FINAL DATA REPORT
Revision 0
GEOTECHNICAL EXPLORATION AND TESTING
SUPPLEMENT 2
DOMINION POWER
NORTH ANNA NUCLEAR POWER STATION
NORTH ANNA 3 PROJECT
MINERAL, LOUISA COUNTY, VIRGINIA

December 16, 2009

VOLUME 1

APPENDIX B.2
SPT Energy Measurement Reports

Prepared By:

MACTEC ENGINEERING AND CONSULTING, INC.
RALEIGH, NORTH CAROLINA

MACTEC PROJECT No. 6468-09-2473

Prepared For:

Bechtel Power Corporation
Subcontractor No. 25161-500-HC4-CY00-00001

North Anna 3 Project

MACTEC Project: 6468-09-2473

SPT Energy Report – Vendor A (supplement 2 – 29 borings) Dated Nov 16 and Dec 2 2009

MACTEC

Engineering and constructing a better tomorrow

November 16, 2009

For Jon Honeycutt With Permission

From: Jon Honeycutt, Staff Professional JC

Reviewed By: Steve Kiser, Principal Professional SK

Subject: **Report of SPT Energy – MACTEC CME-550x ATV**
Hammer Serial No. MEC-05 Automatic Hammer
WORK INSTRUCTION No. 8 (DCN:NAP-077)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Jonathan Honeycutt, 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 September 2, 2009, during drilling of Boring M-9 at the referenced site. The testing was performed by Jonathan Honeycutt from approximately 8:30 AM to 10:00 AM on September 2 under clear skies with a temperature of about 65 degrees Fahrenheit. The boring was drilled by MACTEC personnel using equipment from the MACTEC Atlanta office. The drilling equipment consisted of a CME-550x model ATV drill rig with an SPT automatic hammer. The drilling tools consisted of AW-J-sized drilling rods and a 2-foot long split-barrel sampler. Mud rotary drilling techniques were used to advance the boring at the time of energy testing. The drill rig operator during sampling was Mr. Ruben Landeros. 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 PAX (Serial No. 3622L), and calibrated accelerometers (Serial Nos. K983 and K0686) and strain gages (Serial Nos. AW#75/1 and AW#75/2). A 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 automatic SPT hammer. The inserted rod was also instrumented with two piezoresistive accelerometers that were bolted to the outside of the rod. The instrumented rod was two feet below the hammer impact point and had a cross-sectional area of approximately 1.22 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.

18 Pages Total

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Calibration Records

The calibration records for all the above are filed in DCN NAP-223.

Calculations for EFV

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

As recommended by ASTM D4633-05, the force-velocity method of energy calculation was used. The equation shown above for calculating EFV, 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 PDIPLOT tables and are also shown graphically in the PDIPLOT 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 generally consistent between individual hammer blows and between the sample depths tested. In general, the first and last one (and sometimes two or more) 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. This may result in more or less hammer blows evaluated for ETR than what is shown on the boring logs.

- The average energy transferred from the hammer to the drill rods for each individual depth interval using the EFV method ranged from 280 foot-pounds to 298 foot-pounds. These average energy transfers correspond to energy transfer ratios (ETR) of 80.0% to 85.1% 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 average energy transfer of the SPT system (for all the depth intervals tested) was 291.2 foot-pounds, with an average ETR of 83.2%.

Attachments: Page 4 Table 1 - Summary of SPT Energy Measurements – 1 Page
Pages 5 – 6 Work Instruction No. 8 DCN:NAP 077 – 2 Pages (without attachments)
Page 7 Record of SPT Energy Measurement – 1 Page
Pages 8 – 17 PDIPLOT Output – 10 Pages
Page 18 Force-Velocity Plot – 1 Page

TABLE 1
SUMMARY OF SPT ENERGY MEASUREMENTS (ASTM D4633-05)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Automatic Hammer Serial Number and Rig Model	Rig Owner	Rig Operator	Boring No. Tested	Date Tested	Drill Rod Size	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)
MEC-05 (CME-550x ATV)	MACTEC Atlanta	Ruben Landeros	M-9	9/2/2009	AW-J	15.4 - 16.9	4 - 5 - 4	16	290	82.9%
						17.9 - 19.4	5 - 6 - 6	17	295	84.3%
						22.9 - 24.4	5 - 6 - 6	19	295	84.3%
						27.8 - 29.3	5 - 7 - 7	19	298	85.1%
						32.8 - 34.3	5 - 8 - 8	22	280	80.0%
								Average for Rig:	**291.2**	**83.2%**

[a]Measured 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. This may result in more or less blows evaluated for ETR than what is shown on the boring logs.

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

[b]Energy 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 EFV and ETR values may differ slightly and insignificantly from those in the PDIPLOT tables due to roundoff.

Prepared By:	Date: 11-16-09		Checked By:	Date: 11-16-09

For Jon Honeycutt
With Permission

Work Instruction No. 8
North Anna 3 Project
MACTEC Engineering and Consulting, Inc.
Project Number: 6468-09-2473

Issued To: Jonathan Honeycutt, Steve Kiser Rev. No. 0

Issued By: D. Steven Copley, P.E. DSC 8-31-09 Date: August 31, 2009

Valid From: August 31, 2009 To: August 31, 2010

Task Description: Perform SPT Energy Measurements

Applicable Technical Procedures or Plans, or other reference:

1. Geotechnical Work Plan (complete copy of current revision available at Field Office), Section 4.2 and Attachment 2 – Drilling and Sampling Procedures (attached)
2. Engineering Specification for Subsurface Investigation and Laboratory Testing, No. 25161-500-3PS-CY00-Q0001, Rev. 000, Issued for use August 21, 2009, Section 3.3 Drilling Equipment (attached)
3. ASTM D 4633-05 (attached)

Specific Instructions (note attachments where necessary): Perform energy measurements for each drill rig on site in general accordance with ASTM D 4633-05. Consult with Site Manager as to schedule for performing the measurements. Hammer weights have been checked, and records will be available on site. All rigs are using automatic hammer systems. Confirm that automatic hammer system is being operated within manufacturer's recommendations or in a typical operating fashion as observed from watching one or two SPT measurements prior to measuring energy. Check each drill rig using all hammer/rod combinations that it will be using. Depths for measurements should be coordinated with the Site Manager. See Site Manager for current boring logs of holes drilled, if available, and use these to plan most effective field measurement program. Submit copies of calibration records for equipment to Principal Professional for review prior to beginning work on site.

Confirm with Site Manager that approval of equipment calibration records have been received prior to beginning field testing. If unexpected conditions are encountered that affect measurements, contact Site Manager or Principal Professional immediately.

Report Format: Prepare standard report in accordance with ASTM D 4633-05 requirements.

Specific Quality Assurance Procedures Applicable: 10CFR21; NQAP 16-01 Procedure For Conforming To Federal Regulation 10CFR21; QAP 20-1; QAP 25-1; Section 306 of the Energy Reorganization Act of 1974. Current revisions apply; copies available in Field Office.

Hold Points or Witness Points: None

Records: All records generated shall be considered QA Records.

Reviewed and Approved By (Note: Only one signature required for issuance):

Project Manager: _____ Date: _____

Principal Professional: D. Aaron Copley Date: 8-31-09

Site Manager: _____ Date: _____

No. of Pages: 15 DCN: NAP077

QA Form 24-1 Revised 8/12/2009

MACTEC

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Telephone: (704) 357-8600 / Facsimile: (704) 357-8638

RECORD OF SPT ENERGY MEASUREMENT

GENERAL INFORMATION		DRILL RIG DATA	
PROJECT:	North Anna 3 Project	MAKE:	CME
LOCATION:	Virginia	MODEL:	550X ATV
PROJECT NO.:	6468-09-2473	SERIAL NO.:	MEC-05
DATE:	9/2/2009	HAMMER TYPE:	AUTO
WEATHER:	65°F SUNNY	ROPE CONDITION:	N/A
INSPECTOR:	JNH	ROD SIZE:	AW-J
DRILLING COMPANY:	MACTEC -	NO. OF SHEAVES:	N/A

BORING DATA

BORING NUMBER:	M-9
DEPTH DRILLED:	Various
TIME DRIVEN:	8:30 AM – 10:00 AM
RIG OPERATOR:	R. ANDERSON
HAMMER OPERATOR:	N/A
PDA PAK SERIAL NO.:	3622L
INSTR. ROD AREA:	1.22 in2
ACCEL. SERIAL NOS.:	A1 - K983 A2 - K0686
STRAIN SERIAL NOS.:	75 AW # 1/2

SAMPLE DEPTH (feet)	SPT N-VALUE (bpf)
15.4-16.9	4-5-4
17.9-19.4	5-6-6
22.9-24.4	5-6-6
27.8-29.3	5-7-7
32.8-34.3	5-8-8

REMARKS: Testing performed in accordance with ASTM D 4633-05

Reviewed By:

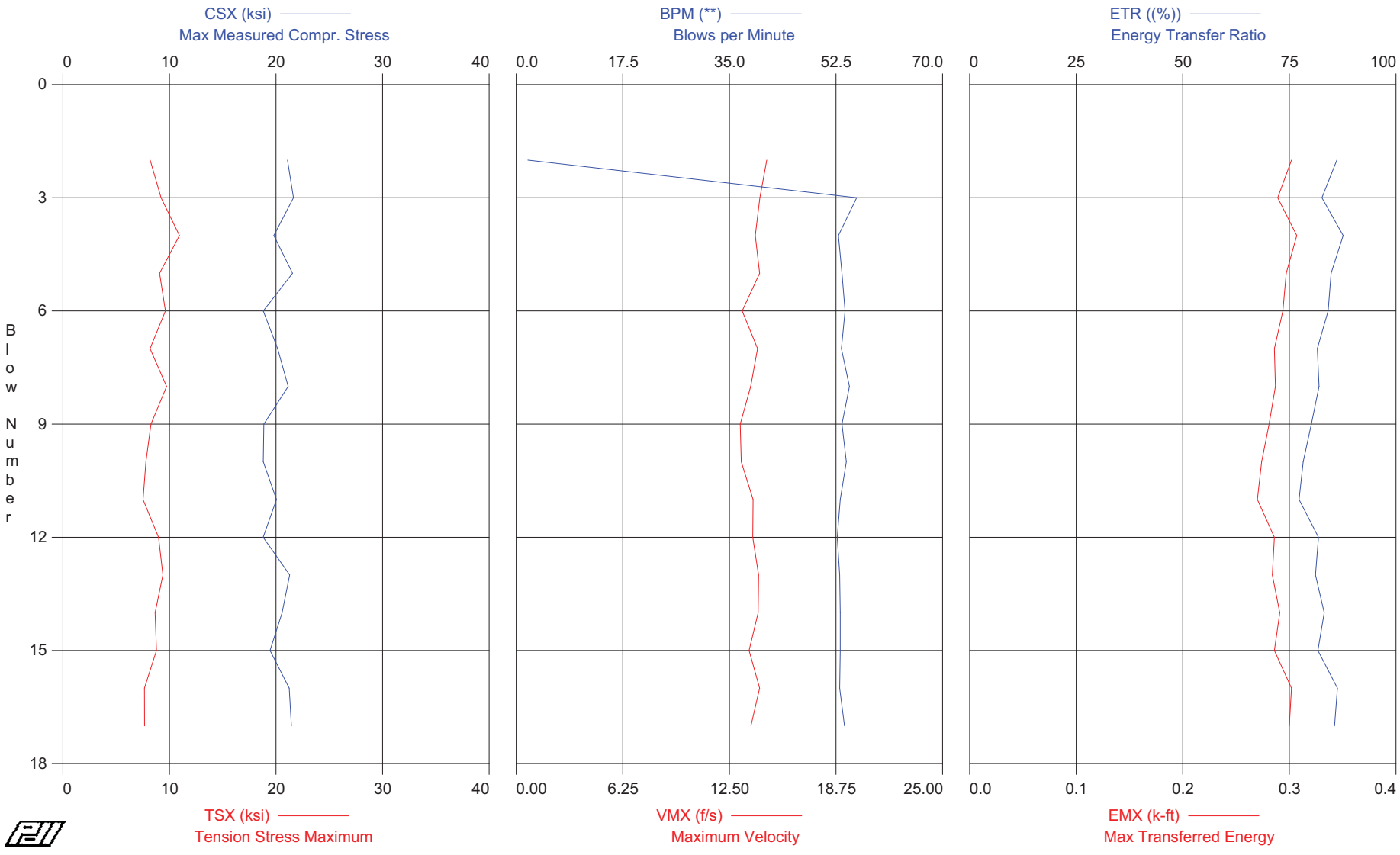
REV. 0

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.2 - Printed: 5-Oct-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M9 (15.4' - 16.9' sample)



NORTH ANNA 3 Project - BORING M9 (15.4' - 16.9' sample)
Rig Serial No. MEC-05; CME 550 X (R.Landerous)
OP: JNH
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 21.00 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	21.1	8.2	14.7	26	0.8	1.9	0.219	86.2	0.302
3	21.6	9.2	14.3	26	0.8	55.9	0.199	82.6	0.289
4	19.8	10.9	14.0	24	0.8	52.9	0.206	87.6	0.307
5	21.6	9.1	14.3	26	0.8	53.5	0.203	84.8	0.297
6	18.8	9.6	13.3	23	0.8	54.0	0.204	84.1	0.294
7	20.1	8.2	14.1	25	0.8	53.4	0.199	81.6	0.286
8	21.1	9.7	13.7	26	0.9	54.7	0.194	82.0	0.287
9	18.9	8.3	13.1	23	0.8	53.5	0.196	80.2	0.281
10	18.8	7.8	13.2	23	0.8	54.2	0.196	78.3	0.274
11	20.0	7.5	13.9	24	0.8	53.2	0.196	77.3	0.270
12	18.8	9.0	13.9	23	0.8	52.7	0.200	81.8	0.286
13	21.3	9.4	14.2	26	0.8	53.1	0.199	81.1	0.284
14	20.6	8.7	14.2	25	0.8	53.2	0.198	83.2	0.291
15	19.4	8.8	13.7	24	0.8	53.2	0.198	81.7	0.286
16	21.2	7.6	14.3	26	0.8	53.1	0.201	86.3	0.302
17	21.4	7.7	13.8	26	0.9	53.9	0.200	85.6	0.300
Average	20.3	8.7	13.9	25	0.8	50.4	0.200	82.8	0.290

Total number of blows analyzed: 16

Time Summary

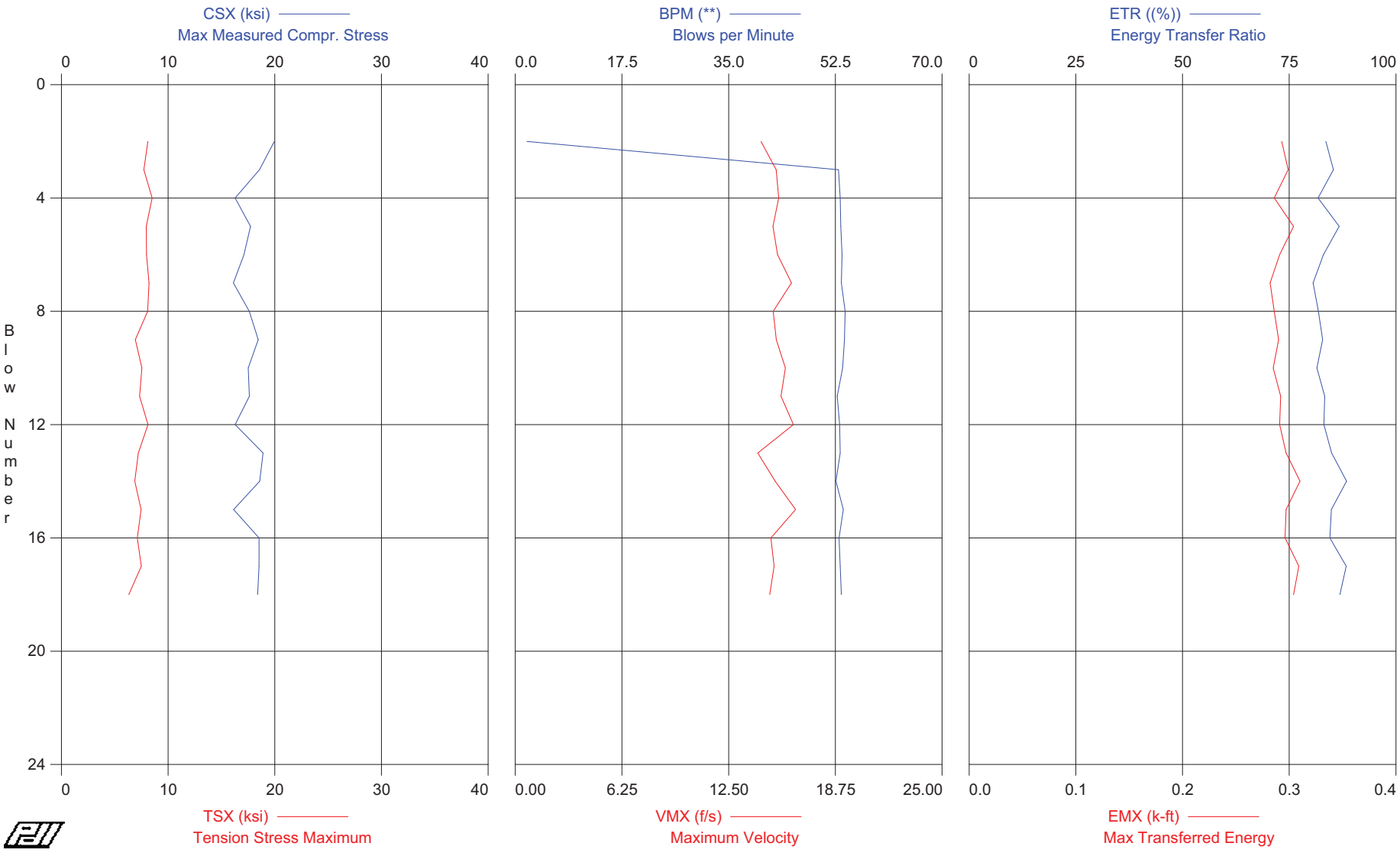
Drive 42 seconds 8:49:27 AM - 8:50:09 AM (9/2/2009) BN 1 - 17

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.2 - Printed: 5-Oct-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M9 (17.9' - 19.4' sample)



NORTH ANNA 3 Project - BORING M9 (17.9' - 19.4' sample)
OP: JNH

Rig Serial No. MEC-425; CME 550 X (R.Landerous)
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 23.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality

BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	20.0	8.1	14.4	24	0.5	1.9	0.198	83.6	0.293
3	18.6	7.7	15.3	23	0.7	53.0	0.190	85.4	0.299
4	16.3	8.5	15.4	20	0.6	53.3	0.189	81.7	0.286
5	17.7	8.0	15.1	22	0.5	53.4	0.198	86.7	0.304
6	17.1	8.0	15.4	21	0.5	53.6	0.194	83.0	0.291
7	16.1	8.2	16.2	20	0.6	53.5	0.190	80.6	0.282
8	17.6	8.1	15.1	21	0.7	54.1	0.184	81.9	0.286
9	18.5	6.9	15.3	23	0.5	54.0	0.191	82.8	0.290
10	17.5	7.5	15.8	21	0.5	53.7	0.187	81.5	0.285
11	17.6	7.3	15.6	22	0.5	52.8	0.190	83.3	0.292
12	16.3	8.1	16.3	20	0.6	53.2	0.184	83.1	0.291
13	18.9	7.2	14.2	23	0.7	53.3	0.191	84.9	0.297
14	18.6	6.9	15.2	23	0.5	52.6	0.195	88.4	0.310
15	16.1	7.5	16.4	20	0.5	53.8	0.190	84.9	0.297
16	18.5	7.1	15.0	23	0.5	53.1	0.193	84.5	0.296
17	18.5	7.5	15.2	23	0.7	53.3	0.189	88.3	0.309
18	18.4	6.3	14.9	22	0.5	53.5	0.188	86.9	0.304
Average	17.8	7.6	15.3	22	0.6	50.4	0.191	84.2	0.295

Total number of blows analyzed: 17

Time Summary

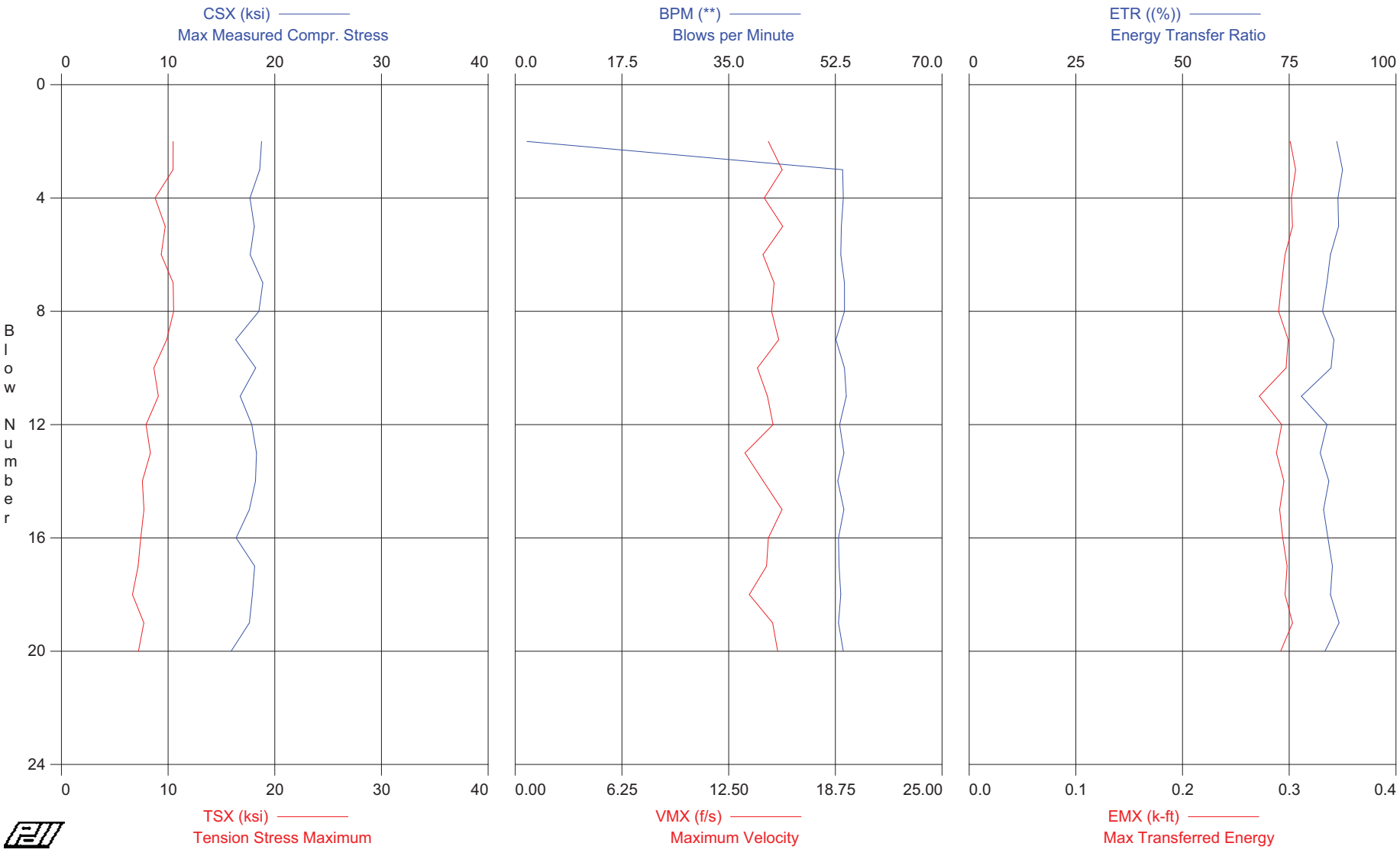
Drive 26 seconds 9:04:01 AM - 9:04:27 AM (9/2/2009) BN 1 - 18

