GULF STATES UTILITIES COMPANY
POST OFFICE BOX 2951 · BEAUMONT, TEXAS 77704
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March 29, 1984
RBG- 17,448
File Code G9.5, G9.8.6.2

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Denton:

River Bend Station Unit 1
Docket No. 50-458

Enclosed for your review are Gulf States Utilities Company's supplemented responses to items identified by the Nuclear Regulatory Commission's Structural and Geotechnical Engineering Branch (SGEB). Enclosure 1 provides the response which will be included in a future amendment to the FSAR.

Sincerely,

Eddie R Grant

for J. E. Booker
Manager-Engineering
Nuclear Fuels & Licensing
River Bend Nuclear Group

JEB/RJK/je

Enclosures

B001
1/1

initial (ρi) plus 100 percent (final) consolidation (ρcf) heave ($\rho i+\rho cf$) indicating that reloading (backfilling) occurred prior to complete consolidation heave. The detailed estimates ($\rho i+\rho c$), which account for partial consolidation, generally follow the measured data through the stripping, dewatering, excavation, and backfilling stages of construction showing excellent agreement.

Concentrating on instrument locations E2 and E4 within the excavation where the majority of the stress changes occur, the plots show that the estimates of final consolidation and measured deformation agree closely at the end of 1978. The measurements also show little movement during recharge. Both these facts infer that actual consolidation may be nearly complete. 2

The detailed estimates, however, indicate greater net movements than measured at the end of 1978. The detailed estimates also slightly underestimate the maximum heave. It is reasoned that if the rate of consolidation were increased in the analysis, the estimate would more closely follow the plots of measured deformation and lie between the detailed estimate and the 100 percent consolidation estimate. From these comparisons it is concluded that the behavior of the foundation soils during excavation and backfilling was as expected. The theoretical analysis, soil modeling, and soil parameters used in the analysis were sufficient to define the behavior. The foundation soils are expected to continue to behave in a manner consistent with the design assumptions.

2.5.4.13.2.2 Category I Structure Settlement Monitoring Results

The results of the ongoing Category I structure settlement monitoring program are shown on Figures 2.5-98 through 2.5-106. [Insert 1] These settlement history plots are presented on a building-by-building basis. All markers for a given structure are included on the plot for the structure. [Insert 2] 11

The plots indicate that most of the settlement occurred during the time period in which there was relatively rapid application of load. By the end of ~~1982~~ 1983 (Day 1187), when most of the loading (structural and backfill) was in-place, the plots generally show a leveling-off in the rate of settlement. The observed magnitudes and time rates of settlement indicate that the estimated values are conservative and that the performance of the foundation systems is satisfactory. [Insert 3]

Inserts

For FSAR Page 2.5-129

Insert 1

Figure 2.5-106a shows the location of settlement markers in the Unit 1 area.

Insert 2

Each plot shows the date of completion of the structures roof. Although the percentage of load in place at that time varies with each structure, the roof completion date may be taken as indicating the time at which approximately 90 percent of load was in place.

Insert 3

Furthermore, the settlement history plots all show a general flattening which indicates the additional settlement due to secondary compression will be small. This is consistent with conclusions drawn by Swiger (Ref 102) that secondary compression will be small where material has been preloaded to values in excess of the structure load. Based on information provided in Section 2.5.4.2.5, the natural material in the site area has experienced a geologic preload in excess of the present loadings. Additionally, the engineered backfill experienced heavy preloading during compaction. Consequently, it is expected that secondary compression effects will be small, and the observed settlement of plant structures confirms this position.

With the exception of marker 34

A comparison of predicted and measured values for total settlement of Seismic Category I structures is shown on Table 2.5-19. In all cases the measured values are less than the total predicted. A comparison of predicted and measured differential settlements is shown on Table 2.5-20. Insert 4 For all points of interest, measured differentials are within the predicted range.

As can be seen from Table 2.5-19, both predicted and measured settlements are essentially uniform across the plant site. This is expected because of the extensive zone of influence of the main excavation area. As is shown in Section 2.5.14.13.2.1, approximately 75 percent of the
11 movement that occurred during the excavation and backfilling operation through 1978 was attributable to strain of the soils below elevation 200 ft. Similarly it is expected that the majority of settlement in the plant area will be the result of strain in the deep soils. Consequently, it is anticipated that differential settlement between adjacent points in the plant area will be small.

This hypothesis is confirmed by the values for measured differential settlement presented in Table 2.5-20. In the case of directly buried Seismic Category I piping, no significant differential settlement between a building and the surrounding soil is expected. Since settlement is a result of strain in the deeper soils, settlement of the soil adjacent to a building will take place essentially as the building settles. Consequently, differential settlement Insert 5 between buried pipes and structures is not monitored.

GSU will continue to monitor deformations until there is essentially no evidence of settlement for 3 months or until
2 construction is complete, whichever is longer. No evidence of settlement shall mean no movement greater than the allowable tolerances for a first order level survey. Once no evidence of settlement has been achieved, a confirmatory program of monitoring will be initiated. This confirmatory program will monitor one marker on each Seismic Category I building on a once per 2 yr basis for the first 10 yr.

After any seismic event greater than or equal to an operating basis earthquake (OBE) an additional set of confirmatory readings will be taken.

Settlement monitoring is performed as described above. The results of this program will be used to verify that actual settlements do not result in excessive differential
11 settlements between structures.

Insert 4, Page 2.5-129a

This discrepancy is attributable to the method of correcting the predicted settlement at marker 34 for the effects of construction schedule. Readings at marker 34 were initiated in April 1981. Consequently, settlement that occurred prior to that date due to the addition of loads in adjacent areas is not reflected in the observations. In order to make a meaningful comparison between the observation and the prediction, it was necessary to adjust the prediction based on observation at an adjacent marker. In general this is accomplished by deducting from the total calculated settlement the amount of settlement that has occurred at an adjacent marker as of the date of the first reading on the marker in question. In this case, the nearest marker is marker 32 on the Standby Service Water Tower, this marker is located approximately 120 ft from marker 34 in an area that is more heavily loaded than the area around marker 34. Therefore, it is reasonable to expect that marker 32 settled more than the location of marker 34 prior to April 1981. Consequently, the corrected prediction of settlement for marker 34 is too low. For all other markers, predicted settlement exceeds measured settlement.

