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Hand Vane Tester
SL810

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User Guide
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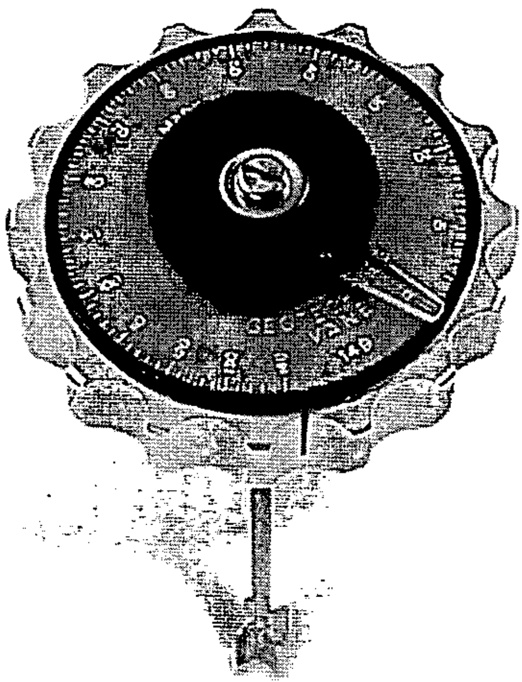
GUIDELINE FOR HAND HELD SHEAR VANE TEST



NZ GEOTECHNICAL SOCIETY INC

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CONTENTS

Preface

The New Zealand Geotechnical Society prepared a draft guideline in 2001, which was distributed to Society members and soil testing laboratories in New Zealand for comment. Following receipt of comments, the guideline was finalized and published.

The committee responsible for preparation of the guideline were Geoffrey Farquhar, Stephen Crawford, Roger High and Steven Anderson.

1.0 Introduction

This guideline has been prepared to help avoid problems in the use of the hand held shear vane in engineering practice. Some users follow the recommendation of Pilcon, the principal vane manufacturer, to use the dial reading as the undrained shear strength, while others use the BS1377 calculation to determine undrained shear strength. This variation in practice has led to confusion, loosely written specifications and contractual disputes.

In response to this problem, the New Zealand Geotechnical Society has developed this guideline for use of the hand held shear vane. The guideline includes a recommended test method for using a hand shear vane, recommendations for the use of the vane in particular applications, and a model clause for earthworks specifications. The test method contained in the Appendix is also published separately to facilitate its use and referencing by IANZ accredited laboratories. Use of this guideline will assist in standardising use of the hand shear vane in geotechnical practice and should minimise confusion and contractual disputes.

2.0 Background

Traditionally Pilcon has been the brand of hand held shear vane used in NZ. Pilcon state that the dial reading is the undrained shear strength, based on correlation with quick undrained compression tests on samples of London Clay. The Pilcon manufacturer uses this empirical calibration to calibrate each vane spring, and each vane dial is individually engraved to match its spring. Pilcon acknowledge that some engineers prefer the BS1377 calculation and have engraved conversion factors on the dial for the two vane blade sizes, 19 mm and 33 mm diameter. However the conversion factors do not take into account changes in blade dimensions and changes in spring stiffness. The BS1377 calculation divides the torque required to shear the soil by the surface area of the cylinder of soil sheared by the vane blade.

There have been two common approaches to reporting the Vane Shear Strength, either:

- use of the dial reading as the undrained strength (Pilcon's recommendation), or
- use of the BS1377 calculation.

This leads to reported Vane Shear Strengths differing by 30% to 50%. Additional confusion over the use of the shear vane has occurred recently with the entry of new brands of shear vane other than Pilcon into the market.

Regular calibration (usually annually and/or to IANZ requirements) of the vane is required to account for changes in its spring stiffness, changes in blade dimensions due to wear, and spring and blade replacement. A calibration should also be carried out if damage to the vane head or blade is suspected. Calibration involves determining the spring constant by applying a known torque to the vane using a series of weights. The blade dimensions are measured using vernier calipers. Thus using the BS1377 calculation, a calibration chart or factor can be devised for a particular vane set (vane head and vane blade) relating the dial reading to the BS1377 value.

