CURTISS WRIGHT Controls
Integrated Sensing

PITOT-STATIC LEAK TESTER
TYPE D51600

Operation & Calibration Manual PIM 417-O
Issue 5 November 2009

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The operating procedures given in this manual have been written on the assumption that personnel performing the procedures have received training of a standard adequate to enable them to do so, and are qualified in the appropriate operating techniques. Such personnel are deemed also to be competent to act at all times with due regard to the safety of themselves and of the equipment.

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INTRODUCTION

This manual describes the operation and calibration of the Penny & Giles Aerospace Limited Pitot-Static Leak Tester (PSLT) Type 051600. The PSLT, known as the 'Micro Leak', provides 1 st Line leak testing of aircraft altitude and airspeed systems. It also provides limited pressure control for the functional testing of pneumatic switches.

If any difficulty is experienced in the use of this manual, contact the following for assistance:

Customer Support
Penny & Giles Aerospace Limited
1 Airfield Road
CHRISTCHURCH
Dorset BH233TH
UK

Telephone: +44 (0) 1202 409409
Facsimile: +44 (0) 1202 484846
E-mail: support@pennyandgiles.com

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SPECIFICATION

1. PHYSICAL DIMENSIONS

Overall Dimensions:	192.3 mm x 110 mm x 210 mm
Front Panel:	147.4 mm x 77 mm
Weight:	2.3 kg, maximum
Output Port:	push-to-fit pipe

2. POWER SUPPLY

Battery Voltage:	10 x 1.5 V d.c.
Battery Current:	600 mA maximum, 300 mA typical, > 1.2 Ah recommended

3. OPERATIONAL LIMITS

A. Pitot

Range (wrt Atmosphere):	0 to 430 knots 0 to 10 inHg 0 to 340 mbar
Normal Rate of Change:	47 mbar / minute
Rapid Rate of Change:	114 mbar / minute
Power Fail Rate of Change:	80 mbar / minute (<47 knots/min @ 400 knots in 1 litre)

B. Static

Range (wrt Atmosphere):	0 to -430 knots 0 to -10 inHg 0 to -340 mbar 0 to +10000 feet
Normal Rate of Change:	56 mbar / minute (1670 ft/min @ 0 ft; 2500 ft/min @ 15000 ft)
Normal Rate Operating in Feet:	1670 feet / minute
Rapid Rate of Change:	136 mbar / minute) 3600 ft/min @ 0 ft; 6000 ft/min @ 15000 ft)
Rapid Rate Operating in Feet:	4000 feet / minute
Power Fail Rate of Change:	< 70 mbar / minute (<2500 ft/min @ 10000 ft above sea level in 1 litre)

4. INPUT

Ambient Vent Source:	-1500 feet (1069 mbar) to 150000 feet (572 mbar)

Pneumatic Pressure from the Aircraft

NOTE: Vacuum performance is reduced above 4500 feet

5. OUTPUT

Pneumatic Load:	5 litres, maximum (Volume of the Aircraft)

6. ACCURACY (At +25°C)

Pitot Leak Accuracy:	± 0.3% FSO (340 mbar) or ± 0.6 knot/minute @ 430 knots
Static Leak Accuracy:	± 0.3% FSO (340 mbar) or ± 37 feet @ 10000 feet above sea level
Maximum Internal Leak Offset:	
Pitot:	0.3 mbar / minute (0.18 knot / minute @ 430 knots) with 1 litre external volume
Static:	0.3 mbar / minute (11 feet / minute @ 10000 feet) with 1 litre external volume

7. RESOLUTION

Pitot Set Point Display/Control:	5 knots
Pitot Actual Pressure Display:	1 knot
Static Set Point Display/Control:	500 feet
Static Actual Pressure Display:	50 feet

8. TEMPERATURE RANGE

Operating:	-20°C to +70°C
Storage:	-40°C to +70°C

9. HUMIDITY RANGE

Able to withstand:	85% R.H. at 40°C

10. RELIABILITY

Mean Time Before Failure:	15000 hours
Mean Time To Repair:	40 minutes

11. TRANSPORTATION

The equipment is supplied in a robust Acrilonitrile-Butadiene-Styrene (ABS) carrying case; dimensions 485 mm x 305 mm x 190 mm; weight 2.6 kg when empty. The equipment is air transportable. Maximum unpressurised altitude is 30,000 feet.

12. ACCESSORIES

The PSLT is normally supplied as part of the 'Micro Leak' Case Assembly Type D51601 (NSN 6C/4920-99-5736969) ***Figure 1*** ***Figure 1***which comprises:

A. ABS Carrying Case (NSN 6C/6160-99-9965244, Penny & Giles Part W109100)
B. The 'Micro Leak' PSLT Type 051600 (NSN 6C/4920-99-5736968)
C. Two Rechargeable Battery Packs (NSN 6C/6130-99-8752912, Penny & Giles Part W109263-2)
D. Battery Charger (NSN 6C/6130-99-2191440, Penny & Giles Part 005101245)
E. Mains Lead (NSN 6C/5995-99-8419116, Penny & Giles Part 130900003)
F. 2m length of 12.7mm OD, 6.35mm Bore, Yellow PVC Hose (NSN 6C/4720-99-7269158, Penny & Giles Part 301006041)
G. Operation and Calibration Manual PIM 417-O.

Figure 1 'Micro Leal' Case Assembly

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DESCRIPTION

1. INTRODUCTION

The Penny & Giles 'Micro Leak' Pitot-Static Leak Tester (PSLT) is a microprocessor-controlled system which primarily generates pitot and static pressures in order to leak test air data equipment to ensure leak rates are compliant with standards specified for it. The PSLT is also capable of providing functional testing of pneumatic switches.

The PSLT (*Figure 2*) is a robust, battery-powered, portable instrument with state-of-the-art microprocessor control, offering the following features:

A. Leak testing of aircraft pitot and static systems.
B. Functional checking of aircraft airspeed and altitude switches.
C. Normal/Rapid Rate Control.
D. Remote reprogramming/maintenance checking utilising secure Infra-Red (IR) communications (Manufacturer Mode only).

Figure 2 'Micro Leak' Pitot-Static Leak Tester

The PSLT is user-friendly, being simple in operation, and its built-in microcontroller enables the unit to function with minimal Operator intervention.
The PSLT comes complete in its own carrying case which is of rugged construction and which has space to house accessories such as the hose, spare battery packs, a battery charger (if applicable), and the operating manual.

