



Budenberg

Budenberg Model 249T Dead-Weight Tester

Operational Instructions



Budenberg

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SAFETY PRECAUTIONS

AIR/GAS SUPPLY

The Model 249T requires a regulated supply of clean dry gas to operate. Any compressed pneumatic source represents a source of considerable potential energy and as with electricity, precautions must be taken to prevent accidents.

Before connecting/disconnecting instruments under test the operator should ensure no pressure is present in the system.

Before connecting/disconnecting the tester from its pressure source the operator should ensure that the pressure source is isolated from the tester. We recommend using a Nitrogen Cylinder as the gas from this is normally dry and clean. Alternatively use compressed air, filtered and dried to remove oil and moisture.

DO NOT USE OXYGEN IN THE SYSTEM, OR CALIBRATE ANY INSTRUMENT THAT MAY COME INTO CONTACT WITH AN OXYGEN SOURCE.

Calibrate only cleaned instruments to avoid contamination of the tester.

MINERAL OILS HEALTH AND SAFETY (C.O.S.H.H.) INFORMATION

Budenberg provides hydraulic mineral oil in 500 ml containers labelled "ISO VG 22" for use up to 2600 bar in dead-weight testers.

MSDS available on request.

LIFTING OF WEIGHTS

Care must be taken when lifting the weights for the dead-weight tester.
Each weight must be lifted individually and never attempt to lift stack of weights on or off the tester.

DATA SHEET

1.1 TESTER DIMENSIONS – PRESSURE CABINET ONLY

Width : 570 mm
Depth : 600 mm
Height : 750 mm
Mass : 31 kg (inclusive of oil fill)
Gas Supply Differential: G1/4
Connection: G1/4

1.2 PRESSURE RANGES

249T : 1/8in² area : 15 to 100 bar (200 to 1,500 lb/in²)
1/16in² area : 30 to 200 bar (400 to 3,000 lb/in²)

1.3 LIQUIDS USED

A hydraulic mineral oil viscosity 20 to 37 cSt at 40°C viscosity grade VG20 to VG37 to ISO3448 (BS4231) is used on the 249T base units. Most users will be able to obtain locally suitable oil (see below) as used in hydraulic machinery. However, for the convenience of users we can supply a 500 ml bottle of oil, viscosity grade VG22.

Oils suitable for testers

The following oils are the commercially available oils suitable for use in the dead-weight tester.

ISO 3448 viscosity grade	Approx. SAE viscosity Classification	Shell	Esso	Mobil
VG22		Tellus 22 Tellus R22	Nuto H22	DTE 22
VG32	10W	Tellus V32 DTE 24	Nuto H32	DTE Oil Light
VG37		Tellus 37 Tellus R37 Tellus T37 Tellus V37		

