

June 27, 2007

Memorandum to File DCN VGCOL 107

From: Steve Kiser *SK*

Reviewed By: Pieter Depree *PD*

Subject: **Report of SPT Energy – MACTEC Atlanta CME 550 ATV
Hammer Serial No. 337153 Automatic Hammer
WORK INSTRUCTION VGCOL 107
Vogle Units 3 & 4 COL Project
Burke County, Georgia
MACTEC Project No. 6141-06-0286**

Steve Kiser, of MACTEC Engineering and Consulting, Inc. (MACTEC), performed energy measurements on the drill rig at the subject site per the referenced Work Instructions. This memorandum summarizes the field testing activities and presents the results of the energy measurements.

SPT Energy Field Measurements

SPT energy measurements were made on February 7, 2007, during drilling of Boring B-1193 at the referenced site. The testing was performed from approximately 10:20 to 11:10 AM under sunny skies and a temperature of about 55 degrees Fahrenheit. The boring was drilled with personnel and equipment from the Atlanta office of MACTEC. The drilling equipment consisted of a CME 550 model ATV-mounted drill rig with an SPT automatic hammer. The drilling tools consisted of AW-J-sized drilling rods and a 2-foot long split tube sampler. Mud rotary drilling techniques were used to advance the boring below the depth at which groundwater was encountered at the time of energy testing. The drill rig operator during sampling was Mr. Robert Banks. Energy measurements were recorded during sampling at the depth intervals shown in Table 1.

The energy measurements were performed with a Pile Driving Analyzer (PDA) model PAK (Serial No. 1430), and calibrated accelerometers (Serial Nos. P5953 and P5094) and strain gages (Serial Nos. AW #144/1 and AW#144/2). An AW-sized steel drill rod, 2 feet long and instrumented with dedicated strain gages, was inserted at the top of the drill rod string immediately below the SPT hammer. The inserted rod was also instrumented with two piezoresistive accelerometers that were bolted to the outside of the rod. The instrumented rod insert had a cross-sectional area of approximately 1.19 square inches and an outside diameter of approximately 1.75 inches at the gage location. The drill rods included in the drill rod string were hollow rods in 5 to 10 foot long sections, with an outside and inside diameter of approximately 1.75 and 1.375 inches, respectively. The recommended operation rate of the hammer is not known. Due to the closed hammer system, the hammer lubrication condition and anvil dimensions could not be observed.

Calibration Records

The calibration records for all the above are filed in DCN VGCOL-14.

Calculations for EFV

The work was done in general accordance with ASTM D 4633-05. The strain and acceleration signals were converted to force and velocity by the PDA, and the data was interpreted by the PDA according to the Case Method equation. The maximum energy transmitted to the drill rod string (as measured at the location of the strain gages and accelerometers) was calculated by the PDA using the EFV method equation, as shown below:

$$EFV = \int F(t) * V(t) * dt$$

Where: EFV = Transferred energy (EFV equation), or Energy of FV

F(t) = Calculated force at time t

V(t) = Calculated velocity at time t

The EFV method of energy calculation is recommended in ASTM Standard D4633-05. The EFV equation, integrated over the complete wave event, measures the total energy content of the event using both force and velocity measurements. The EFV values associated with each blow analyzed are tabulated in the attached PDILOT tables and are also shown graphically in the PDILOT charts.

Calculations for ETR

The ratio of the measured transferred energy (EFV) to the theoretical potential energy of the SPT system (140 lb weight with the specified 30 inch fall) is the ETR. The ETR values (as percent of the theoretical value) are shown in Table 1.

Comparison of ETR to Typical Energy Transfer Ratio Range

Based on a research report published by the Florida Department of Transportation (FDOT) (Report WPI No. 0510859, 1999), the average ETR measured for automatic hammers is 79.6%. The standard deviation was 7.9%; therefore, the range of ETRs within one standard deviation of the average was reported to be 71.7% to 87.5%. This range of ETRs was also consistent with other research that was cited in the FDOT research paper; however, maximum and minimum ETR values of up to 98% and 56%, respectively, were reported in the literature. The ETR values shown in Table 1 are generally within the range of typical values for automatic hammers as reported in the literature.

Discussion

Based on the field testing results, observations from the SPT energy measurements are summarized below:

- The data obtained by the PDA are consistent between individual hammer blows and between the sample depths tested. In general, the first and last one (and sometimes two) hammer blow records recorded by the PDA produced poor quality data (which is relatively common) and, as such, the record(s) was(were) not used in the data reduction.

- The average energy transferred from the hammer to the drill rods for each individual depth interval using the EFV method ranged from 266 foot-pounds to 307 foot-pounds. These average energy transfers correspond to energy transfer ratios (ETR) of 76% to 88% of the theoretical energy (350 foot-pounds) of the SPT hammer.
- The average at each depth interval was calculated as the transferred energy for each analyzed blow of the depth intervals divided by the total number of hammer blows analyzed. The overall weighted average energy transfer of the SPT system (for all the depth intervals tested) was 286.9 foot-pounds, with a weighted average ETR of 82.0%.

Attachments: Page 4 Table 1 - Summary of SPT Energy Measurements – 1 Page
Page 5 Work Instruction – DCN VGCOL 107 – 1 Page
Page 6 Record of SPT Energy Measurement – 1 Page
Pages 7 - 15 PDILOT Output – 9 Pages

TABLE 1
SUMMARY OF SPT ENERGY MEASUREMENTS (ASTM D4633-05)

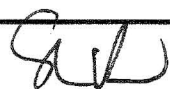

Vogtle Units 3 and 4 COL Project
 Burke County, Georgia
 MACTEC Project No. 6141-06-0286

Rig Serial No.	Rig Owner	Rig Operator	Boring No. Tested	Rod Size	Date Tested	Sample Depth (feet)	SPT Blow Count (blows per six inches)	No. of Blows Analyzed	Average Measured Energy (Average EFV) (ft-lbs) ^a	Energy Transfer Ratio (%) ^b (Average ETR)
337153 (CME 550 ATV)	MACTEC Atlanta	Robert Banks	B-1193	AW-J	2/7/2007	63.5 - 65.0	5 - 20 - 15	36	307	87.7%
						68.5 - 70.0	14 - 32 - 15	61	266	76.0%
						73.5 - 75.0	7 - 10 - 13	31	297	84.9%
						78.5 - 80.0	8 - 9 - 11	29	295	84.3%
							Weighted Average for Rig:	286.9	82.0%	

^aMeasured Energy is energy based on the EFV method, as outlined in ASTM D4633-05, for each blow recorded by the PDA. In some cases, the initial and final one to two blows produced poor quality data, and were not used to calculate the Average Measured Energy.

EFV = EMX * 1000 lbs/kip, where EMX equals the maximum transferred energy measured by the PDA (see attached PDA data).