2. GENERAL DESCRIPTION

The PSLT is of modular design to facilitate easy repair. It comprises the following main assemblies:

A. Case
B. Front Panel Assembly
C. Panel Electronic Circuit (PEC)
D. Battery Pack
E. Pneumatic Assembly.

3. CASE

The yellow plastic case is constructed in three parts for ease of manufacture and repair. The two mating sides and the front panel are secured together with silicone 0- ring seals embedded between to protect against ingress of dirt and moisture. An internal conductive coating provides protection against EMC. The case material offers good resistance to abrasion and to moisture absorption, and provides excellent short-term heat resistance in the absence of external stresses. It also offers resistance to a wide range of organic, chemical, lubricant and fuel contaminants. The ports at the base of the case are protected from damage by moulded feet which protrude beyond them. Similarly, the keys and display on the front panel are all recessed below moulded shoulders for maximum protection. A shoulder strap is provided with the PSLT for ease of carrying, and leaves the Operator's hands free for operating the keys.

4. FRONT PANEL

The front panel comprises a six-key membrane keypad, a Liquid Crystal Display (LCD) and an Infra-Red (IR) transceiver for use with the Communications Mode. IR communications provides secure hands off, no connection remote programming and test facilities. The tactile keys are sealed to IP66 and key spacing is designed to allow operation with a gloved hand. The front panel incorporates a clear screen which provides impact protection to the LCD. The LCD has an inherent Polaroid fitter and the display is backlit to enable visibility in all degrees of background light.

The LCD display comprises 2 lines of 20 characters in black on a green background. Full graphic and alpha-numeric capability is provided and the software is designed so that all PSLT "functions can be accessed and controlled from the menus presented on the! front panel display. Located each side of the main display are four yellow tabs bearing captions in black letters. The captions apply to the flags displayed on screen during operation.

5. PANEL ELECTRONIC CIRCUIT (PEC)

Mounted underneath the front panel and forming part of the front panel assembly is a multi-layer Panel Electronic Circuit (PEC), on which a microcontroller and other electronic components are mounted. The microcontroller controls all functions of the PSLT.

The PEC provides the interconnections between the various PSLT assemblies.

6. BATTERY PACK

There are two battery options available:

1) The use of a battery pack containing NiMH cells and integrated with a gas gauge (12.5V).
2) The use of a battery holder fitted with 10 size AA (or MN 1500) dry cell batteries (15V).

The batteries are housed within a centrally-located battery compartment and electrical connections are made by means of a power lead which feeds into the battery compartment from the cavity above and terminates in a three-way connector.

The front cover to the battery compartment is removeable and is fitted with a polypropylene retaining strap, or lanyard. Sealing is provided by a neoprene foam seal and the cover is secured to the case using two 90 degree, or % turn, slotted Dzus fasteners. The battery compartment covers are manufactured from nickel-plated aluminium alloy and when the batteries are sealed within the compartment, they are fully protected against the environment.
During operation, the system monitors power usage and provides a front panel indication when the energy levels drop below 15 minutes (approximately) of available power.

7. PNEUMATIC ASSEMBLY

The pump, pressure sensor, and valves are mounted on a pneumatic block which is attached to a metal baseplate to form a single pneumatic assembly; eliminating the need for unnecessary pipework and connectors. The block, which is manufactured out of aluminium alloy, is hollowed out to form a 180ml. volume reservoir which dampens out pressure pulses and aids control stability. Galleries are machined in the block to interconnect the pump, pressure sensor, valves and outlet ports.

The baseplate of the pneumatic assembly is secured to one half of the case. There are three pneumatic ports: the output port for connection to the aircraft, a breather port, and the reference port for the transducer. The output port, which projects externally from the case, is sealed against leaks and is protected by a blanking cap which is attached to it by lanyard to minimise loose object hazards.

The pump is of oil-free diaphragm construction, sealed against normal operating environmental conditions. It is driven by d.c. motor and is capable of delivering up to ± 500 mbar to the output port at a rate of 4 litres/minute at atmospheric pressure.

Within the PSLT are four miniature d.c. solenoid valves operated from four Pulse Width Modulated (PWM) ports. Two 3/2 changeover valves control the direction of air flow. The third valve (normally-closed) is used to vent the controlled pressure to atmosphere during a Vent Cycle. The fourth valve is a normally-open vent valve with restricted orifice. This provides a slow vent to safely reduce the system pressure to atmosphere in the event of either a power failure or an overpressure condition.

Pressure measurements are made by a differential silicon transducer connected on one side to atmosphere (via the reference port), and the other to the controlled pressure source (aircraft pneumatic systems) via the output port. The transducer interfaces wi1th the microcontroller via an Analogue-to-Digital Converter (ADC). The transducer has integral signal conditioning and temperature compensation. The operating range is -340 mbar to 340 mbar and typical compensated accuracy is ± 0.3% Full Scale Output (FSO).

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OPERATION

1. INTRODUCTION

The PSLT is designed to perform the following basic functions:
A. Positive and negative pressure generation
B. Differential pressure measurement
C. Pressure rate control
D. Control of Set Point pressure
E. Accurate measurement of external leak: rate
F. Automatic timing during tests.

Throughout the operations cycle, the PSLT Built-In Test Equipment (BITE) carries out self-diagnostic checks to accurately assess the output states of the battery and the Transducer dedicated supply. It also monitors pressure to detect an Overpressure condition, initiating an automatic vent if one is detected.

All PSLT functions can be accessed and controlled via menu screens and the front panel keypad, see *Figure 3*.

Figure 3 PSLT Front Panel

Six membrane keys are provided:

A. **PWR** Applies power to the equipment.
B. **+** Nudges parameter values by set increments.
C. **-** Nudges parameter values by set decrements.
D. **SEL** Selects menu option; Pitot or Static mode of operation; and the preferred measuring units for each test or pressure control sequence. Is used within a test to skip from one stage to the next. In Pressure Control Mode is used to toggle between the pressure monitor and leak rate displays.
E. **START** Initiates all tests and pressure control sequences. When pressed in conjunction with the PWR key during power up, gives access to a Maintenance Mode.
F. **STOP** Aborts the test and initiates a Vent Cycle.

2. OPERATIONAL MODES

Five modes of operation are available. Three primary operational modes are available following normal power up, while a fourth, subsidiary, mode is accessed during power up by pressing the PWR key with the START key. The fifth mode, the Communications mode, utilises the front panel IR transceiver to establish a serial communications link between the PSLT and a remote PC for use in downloading software and for ATE. This mode is for Manufacturer's use only and no further information shall be provided within this manual.

A. Leak Test Mode

The Leak Test Mode (Main Menu 1) is used for leak testing the aircraft pneumatic systems. Within this mode, the Operator may select which channel is tested, Pitot or Static, in which units of measurement the test is conducted, and is able to set individual values for the test parameters.

