

5.6.1
SUMMARY

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

PRESENTATION OF INVESTIGATION FINDINGS
OF THE
SETTLEMENT OF THE DIESEL GENERATOR BUILDING
AND PLANT AREA FILL

CONSUMERS POWER COMPANY

MIDLAND NUCLEAR POWER PLANT
UNITS 1 AND 2

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1. Scope of Investigation

The NRC Region III office performed an investigation to obtain information relating to design and construction activities affecting the Diesel Generator Building foundation and plant area fill and the activities involved in the identification and reporting of the settlement of the building.

The investigation consisted of 240 onsite hours by three NRC inspectors and included examination of pertinent records and procedures and interviews with personnel at the Midland Site, the Consumers Power Company offices in Jackson, Michigan, and the Bechtel Power Corporation offices in Ann Arbor, Michigan.

2. Identification and Reporting of Diesel Generator Building Settlement

Inspection Facts

- Bechtel surveyors first noticed unusual settlement on July 22, 1978, while performing routine survey measurements.
- The result of the survey with unusual settlement was routinely transmitted to Bechtel Engineering.
- Field Project Engineer instructed surveyors to recheck survey and perform survey more frequently. The building was monitored for about one month.
- Apparent settlement continued and when it exceeded the values presented in the FSAR, a nonconformance report was prepared on August 18, 1978.
- On or about August 21, 1978, the NRC Resident Inspector was informed of the settlement.
- After an exploratory boring program began on August 25, 1978, and preliminary data indicated deficient material, CPCo reported the incident under 10 CFR 50.55(e).
- Formal notification was made on September 29, 1978.

Conclusion

CPCo, after preliminary evaluation of the safety implications, notified the NRC in accordance with 10 CFR 50.55(e).

Finding

Compliance of 10 CFR 50.55(e), reportability requirements.

3. Review of PSAR/FSAR Commitments

Inspection Facts

- FSAR Tables 2.5-9 and 2.5-14 identified the type of foundation material to be controlled compacted cohesive (clay) fill.
- Bechtel Design Drawing C-45 (class 1 fill material areas) specify Zone 2 random fill as any material free of organics with no restrictions on gradation.
- FSAR Figure 2.5-48 (estimated ultimate settlements) indicates the Diesel Generator Building to be approximately 3 inches.
- FSAR Section 3.8.5.5 (structural acceptance criteria) indicates shallow spread footing foundation settlements to be 1/2 inch or less on compacted fill. The Diesel Generator Building had a shallow spread footing foundation.

Conclusions

- a. The FSAR did not accurately state the design basis or type of fill material supporting class 1 structures.
- b. The FSAR included conflicting values for the settlement of the Diesel Generating Building founded on spread footing.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion III (design control); failure to translate design basis as specified in the license application into instructions, procedures or drawings.

4. Effect of Ground Water on Plant Area Fill

Inspection Facts

- PSAR Amendment No. 1 and Dames and Moore report on foundation investigation indicates a planned drainage system to maintain the ground water level in the plant fill at elevation 603.
- PSAR Amendment No. 3 indicates this underdrainage system has been eliminated and the ground water is assumed to rise concurrently with the cooling pond to elevation 625.
- Bechtel consultant (Dr. Peck) has indicated that small changes in moisture content of the soil will probably result in increased compressibility.

Conclusion

It has not been fully determined whether the full effects of saturating the fill was taken into account in the design basis.

Finding

Unresolved matter pending licensee evaluation on the effects of permitting the ground water to rise in the plant area fill.

5. Compaction Requirements for Plant Area Fill

Inspection Facts

- PSAR Amendment No. 3 required the following compaction:
 - Clay - 100% of maximum density using a compactive energy of 20,000 ft-lbs (equivalent to 95% of maximum density using ASTM 1557 Method D with 56,000 ft-lb energy).
 - Sand - 85% relative density.
- Bechtel Specification C-210 requirements:
 - Clay - 95% of maximum density using ASTM 1557 Method D (same as PSAR)
 - Sand - 80% relative density (less than PSAR)
- Bechtel implemented requirements:
 - Clay - 95% of maximum using Bechtel Modified Test Method using 20,000 ft-lbs (less than that required by the PSAR and Specification).
 - Sand - 80% relative density (less than PSAR required but met Specification requirement).