^bEnergy Transfer Ratio is the Measured Energy divided by the theoretical SPT energy of 350 foot-pounds (140 pound hammer falling 2.5 feet). The average ETR values may differ slightly and insignificantly from those in the PDILOT tables due to roundoff.

Prepared By: 	Date: 6-27-07	Checked By: 	Date: 7/3/07
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Work Instructions – SPT Energy MACTEC CME-550 (Banks)

(Hammer #337153)

Vogle COL Project
Project No. 6141-06-0286

Issued To: Steve Kiser

Location: Vogle COL Project Field Office Date: 12/20/06

Issued By: Matthew F. Cooke, Site Coordinator

Valid From: 12/20/06 To: 12/20/07

Task Description: Measurement of energy transferred to the drill string rods from a Standard Penetration Test (SPT) automatic hammer mounted on a drill rig. Testing will be performed using a Pile Driving Analyzer (PDA) model PAK at various depth intervals below a depth of approximately 10 feet below the ground surface for the above referenced rig drilling SPT borings at the Vogle COL Site.

Applicable Technical Procedures or Plans, or other reference: ASTM D4633-05 Standard Test Method for Energy Measurement for Dynamic Penetrometers.

Specific Instructions (note attachments where necessary): Obtain energy measurements with the PDA at various depth intervals below a depth of about 10 feet below the ground surface in general accordance with ASTM D4633-05. Perform energy measurement testing for the above referenced drill rig.

Report Format: Written report documenting results of field testing in general accordance with ASTM D4633-05, to include completed Summary of Daily Observations and Testing, Record of SPT Energy Measurement sheet(s), and PDILOT output data.

Specific Quality Assurance Procedures Applicable: None

Hold Points or Witness Points: Direction to perform energy measurements received from the Site Coordinator.

Records: All records generated shall be considered QA Records.

Reviewed and Approved By (Note: Only One Signature is Required to Issue):

Project Manager: Date:

Project Principal: Date:

Site Coordinator:  Date: 12/20/06

No. of Pages: 1 DCN: VGCOL 107

2801 YORKMONT ROAD, SUITE 100 D CHARLOTTE, NC 28208
Telephone: (704) 357-8600 / Facsimile: (704) 357-8638

RECORD OF SPT ENERGY MEASUREMENT

GENERAL INFORMATION		DRILL RIG DATA	
PROJECT:	ALWR Vogtle COL Site	MAKE:	CME
LOCATION:	Waynesboro, Georgia	MODEL:	550 ATV
PROJECT NO.:	6141-06-0286	SERIAL NO.:	337153
DATE:	2-7-07	HAMMER TYPE:	AUTOMATIC
WEATHER:	SUNNY - NICE 55°	ROPE CONDITION:	N/A
INSPECTOR:	Steve Kiser	ROD SIZE:	AW-J
DRILLING COMPANY:	MACTEC ATLANTA	NO. OF SHEAVES:	N/A

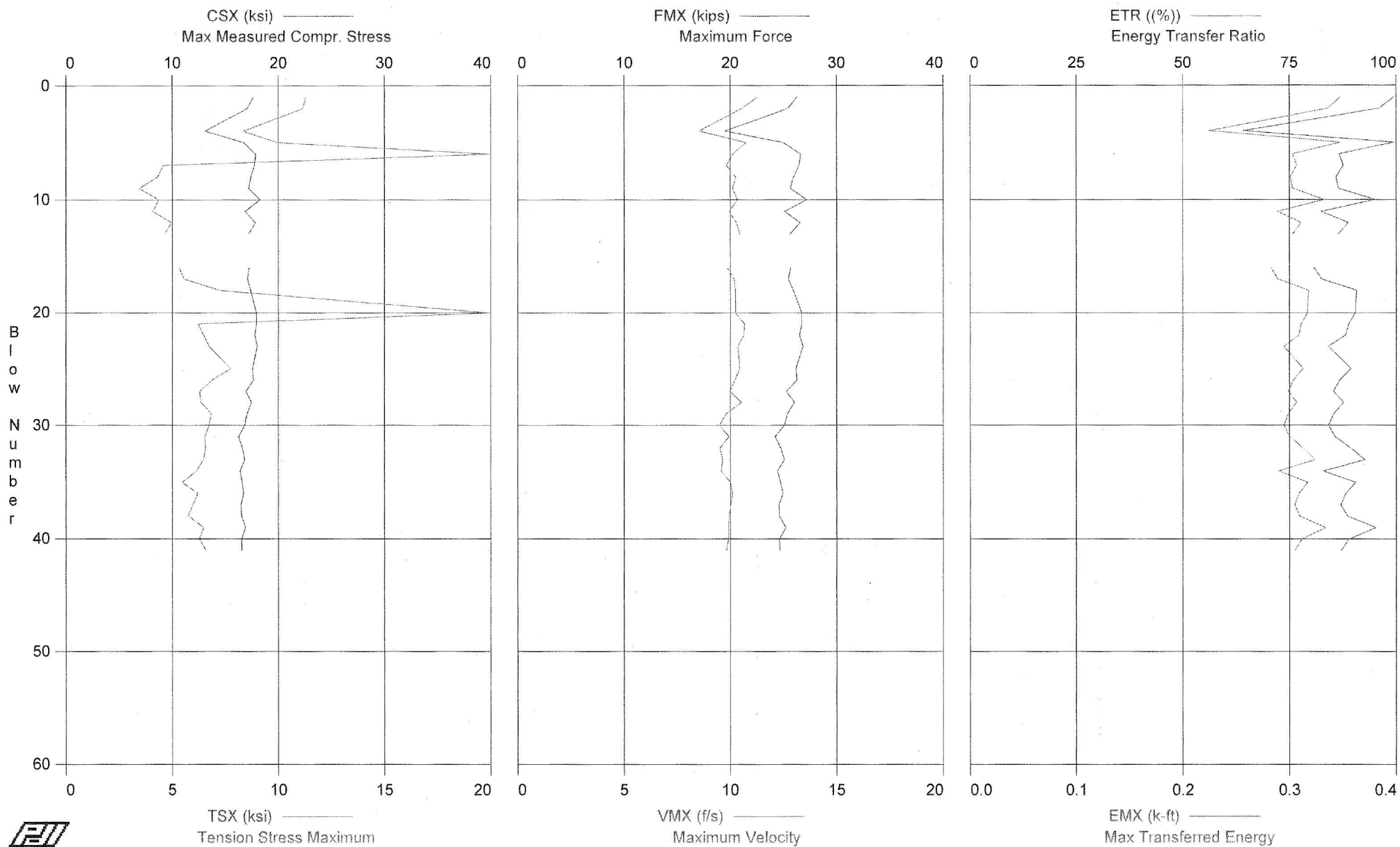
BORING DATA

BORING NUMBER:	B-1193		
DEPTH DRILLED:	150' PLANNED		
TIME DRIVEN:	11:20 AM		
RIG OPERATOR:	ROBERT BANKS		
HAMMER OPERATOR:	N.R.		
PDA PAK SERIAL NO.:	1430	1430	1430
INSTR. ROD AREA:	1.19 in ²		
ACCEL. SERIAL NOS.:	P5753 / P5094		
STRAIN SERIAL NOS.:	144 AW 1/2		

