MACTEC

APPENDIX F

Report of SPT Energy Measurements
By GRL Engineers

GRL engineers, inc.
Dynamic Measurements and Analyses

September 12, 2005

MACTEC Engineering and Consulting, Inc.
396 Plasters Avenue, N.E.
Atlanta, GA 30324

Attention: Mr. Allen Lancaster

Re: Summary Report for SPT Energy Measurements
Plant Vogtle
Augusta, GA

GRL Job No. 059063

Dear Mr. Lancaster:

This report summarizes the results from the Standard Penetration Test (SPT) energy measurements performed for two drilling rigs, at the above referenced project. Graphical and tabular summaries of the dynamic test results are included with this report. The field testing was performed during our site visit on September 6 and 7, 2005.

The purposes of the SPT energy measurements were to provide energy transfer measurements for the SPT N values obtained from two drill rigs and drillers. To meet this objective, a PAK Model Pile Driving Analyzer® (PDA) was used to acquire and process the dynamic test data. Additional information regarding the testing equipment and analytical procedures is included in Appendix A.

Soil Information

The reported soil profile consisted mainly of silty or clayey sands underlain by silty sand or silty clay marl. The upper silty or clayey sands generally ranged from medium dense to loose and continued to depths ranging from 70 to 90 feet below existing grade. The silty sands or silty clays of the marl continued to the boring termination depths which range from approximately 100 to 125 feet below the existing ground surface. A detailed discussing of the subsurface conditions is beyond the scope of this report. The reader is referred to the proper geotechnical investigation report for further details.

Test Sequence

As directed by MACTEC, GRL was requested to obtain SPT energy measurements for two drill rigs at three general depth ranges. At least one energy measurement for each rig was to be obtained between the depths of 5 to 20 feet, 30 to 50 feet and below the depths of 75 to 100 feet. Therefore, GRL performed energy measurements between these depths with a total of three samples taken for each drill rig between these general depth locations. Specifically, measurements were provided at 6 to 7.5, 10.5 to 12, 13.5 to 15, 28.5 to 30, 33.5 to 35, 38.5 to 40, 98.5 to 100, 103.5 to 105 and 108.5 to 110 feet for drill rig number 1 (Truck No. 1344). For drill rig number 2 (Truck No. 1338) energy measurements were provided at 9 to 10.5, 10.5 to 12, 13.5 to 15, 38.5 to 40, 43.5 to 45, 48.5 to 50, 93.5 to 95, 98.5 to 100 and 103.5 to 105 feet. All SPT samples were driven for a total of 3 six-inch increments, or 1.5 feet.

DYNAMIC TESTING ANALYSES AND RESULTS
Energy Transfer Measurements

A PAK model Pile Driving Analyzer was used to take measurements of strain and acceleration. The strain and acceleration measurements were taken on the 2 ft long NW rod located directly below the CME automatic hammer. The strain and acceleration signal were conditioned and converted to force and velocities by the PDA. The PDA interprets the measured dynamic data according to the Case Method equation. The dynamic test data was evaluated for maximum force and velocity at the gage location. These quantities are presented in the summaries of the dynamic test results in Appendix B.

Force and velocity records from the PDA were also viewed graphically on a LCD screen to evaluate data quality. All force and velocity records were also digitally stored for subsequent laboratory analysis.

The maximum energy transferred to the gage location was calculated using two equations. The first equation, labeled EFV, calculated the maximum transferred energy by integrating both the force and velocity records over time as follows:

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

Where: $F(t)$ = the force at time t
$V(t)$ = the velocity at time t

The integration begins at the time the hammer impacts the ram and continues until the maximum transferred energy is reached.

The second equation, EF2, calculates the transferred energy using the assumed proportionality between force and velocity to express the transferred energy in terms of one measured quantity, the force. By assuming that the force and velocity are proportional, the EF2 equation assumes that the drill rod is of constant cross-sectional area. This is seldom the case since the threaded connections between drill rod sections result in an increase in cross-sectional area at each connection. The EF2 equation can be expressed as:

$$EF2 = (c/EA)\int[F(t)]^2 dt$$

Where: c = the stress wavespeed in the drill rod
E = The modules of elasticity of the drill rod
A = cross-sectional area of the drill rod at the gage location
$F(t)$ = the force at time t

The integration begins at the hammer impact time and continues to a cutoff time corresponding to the first occurrence of a zero force after impact. This is the method specified in ASTM D-46633-86, Standard Test Method for Stress Wave Energy Measurement for dynamic Penetrometer Systems. However, this ASTM standard has expired and a new standard has yet to be adopted. The new proposed standard specifies that the energy calculations be performed in accordance with the EFV method. The expired ASTM standard requires that the cutoff time fall within a time of 0.9($2L/c$) and 1.2($2L/c$) where L is the length between the gage location and the bottom of the sampler. ASTM also requires that several correction factors be applied based upon the distance between the impact point and the measuring station, the overall rod length, and a velocity correction factor. For informational purposes, the energy calculated from this method is contained in the summary tables presented in Appendix B. However, none of the ASTM correction factors have been applied.

Discussion of Test Results

Tables 1 and 2 contain a summary of the average energy transfer calculated using the EFV equation for each drilling rig and SPT sample with dynamic measurements. As noted earlier, the EF2 equation is based upon a uniform cross-sectional area. However, increases or decreases in the rod cross-sectional area typically occur at the rod connections. Therefore, the average energy transfer using the EF2 equation in Tables 1 and 2 should not be considered reliable or representative of the true energy transfer. Dynamic measurement of the energy transfer to the drill rods using the EFV equation ranged from 227 ft-lbs for sample B1013, SS-5 to 277 ft-lbs for sample B1008, SS-26, for drill rig number 1 (Truck No. 1344). This corresponds to a transfer efficiency ranging from 65 to 79% of the theoretical SPT hammer energy of 350 ft-lbs. Dynamic measurements of the energy transfer for drill rig number 2 (Truck No. 1338) ranged from 250 ft-lbs for sample B1006-SS-7 to 304 ft-lbs for sample B1006-SS-17. This corresponds to a transfer efficiency ranging from 71 to 87% of the theoretical SPT hammer energy of 350 ft-lbs. The average transferred energies for all nine samples collected for each drill rig were 252 ft-lbs and 282 ft-lbs, respectively for drill rig number 1 (Truck 1344) and drill rig number 2 (Truck No. 1338). These average transferred energies correspond to transfer efficiencies of 72 and 80%, respectively.

Conclusions

Based upon the dynamic test data obtained, the following conclusions are presented:

1 - Loose connections in the drill string were sometimes observed in the force and velocity records. Use of the EF2 equation (as specified in the expired ASTM Standard) would result in a lower calculated or inconsistent energy transfer to the drill rod in these cases and is therefore not considered representative of the true energy transfer. Energy transfer values calculated using the EFV equation are not adversely affected by the connectors and therefore are considered a better indication of transferred energy.

2 - Dynamic measurements of the transferred energy to the drill rods using the EFV equation ranged from 227 to 277 ft-lbs for drill rig number 1 (Truck No. 1344). This corresponds to a transfer efficiency ranging from 65 to 79% of the theoretical SPT hammer energy of 350 ft-lbs.

3 - Dynamic measurements of the transferred energy to the drill rods using the EFV equation ranged from 250 to 304 ft-lbs for drill rig number 2 (Truck No. 1338). This corresponds to a transfer efficiency ranging from 71 to 87% of the theoretical SPT hammer energy of 350 ft-lbs.

4 - The average energy for the nine SPT samples collected for each drill rig was 252 and 282 ft-lbs for drill rig number 1 (Truck 1344) and drill rig number 2 (Truck 1338), respectively. These average energy transfers correspond to transfer efficiencies of 72 and 80%, respectively.

We appreciate the opportunity to be of assistance 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.

Respectfully,
GRL Engineers, Inc.

Scott D. Webster dms

Scott D. Webster, P.E.

Karen Webster TJ

Karen Webster

SDW:KW:dms

TABLE 1: Summary of STP Energy Measurements
CME 55 Drill Rig - Truck 1344
Plant Vogtle

Borehole & Sample No.	Test Date	Reported Sample Depth (feet)	Reported Blow Count (blows/6")	SPT Field N Value	Avg. Energy Transferred FV Method (ft-lbs)	Energy Transfer Efficiency1 (%)	Avg. Energy Transferred F2 Method (ft-lbs)	Blow per Minute (bpm)
B1013-SS5	9/7/2005	6-7.5	5-6-6	12	227	65	128	48
B1013-SS8	9/7/2005	10.5-12	16-17-10	17	246	70	151	47
B1013-SS10	9/7/2005	13.5-15	4-4-18	22	238	68	142	47
B1013-SS13	9/7/2005	28.5-30	10-8-8	16	247	71	147	47
B1013-SS14	9/7/2005	33.5-35	12-14-20	34	251	72	151	46
B1013-SS15	9/7/2005	38.5-40	7-10-12	22	256	73	145	47
B1008-SS26	9/6/2005	98.5-100	18-24-41	65	277	79	161	45
B1008-SS27	9/6/2005	103.5-105	18-23-30	53	262	75	152	45
B1008-SS28	9/6/2005	108.5-110	17-21-50/3"	71/9"	263	75	152	46

Notes: All boring information and blow counts were reported to GRL by MACTEC.
1 - Energy transfer efficiency is the energy calculated by the FV method divided by the SPT hammer potential energy of 140 lbs times 2.5 foot drop height or 350 ft-lbs.

TABLE 2: Summary of STP Energy Measurements
CME 75 Drill Rig - Truck 1338
Plant Vogtle

Borehole & Sample No.	Test Date	Reported Sample Depth (feet)	Reported Blow Count (blows/6")	SPT Field N Value	Avg. Energy Transferred FV Method (ft-lbs)	Energy Transfer Efficiency1 (%)	Avg. Energy Transferred F2 Method (ft-lbs)	Blow per Minute (bpm)
B1006-SS7	9/6/2005	9-10.5	4-2-2	4	250	71	154	52
B1006-SS8	9/6/2005	10.5-12	3-4-4	8	260	74	156	51
B1006-SS10	9/6/2005	13.5-15	4-6-5	11	268	77	148	51
B1006-SS15	9/6/2005	38.5-40	4-6-4	10	299	85	186	52
B1006-SS16	9/6/2005	43.5-45	1-1-1	2	301	86	189	54
B1006-SS17	9/6/2005	48.5-50	1-4-4	8	304	87	188	51
B1006-SS26	9/7/2005	93.5-95	5-6-8	14	292	83	172	51
B1006-SS27	9/7/2005	98.5-100	5-7-12	19	281	80	160	52
B1006-SS28	9/7/2005	103.5-105	18-17-11	28	287	82	176	52

Notes: All boring information and blow counts were reported to GRL by MACTEC.
1 - Energy transfer efficiency is the energy calculated by the FV method divided by the SPT hammer potential energy of 140 lbs times 2.5 foot drop height or 350 ft-lbs.

Appendix A

An Introduction into Dynamic Pile Testing Methods

APPENDIX A
AN INTRODUCTION INTO DYNAMIC PILE TESTING METHODS

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

1. BACKGROUND

Modern procedures of design and construction control require verification of bearing capacity and integrity of deep foundations during both preconstruction test programs and production installation. Dynamic pile testing methods meet this need economically and reliably, and therefore, form an important part of a quality assurance program when deep foundations are executed. Several dynamic pile testing methods exist; they have different benefits and limitations and different requirements for proper execution.

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. The method is therefore 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 an evaluation of various quantities based on closed form solutions of the wave equation, a partial differential equation describing the motion of a rod under the effect of an impact. Conveniently, measurements and analyses are done by a single piece of equipment: the Pile Driving Analyzer® (PDA). However, for bearing capacity evaluations an important additional method is CAPWAP® which performs a much more rigorous analysis of the dynamic records than the simpler Case Method.

A related analysis method is the "Wave Equation Analysis" which calculates a relationship between bearing capacity and pile stress and field blow count. The GRLWEAP™ program performs this analysis and provides a complete set of helpful information and input data.

The following description deals primarily with the "High Strain Test" Method of pile testing. However, for the sake of completeness, two types of "Low Strain Tests" are also mentioned: the Pile Integrity Test™ (PIT) and Cross Hole Sonic Logging conducted with the Cross Hole Analyzer (CHA).

2. RESULTS FROM PDA DYNAMIC TESTING

There are two main objectives of high strain dynamic pile testing:

- *Dynamic Pile Monitoring* and
- *Dynamic Load Testing.*

Dynamic pile monitoring is conducted during the installation of impact driven piles to achieve a safe and economical pile installation. Dynamic load testing, on the other hand, has as its primary goal the assessment of pile bearing capacity. It is applicable to both drilled shafts and impact driven piles during restrike.

2.1 DYNAMIC PILE MONITORING

During pile installation, the sensors attached to the pile measure pile top force and velocity. A PDA conditions and processes these signals and calculates or evaluates:

- *Bearing capacity* at the time of testing, including an assessment of shaft resistance development and driving resistance. This information supports formulation of a driving criterion.

- *Dynamic pile stresses* axial and averaged over the pile cross section, both tensile and compressive, during pile driving to limit the potential of damage either near the pile top or along its length. Bending stresses can be evaluated at the point of sensor attachment.

- *Pile integrity* assessment by the PDA is based on the recognition of certain wave reflections from along the pile. If detected early enough, a pile may be saved from complete destruction. On the other hand, once damage is recognized measures can be taken to prevent reoccurrence.

- *Hammer performance* parameters including the energy transferred to the pile, the hammer speed in blows per minute and the stroke of open ended diesel hammers.

2.2 DYNAMIC PILE LOAD TESTING

Bearing capacity testing of either driven piles or drilled shafts employs the basic measurement approach of dynamic pile monitoring. However, the test is done independent of the pile installation process and therefore a pile driving hammer or other dynamic loading device may not be available. If a special ram has to be mobilized then its weight should be between 0.8 and 2% of the test load (e.g. between 4 and 10 tons for a 500 ton test load) to assure sufficient soil resistance activation.

For a successful test, it is most important that the test is conducted after a sufficient waiting time following pile installation for soil properties approaching their long term condition or concrete to properly set. During testing, PDA results of pile/shaft stresses and transferred energy are used to maintain safe stresses and assure sufficient resistance activation. For safe and sufficient testing of drilled shafts, ram energies are often increased from blow to blow until the test capacity has been activated. On the other hand, restrike tests on driven piles may require a warm hammer so that the very first blow produces a complete resistance activation. Data must be evaluated by CAPWAP for bearing capacity.

After the dynamic load test has been conducted with sufficient energy and safe stresses, the CAPWAP analysis provides the following results:

- *Bearing capacity i.e.* the mobilized capacity present at the time of testing
- *Resistance distribution* including shaft resistance and end bearing components
- *Stresses in pile or shaft* calculated for both the static load application and the dynamic test. These stresses are averages over the cross section and do not include bending effects or nonuniform contact stresses, e.g. when the pile toe is on uneven rock.
- *Shaft impedance vs. depth*; this is an estimate of the shaft shape if it differs substantially from the planned profile
- *Dynamic soil parameters* for shaft and toe, i.e. damping factors and quakes (related to the dynamic stiffness of the resistance at the pile/soil interface.)

3. MEASUREMENTS

The following is a general summary of dynamic measurements available to solve typical deep foundation problems.

3.1 PDA

The basis for the results calculated by the PDA are pile top strain and acceleration measurements which are converted to force and velocity records, respectively. The PDA conditions, calibrates and displays these signals and immediately computes average pile force and velocity thereby eliminating bending effects. Using closed form Case Method solutions, based on the one-dimensional linear wave equation, the PDA calculates the results described in the analytical solutions section below.

3.2 HPA

The ram velocity may be directly obtained using radar technology in the Hammer Performance Analyzer™. For this unit to be applicable, the ram must be visible. The impact velocity results can be automatically processed with a PC or recorded on a strip chart.

3.3 SAXIMETER™

For open end diesel hammers, the time between two impacts indicates the magnitude of the ram fall height or stroke. This information is not only measured and calculated by the PDA but also by the convenient, hand-held Saximeter.

3.4 PIT

The Pile Integrity Tester™ (PIT) helps in detecting major defects in concrete piles or shafts or assess the length of a variety of deep foundations, except steel piles. PIT performs the so-called "Pulse-Echo Method" which only requires the measurement of motion (e.g., acceleration) at the pile top caused by a light hammer impact. PIT also supports the so-called "Transient Response Method" which requires the additional measurement of the hammer force and an analysis in the frequency domain. PIT may also be used to evaluate the unknown length of deep foundations under existing structures.

3.5 CHA

This test requires that at least two tubes (typically steel tubes of 50 mm diameter) are installed vertically in the shaft to be tested. A high frequency signal is generated in one of the water filled tubes and received in the other tube. The received signal strength and its First Time of Arrival (FAT) yield important information about the concrete quality between the two tubes. The transmitting and recording of the signal is repeated typically every 50 mm starting at the shaft bottom and all records together establish a log or profile of the concrete quality between the two tubes. The total number of tubes installed depends on the size of the drilled shaft. The more tubes are present the more profiles can be constructed.

4.ANALYTICAL SOLUTIONS

4.1 *BEARING CAPACITY*

4.1.1 WAVE EQUATION

GRL has written the GRLWEAP™ program which calculates a relationship between bearing capacity, pile stress and blow count. This relationship is often called the "bearing graph." Once the blow count is

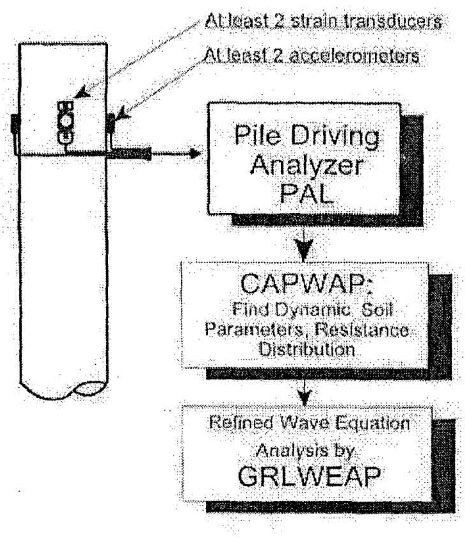


Figure 1. Block Diagram of Refined Wave Equation Analysis

known from pile installation logs, the bearing graph yields the bearing capacity. This approach requires no measurements other than blow count. Rather it requires an accurate knowledge of the various parameters describing hammer, driving system, pile and soil. The wave equation is also very useful during the design stage of a project for the selection of hammer, cushion and pile size.

After dynamic pile monitoring and/or dynamic load testing has been performed, the "Refined Wave Equation Analysis" or RWEA (Figure 1.) is often performed by inputting the PDA and CAPWAP calculated parameters. With many of the dynamic parameters verified by the dynamic tests, it is a more reliable basis for a safe and sufficient driving criterion.

4.1.2 CASE METHOD

The Case Method is a closed form solution based on a few simplifying assumptions such as ideal plastic soil behavior and an ideally elastic and uniform pile. Given the measured pile top force, F(t), and pile top velocity, v(t), the total soil resistance is

$$R(t) = \tfrac{1}{2}\{[F(t) + F(t_2)] + Z[v(t) - v(t_2)]\} \qquad (1)$$

where

- t = a point in time after impact
- t_2 = time t + 2L/c
- L = pile length below gages
- c = $(E/\rho)^{1/2}$ is the speed of the stress wave
- ρ = pile mass density
- Z = EA/c is the pile impedance
- E = elastic modulus of the pile (ρ c^2)
- A = pile cross sectional area

The total soil resistance consists of a dynamic (R_d) and a static (R_s) component. The static component is therefore

$$R_s(t) = R(t) - R_d(t) \qquad (2)$$

The dynamic component may be computed from a soil damping factor, J, and the pile velocity, $v_t(t)$ which is conveniently calculated for the pile toe. Using wave considerations, this approach leads immediately to the dynamic resistance

$$R_d(t) = J[F(t) + Zv(t) - R(t)] \qquad (3)$$

and finally to the static resistance by means of Equation 2.

