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November 30, 1990

U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, D.C. 20555

Attention: Document Control Desk

Gentlemen:

SUBJECT: Grand Gulf Nuclear Station
Unit 1
Docket No. 50-416
License No. NPF-29
Response to RAI Regarding Settlement
of Category I Structures
AECM-90/0209

The NRC Staff has performed a preliminary review of the settlement data related to Grand Gulf Unit 1 Category I structures as given in the Updated Final Safety Analysis Report, Figure 2.5-75. In addition, on April 16 and 17, 1990, the Staff met with Grand Gulf to discuss settlement monitoring and to tour the unit.

Following this meeting the Staff in a letter dated August 21, 1990 (MAEC-90/0209), requested that additional information be provided. Attached is Grand Gulf's response to this request for additional information. If additional information is needed, please contact us.

Yours truly,

WTC/WKH:mtc
Attachment

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REQUEST

1.a) Provide a comparison of measured total and differential settlements with i) predicted and ii) allowable settlements for all seismic Category I structures, along with explanations for differences, if any, between the predicted and measured settlements for each seismic Category I structure.

RESPONSE

Table 1 is attached to illustrate the total measured settlement for seismic Category I structures. This table includes survey data gathered up to May, 1990. As shown in the table, the maximum total settlement of any building is approximately 1-1/2 inches. Predicted settlement values are close to the measured values and any differences are minor relative to the exceedance values noted in UFSAR Section 2.5.4.13.1. Minor differences between predicted and measured settlement values can be attributed to a variety of factors, the dominant factor being survey accuracy. Although some measured values exceed predicted settlement, the total settlement of structures has essentially remained unchanged since 1981. This is supported by UFSAR Figures 2.5-75a through 2.5-75h and data from the last two surveys. Additionally, as shown in Table 2, total settlement is less than 45% of the exceedance values in UFSAR Section 2.5.4.13.1. Based on these facts, Grand Gulf will not surpass the UFSAR exceedance settlement for the life of the plant.

Differential settlement (tilt) has remained essentially unchanged since 1981. Allowable differential settlement for the Containment structure is 0.6 inches and 1.15 inches for the Auxiliary Building, as stated in UFSAR Section 2.5.4.13.1. A comparison of calculated to allowable differential settlement is provided for both the Auxiliary and Containment buildings by Table 3. Additionally, differential settlement between survey markers in other seismic Category I buildings is provided by Table 3. Furthermore, field inspections of the horizontal seismic gap between the Auxiliary and Containment buildings reveal that closure of the gap is not evident. Based on the rate of calculated differential settlement from 1981 to present, differential settlement is as expected and poses no concerns.

TABLE 1

PREDICTED VS MEASURED TOTAL SETTLEMENT VALUES
(Based on Data to May 1990)

	Settlement			Percent of Dead Load Completed
	Maximum *Predicted (in.)	Current **Measured (in.)		
Containment - Unit 1	0.8	1.0	(1.1)	100***
Containment - Unit 2****	0.8	1.0	(1.0)	40
Auxiliary Bldg - Unit 1	1.0	1.1	(1.5)	100
Auxiliary Bldg - Unit 2	1.0	0.2	(0.3)	10
Radwaste Bldg	0.8	0.6	(0.8)	100
Control Bldg	0.5	0.6		96
SSW Basin - Basin A	0.7	0.4	(0.4)	100% water***
SSW Basin - Basin B	0.7	0.3	(0.4)	100% water***
Diesel Gen. Bldg - Unit 1	0.8	0.1	(0.2)	100

* Based on elastic modulus values as determined from rebound measurements. Refer to UFSAR Figure 2.5-90 for predicted total settlements for different assumed groundwater levels. (These values are 40-year predictions.)

** Values given are average of two settlement markers except for control building where there is only one marker. Values in parentheses are for the marker with greater settlement.

