TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

April 6, 1984

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority) 50-391

By my letter to you dated January 12, 1984, TVA provided a preliminary design for remedial action to resolve the issue of potential liquefaction at Watts Bar Nuclear Plant. Enclosed is TVA's report on the as-built configuration of the underground barrier (trench A) constructed along the Essential Raw Cooling Water (ERCW) pipeline.

If you have any questions concerning this matter, please get in touch with D. P. Ormsby at FTS 858-2682.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 6th day of April 1984

Paulette H. White

Notary Public
My Commission Expires 9-5-84

Enclosure
cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attn: Mr. James P. O'Reilly Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

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PDR ADOCK 05000390
A PDR

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ENCLOSURE

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

REMEDIAL ACTION TO RESOLVE LIQUEFACTION ISSUE

As-Built Configuration of Underground Barrier (Trench A)

Reference: L. M. Mills's letter to E. Adensam dated January 12, 1984, which provided a description of TVA's remedial action to resolve the issue of the potential for liquefaction beneath the ERCW pipeline.

The as-built configuration of the underground barrier was different from the barrier configuration used in the preliminary design as discussed in the referenced letter. The difference relates to the geometry of the cross-section. The cross-sections used in the preliminary analysis assumed an idealized uniformly flat lying base since sufficient site-specific top-of-rock data was not available. Excavations during barrier construction revealed a downhill slope of the top-of-rock varying from approximately 1° to 11°. The effect of the actual shape of the rock surface was incorporated in the final analysis and design.

The criteria used in the preliminary analysis and design, described in the referenced letter, was reviewed to define the criteria for the final analysis and design. This review resulted in the determination that the assumption that all passive resistance is nonexistent during the earthquake is unrealistic. This is because the soil liquefaction that would be necessary for complete loss of passive resistance will not be simultaneous with the start of the earthquake and not likely by the time of peak acceleration. In addition, the time required for progressive failure and riverward movement of the soils supplying the passive resistance would far exceed the time of the earthquake. A major conservatism not removed from the analysis is the assumption that the peak acceleration acts on the barrier mass as a constant static force. In reality, this is a short term cyclic force which randomly reverses itself and its orientation.

Figure 1 is a summary of the design parameters and criteria used in the stability analyses of the as-built cross-sections. As shown in the summary, the shear strengths of the alluvial sands (i.e., potentially liquefiable sands) have been assumed to be reduced during the earthquake. This was done to acknowledge the possibility that some strength loss in alluvial sands may occur during the earthquake. The magnitudes of the strength reduction, 50 percent of cohesion and 30 percent of angle of internal friction, was based on engineering judgement and is considered reasonable and conservative for the material.

Figure 2 is a plan of the area showing the locations of the as-built cross-sections. Figures 3 through 6 are representative cross-sections along the centerline of Trench A. Figure 1 provides a summary of results of the stability analysis for each cross-section. Results for station 6+78 are not shown because the soil profile was not identified above the top of shale. This is not considered critical to the overall summary of the results, since the other 17 of the 18 cross-sections were analyzed and found to be adequate. The results are provided for two sets of analyses representing "during earthquake" and "after earthquake" conditions for two different potential failure planes. The "during earthquake" analysis shows the stability of the barrier when the barrier mass is subjected to the peak acceleration, complete liquefaction of sands for the active earth pressure, and considers partial passive (reduced) earth resistance. The "after earthquake" analysis shows the stability of the barrier after the earthquake and considers complete (postulated) liquefaction of the saturated alluvial sands for the active earth pressure and complete loss of downstream passive resistance. The two potential failure planes are shown on the representative cross-sections (figures 3 through 6) at (1) the top of weathered shale (A), and (2) the interface between the 95- and 100-percent maximum dry density fill (B). Appendix A provides the summaries of in-place density and moisture quality control tests conducted on the fill materials during construction of Trench A.

APPENDIX A

WATTS BAR NUCLEAR PLANT

SUMMARIES OF IN-PLACE DENSITY AND MOISTURE TESTS

ON FILL MATERIALS FOR THE UNDERGROUND BARRIER (TRENCH A)

