.4			EP	518.08	
1980	7	2	7	50	33.0	47.300N	70.330W	10	FELT		3.1			EP	490.82	
1980	9	4	4	30	56.0	41.110N	73.750W	13			3.2			LD	313.74	
1980	9	8	5	57	55.0	44.630N	69.000W	9	FELT		3.2		3.2	NS	247.60	
1980	10	24	17	27	36.0	41.320N	72.970W	7	IV		2.8			NS	242.29	
1980	10	25	0	41	29.0	41.330N	72.980W	6	IV		2.7			NS	242.04	
1981	2	19	7	7	10.0	45.950N	74.930W	18			3.3			EP	470.30	
1981	4	13	17	31	38.0	45.920N	65.690W	18			3.7			EP	530.44	
1981	6	16	17	55	04.0	47.470N	70.000W	8			3.7			EP	512.37	
1981	6	29	22	42	35.1	43.570N	71.550W				3.1		3.0	NS	93.81	
1981	7	4	23	15	33.0	45.160N	74.640W	13			3.7			EP	394.24	
1981	7	5	21	47	23.0	45.150N	74.640W	13			3.4			EP	393.56	
1981	10	21	16	49	06.7	41.150N	72.580W	6	V		3.8			PD	241.43	
1981	11	28	5	12	03.0	47.030N	65.610W	5			3.7			EP	567.81	
1981	12	6	16	11	27.0	45.330N	72.640W	3			3.3			EP	310.69	
1982	1	9	12	53	52.0	47.000N	66.600W	5	V	5.7	5.8			EP	565.64	MS =5.2
1982	1	9	13	7	38.0	47.000N	66.600W	5			3.5			EP	565.64	
1982	1	9	13	43	17.0	47.000N	66.600W	5			3.3			EP	565.64	
1982	1	9	13	47	36.0	47.000N	66.600W	5			3.3			EP	565.64	
1982	1	9	13	52	21.0	47.000N	66.600W	5			3.9			EP	565.64	
1982	1	9	15	2	49.0	47.000N	66.600W	5			3.2			EP	565.64	
1982	1	9	16	35	45.0	47.000N	66.600W	5	- IV		5.1			EP	565.64	MS =3.9
1982	1	9	17	27	54.0	47.000N	66.600W	5			3.9			EP	565.64	
1982	1	9	17	37	36.0	47.000N	66.600W	5			3.2			EP	565.64	
1982	1	9	22	45	10.0	47.000N	66.600W	5			3.7			EP	565.64	
1982	1	9	23	17	39.0	47.000N	66.600W	5			3.1			EP	565.64	
1982	1	11	21	41	08.0	47.000N	66.600W	5	- IV	5.4				EP	565.64	
1982	1	11	21	53	15.0	47.000N	66.600W	5			3.1			EP	565.64	
1982	1	11	21	53	51.0	47.000N	66.600W	5			3.3			EP	565.64	
1982	1	11	22	2	44.0	47.000N	66.600W	5			3.1			EP	565.64	
1982	1	11	22	35	33.0	47.000N	66.600W	5			3.4			EP	565.64	
1982	1	12	1	59	01.0	47.000N	66.600W	5			3.5			EP	565.64	
1982	1	12	2	1	39.0	47.000N	66.600W	5			3.2			EP	565.64	
1982	1	12	2	3	45.0	47.000N	66.600W	5			3.1			EP	565.64	
1982	1	12	5	27	01.0	47.000N	66.600W	5			3.1			EP	565.64	
1982	1	12	13	33	32.0	47.000N	66.600W	5			3.3			EP	565.64	
1982	1	13	17	5	19.0	47.000N	66.600W	5			3.1			EP	565.64	
1982	1	13	17	56	43.0	47.000N	66.600W	5			4.0			EP	565.64	

TABLE 230.7-1 (Cont'd)

UPDATED AND REVISED TABLE 2.5-5 OF THE SEABROOK STATION FSAR
LATITUDE 40.0N TO 48.0N LONGITUDE 64.0W TO 75.0W

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	DISTANCE	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		(KM.)	
1982	1	13	17	51	44.0	47.000N	65.600W	5			3.7			EP	565.64	
1982	1	15	12	37	42.0	47.000N	65.600W	5			3.9			EP	565.64	
1982	1	15	14	36	37.0	47.000N	66.600W	5			3.2			EP	565.64	
1982	1	17	13	33	56.0	47.000N	66.600W	5			3.6			EP	565.64	
1982	1	19	0	14	42.0	43.500N	71.600W	8	V	4.4	4.5	4.7		EP	90.47	
1982	1	23	8	56	47.0	47.000N	66.600W	5			3.2			EP	565.64	
1982	1	26	5	0	30.0	47.000N	66.600W	5			3.3			EP	565.64	
1982	1	27	1	35	56.0	47.450N	70.420W	10	FELT		3.3			EP	506.91	
1982	2	27	17	34	58.0	47.000N	66.600W	5	FELT		3.4			EP	565.64	
1982	3	1	9	33	57.0	47.000N	66.600W	5	FELT		3.4			EP	565.64	
1982	3	16	11	14	01.0	47.000N	66.600W	5			3.5			EP	565.64	
1982	3	19	3	27	20.0	47.000N	66.600W	5			3.2			EP	565.64	
1982	3	31	21	2	20.0	47.030N	66.570W	5	IV	5.0				EP	567.04	
1982	4	2	13	50	12.0	47.000N	66.600W	5	IV		4.3			EP	565.64	
1982	4	2	19	49	45.0	47.000N	66.600W	5			3.1			EP	565.64	
1982	4	8	4	54	34.0	47.000N	66.600W	5	III		3.4			EP	565.64	
1982	4	11	18	0	53.0	47.000N	66.600W	5	IV		4.1			EP	565.64	
1982	4	11	18	27	19.0	47.000N	66.600W	5			3.2			EP	565.64	
1982	4	13	22	47	21.0	47.000N	66.600W	5	III		4.1			EP	565.64	
1982	4	28	6	36	02.0	47.000N	66.600W	5			3.4			EP	565.64	
1982	5	6	16	21	07.0	47.000N	66.600W	5			3.9			PD	565.64	
1982	6	16	11	43	00.0	47.010N	66.370W	7			4.6			EP	549.78	
1982	7	13	2	19	49.0	46.060N	74.550W	17	IV		3.8			EP	458.25	
1982	7	28	5	35	37.0	47.000N	66.600W	5			3.7			EP	565.64	
1982	8	12	20	43	18.0	47.000N	66.600W	5			3.3			EP	565.64	
1982	8	29	2	7	11.0	47.370N	70.380W	20			3.4			EP	498.26	
1982	9	19	1	37	17.0	47.000N	66.600W	5			3.1			EP	565.64	
1982	10	25	15	31	33.0	47.000N	66.600W	5			3.5			EP	565.64	
1982	12	4	16	8	32.0	47.540N	70.220W	16			3.3			EP	518.15	

THIS CATALOG LISTS 703 EARTHQUAKES
EPICENTRAL DISTANCES ARE COMPUTED FOR SITE LOCATED AT 42.899N 70.849W
SEE FOLLOWING PAGE FOR CATALOG EXPLANATION

TABLE 230.7-1 (Cont'd)

EARTHQUAKE CATALOG EXPLANATION

MAGNITUDES

MB = BODY WAVE MAGNITUDE
MN = MBLG MAGNITUDE (NUTTLI,1973)
ML = RICHTER LOCAL MAGNITUDE
MC = CODA LENGTH MAGNITUDE

INTENSITY I(MM)

INTENSITIES ARE MAXIMUM EPICENTRAL MODIFIED MERCALLI INTENSITIES; A LEADING MINUS SIGN INDICATES A RANGE; I.E. - VII IMPLIES VI - VII

REMARKS

FA = TOTAL FELT AREA
MO = SEISMIC MOMENT
MS = SURFACE WAVE MAGNITUDE

REFERENCES

REF	DATA SOURCE
BB	BRADLEY AND BENNETT(1965)
BH	BOLLINGER AND HOPPER(1971)
BK	BROOKS(1960)
BO	BOLLINGER(1969,1973)
CG	U. S. COAST AND GEODETIC SURVEY
DD	DOCEKAL(1970)
DW	DEWEY(PERSONAL COMMUNICATION)
EH	EARTHQUAKE HISTORY OF THE U.S.(1958,1973)
EP	EARTH PHYSICS BRANCH, OTTAWA, CAN.
IS	INTERNATIONAL SEISMOLOGICAL SUMMARY
LD	BULLETINS, LAMONT-DOHERTY GEOLOGICAL OBS.
MA	MATHER AND GODFREY(1927)
MT	BULLETINS, M.I.T. SEISMOGRAPH NETWORK
MM	MCCLAIN AND MYERS(1970)
NB	NUTTLI AND BRILL(1981) NUREG/CR-1577
NJ	NEW JERSEY GEOLOGICAL SURVEY
NO	N.O.A.A. EARTHQUAKE DATA FILE
NS	BULLETINS, NORTHEAST U.S. SEISMOGRAPH NETWORK
NU	NUTTLI(1974)
PD	PRELIM. DETERMINATION OF EPICENTERS,U.S.G.S.
PM	POMEROY(PERSONAL COMMUNICATION)
SL	BULLETINS, ST. LOUIS UNIV. SEISMOGRAPH NETWORK
SM	SMITH(1962,1964)
US	U.S. EARTHQUAKES SERIES, 1928-1980
WE	WESTON OBSERVATORY
WG	WESTON GEOPHYSICAL CORPORATION

TABLE 230.7-2

NEW HAMPSHIRE JANUARY 19, 1982
STRONG MOTION DATA
FROM THE U.S. ARMY
CORPS OF ENGINEER'S TAPE
(F.CHANG)

STATION	SITE LOCATION	COMPONENT	CORRECTED PEAK ACCEL (CM/SEC/SEC)	VELO (CM/SEC)	DISP (CM)
FRANKLIN FALLS DAM EPI. DIST. = 5 KM.	DOWNSTREAM	L-225	140.70	2.03	0.16
		UP	271.00	1.73	0.08
		T-135	377.86	2.87	0.17
FRANKLIN FALLS DAM EPI. DIST. = 5 KM.	RIGHT ABUTMENT	L-45	287.70	2.67	0.25
		UP	172.89	1.85	0.41
		T-315	539.96	5.59	0.42
FRANKLIN FALLS DAM EPI. DIST. = 5 KM.	CREST	L-45	123.96	2.67	0.36
		UP	114.31	2.89	0.47
		T-315	306.83	4.06	0.33
UNION VILLAGE DAM EPI. DIST. = 62 KM.	CREST	L-245	22.45	0.46	0.04
		UP	23.17	0.42	0.04
		T-155	25.07	0.50	0.05
UNION VILLAGE DAM EPI. DIST. = 62 KM.	LEFT ABUTMENT	L-245	9.49	0.15	0.03
		UP	6.21	0.17	0.05
		T-155	6.73	0.23	0.06
UNION VILLAGE DAM EPI. DIST. =62 KM.	DOWNSTREAM	L-245	37.01	0.82	0.08
		UP	28.90	0.45	0.07
		T-155	22.58	0.47	0.05
NORTH HARTLAND DAM EPI. DIST. = 62.5 KM.	ABUTMENT	L-15	11.08	0.19	0.05
		UP	3.75	0.14	0.04
		T-285	6.84	0.22	0.06
NORTH HARTLAND DAM EPI. DIST. = 62.5 KM.	CREST	L-15	37.34	0.76	0.12
		UP	16.73	0.46	0.09
		T-285	38.19	0.87	0.13

TABLE 230.7-2 (Cont'd)

STATION	SITE LOCATION	COMPONENT	CORRECTED PEAK ACCEL (CM/SEC/SEC)	VELO (CM/SEC)	DISP (CM)
NORTH SPRINGFIELD DAM EPI. DIST. = 77.5 KM.	CREST	L-275	24.38	0.56	0.06
		UP	22.45	0.34	0.06
		T-185	21.54	0.41	0.09
NORTH SPRINGFIELD DAM EPI. DIST. = 77.5 KM.	DOWNSTREAM	L-275	31.08	0.41	0.07
		UP	13.66	0.21	0.05
		T-185	22.59	0.29	0.06
BALL MOUNTAIN DAM EPI. DIST. = 105 KM.	CREST	L-30	8.80	0.37	0.08
		UP	11.97	0.34	0.07
		T-300	10.03	0.37	0.07
WHITE RIVER JUNCTION (VA HOSPITAL) EPI. DIST. = 61 KM.	BASEMENT	L-270	15.20	0.33	0.06
		UP	21.81	0.38	0.08
		T-180	31.03	0.57	0.12