B. Pressure Control Mode

The Pressure Control Mode (Main Menu 2) is used for controlling pressure in order to test aircraft airspeed and altitude instruments and switches. The Operator is provided with the same facilities as in Leak Test Mode.

C. Setup Mode

The Setup Mode (Main Menu 3) provides the Operator with the ability to alter the default times for Settling Period, Checking Period, and Power Down Period.

D. Maintenance Mode

The Maintenance Mode gives access to six Maintenance Menus. These menus are not part of normal operating procedure, but are used to interrogate Built-In Test parameters during maintenance operations. They are accessed during power up by pressing the START key at the same time as the PWR key. Use of this mode is required during PSLT calibration.

3. OPERATIONAL OVERVIEW

Once the test conditions have been selected and the START key pressed, the PSLT automatically carries out the required sequence without further Operator intervention, although the Operator may opt for a faster rate of pressurization by keeping the START key held down until the selected Set Point has been reached. As the Set Point approaches, the faster rate is abandoned and the PSLT controls to the Set Point at the normal rate. The rate of pressure increase or decrease is automatically controlled to within prescribed limits of accuracy. On reaching the Set Point, the PSLT initiates a volume settlement period for a user defined time (default 2 minutes) and then measures the rate of leakage in the selected units of measurement over a further check period (default 3 minutes), calculating and displaying the resultant leakage rate on completion. If required, the SEL key may be used to skip from one stage to the next. The test may be terminated at any time via the STOP key. Pressed once, it gives access to the Pressure Monitor Mode. Pressed a second time it initiates a Vent Cycle to return the equipment to normal atmospheric pressure.

For tests where accurate absolute pressure measurement is required, i.e. for Static tests measured in feet, the Operator must enter the Pressure Of The Day (POTD). The PSLT will automatically recalibrate itself to carry out precision measurement to the point selected.

4. SETUP

CAUTION: **ENSURE THAT THE HOSE FROM THE PSLT IS CONNECTED TO THE CORRECT AIRCRAFT SYSTEM. FAILURE TO DO SO MAY RESULT IN DAMAGING PRESSURES BEING APPLIED TO THE SYSTEM UNDER TEST.**

A. Connect the PSLT port to the pitot or static system under test and ensure the connection is leak tight.

B. Apply power to the PSLT by pressing the PWR key. The system performs an internal self-diagnostic test routine and the screen displays the version of software installed (*Figure 4*). For a short time during power up, an initial battery status indicator will be displayed (*Figure 5*), providing the Operator with an estimate of percentage battery life available (20% to 100% in 20% steps).

Figure 4 Initial Power On Screen

Figure 5 Battery Status (80% Power Available)

C. Following successful completion of the self-test routine, the screen displays the first main menu, Menu 1, Leak Test (*Figure 6*). The menu option required is selected by pressing the SEL key. Pressing once when Menu 1 is displayed calls up Menu 2, Pressure Control. Pressing a second time calls up Menu 3, Setup. Pressing a third time calls up Menu 1 again, and so on.

Figure 6 Menu Option 1

NOTES:

1. **If the self-test routine detects a fault the screen will not display the first main menu. Instead a fault message is displayed, together with a fault code. In the event of a fault message appearing on the screen, contact Penny & Giles at the address given on page 1 of this manual, quoting the code displayed.**
2. **Whilst in a main menu screen, the +/- keys may be used to increase or decrease screen contrast to suit ambient lighting conditions.**
3. **At this time the VENTED flag is visible on the left- hand side of the screen, whilst on the right-hand side the flag for the current (last set) mode, either Pitot or Static, is displayed. (The flag shown in Fig. 6 is for Pitot, which is the default mode for the first power up of the equipment.)**
4. **If the energy remaining in the Battery Pack is down to approx. 15 minutes operation (the exact life remaining depends on the individual batteries employed and the operations previously undertaken) then the BATT LOW flag will be displayed on the lower left-hand side of the screen. The flag indication flashes continuously whilst displayed**

D. The PSLT can be manually powered down in any of the screens. In addition, provided the system is vented, the equipment will automatically power down if the Operator fails to interact with any interactive screen within a defined period. The duration of this period, known as the Power Down Period, may be changed by the Operator within Menu 3.

5. LEAK TEST MODE

A. When the opening screen for Main Menu 1 is displayed press the START key to initiate the Leak Test Routine. The display prompts the Operator to select the mode type and displays the current mode, e.g. 'Currently PITOT' {*Figure 7*).

NOTE: The first time the PSLT operates, the default mode is Pitot. Thereafter, the default mode is the last mode selected in previous tests.

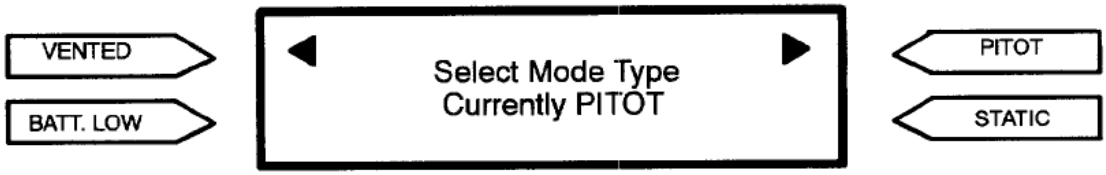

Figure 7 Selecting Operational Mode

B. Select the desired mode by using the SEL key to toggle between Pitot and Static. As the selected mode is changed, the associated flag will change correspondingly. The presence of the appropriate flag is a constant reminder during later stages of the test of which mode has been selected. This reduces the risk of inadvertently applying incorrect pressures to the system under test.

C. Once the mode has been selected, press START. The screen prompts the Operator to select the preferred units of measurement for the test. The first time the PSLT operates the default units are knots (*Figure 8*). Thereafter the default units are the last units selected in previous tests. The SEL key is used to select different units. Press once to select inches of mercury (inHg) and twice to select millibar (mbar). Pressing a third time returns the display to knots. If the Static mode has been selected, a fourth option of feet is available, appearing after millibar.

