

6000 SERIES OF PNEUMATIC DEADWEIGHT TESTERS

USER MANUAL



SI-BARNET DEADWEIGHT TESTER

6000 SERIES

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Please read these instructions carefully prior to installing and using the Tester. The pressure built up internally during use can be extremely high. Ensure that all connections are made correctly.

SPECIFICATIONS

MODEL:	Single Piston, Pressure or Vacuum. External Pressure or Vacuum supplied via Input Connector (1/8"BSP Female)
RANGE:	Pressure (see Table 1) Page 3. Vacuum (see Table 2) Page 3.
ACCURACY:	(see Calibration Certificate)
TRACEABILITY:	NIST, NVLAP Accredited Calibration Optional
STANDARD CORRECTIONS:	Gravity: 9.80665 m/s ² Temperature: 20 °C Air Density: 1.2 kg / cu.m
WEIGHTS:	Non-magnetic Stainless Steel contained in Wooden case (Pressure) Non-magnetic Stainless Steel contained in Plastic case (Vacuum conversion kit).
OPERATING MEDIUM:	Dry, high purity Nitrogen from external source or Vacuum via external pump.
WEIGHT:	6390 DWT 9 Kg. Weights: 40 Kg. 6410 Kit: 3 Kg.
DIMENSIONS:	6390 DWT 455 x 340 x 400 6410 Conversion kit 320 x 300 x 110 max.
STANDARD ACCESSORIES:	See Table 3. Page 9.
OPTIONAL ACCESSORIES:	See Table 3. Page 9.
ORDERING CODES:	Pressure: See Table 1. Page 3. Vacuum Conversion Kit: See Table 2. Page 3.

DESCRIPTION

The SI-BARNET 6000 SERIES of pneumatic Deadweight Testers provide reliable primary standards of PRESSURE and VACUUM for use in all calibration environments.

The testers consist of precision piston/cylinder (PCU) assemblies of known effective area mounted onto a rigid aluminum baseplate. Stainless Steel weights of known mass are mounted onto the PCU assemblies and are balanced by either pressure or vacuum until they "float" and spin freely thus generating a known pressure. A pressure gauge to monitor system pressure and control valves to finely adjust pressure are mounted to the base, which can be leveled by means of three adjustable feet and a spirit level.

The set of non-magnetic weights is housed in a sturdy wooden carrying case and comes complete with a set of "quick-fit" adaptors and seals for easy mounting of the items under test to the Deadweight Tester.

A list of standard and optional accessories is shown in Table 3, Page 9.

There are basically two models available :-

MODEL 6390.....PRESSURE ONLY

See Table 1. for pressure ranges and model numbers.

MODEL 6410.....VACUUM CONVERSION KIT. CONVERTS MODEL 6390 FOR VACUUM USE.

See Table 2. for vacuum ranges and model numbers.

Model 6390 requires an EXTERNAL PRESSURE SOURCE of clean dry air or gas, usually in the form of bottled gas fitted with a pressure regulator to control the output pressure to a maximum of 700 psi. We STRONGLY RECOMMEND the use of DRY, HIGH PURITY NITROGEN, known as "WHITE SPOT" nitrogen for this purpose.

It is most important that only clean, dry gas is used as any contamination will seriously affect the performance and may permanently damage the Deadweight Tester.

Model 6410 Vacuum Conversion requires an EXTERNAL VACUUM SOURCE usually in the form of an electrically operated vacuum pump.

CAUTION, TO AVOID DAMAGE TO INSTRUMENTS UNDER TEST:-

1. **DO NOT** apply positive pressure to a Vacuum instrument.
2. **DO NOT** apply vacuum to a positive Pressure instrument.