There are a number of ways in which Eq. 1 through 3 could be evaluated. Most commonly, T is set to that time at which the static resistance becomes maximum. The result is the so-called **RMX** capacity. Damping factors for RMX typically range between 0.5 for coarse grained materials to 1.0 for clays. The **RSP** capacity (this method is most commonly referred to in the literature, yet it is not very frequently used) requires damping factors between 0.1 for sand and 1.0 for clay. Another capacity, **RA2**, determines the capacity at a time when the pile is essentially at rest and thus damping is small; RA2 therefore requires no damping parameter. In any event, the proper Case Method and its associated damping parameter is most conveniently found after a CAPWAP analysis has been performed for one record. The capacities for other hammer blows are then quickly calculated for the thus selected Case Method and its associated damping factor.

The static resistance calculated by either Case Method or CAPWAP is the mobilized resistance at the time of testing. Consideration therefore has to be given to soil setup or relaxation effects and whether or not a sufficient set has been achieved under the test loading that would correspond to a full activation of the ultimate soil resistance.

The PDA also calculates an estimate of shaft resistance as the difference between force and velocity times impedance at the time immediately prior to the return of the stress wave from the pile toe. This shaft resistance is not reduced by damping effects and is therefore called the total shaft resistance **SFT**. A correction for damping effects produces the static shaft resistance estimate, **SFR**.

The Case Method solution is simple enough to be evaluated "in real time," i.e. between hammer blows, using the PDA. It is therefore possible to calculate all relevant results for all hammer blows and plot these results as a function of depth or blow number. This is done in the PDI-PLOT program or formerly in the DOS based PDAPLOT program.

4.1.3 CAPWAP

The CAse Pile Wave Analysis Program combines the wave equation pile and soil model with the Case Method measurements. Thus, the solution includes not only the total and static bearing capacity values but also the shaft resistance, end bearing, damping factors and soil stiffness values. The method iteratively calculates a number of unknowns by signal matching. While it is necessary to make hammer performance assumptions for a GRLWEAP analysis, the CAPWAP program works with the pile top measurements. Furthermore, while GRLWEAP and Case Method require certain assumptions regarding the soil behavior, CAPWAP calculates these soil parameters based on the dynamic measurements.

4.1.4 Capacity of damaged piles

Occasionally piles are damaged during driving and such damage may be indicated in the PDA collected records, if it occurs below the sensor location. Damage on steel piles is often a broken splice, a collapsed pile bottom section, a ripped of flange on an H-pile or a sharp bend (a gradual dog leg is usually not recognized in the records). For concrete piles, among the problems encountered are cracks, perpendicular due to the pile axis, which deteriorate into a major damage, slabbing (loss of concrete cover) or a compressive failure at the bottom which in effect makes the pile shorter.

Damaged piles, with beta values less than 0.8 should never be evaluated for bearing capacity by the Case Method alone, because these are non-uniform piles which therefore violate the basic premise of the Case Method: a uniform, elastic pile.

Using the CAPWAP program, it is sometimes possible to obtain a reasonable match between computed and measured pile top quantities. In such an analysis the damaged section has to be modeled either by impedance reductions or by slacks. For piles with severe damage along their length it may be necessary to analyze a short pile. It should be born in mind, however, that such an analysis also violates the basic principles of the CAPWAP analysis, namely that the pile is elastic. Also, the nature of the damage is never be known with certainty. For example, a broken splice could be a cracked weld either with the neighboring sections lining up well or shifted laterally. In the former case the stresses would be similar to those in the undamaged pile; in the latter situation, high stress concentrations would develop. A sharp bend or toe damage present equally unpredictable situations under sustained loads which may cause further structural deterioration. If a short pile is analyzed then the lower section of the pile below the damage may offer unreliable end bearing and therefore should be discounted.

It is GRL's position that damaged piling should be replaced. Utilizing the CAPWAP calculated capacities should only be done after a very careful consideration of the effects of a loss of the foundation member while in service. Under no circumstances should the CAPWAP calculated capacity be utilized in the same manner in which the capacity of an undamaged pile be used. Under the best of circumstances the capacity should be used with an increased factor of safety and discounting all questionable capacity components. This evaluation cannot be made by GRL as it involves consideration of the type of structure, its seismic environment, the nature of the loads expected, the corrosiveness of the soil material, considerations of scour on the shortened pile, etc.

4.2 *STRESSES*

During pile monitoring, it is important that compressive stress maxima at pile top and toe and tensile stress maxima somewhere along the pile be calculated for each hammer blow.

At the pile top (location of sensors) both the maximum compression stress, **CSX**, and the maximum stress from individual strain transducers, **CSI**, are directly obtained from the measurements. Note that CSI is greater than or equal to CSX and the difference between CSI and CSX is a measure of bending in the plane of the strain transducers. Note also that all stresses calculated for locations below the sensors are averaged over the pile cross section and therefore do not include components from either bending or eccentric soil resistance effects.

The PDA calculates the compressive stress at the pile bottom, **CSB**, assuming (a) a uniform pile and (b) that the pile toe force is the maximum value of the total resistance, R(t), minus the total shaft resistance, SFT. Again, for this stress estimation uniform resistance force are assumed (e.g. not a sloping rock.)

For concrete piles, the maximum tension stress, **TSX**, is also of great importance. It occurs at some point below the pile top. The maximum tension stress, again averaged over the cross section and therefore not including bending stresses, can be computed from the pile top measurements by finding the maximum tension wave (either traveling upward, W_U, or downward, W_d) and reducing it by the minimum compressive wave traveling in opposite direction.

$$W_u = ½[F(t) - Zv(t)] \tag{4}$$

$$W_d = ½[F(t) + Zv(t)] \tag{5}$$

CAPWAP also calculates tensile and compressive stresses along the pile and, in general, more accurately than the PDA. In fact, for non-uniform piles or piles with joints, cracks or other discontinuities, the closed form solutions from the PDA may be in error.

4.3 *PILE INTEGRITY BY PDA*

Stress waves in a pile are reflected wherever the pile impedance, $Z = EA/c = \rho cA = A \sqrt{(E\ \rho)}$, changes. Therefore, the pile impedance is a measure of the quality of the pile material (E, ρ, c) and the size of its cross section (A). The reflected waves arrive at the pile top at a time which is greater the farther away from the pile top the reflection occurs. The magnitude of the change of the upward traveling wave (calculated from the measured force and velocity, Eq. 4) indicates the extent of the cross sectional change. Thus, with β (**BTA**) being a relative integrity factor which is unity for no impedance change and zero for the pile end, the following is calculated by the PDA.

$$\beta = (1 - \alpha)/(1 + \alpha) \tag{6}$$

with

$$\alpha = ½(W_{UR} - W_{UD})/(W_{Di} - W_{UR}) \tag{7}$$

where

W_{UR} is the upward traveling wave at the onset of the damage reflected wave. It is caused by resistance.

W_{UD} is the upwards traveling reflection wave due to the damage.

W_{Di} is the maximum downward traveling wave due to impact.

It can be shown that this formulation is quite accurate as long as individual reflections from different pile impedance changes have no overlapping effects on the stress wave reflections. Without rigorous derivation, it has been proposed to consider as slight damage when β is above 0.8 and a serious damage when β is less than 0.6.

4.4 *HAMMER PERFORMANCE BY PDA*

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

$$E(t) = {}_0\int^t F(\tau)v(\tau)\, d\tau \qquad (8a)$$

The maximum of the E(t) curve is often called **ENTHRU;** it is the most important information for an overall evaluation of the performance of a hammer and driving system. **ENTHRU** or **EMX** allow 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.

$$e_T = EMX/E_R \qquad (8b)$$

where

E_R is the hammer manufacturer's rated energy value.

Both Saximeter and PDA calculate the stroke (**STK**) of an open end diesel hammer using

$$STK = (g/8)\, T_B^{\,2} - h_L \qquad (9)$$

where

g is the earth's gravitational acceleration,
T_B is the time between two hammer blows,
h_L is a stroke loss value due to gas compression and time losses during impact (usually 0.3 ft or 0.1 m).

4.5 *DETERMINATION OF WAVE SPEED*

An important facet of dynamic pile testing is an assessment of pile material properties. Since, n most cases general force is determined from strain by multiplication with elastic modulus, **E**, and cross sectional area, **A**, the dynamic elastic modulus has to be determined for pile materials other than steel. In general, the records measured by the PDA clearly indicate a pile toe reflection as long as pile penetration per blow is greater than 1 mm or .04 inches. The time between the onset of the force and velocity records at impact and the onset of the reflection from the toe (usually apparent by a local maximum of the wave up curve) is the so-called wave travel time, T. Dividing 2L (L is here the length of the pile below sensors) by T leads to the stress wave speed in the pile:

$$c = 2L/T \qquad (10)$$

The elastic modulus of the pile material is related to the wave speed according to the linear elastic wave equation theory by

$$E = c^2\rho \qquad (11)$$

Since the mass density of the pile material, ρ, is usually well known (an exception is timber for which samples should be weighed), the elastic modulus is easily found from the wave speed. Note, however, that this is a dynamic modulus which is generally higher than the static one and that the wave speed depends to some degree on the strain level of the stress wave. For example, experience shows that the wave speed from PIT is roughly 5% higher than the wave speed observed during a high strain test.

Other Notes:

- If the pile material is nonuniform then the wave speed c, according to Eq. 10, is an average wave speed and does not necessarily reflect the pile material properties of the location where the strain sensors are attached to the pile top. For example, pile driving often causes fine tension cracks some distance below the top of concrete piles. Then the average c of the whole pile is lower than the wave speed at the pile top. It is therefore recommended to determine E in the beginning of pile driving and not adjust it when the average c changes during the pile installation.

- If the pile has such a high resistance that there is no clear indication of a toe reflection then the wave speed of the pile material must be determined either by assumption or by taking a sample of the concrete and measuring its wave speed in a simple free column test. Another possibility is to use the proportionality relationship, discussed under "DATA QUALITY CHECKS" to find c as the ratio between the measured velocity and measured strain.

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 PDA or PIT 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 certain relationships.

5.1 PROPORTIONALITY

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 pile, force and velocity measured at the pile top are proportional

$$F = v\,Z = v\,(EA/c) \tag{12a}$$

This relationship can also be expressed in terms of stress

$$\sigma = v\,(E/c) \tag{12b}$$

or strain

$$\epsilon = v\,/\,c \tag{12c}$$

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.

5.2 *NUMBER OF SENSORS*

Measurements are always taken at opposite sides of the pile so that the average force and velocity in the pile can be calculated. The velocity on the two sides of the pile is very similar even when high bending exists. Thus, an independent check of the velocity measurements is easy and simple.

Strain measurements may differ greatly between the two sides of the pile when bending exists. It is even possible that tension is measured on one side while very high compression exists on the other side of the pile. In extreme cases, bending might be so high that it leads to a nonlinear stress distribution. In that case the averaging of the two strain signals does not lead to the average pile force and proportionality will not be achieved.

When testing drilled shafts, measurements of strain may also be affected by local concrete quality variations. It is then often necessary to use four strain transducers spaced at 90 degrees around the pile for an improved strain data quality. The use of four transducers is also recommended for large pile diameters, particularly when it is difficult to mount the sensors at least two pile widths or diameters below the pile top.

6. LIMITATIONS, ADDITIONAL CONSIDERATIONS

6.1 MOBILIZATION OF CAPACITY

Estimates of pile capacity from dynamic testing indicate the **mobilized pile capacity at the time of testing**. At very high blow counts (low set per blow), dynamic test methods tend to produce lower bound capacity estimates as not all resistance (particularly at and near the toe) is fully activated.

6.2 TIME DEPENDENT SOIL RESISTANCE EFFORTS

Static pile capacity from dynamic method calculations provide an estimate of the axial pile capacity. Increases and decreases in the pile capacity with time typically occur as a result of soil setup and relaxation. Therefore, **restrike testing usually yields a better indication of long term pile capacity than a test at the end of pile driving**. Often a wait period of one or two days between end of driving and restrike is satisfactory for a realistic prediction of pile capacity but this waiting time depends, among other factors, on the permeability of the soil.

6.2.1 SOIL SETUP

Because excess positive pore pressures often develop during pile driving in fine grained soils (clays, silts or even fine sands), the capacity of a pile at the time of driving may often be less than the long term pile capacity. These pore pressures reduce the effective stress acting on the pile thereby reducing the soil resistance to pile penetration, and thus the pile capacity at the time of driving. As these pore pressures dissipate, the soil resistance acting on the pile increases as does the axial pile capacity. This phenomena is routinely called soil setup or soil freeze. There are numerous other reasons for soil setup such as realignment of clay particles, arching that reduces effective stresses during pile installation in ver dense sands, soil fatigue in over-consolidated clays etc.

6.2.2 RELAXATION

Relaxation capacity reduction with time has been observed for piles driven into weathered shale, and may take several days to fully develop. Where relaxation occurs, pile capacity estimates based upon initial driving or short term restrike tests can significantly overpredict long term pile capacity. Therefore, piles driven into shale should be tested after a minimum one week wait either statically or dynamically with particular emphasis on the first few blows. Relaxation has also been observed for displacement piles driven into dense saturated silts or fine sands due to a negative pore pressure effect at the pile toe. In general, relaxation occurs at the pile toe and is therefore relevant for end bearing piles. Restrike tests should be performed and compared with the records from early restrike blows in order to avoid dangerous overpredictions

6.3 CAPACITY RESULTS FOR OPEN PILE PROFILES

Open ended pipe piles or H-piles which do not bear on rock may behave differently under dynamic and static loading conditions. Under dynamic loads the soil inside the pile or between its flanges may slip and produce internal friction while under static loads the plug may move with the pile, thereby creating end bearing over the full pile cross section. As a result both friction and end bearing components may be different under static and dynamic conditions.

6.4 CAPWAP ANALYSIS RESULTS

A portion of the soil resistance calculated on an individual soil segment in a CAPWAP analysis can usually be shifted up or down the shaft one soil segment without significantly altering the signal match quality. Therefore, use of the CAPWAP resistance distribution for uplift, downdrag, scour, or other geotechnical considerations should be made with an understanding of these analysis limitations.

6.5 STRESSES

PDA and CAPWAP calculated stresses are average values over the cross section. Additional allowance has to be made for bending or non-uniform contact stresses. To prevent damage it is therefore important to maintain good hammer-pile alignment and to protect the pile toes using appropriate devices or an increased cross sectional area.

In the United States is has become generally acceptable to limit the dynamic installation stresses of driven piles to the following levels:

90% of yield strength for steel piles

85% of the concrete compressive strength - after subtraction of the effective prestress - for concrete piles in compression

100% of effective prestress plus ½ of the concrete's tension strength for prestressed piles in tension

70% of the reinforcement strength for regularly reinforced concrete piles in tension

300% of the static design allowable stress for timber

Note that the dynamic stresses may either be directly measured at the pile top by the PDA or calculated by the PDA for other locations along the pile based on the pile top measurements. The above allowable stresses also apply to those calculated by wave equation.

6.6 ADDITIONAL DESIGN CONSIDERATIONS

Numerous factors have to be considered in pile foundation design. Some of these considerations include

- additional pile loading from downdrag or negative skin friction,
- lateral and uplift loading requirements
- effective stress changes (due to changes in water table, excavations, fills or other changes in overburden),
- long term settlements in general and settlement from underlying weaker layers and/or pile group effects,
- loss of shaft resistance due to scour or other effects,
- loss of structural pile strength due to additional bending loads, buckling (the dynamic loads general due not cause buckling even though they may exceed the buckling strength of the pile section), corrosion etc.

These factors have not been evaluated by GRL and have not been considered in the interpretation of the dynamic testing results. The foundation designer should determine if these or any other considerations are applicable to this project and the foundation design.

6.7 WAVE EQUATION ANALYSIS RESULTS

The results calculated by the wave equation analysis program depend on a variety of hammer, pile and soil input parameters. Although attempts have been made to base the analysis on the best available information, actual field conditions may vary and therefore stresses and blow counts may differ from the predictions reported. Capacity predictions derived from wave equation analyses should use restrike information. However, because of the uncertainties associated with restrike blow counts and restrike hammer energies, correlations of such results with static test capacities with have often displayed considerable scatter.

As for PDA and CAPWAP, the theory on which GRLWEAP is based is the one-dimensional wave equation. For that reason, stress predictions by the wave equation analysis can only be averages over the pile cross section. Thus, bending stresses or stress concentrations due to non-uniform impact or uneven soil or rock resistance are not considered in these results. Stress maxima calculated by the wave equation are usually subjected to the same limits as those measured directly or calculated from measurements by the PDA.

7. FACTORS OF SAFETY

Run to failure, static or dynamic load tests yield an ultimate pile bearing capacity, R_{ult}. If this failure load were applied to the pile, then excessive settlements would occur. Therefore, it is absolutely necessary that the actually applied load, also called the design load, R_d (or working load or safe load), is less than R_{ult}. In most soils, to limit settlements, it is necessary that R_{ult}, is at least 50% higher than R_d. This means that

$$R_{ult} \geq 1.5\ R_d,$$

or the Factor of Safety has to be at least 1.5.

Unfortunately, neither applied loads nor R_{ult} are exactly known. One static load test may be performed at a site, but that would not guarantee that all other piles have the same capacity and it is to be expected that a certain percentage of the production piles have lower capacities, either due to soil variability or due to pile damage. If, for example, dynamic pile tests are performed on piles in shale only a short time after pile installation, then the test capacity may be higher than the long term capacity of the pile. On the other hand, due to soil setup, piles generally gain capacity after installation and since tests are only done a short time after installation, a lower capacity value is ascertained than the capacity that eventually develops.

Not only bearing capacity values of all piles are unknown, even loads vary considerably and occasional overloads must be expected. We would not want a structure to become unserviceable or useless because of either an occasional overload or a few piles with low capacity. For this reason, and to avoid being overly conservative which would mean excessive cost, modern safety concepts suggest that the overall factor of safety should reflect both the uncertainty in loads and resistance. Thus, if all piles were tested statically and if we carefully controlled the loads, we probably could live with F.S. = 1.5. However, in general, depending on the building type or load combinations and as a function of quality assurance of pile foundations, a variety of Factors of Safety have been proposed.

For example, for highway related loads and based on AASHTO specifications, the Federal Highway Administration proposes the following:

F.S.= 2.00 for static load test with wave equation.

F.S.=2.25 for dynamic testing with wave equation analysis.

F.S.=2.50 for indicator piles with wave equation analysis.

F.S.=2.75 for wave equation analysis.

F.S.=3.00 for Gates or other dynamic formula.

It should be mentioned that all of these methods should always be combined with soil exploration and static pile analysis. Also, specifications of what are occasionally updated and therefore the latest version should be various consulted for the appropriate factors of safety.

Codes, among them PDCA, ASCE, or specifications issued by State Departments of Transportation specify different factors of safety. However, the range of recommended overall factors of safety in the United States varies between 1.9 and 6.

It is the designer's responsibility to identify design loads together with the adopted safety factor concept and associated construction control procedure. The required factors of safety should be included in design drawings or specifications together with the required testing. Only contractors bid for the work and develop the most economical solution. This should include a program of increased testing for lower required pile capacities. This will also help to reduce the confusion that often exists on construction sites as to design loads and require capacities. In any event, it cannot expected that the test engineer is aware of and responsible for the variety of considerations that must be met to find the appropriate factor of safety.

