

OPERATING MANUAL

# DEADWEIGHT TESTERS

PRESSURE MEASUREMENT PRODUCTS

***Superb***  
INSTRUMENTATION



TEST EQUIPMENT

# SUPERB-BARNET DEADWEIGHT TESTER

## 9000 SERIES

### OPERATING MANUAL

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.

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# 9000 SERIES DEADWEIGHT TESTER

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## DESCRIPTION

1 The 9000 Series Deadweight Tester (DWT) provides a means of testing pressure indicating instruments for calibration accuracy. The design uses the piston gauge principle in which an applied pressure within the system balances a known mass applied to a piston of known effective area. In an alternative mode of use the DWT can be used to compare the readings on a test instrument directly with those on a standard instrument.

2 A DWT (Fig 1A and Fig 1B) comprises base plate/manifold with either one or two piston assemblies (depending on the pressure range of the particular model), two test stations (for instrument mounting), a fluid reservoir, and a ram screw pressure generating mechanism. Standard accessories provided with the DWT are listed in Table 1 followed by optional accessories which are also available. Full information is provided to enable corrections to be made for pressure, temperature and gravity variations.

3 The ram is capable of direct pressure generation from zero to the maximum pressure rating of the DWT or 1100 bar if the DWT is functioning in the comparison mode. The DWT incorporates an automatic change over from low to high pressure. A pressure relief valve restricts the pressure in the system to 41 bar prior to high pressure engagement, and a reference groove (Fig 2) in the ram screw indicates engagement of the high pressure mechanism.

4 The DWT has four adjustable feet to enable the unit to be correctly levelled. This ensures that the pistons are in the vertical plane, essential for both accuracy and reliable performance.

5 The 9000 Series DWT's are specified in Table 2. A motorised version of each DWT is available signified by a prefix M to the Machine Number (for example: motorised two plunger machine, range 1-1100 bar is M9260/6). In a motorised machine an electric motor is used to operate the weight carrier(s) via a belt and pulley arrangement. Standard motors fitted are single phase, 220/240 volt, 50 Hz ac but alternative motors to suit different power supplies are available.

6 The fluid supplied for use in the DWT is one of three formulations dependent on the tester pressure range, either DW6292 (up to 350 bar), DW6293 (up to 700 bar) or DW6294 (up to 1100 bar). These fluids have been formulated to remain fluid at high pressure and ensure no corrosion to internal parts of the tester. In addition the fluids do not oxidise in air or emulsify or mix with water.

7 The fluid capacity of the DWT is 325 cc (reservoir 257 cc and barrel swept volume 68 cc) and the initial supply of fluid comprises a 1 litre bottle. Further supplies are readily available from Superb Instrumentation.

