NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

General Offices • Selden Street, Berlin, Connecticut

P.O. BOX 270
HARTFORD, CONNECTICUT 06141-0270
(203) 666-6911

February 1, 1984

Docket No. 50-423
B-11017

Mr. B. J. Youngblood
Chief Licensing Branch No. 1
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

Millstone Nuclear Power Station, Unit No. 3
Transmittal of Meeting Summary and
Viewgraphs Presented in Applicant's
January 5, 1984 Meeting with
Geosciences Branch

Attached are three (3) sets of the January 5, 1984 Geosciences Branch meeting summary, including responses to the staff's informal questions received prior to the meeting and copies of the viewgraphs employed in the presentations.

The informal questions were addressed during the presentations and are again summarized here to reiterate Northeast Utilities Service Company's position on the New Brunswick earthquake.

Also enclosed is one (1) set of the trench mapping done at New Brunswick by Weston Geophysical Corporation and presented at the meeting.

If you have any questions regarding this information, please contact our licensing representative, Ms. C. J. Shaffer, directly.

Very truly yours,

NORTHEAST UTILITIES SERVICE COMPANY

W. G. Counsil

W. G. Counsil
Senior Vice President

By R. W. Bishop
Corporate Secretary

B001
1/1

cc: Ms. E. L. Doolittle
NRC Project Manager

Mr. Robert Jackson
Chief, Geosciences Branch

Mr. Steve Brocoum
Section Leader, Geosciences Branch

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NORTHEAST NUCLEAR ENERGY COMPANY

January 25, 1984

NE-84-L-91

MEMO

TO: Distribution*

FROM: C. J. Shaffer C.J. Shaffer 1/25/84

SUBJECT: Summary of Millstone Unit No. 3 Geosciences Branch Meeting on the New Brunswick Earthquake

On January 5, 1984, Northeast Utilities Service Company (NUSCO) representatives and their consultants, Weston Geophysical Corporation (WGC), met with the Nuclear Regulatory Commission Geosciences Branch at Bethesda, Maryland to present and discuss additional information on the New Brunswick earthquake. It was decided at the November 29, 1983 meeting with the Geosciences Branch that the applicant would meet with the staff to present additional technical information as it became available and prior to submittal of such information in report form.

Opening remarks were presented by Ms. E. L. Doolittle, NRC Project Manager for Millstone Unit 3, and Ms. C. J. Shaffer, Generation Facilities Licensing, NUSCO. Following the opening remarks presentations were made in the following order.

The NRC Staff issued 5 informal questions prior to the January 5 meeting. These questions were addressed during presentations and are summarized and attached here as part of the meeting summary (Attachment 1).

The viewgraphs and maps of the exploratory trenching that Weston Geophysical employed in their presentations are attached.

I. WGC New Brunswick Report - G. Klimkiewicz

A. Conclusions of the New Brunswick Report

1. New Brunswick activity is correlated to a Geologic/Tectonic structure in the Central Miramichi Anticlinorium Region.

2. Distinctive Geologic/Geophysical characteristics exist for this structure.

3. There is sufficient historical seismicity for Canadian authorities to conclude that this area lies in a higher seismic region (National Building Code for Canada).

4. On the basis of intensive investigations it can be concluded post-factum that a seismic zone exists in the Central Miramichi Area.

5. Ongoing studies now suggest that historical earthquakes previously located near the Bay of Fundy likely originated in the Central Miramichi Region.

B. Summary of Evidence that Relate the New Brunswick Seismicity to Tectonics of the New Brunswick Region

1. The January 9, 1982 New Brunswick earthquake and aftershocks are constrained to a defined epicentral area; this is the best monitored NEUS earthquake sequence.

2. The tectonic structure within which the sequence occurred is defined as a fault bounded, counter-clockwise rotated crustal block of several hundred km^2 area dimension.

3. This block is defined on the basis of surface geological expression, geophysical signature, and 3-D gravity modeling.

4. Northwest trending shear zones identified by surface geologic mapping, geophysical methods (EM and VLF), and exploratory trenching are located above the 1982 sequence. These zones exhibit multiple deformations, are dated as post-Carboniferous, and exhibit a long history of activity.

