EXPLANATION SHEET CPTu Testing, Calibration & PPDT

CPTu

IGS undertakes all CPTu testing using "industry best practice". Part of this is to follow the intent of the de facto "world benchmark standard" ISO 22476-1-2012. IGS will normally establish several CPTu cones to your site that have all sensors calibrated to exceed that ISO standard's highest-level requirement.

As our experience shows that CPTu sensors all drift slightly with use, we will commit to (a) provide fresh calibrations for every cone used at the start of your job and (b) re-calibrate every deployed cone at the end of the job. Re-calibrations will be compared to pre-job calibrations to confirm CPT accuracy during the whole project. Note that this is IGS "business as usual". We calibrate, q_c, f_s, u and NAR (Net Area Ratio).


INTERNATIONAL STANDARD

ISO 22476-1

First edition 2012-06-15

Geotechnical investigation and testing — Field testing —

Part 1: Electrical cone and piezocone penetration test

Reconnaissance et essais géotechniques — Essais en place — Partie 1: Essais de pénétration au cône électrique et au piézocône

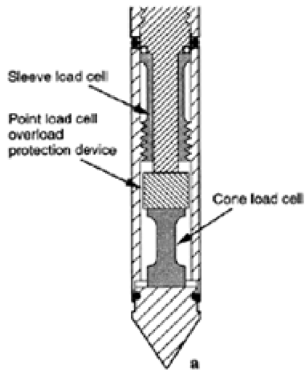
We refer you to the attached sheet with every quotation that explains IGS's system of "Test Methods". Normal run-of-the-mill CPTu testing (done by everyone) is covered by Method IGS-2S or IGS-2C. Note that this can be a trade-off between pore pressure response and productivity, with a bias to productivity (to suit many clients' wishes).

A more rigorous approach to management of pore pressure response is covered under the IGS Method IGS-3S and IGS-3C (or even IGS-4C/ 4S). We will seek your direction on the Test Method to adopt before each test - or overall for the project. But, if given no direction, our "default" will be Method 3C or 3S. Note that as some materials are dilatant, rigorous management of pore pressure response under these categories can slow test rates (ie productivity) somewhat.

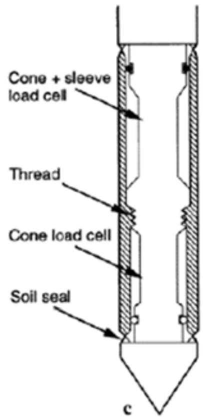
S & C Type Cones

Both C-Type and S-Type can be piezo or non-piezo. If piezos the piezometer elements are the same in each - there is no difference in the accuracy of pore pressure readings made by either cone type.

Each cone type has a load cell 100% focused on measurement of tip resistance - there is no difference in the accuracy of tip readings made by either C-Type or S-Type cones.



In a C-Type cone the sleeve load cell is sized to suit the sleeve load capacity of the cone. This must arguably make it at least potentially more sensitive than determination of sleeve resistance by an S-Type cone; a small load cell is used to measure a small load. However, it also limits the sleeve capacity available and in hard and dense soils this can "refuse" a test long before tip capacity is reached.



In an S-Type cone the sleeve friction is determined by subtracting the reading of one large load cell from that of another large load cell. This must arguably make it at least potentially less sensitive than determination of sleeve resistance by a C-Type cone. However in an S-Type cone there is effectively no limit to the sleeve capacity and thus in hard and dense soils deeper tests are typically possible.

There is no doubt that an S-Type cone is more stable during a test and during a job, showing less "drift" and less need for adjustment or repair during the calibration process. It is also much stronger and more durable physically and hence less damage/drift prone. In addition, IGS' highest resolution cones, our 3 & 10 MPa are S-type cones.

Calibration

Any CPT cone must be calibrated properly over the range that it will be working. <u>There is an obvious and clear connection between the materials you intend to test and the appropriate capacity of the cone and the rigour of the calibration undertaken.</u>

All of our cones are calibrated in three stages, over the bottom 1% of the full-scale range, over the bottom 10% of the full-scale range and then over the full-scale range of the load cells. Several points are calibrated in each of the range sections.

The same rigour is applied to calibration of the tip qc, sleeve friction f_s and pore pressure u.

During the calibration of pore pressure, qc changes induced by the pore pressure changes are also plotted, yielding a very high quality and proper calibration of the Net Area Ratio; a cone parameter that is required for calculating qt from qc and pore pressure.

