This manual describes the history, circuitry, setting-up and operating instructions for the MRL Smoke Chamber IR Scanning Radiometer (2 to 15 μm waveband) for the Australian Smoke Programme. It describes in detail the progress over a number of years of the modifications required and the reasons for these modifications from the original design in 1979.
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1. INTRODUCTION

The smoke chamber, which is situated at MRL, was built and developed to investigate the transmission properties of current and novel obscurants. The chamber can be used to investigate transmission in the visible and infrared, up to 15 μm.

This manual should be used as the current working and maintenance manual; it contains sufficient detail to duplicate, set up and maintain the facility.

Earlier reports describe the associated data logging system (ref.1) and the philosophy behind the smoke chamber (ref.2).

2. HISTORY

This transmissometer system was developed in 1979 in ERL (IOC Group) as its contribution to the Australian smoke programme. MRL's contribution is the running of the Smoke Chamber and testing and development of various obscurants.

The visible and short waveband IR region was measured by using several discrete passband filters switched into the optical train in turn, and the IR band from 2 to 15 μm by using a continuously rotated Circular Variable Filter (CVF).

For the IR system, since low level signals were contemplated, synchronous detection was chosen as desirable, and because of the wide spectrum (2 to 15 μm) a Golay cell was required as the detector, this being the only available detector to conform to low level signals, wide dynamic range and wide spectral response.

The IR source needed to have a large proportion of IR content, and so the choice was between a glow bar from Oriel, or a Nernst Glower (NG). A NG was chosen because of its higher temperature output above 1000°K. Two suppliers of NGs are Perkin Elmer and Barr and Stroud (used in the Beckman IR4 Spectrometer).

At the time of system design, an Oriel Circular Variable Filter set (CVF) was available with the required accuracy in wavelength and transmission and was used to design a three filter set covering a range of 2 to 15 μm in the three sections:

(a) 2.46 to 4.48 μm;

(b) 4.47 to 8.04 μm; and

(c) 8.24 to 14.57 μm.

Initially this system was designed to use a chart recorder and the appropriate data reduction carried out at a selected number of points, with the idea that in the future a computer data logging system would be used: hence the CVF has a graticule marked in 100 pulses/marks/segment, but only every one-tenth could be used by the chart recorder.

The concept was to note 'no input' reading level from the Golay cell, with the NG blanked off. The system and chart recorder are then started and the reading level recorded with no smoke present ('no smoke' run). Smoke or other obscurant is then introduced into the chamber and a set of measurements called the 'smoke' run are recorded. As noise is a problem, several sets of readings, ie several revolutions of the CVF, need to be taken and each point
(ie each wavelength interval) averaged for both 'no smoke' and 'smoke' runs. There are usually 3 and sometimes 5 revolutions of the CVF to be averaged in this way.

2.1 The electronic design

A standard laboratory synchronous detector circuit was used, taking its reference from the Oriel chopper at the Nernst Glower end of the transmissiometer, and generating an ac signal at approximately 15 Hz. A 15 Hz chopping frequency was chosen since the Golay cell cannot adequately follow signals faster than this, and still retain sufficient gain. This factor dictated the speed at which the CVF could revolve.

The system wavelength resolution is defined by the size of the image focussed on the CVF, the limited speed of response of the Golay cell, and the scan rate of the filter. Sampling at the rate of 458 samples/complete revolution in 33.3 s provided a resolution of 100 samples/filter segment, in a time sufficiently short to prevent significant changes in the obscurant sample, such as settling(ref.1).

A mass produced IR source and detector were available from Hewlett Packard as an integral unit, with quite high resolution and speed. This HEDS1000 was used for reading the CVF graticule using a comparator IC LM311 with a small amount of hysteresis. The signal was, however, too fast for the chart recorder to follow and so each 100 pulse train was divided by 10, using a time-out/reset circuit which incorporated a gated free running oscillator into a counter, the output of which triggered the 'synchronisation pulse detected' monostable which is set for 1.5 s pulse. The same triggering action resets the divide by 10 counter.

The signal from the Golay cell was ac amplified through a low noise amplifier with a gain of 5, before being synchronously detected; some gain and isolation being necessary to get sufficient signal to be handled by the synchronous detector, and prevent loading of the high impedance Golay output signal by periodic clamping of the synchronous detector, respectively. This dc signal from the integrating synchronous detector was passed down a transmission line to the chart recorder. Since the chart recorder could not follow signals greater than a couple of cycles, this system appeared quite satisfactory.

Deflections corresponding to transmission at each wavelength of concern were measured from the chart records and tabulated for 3 runs, and then averaged. A 'no smoke' or clear air run, and a 'smoke' or obscurant run were manipulated in this way before the mass extinction coefficient for each wavelength could be calculated. Since the mass extinction coefficient is calculated from ratios of 'smoke' and 'no smoke' readings, absolute readings were unimportant, as long as the signal was greater than the noise and precautions were taken to prevent amplifier 'bottoming' during current alignment. Therefore long term deterioration of the IR source or the detection system was basically unimportant: short term drift, however, could cause errors.

To minimise these errors the Nernst Glower was set to run at a (low) colour temperature (1000°K), and for stability a dc power supply was designed using the constant current collector characteristics of the transistor. Since the original Nernst Glowers were sintered, switching on and off resulted in a high failure rate, and so when not in use the Nernst Glowers were put in 'standby' mode, using sufficient current to keep them self sustaining. This meant a running current of 0.7 A and a standby current of 0.2 A for the 3 mm diameter Nernst Glower.
The original Nernst Glowers used were probably spares from the Beckman IR4 spectrometer of 1.5 mm diameter: these required 0.6 A to run at 2100\(^\circ\)K, and 0.2 A for 'standby'. These Nernst Glowers were superseded by the Perkin Elmer type No 221-0451, a true ceramic, which is 30 mm long and has a diameter of 3 mm, requiring similar currents able to run at 1000\(^\circ\)K.

Both Nernst Glowers require heating to start them, and until recently heaters from the Beckman IR4 were used - these required some 5 A at 10 V.

The Nernst Glower housing and lens assembly were modified Oriel types Nos 6361 and 6362 respectively. Mica brackets held the 'glower and heaters in position, and not being mechanically reliable needed mica wedges to separate the elements to their desired positions subsequent to any movement and/or installation.

A Nernst Glower is a ceramic mixture of zirconium, yttrium, thorium and other oxides, which is heated externally to 400\(^\circ\)C before it will pass sufficient current to sustain itself.

The Smoke Chamber system was computerised using an LSI 11/03 computer; the PDP 11/34 mainframe was used to develop the programmes which were then run on the LSI 11/03. A configuration was devised to conform to the initial specifications, and was initially oriented to the 2 to 15 \(\mu\)m region which is still the region of main area of interest. After installation, a 'setting up' procedure needed to be closely followed. The initial extinction coefficient results were no better than those obtained using the 10 points measured from the chart recorder, but subsequently the system was improved to such an extent that the test results from various calibration filters eventually conformed remarkably well with published data, as various problems were identified and solved.

2.2 Future developments

Since the electronics are spread over several boxes and parts of the system are duplicated and or redundant a tidier electronic design, which is functionally identical to the existing system, is contemplated. In the event of a catastrophic failure, it is desirable that the existing system can be readily replaced by this updated version.

Also, since the Golay cell is expensive and has a comparatively slow response (25 Hz), a faster detector system should be found, which would then increase the speed of data logging by at least ten times. This should make the system perform closer to a real time situation ie less probability of particle differential fall-out due to the 33 s CVF revolution.

Another point to be considered is the heating of the Platinum NG heaters which will probably require a constant current source because of the wide tolerances of the CZ12 NTC resistors used: ie their heating time constants appear to change by at least 3:1, which causes problems.

3. PRESENT SYSTEM DESCRIPTION

3.1 Source

The Nernst Glower housing is still being developed. The original housing was one from the Oriel range but modified to hold the Nernst Glower. A new chopper which was installed in the side wall caused noise and vibration so this was changed to a vertical mounting. (Vibration will reduce the life
of the Nernst Glower and so resonances had to be eliminated by muffling or design.) A 5 mm square aperture is placed at the focal point of a bloomed germanium transmitting lens. (See figure 1).

A Nernst Glower is designed to operate in air at a temperature of 2100°K (1827°C). What appears to be a polarising problem within the Nernst Glower, when using a dc power source beyond 0.8 A, is eliminated by using a controlled ac power supply. This ac power supply was designed to drive the Nernst Glower from its "dc @ 1000°K" capability to an upgraded limit of 2000°K. This alone should give a 4:1 increase in useful IR energy in the range 2 to 15 μm.

The Nernst Glower has a negative resistance coefficient with a slope -7.3 Ω/A at an operating temperature of 2100°K, the current required being 2.1 A. Therefore the Nernst Glower power supply needs to deliver 92 W, but to first 'strike' the Nernst Glower a voltage in excess of 70 V is required. (See figure 2).

A Cadmium Sulphide (CdS) detector is used as the sensing element for luminous flux control. This detector is in a bridge circuit with the $I_{NG \text{ SET}}$ potentiometer feeding into a high gain operational amplifier ($A_v = 100$), then to the controlling transistor network to the magnetic amplifier. Circuit layout problems have been taken into consideration (ie earth loops considered).

The power supply is a controlled current unit using a magnetic amplifier, which was designed in AEL, for control from a single transistor. This magnetic amplifier has been designed to produce a near sine-wave output even when operated at maximum dc input (which provides maximum power to the NG). The objective of the smoothly varying ac waveform was to minimise rapid current changes and to prevent build up of polarising effects in the NG.

Another problem which is not normally encountered is the heaters required to start the NG. Since the NG runs at such a high temperature, platinum heaters were the choice of the NG manufacturers. This material has a large positive temperature coefficient such that at the running temperature it requires 60 V at 2 A (30 Ω) but when cold the resistance is much lower and it draws excessive current from the transformer. Therefore a Negative Temperature Coefficient (NTC) resistor had to be found that could handle 2 A while running; its resistance has to drop to parts of ohms when hot, and be at least 30 Ω resistance when cold. A CZ12 was the only device available.

Once the NG became self sustaining the heaters needed to be switched off, and so a unique method was devised to achieve this. Using the forward voltage drops across 3 diodes (1N5626), and a small bridge rectifier and smoothing capacitor, to give a dc 'signal'; an opto isolator of the type H13A1 was used to sense the NG current. The sensed $I_{NG}$ is fed into a comparator which is set to switch at $I_{NG}$ greater than 0.3 A, which is the minimum sustaining current for the NG. A solid state relay is used to switch off the heaters - this method cannot burn contacts and is a zero voltage crossing switch which reduces RFI potential problems.

3.2 Chopper

A controlled chopper was decided to be necessary and a loudspeaker was found to have the appropriate characteristics. A 12 W 8 Ω high resilience loudspeaker has the necessary depth of throw and frequency response with
the power to drive a chopper blade over a 7 mm distance. The shaft should be longitudinally polished to reduce wearing of the bearings, and the chopper positioned vertically, also to reduce bearing wear, but more importantly to reduce vibration and noise. (See figures 1 and 3).

The chopper driver consists of two transistors, one of which biases the chopper blade from half open to fully open, and the other drives the blade fully closed, on command.

Adjustments for various choppers (resilience change) is controlled by either paralleling 27 Ω 12 W resistors to adjust the 'opening' bias, and/or to series 1 Ω 12 W resistors for driving the blade closed. Normally this circuit and chopper combination will function up to 50 Hz, and some as high as 70 Hz: the requirement, in fact, is only 15 Hz (13.7 Hz). No other device so far has been found to give at least 5 mm throw and at least 20 Hz response.

3.3 Sampling and detection

The radiometer consists of various parts - some mechanical, others optical and electronics (see figures 4 to 7, Table 1).

The electronics block diagram (and schedule) are shown in figure 8 and Table 2.

IR radiation from the NG crosses a 5 m path length and enters a germanium lensed telescope focusing on a slit 1.2 mm wide with the CVF wheel directly behind. The resolution varies with the filter segment in use and is 1.99 x 10⁻² μm, 3.67 x 10⁻² μm, 6.4 x 10⁻² μm respectively, as resolved by the computer(ref.1,2).

Being a pneumatic operating device, and therefore its microphonic nature, the Golay cell is mounted on an antivibration mount. It is positioned behind the CVF (see figures 9 and 10).

The chopped IR energy, being generated by the 'driver chopper', is amplified within the detector housing before being cabled to another low noise ac coupled amplifier which feeds into the synchronous detector system.

The CVF is driven via a gearbox from a mains synchronous motor and the CVF wheel takes 33.3 s to turn one revolution. The CVF is a 3 segmented filter set, set in a wheel to which is attached a glass rim with a vacuum deposited nichrome graticule which has 100 marks/segment, and a synchronising mark just prior to segment No 1 (see figures 11 and 12). These marks are detected using a HEDS1000 light and detector unit (see figures 13 and 14) which has a sharp focus to detect each mark as it passes through its operating field. The signal is 'squared up' using an LM311 comparator, the output of which is termed 'Read Pulses'. (The HEDS1000 was originally designed by Hewlett Packard to be used in bar code readers).

These 'Read Pulses' go to four areas, one being the synchronous detector; another the data logger, the third area generates a more suitable pulse train for writing on the backup chart recorder, and the fourth area generates suitable delays and pulse widths for the controlled chopper (and the synchronous detector) (see figure 16). The chart recorder can only resolve one-tenth the 'Read Pulses' speed and so a divide by ten circuit is used, with a pulse stretching monostable generating a pulse suitable for
use with the chart recorder. This circuit has a gated (by the Read Pulses) oscillator and counter which gives a 'carry out' signal only on the synchronising pulse (see figures 15 and 26).

