

July 29, 1982

Docket No. 50-409
LS05-82-07-071

Mr. Frank Linder
General Manager
Dairyland Power Cooperative
2615 East Avenue South
LaCrosse, Wisconsin 54601

Dear Mr. Linder:

SUBJECT: SEP SAFETY TOPIC II-4.F, SETTLEMENT OF FOUNDATIONS AND
BURIED EQUIPMENT - LACROSSE BOILING WATER REACTOR

Enclosed is a copy of our evaluation of Systematic Evaluation Program
Topic II-4.F, "Settlement of Foundations and Buried Equipment." This
assessment compares your site condition, as described in the Docket
and references with the criteria currently used by the regulatory staff
for licensing new facilities. Please inform us if your site condition
differs from the licensing basis assumed in our assessment.

Our review of this topic is complete and this evaluation will be a
basic input to the Integrated Safety Assessment for your facility,
unless you identify changes needed to reflect the existing site condition
at your facility. This topic assessment may be revised in the future
if your facility design is changed or if NRC criteria relating to this
topic are modified before the Integrated Assessment is completed.

Sincerely,

SEOY
DSU USE (38)
ADD: G. Staley
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Dennis M. Crutchfield, Chief
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Enclosure:
As stated

cc w/enclosure:
See next page

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DATE	7/22/82	7/24/82	7/26/82	7/26/82	7/26/82	7/28/82	7/28/82

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SYSTEMATIC EVALUATION PROGRAM TOPIC ASSESSMENT

TOPIC: II-4.F - SETTLEMENT OF STRUCTURES AND BURIED EQUIPMENT

PLANT NAME: LA CROSSE BOILING WATER REACTOR PLANT (LACBWR)

DOCKET NUMBER: 50-409

TAC NUMBER: 41269

Prepared by: Dr. Jerome R. Pearring, HGEB, GES

I. INTRODUCTION

This topic pertains to the Geotechnical Engineering Review of subsurface materials and foundations to assess the static and seismically induced settlement of critical structures and buried equipment.

II. REVIEW CRITERIA

The current criteria for review of this topic are contained in NUREG-0800, Standard Review Plan Section 2.5.4, "Stability of Subsurface Materials and Foundations."

III. RELATED SAFETY TOPICS AND INTERFACES

Geotechnical engineering aspects of slope stability are reviewed under Topic II-4.D. Other interface topics include:

- II.3.B, "Flooding Potential and Protective Requirements";
- II.3.C, "Safety-Related Water Supply (Ultimate Heat Sink)";
- II-4.E, "Dam Integrity";
- III.A, "Effects of High Water Level on Structures";
- III.C, "In-Service Inspection of Water Control Structures";
- III-6, "Seismic Design Considerations";
- IX-3, "Station Service and Cooling Water Systems"; and
- XVI, "Technical Specifications".

IV. REVIEW GUIDELINES

In general, the review process was conducted in accordance with the procedures described in Standard Review Plan (NUREG-0800) Section 2.5.4. The geotechnical engineering aspects of the design and as-constructed conditions of structures were reviewed and compared to current criteria, and the safety significance of any differences was evaluated.

V. TOPIC EVALUATION

The LaCrosse Boiling Water Reactor (LACBWR) site is located approximately 19 mi south of the City of LaCrosse, Wisconsin and approximately 1 mi south of the Village of Genoa, Wisconsin on the east bank of the Mississippi River. The Mississippi River Valley which is bordered by nearly vertical bluffs of flat lying sedimentary sandstone strata is approximately 2.6 mi wide at this location.

The main plant facilities include a reactor containment building, turbine building, 350 ft high stack, gas vault structure, diesel generator building, waste disposal building, crib house and a circulating water system. All of the facilities except the crib house and the circulating water system are supported on piles. Figure 1 presents a site location plan for the LACBWR plant facilities.

