APPENDIX C

CONE PENETROMETER CALIBRATION CERTIFICATES

APPENDIX C

CALIBRATION VERIFICATION FOR CONE PENETRATION TESTING

Fugro's cone penetrometer manufacturing and calibration procedures include ISO 9001, ASTM D5778-2007 and European cone penetrometer standards. Cone penetrometers 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 readings
- Pore Pressure transducer calibration
- Slope indicator calibration

Calibration Verification Methodology

Manufactured and calibrated according to ISO 9001, the calibration values of the electric cone penetrometers used for this project were verified before and after fieldwork utilizing the following A2LA and/or ANSI/NCSL approved verification systems.

Tip and Friction

Load cell:	Geotac
Calibrated by:	Empire Calibration, Inc. (A2LA approved)
Calibration date:	February 27, 2009
Load cell model:	560K
Load cell serial no:	129739
Capacity:	50,000 lbs

Pore Pressure Transducer

Digital Pressure Indicator

Calibrated by:	Empire Calibration, Inc. (AL2A approved)
Manufactured by:	Eaton
Model number:	UPS 3000CC
Serial number:	A0813
Calibration date:	November 11, 2008

Cone Penetrometer Temperature

Digital Thermometer	
Calibrated by:	Empire Calibration, Inc. (AL2A approved)
Manufactured by:	Digi-sence
Model Number:	8528-40
Serial Number:	C95005824
Calibration date:	November 12, 2008

Utilizing the above systems each was load and pressure tested as follows:

Tip:	0-20,000 lb.
Friction:	0-7,500 lb.
Pore Pressure:	0-350 PSI
Temperature effect	30 Degrees Fahrenheit – 115 Degrees Fahrenheit

Under each load/pressure increment, the cone penetrometer readings are recorded in millivolts (mV). Load/pressure (pounds/psi) load increments and corresponding cone readings in mV are input into **HGL Instrument Verificaton** software to obtain linear regression and correlation coefficient (R^2) values (See attached **HGL Instrument Verification** Forms).

Additionally, load/pressure increments and cone readings were also input into a calibration **Verification Certificate Program** to calculate each cone penetrometer's calibration value in MPa units (See attached **Calibration Verification Certificates** for each cone penetrometer). The last column in these forms represents the calibration values of tip, friction and pore pressure.

Calculation Example

Load Increment, P1	= 590 lb.
	= 0.295 tons
Tip Reading	= 35.2 mV
Tip Area, A= $15cm^2$	= 0.0161 sq. ft.
Tip Pressure	= P1/A = 0.295/0.0161
	= 18.32298 tsf
Tip Pressure Per mV	= 18.32298/35.2 mV
	= 0.520539 tsf/mv
Tip Pressure Per Volt	= 0.520539 x 1,000
	= 520.539 tsf/volt
	= 49.847 MPa/Volt
Tip Calibration Valve	~ 50 Mpa/Volt

Temperature Calibration:

Cone Penetrometers are placed in a temperature-controlled enclosure and zero readings recorded in mV at intervals between 30 degrees (F) and 115 degees (F). Temperatures and zero readings (mV) are entered into the **Calibration Verification Certificate** software which calculates the deviation between the maximum and minimum zero readings (mV) for the tip friction and pore pressure channels.

Data Recording

During the cone penetration test, the calibration numbers are automatically recorded in CPT test data files along with the following information (See attached CPT test data file, 6710.DEP):

- Date of CPT test
- Starting time of test
- Project Number
- CPT test number
- Operator name
- Elevation, starting depth, water depth
- Cone serial number
- Number of cone channels (3)
    - Tip calibration (50 MPa)
    - Friction calibration (0.5 MPa)
    - Pore Pressure Calibration (2.5 MPa)
    - Slope calibration (525)
- Initial baseline (zero) readings for depth, tip, friction, pore pressure and slope.

CPT Checklist

Operator ______________________________ Rig: ________ Data: ____________

CPT Number

1. Record GPS coordinates of location	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Cone is clean, quad rings in place (Loading tip and friction)	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Check initial zero readings and record	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Check for cross talk (Observe friction while loading tip)	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Install saturated piezo element, de-aire cone	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Enter Labels (Correct Location and Job Number)	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. Check depth for accuracy	☐	☐	☐	☐	☐	☐	☐	☐	☐
8. Start CPT mode and wait one minute for zero readings	☐	☐	☐	☐	☐	☐	☐	☐	☐
9. Advance CPT to depth monitoring all channels	☐	☐	☐	☐	☐	☐	☐	☐	☐
10. End of test - pull cone rods and stop CPT mode	☐	☐	☐	☐	☐	☐	☐	☐	☐
11. Check final zero readings and record	☐	☐	☐	☐	☐	☐	☐	☐	☐
12. Remove used piezo element and clean cone, remove quad rings, remove all soil from quad ring groves and insure sleeve moves freely	☐	☐	☐	☐	☐	☐	☐	☐	☐
13. Plot data, check plot. Are tip and friction and Piezo data correct? Is friction ratio within range?	☐	☐	☐	☐	☐	☐	☐	☐	☐

MACTEC WORK ORDER NUMBER: 200903213
MACTEC PROJECT NAME: EXELON TEXAS COL PROJECT-SUPPLEMENTAL INVESTIGATION, INCLUDING UHS
MACTEC PROJECT NUMBER: 6468-07-1777

CPT INITIAL and FINAL ZERO READINGS

				Tip		Friction		P. Pressure		Inclination	
CPT No	Date	Cone Type	Serial No	Initial	Final	Initial	Final	Initial	Final	Initial	Final
C-3101	06-Mar-2009	F7.5CKE2HAW2	1701-1498	0.014246	0.011719	0.009302	0.006673	-0.004492	-0.004395	-0.001891	-0.00334
C-3102	06-Mar-2009	F7.5CKE2HAW2	1701-1498	0.014465	0.013794	0.009045	0.006795	-0.00459	-0.004492	-0.001621	-0.002969
C-3110	06-Mar-2009	F7.5CKE2HAW2	1701-1498	0.015564	0.013428	0.010339	0.007975	-0.00459	-0.004297	-0.000115	-0.001022
C-3201	05-Mar-2009	F7.5CKE2HAW2	1701-1498	0.013428	0.010986	0.009766	0.007121	-0.00459	-0.004395	0.000025	-0.001257
C-3204	04-Mar-2009	F7.5CKE2HAW2	1701-1498	0.012439	0.011312	0.009497	0.008423	-0.00459	-0.004492	-0.001895	-0.000671
C-3205	05-Mar-2009	F7.5CKE2HAW2	1701-1498	0.015137	0.013306	0.011523	0.008667	-0.004688	-0.00459	0.00026	-0.002272
C-3206	04-Mar-2009	F7.5CKE2HAW2	1701-1498	0.012085	0.010986	0.010376	0.008219	-0.00459	-0.004395	0.000801	-0.001139
C-3207	06-Mar-2009	F7.5CKE2HAW2	1701-1498	0.017114	0.013794	0.012048	0.008748	-0.004688	-0.004297	0.000357	-0.00263
C-3208	05-Mar-2009	F7.5CKE2HAW2	1701-1498	0.013354	0.011312	0.00885	0.006388	-0.00459	-0.004297	0.001945	-0.002741
C-3209	04-Mar-2009	F7.5CKE2HAW2	1701-1498	0.012427	0.011963	0.009595	0.008423	-0.00459	-0.00446	-0.000959	-0.001589
C-3211	04-Mar-2009	F7.5CKE2HAW2	1701-1498	0.012842	0.010376	0.013379	0.008423	-0.004688	-0.004395	0.00199	-0.000801
C-3212	05-Mar-2009	F7.5CKE2HAW2	1701-1498	0.013086	0.011312	0.007996	0.006632	-0.004492	-0.004297	-0.001037	-0.001276