*** Intermittent filling and emptying of water from the Containment Building and SSW Basin can produce coincident fluctuations in the measured settlement values.

**** Unit-2 containment settlement monitoring ceased on November 1981.

TABLE 2

STRUCTURE	TOTAL SETTLEMENT - INCHES		
	EXCEEDANCE VALUE	MAXIMUM 5/90	RATIO ? CURRENT MAXIMUM .O EXCEEDANCE
Containment-1	3.5	1.1	0.31
Auxiliary-1	3.5	1.5	0.43
Radwaste	3	0.8	0.27
Control	3	0.7	0.23
Diesel Generator	3	0.2	0.07

TABLE 3
STRUCTURE TILTING SUMMARY

STRUCTURE	SETTLEMENT MARKER	SETTLEMENT (IN.) 5/90	DELTA TILT (INCHES)	ALLOW.	RATIO OF MEAS. TILT TO ALLOW.
Auxiliary-1	9A	-0.60			
			0.89	1.15	0.77
Auxiliary-1	15A	-1.49			
Containment-1	11	-1.12			
			0.33	0.6	0.55
Containment-1	13	-0.79			
Turbine-1	52	+0.014			
			0.001		
Turbine-1	53	+0.015			
Diesel Gen.-1	5	-0.19			
			0.09		
Diesel Gen.-1	7	-0.05			

Note: 1. Negative numbers indicate settlement, positive numbers indicate heave.

REQUEST

1.b) Explain the consequences, if any, of the measured settlements that may exceed the allowable settlements for each seismic Category I structure.

RESPONSE

Measured settlement to-date is well below exceedance values given in Grand Gulf's UFSAR and settlement plots demonstrate that structures are no longer settling. In addition, no appreciable settlement has been recorded for approximately eight (8) to ten (10) years. This is supported by UFSAR Figures 2.5-75a through 2.5-75h and data from the last two surveys.

These facts clearly indicate that measured settlements will not reach exceedance values.

REQUEST

1.c) In addition to evaluating the differential settlement between adjacent structures, determine the tilting of each structure. For example, according to Fig. 2.5-75, in the updated FSAR, there appears to be a difference in settlement of about 0.6 inches between the Auxiliary Building markers P-9 and P-15 which are on either side of the Containment.

Discuss the safety significance of this differential settlement of the Auxiliary Building, as recorded by markers P-9 and P-15.