The approximate average plant grade is +639 ft msl. The LACBWR plant facilities are situated on 14 ft to 20 ft of fill sand and gravel materials which were hydraulically placed over 100-130 ft of glacio-fluvial deposits overlying bedrock. Borings indicate that the bedrock surface is sloping with an elevation of approximately +509 ft mean sea level (msl) in the area beneath the reactor building to an elevation of approximately +50 ft msl near the river. Recorded measurements indicate the ground water level to be at about elevation +626 ft msl (Ref. 1).

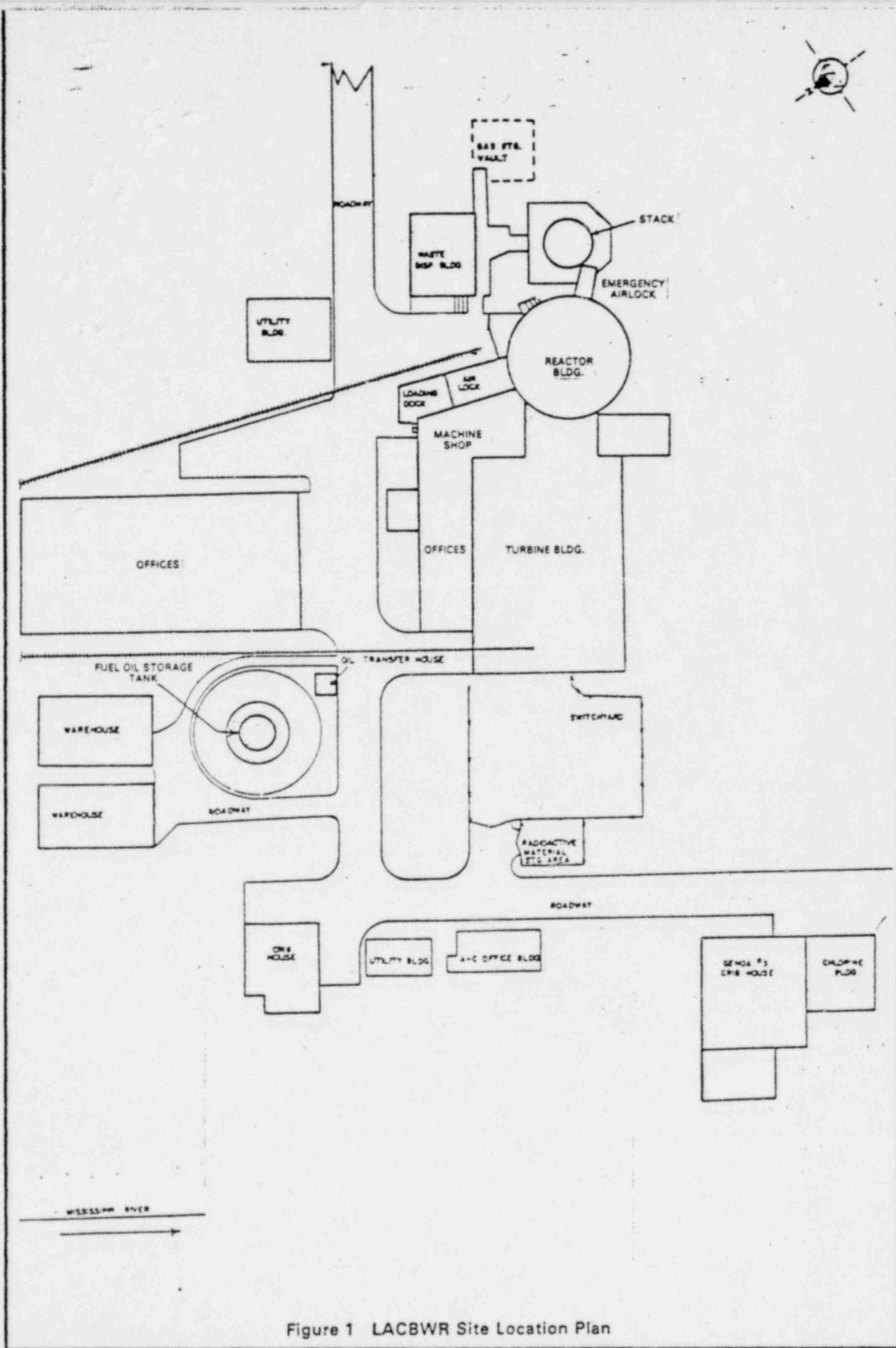


Figure 1 LACBWR Site Location Plan

Properties of Subsurface Materials

The initial soil investigations at the LaCrosse site were conducted in 1962. Between 1962 and 1980 soil test borings were made at 36 locations in the site vicinity. Of this number, five were associated with subsurface investigations in the power station area, four were associated with the switchyard area, and one was drilled to locate an offsite borrow area for construction fill materials. The remaining 23 were associated with subsurface investigations in the main plant facility area (see Fig. 2). The licensee has presented boring logs depicting the soil conditions encountered in these investigations (Refs. 1, 2, 3, & 4). Field investigation effort included standard penetration tests (SPT) and split-barrel sampling in accordance with ASTM D-1586-67 procedures. Relatively undisturbed samples were also obtained at several locations in thin walled tubes using an Osterberg piston sampler. Laboratory testing of soil samples was accomplished to determine index properties and to establish soil strength parameters. Testing included specific gravity determinations in accordance with ASTM D-854-58, particle size analysis testing in accordance with ASTM D-422-63, relative density determinations in accordance with ASTM D-2049-69 and cyclic triaxial testing in accordance with the procedures of NUREG-0031 (Ref. 5). A generalization of the site soil profile developed from the geotechnical investigations performed at the site is presented in Figure 3.

Static Settlement of Structures

The reactor containment structure, turbine building, diesel generator building, stack, waste disposal building and the gas vault are supported on cast-in-place concrete piles consisting of closed end 8-in diameter bottom steel shells driven to develop a 50-ton capacity and filled with concrete specified to have a minimum 28-day compressive strength of 3500 psi (Refs. 6, 7, 8). Using the data presented in References 6, 7, and 8, the staff has independently estimated the bearing capacity of the