[illegible]

REMARKS:

Plant Vogtle COL Project - Boring B-1193; 63.5' - 65' Sample



Plant Vogtle COL Project - Boring B-1193; 63.5' - 65' Sample

Rig Serial No. 337153 (MACTEC Atlanta CME 550 ATV)

OP: SEK

Test date: 7-Feb-2007

AR: 1.49 in²

SP: 0.492 k/ft³

LE: 69.00 ft

EM: 30,000.0 ksi

WS: 16,807.9 f/s

JC: 0.60

CSX: Max Measured Compr. Stress

BPM: Blows per Minute

TSX: Tension Stress Maximum

EF2: Energy of F²

FMX: Maximum Force

ETR: Energy Transfer Ratio

VMX: Maximum Velocity

EMX: Max Transferred Energy

DFN: Final Displacement

BL#	depth ft	CSX ksi	TSX ksi	FMX kips	VMX f/s	DFN in	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
1	0.00	17.64	11.29	26	11.3	3.06	0.0	0.286	99.5	0.348
2	0.00	17.06	11.16	25	10.5	7.53	57.0	0.279	96.0	0.336
4	0.00	13.10	8.35	20	8.5	1.81	55.5	0.168	64.2	0.225
5	0.00	16.77	9.96	25	10.7	0.43	53.0	0.282	99.5	0.348
6	0.00	17.87	27.03	27	10.1	-6.71	56.0	0.267	86.7	0.303
7	0.00	17.76	4.58	26	9.8	1.25	54.4	0.257	87.6	0.307
8	0.00	17.41	4.31	26	10.3	0.54	55.4	0.254	86.0	0.301
9	0.00	17.21	3.45	26	10.1	0.86	54.7	0.238	86.5	0.303
10	0.00	18.26	4.37	27	10.4	1.13	54.9	0.265	95.2	0.333
11	0.00	16.86	4.09	25	9.9	1.59	55.5	0.225	82.4	0.289
12	0.00	17.83	4.97	27	10.3	0.98	54.8	0.256	88.8	0.311
13	0.00	17.18	4.63	26	10.5	0.88	55.0	0.247	86.5	0.303
16	0.00	17.24	5.32	26	9.9	0.20	54.7	0.237	80.8	0.283
17	0.00	17.08	5.56	25	10.2	0.20	54.9	0.241	82.5	0.289
18	0.00	17.40	7.25	26	10.2	1.64	55.5	0.255	90.8	0.318
20	0.00	17.94	27.62	27	10.3	-20.07	55.7	0.265	90.5	0.317
21	0.00	17.93	6.22	27	10.7	0.40	54.5	0.261	88.9	0.311
22	0.00	17.79	6.48	26	10.6	0.14	54.9	0.267	88.2	0.309
23	0.00	18.01	6.74	27	10.4	-0.42	54.9	0.269	84.2	0.295
25	0.00	17.56	7.74	26	10.4	1.28	54.4	0.253	89.4	0.313
26	0.00	17.64	6.86	26	10.2	0.61	54.6	0.255	86.8	0.304
27	0.00	16.95	6.30	25	10.0	0.89	53.9	0.235	85.3	0.299
28	0.00	17.48	6.35	26	10.5	0.97	55.0	0.248	87.8	0.307
29	0.00	17.03	6.86	25	9.8	1.45	55.9	0.240	85.4	0.299
30	0.00	16.84	6.73	25	9.5	1.15	54.4	0.241	84.2	0.295
31	0.00	16.24	6.54	24	9.9	0.26	53.5	0.255	85.7	0.300
32	0.00	16.60	6.57	25	9.5	0.90	54.9	0.249	89.4	0.313
33	0.00	16.83	6.48	25	9.6	1.19	55.4	0.250	92.7	0.324
34	0.00	16.41	6.15	24	9.6	0.73	54.2	0.239	82.9	0.290
35	0.00	16.59	5.48	25	10.0	0.93	55.3	0.246	90.5	0.317
36	0.00	16.73	6.20	25	10.1	0.82	54.5	0.251	88.2	0.309
37	0.00	16.48	5.97	25	10.0	1.16	54.7	0.241	87.0	0.305
38	0.00	16.53	5.75	25	9.9	1.51	54.4	0.239	88.7	0.310
39	0.00	16.92	6.48	25	9.9	1.34	55.5	0.254	95.3	0.334
40	0.00	16.52	6.28	25	9.9	1.33	54.6	0.242	89.0	0.312
41	0.00	16.55	6.58	25	9.8	1.24	53.6	0.247	87.1	0.305
Average		17.06	7.57	25	10.1	0.37	54.9	0.250	87.8	0.307