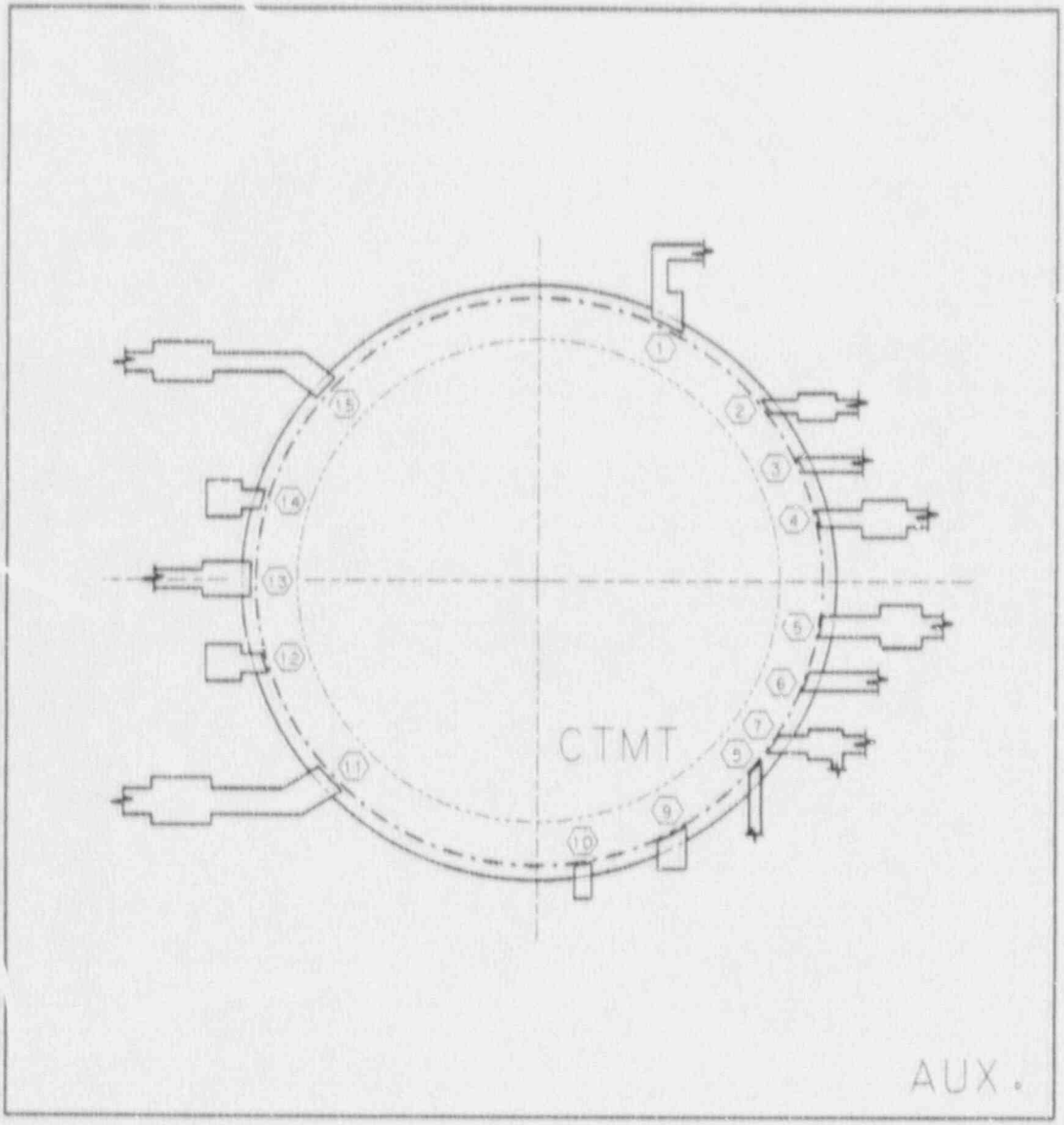
RESPONSE

In the April 17, 1990, NRC General Site Tour, it was noted that the gap beneath an Auxiliary Building wall and the Containment base mat appeared to be missing. A subsequent investigation by Entergy confirmed that the gap was not provided in nine (9) locations (see attached Figure 1) and failed to locate existing documentation which accepted this condition. A material nonconformance report (MNCR 0048-90) was written to document and address this condition. Based on this discovery, the information provided to the NRC on April 16, 1990 which showed that the Auxiliary and Containment buildings have moved towards one another, was re-evaluated. Further investigation revealed that the buildings are actually tilting in the same direction and, since the buildings are in contact in the vertical direction, there is no differential settlement between Auxiliary and Containment Buildings. The initial error in determining the measured differential settlement was due to the method used in combining the data for Containment points 11 and 13 with the relocated Containment points 11A and 13A.

A summary of structure tilting, including settlement data accrued up to May, 1990, is provided in Table 3.

Allowable differential settlements for the Auxiliary and Containment Buildings are 1.15 inches and 0.6 inches, respectively. These values are based on maintaining a minimum clearance between buildings to preclude building contact during an OBE occurrence considering the worst case scenario of the two structures tilting toward one another along the same axis. The measured differential settlements of 0.89' and 0.33" on the Auxiliary Building and Containment, respectively, are of no safety significance since both these values are less than the UFSAR allowables and the structures are tilting in the same direction. Furthermore, field inspections of the seismic gap between the Auxiliary and Containment Buildings reveal that actual closure of the gap is not evident.