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.2 - Printed: 5-Oct-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M9 (22.9' - 24.4' sample)



NORTH ANNA 3 Project - BORING M9 (22.9' - 24.4' sample)
OP: JNH
Rig Serial No. MEC-05; CME 550 X (R.Landerous)
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 28.40 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	18.8	10.5	14.8	23	0.6	1.9	0.218	86.1	0.301
3	18.6	10.5	15.6	23	0.7	53.7	0.214	87.5	0.306
4	17.7	8.8	14.6	22	0.6	53.8	0.214	86.4	0.302
5	18.1	9.7	15.7	22	0.6	53.5	0.208	86.6	0.303
6	17.7	9.4	14.5	22	0.6	53.4	0.215	84.7	0.296
7	18.9	10.5	15.2	23	0.7	54.0	0.210	83.8	0.293
8	18.5	10.5	15.0	23	0.7	54.0	0.203	82.8	0.290
9	16.3	9.9	15.4	20	0.6	52.6	0.214	85.5	0.299
10	18.2	8.7	14.2	22	0.6	54.0	0.210	84.8	0.297
11	16.8	9.1	14.8	20	0.6	54.3	0.197	77.8	0.272
12	17.8	7.9	15.1	22	0.7	53.2	0.199	83.8	0.293
13	18.3	8.3	13.5	22	0.6	53.9	0.202	82.3	0.288
14	18.2	7.6	14.5	22	0.7	52.9	0.199	84.3	0.295
15	17.6	7.7	15.6	21	0.6	53.9	0.199	83.0	0.291
16	16.4	7.4	14.8	20	0.6	53.0	0.205	84.1	0.294
17	18.1	7.2	14.7	22	0.7	53.1	0.201	85.1	0.298
18	17.9	6.7	13.7	22	0.6	53.4	0.205	84.6	0.296
19	17.6	7.7	15.1	21	0.5	53.0	0.211	86.7	0.303
20	15.9	7.2	15.4	19	0.6	53.8	0.200	83.4	0.292
Average	17.8	8.7	14.9	22	0.6	50.8	0.207	84.4	0.295

Total number of blows analyzed: 19

Time Summary

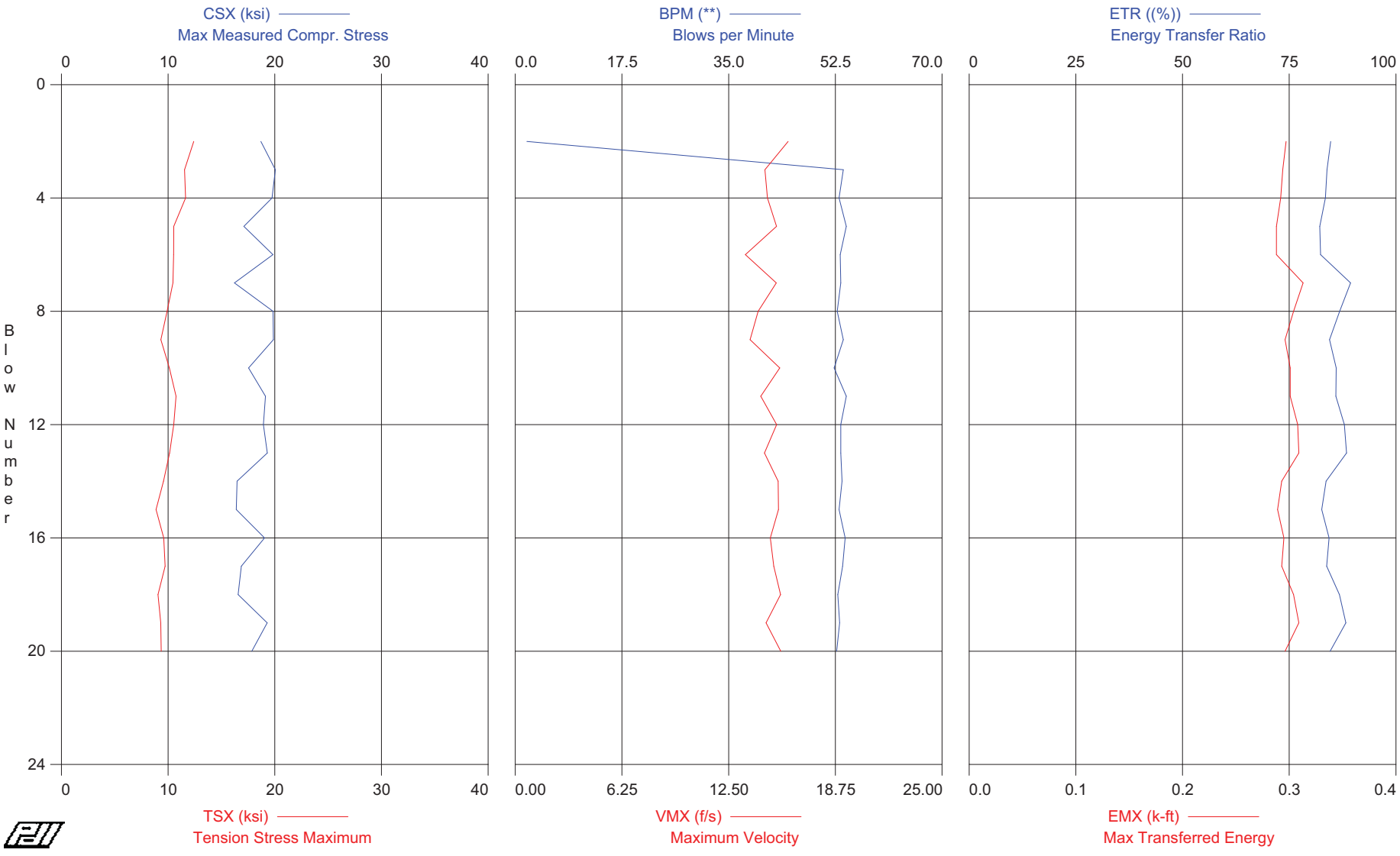
Drive 31 seconds 9:20:31 AM - 9:21:02 AM (9/2/2009) BN 1 - 20

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.2 - Printed: 5-Oct-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M9 (27.8' - 29.3' sample)



NORTH ANNA 3 Project - BORING M9 (27.8' - 29.3' sample)
OP: JNH

Rig Serial No. MEC-05; CME 550 X (R.Landerous)
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 34.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality

BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	18.7	12.4	16.0	23	0.6	1.9	0.224	84.7	0.297
3	20.1	11.5	14.6	24	0.8	53.8	0.222	83.9	0.294
4	19.7	11.6	14.8	24	0.7	53.1	0.218	83.5	0.292
5	17.1	10.5	15.3	21	0.6	54.3	0.209	82.2	0.288
6	19.8	10.5	13.5	24	0.8	53.3	0.217	82.3	0.288
7	16.2	10.5	15.3	20	0.6	53.4	0.213	89.4	0.313
8	19.8	9.9	14.2	24	0.5	52.8	0.223	86.8	0.304
9	19.9	9.3	13.8	24	0.8	53.8	0.218	84.4	0.296
10	17.5	10.1	15.5	21	0.6	52.3	0.221	86.0	0.301
11	19.1	10.7	14.4	23	0.5	54.3	0.218	85.9	0.301
12	18.9	10.5	15.3	23	0.7	53.4	0.215	87.9	0.308
13	19.3	10.1	14.6	24	0.5	53.4	0.217	88.4	0.309
14	16.5	9.6	15.4	20	0.6	53.6	0.212	83.6	0.293
15	16.4	8.9	15.4	20	0.6	53.1	0.213	82.6	0.289
16	19.0	9.6	14.9	23	0.7	54.1	0.210	84.3	0.295
17	16.9	9.7	15.1	21	0.6	53.7	0.212	83.8	0.293
18	16.6	9.1	15.5	20	0.6	52.9	0.213	86.8	0.304
19	19.3	9.3	14.7	24	0.7	53.2	0.213	88.3	0.309
20	17.9	9.4	15.6	22	0.6	52.7	0.214	84.6	0.296
Average	18.4	10.2	14.9	22	0.6	50.7	0.216	85.2	0.298

Total number of blows analyzed: 19

Time Summary

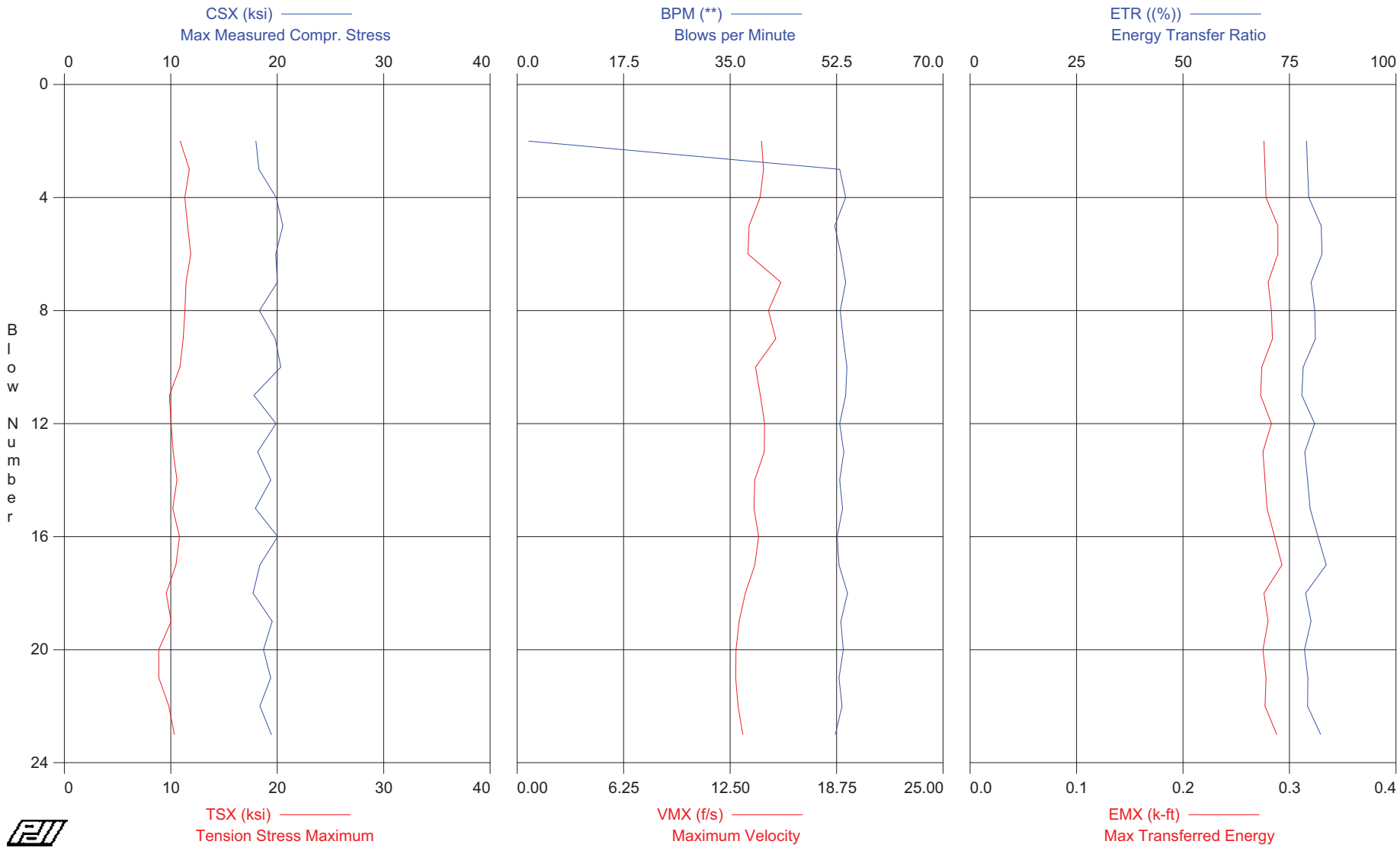
Drive 44 seconds 9:36:26 AM - 9:37:10 AM (9/2/2009) BN 1 - 21

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.2 - Printed: 5-Oct-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M9 (32.8' - 34.3' sample)



NORTH ANNA 3 Project - BORING M9 (32.8' - 34.3' sample)
Rig Serial No. MEC-05; CME 550 X (R.Landerous)
OP: JNH
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 38.30 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

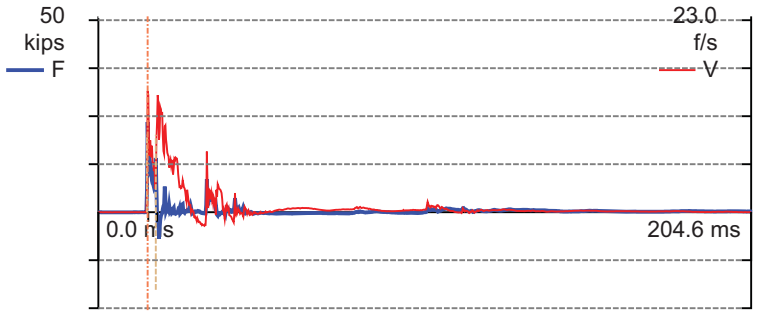
BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	18.0	10.9	14.3	22	0.8	1.9	0.222	79.0	0.276
3	18.3	11.7	14.5	22	0.8	53.0	0.231	79.2	0.277
4	19.9	11.3	14.3	24	1.0	54.0	0.230	79.6	0.278
5	20.5	11.6	13.6	25	0.9	52.2	0.238	82.4	0.289
6	19.9	11.9	13.5	24	0.9	53.2	0.241	82.7	0.289
7	20.0	11.4	15.5	24	0.9	54.0	0.234	80.1	0.280
8	18.3	11.3	14.7	22	0.9	53.1	0.240	80.9	0.283
9	19.8	11.2	15.2	24	0.9	53.6	0.236	81.1	0.284
10	20.3	10.9	14.0	25	1.0	54.2	0.235	78.2	0.274
11	17.8	9.9	14.3	22	0.9	54.0	0.231	77.9	0.273
12	19.9	10.0	14.5	24	1.0	53.0	0.235	80.9	0.283
13	18.2	10.2	14.5	22	0.8	53.7	0.236	78.6	0.275
14	19.4	10.6	13.9	24	0.9	53.0	0.231	79.2	0.277
15	17.9	10.2	13.9	22	0.8	53.5	0.228	79.8	0.279
16	20.0	10.8	14.2	24	1.0	52.6	0.238	81.7	0.286
17	18.4	10.5	14.0	22	0.9	52.9	0.235	83.6	0.293
18	17.7	9.6	13.4	22	0.8	54.3	0.231	78.8	0.276
19	19.5	10.0	13.0	24	1.0	53.2	0.230	80.0	0.280
20	18.7	8.9	12.9	23	0.8	53.6	0.229	78.5	0.275
21	19.4	8.9	12.8	24	1.0	52.9	0.232	79.3	0.278
22	18.4	9.8	13.0	22	0.8	53.4	0.228	79.2	0.277
23	19.5	10.3	13.2	24	0.9	52.3	0.232	82.3	0.288
Average	19.1	10.5	14.0	23	0.9	51.0	0.233	80.1	0.280

Total number of blows analyzed: 22

Time Summary

Drive 36 seconds 9:50:03 AM - 9:50:39 AM (9/2/2009) BN 1 - 23

Project: NORTH ANNA 3
Pile: BORING M9(17.9-19.4) - Description: CME 550X(R.LANDEROUS)
Operator: JNH



BN 13
9/2/2009 9:04:21 AM

LP	0.00	ft	LE	23.40	ft
CSX	18.9	ksi	AR	1.22	in^2
CSI	19.5	ksi	EM	30,000.0	ksi
TSX	7.2	ksi	SP	0.492	k/ft3
EMX	0.3	k-ft	WS	16,807.9	f/s
STK	4.80	ft	WC	16,807.9	f/s
FVP	0.75	[]	JC	0.70	[]
SFR	3	kips	2L/c	2.78	ms
RX5	8	kips	EA/c	2.2	ksec/ft
RMX	6	kips	FR	5.000	kHz

MACTEC

Engineering and constructing a better tomorrow

November 16, 2009

For Jon Honeycutt With Permission

From: Jon Honeycutt, Staff Professional

Reviewed By: Steve Kiser, Principal Professional

Subject: **Report of SPT Energy – MACTEC CME-45c Track Hammer Serial No. MEC-12 Automatic Hammer**
WORK INSTRUCTION No. 8 (DCN:NAP-077)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Jonathan Honeycutt, 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 September 2, 2009, during drilling of Boring M-8 at the referenced site. The testing was performed by Jonathan Honeycutt from approximately 11:20 AM to 12:50 PM on September 2 under clear skies with a temperature of about 65 degrees Fahrenheit. The boring was drilled by MACTEC personnel using equipment from the MACTEC Raleigh office. The drilling equipment consisted of a CME 45c model track drill rig with an SPT automatic hammer. The drilling tools consisted of AW-J-sized drilling rods and a 2-foot long split-barrel sampler. Mud rotary drilling techniques were used to advance the boring at the time of energy testing. The drill rig operator during sampling was Mr. Donnie Rhodes. 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 PAX (Serial No. 3622L), and calibrated accelerometers (Serial Nos. K983 and K0686) and strain gages (Serial Nos. AW#75/1 and AW#75/2). A 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 was two feet below the hammer impact point and had a cross-sectional area of approximately 1.22 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.

18 Pages Total

MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100 • Charlotte, NC 28208 • Phone: 704.357.8600

www.mactec.com

Calibration Records

The calibration records for all the above are filed in DCN NAP-223.

Calculations for EFV

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

As recommended by ASTM D4633-05, the force-velocity method of energy calculation was used. The equation shown above for calculating EFV, 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 PDIPLOT tables and are also shown graphically in the PDIPLOT 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 generally consistent between individual hammer blows and between the sample depths tested. In general, the first and last one (and sometimes two or more) 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. This may result in more or less hammer blows evaluated for ETR than what is shown on the boring logs.

- The average energy transferred from the hammer to the drill rods for each individual depth interval using the EFV method ranged from 292 foot-pounds to 305 foot-pounds. These average energy transfers correspond to energy transfer ratios (ETR) of 83.4% to 87.1% 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 average energy transfer of the SPT system (for all the depth intervals tested) was 297.1 foot-pounds, with an average ETR of 84.9%.

Attachments: Page 4 Table 1 - Summary of SPT Energy Measurements – 1 Page
Pages 5 - 6 Work Instruction No. 8 DCN:NAP 077– 2 Pages (without attachments)
Page 7 Record of SPT Energy Measurement – 1 Page
Pages 8 – 17 PDIPLOT Output – 10 Pages
Page 18 Force-Velocity Plot – 1 Page

TABLE 1
SUMMARY OF SPT ENERGY MEASUREMENTS (ASTM D4633-05)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Automatic Hammer Serial Number and Rig Model	Rig Owner	Rig Operator	Boring No. Tested	Date Tested	Drill Rod Size	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)
MEC-12 (CME-45c Track)	MACTEC Raleigh	Donnie Rhodes	M-8	9/2/2009	AW-J	23.7 - 25.2	19 - 17 - 16	52	293	83.7%
						28.7 - 30.2	4 - 6 - 11	21	292	83.4%
						33.7 - 35.2	4 - 7 - 7	18	293	83.7%
						38.7 - 40.2	5 - 8 - 11	24	300	85.7%
						43.7 - 45.2	13 - 14 - 15	41	305	87.1%
								Average for Rig:	**297.1**	**84.9%**

[a]Measured 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. This may result in more or less blows evaluated for ETR than what is shown on the boring logs.

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

[b]Energy 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 EFV and ETR values may differ slightly and insignificantly from those in the PDIPLOT tables due to roundoff.

Prepared By: L C. Date: 11-16-09		Checked By: SLL Date: 11-16-09

For Jon Honeycutt With Permission

Work Instruction No. 8
North Anna 3 Project
MACTEC Engineering and Consulting, Inc.
Project Number: 6468-09-2473

Issued To: Jonathan Honeycutt, Steve Kiser Rev. No. 0

Issued By: D. Steven Copley, P.E. DSC 8-31-09 Date: August 31, 2009

Valid From: August 31, 2009 To: August 31, 2010

Task Description: Perform SPT Energy Measurements

Applicable Technical Procedures or Plans, or other reference:

1. Geotechnical Work Plan (complete copy of current revision available at Field Office), Section 4.2 and Attachment 2 – Drilling and Sampling Procedures (attached)
2. Engineering Specification for Subsurface Investigation and Laboratory Testing, No. 25161-500-3PS-CY00-Q0001, Rev. 000, Issued for use August 21, 2009, Section 3.3 Drilling Equipment (attached)
3. ASTM D 4633-05 (attached)

Specific Instructions (note attachments where necessary): Perform energy measurements for each drill rig on site in general accordance with ASTM D 4633-05. Consult with Site Manager as to schedule for performing the measurements. Hammer weights have been checked, and records will be available on site. All rigs are using automatic hammer systems. Confirm that automatic hammer system is being operated within manufacturer's recommendations or in a typical operating fashion as observed from watching one or two SPT measurements prior to measuring energy. Check each drill rig using all hammer/rod combinations that it will be using. Depths for measurements should be coordinated with the Site Manager. See Site Manager for current boring logs of holes drilled, if available, and use these to plan most effective field measurement program. Submit copies of calibration records for equipment to Principal Professional for review prior to beginning work on site.

Confirm with Site Manager that approval of equipment calibration records have been received prior to beginning field testing. If unexpected conditions are encountered that affect measurements, contact Site Manager or Principal Professional immediately.

Report Format: Prepare standard report in accordance with ASTM D 4633-05 requirements.

Specific Quality Assurance Procedures Applicable: 10CFR21; NQAP 16-01 Procedure For Conforming To Federal Regulation 10CFR21; QAP 20-1; QAP 25-1; Section 306 of the Energy Reorganization Act of 1974. Current revisions apply; copies available in Field Office.

Hold Points or Witness Points: None

Records: All records generated shall be considered QA Records.