Insert 5, Page 2.5-129a

This may be demonstrated by examining the settlement records for BF Tunnel (Figure 2.5-103). BF Tunnel exerts a bearing pressure of approximately 2.3 ksf at an average elevation of 65 ft msl. The load that would be exerted by an equivalent volume of backfill is approximately 3.6 ksf. As shown in Table 2.5-17 bearing pressures for the Fuel, Diesel Generator, and Reactor Buildings vary from 6 to 8 ksf.

Figure 2.5-103 shows that settlement of the BF tunnel (Markers 9 & 10) has been essentially uniform. The differential settlement over the length of the tunnel is 0.12 in. In the period between September 1981 and December 1983, markers 9 and 10 settled approximately 0.66 in. and 0.78 in., respectively. In the same period of time, the west side of the Diesel Generator Building, markers 3 and 4 (Figure 2.5-98) settled 0.48 and 0.84 in., respectively, and marker 12 on the east side of the Fuel Building (Figure 2.5-1-1) settled 0.90 in. The differential settlement between the east end of BF Tunnel and the Diesel Generator Building may be computed as the difference between the average settlements of markers 3 and 4 and the settlement at marker 9, Or (0.48 + 0.84)/2 - 0.66 = 0 in. Between the west end of BR Tunnel and the Fuel Building, differential settlement is 0.90 - 0.78 = 0.12 in.

Predicted differential settlement can be determined using the values presented in Table 2.5-19 and the observed settlements as of September 1981. For markers 3 and 4, the observed settlements in September 1981 were 1.6 in. and 1.5 in., respectively. Settlement remaining after September 1981 is therefore the predicted total minus the measurement, or 3.8 - 1.6 = 2.2 in. for marker 3 and 4.0 - 1.5 = 2.5 in. for marker 4. The average for markers 3 and 4 is 2.35 in.

For marker 9, settlement remaining after September 1981 equals total settlement or 2.4 in. Therefore, predicted differential settlement equals 2.4 - 2.35 = 0.05 in., which compares favorably with the observed differential settlement of 0 in.

Similarly for marker 12, settlement remaining after September 1981 is 4.5 - 1.5 = 3.0 in. For marker 10, post-September 1981 settlement equals total settlement or 3.0 in. Predicted differential therefore equals zero, which compares favorably with 0.12 in. observed differential.

In the case of the remote air intake line HVC-018-7-3, (Figure 2.5-107), similar behavior may be expected. As shown on Figure 2.5-107, sheet 2, the soil profile below this line is equivalent to the soil profile below BF Tunnel. Predicted settlement for a

Insert 5 (cont'd.)

point on the line 50 ft east of the Fuel Building has been calculated as 3.9 in. As shown on Table 2.5-19, predicted total settlement is 2.4 in. for marker 9 and 4.1 in. for marker 11. The predicted settlement for marker 9, however, includes a correction for construction schedule. Settlement readings were initialted in September of 1981 for marker 9 as compared to March 1980 for adjacent marker 3. Between march 1980 and September 1981, the settlement at marker 3 was 1.6 in. This value was deducted from the prediction for marker 9 so that a more meaningful comparison between observation and prediction could be made. Similar corrections were made to the predictions for markers 10, 38, 29, 33, and 34 for which initial readings were delayed in relation to other markers due to construction schedule.

The uncorrected prediction of total settlement at marker 9 is 2.4 + 1.6 = 4.0 in. Maximum differential settlement between marker 9 and a point on the remote air intake line 50 ft from the Fuel Building is 4.1 - 3.9 = 0.2 in. Maximum differential settlement between the same point on the remote air intake and marker 9 is 4.1 - 4.0 = 0.1 in. In both cases, the structure moves down relative to the pipe. To account for uncertainties in the analysis, the pipe is designed for 0.5 in. of differential settlement.

Given the good agreement between the prediction and the observation of settlement of BF Tunnel and the similarity of soil profiles and loadings between BF Tunnel and the remote air intake, it is concluded that predicted differential settlement is a conservative estimate of the real differential settlement.

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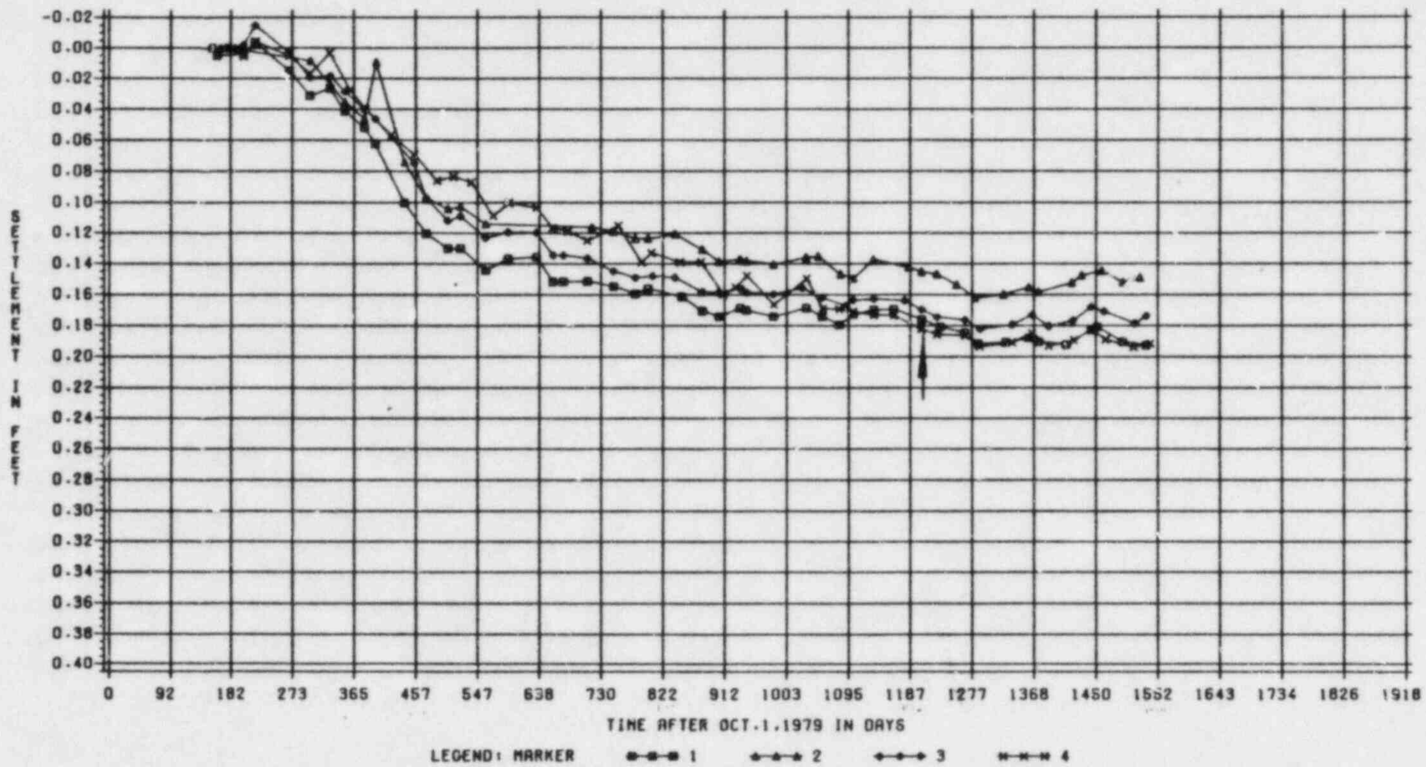
RBS FSAR