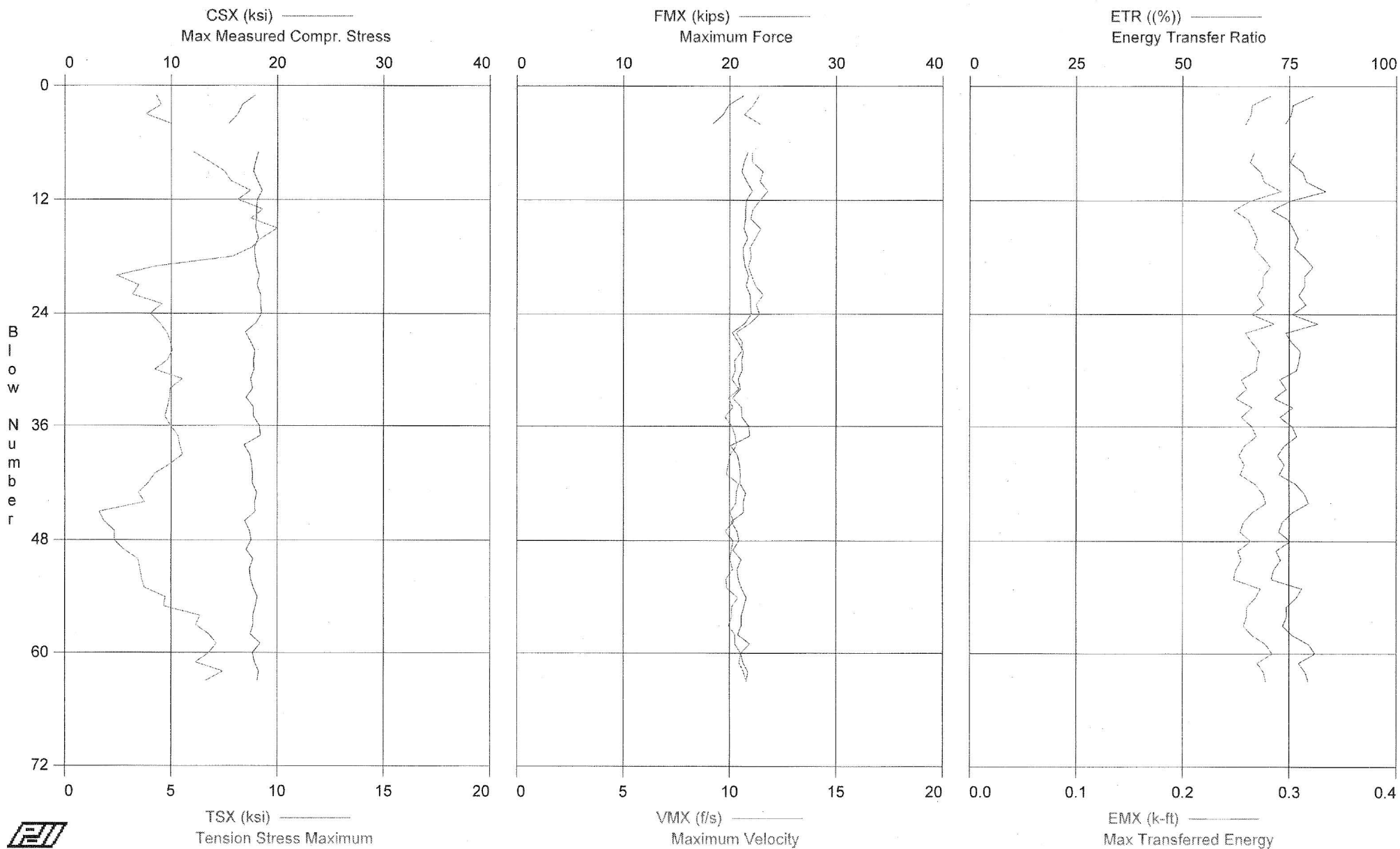
Total number of blows analyzed: 36

Time Summary

Drive 44 seconds

10:24:11 AM - 10:24:55 AM (2/7/2007) BN 1 - 41

Plant Vogtle COL Project - Boring B-1193; 68.5' - 70' Sample



Plant Vogtle COL Project - Boring B-1193; 68.5' - 70' Sample
OP: SEK

Rig Serial No. 337153 (MACTEC Atlanta CME 550 ATV)
Test date: 7-Feb-2007

AR: 1.19 in²
LE: 74.00 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft³
EM: 30,000.0 ksi
JC: 0.60

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
FMX: Maximum Force
VMX: Maximum Velocity
DFN: Final Displacement

BPM: Blows per Minute
EF2: Energy of F²
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	depth ft	CSX ksi	TSX ksi	FMX kips	VMX f/s	DFN in	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
16,928,926.00	17.88	4.31	21	11.4	1.06	0.0	0.208	80.5	0.282	
26,928,926.00	16.72	4.53	20	11.1	1.17	54.7	0.194	75.8	0.265	
36,928,926.00	16.29	3.81	19	10.7	1.06	55.2	0.192	75.4	0.264	
46,928,926.00	15.44	5.00	18	11.4	0.87	53.6	0.193	74.0	0.259	
76,928,926.00	18.21	6.05	22	11.0	1.56	54.0	0.207	76.3	0.267	
86,928,926.00	17.93	6.80	21	11.1	1.17	54.4	0.203	75.1	0.263	
96,928,926.00	17.74	7.51	21	11.6	1.37	54.6	0.207	78.1	0.273	
106,928,926.00	18.13	7.81	22	11.4	0.87	53.4	0.215	78.9	0.276	
116,928,926.00	18.57	8.73	22	11.8	1.29	53.7	0.223	83.5	0.292	
126,928,926.00	18.11	8.13	22	11.4	0.76	54.4	0.213	75.4	0.264	
136,928,926.00	18.03	9.31	21	11.1	0.82	54.1	0.204	70.8	0.248	
146,928,926.00	18.03	8.75	21	11.0	0.72	54.0	0.214	74.6	0.261	
156,928,926.00	17.93	10.00	21	11.4	0.44	54.4	0.214	76.0	0.266	
166,928,926.00	18.21	9.28	22	11.2	1.89	53.9	0.214	77.0	0.270	
176,928,926.00	17.85	8.80	21	10.9	1.46	53.4	0.212	76.2	0.267	
186,928,926.00	17.90	7.88	21	11.0	0.77	54.0	0.211	78.6	0.275	
196,928,926.00	18.02	4.31	21	10.9	1.31	53.8	0.213	80.5	0.282	
206,928,926.00	18.30	2.44	22	11.0	0.60	54.3	0.216	78.6	0.275	
216,928,926.00	18.09	3.47	22	11.2	0.93	54.1	0.216	78.6	0.275	
226,928,926.00	18.42	3.19	22	11.6	0.67	52.8	0.205	77.2	0.270	
236,928,926.00	18.43	4.58	22	11.2	0.85	53.2	0.207	78.9	0.276	
246,928,926.00	18.51	4.02	22	11.4	0.91	54.3	0.201	75.7	0.265	
256,928,926.00	18.00	4.46	21	11.0	0.44	54.2	0.216	81.7	0.286	
266,928,926.00	17.00	4.78	20	10.3	0.69	54.0	0.195	74.1	0.259	
276,928,926.00	17.48	4.97	21	10.6	0.91	54.1	0.201	75.6	0.265	
286,928,926.00	17.88	5.05	21	10.6	0.38	54.0	0.216	77.6	0.272	
296,928,926.00	17.77	4.82	21	10.2	1.15	54.3	0.209	77.3	0.270	
306,928,926.00	17.80	4.23	21	10.3	0.36	54.1	0.214	76.7	0.269	
316,928,926.00	17.48	5.53	21	10.1	0.22	54.0	0.205	72.8	0.255	
326,928,926.00	17.68	4.96	21	10.4	0.21	53.8	0.207	74.3	0.260	
336,928,926.00	17.05	4.93	20	9.9	0.39	53.9	0.196	71.5	0.250	
346,928,926.00	17.75	4.83	21	10.1	0.19	54.0	0.209	75.9	0.265	
356,928,926.00	17.76	4.72	21	9.8	0.86	53.7	0.203	72.8	0.255	
366,928,926.00	18.33	4.98	22	10.1	0.47	54.5	0.211	75.7	0.265	
376,928,926.00	18.41	5.32	22	10.3	0.48	53.6	0.211	76.8	0.269	
386,928,926.00	16.88	5.42	20	10.3	1.28	54.1	0.199	73.8	0.258	
396,928,926.00	17.43	5.54	21	10.0	0.37	53.8	0.191	72.3	0.253	
406,928,926.00	17.59	4.98	21	9.9	0.81	54.2	0.200	73.8	0.258	
416,928,926.00	17.68	4.24	21	9.9	0.77	54.2	0.199	72.7	0.254	
426,928,926.00	17.65	3.93	21	10.4	0.63	54.0	0.202	76.5	0.268	
436,928,926.00	18.07	3.46	21	10.3	1.46	54.3	0.205	78.5	0.275	
446,928,926.00	17.87	3.75	21	10.3	1.10	53.6	0.206	79.5	0.278	
456,928,926.00	17.91	1.62	21	10.0	0.96	53.6	0.202	75.7	0.265	
466,928,926.00	16.94	1.84	20	10.2	0.84	54.1	0.190	73.3	0.257	
476,928,926.00	17.38	2.33	21	9.8	1.22	53.6	0.194	72.6	0.254	
486,928,926.00	17.55	2.34	21	10.2	1.20	54.0	0.202	75.3	0.264	
496,928,926.00	17.07	2.78	20	10.1	1.22	53.8	0.195	71.9	0.252	
506,928,926.00	17.73	3.44	21	10.0	1.11	53.7	0.196	73.0	0.255	
516,928,926.00	17.41	3.55	21	10.2	1.05	54.2	0.192	71.4	0.250	
526,928,926.00	17.49	3.61	21	9.8	1.17	53.8	0.190	70.8	0.248	
536,928,926.00	17.74	3.75	21	9.9	1.56	54.1	0.196	78.0	0.273	
546,928,926.00	18.14	4.73	22	10.4	1.93	53.5	0.208	76.6	0.268	
556,928,926.00	17.95	4.66	21	10.1	0.83	54.2	0.202	74.4	0.260	
566,928,926.00	17.74	6.37	21	10.1	1.21	53.6	0.201	74.4	0.260	
576,928,926.00	17.72	6.17	21	10.0	1.29	54.2	0.200	73.5	0.257	
586,928,926.00	17.46	6.78	21	10.3	1.65	53.5	0.203	75.7	0.265	
596,928,926.00	18.41	7.14	22	10.2	1.17	53.9	0.215	79.5	0.278	
606,928,926.00	17.68	6.79	21	10.5	1.13	53.9	0.206	81.0	0.284	
616,928,926.00	17.87	6.16	21	10.4	1.34	54.0	0.205	77.2	0.270	
626,928,926.00	18.25	7.45	22	10.7	0.92	54.0	0.211	78.7	0.276	
636,928,926.00	18.13	6.63	22	10.8	1.06	53.8	0.206	79.5	0.278	
Average	17.75	5.27	21	10.6	0.96	54.0	0.205	76.0	0.266	