TABLE 1

MODEL NO.	PRESSURE RANGE			NO. WEIGHTS PER SET
	lbf/in ²	kgf/cm ²	bar	
6390-4	2 to 600			13
6390-5		0.1 to 40		14
6390-6			0.1 to 40	14

TABLE 2

VACUUM CONVERSION KIT NO.	VACUUM RANGE			NO. WEIGHTS PER SET
	In.Hg.	mm.Hg.	bar	
6410-4	-0.3 to -30"			11
6410-5		-7.6 to -760		14
6410-6			-0.01 to -1	15

INSTALLATION OF MODEL 6390 DEADWEIGHT TESTER

1. Refer to Figure 1 of this manual.
2. Close Valve (4) gently fully clockwise.
3. Open Valve (6) gently fully counterclockwise.
4. Connect air/gas supply at a maximum pressure of 700 psi to union (10) at the rear of the machine.
5. Level the Deadweight Tester by adjusting the three leveling feet (9) to the spirit level placed centrally on the weight carrier (3).
6. Select the correct "quick-fit" adaptor from the selection provided to suit the item(s) to be tested. Before fitting it ensure that the item(s) to be tested is/are internally clean. If oil, water, chemicals or dirt of any kind are sucked into the Deadweight Tester from contaminated instruments the PCU assemblies may be seriously damaged.
7. Fit the "quick-fit" adaptor to the item(s) to be tested using an appropriate seal from the selection provided and tighten with a suitable spanner.
8. Fit the item(s) under test to the Test Station(s) (8). Screw all the way down by hand only, no spanners are necessary.
9. The item(s) is/are now ready for test.

OPERATING PROCEDURE FOR MODEL 6390 DEADWEIGHT TESTER

1. Ensure air / gas supply is turned on at source and is available to the Deadweight Tester at 10% above the maximum test pressure required (700 PSI MAXIMUM).
2. Close Valves (4) and (6) gently fully clockwise.
3. Select the weights for the required pressure and place them onto the weight carrier (3). **THE PRESSURE GENERATED WILL BE THE SUM OF THE PRESSURES MARKED ON THE WEIGHTS PLUS THE PRESSURE MARKED ON THE WEIGHT CARRIER.**
4. Apply pressure to the system by SLOWLY opening Valve (4) anti-clockwise until the weights start to rise and then close again, gently fully clockwise. The weights should float at approximately Mid-travel of the PCU assembly i.e. the bottom of the first weight should be aligned with the 'red' line on the Indicator Rod (2) Refer to Figure 2. If the weights are too high or against the travel stop, open Valve (6) counterclockwise VERY SLOWLY and then close again quickly to lower the weights to their correct position. The approximate pressure in the system is indicated by the monitor gauge (5).
5. Spin the weights clockwise by hand at approximately 60 rpm and maintain the "floating" condition by adjusting Valves (4) and (6).
6. To increase pressure add the required weights to the weight stack and repeat the procedure as above. **WEIGHTS SHOULD NOT BE ADDED OR SUBTRACTED WHILE THE WEIGHT STACK IS STILL SPINNING.**
7. To decrease pressure ensure Valve (4) is closed fully clockwise and remove weights as required. SLOWLY open Valve (6) until the weights fall to the 'red' line once more. Spin the weight stack and maintain the "floating" condition as before.

IMPORTANT

1. DO NOT rotate the weight stack while against the top or bottom travel stops.
2. ALWAYS add and remove weights carefully.
3. DO NOT rapidly increase or decrease pressure in the system.

Failure to observe the above precautions could result in serious damage to the PCU assembly.