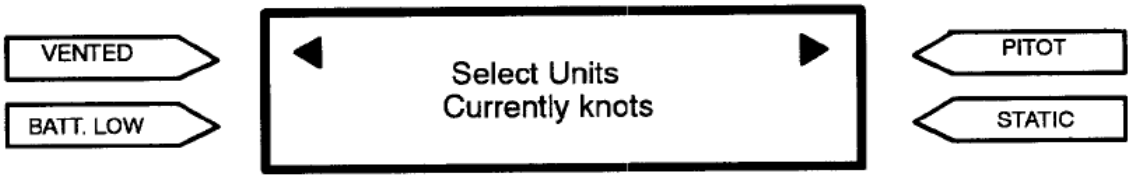

Figure 8 Selecting Units of Measurement

CAUTION: **WHEN CARRYING OUT STATIC LEAK TESTS IN KNOTS, CARE MUST BE TAKEN AS THE PSLT IS OPERATING IN THE NEGATTIVE PRESSURE MODE I.E. EVACUATING PRESSURE FROM THE AIRCRAFT, WHICH MAY LEAD TO DAMAGE TO SENSITIVE INSTRUMENTS IF INCORRECT PRESSURES ARE APPLIED.**

D. With the correct units displayed, press the START key. The first time of operation, the PSLT will operate using its default parameter settings, unless otherwise changed by the Operator. These default settings are as follows:

(1) Set Point: 130 knots (or 30 mbar or 0.8 inHg or 1000 feet, depending on the units selected. Note that for Static Mode, values are negative.)

(2) Setting Period: 2 minutes

(3) Checking Period 3 minutes
(4) Power Down Period: 2 minutes.

The Set Point value can be changed within this menu but the remaining parameters must be changed via Main Menu 3 (refer to paragraph 7).

E. When the default Set Point is displayed, for example 130 knots (*Figure 9*), a new Set Point can be entered by means of the +/ - keys.

Figure 9 Default Set Point

F. When the units selected are knots, values are incremented/decremented by an initial step of 75, between 0 knot and ± 75 knot, and thereafter in 5 knot steps to ±430 knots.
G. When the units selected are inHg, values are incremented/decremented by an initial step of 0.25, between 0 inHg and ±0.25 inHg, with a second step of 0.15 inHg between ±0.25 inHg and ±0.40 inHg. Thereafter, values are incremented / decremented in 0.20 inHg steps to ±10 inHg.
H. When the units selected are mbar, values are incremented/decremented by an initial step of 9 mbar, between 0 mbar and ±9 mbar, with a second step of 6 mbar between ±9 mbar and ±15 mbar. Thereafter, values are incremented / decremented in 5 mbar steps up to ±340 mbar.
J. When units are feet, values are incremented / decremented by an initial step of 500, between 0 feet and 500 feet, and thereafter in 100 feet steps up to 10000 feet (Static only).
K. If the Static mode is selected and the preferred units are feet then the Pressure Of The Day (POTD) must be entered following the setting of the Set Point value. (This provides the PSLT differential pressure transducer with an accurate reference against which it can measure pressure; thus enabling altitude switches to be tested.) POTD is entered in mbar. The default value is 1013 mbar and it can be nudged up or down between 572 mbar (15000 ft) and 1069 mbar (-1500 ft) using the +/- keys in increments/decrements of 1 mbar, or more rapidly if the key is held down.

NOTE: Set the Altimeter Baro Set on the aircraft to 1013.25 mBar (i.e. standard atmosphere), and not POTD as entered into the PSLT. Failure to do so will result in an error between the altitude displayed on the PSLT and that displayed by the Altimeter.

L. When the Set Point has been entered in the preferred measurement units, press the START key. The screen displays a caption to check the appropriate hose (*Figure 10*). This is a reminder to the Operator that inappropriate pressures applied to the aircraft may cause damage.

NOTE: **When the START key is pressed, the Set Point selected will be saved as the default value for the next test and each measuring unit has its own default value.**

Figure 10 Pre-Pressurisation Screen

M. Press START. The software starts to pressurise the system at a rate of 47 mbar/minute for Pitot or 56 mbar/minute for Static. However, it is possible to select a faster rate of pressurization. The default method of selection is by pressing and holding the START key. The PSLT then pressurises at the faster rate of 114 mbar/minute or 136 mbar/minute, respectively, until the either the Set Point is reached or the START key is released, whereupon the PSLT returns to pressurising at the normal rate. This may be changed, however, by means of Maintenance Menu 6, Fast Rate Mode (refer to paragraph 8. Maintenance Mode). If the Rate Toggle Mode is set via this menu then during pressurization the START key is used to toggle between the normal and fast rates of pressurization using discrete key presses rather than pressing and holding. i.e. !having pressed START to initiate system pressurization, pressing START a second time selects the faster rate, while pressing it a third time returns the system to the normal rate, and so on.

CAUTION: **WHEN THE FAST RATE IS SELECTED AND THE PSLT IS OPERATING IN THE STATIC MODE USING MILLIBARS, INCHES OF MERCURY OR KNOTS, THE PUMP MAY GENERATE RATES IN EXCESS OF THE VSI GAUGE MAXIMUM. IT IS RECOMMENDED, THEREFORE THAT FOR HELICOPTERS ONLY THE NORMAL RATE IS USED . FOR FIXED WING AIRCRAFT, ONLY THE NORMAL RATE SHOULD BE USED WHEN COMMENCING TESTS AT AN ALTITUDE OF 13000 OR HIGHER**

N. As soon as the pressurization starts, the VENTED flag extinguishes. During this time, the display not only shows the Set Point value, but also the Actual value (*Figure 11*).

P. While the test sequence continues automatically, it is possible for the Operator to intervene if required. Once system pressurization has commenced, the SEL key allows the Operator to skip forward from any stage to the next. Following pressurization, the START key can be used to return to the beginning and repeat the test. In addition, the +/- keys can be used to return to the beginning of the 1test and alter the value of the Set Point.

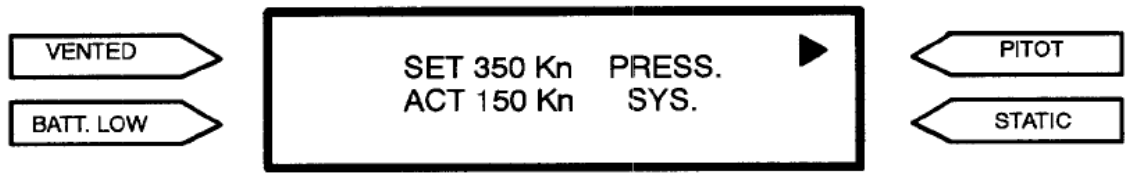

Figure 11 System Pressurisation

Q. If STOP is pressed at any time during the test, the test is paused and the PSLT goes into the Pressure Monitor Mode. Actual pressure and leakage rate per minute are displayed (*Figure 12*. To return to the test, the START key is pressed. If the test is to be aborted, the STOP key is pressed a second time to initiate a Vent Cycle in which the' system vents to atmosphere at a rate of 47 mbar/minute for Pitot or 56 mbar/rnlnute for Static. As with the START key (paragraph 5.M.), it is possible to use the STOP key to select a faster vent rate of 114 mbar/minute or 136 mbar/minute, respectively. While the system is venting, the screen displays the pressure remaining in the system (*Figure 13*). When the system has vented, the screen will display the caption 'SYSTEM VENTED' and the VENTED flag appears.

