STRUCTURAL EVALUATION OF THE DIESEL GENERATOR BUILDING - ASSESSMENT OF THE STRUCTURAL PERFORMANCE CAPABILITY AND SERVICEABILITY AS POTENTIALLY AFFECTED BY SETTLEMENT INDUCED CRACKING

TERA CORPORATION

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1.0 ABSTRACT

An engineering evaluation has been completed to assess the structural performance capability and serviceability of the Midland plant diesel generator building (DGB) as potentially affected by settlement induced cracking. The evaluation was initiated by TERA Corporation as part of the Midland Independent Design and Construction Verification Program (IDCVP). The performance requirements for the DGB were identified and the acceptance criteria for meeting these requirements were reviewed. Information generated by the Midland project as well as independent calculations and evaluations by the IDCVP review team serve as input to the conclusions of the engineering evaluation. It was concluded that the existing cracks, generally being of small size, are not indicative of a condition that would compromise the capability of the DGB in meeting its intended performance requirements.

Furthermore, it was judged that significant future cracking is unanticipated and the DGB is expected to remain serviceable without further remedial action at this time. Consumers Power Company (CPC) commitments to verify continued serviceability were reviewed and found to be acceptable. Certain recommendations have been offered for consideration that are intended to improve available information and reduce operational constraints.

2.0 OVERVIEW OF REVIEW PROCESS

This engineering evaluation was undertaken as part of a broader assessment of the quality of the design and constructed product of the Midland plant Standby Electric Power (SEP) system. The specific scope of review documented herein includes a structural evaluation of the diesel generator building (DGB), the structure which houses four emergency diesel generators which are principal components of the SEP system. The main emphasis of the review is on the civil/structural design considerations for the DGB and how settlement induced cracking may potentially affect the intended performance requirements. Accordingly, this evaluation addresses the following topics within the Midland IDCVP:

- Topic III.5-2 - Civil/Structural Design Considerations
- Topic III.6-2 - Foundations, and
- Topic III.7-2 - Concrete/Steel Design;

therefore, representing partial fulfillment of the structural design review scope pertaining to SEP system. This evaluation has required input from other ongoing topic reviews such as:

- Topic III.1-2 - Seismic Design/Input to Equipment, and
- Topic III.2-2 - Wind and Tornado Design/Missile Protection;

however, these evaluations are documented under separate covers. The DGB construction/installation documentation reviews and the associated physical verification have not been completed and are not documented in this evaluation. Accordingly, should the results of these evaluations affect the conclusions drawn herein, the engineering evaluation will be appropriately revised.

The review concept includes a determination of the DGB performance requirements and important design inputs (i.e. engineering data and assumptions); an evaluation of their accuracy, consistency, and adequacy; and an evaluation of the implementation of these commitments. Current licensing criteria are utilized as a baseline as well as consideration of various other regulatory criteria which evolved during the licensing process. Given the unique circumstances associated with the DGB design and construction processes, the IDCVP assessment used the intent of today's licensing criteria and corresponding margins of safety and reliability.

The review draws upon two principal sources of information; that generated by the Midland project (e.g. Bechtel calculations, consultant reports, testimony, etc.) and by the IDCVP review team (e.g. independent calculations and evaluations, etc.). Pertinent background data and references are documented in Section 3.0. Conclusions are reached through an integrated assessment of these data, discussions with Midland project personnel, as well as engineering judgement.

The following individuals made technical contributions to this engineering evaluation:

Dr. Jorma Arros	-	Structural Reviewer, Midland IDCVP and Senior Structural Engineer, TERA Corporation
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Mr. Howard Levin	-	Project Manager, Midland IDCVP and Manager, Engineering, TERA Corporation
Dr. Christian Mortgat	-	Lead Technical Reviewer, Standby Electric Power System Structural Review, Midland IDCVP and Principal Structural Engineer, TERA Corporation

The following chronology of external interactions transpired as part of this review.

Date	Activity
August 24, 1983	Review team members observe NRC task force meeting on structural rereview of DGB at Bechtel's Ann Arbor, Michigan offices.
November 17, 1983	Review team members inspect diesel-generator building.
November 18, 1983	Review team members discuss civil/structural design considerations for the DGB and collect information at Bechtel's Ann Arbor, Michigan offices.
December 12-16, 1983	Review team members review DGB finite element and seismic stick models at Bechtel's Ann Arbor, Michigan offices.

3.0 BACKGROUND DATA AND REFERENCES

The following table identifies references and sources of information that were selected for review and served as input to this engineering evaluation. The numbers in the left margin correspond to references made within the body of the engineering evaluation.

ATTACHMENT B, PI-3201-001, REV 2.

REFERENCES/SOURCES OF INFORMATION

TOPIC TITLE Civil/Structural Design Considerations, Foundations, Concrete/Structural Steel TOPIC NO. III.5-2, III.6-2, III.7-2 PAGE 1 OF 3

ENGINEERING EVALUATION Structural Eval. of the Diesel Generator Bldg CONT. ID. NO. 3201-001-031 REV 0 DATE 12/30/83

	ORIGINATING ORG./ AUTHOR	IDENTIFICATION/ NUMBER	REV.	DATE	TITLE	WHERE/HOW LOCATED	DOCUMENT TYPE
1.	Bechtel	File 0485.16/B1.3 Serial 22423	48	5/83	Final Safety Analysis Report	Ann Arbor	FSAR
2.	NRC	50-329/330	0	10/21 83	Report on the Review of the Diesel Generator Building - Midland	Docket	Report
3.	Bechtel	--	0	8/24/ 83	Midland Units 1 and 2 Diesel Gen. Bldg. Exec. Summary	Ann Arbor, 11/18/83 Meeting	
4.	Wiedner	testimony at pp 10804-11007	0	9/8/ 82	Testimony of Karl Wiedner for the Midland Plant Diesel Gen. Bldg.	Docket	Testimony
5.	CPC	File 0485.16, B3.0.3, Serial	0	6/17/ 82	Technical Report-Structural Stresses Induced by Differential	CPC, Jackson	Report
		17228			Settlement of the Diesel Generator Bldg.		
6.	CPC		3	9/79	Response to NRC regarding Plant Fill	Docket	Report
7.	ACI	ACI 318-77			Building Code Requirements for Reinforced Concrete	Library	Standard
8.	ACI	ACI 349-76			Code Requirements for Nuclear Safety Related Concrete Structures	Library	Standard
9.	TERA	PI-3201-009	3	7/15/ 83	Engineering Program Plan	IDCVP Proj. Files	Project Instruction
10.	Sozen	--	0	2/11/ 82	Eval. of the Effect on Structural Strength of Cracks in the Walls of	Transcript at 10950	Report
					the Diesel Generator Building		
11.	Peck	Testimony at p. 10180	0	12/6/ 82	Testimony of Ralph Peck	Transcript at 10180	Report
12.	Corley, et. al.	--	0	4/19/ 82	Effects of Cracks on Serviceability of Structures at Midland	Transcript at 11204	Report
					Plant		
13.	CPC	FSAR Ch. 16	45	9/82	Tech. Spec. 16.3/4.13 Settlement Monitoring	Ann Arbor	FSAR
14.	CPC	Exhibit 29R	0	--	DGB Areas for Crack Width Monitoring During Operation of the Plant	Ann Arbor, 11/18/83	Partial/ Corres.
						Meeting	
15.	Bechtel	DQ-52.0(Q)	2	9/9/ 83	Diesel Gen. Bldg. Reanalysis Using Revised Settlement Load Case	Ann Arbor	Calc

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REFERENCES/SOURCES OF INFORMATION

TOPIC TITLE Civil/Structural Design Considerations, Foundations, Concrete/Structural Steel TOPIC NO. III.5-2, III.6-2 III.7-2 PAGE 2 OF 3

ENGINEERING EVALUATION Structural Eval. of the Diesel Generator Bldg CONT. ID. NO. 3201-001-031 REV 0 DATE 12/30/83

	ORIGINATING ORG./ AUTHOR	IDENTIFICATION/ NUMBER	REV.	DATE	TITLE	WHERE/HOW LOCATED	DOCUMENT TYPE
16.	Bechtel	DQ-52.1(Q)	1	8/27/82	DGB Settlement Analysis - Load Case 1A	Ann Arbor	Calc
17.	Bechtel	DQ-52.2(Q)	0	5/12/82	DGB Settlement Analysis - Load Case 1B	Ann Arbor	Calc
18.	Bechtel	DQ-52.3(Q)	1	9/28/83	DGB Surcharge Condition (2A)	Ann Arbor	Calc
19.	Bechtel	DQ-52.4(Q)	0	6/28/82	DGB Settlement for 40 yr Life (2B)	Ann Arbor	Calc
20.	Bechtel	DQ-52.6(Q)	1	9/7/83	DGB Analysis for Uniform Torsion	Ann Arbor	Calc
21.	Bechtel	DQ-52.7(Q)	1	9/7/83	DGB Anal. Imposing 40 yr displacements	Ann Arbor	Calc
22.	Bechtel	DQ-12(Q)	1	4/15/83	DGB Reanalysis (including cracking of concrete)	Ann Arbor	Calc
23.	Bechtel	DQ-52.0-C7(Q)	0	5/18 82	Optcon ACI-349 - Nonseismic Load Cases 7-18 - Diesel Gen. Bldg. Settlement Analysis (partial)	Ann Arbor	Calc
24.	Bechtel	DQ-52.0-C2(Q)	0	5/47/82	DGB Load Combination (partial)	Ann Arbor	Calc
25.	Bechtel	DQ-52.2-C5(Q)	0	5/12/82	DGB Settlement Analysis - Load Case 1B - Free Body Analysis of Trial #3 (partial)	Ann Arbor	Calc
26.	Bechtel	DQ-52.3-C7(Q)	0	9/28/83	DGB - Settlement Case 2A - Free Body Analysis on Best Fit (Surcharge) (Partial)	Ann Arbor	Calc
27.	Bechtel	DQ-52.4-C4(Q)	0	5/12/82	DGB Analysis - Free Body Analysis of Best Fit 40-Year Case	Ann Arbor	Calc
28.	Bechtel	DQ-23-C4(Q)	0	12/11/81	DGB Roller Support (FSAR Criteria)	Ann Arbor	Calc
29.	Bechtel	S-110	1	11/11 82	Static & Dynamic Spring Constant of DGB for Structural Stress Anal.	Ann Arbor	Calc
30.	Bechtel	S-175	3	2/22/82	Update of Settlement Prediction DGB - After Surcharge Removal	Ann Arbor	Calc
31.	Bechtel	S-238	0	7/15/82	Settlement of DGB Between 9/14/79 and 12/31/2021	Ann Arbor	Calc

REFERENCES/SOURCES OF INFORMATION

TOPIC TITLE Civil/Structural Design Considerations, Foundations, Concrete/Structural Steel TOPIC NO. III.5-2, III.6-2 III.7-2 PAGE 3 OF 3

ENGINEERING EVALUATION Structural Eval. of the Diesel Generator Bldg CONT. ID. NO. 3201-001-031 REV 0 DATE 12/30/83

	ORIGINATING ORG./ AUTHOR	IDENTIFICATION/ NUMBER	REV.	DATE	TITLE	WHERE/HOW LOCATED	DOCUMENT TYPE
32.	Bechtel	SQ-147(Q)	1	5/2/83	Seismic Analysis of DGB and DG Pedestal	Ann Arbor	Calc
33.	Bechtel	DQ-52.11(Q)	0	9/9/83	DGB: Reduction of Settlement Data (Partial)	Ann Arbor	Calc
34.	Bechtel	SK-C-2343-1/24	F	12/5 83	Settlement Data for DGB	Ann Arbor	Drawing
35.	CPC	File 0485.16 Serial 18371	0	8/2/82	Midland Concrete Wall Repair Program	Att. 2 to Testimony of Corley @ p.11206	Letter
36.	NRC	50-329/330	0	9/29/81	Trip Report - Midland DGB Structural Design Audit	Docket	Report
37.	Neville	Lib. of Congress No. 72-12066	1	1975	Properties of Concrete	Library	Text Book
38.	TERA	3201-003-007	0	12/30/83	Structural Analysis of Diesel Generator Building	IDCVP Proj. Files	Calc
39.	Bechtel	DQ-14(Q)	1	8/12/83	Response to NRC Question 26 Re: Diesel Generator Building	Ann Arbor	Calc
40.	Bechtel	DQ-23(Q)	1	10/11/83	DGB Reanalysis (in support of public hearing testimony)	Ann Arbor	Calc

4.0 ACCEPTANCE CRITERIA

4.1 LOAD COMBINATIONS

The loads and load combinations employed for the original design and analysis were provided in the FSAR subsection 3.8.6.3 (revision 0, dated November 1977). These original design criteria did not contain settlement effects. Four additional loading combinations were established and committed for consideration as a result of Question 15 of the NRC Requests Regarding Plant Fill of September 1979. These loading combinations combined differential settlement with long-term operating loads and either wind or the operating basis earthquake (OBE). As Wiedner (reference 4) and CPC (reference 5) point out these expressions are more stringent than the requirements of ACI 318 (reference 7), but less stringent than ACI 349 (reference 8). In the latter case the loading combinations combine differential settlement with extreme loads such as tornadoes and the safe shutdown earthquake (SSE). Subsequently, in response to Question 26 of the NRC Requests Regarding Plant Fill, a commitment was made to undertake a separate structural reanalysis of the DGB in accordance with ACI-349 as supplemented by NRC Regulatory Guide 1.142 for comparison purpose only.

