APPENDIX J
Standard Penetration Test
Hammer Calibration Results

DRAFT

Calculation Checksheet

Project No. 18788-003-00 _____ Project Title: Mid Barataria Diversion (BA-153)

Deliverable Title: Corrected SPT Number (N_{60}); Establish Soil Properties for Granular Soil

Calculations Description: The standard penetration number is a function of the input driving energy and its dissipation around the sampler into the surrounding soil. The variations of correction to borehole diameter, sampler and rod length are based on recommendations by Seed et al. (1985) and Skempton (1986). The hammer efficiency for the SPT hammer on each of the drill rigs used for the above project were taken from the respective hammer calibration reports. Supporting information is attached.

Soil properties for granular soil were established for the above project based on various references attached.

Originator: VT _____ Checked by: D. Clay _____ Date: 11/11/2013

Checking method (describe): _____

_____

Comments: _____

_____

Attach checksheets, numbered consecutively.

Soil Properties for Mid Barataria Diversion Project (BA-153)

Soil Type/Relative Density	Unit Weight (pcf)	Cohesion (psf)	Effective Friction Angle (deg)	SPT Blows Corrected (N_{60})
Silt				
Very Loose	113	200	8	0-4
Loose	115	200	10	5-10
(USACE) Medium Dense	117	200	15	11-30
Dense	122	200	20	31-50
Very Dense	125	200	25	51+
Silty (>12%) Sand(>50%)/ Clayey(>12%) Sand (>50%)				
Very Loose	118	0	25	0-4
Loose	120	0	28	5-10
(USACE for SM) Medium Dense	122	0	30	11-30
Dense	125	0	33	31-50
Very Dense	128	0	35	51+
Poorly Graded Sand				
Very Loose	122	0	28	0-4
Loose	122	0	30	5-10
(USACE) Medium Dense	122	0	33	11-30
Dense	128	0	39	31-50
Very Dense	130	0	41	51+

Clay properties are based on lab testing performed for the project

Soil Parameters for S-Case:

Silt: Cohesion=0 psf, phi=28

Clay: Cohesion=0 psf, phi=23

Prepared By:

Name: Venu Tammineni

Date: 11/08/2013

Reviewed By:

Name: Charlie Eustis

Date: 11/08/13

$$N_{60} = \frac{N \, \eta_H \, \eta_B \, \eta_S \, \eta_R}{60}$$

Where

N_{60} = standard penetration number, corrected for field conditions

N = measured penetration number

η_H = hammer efficiency (%)   From hammer calibration

η_B = correction for borehole diameter = 1.0 for 4" borehole
     = 1.05 for 6" borehole

η_S = sampler correction = 1.0

η_R = correction for rod length   >30' = 1.0   12'-20' = 0.85
     20'-30' = 0.95   0'-12' = 0.75

- Variations of η_H, η_B, η_S and η_R, based on recommendations by Seed et al. (1985) and Skempton (1986) (attached)

- Hammer efficiency was measured for each drill rig (Appendices C through E — Geotechnical Data Report)

Equation and Factors From:

Principals of Foundation Engineering 5E, Braja M. Das 2004

GeoEngineers
Earth Science + Technology

**US Army Corps
of Engineers**

ENGINEERING AND DESIGN

Design of Sheet Pile Walls

ENGINEER MANUAL

Table 3-1
Granular Soil Properties (after Teng 1962)

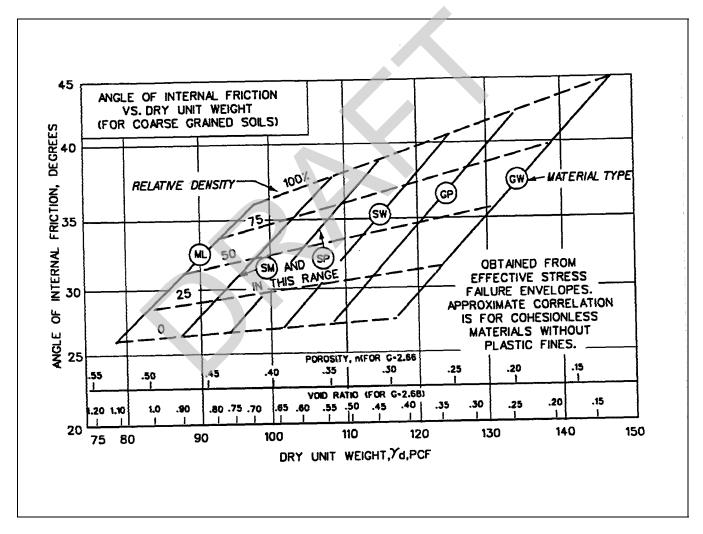| Compactness	Relative Density (%)	SPT N (blows per ft)	Angle of Internal Friction (deg)	Unit Weight	
				Moist (pcf)	Submerged (pcf)
Very Loose	0-15	0-4	<28	<100	<60
Loose	16-35	5-10	28-30	95-125	55-65
Medium	36-65	11-30	31-36	110-130	60-70
Dense	66-85	31-50	37-41	110-140	65-85
Very Dense	86-100	>51	>41	>130	>75

Figure 3-1. Cohesionless Soil Properties (after U.S. Department of the Navy 1971)

Hurricane and Storm Damage Risk Reduction System Design Guidelines

INTERIM

New Orleans District Engineering Division
With Revisions through June 2012

US Army Corps of Engineers ®

Table 3.3 Typical Values for Silts, Sands, and Riprap

Soil Type	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degree)
Silt	117	200	15
Silty Sand	122	0	30
Poorly graded sand	122	0	33
Riprap	132	0	40

Notes:
1. Weight of riprap may vary based on the filling of the riprap voids over time.
2. ~~Un~~drained soil parameters for S-Case are:
   i. Silt Cohesion = 0 psf, phi = 28
   ii. Clay Cohesion = 0 psf, phi = 23
3. Engineering judgment or laboratory test data (if available) should be used in determining soil properties of clayey silts, clayey sands, and sandy silts if they exist in the foundation.

F. Reserved.

G. At pipeline crossings, the allowable FOS shall be 1.5 for the gross section for a distance of 150 ft on either side of the C/L of the pipeline or an appropriate distance determined by engineering assessment. This analysis should be performed with flood side water at the SWL.
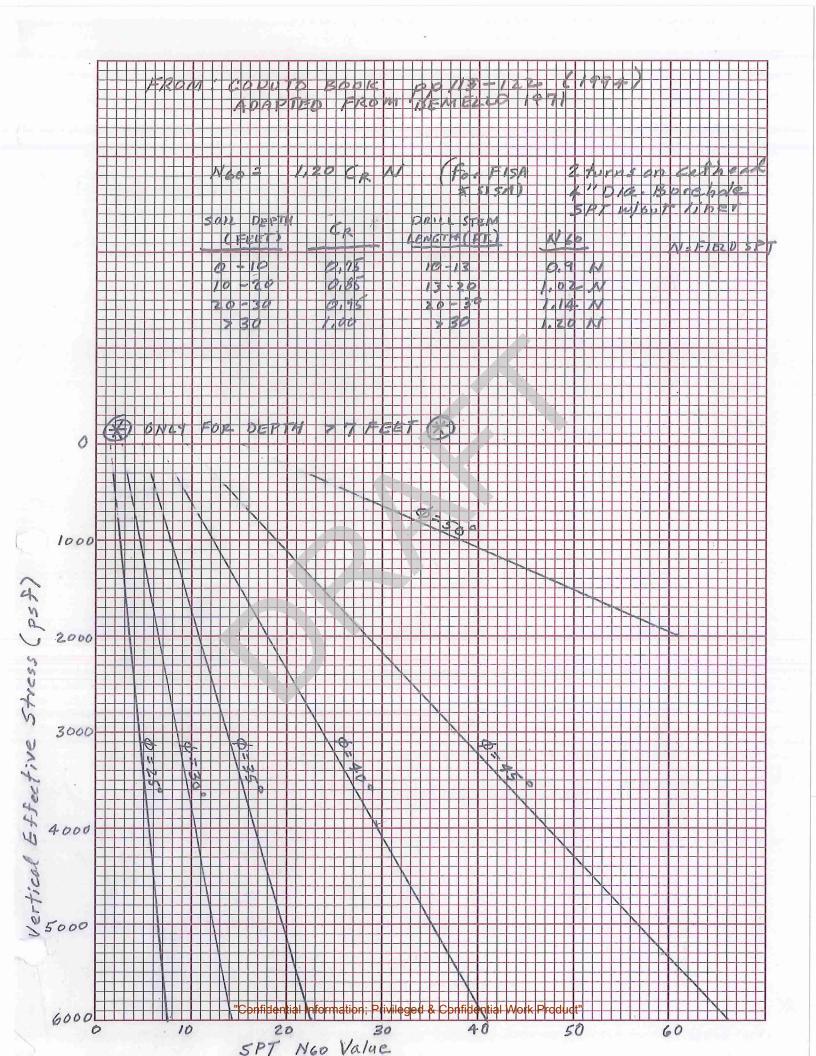
3.1.3 Seepage Analysis

3.1.3.1 Definitions

Stage or Water Surface Elevation (WSE) – the height of water against a levee or floodwall. Water height is measured as the vertical distance above or below a local or national elevation datum.

Design Water Surface Elevation (DWSE) – the stage or water level to be used in deterministic analyses such as the geotechnical, structural stability, and seepage analyses. For the HSDRRS, the DWSE is found from the AWSE and its associated uncertainty at the selected confidence limit, where uncertainty is represented by normal distribution, and the confidence limit is 90%:

AWSE = best fit for 50% confidence level
DWSE = 90% confidence level

FROM: CODUTO BOOK pp. 118-122 (1994)
ADAPTED FROM BAZARAA 1971

$N_{60} = 1.20 \, C_R \, N$ (for FISA & SISA)   2 turns on cathead
     4" Dia. Borehole
     SPT w/out liner

SOIL DEPTH (FEET)	C_R	DRILL STEM LENGTH (FT.)	N_{60}
0 - 10	0.75	10 - 13	0.9 N
10 - 20	0.85	13 - 20	1.02 N
20 - 30	0.95	20 - 30	1.14 N
> 30	1.00	> 30	1.20 N

N = FIELD SPT

⊛ ONLY FOR DEPTH > 7 FEET ⊛

Graph: Vertical Effective Stress (psf) vs SPT N_{60} Value, with curves labeled $\phi = 25°$, $\phi = 30°$, $\phi = 35°$, $\phi = 40°$, $\phi = 45°$, $\phi = 50°$.

Job No. 1332046-1

Report on:
SPT Energy Measurements
Diedrich D50: Track Mounted Drill Rig
Automatic Hammer Calibration: SN# 268
Baton Rouge, Louisiana

Prepared for:
Southern Earth Sciences, Inc.
By Jon Honeycutt & Brian Mondello, P.E.

December 3rd, 2013

GRL engineers, inc.

Dynamic Measurements and Analyses

www.GRLengineers.com   info@GRLengineers.com

December 3, 2013

Mr. Mike Juneau, P.E.
Southern Earth Sciences, Inc.
11638 Sun Belt Court
Baton Rouge, Louisiana

Re: SPT Energy Measurements
        Diedrich D50 - Automatic Hammer Calibration
        GRL Job No. 1332046-1

Mr. Juneau:

This report presents the results of Standard Penetration Test (SPT) dynamic energy measurements performed December 2, 2013 on one (1) SPT sampling system at the referenced project site. The objective of the testing was to obtain the SPT energy measurements for the purpose of documenting the hammer energy transfer efficiency. A PDA system, Model PAX, was used to acquire and process the dynamic test data obtained through an instrumented drill rod section. All energy measuring and processing equipment are manufactured by Pile Dynamics, Inc. General information regarding the testing equipment and procedures is provided in Appendix A. Testing results are presented in Appendix B.

Drill Rig and SPT Hammer Details

Testing was conducted on a SPT drilling rig/hammer system that was identified to us as a Diedrich D50 track-mounted drill rig. The SPT system utilized a Diedrich automatic hammer system. The hammer reportedly consisted of a 0.14 kip hammer weight with a 30-inch (2.5 feet) drop height, corresponding to a potential energy value of 0.35 kip-ft.

Type AW-J drilling rods were used during testing. The SPT energy measurements were made using an approximately 3-foot long instrumented AW-J type rod segment inserted into the drill string immediately below the anvil of the hammer. The cross-sectional area of the AW-J instrumented rod segment is 1.16 in^2.

Louisiana Office: 511 Old Covington Hwy • Hammond, LA 70402 USA • 985.640.7961 • GRL-LA@GRLengineers.com
Central Office: 30725 Aurora Road • Cleveland, OH 44139 USA • 216.831.6131 • fax 216.831.0916 • www.GRLengineers.com
"Confidential Information; Privileged & Confidential Work Product"

California	Colorado	Florida	Illinois	North Carolina	Ohio	Pennsylvania
323.441.0965	303.666.6127	407.826.9539	847.221.2750	704.593.0992	216.831.6131	610.459.0278

_____

DYNAMIC TESTING FIELD DETAILS

Instrumentation

A PDA system was used to obtain and process dynamic measurements of strain and acceleration taken on the instrumented AW-J rod segment located between the hammer and drill string. Strain and acceleration signals were conditioned and converted to forces and velocities by the PDA. For each hammer blow, the PDA provided the following quantities: maximum force (FMX), maximum velocity (VMX), maximum displacement (DMX), maximum transferred energy (EFV), energy transfer ratio (ETR), and hammer blow rate per minute (BPM). Force and velocity records from the PDA were also viewed on a graphic LCD screen to evaluate data quality.
.

Test Sequence

Dynamic measurements were made at a test boring location at the referenced project site. SPT sampling and dynamic measurements were conducted at starting depths ranging from 25 and 35 ft. Energy measurements were obtained over three 6-inch increments for each sample depth. Based on ASTM 4633-10 requirements, only energy measurements obtained over the last one-foot of driving were used for hammer efficiency evaluation. The reported SPT N-values ranged between 12 and 15 blows/foot.

DYNAMIC TESTING ANALYSIS AND RESULTS

Complete testing and analyses results are presented in Appendix B. A summary of the testing results for the test boring are provided in Table1. PDIPLOT summaries of test records obtained under typical hammer blows from each test sequence are also included.

Energy Transfer Measurements

The PDA interprets the measured dynamic data according to the Case Method equations. Appendix B contains PDA output quantities plotted and printed as functions of hammer blow number for each depth sequence.

_____

The maximum transferred energy (EFV) was calculated by integrating the product of the force and velocity records over the time duration of each test record as follows:

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

Where, *F(t) and V(t)* are the time records of force and velocity, respectively.

The Energy Transfer Ratio (ETR) was calculated as:

$$ETR = EFV/PE$$

Where, *PE* is the potential energy = 140 lbs x 30 inches = 0.14 kips x 2.5 ft = 0.350 kip-ft.

Summary of Testing Results

"Diedrich D50" – Automatic Hammer – AW-J Rod

EFV values ranged between 0.290 and 0.315 kip-ft with an overall average of 0.299 kip-ft and a standard deviation of 0.014 kip-ft. The corresponding ETR values ranged from 82% to 90%, with an overall average of 85% and a standard deviation of 4.0%. The hammer blow rate ranged from 50 to 51 blows/minute (BPM) with an overall average of 50 BPM and standard deviation of 0.3 BPM.

_____

We appreciate the opportunity to be of assistance to you on this project. Please do not hesitate to contact us if you have any questions regarding this report, or if we may be of further service.

Very truly yours,
GRL Engineers, Inc.

Jonathan Honeycutt
GRL Engineer

Brian Mondello, P.E.
GRL Engineer

Enclosed: Appendices A and B

SPT Hammer Calibration – Diedrich D50 Automatic, SN# 268

Table 1: Summary of Results

Project: Southern Earth Science| GRL Job No. 1332046-1
Rig: Diedrich D50, Serial No. 268
Hammer Type: Automatic

Boring I.D.	Test Date	Rod[1] Length (ft)	Sample[2] Depths (ft)	Sample No.	Reported blows per 6 inches (blows/6")	Reported SPT blow count (blows/foot)	Blows Analyzed	Average Hammer Rate (bpm)	Avg. Max. Compressive Force (kips)	Average Maximum Velocity (ft/sec)	Average Transferred Energy (lb-ft)	Average[3] Transfer Ratio (%)
Boring # 1	02-Dec-2013	28.9	25-26.5	SS1	4-5-7	12	12	50.7	28.0	20.0	291	83.2
		36.9	30-31.5	SS2	5-6-6	12	12	50.2	32.0	23.3	315	90.0
		41.9	35-36.5	SS3	6-8-7	15	12	50.1	29.0	20.8	290	82.8
							Average:	50.3	29.7	21.4	299	**85.3**
							Standard Deviation:	0.3	2.1	1.7	14.2	**4.0**

Notes:

1 - Total rod length, including sampler, below gages

2 - Depths measured from below reference elevation

3 - Ratio of average transferred energy (EFV) to theoretical potential energy of 350 ft-lbs (140 lbs x 30 inch drop)

APPENDIX A
AN INTRODUCTION INTO SPT DYNAMIC PILE TESTING

The following has been written by GRL Engineers, Inc. and may only be copied with its written permission.

1. BACKGROUND

The Standard Penetration Test is frequently conducted as an in-situ assessment of soil strength. This test requires that a 140 lb weight is dropped 30 inches onto a drive rod at whose bottom a sampler is usually installed. The sampler is driven for 18 inches; the number of blows required for the last 12 inches of driving is the so-called N-value. The N-value may be used as a strength indicator for foundation design or as a means of assessing the liquefaction potential of soils.

Obviously, the SPT hammer efficiency is an important consideration when using the N-values for design purposes. Measurements have indicated that the energy in the drive rod is sometimes only 30% and and may reach 90% of the potential or rated energy of the SPT hammer (E-rated = 0.35 kip-ft or 0.475 kJ). The type of hammer used to drive the rod is the main reason for these variations. On the average, the energy in the drive rod is 60% of the standard rated energy.

Because of the variability of energy, methods based on N-values are considered unreliable. However, measurements during SPT testing using the Case Method can be done on a routine basis and these measurements yield the transferred energy values. With measured energy, EMX, known, an adjustment of the measured N-value, N_m, can be made as follows.

$$N_{60} = N_m [E_m / (0.6E_r)] \qquad (1)$$

Thus, if the measured energy value is equal to the normally expected transferred energy of 60% of E-rated then the adjusted and measured N-values are identical. On the other hand, if the measured energy is only 30% then the adjusted blow count will be reduced by 50%.

2. DYNAMIC TESTING AND ANALYSIS METHODS APPLIED TO SPT

The Case Method of dynamic pile testing, named after the Case Institute of Technology where it was developed between 1964 and 1975, requires that a substantial ram mass (e.g. a pile driving hammer) impacts the pile top such that the pile undergoes at least a small permanent set. Thus, the method is also referred to as a "High Strain Method". The Case Method requires dynamic measurements on the pile or shaft under the ram impact and then a calculation of various quantities. Conveniently, for SPT applications, the measurements and analyses are done by a single piece of equipment: the SPT Analyzer. The Pile Driving Analyzer® (PDA) is also suitable to perform these measurements and data processing.

A related analysis method is the "Wave Equation Analysis" which calculates a relationship between bearing capacity, pile stresses, transferred energy and field blow count. The GRLWEAP™ program performs this analysis and provides a complete set of helpful information and input data. This program can be used very effectively to simulate the SPT driving process.

3. MEASUREMENTS

GRL uses equipment manufactured by Pile Dynamics, Inc. The system includes either an SPT-Analyzer™ (SPTA) or a Pile Driving Analyzer® (PDA), an instrumented rod section and two accelerometers. SPT energy testing is very closely related to and borrows procedures from dynamic pile testing. Those interested in the basis of the SPT energy testing method may obtain extensive literature on dynamic pile testing from GRL Engineers, Inc.