DESCRIPTION

2.1 GENERAL

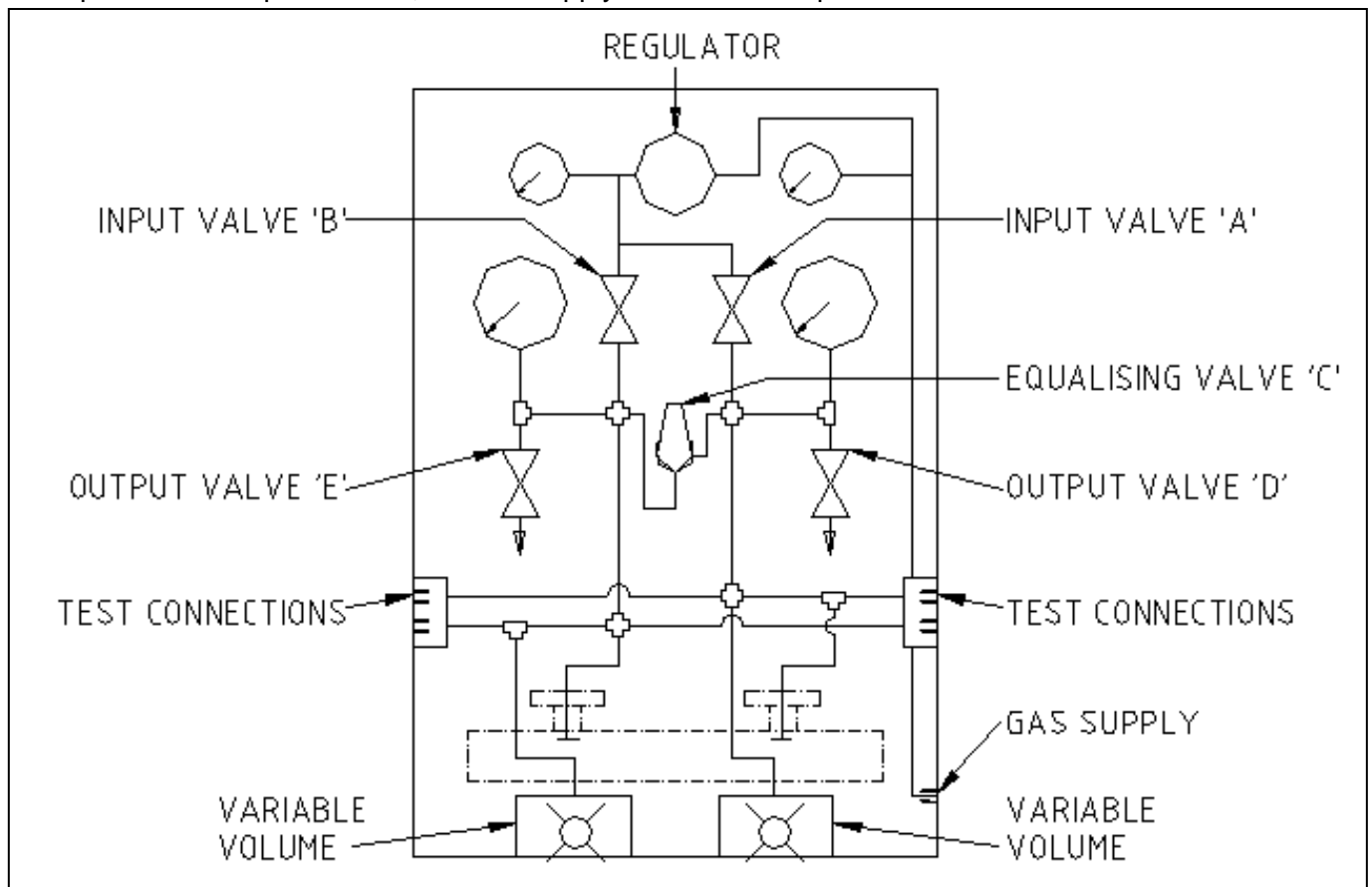
The Model 249T is used for the calibration of differential pressure (DP) cells at high static line pressures on gas. This type of calibration is especially important for fiscal metering of large flows of gas using orifice plates

2.2 PRINCIPAL OF OPERATION

Two piston units (oil lubricated piston units on Model 249T are connected to each side of a DP cell. These are then balanced at a static gas pressure specified. Once balanced, they are isolated from each other and small weights (in. water or mbar) are added to the piston unit connected to the high side of the DP cell, thus developing a differential pressure across the DP cell. The differential pressure generated depends only on the effective area of the piston unit and the masses of the small differential pressure weights.

2.3 CIRCUIT

The two piston units are mounted in an aluminium block and loaded with stainless steel weights. Each piston unit is controlled by its own control instrumentation and variable volume adjuster. These are used to help balance the piston units, and also apply the differential pressure.



SCHEMATIC DIAGRAM OF MODEL 249T



INSTALLATION

3.1 UNPACKING THE TESTER

As soon as possible after delivery open the packaging of the system and check that you have all the items detailed in the packing list in section 3.4.

As you are unpacking the items, examine them for signs of damage or breakage during transit.

If any items are missing get in touch immediately with Budenberg to inform us of the shortage.

3.2 ENVIRONMENTAL REQUIREMENTS

When siting the tester if not in a temperature controlled laboratory look for an area that satisfies the following criteria as much as possible

- a constant temperature area free from draughts and sources of heat or cold
- an area free from noise and vibration if possible an area away from any constantly used pathways
- a clean dry area free from corrosive liquids or vapours.

A strong, stable, level table or workbench with the capability of supporting the system (approx. 250Kg) with sufficient space to operate is required.

3.3 ASSEMBLY OF BASE UNITS

The Model 249T is supplied packaged on a pallet.