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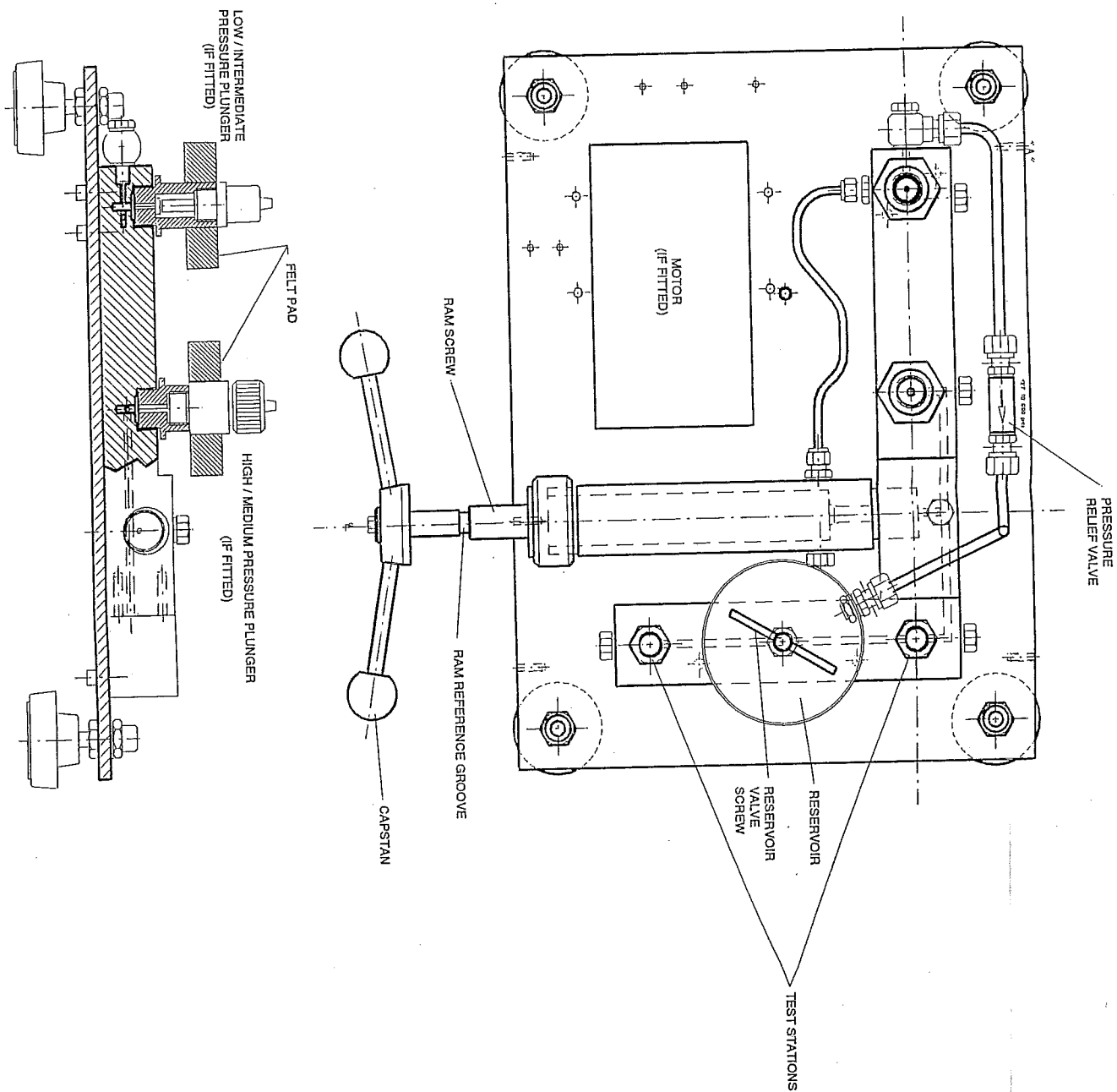


Fig 1B Internal View of 9000 Series Tester

## INSTALLATION AND PRIMING

### Unpacking

- 8 Remove the DWT from the transit packing and check that all items supplied are present (see Table 1).

### Filling fluid reservoir

- 9 Fill the fluid reservoir as follows:

- 9.1 Place the DWT on a rigid clean surface with its front less than 40 mm from the edge to allow for the rotation of the capstan.

- 9.2 Unscrew and remove the reservoir valve screw and spring.

- 9.3 Remove the reservoir cover and fill the reservoir with fluid to the top of the brass nut on the side of the reservoir.

Note: Ensure that the fluid used is correct for the pressure rating (see para 6).

- 9.4 Replace the reservoir cover.

### Priming

- 10 Prime the fluid system as follows:

- 10.1 Replace the reservoir valve screw and spring and firmly tighten, then unscrew four full turns.

- 10.2 Check that blanking plugs are fitted to the Test Stations.

- 10.3 Screw the capstan fully out (anti-clockwise) and check that the fluid level in the reservoir drops.

- 10.4 Screw the capstan fully in (clockwise); this causes the fluid to be returned to the reservoir.

- 10.5 Repeat 10.3 and 10.4 until little air is present in the returned fluid.,

- 10.6 Screw the capstan fully out.