TABLE 2.5-19

TOTAL SETTLEMENTS OF MAJOR STRUCTURES

Settlement Marker No.		Predicted Total Settlement (In)		Measured Total Settlement (In)	
		Unit 2 In Place	Unit 2 Excavated	As of June, 1983	As of December, 1983
Diesel	1	3.5	3.4	2.3	2.3
Generator	2	3.8	3.7	1.8	1.8
Building	3	3.8	3.6	2.2	2.1
	4	4.0	3.8	2.2	2.3
Control	5	3.8	3.7	2.1	2.1
Building	6	3.4	3.3	1.8	1.7
	7	4.0	3.7	2.0	2.1
	8	4.0	3.7	1.9	2.0
BF Tunnel	9	2.4	2.1	0.5	0.6
	10	3.0	2.5	0.7	0.8
Fuel	11	4.1	3.7	2.1	2.2
Building	12	4.5	4.0	2.3	2.4
	13	4.4	3.5	1.6	1.7
	14	4.7	3.8	1.9	1.9
Reactor	15	4.6	4.0	2.2	2.4
Building	16	4.5	4.0	2.4	2.4
	17	4.9	4.0	2.4	2.4
Auxiliary	18	4.2	3.8	2.3	2.4
Building	19	4.1	3.6	2.1	2.1
	20	4.9	3.9	2.4	2.5
	21	4.7	3.7	2.4	2.4
Main Steam	22	4.5	3.8	2.0	2.0
Tunnel	23	4.4	3.8	1.7	1.9
Turbine	24	4.3	3.7	1.7	1.8
Building	25	3.6	3.1	1.6	1.7
	26	4.4	3.7	1.8	1.9
	27	3.7	3.1	1.7	1.8
E Tunnel	28	4.4	3.8	1.7	1.7
	29	3.8	2.8	1.4	1.4
Standby	30	3.8	2.7	1.5	1.5
Service	31	4.4	3.2	1.6	1.7
Water Tower	32	4.3	2.4	1.4	1.4
G Tunnel	33	3.6	2.6	1.2	1.2
	34	3.8	0.4	0.8	0.7

DIESEL GENERATOR BUILDING SETTLEMENT



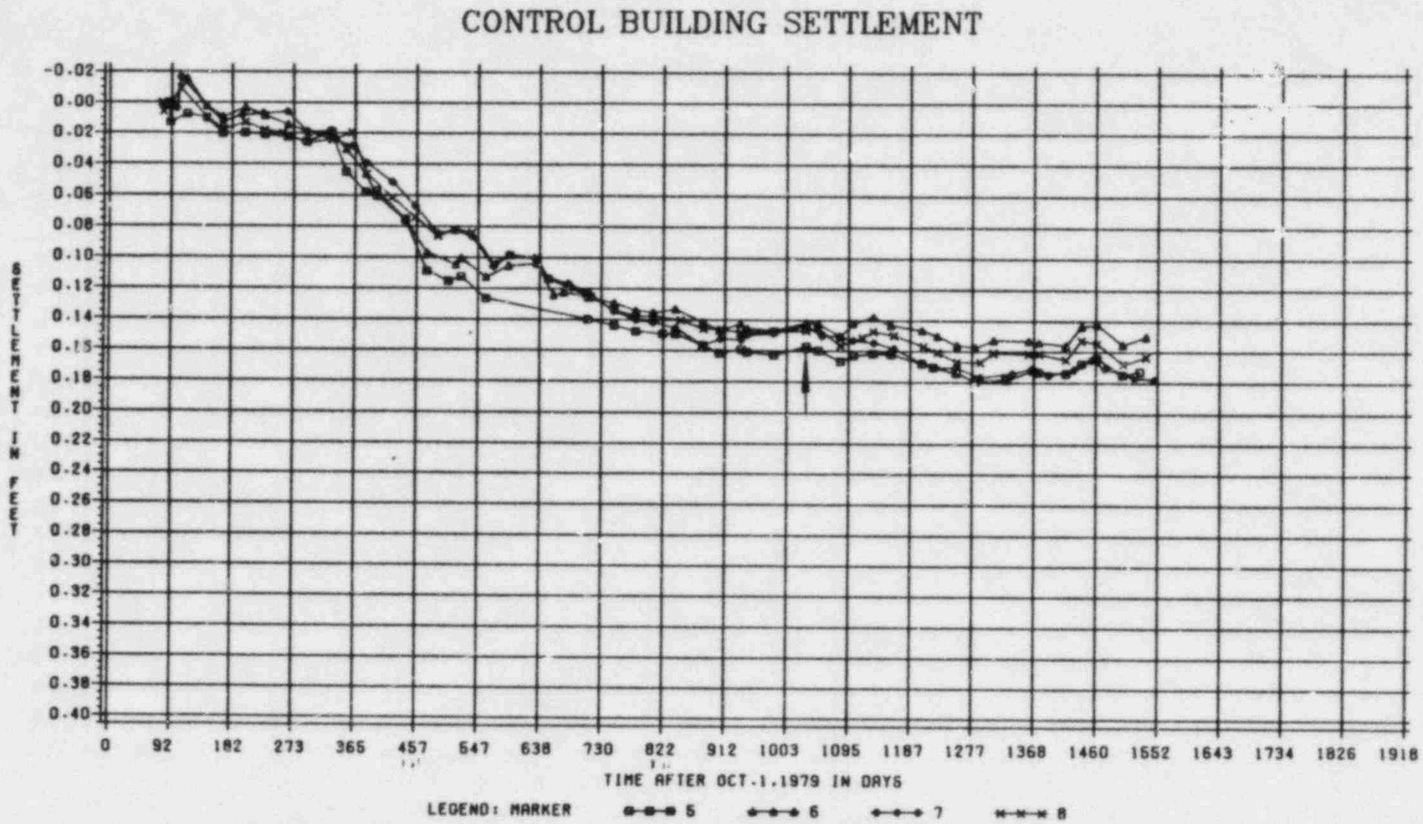
NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT ARE SHOWN ON TABLE 2.5-19