3.1 SPT Analyzer or Pile Driving Analyzer

The basis for the results calculated by the SPTA or PDA are strain and acceleration measured in an instrumented rod section. These signals are converted to rod top force, F(t), and rod top velocity, v(t). The SPTA or PDA conditions, calibrates and displays these signals and immediately computes average pile force and velocity thereby eliminating bending effects. The product of these two

A-1

measurements is then integrated over time which yields the energy transferred to the instrumented section as a function of time (see Section 4.1).

For convenience and accuracy, strain measurements are usually taken on an instrumented section of SPT drive rod. Ideally, the section properties of the instrumented rod and those of the drive rod are the same, however, using subs, other sections can also be utilized.

For the instrumented section, PDI provides a force calibration in such a way that the output of the instrumented rod is directly calculated without the need for an accurate elastic modulus or cross sectional area of the rod section.

The acceleration measurements are often demanding in the SPT environment, because of high frequency and high acceleration motion components. An experienced measurement engineer, therefore, has to evaluate the quality of this data before final conclusions are drawn from the numerical results calculated by SPTA or PDA.

SPTA or PDA records are taken while the standard N-value is acquired in the conventional manner. This then allows a direct correlation between N-value and average transferred energy.

3.2 HPA

The SPT hammer's ram velocity may be directly obtained using radar technology in the Hammer Performance Analyzer™. The impact velocity results can be automatically processed with a PC or recorded on a strip chart. HPA measurements yield a hammer kinetic energy, but not the energy transferred to the drive rod.

4 RECORD EVALUATION BY SPTA OR PDA

4.1 HAMMER PERFORMANCE

The PDA calculates the energy transferred to the pile top from:

$$E(t) = {}_0\int^t F(\tau)v(\tau)\, d\tau \tag{2}$$

The maximum of the E(t) curve is often called **ENTHRU or EMX;** it is the most important quantity for an overall evaluation of the performance of a hammer and driving system. **EMX** allows for a classification of the hammer's performance when presented as, e_T, the rated transfer efficiency, also called energy transfer ratio (**ETR**) or global efficiency.

$$e_T = EMX/E_R \tag{3}$$

where E_R is the hammer manufacturer's rated energy value or 0.35 kip-ft (0.475 kJ) in the case of the SPT hammer.

Often in the SPT literature one finds also reference to the EF2 energy. This evaluation is based on assumed proportionality between force and velocity (see also Section 5):

$$v(t) = F(t) / Z \tag{4}$$

where $Z = EA/c$ is the pile impedance, E is the elastic modulus, A is the cross sectional area and c is the speed of the stress wave in the pile material..

Combining equations 2 and 4 leads to

$$EF(t) = {}_0\int^t F(\tau)^2 / Z\, d\tau \tag{5}$$

The EF2 transferred energy value is the EF-value at the time t = 2L/c, where L is the drive rod length and c is the stress wave speed in steel (16,800 ft/s or 5,124 m/s). Since the force is easier to measure than both force and velocity, Equation 5 is preferred by some test engineers. However, the EF method is fraught with errors and certain correction factors have to be applied to make it approximately correct. Among the error sources are the following:

- Proportionality is often violated prior to time 2L/c. The proportionality between force and velocity in a downward traveling wave only holds if the wave does not encounter a disturbance prior to reflecting off the pile toe. Such disturbances include a change in cross sectional area, an open or loose splice or joint, or resistance along the shaft.

- Using only one force measurement precludes a data quality check based on the proportionality between force and velocity. Thus, a force measurement that is for some reason in error may not be detectable, which will lead to errors in the EF2 value. Data quality checks will be discussed further in Section 5.

A-2

The use if EF2 is therefore not recommended but it is often included in result presentations for the sake of completeness.

4.2 STRESSES

During SPT monitoring, it is also of interest to monitor compressive stresses at both the top of the drive rod and at its bottom.

At the pile top (location of sensors) the maximum compression stress averaged over the rod's cross section, **CSX**, is directly obtained from the measurements. Note that this stress value refers to the instrumented section. If the rod has a different cross sectional area then the stress in the rod will be different from CSX.

The SPTA or PDA can also calculate, in an approximate manner, the force at the rod bottom, **CFB**. To obtain the corresponding stress, this force value should be divided by the appropriate cross sectional area, e.g. by the rod area just above the sampler or by the sampler area itself. Of course, non-uniform stress components as they might occur at the sampler tip due to a sloping rock are not considered in this calculation.

5. DATA QUALITY CHECKS

Quality data is the first and foremost requirement for accurate dynamic testing results. It is therefore important that the measurement engineer performing SPTA or PDA tests has the experience necessary to recognize measurement problems and take appropriate corrective action should problems develop. Fortunately, dynamic pile testing allows for certain data quality checks because two independent measurements are taken that have to conform to the so-called proportionality relationship.

As long as there is only a wave traveling in one direction, as is the case during impact when only a downward traveling wave exists in the rod, force and velocity measured at its top are proportional

$$F = v\, Z \tag{5}$$

where Z is again the pile impedance, Z = EA/c. This relationship can also be expressed in terms of stress

$$\sigma = F/A = v\,(E/c) \tag{6}$$

or strain

$$\epsilon = \sigma/E = v\,/\,c \tag{7}$$

This means that the early portion of strain times wave speed must be equal to the velocity unless the proportionality is affected by high friction near the pile top or by a pile cross sectional change not far below the sensors. Checking the proportionality is an excellent means of assuring meaningful measurements but is only truly meaningful for perfectly uniform rods. Open or loose splices, for example, will lead to a non-proportionality. For SPT rods it is fortunate that usually no soil resistance acts along the shaft and for that reason, proportionality can exist until the stress wave returns from sampler top or rod bottom unless connectors are not sufficiently tightened or have a significant mass.
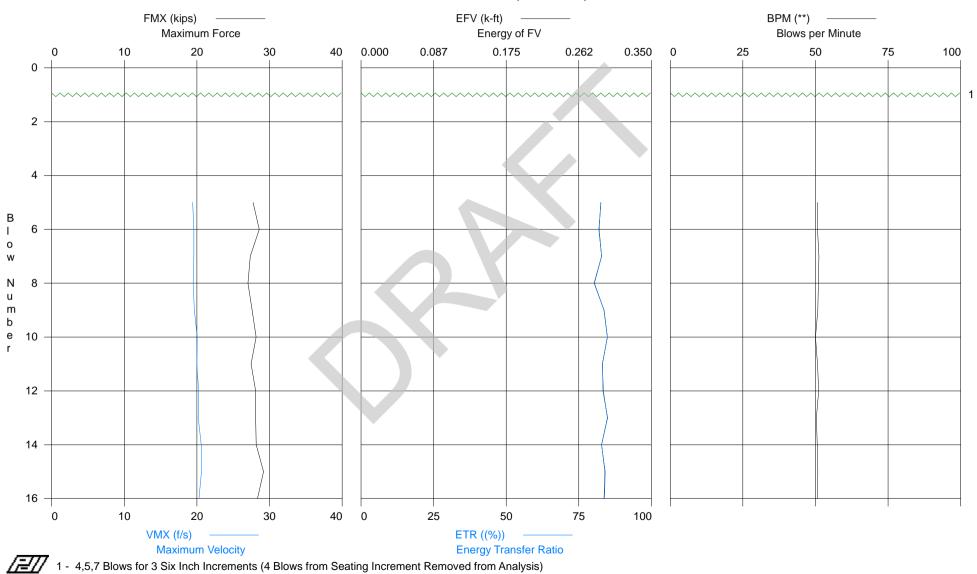
Velocity data quality can also be checked by looking at the final displacement, DFN, which is calculated from the acceleration by double integration. If the calculated final displacement is much higher or lower than indicated by the N-value, the accelerometer attachment may be loose or the sensor may be faulty. If major drift in the velocity is observed, the EMX value may be in error, even though proportionality from impact to time 2L/c exists. In this case, it may be useful to evaluate the energy transferred to the drill rod at time 2L/c, which is calculated by the PDA or SPTA as the E2E quantity.

Southern Earth Science - SPT Hammer Calibration - SS1 @ 25 FT
Diedrich D50 Automatic, SN#268, AWJ

1 - 4,5,7 Blows for 3 Six Inch Increments (4 Blows from Seating Increment Removed from Analysis)

Southern Earth Science - SPT Hammer Calibration - SS1 @ 25 FT   Diedrich D50 Automatic, SN#268, AWJ
OP: M.J.   Test date: 2-Dec-2013

AR:	1.16 in^2						SP:	0.492 k/ft3
LE:	28.90 ft						EM:	30,000 ksi
WS:	16,807.9 f/s						JC:	0.00

FMX: Maximum Force	BPM: Blows per Minute
VMX: Maximum Velocity	E2E: Energy of FV at 2L/c
VT1: Velocity at Time 1	EFV: Energy of FV
DMX: Maximum Displacement	ETR: Energy Transfer Ratio
DFN: Final Displacement	

BL#	depth	FMX	VMX	VT1	DMX	DFN	BPM	E2E	EFV	ETR
	ft	kips	f/s	f/s	in	in	**	k-ft	k-ft	(%)
5	0.00	28	19.4	19.4	1.12	0.56	50.6	0.271	0.289	82.64
6	0.00	29	19.6	19.6	1.14	0.61	50.7	0.272	0.287	81.90
7	0.00	27	19.6	19.6	1.04	0.26	51.2	0.274	0.290	82.87
8	0.00	27	19.5	19.5	0.97	0.13	51.0	0.270	0.281	80.41
9	0.00	28	19.6	19.6	0.97	0.62	50.8	0.272	0.293	83.65
10	0.00	28	20.0	20.0	0.95	0.37	50.0	0.278	0.297	84.84
11	0.00	27	20.0	20.0	0.87	-0.08	50.7	0.278	0.291	83.17
12	0.00	28	20.3	20.3	0.82	0.16	51.1	0.274	0.292	83.31
13	0.00	28	20.2	20.2	0.83	0.29	50.3	0.275	0.297	84.95
14	0.00	28	20.6	20.6	0.76	0.00	50.6	0.276	0.290	82.81
15	0.00	29	20.6	20.6	0.73	0.11	50.8	0.276	0.294	84.11
16	0.00	28	20.3	20.3	0.72	0.01	50.7	0.273	0.293	83.85
Average		28	20.0	20.0	0.91	0.25	50.7	0.274	0.291	83.21

Total number of blows analyzed: 12

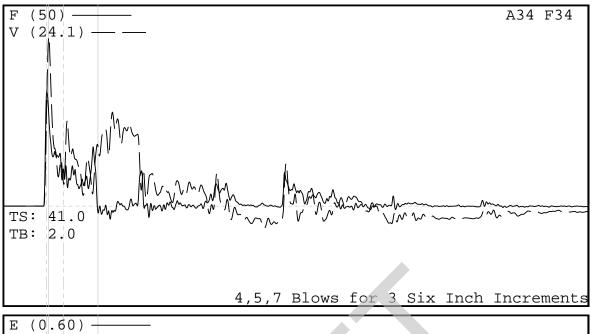| BL#	depth (ft)	Comments
1	0.00	4,5,7 Blows for 3 Six Inch Increments (4 Blows from Seating Increment Removed from Analysis
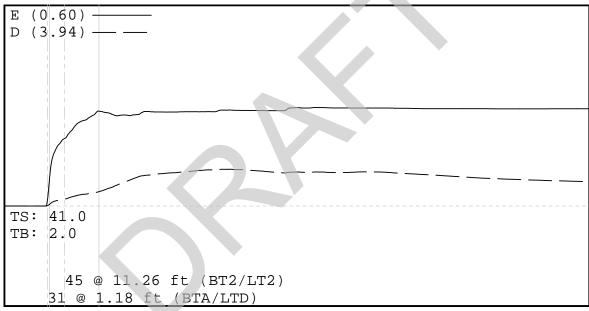
Time Summary

Drive   18 seconds   9:25:45 AM - 9:26:03 AM (12/2/2013) BN 1 - 16

F (50) ———
V (24.1) —— ——
A34 F34

TS: 41.0
TB: 2.0

4,5,7 Blows for 3 Six Inch Increments

E (0.60) ———
D (3.94) —— ——

TS: 41.0
TB: 2.0

45 @ 11.26 ft (BT2/LT2)
31 @ 1.18 ft (BTA/LTD)

Project Information
PROJECT: Southern Earth Science - SPT Hammer
PILE NAME: SS1 @ 25 FT
DESCR: Diedrich D50 Automatic, SN#268, AWJVT1
OPERATOR: M.J.
FILE: SS1 25 FT.W01
12/2/2013 9:26:03 AM
Blow Number 16

Pile Properties
LE   28.90 ft
AR   1.16 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   2.1 ksec/ft
2L/C   3.44 ms
JC   []

Quantity Results
FMX alib 28 kips
VMX 20.3 f/s
20.3 f/s
DMX 0.72 in
DFN 0.01 in
BPM 50.7 bpm
E2E 0.27 k-ft
EFV 0.29 k-ft
ETR 83.8 (%)

Sensors
F3: [171AWJ-1] 215.18 (1)
F4: [171AWJ-2] 214.69 (1)
A3: [K3540] 382 mv/5000g's (1)
A4: [K2615] 285 mv/5000g's (1)
CLIP: OK

Southern Earth Science - SPT Hammer Calibration - SS2 @ 30 FT
Diedrich D50 Automatic, SN#268, AWJ

FMX (kips) ———	EFV (k-ft) ———	BPM (**) ———
Maximum Force	Energy of FV	Blows per Minute

VMX (f/s) ———
Maximum Velocity

ETR ((%)) ———
Energy Transfer Ratio

1 - 5,6,6 Blows for 3 Six Inch Increments (5 Blows from Seating Increment Removed From Analysis)

Southern Earth Science - SPT Hammer Calibration - SS2 @ 30 FT   Diedrich D50 Automatic, SN#268, AWJ
OP: M.J.   Test date: 2-Dec-2013

AR:	1.16 in^2							SP:	0.492 k/ft3
LE:	36.90 ft							EM:	30,000 ksi
WS:	16,807.9 f/s							JC:	0.00

FMX:	Maximum Force	BPM:	Blows per Minute
VMX:	Maximum Velocity	E2E:	Energy of FV at 2L/c
VT1:	Velocity at Time 1	EFV:	Energy of FV
DMX:	Maximum Displacement	ETR:	Energy Transfer Ratio
DFN:	Final Displacement		

BL#	depth	FMX	VMX	VT1	DMX	DFN	BPM	E2E	EFV	ETR
	ft	kips	f/s	f/s	in	in	**	k-ft	k-ft	(%)
6	0.00	35	23.9	23.9	1.37	1.37	50.0	0.299	0.318	90.82
7	0.00	33	23.5	23.5	1.40	1.40	50.1	0.300	0.320	91.44
8	0.00	34	23.8	23.8	1.40	1.40	50.7	0.302	0.321	91.58
9	0.00	31	22.2	22.2	1.23	1.23	50.3	0.293	0.306	87.52
10	0.00	31	22.9	22.9	1.19	1.14	50.4	0.294	0.308	88.04
11	0.00	35	24.2	24.2	1.25	1.25	50.2	0.306	0.322	92.04
12	0.00	34	23.4	23.4	1.29	1.29	50.0	0.302	0.320	91.40
13	0.00	31	22.6	22.6	1.04	0.85	50.5	0.298	0.306	87.47
14	0.00	30	22.8	22.8	1.08	0.94	49.9	0.301	0.311	88.84
15	0.00	32	23.3	23.3	1.12	0.94	50.3	0.303	0.315	89.94
16	0.00	32	23.9	23.9	1.26	1.22	49.9	0.306	0.322	91.88
17	0.00	31	23.1	23.1	1.21	0.98	50.6	0.300	0.309	88.40
	Average	32	23.3	23.3	1.24	1.17	50.2	0.300	0.315	89.95

Total number of blows analyzed: 12

BL#	depth (ft)	Comments
1	0.00	5,6,6 Blows for 3 Six Inch Increments (5 Blows from Seating Increment Removed From Analys
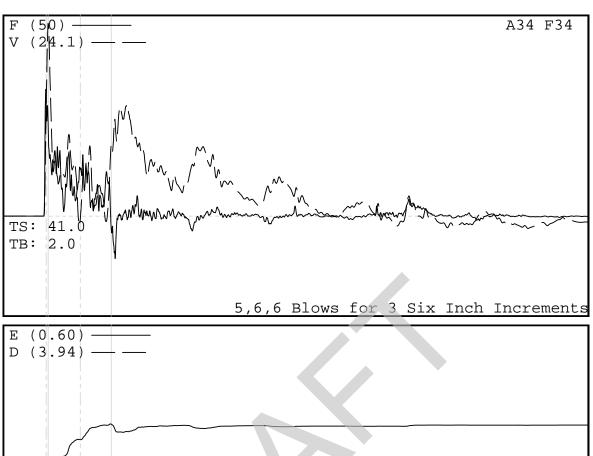
Time Summary
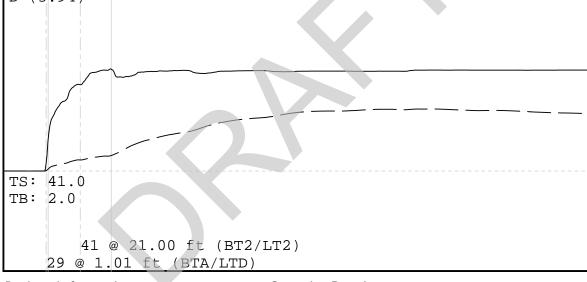
Drive   19 seconds   10:48:40 AM - 10:48:59 AM (12/2/2013) BN 1 - 17

```
F (50) ————————                                A34 F34
V (24.1) —— ——
TS: 41.0
TB: 2.0
                              5,6,6 Blows for 3 Six Inch Increments
```



```
E (0.60) ————————
D (3.94) —— ——
TS: 41.0
TB: 2.0
        41 @ 21.00 ft (BT2/LT2)
        29 @ 1.01 ft (BTA/LTD)
```

Project Information
PROJECT: Southern Earth Science - SPT Hamm
PILE NAME: SS2 @ 30 FT
DESCR: Diedrich D50 Automatic, SN#268, AWJVT1
OPERATOR: M.J.
FILE: SS2 30 FT.W01
12/2/2013 10:48:58 AM
Blow Number 17

Pile Properties
LE   36.90 ft
AR   1.16 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   2.1 ksec/ft
2L/C   4.39 ms
JC   []

Quantity Results
FMX alib31ikips
VMX 23.1 f/s
VT1 23.1 f/s
DMX 1.21 in
DFN 0.98 in
BPM 50.6 bpm
E2E 0.30 k-ft
EFV 0.31 k-ft
ETR 88.4 (%)

Sensors
F3: [171AWJ-1] 215.18 (1)
F4: [171AWJ-2] 214.69 (1)
A3: [K3540] 382 mv/5000g's (1)
A4: [K2615] 285 mv/5000g's (1)
CLIP: OK

Southern Earth Science - SPT Hammer Calibration - SS3 @ 35 FT
Diedrich D50 Automatic, SN#268, AWJ

1 - 6,8,7 Blows for 3 Six Inch Increments (6 Blows from Seating Increment Removed From Analysis)

Southern Earth Science - SPT Hammer Calibration - SS3 @ 35 FT   Diedrich D50 Automatic, SN#268, AWJ
OP: M.J.   Test date: 2-Dec-2013

AR:	1.16 in^2						SP:	0.492 k/ft3	
LE:	41.90 ft						EM:	30,000 ksi	
WS:	16,807.9 f/s						JC:	0.00	

