HARTSVILLE NUCLEAR PLANT, ALL UNITS

SPRAY POND CENTRAL AND SUPPORT EARTHFILL

MOISTURE CONTENT OUTSIDE OF LIMITS

10 CFR PART 50.55(e) REPORT NO. 2 (FINAL)

NCR-HNP-B11 AND NCR-HNP-B12

On October 13, 1978, TVA notified NRC-OIE Region II Inspector, Tom Burdette, of a potentially reportable condition regarding essential service water (ESW) spray pond central and support earthfill being placed with moisture content outside of acceptable limits. TVA followed up this initial notification by submitting a written interim report on this subject to NRC-OIE Region II on November 13, 1978.

This is our final report to you on the subject NCR's.

Description of Condition

From July 5 to September 15, 1978, approximately 58,000 cubic yards of Category I earthfill was placed in an area between the four essential service water (ESW) spray ponds (see Figure 1). Approximately 75 percent of this earthfill was placed in the central fill area. The remaining earthfill was placed southeast of the northwestern spray pond in a 70-foot-wide area designated to support the 5-foot-thick clay liner (spray pond support fill). No part of the clay liner was constructed.

During this period of time, a portion of both the central fill and the support fill was placed with moisture contents outside the specified limits of two percent above and two percent below optimum moisture content. In addition, undisturbed block samples, shear strength tests on the block samples, and Atterberg limit tests for the earthfills were not taken as required in Hartsville Construction Specification N6C-875.

Construction control testing consisted of sand-cone density tests and

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moisture content tests to determine the degree of fill compaction and the deviation from optimum moisture content. A total of 39 sets of control tests were performed on the 58,000 cubic yards of compacted earthfill as opposed to the minimum requirement of 29 tests (one test per 2,000 cubic yards).

Results from eight of the 39 moisture content tests were outside the specified limits. Three of these tests were performed on samples of the spray pond support fill and five were performed on samples of the central fill. Moisture contents of the support fill samples were between 2.4 and 2.9 percent below optimum. Results of the tests from the central fill were between 2.1 percent above optimum and 3.2 percent below optimum. The degree of compaction for these eight samples ranged from 102.4 percent to 110.8 percent of the standard maximum dry density.

Initial construction control testing revealed the degree of compaction of six samples of central fill was below the required 100 percent standard maximum dry density. However, before construction proceeded all of the earthfill in the area of the tests was reworked and rerolled. Retests showed that the reworked earthfill was compacted adequately and had acceptable moisture contents.

Cause of Deficiency

Mathematical errors made by three construction inspectors in computing moisture contents were the cause for earthfill being placed which did not meet moisture content specifications. The mistakes were subsequently discovered by Hartsville construction personnel during a review of the construction control test reports. At this time, several layers of earthfill had already been placed over the material in question.

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Investigation of the above nonconformance revealed that undisturbed block samples and Atterberg limit tests for all of the earthfill placed in this construction period had not been taken due to a misinterpretation of the construction specification requirements.

Safety Implications

The results of the testing program just completed by TVA have revealed that the as-placed earthfill strengths exceed the required design strengths for earthfill in these areas. Subsequently, there are no safety implications associated with the nonconforming earthfill discussed in this report.

Testing Program

a. Scope

TVA initiated a program to sample the in-place earthfill and to test the shear strengths of undisturbed earthfill samples. Earthfill samples were obtained by five undisturbed borings and five auger borings taken within five feet of the undisturbed borings. The potentially weakest layers of the sampled fill were determined, and the shear strengths of those undisturbed samples were tested.

b. Field exploration

When sand-cone density tests were made during construction of the fill, horizontal control of the test locations was not recorded but the test elevations were documented. For this reason it was not possible to sample the earthfill at the exact locations where the nonconformances were recorded.

Because the area which was backfilled during the 1978 construction season contained a V-shaped valley, the natural ground contours

provided lateral containment for the area where the nonconforming earthfill was placed. This natural depression (see Figure 1) extended north-south along the full length of the fill area. In the central fill area, the five moisture content tests with nonconforming results were taken between elevations 520 feet and 525 feet. The three nonconforming test results for the spray pond support fill came from between elevations 528 feet and 530 feet. As shown by the contours on Figure 1, the elevations for each respective fill area were confined to a band which varied from 100 to 200 feet in width.

A program of sampling which took advantage of this restricted fill area was devised. Five undisturbed borings near the centerline of the valley encountered most of the affected earthfill. Three undisturbed borings, approximately 110 feet apart, were made in the central fill. The average depth of sampling was 11.5 feet. The elevation of the midpoint of the borings was between 520 feet and 522 feet. Two undisturbed borings were made in the spray pond support fill. The average depth of sampling for these two borings was 9.0 feet, and the midpoint elevation of each boring was 528 feet. The midpoint elevation or the elevation of the center of the undisturbed borings was selected to be near the median elevation of the range of elevations from which the nonconforming data for each type of fill was obtained. By selecting the midpoint elevation of each undisturbed boring near the median elevation of the nonconforming construction control tests, a possible deviation from the documented elevation of the nonconforming earthfill layer was taken into account.

c. Laboratory testing

Earthfill samples, both undisturbed and auger samples, were taken to TVA's Singleton Materials Engineering Laboratory and tested in a two-phase testing program. Phase 1 of the testing program was used to examine the undisturbed samples to determine if earthfill nonconformances similar to the ones observed in the construction control tests were encountered in the fill sampled by borings. In addition, most of the required documenting Atterberg limit tests were performed, and unconfined compression tests were performed as index strength tests. Phase 2 of the testing program was used to test the shear strengths of the worst cases of earthfill nonconformance.