Figure 12 Test Aborted

Figure 13 Venting

NOTE: When STOP is used to abort the test while the system is not in a pressure sequence the screen will revert to displaying the opening screen of Main Menu 1

R. When Set pressure has been achieved, the PSLT enters its settling mode (either the default time of 2 minutes or the time set under Main Menu 3). The screen displays the caption 'SETTLE' and also the remaining time (*Figure 14*).

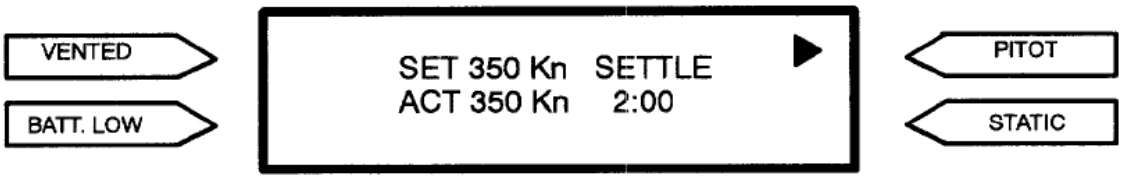

Figure 14 Settling Period

S. Following the settling period, and before entering the checking period, the PSLT carries out a coarse leak check. If system pressure drops by 33% or more from the Set Point during this time, the leak check is halted and the screen displays a 'COARSE LEAK FAIL.' caption, together with the failure rate (*Figure 15*). This screen will continue to be displayed until accepted by the Operator. This may be in one of several ways. If the failure is due to something simple like a poor hose connection then, once rectified, the Operator can press either the START key to return to the beginning of the test, or the SEL key to continue the test from the point of failure. To abort the test completely, the STOP key is pressed as normal.

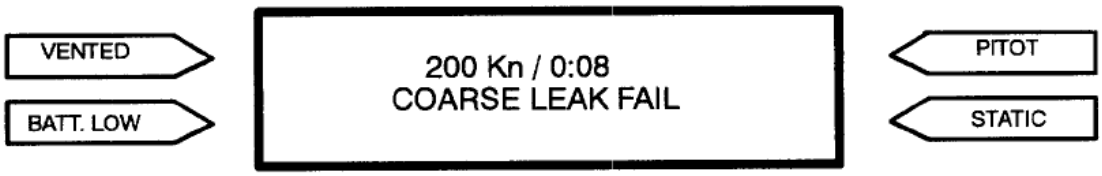

Figure 15 Coarse Leak Check

T. If the system passes the coarse leak check the PSLT continues with the main leak check. During the check period, the real time leakage is displayed in the units in which the test is being conducted. The caption 'CHECK' and the elapsed time are also displayed (*Figure 16*).

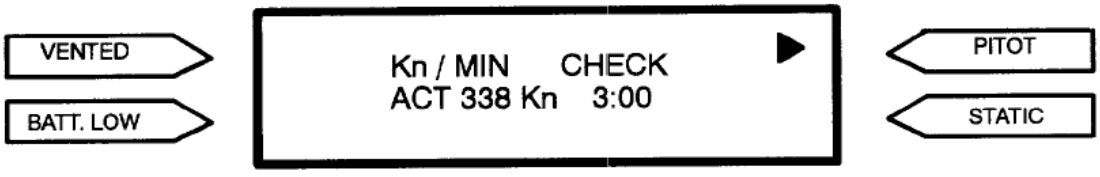

Figure 16 Checking Period

V. At the end of the checking period, the screen will display the total leakage over the set time period, together with a message that the test is completed (*Figure 17*).

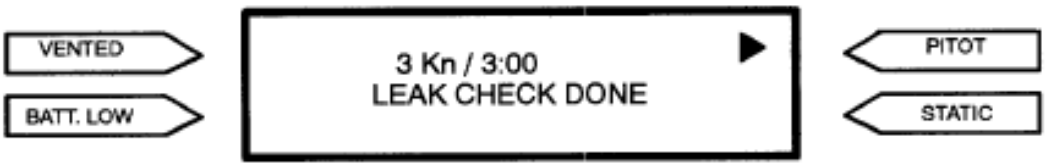

Figure 17 Leak Test Completed

W. Pressing START after the initial leak test has been completed restarts the test. The test will also be restarted if START is pressed when in the Pressure Monitor Mode. Alternatively, if in place of the START key the +/keys are used, the test will restart at a new Set Point (either incremented or decremented) .

X. If no further leak tests are to be carried out, press STOP twice to initiate a Vent Cycle. As before (paragraph 5.0.), the rate the PSLT vents to atmosphere can be controlled via the STOP key. When vented, the screen will display the caption 'SYSTEM VENTED' and the VENTED flag appears.

Y. Press the PWR key to switch the equipment off. However, if the equipment is left powered up, then 5 seconds after the system has successfully vented the display reverts back to the Main Menu 1 ready to initiate new tests.

6. PRESSURE CONTROL MODE

A. The Pressure Control Mode is used to 1test the accuracy of Airspeed and Altitude indicators and switches. Whl3n the opening screen for Main Menu 2 is displayed press the START key to initiate pressure control. The display prompts the Operator to select the mode type and displays the current mode, as shown in *Figure 7*.

B. The preferred measuring units and the value of the Set Point are selected as described in paragraphs 5.C. to K.

C. Press the START key. The screen in *Figure 10* is displayed.

D. Press START a second time. The software starts to pressurise the system at a rate of 47 mbar/minute for Pitot or 56 mbar/minute for Static. If required, the START key can be used to pressurise the PSLT at the higher rate of 114 mbar/minute for Pitot or 136 mbar/minute for Static (paragraph 5.M.).

E. As soon as the pressurization starts, the VENTED flag extinguishes. During this time, the display not only shows the Set Point value, but also the Actual value (*Figure 18*).

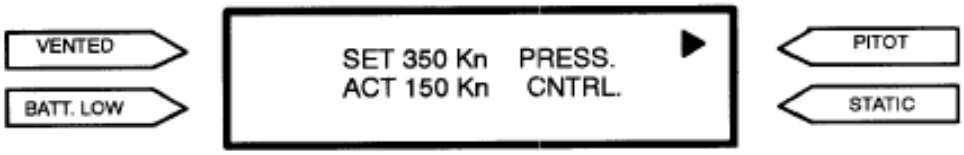

Figure 18 System Pressurisation

F. In this mode, the system will continue to control to the Set Point until the STOP key is pressed to enter the Pressure Monitor Mode. As with the Leak Test Mode, the Pressure Control Mode allows the Operator to restart the test and to increase or decrease the value of the Set Point while the system is pressurised. When monitoring pressure, the SEL key can be used to toggle between the pressure monitor display and a leak rate display (*Figure 19*).