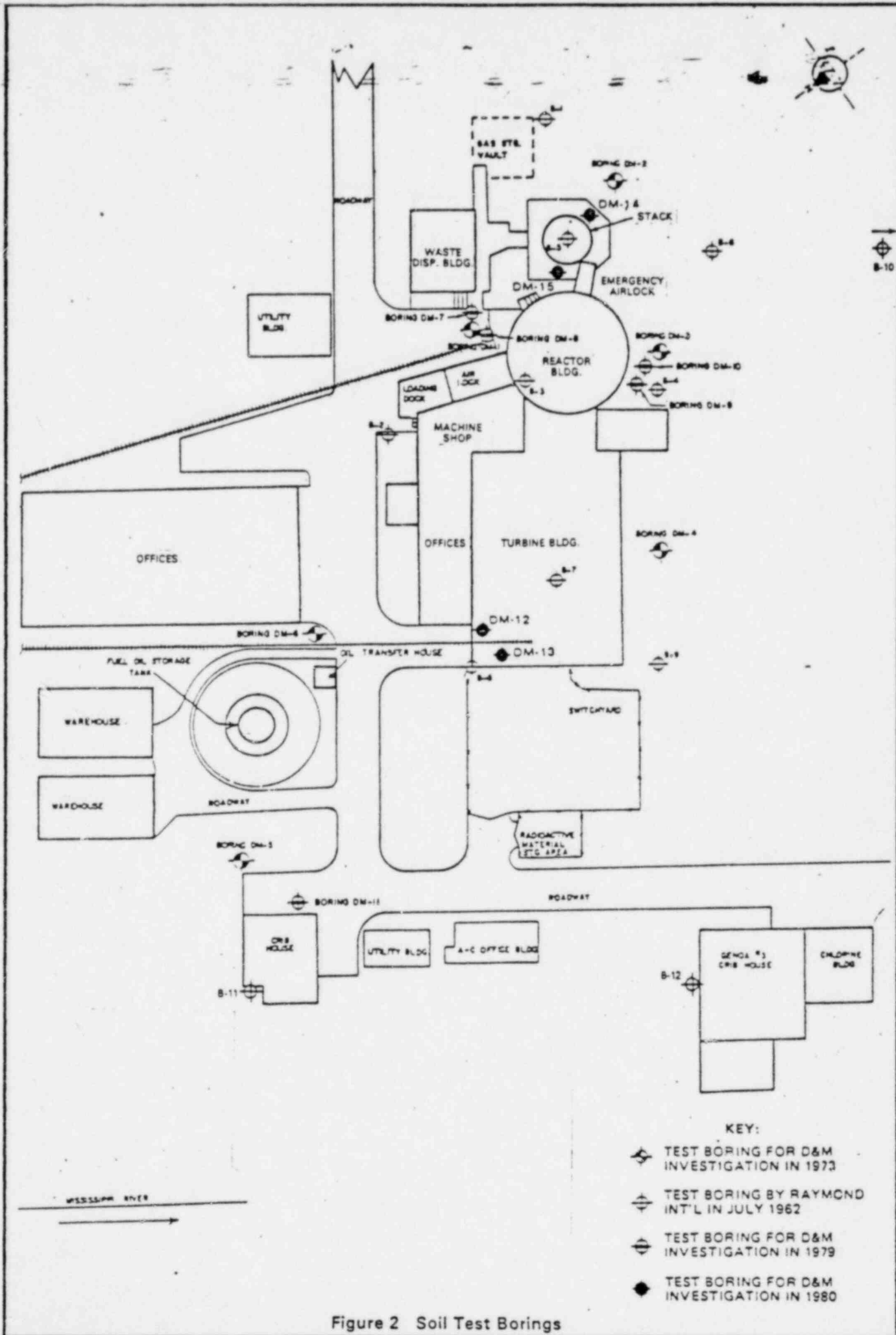


Figure 2 Soil Test Borings

inplace piles using the procedures of References 9 and 10. Results indicate that the piles can be expected to safely carry a loading of greater than 50 tons per pile without significant settlement under static loading conditions.

The crib house and associated water intake and discharge piping are not designated as seismic Category I structures. In February 1981, an emergency service water system was installed which utilizes portable pumps and hoses. The availability and design adequacy of the emergency service water supply system for seismic events has been reviewed by the staff which resulted in the issuance of a license amendment governing availability and surveillance (Ref. 11). The safety evaluation of "Safety-Related Water Supply" is addressed in SEP topic II.3.C.

There are no seismic Category I or safety-related electrical ducts, manholes, fuel lines or other structures or equipment supported on or buried in soil or rock at this plant other than the seismic Category I pile supported structures identified above (Ref. 12).

Liquefaction and Seismic Settlement

The safe shutdown earthquake (SSE) peak ground acceleration postulated for the LaCrosse site is 0.12g with an equivalent duration (NEQ) of 5 cycles. Results of standard penetration tests (SPT) undertaken by the licensee in 1980 show a range in N-values in clean sand below the water table beneath the turbine building of from 12-34 blows/ft. SPT N-values taken beneath the stack ranged from 23 to over 50 blows/ft (Ref. 4). Based on the staff's review of the site foundation conditions the borings under the turbine and stack foundations are considered representative for other adjacent structures that are pile supported including the reactor containment building.