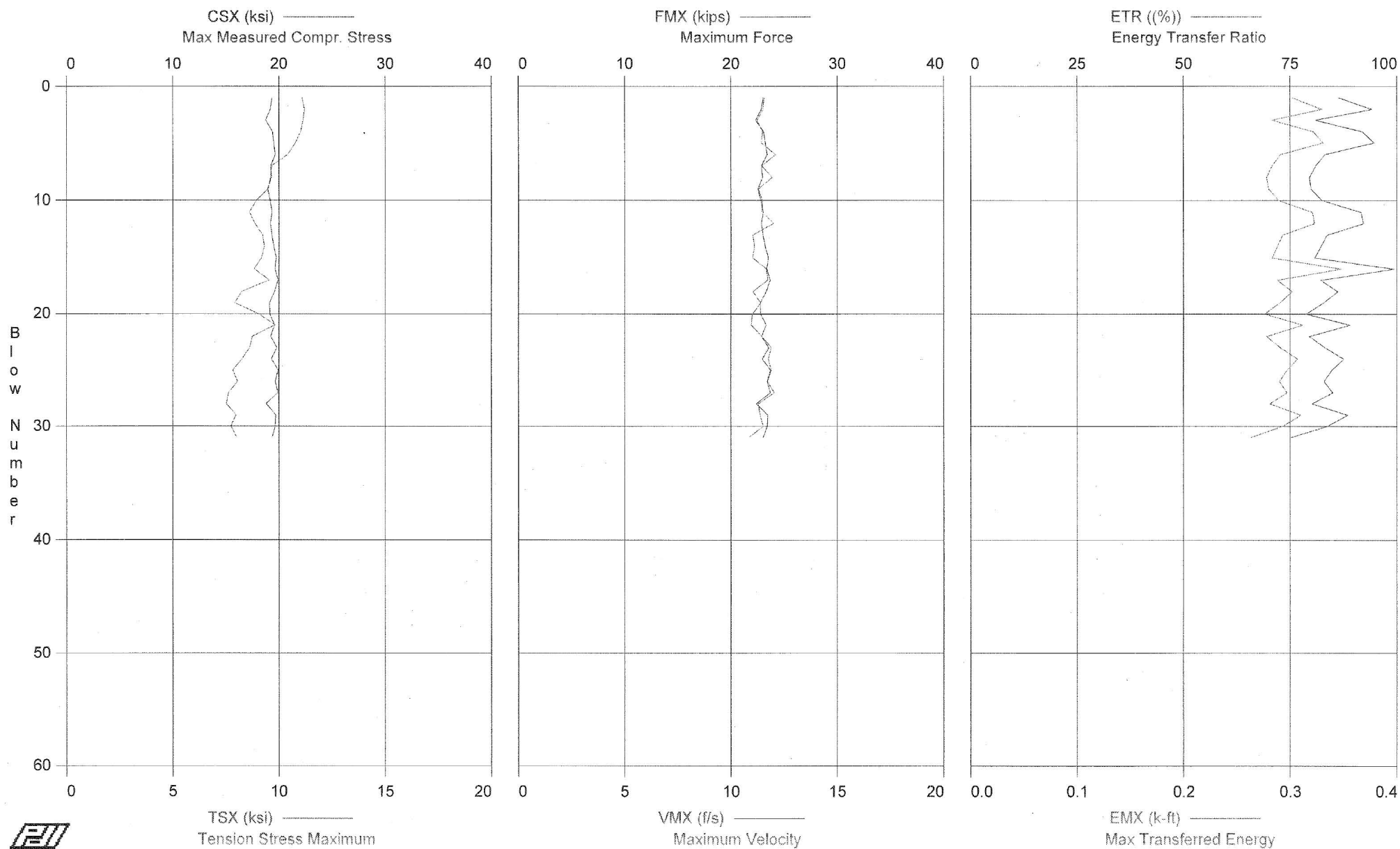
Total number of blows analyzed: 61
694 of 724