Reviewed and Approved By (Note: Only one signature required for issuance):

Project Manager: _____ Date: _____

Principal Professional: D. Aaron Copley Date: 8-31-09

Site Manager: _____ Date: _____

No. of Pages: 15 DCN: NAP077

QA Form 24-1 Revised 8/12/2009

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

RECORD OF SPT ENERGY MEASUREMENT

GENERAL INFORMATION		DRILL RIG DATA	
PROJECT:	North Anna 3 Project	MAKE:	CME
LOCATION:	Virginia	MODEL:	45C TRACK
PROJECT NO.:	6468-09-2473	SERIAL NO.:	MEC-~~+3~~ 12 SN 11-16-09
DATE:	9/2/2009	HAMMER TYPE:	AUTO
WEATHER:	SUNNY 65°F	ROPE CONDITION:	N/A
INSPECTOR:	JNH	ROD SIZE:	AW-J
DRILLING COMPANY:	MACTEC - RALEIGH	NO. OF SHEAVES:	N/A

BORING DATA	
BORING NUMBER:	M-8
DEPTH DRILLED:	Various
TIME DRIVEN:	11:20 AM - 12:50 PM
RIG OPERATOR:	D. RHODES
HAMMER OPERATOR:	N/A
PDA PAK SERIAL NO.:	3622L
INSTR. ROD AREA:	1.22 in²
ACCEL. SERIAL NOS.:	#1-K983 : #2-K0686
STRAIN SERIAL NOS.:	25AW #1/2

SAMPLE DEPTH (feet)	SPT N-VALUE (bpf)
23.7-25.2	19-17-16
28.7-30.2	4-6-11
33.7-35.2	4-7-7
38.7-40.2	5-8-11
43.7-45.2	13-14-15

REMARKS: Testing performed in accordance with ASTM D 4633-05

Reviewed By:

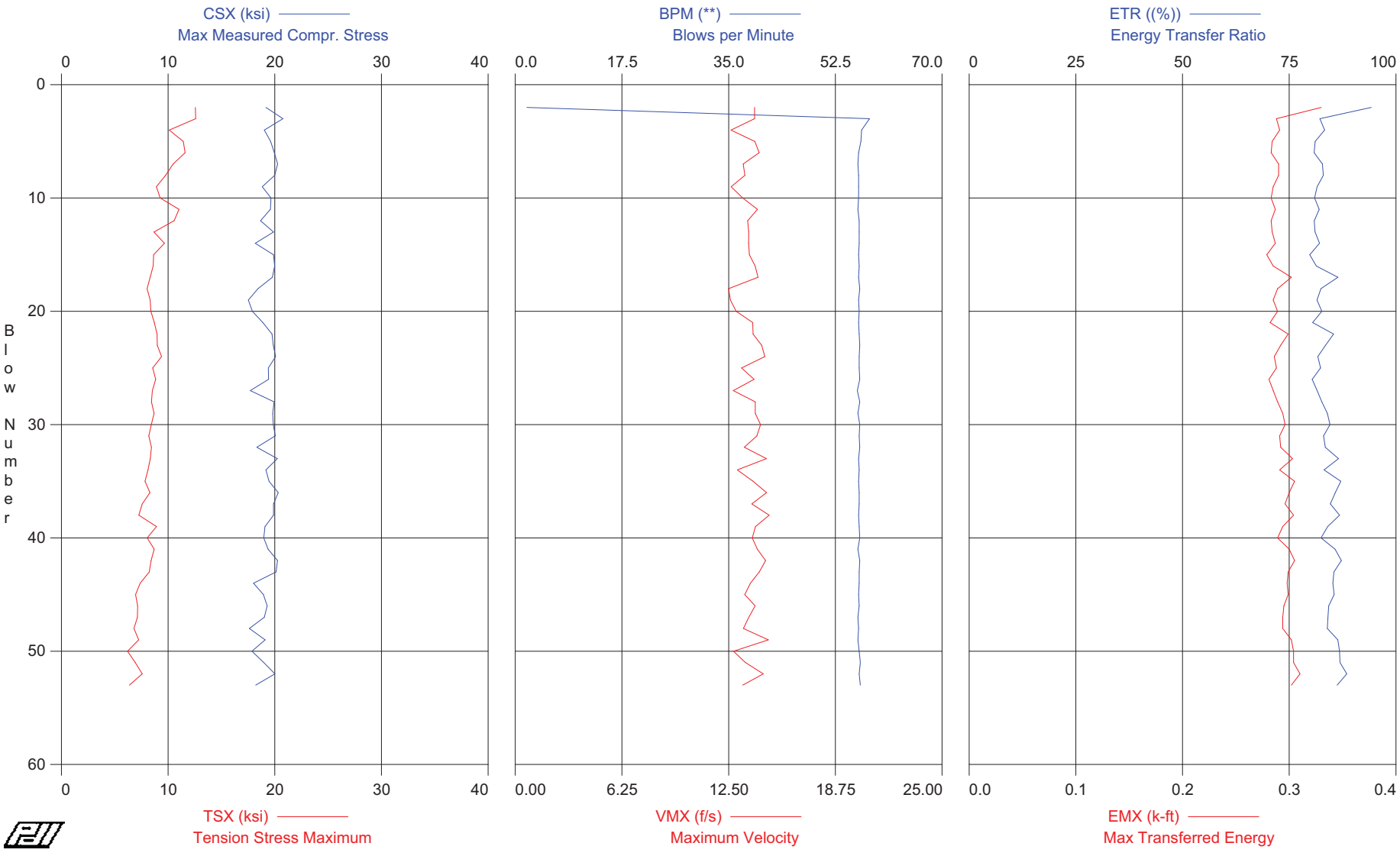
REV. 0

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M-8 (23.7' - 25.2' sample)



NORTH ANNA 3 Project - BORING M-8 (23.7' - 25.2' sample)
Rig Serial No. MEC-12; CME-45c Track (D. RHODES)
OP: JNH
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 29.20 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	19.2	12.6	14.0	23	0.8	1.9	0.291	94.2	0.330
3	20.8	12.6	14.0	25	0.8	58.1	0.277	82.2	0.288
4	19.0	10.1	12.6	23	0.8	56.8	0.273	83.3	0.291
5	19.6	11.4	14.0	24	0.8	56.7	0.267	81.1	0.284
6	20.0	11.6	14.3	24	0.8	56.3	0.267	80.8	0.283
7	20.3	10.5	13.4	25	0.9	56.2	0.272	82.8	0.290
8	20.0	9.8	13.5	24	0.8	56.3	0.272	83.0	0.290
9	18.8	8.9	12.6	23	0.8	56.3	0.268	81.5	0.285
10	19.6	9.3	13.3	24	0.8	56.3	0.270	80.9	0.283
11	19.6	11.0	14.2	24	0.8	56.2	0.266	82.0	0.287
12	18.7	10.6	13.6	23	0.8	56.4	0.267	80.9	0.283
13	19.9	8.7	13.7	24	0.8	56.4	0.266	81.1	0.284
14	18.2	9.7	13.7	22	0.7	56.4	0.264	82.1	0.287
15	19.9	8.6	13.7	24	0.8	56.3	0.267	79.8	0.279
16	20.0	8.6	14.0	24	0.8	56.4	0.270	81.4	0.285
17	19.8	8.3	14.2	24	0.8	56.3	0.266	86.4	0.302
18	18.4	8.0	12.5	22	0.8	56.5	0.266	82.4	0.289
19	17.5	8.3	12.6	21	0.8	56.3	0.270	81.5	0.285
20	17.9	8.4	12.9	22	0.8	56.4	0.264	82.6	0.289
21	18.9	8.7	13.9	23	0.8	56.3	0.268	80.5	0.282
22	19.7	9.0	13.9	24	0.8	56.4	0.265	85.4	0.299
23	19.9	9.0	14.4	24	0.8	56.5	0.263	83.5	0.292
24	20.1	9.4	14.6	24	0.8	56.4	0.266	81.7	0.286
25	19.4	8.6	13.3	24	0.8	56.4	0.269	82.3	0.288
26	19.4	8.8	14.0	24	0.8	56.5	0.263	80.4	0.281
27	17.7	8.5	12.8	22	0.8	56.1	0.272	81.5	0.285
28	19.9	8.4	14.1	24	0.8	56.5	0.268	82.7	0.289
29	19.8	8.7	14.1	24	0.8	56.2	0.267	83.9	0.294
30	19.9	8.4	14.4	24	0.8	56.5	0.266	84.6	0.296
31	20.0	8.2	14.2	24	0.8	56.4	0.270	83.0	0.291
32	18.3	8.4	13.4	22	0.8	56.5	0.265	83.4	0.292
33	20.2	8.3	14.7	25	0.8	56.3	0.267	86.5	0.303
34	19.2	8.1	13.0	23	0.8	56.4	0.268	83.1	0.291
35	19.5	7.8	13.9	24	0.8	56.3	0.266	87.1	0.305
36	20.3	8.3	14.7	25	0.8	56.4	0.268	85.8	0.300
37	19.9	7.6	13.9	24	0.8	56.4	0.272	84.6	0.296
38	19.9	7.3	14.9	24	0.8	56.3	0.265	86.8	0.304
39	19.1	8.9	14.1	23	0.8	56.4	0.271	84.0	0.294
40	19.0	8.0	13.9	23	0.8	56.5	0.268	82.4	0.289
41	19.4	8.7	14.2	24	0.8	56.2	0.268	85.7	0.300
42	20.3	8.4	14.7	25	0.8	56.5	0.271	87.2	0.305
43	20.1	8.2	14.3	25	0.8	56.4	0.274	85.5	0.299
44	18.0	7.4	13.8	22	0.7	56.4	0.264	85.2	0.298
45	18.9	7.0	13.4	23	0.8	56.3	0.277	85.5	0.299
46	19.3	7.1	14.0	24	0.8	56.4	0.272	84.2	0.295
47	19.0	7.1	13.7	23	0.8	56.2	0.271	84.1	0.294
48	17.6	6.8	13.4	21	0.7	56.3	0.268	83.9	0.294
49	19.1	7.2	14.8	23	0.7	56.2	0.267	86.4	0.302
50	17.9	6.2	12.8	22	0.8	56.4	0.273	86.8	0.304
51	19.0	6.9	13.5	23	0.8	56.6	0.273	86.9	0.304
52	20.0	7.6	14.5	24	0.8	56.4	0.272	88.5	0.310
53	18.2	6.4	13.3	22	0.8	56.6	0.268	86.2	0.302
Average	19.3	8.7	13.8	24	0.8	55.4	0.269	83.8	0.293

Total number of blows analyzed: 52

Time Summary

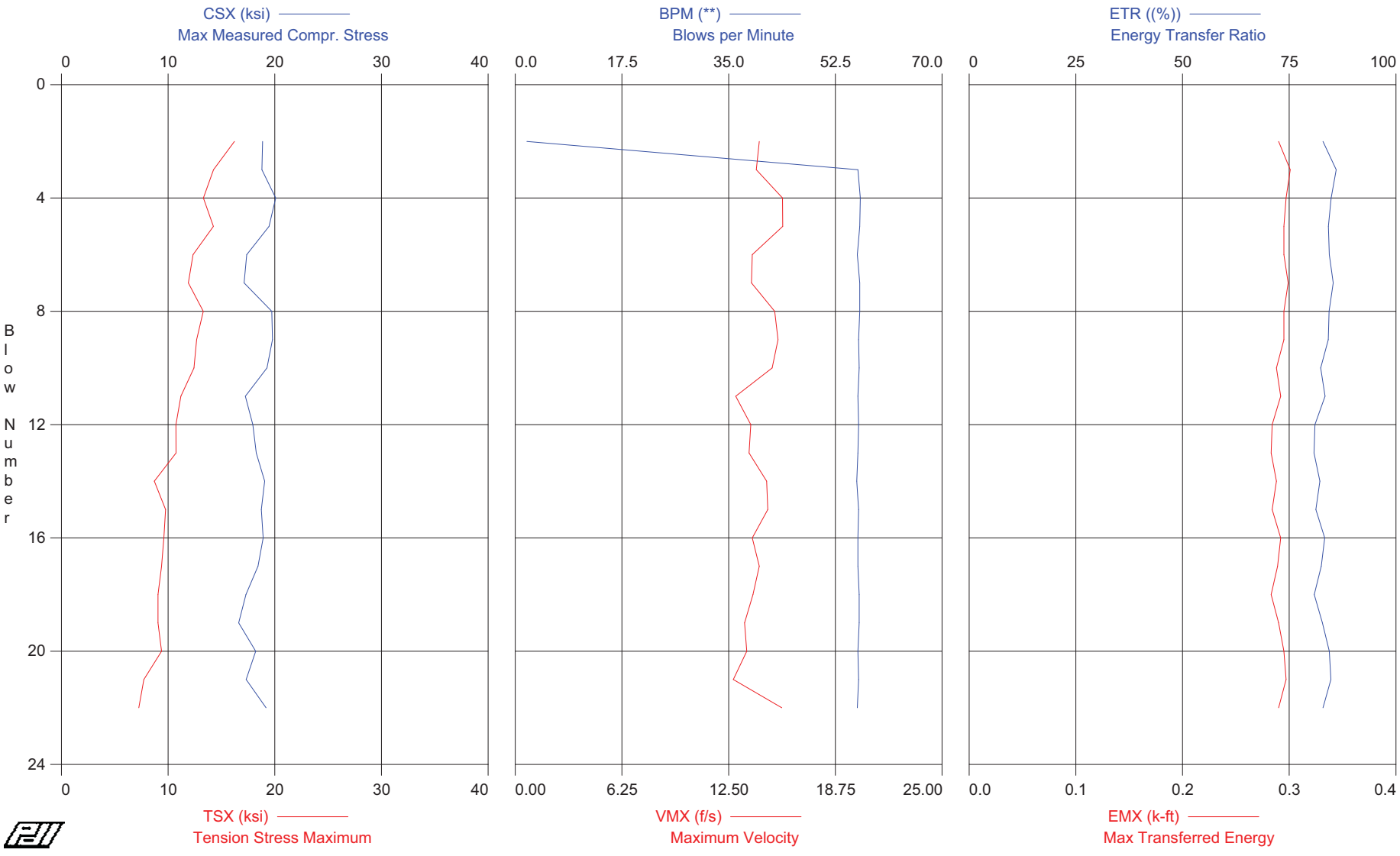
Drive 1 minute 25 seconds 11:23:35 AM - 11:25:00 AM (9/2/2009) BN 1 - 53

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M-8 (28.7' - 30.2' sample)



NORTH ANNA 3 Project - BORING M-8 (28.7' - 30.2' sample)
OP: JNH
Rig Serial No. MEC-12; CME-45c Track (D.Rhodes)
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 34.20 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	18.9	16.2	14.3	23	0.8	1.9	0.274	82.9	0.290
3	18.8	14.3	14.1	23	0.8	56.2	0.273	86.0	0.301
4	20.1	13.3	15.7	25	0.7	56.6	0.272	84.8	0.297
5	19.5	14.2	15.7	24	0.7	56.5	0.263	84.2	0.295
6	17.4	12.3	13.9	21	0.7	56.1	0.263	84.4	0.295
7	17.1	11.9	13.8	21	0.7	56.5	0.259	85.3	0.299
8	19.7	13.3	15.2	24	0.7	56.5	0.267	84.3	0.295
9	19.8	12.7	15.4	24	0.7	56.3	0.268	84.1	0.295
10	19.3	12.4	15.1	24	0.7	56.4	0.258	82.4	0.288
11	17.2	11.2	12.9	21	0.8	56.2	0.259	83.4	0.292
12	17.9	10.7	13.8	22	0.7	56.3	0.261	81.0	0.284
13	18.3	10.7	13.7	22	0.7	56.2	0.260	80.8	0.283
14	19.0	8.7	14.7	23	0.7	56.0	0.256	82.2	0.288
15	18.7	9.8	14.8	23	0.7	56.3	0.258	81.2	0.284
16	18.9	9.6	13.9	23	0.8	56.2	0.255	83.3	0.292
17	18.4	9.4	14.3	22	0.7	56.2	0.256	82.5	0.289
18	17.3	9.1	13.9	21	0.7	56.4	0.254	80.9	0.283
19	16.6	9.0	13.4	20	0.7	56.4	0.255	82.8	0.290
20	18.2	9.4	13.6	22	0.8	56.2	0.256	84.4	0.295
21	17.3	7.7	12.8	21	0.7	56.3	0.259	84.8	0.297
22	19.2	7.3	15.6	23	0.7	56.1	0.254	82.9	0.290
Average	18.5	11.1	14.3	23	0.7	53.7	0.261	83.3	0.292

Total number of blows analyzed: 21

Time Summary

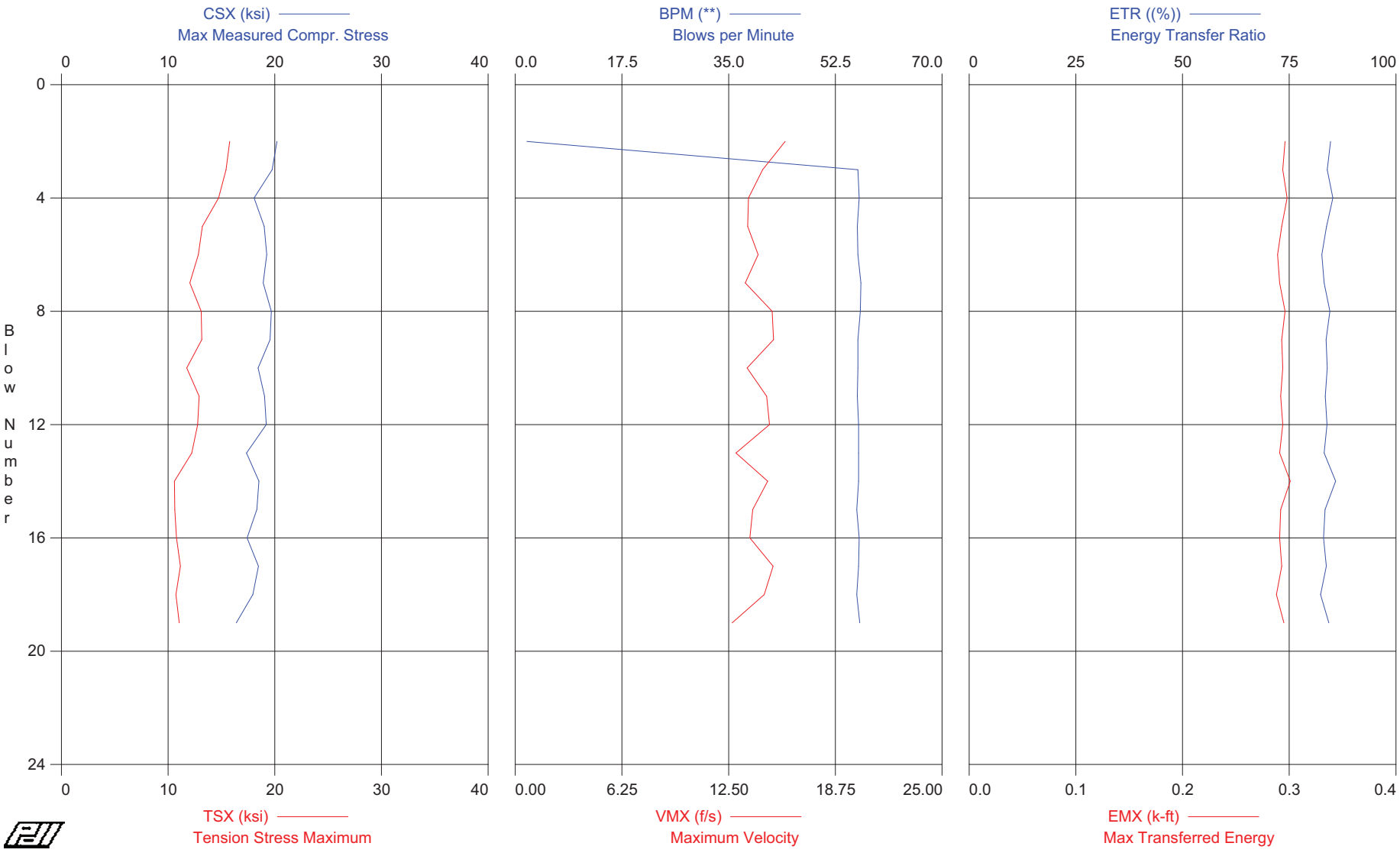
Drive 35 seconds 11:47:18 AM - 11:47:53 AM (9/2/2009) BN 1 - 22

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M-8 (33.7' - 35.2' sample)



NORTH ANNA 3 Project - BORING M-8 (33.7' - 35.2' sample)
Rig Serial No. MEC-12; CME-45c Track (D.Rhodes)
OP: JNH
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 39.20 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	20.2	15.8	15.8	25	0.7	1.9	0.262	84.7	0.296
3	19.8	15.4	14.5	24	0.8	56.2	0.267	83.9	0.294
4	18.1	14.7	13.7	22	0.8	56.4	0.268	85.2	0.298
5	19.0	13.2	13.6	23	0.8	56.1	0.266	83.8	0.293
6	19.2	12.8	14.2	23	0.8	56.2	0.261	82.6	0.289
7	18.9	12.0	13.5	23	0.8	56.7	0.260	83.2	0.291
8	19.7	13.1	15.0	24	0.7	56.6	0.262	84.5	0.296
9	19.6	13.2	15.1	24	0.7	56.2	0.260	83.6	0.293
10	18.4	11.7	13.6	23	0.8	56.2	0.257	83.9	0.294
11	19.0	12.9	14.7	23	0.7	56.1	0.260	83.4	0.292
12	19.2	12.8	14.9	23	0.7	56.3	0.259	83.9	0.294
13	17.3	12.2	12.9	21	0.7	56.3	0.261	83.2	0.291
14	18.5	10.6	14.8	23	0.7	56.3	0.256	85.9	0.301
15	18.3	10.6	13.9	22	0.7	56.0	0.257	83.4	0.292
16	17.4	10.8	13.7	21	0.7	56.4	0.255	83.0	0.291
17	18.5	11.2	15.1	23	0.7	56.3	0.252	83.7	0.293
18	17.9	10.7	14.6	22	0.7	56.0	0.253	82.3	0.288
19	16.4	11.0	12.7	20	0.7	56.5	0.262	84.3	0.295
Average	18.6	12.5	14.2	23	0.7	53.3	0.260	83.8	0.293

Total number of blows analyzed: 18

Time Summary

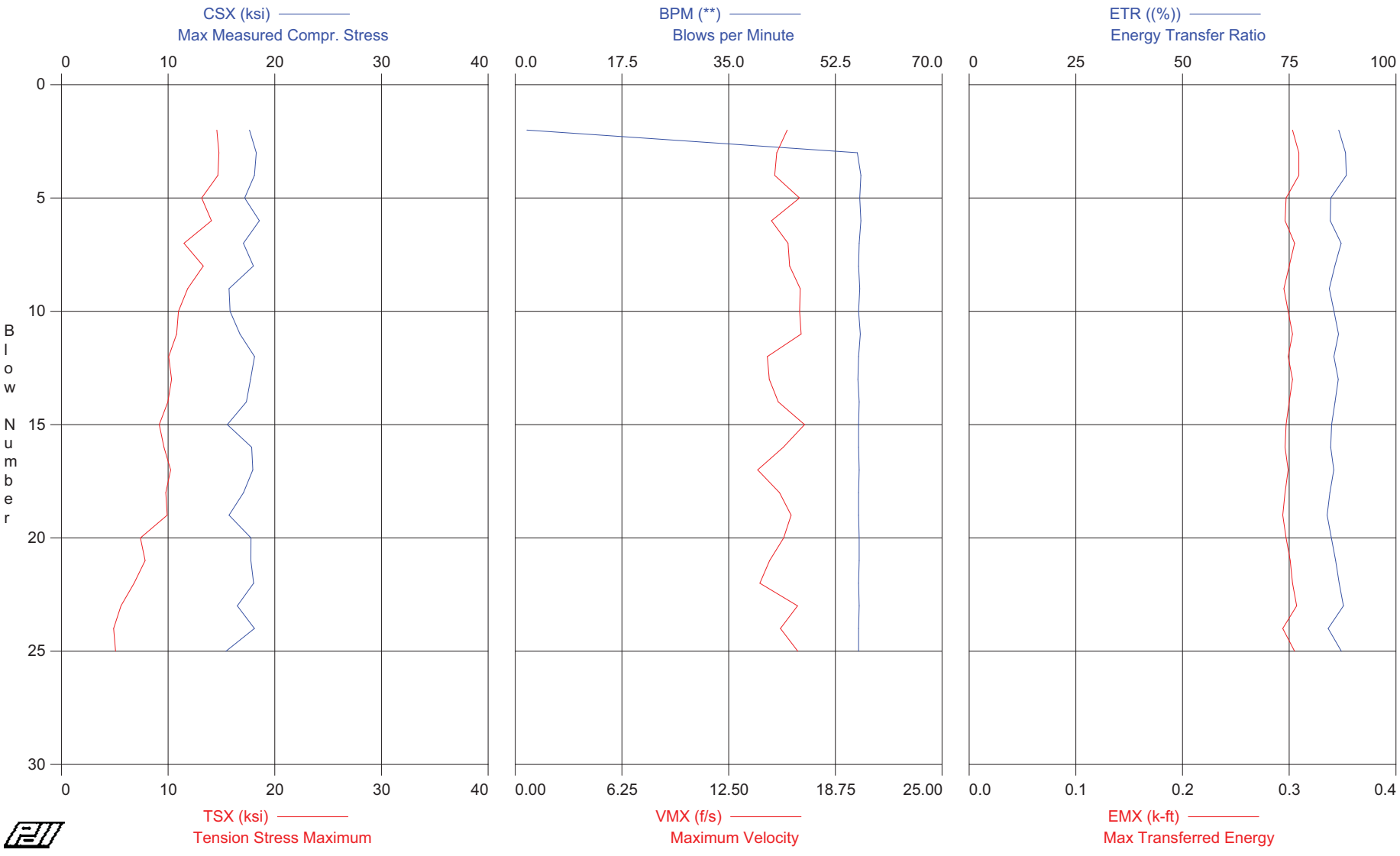
Drive 4 minutes 56 seconds 11:55:59 AM - 12:00:55 PM (9/2/2009) BN 1 - 20