3.4 PACKING LIST

The system carton should contain: -

- 1 - copy of the operating and maintenance instructions (this manual).
- 1 - Model 249T base unit
- 2 - 1/8in² or 1/16in² Piston units (as ordered).
- 2 - Main Weight Set (Static Pressure)
- 1 - Set of differential weights
- 1 - 500 ml bottle of oil (Model 249T)
- 1 - certificate of calibration
- 1 - spirit level

Model 249T – bar or Kg/cm² MAIN STATIC WEIGHTS

MAIN STATIC WEIGHTS			
ITEM	QUANTITY	1/8in² PRESSURE	1/16in² PRESSURE
PISTON & M.U.W & TRIM MASS HOLDER	2	15	30
TOP LOADING STATIC WEIGHT	10	15	30
TOP LOADING STATIC WEIGHT	4	5	10
DIFFERENTIAL WEIGHTS - mbar			
DIFFERENTIAL WEIGHT	1	1000	2000
DIFFERENTIAL WEIGHT	1	500	1000
DIFFERENTIAL WEIGHT	2	200	400
DIFFERENTIAL WEIGHT	1	100	200
DIFFERENTIAL WEIGHT	1	50	100
DIFFERENTIAL WEIGHT	2	20	40
DIFFERENTIAL WEIGHT	1	10	20
DIFFERENTIAL WEIGHT	1	5	10
DIFFERENTIAL WEIGHT	1	2.5	5

Model 249T – lb/in² MAIN STATIC WEIGHTS

MAIN STATIC WEIGHTS			
ITEM	QUANTITY	1/8in² PRESSURE	1/16in² PRESSURE
PISTON & M.U.W & TRIM MASS HOLDER	2	200	400
TOP LOADING STATIC WEIGHT	12	200	400
TOP LOADING STATIC WEIGHT	2	100	200
DIFFERENTIAL WEIGHTS – in. water			
DIFFERENTIAL WEIGHT	1	400	800
DIFFERENTIAL WEIGHT	1	200	400
DIFFERENTIAL WEIGHT	1	100	200
DIFFERENTIAL WEIGHT	1	50	100
DIFFERENTIAL WEIGHT	2	20	40
DIFFERENTIAL WEIGHT	1	10	20
DIFFERENTIAL WEIGHT	1	5	10
DIFFERENTIAL WEIGHT	2	2	4
DIFFERENTIAL WEIGHT	1	1	2

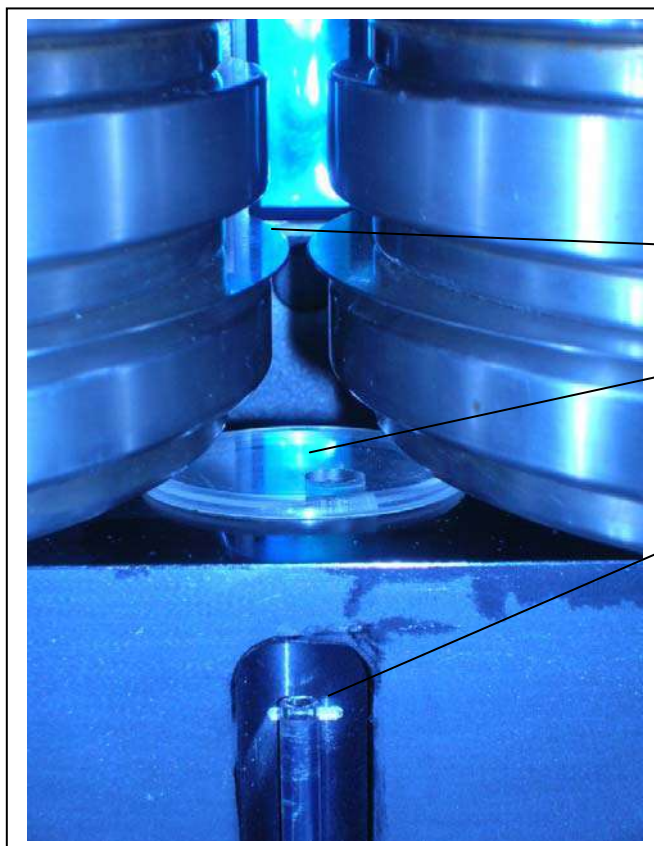
**WEIGHT SETS CAN MANUFACTURED FOR ALTERNATIVE PRESSURE UNITS.
 WEIGHT SETS CAN MANUFACTURED FOR LOCAL GRAVITY.
 CONSULT YOUR LOCAL DISTRIBUTOR FOR ADVICE ON AVAILABILITY.**

Assembly of the Model 249T

- (1) Obtain a firm bench, on which to mount the tester, capable of withstanding a load of 250kg. It is recommended that the dimensions of the top surface should exceed 1500mm in width x 650mm in depth to provide adequate working area. There should be no obstructions within one metre above the bench surface.
- (2) Position the three level plates onto the bench surface and fix in position. The front two plates should be positioned 40mm from the front edge of the bench to allow adequate clearance for the handwheels.
- (3) Fit the fixed foot to the rear of the tester base and the two adjustable feet to the front.
- (4) Lift tester, at least two people will be required and place on level plates fixed to bench.
- (5) Place the spirit level on one of the piston units and set the tester level by adjusting the front two knurled feet. Place spirit level on other piston unit to check level.