TABLE 230.7-3

RELATIONSHIPS OF INTENSITY (MM) TO PEAK HORIZONTAL ACCELERATION (A_H)

$$\text{Log } A_H = a + bI_{(MM)}$$

DATA SET	a	b	A_H for I_o = VIII cm./sec²	A_H for I_o = VIII g.
Trifunac and Brady (1975)* Proposed Relationship IV $\leq I_o \leq$ X	0.014	0.300	259.4	0.265
Regression on Seven Mean Values** III, IV, V, VI, VII, VIII, X	0.205	0.273	244.9	0.250
Regression on Six Mean Values** IV, V, VI, VII, VIII, X	0.117	0.284	244.9	0.250
Regressions on				
C.I.T.† (376 Data Points)	-0.172	0.317	231.2	0.236
C.I.T. + N.H.†† at V	-0.016	0.294	216.8	0.221
C.I.T. + N.B.††† at IV#	0.272	0.250	187.1	0.191
C.I.T. + N.B. at V#	0.044	0.286	214.8	0.219
C.I.T. + N.H. at V + N.B. at IV	0.392	0.233	180.3	0.184
C.I.T. + N.H. at V + N.B. at V	0.182	0.266	204.2	0.208

† C.I.T. (376 Peak horizontal acceleration values from California Institute of Technology Data Base from Chang (1978))

†† N.H. (6 Peak horizontal acceleration values for January 19, 1982 at Franklin Falls Dam only)

††† N.B. (8 Peak horizontal acceleration values for March 31, 1982)

* Trifunac and Brady (1975) results based on 374 data points

** Mean Values taken from Table 3 of Trifunac and Brady

\# Due to uncertainty on epicentral intensity, I_o, for the N.B. earthquake, regression models are derived for different I_o values

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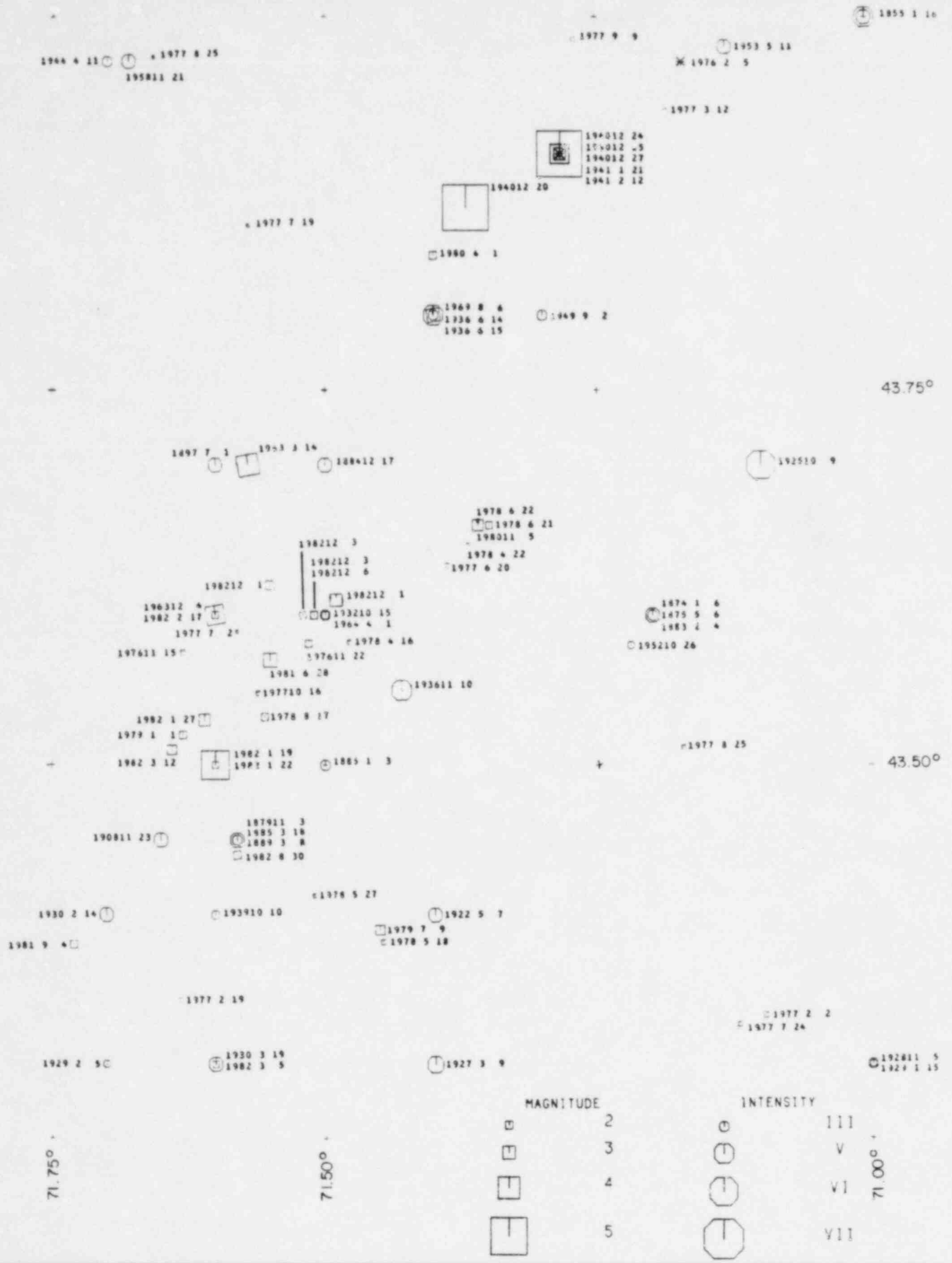
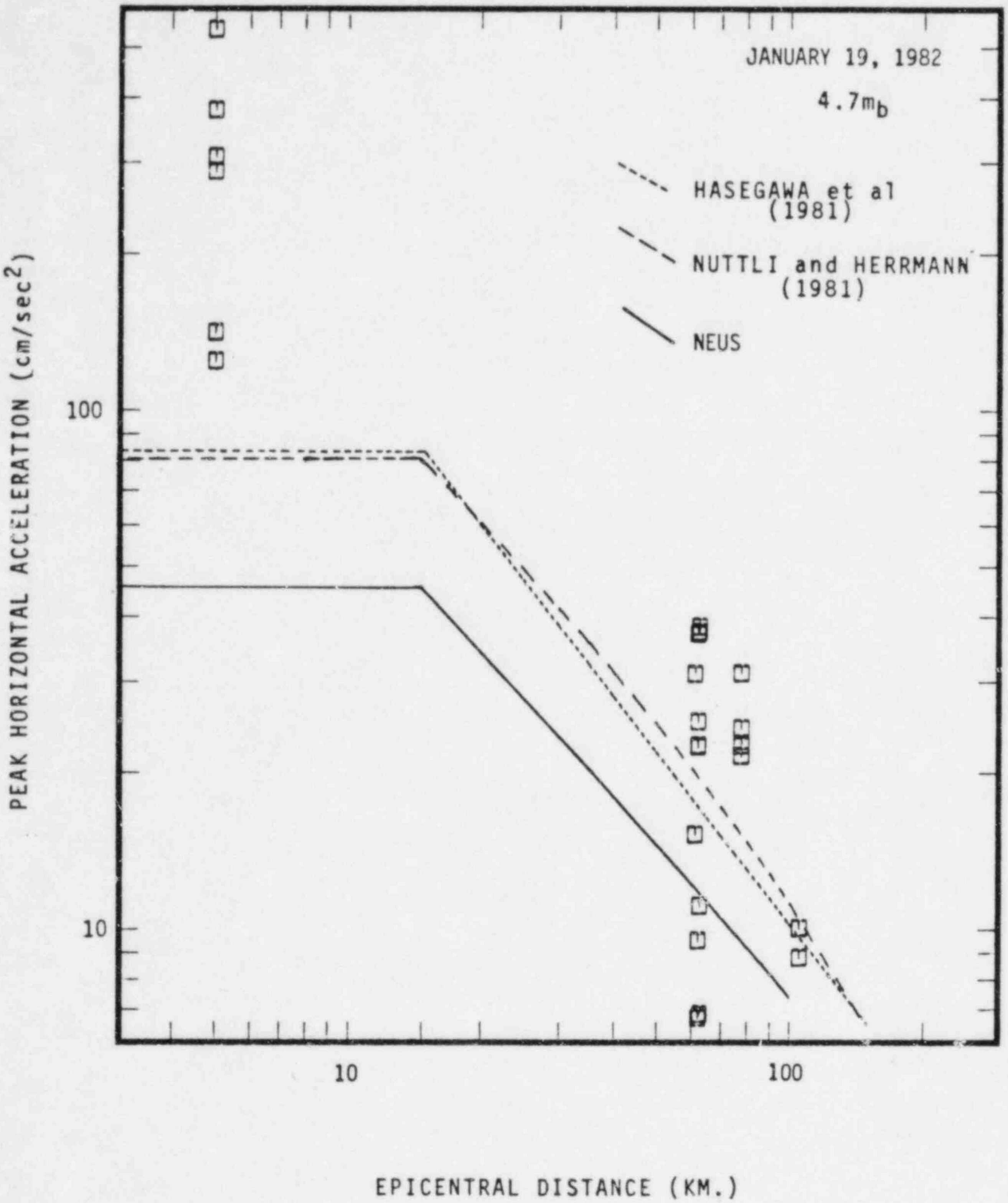


PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
SEABROOK STATION - UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

HISTORICAL EPICENTRAL DATA
AROUND OSSIPEE, NEW HAMPSHIRE

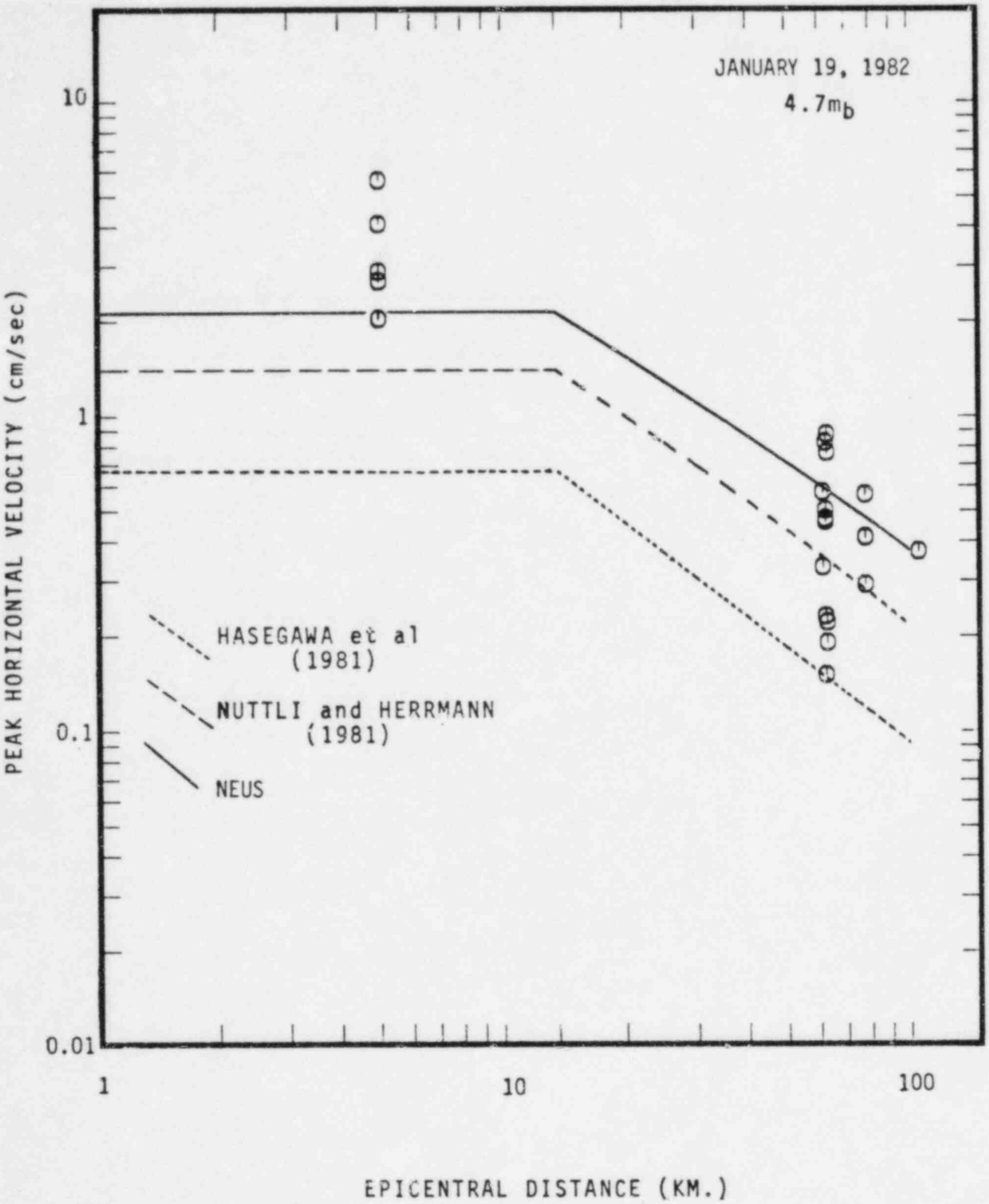
FIGURE 230.7-2



PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
SEABROOK STATION - UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