FMX:	Maximum Force					BPM:	Blows per Minute		
VMX:	Maximum Velocity					E2E:	Energy of FV at 2L/c		
VT1:	Velocity at Time 1					EFV:	Energy of FV		
DMX:	Maximum Displacement					ETR:	Energy Transfer Ratio		
DFN:	Final Displacement								

BL#	depth	FMX	VMX	VT1	DMX	DFN	BPM	E2E	EFV	ETR
	ft	kips	f/s	f/s	in	in	**	k-ft	k-ft	(%)
7	0.00	27	19.6	19.6	0.80	-0.02	49.7	0.255	0.258	73.78
8	0.00	27	19.3	19.3	0.86	0.24	50.3	0.254	0.257	73.46
9	0.00	26	19.4	19.4	0.83	-0.08	50.3	0.252	0.254	72.65
10	0.00	29	19.3	19.3	0.97	0.36	48.4	0.265	0.270	77.15
11	0.00	30	21.1	21.1	1.03	0.38	51.6	0.286	0.291	83.17
12	0.00	29	20.9	20.9	0.95	-0.06	50.1	0.280	0.284	81.03
13	0.00	29	20.5	20.5	0.92	0.23	49.9	0.290	0.294	84.01
14	0.00	30	21.7	21.7	0.77	0.10	50.3	0.296	0.301	86.11
15	0.00	31	21.8	21.8	0.70	0.02	50.0	0.300	0.305	87.16
16	0.00	30	21.7	21.7	0.72	-0.07	50.1	0.298	0.304	86.81
17	0.00	30	21.6	21.6	0.79	0.20	50.3	0.297	0.303	86.60
18	0.00	30	21.4	21.4	0.85	0.51	49.9	0.302	0.308	87.86
19	0.00	29	21.1	21.1	0.81	0.29	50.1	0.300	0.304	86.79
20	0.00	29	21.6	21.6	0.80	0.24	50.4	0.300	0.305	87.25
21	0.00	29	21.5	21.5	0.81	0.26	49.8	0.305	0.309	88.39
Average		29	20.8	20.8	0.84	0.17	50.1	0.285	0.290	82.81

Total number of blows analyzed: 15

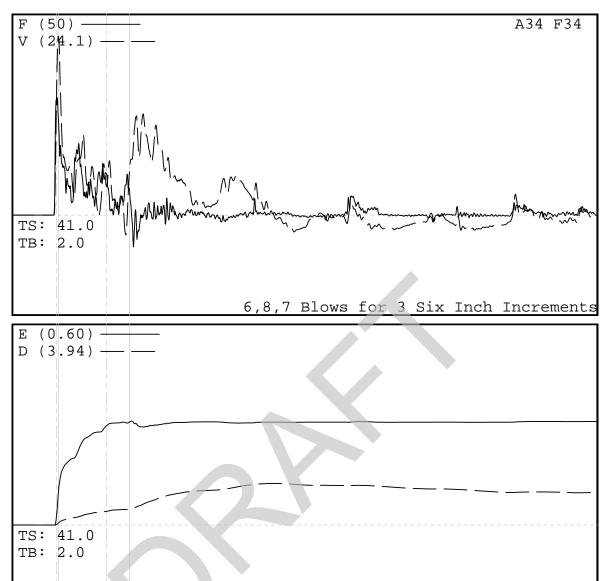| BL#	depth (ft)	Comments
1	0.00	6,8,7 Blows for 3 Six Inch Increments (6 Blows from Seating Increment Removed From Analysi

Time Summary

| Drive | 24 seconds | | 11:09:58 AM - 11:10:22 AM (12/2/2013) BN 1 - 21 |

F (50)
V (24.1)

A34 F34

TS: 41.0
TB: 2.0

6,8,7 Blows for 3 Six Inch Increments

E (0.60)
D (3.94)

TS: 41.0
TB: 2.0

52 @ 30.46 ft (BT2/LT2)
38 @ 1.01 ft (BTA/LTD)

Project Information
PROJECT: Southern Earth Science - SPT Hamm
PILE NAME: SS3 @ 35 FT
DESCR: Diedrich D50 Automatic, SN#268, AWJVT1
OPERATOR: M.J.
FILE: SS3 35 FT.W01
12/2/2013 11:10:21 AM
Blow Number 21

Pile Properties
LE   41.90 ft
AR   1.16 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   2.1 ksec/ft
2L/C   4.98 ms
JC   []

Quantity Results
FMX alib29 kips
VMX 21.5 f/s
VMX 21.5 f/s
DMX 0.81 in
DFN 0.26 in
BPM 49.8 bpm
E2E 0.30 k-ft
EFV 0.31 k-ft
ETR 88.4 (%)

Sensors
F3: [171AWJ-1] 215.18 (1)
F4: [171AWJ-2] 214.69 (1)
A3: [K3540] 382 mv/5000g's (1)
A4: [K2615] 285 mv/5000g's (1)
CLIP: OK

Version 2012.113.004

FUGRO CONSULTANTS, INC.

6100 Hillcroft, Houston, Texas 77081
Tel: 713-369-5400
www.fugroconsultants.com

SPT Calibration Report – Fugro Drill Rig SN#361982

Project No: 04.55124092

To: Jennifer Aguettant
          Project Manager

From: Michael A. Norfleet, P.E.

Date: September 25, 2013

Subject: **SPT Hammer Energy Calibrations**

Fugro Consultants, Inc. (Fugro) is pleased to present the results of the Standard Penetration Test (SPT) energy calibration measurements conducted on September 20, 2013 at the Fugro Facilities Yard, in Houston, Texas.

Purpose and Scope. The purpose of SPT energy calibration described herein is to determine the average energy transferred from the exploration rig's hammer to the drilling rods during SPT sampling. The energy testing methods are described in the ASTM D4633 Standard Test Method for Energy Measurement of Dynamic Penetrometers. The measured energy may then be used to correct the measured SPT N-values to a standardized energy level, typically 60% of the theoretical energy (N_{60}).

Summary of Scope:

- mobilize PDA equipment and personnel to the drill rig location,

- provide energy calibrations by measuring the force (from strain) and velocity (from acceleration) using an instrumented rod section and a PDA.

- present the test results and findings.

Test Summary

Instrumentation and Test Sequence. SPT energy testing was performed in general accord with ASTM D4633 using the Pile Driving Analyzer (PDA) model PAX (SN 3846L) in conjunction with an instrumented 2-foot section of NWJ drilling rod (SN 333NWJ), both manufactured by Pile Dynamics, Inc. of Cleveland, Ohio. The instrumented rod consists of two strain sensors in full-bridge configuration with each strain bridge mounted to cancel any bending in the rod section. Attachment 1 includes a calibration certificate for the rod section. Two accelerometers are also bolted directly to the rod section during data collection. To collect data, the instrumented rod section was threaded tightly onto the top of the drill-rod string, just underneath the SPT hammer. For selected sampling intervals, the PDA digitized and stored strain and acceleration data at a sampling rate of 100 kHz for each impact of the SPT hammer. During the hammer impact, the

PDA multiplied the strain wave by the rod area and modulus to obtain the force wave, and integrated the acceleration to obtain the velocity wave. By integrating the product of force and velocity over the time of the impact, the PDA can then determine the net energy delivered to the sample rods during each blow. The PDA operator reviewed the results, performed data quality checks, and obtained an adequate number and range of sample SPT blows to properly characterize the hammer energy performance for Fugro Drill Rig #361982 tested.

The automatic SPT hammer was operated by the lead driller on Rig #361982. The drill rig used NWJ drill rods. Fugro tested the attached automatic hammer for this report, which had no serial number or identifying marks. The automatic hammer was completely encased for safety reasons and appeared to be in good operating condition. During normal drilling operations on Rig #361982 four data sets were collected as listed below in Table 1 (exceeding the minimum of three required by ASTM D4633). Each table includes the date, location, sample starting depths, the blow count for each 6-inch depth interval, and the uncorrected N-value (sum of last two blow counts).

Table 1: Summary of SPT Data Sets – Automatic Hammer on Rig #361982

Test Date	Data Set No.	Boring Location	Sample Depth	150mm Blow Counts and N-value
09-20-13	SPT-1	Fugro Yard	10 ft	3 / 2 / 2 N=4
09-20-13	SPT-2	Fugro Yard	12 ft	2 / 3 / 4 N=7
09-20-13	SPT-3	Fugro Yard	14 ft	7 / 7 / 9 N=16
09-20-13	SPT-4	Fugro Yard	16 ft	17 / 21 / 24 N=45

Evaluation of SPT Energy. Test results were evaluated utilizing the F-V energy method described in ASTM D4633. The PDA computes EMX, the energy transferred to the rods as measured at the gage location using force, F(t), and velocity, v(t), by the following equation:

$$EMX = EFV = \int_a^b F(t) \cdot v(t)\, dt$$

The time "a" corresponds to the start of the record just before impact of the hammer and "b" is the time the energy transferred reaches a maximum value.

Discussion of SPT Calibration Results

In Attachment 2 we present field notes, wave traces for representative hammer blows, and plots and tables prepared from the PDA data for each data set. Each PDA plot contains three main graphs.   The left-hand graph shows CSX (maximum average compressive stress) and CSI (maximum individual gage stress) plotted versus blow number. Together these plots show the difference between the two force measurements. The center plot shows EMX (maximum energy) and ETR (EMX divided by theoretical hammer energy).   These plots indicate the hammer efficiency and consistency during testing. The right-hand graph shows FMX (maximum force) and BPM (blows per minute) to give a relative hammer "operational performance" during testing. The tabulated output for each data set also includes statistical evaluations: average, maximum, minimum, and standard deviation. To arrive at overall performance of the hammer tested, we used the average statistical evaluations from the data sets, shown in Table 2.

The uncorrected N-values can be corrected using the following equations:

$$N_{60} = N_{measured} \text{ x Correction Factor}$$

$$N_{60} = N_{measured} \text{ x (ETR/60\%)}$$

The average value of all the ETR values for each data set was used in the above equation to calculate an average correction factor. These correction factors may be applied to N-values from sampling intervals in these and other borings not tested with the PDA, provided the hammers are not modified and are maintained in their current condition.

Table 2: Summary of SPT Results – Automatic Hammer on Rig #361982

Data Set	BPM	FMX (kips)	EMX (k-ft)	ETR (%)	$N_{measured}$	N_{60}
SPT-1	32	39	0.264	76	4	6
SPT-2	47	41	0.337	96	7	10
SPT-3	44	40	0.290	83	16	23
SPT-4	50	40	0.307	88	45	64
Average Overall Performance	43	40	0.300	86	**Correction Factor = 1.43**	

Conclusions

Fugro obtained SPT energy measurements for one automatic hammer attached to Fugro Drill Rig #361982 during sampling events on 9/20/2013 in the Fugro Facilities Yard. The hammer appeared to be operating normally. Tables 1 to 2 above summarize the data collected and the average calculated transferred energies in accordance with ASTM D4633. On average, the ETR, Energy Transfer Ratio, was 86% for the automatic hammer attached to Fugro Drill Rig #361982.

We appreciate the opportunity to be of service. Please call us if you have any questions or comments concerning the field notes, SPT plots and tables, or when we may be of further assistance.

Sincerely,
FUGRO CONSULTANTS, INC.

Michael Norfleet, P.E.
Sr. Project Professional

Attachments:

Attachment 1: Test Photos and Sensor Calibrations
Attachment 2: Fugro Drill Rig #361982 SPT Test Records and Field Notes

ATTACHMENT #1

Test Photos and Sensor Calibrations

Rig #361982 Plaque

Striking Surface Attachment to Instrumented Rod
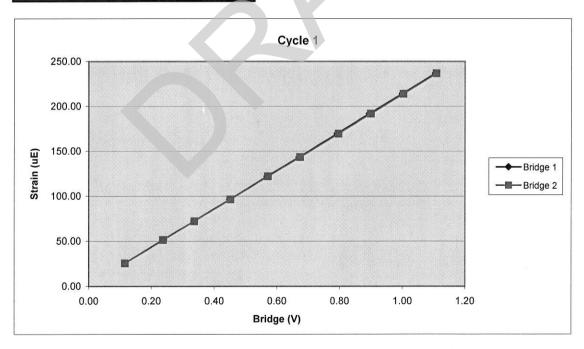
Mounted Automatic Hammer on Rig #361982

333NWJ		Cycle 1		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1038.93	25.63	0.12	0.12
3	2112.50	51.34	0.24	0.24
4	2998.51	72.10	0.34	0.34
5	4030.95	96.42	0.45	0.45
6	5109.63	121.88	0.57	0.57
7	6031.46	143.53	0.67	0.67
8	7140.85	169.65	0.79	0.80
9	8079.21	191.78	0.90	0.90
10	9034.10	214.09	1.00	1.00
11	9994.90	236.67	1.11	1.11

| Bridge 1		Bridge 2	
Force Calibration (lb/V)	9062.28	Force Calibration (lb/V)	9020.00
Offset	-38.24	Offset	-28.48
Correlation	0.999990	Correlation	0.999989
Strain Calibration (μE/V)	213.39	Strain Calibration (μE/V)	212.39
Offset	0.56	Offset	0.79
Correlation	0.999996	Correlation	0.999994
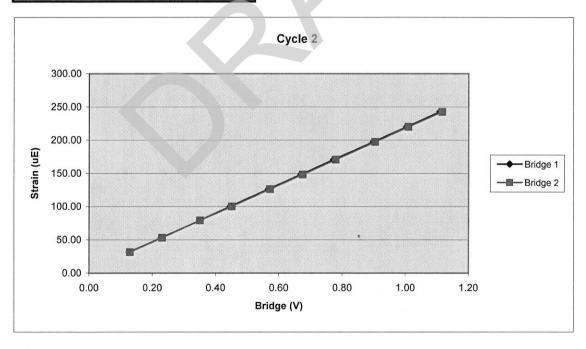
Force Strain Calibration	
EA (Kips)	42468.92
Offset	-61.97
Correlation	0.999998

Cycle 1

333NWJ		Cycle 2		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1138.32	31.42	0.13	0.13
3	2045.78	53.13	0.23	0.23
4	3129.98	79.01	0.35	0.35
5	4010.08	99.98	0.45	0.45
6	5118.68	126.12	0.57	0.57
7	6067.28	148.26	0.67	0.67
8	7005.84	170.48	0.77	0.78
9	8154.78	197.38	0.90	0.90
10	9110.07	219.90	1.00	1.01
11	10089.37	242.56	1.11	1.12

Bridge 1		Bridge 2	
Force Calibration (lb/V)	9123.54	Force Calibration (lb/V)	9074.39
Offset	-49.69	Offset	-53.66
Correlation	0.999993	Correlation	0.999988
Strain Calibration (µE/V)	215.17	Strain Calibration (µE/V)	214.02
Offset	3.89	Offset	3.79
Correlation	0.999998	Correlation	0.999998
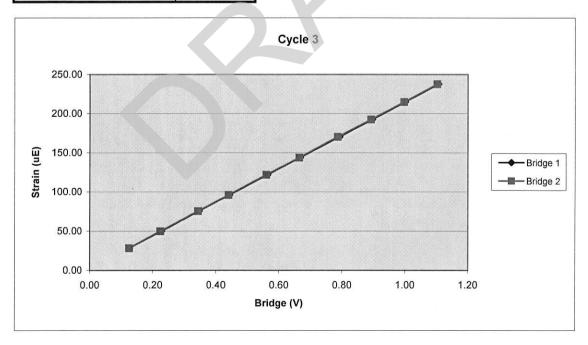
Force Strain Calibration	
EA (Kips)	42400.74
Offset	-214.40
Correlation	0.999992

Cycle 2

333NWJ		Cycle 3		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1125.52	28.24	0.13	0.12
3	2016.06	49.68	0.23	0.22
4	3101.05	75.29	0.35	0.34
5	3977.02	95.97	0.44	0.44
6	5073.81	121.83	0.56	0.56
7	6005.68	143.75	0.67	0.66
8	7133.76	170.21	0.79	0.79
9	8082.95	192.52	0.90	0.89
10	9043.75	214.97	1.00	1.00
11	10017.53	237.71	1.11	1.10

Bridge 1		Bridge 2	
Force Calibration (lb/V)	9067.17	Force Calibration (lb/V)	9087.50
Offset	-32.75	Offset	-17.10
Correlation	0.999991	Correlation	0.999996
Strain Calibration (µE/V)	213.44	Strain Calibration (µE/V)	213.91
Offset	1.42	Offset	1.79
Correlation	0.999998	Correlation	0.999998

Force Strain Calibration	
EA (Kips)	42481.93
Offset	-93.13
Correlation	0.999995

Cycle 3

Bridge Excitation (V)   5
Shunt Resitor (ohm)   60.4k

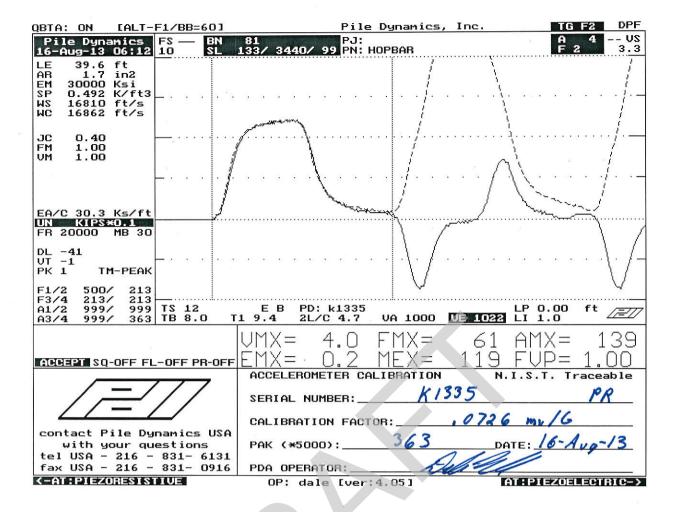| Calibration Factors	333NWJ		
Bridge 1 (µE/V)	214.00	Bridge 2 (µE/V)	213.44
EA Factor (Kips)	42450.53	Area (in^2)	1.42

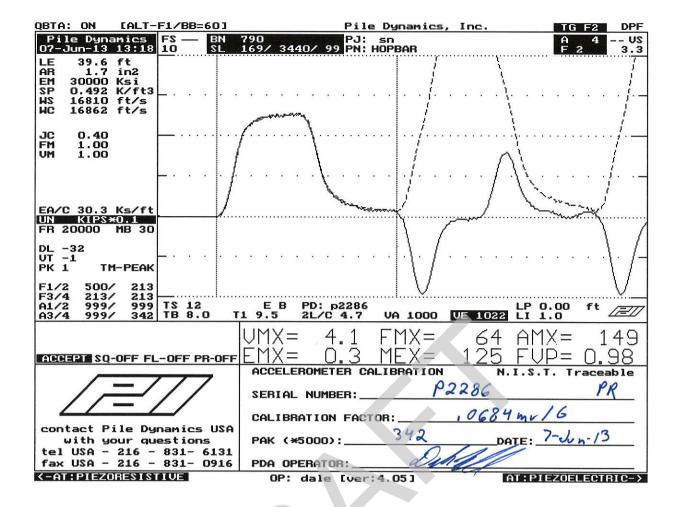Calibrated by: _____

Calibrated Date: 3/26/2013

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

| Pile Dynamics | FS — | BN | 81 | PJ: | | A | 4 | -- VS |
| 16-Aug-13 06:12 | 10 | SL | 133/ 3440/ 99 | PN: HOPBAR | | F | 2 | 3.3 |

```
LE    39.6 ft
AR     1.7 in2
EM   30000 Ksi
SP   0.492 K/ft3
WS   16810 ft/s
WC   16862 ft/s

JC    0.40
FM    1.00
VM    1.00




EA/C 30.3 Ks/ft
UN    KIPS*0.1
FR 20000   MB 30

DL  -41
VT  -1
PK  1       TM-PEAK

F1/2  500/   213
F3/4  213/   213
A1/2  999/   999
A3/4  999/   363
```

TS 12   E B   PD: k1335   LP 0.00   ft
TB 8.0   T1 9.4   2L/C 4.7   VA 1000   VE 1022   LI 1.0

VMX=   4.0   FMX=   61   AMX=   139
EMX=   0.2   MEX=   119   FVP= 1.00

ACCEPT SQ-OFF FL-OFF PR-OFF

ACCELEROMETER CALIBRATION   N.I.S.T. Traceable

SERIAL NUMBER: _____K1335_____PR_____

CALIBRATION FACTOR: _____.0726 mv/G_____

PAK (*5000): _____363_____   DATE: 16-Aug-13

PDA OPERATOR: _____

contact Pile Dynamics USA
   with your questions
tel USA - 216 - 831- 6131
fax USA - 216 - 831- 0916

<-AT:PIEZORESISTIVE->   OP: dale [ver:4.05]   AT:PIEZOELECTRIC->

Smart Sensor

Smart Chip Programmed By ___DB___ **on** _16-Aug-13_ **CRC Value** _A6Bf_____

ATTACHMENT #2

Fugro Drill Rig #361982 SPT Records and Field Notes

Fugro Consultants, Inc.