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M-8 (38.7' - 40.2' sample)



NORTH ANNA 3 Project - BORING M-8 (38.7' - 40.2' sample)
OP: JNH
Rig Serial No. MEC-12; CME-45c Track (D. Rhodes)
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 44.20 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	17.6	14.6	15.9	22	0.6	1.9	0.274	86.6	0.303
3	18.3	14.8	15.3	22	0.5	56.1	0.274	88.2	0.309
4	18.1	14.7	15.2	22	0.5	56.7	0.269	88.4	0.309
5	17.2	13.1	16.7	21	0.6	56.5	0.258	84.7	0.297
6	18.6	14.1	15.0	23	0.7	56.7	0.260	84.6	0.296
7	17.1	11.5	16.0	21	0.5	56.4	0.255	87.2	0.305
8	18.0	13.3	16.1	22	0.6	56.3	0.258	85.7	0.300
9	15.7	11.8	16.7	19	0.5	56.5	0.253	84.4	0.295
10	15.8	11.0	16.7	19	0.5	56.3	0.257	85.5	0.299
11	16.7	10.8	16.7	20	0.6	56.6	0.253	86.5	0.303
12	18.1	10.1	14.8	22	0.7	56.3	0.257	85.5	0.299
13	17.7	10.3	14.9	22	0.7	56.2	0.253	86.5	0.303
14	17.3	10.0	15.4	21	0.5	56.4	0.257	85.7	0.300
15	15.6	9.2	16.9	19	0.5	56.3	0.251	84.9	0.297
16	17.8	9.6	15.7	22	0.6	56.3	0.248	84.7	0.296
17	17.9	10.2	14.2	22	0.5	56.4	0.252	85.4	0.299
18	17.1	9.8	15.5	21	0.5	56.3	0.253	84.5	0.296
19	15.7	9.9	16.2	19	0.5	56.3	0.250	83.9	0.294
20	17.8	7.4	15.7	22	0.6	56.4	0.247	84.9	0.297
21	17.8	7.8	14.9	22	0.7	56.4	0.250	85.9	0.301
22	18.0	6.8	14.3	22	0.5	56.3	0.250	86.7	0.303
23	16.5	5.6	16.5	20	0.5	56.4	0.248	87.7	0.307
24	18.1	4.9	15.5	22	0.6	56.3	0.247	84.1	0.294
25	15.4	5.1	16.6	19	0.5	56.3	0.247	87.2	0.305
Average	17.2	10.3	15.7	21	0.6	54.1	0.255	85.8	0.300

Total number of blows analyzed: 24

Time Summary

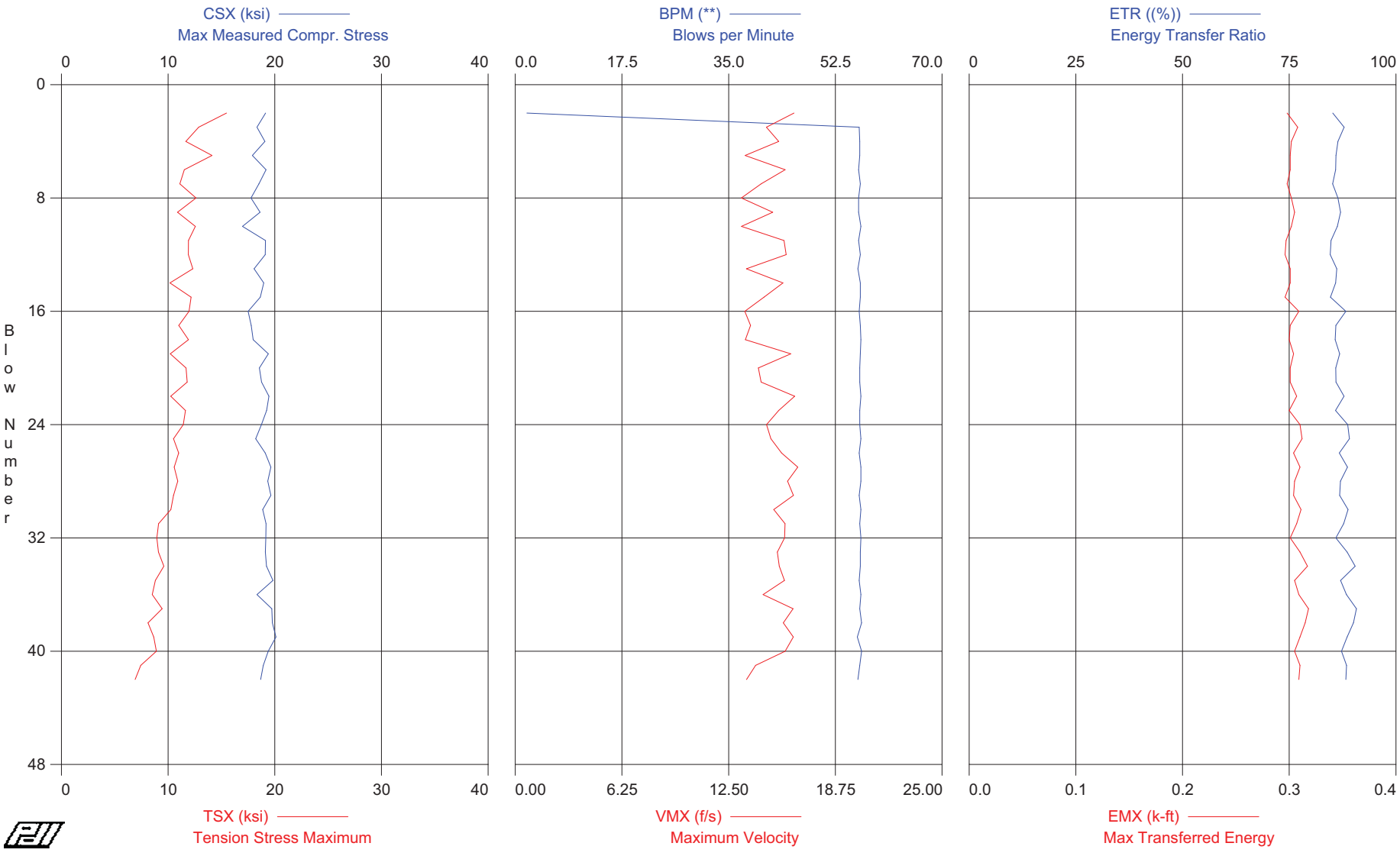
Drive 4 minutes 22 seconds 12:10:11 PM - 12:14:33 PM (9/2/2009) BN 1 - 26

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M-8 (43.7' - 45.2' sample)



NORTH ANNA 3 Project - BORING M-8 (43.7' - 45.2' sample)
OP: JNH
Rig Serial No. MEC-12; CME-45c Track (D. Rhodes)
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 49.20 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	19.1	15.5	16.3	23	0.7	1.9	0.254	85.2	0.298
3	18.3	12.9	14.7	22	0.7	56.4	0.268	87.9	0.308
4	19.1	11.7	15.4	23	0.7	56.5	0.261	86.4	0.302
5	17.9	14.1	13.5	22	0.8	56.5	0.260	86.0	0.301
6	19.2	11.5	15.8	23	0.7	56.3	0.261	85.9	0.301
7	18.5	11.1	14.4	23	0.7	56.6	0.262	85.2	0.298
8	17.8	12.6	13.2	22	0.7	56.3	0.261	86.4	0.302
9	18.6	10.9	15.1	23	0.7	56.3	0.259	87.0	0.305
10	17.0	12.6	13.3	21	0.7	56.7	0.258	86.3	0.302
11	19.1	11.9	15.7	23	0.7	56.3	0.258	84.8	0.297
12	19.1	11.9	15.9	23	0.7	56.6	0.259	84.6	0.296
13	18.1	12.3	13.5	22	0.7	56.2	0.261	86.1	0.301
14	19.0	10.2	15.7	23	0.7	56.6	0.261	85.9	0.301
15	18.7	12.2	14.6	23	0.7	56.6	0.256	84.7	0.296
16	17.5	12.0	13.4	21	0.7	56.4	0.261	88.3	0.309
17	17.8	11.0	13.8	22	0.7	56.6	0.264	85.9	0.301
18	18.0	11.9	13.5	22	0.7	56.7	0.264	85.8	0.300
19	19.4	10.2	16.1	24	0.7	56.6	0.264	86.8	0.304
20	18.6	11.7	14.2	23	0.7	56.5	0.266	85.9	0.301
21	18.8	11.8	14.4	23	0.7	56.5	0.263	86.0	0.301
22	19.4	10.3	16.4	24	0.7	56.7	0.265	87.8	0.307
23	19.2	11.6	15.4	23	0.7	56.5	0.261	85.8	0.300
24	18.8	11.4	14.7	23	0.7	56.5	0.260	88.7	0.310
25	18.2	10.5	15.0	22	0.7	56.7	0.262	89.1	0.312
26	19.1	11.0	15.6	23	0.7	56.4	0.262	86.7	0.304
27	19.6	10.6	16.6	24	0.7	56.7	0.265	88.6	0.310
28	19.4	10.9	16.0	24	0.7	56.7	0.258	87.0	0.305
29	19.6	10.5	16.3	24	0.7	56.4	0.265	86.8	0.304
30	18.9	10.3	15.1	23	0.7	56.7	0.269	88.8	0.311
31	19.2	9.1	15.8	23	0.7	56.5	0.261	87.8	0.307
32	19.2	9.0	15.8	23	0.7	56.7	0.262	85.9	0.301
33	19.1	9.1	15.3	23	0.7	56.6	0.263	88.6	0.310
34	19.2	9.6	15.5	23	0.7	56.6	0.264	90.4	0.317
35	19.8	8.8	15.8	24	0.7	56.4	0.260	87.0	0.305
36	18.3	8.5	14.5	22	0.7	56.7	0.261	88.4	0.309
37	19.7	9.4	16.3	24	0.7	56.5	0.265	90.8	0.318
38	19.8	8.1	15.7	24	0.7	56.8	0.263	90.1	0.315
39	20.1	8.7	16.3	25	0.7	56.1	0.262	88.6	0.310
40	19.4	8.9	15.8	24	0.7	56.8	0.263	87.2	0.305
41	18.9	7.4	14.1	23	0.8	56.5	0.259	88.4	0.310
42	18.7	6.9	13.5	23	0.8	56.2	0.265	88.3	0.309
Average	18.9	10.7	15.1	23	0.7	55.2	0.262	87.1	0.305

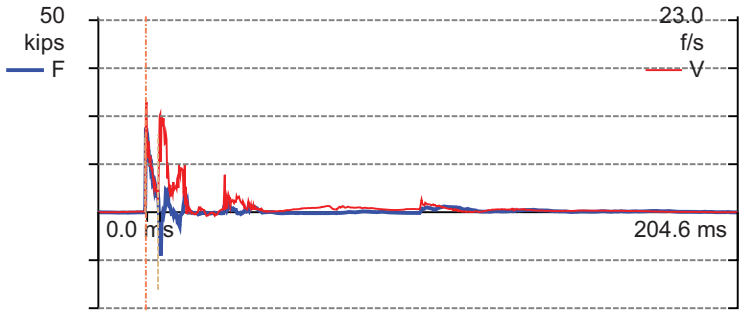
Total number of blows analyzed: 41

Time Summary

Drive 1 minute 47 seconds 12:24:49 PM - 12:26:36 PM (9/2/2009) BN 1 - 42

Project: NORTH ANNA 3
Pile: BORING M8 (28.7-30.2) - Description: CME 45C TRACK(D. RHODES)
Operator: JNH

BN 11
9/2/2009 11:47:41 AM



LP	0.00	ft
CSX	17.2	ksi
CSI	18.0	ksi
TSX	11.2	ksi
EMX	0.3	k-ft
STK	4.28	ft
FVP	0.75	[]
SFR	0	kips
RX5	4	kips
RMX	3	kips

LE	34.20	ft
AR	1.22	in^2
EM	30,000.0	ksi
SP	0.492	k/ft3
WS	16,807.9	f/s
WC	16,807.9	f/s
JC	0.70	[]
2L/c	4.07	ms
EA/c	2.2	ksec/ft
FR	5.000	kHz

MACTEC

Engineering and constructing a better tomorrow

November 16, 2009

For Jon Honeycutt with permission

From: Jon Honeycutt, Staff Professional JC

Reviewed By: Steve Kiser, Principal Professional SK

Subject: **Report of SPT Energy – MACTEC CME 55 Track (RAL)**
Hammer Serial No. MEC-21 Automatic Hammer
WORK INSTRUCTION No. 8 (DCN:NAP-077)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Jonathan Honeycutt, 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 September 1, 2009, during drilling of Boring M-30(DH) at the referenced site. The testing was performed by Jonathan Honeycutt from approximately 4:05 PM to 4:45 PM on September 1 under clear skies with a temperature of about 75 degrees Fahrenheit. The boring was drilled by MACTEC personnel using equipment from the MACTEC Raleigh office. The drilling equipment consisted of a CME 55 model track drill rig with an SPT automatic hammer. The drilling tools consisted of AW-J-sized drilling rods and a 2-foot long split-barrel sampler. Mud rotary drilling techniques were used to advance the boring at the time of energy testing. The drill rig operator during sampling was Mr. Thomas Hahn. 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 PAX (Serial No. 3622L), and calibrated accelerometers (Serial Nos. K983 and K0686) and strain gages (Serial Nos. AW#75/1 and AW#75/2). A 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 1.22 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.

18 Pages Total

MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100 • Charlotte, NC 28208 • Phone: 704.357.8600

www.mactec.com

Calibration Records

The calibration records for all the above are filed in DCN NAP-223.

Calculations for EFV

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

As recommended by ASTM D4633-05, the force-velocity method of energy calculation was used. The equation shown above for calculating EFV, 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 PDIPLOT tables and are also shown graphically in the PDIPLOT 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 generally consistent between individual hammer blows and between the sample depths tested. In general, the first and last one (and sometimes two or more) 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. This may result in more or less hammer blows evaluated for ETR than what is shown on the boring logs.

- The average energy transferred from the hammer to the drill rods for each individual depth interval using the EFV method ranged from 302 foot-pounds to 317 foot-pounds. These average energy transfers correspond to energy transfer ratios (ETR) of 86.3% to 90.6% 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 average energy transfer of the SPT system (for all the depth intervals tested) was 306.1 foot-pounds, with an average ETR of 87.4%.

Attachments: Page 4 Table 1 - Summary of SPT Energy Measurements – 1 Page
Page 5 - 6 Work Instruction No. 8 DCN:NAP 077– 2 Pages (without attachments)
Pages 7 Record of SPT Energy Measurement – 1 Page
Pages 8 – 17 PDIPLOT Output – 10 Pages
Page 18 Force-Velocity Plot – 1 Page

TABLE 1
SUMMARY OF SPT ENERGY MEASUREMENTS (ASTM D4633-05)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Automatic Hammer Serial Number and Rig Model	Rig Owner	Rig Operator	Boring No. Tested	Date Tested	Drill Rod Size	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)
MEC-21 (CME 55 Track)	MACTEC Raleigh	Thomas Hahn	M-30 (DH)	9/1/2009	AW-J	11.1 - 12.6	4 - 6 - 6	16	304	86.9%
						13.7 - 15.2	4 - 7 - 7	19	302	86.3%
						18.7 - 20.2	6 - 7 - 6	19	317	90.6%
						23.7 - 25.2	7 - 8 - 10	25	307	87.7%
						28.7 - 30.2	11 - 14 - 15	40	303	86.6%
								Average for Rig:	**306.1**	**87.4%**

[a]Measured 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. This may result in more or less blows evaluated for ETR than what is shown on the boring logs.

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

[b]Energy 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 EFV and ETR values may differ slightly and insignificantly from those in the PDIPLOT tables due to roundoff.

Prepared By: L C. Date: 11-16-09		Checked By: [signature] Date: 11-16-09

For Jon Honeycutt
With Permission

Work Instruction No. 8
North Anna 3 Project
MACTEC Engineering and Consulting, Inc.
Project Number: 6468-09-2473

Issued To: Jonathan Honeycutt, Steve Kiser Rev. No. 0

Issued By: D. Steven Copley, P.E. DSC 8-31-09 Date: August 31, 2009

Valid From: August 31, 2009 To: August 31, 2010

Task Description: Perform SPT Energy Measurements

Applicable Technical Procedures or Plans, or other reference:

1. Geotechnical Work Plan (complete copy of current revision available at Field Office), Section 4.2 and Attachment 2 – Drilling and Sampling Procedures (attached)
2. Engineering Specification for Subsurface Investigation and Laboratory Testing, No. 25161-500-3PS-CY00-Q0001, Rev. 000, Issued for use August 21, 2009, Section 3.3 Drilling Equipment (attached)
3. ASTM D 4633-05 (attached)

Specific Instructions (note attachments where necessary): Perform energy measurements for each drill rig on site in general accordance with ASTM D 4633-05. Consult with Site Manager as to schedule for performing the measurements. Hammer weights have been checked, and records will be available on site. All rigs are using automatic hammer systems. Confirm that automatic hammer system is being operated within manufacturer's recommendations or in a typical operating fashion as observed from watching one or two SPT measurements prior to measuring energy. Check each drill rig using all hammer/rod combinations that it will be using. Depths for measurements should be coordinated with the Site Manager. See Site Manager for current boring logs of holes drilled, if available, and use these to plan most effective field measurement program. Submit copies of calibration records for equipment to Principal Professional for review prior to beginning work on site.

Confirm with Site Manager that approval of equipment calibration records have been received prior to beginning field testing. If unexpected conditions are encountered that affect measurements, contact Site Manager or Principal Professional immediately.

Report Format: Prepare standard report in accordance with ASTM D 4633-05 requirements.

Specific Quality Assurance Procedures Applicable: 10CFR21; NQAP 16-01 Procedure For Conforming To Federal Regulation 10CFR21; QAP 20-1; QAP 25-1; Section 306 of the Energy Reorganization Act of 1974. Current revisions apply; copies available in Field Office.

Hold Points or Witness Points: None

Records: All records generated shall be considered QA Records.

Reviewed and Approved By (Note: Only one signature required for issuance):

Project Manager: _____ Date: _____

Principal Professional: D. Aaron Copley Date: 8-31-09

Site Manager: _____ Date: _____

No. of Pages: 15 DCN: NAP077

QA Form 24-1 Revised 8/12/2009

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

RECORD OF SPT ENERGY MEASUREMENT

GENERAL INFORMATION		DRILL RIG DATA	
PROJECT:	North Anna 3 Project	MAKE:	CME
LOCATION:	Virginia	MODEL:	55 Track
PROJECT NO.:	6468-09-2473	SERIAL NO.:	MEC-21
DATE:	9/1/2009	HAMMER TYPE:	Auto
WEATHER:	Sunny 75°F	ROPE CONDITION:	N/A
INSPECTOR:	JNH	ROD SIZE:	AW-J
DRILLING COMPANY:	MACTEC - Raleigh	NO. OF SHEAVES:	N/A

BORING DATA			
BORING NUMBER:	M-30(DH)		
DEPTH DRILLED:	Various		
TIME DRIVEN:	4:05 pm - 4:45 pm		
RIG OPERATOR:	T. HAHN		
HAMMER OPERATOR:	N/A		
PDA PAK SERIAL NO.:	3622L		
INSTR. ROD AREA:	1.22 in2		
ACCEL. SERIAL NOS.:	A1-K983 : A2-K0686		
STRAIN SERIAL NOS.:	75AW # 1 / 2		

SAMPLE DEPTH (feet)	SPT N-VALUE (bpf)							
11.1 - 12.6	4-6-6							
13.7 - 15.2	4-7-7							
18.7 - 20.2	6-7-6							
23.7 - 25.2	7-8-10							
28.7 - 30.2	11-14-15							

REMARKS: Testing performed in accordance with ASTM D 4633-05

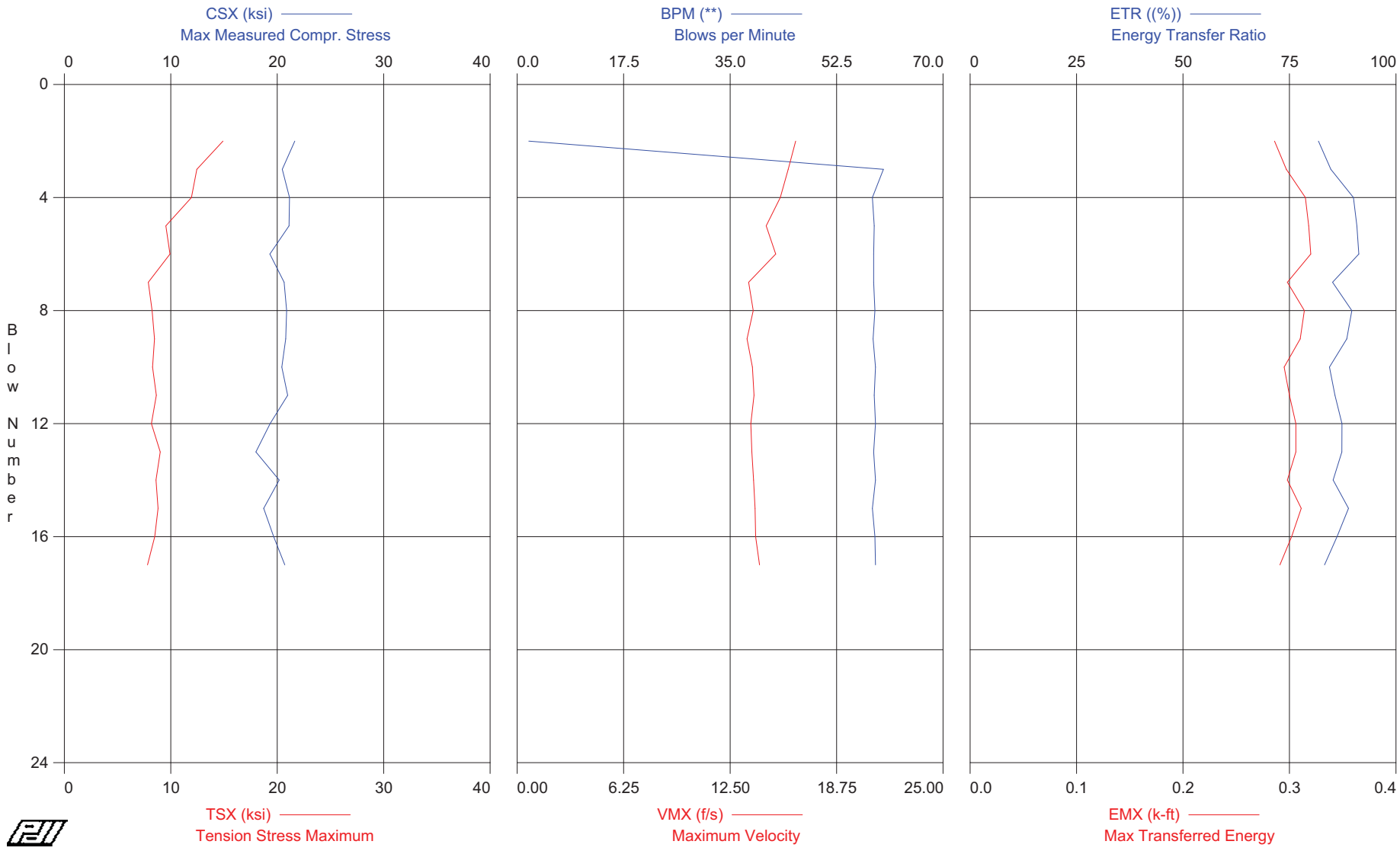
Reviewed By:

