UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454
	)	50-455
(Byron Station, Units 1 and 2)	)	

TESTIMONY OF INA ALTERMAN ON LEAGUE CONTENTION 106

ALTERMAN SUMMARY

This testimony addresses the geological aspects of League contention 106. It incorporates relevant sections of the SER. It makes the following points:

1. The Plum River and Sandwich Faults lie approximately five and six miles from the site, respectively. The Illinois Geological Survey has conducted detailed investigations of these faults. The evidence demonstrates that these are Paleozoic faults with later movement probably not after the Cretaceous Period (65 million years before present). As no seismicity is associated with either fault, and no evidence for surface displacement more recent than 125,000 years (the youngest age of the Illinoisan till) has been observed, these faults are considered noncapable within the meaning of 10 CFR Part 100, Appendix A.

2. The Applicant has performed excavation mapping and a fault-specific geotechnical investigation demonstrating that minor subsurface faults present at the site are covered by a flat-lying and undisturbed overburden of Pleistocene glacial drift, loess, and alluvium interpreted to be no younger than 125,000 years. There is no evidence of surface displacement or capable faults within the meaning of 10 CFR Part 100, Appendix A, at or within five miles of the site.

3. Strain gauges are designed to measure the strain rate along faults. At present strain gauges have not been devised to measure the vanishingly small strain rates that may exist along the Plum River and Sandwich Faults. The fact that there has not been movement in these zones in at least the last 125,000 years, coupled with the lack of earthquake occurrences, indicates that strain is minimal and, therefore, neither earthquakes nor movement is likely enough to occur on these zones such that it must be considered for Byron design purposes.

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TESTIMONY OF INA B. ALTERMAN REGARDING
LEAGUE CONTENTION 106

Q1. Please state your name and affiliation.

A1. My name is Ina B. Alterman. I am a staff Geologist in the Geosciences Branch in the Office of Nuclear Reactor Regulation U. S. Nuclear Regulatory Commission. A copy of my professional qualifications is attached.

Q2. What is the purpose of your testimony?

A2. The purpose of this affidavit is to address the staff position with regard to geologic aspects of League Contention 106.

Q3. Do you adopt Sections 2.5.1 and 2.5.3 of the February 1982 Byron Safety Evaluation Report (SER) on the geology of the Byron site as part of your testimony?

A3. Yes. As the geology reviewer of the FSAR for the Byron site, I wrote Section 2.5.1 and 2.5.3 of the SER (copies attached) and adopt them as part of my testimony concerning Contention 106.

Q4. What is the staff position about the age and capability of the Sandwich Fault.

A4. At the construction permit stage of review, the Sandwich Fault, the northern end of which comes within seven miles of the site, was determined to have formed in association with the nearby and subparallel LaSalle Anticlinal Belt which is dated as post-Pennsylvanian (290 million years before the present (mybp) to pre-Mesozoic (240 mybp).[1] The minor faults within the site region were determined to be pre-Sangamonian (125,000 ybp) based on unfaulted Pleistocene till overlying the faults, and probably pre-Cretaceous (63 mybp) based on regional geologic history. Since the construction permit stage, the Illinois Geological Survey has performed a detailed study of the Sandwich Fault Zone to determine its extent, amount of offset, age, and nature of faulting. See Circular 505 (1978).[2]

Detailed investigation by the Illinois Survey of the Sandwich Fault Zone confirmed that no glacial material nor subjacent residual soil was offset anywhere along the entire length of the fault wherever the young material was observed. Reexamination of glacial tills have strongly supported an Illinoian age (500,000-125,000 ybp) for the tills at the Byron site and in the Byron area.[3] This would require the undisturbed residual soil beneath the till to be of the Yarmouth interglacial period (600,000 ybp). See also the discussion of this matter in 2.5.1 of the SER.

Q5. What is the Staff position on the capability of minor faults found during mapping of excavations for Category I structures?