Results of an NRC staff safety evaluation concerning liquefaction potential at the LaCrosse site were reported in August 1980 (Ref. 13). Based upon an evaluation of information provided by the licensee, the staff concluded in that report that the materials under the existing

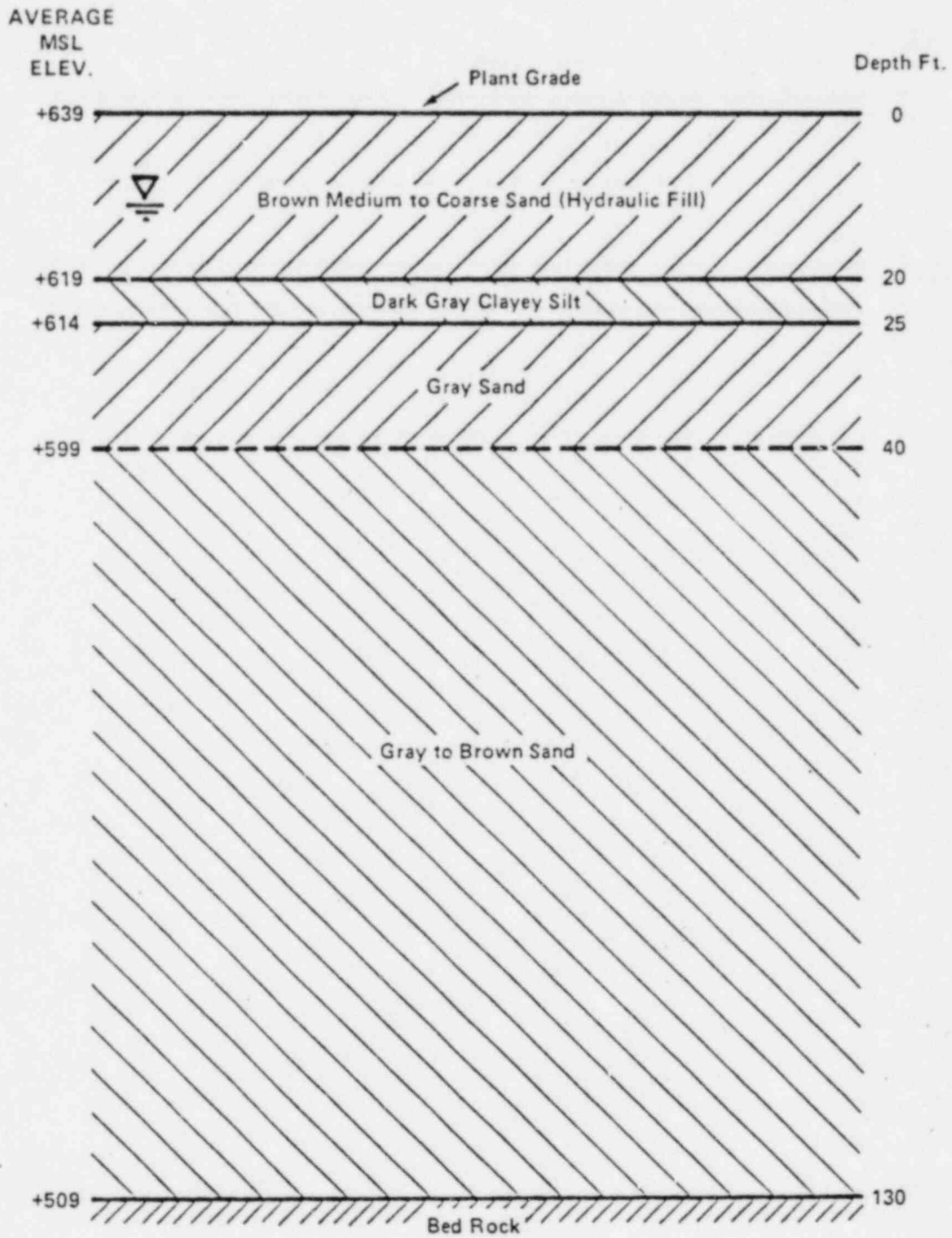


Figure 3 Generalized Soil Profile

turbine building, stack, and the reactor containment structure are adequately safe against liquefaction effects for an earthquake up to a magnitude 5.5 with a peak ground acceleration of 0.12g.

Based upon the information presented by the licensee that all plant seismic Category I structures are supported upon piles and the results of the staff's previous studies, the staff concludes that induced settlements of seismic Category I structures would not be significant under the postulated dynamic conditions.