The following loads were considered in the reanalysis:

(a) dead loads (D)

(b) effects of settlement combined with creep, shrinkage and temperature (T)

(c) live loads (L)

(d) wind loads (W)

(e) tornado loads (W')

(f) OBE loads (E)

(g) SSE loads (E')

(h) thermal effects (T_o)

It is to be noted that thermal effects appear twice by virtue of the manner in which the loading combinations were developed. The load combination established and committed to in response to NRC Requests Regarding Plant Fill, Question 15 are as follows:

a. $1.05\ D + 1.28\ L + 1.05\ T$

b. $1.4\ D + 1.4\ T$

c. $1.0\ D + 1.0\ L + 1.0\ W + 1.0\ T$

d. $1.0\ D + 1.0\ L + 1.0\ E + 1.0\ T$

A number of load cases appearing in the load combinations for Seismic Category I structures listed in FSAR Subsection 3.8.6.3 do not occur in the diesel generator building and other load combinations can be eliminated from the analysis after comparison with more severe loads or load equations (reference 5). As a result the remaining load combinations to be considered are:

e. $1.4\ D + 1.7\ L$

f. $1.25\ (D + L + W) + 1.0\ T_o$

g. $1.4\ (D + L + E) + 1.0\ T_o$

h. $0.9\ D + 1.25\ E + 1.0\ T_o$

i. $1.0\ (D + L + E') + 1.0\ T_o$

j. $1.0\ (D + L + W') + 1.0\ T_o$

4.2 ALLOWABLE MATERIAL LIMITS

In accordance with regulatory requirements, the maximum rebar tensile stress allowed in the diesel generator building rebar should not exceed 0.90 f_y (where f_y equals yield strength) for computation of section capacities. Because the diesel generator building rebar has an f_y value of 60 ksi, the maximum allowable tensile rebar stress due to flexural and axial loads is 54.0 ksi. Accordingly, reinforced concrete section capacities for the diesel generator building were based on this maximum allowable rebar stress value (54 ksi), a design concrete compressive strength of 4000 psi and a maximum allowable concrete compressive strain level of 0.003 in./in.

5.0 BASES FOR SAMPLE SELECTION

The diesel generator building (DGB) was selected for review because it serves an important support function in providing protection against external hazards for the diesel generators which are integral components of the Standby Electric Power (SEP) System. The DGB falls within the sample selection boundaries defined in the Engineering Program Plan (reference 9). Commitments were made in this reference to review civil/structural design considerations for the DGB including foundations and concrete/steel design. Based on programmatic commitments, emphasis is to be placed on structural performance and not detailed soil mechanics aspects which are not within the scope of the Midland Independent Design and Construction Verification Program (IDCVP).

This engineering evaluation addresses the potential effects of settlement induced cracking on the ability of the DGB to meet its intended performance requirements. Accordingly, verification of the Midland project treatment of the settlement/cracking issues which have affected several structures at the Midland site is addressed herein. While a structural review of the auxiliary building is also within the IDCVP scope as part of the Auxiliary Feedwater (AFW) system review, the specific settlement/cracking issue as it may affect the auxiliary building is not being treated directly by the IDCVP. Thus, this evaluation of the DGB represents the IDCVP sample addressing the settlement/cracking issues.

It is estimated that approximately one third of the project's calculations and evaluations addressing the structural design of the DGB were selected for review. Emphasis was placed on the selection of portions of the project's evaluations that address controlling design conditions (e.g. important load combinations producing the highest predicted stresses or strains, as appropriate). Principal project consultant reports were reviewed as well as other docketed information that documents CPC commitments to the NRC (see section 3.0).

6.0 ENGINEERING EVALUATION

6.1 BUILDING PERFORMANCE REQUIREMENTS

The diesel generator building (DGB) is a two story reinforced concrete box type building partitioned into four bays, each bay containing one diese' powered electric generator (see Figure 6-1). The purpose of the diesel generators is to supply standby electrical power to operate the Midland plant during power outages and to provide the necessary power to ensure safe shutdown of the plant in the event of a design basis event. Accordingly, the diesel generators and the DGB are classified as Seismic Category I, and as a result must maintain functionability during external events such as earthquakes and tornadoes.

The DGB provides protection for the diesel generators and associated supply and service lines, instruments and equipment, assuring ready availability of this supplementary power source. This protective function includes not only the normal sheltering of building contents from rain, snow, wind, and ice, but in addition, resistance to the effects of earthquakes and tornadoes including tornado generated missiles. It is these latter effects which are of principal structural interest, and which dictate a more massive type of construction than normally would be employed for shelter from the commonly considered weather extremes.

The DGB was founded on plant fill and constructed between the Fall of 1977 and the Spring of 1979. During that period it was discovered that the building was experiencing an unusual rate of unequal settlement, and duct banks had made contact with the footings which led to building distortion and reinforced concrete cracking. The details of the settlement monitoring, duct structural modifications, and surcharge consolidation program are described in detail in references 3 and 5.

6.2 ACCEPTANCE CRITERIA

In response to applied loadings (dead, live, earthquake-induced, wind, tornado, tornado missiles) and certain secondary effects such as settlement, local internal forces are developed throughout the structure. These local forces consist of in-plane forces, sometimes termed membrane forces, and out-of-plane forces, i.e., transverse shear forces, and bending moments. In design it is customary for the internal forces associated with a particular loading to be multiplied by a specified "load factor" and these load factored sets must be combined for the several specified loadings to obtain what may be called a local internal demand. This demand must not exceed the local "strength", i.e., capacity of the structure. The acceptance criteria consists of the following:

- Statements of the several different load combinations that must be satisfied, and the load factors to be applied to each of the loadings (dead, live, tornado, etc.) within that combination.

- Specific expressions, or procedures, for determining the local strength which must not be exceeded.

It may be noted that certain of the specified load combinations focus on serviceability of the structure. These do not include the infrequent extreme loadings, but incorporate relatively large load factors to assure a modest demand/capacity ratio for (unfactored) loadings experienced in normal operating conditions. For the combinations which include extreme and rare loadings, safety in the sense of protecting personnel and equipment, yet retaining functionability, is the primary consideration rather than serviceability. Thus crack widths, including those widths which may reflect yielding of the tension rebars, are not a consideration provided that they do not imply a reduction in the local strengths. Accordingly, such specified factored load combinations typically incorporate smaller specified load factors. In effect a larger demand/capacity ratio for these unfactored load combinations is acceptable for these rare conditions.

It should be noted that the specified expressions, or procedures, for determining the local internal strength do not typically include any direct limitation on rebar tensile strain, or on crack widths which accompany such strain, although there are indirect limitations for certain conditic s. (Note that the limiting condition specified by various ACI codes (referenc s 7 and 8) are related to maximum allowable concrete compressive strains where a value of 0.003 in./in. is specified). This strain reflects the fact that certain components of local strength are not sensitive to rebar strain but only to the tensile yield strength of the rebars. As an example, full development of the local out-of-plane bending strength of a slab, or beam, with a modest rebar ratio may imply tensile rebar strain into the yield range. Indeed this is specifically recognized by codes which specify that, for rebar strains in excess of the elastic strain at yield stress the stress must be assumed to be constant at the yield stress value. This approach often is overlooked because, for the majority of local conditions of interest it is computationally much more convenient to evaluate local sections on the assumption that the steel strains remain within the elastic range, and to compute rebar stresses associated with the particular factored load combination demand rather than to compute the local section strength, per se. In some cases this approach is slightly conservative, but often there is no difference whatever. However, the fact that there are circumstances, where small tensile rebar strains into the yield range occur, yet are acceptable, and do not degrade the required local strength, may be unrecognized because of the focus on elastic behavior inherent in the computation process. Margins of strength, as reflected in codes, are implicitly based on the ductile behavior of structural systems as just noted.

6.2.1 Structural Primary Loadings

The DGB must resist the following principal primary loadings:

- Gravity- induced dead and live loads
- Earthquake- induced loads
- Tornado- induced differential air pressure
- Tornado- borne missiles

Gravity- induced loads produce out-of-plane shear forces and bending moments in the floor and roof systems and in portions of the walls immediately adjacent thereto. These loads also produce in-plane forces in the walls and, of course, bending moments and shear forces in the strip footings.

Earthquake- induced loads produce in-plane forces in the walls which are substantial, and more modest in-plane forces in floor and roof slabs. They also produce out-of-plane shear forces in floor and roof slabs and walls.

Tornadic winds produce in-plane and out-of-plane forces in walls and roofs. Tornado- induced differential air pressures are the principal source of out-of-plane shear forces and bending moments in floor systems and walls, and they also produce in-plane forces.

Tornado- borne missiles produce highly localized out-of-plane loading of the walls. The capacity of the wall to resist such missiles is evaluated independently of all other loadings.

6.2.2 Secondary Loadings

Restrained non-load-induced volume changes (e,g., due to concrete shrinkage and or temperature strains) may produce internal forces. It has long been recognized that these forces rarely have any significant effect on the local strengths, and in most cases they are neglected. The reasons relate directly to the ductility of the tension rebars. If the local strength is mobilized, by an imposed set of local demand forces, it typically will be the same whether or not the forces associated with the non-load induced effects are included. The difference will be that the tensile rebar strain,including some yield strain, will be larger when these secondary forces are luded. This yielding has the effect of decreasing, and sometimes completely eliminating, the local forces which were initialy introduced by the non-load effect. It is for this reason that the forces associated with such non-load induced effects often are termed "self-relieving" or secondary.

In the design of most reinforced concrete buildings the local internal forces arising from restrained shrinkage and thermal strains as well as that induced by settlement are not included in the application of the strength criteria. In the design of nuclear safety related concrete structures it is the accepted practice to account for through-the-wall thermal gradients, although shrinkage effects are not typically included. Even accounting for the thermal gradients is a conservative requirement the justification for which is at least debatable. However they were accounted for in the DGB design as required by the acceptance criteria. It may be noted that underlying codes, from which the acceptance criteria were developed, typically called for inclusion of these non-load-induced forces with the load-induced forces only where their structural effects may be significant. In the case of the DGB it may reasonably be debated whether such effects are indeed "significant", as envisioned by the code.

