December 15, 2004

Mr. Alex Matthiessen
Executive Director
Riverkeeper, Inc.
25 Wing & Wing
Garrison, NY 10524-9910

Dear Mr. Matthiessen:

On behalf of the Nuclear Regulatory Commission (NRC), I am responding to your letter of August 12, 2004, to Mr. Samuel Collins, Regional Administrator for NRC Region I, in which you expressed concern about the existing seismic analysis for Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point). You requested that the seismic hazard analysis be updated for Indian Point, particularly in relation to the spent fuel pools and the independent spent fuel storage facility (ISFSI). In addition, you stated that the facility should be subjected, both now and during a license renewal process, to the same criteria applied to any new facility that would be built on existing or new sites. As a basis for these requests, you provided information prepared by Dr. Lynn Sykes of the Lamont-Doherty Earth Observatory. Further, you stated that a few seismic monitoring stations near Indian Point have been closed, resulting in a lack of vital data to assess local faults. Thus, you requested the NRC to help find new sources of funding to reopen the monitoring stations.

As you are aware from the NRC's public meeting held on July 15, 2004, Entergy Nuclear Operations, Inc. notified the NRC of its intent to store spent nuclear fuel in dry casks on the Indian Point site in an ISFSI, commencing in late 2005. Entergy intends to use the General License granted under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, Subpart K. The NRC will periodically inspect the design, fabrication, and use of the dry cask storage system to ensure that the radiation safety requirements, licensing and other NRC requirements are met. During the meeting, Dr. Sykes presented a statement about earthquake risks to spent fuel at Indian Point, which was included as an attachment to your letter.

In your letter, you assert that the seismic design spectrum used in the 1970's is likely to be too low, and hence, not as safe at high frequencies as previously supposed. Thus, you request that the NRC take immediate action to ensure a competent and independent authority on seismic research conduct an updated seismic hazard analysis for Indian Point, particularly in relation to the high-density spent fuel pools and the proposed dry cask storage facility. You state that most earthquakes in southern New York and northern New Jersey occur in two 20-mile wide belts situated within the older rocks of the region. You further contend that, if spent fuel is stored at Indian Point for the next 40 years (assuming operating licenses for the reactors are extended an additional 20 years), the chance of an earthquake occurring along either of those two belts is about 23% (27% in your attachment). In response to the concerns raised in your letter, the NRC staff conducted a systematic review of the latest seismic studies relevant to Indian Point. Based on its review, the NRC staff concludes that the seismic conditions at the Indian Point site have undergone thorough geologic and seismic investigations. The NRC staff also concluded that the seismic design provides sufficient safety margin to potential damaging earthquakes. Further details are provided in the enclosed staff responses to the specific issues raised in your letter.

Regarding the seismic analysis in relation to the spent fuel storage at Indian Point, you state that dry casks, critical piping and spent fuel assemblies, are likely to be more sensitive to shaking at higher frequencies at sites east of the Rocky Mountains. In this regard, the licensee plans to store spent fuel assemblies at Indian Point in an NRC-approved dry cask storage system (DCSS) in an ISFSI using the General License granted under the NRC's regulations in 10 CFR Part 72. An ISFSI at the Indian Point site must be designed to withstand the effects of natural phenomena, including earthquakes, in accordance with 10 CFR 72.122. For a site with a co-located nuclear power plant, the existing geological and seimological design criteria for the nuclear power plant may be used. The casks used in the DCSS are massive, robust, and very rigid structures. In addition, the ISFSI must be designed such that during and following a seismic event, the casks do not tip over and any forces or the loads on the casks do not exceed the applicable design criteria in the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code) and the American Concrete Institute Code (ACI Code). Even though the casks are not allowed to tip over during a seismic event, the NRC requires additional analyses, which include the consideration of a non-mechanistic tip-over event and a cask drop event, and the resulting forces or loads must not exceed the applicable design criteria in the ASME and ACI Codes. Furthermore, the analysis of the non-mechanistic tip-over event is done to confirm that the DCSS will maintain its structural integrity without any breach to the outer confinement. In addition, the assumptions used in both the cask drop analysis and non-mechanistic tip-over analysis impose loads on the DCSS in the range of 30g to 70g, which far exceeds the loads from any potential earthquakes at a given site within the continental U.S. In addition, NRC-sponsored parametric studies (over last 25 years) have also confirmed that the DCSS designs have significant safety margins against potential cask tip-over and sliding during a design-basis earthquake event.

