ILLINOIS POWER COMPANY

U-0348
L30-81(12-31)-6
500 SOUTH 27TH STREET, DECATUR, ILLINOIS 62525

December 31, 1981

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Mr. James R. Miller, Chief
Standardization & Special Projects Branch
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Miller:

Clinton Power Station Unit 1
Docket No. 50-461

In the course of developing responses to NRC's request for information on seismic soil-structure interaction analysis, including soil properties variation, a review of the dynamic soil properties was undertaken. The goal of the review was to define the upper and lower bound curves of soil shear modulus values. At the same time it was decided to develop site specific response spectra for Clinton site. For this purpose an estimate of shear wave velocities for soils present below the foundation mat was required. A review of the shear wave velocities given in FSAR figures 2.5-369 thru 2.5-371 suggested that in light of the knowledge gained from recent geophysical tests conducted at various sites of comparable soil deposits, the shear wave velocities given in these figures were too high. The shear wave velocities given in the FSAR were computed from the measured compressional wave velocities and estimated Poisson's ratio. In view of the current knowledge the estimated values of Poisson's ratio are considered too low.

Based on the above, a thorough review of the shear wave velocities and the low-strain soil moduli, was started by Dames & Moore. In order not to delay the work on site-specific response spectra, an estimated value of 2500 ft/sec for the Illinoian till layer and 1000 ft/sec for the structural fill layer was given to Weston Geophysical, with the understanding that for the Illinoian till layer the velocity could range between 2000-2500 ft/sec and a variation in this range will not have any significant impact on the site specific response spectra.

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Dames & Moore has completed its review of the shear wave velocities and the low strain soil moduli values. Results of this review are documented in the attached revised FSAR figures 2.5-369 thru 2.5-371, and tables 2.5-46 and 2.5-48.

We have evaluated the effect of the above changes on the plant design and determined that there is no impact on the design. We believe that these changes have only a conservative effect on the site specific response spectra, if any. Weston Geophysical has been informed of the latest revision in the shear wave velocity of the Illinoian till layer (from 2500 ft/sec to 2100 ft/sec) and they are proceeding to incorporate the effect of this, if any, in their work of site specific response spectra development.

The revised FSAR tables and figures included here will be docketed in the next amendment of the FSAR.

Sincerely,

J. D. Geier
HBP

J. D. Geier
Manager
Nuclear Station Engineering

HBP/lt

Attachments

cc: J. H. Williams, NRC Clinton Project Manager
H. H. Livermore, NRC Resident Inspector
R. Jackson, NRC Chief Geosciences Branch
G. Giese-Koch, NRC Geosciences Branch
B. Jagannath, NRC HGEB

AVERAGE THICKNESS IN FEET (NOT TO SCALE)	GRAPHIC COLUMN		UNIT DESCRIPTION	COMPRESSIONAL WAVE VELOCITY FT/SEC	POISSONS RATIO	SHEAR WAVE VELOCITY FT/SEC	UNIT WEIGHT (pcf)	
							DRY	WET
7		OVERBURDEN	LOESS, weathered; overlain by organic topsoil					
9		OVERBURDEN	WISCONSINAN GLACIAL TILL, weathered to brown, moist	2000	0.37	900	110	130
19		OVERBURDEN	WISCONSINAN GLACIAL TILL, unweathered	5700	0.48	1100	115	135
12		OVERBURDEN	INTERGLACIAL ZONE; local ALLUVIAL DEPOSITS					
113		OVERBURDEN	ILLINOIAN GLACIAL TILL; local OUTWASH AND LACUSTRINE DEPOSITS					
10		OVERBURDEN	LACUSTRINE DEPOSIT (Yarmouthian)	500	0.46	2100	135	147
65		OVERBURDEN	PRE-ILLINOIAN GLACIAL TILL locally underlain by PRE-ILLINOIAN LACUSTRINE DEPOSIT					
5		BEDROCK	LIMESTONE					
15		BEDROCK	SHALE	10,500	0.29	5700	155	160
		BEDROCK	SILTSTONE					

NOTE:
REFER TO LEGEND ON FIGURES [illegible]275 AND 2.5-276 FOR DETAILED DESCRIPTION OF OVERBURDEN UNITS.