| - INDICATES DATE OF COMPLETION OF ROOF

FIGURE 2.5-98

SETTLEMENT HISTORY
DIESEL GEN. BLDG

RIVER BEND STATION
FSAR

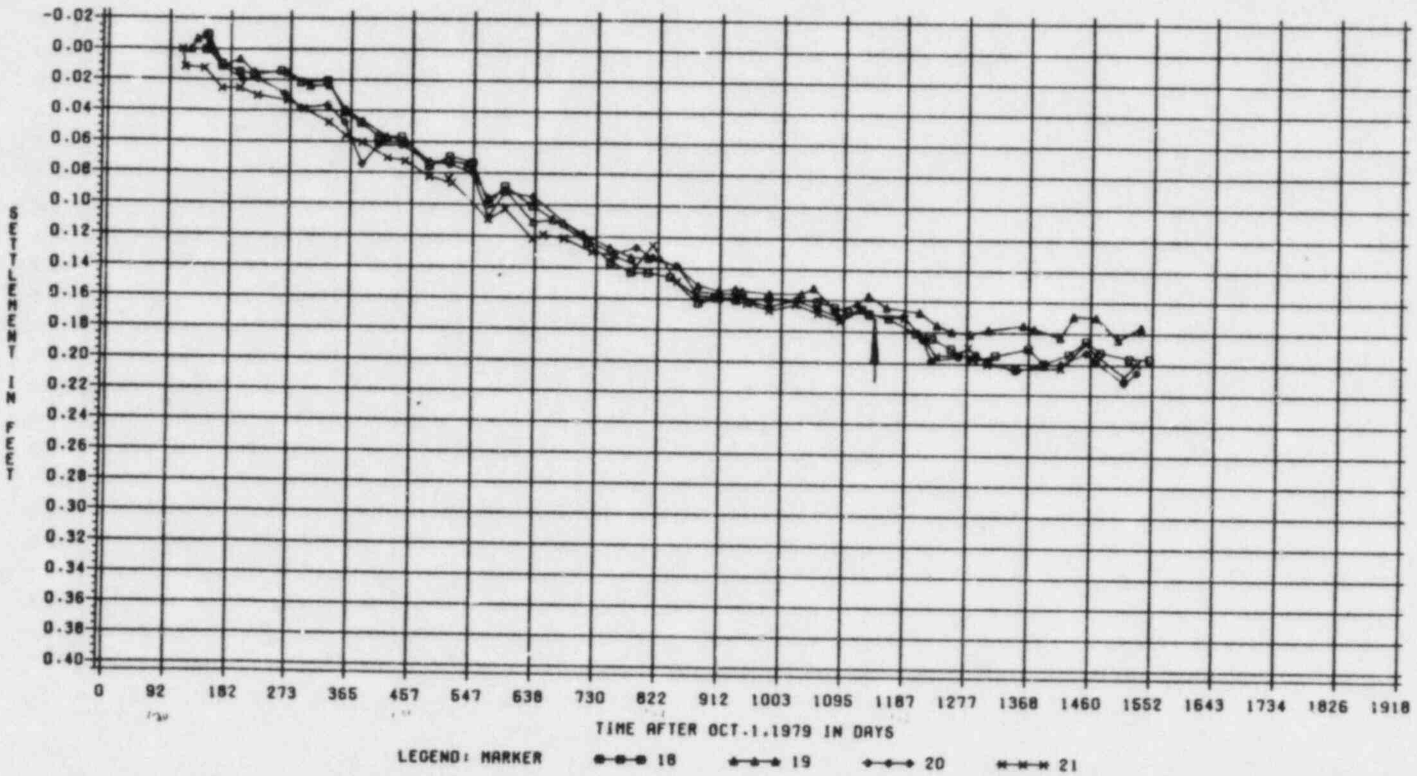


NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT ARE SHOWN ON TABLE 2.5-19