PEAK HORIZONTAL ACCELERATION FOR THE JANUARY 19, 1982 EARTHQUAKE

FIGURE 230.7-3



PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE SEABROOK STATION - UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT	PEAK HORIZONTAL VELOCITY FOR THE JANUARY 19, 1982 EARTHQUAKE
	FIGURE 230.7-4

Question 230.8

Discuss the correlation of the Central New Brunswick sequence of events beginning January 9, 1982 with geologic structure or tectonic provinces and the significance of these events with respect to the OBE and SSE. Present all available information for these events on locations, depths, focal mechanisms, and correlation with past seismicity. Discuss the effect of any strong motion data resulting from these events upon empirical strong motion relationships used in determining the OBE and SSE.

Response 230.8

In order to answer this question, the Public Service Company of New Hampshire (PSCNH) has sponsored jointly with other New England utilities a substantial program of seismological and geological studies related to the 1982 New Brunswick earthquakes. These studies were carried out by Weston Geophysical Corporation, from September 1982 to July 1983. A detailed report of these investigations entitled "Seismological and Geological Studies, Miramachi Area, New Brunswick, and Central New Hampshire" was filed with the NRC on August 25, 1983, by PSCNH as a proprietary document.

The question has three distinct parts (1) the correlation of the earthquake sequence with geologic structure or tectonic provinces; (2) the parameters of recent 1982 events, and relation to past seismicity; (3) on the New Brunswick strong motion data as affecting relationships used in determining the OBE and SSE.

1. Earthquake Correlation With Geologic Structure or Tectonic Provinces

   A convergence of evidence from geological, geophysical and seismological studies reveals the existence of a seismogenic structure in the immediate epicentral areas of the January and June 1982 earthquake sequences.

   From geological observations, major faults are known, either bounding and/or cutting the Miramichi Massif and the included North Pole pluton. The Miramichi Massif is comprised of a complex sequence of multiply folded and metamorphosed Cambro-Ordovician sedimentary, volcanic, and igneous rocks intruded by Devonian igneous rocks. The widespread Devonian intrusive event is in part responsible for the low gravity geophysical signature of the Miramichi Massif, which indicates the body is widespread and likely interconnected at depth.

The rocks in the immediate epicentral area are all representative of the Miramichi Massif described above. The area is underlain by a Devonian granitic body; the North Pole pluton.

Faults forming the boundaries of the major lithic and structural terranes as well as intrazonal faulting often show a multiple history of deformation. This is not an unusual observation as faulted rock is weak and will tend to fail repeatedly as stress fields vary. Mylonitic fault zones forming the boundaries of and traversing the Miramichi Massif show evidence of subsequent brittle failure resulting in a multiply fractured and silicified mylonite breccia zone. Such is the case with the Catamaran Fault which cuts east-west across the Miramichi Massif just south of the epicentral area. This deformed zone cuts the Massif into northern and southern blocks and may influence stress concentrations along structural and/or lithologic discontinuities in the northern block, resulting in the observed stress release.

From geophysical measurements, significant gravity and magnetic anomalies are found in spatial coincidence with the geological structures. Location, amplitude and gradient of the gravity anomalies have been used to model crustal blocks in the epicentral region. Taking into account the complex structural and lithological associations at the surface with the geophysical and seismological evidence, it is possible to hypothesize significant stress accumulation along lithologic/structural discontinuities at focal depths corresponding to modeled geophysical anomalies and potentially associated seismic events. The Trousers Lake event (June 16, 1982) is probably related to boundary faults and lithologic variations associated with the northwestern margin of the Miramichi Massif. The larger January, 1982 events in the central Miramichi Massif may be associated at depth with the boundary of the North Pole pluton in the surrounding metasediments. From seismological analysis, observed focal depths and faulting mechanism of some larger 1982 events are compatible with gravity modeling results. A review of the past seismicity in the 1982 epicentral area and its vicinity (next subsection) suggests that the tectonic structure considered responsible for the 1982 sequences has indeed been seismically active before.

During early Fall 1983, the New Brunswick Department of Natural Resources - Geological Survey Branch in conjunction with the Canadian Atomic Energy Control Board excavated two areas in the immediate vicinity of the Miramichi epicentral

zone. In the first area, a previously identified post glacial bedrock offset (crack in road) was examined. Exposure of a large section of rock indicates that the crack is of limited extent and therefore non-tectonic. In the second area, (Figure 230.8-A), an east-west trench approximately 70 meters long and 5 meters wide was made to intersect a N40°W trending EM and VLF anomaly identified by the New Brunswick Survey. The aeromagnetic data immediately south of the North Pole pluton and the interpretation of black and white aerial imagery (Figure 4.3, Weston Geophysical, 1983) indicate a similar northwest trend.

A N40°W 65°SW (apparent) dipping fault zone comprised of gouge, breccia, flinty crush rock and pervasive fracturing was exposed in the trench. Based on observed structural elements and detailed mapping, the fault zone has a complex and multiple brittle tectonic history of which at least one motion was clearly right lateral strike-slip.

The overlying till (Wisconsin) at this fault location has been broken and is separated by weathered granitic rock, breccia and gouge plastically emplaced into the till (Figure 230.8-B). This injected material extends to just below the existing ground surface. It is clear that part of this disruption, horizontal shearing of the breccia and gouge, is glacial (non-tectonic) in nature. The mechanism of the injection and raised elements of the breccia and weathered granite are related to tectonic and/or glacial processes, contemporaneous with or subsequent to Wisconsin ice loading.

Detailed mapping documents the long history of tectonic deformation along this fault. This fault, particularly in view of its conformance with the larger structural fabric, supports a "tectonic structure" earthquake relationship.

Since these 1982 earthquakes are associated with a localized structure in Central New Brunswick, 565 km from the Seabrook site, these events have no significance on the Seabrook OBE and the SSE. The New Brunswick events did not exceed the intensity VIII assumed "at the site" for Seabrook. The observed epicentral intensity and magnitude of the New Brunswick main shock are not greater than those usually assigned to the nearest large earthquake, the Cape Ann 1755 event used for determining the SSE.

In summary, the applicant considers the 1982 New Brunswick activity related to a local tectonic structure. The horizontal acceleration level (0.25g) of the present SSE, based on an assumed intensity VIII at the site, is more than adequate to accommodate the ground motion from such a distant source. In fact, it can accommodate the earthquake potential of the New Brunswick event simply associated with the site province.

2. Parameters of Recent 1982 Events and Correlation with Past Seismicity

The report on the New Brunswick studies presents in detail the parametric information currently available on the 1982 sequence, and a review of the historical seismicity. A summary of important data and conclusions is now abstracted for a formal response.

The New Brunswick sequence began on January 9, 1982 with a main shock of magnitude m_b = 5.7 at 12:53 U.T. Three of the larger aftershocks, equal to or greater than m_b = 5.0, occurred on January 9 at 16:36 U.T. (m_b = 5.1), on January 11 at 21:21 U.T. (m_b = 5.4), and on March 31, at 21:02 U.T. (m_b = 5.0). Figure 230.8-1 shows the relative spatial location of these four ruptures, as inferred from fault plane data and microearthquake distributions.

More than 50 aftershocks larger than m_b = 3.0 occurred up to the end of 1982, and thousands of smaller shocks were also recorded by sensitive instruments temporarily deployed in the immediate epicentral area, and by permanent regional stations of the Canadian and American networks. Wetmiller et al. (1982) and Adams and Wetmiller (1983) have discussed this earthquake sequence at professional meetings; Wetmiller et al. (1983) have just submitted for publication a detailed study of the aftershock activity.

Table 230.7-1 gives the origin times, locations, depths, and magnitudes of all events with m_b greater than 3.0, as currently available for the year 1982. This sequence of events is the best ever recorded for the northeast; for this reason, the number of located smaller events is larger than that of any other important sequences. Yet the New Brunswick sequence appears to be normal and consistent with other known sequences, such as that of 1925 La Malbaie, the 1935 Timiskaming and the 1944 Cornwall-Massena earthquakes, considering the respective magnitudes and the distribution of larger aftershocks.

At present, only the main shock has been the object of in-depth analyses. Nabelek et al. (1982), and Hasegawa (1983) have presented an abstract of their research, while Choy et al. (1983) have published their study. There is a general good agreement between most of the source parameter estimates: location, depth, faulting mechanism and moment. The epicentral coordinates of the main shock are 47.00°N and 66.60°W, ± 3 km. They are at the center of a 6 km north-south by 6 km east-west area which contains most of the located aftershocks. The seismic ruptures have occurred predominantly on two conjugate planes, shown on Figure 230.8-1, roughly trending north (Adams and Westmiller, 1983). Micro-activity is distributed from depth ranging from almost 0 to 7 km, in a V-shape pattern, with each limb about 2 km thick. The focal depth for the main shock is estimated at 7 km, ± 3 km. The prevalent faulting mechanism for the four larger events and the deeper microearthquakes is thrust under compressional force in the east-west direction. The source parameters of Nabelek et al. (1982) and Hasegawa (1983) are shown on Table 230.8-1 and those from Choy et al. (1983) on Table 230.8-2.

The only significant descrepancy between the source parameter estimates is the inferred stress drop. Nabelek et al. (1982), in an abstract for an oral presentation, have considered as a favored option a higher stress drop. This controversy is still unresolved. Conceptually one associates smaller dimensions, higher frequency spectral content, and the possibility of a new rupture with higher stress drop. Reactivation of an older zone of weakness is more common for a lower stress drop.

A second important event occurred on June 16, 1982 near Trousers Lake, about 30 km west of the January 9 epicenter. The focal depth was estimated to be about 7 km, and the m_{blg} equal to 4.8. The significance of this event is that its location coincides well with the sharp gravity gradient on the west side of an inferred crustal block, while the larger January sequence locates approximately on the opposite eastern side, as shown on Figure 230.8-2.

The January and June 1982 seismic activity is consistent with the past regional seismicity. Figure 230.8-3 is a regional epicentral map, 2° x 3° around the January 1982 sequence. All known events with M greater than or equal to 2.0, or I_o greater than or equal to II are included and identified by date for reference to Table 230.8-3. Considering the sparse population within a 75 km radius of

the 1982 epicentral area and the lack of a regional New Brunswick station until 1971, when one was installed in Fredericton, it can be assumed that most of the non-instrumental epicenters are subject to a large location uncertainty, possibly many tens of kilometers. The instrumental locations from the last decade are subject to a smaller uncertainty, in the order of 5 to 10 km. Thus, the possibility exists that some of these historical epicenters are mislocated and did occur in the same epicentral area as those of 1982. The existence of a seismogenic structure capable of generating earthquakes as large as that of January 9, 1982, with an m_b = 5.7, is supported by the past seismicity. In particular, the occurrence of recent events with m_b = 3.7 on November 28, 1981, m_b = 2.5 on September 7, 1981 and m_b = 2.6 on January 4, 1977, in the epicentral area, confirms the inference of a seismogenic structure, continuously active, and somewhat similar to others k[illegible] in the northeast.

