

MEMORANDUM FOR: ACRS Members

FROM: C. P. Siess

SUBJECT: REPORT OF AD HOC SUBCOMMITTEE ON FOUNDATION PROBLEMS
AND REMEDIAL ACTIONS AT MIDLAND PLANT UNITS 1 AND 2

The Ad Hoc Subcommittee met in Washington, D.C. on 29 April 1982. Those in attendance were:

C. P. Siess, ACRS Member
W. M. Mathis, ACRS Member
R. J. Scavuzzo, Consultant
J. D. Osterberg, Consultant
Z. Zudans, Consultant

Presentations were made by the NRC Staff and the Consumers Power Company, Applicant.

The meeting was requested by the NRC Staff to discuss with the ACRS proposed remedial actions for soils-related structural settlement problems at the Midland site. The nature, scope, and status of the Staff's review of two to three year were highlighted. The NRC Staff has requested comments from the ACRS on the adequacy of the Staff requirements, and review of the remedial actions being taken or proposed by the Applicant.

Problem

Plant grade is at El. 634 feet. Good foundation material, of unquestioned capability is found at El. 595 to 600 feet. The containment buildings and a large portion of the auxiliary building are founded on the good material. The remaining Category 1 structures are founded on compacted fill material about 25 to 30 feet thick. This fill, consisting of both granular and cohesive materials, was inadequately compacted. It is extremely variable in density and ranges from reasonably good to extremely poor foundation material.

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The deficiency of the fill was discovered in July 1979 when the settlement of the partially completed diesel generator building reached about 7 to 8 inches, more than twice the expected settlement.

Potential Consequences

The potential consequences of the inadequately compacted fill material are:

- a. Excessive settlement of structures founded on it.
- b. Excessive settlement of piping, electrical ducts, and tanks buried in it.
- c. Liquefaction during a seismic event of those portions of the fill consisting of granular materials.

Affected Structures and Components

- a. Diesel Generator Building
- b. Auxiliary Building
 - Control tower
 - Electrical penetration areas
 - Feedwater isolation valve pits.
- c. Service Water Pump Structure
- d. Borated Water Storage Tank
- e. Underground Utilities
 - Service water piping
 - Borated water piping
 - Diesel fuel piping and storage tanks
 - Control room pressurization lines and tanks
 - Electrical duct banks

Remedial Actions

The remedial actions are of several kinds, as described in very general terms below:

- a. Underpinning to extend the foundation to the original soil. This is being done for the Service Water Pump Structure and portions of the Auxiliary Building (i.e. the Control Tower, the Electrical Penetration Areas and the Feedwater Isolation Valve Pits.)
- b. Surcharge to accelerate settlement and thus reduce future settlements. This is being done for the Diesel Generator Building and the Borated Water Storage Tank.
- c. Rebedding and/or replacing portions of the buried piping.
- d. Permanent dewatering of a major portion of the site to reduce the probability of liquefaction of the fill material due to an earthquake.
- e. Extensive monitoring of all affected structures and components, including those for which no remedial action is deemed necessary.

Seismic Considerations

The Midland Plant was designed for a SSE characterized by a zero-period acceleration of 0.12 g and a "modified" Housner spectrum. The modification consisted of increasing the acceleration in the regions between about 1.5 and 5 Hz.

More recently, Site Specific Response Spectra (SSRS) have been developed for the Midland Plant site. The SSRS being used to reevaluate seismic margins, and for the design of underpinning, yield accelerations up to twice those for the original spectra at frequencies above about 5 Hz. In this range, they correspond fairly closely to R.G. 1.60 spectra anchored at a zero-period acceleration of 0.12 g. For frequencies below 3 to 5 Hz the SSRS accelerations are less than those for either the original design spectra or the R.G. 1.60 spectra.

Some of the new construction (underpinning) was designed before the SSRS were decided upon. For the seismic response analysis of these structures, spectra corresponding to 1.5 times the "FSAR Spectra" were used. The Applicant has stated that these spectra envelope the SSRS.

With regard to liquefaction, it was stated that the "loose granular backfill supporting Seismic Category 1 facilities is safe against liquefaction for earthquakes that produce a peak ground surface acceleration of 0.19 g or less provided the groundwater elevation in the backfill is maintained at or below El. 610 ft." The permanent dewatering system will maintain the groundwater level at El. 595 ft. to provide margin to permit repair or replacement of the dewatering system if it should fail.

The seismic input criteria and the SSRS were not reviewed by the Ad Hoc Subcommittee at this meeting. We recommend that this be considered by the Midland Plant Subcommittee, especially with respect to the need for and criteria for dewatering to reduce the probability of liquefaction.

Findings

The NRC Staff's approach to the remedial measures is essentially to require that the corrected plant should comply with all regulations and licensing requirements; that is, that it should be as good as it would have been if it had been designed and constructed in accordance with all commitments in the FSAR. Within this framework, the NRC Staff has made a thorough review. We found essentially no aspects of the remedial actions that had not been considered by the Applicant or the Staff. The Staff's approach is typically conservative, in some cases perhaps overly so. The Staff's requirements for monitoring are elaborate and appropriately thorough.