Your letter states that the NRC should subject Indian Point to the same stringent requirements for license renewal that are applied to companies seeking to build new reactors on existing or new sites. The highest priority at the NRC is ensuring the health and safety of the public and the environment. The license renewal requirements specified in 10 CFR Part 54 are based on the principles that: (1) operating plants will continue to maintain adequate levels of safety during the plant's life under the requirements of their original licenses, and (2) each plant's licensing basis is required to be maintained during the renewal term. The NRC relies on the regulatory process to provide reasonable assurance that current operating nuclear power plants continue to maintain an adequate level of safety. Over the life of the plants, this level of safety has been enhanced as a result of improvements in technology or based on operating experience, including experience with aging of nuclear power plants. The NRC issues generic communications, which require implementation by nuclear power plant licensees, as appropriate, to maintain safety. The NRC also requires licensees to routinely test, monitor, and maintain systems, structures, and components relied on for safety to provide assurance that they will perform as intended. Routine oversight of licensee activities is provided by the NRC's onsite inspectors and Regional specialists.

Although Entergy has informed the NRC staff of its intent to submit a number of future license renewal applications, the NRC staff has not been told whether Indian Point will be included as one of the future submittals. Should the NRC receive a renewal application for Indian Point in the future, the NRC will review both the safety and environmental issues associated with the application. Specifically, the licensee must provide the NRC with an evaluation of the technical aspects of plant aging to ensure that important systems, structures, and components will

continue to perform their intended function in accordance with the plant's current licensing basis during the period of extended operation . The licensee must also describe the aging management programs and activities that will be relied on to manage aging. In addition, to support plant operation for the additional 20 years, the licensee must prepare an evaluation of the potential impact on the environment. The NRC reviews the application, documents its evaluations in a safety evaluation report and supplemental environmental impact statement, and performs verification inspections at the licensee's facilities. If a renewed license is approved, the licensee must continue to comply with all existing regulations and commitments associated with the current operating license as well as those additional activities required as a result of license renewal. Licensee activities continue to be subject to NRC oversight in the period of extended operation.

I appreciate the opportunity to respond to your concerns, and I hope that you find this information useful.

Sincerely,

/RA/

Cornelius F. Holden, Director
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

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RESPONSE TO QUESTIONS RAISED BY RIVERKEEPER, INC.

REGARDING SEISMIC HAZARD ANALYSIS AT

INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3

The questions and comments presented in the August 12, 2004, letter, with attachment, from Riverkeeper, Inc., and the Nuclear Regulatory Commission (NRC) staff responses are as follows:

Source Characterization

1. A great deal more information on earthquakes has become available since the hazard analysis that was performed decades ago regarding the risk of damage to Indian Point posed by seismic activity. For example, a sequence of earthquakes started in August 2003 is being studied by the Lamont-Doherty Earth Observatory near the New Jersey and Pennsylvania border about 75 miles southwest of Indian Point. These earthquakes are particularly pertinent to the potential for earthquakes near Indian Point because they are associated with the same fault system (the Ramapo fault).

Staff Response:

The attached Figure 1 shows the seismic activity, since 1974, in the area within a 200 km radius of Indian Point. There are a total of 63 events that occurred during the period, with magnitudes ranging from 1.1 to 4.1. The earthquake catalog is based on the U.S. Geological Survey (USGS) National Seismic Network. Only two earthquakes have occurred (magnitude 3.8 on August 26, 2003, and magnitude 2.4 on October 1, 2003) near the border between Pennsylvania and New Jersey. There is no obvious earthquake sequence based on the seismic catalog for the border area. Furthermore, these earthquakes are not necessarily associated with the Ramapo fault because the earthquake epicenters project farther north than the fault traces. Earthquakes with magnitudes less than 5 are unlikely to cause any damage to nuclear power plant facilities because of the stringent design requirements for nuclear power plant structures and associated equipment. Larger earthquakes have occurred before 1974 (when seismic instruments were used to register seismic events). The two largest earthquakes, with magnitude of about 5.2, occurred in 1737 and in 1884, respectively, but their locations are uncertain (Figure 1 shows the estimated coordinates provided in Indian Point 2 Updated Final Safety Analysis Report (UFSAR)). Earthquakes of this size, often can cause damage, such as chimney collapse and cracks on the walls in residential buildings, but are unlikely to cause any noticeable damage to a nuclear facility.