3. New Brunswick strong motion data and their effect on relationships used for the OBE and SSE determination.

In January 1983, the Earth Physics Branch of E.M.R. Canada made available in digital form five accelerograms from two New Brunswick aftershocks (March 31, and May 6, 1982); in February 1983, it published the open-file report 82-31, "Strong motion records from Miramichi, New Brunswick, 1982 Aftershocks," by Weichert, D. W. et al. Table 230.8-4, abstracted from that report, identifies the five records that were of sufficiently good quality among fifteen to be digitally processed.

Table 230.8-5, from the same report, lists the site and instrument characteristics. The foundation conditions at Holmes Lake and Loggie Lodge are described as "massive concrete fireplace hearth on 5 m alluvium" and "major granite boulder on 5 m alluvium", respectively. The Indian Brook site is on "granite boulder on gravel", while the Mitchell Lake Road site is said to be "bedrock". Seismic refraction surveys and a geological inspection were conducted in October 1982 by Weston Geophysical at the Holmes Lake, Loggie Lodge and Mitchell Lake Road sites. Some location uncertainty resulted from the fact that certain original sites had been closed or relocated during the Summer. Considering this uncertainty, the results of these surveys are in general agreement with those foundation conditions cited on Table 230.8-5. Except for Mitchell Lake Road, site conditions are not comparable to the Seabrook rock foundations.

As shown on Table 230.8-4, the frequencies associated with the peak accelerations of the March 31 event (m_b = 4.8 to 5.0), are notably high, 18 to 47 Hz, often higher than the average natural frequency (25 Hz) of the SMA-1 listed in Table 230.8-5. In these cases, D. H. Weichert et al. (1982) have recommended caution in accepting the validity of the instrumental correction for accelerations. D. H. Weichert (1983), in his oral communication to the Seismological Society in Salt Lake City, has firmly stated that the SMA-1 gradually becomes a displacement meter beyond its natural frequency, with a magnification of about fifty. Thus, the high acceleration values obtained when standard correction routines are applied to the recorded high frequency oscillations are most likely invalid. This problem was also discussed with P. N. Mork of the U.S. Geological Survey, who pointed out in the same vein that all response spectra of SMA-1 records are routinely cut off at 25 Hz by the U.S.G.S. to avoid presenting unreliably corrected data. For these two reasons, foundation particularities and partly invalid instrumental correction, taken separately or jointly, the strong motion acceleration data set from the New Brunswick aftershocks is not, at the present time, a sufficient basis for questioning the validity of the Seabrook design spectrum at high frequencies.

In should be clear that the applicant does not deny the presence of high frequency accelerations of very short duration in the near field. This could well be a characteristic of near field observations for some of the seismic sources in the northeast. The applicant is only stating, with others, that the SMA-1 accelerograph, because of its narrow response curve, may not be a suitable instrument for high frequencies. Figure 230.8-4 shows the amplitude response curve of the SMA-1 accelerograph. It can be seen that beyond the natural frequency of the transducer, the correction factor gets to be very large, due to fast roll off of the curve. It seems that a broad band digital accelerometer is indeed needed for assuring the correct recovery of ground motion amplitudes over the entire source spectrum.

It is interesting to note that recordings of a magnitude m_b = 3.5 New Brunswick aftershock made in January 1982 by the U.S.G.S. with a broad band digital system (Cranswick et al. 1982) did not show anomalously high horizontal acceleration values associated with frequencies higher than 25 Hz. Another finding by Cranswick et al. (1982) was the great difference in signatures at two stations relatively

close to an epicenter and at similar distances, but along different azimuths and with diverse topography, stressing the importance of site conditions.

In the case of the Mitchell Lake Road recording for the March 31, 1982 event, a site reported as firm rock, the high frequency motion observed could well be attributed to some special effects associated with the near field. The estimated epicentral distance is 4 km, and the focal depth is inferred to be quite shallow, i.e. about 4 km on the basis of aftershock distribution (0 to 4 km). Assuming a fault length of 3 to 3-1/2 km, using Nuttli's relationship (1983) for mid-plate events, one sees that Mitchell Lake Road site was very close to, almost above, the end point of the rupture. This is confirmed by the relatively large value of the vertical component recorded. This is an unusual case; as a singular data point, it does not impact the design spectra for Seabrook.

With regard to the confirmatory issue described in Section 2.5.2.6.3 of the S.E.R., not explicitly mentioned in the RAI 230.8, the applicant is compelled to respond that neither the New Hampshire or the New Brunswick strong motion data sets offer a sufficient and reliable basis to study the appropriateness of the vertical/horizontal ratio beyond 33 Hz. As stated by Chang (1983), the peak frequencies of the acceleration from the New Hampshire event range from 11 to 21 Hz. In the case of the New Brunswick data, the range is from 18 to 44 Hz for the horizontal and 37 to 47 Hz for the vertical acceleration. Thus this last data is beyond the 25 Hz natural frequency of the instrument, in the range of unreliable correction. In this context, the applicant concurs with the NRC's staff which "sees no reason not to accept the applicant's variance" from RG 1.60 used for the vertical component of the design spectra at high frequencies, as stated in the SER.

It should be noted that peak velocities of the March 31, 1982 event, in general associated with a lower frequency, e.g., 15 Hz, appear to be in agreement with some of the current models extrapolated to near field distances, as shown on Figure 230.8-5. Weichert (1983) had noted the same, and found the values compatible with an inferred intensity I_o = V (IV was observed at 50 km), and the absence of damage.

If, aside from their validity, the New Brunswick recorded accelerations (8 horizontal data point for the March 31, 1982 event) are pooled with the CIT data, with an I_o

assumed equal to V(MM), then the new relationship predicts 0.219g for an intensity VIII; if the I_0 is assumed to be lV(MM), the regression gives 0.189g for an intensity VIII. If both sets of new data (N.H. and N.B.) are pooled with the CIT data, the resulting values for an intensity VIII are 0.184g or 0.208g (see Table 230.7-3).

On the basis of this review of site conditions, near field effects, and instrumental correction validity, it is concluded that the New Brunswick data set, as currently available, does not affect the OBE and SSE at Seabrook.

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TABLE 230.8-1

SOURCE PARAMETERS OF THE
JANUARY 9, 1982 (5.7 MB) EARTHQUAKE

		NABELEK ET AL. (1982)			HASEGAWA (1983)
		S.P.B.	L.P.B.	S.W.	S.P.B. AND S.W.
STRIKE	*	3°	4°	5°	185 - 205°
DIP	*	33°	35°	40°	35 - 65°
DEPTH	*		7	9 KM.	6 - 10 KM.
RAKE	*	98°	94°	93°	70 - 110°
MOMENT	*	1.5 X 10**24 DYNE-CM.			1.5 X 10**24 DYNE-CM.
STRESS DROP	*	60-120 BARS. (T 0.6)	900 BARS. (T 1.0)		40 - 120 BARS.
FAULT AREA	*	25 SQ KM.			22 - 32 SQ KM.

S.P.B. - FROM SHORT PERIOD BODY WAVES
L.P.B. - FROM LONG PERIOD BODY WAVES
S.W. - FROM SURFACE WAVES

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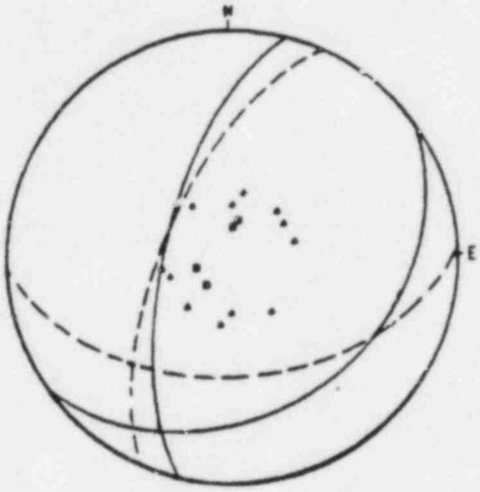
TABLE 230.8-2

A Summary of the Rupture Characteristics Inferred From the Broadband Analysis of the New Brunswick Earthquake of January 9, 1982 (U.S.G.S.)

Parameter	Value
Depth	9.0 ± 1.3 km
Strike*	195°
Dip	65°
Rake	70°
Rupture direction†	30° ± 30° clockwise from updip direction
Rupture length	5.5 ± 1.0 km
Rupture width	3.8 ± 1.0 km
Percent unilateral rupture	40%
Moment	$4.7 \pm 1.1 \times 10^{24}$ dyne cm
Radiated energy	1.0×10^{20} dyne cm
Apparent stress	10 bars
Dynamic stress drop	65 ± 35 bars
Static stress drop	41 ± 20 bars

OT 1253:51.7; NEIS location 46.984°N, 66.656°W, m_b 5.7.
*However, see Figure 5a for bounds on the fault planes.
†Assuming a rupture velocity of 0.75β.



The range of focal mechanisms that fit the observed amplitude data are represented by plotting the two extreme solutions of type I and type II solutions listed in Table 1. (*a*) For type I, the strike, dip, and rake for the solid lines are 195°, 65°, and 70°. For the dashed lines, they are 205°, 65°, and 50°. Triangles are takeoff angles of *P* and *pP* from GDSN stations used in the broadband analysis. The squares are *sP* takeoff angles. All takeoff angles are plotted on a lower hemisphere projection.

CHOY ET AL.: TELESEISMIC ANALYSIS OF NEW BRUNSWICK EARTHQUAKE

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TABLE 230.8-3

HISTORICAL SEISMICITY AROUND THE NEW BRUNSWICK 1982 EVENTS
LATITUDE 46.0 TO 48.0 LONGITUDE 65.0 TO 69.0

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	REMARKS
1924	7	9	0	0		46.500N	66.500W		V					EP	
1852	8	2	23	0		47.600N	65.600W		III					EP	
1883	4	3	22	0		46.600N	67.950W		II					EP	
1896	5	15	23	0		46.000N	66.690W		IV					EP	
1908	8	8	12	0		46.300N	67.600W		VI					EP	
1922	7	2	22	25	35.	46.500N	66.600W		VI					EP	
1928	12	25	2	0		46.200N	67.300W		II					EP	
1930	1	4	14	30	38.	46.730N	65.930W					4.6		EP	
1930	10	16	0	35		46.900N	65.630W		II					EP	
1938	6	15	5	7	43.	46.500N	66.800W		- IV					EP	
1941	8	30	10	21	25.	46.100N	67.900W					3.7		EP	
1944	6	6	5	0		47.600N	65.650W		III					EP	
1957	8	4	12	40	58.	46.590N	67.080W					3.7		EP	
1961	1	29	0	49	39.	46.380N	66.930W					3.8		EP	
1962	1	31	14	32	38.	47.500N	67.130W					3.5		EP	
1962	3	25	5	15	05.	47.570N	66.020W					4.0		EP	
1963	8	1	6	34	16.	46.800N	66.500W					3.0		EP	
1964	10	17	14	13	07.	47.670N	67.250W					3.9		EP	
1965	8	31	8	38	44.	46.000N	65.280W					3.2		EP	
1966	7	7	1	10	58.	47.900N	65.750W					2.3		EP	
1966	7	24	23	56	30.	47.920N	66.[illegible]60W					2.9		EP	
1966	9	28	20	11	35.	46.920N	65.250W					3.2		EP	
1967	1	25	5	4	59.	47.250N	66.750W					2.2		EP	
1967	3	14	1	49	05.	46.170N	67.330W					2.0		EP	
1967	4	28	12	23	32.	46.300N	67.900W	14	IV			2.5		US	
1968	5	27	19	21	56.	46.900N	66.660W	18				3.3		EP	
1974	3	16	7	10	11.	46.070N	67.120W	18				2.4		EP	
1975	2	28	18	40	21.	46.390N	64.010W	18				2.9		EP	
1975	8	27	22	28	22.	46.800N	65.340W	19				3.0		EP	
1976	1	18	9	3	57.3	46.800N	65.710W					1.9		CE	
1976	2	20	14	42	26.	47.750N	65.950W					2.1		LD	
1976	9	3	0	44	39.2	46.890N	66.870W				1.4			CE	
1976	12	23	9	45	06.8	46.580N	67.450W				2.6			LD	
1977	1	4	5	14	46.1	47.070N	66.520W				2.6	1.4		CE	
1977	1	18	3	54	18.7	46.720N	67.430W				2.7	1.6		NS	
1977	1	25	11	24	26.9	46.690N	67.420W				2.7	1.4		NS	
1977	2	6	9	1	18.0	46.820N	65.730W				3.0	1.6		NS	
1977	2	13	22	55	59.	45.720N	66.290W				2.8			LD	
1977	2	15	9	3	19.5	46.540N	67.440W				2.7			NS	
1977	2	24	12	48	40.2	46.710N	67.390W				2.8	1.9		NS	