II. New Brunswick Seismology - G. Leblanc

A. Parameters of Mainshocks

B. Aftershock Pattern

C. Conclusions - see responses to Questions 1 and 3 (Attachment 1)

III. New Brunswick Geophysics - J. Imse

A. Magnetic Anomalies

B. Gravity Anomalies and Modeling

C. Conclusions - see responses to Questions 1 and 2 (Attachment 1)

IV. New Brunswick Geology - J. Drobinski

A. Trench Mapping

B. Brittle Structure

C. Conclusions - see responses to Questions 1 and 2 (Attachment 1)

V. Comparative Seismological Analyses - G. Klimkiewicz

A. Methodology for Derivation of Recurrence Models

B. Comparison of Recurrence Models

C. Comparison of Low Magnitude Activity Rates

D. Conclusions - see response to Questions 4 and 5 (Attachment 1)

VI. Action Items

1. Relocation of Bay of Fundy Earthquake - any relocation of important historical seismicity to the central New Brunswick region will farther substantiate the position that a presently seismically active structure exists in this region. These relocations are not explicitly relied upon to establish the definition or seismicity of the New Brunswick tectonic structure.

   Northeast Utilities through Weston Geophysical Corporation will take a more active role in attempting to relocate the 1869 Bay of Fundy earthquake.

2. Geophysical and geological comparisons of the Millstone Unit 3 site and the New Brunswick epicentral area are ongoing. These comparisons will be provided in the Final Report to be issued in late March to April 1984. A meeting to present this information to the staff is tentatively scheduled for early March.

* W. G. Counsil
C. F. Sears
R. P. Werner
R. E. Busch
B. L. Carison
S. Orefice
R. R. Viviano
R. N. Smart
W. J. Briggs
C. G. Bell
R. T. Laudenat
R. L. McGuinness
GFL Memo File
MP3 Docket File

GSB Meeting - January 5, 1984

Name	Company
Steve Brocoum	NRC/GSB - Section Leader, Geology
Tom Cardone	NRB/GSB - Geologist
E. L. Doolittle	NRC/DL - Licensing Project Manager
A. K. Ibrahim	NRC/GSB - Seismologist
Bob Jackson	NRC/GSB - Chief, GSB
Jeff Kimball	NRC/GSB - Seismologist
R. B. McMullen	NRC/GSB - Geologist
Leon Reiter	NRC/GSB - Section Leader, Seismology
R. L. Rothman	NRC/GSB - Seismologist
Annette Vietti	NRC/DL
Chris Bell	NUSCO (GCE)
Bruce Carlson	NUSCO (Project)
Bob McGuinness	NUSCO (GFL)
C. J. Shaffer	NUSCO (GFL)
Robert N. Smart	NUSCO (GCE)
J. Drobinski	Weston Geophysical - Geologist
Richard Holt	Weston Geophysical - Geophysicist
John Imse	Weston Geophysical - Geologist/Geophysicist
George Klimkiewicz	Weston Geophysical - Seismologist
G. Leblanc	Weston Geophysical - Seismologist
L. D. Schultz	Weston Geophysical - Geologist
Malcolm Philips	Bishop, Liberman, Cook, Purcell & Reynolds - Attorney
John Jacobson	Yankee Atomic Electric

ATTACHMENT 1

MEMORANDUM

TO: NORTHEAST UTILITIES
Licensing Group
PO Box 270
Hartford, CT 06101

FROM: G. C. Klimkiewicz
WESTON GEOPHYSICAL CORPORATION
PO Box 550
Westboro, MA 01581

DATE: January 10, 1984

SUBJECT: Summary Of January 5, 1984 Meeting On MNP-3,
U.S. NRC Phillips 110, Bethesda, MD
WGC - R-498

Attached are viewgraphs employed by Weston Geophysical personnel in their presentations made during the January 5, 1984 meeting. These slides are provided in the approximate sequence in which they were shown and are also annotated with initials of the presentor, reference to a figure number in the WGC New Brunswick Report, and to overlays that were illustrated during presentations.

Per request of both WGC and NU, the NRC staff issued 5 informal questions prior to the January 5 meeting; these questions were addressed during presentations and questions 1, 2, and 3 were verbally answered at one point during the meeting. Summarized below are answers to the informal questions as they were given in a discussion format during the meeting.