- 10.7 Screw the reservoir valve screw fully clockwise and firmly tighten.

### Levelling

- 11 Set the equipment level as follows:

- 1.1 Using the capstan pressurise the system until a weight carrier floats approximately midway between the red marks on the indicator rod.

- 1.2 Place the spirit level on the floating weight carrier and level the DWT by means of the four adjustable feet. The bubble must be in the centre of the small black circle and the DWT must not rock.

TABLE 1 - ACCESSORIES

| Serial | Item  |
|--------|---|
|        | <u>Standard Accessories</u>   |
| 1      | Certificate of Accuracy for Deadweight Tester.  |
| 2      | Certificate(s) of Test and Inspection for Deadweight TesterPlunger(s)   |
| 3      | Operating Manual (This Manual)  |
| 4      | Operating Fluid   |
| 5      | Wooden Carrying Case containing<br>Set of Stainless Steel Weights (see Table 2)<br>Set of Adaptors<br>1/8", 1/4", 3/8", 1/2" BSP<br>3/8" BSP (male) x 3/8" BSP (female) right angle adaptor<br>Spirit Level<br>Dust Cover<br>Set of Seals |
|        | <u>Optional Accessories</u>   |
| 6      | Conversion Weight Set:<br>converts any specified Deadweight Tester for use with<br>any alternative unit of pressure.  |
| 7      | Fractional Weight Set:<br>allows smaller increments of pressure to be generated<br>and measured.  |
| 8      | 'Oxytester' :<br>connects directly to a 9000 Series Deadweight Tester and<br>provides a flexible baffle between the Deadweight Tester<br>fluid and the fluid in the instrument under test.  |
| 9      | Motor Kit:<br>to convert from Manual to Motorised Tester  |



TABLE 2 - 9000 SERIES DEADWEIGHT TESTERS

| Machine Number | Number of Plungers | Pressure Range      |                     |         | Number of Weights Per Set |
|----------------|--------------------|---------------------|---------------------|---------|---------------------------|
|                |                    | lbf/in <sup>2</sup> | Kgf/cm <sup>2</sup> | bar     |                           |
| 9120/4         | 1                  | 10-500              |                     |         | 12                        |
| 9120/5         | 1                  |                     | 1-35                |         | 13                        |
| 9120/6         | 1                  |                     |                     | 1-35    | 13                        |
| 9130/4         | 1                  | 20-1000             |                     |         | 12                        |
| 9130/5         | 1                  |                     | 2-75                |         | 14                        |
| 9130/6         | 1                  |                     |                     | 2-75    | 14                        |
| 9150/4         | 1                  | 50-5000             |                     |         | 12                        |
| 9150/5         | 1                  |                     | 5-350               |         | 13                        |
| 9150/6         | 1                  |                     |                     | 5-350   | 13                        |
| 9170/4         | 1                  | 100-10000           |                     |         | 12                        |
| 9170/5         | 1                  |                     | 10-700              |         | 13                        |
| 9170/6         | 1                  |                     |                     | 10-700  | 13                        |
| 9180/4         | 1                  | 100-16000           |                     |         | 15                        |
| 9180/5         | 1                  |                     | 10-1100             |         | 17                        |
| 9180/6         | 1                  |                     |                     | 10-1100 | 17                        |
| 9230/4         | 2                  | 10-5000             |                     |         | 12                        |
| 9230/5         | 2                  |                     | 1-350               |         | 13                        |
| 9230/6         | 2                  |                     |                     | 1-350   | 13                        |
| 9250/4         | 2                  | 10-10000            |                     |         | 12                        |
| 9250/5         | 2                  |                     | 1-700               |         | 13                        |
| 9250/6         | 2                  |                     |                     | 1-700   | 13                        |
| 9260/4         | 2                  | 10-16000            |                     |         | 15                        |
| 9260/5         | 2                  |                     | 1-1100              |         | 17                        |
| 9260/6         | 2                  |                     |                     | 1-1100  | 17                        |

## OPERATION

### General

12 Before commencing operation, identify tester model and relevant operating mode (Low pressure or High pressure) from Table 3. Note that comparison mode is applicable to all models.