Pre-Job Calibration Verification

HGL Instrument Verification

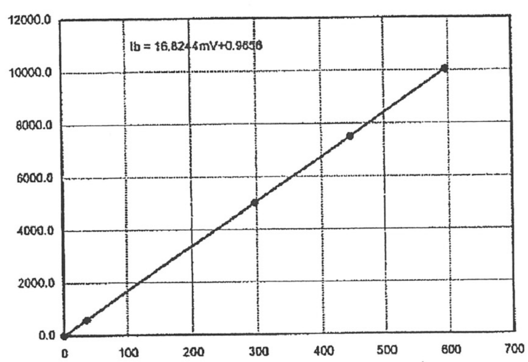
DATE: 2/16/2009 Instrument No.: ft Location: Houston LVDT?: [ ] Yes; [X] No

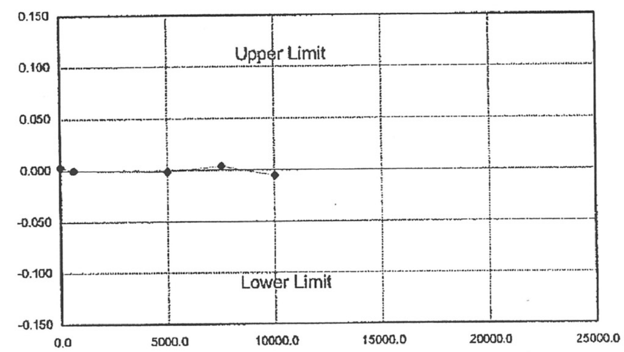
Type Analysis: [X] BF; [ ] NonBF; [X] FS; [ ] Abs. Reading Resolution of Instrument: 0.000001

Instrument Identification/Data	
Type	Cone Penetrometer-TIP
Manufacturer	Fugro
Model Number	F7.5CKE3SW2/B
Serial Number	1701-1498(Tip)
HGL Instrument Number	ft
Excitation (V)	
Gain/Span Setting	NA
Full Range Output (V)	
Full Range/Capacity (lb)	33716
Date Verified	2/16/2009
Date Due	2/16/2010
Service Status	In Service
Accept. Abs. or FS Error (%)	0.1 [X] FS; [ ] Abs.
Verification/Standard Equipment	
Type	Load Cell (A2AL APPROVED)
Manufacturer	INTERFACE
Model Number	FT451-50K
Serial Number	129739
HGL Instrument Number	
Date Verified	
Temperature	°C = °F
Linear Regression, Uncertainty, & Error Summary	
Correlation Coeff. (R^2)	0.999999967
Intercept (lb)	0.965552009
Slope (lb/mV)	16.824355
Verification (Calib.) Factor	16.82435500
Verification Factor Units	lb/mV
Absolute Zero (V)	
Floating Zero (V)	
Combined Uncertainty (lb)	0.237819073
Coverage Factor	2
Expanded Uncertainty (lb)	0.475638145
Max. Abs. or FS Error (%)	-0.01 [X] FS; [ ] Abs.

Instrument mV	Standard lb	Prediction lb	Abs. Error lb	Full Scale Error (%)
0.000000	0.0	1.0	1.0	0.00
35.600000	600.0	599.9	0.1	0.00
297.400000	5005.0	5004.5	0.5	0.00
445.200000	7490.0	7491.2	1.2	0.00
595.400000	10020.0	10018.2	1.8	-0.01
893.800000	15040.0	15038.6	1.4	0.00
1188.200000	19990.0	19991.7	1.7	0.00

MTS [ ] Yes; [X] No





Uncertainity Budget Analysis For ft							
Source of Uncertainty	Value in lb	Distribution	Divisor	Type	Uncertainty (u_i)	u_i^2	Comments
Standard's Uncertainty		N	2.0000	B			
Abs. Error-STDEV[1]	0.2378	N	1.0000	A	0.2378	0.0566	
Resolution of Instrument	0.0000	R	3.4641	B	0.0000	0.0000	
Repeatability[2]		N	1.0000	A			
Resolution of Standard	#N/A	R	3.4641	B			
Combined Uncertainty	0.2378	Coverage Factor			2	for 95% confidence level.	
Expanded Uncertainty (Best Measurement Capability)[3]		0.476		lb			

(1) This equation follows the approach presented by A2LA, not that typically used in uncertainty calculations; i.e., STDEV of the Mean. (2) This value is unique for type (model) of equipment.

(3) This uncertainty represents an expanded uncertainty expressed as approximately the 95% confidence level using a coverage factor of k=2.

Verified By: DS Input By: ______ Reviewed By: ______ Checked By: RY

File:

Remarks:

2000.2 (06/14/07) Tip1498, 2-16-2009 3/3/2009 FUGRO CONSULTANTS INC

HGL Instrument Verification

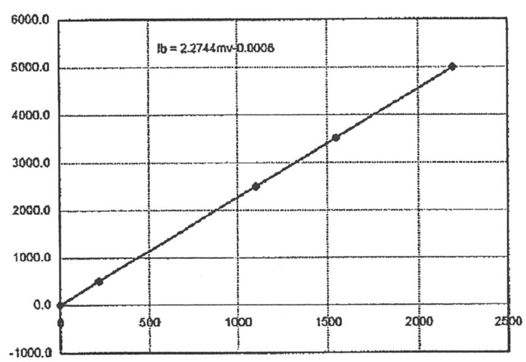
DATE: 2/16/2009 Instrument No.: ft100 Location: ______ LVDT?: [ ]Yes; [X]No

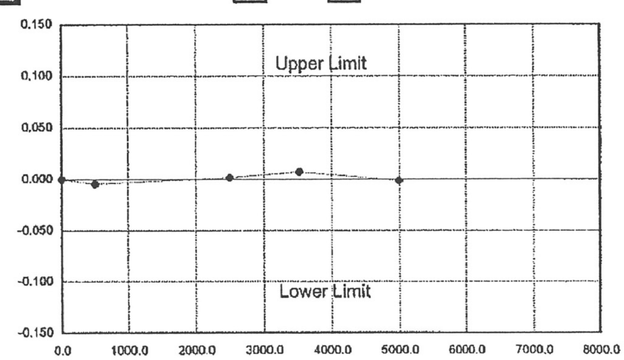
Type Analysis: [X]BF; [ ]NonBF; [X]FS; [ ]Abs. Reading Resolution of Instrument: 0.000001

