MODEL 3000A
HYDROCARBON ANALYSER
OPERATING MANUAL

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4.01	REPRINT	05/03

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1. UNPACKING INSTRUCTIONS

This instrument is packaged for general freight purposes. It should withstand the occasional "bumps and knocks" which occur during transit.

Please check the instrument for damage however, and report any damage within 24 hours to the factory or its Sales Office or Distributor.

1. Before any connection is made, unscrew the 4 cross head screws on instrument cover lid.

2. Slide lid back to reveal the internal assemblies of the instrument.
   NOTE: Do not take the cover off with power connected.

3. Check that all PCB's are firmly in their mating connectors on the front of each PCB.

4. Check f or any loose or broken parts which may have occurred during transit.

5. Slide lid back and re-do the screws (do this before connecting power).

6. Read through the rest of this manual thoroughly and then carry out the installation.

2. FOREWORD

This instruction book is for operational use only and is not a maintenance handbook. Maintenance handbooks are normal issue to distributors and service agents only but can be purchased by customers if they wish to carry out their own servicing. All warranty will cease however, if a customer carries out his own servicing during the warranty period unless special arrangements have been made in writing. Servicing should be carried out every 2700 hours of use. This instruction book covers the operation of the Signal Model 3000A.

The model 3000A is for air analysis. It uses H2 fuel, a sample flow rate nominally 10-18 cc/mm factory set and has a lower range of 0-4 ppm.

3. INTRODUCTION

3.1 Detector

The flame ionization detector works by ionising the sample gas by combustion in a hydrogen flame. Ions produced in this process are collected at a polarized electrode outside the combustion zone. The polarizing voltage across the detector must be high enough to stop any recombination of the electrons and positive ions produced in the flame. If the voltage is too low, all of the electrons may not reach the collector electrode causing insensitivity and, with larger samples, non-linearity. The resultant electrical current, proportional to the mass of hydrocarbon present in the flame, is of the order 10e-12 to 10e-7 amps; it is then amplified to produce the instrument signal.

When the sample gas is composed of gases of different carbon number, the detector will respond to the ppm/carbon number. e.g. l0 ppm methane and l0 ppm propane in air will produce a reading of 40 ppm methane equivalent. The user may calibrate the instrument with a methane or propane standard; all readings will then be either methane or propane equivalent, respectively.

3.2 Detector Gas Control

The stability of the air and fuel flows to the detector is important to maintain detector stability and sensitivity. The optimum performance of the detector is particularly dependent on the ratio of hydrogen to sample gas flow rate, since this ratio affects the flame temperature and therefore the ionization efficiency. The ratio of air to fuel should be 10:1. The gas flows are fixed at the factory and should not require adjustment. If adjustment should be necessary, it should only be carried out during service by an authorized service engineer. The fuel mixture is automatically enriched during ignition.

3.3 Sample/Bypass System

The small sample flow rate (about 8 ml/min) to the detector would give an impossibly long response time if it were not used with a bypass system. The bypass system uses a high sample flow rate (about 5L/min) to give a rapid turnover of sample gas and therefore a rapid response time. Most of the sample gas is dumped but a very small proportion of the gas is passed to the detector.

As the flame ionization detector is mass sensitive, that is, its response is proportional to the total mass of hydrocarbon entering the detector per unit time, any changes in pressure in the sample system brought about by changes in sample flowrate will have a directly proportional effect on detector response.

The model 3000A uses air to compensate for variations in sample flow to the instrument to maintain a constant pressure in the sample system and a constant flow to the detector. The bypass air is added to the sample flow after the sample take-off point to the detector and therefore does not dilute the sample. The constant pressure maintained in the sample system by the back pressure regulator produces a constant flow through the orifice at the vent outlet, composed of a mixture of sample and bypass air.

Excess bypass air exits the instrument via the bypass vent and the back pressure regulator. This system ensures that no sample gas comes into contact with the back pressure regulator; problems associated with contamination of the regulator with sample gas and exposing the regulator to high temperatures are therefore avoided.

3.4 Electronic Arrangement

An electrical potential of approximately 200 Volts across the flame jet and an ion collector electrode suspended above the flame produces an ion current in the detector proportional to Hydrocarbons.

This current is very low, in the order of approximately 10-12 Amp. This current is amplified using the very latest in electronic circuitry.

A high impedance FET op amplifier is used and all the range change switching utilizes solid state FET analogue switches. The range change is facilitated with "up down" push buttons on the front panel. Auto-range change is also incorporated as standard and the ranges can be selected remotely with three lines of TTL to the appropriate rear panel connection pins. (See operation instructions).

