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March 19, 1990

the southern electric system

W. G. Hairston, III
Senior Vice President
Nuclear Operations

ELV-01376
0261

Docket Nos. 50-424
50-425

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

VOGTLE ELECTRIC GENERATING PLANT
SETTLEMENT MONITORING PROGRAM ADDITIONAL INFORMATION

Shown below are our responses to the request for additional information on our settlement monitoring program as requested in the NRC letter dated November 21, 1989, from Mr. J. B. Hopkins to Mr. W. G. Hairston, III.

Also enclosed are 3 (three) copies of each Attachment referenced in our response.

Request 1(a)

Provide a detailed description of the surveying procedures used to relocate settlement markers including the details of quality control/quality assurance procedures. The staff is particularly interested in the methods and results of relocating markers from inside a structure to a location outside the structure.

Response

The current surveying procedures used by Plant Vogtle to monitor the settlement of major structures are outlined in Nuclear Operations procedure 84301-C. Prior to the issuance of this procedure in November 1989, construction specification X2AP01 section C10.1 governed the technical requirements of the settlement monitoring program. The relocation of a marker is addressed in C10.1.5.C.6. This section states "the elevations of the relocated markers shall be established by a double run in both the forward and backward direction from the original markers using the standards for First-Order Class 2 leveling." An example of this process is shown on Attachment 1. This example shows the relocation of Marker 149 from the base slab of the Auxiliary Feedwater Pumphouse to the exterior wall.

A001 1/3 Drawings
TO: Reg Files-1
J. Hopkins (PM)-2

Specification X2AP01 Section C10.1.2 specifies the quality standards required within the surveying procedures. This section states "first order and second order leveling shall be performed in accordance with accepted standard practice as described in NOAA Manual NOS NGS-3 or other accepted references. In case of conflict between the standard practices used and the requirements of this specification, the more restrictive of the two shall govern."

A copy of the construction specification X2AP01 Section C10.1 has been included in Attachment 2 and a copy of procedure 84301-C in Attachment 3.

Request 1(b)

State if, and how, the surveying procedures used in the settlement monitoring program at Vogtle meet the standards of professional surveying procedures accepted in the field of surveying.

Response

Georgia Power procedure 84301-C section 3.4.1 and construction specification X2AP01 C10.1.2 require all settlement markers to be surveyed to First-Order Class 2 leveling as described in NOAA Manual NOS NGS-3 (Geodetic Leveling) or other accepted references. In case of a conflict between the standard practices used and the requirements of this procedure, the more restrictive of the two shall govern. These requirements assure Vogtle surveying procedures meet standard professional surveying procedures accepted in the field of surveying.

Request 2(a)

Provide a layout and longitudinal section of buried pipelines showing location of markers; areas where the pipes are embedded in soils; and area where they are routed through tunnels.

Response

Sketch SK-A-SMP-001 is enclosed, as part of Attachment 4, to show the layout of all seismic Category 1 buried pipelines and the settlement markers in the area where the pipes enter a seismic Category 1 structure. The isometric drawings for these lines are also included in Attachment 4 to show the routing of these pipes.

Request 2(b)

Provide calculated and actual differential settlements experienced by buried pipes going from soil to Category 1 structures, and compare them with the allowable differential settlements.

Response

All Category 1 buried pipelines entering a structure have been reviewed to compare the calculated and actual differential settlements with the allowable differential settlements. This review was based on the settlement data issued in August 1989. The following is a list of assumptions used for this comparison:

- For conservatism, assume the pipe to have a settlement equal to zero. In other words, the differential settlement between the pipe and the structure will equal the total settlement of the structure from the date the pipe/support was installed.

- No differential settlement loads will be induced in the pipe supports whenever the pipe is embedded in concrete or grout. The system installation date will be based on the installation date of the exterior spools.

- No differential settlement stresses will be induced in the pipe until the support has been installed. This occurs whenever the pipe penetrates a sleeve and movement is allowed. The system installation date will be based on the installation date of the closest support to the penetration.

The results of this comparison are shown in Attachment 5. Please note that for the purpose of this response, we have defined the "calculated differential settlement" as the design differential settlement shown in design criteria DC-1017 of the Vogtle Nuclear Plant Design Manual, the "actual differential settlement" as the settlement obtained from the surveying data of the settlement marker in the area where the pipes enter the seismic category 1 structures, and the "allowable differential settlement" as the maximum differential settlement of piping systems allowed by the ASME Code (reference calculations X4CPS-0167 and X4CPS-0168).

Settlements of the following structures were reviewed:

1) The diesel generator building
2) The diesel fuel oil storage tanks
3) The NSCW valvehouses
4) The tunnels interfacing with the NSCW towers
5) The buried pipes interfacing with these structures.

After compiling available data, computations were made for the overburden pressure at the center of the marl prior to the start of site excavation and at the end of backfill operations. The initial overburden pressure at the center of the marl was calculated to be 10.26 ksf, and the stress at the center of the marl layer at the end of backfill placement was 11.56 ksf. The increase in stress was due to the compacted backfill unit weight or loads being heavier than the initial medium-dense naturally deposited soils. The corresponding recompression of the marl due to the 90 feet of backfill was estimated to be 1.95 inches.

Using the load history provided in Figure 13 of DC-1000C, the bearing pressures of the referenced structures were computed to determine the consolidation effects in the marl related to the imposed structural loads and the backfill. Using the diesel generator building load condition and backfill weight beneath the foundation slab, a total compression of 1.84 inches was estimated for the marl layer. For this structure and loading condition, the weight of backfill alone (placed to the bottom of the foundation slab at El. 211 ft.) accounted for a full 90 percent of the imposed load on the marl. The final nine feet of backfill placed outside the building, and the weight of the structure itself accounted for the remaining 10 percent.

The effects of these two loading conditions, when computed for the mid-layer depth of the marl, were found to vary by only 1/2 percent. This explains the similar settlements computed for points which can be some distance apart, one point being under the center of the building and the other out in the fill. Newmark's chart and other appropriate stress distribution influence diagrams were used in order to test individual stress cases at a particular point. The difference in settlement (1.95" versus 1.84") denotes a differential settlement of only about 0.1 inch, and would fall within calculated differential settlement of 0.3 inches recorded in Table 7 of DC-1017.

The data displayed in Attachment 5 shows two cases in which the actual differential settlement slightly exceeds the allowable differential settlement. Slightly exceeding the allowable settlement does not represent an overstressed condition because the method of calculating the actual differential settlement (assuming the pipe to have a settlement equal to zero) is proven to be overly conservative by the computations discussed above. These computations determined that the backfill encasing the pipes outside the structures and the building structures themselves have actually settled approximately the same magnitude, which is within the design criteria.

This information should address your questions raised during the inspection held at the Vogtle Electric Generating Plant on September 26, 1989.

Should you have additional questions please inquire.

Sincerely,

W. G. Hairston, III

WGH,III/JLL/gm

Attachments

xc: Georgia Power Company
Mr. C. K. McCoy (w/att. 1-3, 5)
Mr. G. Bockhold, Jr. (w/att. 1-5)
Mr. R. M. Odom (w/att. 1-3, 5)
Mr. P. D. Rushton (w/att. 1-3, 5)
NORMS (w/att. 1-5)

U. S. Nuclear Regulatory Commission
Mr. S. D. Ebneter, Regional Administrator (w/att. 1-3, 5)
Mr. T. A. Reed, Licensing Project Manager, NRR
Mr. R. F. Aiello, Senior Resident Inspector, Vogtle (w/att. 1-3, 5)

Attachment 1

Relocation of Marker 149 (AFWPH Base Slab)
To Marker 149-R (AFWPH Exterior Wall)

Present Elevation of Marker 149 on May 1, 1989 = 214.965

Forward Run = +6.0950 (Marker 149 to Marker 149-R)
Backward Run = -6.0951 (Marker 149-R to Marker 149)

Compute the following corrections and add or subtract to both runs:

- o Instrument Error
- o Temperature
- o Rods Used
- o Curvature and Refraction
- o Orthometric

<u>Computations Without Correction</u>

Elevation of Marker 149 (05/01/89)	= 214.96500
Mean of both runs (using sign of forward run)	= +6.09505
Final Elevation	221.06005

This Elevation, 221.060 is assigned to relocated Marker 149-R.
Note: This is not the elevation of the day of the transfer, but an elevation based on the last reading of the original marker.

ATTACHMENT 2

SPECIFICATION NO. X2AP01

SECTION C10.1

OBTAINING AND RECORDING FOUNDATION SETTLEMENT DATA

CIVIL-STRUCTURAL

CONSTRUCTION SPECIFICATION

FOR THE

GEORGIA POWER COMPANY

ALVIN W. VOGTLE PLANT

UNITS 1 AND 2

BURKE COUNTY, GEORGIA

SPECIFICATION NO. X2AP01

DIVISION C10

SECTION NO. C10.1

OBTAINING AND RECORDING FOUNDATION SETTLEMENT DATA

REVISION 11

March 22, 1988

PROJECT CLASS 62C

BECHTEL JOB 9510
BECHTEL POWER CORPORATION
WESTERN POWER DIVISION
NORWALK, CALIFORNIA

Bechtel Western Power Corporation
ENGINEERS — CONSTRUCTORS
SAN FRANCISCO LOS ANGELES

CIVIL-STRUCTURAL

CONSTRUCTION SPECIFICATION

FOR THE

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REVISION 11

March 22, 1988

PROJECT CLASS 62C

JOB NUMBER 9510
BECHTEL POWER CORPORATION
NORWALK, CALIFORNIA

REV NO	DATE	REVISIONS	ENG	CNTRL	SOILS	APE	PE	PROJ AE	LIC ENG
7	10-18-84	Incorporated CSCN 445 (Paragraph C10.1.6A) General Revision							
6	2-17-84	Incorporated CSCN 416 (Paragraph C10.1.6.B)							
5	7-8-83	Incorporated CSCN 340, Paragraph C10.1.5.A							
4	3-14-80	Incorporate CSCN 98							
3	9-21-79	Incorporate CSCN No. 76							
2	1-23-79	Incorporate CSCN No. 27, Paragraphs C10.1.5,							
Δ		A.3 and 4							
1	8-1-78	General Revision							

REV NO	DATE	REVISIONS	ENG	CHK	EGS	APE	PE	PQ AE	LIC ENG
8	1-6-85	Incorporated CSCN No. 490 (Paragraph							
		C10.1.6.B.5)							
9	10-4-85	Incorporate CSCN No. 542 as modified							
	—	(Paragraph C10.1.5,C,2), General Revision							
10	6-13-86	Incorporate CSCN No. 571 (Paragraph							
		C10.1.7,A,2)							
11	3-22-88	General Revision							

CONTENTS

C10.1.1 PURPOSE

This section covers technical requirements for:

1. Establishing permanent benchmarks, control monuments and settlement markers on major structures to record their settlement.