| - INDICATES DATE OF COMPLETION OF ROOF

FIGURE 2.5-49
SETTLEMENT HISTORY CONTROL BLDG
RIVER BEND STATION FSAR

AUXILIARY BUILDING SETTLEMENT

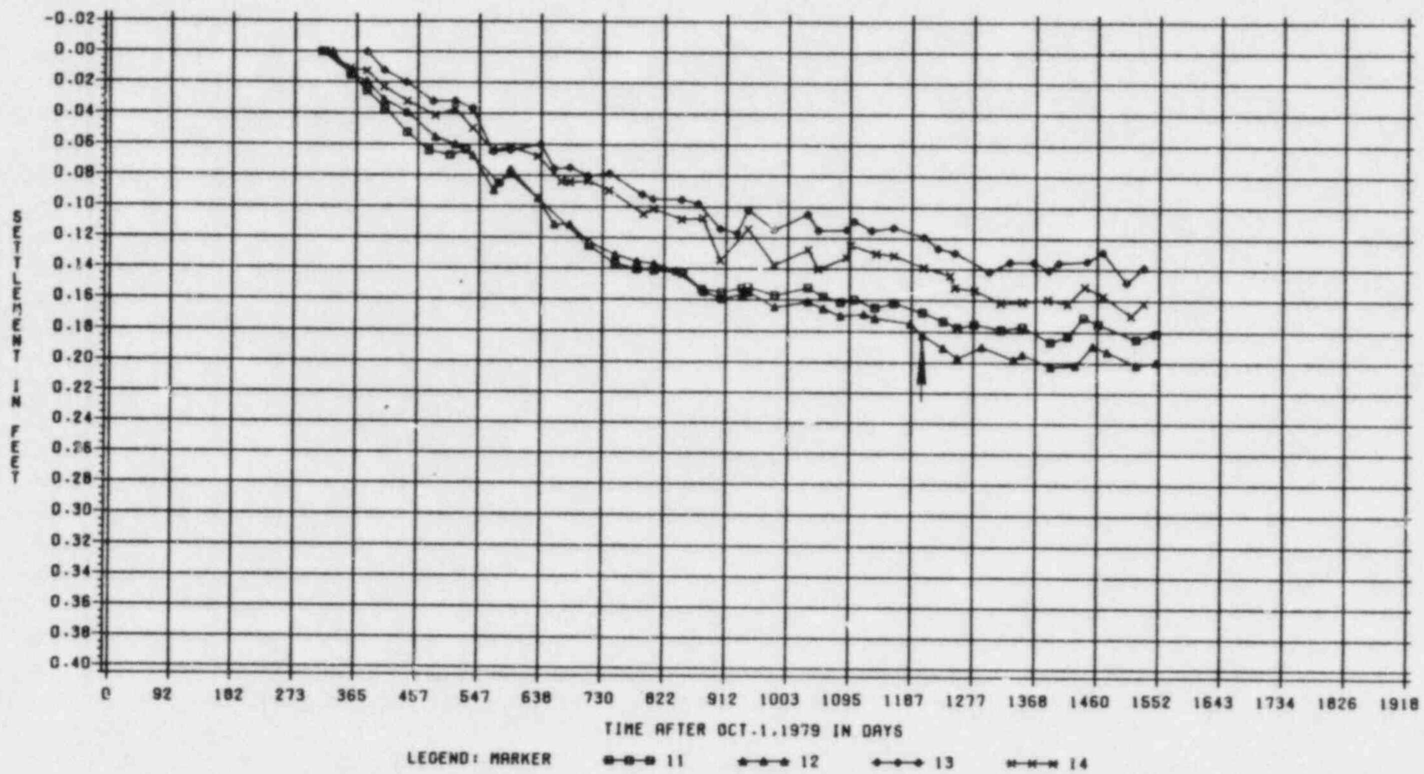


NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT ARE SHOWN ON TABLE 2.5-19

- INDICATES DATE OF COMPLETION OF ROOF

FIGURE 2.5 - 100
SETTLEMENT HISTORY
AUX BLDG
RIVER BEND STATION
FSAR

FUEL BUILDING SETTLEMENT



NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT ARE SHOWN ON TABLE 2.5-19

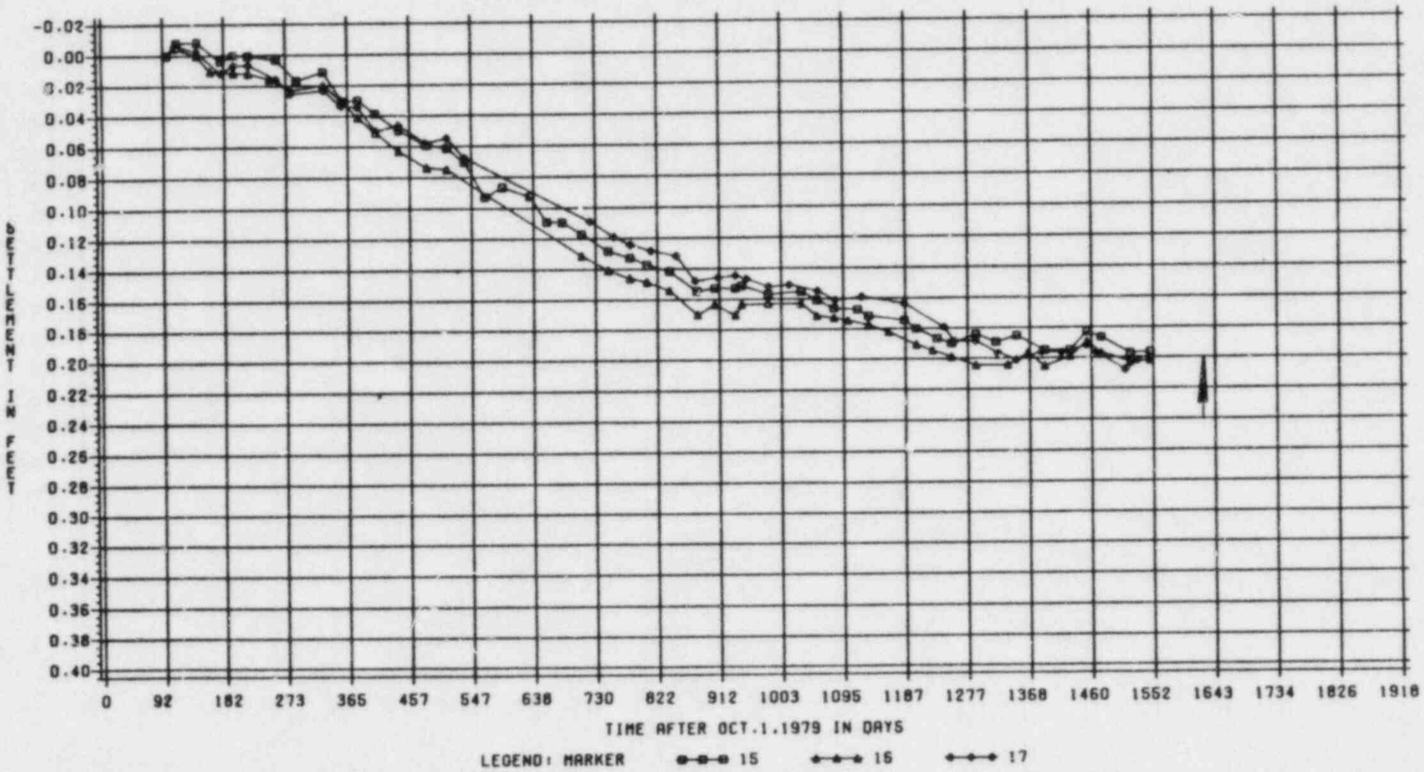
↑ - INDICATES DATE OF COMPLETION OF ROOF

