UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of	)	Docket Nos. 50-329-OM&OL
Consumers Power Company	)	50-330-OM&OL
(Midland Plant, Units 1 and 2)	)	

TESTIMONY OF HARI NARAIN SINGH CONCERNING
SERVICE WATER PUMP STRUCTURE

Q-1. Please state your name and position with the U.S. Army Corps of Engineers.

A. My name is Hari N. Singh. I am a Civil Engineer in the Geotechnical Branch of the Engineering Division, NCD in Chicago, Illinois, U.S. Army Corps of Engineers.

Q-2. How did the U.S. Army Corps of Engineers get involved in the review process of the Midland Plant, and what are the areas of its responsibilities.

A. Pursuant to an interagency agreement between the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Army Corps of Engineers (the Corps) which became effective in September 1979, the Corps undertook to provide technical assistance to the NRC. The Corps provides assistance on the geotechnical engineering aspects of the Midland Plant.

Q-3. Have you prepared a statement of your professional qualifications?

A. Yes, a copy is attached.

Q-4. Please state the nature of your responsibilities with respect to the Midland Plant.

A. My involvement with the Midland Plant began in May 1980, when I was assigned the responsibility as the Corp's lead reviewer for the geotechnical concerns at the Midland Plant as lead reviewer, I worked with engineers and geologists of the Geotechnical Engineering Section of the Detroit District, who were engaged in reviewing the materials used in the foundation design of the plant. As the full-time lead reviewer, my responsibilities were to coordinate with all the reviewers, examine their comments, perform my own review, discuss comments with the Section Chief and prepare a final letter report to be transmitted to the NRC. The structures being reviewed include the following: 1) Auxiliary Building; 2) Reactor Building Units 1 and 2; 3) Diesel Generator Building; 4) Borated Water Storage Tanks Units 1 and 2; 5) Service Water Pump Structure; 6) Diesel Fuel Storage Tanks; 7) Seismic Category I Piping and Conduits; 8) Retaining Walls; and, 9) the dikes adjacent to the Emergency Cooling Water Reservoir (ECWR).

Q-5. What are the existing soil problems at the Service Water Pump Structure?

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A. The Service Water Pump Structure is located in the southeast corner of the power block area adjacent to the Cooling Pond. The structure is rectangular in shape with overall dimensions of 106'x 86'. The structure is built on two levels with the main part founded on natural material at elevation 587.00, and the small northern portion founded on compacted fill materials, at elevation 616.00. Figures 18 and 19 of Attachment-1 show the plan and a typical section of the structure. The northern portion is cantilevered off the main portion.

Subsequent to the excessive settlements of the compacted fill under the Diesel Generator Building, borings were taken in all the compacted fill under Category I structures. Such borings taken in the compacted fill under the Service Water Structure had revealed that fill materials consist of soft to very stiff clay and loose to very dense sand (50.55(e) report of 10 August 1979). Based on these borings, it was concluded that some fill material areas of the northern portion of the Service Water Structure were not sufficiently compacted.

As a consequence of poor compaction, the foundation soils do not provide adequate support to the portion of the Service Water Pump Structure foundation on fill materials. The existing dead load of the northern part is being partially carried by the main structure through cantilever action. This change in structural behavior of the northern portion of the structure introduced additional bending and shear stresses in the structure causing cracks on the cross walls (See Figures 23, 24, & 25 of Attachment-1). Further, unless the poor fill materials are corrected, its reactive support to the structure would continue to diminish increasing the cantilever action, jeopardizing the safety of the structure. Since the fill supported structure is not designed to act as cantilever from the main structure, its safety is being threatened by continued reduction in foundation support.

Q-6. What was the originally proposed remedial measures?

A. To stabilize the fill supported portion of the Service Water Pump Structure (to eliminate cantilever action), the applicant originally planned to support the northern wall of the structure with 16-13" diameter concrete filled steel piles with 100 tons capacity each. Figures 20, 21, and 22 of Attachment-1 shows the plan view of the piles as well as the method of transferring vertical loads from the wall to the piles by a system of reinforced concrete corbels. The piles were to be driven in to the natural soil through pre-drilled holes in the compacted fill materials. This proposal was furnished to the NRC through 50.55(e) report (Interim report 6 dated 11 June 1979).