Filling the base unit with liquid – MODEL 249T

- (1) Wind both variable volume handles fully clockwise. Unscrew reservoir spindle on the main aluminium manifold and remove completely with the reservoir cover.
- (2) Fill reservoir with appropriate liquid until level with the level indicated on the front face of the aluminium block. Use the oil supplied or an approved substitute for oil systems.
- (3) Wind screw pump handle fully anti-clockwise.
- (4) Allow 5 minutes for the liquid to level out, then top up reservoir if necessary.



SIGHTING EDGE USED FOR BALANCING

RESERVOIR

OIL LEVEL INDICATING SIGHT TUBE

- (1) Ensure all valves are closed and regulator is fully turned anti-clockwise.
- (2) Remove red cap from connection on right-hand side of tester.
- (3) Connect gas supply from either bottle gas (i.e. nitrogen) or a gas booster. Ensure gas is clean and dry. Whilst the tester can accept gas supply pressure of up to 400 bar, it is for ease of use, recommended that the supply pressure be limited to 120% FSD of range being calibrated/verified.

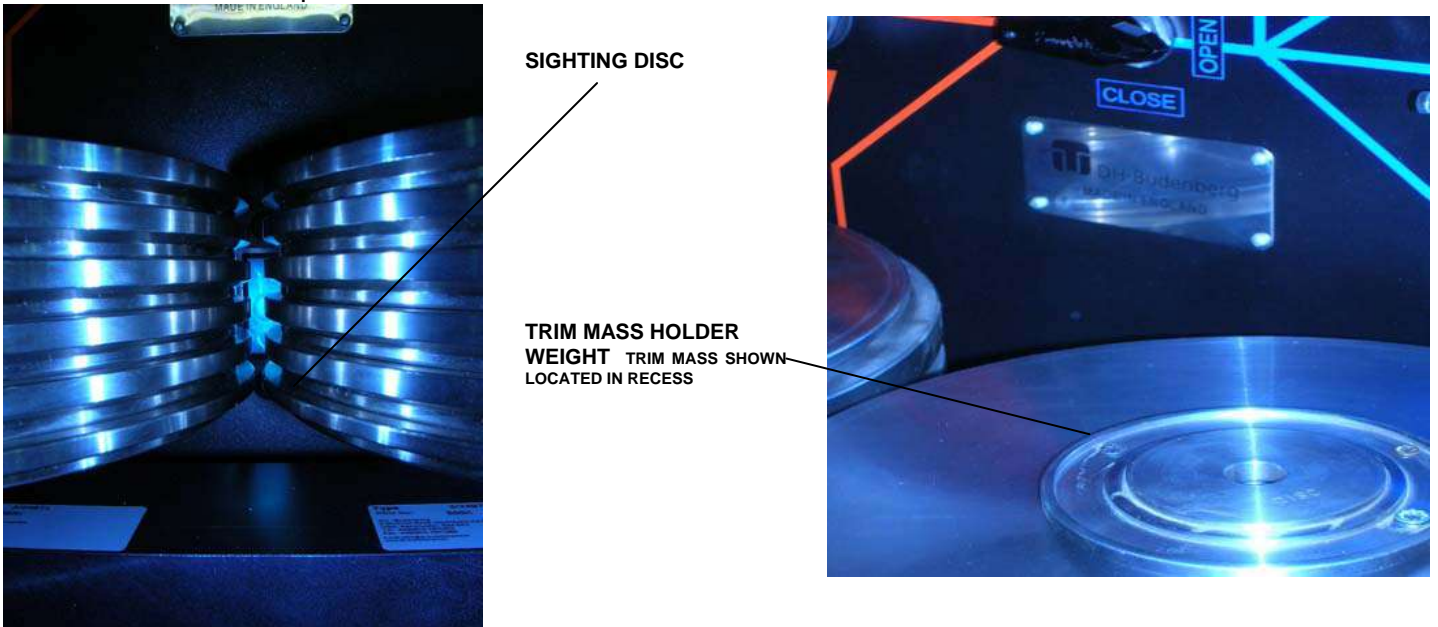
OPERATING INSTRUCTIONS

4.1 PROCEDURE

OPERATION

Balancing the Piston Units

- 4.1.1 Turn the safety torch that protrudes from the rear of the tester on thereby illuminating the sighting panel.
- 4.1.2 Having pressurised the tester to the approximate working pressure, spin both sets of weights in the same direction.
- 4.1.3 Rotate the volume adjuster handwheels until one of the piston unit rises.
- 4.1.4 Add small loose weights into trim mass holder (Model 249T) of the floating piston unit until it starts to descend.
- 4.1.5 Repeat operations 4.1.3 and 4.1.4 until both pistons are floating at the same height relative to each other. This may be verified by viewing the sighting edges of the start weights against the illuminated sighting panel.
- 4.1.6 The tester/PCUs are now in balance. Note reading of D.P. cell and adjust if required.
- 4.1.7 This operation will take about 10 minutes.