The 'Read Pulses' from the HEDS1000 comparator latch the synchronously detected IR signal into a sample and hold circuit (see figure 16). This had been found necessary since the synchronised signal is only valid at one point in time, due to the Golay cell response and the synchronous detector type used, so the chart recorder printout is basically a stepped trace.

It should be noted that electrically, the Read Pulses are shifted one pulse which would cause the apparent CVF position marker to be out of step with the IR signal; but since only 96 of the 100 pulses available are used, the software takes this apparent discrepancy into account by only using, and aligning the correct wavelength position of the CVF. Hence the software looks at 100 pulses, but ignores one pulse at each end because of non linearities at the filters ends. The first pulse, however, is used to initiate the chopping sequence. The chart recorder cannot resolve less than 4 pulse widths and so was not affected by this problem in the past.

Timing and phasing of the various driver signals derived from the CVF Read Pulses need to be tuned for maximum signal from the Golay cell, and so are probably more complex than need be.

The timing is initiated from the CVF Read Pulses HEDS1000 comparator circuit. As it has been said before, it branches to four main areas: the one considered now is to the synchronous detector circuitry (see figures 17 to 21). This has two delay branches, one delay approximately 30 ms triggers the chopper driver at the NG end; the other delays and 'latches' the synchronous detector - an initial delay of approximately 5.5 ms and then a 31 ms 'on' time for the synchronous detector.

These three delays (monostables) are tuned so the computer does an analogue to digital conversion at the peak of the IR signal, (see figure 22). The top is comparatively flat, and the edges can and do vary in time due to the variation in spacing of the CVF graticule marks.

3.4 Power supplies

The power supplies need not be described in any detail as they are fairly standard, mostly of the IC type. However, the Golay cell power supply (see figures 23 to 25) can be classified as a high loss (high impedance) type which relies on a high voltage (approximately 130 V dc) and large resistors (18 kΩ) for filtering, and the output only becomes 24 V when loaded with the appropriate Golay amplifier circuit. That is, the filtering in particular divides down the ripple content. The Golay's 'lamp' power supply, however, is a discrete component circuit. This lamp circuit also incorporates a constant current device (within the Golay cell housing).

4. COMPUTER INTERFACING AND CONFIGURATION

4.1 Computer system hardware

The computer data logger is an LSI 11/03 Q-bus frame and CPU, with a parallel card, two serial cards, and analogue to digital conversion card DRV11, DLV11, DLV11-J, DT2764 respectively, talking to the outside world (see figure 27). The serial cards DLV11 and DLV11-J talk to the console
(keyboard and VDU), plotter and printer, all through software 'handlers' and so are not normally associated directly with user control. DEC standard addressing is normally used.

Because 'bit 15' can be easily read by the Macro instruction TST the parallel card 'DRV11 bit 15 input' is the logical bit to use to fast read the pulses from the CVF Read Pulses.

The DT2764 is a 12 bit analogue to digital converter card specifically designed by Data Translation to suit the DEC/LSI Q-bus. It has been configured for single ended input, which then dictates that 16 channels are available (the first channel is used), and an input voltage range of ±10 V, using 2's compliment at the output. This gives the ADC output to input range of 2047 (decimal) equivalent to 9.99 V, and -2048 (decimal) equivalent to -10.0 V.

It should be noted that the computer must be switched on before the Golay cell radiometer output becomes meaningful, as the computer, when switched off, loads the CVF Read Pulses, and prevents them from being read even by the chart recorder.

4.2 Chart recorder backup

The chart recorder used is a Curken model 250-3A. The radiometer electronics produces the 'divide by 10 Read Pulses' which use channel No 1 of this 3-pen X-T recorder to display the 'position' of the IR on the CVF. A trace of about 20 mm high is sufficient, and this allows the majority of paper width to be used for both IR and visible radiometer results. Channel No 3 records the visible radiometer which has ten filter positions, but three are used, namely, eye-response, 1.06 μm, and 0.72 μm filters; while channel No 2 shows the IR vs wavelength response. The visible radiometer system has not yet been incorporated in the computer system.

These three signals should be carried from the radiometer table at the end of the smoke chamber to the computer room, which also houses this chart recorder, via twin shielded cables, to reduce interference both into and out of the cables. Earth loop problems are reduced by referring the signals back to the radiometers, and only earthing the shield at one place. A 10 kΩ or higher resistor could be taken from signal return to earth to prevent signals floating.

5. SETTING UP/TUNING THE SYSTEM

To obtain the best possible performance from this overall system, each stage needs to be individually optimised and then collectively tuned. Using the proposed methods, an increase of perhaps five times in sensitivity could be achieved, compared to only trimming the sections individually. The radiometer only 'takes' relative readings and so overall trimming improves the noise figure and dynamic range; the accuracy is basically unaffected.

5.1 Nernst Glower

The Nernst Glower needs to be run as hot as possible without melting its connecting leads. The top lead is subjected to more heat stress via radiation and convection than the bottom one, and so an empirical method is used to determine maximum Nernst glower temperature (see figure 28). Platinum, the lead material, melts at 1942°K but is approximately 3 mm away from the Nernst glower which could therefore be run 200°K higher. The better scheme would be to keep the leads well below their melting point and have the Nernst Glower temperature set to about 2000°K or 1730°C (which can
be read on an optical pyrometer). For this temperature to be reached, the Nernst Glower needs a current of 1.8 A. With efficient reflectors this current may be reduced, and possibly a decrease in temperature could be tolerated. A four times improvement in IR energy is sought compared with the original dc drive and 1000°K response.

To adjust the Nernst Glower power supply (see figures 29 to 32): set the 'run/standby' switch to 'run', set the 'set standby current' potentiometer to maximum resistance, set the 'heater off' potentiometer to the 'high' side (positive end), and set the Nernst Glower current potentiometer to approximately 1 kΩ (one-fifth of maximum resistance). Place a voltmeter across the heater transformer primary, setting the meter for 250 V ac range. On switching the mains, the 'mains' indicator should glow, and no volts read on the meter. Turn the 'heaters off' potentiometer down until the meter reads mains voltage of 230 V ac. The heaters will take about 20 s to begin to glow, and heat the Nernst Glower. This delay is due to the CZ12 negative temperature coefficient resistance (NTC) which prevents current surge into the platinum heaters. After about 90 s the Nernst Glower comes up to temperature as set by the $I_{NG}$ potentiometer; there is normally an overshoot of perhaps 0.3 A for a second before dropping back to its set running current. The heaters should also have switched off (ac voltmeter reading). The Nernst Glower current should be about 1.4 A. Switch to 'standby', and adjust standby current to 0.3 A with the 'standby' potentiometer; the heaters should not switch on at this level. Reduce the 'set $I_{NG}$' potentiometer so $I_{NG}$ drops to 0.2 A and then adjust the 'set heaters off' potentiometer until the heaters switch on (ac volt meter). Before the heaters begin to glow, readjust the $I_{NG}$ potentiometer back to 0.3 A, whereby the heaters should again switch off. Put the power supply into the 'RUN' mode and readjust the $I_{NG}$ potentiometer to set the current to 1.6 A. (This reduces the IR level somewhat but increases the Nernst Glower's life - unless more IR is really required).

This power supply should then be ready to use.

The Nernst Glower bar or heater wires should never be touched because contamination can destroy these parts.

5.2 Chopper

The chopper needs to be checked for proper operation. With the Nernst Glower lens assembly removed (the 85 x 60 mm flanged tube), look at the chopper blade to determine its rest position (see figure 1). It should be approximately half way across the 5 mm square aperture. Switch on the NG power supply (with chopper connected) and note that the chopper blade should pull down and fully open the aperture. Drive the chopper input terminals with a 0 to +5 V square wave at 15 Hz, and note the swing of the chopper blade. It should fully close off the aperture. There are two points to watch while trimming this:

1) the blade should have an overall travel of 6 mm minimum and completely open and completely close the aperture; and

2) the chopper should not bottom on its housing in either direction.

If the chopper travel is critical then both mechanical and electrical adjustments are required. Mechanical adjustments could take the form of shims under the chopper housing, or replacing the blades (and this is not recommended). Electrical adjustments are simpler.
Without any square wave signal the chopper should open the aperture; however, if it closes then the chopper drive leads are crossed. If the opening travel is not far enough (or too far) adjust/pad the 27 Ω resistors. When driving the chopper circuit with a 15 Hz 5 V signal adjust the 1 Ω resistors to effect sufficient travel of the blade.

5.3 Source collimator lens

The lens assembly is replaced, and the NG and lens pointed such that at least a clear 3 m path length is needed for collimating the IR beam. The area should be darkened to IR signals so that stray signals will not be read by the aligning IR detector, and mark the receiving area to show limiting (and centre) positions of view of the NG assembly. The objective is to get as small and uniform a spot as possible which is both round and has the IR level consistently flat over that area, by adjusting the focus of the lens. A hand held PbS detector circuit is suitable as an indicator for this procedure. Refer figure 33. The IR beam axis should be determined and a line marked on the source housing to aid alignment with the Golay radiometer's telescope. This position is trimmed later when overall system tuning is carried out.

5.4 Sampling indicator (read pulses)

If the CVF HEDS1000 detector needs to be shifted/adjusted, then the computer must be recalibrated. Focusing of the HEDS1000 detector needs care. Measurements are taken from the top face of its housing and are typically 4.27 mm to target surface. There may be a variation of 0.5 mm for maximum signal for best focus, and so the focus distance should only have a ±0.2 mm discrepancy from its natural focus; its image diameter is 0.17 mm. The central wavelength of the detector is 700 nm. There is no adjustment for the HEDS1000 after it is soldered into position, so this information must be implemented precisely for aligning (installing) a new detector. In service, using the glass substrate with nichrome markings (see figure 12), its output to the LM311 comparator should be in the order of 0.9 V PP with an average/dc level of +1.4 V dc (see figure 13). This 1.4 V dc is also the level at which the comparator is set. 'No signal' is equivalent to 'low' V out. This signal is available at the rear end of the Golay cell housing on a BNC connector marked 'Read Pulse' (see figure 6).

(a) The CVF itself houses three Δλ segments (see figure 11); however, Nos 2 and 3 sections have been installed back to front and only give the pretence of normality when the results are plotted. This is corrected in the computer programme, but only needs to be recognised as a phenomenon here.

To adjust any of the Golay's signal path the CVF needs to be put in its maximum transmission position, which is 200° as marked on the position graticule as viewed through the port above the IOC Group's Logo, and the drive motor to the CVF switched off. The 'Read Pulses' lead is taken off the Radiometer, from the synchronous detector, and plugged into the 'CVF Simulator' box (see figure 34)*. This then gives a constant output from the Golay cell that for all intents and purposes drives the chopper, synchronous detector and computer as though the system is fully functional.

* Available at Electronics Research Laboratory
5.5 Golay detector

Since the Golay cell box should never be opened, only a superficial description needs to be given. The Golay cell is a pneumatic cell that changes its volume when energy falls onto its input window; the cell wall on the aft side moves and deflects a light beam from a constant current light emitting device. There are two sections to the Golay 'electronics', one being the light emitter and detector, and the other is the low noise dc amplifier. The cell itself, of the Golay cell, comprises two sections with a slow leak between them. When in the presence of a high ambient energy source the working part of the cell can go into a nonlinear region, but recovers, so the built in preamplifier will also work over its linear range. The signal of concern 'rides' on the ambient light level. The signals to date are in the order of 6 mV PP of random noise (no IR input) and 600 mV PP for maximum signal.

5.6 Detector telescope

The Golay cell's telescope should not need to be adjusted, but may be cleaned with an alcohol dampened soft cloth, being careful not to scratch the germanium lens's bloomed surface. If need be, the telescope is focused by using the CVF Simulator, tuning the telescope for maximum Golay cell output. Since the optical and mechanical axes are not coincident if this focus is varied, then the whole system needs to be recalibrated.

To 'point' the radiometer for maximum signal the CVF Simulator needs to be used while the CVF itself has been set to the 200° mark and the motor switched off. The Golay output is monitored by a CRO, and the whole housing moved/wedged etc for maximum output (the objective being to centre the telescope objective lens in the beam from the Nernst Glower, and to ensure that the lens axis is sufficiently aligned with the beam axis to maximise signal). The electronics can be tuned for maximum output from the synchronous detector.

5.7 Electronic circuit tuning

The IR signal from the synchronous detector gets a final dc amplification with an appropriate offset voltage to force the analogue signal to the computer to be always positive, and not overloaded by varying its gain (see figure 16). Positive 9.8 V should be maximum signal for the analogue to digital converter. Set the offset potentiometer such that with no IR input to the Golay cell, with the telescope 'capped', the output to the A/D converter should now be small but positive - say +15 mV. This should be done with no IR signal, but the CVF itself should be turning. The time at which the computer takes a reading is critical (see figure 22). With too short a time the signal is still rising up to the value, but with too long a time the synchronous detector has begun to 'clamp', preparing for the next signal pulse.

In order to generate the proper timing of chopper drive, synchronous detection and sample and hold circuits, the first (of the 100 pulses in each segment) pulse detected initiates the timing sequence controlled by 'monostable' delays such that the first analogue to digital conversion reading is invalid.

This area of the circuit operation is as follows: when the CVF pulse goes high a Read Pulse is generated which is detected by the computer (and the divide by ten circuit for the chart recorder), and if it is detected as a 'read pulse' and not a 'synchronising pulse' an A/D conversion is performed, and stored. But since on the first pulse (of each segment) the synchronous detection and integration circuitry have not the desired time
scale, this reading would be erroneous. But as well, since this first reading also appears to suffer from edge/end effects (reflections) from the mounting (of the filter segments) and out of tolerance (linearity) of the wavelength vs angular rotation of the filter, this first reading is set to zero, as an error, and therefore not graphed.