Some of the cataloged earthquakes occurred in an area that might be related to the Ramapo fault system, based on the spatial relationship between the fault system and the earthquakes. The Ramapo fault system is a group of Mesozoic age faults, extending from southeastern New York to northern New Jersey, as well as further southwest. The fault system is composed of a series of southeast-dipping, northeast-striking faults. Various faults of the system contain evidence of repeated slip in various directions since Proterozoic time, including Mesozoic extensional reactivation. However, the USGS staff, who reviewed 31 geologic features in the Appalachian Mountains and Coastal Plain and compiled a National Database on Quaternary

Faulting (Crone and Wheeler, 2000), listed the Ramapo fault system in the C category because the fault system lacks evidence for Quaternary slip. They further pointed out that the Ramapo fault system, and 17 other geologic features, "have little or no published geologic evidence of Quaternary tectonic faulting that could indicate the likely occurrence of earthquakes larger than those observed historically" (Wheeler and Crone, 2004). Among these faults, the Ramapo fault system is one of the three that underwent a paleoseismological study. In two trenches excavated across the Ramapo fault, no evidence of Quaternary tectonic faulting was found (Wheeler and Crone, 2000).

2. New research suggests that damaging earthquakes could nucleate at a shallower depth than previously thought.

Staff Response:

Large uncertainties exist in determining earthquake nucleating depth using seismic instruments. Although a few large damaging earthquakes in the world have nucleated at shallower depths than expected, most damaging earthquakes nucleate deeper than smaller earthquakes because the shallower part of the earth cannot accumulate enough strain. Furthermore, the nucleating depth of an earthquake is dependent on regional tectonics. In the area around the Indian Point plant site, there is no evidence to indicate that earthquakes nucleate at unusually shallower depth.

3. An event of that size (M 5.2) has occurred historically along the two belts [Dr. Sykes] described about once every 150 years.

Staff Response:

Since there were only two historical events with magnitudes 5.2, it is uncertain that the time difference between the events would have a return period for the same size earthquakes. In addition, it is not possible to associate these historical earthquakes with any specific fault system or geologic feature because their locations are based on earthquake intensity contours, which may be controlled by many factors that are not necessarily, or directly associated with, seismic energy. Therefore, the staff disagrees with the conclusion that the magnitude 5.2 earthquake repeats itself every 150 years.

4. But it is obvious that the seismic hazard analysis for Indian Point- which is situated adjacent to the Ramapo fault- clearly needs to be updated.

Staff Response:

As mentioned above, the Ramapo fault system, a key fault system in the area, is very unlikely to generate any earthquakes larger than historical earthquakes based on paleoseismic and geologic investigations. The original design of Indian Point and later analyses have taken these earthquakes into consideration.

Seismic hazard studies at Indian Point and other nuclear power plants nationwide are reviewed beyond the originally proposed design period. In 1980's, under the sponsorship of the NRC, the Lawrence Livermore National Laboratory (LLNL) carried out a probabilistic seismic hazard analysis for each individual nuclear power plant site east of the Rocky Mountains. The utility

industry developed its own probabilistic seismic hazard analysis for the same sites. This analysis was conducted by the Electric Power Research institute (EPRI). The final seismic hazard calculations from LLNL and EPRI were used in the resolution of a generic issue (see NRC Generic Letter (GL) 88-20, "Individual Plant Examination For Severe Accident Vulnerabilities," dated November 23, 1988) and in developing plant-specific guidelines for performing the seismic portion of Individual Plant Examination External Event (IPEEE).