The Corps of Engineers reviewed the proposal, but because of insufficient information it could not evaluate the adequacy of the proposal. In its letter report of 7 July 1980 (Attachment-2), the Corps of Engineers requested the information required for the review. A brief description of the information required is as follows:

(a) Analysis for capacity of the piles against vertical as well as lateral loads.

(b) Engineering properties of the natural soils as well as compacted fill materials through which the piles were to be driven.

(c) An analysis for the negative skin friction on piles which were inevitable due to future settlement of the fill materials.

(d) Total actual load to be transmitted to the ground through the piles.

(e) Analysis for possible settlement that could occur between the pile supported end and the portion of the structure placed on natural material.

(f) Dynamic analysis of the 100 tons capacity piles.

The applicant's response to these requests was not satisfactory. The Corps of Engineers report of 15 April 1981 (Attachment-3) provides the details.

Q-7. What is the currently proposed remedial measures?

A. During the NRC structural audit in March 1981, the applicant gave an indication that it had revised its proposed remedial measures for the Service Water Pump Structure. Preliminary drawings for the new proposal were displayed during the audit, one in the first week of May 1981 and another on 17 September 1981, the applicant provided the following details:

The current remedial measures consists of providing a continuous 4' wide concrete underpinning wall under the outer walls of the fill supported portion of the Service Water Pump Structure. The foundation wall will be carried down from the underside of the existing foundation slab through the fill materials to the natural soil. Thus, the structure loads will be carried by the foundation walls to the natural soil without stressing the problem fill materials. The walls will be 30' high with a belled bottom of 6' width to distribute the load on larger area. The walls will be constructed in small sections from tunnels which will be advanced simultaneously from access shafts located at northeast and northwest corners of the building.

Q-8. Did Corps of Engineers review the currently proposed remedial measures, if so what were the results?

A. The information pertaining to the new remedial action furnished by the applicant in the May and September meetings at Bethesda, MD, and also transmitted officially to the Corps of Engineers were reviewed. The review comments are provided in the minutes of the 17 September meeting prepared by H.N. Singh of the Corps of Engineers, North Central Division, Chicago, Illinois (Attachment 4). A summary of the review comments are as follows:

(a) Bearing Capacity: Bearing capacity analysis and the corresponding shear strength parameters were neither discussed during the meetings nor provided in the applicant's submission of 26 August 1981, therefore, the adequacy of the foundation soil in shear failure could not be evaluated.

(b) Since the underpinning walls will be built in sequence of sections (See Attachment 5) and the initially built sections would be required to

support the weight of the overhang when the tunnels are advanced considerable distances from the access shafts, it is probable that sections (piers) 1 & 3 on either end of the north wall will be highly overloaded. This concern was expressed by the Corps and the NRC staff during the meeting of 17 September 1981 at Bethesda. The applicant has not demonstrated by analysis that foundation soil under these piers are safe against shear failure under the maximum probable load during the construction period.

(c) According to page 5, section 7 of the applicant's submission of 26 August 1981, it appears that the static structural analysis has not been completed. However, at the September meeting at Bethesda, when the applicant presented the preliminary details of its new proposal, it was stated by the applicant's consultant (Bechtel Corporation) that the structure has been analysed for static load representive soil media under the underpinning wall with springs of appropriate stiffness. The details of the spring constants were not presented. Therefore, the Corps of Engineers has not been able to review the details of soil stiffness used in the analysis.

(d) The dynamic spring constants were reported to be evaluated on the basis of the "Elastic Half Space Theory", but detailed analysis were not furnished. Therefore, the Corps has not been able to evaluate the dynamic stiffness of the soils.

9. Conclusions. Corps of Engineers has not evaluated the adequacy of the soils that are going to support the underpinning walls, because of the following information are still needed to complete the review:

(a) Report on soil exploration and testings performed by the Woodward-Clyde Consultants for the borings in the area of the Service Water Pump Structure.

(b) Bearing capacity analysis and the resulting factor of safety for the soils, under the underpinning walls, using the results of the tests preformed by Woodward-Clyde Consultants on samples taken from Boring COE-16.

(c) Bearing capacity analysis and factor of safety for the soils under the piers (piers located at northeast and southeast corners of the structure) that are subject to higher loads during normal plant operation period.

(d) Soil spring constants evaluation for static and dynamic load.

(e) An analysis showing that the soils under the main portion of the structure is adequate to support the additional loads likely to be brought upon them during construction period through building post-tensioning.