There are significant differences between the two BS1377 test methods (for the laboratory vane and the in situ or large field vane) and the proposed New Zealand Geotechnical Society test method for the hand vane (refer to Appendix).

3.0 Recommended Practice

3.1 It is recommended that the Vane Shear Strength of cohesive soils, measured by hand held shear vane in New Zealand geotechnical practice and earthworks quality control testing, be determined using the BS1377 calculation.

3.2 It is recommended that the dial reading adjusted using the BS1377 calculation be referred to as the **Vane Shear Strength**.

3.3 It is recommended that use of the hand held shear vane conform to the test method presented in the Appendix, and to the procedures and practice outlined in this guideline.

4.0 Undrained Shear Strength

As noted in the introduction, some users use the dial reading as the undrained strength, some use the dial reading adjusted using the BS1377 calculation, and others use different values. Users are cautioned to make their own interpretation of the undrained shear strength in relation to the Vane Shear Strength.

5.0 Particular Applications of the Hand Held Shear Vane

5.1 Using the Shear Vane in Boreholes and Pits

5.1.1 The shear vane can be used in boreholes and pits with extension rods. The maximum length of extension rods that can be practically used without bending is about 3 to 4 metres for stiff soils and 4 to 5 metres for medium strength soils. Note that use of too many rods can lead to problems where the full torque being applied by the vane head is not transferred to the blade. Rods shall be of sufficient stiffness for the intended application. To avoid damaging the spring, use both spanners when attaching or detaching extension rods.

5.1.2 In boreholes and pits, the vane blade must be pushed sufficiently below the depth of soil disturbed by augering, excavation or drilling, but do not push the extension rods into the soil.

5.1.3 Report the depth of each test.

5.1.4 It is conventional on borehole and pit logs to report results where both Vane Shear Strength and Remoulded Vane Shear Strength are measured, as Vane Shear Strength/Remoulded Vane Shear Strength, e.g. 95/32 (kPa).

5.2 Using the Shear Vane in Drill Core or Tube Sample

5.2.1 Where the shear vane is used either in the end of drill core while it is still inside the core barrel or in the end of a sample within a thin wall sample tube, it should be noted on the borehole log so that it is clear that the test has not been performed in the bottom of the borehole.

5.2.2 The material being tested should always be confined, i.e. the test should not be performed on extruded core.

5.2.3 Vane Shear Strengths obtained from tests in drill core and tube samples are usually regarded as indicative only.

6.0 Model Clause For Shear Vane Testing In Earthworks Specifications

The clause below gives typical information for use in an earthworks specification. A clause of this type must be based on laboratory testing of materials specific to each project site.

Shear Vane Testing

Parameter	Test and standard	Location & frequency	Average Vane Shear Strength (Note 1)	Running Average of any 10 consecutive Average Vane Shear Strengths (RATA or Running Average of Ten Averages)
Vane Shear Strength	Test Method for Determining the Vane Shear Strength of a Cohesive Soil using a Hand Held Shear Vane, NZ Geotechnical Society, 2001	Each compacted layer, 1 per .... m^3 (Note 2)	.... kPa minimum (Note 3)	.... kPa minimum (Note 3)

Note 1 The Average Vane Shear Strength shall comprise the average of 4 Vane Shear Strengths taken over the test site (a 1 m^2 area). Tests must be performed in a location within the test area where the test is not influenced by the disturbance caused by previous tests.

The individual Vane Shear Strengths should be reported together with the calculated Average Vane Shear Strength. Strengths should be reported to the nearest 1 kPa.