In response to GL 88-20, Indian Point completed a comprehensive IPEEE review in 1995. As part of the IPEEE for the seismic hazards, Indian Point completed an evaluation using a seismic probabilistic risk assessment for seismic events beyond the design basis. For this IPEEE process, the LLNL mean seismic hazard curve was used as input for a seismic event. The seismic fragilities of structures and equipment were then developed by a combination of specific calculations and use of generic fragilities for equipment, which met screening criteria for seismic ruggedness. The combination of hazard curves and the seismic fragilities provided a range of seismic plant damage states, which were then treated as "initiating events." These initial events were propagated through the plant model which was modified to reflect the seismic induced equipment failures events. As a result of the IPEEE program, IPEEE review spectrum was established.

Figure 2, attached, shows (a) the IPEEE review spectra anchored at 0.5 g and 0.38 g for Units 2 and 3, (b) the controlling earthquake (based on LLNL, magnitude of 5.7 at a epicentral distance of 14 km and assumed depth of 10 km) ground motion spectrum (with a reference probability of 10^{-5}), and (c) the historical earthquake (magnitude of 5.2 at a epicentral distance of 14 km and assumed depth of 10 km) ground motion spectrum. For the ground motion prediction relative to both controlling and historical earthquakes, the NRC staff used an Atkinson and Boore attenuation relationship (Atkinson and Boore, 1995). A comparison of these spectra shows that both the controlling earthquake and the historical earthquake are enveloped by both IPEEE review spectra for Unit 2 and 3 up to about 15 Hz, although IPEEE review spectrum for Unit 3 is lower than controlling earthquake at about 15 Hz. Since the natural frequency range for most structures and equipment at nuclear power plants falls below 10 Hz, ground motions above 15 Hz will not likely damage major structures, systems, and components at Indian Point. High frequency ground motion above 10 Hz generally affects active components such as relays and contacts, which are subject to chatter. Relays and components, with high frequency sensitivity, have been explicitly addressed in IPEEE evaluations.

5. It doesn't take a long feature like the Ramapo Fault to generate a damaging earthquake. The 1737 and 1884 shocks of M 5.2 probably had rupture lengths of only about 5 miles.

Staff Response:

It is not possible to determine the rupture lengths of the 1737 and 1884 earthquakes since there are no records to indicate any surface rupture at the time these earthquakes took place. However, paleoseismic studies and geological studies have shown no evidence of Quaternary faulting along the Ramapo fault system that could indicate the likely occurrence of earthquake larger than historical ones (Crone and Wheeler, 2000).

<u>Ground Motion Attenuation Relationships</u>

6. In the 1970's measurements of acceleration came almost exclusively from earthquakes in the western U.S. and Japan and were assumed to be the same for the rest of the U.S. Measurements are now available for several earthquakes in eastern North America, which indicate that seismic shaking is greater at high frequencies- those from about 3 to 100 Hz (cycle per second) than it is for earthquakes of comparable magnitude in California and Japan.

Staff Response:

Since the 1970's, empirical ground motion estimation has advanced considerably. There are now over a dozen ground motion attenuation relationships specifically for the Central and Eastern United States (CEUS). Some of these attenuation relationships have been compared with the recently recorded strong motion recordings from the Au Sable Forks earthquake (Atkinson and Sonley, 2003), and the comparison shows that they are in general agreement with the few ground motion recordings that are available for the CEUS (see attached Figure 3). As shown in Figure 2, structures, systems, and components at Indian Point have adequate margins of safety at frequencies from 3 to 10 Hz.

7. New data, for example, are now available for the 2002 Au Sable Forks, Adirondacks NY shock, which was of similar magnitude to the 1884 New York City earthquake.

Staff Response:

Strong motion records from one earthquake usually do not significantly change an attenuation relationship. Moreover, seismologists continually update their attenuation relationships, as more strong motion recordings become available. Strong motion data from the Au Sable Forks earthquake had been used in comparing several existing attenuation relationships (Atkinson and Sonley, 2003). The result indicates that the data are in agreement with those attenuation relationships currently used for the CEUS (Figure 3).

Safety Consequences

8. While the probability of a damaging earthquake may be low, damage to various facilities at Indian Point may have dire secondary consequences for the region.

