

**FINAL DATA REPORT Rev 0
GEOTECHNICAL EXPLORATION AND TESTING**

**EXELON TEXAS COL PROJECT
VICTORIA COUNTY, TEXAS
COOLING BASIN**

July 18, 2008

VOLUME 2

Prepared By:

**MACTEC Engineering and Consulting, Inc.
Raleigh, North Carolina**

MACTEC Project No. 6468-07-1777

Prepared For:

**Bechtel Power Corporation
Subcontract No. 25352-102-HC4-CY00-00001**

Contents

**Appendix C – Cone Penetrometer Test Results
Appendix D – Geophysical Test Data**

**FINAL DATA REPORT Rev 0
GEOTECHNICAL EXPLORATION AND TESTING**

**EXELON TEXAS COL PROJECT
VICTORIA COUNTY, TEXAS
COOLING BASIN**

July 18, 2008

**VOLUME 2
Appendix C – Cone Penetrometer Test Results**

Prepared By:

**MACTEC Engineering and Consulting, Inc.
Raleigh, North Carolina**

MACTEC Project No. 6468-07-1777

Prepared For:

**Bechtel Power Corporation
Subcontract No. 25352-102-HC4-CY00-00001**

FUGRO CONSULTANTS, INC.



March 14, 2008
Report Number 1907-0075

6105 Rookin Road
Houston, Texas 77074
Tel: 713-346-4000
Fax: 713-346-4002

Mr. Scott Auger, P.E., PMP
Mactec Engineering and Consulting, Inc.
3301 Atlantic Avenue
Raleigh, North Carolina 27604

**REPORT FOR
SEISMIC PIEZOCONE PENETRATION TESTING
AND RELATED SERVICES
EXELON TEXAS PROJECT UNIT 3
VICTORIA, TEXAS
MACTEC PROJECT # 6468071777**

Dear Mr. Auger:

Fugro is pleased to enclose the data report for Cone Penetration Testing (CPT) at the Exelon Texas Col Unit 3 site at Victoria, Texas. Cone Penetration Tests were carried out according to ASTM 5778-2000, "Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils" standard test method.

For your information, the soil stratigraphy was identified using Campanella and Robertson's Simplified Soil Behavior Chart. Please note that because of the empirical nature of the soil behavior chart, the soil identification should be verified locally. Some soils, such as glacial till, cemented soils and calcareous soils are outside the scope of these soil behavior charts."

Cone Penetration Test data was collected utilizing Fugro's digital cone penetrometer systems that were mounted on a purpose-built 25-ton capacity truck-mounted unit and a 15-ton capacity ATV track-mounted unit.

The Fugro Organization has been developing and deploying Cone Penetration Testing (CPT) systems since the early 1940's. We currently own and operate over 600 onshore and offshore cone deployment systems worldwide. Fugro developed the first commercial cone penetrometer in the 1960's and has manufactured and utilized the industry standard in electronic cone penetrometers since that time.

The following sections summarize the CPT test method and our site investigation activities:

1.0 Summary of CPT Test Method

A penetrometer assembly with a conical point having a 60° apex angle and a cone base area of 15 cm² is advanced through the soil at a constant rate of 2 centimeters per second. The force on the conical point (cone) required to penetrate the soil is measured by strain gages at a minimum of every 2 centimeters of penetration. Stress is calculated by dividing the measured force (total cone force) by the cone base area to obtain cone resistance, q_c .



A friction sleeve is present on the penetrometer immediately behind the cone tip, and the force exerted on the friction sleeve is measured by strain gages attached to load cells at the top and bottom of the sleeve assembly, at a minimum of every 2 cm of penetration. Stress is calculated by dividing the measured force by the surface area (200 cm^2) of the friction sleeve to determine friction sleeve resistance, f_s .