Turbine Building Floor Support Grouting

In July 1980, borings drilled under the turbine building (Borings DM-12 and DM-13) encountered voids at several locations beneath the "on grade" concrete floor slab. In order to identify the lateral and vertical extent of the voids and to investigate potential for voids under other safety-related structures, the licensee accomplished an exploratory drilling program at the site. The licensee reports that results of the program indicate voids ranging in depths up to 10 in. existed only within the turbine building area (Ref. 14). Although voids of this relatively small size would not significantly effect lateral support to the 310 fifty to seventy ft long piles supporting the turbine building or the integrity of the overall turbine building pile foundation under dynamic loading conditions, the licensee accomplished an injection grouting program to fill the voids and restore continuous "on-grade" support to the turbine building concrete floor (Ref. 15). About 460 cu ft of grout was injected under a floor area of approximately 10,000 sq ft. The grouting program was completed on October 28, 1980.

VI. Conclusions

Based on the review of licensee's submittal and of other available referenced data, the staff concurs with the licensee's conclusion (Ref. 16) that the pile supported safety-related structures, systems and components are not expected to experience excessive settlements under static or dynamic conditions.

VII. References

1. Dairyland Power Cooperative - "Seismic Evaluation of the LaCrosse Boiling Water Reactor", January 11, 1974.
2. Dairyland Power Cooperative - "Soil Test Borings - Drawing No. L-475-2B", 22 June, 1962.
3. Dairyland Power Cooperative - "Liquefaction Potential at LaCrosse Boiling Water Reactor (LACBWR) Site Near Genoa, Vermon County, Wisconsin", September 28, 1979.
4. Dairyland Power Cooperative - "Final Assessment of Liquefaction Potential at LACBWR Site" July 25, 1980.
5. NUREG-0031, "Laboratory Triaxial Testing Procedures to Determine the Cyclic Strength of Soils: Final Report", Silver, M. L., June 1977.
6. Sargent and Lundy Report SL-2003 "Containment Vessel Pile Driving Operations for 50 Mwe Boiling Water Reactor at Genoa, Wisconsin," February 25, 1963.
7. Allis-Chalmers Report - "Generator Plant of LACBWR, Report of Pile Driving Operations, 60 MW Steam Turbo-Generator, Genoa, Wisconsin," 21 August 1963.
8. Allis-Chalmers Specifications 41-551 Revision 1 October 1, 1963 - "Specifications for Excavation, Piles, Erection Foundation and Backfill LACBWR Project - Reactor Plant."
9. Vesic, Aleksandar S. - "Design of Pile Foundations", National Cooperative Highway Research Program Number 42, Chapter 3, Transportation Research Board, National Research Council, Washington, D.C. - 1977.
10. Terzaghi, K. and Peck, R. B. - "Soil Mechanics in Engineering Practice" John Wiley & Sons Inc., N.Y. 1967.

11. License Amendment 24 to Provisional Operating License DPR-45, NRC Letter, Crutchfield to Linder, February 25, 1981.
12. Telephonic Conference Call - NRC staff and Dairyland Power Cooperative Representative Mr. David Rybarik, June 10, 1982.
13. NRC Letter, "Safety Evaluation by the office of Nuclear Reactor Regulation Relating to Liquefaction Potential at the LaCrosse Site," Denton to Linder, August 29, 1980.
14. Dairyland Power Cooperative Letter, Linder to Crutchfield, LAC-7131, September 9, 1980.
15. Dairyland Power Cooperative Letter, Linder to Crutchfield, LAC-7253, November 26, 1980.
16. Dairyland Power Cooperative Letter, Linder to Eisenhut, LAC-8146, March 9, 1982, Subject: "Dairyland Power Cooperative LaCrosse Boiling Water Reactor (LACBWR) Provisional Operating License No. DPR-45 SEP TOPIL II-4.F - Settlement of Foundations and Buried Equipment, and SEP TOPIC III-3.A - Effects of High Water Level on Structures."