Where the Staff had reason to believe that it did not have adequate expertise or experience in some of the specialized areas involved in evaluating the problem and the remedial measures, it has engaged consultants. Although there is some question whether the Staff and its consultants have the expertise and experience to judge the ability of the structures to serve their required functions with remedial measures short of those required to bring them into full compliance with the original criteria, requirements, and commitments, there is no question that they are adequately competent to achieve compliance with the licensing requirements.

We are reasonable confident, subject to resolution of the question of seismic input as it relates to soil liquefaction, that the remedial measures, if completed to the satisfaction of the NRC Staff, will restore the affected structures to an acceptable condition. We consider the monitoring programs to be important and believe that the NRC Staff's requirements are appropriate.

Overall, we find the Staff's approach and requirements to be adequate to insure no undue risk to the health and safety of the public. There was some feeling in the Subcommittee of "overkill" in some of the Staff's requirements. This, however, was probably the result of the Staff's attention to licensing criteria as opposed to an evaluation of the modification's contribution to risk or consequences.

Recommendations

We recommend:

1. That the Midland Plant Subcommittee review the adequacy of the seismic input criteria and the SSRS and its relation to the proposed permanent site dewatering as a means of reducing the probability of liquefaction due to an earthquake.
2. That, subject to a finding by the Midland Plant Subcommittee regarding the adequacy of the seismic input criteria, the ACRS recognize the adequacy of the NRC Staff's efforts as outlined in this report and consider the proposed remedial measures as a matter that can and should be resolved in a manner satisfactory to the NRC Staff.
3. That the EDO be informed at this time that the ACRS has found the Staff's approach to be acceptable, subject to the further review mentioned in item 1 above.

cc: ACRS Staff

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SECTION

1.7 Summary of Outstanding Items

As a result of the staff's safety review of the Midland plant OL application, a number of items remain open at this time. The lack of final detailed design information related to the soils problems has made it difficult for the staff to complete certain areas of the OL review. A number of open items, not necessarily related to the soils proceedings, remain outstanding because final staff positions have not yet been reached or because agreement between the staff and the applicant has not been reached. In several instances, additional information and/or commitments are needed from the applicant before the item can be resolved or reclassified as a confirmatory issue. Staff review of these items must be completed prior to a decision on issuance of an operating license. Final staff review and resolution of these items will be presented in one or more supplements to this report.

The outstanding open items, with appropriate references to subsections of this report, are listed below.

- STAFF (1) Nearby Explosive Hazards (2.2)
- STAFF (2) Turbine Missiles (3.5.1.3)
- STAFF (3) Tornado Missile Protection (3.5.2) *Burst of new-fuel storage area*
- APPLICANT* (4) Analysis of RCS and Core Components (3.9.2, 4.2.1.2, 4.2.1.3, 6.2.1.4)
- Some differences* (5) Soils Settlement Issue (2.4.4, 2.4.6, 2.5.2, 2.5.4, 3.7.1, 3.7.2, 3.7.3, 3.8.1, 3.8.2, 3.8.3, 3.8.4, 3.9.3)
- APPLICANT* (6) Seismic and Environmental Qualification of Equipment (3.10, 3.11)
- APPLICANT* (7) Natural Circulation Cooldown Analyses (5.4.2) ⁴
- APPLICANT* (8) HPI Line Makeup Nozzle Cracking (5.4.3.1)
- CONFLICT* (9) Reactor Vessel Head Vent (5.4.7)
- APPLICANT* (10) Secondary System Containment Valve Testing (6.2.6)
- APPLICANT* (11) Leak Testing of DHR and RBCWS Containment Valves (6.2.6)
- APPLICANT* (12) Appendix R (Fire Protection) (9.5.1) $\left\{ \begin{array}{l} \text{Safe S/D capability} \\ \text{Alternative S/D capability} \end{array} \right.$
- STAFF* (13) AFW Ring Header Distortion (10.4.9)
- INP/STAFF* (14) Emergency Preparedness Plan (13.3)
- APPLICANT* (15) Control Room Design Review (18.0)
- STAFF* (16) Shutdown Decay Heat Removal Requirements (10.4.9, Appendix C)

1.9 License Conditions

There are several issues for which a license condition may be desirable to ensure that staff requirements are met during plant operation. The license condition may be in the form of a condition in the body of the Operating Licenses, or a limiting condition for operation in the Technical Specifications appended to the licenses. These items, with appropriate references to subsections of this report, are listed below.

- (1) Groundwater Monitoring (2.4.6.4)
- (2) Itemized Documentation of Inadequate Core Cooling Instrumentation (4.4.4.1)
- (3) Testing of Relief and Safety Valves - II.D.1 (5.2.2.1)
- (4) Inservice Inspection Program (5.2.4)
- (5) AFW Level Control Details (5.5.3)
- (6) Postaccident Sampling - II.B.3 (6.1.1.3, 7.5.3, 9.3.4.3)
- (7) Control of Heavy Loads (9.1.5)
- (8) Secondary Water Chemistry Monitoring and Control Program (10.3.5)
- (9) B&W Plant Experience on Shift During Startup (13.1.2)
- (10) Emergency Operating Procedures per ATOG Program (13.5.2.3)
- (11) Small-Break LOCA Model (15.7.9)