6100 Hillcroft, 77081
P.O. Box 740010
Houston, TX 77274
Ph: (713) 369-5400 F (713) 369-5518

Project #	04.55124092
Project Name	
SPT Tester	Michael Norfleet
Rig(s)	CME 850 – SN#361982
Rig Operator(s)	Jose
Test Date(s)	9/20/13

SPT ENERGY CALIBRATION – HAMMER: Rig #361982

Rig and Hammer Description

CME 850 Track mounted Drill Rig, Serial Number #361982
Automatic hammer attached, no identifying marks

Notes on Operational Performance

Hammer appears to be in good operational conditions
"LE" – Effective Length of Rod Sections input into SPT Analyzer

Instrumentation

Name: 333NWJ Area: 1.42 in^2	
Strains: F3: 333NWJ-1, Gage Factor = 214.00 µε/V	Accelerometers: A3: K1335, Gage Factor = 363 (mV/G x 5000)
F4: 320NWJ-2, Gage Factor = 213.44 µε/V	Accelerometers: A4: P2286, Gage Factor = 342 (mV/G x 5000)

Data Set 1   **Location:** Fugro Yard   **Rig:** 361962   **Time:** 9/20/13 10:05

Starting depth of sample	10ft
Gage location from tip of sampler "LE"	"LE" = 35.5in + 120in + 10in = 165.5in = 13.79ft
List of rod sections from sampler to instrument	Sampler / [5ft x 2] / Instrument / Hammer
Length from impact surface to gages	18 inches
Blows observed (uncorrected)	3/ 2 / 2 per 6 inches N=4
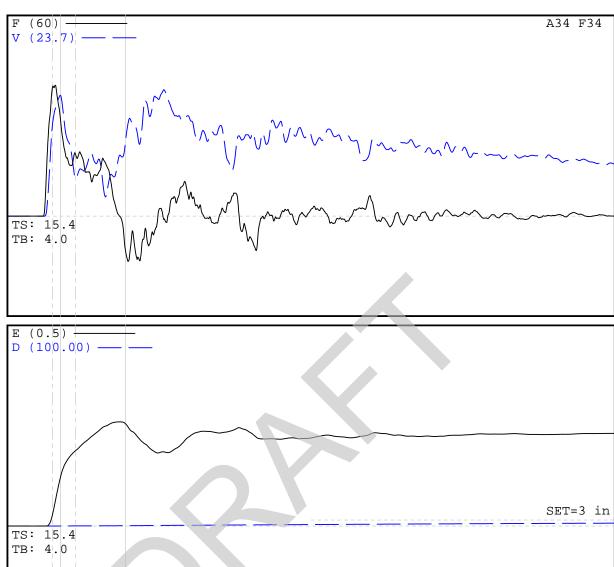
Data Set 2   **Location:** Fugro Yard   **Rig:** 361962   **Time:** 9/20/13 15:57

Starting depth of sample	12ft
Gage location from tip of sampler "LE"	"LE" = 35.5in + 120in + 60in + 10in = 225.5in = 18.79ft
List of rod sections from sampler to instrument	Sampler / [10ft][5ft] / Instrument / Hammer
Length from impact surface to gages	18 inches
Blows observed (uncorrected)	2 / 3 / 4 per 6 inches N=7

Data Set 3   **Location:** Fugro Yard   **Rig:** 361962   **Time:** 9/20/13 10:19

Starting depth of sample	14ft
Gage location from tip of sampler "LE"	"LE" = 35.5in + 120in + 60in + 10in = 225.5in = 18.79ft
List of rod sections from sampler to instrument	Sampler / [10ft][5ft] / Instrument / Hammer
Length from impact surface to gages	18 inches
Blows observed (uncorrected)	7 / 7 / 9 per 6 inches N=16

Data Set 4   **Location:** Fugro Yard   **Rig:** 361962   **Time:** 9/20/13 10:40

Starting depth of sample	16ft
Gage location from tip of sampler "LE"	"LE" = 35.5in + 120in + 120in + 10in = 285.5in = 23.79ft
List of rod sections from sampler to instrument	Sampler / [10ft][10ft] / Instrument / Hammer
Length from impact surface to gages	18 inches
Blows observed (uncorrected)	17 / 21 / 24 per 6 inches N=45

Project Information
PROJECT: 04.55124092
PILE NAME: SPT-1 RIG 361982 10FT FUGRO YARD
DESCR: SAMPLE 10FT
OPERATOR: MAN
FILE: SPT-1 RIG 361982 10FT FUGRO YARD
9/20/2013 11:14:50 AM
Blow Number 4

Pile Properties
LE   13.79 ft
AR   1.42 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   2.5 ksec/ft
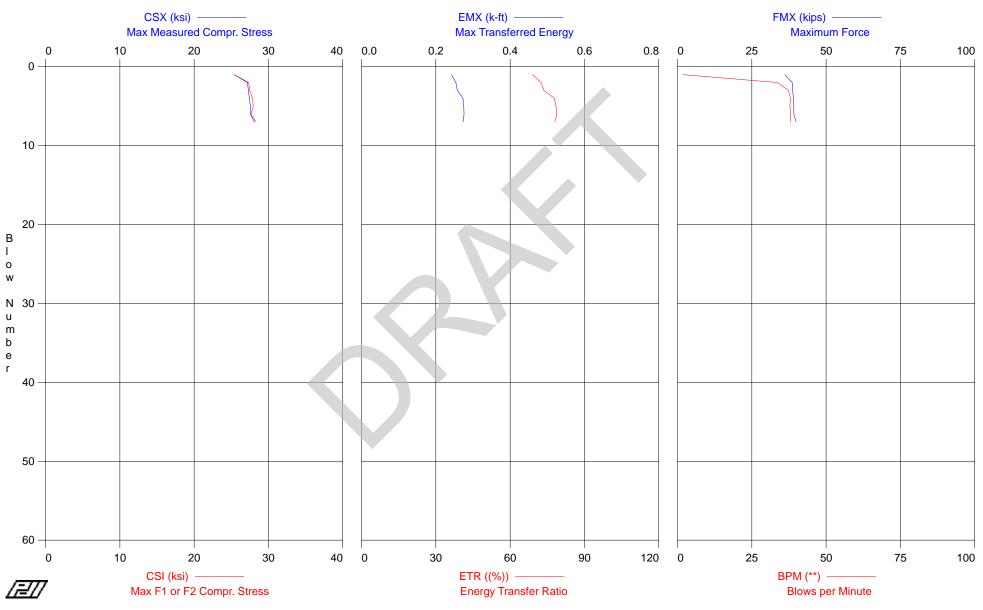2L/C   1.64 ms
JC   []
LP   10.75 ft

Quantity Results
CSX 27.4 ksi
CSI 27.9 ksi
EMX   0.3 k-ft
ETR 77.9 (%)
FMX   39 kips
BPM 38.0 bpm
QNV 0.00 []
QNV 0.00 []
QNV 0.00 []

Sensors
F3: [SPT-333NWJ-1] 214 (1)
F4: [SPT-333NWJ-2] 213.44 (1)
A3: [K1335] 363 mv/5000g's (1)
A4: [2286] 342 mv/5000g's (1)
CLIP: OK

CSX (ksi) ————
Max Measured Compr. Stress

EMX (k-ft) ————
Max Transferred Energy

FMX (kips) ————
Maximum Force

Blow Number

CSI (ksi) ————
Max F1 or F2 Compr. Stress

ETR ((%)) ————
Energy Transfer Ratio

BPM (**) ————
Blows per Minute

04.55124092 - SPT-1 RIG 361982 10FT FUGRO YARD
OP: MAN

SAMPLE 10FT
Test date: 20-Sep-2013

AR:	1.42 in^2	
LE:	13.79 ft	
WS:	16,807.9 f/s	

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.00

CSX: Max Measured Compr. Stress
CSI: Max F1 or F2 Compr. Stress
EMX: Max Transferred Energy

ETR: Energy Transfer Ratio
FMX: Maximum Force
BPM: Blows per Minute

BL#	BLC	CSX	CSI	EMX	ETR	FMX	BPM
	bl/ft	ksi	ksi	k-ft	(%)	kips	**
1	6	25	25	0.242	69	36	2
2	6	27	27	0.254	73	39	34
3	6	27	27	0.258	74	39	37
4	4	27	28	0.273	78	39	38
5	4	28	28	0.275	79	39	38
6	4	28	28	0.276	79	39	38
7	4	28	28	0.273	78	40	38
Average		27	27	0.264	76	39	32
Std. Dev.		1	1	0.012	4	1	12
Maximum		28	28	0.276	79	40	38
@ Blow#		7	7	6	6	7	6
Minimum		25	25	0.242	69	36	2
@ Blow#		1	1	1	1	1	1
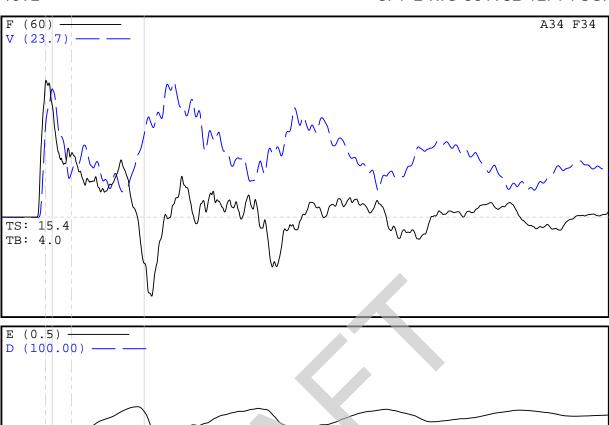
Total number of blows analyzed: 7

Time Summary

Drive   10 seconds   11:14:45 AM - 11:14:55 AM (9/20/2013) BN 1 - 7

F (60)
V (23.7)
A34 F34

TS: 15.4
TB: 4.0

E (0.5)
D (100.00)

SET=2 in

TS: 15.4
TB: 4.0

42 @ 6.72 ft
30 @ 1.38 ft

Project Information
PROJECT: 04.55124092
PILE NAME: SPT-2 RIG 361982 12FT FUGRO YARD
DESCR: SAMPLE 12FT
OPERATOR: MAN
FILE: SPT-2 RIG 361982 12FT FUGRO YARD
9/20/2013 11:28:47 AM
Blow Number 4

Quantity Results
CSX 28.7 ksi
CSI 29.0 ksi
EMX 0.3 k-ft
ETR 96.4 (%)
FMX 41 kips
BPM 52.2 bpm
QNV 0.00 []
QNV 0.00 []
QNV 0.00 []

Pile Properties
LE   18.79 ft
AR   1.42 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   2.5 ksec/ft
2L/C   2.32 ms
JC   []
LP   12.83 ft

Sensors
F3: [SPT-333NWJ-1] 214 (1)
F4: [SPT-333NWJ-2] 213.44 (1)
A3: [K1335] 363 mv/5000g's (1)
A4: [2286] 342 mv/5000g's (1)
CLIP: OK

04.55124092 - SPT-2 RIG 361982 12FT FUGRO YARD

CSX (ksi)
Max Measured Compr. Stress

EMX (k-ft)
Max Transferred Energy

FMX (kips)
Maximum Force

CSI (ksi)
Max F1 or F2 Compr. Stress

ETR ((%))
Energy Transfer Ratio

BPM (**)
Blows per Minute

04.55124092 - SPT-2 RIG 361982 12FT FUGRO YARD
OP: MAN

SAMPLE 12FT
Test date: 20-Sep-2013

AR:	1.42 in^2					SP:	0.492 k/ft3
LE:	18.79 ft					EM:	30,000 ksi
WS:	16,807.9 f/s					JC:	0.00

CSX: Max Measured Compr. Stress
CSI: Max F1 or F2 Compr. Stress
EMX: Max Transferred Energy

ETR: Energy Transfer Ratio
FMX: Maximum Force
BPM: Blows per Minute

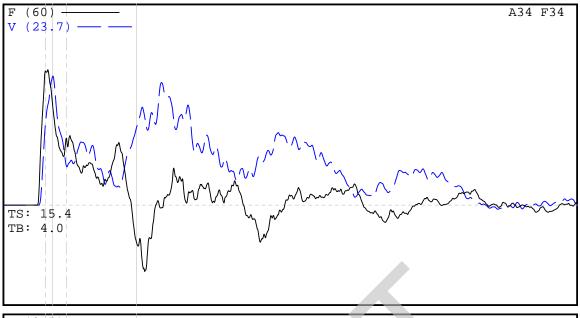| BL#	BLC	CSX	CSI	EMX	ETR	FMX	BPM
	bl/ft	ksi	ksi	k-ft	(%)	kips	**
1	4	28	28	0.303	86	40	2
2	4	28	29	0.359	103	40	53
3	6	30	30	0.333	95	42	53
4	6	29	29	0.337	96	41	52
5	6	29	29	0.346	99	41	53
6	8	29	29	0.337	96	41	53
7	8	29	29	0.338	97	41	53
8	8	29	29	0.337	96	41	52
9	8	29	29	0.341	98	41	52
Average		29	29	0.337	96	41	47
Std. Dev.		0	0	0.014	4	1	16
Maximum		30	30	0.359	103	42	53
@ Blow#		3	3	2	2	3	3
Minimum		28	28	0.303	86	40	2
@ Blow#		1	1	1	1	1	1

Total number of blows analyzed: 9

Time Summary

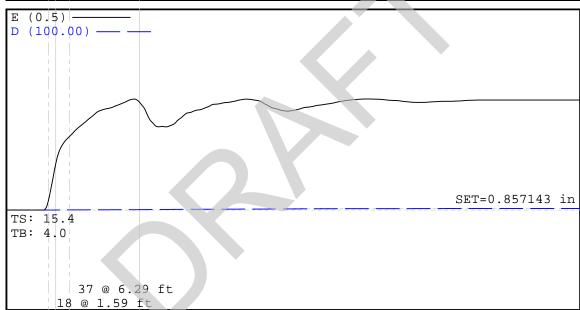Drive   9 seconds   11:28:44 AM - 11:28:53 AM (9/20/2013) BN 1 - 9

F (60) ——
V (23.7) —— ——
A34 F34

TS: 15.4
TB: 4.0

E (0.5) ——
D (100.00) —— ——

SET=0.857143 in

TS: 15.4
TB: 4.0

37 @ 6.29 ft
18 @ 1.59 ft

Project Information
PROJECT: 04.55124092
PILE NAME: SPT-3 RIG 361982 14FT FUGRO YARD
DESCR: SAMPLE 12FT
OPERATOR: MAN
FILE: SPT-3 RIG 361982 14FT FUGRO YARD
9/20/2013 11:45:23 AM
Blow Number 9

Pile Properties
LE   18.79 ft
AR   1.42 in^2
EM   30000 ksi
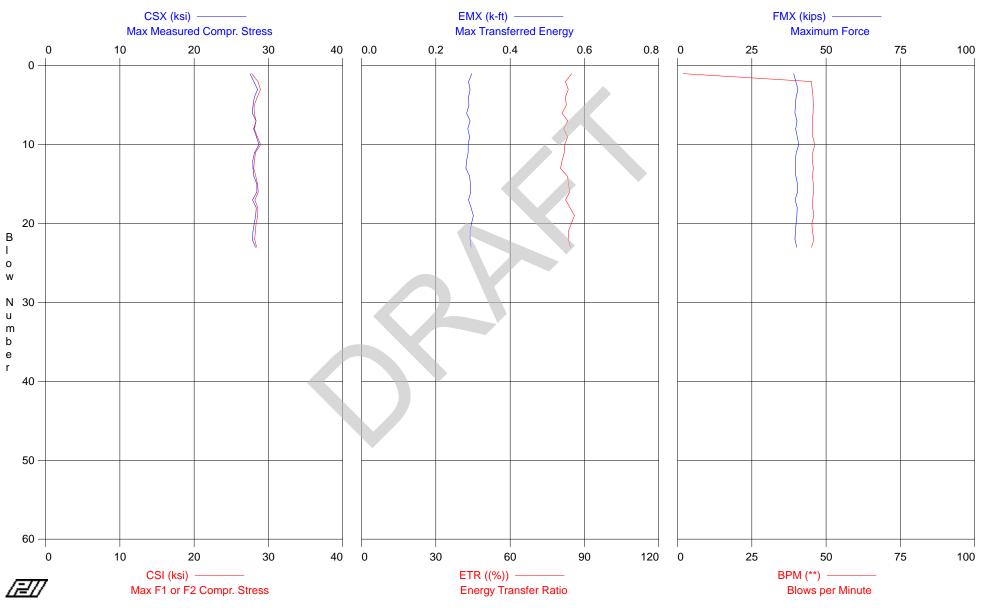SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   2.5 ksec/ft
2L/C   2.24 ms
JC   []
LP   14.64 ft

Quantity Results
CSX 28.4 ksi
CSI 28.5 ksi
EMX 0.3 k-ft
ETR 83.2 (%)
FMX 40 kips
BPM 45.5 bpm
QNV 0.00 []
QNV 0.00 []
QNV 0.00 []

Sensors
F3: [SPT-333NWJ-1] 214 (1)
F4: [SPT-333NWJ-2] 213.44 (1)
A3: [K1335] 363 mv/5000g's (1)
A4: [2286] 342 mv/5000g's (1)
CLIP: OK

Version 2012.113

Fugro Consultants, Inc. - Case Method & iCAP® Results

04.55124092 - SPT-3 RIG 361982 14FT FUGRO YARD

CSX (ksi) ——————
Max Measured Compr. Stress

EMX (k-ft) ——————
Max Transferred Energy

FMX (kips) ——————
Maximum Force

Blow Number

CSI (ksi) ——————
Max F1 or F2 Compr. Stress

ETR ((%)) ——————
Energy Transfer Ratio

BPM (**) ——————
Blows per Minute

04.55124092 - SPT-3 RIG 361982 14FT FUGRO YARD
OP: MAN

SAMPLE 12FT
Test date: 20-Sep-2013

AR:	1.42 in^2		SP:	0.492 k/ft3
LE:	18.79 ft		EM:	30,000 ksi
WS:	16,807.9 f/s		JC:	0.00