DURING CALIBRATION

When the tester is correctly set up and there are no leaks the piston should “float” for many minutes without it being necessary to touch the screw pump handwheel. If the piston continues to fall, check the connections for leaks.

During calibration, the weights should be rotated by hand. It is desirable that the weights should only be rotated when approximately the correct pressure is obtained. Weights should not be brought to rest by fully releasing the pressure and allowing the piston head to rotate against its stop under the full load of the weight pile.

Stops come into action if the pressure is too high or too low and it is essential that the weights should be spinning freely whilst taking readings. At the lowest pressures the weights will not spin for more than a few seconds unless a very thin oil is used, but providing the weight is rotated by hand before taking a reading and is obviously “floating” an accurate reading will be given.

4.2 CONNECTION OF DIFFERENTIAL PRESSURE CELL

- 4.2.1 Remove the blanking plugs from either of the differential pressure connections on the side of the tester.
- 4.2.2 Connect to each port a length of small bore metal tubing keeping the length to the minimum required.
- 4.2.3 Connect the free end of each length of metal tubing to the ports on the differential pressure cell.
- 4.2.4 The “red” port on the tester should be connected to the “high” port on the D.P. cell and the “blue” to the “low”.

4.3 LOADING THE TESTER

- 4.3.1 Place onto each piston unit, its appropriate starting weight with sighting edge. These weights **MUST** always be loaded for any test to be carried out. Load additional main weights as necessary to achieve the desired working pressure.

4.4 PRESSURISING THE TESTER – MODEL 249T

- 4.5.1 Rotate volume adjuster handwheels so that their indicating pointers are in mid-position.
- 4.5.2 Open OIL FILL valves situated on the front face of the PCU manifold.
- 4.5.3 Remove reservoir cover, and pour in hydraulic mineral oil until it reaches the indicated position on the oil level indicator (situated on front face of PCU manifold).
- 4.5.4 Close OIL FILL valves situated on the front face of the PCU manifold.
- WARNING:** These valves should **NEVER** be operated when pressure is in the measuring system.
- 4.5.5 Fully rotate pressure regulator knob anti-clockwise.
- 4.5.6 Close valves “C” and “D”
- 4.5.7 Rotate the equalising valve handle anti-clockwise to the horizontal “OPEN” position.
- 4.5.8 Open valves “A” or “B”.
- 4.5.9 Turn on, or open gas supply to tester.
- 4.5.10 Turn regulator control knob clockwise and admit gas to the tester. Continue rotating the control knob until the two 80mm dial gauges indicate the desired working pressure. At this point, depending on the accuracy of the gauges and the tolerances of the P.C.U.’s and weights, one or both pistons may be floating.
- 4.5.11 Close valve “A” or “B” as appropriate.

4.5 TAKING DIFFERENTIAL PRESSURE READINGS

- 4.5.1 Shut the equalising valve C to vertical position.
- 4.5.2 Re-align the sighting edges, if necessary with the volume adjusters, and check that the instrument reading is the same. If the readings are different then the piston units are not in balance and the equalising valve C should be opened and the piston units re-balanced as previously described. If one piston unit should fall more rapidly than the other then it is likely that there is a leak on that particular side. Carry out tests on pipework to D.P. cell to see where the leak is, correct and then re-balance as previously described.

- 4.5.3 Add differential weight to value required to H.P. side (red or blue) and level the sighting discs within the marked band on the sighting panel using the volume adjusters. After a settling time no longer than 30 seconds, take a reading.
- 4.5.4 Add next differential weight to value required to the same side and bring back into balance, with each other using the volume adjusters, after a settling time take a reading. Repeat until all readings at that working pressure have been taken.
- 4.5.5 At the end of the readings check zero reading to see no change has occurred.

NOTE: The ranging and checking of the D.P. cell will vary according to different requirements. Therefore, the above is only a guide to the tests to be carried out.