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - BORING M-30(DH) (11.1' - 12.6' sample)



NORTH ANNA 3 Project - BORING M-30(DH) (11.1' - 12.6' sample)
Rig Serial No. MEC-21; CME 55 (T.Hahn)
OP: JNH
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 16.60 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	21.6	14.9	16.3	26	0.8	1.9	0.251	81.8	0.286
3	20.5	12.4	15.9	25	0.8	60.2	0.246	84.7	0.297
4	21.2	11.9	15.4	26	0.9	58.4	0.243	90.0	0.315
5	21.1	9.5	14.6	26	0.9	58.7	0.244	90.8	0.318
6	19.3	9.9	15.2	24	0.8	58.6	0.242	91.3	0.320
7	20.6	7.9	13.6	25	0.9	58.6	0.236	85.1	0.298
8	20.9	8.2	13.9	25	0.9	58.8	0.235	89.6	0.314
9	20.8	8.5	13.5	25	0.9	58.5	0.234	88.5	0.310
10	20.4	8.3	13.8	25	0.8	58.9	0.233	84.4	0.295
11	21.0	8.6	13.9	26	0.8	58.7	0.234	85.7	0.300
12	19.3	8.2	13.7	24	0.8	58.9	0.235	87.3	0.306
13	18.0	9.0	13.8	22	0.8	58.6	0.235	87.3	0.306
14	20.2	8.6	13.9	25	0.8	58.9	0.228	85.3	0.298
15	18.7	8.8	14.0	23	0.8	58.4	0.235	88.9	0.311
16	19.7	8.5	14.0	24	0.8	58.8	0.231	86.2	0.302
17	20.7	7.8	14.2	25	0.8	58.9	0.230	83.2	0.291
Average	20.3	9.5	14.4	25	0.8	55.2	0.237	86.9	0.304

Total number of blows analyzed: 16

Time Summary

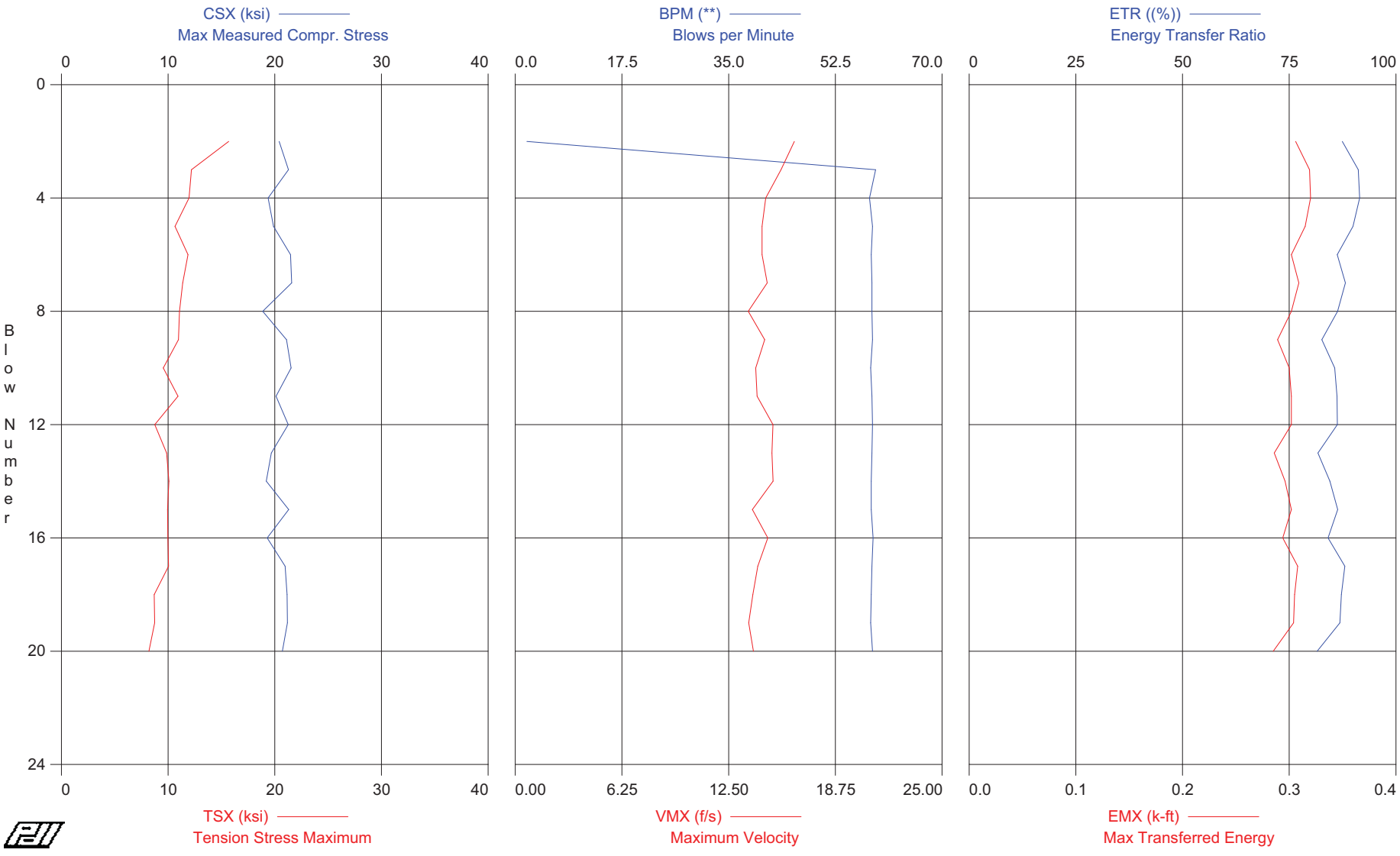
Drive 1 minute 44 seconds 3:54:35 PM - 3:56:19 PM (9/1/2009) BN 1 - 18

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - BORING M-30(DH) (13.7' - 15.2' sample)



NORTH ANNA 3 Project - BORING M-30(DH) (13.7' - 15.2' sample)
OP: JNH

Rig Serial No. MEC-21; CME 55 (T.Hahn)
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 19.20 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality

BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	20.4	15.7	16.4	25	0.8	1.9	0.273	87.4	0.306
3	21.3	12.2	15.6	26	0.8	59.1	0.257	91.2	0.319
4	19.4	12.0	14.7	24	0.8	58.1	0.265	91.5	0.320
5	19.9	10.7	14.5	24	0.8	58.6	0.264	89.9	0.315
6	21.5	11.9	14.5	26	0.9	58.4	0.261	86.3	0.302
7	21.6	11.4	14.8	26	0.9	58.5	0.260	88.2	0.309
8	18.9	11.1	13.6	23	0.8	58.5	0.257	86.3	0.302
9	21.1	11.0	14.6	26	0.9	58.6	0.251	82.6	0.289
10	21.5	9.6	14.1	26	1.0	58.3	0.261	85.7	0.300
11	20.1	10.9	14.2	25	0.8	58.5	0.260	86.2	0.302
12	21.3	8.8	15.1	26	0.9	58.6	0.252	86.3	0.302
13	19.7	9.9	15.0	24	0.9	58.5	0.247	81.7	0.286
14	19.2	10.1	15.1	23	0.8	58.4	0.250	84.5	0.296
15	21.3	9.9	13.9	26	1.0	58.4	0.253	86.4	0.302
16	19.3	10.0	14.8	24	0.8	58.7	0.253	84.1	0.294
17	21.0	10.1	14.2	26	0.8	58.5	0.255	88.0	0.308
18	21.2	8.7	13.9	26	0.9	58.4	0.250	87.2	0.305
19	21.2	8.7	13.7	26	0.9	58.3	0.253	86.9	0.304
20	20.7	8.2	14.0	25	0.8	58.6	0.253	81.5	0.285
Average	20.5	10.6	14.5	25	0.9	55.5	0.257	86.4	0.302

Total number of blows analyzed: 19

Time Summary

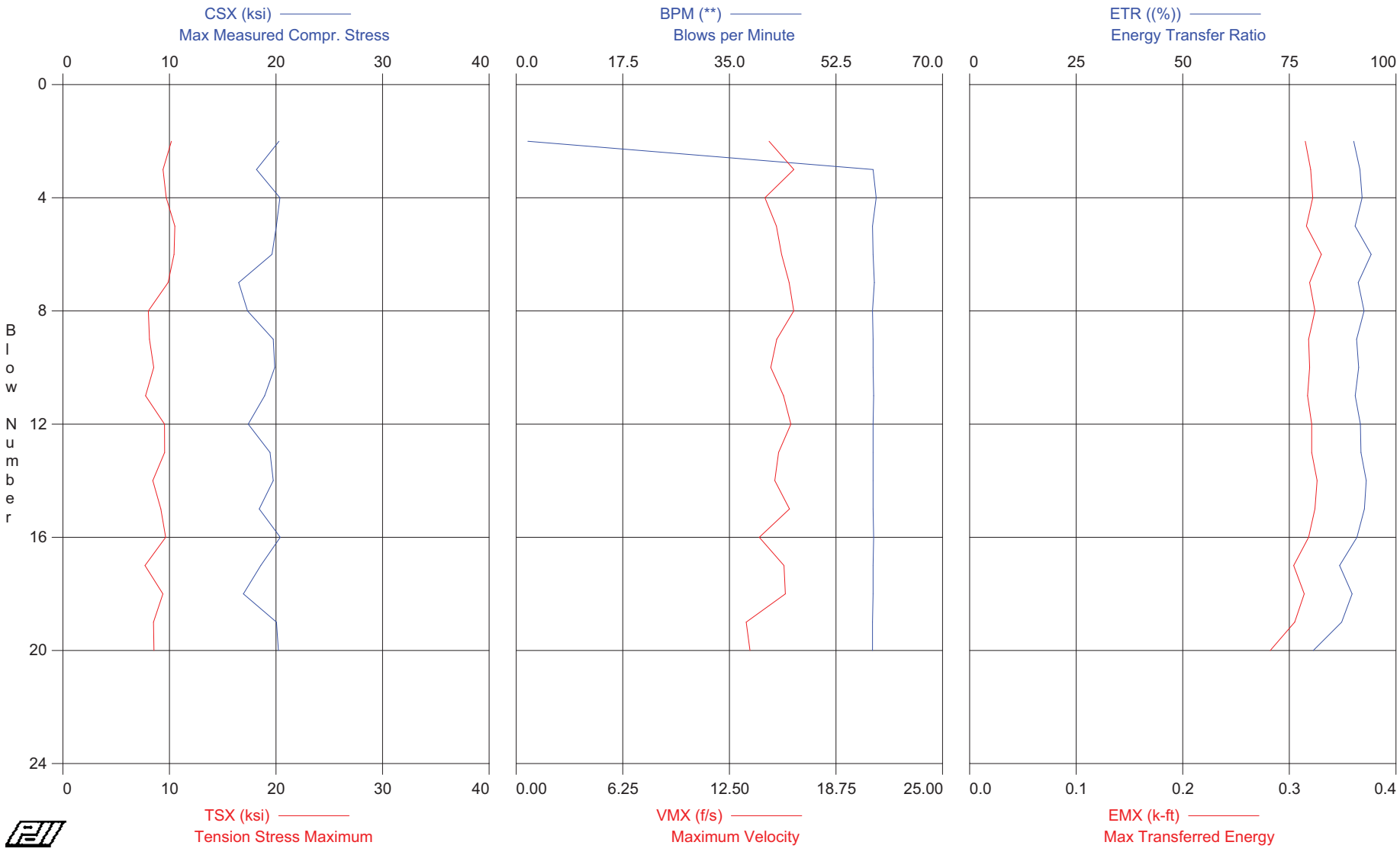
Drive 34 seconds 4:05:23 PM - 4:05:57 PM (9/1/2009) BN 1 - 20

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - BORING M-30(DH) (18.7' - 20.2' sample)



NORTH ANNA 3 Project - BORING M-30(DH) (18.7' - 20.2' sample)
OP: JNH

Rig Serial No. MEC-21; CME 55 (T.Hahn)
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 24.20 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality

BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	20.3	10.2	14.8	25	0.5	1.9	0.239	90.1	0.315
3	18.2	9.4	16.3	22	0.6	58.6	0.234	91.6	0.320
4	20.4	9.7	14.6	25	0.8	59.1	0.237	92.0	0.322
5	20.0	10.5	15.3	24	0.5	58.5	0.241	90.4	0.316
6	19.6	10.4	15.6	24	0.7	58.6	0.234	94.2	0.330
7	16.5	9.9	16.0	20	0.6	58.8	0.235	91.2	0.319
8	17.3	8.0	16.3	21	0.6	58.5	0.230	92.5	0.324
9	19.7	8.1	15.3	24	0.7	58.6	0.234	90.8	0.318
10	19.9	8.5	14.9	24	0.5	58.6	0.233	91.3	0.319
11	18.9	7.8	15.7	23	0.5	58.7	0.233	90.4	0.317
12	17.4	9.5	16.1	21	0.6	58.6	0.234	91.7	0.321
13	19.4	9.6	15.4	24	0.5	58.6	0.237	91.8	0.321
14	19.7	8.4	15.2	24	0.7	58.6	0.230	93.0	0.326
15	18.4	9.2	16.0	22	0.6	58.6	0.232	92.6	0.324
16	20.4	9.6	14.3	25	0.5	58.7	0.235	90.9	0.318
17	18.6	7.7	15.7	23	0.7	58.6	0.228	86.8	0.304
18	16.9	9.4	15.8	21	0.6	58.6	0.231	89.7	0.314
19	20.0	8.5	13.5	24	0.8	58.5	0.227	87.3	0.305
20	20.2	8.5	13.7	25	0.8	58.5	0.228	80.6	0.282
Average	19.1	9.1	15.3	23	0.6	55.6	0.233	90.5	0.317

Total number of blows analyzed: 19

Time Summary

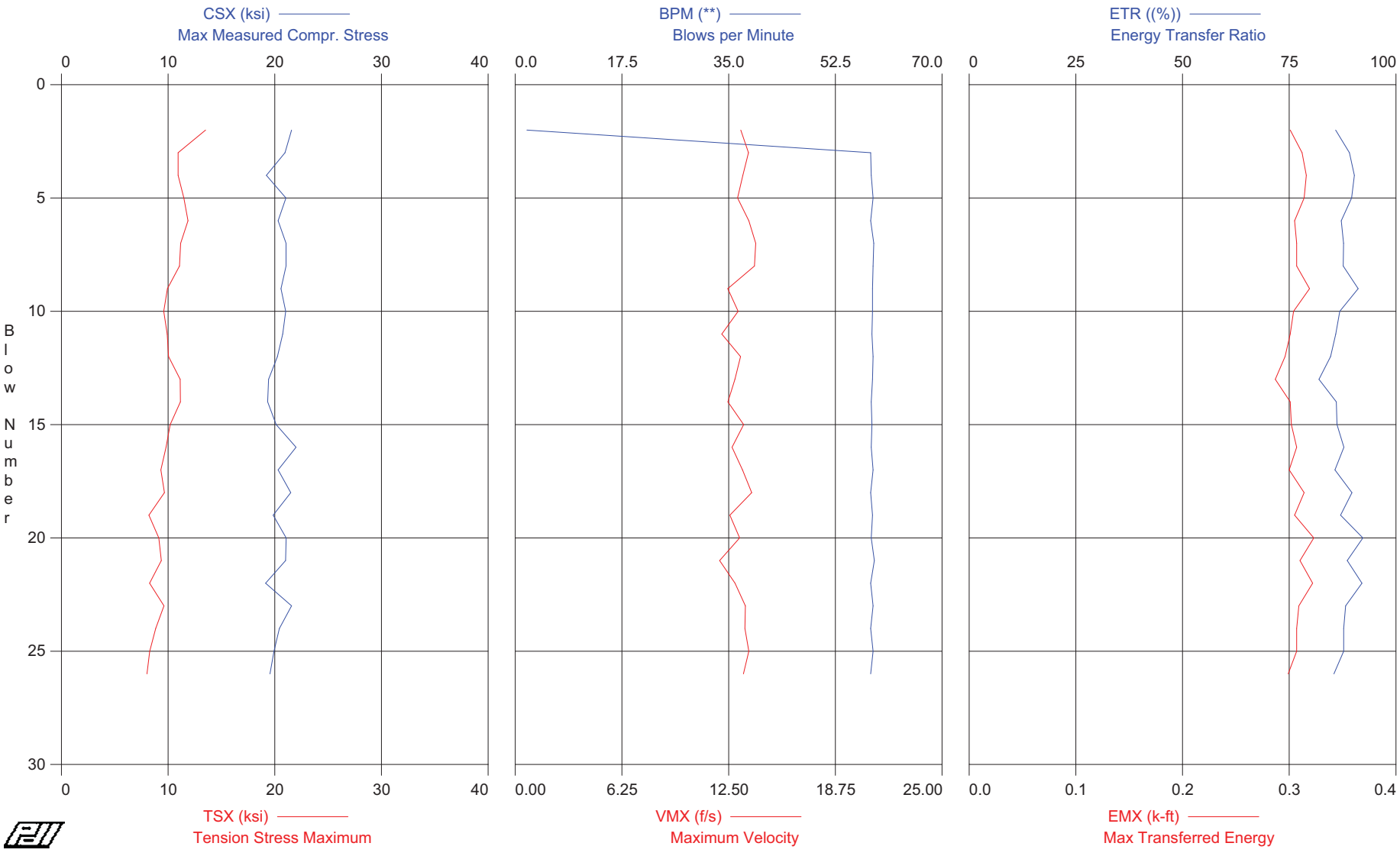
Drive 31 seconds 4:15:08 PM - 4:15:39 PM (9/1/2009) BN 1 - 20

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - BORING M-30(DH) (23.7' - 25.2' sample)



NORTH ANNA 3 Project - BORING M-30(DH) (23.7' - 25.2' sample)
OP: JNH
Rig Serial No. MEC-21; CME 55 (T.Hahn)
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 29.20 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	21.6	13.5	13.2	26	0.9	1.9	0.249	85.9	0.301
3	21.0	10.9	13.7	26	0.9	58.3	0.251	89.1	0.312
4	19.2	10.9	13.3	23	0.8	58.4	0.256	90.3	0.316
5	21.0	11.5	13.0	26	0.9	58.7	0.255	89.6	0.314
6	20.3	11.9	13.7	25	0.8	58.3	0.254	87.2	0.305
7	21.0	11.2	14.1	26	0.8	58.8	0.251	87.7	0.307
8	21.1	11.1	14.0	26	0.8	58.7	0.255	87.7	0.307
9	20.6	9.9	12.5	25	0.9	58.6	0.254	91.2	0.319
10	21.0	9.6	13.1	26	0.9	58.6	0.253	86.8	0.304
11	20.7	9.9	12.1	25	1.0	58.5	0.252	85.9	0.301
12	20.2	10.0	13.2	25	0.9	58.7	0.249	84.7	0.296
13	19.4	11.1	12.9	24	0.8	58.6	0.255	82.0	0.287
14	19.3	11.2	12.5	24	0.8	58.4	0.252	86.0	0.301
15	20.1	10.2	13.4	25	0.8	58.5	0.257	86.2	0.302
16	22.0	9.8	12.7	27	1.0	58.4	0.257	87.8	0.307
17	20.3	9.3	13.3	25	0.9	58.7	0.252	85.7	0.300
18	21.5	9.7	13.9	26	0.9	58.3	0.258	89.7	0.314
19	19.9	8.2	12.6	24	0.8	58.6	0.261	87.0	0.305
20	21.1	9.1	13.1	26	0.9	58.4	0.251	92.3	0.323
21	21.0	9.4	12.0	26	0.8	58.9	0.255	88.6	0.310
22	19.1	8.3	12.9	23	0.8	58.3	0.257	92.0	0.322
23	21.6	9.6	13.5	26	0.9	58.7	0.254	88.2	0.309
24	20.4	8.8	13.5	25	0.8	58.3	0.260	87.7	0.307
25	19.9	8.3	13.7	24	0.8	58.7	0.257	87.8	0.307
26	19.5	8.0	13.4	24	0.8	58.3	0.259	85.5	0.299
Average	20.5	10.1	13.2	25	0.9	56.3	0.255	87.7	0.307

Total number of blows analyzed: 25

Time Summary

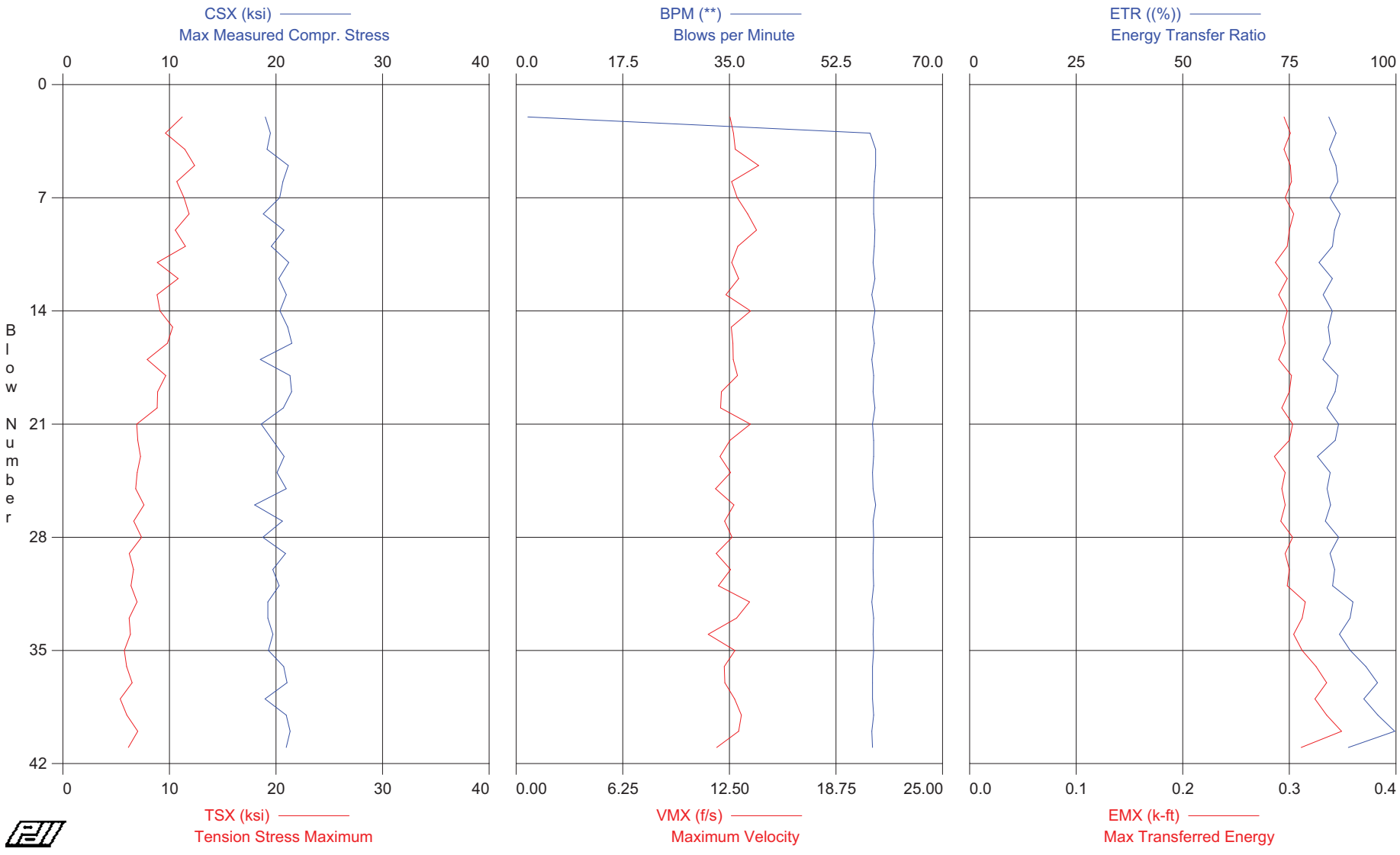
Drive 50 seconds 4:23:26 PM - 4:24:16 PM (9/1/2009) BN 1 - 27

