APPENDIX 2G

STATIC DYNAMIC ROCK PROPERTIES

The information contained in this appendix was not revised, but has been extracted from the original FSAR and is provided for historical information.

APPENDIX 2G

STATIC AND DYNAMIC ROCK PROPERTIES

TABLES

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TABLE 2G-1

UNCONFINED COMPRESSION TESTS

Test No.	Location	Hole No.	Depth (ft)	Rock Type	Unconfined Compressive Strength q_u (psi)	Axial Strain@ Failure %	Initial Tangent Modulus (psi)	Secant Modulus @ 50% q_u (psi)	Poisson's Ratio Initial Load	Poisson's Ratio Secant Value @ 50% qu
E1A	Reactor 1	E1-1	31.4- 31.8	Diorite	22,400	.21	12 x 106	12 x 106	.29	.25
E1D			78.3- 78.7	Diorite	19,520					
E1F			79.1- 79.5	Diorite	19,820	.21	9.3 x 10^6	9.3 x 106	.25	.25
E1G			79.5- 79.9	Diorite	19,400	.20	13 x 106	11 x 106	---	---
E2A	Reactor 2	E2-1	49.6- 50.0	Diorite	18,020	.20	12 x 106	10 x 106	.36	.28
E2B			50.0- 50.4	Diorite	Failed by	splitting.	Do not report.			
E2C			50.4- 50.8	Diorite	15,530	.17	12 x 106	9.9 x 106	.18	.20
E2G			138.7-139.1	Diorite	5,970					
E2J			139.4-139.8	Diorite	11,610	.21	12 x 106	9.7 x 106	.21	.23
E2M			141.9-142.3	Diorite	18,610	.20	10 x 106	10 x 10^6	.23	.25
B7B	Near Reactors	B7	27.8- 28.2	Schist	17,940	.20	11 x 106	10 x 106	.17	.19
B42D	Contact	B42	123.5-123.9	Diabase	27,600	.27	11 x 106	10 x 106	.21	.26
B42F			141.3-141.7	Schist	16,500	.21	9.1 x 106	8.0 x 106	.18	.21
B42H			142.7-143.1	Schist	11,970	.18	10 x 106	7.4 x 106	---	---
F1A	Tunnel	F1A	127.5-127.9	Diorite	16,130	.19	11 x 10^6	9.9 x 106	.33	.28
F1B			127.9-128.3	Diorite	13,950					
F2A	Tunnel	F2	246.3-246.7	Schist	6,060					
F2C			247.2-247.6	Schist	6,000					
F2F			260.3-260.7	Schist	6,330					

NOTE: In tests for which values of axial strain at failure, modulus, and Poisson's ratio are omitted, the strain-gage readings appear to be unreliable, No stress-strain curves are plotted for these tests.

TABLE 2G-2

LABORATORY COMPRESSION WAVE VELOCITY MEASUREMENTS

Test No.	Location	Hole No.	Depth (Feet)	Rock Type	Density (gm/cm^3)	Laboratory Compression Wave Velocity @ 0 psi	@ 3000 psi
E 1 H	Reactor 1	E 1 - 1	79.9 - 80.3	Diorite	2.81	19,460	19,880
E 2 E	Reactor 2	E 2 - 1	51.2 - 51.6	Diorite	2.83	18,860	19,090
E 2 H	Reactor 2	E 2 - 1	139.1 - 139.4	Diorite	2.77	20,050	20,300
B 42 B	Contact	B 42	122.5 - 123.0	Diabase	2.84	18,600	18,800
B 42 G	Contact	B 42	141.8 - 142.3	Schist	2.77	16,960	17,320
F 1 D	Tunnel	F 1 A	128.7 - 129.2	Diorite	2.79	20,050	20,340
F 2 D	Tunnel	F 2	259.0 - 259.4	Schist	2.86	18,110	18,370

TABLE 2G-3

STRENGTH, VELOCITY, AND HARDNESS DATA
SAMPLES FROM TUNNEL ALIGNMENTS
SERIES 1

Boring No.	Depth, ft.	Rock Mechanics Laboratory Number	Unit Weight Dry gm/cc	Sonic Velocity, fps (Dry) Axial Load psi: 0	100	500	1000	Ultimate Unconfined Compressive Strength psi	L/D Ratio	Modulus of Elasticity psi x 10^6: E_i	$E_{t_{50}}$	Rock Hardness: H_R	H_S	H_A	H_T	A_R	Rock Description	Remarks
M - 1	167.0.267.1	73-49	2.93	17,564	17.606	17.404	17.691	33,954	3.72	0.24	1.29	52	ID	6.U	132	16.7	Diorite - fine grained; some quartz, feldspar, mafics, and iron sulfides	Failed along iron stained joint
ADT-2	266.6-267.6	73-50	2.66	16.992	16.492	16.193	16.505	22,587	2.76	0.94	4.m,	49	01	6.06	120	I8.9	Diorite - coarse grained; primarily feldspar and biotite; slight foliation developed	
ADT-2	267.0-267.7	73-51	2.m	16.271	16.312	16.437	16.479	15,580	3.26	1.46	6.32	36	68	4.01	m	16.0	Quartz diorite - very fine grained; quartz, feldspars, ● lcrr. and mafics; med. gray	
ADT-4	250.0-250.8	73-52	2.73	16.370	15,434	16.496	16.631	19.306	4.03	0.80	6.01	32	62	3.61	61	9.9	Diorite - medium to fine grained; highly micaceous; cuartz, feldspar. mica, mafics; lite gray; some foliation developed.	
M - I	255.4-256.0	73-53	2.11	16.410	16.616	15,570	15,570	20,895	2.26	0.91	4.84	33	71	6.00	7Y	6.9	Diorite - medium grained; quartz, feldspar, ● ical. mafics; medium gray; somewhat slickersided.	Failed along pre-existing but healed fracture
ADT-11	222.5-223.6	73-64	---	14.996	16.014	I8.014	16.071	10,060	2.61	0.39	2.86	34	69	5.00	76	12.1	Schistose diorite - fine grained; high biotite content; foliation developed tc fair degree	
ADT-13	213.0-213.7	73-66	2.71	17.063	16,996	17.336	17.611		2.71			47	88	6.94	125	9.1	Diorite - med. to coarse grained; quartz, feldspar, biotite, mafics; and iron sulfides	
M-17	189.0-189.8	73-w	3.01	17,007	17.007	17,079	17.07,	7.026	4.04	0.62	5.40	60	I2	4.66	108	16.4	Diabase - fine grained; feldspar, pyrite and mafics; dark gray	Failed along calcite filled joint
AIT-1	250.0-250.9	73-57	2.89	16.343	16.423	16.747	16,624	21,290	3.42	1.44	6.10	61	Is	4.66	108	8.0	Quartz diorite - coarse grained; high quartz-feldspar content, also ● lcu; rd. to lite gray	Failed along pn-•rlst,n# but healed fracture
AIT-7	198.5-199.8	73-I)		14,682	14,682	14,789	14,84	6.910	2.61	0.31	1.U)	46	67	4.76	99	10.:	Biotite schist - med. to fine grained; quartz, feldspar, and mafics; fine foliation nll developed	Failed along iron stained joint
AIT-8	195.0-196.2	73-59	2.83	17,686	17,686	17.624	17.911	19.163	2.72	1.43	2.61	37	58	6.13	83	11.	Biotite schist - rd. grained; well developed fine foliation with quartz-rich layers; med. gray	
f-6	196.3-196.9	73-60	2.11	16.662	16.640	16,684	16.771	22,312	3.16	1.36	6.11	46	73	4.88	101	16.	Schistose quartz diorite - fine to med. grained; quartz, feldspar biotite; foliation fair; med. to dk. gr	
F-5	205.3-205.9	73-61	2.78	15,989	15,989	16.066	16.111	24,796	3.41	1.22	4.87	46	70	3.33	84	11.	Diabase - very fine grained; primarily feldspar and mafics; dark gray	Failed along pre-existing but healed fracture
AIT-18	141.2-142.3	73-62	2.82	16,493.	16.627	16.627	16.621	19,036	4.01	1.07	6.36	:39	71	3.23	70	7.:	Quartzitic Schist - rd. grained; mostly quartz, feldspar, and biotite with iron sulfides; foliation only fairly developed; med. gray	

E_i - initial tangent modulus

E_{t50} - tangent modulus at 50% of the ultimate unconfined strength.

H_R - Schmidt (L-type) Rebound Hardness

H_S - Shore Scleroscope (C-2 type) Hardness

H_A - Modified Taber Abrasion Hardness

H_T = $H_R\sqrt{H_A}$

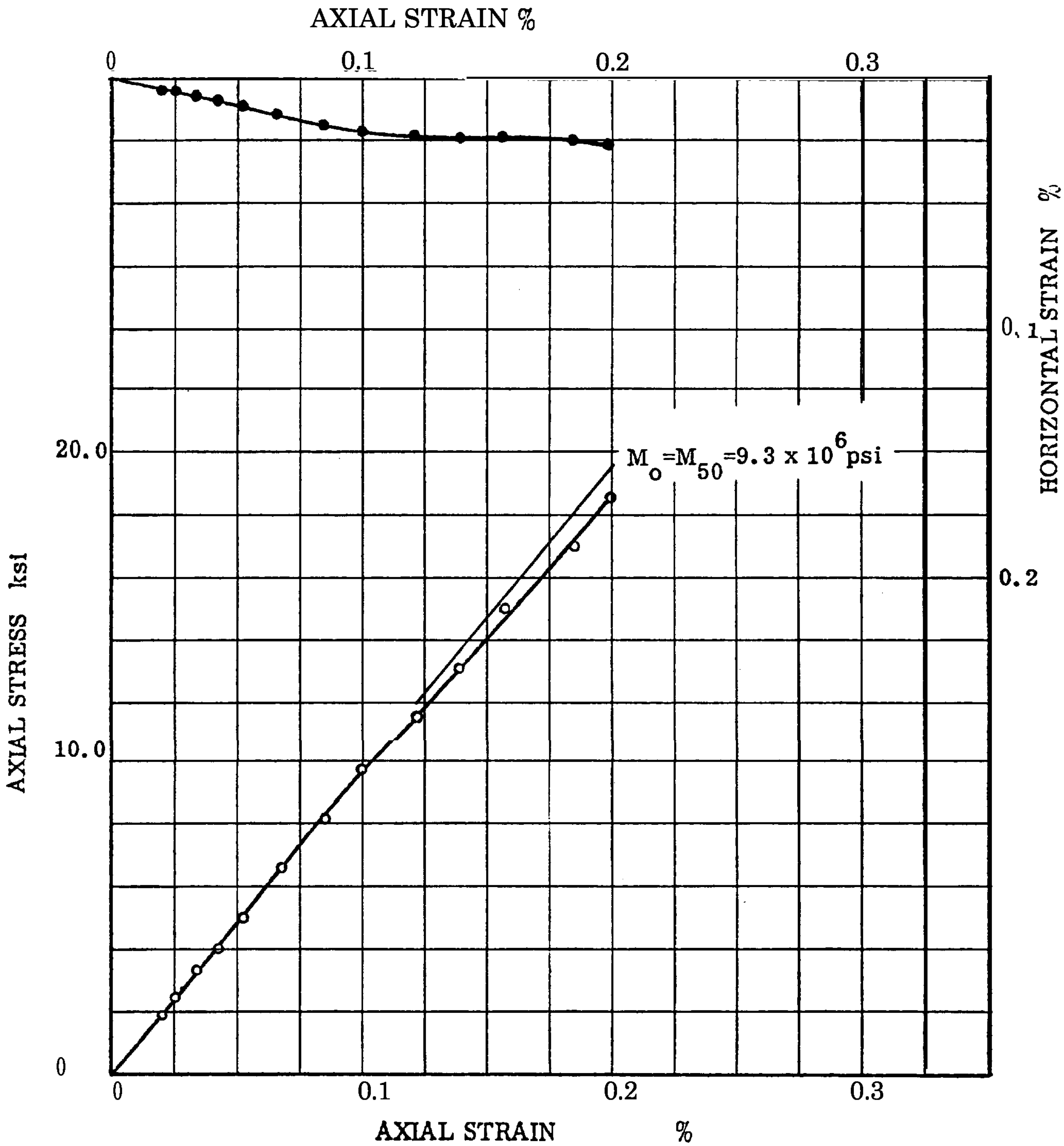
A_R - Rock Abrasiveness

APPENDIX 2G

STATIC AND DYNAMIC ROCK PROPERTIES

FIGURES

NOTE: The stress-strain curves shown in Figures **2G-1** through **2G-11** are terminated at the last strain reading before sudden, brittle failure. The maximum compressive load at failure was recorded by the testing machine and was used to calculate the compressive strengths contained in Table **2G-1**. 45