4.6 CHANGING THE WORKING STATIC PRESSURE

- 4.7.1 Remove differential weights and small balancing weights.
- 4.7.2 Open equalising valve (C)
- 4.7.3 Apply main weights to required working pressure.
- 4.7.4 Repeat required procedures as described above

4.7 PRESSURE RELEASE

- 4.8.1 Shut off gas supply
- 4.8.2 Open equalising valve C and open release valves D and E
- 4.8.3 Slowly open valves A and B until all gauges read zero.
- 4.8.4 When tester is not in use close valves A and B, leave valves C, D and E open and remove all weights to a place of safe keeping.

4.8 TEMPERATURE MEASUREMENT OF PISTON UNITS

For many purposes, such as calibrating most type of dial gauges and transducers, accurate knowledge of the temperature of a piston unit is not necessary. However, in order to achieve the utmost accuracy from a dead-weight tester it is important to know the temperature of the piston unit as close as possible to the working part of the unit.

In laboratories where the room temperature is controlled it is most likely that the temperature of the working parts of the unit will not differ from the ambient temperature by more than 0.5°C. When working in uncontrolled temperatures, however, one would have to measure the temperature of the piston unit

A possible way to do this is to use a disc shaped thermistor type probe sensing element taped to the outer surface of the piston unit. The sensing element should be insulated from the ambient temperature by covering the element with a thin strip of polystyrene, or other insulating material, then taping this to the piston unit.

We can supply a suitable instrument. Consult your local distributor for advice on availability

FAULT FINDING

The following chart is an aid to fault finding on your equipment in case of a fault occurring.

Fault	Possible cause	Remedy
Equipment does not provide any output pressure.	No air supply connected/leaking	Check supply Check for leaks, replace seals
	Regulator not set correctly	Adjust so regulated supply gauge (top left-hand corner) register approximately 110% FSD of instrument being calibrated/verified
	Differential pressure connections leaking	Check for leaks, replace seals
	Reservoir Valve is open/Drain valve is open	Close valve and try again.
	Pressure leaking past valves 'D' or 'E'	Ensure valve is fully shut. Open and then close to remove any debris off valve seat
	If unable to locate a cause.	Return tester to Budenberg for investigation.
Equipment provides pressure but pressure decays to zero	Incorrect operating procedure being used.	Ensure that correct operating procedure is being followed (Refer to section 4)
	Pressure leaking past valves 'D' or 'E'	Ensure valve is fully shut. Open and then close to remove any debris off valve seat
	No liquid in tester (Model 249T ONLY)	Check that tester is filled with liquid. Fill the equipment with fluid as necessary. Refer to section 3 (Filling the equipment with liquid).
	If unable to locate a cause.	Return tester to Budenberg for investigation.
	Internal damage	Return tester to Budenberg for investigation.
Equipment provides pressure but pressure increases without operator input	Pressure leaking past valves 'A' or 'B'	Ensure valve is fully shut. Open and then close to remove any debris off valve seat

PERIODIC MAINTENANCE

6.1 CLEANING THE UNIT AND CHECKING THE LIQUID LEVELS.

Cleaning the units and checking the liquid levels (Model 249T) is the only periodic maintenance required. With normal use, no further maintenance should be necessary. If required, the system can be returned to our works for re-conditioning. Accuracy, overhaul and re-certification is also explained in corrective maintenance.

Oil operation

Keep the system clean and free from spilt oil. Do not use any cleansing solvents as they may damage the seals.

Ensure that the reservoir contains sufficient liquid to carry out any calibrations required. If necessary top up the reservoir with the same liquid that is already being used. Do not mix various types or brands of liquid in the tester.

If the oil in the system becomes dirty it should be drained, to prevent contamination and damage to the system.

CORRECTIVE MAINTENANCE

7.1 GENERAL

This section contains details on stripping the unit and replacing the spare parts which are listed in section 8. The component identification numbers in brackets in each procedure refer to the following drawings

7.2 OIL FILL VALVE – MODEL 249T ONLY

The spindles of the valves are sealed with an “O” ring and this can be renewed or the valve cleaned by unscrewing the gland nut and removing the spindle. If removing spindle, the sealing washer at the bottom of the gland nut should be visually inspected for any signs of damage.

ALL OTHER VALVES USED ON MODEL 249T ARE SUPPLIED AS A COMPLETE ASSEMBLY

7.3 INDICATING GAUGES

Should a gauge become defective or damaged it should be replaced or returned for repair.

7.4 VOLUME ADJUSTER

To renew the “O” ring seals items 9 and 10, remove the two nuts on either side of the handle and the two set screws on the underside of the base plate that retain the bearing plate. Rotate handwheel clockwise until the bearing plate end disengages from the two pillars then pull the assembly free.