FIGURE 1



PLAN VIEW

NOTE: VERTICAL SEISMIC GAP IS ABSENT AT LOCATIONS 1, 2, 4, 5, 7, 11, 13, 14 AND 15.

TABLE 3
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Containment-1	13	-0.79			
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Turbine-1	53	+0.015			
Diesel Gen.-1	5	-0.19			
			0.09		
Diesel Gen.-1	7	-0.05			

Note: 1. Negative numbers indicate settlement, positive numbers indicate heave.

REQUEST

1.d) Provide sample calculations showing the determination of allowable differential settlement of pipe penetrations in the buildings.

RESPONSE

Methodology:

The method of analysis is to mathematically model each of the piping systems from the penetration in one building to a point in the other building, including rigid supports, far removed from the differential movement. A detailed stress analysis is performed utilizing piping stress analysis program ME-101, with a unit differential vertical movement applied to the support(s) in one building while supports in the other building are assumed stationary. A maximum allowable differential settlement is then obtained by dividing the maximum stress from this analysis into the stress allowable (3.0 Sc). The piping allowable stresses resulting from differential settlement between buildings are limited to the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Division I, Paragraph NC 3652.3, Equation 10a.

Sample Calculation:

Data:

Penetration No.		21
Pipe	=	18" Ø
System	=	RHR
Stress Problem	=	69A
Elevation	=	132'-9"
Location	=	AUX/CTMT (AZ 334)

From the piping stress analysis, the maximum stress for the affected piping, σ, is 29.2 ksi for a unit differential movement.

Therefore, allowable differential settlement based on maximum allowable piping stress, is:

$$\frac{3\ Sc}{\sigma} = \frac{45}{29.2} = 1.54"$$

REQUEST

1.e) At two penetrations (Nos. 27 and DP-44A), the measured differential settlements have reached 80% of the allowable differential settlements, whereas, at eight other penetrations (shown in a table provided to the staff at the site on April 17, 1990), the ratios of actual to allowable differential settlements range from only 4% to 56%. All ten penetrations were installed in the same year, 1980. Perform an engineering review of the causes and effects of the relatively larger differential settlements at the two penetrations mentioned above.

RESPONSE

As noted in the response to question 1.c, there has been no differential settlement between the Auxiliary Building and the Containment. This is supported by field inspections which show that the horizontal distance between the two buildings has no evidence of closure and also by the absence of concrete spalling beneath the nine (9) Auxiliary Building walls where the seismic gap was not installed. Both the presence of measured differential settlement and the variations in its values at penetrations between the Auxiliary and Containment Buildings are attributed to survey level tolerance. The allowable survey closure error for the typical level survey equates to approximately 50% of the allowable differential settlement for the penetrations listed in the table provided to the staff on April 17, 1990. Variations due to settlement tolerance can be traced to the settlement data at the dates of piping installation. For example, Penetrations 26 and 27 are located at the same plant azimuth, but the piping in these penetrations was installed approximately seven months apart. Survey data obtained at the time of the piping installations reveals differences in survey marker elevations of 1/4 inch at marker P13 and over 1/8 inch at marker P9. The penetrations listed in the table were intentionally selected for detailed scrutiny since they are the penetrations with the smallest allowable differential settlement values.

The ratio of actual to allowable differential settlement for penetration DP-44A is different than others listed in the table provided to the staff on April 17, 1990 since DP-44A is located between different structures than the other penetrations. Furthermore, survey tolerance contributes to the high ratio at DP-44A.

Request

2.5) Document the reasons for the destruction of settlement markers and for the unavailability of settlement data for extended periods of time in the case of some seismic Category I structures as noted from FSAR Fig. 2.5-75.

