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

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MEMORANDUM FOR: Richard P. Denise, Assistant Director for Site Technology, DSE

THRU: Robert E. Jackson, Acting Chief
Geosciences Branch, DSE

FROM: A. T. Cardone, Geologist
Geology and Seismology Section
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SUBJECT: STATUS OF REVIEW - BIG ROCK POINT SYSTEMATIC EVALUATION PROGRAM REVIEW - TAC NO. 07342

Material Reviewed

I have reviewed:

1. The Hazards Summary Report, Vol. II, received December 11, 1961.

2. "Geology and Hydrology of the Proposed Reactor Site at Big Rock Point, near Charlevoix, Michigan by James H. Zumberge, received in Hazards Summary Report.

3. "Seismicity of the Charlevoix, Michigan Area" by Prof. James T. Wilson, received in Hazards Summary Report.

4. "Sink Hole Formation in Quarry Floor at Petoskey Plant, Section 3, T34N, R6W, Emmet County," by William A. Walden, Geologist, Michigan Department of Natural Resources, January 7, 1977.

5. "Big Rock Nuclear Power Plant Hydrological Survey," by the Institute of Science and Technology, Great Lakes Research Division, Special Report No. 9, the University of Michigan, November, 1961.

6. "Devonian Strata of Emmet and Charlevoix Counties, Michigan" by R. V. Kesling, R. T. Sehall, and H. O. Sorensen, 1974.

7. "Geology of the Great Lakes" by Jack L. Hough, University of Illinois Press, Urbana, 1958.

and "Big Rock Nuclear Power Point Hydrological Survey," respectively. These reports discuss the geologic and hydrologic conditions of northern Michigan and Lake Michigan. They do not however, provide the kind of regional and site geologic information needed to perform a review of a nuclear power plant site under "new plant" criteria. The information is inadequate to complete our final review and must be supplemented either by additional information from CPC or acquired by the staff. Specific comments and questions will be provided in a later memo.

Karst Topography (Solutioning) Near the Site

The Ayers' report contains a detailed description of the topography and bathymetry of Little Traverse Bay, the body of water approximately 12 miles long and 6 miles wide, adjacent to the site and the Penn-Dixie quarry. The report states on page 3, "The bathymetry of Little Traverse Bay is characterized by submerged slopes of irregular width which descend into the depths of the bay, and by a high degree of irregularity of the bottom topography. Maximum depth in the bay occurs in a small area in the bay mouth where, about two miles north of Big Rock Point, depths into bedrock in excess of 300 feet are charted." (See figure 1 on page 4). The average depth of the bay is approximately 100 feet. About a mile from shore between the town of Bay Shore and the Penn-Dixie Cement Company plant the bottom drops steeply from 50 feet to more than 175 feet. Similar but less pronounced landward extensions of deeper water lie about a mile north and west of the Penn-Dixie plant and about a mile north and west of Petoskey. These points are between 6 and 9 miles east of the nuclear plant site. The report concludes that the structure of the bedrock in the region is irregular, which may be due to solution, slumpage, and recementation of the underlying strata in the past.

Evidence of karst topography also exists in the Penn-Dixie and Medusa quarries. During my visit to the Penn-Dixie quarry I was informed of a sink hole that was encountered while blasting the limestone. It was described in a report by William A. Walden, from the Department of Natural Resources, Michigan, as 30 feet in diameter and more than 65 feet deep. In a telephone conversation with Paul Carney on December 13, 1978 he informed me that another sink hole was recently encountered in a drill hole at the quarry which was at least 30 feet deep extending from 120 to 150 feet below ground surface.

8. Haven Nuclear Plant Units 1 and 2, PSAR, Wisconsin Utilities Project, 1978.

9. "Soil Report on the Subsurface Investigation from the Big Rock Point Plant in Charlevoix, Michigan" by Soil Testing Services, Inc., March 7, 1960.

Site Visit

On November 16, 1978, T. M. Cheng, S. Nowicki of NRC staff and I visited the site to meet with Consumer Power Company (CPC) representatives and to tour the plant area. Because of the possibility of solutioning of the limestone at or near the plant, based on a review of geologic and topographic maps, I had asked to see all significant bedrock exposures in the site vicinity during the site visit. W. J. Bekius, a representative of CPC, arranged a tour of the Penn-Dixie Cement Company limestone quarry located approximately 8 miles northeast of the site. I also visited the Medusa Cement Company limestone quarry located several miles southwest of the site. This visit was not prearranged. Both quarries are located adjacent to Lake Michigan. During the visit I focused on the following review topics:

a) Regional and Site Geology
b) Karst Topography (solutioning) near the site
c) Faulting and seismic reflection profiling in Lake Michigan
d) Geotechnical Engineering

At the time of the visit three borings were being made to determine the site stratigraphy and the engineering properties of the strata underlying the plant structures for future use in determination of site response spectra. The geologist monitoring the drilling indicated in the field logs that vugs measuring several inches vertically were encountered at the 138 foot depth below surface elevation 590 feet, but no large cavities had been discovered to date.