The circuit is such that a reading on the A/D converter is taken just prior to the chopper closing off the IR signal at the Nernst Glower (approximately 3 ms chopper reaction time). Timing of the chopper drive monostable is not especially critical, but is a compromise of maximum available signal being effectively read, and settling time for the synchronous detector to define the zero point of the signal. Period is approximately 73 ms, with the chopper-shut time of 30 ms (29 ms).

The synchronous detector needs a delay from this reference edge of 4 ms so the IR signal can be read by the signal reading/latching system before the synchronous detector switches over to admitting the IR signal. The synchronous detector passes this IR signal for 34.5 ms, but the Golay cell will not peak until about the 26th ms; therefore there is only about 3 ms in which the signal out of the last amplifier is at its peak and is there to be read by the A/D converter. Therefore the 'art' of tuning this system is to reduce droop at point a) and make point b) as high and flat as possible (on the sample and hold (S/H) input waveform) using the Read Pulses on the reference edge. (Rising edge latches the S/H circuit) (see figure 22).

5.8 Chart recorder time reference

Because the chart recorder can only follow one-tenth the speed of the computer, the 100 Read Pulses need to be divided down to 10 modified Read Pulses, and the synchronising pulse needs to be broadened. The Read Pulses are put through a divide by 10 counter - a 4017 - which then triggers a 1 s monostable. The 'high' value of the Read Pulses enables the 340 Hz oscillator which is counted by the 4024. Normally the count is cut short by the falling edge of the Read Pulse and resets this counter, but when the synchronising pulse is encountered, the 4024 terminally counts; it resets the 4017 and triggers a 1.5 s monostable. These two monostable pulses are summed and fed to the chart recorder channel No 1.

6. PROGRAMMING

Two programmes MRLV20 and MRLGRP form a suite to obtain and display IR data from the Smoke Chamber.

The philosophy is to keep the current version of the running programme, both MRLV20 and MRLGRP along with IRUN(=1), on the 'data disc' (DK:) which then ensures that the data gathered is relevant, and if an outdated programme is used it should be readily detected by reading the onboard (disc) programme.

The programme, MRLV20, for the Data Logger section was mainly written in Fortran for ease of programme maintenance, and is Menu driven for ease of use. Each selection is a subroutine with a Common Block (of memory) for passing data and parameters. Reference 1 describes the data reading and storing Macro subroutine, READ43.MAC, with sufficient detail to not need describing here. (The listing is in Appendix I.)

MRLGRP uses existing data on disc, and was written to graph not only Mass Extinction Coefficient but also the Raw Data ('smoke' and 'no smoke' readings on the same graph). Also it provides a Percentage graph of 'smoke run' for
comparing filter calibration results for checking system integrity (a 'fall back' system whereby a problem may be solved by using a 'lower level' result).

Since machine limitations (PDP 11/34, VT103/440) negate a single programme editable at one session, these two programmes needed to be suitably divided into several sections and 'linked' (the PDP word for joining and compiling of several programmes to make one large one).

6.1 Graphing routines

(1) MRLGRP.FOR, (figures 35 to 38 show flow charts, and Appendix II the listing), is the filename which comprises the MAIN routine (figure 35) consisting of initialising and setting of data blocks, variables and manipulating the Menu. There are four subroutine calls, selected via the Menu, one for RERUN which reads run data from the disc, and three to RAW (IFIIL) which pass the appropriate flag for the required graph type. 'End Programme' waits a short time before the computer returns to the Operating System and presents the period (.) prompt.

(a) Subroutine LOCLIN ('locate line'), figure 36, draws to the current X and Y coordinates (calculated in the subroutine RAW (IFIIL)) and if the graphing is not out of range will put the 'pen down' and returns to the calling programme; if out of range this subroutine lifts the pen. It is called from the graphing of Extinction Coefficient.

(b) Subroutine RERUN, figure 37, asks for a run number and then loads three files of data from disc into memory; these files are INSNK00.DAT 'no smoke', ISMK00.DAT 'smoke', and ICLK00.DAT 'calculations' (---00.DAT is a run number between 01 and 50) ('background' is not necessary here).

(c) Subroutine CLS, figure 38, clears the Visual Display Unit (VDU) by writing twenty five lines. Mode switching of the VDU is not satisfactory since several VDU types may be used.

(2) MRL3.FOR listed in Appendix III is the filename which holds the

(a) Subroutine RAW(IFIL), figure 39, which is the main graph drawing routine. If IFIL=0 the graph draws Raw Data, a graph of absolute values of 'no smoke' and 'smoke' against wavelength position of the Circular Variable Filter (CVF). (Comparison of this with previous tests can point to system misalignment or contamination.) If IFIL=1 the graph drawn is for Filter Calibration which is the percentage ratio 'smoke' x 100 vs wavelength position of the CVF.

If IFIL = 2 the Mass Extinction Coefficient is drawn; identical to the data logger programme MRLV20.

(b) Subroutine CLIN is very similar to LOCLIN except the limits have been changed. This is called from graphing both 'raw data' and 'filter calibration'.

6.2 Data logging routines

The main data logging programme MRLV20 is formed by 'linking' four editable files; MRLV20.FOR, MRLV21.FOR, MRLV22.FOR and READ43.MAC (listings are in Appendices I,IV,V and VI). (There is a variation of MRLV20 called MRLF20
which allows a greater concentration of obscurant from $\approx 100$ g to $\approx 30$ kg so fog oils may be tried for their extinction coefficients (MRL20's concentration allowed is from 1 mg to 100 g.)

(1) MRL20.FOR, figure 40, comprises the MAIN routine which consists of a 'common block' of RAM (Random Access Memory), fixed data block for generating run numbers for dynamic file name construction, wavelength number generation equations, initialising routines. It reads the current run number stored on disc, and a menu which calls nine subroutines, the 'no smoke' subroutine twice.

(a) Subroutine GRP, figure 41, is the actual graphing subroutine which consists of the 'common block', it assigns the plotter handler to 'logical unit No 3', and then prepares for plotting - such as 'paper, pen, plotter ready?'. (The plotter used is a Houston Instrument DMP-4 A4 size single pen X-Y plotter having a step size of 0.1 mm.) After defining the Origin point the borders are drawn using 'tick' markers for later annotation. Labelling and annotation is followed by printing the appropriate data, and finally the Mass Extinction Coefficient is drawn. The initial position (X and Y coordinates) is determined and LOCLIN is called to position and (normally) to put the 'pen down'; from here each segment is drawn via LOCLIN; 100/points are determined per segment of the CVF, and if out of range the pen is 'lifted'. At the end of each segment the pen returns to the origin. Segments numbers 2 and 3 were installed in reverse, and so the plotter plots these two from right to left.

(b) Subroutine LOCLIN is identical to the one described in paragraph 6.1(a) above.

(2) MRL21.FOR, figures 42 and 43 (listing in Appendix V) holds the subroutines RERUN and ERROP.

(a) Subroutine RERUN, figure 42, reloads data files 'nosmoke', 'smoke', and calculations stored on disc back into memory; and is described in paragraph 6.1(b) above.

(b) Subroutine ERROP(x,x,x), figure 43, an error detecting subroutine, has passed to it two variables which are compared to statistical limits which, if not returned to zero, give a confidence inference of 90% for that particular plotted reading.

(3) MRL22.FOR, figures 44 to 48 (listing in Appendix VIII) holds the subroutine CLS which clears the VDU screen, WEN resets the run number, NUR alters the run number, NSK(IBAK) does 'background' and 'no smoke' data gathering, SK does smoke data gathering, CLC calculates each point, TABUL tabulates results, and FIN updates run number before ending the programme session.

(a) Subroutine CLS clears the VDU screen by writing 25 blank lines to the screen. This subroutine is identical to the one described in paragraph 6.1(c) above.
(b) Subroutine WEN*, figure 44, is used when installing a new data disc. It resets the IRUN counter to '1'. This subroutine reduces the problem of over-running the IRUN numbers, ie it keeps the run numbers below 50.

(c) Subroutine NUR*, figure 45, allows a single key-stroke to increment the run number, or to change the current run number for the purposes of reloading a set of data files from disc, or updating/upgrading data, eg using existing data to patch up an incomplete set of data files. (A calculation file may need to be copied so a particular run number has the three files required for reloading).

(d) Subroutine NSK(IBAK), figure 46, is used to obtain a background file, and a no smoke file. If IBAK=0 a 'no smoke' run is implied; but if IBAK=1 a 'background' run is implied. The main difference between these two 'set-ups' is that the background needs the Nernst Glower blanked off so any hot spots/reflections etc in the Spectro-radiometer and Smoke Chamber itself are noted and then can be subtracted from the 'no smoke' and 'smoke' runs before they are manipulated or stored on disc.

Looking at figure 46 shows minimal differences except for 'averaging' and 'storing'; the main difference is blanking off of the Nernst Glower source, to get a background-reading set of data, the 'numbers' of which vary with the CVF wheel position.

Since time-of-day will pinpoint the run data this needs to be put in by hand because the 'line time clock' built into the computer has been disabled, so timing in the Macro data gathering loop can be guaranteed.

To gain more reliable data, averaging at each wavelength is required, but since memory space is limited a maximum of 7 revolutions, of the CVF, can be stored in RAM before averaging. Normally 3 to 5 revolutions would be used.

When the parameters are set, the Macro READ43.MAC, figures 51 to 58, COLDAT (collect data) is called(ref.1). On returning from COLDAT, each wavelength position is averaged before being stored in the respective disc file. This subroutine NSK(IBAK) returns control to the menu.

(e) Subroutine SK, figure 47, is similar to NSK(IBAK) in that it is used to collect and store smoke/obscurant data. It asks for time-of-day, smoke type description, temperature and humidity in the Smoke Chamber itself, and then the number of revolutions of the CVF required (3 to 5 revolutions) before calling the data collecting Macro COLDAT. Each wavelength is averaged and then background is subtracted before being stored in the smoke array ISMK(I), and finally stored onto disc.

(f) Subroutine CLC, figure 48, calculates the Mass Extinction Coefficient when given the amount of material that was used during the 'smoke run'. The Mass Extinction Coefficient parameters are

* NEW and RUN may be interpreted by the computer as command words which could make it 'crash', so the simplest method is to reverse the words to WEN and NUR respectively.
tested in the ERROP subroutine to determine if the reading is within the 90% confidence area, if not it will be forced to zero where the graphing routine will detect it as an error and not graph that point, but leave a hole in the graph at that position. The ACALC(I) data, date, time, concentration, temperature and humidity are then stored onto disc before returning to the menu.

(g) Subroutine TABUL, figure 49, writes all the data to the VDU. It includes number of revolutions used, date, time of 'no smoke' and 'smoke', temperature, humidity, smoke description, concentration, and the three files of data ACALC(I), INOSMK(I), ISMK(I) against ALAMDA(I).

(This part of the programme has hard-copy printout 'commented out' since there is no readily usable printer in the Smoke Chamber building.)

The programme then returns to the Menu.

(h) Subroutine FIN, figure 50, increments the IRUN counter which is then stored onto disc, after which the programme session (data logging) ends.

To completely describe the MRL Smoke Chamber Instrumentation and Recording System the Macro data gathering and storing subroutines are flow diagrammed in figures 51 to 58.

A breakdown of each flow diagram is:

Figure 51 -
The main controlling Macro COLDAT, with parameters passed, and called from the Fortran;

Figure 52 -
Subroutine READ. It reads and stores one CVF wheel of data;

Figure 53 -
PRMT is a short subroutine which displays a prompt on the VDU;

Figure 54 -
Subroutine ECD is the 'edge change detector' which detects a HEDS1000 Read Pulse;

Figure 55 -
Subroutine CNVT performs an analogue to digital conversion when required;

Figure 56 -
Subroutine TRS controls the data gathering for 100 pulses or readings each segment;

Figure 57 -
Subroutine TIM2 is a software timer which is used in taking intersegment background readings;

Figure 58 -
Subroutine TIM1 is a software timer for 1 ms which needs to be adjusted to suit whatever LSI system is used. Each LSI system has a specific data clock rate which determines the instruction timing.
7. ACKNOWLEDGEMENTS

This radiometer was conceived in October 1979 for the Australian smoke programme by Dr D. Gambling ERL (IOC Group) to determine the effectiveness of various IR obscurants in controlled conditions. The chemistry and chamber structure is the responsibility of personnel at MRL, in particular Mr R. Hancox MRL (EMG Group), and the radiometer (transmissometer) and data reduction responsibility now is Mr O. Scott's at ERL (IOC Group) who also determined the problem areas which were eventually resolved. The electronic system was initially designed by Mr R. Dale, and the concept and optics designed by Dr D. Gambling.
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**Notes**

- **Date**
  - **Original Issue**
  - **Description of Change**
  - **APPD**

**Sheet**

- **No** 4

**PL**

- **99658**

**Page**

- **1**

- **595x827**
TABLE 2. GOLAY RADIOMETER

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<th>FIND NUMBER</th>
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<td>A2</td>
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DEFENCE RESEARCH CENTRE SALISBURY

TITLE: GOLAY RADIOMETER

PARTS LIST FOR 102492002
<table>
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<tr>
<td>1</td>
<td>Ingram, J.D.</td>
<td>&quot;A Data Logging System for the MRL Smoke Chamber&quot;. ERL Special Document ERL-0250-SD, September 1982</td>
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</tbody>
</table>
APPENDIX I

READ43.MAC

; .TITLE READ43.MAC
; OLD .TITLE READ43.MAC
; LINK OBJ OF MRLV20.FOR, MRLV21.FOR, MRLV22.FOR, READ43.MAC
; .GLOBL COLDAT
; .MCALL .PRINT, .EXIT, .TTYOUT, .TTYIN