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 16-Nov-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - BORING M-30(DH) (28.7' - 30.2' sample)



NORTH ANNA 3 Project - BORING M-30(DH) (28.7' - 30.2' sample) Rig Serial No. MEC-21; CME 55 (T.Hahn)
OP: JNH Test date: 1-Sep-2009

AR: 1.22 in^2 SP: 0.492 k/ft3
LE: 34.20 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

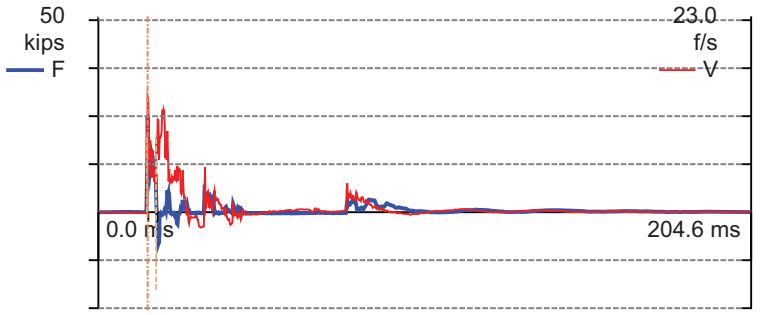
BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	19.0	11.2	12.5	23	0.8	1.9	0.273	84.2	0.295
3	19.5	9.6	12.7	24	0.8	58.1	0.285	85.9	0.301
4	19.2	11.4	12.8	23	0.8	59.0	0.285	84.4	0.295
5	21.1	12.4	14.2	26	0.8	59.0	0.273	85.9	0.301
6	20.6	10.7	12.6	25	0.8	58.8	0.279	86.4	0.302
7	20.3	11.4	13.0	25	0.9	58.7	0.275	84.5	0.296
8	18.8	11.8	13.6	23	0.8	58.7	0.277	86.9	0.304
9	20.7	10.5	14.1	25	0.8	58.9	0.272	85.6	0.300
10	19.6	11.5	13.0	24	0.8	58.8	0.276	85.1	0.298
11	21.2	8.9	12.6	26	0.9	58.6	0.271	82.0	0.287
12	20.3	10.8	13.0	25	0.8	58.9	0.273	85.1	0.298
13	21.0	8.8	12.3	26	1.0	58.4	0.274	82.9	0.290
14	20.4	9.1	13.7	25	0.8	58.9	0.267	85.1	0.298
15	21.1	10.3	12.6	26	0.9	58.5	0.269	84.1	0.294
16	21.5	9.8	12.7	26	0.9	58.8	0.273	84.6	0.296
17	18.5	7.9	12.7	23	0.8	58.4	0.277	82.9	0.290
18	21.3	9.7	13.0	26	0.9	58.7	0.270	86.4	0.302
19	21.5	8.9	12.0	26	0.8	58.6	0.272	85.7	0.300
20	20.7	8.9	12.0	25	1.0	58.9	0.266	83.8	0.293
21	18.6	6.9	13.7	23	0.8	58.5	0.270	86.5	0.303
22	19.7	7.0	12.5	24	0.8	58.7	0.270	85.8	0.300
23	20.8	7.3	11.9	25	0.8	58.7	0.272	81.6	0.286
24	20.1	7.0	12.6	25	0.7	58.5	0.268	84.6	0.296
25	21.0	6.8	11.7	26	0.7	58.6	0.270	83.8	0.293
26	18.0	7.6	12.8	22	0.8	59.0	0.269	84.6	0.296
27	20.6	6.7	12.2	25	0.9	58.6	0.262	83.5	0.292
28	18.8	7.4	12.7	23	0.8	58.7	0.273	86.6	0.303
29	20.9	6.2	11.7	25	1.0	58.6	0.266	84.6	0.296
30	19.7	6.6	12.6	24	0.9	58.6	0.266	85.6	0.300
31	20.3	6.4	11.9	25	1.0	58.7	0.263	85.1	0.298
32	19.2	7.0	13.7	23	0.8	58.4	0.269	89.9	0.315
33	19.2	6.2	12.9	23	0.8	58.7	0.270	89.2	0.312
34	19.7	6.3	11.3	24	1.0	58.6	0.263	86.7	0.304
35	19.3	5.8	12.8	24	0.8	58.7	0.266	89.3	0.312
36	20.7	6.0	12.2	25	0.7	58.5	0.262	93.0	0.325
37	21.0	6.5	12.2	26	0.7	58.5	0.264	95.7	0.335
38	19.0	5.4	12.8	23	0.8	58.5	0.266	92.5	0.324
39	21.0	6.0	13.2	26	0.7	58.7	0.264	95.8	0.335
40	21.3	7.0	13.0	26	0.7	58.4	0.270	99.7	0.349
41	21.0	6.1	11.8	26	0.8	58.5	0.269	88.8	0.311
Average	20.2	8.3	12.7	25	0.8	57.2	0.270	86.6	0.303

Total number of blows analyzed: 40

Time Summary

Drive 2 minutes 41 seconds 4:32:18 PM - 4:34:59 PM (9/1/2009) BN 1 - 41

Project: NORTH ANNA 3
Pile: BORING M30-DH(18.7-20.2) - Description: CME 55 (T.HAHN)
Operator: JNH



BN 19
9/1/2009 4:15:38 PM

LP	0.00	ft	LE	24.20	ft
CSX	20.0	ksi	AR	1.22	in^2
CSI	20.4	ksi	EM	30,000.0	ksi
TSX	8.5	ksi	SP	0.492	k/ft3
EMX	0.3	k-ft	WS	16,807.9	f/s
STK	3.93	ft	WC	16,807.9	f/s
FVP	0.83	[]	JC	0.70	[]
SFR	1	kips	2L/c	2.88	ms
RX5	5	kips	EA/c	2.2	ksec/ft
RMX	5	kips	FR	5.000	kHz

MACTEC

Engineering and constructing a better tomorrow

December 2, 2009

From: Jon Honeycutt, Staff Professional JNH 12/2/09

Reviewed By: Steve Kiser, Principal Professional SLK 12-2-09

Subject: **Report of SPT Energy – MACTEC CME-55 Trailer (RAL)**
Hammer Serial No. MEC-425 Automatic Hammer
WORK INSTRUCTION No. 8 (DCN:NAP-077)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Jonathan Honeycutt, 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 September 2, 2009, during drilling of Boring M-11 at the referenced site. The testing was performed by Jonathan Honeycutt from approximately 10:05 AM to 11:15 AM on September 2 under clear skies with a temperature of about 65 degrees Fahrenheit. The boring was drilled by MACTEC personnel using equipment from the MACTEC Raleigh office. The drilling equipment consisted of a CME-55 model trailer-mounted drill rig with an SPT automatic hammer. The drilling tools consisted of AW-J-sized drilling rods and a 2-foot long split-barrel sampler. Mud rotary drilling techniques were used to advance the boring at the time of energy testing. The drill rig operator during sampling was Mr. Phil Pitts. 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 PAX (Serial No. 3622L), and calibrated accelerometers (Serial Nos. K983 and K0686) and strain gages (Serial Nos. AW#75/1 and AW#75/2). A 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 was two feet below the hammer impact point and had a cross-sectional area of approximately 1.22 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.

14 Pages Total

MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100 • Charlotte, NC 28208 • Phone: 704.357.8600

www.mactec.com

Calibration Records

The calibration records for all the above are filed in DCN NAP-223

Calculations for EFV

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

As recommended by ASTM D4633-05, the force-velocity method of energy calculation was used. The equation shown above for calculating EFV, 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 PDIPLOT tables and are also shown graphically in the PDIPLOT 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 generally consistent between individual hammer blows and between the sample depths tested. In general, the first and last one (and sometimes two or more) 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. This may result in more or less blows evaluated for ETR than what is shown on the boring logs. The test results collected at depths of 23.9 and 28.9 feet were not used in the determination of the ETR due to inconsistency in transferred energy between successive hammer blows.

- The average energy transferred from the hammer to the drill rods for each individual depth interval using the EFV method ranged from 278 foot-pounds to 310 foot-pounds. These average energy transfers correspond to energy transfer ratios (ETR) of 79.4% to 88.6% 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 average energy transfer of the SPT system (for all the depth intervals tested) was 298.6 foot-pounds, with an average ETR of 85.3%.

Attachments: Page 4 Table 1 - Summary of SPT Energy Measurements – 1 Page
Pages 5-6 Work Instruction No. 8 – DCN:NAP-077 – 2 Pages (without attachments)
Page 7 Record of SPT Energy Measurement – 1 Page
Pages 8 – 13 PDIPLOT Output – 6 Pages
Page 14 Force-Velocity Plot – 1 Page

TABLE 1
SUMMARY OF SPT ENERGY MEASUREMENTS (ASTM D4633-05)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Automatic Hammer Serial Number and Rig Model	Rig Owner	Rig Operator	Boring No. Tested	Date Tested	Drill Rod Size	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)
MEC-425 (CME 55 Trailer)	MACTEC Raleigh	Phil Pitts	M-11	9/2/2009	AW-J	33.9 - 35.4	5 - 6 - 6	17	278	79.4%
						38.9 - 40.4	4 - 7 - 8	20	304	86.9%
						43.9 - 45.4	6 - 7 - 8	21	310	88.6%
								Average for Rig:	**298.6**	**85.3%**

[a]Measured 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. This may result in more or less blows evaluated for ETR than what is shown on the boring logs.

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

[b]Energy 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 EFV and ETR values may differ slightly and insignificantly from those in the PDIPLOT tables due to roundoff.

Prepared By:	Date: 12/2/09		Checked By:	Date: 12-2-09

Work Instruction No. 8
North Anna 3 Project
MACTEC Engineering and Consulting, Inc.
Project Number: 6468-09-2473

Issued To: Jonathan Honeycutt, Steve Kiser Rev. No. 0

Issued By: D. Steven Copley, P.E. DSC 8-31-09 Date: August 31, 2009

Valid From: August 31, 2009 To: August 31, 2010

Task Description: Perform SPT Energy Measurements

Applicable Technical Procedures or Plans, or other reference:

1. Geotechnical Work Plan (complete copy of current revision available at Field Office), Section 4.2 and Attachment 2 – Drilling and Sampling Procedures (attached)
2. Engineering Specification for Subsurface Investigation and Laboratory Testing, No. 25161-500-3PS-CY00-Q0001, Rev. 000, Issued for use August 21, 2009, Section 3.3 Drilling Equipment (attached)
3. ASTM D 4633-05 (attached)

Specific Instructions (note attachments where necessary): Perform energy measurements for each drill rig on site in general accordance with ASTM D 4633-05. Consult with Site Manager as to schedule for performing the measurements. Hammer weights have been checked, and records will be available on site. All rigs are using automatic hammer systems. Confirm that automatic hammer system is being operated within manufacturer's recommendations or in a typical operating fashion as observed from watching one or two SPT measurements prior to measuring energy. Check each drill rig using all hammer/rod combinations that it will be using. Depths for measurements should be coordinated with the Site Manager. See Site Manager for current boring logs of holes drilled, if available, and use these to plan most effective field measurement program. Submit copies of calibration records for equipment to Principal Professional for review prior to beginning work on site.

Confirm with Site Manager that approval of equipment calibration records have been received prior to beginning field testing. If unexpected conditions are encountered that affect measurements, contact Site Manager or Principal Professional immediately.

Report Format: Prepare standard report in accordance with ASTM D 4633-05 requirements.

Specific Quality Assurance Procedures Applicable: 10CFR21; NQAP 16-01 Procedure For Conforming To Federal Regulation 10CFR21; QAP 20-1; QAP 25-1; Section 306 of the Energy Reorganization Act of 1974. Current revisions apply; copies available in Field Office.

Hold Points or Witness Points: None

Records: All records generated shall be considered QA Records.

Reviewed and Approved By (Note: Only one signature required for issuance):

Project Manager: _____ Date: _____

Principal Professional: D. Aaron Copley Date: 8-31-09

Site Manager: _____ Date: _____

No. of Pages: 15 DCN: NAP077

QA Form 24-1 Revised 8/12/2009

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

RECORD OF SPT ENERGY MEASUREMENT

GENERAL INFORMATION		DRILL RIG DATA	
PROJECT:	North Anna 3 Project	MAKE:	CME
LOCATION:	Virginia	MODEL:	55-Trailer Mounted
PROJECT NO.:	6468-09-2473	SERIAL NO.:	MEC 425
DATE:	9/2/2009	HAMMER TYPE:	Auto
WEATHER:	Sunny 65°F	ROPE CONDITION:	N/A
INSPECTOR:	JNH	ROD SIZE:	AW-J
DRILLING COMPANY:	MACTEC - Raleigh	NO. OF SHEAVES:	N/A

BORING DATA

BORING NUMBER:	M-11									
DEPTH DRILLED:	Various									
TIME DRIVEN:	10:05 AM - 11:15 AM									
RIG OPERATOR:	P.P.H.S									
HAMMER OPERATOR:	N/A									
PDA PAK SERIAL NO.:	3622L									
INSTR. ROD AREA:	1.22 in²									
ACCEL. SERIAL NOS.:	A1-K983 : A2-K0686									
STRAIN SERIAL NOS.:	75 AW #1/2									

SAMPLE DEPTH (feet)	SPT N-VALUE (bpf)
23.9 - 25.4	6 - 8 - 8
28.9 - 30.4	6 - 11 - 12
33.9 - 35.4	5 - 6 - 6
38.9 ~~38.4~~ - 40.4	4 - 7 - 8
43.9 - 45.4	6 - 7 - 8

JNH 9/2/09

REMARKS: Testing performed in accordance with ASTM D 4633-05

Reviewed By:

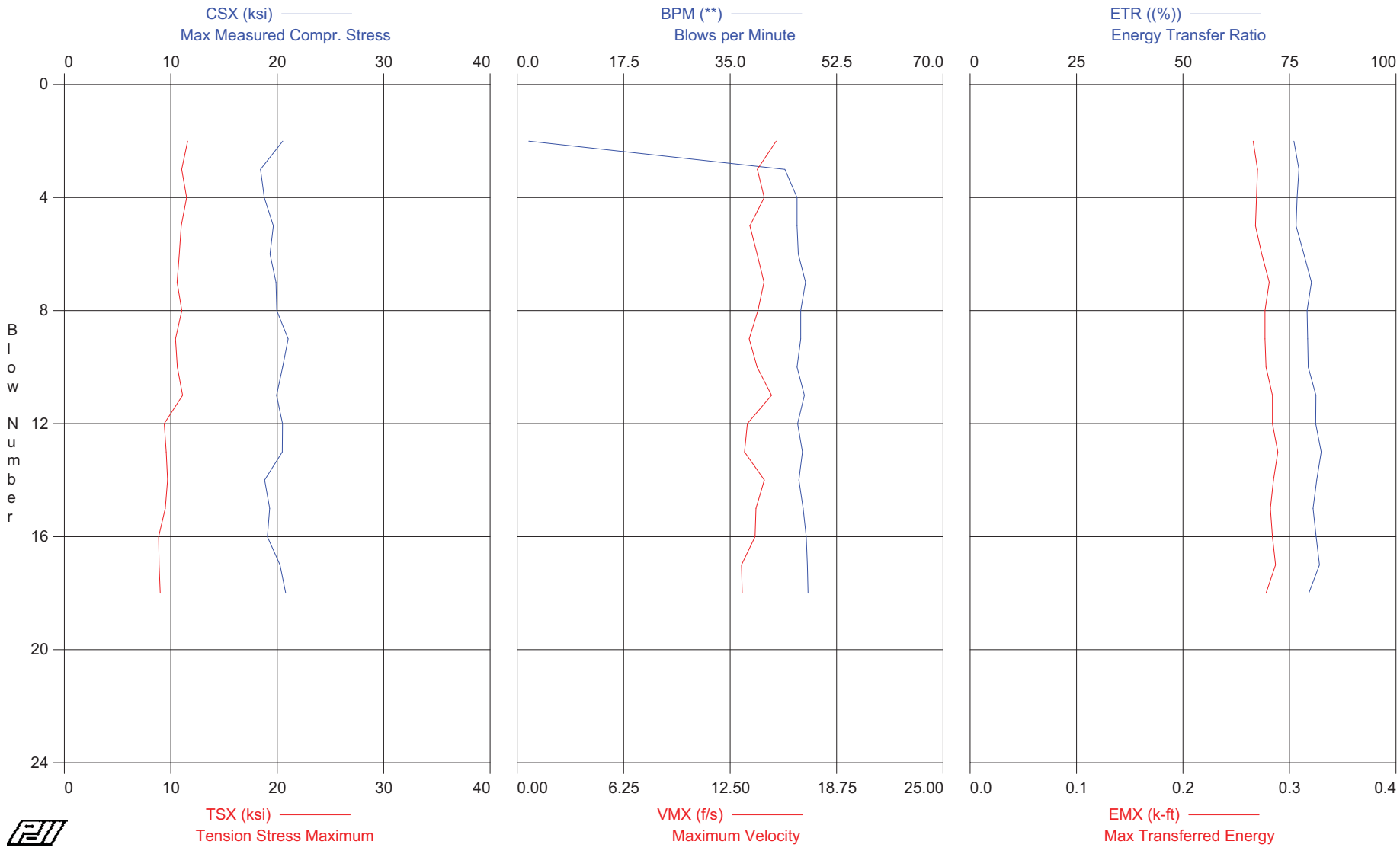
REV. 0

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 2-Dec-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M-11 (33.9' - 35.4' sample))



NORTH ANNA 3 Project - BORING M-11 (33.9' - 35.4' sample))
OP: JNH
Rig Serial No. MEC-425; CME 55 TRAILER (RAL) (P.Pitts)
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 39.40 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	20.5	11.6	15.2	25	0.9	1.9	0.217	76.1	0.266
3	18.4	11.0	14.1	22	0.8	44.0	0.221	77.2	0.270
4	18.8	11.5	14.5	23	0.8	46.0	0.217	76.8	0.269
5	19.6	11.0	13.7	24	0.8	46.0	0.221	76.5	0.268
6	19.3	10.8	14.1	24	0.8	46.2	0.224	78.4	0.274
7	19.9	10.6	14.5	24	0.8	47.4	0.219	80.2	0.281
8	20.0	11.0	14.1	24	0.8	46.6	0.219	79.1	0.277
9	21.0	10.4	13.6	26	0.9	46.6	0.221	79.3	0.277
10	20.5	10.6	14.1	25	0.8	46.0	0.220	79.4	0.278
11	19.9	11.1	14.9	24	0.7	47.2	0.221	81.2	0.284
12	20.5	9.4	13.5	25	0.9	46.1	0.220	81.2	0.284
13	20.5	9.6	13.3	25	0.9	46.9	0.222	82.4	0.289
14	18.8	9.7	14.5	23	0.7	46.3	0.224	81.4	0.285
15	19.3	9.5	14.0	24	0.8	47.0	0.224	80.5	0.282
16	19.1	8.9	14.0	23	0.7	47.5	0.228	81.3	0.284
17	20.3	8.9	13.2	25	0.7	47.7	0.224	82.0	0.287
18	20.8	9.0	13.2	25	0.9	47.8	0.222	79.5	0.278
Average	19.8	10.3	14.0	24	0.8	44.0	0.221	79.6	0.278

Total number of blows analyzed: 17

Time Summary

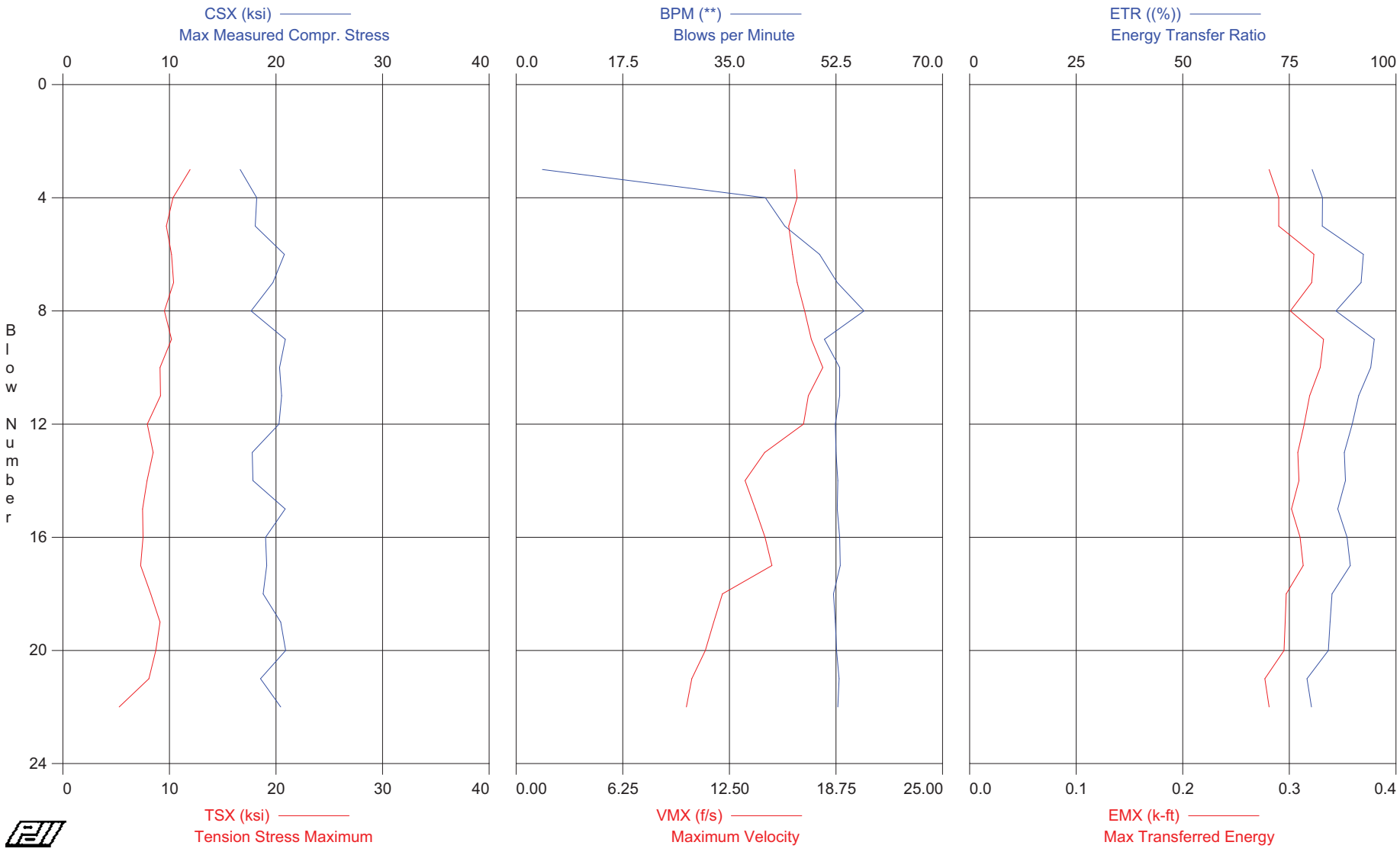
Drive 27 seconds 10:44:52 AM - 10:45:19 AM (9/2/2009) BN 1 - 18