Instrument Identification/Data	
Type	Cone Penetrometer
Manufacturer	Fugro
Model Number	F7.5CKEW2/B
Serial Number	1701-1498 (Friction)
HGL Instrument Number	ft100
Excitation (V)	
Gain/Span Setting	NA
Full Range Output (V)	
Full Range/Capacity (lb)	16858
Date Verified	2/16/2009
Date Due	2/16/2010
Service Status	In Service
Accept. Abs. or FS Error (%)	0.1 [X]FS; [ ]Abs.
Verification/Standard Equipment	
Type	Load Cell (A2AL APPROVED)
Manufacturer	INTERFACE
Model Number	FT451-50K
Serial Number	129739
HGL Instrument Number	
Date Verified	
Temperature	°C = °F
Linear Regression, Uncertainty, & Error Summary	
Correlation Coeff. (R^2)	0.999999941
Intercept (lb)	-0.000583427
Slope (lb/mv)	2.274385049
Verification (Calib.) Factor	2.27438505
Verification Factor Units	lb/mv
Absolute Zero (V)	
Floating Zero (V)	
Combined Uncertainty (lb)	0.178993019
Coverage Factor	2
Expanded Uncertainty (lb)	0.357986039
Max. Abs. or FS Error (%)	0.01 [X]FS; [ ]Abs.

Instrument mv	Standard lb	Prediction lb	Abs. Error lb	Full Scale Error (%)
0.000000	0.0	0.0	0.0	0.00
221.700000	505.0	504.2	0.8	0.00
1101.500000	2505.0	2505.2	0.2	0.00
1548.200000	3520.0	3521.2	1.2	0.01
2193.900000	4990.0	4989.8	0.2	0.00
3299.600000	7505.0	7504.6	0.4	0.00

MTS [ ]Yes; [X]No





Uncertainity Budget Analysis For ft100							
Source of Uncertainty	Value in lb	Distribution	Divisor	Type	Uncertainty (u_i)	u_i^2	Comments
Standard's Uncertainty		N	2.0000	B			
Abs. Error-STDEV[1]	0.1790	N	1.0000	A	0.1790	0.0320	
Resolution of Instrument	0.0000	R	3.4641	B	0.0000	0.0000	
Repeatability[2]		N	1.0000	A			
Resolution of Standard	#N/A	R	3.4641	B			
Combined Uncertainty	0.1790	Coverage Factor			2	for 95% confidence level.	
Expanded Uncertainty (Best Measurement Capability)[3]		0.358		lb			

(1) This equation follows the approach presented by A2LA, not that typically used in uncertainty calculations; i.e., STDEV of the Mean. (2) This value is unique for type (model) of equipment.

(3) This uncertainty represents an expanded uncertainty expressed as approximately the 95% confidence level using a coverage factor of k=2.

Verified By: DS Input By: ______ Reviewed By: ______ Checked By: RY

File: ______

Remarks: ______

2000.2 (05/14/07) Fric1498, 2-16-2009 3/3/2009 FUGRO CONSULTANTS INC

HGL Instrument Verification

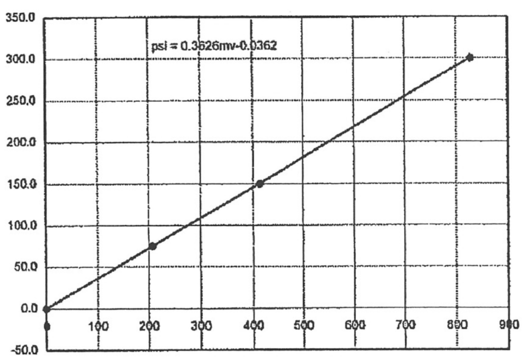
DATE: 2/16/2009 Instrument No.: pt Location: Houston LVDT?: [ ] Yes; [X] No

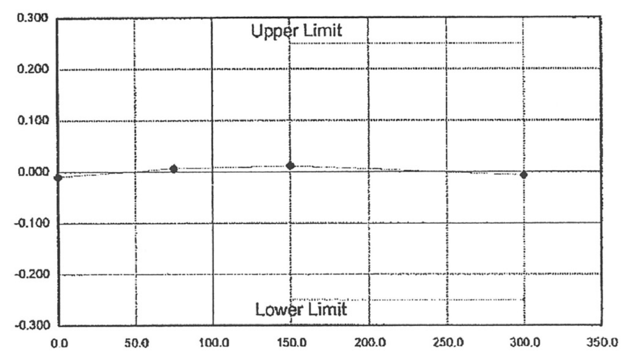
Type Analysis: [X] BF; [ ] NonBF; [X] FS; [ ] Abs. Reading Resolution of Instrument: 0.000001

Instrument Identification/Data	
Type	Cone Penetrometer
Manufacturer	Fugro
Model Number	F7.5CKEW2/B
Serial Number	1701-1576-7056-1-133 (Piezo)
HGL Instrument Number	pt
Excitation (V)	
Gain/Span Setting	NA
Full Range Output (V)	
Full Range/Capacity (psi)	360
Date Verified	2/16/2009
Date Due	2/16/2010
Service Status	In Service
Accept. Abs. or FS Error (%)	0.25 [X] FS; [ ] Abs.
Verification/Standard Equipment	
Type	PT(ANSI/NCSL APPROVED)
Manufacturer	Eaton
Model Number	UPS3000CC
Serial Number	A0813
HGL Instrument Number	
Date Verified	
Temperature	°C = °F
Linear Regression, Uncertainty, & Error Summary	
Correlation Coeff. (R^2)	0.999999916
Intercept (psi)	-0.036248388
Slope (psi/mv)	0.362594071
Verification (Calib.) Factor	0.36259407
Verification Factor Units	psi/mv
Absolute Zero (V)	
Floating Zero (V)	
Combined Uncertainty (psi)	0.004725147
Coverage Factor	2
Expanded Uncertainty (psi)	0.009450294
Max. Abs. or FS Error (%)	0.01 [X] FS; [ ] Abs.