Where there is a significant difference in the Vane Shear Strengths for one location, i.e. more than 20%, and this difference is due only to natural variation in the soil, report the strengths as a range, e.g. 95 to 126 kPa. If one strength is considered erroneous and should be rejected, e.g. due to a rock or stone in the soil, report the Vane Shear Strength with a note as to why it should be rejected. Also report if the erroneous reading is excluded from the calculated Average Vane Shear Strength.

Note 2 The frequency of Vane Shear Strength testing depends on the scale of the earthworks.

Note 3 Minimum values depend on material type and the results of laboratory and/or field testing.

The hand shear vane used for testing shall have a current calibration.

APPENDIX

Test Method for Determining the Vane Shear Strength of a Cohesive Soil using a Hand Held Shear Vane
New Zealand Geotechnical Society, 2001

1.0 Scope

1.1 This test covers the determination of the Vane Shear Strength of a cohesive soil by means of a hand held shear vane.

2.0 Apparatus

1.2 Vane head (torsion head), complete with pointer, stop pin, circumferential graduated scale, calibrated torsion spring and serial number.

1.3 Vane blades: The standard size 19 mm diameter by 29 mm high vane blade including shaft with thread for connecting directly to vane head or to extension rods. Alternative blade sizes are available for softer materials. The area ratio of the vane, expressed as a percentage, as given by the following equation, shall be as low as possible and shall not exceed 25%.

$$\text{Area ratio} = \left[\frac{8T(D-d)+\pi d^2}{\pi D^2} \right] \times 100$$

where

D is the overall blade width measured to 0.1mm (in mm).
T is the thickness of the blades measured to 0.01 mm (in mm).
d is the diameter of vane rod, including any enlargement due to soldering, measured to 0.1mm (in mm).

1.4 Extension rods: Rods shall be of sufficient stiffness for the intended application.

1.5 Calibration chart or factor for the particular vane kit giving the Vane Shear Strength for the dial readings. The chart or factor bears the serial numbers of both the vane head and vane blade, and is only applicable to the particular vane head and blade.

1.6 Carrying case complete with two spanners for disconnecting the vane blades and an adaptor to connect extension rods to the vane head.

3.0 Procedure

1.7 Check that the soil type to be tested is cohesive and suitable for Vane Shear Strength determination by the shear vane (very sandy or brittle soils are unsuitable).

1.8 Record the serial number of the vane head and the vane blade to be used on the appropriate test sheet.

1.9 Check that the vane head and vane blade are both clean and dry, and that the pointer is free to move and does not stick at any position on the head.

1.10 Check that the vane blade is the correct size and is not bent, worn or damaged. Check that the vane blade shaft is not bent or damaged. It is important to fit the vane blade to the vane head using both spanners to avoid damaging the spring.

1.11 Hold the shear vane perpendicular to the soil surface and push the vane blade into the soil to a depth at least twice the length of the vane blade, usually 70 to 80 mm and which is sufficient to ensure that shearing will take place on the vertical edges of the vane blade without movement of the undisturbed soil surface. The depth of vane embedment should not exceed the length of the vane blade shaft. Avoid any excessive sideways movement when pushing the vane into the soil. Where the vane is unable to be pushed into the soil to the required depth, the test shall be regarded as finished (refer to reporting of results in section 5.1.2).

1.12 Check that the vane pointer is at the correct starting position on the vane head.

1.13 Hold the vane head in one hand (or both hands) clear of the pointer and rotate the vane head at a uniform rate of one revolution per minute, i.e. slowly. This can be checked against the second hand of a watch. Do not load the spring beyond the maximum value on the dial or the calibration chart, otherwise the spring could be damaged.

1.14 When the soil shears, the force on the torsion device is released and the pointer registers the maximum deflection to which the spring was subjected. Record the maximum deflection reading to the nearest whole unit, from the scale on the vane head appropriate to the blade size. Using the calibration chart or factor, convert this reading to the Vane Shear Strength.