2. Taking periodic settlement readings at markers installed at selected locations in major structures.

3. Recording settlement data to monitor the settlement of major structures.

4. Settlement data recorded by Georgia Power Company Construction for Bechtel Engineering.

C10.1.2 QUALITY STANDARDS

A. GENERAL

1. Georgia Power Company shall control its activities to the extent applicable so that the quality of items and services furnished will meet the requirements of this specification and other contract documents.

2. First order and second order leveling shall be performed in accordance with accepted standard practice as described in NOAA Manual NOS NGS-3 or other accepted references. In case of conflict between the standard practices used and the requirements of this specification, the more restrictive of the two shall govern.

C10.1.3 DRAWINGS

1. Where reference to drawings is made in this specification the following drawings shall be used.

2. The Bechtel engineering drawings listed below are not attached to this specification but shall be considered to constitute part of this specification.

Drawing No.	Title	
AX2D55V001	Settlement Observation Markers Location and Detail	
AX2D55V002	Settlement Observation Markers Record Table	Sht 1
AX2D55V003	Settlement Observation Markers Record Table	Sht 2

Drawing No.	Title	
AX2D55V004	Settlement Observation Markers Record Table	Sht 3
AX2D55V005	Settlement Observation Markers Record Table	Sht 4
AX2D55V006	Settlement Observation Markers Graph	Sht 1
AX2D55V007	Settlement Observation Markers Graph	Sht 2
AX2D55V008	Settlement Observation Markers Graph	Sht 3
AX2D55V009	Settlement Observation Markers Graph	Sht 4
AX2D55V010	Settlement Observation Markers Graph	Sht 5
AX2D55V011	Settlement Observation Markers Graph	Sht 6
AX2D55V012	Settlement Observation Markers Graph	Sht 7
AX2D55V013	Settlement Observation Markers Graph	Sht 8
AX2D55V014	Backfill Dewatering Observation	
AX2D55V015	Settlement Observation Markers Record Table	Sht 5
AX2D55V016	Settlement Observation Markers Record Table	Sht 6
AX2D55V017	Settlement Observation Markers Graph	Sht 9
AX2D55V018	Settlement Observation Markers Graph	Sht 10
AX2D55V019	Settlement Observation Markers Graph	Sht 11
AX2D55V020	Settlement Observation Markers Graph	Sht 12

Drawing No.	Title	
AX2D55V021	Settlement Observation Markers Record Table	Sht 7
AX2D55V022	Settlement Observation Markers Record Table	Sht 8
AX2D55V023	Settlement Observation Markers Record Table	Sht 9
AX2D55V024	Settlement Observation Markers Graph	Sht 2A
AX2D55V025	Settlement Observation Markers Graph	Sht 3A
AX2D55V026	Settlement Observation Markers Graph	Sht 5A
AX2D55V027	Settlement Observation Markers Graph	Sht 6A
AX2D55V028	Settlement Observation Markers Graph	Sht 7A
AX2D55V029	Settlement Observation Markers Graph	Sht 1A
AX2D55V030	Settlement Observation Markers Graph	Sht 4A
AX2D55V031	Settlement Observation Markers Graph	Sht 9A
AX2D55V032	Settlement Observation Markers Graph	Sht 10A
AX2D55V050	Settlement Summary Turbine Building - Unit 1	
AX2D55V051	Settlement Summary Turbine Building - Unit 2	
AX2D55V052	Settlement Summary Control Building - Sheet 1	
AX2D55V053	Settlement Summary Control Building - Sheet 2	
AX2D55V054	Settlement Summary Containment Building - Unit 1	
AX2D55V055	Settlement Summary Containment Building - Unit 2	

Drawing No.	Title
AX2D55V056	Settlement Summary Fuel Handling Building - Sheet 1
AX2D55V057	Settlement Summary Fuel Handling Building - Sheet 2
AX2D55V058	Settlement Summary Auxiliary Building - Sheet 1
AX2D55V059	Settlement Summary Auxiliary Building - Sheet 2
AX2D55V060	Settlement Summary NSCW Tower 1A
AX2D55V061	Settlement Summary NSCW Tower 1B
AX2D55V062	Settlement Summary NSCW Tower 2A
AX2D55V063	Settlement Summary NSCW Tower 2B

The exact locations of the settlement observation markers shown on drawing AX2D55V001 are provided on the forming drawings for the individual structures.

C10.1.4 REFERENCE ELEVATION MONUMENTS

A.. PERMANENT BENCHMARKS

1. General

a. Construction, with the aid of Engineering, shall set and maintain a minimum of two permanent benchmarks within the property of the plant site. These permanent benchmarks shall be similar to those set by Goldberg, Zoino, Dunnicliff and Associates (formerly Soil and Rock Instrumentation) in 1974 and 1978. Unless otherwise directed by Engineering the deep benchmarks set by Goldberg, Zoino, Dunnicliff and Associates (GZD) shall serve as the permanent benchmarks.

b. Permanent benchmarks shall be located near the structures for convenient access, but a sufficient distance away so that they are outside the influence of foundation settlements, and construction activities. This distance shall be approved by Engineering.

c. The elevation of the benchmarks shall be set from the nearest permanent benchmark established or accepted by the USGS, USC&GS or other nationally acceptable surveying standard or agency. These benchmarks shall be other than the GZD benchmarks.

d. Each benchmark shall be protected by four 4-inch steel pipe guard posts filled with concrete and painted yellow.

e. Periodic elevation checks against the USGS or USC&GS permanent benchmarks shall be made at 6-month intervals throughout the duration of the monitoring program.

f. The existing GZD benchmarks are located at N80+00, E50+00 and N80+00, E139+00.

g. The annular space between the invar rod and the 1 inch diameter pipe shall be kept filled with oil. SAE 80 oil, transformer oil or other light grade oil shall be used.

2. Description of Deep Benchmarks

Each deep benchmark shall include a steel benchmark tip, installed approximately 20 feet into the marl and grouted in position with a cement grout. Three-eighths inch riser pipe shall extend from the tip to a point approximately 10 feet below ground surface. At this level a conversion shall be made to low thermal coefficient invar steel rod. The upper end of the invar steel shall be approximately 1 foot above ground surface. A 1 inch black steel pipe protective sleeve shall be installed over the riser pipe. This protective sleeve is not attached to the benchmark tip or riser pipe and therefore isolates the riser pipe from lateral friction forces. A removable protective cap shall be placed over the invar steel rod as surface protection. Reference SK-2-C-111.

3. Installation Procedure

The installation procedure is outlined below:

a. Advance NW (3 inch) flush joint casing to approximately 5 feet into the stiff clay marl stratum.

b. Advance the borehole using an NW tri-cone roller bit to the design location (approximately 20 feet) in the marl. Flush the hole with clean water until the return water is clear.

c. Remove the drill rods and determine the exact depth of the borehole.

d. Lower the rebar anchor, adding lengths of 3/8-inch steel riser pipe as necessary, heavily greasing the outside of all 3/8-inch pipe couplings and tightening all couplings wrench tight. When the benchmark tip is 10 feet above the bottom of the borehole, and the 3/8-inch steel pipe has reached the surface, convert from the pipe to 1/4 inch invar steel rod and lower the tip until it rests on the bottom of the borehole.

e. Slide the 1-inch pipe over the 3/8-inch riser pipe, adding lengths as necessary, until it comes to rest on the top of the rebar anchor.

f. Lower the polyethylene grout tube to the bottom of the hole, keeping track of lengths. Pull the 1-inch pipe up 15 feet and hold in place at ground surface. Mix 2 bags of cement into 12 gallons of clean water and pump 5 gallons of the mix through the grout tube to fill approximately 14 feet of annular space between uncased hole and rebar anchor. Withdraw the grout tube 20 feet and wash out. Leave to set overnight.

g. Lower the 1-inch pipe to rest on the hardened cement grout, adding more lengths as necessary.

h. Lower the grout tube to 1 foot above the hardened grout. Pump a bentonite slurry, approximately 50 pounds bentonite to 45 gallons water, until undiluted return is noted at the surface.

i. Pull all drill casing.

j. Pull the 1-inch pipe until the bottom is between 5 and 8 feet above the top of the rebar anchor, and clamp in place at the ground surface.

k. Regrout with bentonite slurry to fill the hole, withdrawing the grout tube.

l. Attach anchor plate, top 12-inch long length of 1-inch pipe, survey tip and 1-inch pipe cap. Add cement grout around 1-inch pipe at top of hole to prevent lateral movement as necessary. Benchmark can now be used by disconnecting the 1-inch pipe at the first coupling (not the cap).