FIGURE 2.5-101

SETTLEMENT HISTORY FUEL BLDG

RIVER BEND STATION FSAR

REACTOR BUILDING SETTLEMENT



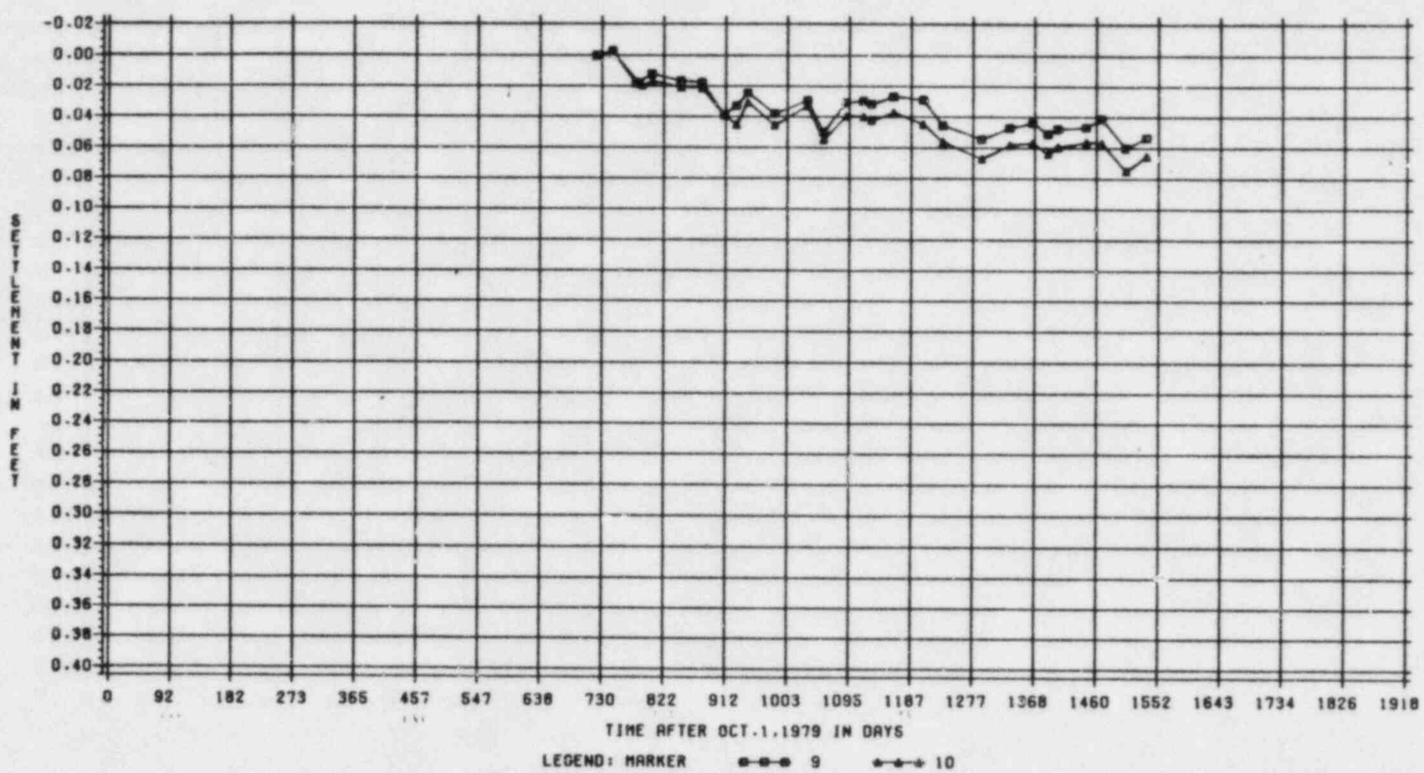
NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT ARE SHOWN ON TABLE 2.5-19

| - INDICATES DATE OF COMPLETION OF ROOF (PLANNED)