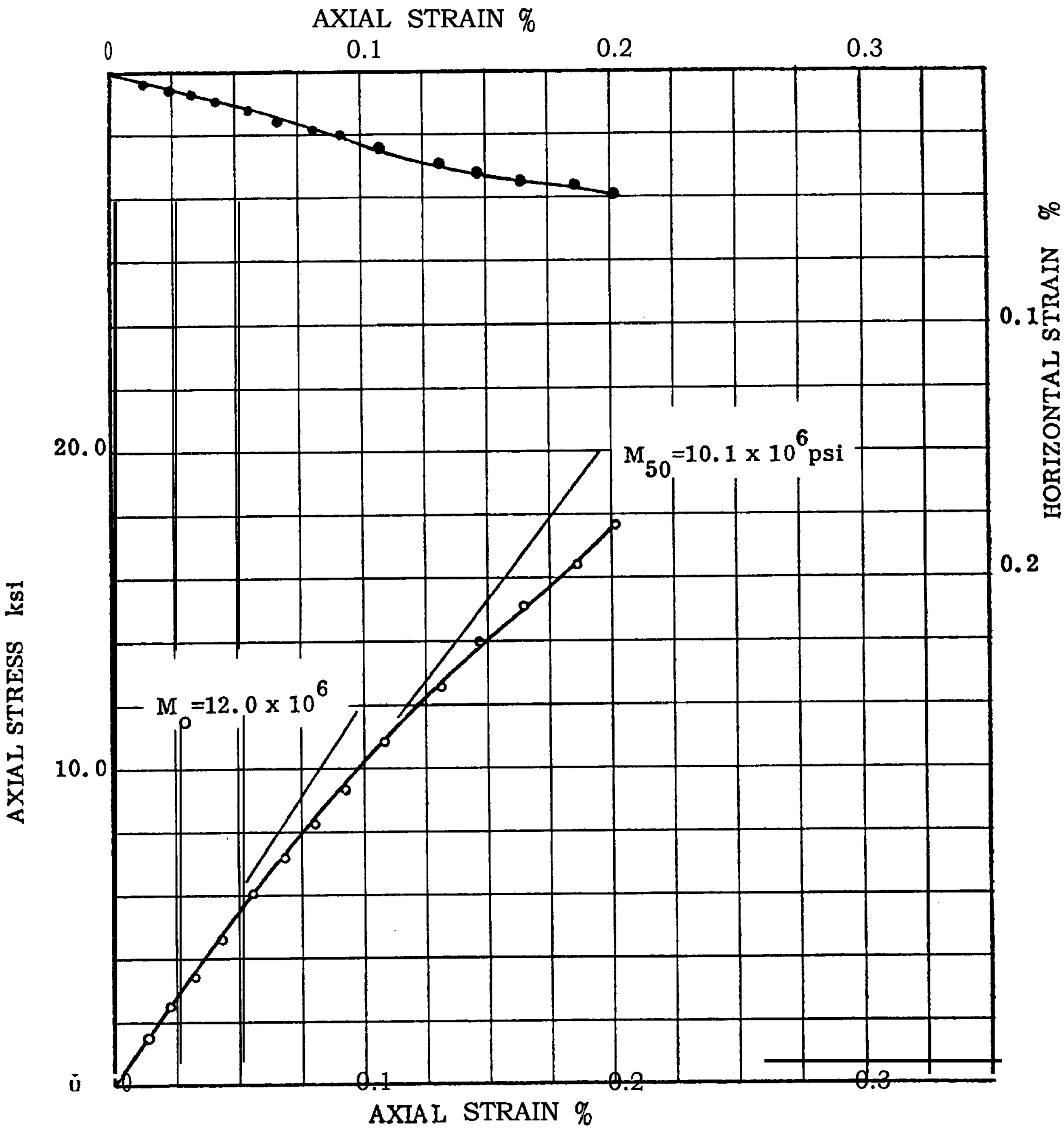


M = Modulus of Deformation

Diorite
Borehole El-l Depth 79.1 to 79.5 ft

UNCONFINED TEST E 1 F STRESS -STRAIN CURVE

FIGURE 2G-1

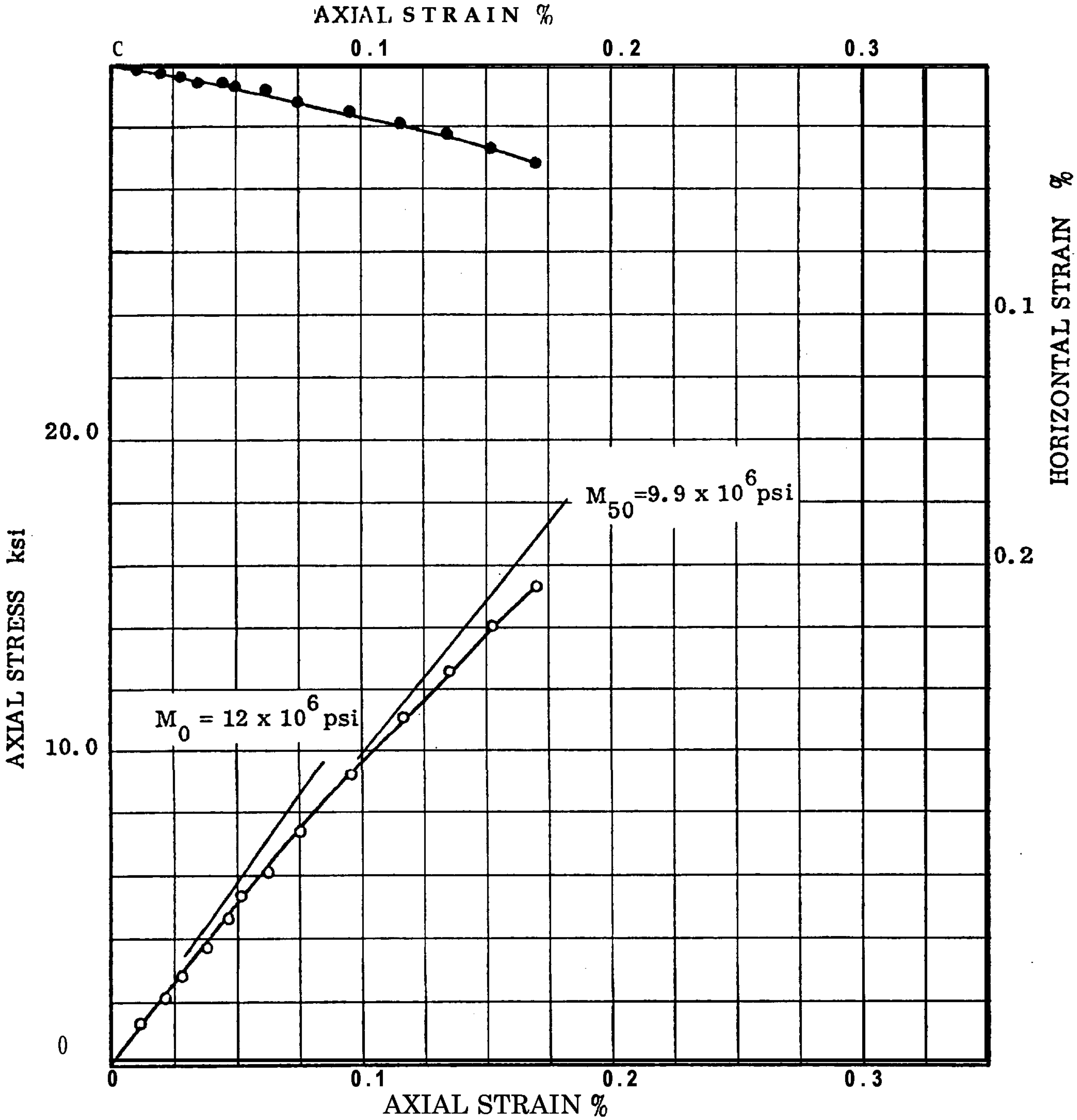


M= Modulus of Deformation

Diorite
Borehole E2-2 Depth 49. 6 to 50. 0ft

UNCONFINED TEST E2A STRESS-STRAIN CURVE

FIGURE 2G-3

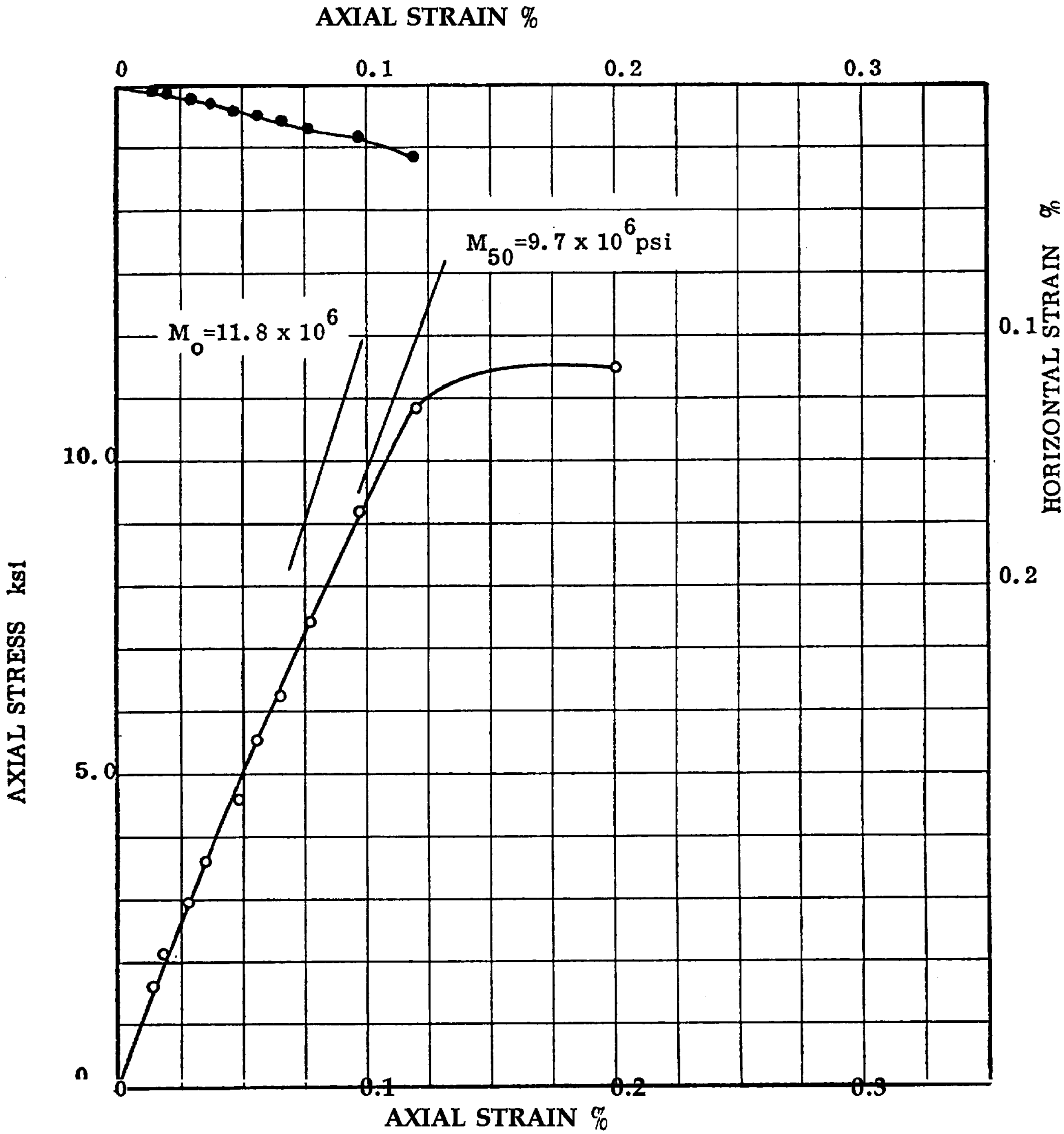


M = Modulus of Deformation

Diorite
Borehole E2-2 Depth 50.4 to 50.8 ft

UNCONFINEDTEST E2C STRESS-STRAIN CURVE

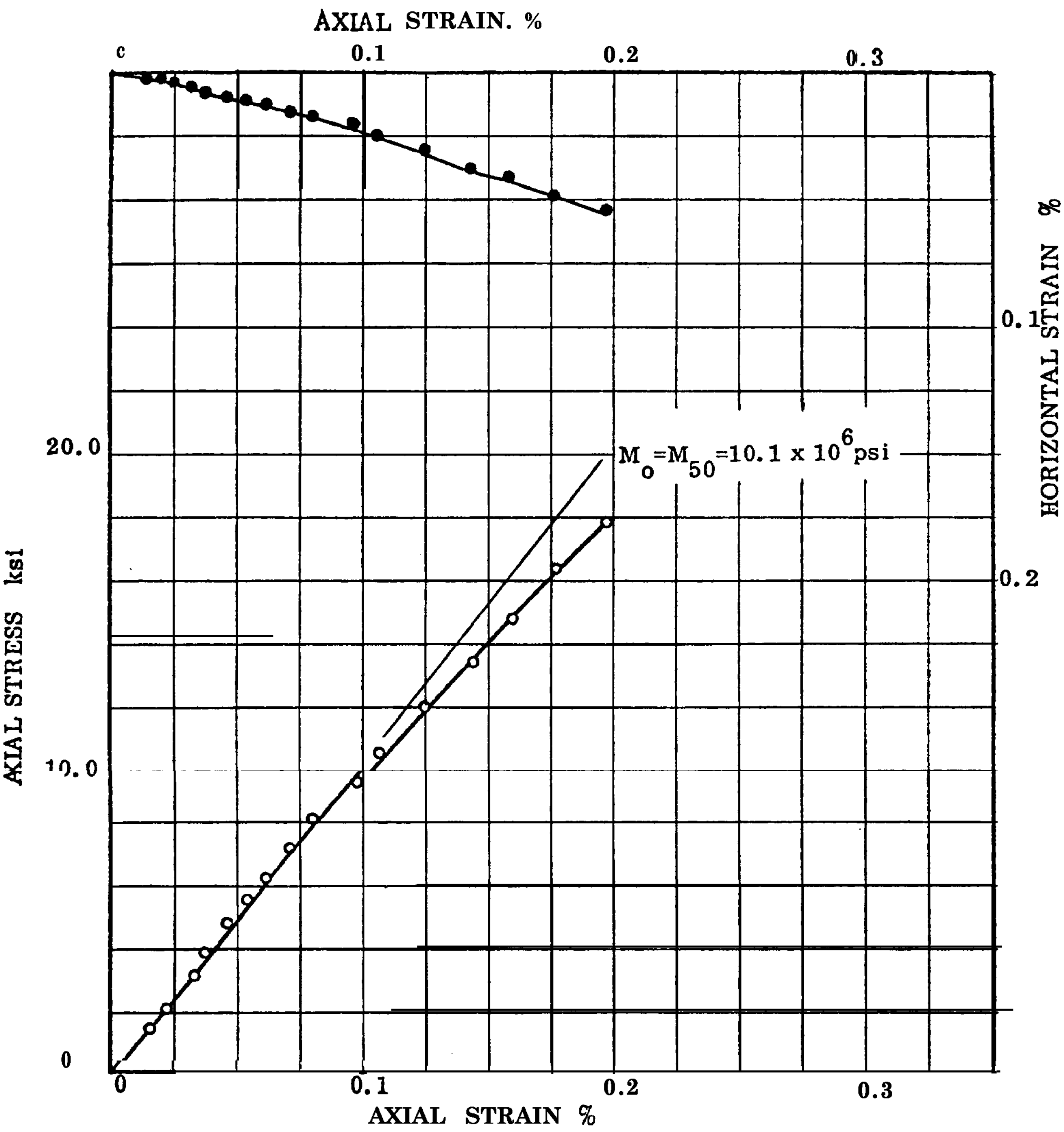
FIGURE 2G-4



M = Modulus of Deformation

Schist
Borehole E2-2 Depth 139.4 to 139.8

UNCONFINED TEST E2 J STRESS-STRAIN CURVE
FIGURE 2G-5

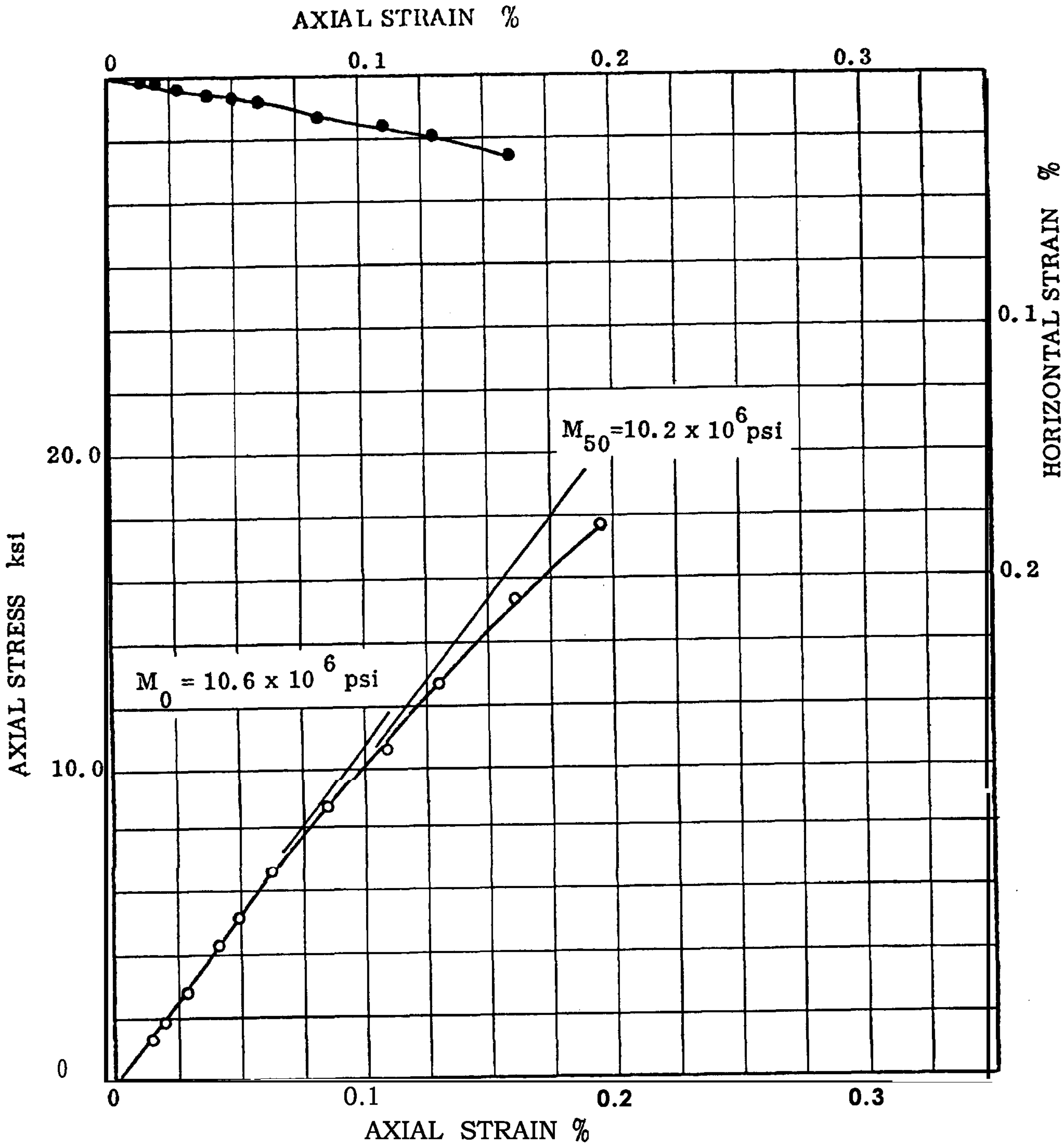


M = Modulus of Deformation

Schist
Borehole E2-2 Depth 141.9 to 142.3 ft

UNCONFINED TEST E2M STRESS -STRAIN CURVE

FIGURE 2G-6

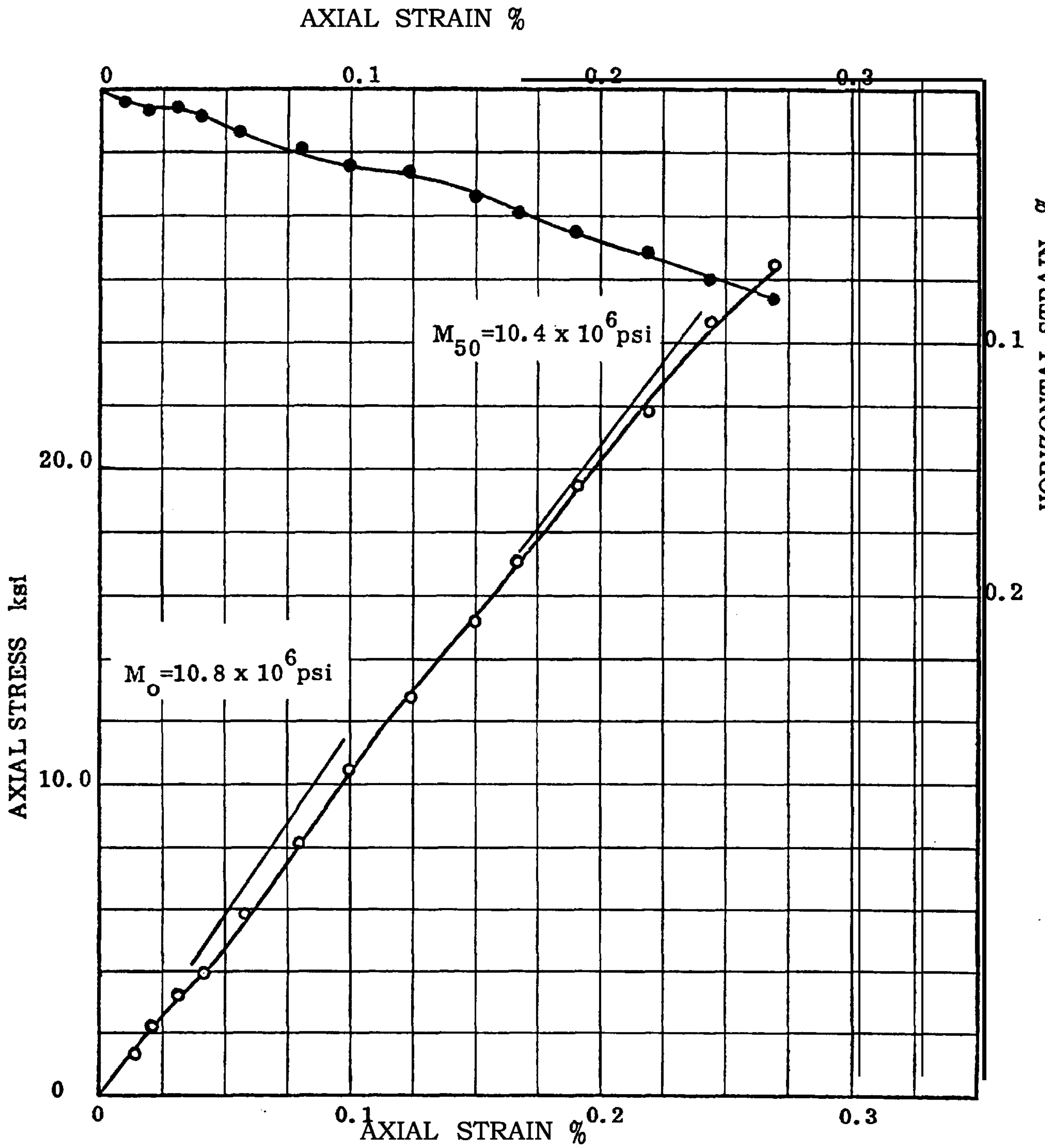


M = Modulus of Deformation

Schist
Borehole B7 Depth 27.8 to 28.2 ft

UNCONFINED TEST B7B STRESS-STRAIN CURVE

FIGURE 2G- 7



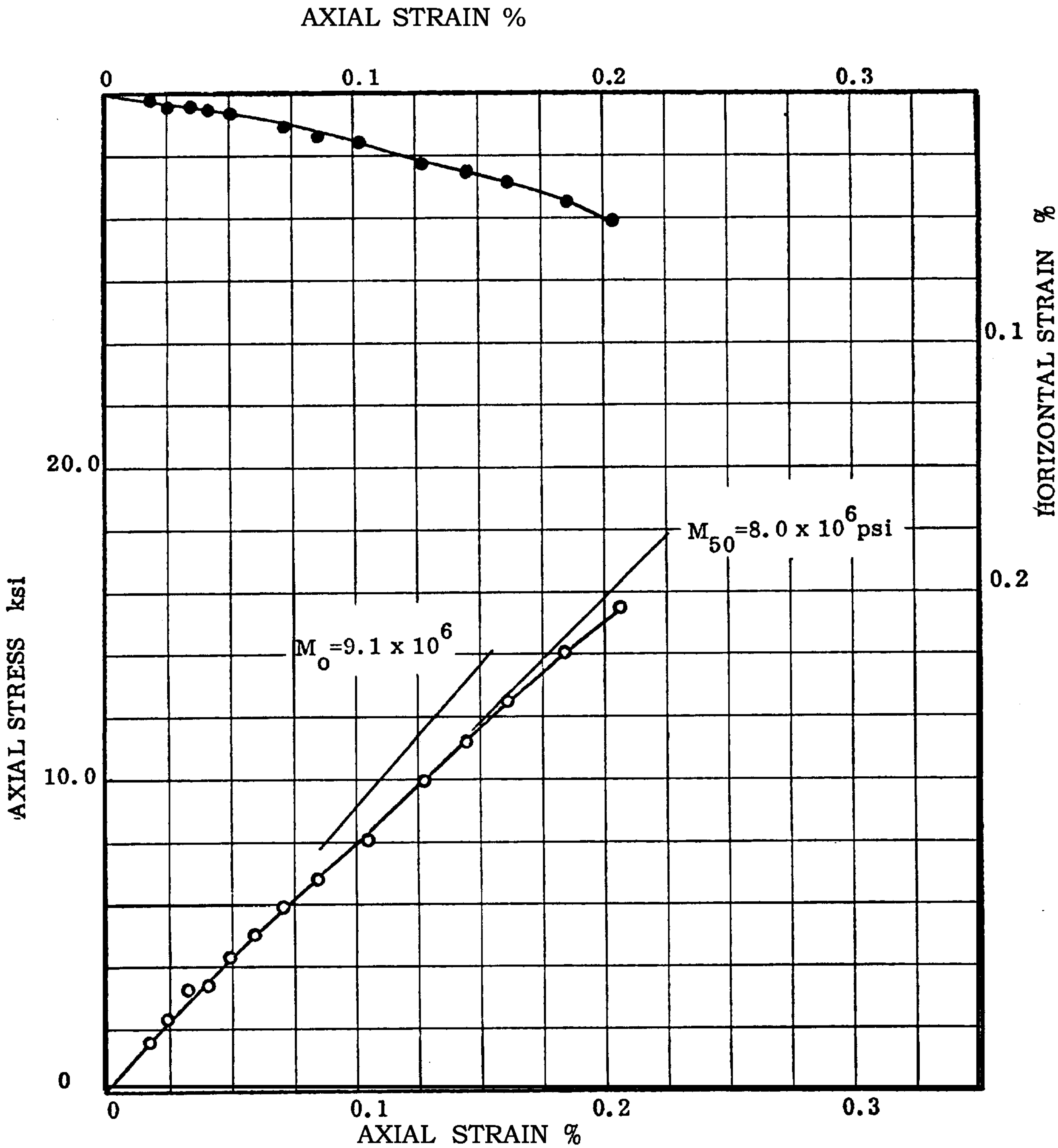
M = Modulus of Deformation

Diabase

Borehole B-12 Depth 123.5 to 12[illegible].9 ft

UNCONFINED TEST B42D STRESS-STRAIN CURVE

FIGURE 2G-8



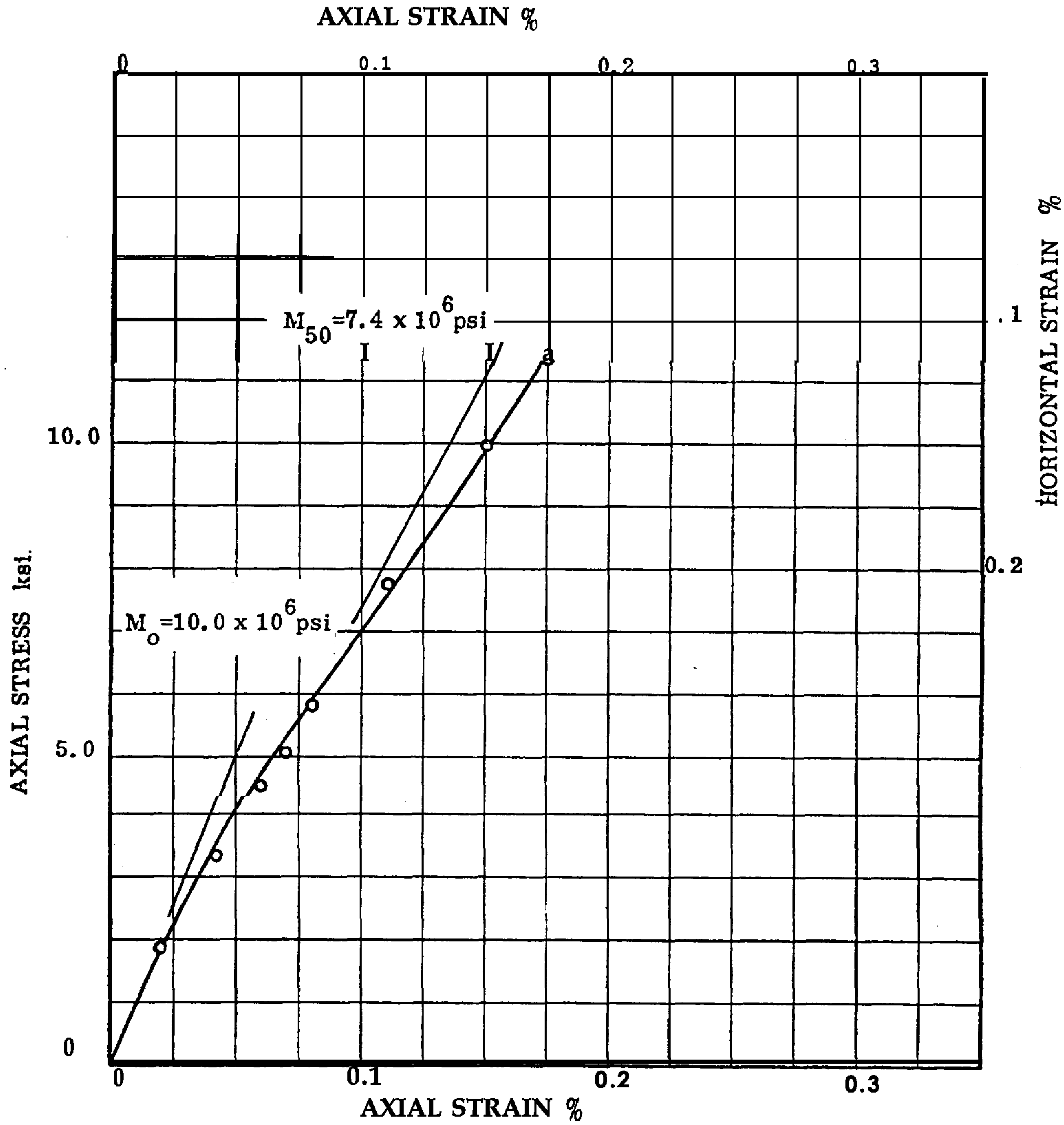
M = Modulus of Deformation

Schist

Borehole B42 Depth 141.3 to 141.7 ft

UNCONFINED TEST B42F STRESS-STRAIN CURVE

FIGURE 2G-9

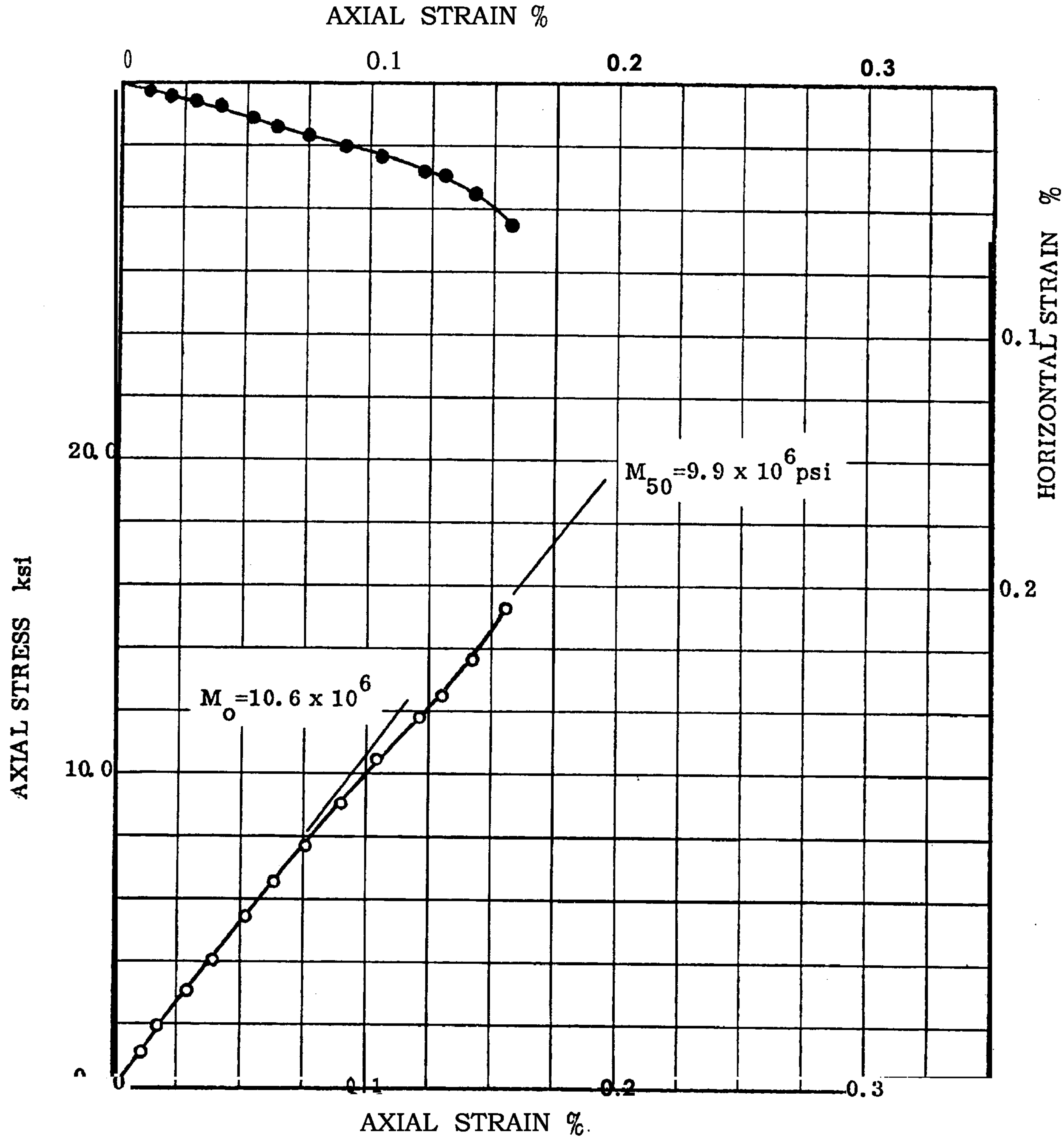


M = Modulus of Deformation

Borehole B42 Schist
Depth 142.7 to 143.1 ft

UNCONFINED TEST B42H STRESS-STRAIN CURVE

FIGURE 2G-10



M = Modulus of Deformation

Diorite
Borehole F1A Depth 127.5 to 127.9 ft

UNCONFINED TEST F IA STRESS-STRAIN CURVE

FIGURE 2G-11

APPENDIX 2H

ROCK STRESS MEASUREMENTS IN BORING OC1A

The information contained in this appendix was not revised, but has been extracted from the original FSAR and is provided for historical information.