4. <u>Procedure to Establish Permanent Benchmark Elevations by Second Order Leveling</u>

a. The maximum limit of the sights shall be 300 feet in length.

b. Backsight and foresight distances shall be approximately equal.

c. Rod readings shall be to the nearest .001 of a foot.

d. Turning points shall be on a metal pin, plate, or well defined points of solid objects.

e. A complete elevation traverse closing at the starting point shall be made. <u>The maximum permissible error in</u> feet will be $\pm 0.035 (\sqrt{\text{distance in miles}})$.

f. Reference Paragraph C10.1.2,A,2.

B. CONTROL MONUMENTS

1. General

a. Control monuments are reference points of known elevation set by Construction throughout the plant site.

b. Selection of control monument locations will be made by Construction and with the approval of Bechtel Engineering after a study of the plant general arrangement drawings so that the monuments will not be subjected to disturbances.

c. The elevations for control monuments shall be established from permanent benchmarks. Periodic elevation checks against the established benchmark shall be made at a maximum of 6-month intervals or when taking level readings of settlement markers at required survey intervals. Control monuments with excessive (>.02 foot) movement shall be replaced in order to continue accurate evaluation of foundation settlement.

d. Control monuments shall consist of concrete placed in a 6 to 8-inch diameter hole 4 feet deep. A brass cap shall be embedded in the top of the concrete.

e. Control monuments which are destroyed or become inaccessible shall be replaced.

f. Each control monument shall be protected by four 4-inch steel pipe guard posts filled with concrete and painted yellow.

2. Procedure to Establish Control Monument Elevations by First Order Leveling

a. The maximum limit of the sights shall be 300 feet in length.

b. Backsight and foresight distances shall be approximately equal.

c. Rod readings shall be to the nearest .001 of a foot.

d. Turning points shall be on a metal pin, plate, or well defined points of solid objects.

e. A complete elevation traverse closing at the starting point shall be made. The maximum permissible error in feet will be $\pm$ 0.017 ($\sqrt{\text{distance in miles}}$). 11

f. Reference Paragraph C10.1.2,A,2.

C10.1.5 SETTLEMENT MARKERS

A. TYPES OF SETTLEMENT MARKERS

1. Settlement markers shall be placed on the columns of structures, set in structure foundations or other places as shown on the drawings.

2. Settlement markers attached to concrete and steel columns shall be located approximately 2 feet above the ground floor.

3. On steel columns the markers shall be a 1-inch round by 2-1/2-inch long steel rod or equivalent, welded to the column. The markers shall be bent up to provide a point placement for the level rod.

4. On concrete columns and walls the markers shall be a 1-inch round concrete anchor projecting 2-1/2-inches from the surface.

5. Settlement markers located in foundation slabs shall be recessed as shown on the drawings.

6. Settlement markers shall be located on the turbine-generator pedestal deck for checking for compliance with deflection criteria provided by the machine manufacturer. These markers shall be recessed as shown on the drawings. Reference Bechtel (SCS) Drawings 1X2D51C001, 1X2D51C002, 1X2D51C004, 2X2D51C001, 2X2D51C002, 2X2D51C004.

B. SETTLEMENT MARKER LOCATION

1. The structures for observation shall include the turbine-generator pedestal, containment structure, auxiliary structure, and other selected major structures as shown on the drawings.

2. The columns to be observed for settlement shall include all the turbine-generator pedestal columns and a portion of the columns of the other structures as shown on the drawings. Settlement markers located on the turbine-generator pedestal deck shall be located as shown on drawings (Reference C10.1.5A6).

3. Each settlement marker shall be assigned a specific number. The numbering for a particular structure shall be in sequence wherever possible and as shown on drawing since this will facilitate the reading and recording of settlement data.

4. Settlement markers set in foundation slabs near columns shall be placed within 18 inches of the columns identified on the drawings.

5. Settlement markers shall be arranged on a structure or foundation so that a transverse or longitudinal settlement profile of the structure can be derived from the individual markers, wherever possible.

6. The location drawing for the settlement observation markers and the settlement record table drawing are for recording of data by construction.

C. SETTLEMENT MARKER INSTALLATION

1. Construction shall install settlement markers shown on the location drawing as soon as:

   a. Steel columns are erected.

   b. Forms are stripped from concrete columns, walls and foundations.

   c. As noted on location drawing.

2. Settlement marker numbers shall be stenciled or otherwise clearly marked on a flat surface adjacent to the marker.

3. Construction shall locate the settlement markers, so that a clear line of sight is available from centralized instrument stations, wherever possible.

4. Using the settlement marker location drawing and the plant general arrangement drawings the locations for the instrument stations shall be established. The scheme with the least number of stations shall be selected to minimize time spent for instrument handling and the recording of settlement data.

5. Any marker which is destroyed or becomes inaccessible shall be immediately replaced as near as possible to the original location and elevation. Construction will tie the elevation of a replaced or relocated marker to that of the old marker, if possible. An adjusted initial elevation shall be established for the new marker so that an uninterrupted settlement observation of the marker can be maintained.

6. In addition to markers which become inaccessible or are accidently destroyed, the 96 markers listed in Table 1 may be moved from their original locations to new engineering - approved locations which provide more convenient access. In each case a new marker shall be installed at the new location. The original markers shall remain in place and shall be available should future readings be requested. The elevations of the relocated markers shall be established by a double run in both the forward and backward direction from the original markers using the standards for first - order Class II Leveling (Paragraph 10.1.4,B,2) 11

C10.1.6 RECORDING OF SETTLEMENT DATA

A. DATA COLLECTED BY CONSTRUCTION

1. A complete set of field notes shall be kept and maintained for the following:

   a. Descriptive location of settlement markers.

   b. Records of settlement data each time a survey is made.

   c. Relocation of settlement markers.

   d. Location and elevation of bench marks and control monuments.

2. After installing the settlement markers, Construction shall record the initial elevations and date as soon as possible. Elevations and settlement readings shall be recorded to the nearest 0.001 of a foot. First order leveling procedures shall be followed (C10.1.4B). The initial elevations for each marker shall be obtained by averaging readings taken from a first order run (double run, double scale). Readings shall be completed within a two day period.

3. When taking level readings, the reference elevation shall be taken from the control monuments established throughout the jobsite. Before taking level readings, the control monuments shall be checked as outlined in Section 10.1.4.B.1.c. Level runs shall depart and close on the same control monument.

4. After the initial settlement marker elevation is established. surveys shall be scheduled at a maximum of 60-day intervals during the construction period. Any deviations of the survey interval shall be approved by the Bechtel Project Civil Engineering Group Supervisor.

5. The frequency of surveys for structures after construction is completed shall be as follows:

   a. For All Structures

      1. Every 60 days through the first year following issuance of an operating license for Unit 2.

      2. Subsequent reading frequency to be based on a review of settlement data.

      3. Subsequent to October 20, 1987 the 58 markers shown in Table 2 may be read at a minimum frequency of once in every 6 month period. Pairs of markers on adjacent structures used in determining differentials and all markers within a single structure shall be read as close as is practical to the same time. 11

b. Additional Requirements for Tanks and NSCW Cooling Towers

1. At the completion of tank installation, with the tank empty, just prior to hydrostatic testing of the tank.

2. At hydrostatic testing of the tank, with the tank filled.

3. Immediately after the hydrostatic testing, with the tank empty.

4. At the completion of filling the tank for plant operation.

c. Unscheduled Readings

1. Settlement observations shall be made immediately following any of the following events: earthquake event equal to or exceeding a free-field acceleration of 1/2 OBE (.06g), groundwater level in the power block area drops more than 10 feet below the reference groundwater level in more than one observation well monitoring the backfill, tornado or other winds with maximum wind speed in excess of 110 mph, standard project flood.

6. Readings for Markers 107-118, 207-218, 301, M-1, M-2, M-4, M-6 and 1-90 (except Markers 5, 14, 20, 26, 32, 40, 48, 54, 63, 72, 81, 87) may be discontinued as of 3-1-84. Readings for markers 308, 310, 423-1, 423-1B may be discontinued as of 10-20-87. Discontinued markers shall be maintained for future use. 11

B. DATA RECORDED BY CONSTRUCTION FOR ENGINEERING

1. Civil/Structural Engineering shall prepare drawings designated as the Settlement Observation Markers Location and Details and Settlement Record Table. Construction shall use prints of the Settlement Observation Markers Record Table drawings to record and transmit data to Civil/Structural Engineering for recording on original drawings. The Settlement Observation Markers Record Table shall include the following:

a. A column with lines for all the settlement markers with spare lines for relocated and additional markers.

b. A column identifying the structure where the marker is located.

c. Two columns for the initial elevations; the first to record the date of the reading and the second to record the elevation.

d. The other columns are for subsequent surveys. Elevations shall be recorded for each marker with a space at the top of each column for the survey date.

e. Computer output clearly presenting the required data may be provided in lieu of marked up record tables.

2. Settlement data received from Construction shall be recorded on the original Settlement Record Table drawings by Engineering.

3. For a relocated marker, an asterisk shall be placed beside the marker number to indicate that the marker was replaced. The initial observation date and elevation shall be crossed out and replaced with the new adjusted initial elevation and date submitted by Construction. This will provide a continuous settlement observation of the marker located on the column, wall or slab.

4. If settlement data is not available for settlement at markers shown on the location drawings, the following shall be recorded.

   a. NI (for marker not installed)

   b. NS (for no settlement)

   c. NA (for data not available)

   d. Other symbols or legend can be added to drawings as required.

   e. Blank spaces and spaces marked NA shall not be left in the Table for a marker number without a clear explanation for omitting settlement information.