1.15 If the soil shears radially without the presence of normal shear failure, either when inserting the vane blade or during the test, then the soil is possibly too brittle or hard or too coarse grained for an accurate test. In this situation, repeat steps 3.3 to 3.8 and if it occurs again, record the fact that the soil was unsuitable for a shear vane test and explain the reason why.

1.16 If a remoulded strength is required, the vane should not be removed from the soil after step 3.8. The vane head should be turned five complete rotations at a speed of approximately 10 seconds per rotation, and steps 3.6 to 3.8 repeated.

1.17 After the tests are completed, dismantle the vane rods, clean and dry the vane blade, wipe the vane head and replace it in its carrying box together with the calibration chart. It is important to dismantle the vane blade from the vane head using both spanners to avoid damaging the spring.

4.0 Calculation

4.1 Calculate the Vane Shear Strength of the soil, τ (in kPa), from the equation:

τ = M/K

where

M is the torque to shear the soil (in Nm).
K is a constant depending on dimensions and shape of the vane.

Assuming the distribution of the shear strength is uniform across the ends and around the curved surface of a cylinder, then:

$K = \pi D^2 H/2 \times (1 + D/3H) \times 10^{-6}$

where

D is the overall width of vane measured to 0.1 mm (in mm).
H is the height of vane measured to 0.1 mm (in mm).

4.2 This calculation is normally done as part of calibration of the vane. Either calculated values are given for the dial readings on the calibration chart or a factor is given for the particular vane kit.

5.0 Reporting

5.1 Report the following:

5.1.1 The test method.

5.1.2 The Vane Shear Strength of the soil. The abbreviation τ can be used. Where the vane could not be pushed into the soil to the required depth, the result shall be reported using the abbreviation UTP (Unable To Penetrate). Where the strength is greater than that able to be measured by the vane, i.e. the pointer reaches the maximum value on the dial without the soil shearing, the result shall be reported in either of the following two ways, e.g. 195+ kPa or >195 kPa.

5.1.3 The Remoulded Vane Shear Strength if carried out. The abbreviation τ_r can be used.

5.1.4 The soil description of the material tested (reference 6.4). A general term such as "fill" may be used where the test is part of earthworks testing.

5.1.5 The location of the test site, its Reduced Level (if known) or the depth from a defined surface.

5.1.6 The date of test.

5.2 Field or laboratory records shall also include the following information which need not necessarily be reported with the test results:

5.2.1 The name of the person who carries out the test.

5.2.2 The serial numbers of the vane head and blade, and the blade dimensions.

5.2.3 Vane head or dial reading for each test (peak, remoulded).

6.0 References

6.1 Head, K.H. (1992) Manual of Soil Laboratory Testing. Vol 1: Soil Classification and Compaction Tests – 2nd Ed.

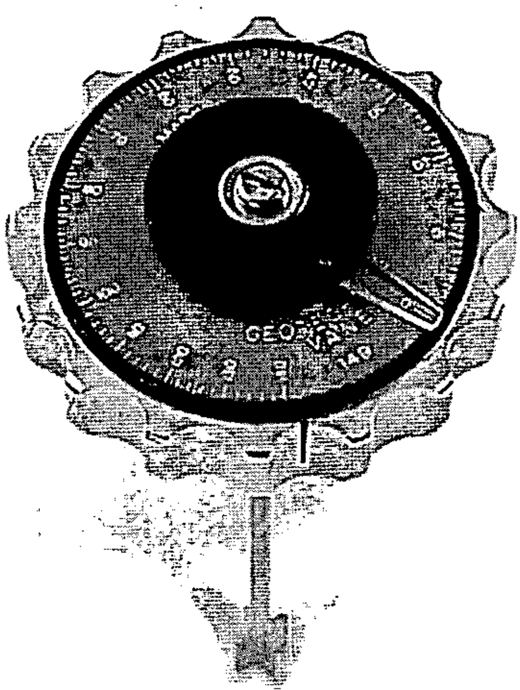
6.2 BS1377: Part 7:1990 Method 3 - Determination of shear strength by the laboratory vane method.