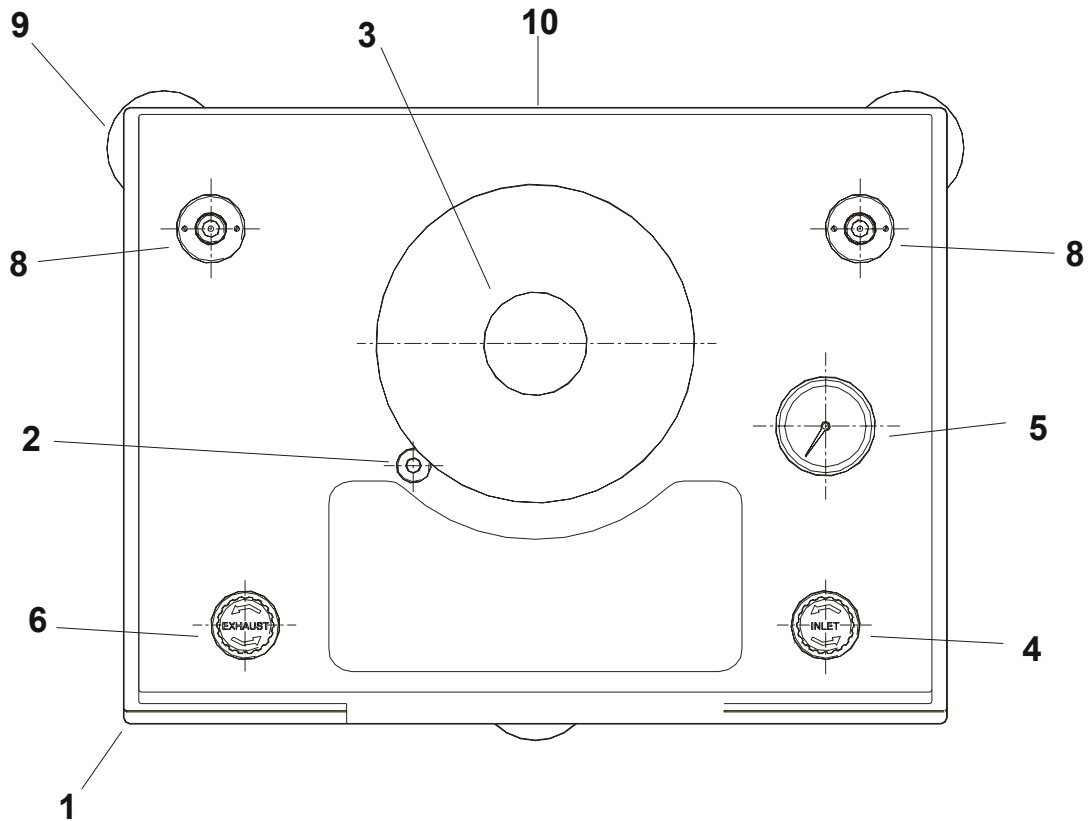
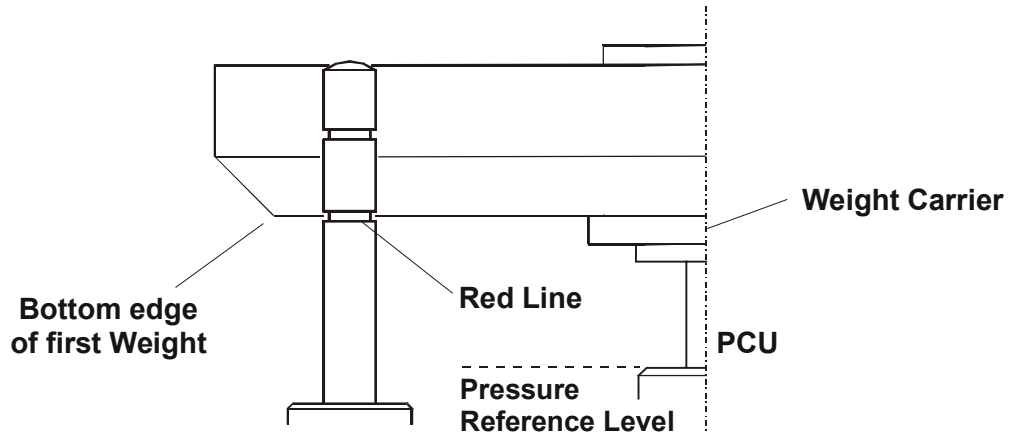
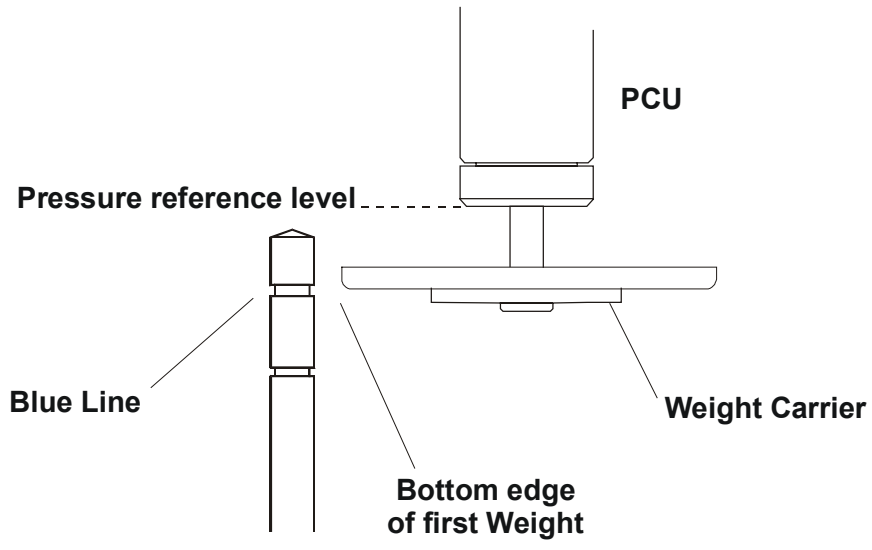