Figure 19 Leak Rate Display

G. As with the Leak Test Mode the STOP key is used to initiate a Vent Cycle and return the equipment to atmospheric pressure. If the equipment remains powered, the display reverts to the Menu 2 Pressure Control screen.

7. SETUP MODE

Main Menu 3, Setup, is used to set up timiing parameters within the system. Default values are set for the settling period, the checking period, and the power down period. The settling period and the checking period are part of the Leak Test Mode. The settling period is the time the system waits from when the set pressure is achieved before continuing with the test. The checking period is the time during which the leakage rate is measured. The power down period is universal to all modes of operation and is the time out period for the PSLT, i.e. the time the PSLT will wait idle before it automatically powers down.

NOTE: Automatic power down is inhibited when the PSLT is pressurised.

The default values set at the factory are suitable for most applications, and the Operator may decide to omit any setup procedure. If the default values are to be changed to suit individual operating requirements, then they are changed via this menu. Following power down of the system the new settings are retained by the system EEPROM memory until further values are set.

The duration of any period is changed as follows:

A. When 'Menu 3 SET UP' is displayed on screen, press the START key.
B. The screen for changing the settling period will be displayed (*Figure 20*).

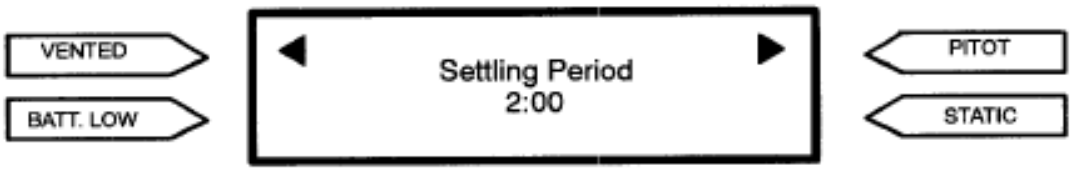

Figure 20 Resetting the Settling Period

C. Press the START key again to select the checking period, a third time to select the power down period.
D. For each period, the default duration is displayed. To alter the time, use the +/- keys to nudge the value up or down. Times are incremented or decremented in 15 second intervals between zero and 5 minutes for the settling and checking periods, and between 0 minutes and 10 minutes for the power down period.
E. To return to the Menu 3 screen, press the START key. Other Main Menus can then be accessed via the SEL key.

8. MAINTENANCE MODE

The Maintenance Mode is accessed whilst the PSLT is powering up by pressing the START key and holding it down while pressing the PWR key. The screen displays the caption 'Maintenance Menu 1 CONTRAST CONTROL'.

Six menus are available:

A. Maintenance Menu 1 CONTRAST CONTROL
B. Maintenance Menu 2 PRESSURE MONITOR
C. Maintenance Menu 3 CALIBRATION
D. Maintenance Menu 4 INTERACTIVE TEST
E. Maintenance Menu 5 BITE
F. Maintenance Menu 6 FAST RATE MODE

As with the main menus, the required menu is selected via the SEL key.

A. Menu 1 is used to alter the screen contrast to suit ambient lighting conditions. Pressing the + key increases the contrast; the - key decreases it. In either case the screen returns automatically to displaying the Maintenance Menu 1 screen.
B. Menu 2 is used to confirm PSLT opera1tion following its calibration.
C. Menu 3 is used during the calibration of the PSL T.
D. Menu 4 is used for interactive testing of the front panel LCD and keypad.
E. Menu 5 is used to test the Batteries, PSU, Transducer, and Flash Program Count.

F. Menu 6 is used to select by which keying method faster pressurization and venting rates are obtained. Pressing the START key gives access to the Rate Toggle Mode screen. Pressing SEL from this screen gives access to the Normal Rate Mode. Pressing SEL again returns to the Rate Toggle Mode. The Normal Rate Mode is the default mode and the faster rate during pressurization is obtained by pressing and holding down the START key (or the STOP key during venting). If the Rate Toggle Mode is selected, the START key (or STOP key) is used with discrete presses to toggle between the normal and fast rates.

To return to the Maintenance Menu 6 screen press the STOP key.

CAUTION: **THE FAST RATE SHOULD BE USED WITH CARE WHEN OPERATING IN THE STATIC MODE (REFER TO PARAGRAPH 5.M)**

Menus 4 and 5 are not used by the Operator. For further information on the use of Menus 2 and 3, refer to Calibration.

To exit the Maintenance Mode, the STOP key is pressed.

9. BATTERY REPLACEMENT

WARNING: **THE MATERIALS USED IN THE CONSTRUCTION OF ALKALINE MANGANESE DIOXIDE BATIERIES ARE CORROSIVE AND MAY CAUSE BURNS TO EYES OR SKIN IF THE BATIERIES ARE PUNICTURED IN ANYWAY. IN CASE OF CONTACT, RINSE AFFECTED AREA MMEDIATELYWITH PLENTY OF WATER AND SE~EK MEDICAL ADVICE. ADDITIONALLY, MANGANESE DIOXIDE IS HARMFUL WHEN INHALED (WHEN DRY) AND IF SWALLOWED. IN CASE OF ACCIDENT SEEK MEDICAL AID IMMEDIATELY.**

A. General

The recommended batteries for use with the PSLT are Duracell LR6 Alkaline Manganese Dioxide Batteries (also known as Size AA or MN1500). Their normal operating voltage range is 1.5Vto 1V per cell under most conditions of PSLT expected load and operating environmental temperature.

The PSLT has demonstrated an operational battery life in excess of 3 hours under the following conditions:

(1) Pump continuously running at maximum rate.
(2) All electronic circuits fully operational
(3) Display operating

Initial battery status is displayed at power up by means of a battery symbol shown briefly during the period the system performs an internal self-diagnostic test routine. It provides an estimate of battery energy shown as a percentage from 20% to 100% in steps of 20%.

When the combined battery voltage drops below 10V, the BATT LOW flag gives a flashing illumination, indicating that the PSLT has approximately 15 minutes running time remaining (the actual value depends on the individual batteries and also the number and type of tests carried out previously).

B. Replacement

To replace the batteries, unfasten the two 90 degree, or 1/4-turn, slotted Dzus fasteners securing the Battery Compartment Cover and carefully remove the cover. Care must be taken not to pull too fast which would result in the battery holder being prematurely expelled from the compartment, leading to possible damage to the connecting power cable. The cover is attached to the case of the PSLT by means of a lanyard made from woven polypropylene. As the cover is removed, the battery holder (which rests on the lanyard) is pulled out by the movement of the lanyard. When the holder is sufficiently proud of the case, disconnect the power cable and remove the holder completely from the compartment by hand.

