DATARAM

INSTRUCTION MANUAL

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If the apparatus fails to conform to the above warranty, and notice is received by MIE from Purchaser within one year from the date of shipment, MIE will, at its option, either repair the defective part or parts or make available a repaired or replacement part. This warranty extends to all parts and labor involved in the required repair to the extent that said repair was not caused by negligence in operation of the apparatus by the Purchaser. MIE will perform the repair at its plant with all shipping and insurance costs paid by the Purchaser or, upon mutual consent of the parties, at a site designated by the Purchaser except, in the latter circumstances, the Purchaser will be responsible to reimburse MIE for all costs associated with travel, per diem and travel time of those MIE individual(s) deemed appropriate to effectuate the repair.

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1.0 GENERAL DESCRIPTION

The MIE Model DataRAM Real-time Aerosol Monitor is a technologically advanced instrument designed to sample the air and to measure the concentration of airborne particles, providing direct and continuous readout as well as electronic recording of the information.

The DataRAM is the result of many years of field experience acquired with its well known predecessor, the MIE model RAM-1, and embodies many technological advances made possible by the latest electronics hardware and software.

The DataRAM is a high sensitivity nephelometric monitor whose light scattering sensing configuration is optimized for the measurement of the concentration of airborne dust, smoke, fumes and mists in industrial and ambient environments.

The DataRAM is a compact , rugged and totally self-contained instrument designed for both portable as well as unattended operation. It is powered either by its internal rechargeable battery, or by an external d.c. or a.c. source. The DataRAM samples the air at a constant (regulated) flow rate by means of a built-in high-reliability diaphragm pump. The sampled air stream passes through the optical sensing stage after which all particles are retained by either a large capacity high-efficiency filter cartridge or on an "analytical" filter for gravimetric and/or chemical analysis (both types provided with the DataRAM). A part of this filtered stream is continuously diverted through and over all optically sensitive areas (lenses, light traps, etc.) to protect them from particle deposition, thus ensuring long-term maintenance free operation. For either manual or programmed/automatic zeroing of the instrument, an electronically controlled latching solenoid valve diverts the entire filtered air stream through the optical sensing stage in order to achieve "zero" air reference conditions. In addition, instrument span checks (secondary calibration) can be performed by insertion of a built-in optical scattering/diffusing element (simply turning a knob on the back panel).

The DataRAM covers an unusually wide measurement range: from 0.0001 mg/m^3 (0.1 µg/m^3) to 400 mg/m^3, a total span of 4 million times, corresponding to the most pristine ambient air levels up to extremely polluted source conditions.

In addition to the auto-ranging real-time concentration readout, the DataRAM provides the user with a wide range of information on its 8-line LCD screen, such as: real time and date, time weighted average concentration, elapsed run time, etc. Menu driven selection of operating parameters, and diagnostic information displays are available. Furthermore, the DataRAM features complete, large capacity, data logging capabilities with retrieval either through its own display (by scrolling) or by "dumping" to an external system (printer, computer, etc.). The stored information includes time and date, average concentration over selected periods, maximum and minimum values and STEL, as well as a tagging code.

Selectable high level alarm function with built-in audible signal and switched output, RS232 data port, and analog output are all part of this versatile instrument.

Several optional sampling accessories are available from MIE for use with the DataRAM such as a cyclone precollector for respirable particle measurements, an omnidirectional ambient air sampling inlet, a PM-10/PM 2.5 size selector, an in-line heater for monitoring in high humidity/fog situations, isokinetic inlets for duct sampling, and a sample dilution accessory for elevated temperature and/or high concentration monitoring conditions. A portable-battery powered printer, and cabling accessories are available from MIE.

To down-load data to a PC or laptop, any serial communications software package (e.g. Microsoft Windows™ 3.1) can be used. Standard spreadsheet packages (e.g. Microsoft Excel™, Lotus™, etc.) can be used for review and archiving.