Many penetrometers are capable of measuring dynamic pore pressure induced during advancement of the penetrometer tip using an internal pressure transducer. These penetrometers are called "piezocones." The piezocone is advanced at a rate of 2 centimeters per second, and readings are taken at a minimum of every 2 centimeters of penetration. The dissipation of excess pore pressure can be monitored by stopping penetration, unloading the push rod, and recording pore pressure as a function of time. When pore pressure becomes constant, it is measuring the equilibrium value or piezometric head at that depth.

Penetrometers are also available with geophones mounted above the friction sleeve for measuring shear wave velocity. These penetrometers are called "seismic cones." The seismic cone is advanced at a rate of 2 centimeters per second, and readings taken at a minimum of every 2 centimeters of penetration. Advancement of the seismic cone is stopped at predetermined intervals (usually 5 or 10 feet). At these intervals shear wave velocity measurements are recorded using a seismograph. Placing a metal beam on the ground and striking the ends of the beam with a hammer generate the shear waves.

2.0 Significance and Use

Tests performed using CPT methods provide a detailed record of penetrometer results, which are used for the evaluation of site stratigraphy, homogeneity and depth to firm layers, voids or cavities, other discontinuities, and correlations with geotechnical and hydrogeological properties of soils. When properly performed at suitable sites, the test provides a rapid means for determining subsurface conditions.

CPT methods provide data used for estimating engineering properties of soil intended to help with the design and construction of earthworks, foundations for structures, and the behavior of soils under static and dynamic loads.

CPT methods test the soil in situ and soil samples are not obtained. The interpretation of the results from the test methods provides estimates of the types of soil penetrated. Engineers may obtain soil samples from parallel borings for correlation purposes since the results of these tests are empirical in nature and yield results regarded as behavior type, but not actual grain size.

3.0 Limitations of Use

Refusal, deflection, or damage to the penetrometer assembly may occur in coarse-grained soil deposits with maximum particle sizes that approach or exceed the diameter of the cone. Partially lithified and/or cemented deposits may cause refusal, deflection, or damage to the penetrometer assembly.

Standard push rods can be damaged or broken under extreme load conditions. The amount of force that push rods are able to sustain is a function of the unrestrained length of the push rods and the weak links in the push rod-penetrometer tip string, such as push rod joints and push rod-penetrometer assembly connections. The force at which rods may break is a function of the equipment configuration and ground conditions during penetration. Excessive rod deflection is the most common cause for rod breakage during deep pushes in dense material with soft overlying soil.



4.0 Equipment

Equipment utilized in conducting Cone Penetrometer Testing include:

1. Digital Standard Cone (CPT) to measure tip and sleeve resistances and probe inclination.
2. Digital Piezocone (CPTu) to measure tip and sleeve resistances, probe inclination and dynamic pore pressure.
3. Digital Seismic Cone (SCPTu) to measure tip and sleeve resistances, probe inclination, dynamic pore pressure, and shear wave velocity.
4. Cone rods with pre strung electrical cone cable.
5. Digital Data Acquisition System including the Digital Connection Box (PCUM), a data logging laptop computer and laser printer.
6. A self-contained CPT rig that contains the hydraulic pushing system, a power supply unit and other tools, equipment and materials necessary.

Digital Piezocone (CPTu) and Digital Seismic Cone (SCPTu) testing was done during this investigation.

4.1 Electric Cone Penetrometers

Fugro utilizes electric cone penetrometers, available in either a 10cm² or 15cm² cone base area that exceed the standards set forth by ASTM-D5778-2000, ISO 9001 and ISSMGE Technical Committee 16. Technical details and specifications of Fugro's Cone Penetrometers are given in Appendix A.

4.2 Cone Rods

Fugro's CPT cone rods are manufactured from high tensile strength steel and have a cross sectional area adequate to sustain, without buckling, the thrust required to advance the penetrometer tip. Prior to testing, an electrical cone cable is prestrung through the cone rods and is connected by a crossover cable to the Data Acquisition System.

Push rods are supplied in 1 meter lengths and must be secured together to bear against each other at the joints to form a rigid-jointed string. The deviation of push rod alignment from a straight axis should be held to a minimum, especially in the push rods near the penetrometer tip, to avoid excessive directional penetrometer drift.

Generally, when a 1-m long push rod is subjected to a permanent circular bending resulting in 1 to 2 millimeter (mm) of center axis rod shortening, the push rod should be discarded. This corresponds to a horizontal deflection of 2 to 3 mm at the center of bending. The locations of push rods in the string should be varied periodically to avoid permanent curvature.

Standard 20-metric ton high tensile strength steel push rods with 36-mm OD, 16-mm ID, and a mass per unit length of 6.65 kg/m are used.



4.3 Data Acquisition System

The digital data acquisition system utilized by Fugro in conducting CPT Testing consists of a PCUM, a portable laptop computer, and a printer.

The digital data acquisition system collects the cone penetrometer's digital signal, which is monitored, recorded and presented in near-real time on the laptop computer.

Information collected during a push is stored digitally as binary data on computer's hard disk and transferred to compact disks. Windows-based programs read the data and convert it to text files. The data files include project description and location, operator, data format information and other pertinent information about the sounding.

Following each push, data collected with a standard CPT cone are presented in a graphical format. The log includes:

1. Cone resistance plot in tons/ft² (TSF)
2. Friction sleeve resistance plot in tons/ft² (TSF)
3. Friction ratio plot in %

Versus depth below ground surface in feet.

For data collected with a piezocone, the log includes, in addition to the above, an additional plot of pore pressure in tons/ft² (TSF), versus depth in feet.

A variety of plotting parameters are available for uniform presentation of data. As stipulated in the ASTM standard, the vertical axis is designated for the depth while the horizontal axis displays the magnitude of the test values recorded. Final plotting scales are determined after all the tests are completed, and takes into consideration test values and depths recorded for the project.

4.4 CPT Rig

A primary component of any CPT system is the CPT rig. Fugro Consultants, Inc. currently owns and operates ten (10) truck-mounted CPT units, four (4) ATV-mounted units, and two (2) skid-mounted units in the United States. The CPT rigs have self contained electrical, hydraulic, and climate control systems and range in weight from 15 to 30 tons. Except for the skid-mounted units, the rigs have hydraulic jacking systems to lift and level the pushing platform. The "dead weight" of the rigs provides the reaction weight necessary for advancing the CPT tools, eliminating the need for time-consuming earth anchoring. Fugro's typical purpose build CPT rigs are shown in Appendix B.

5.0 Calibration

Fugro's cone penetrometer manufacturing and calibration procedures include ISO 9001, ASTM D-5778-2000, and European cone penetration standards. The calibration tests include load testing over the full range of output for each cone. Cones are tested and calibrated for the following:

- Mechanical Calibration
- Cross-talk Check
- Dimension Check
- Seal / O-Ring Check
- Electronic Calibration



- Temperature Effect
- Pre and Post Test Voltage Readings (zeros)
- Full Scale Output Load Reading
- Pore Pressure effect on tip and friction readings
- Pore Pressure Transducer calibration

Fugro's cone penetrometer calibration zeros are checked and verified before and after each sounding. Periodic full-scale calibration is likewise conducted according to the Quality Assurance and Quality Control procedures as specified in ASTM D-5778-2000.

During this investigation, utilized cone penetrometers, were load range checked and calibration verified before and after the project. Calibration Verification is documented in our report dated January 24, 2008.

6.0 Test Procedure

Prior to beginning a sounding, a site survey is performed to ensure hazards such as underground utilities will not be encountered. The rig is positioned over the location of the sounding and the leveling jacks are lowered to raise the machine mass off the rig's suspension system. The hydraulic rams of the penetrometer thrust system are set to as near vertical as possible by adjusting the leveling jacks. Once the rig is set level, the data acquisition system is power up, and standard Fugro CPT checklist procedures are followed.

During this investigation, for each CPT test initial and final zero readings were recorded and included in Appendix C. In addition to standard cone penetrometer checklist during piezocone penetration testing the following procedures were followed:

1. Assemble the piezo elements with all fluid chambers submerged in the de-aired medium (silicon oil) used to prepare the elements. Flush all confined areas with fluid to remove air bubbles, tighten the cone tip to effectively seal the flat surfaces and apply vacuum pressure to piezo tip section.
2. If unsaturated soil is first penetrated and it is desired to obtain accurate dynamic pore pressure response once below the groundwater, it may be necessary to prebore or sound a pilot hole to the water table. In many cases the piezocone fluid system may be cavitated during penetration through unsaturated soil or in dilating sand layers below the water table, which can adversely affect dynamic response. The prebore technique was not used on this project.

The CPT rig was placed over the location and leveled with leveling jacks. After insuring the cone was cleaned and the seals were in place, the cone was prepared as in step 1 above. The cone was then suspended over the location and lowered until the tip was above the ground surface, but not in contact with it.

Labels were entered into the computer to identify the CPT sounding and location. The test was then started on the computer. After starting the test software the operator waits for 30 seconds to allow the system to collect zero readings before lowering the cone to the ground surface and advancing the penetrometer into the soil.

The penetrometer is pushed into the soil at a rate of 2 cm per second. A shaft encoder that is connected to the cone rod using a slip ring plate measures depth. A steel cable is attached to slip ring plate. The cable is then routed over a pulley then attached to a spring-loaded wheel on the shaft encoder. As the cone rod penetrates the soil the cable turns the wheel on the encoder and counts the depth.



The readings from the penetrometer and encoder are sent to the computer, which displays the data graphically and numerically on screen in real time. The raw data is also stored on the computer hard drive. After the desired depth or refusal is reached, the penetrometer and cone rod are pulled from the ground. When the penetrometer is hanging free above the ground, post test zero readings are recorded and the data stored.

CPT soundings may encounter refusal prior to reaching the desired depth for several reasons. These reasons include:

- The CPT rig cannot generate enough downward force to continue penetration.
- The CPT rig is lifting off the ground while pushing.
- The slope of the penetrometer exceeds angle limits.
- There is not enough lateral support from the soil to prevent the cone rod from bowing and breaking as it is advanced. Casing can help in this situation, however it is not always possible to advance casing to the depth required.

If refusal is due to slope the operator will terminate the sounding and determine the cause. The test will also be terminated if there is a problem with the data observed during the test. After correcting the problem, the operator will move over and re-push the test.

Pore Pressure Dissipation Testing was performed during some CPT soundings. Penetration is temporarily stopped at the location of interest, and the force is released from the cone rods. Pore pressure versus time is recorded during the dissipation test. Pressures are monitored until equilibrium pore pressure is reached or 50% of the initial pore pressure is dissipated. In fine grained soils of very low hydraulic conductivity, very long times may be required to reach the 50% dissipation. Some dissipation tests were terminated prior to reaching 50% pressure at the direction of the client.

7.0 Quality Assurance and Quality Control

As part of Fugro's QA procedures, when a digital data acquisition system is activated, the serial number, calibration values for each channel, calibration date and calibration due dates will automatically be recorded in each CPT test file along with the initial and final zero readings of the cone penetrometer.

Upon completion of a project, the field data is transmitted electronically or by overnight mail to the main office in Houston, Texas, where it is processed, reviewed and finalized. The original, unprocessed data is stored in a large capacity, limited access storage medium where it is kept indefinitely for future reference as a confidential records.

The integrity of the measurements are checked and verified to ensure that the logs generated are as accurate as possible. Rod spikes, which are generated naturally when the pushing is stopped to add rods while advancing the sounding, are identified and edited out.