Replace the spent batteries with new batteries, taking care to fit them with the correct polarity.

NOTE: **Always replace the complete set of batteries at one time.**

C. Storage

Spare batteries may be stored for prolonged periods at standard room temperature without significant losses. Typical retained life is 85% after five years storage at 20°C. Short term exposure to storage temperatures above 45°C is acceptable. Stored batteries should be kept in the their original packaging and contact with metal objects should be avoided to prevent any risk of short-circuiting which might result in leakage, or in extreme cases, battery explosion.

D. Disposal

These batteries contain insufficient quantities of mercury, cadmium and lead to be subject to EC requirements on batteries containing certain dangerous substances. Unless disposed of in bulk, spent batteries may be disposed of with normal domestic waste. Care must be taken, however, as the materials used in them are corrosive and may cause burns to the skin and eyes. Do not crush or puncture the batteries on disposal.

10. BATTERY CHARGER

WARNINGS:

1. **THE BATTERY CHAFIGER ENCLOSURE IS NOT DESIGNED TO ANY SPECIFIC IP RATING AND IS THEREFORE NOT PBOTECTED AGAINST WATER. DO NOT USE OUTSIDE IN UNSHELTERED LOCATIONS AS THIS CARRIES A HIGH RISK OF ELECTROCUTION FOR THE USER.**
2. **THE MATERIALS USIED IN THE CONSTRUCTION OF NICKEL METAL HYDRIDE BATTERIES ARE CORROSIVE AND M)~Y CAUSE BURNS TO EYES OR SKIN IF THE BATTEBIES ARE PUNCTURED IN ANY WAY. IN CASE OF CONTACT, RINSE AFFECTED AREA IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE. ADDITIONALLY, NICKEL HYDROXIDE IS HARMFUL WHEN INHALED AND IF SWALLOWED. IN CASE OF ACCIDENT SEEK MEDICAL AID IMMEDIATELY.**

A. General

As an option to using Alkaline Manqanese Dioxide batteries, the PSLT is supplied with two battery packs containing NiMH rechargeable batteries. Prior to use, they must be fully charged using the Accumax C512MD-01 Battery Charger provided as part of the 'Micro Leak' Case Assembly. The C512MD-01 is a 2-channel microcontroller-based equipment which discharges and recharges batteries automatically to ensure that they operate at full capacity and that the risk of damage due either to the memory effect or to over -charging is reduced.

Safety features include the following:

1) Visual Warning and Power Cut-Out for Reversed Battery Connection.
2) Current Limiting and Power Cut-Out for a Shorted Output.
3) Power Cut-Out/Time-Out in the event of a Charge Control Error.
4) Thermal Limit Monitor.
5) 3.15A Slow Blow Fuse protection for the Power Supply.
6) 7.5A Fused Output.

B. Applying Power to the Charger

The C512MD-01 may be powered from any a.c. mains supply within the range 100 to 253V a.c., 50 to 60Hz and no pre-selection of the supply to be used is necessary. Power is applied to the charger as follows:

1) Connect the charger to the mains supply using the standard IEC mains lead supplied.
2) On the charger, press the rear panel rocker switch to the ON position.
   The front panel power indicator (green LED) should illuminate.

C. Charging Batteries

CAUTION: ONCE CHARGING HAS COMMENCED, IT IS ESSENTIAL NOT TO DISCONNECT THE BATTERY PACKS FROM THE CHARGER UNTIL CHARGING IS COMPLETE AND BOTH LED ARE ILLUMINATED. FAILURE TO COMPLY MAY RESULT IN DAMAGE TO THE GAS GAUGE CIRCUITRY.

1) When power is applied to the unit, the charger samples each of the channels in order to detect the presence of a battery pack.
2) Connect the first rechargeable battery pack to the Channel 1 connector on the charger, and the second battery pack to the Channel 2 connector. The front panel yellow LED associated with each channel should start to blink, indicating that the presence of the battery packs has been detected.
3) The battery pack connected to Channel 1 is discharged first. When completely discharged, the charger automatically commences the charging cycle. On completion, the Channel 1 indication will stop blinking and remain permanently illuminated.
4) The discharging and charging 01f the second battery pack then commences. When the LED for both channels are permanently illuminated the batteries are fully charged and ready for use.

5) Disconnect the two battery packs from the charger. The Channel 1 and 2 LED extinguish on removal of the battery packs.

D. Troubleshooting

1) If the front panel power LED fails to illuminate, check that the connected supply is within the correct range. If it is, check the condition of the fuse located in the mains inlet moulding at the rear of the charger. Replacement fuses should be 3.15A T Antisurge type.
2) When using the charger to charge the supplied battery packs for the first time (Le. prior to use), it may be that either of the yellow front panel LED fails to illuminate when the packs are connected to the charger. NiMH batteries will sometimes discharge to a voltage much lower than their nominal terminal voltage when they have been stored for an extended period. Under these conditions, the voltage within the packs is too low to be detected by the sense circuitry within the charger. The charger thus fails to detect the presence of the battery packs and will not commence the charging sequence.

   To overcome this problem the battery detect circuitry within the charger needs to be overridden. This is done by switching the rocker switch on the charger rear panel to the ON position prior to applying power to the charger (a reversal of the normal sequence).

   Once the battery packs have been 'fully charged in this manner, they regain their nominal terminal voltage and can be subsequently charged in the conventional manner.

3) If the charger detects a fault during operation the red front panel Fault LED starts to blink in sequence with the LED for the working channel. This fault could be associated with either the battery pack, the connection between the pack and the charger, or a fault within the charger itself. If checking the interconnection and/or connecting a different pack does not irradicate the fault, then the fault is likely lie with the charger.
4) In the event of difficulties with either the battery packs or the charger, contact Penny & Giles at the address given at the front of this manual.

CALIBRATION

1. INTRODUCTION

The PSLT must be calibrated on a two-yearly basis against a Primary Calibration Standard, which is itself traceable to a National Standard. Following calibration against such a standard, the PSLT may be classed as a Secondary Standard item of equipment.

Calibration shall be carried out under the following conditions:

A. Temperature: + 15°C to +30°C
B. Air Pressure: 860 to 1060 mbar, Abs.
C. Relative Humidity: 20 to 70%

2. EQUIPMENT REQUIRED

The equipment required to carry out calibration is listed in *Table 1*

Table 1 Equipment Required

REF.	ITEM
1	Primary Calibration Standard - Pressure Controller capable of generating pressure over the range ± 340 mbar with an accuracy of ±0.01 mbar or better.
2	Power Supply Unit (PSU) for the Pressure Controller.
3	Flexible Push-On Hose - Sized to fit 7 mm outside diameter coupling.