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 2-Dec-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M-11 (38.9' - 40.4' sample)



NORTH ANNA 3 Project - BORING M-11 (38.9' - 40.4' sample)
Rig Serial No. MEC-425; CME 55 TRAILER (RAL) (P.Pitts)
OP: JNH
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 44.40 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
3	16.6	11.9	16.3	20	0.6	4.3	0.202	80.4	0.281
4	18.2	10.3	16.5	22	0.6	40.9	0.203	82.8	0.290
5	18.1	9.7	16.0	22	0.6	44.1	0.207	82.7	0.290
6	20.8	10.2	16.2	25	0.4	49.8	0.233	92.4	0.323
7	19.7	10.4	16.5	24	0.7	52.7	0.227	91.8	0.321
8	17.7	9.5	16.9	22	0.6	57.1	0.212	85.9	0.301
9	20.9	10.2	17.3	25	0.4	50.6	0.231	94.9	0.332
10	20.3	9.1	18.0	25	0.5	53.1	0.230	94.1	0.329
11	20.5	9.2	17.1	25	0.4	53.1	0.228	91.3	0.319
12	20.3	7.9	16.8	25	0.5	52.4	0.229	89.7	0.314
13	17.8	8.5	14.6	22	0.7	52.5	0.226	87.9	0.308
14	17.8	7.9	13.4	22	0.4	52.8	0.227	88.2	0.309
15	20.9	7.5	14.0	25	0.5	52.7	0.229	86.3	0.302
16	19.0	7.5	14.6	23	0.4	53.1	0.222	88.5	0.310
17	19.1	7.3	15.0	23	0.4	53.2	0.220	89.3	0.313
18	18.8	8.2	12.1	23	0.5	52.1	0.224	85.0	0.297
19	20.4	9.1	11.6	25	0.6	52.4	0.227	84.6	0.296
20	20.9	8.7	11.1	26	0.6	52.6	0.229	84.2	0.295
21	18.5	8.1	10.3	23	0.5	53.0	0.217	79.2	0.277
22	20.4	5.3	10.0	25	0.7	52.8	0.212	80.2	0.281
Average	19.3	8.8	14.7	24	0.5	49.3	0.222	87.0	0.304

Total number of blows analyzed: 20

Time Summary

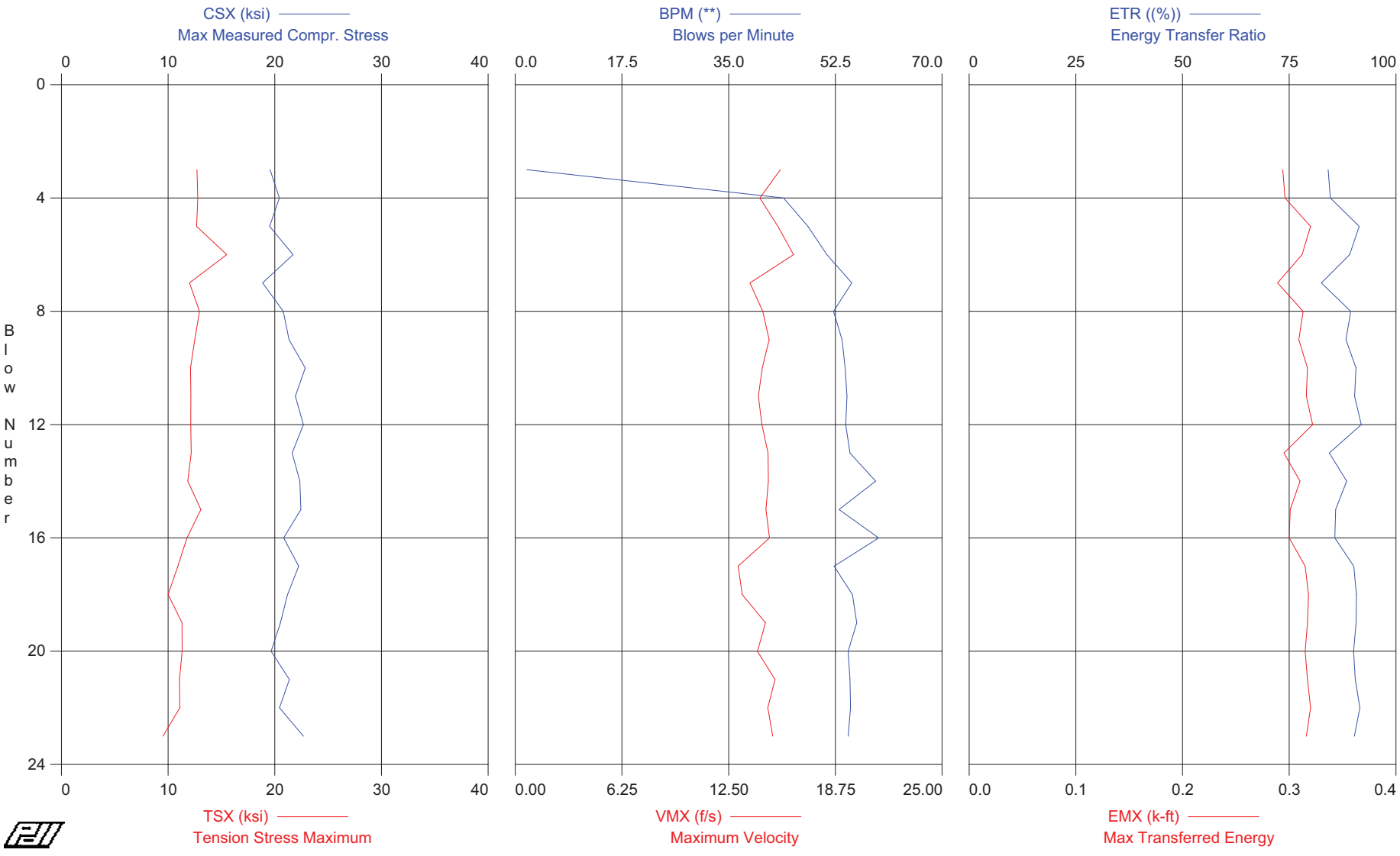
Drive 1 minute 24 seconds 10:54:32 AM - 10:55:56 AM (9/2/2009) BN 1 - 22

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 2-Dec-2009

Test date: 2-Sep-2009

NORTH ANNA 3 Project - BORING M-11 (43.9' - 45.4' sample)



NORTH ANNA 3 Project - BORING M-11 (43.9' - 45.4' sample)
OP: JNH
Rig Serial No. MEC-425; CME 55 TRAILER (RAL) (P.Pitts)
Test date: 2-Sep-2009

AR: 1.22 in^2
LE: 49.40 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

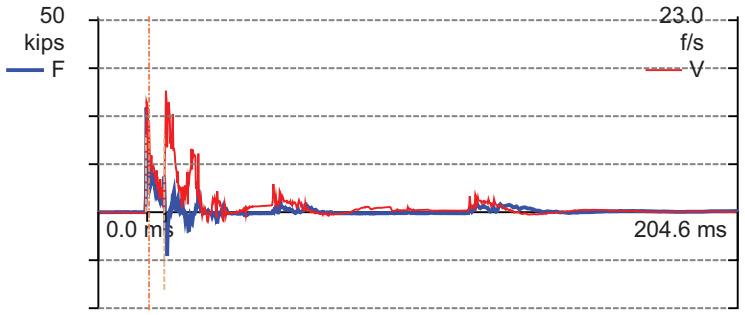
BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
3	19.6	12.7	15.5	24	0.8	1.9	0.237	84.1	0.294
4	20.4	12.8	14.3	25	0.8	44.0	0.235	84.6	0.296
5	19.5	12.7	15.4	24	0.8	48.0	0.259	91.4	0.320
6	21.7	15.5	16.3	26	0.9	51.1	0.245	89.2	0.312
7	18.9	12.0	13.7	23	0.8	55.2	0.234	82.5	0.289
8	20.8	12.9	14.5	25	0.8	52.2	0.255	89.4	0.313
9	21.3	12.5	14.9	26	0.8	53.6	0.252	88.3	0.309
10	22.9	12.1	14.5	28	0.9	54.1	0.259	90.6	0.317
11	21.9	12.1	14.2	27	0.9	54.4	0.259	90.3	0.316
12	22.7	12.1	14.4	28	0.9	54.2	0.259	91.9	0.322
13	21.6	12.2	14.8	26	0.8	54.9	0.244	84.4	0.295
14	22.3	11.8	14.8	27	0.8	59.1	0.255	88.5	0.310
15	22.4	13.1	14.7	27	0.9	53.1	0.242	85.9	0.301
16	20.8	11.8	14.9	25	0.8	59.6	0.241	85.7	0.300
17	22.2	10.9	13.1	27	1.0	52.3	0.257	90.1	0.315
18	21.2	10.0	13.3	26	0.8	55.3	0.256	90.8	0.318
19	20.5	11.3	14.7	25	0.8	56.0	0.257	90.7	0.317
20	19.7	11.3	14.2	24	0.8	54.6	0.251	90.1	0.315
21	21.4	11.1	15.2	26	0.8	54.9	0.249	90.5	0.317
22	20.4	11.1	14.8	25	0.8	55.0	0.257	91.6	0.320
23	22.7	9.5	15.1	28	0.8	54.6	0.259	90.3	0.316
Average	21.2	12.0	14.6	26	0.8	51.3	0.251	88.6	0.310

Total number of blows analyzed: 21

Time Summary

Drive 1 minute 7 seconds 11:05:53 AM - 11:07:00 AM (9/2/2009) BN 1 - 23

Project: NORTH ANNA 3
Pile: BORING M-11 (43.9-45.4) - Description: CME 55 TRAILER(P.PITTS)
Operator: JNH



BN 11
9/2/2009 11:06:47 AM

LP	0.00	ft	LE	49.40	ft
CSX	21.9	ksi	AR	1.22	in^2
CSI	22.6	ksi	EM	30,000.0	ksi
TSX	12.1	ksi	SP	0.492	k/ft3
EMX	0.316	k-ft	WS	16,807.9	f/s
STK	4.59	ft	WC	16,807.9	f/s
FVP	0.94	[]	JC	0.70	[]
SFR	1	kips	2L/c	5.88	ms
RX5	6	kips	EA/c	2.2	ksec/ft
RMX	4	kips	FR	5.000	kHz

MACTEC

Engineering and constructing a better tomorrow

December 2, 2009

From: Jon Honeycutt, Staff Professional JWH 12/2/09

Reviewed By: Steve Kiser, Principal Professional SVK 12-2-09

Subject: **Report of SPT Energy – MACTEC CME 55-LC Track (RAL)**
Hammer Serial No. MEC-02 Automatic Hammer
WORK INSTRUCTION No. 8 (DCN:NAP-077)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Jonathan Honeycutt, 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 September 1, 2009, during drilling of Boring M-10(DH) at the referenced site. The testing was performed by Jonathan Honeycutt from approximately 2:30 PM to 4:00 PM on September 1 under clear skies with a temperature of about 75 degrees Fahrenheit. The boring was drilled by MACTEC personnel using equipment from the MACTEC Raleigh office. The drilling equipment consisted of a CME 55-LC model track drill rig with an SPT automatic hammer. The drilling tools consisted of AW-J-sized drilling rods and a 2-foot long split-barrel sampler. Mud rotary drilling techniques were used to advance the boring at the time of energy testing. The drill rig operator during sampling was Mr. David White. 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 PAX (Serial No. 3622L), and calibrated accelerometers (Serial Nos. K983 and K0686) and strain gages (Serial Nos. AW#75/1 and AW#75/2). A 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 was two feet below the hammer impact point and had a cross-sectional area of approximately 1.22 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.

18 Pages Total

MACTEC Engineering and Consulting, Inc.
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www.mactec.com

Calibration Records

The calibration records for all the above are filed in DCN NAP-223.

Calculations for EFV

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

As recommended by ASTM D4633-05, the force-velocity method of energy calculation was used. The equation shown above for calculating EFV, 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 PDIPLOT tables and are also shown graphically in the PDIPLOT 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 generally consistent between individual hammer blows and between the sample depths tested. In general, the first and last one (and sometimes two or more) 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. This may result in more or less hammer blows evaluated for ETR than what is shown on the boring logs.

- The average energy transferred from the hammer to the drill rods for each individual depth interval using the EFV method ranged from 275 foot-pounds to 302 foot-pounds. These average energy transfers correspond to energy transfer ratios (ETR) of 78.6% to 86.3% 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 average energy transfer of the SPT system (for all the depth intervals tested) was 283.6 foot-pounds, with an average ETR of 81.0%.

Attachments: Page 4 Table 1 - Summary of SPT Energy Measurements – 1 Page
Page 5 - 6 Work Instruction No. 8 DCN:NAP 077– 2 Pages (without attachments)
Pages 7 Record of SPT Energy Measurement – 1 Page
Pages 8 – 17 PDIPLOT Output – 10 Pages
Page 18 Force-Velocity Plot – 1 Page

TABLE 1
SUMMARY OF SPT ENERGY MEASUREMENTS (ASTM D4633-05)
North Anna 3 Project
Louisa County, Virginia
MACTEC Project No. 6468-09-2473

Automatic Hammer Serial Number and Rig Model	Rig Owner	Rig Operator	Boring No. Tested	Date Tested	Drill Rod Size	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)
MEC-02 (CME 55-LC Track)	MACTEC Raleigh	David White	M-10 (DH)	9/1/2009	AW-J	11.7 - 13.2	3 - 4 - 5	9	302	86.3%
						14.3 - 15.8	4 - 3 - 5	12	280	80.0%
						19.2 - 20.7	4 - 4 - 5	13	275	78.6%
						24.2 - 25.7	2 - 3 - 4	9	280	80.0%
						29.2 - 30.7	2 - 3 - 5	10	286	81.7%
								Average for Rig:	**283.6**	**81.0%**

[a]Measured 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. This may result in more or less blows evaluated for ETR than what is shown on the boring logs.

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

[b]Energy 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 EFV and ETR values may differ slightly and insignificantly from those in the PDIPLOT tables due to roundoff.

Prepared By:	Date: 12/2/09		Checked By:	Date: 12-2-09

Work Instruction No. 8
North Anna 3 Project
MACTEC Engineering and Consulting, Inc.
Project Number: 6468-09-2473

Issued To: Jonathan Honeycutt, Steve Kiser Rev. No. 0

Issued By: D. Steven Copley, P.E. DSC 8-31-09 Date: August 31, 2009

Valid From: August 31, 2009 To: August 31, 2010

Task Description: Perform SPT Energy Measurements

Applicable Technical Procedures or Plans, or other reference:

1. Geotechnical Work Plan (complete copy of current revision available at Field Office), Section 4.2 and Attachment 2 – Drilling and Sampling Procedures (attached)
2. Engineering Specification for Subsurface Investigation and Laboratory Testing, No. 25161-500-3PS-CY00-Q0001, Rev. 000, Issued for use August 21, 2009, Section 3.3 Drilling Equipment (attached)
3. ASTM D 4633-05 (attached)

Specific Instructions (note attachments where necessary): Perform energy measurements for each drill rig on site in general accordance with ASTM D 4633-05. Consult with Site Manager as to schedule for performing the measurements. Hammer weights have been checked, and records will be available on site. All rigs are using automatic hammer systems. Confirm that automatic hammer system is being operated within manufacturer's recommendations or in a typical operating fashion as observed from watching one or two SPT measurements prior to measuring energy. Check each drill rig using all hammer/rod combinations that it will be using. Depths for measurements should be coordinated with the Site Manager. See Site Manager for current boring logs of holes drilled, if available, and use these to plan most effective field measurement program. Submit copies of calibration records for equipment to Principal Professional for review prior to beginning work on site.

Confirm with Site Manager that approval of equipment calibration records have been received prior to beginning field testing. If unexpected conditions are encountered that affect measurements, contact Site Manager or Principal Professional immediately.

Report Format: Prepare standard report in accordance with ASTM D 4633-05 requirements.

Specific Quality Assurance Procedures Applicable: 10CFR21; NQAP 16-01 Procedure For Conforming To Federal Regulation 10CFR21; QAP 20-1; QAP 25-1; Section 306 of the Energy Reorganization Act of 1974. Current revisions apply; copies available in Field Office.

Hold Points or Witness Points: None

Records: All records generated shall be considered QA Records.

Reviewed and Approved By (Note: Only one signature required for issuance):

Project Manager: _____ Date: _____

Principal Professional: D. Aaron Copley Date: 8-31-09

Site Manager: _____ Date: _____

No. of Pages: 15 DCN: NAP077

QA Form 24-1 Revised 8/12/2009

MACTEC

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

RECORD OF SPT ENERGY MEASUREMENT

GENERAL INFORMATION		DRILL RIG DATA	
PROJECT:	North Anna 3 Project	MAKE:	CME
LOCATION:	Virginia	MODEL:	55LC TRACK
PROJECT NO.:	6468-09-2473	SERIAL NO.:	Mec-02
DATE:	9/1/2009	HAMMER TYPE:	Auto
WEATHER:	Sunny 75°F	ROPE CONDITION:	N/A
INSPECTOR:	JNH	ROD SIZE:	AW-J
DRILLING COMPANY:	MACTEC - Raleigh	NO. OF SHEAVES:	N/A

BORING DATA			
BORING NUMBER:	M-10 (Def)		
DEPTH DRILLED:	Various		
TIME DRIVEN:	2:30 pm - 4:00 pm		
RIG OPERATOR:	D. White		
HAMMER OPERATOR:	N/A		
PDA PAK SERIAL NO.:	3622L		
INSTR. ROD AREA:	1.22 in 2		
ACCEL. SERIAL NOS.:	A1-K983 ; A2-K0686		
STRAIN SERIAL NOS.:	75W #1/2		

SAMPLE DEPTH (feet)	SPT N-VALUE (bpf)
7-8.5	3-4-5
14.3-15.8	4-3-5
19.2-20.7	4-4-5
24.2-25.7	2-3-4
29.2-30.7	2-3-5

REMARKS: Testing performed in accordance with ASTM D 4633-05

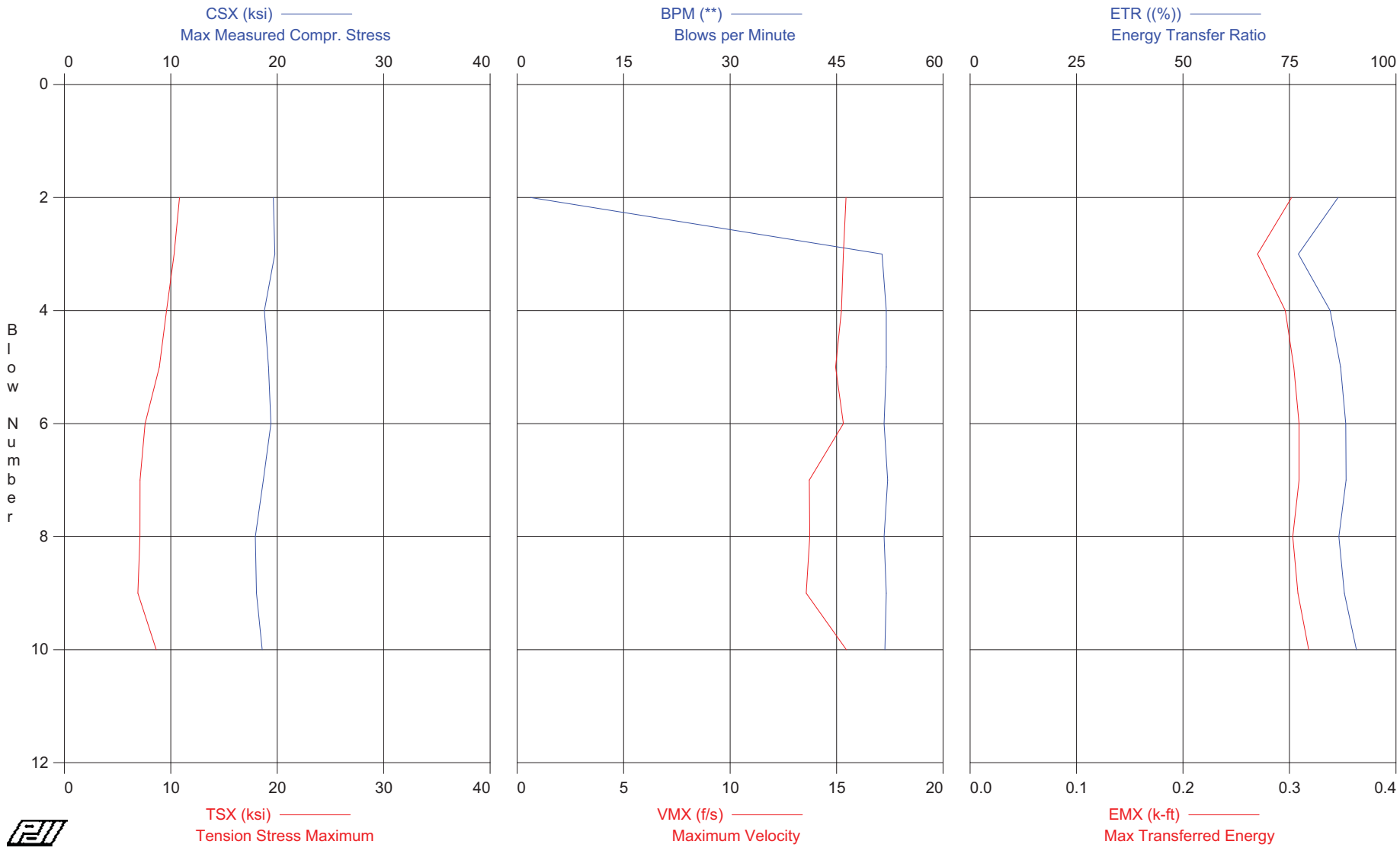
Reviewed By:

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 2-Dec-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - Boring M-10(DH) (11.7' - 13.2' sample)



NORTH ANNA 3 Project - Boring M-10(DH) (11.7' - 13.2' sample)
OP: JNH
Rig Serial No. MEC-02; CME 55LC (RAL) (D.White)
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 17.50 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	19.6	10.8	15.4	24	0.8	1.9	0.226	86.4	0.302
3	19.8	10.3	15.3	24	0.7	51.4	0.219	77.1	0.270
4	18.8	9.6	15.2	23	0.7	52.0	0.224	84.6	0.296
5	19.2	8.9	15.0	23	0.7	52.0	0.224	87.0	0.304
6	19.4	7.6	15.3	24	0.7	51.7	0.220	88.2	0.309
7	18.7	7.1	13.7	23	0.7	52.2	0.213	88.3	0.309
8	17.9	7.1	13.7	22	0.7	51.7	0.210	86.6	0.303
9	18.1	6.9	13.6	22	0.7	52.0	0.208	87.9	0.308
10	18.6	8.6	15.5	23	0.7	51.8	0.215	90.7	0.318
Average	18.9	8.6	14.7	23	0.7	46.3	0.218	86.3	0.302