13 Rotation of the weight stack is either manual, where no motor is fitted (no prefix M to tester number), or motorised where a motor is fitted (prefix M before tester number). Motorised testers must only be operated by power and not manually because manual operation could damage the drive pins and cause inaccuracy during subsequent use.

14 For manual rotation proceed as follows:

14.1 Grasp the weight stack firmly in both hands.

14.2 Turn the weight stack clockwise (viewed from above) at a speed of approximately 1 revolution per second, taking care to avoid trapping the hands between the weights and the test instrument.

15 Commencing and ending rotation on motorised tester entails setting the motor switch to 'ON' and 'OFF' respectively. A full weight stack may require light manual assistance to commence rotation. To drive the weight stack on the dead weight tester at a constant speed of approximately 70 rpm, a synchronous motor has been selected for both its quiet operation and low heat output characteristics.

After partially pressurising the system, the motor should be switched "ON" to initiate clockwise rotation of the weights.

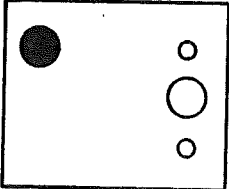
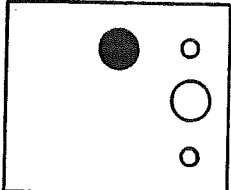
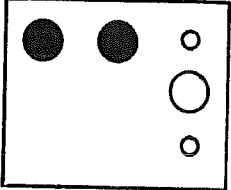
Manual assistance may be required to overcome inertia, especially with a full weight stack.

It is possible that a "chattering" noise may emanate from a stalled motor due to rotor oscillation between poles; this is NOT detrimental to the motor but its occurrence during testing may indicate a "bottoming" of the weight stack. Continuous rotation of the weight stack at its bottom position should be avoided.

Note...

Before connecting motorised equipment to power supply, ensure that voltage is as stated by supply inlet.

Table 3  
Pressure Mode Identification

| Machine Type  | Pressure Range |                    |         | Operating Mode (pressure) |           |
|---|----------------|--------------------|---------|---------------------------|-----------|
|   | bar            | lb/in <sup>2</sup> |         |                           |           |
|                    | 1-35           | 10 - 500           | Para 16 | LOW                       |           |
|   | 2-75           | 20 - 1000          | Para 16 | LOW                       |           |
|                    | 5-350          | 50 - 5000          | Para 17 | HIGH                      |           |
|   | 10-700         | 100 - 10000        | Para 17 | HIGH                      |           |
|   | 10-1100        | 100 - 16000        | Para 17 | HIGH                      |           |
| <p>A      B</p>  | 1-35           | 10 - 500           | Para 16 | LOW                       | PLUNGER A |
|   | 5-350          | 50 - 5000          | Para 17 | HIGH                      | PLUNGER B |
|   | 10-700         | 100 - 10000        | Para 17 | HIGH                      | PLUNGER B |
|   | 10-1100        | 100 - 16000        | Para 17 | HIGH                      | PLUNGER B |

### Low Pressure Plunger Mode

16 Proceed to operate in this mode (left hand plunger if fitted) as follows:

16.1 Ensure that priming sequence (para 10) has been carried out.

16.2 Fit the instrument under test to Test Station using the appropriate adaptor. Screw fully clockwise, finger tight only.

16.3 Close reservoir valve screw (fully clockwise).

16.4 Place the first weight on to the weight carrier.

16.5 Rotate the weight stack (if motorised, set motor switch to 'ON').

16.6 Apply pressure by turning the capstan clockwise until the weight floats with the lower edge of the first weight aligned between the upper and lower red marks on the indicator rod. (see fig 3)

16.7 Apply further weight and repeat procedures in para 16.5 (Non Motorised only) and 16.6 until required pressure is obtained.