5. GPC field survey shall monitor differential settlement at structure interfaces where piping has been permanently installed. GPC field mechanical engineering shall provide Engineering and the survey settlement supervisor the date at which piping has been permanently installed at each interface. GPC construction shall notify Engineering immediately if the differential settlement attains or exceeds 75 percent of the amount used in design at an interface subsequent to permanent installation of piping.

C. ANALYSIS OF SETTLEMENT BY ENGINEERING

1. Settlement Graphs

   a. From the Settlement Record Table Drawings, Civil/ Structural Engineering shall prepare settlement graphs which will indicate settlement versus time.

   b. The total settlement for each settlement marker shall be plotted on a graph each time survey information is received from Construction. A uniform scale shall be used for all structures. This will enable engineering to read relative settlement of various structures at various stages of construction.

c. The horizontal axis shall show the time of settlement in days.

d. The vertical axis shall show the total settlement in tenths of a foot.

e. Two settlement curves may be drawn on each graph with adequate clarity. If required settlement curves for all settlement markers on one line of structure may be drawn on the same graph, so that relative settlements from one marker to the other can be compared. This will show unequal settlement, tilting and uplift.

f. The graphs shall be aligned both horizontally and vertically to each other. Survey dates shall be recorded at the top of the graph to correspond to the data points on the curve. The horizontal scale for time in days shall be shown at the bottom of the sheet. The vertical scale for settlement in tenths of feet shall be shown on the left side of each graph.

g. A vertical line shall be placed on each graph and identified to represent when the loading of major equipment occurred or when the hydro testing of equipment such as the boiler has taken place and duration. Major concrete pours, unusually heavy rainfall, snow, flooding and other adverse environmental factors shall be similarly marked to enable Engineering to monitor structure behavior at such occasions. Dates of the above shall be supplied by Construction to Engineering.

2. Data Evaluation

a. Engineering shall review the settlement graphs each time settlement data is plotted.

b. The recorded settlement of each marker shall be compared to the maximum estimated total settlement at that location. Differential settlement between adjacent markers shall be compared to the maximum estimated differential settlement at the corresponding location.

D. DATA TO BE RECORDED AFTER CONSTRUCTION IS COMPLETED

1. At the completion of construction the settlement monitoring and evaluation program will be turned over to Georgia Power Company for continuation.

C10.1.7 TRANSMITTAL OF SETTLEMENT DATA

A. TRANSMITTAL BY CONSTRUCTION

1. Construction shall transmit the settlement data to Bechtel Engineering within 15 days after completion of survey measurements for settlement data at the survey interval specified in Section 10.1.6.A.4.

2. Two full size prints of recorded data or two copies of computer printout are to be accompanied by a letter of transmittal, and shall be forwarded as follows:

   a. Drawings and data, with the original and one copy of the transmittal letter, are to be sent to:

      Bechtel Power Corporation
      Bechtel Western Power Company
      P.O. Box 60860 Terminal Annex
      Los Angeles, California 90060
      Attention: A. Sanders, Project Engineer

TABLE 1

MARKERS TO BE RELOCATED TO IMPROVE ACCESS

Marker No.	Location - Unit 1
100	Turbine Building (Non Category 1)
101	
102	
103	
104	
105	
106	
164	Main Steam Tunnel (Non Category 1)
165	
166	
167	
168	
157	Radwaste Transfer Building (Non Category 1)
159	Radwaste Solidification Building (Non Category 1)
160	
161	
121	Control Building
122	
162	
169	
223	
423-1A	
172	Cat 1 Tunnel
126	Fuel Handling Building
127	
151	
229	
257	
128	Auxiliary Building
133	
134	
136	
233	
234	
235	

TABLE 1 (Continued)

MARKERS TO BE RELOCATED TO IMPROVE ACCESS (CONTINUED)

Marker No.	Location - Unit 1
149	Auxiliary Feedwater Pumphouse
150	
145	Diesel Fuel Oil Storage Tank Pumphouse
146	
199	
1000	
153	NSCW Valve Houses
1001	
1003	
1004	
129	Diesel Generator Building
130	
131	
132	
123	Containment
124	
125	

Marker No.	Location - Unit 2
200	Turbine Building (Non Category 1)
201	
202	
203	
204	
205	
206	
263	
264	Main Steam Tunnel (Non Category 1)
265	
267	
283	
222	Control Building
224	
266	
423-2	

TABLE 1 (Continued)

MARKERS TO BE RELOCATED TO IMPROVE ACCESS (CONTINUED)

Marker No.	Location - Unit 2
270	Category 1 Tunnels
228	Fuel Handling Building
230	
258	
231	Auxiliary Building
232	
237	
238	
284	
247	Auxiliary Feedwater Pumphouse
248	
253	Diesel Fuel Oil Storage Tank Pumphouse
254	
295	
296	
260	NSCW Valvehouses
297	
299	
2000	
249	Diesel Generator Building
250	
251	
252	
225	Containment Building
226	
227	
426	
427	

TABLE 2

LIST OF MARKERS WHOSE READING FREQUENCY WILL BE

REDUCED FROM ONCE EVERY 60 DAYS TO ONCE EVERY 6 MONTHS

Marker No.	Location - Unit 1
100	Turbine Building (Non Category 1)
101	
102	
103	
104	
105	
106	
163	
164	
165	Main Steam Tunnel (Non Category 1)
166	
167	
168	
159	Radwaste Solidification Building (Non Category 1)
160	
161	
119	Control Building
120	
121	
169	
170	
220	
420-1	
423-1A	
137	Category 1 Tunnels
171	
172	
173	
174	
175	
176	
177	
184	
191	
196	
198	

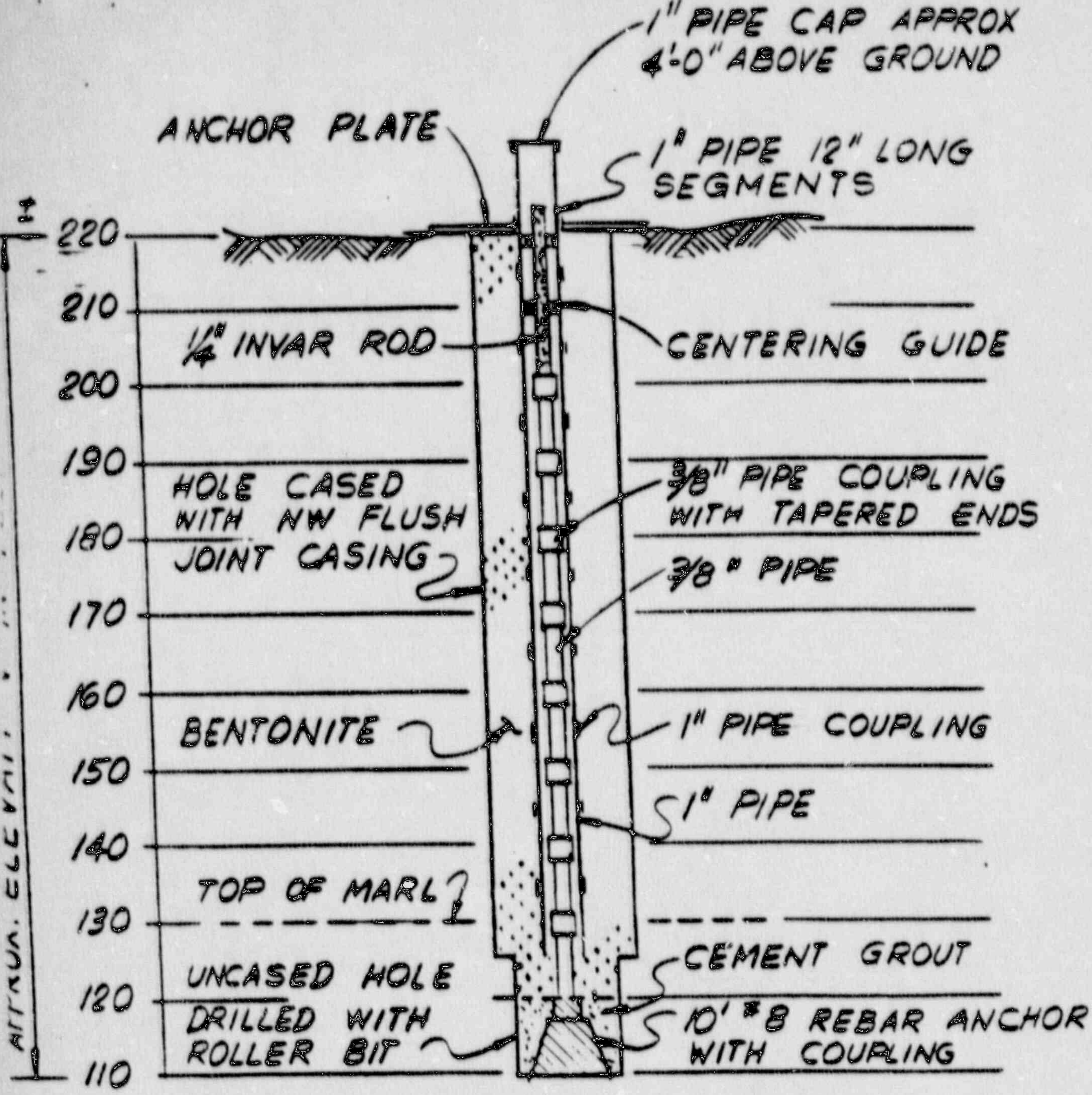
TABLE 2 (Continued)

LIST OF MARKERS WHOSE READING FREQUENCY WILL BE

REDUCED FROM ONCE EVERY 60 DAYS TO ONCE EVERY 6 MONTHS (CONTINUED)