FIGURE 1
LAYOUT OF MODEL 6390 DEADWEIGHT TESTER

ITEM	DESCRIPTION
1.	Model 6390 Deadweight Tester
2.	Indicator Rod
3.	Weight Carrier
4.	Inlet Valve
5.	Monitor Gauge
6.	Outlet Valve (exhaust)
8.	Test Stations
9.	Leveling Feet
10.	Pressure Input Connection (1/8" BSP Female)



MODEL 6390



MODEL 6410

**FIGURE 2
'MID-FLOAT' POSITION OF MODELS 6390 AND 6410 WEIGHTS**

INSTALLATION OF MODEL 6410 VACUUM CONVERSION KIT

1. Refer to figure 3 on page 8 of this manual. Unscrew and remove the Pressure PCU/carrier assembly from its station (take great care not to touch the polished surface of the piston with fingers). Place in a sealable plastic bag and store in the 6410 case for safe keeping.
2. Fit the Vacuum Conversion assembly to the station. Position the assembly as required and then tighten the fixing screw by hand.
3. Open Valve (7) gently fully anti-clockwise.
4. Connect Vacuum supply to Union (10) at the rear of the machine.
5. Level the Deadweight Tester by adjusting the three leveling feet (9) to the spirit level placed on the weight carrier.
6. Select the correct "quick-fit" adaptor from the selection provided to suit the item(s) to be tested. **Before fitting it ensure that the item(s) to be tested is/are internally clean. If oil, water, chemicals or dirt of any kind are sucked into the Deadweight Tester from contaminated instruments the PCU assemblies may be seriously damaged.**
7. Fit the "quick-fit" adaptor to the item(s) to be tested using an appropriate seal from the selection provided and tighten with a suitable spanner.
8. Fit the item(s) under test to the Test Station(s) (8). Screw all the way down by hand only, no spanners are necessary.
9. The item(s) is/are now ready for test.