6.3 BS1377: Part 9:1990 Method 4.4 - Determination of the in-situ vane shear strength of weak cohesive soils.

6.4 New Zealand Geotechnical Society Guidelines for the Field Description of Soils and Rocks in Engineering Use.

6.5 New Zealand Geotechnical Society Guideline for Hand Held Shear Vane Test, August 2001.

TEST METHOD FOR DETERMINING THE VANE SHEAR STRENGTH OF A COHESIVE SOIL USING A HAND HELD SHEAR VANE



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5.2.2 The serial numbers of the vane head and blade, and the blade dimensions.

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6.3 BS1377: Part 9:1990 Method 4.4 - Determination of the in-situ vane shear strength of weak cohesive soils.

6.4 New Zealand Geotechnical Society Guidelines for the Field Description of Soils and Rocks in Engineering Use.

6.5 New Zealand Geotechnical Society Guideline for Hand Held Shear Vane Test, August 2001.

<u>Service Instructions for the SL810 Impact Shear Vane</u>

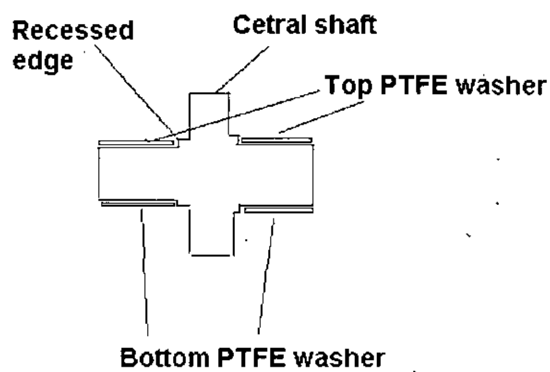
NB This is intended as a guide only. Serious repairs should be forwarded to Geotechnics Ltd (we will provide as much information as possible in the event of serious damage, with the intention that the unit will not need to be sent back to NZ)