Time Summary

Drive 1 minute 9 seconds

10:39:50 AM - 10:40:59 AM (2/7/2007) BN 1 - 63

Plant Vogtle COL Project - Boring B-1193; 73.5' - 75' Sample



Plant Vogtle COL Project - Boring B-1193; 73.5' - 75' Sample
OP: SEK

Rig Serial No. 337153 (MACTEC Atlanta CME 550 ATV)
Test date: 7-Feb-2007

AR: 1.19 in²
LE: 79.00 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft³
EM: 30,000.0 ksi
JC: 0.60

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
FMX: Maximum Force
VMX: Maximum Velocity
DFN: Final Displacement

BPM: Blows per Minute
EF2: Energy of F²
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	depth ft	CSX ksi	TSX ksi	FMX kips	VMX f/s	DFN in	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
1	0.00	19.36	11.10	23	11.6	1.70	0.0	0.233	86.4	0.302
2	0.00	19.20	11.21	23	11.5	2.13	54.1	0.229	94.3	0.330
3	0.00	18.77	11.14	22	11.2	2.00	54.6	0.218	80.9	0.283
4	0.00	19.39	11.02	23	11.5	2.91	54.3	0.229	92.0	0.322
5	0.00	19.52	10.78	23	11.4	2.83	54.3	0.235	94.7	0.331
6	0.00	19.68	10.42	23	12.1	1.96	54.3	0.230	83.2	0.291
7	0.00	19.22	9.66	23	11.4	1.95	54.9	0.225	81.0	0.283
8	0.00	19.30	9.60	23	11.9	1.68	54.0	0.218	79.6	0.278
9	0.00	18.95	9.50	23	11.3	2.62	53.9	0.214	79.9	0.280
10	0.00	19.16	8.95	23	11.5	2.00	53.5	0.220	82.5	0.289
11	0.00	19.37	8.62	23	11.5	2.70	54.9	0.224	91.6	0.321
12	0.00	19.21	8.86	23	12.0	3.40	54.2	0.221	92.2	0.323
13	0.00	19.35	9.22	23	11.0	4.65	53.7	0.220	83.7	0.293
14	0.00	19.50	9.32	23	11.1	2.06	53.9	0.226	82.2	0.288
15	0.00	19.75	9.19	24	11.0	1.33	53.9	0.231	80.8	0.283
16	0.00	19.64	8.84	23	11.7	2.29	54.3	0.239	99.4	0.348
17	0.00	19.91	9.55	24	11.7	2.47	54.3	0.230	82.2	0.288
18	0.00	19.59	8.26	23	11.0	2.19	53.5	0.228	86.2	0.302
19	0.00	19.12	7.91	23	11.4	1.73	54.4	0.216	82.8	0.290
20	0.00	19.14	9.06	23	11.0	1.78	54.0	0.221	78.7	0.276
21	0.00	19.59	9.82	23	10.9	3.88	54.2	0.217	89.1	0.312
22	0.00	19.23	8.75	23	11.5	2.46	54.6	0.213	79.5	0.278
23	0.00	19.80	8.62	24	11.9	1.55	53.8	0.222	83.2	0.291
24	0.00	19.29	8.27	23	11.8	1.43	53.9	0.230	87.6	0.307
25	0.00	19.93	7.82	24	11.9	1.32	54.3	0.228	84.8	0.297
26	0.00	19.66	8.05	23	11.7	1.93	54.2	0.226	83.0	0.290
27	0.00	19.92	7.64	24	12.0	1.29	53.7	0.222	85.0	0.297
28	0.00	18.81	7.52	22	11.3	1.44	54.3	0.210	80.2	0.281
29	0.00	19.70	7.98	23	11.4	1.55	54.4	0.227	88.5	0.310
30	0.00	19.66	7.74	23	11.5	0.76	54.0	0.227	83.7	0.293
31	0.00	19.36	8.02	23	10.9	1.51	53.8	0.212	75.2	0.263
Average		19.42	9.11	23	11.5	2.11	54.1	0.224	85.0	0.297