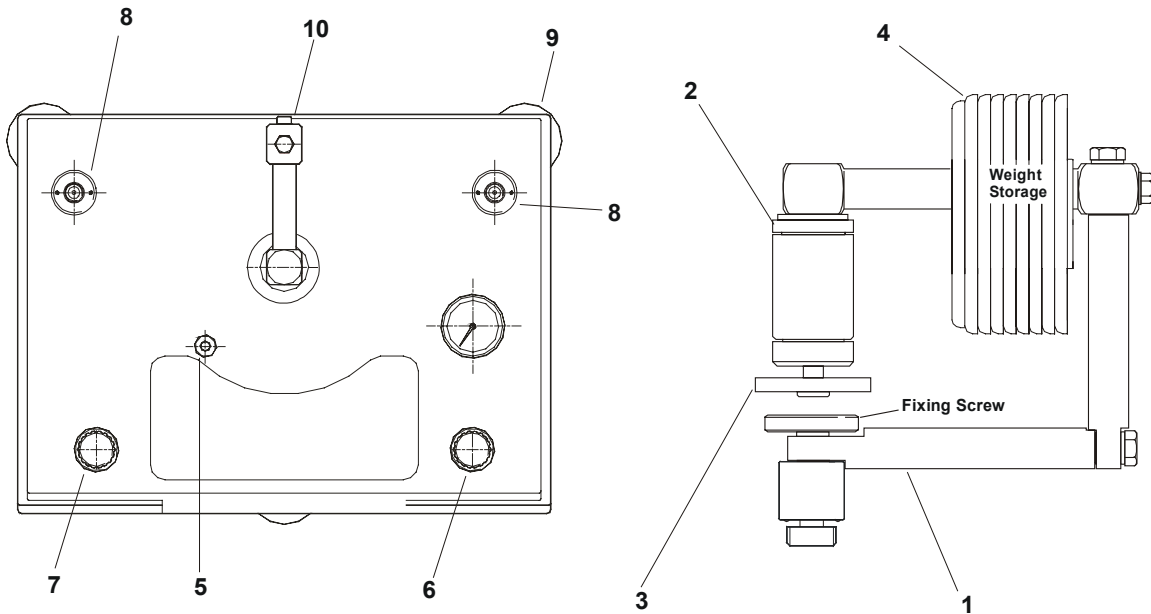
OPERATING PROCEDURE FOR TYPE 6410 DEADWEIGHT TESTER

1. Ensure Vacuum supply is turned on at source.
2. Close Valves (6) and (7) gently fully clockwise.
3. Select the weights for the required Vacuum and place them onto the weight carrier (3). **THE VACUUM GENERATED WILL BE THE SUM OF THAT MARKED ON THE WEIGHTS PLUS THAT MARKED ON THE WEIGHT CARRIER.**
4. Apply vacuum to the system by slowly opening Valve (6) anti-clockwise until the weights start to rise and then close again, gently fully clockwise. The weights should be at approximately mid-travel of the PCU assembly i.e. the bottom of the first weight should be aligned with the 'blue' line of the Indicator Rod (5) Refer to Figure on page 6. If the weights are too high or against their travel stop, open Valve (7) anti-clockwise VERY SLOWLY and then close again quickly to lower the weights to their correct position.
5. Spin the weights clockwise by hand at approximately 60 rpm and maintain the "floating" condition by adjusting Valves (6) and (7).
6. To increase vacuum add the required weights to the weight stack and repeat the procedure above. **WEIGHTS SHOULD NOT BE ADDED OR REMOVED WHILE THE WEIGHT STACK IS STILL SPINNING.**
7. To decrease vacuum, ensure that Valve (6) is closed fully clockwise and remove weights as required. Open Valve (7) SLOWLY until the weights fall to the 'blue' line once more. Spin the weight stack and maintain the 'floating' condition as before.

IMPORTANT

1. DO NOT rotate the weight stack while against the top or bottom travel stops.
2. ALWAYS add and remove weights carefully.
3. DO NOT rapidly increase or decrease Vacuum in the system.

Failure to observe the above precautions could result in serious damage to the PCU assembly.