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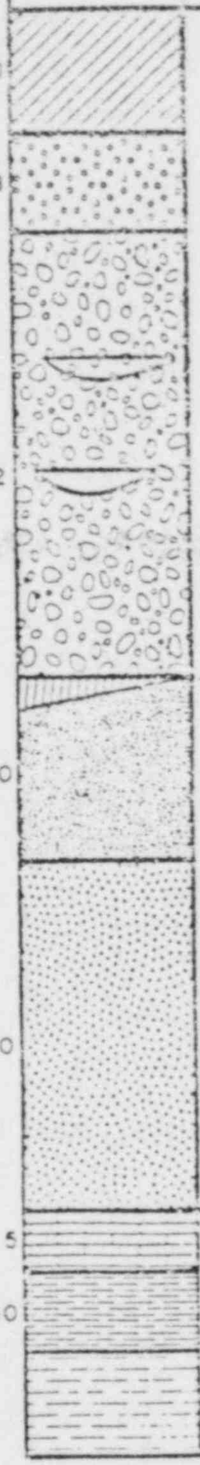
FINAL SAFETY ANALYSIS REPORT

FIGURE 2.5-369

TYPICAL GEOLOGIC PROFILE SHOWING GEOPHYSICAL PROPERTIES - STATION SITE



Average Thickness in Feet (Not to Scale)	Unit Description		Compressional Wave Velocity FT/SEC	Poissons Ratio	Shear Wave Velocity FT/SEC	Unit Weight (pcf) Dry	Unit Weight (pcf) Wet
10	OVERBURDEN	SALT CREEK ALLUVIUM; overlain by organic topsoil	2000	0.37	900	100	122
8							
112	OVERBURDEN	ILLINOIAN GLACIAL TILL; local OUTWASH AND LACUSTRINE DEPOSITS					
20	OVERBURDEN	PRE-ILLINOIAN LACUSTRINE AND GLACIAL TILL DEPOSITS present locally	7300	0.46	2000	135	145
140	OVERBURDEN	BEDROCK VALLEY OUTWASH DEPOSIT (Pre-Illinoian Mahomet Valley Deposit)	5800	0.45	1750	109	127
5	BEDROCK	LIMESTONE	10,500	0.29	5700	155	160
10	BEDROCK	SHALE					
	BEDROCK	SILTSTONE					

NOTE:

REFER TO BORING D-11 AND LEGEND ON FIGURE 2.5-277 FOR [illegible] DESCRIPTION OF OVERBURDEN UNITS.

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FIGURE 2.5-370

TYPICAL GEOLOGIC PROFILE SHOWING GEOPHYSICAL PROPERTIES - DAM SITE

Average Thickness in Feet (Not to Scale)	Graphic Column		Unit Description	Compressional Wave Velocity FT/SEC	Poissons Ratio	Shear Wave Velocity FT/SEC	Unit Weight (pcf) Dry	Unit Weight (pcf) Wet
7 7			SALT CREEK ALLUVIUM; overlain by organic topsoil	2000	0.37	900	105	125
81		OVERBURDEN	ILLINOIAN GLACIAL TILL local OUTWASH AND LACUSTRINE DEPOSITS	7500	0.46	2100	132	145
10		OVERBURDEN	LACUSTRINE DEPOSIT (Yarmouthian)					
65		OVERBURDEN	PRE-ILLINOIAN GLACIAL TILL; local OUTWASH DEPOSITS					
25		OVERBURDEN	PRE-ILLINOIAN OUTWASH AND ALLUVIAL DEPOSIT					
110		OVERBURDEN	BEDROCK VALLEY OUTWASH DEPOSIT (Pre-Illinoian Mahomet Valley Deposit)	6000	0.45	1800	106	124
20		BEDROCK	SILTSTONE	10,000	0.28 TO 0.30	5300 TO 5500	155	160
30		BEDROCK	SHALE COAL					

NOTE:

[illegible]

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FIGURE 2.5-371

TYPICAL GEOLOGIC PROFILE SHOWING GEOPHYSICAL PROPERTIES - SECTION E-E' ALONG NORTH FORK OF SALT CREEK

TABLE 2.5-46

FIELD SHEAR WAVE VELOCITY TABULATION

ESTIMATED VELOCITY (ft/sec)	SOURCE	MATERIAL TYPE	DEPTH (feet)
900*	Geophysical P-14	Low-velocity surface layer	0-16
1100	Geophysical P-14	Wisconsinan till	16-47
2100	Geophysical P-14	Illinoian glacial till	47-237
5700	Geophysical P-14	Top of bedrock	237+
900*	Geophysical D-11	Salt Creek alluvium	0-18
2000-2100	Geophysical D-11	Illinoian glacial till	18-150
1800	Geophysical D-11	Bedrock valley outwash deposit	150-290
5700	Geophysical D-11	Top of bedrock	290+
900*	Geophysical D-31	Salt Creek alluvium	0-14
2100	Geophysical D-31	Illinoian glacial till	14-195
1800	Geophysical D-31	Bedrock valley	195-305
5300-5500	Geophysical D-31	Top of bedrock	305+

*Measured.