Marker No.	Location - Unit 1
124	Containment Unit 1
149	Auxiliary Feedwater Pumphouse
150	
129	Diesel Generator Building
130	
131	
132	
145	Diesel Fuel Oil Storage
146	
199	
1000	
143	Category 1 Tanks
144	
147	
148	
138	NSCW Cooling Tower
152	& Valvehouse
1001	
1002	

Marker No.	Location - Unit 2
202	Turbine Building (Non Category 1)
206	
420-2	Control Building



FOR GUARD POST
DETAILS REF DWG AX2D55V001

BECHTEL
LOS ANGELES

GEORGIA POWER COMPANY
ALVIN W. VOGTLE NUCLEAR PLANT

SCHEMATIC OF DEEP BENCHMARK

ISSUED FOR INFORMATION										
ISSUED FOR INFORMATION										
REVISIONS	DATE	DR.	CHK.	SUPV.	EGS	CHF	P.E.	D.A.E.	ENG. MGR.	DATE

SCALE: NTS | DRAWING NO. SK-2-C-111 | REV. 5

JOB NO. 9510

SIZE A 8½ x 11

ATTACHMENT 3

PROCEDURE NO. 84301-C

MONITORING SETTLEMENT OF MAJOR STRUCTURES

MONITORING SETTLEMENT OF MAJOR STRUCTURES

1.0 PURPOSE

To provide a method for monitoring the settlement of markers installed at selected locations in major structures.

2.0 PRECAUTIONS AND LIMITATIONS

2.1 RADIATION PRECAUTIONS

Observe Radiation Protection Procedures and obtain a Radiation Work Permit when required.

2.2 SAFETY PRECAUTIONS

Observe safety rules contained in Georgia Power Company, SAFETY, Section "0".

3.0 PREREQUISITES OR INITIAL CONDITIONS

3.1 FREQUENCY

3.1.1 Settlement markers will be surveyed every 60 days, unless noted otherwise in Appendix A, through the first year following issuance of the operating license for Unit 2. Markers surveyed on a 60-day cycle are listed in Appendix B.

3.1.2 At the end of the period stated in Step 3.1.1., Georgia Power Company may propose a reduction in the frequency and number of markers monitored.

3.1.2.1 To justify any reduction in markers, a brief technical report with supporting settlement data, graphical plots, and an evaluation of the settlement effects for each marker must be performed and submitted to the Nuclear Regulatory Commission.

3.1.3 Settlement markers will be surveyed immediately upon any of the following occurrences:

a. An earthquake event equal to or exceeding a free-field acceleration of 1/2 Operating Basis Earthquake (.06g).

b. The groundwater level in the power block area drops more than 10 feet below the reference groundwater level in more than one observation well monitoring the backfill.

c. Following an extreme environmental event (tornado, major flood, etc.).

3.2 TEST EQUIPMENT

3.2.1 The following type of equipment shall be used in performing the monitoring:

a. Wild N3 Precision Level with 0.02 foot range micrometer and tripod or equivalent.

b. A pair of Wild leveling staffs (or equivalent) 10 feet in length with a high scale and a low scale on each face shall be used with the exception of structures having insufficient clearance to utilize them. These staffs are of a one-piece design and have a known constant of 10.509 feet between the high and low scales. A reading strip of Invar low thermal coefficient steel is attached to the face of each staff and is divided into 0.02 feet increments for each scale.

c. A pair of Wild leveling staffs (or equivalent) 6 feet in length with a high scale and a low scale on each face shall be used on structures having insufficient clearance to utilize the 10 feet staffs. These staffs are of a one-piece design and have a known constant of 10.509 feet between the high and low scales. A reading strip of Invar low thermal coefficient steel is attached to the face of each staff and is divided into 0.02 feet increments for each scale.

d. K. & E. industrial short staffs (or equivalent) of an appropriate length will be utilized when insufficient clearance within a structure prevent use of the Wild leveling staffs. These short staffs (scales) are graduated in increments of 0.1 inch.

e. Turning plates

f. Flashlight (when required)

g. Level Forms

h. Tripod Stabilizing device

i. Three radios (when required)

j. Hard hat for each member

k. Dosimetry equipment (when required)

l. Matched spacers (when required)

m. A calibrated 100 foot steel surveying tape graduated in 0.01 foot increments, with a 10 pound weight attachable to the bottom of the tape (when required).

3.3 SURVEY LEVEL BOOKS

3.3.1 Level Books shall be maintained for the structures being surveyed. The level books shall have the following titles:

a. Elevation Checks of Settlement Markers
Vogtle Electric Generating Plant
Control Building - Units 1 & 2
Fuel Handling Building - Units 1 & 2.

b. Elevation Checks of Settlement Markers
Vogtle Electric Generating Plant
Turbine Building - Units 1 & 2.

c. Elevation Checks of Settlement Markers
Vogtle Electric Generating Plant
Auxiliary Building - Units 1 & 2
Radwaste Transfer Building.

d. Elevation Checks of Settlement Marks
Vogtle Electric Generating Plant
Nuclear Service Cooling Water Towers - Unit 1.

e. Elevation Checks of Settlement Markers
Vogtle Electric Generating Plant
Nuclear Service Cooling Water Towers - Unit 2.

f. Elevation Checks of Settlement Markers
Vogtle Electric Generating Plant
Refueling Water Storage Tank - Units 1 & 2
Reactor Make-Up Water Storage Tank - Units 1 & 2.

g. Elevation Checks of Settlement Markers
Vogtle Electric Generating Plant
Diesel Generator Building - Units 1 & 2
Diesel Fuel Oil Storage Building - Units 1 & 2.

h. Elevation Checks of Settlement Markers
Vogtle Electric Generating Plant
Auxiliary Feedwater Pump House - Units 1 & 2
Condensate Storage Tank - Units 1 & 2
Radwaste Solidification Building.

i. Elevation Checks of Settlement Markers
Vogtle Electric Generating Plant
Containment Building - Units 1 & 2.

NOTE

All or parts of some level books listed above will not be used until Unit 2 is operational.

3.4 SURVEY LEVEL PREREQUISITES

3.4.1 All settlement markers shall be surveyed to First-Order class 2 leveling as described in NOAA Manual NOS NGS-3 or other accepted references (See Step 3.5.1).

3.4.2 The level will be allowed to acclimatize a minimum of 15 minutes before starting to observe.

3.4.3 The level will be pegged daily before use to determine the collimation error of the instrument. The instrument shall be adjusted when collimation error exceeds 0.005 feet/100 feet, plus-minus.

3.4.4 An umbrella shall be used to shade the instrument and tripod in sunny weather.

3.4.5 In order to minimize refraction errors, running of the level circuit shall begin no earlier than 1 1/2 hours after sunrise and end no later than 1/2 hour before sunset. This instruction shall be waived when leveling within the controlled environment of a structure.

3.5 QUALITY STANDARDS

3.5.1 First Order Leveling shall be performed in accordance with accepted standard practice as described in NOAA Manual NOS NGS-3 or other accepted references. In case of conflict between the standard practices used and the requirements of this procedure, the more restrictive of the two shall govern.

4.0 MAIN BODY

4.1 PERMANENT BENCHMARKS

4.1.1 There are two permanent benchmarks located near the structures for convenient access, but are a sufficient distance away so that they are outside the influence of foundation settlements.

4.1.1.1 The two permanent benchmarks are located at N80+00, E50+00 and N80+00, E139+00.

4.2 CONTROL MONUMENTS

4.2.1 Control monuments are reference points of known elevation set throughout the plant site.

4.2.2 The elevations for control monuments are established from permanent benchmarks. Periodic elevation checks against the established benchmark shall be made at a maximum of 6-month intervals or when taking level readings of settlement markers at required survey intervals. Control monuments with excessive (0.02 foot) movement shall be replaced in order to continue accurate evaluation of foundation settlement.

4.2.3 Control monuments which are destroyed or become inaccessible shall be replaced.

4.2.4 Procedure to establish Control Monument Elevations upon need of replacement and when performing periodic checks:

a. Elevation shall be established by First Order Leveling.

b. The maximum limit of the sights shall be 197 feet in length.

c. Backsight and foresight distances shall be approximately equal.

d. Rod readings shall be to the nearest 0.0001 of a foot.

e. A complete elevation traverse closing at the starting point shall be made. The maximum permissible error in feet will be plus or minus (0.0168 x the square root of the distance in miles).

f. Reference Step 3.5.1.

4.3 SETTLEMENT MARKERS

4.3.1 Settlement markers are placed on the columns of structures, set in structure foundations, or other places as shown on the appropriate forming drawings.

4.3.2 Each settlement marker is assigned a specific number and the number is stencilled on a flat surface adjacent to the marker.

4.3.3 Settlement markers are arranged on the structure or foundation so that a transverse or longitudinal settlement profile of the structure can be derived from the individual markers.

4.3.4 Settlement markers that have been relocated are listed with a suffix 'R'.

4.3.5 Any settlement marker which is destroyed or becomes inaccessible shall be immediately replaced as near as possible to the original location and elevation. If possible, tie the elevation of a replaced or relocated marker to that of the old marker. An adjusted initial elevation shall be established for the new marker so that an uninterrupted settlement observation of the marker can be obtained.

4.4 ORDER OF SURVEYING

4.4.1 All settlement markers on drawings AX2D55V001 and AX2D55V014 shall be surveyed except markers:

a. 107-118, 207-218, 301, M-1, M-2, M-4, M-6.

b. 1-90 (except markers 5, 14, 20, 26, 32, 40, 48, 54, 63, 72, 81, 87).