Due to the resolution of the 3 1/2 digit display, on the Model 3001 and 3101 a multiplier is used when the 4000 and 10,000 ranges are selected. This is simplified by the illumination of the LED on the front panel marked "PPM x 1000". When this light is illuminated, simply multiply the digital display by 1000. The display on the front panel is a 3 1/2 digit liquid crystal (LCD).

3.5 Data Acquisition and Computer Interfacing

When using data acquisition both a 0-by and a 0-10 mA step change output signifies range selection. An output can be connected to a spare chart recorder pen and the step change records the range whilst another pen records the detector output.

A three line BCD coded output is also available to signify range selection for more intelligent data acquisition systems.

For computerized data acquisition you may wish to have the computer change range rather than rely on the auto range change function. This may be necessary if you are using an 8 Bit A-D converter and the ranges need only be changed twice to cover the entire range. A facility for this is incorporated where the computer sends a logic 0 TTL signal which is connected to the remote range function rear panel pin. This acquires a remote range function and a further three lines of BCD TTL logic 0 will select the range require.

When the computer has acquired the remote range change function, the light illuminates in the "REM" front panel button.

If for any reason the operator at the instrument wishes to take back local range switching then pushing the "REM" button takes back to local, the range change function.

Therefore, the computer can always take remote range function prior to sending remote range change instructions. (For actual PIN and logic data see the OPERATIONS SECTION).

The option No.12, zero gas/span gas/sample gas/selector valve is arranged so that a remote logic 0 signal to the rear `D' connector will energise the solenoid valve situated inside the oven. Energizing this solenoid will select the sample gas, de-energizing it will select the calibration gases.

3.6 Safety and Flame Out Alarm

This instrument was designed so that no possibility of Hydrogen gas build up can occur inside the enclosure. The whole instrument enclosure is ventilated so that any possible leak is diluted and ventilated. The "flame out" device senses whenever a flame is extinguished and shuts off the flow of fuel. The shut off valve is mounted on the rear panel so that any possibility of leaks upstream of the shut off valve will occur on the outside of the enclosure, thus preventing H2 build up.

A SPDT alarm contact for remote alarm of flame out is available on the appropriate rear panel pin connections.

4. SPECIFICATIONS

RANGES: Push button "up" and “down” front panel control. Auto-range change standard.

Model 3000A
0-4, 0-10, 0-40, 0-100, 0-400, 0-1000, 0-4000, 0-l0,000 ppm propane equivalent. Other special ranges available on request, (Linearity spec. not held above 10% propane).

DISPLAY: 3 1/2 digit LCD indicates directly in concentration ppm.

OUTPUTS: 0-10V DC and 0-10 mA standard.
Also 3 line BCD TTL 7V DC and 0-7 mA output identifies range selected.

FLAME OUT: A SPDT contact is provided for remote flame out alarm.

INPUTS : A logic 0 to the remote range function pin connection and a further 3 lines of TTL logic 0 plus one return acquires remote function and remote range change. The "REM" button on the front panel acquires local range function after the logic 0 remote function has been applied.-
(See Data Acquisition section for description).

POWER: ll0V AC 220V/240V AC 50/60 Hz 750Watt.

SAFETY:	The instrument has been constructed in accordance with prescribed safety standards. All high voltage/current is shielded inside the instrument. The detector and all H2 lines are in ventilated areas. In the unlikely event of an H2 leak no H2 build up can occur. A flame sensor interlocks flame out shut off valves. This shut off valve is mounted on the rear panel so that any possible leaks on the upstream side of these valves will occur outside in a ventilated area.
DETECTOR:	Flame Ionization Detector with cylindrical collector complete with flame out detector and igniter housed in self contained separately controlled heater assembly.
IGNITION:	By front panel push button in conjunction with manual adjustment of `air' flow regulator.
RESPONSE:	95% of reading in less than 3 seconds.
ACCURACY & REPEATABILITY:	Better than +7- 1% FSD.
ZERO DRIFT:	2% in 24 hours on most sensitive range.
DETECTOR NOISE:	Model 3000A = 0-12 ppm C3H8 equivalent.
LINEARITY:	0-100% FSD to a straight line, better than 0-5% FSD on all ranges.
TEMPERATURE EFFECT:	Ambient temperature changes of 10 deg.C to 30 deg.C have less than 1% FSD effect on reading.
CARBON NUMBER CORRELATION:	Less than 5% difference of ppm carbon number between toluene, hexane, propylene and propane when using H2He fuel.
SAMPLE SYSTEM:	Sample system all in 316 S.S./PTFE.
OPTION:	Optional diaphragm pump and gas select span/zero/sample valves, 316 S.S. is available.
FUEL:	Model 3000A 60 cc/mm H2.
AIR:	Detector uses 600 cc/mm HC free air (preferably supplied through

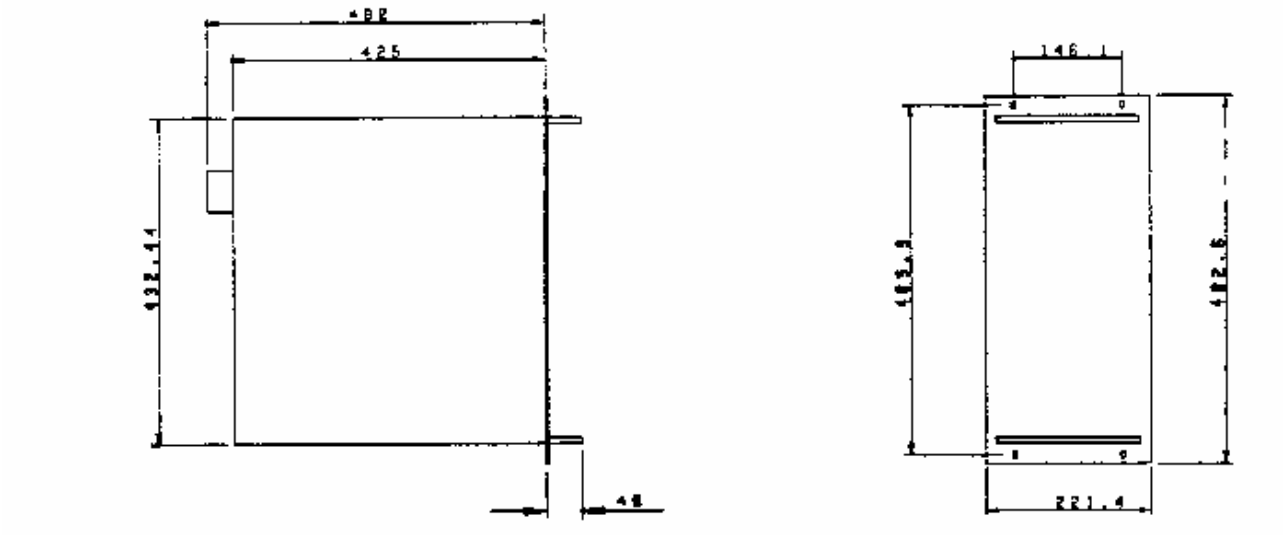
5. INSTALLATION

The Series 3000 can be installed in a standard 19" rack or it can be mounted on a bench. Feet under the front of the instrument can be tilted upwards to angle the instrument when using it on a bench. Under no circumstances cover the top louvered ventilation holes.

When using it in a complete analyser console, it should be mounted in a ventilated area and not above a heated area. Heat will be generated inside the instrument which will need to be removed. Therefore fans in the rack system will, be required if heat cannot escape. Leave at least 30 mm space above the instrument for ventilation.

Adequate shielding of the high impedance amplifier is incorporated but care should be taken to keep high current/voltage switching away from this instrument.

A mains power filter is also incorporated and this should protect the instrument from mains power surges.



5.1 Recorder Outputs

A 0-7V DC and 0-7 mA is produced in a step change of eight steps proportional to the eight ranges for recorder purposes and also a 3 line TTL signal is produced for digital data acquisition of range selection. This is particularly useful when the "Auto" range function is chosen.

A 0-10V DC and 0-10 mA is also provided on the rear panel connector for detector output data.

5.2 Output of Remote Range Change

TTL level loads can be connected to the appropriate pins for remote range coded information:

000 = range 1
001 = range 2
010 = range 3
011 = range 4
100 = range 5
101 = range 6
110 = range 7

0 = 0V
1 = +5V

Also for analogue recorders both 0-7V DC and 0-7 mA output changes from zero to full scale in eight steps corresponding to the eight ranges.

0V = range 1
lV = range 2
2V = range 3, etc.

5.3 Remote Control of Range Change

In order to facilitate remote control of range changing connect a logic 0 level to the pin no. 6 on the rear panel D connector. This will take the control of the range change from the front panel. To select the desired range connect three lines of logic in the following order.

000 range 1
001 = range 2
010 = range 3
011 = range 4
100 = range 5
101 = range 6
110 = range 7
111 = range 8

0 = Open circuit
1 = Closed Circuit to Return Line Pin No 4

5.4 Remote Control of Sample/Calibration Gas Selector

The facility to select sample gas or calibration gas does not allow you to select the positions of `Zero' `Span' and `Sample'. The remote logic level input only controls the selection of the sample or calibration gas valve. To operate this firstly decide which gas you require selection of, i.e. Zero gas or Span gas and select this manually using the gas selector switch (No.3) behind the left side door panel. **DO NOT** leave this selector switch in the sample position as this will override the remote actuation.

The application of logic 0 level to pin 1 or a short circuit link from pin 1 to pin 4 will select sample, the removal of this link will select calibration gas.

5.5 Rear Panel Connections

Rear Panel D Connector Pin Nos.

Input/Output ports

1. Remote TTL logic 0, input for Sample/Cal valve (where fitted).
2. Flame out remote alarm SPDT contact No. 2 (Normally open).
3. Methane only 0-10 mA output model 3100 and 3101 only.
4. Return line (Ground).
5. Remote range input TTL logic line 1.
6. Remote range function enable TTL logic 0 input (See data acquisition section for explanation).
7. Remote range indication output TTL logic line 1.
8. Total Hydrocarbon output 0-by DC (This is used on all models for Total Hydrocarbon detector output.
9. Total Hydrocarbon Analyser output as No. 8 but 0-10 mA.
10. Remote temperature input. 0-200 deg.C can be set by applying a continuous voltage of 0-2V DC. 10 mV per deg.C for setting required temperature. (When remote temp. enable is actuated).
11. Remote temperature enable TTL logic 0 (or link to ground).
12. Remote CH4 selection (link to ground).
13. Non Methane output 0-10 mA Models fitted with Option 1 only.
14. Flame out remote alarm SPDT contact No. 1 (normally closed).
15. Flame out remote alarm SPDT common contact.

16. Methane only 0-lOV DC output Models fitted with Option 1 only.
17. Non-Methane output 0-iCy DC Models fitted with Option 1 only.
18. Remote range indication input TTL logic Line 0.
19. Remote range indication input TTL logic Line 2.
20. Remote range indication output TTL logic Line 0.
21. Remote range indication output TTL logic Line 2.
22. Remote range indication analogue 0-by DC.
23. Remote range indication analogue 0-10 mA.
24. Make no connection to this pin.
25. Remote ignition (5 sec. contact to ground).

NOTE all logic TTL levels may use a short circuit to ground (if TTL levels are not available). Connected to return line Pin No. 4.

All TTL logic 1 outputs will drive a transistorized relay (prior to load) connected to return line pin No. 4.

5.6 Installation Procedure

IMPORTANT

This analyser is a very sensitive detector of hydrocarbons. As hydrocarbons in the way of oil and detergents etc. are around us everywhere, it is extremely important that you **DO NOT USE** any contaminated tubing.

If contamination is experienced it will be seen as short term drift on the lowest range but can increase dramatically depending on severity.

Sometimes contamination is left in the sample filter and this leaves a very high background reading, (simply changing the filter will cure this).

1. All Signal gas components are purged in an oven at 250 deg.C. with Air for at least 2 hours. If you have any doubts, telephone our Sales Office or Distributor.

2. **Rear Panel Tube Fittings**
   It is recommended that the tube be inserted into the tube fitting aperture and held firm against the end stop. 1/4" OD tube is required for all fittings except fuel which requires 1/8" OD tube. It is recommended that stainless steel or 0.060" walled PTFE tube be used.

   The tube fitting nut should be rotated clockwise until "finger tight" a suitable wrench should be used to tighten the tube fitting up on the tube and 1 1/4 turns after "finger tight" is necessary. Whenever these fittings are undone, the remaking of these fittings only require that the nut is done up "finger tight" and then "nipped" slightly with the wrench. Do not over tighten at this stage, otherwise the fitting will be damaged.

3. Connect up to the rear panel port marked "FUEL" 112. Set to 30 psi on the supply. (Do not adjust the front panel `locked' regulator).

4. **Air**

   Connect up to the 1/4" tube fitting on the rear panel marked `Air', hydrocarbon free air from a gas cylinder or, alternatively from a compressed air line fitted with a Signal catalytic air purifier Model AS8O. Set 30 psi on the supply regulator. (Do not adjust the front panel regulator at this stage).

5. **Sample**

   Connect up the Sample Gas to the rear panel tube port marked `Sample'. Set approximately 0 to 5 psi on the supply.

6. Connect up the calibration gas to the port on the rear panel marked `Span' where fitted. Set approximately 0 to 5 psi on the supply.

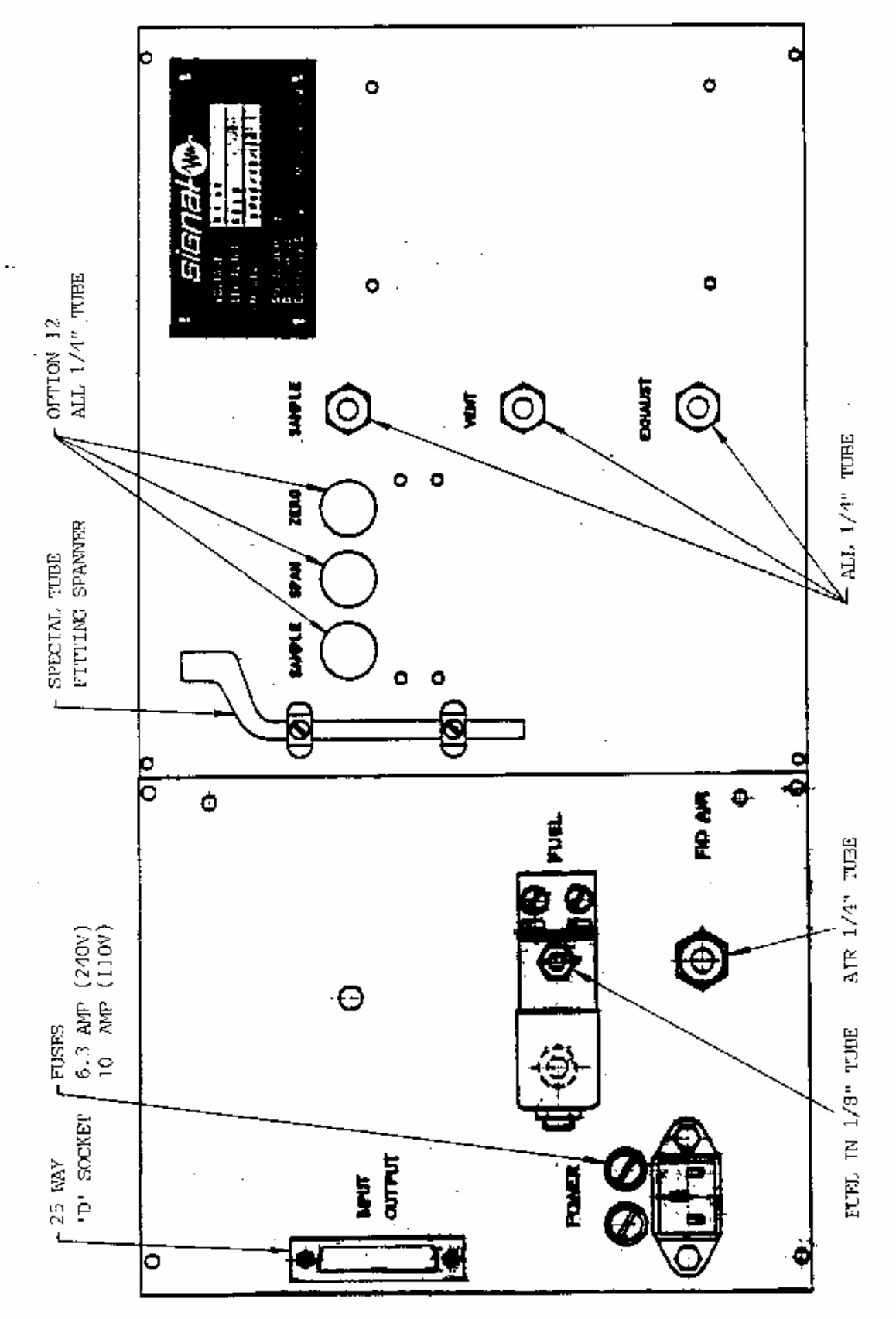
7. Connect up zero gas to the port on the rear panel marked `Zero' where fitted. Set approximately 0 to 5 psi on the supply.
   Always use a calibration gas with air diluent.

8. Connect up 220/240 50 Hz to the power input socket (110V 60 Hz where designated on rear name plate).

9. Connect up to the connector on the rear panel marked "INPUT, OUTPUT ports" the appropriate recorder and data acquisition connections.

10. The detector will produce water vapour which will condense in the detector vent tube. Under no circumstances connect a vent tube to the detector vent bulkhead connector on the rear panel which rises above the level of this bulkhead connector; otherwise water will collect in the tube and cause interference on the detector. If you need to vent the detector gas away from the place of operation always ensure that the vent tube slopes downwards.

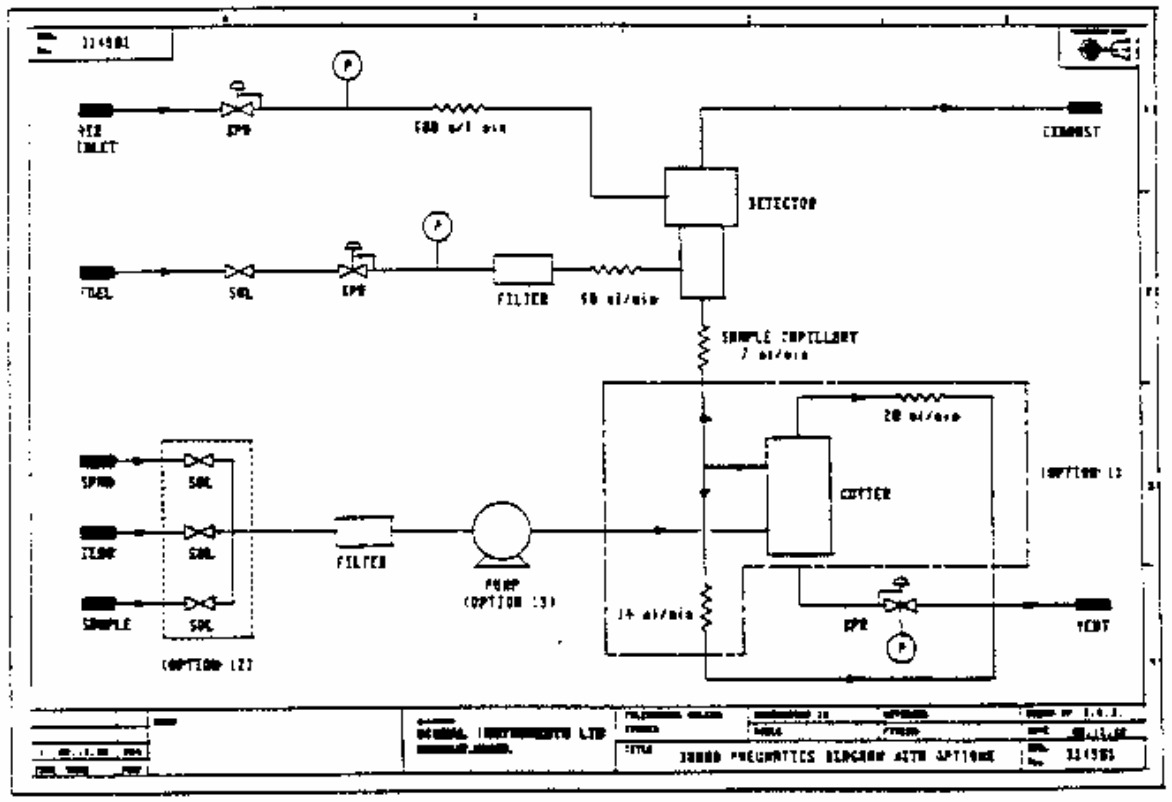
5.7 Rear Panel Layout



6 PNEUMATIC DIAGRAMS

6.1 Flow Control Circuit

6.2 Flow Control Circuit with Options

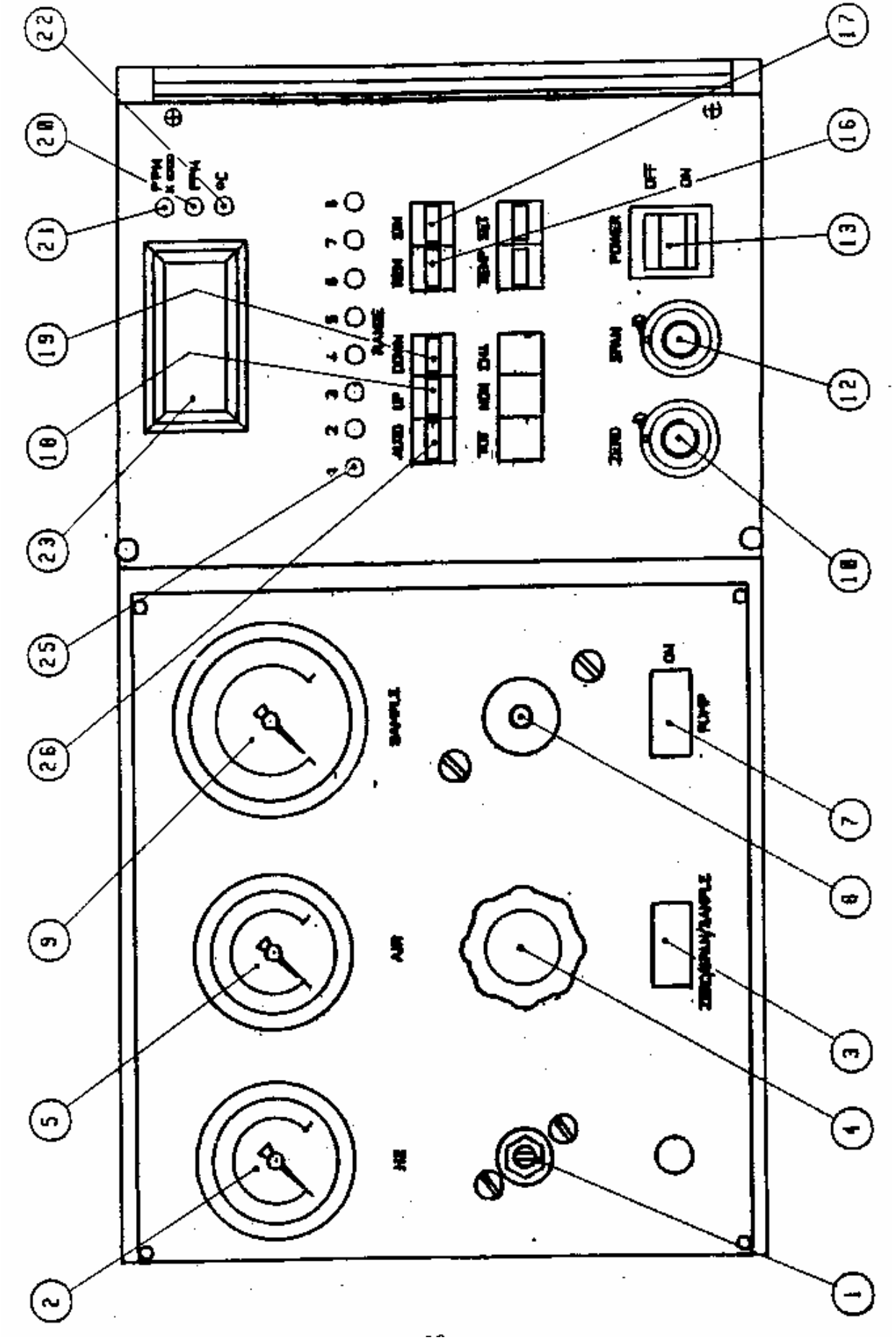


7. SETTING UP & CALIBRATION

7.1 Front Panel Layout

1. Hydrogen Pressure Regulator
2. Hydrogen Pressure Gauge
3. Zero/Span/Sample gas selector switch (option No.13)
   Left - Zero Gas,Centre = Span Gas, Right = Sample Gas
4. Air Pressure Regulator.
5. Air Pressure Gauge.
6.
7. Sample Pump ON/OFF switch (Where fitted).
8. Sample Pressure Regulator.
9. Sample Pressure Gauge.
10. Display Zero Control.
11.
12. Instrument SPAN Calibration Control.
13. Mains Power ON/OFF Switch.
14.
15.
16. Range remote switch (only takes back local control) (see Data Acquisition section for explanation).

17. Detector ignition switch (Light illuminates with flame being ignited or during the first 5 minutes flame out override after pressing ignition button).
18. Range upward change switch.
19. Range downward switch.
20. Display PPM light.
21. Display x 1000 multiplier light (When this illuminates, multiply the reading on the display by 1000).
22. Display deg.C light.(This illuminates when either the Temp or Set switches have been pressed.)
23. Display directly in PPM (Or PPM divided by 1000 when PPM x 1000 light is illuminated).
24.
25. Range selected indicators.
26. Automatic range change select (when pressed the range will change within preset high and low limits for recorder output of range selected). (See installation instructions).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3
4
1
POWER
SPAN
ZERO
PUMP
SAMPLE
AIR

7.2 Setting Up Instructions

1. Connect up mains supply to rear panel of instrument – check serial number plate for power requirement.

2. Switch power ON the front panel.

3. Allow 30 minutes to warm up.

4. Connect up fuel and air supplies as indicated. Set both input pressures to 30 psi and ensure that no leaks are present.

5. Press the "IGN" button. The light of the "IGN" switch will illuminate to signify that the flame-out circuit is overridden. This will automatically open the fuel valve. Allow 3 minutes for fuel to reach the detector.

6. Check the air and fuel front pressure gauges and ensure that both indicate a nominal reading of 10-15 PSIG.

7. Ad-lust zero dial fully clockwise and set span to approx. 7 and switch range to No. 2. Turn the air pressure regulator gradually anti-clockwise to obtain a steady reading of 8 psig. Press button marked "IGN" until the LED bar graph shoots across to the right. Turn the air pressure regulator clockwise to obtain a steady reading of 15 psig on the air pressure gauge.

8. Allow a further 5 minutes for the baseline to settle and introduce span and zero gases using the sample/cal switch located behind left side door panel. (This facility is option No. 13). Select left side of switch for zero gas, centre of switch for span gas and right side of switch for sample gas.

   Select zero gas (hydrocarbon free air from Signal Model AS80) and set LCD display to zero by adjusting the zero potentiometer.

   Select span gas and choose an appropriate range to match the gas concentration. Adjust span potentiometer so that meter reads correct gas concentration.

9. Switch on pump (if applicable). Allow sample gas to flow. This is shown on the sample pressure gauge which should show a steady reading of approx. 3 psi - but see instrument test sheet for optimum factory set flow. Contamination will cause a very high background and the instrument will need servicing if this occurs.

10. The display on the front panel is used by reading directly in ppm. It is necessary to note that when the highest ranges are selected on this model, a ppm multiplier comes in which is displayed when the LED marked "PPM x 1000" is illuminated.

    When this LED is illuminated you simply multiply the reading by 1000.

11. To change the range press the "up" or "down" button and note the LED which illuminates, this LED indicates the range. 1,2,3,4,5,6,7,8 corresponds to 4,10,40,100,400, 1000, 4000, 10,000 ppm on the Model 3000A.

    NOTE: The LED Display is set in ranges of Decade formation i.e. 0-10, 0-100, 0-1000, and 10,000 ppm.

    The range numbers 1, 3, 5, 7 are intermediate ranges for chart recording purposes only. They are 0-4, 0-40, 0-400, 0-4000. It is intended that these ranges are used whenever the output readings from the instrument are in either extreme of zero or full scale on the decade range which has been selected i.e. if the reading on the chart recorder was 9 ppm, then switching to the next decade would put it at only 9 ppm in 100 range. Selecting the 40 would set the recorder pen nearer mid-way. - This is particularly useful when using the Auto-range.

12. Auto-range Change Pressing the "Auto" button will facilitate an automatic range change facility.

7.3 Calibration

The FID flame produces a standing current with no hydrocarbons being present. This standing current is normally offset using the "zero" control, on the front panel. This "zero" control injects a reverse current into the detector which "backs off" the existing current to zero. The zero control is therefore independent of the amplifier gain setting (span control).

Selecting Span and Zero Gases

The option No. 12 in the Signal sales catalogue is for a dual gas selector.
The switch No. 3 behind the left side door panel is used to select each of these three gases:
The left side selects zero gas, the centre selects span gas and right side selects sample gas.

The zero control is set when using a zero reference gas. This zero reference gas should be Hydrocarbon free air. (Preferably using a Signal Model AS8O Catalytic Air Purifier).

The amplifier gain should be set against a Hydrocarbon gas of known concentration. This hydrocarbon gas should have an air diluent.

The amplifier gain will remain such that the response is linear throughout the range of the instrument and that a true zero back off in the detector will remain at zero throughout any range on the instrument. If, however, the zero setting was inadvertently set to + l ppm, this would add to the analyser reading 1 ppm throughout its range, it would not alter the gain setting and therefore change the response axis.

NOTE: See paragraph 3.1 for information related to detector response to gas carbon number.

The amplifier gain control "SPAN" on the front panel has enough range to cover Methane calibration at one end through Propane to Hexane calibration at the other end.

8. SERVICE INSTRUCTIONS

In order to maintain this instrument in a fully operational manner and to keep it working in accordance with the published specifications, the instrument must be fully serviced every 2700 hours of use. This is 4 months in continuous operation.

Servicing must be carried out by the factory or alternatively an authorized service dealer. A service maintenance workshop manual is available for those customers who wish to carry out their own servicing.

If 2700 hours elapse during the first 12 months, warranty for this instrument is only applicable, if the instrument has been serviced by the factory or an authorized service dealer or if prior arrangement in writing has been made with the user for customers wishing to carry out their own routine servicing. The following parts should be ordered with the service workshop manual, and a list of special instruments and tools is also available upon request.

8.1 SPARE PARTS

Spare Parts Kit - Suitable for one year's operation (Part No. 3000/314010)

Comprises: -

Tube Filter
7010 Diaph. Flap Valve & `0' ring
Valve Viton for 7010
`0' Ring 34.65 x 1.78 Viton
`0' Ring 3.68 x 1.78 Viton
Fuse (Power supply Board)
Fuse (Mains in) 6A
Ignition Coil
1/4" Nut Brass
1/4" Ferrule Brass
1/4" Nut St.St.
1/4" Ferrule St.St.
1/8" Nut Brass
1/8" Ferrule Brass
`D' Type Scr. Down Cover
Sample Capillary
Fuse (Mains In) l0A

Spare Parts Kit - Additional - (Part No. 3000/314020)

Comprises: -

Spares Kit as above
Detector Jet
Cardboard Box
Signal Spares Label
Self Seal bags
Jointing Compound
1/4" Male Connector
1/8" Male Connector
Grade 100 Filter Disc
`0' Ring
`0' Ring
M4 Bonded Seal

The service schedule is as follows:-

1. Strip down and clean detector and replace, if necessary, the jet.

2. Replace the pump diaphragm and reed valves (if pump is fitted).

2a Re-grease the pump bearings.

3. Replace the sample/calibration valve seals and seats (if valve is fitted).

4. Replace the sample filter.

5. Remove and clean the fuel and air filters.

6. Re-optimise flows of fuel and air.

7. Check operation of fuel and air regulators.

8. Check and re-align, if necessary, the operation of the electrometer, amplifier and the auto-range changes.

9. Check and replace, if necessary, the relays for flame-out, ignition and flame-out alarm.

10. Check the calibration of the temperature control circuits.

11. Carry out 24 hour zero stability check.

12. Carry out 2 hour span stability check.