START:
MOV $0, R2 ; INITIALLY JAMS R2 LOW
MOV R2, R1
JSR PC, ECD
JSR PC, ECD
MOV @CTR, R4
CMP $300, @CTR
BPL START
JSR PC, PRMT
BR START

; ; CRLF3:
JSR PC, CRLF

CRLF2:
JSR PC, CRLF

CRLF:
TSTB @#177564
BPL -4
MOV $15, @#177566
TSTB @#177564
BPL -4
MOV $12, @#177566
RTS PC

; ; PRMT:
JSR PC, CRLF
TSTB @#177564
BPL -4
MOV $45, @#177566
TSTB @#177564
BPL -4
MOV $40, @#177566
RTS PC

; ; CIN:
TSTB @#177560
BPL -4
MOV #@177562, R0
BIC $177600, R0
RTS PC

; ; CO:
TSTB @#177564
BPL -4
MOV R0, @#177566
RTS PC

; ; TIM1:
; 1 MILLISECOND TIMER
**LP1:**
MOV $60, R0

**COM:**
R2
COM R2
DEC R0
BNE LP1
RTS PC

**TIM2:**
MOV $2220, R5

**LP4:**
JSR FC, TIM1
DEC R5
BNE LP4
RTS PC

**CNVT:**
MOV $1, @$177000

**TSTB:**
@$177000

**BPL**
,-4

**MOV**
@$177002+(R4)+

**INC**
@$COUNT+(R4)+

**LLL:**

**ITEM PATCH TO OVERRIDE ADC NON EXISTENT CARD**

**RTS**
PC

**TRS:**
MOV $100, R5

**LP5:**
JSR FC, ECD
JSR FC, CNVT
JSR FC, TIM1
DEC R5
BNE LP5
RTS PC

**ECD:**
MOV $0, @$CTR

**LP7:**
JSR FC, TIM1

**_CMP:**
@$17000,@CTR

**BMI**
LP9

**LP11:**
MOV @$1677774,R1

**BIC**
$777777,R1

**CMP**
R1, R2

**BEQ**
LP10

**MOV**
R1, R2

**RTS**
PC

**LP9:**
DEC @$CTR

**BR**
LP11

**LP10:**
INC @$CTR

**BR**
LP7
; BEFORE THIS PROGRAM IS USED DETSTR INTO R4
; R4 THEN CURRENT STORE LOCATION
; READS ONE REVOLUTION OF FILTER WHEEL POINTS
; INITIALIZE JAMS R2 LOW
; FINDS RISING EDGE
; FINDS FALLING EDGE
; LONG CNT IS SYNC PULSE
READ:
    MOV $0,R2
    JSR PC,ECD
    JSR PC,ECD
    CMP $300,+#CTR
    BPL READ
    MOV $3,R3

LP14:
    MOV $0,R2
    JSR PC,TRS
    JSR PC,TIM2
    MOV $0,(R4)+
    JSR PC,CNT
    MOV $0,(R4)+
    DEC R3
    BNE LP14
    MOV $0,(R4)+
    MOV $0,(R4)+
    LP13:
    RTS PC

; COLDAT:
; READS & STORES 'ONE REVOLUTION' OF DATA
; TIMES THE NUMBER OF REVS REQD.
; DISABES INTERRUPTS
; DUMMY (USED TO PASS NUMBER OF PARAMETERS)
; REVS
; PUTS STORE START ADDR IN R4
; STORES CURRENT NUMBER OF REVS
; TEMPORARY COUNTER FOR ADC DATA INPUTTING
; CLEARS TEMP STORE AREA

CL5:
    MOV $0,+#167770
    TST (R5)+
    MOV (R5)+,R1
    MOV @R5+,R0
    MOV -R1,R4
    MOV R0,+#REVS
    MOV $2200,R0
    MOV $0,+#COUNT

REV1:
    INC @REVS
    DEC @REVS
    BNE REVEN0
    JSR PC,READ
    JSR PC,PRMT
    BR REV1

REVEN0:
    RTS PC

; COUNTER:
; .BLKW 1
CTL:
; .BLKW 1
REVS:
.BLKW 1
.EVEN

; ;

.END START
APPENDIX II

MRLGRP.FOR

FILENAME: MRLGRP.FOR
OLD FILE NAME FILENAME: MRLMAN.FOR
LINK OBJS OF MRLGRP.FOR,MRL3.FOR
MODIFIED FOR GRAPHING ONLY
MRL SMOKE CHAMBER PROGRAMME
ACCEPTS GOLAY CELL INPUT
STORES & ANALYZES DATA

COMMON INOSHK(312),ISHK(312),ACALC(312),ALAMDA(103),
*ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISHKR
*,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX, IYY

LOGICAL*4 ANSKT,ASMKT,_RING
LOGICAL*4 DT1, DT2, DT3

DYNAMIC GENERATION OF WAVELENGTH NUMBERS
===============================================

AMCEN1=3.4155
AMCEN1=3.5125
AMCEN2=6.2020
AMCEN2=6.2762
AMCEN3=11.4972
AMCEN3=11.3072
AMCEN3=11.4381
AMDEL1=0.0200707
AMDEL2=0.0372490
AMDEL2=0.0371111
AMDEL3=0.0659303
AMDEL3=0.0566809

ALAMDA(1)=(AMCEN1-AMDEL1/2.)-49.*AMDEL1
ALAMB(1)=(AMCEN2+AMDEL2/2.)+49.*AMDEL2
ALAM(1)=(AMCEN3+AMDEL3/2.)+49.*AMDEL3
DO 530 I=2,100
AI=1
ALAMDA(I)=ALAMDA(1)+AMDEL1*AI
ALAMB(I)=ALAMB(1)-AMDEL2*AI
ALAM(I)=ALAM(1)-AMDEL3*AI
530 CONTINUE

END OF DYNAMIC WAVELENGTH GENERATION
=========================================

DATA NRUN/'01', '02', '03', '04', '05', '06', '07', '08', '09', '10',
+ '11', '12', '13', '14', '15', '16', '17', '18', '19', '20',
+ '21', '22', '23', '24', '25', '26', '27', '28', '29', '30',
+ '31', '32', '33', '34', '35', '36', '37', '38', '39', '40',
+ '41', '42', '43', '44', '45', '46', '47', '48', '49', '50'/

INITIALIZE COMMON VARIABLES TO ZERO

DO 3 I=1,10
RING(I)=0
CONTINUE

CALL ASSIGN (2,'DY1:IRUN.DAT',0,'OLU')
READ (2,9) IRUN
FORMAT (I2)
CALL CLOSE (2)

CALL CLS
TYPE 10
FORMAT (/////)
TYPE 13
FORMAT (10X,'GRAPhING ROUTINES'/)
IRUN=1
TYPE 30
FORMAT (/'20X,'M E N U'/20X,'='* 15'/')
IF (IRUN.GT.49) IRUN=1
TYPE 35, IRUN
FORMAT (10X,'RUN NUMBER IS $'*,I2'/')
TYPE 40
FORMAT (5X,'GIVE A DIGIT BETWEEN 1 & 5'/)
TYPE 50

FORMAT (10X,'1 = LOAD DISC-STORED DATA INTO RAM'/10X,'2 = GR
APH EXTINCTION COEFFICIENT'/)
TYPE 60
FORMAT (10X,'3 = GRAPH RAW DATA'/10X,'4 = GRAPH FILTER CALIBRAT
ION'/10X,'5 = END PROGRAMME')
READ (5,*) JA
IF (JA.LT.1.OR.JA.GT.5) GO TO 80
GO TO (100,105,110,115,999) JA
GOTO SUBROUTINES

IFIL=2
CALL RAW(IFIL)
GO TO 160

CALL RERUN
GO TO 160

IFIL=0
CALL RAW(IFIL)
GO TO 160

IFIL=1
CALL RAW(IFIL)
GO TO 160

CALL CLS
DO 190 I = 1,10000
CONTINUE
GO TO 80

CONTINUE
TYPE 998
FORMAT (1X,'END OF PROGRAMME')
LOCATES START OF LINE AND PUTS PEN DOWN

SUBROUTINE LOCLIN

COMMON INOSMK(312), ISMK(312), ACALC(312), ALAMDA(103),
  *ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSKT, INSKR, ASMKT, ISMKR
  *, TH, RH, CONC, IBAKGD, IRUN, NRUN(50), IXX, IYY

IF (IYY.GT.1200.OR.IYY.LE.0) GO TO 335
WRITE (3,300) IXX,IYY
WRITE (3,305) PEN DOWN.
330 RETURN
335 WRITE (3,310) PEN UP
GO TO 330
300 FORMAT('A',I6,' ',I6,' ')
305 FORMAT('D ')
310 FORMAT('U ')
END

RE-RUN OF EXISTING DATA STORED ON DISC

SUBROUTINE RERUN

COMMON INOSMK(312), ISMK(312), ACALC(312), ALAMDA(103),
  *ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSKT, INSKR, ASMKT, ISMKR
  *, TH, RH, CONC, IBAKGD, IRUN, NRUN(50), IXX, IYY

INTEGER*2 DINK(7), DISK(7), DICK(7)

DATA DINK/'DY','1','IN','SK','00','D','AT'/
DATA DISK/'DY','1','IS','HK','00','D','AT'/
DATA DICK/'DY','1','IC','LK','00','D','AT'/

CALL CLS
705 TYPE 710
710 FORMAT (10X,'RE-RUN OF PREVIOUS DISC-STORED DATA'/5X,'GIVE
  *R U N N U M B E R YOU WANT TO SEE' )
  READ (5,711) IRUN
711 FORMAT (I2)

DINK(5)=NRUN(IRUN)
CALL ASSIGN (2,DINK,14,'OLD')
READ (2,715) (INOSMK(I),I=1,312)
715 FORMAT (63((I10,2X),/))
READ (2,716) DT1, DT2, DT3, ANSKT, INSKR
716 FORMAT (A2*A3*A2,5X,A4,5X,I2)
CALL CLOSE (2)

DISK(5)=NRUN(IRUN)
CALL ASSIGN (2,DISK,14,'OLD')
READ (2,720) (ISMK(I),I=1,312)
720 FORMAT (63((I10,2X),/))
READ (2,721) DT1, DT2, DT3, ASMKT, ISMKR, (RING(I), I=1, 10)

721 FORMAT (A2, A3, A2, 5X, A4, 5X, I2, 10A4)
CALL CLOSE (2)

C

DICK(5)=NRUN(IRUN)
CALL ASSIGN (2, DICK, 14, 'OLD')
READ (2, 725) (ACALC(I), I=1, 312)

725 FORMAT (63(5(F6.3, 2X), /))
READ (2, 726) DT1, DT2, DT3, ASMKT, CONC, TH, RH, IBAKGD

726 FORMAT (A2, A3, A2, 5X, A4, 5X, F6.4, 5X, F6.2, 5X, F6.2, 5X, I6)
CALL CLOSE (2)

C

TYPE 730, IRUN, DT1, DT2, DT3, (RING(I), I=1, 10), CONC

730 FORMAT (/'5X, 'RUN *', I2, 5X, 'DATE:', A2, A3, A2, 5X, 'SHOE TYPE:-',
*10A4/5X, 'CONCENTRATION *', F6.4, ' GMS/CUB.METRE'//10X, 'IS THIS THE
*CORRECT RUN ? Y/N')
READ (5, 735) COR

735 FORMAT (A1)
IF (COR .NE. 'Y') GO TO 705
RETURN
END

C

C

SUBROUTINE CLS

C

SCREEN

TYPE 5

5 FORMAT (// repeat 10 times //)
RETURN
END

C
APPENDIX III

MRL3.FOR

FILENAME: MRL3.FOR

LINK OBJS OF MRLGRP.FOR, MRL3.FOR

MRL SMOKE CHAMBER PROGRAMME
ACCEPTS GOLAY CELL INPUT
STORES & ANALYZES DATA

X

DRAWS A GRAPH OF RAW DATA IFIL=0
DRAWS FILTER CALIBRATION IFIL=1
DRAWS EXTINCTION COEFFICIENT IFIL=2

SUBROUTINE RAW(IFIL)

COMMON INOSHK(312), ISHK(312), CALC(312), ALAMBA(103),
*ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSKT, INSKR, ASMKT, ISMKR
*TH, RH, CONC, IBAKGU, IRUN, NRUN(50), IX, IYY

CALL ASSIGN(3, 'PL:' ,0, 'NEW', 'NC')
CALL ASSIGN(3, 'TT:' ,0, 'NEW', 'NC')
CALL ASSIGN(3, 'LP:' ,0, 'NEW', 'NC')

CALL CLS

501 FORMAT ('///20X, 'FILTER CALIBRATION'///10X, 'PAPER
*R READY Y/N ?'//)
510 IF (IFIL.EQ.0) GO TO 512
   IF (IFIL.EQ.2) GO TO 300
   TYPE 501
   GO TO 504
300 TYPE 305
   GO TO 504
305 FORMAT ('///10X, 'GRAPHING EXT. COEFF'///10X, 'PAPER READY Y/N ?'//)
512 TYPE 500

500 FORMAT ('///20X, 'GRAPHING RAW DATA'///10X, 'PAPER
*READY Y/N ?'//)
504 READ (5, 505) PAP
505 FORMAT (A1)
   IF (PAP.NE.'Y') GO TO 510
   TYPE 520
520 FORMAT (10X, 'PEN READY Y/N ?'//)
   READ (5, 525) PEN
525 FORMAT (A1)
   IF (PEN.NE.'Y') GO TO 510
530 TYPE 540
540 FORMAT (10X, 'PLOTTER ACTIVE Y/N ?'//)
   READ (5, 543) PLT
545 FORMAT (A1)
   IF (PLT.NE.'Y') GOTO 530