4.4.2 If a structure's settlement markers are inaccessible due to equipment in the way or excess radiation, contact Manager - Technical Support or designee for decision on what action to take.

4.4.3 The survey markers may be surveyed in any order.

4.5 SURVEY LEVEL PROCEDURE

4.5.1 The level shall be stationed approximately half way between turning points. Maximum imbalance shall be limited to 16.5 feet per set-up and 33 feet per section or loop.

4.5.2 Sight distance shall be limited to a maximum of 197 feet. The sight distances will be reduced as atmospheric conditions warrant.

4.5.3 Differences in elevation between turning points shall not exceed 6 feet. This instruction shall be waived when leveling within the controlled environment of a structure, or when chaining up or down is required to reach different elevations of a structure.

4.5.4 Readings below 1.6 feet above ground will not be permitted on the center cross hair. This instruction shall be waived when leveling within the controlled environment of a structure.

4.5.5 Sight distances will be determined by reading half-stadia on the staff, except for distances of 8 feet or less, which shall be measured with a tape.

4.5.6 The split bubble shall be in coincidence at the time the staff is read.

4.5.7 The observation sequence shall be (1) back-sight-low scale (2) backsight-low stadia hair (3) foresight-low scale (4) foresight-low stadia hair. If balance is within tolerance, continue reading (5) foresight-high scale (6) backsight-high scale.

4.5.8 A constant of 10.509 feet exists between the high and low scales on the leveling staffs (if Wild leveling staffs are used). If backsight or foresight readings exceed this constant by more than 0.001 feet, plus-minus, reread the sequence with the exception of the stadia hairs.

4.5.9 The difference in elevation between the high scale readings and the low scale readings should agree within 0.001 feet, plus-minus. If not, reread the sequence with the exception of the stadia hairs.

4.5.10 If a settlement marker, tape or scale is direct read, add the constant of 10.509 feet to what would be the backsight or foresight high scale reading to ensure continuity of the field survey notes.

4.6 TURNING POINTS

4.6.1 Appropriate turning points shall be set solidly for the ground conditions encountered, with turning plates being used on solid ground or paved surfaces, and turning pins being driven in soft ground.

4.6.2 Existing features such as spikes in railroads, rocks, etc. shall be avoided.

4.7 USING LEVELING STAFFS, SCALES, AND TAPES

4.7.1 Struts shall be used to support 10 foot staffs whenever possible.

4.7.2 The staffs shall be employed in a leap frog fashion. (i.e. The staff that is used going into (-) a station will also be used coming off (+) that same station.)

4.7.3 The staff that is used in the initial reading (+) shall be used for the final reading (-) at the end of a section of the tie of a loop.

4.7.4 The staff shall be in place for a minimum of 20 seconds prior to being read to allow for stabilization of the turning point and shall not depart the turn until all foresight and backsight readings are made.

4.7.5 Matched spacers shall be placed under each leveling staff when markers are recessed in protective valve boxes and prevent the staff from being placed directly on the marker. This will maintain the true difference in elevation by reducing backsight and foresight readings the same amount.

4.7.6 When chaining up or down is required, a calibrated 100 foot steel surveying tape graduated in 0.01 foot increments shall be suspended with a 10 pound weight attached to the bottom end. The tape will be direct read and the temperature of the tape shall be recorded in the field notes.

4.7.7 When the K. & E. industrial short staffs (or the equivalent) are used the scales on the staffs will be direct read and the reading converted to feet BEFORE adding the micrometer reading. Dividing the inches read by 12 changes the reading to feet.

4.7.8 Index error for the scales shall be determined by comparison of readings with a Wild leveling staff (or equivalent) on a common turning point. Temporary letter designations will be assigned to these scales when used in pairs. These designations shall be recorded in the field notes to ensure applying the correct index error for the scale used.

4.7.9 Markers vertically mounted may be direct read when necessary. Record only the micrometer reading and state that the marker was read direct in the field notes.

4.8 CIRCUIT SCHEME FOR SURVEYING

4.8.1 When there is a need to establish new control monuments, they shall be run in both the forward and backward direction unless ties are available to benchmarks of equal or higher order. In this case, the leveling shall be in the forward direction only.

4.8.2 When permanent benchmark and control monument elevations are being verified they will require only a run in the forward direction.

4.8.3 Benchmark and control monument elevations being transferred shall be run in both the forward and backward direction.

4.8.4 When monitoring settlement markers are placed in major structures they shall be double run in both the forward and backward direction from a control monument to the first marker or permanent turning point encountered within the structure.

4.8.4.1 Once within the confines of a structure, double run levels will not be required unless initial elevations are being determined (when settlement markers need to be replaced or relocated). The circuit will, however, return to the starting marker or permanent turning point.

a. When determining initial elevations of settlement markers, the level circuit to determine the elevation shall be completed within a 48 hour period, or else the circuit will have to be reinitiated.

b. Settlement markers being relocated will be double run in both the forward and backward direction.

4.8.5 Should a survey circuit be delayed or halted, a stable, well protected temporary benchmark shall be established. Otherwise, the circuit shall be reinitiated when surveying resumes.

4.8.6 Sections of leveling failing to meet the required tolerances (see Subsection 5.1) shall be rerun in the forward and/or backward direction until a satisfactory closure is obtained.

4.9 FIELD SURVEY NOTES, COMPUTATIONS, AND RECORDS

4.9.1 The survey section (survey crew) shall keep field notes on standard leveling forms of the National Geodetic Survey, see example Figure 1.

4.9.2 Leveling forms shall also contain the:

a. Descriptive number of settlement marker.

b. Record of any relocation of settlement markers.

c. Identification of each member participating in the survey.

d. Signature of the person who completed the form.

e. Serial number for the Surveying level and rods used.

4.9.3 Survey leveling computations for each settlement marker will be performed by a computer thru a settlement monitoring software program.

4.9.4 Copies of the leveling forms shall be bound into level books as outlined in Step 3.3.1.

4.9.5 The original leveling forms shall be sent to the Nuclear Operations Document Control for permanent plant as per the surveillance task sheet schedule.

4.9.6 According to the same schedule, the survey section shall send to Manager - Technical Support (MTS) a listing of the settlement marker elevations and any settlement for the last survey reading. This printout shall be accompanied by a cover letter. The MTS shall be informed through the listing or cover letter any settlement markers that were relocated since the last survey.

4.9.7 The MTS or designee shall submit the results obtained by the survey section, accompanied by a Request for Engineering Assistance (REA), to a Design Agency for settlement data analysis.

4.10 SETTLEMENT ANALYSIS

4.10.1 The Responsible Design Agency (RDA) shall perform the analysis of settlement data and disposition the REA.

4.10.2 RDA shall use the listing of the survey results and prepare settlement graphs which will indicate settlement versus time.

4.10.2.1 The graphs shall show total settlement for each settlement marker and shall be plotted on the graph each time survey information is received.

4.10.2.2 Two settlement curves may be drawn on each graph.

4.10.2.3 If required, settlement curves for all settlement markers on one line of a structure may be drawn on the same graph. This will show relative settlements from one marker to another, unequal settlement, tilting, and uplift.

4.10.3 The settlement results shall be compared to acceptance criteria as outlined in Subsection 5.2.

4.10.4 RDA shall disposition the REA and send a summary report with a cover letter along with the REA to the MTS documenting the results of the analysis.

4.10.5 If the settlement analysis results are outside of the acceptance criteria as outlined in subsection 5.2, RDA will disposition the REA accordingly.

4.10.6 The MTS or designee shall transmit the data analysis package received from RDA, along with a copy of the REA, to the Nuclear Operations Document Control for permanent storage.

5.0 ACCEPTANCE CRITERIA

5.1 TOLERANCES ON SURVEYING

5.1.1 Agreement of observed elevation differences before correction, observed backward and forward during:

a.	One-setup section	plus/minus 0.0033 ft.
b.	Two runnings of a section less than 0.062 mi. (325 ft.) in length.	plus/minus 0.0042 ft.
c.	Section forward and backward more than 0.062 mi (325 ft) in length.	plus/minus (0.0168 X Sq. Root of M)
d.	Loop or line where M=length in miles.	plus/minus (0.021 X Sq. Root of M)

5.2 ELEVATION DIFFERENTIALS

5.2.1 The actual total structure settlements will be compared with the predicted settlement totals in FSAR figure 2.5.4.8 and design settlement totals given by the Bechtel Corporation.

5.2.2 Where applicable, differential settlement between adjacent markers (i.e. across structure interfaces) shall be compared to the maximum estimated differental settlement at the corresponding location.

6.0 REFERENCES

6.1 FSAR, Section 2.5.4.13.2.

6.2 NOAA Manual NOS NGS-3 (Supercedes Coast and Geodetic Survey Special Publication No. 239, 1948).

6.3 Coast and Geodetic Survey Special Publication No. 240, Manual of Leveling Computation and Adjustment, by Howard S. Rappleye, 1948.

6.4 Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys prepared by Federal Geodetic Control Committee.