A5. According to an August 1975 report by the applicant,[4] subsequent responses to staff questions concerning information in this report[5], staff testimony at the construction permit hearing on the minor site faults in August, 1975,[6], and a letter report by members of the Illinois Geological Survey staff,[7] it was determined that the faults in the excavations were parallel and subparallel with the Sandwich fault and had about 1 to 6 inches of offset. These faults were overlain by an interglacial residual soil and glacial till that were not offset. Since the minimum age of the residual soil must be 70,000 ybp (the last interglacial period) the faults were determined to be non-capable according to the criteria established in Appendix A to 10 CFR Part 100.

Q6. When was the Plum River Fault discovered and what is the Staff position on its capability?

A6. The Plum River Fault Zone, which comes within 5.3 miles of the site, was originally thought to be an anticlinal structure. A detailed study done by the Illinois Survey provided evidence that it was a fault zone with several hundred feet of offset. The staff position on the non-capability of the Plum River Fault Zone (discussed in section 2.5.1 of the SER) was based on information and analysis in the Illinois Survey report on the Plum River Fault Zone including the age of the overlying residual soil and glacial till, the lack of fault escarpment and regional tectonic history. See Circular 491 (1976).[8]

Q7. In its response to Staff interrogatories in this case, the League suggests that there is a connection between the Plum River Fault Zone and the minor excavation faults at the site. Is there any evidence to connect these?

A7. No. The evidence as reported in the Applicant's Fault Specific Geotechnical Investigation Report,[4], and observed by geologists of the NRC, U. S. Geological Survey and Illinois State Geological Survey, does not indicate any relationship between the Plum River Fault Zone which strikes east-west and the minor faults, which strike N70W (North 70° West). The minor faults at the site, however, are parallel with the Sandwich Fault Zone and are considered to have been formed in response to the same stresses that produced the Sandwich Fault. The minor faults and the Sandwich Fault Zone have been shown to be non-capable. Furthermore, detailed investigation by the Illinois Survey led to the conclusion that the Plum River and Sandwich Fault Zones are not continuous although they probably formed during the same tectonic events.

Q8. In its further response to Staff interrogatories in this case, the League claims that not enough work has been done to find decisive evidence as to whether or not the Plum River Fault is capable. The League attributes this position to a Dr. Henry Woodard. What was the nature of the investigation of this fault zone?

A8. The investigation reported by the Illinois Survey (Circular 491)[8] included detailed field mapping, well records, drill cores and sample studies, and seismic refraction work. Computer-constructed base maps were developed from the subsurface information.

Q9. What was the nature of the post-Construction Permit Illinois Survey review of the Sandwich Fault?

A9. The Illinois Survey Sandwich Fault Zone study (Circular 505)[2] included all the elements cited in response to Question 8 above, plus downhole geophysical logging and earth resistivity profiles. All of the latest techniques available were applied to the separate studies of the area.

Q10. In its further response to Staff interrogatories in this case, the League suggests that strain gauge tests ought to be applied to the Plum River Fault Zone to determine any possible future movements of the fault. Can a strain gauge test help in this determination?

A10. No. Strain is the response of a body, in this case a body or volume of crustal rock, to deforming stresses. All areas of the crust are subject to stresses, but these are the equilibrium stresses that do not deform. When the stresses in one set of directions (N-S, E-W, vertical, etc.) greatly exceed the stresses in all other directions, they are referred to as the deviatoric or deforming stresses. The volume of rock responds by being compressed, or shortened, if the deviatoric stresses are compressive; extended or elongated, if the stresses are tensional; or twisted if the

compressive stresses are in the form of a shear couple, acting in the same plane but not along the same line. Rupture will occur when the rock has reached the limit of its ability to compress, stretch or twist, and the stresses are sufficient to overcome the cohesion and frictional resistance of the rock.

Measurement of strain, therefore, is the amount of shortening, elongation or rotation that a volume of rock is experiencing. The quantity of measurement used is a percentage or ratio of the change in the length of lines within the rock body (dL) over the original undeformed length (L).

The strain rate is the percent change in a given period of time. Strain gauges are designed to measure the strain rate along faults. Although there are several sophisticated instruments, the basic idea of the strain gauge is bolting a wire of known length across a zone that is suspected of being strained measurably, and measuring the change in the length or the straightness of the wire over a given period of time. For the San Andreas Fault in California, where the movement along the fault is, conservatively, about two centimeters per year, instruments are capable of measuring the small increments of strain.