Conclusions

- a. Bechtel translated PSAR compaction requirement for clay in construction specification, however, failed to follow requirement.
- b. Bechtel did not translate PSAR compaction requirement for sand to construction specification.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion V (procedures); failure to implement construction specification requirements.

6. Moisture Control Requirements for Plant Area Fill

Inspection Facts

- Bechtel Specification C-210 required moisture conditioning in the borrow areas such that the moisture prior to compaction was within plus or minus 2% of optimum moisture content.
- CFCo and Bechtel QA identified that the moisture control was not being implemented prior to compaction on July 22, 1977.
- No association was made with a laboratory compaction standard (i.e., optimum moisture-maximum density curve) prior to compaction.
- From July 22, 1977, until June 1, 1978, Bechtel project engineering failed to provide adequate direction for control of moisture content.

Conclusion

For all practical purposes, moisture control was not implemented prior to the settlement failure of the Diesel Generator Building.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion XVI (corrective action); failure to take corrective action in a timely manner.

7. Subgrade Preparation of Plant Area Fill

Inspection Facts

- PSAR Amendment No. 3 and Dames and Moore foundation investigation report indicated that if the construction schedule required foundation excavation to be left open during the winter that at least 3 1/2 feet of material be excavated before resumption of soils work or that same amount of cover material remain in place to prevent softening of subgrade soils due to frost action.
- Bechtel Specification C-210 only prohibited placement of soils frozen surfaces but did not include provision for frost protection or, removal of material prior to resumption of work.
- Correspondence indicates that approximately only 2 inches of frozen/thawed soil was removed prior to resumption of soils work.

Conclusions

- a. PSAR requirement was not translated into the specification for soils work to preclude placement of soil over subgrade effected by frost action.
- b. Soil was not protected from frost action nor removed prior to resuming work.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion III (design control); failure to translate requirements into instructions or procedures.

8. Nonconformance Reports Identified

Inspection Facts

- CPGO and Bechtel QA identified repeated nonconforming conditions in the following areas of soils work:

Failing compaction tests due to using incorrect maximum lab density.

Moisture control tolerance.

Inadequate inspection.

Violation of lift thickness.

Gradation tests not taken.

Gradation requirements not met.

Inadequate test frequency.

Foremen directing soils not familiar with specification requirements.

- The most frequently used engineering disposition was to accept "use as is" with or without sound engineering basis.

Conclusion

The root of the deficiencies was not adequately corrected to preclude continued degradation of the quality of a safety related activity.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion XVI (corrective action); failure to take adequate corrective action to preclude repetition.

9. Settlement Calculations for Plant Area Fill

Inspection Facts

- Bechtel settlement calculations for the Diesel Generator Building were based on a uniform mat foundation with a uniformly distributed load intensity of 3000 psf.
- FSAR Section 3.8.4.1.2 (Diesel Generator Building) indicates the foundation to be a spread footing type with a load intensity of 4000 psf with independent diesel generator pedestal.
- Borated water storage tanks are supported by a circular spread footing. The settlement calculations were based on a uniform circular mat foundation.
- FSAR Table 2.5-16 indicates the soil compressibility parameter to be 0.003 for the soil between elevation 603 and 634. Settlement calculations assumed an index of compressibility of 0.001.

Conclusion

The estimated settlement values for the Diesel Generator Building and Borated water tanks shown in FSAR Figure 2.5-48 were based on conditions that are at variance to existing conditions such as foundation type, load intensity and soil compressibility.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion III (design control); failure to translate design basis as specified in the license application into instructions, procedures or drawings.