CSX: Max Measured Compr. Stress	ETR: Energy Transfer Ratio
CSI: Max F1 or F2 Compr. Stress	FMX: Maximum Force
EMX: Max Transferred Energy	BPM: Blows per Minute

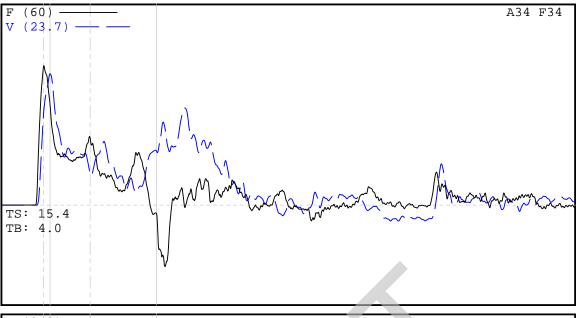| BL# | BLC | CSX | CSI | EMX | ETR | FMX | BPM |
	bl/ft	ksi	ksi	k-ft	(%)	kips	**
1	14	28	28	0.297	85	39	2
2	14	28	29	0.288	82	40	45
3	14	29	29	0.292	83	41	45
4	14	28	28	0.288	82	40	46
5	14	28	28	0.289	83	40	46
6	14	28	28	0.283	81	40	46
7	14	28	28	0.292	83	40	45
8	14	28	28	0.286	82	40	45
9	14	28	29	0.291	83	40	46
10	14	29	29	0.287	82	41	46
11	14	28	28	0.287	82	40	46
12	14	28	28	0.283	81	40	45
13	14	28	28	0.281	80	40	46
14	14	28	28	0.291	83	40	45
15	18	28	29	0.293	84	40	46
16	18	28	29	0.294	84	40	46
17	18	28	28	0.288	82	40	46
18	18	28	29	0.295	84	40	46
19	18	28	29	0.301	86	40	46
20	18	28	28	0.296	85	40	45
21	18	28	28	0.292	84	40	45
22	18	28	28	0.292	83	40	46
23	18	28	28	0.295	84	40	45
Average		28	28	0.290	83	40	44
Std. Dev.		0	0	0.005	1	0	9
Maximum		29	29	0.301	86	41	46
@ Blow#		10	10	19	19	10	10
Minimum		28	28	0.281	80	39	2
@ Blow#		1	1	13	13	1	1

Total number of blows analyzed: 23

Time Summary

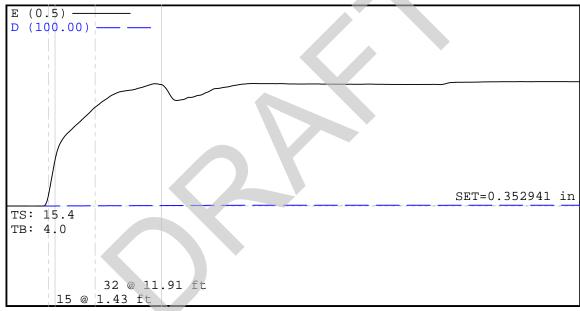Drive   29 seconds   11:45:13 AM - 11:45:42 AM (9/20/2013) BN 1 - 23

A34 F34

F (60)
V (23.7)

TS: 15.4
TB: 4.0

E (0.5)
D (100.00)

SET=0.352941 in

TS: 15.4
TB: 4.0

32 @ 11.91 ft
15 @ 1.43 ft

Project Information
PROJECT: 04.55124092
PILE NAME: SPT-4 RIG 361982 16FT FUGRO YARD
DESCR: SAMPLE 12FT
OPERATOR: MAN
FILE: SPT-4 RIG 361982 16FT FUGRO YARD
9/20/2013 12:09:46 PM
Blow Number 12

Pile Properties
LE   23.79 ft
AR   1.42 in^2
EM   30000 ksi
SP   0.492 k/ft3
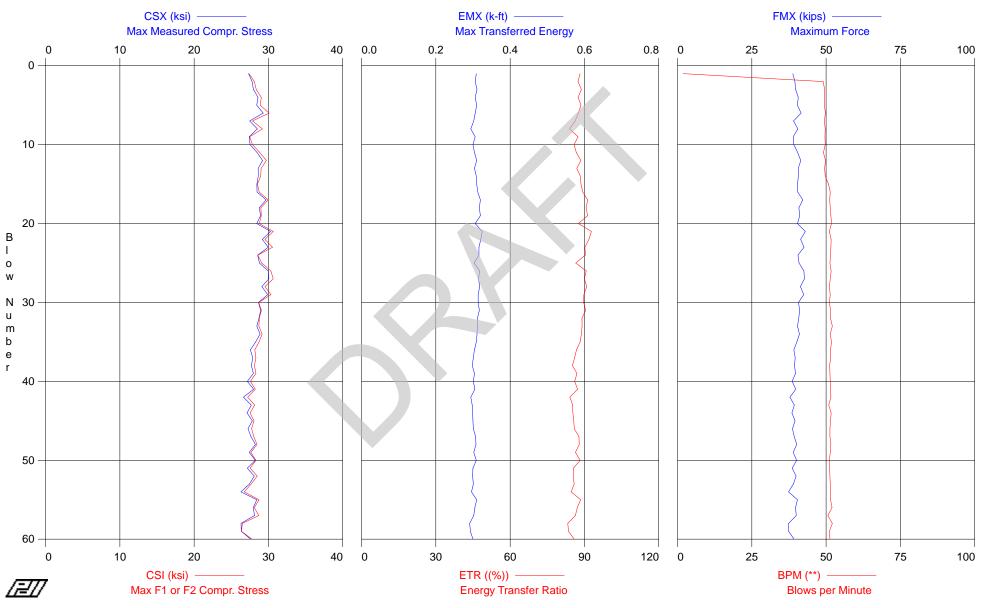WS   16807.9 f/s
EA/C   2.5 ksec/ft
2L/C   2.84 ms
JC   []
LP   16.35 ft

Quantity Results
CSX 29.2 ksi
CSI 29.7 ksi
EMX   0.3 k-ft
ETR 88.6 (%)
FMX   41 kips
BPM 49.8 bpm
QNV 0.00 []
QNV 0.00 []
QNV 0.00 []

Sensors
F3: [SPT-333NWJ-1] 214 (1)
F4: [SPT-333NWJ-2] 213.44 (1)
A3: [K1335] 363 mv/5000g's (1)
A4: [2286] 342 mv/5000g's (1)
CLIP: OK

CSX (ksi) ──────
Max Measured Compr. Stress

EMX (k-ft) ──────
Max Transferred Energy

FMX (kips) ──────
Maximum Force

Blow Number

CSI (ksi) ──────
Max F1 or F2 Compr. Stress

ETR ((%)) ──────
Energy Transfer Ratio

BPM (**) ──────
Blows per Minute

04.55124092 - SPT-4 RIG 361982 16FT FUGRO YARD
OP: MAN

SAMPLE 12FT
Test date: 20-Sep-2013

AR: 1.42 in^2		SP: 0.492 k/ft3
LE: 23.79 ft		EM: 30,000 ksi
WS: 16,807.9 f/s		JC: 0.00

CSX: Max Measured Compr. Stress		ETR: Energy Transfer Ratio
CSI: Max F1 or F2 Compr. Stress		FMX: Maximum Force
EMX: Max Transferred Energy		BPM: Blows per Minute

BL#	BLC bl/ft	CSX ksi	CSI ksi	EMX k-ft	ETR (%)	FMX kips	BPM **
1	34	27	27	0.309	88	39	2
2	34	28	28	0.306	87	39	49
3	34	28	28	0.311	89	40	50
4	34	29	29	0.306	87	41	50
5	34	28	29	0.310	89	40	49
6	34	29	30	0.306	88	42	50
7	34	27	28	0.302	86	39	49
8	34	29	29	0.294	84	40	50
9	34	27	27	0.306	87	39	50
10	34	28	28	0.300	86	39	50
11	34	28	29	0.304	87	40	49
12	34	29	30	0.310	89	41	50
13	34	29	29	0.304	87	41	50
14	34	29	29	0.309	88	41	50
15	34	28	29	0.310	89	40	51
16	34	28	29	0.313	89	40	51
17	34	30	30	0.320	91	42	51
18	42	29	29	0.317	91	41	51
19	42	29	29	0.320	91	41	52
20	42	28	29	0.306	88	40	52
21	42	30	31	0.325	93	43	51
22	42	29	30	0.321	92	41	52
23	42	30	31	0.316	90	43	52
24	42	29	29	0.316	90	41	52
25	42	29	29	0.303	86	41	51
26	42	30	30	0.318	91	43	52
27	42	30	31	0.315	90	43	51
28	42	29	30	0.318	91	41	51
29	42	30	30	0.314	90	42	51
30	42	29	29	0.314	90	41	51
31	42	29	29	0.317	91	41	52
32	42	29	29	0.312	89	41	52
33	42	28	29	0.312	89	40	52
34	42	29	29	0.311	89	41	51
35	42	28	29	0.309	88	40	52
36	42	28	28	0.304	87	39	52
37	42	28	28	0.301	86	40	52
38	42	28	28	0.298	85	39	51
39	48	28	28	0.304	87	40	51
40	48	27	28	0.301	86	39	51
41	48	28	28	0.305	87	40	52
42	48	27	27	0.294	84	38	52
43	48	28	28	0.298	85	39	51
44	48	27	28	0.299	85	39	52
45	48	28	28	0.300	86	40	52
46	48	27	28	0.301	86	39	51
47	48	28	28	0.307	88	39	51
48	48	28	28	0.308	88	40	52
49	48	27	28	0.302	86	39	51
50	48	28	28	0.309	88	40	51
51	48	27	28	0.300	86	39	51
52	48	28	29	0.299	85	40	51
53	48	27	28	0.301	86	39	51
54	48	26	27	0.296	85	37	51
55	48	28	29	0.310	88	40	52
56	48	28	28	0.305	87	40	52
57	48	28	29	0.302	86	40	51
58	48	26	26	0.291	83	37	52
59	48	26	26	0.293	84	37	51
60	48	28	28	0.300	86	39	51
61	48	27	27	0.298	85	38	52
62	48	28	28	0.307	88	39	52

04.55124092 - SPT-4 RIG 361982 16FT FUGRO YARD
OP: MAN

SAMPLE 12FT
Test date: 20-Sep-2013

	CSX	CSI	EMX	ETR	FMX	BPM
	ksi	ksi	k-ft	(%)	kips	**
Average	28	29	0.307	88	40	50
Std. Dev.	1	1	0.008	2	1	6
Maximum	30	31	0.325	93	43	52
@ Blow#	21	21	21	21	21	33
Minimum	26	26	0.291	83	37	2
@ Blow#	54	59	58	58	54	1

Total number of blows analyzed: 62

Time Summary

Drive   1 minute 11 seconds   12:09:33 PM - 12:10:44 PM (9/20/2013) BN 1 - 62

DRAFT

GEOENGINEERS

11955 Lakeland Park Blvd. Ste. 100
Baton Rouge, Louisiana 70809
225.293.2460

January 13, 2014

HDR Engineering, Inc.
2365 Iron Point Road, Suite 300
Folsom, CA 95630

Attention: Mr. Mark Stanley, GE
Senior Geotechnical Advisor

Subject: Letter Report
SPT Energy Measurement
Cathead-Operated Safety Hammer on Marsh Buggy #23 Drill Rig
State of Louisiana Coastal Protection and Restoration Authority
Mid Barataria Diversion (BA-153) Project
Plaquemines Parish, Louisiana
File No. 18274-001-00, Task 0300

GeoEngineers, Inc. (GeoEngineers) recently completed the standard penetration test (SPT) energy measurement testing on the cathead operated safety hammer of the Marsh Buggy #23 drill rig. The drill rig is owned and operated by Specialized Environmental Resources (SER).

Measurements were made January 10, 2014 by Ivy A. Harmon, a GeoEngineers staff engineer, using a Pile Dynamic Analyzer (PDA) model PAX and a calibrated, instrumented drill rod. The energy testing was completed between 27.5 and 39 feet below the ground surface. Measurements were recorded at four depth intervals; this report includes results from three depth intervals. The unused depth interval was determined to not provide representative test data.

The drill rig used was a pontoon-tracked marsh buggy, SER #23, hull identification MBD#01 WWC-709. The driller was Johnny Gallow, and John Francis was the drilling assistant. The hammer was a CME-style cathead-driven safety hammer in good condition. The 1-inch diameter rope was in good condition, and was wrapped 1 turn around the cathead. The drill rod used is proprietary to SER and is light-weight shot-hole casing type rod. The SPT procedures were conducted in general accordance with ASTM D-1586-08-a. GeoEngineers observed that the driller was hesitant when performing the initial SPT operations due to the presence of instrumentation, but as he gained confidence in the testing equipment the procedure continued normally. The hesitation during the first test made the record unusable as a measurement of the SPT energy.

A summary of the energy measurement results is included in the table below for selected test intervals between 27.5 and 39 feet below the ground surface. Based on the collected data, the overall average energy measured in the drill pipe was about 58% of the expected SPT hammer energy.

SPT HAMMER ENERGY MEASUREMENT RESULTS

Depth Increment (ft)	Cathead/Hammer Operator	Average Energy Transfer Ratio (%)	Penetration Resistance (Blows/ft)
27.5 to 29	J. Gallow	53.5	24
30 to 31.5	J. Gallow	57.3	15
37.5 to 39	J. Gallow	62.4	20

Measurement details are available in the attached PDA output reports, including an example Force-Velocity-Time graph generated may a single sample blow at each test increment.

We appreciate the opportunity to work with HDR on this project. Please call up at 225.293.2460 if you have any comments or questions.

Sincerely,

GeoEngineers, Inc.

Ivy A. Harmon, E.I.   Charles L. Eustis, P.E.
Staff Geotechnical Engineer   Principal

Appendix A. SPT Energy Measurement Reports

MID BARATARIA CALIBRATION   SER MARSH BUGGY, 27.5-29

```
F (30) ──────────                                          A34 F34
V (24.0) ── ── ──




TS: 25.6
TB: 17.5




F3 (30) ──────────
F4 (30) ── ── ──




TS: 25.6
TB: 17.5
                    LTT @ 24.68 ft
          30.0 @ 7.53 ft
              19.0 @ 12.13 ft
```

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: SER MARSH BUGGY, 27.5-29
DESCR: SPT ENERGY MEASURE
OPERATOR: IAH
FILE: SER MARSH BUGGY, TEST 2.W01
1/10/2014 9:22:00 AM
Blow Number 27

Quantity Results
FMX   25 kips
VMX   15.3 f/s
DMX   0.53 in
EMX   0.22 k-ft
CSX 35.30 ksi
CSI 37.02 ksi
BTA   19.0 (%)
RX9   4 kips
BPM   15.4 bpm

Pile Properties
LE   34.30 ft
AR   0.70 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   1.2 ksec/ft
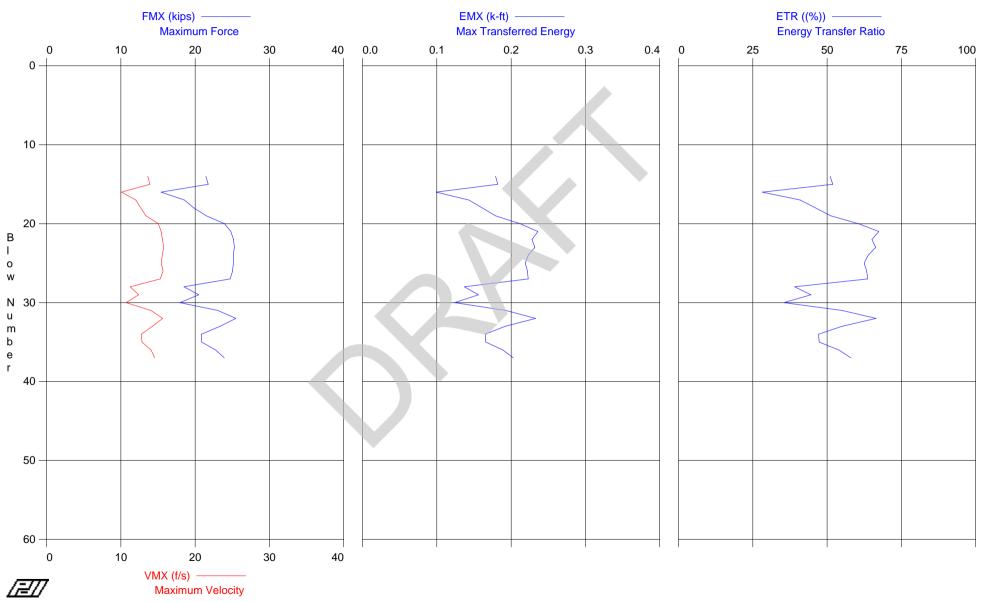2L/C   4.10 ms
JC   0.90 []
LP   28.62 ft

Sensors
F3: [402SW-1] 210.62 (1)
F4: [402SW-2] 204.74 (1)
A3: [K1578] 325 mv/5000g's (1)
A4: [K1580] 355 mv/5000g's (1)
CLIP: OK

MID BARATARIA CALIBRATION - SER MARSH BUGGY, 27.5-29

FMX (kips) ————
Maximum Force

EMX (k-ft) ————
Max Transferred Energy

ETR ((%)) ————
Energy Transfer Ratio

Blow Number

VMX (f/s) ————
Maximum Velocity

GeoEngineers, Inc.
Case Method & iCAP® Results

MID BARATARIA CALIBRATION - SER MARSH BUGGY, 27.5-29   SPT ENERGY MEASURE
OP: IAH   Test date: 10-Jan-2014

AR: 0.70 in^2		SP: 0.492 k/ft3
LE: 34.30 ft		EM: 30,000 ksi
WS: 16,807.9 f/s		JC: 0.90

FMX: Maximum Force   CSX: Max Measured Compr. Stress
VMX: Maximum Velocity   BTA: BETA Integrity Factor
DMX: Maximum Displacement   RX9: Max Case Method Capacity (JC=0.9)
EMX: Max Transferred Energy   BPM: Blows per Minute
ETR: Energy Transfer Ratio
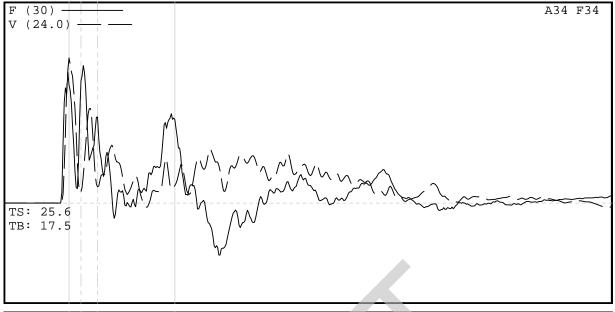
BL#	depth ft	BLC bl/ft	FMX kips	VMX f/s	DMX in	EMX k-ft	ETR (%)	CSX ksi	BTA (%)	RX9 kips	BPM **
14	28.05	22	21	13.6	0.59	0.18	51.0	30.64	20.0	4	35.0
15	28.09	22	22	13.9	0.58	0.18	51.9	31.10	21.0	4	35.0
16	28.14	22	15	10.1	0.55	0.10	28.2	22.01	16.0	5	32.6
17	28.18	22	19	12.0	0.55	0.14	40.9	26.50	22.0	5	35.9
18	28.23	22	20	12.7	0.55	0.16	46.1	28.32	21.0	5	34.3
19	28.27	22	22	13.4	0.55	0.18	51.2	30.74	24.0	5	34.2
20	28.32	22	24	15.0	0.57	0.21	60.5	34.22	23.0	5	35.1
21	28.36	22	25	15.4	0.62	0.24	67.4	35.44	23.0	5	34.8
22	28.41	22	25	15.6	0.57	0.23	65.1	35.97	14.0	4	35.3
23	28.45	22	25	15.8	0.58	0.23	66.3	36.12	17.0	5	34.2
24	28.50	22	25	15.6	0.55	0.22	63.8	35.90	16.0	3	35.6
25	28.54	26	25	15.4	0.51	0.22	62.5	35.91	15.0	4	35.9
26	28.58	26	25	15.7	0.53	0.22	63.3	35.78	17.0	4	35.2
27	28.62	26	25	15.3	0.53	0.22	63.6	35.30	19.0	4	15.4
28	28.65	26	18	11.3	0.46	0.14	39.1	26.42	23.0	6	35.2
29	28.69	26	20	12.4	0.46	0.16	44.6	29.28	24.0	4	26.5
30	28.73	26	18	10.7	0.46	0.12	35.4	25.61	24.0	4	29.5
31	28.77	26	23	14.1	0.46	0.19	55.1	32.94	23.0	4	35.7
32	28.81	26	25	15.6	0.53	0.23	66.5	36.41	21.0	4	30.9
33	28.85	26	23	14.2	0.46	0.19	55.0	33.34	17.0	5	14.4
34	28.88	26	21	12.8	0.46	0.17	47.1	29.79	20.0	5	33.0
35	28.92	26	21	12.8	0.46	0.17	47.3	29.83	27.0	4	34.7
36	28.96	26	23	14.1	0.46	0.19	54.0	32.53	22.0	5	33.3
37	29.00	26	24	14.6	0.46	0.20	58.0	34.16	22.0	4	33.7
		Average	22	13.8	0.52	0.19	53.5	31.84	20.5	4	32.3
		Std. Dev.	3	1.7	0.05	0.04	10.6	3.92	3.3	1	5.7
		Maximum	25	15.8	0.62	0.24	67.4	36.41	27.0	6	35.9
		@ Blow#	32	23	21	21	21	32	35	28	17