2.0 SPECIFICATIONS

- Concentration Measurement ranges (auto-ranging)[1]:

  0.1 to 999.9 $\mu g/m^3$ (resolution : 0.1 $\mu g/m^3$)
  1.00 to 39.99 mg/m^3 (resolution : 0.01 mg/m^3)
  40.0 to 399.9 mg/m^3 (resolution : 0.1 mg/m^3)

- Scattering coefficient range: 1.5×10^{-7} to $6 \times 10^{-1} m^{-1}$ (approx.) at $\lambda = 880nm$.
- Concentration display averaging/updating time[2]: 1 or 10 seconds.
- Precision/repeatability over 1-hour (2-sigma)[3]:

  $\pm$ 0.3 $\mu g/m^3$ for 10 second averaging
  $\pm$ 1.0 $\mu g/m^3$ for 1 second averaging

- Accuracy[1]: $\pm$ 5% of reading $\pm$ precision.
- Temperature coefficient of zero level: <0.05 $\mu g/m^3$ per °C.
- Particle size range of maximum response: 0.1 to 10µm.
- Sampling flowrate[2]: 1.7 to 2.3 liters/minute.
- Sampling flowrate stability (long term)[4]: $\pm$ 5% (up to max. pump loading).
- Purge/clean air HEPA cartridge filter replacement time (typical): >5 years (@ constant 1 mg/m^3).
- Alarm level adjustment range[2] : 0.1 $\mu g/m^3$ to 399.9 mg/m^3.
- Alarm integration time[2]: real time (1 or 10 sec.), or STEL (15 min.).
- Data logging averaging periods[2] : 1 second to 4 hours.
- Total number of data points in memory: 10,000 (each point: average, minimum and maximum concentrations).
- Logged data:
  - For each data point: average, minimum and maximum concentrations, time/date, and data point number.
  - Run summary: tag number of logged points, start time/date, total run elapsed time, averaging time, data logging averaging period, calibration factor, STEL concentration, STEL occurrence time after start, overall average concentration, overall maximum and minimum concentrations with data point number.
- Number of data tags: 10
- Real-time and date data: seconds, minutes, hours, day of month, month and year, with leap year compensation.
- Clock accuracy: $\pm$ 1 minute/month, or better.
- Elapsed time range: 1 second to 99 days.
- Time keeping and data storage duration: >10 years.
- Automatic zeroing time interval range[2]: 1 to 20 hours
- Readout display: LCD 120 x 64 dots, 15 characters x 8 lines, 57.6 x 38.4 mm active area.
- Internal battery: rechargeable sealed lead-acid, 6.5 Ahr, 6 V nominal.
- Operating time with initial full battery charge[4]: >24 hours (new battery).
- Operating time with charger: continuous and unlimited.

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[1] Referred to gravimetric calibration with AC Fine test dust (mmd = 2 to 3 µm, $\sigma g = 2.5$).
[2] User selectable.
[3] At constant temperature.
[4] At 25°C.

- Charging time: 4 hours nominal (with DataRAM charger).
- Charging input power: 100/240 VAC, 50/60 Hz, 50 VA
- External d.c. power (optional): 6V @ 3 A
- Analog output (auto-ranging)[5]: 0 to 5V, for 0 to 4 mg/m^3
  0.5 to 5V, for 4 to 40 mg/m^3
  0.5 to 5V, for 40 to 400 mg/m^3
  - Output impedance: <10 ohms.
  - Short circuit current: 3mA.
  - Load impedance: >2 Kohms
- Digital output: RS232, 9600 baud, data bit: 8, stop bits: 1, parity: none.
- Alarm output: switched, 1A @ 10V max., resistance < 0.1 Ω.
- Alarm sound intensity: 90dB @ 1m.
- Sound level (acoustic noise) in run mode: 40dB @ 1m
- Fuse: 1A, fast.
- Operating environment: 0°C to 40°C (32°F to 104°F), 0 to 95% RH
- Storage environment: -20°C to 60°C
- Dimensions: 134 mm H (5.28 in) x 184 mm W (7.25 in) x 346 mm D (13.63 in)
- Weight: 5.3 kg (11.7 lbs)

[5]Range identified on LCD screen.

3.0 USER GUIDELINES

3.1 Handling Instructions

The DataRAM is a sophisticated optical/electronic instrument and should be handled correspondingly. Although the DataRAM is very rugged, it should not be subjected to excessive shock, vibration, temperature or humidity. As a practical guideline, the DataRAM should be handled with the same care as a portable CD player.

If the DataRAM has been exposed to low temperatures (e.g. in the trunk of a car during winter) for more than a few minutes, care should be taken to allow the instrument to return near room temperature before operating it. This is advisable because water vapor may condense on the interior surfaces of the DataRAM causing temporary malfunction or erroneous readings. Once the instrument warms up to near room temperature such condensation will have evaporated. If the DataRAM becomes wet (e.g. due to water sprays, exposure to rain, etc.) dry its case and inlet fitting with a cloth before operating.

Whenever the DataRAM is shipped care should be taken in placing it in its carrying case and repackaging it in its original cardboard box with the factory provided packing/protection padding.