10. Settlement of Administration Building Footings

Inspection Facts

- Administration Building was originally supported by Zone 2 random fill material.
- Administration building foundation material was tested to the same compaction requirements as class 1 fill.
- Administration Building foundation material was placed similar to class 1 fill; by hand held and motorized equipment.
- Backtel report identified basic cause of administration failure as being due to the result of repeated erroneous selection of laboratory compaction standard (i.e., incorrect selection of moisture-density standard for soil material being compacted).
- Only two borings were authorized to investigate the extent of the deficient soil outside the Administration Building area. Administration failure was then considered to be local condition.
- CFCo management (Corporate Project Engineer and Manager) were not properly informed of the Administration Building settlement.

Conclusions

- a. CFCo did not adequately investigate the extent of the soil deficiency in the rest of the class 1 fill.
- b. No program changes were implemented to preclude the continued erroneous selection of the laboratory compaction standard.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion XVI (corrective action); failure to take adequate corrective action to identify the extent of the deficiency nor preclude repetition.

11. Interface Between Diesel Generator Building and Electrical Duct Banks

Inspection Facts

- Bechtel Electrical Design Drawing E-502 includes a detail to provide separation between the duct banks and diesel generator footing (i.e., styrofoam bond breaker to permit settlement of the Diesel Generator independent of the duct banks).
- Bechtel Construction Drawing C-45 permits the use of random fill Zone 2.
- Correspondence from Bechtel engineering to field (December 27, 1974) permits the use of lean concrete as replacement for Zone 1 and 2 material.
- Bechtel field used concrete around electrical duct banks under the diesel generator footings.

Conclusion

Due to permitting the use of concrete indiscriminately as random fill the uniform settlement of the Diesel Generator Building was restricted in the areas of the duct banks.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion V (procedures); failure to provide adequate instructions to preclude the use of a material that would cause differential settlement.

12. Soils Placement and Inspection Activities

Inspection Facts

- Bechtel Design Criteria C-501 requires soils operations to be performed under technical supervision of a qualified soils engineer to verify all materials are placed and compacted in accordance with criteria.
- Labor foreman were directing soil operations relative to test locations, test frequency, compaction and moisture.
- Bechtel field and QC inspectors were rarely in the areas where soil operations took place.
- Accuracy of test locations were a chronic problem.
- Moisture was added to the soil after compaction if moisture test failed.

Conclusion

Personnel directing the soils operation were not trained in the area of soils work nor were they considered to be qualified soils engineers.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion II (Quality Assurance); failure to provide training to personnel performing safety related activities.

13. Inspection Procedures for Plant Fill

Inspection Facts

- Bachtel Procedure C-1.02 (compacted backfill) was written as a replacement for Procedures C-210-4 and C-211-1.
- Procedure C-1.02 relaxed certain inspection point to surveillance only. For example:

<u>Activity</u>	<u>Inspection Procedure</u>		
	<u>C-210-4</u>	<u>C-211-1</u>	<u>C-1.02</u>
Material Free of Organics	-	I	S(V)
Material Moisture Conditioned	S	I	S(V)
Material Not Frozen	-	I	S(V)
Compacted to Density	W	S	S(V)
Lift Thickness Required	W	I	S(V)

Conclusions

- a. Inspection procedures for soils work were relaxed from original procedural requirements to leaving insufficient mandatory hold points to ascertain backfill materials were installed to requirements.
- b. It was ascertained that surveillance was infrequent and inadequate to verify conformance.

Finding

Item of noncompliance with 10 CFR 50, Appendix B, Criterion X (inspection); failure to provide adequate inspection plans.

14. Final Conclusions

- There was inadequate control and supervision of plant fill material placement.
- Corrective action regarding nonconformance related to plant fill was either not taken or was inadequate.
- Certain design bases and construction specifications were not followed.
- Weaknesses exist in the interface between various components within the construction contractor's organization.
- The PSAR contains inconsistent, incorrect and unsupported statements.