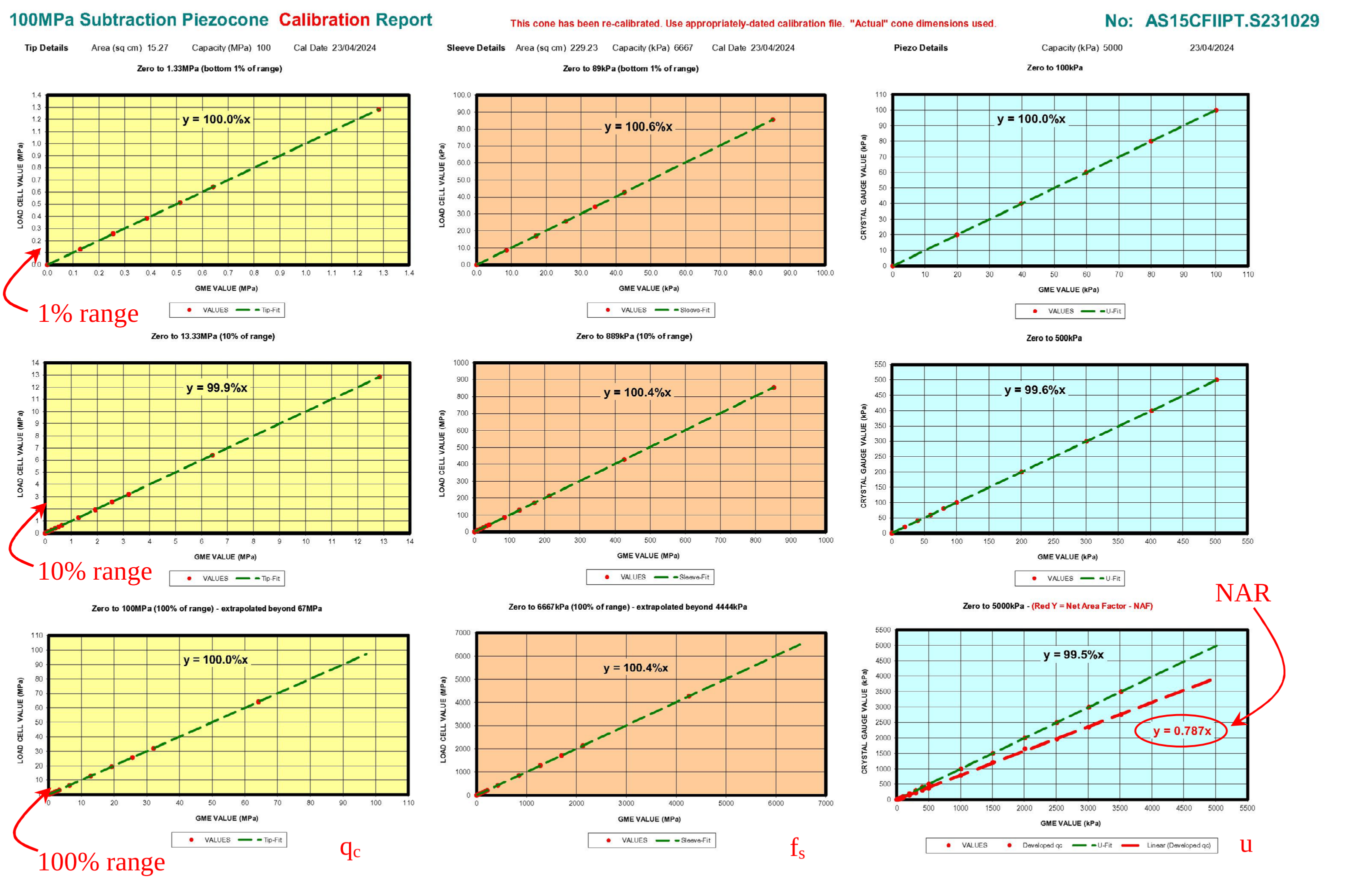
Actual cone dimensions and ratios are measured at every calibration and the actual dimensions are taken into account.

Load cells inside CPT cones are designed to work over a significant portion of their elastic range so that the strain gauges have something significant to measure. This leads to the load cells being susceptible to drift with test frequency. While this strain-related drift is typically relatively small, in CPTs load cell accuracy is critical. Also, it just makes good sense to make sure that the equipment you are using to test something (for someone) is actually measuring correctly.