1. The crucial lines of evidence that relate the New Brunswick seismicity [sequence beginning January 9, 1982] to tectonics of the New Brunswick region include the convergence of certain seismological, geophysical, and geological data. The spatial and temporal distribution of the 1982 earthquake sequence is clearly indicative of a seismogenic source with large dimensions. The apparent extension to the north of the two rupture planes, from January to April 1982 and from 1982 to 1983, confirms the concept of a large zone of weakness. The observed pattern of recent instrumental data [last 15 years] illustrates the continuous character of the localized seismicity; the same argument is reinforced by the occurrence in the region within the last century and a half of larger magnitude events with rather

uncertain epicentral locations [50 to 100 km], thus quite compatible with an association to the Central New Brunswick seismogenic structure. On the basis of other geoscientific data, the tectonic structure to which the N.B. seismicity is spatially correlated is defined as a fault bounded, counter-clockwise rotated crustal block of several hundred km² areal dimension. This block is defined on the basis of surface geologic expression, geophysical signature and 3-D gravity modeling. Boundaries for this crustal block include the Catamaran Fault to the south, the steep gravity gradient [inferred thrust fault] to the west, brittle faults to the north, and NW gravity gradients to the east [see Figures G-1, G-2, Plate 4.7]. Structural fabric [magnetic anomaly trend] is prominently oriented NW within the crustal block; this orientation is interpreted to result from counter-clockwise rotation of this crustal block. Three-dimensional gravity modeling illustrates that the January, 1982 sequence is hypocentrally located within the eastern part of the crustal block, and that the June, 1982 event is located near the western margin of the crustal block [see Figure 4.4A]. Surface geologic signature of the tectonic structure includes NW trending shear zones identified by geologic mapping, EM and VLF anomalies, and exploratory trenching; these zones exhibit multiple deformations, are now dated as post-Carboniferous, and exhibit a long history of tectonic activity. Emplacement of Pleistocene glacial material within the fault zone [1-1/2 meters below base of till] can have either a tectonic, glacial, or peri-glacial explanation. At present, the last movement along these NW zones is not known with certainty, however, no effects of the 1982 sequence have been observed or are suggested on the basis of the exploratory trenching.

2. The NW shear zones observed in the crustal block denoted as the N.B. tectonic structure are apparently unique for the central N.B. region on the basis of the pattern of air-mag anomalies and geologic mapping. These shear zones appear to be truncated by the Catamaran Fault. The Catamaran Fault clearly is genetically involved in the tectonic process that resulted in the rotation of the N.B. tectonic structure. The interpretation is that presently the area encompassing NW shear zones [i.e. tectonic structure], which exhibits a long deformational history, represents a weakened crustal block that is perferentially localizing stress vs. the E-W oriented Catamaran Fault. It is noted, as was stated at the meeting, that a neotectonic model for this region of interest suggests continuing counter-clockwise rotation of the above crustal block at very low deformational rates [J. Chandra, personal communication, December, 1983]. Given the location uncertainty, some low

level N.B. seismicity may be spatially correlated to the Catamaran Fault as may be necessary for this neotectonic model.

3. The dimensions, boundaries, and technical bases for the N.B. tectonic structure are discussed in the response to Question 1.

In the time frame preceeding the January 5 meeting, WGC had been tracking the relocation studies of Dr. K. Burke, University of N.B. Any relocation of important historical seismicity to the central N.B. region will further substantiate the position that a presently seismically active structure exists in this region. These relocations are not explicitly relied upon to establish the definition or seismicity of the N.B. tectonic structure.

Criteria used to relocate historical seismicity, in general, include the pattern of Modified Mercalli intensities observed over a broad region, ideally including areas wherein the event was not felt. On the basis of this pattern of intensities, vectors can be drawn along many azimuths to point towards domains of increasing intensity. The general epicentral area can thus be identified. The identification of the exact epicentral area by this method has large associated uncertainty, particularly for the case of sparse populations as is the case for central N.B. This limitation is recognized, however, the relocations of some events to the general area of the N.B. tectonic structure will provide critical substantiation of the importance of this feature.

Earthquakes considered for relocation include the 1855, 1869, 1922 and 1937 events [see Figure S-1]. Other events in the instrumental era after 1940 may also be considered for relocation.