App-A-PDA-9-01

Appendix B:

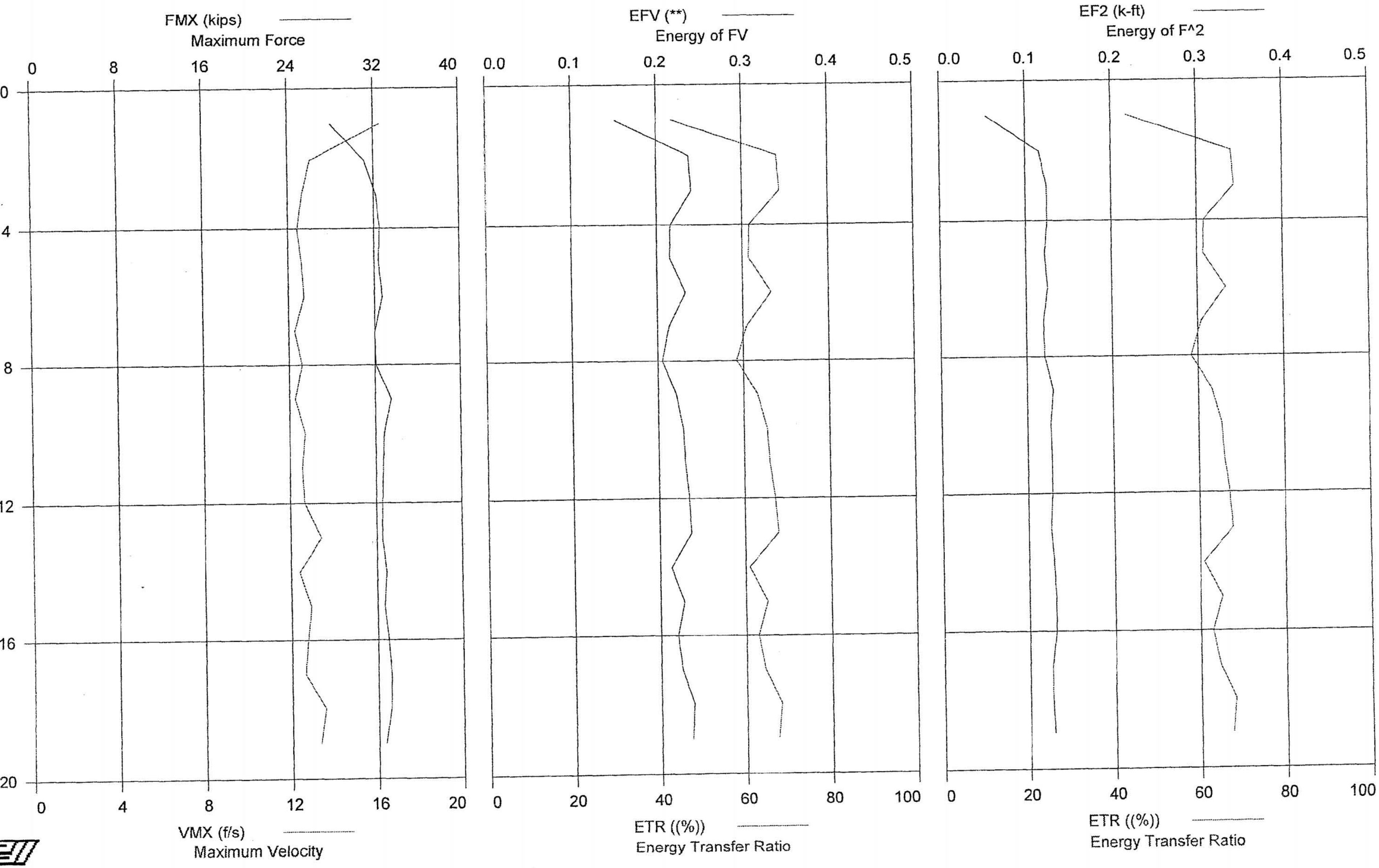
SPT Energy Measurement

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

PLANT VOGTLE - RIG 1 - B-1013-SS-5

Test date: 7-Sep-2005



PLANT VOGTLE - RIG 1 - B-1013-SS-5 SPT
OP: SDW Test date: 7-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 11.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	28	16.3	0.152	**	0.054	43.5
2	0.00	AV1	31	13.0	0.238	**	0.116	68.1
3	0.00	AV1	32	12.7	0.241	50.9	0.125	68.7
4	0.00	AV1	33	12.4	0.216	47.8	0.125	61.6
5	0.00	AV1	32	12.6	0.215	48.0	0.122	61.4
6	0.00	AV1	33	12.7	0.233	47.7	0.125	66.6
7	0.00	AV1	32	12.3	0.213	47.8	0.120	60.8
8	0.00	AV1	32	12.6	0.205	48.0	0.121	58.4
9	0.00	AV1	33	12.3	0.221	47.5	0.130	63.2
10	0.00	AV1	33	12.7	0.229	47.5	0.127	65.4
11	0.00	AV1	33	12.6	0.231	48.0	0.128	65.9
12	0.00	AV1	33	12.7	0.235	47.2	0.128	67.1
13	0.00	AV1	33	13.4	0.237	47.7	0.126	67.7
14	0.00	AV1	33	12.4	0.213	47.7	0.129	60.9
15	0.00	AV1	33	12.9	0.228	47.6	0.131	65.1
16	0.00	AV1	33	12.7	0.220	47.3	0.131	62.8
17	0.00	AV1	33	12.6	0.225	47.6	0.126	64.4
18	0.00	AV1	33	13.5	0.238	47.6	0.126	68.0
19	0.00	AV1	33	13.3	0.236	47.2	0.128	67.3

Time Summary

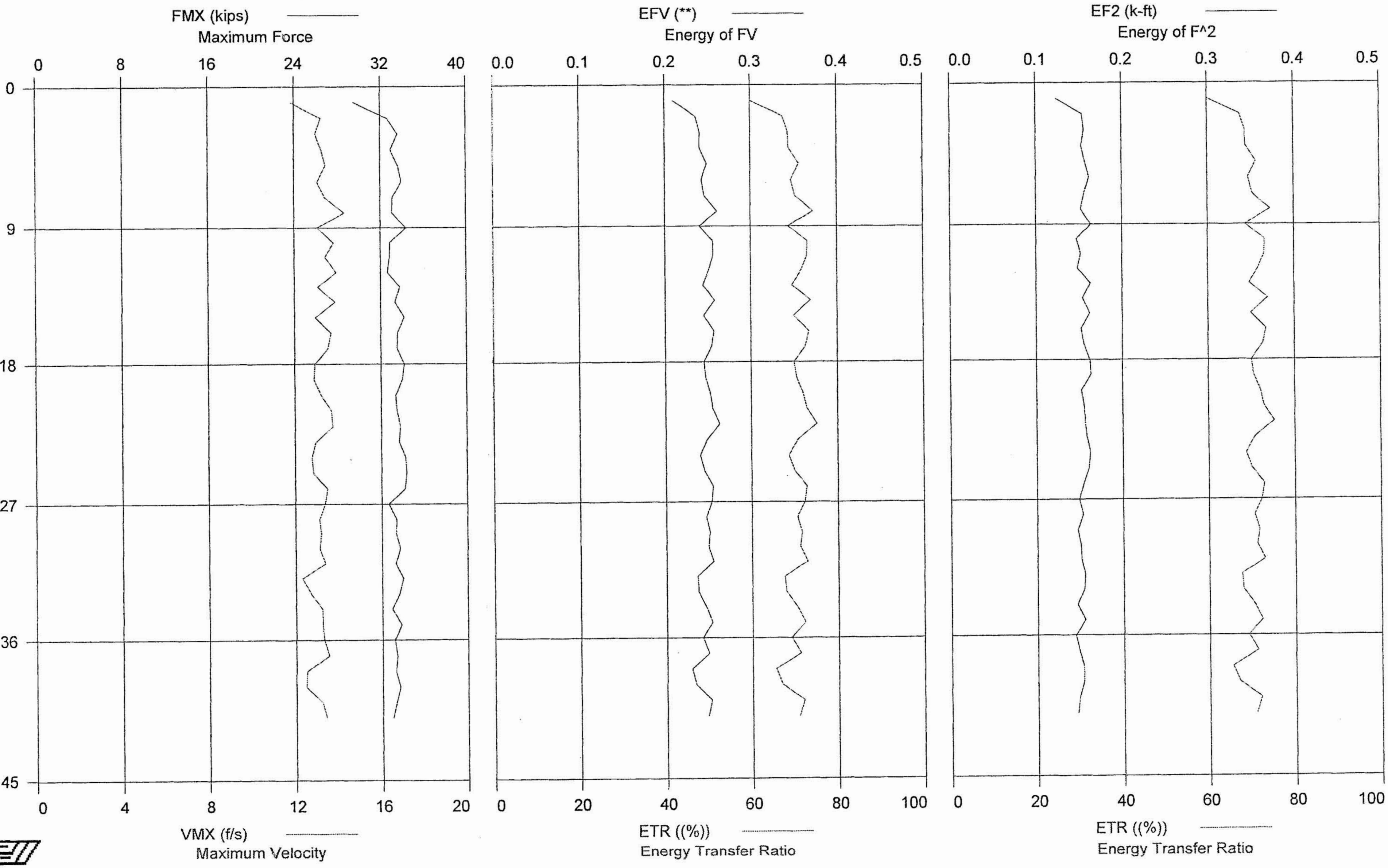
Drive 5 minutes 25 seconds 11:43:14 AM - 11:48:39 AM (9/7/2005)

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

PLANT VOGTLE - RIG 1 - B-1013-SS-8

Test date: 7-Sep-2005



Case Method Results PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 1 - B-1013-SS-8 SPT
OP: SDW Test date: 7-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 16.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	30	11.9	0.210	133.3	0.124	60.0
2	0.00	AV1	33	13.2	0.236	46.3	0.154	67.6
3	0.00	AV1	34	13.0	0.241	43.6	0.156	68.7
4	0.00	AV1	33	13.3	0.241	39.3	0.153	68.9
5	0.00	AV1	34	13.5	0.249	47.4	0.157	71.3
6	0.00	AV1	34	13.1	0.243	47.2	0.162	69.5
7	0.00	AV1	33	13.4	0.246	47.4	0.156	70.3
8	0.00	AV1	33	14.3	0.261	47.2	0.152	74.5
9	0.00	AV1	34	13.1	0.240	47.1	0.164	68.7
10	0.00	AV1	33	13.8	0.256	47.2	0.147	73.1
11	0.00	AV1	33	13.4	0.256	46.9	0.152	73.1
12	0.00	AV1	33	13.9	0.251	47.4	0.148	71.7
13	0.00	AV1	34	13.1	0.244	47.1	0.163	69.6
14	0.00	AV1	33	13.9	0.258	47.1	0.154	73.8
15	0.00	AV1	34	13.0	0.245	47.1	0.162	69.9
16	0.00	AV1	34	13.7	0.257	47.1	0.152	73.4
17	0.00	AV1	34	13.5	0.254	46.7	0.155	72.7
18	0.00	AV1	34	12.9	0.245	47.3	0.162	70.0
19	0.00	AV1	34	12.9	0.247	46.8	0.163	70.5
20	0.00	AV1	33	13.2	0.252	47.2	0.152	72.0
21	0.00	AV1	33	13.7	0.255	47.2	0.155	72.9
22	0.00	AV1	34	13.7	0.263	46.9	0.156	75.2
23	0.00	AV1	34	12.9	0.248	47.0	0.158	70.7
24	0.00	AV1	34	12.8	0.240	46.9	0.162	68.7
25	0.00	AV1	34	12.8	0.245	46.9	0.160	70.0
26	0.00	AV1	34	13.5	0.255	46.9	0.154	72.8
27	0.00	AV1	33	13.4	0.253	47.0	0.149	72.3
28	0.00	AV1	33	13.1	0.247	46.6	0.153	70.6
29	0.00	AV1	33	13.2	0.251	46.9	0.147	71.6
30	0.00	AV1	34	13.1	0.249	46.9	0.150	71.1
31	0.00	AV1	33	13.4	0.255	46.8	0.151	72.9
32	0.00	AV1	34	12.3	0.236	47.0	0.155	67.5
33	0.00	AV1	34	12.7	0.237	47.0	0.154	67.8
34	0.00	AV1	33	13.2	0.246	47.0	0.146	70.4
35	0.00	AV1	34	13.2	0.253	47.0	0.155	72.3
36	0.00	AV1	33	13.3	0.242	46.7	0.144	69.1
37	0.00	AV1	33	13.5	0.249	46.8	0.148	71.2
38	0.00	AV1	33	12.5	0.229	46.5	0.153	65.4
39	0.00	AV1	34	12.5	0.234	46.7	0.153	66.9
40	0.00	AV1	33	13.2	0.252	46.5	0.148	72.0
41	0.00	AV1	33	13.4	0.248	46.8	0.146	70.8

Time Summary

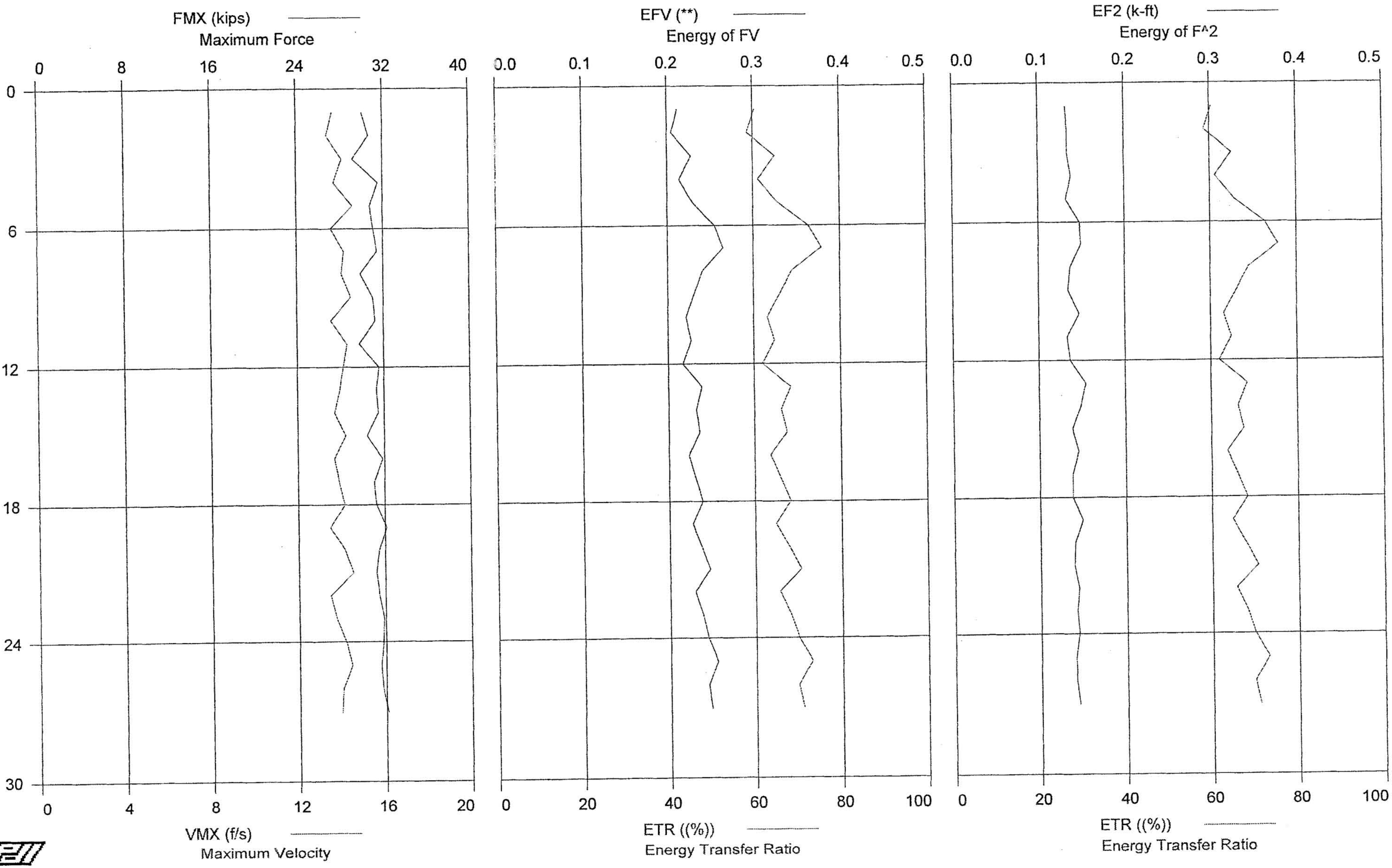
Drive 55 seconds 12:07:37 PM - 12:08:32 PM (9/7/2005)

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

Test date: 7-Sep-2005

PLANT VOGTLE - RIG 1 - B-1013-SS-10



PLANT VOGTLE - RIG 1 - B-1013-SS-10 SPT
OP: SDW Test date: 7-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 19.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	30	13.7	0.212	**	0.132	60.5
2	0.00	AV1	31	13.4	0.205	47.5	0.134	58.7
3	0.00	AV1	29	14.1	0.228	116.3	0.134	65.0
4	0.00	AV1	32	13.7	0.214	72.6	0.138	61.2
5	0.00	AV1	31	14.6	0.230	47.0	0.132	65.7
6	0.00	AV1	31	13.6	0.255	113.6	0.148	72.7
7	0.00	AV1	31	14.2	0.265	47.3	0.149	75.7
8	0.00	AV1	30	14.1	0.241	47.4	0.137	68.9
9	0.00	AV1	31	14.5	0.231	47.4	0.134	66.1
10	0.00	AV1	31	13.6	0.221	47.0	0.147	63.1
11	0.00	AV1	30	14.3	0.227	47.3	0.133	64.8
12	0.00	AV1	32	14.1	0.217	104.3	0.136	61.9
13	0.00	AV1	31	13.9	0.239	116.3	0.154	68.4
14	0.00	AV1	31	13.7	0.232	103.8	0.148	66.2
15	0.00	AV1	30	14.2	0.236	81.6	0.138	67.5
16	0.00	AV1	32	13.7	0.223	47.1	0.145	63.7
17	0.00	AV1	31	13.9	0.231	35.0	0.138	66.0
18	0.00	AV1	31	14.1	0.239	46.7	0.138	68.3
19	0.00	AV1	32	13.5	0.227	47.0	0.149	64.8
20	0.00	AV1	31	14.1	0.237	47.0	0.140	67.7
21	0.00	AV1	31	14.5	0.247	46.9	0.139	70.6
22	0.00	AV1	31	13.5	0.229	47.0	0.144	65.5
23	0.00	AV1	32	13.7	0.238	46.9	0.142	68.1
24	0.00	AV1	32	14.1	0.244	46.9	0.144	69.8
25	0.00	AV1	32	14.4	0.255	46.9	0.140	72.9
26	0.00	AV1	32	14.0	0.244	47.0	0.141	69.7
27	0.00	AV1	32	13.9	0.248	46.8	0.144	70.9