In the initial design of the DGB it would not reasonbly have been assumed that the forces associated with foundation settlement could be significant nor, that they should be included with the load-induced forces in the factored load combinations. Clearly, the building was designed for continuous support on what was intended to be a relatively homogeneous soil medium. Thus the designer could justifiably assume that there would be little if any redistribution of the upward soil reactions on the strip footings due to major point-to-point variations in local stiffness of the supporting medium. When the building was only partly completed it became evident that such stiffness variations did, in fact, exist i.e., a very stiff support at the location of footing contact with ducts, together with poorly consolidated soil (low in stiffness, and non-uniform) elsewhere. These conditions caused an extreme example of non-uniform settlement which did indeed induce internal forces sufficient to cause cracks in the walls of the then partially completed structure.

Upon noting that the settlement had led to interference between the foundation and buried ducts, the unintended footing-to-duct connections were physically disengaged and the unsatisfactory foundation condition was corrected by a surcharge loading procedure. It is to be noted (reference 36) that the surcharge loading procedure began on January 26, 1979, incrementally, and that construction of the DGB continued thereafter. The final surcharge placement took place between March 22, 1979 and April 7, 1979, just as the roof and parapet construction was completed. The subsequently completed DGB structure has been in place, in its completed condition for more than four years with no indications of additional distress in any way comparable to that associated with the footing-to-duct contact and the poorly consolidated soil. It may be argued that the structure now is supported as was intended at the time of design, that the effects of any future differential settlement will not be significant, and that the effects of such cracking as developed in the partially completed structure also are not significant to local internal strengths relied upon to resist the forces associated with applied load combinations. From all this it would naturally follow that the internal forces induced by differential settlements need not necessarily be included with the load-induced forces in the combinations specified by the acceptance criteria. These arguments may be justified but, in fact, there is a licensing commitment to include the settlement-induced forces in the relevant load combinations.

Since the internal forces induced by a specific non-uniform settlement are self-relieving (as was described earlier, for thermally induced forces), why must they be included; i.e., when may their effects be "significant". In some structures the magnitude of possible future settlement may be uncertain, and there may be little or no prospect for monitoring of the settlement or the state of the structure during its service life. Accordingly, inclusion of settlement-induced forces in the design would be appropriate to limit the possible development of structural distress which would be costly to repair, or which in some special cases, like a containment structure, may affect functionability by creation of large liner strains. For other structures these forces might prudently be included to avoid excessive yield strains in the tension rebars (and the associated large crack widths) which might degrade the local internal strength under some set of the local internal forces associated with applied loads, particularly if no monitoring of the structure for such effects could be anticipated.

For the DGB structure the principal structural elements are relatively accessible, and a monitoring program is planned. Nevertheless it is required to demonstrate by application of the relevant acceptance criteria, including the effects of differential settlement, that the local internal strengths are not presently degraded and are unlikely to be degraded by any probable future differential settlements. The acceptance criteria do not include any specification of the method by which the associated internal forces are to be determined. This is an important consideration in any effort to apply the acceptance criteria. There are essentialy three alternatives:

a) One may assume a magnitude and distribution of differential settlement and impose this displacement pattern upon the structure. In contrast to the situation at the design stage the analyst for the DGB has settlement measurements to consider in arriving at the postulated differential settlements to be used.

b) One may postulate one or more perturbations of the distribution of upward soil reactions associated with dead load which may be associated with differential settlement, and determine the local internal forces for each. It will be apparent that this approach produces the forces due to dead loads plus differential settlement. This is not an unreasonable approach, if sufficient attention is given to parametric variations, particularly if the analyst lacks data on differential settlement which he considers sufficiently precise to use directly in method (a).

c) One may postulate the local internal forces directly from the observed condition of an (existing) structure; i.e., the crack widths in the DGB. This is an option clearly not available at the time of design.

The method of imposed differential settlements may lead to unrealistically large internal forces unless the analysis can account for cracking, and time-dependent concrete properties. The cost-benefit of such an analysis may not be justified, particularly if other suitable options (b or c) exist.

The method of analyzing the dead load condition for several postulated distributions of soil reaction is suitable, but it may be difficult to choose sets of distributions which cover the possible differential settlements but which are not unjustifiably extreme.

For the DGB, which has been observed in its completed state for more than four years, inference of the internal local forces from the condition of the existing structure (c) seems to be the most attractive approach. It is the most direct. It is particularly attractive since any significant changes in the condition of the structure will be observable during its service life. Observations related to this approach follow.

6.3 EVALUATION OF BUILDING PERFORMANCE CAPABILITY

The performance capability of the structure is to be assessed in two steps: the first one considering the building in its present state and the other addressing its structural integrity and serviceability over the next 40 years. Inputs to the evaluation are keyed to a number of elements such as: available physical data, analytical studies, understanding of concrete behavior and engineering judgement.

6.3.1 Available Data

The most important data available to estimate the present state of stress in the DGB consists of:

1. Observations of the building as it exists today.
2. The record of the crack monitoring program.
3. The settlement history of the building.

The cracks have been surveyed on several occasions (Reference 3). The maximum crack width recorded during the monitoring program prior to isolation of the duct banks was 28 mils. After the isolation of the duct banks, the cracks decreased in size (testimony Peck and Weidner references 11 and 4 respectively) implying a stress decrease in the higher stressed areas. Presently the largest cracks are of the order of 20 mils. An evaluation of the existing cracks has been performed by two Bechtel consultants, Dr. Mete Sozen (reference 10) of the University of Illinois and Dr. W. Gene Corley (reference 12) of the Portland Cement Association.

The building settlements have been monitored at close intervals during the construction period and thereafter. Figure 6-2 presents the location of the settlement markers indicating where survey measurements are taken. The data spans over a period of 5 years with measurements taken approximately every other week. This large amount of data allows one to follow the settlement history through the stages of construction, duct bank isolation, surcharge period, dewatering, and up through the present. It also provides a means of assessing potential random and systematic errors in the measurements. The Midland project has concluded that significant errors exist in the measurements due to a variety of circumstances. A study of these data is presented in the following section.

6.3.2 Midland Project Evaluations

The Midland project followed two separate approaches to estimate the state of stress in the building:

- study of the cracking history
- study of the settlement history.

The future state of stress due to settlement was estimated based upon predicted settlements.

6.3.2.1 Evaluation of DGB Based on Observed Cracking

In its present condition the DGB has cracks which appear to be settlement-induced or settlement-intensified, generally arising during the early construction phases. Maximum present crack widths are reported to be about 20 mils, and Dr. Sozen (reference 10) has shown that the associated rebar stress as estimated in a region of numerous cracks, adjacent to a duct bank penetration of the center wall, may be judged to be between 20 and 30 ksi. We find his evaluation to be reasonable incorporating techniques that are state of the art, widely accepted and supported by laboratory tests. Dr. Sozen also has argued that the presence of initial cracks does not degrade the capacity of a reinforced concrete element in any of the important structural modes; i.e., direct tension force, direct compression force, in-plane shear force, and out-of-plane bending. Again, we agree with Dr. Sozen that precracks of the width thus far evidenced in the walls of the Midland DGB would not significantly degrade capacities in the several modes developed by the principal loadings, and in their required factored combinations.

Dr. Sozen did not specifically address the possible influence of an initial rebar stress which is associated with a self-relieving internal force, that is, a force caused by foundation settlement. He does not indicate his opinion whether or not the self-relieving internal force implied by the initial rebar stress should be included with the internal forces due to applied loadings or can be neglected because it is self-relieving. It is our understanding that the Bechtel evaluations of the DGB for the effects of dead load plus foundation settlement did not utilize the initial rebar stress magnitude estimated by Dr. Sozen but rather computed it based on the settlement history of the building.

6.3.2.2 Evaluation of DGB Based on Settlement History

The settlement effects were modeled by Bechtel into the structure considering four distinct time periods. Measured or estimated settlement values corresponding to each of the time periods were used:

- Case IA: 3/28/78 to 8/15/78 (Structure partially completed to elevation 656.5') - A long hand calculation was used to determine the stresses due to early settlements. The structure was assumed fully cracked and the stresses in the reinforcing steel were assessed based upon local strains corresponding to an imposed differential settlement (reference 16).

- Case IB: 8/15/78 to 1/5/79 (Structure partially completed to elevation 662.'0.) - The duct banks were seperated from the structure which caused the north wall to settle rapidly. (reference 17)

- Case 2A: 1/5/79 to 8/3/79 (Structure in process of completion.)- Surcharge period. (reference 18)

- Case 2B: Forty year settlement composed of:

  - measured settlements from 8/3/79 to 12/31/81, and

  - predicted secondary consolidation settlement from 12/31/81 to 12/31/2025. (reference 19)

The last three analyses used a finite element model having stiffness corresponding to an uncracked condition. In these analyses the foundation stiffnesses have been varied, in an iterative process, to achieve final settlements approximating a set of target settlements. These target settlements were based upon a linear best fit through the measured settlement data. The analyses have been criticized (reference 2) because the analytically predicted settlements do not match variations in the measured settlements. It is appropriate to ask whether the iterated non-linear foundation stiffnesses are realistic since the target settlements were not the measured settlements but a linear best fit, essentially assuming rigid motion of the North and South walls. The best fit data were utilized in an attempt to deal with scatter in the measured data. Such scatter potentially due to either random or systematic errors was estimated to be of the order of plus or minus 0.125 inches.

In our opinion the described method of accounting for foundation stiffnesses utilizing the linear best fit data may not be satisfactory for correlation with observed cracking in relation to differential settlement. We concur that settlement measurements may not be of sufficient accuracy to permit a precision computation of settlement-induced internal forces. Furthermore, the marker locations are spaced at wider intervals than would be desirable as input to analyses of building strains. Nevertheless, the general level of stress implied by the magnitude of cracking is not in contradiction to that which may be derived from the measured settlement data, realistically accounting for flexibility including consideration of phenomena such as creep (see section

6.3.3 for a more detailed discussion). As discussed in Section 6.2.2, an exact determination of secondary stress levels is of lesser importance given the nature of the loading and the fact that capacity is not adversely affected.

In separate sensitivity studies Bechtel engineers considered among others, the two following cases:

- The zero spring condition analysis (reference 3) which investigated the structure's ability to span any soft soil condition. A zero soil spring value was used at the junction of the south wall and east center wall. Soil values were increased linearly back to their original value within a distance of approximately 15 feet from the zero spring. The stresses in the building underwent moderate increase in the area of the bridging. In our judgement this is a reasonable approach, but one may ask whether the size and locations of such postulated "soft" zones were bounding.

- The imposed 40 year settlement analysis (reference 21) which forced the building to match the predicted settlement values at 10 points along the foundation. This analysis led to very large reaction forces at the points of imposed settlements, and some of these acted downward on the structure, i.e., implying tensions in the soil, which is not possible. Moreover, the analysis indicated very large rebar tensile stresses, where at several points a multiple of the yield strength was indicated. Of course the structure does not display the very wide cracks which would accompany such high stresses. For these reasons Bechtel engineers concluded that the settlement measurements cannot be an accurate representation of the actual settlement nonuniformities.

We have noted that the settlement data may not be an adequate basis for computing settlement effects. However, we believe the described analysis exaggerates the effects of the displacement input data which was questioned by the project. Our reasons are that the analysis assumed uncracked concrete and used the short-term concrete modulus of elasticity. Appropriate reduction of the concrete modulus, to reflect creep under sustained loading, would have lead to reactions and internal forces perhaps 50 percent less than were obtained. Decreases in stiffness associated with concrete cracking could result in additional large reductions. An excellent discussion of the physical and engineering significance of creep is found in chapter 6 of reference 37.