In phase 1 of the testing program, moisture content tests, dry density (unit weight) tests, unconfined compression tests, one-point compaction tests, and Atterberg limit tests were performed on each representative layer of undisturbed earthfill. Results from the one-point compaction tests were used to determine each layer's soil class from the family of compaction control curves. Information from moisture content and dry density tests was then used to compute percent compaction and deviation from optimum moisture content for each earthfill layer. Unconfined compression tests were performed on most undisturbed earthfill samples to allow a relatively quick check of shear strength. Atterberg limit tests were performed on each representative layer to replace the Atterberg limit tests which were originally omitted during construction control testing (see Table 2 for a summary of the test data).

Data from phase 1 tests indicated that the undisturbed samples contained some material with moisture contents which were similar to those in the

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nonconforming construction control tests. Moisture contents ranged between 2.9 percent and 2.2 percent below optimum as compared to the nonconforming construction control test data which ranged between 3.2 percent and 2.1 percent below optimum. Undisturbed borings US-1 and US-4 contained earthfill with moisture contents which exceeded the two percent above optimum specification limit. This data ranged from 3.2 percent to 2.7 percent above optimum as compared to a maximum 2.1 percent above optimum for the construction control tests.

Phase 1 testing also showed seven representative earthfill layers which were compacted to less than 100 percent standard maximum dry density. Percent compactions for these samples ranged from 96.5 percent to 99.6 percent. All of these layers were compacted in excess of Class A requirements (95 percent) but below the 100 percent required for Class (A-1) soil.

Earthfill samples with less than 100 percent compaction were all placed above optimum moisture content. Tests on four of the seven undercompacted layers indicated moisture contents which exceeded the specified moisture content limit of optimum +2 percent.

Results of the unconfined compression tests indicated that the shear strengths of all the nonconforming samples were adequate or exceeded requirements for the unconsolidated-undrained condition. Unconfined compression test data which corresponds to the nonconforming layers ranged from 1.6 to 5.3 tons per square foot. This translated to approximate cohesion strengths (c) between 0.8 and 2.65 tons per square foot as compared to the 0.8-ton-per-square-foot design requirement.

Undisturbed samples from eight of the representative earthfill layers

were selected for phase 2 testing. The worst cases of compaction and moisture content nonconformance were included in the samples selected for phase 2 testing. Three of the samples selected were within specified degree of compaction limits but did not meet moisture content requirements. One sample conformed to moisture content requirements but did not conform to the degree of compaction requirements. Three samples did not conform to either the moisture content requirements or the degree of compaction requirements. The remaining sample met the specified degree of compaction and moisture content requirements. Four samples were selected from both the central fill and the spray pond support fill for phase 2 testing.

PHASE 2 TEST SAMPLES (TABLE 1.0)

Sample No.	Deviation from Optimum Moisture Content (Percent)	Degree of Compaction (Percent)
I	+2.9*	98.7*
II	-1.4	104.4
III	+0.7	98.5*
IV	-2.9*	108.2
V	+3.2*	96.5*
VI	+2.7*	97.3*
VII	-2.9*	105.0
VIII	-2.5*	103.1

*Nonconforming test data

Triaxial compression Q and R tests were performed on undisturbed samples from each of the eight selected layers. Failure envelopes were constructed for the unconsolidated-undrained condition (Q) and the consolidated-undrained condition (R). Excess pore water pressures were monitored during the saturated R tests to measure the materials effective ($\bar{R}$) shear strength. (The $\bar{R}$ strength is comparable to the consolidated-drained (S) strength as defined in the Hartsville Preliminary Safety Analysis Report.) The failure envelopes were plotted on a common graph for comparison with the assumed design properties for each respective consolidation/drainage conditions (see Figures 2 through 4).

d. Discussion of test results

Results of the Q triaxial tests demonstrated that the unconsolidated-undrained shear strength of this fill is acceptable. All samples had angles of internal friction (Ø) which were two to five times greater than the design requirement of eight degrees. Six of the eight samples had a greater cohesion strength (c) than required. Although the cohesion strengths for sample III (c = 0.47 ton per square foot) and sample V (c = 0.66 ton per square foot) are below the 0.8-ton per-square-foot cohesion strength used in design, the high angles of internal friction (42.0 degrees and 25.5 degrees, respectively) show a substantial contribution in raising the shear strength of these samples above the design shear strength for normal stresses exceeding 0.5 ton per square foot. (It should also be noted that

end of construction cases of the stability analysis made during design, based on the Q shear strength (c = 0.8 ton per square foot), had safety factors of approximately 3 or greater.) This fill has also been consolidating for 10 months.