**FIGURE 3
LAYOUT OF MODEL 6390 WITH 6410 CONVERSION KIT FITTED**

ITEM	DESCRIPTION	
1.	Vacuum Adapter	} 6410 Vacuum conversion kit
2.	PCU Assembly	
3.	Weight Carrier	
4.	Vacuum Weight Set	
5.	Indicator Rod	
6.	Inlet Valve	
7.	Outlet Valve (exhaust)	
8.	Test Station	
9.	Leveling Feet	
10.	Vacuum Input Connection (1/8" BSP Female)	

ITEM	DESCRIPTION
STANDARD ACCESSORIES FOR 6390 DWT	
1	Certificate of Accuracy for Deadweight Tester
2	Certificates of Test and Inspection for Deadweight Tester PCU Assemblies
3	User Manual (this manual).
4	Set of Stainless Steel, BSP Adaptors (quick-fit type)
5	Set of various seals to suit adaptors above
6	Spirit Level
7	Set of non-magnetic Stainless Steel Weights (PRESSURE) housed in a wooden carrying case.
8	Dust cover for Deadweight Tester
OPTIONAL ACCESSORIES	
9	6410 Vacuum Conversion Kit comprising of Vacuum adapter, PCU assembly, Weight carrier and a set of non-magnetic vacuum weights housed in a plastic carrying case.
10	Conversion Weight Set (PRESSURE) Converts any specified Deadweight Tester for use with any alternative unit of pressure.
11	Conversion Weight Set (VACUUM As above but for use only with model 6410 machines.
12	Fractional Weight Set (PRESSURE ONLY) Enables smaller increments of pressure to be measured.
13	Set of four Stainless Steel, NPT Adaptors. Part No. DW6127 (quick-fit type).

**TABLE 3
ACCESSORIES**

CARE AND MAINTENANCE

Deadweight Testers are precision instruments and must be treated accordingly. For maximum and lasting efficiency, the working parts must be kept free from dust of all kinds. NOTE:- ALWAYS REPLACE DUST COVER WHEN MACHINE IS NOT IN USE.

The PCU assemblies must be kept perfectly DRY AND POLISHED, in this condition they will spin and "float" freely. When they do require re-polishing, use a soft, lint free cloth such as a camera lens cloth/cleaner. Great care must be taken!

WARNING

1. DO NOT touch polished surface with fingers.
2. Avoid using solvents where possible.
3. NEVER use abrasives of any kind.

Control valves must only be closed "finger" tight otherwise the tapered seats may become permanently damaged.

A Spares Kit (part No. DWSK6000) consisting mainly of seals, is available for routine maintenance.

RE-CALIBRATION AND OVERHAUL

We recommend that our Deadweight Testers should be overhauled and re-calibrated on a regular basis. The period between overhaul/re-calibration obviously depends on frequency and conditions of use but we consider the minimum to be 1 YEAR and the maximum to be 3 YEARS.

When ordering spares or requiring information on SI-BARNET Deadweight Tester please quote model and serial number.

PRESSURE CORRECTIONS

Pressure correction is required for high accuracy work and is due to the effects of pressure on the PCU assembly during operation. By reference to the certificate of calibration provided the actual pressure in the system can be obtained. All values relate to the environmental conditions stated on the certificate.

The pressure in the system when the carrier is loaded with major weights can be read directly from the second column of the certificate.

The pressure in the system when the carrier is loaded with incremental weights is given together with the pressure in the system when the carrier is loaded with major and incremental weights. From these values, assuming effects are linear, the incremental weight corrections over the range may be calculated.

If the DWT is located at a position where the values of the gravitational acceleration and temperature of the operation are the same as those values specified for calibration, then the Actual Pressure is fully corrected. If the DWT is used under different conditions then further correction is necessary (see Figure 4). The reference level is specified on the certificate.