SEABROOK STATION

ROCK STRESS MEASUREMENTS
IN BORING OC1A

for

Yankee Atomic Electric Company
and
Public Service Company of New Hampshire

September 1973

by

Geotechnical Engineers, Inc.
934 Main Street
Winchester, Massachusetts 01890

SEABROOK STATION

ROCK STRESS MEASUREMENTS
IN BORING OC1A

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SUMMARY

Rock stress measurements were made in June and July 19'73 at depths of 33 ft to 42 ft in vertical Boring OC1A, which is about 34 ft from the center of proposed Reactor No. 1 of Seabrook Station.

The results of five measurements of compressive stresses in the horizontal plane were:

Largest stress: 1240 psi (150 to 2150 psi)
Smallest stress: 860 psi (50 to 1570 psi)

The vertical stress can be assumed equal to the overburden stress of about 50 psi. The average direction of the largest stress in the horizontal plane was N 40 E ($\pm$ 36°). These results compare well with other stress measurements in New England. (Fig. 18).

The rock at this location consists of a medium-grained, massive, quartz-diorite that contains pegmatitie dikes ranging in thickness from inches to two feet. See Figs. 2 and 3 for logs of Boring OC1A and El-l. The latter hole is NX-size and is located at the center of proposed Reactor No. 1.

The stress measurements were made by inserting a 6-arm borehole gage in a 1.5 in. diameter hole and overcoring with a bit that cuts a 4.31 in. diameter core around the inner hole. The rock modulus was measured by testing the annular core in a cell constructed to apply stress to the exterior of the annulus while making deformation measurements in the inner hole with the borehole gage.

SEA BROOK STATION

ROCK STRESS MEASUREMENTS IN BORING OC1A

for

Yankee Atomic Electric Company

and

Public Service Company of New Hampshire

Geotechnical Engineers, Inc. September 10, 1973

1. INTRODUCTION

1.1 Background

Measurements of seismic velocities in the bedrock at the plant site at Seabrook Station were made in the spring of 1969 by Weston Geophysical Research. These measurements indicated that the velocity in the Newburyport granodiorite ranged from 16500 fps to 18500 fps, whereas in the Kittery Schist the velocity was about 13000 fps. The velocities in the granodiorite were slightly on the high side, although not unusual in the area, and could be taken as a possible indication of in-situ stresses in the bedrock. Therefore, a modest program of stress measurement was undertaken in the zone where high velocities were measured at the location of one of the two proposed reactors. The measurements were made during June and July 1973.

1.2 Purpose

The purpose of this report is to present the results of measurements of in-situ stresses in the Newburyport granodiorite in vertical Boring OC1A at a depth of 31 to 43 ft using the overcoring technique. The coordinates of this hole are N20413, E796'71.

1.3 Scope

One hole was drilled near the center of proposed Reactor #1 at Seabrook Station for the purpose of measuring in-situ stresses. Eleven measurements

were made using the overcoring technique. Each measurement consisted of three deformation readings in the horizontal plane on axes oriented 120° apart. Of the eleven attempts, the data from five of the measurements, at depths of 33 ft 9 in. to 41 ft 5 in., were deemed suitable for analysis and are reported herein. The other measurements gave poor or marginal information because of rock fracture and /or equipment breakdown during overcoring.

Moduli of elasticity of the rock were measured (a) on two annular cylinders of rock removed after overcoring, and (b) intact specimens oriented such that the load was' applied in the direction of the axis that was horizontal in-situ. These moduli were used with the measured deformations and published formulae to compute the magnitude and direction of the largest and smallest normal stresses in the horizontal plane. The vertical stress was assumed to be *equal* to the overburden *pressure.*

The test procedures used are described in detail in Appendix A and B.

The tests were carried out in the field by Pierre Le Francois under the direction of Geotechnical Engineers Inc. The drilling was performed by the American Drilling and Boring Company.

2. METHOD OF MEASUREMENT

2.1 General

The overcoring technique consists of three phases:

1. Measurement of borehole expansion during overcoring.

2. Determination of the modulus of elasticity of the rock, for rebound to zero stress, preferably at the point of measurement, and

3. Computation of stresses using the theory of linear elasticity and the measured deformations and moduli.

Each of the above steps are described briefly in subsequent subsections.

2.2 The Overcoring Technique

Fig. 1 is a sketch of the appearance of the hole during overcoring. A PX hole, 5. O-in. diameter, was first drilled with a single-tube core barrel to the desired depth. In this case, this depth was the shallowest at which the rock was continuous enough to be tested, which turned out to be 31 to 43 ft below ground surface. Logs of Boring OC1A and Boring El-l (NX-size), which are about 14 ft apart, are shown in Figs. 2 and 3, respectively.

An EX single-tube core barrel, 1.5 in, 0. D. , was then carefully centered in the bottom of the PX hole and drilled to a depth of about 2 ft. The recovered EX core was examined to determine whether the rock was sufficiently continuous to attempt a measurement. If the core was unbroken, or only jointed once or twice, then an attempt was made.

The borehole gage, which is described in Subsection 2.3, was then lowered into the hole using orientation rods. These rods were used to preserve the orientation of the measuring points and for measuring depths accurately when the borehole gage was lowered into the hole. The measuring points on the borehole gage were at least 3.5 in. below the bottom of the PX core barrel (Fig. 1) so that a minimum depth of overcoring would be needed for a measurement, and to allow two measurements for each EX run if the rock did not break.

Overcoring with the PX single-tube core barrel was then carried out. Readings of deformation on three axes 120° apart in the horizontal plane were taken continuously until the PX core barrel was about 5 in. below the measuring points, or until the readings stopped changing rapidly.

The procedure for carrying out each measurement is described in detail in Appendix A.

2.3 The Borehole Gage

A photograph of the instrument, the hose, the readout, and the pressure application system is shown in Fig. 4. The instrument, without its vinyl sheath, is shown in Fig. 5. The deformation is measured by bending of the cantilevers that are seen at the left in Fig. 5. The readout. of the strain gages on the cantilever arms is proportional to the movement of the tips of the cantilevers. In this instrument three pairs of cantilevers were installed 120° apart. In principle only three cantilevers are needed, but a fourth is necessary to be able to compute body movement of the instrument within the hole. To eliminate this computation, the cantilevers were installed in pairs such that body movements cause zero output on the readout device. The instrument was designed and constructed by Pierre Le Francois.

The tips of the cantilevers are attached to the vinyl sheath, Fig. 4, such that when air pressure (or bottlednitrogen pressure) is applied inside, the cantilevers are forced against the side of the hole. Hence the hose serves the dual purpose of protecting the strain gage leads and passing air to the instrument. The readout is made on a conventional strain gage indicator.

2.4 Measurement of Modulus of Rock

To obtain the best value of the modulus of elasticity of the rock in the zone tested, it is necessary to remove the overcored annular cylinder of rock from the hole and test it in a rock modulus cell. In Fig. 6 an annular core is shown in the cell with the borehole gage in the central hole of the core. To determine the modulus one applies pressure to the outside of the core, up to about 3000 psi, and then removes it in increments, measuring the deformation of the central hole for each pressure decrement. In this way one reproduces reasonably well in the core the stresses that it underwent during overcoring. The details of the measurement procedure are given in Appendix B.

In the present case the rock in Boring OC1A, at the measuring points, was so broken up that only two satisfactory annular cores of sufficient length (16 in.) were recovered. They both contained slightly healed joints that broke during testing, although satisfactory results were obtained from both.

'To supplement the measurement of modulus on the annular cores, intact specimens of rock from Boring OC1A, from depths where stress measurements were made, were tested in unconfined compression. The specimens were loaded in the direction of the axis that was horizontal in-situ so that the load was in the same direction as in situ. The rebound modulus of these specimens was measured with the aid of strain gages glued on the sides of the specimens.

2.5 Computation of Stresses

The major and minor stresses in the horizontal plane were computed from the measurements using the following formulae from Obert (1 966):

$$p = \frac{Ek}{6d} (R_1 + R_2 + R_3) \qquad (1)$$

$$q = \frac{\sqrt{2}\, Ek}{12d} \sqrt{(R_1 - R_2)^2 + (R_2 - R_3)^2 + (R_3 - R_1)^2} \qquad (2)$$

where:

p = Stress at center of Mohr circles of stress, psi
q = Radius of Mohr circle of stress , psi
E= Modulus of elasticity measured for same stress changes as occurred in situ, psi
d = Diameter of central hole in which instrument is placed, in.
kR = Horizontal expansion of the diameter of the borehole during overcoring. The subscripts refer to axes that are 120° apart in the plane perpendicular to the axis of the borehole gage - in this case horizontal. R is the reading in microinches/inch ($\mu\epsilon$) and k is the instrument calibration in in. /$\mu\epsilon$

From the values p and q one can compute the largest and smallest stresses in the plane perpendicular to the axis of the borehole gage from:

$$\sigma_I = p + q \qquad (3)$$

$$\sigma_{II} = p - q \qquad (4)$$

The direction of stress σ_I is obtained from the formula: [1]:

$$\alpha = 1/2 \tan^{-1} \frac{\sqrt{3}\,(R_2 - R_3)}{2R_1 - (R_2 + R_3)} \qquad (5)$$

where: α = angle measured from the direction of R_1 to the direction of σ_I in the counterclockwise direction.

Reference (1) Obert, Leonard (1966) "Determination of the Stress in Rock - A State of the Art Report," Presented at the 69th Annual Meeting of the ASTM, Atlantic City.

1) Eq. (5) contains $\sqrt{3}$ in the argument rather than 3, which was shown in the Reference (1) by error, but was correct in an earlier reference.

Equation (5) is subject to the following restrictions:

If $R_2 > R_3$ and $R_2 + R_3 < 2R_1$, then $0 < \alpha < 45^\circ$
and $R_2 + R_3 > 2R_1$, then $45^\circ < \alpha < 90^\circ$
If $R_2 < R_3$ and $R_2 + R_3 > 2R_1$, then $90^\circ < \alpha < 135^\circ$
and $R_2 + R_3 < 2R_1$, then $135^\circ < \alpha < 180^\circ$

All but Eq. (5) above are based on the assumption that a plane stress condition exists at the measuring point in situ, i.e. that the vertical stress is zero. Since the vertical stress is very close to the overburden stress of about. 50 psi, which is small compared to the magnitude of horizontal stresses of interest, the plane stress assumption is appropriate in this case. Hence the computed stresses are dependent only on the modulus of elasticity and not on Poisson's ratio of the rock.

3. TEST DATA AND RESULTS

3.1 Calibrations

The results of calibrations of the instrument and measurements of rock modulus are shown in Table 1. Direct calibration of Instrument, No, 2 with a micrometer yielded k = 10 μ in. /$\mu\epsilon$. Since 5 $\mu\epsilon$ can be read, the instrument can be used to discern movements in the borehole as small as 5 x 10^{-5}in. Instrument, No. 1 was not calibrated directly, but it is capable of discerning movements of 2 x 10^{-5}in. in the borehole.

The borehole gages were calibrated under conditions similar to in-situ conditions by using an annular aluminum cylinder of known modulus (10 x 10^6 psi) as a standard. Table 1 shows that Instrument No. 2 yielded k = 8.6 μ in./$\mu\epsilon$, as compared with 10 μ in./$\mu\epsilon$ for the direct calibration above. Since the calibration in the rock modulus cell models very closely the in-situ testing conditions and since the modulus of aluminum is well known, the value of k = 8.6 μ in. /$\mu\epsilon$ for Instrument No. 2 is the better value and was used herein. * Similarly k = 4.4 μ in./$\mu\epsilon$ was used for Instrument No. 1.

Two annular cores of granodiorite were retrieved that could be tested in the rock modulus cell. The second of these, near tests OC1A-8/9, broke and had to be glued with epoxy to complete the test, The results in Table 1 show that the moduli of the two cores were 4.1 and 3.0 x 10^6 psi. The modulus for the pegmatite (Test OClA-2) was assumed to be 4.1 x 10^6 psi also since it was harder but seemed to contain a greater number of healed joints than the granodiorite.

As a check on the modulus values obtained for the annular cores of granodiorite, additional tests were made by cutting 1.2 in. cube samples from some of the broken cores, gluing on strain gages, and loading them horizontally. The moduli were:

---

*The direct calibration was made without the vinyl sheath in place. The cantilevers were therefore unstressed. When the gage is in the borehole, the cantilevers are stressed to half their elastic limit. Hence, the direct calibration is not as appropriate as the calibration which makes use of a standard annular cylinder.

From Test	Rock*	Rebound Modulus 10^6 psi
OC1A-2	Granodiorite	12
OC1A-2	Pegmatite	12
OC1A-3	Granodiorite	5
OC1A-7	Granodiorite	11

× Specimens were cubes 1.2 in. on a side.

The range of possible moduli of the granodiorite is from about 3 to 12 x 10^6 psi. The larger values were measured on small intact specimens using strain gages, whereas the smaller values were measured on the annular *cores* using a loading sys tern and measuring device which were identical for practical purposes to in situ conditions. Hence the moduli used in the computations were those measured on the annular cores. The fact that one intact specimen of granodiorite had a modulus of only 5 x 10^6 psi gives some confidence in the use of a still lower modulus for the large annular cores, because they can be expected to contain more defects than the smaller specimens.

3.2 In Situ Stresses and Directions

Table 2 shows the test conditions and the computed calibrations and moduli. Table 3 shows the readings selected from the data in Figs. 7 to 11 together with the stresses and directions computed from Eys. (3), (4), and (5). The dimensions of the overcored hole for each test are shown in Figs. 12-16, and photographs of the annular cores recovered, including the ones for which moduli were measured, are shown in Fig. 17.

Fig. 18 shows to scale the computed stresses and directions for the best estimated values. Table 3 shows the numerical values for these best estimates as well as other possible values for Tests OC1A-2, 7, and 9. These additional values arise from alternate selections of the changes in reading from Figs. 7, 10, and 11.

The largest normal stress in the horizontal plane (σ_I) is compressive, ranges from 150 to 2150 psi, and averages 1240 psi. The smallest normal stress in the horizontal plane (σ_{II}) is also compressive, ranges from 50 to 1570 psi, and averages 860 psi. The direction of σ_I is N 40 E $\pm$, 36°. In giving this direction, the direction for Test OC1A-5 is neglected because the stress was so small in that test that the computed direction is not meaningful.

4. DISCUSSION OF RESULTS

The stresses and directions in Fig. 18 show that the direction of the major stress in the horizontal plane is generally NE-SW. The magnitude of this stress is best taken as the average of the five satisfactory measurements, since inherent variations in the stress and direction can occur within any given block of rock in situ, particularly near surface. This average is 1240 psi (87 bars) for the major stress and 860 psi (61 bars) for the minor stress in the horizontal plane. The vertical stress is assumed equal to the overburden pressure of about. 50 psi,

At the bottom of Fig. 18 is a tabulation of some known previous stress measurements in New England (Sbar and Sykes, 1973). The general agreement. between the stresses at Seabrook and those elsewhere in New England is clear. The direction of the major stress is also in reasonable agreement. The range of error in the computed direction, simply due to alternate selections of the changes that occurred during overcoring, is such as to place all of the earlier values essentially within the possible total range for the present case.

It should be noted that the technique used herein for modulus measurement is really nothingmore than a method for reapplying the in-situ stresses under laboratory conditions. Hence the computed stresses are in fact independent of the absolute values of the modulus and the instrument calibration constant. If the researchers who made the previous measurements did not use a similar approach, then the agreement of all the data may be fortuitous.

By measuring the deformation of an annular specimen of rock in the laboratory one eliminates many potential sources of error. However, the damage done to the core during drilling is not taken into account. If the rock in-situ contains microfractures, they may be opened during drilling of the EX and the PX holes. When this annulus is brought to the laboratory, its modulus is likely to be lower than in situ. Previous work by Obert (1962) indicates that until the stress levels reach about 50% of the crushing strength of the intact rock, the effect of stress relief is likely to be low. The effect in the present case is probably low because the crushing strength is more than four times the highest stress that was measured.

Reference (2) Sbar, M. L. and Sykes, L. R. (1973) "Contemporary Compressive Stress and Seismicity in Eastern North America: An Example of Intra-Plate Tectonics," Geological Society of America Bulletin, Volume 84, No. 6, p. 1871.

Reference (3) Obert, Leonard (1962) "Effects of Stress Relief and Other Changes in Stress on the Physical Properties of Rock," Bureau of Mines, RI 6053.

TABLES

TABLE 1 CALIBRATIONS

A. DIRECT CALIBRATION WITH MICROMETER

Inst No.	Change in Reading per 10^{-3} in. for each Channel, $\mu\epsilon$				Instrument Calibration k μ in. /$\mu\epsilon$
	R_1	R_2	R_3	Avg	
2	100	100	103	101	10

B. CALIBRATIONS USING ANNULAR CORES IN ROCK MODULUS CELL

Inst No.	Change in Reading per 10^3 psi for each Channel, $\mu\epsilon$				k	E	Medium
	R_1	R_2	R_3	R_{Avg}	μ in. /$\mu\epsilon$	10^6 psi	--
1	76	78	76	77	<u>4.4</u>	10	Al
2	40	41	39	40	<u>8.6</u>	10	Al
	41	39	39	40	<u>8.6</u>	10	Al
1	200	173	192	188	4.4	4.1	OC1A-4 diorite
2	135	140	130	135	8.6	3.0	OC1A-8/9 diorite

Underlined values computed using equation for thick-walled cylinder under external pressure for OD = 4.31 in, ID = 1.50 in.: $kR = 3.43 \frac{p}{E}$. The quantity kR is equal to the diametral deformation. Al = Aluminum.

TABLE 2 TEST CONDITIONS FOR STRESS MEASUREMENTS

Test No.	Depth ft-in.	Inst. No.	Inst. Calib. k μ in. /$\mu\epsilon$	Modulus E 10^6 psi	True Azimuth Channel #1 deg.	Rock Type
OC1A-2	33 - 9½	2	8.6	4.1	285	Pegmatite
OC1A-5	36 - 9	1	4.4	4.1	165	Granodiorite
OC1A-6	38 - 3	2	8.6	4.1	285	Granodiorite
OC1A-7	39 - 3	2	8.6	3.0	255	Granodiorite
OC1A-9	41 - 5	2	8.6	3.0	240	Granodiorite

μ in. = microinches

$\mu\epsilon$ = microstrain

k = instrument calibration

E = modulus of elasticity used for computation of stresses (see Table 3)

All tests performed in vertical Boring OC1A. Coordinates 20413N; 79671E. Ground El. 28.0. Hole diameter = 5.0 in. Core O.D. = 4.3 in. Hole O. D. in which instrument placed = 1.5 in. Of eleven attempts made to measure stresses, five were successful.

TABLE 3 DATA AND RESULTS OF STRESS MEASUREMENTS

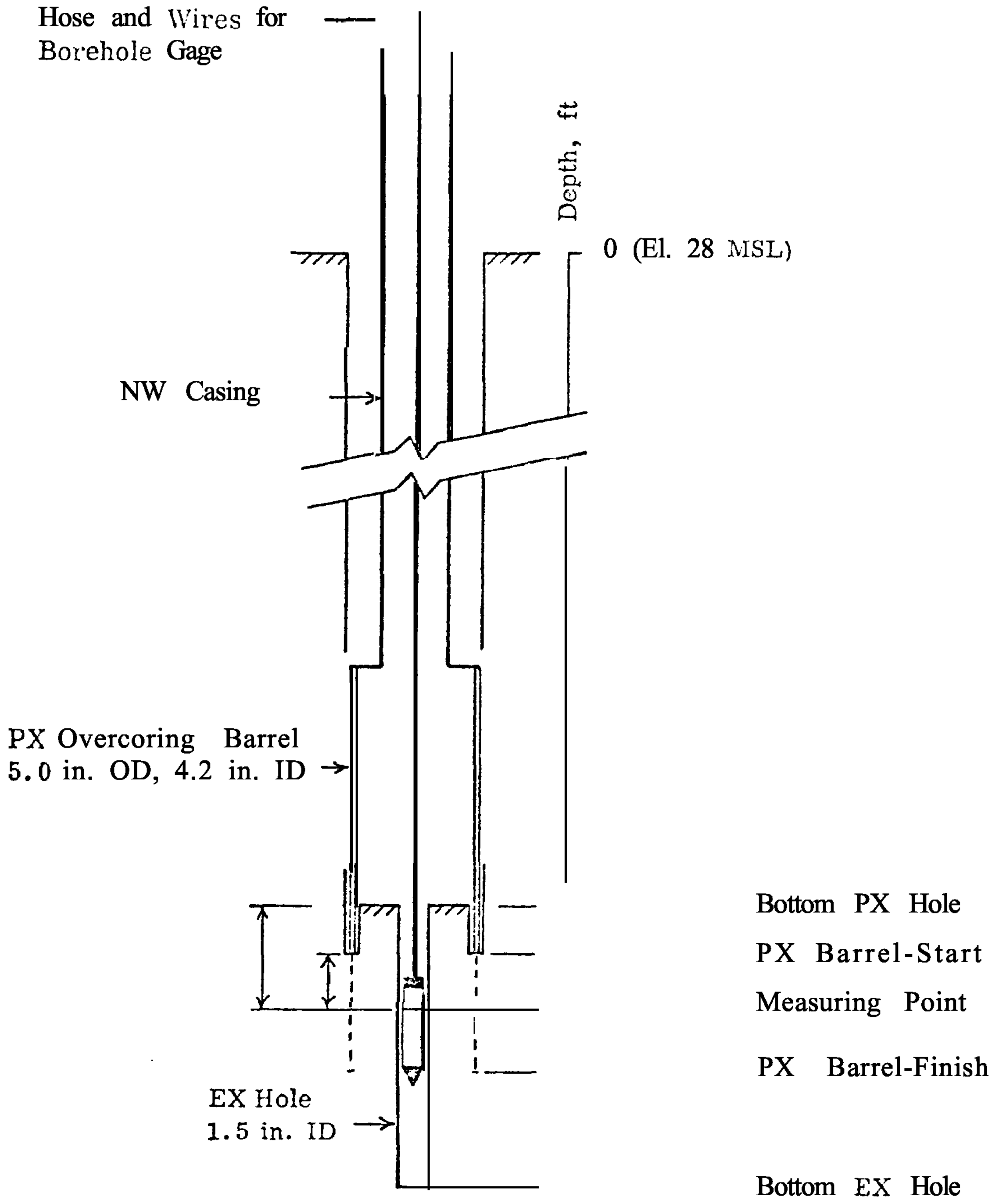
Test No.	Depth	Reading Change during Overcoring 1) 3)			Compressive Stress in Horizontal Plane 2)		True Bearing of σ_I
		R_1	R_2	R_3	σ_I	σ_{II}	
	ft-in.	$\mu\epsilon$	$\mu\epsilon$	$\mu\epsilon$	psi	psi	
OC1A-2	33 - 9½	80	95	125	1335	1025	N 38 E
		80	95	(90)	(1090)	(990)	(N 5 E)
OC1A-5	36 - 9	20	30	0	150	50	N 55 W
OC1A-6	38 - 3	60	110	90	1190	850	N 3 E
OC1A-7	39 - 3	250	150	250	2150	1570	N 45 E
		250	(200)	(200)	(2010)	(1710)	(N 75 E)
		250	150	(200)	(1970)	(1470)	(N 60 E)
OC1A-9	41 - 5	90	195	100	1400	800	N 48 E
		(130)	195	100	(1470)	(970)	(N 36 E)

1) Readings are shown for data from Channels 1, 2, and 3 on instrument. For all tests except OC1A-5, the numbering of the channels, each 120° apart, was counterclockwise. For OC1A-5 it was clockwise. In the equations for computation of the angle between the σ_I and the Channel 1 directions, the numbering is assumed to be clockwise. Hence for all but Test OC1A-5, R_2 and R_3 should be exchanged when computing this angle. See text for equations used for computations.

2) The vertical stress is assumed to be equal to the overburden, i.e. about 50 psi. Hence the stresses shown for the horizontal plane are close to the major and the intermediate principal stresses at each point tested.

3) Numbers in parentheses are alternate possible selections of reading changes during each test from the plots in Figs. 7, 10, and 11. These alternates are not considered quite as probable as the ones without parentheses, but they are included, together with the resulting stresses and stress directions to provide insight into the significance and dependability of the results as they are affected by this one source of error.

FIGURES



Yankee Atomic Electric Company / Geotechnical Engineers, Inc. Winchester, Massachusetts	SEABROOK STATION	SKETCH OF HOLE DURING OVERCORING
	Project 7286	Sept. 10. 1973 FIG. 1

SEABROOK STATION
LOG OF BORING OC1A

Coordinates: N 20413; E 79671 Logged by I'. LeFrancois

Top El. (MSL): 28.0 Date Logged August 1973

Depth (ft)	BREAKS	DIP / CONDITION OF CORE	GRAPHIC LOG	DESCRIPTIVE NOTES
30	Multiple drilling breaks	60° Joint rusty 30° Joint slightly rusty	①	Pegmatite dike, coarse grained. Contact: 60° dip
32		Joint set intersecting at. 30°		Quartz diorite. Dark gray, medium grain, massive texture. Quartz ~ 15%, Feldspar- 35%, Ferromagnesium ~ 40%, Biotite ~ 10%
		Multiple joints, with pieces from 1/4" to 3" long. Dip from 20 to 70°	②	
34			③	Pegmatite dike, coarse grained. Contact 45° dip Quartz diorite as above.
36		55° Tight joint broken by drilling	④	
	Drilling break	35°	⑤	
38		70° Tight joint 40° Rusted joint 40° Two tight joints, rusty	⑥	Pegmatite dike, 2" wide, at about 40° dip.
			⑦	Quartz diorite as above.
40		60° Rusty joint 20° Rusty joint 40° Two tight joints	⑧	
	Drilling break	0°	⑨	
42		6 0° Tight joint		
	Drilling breaks	60° Tight joint	⑩ ⑪	
44				

Depth ft

REMARKS - Log is shown, to a large scale, only for range of depth where stress measurements were attempted. Photographs of cores from tested depths are shown in Fig. 17. Log of Boring El-1, 14 ft away, shown in Fig. 3. Depth of stress measurements are shown above by: ① = OC1A-1.

FIG. 2

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SEABROOK STATION
LOG OF BORING El-1

Coordinates: N 20400; E 79675 — Logged by: J. R. Rand

Top El. (MSL): 25.9 — Date Logged: Dec. 26, 1972

BREAKS	DIP CONDITION OF CORE		GRAPHIC LOG	DESCRIPTIVE NOTES
Core Breaks on low angle (30°) joints @ Chips to 1' intervals	Rusty 70° joint even Chips-Rusty 70° joint Chips, rusty moderate weathering minor vugging	Rock is fresh. Locally affected by slight to moderate weathering on joints as shown. Most joints dip about 30° at .3' to 1' intervals.		Quartz diorite, medium fine grained, medium grey. Massive texture (not. notabl foliated. Locally intruded by pegmatite veinlets as shown. Pegmatite Veinlet, 65° Dip Pegmatite Veinlet, 75° Dip Pegmatite Veinlet
Breaks on low angle joints @ .5' to 1.5' intervals	Chips, rusty 60° joint minor rust 65° joint slight weathering	Rock is fresh. Slight weathering to minor rusty coatings on some joints.		Quartz diorite, as above, massive, medium fine grained, medium grey.
	65° joint clean, minor rust	Joints are normally clean. Not rusty.		
Breaks @ .5' to 2' pieces	70° joint minor rust 70° joint rough slight weathering moderately weathered	Rock is fresh. Low angle joints @ 30° to 35° dips. Joints not rusty except as shown.		Quartz diorite as above. Mostly medium fine grain medium grey low angle (30° to 35") joints @ .5' to 2' intervals.
Breaks @ .3' to 3' pieces	slight weathering slightly weathered rusty	Rock is fresh. Slight to moderate weathering, rust on occasional joints as shown.		Rock becomes coarse-grained Quartz diorite @ 72.6' depth. 50° dip on intrusive, welded contact. Reactor excavation

Depth ft: 0, 10, 20, 30, 40, 50, 60, 70

REMARKS - The total depth of this boring is 150 ft, as shown in the log submitted by J. R. Rand for the PSAR for Seabrook Station. This partial log is taken from the original and is included to cover the rock above and immediately below the zone where stres measurements were made, i.e. from 33 - 44 ft.

FIG. 3

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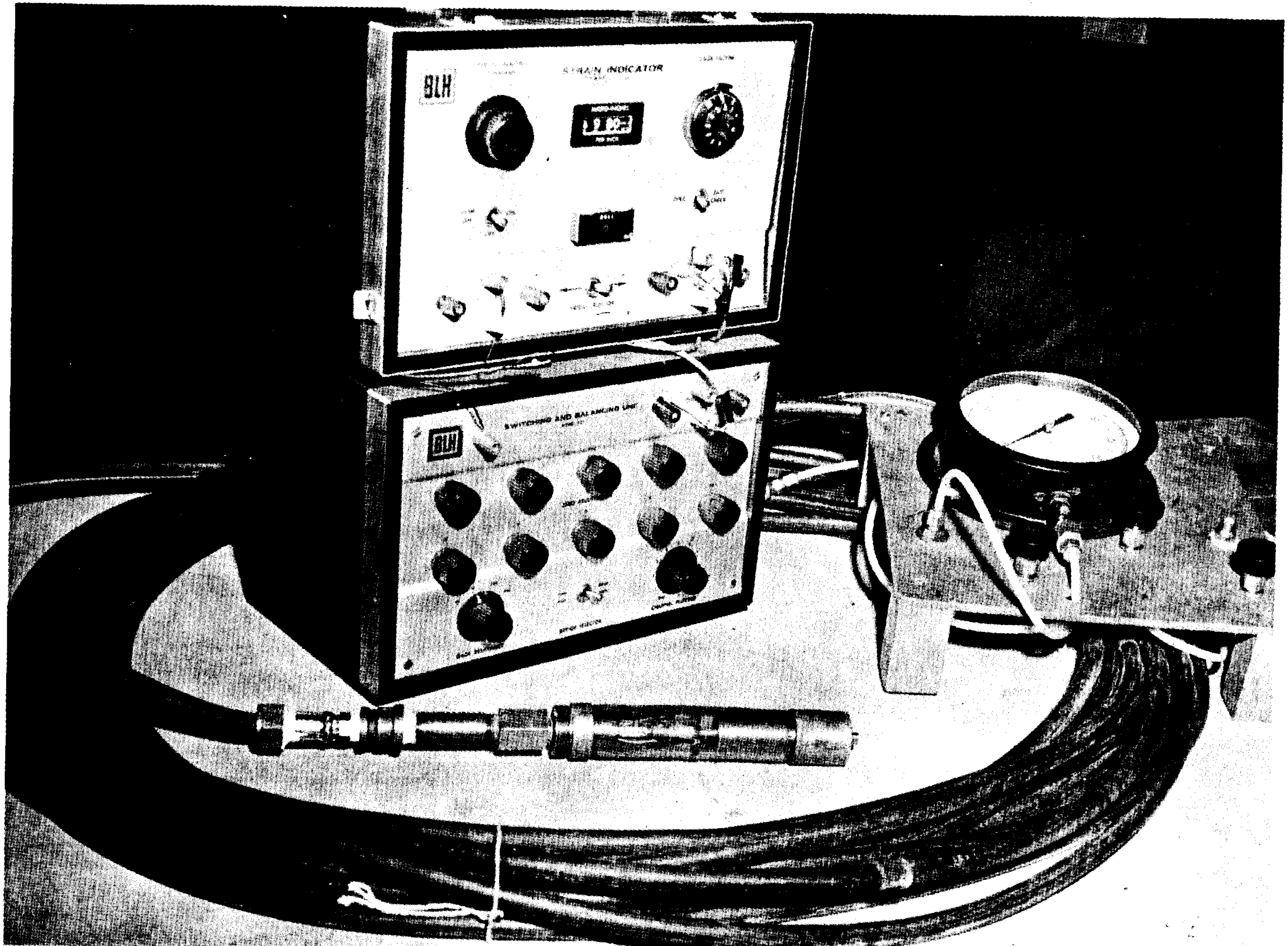
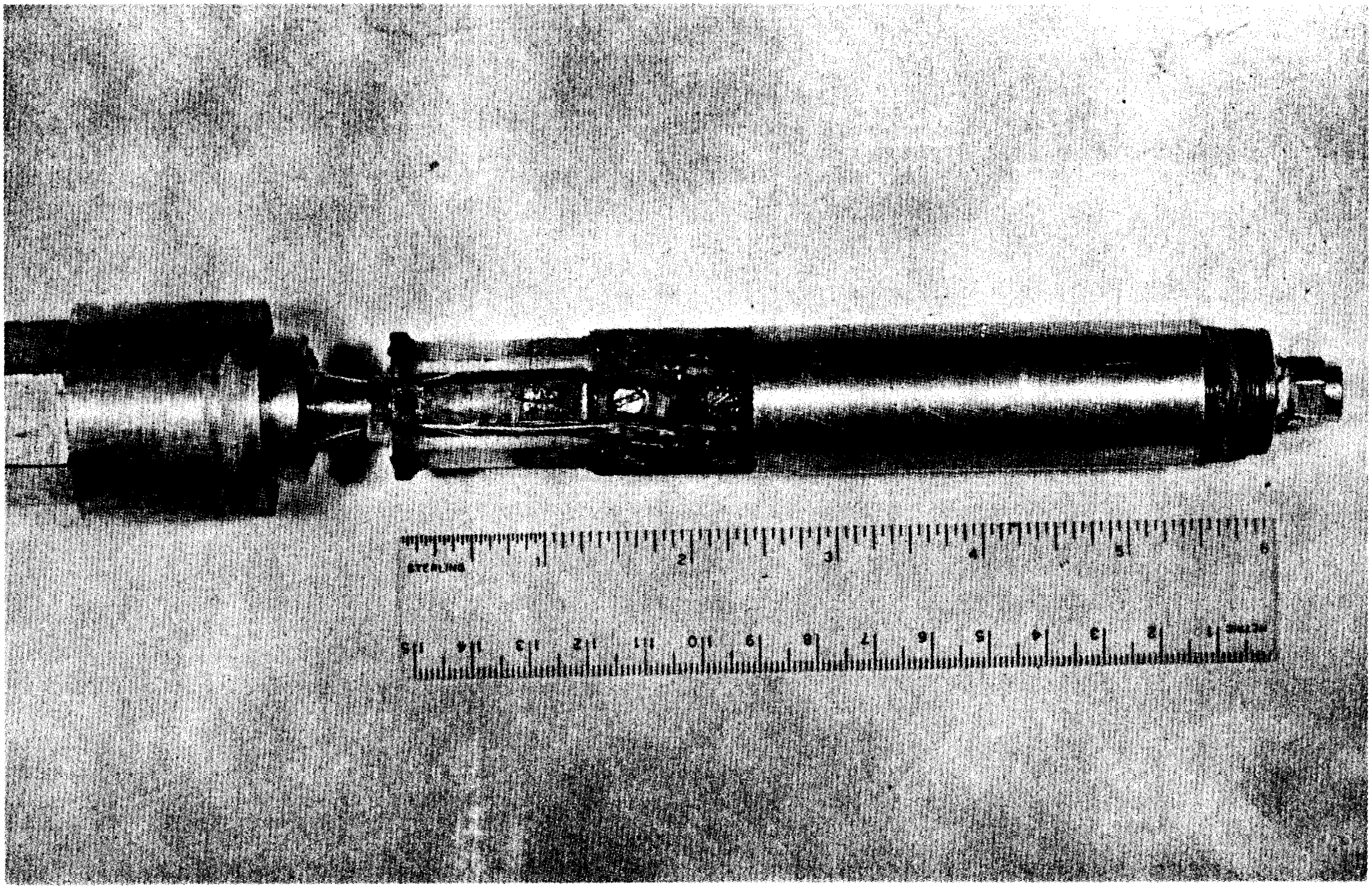


FIG. 4

BOREHOLE GAGE SYSTEM

Geotechnical Engineers Inc.

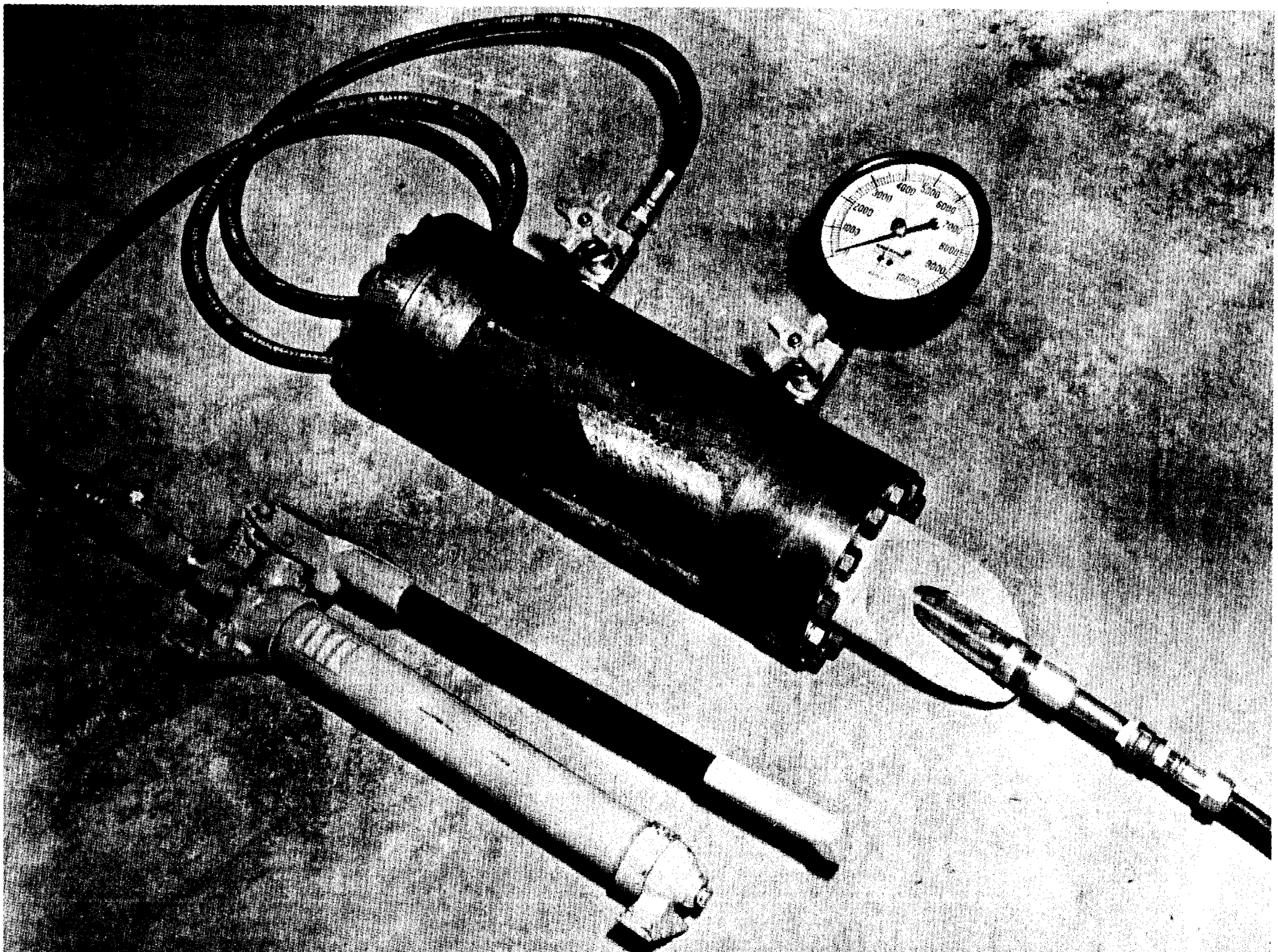


BOREHOLEGAGE
(vinyl sheath removed)

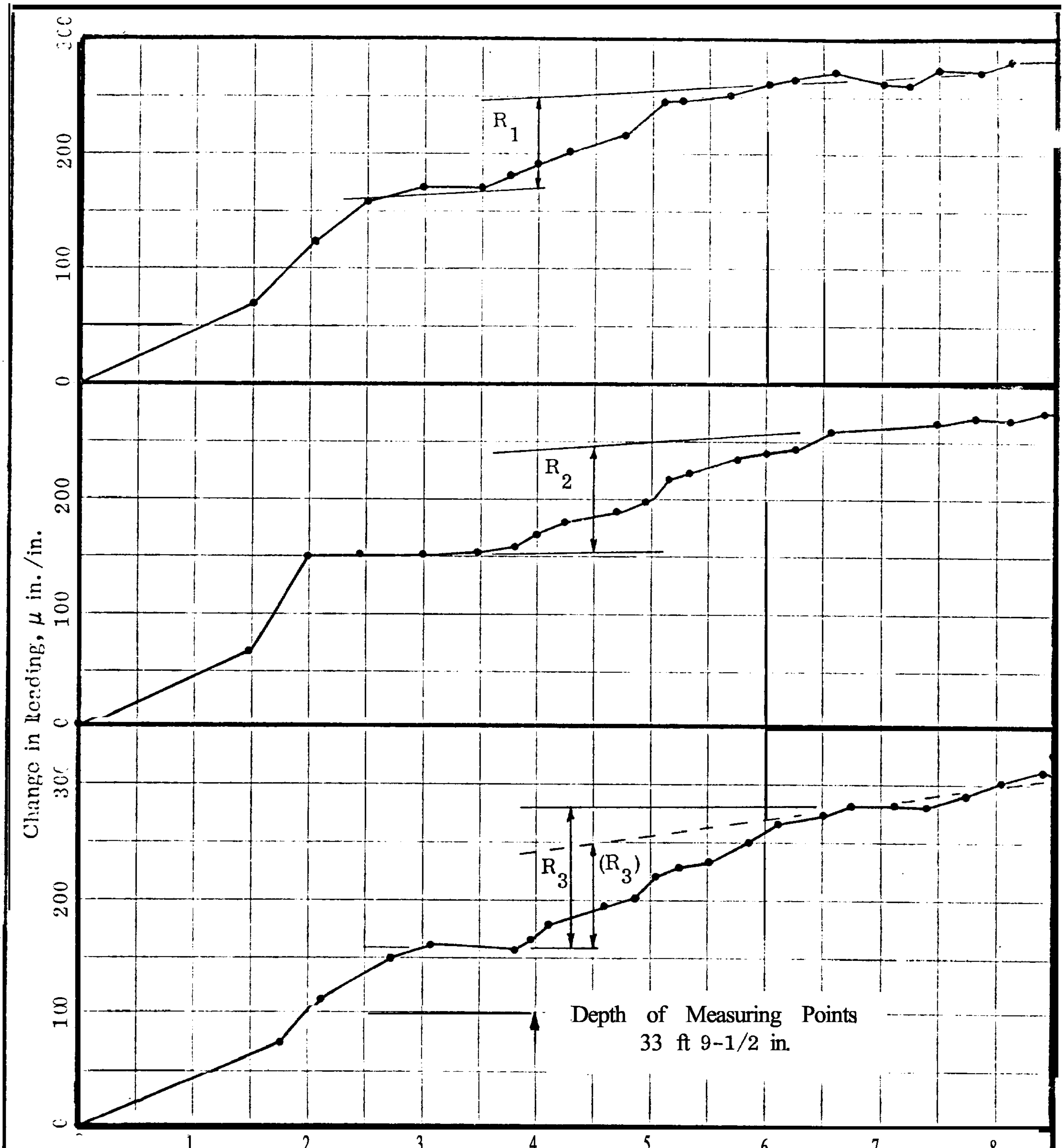
FIG. 5

Geotechnical Engineers Inc.

FIG. 6



ROCK MODULUS CELL

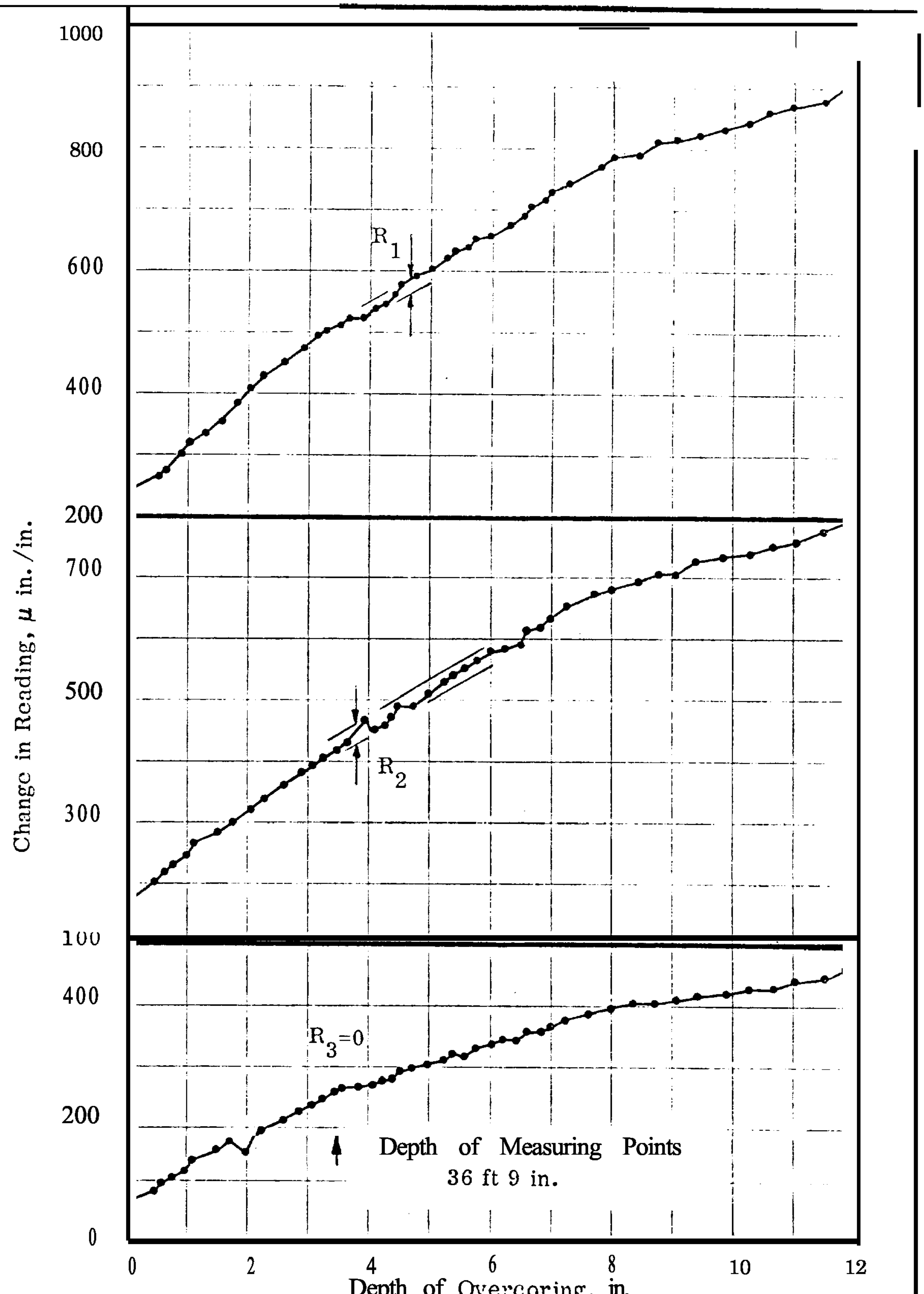


Depth of Overcoring, in.

Instrument Calibration 116 μ in. /in. = 0.001 in.

Note: Hole I.D. = 1.495 in.
0. D. = 4.31 in.

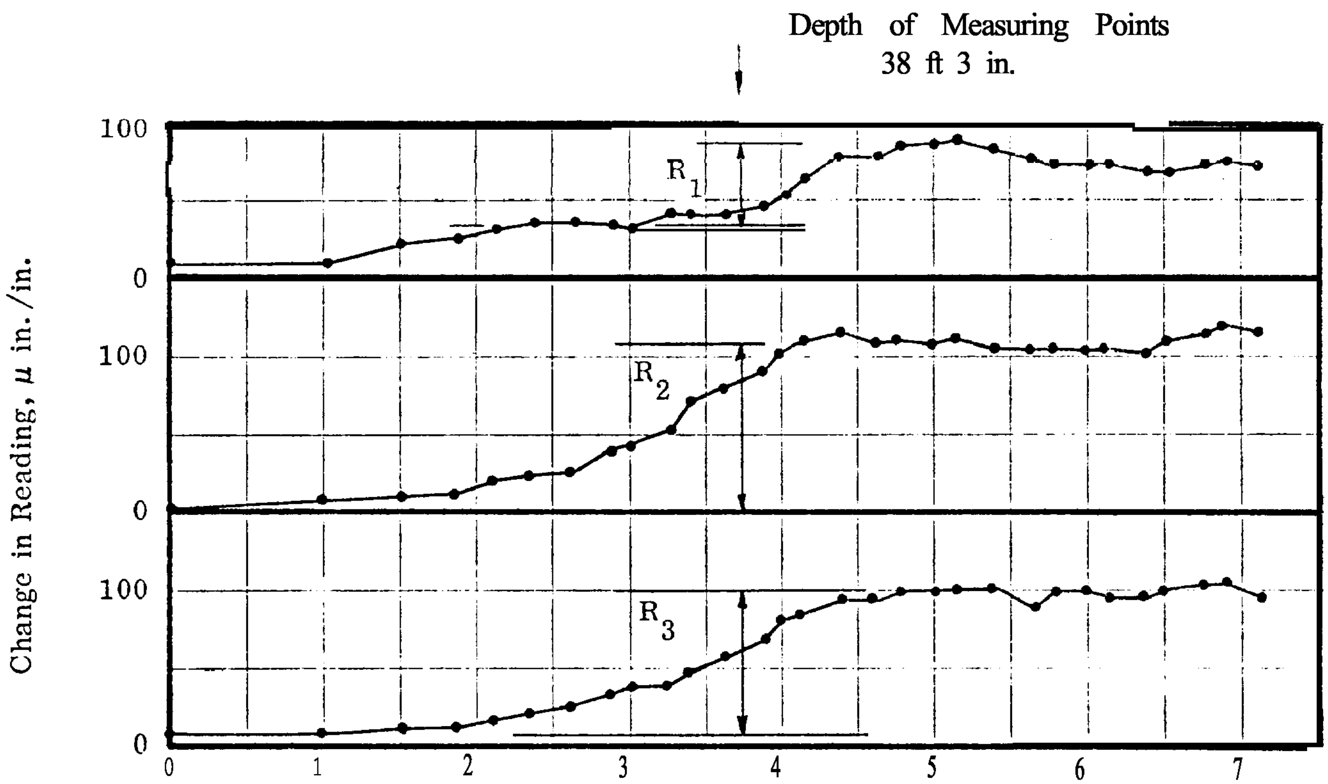
Yankee Atomic Electric Company	SEABROOK STATION	DATA FROM STRESS MEASUREMENTS 'TEST OC1A-2
Geotechnical Engineers, Inc. Winchester, Massachusetts	Project 7286	Aug. 8, 1973 FIG. 7



Instrument Calibration 230 μ in./in. = 0.001 in.

Note: Hole I.D. = 1.495 in O.D. -4.31 in.

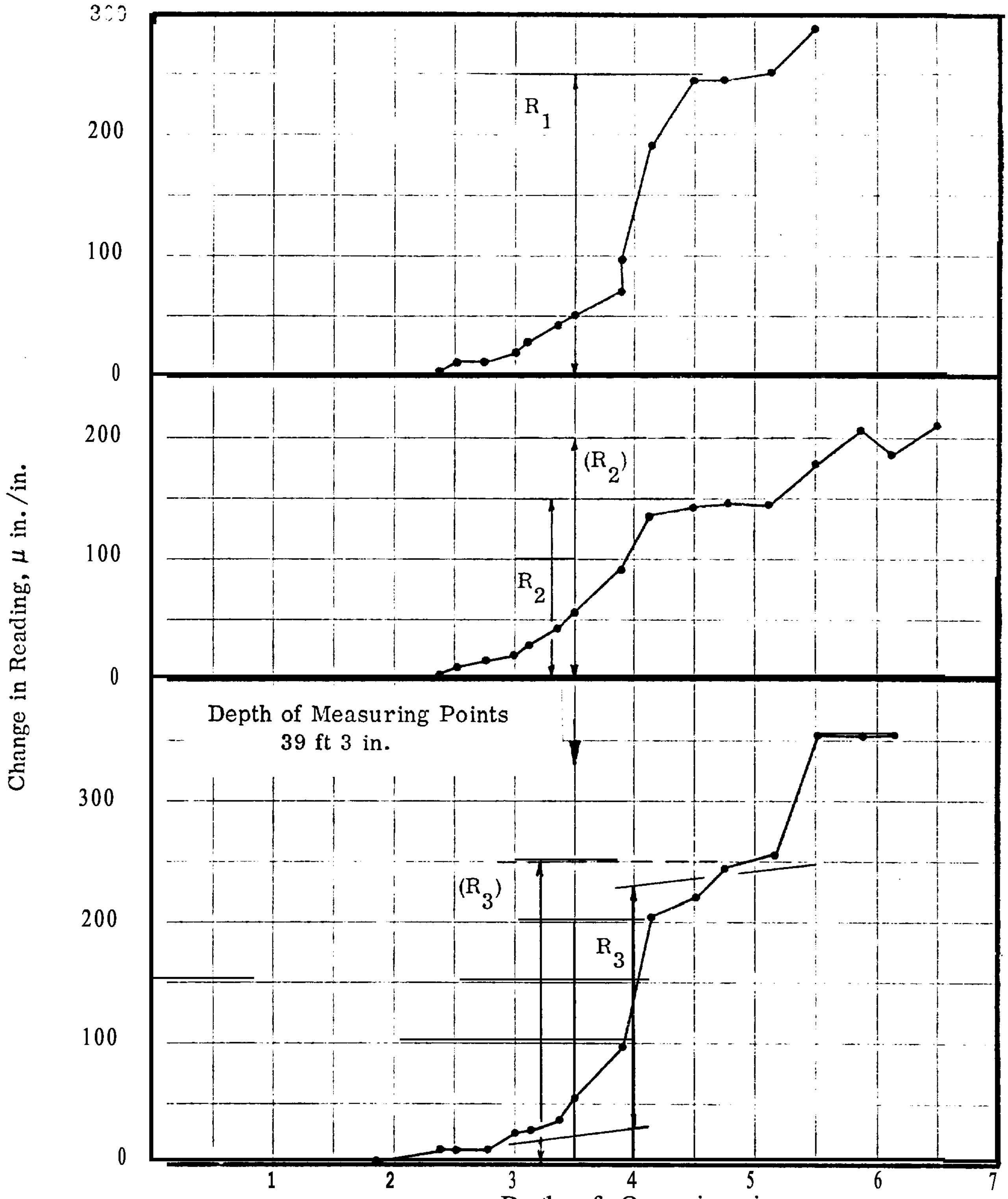
Yankee Atomic Electric Company Geotechnical Engineers, Inc. Winchester, Massachusetts	SEABROOK STATION Project 7286	DATA FROM STRESS MEASUREMENTS TEST OC1A-5 Aug. s, 1973 FIG. 8



Instrument Calibration 116 μ in. /in. = 0.001 in.

Note: Hole I.D. = 1.495 in.
O.D. = 4.31 in.

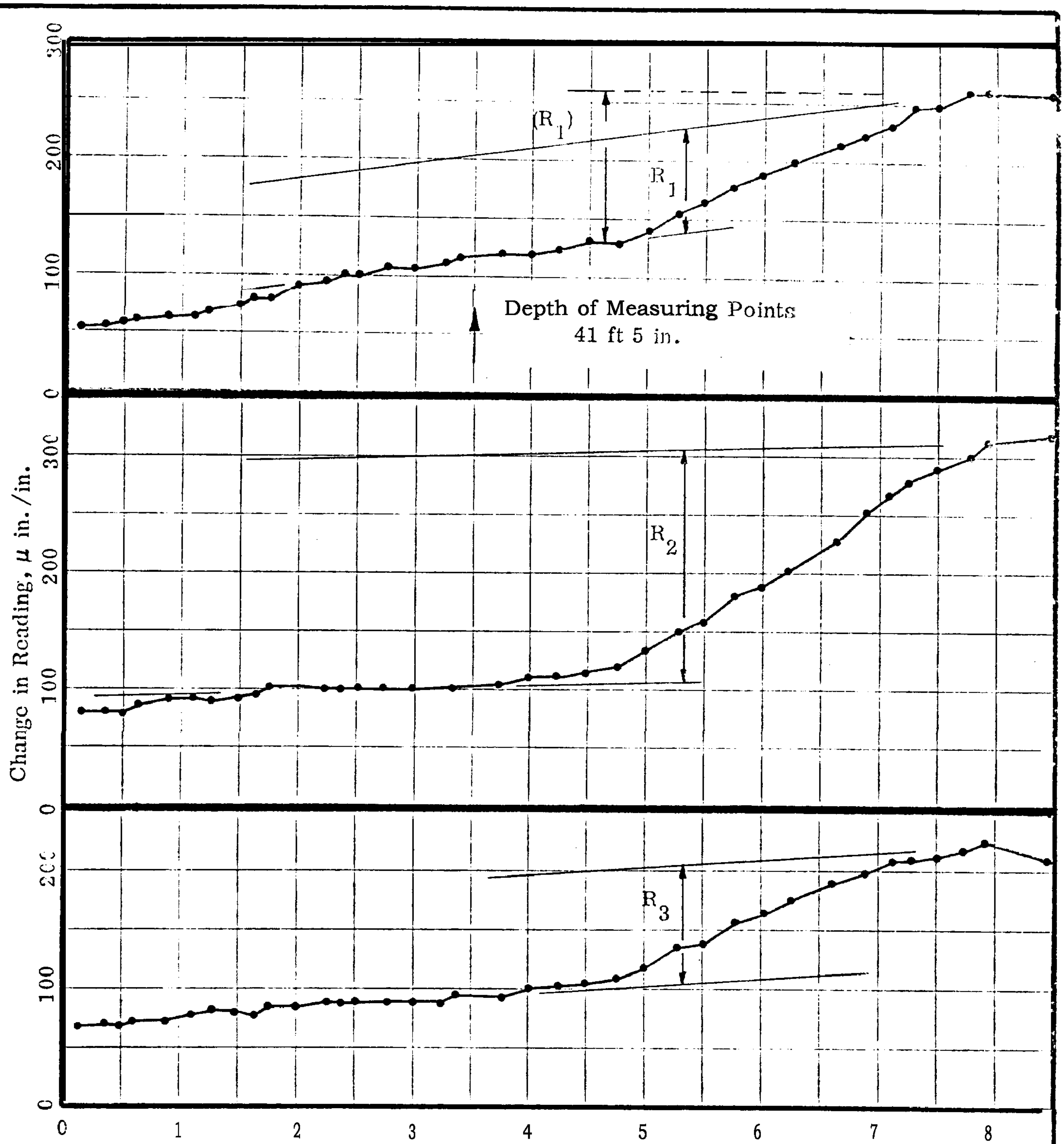
Yankee Atomic Electric Company	SEABROOK STATION	DATA FROM STRESS MEASUREMENTS TEST OC1A-6
Geotechnical Engineers, Inc. Winchester, Massachusetts	Project 7256	Aug. 8, 1973 FIG. 9



Instrument Calibration 116 μ in./in. = 0.001 in.

Note: Hole I.D. = 1.495 in.
0. D. = 4.31 in.

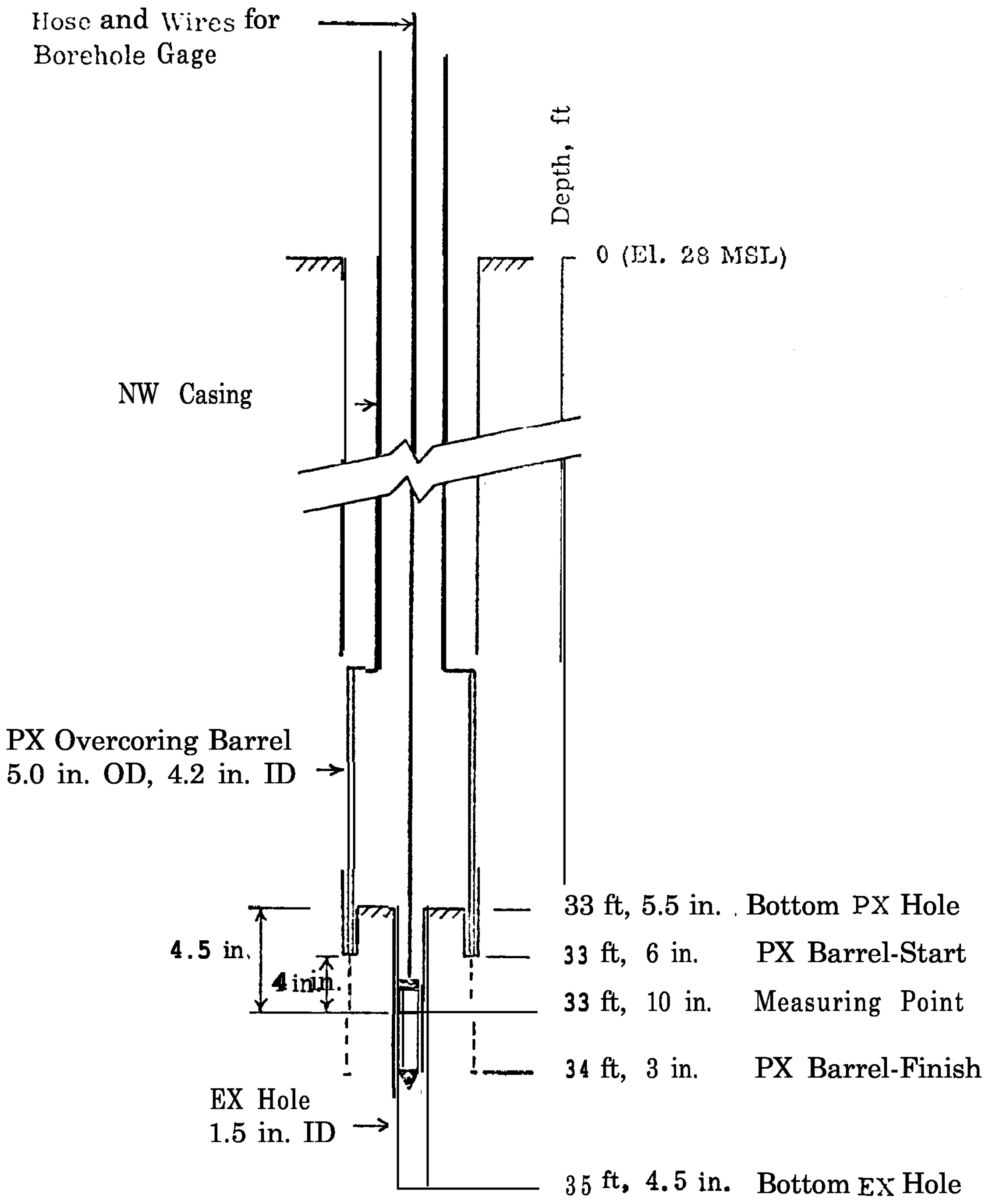
Yankee Atomic Electric Company	SEABROOK STATION	DATA FROM STRESS MEASUREMENTS TEST OC1A-7
Geotechnical Engineers, Inc. Winchester, Massachusetts	Project 7286	Aug. 8, 1973 FIG. 10



Depth of Overcoring, in.
Instrument Calibration 116 μ in. /in. = 0.001 in.

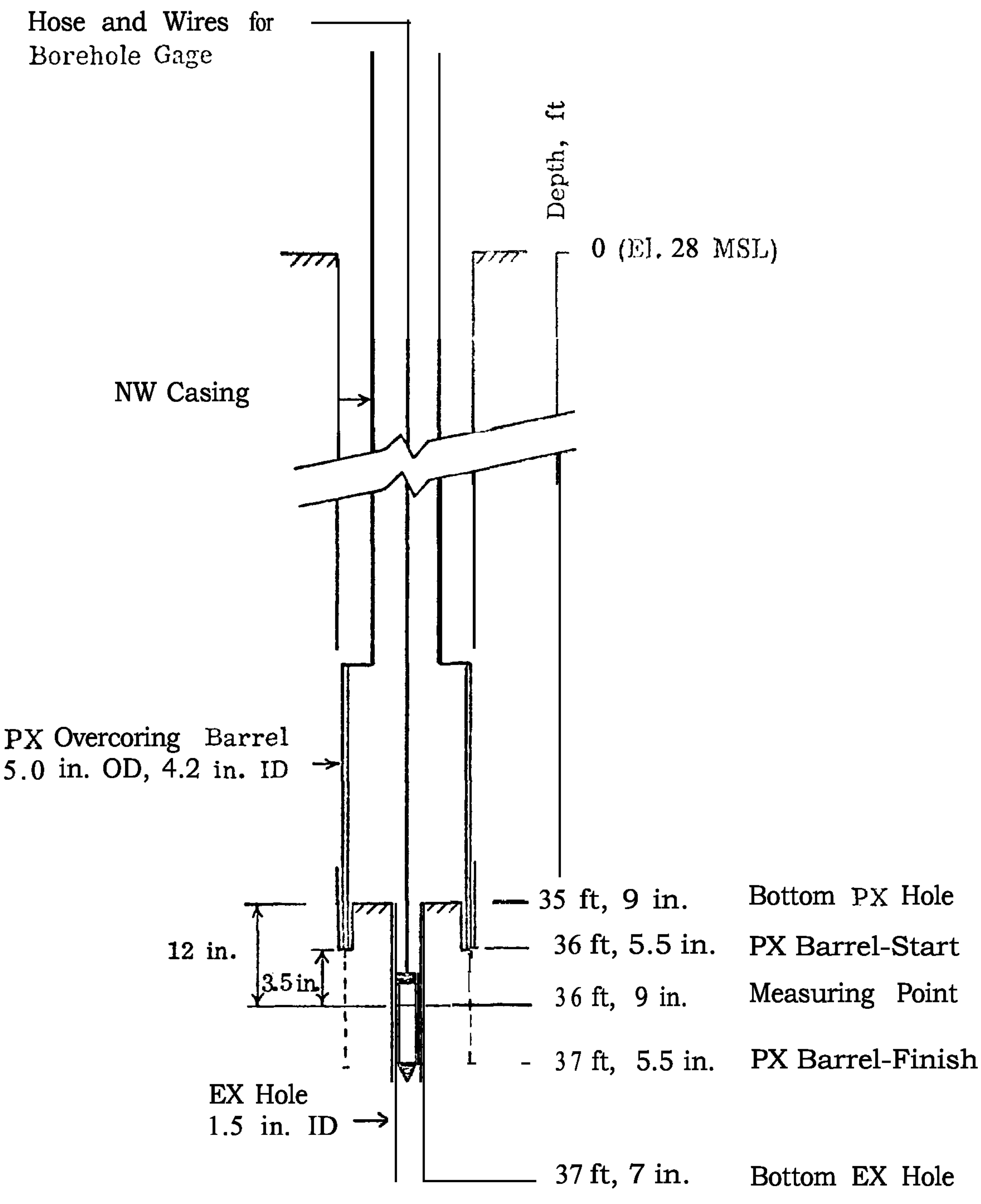
Note: Hole I.D. = 1.495 in.
0. D. = 4.31 in.

Yankee Atomic Electric Company	SEABROOK STATION	DATA FROM STRESS MEASUREMENTS TEST OC1A-9
Geotechnical Engineers, Inc. Winchester, Massachusetts	Project 7286	Aug. 8, 1973 FIG. 11



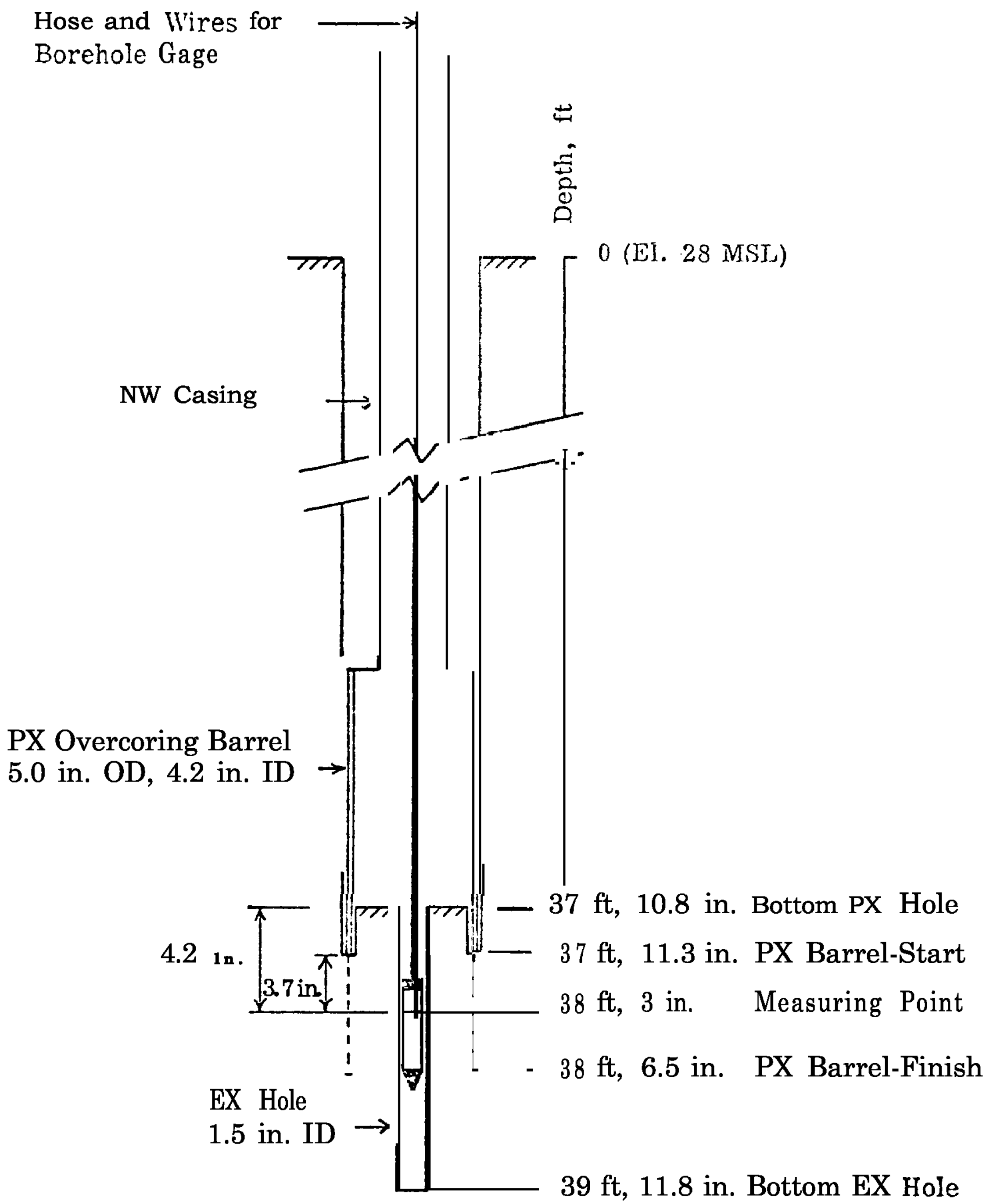
Yankee Atomic Electric Company	SEABROOK STATION	TEST OC1A-2 HOLE DIMENSIONS
Geotechnical Engineers, Inc. Winchester, Massachusetts	Project 7236	June 20, 1973 FIG. 12

GEOTECHNICAL ENGINEERS, INC.



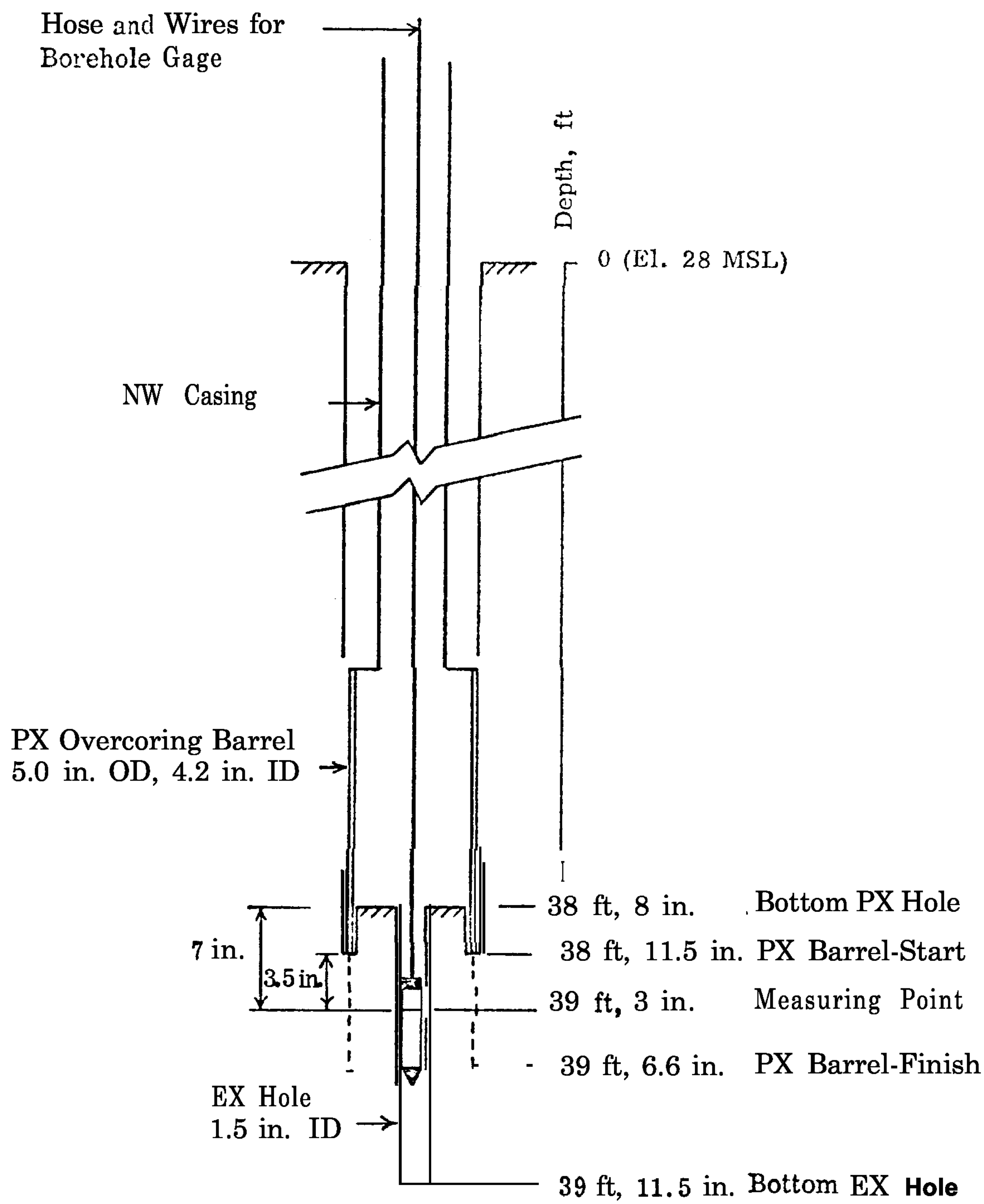
Yankee Atomic Electric Company	SEABROOK STATION	TEST OC1A-5 HOLE DIMENSIONS
Geotechnicsl Engineers, Inc. Winchester, Massachusetts	Project 7286	June 27, 1973 FIG. 13

GEOTECHNICAL ENGINEERS INC.



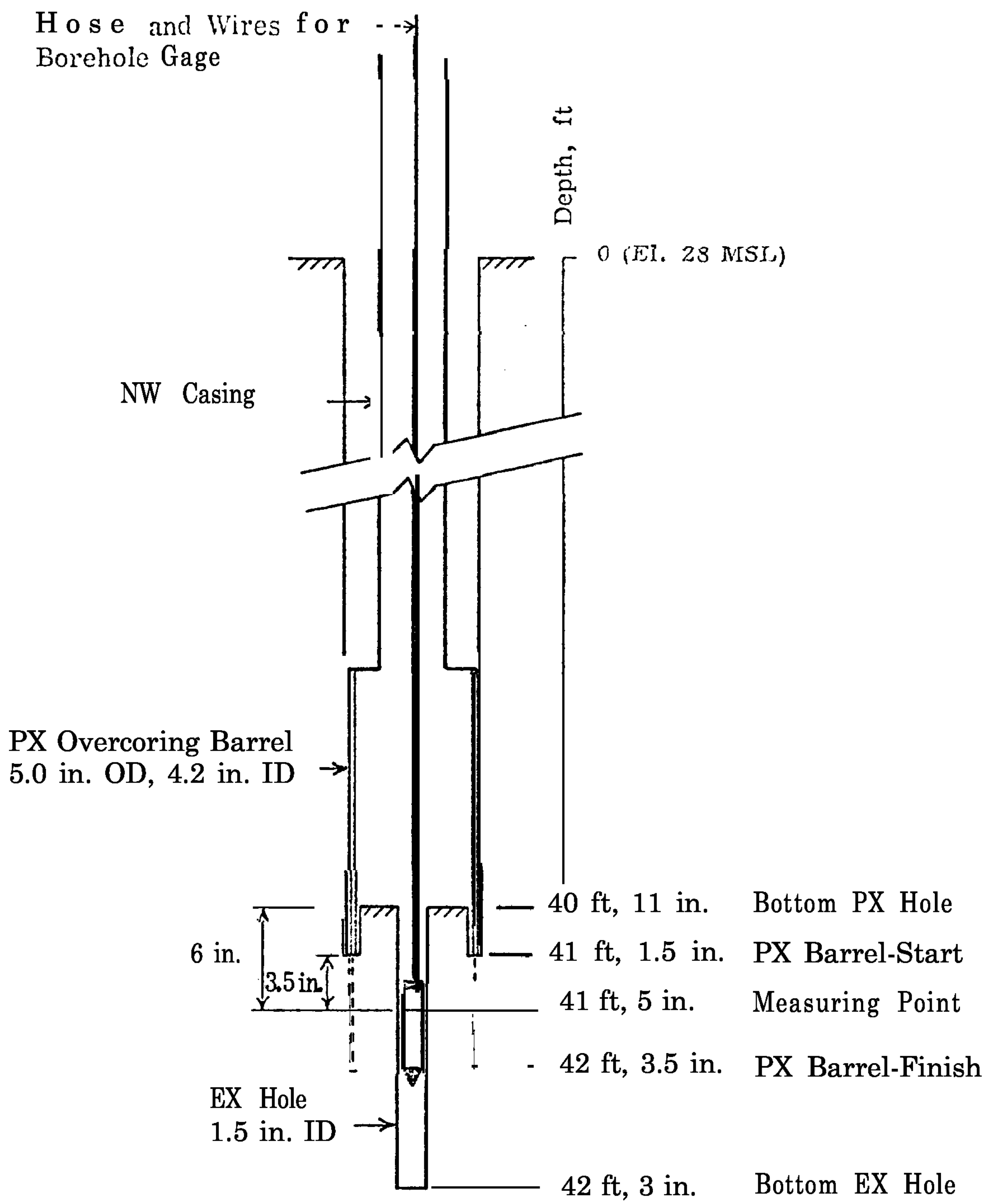
Yankee Atomic Electric Company	SEABROOK STATION	TEST OCIA-6 HOLE DIMENSIONS
Geotechnical Engineers, Inc. Winchester, Massachusetts	Project 7286	June 28, 1973 FIG. 14

GEOTECHNICAL ENGINEERS INC.

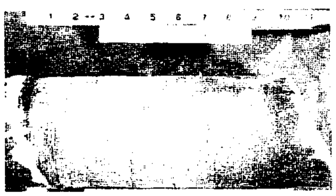


Yankee Atomic Electric Company	SEABROOK STATION	TEST OC 1A-7 HOLE DIMENSIONS
Geotechnical Engineers, Inc. U-inches ter, Massachusetts	Project 7286	June 28, 1973 FIG. 15

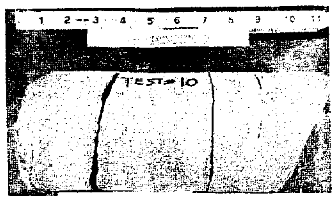
GEOTECHNICAL ENGINEERS INC.



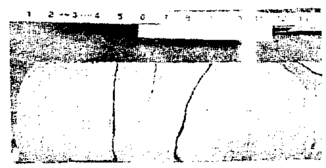
Yankee Atomic Electric Company	SEABROOK STATION	TEST OC1A-9 HOLE DIMENSIONS
Geotechnical Engineers, Inc. Winchester, Massachusetts	Project 7256	June 29, 1973 FIG. 16



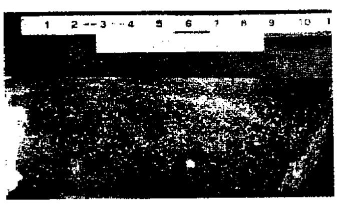
OC1A-9 T DEPTH 41'5"



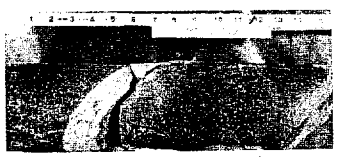
OC1A-10 T DEPTH 43'4-1/2"



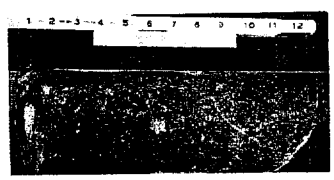
OC1A-11 T DEPTH 43'8"



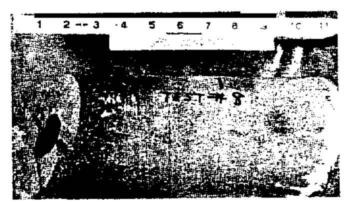
OC1A-5 T DEPTH 36'9"



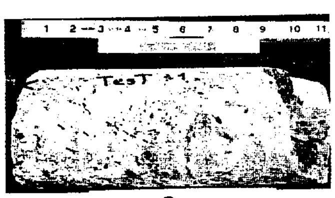
OC1A-6 T DEPTH 38'3"



OC1A-7 T DEPTH 39'3"

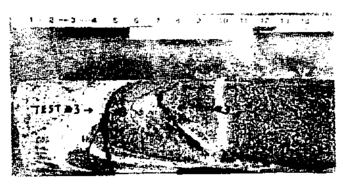


OC1A-8 T DEPTH 40'



OC1A-1 T DEPTH 31'3"

OC1A-2 T DEPTH 33'9-1/2"



OC1A-3 T DEPTH 34'8-1/2"

OC1A-4 T DEPTH 36'1-1/2"

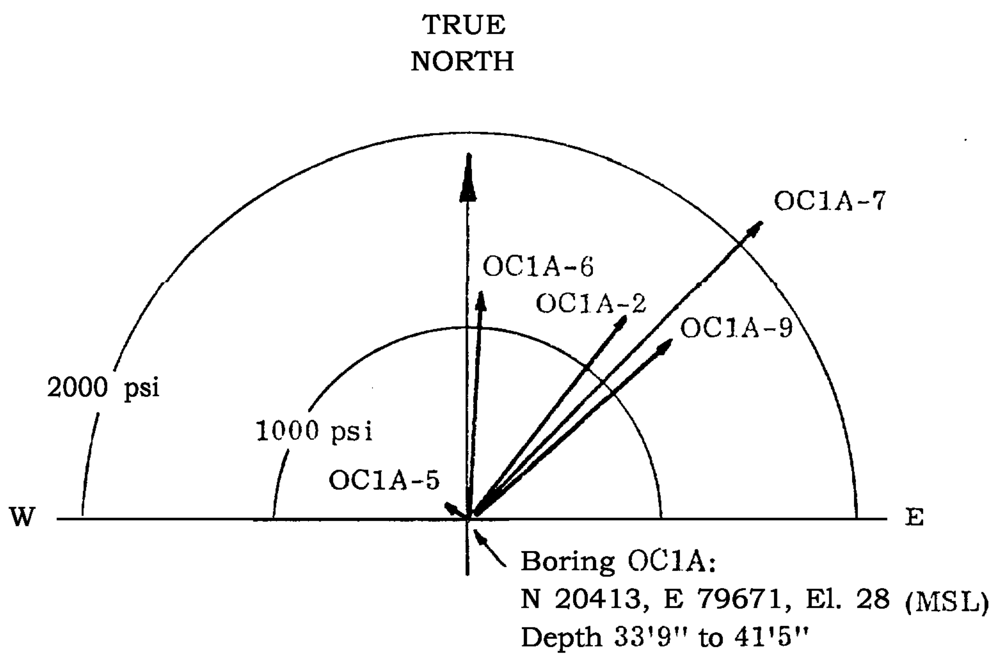
T DEPTH OF CANTILEVER TIPS DURING OVERCORING

CORES FROM STRESS MEASUREMENTS

Project 7286

FIG. 1'7

Geotechnical Engineers Inc



MAXIMUM IN-SITU COMPRESSIVE STRESSES ON HORIZONTAL PLANE
Seabrook Nuclear Station, New Hampshire
June - July, 1973

PREVIOUS STRESS MEASUREMENTS IN NEW ENGLAND *

Location	σ_I bars	σ_{II} bars	Bearing	Rock Type
Barre, Vt.	118	54	N 14 E	Granite
Proctor, Vt.	90	35	N 4 W	Dolomite
Tewksbury, Mass.	81	45	N 2 W	Paragneiss
W. Chelmsford, Mass.	145	76	N 56 E	Granite
Seabrook, N. H.	85	59	N 40 E	Granodiorite
Range	(8 - 145)	(3 - 106)	($\pm$ 36°)	

All stresses measured at depths less than 50 m (160 ft)
Stresses are compressive
One bar is 14.5 psi

*Sbar, M. L. and Sykes, L. R. (1973) "Contomporary Compressive Stress and Seismicity in Eastern North America: An Example of Intra-Plate Tectonics, " Geological Society of America Bulletin, Volume 84, No. 6, p. 1871.

Yankee Atomic Electric Company / Geotechnical Engineers, Inc. Winchester, Massachusetts	SEABROOK STATION	SUMMARY OF STRESS MEASUREMENTS
	Project 7286	Sept. 7, 1973 Fig. 18

GEOTECHNICAL ENGINEERS INC.

APPENDIX A

APPENDIX A

Test Procedure For

MEASUREMENT OF STRESSES IN ROCK
BY OVERCORING TECHNIQUE
IN VERTICAL HOLE

Geotechnical Engineers, Inc. September 1973

NOTE: HANDLE THE INSTRUMENT, HOSE, ORIENTATION RODS AND ALL ASSOCIATED EQUIPMENT VERY CAREFULLY TO PREVENT KINKING HOSE, LEAKS, AND INSTRUMENT DAMAGE.

1. Drill a pilot NX hole to examine the type and quality of rock. Make measurements only in zones where NX cores are primarily longer than 10 in.

2. In a hole about 5-10 ft from pilot hole, drill through poor zones with large diameter double-tube core barrel to reach measuring zone as quickly as possible. Then continue with PX overcore barrel to desired depth in three to five foot runs, each time examining the core to determine whether the rock is suitable for a measurement.

3. If the last run of PX core was suitable to try a measurement, attach the EX core barrel to the rods at the bottom end of the PX barrel with an adapter specially designed for that purpose. The adapter ensures that the EX core barrel is centered in the PX hole.

4. Drill the EX hole about 2 ft beneath the bottom of the previous bottom elevation of the PX bit and then withdraw the EX core.

5. Examine the EX core carefully to determine whether the rock is good enough for a stress measurement. The core pieces preferably should contain only drilling breaks and no natural fractures. If a natural fracture is more than 10 in. below the top, then a measurement near the top of the hole can be attempted.

6. Return the PX overcore bit to the bottom of the hole.

7. Wash through the BW casing rods and out the bottom of the PX bit for 15 minutes to remove all cuttings.

8. Measure accurately (to 1/8 in.) the depth from the surface reference point to the top of the rock at the bottom of the PX (not EX) hole. Enter the measurement on a sketch of the hole.

9. Measure and mark the required length on the orientation rods, so that measuring points will be at the proper depth.

10. Thread the instrument hose through the swivel at the top of the drive rod, attach gasket and reducing coupling, then attach to swivel. Do not over-tighten as this action may damage the instrument hose.

11. Attachinstrument leads to readout device and check readout to ensure that the strain gages can be read, that nothing is wrong with the instrument, and record the direction of reading change that corresponds to expansion of hole. Record instrument number. Record arrangement of leads on readout device.

12. Select desired orientation of measuring points on instrument. If possible, orient one axis in direction of anticipated major stress. Record orientation.

13. Lower the instrument in the hole after attaching it to the orientation rod with the special fitting for the instrument. The orientation of the cantilevers in the instrument relative to the orientation line on the rods must be recorded on the data sheet. Lower the instrument slowly and carefully, pulling up with slight pressure on the instrument hose so that the instrument is held in the orientation device. When the instrument goes below water, apply pressure inside the vinyl sheath to ensure that no water can enter. Use 2 psi pressure per foot of depth (or 1 kg/cm^2 per 30 ft of depth) as a minimum, but do not apply so much that the instrument will be over inflated and cannot be inserted into the EX hole.

14. Insert the instrument into the EX hole very carefully and without banging it on the lip of the EX hole. It helps to use a tapered point on the lower end of the instrument so that the EX hole can be found easily. Lower to the desired elevation and make sure that this elevation is accurate. Record the depth to the measurement point on the instrument from the surface reference point to the nearest 1/8 in.

15. Before inflating, make sure that the orientation of the measuring points relative to the line on the orientation rods and relative to a fixed azimuth reference is correct and record the orientation.

16. Inflate the instrument to a pressure of about 4 kg/cm^2 greater than the water pressure at that depth, but not greater than about 6 kg/cm^2 above the water pressure.

17. Remove the orientation rods carefully, making sure that the orientation fitting at the bottom does not catch on the hose on the way up. The rods should be unhooked carefully so that the connectors will not be broken.

18. Screw the drive rod (to which the swivel is attached) to the top of the drill rods using the special adapter. During this process the instrument hose has to be pulled up slightly through the swivel until the hose is straight in the drill rods.

19. Pull the PX barrel off the bottom of the hole slightly and start the drilling fluid running through the system.

20. Take readings continuously on the instrument readout device until the readings have stabilized with the water running and the PX barrel turning without any downward pressure.

DO NOT START OVERCORING UNTIL THE READINGS HAVE STABILJZED

21. When a plot shows that the readings are stable, which may take about 20 minutes, then set the readout to a convenient starting point so that the subsequent readings can be taken easily.

22. Apply slight downward pressure on the PX bit to start the overcoring. Drill at a rate of about 1/2 in. per minute (24 min. per foot), A slightly faster rate could be used if the rock is particularly good. The core catcher should be in place during this operation to ensure that the annular core will be recovered later. The core catcher may cause some extraneous vibrations.

23. Take readings during overcoring in the following sequence:

    TIME DEPTH GAGE 1 GAGE 2 GAGE 3

    Take readings continuously during overcoring, so that as good a graph as possible can be prepared. The driller should call out the overcoring depth to the nearest 1/8 in. when requested by the recorder. Then the person making the strain gage readings should provide his readings. A third person records all readings given to him and the time to the nearest ten seconds.

BE READY TO STOP THE DRILL DURING OVERCORING ANYTTME THAT THE READINGS START TO FLUCTUATE RAPIDLY-HAVE A SIGNAL PREARRANGED. ROTATION OF INSTRUMENT IN HOLE MAY DAMAGE IT.

24. When the readings stop changing during overcoring, stop the downward pressure and rotation but continue water flow. Continue the recording until the readings have again stabilized. During this wait, plot the readings taken in Step 23.

25. Lower the orientation rods into the hole and attach to instrument after detaching the drive rod from the drill rod at the top. When lowering the orientation rods, be sure that the hose is not cut or damaged.

26. Release the pressure in the instrument to that required to keep the water out. Wait until the pressure down at the instrument is at this level.

27. At this stage the instrument may be lowered to make a second stress measurement (to Step 14) or the instrument may be removed. The orientation rods are desirable for removal because if they are not used the top of the instrument can get caught on the lower lip of the drill rods at the top of the PX barrel. Remove from hole carefully and slowly, reducing internal pressure gradually if necessary.

28. Loosen the reducing coupling at the swivel, detach instrument from readout device, unthread the instrument hose from the swivel carefully, and put the instrument in a safe place, Examine the instrument and the hose for damage. Recheck instrument readout.

29. Attach the drive rod to the drill rod.

30. Remove the annular core.

31, With a crayon mark the location where the measuring points were on the annular core.

32. Carefully and in detail describe the core, particularly within 3 in., on each side of the measurement point. Photograph the core wet and dry, making sure that the crayon mark shows up.

33. *To* determine the modulus of the rock for computation of stresses, it is necessary to have a core with a length of 12 in. or more. Save such a piece from the measurement elevation so that it may be tested in the laboratory or field.

CHECK THE DATA SHEET, SKETCHES AND DESCRIPTIONS TO ENSURE THAT ALL DATA NEEDED FOR UNDERSTANDING THE TEST HAVE BEEN RECORDED. LIST THE NAMES OF ALL PERSONNEL AT THE SITE.

APPARATUS

1. Borehole gage for EX hole (1.5-m. dia.) including hose containing lead wires and air tube.

2. Portable strain gage readout system, including strain indicator and switching and balancing unit for three strain gages.

3. Dry nitrogen supply system, pressure gage, and pressure regulator. Pressure required is 100 psi plus hydrostatic pressure at greatest depth below water level at which instrument will be used.

4. Drilling system for overcoring, including hydraulic drill rig, SW casing for seating to rock, NW casing for use as drill rod for overcoring bit, 5 in. by 4-3/16 in. (PX) overcoring bit 5 ft long, 2 and 5-ft-long EX core barrel (1.5 in. 0. D.) adaptor to attach EX core barrel to bottom of overcoring bit. Swivel to allow passage of instrument hose so that it will not twist during test but drill water will not leak appreciably.

5. Data sheets, form attached.

6. Orientation rods for setting the borehole gage elevation and for maintaining orientation of borehole gage.

7. Compass for determining orientation of borehole gage.

APPENDIX A

OVERCORING READINGS - SEABROOK II, NEW HAMPSHIRE

Hole No. ____________________ Depths ____________________ Project No. ______ Date ________ Test _____

Hole Location ____________________ Bot. 5-in. Hole ____________________ Driller ____________________

____________________ Rot. EX Hole ____________________ Engineer ____________________

El. Top of Hole ____________________ Pins on Gage ____________________ Weather ____________________

El. Datum ____________________ Dimensions in ____________________ ____________________ Page _____

Orientation of Gage ____

	Time	Elapsed Time	Overcore Depth	Strain Gage Readings								
				1	2	3	4	5	6	7	8	9
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												

Remarks ____ Geotechnical Engineers, Inc

GEOTECHNICAL ENGINEERS INC

APPENDIX B

APPENDIX B

MEASUREMENT OF MODULUS OF ANNULAR ROCK CORE

Geotechnical Engineers Inc. September 1973

1. Prepare rock modulus cell by inserting membrane, filling with hydraulic fluid (trapping as little air as possible) and securing end plates.

2. Break rock annulus that was removed from hole in field into sections not less than 12 in. long and such that points within EX hole at which borehole gage measurements were made in field can be close to center of rock modulus cell if possible.

3. Insert core in cell.

4. Insert borehole gage in cell, preferably at same location as in field.

5. Apply 100 psi nitrogen pressure to interior of gage to secure it in proper location. Preferably use same pressure as was used in-situ during overcoring (after subtracting in-situ water pressure).

6. Connect leads from borehole gage to strain gage readout device, using same wires, lengths, and hook-up as in-situ.

7. Take initial gage readings until readings are stable.

8. Apply pressure to exterior of rock annulus in increments of 500 psi until the compression of the diameters is equal to theirextension during overcoring but do not exceed 3000 psi unless an axial load is put on the core. Record all strain gage readings each time an increment is applied. Allow for equilibrium to be reached before adding each new increment.

9. Release the pressure in decrements of 500 psi, taking readings as before.

10. Reapply the maximum stress in 1000 psi increments. Repeat the loading and unloading until results are consistent.

11. Using the diameter changes measured in the field and in the laboratory, together with the stresses applied in the laboratory, compute the rock modulus and the stress in situ. For the rock modulus cell:

$$u = kR = \frac{2\,db^2}{(b^2 - d^2)} \quad \frac{P}{E}$$

where: u = diametral deformation
k = instrument calibration
R = instrument reading
d = I.D. of core
b = O. D. of core
P = external pressure
E = rock modulus

APPENDIX B

APPENDIX 21

GEOTECHNICAL REPORT ADDITIONAL PLANT SITE BORINGS

The information contained in this appendix was not revised, but has been extracted from the original FSAR and is provided for historical information.

GEOTECHNICAL REPORT
ADDITIONAL PLANT-SITE BORINGS
FOR WATER AND OIL STORAGE TANKS, SETTLING BASIN, RETAINING WALL, SEAWALL, AND RIP-RAP STRUCTURES
G-SERIES BORINGS

SEABROOK STATION, NEW HAMPSHIRE

Submitted to
YANKEE ATOMIC ELECTRIC COMPANY

GEOTECHNICAL ENGINEERS INC.
1017 Main Street
Winchester, Massachusetts 01890

Project 7286
October 21, 1974

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose

The purpose of the geotechnical investigation was to provide soil and bedrock descriptions pertinent to the design and construction of several proposed structures which will be located at the plant site, including water and oil storage tanks, settling basin, retaining wall, seawall, and rip-rap structures.

1.2 Scope

A subsurface investigation, consisting of a total of 12 borings and 1 test pit was made for the following areas:

a. Water and Oil Tanks At Fire Pump House - One boring was made at the center of the fuel oil storage tank, using standard split-spoon sampling techniques to refusal for the purpose of investigating deposits that may cause settlement problems. Because no unsuitable deposits were encountered at the site for the proposed oil storage tank and based on the general knowledge of site geology, supplementary borings for the proposed water tanks were not done.

b. Settling Basin - A series of three borings was made in the area of a proposed settling basin using standard split-spoon sampling techniques to refusal for the purpose of investigating soil conditions at the proposed inlet and outlet structures for the basin, and also to examine the in-situ soil for possible use as construction materials for the dikes. In addition, a test pit bag sample was taken near the center of the settling basin, tested for grain size distribution, and examined as a possible dike material.

c. Retaining Wall - A series of four borings was made for a proposed retaining wall for the purpose of locating and sampling the dense glacial till. These borings were advanced by first "washing" to establish the top of the till layer, then sampling this layer by split-spoon techniques, and finally advancing the borehole to refusal using a roller bit. Based on the results of geophysical surveys and other borings drilled into bedrock in the vicinity, it is believed that refusal does correspond to the bedrock surface in these holes.

2.0 BORING AND TEST PIT DATA

2.1 Table and Figures

Table I is a summary of the boring data including boring location, "as-bored" coordinates, ground elevation, depth to glacial till, and depth to top of bedrock.

The locations of the borings and one exploratory test pit are included in Fig. 1. Fig. 2 shows the grain size curve from a sieve analysis which was performed on a sample from the test pit.

2.2 Boring and Test Pit Logs

Logs of the borings and one exploratory test pit are included in Appendix I. Driller's boring logs are included in Appendix II.

TABLES

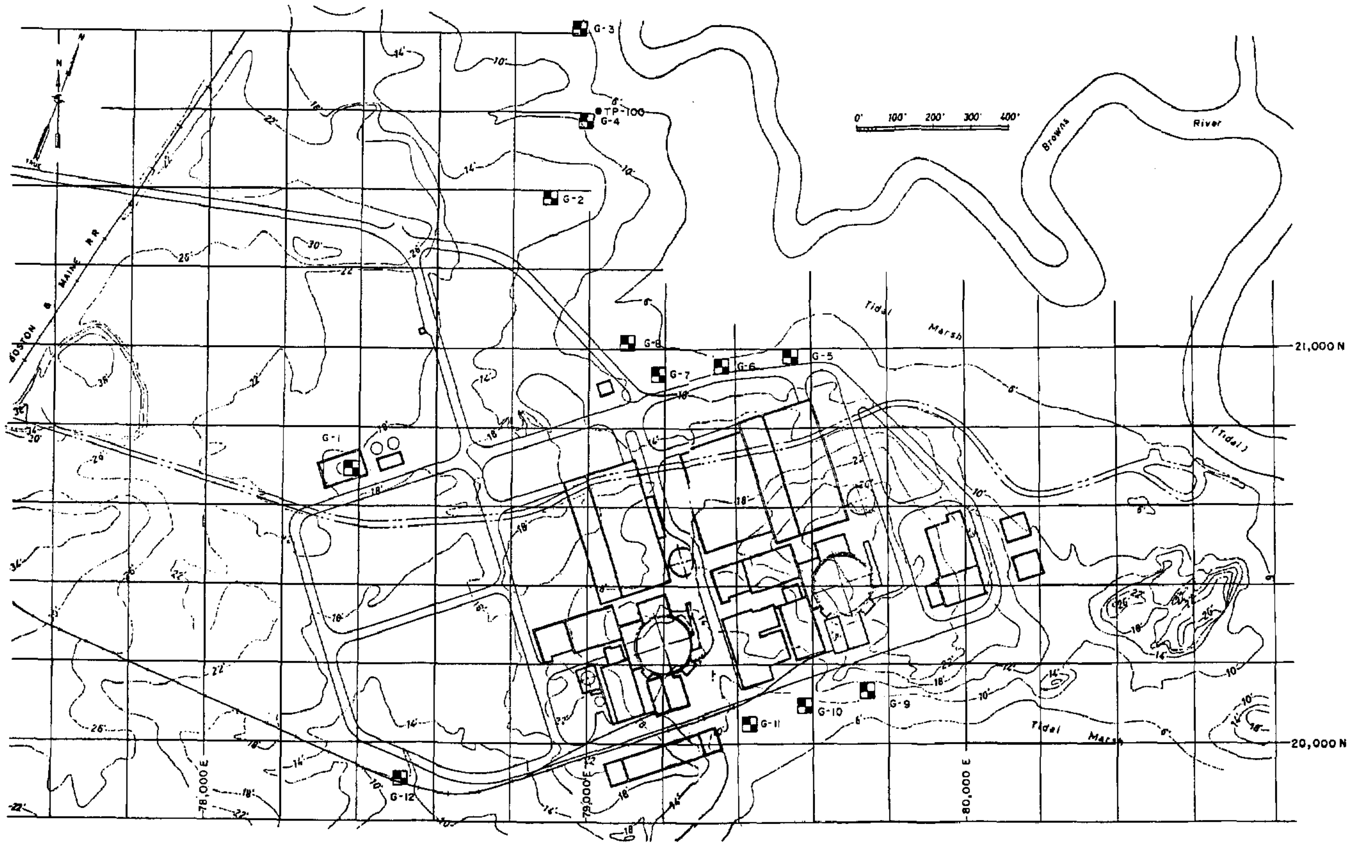
TABLE I

SURIRIARY OF BORING DATA

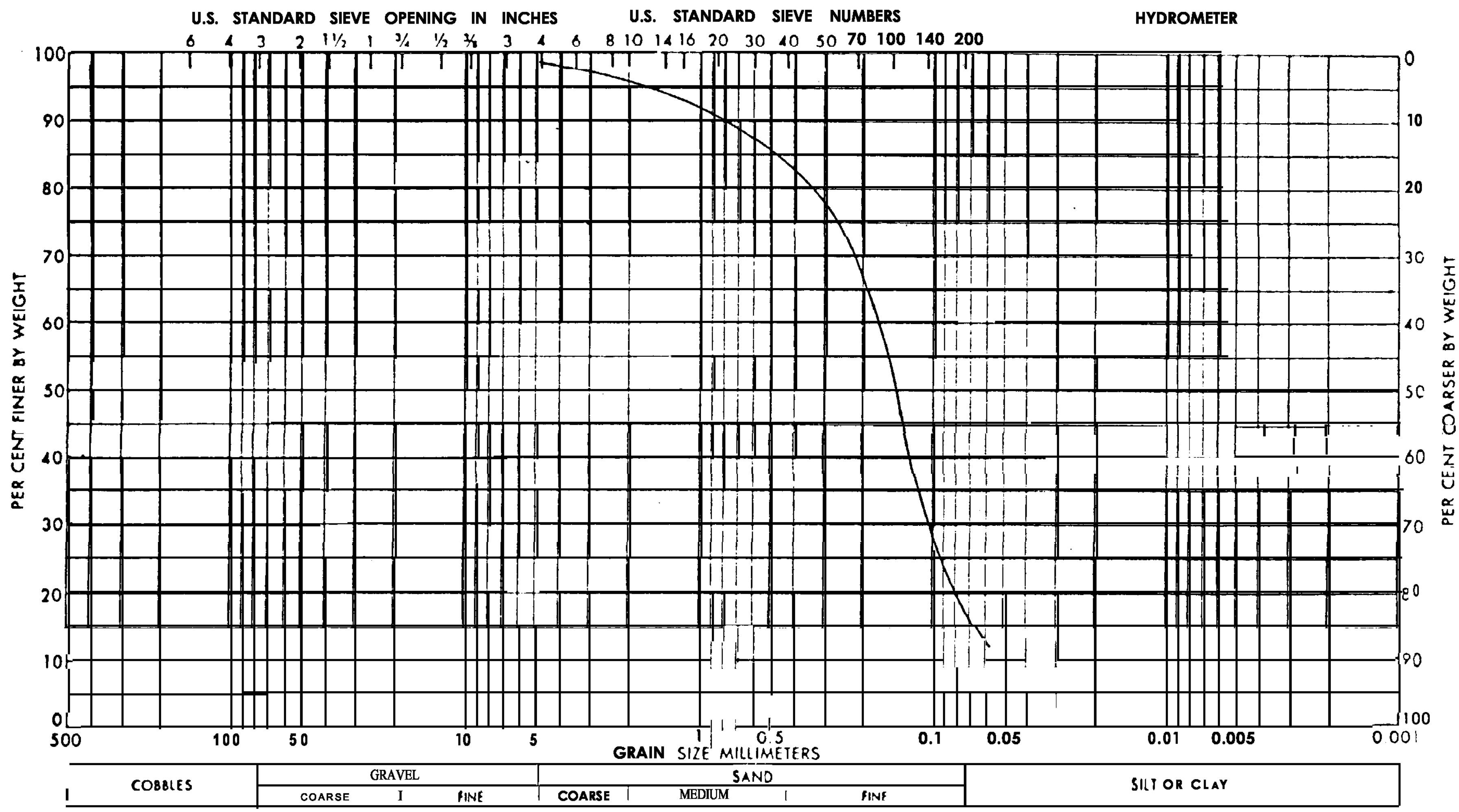
Boring No.	Boring Location	As-bored Coord.	Ground Elev ft	Depth to Top of Till ft	Depth to Top of Bedrock ft
G-1	Oil Storage Tank	29,690N 78,370E	17.3	8.0	--
G-2	Settling Basin (Inlet)	21,380N 78,900E	15.9	5.0	--
G-3	Settling Basin (Outlet)	21,717N 78,949E	9.4	28.0	--
G-4	Settling Basin (additional)	21,571N 78,992E	9.6	19.0	--
G-5	Retaining Wall	20,969N 79,525E	7.8	9.0	9.7”
G-6	Retaining Wall	20,949N 79,349E	8.2	10.8	19.5*
G-7	Retaining Wall	20,932N 79,175E	8.6	11.5	23.2”
G-8	Retaining Wall	21,006N 79,107E	7.3	10.5	19.0”
G-9	Seawall	20,123N 79,720E	9.5	--	10.5
G-10	Seawall	20,083N 78,587E	7.9	--	6.8
G-11	Seawall	20,042N 79,455E	6.8	--	15.9
G-12	Rip-Rap	19,898N 78,500E	7.2	--	11. o*

*In these holes the boring was made to refusal and no rock was cored. However, based on the results of geophysical surveys and other borings drilled into bedrock in the vicinity, it is believed that refusal does correspond to the bedrock surface.

FIGURES



PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE SEABROOK STATION	SEABROOK STATION SITE TOPOGRAPHY AND PLOT PLAN PLAN OF BORING LOCATIONS
UNITED ENGINEERS & CONSTRUCTORS GEOTECHNICAL ENGINEERS, INC.	OCT. 17, 1974 FIG. 1 G - SERIES BORINGS



Yankee Atomic Electric Co.	Seabrook Station	GRAIN SIZE CURVE TEST PIT #100 TP - SAMPLE
Geotechnical Engineers, Inc. Winchester, Massachusetts	Project 7286	Oct. 1974 Fig. 2

APPENDIX I

BORING NO. G-1

pg. 1 of 1

Proj. No. : 7286

Date: Sent. 30. 1974

Described by: W. Pitt

Ground Elevation +17.3 ft

Depth to Water Level: depth at ground elev. 0700; 10/1/74

Sample NO.	Depth ft	Number of Blows per 6"	Description
S-1	0.0-1.0	1-2	Black, soft PEAT and organic SILT; highly decomposed
S-1A	1.0-2.0	6-14	Gray-brown, gravelly, sandy, slightly organic SILT, contains subangular gravel up to 35 mm in size.
s-2	3.0-5.0	11-16 32-23	Rust brown and brown slightly mottled gravelly, sandy SILT, trace clay. Contains gravel up to 13 mm in size. Moderate reaction to shaking test. Low plasticity.
s-3	5.0-6.5	27-39 57	Similar to S-2. Contains gravel up to 35 mm in size.
			color change
s-4	10.0-11.5	100/4"	140# hammer gray, very dense, sandy, gravelly SILT trace clay.
		5/2" 28-22	300# hammer contains broken pieces of gravel up to 35 mm
s - 5	15.0-16.5	5 4 100/4"	140# hammer Similar to S-4
		12/2" 40	300# hammer
			Casing refusal at 16.5 Bottom of Borehole
			End of Exploration

BORING NO. G - 2

pg. 1 of 1

Proj. No. : 7286

Date: Oct. 1, 1974

Described by: W. Pitt

Ground Elevation +15.9 ft

Depth to Water Level: -5.1' measured at 0715, 10/2/74

Sample No.	Depth ft	Number of Blows per 6"	Description
S-1	0. 0-1.0	2-5	Light brown, silty fine SAND. Contains root fibers and decomposed organic matter.
S-1A	1.0-2.0	3-2	Dark brown/rust brown/gray mottled; fine sandy SILT, trace fine gravel
s-2	3. o-4.5	17-50/0" 22-42	140# hammer 300# hammer Light brown, gravelly, sandy SILT. Contains gravel from various lithologies up to 35 mm in size.
s-3	5.0-7.0	15 23 23 33	Light brown silty, gravelly, fine to coarse SAND widely graded,' resembles glacial till
s-4	LO. 0-11.5	57-100 33	140# hammer 300# hammer Gray brown /rust brown slightly mottled dense, silty, gravelly SAND (similar to S-3) Contains broken pieces of gravel up to 35 mm in size. Casing refusal met at 13.8' Roller bit refusal at 14.5' Bottom of Borehole
			End of Exploration

GEOTECHNICAL ENGINEERS INC.

BORING NO. G-3

Proj. No. : 7286

Date: Oct. 1, 1974'

Described by: W. Pitt

Ground Elevation +9.4 ft

Depth to Water Level: -2.1 measured at 0730, 10/2/74

Sample No.	Depth ft	Number of Blows per 6"	Description
S-1	0.0-2.0	1/1.5' 2/.5'	Brown grading to buff, soft, homogeneous SILT, trace clay. Upper 1-2" contains grass and shallow root zone.
s-2	3. O-5.0	10-20 21-20	Similar to S-l, buff/rust brown mottled, contains black spots - decomposed organic matter? ?; trace roots and mica particles
s-3	6.0-7.0	14-16	Light brown, loose, silty fine SAND, trace clay
S-3A	7.0-8.0	22-32	Rust brown/buff medium dense, mottled SILT, little to trace clay. Low plasticity.
s-4	10.0-12.0	2-4 4-5	Gray, medium stiff homogeneous CLAY; high plasticity
s-5	15.0-17.0	2-3 3-4	Similar to S-4
S-6	19.5-20.0	32	Gray-brown silty, sandy, GRAVEL; trace clay. Contains angular pieces of gravel up to 25 mm. Well-graded.
S-6A	20. o-21.5	20-12	Light brown, gravelly, sandy CLAY. Contains gravel pieces up to 25 mm in size
S-7	25-25.5	100/3" 50/2"	140# hammer Similar to S-6, very dense 300# hammer (Resembles glacial till)
			continued)

21.5'

GEOTECHNICAL ENGINEERS INC

BORING NO. G-3

(Concluded)

Proj. No. : 7286

Date: Oct. 1, 1974

Described by: W. Pitt

Ground Elevation +9.4 ft

Depth to Water Level: -2.1 measured at 0730, 10/2/74

Sample NO.	Depth ft	Number of Blows per 6"	Description
S-8	30.0-31.5	25 25 58	Gray, very dense, silty fine SAND, some gravel up to 30 mm in size
s-9	34'10"→	100/0" 20/0"	140# hammer 300# hammer — No recovery Casing refusal at 34'10" Bottom of Borehole
			End of Exploration

BORING NO. G-4

Proj. No. : 7286

Date: Oct. 2, 1974

Described by: W. Pitt

Ground Elevation +9.6 ft
Depth to Water Level: Not taken

Sample No.	Depth ft	Number of Blows per 6"	Description
S-1	0.0-0.5	1	Dark brown, fibrous PEAT and organic SILT
S-1A	0.5-2.0	1-1-2	Light brown, fine sandy SILT or silty fine SAND
S-2	3.0-5.0	6-10 22-42	Light brown/dark brown/rusty brown slightly mottled, medium dense, silty, gravelly fine SAND. Contains gravel up to 35 mm in size.
S-3	6-7.5	100/5" 3/1" 35-60	140# hammer / 300# hammer — Similar to S-Z, medium dense to dense
	8.0		Large cobble
S-4	10.0-11.5	25-50 57	Similar to S-3, coarse to fine SAND Widely graded
S-5	15.0-16.2	100'0" 42 60 75 /3"	140# hammer Similar to S-4 / 300# hammer
S-6	20-21	76-76	Gray, very dense, gravelly, silty coarse to fine SAND; little to trace clay. (Till) Roller bit refusal at 22.5 Bottom of Borehole
			End of Exploration

(Margin annotation beside S-2 to S-5: Increase in sand and gravel sizes ↓)

Stratum boundaries marked in left margin: 19, 22.5

BORING NO. G-5

Proj. No.: 7286

Date: Oct. 3, 1974

Ground Elevation +7.8 ft

Depth to Water Level: Not taken

Described by: W. Pitt

Sample No.	Depth ft	Number of Blows per 6"	Description
			Drove casing to 9.0', where encountered strata change - casing refusal Split-spoon at 9.0 - 9.7
S-1	9.0-9.7	58-100/2" 5/0"	140# hammer 300# hammer gray/brown slightly mottled, very dense silty, gravelly, SAND; little to to trace clay, (Till) Roller bit refusal at 9. 7' Bedrock ? Bottom of Borehole
			End of Exploration

BORING NO. G-G

Proj. No.: 7286

Date: Oct. 3, 1974

Described by: W. Pitt

Ground Elevation +8.2 ft

Depth to Water Level: Not taken

Sample No.	Depth ft	Number of Blows per 6"	Description
			Drove casing to refusal - 9.0' Roller bitted to 10.8' - strata change Split-spoon attempt at 10. 8'
S-1	10.8-12.3	57 100/4" 8/2" 30	140# hammer gray, very dense, sandy, gravelly SILT, trace to little clay. (Till) 300# hammer Roller bit refusal at 19.5' Bottom of Borehole
			End of Exploration

BORING NC). G-7

Proj. No. : 7286

Date: Oct. 3. 1974

Described by: W. Pitt

Ground Elevation +8.6 ft

Depth lo Water Level: Not taken

	Sample No.	Depth ft	Number of Blows per 6"	Description
				Drove casing to 10' Roller bitted to 11.5' - strata change
11.5	S-1	11.5-13.0	24 92 22	140# hammer gray, very dense gravelly, silty SAND trace to little clay. (Till) 300# hammer Roller bitted to refusal at 23.2
23.2				Bottom of Borehole
				End of Exploration

BORING NO. G-8

Proj. No. : 7286

Date: October 7, 1974

Described by: W. Pitt

Ground Elevation +7.3

Depth to Water Level: Not Taken

Elevation	Sample No.	Depth it	Number of Blows per 6"	Description
		10.1 →	→	Cobble. Drove casing to refusal at 10.5. Strata change.
10.5	S-1	10.5-12.0	18-16-24	Gray, medium dense clayey silty, SAND, little to trace. Gravel contains subround gravel up to 15 mm in size. Medium plasticity, well graded. Moderate reaction to shaking test.
19.0				Bottom of borehole, roller bit refusal at 19.0'.

BORING NO. G-9

Proj. No. : 7286

Date: October 9, 1974

Described by: W. Pitt

Ground Elevation +9.5 ft
Depth to Water Level: Not Taken

Depth (margin)	Run No.	Depth ft.	Recovery and RQD %	Description
				No Samples -- Washed through overburden
10.5'				TOP OF ROCK
	NX-1'	10.5-15.5	REC = 100% RQD = 96%	Gray/white mixed fine and medium grained DIORITE. Minor jointing. Fresh and hard throughout. Minor slickensiding on joint surfaces.
	NX-2	15.5-20.5	REC = 100% RQD = 76%	Similar to NX-1; minor to moderately jointed. Joints rusty; vuggy. Moderate weathering on joint surfaces.
	NX-3	20.5-25.5	REC = 100% RQD = 80%	Similar to NX-2; high angle jointing with calcite infilling.
25.5'				Bottom of boring @ El. -35.0 ft

BORING NO. G-10

pg. 1 of 1

Proj. No. : 7286

Date: October 8, 1974

Ground Elevation +7.9 ft

Described by: W. Pitt

Depth to Water Level: Not Taken

	Run No	Depth ft.	Recovery and RQD %	Description
				No Samples -- Washed through overburden TOP OF ROCK
6.5,				Roller bitted to 7.0 ft
	NX-1	7.0-12.0	REC = 98% RQD = 65%	Gray, mixed fine and medium g-rained DIORITE. Moderately jointed. Generally fresh and hard throughout. Moderately weathered; rusty on joint surfaces.
	NX-2	12.0-17.0	REC = 100% RQD = 62%	Similar to NX-1; intact rock generally fresh and hard. Moderate to severe weathering on joint surfaces.
	NX-3	17.0-22.0	REC = 100% RQD = 75%	Similar to NX-2; generally fresh and hard throughout. Moderate we'athering on joint surfaces.
22.0'				Bottom of boring @ El. -29.9 ft.

BORING NO. G-11

Proj. No. : 7286

Date: October 8. 1974

Ground Elevation +6.8 ft

Depth to Waler Level: Not Taken

Described by: W. Pitt

	Run No.	Depth ft.	Recovery and RQD %	Description
				No Samples -- Washed through overburden TOP OF ROCK
15.9'				Roller bitted to 16.0 ft
	NX-1	16. 0--21.0	REC = 92% RQD = 55%	Gray, mixed fine and medium grained DIORITE; semi-schistose in texture. Moderately jointed with several high angle joints. Generally hard and fresh throughout with minor clay infilling on slicked joint surfaces.
	NX-2	21. 0-26.0	REC = 100% RQD = 67%	Similar to NX-1, moderately hard; vuggy in places with several weathered, high angle joints.
	NX-3	26. 0-31.0	REC = 96% RQD = 68%	Similar to NX-2; moderate to severe weathering on joint surfaces.
31.0'				Bottom of boring @ El. -37.8 ft.

BORING NO. G-12

pg. 1 of 1

Proj. No. : 7286

Date: October 10, 1974

Described by: W. Pitt

Ground Elevation. +7.2 ft
Depth to Water Level: Not Taken.

	Sample No.	Depth ft	Number of Blows per 6"	Description
	S-1	0.0-1.0	1-4	Brown-black soft PEAT and organic SILT, highly decomposed, root mass throughout.
1.	S-1A	1.0-2.0	6-6	Gray-dark brown mottled, loose fine to medium SAND, little to trace silt.
5.				- - - - - - - - C O L O R C H A N G E - - - - - - - - -
	s-2	5.0-6.5	-12-21-28	Gray, slightly micaceous, similar to S-1A.
9.0	s-3	10.0-10.9	5-100/5" 10/0"	140# hammer. Gray, homogeneous CLAY 300# Hammer. High plasticity
11.				Bottom of hole
				Roller bitted 1" - refusal. Bedrock or large boulder. End of exploration.

GEOTECHNICAL ENGINEERS INC.

DESCRIPTION OF EXPLORATORY TEST PITS

Test Pit #100

Location tp adjacent to DH-G-4
Coord. 21, 572N - 78,993E

Date October 3, 1974

Ground Elev. : +9.6

Depth to Water: Not encountered

Project 7286

Depth ft	Soil Description
0-1.0	Black-brown fibrous PEAT and organic SILT
1.0 →	TP Sample - light brown-yellow brown, loose, silty fine SAND, cobbles >3" found. throughout. Test pit was hand dug to a depth of approximately 2 ft

1.0'

APPENDIX 2

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 1 OF 1
DATE
HOLE NO. G-1
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric Co. ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specificat PROJ NO 7236
SAMPLES SENT TO Delivered to Geotech at Site OUR JOB NO. 4035

GROUND WATER OBSERVATIONS

At 2" after 14 Hours

At ____ after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	NW	S/S	
Size I.D.	3"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	9/30/74	
COMPLETE	"	
TOTAL HRS.		

BORING FOREMAN K. Allen
INSPECTOR
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE N	o	
	3	0'-1'	D	1	2		w/loose	1'	Leaves, root matter, sandy	1	24"	
	6	1'-2'	D	5	14		moist		silt (muddy)	1a		
	14						m/dense					
	16	3'-5'	D	11	16	32	moist		Brown fine SAND, some silt	2	24"	10
	37					23	very		trace coarse sand & fine			
	7	5'-6.5'	D	37	39	57	dense		to coarse gravel	3	18"	12
	45											
	65											
	100							9'				
	100-			4"	8"							
		10'-11.5'	D	100	33	22	moist			4	18"	12
				(140)	(300)		hard		Gray clayey SILT, little fine			
									to medium sand & fine to			
									coarse gravel (TILL)			
					4"	8"						
		15'-16.5'	D	124	100	82	"	16.5'		5	18	1"
				(140)	(300)							
									Bottom of Boring - 16.5'			

GROUND SURFACE TO 16' USED NW CASING: THEN sampled to 16.5'

Sample Type
O-Dry C=Cored W-washed
UP: Undisturbed Piston
TP= Test Pit A=Auger V=Vane Test
UT= Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb Wt. x 30" fa on 2" O.D. Sampler

Cohesionless Density	
0-10	Loose
10-30	Med. Dense
30-50	Dense
50 +	Very Dense

Cohesive Consistency		
0-4	Soft	30 + Hard
4-8	M/Stiff	
8-15	Stiff	
15-30	V-Stiff	

SUMMARY:
Earth Boring 16.5'
Rock Coring
Samples 5

HOLE NO G-1

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 1 OF 1
DATE
HOLE NO. G-2
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric Co. ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specification PROJ. NO. 7286
SAMPLES SENT TO Delivered to Geotech at Site OUR JOB NO. 4-85

GROUND WATER OBSERVATIONS
at 4' after 1/2 Hours
at ____ after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	NW	S/S	-
Size I.D.	3"	1-3/8"	-
Hammer Wt.	300"	140#	BIT
Hammer Fall	24"	30"	Roller

	Date	Time
START	10/1/74	
COMPLETE	"	

TOTAL HRS.
BORING FOREMAN K. Allen
INSPECTOR W. Fitt
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec
	4	0'-2'	D	2	5	3	moist	1'	Sandy SILT (Topsoil)	1	24	
	17					2	loose		Brown fine SAND, trace fine			
	20	2'-3.5'	D	17	50/0'	22	dry		gravel, trace of	2	18	1'
	80			(100)		42	very	4'	Boulders			
	115					(300)	dense					
	2	5'-7'	D	15	23	23	wet			3	24	1'
	5					33	very		Brown fine silty SAND, some			
	2						dense		coarse sand & fine-coarse			
	45								gravel, trace Boulders			
	90											
	65	10'-11.5'	D	57	100	33	"			4	18	1'
	160			(140)		(300)			(Refusal cas.-12'6"-drilled			
	123/6"								w/roller bit to 14'6")			
								14.5				
									Bottom of Boring - 14.5'			

GROUND SURFACE TO 12'6" USED NW CASING: THEN Roller bit to 14.5'

Sample Type
D=Dry C=Cored W=Washed
UP: Undisturbed Piston
TP= Test Pit A=Auger V=Vane Test
UT= Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 14.5'
Rock Coring
Samples 4

HOLE NO. G-2

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R I

SHEET 1 OF 1
DATE
HOLE NO. G-3
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric Co. ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specif[illegible] PROJ NO 7286
SAMPLES SENT TO Delivered to Geotech at Site OUR JOB NO 4-85

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.
At ____ after ____ Hours	Type	NW	S/S	
	Size O.	3"	1-3/8"	
At ____ after ____ Hours	Hammer Wt	300#	140#	BIT
	Hammer Fall	24"	30"	

	Date	Time
START	10/1/74	
COMPLETE	10/2/74	
TOTAL HRS.		
BORING FOREMAN	K. Allen	
INSPECTOR	[illegible]	
SOILS ENGR.		

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec
	1	0'-2'	D	P U	S H		wet			1	24"	24"
	3						soft					
	4								Brown SILT			
	7	3'-5'	D	10	20	21	wet			2	24"	18"
	14					20	hard					
	10						wet	6'				
	13	6'-7'	D	14	16		dense	7'	Brn. fine silty SAND Lens)	3	12"	12"
	30	7'-8'	D	22	32		wet		Brown silty CLAY			
	32						hard	9'				
	[illegible]											
	24	10'-12'	D	2	4	4	wet			4	24"	24"
	28					5	stiff					
	30								Gray CLAY			
	20											
	30						wet					
	25	15'-17'	D	2	3	3	medium			5	24"	24"
	25					4	stiff					
	25											
	25						wet	19'				
	45	19.5'-20'	D	32			dense	20'	Gray GRAVEL (fractures)	6	6"	6"
	44	20'-21.5'	D	20	12	17	wet	21.5'	Brown sandy CLAY	6a	18"	12
	9						very					
	17						stiff		Brown silty sandy GRAVEL			
	40											
	[illegible]											
	45	25'-25.5'	D	100	50		wet			7	6"	6"
	30			(140)	(300)		very					
	45						dense	28'				
	65											
	75								Gray silty fine SAND, little fine-medium gravel			
	44	30'-31.5'	D	25	25	58	"			8	18"	14"
	40											
	45											
	90											
	175	@ 34'10"	D	100/0"	20/0"		"	34'10"				
	(10")			(140)	(300)							
									Bottom of Boring - 34'10" Refusal			

GROUND SURFACE TO 34'10" USED [illegible] CASING: THEN Refusal

Sample Type	Proportions Used		140 lb Wt. x 30" fall on 2" O.D. Sampler		SUMMARY:
D=Dry C=Cored W=Washed	trace	0 to 10%	Cohesionless Density	Cohesive Consistency	Earth Boring 34'10"
UP: Undisturbed Piston	little	10 to 20%	0-10 Loose	0-4 Soft 30+ Hard	Rock Coring
TP= Test Pit A-Auger V-Vane Test	some	20 to 35%	10-30 Med. Dense	4-8 M/Stiff	Samples 8
UT= Undisturbed Thinwall	and	35 to 50%	30-50 Dense	8-15 Stiff	HOLE NO G-3
			50+ Very Dense	15-30 V-Stiff	

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 1 OF 1

DATE

HOLE NO. G-4

LINE & STA.

OFFSET

SURF. ELEV.

TO Yankee Atomic Electric Co. ADDRESS Westboro, Mass.

PROJECT NAME Circulating Water System LOCATION Seabrook, N.H.

REPORT SENT TO Distrubution as per Speci[illegible] PROJ. NO. 7286

SAMPLES SENT TO Delivered to Geotech at Sit[illegible] OUR JOB NO. 4-85

GROUND WATER OBSERVATIONS

At 1'6" after 23 Hours

At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR
Type	NW	S/S	- -
Size I.D.	3"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	10/2/74	
COMPLETE	"	

TOTAL HRS.

BORING FOREMAN K. Allen

INSPECTOR

SOILS ENGR.

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec
1	0'-2'	D	1	1	1	wet	11	('ionsoil.l) Crown SILT	1	24"	6"
1					2	soft					
17						wet		Brown fine sandy SILT			
10	3'-5'	D	6	10	22	very	4'		2	24"	18"
26					42	dense					
10			6"	6"							
7	6'-7.5'	D	100	38	60	"		Brown fine SAND, some coarse	3	18"	18"
100			(140)	(300)				sand & fine-coarse gravel			
2								trace of silt			
48											
72	10'-11.5'	D	25	50	57	"			4	18"	18"
90											
90											
125											
125											
20	15'-16.2'	D	50(	j 42	60	"			5	15"	15"
21			75/3"	(300)							
26											
75							19'				
16								Gray silty SAND, some fine			
	20'-21'	D	76	76		"		to coarse gravel	6	12"	12"
							22.5'				
								Bottom of Boring - 22.5'			
								Refusal - Roller Bit			

GROUND SURFACE TO 20' USED NW CASING: THEN Roller bit to refusal

Sample Type
D=Dry C=Cored W=Washed
UP= Undisturbed Piston
TP= Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 22.5'
Rock Coring
Samples 6

HOLE NO. G-

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 1 OF __
DATE __
HOLE NO. G-5
LINE & STA. __
OFFSET __
SURF. ELEV. __

TO Yankee Atomic Electric Co.
ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System
LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specification
PROJ. NO. 7286
SAMPLES SENT TO Delivered to Geotech. at Site
OUR JOB NO. 4-35

GROUND WATER OBSERVATIONS			CASING	SAMPLER	CORE	BAR
At - __ after __ Hours		Type	NW	S/S		
		Size I.D.	3"	1-3/8"		
At - __ after __ Hours		Hammer Wt	300#	140#	BIT	
		Hammer Fall	24"	30"		

	Date	Time
START	10/4/74	a.m. p.m.
COMPLETE	"	a.m. p.m.
TOTAL HRS.		
BORING FOREMAN	K. Allen	
INSPECTOR		
SOILS ENGR.		

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec
	1											
	7											
	17								Casing Refusal @ 9'			
	21								Top of TILL 9' - sampled			
	28											
	100+											
	42											
	30											
	75				2"	0"	wet	9'				
		9'-9'8"	D	58	100	50	very		Gray fine silty SAND, some	1	8"	6
					(140)	(300)	dense	9'8"	fine-coarse gravel			
									Bottom of Boring - 9'8"			
									Refusal w/roller bit			

GROUND SURFACE TO 9' USED NW CASING: THEN Refusal w/roller bit

Sample Type	Proportions Used	140 lb Wt. x 30" fall on 2" O.D. Sampler Cohesionless Density	Cohesive Consistency	SUMMARY:
D-Dry C=Cored W=Washed	trace 0 to 10%	0-10 Loose	0-4 Soft 30 + Hard	Earth Boring 9'8"
UP: Undisturbed Piston	little 10 to 20%	10-30 Med. Dense	4-8 M/Stiff	Rock Coring
TP= Test Pit A=Auger V=Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff	Samples 1
UT-Undisturbed Thinwall	and 35 to 50%	50 + Very Dense	15-30 V-Stiff	HOLE NO. G-5

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 1 OF 1
DATE
HOLE NO. G-6
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric Co. ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specification PROJ. NO. 7286
SAMPLES SENT TO Delivered to Geotech. at Site OUR JOB NO. 4-85

GROUND WATER OBSERVATIONS
At ______ after ______ Hours
At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR.
Type	NW	S IS	
Size I.D.	3"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	10/4/74	
COMPLETE		
TOTAL HRS.		

BORING FOREMAN K. Allen
INSPECTOR [illegible]
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From- To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec
	4											
	14								Casing Refusal @ 9'			
	30								Strata change @ 9'9"			
	[illegible]								(TILL)			
	42											
	100+											
	70											
	120											
	110							9'				
					4"	8"	wet					
		10'9"-12'	[illegible]	57	100	38	very		Gray fine SAND, some fine to coarse gravel, little silt	1	18	14
					(140)	(300)	dense					
								19'6"				
									Bottom of Boring - 19'6" Refusal w/roller bit			

GROUND SURFACE TO 9' USED NW CASING: THEN Roller bit to refusal (rock?)

Sample Type	Proportions Used	140 lb Wt. x 30" fall on 2" O.D. Sampler Cohesionless Density	Cohesive Consistency	SUMMARY:
D= Dry C=Cored W=Washed	trace 0 to 10%	0-10 Loose	0-4 Soft	Earth Boring 19' 6"
UP: Undisturbed Piston	little 10 to 20%	10-30 Med. Dense	4-8 M/Stiff	Rock Coring
TP=Test Pit A=Auger V=Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff	Samples 1
UT=Undisturbed Thinwall	and 35 to 50%	50 + Very Dense	15-30 V-Stiff 30 + Hard	HOLE NO. G-6

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R I

SHEET 1 OF 1
DATE
HOLE NO. C-7
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric
ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System
LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specification
PROJ. NO 723
SAMPLES SENT TO Delivered to Geotech. at Site
OUR JOB NO. 4-25

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.
At - after ___ Hours	Type	NW	S/S	
	Size I.D.	3"	1-3/8"	
Al after - - Hours	Hammer Wt.	300	140	BIT
	Hammer Fall	24	30"	

	Date	Time
START	10/4/74	a.m. p.m.
COMPLETE	"	a.m. p.m.

TOTAL HRS.
BORING FOREMAN [illegible]
INSPECTOR [illegible]
SOILS ENGR.

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From – To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc Rock-color, type, condition, hardness, Drilling time, seams and etc	SAMPLE No.	Pen	Rec
	1											
	17											
	24								Casing Refusal @ 10'			
	45								Strata Change (TILL) @ 11'6			
	51											
	42											
	30											
	40											
	40											
							wet	11'6'				
		11'6"-13'	D	24	92	22	very dense		Gray fine SAND, some fine to coarse gravel, little silt	1	18	1[illegible]
								23'2"	Bottom of Boring - 23'2" Roller Bit Refusal			

GROUND SURFACE TO 10' USED NW CASING: THEN Used Roller Bit to 23'2"

Sample Type
D-Dry C=Cored W=Washed
UP: Undisturbed Piston
TP= Test Pit A-Auger V=Vane Test
UT= [illegible]

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	

SUMMARY:
Earth Boring 23'2"
Rock Coring
Samples 1

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 1 OF 1
DATE
HOLE NO. G-8
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric ADDRESS Westboro, Mass.
PROJECT NAME Circ. Water System LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specific... PROJ. NO. 7286
SAMPLES SENT TO Delivered to Geotech... OUR JOB NO. 4-83

GROUND WATER OBSERVATIONS
At ______ after ______ Hours
At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR
Type	NW	S / S	- - - -
Size I.D.	3"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	10/7/74	a.m. p.m.
COMPLETE	"	a.m. p.m.

TOTAL HRS.
BORING FOREMAN
INSPECTOR
SOILS ENGR.

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No	Pen	Rec
	1											
	5											
	6								Casing Refusal @ 10'6"			
	15											
	16											
	17											
	16											
	15											
	21											
								10'6"				
		10'6"-12'	3	17	15	24	wet dense		Gray fine SAND, some fine to coarse gravel, little silt:	1	15	14
								19'				
									Bottom of Boring - 13' Roller Bit Refusal			

GROUND SURFACE TO 10'6" USED NW" CASING: THEN Roller bit refusal

Sample Type	Proportions Used		140lb Wt. x 30" fall on 2" O.D. Sampler				SUMMARY:
D= Dry C=Cored W=Washed	trace	0 to 10%	Cohesionless Density		Cohesive consistency		Earth Boring 19'
UP= Undisturbed Piston	little	10 to 20%	0-10	Loose	0-4 Soft	30 + Hard	Rock Coring
TP=Test Pit A=Auger V=Vane Test	some	20 to 35%	10-30	Med. Dense	4-8 M/Stiff		Samples 1
UT= Undisturbed Thinwall	and	35 to 50%	30-50	Dense	8-15 Stiff		
			50+	Very Dense	15-30 V. Stiff		HOLE NO. G-8

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R I.

SHEET 1 OF 1
DATE
HOLE NO. C-9
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specification PROJ. NO. 7780
SAMPLES SENT TO Delivered to Geotech.at Site OUR JOB NO. 4-85

GROUND WATER OBSERVATIONS

At 2' after 1/4 Hours

At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR.
Type	NW		NWD?
Size I D	3"		
Hammer Wt.	300#		BIT
Hammer Fall	24"		

	Date	Time
START	10/7/74	a.m. p.m.
COMPLETE	"	a.m. p.m.

TOTAL HRS.
BORING FOREMAN [illegible]
INSPECTOR [illegible]
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec
									OVERBURDEN			
								10'6"				
		10'6"-15'6"	C	3 MIN/FT						C1	60	60"
									Gray QUARTZ DIORITE			
		15'6"-20'6"	C	6 MIN/FT						C2	60	61"
		20'6"-25'6"	C	5 MIN/FT						C3	60	59"
								25'6"				
									Bottom of Boring - 25'6" cored 15'			

GROUND SURFACE TO 10'6" USED NW" CASING: THEN Cored

Sample Type	Proportions Used	140 lb Wt. x 30" fall on 2" O.D. Sampler		SUMMARY:
D=Dry C=Cored W=Washed	trace 0 to 10%	Cohesionless Density	Cohesive Consistency	Earth Boring 10'6
UP- Undisturbed Piston	little 10 to 20%	30-50 Dense	8-15 S.Stiff 30 + Hard	Rock Coring 15'
TP=Test Pit A-Auger V=Vane Test	some 20 to 35%	10-30 Med. Dense	4 - 8 M/Stiff	Samples ---
UT=Undisturbed Thinwall	and 35 to 50%			HOLE NO.

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 1 OF 1
DATE
HOLE NO. C-10
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specificat PROJ. NO 7286'
SAMPLES SENT TO Delivered to Geotech.at Site OUR JOB NO. 4-85

GROUND WATER OBSERVATIONS
At ______ after ______ Hours
At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR.
Type	NW		NXD3
Size I.D.	3"		
Hammer Wt.	300#		BIT
Hammer Fall	24"		dia

	Date	Time
START	10/7/74	a.m. p.m.
COMPLETE	10/8/74	a.m. p.m.

TOTAL HRS.
BORING FOREMAN K.Allen
INSPECTOR W.Pitt
SOILS ENGR.

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From-To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc	Sample No.	Pen	Rec
								7'	OVERBURDEN			
		7'-12'	C	3-5	Min/Ft					C1	60'	60"
		12'-17'	C	3-5	Min/Ft				Gray DIORITE	C2	60'	60"
		17'-22'	C	4	Min/Ft			22'		C3	60'	60"
									Bottan ofboring- 22'			

GROUND SURFACE TO 7' USED NW "CASING: THEN Cored to 22'

Sample Type
D-Dry C=Cored W=Washed
UP: Undisturbed Piston
TP= Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 7'
Rock Coring 15'
Samples ---

HOLE NO. C-10

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R I.

SHEET 1 OF 1
DATE
HOLE NO. G-11
LINE & STA.
OFFSET
SURF ELEV.

TO Yankee Atomic Electric ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System LOCATION Seabrook, N.H.
REPORT SENT TO Distrubution as per Specificatic PROJ. NO 7286
SAMPLES SENT TO Delivered to Geotech.at Site OUR JOB NO. 4-85

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		Date	Time
At ______ after ______ Hours	Type	NW	-	NXD3	START	10/8/74	a.m. p.m.
	Size I.D.	3"	—	-	COMPLETE	"	a.m. p.m.
At ______ after ______ Hours	Hammer Wt	300#	—	BIT	TOTAL HRS.		
	Hammer Fall	24"	—	dia	BORING FOREMAN	K. Allen	
					INSPECTOR		
					SOILS ENGR.		

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From- To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc	SAMPLE No	Pen	Rec
									OVERBURDEN			
								16'				
		16'-21'	C	4	Min/Ft					C1	60	55"
		21'-26'	C	4	Min/Ft				Gray DIORITE	C2	60	60"
		26'-31'	C	7	Min/Ft					C3	60	60"
								31'				
									Bottom of Boring - 31'			

GROUND SURFACE TO 16' USED NW" CASING: THEN Cored to 31'

Sample Type	Proportions Used	140 lb Wt. x 30" fall on 2" O.D. Sampler Cohesionless Density	Cohesive Consistency	SUMMARY:
D=Dry C=Cored W=Washed	trace 0 to 10%	0-10 Loose	0-4 Soft	30 + Hard	Earth Boring 16'
UP- Undisturbed Piston	little 10 to 20%	10-30 Med. Dense	4-8 M/Stiff	Rock Coring 15'
TP= Test Pit A=Auger V-Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff	Samples --
UT=Undisturbed Thinwall	and 35 to 50%			HOLE NO.

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R I

SHEET 1 OF
DATE
HOLE NO. G-12
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric | ADDRESS Westboro, Mass.
PROJECT NAME Circulating Water System | LOCATION Seabrook, N.H.
REPORT SENT TO Distribution as per Specification | PROJ NO 7285
SAMPLES SENT TO Delivered to Geotech at Site | OUR JOB NO. 4-25

GROUND WATER OBSERVATIONS

At ______ after ______ Hours
Top of Ground
At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR.
Type	NW	/S	
Size I.D.	3"	1-3/8"	2-15/16"
Hammer Wt	300#	140#	BIT
Hammer Fall	24"	30"	Roller

	Date	Time
START	10/10/74	
COMPLETE	"	
TOTAL HRS.		
BORING FOREMAN	K. Allen	
INSPECTOR		
SOILS ENGR.		

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	No	Pen	Rec
1	0'-1'	D	1	4		w/m/s	1'	Brown PEAT	1	12"	6"
7	1'-2'	D	6	6		wet			1a	12"	3"
14						medium					
15						dense		Gray fine silty SAND			
71											
33	5'-6'6"	D	12	21	28	wet			2	18"	12"
35						dense					
37							9'				
32								Gray CLAY			
	10'-10'11"	D	5	3/5"	100/0"	wet	10'11"		3	11"	11"
			(140#)	(140#)		stiff	11'	~~Roller Bit Refusal @ 11'~~			
								Bottom of Boring- 11' Refusal			

GROUND SURFACE TO 10' USED NW CASING: THEN Sampled to 11'

Sample Type
D=Dry C=Cored W=Washed
UP: Undisturbed Piston
TP= Test Pit A=Auger V=Vane Test
UT- Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0 - 4	Soft
10-30	Med. Dense	4 - 8	M/Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	v-Stiff
		30 +	Hard

SUMMARY:
Earth Boring 11'
Rock Coring ---
Samples 3

HOLE NO. G-1