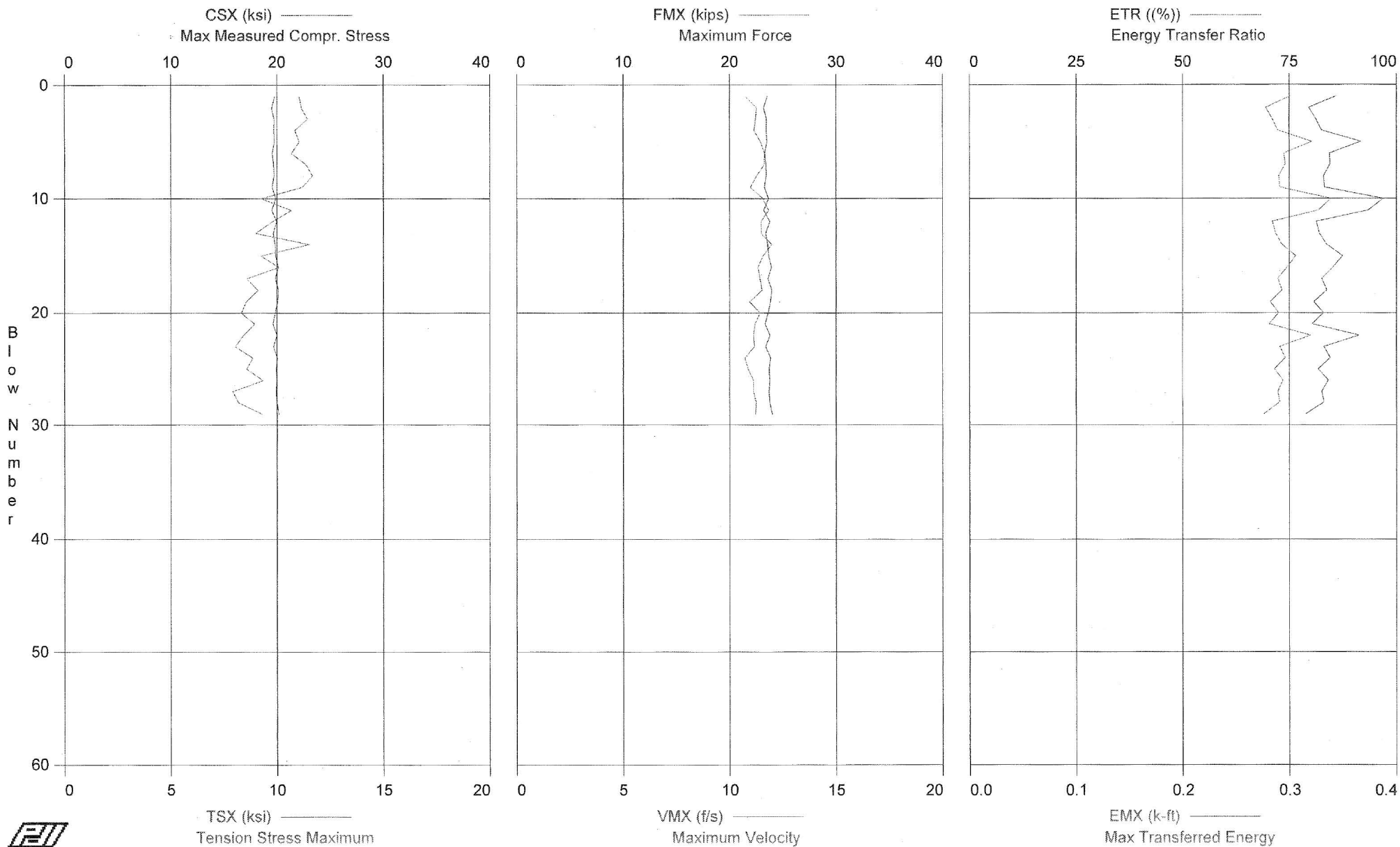
Total number of blows analyzed: 31

Time Summary

Drive 33 seconds

10:54:40 AM - 10:55:13 AM (2/7/2007) BN 1 - 31

Plant Vogtle COL Project - Boring B-1193; 78.5' - 80' Sample



Plant Vogtle COL Project - Boring B-1193; 78.5' - 80' Sample
OP: SEK

Rig Serial No. 337153 (MACTEC Atlanta CME 550 ATV)
Test date: 7-Feb-2007

AR: 1.19 in²
LE: 84.00 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft³
EM: 30,000.0 ksi
JC: 0.60

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
FMX: Maximum Force
VMX: Maximum Velocity
DFN: Final Displacement

BPM: Blows per Minute
EF2: Energy of F²
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	depth ft	CSX ksi	TSX ksi	FMX kips	VMX f/s	DFN in	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
1	0.00	19.80	11.05	24	10.7	1.99	0.0	0.234	86.0	0.301
2	0.00	19.50	11.15	23	11.3	1.77	55.4	0.225	79.5	0.278
3	0.00	19.72	11.44	23	11.2	4.48	53.7	0.226	81.2	0.284
4	0.00	19.70	10.84	23	11.2	2.93	54.2	0.228	82.5	0.289
5	0.00	19.75	11.04	23	11.5	3.02	53.4	0.228	91.7	0.321
6	0.00	19.57	10.68	23	11.6	1.95	54.3	0.222	84.4	0.295
7	0.00	19.69	11.37	23	11.6	2.75	54.6	0.225	84.4	0.296
8	0.00	19.71	11.67	23	11.3	1.82	54.1	0.228	83.0	0.290
9	0.00	19.56	11.17	23	11.0	2.86	53.6	0.225	83.2	0.291
10	0.00	19.89	9.25	24	11.6	2.86	53.6	0.231	96.9	0.339
11	0.00	19.51	10.68	23	11.8	2.44	54.8	0.236	93.5	0.327
12	0.00	19.97	9.79	24	11.5	0.56	54.2	0.229	81.3	0.284
13	0.00	19.64	8.99	23	11.5	2.07	53.9	0.219	82.0	0.287
14	0.00	19.81	11.51	24	12.0	4.37	53.9	0.224	83.7	0.293
15	0.00	19.88	9.24	24	11.6	2.11	54.3	0.225	87.5	0.306
16	0.00	20.11	10.09	24	11.3	2.81	53.8	0.230	85.2	0.298
17	0.00	19.83	8.58	24	11.4	1.12	54.2	0.220	82.6	0.289
18	0.00	20.13	9.10	24	11.5	0.38	53.9	0.227	83.8	0.293
19	0.00	20.04	8.55	24	10.9	1.89	54.0	0.224	80.7	0.282
20	0.00	19.85	8.32	24	11.4	1.19	53.7	0.221	83.0	0.290
21	0.00	19.61	8.95	23	11.2	1.49	54.5	0.220	80.3	0.281
22	0.00	20.00	8.42	24	11.1	1.81	54.2	0.234	91.3	0.320
23	0.00	19.65	8.04	23	11.2	2.28	54.0	0.220	83.1	0.291
24	0.00	20.04	8.87	24	10.7	1.70	53.7	0.229	84.6	0.296
25	0.00	19.92	8.57	24	10.9	0.82	54.2	0.221	81.7	0.286
26	0.00	19.98	9.34	24	11.1	1.84	53.7	0.231	84.1	0.294
27	0.00	19.92	7.93	24	11.1	1.67	54.2	0.223	82.6	0.289
28	0.00	19.98	8.17	24	11.3	0.92	53.7	0.234	83.1	0.291
29	0.00	20.18	9.30	24	11.2	0.53	54.6	0.227	78.8	0.276
Average		19.82	9.73	24	11.3	2.01	54.1	0.226	84.3	0.295

Total number of blows analyzed: 29

Time Summary

Drive 31 seconds

11:08:23 AM - 11:08:54 AM (2/7/2007) BN 1 - 29

June 27, 2007

Memorandum to File DCN VGCOL 154

From: Steve Kiser *SK*

Reviewed By: Pieter Depree *PD*

Subject: **Report of SPT Energy – Gregg Drilling Fraste Track**
Hammer Serial No. XO2958 Automatic Hammer
WORK INSTRUCTION VGCOL 154
Vogle Units 3 & 4 COL Project
Burke County, Georgia
MACTEC Project No. 6141-06-0286

Steve Kiser, of MACTEC Engineering and Consulting, Inc. (MACTEC), performed energy measurements on the drill rig at the subject site per the referenced Work Instructions. This memorandum summarizes the field testing activities and presents the results of the energy measurements.

SPT Energy Field Measurements

SPT energy measurements were made on February 7, 2007, during drilling of Boring B-3014 at the referenced site. The testing was performed from approximately 4:25 to 5:05 PM under sunny skies with breezy conditions and a temperature of about 60 degrees Fahrenheit. The boring was drilled with personnel and equipment from Gregg Drilling. The drilling equipment consisted of a Fraste model track-mounted drill rig with an SPT automatic hammer. The drilling tools consisted of NW-J-sized drilling rods and a 2-foot long split tube sampler. Mud rotary drilling techniques were used to advance the boring below the depth at which groundwater was encountered at the time of energy testing. The drill rig operator during sampling was Mr. Marshall Burnett. Energy measurements were recorded during sampling at the depth intervals shown in Table 1.

The energy measurements were performed with a Pile Driving Analyzer (PDA) model PAK (Serial No. 1430), and calibrated accelerometers (Serial Nos. P5953 and P5094) and strain gages (Serial Nos. NW #146/1 and NW#146/2). An NW-sized steel drill rod, 2 feet long and instrumented with dedicated strain gages, was inserted at the top of the drill rod string immediately below the SPT hammer. The inserted rod was also instrumented with two piezoresistive accelerometers that were bolted to the outside of the rod. The instrumented rod insert had a cross-sectional area of approximately 1.49 square inches and an outside diameter of approximately 2.625 inches at the gage location. The drill rods included in the drill rod string were hollow rods in 5 to 10 foot long sections, with an outside and inside diameter of approximately 2.625 and 2.25 inches, respectively. The recommended operation rate of the hammer is not known. Due to the closed hammer system, the hammer lubrication condition and anvil dimensions could not be observed.