Instrument mv	Standard psi	Prediction psi	Abs. Error psi	Full Scale Error (%)
0.000000	0.0	0.0	0.0	-0.01
207.000000	75.0	75.0	0.0	0.01
413.900000	150.0	150.0	0.0	0.01
827.400000	300.0	300.0	0.0	-0.01

MTS [ ] Yes; [X] No





Uncertainity Budget Analysis For pt							
Source of Uncertainty	Value in psi	Distribution	Divisor	Type	Uncertainty (u_i)	u_i^2	Comments
Standard's Uncertainty		N	2.0000	B			
Abs. Error-STDEV[1]	0.0047	N	1.0000	A	0.0047	0.0000	
Resolution of Instrument	0.0000	R	3.4641	B	0.0000	0.0000	
Repeatability[2]		N	1.0000	A			
Resolution of Standard	#N/A	R	3.4641	B			
Combined Uncertainty	0.0047	Coverage Factor			2	for 95% confidence level.	
Expanded Uncertainty (Best Measurement Capability)[3]		0.009		psi			

(1) This equation follows the approach presented by A2LA, not that typically used in uncertainty calculations; i.e., STDEV of the Mean. (2) This value is unique for type (model) of equipment.

(3) This uncertainty represents an expanded uncertainty expressed as approximately the 95% confidence level using a coverage factor of k=2.

Verified By: DS Input By: ______ Reviewed By: ______ Checked By: RY

File:

Remarks:

ACCREDITED CALIBRATION CERTIFICATE 1991.01

interface
ADVANCED FORCE MEASUREMENT

LOAD CELL CALIBRATION CERTIFICATION

CUSTOMER : FUGRO CONSULTANTS INC.
ADDRESS : Houston,TX 77081
CONDITION: AS FOUND & FINAL S.O. #: 78664 P.O. #: L-2563
MODEL: FT451-50K SERIAL: 129739 BRIDGE: A CAPACITY: 50 Klbf
PROCEDURE: C-1257

INPUT RESISTANCE: 376.3 OHM OUTPUT RESISTANCE: 354.7 OHM
ZERO BALANCE : 0.166 %RO

TEST CONDITIONS

TEMPERATURE: 74 °F HUMIDITY: 30 % EXCITATION: 10 VDC

TRACEABILITY

FORCE STANDARD	: STD-14	NIST #: 822/273338-06	DUE: 15-MAR-10
STANDARD INDICATOR	: BRD295	NIST #: 512727	
TEST INDICATOR	: BRD297	NIST #: 512727	

SHUNT CALIBRATION

	Shunt (± 0.01%)	Output	Straight Line Conversion	Connections*
Tension	Kohm	.00000 mV/V	.0000 Klbf	
Compression	60 Kohm	-1.46285 mV/V	33.650 Klbf	-Out to +Exc

*For models wired with +Sense, -Sense, or -SCal leads, resistor connections are actually to these leads in place of +Exc, -Exc, or -Out respectively.

PERFORMANCE

	RATED OUTPUT	SEB OUTPUT	NONLINEARITY	HYSTERESIS	SEB
TENSION	.00000 mV/V	.00000 mV/V	.000 %FS	.000 %FS	± .000 %FS
COMPRESSION	-2.17387 mV/V	-2.17364 mV/V	-.027 %FS	.045 %FS	± .022 %FS

STATIC ERROR BAND (SEB) - The band of maximum deviations of the ascending and descending calibration points from a best fit straight line through zero OUTPUT. It includes the affects of NONLINEARITY, HYSTERESIS, and nonreturn to MINIMUM LOAD.

TEST LOAD APPLIED (Klbf)	RECORDED READINGS (mV/V) Tension	Compression
0		.00000
10		-.43434
20		-.86897
30		-1.30378
40		-1.73876
50		-2.17387
20		-.86994
0		-.00018

[illegible]

TECHNICIAN : ________ Josh Smith DATE :14-MAR-08

INTERFACE INC.
7401 EAST BUTHERUS DRIVE · SCOTTSDALE, ARIZONA 85260, U.S.A.
TELEPHONE (480)948-5555 · FAX (480)948-1924

F16-40-1266

ACCREDITED CALIBRATION CERTIFICATE 1991.01

INTERFACE
ADVANCED FORCE MEASUREMENT

LOAD CELL CALIBRATION CERTIFICATION

CUSTOMER : FUGRO CONSULTANTS INC.
ADDRESS : Houston,TX 77081
CONDITION: FINAL   S.O. #: 78664 P.O. #: L-2563
MODEL: FT451-50K   SERIAL: 129739   BRIDGE: A   CAPACITY: 12.5 Klbf
PROCEDURE: C-1257

INPUT RESISTANCE: 374.7 OHM   OUTPUT RESISTANCE: 353.0 OHM
ZERO BALANCE : -0.386 %RO

TEST CONDITIONS

TEMPERATURE: 75 °F   HUMIDITY: 30 %   EXCITATION: 10 VDC

TRACEABILITY

FORCE STANDARD	: STD-22	NIST #: 822/275431-07	DUE: 15-SEP-11
STANDARD INDICATOR	: BRD106	NIST #: 512727	
TEST INDICATOR	: BRD300	NIST #: 512727	

SHUNT CALIBRATION

	Shunt (± 0.01%)	Output	Straight Line Conversion	Connections*
Tension	60 Kohm	1.46154 mV/V	33.590 Klbf	-Out to -Exc
Compression	Kohm	.00000 mV/V	.0000 Klbf	

*For models wired with +Sense, -Sense, or -SCal leads, resistor connections are actually to these leads in place of +Exc, -Exc, or -Out respectively.

PERFORMANCE

	RATED OUTPUT	SEB OUTPUT	NONLINEARITY	HYSTERESIS	SEB
TENSION	.54411 mV/V	.54388 mV/V	-.073 %FS	.066 %FS	± .044 %FS
COMPRESSION	.00000 mV/V	.00000 mV/V	.000 %FS	.000 %FS	± .000 %FS

STATIC ERROR BAND (SEB) - The band of maximum deviations of the ascending and descending calibration points from a best fit straight line through zero OUTPUT. It includes the effects of NONLINEARITY, HYSTERESIS, and nonreturn to MINIMUM LOAD.

TEST LOAD APPLIED (Klbf)	RECORDED READINGS (mV/V) Tension	Compression
0.0	.00000	
2.5	.10868	
5.0	.21743	
7.5	.32609	
10.0	.43489	
12.5	.54411	
5.0	.21779	
0.0	.00026	

[illegible]

TECHNICIAN : Josh Smith   DATE :14-MAR-08

INTERFACE INC.
7401 EAST BUTHERUS DRIVE · SCOTTSDALE, ARIZONA 85260, U.S.A.
TELEPHONE (480)948-5555 · FAX (480)948-1924

F15-40-1206

PAGE 1 OF 1

Empire Calibration, Inc.
9219 Katy Fwy, Suite 201
Houston, TX 77024
Tel: 713-464-1116
Fax: 713-464-1118

Certificate of Calibration

Calibration report # PG-XPE-001-08

Customer: Fugro Consultants, Inc.
Geotechnical Laboratory
6100 Hillcroft
Houston TX 77081
Zhong Zheng

Type of Instrument: Pressure
Manufacturer: EATON
Model #: UPS 3000 CC
Serial #: A0813
Laboratory ID #: XPE-001

Calibration Tech : Chris Garcia
Calibration date: 11/11/2008
Calibration due: 11/11/2010

Reference standards used: ASTM D5720-95
Empire Calibration procedure used: EC-PRS-220