TABLE 230.8-3 (Cont'd)

HISTORICAL SEISMICITY AROUND THE NEW BRUNSWICK 1982 EVENTS
LATITUDE 46.0 TO 48.0   LONGITUDE 65.0 TO 68.0

ORIGIN TIME						HYPOCENTRAL LOCATION				MAGNITUDE				REF	REMARKS
YEAR	MO	DA	HR	MN	SEC	LAT.	LONG.	Z(KM.)	I(MM)	MB	MN	ML	MC		
1977	4	6	6	38	42.1	46.570N	67.530W				2.4	1.2		LD	
1977	7	19	5	53	06.	46.250N	66.090W				2.0			CE	
1977	7	19	9	43	03.2	46.340N	65.830W					1.6		CE	
1977	9	1	1	0	58.4	47.450N	66.510W					1.3		CE	
1977	10	24	18	9	12.0	47.000N	67.050W				3.0			CE	
1977	12	5	19	17	50.0	46.070N	67.980W				1.5			CE	
1977	12	16	9	2	09.	46.090N	65.800W				2.7			LD	
1978	7	23	5	16	42.6	46.670N	66.500W				2.3			NS	
1978	8	7	17	54	47.7	46.850N	66.990W				1.8			WE	
1980	3	24	7	55	25.0	46.010N	65.900W	18				2.1		EP	
1980	8	13	21	38	23.0	47.330N	66.990W	18			2.3			EP	
1980	9	10	17	30	12.0	46.520N	67.110W	18			2.5			EP	
1981	9	7	21	0	38.0	47.000N	65.500W	5			2.5			EP	
1981	11	28	5	12	03.0	47.030N	66.610W	5			3.7			EP	
1981	12	20	20	9	15.0	47.970N	66.780W	18				2.5		EP	
1982	1	6	10	3	55.0	47.000N	66.600W	5			1.8			EP	
1982	1	9	12	53	52.0	47.000N	66.600W	5	V	5.7	5.8			EP	MS =5.2
1982	1	9	13	4	27.0	47.000N	66.600W	5			2.6			EP	
1982	1	9	13	9	38.0	47.000N	66.600W	5			3.5			EP	
1982	1	9	13	38	33.0	47.000N	66.600W	5			3.0			EP	
1982	1	9	13	49	17.0	47.000N	66.600W	5			3.3			EP	
1982	1	9	13	49	36.0	47.000N	66.600W	5			3.3			EP	
1982	1	9	13	52	21.0	47.000N	66.600W	5			3.9			EP	
1982	1	9	14	36	14.0	47.000N	66.600W	5			3.0			EP	
1982	1	9	15	2	49.0	47.000N	66.600W	5			3.2			EP	
1982	1	9	16	36	45.0	47.000N	66.600W	5	- IV		5.1			EP	MS =3.9
1982	1	9	17	27	54.0	47.000N	66.600W	5			3.8			EP	
1982	1	9	17	57	36.0	47.000N	66.600W	5			3.2			EP	
1982	1	9	22	13	18.0	47.000N	66.600W	5			3.0			EP	
1982	1	9	22	45	10.0	47.000N	66.600W	5			3.7			EP	
1982	1	9	23	12	39.0	47.000N	66.600W	5			3.1			EP	
1982	1	10	21	12	22.0	47.000N	66.600W	5			3.0			EP	
1982	1	11	21	41	08.0	47.000N	66.600W	5	- IV	5.4				EP	
1982	1	11	21	53	15.0	47.000N	66.600W	5			3.1			EP	
1982	1	11	21	53	51.0	47.000N	66.600W	5			3.3			EP	
1982	1	11	22	2	44.0	47.000N	66.600W	5			3.1			EP	
1982	1	11	22	26	33.0	47.000N	65.600W	5			3.4			EP	
1982	1	12	1	58	01.0	47.000N	65.500W	5			3.5			EP	
1982	1	12	2	1	39.0	47.000N	66.600W	5			3.2			EP	
1982	1	12	2	9	45.0	47.000N	66.500W	5			3.1			EP	

TABLE 230.8-3 (Cont'd)

HISTORICAL SEISMICITY AROUND THE NEW BRUNSWICK 1982 EVENTS
LATITUDE 46.0 TO 48.0 LONGITUDE 65.0 TO 68.0

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	REMARKS
1982	1	12	5	29	01.0	47.000N	66.600W	5			3.1			EP	
1982	1	12	11	49	31.0	47.000N	66.600W	5			2.9			EP	
1982	1	12	13	38	33.0	47.000N	66.600W	5			3.3			EP	
1982	1	12	21	47	40.0	47.000N	66.600W	5			2.9			EP	
1982	1	13	0	39	10.0	47.000N	66.600W	5			2.9			EP	
1982	1	13	2	5	44.0	47.000N	66.600W	5			3.0			EP	
1982	1	13	7	24	05.0	47.000N	66.600W	5			3.0			EP	
1982	1	13	17	[illegible]	19.0	47.000N	66.600W	5			3.1			EP	
1982	1	13	17	56	43.0	47.000N	66.600W	5			4.0			EP	
1982	1	13	17	59	44.0	47.000N	66.600W	5			3.7			EP	
1982	1	13	19	16	23.0	47.000N	66.600W	5			3.0			EP	
1982	1	15	8	28	55.0	47.000N	66.600W	5			3.0			EP	
1982	1	15	12	37	42.0	47.000N	66.600W	5			3.8			EP	
1982	1	15	14	36	37.6	47.000N	66.600W	5			3.2			EP	
1982	1	17	13	33	56.6	47.000N	66.600W	5			3.6			EP	
1982	1	18	19	34	51.0	47.000N	66.600W	5			3.0			EP	
1982	1	23	8	56	47.0	47.000N	66.600W	5			3.2			EP	
1982	1	26	5	0	30.0	47.000N	66.600W	5			3.3			EP	
1982	1	28	18	27	41.0	47.000N	66.600W	5			2.7			EP	
1982	2	9	18	19	28.0	46.990N	66.450W	18			2.6			EP	
1982	2	17	20	53	11.0	47.000N	66.600W	5			1.9			EP	
1982	2	24	4	43	01.0	47.000N	66.600W	5	FELT		2.9			EP	
1982	2	27	17	34	58.0	47.000N	66.600W	5	FELT		3.4			EP	
1982	3	1	9	33	57.0	47.000N	66.600W	5			3.4			EP	
1982	3	3	0	28	32.0	47.000N	66.600W	5			2.8			EP	
1982	3	4	6	6	31.0	47.000N	66.600W	5			2.9			EP	
1982	3	13	11	38	13.0	47.000N	66.600W	5			2.9			EP	
1982	3	13	23	27	51.0	47.000N	66.600W	5			2.9			EP	
1982	3	14	13	52	58.0	47.000N	66.600W	5			2.7			EP	
1982	3	16	11	14	01.0	47.000N	66.600W	5			3.5			EP	
1982	3	16	14	43	09.0	47.000N	66.600W	5			2.8			EP	
1982	3	16	19	1	09.0	47.000N	66.600W	5			2.8			EP	
1982	3	19	3	27	20.0	47.000N	66.600W	5			3.2			EP	
1982	3	18	21	34	16.0	47.000N	66.600W	5			2.9			EP	
1982	3	19	2	49	31.0	47.000N	66.600W	5			2.6			EP	
1982	3	20	1	32	57.0	47.000N	66.600W	5			2.5			EP	
1982	3	20	3	9	11.0	47.000N	66.600W	5			3.0			EP	
1982	3	20	4	35	17.0	47.000N	66.600W	5			2.5			EP	
1982	3	21	2	33	41.0	47.000N	66.600W	5			2.3			EP	
1982	3	26	5	36	40.0	47.000N	66.600W	5			2.9			EP	

TABLE 230.8-3 (Cont'd)

HISTORICAL SEISMICITY AROUND THE NEW BRUNSWICK 1982 EVENTS
LATITUDE 46.0 TO 48.0   LONGITUDE 65.0 TO 69.0

ORIGIN TIME YEAR	MO	DA	HR	MN	SEC	HYPOCENTRAL LOCATION LAT.	LONG.	Z(KM.)	I(MM)	MAGNITUDE MB	MN	ML	MC	REF	REMARKS
1982	3	26	13	38	07.0	47.000N	66.600W	5			2.9			EP	
1982	3	31	21	2	20.0	47.000N	66.570W	5	IV	5.0				EP	
1982	3	31	21	49	19.0	47.000N	66.600W	5			2.9			EP	
1982	4	2	13	50	12.0	47.000N	66.600W	5	IV		4.3			EP	
1982	4	2	19	49	45.0	47.000N	65.500W	5			3.1			EP	
1982	4	4	0	46	14.0	47.000N	65.600W	5			2.6			EP	
1982	4	6	11	52	17.0	47.000N	66.600W	5			2.5			EP	
1982	4	8	4	54	34.0	47.000N	66.600W	5	III		3.4			EP	
1982	4	10	1	58	59.0	47.000N	65.600W	5			2.9			EP	
1982	4	11	18	0	53.0	47.000N	66.600W	5	IV		4.1			EP	
1982	4	11	18	7	05.0	47.000N	65.500W	5			2.7			EP	
1982	4	11	18	27	19.0	47.000N	66.600W	5			3.2			EP	
1982	4	11	20	6	59.0	47.000N	66.600W	5			2.9			EP	
1982	4	18	22	47	21.0	47.000N	66.600W	5	III		4.1			EP	
1982	4	21	17	14	39.0	47.000N	66.600W	5			2.7			EP	
1982	4	26	6	36	02.0	47.000N	66.600W	5			3.4			EP	
1982	5	6	16	48	07.0	47.000N	66.600W	5			3.9			PD	
1982	6	16	11	43	00.0	47.010N	66.970W	7			4.6			EP	

THIS CATALOG LISTS 138 EARTHQUAKES
SEE FOLLOWING PAGE FOR CATALOG EXPLANATION

Weston Geophysical

TABLE 230.8-3 (Cont'd)

EARTHQUAKE CATALOG EXPLANATION

MAGNITUDES

MB = BODY WAVE MAGNITUDE
MN = PSLG MAGNITUDE (NUTTLI,1973)
ML = RICHTER LOCAL MAGNITUDE
MC = CODA LENGTH MAGNITUDE

INTENSITY I(MM)

INTENSITIES ARE MAXIMUM EPI-CENTRAL MODIFIED MERCALLI INTENSITIES: A LEADING MINUS SIGN INDICATES A RANGE: I.E. - VII IMPLIES VI - VII

REMARKS

FA = TOTAL FELT AREA
MO = SEISMIC MOMENT
MS = SURFACE WAVE MAGNITUDE

REFERENCES

REF	DATA SOURCE
BB	BRADLEY AND BENNETT(1965)
BH	BOLLINGER AND HOPPER(1971)
BK	BROOKS(1960)
BO	BOLLINGER(1969,1973)
CG	U. S. COAST AND GEODETIC SURVEY
DO	DOCEKAL(1970)
DW	DEWEY(PERSONAL COMMUNICATION)
EH	EARTHQUAKE HISTORY OF THE U.S.(1958,1973)
EP	EARTH PHYSICS BRANCH, OTTAWA, CAN.
IS	INTERNATIONAL SEISMOLOGICAL SUMMARY
LD	BULLETINS, LAMONT-DOHERTY GEOLOGICAL OBS.
MA	MATHER AND GODFREY(1927)
MI	BULLETINS, M.I.T. SEISMOGRAPH NETWORK