#### Notes...

(1) Ensure that the ram indicator groove is fully visible (see fig 2).  
(ie. do not engage the high pressure system)

(2) With the weights floating and spinning the pressure generated in the system is the pressure marked on the weights plus the weight carrier pressure (corrected as in para 19 if required).

16.8 Reduce pressure by screwing the capstan fully out (anti-clockwise).

16.9 Stop the weight stack spinning (if motorised, set motor switch to 'OFF').

16.10 Remove the weights from the carrier weight.

16.11 Unscrew the reservoir valve four turns.

16.12 Remove the instrument under test.

16.13 Refit the blanking plug to the test station.

16.14 On conclusion of testing switch power 'OFF' at supply if motorised.

## High Pressure Plunger Mode

17 Proceed to operate in this mode (right hand plunger if fitted) as follows:

17.1 Ensure that priming sequence (para 10) has been carried out.

17.2 Remove low pressure weight carrier if double plunger model.

17.3 Fit the instrument under test to a test station using appropriate adaptor. Screw the adaptor to the Test Station finger tight only.

17.4 Close reservoir valve screw (fully clockwise).

17.5 Place the first weight onto the weight carrier.

17.6 Rotate the weight stack (if motorised, set motor switch to 'ON').

17.7 Apply pressure by turning the capstan clockwise until the weight stack floats with the lower edge of the first weight aligned between the upper and lower red marks on the indicator (see fig 3).

### Notes...

(1) Dependent on the weight selected, this condition may occur prior to engaging the high pressure mechanism (see fig 2).

(2) With the weights floating and spinning the pressure generated in the system is the pressure marked on the weights, multiplied by the machine constant, marked on the label fixed at the rear of the DWT, plus the weight carrier (corrected as in para 19 if required).

17.8 Reduce pressure to zero by screwing the capstan fully out (anti clockwise).

17.9 Stop the weight stack spinning (if motorised set motor switch to 'OFF').

17.10 Remove the weights from the weight carrier.

17.11 Unscrew the reservoir valve four turns.

17.12 Remove the instrument under test.

17.13 Refit the blanking plug to the test station.

17.14 Replace low pressure weight carrier, ensuring correct location (double plunger model only).

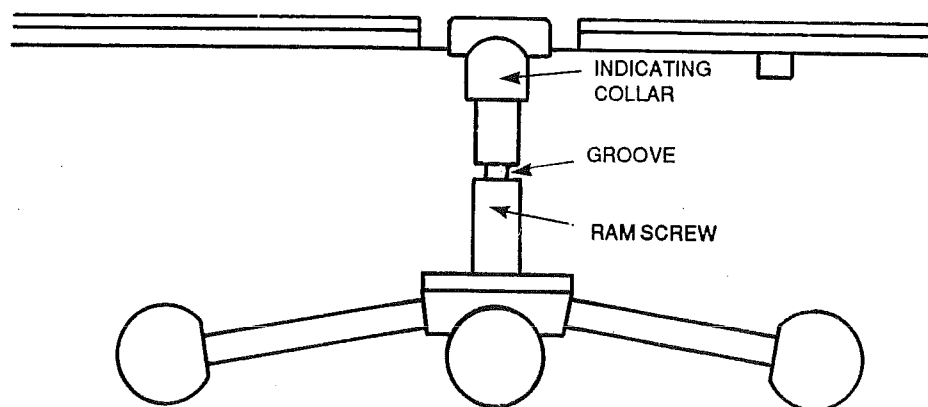


Fig 2 Ram reference groove (low pressure position)