Environmental conditions.
Temperature : 22 - 24 deg C
Relative Humidity: 50 - 55 %

Full scale reading : 500 psi | 100 psi | 250 psi
Tolerance: +/- 2 psi | +/- 1 psi | +/- 2 psi

AS FOUND

Reference Pressure psi	psi	Deviation psi
0.00	0.0	0
51.33	51.1	-0.21
103.42	103.0	-0.42
154.87	154.6	-0.24
199.66	199.3	-0.32
258.43	258.7	0.27
301.53	300.9	-0.63
352.56	351.9	-0.66
404.77	403.8	-0.97
449.69	448.7	-0.99
499.71	498.6	-1.11

AS FOUND

Reference Pressure psi	psi	Deviation psi
0.00	0.08	0.08
10.33	10.24	-0.09
20.42	20.31	-0.11
30.51	30.26	-0.25
40.21	39.89	-0.32
50.77	50.43	-0.34
61.23	60.78	-0.45
70.05	69.65	-0.40
80.77	80.34	-0.43
90.44	89.97	-0.47
101.11	100.56	-0.55

AS FOUND

Reference Pressure psi	psi	Deviation psi
0.00	0.04	0.04
26.51	26.32	-0.19
49.89	49.67	-0.22
75.66	75.18	-0.48
101.10	100.75	-0.35
124.78	124.36	-0.42
150.98	150.56	-0.42
175.33	174.78	-0.55
200.89	200.33	-0.56
224.60	224.21	-0.39
247.89	247.11	-0.78

Calibration report # RG-XPE-001-08

Adjustments made : No

Comments:

Instruments used.

Instrument	Serial number	Cal date	Cal due
Fluke 500 PSI Pressure Module	93650707	4/24/2008	4/24/2009

This calibration was performed using processes having test uncertainty ratios of four or more times greater (4:1) than the instrument or parameter being calibrated, unless otherwise noted. All uncertainties expressed are expanded uncertainties and have been estimated at the 95% confidence level (k=2).

The instrument listed in this report has been tested and calibrated using equipment whose accuracy is traceable to the National Institute of Standards and Technology and was done in compliance with ISO/IEC 17025:2005 and ANSI/NCSL Z540-1.

The calibration performed on this instrument and the information contained in this report are provided in order to maintain compliance with ASTM D5720-95 and to improve the accuracy and reliability of this instrument.

ACCREDITED
Certificate # 1201.01

Certified by: Chris Garcia

Date: 11/11/2008

Chris Garcia
Empire Calibration, Inc.

Empire Calibration, Inc.
9219 Katy Freeway, Suite 201
Houston, TX 77024

Tel: (713) 464-1116
Fax: (713) 464-1118

Certificate of Calibration

Calibration report # Therm-C95005824-08

Customer: Fugro Consultants, Inc.
Geotechnical Laboratory
6100 Hillcroft
Houston TX 77081
Zhong Zheng

Type of Instrument: Digital Thermometer
Manufacturer: Digi - Sense
Model #: 8528-40
Serial #: C95005824
Laboratory ID #: TD 001

Calibration Tech : Chris Garcia
Calibration date: 11/12/2008
Calibration due: 11/12/2009

Reference standards used: ASTM E220; E1137; E608
Empire Calibration procedure used: EC-TMP-220

Condition as found: In tolerance
Condition as left: In tolerance

Environmental conditions.
Temperature : 20-21 deg C
Relative Humidity: 41-43%

Type of Temperature Sensor: K

Reference Temp. (°F)	AS FOUND (°F)	Deviation (°F)
0.0	0.8	0.8
100.0	99.6	-0.4
200.0	199.6	-0.4
300.0	299.8	-0.2
400.0	399.9	-0.1
500.0	500.0	0.0
700.0	700.0	0.0
1000.0	1000.0	0.0

Reference Temp. (°F)	AS LEFT (°F)	Deviation (°F)
0.0	0.8	0.8
100.0	99.6	-0.4
200.0	199.6	-0.4
300.0	299.8	-0.2
400.0	399.9	-0.1
500.0	500.0	0.0
700.0	700.0	0.0
1000.0	1000.0	0.0

Tolerance: +/- 3.96 °F

Calibration report # Therm-C95005824-08

Adjustments made : No

Comments:

Instruments used.

Instrument	Serial number	Cal date	Cal due
Omega CL23A	T-216366	5/2/2008	5/2/2009

This calibration was performed using processes having test uncertainty ratios of four or more times greater (4:1) than the instrument or parameter being calibrated, unless otherwise noted. All uncertainties expressed are expanded uncertainties and have been estimated at the 95% confidence level (k=2).

The instrument listed in this report has been tested and calibrated using equipment whose accuracy is traceable to the National Institute of Standards and Technology and was done in compliance with ISO/IEC 17025:2005 and ANSI/NCSL Z540-1.

The calibration performed on this instrument and the information contained in this report are provided in order to maintain compliance with the listed test method(s) (per the parameters checked in this report) and/or the manufacturers or customers specifications.

ACCREDITED
Certificate # 1201.01

Certified by: Chris Garcia   Date: 11/12/2008

Chris Garcia
Empire Calibration, Inc.

Post-Job Calibration Verification

Calibration Verification Certificate

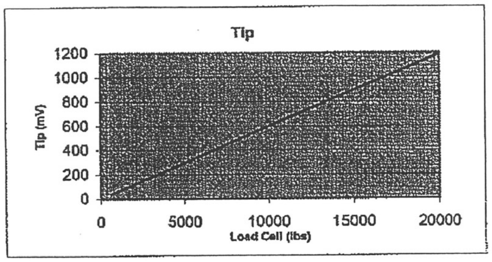
Device Type: Piezo Cone Penetrometer

Device Number: **F7.5CKEW2/B 1701-1498**

TIP CALIBRATION

Tip area = 15 cm2 = 0.0161 ft2
Tip readings in mV

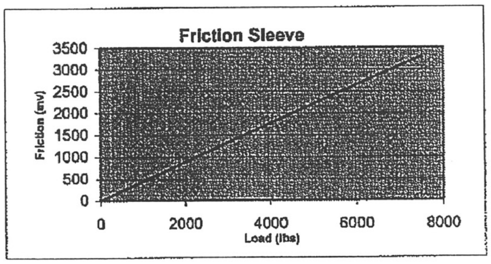
Load lb	Load Tons	load/area tsf	Tip mV	TIP Cal Factor Mpa
0	0	0	0	0
600	0.3	18.63354	35.6	50.1224832
5005	2.5025	155.4348	297.4	50.0488893
7490	3.745	232.6087	445.2	50.0331664
10020	5.01	311.1801	595.4	50.0484023
15040	7.52	467.0807	893.8	50.0424786
19990	9.995	620.8075	1188.2	50.0327729