6.5 Bechtel Engineering Specification NO. X2AP01, Section C10.1.

6.6 DC 1000-C Section 4.2.5

6.7 DC 1017 Tables 6 & 7

6.8 PROCEDURES

6.8.1 30145-C, "Groundwater Monitoring"

6.8.2 55022-C, "Seismic Monitoring System Instrumentation System"

6.9 DRAWINGS

Drawing No.	Title
AX2D55V001	Settlement Observation Markers Location and Detail
AX2D55V002	Settlement Observation Markers Record Table Sht. 1
AX2D55V003	Settlement Observation Markers Record Table Sht. 2
AX2D55V004	Settlement Observation Markers Record Table Sht. 3
AX2D55V005	Settlement Observation Markers Record Table Sht. 4
AX2D55V006	Settlement Observation Markers Graph Sht. 1
AX2D55V007	Settlement Observation Markers Graph Sht. 2
AX2D55V008	Settlement Observation Markers Graph Sht. 3
AX2D55V009	Settlement Observation Markers Graph Sht. 4
AX2D55V010	Settlement Observation Markers Graph Sht. 5
AX2D55V011	Settlement Observation Markers Graph Sht. 6
AX2D55V012	Settlement Observation Markers Graph Sht. 7
AX2D55V013	Settlement Observation Markers Graph Sht. 8
AX2D55V014	Backfill Dewatering Observation
AX2D55V015	Settlement Observation Markers Record Table Sht. 5
AX2D55V016	Settlement Observation Markers Record Table Sht. 6

Drawing No.	Title
AX2D55V017	Settlement Observation Markers Graph Sht. 9
AX2D55V018	Settlement Observation Markers Graph Sht. 10
AX2D55V019	Settlement Observation Markers Graph Sht. 11
AX2D55V020	Settlement Observation Markers Graph Sht. 12
AX2D55V021	Settlement Observation Markers Record Table Sht. 7
AX2D55V022	Settlement Observation Markers Record Table Sht. 8
AX2D55V023	Settlement Observation Markers Record Table Sht. 9
1X2D05V002	NSCW and Misc Category 1 Structures Key Plan - Unit 1
2X2D05V002	NSCW and Misc Category 1 Structures Key Plan - Unit 2

END OF PROCEDURE TEXT

APPENDIX A
MARKERS WHOSE READING FREQUENCY SUBSEQUENT TO

OCTOBER 1987 IS ONCE EVERY 6 MONTHS

Marker No.	Location - Unit 1
100R	Turbine Building
101R	
102R	
103R	
104R	
105R	
106	
163	
164R	
165R	Main Steam Tunnel
166R	
167R	
168R	
159R	Radwaste Solidification Building
160R	
161R	
119	Control Building
120	
121R	
169R	
170	
220	
420-1	
423-1A	
191	Tunnel 1T2B
196	
173	Tunnel 1T3A
177	
184	
174	Tunnel 1T3B
175	
176	
171	Tunnel 1T4A
172R	
137	Tunnel 1T5A
198	

APPENDIX A

MARKERS WHOSE READING FREQUENCY SUBSEQUENT TO OCTOBER 1987 IS ONCE EVERY 6 MONTHS

Marker No.	Location - Unit 1
124	Containment Unit 1
149R 150R	Auxiliary Feedwater Pumphouse
129R 130R 131R 132R	Diesel Generator Building
145R 146R 199R 1000R	Diesel Fuel Oil Storage Tank Pumphouse
143 144 147 148	Condensate Storage Tanks
138 152 1001R 1002	NSCW Cooling Tower & Valvehouse
503 504 505 506 507 508 509 510 511 512	Natural Draft Cooling Towers

Marker No.	Location - Unit 2
202R 206	Turbine Building (Non Category 1)
420-2	Control Building

APPENDIX B

LIST OF MARKERS SURVEYED ONCE EVERY 60 DAYS

Marker No.	Location - Unit 1
128R	Auxiliary Building
133R	
134R	
136R	
181	
183	
186R	
187	
1006	
123R	Containment Building
125R	
122	Control Building
162	
126	
127	
151R	
139	NSCW Cooling Towers and Valve Houses
140	
141	
142	
153R	
1003R	
1004R	
1005	
156	Radwaste Solidification Building
157	
158	
189	Refueling Water Storage Tank
192	Reactor Makeup Water Storage Tank
185R	Main Steam Tunnel ITI
190	Tunnel 1T2B
193	
194	

Marker No.	Location-Unit 1
178	Tunnel 1T3A
179	
180	
182	
135	Tunnel 1T5A
197	
188	Tunnel 1T5B
154	Radwaste Transfer Tunnel
155	
5	Turbine Building
14	
20	
26	
32	
40	
308	
310	

Marker	Location - Unit 2
231R	Auxiliary Building
232R	
233	
234	
235	
237R	
238R	
278	
281	
282	
284R	
247R	Aux Feedwater Pumphouse
248R	
225R	Containment Building
226	
227R	
426	
427	
219	Control Building
221	
222R	
223	
224	
261	
266R	
269	

Marker No.	Location - Unit 2
249R	Diesel Generator Building
250R	
251R	
252R	
228	Fuel Handling Building
229	
230	
257	
258R	
242	NSCW Towers and Valve Houses
243	
244	
245	
246	
259	
260R	
297R	
298	
299R	
2000R	
2001	
239	Refueling Water Storage Tank
287	
240	Reactor Makeup Water Storage Tank
290	
255	Condensate Storage Tanks
256	
253R	Diesel Fuel Oil Storage Tank Pump House
254R	
295R	
296R	
264R	Main Steam Tunnel 2T1
265R	
267R	
283R	
2000	
286	Tunnel 2T2B
288	
291	
292	

Marker No.	Location - Unit 2
236	Tunnel 2T3B
271	
279	
280	
272	Tunnel 2T3B
273	
274	
275	
276	
277	
268	Tunnel 2T4A
270R	
241	Tunnel 2T5A
293	
294	
285	Tunnel 2T5B
289	
48	Turbine Building
54	
63	
72	
81	
87	
200R	
201R	
203R	
204R	
205R	
262	
263R	
603	Natural Draft Cooling Towers
604	
605	
606	
607	
608	
609	
610	
611	
612	

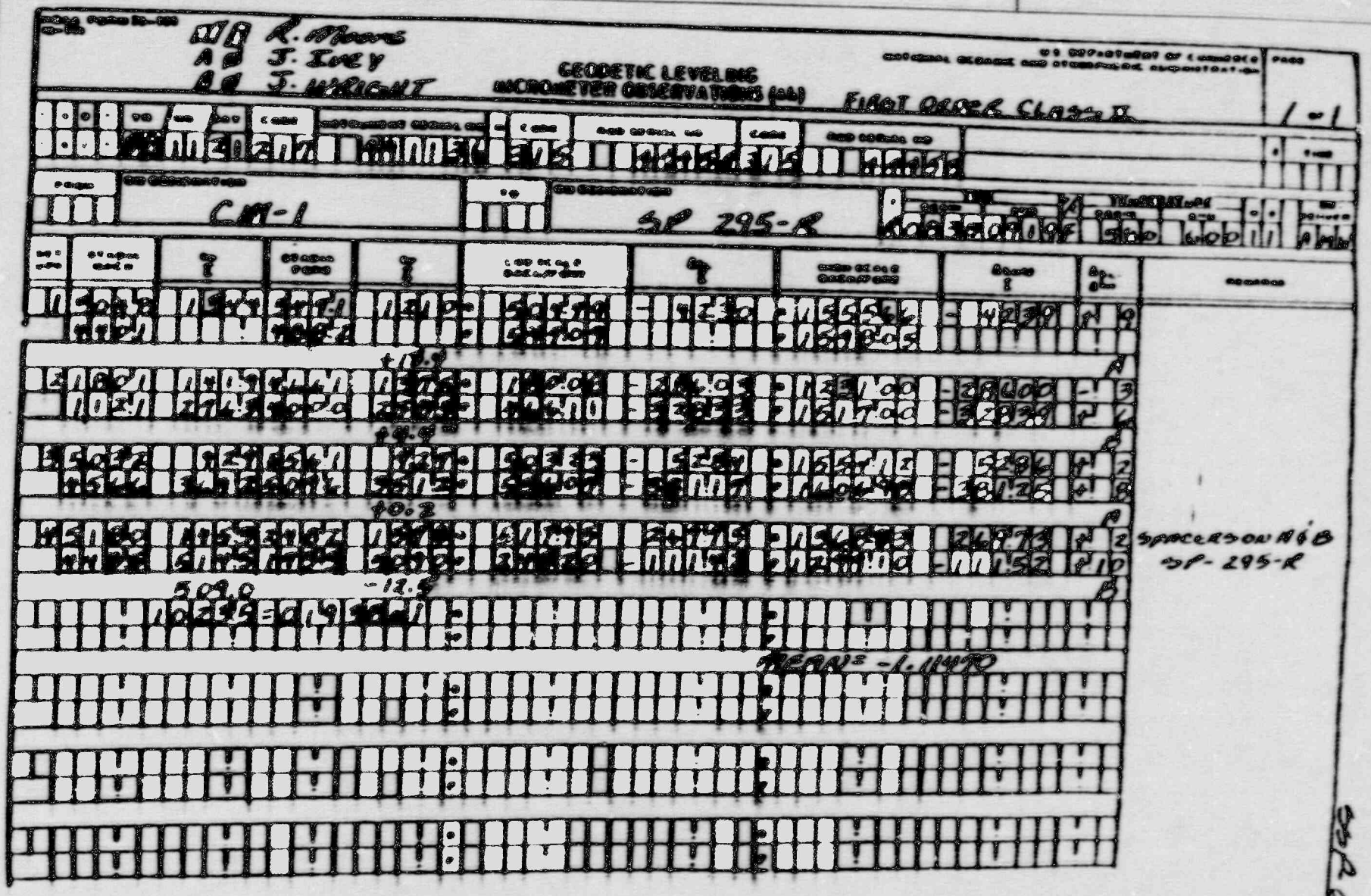
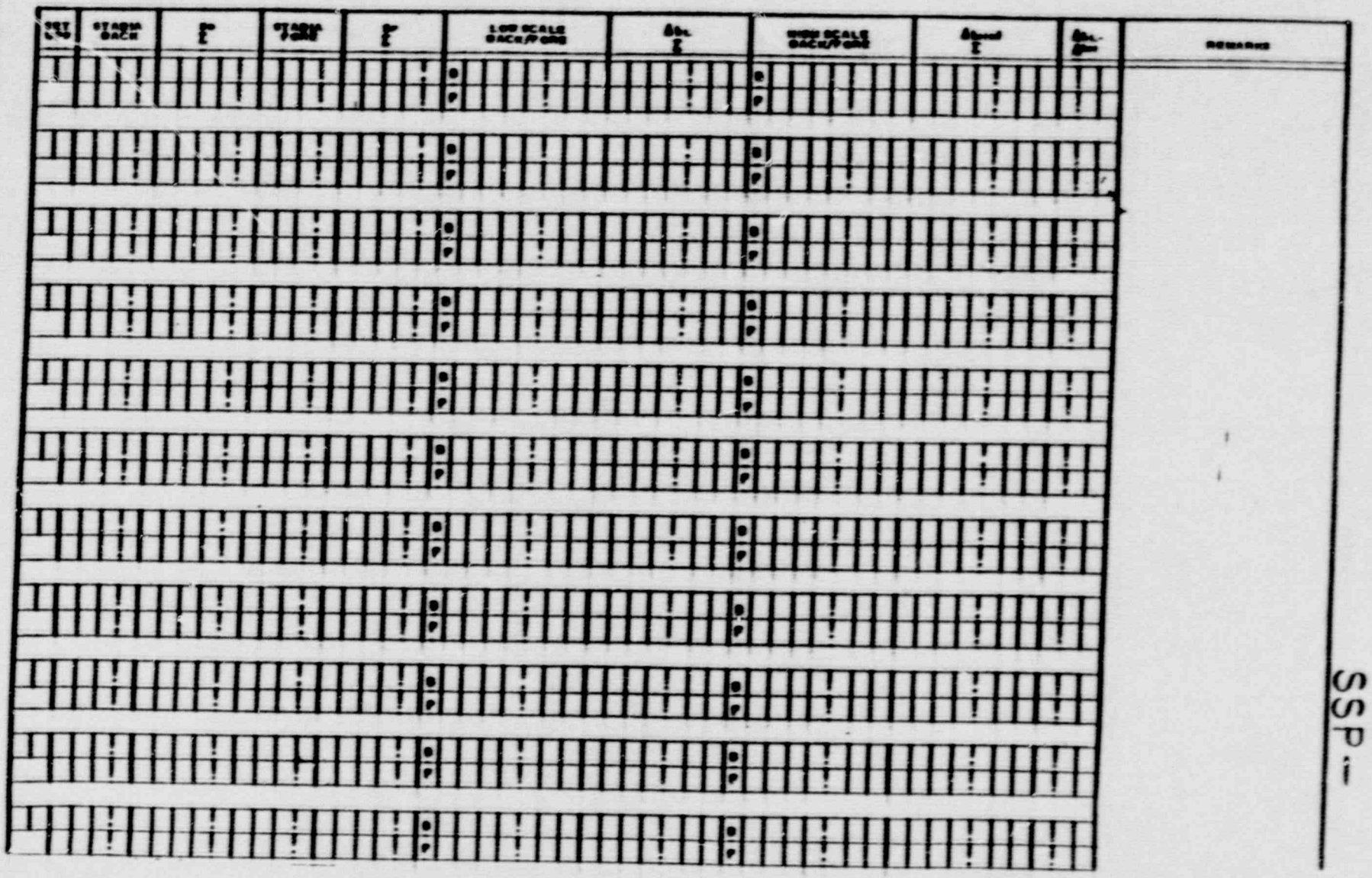