Time Summary

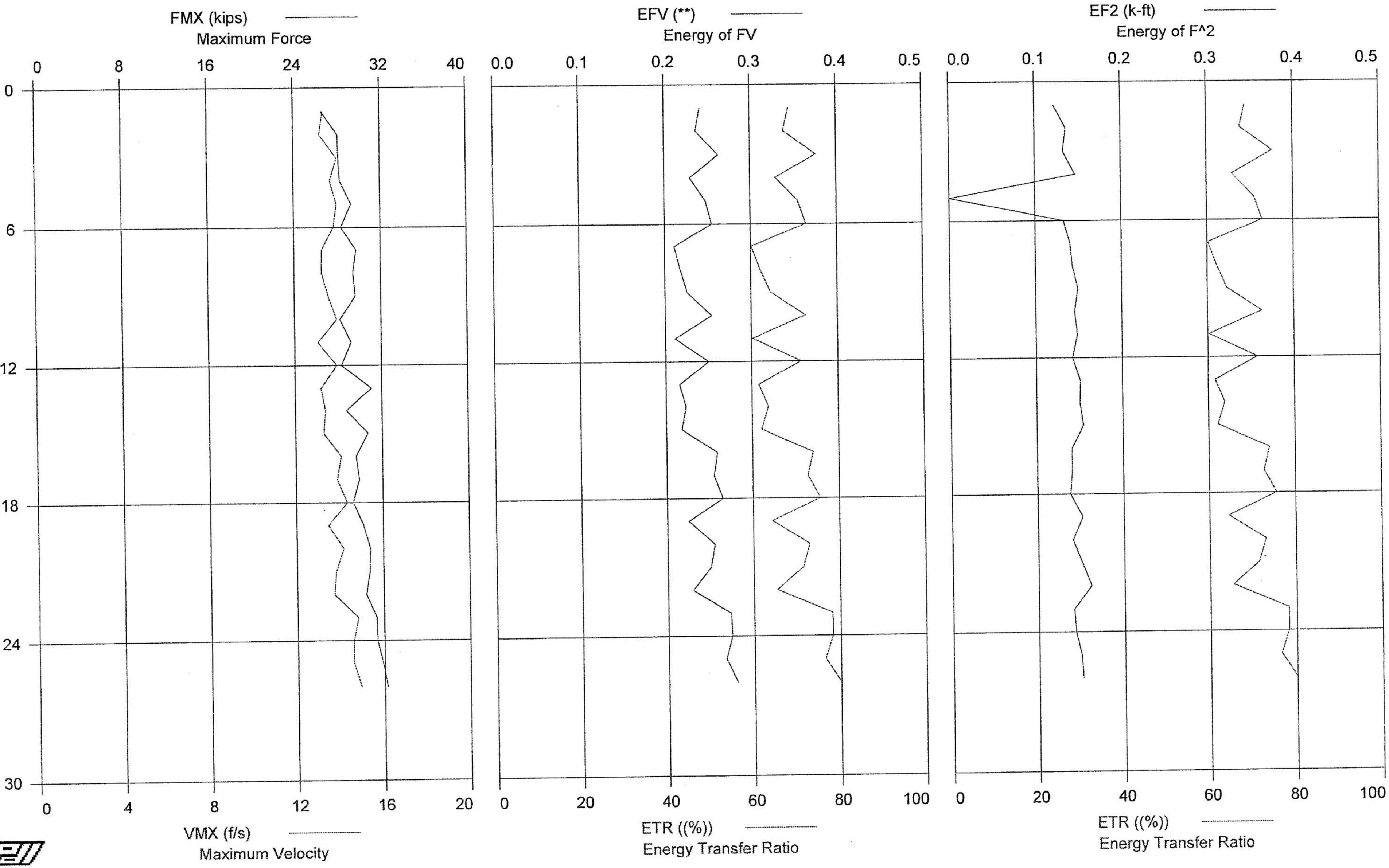
Drive 35 seconds 12:21:57 PM - 12:22:32 PM (9/7/2005)

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

Test date: 7-Sep-2005

PLANT VOGTLE - RIG 1 - B-1013-SS-13



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 1 - B-1013-SS-13
OP: SDW

SPT
Test date: 7-Sep-2005

AR: 2.30 in^2
LE: 34.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	27	13.4	0.242	57.4	0.122	69.0
2	0.00	AV1	28	13.2	0.237	47.6	0.136	67.7
3	0.00	AV1	28	14.0	0.263	46.7	0.133	75.3
4	0.00	AV1	28	13.7	0.230	47.2	0.147	65.8
5	0.00	AV1	29	14.0	0.248	47.1	0.000	71.0
6	0.00	AV1	28	13.8	0.255	47.4	0.133	72.8
7	0.00	AV1	30	13.3	0.211	47.0	0.140	60.2
8	0.00	AV1	29	13.3	0.218	47.4	0.143	62.2
9	0.00	AV1	30	13.6	0.226	46.9	0.149	64.5
10	0.00	AV1	28	13.9	0.254	46.9	0.145	72.6
11	0.00	AV1	29	13.1	0.211	47.2	0.148	60.3
12	0.00	AV1	28	13.9	0.250	46.4	0.142	71.5
13	0.00	AV1	31	13.2	0.216	46.6	0.151	61.6
14	0.00	AV1	29	13.4	0.223	46.8	0.150	63.8
15	0.00	AV1	31	13.3	0.218	46.8	0.154	62.2
16	0.00	AV1	30	14.1	0.259	47.0	0.140	74.0
17	0.00	AV1	30	13.9	0.255	46.9	0.140	72.7
18	0.00	AV1	29	14.4	0.265	46.7	0.138	75.6
19	0.00	AV1	30	13.5	0.225	47.0	0.152	64.4
20	0.00	AV1	31	14.2	0.255	47.1	0.140	73.0
21	0.00	AV1	31	13.8	0.250	47.1	0.151	71.4
22	0.00	AV1	30	13.7	0.229	46.9	0.161	65.4
23	0.00	AV1	31	14.8	0.273	47.1	0.141	78.1
24	0.00	AV1	31	14.6	0.274	46.8	0.143	78.2
25	0.00	AV1	32	14.6	0.267	46.7	0.149	76.4
26	0.00	AV1	32	14.9	0.280	46.8	0.151	79.9

Time Summary

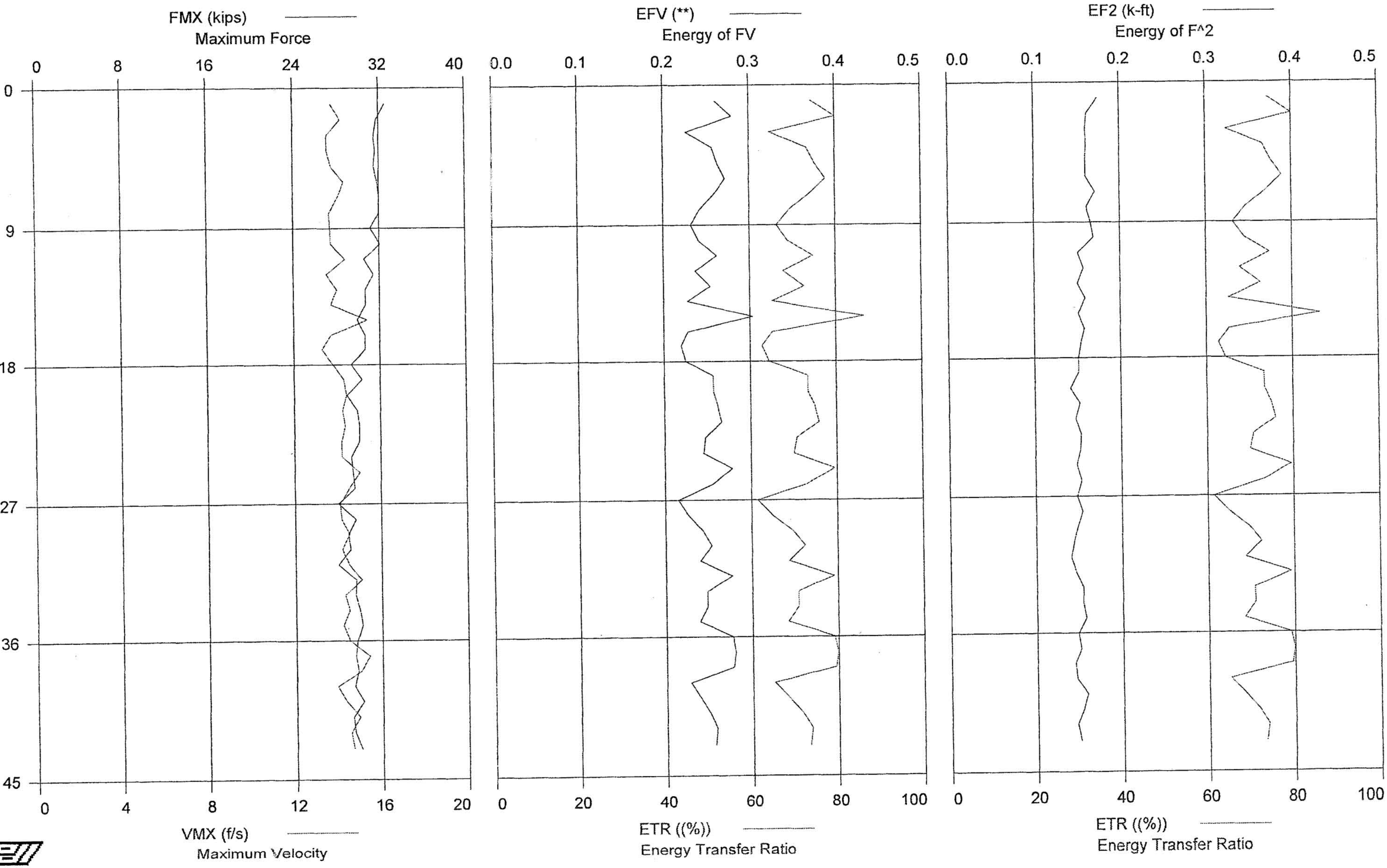
Drive 32 seconds 1:42:54 PM - 1:43:26 PM (9/7/2005)

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

PLANT VOGTLE - RIG 1 - B-1013-SS-14

Test date: 7-Sep-2005



Case Method Results PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 1 - B-1013-SS-14 SPT
OP: SDW Test date: 7-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 39.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	92.00	AV1	33	13.8	0.261	19.1	0.175	74.5
2	0.00	AV1	32	14.2	0.280	37.2	0.162	80.1
3	0.00	AV1	32	13.6	0.227	47.2	0.160	64.8
4	0.00	AV1	32	13.6	0.257	41.6	0.161	73.3
5	0.00	AV1	32	13.8	0.263	47.4	0.160	75.2
6	0.00	AV1	32	14.3	0.272	69.0	0.160	77.7
7	0.00	AV1	32	14.1	0.259	47.3	0.171	73.9
8	0.00	AV1	32	13.7	0.242	47.2	0.161	69.2
9	0.00	AV1	31	13.7	0.232	46.9	0.166	66.3
10	0.00	AV1	32	13.7	0.241	46.9	0.169	68.8
11	0.00	AV1	31	14.4	0.262	47.1	0.151	74.8
12	0.00	AV1	31	13.5	0.237	46.9	0.157	67.8
13	0.00	AV1	31	14.0	0.254	46.7	0.150	72.6
14	0.00	AV1	31	13.7	0.228	46.9	0.159	65.2
15	0.00	AV1	30	15.4	0.303	46.5	0.151	86.5
16	0.00	AV1	31	13.7	0.228	46.5	0.158	65.2
17	0.00	AV1	31	13.3	0.220	46.8	0.154	62.8
18	0.00	AV1	29	13.8	0.225	46.2	0.151	64.4
19	0.00	AV1	30	14.3	0.257	46.7	0.151	73.3
20	0.00	AV1	29	14.4	0.257	46.1	0.141	73.4
21	0.00	AV1	30	14.2	0.262	46.6	0.152	74.9
22	0.00	AV1	30	14.4	0.266	46.4	0.147	75.9
23	0.00	AV1	30	14.2	0.247	46.3	0.153	70.7
24	0.00	AV1	29	14.2	0.245	45.8	0.152	70.0
25	0.00	AV1	29	15.0	0.278	46.3	0.148	79.4
26	0.00	AV1	30	14.5	0.255	46.1	0.153	72.9
27	0.00	AV1	28	14.1	0.215	45.5	0.148	61.4
28	0.00	AV1	30	14.1	0.227	46.3	0.154	64.9
29	0.00	AV1	29	14.5	0.243	46.3	0.148	69.5
30	0.00	AV1	29	14.2	0.253	45.9	0.144	72.4
31	0.00	AV1	28	14.5	0.240	45.6	0.140	68.6
32	0.00	AV1	30	15.1	0.277	46.1	0.146	79.1
33	0.00	AV1	30	14.3	0.248	46.0	0.154	70.7
34	0.00	AV1	30	14.5	0.248	45.9	0.154	70.8
35	0.00	AV1	30	14.2	0.239	45.8	0.157	68.3
36	0.00	AV1	30	14.5	0.277	45.3	0.148	79.1
37	0.00	AV1	30	15.4	0.280	45.5	0.151	79.9
38	0.00	AV1	30	15.0	0.278	45.7	0.144	79.4
39	0.00	AV1	29	13.9	0.228	45.8	0.146	65.0
40	0.00	AV1	30	14.3	0.239	45.8	0.158	68.3
41	0.00	AV1	29	14.9	0.250	45.7	0.153	71.6
42	0.00	AV1	29	14.5	0.258	45.9	0.146	73.7
43	848.00	AV1	30	14.6	0.256	45.6	0.150	73.2

Time Summary

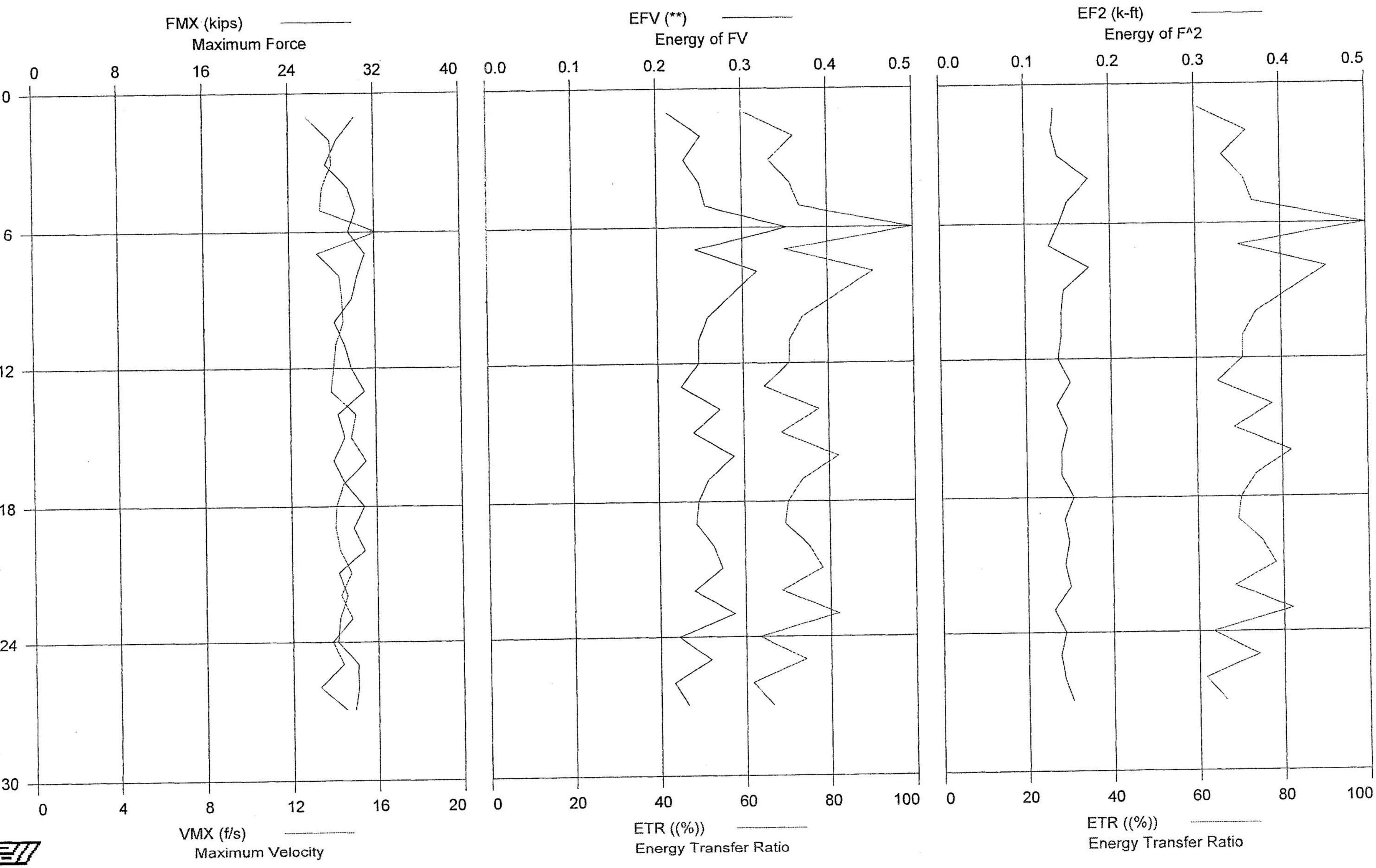
Drive 1 minute 1:57:14 PM - 1:58:14 PM (9/7/2005)

GRL Engineers, Inc. - Case Method Results

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

Test date: 7-Sep-2005

PLANT VOGTLE - RIG 1 - B-1013-SS-15



PLANT VOGTLE - RIG 1 - B-1013-SS-15 SPT
OP: SDW Test date: 7-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 44.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	30	12.8	0.213	105.8	0.135	60.8
2	0.00	AV1	29	14.0	0.252	46.8	0.132	72.1
3	0.00	AV1	27	14.0	0.232	46.7	0.139	66.3
4	0.00	AV1	30	13.6	0.250	98.7	0.175	71.4
5	0.00	AV1	30	13.5	0.257	81.5	0.150	73.5
6	0.00	AV1	30	16.1	0.353	127.9	0.140	100.8
7	0.00	AV1	31	13.3	0.245	47.0	0.128	70.0
8	0.00	AV1	30	14.4	0.317	80.9	0.175	90.7
9	0.00	AV1	30	14.5	0.288	38.3	0.145	82.4
10	0.00	AV1	28	14.5	0.259	46.4	0.142	74.0
11	0.00	AV1	29	14.2	0.248	46.2	0.142	71.0
12	0.00	AV1	30	14.0	0.248	46.2	0.138	70.8
13	0.00	AV1	31	13.9	0.227	46.3	0.152	64.9
14	0.00	AV1	28	15.1	0.272	46.6	0.136	77.7
15	0.00	AV1	29	14.8	0.241	46.4	0.148	68.8
16	0.00	AV1	28	15.5	0.288	45.9	0.141	82.1
17	0.00	AV1	29	14.5	0.258	46.4	0.141	73.7
18	0.00	AV1	31	14.1	0.246	45.8	0.155	70.3
19	0.00	AV1	30	14.1	0.243	46.0	0.144	69.5
20	0.00	AV1	31	14.3	0.263	45.9	0.149	75.1
21	0.00	AV1	28	14.8	0.273	46.2	0.144	78.1
22	0.00	AV1	29	14.3	0.240	45.5	0.150	68.5
23	0.00	AV1	28	14.8	0.287	45.9	0.131	82.0
24	0.00	AV1	28	13.9	0.222	45.9	0.144	63.3
25	0.00	AV1	30	14.4	0.259	45.5	0.138	74.1
26	0.00	AV1	30	13.3	0.216	46.3	0.143	61.6
27	0.00	AV1	30	14.5	0.232	45.1	0.152	66.3