REF	DATA SOURCE
MM	MCCLAIN AND MYERS(1970)
NB	NUTTLI AND BRILL(1981) NUREG/CR-1577
NJ	NEW JERSEY GEOLOGICAL SURVEY
NO	N.O.A.A. EARTHQUAKE DATA FILE
NS	BULLETINS, NORTHEAST U.S. SEISMOGRAPH NETWORK
NU	NUTTLI(1974)
PD	PRELIM. DETERMINATION OF EPICENTERS,U.S.G.S.
PM	POMEROY(PERSONAL COMMUNICATION)
SL	BULLETINS, ST. LOUIS UNIV. SEISMOGRAPH NETWORK
SM	SMITH(1962,1964)
US	U.S. EARTHQUAKES SERIES, 1928-1980
WE	WESTON OBSERVATORY
WG	WESTON GEOPHYSICAL CORPORATION

TABLE 230.8-4

STRONG MOTION RECORDS FROM THE
NEW BRUNSWICK AFTERSHOCKS OF
MARCH 31, 1982 AND MAY 6, 1982
(ABSRACTED FROM WEICHERT ET AL. 1982)

EVENT	SITE LOCATION	COMPONENT	CORRECTED PEAK ACCEL (CM/S/S)	ACC-FREQ (HZ)	VELO (CM/S)	DISP (CM)	EPICENTRAL DISTANCE (KM)
31 MARCH 1982	HOLMES LAKE	L-018	178.00	18	1.31	0.03	6
		UP	151.00	37	0.53	0.02	6
		T-298	340.00	41	1.37	0.05	6
31 MARCH 1982	MITCHELL LAKE ROAD	L-118	149.00	18/25	1.81	0.05	4
		UP	571.00	37/62	2.90	0.07	4
		T-028	251.00	22	1.91	0.05	4
31 MARCH 1982	LOGGIE LODGE	L-189	292.00	22	1.80	0.06	6
		UP	302.00	47	1.82	0.11	6
		T-099	544.00	28/35	4.11	0.18	5
31 MARCH 1982	INDIAN BROOK	L-321	417.00	24	2.72	0.06	3
		UP	144.00	25/40	0.90	0.03	3
		T-231	405.00	24	3.11	0.12	3
06 MAY 1982	LOGGIE LODGE	L-139	115.00	10/25	1.36	0.03	7
		UP	66.00	19	0.71	0.01	7
		T-099	146.00	13	1.76	0.08	7

TABLE 230.8-5

Site and SMA Instrumentation Information

Site Name	Location (Lat N, Long W)	Installation (1982) and Kinemetrics Serial No.	Foundation/Subsoil	Sensitivity mm/G	Nat. Freq. Hz	Direction of L
1 Holmes Lake	46° 56.73' 66° 35.67'	03 Feb. 20:00 4935	massive concrete fiveplace hearth on 5 m alluvium	L 18.8 V 19.8 T 19.3	25.5 26.0 25.0	18°
2 Mitchell Road	47° 02.05' 66° 36.62'	04 Feb. 16:30 4934	bedrock	18.6 20.3 17.6	26.0 24.9 26.4	118°
	47° 02.05' 66° 36.70'	04 June 18:20		same		0°
3 Loggie Lodge	46° 58.15' 66° 31.74'	04 Feb. 20:45 4936	major granite boulder on 5 m alluvium	19.0 20.0 19.2	25.5 24.9 25.7	189°
		05 June 16:33	site closed			
4 Indian Brook	46° 58.73' 66° 34.85'	05 Feb. 20:00 4937	granite boulder on gravel	19.1 18.7 18.3	25.5 26.1 25.7	321°
		06 June 15:00	site closed			
7 Bear Lakes	46° 55.71' 66° 29.08'	07 Feb. 18:30 1064	concrete pad on gravel	38.0 33.6 36.2	18.8 17.6 19.1	170°
		07 June 13:38	site closed			
12 Indian Brook II	46° 59.6' 66° 35.8'	06 June 15:47 4937	bedrock	same as site 4		0°

Weichert, D.H., Pomeroy, P.W.*, Munro, P.S.**, and Mork, P.N.***
Earth Physics Branch Open File Report 82-31
Ottawa, Canada, 1982

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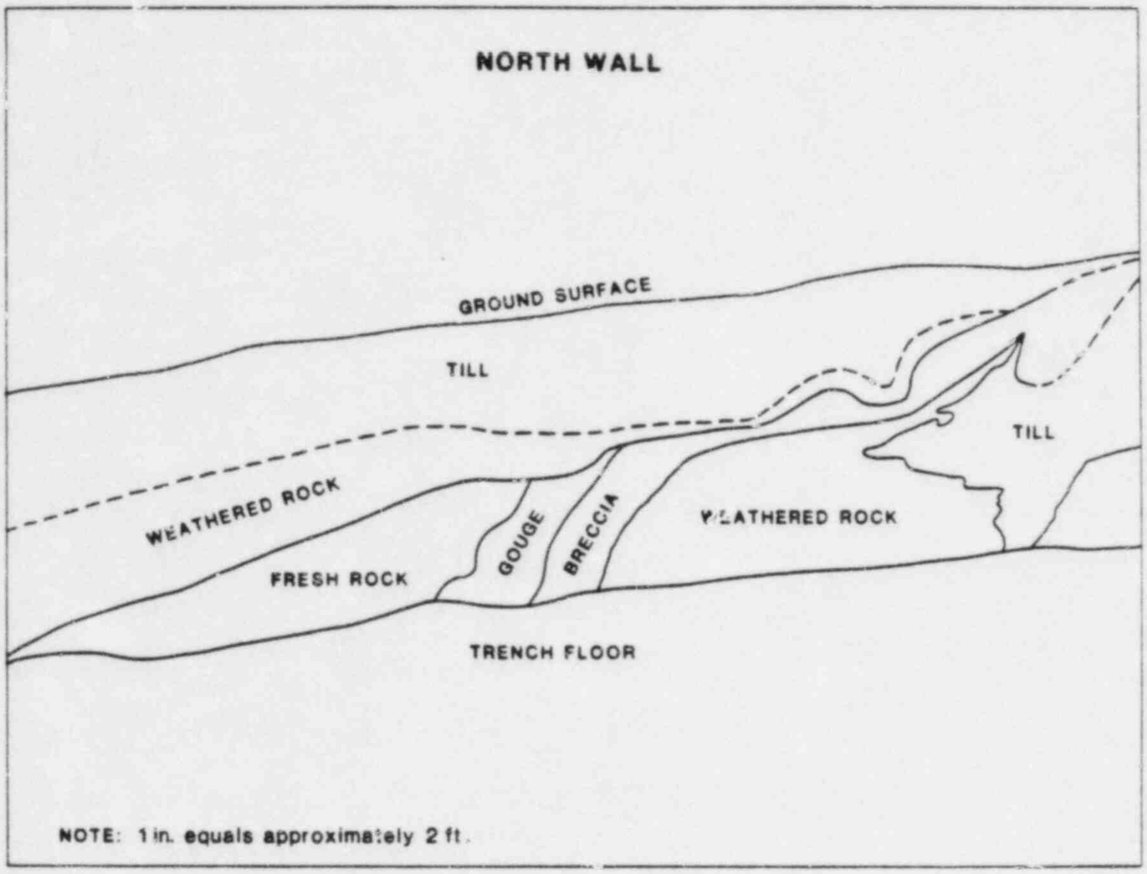

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
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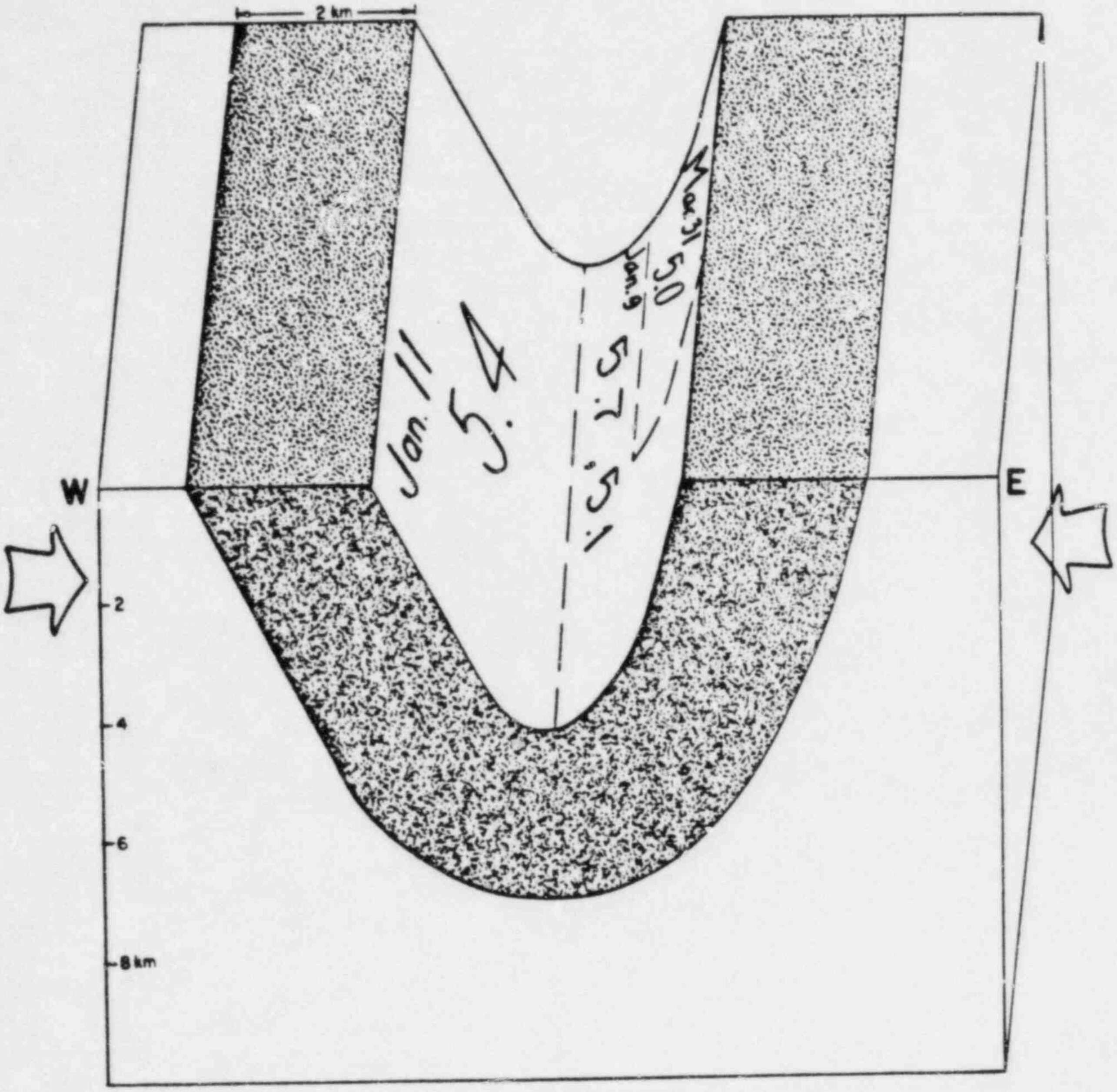
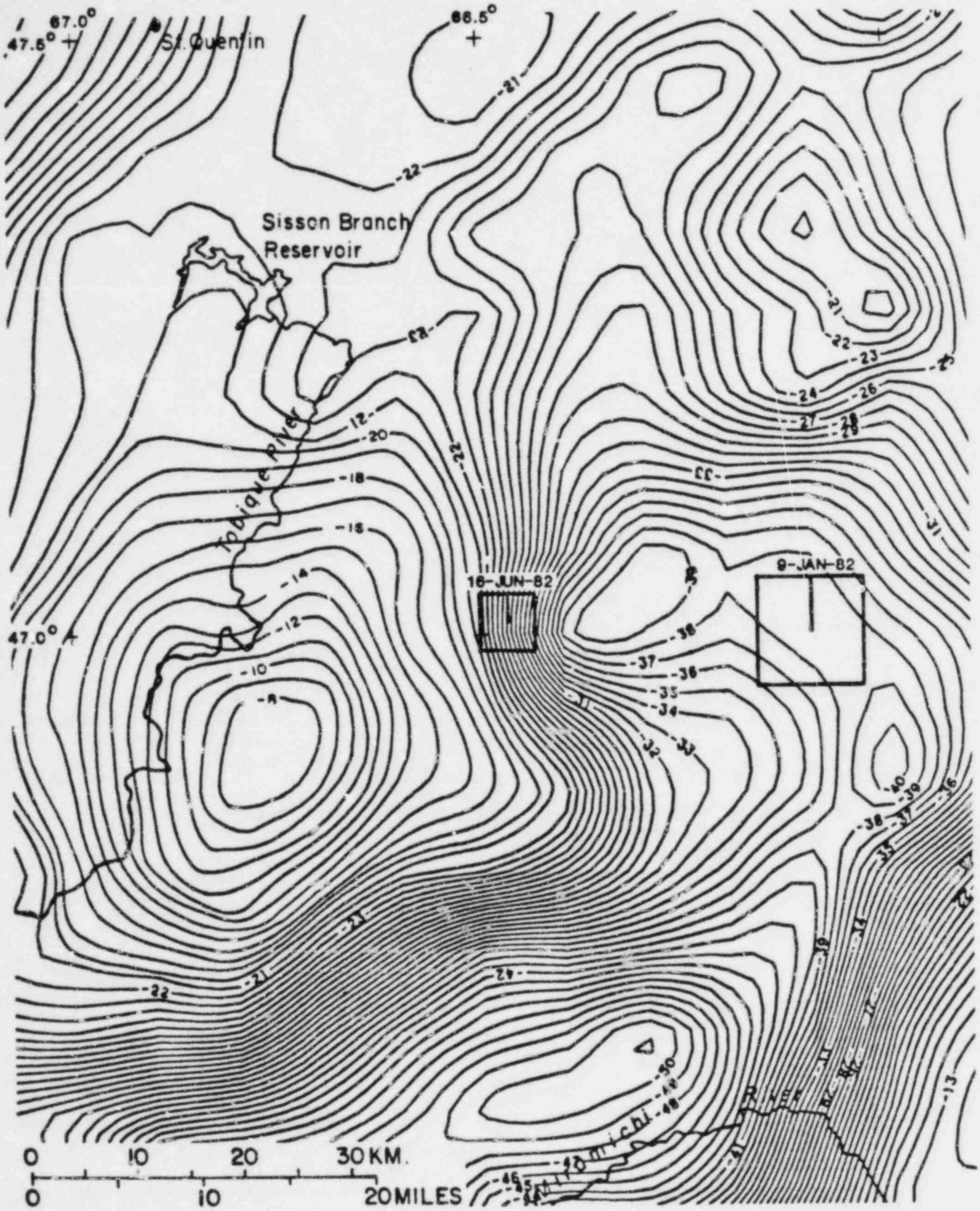
GENERALIZED SKETCH
NORTH WALL OF TRENCH