DRAW, PLOT, ETC
C ACTIVATE PLOTTER
WRITE (3,650)
C PLOTTER ACTIVE, HOME(BOT.L/H CNK),POSITION 2CM UP AND
C ALONG ORIGIN AT THAT POINT
 650 FORMAT(’H A100,200 0 ’)
C C
C GO TO 888
IF (IFIL.EQ.2) GO TO 310
 590 FORMAT(’R’,I5,’+,I5,’ ’)
 595 FORMAT(’M20 ’)
C 595 = TICK FOR X-AXES AND Y-AXES
C C DRAW BORDER OF GRAPH RAW DATA & FILTER CAL
WRITE (3,565)
DO 600 I=1,15
WRITE (3,595)
C WRITE (3,565)
WRITE (3,605)
 605 FORMAT(’R150,0 ’)
 600 CONTINUE
C C
DO 610 I=1,10
WRITE (3,595)
C WRITE (3,565)
WRITE (3,615)
 615 FORMAT(’R0,100 ’)
 610 CONTINUE
C C
DO 620 I=1,15
WRITE (3,595)
C WRITE (3,565)
WRITE (3,625)
 625 FORMAT(’R-150,0 ’)
 620 CONTINUE
C C
DO 630 I=1,10
WRITE (3,595)
C WRITE (3,565)
WRITE (3,635)
 635 FORMAT(’R0,-100 ’)
 630 CONTINUE
WRITE (3,575)
C C END OF BORDER
LAB=0
IXX=-100
IYY=-25
WRITE (3,560) IXX,IYY
DO 660 I=1,10
WRITE (3,655) LAB
LAB=LAB+1
WRITE (3,615)
WRITE (3,710)
C C STEP VERTICAL
 660 CONTINUE
WRITE (3,655) LAB
GO TO 215
C C DRAW EXTINCTION BORDER
WRITE (3,565)
DO 315 I=1,15
WRITE (3,595)
C
WRITE (3,565)
WRITE (3,605)
315 CONTINUE
C
DO 316 I=1,6
WRITE (3,595)
C
WRITE (3,565)
WRITE (3,317)
317 FORMAT('R0,-200 ')
316 CONTINUE
C
DO 318 I=1,15
WRITE (3,595)
C
WRITE (3,565)
WRITE (3,625)
318 CONTINUE
C
DO 319 I=1,6
WRITE (3,595)
C
WRITE (3,565)
WRITE (3,320)
320 FORMAT('R0,-200 ')
319 CONTINUE
WRITE (3,575)
C
END OF BORDER
LAB=0
IXX=-80
IYY=-25
WRITE (3,560) IXX,IYY
DO 210 I=1,7
WRITE (3,655) LAB
LAB=LAB+1
WRITE (3,317)
WRITE (3,710)
210 CONTINUE
C
WRITE LABELLING
C
215 LAB=0
IXX=-60
IYY=-50
WRITE (3,560) IXX,IYY
C
POSITION ABSOLUTE
DO 645 I=1,15
WRITE (3,655) LAB
655 FORMAT('S12 '+'I2','_')
C
HEIGHT=2.5mm,ROTATION=NORMAL
LAB=LAB+1
WRITE (3,705)
C
MOVE TO NEXT LOCATION
645 CONTINUE
WRITE (3,655) LAB
705 FORMAT('R105,0 ')
710 FORMAT('R-50,0 ')
C
C
ANNOTATION
C
IXX=650
IYY=-120
WRITE (*,560) IXX,IYY
WRITE (*,665)
665 FORMAT('S12 WAVELENGTH (\mu m)')
C
HEIGHT=3mm, ROTATION=NORMAL
IXX=-100
IYY=200
WRITE (*,560) IXX,IYY
IF (IFIL.NE.2) GO TO 220
WRITE (*,225)
225 FORMAT('S42 EXTINCTION COEFFICIENT (SQM/GM)')
GO TO 230
220 WRITE (*,3,670)
670 FORMAT('S42 NORMALLIZED DATA (N/10)')
C
HEIGHT=3mm, ROTATION=270
230 IXX=0
IYY=1230
WRITE (*,560) IXX,IYY
WRITE (*,675) THR
C
675 FORMAT('S12 TEMP:-','F6.2','C REL.HUMIDITY:-','F6.2','%')
IXX=450
IYY=1350
WRITE (*,560) IXX,IYY
WRITE (*,3,680) DT1,DT2,DT3,ASMKT,IRUN
680 FORMAT('S12 DATE:-','A2','/','A3','/','A2',' TIME:-','A4',' RUN
**','I2','_')
IXX=200
IYY=1290
WRITE (*,560) IXX,IYY
WRITE (*,3,685) (RING(I),I=1,10)
685 FORMAT('S12 SMOKE TYPE:-','10A4','_')
IXX=150
IYY=1450
WRITE (*,560) IXX,IYY
420 FORMAT('S13 FILTER CALIBRATION_')
IF (IFIL.EQ.0) GO TO 410
IF (IFIL.EQ.2) GO TO 235
WRITE (*,3,420)
GO TO 470
235 WRITE (*,3,240)
240 FORMAT('S13 MRL SMOKE CHAMBER MEASUREMENTS_')
GO TO 470
410 WRITE (*,3,690)
690 FORMAT('S13 MRL SMOKE CHAMBER RAW DATA_')
C
C
END OF ANNOTATION
C
470 FIL=Fil
560 FORMAT('A','I5','','I5','_')
C
PLOTTING ACTUAL VALUES FROM DATA
C
==================================
C
720 FORMAT('M21 _')
565 FORMAT('D _')
C PEN DOWN
575 FORMAT('U _')
FEN UP
WRITE (3,575)

IF (IFIL.EQ.0) GO TO 888
IF (IFIL.EQ.2) GO TO 350

****FILTER CALIBRATION****
Ixx=INT((ALAMDA(3)*150)+0.5)
ANOS=FLOAT(INOSMK(3))
IF (ANOS.EQ.0) IYY=0
IF (ANOS.EQ.0) GO TO 400
IYY=INT(FLOAT(ISMK(3))/ANOS*1000+0.5)

CALL CLIN
DO 440 I=3,100
Ixx=INT((ALAMDA(I)*150)+0.5)
ANOS=FLOAT(INOSMK(I))
IF (ANOS.EQ.0) IYY=0
IF (ANOS.EQ.0) GO TO 401
IYY=INT(FLOAT(ISMK(I))/ANOS*1000+0.5)

CALL CLIN
CONTINUE
WRITE (3,575)

Ixx=INT((ALAMD(3)*150)+0.5)
ANOS=FLOAT(INOSMK(106))
IF (ANOS.EQ.0) IYY=0
IF (ANOS.EQ.0) GO TO 402
IYY=INT(FLOAT(ISMK(106))/ANOS*1000+0.5)

CALL CLIN
DO 450 I=106,202
Ixx=INT((ALAMD(I-103)*150)+0.5)
Ixx=INT((ALAMD(I-105)*150)+0.5)
ANOS=FLOAT(INOSMK(I))
IF (ANOS.EQ.0) IYY=0
IF (ANOS.EQ.0) GO TO 403
IYY=INT(FLOAT(ISMK(I))/ANOS*10000+0.5)

CALL CLIN
CONTINUE
WRITE (3,575)

Ixx=INT((ALAM(3)*150)+0.5)
ANOS=FLOAT(INOSMK(209))
IF (ANOS.EQ.0) IYY=0
IF (ANOS.EQ.0) GO TO 404
IYY=INT(FLOAT(ISMK(209))/ANOS*10000+0.5)

CALL CLIN
DO 460 I=209,305
Ixx=INT((ALAM(I-206)*150)+0.5)
Ixx=INT((ALAM(I-208)*150)+0.5)
ANOS=FLOAT(INOSMK(I))
IF (ANOS.EQ.0) IYY=0
IF (ANOS.EQ.0) GO TO 405
IYY=INT(FLOAT(ISMK(I))/ANOS*10000+0.5)

CALL CLIN
CONTINUE
WRITE (3,575)
GO TO 430

****NOSMOKE THEN SMOKE PLOT****
888  IXX=INT((ALAMDA(3)*150)+0.5)
     IYY=INT(FLOAT(INOSMK(3))/2+0.5)
     CALL CLIN
     DO 570 I=3,100
     IXX=INT((ALAMDA(I)*150)+0.5)
     IYY=INT(FLOAT(INOSMK(I))/2+0.5)
     CALL CLIN
     570  CONTINUE
     WRITE (3,575) X

88
     IXX=INT((ALAM(3)*150)+0.5)
     IYY=INT(FLOAT(INOSMK(106))/2+0.5)
     CALL CLIN
     DO 580 I=106,202
     IXX=INT((ALAM(I-103)*150)+0.5)
     IYY=INT(FLOAT(INOSMK(I))/2+0.5)
     CALL CLIN
     580  CONTINUE
     WRITE (3,575)

C
     PEN UP --- AT END OF PLOTTING

C

88  IXX=INT((ALAMDA(3)*150)+0.5)
     IYY=INT(FLOAT(ISMK(3))/2+0.5)
     CALL CLIN
     DO 70 I=3,100
     IXX=INT((ALAMDA(I)*150)+0.5)
     IYY=INT(FLOAT(ISMK(I))/2+0.5)
     CALL CLIN
     70  CONTINUE
     WRITE (3,575)

C
     IXX=INT((ALAM(3)*150)+0.5)
     IYY=INT(FLOAT(ISMK(106))/2+0.5)
     CALL CLIN
     DO 80 I=106,202
     IXX=INT((ALAM(I-103)*150)+0.5)
     IYY=INT(FLOAT(ISMK(I))/2+0.5)
     CALL CLIN
     80  CONTINUE
     WRITE (3,575) X

C
     IXX=INT((ALAM(3)*150)+0.5)
     IYY=INT(FLOAT(ISMK(209))/2+0.5)
     CALL CLIN
     DO 85 I=209,305
     IXX=INT((ALAM(I-206)*150)+0.5)
IYY=INT(FLOAT(ISMK(I))/2+0.5)
CALL CLIN
CONTINUE
GO TO 430

C

*****EXTINCTION PLOT*****
Ixx=INT((ALAMDA(3)*150)+0.5)
Iyy=INT((ACALC(3)*200)+0.5)
CALL LOCLIN
DO 355 I=3*100
   Ixx=INT((ALAMDA(I)*150)+0.5)
   Iyy=INT((ACALC(I)*200)+0.5)
   CALL LOCLIN
355 CONTINUE
WRITE (3,575)
C

Ixx=INT((ALAMD(3)*150)+0.5)
Iyy=INT((ACALC(108)*200)+0.5)
CALL LOCLIN
DO 360 I=108,202
   Ixx=INT((ALAMD(I-103)*150)+0.5)
   Iyy=INT((ACALC(I)*200)+0.5)
   CALL LOCLIN
360 CONTINUE
WRITE (3,575)
C

Ixx=INT((ALAM(3)*150)+0.5)
Iyy=INT((ACALC(209)*200)+0.5)
CALL LOCLIN
DO 365 I=209,305
   Ixx=INT((ALAM(I-206)*150)+0.5)
   Iyy=INT((ACALC(I)*200)+0.5)
   CALL LOCLIN
365 CONTINUE

C

WRITE (3,575)
C

PEN UP ---- AT END OF PLOTTING
C

WRITE (3,640)
FORMAT('H @ ')
C

INACTIVATE PLOTTER
700 FORMAT('A',I6,',',I6,' ',)
CALL CLOSE (3)

C

TYPE 550
550 FORMAT (//10X,'END OF GRAPHING',10X,'PRESS RETURN KEY//)
READ (5,555) DUD
555 FORMAT (A1)
RETURN

C

LOCATES START OF LINE AND PUTS PEN DOWN
C

SUBROUTINE CLIN
C

COMMON INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
C IF (IYY.GT.1000.0.R.IYY.LE.0) GO TO 35
WRITE (3,30) IXX,IYY
WRITE (3,5)
C PEN DOWN
33 RETURN
35 WRITE (3,10)
C PEN UP
GO TO 33
30 FORMAT(‘A’,I6,’’,I6,’ ’)
5  FORMAT(‘D ’)
10  FORMAT(‘U ’)
END
APPENDIX IV

FILENAME: MRLV20.FOR

OLD FILENAME: MRLMAN.FOR

LINK OBJS OF MRLV20.FOR, MRLV21.FOR, MRLV22.FOR, READ43.MAC

MRL SMOKE CHAMBER PROGRAMME
ACCEPTS GOLAY CELL INPUT
STORES & ANALYZES DATA
MODIFIED TO USE 312 BACKGROUND READINGS

COMMON TEMP(2200), INOSMK(312), ISMK(312), ALCALC(312), ALAMDA(103),
* ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSK, INSKR, ASMKT, ISMKR
** TH, RH, CONC, IBAKGD, IRUN, NRUN(50), IXX, IYY, IBACK(312)

LOGICAL*4 ANSK, ASMKT, RING
LOGICAL*4 DT1, DT2, DT3

DATA NRUN/'01', '02', '03', '04', '05', '06', '07', '08', '09', '10',
    '11', '12', '13', '14', '15', '16', '17', '18', '19', '20',
    '21', '22', '23', '24', '25', '26', '27', '28', '29', '30',
    '31', '32', '33', '34', '35', '36', '37', '38', '39', '40',
    '41', '42', '43', '44', '45', '46', '47', '48', '49', '50'/