Staff Response:

Earthquakes that have occurred historically in the area are very unlikely to cause any damage to the nuclear facilities at Indian Point. The Ramapo fault system has been categorized as C type fault because the fault system has little or no published geologic evidence of Quaternary tectonic faulting that could indicate the likely occurrence of earthquakes larger than those observed historically. In addition, the earthquake ground motion for which nuclear power plants are designed are much more conservatively determined than those for commercial and residential buildings. In fact, the design requirements for nuclear power plants are considered sufficiently stringent to ensure structures remain functional so that the plant can safely shut down following a damaging earthquake. Therefore, it is unlikely for potential earthquakes in the area to cause any damages to the Indian Point nuclear facilities.

9. The lack of more extensive knowledge of earthquakes and active faults in this area should result in conservative judgments about risks to critical structures like nuclear power facilities and their spent fuel storage systems.

Staff Response:

The methods endorsed by the NRC for the design of nuclear facilities ensure reasonable conservatism with design of safety-related structures and components. Safety margins are embedded in the design process. Other agencies both in the U.S. and abroad view the NRC's criteria as conservative references for safe seismic design.

10. It is now obvious that Entergy has not commissioned an up-to-date assessment of the seismic hazard posed to the plant based on the latest research.

Staff Response:

USGS and other researchers are constantly updating their national seismic hazards to incorporate new seismic sources and new ground motion attenuation studies. The NRC's Office of Nuclear Regulatory Research is currently reviewing the latest USGS seismic hazard results to ensure that there is no significant seismic hazard increase due to these updates. Should any significant hazards be identified in this, or any subsequent, review, the NRC will take actions as deemed appropriate.

11. This is an extremely timely matter given Entergy's interest in seeking a 20 –year license renewal from the Nuclear Regulatory Commission that would extend their license to operate at Indian Point 2 and 3 to 2033 and 2035, respectively.

Staff Response:

Should an application for an extension of the Indian Point operating licenses for 20 more years be submitted by the licensee, the application will be subjected to the regulatory requirements in 10 CFR 50.54 and would involve a comprehensive review of passive equipment for age-related degradation mechanisms. The issues raised in your letter are not pertinent to any consideration of a facility license renewal.

<u>Regional Earthquake Monitoring</u>

12. The NRC requirements of Entergy with respect to seismic monitoring at Indian Point are not apparent. Furthermore, it is not clear at what point the NRC decided to change its requirements regarding seismic monitoring at Indian Point.

Staff Response:

NRC regulations require operators of nuclear power plants to have suitable instrumentation so that the seismic response of nuclear power plant features important to safety can be evaluated promptly after an earthquake (additional guidance can be found in Regulatory Guide 1.12). Entergy has on-site seismic equipment installed to monitor seismic vibrations. The NRC has not changed its requirement regarding seismic monitoring at the Indian Point facility.

13. Finally, over years, a few seismic monitoring stations near Indian Point have been closed due to funding cutbacks, thereby resulting in a lack of vital data needed to assess activity of local faults and potential for negatively impacting Indian Point, particularly the spent fuel pools and reactor buildings. We request that NRC help to ensure that a new source of funding is developed to reopen these monitoring stations.

Staff Response:

The process of seismic monitoring at the nuclear facilities is governed by licensee commitments in their FSAR. Indian Point has on-site equipment to monitor seismic activities. Regionally, the area is monitored by U.S. National Seismic Network and other regional seismic networks, such as Lamont Cooperative Seismic Network (LCSN) and the seismic network maintained by the Weston Observatory at Boston College. Seismic networks in the area have been improved in both equipment and station distribution over the years. Many advanced pieces of equipment have replaced older seismic instruments.

14. Needless to say, the cost of burden associated with more extensive research into the plant's vulnerability to an earthquake should not be placed on the public. The public is already subsidizing Entergy's operation of Indian Point in so many different ways.

Staff Response:

The NRC does not have jurisdiction over matters involving the recovery of any costs for operation of the facility. Your concerns would be better addressed to the New York State Public Service Commission.