FRICTION CALIBRATION

Sleeve area = 200 cm2 = 0.2153 ft2
Friction readings in mV

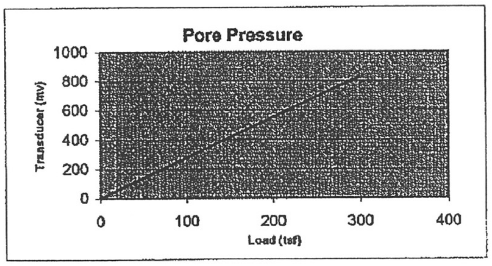
Load lb	Load Tons	load/area tsf	Friction mV	Friction Cal Factor Mpa
0	0	0	0	0
505	0.2525	1.172782	221.7	0.50656929
2505	1.2525	5.817464	1101.5	0.50575059
3520	1.76	8.17464	1548.2	0.50562527
4990	2.495	11.58848	2193.9	0.50582104
7505	3.7525	17.42917	3299.6	0.50582766



PORE PRESSURE TRANSDUCER CALIBRATION

Serial : 7056-1-133
Pore Pressure readings in mV

Pressure psi	Pressure tsf	Transducer readings mV	P.Pres. Cal Factor Mpa
0	0	0	0
75	5.4	207	2.49810456
150	10.8	413.9	2.49870812
300	21.6	827.4	2.4999161



Temperature Calibration (30 - 115 degrees F)

Temp (deg	TIP (mV)	FRIC (mV)	PIEZO (mV)
30	0.985	0.874	-0.742
50	1.023	0.924	-0.201
75	1.278	1.112	0.278
100	1.323	1.201	0.943
115	1.446	1.541	1.783

Deviation	mV	Mpa	% Full Scale
Tip	0.461	0.02305	0.0461
Friction	0.667	0.000334	0.0667
Piezo	2.525	0.006313	0.2525

TIP CALIBRATED BY INTERFACE (A2LA APPROVED) LOAD CELL:
Model FT451-50K, Serial No. 129739
FRICTION CALIBRATED BY INTERFACE (A2LA APPROVED) LOAD CELL:
Model FT451-50K, Serial No. 129739
PORE PRESSURE TRANSDUCER CALIBRATED BY EMPIRE CALIBRATION, INC (AANSI/NCSL APPROVED)
Pressure Indicator Model: UPS3000CC, Serial : A0813
TEMPERATURE CALIBRATED BY EMPIRE CALIBRATION, INC (A2LA APPROVED)
Model # 8528-40, Serial # C95005824, ID # TD-001

For Dennis Stauffer With Permission

Calibration Verified by: Dennis Stauffer SC Date: 2/16/2009

Checked By : Recep Yilmaz RY Date: 2/16/2009

Calibration Verification Certificate

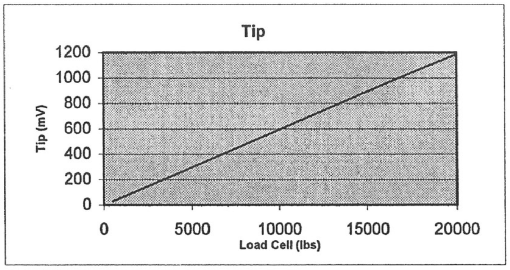
Device Type: Piezo Cone Penetrometer

Device Number: **F7.5CKEW2/B 1701-1498**

TIP CALIBRATION

Tip area = 15 cm2 = 0.0161 ft2
Tip readings in mV

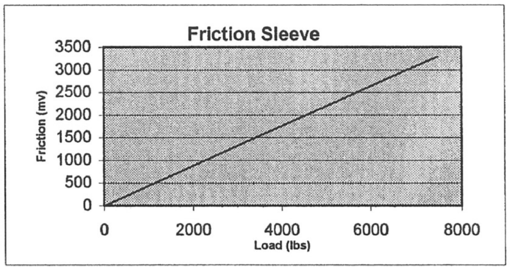
Load lb	Load Tons	load/area tsf	Tip mV	TIP Cal Factor Mpa
0	0	0	0	0
500	0.25	15.52795	29.7	50.066229
4990	2.495	154.9689	296.5	50.0503564
7510	3.755	233.2298	446.3	50.0431198
10005	5.0025	310.7143	594.4	50.0575533
15015	7.5075	466.3043	892.1	50.0544996
20010	10.005	621.4286	1188.8	50.0575533



FRICTION CALIBRATION

Sleeve area = 200 cm2 = 0.2153 ft2
Friction readings in mV

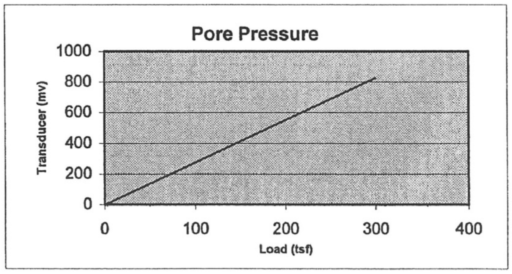
Load lb	Load Tons	load/area tsf	Friction mV	Friction Cal Factor Mpa
0	0	0	0	0
500	0.25	1.16117	220.3	0.50474111
2490	1.245	5.782629	1095.9	0.50529104
3505	1.7525	8.139805	1542.8	0.50523283
5000	2.5	11.6117	2198.4	0.50579725
7490	3.745	17.39433	3295.3	0.50547541



PORE PRESSURE TRANSDUCER CALIBRATION

Serial : 7056-1-133
Pore Pressure readings in mV

Pressure psi	Pressure tsf	Transducer readings mV	P.Pres. Cal Factor Mpa
0	0	0	0
75	5.4	206.9	2.49931196
150	10.8	414	2.49810456
300	21.6	828.1	2.4978029



Temperature Calibration (30 - 115 degrees F)

Temp (deg	TIP (mV)	FRIC (mV)	PIEZO (mV)
30	0.990	0.863	-0.643
50	1.134	0.899	-0.197
75	1.352	0.994	0.307
100	1.457	1.107	0.875
115	1.509	1.423	1.621

Deviation	mV	Mpa	% Full Scale
Tip	0.519	0.02595	0.0519
Friction	0.560	0.00028	0.056
Piezo	2.264	0.00566	0.2264

TIP CALIBRATED BY INTERFACE (A2LA APPROVED) LOAD CELL:
Model FT451-50K, Serial No. 129739
FRICTION CALIBRATED BY INTERFACE (A2LA APPROVED) LOAD CELL:
Model FT451-50K, Serial No. 129739
PORE PRESSURE TRANSDUCER CALIBRATED BY EMPIRE CALIBRATION, INC (AANSI/NCSL APPROVED)
Pressure Indicator Model: UPS3000CC, Serial : A0813
TEMPERATURE CALIBRATED BY EMPIRE CALIBRATION, INC (A2LA APPROVED)
Model # 8528-40, Serial # C95005824, ID # TD-001