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT
SUMMARY OF EARTHFILL TEST DATA - MOISTURE CONTENT

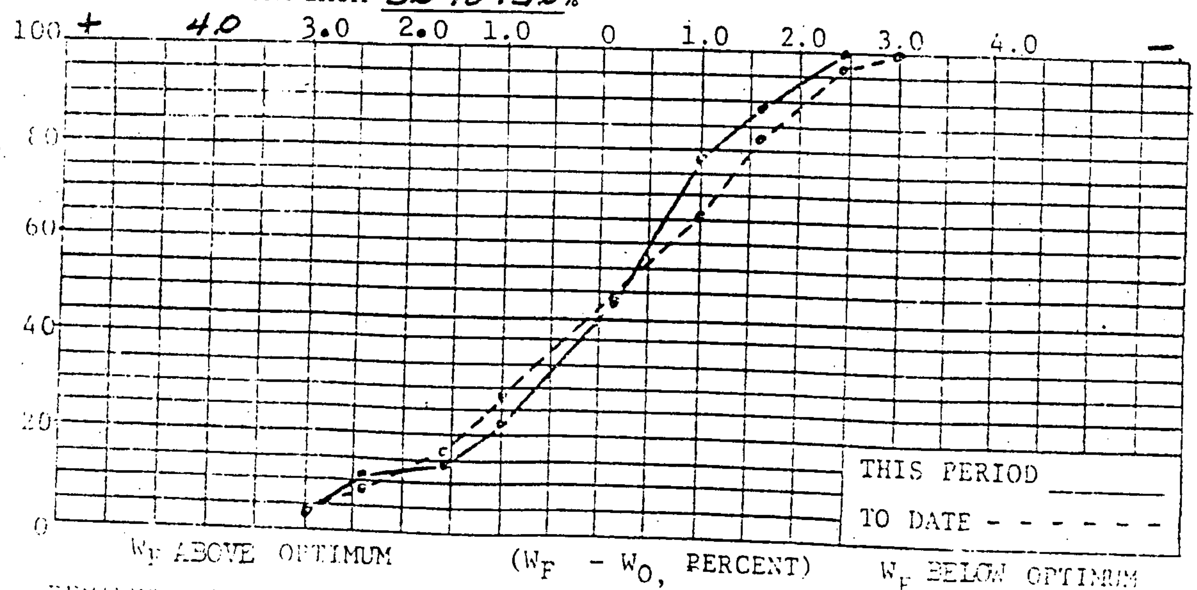
FEATURE: UNDERGROUND BARRIER - TRENCH A
DATE: 9-30-83 TO: 10-22-83 TEST NO.: 1351 TO: 1390
PART: I SECTION: 52A (A) PREPARED BY: W.S. WOODLEE

$(W_F - W_O)$, PERCENT		PLOT THIS COL	PREV CUM F	THIS PERIOD FREQUENCY (F)	THIS PERIOD F	THIS PERIOD CUM F	THIS PERIOD CUM %	TO DATE F	TO DATE CUM F	TO DATE CUM %
W_F ABOVE OPT	+4.6	5.2								
	3.9	4.5								
	3.1	3.8								
	2.5	3.0	2	I	1	1	3.7	3	3	4.5
	1.8	2.4	3	II	2	3	11.1	3	6	9.0
	1.1	1.7	7	I	1	4	14.8	5	11	16.4
PLOT 0	0.4	1.0	13	II	2	6	22.2	8	19	28.4
	+0.3	-0.3	20	HHT-II	7	13	48.1	14	33	49.3
	0.4	1.0	23	HHT-III	8	21	77.8	11	44	65.7
W_F BELOW OPT	1.1	1.7	32	III	3	24	88.9	12	56	83.6
	1.8	2.4	38	III	3	27	100.0	9	65	97.0
	2.5	3.0	40					2	67	100.0
	3.1	3.8								
	3.9	4.5								
	-4.6	5.2								
	TOTALS	NA	40	--	--	27	--	--	67	--

SPECIFICATION SOURCE: DWG.#10N213-2 R2

	PREV	THIS PERIOD	TO DATE
AVG FILL MOISTURE CONTENT, W_F, %	18.9	19.8	19.3
AVG OPTIMUM MOISTURE CONTENT, W_O, %	19.4	20.0	19.6
MEAN VARIATION $(W_F - W_O)$, %	-0.5	-0.2	-0.3

SPECIFIED MINIMUM -3.0 TO +3.0%



SW 11-5-83

REMARKS: THIS IS THE FINAL ANALYSIS FOR TYPE A FILL COMPACTION

INSPECTED/CHECKED/VERIFIED IN ACCORDANCE WITH R 4 OF [illegible] SW

W. Curtis Woodlee 11-5-83

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT
SUMMARY OF EARTHFILL TEST DATA - DENSITY

FEATURE: UNDERGROUND BARRIER — TRENCH A
DATE: 9-30-83 TO: 10-22-83 TEST NO.: 1351 TO: 1390
PART: I SECTION: 52A (A) PREPARED BY: W.S. WOODLEE