Time Summary

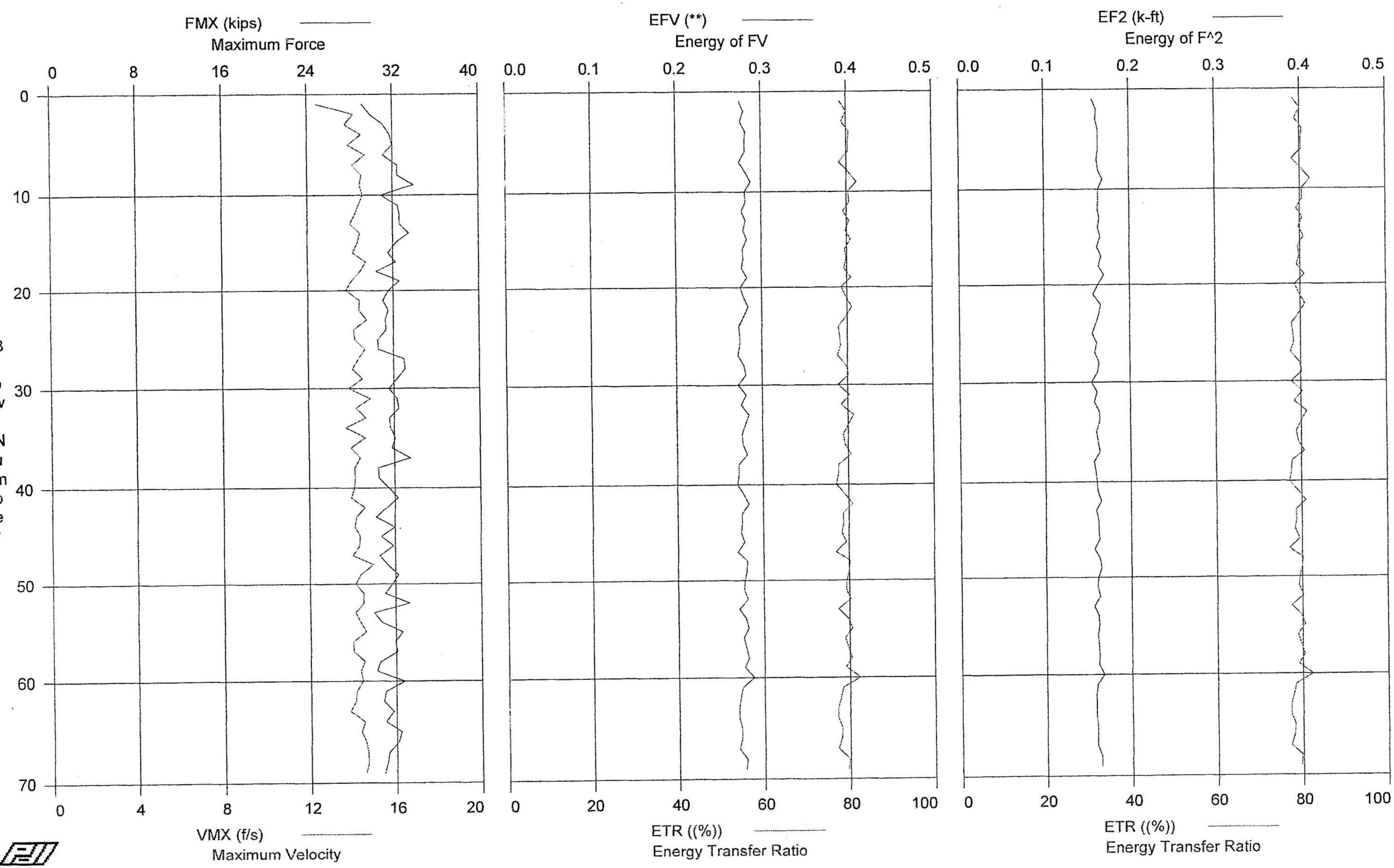
Drive 37 seconds 2:07:11 PM - 2:07:48 PM (9/7/2005)

DIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

Test date: 6-Sep-2005

PLANT VOGTLE - RIG 1 - B-1008-SS-26



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 1 - B-1008-SS-26 SPT
OP: SDW Test date: 6-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 104.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	29	12.4	0.275	**	0.157	78.5
2	0.00	AV1	30	14.2	0.280	51.1	0.162	80.0
3	0.00	AV1	31	13.8	0.276	46.7	0.161	78.8
4	0.00	AV1	32	14.5	0.282	46.2	0.164	80.6
5	0.00	AV1	32	13.9	0.281	46.6	0.164	80.3
6	0.00	AV1	31	14.7	0.281	46.4	0.164	80.4
7	0.00	AV1	32	14.1	0.274	46.4	0.162	78.2
8	0.00	AV1	32	14.5	0.282	46.6	0.164	80.4
9	0.00	AV1	34	14.5	0.288	46.6	0.169	82.3
10	0.00	AV1	31	14.6	0.281	46.5	0.164	80.4
11	0.00	AV1	32	14.4	0.282	46.0	0.164	80.6
12	0.00	AV1	33	14.2	0.277	46.3	0.163	79.2
13	0.00	AV1	33	14.0	0.282	46.2	0.165	80.6
14	0.00	AV1	33	14.4	0.279	46.3	0.163	79.7
15	0.00	AV1	32	14.3	0.283	46.0	0.166	80.9
16	0.00	AV1	32	14.1	0.278	46.2	0.162	79.5
17	0.00	AV1	32	14.7	0.279	45.9	0.167	79.8
18	0.00	AV1	30	14.5	0.277	45.8	0.164	79.3
19	0.00	AV1	33	14.0	0.283	46.1	0.170	81.0
20	0.00	AV1	32	13.8	0.275	45.7	0.163	78.7
21	0.00	AV1	31	14.4	0.279	45.9	0.157	79.7
22	0.00	AV1	32	14.4	0.284	45.7	0.166	81.1
23	0.00	AV1	31	14.7	0.279	45.6	0.164	79.7
24	0.00	AV1	31	14.1	0.273	45.5	0.160	77.9
25	0.00	AV1	31	14.2	0.274	45.6	0.156	78.2
26	0.00	AV1	31	14.6	0.274	45.6	0.161	78.4
27	0.00	AV1	33	14.4	0.272	45.2	0.159	77.6
28	0.00	AV1	33	14.1	0.279	45.8	0.164	79.7
29	0.00	AV1	32	14.5	0.281	45.1	0.162	80.3
30	0.00	AV1	32	13.9	0.272	45.4	0.155	77.8
31	0.00	AV1	32	14.9	0.281	45.2	0.161	80.3
32	0.00	AV1	32	14.2	0.275	45.5	0.158	78.4
33	0.00	AV1	32	14.7	0.284	45.4	0.164	81.3
34	0.00	AV1	32	13.7	0.280	45.2	0.164	80.1
35	0.00	AV1	32	14.6	0.276	45.6	0.160	78.8
36	0.00	AV1	32	14.0	0.277	45.5	0.162	79.2
37	0.00	AV1	33	14.4	0.282	45.7	0.164	80.6
38	0.00	AV1	30	14.1	0.272	45.1	0.157	77.7
39	0.00	AV1	31	14.2	0.272	45.7	0.159	77.6
40	0.00	AV1	31	14.1	0.270	45.5	0.160	77.1
41	0.00	AV1	32	14.0	0.277	45.0	0.161	79.1
42	0.00	AV1	31	14.6	0.283	45.6	0.165	80.9
43	0.00	AV1	30	14.2	0.275	44.6	0.159	78.6
44	0.00	AV1	32	14.1	0.275	45.4	0.162	78.7
45	0.00	AV1	31	14.4	0.274	44.8	0.162	78.3
46	0.00	AV1	32	14.3	0.278	45.2	0.163	79.4
47	0.00	AV1	31	14.0	0.270	45.3	0.157	77.0
48	0.00	AV1	31	15.0	0.281	45.1	0.163	80.2
49	0.00	AV1	32	14.4	0.280	44.8	0.165	79.9
50	0.00	AV1	32	14.1	0.278	44.3	0.161	79.4
51	0.00	AV1	31	14.5	0.277	44.8	0.160	79.3
52	0.00	AV1	33	14.5	0.281	45.1	0.163	80.2
53	0.00	AV1	30	14.1	0.271	44.4	0.156	77.4
54	0.00	AV1	31	14.3	0.279	45.0	0.161	79.6
55	0.00	AV1	33	14.6	0.282	45.0	0.162	80.6
56	0.00	AV1	32	14.0	0.276	44.5	0.160	78.9
57	0.00	AV1	32	14.0	0.279	44.7	0.161	79.7
58	0.00	AV1	31	14.5	0.282	44.9	0.162	80.5
59	0.00	AV1	30	14.3	0.277	44.7	0.161	79.1
60	0.00	AV1	33	14.4	0.288	44.8	0.167	82.4
61	0.00	AV1	31	14.1	0.274	44.6	0.159	78.4
62	0.00	AV1	31	14.1	0.272	44.7	0.158	77.9

PLANT VOGTLE - RIG 1 - B-1008-SS-26 SPT
OP: SDW Test date: 6-Sep-2005

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
64	0.00	AV1	31	14.5	0.270	44.7	0.158	77.2
65	0.00	AV1	32	14.4	0.273	44.6	0.159	78.1
66	0.00	AV1	32	14.6	0.273	45.0	0.159	78.0
67	0.00	AV1	31	14.7	0.270	44.6	0.159	77.2
68	0.00	AV1	31	14.7	0.279	44.7	0.164	79.8
69	0.00	AV1	31	14.6	0.278	44.4	0.164	79.5

Time Summary

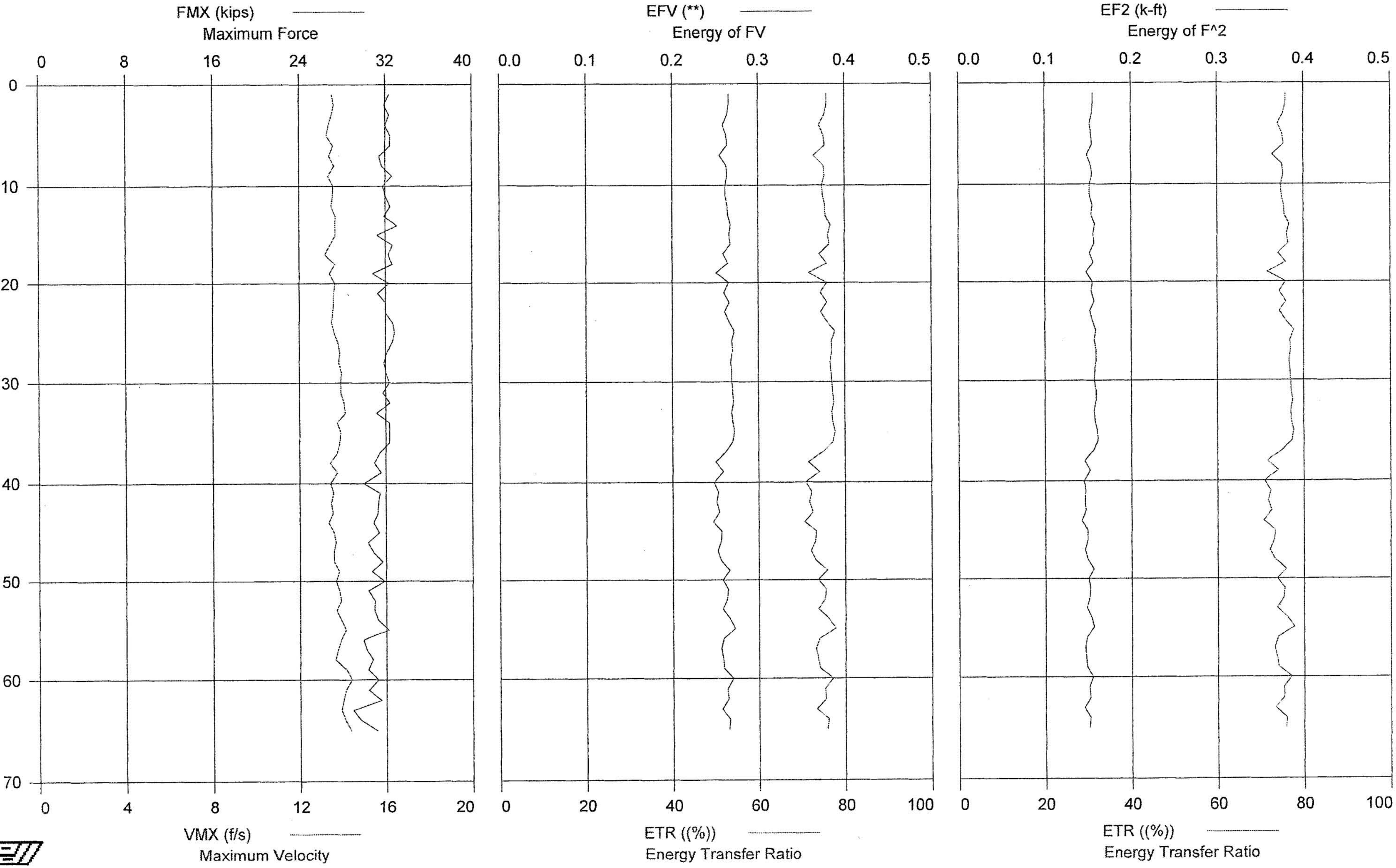
Drive 1 minute 30 seconds 3:22:58 PM - 3:24:28 PM (9/6/2005)

GRL Engineers, Inc. - Case Method Results

IPLOT Ver. 2005.1 - Printed: 8-Sep-2005

Test date: 6-Sep-2005

PLANT VOGTLE - RIG 1 - B-1008-SS-27



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 1 - B-1008-SS-27
OP: SDW

SPT
Test date: 6-Sep-2005

AR: 2.30 in^2
LE: 109.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	32	13.5	0.266	**	0.156	75.9
2	0.00	AV1	32	13.6	0.266	47.0	0.156	75.9
3	0.00	AV1	32	13.5	0.264	47.0	0.155	75.4
4	0.00	AV1	32	13.4	0.259	47.0	0.152	74.1
5	0.00	AV1	32	13.3	0.263	46.8	0.154	75.1
6	0.00	AV1	32	13.6	0.264	46.8	0.155	75.5
7	0.00	AV1	31	13.4	0.255	46.9	0.149	72.9
8	0.00	AV1	32	13.6	0.263	46.6	0.153	75.1
9	0.00	AV1	33	13.3	0.264	46.7	0.155	75.4
10	0.00	AV1	32	13.6	0.262	46.7	0.152	74.8
11	0.00	AV1	32	13.6	0.262	46.7	0.152	75.0
12	0.00	AV1	32	13.5	0.264	46.3	0.155	75.4
13	0.00	AV1	32	13.7	0.265	46.3	0.154	75.6
14	0.00	AV1	33	13.7	0.268	46.2	0.158	76.7
15	0.00	AV1	31	13.7	0.266	45.7	0.156	76.1
16	0.00	AV1	33	13.4	0.268	46.4	0.157	76.5
17	0.00	AV1	32	13.2	0.259	46.3	0.152	74.1
18	0.00	AV1	33	13.7	0.265	45.9	0.156	75.8
19	0.00	AV1	31	13.4	0.251	45.7	0.148	71.7
20	0.00	AV1	32	13.7	0.266	45.9	0.155	75.9
21	0.00	AV1	31	13.6	0.260	45.8	0.154	74.4
22	0.00	AV1	32	13.6	0.266	46.0	0.157	75.9
23	0.00	AV1	32	13.6	0.261	45.9	0.152	74.5
24	0.00	AV1	33	13.5	0.266	45.6	0.155	75.9
25	0.00	AV1	33	13.6	0.272	46.1	0.159	77.7
26	0.00	AV1	33	13.8	0.269	45.3	0.157	76.9
27	0.00	AV1	32	13.9	0.270	45.9	0.159	77.0
28	0.00	AV1	32	13.8	0.268	45.0	0.159	76.6
29	0.00	AV1	32	14.0	0.269	45.6	0.158	76.8
30	0.00	AV1	32	13.9	0.269	45.3	0.157	77.0
31	0.00	AV1	32	13.9	0.270	45.6	0.159	77.1
32	0.00	AV1	32	14.1	0.271	44.9	0.159	77.5
33	0.00	AV1	31	14.1	0.269	45.1	0.157	77.0
34	0.00	AV1	32	13.7	0.270	45.0	0.158	77.2
35	0.00	AV1	32	13.9	0.272	44.7	0.160	77.7
36	0.00	AV1	32	13.9	0.270	45.3	0.161	77.2
37	0.00	AV1	31	13.8	0.262	45.3	0.156	75.0
38	0.00	AV1	31	13.4	0.250	44.8	0.146	71.5
39	0.00	AV1	32	13.7	0.259	45.6	0.152	74.0
40	0.00	AV1	30	13.4	0.248	45.1	0.145	70.9
41	0.00	AV1	31	13.6	0.253	45.2	0.147	72.3
42	0.00	AV1	31	13.5	0.251	45.0	0.146	71.7
43	0.00	AV1	31	13.5	0.254	45.1	0.147	72.5
44	0.00	AV1	31	13.3	0.247	45.1	0.142	70.6
45	0.00	AV1	31	13.6	0.257	45.4	0.149	73.3
46	0.00	AV1	30	13.7	0.256	45.2	0.149	73.1
47	0.00	AV1	31	13.6	0.252	45.2	0.146	72.1
48	0.00	AV1	32	13.6	0.256	45.7	0.149	73.2
49	0.00	AV1	31	13.8	0.266	45.0	0.156	75.9
50	0.00	AV1	32	13.7	0.258	44.9	0.150	73.7
51	0.00	AV1	30	13.8	0.264	44.7	0.152	75.5
52	0.00	AV1	31	13.9	0.263	45.1	0.151	75.2
53	0.00	AV1	31	13.7	0.258	44.6	0.148	73.8
54	0.00	AV1	31	13.9	0.266	45.6	0.153	76.1
55	0.00	AV1	32	14.1	0.272	45.0	0.156	77.7
56	0.00	AV1	30	13.9	0.259	45.1	0.148	74.0
57	0.00	AV1	30	13.8	0.256	45.4	0.146	73.1
58	0.00	AV1	31	13.6	0.258	45.5	0.147	73.6
59	0.00	AV1	30	14.1	0.259	45.2	0.148	74.1
60	0.00	AV1	31	14.4	0.270	44.7	0.155	77.1
61	0.00	AV1	30	14.1	0.263	46.0	0.151	75.3
62	0.00	AV1	32	14.0	0.264	45.6	0.152	75.4
[illegible]	[illegible]	AV1	30	13.9	0.257	45.2	0.145	73.3

PLANT VOGTLE - RIG 1 - B-1008-SS-27 SPT
OP: SDW Test date: 6-Sep-2005

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
64	0.00	AV1	30	14.1	0.266	45.8	0.152	76.0
65	0.00	AV1	31	14.4	0.265	44.5	0.151	75.8