Calibration Verified by: Sheldon Collins Date: 3/11/2009

Checked By : Recep Yilmaz Date: 3/11/2009

HGL Instrument Verification

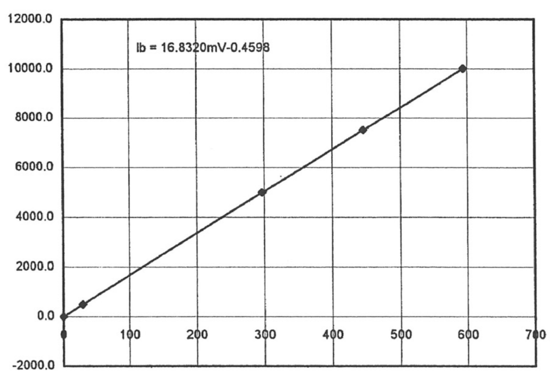
DATE: 3/11/2009 Instrument No.: ft Location: Houston LVDT?: [ ] Yes; [X] No

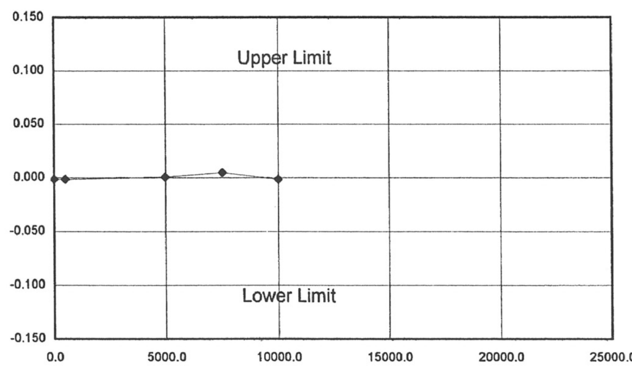
Type Analysis: [X] BF; [ ] NonBF; [X] FS; [ ] Abs. Reading Resolution of Instrument: 0.000001

Instrument Identification/Data	
Type	Cone Penetrometer-TIP
Manufacturer	Fugro
Model Number	F7.5CKE3SW2/B
Serial Number	1701-1498(Tip)
HGL Instrument Number	ft
Excitation (V)	
Gain/Span Setting	NA
Full Range Output (V)	
Full Range/Capacity (lb)	33716
Date Verified	3/11/2009
Date Due	3/11/2010
Service Status	In Service
Accept. Abs. or FS Error (%)	0.1 [X] FS; [ ] Abs.
Verification/Standard Equipment	
Type	Load Cell (A2AL APPROVED)
Manufacturer	INTERFACE
Model Number	FT451-50K
Serial Number	129739
HGL Instrument Number	
Date Verified	
Temperature	°C = °F
Linear Regression, Uncertainty, & Error Summary	
Correlation Coeff. (R^2)	0.999999988
Intercept (lb)	-0.459770079
Slope (lb/mV)	16.83195614
Verification (Calib.) Factor	16.83195614
Verification Factor Units	lb/mV
Absolute Zero (V)	
Floating Zero (V)	
Combined Uncertainty (lb)	0.17795124
Coverage Factor	2
Expanded Uncertainty (lb)	0.355902481
Max. Abs. or FS Error (%)	0.00 [X] FS; [ ] Abs.

Instrument mV	Standard lb	Prediction lb	Abs. Error lb	Full Scale Error (%)
0.000000	0.0	-0.5	0.5	0.00
29.700000	500.0	499.4	0.6	0.00
296.500000	4990.0	4990.2	0.2	0.00
446.300000	7510.0	7511.6	1.6	0.00
594.400000	10005.0	10004.5	0.5	0.00
892.100000	15015.0	15015.3	0.3	0.00
1188.800000	20010.0	20009.4	0.6	0.00

MTS [ ] Yes; [X] No





Uncertainity Budget Analysis For ft							
Source of Uncertainty	Value in lb	Distribution	Divisor	Type	Uncertainty (u_i)	u_i^2	Comments
Standard's Uncertainty		N	2.0000	B			
Abs. Error-STDEV[1]	0.1780	N	1.0000	A	0.1780	0.0317	
Resolution of Instrument	0.0000	R	3.4641	B	0.0000	0.0000	
Repeatability[2]		N	1.0000	A			
Resolution of Standard	#N/A	R	3.4641	B			
Combined Uncertainty	0.1780	Coverage Factor		2		for 95% confidence level.	
Expanded Uncertainty (Best Measurement Capability)[3]		0.356		lb			

(1) This equation follows the approach presented by A2LA, not that typically used in uncertainty calculations; i.e., STDEV of the Mean. (2) This value is unique for type (model) of equipment.

(3) This uncertainty represents an expanded uncertainty expressed as approximately the 95% confidence level using a coverage factor of k=2.

Verified By: SC Input By: Reviewed By: Checked By: RY

File:

Remarks:

HGL Instrument Verification

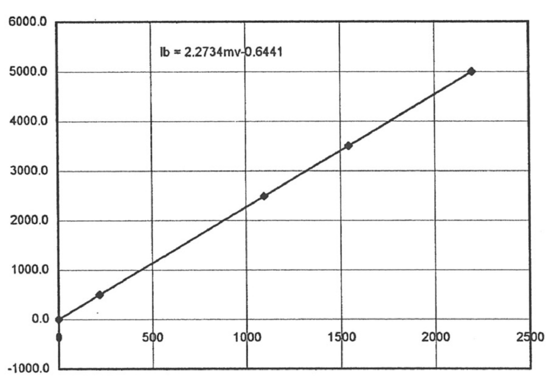
DATE: 3/11/2009 Instrument No.: ft100 Location: LVDT?: [ ] Yes; [X] No

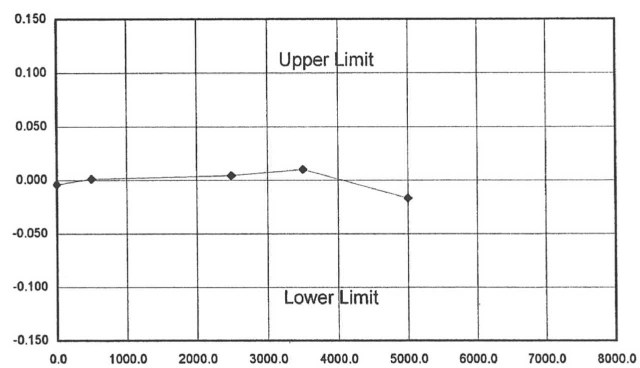
Type Analysis: [X] BF; [ ] NonBF; [X] FS; [ ] Abs. Reading Resolution of Instrument: 0.000001

Instrument Identification/Data	
Type	Cone Penetrometer
Manufacturer	Fugro
Model Number	F7.5CKEW2/B
Serial Number	1701-1498 (Friction)
HGL Instrument Number	ft100
Excitation (V)	
Gain/Span Setting	NA
Full Range Output (V)	
Full Range/Capacity (lb)	16858
Date Verified	3/11/2009
Date Due	3/11/2010
Service Status	In Service
Accept. Abs. or FS Error (%)	0.1 [X] FS; [ ] Abs.
Verification/Standard Equipment	
Type	Load Cell (A2AL APPROVED)
Manufacturer	INTERFACE
Model Number	FT451-50K
Serial Number	129739
HGL Instrument Number	
Date Verified	
Temperature	°C = °F
Linear Regression, Uncertainty, & Error Summary	
Correlation Coeff. (R^2)	0.999999679
Intercept (lb)	-0.64407662
Slope (lb/mv)	2.273380399
Verification (Calib.) Factor	2.27338040
Verification Factor Units	lb/mv
Absolute Zero (V)	
Floating Zero (V)	
Combined Uncertainty (lb)	0.394103417
Coverage Factor	2
Expanded Uncertainty (lb)	0.788206834
Max. Abs. or FS Error (%)	-0.02 [X] FS; [ ] Abs.