Miscellaneous Concern

You questioned the accuracy of a licensee statement that an earthquake with a peak ground acceleration of 0.15 g is equivalent to a Richter magnitude of approximately 6.0.

Staff Response:

The NRC staff notes that a peak ground acceleration value and an earthquake magnitude cannot be directly correlated.

REFERENCES

1. Anthony Crone and Russell Wheeler, 2000, "Data for Quaternary faults, liquefaction features, and possible tectonic features in the Central and Eastern United States, east of the Rocky Mountain front," USGS Open-File Report 00-260.

2. Russell Wheeler and Anthony Crone, 2004, Paleoseismological Targets in the Eastern United States, Geological Society of America, Abstracts and Programs, Vol. 30.

3. Gail Atkinson and Eleanor Sonley, 2003, Ground Motions from the 2002 Au Sable Forks, New York M 5.0 Earthquake, Seismological Research Letters, Vol. 74, No. 3, 339-349.

4. Gail Atkinson and David Boore, 1995, Ground Motion Relations for Eastern North America, Bulletin of Seismological Society of America, Vol. 85, No. 1, 17-31.

5. NRC Regulatory Guide 1.12., “Nuclear Power Plant Instrumentation for Earthquakes,” 1997.

Attachments: Figures 1 - 3

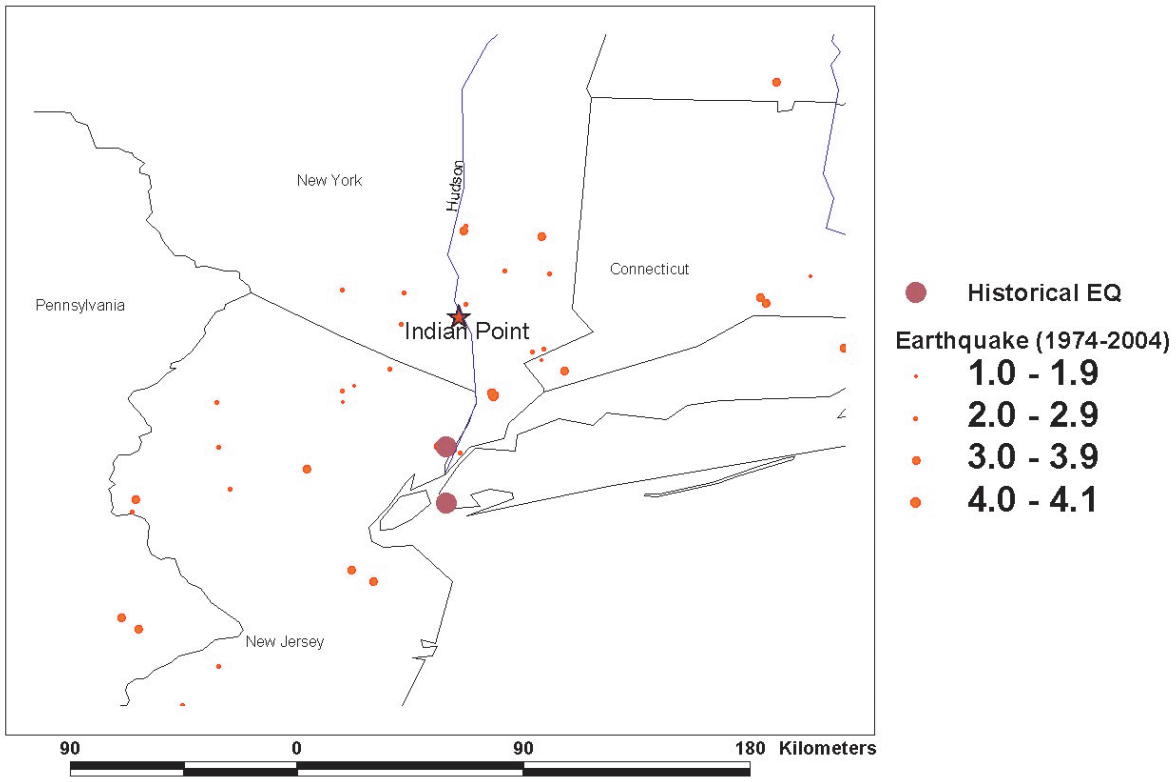

Figure 1. Earthquake activities near Indian Point since 1974. Historical earthquake epicenters are based on FSAR, 1985.