Time Summary

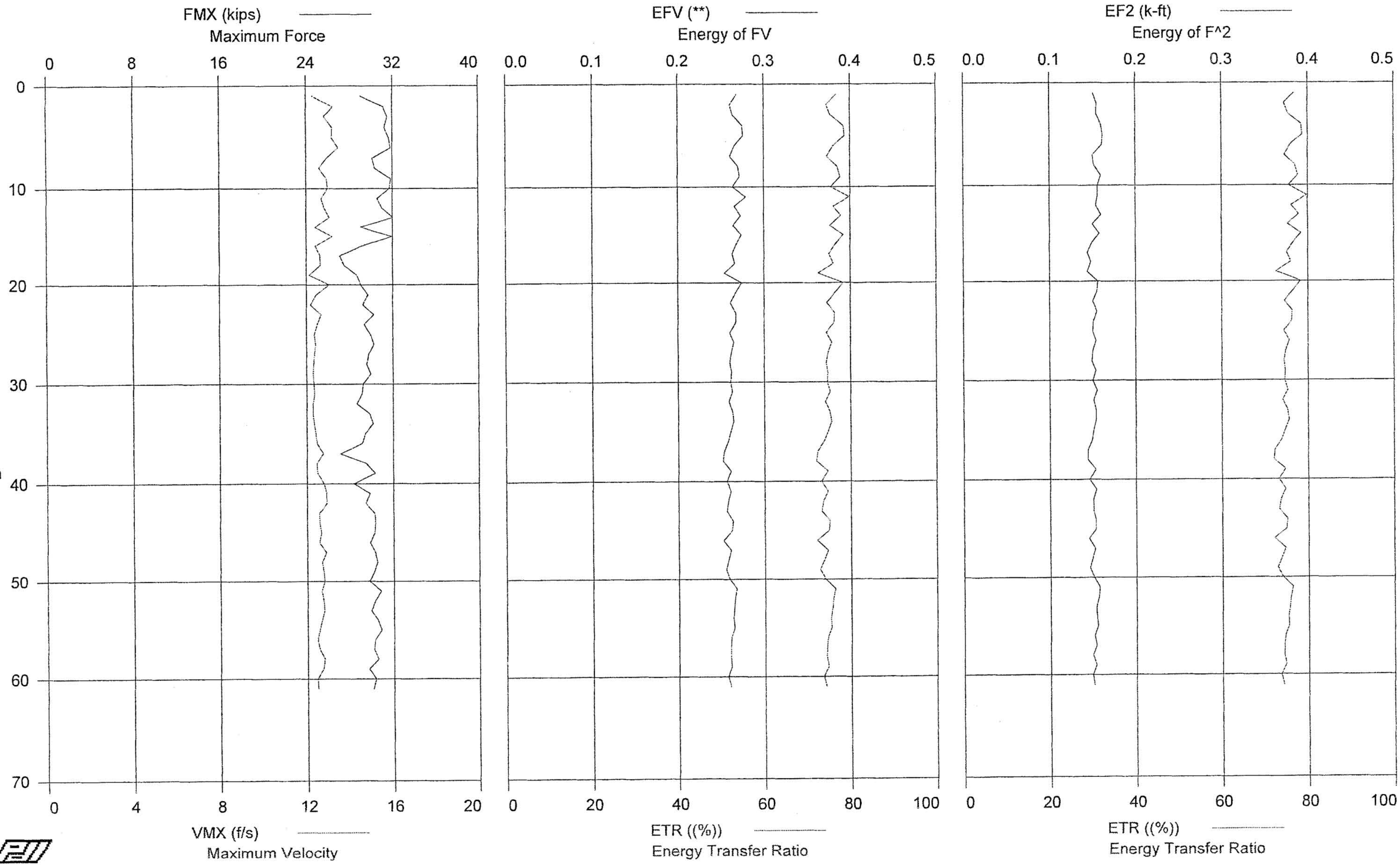
Drive 1 minute 24 seconds 3:45:17 PM - 3:46:41 PM (9/6/2005)

GRL Engineers, Inc. - Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

Test date: 6-Sep-2005

PLANT VOGTLE - RIG 1 - B-1008-SS-28



PLANT VOGTLE - RIG 1 - B-1008-SS-28 SPT
OP: SDW Test date: 6-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 114.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	29	12.3	0.269	**	0.151	76.8
2	0.00	AV1	31	13.2	0.261	47.3	0.155	74.5
3	0.00	AV1	32	12.8	0.264	47.3	0.155	75.5
4	0.00	AV1	31	13.2	0.275	23.5	0.160	78.5
5	0.00	AV1	32	13.2	0.276	46.2	0.162	78.8
6	0.00	AV1	32	13.5	0.266	47.3	0.161	76.0
7	0.00	AV1	30	12.9	0.261	23.4	0.150	74.6
8	0.00	AV1	30	12.6	0.270	47.1	0.152	77.1
9	0.00	AV1	32	12.9	0.272	23.3	0.160	77.7
10	0.00	AV1	32	13.0	0.264	46.4	0.156	75.6
11	0.00	AV1	31	12.7	0.279	**	0.156	79.8
12	0.00	AV1	31	12.8	0.266	46.2	0.154	76.1
13	0.00	AV1	32	13.1	0.273	**	0.160	77.9
14	0.00	AV1	29	12.4	0.264	45.8	0.150	75.3
15	0.00	AV1	32	13.2	0.274	**	0.158	78.4
16	0.00	AV1	29	12.4	0.268	45.6	0.149	76.5
17	0.00	AV1	27	12.6	0.263	45.4	0.144	75.1
18	0.00	AV1	27	12.6	0.266	**	0.148	76.0
19	0.00	AV1	29	12.1	0.254	22.7	0.144	72.6
20	0.00	AV1	29	13.1	0.274	45.1	0.156	78.3
21	0.00	AV1	30	12.4	0.267	45.2	0.155	76.4
22	0.00	AV1	29	12.2	0.261	**	0.150	74.5
23	0.00	AV1	30	12.7	0.267	22.6	0.155	76.3
24	0.00	AV1	29	12.5	0.267	45.0	0.151	76.2
25	0.00	AV1	30	12.4	0.260	22.6	0.150	74.4
26	0.00	AV1	30	12.4	0.265	44.8	0.154	75.6
27	0.00	AV1	30	12.4	0.262	45.1	0.150	74.8
28	0.00	AV1	30	12.3	0.260	22.7	0.149	74.4
29	0.00	AV1	30	12.3	0.262	22.7	0.154	74.7
30	0.00	AV1	29	12.3	0.261	45.4	0.150	74.5
31	0.00	AV1	29	12.4	0.263	22.6	0.155	75.3
32	0.00	AV1	29	12.3	0.259	45.2	0.151	74.1
33	0.00	AV1	30	12.3	0.263	45.7	0.154	75.2
34	0.00	AV1	30	12.3	0.264	45.6	0.154	75.6
35	0.00	AV1	29	12.4	0.261	22.7	0.151	74.7
36	0.00	AV1	29	12.5	0.258	22.8	0.149	73.8
37	0.00	AV1	27	12.7	0.253	**	0.144	72.3
38	0.00	AV1	29	12.5	0.252	45.6	0.144	72.0
39	0.00	AV1	30	12.5	0.261	45.6	0.153	74.7
40	0.00	AV1	28	12.8	0.256	45.1	0.146	73.2
41	0.00	AV1	30	12.9	0.261	45.8	0.154	74.7
42	0.00	AV1	29	12.9	0.258	45.7	0.150	73.6
43	0.00	AV1	30	12.6	0.256	45.5	0.150	73.1
44	0.00	AV1	30	12.6	0.263	46.1	0.153	75.1
45	0.00	AV1	30	12.6	0.262	45.6	0.153	74.9
46	0.00	AV1	30	12.5	0.252	45.6	0.145	72.1
47	0.00	AV1	30	12.9	0.261	45.4	0.152	74.6
48	0.00	AV1	30	12.7	0.258	45.6	0.149	73.8
49	0.00	AV1	30	12.7	0.255	45.7	0.146	72.8
50	0.00	AV1	30	12.8	0.259	46.0	0.151	74.0
51	0.00	AV1	31	12.6	0.267	46.0	0.157	76.2
52	0.00	AV1	30	12.7	0.265	45.3	0.156	75.8
53	0.00	AV1	30	12.8	0.264	46.0	0.153	75.6
54	0.00	AV1	31	12.6	0.263	45.3	0.154	75.3
55	0.00	AV1	31	12.5	0.264	46.0	0.155	75.3
56	0.00	AV1	30	12.4	0.261	45.8	0.151	74.5
57	0.00	AV1	30	12.6	0.260	45.8	0.153	74.3
58	0.00	AV1	31	12.8	0.260	45.9	0.149	74.2
59	0.00	AV1	30	12.7	0.261	45.9	0.153	74.6
60	0.00	AV1	30	12.4	0.257	45.9	0.149	73.6
61	0.00	AV1	30	12.5	0.260	45.9	0.151	74.2

PLANT VOGTLE - RIG 1 - B-1008-SS-28
SPT
OP: SDW
Test date: 6-Sep-2005

	FMX	VMX	EFV	BPM	EF2	ETR
	kips	f/s	**	**	k-ft	(%)
Average	30	12.6	0.263	41.1	0.152	75.2

Total number of blows analyzed: 61

Time Summary

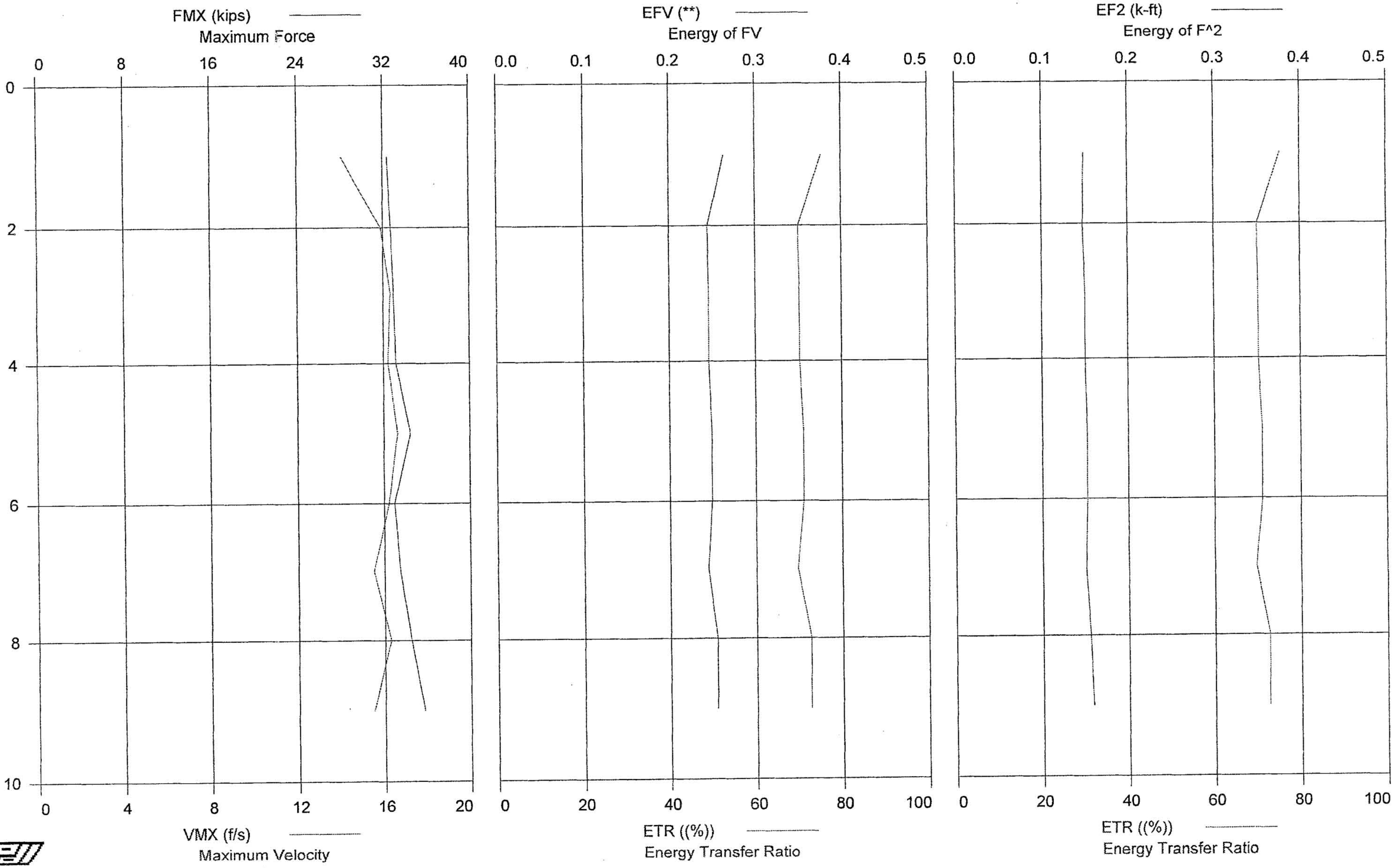
Drive 1 minute 58 seconds 4:09:03 PM - 4:11:01 PM (9/6/2005)

GRL Engineers, Inc. - Case Method Results

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

Test date: 6-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-7



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-7
OP: SDW

SPT
Test date: 6-Sep-2005

AR: 2.30 in^2
LE: 14.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	32	14.1	0.264	**	0.149	75.4
2	0.00	AV1	33	15.9	0.245	53.0	0.148	70.0
3	0.00	AV1	33	16.3	0.246	52.4	0.150	70.2
4	0.00	AV1	33	16.2	0.246	52.3	0.150	70.3
5	0.00	AV1	34	16.6	0.249	52.3	0.152	71.1
6	0.00	AV1	33	16.2	0.249	52.2	0.152	71.0
7	0.00	AV1	33	15.5	0.244	52.5	0.150	69.6
8	0.00	AV1	34	16.3	0.254	52.3	0.155	72.6
9	0.00	AV1	36	15.5	0.254	52.1	0.158	72.6

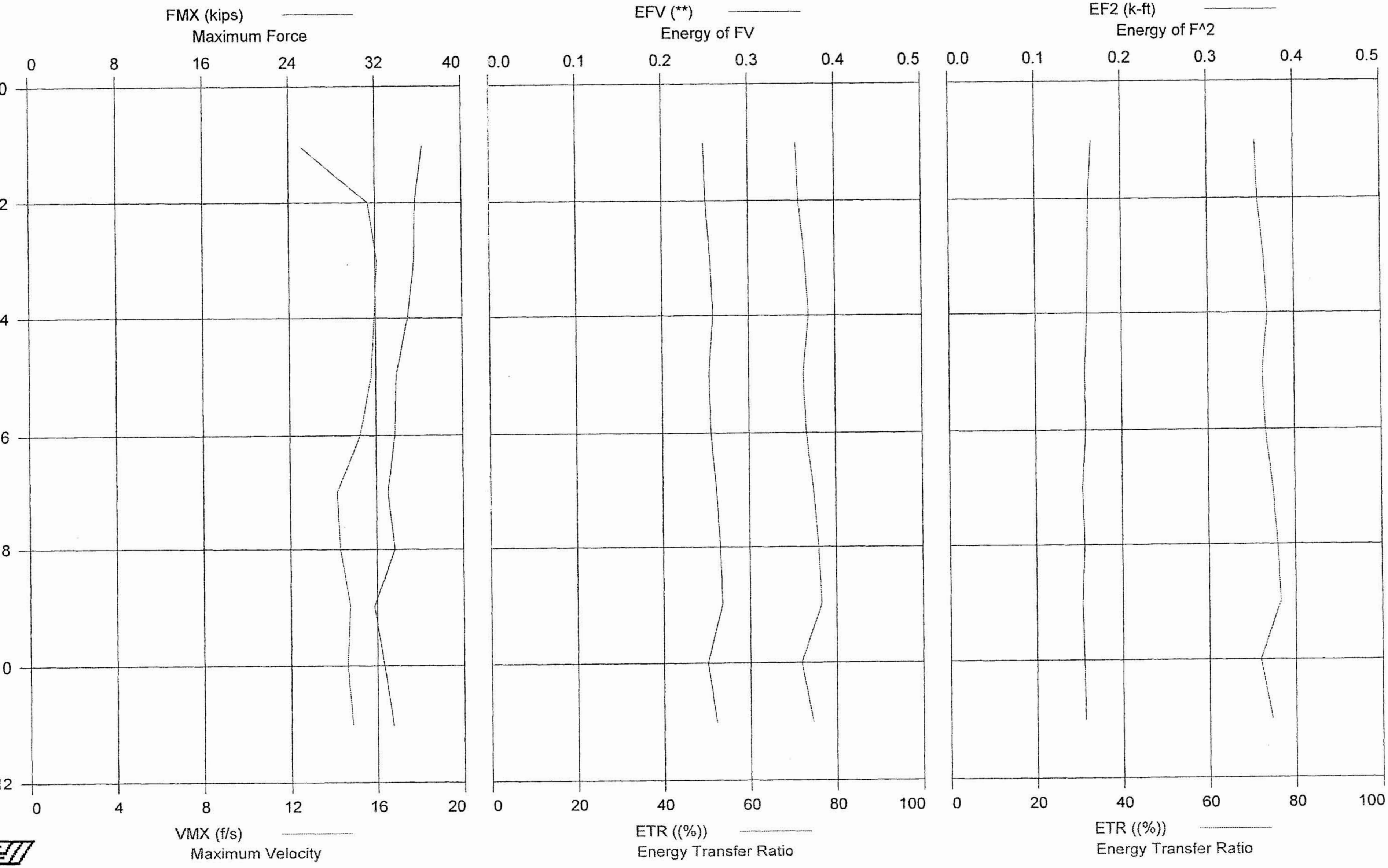
Time Summary
Drive 9 seconds 2:35:08 PM - 2:35:17 PM (9/6/2005)

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

PLANT VOGTLE - RIG 2 - B-1006-SS-8

Test date: 6-Sep-2005



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-8
OP: SDW

SPT
Test date: 6-Sep-2005

AR: 2.30 in^2
LE: 14.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	36	12.5	0.249	**	0.166	71.1
2	0.00	AV1	36	15.7	0.251	51.8	0.162	71.7
3	0.00	AV1	36	16.1	0.256	51.6	0.161	73.1
4	0.00	AV1	35	15.9	0.259	51.3	0.160	73.9
5	0.00	AV1	34	15.8	0.254	51.5	0.157	72.6
6	0.00	AV1	34	15.3	0.256	51.3	0.158	73.3
7	0.00	AV1	33	14.2	0.262	51.5	0.154	74.9
8	0.00	AV1	34	14.3	0.266	51.3	0.156	76.0
9	0.00	AV1	32	14.8	0.268	51.5	0.153	76.5
10	0.00	AV1	33	14.6	0.251	51.5	0.155	71.8
11	0.00	AV1	33	14.9	0.261	51.4	0.156	74.5