TABLE 2.5-48

PARAMETERS FOR ANALYSIS OF ROCK-SOIL-STRUCTURE INTERACTION

	COHESIONLESS SOIL	COHESIVE SOILS				
	COMPACTED STRUCTURAL FILL	RECOMPACTED WISCONSINAN GLACIAL TILL OF WEDRON FORMATION TYPE A MATERIAL (AS COMPACTED)	RECOMPACTED WISCONSINAN GLACIAL TILL OF WEDRON FORMATION TYPE A MATERIAL (SATURATED)	LOESS	WISCONSINAN GLACIAL TILL OF WEDRON FORMATION	INTERGLACIAL DEPOSITS
DENSITY (pcf): Dry density	123	127	128	101	118	115
Wet density	132	141	144	120	137	131
POISSON'S RATIO: Dynamic	0.40	0.40	0.40	0.37	0.48	0.48
Static	0.30	0.40	0.40	0.40	0.40	0.40
STATIC MODULUS OF ELASTICITY (Es)						
In-situ modulus (psf)	--	8.0×10^5	2.0×10^5	2.0×10^5	13.1×10^5	15.1×10^5
Increase with surcharge $dEs/d\sigma_m'$ (psf/psf)	350	0	0	0	0	0
DYNAMIC MODULUS OF ELASTICITY (psf)						
Single amplitude						
Shear strain = 1.0%	$22{,}000(\sigma_m')^{1/2}$	11×10^5	3×10^5	3×10^5	12×10^5	9×10^5
= 0.1%	$90{,}000(\sigma_m')^{1/2}$	39×10^5	8×10^5	8×10^5	36×10^5	33×10^5
= 0.01%	$207{,}000(\sigma_m')^{1/2}$	98×10^5	34×10^5	33×10^5	80×10^5	80×10^5
= 0.001%	$271{,}000(\sigma_m')^{1/2}$	148×10^5	76×10^5	74×10^5	130×10^5	130×10^5
= 0.0001%	$280{,}000(\sigma_m')^{1/2}$	162×10^5	95×10^5	93×10^5	160×10^5	160×10^5
STATIC MODULUS OF RIGIDITY (Gs)						
In-situ modulus (psf)	--	3.0×10^5	0.7×10^5	0.7×10^5	4.7×10^5	5.4×10^5
Increase with surcharge $dGs/d\sigma_m'$ (psf/psf)	135	0	0	0	0	0
DYNAMIC MODULUS OF RIGIDITY (psf)						
Single amplitude						
Shear strain = 1.0%	$8{,}000(\sigma_m')^{1/2}$	4×10^5	1×10^5	1×10^5	4×10^5	3×10^5
= 0.1%	$32{,}000(\sigma_m')^{1/2}$	14×10^5	3×10^5	3×10^5	12×10^5	11×10^5
= 0.01%	$74{,}000(\sigma_m')^{1/2}$	35×10^5	12×10^5	12×10^5	27×10^5	27×10^5
= 0.001%	$97{,}000(\sigma_m')^{1/2}$	53×10^5	27×10^5	27×10^5	44×10^5	44×10^5
= 0.0001%	$100{,}000(\sigma_m')^{1/2}$	58×10^5	34×10^5	34×10^5	54×10^5	54×10^5
DAMPING						
Percent of critical damping						
Single amplitude						
Shear strain = 1.0%	16	20	20	20	20	20
= 0.1%	14	9	15	15	9	9
= 0.01%	6	5	10	10	5	5
= 0.001%	2	3	6	6	3	3
= 0.0001%	1	2.5	4	4	2.5	2.5

TABLE 2.5-48 (continued)