7.5 PISTON/CYLINDER UNIT

As the piston/cylinder unit represents a high proportion of the total value of the tester, it should always be handled with care and every effort made to keep it clean.

The piston/cylinder unit is made to extremely fine limits of accuracy and it is not advisable to dismantle it. If it is necessary to clean it, the piston and cylinder bore must be oiled immediately, in order to protect the high grade finish.

Should the unit become damaged it should be returned complete for replacement or repair. Parts from different units are not interchangeable as they have to be weighed and evaluated as a whole.

The serial number of the piston/cylinder unit appears in the certificate of accuracy and is marked on the body of the unit. This number, as well as the tester serial number should always be quoted in correspondence concerning the piston/cylinder unit.

The piston/cylinder connections should be blanked if it is removed from the tester. If the unit is taken off for any reason it should be stored upside-down, resting on its weight carrier.

TO CHANGE OR INSPECT PISTON UNITS

Ensure pressure has been released as described.
Remove all weights including piston heads.

MODEL 249T – Use appropriate ‘tommy bar’ in drilled side holes of each piston unit and unscrew in an anti-clockwise direction from the tester block.

Cleaning the Piston Unit – see diagrams for construction

The piston must be kept clean and dry. Under normal operating conditions the piston will rotate for approximately ½ minute at any pressure. If the rotation is unsatisfactory or a squealing noise is heard, remove the piston unit from tester. Unscrew the cap until the piston is free. Rub piston and cylinder with a clean, dry fluff-free cloth. Do not finger the working surfaces. If the contamination is very bad a little solvent may be used. In normal use it should only be necessary to clean the unit once or twice a week. If the period is very much shorter and only clean gauges have been used examine the air or gas supply for contamination.

After cleaning a piston unit, re-assemble taking care when re-fitting piston into the cylinder block.

Re-fit the new or cleaned piston unit to the tester block in the reverse of above. Ensure seals have not been damaged before re-fitting PCUs

The serial number of the piston unit is marked on the outside of the piston unit. This number, as well as the tester number should always be quoted in correspondence concerning the piston unit.

7.6 FACTORY OVERHAUL AND RE-CERTIFICATION OF DEAD-WEIGHT TESTERS MAINTENANCE OF ACCURACY.

The accuracy of a dead-weight tester depends primarily on the effective area of the piston unit and on the weights applied to the piston. The effective area of the piston unit can be affected by wear of the unit. This is generally caused by contamination of the oil in the tester by foreign matter from instruments being calibrated, by water, or by chemicals from instruments, or by rust or corrosion caused by contaminants.

Weights are made of austenitic stainless steel which are entirely stable. They should be periodically cleaned using a non abrasive method to remove any foreign matter.

NEED FOR OVERHAUL AND RE-CERTIFICATION

We recommend that the tester be returned to us for overhaul and re-certification at any time if when used in accordance with instructions:

- (a) The piston does not spin freely.
- (b) The rate of fall of the piston is appreciably greater than when new and makes use of the tester difficult.
- (c) The weights are damaged.
- (d) The tester cannot be made to operate satisfactorily due to wear or damage to pump piping or valves which cannot be rectified by the user.

When high accuracy is required from the tester, it should be returned for overhaul and re-certification more frequently. The actual period will depend on how the tester is used. A tester kept in a laboratory and carefully used might need to be returned every two to three years. A tester carried from site to site and used for calibrating high accuracy gauges or transducers from industrial process plant or for measuring pressures directly might well need to be returned at intervals of less than a year.

The actual period between overhaul and re-certification should be fixed by the user in the light of the above comments taking into account the requirements of any inspection authority, which might be involved.

IDENTIFICATION OF WEIGHTS

All weight sets supplied with a dead-weight tester have allocated, and are marked, with a weight set number. Additionally, if users wish to ensure that only specific weights are used with an individual dead-weight tester or piston and cylinder unit, then the serial number of the tester, and/or piston cylinder unit may also be marked on the main weights. Regrettably due to size, increment weights can only be marked with the serial number of a piston and cylinder unit.

OVERHAUL AND RE-CERTIFICATION

To provide the best possible service, the tester should be returned as complete units comprising the base, the piston and cylinder unit, and all the weights. Users may at their discretion elect to service the base themselves and only return the piston and cylinder unit with weights for overhaul. In such instances, certification issued after overhaul can only refer to the piston and cylinder and weight set numbers and not to the base to which they were originally fitted.

Tester bases will be stripped, all pipework cleaned, all seals replaced, worn components replaced where desirable, and all reassembled and tested.