Response

During construction, settlement marks were placed at available locations in the plant. As construction proceeded, markers would become inaccessible from placement of equipment or other items blocking the settlement marker. Markers were also destroyed by construction activities. Location of a replaced or relocated marker was influenced by construction activities, accessibility, and how much of the building had been constructed. When possible, the new marker was tied to the old marker. An adjusted initial elevation was established for the new marker so that an uninterrupted settlement observation for the marker could be maintained.

The unavailability of settlement data for extended periods of time may be attributed to such factors as:

- inaccessibility of settlement markers as a result of equipment placement, temporary floor removal, etc.
- unclear directions as to which organization should have responsibility following transfer of the survey program from Bechtel to Entergy Operations.
- lack of UFSAR guidance on post-construction survey requirements following completion of the construction phase.

In 1982, Corrective Action Request (CAR 577) was issued to document the fact that the settlement survey was not being conducted. As a result of NPE's assessment in addressing CAR 577, the survey frequency was changed and the FSAR updated accordingly. The UFSAR now requires a survey at six month intervals for five years following completion of construction and annually thereafter. In addition, inaccessible markers were relocated, in some cases outside the existing building, making them more accessible.

Since these improvements have been implemented, settlement surveys have been performed at six month intervals, except for the turbine pedestals which are surveyed during outages.

Request

2.B) Describe the surveying procedures used to re-establish the destroyed settlement markers, paying special attention to:

i) The Quality Assurance aspects of accurately transferring the settlement data from the destroyed markers to the new markers, and

ii) The proper maintenance and assurance of the accuracy of permanent benchmarks used in settlement monitoring.

Response

In a meeting with the NRC on April 16, 1990, GGNS reviewed the applicable surveying procedures. Of note:

Bechtel Construction Phase

The settlement markers were placed on columns, walls, and foundations of the various structures. Normal construction activities such as the addition of floors, walls, cable trays, or equipment would destroy or cause a marker to become inaccessible. When possible, the replaced or relocated marker was tied to the old marker using 3-wire leveling with elevation and settlement readings recorded to the nearest 0.001 foot. An adjusted initial elevation was provided for the new marker providing an uninterrupted settlement observation. Data collected was recorded in a Settlement Data Table with locations of markers shown on Drawing C-0132.

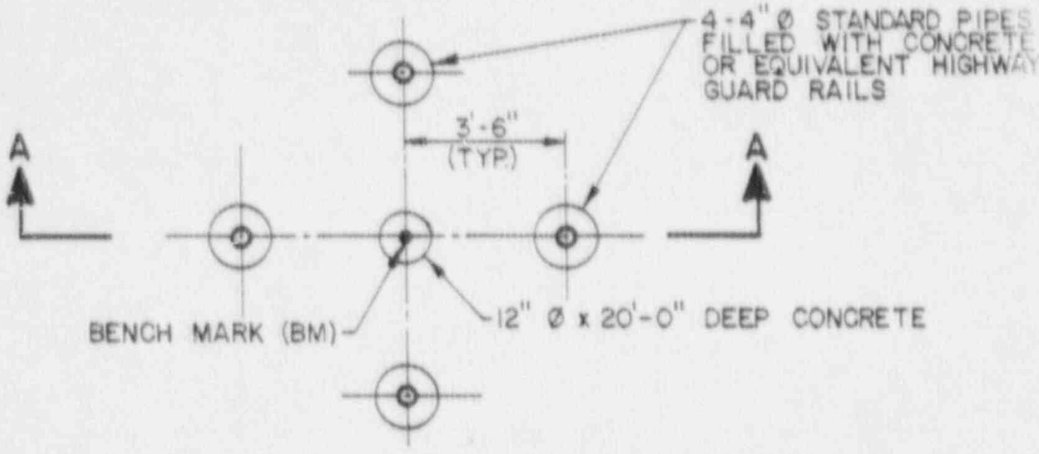
The settlement markers were read at approximately 30 day intervals. A set of settlement graphs were also prepared showing total settlement for each structure against time. This work was performed in accordance with Specification 9645-C-195.0 of the Bechtel Construction Program.