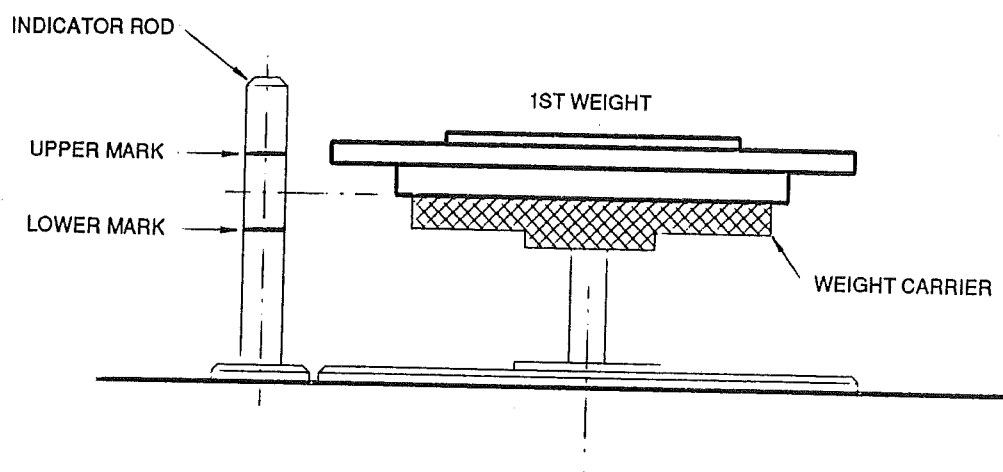


Fig 3 Position of floating weights for correct reading

### Pressure Comparison Mode

18 Proceed to operate in this mode (all models) as follows:

18.1 Ensure that priming sequence (para 10) has been carried out.

18.2 Remove the blanking plugs from the test stations.

18.3 Fit the standard instrument and the instrument under test to the test stations using appropriate adaptors. Screw fully clockwise, finger tight only.

18.4 Close reservoir valve screw (fully clockwise).

18.5 Screw the capstan in (clockwise) to increase the pressure to the required value.

18.6 On completion of comparison tests reduce pressure to zero by screwing the capstan fully out (anti-clockwise).

18.7 Unscrew the reservoir valve screw four turns.

18.8 Remove the instruments and refit the blanking plugs.

## 19. Do's and Don'ts for operating Deadweight Testers

### Don'ts

- 19.1 Do not remove low pressure insert or high pressure carrier from plungers.
- 19.2 Do not use spanners on "quick fit" adaptors (finger tight all the way down is all that is required).
- 19.3 Do not touch plunger operating surfaces (they could be damaged).
- 19.4 Do not remove cover.
- 19.5 Do not transport deadweight tester with oil in the system.
- 19.6 Do not rotate weight stack in top or bottom position especially by motor.
- 19.7 Do not allow fluid level to fall below the recommended minimum level.

### Do's

- 19.8 Do have the deadweight tester and weight stack set recalibrated at regular intervals.
- 19.9 Do ensure that the FLOATING weight stack is level in both planes.
- 19.10 Change oil regularly to flush out contaminants.



## CORRECTIONS

### Pressure Corrections

20 Pressure correction is required for high accuracy instruments due to the effect of pressure on the Effective Area of the plunger in operation. Application of the Correction Table found on the reverse side of the Certificate of Accuracy, enables ACTUAL PRESSURE of the system to be obtained. Procedure for using the correction table is as follows:

20.1 For major weights, the INDICATED PRESSURE is located in the left hand column of the appropriate plunger correction table. The corrected ACTUAL PRESSURE is read directly from the right hand column.

20.2 For intermediate values, pressures should be interpolated from the nearest higher and lower major weight values, assuming the relationship is linear.

21 If the DWT is located at a position where the values of the gravitational acceleration and temperature of 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 fig 4). The reference point in each instance is top of Test Stations.