4.& 5. Evidence for the implication that the N.B. region is more seismically active than the MNP-3 site area is established from comparisons of seismic activity rates and recurrence models derived for alternative regions around both of these areas. On the basis of seismicity observed for broader regions in N.B. and S. New England, the N.B. region is characterized by approximately a factor of 3 more annual seismicity per unit area. This relative seismicity difference translates into approximately 0.5 m_b unit difference between the regions for a common annual frequency of occurrence of 10^{-4} per normalized area [see Figure C-3].

Comparative studies illustrate that seismicity of the broad Southern Appalachian Tectonic Province [~ 90,000 km^2]

is similar to that derived for the broad central N.B. region [~ 50,000 km²]. Normalized recurrence is observed to be similar [overlay of Figure C-3 and C-6] and in addition, previous SSRS criteria for the SATP included a 5.8 ± 0.5 m_b and 0 to 25 km epicentral distance. A suggestion was made at the January 5 meeting that the observed and quantifiable seismicity difference among the MNP-3 and N.B. regions [~ 0.5 m_b at 10^{-4}/yr/1963 km²] and the similarity of seismicity for the SATP [5.8 m_b SSRS] and the N.B. region could provide a basis for assessing seismic design criteria for the MNP-3 site. A lower magnitude SSRS than that modeled after the N.B. 1982 event [5.7 m_b] is supported for the MNP-3 site by the comparative seismicity studies.

Seismic activity in the restricted region of the N.B. tectonic structure [~ 4200 km²] was compared to the broader N.B. region and also to several regions drawn about the MNP-3 site. This comparison illustrated greater activity in the vicinity of the structure relative to the 50,000 km² N.B. region [overlay of Figure C-3 and C-5]. In addition, this analysis suggests a factor of 4.5 to 6 greater seismic activity rate for the limited area of the N.B. structure relative to the region of the MNP-3 site [see Table 1]. Finally, the immediate site region [radius of 25 km] is apparently less seismically active than adjacent regions as is observed from the patterns of historical and recent seismicity. It was noted that the MNP-3 immediate region is among the earliest populated regions in the Northeast and also is among the earliest densely seismographically monitored areas in the Northeast due to the operation of the University of Connecticut network beginning in 1971.

Geophysical and geological comparisons of the MNP-3 site area and the N.B. epicentral area were not available for the January 5 meeting. These comparisons would be provided in the Final Report to be issued in late March to April, 1984. Identification of potential areas of 5.8 m_b earthquakes outside of the MNP-3 immediate site and the N.B. epicentral area is considered to be a generic issue and may not be relevant to the assessment of seismic design criteria at the MNP-3 site. The main issue involves assessing whether or not the MNP-3 site area is a likely location for a much larger than historical earthquake. On the basis of comparative seismicity analyses, the conclusion was made that the MNP-3 site area is not a likely location for a significantly larger than historical earthquake, and thus Operating License review based on a 5.8 m_b SSRS may be unnecessarily conservative.

G. Klimkiewicz

GK/rf-0388M

INFORMAL NRC STAFF QUESTIONS FOR THE JANUARY 5, 1984 MEETING WITH NORTHEAST UTILITIES

1. Summarize the crucial lines of evidence, including work completed since the report was written, that relates the New Brunswick Seismicity to the tectonics of the New Brunswick Region.

2. Are the NW-SE shear zones unique to the Devonian Pluton in the Miramichi Anticlinorium? Are they truncated by the Catamaran Fault? Is there any evidence that these or any other mapped tectonic structures are related to the seismogenic feature?

3. What are the dimensions and boundaries of the New Brunswick seismogenic structure? What are the bases for the dimensions and boundaries. Explain the criteria you have used to relocate historic events from elsewhere to the vicinity of 1982 events. Which historic events are you suggesting should be relocated?

4. Provide evidence to support the implication in the report that the New Brunswick region has a higher level of seismicity than the region in the vicinity of Millstone? (Naragansett Basin and Central Connecticut with and without Moodus). Are there areas in the vicinity of Millstone that should be considered as potential sources of larger than historic earthquakes.

5. What characteristics of the geological, geophysical and seismological features (Devonian plutons geophysical gradients, level of seismicity etc) in the Miramichi Anticlinorium are unique to cause this region but not other regions with similar features to generate earthquakes the size of the 1982 New Brunswick event? Describe the elements of your report that could be used as a screening tool to identify other regions in the vicinity of the Millstone site that may be potential generators of a M=5.8 earthquake.