Total number of blows analyzed: 24

Time Summary

Drive   1 minute 13 seconds   9:21:08 AM - 9:22:21 AM (1/10/2014) BN 1 - 37

```
F (30) ─────    ───                           A34 F34
V (24.0) ──     ───
TS: 25.6
TB: 17.5
```

```
F3 (30) ─────   ───
F4 (30) ──      ───
TS: 25.6
TB: 17.5
              0.0 @ 12.55 ft
              0.0 @ 6.69 ft
```

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: SER MARSH BUGGY, 30-31.5
DESCR: SPT ENERGY MEASURE
OPERATOR: IAH
FILE: SER MARSH BUGGY, TEST 3.W01
1/10/2014 9:41:29 AM
Blow Number 15

Pile Properties
LE	37.30 ft
AR	0.70 in^2
EM	30000 ksi
SP	0.492 k/ft3
WS	16807.9 f/s
EA/C	1.2 ksec/ft
2L/C	4.46 ms
JC	0.90 []
LP	31.28 ft
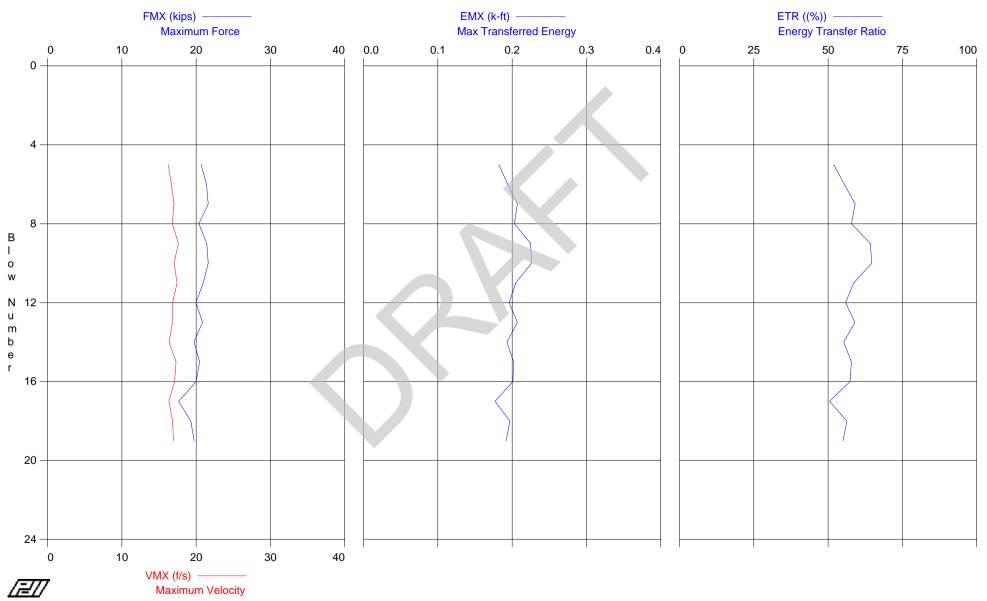
Quantity Results
FMX	20 kips
VMX	17.3 f/s
DMX	0.71 in
EMX	0.20 k-ft
CSX	29.23 ksi
CSI	30.66 ksi
BTA	0.0 (%)
RX9	11 kips
BPM	36.5 bpm

Sensors
F3: [402SW-1] 210.62 (1)
F4: [402SW-2] 204.74 (1)
A3: [K1578] 325 mv/5000g's (1)
A4: [K1580] 355 mv/5000g's (1)
CLIP: OK

GeoEngineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 13-Jan-2014

Test date: 10-Jan-2014

MID BARATARIA CALIBRATION - SER MARSH BUGGY, 30-31.5

FMX (kips) ———
Maximum Force

EMX (k-ft) ———
Max Transferred Energy

ETR ((%)) ———
Energy Transfer Ratio

VMX (f/s) ———
Maximum Velocity

MID BARATARIA CALIBRATION - SER MARSH BUGGY, 30-31.5

OP: IAH

SPT ENERGY MEASURE
Test date: 10-Jan-2014

AR:	0.70 in^2	SP: 0.492 k/ft3
LE:	37.30 ft	EM: 30,000 ksi
WS:	16,807.9 f/s	JC: 0.90

FMX: Maximum Force	CSX: Max Measured Compr. Stress
VMX: Maximum Velocity	BTA: BETA Integrity Factor
DMX: Maximum Displacement	RX9: Max Case Method Capacity (JC=0.9)
EMX: Max Transferred Energy	BPM: Blows per Minute
ETR: Energy Transfer Ratio	

BL#	depth	BLC	FMX	VMX	DMX	EMX	ETR	CSX	BTA	RX9	BPM
	ft	bl/ft	kips	f/s	in	k-ft	(%)	ksi	(%)	kips	**
5	30.58	12	21	16.2	1.07	0.18	51.9	29.52	0.0	12	24.3
6	30.67	12	21	16.7	1.08	0.19	55.5	30.56	0.0	6	29.0
7	30.75	12	22	17.0	1.08	0.21	59.1	30.90	0.0	10	32.3
8	30.83	12	20	16.8	1.04	0.20	57.9	29.10	0.0	11	28.8
9	30.92	12	21	17.6	1.02	0.23	64.2	30.62	0.0	10	29.6
10	31.00	12	22	17.0	1.01	0.23	64.7	30.89	0.0	4	31.0
11	31.06	18	21	17.4	0.79	0.21	58.6	29.94	0.0	13	30.7
12	31.11	18	20	16.8	0.75	0.20	55.9	28.53	0.0	10	32.0
13	31.17	18	21	16.8	0.75	0.21	59.0	29.81	0.0	9	32.2
14	31.22	18	20	16.3	0.73	0.19	55.2	28.15	0.0	15	34.2
15	31.28	18	20	17.3	0.71	0.20	57.8	29.23	0.0	11	36.5
16	31.33	18	20	17.1	0.73	0.20	57.4	28.58	0.0	11	35.5
17	31.39	18	18	16.3	0.67	0.18	50.5	25.22	0.0	9	32.1
18	31.44	18	19	16.8	0.67	0.20	56.3	27.54	0.0	11	39.8
19	31.50	18	20	16.9	0.67	0.19	55.0	28.19	0.0	15	36.8
		Average	20	16.9	0.85	0.20	57.3	29.12	0.0	10	32.3
		Std. Dev.	1	0.4	0.17	0.01	3.7	1.46	0.0	3	3.7
		Maximum	22	17.6	1.08	0.23	64.7	30.90	0.0	15	39.8
		@ Blow#	7	9	6	10	10	7	5	19	18

Total number of blows analyzed: 15

Time Summary
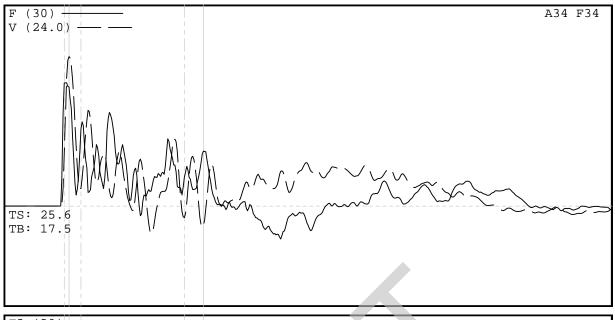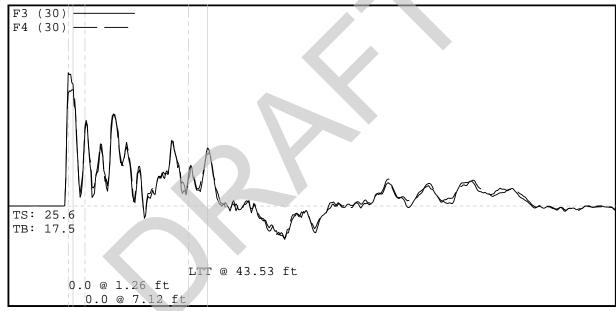
Drive   35 seconds   9:41:02 AM - 9:41:37 AM (1/10/2014) BN 1 - 19

```
F (30)
V (24.0)                                        A34 F34

TS: 25.6
TB: 17.5
```



```
F3 (30)
F4 (30)

TS: 25.6
TB: 17.5

                    LTT @ 43.53 ft
0.0 @ 1.26 ft
  0.0 @ 7.12 ft
```

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: SER MARSH BUGGY, 37.5-39
DESCR: SPT ENERGY MEASURE
OPERATOR: IAH
FILE: SER MARSH BUGGY, TEST 5_1.W01
1/10/2014 10:12:11 AM
Blow Number 13

Pile Properties
LE   47.30 ft
AR   0.70 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   1.2 ksec/ft
2L/C   5.65 ms
JC   0.90 []
LP   38.33 ft
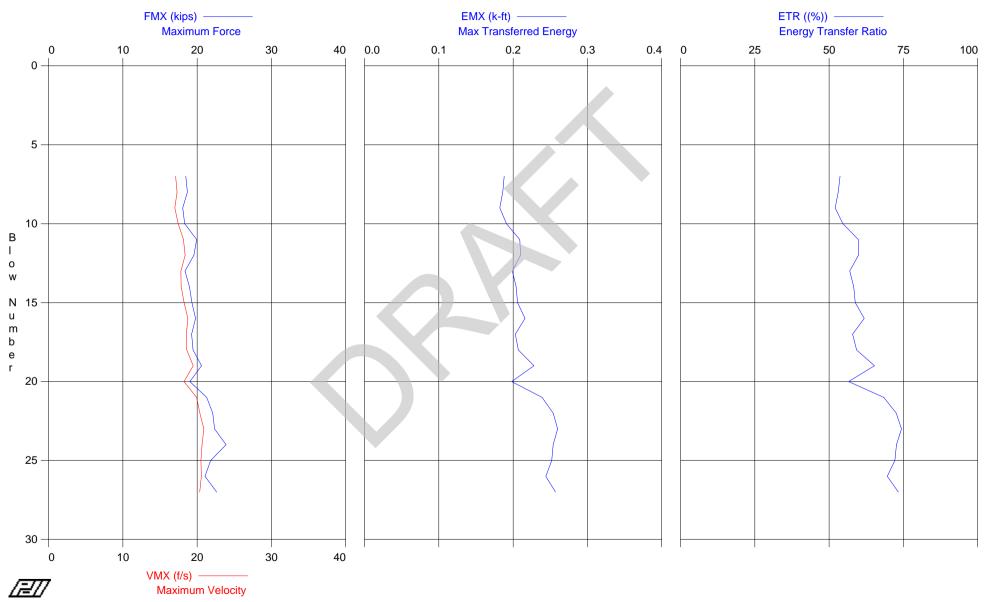
Quantity Results
FMX   18 kips
VMX   17.8 f/s
DMX   0.68 in
EMX   0.20 k-ft
CSX   26.22 ksi
CSI   28.35 ksi
BTA   0.0 (%)
RX9   13 kips
BPM   37.7 bpm

Sensors
F3: [402SW-1] 210.62 (1)
F4: [402SW-2] 204.74 (1)
A3: [K1578] 325 mv/5000g's (1)
A4: [K1580] 355 mv/5000g's (1)
CLIP: OK

GeoEngineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 13-Jan-2014

Test date: 10-Jan-2014

MID BARATARIA CALIBRATION - SER MARSH BUGGY, 37.5-39

FMX (kips) ————
Maximum Force

EMX (k-ft) ————
Max Transferred Energy

ETR ((%)) ————
Energy Transfer Ratio

VMX (f/s) ————
Maximum Velocity

MID BARATARIA CALIBRATION - SER MARSH BUGGY, 37.5-39
OP: IAH

SPT ENERGY MEASURE
Test date: 10-Jan-2014

AR:	0.70 in^2				SP:	0.492 k/ft3
LE:	47.30 ft				EM:	30,000 ksi
WS:	16,807.9 f/s				JC:	0.90

FMX: Maximum Force
VMX: Maximum Velocity
DMX: Maximum Displacement
EMX: Max Transferred Energy
ETR: Energy Transfer Ratio

CSX: Max Measured Compr. Stress
BTA: BETA Integrity Factor
RX9: Max Case Method Capacity (JC=0.9)
BPM: Blows per Minute

BL#	depth ft	BLC bl/ft	FMX kips	VMX f/s	DMX in	EMX k-ft	ETR (%)	CSX ksi	BTA (%)	RX9 kips	BPM **
7	38.00	14	18	17.1	0.86	0.19	53.7	26.38	0.0	12	35.0
8	38.06	18	19	17.3	0.68	0.19	53.1	26.69	0.0	13	35.5
9	38.11	18	18	17.0	0.67	0.18	52.0	25.81	0.0	11	35.6
10	38.17	18	18	17.4	0.70	0.19	54.6	26.16	0.0	13	37.0
11	38.22	18	20	18.2	0.72	0.21	59.8	28.48	0.0	13	36.9
12	38.28	18	20	18.4	0.67	0.21	59.9	27.93	0.0	12	36.2
13	38.33	18	18	17.8	0.68	0.20	57.0	26.23	0.0	13	37.7
14	38.39	18	19	17.8	0.67	0.20	58.3	27.10	9.0	8	36.8
15	38.44	18	19	18.2	0.68	0.21	58.8	27.57	5.0	14	37.4
16	38.50	18	20	18.8	0.67	0.22	61.8	28.27	1.0	14	36.8
17	38.55	22	19	18.5	0.61	0.20	57.9	27.51	1.0	14	35.8
18	38.59	22	19	18.6	0.57	0.21	59.3	27.78	4.0	11	36.7
19	38.64	22	21	19.5	0.66	0.23	65.3	29.43	3.0	16	37.2
20	38.68	22	19	18.2	0.57	0.20	56.6	27.18	3.0	11	36.0
21	38.73	22	21	19.9	0.68	0.24	68.4	30.41	0.0	17	35.3
22	38.77	22	22	20.4	0.67	0.25	72.6	31.58	1.0	15	36.4
23	38.82	22	22	20.9	0.70	0.26	74.4	31.92	4.0	17	36.7
24	38.86	22	24	20.7	0.70	0.25	72.7	34.13	0.0	14	37.4
25	38.91	22	22	20.5	0.62	0.25	72.1	31.18	0.0	13	34.7
26	38.95	22	21	20.6	0.65	0.24	69.6	30.08	2.0	15	37.1
27	39.00	22	23	20.3	0.62	0.26	73.3	32.32	0.0	14	37.7
	Average		20	18.9	0.67	0.22	62.4	28.77	1.6	13	36.5
	Std. Dev.		2	1.3	0.06	0.03	7.3	2.31	2.3	2	0.9
	Maximum		24	20.9	0.86	0.26	74.4	34.13	9.0	17	37.7
	@ Blow#		24	23	7	23	23	24	14	21	13

Total number of blows analyzed: 21

Time Summary

Drive 44 seconds 10:11:51 AM - 10:12:35 AM (1/10/2014) BN 1 - 27

August 1, 2013

HDR Engineering, Inc.
2365 Iron Point Road, Suite 300
Folsom, CA 95630

Attention: Mr. Mark Stanley, GE
                 Senior Geotechnical Advisor

Subject: Letter Report
                 SPT Energy Measurement
                 Cathead-Operated Safety Hammer on Failing 1500 Drill Rig
                 State of Louisiana Coastal Protection and Restoration Authority
                 Mid Barataria Diversion (BA-153) Project
                 Plaquemines Parish, LA
                 File No. 18274-001-00, Task 0300

GeoEngineers, Inc. (GeoEngineers) is sending this document to report on the recent standard penetration test (SPT) energy measurement testing we completed on the Failing 1500 drill rig with the cathead-operated safety hammer. Testing was completed prior to mobilizing the drilling equipment to the project site in Plaquemines Parish, Louisiana.

Measurements were made by Ivy A. Harmon, a GeoEngineers staff engineer, using a PDA model PAX and a calibrated, instrumented drill rod. The energy testing was completed between 25 and 34.5 feet below the ground surface. Measurements were taken at three depth intervals; this report includes results from the each depth interval.

The drill rig used was a truck-mounted Failing 1500 Drill Rig, GeoEngineers Rig 49. The hammer was a CME-style cathead-driven safety hammer in good condition. In general, the rope was in very good condition (a nearly new, 1-inch diameter rope was used). The rope was typically wrapped 2 ¼ turns around the cathead. The SPT procedures were conducted in general accordance with ASTM D1586-08a. We observed that the driller was hesitant when performing initial STP operations due to the presence of instrumentation, but as he gained confidence in the testing equipment the procedure continued normally.

A summary of the energy measurement results is included in the table below for selected increments between 25 and 34.5 feet below the ground surface. Based on the collected data (see the table below), the overall average energy measured in the drill pipe was about 72% of the expected SPT hammer energy.

SPT HAMMER ENERGY MEASUREMENT RESULTS

Depth increment (ft)	Cathead/Hammer Operator	Average Energy Transfer Ratio (%)	Penetration Resistance (Blows/ft)
25 to 26.5	R. Clark	56.4	6
30 to 31.5	R. Clark	80.3	39
33 to 34.5	R. Clark	78.2	36

Measurement details are available in the attached PDA output reports, including an example Force-Velocity-Time graph generated by a single sample blow at each depth.

We appreciate the opportunity to work with HDR Engineering, Inc. on this project. Please call us at 225.293.2460 if you have any comments and questions.

Sincerely,
GeoEngineers, Inc.

Ivy A. Harmon, E.I.
Staff Geotechnical Engineer

Charles L. Eustis, P.E.
Principal

Appendix A. SPT Energy Measurement Reports

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Confidential Information: Privileged and Confidential Work Product.

Copyright© 2014 by GeoEngineers, Inc. All rights reserved.