3. CALIBRATION PROCEDURE

Pressure sensing within the PSLT is carried out by a silicon differential pressure transducer, which provides a voltage output directly proportional to the measured pressure. The PSLT software has been designed to recalibrate the transducer automatically with minimal Operator intervention.

To calibrate the PSLT:

A. Connect the PSLT to the Pressure Controller (*Table 1*, Ref. 1), using a push-on type flexible hose with 7 mm OD fitting at the PSLT connector *Table 1*, Ref. 3). Apply power to the Controller from its dedicated PSU (*Table 1*, Ref. 2) and access the Maintenance Mode by pressing the START key and holding it down whilst pressing 1the PWR key. The screen displays the caption 'Maintenance Menu 1 CONTRAST CONTROL'.

B. Press the SEL key twice to select Maintenance Menu 3, CALIBRATION. The screen prompts for a password (*Figure 20*). The password is a 4-digit number and four asterisks are displayed; the first of which (reading from the left) is shown flashing. Use one of the +/ - keys to change the first asterisk (*) to a digit then use them to raise or lower the digit to the correct value. Press SEL. The cursor moves to the second digit which starts flashing. Using the +/ - keys enter the second digit. Repeat for the remaining two digits. If the wrong password is entered, the caption 'INCORRECT PASSWORD' is shown momentarily before the screen reverts back to that shown in *Figure 21*.

Figure 21 Password Entry

C. Press the START key. The screen displays the first Set Point for calibration (*Figure 22*). The value displayed for the 'current' pressure should be zero but will vary, depending on whether there! is any pressure residue in the system.

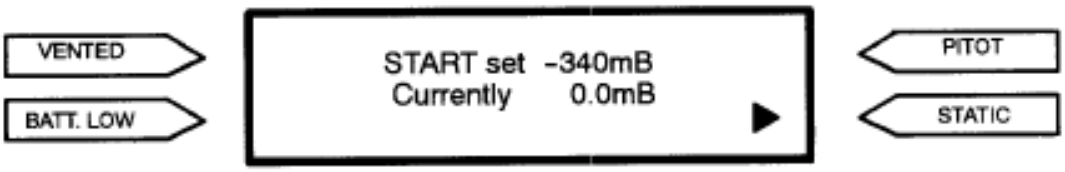

Figure 22 Calibrating at First Set Point

D. There are five calibration Set Points: -340 mB, -170 mB, 0 mB, 170 mB, and 340 mB.
E. Set the Pressure Controller to generate a pressure of -340 mbar. Allow the Controller to stabilise at the control point.
F. When the pressure has stabilised, make a note of the PSLT reading, e.g. 'Currently -338.7 mB', if required for any calibration records. Any record made is purely for the Operator's benefit since correction of the transducer is carried out automatically by the PSLT.
G. Press the START key on the PSL T. The PSLT automatically calibrates and corrects the pressure at the Set Point such that the pressure displayed on screen changes to read 'Currently -340.0 mB'.

NOTE: **The PSL T system is protected against too great a Set Point pressure change being made in a single step. If the pressure is accepted, the screen will change to display 'START set * '.**

H. Press the SEL key to move to the next Set Point for calibration (-170 mbar).
J. Set the Pressure Controller to generate a pressure of -170 mbar. Allow the Controller to stabilise at the control point.
K. Press the START key on the PSLT to commence calibration. If required, note the initial PSLT reading, e.g. 'Currently -172.4 mB' as shown in *Figure 23*.

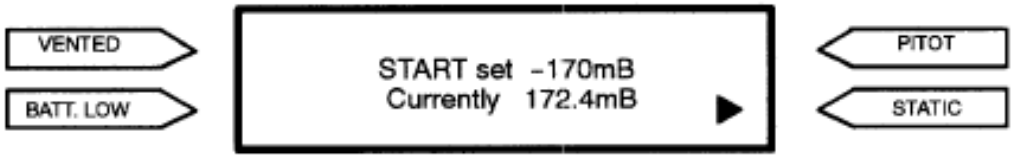

Figure 23 Calibrating at Second Set Point

L. Repeat the procedure for each of the remaining Set Points.

NOTE: **Whilst in this menu, the SEL key may be used to skip through the different Set Points to reach a particular Set Point. This facility is useful, for example, if the Operator is unhappy with the calibration of any Set Point and wishes to repeat it without repeating the complete sequence. However, for full calibration, all Set Points must be individually calibrated.**

M. Press the STOP key to exit the Calibration routine at any stage and return to the Maintenance Menu 3 screen.

Following Calibration, the equipment is subjected to a functional check to confirm that calibration has been carried out correctly.

4. POST-CALIBRATION FUNCTIONAL CHECKS

A. Select Maintenance Menu 2, PRESSURE MONITOR.

NOTE: **Within this menu, pressure is monitored in mbar only.**

B. Set the Pressure Controller to generate a pressure of -340 mbar. When pressure has been achieved, allow the' Controller to settle at the control point.
C. Confirm that the pressure recorded for the PSLT is within ± 1 mbar.
D. Set the Pressure Controller to generate each of the remaining pressures in turn and confirm that the PSLT readings are again within ± 1 mbar.

NOTE: Tolerances apply only to measurements at ambient temperature.

E. Set the Controller to generate POTD. When the PSLT is vented, press the PWR key to power down the equipment and disconnect it from the Pressure Controller. Replace the blanking cover over the PSLT port to protect it from ingress of contaminants.

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Penny & Giles Aerospace Ltd.
1 Airfield Road Christchurch Dorset BH23 3TH UK

Tel. +44 1202 409409 Fax +44 1202 484846
Registered in England No. 2336358
VAT Registration No. 806 6586 08

Penny+Giles
A Curtiss-Wright Company

Penny & Giles – Product Support

Revision / Date	: 14th March 2005
Document Title	: Microleak Password.
Equipment Affected	: Microleak Unit
Part Numbers	: D51600 / D51601
Classification	: Information

Information:
The original calibration password was removed from the operator's manual: PIM 417-O due to various customer requests as the information was being used by the wrong operators and was therefore resulting in inaccurate or unserviceable units.

NOTE: Please retain this document separately to the operator's manual.

Entering the Calibration Password:
Power up the UUT with the START key pressed. Select "Maintenance Menu 3 - CALIBRATION CONST", and press "START". Enter the password as "1771" by using the "+/-" keys, "SEL" and "START".

Contact Information:
Title: Customer Support Department
Location: Penny & Giles Aerospace, United Kingdom
Telephone: +44 (0) 1202 409409
Fax: +44 (0) 1202 484846
Email: Support@pgaero.co.uk