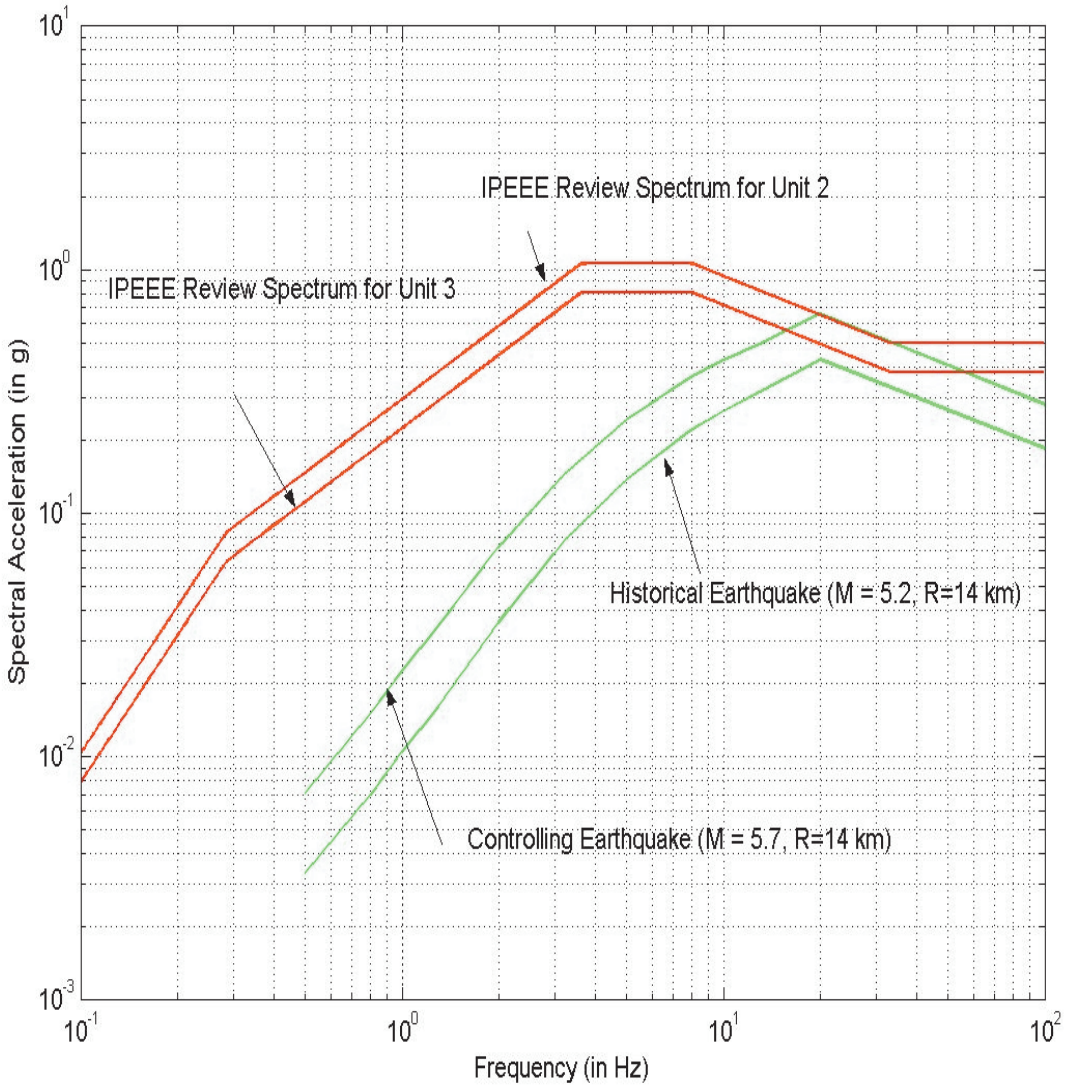

Figure 2. Design spectra and potential ground motion at the Indian Point site.