FIGURE 230.8-B



PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE SEABROOK STATION - UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT	THREE-DIMENSIONAL VIEW OF NEW BRUNSWICK FAULT PLANES FIGURE 230.8-1



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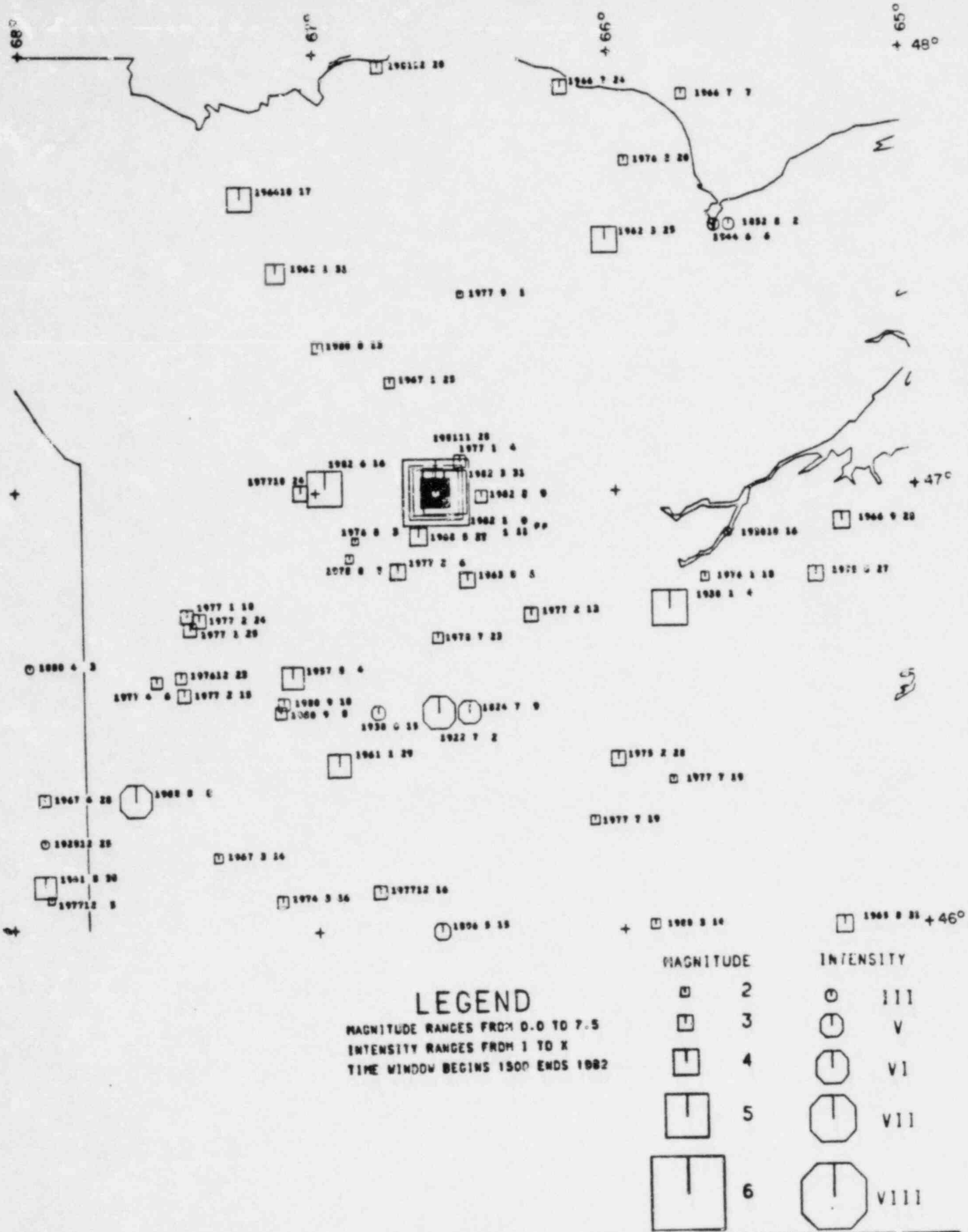
JANUARY 9, AND JUNE 16, 1982
EPICENTERS ON THE TOTAL BOUGUER MAP

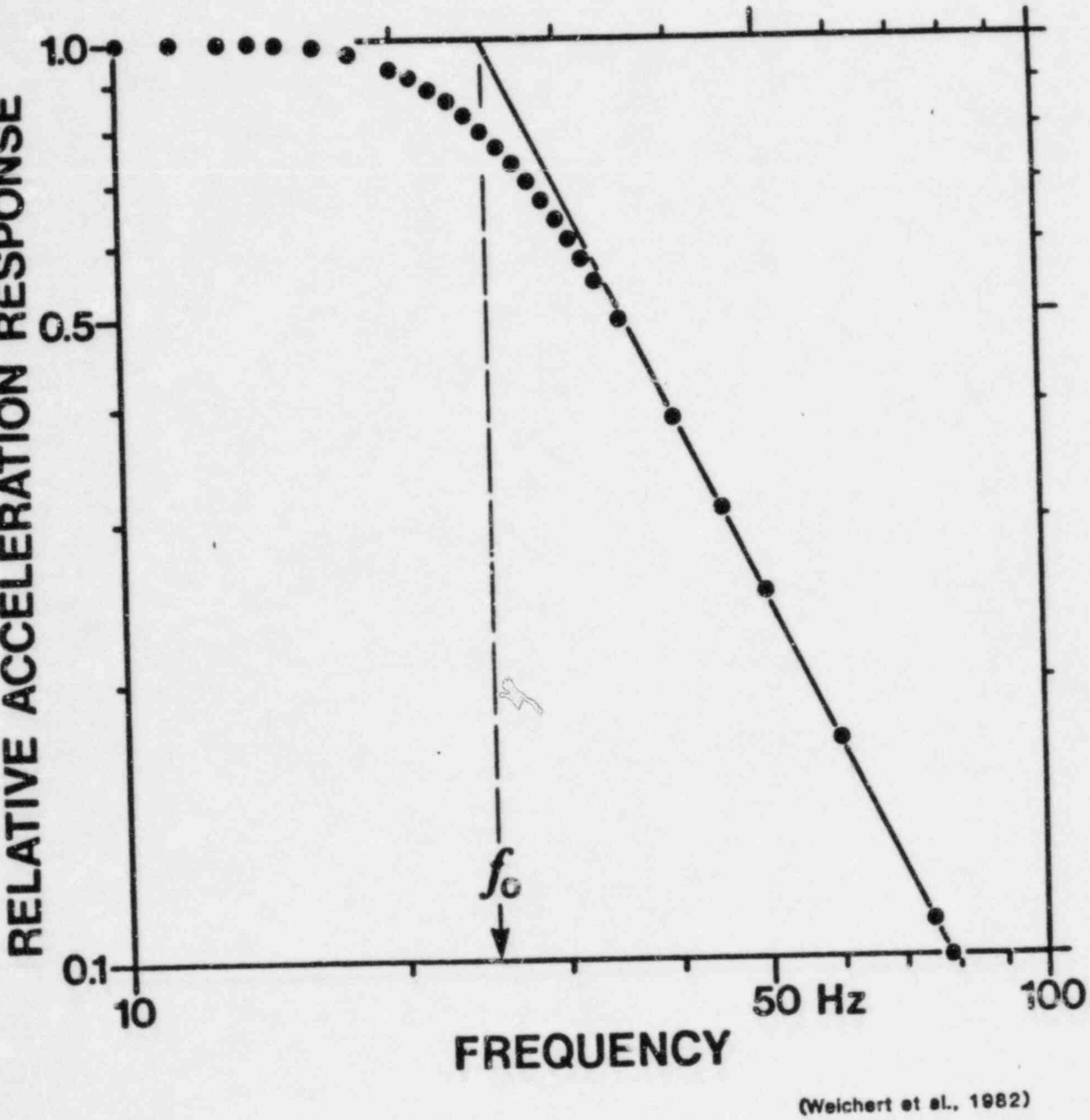
FIGURE 230.8-2



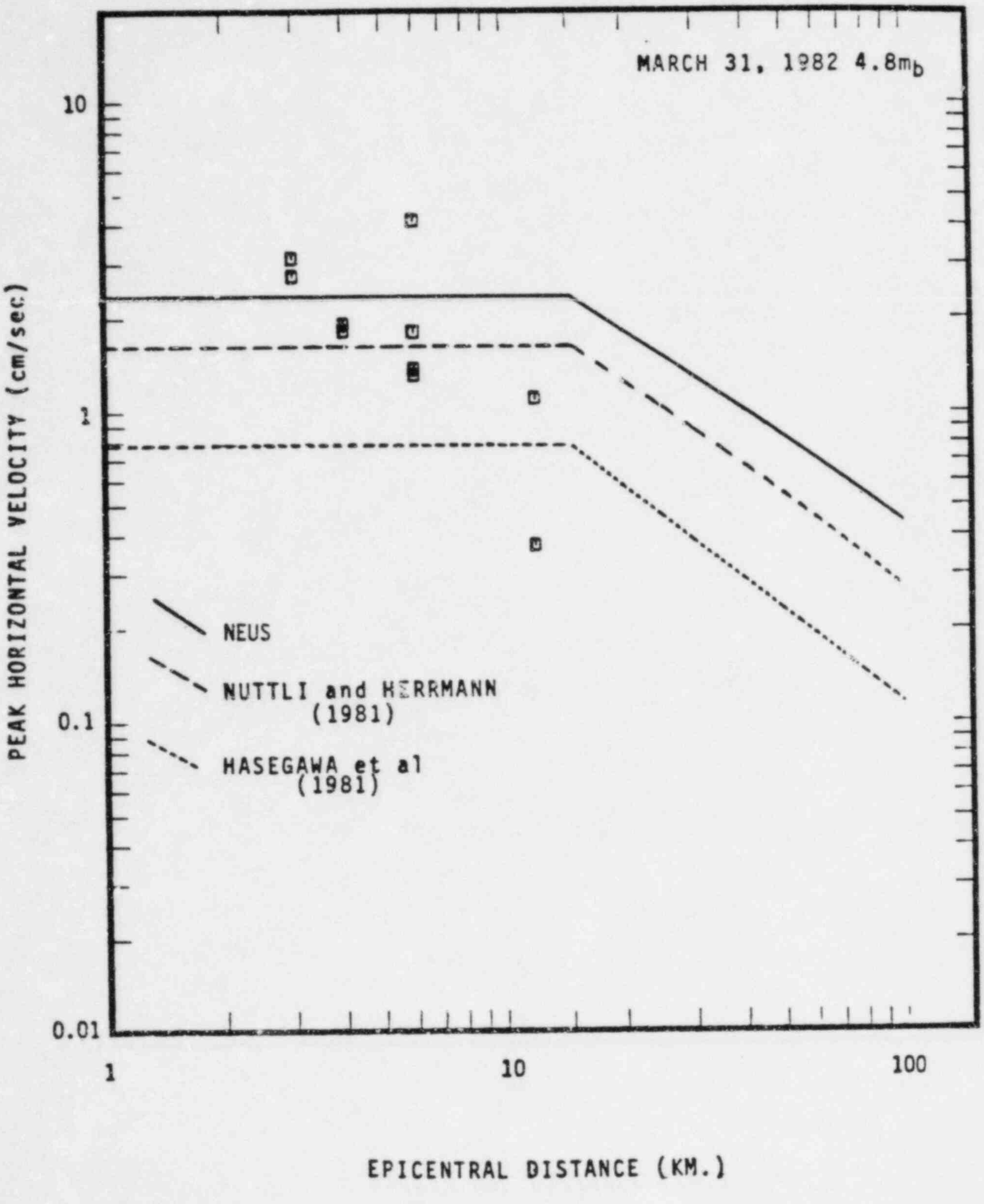
PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
SEABROOK STATION - UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