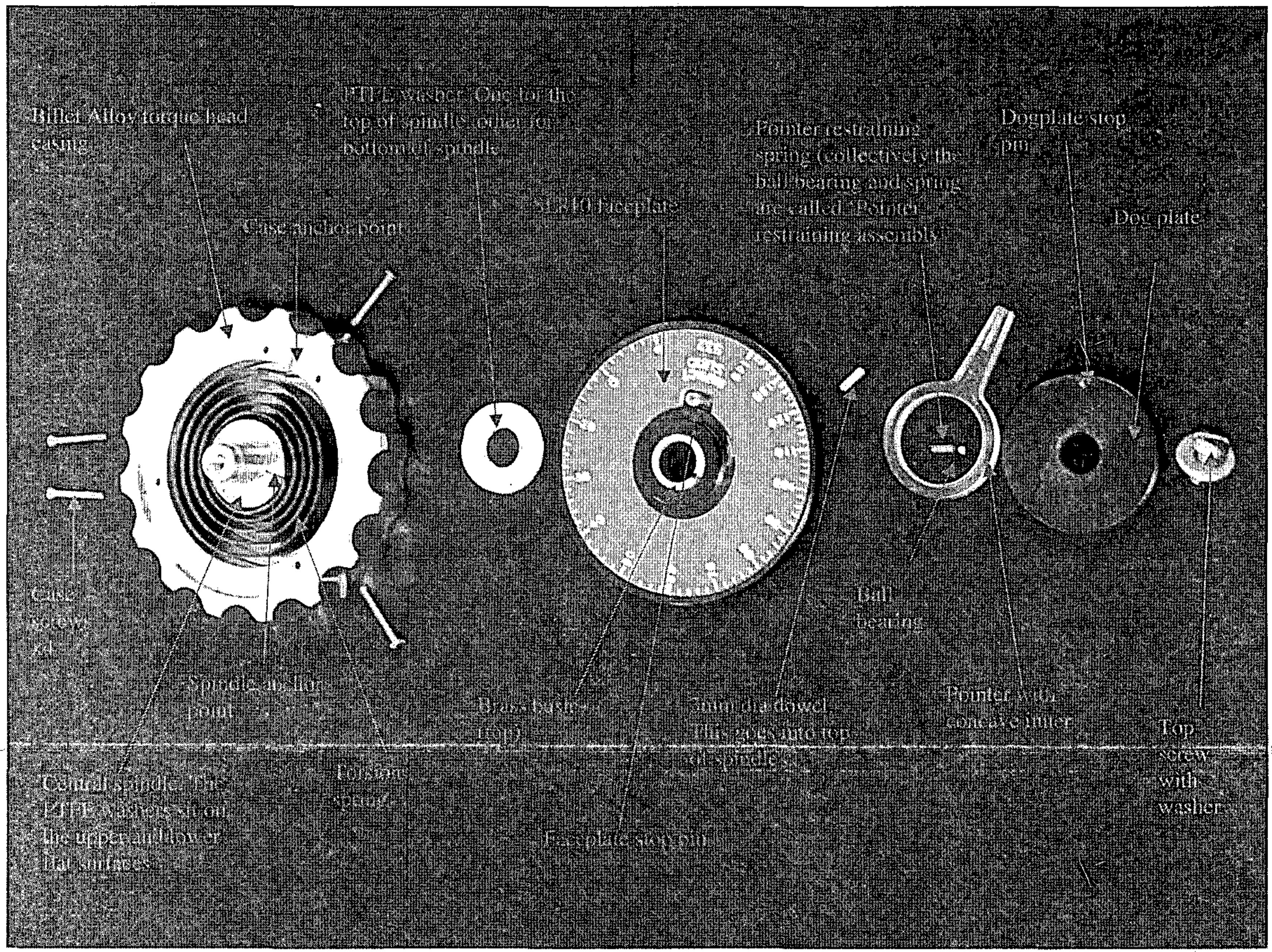
Dismantle instructions

- Remove top screw and washer
- Remove the black oxide coated dog plate. This can be hard to remove sometimes, so we suggest that you carefully lever the dog plate off using two flat head screwdrivers on opposite sides of the dog plate. Carefully lever the dog plate away from the unit.
- With a pair of needle nose pliers, remove the 3mm dowel that can be seen at the top of the central spindle. This dowel has a tapered edge which should go into the hole in the spindle. Please note that if you insert this dowel too far (for re-assembly) it will impede the Top Screw.
- Remove the four case screws from the underside of the Billet Alloy casing
- Gently tap the underside of the spindle (which can be seen poking out of the bottom of the Alloy casing) with a soft rubber mallet. You will notice that this will lift the faceplate.
- Remove face plate
- Remove the top PTFE washer. Sometimes this can get stuck onto the underside of the faceplate.

Re-assembly instructions

- Reverse dismantle instructions
- Be careful to align the PTFE washers so that they sit into the small machined recesses on the spindle itself. If these washers are not aligned properly the torque will not turn when fully re-assemble. I have included a crude sketch below which I hope indicates this.




Billet Alloy torque head casing
PTFE washer. One for the top of spindle, other for bottom of spindle
SL810 Faceplate
Pointer restraining spring (collectively the ball bearing and spring are called "Pointer restraining assembly")
Dogplate stop pin
Dog plate
Case anchor point
Case screws x4
Spindle anchor point
Brass bush (top)
3mm dia dowel. This goes into top of spindle
Ball bearing
Pointer with concave inner
Top screw with washer
Central spindle. The PTFE washers sit on the upper and lower flat surfaces
Torsion spring
Faceplate stop pin