All shear strengths measured by the triaxial R tests exceeded the design properties. Cohesions ranged from 0.40 to 1.90 tons per square foot as compared to a 0.3-ton-per-square-foot cohesion design strength. The lowest angle of internal friction value was 17 degrees (the design friction angle is 15 degrees).

$\bar{R}$ triaxial test data showed that the earthfills exceeded the design shear strengths through the range of normal stresses which will be experienced in the fill. Seven of the eight samples had friction angles and cohesions which were equal to or better than the design properties. Sample IV's angle of internal friction was 24.8 degrees which is 4.2 degrees less than the design friction angle of 29 degrees. However, the cohesion strength (c) of sample IV was 0.48 ton per square foot which exceeds the design value of 0.0 ton per square foot. Because of the combination of high cohesion strength and low angle of internal friction, the failure envelope for sample IV intersected the design failure envelope at a normal stress in excess of 5.0 tons per square foot. Normal stresses in the spray pond fill will not exceed 3.5 tons per square foot; therefore, the shear strengths are adequate.

e. Conclusions

Although the nonconforming moisture contents recorded during construction control testing were drier than the moisture contents recorded in phase 1 testing, the triaxial testing results indicate

that the shear strength of slightly drier earthfill would be acceptable. The lowest moisture content which was recorded during construction control testing is 3.2 percent below the optimum. Moisture content for both sample IV and sample VII, as determined during phase 1 testing, is 2.9 percent below the optimum, a 0.3 percent difference from the lowest moisture content determined during construction. If the as-placed moisture content of earthfill is lowered, the Q shear strengths would tend to increase and the saturated R and $\bar{R}$ shear strengths would decrease slightly. Since the tested Q shear strengths are adequate, the shear strength at 3.2 percent below the optimum would also be adequate. The R and $\bar{R}$ shear strengths would be slightly lower but, based on TVA's engineering judgment and research studies, would still be adequate. Therefore, the fill is adequate.

Table 2 and Table 1 list the Atterberg limit [illegible] lace the 58 tests which were omitted during construction [illegible] testing. Table 2 (phase 1) contains plasticity indexes for 55 samples all of which exceed the minimum allowable plasticity index of 5. Table 1 (phase 2) contains plasticity index data for an additional 13 tests. All recorded PI's are adequate.

Corrective Action

Because of the satisfactory results of the testing program, TVA will proceed with construction as planned in the area of the ESW spray ponds. No corrective action is needed.

Action Taken to Prevent Recurrence

To prevent recurrence of this type of nonconformance, the CONST QCI Manual is being revised where not previously indicated to include the type of test to be conducted, frequency of inspection and acceptance criteria as required by the Hartsville Construction Specification N6C-875, "Earth and Rock Foundation and Fills," and thereby prevent future misinterpretations. The CONST QA Staff will continue to update the QCI Manual as necessary to reflect construction specification revisions. Site QC inspectors will then be retrained to the revised QCI's to establish their cognizance of applicable requirements including proper recording of test data.

In order to prevent mathematical errors in test results on earthfill from going undetected for a long time such that major corrective actions are necessary, the site QC unit will review test documentation in a timely manner to enable errors to be caught before extensive additional work is accomplished and a "checked by" block was added to compaction test forms to record this review.

Table 2

HARTSVILLE NUCLEAR PLANTS A AND B

IN-PLACE EARTHFILL TESTING

SUMMARY OF LABORATORY TEST DATA

PHASE 1 DATA

[illegible] 2 DATA

	Elevation	Soil Layer	Soil Symbol	Field Moisture w_f %	Saturation %	Atterb. Limits Liq. Limit %	Atterb. Limits Plastic. Index %	Dry Dens. pcf	Void Ratio	Unconfined Compression Undisturbed tsf	One-Point Compaction Data Soil Class	Moisture w %	Dry Density pcf	Maximum Dry Density pcf	Optimum Moisture w_o %	w_f-w_o %	Compaction %	Triaxial Q φ deg.	Triaxial Q c tsf	Saturated Triaxial R Apparent φ deg.	Apparent c tsf	Effective φ deg.	Effective c tsf
	Boring US-1, Station N1+60, Range W8+00, Surface Elevation 525.3, Undisturbed Samples																						
	524.8-523.6	1	CL	17.4	93.2	36.8	17.3	112.1	.504		I	16.5	109.2	109.9	17.0	0.4	102.0						
	523.6-522.4	1	CL	16.9	93.3	35.2	18.0	113.3	.488	5.2	I	16.5	109.2	109.9	17.0	-0.1	103.1						
	522.4-521.2	2	CL	19.1	97.6	45.3	23.6	111.0	.535		*II	17.6	104.6	106.4	18.7	0.4	104.3						
	521.2-520.0	3	CL	16.6	86.9	37.7	17.7	111.8	.519	2.9	IIb	14.5	102.7	[illegible]	18.2	-1.6	104.3						
	520.0-518.8	3	CL	16.7	92.0	39.4	18.9	113.1	.496		IIb	14.5	102.7	107.2	[illegible]	-1.5	105.5						
	518.8-517.6	4	CL	20.0	94.2	35.4	17.3	107.5	.574	2.6	*IIb	16.0	104.3	107.2	[illegible]	1.8	100.3	15.0	1.63	17.0	0.92	30.0	0.07
SAMPLE I	517.6-516.4	5	CL	21.1	94.2	43.2	21.7	105.8	.611	4.1	*IIb	16.0	104.3	107.2	18.2	2.9	98.7						
	516.4-515.2	6	CL	16.3	87.6	34.2	16.1	112.5	.503	3.5	*IIa	16.1	105.8	108.0	17.9	-1.6	104.2						
	Auger Samples																						
	525.3-524.8		CL	19.6	---	38.6	17.1					--	--										
	522.8-520.8		CL	--	--	39.8	22.4					17.6	104.6										
	518.8-516.8		CL	--	--	40.3	20.2					16.0	104.3										
	516.8-514.8		CL	--	--	37.9	18.2					16.1	105.8										
	Boring US-2, Station N2+80, Range W8+00, Surface Elevation 528.3, Undisturbed Samples																						
	527.0-525.5	1	CL	16.1	96.4	37.4	20.0	116.2	.451		Ib	15.4	109.8	110.7	16.5	-0.4	105.0						
	525.5-524.3	1	CL	17.2	95.1	36.5	16.9	113.1	.485		Ib	15.4	109.8	110.7	16.5	0.7	102.2						
	524.3-523.1	1	CL	16.5	92.8	37.6	18.0	114.0	.479	5.4	Ib	15.4	109.8	110.7	16.5	0.0	103.0						
	523.1-521.9	2	CL	19.8	92.7	41.9	20.1	107.7	.582		III	18.7	103.0	103.5	20.0	-0.2	104.1						
	521.9-520.6	2	CL	18.3	91.2	38.2	18.1	109.2	.543	2.3	III	18.7	103.0	103.5	20.0	-1.7	105.5						
	520.6-519.4	2	CL	18.2	87.4	41.1	19.6	107.6	.561	3.2	III	18.7	103.0	103.5	20.0	-1.8	104.0						
	519.4-518.2	2	CL	17.8	81.4	39.7	18.5	106.0	.550		III	18.7	103.0	103.5	20.0	-2.2	102.4	23.0	2.00	26.5	1.15	32.5	0.05
SAMPLE II	518.2-517.0	3	CL	16.5	89.9	34.4	16.8	112.8	.456	3.9	IIa	17.0	106.7	108.0	17.9	-1.4	104.4						
	Auger Samples																						
	528.3-527.8		CL	22.2	--	39.0	17.0					--	--										
	527.8-527.0		CL	19.3	--	41.7	18.5					--	--										

*Compaction characteristics were determined from the companion auger boring sample.

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Table 2

HARTSVILLE NUCLEAR PLANTS A AND B

IN-PLACE EARTHFILL TESTING

SUMMARY OF LABORATORY TEST DATA
(Continued)

PHASE 1 DATA | PHASE 2 DATA

Sample	Elevation	Soil Layer	Soil Symbol	Field Moisture w_f %	Saturation %	Atterb. Limits Liq. Limit %	Atterb. Limits Plastic. Index %	Dry Dens. pcf	Void Ratio	Unconfined Compression Undisturbed tsf	One-Point Compaction Data: Soil Class	Moisture w %	Dry Density pcf	Maximum Dry Density pcf	Optimum Moisture w_o %	w_f-w_o %	Compaction %	Triaxial Q φ deg.	Triaxial Q c tsf	Saturated Triaxial R Apparent φ deg.	Apparent c tsf	Effective φ deg.	Effective c tsf
	Boring US-3, Station N3+80, Range W8+00, Surface Elevation 530.8, Undisturbed Samples																						
	527.0-525.8	1	CL	17.6	89.2	37.6	18.4	110.1	.5[illegible]1		IIa	15.9	105.6	108.0	17.9	-6.3	101.9						
	525.8-524.6	1	CL	16.2	89.8	35.1	16.1	112.8	.4[illegible]4	3.2	IIa	15.9	105.6	108.0	17.9	-1.7	104.4						
	524.6-523.4	1	CL	17.3	91.1	39.0	18.5	111.6	.516		IIa	15.9	105.6	108.0	17.9	-0.6	103.3						
SAMPLE III	523.4-522.2	1	CL	18.6	87.2	36.3	16.9	106.4	.573	1.7	IIa	15.9	105.6	108.0	17.9	0.7	98.5	42.0	0.47	28.2	1.90	31.5	0.5[illegible]
SAMPLE IV	522.2-521.0	2	CL	18.5	91.3	40.6	20.3	108.8	.543	5.3	*Va	20.8	100.4	100.6	21.4	-2.9	108.2	19.0	1.90	19.0	1.08	24.8	0.4[illegible]
	521.0-519.8	2	CL	23.1	94.8	46.9	24.2	102.7	.6[illegible]6	2.5	*Va	20.8	100.4	100.6	21.4	1.7	102.1						
	519.8-518.6	3	CL	18.6	97.2	38.0	19.2	110.7	.511		IIIa	16.0	101.2	104.4	19.6	-1.0	106.0						
	518.6-517.4	3	CL	18.5	90.3	37.8	16.5	107.9	.5[illegible]0	3.0	IIIa	16.0	101.2	104.4	19.6	-1.1	103.4						
	517.4-516.2	4	CL	19.6	92.7	40.6	21.2	107.4	.530	1.7	*IIa	16.6	102.4	105.4	19.1	0.3	101.9						
	Auger Sampling																						
	530.8-530.3		CL	15.5	--	35.0	15.[illegible]					--	--										
	530.3-528.3		CL	18.4	--	41.0	19.1					--	--										
	528.3-527.6		CL	16.6	--	35.5	18.0					--	--										
	522.3-520.3		CL	--	--	43.4	22.6					20.8	100.4										
	518.3-516.0		CL	--	--	31.9	13.8					16.6	102.4										
	Boring US-4, Station N4+10, Range W8+60, Surface Elevation 532.3, Undisturbed Samples																						
SAMPLE V	531.8-530.5	1	CL	20.2	90.5	39.8	18.0	105.2	.6[illegible]2	1.9/1.6	IIa	15.6	108.0	109.0	17.0	3.2	96.5	25.5	0.66	23.0	0.44	31.0	0.00
	530.5-529.3	1	CL	19.8	92.3	40.2	18.7	107.6	.5[illegible]5	4.0	IIa	15.6	108.0	109.0	17.0	2.8	98.7						
SAMPLE VI	529.3-528.1	1	CL	19.7	90.6	40.8	18.8	106.1	.5[illegible]8	4.1	IIa	15.6	108.0	109.0	17.0	2.7	97.3	23.5	1.30	30.0	0.67	32.7	0.00
	528.1-526.9	2	CL	21.2	86.5	41.7	17.9	102.3	.672	4.0	IIIa	18.5	102.0	103.6	20.2	1.0	98.7						
	526.9-525.7	2	CL	19.0	87.2	39.5	17.1	106.8	.555		IIIa	18.5	102.0	103.6	20.2	-1.2	103.1						
	525.7-524.5	2	CL	20.5	87.7	39.6	16.5	104.2	.642	5.2	IIIa	18.5	102.0	103.6	20.2	0.3	100.6						
	524.5-523.3	3	CL	20.6	83.4	42.9	20.4	103.2	.663	4.1	IIIa	19.6	103.5	103.6	20.2	0.4	99.6						
	Auger Sample																						
	532.3-531.8		CL	24.2	--	43.3	20.5					--	--										
	Boring US-5, Station N4+80, Range W8+20, Surface Elevation 533.0, Undisturbed Samples																						
	532.5-531.3	1	CL	18.5	93.0	39.5	17.2	111.0	.547		IIa	18.5	104.4	104.9	19.5	-1.0	105.8						
	531.3-530.1	1	CL	20.6	92.6	39.1	17.6	106.1	.606	3.0	IIa	18.5	104.4	104.9	19.5	1.1	101.1						
	530.1-528.9	2	CL	20.3	87.9	41.8	18.5	104.2	.623		IIIa	19.1	102.7	103.6	20.2	0.1	100.6						
	528.9-527.7	2	CL	19.1	84.6	40.9	17.6	104.8	.609	4.9	IIIa	19.1	102.7	103.6	20.2	-1.1	101.2						
	527.7-526.5	2	CL	20.6	90.3	40.0	16.8	105.2	.62[illegible]		IIIa	19.1	102.7	103.6	20.2	0.4	101.5						
SAMPLE VII	526.5-525.3	3	CL	18.0	83.2	38.7	16.4	107.6	.596	4.0	III	19.1	100.4	102.5	20.9	-2.9	105.0	30.0	1.10	17.0	0.40	31.9	0.00
SAMPLE VIII	525.3-524.1	3	CL	18.4	81.6	39.3	16.8	105.7	.619	4.2	III	19.1	100.4	102.5	20.9	-2.5	10[illegible].1	23.5	1.28	24.0	0.85	31.0	0.03
	Auger Sample																						
	533.0-532.5		CL	27.4	--	43.0	21.0					--	--										

*Compaction characteristics were determined from the companion auger boring sample.

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Table 3

HARTSVILLE NUCLEAR PLANTS A AND B

IN-PLACE EARTHFILL TESTING

ADDITIONAL ATTERBERG LIMIT TESTS (Phase 2)

Boring No.	Soil Layer	Approximate Elevation ft	Liquid Limit %	Plasticity Index %
US-1	1	524	37.0	17.6
US-1	4	518	38.6	19.5
US-2	1	526	35.9	19.2
US-2	2	520	39.6	19.1
US-3	1	527	37.1	17.8
US-3	1	526	34.9	15.2
US-3	3	519	37.5	18.8
US-4	2	527.5	42.2	18.1
US-4	2	527	39.2	17.1
US-4	2	526	41.3	18.6
US-5	1	532	38.0	19.4
US-5	2	529.5	42.3	19.1
US-5	2	529	40.2	18.0

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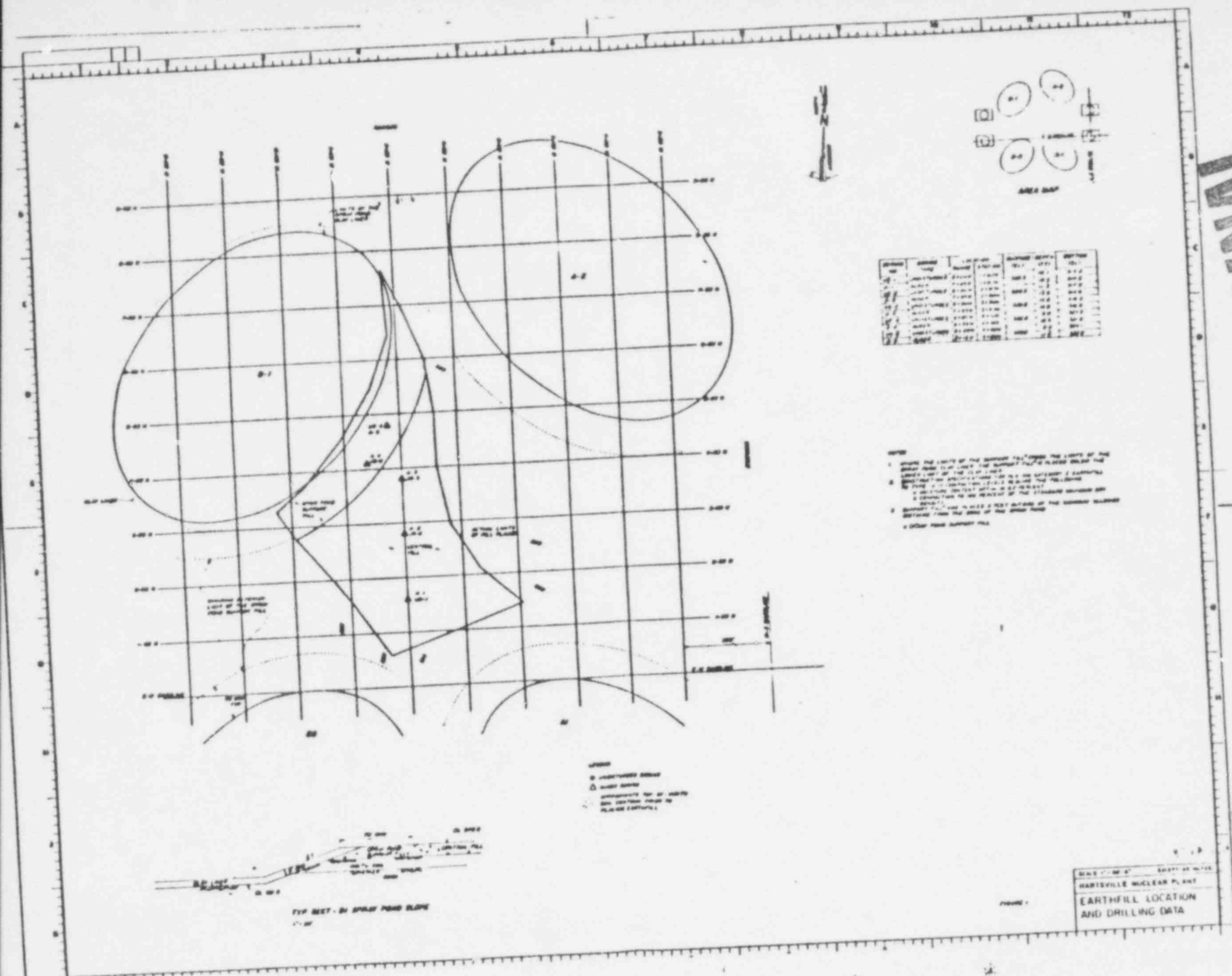
HARTSVILLE NUCLEAR PLANT
EARTHFILL LOCATION
AND DRILLING DATA

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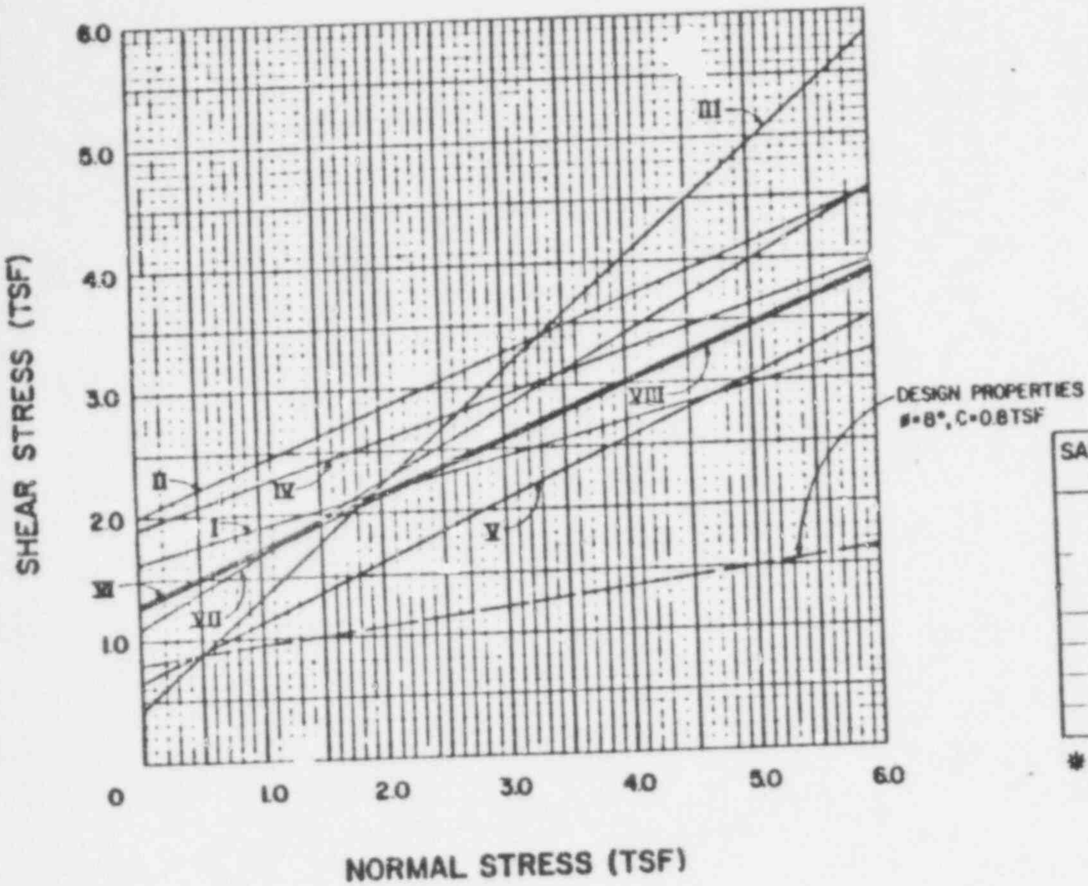
NOTES
1. SEE TABLE 2 FOR COMPLETE SUMMARY OF LABORATORY TEST DATA.



SAMPLE NO.	Ø (DEGREES)	C (TSF)	FILL TYPE *
I	15.0	1.63	C
II	23.0	2.00	C
III	42.0	0.47	C
IV	19.0	1.9	C
V	25.5	0.66	S
VI	23.5	1.3	S
VII	30.0	1.10	S
VIII	23.5	1.28	S

* C=CENTRAL FILL
S=SUPPORT FILL

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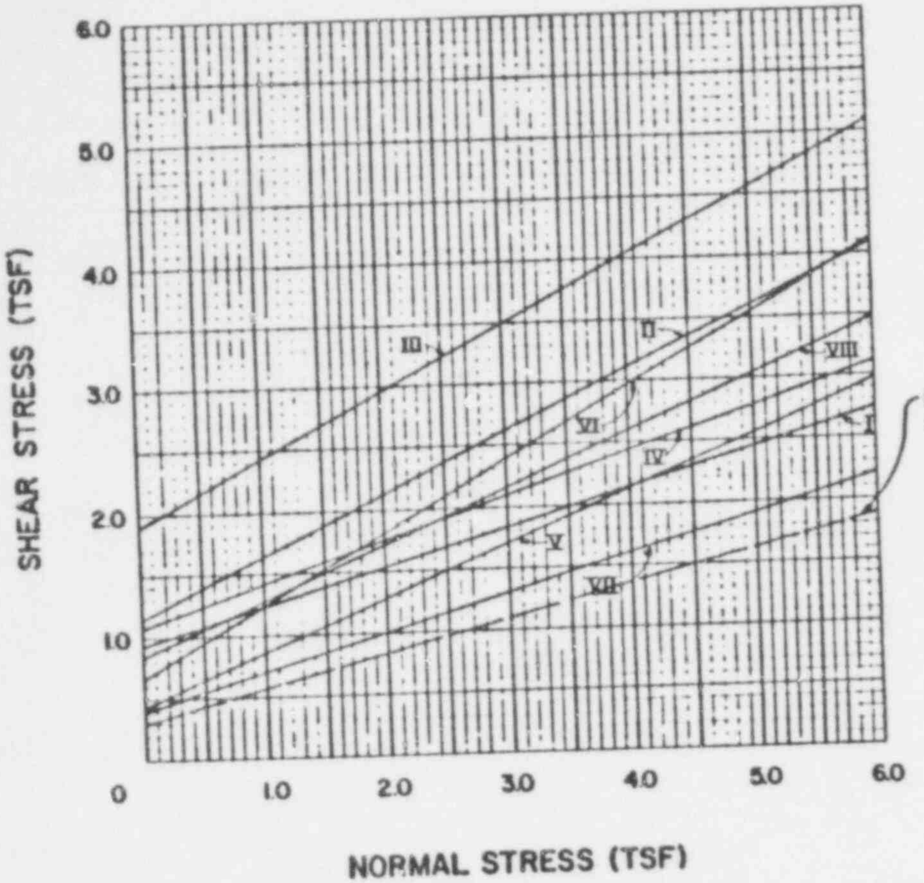
FIGURE 2

HARTSVILLE NUCLEAR PLANT

INPLACE EARTHFILL TESTING

UNCONSOLIDATED - UNDRAINED (Q)
TRIAXIAL COMPRESSION TEST
RESULTS

NOTES
1. DESIGN PROPERTIES LISTED ON THE GRAPH CORRESPOND TO CATEGORY I, CLASS (A-I) TRIAXIAL R TEST STRENGTHS FOR THE SUPPORT FILL. TRIAXIAL R TEST DESIGN PROPERTIES FOR THE CENTRAL FILL, CATEGORY I, CLASS (A), ARE LOWER: ø = 15°, C = 0.1 TSF.
2. SEE TABLE 2 FOR COMPLETE SUMMARY OF LABORATORY TEST DATA.