Regional and Site Geology

The Final Hazard Summary Report for Big Rock Point contains two reports which briefly discuss the geologic conditions at the site and its environs. Two University of Michigan Professors, James H. Zumberge and John C. Ayers, et al, authored the reports "Geology and Hydrology of the Proposed Reactor Site at Big Rock Point, near Charlevoix, Michigan"

I visited the Medusa Cement Company quarry which is located several miles west of the nuclear site on the shore of Lake Michigan. I was not invited by the Medusa Company to visit the quarry, so I was able to make only a cursory inspection. Across the quarry from where I stood, I observed what I strongly believe to be a sink hole in the south wall of the quarry.

It is evident that the site is flanked, within approximately 2 miles to not more than 6 miles, on at least three sides by collapse structure and/or sink holes. The boring logs from the site show that the Rock Quality becomes very poor below elevation 545 down to at least elevation 465 where the deepest borings were terminated.

In summary Karst solutioning and collapse structure occur near and possibly beneath the site. This conclusion is based on:

1. Identification of offshore topography indicative of limestone collapse.

2. My review of reports numbers 2, 4, 5, 6 and 7 under the heading Material Reviewed above.

3. Telephone conversation with Paul Carney, Penn-Dixie geologist.

4. Site visit on November 16, 1978.

Therefore, a thorough investigation of the limestone bedrock supporting the nuclear plant structures is required to provide assurance of adequate support for the plant structures. If possible, the foundation investigation portion of the review should become the responsibility of the Geotechnical Engineering Section with the assistance of the U. S. Corps of Engineers.

Faulting and Seismic Reflection Profiling in Lake Michigan

During the June 22, 1978 site visit by NRC staff to the proposed Haven Nuclear Power Plant site, Stone and Webster presented new data, consisting of seismic reflection lines to be used in the interpretation of the Lake Michigan area subsurface geology. Interpretation of the data was presented in a preliminary geologic map of the lake bottom showing inferred NNE trending faults.

A review by NRC staff of the data on Lake Michigan geology is in progress for the Haven site review. The staff's preliminary Safety Evaluation of Faulting in Lake Michigan, issued by memo from R. Denise to B. Grimes on October 11, 1978 concludes:

> "Lake Michigan is located in the Central Stable Region tectonic province. This province is generally characterized by gentle arches, domes and basins which formed during the Paleozoic Era more than 225 million years ago. Faulting was widespread in the Central Stable Region during the era and the discovery of faulting within Paleozoic rock units beneath Lake Michigan is not unexpected.
>
> "There is no known geologic evidence of tectonic deformation or faulting in the region subsequent to that time. Based on the tectonic history of the Central Stable Region and the absence of historic seismicity under Lake Michigan, we have a high degree of confidence that the faults beneath Lake Michigan are geologically old and pose no potential to increase the earthquake hazard of the region."

On the same basis provided in the above safety evaluation we can conclude that any faulting at the Big Rock Point site would be of the same type.

Geotechnical Engineering

The soil report by Soil Testing Services, Inc. describes the soil conditions, based on the boring logs at the site, as follows:

> "...the surface soil consisted of loose to medium dense sand with varying amounts of gravel, limestone chips and silt extending to depths varying from 2 to 4 feet. Below this, predominantly medium dense to dense fine to coarse sand with some gravel and limestone chips and varying amounts of silt was observed to depths varying from 6 to 8 feet, immediately underlain by fine to coarse sand with some clay, silt and gravel in a dense to extremely dense state extending with only minor interruptions to limestone bedrock at depths varying from 34 to 55 feet. The minor interruptions mentioned consist of occasional layers of more permeable sand containing few fines and occasional layers of boulders. The underlying limestone is in a broken and fractured state. Recovery varied all the way from 0% to 100% during coring operations."

The report also states that a thorough analysis indicated that the soils generally contain appreciable clay, being on the order of 20 percent, therefore in my opinion liquefaction potential does not appear to be a problem at this site. The anticipated settlement based on laboratory testing and analyses was less than one inch.

A small three-eights inch wide settlement crack was observed in the foundation of the umbilical corridor between the containment and intermediate building. Other minor cracks and spalling was observed in the turbine building and intake structure. There is no obvious major settlement of structures, based on my visual inspection.

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