FIGURE 2.5-102
SETTLEMENT HISTORY REACTOR BLDG
RIVER BEND STATION FSAR

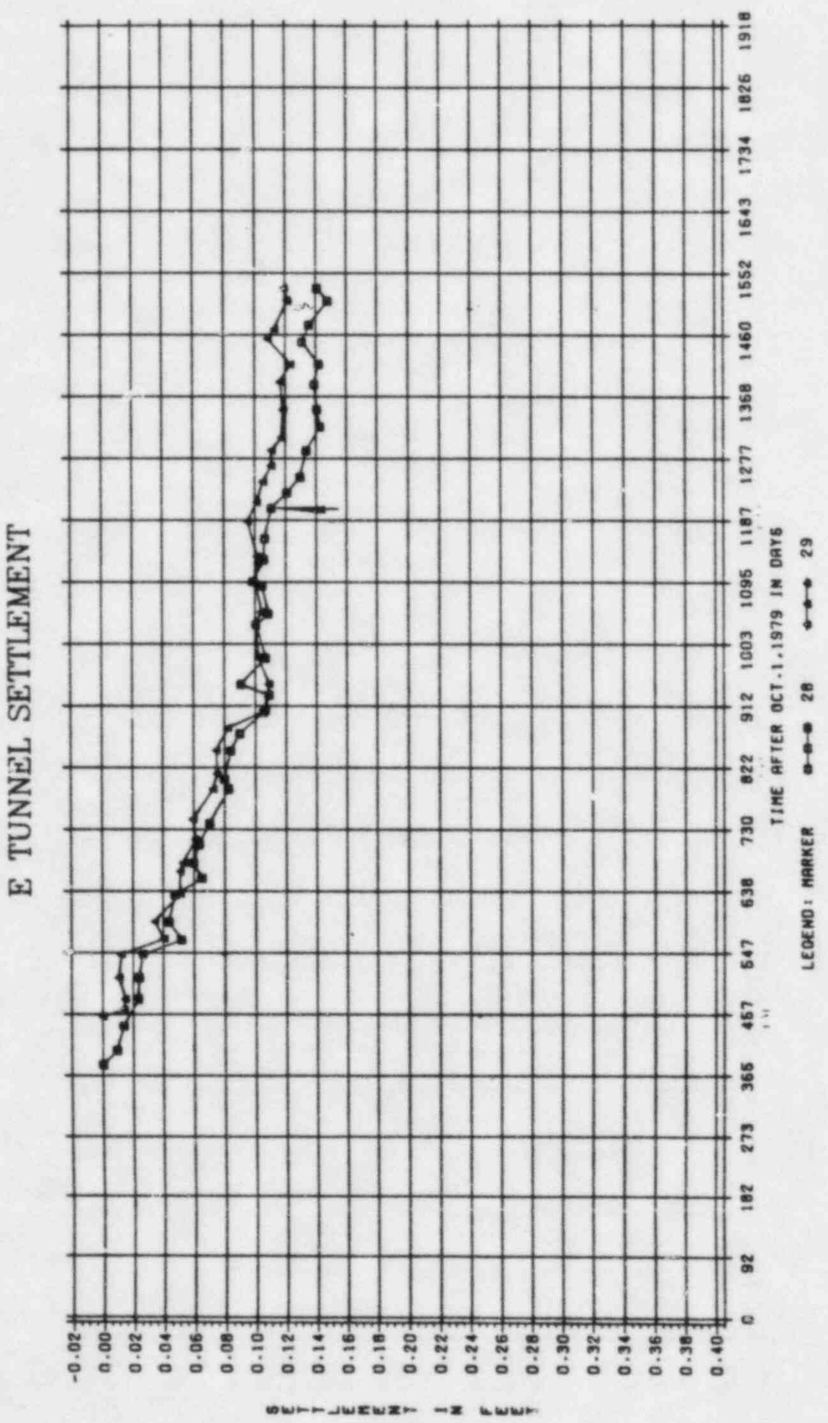
Enclosure 1 (cont'd.)

BF TUNNEL SETTLEMENT



NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT ARE SHOWN ON TABLE 2.5-19