Operation Phase

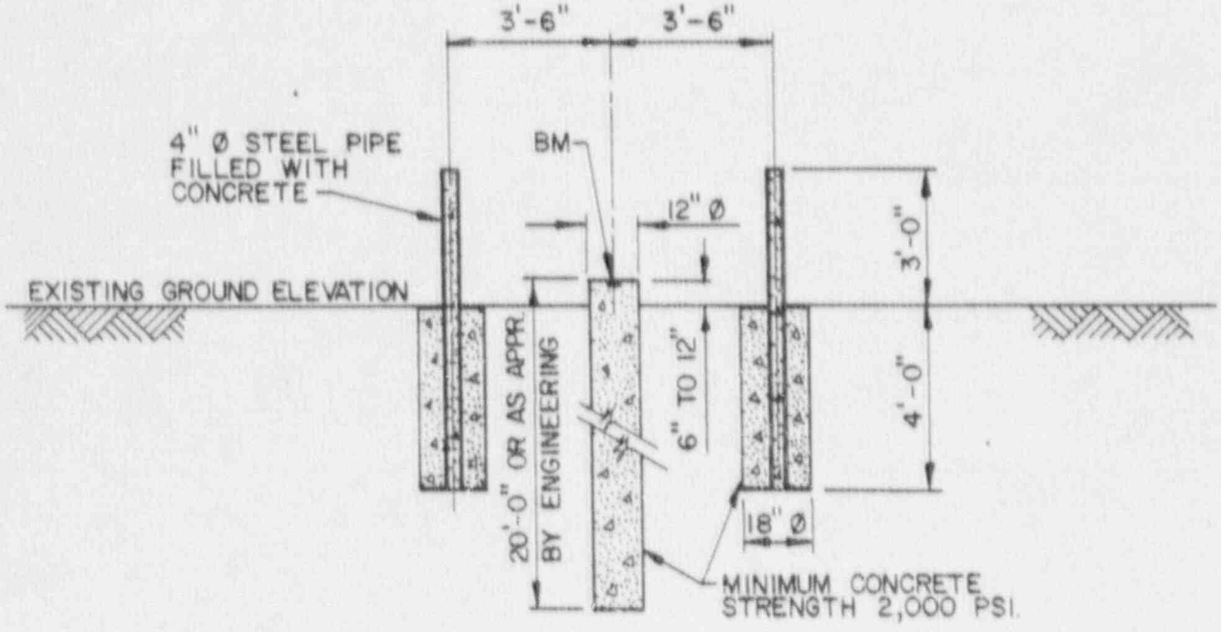
There have been no settlement markers destroyed since the Surveying Monitoring Program was turned over to Entergy Operations. Any future destruction of settlement markers will be documented on nonconformance reports with new markers being installed per a controlled design change program with QP inspections.

Permanent Benchmarks

The two permanent bench marks are located within the Owner Controlled Area of the plant site. These markers are located away from any major structure to prevent disturbance to the bench marks. Permanent bench mark no. 1 is located between the security boundary fences south of the Unit 1 warehouse and requires a security guard to unlock a security gate for admittance. Permanent bench mark no. 2 is located approximately 300 feet northwest of the Unit 2 Turbine Building and is protected by 4 steel posts (see attached Figure 2).



PLAN



SECTION A-A

FIGURE 2

Request

2.C Provide a report describing the proposed improvements in surveying procedures that were identified in the August 16, 1990 Summary of the Meetings on April 16-17, 1990.

Response

The GGNS Settlement Monitoring Program was established in 1976 using the Coast and Geodetic Survey's Manual of Geodetic Leveling, Special Publication No. 239. At that time, three-wire leveling was considered the most precise method for the determination of elevation and was used during construction of GGNS. Special Publication No. 239 was superseded in 1981 by NOAA Manual NOS NGS 3, Geodetic Leveling, and the present surveying method used at GGNS does not meet first-order requirements of this document.