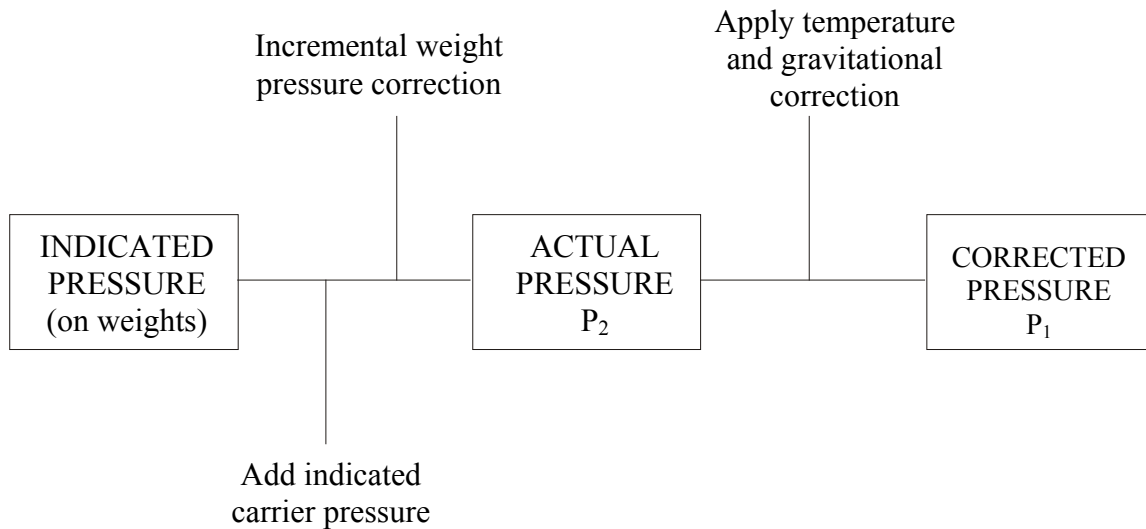


FIGURE 4
PRESSURE CORRECTIONS

TEMPERATURE AND GRAVITY CORRECTIONS

Deadweight testers are manufactured to give an accurate pressure reference at the specified temperature and gravity values indicated on the certificates. The following Standard Values are applied during calibration unless otherwise requested during manufacture (see Certificate).

Standard Gravitational acceleration (G) 9.80665 m/s²
Standard Temperature (T) 20°C

$$P_1 = P_2 \left(1 + \alpha (T - t) \right) \frac{g}{G}$$

Where:

P_1 = Corrected Pressure
 P_2 = ACTUAL PRESSURE
 α = Coefficient of Linear Expansion
(The value for a specific piston / cylinder assembly (PCU) is shown on the Calibration Certificate)
 T = DWT calibrated temperature (°C)
 t = Temperature at position of DWT (°C)
 g = Gravitational acceleration at position of DWT
 G = DWT calibrated gravitational acceleration

The value of gravitational acceleration (g) varies with latitude, height above sea level and geological conditions at the location of the DWT. When the gravitational acceleration varies from that for which the DWT was calibrated, the above correction must be made. The local value of gravitational acceleration (g) can be obtained as follows:

Data from the appropriate geophysical authority

Approximated from the Nomogram (Figure 5).

Calculated from the formula:

$$g = 9.7803184 \left(1 + 0.0053024 \sin^2 L - 0.0000038086 H \right)$$

Where

L = geographical latitude, H = height above sea level in meters and units of g are m/sec²

HEIGHT CORRECTIONS

Tests carried out at locations other than the test stations may require corrections for fluid heights. The pressure exerted by a column of fluid 25.4 mm high will not exceed 0.0025 bar using the recommended fluids.

Explanation of Nomogram
 A straight line passing through the known values of altitude (H) and latitude (L) of the site of the DWT, when extended to scale 'g', will indicate the approximate value of 'g'.