DYNAMIC GENERATION OF WAVELENGTH NUMBERS
=====================================================================

AMCEN1=3.5125
AMCEN2=6.2762
AMCEN3=11.4381
AMDEL1=0.0200707
AMDEL2=0.0372490
AMDEL3=0.0659303

ALAMDA(1)=(AMCEN1-AMDEL1/2.)-49.*AMDEL1
ALAMD(1)=(AMCEN2+AMDEL2/2.)+49.*AMDEL2
ALAM(1)=(AMCEN3+AMDEL3/2.)+49.*AMDEL3
DO 200 I=2,100
AI=I
ALAMDA(I)=ALAMDA(1)+AMDEL1*AI
ALAMD(I)=ALAMD(1)-AMDEL2*AI
ALAM(I)=ALAM(1)-AMDEL3*AI
CONTINUE

200 END OF DYNAMIC WAVELENGTH GENERATION
=====================================================================

INITIALIZE COMMON VARIABLES TO ZERO

J=1
DO 1 I=1,2200
    J=J+1
    ITEMP(I)=J
    CONTINUE
1

DO 3 I=1,10
RING(I)=0
CONTINUE

C
INSR=3
ISMKR=3
TH=00.0
RH=00.0
CONC=00.0
IBAKRD=0
C
C
CALL ASSIGN (2, 'DY1:IRUN.DAT', 0, 'OLD')
READ (2, 9) IRUN
FORMAT (I2)
CALL CLOSE (2)
C
C
CALL CLS
TYPE 10
FORMAT ('///')
TYPE 13
FORMAT (10X, 'SMOKE CHAMBER MEASUREMENTS
*///')
TYPE 18
FORMAT (10X, 'GIVE DATE EG 02NOV82/')
READ (5, 20) DT1, DT2, DT3
FORMAT (A2, A3, A2)
TYPE 30
FORMAT ('///20X,'M E N U'/20X,'========')
IF (IRUN.GT.49) IRUN=1
TYPE 34, IRUN
FORMAT (10X, 'RUN NUMBER IS ', I2)
TYPE 40
FORMAT (5X, 'GIVE A DIGIT BETWEEN 1 & 10')
TYPE 50
FORMAT (10X, '1 = TAKE BACKGROUND READINGS'/10X, '2 = NO SMOKE MEAS
UREMENT'/10X, '3 = SMOKE MEASUREMENT')
TYPE 60
FORMAT (10X, '4 = CALCULATE DATA'/10X, '5 = GRAPH RESULTS')
TYPE 70
FORMAT (10X, '6 = TABULATE RESULTS'/10X, '7 = NEW DATA DISKETTE HAS
* BEEN INSTALLED')
TYPE 75
FORMAT (10X, '8 = NEW RUN NUMBER REQUIRED'/10X, '9 = CLOSE DOWN CO
MPUTER FOR THE DAY')
TYPE 77
FORMAT (10X, '10= RE-RUN OF PREVIOUS DISC-STORED DATA')
READ (5, *) JA
IF (JL.ALT.10) GO TO 80
GO TO (95, 100, 110, 120, 130, 140, 143, 145, 150, 155) JA
C
GOTO SUBROUTINES
95
IBAK=1
CALL NSK(IBAK)
GO TO 160
100
IRAK=0
CALL NSK(IBAK)
GO TO 160
110
CALL SK
GO TO 160
120 CALL CLC
GO TO 160
130 CALL GRP
GO TO 160
140 CALL TABUL
GO TO 160
143 CALL WEN
GO TO 160
145 CALL NUR
GO TO 160
150 CALL FIN
GO TO 999
155 CALL RERUN
GO TO 160
160 CALL CLS
DO 190 I = 1,10000
190 CONTINUE
GO TO 80
999 CONTINUE
TYPE 998
998 FORMAT (1X,'END OF PROGRAMME')
END

C C C C C
C DRAWS A GRAPH OF EXTINCTION COEFFICIENT V WAVELENGTH
C C C C C
C SUBROUTINE GRP
C C COMMON ITMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
* ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANFST,INSKRT,ASMKT,ISMKR
* ,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IRACK(312)
C C CALL ASSIGN(3,'PL','0','NEW','NC')
C CALL ASSIGN(3,'TT','0','NEW','NC')
C CALL ASSIGN(3,'LP','0','NEW','NC')
C C CALL CLS
510 TYPE 500
500 FORMAT (///20X,'G R A P H I N G '////10X,'PAPER READY Y/N ?'/)
READ (5,505) PAP
505 FORMAT (A1)
IF (PAP.NE.'Y') GO TO 510
TYPE 520
520 FORMAT (10X,'PEN READY Y/N ?'/)
READ (5,525) PEN
525 FORMAT (A1)
IF (PEN.NE.'Y') GO TO 510
530 TYPE 540
540 FORMAT (10X,'PLOTTER ACTIVE Y/N ?'/)
READ (5,545) PLT
545 FORMAT (A1)
IF (PLT.NE.'Y') GOTO 530
C C DRAW, PLOT, ETC
ACTIVATE PLOTTER
WRITE (3,650)

PLOTTER ACTIVE, HOME (ROT.L/H CNR) , POSITION 2CM UP AND ALONG ORIGIN AT THAT POINT

650 FORMAT (' H A100,200 D ')

GO TO 888

DRAW BORDER OF GRAPH

590 FORMAT (' R ',I5,' ',',',',15,' ')
595 FORMAT (' M20 ')

595 = TICK FOR X-AXES AND Y-AXES

WRITE (3,565)
DO 600 I=1,15
WRITE (3,595)

C
WRITE (3,565)
WRITE (3,605)

605 FORMAT (' R150,0 ')
600 CONTINUE

C
DO 610 I=1,6
WRITE (3,595)

C
WRITE (3,565)
WRITE (3,615)

615 FORMAT (' R0,200 ')
610 CONTINUE

C
DO 620 I=1,15
WRITE (3,595)

C
WRITE (3,565)
WRITE (3,625)

625 FORMAT (' R-150,0 ')
620 CONTINUE

C
DO 630 I=1,6
WRITE (3,595)

C
WRITE (3,565)
WRITE (3,635)

635 FORMAT (' R0,-200 ')
630 CONTINUE

C END OF BORDER

WRITE LABELLING

C
LAB=0
IXX=-60
IYY=-50
WRITE (3,560) IXX,IYY

C
POSITION ABSOLUTE
DO 645 I=1,15
WRITE (3,653) LAB

655 FORMAT (' S12 ',',I2,',',_ ')

C
HEIGHT=2.5mm, ROTATION=NORMAL
LAB=LAB+1
WRITE (3,705)

C
MOVE TO NEXT LOCATION

645 CONTINUE
WRITE (3,655) LAB
705 FORMAT('R105,0 ')
710 FORMAT('R-50,0 ')
C
LAB=0
IXX=-80
IYY=-25
WRITE (3,560) IXX,IYY
DO 660 I=1,7
WRITE (3,655) LAB
LAB=LAB+1
WRITE (3,615)
WRITE (3,710)
C
660 CONTINUE
C
C ANNOTATION
C
IXX=650
IYY=-120
WRITE (3,560) IXX,IYY
WRITE (3,665)
665 FORMAT('S12 WAVELENGTH (uM) ')
C
HEIGHT=3mm, ROTATION=NORMAL
IXX=-100
IYY=200
WRITE (3,560) IXX,IYY
WRITE (3,670)
670 FORMAT('S42 EXTINCTION COEFFICIENT (SQM/GM) ')
C
HEIGHT=3mm, ROTATION=270
IXX=0
IYY=1230
WRITE (3,560) IXX,IYY
WRITE (3,575) TH*RH, CONC
C
675 FORMAT('S12 TEMP:-',F6.2,'C, REL. HUMIDITY:-',F6.2,'% CONC '
*TRATION:-',F6.4,' GM/CUB. METRE ')
IXX=450
IYY=1350
WRITE (3,560) IXX,IYY
WRITE (3,580) DT1, DT2, DT3, ASHK, IRUN
680 FORMAT('S12 DATE:-',A2,'/',A3,'/',A2,' TIME:-',A4,' RUN '
**I2, '_')
IXX=200
IYY=1290
WRITE (3,560) IXX,IYY
WRITE (3,685) (RING(I), I=1,10)
685 FORMAT('S12 SMOKE TYPE:-',10A4,' '_')
IXX=150
IYY=1450
WRITE (3,560) IXX,IYY
WRITE (3,690)
690 FORMAT('S13 MRL SMOKE CHAMBER MEASUREMENTS... ')
C
C END OF ANNOTATION
C
560 FORMAT('A',I5,',',I5,',',)
C
C PLOTTING ACTUAL VALUES FROM DATA
C
=====================================
720 FORMAT('M21 ')
565 FORMAT('D ')
C PEN DOWN
575 FORMAT('U ')
C PEN UP
WRITE (3,575)
C
888 IXX=INT((ALAMDA(3)*150)+0.5)
IYY=INT((ACALC(3)*200)+0.5)
CALL LOCLIN
DO 570 I=3,100
IXX=INT((ALAMDA(I)*150)+0.5)
IYY=INT((ACALC(I)*200)+0.5)
CALL LOCLIN
570 CONTINUE
WRITE (3,575)
C
IXX=INT((ALAMD(3)*150)+0.5)
IYY=INT((ACALC(106)*200)+0.5)
CALL LOCLIN
DO 580 I=106,202
IXX=INT((ALAMD(I-103)*150)+0.5)
IYY=INT((ACALC(I)*200)+0.5)
CALL LOCLIN
580 CONTINUE
WRITE (3,575)
C
IXX=INT((ALAM(3)*150)+0.5)
IYY=INT((ACALC(209)*200)+0.5)
CALL LOCLIN
DO 585 I=209,305
IXX=INT((ALAM(I-206)*150)+0.5)
IYY=INT((ACALC(I)*200)+0.5)
CALL LOCLIN
585 CONTINUE
WRITE (3,575)
C PEN UP ---- AT END OF PLOTTING
C
WRITE (3,640)
640 FORMAT('H @ ')
C INACTIVATE PLOTTER
700 FORMAT('A',I6,';','I6,' ')
CALL CLOSE (3)
C
TYPE 550
550 FORMAT ('//10X,'END OF GRAPHING',10X,'PRESS RETURN KEY'//)
READ (5,555) DUD
555 FORMAT (A1)
RETURN
END
C
C LOCATES START OF LINE AND PUTS PEN DOWN
C SUBROUTINE LOCLIN
C
COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
*ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSKT, INSKR, ASMKT, ISMKR
*TH, RH, CONC, IBAKGD, IRUN, NRUN(50), IXX, IYY, IBACK(312)

C

IF (IYY .GT. 1200 .OR. IYY .LE. 0) GO TO 335
WRITE (3,300) IXX, IYY
WRITE (3,305)

C PEN DOWN

330 RETURN

335 WRITE (3,310)

C PEN UP
GO TO 330

300 FORMAT ('A', 'I6', ',', 'I6', '')

305 FORMAT ('D ')

310 FORMAT ('U ')
END
APPENDIX V

FILENAME:- MRL21.FOR

OLD FILENAME:- MRL1.FOR

LINK OBJs OF MRLV20.FOR, MRLV21.FOR, MRLV22.FOR, READ43.MAC

MRL SMOKE CHAMBER PROGRAMME
ACCEPTS GOLAY CELL INPUT
STORES & ANALYZES DATA

MODIFIED TO USE 312 BACKGROUND READINGS

RE-RUN OF EXISTING DATA STORED ON DISC

SUBROUTINE RERUN

COMMON ITEMP(2200), INOSMK(312), ISMK(312), ACALC(312), ALAMDA(103), *ALAMB(103), ALAMC(105), RING(I), DT1, DT2, DT3, ANSKT, INSKR, ASMKT(I), SMKR *
,TH, RH, CONC, IBAKG, IRUN, NRUN(50), IXX, IYY, IBACK(312)

INTEGER*2 DINK(7), DISK(7), DICK(7)

DATA DINK('DY', '1', 'IN', 'SK', '00', 'D', 'AT')/
DATA DISK('DY', '1', 'IS', 'MK', '00', 'D', 'AT')/
DATA DICK('DY', '1', 'IC', 'LK', '00', 'D', 'AT')/

TYPE 700
FORMAT (10X, 'WRITE DOWN EXISTING RUN NUMBER',/10X, 'NOW PRESS RETURN KEY')
READ (5, 795) DUD

795 FORMAT (A1)
CALL CLS

705 TYPE 710
FORMAT (10X, 'RE-RUN OF PREVIOUS DISC-STORED DATA'/5X, 'GIVE RUN NUMBER YOU WANT TO SEE')
READ (5, 711) IRUN

711 FORMAT (I2)

DINK(5) = NRUN(IRUN)
CALL ASSIGN (2, DINK, 14, 'OLD')
READ (2, 715) (INOSMK(I), I=1, 312)

713 FORMAT (63(S(I10, 2X),/))
READ (2, 716) DT1, DT2, DT3, ANSKT, INSKR

716 FORMAT (A2, A3, A2, 5X, A4, 5X, I2)
CALL CLOSE (2)

DISK(5) = NRUN(IRUN)
CALL ASSIGN (2, DISK, 14, 'OLD')
READ (2, 720) (ISMK(I), I=1, 312)

720 FORMAT (63(S(I10, 2X),/))
READ (2, 721) DT1, DT2, DT3, ASMKT, I, SMKR, (RING(I), I=1, 10)

721 FORMAT (A2, A3, A2, 5X, A4, 5X, I2, 10A4)
CALL CLOSE (2)

DICK(5) = NRUN(IRUN)
CALL ASSIGN (2, DICK, 14, 'OLD')
READ (2, 725) (ACALC(I), I=1, 312)

725 FORMAT (63(S(F6.3, 2X),/))
READ (2, 726) DT1, DT2, DT3, ASMKT, CONC, TH, RH, IBAKG


FORMAT (A2,A3,A2,5X,A4,5X,F6.4,5X,F6.2,5X,F6.2,5X,16)
CALL CLOSE (2)