Although the GGNS Settlement Monitoring Program continues to meet the requirements under which the plant was licensed, the following improvements are being evaluated for potential enhancement:

1) Establish points so that differential settlement between structures can be directly measured.

2) Upgrade survey equipment for increased accuracy.

3) Establish points to directly monitor the horizontal seismic gap between Category I structures.

4) Monitor the identified surface cracks on the exterior walls of the Turbine and Auxiliary Buildings.

5) Monitor the condition of walls in direct contact between the Auxiliary and Containment Buildings.

Request

3.0 Discuss the results of groundwater monitoring at the site and provide an evaluation of the effects of fluctuation in groundwater level, if any, on the stability and settlement of structures.

Response

Groundwater Monitoring

From January through July, 1983, Well DW-8 (see Figure 3) exceeded the design maximum groundwater elevation of 109.00 ft. MSL. The highest water level recorded during this period was 110.21 ft. MSL in February, 1983. The high groundwater elevation was reported to NRC via AECM-84/0020 in March, 1984. Since this initial exceedance, there have been additional groundwater level exceedance events. These were reported in March, 1985 (AECM-85/0088), February, 1986 (AECM-86/002), March, 1986 (AECM-86/0202), March, 1990 (AECM-90/0062), April, 1990 (AECM-90/0083) and September, 1990 (AECM-90/0183).

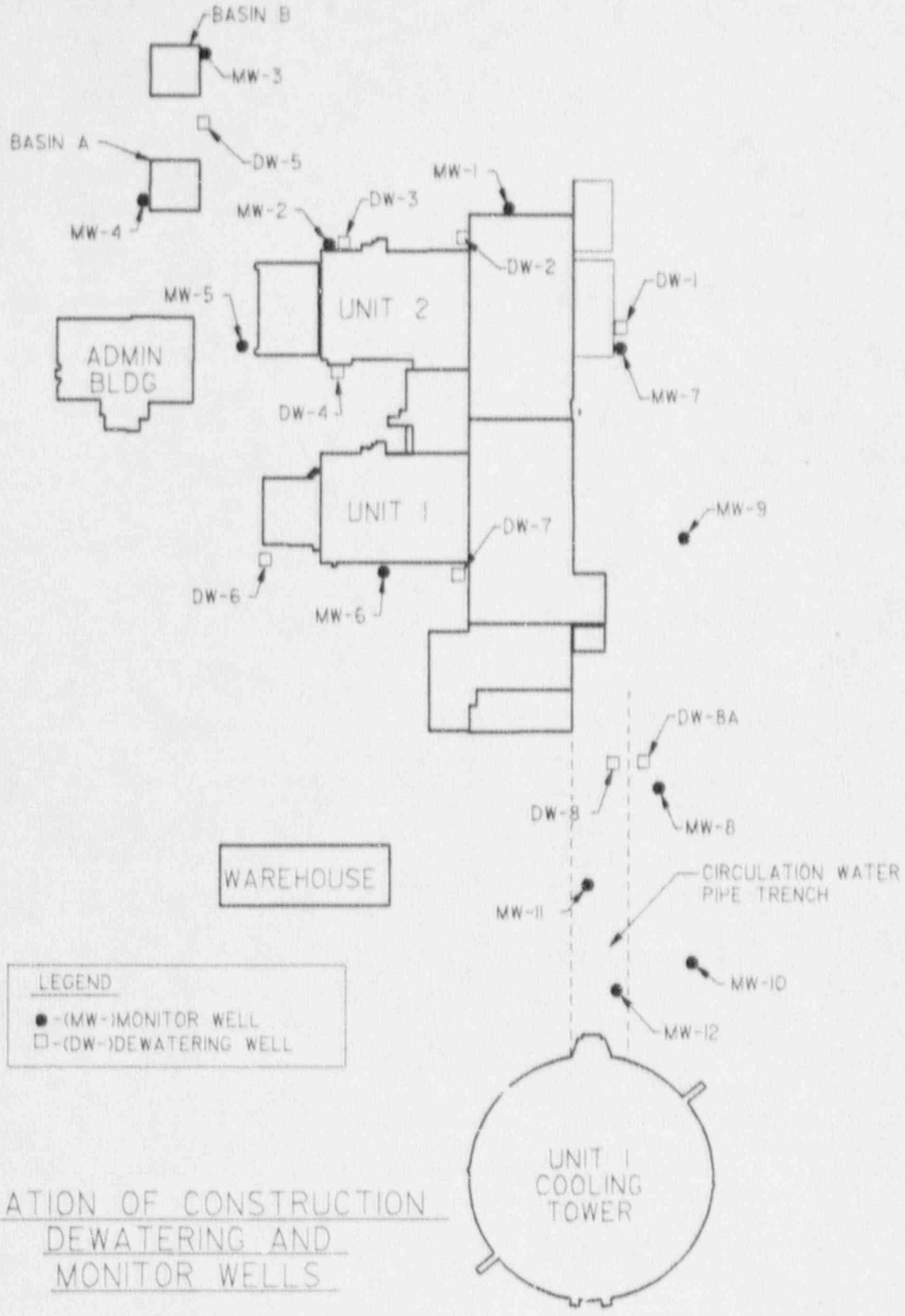
Presently, data is still being obtained to help further clarify flow patterns and sources of recharge. Additional monitoring wells are being installed along with a visual examination of the cooling tower basin and circulating water pipes during RF04. In response to a separate NRC request a more thorough report addressing groundwater monitoring at GGNS will be completed and submitted to the NRC by the end of December, 1990.