HISTORICAL DATA AROUND THE NEW BRUNSWICK 1982 EVENTS

FIGURE 230.8-3



PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE SEABROOK STATION - UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT	AMPLITUDE RESPONSE CURVE OF THE SMA-1 ACCELEROGRAPH FIGURE 230.8-4



PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE SEABROOK STATION - UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT	PEAK HORIZONTAL VELOCITY FOR THE MARCH 31, 1982 EARTHQUAKE FIGURE 230.8-5

Question 230.10

Considerable geological and seismological research has been carried out in New England during the past few years by state geological surveys, universities, consulting firms and the USGS. Many of the publications reporting the results of this research have been published after docketing of the FSAR. Many of these publications are referenced in the NRC, 1981, NUREG/CR-2131, New England Seismotectonic Study, FY 1979. Others appear in various earth science publications. Update the FSAR to include an assessment of the most recent earth sciences research as to their significance to the geologic and seismic safety of the site.

Response 230.10

The applicant and its consultants have reviewed the summaries of "The New England Seismotectonic Study activities during FY 1979" (NUREG/CR-0939), by P.J. Barosh and others. Similar reports for the Fiscal Year 1980 (NUREG/CR-2131) and the Fiscal Year 1981 (NUREG/CR-3253) have also been reviewed. This study program was a six year effort, to be concluded at the end of Fiscal Year 1982. The report for FY 1982, not yet available, is nticipated as a final report for the six year program, and as such should be more synthetic than analytic in its content. This present review has been selective of those research summaries that in topic or areal coverage could have some impact on the geologic and seismic safety of the Seabrook site.

Each annual report contains from 25 to 30 summaries describing work in progress and, sometimes, preliminary findings. Selectivity is in order since in the author's words: "Each year the study consists of a wide variety of scattered investigations, each of which is systematically providing needed information on a particular region or area of higher seismicity (NUREG/CR-0939)." In the introduction to each annual report, Barosh summarizes the key findings of the year. Our assessment of these reports confirms our preliminary response (March, 1982) to the above Question that none of the more recent publications bear significantly or adversely on the safety of the Seabrook site.

Among Barosh's important findings and repeated themes:

1. A very uneven distribution of earthquakes exists throughout New England, with concentrations in a few areas only.

2. The population and seismograph distributions do not appear to have greatly biased the results (i.e. the earthquake distribution).

3. There is a poor correlation of seismic activity with Paleozoic structures but a closer relationship of earthquakes with Mesozoic features, particularly those related to Cretaceous Continental Margins, can be found.

4. High angle extensional faults are known or predictable in most active areas.

5. Active areas are generally located in lowlands, with altitudes below 300 M. The exceptions are the White Mountains in New England, and the Adirondack Mountains in New York.

6. Seismically active lowland areas are presently subsiding. Passamaquoddy Bay and some part of the southern Maine coast are good examples of subsidence, while the Adirondack area and central New Brunswick, also active, are regions of crustal uplift. Seismicity is thus associated with vertical crustal movements.

7. The epicentral patterns parallel the general trend of geologic structures, thus implying that old faults are currently reactivated.

These summary statements have no direct implication on the seismic safety of the Seabrook site, since they do not question the adequacy of the 1755 Cape Ann earthquake as the Safe Shutdown Earthquake. Although Barosh explicitly rejects the correlation of seismicity with Mafic Plutons, and specifically considers the Cape Ann area one of many examples where earthquakes occur in embayments because Cretaceous continental margins are sagging, his hypothetical tectonic model does not imply at this time any need to modify the present S.S.E.

Besides the investigations carried out under the New England Seismotectonic Study Program, abundant research on seismological topics and tectonic models related to New England has been undertaken since the preparation of F.S.A.R. sections 2.5.1 and 2.5.2. A selective list of relevant references that were reviewed is attached.

For the purpose of assessing their significance to the seismic safety of the site, these contributions can be sorted in two groups: first, seismotectonics and COCORP studies; second, studies of specific earthquakes and seismic parameters.

1. <u>Seismotectonics and COCORP studies</u>

The recent availability of data from expanded local seismographic networks, both in Eastern United States and

Canada, has made possible the study of earthquake distribution, both spatial and temporal, earthquake mechanism, inferred stress regime, correlation of seismicity with known geological structures and preliminary definition of seismic zones. Sykes (1978), Yang and Aggarwal (1981), Barosh (1982), Pulli (1983) have reviewed older and recent information and, on that basis, formulated their own conclusions on the causes of current earthquakes. Although there is a general agreement between these authors on most of their observations and some of their interpretations, they nevertheless show differences in the emphasis given to the significance of these interpretations.

If the concept of reactivation is common to Sykes (1978), Yang and Aggarwal (1981), and Barosh (1983), in the generation of earthquakes, differences exist with respect to which structures are reactivated. For Sykes, the pre-existing zones of weakness that are reactivated are identified in "the Appalachians as pre-existing faults that trend nearly parallel to present-day continental margins as well as along features transverse to the margins." Continental extensions of old transform faults are considered potential locales of higher seismicity. In the case of large historic shocks in Massachusetts coincident with a northwest trending lineament, Sykes still wonders if it is possible that they could be associated with northeast striking Triassic structures. On this point of earthquake association with structures, Yang and Aggarwal are more restrictive and do not support a seismic trend in New England transverse to the Appalachians. They also propose that earthquakes on the eastern margin of the Appalachians occur along existing faults, in response to stresses generated by the thermally induced horizontal gravity variations in the oceanic lithosphere offshore. They see two distinct seismogenic provinces in the northeast: the Adirondack - Western Quebec Province and the Appalachian Province. Uniformity of horizontal compressive stress orientation within each of these provinces is one of their major conclusions. This position is in agreement with Zoback and Zoback (1980, 1981).

The consistency of stress orientations as deduced from fault plane solution of local earthquakes is not fully accepted by Pulli and Toksoz (1981) and Pulli (1983), for the Appalachian Province. They recognize the existence of a trend, i.e. consistency between many of the solutions, but admit clear differences. They wisely point out that the current data were obtained from relatively small to moderate earthquakes, with shallow foci, and that in such cases the compressive stress distribution is more likely to be influenced by local features. Graham and Chiburis (1980) had reached a similar conclusion.

The general agreement among all researchers that seismicity patterns based on recent instrumental data are remarkably similar to those obtained from the historical record is in support of FSAR section 2.5.2.1. This observed spatial stationarity is a fundamental element in the selection process of the S.S.E. Current divergence of opinions on the temporal stationarity of earthquake rates of occurrence is indicative of both the relatively short observation time and the need for better data.

Data generated by the current COCORP program (Brown et al, 1983, Ando et al, 1983, Oliver et al, 1983) confirm that the intraplate crust, and this applies to New England, is more structurally and lithologically complex than was thought. There is evidence of large-scale thrusting with considerable horizontal transport of off-shelf metasediments over coeval, undeformed lower Paleozoic rocks. Vertical complexity is also supported by the presence of metasedimentary rocks under zones of igneous rocks, even at great depths, emphasizing the importance of the Wilson cycle. The COCORP northeast traverse in New York, Vermont and New Hampshire reveals the existence of numerous east- and west-dipping reflectors, of arched reflections possibly representing folds, and of Moho- reflections. The eastern boundary of the Green Mountains seems to be defined by a major east-dipping crustal thrust zone or fold line that reaches to depths of at least 9 Km. Although more profiles, extended to the east and parallel to these already acquired are needed to map the entire substructure of New England, the first COCORP data for the northeast indicate that as the hypocentral accuracy increases, the association of current seismicity to specific fault and geologic structures may become a reality. In this sense, these recent findings can be seen as significant to the site safety, since the causative structures will gradually be identified.

2. Studies of Specific Earthquakes & Seismic Parameters.

Responses 230.7 and 230.8 have incorporated or referred to studies of the New Hampshire and New Brunswick earthquakes of January 1982. Other less important earthquakes have been analyzed individually (see reference list) for the purpose of obtaining fault plane solutions, intensity attenuation data, and possible correlation to geologic features. Three sets of fault plane solutions are found in Graham and Chiburis (1980), Yang and Aggarwal (1981), and Pulli and Toksoz (1981). With respect to events from New England and closer to the Seabrook site, there is a sufficient number of

similar solutions to support the predominance of thrust faulting mechanism. However, the orientation of P axes varies too much to yield a prevalent unequivocal azimuth.

The association of recent hypocenters with individual faults has not been attempted in New England as in New Jersey and New York (Ramapo Fault). Ebel (1982, 1983), studying the aftershocks of the 1979 Bath, Maine earthquake, has suggested a possible correlation of the seismic activity with the Cape Elizabeth fault. Although his data set is limited, a correlation is possible. In a similar way, Pulli et al (1983) have noticed that the probable fault plane of the Gaza, New Hampshire event (N20°E) is "parallel to the local structural grain of the area and the trend of instrumentally located earthquakes." In the Seismological and Geological Studies, Miramichi Area, New Brunswick and Central New Hampshire" (Weston Geophysical, 1983), the same earthquake had been associated with a northeast trending seismic lineament which also includes the 1940 earthquakes. The lineament is parrallel to or coincident with remote sensing lineations (N10E-N20E) which correlate in the field with mapped faults and joints.

These studies of recent earthquakes have no impact on the selection and adequacy of the S.S.E. for Seabrook. They do however add more reliable information towards the elaboration and selection of those tectonic models which will explain the region's larger earthquakes.

The study of source-parameter relations for mid-plate earthquakes by Nuttli (1983) constitutes a significant step in earth science research with potential applications to seismic hazard and determination of S.S.E., in that it reduces the dimensions of fault structures previously associated with given magnitudes. Clearly these new relations will become more important as observed seismicity is associated with identified structures and the earthquake potential of these structures is integrated in the selection of the S.S.E.

With respect to the prediction of seismic ground motion estimates for the New England region, two significant contributions were made by Klimkiewicz (1982) and Klimkiewicz et al (1982). In the first study, the uncertainty of calculated rates of occurrence is traced down to various sources, e.g. choice of particular m_b-I_o or m_b-M_L correlations, definition of complete intervals, selection of cell-widths, etc. In the second study thousands of intensity data points, from earthquakes with

well defined magnitudes, including some from the New Hampshire and New Brunswick 1982 earthquakes, are combined to derive, using the multiple regression technique, an intensity attenuation model which defines median estimates of I_o (and associated standard deviation) as a function of magnitude and distance. These studies have contributed to the definition of seismic hazard and associated uncertainty.

In summary, neither the seismological and geological data or research of the last three years have produced results which would change the selection of the S.S.E. for Seabrook.

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