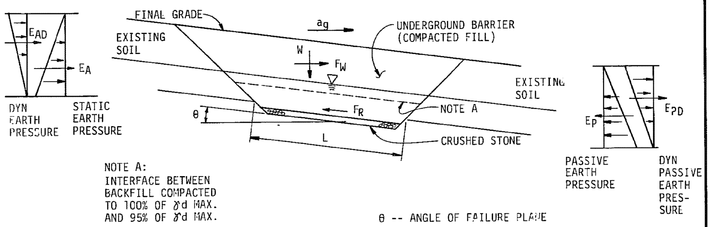
REVISED BY AMENDMENT 59

FIGURE 2.5-583

WATTS BAR NUCLEAR PLANT
REMEDIAL TREATMENT FOR POTENTIAL SOIL LIQUEFACTION
STABILITY ANALYSIS SUMMARY

LOAD DIAGRAM



NOTE A:
INTERFACE BETWEEN BACKFILL COMPACTED TO 100% OF γ_d MAX. AND 95% OF γ_d MAX.

θ -- ANGLE OF FAILURE PLANE

ANALYSIS CASES

CASE		DESCRIPTION	FACTOR OF SAFETY
I	-	DURING EARTHQUAKE BUT PRIOR TO LIQUEFACTION (REDUCED PASSIVE PRESSURE ASSUMED TO ACT)	$FS = \frac{F_R + (E_{PX} - E_{PDX})}{E_{AX} + E_{ADX} + F_{WX} + W_X} \geq 1.0$
II	-	AFTER EARTHQUAKE AND AFTER LIQUEFACTION (NO PASSIVE PRESSURE ASSUMED)	$FS = \frac{F_R}{E_{AX} + W_X} \geq 1.0$

F_R - SLIDING RESISTANCE DUE TO THE SHEAR STRENGTH OF THE COMPACTED FILL.
$F_R = \Sigma N_{EFF} \tan \phi + CL$

F_W - HORIZONTAL SEISMIC FORCE CAUSED BY THE ACCELERATION OF THE UNDERGROUND BARRIER.
$F_W = W a_g$, ($F_{WX} = F_W \cos \theta$)

E_A - EARTH PRESSURE * = $\frac{\gamma H^2 K_a}{2}$, ($E_{AX} = E_A \cos \theta$)

E_{AD} - DYNAMIC EARTH PRESSURE * = $E_A a_g$, ($E_{ADX} = E_{AD} \cos \theta$)

E_P - PASSIVE EARTH PRESSURE * = $\frac{\gamma H^2 K_p}{2}$, ($E_{PX} = E_P \cos \theta$)

E_{PD} - DYNAMIC PASSIVE EARTH PRESSURE * = $E_P a_g$, ($E_{PDX} = E_{PD} \cos \theta$)

W - WEIGHT OF BARRIER, $W_X = W \sin \theta$

X - COMPONENT OF FORCE/LOAD ALONG THE FAILURE PLANE

* - INCLUDES WATER PRESSURE

MATERIAL PROPERTIES

	UNIT WEIGHTS (PCF)			R TEST (NAT'L MOISTURE)		R TEST (SATURATED)	
	γ_M	γ_{SAT}	γ_{SUB}	ϕ	C(TSF)	ϕ	C(TSF)
IN SITU MATERIALS							
ALLUVIAL CLAYS AND SILTS	120	123	61	28°	0.4	14°	0.2
ALLUVIAL SANDS							
PRIOR TO EARTHQUAKE	119	124	62	28°	0.4	14°	0.2
DURING EARTHQUAKE	119	124	62	20°	0.2	10°	0.1
AFTER LIQUEFACTION	-	120	58	-	-	0°	0
BASEL GRAVEL	120	130	68	-	-	30°	0
COMPACTED FILL (BORROW MATERIALS)							
@ 95% γ_{DMAX}							
TRENCH A	117	126	64	-	-	15°	0.1
TRENCH B	117	126	64	-	-	15°	0.1
@ 100% γ_{DMAX}							
TRENCH A	123	130	68	-	-	16°	0.25
TRENCH B	123	130	68	-	-	14°	0.35
SPOIL MATERIAL[7]	110	115	53	-	-	24°	0