Calibration Records

The calibration records for all the above are filed in DCN VGCOL-14.

Calculations for EFV

The work was done in general accordance with ASTM D 4633-05. The strain and acceleration signals were converted to force and velocity by the PDA, and the data was interpreted by the PDA according to the Case Method equation. The maximum energy transmitted to the drill rod string (as measured at the location of the strain gages and accelerometers) was calculated by the PDA using the EFV method equation, as shown below:

$$EFV = \int F(t) * V(t) * dt$$

Where: EFV = Transferred energy (EFV equation), or Energy of FV

F(t) = Calculated force at time t

V(t) = Calculated velocity at time t

The EFV method of energy calculation is recommended in ASTM Standard D4633-05. The EFV equation, integrated over the complete wave event, measures the total energy content of the event using both force and velocity measurements. The EFV values associated with each blow analyzed are tabulated in the attached PDILOT tables and are also shown graphically in the PDILOT charts.

Calculations for ETR

The ratio of the measured transferred energy (EFV) to the theoretical potential energy of the SPT system (140 lb weight with the specified 30 inch fall) is the ETR. The ETR values (as percent of the theoretical value) are shown in Table 1.

Comparison of ETR to Typical Energy Transfer Ratio Range

Based on a research report published by the Florida Department of Transportation (FDOT) (Report WPI No. 0510859, 1999), the average ETR measured for automatic hammers is 79.6%. The standard deviation was 7.9%; therefore, the range of ETRs within one standard deviation of the average was reported to be 71.7% to 87.5%. This range of ETRs was also consistent with other research that was cited in the FDOT research paper; however, maximum and minimum ETR values of up to 98% and 56%, respectively, were reported in the literature. The ETR values shown in Table 1 are generally within the range of typical values for automatic hammers as reported in the literature.

Discussion

Based on the field testing results, observations from the SPT energy measurements are summarized below:

- The data obtained by the PDA are consistent between individual hammer blows and between the sample depths tested. In general, the first and last one (and sometimes two) hammer blow records recorded by the PDA produced poor quality data (which is relatively common) and, as such, the record(s) was(were) not used in the data reduction.

- The average energy transferred from the hammer to the drill rods for each individual depth interval using the EFV method ranged from 273 foot-pounds to 278 foot-pounds. These average energy transfers correspond to energy transfer ratios (ETR) of 78% to 79% of the theoretical energy (350 foot-pounds) of the SPT hammer.
- The average at each depth interval was calculated as the transferred energy for each analyzed blow of the depth intervals divided by the total number of hammer blows analyzed. The overall weighted average energy transfer of the SPT system (for all the depth intervals tested) was 276.0 foot-pounds, with a weighted average ETR of 78.9%.

Attachments: Page 4 Table 1 - Summary of SPT Energy Measurements – 1 Page
Page 5 Work Instruction – DCN VGCOL 154 – 1 Page
Page 6 Record of SPT Energy Measurement – 1 Page
Pages 7 - 12 PDILOT Output – 6 Pages

TABLE 1
SUMMARY OF SPT ENERGY MEASUREMENTS (ASTM D4633-05)

Vogtle Units 3 and 4 COL Project
Burke County, Georgia
MACTEC Project No. 6141-06-0286

Rig Serial No.	Rig Owner	Rig Operator	Boring No. Tested	Rod Size	Date Tested	Sample Depth (feet)	SPT Blow Count (blows per six inches)	No. of Blows Analyzed	Average Measured Energy (Average EFV) (ft-lbs) ^a	Energy Transfer Ratio (%) ^b (Average ETR)
XO2958 (Fraste Track)	Gregg Drilling	Marshall Burnett	B-3014	NW-J	2/7/2007	13.5 - 15.0	13 - 15 - 18	43	273	78.0%
						18.5 - 20.0	16 - 16 - 16	45	278	79.4%
						23.5 - 25.0	15 - 12 - 10	38	277	79.1%
							Weighted Average for Rig:	276.0	78.9%	

^aMeasured Energy is energy based on the EFV method, as outlined in ASTM D4633-05, for each blow recorded by the PDA. In some cases, the initial and final one to two blows produced poor quality data, and were not used to calculate the Average Measured Energy.

EFV = EMX * 1000 lbs/kip, where EMX equals the maximum transferred energy measured by the PDA (see attached PDA data).

^bEnergy Transfer Ratio is the Measured Energy divided by the theoretical SPT energy of 350 foot-pounds (140 pound hammer falling 2.5 feet). The average ETR values may differ slightly and insignificantly from those in the PDILOT tables due to roundoff.

Prepared By: <i>AW</i>	Date: <i>6-27-07</i>	Checked By: <i>WAL</i>	Date: <i>7/31/07</i>
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**Work Instructions – SPT Energy Gregg Drilling FRASTE (Poole)
(Hammer #XO2958)**

Vogtle COL Project
Project No. 6141-06-0286

Issued To: Steve Kiser _____
Location: Vogtle COL Project Field Office _____ Date: 1/17/07 _____
Issued By: Matthew F. Cooke, Site Coordinator _____
Valid From: 1/17/07 _____ To: 1/17/08 _____

Task Description: Measurement of energy transferred to the drill string rods from a Standard Penetration Test (SPT) automatic hammer mounted on a drill rig. Testing will be performed using a Pile Driving Analyzer (PDA) model PAK at various depth intervals below a depth of approximately 10 feet below the ground surface for the above referenced rig drilling SPT borings at the Vogtle COL Site.

Applicable Technical Procedures or Plans, or other reference: ASTM D4633-05 Standard Test Method for Energy Measurement for Dynamic Penetrometers.

Specific Instructions (note attachments where necessary): Obtain energy measurements with the PDA at various depth intervals below a depth of about 10 feet below the ground surface in general accordance with ASTM D4633-05. Perform energy measurement testing for the above referenced drill rig.

Report Format: Written report documenting results of field testing in general accordance with ASTM D4633-05, to include completed Summary of Daily Observations and Testing, Record of SPT Energy Measurement sheet(s), and PDILOT output data.

Specific Quality Assurance Procedures Applicable: _____ None _____

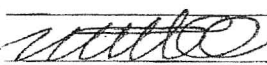
Hold Points or Witness Points: Direction to perform energy measurements received from the Site Coordinator.

Records: All records generated shall be considered QA Records.

Reviewed and Approved By (Note: Only One Signature is Required to Issue):

Project Manager: _____ Date: _____

Project Principal: _____ Date: _____

Site Coordinator:  _____ Date: 1/17/07 _____

No. of Pages: _____ 1 _____ DCN: _____ VGCOL 154 _____