Time Summary

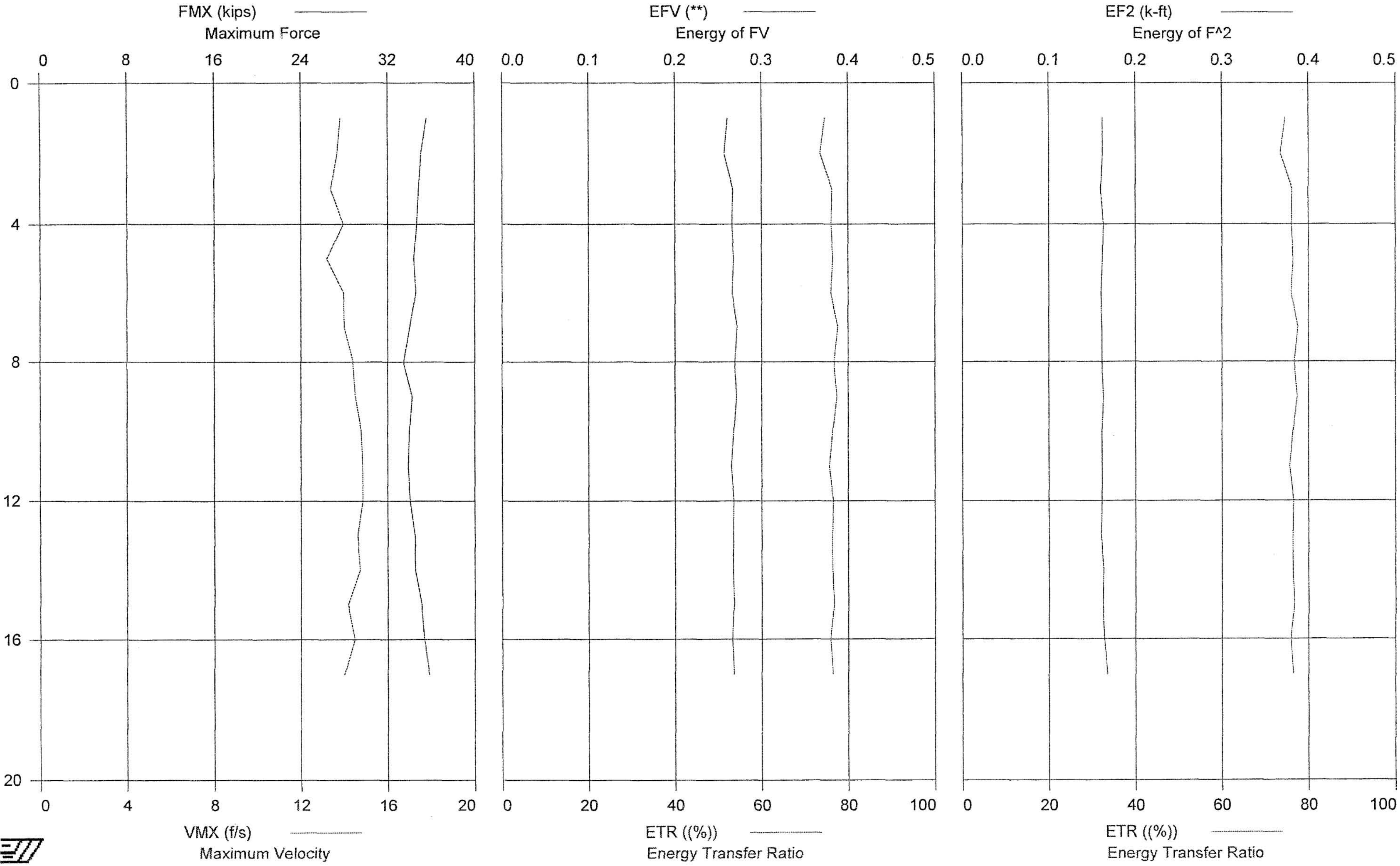
Drive 11 seconds 2:45:19 PM - 2:45:30 PM (9/6/2005)

GRL Engineers, Inc. - Case Method Results

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

Test date: 6-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-10



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-10 SPT
OP: SDW Test date: 6-Sep-2005

AR: 2.30 in^2
LE: 19.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	36	13.8	0.261	**	0.162	74.7
2	0.00	AV1	35	13.7	0.257	51.5	0.162	73.5
3	0.00	AV1	35	13.4	0.267	51.2	0.160	76.3
4	0.00	AV1	35	14.0	0.266	51.3	0.163	76.1
5	0.00	AV1	34	13.2	0.268	51.4	0.162	76.5
6	0.00	AV1	35	14.0	0.266	51.3	0.160	76.0
7	0.00	AV1	34	14.0	0.272	51.2	0.161	77.6
8	0.00	AV1	33	14.4	0.269	51.4	0.161	76.7
9	0.00	AV1	34	14.5	0.271	51.2	0.163	77.4
10	0.00	AV1	34	14.8	0.268	51.4	0.161	76.5
11	0.00	AV1	34	14.8	0.265	51.3	0.161	75.6
12	0.00	AV1	34	14.9	0.268	51.3	0.161	76.5
13	0.00	AV1	34	14.6	0.267	51.4	0.160	76.4
14	0.00	AV1	35	14.7	0.267	51.2	0.163	76.4
15	0.00	AV1	35	14.2	0.268	51.4	0.162	76.7
16	0.00	AV1	35	14.5	0.266	51.2	0.164	75.9
17	0.00	AV1	36	14.0	0.268	51.5	0.167	76.4

Time Summary

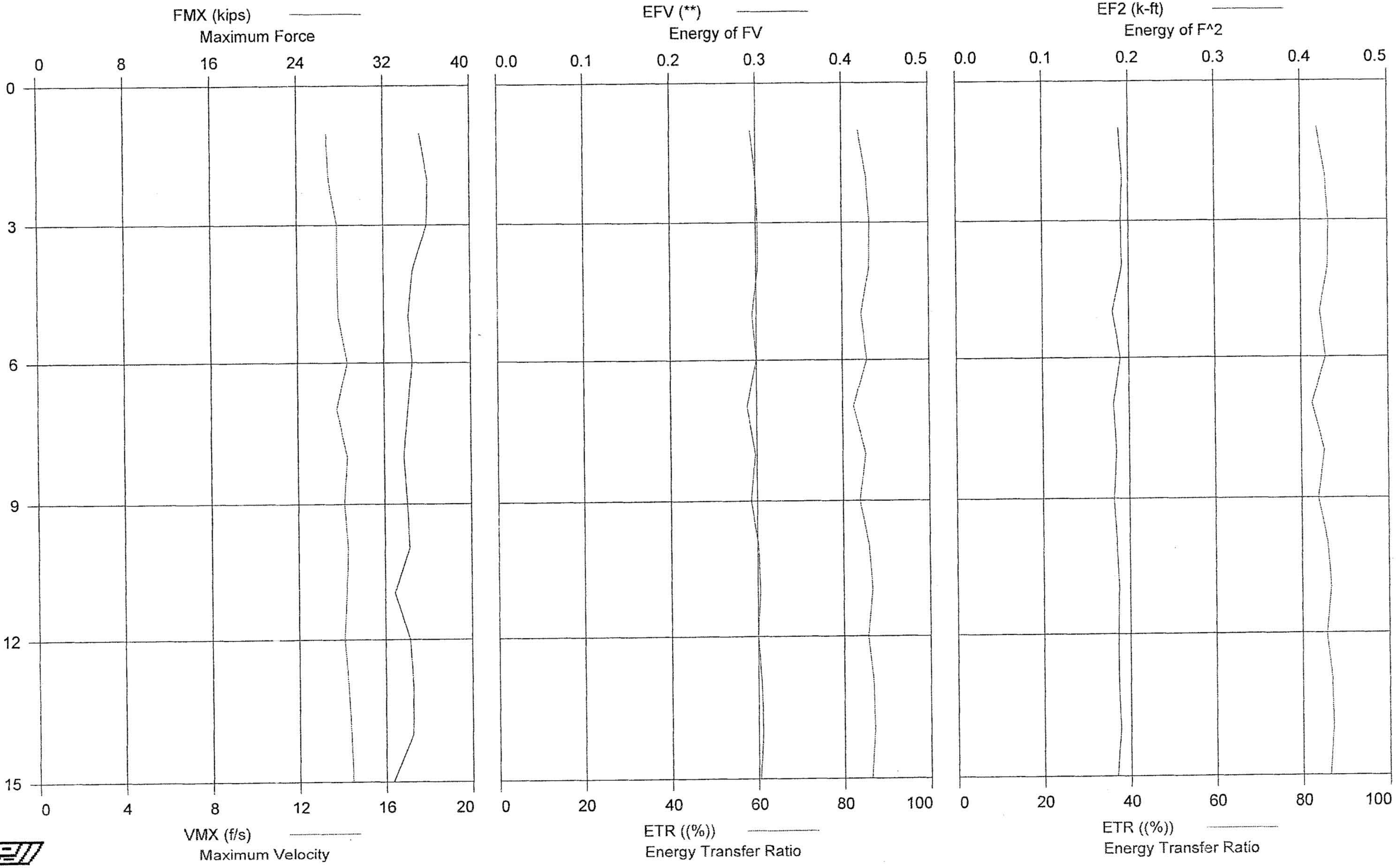
Drive 19 seconds 2:55:19 PM - 2:55:38 PM (9/6/2005)

GRL Engineers, Inc. - Case Method Results

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

Test date: 6-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-15



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-15 SPT
OP: SDW Test date: 6-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 44.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	35	13.4	0.294	**	0.189	83.9
2	0.00	AV1	36	13.5	0.300	52.7	0.193	85.7
3	0.00	AV1	36	13.9	0.302	51.8	0.191	86.4
4	0.00	AV1	35	13.9	0.302	51.8	0.192	86.2
5	0.00	AV1	34	13.9	0.295	51.6	0.181	84.4
6	0.00	AV1	35	14.3	0.300	52.0	0.190	85.6
7	0.00	AV1	34	13.8	0.289	51.7	0.182	82.5
8	0.00	AV1	34	14.3	0.298	51.7	0.185	85.3
9	0.00	AV1	34	14.1	0.293	51.9	0.182	83.8
10	0.00	AV1	34	14.3	0.301	51.8	0.185	85.9
11	0.00	AV1	33	14.2	0.303	51.7	0.187	86.7
12	0.00	AV1	34	14.1	0.300	51.8	0.186	85.6
13	0.00	AV1	35	14.3	0.304	51.8	0.186	86.8
14	0.00	AV1	34	14.4	0.305	51.8	0.188	87.0
15	0.00	AV1	33	14.5	0.302	51.8	0.184	86.3

Time Summary

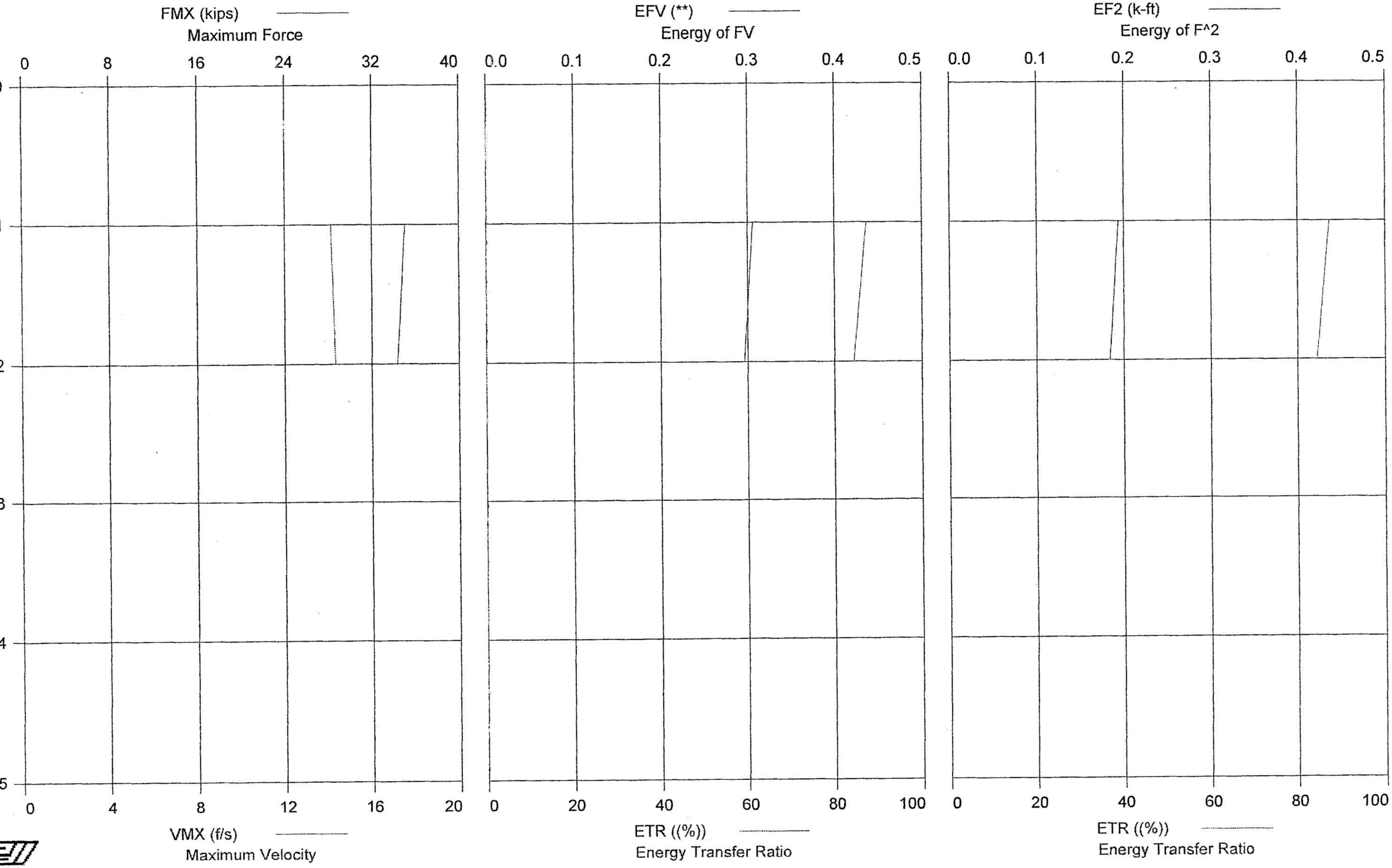
Drive 17 seconds 4:32:23 PM - 4:32:40 PM (9/6/2005)

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

PLANT VOGTLE - RIG 2 - B-1006-SS-16

Test date: 6-Sep-2005



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-16
OP: SDW

SPT
Test date: 6-Sep-2005

AR: 2.30 in^2
LE: 49.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL#	depth	TYPE	FMX	VMX	EFV	BPM	EF2	ETR
end	ft		kips	f/s	**	**	k-ft	(%)
1	0.00	AV1	35	14.1	0.306	**	0.194	87.3
2	0.00	AV1	34	14.3	0.296	54.3	0.184	84.4

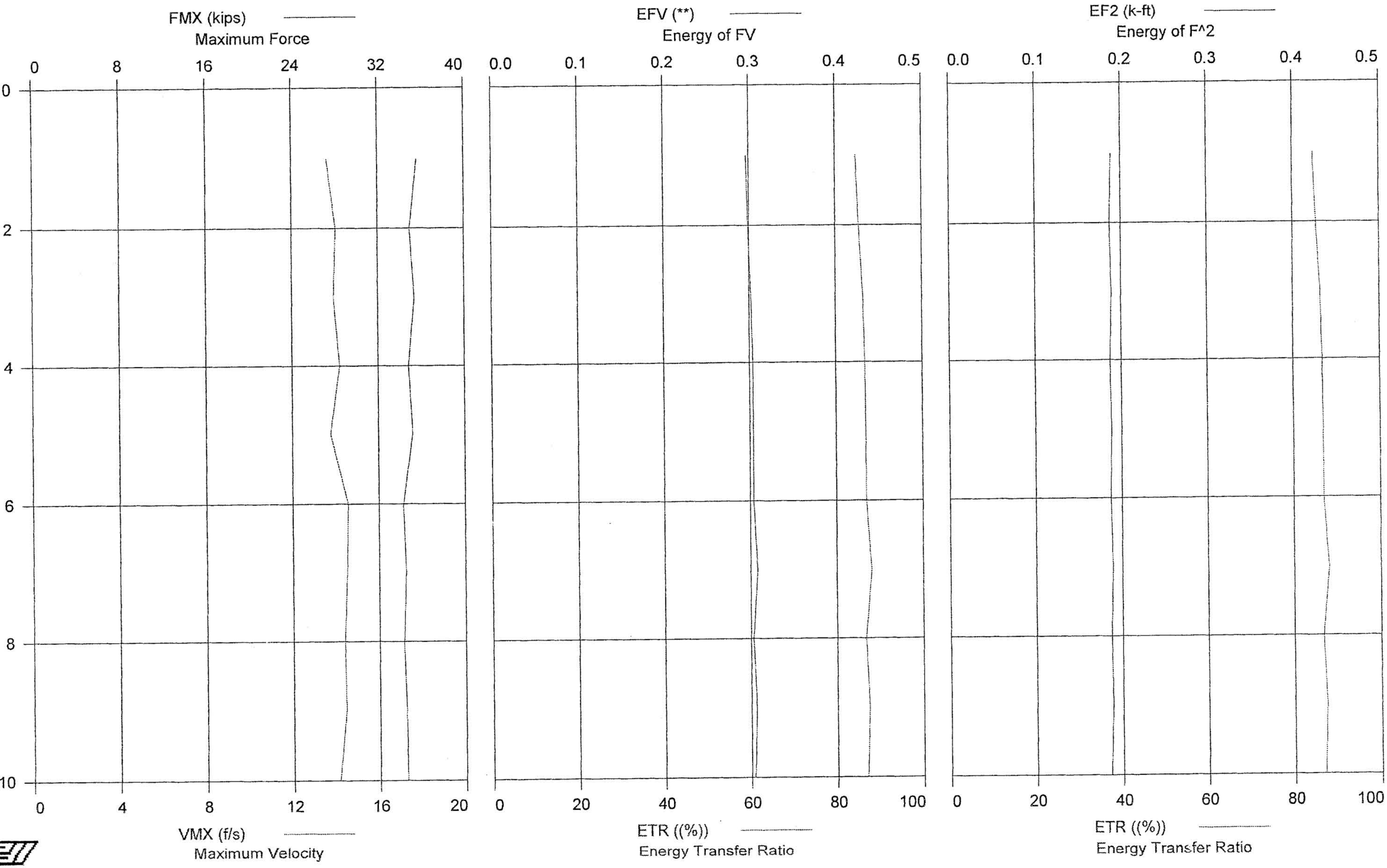
Time Summary
Drive 1 second 4:44:31 PM - 4:44:32 PM (9/6/2005)

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

PLANT VOGTLE - RIG 2 - B-1006-SS-17

Test date: 6-Sep-2005



PLANT VOGTLE - RIG 2 - B-1006-SS-17 SPT
OP: SDW Test date: 6-Sep-2005

AR: 2.30 in^2 SP: 0.492 k/ft3
LE: 54.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.70

FMX: Maximum Force BPM: Blows per Minute
VMX: Maximum Velocity EF2: Energy of F^2
EFV: Energy of FV ETR: Energy Transfer Ratio

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	36	13.6	0.297	**	0.189	84.8
2	0.00	AV1	35	14.1	0.299	50.8	0.187	85.4
3	0.00	AV1	35	13.9	0.302	50.6	0.189	86.3
4	0.00	AV1	35	14.2	0.304	50.4	0.187	86.8
5	0.00	AV1	35	13.8	0.304	50.5	0.188	86.8
6	0.00	AV1	34	14.6	0.304	50.3	0.187	86.9
7	0.00	AV1	34	14.5	0.308	51.7	0.189	88.0
8	0.00	AV1	34	14.4	0.303	51.8	0.187	86.6
9	0.00	AV1	34	14.4	0.306	51.8	0.188	87.4
10	0.00	AV1	35	14.1	0.304	52.0	0.186	86.9

