Supplement to the Zekkos et al (2004) 2nd International Site Characterization Conference paper
Available by the Geoengineer website at: http://www.geoengineer.org/zekkosetal-isc2004.html

Table 1: Sources of error, uncertainty and bias in performance of the Standard Penetration Test (SPT)

Category	Type of source	Effect	Quantitative or qualitative influence on N value	Source
A. Sources depending on type of soil				
A-1	Vertical Stress	Vertical stress affects confinement of sample	Increased vertical stress increases N values. Apply Liao and Whitman (1986a) factor	Liao and Whitman (1986a)
A-2	Mineralogy	Limited data. Significant influence	N-value decreases 55% with 10% added mica without decrease in friction angle	Barthelamy (1974)
A-3	Coarse gravel or cobbles in soil	Sampler becomes clogged or impeded	Increases greatly N value	Kulhawy and Mayne (1990)
A-4	Minor horizontal stress	Important influence. In-situ horizontal stress have at least twice the proportional affect of vertical stress	Higher horizontal stresses increase the N value.	Schmertmann (1975)
A-5	Geologically aged sand deposits	Geologically aged sand deposits may be affected by ageing processes (diagenesis, cementation, bonding) or jointing	Increase or decrease depending on the process	Barton (1990)
B. Sources due to presence of water				
B-1	Pore pressures	Pore pressure development depends on rate of penetration.	In dense soil faster rate of penetration reduces N, in loose soil increases N. Not quantified yet	Schmertmann (1975)

B-2	Moisture sensitive behavior of geologically aged sands	Reduction in strength due to moisture sensitive behavior	Reduction in N value	Barton (1990)
C. Reducible sources related to equipment and its maintenance				
C-1	Energy Ratio	Uncertainty depends on type of hammer used, cathead, rope, and whether the energy ratio was measured.	Recommendations provided in ASTM D6066-96 and Youd et al. (2001)	ASTM D6066-96, Youd et al. 2001
C-2	Borehole diameter	Larger borehole diameter reduces confinement.	Decrease N value. Apply deterministic correction factors based on NCEER recommendations (Youd et al. 2001)	Youd et al. 2001
C-3	Sampler	Different samplers (diameter, thickness) affect the resistance to penetration. Use only standard sampler.	For standard sampler without liners N values decrease. Apply deterministic correction factors for liners based on NCEER recommendations (Youd et al. 2001)	Youd et al. 2001
C-4	Rod Length	Rod length affects bending of rods.	Smaller lengths increase N value. Apply deterministic correction factors based on NCEER recommendations (Youd et al. 2001)	Youd et al. 2001
C-5	Lack of hammer free fall because of ungreased	Hammer energy reduced	Increases	Kulhawy and Mayne (1990)

	sheaves, new stiff rope on weight			
C-6	Use of bent drill rods	Inhibited transfer of energy of sampler	Increases	Kulhawy and Mayne (1990)
C-7	Bottom vs. side discharge bits	Do not use bottom discharge bits, because disturb tested soil	Bottom discharge bits decrease N value	ASTM 1586-99
C-8	Type of drilling equipment	Some influence expected.	Depends on drilling equipment. Use ASTM 1586-99 recommendations	ASTM 1586-99
D. Reducible sources with careful site investigation procedure				
D-1	Inadequate cleaning of hole	SPT is not made in original in-situ soil, and therefore soil may become trapped in sampler and be compressed as sampler is driven, reducing recovery	Increases	Kulhawy and Mayne (1990)
D-2	Failure to maintain adequate head of water in the borehole	Bottom of borehole may become quick	Decreases	Kulhawy and Mayne (1990)
D-3	Hammer weight inaccurate	Hammer energy varies (driller supplies weight; variations of 5-7% are common)	Increases or decreases	Kulhawy and Mayne (1990)
D-4	Careless measurement of hammer drop	Hammer energy varies	Increases or decreases	Kulhawy and Mayne (1990)
D-5	Sampler driven above bottom of	Sampler driven in artificially densified soil	Increases greatly	Kulhawy and Mayne (1990)

	casing			
D-6	More than two turns on cathead	Decreases energy ratio	Increases. Quantified in ASTM. Avoid by performing test according to ASTM 1586-99.	ASTM 1586-99
D-7	Hammer strikes drill rod collar eccentrically	Hammer energy reduced	Increases	Kulhawy and Mayne (1990)
D-8	Incomplete release of rope in each drop	Hammer energy reduced	Increases	Kulhawy and Mayne (1990)
D-9	Tightness of connections	Loose connections reduce energy transfer	Increases	
E-10	Careless blow count	Inaccurate results	Increases or decreases	Kulhawy and Mayne (1990)
E. Irreducible sources in investigation procedure				
E-1	Human factor	Tired driller decrease the energy in the system. Mood of driller	Unquantified	
E-2	Weather and site conditions	Difficult conditions will affect N values.	Unquantified	