Instrument mv	Standard lb	Prediction lb	Abs. Error lb	Full Scale Error (%)
0.000000	0.0	-0.6	0.6	0.00
220.300000	500.0	500.2	0.2	0.00
1095.900000	2490.0	2490.8	0.8	0.00
1542.800000	3505.0	3506.7	1.7	0.01
2198.400000	5000.0	4997.2	2.8	-0.02
3295.300000	7490.0	7490.8	0.8	0.00

MTS [ ] Yes; [X] No





Uncertainity Budget Analysis For ft100							
Source of Uncertainty	Value in lb	Distribution	Divisor	Type	Uncertainty (u_i)	u_i^2	Comments
Standard's Uncertainty		N	2.0000	B			
Abs. Error-STDEV[1]	0.3941	N	1.0000	A	0.3941	0.1553	
Resolution of Instrument	0.0000	R	3.4641	B	0.0000	0.0000	
Repeatability[2]		N	1.0000	A			
Resolution of Standard	#N/A	R	3.4641	B			
Combined Uncertainty	0.3941		Coverage Factor		2	for 95% confidence level.	
Expanded Uncertainty (Best Measurement Capability)[3]		0.788		lb			

(1) This equation follows the approach presented by A2LA, not that typically used in uncertainty calculations; i.e., STDEV of the Mean. (2) This value is unique for type (model) of equipment.

(3) This uncertainty represents an expanded uncertainty expressed as approximately the 95% confidence level using a coverage factor of k=2.

Verified By: SC Input By: Reviewed By: Checked By: RY

File:

Remarks:

HGL Instrument Verification

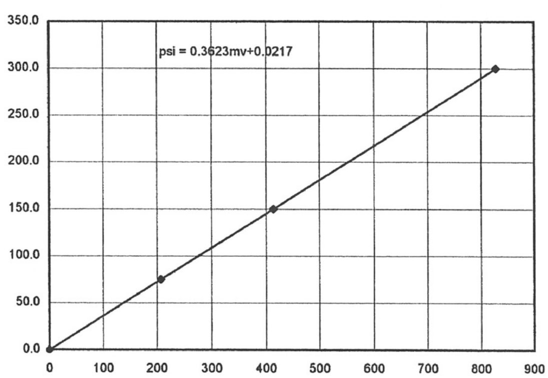
DATE: 3/11/2009 Instrument No.: pt Location: Houston LVDT?: [ ] Yes; [X] No

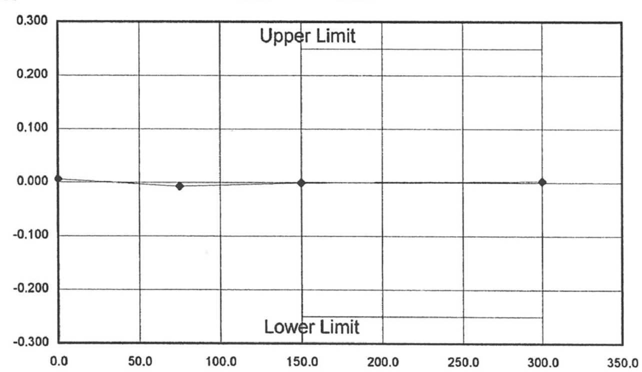
Type Analysis: [X] BF; [ ] NonBF; [X] FS; [ ] Abs. Reading Resolution of Instrument: 0.000001

Instrument Identification/Data	
Type	Cone Penetrometer
Manufacturer	Fugro
Model Number	F7.5CKEW2/B
Serial Number	1701-1576-7056-1-133 (Piezo)
HGL Instrument Number	pt
Excitation (V)	
Gain/Span Setting	NA
Full Range Output (V)	
Full Range/Capacity (psi)	360
Date Verified	3/11/2009
Date Due	3/11/2010
Service Status	In Service
Accept. Abs. or FS Error (%)	0.25 [X] FS; [ ] Abs.
Verification/Standard Equipment	
Type	PT(ANSI/NCSL APPROVED)
Manufacturer	Eaton
Model Number	UPS3000CC
Serial Number	A0813
HGL Instrument Number	
Date Verified	
Temperature	°C = °F
Linear Regression, Uncertainty, & Error Summary	
Correlation Coeff. (R^2)	0.999999974
Intercept (psi)	0.021738929
Slope (psi/mv)	0.36225883
Verification (Calib.) Factor	0.36225883
Verification Factor Units	psi/mv
Absolute Zero (V)	
Floating Zero (V)	
Combined Uncertainty (psi)	0.005582219
Coverage Factor	2
Expanded Uncertainty (psi)	0.011164439
Max. Abs. or FS Error (%)	-0.01 [X] FS; [ ] Abs.

Instrument mv	Standard psi	Prediction psi	Abs. Error psi	Full Scale Error (%)
0.000000	0.0	0.0	0.0	0.01
206.900000	75.0	75.0	0.0	-0.01
414.000000	150.0	150.0	0.0	0.00
828.100000	300.0	300.0	0.0	0.00

MTS [ ] Yes; [X] No





Uncertainity Budget Analysis For pt							
Source of Uncertainty	Value in psi	Distribution	Divisor	Type	Uncertainty (u_i)	u_i^2	Comments
Standard's Uncertainty		N	2.0000	B			
Abs. Error-STDEV[1]	0.0056	N	1.0000	A	0.0056	0.0000	
Resolution of Instrument	0.0000	R	3.4641	B	0.0000	0.0000	
Repeatability[2]		N	1.0000	A			
Resolution of Standard	#N/A	R	3.4641	B			
Combined Uncertainty	0.0056	Coverage Factor			2	for 95% confidence level.	
Expanded Uncertainty (Best Measurement Capability)[3]		0.011		psi			

(1) This equation follows the approach presented by A2LA, not that typically used in uncertainty calculations; i.e., STDEV of the Mean.

(2) This value is unique for type (model) of equipment.

(3) This uncertainty represents an expanded uncertainty expressed as approximately the 95% confidence level using a coverage factor of k=2.

Verified By: SC Input By: ________ Reviewed By: ________ Checked By: RY

File:

Remarks: