

Instruction Manual

Spectron 300E Portable Leak Detector

Description

Item Number

Spectron 300E 220/240 V, 50/60 Hz

D154-71-000

Spectron 300E 110 V, 50/60 Hz

D154-73-000

Spectron 300E 115 V, 50/60 Hz

D154-74-000



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Declaration of Conformity

We, Edwards High Vacuum International,
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declare under our sole responsibility that the product(s)

Spectron 300E Portable Leak Detector	D154-71-000 D154-73-000 D154-74-000
Visco Probe Accessory	D169-59-000

to which this declaration relates are in conformity with the following standard(s)
or other normative document(s)

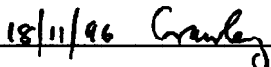
EN50081-1	Electromagnetic Compatibility, General Emission Standard. Generic Standard Class: Domestic, Commercial & Light Industry.
EN50082-1	Electromagnetic Compatibility, General Immunity Standard. Generic Standard Class: Domestic, Commercial & Light Industry.

following the provisions of

73 / 023 / EEC	Low Voltage Directive.
89 / 336 / EEC	Electromagnetic Compatibility Directive.



Dr. A.P. Troup, Director of Technology



Date and Place

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1 INTRODUCTION

1.1 Scope of this manual

This manual provides installation and maintenance instructions for the Edwards Spectron 300E Portable leak detector.

This manual contains essential safety information which supplements the safety features of the Spectron 300E leak detector. Safety procedures are highlighted as WARNING and CAUTION instructions. You must obey these instructions. The use of WARNINGS and CAUTIONS is defined below.

WARNING

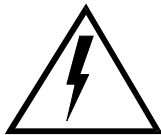
Warnings are given when failure to observe the instruction could result in injury or death to persons.

CAUTION

Cautions are given where failure to observe the instruction could result in damage to the equipment, associated equipment and process.

The safety markings used on the equipment are:

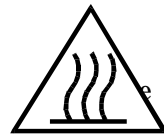
Caution -
risk of
electrical
shock



Caution -
Refer to
accompanying
documents



Caution -
Hot

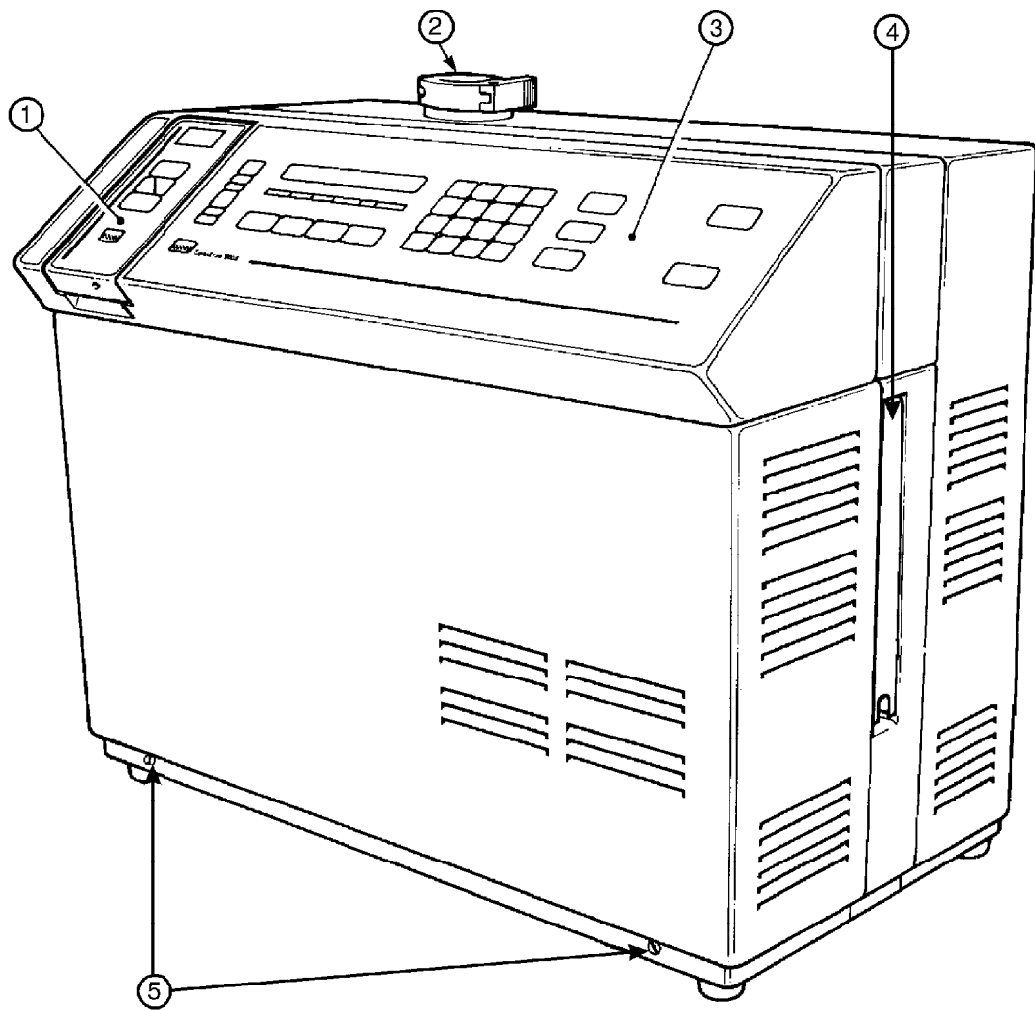


1.2 General

The Spectron 300E is a mass spectrometer leak detector based on the search gas leak location and measurement technique. The spectron 300E comprises a vacuum console, which houses the pumping system and vacuum control electronics, and a hand held control module to give the operator all the information and control needed. This can be from a distance of up to 25m when used with an extension cable accessory.

The Spectron 300E is microprocessor based, and features read out of leak rate in a selection of units over the full measurement range. The vacuum system is continuously monitored by the processed which will detect most malfunctions and indicate an appropriate error message.

The mantissa of the leak rate shown on the 50 segment bar graph display (of the hand held control module) whilst the exponent of the leak rate is shown on the digital display during a valid test mode. The hand held unit has four push button switches for selection of manual or auto ranging and zeroing, in addition to a socket for headphones providing an audio output when working in noisy environments. When not in use the hand module can be attached to the vacuum console so that its display complements the front panel.



1. Hand held control module
2. Pumping port
3. Main control panel
4. Carrying handle (one each side)
5. Cover retaining screws (two each side)

Figure 1.1 - Spectron 300E general view

1.3 Operation - overview

The following paragraphs contain a brief description of the main functions of the Spectron 300E.

Automatic Start Up, Standby, and Close Down

The Spectron 300E will go to any of these conditions at the push of a button, and, when ready for operation it will switch on the filament and check that the electron emission current is correctly controlled before indicating READY TO TEST on the alpha numeric display.

Automatic zero

Zeroing between tests can be automatic, if required. The zero can also be manually adjusted by push button during testing should the test method require it.

Automatic tuning and calibration

The Spectron 300E will automatically tune to the peak and calibrate itself when the option is selected and when an external quartz helium reference leak is fitted.

Automatic test cycle

The test mode is selected automatically to accommodate any inlet pressure from atmospheric pressure downwards, after the TEST button is pressed. This is achieved by carefully matching the advanced control system to a specially designed vacuum system.

Auto ranging

The microprocessor will automatically select the correct leak rate range, from a range of 12 decades. The range can also be manually selected and held by a push button.

Visual display

Operator information is provided on a direct read out alpha numeric display with digital index. The display will indicate pressures, filament hours, vacuum status or leak rates as required. Pressure is shown in units of mbar, Pascal or torr and leak rates in mbar ls^{-1} , Pa ls^{-1} , $\text{Pa m}^{3\text{s}^{-1}}$ or torr ls^{-1} , atm ccs^{-1} , the leak rates being in helium or air equivalent. During a test LEDs indicate the current test mode - massive, gross or fine.

Operator control

The test cycle sequence is controlled from the front panel. Part control is available on the hand held control module which can be located up to 25m (82 ft) from the vacuum console.

Reject and audio

A REJECT test result shown on the alpha numeric display indicates a test where the leak rate has exceeded the pre-set Reject level. An audio output is also provided giving a rising audio frequency with increasing leak rate on the control panel or headphones on the hand held unit when working remotely.

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2 TECHNICAL DATA

2.1 Operating and storage conditions

The Spectron 300E leak detector is designed for freestanding indoor use only.

Ambient temperature range (operating)	12 to 32 °C
Ambient temperature range (storage)	-30 to 70 °C
Relative humidity (non condensing)	10 to 90 %
Maximum altitude	2000 m
Enclosure rating	IP20

2.2 Performance

2.2.1 Sensitivity

Leak Mode	Range
Massive	4×10^3 to 3×10^4
Gross	9×10^{-1} to 3×10^{-8}
Fine	9×10^{-2} to 4×10^{-10}

2.2.2 Measurement limits

Amplifier drift *	< 0.3 % of full scale deflection after warm up (measured in accordance with AVS Standard 2.1. See Note)
Noise *	< 3.5 % of full scale deflection after warm up (measured in accordance with AVS Standard 2.1. See Note)

* Applies to most sensitive amplifier range of the Spectron 300E.

Note: Recommendations of the AVS Sub-committee for the calibration of leak detectors have been incorporated (J.Vac.Sci.Technol.A10(1), Jan/Feb 1992). The procedures for determination of noise and drift values for the mass spectrometer in the Spectron 300E leak detector follows AVS Standard 2.1 Rev - 1973 (J.Vac.Sci.Technol. 10/4, July/Aug 1973).

2.2.3 Response time limits

Response time	< 1 s for Fine < 2 s for Gross
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2.2.4 Start-up/closedown times

Warm-up time (to READY)	9 minutes
Closedown time (to CLOSED DOWN)	11 minutes

2.2.5 Maximum internal pressure

Maximum internal pressure	1500 mbar absolute
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Note: The Spectron 300E is not designed for operation above atmospheric pressure (in the range 75 to 110 kPa). Standard Edwards accessories for over pressure leak testing are available for use with the Spectron 300E.

2.2.6 Leak detection mass ranges

The Spectron 300E can be set to detect trace gas for masses 2, 3 and 4.

2.3 Mechanical data

Size (H x W x D) mm	450 x 600 x 340
Weight	52 kg
Valves	Gross, test, roughing - PV10EK Air admit, backing - PV5EK
Maximum acoustic noise emission	< 70 dB(A)
Seals	Elastomer
Vacuum gauges	Manifold pressure - PRM10 Backing pressure - Thermocouple gauge High Vacuum - PRL 10
Test port	KF25
Backing/Roughing pump	E2M1.5 with interstage (1.8 m ³ h ⁻¹ , 50 Hz) (2.2 m ³ h ⁻¹ , 60 Hz)
Diffusion pumps	Two E040/55 air cooled special - high helium compression

2.4 Electrical data

Voltage	220/240 V	50/60 Hz + 6 % - 10 %
	100 V	50/60 Hz ± 10 %
	115 V	50/60 Hz ± 10 %
Reject relay	15A, 240 V	
Recorder output socket	0 to 5 V d.c. output into a minimum of 2kΩ (requires a 3.5 mm mono jack)	
Headphone output socket	Recommended accessory D15471370 has the required impedance (requires a 3.5 mm mono jack)	
Printer output	RS232	

2.5 Display and controls

2.5.1 Hand held control unit

The hand held control module is attached to the vacuum console seated in a recess so that its display/controls conveniently supplement the controls on the console.

- a. 50 segment bar graph display with 1 1/2 digit exponent for leak rate indication.
- b. Exponent display indicates test mode.
- c. Four controls for manual/auto ranging and zeroing.
- d. Socket for headphones.

2.5.2 Main unit

a) Push switches

Peak, Calibrate, Gross, Backing, Leak Rate, Pressure, State, Time, 0-9 Key Pad, and "+" (Sign change), "." (Volume Control), Enter, Clear, Scroll, Adjust, Start Up, Standby, Close Down, Test and Finish.

Display selection - Leak rate, pressures, state and time.

b) Display

i 16 character alpha numeric

ii Mode indication

c) other features

i Audio speaker with volume control

ii Recorder output

iii Visco probe outlet

iv RS232 connection for printer

2.6 Construction details

2.6.1 Materials exposed to internal vacuum conditions

ROUGHING/BACKING

Aluminium (vacuum fittings)

Stainless steel (flexible pipelines and filters)

Phosphor bronze (filters)

Fluoroelastomer (seals)

Brass (backing valve)

Platinum/10%rhodium (Pirani PRM gauge filament)

Nickel (PRM Gauge)

PTFE (Pirani gauge feed through)

Nitrile (seals)

Ultragrade 15 rotary pump oil

HIGH VACUUM

Aluminium (vacuum manifold)
Stainless steel (flexible pipelines)
Nitrile (Seals)
Santovac 5 diffusion pump oil
Zinc plating (within diffusion pump body)
Stainless steel (ion source components)
Ceramics (ion source insulation)
Glass (ion source and detector feedthroughs)
Nickel (filament pins)
NiloK (filament pins)
Thorium-oxide coated iridium (primary filament 1)
Tungsten (secondary filament 2)
Gold plated tungsten (Pirani PRL gauge filament)
PTFE (PRL Gauge)
Phosphor bronze (filters)
Fluoroelastomer (seals)

2.7 Pump fluid data

Fluid	Pour Point °C	Flash Point °C	Auto-ignition °C
Santovac 5	+ 5	288	590
Ultragrade 15	-18	220	355

2.8 Diffusion pump fluid charge

EO40/55 22 ml Santovac 5

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3 INSTALLATION

3.1 Unpacking and inspection

Remove all packing materials and protective covers and check the Spectron 300E Portable leak detector.

If the leak detector is damaged, notify your supplier and carrier in writing within three days; state the item number of the leak detector together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not use the leak detector.

Check that your package contains the following items:

Qty	Description	Check
1	Spectron 300E leak detector	
1	Electrical supply lead D15471635 240V only	
1	Electrical supply lead D15471393 100/115V units	
1	1 litre oil	
1	Spares carton (including tools)	
1	Gas ballast tool D15471614	

If any of the above items are missing, please notify your supplier in writing within three days.

3.2 General

WARNING

Do not connect the electrical supply until the installation procedures have been completed. Installation should only be carried out by qualified personnel.

CAUTION

The rotary pump must be filled with the appropriate oil before the leak detector is operated.

CAUTION

Do not operate the equipment without following all the instructions for installation or the leak detector may not function as expected.

*Note: Do not alter or substitute parts without reference to EHVI authorised service departments.
No parts other than those supplied by EDWARDS should be fitted to Spectron 300E Consoles.*

3.3 Installation

This section deals with preparing the Spectron 300E for operation. A transit clamp on the rotary pump must be removed (this is painted red). There is a blank in the pumping inlet of the rotary pump which must be removed and replaced with an 'O' ring carrier. The pump has to be filled with oil (supplied). There are blanks in the backing spouts and pumping ports of both diffusion pumps which have to be removed and replaced with 'O' ring carriers. The diffusion pumps are already filled with the correct oil charge.

3.3.1 Removing the front and rear panels

WARNING

Remember to reconnect the earth straps - one on each panel.

Note: When the panels are removed check that all the vacuum connections are secure before proceeding.

Locate the cover fasteners (two at the bottom of each panel) and with a screwdriver give each fastener a quarter turn anti-clockwise. Ease out the panel and, before lifting off, remove the earth strap. There is one earth strap on each panel. Reassemble in reverse order.

3.3.2 Rotary pump E2M1.5

CAUTION

The rotary pump must be filled with the appropriate oil before the leak detector is operated.

Note: It is recommended that, before the Spectron 300E is connected to the electrical supply, the exhaust be connected to either an oil mist filter or to a separate exhaust line.

Oil mist filters for rotary pumps are available from Edwards. They are fitted to the pump exhaust ports and are used to capture oil mist which could otherwise be emitted to the atmosphere with effluent gas either when gas ballasting or when pumping high gas concentrations.

Remove the transit clamp (painted red) from between the chassis and the underside of the pump. Use the 6 mm Allen key to remove the bolt from the underside of the unit. To do this you can support the unit on two wooden blocks but take care not to tilt the unit by more than 40 deg. This is to prevent diffusion pump oil getting into the vacuum system. Locate the plastic cap marked oil on the top of the pump and remove. Fill with oil using funnel supplied to about halfway on the sight glass at the front of the pump (see Section 7.3.1).

Rotary pump blank (refer to Figure 3.1)

Undo the clamping ring on top of the rotary pump which holds the T piece to the pump. Gently lift the T piece and flexible hose away from the top of the pump, just enough to enable the 10/10 mm blank to be removed.

Replace the blank with the 10/10 mm 'O' ring carrier and 'O' ring supplied. Reconnect the T piece.

The outlet mist filter recommended for use with the rotary pump is the EMF3.

3.3.3 Diffusion pumps EO40/55

WARNING

Remember to reconnect the earth straps - one on each panel.

Note: Some units have an additional cooling fan fitted to the base. This fan can be removed if required to gain easier access. Simply unscrew the two black retaining screws and lift the fan out of the way.

The diffusion pumps (DP1 and DP2) are accessed by first removing the rear panel.

Diffusion pump blanks (refer to Figure 3.2)

Unscrew the KF10 clamping ring from the backing spout of Diffusion pump 2 (DP2). Remove the red thumbscrew completely and remove the bolt and clamp to gain access. Next, remove the KF40 size clamping ring from the pumping port of DP2. The pump will drop slightly enabling the blanks in the pumping port and backing spout to be removed. Remove these completely.

Unscrew the KF10 clamping ring from the backing spout of DP1, and also the KF40 clamping ring from the pumping port on top of the pump. The pump will drop slightly enabling the blanks in the pumping port and the backing spout to be removed.

Position one of the KF40 Co-seals onto the pumping port of DP1. Use a large screwdriver to raise the pump up to the manifold connection and fit the KF40 clamping ring. Tighten thumbscrew. To assist whilst fitting the KF40 clamp it is useful to place a small block underneath the pump to hold it in position.

Fit the second KF40 Co-seal to DP2 and with the aid of a large screwdriver, wedged underneath the pump to raise it up to the manifold connection, fit the KF40 clamping ring. Tighten the thumbscrew.

Next, fit the KF 10/16 baffle to the backing spout of DP1, using the 'O' ring from the removed blank, and the flexible pipework with the 16 mm size facing uppermost into the flexible pipe. Use the KF10 clamping ring. Remember to swing the red thumbscrew round to the opposite side of the pipe before tightening (refer to Figure 3.2).

Finally fit the KF10/10 baffle to the backing spout of DP2, using the 'O' ring from the removed blank, and the rigid pipework using the KF10 clamping ring. It is necessary to push the open clamping ring from behind the pipework in order to fit the clamping ring bolt and thumbscrew. Replace the covers.

3.4 Fitting the rotary pump accessory kit

Should you require to use your Spectron 300E with the external rotary pump accessory kit (D154-71-540), please proceed as follows.

1. If appropriate, disconnect the mains power supply and allow the unit to cool down for about 20 minutes. Vent to atmosphere using the manual vent control on the rear face of the manifold beneath the PRM10K gauges.
2. Remove the rear cover of the leak detector as in section 3.3.1.
3. Remove the panel with the cooling fan attached from the left hand side of the leak detector. Use a cross point screwdriver to remove the four retaining screws and gently lower the panel with the fan on it away from the hole. Disconnect fan.
4. Using a 3 mm A/F 'L' shaped hexagonal key (Allen key) remove the blanking plate from the nearest end of the manifold to which will be fitted the connection pipework (see Figure 3.3). Note the 'O' ring in the groove around the port is to be re-used.
5. Identify the adapter pump connection (Figure 3.3, item 1) and locate this item, with the tube port pointing downwards (as in the diagram) and using the four M4 x 30 screws (Figure 3.3, item 2) with the 3 mm A/F 'L' shaped hexagonal key fit the adapter to the manifold. Take care that the 'O' ring is again located correctly in the groove on the manifold port.
6. Next fit the NW25 x 500 mm flexible connection (Figure 3.3, item 3) to the adapter pump connection (Figure 3.3, item 1) with a KF25 clamping ring (Figure 3.3, item 4).
7. Remove the plastic blank from the side of the leak detector immediately beneath the handle at the near side to the adapter.
8. Feed the NW25 stainless steel x 500 mm flexible connection (Figure 3.3, item 3) through the hole left by removing the plastic blank.
9. A suitable KF25 flexible hose is required to fit your rotary pump to the flexible connection (Figure 3.3, item 3).

Connect this flexible hose to your rotary pump pumping port using a KF25 clamping ring centring ring and 'O' ring or other suitable adapter if necessary.

10. To blank off the internal rotary pump roughing connection, it is necessary to replace the standard 'O' ring carrier with a blank carrier. Remove the front cover of the leak detector and locate the T piece (Figure 3.1,item 1) connection on the top of the internal rotary pump. Disconnect the flexible hose from the left hand side of the T piece and remove the KF10 'O' ring and carrier. Insert the blank carrier and 'O' ring in place to blank off the rotary pump and re-connect the flexible hose to the T piece.

Refit fan (after connecting mains lead). Refit panel.

Note: Remember to store items removed in a safe place for possible re-use.

When you are using the auxiliary pump facility you must remember to enter the ADJUST MODE and select item number 12. (Refer to section 5.14). Then select external roughing pump fitted (Option 1 = FITTED).

To return to operation without the external pump simply remove the flexible roughing pipe on the internal rotary pump and take out the blank. Refit the original 'O' ring and carrier again.

Disconnect the flexible hose from the side of the leak detector and fit the KF25 blank in its place.

It is important to select external pump NOT fitted in ADJUST MODE when the facility is not in use (Option 0 = ABSENT) otherwise oil may contaminate the vacuum system.

3.5 Electrical power supply

WARNING

Ensure that the electrical installation of the Spectron conforms with your local and national safety requirements. It must be connected to a suitably fused and protected supply and a suitable earth point - connect the electrical supply cable as follows:

**GREEN AND YELLOW to EARTH (GROUND)
BROWN to LIVE
BLUE to NEUTRAL**

This equipment is designed to be used with a separable electrical supply and not permanently connected to the electrical supply.

There is no selection of a.c. voltage rating on the Spectron 300E. The leak detector is supplied set to the a.c. operating voltage and frequency specified by the customer when placing an order. This should be confirmed by comparing the local electrical supply with operating voltage detailed on the label attached to the rear panel.

3.6 Connections

The hand held control module will normally be connected to the vacuum console via a multipole connector. If you are using an extension cable (to operate up to 25 m from the leak detector) remove the connector of the hand held unit from the console. Grip the plug and pull the sliders back on the body until the plug releases. Connect the extension cable in its place and the hand held unit to the other end of the cable.

Connect the Spectron 300E power cable to a suitable electrical supply. The unit can be connected to a normal domestic supply via a standard plug, rated at 13 Amps (220/240 V) or 25 Amps (100/115 V).

3.7 Gas ballasting the rotary pump with the air bleed assembly

The standard gas ballast connector on the rotary pump has been replaced by an interstage introduced to provide a Visco Probe facility without the need for a secondary pump. This inlet has been connected to a quick-fit connector on the rear panel of the leak detector via a length of rubber vacuum tubing. This inlet is also used to gas ballast the rotary pump when required. A quick-fit coupling (air bleed assembly) complete with a restrictor is provided for this purpose. The quick-fit coupling simply pushes onto the quick-fit connector. It is released by pulling on the outer sleeve of the connector.

When to use the gas ballast facility:

1. To get rid of condensates in the pump oil. This will show up as high backing pressure.
2. To pump out helium dissolved in the rotary pump oil. This shows up as background helium measurements.

To gas ballast proceed as follows:

Run the leak detector in standby, and push the air bleed assembly into the Visco Probe connector. Leave for about 15 - 20 minutes or until contaminants have been removed.

Key to Figure 3.1

- 1 Tee piece
- 2 10/10 mm blank

Key to Figure 3.2

- 1 Pumping port
- 2 40 mm blanks
- 3 Pumping port
- 4 Diffusion Pump number 2 (DP2)
- 5 10/10 mm blank
- 6 Backing spout
- 7 10/16 mm blank
- 8 Backing spout
- 9 Diffusion pump number 1 (DP1)

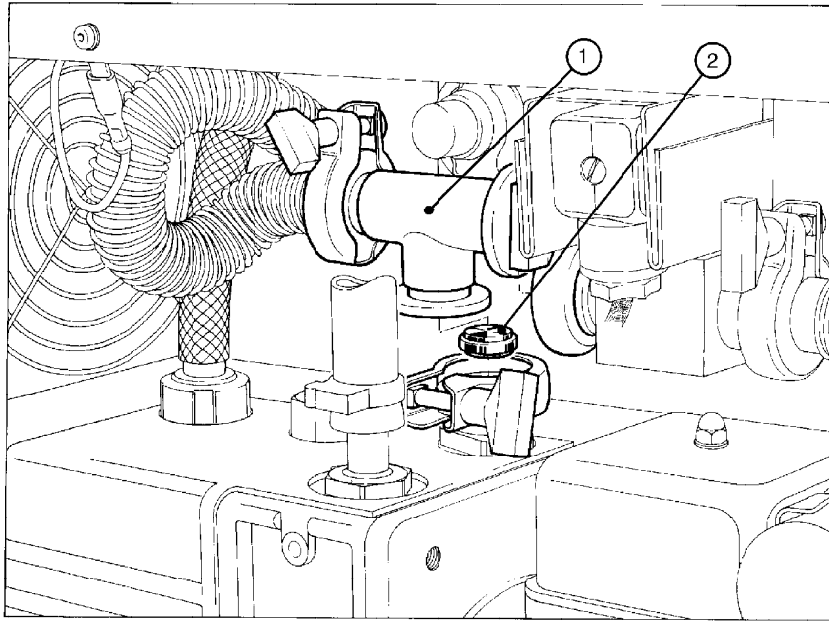


Figure 3.1 - Front cover removed showing rotary pump blank

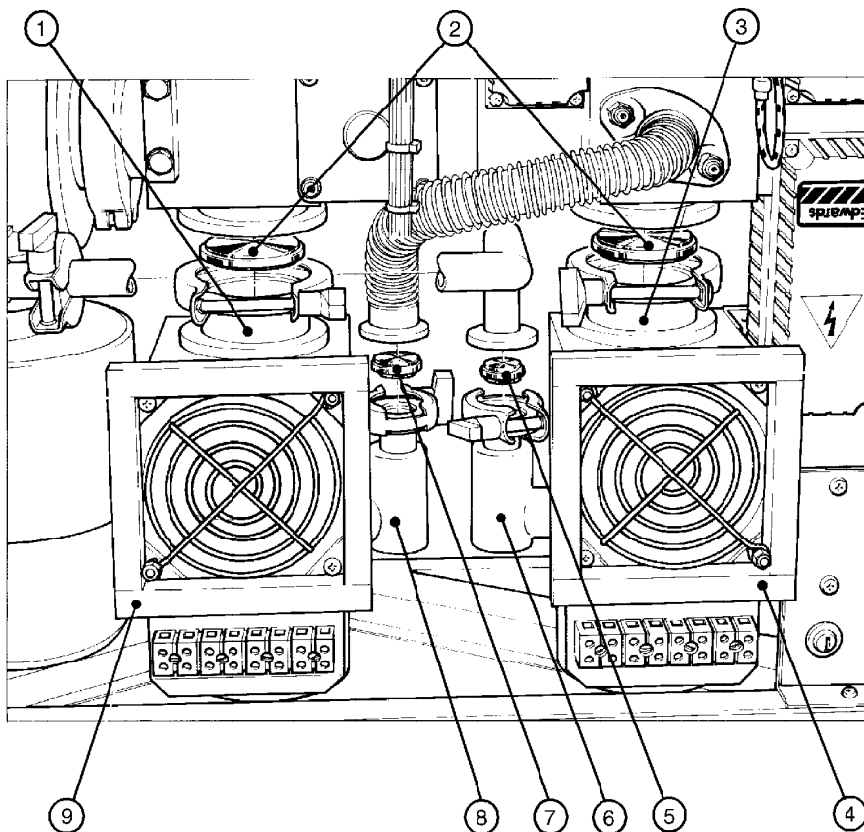


Figure 3.2 - Rear cover removed showing diffusion pump inlet blanks (2 x 40 mm) and outlet blanks 1 x 10/16 mm and 1 x 10/10 mm

Key to Figure 3.3

- 1 Adapter pump connection
- 2 M4 x 30 screws
- 3 Flexible connection
- 4 KF25 clamping ring with 'O' ring/carrier

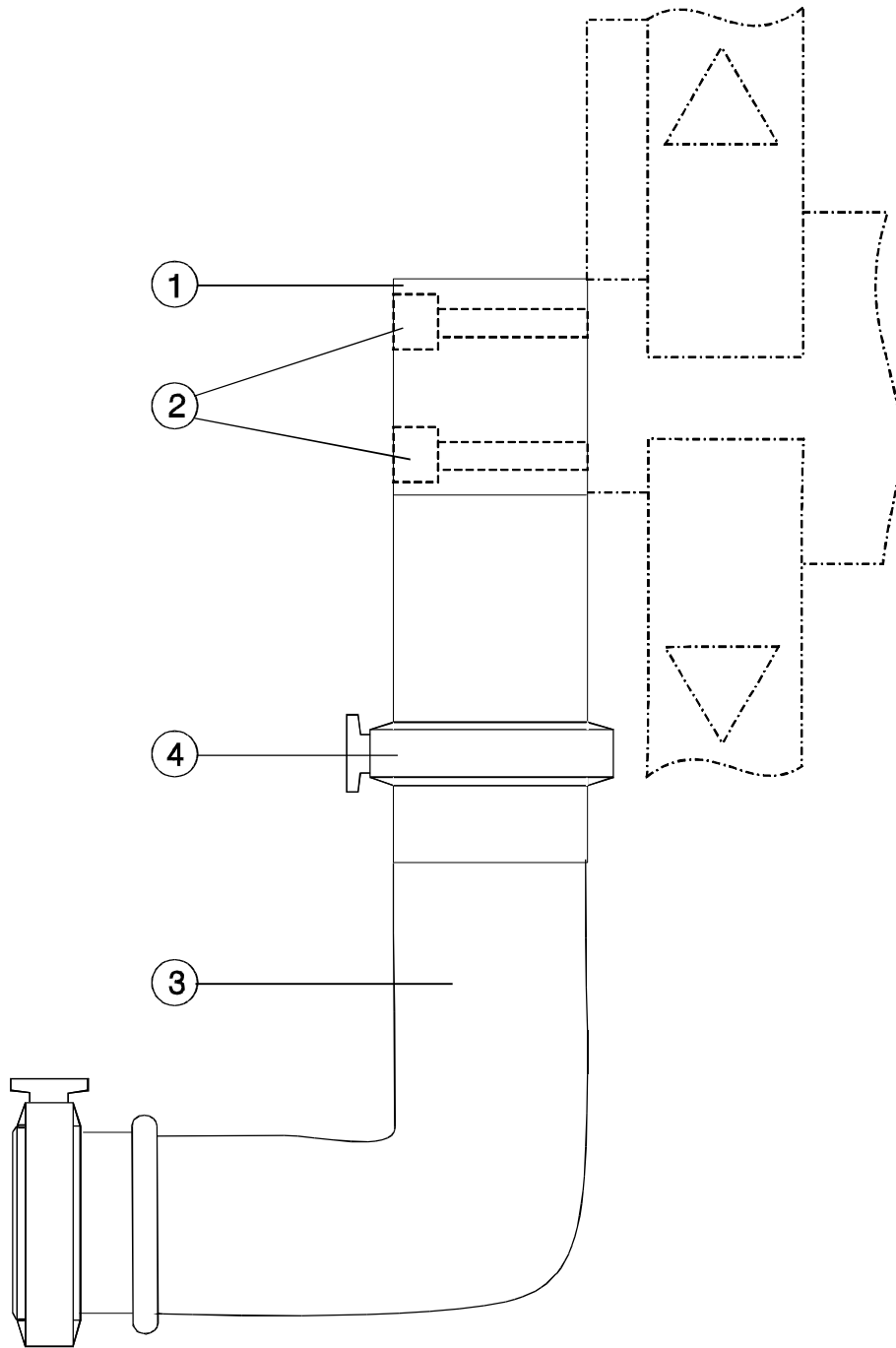


Figure 3.3 - Rotary pump accessory connection details

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4 OPERATION

4.1 General description

WARNING

Do not operate the Spectron 300E in flammable or explosive atmospheres or to pump flammable or explosive gases or gas mixtures.

The Spectron 300E is a fully automatic leak detector, controlled by microprocessor based electronics. The test piece is connected onto the test port and evacuated. Helium search gas passing through a leak in the test piece is detected by a mass spectrometer operating under high vacuum conditions. Gauges continuously monitor the backing pressure, fine pressure, and manifold pressure and there is full protection of the unit in the event of operator or machine error.

The Spectron 300E uses three test modes to cover the range 4000 to 4×10^{-10} mbar ls⁻¹. These are MASSIVE, GROSS and FINE.

In MASSIVE mode about one part in 100,000 of the gas pumped from the test piece is sampled into the mass spectrometer, so that large leaks can be found as soon as the test cycle is started. In GROSS mode, 1 part in 10 is sampled and in the FINE mode all the gas pumped from the test piece passes through the diffusion pumps. FINE mode is recommended for the majority of applications.

With the Spectron 300E in the READY TO TEST condition, pressing **test** will automatically cycle the leak detector through MASSIVE and GROSS to FINE mode. The change from MASSIVE to GROSS and GROSS to FINE is dependent of the pressure in the test piece being less than parameter 3 and parameter 1 respectively (see Section 4.6), as measured by the manifold Pirani gauge. These parameters can be adjusted to suit the application. If a large leak is present, so preventing the generation of the necessary vacuum in the test piece, the Spectron 300E will hold in either MASSIVE or GROSS modes until the leak is detected. Alternatively, selecting GROSS HOLD will prevent the Spectron 300E from passing beyond the GROSS mode.

Microswitches on the TEST, ROUGHING and GROSS valves signal the processor if there is a valve failure. Should any one of the valves fail an error message is displayed.

A magnetic sector field mass spectrometer converts helium pressure into an electrical signal. This signal is processed, taking into account the mode of operation and the concentration of search gas. Calculations are made and the leak rate is displayed in the units selected on the process control module.

4.2 Main vacuum components

Roughing backing pump	E2M1.5 Interstage pump
Diffusion pumps x 2	EO40/55 Santovac oil 250W
Test valve	PV10EK

Roughing valve	PV10EK
Backing valve	PV5 EK
Air admittance valve	PV5 EK
Gross leak valve	PV10EK
Fine vacuum gauge	PRL10K
Manifold vacuum gauge	PRM10K
Backing vacuum gauge	Thermocouple gauge

4.3 Mass spectrometer helium detector

The helium level in the high vacuum part of the Spectron 300E is converted to an electrical signal by the mass spectrometer. In addition to measuring the helium signal, the mass spectrometer also measures the system total pressure. The signal recorded is displayed on the Spectron 300E by pressing the **pressure** button, provided the mass spectrometer filament is on. The total ion pressure indication extends the spectrometer pressure measurement to pressures lower than can be indicated by the Pirani gauge.

4.4 Vacuum system operation (Fig 4.1)

4.4.1 Starting up

WARNING

Ensure that any item fitted to the test port is clamped in position to avoid its falling in the event of an electrical supply failure or sudden vacuum loss.

Note: The following paragraphs assume that the **state** button has been pressed so that only vacuum sequence stage labels will display.

When the **start up** button is pressed (on the vacuum console) the rotary pump starts. In 7 seconds the backing valve opens and the label START UP displays. As the backing pressure (measured by the thermocouple gauge, P2 on the schematic diagram Figure 4.1) falls below 2×10^{-1} mbar, the diffusion pump switches on (if the pressure should rise above 3.5×10^{-1} mbar, the diffusion pump will switch off). The label PUMP DOWN displays. When the mass spectrometer pressure falls below 5×10^{-4} mbar, the label STANDBY will display. The mass spectrometer filament remains off.

4.4.2 Leaving STANDBY

Press **finish** to bring the Spectron 300E into the READY TO TEST condition. Pressing **test** can also be used to leave STANDBY by starting the leak test routine. In this case the test port should be blanked or a test piece fitted. If either **finish** or **test** are pressed when the Spectron 300E is in STANDBY, following an automatic zero routine for the pre-amplifier, the filament current will ramp up slowly until electron emission is established. When the required emission current is available the leak rate is displayed on the control module.

4.4.3 MASSIVE mode

The rotary pump evacuates the test piece through the roughing valve (RV). About 1 part in 10^{-5} of the gas from the test piece is sampled through the sintered leak (ML) and passes into the high vacuum region, containing the mass spectrometer. Leaks over the range 4×10^{-3} to 3×10^{-4} ls^{-1} can be detected. When the manifold pressure (P1) falls below the massive/gross change over pressure point, the Spectron 300E will automatically pass into the GROSS mode.

4.4.4 GROSS mode

The test piece is evacuated by the rotary pump through the roughing valve (RV). About 1 part in 10 of the gas from the test piece is sampled through the gross leak valve (GV) which incorporates a restrictor (R). Leaks over the range 9×10^{-1} to 3×10^{-8} mbar ls^{-1} , can be detected. When the manifold pressure falls below the GROSS/FINE change over pressure, the Spectron 300E will automatically pass into FINE mode unless the GROSS HOLD condition has been selected.

4.4.5 GROSS (gross hold)

When GROSS is selected the Spectron 300E will not cycle into FINE test mode. The rotary pump continues to evacuate the test piece and only about 1 part in 10 of the gas load from the test piece is sampled by the high vacuum part of the Spectron 300E. Normally the backing and roughing valve open together unless the massive/gross change-over pressure is higher than 10^{-1} mbar when the system will cycle with the valves opening separately to ensure correct roughing/backing procedure. Consequently the pressure rise in the mass spectrometer, due to condensable gases from the test piece, is small.

The cycle time is significantly reduced at the expense of a loss of about 10 times in the minimum detectable leak rate when GROSS HOLD is selected. Response to leaks will be a little slower than in FINE testing, particularly for large test pieces.

4.4.6 FINE mode

This is the normal leak testing mode. The test piece is pumped down by the diffusion pump through the test valve (TV), valves RV and GV are closed. Leaks over the range 9×10^{-2} to 4×10^{-10} mbar ls^{-1} can be detected. (See Figure 4.1).

4.4.7 STANDBY

In STANDBY the mass spectrometer filament and the roughing pump are switched off. If STANDBY is selected when in FINE mode, the test valve will remain open and the test piece (if fitted) will continue to be pumped by the diffusion pump. The label STANDBY TPUV (Test Port Under Vacuum) will be displayed as a reminder that the **finish** button should be pressed before removing the test piece or blank from the test port. When not in immediate use, it is recommended that the Spectron 300E is left in STANDBY TPUV with the test port blanked in order to keep the manifold clean.

4.4.8 Finishing leak test

When the **finish** button is pressed the leak test will be terminated. The Test valve (TV), Roughing valve (RV), and the Gross valve (GV), if open, will close. The Air admittance valve

(A/AV) will open. The label FINISH will display until the pressure in the test piece has risen to 10^{+2} mbar, when the label READY TO TEST will display. (See Figure 4.1).

4.4.9 Closing down

The Spectron 300E is closed down by pressing the **close down** button. Closing down by disconnecting the Spectron 300E from the mains supply, or by switching off at the circuit breaker, is not recommended except in emergencies. Frequent use of this method will cause a loss of fluid from the diffusion pumps, decreasing the service interval. When **close down** is pressed the diffusion pump heater switches off together with the roughing pump and mass spectrometer power supplies. The label CLOSING DOWN displays. The cooling fans will continue to run.

After about 10 minutes, when the diffusion pumps have cooled, the backing valve closes and the backing pump and cabinet fans switch off. The label CLOSED DOWN displays. Power for the electronics and the cooling fans remain on.

4.5 Calibration technique

The Leak Rate Indication (LRI) is matched to the calibration reference value by multiplying the signal from the mass spectrometer by the appropriate scale factor. If the mass spectrometer sensitivity (output signal for a given helium level) should fall, then the scale factor will increase at the next calibration to ensure that the Spectron 300E again reads accurately. If the scale factor is outside the range set in 'parameters', the Spectron 300E will indicate a calibration error. This can be corrected by resetting the emission current to change the sensitivity of the mass spectrometer (see Section 7). An increase in the scale factor will produce an increase in the noise level on the LRI which may be noticeable on the most sensitive range.

The sensitivity of the Spectron 300E varies according to the mode selected. FINE mode is considered to be the normal mode for testing. Calibration in other modes is referenced to FINE mode. In GROSS and MASSIVE test modes, most of the helium is diverted to the roughing pump. To enable the Spectron 300E to indicate true leak rate, the signal is scaled by the Diversion factor (D) which corresponds to the proportion of gas diverted to the roughing pump. For example, in gross mode only 1 part in 10 of the total helium pumped from the test piece passes into the mass spectrometer. The mode factor in this case is 10. The diversion factor is automatically calculated during a GROSS mode calibration.

The mode factor is checked for GROSS mode by making an external calibration with the Spectron 300E set to GROSS HOLD. The mode factor for MASSIVE is preset and should not normally require calibration. The accuracy to be expected in MASSIVE is lower than is achievable in other modes. For very large leaks the LRI will be determined by the amount of search gas that can be supplied to the leak.

The Spectron 300E LRI can be set in a variety of units, for helium or air equivalent (see Section 5), and for different concentrations of search gas. It can also be set for operation with accessories such as the visco probe, in which only part of the total gas load is sampled by the Spectron 300E.

The LRI is calculated from the formula:

$$\text{LRI} = \frac{\text{I} \times \text{S} \times \text{D} \times \text{U} \times \text{E} \times \text{Y}}{\text{C}}$$

- I = Ion current from the mass spectrometer
- S = Scale factor - nominally 1.0 for a correctly adjusted system
- D = Diversion factor - reciprocal of proportion of gas sampled by the mass spectrometer
(D = 1 for fine and high sensitivity modes)
- U = Units factor - depends on leak rate units selected
- E = Helium/Air Equivalent factor
E = 1 for air equivalent
E = 2.7 for helium equivalent
- Y = Accessory factor - reciprocal of proportion of test gas sampled at Spectron 300E test port
Y = 1 for vacuum testing without auxiliary equipment, see Section 5.14
- C = Helium concentration of the test gas - assuming the Spectron 300E was calibrated with pure helium

Normally S,D,U and E will not be apparent to the user. In the event of a fault occurring which affects S or D an error message will be displayed.

4.6 Parameters

Note: All pressure parameters are in mbar, all leak rate parameters are in mbar ls⁻¹.

This is a list of the Spectron 300E operating parameters.

- 0 - REJECT LEVEL
- 1 - G/F CH/OVER P
- 2 - FIL ON/OFF P
- 3 - M/G CH/OVER P
- 4 - TOT PR SENS
- 5 - MODE RESET
- 6 - FIL OFF MS
- 7 - SCALE FAC HE
- 8 - SCALE FAC HDH3
- 9 - SCALE FAC H2
- 10 - GROSS FAC HE
- 11 - GROSS FAC HDH3
- 12 - GROSS FAC H2

- 13 - MASSIVE FACTOR HE
- 14 - MASSIVE FAC HDH3
- 15 - MASSIVE FAC H2
- 16 - LOW SENSAMP
- 17 - EXT REF LEAK
- 18 - ACCESSORY FAC

Factors 7 - 9 are automatically re-calculated during normal calibration with a reference leak of the relevant search gas when the correct search gas has been entered.

Factors 10 - 12 are re-calculated during a gross calibration with a reference leak of the relevant search gas when the correct gas has been entered.

REJECT LEVEL

- 0 This is the leak rate value that if exceeded causes the Spectron 300E to energise the reject relay (hence closing the contacts) and assign the label FAIL (if selected). If intermittent reject is selected the relay contacts will open if the leak falls below 90% of the reject level. The units are those which have been selected for leak rate display. The relay contacts are taken to the rear panel of the Spectron 300E. The mimic diagram is shown for the normally open condition (de-energised).

G/F CH/OVER P Gross to fine changeover pressure parameter.

- 1 When the pressure on P1 (test port Pirani) is less than this value with the Spectron 300E in gross test mode (gross hold not selected) the Spectron 300E will automatically go from gross to fine test mode.

FIL ON/OFF P - Filament on/off pressure parameter (Filament pressure trip)

- 2 This is the pressure measured by P3, the mass spectrometer Pirani gauge (PRL10), at which the mass spectrometer will be switched off in any test mode. The Spectron 300E also has a preset automatic override of 3.0×10^{-3} mbar to this value. The mass spectrometer must be at less than 50% of this pressure for the filament to switch on again.

M/G CH/OVER P Massive to gross changeover pressure parameter

- 3 When the pressure on P1 (test port Pirani) falls below this value the Spectron 300E will automatically go from massive to gross test mode.

TOT PR SENS Total pressure sensitivity

- 4 This represents the sensitivity of the total pressure indication of the mass spectrometer head.

MODE RESET

- 5 If the pressure measured by the mass spectrometer Pirani (P3) is above this value, the Spectron 300E will revert to its previous test mode. For example, gross to massive. If the pressure measured by the mass spectrometer is above 0.3 times this value, the Spectron 300E will revert to its previous test mode.

FIL OFF MS

- 6 If the pressure measured by the mass spectrometer is above this value the Filament will switch off. (Filament Pressure Trip).

SCALE FACTOR

- 7-9 The scale factor, calculated during calibration, indicates the mass spectrometer sensitivity. The nominal value is 10. A value of less than one indicates increased sensitivity and greater than one decreased sensitivity.

GROSS FACTOR

- 10-12 The gross factor, calculated during a gross calibration, is the diversion factor for gross test mode. A gross factor of 10 indicates that 1 part in 10 of the test gas is reaching the mass spectrometer.

MASSIVE FACTOR

- 13-15 This parameter is the diversion fact for the massive test mode. A massive factor of 1.0×10^5 indicates that 1 part in 1.0×10^5 , of the test gas is reaching the mass spectrometer.

LOW-SENS-AMP Low sensitivity amplifier factor

- 16 This is the correction factor for the low sensitivity amplifier and is determined at the factory. It enables the Spectron 300E to read correctly on both amplifiers.

EXT REF LEAK External reference leak

- 17 This is the value in mbar ls^{-1} of the external reference leak used in calibration.

ACCESSORY FACTOR

- 18 The accessory factor is for use when operating the Spectron 300E with accessories, for example, a Visco probe. The accessory factor for a particular accessory is provided with the accessory.

Key to Figure 4.1

A/AV	Air admittance valve PV5EK
BV	Backing valve PV5EK
TV	Test valve PV10EK
RV	Roughing valve PV10EK
GV	Gross leak valve PV10EK
MS	Mass spectrometer
PA	Pre-amplifier/backing volume
DP1/2	Diffusion pumps EO40/55
GL	Gross leak
ML	Massive leak
RP	Roughing pump (external)
P1	Test port Pirani PRM10
P2	Internal thermocouple gauge
P3	Mass spec pirani PRL10
TP	Test port
R	Special restrictor
BC	Blanking carrier (for external roughing pump)
BP	Backing pump E2M1.5

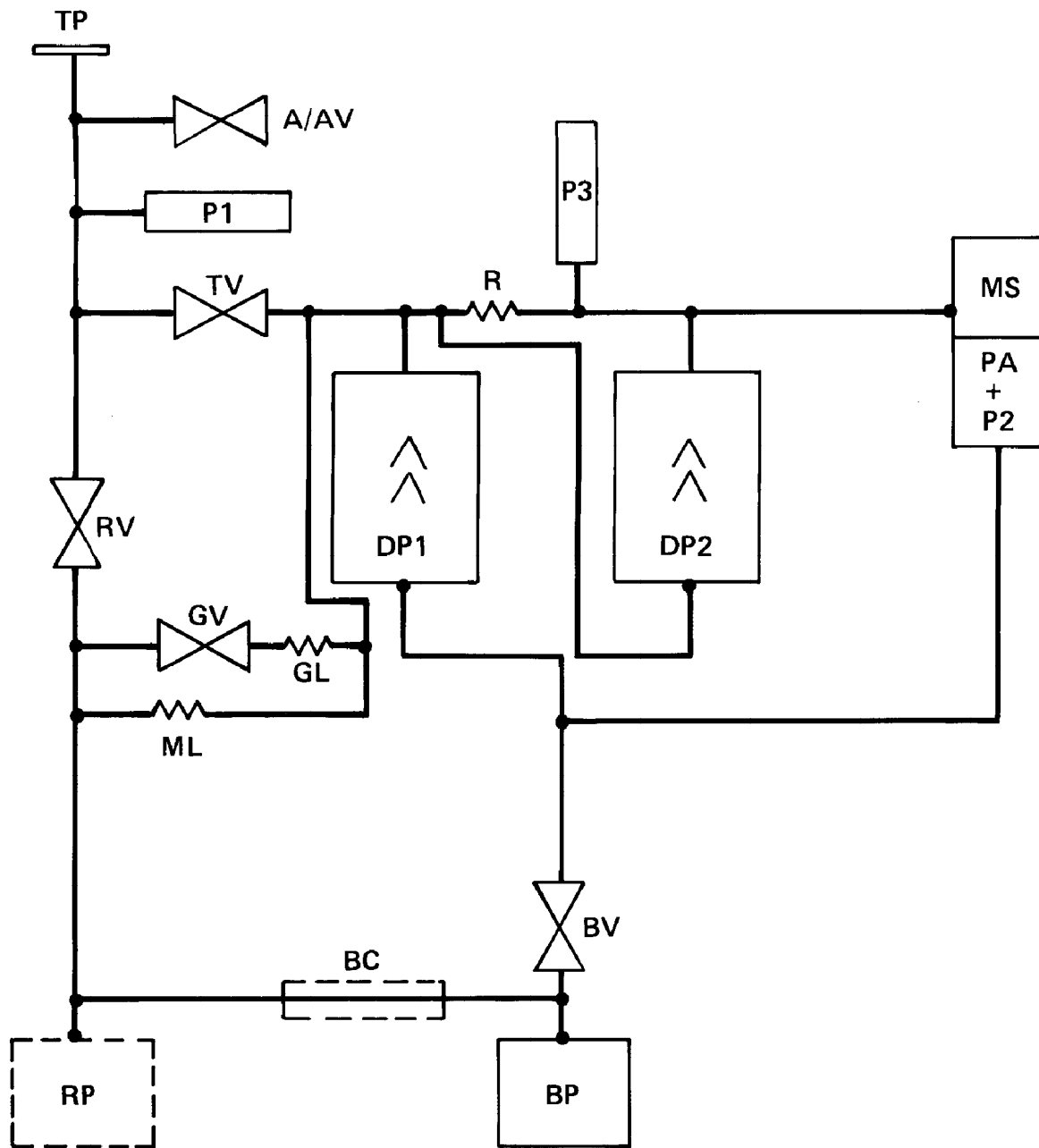


Figure 4.1 - Spectron 300E block schematic

4.7 Operation - normal

WARNING

Before operating the Spectron 300E ensure that the initial installation as detailed in Section 3 has been carried out.

WARNING

Ensure that any item fitted to the test port is clamped in position to avoid its falling in the event of an electrical supply failure or sudden vacuum loss.

This section gives a brief summary of the difference between the normal and extended modes of operation, followed by a detailed description of the Spectron controls. If familiar with the operating controls then continue from Section 4.8.5 - Starting up and Operation.

Read this section thoroughly and become familiar with NORMAL operation before reading Section 4.9 - EXTENDED operation.

4.7.1 Operating modes

The Spectron 300E can be operated in two different modes, NORMAL or EXTENDED. Both modes give the operator similar control over the leak testing sequence.

In the normal mode zeroing and peaking are automatic at the touch of a button. In the extended mode the user has the option of manual control over these operations. Gross Mode calibration is also available in Extended Mode (see Section 4.9).

The operating mode is indicated on the main display in the READY TO TEST mode. In normal operation the labels READY TO TEST PN or READY TO TEST SN is displayed where the 'N' indicates normal operation. (P and S indicate either primary or secondary filament in use). In extended mode the labels READY TO TEST PE or READY TO TEST SE are displayed.

The Adjust Mode is used to change from one operation to another. Section 5 details how this is done.

The rest of the section assumes that the Spectron 300E is in NORMAL operation. All units reach the customer initially set for NORMAL operation.

4.7.2 Standby and leak test modes

This section indicates each mode and gives a brief statement of the condition of the Spectron 300E when in that particular mode.

Standby modes

Displayed label	Comment
STANDBY	The filament is off. Test valve is closed. The test port is at atmosphere and the backing led is on.
STANDBY TPUV	The filament is off (test port under vacuum). Test valve open and test port pumped by the vacuum system. BACKING led and FINE led are on. STANDBY TPUV is selected by pressing the standby button when in FINE.

Leak test modes

The exponent on the hand held control module is displayed only when in one of the three test modes MASSIVE, GROSS (including GROSS HOLD) and FINE.

Displayed label	Comment
FINISH	The Spectron 300E is in a safe mode but the test port pressure is below $1.0 \times 10^{+2}$ mbar.
READY TO TEST	The Spectron 300E is in a safe mode and the test piece may be removed. The test port pressure is greater than $1.0 \times 10^{+2}$ mbar. The filament is on.
MASSIVE	The test piece is pumped by the roughing pump and gas is sampled through a metrosil leak. The Spectron 300E will go into GROSS mode if test port pressure is less than the MASSIVE to GROSS change-over pressure (Section 5.10 parameter 3) and the filament is on. The MASSIVE led will switch on, and the leak rate exponent will also be on. If pressure in the backing line as measured by the thermocouple gauge head P2 rises, the roughing valve will be closed to enable the system to be pumped out further by the rotary pump until a suitable pressure is reached.

Displayed label	Comment
GROSS	The test piece is pumped by the rotary pump and gas is sampled through the gross leak valve. The GROSS mode led is on. The Spectron 300E will go into FINE mode if the test port pressure is less than the GROSS to FINE mode change-over pressure (Section 5.10 parameter 1). The Spectron 300E can be manually forced into FINE mode by pressing <i>test</i> when in GROSS mode provided that the test port pressure is less than 6.00×10^{-2} mbar and that GROSS HOLD is not set. This is mainly suitable for small test volumes such as sniffer probes and shortens the time to reach the proper vacuum conditions for leak testing. As in MASSIVE mode if pressure in the system rises too high the roughing valve will be closed again and the system pumped out until a suitable pressure is reached.
GROSS HOLD	When GROSS HOLD is selected the unit will not progress to FINE. The GROSS HOLD led on the gross switch and GROSS mode led will both switch on.
FINE	This is the normal test condition. The test piece is pumped directly by the diffusion pump. The FINE led is on.
BACKING	When testing for a large leak in MASSIVE mode with the backing valve closed, helium will slowly build up in the backing volume. If this level becomes unacceptable then the normally automatic backing routine can be selected manually by pressing the BACKING switch on the front panel. When in BACKING the roughing valve closes. The BACKING switch led is on.

4.7.3 Hand held control module (Figures 4.2 and 4.4)

During a valid test mode, the mantissa of the leak rate is shown on the 50 segment bar graph display whilst the exponent of the leak rate is shown on the digital display (of the hand held control unit). Furthermore the hand held unit has four front button switches for selection of manual or auto ranging and zeroing, in addition to a socket for headphones providing an audio output when working in noisy environments.

4.7.4 Spectron 300E displays

An indication of leak rate is also given via a loudspeaker situated on the front of the Spectron 300E. This indication is in the form of an audible note, the frequency of which increases with the leak rate indication. The volume is controlled by the decimal point push switch on the numerical front panel. This feature is useful when initially searching for a leak 'out-of-sight' of a unit. A socket for headphones is also provided on the hand held control module. Suitable headphones D154-71-370 are available. The jack is 3.5 mm stereo, and the two 32 ohm phones are connected in series.

A recorder output is provided on the rear panel, 0 to 5 V output, minimum load impedance 2 kohms. This output relates to the leak rate displayed on the main display and is linear.

The 16 character alpha-numeric display on the vacuum console provides continuous system information sent to the display from the internal computer, which is housed in the vacuum console, to inform the operator of the exact state of the process, for example, READY TO TEST.

The display will depend upon whether STANDARD DISPLAY or DIAGNOSTIC DISPLAY has been selected in the << ADJUST MODE menu 5 << FUNCTIONS. See Figure 5.2. It is assumed here that STANDARD DISPLAY has been selected. All units are set for STANDARD DISPLAY before leaving the factory.

There are four visual display indications on the Spectron 300E, the sixteen character alpha-numeric display, the 50 segment bar graph readout of leak rate with exponent display and the leak test mode leds.

Alpha-numeric display

The sixteen character alpha-numeric display is controlled by the four push buttons beneath it (Group 1 on Figure 4.2). They select the information that is displayed, for example, system status etc. The user can interrogate the Spectron 300E at any time during a sequence with these buttons. This display is the information link between the Spectron 300E and the user.

Leak rate display (bar graph)

The bar graph on the hand held unit displays the mantissa of the leak rate that is detected, for example, 7.8 for a leak rate of 7.8×10^{-8} mbar ls⁻¹. The bar graph will display a single moving bar if the leak rate goes negative. The single bar at the top of the display indicates that auto ranging has been selected.

Digital display (hand held unit)

The digital display on the hand held unit displays the exponent of the leak rate, for example, -8 for a leak rate of 7.8×10^{-8} mbar ls⁻¹.

When in normal or diagnostic display the led will be on when in a valid test mode. The led will sometimes flash when in extended mode if 'zero' or 'peak offset' have been selected.

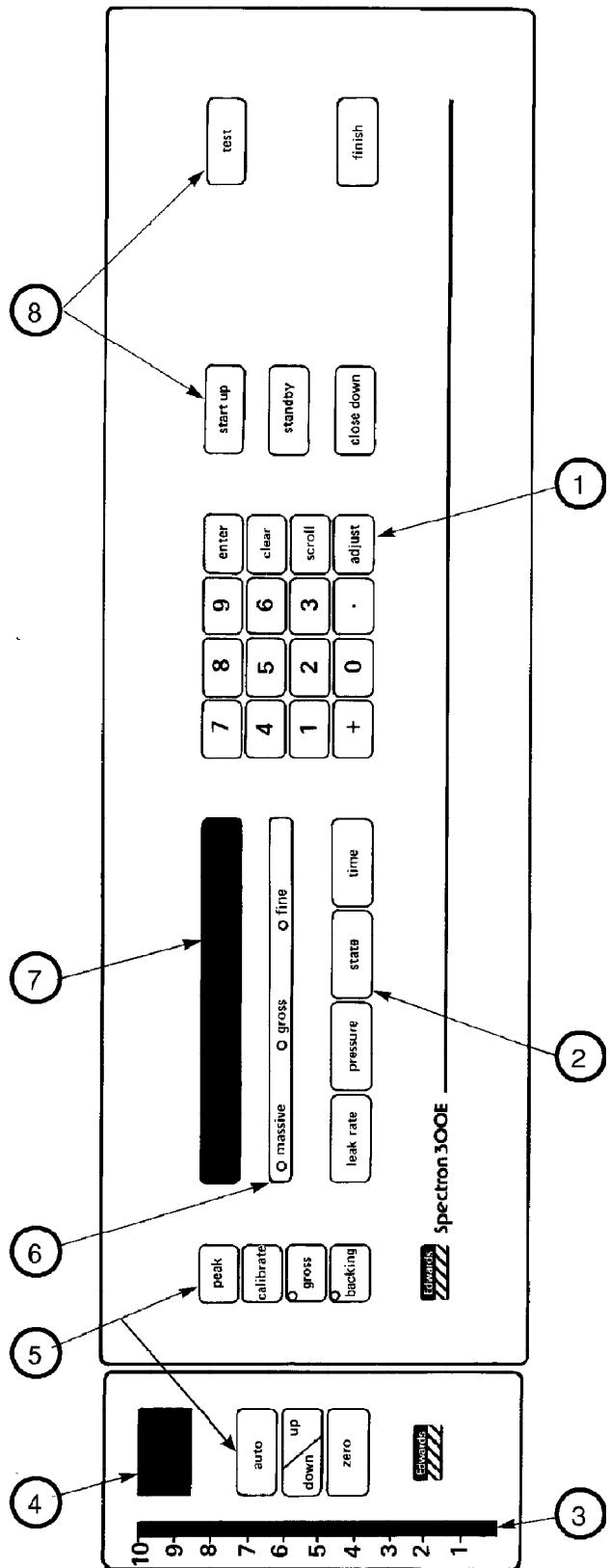
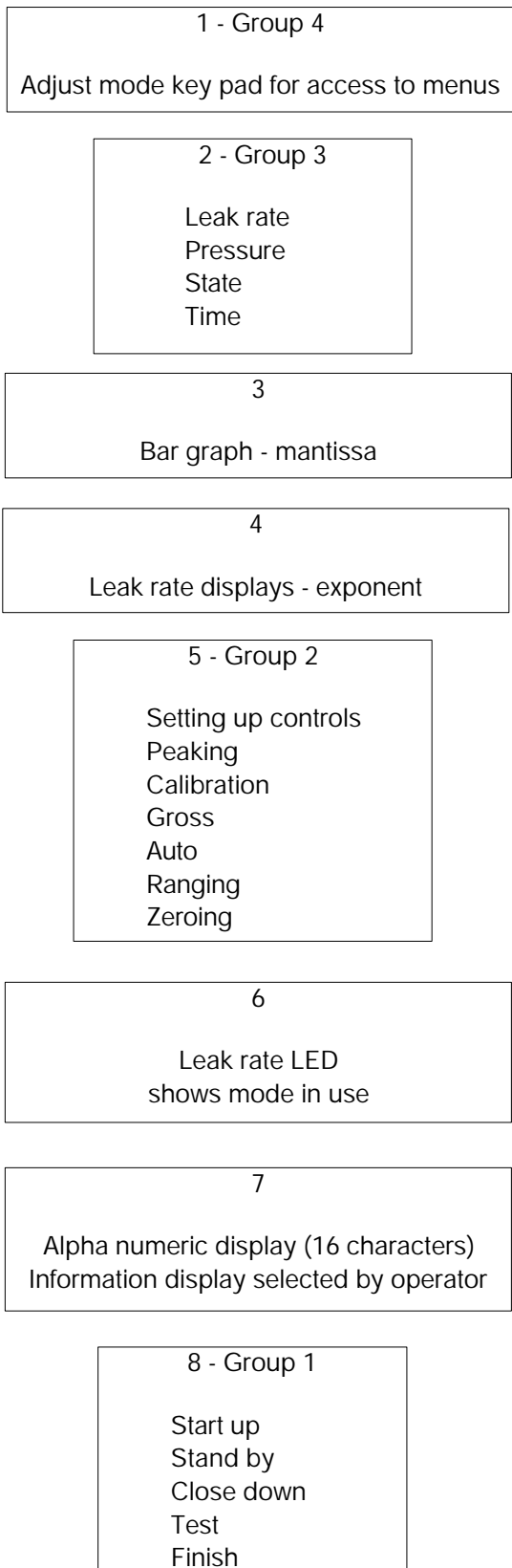


Figure 4.2 - Control panel and control groups

Leak test mode led's

Note: The backing switch led will be on in STANDBY and BACKING hold.

There are three test modes. Each one is labelled with an adjacent led which is on when that particular mode is in use. These modes are MASSIVE, GROSS and FINE.

If the led's are not switched on during operation the Spectron will be in either STANDBY, READY TO TEST, a part of the pumpdown/closedown sequence, or in an error stage (error messages are discussed in Section 5.21).

4.8 Spectron 300E controls (Figure 4.2)

4.8.1 Group 1 controls

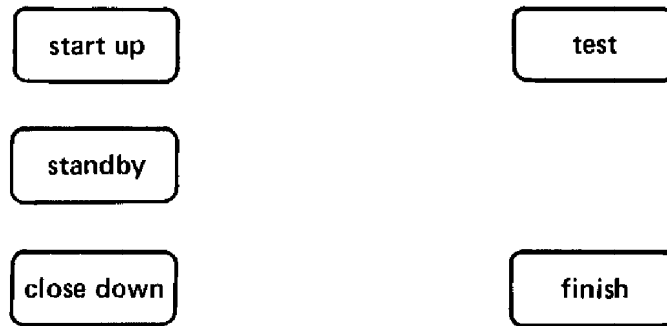


Figure 4.3 - Group 1 controls

These switches give the operator control of the vacuum sequence, that is, START UP, STANDBY, FINISH, TEST, and CLOSEDOWN.

- start up - Pressing **start up** starts the pump down Procedure. See Section 4.4 for the full procedure.
- standby - Pressing **standby** when the Spectron is in the correct operating condition (that is, ready to test, finish, or fine) causes the BACKING led to switch on and the label STANDBY or STANDBY TPUV (Test Port Under Vacuum) to display. The FINE led will also be ON.

The filament is switched off.
- finish - Pressing **finish** at any time (except when peaking, calibrating, or zeroing) will finish a leak test cycle. The label READY TO TEST will then display.
- test - Pressing **test** will start the test cycle.
- close down - Pressing **close down** at any time starts the closing down procedure. See Section 4.4 for the full procedure.

4.8.2 Group 2 controls

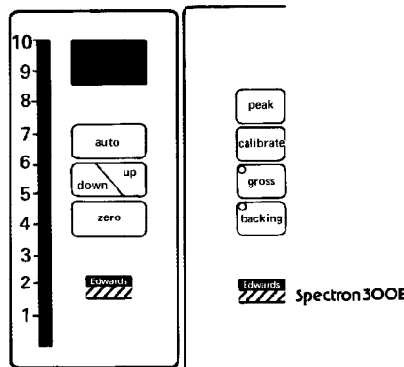


Figure 4.4 - Group 2 controls

These controls are used for 'setting-up' the Spectron before use. Auto peaking, Calibration, Ranging and Zeroing are discussed later in this section (Auto peaking 4.8.8, Calibration 4.8.9, Ranging 4.8.10 and Zeroing 4.8.11.)

- gross - Pressing **gross** at any time (except during pump down) will select gross hold and the GROSS HOLD led will switch ON. Press **gross** again to cancel this selection.
- backing - Press to switch on the backing pump manually when required. The BACKING led will switch ON.

4.8.3 Group 3 controls

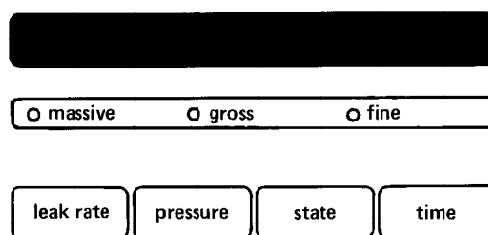


Figure 4.5 - Group 3 controls (Display buttons)

There are four switches in group 3. These are labelled **leak rate**, **pressure**, **state** and **time**. They can be pressed at any time by the operator while the vacuum sequence is running. Each switch is pressed repeatedly to read the items listed. Standard display is listed here. Diagnostic display is in Section 5.7.3.

STANDARD DISPLAY

Note: For details of displays when *DIAGNOSTIC DISPLAY* has been selected refer to Section 5.7.3.

- leak rate - Displays the leak rate with the selected leak rate units or the parameter status. If the parameters are all correct the display will be PARAMETERS OK (parameters, see Section 5.10). If not, an error message for that particular parameter error will be displayed, for example, FAIL SCALE FACTOR.
- pressure - Displays the backing pressure, the test port pressure, mass spectrometer pressure as measured by Pirani PRL10K (Head PR), and mass spectrometer pressure measured by the spectrometer (Head MS).
- state - Displays a state label, for example, FINE or an error label for example, NO PEAK FOUND. Filament and mode indication is also given, for example, READY TO TEST.
- time - Displays filament run hours.

4.8.4 Group 4 controls

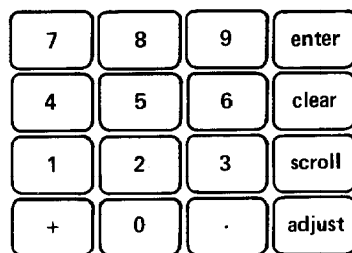


Figure 4.6 - Group 4 controls

These switches enable the user to enter the adjust mode and select different modes of operation, for example, NORMAL/EXTENDED mode of operation or to enter/change the Spectron 300E parameters, for example, gross/fine change-over pressure. For operational details refer to Sections 5.1, 5.7 and Figures 5.3, 5.4, 5.5 and 5.6.

4.8.5 Starting up and operation

WARNING
Ensure that any item fitted to the test port is clamped in position to avoid its falling in the event of an electrical supply failure or sudden vacuum loss.

Note: If the Spectron 300E has been switched off for more than 6 months, the back-up battery may be discharged resulting in loss of contents of the random access memory (RAM). If so, when switching on, the label MEMORY FAULT will display. Refer to the Spectron parameters certificate supplied with each unit and re-enter values of the following: massive factor, gross factor, low sensitivity amplifier factor, and total pressure sensitivity factor. This is done in the ADJUST mode menu item 8 (Section 5.10). If the tune voltage is greater than 147V, or less than 133V, the Spectron will need to be retuned manually (refer to Manual peaking Section 4.9.1). The remaining calibration factors will be re-calculated on performing a full calibration.

1. Switch the power on with the double-pole isolation switch on the rear panel. If an overload occurs during use, this switch will automatically cut out and switch the power off. The message CLOSED DOWN will be displayed.
2. Press **start up** on the vacuum console. The label START UP will display for about a minute followed by PUMP DOWN when the backing pressure falls below 2×10^{-1} mbar. If the system is cold it may revert momentarily to START UP then return to PUMP DOWN.
3. Pump down will continue. After about four minutes when the diffusion pump has warmed up, and the system pressure has fallen below 5×10^{-4} mbar, the label STANDBY will display.
4. To prepare for leak testing press - finish - on the vacuum console. The system will go to the FINISH mode and the label FILAMENT WARM UP will display. When the Spectron 300E is ready to leak test, the leak rate will be displayed on the control unit with the label READY TO TEST on the console.

Note: At times a negative leak rate will be displayed. This is shown by a single bar indicating leak rate on the led bar display. The digital display will indicate the actual reading. This can be a 'clean-up' in the background reading or a small amplifier drift. It can be removed by using the zero control (see Section 4.8.11 if in Normal operation or Section 4.9.3 if in Extended operation).

5. Connect a test piece to the test port, making sure that it has been properly clamped and press the **test** button. The Spectron 300E will automatically go through the test modes (MASSIVE, GROSS and FINE) until the most suitable mode for testing is found. The mode will be indicated by one of the leak test leds on the console switching on.

Sometimes, particularly soon after switch on, the Spectron 300E will hold in gross mode due to the inability of the internal pump to reach the change-over pressure. If the **test** button is pressed at this time then FINE mode will be selected provided the test port pressure is less than 6×10^{-2} mbar.

6. To finish a leak test sequence simply press the **finish** button. The test port will be vented to atmosphere and the label READY TO TEST will be displayed. The test piece can then be removed, after removing the clamp, and another fitted.

7. To put the Spectron 300E into STANDBY, press the **standby** button when in either READY TO TEST or FINISH modes. The label STANDBY will display.

To put the Spectron 300E in STANDBY TPUV (Test Port Under Vacuum) press **standby** when in FINE.

The label STANDBY TPUV will display and the FINE and BACKING leds will switch on. DO NOT REMOVE THE TEST PIECE. To exit standby mode, press either finish or **test** (refer to Figure 4.3).

It is recommended that the test port manifold is kept clean when not testing by leaving the system in FINE or STANDBY TPUV.

8. To close down the Spectron 300E at any time press the **close down** button on the vacuum console. The Spectron 300E will go into a controlled shutdown procedure and the CLOSING DOWN label will display. The mass spectrometer is switched off. All valves and pumps will be switched off, except for the backing pump and backing valve.

The cooling fans will remain on. After about ten minutes the label CLOSED DOWN will display indicating that the closing down process is complete. Only the cooling fans will remain on.

The system can then be vented to atmosphere if required.

4.8.6 Quick start up (Figure 4.8)

The quick start up guide (Figure 4.8) shows the normal procedure for using the instrument, but this assumes that the instrument is fully calibrated. For instruments not fully calibrated the following section describes the Setting Up procedure.

4.8.7 Setting up

Before leak testing the Spectron 300E has to be fully calibrated. The Spectron was fully calibrated at the factory and the values of the calibration parameters are shown on the Spectron certificate supplied with this unit. These values are contained in memory. In the event of a memory fault (Section 5.21.1) the Spectron will 'restart' with the nominal values for the parameters. It would then be necessary to re-enter the particular values for your instrument (Section 5.10).

The procedures that have to be carried out by the operator from time to time are Peaking, Calibrating and Zeroing. Ranging is selected by the user when required.

Selecting NORMAL operation

Press **adjust**. The display will read << ADJUST MODE. Press **5** followed by **enter**.

The display will read << FUNCTIONS. Press **2** followed by **enter**. The display will read << OPERATION.

Scroll to 0 = NORMAL and enter **0**. Press **adjust** to return to normal working.

Spectron 300E is now set for normal operation.

You can return to the top of the menu if you make an error by pressing **adjust** to start again.

4.8.8 Auto peaking (Figure 4.9)

Note: If PEAK NOT FOUND is displayed, refer to Section 5.21.8 Errors. Make sure that helium is actually present whilst auto peaking and leak valve is open. If PEAK NOT FOUND is displayed the peak volts value will not have been changed from its original value.

Before the Spectron 300E is used to detect helium leaks it must first be peaked to a helium source. The unit can be automatically peaked in GROSS or FINE (but not in READY TO TEST). Simply fit an external helium source to the test port and place the unit in a suitable test mode, for example, FINE and then press the **peak** button. Message comes up PK AUTO IF READY. Press **auto** for auto peaking. Press **peak** to abort if leak has not been put on test port. Pressing **auto** will cause the tuning voltage in the mass spectrometer to be automatically adjusted to maximise the helium signal. This is auto peaking. The Spectron 300E scans once over a band of $\pm 10\%$ of the current peak voltage to find the new value. It scans again over a reduced band to find the peak more accurately.

Normal operation

Peak - See Figure 4.9

4.8.9 Calibrating (Figure 4.9)

CAUTION

Do not enter the adjust mode whilst making a calibration choice, or before entering the external reference leak value when requested, as this will cause the Spectron 300E to start a calibration routine prematurely.

Note: The Spectron 300E should be switched on for at least 30 minutes, with the filament on for at least 20 minutes, to ensure an accurate calibration.

Note: It is recommended that a powder leak of at least 5×10^{-7} mbarl/s be used for calibrating the Spectron 300E in Gross mode.

*Note: To abort the calibration routine, except when label 'CAL WHEN READY' is displayed, press **calibrate**.*

Calibration using a reference leak (see also Section 4.5)

Fit a helium leak to the test port. Ensure that the isolation valve on the leak is open. Place the Spectron 300E in fine mode. Peak for helium as in Section 4.8.8. Press **calibrate**, the label EXT REF n.nn-n will display where n.nn-n is the reference leak value last selected. If the Spectron 300E is being calibrated for the first time, a nominal value of reference leak will be displayed. This is 2.5×10^{-8} mbar ls⁻¹. If you wish to change the value displayed press the **clear** button and enter your new value, otherwise press **enter**.

The label 'ZERO WHEN READY' will display. Close the reference leak valve or remove helium from the leak, if using a powder leak. Wait until the leak rate has reached a stable zero level. This may have a negative or positive value.

Press **zero**. The label 'ZEROING' will display followed by the label 'CAL WHEN READY'. Open the reference leak valve or apply helium to the leak, if using a powder leak. When the reading has stabilised press **calibrate**. The label 'CALIBRATING' will display.

When calibration is complete, the label CALIBRATED P or CALIBRATED S will display, depending on which filament is in use and the Spectron 300E will revert to the test mode it was in prior to calibrating. If the label FAIL- SCALE FACTOR or FAIL -GROSS FACTOR appears, refer to Section 5.21.10.

The reference leak value used for calibration should always be converted to units of mbar ls (air equivalent) (see Section 6.2) before entering. It is not necessary to change the leak rate units in the Adjust mode to do this. Remember also to correct the reference leak for temperature if using a quartz leak. if using a powder leak temperature correction is not necessary.

When performing calibration with a helium concentration of other than 100%, for example, 50% helium gas sprayed over a sintered leak, enter the external reference leak value after it has been corrected for low helium concentration. From the example enter a leak value of $\times 0.5$ for 50% helium. This is because the Spectron 300E assumes 100% helium concentration during calibration.

Calibrate - See Figure 4.9.

4.8.10 Ranging

See Figure 4.9 - Ranging

The **auto** and **up/down** buttons control the leak rate index

Auto ranging

To select ranging, press the **auto** button. Top bar on 50 segment display will switch on. To cancel auto ranging, and select a fixed range, press either **up** or **down** buttons a sufficient number of times to select the range required.

Fixed range

To increase the maximum detectable leak rate by a factor of 10, for example, (10×10^{-7} to 10×10^{-6}), press the **up** button.

To decrease the maximum detectable leak rate by a factor of 10, for example, (10×10^{-6} to 10×10^{-7}), and hence achieve the greater sensitivity, press the **down** button.

4.8.11 Zeroing

See Figure 4.9 - Zeroing leak rate normal operation

The zero control is used to zero the leak rate indication (LRI). When zeroing the leak rate follow the actions in Figure 4.9.

4.9 Operation - extended

This mode of operation is intended to supplement the normal operating procedure detailed in Section 4.7. Therefore, before using the Spectron 300E in Extended operation, users should first familiarise themselves with Section 4.7.

Extended operation is basically the same as normal operation but with more detailed control when PEAKING, CALIBRATING or ZEROING.

The facilities detailed in this section are as follows:

Peaking (4.9.1)	Automatic peaking Manual peaking (offset and ramp, up or down)
Calibrating (4.9.2)	Normal Gross mode
Zeroing (4.9.3)	Automatic zero Manual zero (ramp up or down)

To enter extended operation proceed as follows:

(Refer to Figure 5.3 ADJUST MODE and FUNCTIONS).

Press **adjust**, the display will read << ADJUST MODE.

Next press **5**, followed by **enter**. The display will change to << FUNCTIONS.

Press **2**, followed by **enter**. The display will change to << OPERATION.

Press **1**, followed by **enter**. Press **adjust** to escape.

Spectron 300E is now set for Extended operation.

4.9.1 Peaking

There are three peaking functions in the extended mode - AUTO PEAKING, MANUAL PEAKING (OFFSET or RAMP), refer to Figures 4.10.

Automatic peaking

The Spectron 300E can be automatically peaked in MASSIVE, GROSS or FINE modes, but not in READY TO TEST. Fit an external helium source to the test port and place the Spectron 300E in a suitable test mode, for example, FINE.

Proceed as follows:

To start auto peak process press **peak** (see Figure 4.10). PEAK ? will display on the console.

Next press **auto** on the hand held control module, AUTO PEAKING will display and when auto peaking is complete the Spectron 300E will return to the test mode it was in before auto peaking was selected.

If NO PEAK FOUND is displayed refer to Section 5.21.8 (faults and errors). Make sure that helium is actually present whilst auto peaking, for example; is the reference leak valve open? If NO PEAK FOUND is displayed the peak volts value will not have been changed from its original value.

Manual peaking offset and ramp

The manual offset facility enables the operator to distinguish the difference between an electronic offset in leak rate reading and a helium background. If a helium background is present a lower reading of leak rate will be observed in peak offset. Manual ramp enables the operator to find the helium peak manually if the tuning voltage is outside the autopeaking range. That is, NO PEAK FOUND displayed (this message might also be caused by other faults, see Section 5.21.8).

To select OFFSET or RAMP enter the << ADJUST MODE (press **adjust**).

Select 5 - FUNCTIONS and scroll to 1 - PEAK TYPE (follow the flow chart on Figure 5.3).

Next enter 1. When << PEAK TYPE is displayed scroll to 0 = OFFSET or 1 = RAMP and enter whichever is required (**0** or **1**).

To return to the top of the << ADJUST MODE menu simply press **adjust** twice.

When in extended mode of operation there may be a requirement to view the mass spectrometer tuning voltage on the alpha-numeric display. To select this proceed as above except that in << FUNCTIONS select 0 - DISPLAY. The display menu will read 0 = STANDARD and 1 = DIAGNOSTIC. For diagnostic display select 1 = DIAGNOSTIC. Then press the **leak rate** button. This causes the following data to be displayed (refer to Figure 5.3 - Functions).

TUNE VOLTS = 140	Ion box voltage on Mass Spectrometer.
-1.28-9LR NOAV	Leak rate, -1.29×10^{-9} mbar ls ⁻¹ , with no zero subtracted and no signal averaging (on the more sensitive leak rate ranges the signal is averaged to reduce noise level).
2.0 -12 A/RNG 5	Current from the mass spectrometer in amps (A). The electronic range of the partial pressure amplifier is also indicated on the scale 0 to 5 when 0 is the least sensitive range.
-1.15-9 ZERO	Indicates the difference in zero level compared to last internal zero check, made on leaving standby. Affected by auto zero and zero ramp.
1.20 -9 MBAR L/S	Leak rate is displayed in the units selected. This example reads 1.2×10^{-9} mbar ls ⁻¹ .

Peak offset (Figure 4.7)

When PEAK OFFSET has been selected, the Spectron 300E can be detuned by pressing **peak** followed by either **up** or **down**. Pressing **up** will increase the tuning voltage by 10%. Similarly pressing **down** will decrease the tuning voltage by 10%. The display when **up** is pressed will be PEAK OFFSET HIGH and for **down** PEAK OFFSET LOW.

The exponent will flash during peak offset.

In order to change from peak offset low to peak offset high or vice-versa the Spectron 300E must first be brought back to the PEAK ? mode by pressing **peak**. This always brings the tune volts back to the middle (or tuned) position. Pressing **peak** when PEAK ? is displayed, will return the Spectron 300E to the previously selected test mode.

If the leak rate indication in either of the detuned conditions is greater than the indication in the tuned condition, then it is possible that the indication in the tuned position is not caused entirely by helium or the Spectron 300E is incorrectly tuned. Figure 4.7 depicts the four basic conditions that may be found. Figure 4.7a is the normal condition in which the Leak Rate Indication (LRI) is maximum at the peak.

Figure 4.7b represents a condition in which the leak rate is higher in PEAK OFFSET LOW than in PEAK? and Figure 4.7c the leak rate is higher in PEAK OFFSET HIGH than in PEAK?.

This condition could indicate that a high background signal at the tuning voltage is being caused by either high pressure operation of the mass spectrometer or a contaminated mass spectrometer, for example, Figure 4.7b, or the Spectron 300E not being tuned to the maximum helium signal, for example, Figure 4.7c.

Figure 4.7d represents the condition in which leak rates at PEAK OFFSET HIGH, PEAK OFFSET LOW and PEAK ? are all non-zero and similar in magnitude to each other. This is caused by a general zero offset in the leak rate. No helium present or helium not detected.

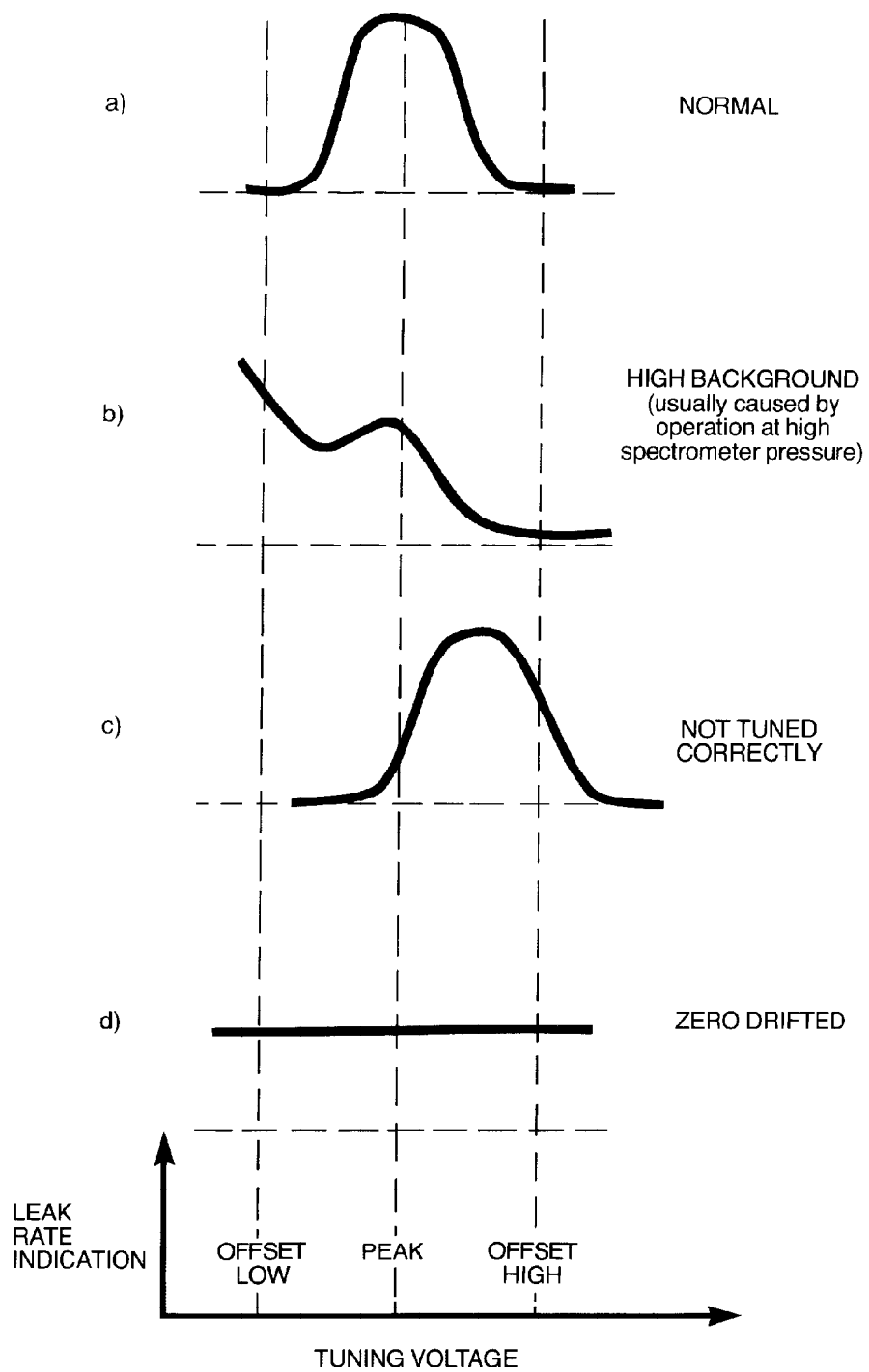


Figure 4.7 - Helium peak offset - extended operation

Peak ramp

PEAK RAMP UP and PEAK RAMP DOWN causes the tuning voltage to ramp up or down so that the optimum tuning voltage can be found manually. The traceable voltage range is from 0 V to 200 V. The exponent flashes during peak ramp.

When PEAK ? is displayed, and the **up** or **down** button is pressed, the tuning voltage will automatically ramp up or down until **peak** is pressed. PEAK ? will be displayed again. Ramping up or down may then be continued or the Spectron 300E returned to the test mode it was in previously by pressing **peak** again.

For other masses the voltage range is doubled.

4.9.2 Calibration (Figure 4.9)

To ensure accurate calibration the Spectron 300E should be switched on for at least 30 minutes, with the filament on for at least 20 minutes.

General

CAUTION

Do not enter the adjust mode whilst making a calibration choice or before entering an external reference leak value when requested, as this will cause the Spectron 300E to start a calibration routine prematurely.

Calibration takes about 20 seconds.

Calibration (detailed in Section 4.5) will check that the scale factor is correct and update it as necessary.

A gross calibration is possible if a suitable external calibration leak is fitted. This should be a leak above 5×10^{-7} mbar ls⁻¹. The gross factor will be updated.

To abort the calibration routine, except when label 'CAL WHEN READY' is displayed, press **calibrate**.

Calibration procedure

Note 1: The reference leak value used for calibration should always be converted to units of mbar ls⁻¹ (air equivalent) before entering. It is not necessary to change the leak rate units in adjust mode to do this. Remember to correct the reference leak for temperature.

Note 2: When performing calibration with a helium concentration of other than 100%, for example, 50% helium gas sprayed over a sintered leak, enter the external reference leak value after it has been corrected for low helium concentration. From the example enter a leak value of $\times 0.5$ for 50% helium. This is because the Spectron 300E assumes 100% helium concentration during calibration.

Fit a reference leak to the test port and place the Spectron 300E in FINE mode. Press **calibrate**

The label EXT REF n.nn-n will display where n.nn-n is the previous value of external leak entered. If this value is to be changed, press **clear** and enter the new value, otherwise simply press **enter**.

Helium leak rate = Air leak rate x 2.7

The label 'ZERO WHEN READY' will display.

Close the reference leak valve or remove helium from the leak, if a powder leak is fitted. Wait until the leak rate has reached a stable zero level. This may have a negative or positive value depending on the zero level selected previously.

On the hand held control module press **zero**. The label 'ZEROING' will display whilst the Spectron 300E is taking zero levels. This will be followed by the label ZEROED momentarily then 'CAL WHEN READY'. Open the reference leak valve or apply helium to the leak, if a powder leak is fitted. When the reading has stabilized press **calibrate**

When calibration is complete the label 'CALIBRATED P' or 'CALIBRATED S' will display, indicating that the unit has completed a calibration for either the primary(P) or secondary(S) filament. The Spectron 300E will revert to the test mode it was in prior to calibration.

The newly calculated values of scale factor can be read in parameters if required (see Section 5.10). If any of these factors are outside the limits defined in the parameter table an error message will be displayed (see Section 5.21.10).

Gross mode calibration

Note 1: The reference leak value used for calibration should always be converted to units of mbar ls^{-1} (air equivalent) before entering. It is not necessary to change the leak rate units in the adjust mode to do this. Remember to correct the reference leak for temperature.

Note 2: When performing calibration with a helium concentration of other than 100% for example 50% helium gas sprayed over a sintered leak, enter the leak value after it has been corrected for low helium concentration. From the example enter leak value x 0.5% helium. This is because the Spectron 300E assumes 100% helium concentration during calibration.

If a calibration is required for the gross factor, fit an external reference leak of at least $5 \times 10^{-7} \text{ mbar ls}^{-1}$ to the test port and place the Spectron 300E in gross hold mode. (The powder leak isolation assembly D163-15-000 is recommended).

Press **calibrate**. The label EXT REF n.nn-n will display where n.nn-n is the last value of external reference leak entered. If you wish to change this value press **clear** and enter the new value, if not then just press **enter**.

The label 'ZERO WHEN READY' will display. Close the reference leak valve or remove helium from the leak if a powder leak is fitted.

Wait until the leak rate has reached a stable zero level. This may have a negative or positive value depending on the zero level selected previously.

Press **zero**. The label 'ZEROING' will display followed by 'ZEROED' momentarily then 'CAL WHEN READY'. Open the reference leak valve or apply helium to the leak if a powder leak is fitted. When the reading has stabilized press **calibrate**. The label 'CALIBRATING' will display.

When calibration is complete the label 'CALIBRATED P' or 'CALIBRATED S' will display, indicating that the unit has completed calibration for either the Primary (P) or Secondary (S) filament. The Spectron 300E will revert to the gross hold mode. The newly calculated value of gross factor can then be read in parameters (Section 5.10).

If the gross factor is outside the limits as defined in the parameter table, the error message FAIL GROSS FACTOR will display (Section 5.21.10).

4.9.3 Zeroing (Figure 4.10)

The zero control varies the Leak Rate Indication (LRI) zero point. There is a choice of two zero functions in extended mode, Automatic ZERO and manual ZERO RAMP UP/DOWN.

Automatic zero

The action of auto zero is the same as for NORMAL operation. Press **zero**. The zero led will flash when ZERO ? displays. Press **auto**. The Spectron 300E will automatically zero the display and then return to the leak test mode that it was in before **auto** was pressed.

Manual ramp up/down (Figure 4.10)

Set on the hand held control module.

To set the zero level to a required value press **zero**. When ZERO ? displays press either the **up** button to ramp the zero point up, or the **down** button to ramp the zero point down. To stop ramping press **zero**. To leave the zeroing mode, when ZERO ? is displayed, press **zero**.

In addition to the above facilities, the leak rate indication may be held at zero in the READY TO TEST mode. This is to enable any signal due to helium being desorbed from high vacuum components to be ignored, and not contribute to the leak rate indication when entering a test mode. See OPTIONS in Section 5.9. (Automatic zeroing).

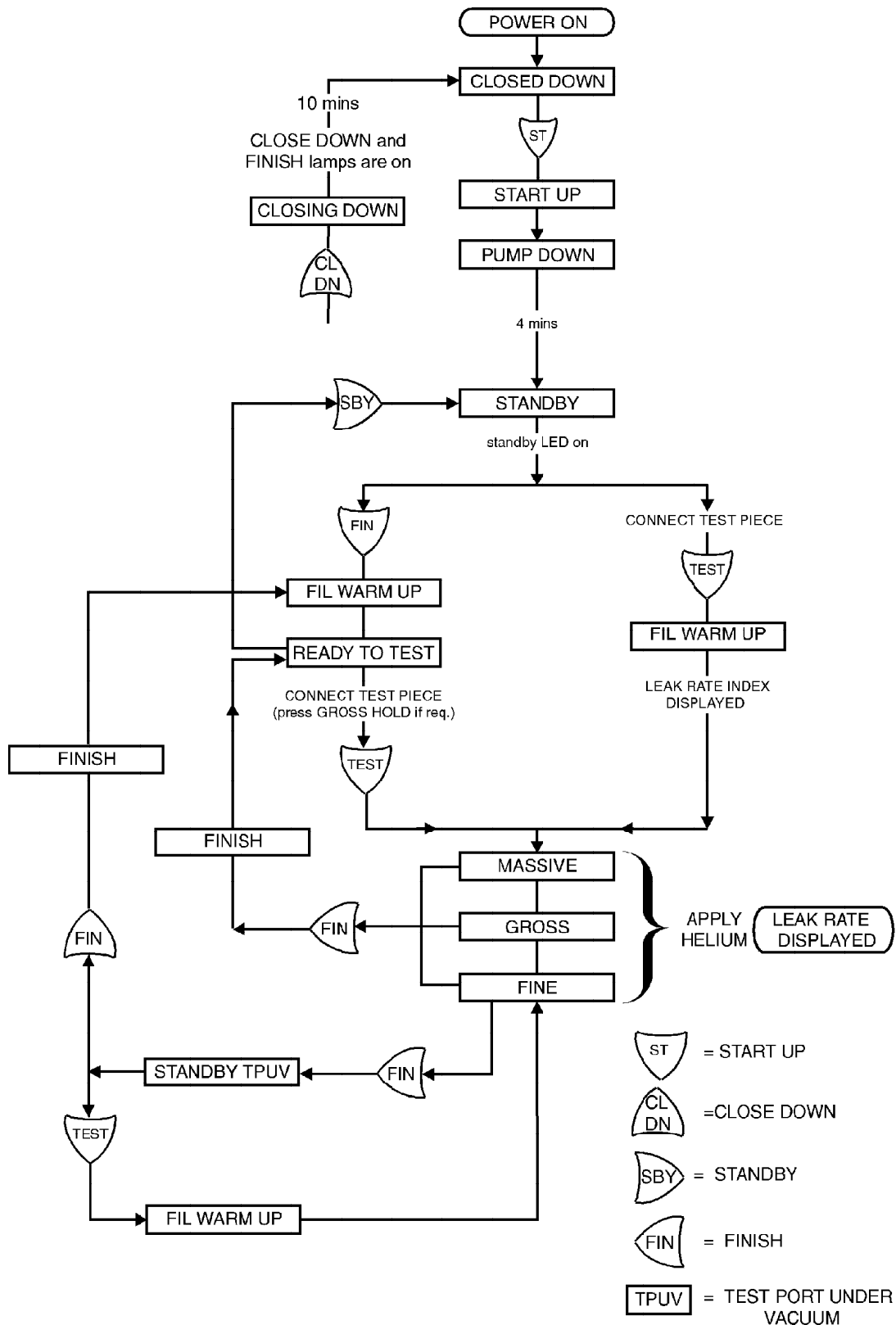


Figure 4.8 - Quick start-up menu

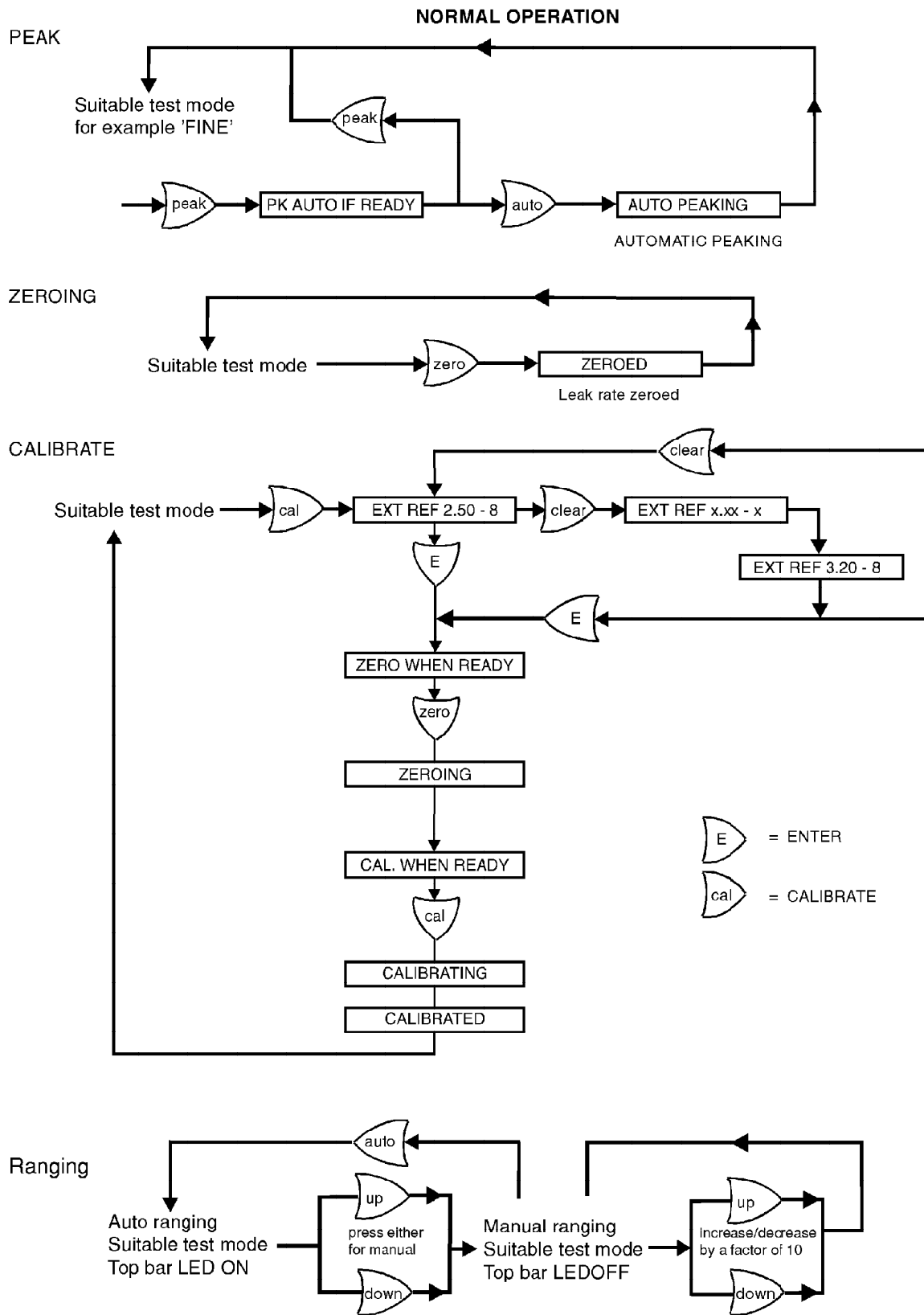
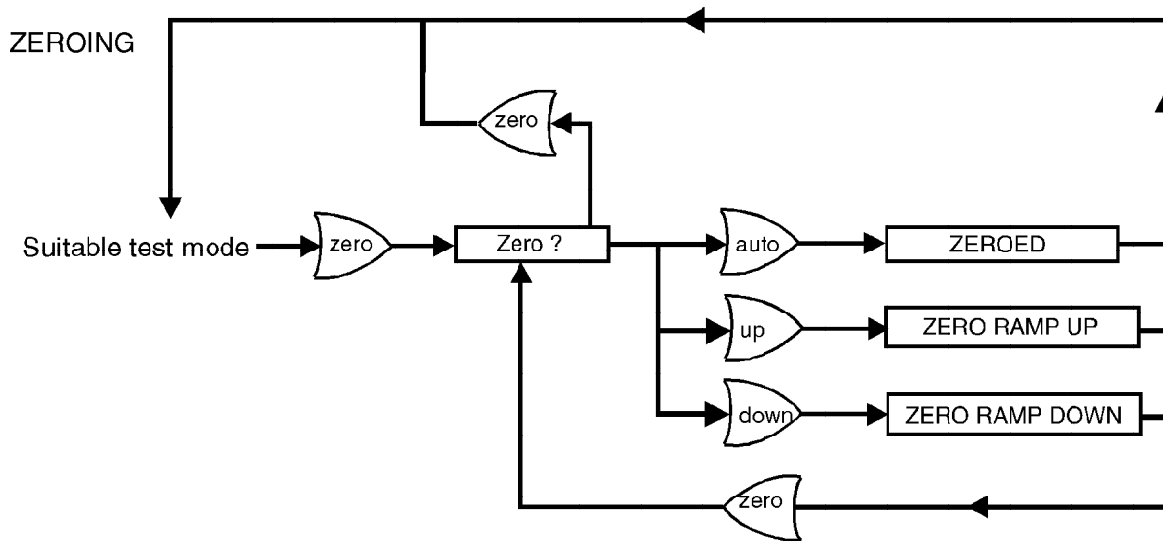
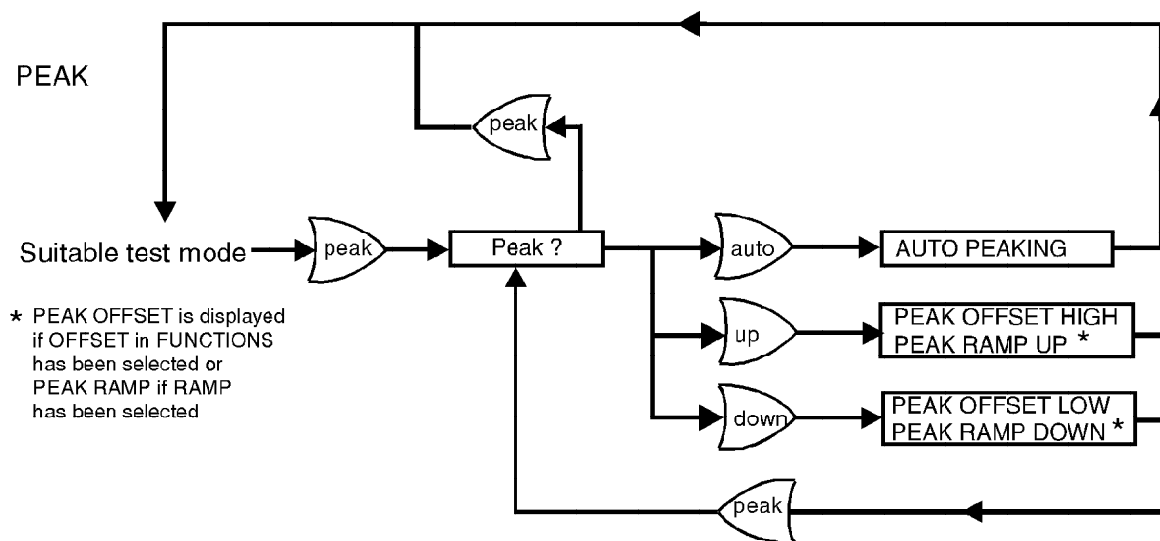


Figure 4.9 - Normal operation menu

EXTENDED OPERATION



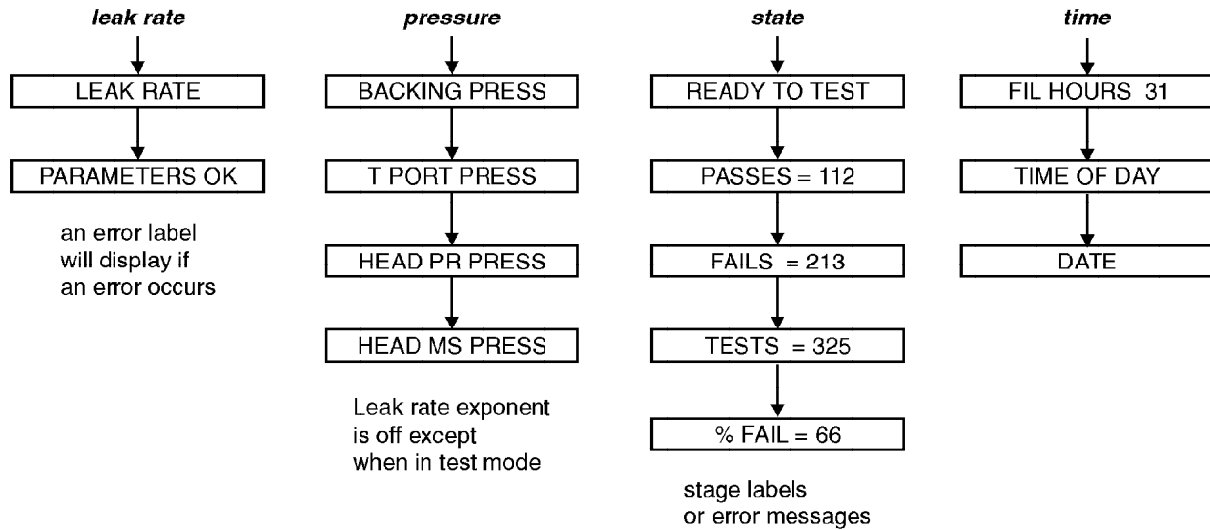
CALIBRATE AND RANGING AS FOR NORMAL OPERATION
(See Figure 4.9)

Figure 4.10 - Extended operation menu

Types of display (press display buttons)

Standard display

In standard display the leak rate exponent is only on when the filament is on and there is correct emission.



Diagnostic display

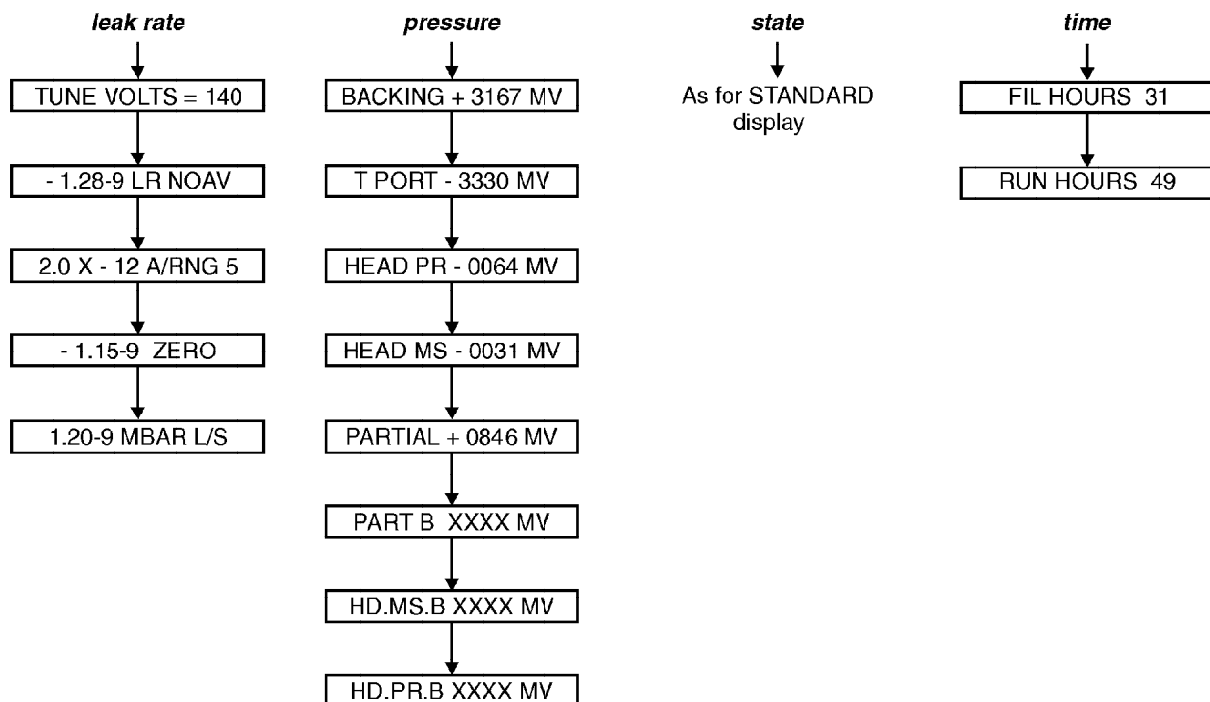


Figure 4.11 - Types of display (press display buttons)

SPECTRON 300E

MASTER PASSWORD SHEET

To prevent unauthorised entry into the INSTALL MODE it is necessary to enter a password. There are three passwords numbered 1, 2 and 3. A password will normally be requested before entering INSTALL MODE.

Passwords 2 and 3 are set to 6241 before the console leaves the factory, enabling the user to access the << INSTALL Menu, then << SYSTEM Menu and by entering the Master Password, set passwords 1, 2 and 3.

The Master password for this SPECTRON 300E Leak Detector is:

9027

If passwords 1, 2 and 3 are either not known, or forgotten, the service engineer may access the menus by using the Master password to override passwords 1, 2 and 3.

This sheet may be removed and stored in a secure location if restricted access to passwords is required.

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5 ADJUST MODE

5.1 General

The actions needed to enter ADJUST MODE are described in this section which also details each facility in numerical order as it appears on the alpha-numeric display.

Menu maps are displayed on Figures 5.3, 5.4, 5.5 and 5.6. These will assist in following the instructions while becoming familiar with the menu structure.

Make adjustments to the working parameters of the Spectron 300E when it is in ADJUST MODE. When in ADJUST MODE the menu titles will display. Each menu is prefixed by two chevrons (<<). Menus are read by pressing **scroll**.

Press **adjust** at any time to enter ADJUST MODE. Entry is indicated by the main menu title in the display reading << ADJUST MODE. This will not affect the vacuum sequence in any way until the new value/instruction is actually entered by pressing **enter**.

A password prevents unauthorised entry into ADJUST MODE. The passwords are numbered 1, 2 and 3. Password 1 is initially set to zero at the factory. Passwords 2 and 3 are set to 6241. When set to zero the passwords are not necessary and will not appear on the display. To activate the three passwords enter ADJUST MODE as above and scroll to menu item 9. Enter the master password and each password in turn will be requested. Enter up to four digits for each password and return to ADJUST MODE. The new passwords should of course be recorded. If the passwords are lost or forgotten, new passwords can be entered or when not required they can be set to zero again for direct entry.

Password 1 protects the parameters such as pressure units which the operator might want to change, but which would not cause much problem if changed in error. Password 2 protects such parameters as option selection which might cause confusion if changed in error. Password 3 protects such parameters as changeover pressure, filament off pressure (for example: Adjust Mode 8) which could cause damage to the Spectron 300E if changed in error.

Press **adjust** at any time to bring the Spectron 300E back to the vacuum sequence. A sequence label will display provided **state** has been pressed. Pressing **adjust** again will return the Spectron 300E to the adjust mode.

Figure 5.1 - Front panel control group 4

Four general controls are used to make adjustments to the Spectron 300E parameters and operating routines. These are the **adjust**, **scroll**, **clear** and **enter** buttons.

- **adjust** - This button is used to bring the Spectron 300E from normal or extended operation into ADJUST MODE where changes to the system parameters may be made.
- **scroll** - This button will only operate when in ADJUST MODE. It is used to scroll through option menus available in ADJUST MODE. Pressing **scroll** will not affect the Spectron 300E operation.
- **clear** - This button is used to clear data displayed in ADJUST MODE when an incorrect entry has been made. The operator can then enter a new value. This key only functions in ADJUST MODE and operates in conjunction with the **enter** button. Data is not actually entered until the **enter** button is pressed.
- **enter** - This button is used to enter data and instructions selected by the operator. When **enter** is pressed the information selected is entered into the Spectron 300E memory.

5.2 User Variables (0 = USER VARIABLES)

5.2.1 Reject level

Note: The reject indication is associated with the numerical value of the leak rate and consequently, when the units of the leak rate are changed it is necessary to reset the reject level to the relevant value in the new units system.

See Figure 5.5 for setting the reject level and changeover pressures.

The Spectron 300E has the facility to indicate that the leak rate has exceeded a predetermined level. This is indicated by the label FAIL which is displayed on the alphanumeric display. At the same time the reject level contacts (rear of console) close. A choice of the ways in which the label is displayed and contacts operate is available and is described under REJECT DISPLAY in Section 5.8.

The Reject relay socket is located on the rear of the Spectron 300E next to the backing pump exhaust port. A plug is supplied.

The reject label will not display (or the reject contacts operate) in the gross hold mode unless gross hold is selected. The label and contacts are inoperative in massive mode.

5.2.2 Change over (C/O)pressure

The user variable parameter 'change-over pressure' is the manifold pressure at which the Spectron 300E will change from gross to fine test mode on a falling pressure. (Change-over is inhibited when GROSS HOLD is selected). The units of change-over pressure are always mbar regardless of the pressure units selected for the display. This eliminates the possibility of an inadvertant change in the parameter when display pressure units are changed.

The value of change-over pressure normally recommended is 3.0×10^{-2} mbar. When testing large vessels it may be necessary to reduce the C/O pressure. The test cycle will be shorter for higher C/O pressures but the filament life will be reduced if excessively high C/O pressures are utilised. A high setting of the C/O pressure may cause the Spectron 300E to change from fine mode back into gross mode due to an excessive increase in the mass spectrometer pressure when the test valve opens. If this happens and a leak cannot be found in gross mode then a lower C/O pressure is indicated.

5.3 Calibration type (1= CALIBRATE TYPE)

See Figure 5.5 for setting the calibration type

5.3.1 Percent helium (CONC HELIUM XXX)

Note: The unit is set for 100% helium at the factory.

This factor permits direct readout of true leak rate even when the search gas is not pure helium. Because the Spectron 300E has to scale the signal from the detector according to the helium level in the search gas there will be an increase in the minimum detectable leak rate. For example, if the Spectron 300E can detect 2×10^{-10} mbar ls⁻¹, with 100 % helium it can detect 10^{-9} mbar ls⁻¹ when using 20 % helium search gas. In this example, on the most sensitive range the noise and drift levels will have to be increased by five times.

When calibrating with helium concentration of other than 100 %, enter leak value after correcting for low helium concentration for example; leak x 0.5 for 50 % helium and enter true helium concentration.

5.3.2 Air/helium equivalent(LEAK TYPE)

Note: The unit is set for Air equivalent at the factory at the factory.

All mass spectrometer leak detectors measure the amount of helium passing through a leak. When helium equivalent is selected the Spectron 300E will indicate the amount of helium passing through into its vacuum system. When air equivalent is selected the amount of air passing through the leak will be calculated assuming the molecular flow conditions (see Section 6.2). Helium equivalent = 2.7 x Air equivalent.

5.4 Leak units (2 = LEAK UNITS)

Note: Values of calibration data should always be entered in MBAR LITRE PER SECOND.

See Figure 5.5 for setting the leak units.

A choice of units used to display leak rate is available, shown here with equivalents:

$$1 \text{ atm ccs}^{-1} = 1 \text{ mbar ls}^{-1} = 10^2 \text{ Pa ls}^{-1} = 10^{-4} \text{ Pa m}^3 \text{ s}^{-1} = 0.76 \text{ torr ls}^{-1}.$$

5.5 Pressure units (3 = PRESSURE UNITS)

Note: All pressure set point parameters are in mbar and must always be entered in mbar. This does not necessitate pressure units of mbar being selected at the time. The user may choose to work in any of the three units available, mbar, torr or Pascal for normal running.

See Figure 5.5 for setting the pressure units.

A choice of units for pressure display is available, shown here with equivalents:

$$1 \text{ mbar} = 10^2 \text{ Pascal} = 0.76 \text{ torr.}$$

5.6 Printer operation (4 = PRINT)

At the end of each test cycle, that is: when FINISH is pressed or AUTO FINISH (see Section 5.18.2) or REJECT/DELAY (see Section 5.18.3) is detected, a label can be printed out on a printer if required. Output is via the 9 way D - type socket on the rear panel and is compatible with a standard RS232-C serial interface, see Section 5.6.6.

The output information to the printer can be a short print out label or a long print out label as required.

The short print out label prints leak rate, leak rate units, pass/fail/abort, time, date and first letter of test mode at finish.

The long print out label prints all the information of the short print out label in addition to the number of tests (T), number of passes (P), number of failures (F), the reject level, and the percentage of failure.

Code for Test mode at FINISH M = MASSIVE
G = GROSS
GH = GROSS HOLD
F = FINE

2.99 - 9 A CC/S PASS
09.599 SEP 87 F Short print out

2.99 - 9 A CC/S ABORT
10.05AM 9 SEPT 87 G Long print out

T = 48 P = 42 F = 6
REJECT < 1.00-513% F

5.6.1 Printer

A suitable R5232 serial input printer must be chosen to operate with the Spectron 300E.

5.6.2 Print menu

See Figure 5.5 for selecting print type and baud rates.

The print menu may be scrolled and selections made when adjust mode 4 is selected.

Enter code for appropriate print type.

Having selected the print type the baud rate menu may be scrolled and selections made.

The display then requests the user to enter the FORMAT number as defined in Section 5.6.5.

5.6.3 Selecting the baud rate

One of the following baud rates must be selected, 110, 300, 600, 1200, 2400 and 4800. The choice depends on the equipment being used. The highest rate consistent with good data transmission should be selected. The baud rate is automatically set to 600 when the Spectron 300E is supplied. When the baud rate is entered the FORMAT NUMBER will be requested.

5.6.4 Setting up the data format

The RS232 interface sends and receives data as 7 bit ASCII characters. The number of bits sent and parity checking can be selected to match the external device. A number is selected to represent the format. The format number is defined by selecting the suitable character length and parity checking and summing the appropriate codes, given in Section 5.6.5.

5.6.5 Calculating the format number

Note: On initial receipt of the instrument, after loading the standard set-up, and after a MEMORY FAULT the data format is set to 8 bits with 2 stop bits and no parity check.

The number of stop bits is fixed at 2

Parity generation check: None = 0
 Even = 8
 Odd = 4

Character length: 7 bits = 2
 8 bits = 3

If 8 bit format is selected the most significant bit will be 0.

Example: To set the device for 8 bits, with no parity check:

8 bits = 3
No Parity = 0

Total = 3

Therefore in this example the FORMAT number is 3

5.6.6 RS232 connections

Note 1: The Spectron 300E may also be connected to devices with other pin configurations; however it is the users responsibility to maintain the correct configuration for a particular serial device. Commonly used connections for a 25 way D-type connect are shown in the table.

Note 2: Earlier units will only operate with a printer configured for even parity check.

The Spectron 300E is wired as defined in the following table:

RS232 SKT Pin No.	Function	25 way D-type
1	GND	1
2	SIGNAL (TXD)	3
3	SIGNAL (RXD)	2
4	RTS	4
5	CTS	5
6	Unused	
7	GND (SIGNAL)	7
8	Unused	
9	Unused	

5.6.7 RS232 data transmission format

The following describes the data set from the D15471916 program and the data received back from the Spectron 300E.

!T - puts the Spectron 300E into telecom mode. Spectron 300E sends error code 0 if successful.

!N - puts the Spectron 300E into normal mode. No reply from Spectron 300E is successful and Spectron 300E was previously in telecom mode. Spectron 300E sends error code if unsuccessful and Spectron 300E was previously in telecom mode.

\ - resets the Spectron 300E input process and stops the Spectron 300E from transmitting the current data block.

!x - where x <> 'T', 'N', or '\': The Spectron 300E will ignore these commands and return binary 1 meaning 'command error'.

The Spectron 300E will decode characters sent as front panel keypresses and return binary 2 if they are illegal and echo them back if they are legal. The D15471916 program will not allow illegal transmissions.

Valid keys are:-

PC	CHARACTER	SPECTRON 300E FRONT PANEL KEY
F1	'l'	STARTUP
F2	'i'	STANDBY
F3	'k'	TEST
F4	'j'	FINISH
F5	'P'	LEAK RATE
F6	'L'	PRESSURE
F7	'S'	STATE
F8	'D'	TIME
F9	'f'	AUTO
F10	'g'	ZERO
SHIFT-F1	'm'	CLOSEDOWN
SHIFT-F5	'g'	AUTO
SHIFT-F6	'd'	PEAK
SHIFT-F7	'c'	CALIBRATE
SHIFT-F8	'b'	GROSS
0 - 9	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	Numeric Keys
Cursor Up	'e'	UP
Cursor Down	'h'	DOWN
+	'+'	+
.	'.'	.
SPACE-BAR	'S'	SCROLL
DEL	127	CLEAR
ENTER	13	ENTER
ESC	27	ADJUST

Byte ? - The Spectron 300E will return to a 22 byte block of information which the D15471916 program will decide.

The data block format is:-

- Byte 0 : FF
- Byte 1 : LEDS low
- Byte 2 : LEDS high
- Byte 3 : Leak rate mantissa
- Byte 4 : Leak rate exponent
- Byte 5 : Flags
- Bytes 6 - 21 : 16 character message
- Byte 22 : Checksum

Byte 0 : always FF

Byte 1 : ignores for this application

Byte 2 : According to the value received, the following LEDs will be lit:-

0 = All off
2 = Gross Hold
4 = Backing
6 = Gross Hold, Backing
8 = Gross
10 = Gross, Gross Hold
12 = Gross, Backing
14 = Gross, Backing, Gross Hold
16 = Massive
18 = Massive, Gross Hold
20 = Massive, Backing
22 = Massive, Backing, Gross Hold
24 = Fine
26 = Fine, Gross Hold
28 = Fine, Backing
30 = Fine, Backing, Gross Hold

Byte 3 : An integer value in the range 0 - 200 representing the scale 0.0 to 10 (e.g. 110 = 5.5).
If >= 200 then this indicates a leak rate error.

Byte 4 : Bits 7 and 6 are not used.

Bit 5 indicates if the leak rate is negative or positive.

1 = negative

0 = positive

Bit 4 indicates if the exponent is negative or positive..

1 = negative

0 = positive

Bits 3 to 0 are the exponent value, normally 0 - 9 but can be 0 - 15.

Byte 5 : The various bits indicate the state of the Spectron 300E.

Bit 0 = in massive

Bit 1 = in gross

Bit 2 = in fine

Bit 3 = no visco

Bit 4 = emission ok

Bit 5 = zeroing

Bit 6 = backing

Bit 7 = range mode where 0 = auto range off and 1 = auto range on

Bytes 6 to 21 : 16 character display message. ASCII text.

Byte 22 : Data block checksum. A single byte sum of bytes 0 to 21 module 256.

5.7 Functions (5 = FUNCTIONS)

The Spectron 300E can be set to operate in three different modes, these are DISPLAYTYPE, PEAK TYPE and NORMAL/EXTENDED operation. Each mode has two different functions. This section describes these functions in detail.

See Figure 5.5 for setting the operation functions.

5.7.1 Displays (0 = DISPLAY)

Two types of alpha-numeric display are available, STANDARD (0 = STANDARD) and DIAGNOSTIC (1 = DIAGNOSTIC). Diagnostic display is useful for diagnosing gauge errors, module errors and setting the mass spectrometer tuning volts (if necessary). Except when servicing or fault finding standard display should be selected. The four display buttons beneath the alpha-numeric display operate as follows:

5.7.2 Standard Display Selected (0 = STANDARD)

leak rate

Leak rate displays in turn the instantaneous value of leak rate in the selected units and the parameter status for example; PARAMETERS OK or an error label.

pressure

Pressure displays in turn the backing pressure, the test port pressure, the head (total pressure) (as indicated on Pirani gauge) and the fine pressure (as indicated by the mass spectrometer).

state

State displays the stage of operation for example; STANDBY/READY TO TEST or machine errors if present, for example; AA VALVE FAIL.

time

Time displays the total filament running hours, time of day and date.

5.7.3 Diagnostic Display Selected (1 = DIAGNOSTIC)

Note: In diagnostic display the leak rate exponent is on even when the filament is OFF. The amplifier current is always valid, but leak rate indication is valid only if the filament is ON.

The following shows the parameters revealed by pressing -leak rate in addition to some typical values.

leak rate

TUNE VOLTS - 140

Ion box voltage on the Mass Spectrometer.

-1.28-9LR NOAV

Leak rate, -1.28×10^{-9} mbar ls⁻¹, with no zero subtracted and no signal averaging (on the more sensitive leak rate ranges the signal is averaged to reduce noise level).

2.0×10^{-12} A/RNG 5

Current from the mass spectrometer in amps(A). The electronic range of the partial pressure amplifier is also indicated on the scale 0 to 5. 0 is the least sensitive range.

-1.15-9 ZERO

Indicates the difference in zero level compared to last internal zero check, made on leaving standby. Affected by auto zero, zero ramp and calibration routine.

1.20-9MBAR L/S

Leak rate is displayed in the units selected. This example reads 1.2×10^{-9} mbar, ls⁻¹.

pressure

(output in millivolts)

Backing - 0167MV

Output from the Backing Thermocouple gauge (PR2)

T PORT - 3330MV

Output from the TEST PORT Pirani gauge (PR1)
Atmospheric setting = - 3330 mV
Vacuum setting = - 64 mV

HEAD PR -0064MV

Output from the FINE PRESSURE Pirani gauge (PR3)
Atmospheric setting = - 3330 mV
Vacuum setting = - 64 mV

PART B + 0846MV

Second channel output. Useful for making comparisons when fault finding

HD-Ms-B -031MV

as above

HD-PR-B -0064MV

as above

HEAD MS -0031MV

Output from the total pressure amplifier

PARTIAL -0846MV

Output from partial pressure amplifier

State

as for standard display

time

FIL HOURS 31

Total filament running hours.

RUN HOURS 49

Total running hours.

5.7.4 Peak type (1 = PEAK TYPE)

Note: Some useful graphs are provided to illustrate peaking in Section 4 - Figure 4.7.

Two types of peaking for helium are available, PEAK OFFSET (0 = OFFSET) and PEAK RAMP (1 = RAMP).

5.7.5 Peak Offset (0 = OFFSET)

When peak offset has been selected pressing the **up** button causes the tuning voltage to rise 10% above the nominal tuning point and pressing the **down** button causes the tuning voltage to fall 10% below the nominal tuning point.

5.7.6 Peak ramp (1 = RAMP)

When peak ramp has been selected pressing the **up** button will cause the tuning voltage to ramp up and pressing the **down** button will cause the tuning voltage to ramp down, enabling the tuning point to be found manually.

5.7.7 Normal and Extended Operation (2 = NORM/EXTENDED)

The Spectron 300E has two modes of operation NORMAL or EXTENDED. In normal operation (see Section 4.7) the operation is at its simplest. Only one action is allocated to the PEAK and ZERO controls, and the CALIBRATE operation requires nominal input from the user.

In extended operation (see Section 4.9) there is choice of function allocated to the PEAK and ZERO controls. The calibrate operation is more flexible. Extended mode of operation is only required for more complex leak testing.

When in the READY TO TEST condition the suffix N on the alpha-numeric display indicates that the Spectron 300E is in normal operation. Suffix E indicates extended operation.

5.8 Reject Display (6 = REJECT DISPLAY)

See Figure 5.6 for Reject display menu.

The Reject display can be set to ON or OFF. If set to ON it may be set to NORMAL or HOLD.

5.8.1 Normal reject display (0 = NORMAL)

When 'normal reject' has been selected the label FAIL will display only when the leak rate rises above a preset value. It will not display if the leak rate falls again below the preset value. The reject relay contacts (rear of Spectron 300E) operate in the same way. That is the contacts close when FAIL is displayed and open again when the leak rate falls below the preset value.

5.8.2 Hold reject display (1 = HOLD)

Note: The reject facility is not operative in the MASSIVE mode and only operates in GROSS mode when HOLD has been selected.

When HOLD has been selected the label FAIL will display when the leak rate rises above a preset value. The label will hold (and the reject contacts remain closed) until the next leak test cycle is started. If the leak rate indication does not rise above the preset value the label PASS will display when the **finish** button is pressed and hold until the next leak test cycle is started.

5.9 Options (7 = OPTIONS)

The options menu enables the operator to choose the Spectron 300E 'set up' and select which accessories are to be fitted. The options menu contains four items as shown in Figure 5.6.

5.9.1 Visco probe (0 = VISCO MODE)

Visco mode must be set on (1 = VISCO) when a Visco probe is fitted. (See also VISCO FITTED, WHICH MUST ALSO BE SET). Set visco mode to normal (0 = NORMAL) if not using a visco probe.

5.9.2 Automatic zeroing (1 = AUTO ZERO FIN)

Note: The leak rate indication must be stable, that is; Exponent LED must not flash before starting the next test cycle otherwise the helium level in the high vacuum system will be taken as zero before it has cleaned up.

When AUTO ZERO FIN is selected (1 - ON) the Spectron 300E will automatically compensate for any change in leak rate zero when FINISH has been pressed and the Spectron 300E is in the READY TO TEST mode. The leak rate indication in this mode will be 0.0×10^{-n} (n is determined by the range selection) regardless of the helium signal level. On selection of one of the leak test modes the leak rate indication will be the difference in the signals before and after the test mode is selected. Consequently any signal due to helium desorbed from the high vacuum components (for example; after detection of a very large leak) will not contribute to the leak rate indication.

5.9.3 Amplifier hold (2 = AMP HOLD)

The Spectron 300E ion current detection system incorporates two preamplifiers each with its own collector. Normally selection of the low sensitivity preamplifier by the microprocessor is automatic such that the lower current (high sensitivity) preamplifier is used unless the ion current level is overloading it. Because of its greater sensitivity the high sensitivity preamplifier has a longer time response than the other preamplifier. In applications where it is not necessary to detect very small leaks (10^{-7} mbar ls⁻¹ in FINEMODE), but where a fast response time is essential, it is possible to hold the low sensitivity amplifier (AMP HOLD) and so achieve the fastest response time.

5.9.4 Visco probe fitted (3 = VISCO FITTED)

VISCO FITTED must be entered (1 - FITTED) when a visco accessory is fitted to the Spectron 300E, otherwise the Spectron 300E will not test in the visco mode. 0 = ABS (ABSENT) is entered when the visco probe is removed. The label VISCOTEST will be displayed when both VISCO MODE and VISCO FITTED have been set on.

5.10 Parameters (8 = PARAMETERS)

5.10.1 User parameters

Eighteen parameters which can be read or entered or changed are used by the Spectron 300E in the vacuum sequence and in calculation of the leak rate (listed in Section 5.10.2). These are 'user parameters', each of which is checked against a high and low limit. If the value lies outside this limit an error message is indicated on the display. The message can be cleared by selecting another function on the display keys. Each Spectron has its own slightly different parameters and these are supplied on a separate certificate with each unit.

A detailed description of the parameters is given in Section 4.6.

The values and ranges shown are recommended levels and will apply to most applications. For example a particular application may require a high change over pressure from gross to test mode in order to reduce the cycle time. This may reduce the service interval due, for example to a small loss in diffusion pump oil caused by the transient pressure rise. Parameters are always entered or read in mbar for pressure and mbar ls⁻¹ for leak rate.

Some of the parameter factors are determined by the Spectron 300E itself during a calibration. These are scale factor, gross factor and massive factor. Gross factor is calculated when calibrating in gross hold.

A practical example of how to change a parameter is given in Section 5.10.3.

See Figure 5.6 - Setting the operating parameters

5.10.2 Parameters

These parameters have provision for the operator to set a tolerance to allow for operating conditions, that is; UPPER LIMIT and LOWER LIMIT.

List of Parameters

- 0 - REJECT LEVEL
- 1 - G/F CH/OVER P
- 2 - FIL ON/OFF P
- 3 - M/G CH/OVER P
- 4 - TOT PR SENS
- 5 - MODE RESET
- 6 - FIL OFF MS
- 7 - SCALE FAC HE
- 8 - SCALE FAC HDH3
- 9 - SCALE FAC H2
- 10 - GROSS FAC HE
- 11 - GROSS FAC HDH3
- 12 - GROSS FAC H2
- 13 - MASSIVE FACTOR HE
- 14 - MASSIVE FAC HDH3
- 15 - MASSIVE FAC H2
- 16 - LOW SENSAMP
- 17 - EXT REF LEAK
- 18 - ACCESSORY FAC

Factors 7 - 9 are automatically re-calculated during normal calibration with a reference leak of the relevant search gas when the correct search gas has been entered.

Factors 10 - 12 are re-calculated during a gross calibration with a reference leak of the relevant search gas when the correct gas mass has been entered.

0 - NOMINAL VALUE SET
 1 - LOWER LIMIT
 2 - UPPER LIMIT

0 = REJECT LEVEL	0	1.0×10^{-5}
	1	1.0×10^{-14}
	2	$1.0 \times 10^{+5}$
1 = G/F CH/OVER P	0	3.0×10^{-2}
	1	1.0×10^{-4}
	2	5.0×10^{-2}
2 = FIL ON/OFF P	0	4.0×10^{-3}
	1	5.0×10^{-5}
	2	5.0×10^{-3}
3 = M/G CH/OVER P	0	7.0×10^{-2}
	1	1.0×10^{-4}
	2	1.5×10^{-1}
4 = TOT PR SENS	0	$8.0 \times 10^{+1}$
	1	1.0×10^0
	2	$2.0 \times 10^{+3}$
5 = MODE RESET	0	1.0×10^{-3}
	1	1.0×10^{-9}
	2	1.0×10^{-3}
6 = FIL OFF MASS SPEC	0	5.0×10^{-4}
	1	1.0×10^{-9}
	2	1.0×10^{-3}
7 = SCALE FAC HE	0	$1.0 \times 10^{+1}$
	1	5.0×10^0
	2	$2.0 \times 10^{+2}$
8 = SCALE FAC HD HE	AS 7	
9 = SCALE FAC H2	AS 7	
10 = GROSS FAC HE	0	$1.5 \times 10^{+1}$
	1	$5.0 \times 10^{+0}$
	2	$5.0 \times 10^{+1}$
11 = GROSS FAC HD H3	0	$1.5 \times 10^{+1}$
	1	$5.0 \times 10^{+0}$
	2	$5.0 \times 10^{+1}$
12 = GROSS FAC H2	0	$1.5 \times 10^{+1}$
	1	$5.0 \times 10^{+0}$
	2	$5.0 \times 10^{+1}$

13 = MASSIVE FAC HE	0	$1.0 \times 10^{+5}$
	1	$2.0 \times 10^{+4}$
	2	$5.0 \times 10^{+5}$
14 = MASSIVE FAC HD H3	AS 13	
15 = MASSIVE FAC H2	AS 13	
16 = LOW SENS AMP	0	9.0×10^{-1}
	1	5.0×10^{-1}
	2	$2.0 \times 10^{+0}$
17 = EXT REF LEAK	0	2.5×10^{-8}
	1	1.0×10^{-12}
	2	$1.0 \times 10^{+3}$
18 = ACCESSORY FAC	0	$1.0 \times 10^{+0}$
	1	5.0×10^{-1}
	2	$1.0 \times 10^{+6}$

5.10.3 Changing a parameter

This is a practical example of how to change a parameter with explanatory notes as guidance. Refer to Figures 5.3, 5.4, 5.5 and 5.6.

Changing the gross/fine change over pressure from 2.5×10^{-2} mbar to 4.0×10^{-2} mbar to reduce the pumpdown time of a large volume with high water vapour pressure.

CONTROL PANEL	
Action	Display
Press adjust	<< ADJUST MODE
<p>Note: When adjust is pressed << ADJUST MODE is displayed. Press scroll. The menu item 0= USER VARIABLES is displayed. (This is the first menu item, the one required in this example.)</p>	
Press 0 Press enter Press enter Press clear Key in new change-over Press enter Press adjust	<< ADJUST MODE 0 REJ LEVEL 1.005-5 (where 1.00 ⁵ is the users reject level CH/OVER P 2.50-2 (where 2.502 is the users change-over pressure Cf-I/OVER P *.* ** CH/OVER P 4.00-2 pressure value on keypad REJ LEVEL 1.00-5 Unit returns to operating mode.

5.11 Passwords (9 = PASSWORDS)

Access to different sections of the menu can be protected by passwords. Three different passwords are used. This enables some sections only to be made available to the operator if required. Passwords are set by first entering the MASTER PASSWORD. The master password is provided at the front of this section, it may be removed if required. If a password is set to 0000 the Spectron 300E will not request a password to be entered and access is not then protected. Passwords may be up to 4 digits.

- Password 1 - protects User Variables, Calibrate Type, Leak Units, Pressure Units, Filament Select, Function, Reject Display and Accessory Factor.
- Password 2 - protects Option and Reset Timer and external pump.
- Password 3 - protects Parameters.
- Master Password - protects Passwords.

See Figure 5.6 for setting the passwords.

5.12 **Timer Reset (10 = RESETTIMER)**

The filament hours timer and Run hours (Spectron 300E ON) timer may be reset. It is recommended that the filament hours timer is reset whenever a different filament is selected or replaced. It is recommended that the Run hours timer is used as a guide to maintenance required and should therefore not normally be reset.

See Figure 5.6 for setting the timers.

5.13 **Mass (11= MASS)**

Mass enables the operator to select any of the 3 search gases for leak detection. These are HELIUM HD/HE3 and HYDROGEN. Each search gas tune voltage is independently tuneable and each search gas has its own scale factor, massive factor, fast factor, H.S. factor, and gross factor. The scale factors are listed in Section 5.10.

See Figure 5.6 for setting Mass selection

5.14 **External pump (12 = EXTERNAL PUMP)**

External pump enables the operator to pump out small volumes faster or larger volumes in a reasonable time. The external 'roughing' pump connection is on the bottom left hand side of the unit. A connecting kit for this is available from Edwards.

See Figure 5.6 for setting external pump selection

5.15 **Test results (13 = TEST RESULTS)**

Note: Test aborted when reject display hold is selected.

At the end of each test cycle, counters are incremented for the total number of tests, number of passes and number of failures. The result of these counts is displayed by scrolling the **state** button. The program also calculates the percentage of failures and this is also displayed.

The function of this menu is to enable the operator to reset or change the pass/fail counters if required, for example; testing another batch or the continuation of a particular batch testing after performing intermediate tests.

See Figure 5.7 for setting test results

The total number of tests is equal to the number of passes plus the number of failures. If a counter goes over 9999 in value all the counters are reset to 0.

If reject display hold has been selected and the test is aborted before the final test mode is entered, the label abort will display, that is; the test finishes in massive or gross, or vacuum system error, mass spectrometer error, or no peak found.

The fail counter and total test counter will increment by 1 regardless of the reject display status. If a printer is being used, ABORT will be printed.

5.16 Auto start-up (14 = AUTO START UP)

Adjust mode option (14 - AUTO START-UP) enables the Spectron 300E to be started up automatically at any given time.

Option 14 enables the operator to switch this function ON or OFF, select the day, either one particular day of the week or Monday to Friday (five days), Monday to Saturday (6 days) or everyday, and select the hour (24 hour clock) and minute.

This whole function is disabled for one minute from the pressing of **close down** to prevent it immediately starting up again if the operator cancels the auto start up. This also means that auto start up will not occur again if the unit is closed down immediately before auto start up time. The label CLOSED DOWN ASU (Auto start up) or CLOSING DOWN ASU will display if this function has been enabled and the unit is closing down or closed down.

See Figure 5.7 for selecting automatic start-up.

5.17 Air admit (15 = AIR ADMIT)

Normally at FINISH the test port is vented to atmosphere 0 = NORMAL. This can be overridden by entering the no vent option, that is, 1 = NO VENT ON FIN (no vent on finish).

See Figure 5.7 for selecting air admit at finish.

5.18 Timed control (16 = TIMED CONTROL)

See Figure 5.8 for timed control menu.

5.18.1 Recalibration (0 = RECALIBRATION)

Note: The recalibrate now will override all labels but can be overridden by EMISSION ERROR and NO PEAK FOUND. The label will continue to display until one of the four display buttons is pressed.

To encourage users to recalibrate at suitable intervals the Spectron 300E after a pre-set time will prompt the user to recalibrate by displaying the message RECALIBRATE NOW. (0 = OFF/ON, 1 = SET INTERVAL).

The time interval between recalibration is in hours, but if zero is entered it will be interpreted as the minimum interval (1/2 hour). The function can be disabled if required. Any number from 0 to 100 may be entered.

5.18.2 Automatic finish (1 = AUTO FINISH)

A preset time in seconds can be set for a test to finish in the final test mode (GROSS HOLD or FINE). When the preset time is exceeded the Spectron 300E will automatically finish the test. The time is entered in decimal units of 0.1, for example; to enter 1 second, the digital number 10 must be entered. Any number from 0 to 255 may be entered.

5.18.3 Reject delay (2 = REJECT DELAY)

Note: The minimum effective reject delay time is 0.4 seconds.

When testing a large volume time must be allowed for the volume to be pumped down and 'cleaned up' before any reject operation becomes valid. This option enables the operation of the reject function to be delayed by up to 25 seconds. As above, time is entered in decimal units of 0.1, for example; to enter 1 second the decimal number 10 must be entered. Any number from 0 to 255 may be entered.

This feature also contains the option of finishing a leak test on the detection of a leak greater than the reject level, that is; (< < FINISH IF REJ/1 = FINISH).

5.19 Key lock (17 = KEY LOCK)

See Figure 5.8 for the keylock menu.

To prevent operators from inadvertently misadjusting the Spectron 300E, certain major keys and functions can be 'locked out' by a password. Password number three is used for this facility.

The lockable keys/functions are:

DISPLAY
CALIBRATE
PEAK
AUTO RANGE
ZERO
GROSS HOLD
START
CLOSE DN
TEST
FINISH

5.20 Clock (18 = CLOCK)

See Figure 5.8 for setting the clock.

Enables the running clock to be reset. Enter the new time, that is; MONTH, DAY, HOUR and MINUTE.

5.21 Fault and error displays

Note: The errors listed in Sections 5.21.2 to 5.21.8 are associated with the **state** button. Parameter errors (Section 5.21.10) are associated with the **leak rate** button.

If a fault should occur during operation, a message will be seen on the alphanumeric display. These messages are called ERROR LABELS, and enable the operator to locate and rectify a fault in the minimum of time. The following paragraphs list errors that may be displayed and discuss possible causes, with actions to take to resume normal operation.

5.21.1 Memory fault

If MEMORY FAULT displays, the Spectron 300E has had a memory fault or new EPROMs have been fitted. All user selections have been lost. The tuning voltage is reset to 140 V. The nominal parameter values have been inserted. Press any of the four display buttons. The label will clear. Re-enter all parameters listed on the parameter certificate which is supplied with the unit. In the ready to test mode, the label NO PEAK FOUND will be displayed, indicating that the unit will need to be re-tuned and re-calibrated.

If the actual tuning voltage is far from the nominal value of 140 V then the autopeaking will not find the helium peak. The error message NO PEAK FOUND will again be displayed.. Under these circumstances the peak will initially have to be found manually in the Extended Mode of operation (see Section 4.9.1).

5.21.2 Error display priorities

Clearing an error display

Press any of the four display buttons beneath the alphanumeric display. The display will revert to the previous selection.

System and valve errors

System and valve errors override all other errors.

Priorities list

GROSS SYSTEM ERROR
BACKING ERROR
GROSS VALVE FAIL
M.S. PRESS HIGH
TEST VALVE FAIL
ROUGHING FAIL

Control errors

Note: EMISSION ERROR and NO PEAK FOUND override all other control errors.

Priorities list

EMISSION ERROR P
EMISSION ERROR S
NO PEAK FOUND
FIL. TRIPPED OUT
GAUGE 3 ERROR
GAUGE 2 ERROR
GAUGE 1 ERROR
AA VALVE FAIL
COOLING ERROR

GAUGE ERRORS 1, 2 or 3 will only display whilst there is a current gauge error. If the gauge error clears, or the label is cleared by the operator pressing a display button, the error label will not appear again in that test cycle even if the error recurs.

If the error, AA VALVE FAIL, GAUGE or COOLING ERROR displays in a test cycle, it can be cleared by pressing a display button. No other control errors will display except EMISSION ERROR or NO PEAK FOUND until the test cycle is completed.

Once cleared, a control error label will not return, even though the error may still be present until the Spectron 300E completes a test cycle. When the label EMISSION ERROR is cleared it will not return unless the filament is switched off then on again.

5.21.3 Valve failures

Note: Do not remove the test piece, if fitted, when TEST VALVE FAIL is displayed.

Note: In the case of the test valve open failed open diagnosis, the label TEST VALVE FAIL can only be reset when a test cycle has been completed

The unit is fully protected for failure of the roughing or test valves.

TEST VALVE FAIL displayed

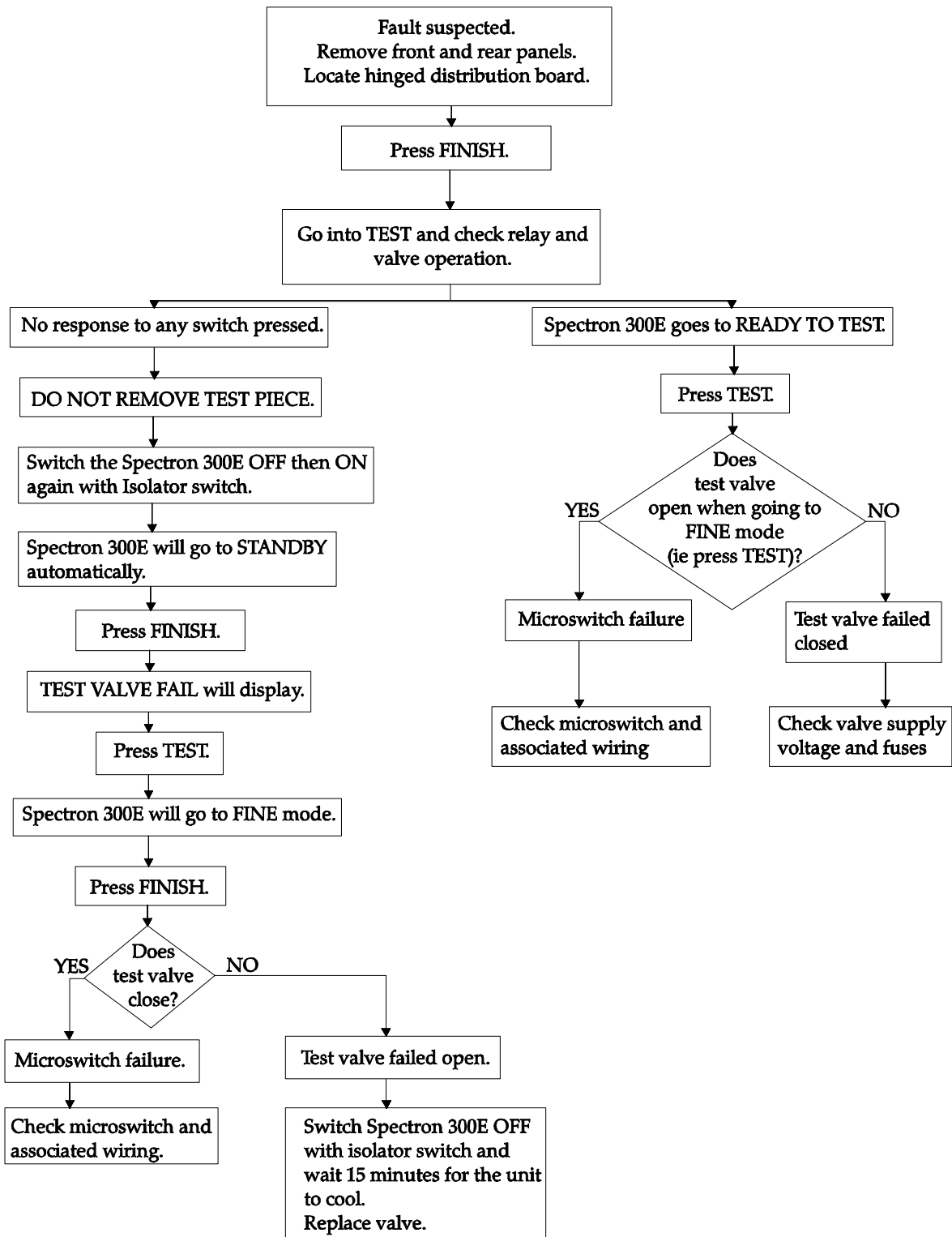


Figure 5.2 - Test valve fail fault tree

A/A VALVE FAIL displayed

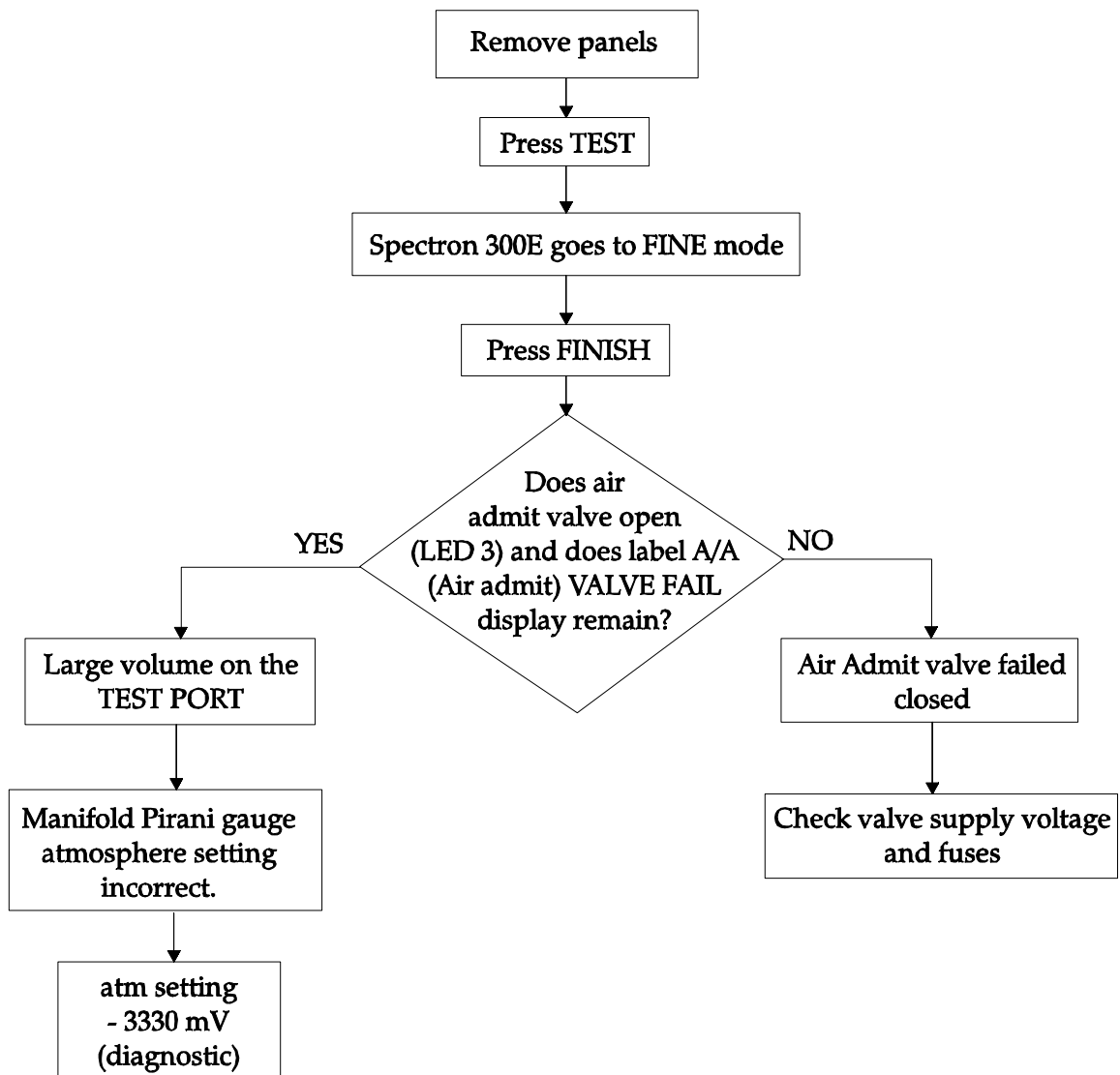
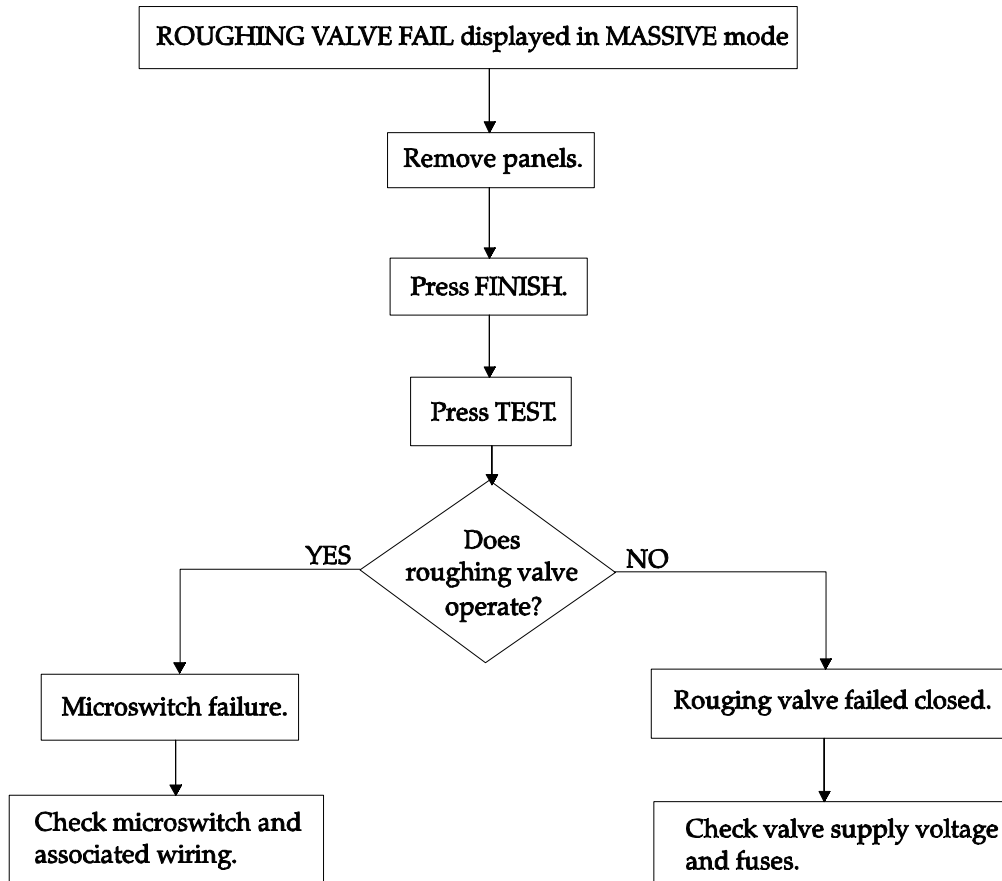


Figure 5.3 - A/A valve fail

a) ROUGHING VALVE FAIL displayed



b) Roughing valve failed to close

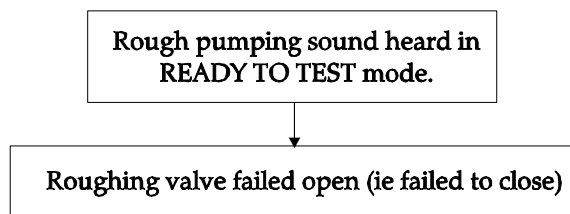


Figure 5.4 - Roughing valve fail

5.21.4 Vacuum system errors Refer to the block schematic Figure 4.1

BACKING ERROR

The backing pressure has risen above 3.0×10^{-1} mbar (measured by the thermocouple gauge P2). This is due to backing pump failure, backing valve failure, system leak, or a large pressure surge. The Spectron 300E will automatically start pump down again if the pressure falls below 1.5×10^{-1} mbar. The diffusion pump and mass spectrometer will switch off when a backing error occurs.

M.S. PRESS HIGH (mass spectrometer pressure high)

M.S. PRESS HIGH is displayed if the system pressure (measured by P3 - PRL10) rises above 5×10^{-3} mbar. The diffusion pump will remain ON but the mass spectrometer is switched OFF. This fault may be due to system leaks or a moderately large pressure burst, or a diffusion pump heater failure. The Spectron 300E will automatically go to PUMPDOWN if pressure at P3 falls below 4×10^{-4} mbar. If required, press STARTUP to start up again, or CLOSEDOWN to closedown.

GROSS SYSTEM ERROR

The vacuum system pressure has risen above 1 mbar (P3 - PRL10). A large vacuum system leak is suspected, or a valve failure. The test piece may have been removed when in the test mode. Press CLOSEDOWN to close down in a controlled manner. When the system has been checked, press START UP to start the Spectron 300E again.

5.21.5 Gauge errors

A gauge error label will display if an error occurs for longer than 2 seconds in any stage of operation, provided no other error has been cleared in that particular test cycle.

A gauge error is defined as a millivolt output outside the numerical range 2 to 3594. The mV output can be displayed by entering the diagnostic display mode (Adjust Mode 5, Function 0, Display 1). Use pressure key to scroll through the output for different gauges.

The gauges are labelled as follows:-

Gauge 1 Backing gauge (P2 type Thermocouple)

Gauge 2 Test port gauge (P1 type PRM10)

Gauge 3 Mass Spectrometer gauge (P3 type PRL10)

The Thermocouple gauge is calibrated at 64 mV for 1 atmosphere and 3500 mV for the lowest vacuum setting.

The PRM10K Pirani gauge is calibrated at - 3330 mV for 1 atmosphere and - 64 mV for the lowest vacuum setting.

The PRL10K Pirani gauge is calibrated at - 3500 mV for 1 atmosphere and - 64 mV for the lowest vacuum setting.

Gauge 1 or Gauge 3 errors might display momentarily if the system is started up from atmosphere. This is due to a flow surge and is not a fault.

If the Pirani gauge is just outside of range it is possible that it can be re-adjusted at the gauge head. The gauge will have to be re-calibrated at atmosphere and at vacuum using a small screwdriver to adjust the trim pots labelled on the red cover of the gauge. Refer to Pirani gauge instructions D021-98-880 supplied with this manual.

WARNING

Dangerous voltages exist within this equipment. When making internal adjustments precautions must be taken to ensure that contact is not made with any suspected high voltage electronics or heated parts, for example; diffusion pump. Servicing should only be carried out by a qualified service engineer.

If the gauge will not adjust a new gauge is required, or there is an electronics fault. The gauge head can be tested by swapping gauges in the controller and looking at the mV output displayed. **DO NOT CONNECT OR DISCONNECT WITH THE POWER ON. THIS WILL RESULT IN DAMAGE TO THE GAUGE.**

A voltage output of 4095 mV on all gauges indicates an electronics fault in the controller - Call for a service engineer under these conditions.

5.21.6 Mass spectrometer errors

FIL TRIPPED OUT

The filament has been turned off by the processor because the Mass Spectrometer pressure as indicated by the PRL10 or the total pressure from the mass spectrometer is too high.

The trip level for the PRL10 is nominally 4×10^{-3} mbar (Adjust Mode 8, Parameter 2).

The trip level for the mass spectrometer total pressure is 5×10^{-4} , mbar (Adjust Mode 8, Parameter 6).

The filament will automatically switch on again if the Pirani gauge is less than 0.5 times the trip value. This most probably indicates that the Mass Spectrometer indicates a high pressure.

Possible faults

- i) Filament turned on too quickly after the instrument has been switched off for a long period of time or being let up to atmospheric pressure recently. Leave in Standby for 20 minutes.
- ii) The Pirani gauge is out of calibration and reads too low, causing the Spectron to reach Standby too quickly. Leave for 10 minutes and try again, Pirani gauge might require re-calibration.
- iii) If the filament has been on sometime before tripping then the Pirani gauge might have gone out of calibration, if it is reading above the trip value or the diffusion pump is not working.

- iv) If the PRL 10 mass spectrometer gauge is reading low pressure then the filament is tripping out because of the Mass Spectrometer total pressure. The most likely cause is damage to the filament. Take out the ion source and replace filaments (see Section 7.5).

EMISSION ERROR

The mass spectrometer filament is switched off if the filament control circuit tries to exceed the maximum filament current. The most likely causes are as follows:-

- i) The head lead has become unplugged, at head or controller.
- ii) The filament has gone open circuit. Switch to secondary filament (Section 5.21.7). Try again. If there is no emission error after changing filaments, then the primary filament is open circuit.
- iii) If both filaments show emission error then the voltage supplies to the ion source might be at fault. (See Section 7.4).
- iv) If the voltage supply is correct, then it is likely that the filaments are damaged or contaminated and require replacement. (See Section 7.5)

5.21.7 Primary to Secondary filament switching

WARNING

When replacing the covers ensure that the earth straps are connected.

If you suspect that the primary filament has become open circuit or that it is not working properly you can switch over to the secondary filament. First close the unit down (see Section 4.4.9) then switch the power OFF and remove the front panel. Refer to Section 7.6 for primary to secondary filament switching. Replace front cover. When the filament has been changed you will need to recalibrate (see Section 4.8.9).

5.21.8 No Peak Found

This label means that the instrument has not been tuned or cannot be tuned to helium, during an autopeak operation.

If there has been a memory fault or the processor deliberately re-set for electronics maintenance the label NO PEAK FOUND will be displayed when the instrument is turned on. This is to indicate that the tuning volts has been set at the default value. The apparent error will not re-appear unless the peak cannot be found next time the instrument has been auto peaked.

The error label will be displayed if the helium peak is not found during auto peaking.

- i) The Spectron may have been auto peaked without any helium present.
- ii) The tuning voltage for helium might be outside the range of auto peaking. The peak will initially have to be found manually (see Section 4.9.1).

- iii) If NO PEAK FOUND continues to display after an auto peaking routine, refer to Section 7.4 and check the ion source continuity. If this is correct the mass spectrometer voltages might be incorrect, or there might be contamination of the filaments causing electrical leakage. Change filaments. (See Section 7.5).

5.21.9 COOLING ERROR

If the message COOLING ERROR is displayed, it is likely that one of the following faults has occurred:-

- i) Fans stopped working. Check that all fans are exhausting hot air.
- ii) Environmental temperature is high or that the ventilation to the instrument is restricted.

5.21.10 PARAMETER ERRORS

Generally, parameter errors are caused by the operator setting particular parameters outside the operating limits of the Spectron 300E. These limits are listed in Section 5.10.2 Parameters. Alternatively some of the parameters may fall outside the limits following a calibration routine. A certificate containing the particular operating parameter values is supplied with each unit. This certificate also contains the unit serial number.

When any of the labels listed below are displayed the parameters may be changed in the ADJUST MODE at menu item 8 = PARAMETERS where all eighteen parameters are listed (see Figure 5.6).

FAIL - REJECT LEVEL	REJECT SET POINT - set too high or too low.
FAIL - G/F C/O P	GROSS to FINE CHANGEOVER PRESSURE set outside limits.
FAIL - FIL ON/OFF	The pressure (P3-PRL10) at which the mass spectrometer filament switches off has been set outside limits. This does not mean that a filament has failed.
FAIL - M/G CH/OP	MASSIVE to GROSS CHANGEOVER PRESSURE set too high or too low.
FAIL - TOT PR SENS	Sensitivity set too high or too low.
FAIL - MODE RESET	MODE RESET PRESSURE set too high or too low. This is the mass spectrometer pressure at which the Spectron 300E will jump back to its previous stage, for example; Fine to gross hold.
FAIL - FIL OFF M/S	FILAMENT OFF MASS SPECTROMETER The pressure trip set too high or too low. (Pressure as measured by the mass spectrometer).

FAIL - SCALE FACTOR	<ul style="list-style-type: none"> i) SCALE FACTOR outside acceptable limits. Check that the tuning is correct, for example; carry out an auto-tune, re-calibrate. ii) If calibration is selected, ensure that the external leak was opened and closed correctly during calibration. iii) Has the unit warmed up completely. For an accurate calibration the unit should be on for more than 30 minutes and the filament for more than 10 minutes. iv) Check that the external reference leak value entered is correct (parameter 17). v) Check that the mass spectrometer magnet is secure. Tighten bolts if necessary.
FAIL - GROSS FACTOR	GROSS FACTOR is outside limits. The unit has been incorrectly calibrated or the gross leak is blocked. The gross valve may have failed closed in a gross hold calibration.
FAIL - MASS FACTOR	MASS FACTOR is outside limits. The unit has been incorrectly calibrated or the massive leak is blocked.
FAIL - LOWSENSAMP	LOW SENSITIVITY AMPLIFIER set too high or too low.
FAIL - EXT-REF LEAK	EXTERNAL reference leak value set too high or too low.

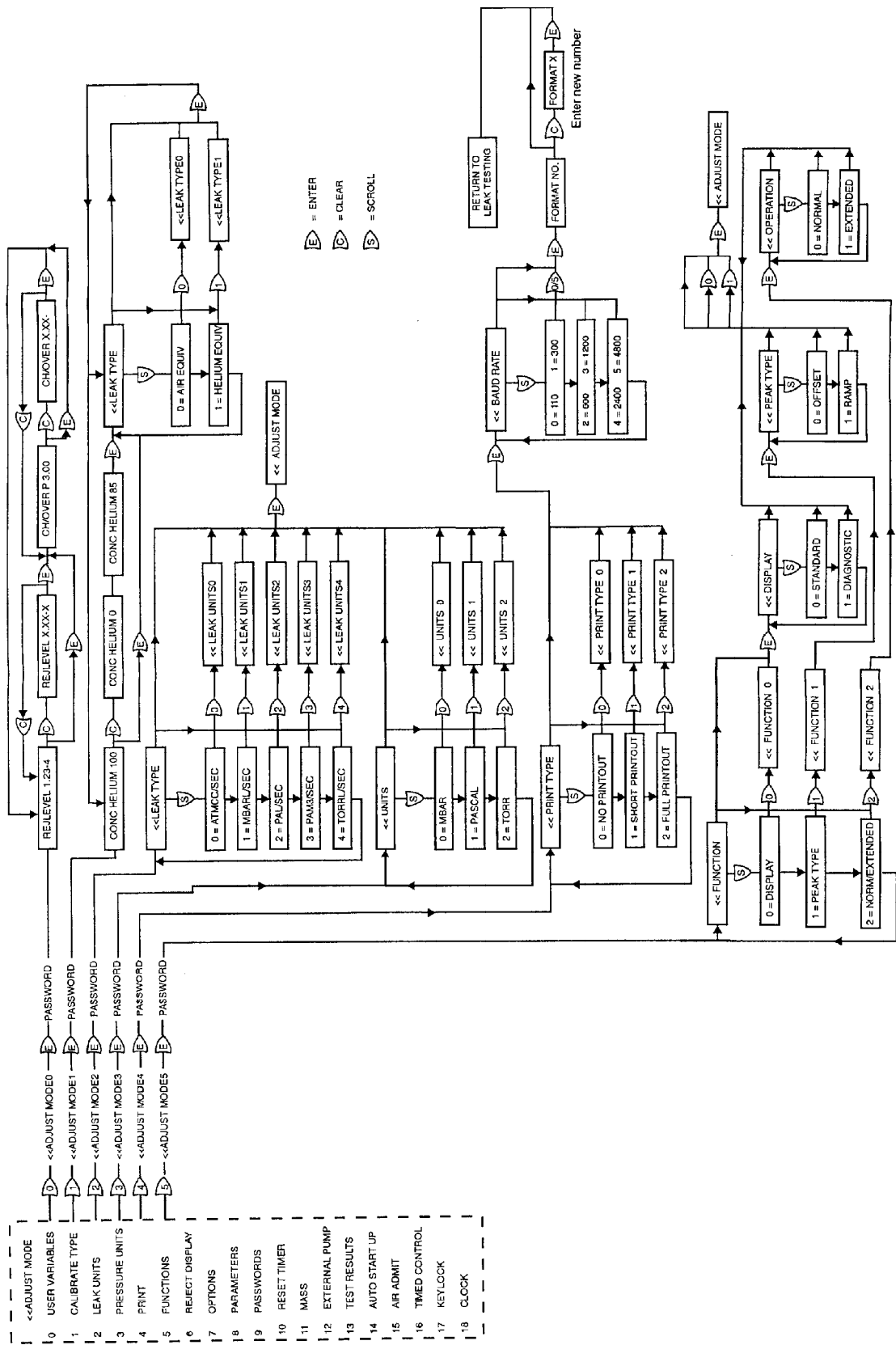


Figure 5.5 - Adjust menu part 1

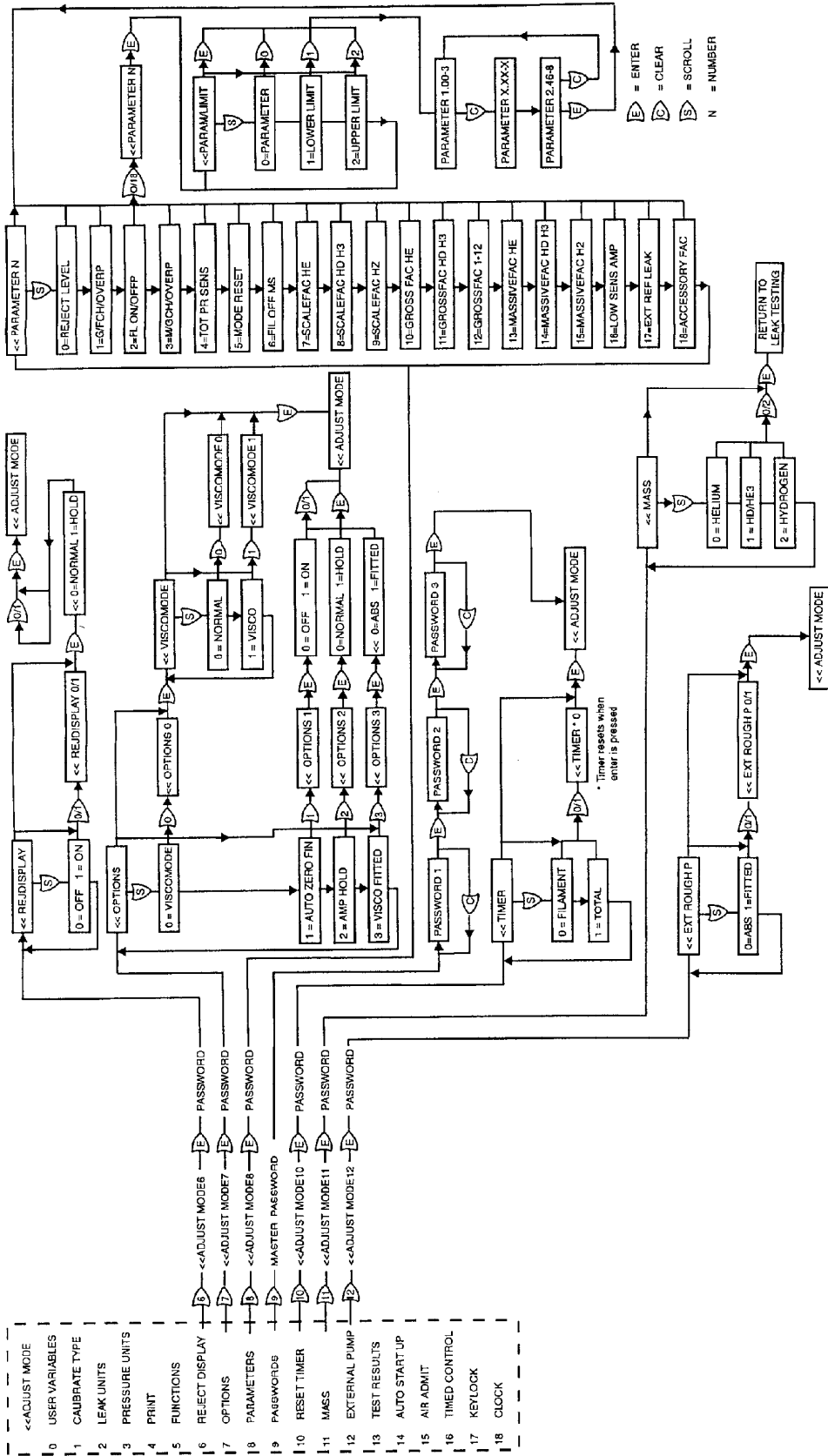


Figure 5.6 - Adjust menu part 2

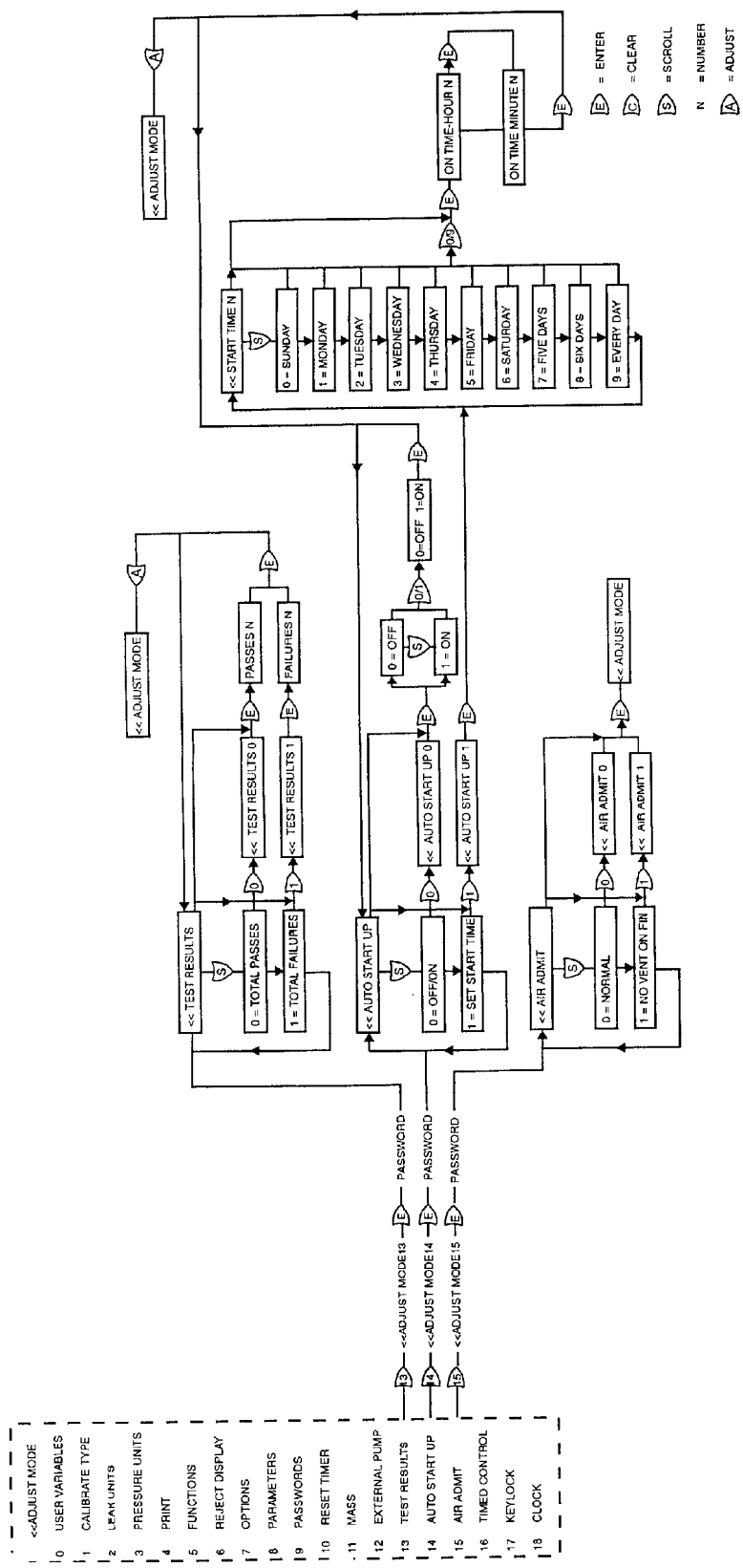


Figure 5.7 - Adjust menu part 3

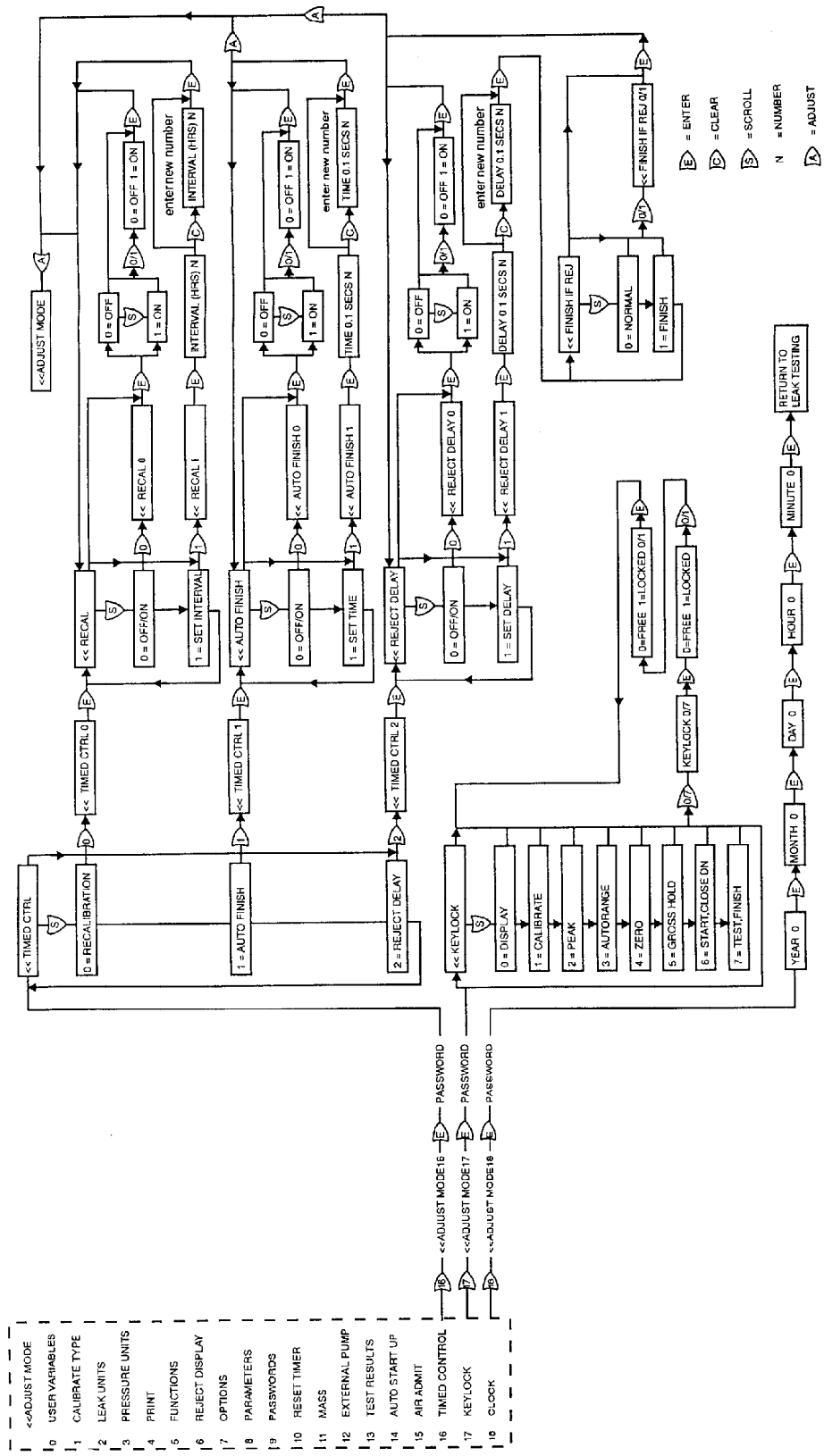


Figure 5.8 - Adjust menu part 4

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6 LEAK TESTING METHODS

6.1 Introduction

Leak testing with helium depends upon detecting the flow of helium through a leak. The flow must be produced by a difference in total pressure between the inside and outside of the vessel under test. A difference in the partial pressure of helium alone, if the total pressures were equal, would be insufficient; the flow of helium would then depend on diffusion, a very slow process.

A pressure difference can be produced by evacuation or by applying pressure, leading to two broad classes of leak testing, vacuum testing and over-pressure testing.

Generally, vacuum testing is preferred for its simplicity. However, because leaks may behave differently according to the direction of applied pressure, it is always important to take into consideration the normal working conditions of a product and its mechanical strength when establishing the leak test method.

6.2 Air/helium equivalent leaks

All mass spectrometer leak detectors measure the amount of helium passing through a leak. When helium equivalent is selected the Spectron will indicate the amount of helium passing into its vacuum system.

More often it is necessary to know the amount of air that would pass through the same leak. This is the air equivalent value (AEV). In order to display the AEV the Spectron divides the helium equivalent value (HEV) by 2.7. This assumed relationship between AEV and HEV is true for molecular type leaks (these leaks, such as porosity in metal, where the diameter of the leak path is very small, that is, collisions between molecules are less likely than collisions between the molecules and the wall). Molecular leaks are to be expected below about 10^{-5} mbar ls⁻¹.

Alternatively leaks can be viscous. Here the gas collisions are more often with themselves rather than with the wall of the leak path. In this case the gas flow depends on its viscosity. Viscous leaks can occur above about 10^{-7} mbar ls⁻¹.

Leaks between 10^{-8} mbar ls⁻¹ and 10^{-4} mbar ls⁻¹ can be either viscous or molecular, and hence quantifying an air leak from a helium leak detector can sometimes be difficult. The change in flow rate through a viscous leak with pressure is different to the change in the flow through a molecular leak, and this can sometimes be used to discriminate between the two types of leak. For molecular leaks the flow is proportional to the pressure difference across the leak. For viscous leaks the flow is determined by the difference of the squares of the pressures on either side of the leak.

6.2.1 Viscous and molecular leaks

This paragraph shows how gas flow through a fixed leak changes with pressure differential and gas type dependant upon whether the leak is viscous or molecular. It also indicates corrections which must be made to the Spectron leak rate reading. If the test conditions are different from the operating conditions, for example, test with helium - operate with air.

Key to formulae:

P = Pressure

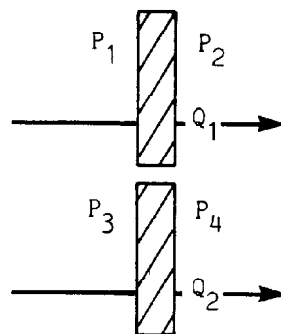
Q = Leak rate

M = Mass

Z = Viscosity

6.2.2 Change in leak with pressure differential

For molecular leaks

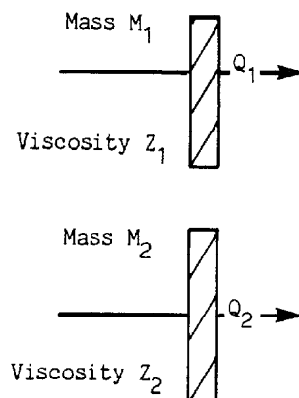


$$\frac{Q_2}{Q_1} = \frac{P_3 - P_4}{P_1 - P_2}$$

For Viscous leak

$$\frac{Q_2}{Q_1} = \frac{P_3^2 - P_4^2}{P_1^2 - P_2^2}$$

6.2.3 Change in leak pressure with gas



For molecular leaks
$$\frac{Q_2}{Q_1} = \sqrt{\left(\frac{M_1}{M_2}\right)}$$

For viscous leaks
$$\frac{Q_2}{Q_1} = \left(\frac{Z_1}{Z_2}\right)$$

6.2.4 General change with pressure and gas

Generally for molecular leaks
$$\frac{Q_2}{Q_1} = \frac{P_3 - P_4}{P_1 - P_2} \sqrt{\left(\frac{M_1}{M_2}\right)}$$

Generally for viscous leaks
$$\frac{Q_2}{Q_1} = \frac{P_3^2 - P_4^2}{P_1^2 - P_2^2} \left(\frac{Z_1}{Z_2}\right)$$

6.3 Vacuum testing

In vacuum testing the test piece is evacuated. Helium is applied to the outside of the test piece and its flow through the leak is detected and measured by the instrument.

Examples of products tested this way are:-

- 1 Vacuum components and plant of all kinds.
- 2 Electronic valves.
- 3 Cathode ray tubes.
- 4 Laser tubes.
- 5 Lamps.
- 6 Cryogenic vessels.
- 7 Pacemakers.
- 8 Containers of various kinds including those for food products and explosives.
- 9 Castings.
- 10 Bellows and other metal fabrications.
- 11 Gas valves and regulators.
- 12 Heating elements.
- 13 Heat exchangers.
- 14 Feedthroughs.

6.3.1 Testing small volumes

The Spectron is ideally suited for testing small volumes. Two methods are recommended. The hood test or spray test.

6.3.2 Hood test

Used where the component is small enough for the leak detector to evacuate and test conveniently. The item or items for test are connected to the test manifold and pumped down. A hood is placed over the items and helium is sprayed into the hood. This is a useful method where many small items are to be tested quickly.

6.3.3 Spray test with probe

This test is the simplest method and offers maximum sensitivity and direct readout of a leak rate in each of the test modes. This is because all the helium entering the leak is available to the leak detector. Leak location with spray probes is dealt with in detail in Section 6.6. The item for test is connected to the test manifold and pumped down. Helium is sprayed over the item with the spray probe.

6.3.4 Testing large volumes

Generally a gas spray probe is used to apply the helium, unless the test requires a high sensitivity for total leak rate, when a hood is used.

An auxiliary pump may be used to assist leak detection. This may be either a separate pump or an integral part of a vacuum process plant that requires testing.

In this situation there are two main points to be remembered:

1. Response time = $\frac{\text{Volume}}{\text{Pumping Speed}}$

This gives typical dwell times under hood for full development of the leakage signal.

2. The indicated leak rate is proportional to the fraction of helium flowing into the leak detector.

For example: if 1/2 the helium is pumped by an auxiliary pump and 1/2 by the leak detector then the indicated leak rate will be 1/2 the true value. The accessory could be automatically compensated by setting the accessory factor to be 2 in this case (see Section 5.10 PARAMETERS).

It follows that a leak detector connected into the backing line of a diffusion pump benefits from the high speed of the diffusion pump in terms of response time, and also shares the gas load with a pump with relatively low pumping speed, for example, a rotary pump.

6.4 Over-pressure testing

In over-pressure testing the test piece is filled with helium, or a mixture of gases containing at least 10% helium, to a pressure above atmospheric. The helium escaping is detected by the instrument. The sensitivity is reduced in proportion to the dilution of the helium in the test gas.

Examples of products tested this way are:-

- 1 Heat exchangers.
- 2 Hydraulic and pneumatic systems.
- 3 Process plant, chemical/petro chemical etc.
- 4 Pressure vessels, valves, filters.
- 5 Airships and balloons.
- 6 Refrigeration/Air conditioning systems.
- 7 Satellite systems.
- 8 Gyroscopes.
- 9 Nuclear fuel rods.
- 10 Hermetic/semi hermetic compressors.
- 11 Automobile components, for example; petrol tanks, torque converters, shock absorbers, gear boxes, wheels etc.

In many cases these products are tested in the overpressure mode because this is the most appropriate method.

There are two categories of overpressure testing:

Where the product is very large or complex, and cannot be placed in a vacuum chamber.

Where the product can be placed in a vacuum chamber and has helium inside or can have it introduced.

6.4.1 Testing large products (for example, items 1 to 5)

As with all leak testing, the purpose is to capture and measure helium flowing from a leak. In this case the sniffer probe is used to capture helium. There are two types of sniffer, a standard (or molecular flow type) and a viscous flow type. Molecular flow sniffer probes are used where maximum sensitivity is important and conditions are good. These probes are approximately 2 metres long and have a 2 second response time.

Where long distances are involved, a visco sniffer probe is used. This probe takes only a sample of the helium gas into the mass spectrometer but allows an acceptably fast response time. Clearly sniffer probes are operator limited and have reduced sensitivity, but have the advantage of finding and pinpointing leaks.

A variation of the sniffing test is not to probe the surface of a product but simply sample the gas in an enclosure around the product. In this case, the partial pressure of helium is important. Each sniffer probe has a theoretical sensitivity of 1 part per million (ppm). An example of this test is that for Satellite fuel systems:

The rise in helium concentration in the surrounding enclosure

$$= \frac{\text{Leak rate (mbar 1/sec)}}{V \text{ (litres) } \times 1000 \text{ (mbar)}} \times 10^6 \text{ ppm}$$

where the leak rate is that indicated by the Spectron, V is the residual volume of the enclosure.

The Spectron 300E can be set up to read directly in ppm using the visco factor and the leak factor to convert mbarl/s to ppm.

6.4.2 Testing helium filled products (for example, items 6 to 11)

Gyroscopes are normally charged with Helium for normal use, and are therefore a perfect item for this test (usually 12ins or smaller glass bell jar on Spectron).

Nuclear fuel rods are charged with some helium during manufacture to facilitate leak test due to the size. The plant generally has an auxiliary pumping system.

Hermetically sealed devices can have helium introduced by the bombing technique. Electronic devices are a major product for this technique.

Industrial products which demand either reasonable leak tightness, for example; refrigeration compressors, or products that need a clean reliable automatic form of testing, are candidates for helium leak testing. Generally speaking, these products are high volume manufacture and often require high internal pressures.

6.5 Leak blockages

Components to be leak tested should always be clean and dry. If manufactured by a clean process, such as vacuum brazing, they should be protected from dust and moisture until the leak test has been completed. The very small holes which cause appreciable leaks under high vacuum are easily blocked by solid particles in the micron size range, which may be small enough to be air-borne. Such blockages may be temporary or intermittent, giving rise to misleading leak test results.

Blockages by liquids can also occur. A capillary of 2 microns diameter, for example, containing water, will be blocked against a gas pressure difference of 1.5 atmospheres by surface tension forces. The water will evaporate into the vacuum applied during leak testing but there will be no leak indication on the Spectron until all the water has evaporated. Then there will be a leak of about 10 mbar litres/s if the capillary is 2 mm long. A thin oil in a similar capillary would flow under a pressure difference of 1 atmosphere, but so slowly that the leak would not appear during practical leak test procedure, thus giving rise to a leak which develops only after the plant has been under vacuum for weeks or months. Hydraulic pressure testing, whether with water or with oil, is therefore better postponed until after the leak test.

6.5.1 Total leak measurement

Helium passing simultaneously through all the leaks in a test piece is collected and measured by the Spectron. For testing by the vacuum method, the test piece is covered by a hood which is flooded inside with helium. The hood may be simply a plastic bag or a more permanent structure such as a metal box or a bell jar, depending on the job in hand. The hood need not be completely closed, but any opening should be at the bottom, so that the air can be swept out by the lighter search gas. Time and helium can be saved by making the hood capable of being roughly evacuated by the Spectron through a separate valved connection, before filling the hood with helium.

The evacuated enclosure method is most suitable for small components that can be filled in advance with helium at atmospheric pressure. They may be tested singly, or in batches, by simply putting them in an enclosure which is pumped by the Spectron.

Sealed components can be tested by an extension of the evacuated enclosure method sometimes referred to as 'bombing'.

The components are placed in a pressure vessel which is filled with helium at atmospheric or higher pressure. Helium enters the components through any leaks, provided the pressure inside them is well below the helium pressure. The components are then placed in the enclosure which is evacuated by the Spectron. Any helium escaping from the components is detected by the instrument.

This method has only a limited application. The time taken for enough helium to enter the component through a leak becomes very long if the leak is fine or the internal volume is large. A gross leak will not be detected if the helium has already escaped when the Spectron test has begun. Spurious indications may be given if the outside of the component has porosity, trapped volumes, or is dirty.

6.6 Leak detecting with probes

An individual leak can be found by localizing helium leaking through it. In vacuum testing, helium is applied by a spray probe. In over-pressure testing a sniffer probe is used.

The audio facility is especially useful in probe testing; it avoids the need to watch both the probe and the leak rate meter. Headphones on a long lead are useful when testing large apparatus. The portable process control module is also a valuable aid in making leak measurements away from the Spectron.

6.6.1 Spray probe

This accessory consists of a jet with a push-button on/off valve. It is supplied with plastic tube for connection to the outlet of the pressure regulator on a helium bottle, and typically requires only 2 psi gauge.

6.6.2 Spray probe handling

The search for a leak should begin at the top of a test piece, working downwards so that as the helium rises it passes only over areas which have already been searched.

The tip of the probe should be about 3 mm away from the surface of the test piece.

The probe should be passed slowly over the area to be searched, moving it at about 1 or 2 centimetres per second. Initially a moderate flow of helium should be used, producing a jet of gas which can easily be felt on the skin at a distance of a few millimetres from the probe tip.

When a leak is found, the flow rate should be reduced to permit the leak to be located precisely. Verify the position of the leak by stopping the flow of helium until the leak rate meter falls to a low value, then repeat the test.

To measure a leak, hold the probe still and wait for the leak rate meter deflection to stabilise. Check that the helium flow is great enough to exclude air from the leak by increasing the flow for a few seconds. Note the leak rate indication.

Mark the position of the leak for repair. It may be masked with adhesive tape or Apiezion Compound Q so that it will not interfere with the location of other leaks.

6.6.3 Sniffer probe (vacuum)

This accessory consists of a hand unit with a 1.5 m length of vacuum tube, with a vacuum coupling that fits the test port. Two probes (50 mm and 150 mm long) are provided. Each has an internal capillary tube adjusted to give a pressure of 5×10^{-5} mbar at the mass spectrometer when sampling air at atmospheric pressure.

6.6.4 Sniffer/Visco probe handling

The search for a leak should begin at the bottom of the test piece, working upwards in the wake of the rising helium.

The tip of the probe should be held about 1mm from the surface of the test piece and passed slowly over the area to be searched, moving at about 1 or 2 centimetres per second.

When a leak is found, verify its position by moving the probe away or closing its valve until the leak rate meter deflection falls, then repeat the test.

The leak may be measured by holding the probe still until the meter deflection stabilizes. Note the leak rate indication. Leaks down to 2×10^{-8} mbar/s can be detected with the vacuum sniffer, and around 10^{-6} mbar/s with a visco probe.

If required, visco probe calibration may be achieved once the visco probe is fitted and the console is in Fine test. (External calibration selected).

Mark the position of the leak for repair. It may be masked with adhesive tape or Apiezion Compound Q so that it will not interfere with the location of other leaks.

6.7 Leak detecting vacuum systems

When connecting a leak detector to a pumping system, there will be a loss in sensitivity as shown in Figure 6.1 since only part of the helium search gas will pass into the leak detector. The loss in sensitivity will depend on the ratio of the conductance (or pump speeds) of the leak detector and connecting hose to the total speed of the pumping system at the point of connection.

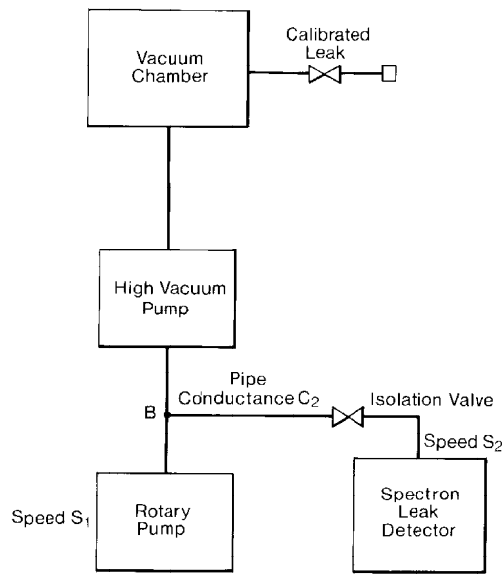


Figure 6.1 - Leak detection of vacuum systems

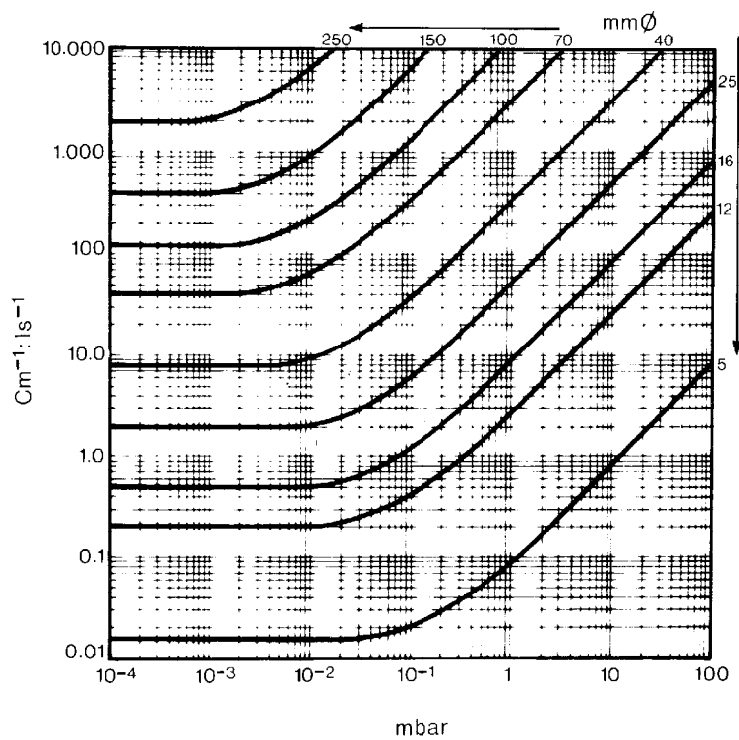


Figure 6.2 - Conductances of round pipes for air at 20 deg C

Because the pumping speed above the high vacuum pump is generally high compared with the pumping speed in the backing line of the test system, the backing line is the best place to connect the leak detector. This is also good practice in preventing any possible contamination of the high vacuum chamber.

The loss in sensitivity due to the relative pumping speeds of the test system and the leak detector can be easily estimated. The conductance of the sample pipe from the test system to the leak detector can be estimated from the graphs in Figure 6.2. The overall sensitivity of the system can be checked by pumping a calibrated leak on the high vacuum chamber of the test system.

The speed of the leak detector at point B in Figure 6.1 is given by the formula:

$$\frac{1}{S} = \frac{1}{S_2} + \frac{1}{C_2}$$

The loss in sensitivity at the leak detector due to the high pumping speed of the rotary pump in the vacuum system is given by:

$$\text{Fractional sensitivity} = \frac{S}{S_1 + S}$$

Suppose a typical large vacuum system with a rotary pump of speed of:

$$S_1 = 40 \text{ ls}^{-1} \text{ and } S = 2 \text{ ls}^{-1}$$

where the conductance of the connecting pipe is negligible and so the fractional sensitivity is approximately 5%.

For the Spectron leak detector, the advised pressure at point B in Figure 6.1 should be less than 1.0×10^{-1} mbar for Gross Mode and less than 1.0×10^{-2} mbar for Fine Mode.

For a connection pipe of 3 meters, 25 mm internal diameter, the conductance from Figure 6.2 is approximately 1 ls^{-1} and so the resultant pumping speed of the leak detection system is $2/3 \text{ ls}^{-1}$, and the fractional sensitivity is approximately 1.6%.

Under these circumstances, the preferred maximum pressures at point B Figure 6.1 are higher: less than 3×10^{-1} mbar for Gross Mode and less than 3×10^{-1} mbar for Fine Mode because of the pressure drop along the connecting pipe. For a pipe of conductance C_2 the maximum allowed pressure drop is:

$$2/C_2 \times 10^{-1} \text{ mbar for Gross Mode and } 2/C_2 \times 10^{-2} \text{ mbar for Fine Mode.}$$

If the above calculation shows the backing pressure of the test system to be marginal or too high for testing in the Fine Mode, then the Spectron should be used in Gross Mode.

In Gross Mode the test port pressure should generally be below 1×10^{-1} mbar.

In Fine Mode the mass spectrometer pressure should generally be below 5×10^{-5} mbar. Gross Mode should be used in dirty applications.

6.7.1 Testing vacuum systems in Gross Hold

Select << ADJUST MODE 15 Air Admit, 1 = No Vent on Finish, **enter**; display so that the test port is not vented on Finish.

Press **Gross Hold** key and ensure that the Gross Hold LED is on, GROSS HOLD selected before pressing the **test** key. When the test system backing pressure is steady, press the **test** key and after about 4 seconds open the isolation valve (see Figure 6.1) to the test system. Leak testing can commence. Always check that the Gross Hold LED is on in the event of a power interruption or after closing down the instrument and then restarting.

After leak testing, close the isolation valve to the test system and then press the **Finish** key.

If it is necessary to disconnect the instrument from the test port couplings, select << ADJUST MODE 15 Air Admit, 0 = Normal, so that the test port will vent on finish (make sure that the isolation valve is closed). Now disconnect the test port couplings.

6.8 Testing the tightness of hermetically sealed components

6.8.1 Introduction

There are two methods of testing hermetically sealed components. The component can be filled with helium (or any tracer gas) during manufacture or pressurised with helium prior to testing.

Components prefilled during manufacture can be tested for helium evolution under vacuum. For components pressurised with helium there are three distinct parts of the test.

- 1 Pressuring the test object under helium.
- 2 Time lapse before applying vacuum.
- 3 Testing for evolution of helium under vacuum in a leak detector.

The measured leak rate is a function of the initial pressure and time of pressurising and the time lapse before vacuum testing. The properties of the test piece affecting the measured leak rate are the internal volume, the size of the surface leaks and also for the pressurising technique the absorption properties of the surfaces of the test piece.

6.8.2 Scope of tests

Prefilling components

For components which have been prefilled with helium, the measured leak rate is a function of the following:

- 1 Internal pressure of helium during manufacture.
- 2 The limit of the leak detector sensitivity.
- 3 The type of leaks (molecular, very large etc.).
- 4 The time between filling and leak testing.

Figure 6.3 shows the features for a typical item under test. The measured leak rate versus leak size is fairly linear for small leaks, but for large leaks the helium escapes through diffusion and the measured leak rate is a function of time.

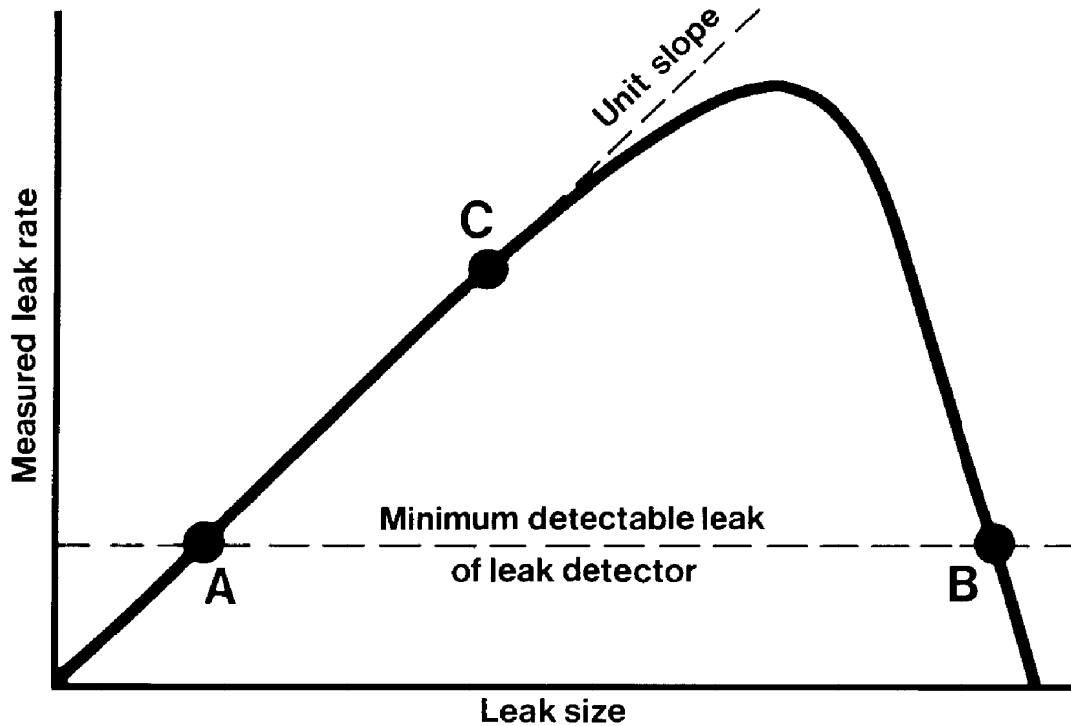


Figure 6.3 - Leak size versus measured leak rate

(Typical item under test pre-filled with helium)

A = Minimum detectable leak - governed by leak detector sensitivity.

B = Maximum detectable leak - governed also by time between manufacture and leak testing.

C = Departure from linearity - governed by the time between manufacture and leak testing.

6.8.3 Pressurising components with helium

For components which have been pressurised with helium just before leak testing the measured leak rate is a function of the following:

- 1 Initial over-pressure of Helium.
- 2 Time of pressurising.
- 3 Internal volume of component under test.
- 4 Time before leak testing.
- 5 The type of leak (molecular or viscous leaks).
- 6 The surface properties of the test piece.

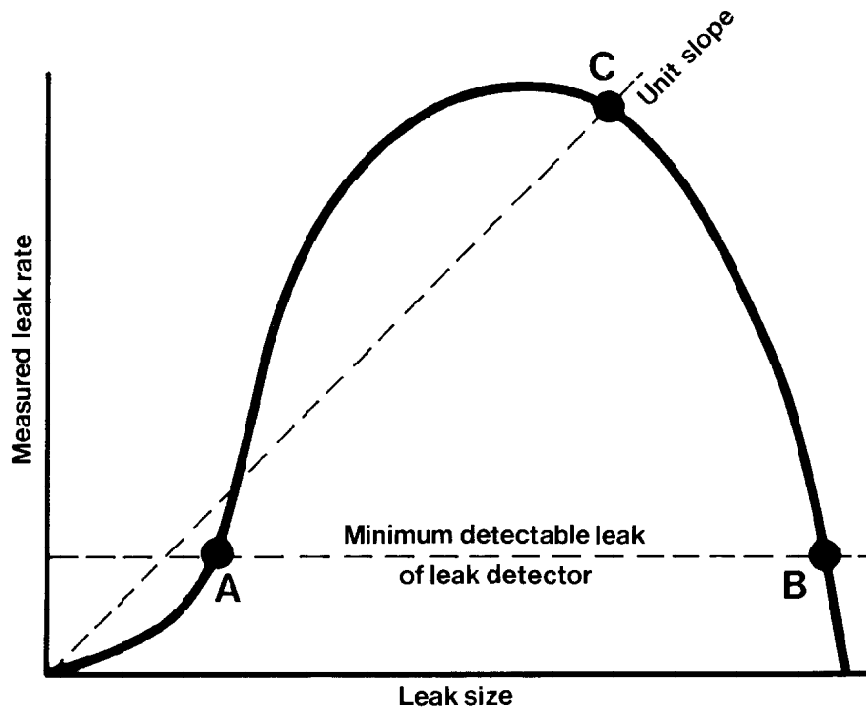


Figure 6.4 - Leak size versus measured leak rate

(Typical item under test pressurised with helium)

A - Minimum detectable leak - governed by leak detector sensitivity.

B - Maximum detectable leak - governed also by time between manufacture and leak testing.

C - Departure from linearity - governed by time between manufacture and leak testing.

Figure 6.4 shows the corresponding features for a typical item under test. For small leaks the helium might not have time to allow a large build up of helium inside the test piece, whereas for larger leaks a pressure significantly above one atmosphere of helium might be reached depending on the over-pressure of helium. However, very large leaks are still not detectable because the helium diffuses away during the time lapse between pressurising and leak testing. The Figure shows the limit of detectability of the leak detector, but this might be below that governed by the surface properties of the item under test which could severely limit the maximum detectable leak size.

6.8.4 Leak testing

For prefilled components there are two important points to note. Firstly the measured leak rate is proportional to the fraction of helium in the gas used to fill the components. Secondly, reproducible results rely on the components being tested at the same time after manufacture.

For components tested after pressuring with Helium it is obvious that, because the results obtained are a function of many variables, that a standard method must be used to give consistent results.

For instance microelectronics and semiconductor devices are tested for the effectiveness of their seals by the standard MIL-STD-883D Method 1014.5, which defines variables such as helium pressure, pressure time, lapse time and reject level for measured leak rate.

The expected measured leak rate can be estimated using the following equation:

$$L_m = \frac{L P_e}{P_o} \left[1 - \exp \left(\frac{-L t_1}{V P_o} \left(\frac{M_a}{M} \right)^{\frac{1}{2}} \right) \right] \times \exp \left[\frac{-L t_2}{V P_o} \left(\frac{M_a}{M} \right)^{\frac{1}{2}} \right]$$

When L_m = the measured leak rate in mbar litres⁻¹ (air equivalent)

L = air equivalent standard leak rate in mbar litres⁻¹

P_e = Pressure of helium exposure mbar

P_o = Atmospheric pressure mbar

M_a = Average molecular weight for air (29)

M = Molecular weight for helium (4)

t = exposure time for over pressure

t_2 = lapsed time between pressurising and leak detection in seconds

V = Internal volume of device in litres

For the measurement of small leaks, tested immediately after helium exposure this equation reduces to:

$$L_m = \frac{P_e t_1}{V P_o}$$

So the measured leak rate is proportional to the product of the helium over-pressure and the time of exposure - Usually t can be increased, but the maximum allowed over-pressure might be limited by the possible damage to the item under test.

6.8.5 Liquid leaks and equivalent tracer gas leak rates

The accurate conversion of liquid leakage rates to equivalent air or helium leak rates assumes the flow characteristics can be determined but in general this is not true. Limits can, however, be placed on the level of liquid leakage through a leaking wall or weld, using as a basis some simple physical results, the first being that for surface tension.

For liquid water, the surface tension at room temperature is about 70 dyne-cm, and completely suppresses water leakage through wall defects of diameter D (microns) if the pressure difference across the wall is less than about $2.9/D$ (Bar). At higher temperatures, or for different liquids, the numerical factor of 2.9 for water surface tension should be linearly scaled for the application.

Dry defects of size D (microns) will have a conductance for trace gas which is calculable for the conditions applicable during the leak test. [See for example, *Modern Vacuum Practice* by Nigel Harris, available from Edwards]. Therefore, ignoring evaporation of liquid from the defect orifice, for trace gas leakage below a certain level there will be NO liquid loss in the application.

In practice, even when the trace gas leakage exceeds this level, the fluid loss will be very slow. The liquid flow tends to depend on the diameter D whereas the trace gas flow will vary as D-cubed for small leakage and D-fourth power for viscous flow. Furthermore, no real leak is simply a round hole, which tends to suppress the leakage, and may be multiple paths of completely differing flow characteristics, which makes calculations unmanageable.

Mass flow conversions for trace gases are somewhat easier to handle, and are instructive as a guideline for liquid leakage to trace gas leak rate factors. Thus for Freon 12, which has a molecular weight of 120.7, and helium, which has a molecular weight of 4, the small leak scenario has a conversion factor of square root of $(4/120.7)$ at common temperature and pressure differential between helium and Freon 12 trace gas leak rates.

In the Freon example, the liquid would normally be at 11 bar gauge, but it is assumed that small leakage rates will allow the material time to reach room temperature within the defect, so that temperature changes will be ignored. Thus the Freon 12 rate will be 11 times the square root of $(4/120.7)$ in comparison with the helium tracer gas leak rate.

The best method in practice is to construct a reference leaker, measure its leakage by both trace gas and liquid loss rate methods, and then deduce the conversion factor, which should apply directly to other tests if the reference leak testing conditions are comparable and the leak defect is of similar nature and characteristic to the defects likely to be encountered.

Keep and mark those rejects: they may well prove to be your best QA pal!

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7 MAINTENANCE

WARNING

Obey the safety instructions given below and take note of appropriate precautions. If you do not, you can cause injury to persons and damage to the equipment.

WARNING

High voltages exist within the console when the electrical supply is switched on. Ensure that maintenance is done by a suitably trained and supervised technician. Obey your local and national safety requirements.

WARNING

Switch off the electrical supply at the circuit breaker on the front panel of the console and remove the separable plug from the electrical supply before carrying out the following maintenance procedures.

WARNING

When carrying out maintenance procedures with the covers removed, high temperatures may exist on all pump and motor casings and the mass spectrometer assembly.

CAUTION

Do not tip the Spectron onto its sides as all the pumps contain oil which will spill and cause contamination of the equipment.

The Console contains components such as pumps, valves and gauges, which have their own separately available instructions.

This section on maintenance deals with the required inspections and anticipated actions for routine operation of the Spectron 300E leak detector.

Contract maintenance (World wide)

Edwards operate a routine maintenance service. Engineers normally visit the customer to carry out an appropriate “run hours” service on the equipment. Special arrangements to suit the customer's requirements can also be made. Details are available on request from your supplier.

7.1 **Cleaning**

Wipe exposed external surfaces with a soft cloth dampened with iso-propyl alcohol (or other suitable proprietary solvent), avoiding liquid spillage into the console. Avoid vapour contact with hot surfaces and ensure adequate ventilation. Smoking must be prohibited when using solvents.

Any large fluid spillage, for example, rotary pump oil, should be absorbed by spreading sand, earth or mineral absorbent and disposed of in accordance with the Local and National Safety regulations.

To remove grime and dirt found in normal use, a proprietary cleaning agent may be used, applied with a damp cloth and removed with clean water, finally drying with a dry, lint free cloth. Dry dusty areas should be vacuumed. It is important that the blades and ducts of all the fans should be cleaned at every service interval, since a build up of dust in the covers will reduce the cooling efficiency and will increase the danger of overheating.

Clean the fan blades and ducts with a soft brush to dislodge the dust, then remove the loose dust with a vacuum cleaner.

7.2 **Removing the panels**

7.2.1 **Removing front and rear panels**

WARNING

Ensure that the earth straps are replaced when replacing panels.

Unscrew the two bolts located in the recesses on either side at the bottom of each panel. Each panel lifts out directly. Disconnect the earth straps.

7.2.2 **Removing the control panel assembly**

Using a cross-point screwdriver remove the six retaining screws from underneath the control panel assembly, two at the front underside and two at each side.

Place a support in front of the unit to support the control panel assembly and gently lift out the panel and rest it on the support face down.

7.3 **Weekly maintenance**

To prepare the Spectron 300E console for all routine maintenance procedures, switch off the circuit breaker, remove the separable plug from the electrical supply, then remove the front panel from console as described in Section 7.2.1 above.

7.3.1 Rotary pump maintenance

A Leak Detector in daily use on clean test pieces should receive the following routine pump maintenance. Also refer to the rotary pump instructions supplied with this manual (A371-21-880).

Inspect the oil level every week. The oil should be halfway up the sight glass, see Figure 7.2. Top up if necessary.

Change the oil every six months/3000 hours operation.

If the pumps are cold, switch the Spectron to Standby for approximately 10 minutes, then press close down and when the PCM displays CLOSED DOWN switch off the circuit breaker, then remove the separable plug from the electrical supply.

Remove the front panel. Using a suitable drip tray to catch the waste oil, unscrew the drain plug, then unscrew the filler cap and drain the oil from the rotary pump. Clean and replace the drain plug, fill the pump with oil halfway between MAX and MIN on the pump sight glass and replace the filler cap.

See Figure 7.2 - Spectron 300E - front cover removed.

Replace front panel, ensuring that the earth strap is re-connected.

7.3.2 Diffusion pump maintenance

CAUTION

Use only Santovac 5 diffusion pump fluid for charging the diffusion pumps.

Check the state of the diffusion pumps fluid every six months when used in a harsh environment or annually for normal use. The diffusion pumps have to be removed to check the fluid, proceed as follows:

Press the **closedown** button. After 10 minutes switch off at the electrical supply isolator. Unplug from the electrical supply. Remove the front and rear panels and earth straps.

Refer to Figure 7.4. The diffusion pumps will have cooled enough to handle and it will then be safe to admit air. Vent the pumps with the manual air admit valve located at the center of the manifold. Never vent the Spectron 300E at the backing line.

- i) Disconnect the electrical supply leads from the terminal block underneath the appropriate fan (making a note of the connections). It is possible to leave the connections on and still check the pump but it is better to remove the pump completely from the unit.

- ii) Unscrew the clamping ring from the backing spout on the diffusion pump. Remove the backing line at the clamp on the diffusion pump backing spout. Remove the two screws which fix the fan housing to the bracket on the diffusion pump, so that the fan can be left in position. Disconnect the power leads from the terminal block.
- iii) Unscrew the clamping ring from the top of the diffusion pump (which connects the pump to the manifold). Carefully remove the pump and 'O' ring carrier from the unit.
- iv) Follow the maintenance procedures given in the instructions supplied with this manual (B302-01-880).

Note: The oil used in the spectron 300E diffusion pump is Santovac 5. Inspect the 'O' rings and wipe them with a lint free cloth. See that they are properly seated and that all the vacuum couplings are tight.

Re-install the pumps following the above procedure in reverse.

WARNING

Ensure that the earth straps are replaced when replacing panels.

Switch on the electrical supply. Press the **Start-Up** button.

Check that the backing pressure falls below 2×10^{-1} mbar within 5 minutes. If new fluid has been added this may outgas for several minutes causing the backing pressure to rise when the diffusion pump heater switches on.

Diffusion pump heaters

Diffusion pump heaters can suffer transitory condensation effects after prolonged storage at high humidity. This may cause apparent insulation breakdown across the heaters (less than 10 M Ω) until the pump heaters have dried out, which, normally, may take a few minutes.

On subsequent warm up the electrical insulation will be restored to its normal very high value.

Thermal snap switches

The snap switch will protect the diffusion pump if the air cooling fails, by switching off the electrical supply to the pump heater when the switch opens. The switch will reset when the pump cools down to a pre-set temperature.

Service of the thermal snap switch and the diffusion pump must be carried out if repeated thermal snap cycles occur.

7.4 Checking the mass spectrometer ion source continuity

If the label EMISSION ERROR is displayed or NO PEAK FOUND and an open circuit filament or ion source error is suspected, disconnect the ion source plug from the ion source.

Check the continuity of the pins. There should be no continuity between any other pins, other than as stated below. There should be no continuity (resistance > 100 MΩ) between any pin and earth. (See Figures 7.5 and 7.6).

Resistance between pins:

1 and 3 = 0.3 ohms

5 and 7 = 0.3 ohms

1 Filament 2

2

3 Filament 2

4 Ion grid

5 Filament 1

6

7 Filament 1

8 Ion box

9 Total pressure collector

If the filaments are open circuit, or if resistance between pins 1 or 3 or 5 or 7 and 8 is < 100 MΩ replace them; or use replacement ion source.

7.5 Replacing the mass spectrometer filaments

The Ion Source is fitted with two non-identical filaments, 1 & 2 at locations marked P & S. Usually these will both be replaced at the same time. Care should be taken not to interchange the two filaments.

Procedure:

- 1 Close down the Leak Detector and wait at least 10 minutes, to allow the equipment to cool.
- 2 Switch off at the isolator and remove the separable plug from the electrical supply.
- 3 Remove the rear panel as described in Section 7.2.1.

WARNING

The ion source and socket will be hot to the touch.

- 4 Remove the socket from the ion source.
- 5 Vent the Leak Detector using the manual air admittance valve at the top of the manifold by unscrewing several turns (do not unscrew it completely).

- 6 Close the manual air admittance valve.
- 7 Remove the clamp from the ion source and carefully withdraw the ion source from the housing.

CAUTION

DO NOT TOUCH THE ION SOURCE except with clean instruments or with gloved hands.

- 8 In a clean environment loosen the screws on the barrel connectors at the two filaments. (See Figure 7.6). Loosen the two screws on the longer connecting leads and carefully lift the connecting leads clear of the filament assemblies.
- 9 Repeat 8 above for the two shorter leads.
- 10 Loosen the screw holding one of the filaments about 1/2 turn and carefully slide the filament out.

Note : The letter (*P* or *S*) is stamped on the girder adjacent to the ion box. *P* indicates that filament 1 should be fitted on that side. Similarly *S* indicates filament 2.

Note: Replacement filaments are packed in coloured boxes for ease of recognition. Filament 1 is packed in a RED box and Filament 2 is packed in a BLACK box.

- 11 Fit the appropriate replacement filament by sliding the assembly under the securing screw as far as it will go. **DO NOT TOUCH THE ASSEMBLY** with fingers.

Note: Primary filament 1 has a white coating with a thin wire in front.

- 12 Tighten (but do not over tighten!) the securing screw.
- 13 Repeat steps 10-12 for the other filament.
- 14 Replace the filament connecting leads and tighten the screws in the barrel connectors. Make a visual check for shorting parts.
- 15 If the ion source is fitted with metal seals, replace the aluminium seal. If the ion source is fitted with Viton seals, the seals may be re-used.
- 16 Replace the source in the housing and tighten the quick release clamp. Replace the electrical socket.
- 17 Replace the rear panel remembering to reconnect the earth leads.
- 18 Switch on at the main isolator and press *Start up*.
- 19 Select Filament 1 for normal operation. See Section 7.6.
- 20 After a suitable warm up period peak and calibrate the leak detector before starting testing.

7.6 Primary to secondary filament switching

7.6.1 All Spectron 300E's prior to serial numbers starting 11D

If you suspect that the primary filament has become open circuit or that it is not working properly you can switch over to the secondary filament. **First close the unit down (see Section 7.5.9) then switch the power OFF and remove the front panel.** Locate switches S1, S2a and S2b on the Ion source PCB (see Figure 7.7). Move all three switches to the left to select the secondary filament. Replace front cover. When the filament has been changed you will need to recalibrate. When both filaments have been changed, select Filament 1 by moving switches S1, S2a and S2b to the right before recalibrating.

7.6.2 All Spectron 300E's after serial numbers starting with 10D or having fully numerical serial numbers

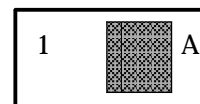
Close unit down as described in Section 7.5 then switch off the electrical supply.

Remove the front panel and disconnect the earth strap.

Locate switch S2 on the ion source PCB (Figure 7.8).

Position A selects Primary filament.

Position 1 selects the Secondary filament.



Replace front cover, ensure that the earth strap is replaced. Switch on electrical supply and start up in normal way. Recalibrate if the filament has been changed.

7.7 Adjusting the filament emission current to correct scale factor

If the label FAIL SCALE FACTOR is displayed after calibrating, check parameter No. 7, 'Mass spectrometer scale factor' (see Section 5.10). To do this press **escape**, << ADJUST MODE will display. Press 8 and **enter**. Enter the password if applicable. Select parameter 7 and **enter**. Select 0 and **enter**. The scale factor will be displayed. Under normal circumstances it will be between 5.00 + 0 and 2.00 + 1. See Section 5.21.10 for possible errors causing the scale factor to fail. If no errors are suspected, then a scale factor of less than 5.00 means that the mass spectrometer is too sensitive and the emission needs reducing. A scale factor of more than 2.001 + 1 means that the mass spectrometer is not sensitive enough and the emission needs increasing.

Set the scale factor to 1 (see Section 5.10) and place the portable into the fine mode with a suitable reference leak connected to the test port.

7.7.1 Adjusting the filament current without using a voltmeter

1. Switch the power OFF.
2. Remove the front and rear panels as described in Section 7.2.1.
3. Locate the Ion power supplies PCB on right hand side of unit (refer to Figure 7.7 or 7.8).
4. With a small screwdriver adjust switch S3, two positions clockwise to increase the filament current or two positions anticlockwise to decrease it. Switch S3 is a ten position switch and each step clockwise will increase the emission current by about 10%.

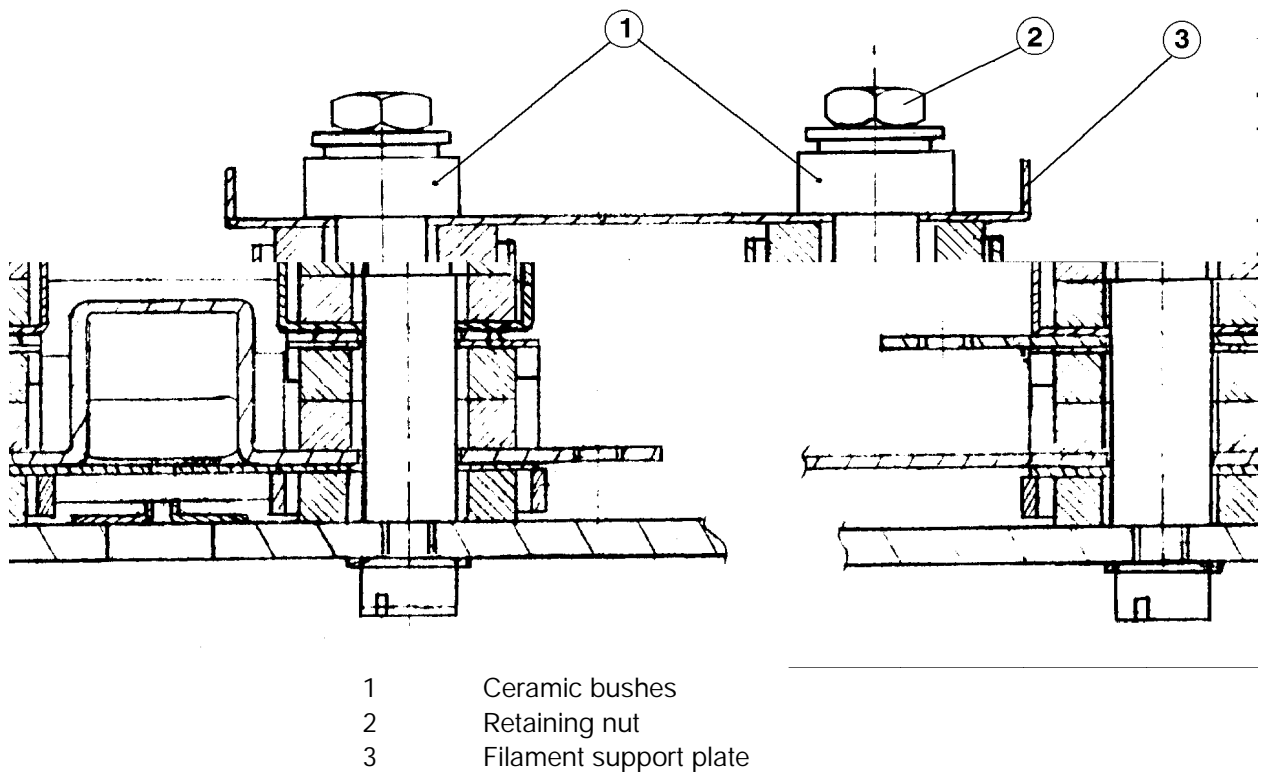


Figure 7.1 - Ceramic bush assembly

7.8 Replacing the ceramic bushes

The top hat ceramics are supplied in the Ion Source Kit (see Service kits Section 9).

The ceramic bushes (Item 1) are positioned on top of the filament support plate (Item 3), see Figure 7.1.

Remove the filaments as described in Section 7.5 and then carefully remove one nut (Item 2), remove one ceramic bush and replace with a new one, replace and tighten the nut. Only replace one ceramic bush at a time so as not to disturb the ion source alignment.

7.9 Distribution board

The hinged distribution board contains the relays, fuses and LEDs. Useful fault finding information is given by the LEDs. The main allocations are listed below (refer to Figure 7.9).

Diffusion Pump	DP1/DP2	RL8	LED	8 (red)
Gross leak valve	GLV	RL7	LED	7 (red)
Test valve	TV	RL6	Lm	6 (red)
Roughing valve	RV	RL5	LED	5 (red)
Backing valve	BV	RL4	LED	4 (red)
Air Admit valve	AAV	RL3	LED	3 (red)
Reject relay		RL2	LED	2 (red)
Rotary Pump		RL1	LED	1 (red)

Fuse FS1	500 mA	12 V supply
Fuse FS2	1 A 220/240 V	anti surge (2 A 115 V) LINE
Fuse FS3	1 A 220/240 V	quick blow (2 A 115 V) FANS
Fuse FS4	1 A 220/240 V	anti surge (2 A 115 V) RELAYS
Fuse FS5	5 A (10 A 115 V)	DIFF PUMPS

The microprocessor detects when vacuum systems components have operated. This enables correct operating sequence instructions to be given to the vacuum system. Listed below are three main components having feedback circuits, operation being confirmed by green LEDs:

Roughing Valve RV LED 9 (green)

Test Valve TV LED 10 (green)

Gross leak valve GLV LED 11 (green)

7.10 Gas ballasting the rotary pump with the air bleed assembly

The standard gas ballast connector on the rotary pump has been replaced by an interstage introduced to provide a Visco Probe facility without the need for a secondary pump. This inlet has been connected to a quick-fit connector on the rear panel of the leak detector via a length of rubber vacuum tubing. This inlet is also used to gas ballast the rotary pump when required. A quick-fit coupling (air bleed assembly) complete with a restrictor is provided for this purpose, D15471614 in the packing list. The quick-fit coupling simply pushes onto the quick-fit connector. It is released by pulling on the outer sleeve of the connector.

When to use the gas ballast facility:

1. To get rid of condensates in the pump oil. This will show up as high backing pressure.
2. To pump out helium dissolved in the rotary pump oil. This shows up as background helium measurements.

To gas ballast proceed as follows:

Run the leak detector in standby, and push the air bleed assembly into the Visco Probe connector. Leave for about 15 - 20 minutes or until contaminants have been removed.

7.11 Rotary pump replacement

The type of rotary pump fitted to the Spectron 300E has been changed.

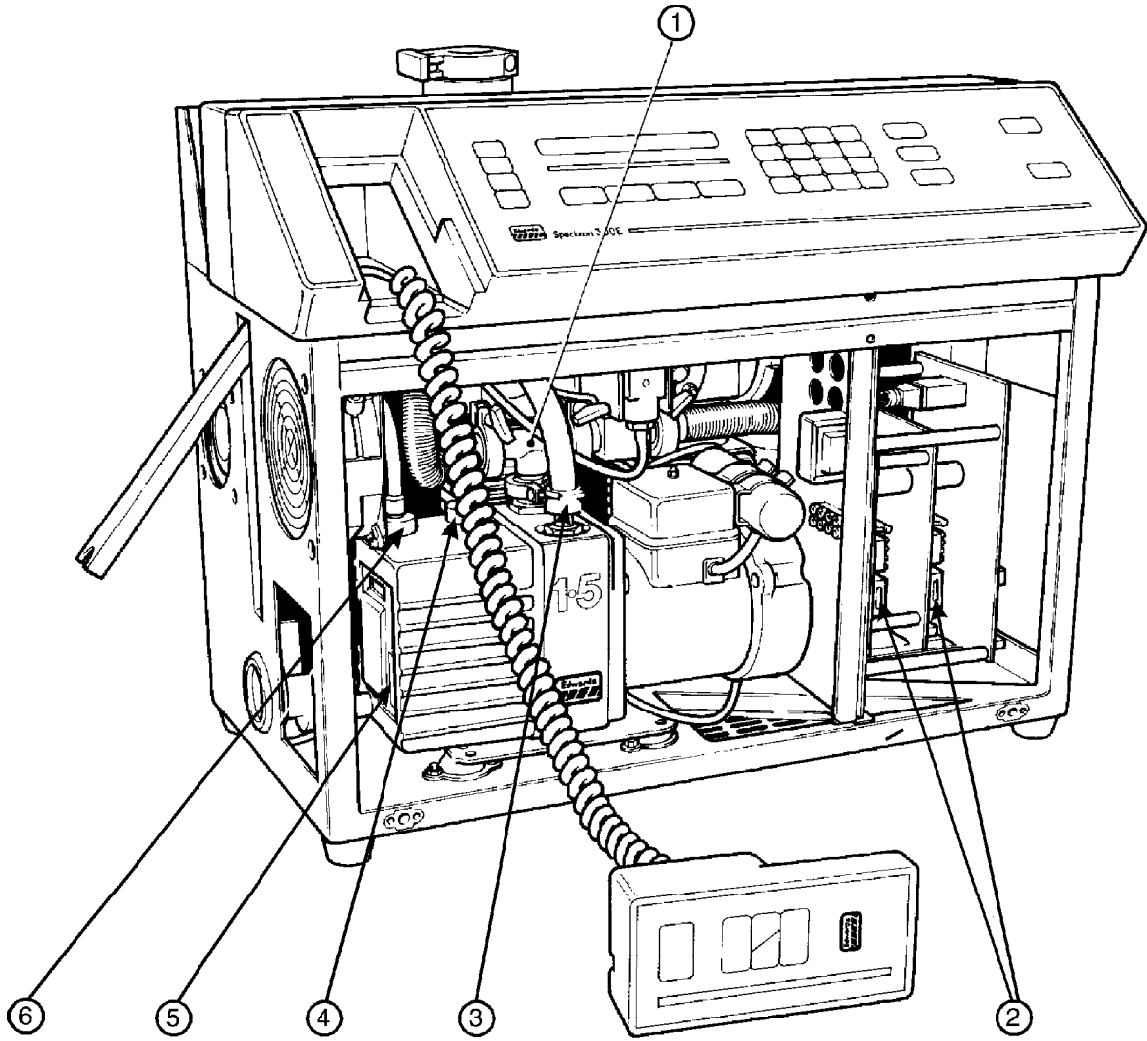
New pumps have been fitted to the D15473000 versions after Serial number 08F M59731.

New pumps have been fitted to the D15474000 versions after Serial number 1?F M5????.

New pumps have been fitted to the D15471000 versions after Serial number 1?F M5????.

For Spectron 300E Leak Detectors manufactured before the above serial numbers, the initial rotary pump replacement only will require a fitting kit Number D154-71-811 for correct installation of the new pumps. Fitting instructions are supplied with the kit.

See Section 9 for pump part numbers.



- 1 Pumping port "T" piece
- 2 1A Anti surge fuses
- 3 Interstage port for visco probe
- 4 Oil filling cap
- 5 Oil sight glass
- 6 Exhaust port

Figure 7.2 - Spectron 300E - front cover removed

Key to Figure 7.3

1. Ion source plug
2. Ion source with filaments
3. Mass spectrometer head assembly
4. Backing volume with thermocouple gauge and pre-amp
5. Diffusion pump 1 heater
6. Diffusion pump 1
7. Diffusion pump 2
8. Diffusion pump 2 heater
9. Rotary pump
10. Pump exhaust
11. Visco probe interstage port
12. Backing valve
13. Gross valve (not shown)
14. Air admit valve
15. Roughing valve
16. Pumping port
17. Test valve
18. Pirani gauge head PRM
19. Pirani gauge head PRL
20. Cooling fans

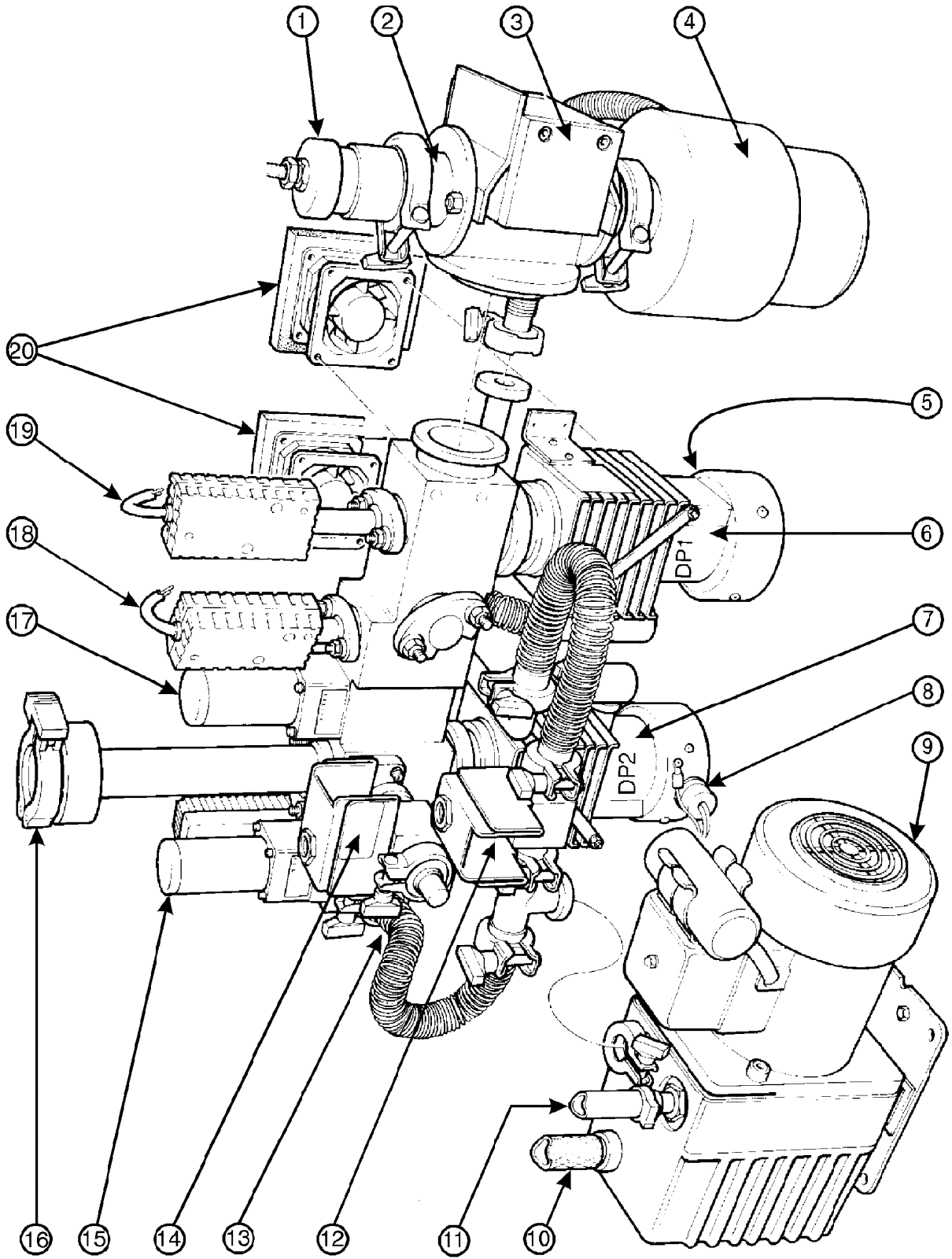
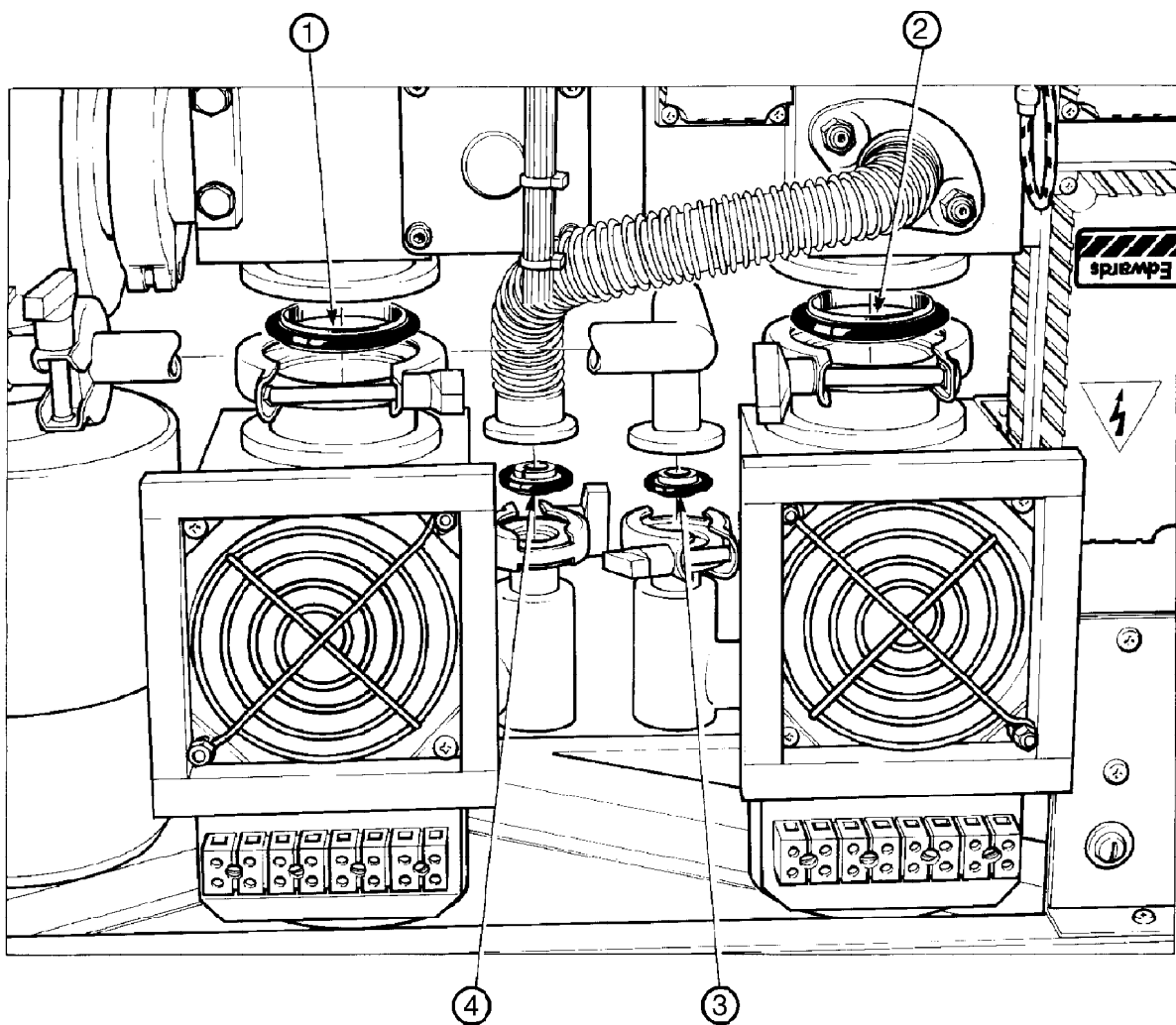


Figure 7.3 - Exploded view of the 300E vacuum system



Key

- 1 KF40 Centring ring with "O" ring
- 2 KF40 Centring ring with "O" ring
- 3 KF16/10 Centring ring with "O" ring
- 4 KF16/10 Centring ring with "O" ring

Figure 7.4 - Diffusion pump oil filling

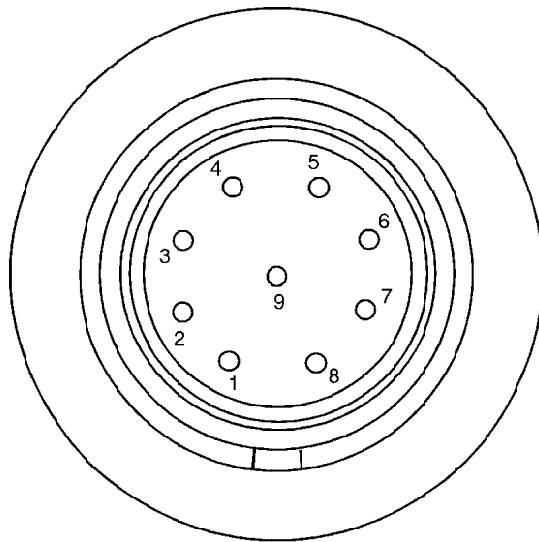
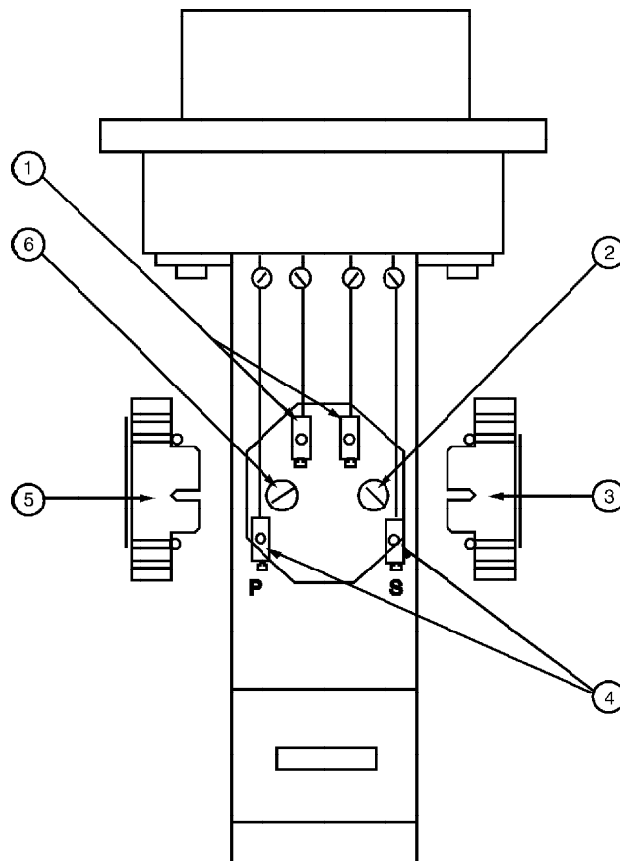


Figure 7.5 - Ion source pin connections



- 1 Short lead barrel connectors
- 2 Filament 2 securing screw
- 3 Filament 2
- 4 Long lead barrel connectors
- 5 Filament 1
- 6 Filament 1 securing screw

Figure 7.6 - Ion source filaments

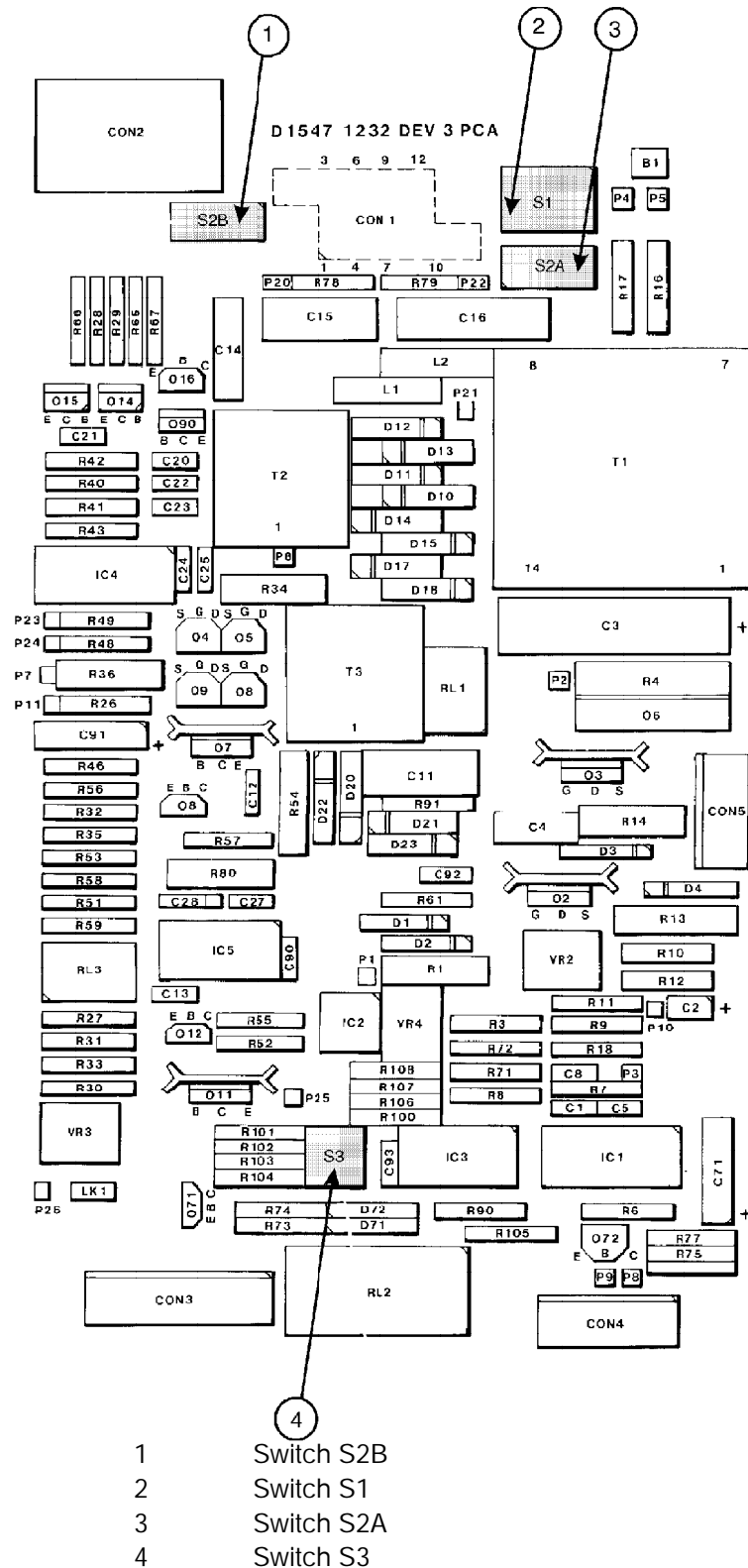
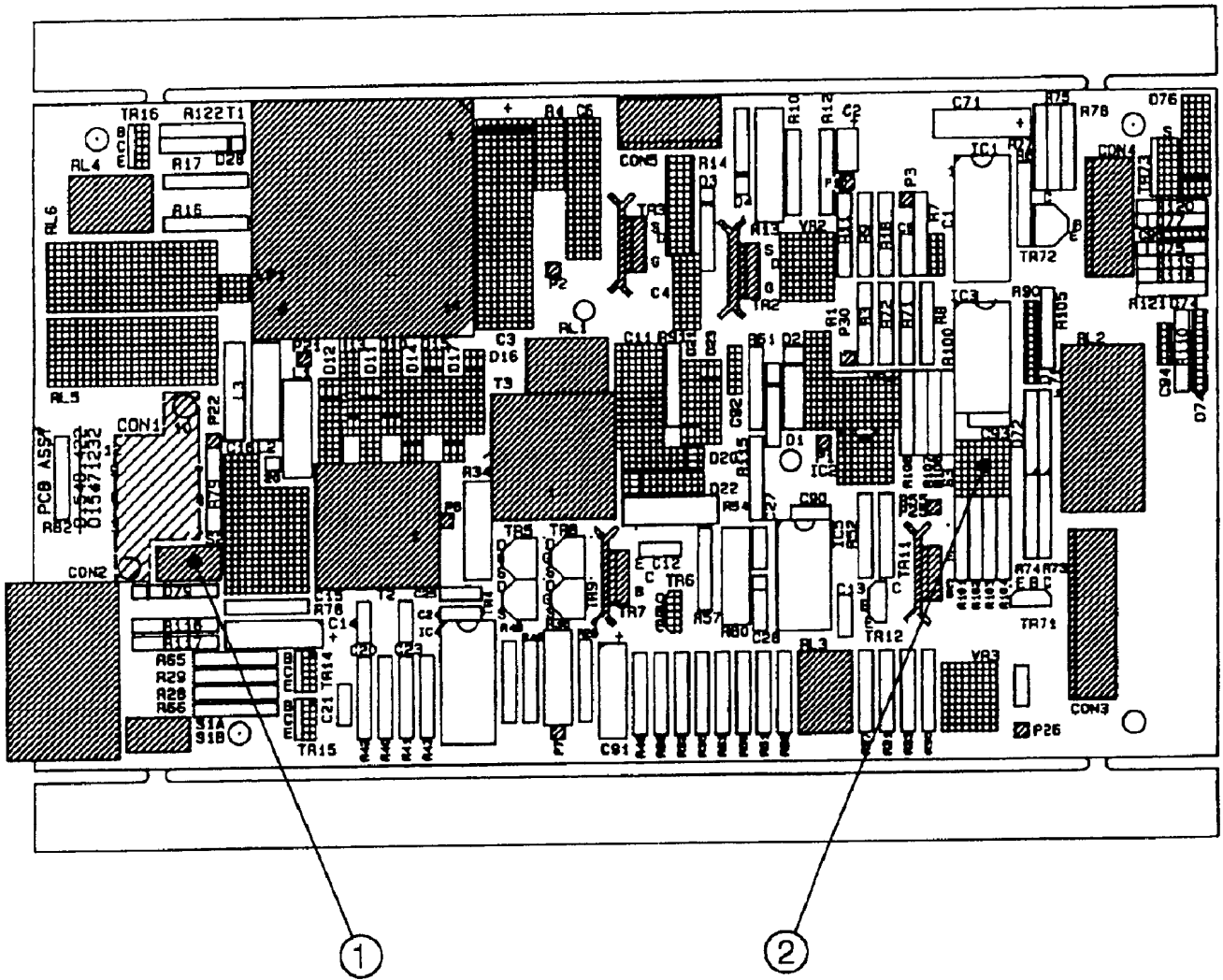
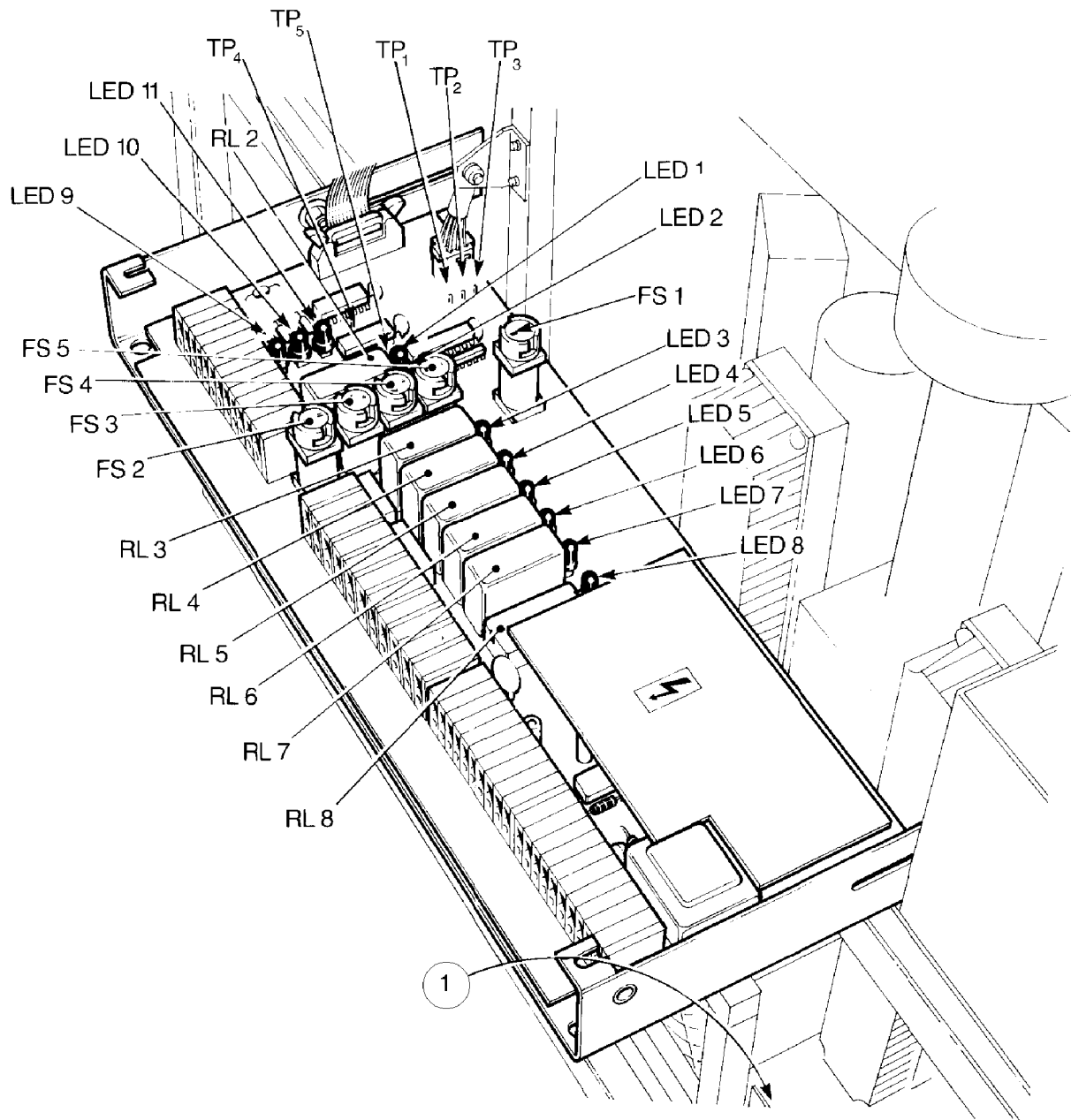


Figure 7.7 - Emission current adjustment (ion source PCB)



- 1 Switch S2
- 2 Switch S3

Figure 7.8 - Emission current adjustment



1 RL1 (15 A rotary pump fuse is located behind the electrical supply input panel)

Figure 7.9 - Spectron 300E Distribution board

CONTENTS

SECTION 8 STORAGE AND DISPOSAL

Section	Title	Page
8.1	Materials	8-1
8.2	Contamination	8-1

8 STORAGE AND DISPOSAL

8.1 Materials

The Edwards Leak Detector contains some items which may require disposal in accordance with local or national regulations. The following items are listed for information:

1. Thorium oxide coated filaments in the mass spectrometer.
2. Lithium batteries on the electronics panel.
3. Santovac 5 Oil used in the diffusion pumps.
4. Oil used in the rotary pumps.
5. Oil mist filters, if used.

8.2 Contamination

If the leak detector has been used to measure contaminated or radio active materials, disposal must be in accordance with the regulations currently in force for those contaminants.

CONTENTS

SECTION 9 ACCESSORIES AND SPARES

Section	Title	Page
9.1	Introduction	9-1
9.2	Accessories	9-1
9.3	Spares	9-1
9.4	Service kits	9-3

9 ACCESSORIES AND SPARES

9.1 Introduction

Edwards products, spares and accessories are available from Edwards companies in Belgium, Brazil, Canada, France, Germany, Hong Kong, Italy, Japan, Korea, Switzerland, United Kingdom, U.S.A, and a world wide network of distributors. The majority of these centres employ Service Engineers who have undergone comprehensive Edwards training courses.

Order spare parts and accessories from your nearest Edwards company or distributor. When ordering, please state for each part required:

- Model and Item Number of your equipment
- Serial number (if any)
- Item Number and description of part

9.2 Accessories

Description	Code Number
Headphones	D154-71-370
Trolley (without pump)	D154-71-500
Vacuum sniffer probe	D169-55-000
Visco probe	D169-59-000
Spray probe MKII	D169-12-000
Powder leak with isolation valve	D163-15-000
Powder leaks for above	
5 x 10 ⁻⁵ to 8 x 10 ⁻⁶ mbarl/sec (red)	D163-05-000
8 x 10 ⁻⁶ to 3 x 10 ⁻⁶ mbarl/sec (blue)	D163-06-000
3 x 10 ⁻⁶ to 1 x 10 ⁻⁶ mbarl/sec (yellow)	D163-07-000
Quartz helium reference leak	
Typically 2 x 10 ⁻⁸ mbarl/sec	D321-07-000
Trolley pump connection kit	D154-71-530
Auxilliary pump connection kit	D154-71-540
Hand held extension lead (12.5 m)	D154-71-750

9.3 Spares

Description	Code Number
Diffusion pump 220/240 V 50/60 Hz (180 V heater)	B302-06-180
Diffusion pump 110/115 V 50/60 Hz (90 V heater)	B302-06-090
Rotary pump E2M1.5 240 V 50/60 Hz	A371-03-919*
Rotary pump E2M1.5 110 V 50/60 Hz	A371-03-902*
Rotary pump fitting kit	D154-71-811*
Ion Source	D154-20-180
Pre-amplifier assembly	D154-71-150
Filaments Set (set of 2)	D154-20-102

* The type of rotary pump fitted to the Spectron 300E has been changed.

New pumps have been fitted to the D15473000 versions after Serial number 08F M59731.

New pumps have been fitted to the D15474000 versions after Serial number 1?F M5????.

New pumps have been fitted to the D15471000 versions after Serial number 1?F M5????.

For Spectron 300E Leak Detectors manufactured before the above serial numbers, the initial rotary pump replacement only will require a fitting kit, Number D154-71-811 for correct installation of the new pumps. Fitting instructions are supplied with the kit.

Description	Code Number
Switch and display panel	D154-71-804
Santovac S5 100 ml	H114-01-001
Ultragrade 15 oil 1 L	H110-26-015
Spectron 300E (Portable)spares kit	D154-71-800

The Spectron 300E (Portable) spares kit contains a selection of 'O' rings, vacuum tubing, fuses and vacuum hardware listed below:

Ordering number for individual items

Code number	Description	Qty
B27158053	Co-seal NW40 Viton	5
D15471102	Thermal snap switch EO40/55 DP	1
C21909004	Fuse 1.6 A Anti-surge 20 mm	6
D03103076	Fuse 500 mA Quick Blow 20 mm	9
D03103077	Fuse 1 A Quick Blow	6
D15304046	Ceramic Spacer	6
D15420062	Tube Insulator Modified	2
D15420079	Heater Assy 3000 Source Spare	1
D15420102	Filament Set 3000 (Spares)	1
D15420166	Filament Lead Kit Spectron	1
D15441089	Dowty Seal 1 /4" BSP	1
D15461049	'O' Ring Dowty	1
D15471112	Relay JA1A-TM-DC 12 V 15 A 240 V d.c.	1
D15471167	Fuse 10A Q/B	12
D15471541	Massive Leak Assy 300E	1
D16716041	Fuse 5A HBC Ceramic SF	12
D31126076	Fuse 1A Anti-Surge 20 mm	12
D31200032	Fuse 250 mA Quick-blow 20 mm	3
D38106058	Split Bush SM1	1
D38251717	Santovac and Syringe 22 ml pack	2
H02120021	'O'ring Dowty	1
H02120022	'O' ring	1
H02120090	'O' ring	1

Code number	Description	Qty
H02124002	'O' ring KF10 NITRILE 15 mm x 5 mm	9
H02124003	'O' ring KF16 NITRILE 18mm x 5 mm	6
H02124005	'O' ring KF25 NITRILE 28mm x 5 mm	2
H02125010	'O' ring VOR	1
H02125263	'O' ring VOR	2
H02126121	'O' ring VIT	3
H02126261	'O' ring VIT	3
H11012015	Oil TW 1 Litre	1
H02100003	Vacuum Tubing	1 metre

Note: One each of these items is supplied with the spares kit unless otherwise stated. The code numbers given are for small quantity packs as detailed in our catalogue.

9.4 Service kits

Description	Code Number
3000 hour / 6 month service kit	D154-71-805
6000 hour / 1 year service kit	D154-71-806
12000 hour / 2 year service kit 240V **	D154-71-807
12000 hour / 2 year service kit 110V **	D154-71-808

** Correct voltage fan supplied with each kit.

Return of BOC Edwards Equipment - Procedure (Form HS1)

Introduction

Before you return your equipment you must warn your supplier if the substances you used (and produced) in the equipment can be dangerous. You must do this to comply with health and safety at work laws.

You must complete the Declaration (HS2) on the next page and send it to your supplier before you dispatch the equipment. If you do not, your supplier will assume that the equipment is dangerous and he will refuse to accept it. If the Declaration is not completed correctly, there may be a delay in processing your equipment.

Guidelines

Take note of the following guidelines:

- Your equipment is '**uncontaminated**' if it has not been used or if it has only been used with substances that are not dangerous. Your equipment is '**contaminated**' if it has been used with any dangerous substances.
- If your equipment has been used with radioactive substances, you must decontaminate it before you return it to your supplier. You must send independent proof of decontamination (for example a certificate of analysis) to your supplier with the Declaration (HS2). Phone your supplier for advice.
- We recommend that contaminated equipment is transported in vehicles where the driver does not share the same air space as the equipment.

PROCEDURE

Use the following procedure:

1. Contact your supplier and obtain a Return Authorisation Number for your equipment.
2. Turn to the next page(s), photocopy and then complete the Declaration (HS2).
3. Remove all traces of dangerous gases: pass an inert gas through the equipment and any accessories which will be returned to your supplier. Drain all fluids and lubricants from the equipment and its accessories.
4. Disconnect all accessories from the equipment. Safely dispose of the filter elements from any oil mist filters.
5. Seal up all of the equipment's inlets and outlets (including those where accessories were attached). You may seal the inlets and outlets with blanking flanges or heavy gauge PVC tape.
6. Seal contaminated equipment in a thick polythene bag. If you do not have a polythene bag large enough to contain the equipment, you can use a thick polythene sheet.
7. If the equipment is large, strap the equipment and its accessories to a wooden pallet. Preferably, the pallet should be no larger than 510mm x 915mm (20" x 35"); contact your supplier if you cannot meet this requirement.
8. If the equipment is too small to be strapped to a pallet, pack it in a suitable strong box.
9. If the equipment is contaminated, label the pallet (or box) in accordance with laws covering the transport of dangerous substances.
10. Fax or post a copy of the Declaration (HS2) to your supplier. The Declaration must arrive before the equipment.
11. Give a copy of the Declaration to the carrier. You must tell the carrier if the equipment is contaminated.
12. Seal the original Declaration in a suitable envelope; attach the envelope securely to the outside of the equipment package. **WRITE YOUR RETURN AUTHORISATION NUMBER CLEARLY ON THE OUTSIDE OF THE ENVELOPE OR ON THE OUTSIDE OF THE EQUIPMENT PACKAGE.**

Return of BOC Edwards Equipment - Declaration (Form HS2)

Return Authorisation Number: _____

You must:

- Know about all of the substances which have been used and produced in the equipment before you complete this Declaration
- Read the Procedure (HS1) on the previous page before you attempt to complete this Declaration
- Contact your supplier to obtain a Return Authorisation Number and to obtain advice if you have any questions
- Send this form to your supplier before you return your equipment

SECTION 1 : EQUIPMENT

Equipment model _____
 Serial Number _____
 Has the equipment been used, tested or operated?
 yes Go to Section 2 no Go to Section 4

FOR SEMICONDUCTOR APPLICATIONS ONLY :

Tool Reference Number _____
 Process _____
 Failure Date _____
 Serial Number of Replacement Equipment _____

SECTION 2 : SUBSTANCES IN CONTACT WITH THE EQUIPMENT

Are any of the substances used or produced in the equipment

- Radioactive yes no
- Biologically active yes no
- Dangerous to human health and safety? yes no

If you have answered 'no' to all of these questions, go to Section 4.

Your supplier will not accept delivery of any equipment that is contaminated with radioactive substances, unless you:

- Decontaminate the equipment
- Provide proof of decontamination

YOU MUST CONTACT YOUR SUPPLIER FOR ADVICE BEFORE YOU RETURN SUCH EQUIPMENT

SECTION 3 : LIST OF SUBSTANCES IN CONTACT WITH THE EQUIPMENT

Substance name	Chemical symbol	Precautions required (for example, use protective gloves, etc.)	Action required after spillage or human contact
1			
2			
3			
4			
5			
6			

SECTION 4 : RETURN INFORMATION

Reason for return and symptoms of malfunction: _____

If you have a warranty claim:

- who did you buy the equipment from ? _____
- give the supplier's invoice number _____

SECTION 5 : DECLARATION

Print your name: _____ Print your job title: _____
 Print your organisation: _____
 Print your address: _____

 Telephone number: _____ Date of equipment delivery: _____

I have made reasonable enquiry and I have supplied accurate information in this Declaration. I have not withheld any information. I have followed the Return of BOC Edwards Equipment Procedure (HS1) on the previous page.

Signed: _____ Date _____

Addresses

EUROPE

HEADQUARTERS

BOC EDWARDS
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West Sussex RH10 2LW

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Tel: +(1) 408 428 1037
TEMPE, AZ
Tel: +(1) 602 777 7007
AUSTIN, TX
Tel: +(1) 512 491 6622

CANADA

MISSISSAUGA, ONTARIO
Tel: +(1) 905 336 9119
Toll free (Canada only): 800 387 4076
Fax: +(1) 905 845 4924

BRAZIL

SAO PAULO
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Fax: +(55) 11 2652766

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2-4-1 Shibakoen, Minato-ku

TOKYO 105-0011

(Vacuum/Abatement)
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