FIGURE 2.5-103
SETTLEMENT HISTORY BF TUNNEL
RIVER BEND STATION FSAR

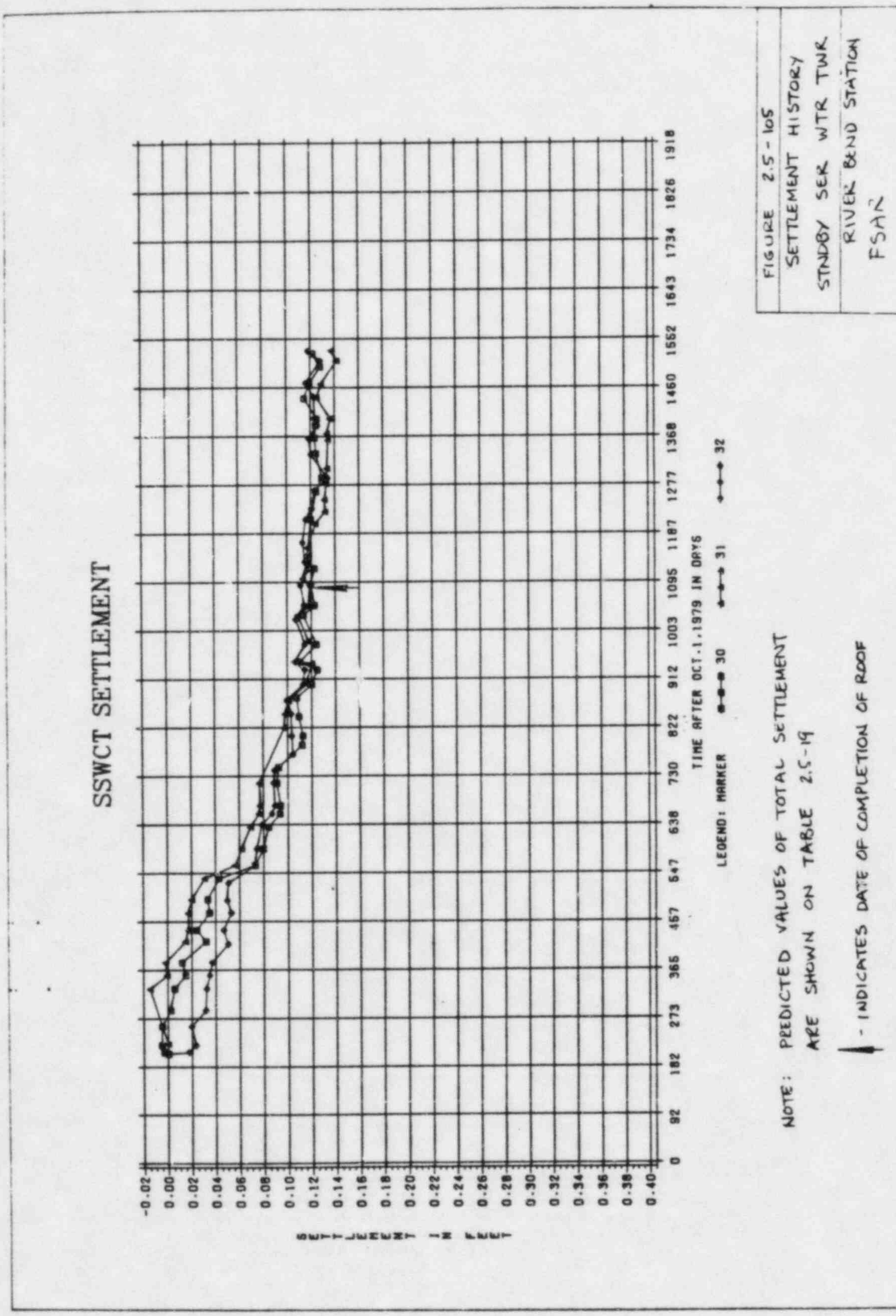


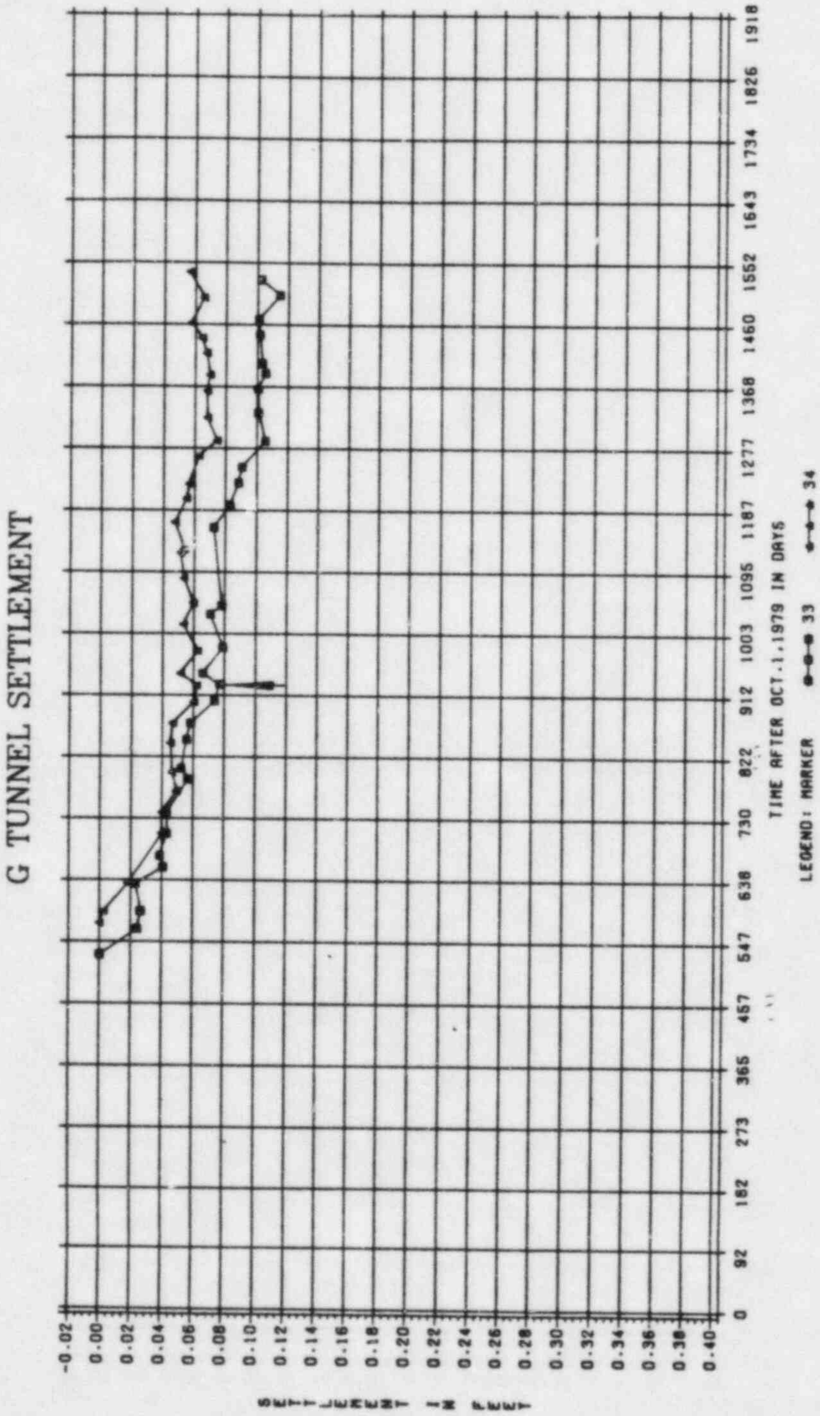
NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT ARE SHOWN ON TABLE 2.5-19

| - INDICATES DATE OF COMPLETION OF ROOF

FIGURE 2.5-104
SETTLEMENT HISTORY
E TUNNEL

RIVER BEND STATION
FSAR


SSWCT SETTLEMENT
SETTLEMENT IN FEET
-0.02 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30 0.32 0.34 0.36 0.38 0.40
0 92 182 273 365 457 547 638 730 822 912 1003 1095 1187 1277 1368 1460 1552 1643 1734 1826 1918
TIME AFTER OCT.1.1979 IN DAYS
LEGEND: MARKER 30 31 32
NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT
ARE SHOWN ON TABLE 2.5-19
- INDICATES DATE OF COMPLETION OF ROOF
FIGURE 2.5-105
SETTLEMENT HISTORY
STNDBY SER WTR TWR
RIVER BEND STATION
FSAR



NOTE: PREDICTED VALUES OF TOTAL SETTLEMENT ARE SHOWN ON TABLE 2.5-19

| - INDICATES DATE OF COMPLETION OF ROOF

FIGURE 2.5-106
SETTLEMENT HISTORY
G TUNNEL

RIVER BEND STATION
FSAR

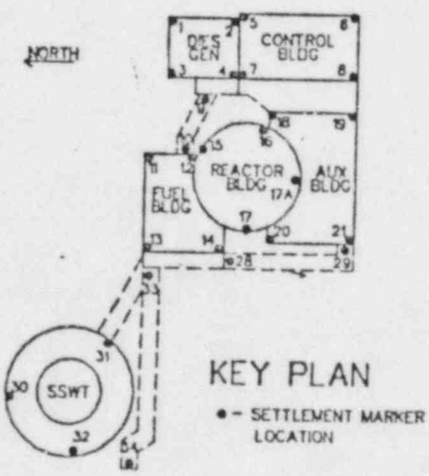


FIGURE 2.5-106a

SETTLEMENT MARKER
LOCATION PLAN - UNIT 1

RIVER BEND STATION
UNIT 1