Along the Plum River and Sandwich Faults, undisturbed residual soils at least 125,000 years old lie across the fault. This

indicates that no measurable strain has occurred over this period. During that time, the San Andreas Fault has moved 2,500 meters. At present, strain gauges have not been devised to measure the vanishingly small strain rates that may exist along the Plum River and Sandwich Faults. Even if such techniques were available, the fact that there has not been movement on these zones in at least the last 125,000 years and most likely not since Pennsylvania time (290 myBP), coupled with the lack of earthquake occurrences, indicates that strain is minimal and therefore neither earthquakes nor movement is likely enough to occur on these zones such that it must be considered in the design of this facility.

REFERENCES

1. Byron and Braidwood SER for CP-NUREG 75/023 (April 4, 1975).

2. The Sandwich Fault Zone of Northern Illinois by Dennis R. Kolata, T.C. Buschbach, and Janis D. Treworgy, Illinois State Geological Survey Circular 505 (1978).

3. Letter to Dr. Ina B. Alterman from Dr. John P. Kempton, Illinois State Geological Survey, dated Nov. 18, 1981.

4. Fault Specific Geotechnical Investigation - Byron Station, dated August, 1975, by Sargent & Lundy Engineers and Dames and Moore, Consultants to Commonwealth Edison Company.

5. Answers to NRC Questions Pertaining to the Fault Specific Geotechnical Invstigations Report, by Sargent and Lundy Engineers, and Dames and Moore, dated October 20, 1975.

6. Testimony of NRC Staff regarding Preliminary Evaluation of Faulting in Byron Station Excavation by Dr. Robert E. Jackson, Geologist, USNRC, August, 1975.

7. Observations relating to the age of the minor faults in the Galena Dolomite at the Byron Nuclear Generating Station of the

Commonwealth Edison Company, by H. B. Wilman, Geologist and Dennis R. Kolata, Ass't. Geologist with the Illinois Survey; Letter Report of Illinois Geological Survey, included as Appendix 2 to "Fault Specific Geotechnical Investigation-Byron Station".

8. Plum River Fault Zone of Northwestern Illinois by Dennis R. Kolata and T.C. Buschbach, Illinois State Geological Survey Circular 491 (1976).

2.5 Geology and Seismology

For this SER, the staff has reviewed all available relevant geologic and seismologic information obtained since the issuance of the SER and a supplement to the SER (SSER) for the construction permit in 1975 in accordance with the SRP, except for a deviation from the SRP, in the determination of the SSE as discussed and justified in Section 2.5.2.4.

In the CP-SER the staff concluded that

(1) Geologic and seismologic investigations and information provided by the applicant and required by Appendix A to 10 CFR 100 provide an adequate basis for determining that no capable faults exist at the plant site or within 5 mi.

(2) Earthquakes that have occurred in the region cannot be related directly to any faults in the area.

(3) Ground motion values of 0.20 g and 0.09 g anchoring Regulatory Guide 1.60 response spectra at the foundation level of rock-supported structures for the SSE and the OBE, respectively, are adequately conservative.

After careful review of the new information as provided and evaluated by the applicant, the staff concludes that there is no basis for altering its conclusions stated in the CP-SER concerning the safety of the Byron site.

The staff has evaluated the FSAR and subsequent documents and information, including excavation mapping, a trenching and drilling program in a solution basin, and new determinations by the Illinois Geological Survey on postulated faults and the age of the glacial till in the site vicinity. The staff has concluded that the applicant has (1) performed site and regional geologic and geophysical investigations, (2) reviewed all available pertinent literature, and (3) provided the staff with all information necessary to evaluate, assess, and support the applicant's conclusions concerning the safety of the Byron site from the geologic and seismologic standpoint, except as noted in subsequent sections. In addition, the staff finds the applicant has satisfied the requirements of and is in compliance with applicable portions of the following:

(1) Appendix A to 10 CFR 50

(2) Appendix A to 10 CFR 100

(3) SRP Sections 2.5.1, 2.5.2, and 2.5.3

(4) Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 2

(5) Those portions of Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants," applicable to the development of geologic and seismologic information relevant to the stratigraphy, lithology, geologic history, and structural geology of the site

(6) Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations"

(7) Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants"

In the following sections, the staff reviews briefly the geologic and seismologic information and bases for its conclusions.

2.5.1 Geology

2.5.1.1 Summary of Regional and Site Geology

The site is located in the Till Plains Section of the Central Lowland Physiographic Province which is characterized by undulating low relief topography of Pleistocene loess, glacial drift, and residuum (1+ million-15,000 years old) overlying horizontal or gently dipping strata of Paleozoic age (600-250 million years before the present (mybp)). The site is underlain by a thin veneer of loess and glacial drift, ranging in thickness from 4 to 27 ft, which overlies Ordovician age (500-430 mybp) bedrock of primarily dolostone. Thickness of the Paleozoic section beneath the site is estimated to be 2000-3000 ft. Beneath this lies the primarily granitic Precambrian (800+ mybp) basement.

At the site, the glacial deposits consist of Illinoisan-stage drift (400,000 to 125,000 ybp), and less. In the PSAR, the applicant stated that the glacial drift was of Illinoisan and Wisconsinan stages of the Pleistocene. Recent studies and reevaluation of the till by the Illinois State Geological Survey have led to the determination that all of the till at and near the site is of

Illinoisan age. The numerical age determinations of the site glacial deposits are based on correlation with glacial deposits in Nebraska and western Iowa, where a volcanic ash interbed in the Kansan drift, the Pearlette ash, has been isotopically dated at 500,000 to 1 million ybp (John Kempton, geologist, Illinois Geological Survey, personal communication). While there are no datable materials in the younger drift formations, calculation of rates of (1) development of interglacial weathered soils, (2) ice-cap formation, (3) advances of the ice, (4) melting, and (5) drift deposits, correlated with sea level curves, allows credible estimates of ages of the Illinoisan and Wisconsinan glacial drift.

The uppermost rock unit below the glacial and soil overburden is the middle Ordovician Galena Group that consists of dolostone strata of the Dunleith and Guttenberg formations. Because of the carbonate content of these rocks, solutioning has occurred along joints, at joint intersections, and along bedding planes. In the site vicinity and at the site, solutioning at joint intersections has resulted in a few solution basins, oval depressions at the surface about 50 ft in diameter. One such basin has been found to be larger, almost 150 ft in diameter. These have been termed sinkholes in the FSAR. However, at a recent meeting, the applicant and his consultants demonstrated by drilling and trenching one solution basin that the horizontal bedding continues undisturbed at the rim and on the floor of the depression, thereby excluding a collapse origin for the basin. They are preparing a report of this investigation to be submitted later. The results of the staff review of the findings will be presented in a supplement to this SER. Drilling and excavations for Category I structures have not uncovered larger voids or caves capable of causing collapse in the Galena Group in the site region. Additionally, Dennis Kolata of the Illinois Geological Survey (personal communication) has confirmed that large scale or extensive solutioning is not characteristic of the dolomitic carbonate rocks of Northern Illinois.

Based on the information presented as the result of the applicant's site investigation and by the Illinois Geological Survey, the applicant concludes that it is unlikely that large voids or caves capable of causing ground collapse are present in the subsurface of the site and site vicinity. The staff concurs with this assessment.

Structurally, the site is located on the northern flank of the Illinois Basin, near the crest of the Wisconsin Arch, in a region characterized by broad upwarped domes, arches and anticlines, and downwarped basins. These are all considered to be Paleozoic in age, based on stratigraphic evidence. The upwarps are commonly associated with faults or fault zones that parallel them and are related in age.

Major faults closest to the site are the east-west trending Plum River Fault, the eastern end of which comes to 5.3 mi northwest of the site, and the Sandwich Fault, 6 mi southwest of the site. Detailed investigations by the Illinois Geological Survey (Ill. Geological Survey Circulars 491 and 505) conclude that these faults predate the Pleistocene epoch because the Illinoisan till that overlies these faults is undisturbed in the vicinity of the faults. Some disturbances of glacial till and blocks of bedrock close to the Plum River Fault have been interpreted as "ice-shove" structures attributed to glacial movement during the Pleistocene period, and not of tectonic origin (Ill. Geol. Survey Circular 395). Knowledge of the regional tectonics supports the conclusion

that there are Paleozoic faults with later movement probably not after the Cretaceous period (65 mybp). As no seismicity is associated with either fault, and no evidence for surface displacement more recent than 125,000 years (the youngest age of the Illinoisan till) has been observed, these faults are considered noncapable within the meaning of Appendix A to 10 CFR 100.