Effects of Fluctuation in Ground Water Level

In predicting the settlement of structures, two groundwater level elevations were considered is the FSAR: Elevation 78.0 ft. MSL and 109.0 ft. MSL. The results are provided in FSAR Fig. 2.5-90. In this figure, the calculated total settlement is provided for each structure for each groundwater elevation. These values are in close agreement to the present actual settlement. In addition to this evaluation, a structural analysis was performed for Unit 1 structures for higher groundwater level and provided to the NRC in a letter dated February 14, 1985, (AECM-85/0035). This analysis showed that an adequate factor of safety exists in the power block area for groundwater levels as high as 114.5 ft. MSL in the vicinity of the Control Building and Standby Service Water Basins and 117 ft. MSL in the area of other safety related power block structures.

In response to the structure analysis, the NRC SER dated August 19, 1985 (MAEC-85/0284) concluded that levels up to 114.5 ft. MSL should not compromise safety related structures. The SER requested reporting of any ground water levels above 109 ft. MSL, and resolution by December, 1990, or provide status and schedule for resolution.

Water levels above 109 ft. MSL have been exceeded only around DW-8 by less than three feet. Other areas around the plant have generally been within the expected range. It is therefore concluded that the minor fluctuations have had a negligible effect upon plant settlement. As noted above, a more thorough report addressing groundwater monitoring at GGNS will be completed by the end of December, 1990.



LOCATION OF CONSTRUCTION DEWATERING AND MONITOR WELLS

FIGURE 3

Request

4. Provide draft amendments to the relevant updated FSAR sections incorporating your responses to the questions above.

Response

Following issuance of this letter, as with all letters issued to the NRC, an UFSAR impact screening will be performed. Information from this letter will be used to update the UFSAR to be consistent with the present level of detail contained in the UFSAR and per guidance of Reg. Guide 1.70, Rev. 3. Any required revisions to the UFSAR will be made and submitted during the next scheduled update period (Rev. 6).

At a minimum, it is expected that UFSAR Table 2.5-10 would be updated to reflect information provided in response to request number 1. In addition, there may be minor additions/rewrites of UFSAR sections 2.5.4.13.1 and/or 2.5.4.6.