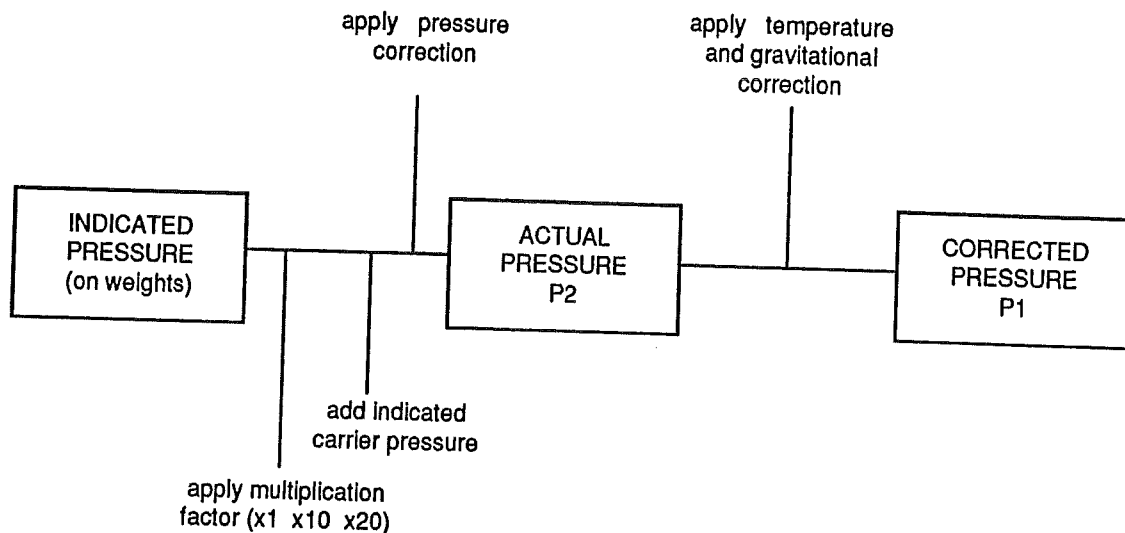


Fig 4 Pressure Corrections

## Temperature and Gravity Corrections

22 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.

- (1) Gravitational acceleration (G) 9.80665 m/s<sup>2</sup>
- (2) Temperature (T) 20°C

Note...

The CORRECTED PRESSURE (P1) is given by:

$$P1 = P2 (1 + 0.000025 (T-t)) \times \frac{g}{G}$$

Where:

- P2 = ACTUAL PRESSURE
- t = temperature at position of DWT (°C)
- T = DWT calibrated temperature (°C)
- G = DWT calibrated gravitational acceleration
- g = gravitational acceleration at position of DWT

23 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:

23.1 Data from the appropriate geophysical authority.

23.2 Approximated from the Nomogram (fig 5)

23.3 Calculated from the formula:

$$g = 9.7803184 (1 + 0.0053024 \sin^2 L - 0.0000059 \sin^2 2L) - 0.000003086 H$$

Where

L = geographical latitude, H = height above sea level in metres and units of g are m/sec<sup>2</sup>

## Height Corrections

24 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.