C

TYPE 730, IRUN, DT1, DT2, DT3, (RING(I), I=1,10), CONC

FORMAT (/3X,'RUN ','/12,5X,'DATE:-','/12,5X,'SMOKE TYPE:-',
*10A4/5X,'CONCENTRATION ','F6.4,' GMS/CUB.METRE'/10X,'IS THIS THE
*CORRECT RUN? Y/N')
READ (5,735) COR

735 FORMAT (A1)
IF (COR.EQ.'Y') GO TO 740
GO TO 705

740 TYPE 745

745 FORMAT (/20X,'RE-INSERT WRITTEN DOWN RUN
*XUN NUMBER BEFORE CLOSING DOWN COMPUTER/',5X,'OR CARRYING ON WITH A
*OTHER LEGITIMATE RUN/',5X,'OR THE DISC DATA FILES MAY BECOME OVE
*R-WRITTEN !'/5X,'PRESS RETURN TO GET TO M E N U')
READ (5,795) DUD
RETURN
END

C

SUBROUTINE ERRFS(V1,V2,IERR)
DIMENSION UV2(17), AV2(17)
DATA UV2//0155.,024.,0335.,044.,054.,064.,074.,084.,014/,
* .24.,332.,44.,54.,64.,738.,825.,92/,
DATA AV2//0034.,0027.,00223.,00194.,00179.,00167.,0016/,
* .00153.,0013.,00118.,00111.,00105.,00102.,00099.,00097/,
* .00096.,00094/,
IERR=0
IF (V1.LT.0.025) GO TO 1
IF(V1.LT.0.1) GO TO 10

C

**********************************************************************

C

VALUES OF V1 BETWEEN 0.1 AND 1.0

J=I+8
DO 29 I=1,9
A=0.1+0.1*FLOAT(I-1)
B=A+0.1
IF(V1.GE.A.AND.V1.LT.B) GO TO 21
GO TO 29

21 IF(V2.LT.AV2(J).OR.V2.GT.UV2(J)) GO TO 1
GO TO 99

29 CONTINUE
GO TO 99

C

**********************************************************************

C

VALUES OF V1 BETWEEN 0.025 AND 0.1

10 IF(V1.GE.0.025.AND.V1.LT.0.03) GO TO 11
DO 19 I=1,7
A=0.03+0.01*FLOAT(I-1)
B=A+0.01
IF(V1.GE.A.AND.V1.LT.B) GO TO 12
GO TO 19

12 IF(V2.LT.AV2(I+1).OR.V2.GT.UV2(I+1)) GO TO 1
GO TO 99
19  CONTINUE
    GO TO 99
C
C *****************************************************************************
C  VALUES OF V1 BETWEEN 0.025 AND 0.03
C
   WRITE(3,*)V1,V2
  11  IF(V2.LT.AV2(1).OR.V2.GT.UV2(1)) GO TO 1
      GO TO 99
C
C *****************************************************************************
C
C  DATA UNACCEPTABLE DUE TO UNACCEPTABLE ERRORS
C
   IERR=1
  99  CONTINUE
      RETURN
      END
APPENDIX VI

MRLV22.FOR

FILENAME: MRLV22.FOR
OLD FILENAME : MRL2.FOR
LINK OBJS OF MRLV20.FOR, MRLV21.FOR, MRLV22.FOR, READ43.MAC
MODIFIED TO USE 312 BACKGROUND READINGS

SUBROUTINE CLS
CLEAR S V D U SCREEN
TYPE 5
FORMAT (.handleClick)
RETURN
END

SUBROUTINE WEN
INITIALIZE IRUN COUNTER FOR NEW DISKETTE

COMMON ITEMP(2200), INOSMK(312), ISMK(312), ACALC(312), ALAMDA(103),
*ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSKT, INSKR, ASMKT, ISMKR
*, TH, RH, CONC, IBAKGD, IRUN, NRUN(50), IXX, IYY, IBACK(312)
IRUN=1
RETURN
END

INCREMENT TRIAL RUN NUMBER
SUBROUTINE NUR

COMMON ITEMP(2200), INOSMK(312), ISMK(312), ACALC(312), ALAMDA(103),
*ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSKT, INSKR, ASMKT, ISMKR
*, TH, RH, CONC, IBAKGD, IRUN, NRUN(50), IXX, IYY, IBACK(312)
CALL CLS
TYPE 800
800 FORMAT (10X, 'CHANGE RUN NUMBER'//10X, 'DO YOU WANT TO INCREASE RUN NUMBER'//10X, 'OR CHANGE THE RUN NUMBER? TYPE I/C')
READ (5, 805) CH
805 FORMAT (A1)
IF (CH.EQ. 'C') GO TO 810
IRUN=IRUN+1
GO TO 820
810 TYPE 830
830 FORMAT (10X, 'GIVE REQUIRED RUN NUMBER')
READ (5, 840) IRUN
840 FORMAT (I2)
TYPE 845, IRUN
845 FORMAT (20X, 'RUN #', I2//10X, 'PRESS RETURN KEY')
READ (5, 850) DUD
850 FORMAT (A1)
820 RETURN
END

C C
NO SMOKE & BACKGROUND SUBROUTINES
SUBROUTINE NSK(IBAK)

COMMON TEMP(220),INOSMK(312),ISHK(312),ACALC(312),ALAMDA(103),
* ALAMDA(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISHKR
* ,TH,THR,CONC,IBAKGD,IRUN,NRUN(50),Ixx,Iyy,IBACK(312)

INTEGER*2 DISK(7),DIS(7)

DATA DISK/'DY', 'I', 'IN', 'SK', '00', 'D', 'AT'/
DATA DIS/'DY', 'I', 'IH', 'AK', '00', 'D', 'AT'/

CLEAR NO SMOKE DATA FIELD
DO 200 I = 1,312
INOSMK(I) = 0
200 CONTINUE

NO SMOKE DATA FIELD CLEARED
TYPE 270
270 FORMAT (//,3X,'USE EXISTING DATA (NOT MORE THAN
* ONE HOUR OLD)' Y/N')
READ (5,275) Y
275 FORMAT (A1)
IF (Y,'NE','Y') GO TO 280
IF (IBAK,EQ.0) GO TO 213
GO TO 223
280 CALL CLS
214 IF (IBAK,EQ.0) GO TO 210
TYPE 211

211 FORMAT (//,10X,'BACKGROUND READINGS'/1
*0X,'BLANK OFF, NERNST GLOWERT/)
GO TO 212
210 TYPE 220
220 FORMAT (//,20X,'NO SMOKE MEASUREMENT'/)
TYPE 225
225 FORMAT (20X,'GIVE TIME EG 0900')
ACCEPT 222,ANSKT
222 FORMAT (A4)
212 TYPE 230
230 FORMAT (/10X,'GIVE A NUMBER BETWEEN 1 & 7 FOR REV'S REQUIRED/')
READ (5,231) INSKR
231 FORMAT (I2)
IF (INSKR,LT.1.OR.INSKR,GT.7) GO TO 214

CALL COLDAT(ITEMP,INSKR)

IF (IBAK,EQ.0) GO TO 218

AVERAGE BACKGROUND READINGS
N=INSKR
DO 219 I=I+311
IB=0
DO 221 J=I+N
IB=IB+ITEMP(311*(J-1)+1)
221 CONTINUE
IBACK(I)=IB/N
219 CONTINUE
GO TO 223
AVGNOG DATA AND STORE IN NSMK ARRAY
N = INSKR
DO 240 I = 1, 311
IB = 0
DO 250 J = 1, N
IB = IB + TEMP(311*(J-1)+I)
250 CONTINUE
INSMK(I) = IB/N-IBACK(I)
240 CONTINUE

STORE ON DISC? # USE CURRENT RUN NUMBER AS PART OF FILE NAME
IF (IBAK.EQ.0) GO TO 213
DIS(5) = NRUN(IRUN)
CALL ASSIGN (2,DIS,14,'NEW')
WRITE (2,243) (INSHK(I),I=1,312)
CALL CLOSE (2)
IF (Y.EQ.'Y') GO TO 266
TYPE 216
GO TO 217

FORMAT (5X,'REMOVE SOURCE BLANK'/IOX,'T
*HEN PRESS ENTER KEY')
DISK(5) = NRUN(IRUN)
CALL ASSIGN (2,DISK,14,'NEW')
WRITE (2,243) (INSHK(I),I=1,312)
243 FORMAT (63(5(I10,2X)/))
WRITE (2,244) DT1, DT2, DT3, ANSKT, INSKR
244 FORMAT (5X,A2,A3,A2,5X,A4,5X,12)
CALL CLOSE (2)
IF (Y.EQ.'Y') GO TO 266

DATE, NOG DATA-START TIME AND NUMBER OF RFVS-ON END OF DATA
217 TYPE 260
260 FORMAT ('/10X,'END OF MEASUREMENT',10X,'PRESS RETURN KEY'/)
READ (5,265) DUD
265 FORMAT (A1)
266 RETURN
END

SMOKE SUBROUTINE

SUBROUTINE SK

COMMON ITEM(2200), INSHK(312), ISMK(312), ACALC(312), ALANDA(103),
* ALAND(103), ALAH(105), RING(10), DT1, DT2, DT3, ANSKT, INSHK, ANSK,
* T, NR, HS, IBAKGD, IBAK(312)
INTEGER*2 DISK(7)
DATA DISK/'DY','1:','IS','MK','00','D','AT'/

DATA RING/10*

CLEAR DATA FIELD
DO 300 I = 1,312
   ISMK(I) = 0
300 CONTINUE

SMOKE DATA FIELD CLEARED
CALL CLS

TYPE 320
FORMAT ('//20X,'SMOKE MEASUREMENT'/)

TYPE 325
FORMAT (20X,'GIVE TIME EG 0930')
ACCEPT 322,AS MKT

TYPE 322
FORMAT (A4)

TYPE 360
FORMAT ('/10X,'GIVE SMOKE TYPE/DESCRIPTION'/)
ACCEPT 370,(RING(I),I=1,10)

TYPE 370
FORMAT (10A4)

TYPE 380
FORMAT ('/10X,'GIVE CHAMBER TEMPERATURE IN DEGREES CENT. '/)
ACCEPT *,TH

TYPE 375
FORMAT ('/10X,'GIVE RELATIVE HUMIDITY IN PERCENT'/)
ACCEPT *,RH

TYPE 230
FORMAT ('/9X,'GIVE A NUMBER BETWEEN 1 & 7 FOR REV5 REQUIRED'/)
READ (5,382) ISMKR

FORMAT (I2)
IF (ISMKR,LT,1,OR,ISMKR,GT,7) GO TO 310

CALL COLDAT(ITEMP,ISMKR)

AVERAGE SMOKE DATA AND STORE IN SMK ARRAY
N = ISMKR
DO 330 I = 1,311
   IB = 0
   DO 340 J = 1,N
      IB = IB+ITEMP(311*(J-1)+I)
340 CONTINUE
   ISMK(I) = IB/N-IBACK(I)
330 CONTINUE

STORE ON DISC? ***USE CURRENT RUN NUMBER
AS PART OF FILE NAME

DISK(5) = NRUN(IRUN)
CALL ASSIGN (2,DISK,14,'NEW')
WRITE (2,342) (ISMK(I),I=1,312)

FORMAT (63(5(I10,2X),'/)
WRITE (2,344) DT1,DT2,DT3,AS MKT,ISMKR,(RING(I),I=1,10)

FORMAT (A2,A3,A2,5X,A4,5X,I2,10A4)
CALL CLOSE (2)
DATE, SMOKE START TIME, SMOKE REV S ON END OF DATA

TYPE 350
FORMAT (10X,'END OF SMOKE MEASUREMENT',10X,'PRESS RETURN KEY')
READ (5,355) DUD

FORMAT (A1)
RETURN
END

CALCULATE SMOKE & NONSMOKE READINGS, FOR RELATIVE VALUES

SUBROUTINE CLC

COMMON ITMPC(2200), INOSMK(312), ISMK(312), ACALC(312), AALMDA(103), *
ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSK, INSKR, ASHK, ISMKR *
*, TH, RH, CONC, IBAKGD, IRUN, NRUN(50), IX, IY, IY, IBACK(312)

INTEGER*2 DISK(7)

DATA DISK/ 'DY', '/11', /IC', '/K', '/00', '/ D', '/AT'/

CLEAR CALC DATA STORE
DO 400 I=1,312
ACALC(I)=0
400 CONTINUE
CLEAN FIELD CLEARED
CALL CLS

TYPE 410
FORMAT (10X,'CALCULATE DATA')
IB=0
IB=IB+INOSMK(102)
IB=IB+INOSMK(205)
IB=IB+INOSMK(308)
IB=IB+ISMK(102)
IB=IB+ISMK(205)
IB=IB+ISMK(308)
IB=IB/6
IB = 0