DRAFT

APPENDIX A
SPT Energy Measurement Reports

MID BARATARIA CALIBRATION - BLUE FAILING TEST 1
OP: IAH

SPT NRG MEAS. 1
Test date: 21-Jun-2013

AR:	2.36 in^2	SP: 0.492 k/ft3
LE:	32.00 ft	EM: 30,000 ksi
WS:	16,807.9 f/s	JC: 0.35

FMX: Maximum Force	EMX: Max Transferred Energy
VMX: Maximum Velocity	ETR: Energy Transfer Ratio
DMX: Maximum Displacement	RX6: Max Case Method Capacity (JC=0.6)
BPM: Blows per Minute	LTD: Length to Damage
EFV: Energy of FV	

Statistics for entire file (15 blows)

	FMX	VMX	DMX	BPM	EFV	EMX	ETR	RX6	LTD
	kips	f/s	in	**	k-ft	k-ft	(%)	kips	ft
Average	26	12.7	0.85	33.2	0.20	0.20	56.4	15	9.67
Std. Dev.	2	0.8	0.27	8.1	0.03	0.03	7.5	4	5.27
Maximum	28	13.7	1.22	37.3	0.23	0.23	65.8	17	12.99
@ Blow#	7	7	2	13	7	7	7	15	1

Time Summary
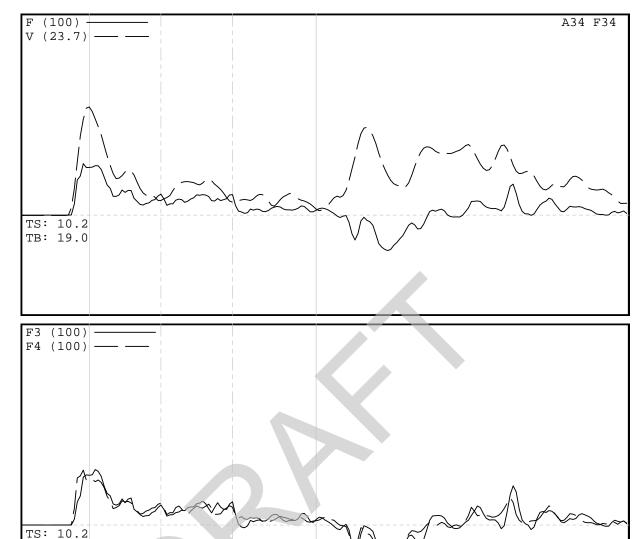
Drive   40 seconds   11:32:40 AM - 11:33:20 AM (6/21/2013) BN 1 - 15

MID BARATARIA CALIBRATION - BLUE FAILING TEST 1

MID BARATARIA CALIBRATION   BLUE FAILING TEST 1

F (100)
V (23.7)   A34 F34

TS: 10.2
TB: 19.0

F3 (100)
F4 (100)

TS: 10.2
TB: 19.0

73 @ 22.63 ft
73 @ 12.57 ft

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: BLUE FAILING TEST 1
DESCR: SPT NRG MEAS. 1
OPERATOR: IAH
FILE: BLUE FAILING TEST 1.W01
6/21/2013 11:32:43 AM
Blow Number 3

Pile Properties
LE   32.00 ft
AR   2.36 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   4.2 ksec/ft
2L/C   3.82 ms
JC   0.35 []
LP   25.00 ft

Quantity Results
FMX   26 kips
VMX   12.7 f/s
DMX   1.14 in
BPM   34.6 bpm
EFV   0.20 k-ft
EMX   0.20 k-ft
ETR   56.8 (%)
RX6   16 kips
LTD 12.57 ft

Sensors
F3: [151 N3-1] 215.1 (1)
F4: [151 N3-2] 216.74 (1)
A3: [K1580] 355 mv/5000g's (1)
A4: [K1578] 325 mv/5000g's (1)
CLIP: OK

MID BARATARIA CALIBRATION - BLUE FAILING TEST 2
OP: IAH
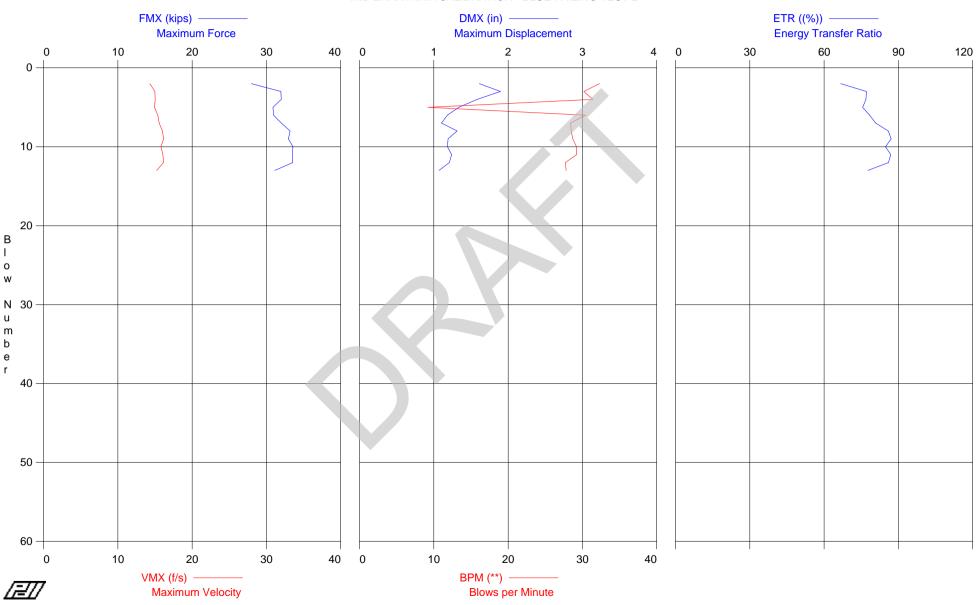
SPT NRG MEAS. 2
Test date: 21-Jun-2013

AR: 2.36 in^2	SP: 0.492 k/ft3
LE: 34.00 ft	EM: 30,000 ksi
WS: 16,807.9 f/s	JC: 0.35

FMX: Maximum Force	EMX: Max Transferred Energy
VMX: Maximum Velocity	ETR: Energy Transfer Ratio
DMX: Maximum Displacement	RX6: Max Case Method Capacity (JC=0.6)
BPM: Blows per Minute	LTD: Length to Damage
EFV: Energy of FV	

Statistics for entire file (12 blows)

	FMX	VMX	DMX	BPM	EFV	EMX	ETR	RX6	LTD
	kips	f/s	in	**	k-ft	k-ft	(%)	kips	ft
Average	32	15.5	1.33	27.8	0.28	0.28	80.3	23	1.73
Std. Dev.	2	0.6	0.24	5.8	0.02	0.02	5.9	3	1.61
Maximum	34	16.2	1.90	32.3	0.31	0.31	87.1	26	7.07
@ Blow#	10	9	3	2	9	9	9	12	13

Time Summary
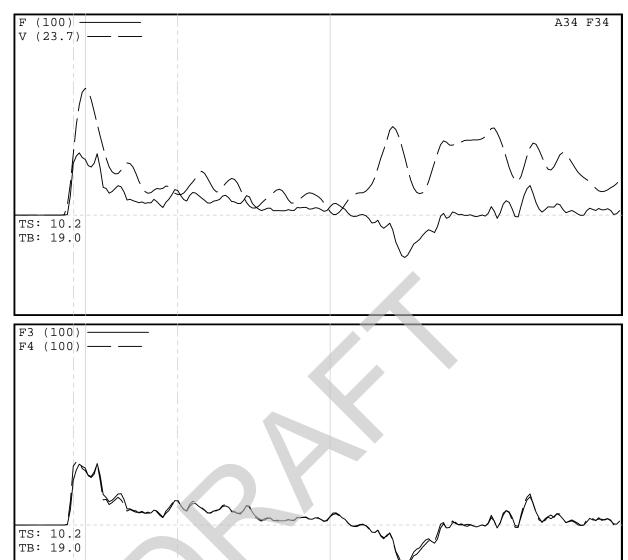
Drive   29 seconds   11:53:12 AM - 11:53:41 AM (6/21/2013) BN 1 - 13

GeoEngineers, Inc. - Case Method & iCAP® Results

MID BARATARIA CALIBRATION - BLUE FAILING TEST 2

FMX (kips) ——————
Maximum Force

DMX (in) ——————
Maximum Displacement

ETR ((%)) ——————
Energy Transfer Ratio

Blow Number

VMX (f/s) ——————
Maximum Velocity

BPM (**) ——————
Blows per Minute

A34 F34

F (100)
V (23.7)

TS: 10.2
TB: 19.0

F3 (100)
F4 (100)

TS: 10.2
TB: 19.0

74 @ 15.79 ft

51 @ 1.25 ft

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: BLUE FAILING TEST 2
DESCR: SPT NRG MEAS. 2
OPERATOR: IAH
FILE: BLUE FAILING TEST 2.W01
6/21/2013 11:53:23 AM
Blow Number 5

Pile Properties
LE   34.00 ft
AR   2.36 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   4.2 ksec/ft
2L/C   4.09 ms
JC   0.35 []
LP   30.00 ft

Quantity Results
FMX   31 kips
VMX 14.9 f/s
DMX 1.34 in
BPM   9.2 bpm
EFV 0.26 k-ft
EMX 0.26 k-ft
ETR 75.6 (%)
RX6   21 kips
LTD 1.25 ft

Sensors
F3: [151 N3-1] 215.1 (1)
F4: [151 N3-2] 216.74 (1)
A3: [K1580] 355 mv/5000g's (1)
A4: [K1578] 325 mv/5000g's (1)
CLIP: OK

Version 2012.114

MID BARATARIA CALIBRATION - BLUE FAILING TEST 3
OP: IAH

SPT NRG MEAS. 3
Test date: 21-Jun-2013
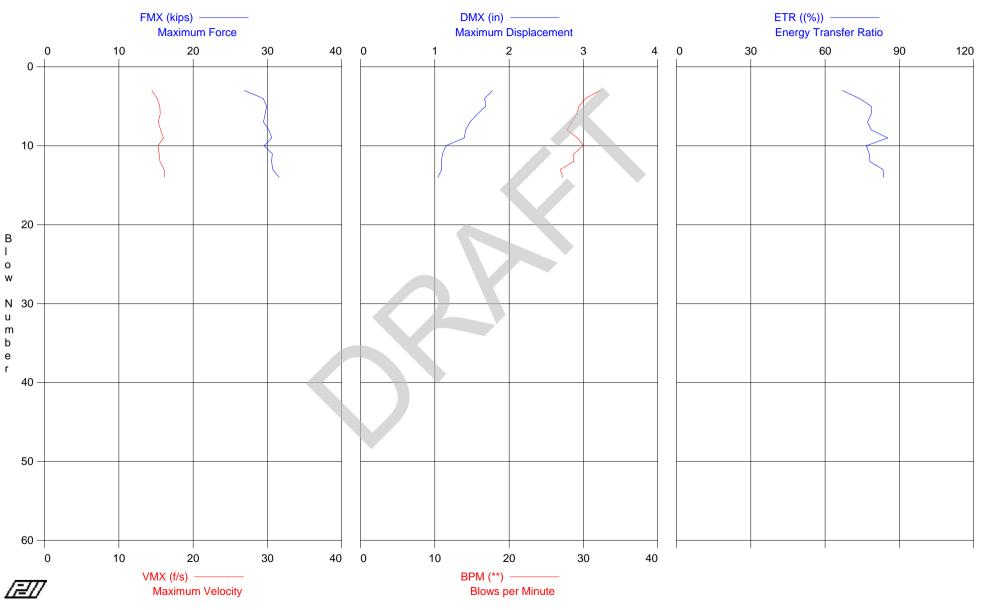
AR: 2.36 in^2	SP: 0.492 k/ft3
LE: 37.00 ft	EM: 30,000 ksi
WS: 16,807.9 f/s	JC: 0.35

FMX: Maximum Force	EMX: Max Transferred Energy
VMX: Maximum Velocity	ETR: Energy Transfer Ratio
DMX: Maximum Displacement	RX6: Max Case Method Capacity (JC=0.6)
BPM: Blows per Minute	LTD: Length to Damage
EFV: Energy of FV	

Statistics for entire file (12 blows)

	FMX	VMX	DMX	BPM	EFV	EMX	ETR	RX6	LTD
	kips	f/s	in	**	k-ft	k-ft	(%)	kips	ft
Average	30	15.5	1.37	29.0	0.27	0.27	78.2	25	5.18
Std. Dev.	1	0.4	0.26	1.4	0.02	0.02	4.6	1	2.77
Maximum	32	16.2	1.78	32.2	0.30	0.30	85.3	27	7.14
@ Blow#	14	14	3	3	9	9	9	9	3

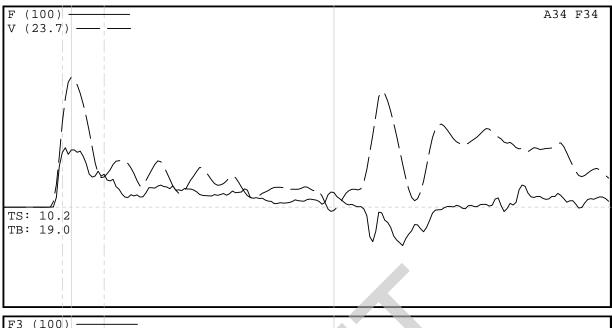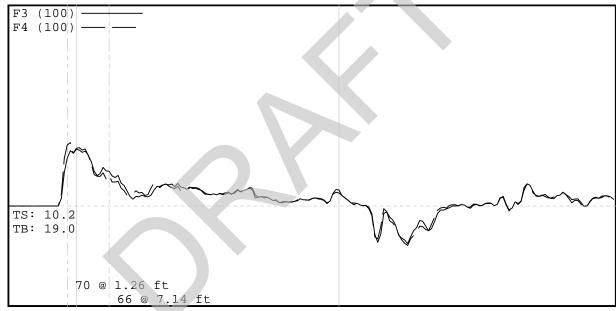Time Summary

Drive   34 seconds   12:06:47 PM - 12:07:21 PM (6/21/2013) BN 1 - 14

MID BARATARIA CALIBRATION - BLUE FAILING TEST 3

FMX (kips) — Maximum Force

DMX (in) — Maximum Displacement

ETR ((%)) — Energy Transfer Ratio

VMX (f/s) — Maximum Velocity

BPM (**) — Blows per Minute

F (100)
V (23.7)

A34 F34

TS: 10.2
TB: 19.0

F3 (100)
F4 (100)

TS: 10.2
TB: 19.0

70 @ 1.26 ft
66 @ 7.14 ft

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: BLUE FAILING TEST 3
DESCR: SPT NRG MEAS. 3
OPERATOR: IAH
FILE: BLUE FAILING TEST 3.W01
6/21/2013 12:07:06 PM
Blow Number 7

Pile Properties
LE   37.00 ft
AR   2.36 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   4.2 ksec/ft
2L/C   4.41 ms
JC   0.35 []
LP   33.00 ft

Quantity Results
FMX   29 kips
VMX   15.3 f/s
DMX   1.47 in
BPM   28.4 bpm
EFV   0.27 k-ft
EMX   0.27 k-ft
ETR   77.1 (%)
RX6   26 kips
LTD   7.14 ft

Sensors
F3: [151 N3-1] 215.1 (1)
F4: [151 N3-2] 216.74 (1)
A3: [K1580] 355 mv/5000g's (1)
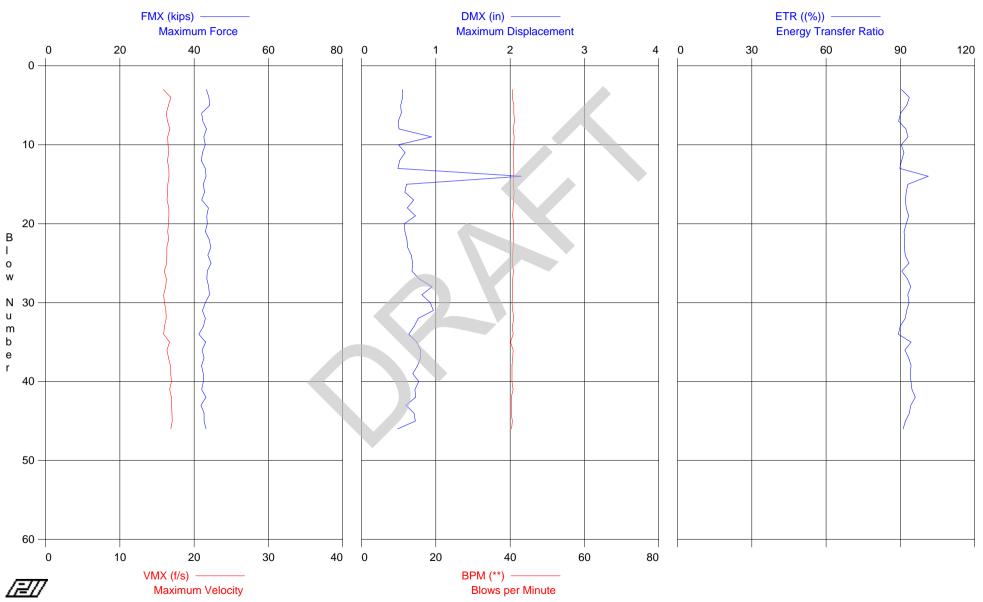A4: [K1578] 325 mv/5000g's (1)
CLIP: OK

Version 2012.114

MID BARATARIA CALIBRATION - SPT 32.33 TO 33.83
OP: NICK MATA

SPT NRG MEAS. 7
Test date: 11-May-2013

AR:	1.32 in^2	SP:	0.492 k/ft3
LE:	38.16 ft	EM:	30,000 ksi
WS:	16,807.9 f/s	JC:	0.35

FMX: Maximum Force
VMX: Maximum Velocity
DMX: Maximum Displacement
BPM: Blows per Minute
EFV: Energy of FV

EMX: Max Transferred Energy
ETR: Energy Transfer Ratio
RX6: Max Case Method Capacity (JC=0.6)
LTD: Length to Damage

Statistics for entire file (44 blows)

	FMX kips	VMX f/s	DMX in	BPM **	EFV k-ft	EMX k-ft	ETR (%)	RX6 kips	LTD ft
Average	43	16.5	0.71	40.7	0.32	0.32	92.5	18	17.80
Std. Dev.	1	0.3	0.25	0.2	0.01	0.01	2.0	1	3.43
Maximum	45	17.1	2.15	41.2	0.36	0.36	101.3	21	19.50
@ Blow#	25	45	14	7	14	14	14	3	12

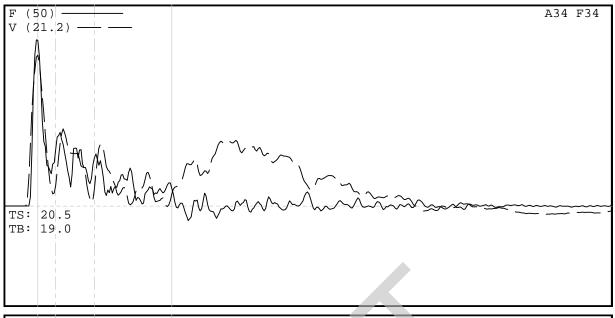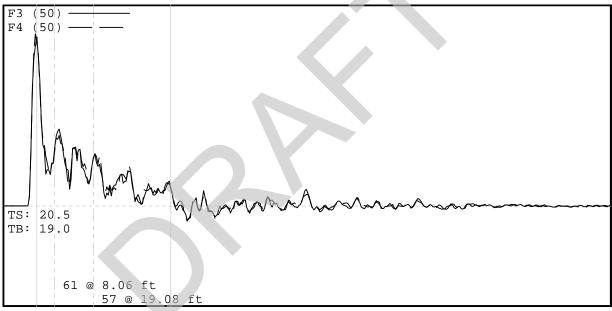Time Summary