	COHESIONLESS SOIL		COHESIVE SOILS			COHESIONLESS SOIL	
	SALT CREEK ALLUVIUM	INTERGLACIAL SAND DEPOSITS	ILLINOIAN GLACIAL TILL	LACUSTRINE DEPOSITS	PRE-ILLINOIAN DEPOSITS	PRE-ILLINOIAN DEPOSITS	ROCK*
DENSITY (pcf): Dry density	100	108	138	123	130	107	156
Wet density	125	120	150	134	145	126	159
POISSON'S RATIO: Dynamic	0.37	0.40	0.46	0.47	0.47	0.40	0.29
Static	0.40	0.40	0.35	0.35	0.35	0.40	0.29
STATIC MODULUS OF ELASTICITY (Es)							
In-situ modulus (psf)	--	--	43.6×10^5	24.9×10^5	42.4×10^5	110×10^5	0.7 to 3.8×10^8
Increase with surcharge $dEs/d\sigma'_m$ (psf/psf)	150	260	0	0	0	1100	0
DYNAMIC MODULUS OF ELASTICITY (psf)							
Single amplitude							
Shear strain = 1.0%	$2,700(\sigma'_m)^{1/2}$	$4,200(\sigma'_m)^{1/2}$	23×10^5	24×10^5	24×10^5	$28,000(\sigma'_m)^{1/2}$	3.6 to 7.8×10^8
= 0.1%	$11,000(\sigma'_m)^{1/2}$	$17,000(\sigma'_m)^{1/2}$	88×10^5	76×10^5	76×10^5	$95,000(\sigma'_m)^{1/2}$	0
= 0.01%	$44,000(\sigma'_m)^{1/2}$	$62,000(\sigma'_m)^{1/2}$	292×10^5	226×10^5	226×10^5	$174,000(\sigma'_m)^{1/2}$	
= 0.001%	$52,000(\sigma'_m)^{1/2}$	$81,000(\sigma'_m)^{1/2}$	496×10^5	338×10^5	338×10^5	$218,000(\sigma'_m)^{1/2}$	
= 0.0001%	$55,000(\sigma'_m)^{1/2}$	$84,000(\sigma'_m)^{1/2}$	584×10^5	412×10^5	412×10^5	$238,000(\sigma'_m)^{1/2}$	
STATIC MODULUS OF RIGIDITY (Gs)							
In-situ modulus (psf)	--	--	16.1×10^5	9.2×10^5	15.7×10^5	40×10^5	0.3 to 1.5×10^8
Increase with surcharge $dGs/d\sigma'_m$ (psf/psf)	54	93	0	0	0	392	0
DYNAMIC MODULUS OF RIGIDITY (psf)							
Single amplitude							
Shear strain = 1.0%	$1,000(\sigma'_m)^{1/2}$	$1,500(\sigma'_m)^{1/2}$	8×10^5	8×10^5	8×10^5	$10,000(\sigma'_m)^{1/2}$	1.4 to 3.0×10^8
= 0.1%	$4,000(\sigma'_m)^{1/2}$	$6,000(\sigma'_m)^{1/2}$	30×10^5	26×10^5	26×10^5	$34,000(\sigma'_m)^{1/2}$	0
= 0.01%	$16,000(\sigma'_m)^{1/2}$	$22,000(\sigma'_m)^{1/2}$	100×10^5	77×10^5	77×10^5	$62,000(\sigma'_m)^{1/2}$	
= 0.001%	$19,000(\sigma'_m)^{1/2}$	$29,000(\sigma'_m)^{1/2}$	170×10^5	115×10^5	115×10^5	$78,000(\sigma'_m)^{1/2}$	
= 0.0001%	$20,000(\sigma'_m)^{1/2}$	$30,000(\sigma'_m)^{1/2}$	200×10^5	140×10^5	140×10^5	$85,000(\sigma'_m)^{1/2}$	
DAMPING							
Percent of critical damping							
Single amplitude							
Shear strain = 1.0%	21	28	22	20	20	20	1 to 2
= 0.1%	10	13	16	9	12	10	
= 0.01%	3	4	7.5	4.5	7.5	3	
= 0.001%	1	1.5	4	3	4	2	
= 0.0001%	0.5	0.5	3	2.5	3	1	

*These values are valid for strain levels on the order of 10^{-4} to 10^{-5} percent.

Notes:
1. σ'_m = mean effective stress (psf).
2. The static modulus of elasticity values for cohesive soils were calculated based on the constrained modulus derived from the reloading portion of the consolidation curve.
3. Pre-Illinoian cohesive deposits include glacial and lacustrine deposits.
4. Pre-Illinoian cohesionless deposits include Mahomet Valley deposits.
5. The selected parameters reflect both the results of geophysical and laboratory tests performed during this investigation and results published and previously developed for similar soils.