The weights will all be checked and brought to within original limits if possible. If one or two weights are missing or beyond economical repair they will be replaced. If more are missing/ beyond economical repair customer instructions will be sought.

The piston unit will be checked for accuracy and sensitivity. If it is not satisfactory for any reason a quotation will be submitted for a replacement unit.

A new certificate of accuracy will be issued for each overhauled tester. Unless otherwise instructed on order when there has been a slight change in area of the piston unit the certificate will reflect this; the accuracy will not be affected by more than 0.03%. For example the certificate of accuracy of an overhauled tester might show that the error does not exceed 0.05% when the original certificate shows that the error did not exceed 0.03%.

We can issue an UKAS certificate of calibration for an overhauled system. Details will be supplied on request.

SPARE PARTS

8.1 SPARE PARTS LIST

This list covers all the items subject to wear. Any enquiries should be addressed to Budenberg.

Unit	Item No.	Description	Part No.
Piston/cylinder MODEL 249T	4A	MODEL 249T PCU – 1/8in ² AREA - PA/7089	YC0384
	4B	MODEL 249T PCU – 1/16in ² AREA - PA/5870	YC0571
	5*	O-Ring 200-126-4470	YR1386
	6*	O-Ring 200-011-4470	YR1370
	7*	O-Ring 200-021-4470	YR1373
	8*	Valve seat PA/5586/2	YC3534
SCREWPRESS	9*	O-Ring 200-010-4470	YR1365
	10*	O-Ring 200-111-4470	YR1380
	11*	Bonded seal 400-025-4490-41	YR1338

Items marked thus * are contained in the bag of seals supplied with the system which is also available as a spare.

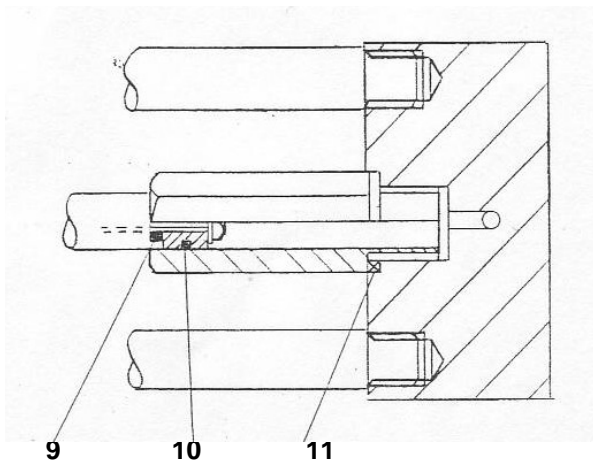
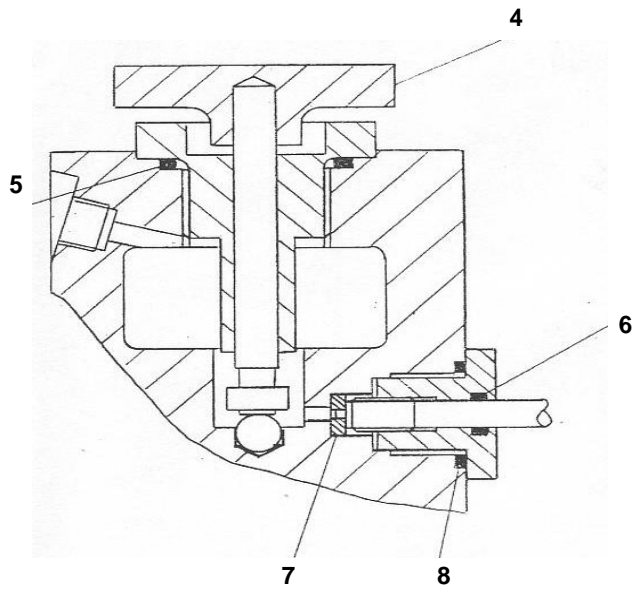
8.2 ORDERING SPARES

When ordering spares or making enquiries always give:

- 1) System Model No. (on front of this manual)
- 2) System serial No. (on nameplate)
- 3) Description of part. See spare parts list.

Whilst every effort is made to ensure that the correct parts are supplied, this cannot be guaranteed unless full information is given.

Ordering spares can be carried out from our service department or the local Budenberg Distributor. Please see www.budenberg.co.uk for details.



9.1 UKAS CERTIFICATE OF CALIBRATION

All testers are available with certificates of calibration on pressure, also calibration of effective area and mass of the piston unit, also the mass of the weights.
Consult your local distributor for advice.

Consult your local distributor for advice on any additional equipment required for calibration requirements.