GEODETIC LEVELING
FIRST ORDER CLASS II
CM-1
SP 295-R
SPACERSON N&B
OF 295-R

FIGURE 1



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SSP-1

FIGURE 1 (CONT'D.)

ATTACHMENT 5

COMPARISON OF DIFFERENTIAL SETTLEMENTS

UNIT 1

COMPARISON OF CALCULATED, ACTUAL, AND ALLOWABLE DIFFERENTIAL SETTLEMENTS
FOR SAFETY-RELATED BURIED PIPES INTERFACING WITH CATEGORY 1 STRUCTURES

PIPE IDENTIFICATION NUMBER	SYSTEM INSTALLATION DATES	MARKER DATA		CALCULATED DIFFERENTIAL SETTLEMENT	ACTUAL DIFFERENTIAL SETTLEMENT	ALLOWABLE DIFFERENTIAL SETTLEMENT
		MARKER NUMBER	BUILDING LOCATION	INCHES	INCHES	INCHES
1-1202-029-6"	04/10/86	153-R	NSCW-1	0.3	0.11	0.46
1-1202-030-6"	04/13/86	153-R	NSCW-1	0.3	0.11	0.36
1-1202-029-6"	01/13/85	196	TUNNEL	0.3	0.37	0.36
1-1202-030-6"	05/28/86	196	TUNNEL	0.3	0.08	0.74
1-2403-044-4"	03/11/84	132-R	DG-1	0.3	0.54	0.85
1-2403-066-3"	02/03/85	132-R	DG-1	0.3	0.29	1.05
1-2403-053-2"	10/14/84	132-R	DG-1	0.3	0.35	1.46
1-2403-051-2"	01/13/85	132-R	DG-1	0.3	0.30	0.59
1-2403-068-3"	02/03/85	132-R	DG-1	0.3	0.29	0.58
1-2403-043-4"	12/23/84	132-R	DG-1	0.3	0.31	0.41
1-2403-044-4"	08/18/86	145-R	DFOST-1	0.25	0.11	0.50
1-2403-066-3"	02/03/85	145-R	DFOST-1	0.3	0.34	0.37
1-2403-053-2"	06/03/86	145-R	DFOST-1	0.3	0.10	0.43
1-2403-069-2"	02/03/85	145-R	DFOST-1	0.5	0.34	0.60
1-2403-051-2"	03/24/85	145-R	DFOST-1	0.3	0.30	0.38
1-2403-068-3"	09/11/86	145-R	DFOST-1	0.3	0.11	0.35
1-2403-043-4"	12/16/84	145-R	DFOST-1	0.5	0.35	0.88

UNIT 2

COMPARISON OF CALCULATED, ACTUAL, AND ALLOWABLE DIFFERENTIAL SETTLEMENTS
FOR SAFETY-RELATED BURIED PIPES INTERFACING WITH CATEGORY 1 STRUCTURES

PIPE IDENTIFICATION NUMBER	SYSTEM INSTALLATION DATES	MARKER DATA		CALCULATED DIFFERENTIAL SETTLEMENT	ACTUAL DIFFERENTIAL SETTLEMENT	ALLOWABLE DIFFERENTIAL SETTLEMENT
		MARKER NUMBER	BUILDING LOCATION	INCHES	INCHES	INCHES
2-1202-029-6"	12/09/86	260-R	NSCW-2	0.3	0.29	0.61
2-1202-030-6"	02/01/87	260-R	NSCW-2	0.3	0.22	0.95
2-1202-029-6"	05/07/86	292	TUNNEL	0.3	0.46	0.55
2-1202-030-6"	05/05/86	292	TUNNEL	0.3	0.46	0.62
2-2403-044-4"	01/29/87	249-R	DG-2	0.3	0.22	0.55
2-2403-066-3"	02/05/87	249-R	DG-2	0.3	0.22	0.58
2-2403-053-2"	12/08/85	249-R	DG-2	0.3	0.71	0.53
2-2403-051-2"	08/10/86	252-R	DG-2	0.3	0.30	1.90
2-2403-068-3"	07/30/86	252-R	DG-2	0.3	0.30	1.95
2-2403-043-4"	09/01/85	252-R	DG-2	0.3	0.68	1.93
2-2403-044-4"	04/13/87/	296-R	DFOST-2	0.25	0.08	0.50
2-2403-066-3"	04/22/87	296-R	DFOST-2	0.3	0.08	2.66
2-2403-053-2"	06/23/87	296-R	DFOST-2	0.3	0.06	0.78
2-2403-069-2"	08/17/86	296-R	DFOST-2	0.25	0.24	0.77
2-2403-051-2"	06/09/87	254-R	DFOST-2	0.3	0.06	0.36
2-2403-068-3"	04/28/87	254-R	DFOST-2	0.3	0.08	0.63
2-2403-043-4"	09/15/87	296-R	DFOST-2	0.5	0.06	1.48

ATTACHMENT 4

LAYOUT AND ISOMETRIC DRAWINGS SHOWING
BURIED SAFETY-RELATED
PIPES ENTERING CATEGORY 1
STRUCTURES

SK-A-SMP-001
1K5-1202-029-04
1K5-1202-029-06
1K5-1202-029-07
1K5-1202-030-05
1K5-1202-030-06
1K5-2403-043-01
1K5-2403-043-02
1K5-2403-044-01
1K5-2403-044-02
1K5-2403-051-01
1K5-2403-051-02
1K5-2403-053-01
1K5-2403-053-02
1K5-2403-058-01
1K5-2403-066-01
1K5-2403-068-01
1K5-2403-068-02
1K5-2403-069-01
2J5-2403-051-01
2J5-2403-053-01
2J5-2403-053-02
2K5-1202-029-01
2K5-1202-029-02
2K5-1202-029-03
2K5-1202-030-01
2K5-1202-030-03
2K5-2403-041-01
2K5-2403-043-01
2K5-2403-043-02
2K5-2403-044-01
2K5-2403-044-02
2K5-2403-044-03
2K5-2403-051-01
2K5-2403-051-02
2K5-2403-053-01
2K5-2403-057-01
2K5-2403-058-01
2K5-2403-066-01
2K5-2403-066-02
2K5-2403-068-01

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