TAKE OUT IBAKGD=IB

BACKGROUND AVERAGED
VOL=4.5*2.63*2.74

VOLUME OF CHAMBER
ALEN=5.0

LENGTH OF DETECTOR PATH
TYPE 420
FORMAT (10X,'GIVE MASS OF SMOKE USED IN GRAMS')
READ (5,* AMASS
CONC=AMASS/VOL
DO 430 I=1,312
   IF (INOSMK(I),EQ,0) GO TO 430
   IF (ISMK(I),EQ,0) GO TO 430
   GOLA=FLOAT(ISMK(I))/FLOAT(INOSMK(I))
   IF (GOLA,L.0,0) GO TO 430
   ACALC(I)=(-ALDG(GOLA))/(ALEN*CONC)
   **********************************
   V1=(FLOAT(INOSMK(I)))/2000
   V2=(FLOAT(ISMK(I)))/2000
   CALL ERROP(V1,V2,IERR)
   IF (IERR.NE,0) ACALC(I)=0.0
   **********************************
   430 CONTINUE
C
C
STORE ON DISC ?  ***USE CURRENT RUN NUMBER
   AS PART OF FILE NAME
C
   DISK(5) = NRUN(IRUN)
   CALL ASSGN (2,DISK,14,'NEW')
   WRITE (2,442) (ACALC(I),I=1,312)
   442 FORMAT (63(F6.2,2X)/)
   WRITE (2,444) DT1,DT2,DT3,ASMKT,CONC,TH,RH,IBAKGD
   444 FORMAT (A2,A3,A2,5X,A4,5X,F6.4,5X,F6.2,5X,F6.2,5X,I6)
   CALL CLOSE (2)
C
C
DATE,SMOKE START TIME, CONCENTRATION, TEMPERATURE
   RELATIVE HUMIDITY, BACKGROUND READING-- ON END OF DATA
C
C
   TYPE 440
C
   440 FORMAT (/10X,'END OF CALCULATIONS',10X,'PRESS RETURN KEY'/)
   READ (5,445) DUD
   445 FORMAT (A1)
   RETURN
   END
C
C
TABULATE RESULTS SUB
C
SUBROUTINE TABUL
C
   COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
   *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ASMKT,INSKR,ASMKR
   *TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
C
   CALL CLS
C
   TYPE 600
C
   600 FORMAT (///20X,'T A B U L A T E  R E S U L T S'//)
   615 TYPE 605
   605 FORMAT (10X,'PRINTER READY  Y/N ?')
   READ (5,610) FR
   610 FORMAT (A1)
IF (PR.NE.'Y') GO TO 615

C
C TYPE 620
C PRINT 620
620 FORMAT (//) TYPE 625
C PRINT 625
625 FORMAT (/'7X,'M R L S M O K E C H A M B E R M E A S U R E M E N T S'/5X,='='.100,=108,'='//)
C PRINT 630,IRUN,DT1,DT2,DT3
TYPE 630,IRUN,DT1,DT2,DT3
630 FORMAT (10X,'RUN ',I2,20X,'DATE:',A2,'',A3,'',A2)
C PRINT 635,ANSKT,INSKR
TYPE 635,ANSKT,INSKR
635 FORMAT (3X,'NOSMOKE:- TIME=',A4,3X,'REVS=',I2)
C PRINT 637,ASMKT,ISMKR
TYPE 637,ASMKT,ISMKR
637 FORMAT (5X,'SMOKE:- TIME=',A4,3X,'REVS=',I2)
C PRINT 640,TH,RH
TYPE 640,TH,RH
640 FORMAT (3X,'CHAMBER TEMPERATURE:- ',F6.2,' C',10X,'RELATIVE HUMIDITY:- ',F6.2,'%')
C PRINT 645,(RING(I),I=1,10)
TYPE 645,(RING(I),I=1,10)
645 FORMAT (3X,'SMOKE DESCRIPTION:- ',10A4)
C PRINT 646,CONC
TYPE 646,CONC
642 FORMAT (15X,'CONCENTRATION:- ',F6.4,' GMS/CUB.METRE')
C PRINT 647,IBAKGD
TYPE 647,IBAKGD
647 FORMAT (15X,'BACKGROUND READING:- ',I6)
C PRINT 650
TYPE 650
C 650 FORMAT (3X,'FILTER ',6X,'EXT.COEFF.',6X,'LAMDA UM:',6X,'NOSMOKE ',I1,'.',6X,'SMOKE ',I1)
C
C J=0
DO 660 I=1,100
K=I+J
C PRINT 665,K,ACALC(I),ALAMDA(I),INOSMK(I),ISMK(I)
TYPE 665,K,ACALC(I),ALAMDA(I),INOSMK(I),ISMK(I)
665 FORMAT (4X,I5,9X,F6.3,8X,F6.3,8X,I6,8X,I6)
660 CONTINUE
C J=-3
DO 670 I=104,203
K=I+J
C PRINT 665,K,ACALC(I),ALAMDA(I-103),INOSMK(I),ISMK(I)
TYPE 665,K,ACALC(I),ALAMDA(I-103),INOSMK(I),ISMK(I)
670 CONTINUE
C J=-6
DO 675 I=207,306
K=I+J
C PRINT 665,K,ACALC(I),ALAM(I-206),INOSMK(I),ISMK(I)
TYPE 665K, ACALC(I), ALAM(I-206), INOSMK(I), ISMK(I)
CONTINUE

PRINT 620
TYPE 620

TYPE 690
FORMAT (/10X, 'TABLE COMPLETED', 10X, 'PRESS RETURN KEY'/)
READ (5, 695) DUD

FORMAT (A1)
RETURN
END

FINISH PROG BY STORING ALL RELAVENT DATA ON DISC

SUBROUTINE FIN

COMMON ITEMP(2200), INOSMK(312), ISMK(312), ACALC(312), ALAMDA(103),
* ALAMD(103), ALAM(105), RING(10), DT1, DT2, DT3, ANSKT, INSKR, ASMKT, ISMKR
*, TH, RH, CONC, IBAKG, IRUN, NRUN(50), IXX, IYY, IBACK(312)

INTEGER*4 DISC(3)
DATA DISC/ 'DY1:', 'IRUN:', 'DAT' /

IRUN=IRUN+1

CALL ASSIGN (2, DISC, 12, 'NEW')
WRITE (2, 888) IRUN

888 FORMAT (I2)
CALL CLOSE (2)

RETURN
END
Figure 1. Existing Nernst Glower housing
Figure 2. Nernst Glower characteristics
Figure 4. Golay cell radiometer
Figure 5. Smoke IR transmissometer general assembly
Figure 6. Radiometer rear view
Figure 7. Radiometer front view
Figure 10. Golay detector (inside cell housing)
Figure 12. Nichrome on glass graticule (read by HEDS1000 detector)
Figure 13. HEDS1000 circuit (Comparator)
Figure 14. HEDS1000 housing and circuit board
Figure 15. Chart recorder read pulses (<10) + Golay amplifier
Figure 16. Sample and hold, and delays, circuit (Card 3)
Figure 17. IR synchronous detector circuit (Card 1)
Figure 18. Synchronous detector housing

Figure 19. Synchronous detector under chassis view
Figure 20. Synchronous detector rear view

Figure 21. Synchronous detector cardset
Figure 22. Electronic waveforms timing
Figure 24. Golay power supply and preamp box

Figure 25. Golay power supply (Circuit figure 23)
Figure 26. Read pulses ÷10 circuit + Golay preamp (Circuit figure 15)
Figure 27. Data-logging/computer block diagram
Figure 28. Empirical graph to determine aperture material temperature at a distance from a hot source (Nernst Glower) at 2000°C
Figure 29. Nernst Glower AC power supply
Figure 30. Chopper driver circuit
Figure 31. Nernst Glower housing to power supply cable
Figure 32. Nernst Glower AC power supply and chopper driver
Figure 33. Handheld IR beam finding detector
Figure 36. Subroutine LOCLIN
Figure 37. Subroutine RERUN
Figure 38. Subroutine CLS
SUBROUTINE RAW(IFIL)

ACTIVATE PLOTTER

IFIL = 0
  Y  'RAW DATA'
  N

IFIL = 2
  N

IFIL = 1
  Y  'FILTER CAL'
  N

PAPER READY
  N
  Y

PEN READY
  N
  Y

PLOTTER READY
  N
  Y

IFIL = 2
  Y  DRAW EXT COEFF BORDER
     LABEL EXT COEFF BORDER
  N

DRAW OTHER BORDER
     LABEL OTHER BORDER

ANNOTATE

IFIL = 0
  Y  TITLE  'RAW DATA'
  N

IFIL = 2
  Y  TITLE  'EXT COEFF'
  N

IFIL = 1
  Y  TITLE  'FILTER CAL'
  N

IPIL = 0
  Y  DRAW HOSMK, SMK
  N

IPIL = 2
  Y  DRAW EXT COEFF
  N

DRAW FILTERS
  N

DEACTIVATE PLOTTER

CALL CLOSE(3)

RETURN

Figure 39. Subroutine RAW(IFIL)
Figure 40. Subroutine MRLV20.FOR
SUBROUTINE GRP

COMMON BLOCK

ASSIGN LOGICAL UNIT 3 TO PLOTTER (NORMALLY)

CALL CLS

'GRAPHING'

'PAPER READY Y/N' Y

'PEN READY Y/N' Y

'PLOTTER ACTIVE Y/N' Y

ACTIVATE PLOTTER

DRAW BORDER

LABEL AXES

ANNOTATE GRAPH

PLOT DATA
POSITION HEAD (CALL LOCLIN)
WRITE GRAPHS SECTION
100 POINTS
SECTOR 1

POSITION HEAD (CALL LOCLIN)
WRITE GRAPHS SECTION
100 POINTS
SECTOR 2

POSITION HEAD (CALL LOCLIN)
WRITE GRAPHS SECTION
100 POINTS
SECTOR 3

DEACTIVATE PLOTTER

'END OF GRAPHING'

INPUT MMD

RETURN

Figure 41. Subroutine GRP
SUBROUTINE RERUN

COMMON BLOCK

DATA FOR FILE NAMES

PRINT WARNINGS

INPUT
GIVE RUN NUMBER REQUIRED

LOAD RUN DATA INTO
APPROPRIATE STORES
INOSMR ( ) ---
ISMK ( ) ---
ACALC ( ) ---

PRINT PERSISTENT DATA

CORRECT
N
Y

PRINT WARNINGS

INPUT DUD

RETURN

Figure 42. Subroutine RERUN
Figure 43. Subroutine ERROP
SUBROUTINE WEN

COMMON BLOCK

IRUN = 1

RETURN

N.B. Initialise IRUN counter for new diskette

Figure 44. Subroutine WEN
Figure 45. Subroutine NUR
Figure 46. Subroutine NSK
SUBROUTINE SK

COMMON BLOCK

DATA FOR STORING ON DISC

CLEAR STORAGE RAM
ISMK(I)

CALL CLS

'SMOKE MEASUREMENTS'

'GIVE TIME'

INPUT ASMX

'GIVE SMOKE DESC'

INPUT RING(I), I = 1, 10

'GIVE TEMP'

INPUT TH

'GIVE REL HUM'

INPUT RH

'GIVE REV'

INPUT ISMX

Y

N

ISMX = 1 OR 7

CALL COLDAT (ITEMP, ISMX)

AVE SACH A

STORE 3'2 A ON DISC,
DATE, TIME, REV, DESCRIPTION
CALL CLOSE DISC

'SMH SMOKE RUN'

INPUT

END

RETURN

Figure 47. Subroutine SK
SUBROUTINE CLC

COMMON BLOCK

DATA FOR STORING ON DISC

CLEAR DATA
STORE ACALC(I) = 0

CALL CLS

INTERSTITIAL BACKGROUND AVERAGED

INPUT AMASS (MASS OF SMOKE IN GMS)

CALCULATE CONCENTRATION

CALCULATE ACALC(I)

CALL ERRP(V1, V2, IERR)

IF IERR = 0

ACALC(I) = 0.0

STORE ON DISC
ACALC(I), I = 1, 312

STORE ON END OF DISC
DATE, SMOKE START TIME, CONCENTRATION, TEMPERATURE, RELATIVE HUMIDITY AND BACKGROUND READING

RETURN

Figure 48. Subroutine CLC
Figure 49. Subroutine TABUL

Figure 50. Subroutine FIN
MACRO SUBROUTINE COLDAT (ITEM, INSKR)

DISABLE INTERRUPTS

PASS PARAMETERS

CLEAR TEMP STORE

INC REVS

DEC REVS

ALL REVS DONE

CALL READ
READ/STORE ON REV OF DATA

CALL PRMT
PRINT % PROMPT ON SCREEN

RETURN

Figure 51. Macro subroutine COLDAT
Figure 52. Subroutine READ

SUBROUTINE READ

REGISTER R1 = NEW LEVEL
REGISTER R2 = OLD LEVEL

JAM R2 LOW

CALL ECD
EDGE CHANGE DETECTOR
(FIND RISING EDGE)

CALL ECD
FIND FALLING EDGE

SYNC PULSE DETECTED

N

SET UP SEGMENTS COUNTER

Y

JAM R2 LOW

CALL TRS
(TAKE & STORE 100 READINGS)

CALL TIM2
(WAIT FOR 1.2 SECS)

STORE DELIMITER
IN ITEMP( )

CALL CNVT
STORE BACKGROUND READING

STORE DELIMITER
IN ITEMP( )

3 SEGMENTS READ

N

Y

STORE 2 DELIMITERS
IN ITEMP( )

RETURN

Figure 52. Subroutine READ
Figure 53. Subroutine PRMT

Figure 54. Subroutine ECD
Figure 55. Subroutine CNVT
Figure 56. Subroutine TRS

SUBROUTINE TRS
(TAKE READINGS SUB)

100D → R5

CALL ECD
(RISING EDGE DETECTED)

CALL CNVT
(CONVERT ADC)
( & STORE )

CALL ECD
(FALLING EDGE DETECTED)

DEC R5

R5 = 0

RETURN
Figure 57. Subroutine TIM2
Figure 58. Subroutine TIM1
MANUAL FOR THE MAINTENANCE OF THE MRL SMOKE CHAMBER INSTRUMENTATION AND RECORDING SYSTEM

J.D. Ingram

August 1986

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618054

Approved for Public Release.
This manual describes the history, circuitry, setting-up and operating instructions for the MRL Smoke Chamber IR Scanning Radiometer (2 to 15 \(\mu\)m waveband) for the Australian Smoke Programme. It describes in detail the progress over a number of years of the modifications required and the reasons for these modifications from the original design in 1979.