Attachment 2

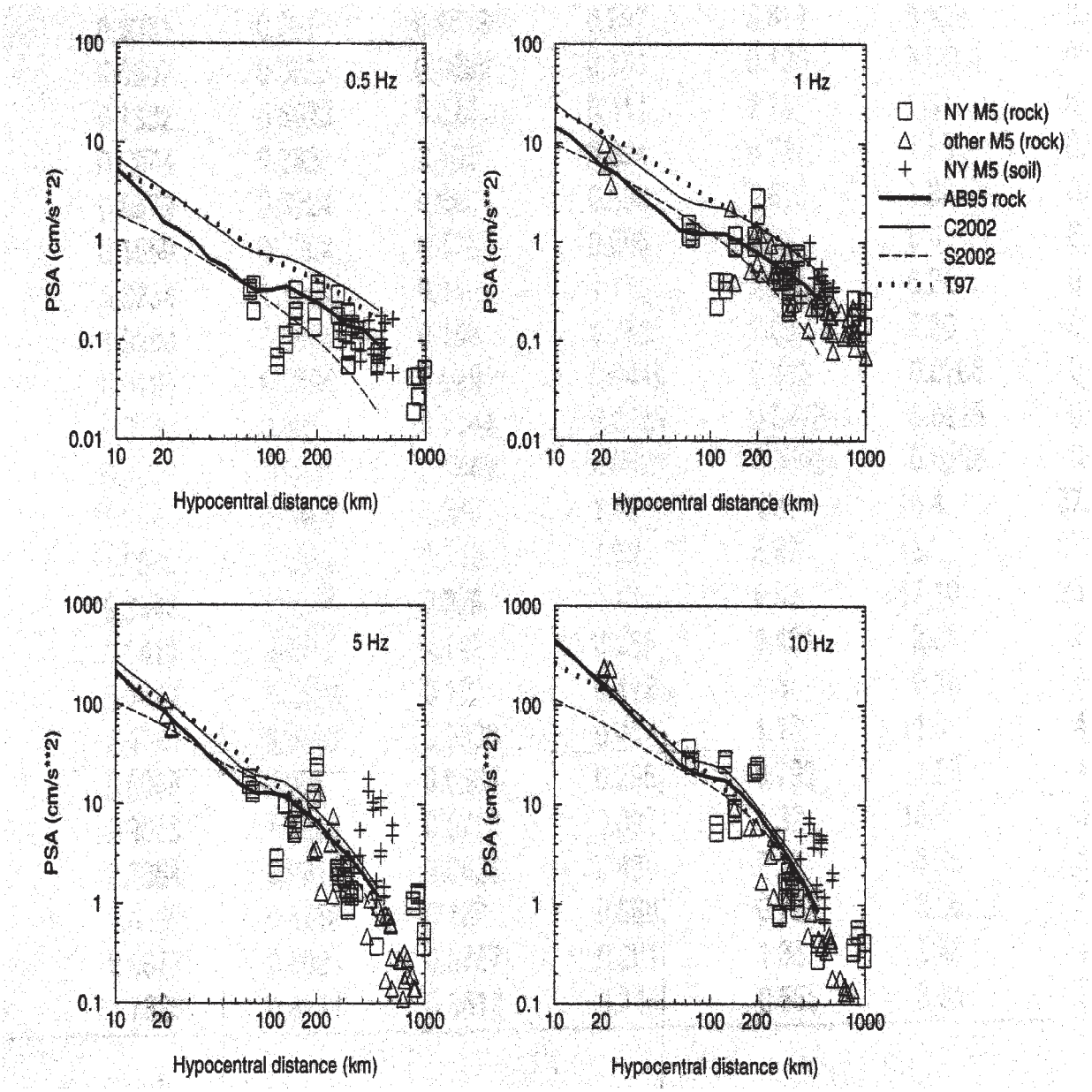

Figure 3. Au Sable Forks earthquake strong motion records are in agreement with several attenuation relationships (Atkinson and Sonley, 2003). AB95: Atkinson and Boore, 1995; C2002: Campbell 2002; S2002: Somerville, et al. 2002; T97: Toro et al., 1997.