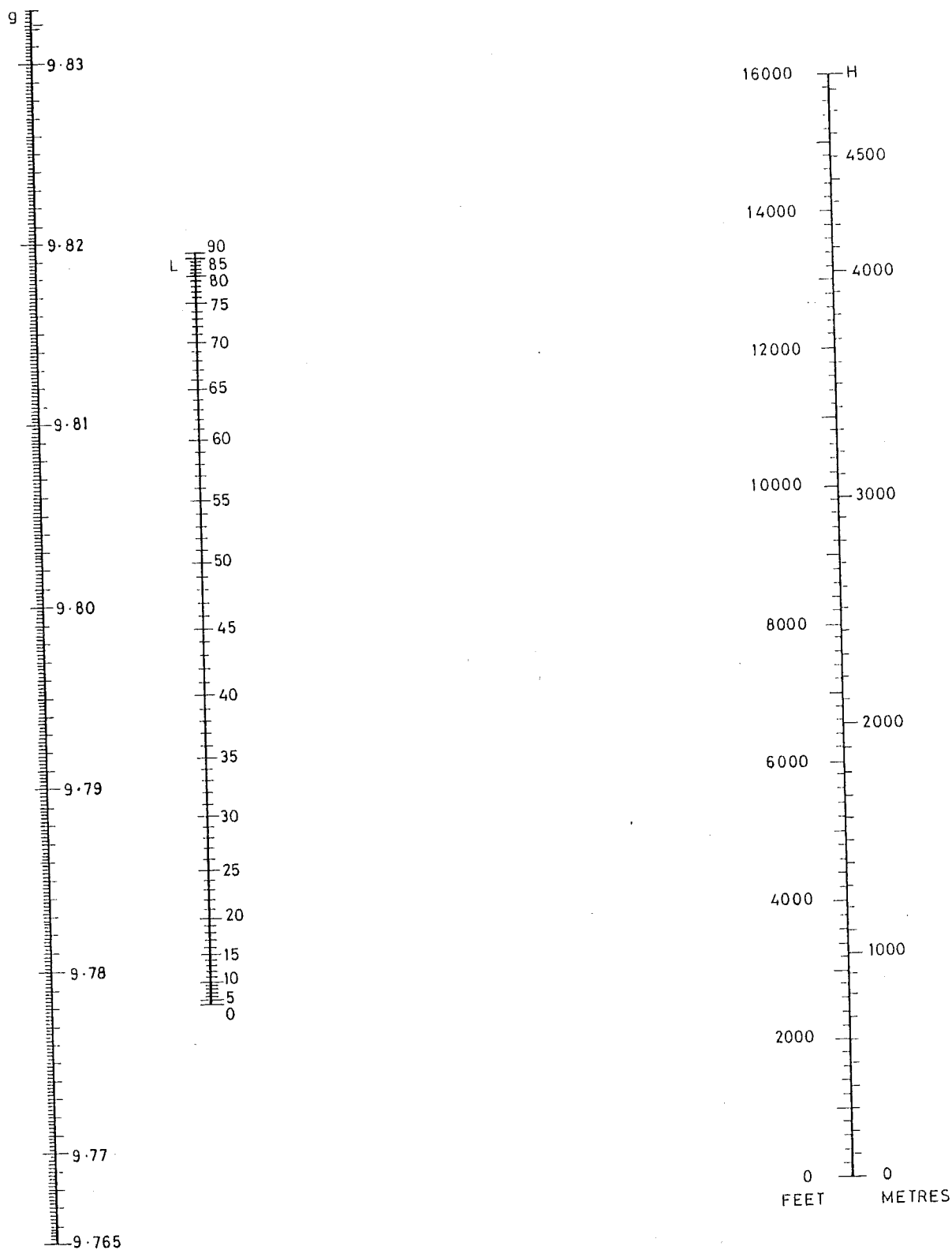


Fig 5 Nomogram for finding the value of 'g' from altitude and latitude

## MAINTENANCE

### General

25 The 9000 Series DWT has been designed to require minimal maintenance. Routine maintenance entails that the equipment is kept free from dirt and dust. The dust cover is to be fitted when the DWT is not in use.

26 Repair maintenance is limited to self evident replacement of seals fluid and felt pads. In motorised DWT's the fuses and drive bels may be replaced.

### User Spares List

| DESCRIPTION                     | PART No.    | No. OFF |
|---------------------------------|-------------|---------|
| 1/8" BSP EXTERNAL DOWTY SEAL    | } DWSK9000  | 5       |
| 1/4" BSP EXTERNAL DOWTY SEAL    |             | 5       |
| 3/8" BSP EXTERNAL DOWTY SEAL    |             | 5       |
| SPARE "O" RINGS FOR ADAPTOR SET |             | 10      |
| FELT PADS                       |             | 4       |
| For motorised model             |             |         |
| DRIVE BELT (SINGLE PLUNGER)     | } DWSKM9000 | 1       |
| DRIVE BELT (DOUBLE PLUNGER)     |             | 1       |
| FUSE                            |             | 2       |
| DWSK9000                        |             | 1       |

### Notes...

- (1) If ordering supplies of fluid, ensure that correct type is ordered for DWT pressure range (para 6).
- (2) If fluid contacts skin, allergic reaction may result. Wash using soap and water.