Total number of blows analyzed: 9

Time Summary

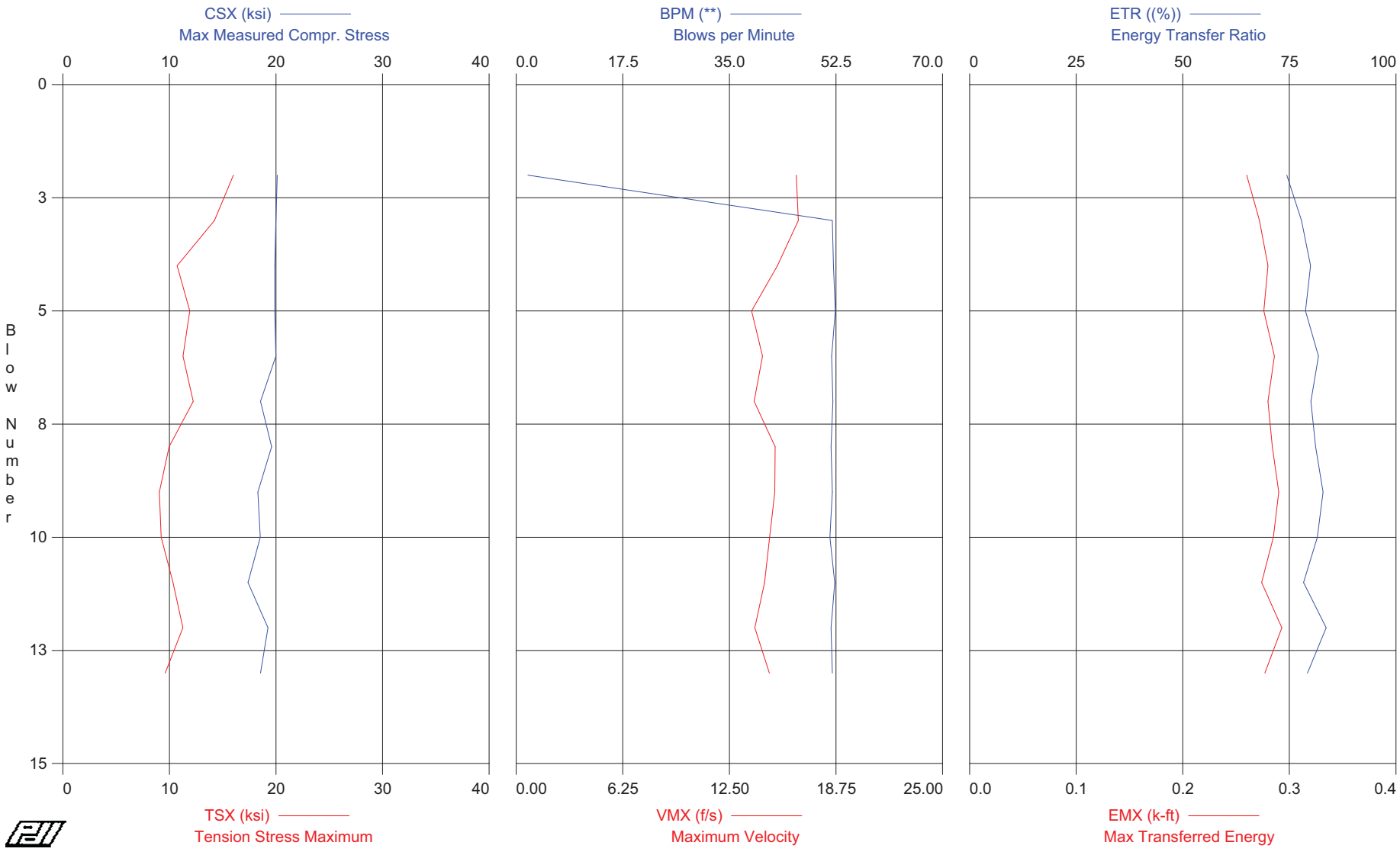
Drive 56 seconds 2:38:44 PM - 2:39:40 PM (9/1/2009) BN 1 - 10

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 2-Dec-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - Boring M-10(DH) (14.3' - 15.8' sample)



NORTH ANNA 3 Project - Boring M-10(DH) (14.3' - 15.8' sample)
Rig Serial No. MEC-02; CME 55LC (RAL) (D.White)
OP: JNH
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 19.50 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	20.1	16.0	16.4	25	0.8	1.9	0.234	74.4	0.260
3	20.0	14.2	16.5	24	0.9	51.9	0.244	77.8	0.272
4	19.9	10.7	15.3	24	0.7	52.1	0.239	80.0	0.280
5	19.9	11.9	13.8	24	0.8	52.4	0.240	78.8	0.276
6	20.0	11.3	14.4	24	0.8	51.8	0.238	81.8	0.286
7	18.6	12.2	14.0	23	0.7	52.0	0.237	80.0	0.280
8	19.6	10.0	15.2	24	0.7	51.7	0.239	81.1	0.284
9	18.3	9.0	15.2	22	0.7	51.9	0.239	82.9	0.290
10	18.5	9.2	14.9	23	0.7	51.5	0.232	81.5	0.285
11	17.4	10.3	14.6	21	0.7	52.3	0.222	78.3	0.274
12	19.2	11.3	14.0	23	0.7	51.7	0.238	83.6	0.293
13	18.5	9.6	14.8	23	0.7	51.9	0.224	79.2	0.277
Average	19.2	11.3	14.9	23	0.7	47.8	0.235	80.0	0.280

Total number of blows analyzed: 12

Time Summary

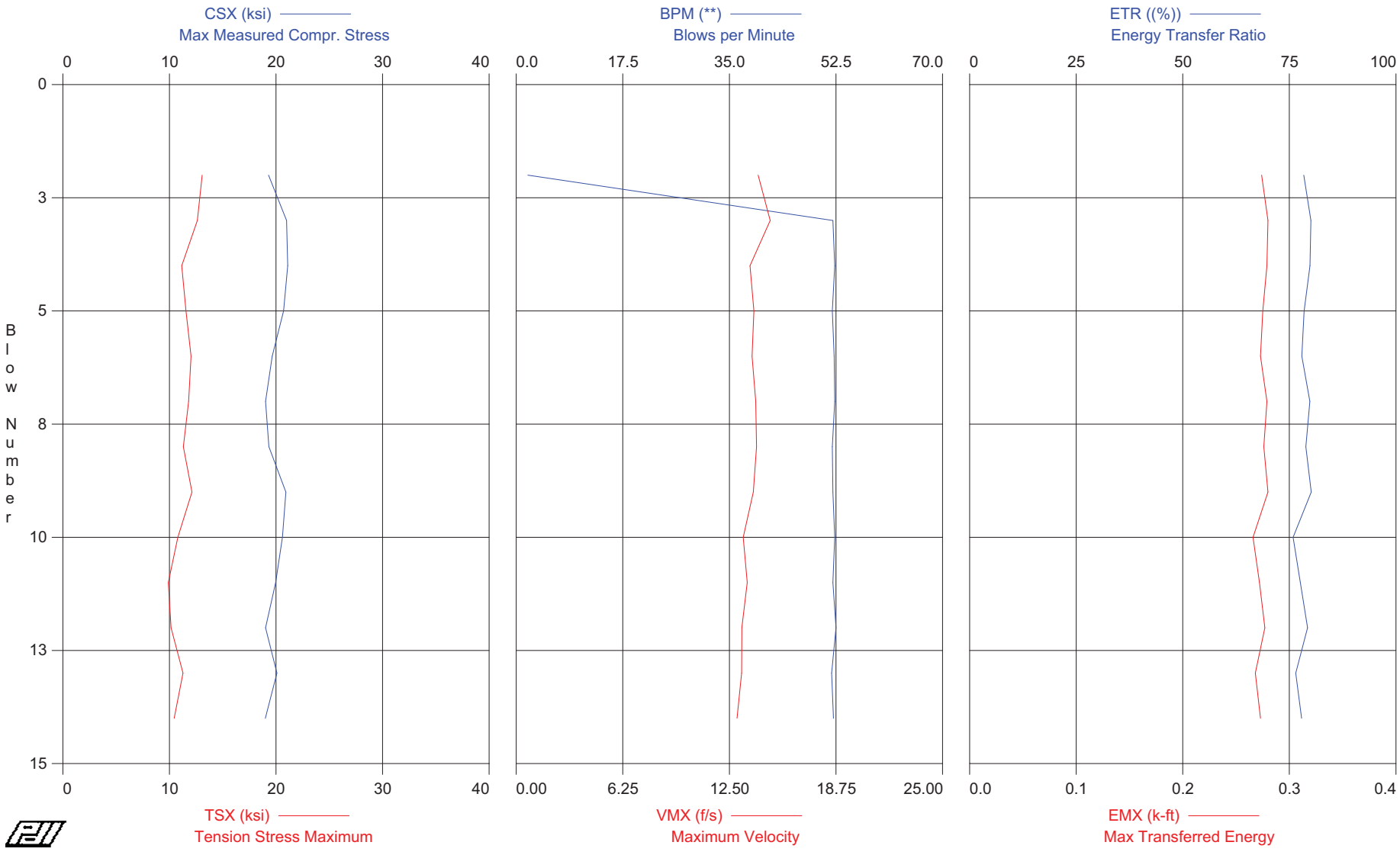
Drive 36 seconds 2:52:26 PM - 2:53:02 PM (9/1/2009) BN 1 - 13

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 2-Dec-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - Boring M-10(DH) (19.2' - 20.7' sample)



NORTH ANNA 3 Project - Boring M-10(DH) (19.2' - 20.7' sample)
Rig Serial No. MEC-02; CME 55LC (RAL) (D.White)
OP: JNH
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 24.70 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	19.3	13.1	14.2	24	0.8	1.9	0.261	78.4	0.274
3	21.0	12.6	14.9	26	0.8	52.0	0.263	80.1	0.280
4	21.1	11.2	13.7	26	0.9	52.3	0.259	79.8	0.279
5	20.7	11.6	13.9	25	0.8	51.9	0.254	78.5	0.275
6	19.6	12.0	13.8	24	0.8	52.2	0.264	77.9	0.273
7	19.0	11.8	14.0	23	0.8	52.3	0.268	79.8	0.279
8	19.3	11.3	14.1	24	0.8	51.9	0.261	78.9	0.276
9	20.9	12.1	13.9	26	0.9	52.0	0.273	80.1	0.280
10	20.6	10.8	13.3	25	0.9	52.3	0.257	75.9	0.266
11	20.0	9.9	13.6	24	0.8	52.0	0.253	77.6	0.272
12	19.0	10.2	13.2	23	0.8	52.5	0.257	79.3	0.277
13	20.1	11.3	13.2	25	0.9	51.8	0.256	76.5	0.268
14	19.0	10.4	13.0	23	0.8	52.1	0.258	77.9	0.273
Average	20.0	11.4	13.8	24	0.8	48.2	0.260	78.5	0.275

Total number of blows analyzed: 13

Time Summary

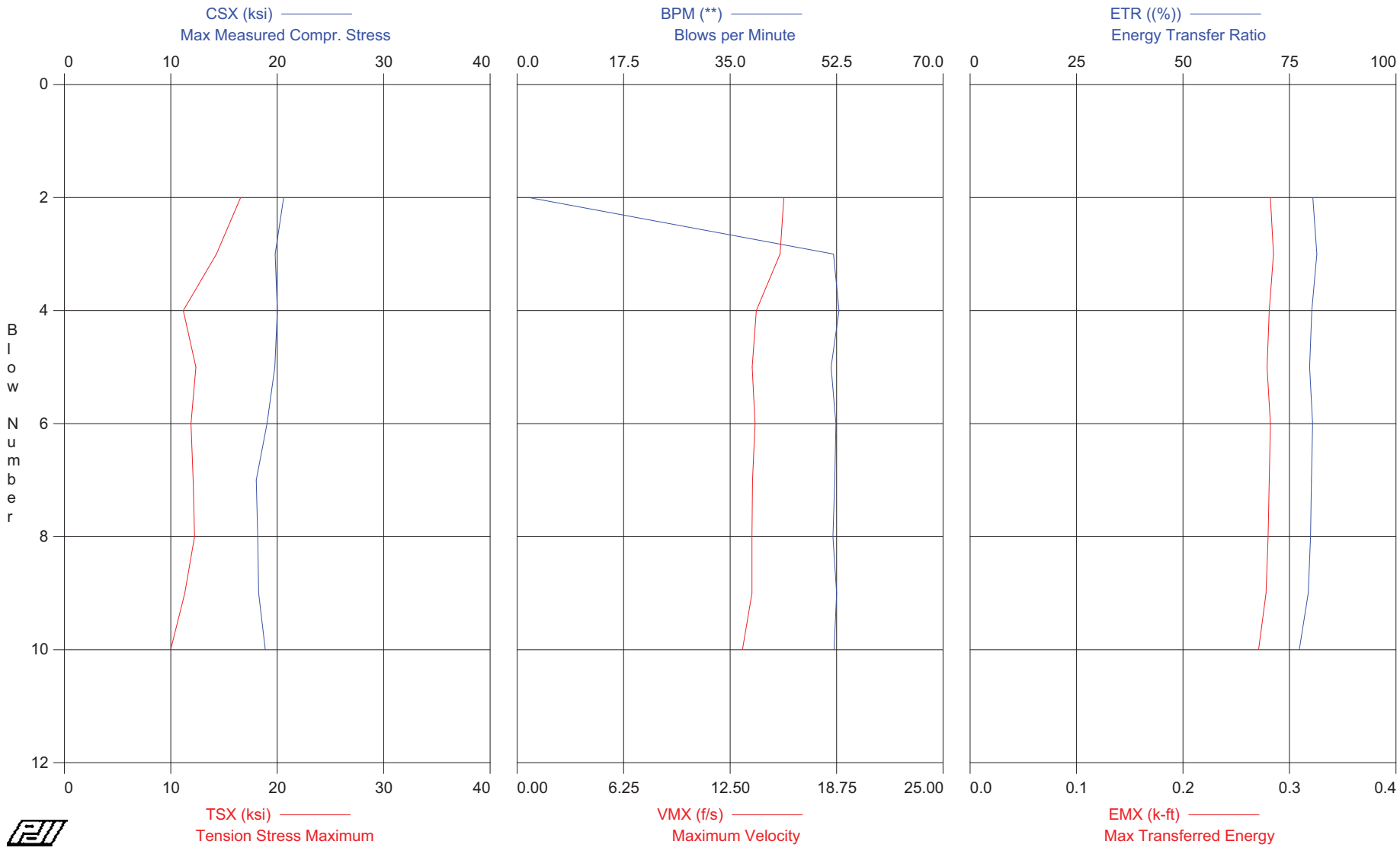
Drive 20 seconds 3:08:11 PM - 3:08:31 PM (9/1/2009) BN 1 - 14

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 2-Dec-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - Boring M-10(DH) (24.2' - 25.7' sample)



NORTH ANNA 3 Project - Boring M-10(DH) (24.2' - 25.7' sample)
OP: JNH
Rig Serial No. MEC-02; CME 55LC (RAL) (D.White)
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 29.70 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	20.6	16.6	15.7	25	0.8	1.9	0.261	80.5	0.282
3	19.8	14.3	15.4	24	0.8	52.0	0.257	81.4	0.285
4	20.0	11.2	14.0	24	0.8	52.9	0.257	80.3	0.281
5	19.8	12.4	13.8	24	0.8	51.6	0.267	79.7	0.279
6	19.0	11.9	14.0	23	0.8	52.4	0.257	80.4	0.282
7	18.0	12.1	13.8	22	0.8	52.2	0.263	80.2	0.281
8	18.2	12.2	13.8	22	0.8	51.9	0.260	79.9	0.280
9	18.3	11.3	13.8	22	0.8	52.5	0.256	79.4	0.278
10	18.9	10.0	13.2	23	0.8	52.1	0.250	77.3	0.271
Average	19.2	12.4	14.2	23	0.8	46.6	0.259	79.9	0.280

Total number of blows analyzed: 9

Time Summary

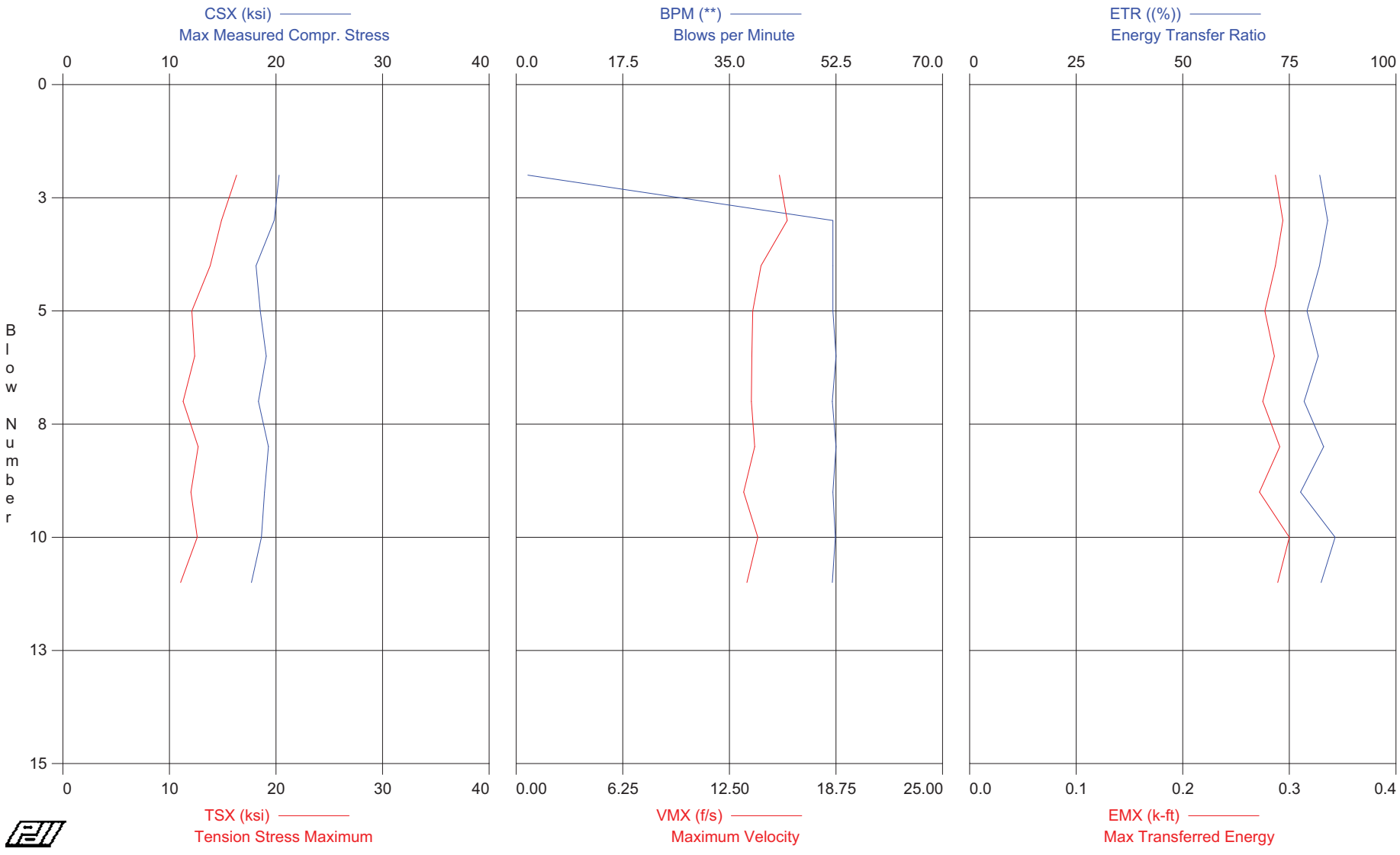
Drive 24 seconds 3:19:54 PM - 3:20:18 PM (9/1/2009) BN 1 - 10

MACTEC Engineering and Consulting, Inc. - Case Method Results

PDIPLOT Ver. 2008.1 - Printed: 2-Dec-2009

Test date: 1-Sep-2009

NORTH ANNA 3 Project - Boring M-10(DH) (29.2' - 30.7' sample)



NORTH ANNA 3 Project - Boring M-10(DH) (29.2' - 30.7' sample)
OP: JNH
Rig Serial No. MEC-02; CME 55LC (RAL) (D.White)
Test date: 1-Sep-2009

AR: 1.22 in^2
LE: 34.70 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.70

CSX: Max Measured Compr. Stress
TSX: Tension Stress Maximum
VMX: Maximum Velocity
FMX: Maximum Force
FVP: Force/Velocity proportionality
BPM: Blows per Minute
EF2: Energy of F^2
ETR: Energy Transfer Ratio
EMX: Max Transferred Energy

BL#	CSX ksi	TSX ksi	VMX f/s	FMX kips	FVP []	BPM **	EF2 k-ft	ETR (%)	EMX k-ft
2	20.3	16.3	15.4	25	0.8	1.9	0.262	82.1	0.287
3	19.8	14.9	15.9	24	0.8	52.0	0.265	84.0	0.294
4	18.1	13.8	14.4	22	0.8	52.0	0.263	82.1	0.287
5	18.5	12.1	13.9	23	0.7	52.0	0.248	79.2	0.277
6	19.1	12.4	13.8	23	0.8	52.5	0.255	81.8	0.286
7	18.4	11.3	13.8	22	0.7	51.9	0.247	78.5	0.275
8	19.3	12.7	14.0	24	0.8	52.5	0.263	83.1	0.291
9	18.9	12.0	13.3	23	0.8	52.0	0.257	77.6	0.272
10	18.6	12.6	14.2	23	0.7	52.4	0.258	85.7	0.300
11	17.7	11.0	13.5	22	0.7	51.9	0.261	82.5	0.289
Average	18.9	12.9	14.2	23	0.8	47.1	0.258	81.7	0.286

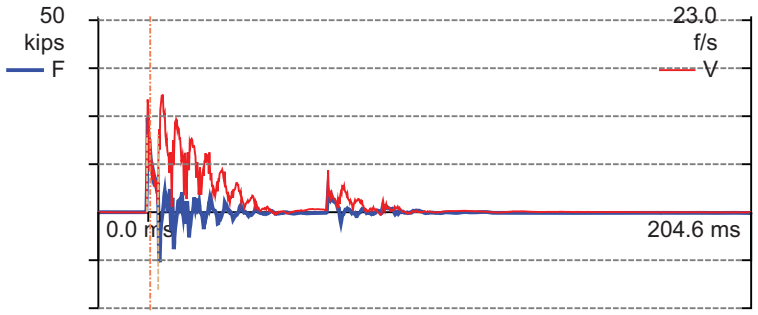
Total number of blows analyzed: 10

Time Summary

Drive 1 minute 25 seconds 3:29:07 PM - 3:30:32 PM (9/1/2009) BN 1 - 11

Project: NORTH ANNA 3
Pile: BORING M-10(DH) (24.2-25.7) - Description: CME 55LC DAVID WHITE
Operator: JNH

BN 5
9/1/2009 3:20:12 PM



LP	0.00	ft	LE	29.70	ft
CSX	19.8	ksi	AR	1.22	in^2
CSI	20.0	ksi	EM	30,000.0	ksi
TSX	12.4	ksi	SP	0.492	k/ft3
EMX	0.279	k-ft	WS	16,807.9	f/s
STK	5.14	ft	WC	16,807.9	f/s
FVP	0.84	[]	JC	0.70	[]
SFR	2	kips	2L/c	3.53	ms
RX5	4	kips	EA/c	2.2	ksec/ft
RMX	2	kips	FR	5.000	kHz