None of the international standards take calibration frequency very seriously – requirements range from 6-12 month intervals or even intervals based on an operator's observations of "what looks right'. Reliance on Reference Value or Zero Offset drift, while convenient is "questionable".

IGS has a policy of calibrating before and after any and every project, and at no longer than seven working-days' intervals on longer jobs. This is a high-quality process and one that leads to very good outcomes. A calibration report is provided with each cone calibration.

An example of a Calibration Report is presented below –



CONE IDENTIFICATION AND DIMENSIONS SHEET
100 MPa Subtraction Piezocone

Note that this cone calibration has been undertaken taking these "actual" dimensions into account
cone area 15.27 cm2 sleeve area 229.23 cm2

INSITU GEOTECH SERVICES
reducing geotechnical uncertainty

	NOMINAL TIP		
Cone No	AS15CFIIPT.S231029		
Type	SUBTRACTION		
Tip Area (sq cm)	15	15.27	actual tip area
Tip Capacity (MPa)	100		deviation = 1.8%
Calibration Date	23 April 2024		

MEASURED TIP DIMENSIONS			ISO 22476-1-2012 requirements			
CD	44.10		43.20	to	44.10	mm
CH	37.40		29	to	38	mm
S	11.60		9	to	12	mm
A	60.00		55	to	65	degrees

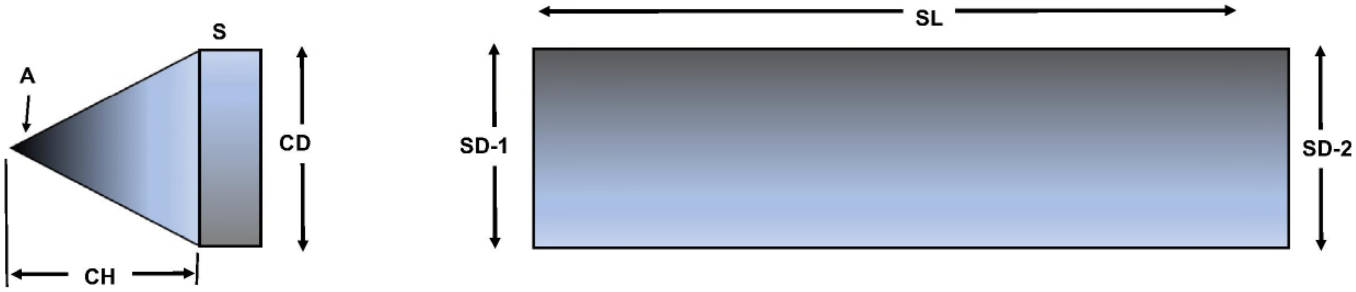
	NOMINAL SLEEVE		
Cone No	AS15CFIIPT.S231029		
Type	SUBTRACTION		
Sleeve Area (sq cm)	225	229.23	actual sleeve area
Sleeve Capacity (kPa)	6667		deviation = 1.9%
Calibration Date	23 April 2024		

MEASURED SLEEVE DIMENSIONS			ISO 22476-1-2012 requirements			
SD-1	44.15		44.10	to	44.45	max 44.2
SD-2	44.18		44.10	to	44.45	max 44.2
SL	165.21		162.3	to	165.3	

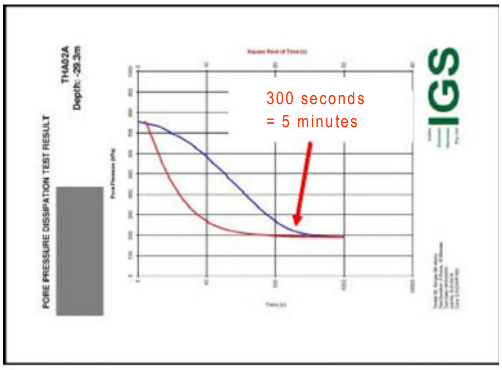
	PORE PRESSURE
Cone No	AS15CFIIPT.S231029
Type	SUBTRACTION
Piezo Capacity (kPa)	5000
Calibration Date	23 April 2024