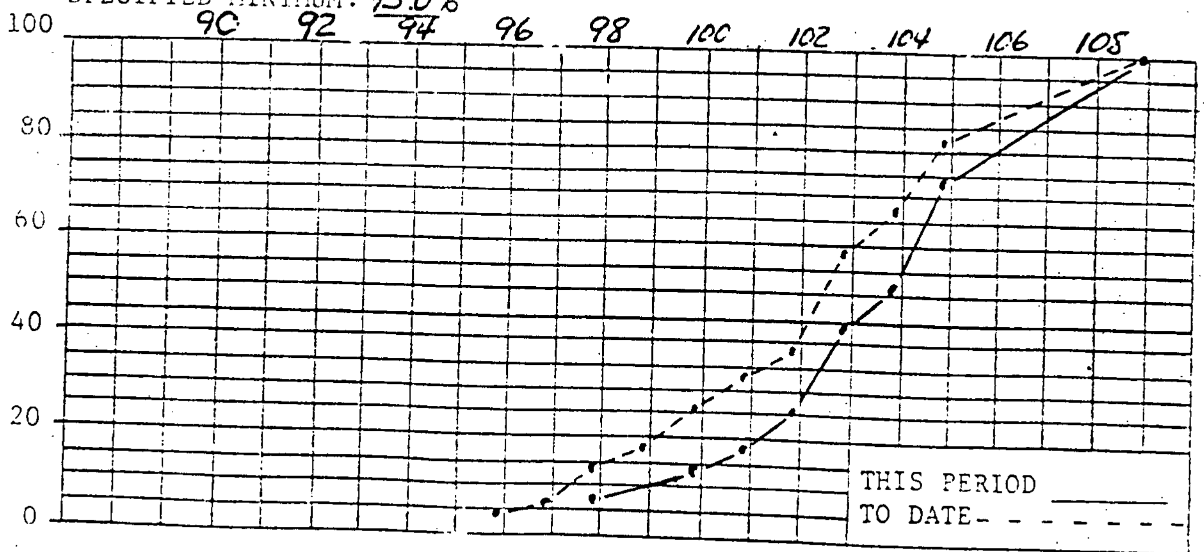
PERCENT COMPACTION ($\gamma_{df} - \gamma_{dL}$) x 100

	PLOT THIS COL	PREV CUM F	THIS PERIOD FREQUENCY (F)	THIS PERIOD F	THIS PERIOD CUM F	THIS PERIOD CUM %	TO DATE F	TO DATE CUM F	TO DATE CUM %
90.0	91.9								
92.0	92.9								
93.0	93.9								
94.0	94.9								
95.0	95.9	3					3	3	4.5
96.0	96.9	4					1	4	6.0
97.0	97.9	8	II	2	2	7.4	6	10	14.9
98.0	98.9	10					2	12	17.9
99.0	99.9	13	II	2	4	14.8	5	17	25.4
100.0	100.9	14	I	1	5	18.5	2	19	28.4
101.0	101.9	19	II	2	7	25.9	7	26	38.8
102.0	102.9	27	HHT	5	12	44.4	13	39	58.2
103.0	103.9	31	II	2	14	51.9	6	45	67.2
104.0	104.9	35	HHT-I	6	20	74.1	10	55	82.1
105.0	108.9	40	HHT-II	7	27	100.0	12	67	100.0
TOTALS		40	— —	— —	27	— —	— —	67	— —

SPECIFICATION SOURCE: DWG #10N213-2 R2

	PREV	THIS PERIOD	TO DATE
AVG FILL DRY DENSITY, γ_{df}, pcf	105.5	105.8	105.6
AVG MAXIMUM DRY DENSITY, γ_{dL}, pcf	104.0	102.6	103.4
MEAN VARIATION $\gamma_{df} - \gamma_{dL}$, pcf	+1.5	+3.2	+2.2

SPECIFIED MINIMUM: 95.0%



SW
11-5-83

PERCENT COMPACTION ($\gamma_{df} \div \gamma_{dL}$) x 100

REMARKS: THIS IS THE FINAL ANALYSIS FOR TYPE A FILL COMPACTIO[N]

INSPECTED/CHECKED/VERIFIED IN ACCORDANCE WITH REV 4 OF WBNP-QCP-2.01. SW

W. Scott Woodlee 11-5-83
INSPECTOR DATE

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT
SUMMARY OF EARTHFILL TEST DATA - MOISTURE CONTENT

FEATURE: UNDERGROUND BARRIER — TRENCH A
DATE: 9-30-83 TO: 10-9-83 TEST NO.: 1347 TO: 1364
PART: I SECTION: 52A (A1) PREPARED BY: W.S. WOODLEE

		PLOT THIS COL	PREV CUM F	THIS PERIOD FREQUENCY (F)	THIS PERIOD F	THIS PERIOD CUM F	THIS PERIOD CUM %	TO DATE F	TO DATE CUM F	TO DATE CUM %
W_F ABOVE OPT	+4.6	5.2								
	3.9	4.5								
	3.1	3.8								
	2.5	3.0								
	1.8	2.4	1							
	1.1	1.7	6					1	1	1.3
PLOT 0	0.4	1.0	13	||				5	6	7.5
	+0.3	-0.3	25	||	2	2	13.3	9	15	18.8
	0.4	1.0	38	~~||||~~	2	4	26.7	14	29	36.3
	1.1	1.7	52	||||	5	9	60.0	18	47	58.8
W_F BELOW OPT	1.8	2.4	61		4	13	80.7	18	65	81.3
	2.5	3.0	65	||				9	74	92.5
	3.1	3.8			2	15	100.0	6	80	100.0
	3.9	4.5								
	-4.6	5.2								
	TOTALS	NA	65	--	--	15	--	--	80	--

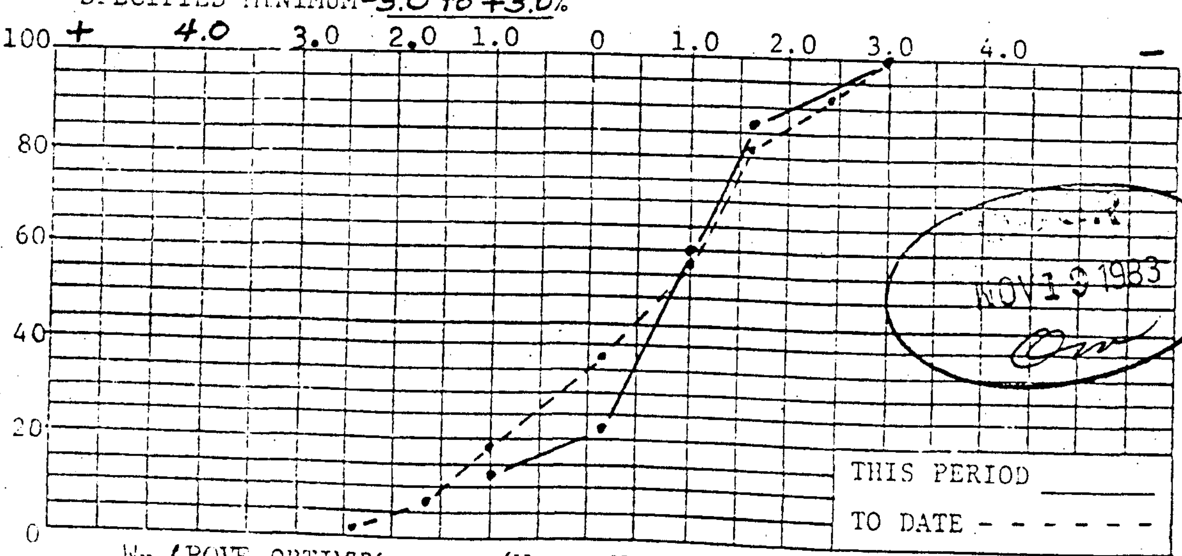
(W_F - W_O), PERCENT

SPECIFICATION SOURCE: DWG.#10N213-2 R2

	PREV	THIS PERIOD	TO DATE
AVG FILL MOISTURE CONTENT, W_F, %	19.7	19.9	19.7
AVG OPTIMUM MOISTURE CONTENT, W_O, %	20.4	20.8	20.5
MEAN VARIATION (W_F - W_O), %	-0.7	-0.9	-0.8

SPECIFIED MINIMUM -3.0 TO +3.0%

SW
11-5-83



W_F ABOVE OPTIMUM (W_F - W_O, PERCENT) W_F BELOW OPTIMUM

REMARKS: THIS IS THE FINAL ANALYSIS FOR TYPE A1 FILL COMPACTION.
INSPECTED/CHECKED/VERIFIED IN ACCORDANCE WITH R 4 OF WBNP-QCP-2.01.