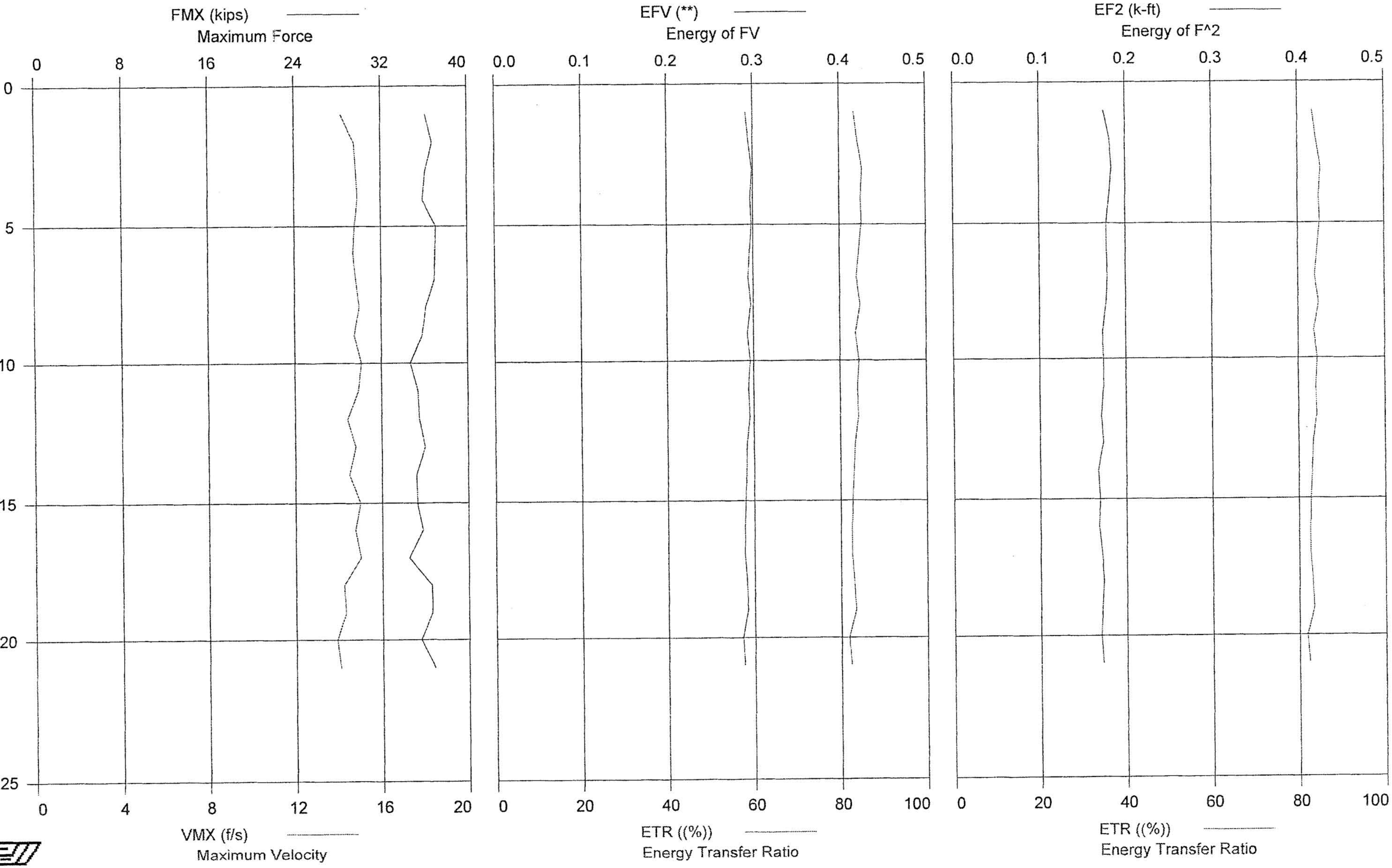
Time Summary
Drive 11 seconds 4:58:48 PM - 4:58:59 PM (9/6/2005)

GRL Engineers, Inc. - Case Method Results

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

Test date: 7-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-26



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-26
OP: SDW

SPT
Test date: 7-Sep-2005

AR: 2.30 in^2
LE: 99.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL#	depth	TYPE	FMX	VMX	EFV	BPM	EF2	ETR
end	ft		kips	f/s	**	**	k-ft	(%)
1	0.00	AV1	36	14.2	0.292	**	0.175	83.5
2	0.00	AV1	37	14.8	0.295	51.3	0.182	84.3
3	0.00	AV1	36	14.9	0.299	51.2	0.184	85.3
4	0.00	AV1	36	14.9	0.297	51.2	0.181	84.9
5	0.00	AV1	37	14.8	0.298	51.3	0.178	85.1
6	0.00	AV1	37	14.7	0.296	51.5	0.178	84.5
7	0.00	AV1	37	14.8	0.294	51.1	0.179	83.9
8	0.00	AV1	36	15.0	0.297	51.4	0.177	84.7
9	0.00	AV1	36	14.8	0.293	51.3	0.173	83.6
10	0.00	AV1	35	15.1	0.296	51.2	0.174	84.4
11	0.00	AV1	35	14.9	0.294	51.5	0.174	84.0
12	0.00	AV1	35	14.4	0.295	51.4	0.171	84.2
13	0.00	AV1	36	14.8	0.292	51.3	0.173	83.3
14	0.00	AV1	35	14.5	0.291	51.3	0.167	83.1
15	0.00	AV1	35	15.0	0.290	51.4	0.169	82.7
16	0.00	AV1	36	14.7	0.289	51.4	0.168	82.6
17	0.00	AV1	34	15.0	0.289	51.2	0.171	82.6
18	0.00	AV1	37	14.2	0.291	51.4	0.173	83.1
19	0.00	AV1	37	14.3	0.292	51.2	0.171	83.4
20	0.00	AV1	36	13.9	0.286	51.4	0.170	81.8
21	0.00	AV1	37	14.0	0.288	51.2	0.172	82.3

Time Summary

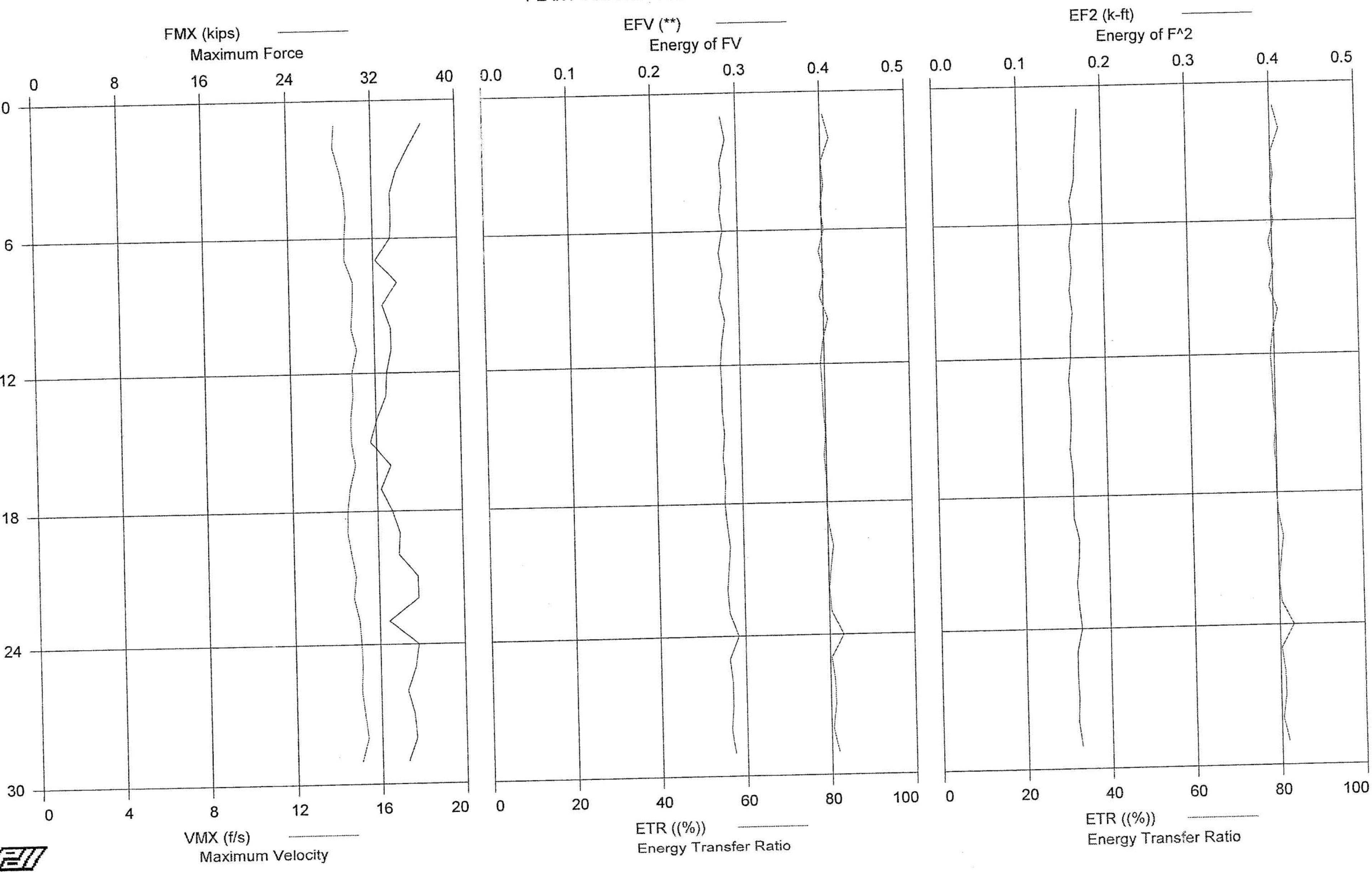
Drive 24 seconds 2:35:27 PM - 2:35:51 PM (9/7/2005)

GRL Engineers, Inc. - Case Method Results

PLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-27

Test date: 7-Sep-2005



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-27
OP: SDW

SPT
Test date: 7-Sep-2005

AR: 2.30 in^2
LE: 104.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	37	14.3	0.282	**	0.172	80.6
2	0.00	AV1	36	14.2	0.287	51.6	0.170	82.0
3	0.00	AV1	34	14.5	0.280	51.8	0.168	80.0
4	0.00	AV1	34	14.7	0.282	51.7	0.167	80.6
5	0.00	AV1	34	14.7	0.279	52.0	0.161	79.7
6	0.00	AV1	34	14.7	0.282	51.9	0.164	80.4
7	0.00	AV1	32	14.6	0.277	52.3	0.160	79.1
8	0.00	AV1	34	15.0	0.281	52.0	0.162	80.3
9	0.00	AV1	33	15.0	0.277	52.0	0.159	79.1
10	0.00	AV1	34	14.9	0.283	52.1	0.162	81.0
11	0.00	AV1	34	15.1	0.279	52.1	0.159	79.7
12	0.00	AV1	33	14.9	0.277	52.3	0.159	79.1
13	0.00	AV1	33	14.9	0.278	52.1	0.156	79.4
14	0.00	AV1	32	14.8	0.278	52.1	0.158	79.5
15	0.00	AV1	31	14.8	0.280	52.2	0.158	79.9
16	0.00	AV1	33	15.0	0.278	52.1	0.156	79.5
17	0.00	AV1	32	14.7	0.280	52.2	0.159	79.9
18	0.00	AV1	33	14.6	0.279	52.2	0.159	79.8
19	0.00	AV1	34	14.6	0.281	52.0	0.159	80.3
20	0.00	AV1	34	14.7	0.284	52.3	0.165	81.2
21	0.00	AV1	36	14.9	0.282	52.0	0.164	80.6
22	0.00	AV1	36	14.8	0.280	52.3	0.161	80.1
23	0.00	AV1	33	15.0	0.282	51.9	0.163	80.5
24	0.00	AV1	36	15.1	0.292	52.1	0.166	83.3
25	0.00	AV1	35	15.1	0.281	52.2	0.160	80.4
26	0.00	AV1	35	15.1	0.284	52.0	0.160	81.1
27	0.00	AV1	35	15.2	0.284	52.1	0.161	81.2
28	0.00	AV1	35	15.3	0.282	52.2	0.160	80.5
29	0.00	AV1	35	15.0	0.286	52.0	0.164	81.7

Time Summary

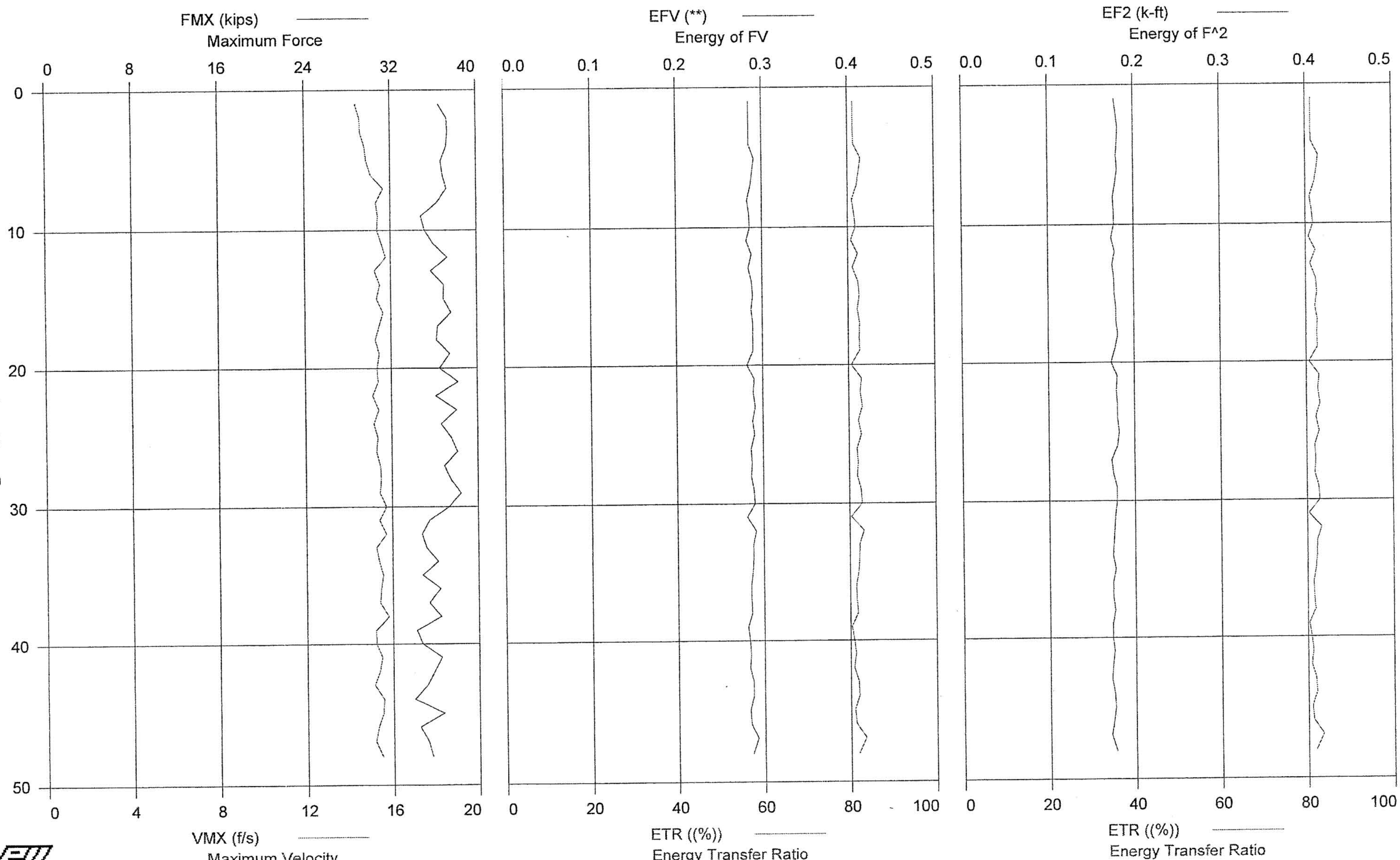
Drive 32 seconds 3:02:56 PM - 3:03:28 PM (9/7/2005)

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

GRL Engineers, Inc. - Case Method Results

Test date: 7-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-28



GRL Engineers, Inc.
Case Method Results

PDIPLOT Ver. 2005.1 - Printed: 8-Sep-2005

PLANT VOGTLE - RIG 2 - B-1006-SS-28
OP: SDW

SPT
Test date: 7-Sep-2005

AR: 2.30 in^2
LE: 109.00 ft
WS: 16,807.9 f/s

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

FMX: Maximum Force
VMX: Maximum Velocity
EFV: Energy of FV

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

BL# end	depth ft	TYPE	FMX kips	VMX f/s	EFV **	BPM **	EF2 k-ft	ETR (%)
1	0.00	AV1	37	14.4	0.285	**	0.178	81.3
2	0.00	AV1	37	14.6	0.285	50.7	0.180	81.3
3	0.00	AV1	37	14.6	0.285	50.5	0.182	81.3
4	0.00	AV1	37	14.8	0.285	50.7	0.181	81.4
5	0.00	AV1	37	14.9	0.291	50.9	0.180	83.0
6	0.00	AV1	37	15.1	0.289	51.9	0.181	82.6
7	0.00	AV1	37	15.7	0.287	51.8	0.179	82.1
8	0.00	AV1	36	15.3	0.283	51.7	0.176	81.0
9	0.00	AV1	35	15.4	0.285	51.7	0.177	81.5
10	0.00	AV1	35	15.4	0.286	51.9	0.177	81.8
11	0.00	AV1	36	15.6	0.282	51.7	0.174	80.7
12	0.00	AV1	37	15.8	0.288	51.8	0.178	82.3
13	0.00	AV1	36	15.2	0.284	51.7	0.175	81.0
14	0.00	AV1	37	15.5	0.288	51.8	0.177	82.3
15	0.00	AV1	37	15.3	0.289	51.9	0.177	82.6
16	0.00	AV1	38	15.6	0.287	51.5	0.179	82.1
17	0.00	AV1	36	15.4	0.289	51.8	0.179	82.6
18	0.00	AV1	36	15.3	0.289	51.6	0.181	82.5
19	0.00	AV1	37	15.4	0.289	51.7	0.178	82.7
20	0.00	AV1	37	15.3	0.282	51.9	0.173	80.6
21	0.00	AV1	38	15.4	0.290	51.6	0.180	83.0
22	0.00	AV1	36	15.1	0.289	51.6	0.179	82.7
23	0.00	AV1	38	15.4	0.291	51.6	0.180	83.1
24	0.00	AV1	37	15.2	0.288	51.9	0.180	82.2
25	0.00	AV1	38	15.4	0.290	51.5	0.182	82.8
26	0.00	AV1	38	15.3	0.286	51.8	0.180	81.8
27	0.00	AV1	37	15.5	0.287	51.6	0.173	82.1
28	0.00	AV1	37	15.5	0.286	51.8	0.175	81.8
29	0.00	AV1	38	15.4	0.289	51.8	0.179	82.7
30	0.00	AV1	37	15.7	0.290	51.8	0.179	82.9
31	0.00	AV1	35	15.4	0.281	51.9	0.177	80.4
32	0.00	AV1	35	15.7	0.291	51.6	0.176	83.3
33	0.00	AV1	35	15.2	0.288	51.9	0.175	82.3
34	0.00	AV1	36	15.4	0.288	51.7	0.174	82.2
35	0.00	AV1	35	15.6	0.287	51.7	0.177	82.0
36	0.00	AV1	36	15.5	0.285	51.8	0.174	81.4
37	0.00	AV1	35	15.4	0.285	51.9	0.174	81.5
38	0.00	AV1	37	15.8	0.286	51.5	0.176	81.8
39	0.00	AV1	34	15.2	0.281	51.9	0.173	80.3
40	0.00	AV1	35	15.2	0.283	51.7	0.173	80.8
41	0.00	AV1	37	15.5	0.284	51.5	0.175	81.2
42	0.00	AV1	36	15.4	0.283	51.9	0.173	80.8
43	0.00	AV1	35	15.1	0.287	51.6	0.172	81.9
44	0.00	AV1	34	15.6	0.287	51.7	0.175	82.0
45	0.00	AV1	37	15.5	0.283	51.8	0.176	80.9
46	0.00	AV1	34	15.3	0.284	51.6	0.174	81.3
47	0.00	AV1	35	15.2	0.292	51.5	0.171	83.5
48	0.00	AV1	36	15.5	0.286	51.5	0.177	81.8

Time Summary

Drive 54 seconds 3:31:41 PM - 3:32:35 PM (9/7/2005)

MACTEC

APPENDIX G

Boring B-1003 Core Photos

Photos not included, available upon request