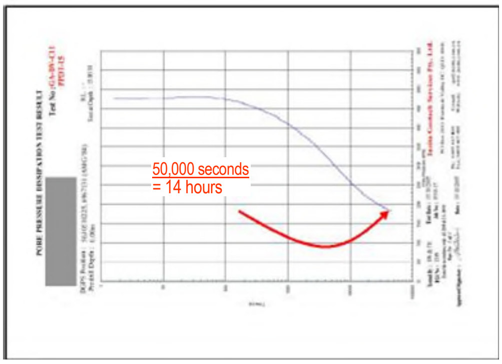
CALIBRATED BY	BD	
DATE	23/04/2024	
NOTES		

CHECKED BY		
DATE		
NOTES		



PPDT (Pore Pressure Dissipation Testing)





Pore Pressure Dissipation Tests in fine-grained materials can run very quickly - eg a few minutes, or very slowly, over a few hours. The time taken depends on the material permeability and on the degree of dissipation being sought. Typically, clients request 50% - ie $t_{50,}$ but some clients pursue higher dissipation percentages; 90% is common enough.

Note that in the event that dissipations run slowly or you are keen to achieve high % dissipations, we can run tests overnight (or longer) - usually achieving around 90% or better over (say) a 12-14 hour test period. A unit rate can be quoted for this; it is a cost-effective process.

The adjacent test plots show PPDT results from two very different materials - the top one reached 100% dissipation in 5 minutes, the lower one took 14 hours (overnight) to achieve something like 90%.

The best-possible Pore Pressure Dissipation Test results are normally achieved if IGS-3C or IGS-3S (or IGS-4C/S) Method testing is adopted for the CPTu.

Note that IGS always adopts very rigorous lab-based piezometer filter saturation procedures, and on the rig subjects each piezo-cone to a final vacuum under de-aired fluid before starting each CPTu push, to achieve the best-achievable overall pore pressure response throughout the test and during dissipations, for any CPTu Method.

MANAGEMENT OF TRANSIENT TEMPERATURE EFFECTS

All respectable cone manufacturers provide CPT load cells that are accurate under any practical stable operating temperature; this is a relatively simple design feature and allows the manufacturers to state that their cones are "temperature compensated", which they mostly do claim. Note the emphasis here on "stable operating temperature".

However, no CPT cones known to IGS are stable during the time in which the cone is changing from one temperature to another – the period of transient temperature change as shown in the Figure below. This effect is noted one way or another in all international standards but is pretty much ignored in much day-to-day testing practice by many/most operators (just ask them if you are in doubt about this).

The only practical way for this to be managed is to halt the CPT push progress when significant temperature changes are under way, and to wait for the cone temperature to stabilise – typically about 10 minutes. This effects: (a) the start of any CPT push as the ground is unlikely to be the same temperature as the cone; and (b) any push that penetrated strong material (which heats the cone) and then continues down through softer material (as the cone cools down).

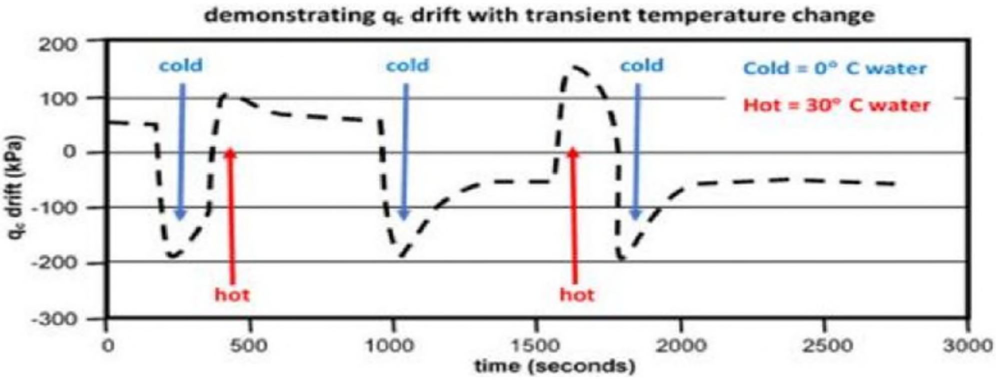


Figure - Changes in zero load q_c values at varying temperatures

This is why IGS' test methods require pauses in the test to allow stabilisation of the temperature of the cone;

At the commencement of any test - "conduct a cone stabilisation for approximately 10 minutes to allow the temperature of the cone to stabilise. This stabilisation shall occur within the first 0.5 to 1.5 metres".

If penetrating into soft materials below strong materials (especially below dense sands) - "the push is to be interrupted for approximately 10 minutes as close as reasonably possible below the interface between the high strength and low strength soils".