SAMPLE NO.	ø (DEGREES)	C (TSF)	FILL TYPE *
I	17.0	0.92	C
II	26.5	1.15	C
III	28.2	1.90	C
IV	19.0	1.08	C
V	23.0	0.44	S
VI	30.0	0.67	S
VII	17.0	0.40	S
VIII	24.0	0.85	S

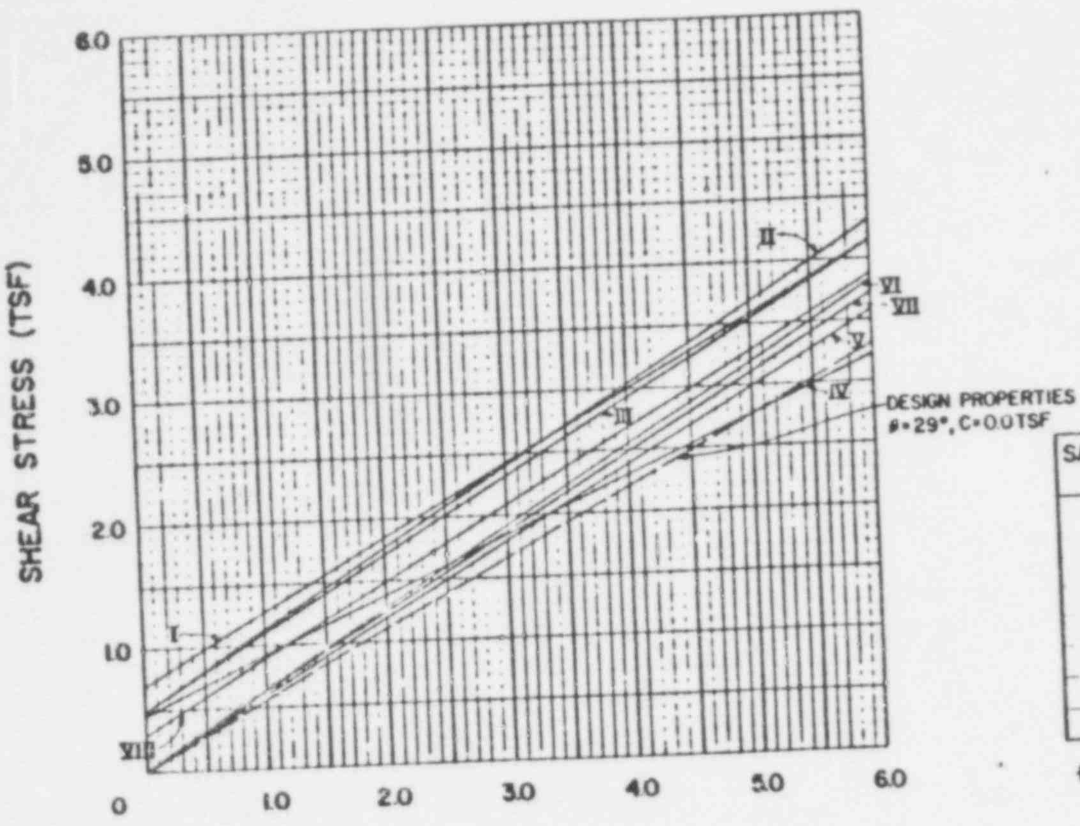
* C = CENTRAL FILL
S = SUPPORT FILL

FIGURE 3

HARTSVILLE NUCLEAR PLANT

INPLACE EARTHFILL TESTING

CONSOLIDATED-UNDRAINED (R) TRIAXIAL COMPRESSION TEST RESULTS



NOTES
1. SEE TABLE 2 FOR COMPLETE SUMMARY OF LABORATORY TEST DATA.
2. THE DESIGN PROPERTIES LISTED BELOW WERE OBTAINED USING DIRECT SHEAR S TESTS.

SAMPLE NO.	ø (DEGREES)	C (TSF)	FILL TYPE *
I	30	0.07	C
II	32.5	0.05	C
III	31.5	0.50	C
IV	24.8	0.48	C
V	31	0.00	S
VI	32.7	0.00	S
VII	31.9	0.00	S
VIII	31.0	0.03	S

* C=CENTRAL FILL
S=SUPPORT FILL

FIGURE 4

HARTSVILLE NUCLEAR PLANT

INPLACE EARTHFILL TESTING

TRIAXIAL COMPRESSION ($\bar{R}$) TEST RESULTS