Prior to the release of the Final Report, the entire set of data is reviewed by a Senior Staff member. In this process, the reviewer conducts a thorough assessment of the data set checking its consistency and accuracy. Should any deviation beyond Fugro's accepted standards occur, the data is rejected and test is redone at Fugro's expense.

8.0 Summary of Testing performed on this project

The table below is a summary of testing done for this project. All CPT testing was done using Fugro's Digital Cone Penetrometer system. All cones used were 15 cm² cones piezocones or seismic cones with the piezo transducer mounted in the U2 position (between the tip and sleeve).



CPT	Date	Depth (feet)	Dissipations ⁽¹⁾ (feet)		Comments
C-2301S	1/2/2008	34.5			Refusal ^{(2) (5)}
C-2301SA	1/2/2008	30			Refusal ^{(2) (5)} Bad seismic data 2-HU 5-29-08
C-2302	1/5/2008	94.7			⁽⁵⁾
C-2303S	2/18/2007	97.2	80.1	82.3 95.6	⁽⁶⁾
C-2304	12/17/2007	60			⁽⁶⁾
C-2305	12/19/2007	60			⁽⁶⁾
C-2306	12/19/2007	60			⁽⁶⁾
C-2307	12/17/2007	60			⁽⁶⁾
C-2308	1/6/2008	86.4			⁽⁵⁾
C-2309	12/19/2007	54.2			⁽⁶⁾
C-2310	12/19/2007	60			⁽⁶⁾
C-2311	1/6/2008	78	58		Refusal ⁽⁶⁾
C-2311A	1/7/2008	100	91.5		⁽⁵⁾
C-2312	1/3/2008	90.2	51.9	70.6	⁽⁵⁾
C-2313	12/20/2007	60			⁽⁶⁾
C-2314	12/19/2007	60			⁽⁶⁾
C-2315	1/7/2008	60			⁽⁵⁾
C-2316	1/8/2008	60			⁽⁵⁾
C-2317	1/7/2008	83.8			⁽⁵⁾
C-2318	12/20/2007	60			⁽⁶⁾
C-2319	12/20/2007	60			⁽⁶⁾
C-2321S	1/4/2008	49.9			Refusal ^{(3) (5)} Bad seismic data 2-HU 5-29-08
C-2321SA	1/4/2008	51			Refusal ^{(3) (5)}
C-2322	1/10/2008	83.9			⁽⁴⁾
C-2323S	1/8/2008	35			Bad seismic data ^{(4) (5)}
C-2323SA	1/9/2008	100	100.1		⁽⁵⁾
C-2324	12/20/2007	60			⁽⁶⁾
C-2328	1/4/2008	60			⁽⁵⁾

Notes:

- Initially dissipation test were planned to be conducted at predetermined depths. Following a review with the client, this procedure was changed to the selection of dissipation test depths by the client's engineer, with the client's engineer observing the test data as the test progressed.
- CPT C-2301S was attempted twice and refused due to soil conditions. No further attempts were made per instructions of MACTEC field engineer.
- CPT C-2321S was attempted twice and refused due to dense/hard soil conditions. No further attempts were made per instructions of Bechtel field engineer.
- CPT C-2323S. There were problems with the seismograph during the first attempt and CPT was terminated. After repairing the seismograph the CPT pushed to the planned depth.
- Track Rig 5000
- Truck Rig 5040

Mactec Engineering and Consulting, Inc.

Mr. Scott Auger, P.E., PMP

Page 8 — Report Number 1907-0075 — Unit 3



Fugro appreciates the opportunity to be of service to Mactec Engineering and Consulting, Inc. If you have any questions, please feel free to contact me at 713-346-4000.

Very truly yours,
FUGRO CONSULTANTS, INC.

A handwritten signature in black ink, appearing to read "Recep Yilmaz". The signature is fluid and cursive, with a large, stylized "Y" and "M".

Recep Yilmaz
Senior Vice President

CPT LOGS

12 Zone Soil Behavior Chart

Classification Data:
Robertson and Campanella UBC-1986