Drive   3 minutes 22 seconds   11:38:29 AM - 11:41:51 AM (5/11/2013) BN 1 - 46

GeoEngineers, Inc. - Case Method & iCAP® Results

Test date: 11-May-2013

MID BARATARIA CALIBRATION - SPT 32.33 TO 33.83

FMX (kips) ——————
Maximum Force

DMX (in) ——————
Maximum Displacement

ETR ((%)) ——————
Energy Transfer Ratio

Blow Number

VMX (f/s) ——————
Maximum Velocity

BPM (**) ——————
Blows per Minute

F (50) ⎯⎯⎯
V (21.2) ⎯ ⎯ ⎯

A34 F34

TS: 20.5
TB: 19.0

F3 (50) ⎯⎯⎯
F4 (50) ⎯ ⎯ ⎯

TS: 20.5
TB: 19.0

61 @ 8.06 ft
57 @ 19.08 ft

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: SPT 32.33 TO 33.83
DESCR: SPT NRG MEAS. 7
OPERATOR: NICK MATA
FILE: SPT 32.33 TO 33.83.W01
5/11/2013 11:41:32 AM
Blow Number 34

Pile Properties
LE   38.16 ft
AR   1.32 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   2.4 ksec/ft
2L/C   4.50 ms
JC   0.35 []
LP   32.33 ft

Quantity Results
FMX   41 kips
VMX   15.9 f/s
DMX   0.64 in
BPM   40.8 bpm
EFV   0.31 k-ft
EMX   0.31 k-ft
ETR   89.1 (%)
RX6   17 kips
LTD   19.08 ft

Sensors
F3: [213BR1] 214.16 (1)
F4: [213BR2] 216.06 (1)
A3: [K1580] -355 mv/5000g's (1)
A4: [K1578] -325 mv/5000g's (1)
CLIP: OK

Version 2012.114

MID BARATARIA CALIBRATION - 1_1
OP: IAH

SPT NRG MEAS. 2
Test date: 13-May-2013

AR: 1.32 in^2		SP: 0.492 k/ft3
LE: 43.16 ft		EM: 30,000 ksi
WS: 16,807.9 f/s		JC: 0.35

FMX: Maximum Force	EMX: Max Transferred Energy
VMX: Maximum Velocity	ETR: Energy Transfer Ratio
DMX: Maximum Displacement	RX6: Max Case Method Capacity (JC=0.6)
BPM: Blows per Minute	LTD: Length to Damage
EFV: Energy of FV	
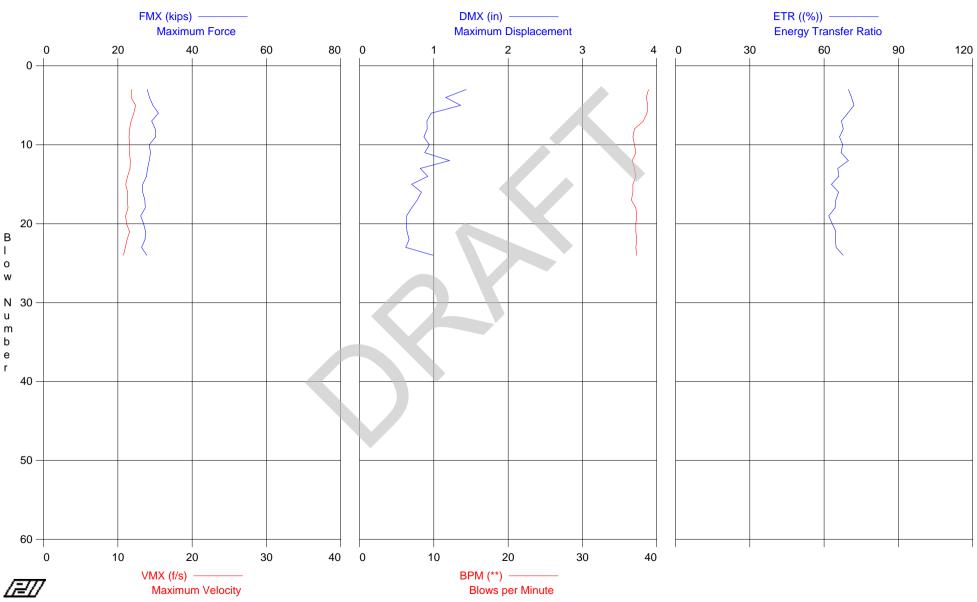
Statistics for entire file (22 blows)

	FMX	VMX	DMX	BPM	EFV	EMX	ETR	RX6	LTD
	kips	f/s	in	**	k-ft	k-ft	(%)	kips	ft
Average	28	11.5	0.89	37.4	0.23	0.23	66.5	6	17.00
Std. Dev.	1	0.4	0.23	0.7	0.01	0.01	2.6	2	4.99
Maximum	31	12.4	1.43	38.9	0.25	0.25	72.1	12	23.03
@ Blow#	6	5	3	3	5	5	5	10	4

Time Summary
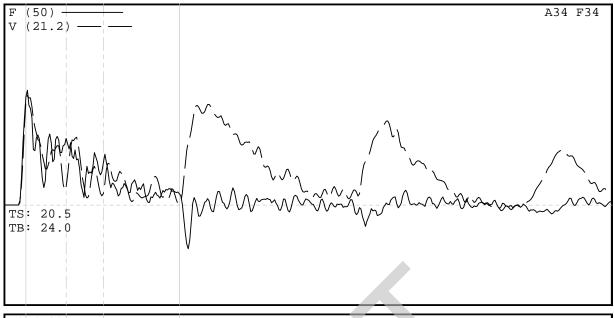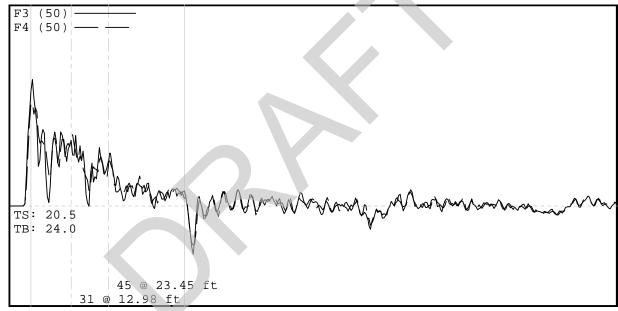
Drive   37 seconds   7:36:53 AM - 7:37:30 AM (5/13/2013) BN 1 - 24

MID BARATARIA CALIBRATION - 1_1

FMX (kips) ——————
Maximum Force

DMX (in) ——————
Maximum Displacement

ETR ((%)) ——————
Energy Transfer Ratio

Blow Number

VMX (f/s) ——————
Maximum Velocity

BPM (**) ——————
Blows per Minute

MID BARATARIA CALIBRATION

F (50)
V (21.2)
A34 F34

TS: 20.5
TB: 24.0

F3 (50)
F4 (50)

TS: 20.5
TB: 24.0

45 @ 23.45 ft
31 @ 12.98 ft

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: 1_1
DESCR: SPT NRG MEAS. 2
OPERATOR: IAH
FILE: 1_1.W01
5/13/2013 7:37:07 AM
Blow Number 10

Pile Properties
LE   43.16 ft
AR   1.32 in^2
EM   30000 ksi
SP   0.492 k/ft3
WS   16807.9 f/s
EA/C   2.4 ksec/ft
2L/C   5.15 ms
JC   0.35 []

Quantity Results
FMX   28 kips
VMX   11.6 f/s
DMX   0.94 in
BPM   37.0 bpm
EFV   0.24 k-ft
EMX   0.24 k-ft
ETR   67.5 (%)
RX6   12 kips
LTD 12.98 ft

Sensors
F3: [213BR1] 214.16 (1)
F4: [213BR2] 216.06 (1)
A3: [K1580] -355 mv/5000g's (1)
A4: [K1578] -325 mv/5000g's (1)
CLIP: OK

MID BARATARIA CALIBRATION - 1_2
OP: IAH

SPT NRG MEAS. 3
Test date: 13-May-2013
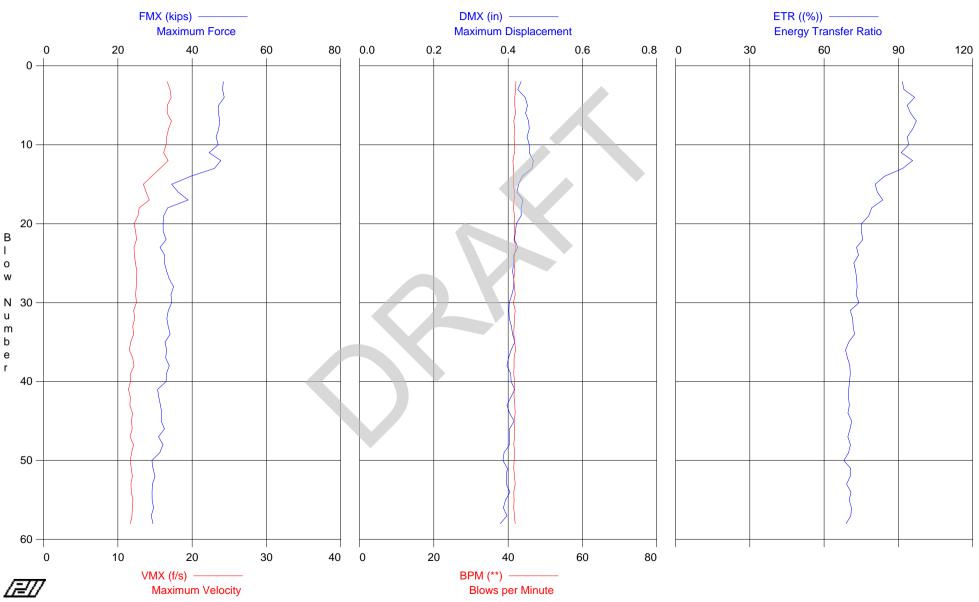
AR:	1.32 in^2	SP:	0.492 k/ft3
LE:	53.16 ft	EM:	30,000 ksi
WS:	16,807.9 f/s	JC:	0.35

FMX: Maximum Force	EMX: Max Transferred Energy
VMX: Maximum Velocity	ETR: Energy Transfer Ratio
DMX: Maximum Displacement	RX6: Max Case Method Capacity (JC=0.6)
BPM: Blows per Minute	LTD: Length to Damage
EFV: Energy of FV	

Statistics for entire file (57 blows)

	FMX kips	VMX f/s	DMX in	BPM **	EFV k-ft	EMX k-ft	ETR (%)	RX6 kips	LTD ft
Average	36	13.2	0.42	41.7	0.27	0.27	77.1	15	13.26
Std. Dev.	6	1.9	0.02	0.2	0.03	0.03	9.5	2	1.35
Maximum	49	17.2	0.47	42.1	0.34	0.34	97.3	20	23.05
@ Blow#	4	7	12	2	7	7	7	7	25

Time Summary

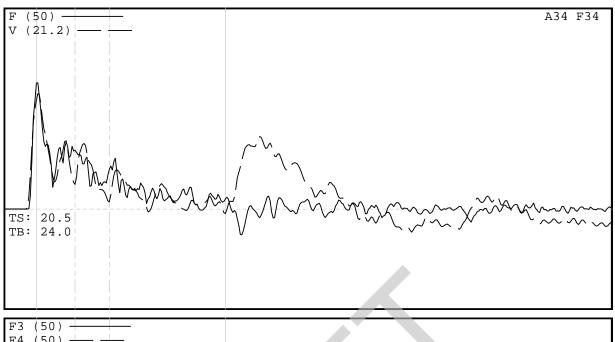Drive   1 minute 22 seconds   8:23:57 AM - 8:25:19 AM (5/13/2013) BN 1 - 58
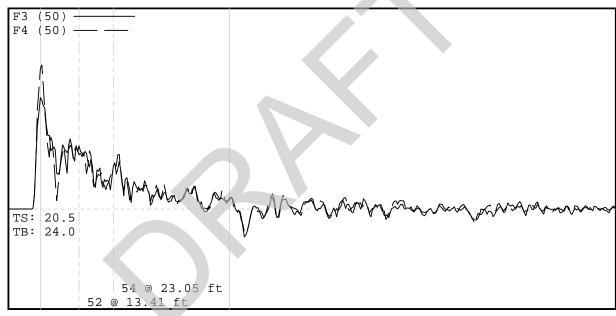
MID BARATARIA CALIBRATION - 1_2

FMX (kips) —————
Maximum Force

DMX (in) —————
Maximum Displacement

ETR ((%)) —————
Energy Transfer Ratio

Blow Number

VMX (f/s) —————
Maximum Velocity

BPM (**) —————
Blows per Minute

F (50)
V (21.2)

A34 F34

TS: 20.5
TB: 24.0

F3 (50)
F4 (50)

TS: 20.5
TB: 24.0

54 @ 23.05 ft
52 @ 13.41 ft

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: 1_2
DESCR: SPT NRG MEAS. 3
OPERATOR: IAH
FILE: 1_2.W01
5/13/2013 8:24:29 AM
Blow Number 23

Pile Properties
LE	53.16 ft
AR	1.32 in^2
EM	30000 ksi
SP	0.492 k/ft3
WS	16807.9 f/s
EA/C	2.4 ksec/ft
2L/C	6.34 ms
JC	0.35 []
LP	47.33 ft

Quantity Results
FMX	31	kips
VMX	12.2	f/s
DMX	0.43	in
BPM	42.1	bpm
EFV	0.26	k-ft
EMX	0.26	k-ft
ETR	73.1	(%)
RX6	14	kips
LTD	13.41	ft

Sensors
F3: [213BR1] 214.16 (1)
F4: [213BR2] 216.06 (1)
A3: [K1580] 355 mv/5000g's (1)
A4: [K1578] 325 mv/5000g's (1)
CLIP: OK

MID BARATARIA CALIBRATION - 1_3
OP: IAH

SPT NRG MEAS. 4
Test date: 13-May-2013

AR: 1.32 in^2		SP: 0.492 k/ft3
LE: 56.16 ft		EM: 30,000 ksi
WS: 16,807.9 f/s		JC: 0.35

FMX: Maximum Force
VMX: Maximum Velocity
DMX: Maximum Displacement
BPM: Blows per Minute
EFV: Energy of FV

EMX: Max Transferred Energy
ETR: Energy Transfer Ratio
RX6: Max Case Method Capacity (JC=0.6)
LTD: Length to Damage
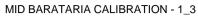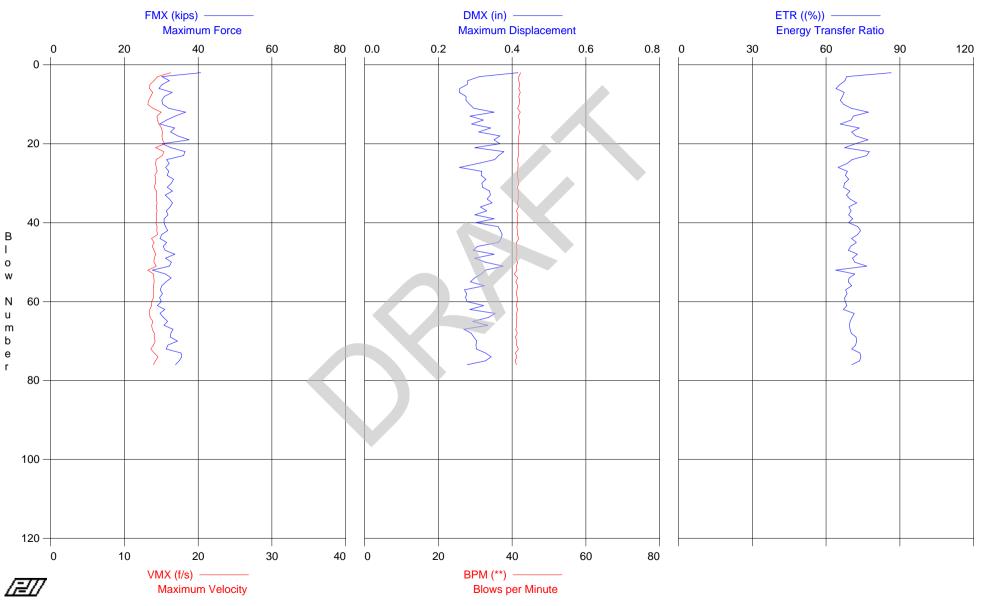
Statistics for entire file (75 blows)

	FMX kips	VMX f/s	DMX in	BPM **	EFV k-ft	EMX k-ft	ETR (%)	RX6 kips	LTD ft
Average	32	14.2	0.32	41.5	0.25	0.25	70.4	13	16.69
Std. Dev.	2	0.5	0.03	0.3	0.01	0.01	3.5	1	1.22
Maximum	41	16.3	0.42	42.3	0.30	0.30	86.5	15	17.60
@ Blow#	2	2	2	2	2	2	2	71	31

Time Summary
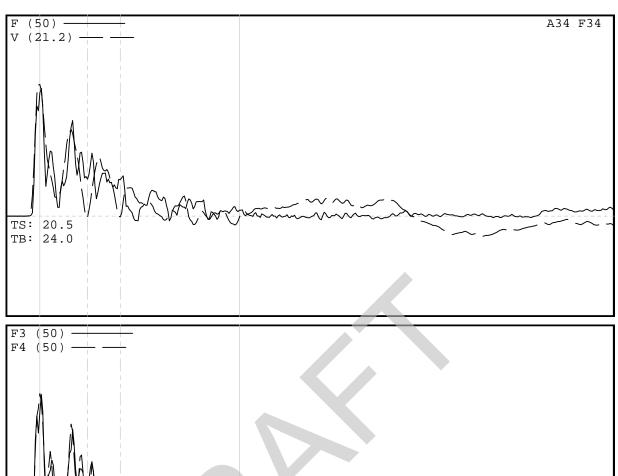
Drive   1 minute 48 seconds   9:06:23 AM - 9:08:11 AM (5/13/2013) BN 1 - 76

MID BARATARIA CALIBRATION - 1_3

FMX (kips) ——————
Maximum Force

DMX (in) ——————
Maximum Displacement

ETR ((%)) ——————
Energy Transfer Ratio

Blow Number

VMX (f/s) ——————
Maximum Velocity

BPM (**) ——————
Blows per Minute

DRAFT

MID BARATARIA CALIBRATION

F (50) ⎯⎯⎯
V (21.2) ⎯ ⎯ ⎯

A34 F34

TS: 20.5
TB: 24.0

F3 (50) ⎯⎯⎯
F4 (50) ⎯ ⎯ ⎯

TS: 20.5
TB: 24.0

49 @ 25.15 ft
40 @ 15.93 ft

Project Information
PROJECT: MID BARATARIA CALIBRATION
PILE NAME: 1_3
DESCR: SPT NRG MEAS. 4
OPERATOR: IAH
FILE: 1_3.W01
5/13/2013 9:07:55 AM
Blow Number 65

Pile Properties
LE	56.16 ft
AR	1.32 in^2
EM	30000 ksi
SP	0.492 k/ft3
WS	16807.9 f/s
EA/C	2.4 ksec/ft
2L/C	6.70 ms
JC	0.35 []
LP	52.33 ft

Quantity Results
FMX	32	kips
VMX	13.9	f/s
DMX	0.29	in
BPM	41.1	bpm
EFV	0.24	k-ft
EMX	0.24	k-ft
ETR	69.7	(%)
RX6	14	kips
LTD	15.93	ft

Sensors
F3: [213BR1] 214.16 (1)
F4: [213BR2] 216.06 (1)
A3: [K1580] 355 mv/5000g's (1)
A4: [K1578] 325 mv/5000g's (1)
CLIP: OK