W. Scott Woodlee 11-5-83

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT
SUMMARY OF EARTHFILL TEST DATA - DENSITY

FEATURE: *UNDERGROUND BARRIER – TRENCH A*

DATE: *9-30-83* TO: *10-9-83* TEST NO.: *1347* TO: *1354*

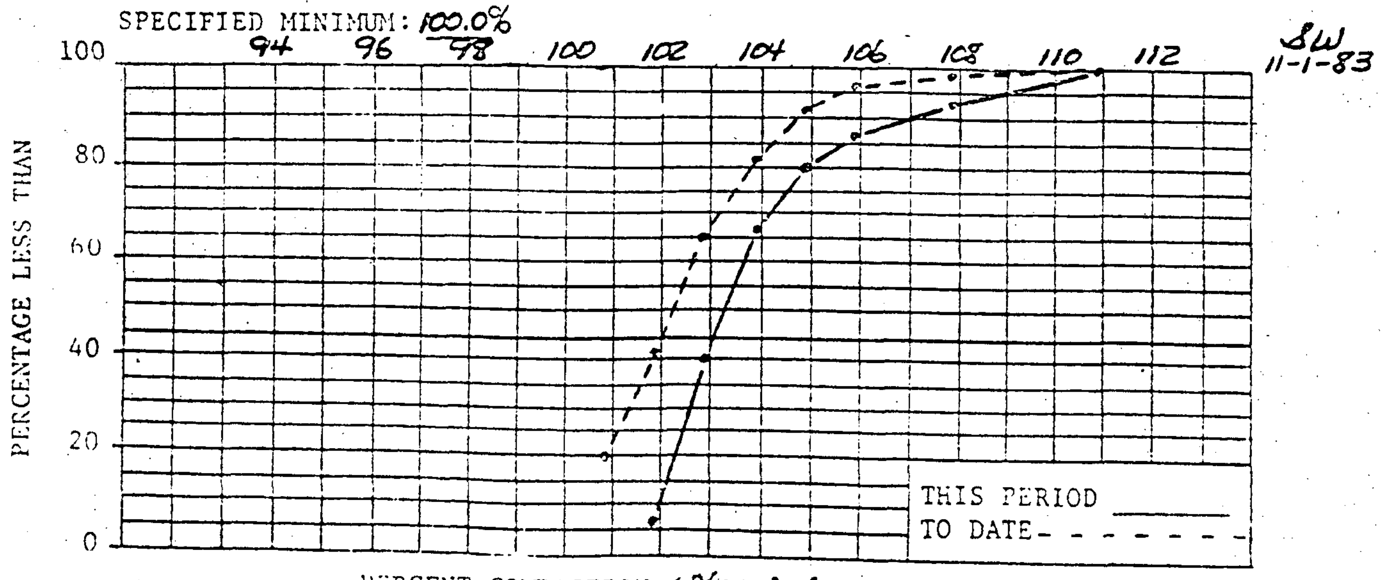
PART: *I* SECTION: *52A (A1)* PREPARED BY: *W.S. WOODLEE*

PERCENT COMPACTION ($\gamma_{df} - \gamma_{dL}$) x 100	PLOT THIS COL	PREV CUM F	THIS PERIOD FREQUENCY (F)	THIS PERIOD F	THIS PERIOD CUM F	THIS PERIOD CUM %	TO DATE F	TO DATE CUM F	TO DATE CUM %
95.0	95.9								
96.0	96.9								
97.0	97.9								
98.0	98.9								
99.0	99.9								
100.0	100.9	16					16	16	20.0
101.0	101.9	32	I	1	1	6.7	17	33	41.3
102.0	102.9	46	~~IIII~~	5	6	40.0	19	52	65.0
103.0	103.9	55	IIII	4	10	66.7	13	65	81.3
104.0	104.9	61	II	2	12	80.0	8	73	91.3
105.0	105.9	64	I	1	13	86.7	4	77	96.3
106.0	106.9								
107.0	107.9	65	I	1	14	93.3	2	79	98.8
108.0	108.9								
109.0	110.9		I	1	15	100.0	1	80	100.0
TOTALS		65	– –	– –	15	– –	– –	80	– –

SPECIFICATION SOURCE: *DWG. #10N213-2 R2*

	PREV	THIS PERIOD	TO DATE
AVG FILL DRY DENSITY, γ_{df}, pcf	104.4	105.2	104.6
AVG MAXIMUM DRY DENSITY, γ_{dL}, pcf	102.1	101.2	101.9
MEAN VARIATION $\gamma_{df} - \gamma_{dL}$, pcf	+ 2.3	+ 4.0	+ 2.7

SPECIFIED MINIMUM: *100.0%*



REMARKS: *THIS IS THE FINAL ANALYSIS FOR TYPE A1 FILL COMPACTION.*

INSPECTED/CHECKED/VERIFIED IN ACCORDANCE WITH REV *4* OF WBNP-QCP-2.01.

W. Scott Woodlee *11-5-83*

INSPECTOR Date