Structural anomalies in the subsurface in the site region (listed in the CP-SER as postulated faults), such as the Janesville Fault in southern Wisconsin and the Oglesby and Tuscola Faults in northern Illinois, have since been reinterpreted by the Wisconsin and Illinois Geological Surveys as irregular erosion surfaces or minor flexures in subsurface bedrock. They are, therefore, not considered significant in the safety evaluation of the Byron station.

Minor faults discovered during the excavation for Category I structures were subject to extensive investigation by the applicant. In a report entitled "Fault Specific Geotechnical Investigation" submitted as Attachment 2.5C of the FSAR, the applicant and his consultants concluded that undisturbed residual soil above the faults was formed about 200,000 years ago, and provided supporting evidence by letter reports from experts of the Illinois Geological Survey. They, therefore, concluded that the faults at the site are noncapable within the meaning of Appendix A to 10 CFR 100. The staff concurs with this conclusion.

2.5.3 Surface Faulting

The applicant has shown through borehole data, geophysical studies, remote sensing techniques, and, since the CP-SER review, excavation mapping and a fault-specific geotechnical investigation that subsurface faults present at the site are covered by a flat-lying and undisturbed overburden of Pleistocene glacial drift, loess, and alluvium interpreted to be no younger than 125,000 years.

Therefore, the applicant has concluded, and the staff concurs, that there is no evidence of surface displacement or capable faults, within the meaning of Appendix A to 10 CFR Part 100, at or within 5 mi of the site.

INA B. ALTERMAN, PH.D.
GEOSCIENCES BRANCH
DIVISION OF ENGINEERING
U. S. NUCLEAR REGULATORY COMMISSION

My name is Ina B. Alterman and I am presently employed as a Geologist in the Geosciences Branch, Division of Engineering, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

PROFESSIONAL QUALIFICATIONS

I have a B.S. in Geology (1963) which was awarded Magna Cum Laude from City College of New York, where I was also a member of Phi Beta Kappa. My Ph.D. in Structural Geology was awarded in 1972 by Columbia University where I held a Faculty Fellowship.

My professional experience began with University teaching and field and laboratory research. I taught Introductory Geology, Historical Geology, and Optical Mineralogy in various colleges (City, Hunter, Barnard and Columbia) as a part-time lecturer while in Graduate School. As a full time Assistant Professor at Lehman College, starting in 1971, I also taught Structural Geology, Tectonics, and Igneous and Metamorphic Petrology until coming to NRC in October, 1979.

My major research activities were grant-funded field mapping, structural analyses of multiple deformation, mechanisms of ductile deformation, and ancient plate tectonics. Some of this mapping, in Pennsylvania, is now included on the latest official geologic map of Pennsylvania, published by the Pennsylvania Geological Survey. For two summers in 1976 and 1977, I did a study of linear structures and brittle fracturing of the earth's crust for the National Aeronautics and Space Administration using Landsat and other remote sensing techniques.

I am often sent papers on various aspects of structural geology to edit and/or review for journals and proceedings volumes (for example, Journal of Geology, Basement Tectonics Vol.). My own publications include articles in the Earth Science Encyclopedia, Petrology Volume (still in press), articles on stratigraphy, mechanisms of slaty cleavage formation, Paleozoic plate tectonics in the Appalachian Piedmont and late brittle faulting in the Appalachians.

At NRC I have been involved in the review of recent geologic features near Rancho Seco, and at the Washington Nuclear Plant No. 2 on the Columbia River Basalt Plateau in Central Washington State. I recently supervised the compilation of information concerning the geologic and tectonic setting for every nuclear facility in California, including university and industrial research reactors and power plants.

I am a member of the following professional and scientific organizations:

Geological Society of America
American Geophysical Union
American Association for the Advancement of Science
New York Academy of Science
Potomac Geophysical Society
Washington Geological Society
Sigma XI
Phi Beta Kappa