	Q TEST		R & S TEST	
CRUSHED STONE	ϕ	C(TSF)	ϕ	C(TSF)
1032 SECTION MATERIAL	39°	1.0	40°	0.5
1075 SECTION MATERIAL	40°	0	40°	0

UNDERGROUND BARRIER ANALYSIS SUMMARY

STATION	SAFETY FACTORS TRENCH A[1] DURING EARTHQUAKE[5] FAILURE PLANE		POST EARTHQUAKE[6] FAILURE PLANE	
	A^3	B^4	A^3	B^4
0+78	1.36	1.62	3.09	4.79
1+28	1.53	1.66	5.44	7.20
1+78	1.42	1.44	5.54	8.37
2+28	1.35	1.35	10.32	18.43
2+78	1.42	1.45	6.98	8.14
3+28	1.28	1.20	4.55	4.65
3+78	1.22	1.21	4.05	4.21
4+28	1.23	1.16	4.07	4.63
4+78	1.17	1.12	3.05	3.31
5+28	1.11	1.10	2.69	2.90
5+78	1.03	1.17	1.63	2.34
6+28	1.05	1.11	1.66	2.02
6+78[2]				
7+28	1.20	1.23	1.79	1.87
7+78	1.16	1.11	1.66	1.62
8+28	1.22	1.17	1.64	1.76
8+78	1.22	1.17	1.66	1.61
9+78	1.41	1.32	2.20	1.98

STATION	SAFETY FACTORS TRENCH B[1] DURING EARTHQUAKE[5] FAILURE PLANE		POST EARTHQUAKE[6] FAILURE PLANE	
	A^8	B^9	A^8	B^9
0+50	1.85	1.48[10]	7.00	18.32[11]
1+00	1.93	1.43[10]	6.00	18.13[11]
1+50	1.83	1.61[10]	4.57	29.71[11]
2+00	1.78	1.74[10]	5.24	24.03[11]
2+50	1.00	1.88[11]	2.28	10.02[12]
3+00	1.39	1.06[4]	2.57	4.14[12]
3+50	2.21	1.09[4]	8.73	4.37[4]
4+00	1.79	NA	16.57	NA
4+50	1.78	NA	17.50	NA
5+00	1.82	NA	18.49	NA
5+50	2.26	NA	34.39	NA
6+00	2.18	NA	32.65	NA

NOTES:

1. SEE FIGURE 2.5-586 FOR A PLAN SHOWING THE LOCATIONS OF THE CROSS-SECTIONS.
2. NOT INCLUDED. SOIL PROFILE NOT IDENTIFIED.
3. FAILURE PLANE IN COMPACTED FILL IMMEDIATELY ABOVE CRUSHED STONE.
4. FAILURE PLANE AT INTERFACE OF 95%/100% γ_{DMAX} COMPACTED FILL.
5. STABILITY DURING EARTHQUAKE INCLUDING PASSIVE PRESSURE CALCULATED USING REDUCED STRENGTHS.
6. STABILITY AFTER EARTHQUAKE ASSUMING NO PASSIVE PRESSURE.
7. MATERIAL FROM ORIGINAL POWERHOUSE EXCAVATION, INCLUDES BASEL GRAVEL AND SHALE BLASTED FROM EXCAVATION. SPREAD BY PANS AND ONLY COMPACTION IS BY SPREADING EQUIPMENT.
8. FAILURE PLANE AT BASE OF CROSS-SECTION.
9. THE USE OF CRUSHED STONE AS WELL AS EARTHFILL ALLOWED FOR SEVERAL POTENTIAL FAILURE PLANES. THE FACTORS-OF-SAFETY GIVEN REPRESENT THE MINIMUM FS FOR POTENTIAL FAILURE PLANES OTHER THAN THAT GIVEN IN NOTE. 8.
10. FAILURE PLANE AT INTERFACE BETWEEN 1032 CRUSHED STONE MATERIAL AND 95% γ_{DMAX} COMPACTED FILL.
11. FAILURE PLANE AT INTERFACE BETWEEN 1032 AND 1075 CRUSHED STONE MATERIALS.
12. FAILURE PLANE AT INTERFACE BETWEEN 1075 CRUSHED STONE MATERIAL AND 100% γ_{DMAX} COMPACTED FILL.
13. NA-NOT AVAILABLE-NO OTHER DEFINED POTENTIAL FAILURE PLANE.