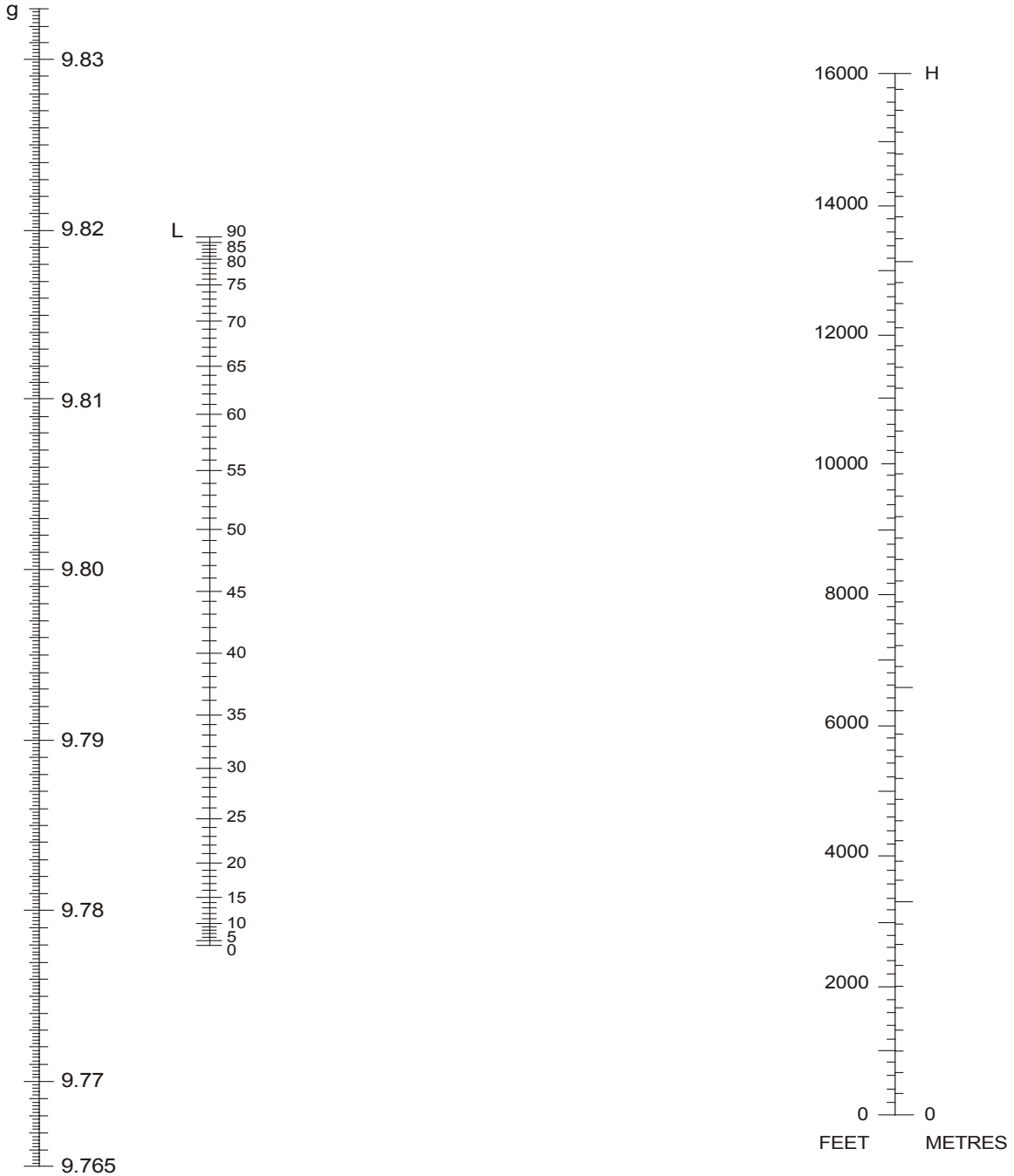


FIGURE 5
NOMOGRAM FOR FINDING THE VALUE OF "g" FROM ALTITUDE AND LATITUDE