Perhaps more important, rebar stresses appear to have been computed on the assumption that the local internal tensile forces developed in the uncracked concrete are unreduced by cracking, i.e., this unreduced force is imposed on the rebars. In our judgment this is not the best physical representation. The rebar stresses are expected to be more nearly indicated by the local strains in the concrete (uncracked) than by the forces in the concrete (uncracked). Thus, the rebar stresses are better approximated by the product of steel modulus and concrete strain (uncracked); i.e., by the product of modular ratio, n, (Youngs modulus of the steel/Youngs modulus of the concrete) and concrete stress.

$$f_s \cong n\, f_c$$

in contrast we believe that the following expression was used

$$f_s \cong \frac{1}{p} f_c$$

where p is the reinforcement ratio (rebar area/section area). This later expression greatly overestimates rebar stress. To illustrate, for p = 0.0043 and n = 8, the suggested approach gives rebar stress about 1/30 of the Bechtel computed value. While reality is likely in between, and the former expression is approximate, we believe that it is a closer representation of the existing situation.

6.3.3 IDCVP EVALUATIONS

In addition to reviewing the information generated by the project and the studies performed by others, the IDCVP concentrated attention on two major elements in the review process:

- Observations of the building and its present state of cracking, and

- The settlement history of the building.
  - Settlement data
  - Gross stress estimation

6.3.3.1 Building Inspection

A careful inspection of the building was performed together with a review of the crack mapping data. As it exists at present, many cracks of small size are evident in the building but there is no evidence to support that these cracks are indicative of a high state of stress in the building and degraded capacity. Past experience and laboratory tests indicate that concrete elements in a state of distress -particularly stiff shear walls of the type in the DGB - exhibit large deformations and cracks, much greater than present in the DGB. This would probably be accompanied by scabbing and other phenomena which are not apparent in the DGB.

Our conclusion from visual inspection of the building is that its state of stress is low and would not impair its performance and functionability. A body of relevant information developed in industry, university and government programs and structural experience supports this conclusion.

6.3.3.2 Settlement Data

A study of the settlement data recorded between 11/24/78 and 8/28/80 is presented in reference 5. We reproduced and expanded this analysis to include the most recent data (reference 38). The two time periods covered were from

5/12/78 to 9/14/79 (reference 33) and 9/14/79 to 8/23/83 (reference 34). Our goal was two fold: (1) assess the overall deformation of the building with time and (2) estimate the random error present in any one set of measurements. We studied the following data.

1. Cumulative settlement recorded overtime.

2. Incremental settlement between successive readings.

3. A measure of the curvature between any three consecutive markers along the foundation as it varies with time. The curvature d''_i at marker i is defined as:

   $$d''_i = 0.5\,(d_{i-1} + d_{i+1}) - d_i$$

   where d_i is the total settlement.

   The quantity d" equals zero when the three points are on a straight line; it remains constant in time if the three points move as a rigid body.

4. A measure of the deformation of the building with respect to its rigid body motion. The rigid body motion is "removed" by computing the vertical position of all markers with respect to the plane defined by three corner markers. This analysis was done both for each incremental reading and cumulatively.

An upper limit of the random error in any set of readings is given by the maximum difference of incremental settlement between any two markers from one reading time to the next. When the building has not experienced any settlement between two readings, this quantity is the random error; it bounds it otherwise. At the beginning of the record, this quantity is large where the building was undergoing large differential settlements and reading accuracy might have been reduced by marker transfer necessitated by the placement of surcharge. However, this quantity decreases rapidly and after June 1979 is never greater than 0.150". After the removal of the surcharge for the readings starting 9/19/79 which we will refer to as the recent readings, the random error is smaller than 0.125", 95 percent of the time which would give a random error of about ± 1/16 of an inch. This implies that a higher level of confidence can be given to the recent measurements.

Jumps in readings from one period to the next are sometimes large implying that the building would rapidly move up or down by a uniform amount. These jumps are attributed to systematic errors in locating the reference elevation.

Figure 6-3 shows the incremental settlement for 6 time periods between July 1978 and August 1979 for the south wall of the DGB. The first three measurements show large differential deformations and introduction of curvature in the wall. The latter ones show stabilization of differential settlements implying that the wall is still settling but as a rigid unit, introducing little additional in-plane bending. For more recent recordings the stabilizing trend is even more noticeable. Study of the foundation curvature variation and deformation of the building with respect to its rigid body motion point toward the same trend. This is supported by an evaluation discussed in reference 4, where it was noted that the settlements occurring during the time periods represented by lines c and d (reference 4, figure DGB-7), were those that are expected of a rigid body. In figure DGB-7, line c represents settlement during the surcharging period (1/79 - 8/79) and line d represents estimated settlement during the post-surcharge period (9/79 - 12/2025). The point here is that the early cracking occurred when the building was only partially completed. Upon completion, the five sided (four walls and a roof) structure is now responding as a stiffer, essentially rigid body as would be expected.

Hence during its construction stage, the building underwent substantial differential settlement that introduced in-plane curvature in the walls with resulting stress and cracking compounded with normal shrinkage cracking. As the building was completed and the concrete aged, its tended to behave more and more as a rigid unit, the whole foundation (or building) moving as a plane (or a unit). The recent data indicates that for the last four years the building has generally settled as a rigid body introducing relatively little additional distortion in the structure. We expect this behavior to persist in time.

One may speculate on the magnitude of the absolute settlements over the service life; however, these are of lesser structural concern to the building itself, and would only affect clearance to obstructions and connected items.

These latter elements can accommodate some degree of distortion and can be modified in the future if warranted.

6.3.3.3 Gross Stress Estimation

Even though we have noted that settlement data may not provide an acceptable basis for computing settlement effects, it is our opinion that if credit had been taken to account for:

- creep and stress relaxation in young concrete,
- reduced stiffness associated with the geometry of the uncompleted structure
- stiffness reduction due to cracking

the exact recorded settlement could have been imposed on the structure without generating stresses in gross contradiction to that observed via crack patterns in the DGB. This would have qualitative value to an overall understanding of building behavior.

In order to improve our understanding of building behavior and to generally qualify the influence of these effects, we modeled the north and south walls of the building using a simplified finite element model (reference 38). As a first order check of our partial model, we reproduced the 40 year imposed settlement analysis performed by Bechtel on the uncracked structure. We obtained stresses within 25 percent of Bechtel's which is reasonable considering the simplified model we used.

We imposed the recorded settlements on the incomplete wall for Case 1A and 1B and on the complete wall for Case 2B. For cracked concrete, the stresses were computed as described in Section 6.3.2.2.

The following approximate maximum values of stress were obtained:

LOADING	STEEL (ksi)
CASE IA	11.3
CASE IB	3.5
CASE 2A	4.6

This leads to a total stress of 19.4 ksi which is in good agreement with Dr. Sozen's independent analysis (see section 6.3.2.1 and reference 10).

We recognize that the above analysis represents a simplified approximation of the very complicated effects of creep and cracking but it provides a qualitative estimate of the state of stress of the building.

We believe the results of our analyses, properly interpreted are both useful and positive, specifically.

- When modified for the effect of concrete creep and concrete cracking the foundation reactions when combined with reactions due to dead load, would not imply a physically impossible state of tension stress in the soil.
- When the rebar tension stresses are properly determined, that is on the basis of strain in the uncracked concrete rather than on the basis of stress in the uncracked concrete, they are quite modest rather than unrealistically large.

6.3.4 IDCVP Assessment/Interpretation of Results

In our opinion the settlement-induced internal forces implied by the associated rebar stresses, as they presently exist in the Midland DGB will not degrade the capacities to resist the internal forces and moments caused by the factored load combinations and therefore the DGB is expected to meet its intended performance requirements. There is reason to believe as supported by recent observations, that the completed building is settling as a rigid unit based upon the stabilized foundation properties. In this mode, the DGB capacity is not expected to be compromised over time. We believe that the settlement-induced, self-relieving, internal forces implied by the present crack widths and associated rebar stresses could safely be ignored in evaluating the building. However, licensing criteria include certain load combinations in which it is specifically required to include the settlement-induced internal forces. Based upon our knowledge of available margins associated with controlling load combinations, we believe that compliance with these criteria can generally be demonstrated, appropriately accounting for creep, relaxation and other phenomena; however, we do not endorse such an endeavor because of the secondary nature of the settlement induced loads and the fact that capacity is unaffected.

6.4 SERVICEABILITY, FUTURE CAPABILITY, AND MONITORING

The previous sections address the significance of settlement induced cracking on the performance capability of the DGB in its current condition. It is important that the DGB continue to meet specified performance requirements over its service life; hence, this section addresses serviceability of the DGB and any actions that may be necessary to identify and mitigate potential future conditions which could compromise the DGB performance.

6.4.1 Midland Project Evaluations and Commitments

The effects of cracks on the serviceability of Midland plant structures were addressed in reference 12. Three principal issues were evaluated:

- Freezing and thawing resistance,
- Chemical attack, and
- Corrosion of reinforcement

It was concluded in reference 12 that observed cracks are not expected to have a significant influence on the durability of the DGB. Accordingly, remedial measures such as epoxy injection were considered unnecessary to ensure long term performance capability. Nevertheless, CPC committed (reference 35) to repair existing cracks which are 20 mils and larger (up to a point in length where the crack remains 10 mils or larger) by epoxy injection and application of a concrete sealant to accessible surfaces.

A Technical Specification (TS) 16.3/4.13 (reference 13) has been proposed to monitor settlement over the service life of the DGB. The specification requires that the total settlement be measured (to nearest 0.01 foot) at least once every 90 days for the first year of operation. The frequency for subsequent years has been left for future determination. The total allowable settlement corresponding to predictions for the service life (12/31/81 thru 12/31/2025) has been specified at 12 markers. Engineering evaluations are required if total settlement reaches 80% of the allowable values (Alert Limit). Additionally, the inspection frequency is to be increased to once every 60 days if the 80% level has been reached.

If the DGB exceeds total allowable settlements, the plant must initiate actions to be in cold shutdown within 30 hours (Action Limit).

CPC has also committed to conduct a crack width monitoring program (reference 14) which includes individual crack width and cumulative crack width measurements at 3 locations over a 10 foot gage length. This program will be conducted once every year for the first five years of operation and at five year intervals thereafter. The following criteria apply:

	Alert Limit	Action Limit
single crack	50 mils	60 mils
cumulative cracks (over 10' gage length)	150 mils	200 mills

identical actions as defined in T.S. 16.3/4.13 are required if these limits are reached.

6.4.2 IDCVP Assessment

We concur with the conclusions drawn in reference 12 relative to the influence of existing cracks on the performance capability of the DGB and its continued serviceability. While significant future cracking is unanticipated, it would only be in these circumstances that we would recommend remedial actions such as epoxy or sealant application to insure continued durability. Furthermore, should such procedures continue to be contemplated for purposes of potential increased protection, we urge that applications of any compounds not be made in such a manner as to mask surfaces so that cracks are not visually accessible. Notwithstanding the potential future inconvenience of removing compounds from selected surfaces, there is a potential that these compounds may influence behavior and modify surface expression of cracks, making future engineering evaluations more difficult.

We recommend that consideration be given to modifying T.S. 16.3/4.13. The following points summarize our evaluation and our recommendations.

- Visual inspection - The building should be examined visually twice a year in concert with an evaluation of settlement data to identify any unusual deviations in crack patterns and gross changes in dimensions. This may represent an additional commitment.

- Total allowable settlement - These limits should be based upon structural/mechanical performance requirements considering items such as the physical clearances to obstructions (e.g. duct banks) and permissible deflections for attached items (e.g. incoming fuel lines). Notwithstanding these considerations, absolute settlements and corresponding rigid body motion of the building is of minor concern to building performance capability other than as it might affect clearances to obstructions and connected items. The existing limits may trigger potentially unnecessary evaluations. A 90-day survey interval appears reasonable for the first year of operation. This approach may represent a redefinition of certain total allowable settlement limits.

- Differential settlement

  - Diesel Generator Building

    Forces induced by differential motion within the DGB are of interest, but generally only at a time at which crack width levels approach an order of magnitude greater than has been observed. Capacity is not expected to be degraded for settlement induced cracks with sizes up to this general level. Even at this point, the residual state of secondary stress in the DGB may be low due to factors discussed in Section 6.3; however, one must evaluate shear transfer mechanics across crack boundaries of dimensions of the same order as the fracture surface roughness. It is recommended for consideration that limits for differential motion between points within the DGB (discounting all rigid body components of motion) be specified such that these motions are correlated with potential future crack widths up to an order of magnitude greater than has been observed to date; thus providing functionally defined limits for differential movements. Remedial effort to protect external surfaces may be considered at approximately half these values. The program may include development of an initial set of data which would provide a baseline for potential future reference. Additional survey data would be collected in the future if indicated by the visual inspection program and absolute settlement measurement surveys. If adopted this approach may represent a redefiniton of allowable settlement limits and a restructuring of the proposed tech specs.

  - Diesel Generator Pedestals

    Although, relatively of lesser concern, at such a time as the diesel generators are run for an extended period, potential differential movement of the isolated diesel generator pedestals is of interest as such movement may affect connected lines. Accordingly, we endorse continued monitoring of pedestal settlement and comparison to functionally defined differential movements.

We conclude that the committed crack monitoring program will produce results which are of engineering interest but not necessarily of safety significance. Accordingly, we do not see a need to specify alert and action limits based upon this program. We base this conclusion primarily on the limited number of locations to be monitored and the fact that appropriate locations are difficult to determine a priori, not knowing how the building will behave in the future. One could specify locations based upon predictions of future response, but if the building responds as predicted, this will be of less interest then if it does not, in which case alternate locations would be more desireable. This is related to our recommendation not to mask surfaces through application of new compounds.

In summary, we conclude that the performance characteristics of the DGB are not likely to be compromised over its service life. Various commitments have been made by CPC to verify continued serviceability. While we conclude that several of these commitments may not be totally necessary, we do not view that safety will be compromised by the specified actions. Certain improvements may be made which may produce valuable information and reduce operational constraints.

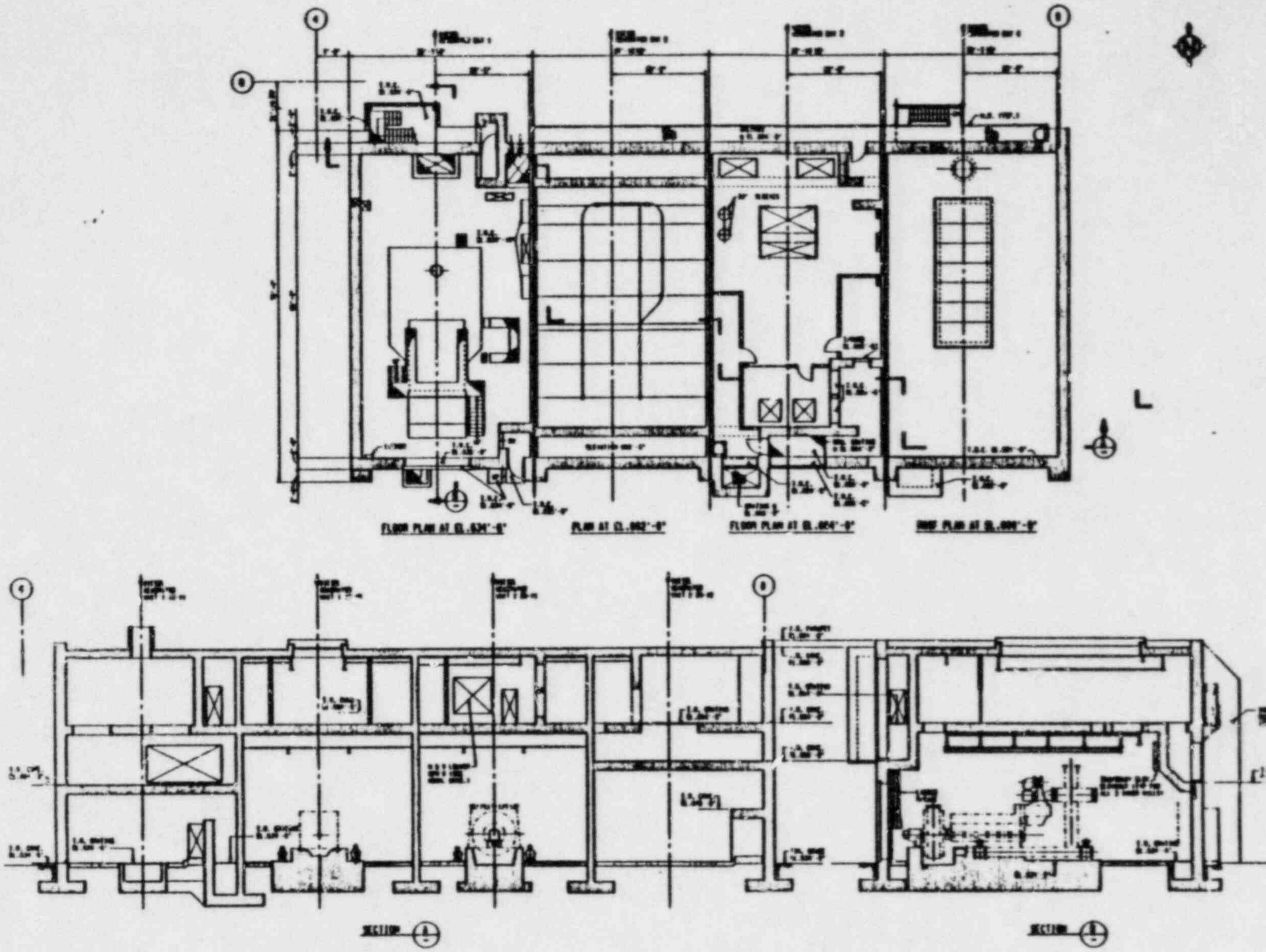

FIGURE 6-1

DIESEL GENERATOR BUILDING
PLAN VIEW AND SECTIONS

TERA CORPORATION

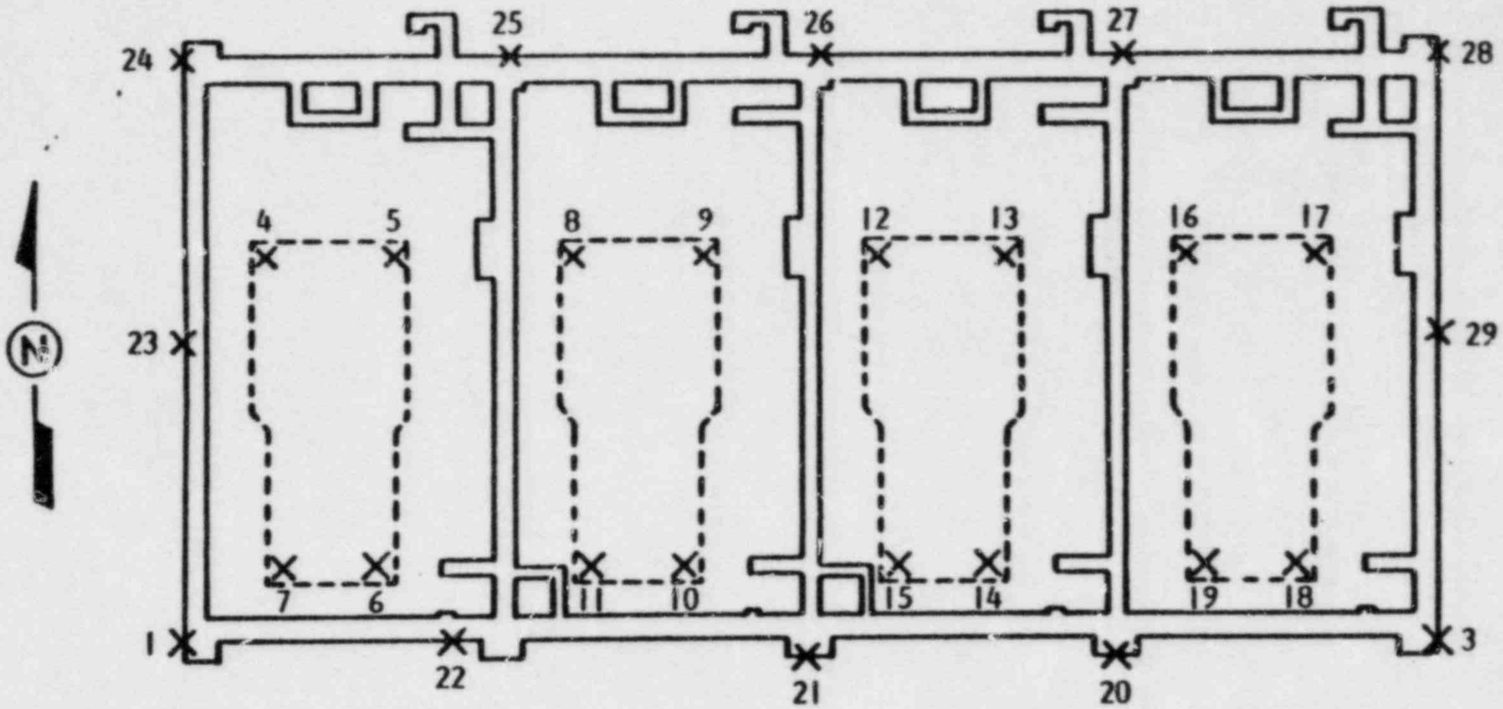

FIGURE 6-2

DIESEL GENERATOR BUILDING SETTLEMENT MARKER LOCATIONS

TERA CORPORATION

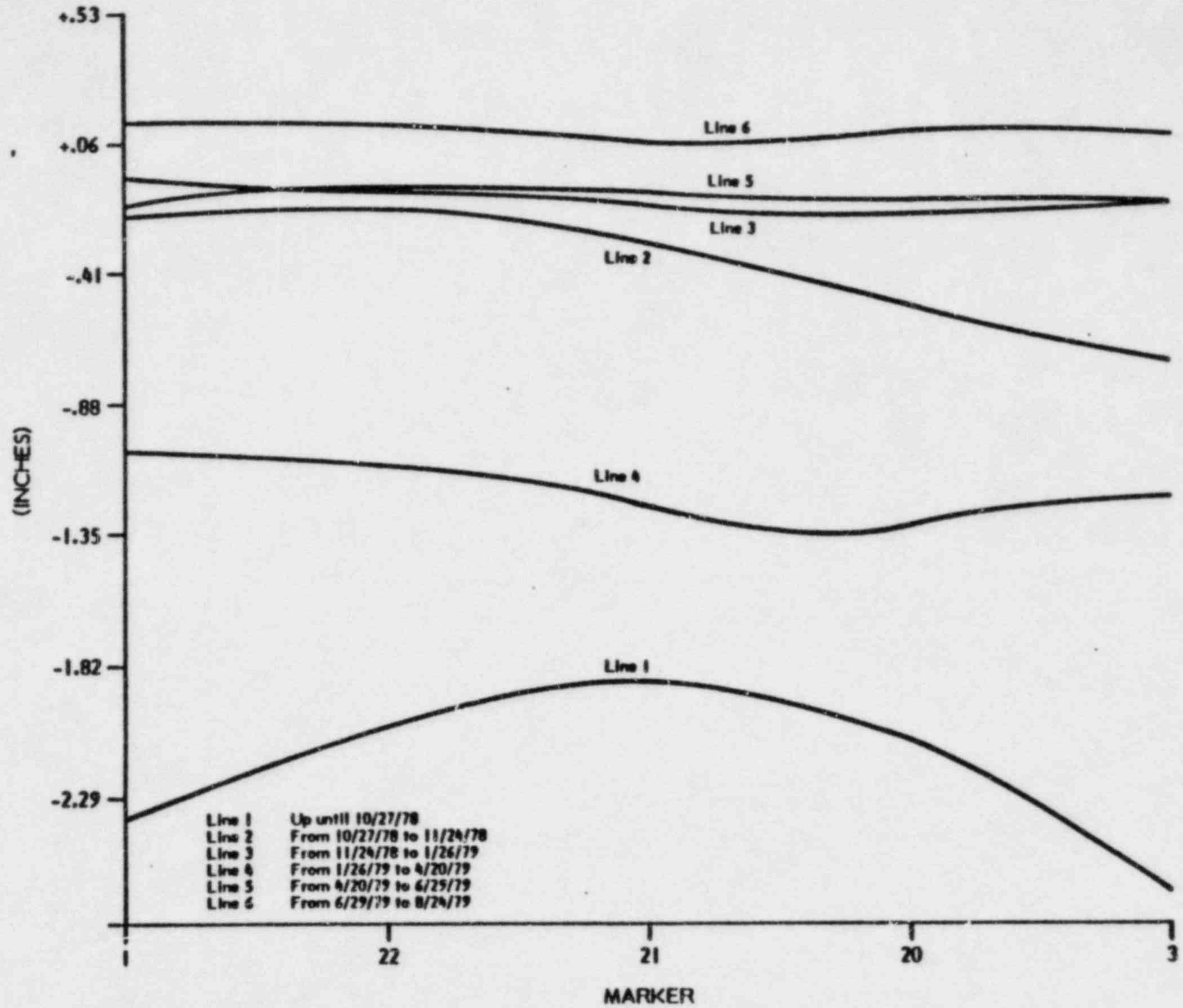

FIGURE 6-3

DIESEL GENERATOR BUILDING
SOUTH WALL
SETTLEMENT INCREMENT

TERA CORPORATION

7.0 CONCLUSIONS

As the diesel generator building exists today it is quite capable of performing its intended design functions. Many cracks of small size are evident in the existing building but there is no evidence to suggest that these cracks — in spite of the various possible mechanisms of origin - generally of small size, would be indicative of a condition that would suggest the DGB is incapable of performing its function. It is our belief that in its present condition this building is fully functional in all respects. Although we believe it is improbable, if excessive localized differential settlement is observed, remedial corrective measures could be undertaken to improve serviceability.

The committed monitoring program clearly will reveal any potential distress. It is suggested that a comprehensive visual inspection of DGB be carried out biannually (twice a year) in concert with the settlement measurement program. In Section 6.4 we have offered certain recommendations for consideration that are intended to improve information collected and reduce operational constraints.

(1)

Docket No. 50-329
Docket No. 50-330

Consumers Power Company
ATTN: Mr. Stephen H. Howell
Vice President
1945 West Parnall Road
Jackson, MI 49201

Gentlemen:

Boiler Plate 1: R. J. Cook
during the period of October 2-31, 1978
The Midland Nuclear Power Plant construction site
NRC Construction Permits No. CPPR-81 and CPPR-82
Messrs. D. B. Miller, J.L. Corley and others of your staff

Boiler Plate 2.a

Boiler Plate 7

Boiler Plate 10.a

Boiler Plate 11

Sincerely

R. F. Heishman, Chief - - -

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

REGION III

Report No. 50-329/79 ; 50-330/79

Docket No. 50-329, 50-330 License No. CPPR-81, CPPR-82

Licensee: Consumers Power Company
(Name/Address)
1945 West Parnall Road
Jackson, MI 49201

Facility Name: Midland Nuclear Power Plant Units 1 and 2

Inspection At: Midland Site, Midland MI
(Location if different from licensee address)

Inspection Conducted: October 2-31, 1979
(Dates of inspection)

Inspectors: R. J. Cook
(signature) (date signed)

(signature) (date signed)

Approved by: D. W. Hayes, Chief
(signature) (date signed)
Projects Section

Inspection Summary

See Attached Page

Inspection Summary

Inspection on October 2-31, 1978 (Report No. 50-329/78 ; 50-330/78-)

Areas Inspected: Examination of the general site condition, settlement of the diesel generator foundations and structures, need for additional seismic braces for Class 1E battery racks, scheduling analysis, information meetings with licensee personnel, location of core flood lines for unit 2, installation of reactor coolant system piping restraints, potential for loose links on States Terminal Blocks, welding of reactor coolant system piping for unit 2, sand blasting operations in unit 1 containment, condition of temporary lay down areas, in place storage condition of electrical equipment, disposition of the noncompliance report (NCR) issued pertaining to bump of unit 1 pressurizer while upending, auxiliary piping systems field welding and fabrication, and status of auxiliary feed pump inplace storage maintenance. This inspection effort involved a total of inspection hours by one NRC inspector.

Results: No items of noncompliance or deviations were identified.

Details

Persons Contacted

* D. Miller, Site Manager
* T. Cooke, Project Superintendent
* J. Corley, QA Section Head, IE&TV
* B. Peck, Construction Supervisor
* R. Whitaker, QA Engineer

G. Keeley, Project Manager
B. Marguglio, Manager, Quality Assurance
W. Bird, Section Head, Quality Engineering
L. Howell, QA Engineer

* W. Barclay, Bechtel Corp Project Field QC Engineer
* L. Dreisbach, Bechtel Corp. Project QA Engineer
* E. Smith, Bechtel Corp. QA Engineer

J. Spence, Bechtel Corp. QC Inspector

* R. Shope, B&W Project Engineer
* J. Ashworth, B&W QC Inspection Supervisor

Numerous other principal staff and personnel were contacted during the reporting period.

* denotes those present during at least one of the four exit interviews conducted during the report period.

Inspection Areas

1. Site Tours

At periodic intervals generalized tours of the facility were performed by the Resident Inspector. During the reporting period, these tours covered essentially every area of the site. These tours were intended to assess the cleanliness of the site; storage condition of equipment and piping used in site construction; the potential for fire or other hazards which might have a deleterious affect on personnel and equipment and to witness construction activities in progress.

2. 50.55(e) Item

Settlement of Diesel Generator Foundations and Structure

Open (Item No. 329/78-13-03; 330/78-13-03) - The licensee has kept the Resident Inspector informed of evaluations being performed pertaining to the settling of the diesel generator building and foundations. Information requested by the Regional Based Inspector for the review of this item has been supplied through the Resident Inspector. The Resident Inspector participated in a portion of the inspection activities of the Regional Inspector conducted on site during the period of October 24-27, 1978.

Class IE Battery Racks, Seismic Brace

On October 29, 1978, the licensee informed the Resident Inspector that based on a Mailgram from the supplier of the battery racks, it had been identified that an additional isolation bar is required in Class IE battery racks to isolate the build up of horizontal momentum during a seismic event. This item had been reported to the USNRC by the supplier of the battery rack (Exide Industrial Battery Division) under the provisions of 10 CFR Part 21.

3. In Place Storage of Electrical Equipment

During the reporting period in place storage of electrical equipments in motor control centers, switchgear rooms and in proximity to the control room were examined. These equipments appear to be protected from weathering conditions.

4. Unit 1 Pressurizer Bump

During the placing of Unit 1 pressurizer, the pressurizer was bumped. B+W generated NCR No. 121 which identified the damages. During this reporting period the status of the NCR No. 121 was examined. Corrective action has not yet been completed

5 Scheduling Analysis

During the reporting period the licensee explained a computerized technique for keeping abreast of the construction schedule and items which might impact on the schedule. The computerized technique allows visibility into the construction progress of those critical path areas which may require more emphasis to avert any major schedule slippage. These analyses have indicated that the fuel load date for Unit 2 has not been altered.

6. Management Meetings

During the reporting period, the Resident Inspector met with the Corporate manager for the QA staff to discuss current enforcement items and the effectiveness of QA overview inspections. Also during the reporting period, meetings were held with the Site Manager to discuss implementation of 10 CFR Part 19. Letters encouraging workmen to identify items of safety significance to their supervisors and the means of contacting the NRC in confidentiality are posted in the Change House.

7. Core Flood Lines

During the reporting period B+W noncompliance reports (NCR) no. 436 and 441 were issued pertaining to an elevation mismatch between the B+W installed portion of the core flood system and the Bechtel Corporation portion of the installed core flood system. These NCR's were reviewed and final disposition has not been completed. It appears that the elevation mismatch has occured by one portion of the system being installed to looser elevation tolerance requirements than the the other portion of the system.

8. Reactor Coolant System Pipe Restraints

The installation of pipe whip restraints around the Unit 2 north steam generator reactor coolant system (RCS) hot leg piping was examined during the reporting period. The RCS hot leg piping was used for a chain hoist pivot point for fitting the restraint. The RCS hot leg piping was not fully welded but was fitted and tacked at this time. The licensee agreed to reverify the RCS hot leg piping alignments. This was accomplished on November 2, 1978.

9. <u>States Terminal Blocks</u>

During the reporting period the licensee informed the Resident Inspector that a Consumers operated fossil plant had tripped off the line as a result of loose links on States Terminal Blocks becoming open circuited. Investigative efforts revealed that the loose links were caused by using nuts with an internal chamfer on a modified terminal which requires a standard hexagon nut. The chamfered nuts were used on earlier styled terminal blocks that require this type of fastener. The licensee is performing inspections of all safety related vendor installed control circuit terminations using States Terminal Blocks to determine if compatible terminals and fastening hardware were used.

10. <u>Welding of Reactor Coolant System (RCS) Piping - Unit 2</u>

During the reporting period, B&W performed RCS pipe welding operations on the Unit 2 hot leg to steam generator nozzles for both steam generators. The welds were examined at various times on both shifts to insure that procedural preheat requirements were being met; controlled weld rod was being used; voltage and amperage were being controlled within the specifications for the size rod being used; that presently calibrated instrumentation was being used; that the fit up was within design limitations; that the welding was being [illegible] previously qualified personnel and that NDE personnel were qualified in the type of examinations performed.

The hot leg nozzle for the south steam generator could not be fitted to the drawing specifications and B+W-NCR no. 144 was generated. A Field Change Authorization no. 04-3015-01 was issued to allow a wider root gap when a specified backing ring is used. The original prints did not detail the fit up geometry when backing rings are used. The licensee stated that the Field Change Request would become an integral part of the as built documentation.

Welder qualification records for welders no. 30, 83, 277, + 279 were reviewed.

Information radiographs for the north steam generator taken after 1" of material was added to the radius were examined.

NDE qualification records were examined for personnel being used in this capacity. No deviations or items of noncompliance were observed.

11. Sand Blasting of Unit 1 Containment

During the report period extensive sand blasting of Unit 1 containment walls was performed. Essentially all areas of the containment were examined to verify protection of safety related equipment. Unit heaters were not covered during the initial stages of sand blasting operations. However, the licensee took immediate steps to cover the heaters and stated that sand would be cleaned [illegible] activities to preclude sand from being blown onto other construction activities when the heaters are energized at a later time. Respirators were required for personnel in containment while sand blast operations are in progress.

12. Temporary Laydown Areas

During the reporting period temporary lay down areas for safety related piping were examined. The piping appears to be adequately stored on dunnage in well drained areas and relatively free from potential contamination.

13. Auxiliary Piping Systems Field Welding and Fabrication

Field fabrication of piping being installed on the 565, 581 and 639 ft elevation levels of the Auxiliary Building was examined. This included witnessing weld preparation and fit up and welding of piping joints in the boric acid addition system, auxiliary feed system and containment spray system and other system joints welded in the auxiliary building. Purge gas flow appeared to be adequate and within procedural limitations. Welding rod appeared to be controlled and withdrawals were being made per procedural control.

14. Auxiliary Feed Pump Inplace Storage Maintenance

The inplace storage condition of the electric drive auxiliary feed pumps 1P05A and 2P05A was examined. Auxiliary feed pump 2P05A was found with the suction and discharge piping butted against the pump casing flange and out of alignment enough to allow open access to the pump casing without the opening being covered. A review of the maintenance information check form F-10120-119 and F1-436 indicated that periodic checks had been made to verify that all openings were closed. It was difficult to establish when the suction and discharge connections had become open as maintenance records indicated the last examination had been made approximately three weeks earlier. During the review of the inplace storage maintenance documentation it appeared that routine maintenance had not been performed on the motor driver and long term maintenance had not been performed on the pump end. However, this was not completely substantiated until the next reporting period and ultimately became an item of noncompliance which is identified in the next subsequent reporting period.

Exit Interview

The Resident Inspector attended the Exit Interview conducted by Mr. E. Gallagher, RIII Reactor Inspector on October 27, 1978.

The Resident Inspector met with licensee representatives (denoted under Persons Contacted) on October 3, October 12, October 19 and October 26, 1978. The inspector summarized the scope and findings of the inspection effort to date. The licensee acknowledged the findings reported herein.

188
4/9 - Fill U-1 tank

4/10 - Tank filled - No hydro - No AI

4/11 - Hydro done with pen light
Bechtel Sub Cont
Hartford
CB&I - QC
> OK
Bechtel QC - No test. No bore scope

4/12 Bechtel QC wrote deviation
Bechtel QC put "buy" tank without bore scope exam.

4/13 CPCo issued Hold Tag on IT-87 / ~~[illegible]~~ - no drain of tank.
& Bechtel QC - no sign on CB&I - QC Records

4/17 Hydro by AI / Bechtel QC with borscope CPCo / CB&I

4/18 CB&I Quals.

188

4 M. Shaeffer

*2 J Coley, QA Sect. Head IE + TV — April 1979

11 V. ASGAONKAR. B+W Project Engineer

1 D. ~~NOTE~~ QA Inspector

6 E. Jones QA Inspector

*12 R Slope B+W Project Eng

(7)* T Cooke. Project Superintendent

*8 L. Dreisbach

*10 D. Thompson

*3 B. Peck

*9 W. Barclay, Bechtel Corp Project Field QC Eng

5 P. Kyner, Field QA Eng

[illegible] 7- [illegible]
No test pits prior [illegible]

Settlement of Diesel Gen Foundations and Structures

During the rpt period the lic has completed adding 20 feet of sand in and around the diesel gen bldg. This is the max amount of sand planned for placement for preloading of the building.

The lic also informed the Res Insp that test pits pertaining to the ~~dd~~ site settlement ~~pr~~ monitoring program are not ~~[illegible]~~ scheduled for digging prior to May 1, 1979. ~~The lic has indicated~~ The lic indicated that they would attempt to give an ~~approx~~ nominal 2 week notice to the NRC prior to ~~ea~~ ~~of~~ test pit excavation.

2. Decay Heat Removal Pump Technical Literature

During the report period the B&W Site Construction Consultant received an assembly diagram (Fig. 13A) for incorporating into the Decay Heat Removal Pump Instruction Manual which was examined by R? This clarifying info should remove any uncertainties and ambiguities ~~while performing it~~ pertinent to the installation of decay heat removal pump impellers during future maintenance

~~#~~ 4. Unconsolidated Concrete in ~~F~~ floor of 568 ft Elevation Of Auxiliary Building

During this reporting period the Res Insp examined a section of unconsolidated concrete in the floor of the Aux Bldg at the 568 ft. elevation. The excavated ~~volume~~ section was approximately 4½' x 1½' x 1' deep. A second smaller section of ~~----~~ unconsolidated concrete was ~~located~~ detected approximately 5 ft from ~~the~~ the larger section on the same elevation. Noncompliance Report No. NCR 2034 has been generated and the licensee is assembling an indepth evaluation program to determine the extent and significance of these unconsolidated areas.

6. Presence of ~~Water~~ Fluid in 350 MCM-3/C B-11 Power Cable

During the reporting period, the Res Insp was informed that a water like fluid was detected in one phase of a 3 phase 350 MCM power cable ~~These~~ from six different reels of cable supplied by Essex. This cable had been ~~to~~ installed in a total of 14 ~~cc~~ circuits which are identified on Noncompliance Report No. NCR-2015. The exact composition of the fluid (or the source of the fluid) is not known at this time and is being analyzed. The adequacy of the cable insulation is also being evaluated by the licensee. ~~Essex has reccomended drying of the installed cables by passing nitrogen gas through the cable. Suspected 350 MCM cable has been removed from all affected safety related power circuits and the licensee is evaluating the quality of cable intended for use in these types of capacities.~~ The licensee is evaluating the quality of 350 MCM power cable used in safety related equipment.

1. Effects of TMI - Unit 2 Incident on the Midland Site.

~~The Res Insp~~ As a result of the March 28, 1979 - Three M. I. Incident the licensee has formed a task force to study the event and determine what similarities, if any, which might ~~may~~ exist at the Midland Plant ~~which might allow a~~ that could allow a similar event to occur and to determine what corrective action may be necessary. The lic has sent representatives to B&W facilities to gather info pertinent to these objectives. The Res Insp had discussions with the lic pertaining to these activities

8. Allegations of Explosion

During the report period allegations of an explosion at the Midland Site was received by the ~~Regional~~ NRC Regional Office - ~~These allegations were discussed~~ The Res Insp had no previous knowledge of such an event occuring at the Midland Site. The Res Insp discussed the possability of such an event ~~....~~ having occurred at the Midland Site with Bechtel ~~Safet~~ Corp on Site Safety Office and Consumers Power Co. The only event which could be determined which might give an illusion of an explosion ~~.....~~ was the planned "blow down" of ~~the~~ a fossil fired boiler owned by Dow Chemical on April 10, 1979.

10. <u>Apparent Overexposure to B&W Radiographers</u>

On April 3, 1979 the Res Insp was informed that two B&W radiographers may have received an accidental overexposure during the previous night. An investigator and the tech specialist were dispatched from the NRC Regional office and performed an investigation of this matter on April 4-5, 1979. The results of their investigative efforts are contained in a ~~seperate report.~~ seperate NRC Inspection Report No. ? ______

11. (Cont)

~~and to "boxed in" support~~

areas "boxed in" by tank supports and wall. Consumers-Power Company also issued ~~QC~~ QC Hold Tags to prevent any work being performed ~~on~~ which would affect the ~~Incore Inst~~ Tank hydrostatic test until ~~a satisfactory~~ an acceptable test could be completed. The examination ~~of dissimilar~~ of those welds in ~~areas~~ the above reference annulus area and boxed in area with a borescope was witnessed by the Res. Insp.

12. Hydrostatic Test of Unit ~~1~~ 2 Incore Instrument Tank 2T-87

(1)

During the report period several attempts were made to hydrostaticaly test the Unit 2 Incore Inst Tank 2T-87. All attempts failed because of the lack of availability of qualified personnel representing the Hartford Boiler Authorized Inspector; ~~the~~ no access to the weld area in the annulus and boxed in areas formed by flooring and support structures ~~respectively~~; the lack of availability of equipment which would allow establishing zero leakage (bore scope); and the physical condition of the tank — no surface moisture present.

A previous attempt had been made to ~~h~~ hydrostatic test this tank (2T-87) on March 15-16, 1979. However the technique used was to examine the

12. (Cont) (2)

areas using a flash light. The CB&I Master Check List for Control and Certification and the ~~Special~~ CB&I Special Check List were initialed and dated by the appropriate representative for the Authorized Inspection Agency, CB&I and Bechtel Corporation.

The authorized Bechtel Corp QC Inspector noted on his Const Quality Control Subcontractor Surveillance Inspection Recor ~~noted~~ that approx 2 ft of vertical weld seam on weld no 1-A (East) 1-B (West) and weld no could not be visually checked due to interference of structural steel and concrete floor. The width of the annulus area formed by flooring and tank wall was not wide enough to accomodate a nominal 1½" diam. bore scope. The thickness of the floor is estimated

~~Ex~~ 12 (Cont) ~~P~~ (3)

to be 24 to 30 inches thick. Consumers ~~Consumers Power~~ Power Co. made a similar notation in their Inspection / Overinspection Record on entry dtd 3/16/79

The procedure used to hydrostatically test the tank, CB&I Hydrostatic Test Procedure HP-71701, ~~[illegible]~~ states in step 7.3 ______ which is in agreement with the requirements of ASME which is referenced in step 2.1 of the above referenced procedure.

Because of geometric limitations the vertical weld seams penetrating the floor area ~~could not~~ physically could not have been examined by use of a flashlight beam to establish zero leakage conditions. On ~~[illegible]~~ april 3, 1979 the licensee (~~Con~~ CPCo) agreed ~~[illegible]~~

12. (Cont)

Failure to inspect all joints and connections as prescribed in ~~CBI~~ ~~Hydro~~ step 7.3 of CBI Hydro Test Proc HP-71701 is considered ~~and~~ an item of noncompliance with 10 CFR 50, Apped B Criteria V.

Exit Interview -

by R. Marsh & M. Oestmann

R III Investigator and Rx Inspector

april 5 and april 27, 1979 respectively

PD april 6, april 13 and april 26, 1979

Appendix A April 2 -30, 1979

10 CFR 50 - - -

CBI Hydr Test Proc HP - 71701
~~Re~~ Step 7.3 states in part, " Inspect
"
- - - -

Contrary to the above, it was determined on April 2, 1979 that all joints and connections ~~could not~~ on Incore Inst Tank No. 2T-87 could not have been physically examined using the tech employed because of confining geometry. ~~using the technique employed~~ ~~[illegible]~~ ~~for visual examination of vertical weld seams in a~~

April 2-30

BP #1 R. J. Cook
during the Period April 2-30, 1978

BP 2a

BP 4

BP 6 thirty

BP 10. b

BP 11

Sincerely Joe.

Inspection on April 2-30, 1979

Examination of site conditions, settlement of diesel gen foundations and structures, adequacy of decay heat removal pump technical lit, unconsolidated concrete at 568 ft elev of Aux Bldg, presence of fluid in 350 MCM - 3/C B-11 power cable, receipt of high carbon content ells, damage to Class 1E battery cell, effects of TMI incident on site operations, follow up on alleged explosion on site, observation of anti-nuclear demonstration, apparent overexposure of B&W radiographers, hydro-test of Unit 1 Incore Inst Tank 1T-87, hydro test of Unit 2 Incore Inst Tank 2T-87

Of the 13

failure to adequately inspect tank vertical welds for zero leakage conditions.

1812

TELEPHONE CALL   Midland Project   GWO 7020

By T. C. Cooke	Of PMO-Construction	Route DBMiller
		DARichards
To File	Of	GSKeeley
Date November 29 19 78 Time 2:10 P.M.		FILE
Subject Call from Starr Eby - Midland Daily News in regards to Diesel Generator Building Settlement		File B 3.0.3

Starr called relative to AP News Release regarding Diesel Generator Building 'Sinking". She had a question concerning which other buildings were indicating excessive settlement. I responded that I was unsure what buildings were referred to in the news release; however, we were not concerned with other buildings settlement at this time.

Starr then asked what exactly was Consumers Power doing to stop the Diesel Generator Building Settlement. I explained that we in essence simply were adding weight to consolidate fill material, thereby stopping settlement of Diesel Generator Building. To clarify the issue I had to explain the concept of concrete wall & footers, the fact that no ground floor slab has been placed, the estimate that we will place approximately 15-20' of sand (maximum) inside and outside the exterior of the Diesel Generator Building in approximately two weeks and an analogy of the cooling pond and power block and impervious exterior dike seal as compared with say a plastic wash basin with a styrofoam or sponge section in one corner representing the power block area which would allow water to penetrate same while not allowing this water to leak through exterior seal into the outside ground water table.

Starr then requested that she be notified when we started our actual fill operation. I agreed to do so unless due to the press of other business it slipped my mind.

cc: U Koschik
N Saari
~~R Cook USNRC - Region III~~

To	File
From	TCCooke
Date	June 13, 1979
Subject	MIDLAND PROJECT GWO 7020 - NRC SITE TOUR AND OBSERVATION OF TEST PITS File: 0460.2 Serial: CSC-4138
CC	*Attendees GSKeeley, P14-408B DBMiller JJZabritski, P14-416 *Bechtel and Consumers attendees only.

CONSUMERS POWER COMPANY
RECEIVED
JUN 14 1979
FIELD QUALITY ASSURANCE
MIDLAND, MICHIGAN

Consumers Power Company

INTERNAL CORRESPONDENCE

NRR meeting on site of June 7, 1979

I. Individuals Present:

Sherif S. Afifi	Bechtel Assistant Chief Soils Engineer
R. E. Lipinski	DSS/NRC
J. P. Knight	DSS/NRC
Daniel M. Gillen	DSS/NRC
C. A. Hunt	Consumers Power Executive Civil Engineer
P. A. Martinez	Bechtel Project Manager
*A. J. Boos	Bechtel Project Field Engineer
*R. J. Cook	Resident Inspector/NRC
*T. E. Vandel (Entrance only)	US NRC Region III
Lyman Heller	US NRC NRR
T. E. Johnson	Bechtel Chief Civil/Structural Engineer
K. Dhar	Bechtel Supervisory Engineer
T. C. Cooke	Consumers Power Project Superintendent
D. E. Sibbald	Consumers Power Senior Construction Advisor
K. Wiedner	Bechtel Engineering Manager
*D. Horn	Consumers Power Quality Assurance Group Supervisor/Civil
R. M. Wheeler	Consumers Power Civil Section Head

*Part time

II. Discussion Tour Comments

A. The individuals from the NRC were extremely interested in cracks in the Auxiliary Building, Service Water Building, and Diesel Generator Building. Many questions were asked regarding differential settlement. They seem to be under the impression that there was a great deal of building settlement other than the Diesel Generator Building and that large cracks exist somewhere on the site. We continually had to reiterate the fact that remedial actions were based on soil borings which showed questionable material and not settlement problems. Mr. Lipinski, in particular, was very interested in why we had cracks and analysis regarding same.

B. During the tour it was apparent that the NRC's questions were oriented towards seismology aspects. They were also interested in whether or not we had re-reviewed the different seismic conditions in the light of our concrete backfill revisions for the Auxiliary Building, wing walls, etc., since the addition of concrete could cause new reactions and forces requiring reanalysis. It was noted that the concrete backfill would be separated from the structures by styrofoam and not tied to the structures. The NRR alluded to possibly more stringent earthquake requirements.

C. When observing the test pits, Mr. Heller expected more sand in the "random fill". It was noted that sand was used primarily around utilities and next to buildings.

D. Mr. Heller appears to be of the view that the simpler engineering fix on the service water overhang, such as concrete backfill as opposed to more complex remedial action, would stand a much better chance of passing review, due at least partially to the fact that much of the available manpower in Washington was involved with Three Mile Island and also because simple straightforward engineering practices will be much easier to discuss in any hearing process. The NRR was informed that piling at the Service Water structure was only for vertical load and that no moments were involved. It appears that possibly Mr. Knight's staff has been reduced from about fifty to near eight, with the forty people being tied up on Three Mile Island activities. There will be a corresponding cutback in the normal amount of licensing activities that will be undertaken by his staff over the next several months.

E. NRR noted that they should receive copies of any Diesel Generator (total site related) material that is being transmitted to Region III directly from the licensee. It also appears that Mr. Knight is more interested in resolving the Midland fill problems in the near future on a "real time basis" as opposed to later review and approval functions such as might be found in going the FSAR route. (Note: Consumer Power Company has been attempting for weeks to arrange a meeting with NRR but it was not until the week of June 4, 1979 that we were able to set a meeting date with them of July 10, 1979.) He recognized that presently the licensee was involved in answering the same or possibly similar questions on three fronts, namely the I&E questions, 50.54f responses and future FSAR revisions, and agreed that it would be beneficial to all parties to consolidate these areas. During the tour it also appeared that in the future NRR may become much more deeply involved in the details in all licensing aspects than they have in the past.

F. It would appear that we should provide more rationale and better arguments for support of duct bank and pipes and man holes, valve pits, etc. during the seismic event. We have to verify or prove that duct banks, for example, will not shear during the earthquake. Mr. Heller was of the opinion that our responses on the safety aspects concerning the borated water storage tank lines will have to be extremely conservative, and that at this point in time for our responses to be accepted, he would be inclined to say that questionable material should be removed and fixed rather than going through some complex explanation as to why it was "acceptable as is" since this was a Category One item which would be required during the postulated accident conditions.

Generally, the NRR personnel appeared to find the information gathered during the tour and observation of the test pits to be of value and the type of information which would expedite their decision making process.

plw

1877

Diesel Gen Bldg Settlem

On Dec. 6, 1979 an Order Modifying Const Permits No — & No was issued by the NRC as a result of findings by [illegible] Region III based inspectors pertaining to settlement of the diesel gen bldg and associated soil settlement. During the report period the Res Insp had discussions with members of the site staff pertaining to the impact of the Order on present site soils activities. The lic stated they planned to honor the provisions of the Order and ~~the present~~ their activities would be aimed at protecting existing safety related buried pipe, conduit ~~in~~ and present excavated areas from expected inclement winter weather.

The licensee stated they had a need to lower the pond water level 3 to 4 feet for repairs to the dyke wall rip-rap

1. <u>Site Tours</u>

— . — — tours of randomly selected areas of the

During one of these tours a cursory examination of ~~[illegible]~~ boric acid storage tank construction was performed to determine any obvious discrepancies in construction activities. No obvious discrepancies ~~[illegible]~~ were noted.

2. Assembly of Unit 1 Rx Coolant Pumps

During the report period the licensee licensee shipped the motor bases for pumps designated —— & —— to the mfgr for repairs. These motor bases were returned to the mfgr primarily for repair of the sealing surfaces which were considered unacceptable for service -

3. Review of Nonconformance Reports.

During the report period additional review of selected ~~a~~ Nonconformance Reports (NCR) was performed with the aid of a Regional Based Co-op student employee. The selection of NCR's being reviewed is based primarily on a use-as-is disposition with minimal supportive information ~~disposition~~. This review of selected NCR's was not completed during the reporting period and is still in progress. Preliminary results based on a relatively small sample pare indicated that ~~even~~ the use-as-is disposition of the NCR's could be substantiated by engineering evaluation. The Res Insp indicated that it would be prudent to include more ~~[illegible]~~ technical justification ~~for~~ for any use-as-is dispositions on the NCR's The licensee tended to agree.

(1)

1. Installation of HVAC ~~Heating Ventilation on Air~~ System

Installation of Heating Ventilation and Air Conditioning (HVAC) components and systems is being ~~pe~~ performed by Zack Const. Co. under subcontract to the Bechtel Corporation. During the work activities to date an exorbitant no. of nonconforming conditions ~~were~~ have been identified by the parties involved ~~with appro~~ ~~with~~ a large percentage of these nonconforming ~~proce~~ conditions (~~approximately 400~~) are unresolved and may require extensive rework to resolve. Because of ~~this~~ the large no of nonconforming conditions, ~~the~~ Bechtel ~~Corp.~~ Corporation has requested that the Zack Const Co show good reason why the existing contract should not be forfeited. Zack Const Co. was originally obligated to ~~to~~ respond to this ~~by~~ mid-December 1979 but has received ~~extensions~~ time extensions and ~~has~~ did not responded during the →

reporting period. However, During the reporting period the Midland ~~Zack~~ Const Co. Project Manager and QC Manager have been replaced.

~~It appears~~ Subsequent to the reporting period Consumers Power Co. has issued a ~~Manage~~ Management Corrective Action Request / Report No. MD-1 address "Failure of Zack Co - — — — "

5. Potential Leaking Radiographer IR-192 Source

During the report period, the Res Insp was informed ~~that~~ by the Regional Office that Peabody Testing at the Midland site had experienced a potentially leaking Ir-192 radiographic source. The Res Insp was informed ~~inquired into this matter and found~~ by Peabody Testing that during the daily monitoring of the radiographic cameras one appeared to be emitting ~~em~~ slightly more radiation than the others. This Camera was wipe tested and showed signs of removable contamination

The ~~camera~~ suspect camera and source were locked in the shielded vault ~~with plastic~~ ~~plus~~ with ~~three~~ four other radiographic cameras of similar design. ~~Also locked in the vault were~~ Floor covering and equipment used during the examination which could have become potentially contaminated were also locked in the vault.

Company Radiological Safety Officers from the corporate offices ~~the~~ located at Foster City, Calif traveled to the site ~~for~~

to further evaluate this situation.

As a result of their visit two Ir-192 suspected leaking sources ~~were~~ and all contaminated material were ~~[illegible]~~ returned to Foster City, California for disposal.

One source was a 56 Ci ~~Ir-192~~ source and the other a 64 Ci source.

Summary

Examination of site conditions, NRC ~~settlement of diesel~~ issuance of Orders modifying construction permits promulgated from settlement of the diesel generator bldg. and associated soil settlements, assembly of Unit 1 Rx Coolant Pumps, review of nonconformance reports, installation of HVAC systems, and leaking radiographer Ir-192 source.

26 man hours

D

B.P # 1:
R.J. Cook
December 1-31, 1979
Midland Nuclear Power Plant Construction site
NRC Construction Permits No. CPPR-81 and No. CPPR-82
Messrs. T.C. Cooke, J.L. Corley and others of your staff

BP 2.a

BP 7

BP 10.a

BP 11

1523

Consumers Power Company

ORAL COMMUNICATIONS RECORD

PROJECTS, ENGINEERING AND CONSTRUCTION - QUALITY ASSURANCE DEPARTMENT

CHRON. FILE NO 0.4.2 (79-10)

PAGE 1 OF 1

QA5-0

DATE OF COMMUNICATION 1/17/79

QA-PE&C PERSONNEL PARTICIPATING J.L. CORLEY, R.G. WOLLNEY, G.T. BLACK JR.

TIME OF COMMUNICATION 1447

OTHER PARTY(S) [redacted]TH E.J. GALLAGHER (NRC RIII)

PREPARED BY G.T. BLACK JR.

PROJECTS AND/OR SUBJECTS DISCUSSED MIDLAND PLANT/ QUALIFICATION OF QUALITY CONTROL PERSONNEL

SUMMARY OF CONVERSATION MR GALLAGHER WAS NOTIFIED OF THE RESULTS OF THE TESTING OF BECHTEL QUALITY CONTROL PERSONNEL PER OUR AGREEMENTS IN PREVIOUS RESPONSES TO I&E REPORT # 79-10.

WE INFORMED MR GALLAGHER THAT BASED ON THE RESULTS OF THE PERSONNEL TESTING, THE LEVEL II QC POST TENSIONING SUPERVISOR WILL BE ALLOWED TO RETURN TO HIS PREVIOUS RESPONSIBILITIES AND A LEVEL II QC PRESENTLY INVOLVED IN POST TENSIONING WILL TAKE HIS PLACE. MR GALLAGHER INDICATED IT WAS UP TO US IF WE WANTED TO RELEASE HIM, AT OUR OWN RISK PRIOR TO REINSPECTION OF TENDONS BEING COMPLETED. WE ACKNOWLEDGE HIS RESPONSE.

G.T. BLACK INDICATED THAT ALL TENDON INSPECTION BY THE ONE QUESTIONABLE QC INDIVIDUAL IS BEING IDENTIFIED FOR ANY ADDITIONAL TENDON RE-INSPECTION RECOMMENDATION. ACTION WAS INCOMPLETE, AT THE TIME, AND WOULD BE INCLUDED IN ANY RESPONSE TO THE ORIGINAL ITEM OF REPORT # 79-10, AS REQUESTED BY MR GALLAGHER.

MR. GALLAGHER EXPRESSED HIS OPINION THAT HE WAS SURPRISED THAT ANYONE MISSED ANY QUESTIONS ESPECIALLY ON THE PERFORMANCE PORTION.

C/C:

W.R. BIRD	F.M. MACRI
T.C. COOKE	B.W. MARGUGLIO
J.L. CORLEY	D.B. MILLER
G.S. KEELEY	D.A. TAGGART