3.2 Safety Instructions

- *Read and understand all instructions in this manual.*
- *Do not attempt to disassemble the instrument. If maintenance is required, return unit to the factory for qualified service.*
- *Never operate DataRAM without its internal filter cassette in place.*
- *The DataRAM should be operated only from the type of power sources described in this manual. Make sure that the battery charger used with the DataRAM has the appropriate input line ratings of your power grid, and appropriate output voltage and current rating to charge the DataRAM battery as specified in the manual.*
- *If the internal battery of the DataRAM has been allowed to discharge completely, recharge the battery for at least 30 minutes before operating the DataRAM.*
- *During battery charging the DataRAM should not rest on its front (i.e. bottom up).*
- *Shut off DataRAM and any external devices (printer, recorder, PC, etc.) before any interconnections are made.*

3.3 Orientation During Operation

The DataRAM can be operated in any of three orientations or attitudes:

a. Horizontally (front panel vertical), resting on its 4 bottom rubber pads.
b. Tilted with front panel up, resting on 2 rear rubber pads and locked down handle.
c. Vertical (front panel horizontal, upwards) resting on 4 rear rubber pads.

This latter position may be incompatible with the preferred orientation of certain inlet accessories (e.g. cyclone, omnidirectional inlet, etc.).

3.4 Sampling Guidelines

3.4.1 Area Sampling

For typical area sampling/monitoring the DataRAM is placed and operated in the area to be monitored. The inlet to the DataRAM should be located centrally with respect to the area to be assessed, away from strong localized air currents due to

fans, blowers, pumps, ventilation intakes/exhausts, etc. This is to ensure representative sampling within the area of interest.

3.4.2 Ambient Air Sampling

For ambient (extramural) sampling/monitoring the following procedures and precautions should be applied:

a. The sampling inlet should be away and above any obstructions whose wake may affect sampling representativeness. Typically, the inlet should be about 1 m (or more) above ground or any major surface (e.g. roof).

b. Under typical ambient horizontal and variable wind conditions, the use of the MIE Omnidirectional Inlet, model DR-OSI is advisable, otherwise particles with inertially equivalent diameters larger that about 1 μm may not be sampled representatively.

c. At ambient relative humidities exceeding 65% to 70% airborne particles are likely to grow by accretion of water. If only the solid portion of the particulates is to be measured, it is advisable to evaporate the adsorbed water by using the MIE Temperature Conditioning Heater model DR-TCH. This applies to any monitoring to be performed under fog or water mist conditions (e.g. marine environment).

d. The DataRAM is not weatherproof. To operate the DataRAM outdoors provisions should be made to protect it from environmental extremes such as temperatures outside its specified range, and precipitation. A small shelter may be required with a modicum of heating during the winter.

3.4.3 Extractive Sampling

Two general categories of extractive sampling arise: a) from a chamber/ vessel/room, and b) from a duct or stack. In the first case the air to be monitored is generally nearly stagnant or gently stirred (by means of a fan or blower). The second case almost invariably involves a flowing stream at typical speeds of the order of 3 to 30 m/s (600 to 6000 ft/min).

To sample either from an enclosure (assuming that the DataRAM is to be located externally to that enclosure), or a duct/stack, a length of tubing can be used to which the following guidelines should be applied:

- Minimize tubing inner diameter thus maximizing transport velocity (a practical lower limit of about 2 mm, or 3/64 in. ID is indicated for reasons of excessive pressure drop).
- Minimize tubing length, especially horizontally running lengths.
- Minimize number of bends or changes in direction.
- Inner diameter changes (at unions, couplings, etc.) in the direction of flow should always be incremental, i.e. the inner diameter should only increase in the direction of flow, in order to minimize internal impaction particle losses.
- Use non-electrostatic tubing. Best is electrically grounded metal, Tygon is acceptable, Teflon is not.

For tubing lengths of less than about 2m (6 ft.), 1/4-inch ID (6.3 mm ID), with 1/16-inch wall thickness Tygon tubing is a practical size which can be stretched over the inlet stem.

a) Enclosure sampling. The inlet should be at some distance from the inner wall to ensure sampling representativeness. Typically, a minimum of 20 or 30 cm (1 ft.) is advisable.

If a particle precollector is required (e.g. cyclone) it should be used as an inlet to the tubing, within the enclosure to be monitored. If there is any pressure difference between the interior of the enclosure to be monitored and the location of the DataRAM, its exhaust port must be connected by tubing to the enclosure, i.e. the air stream extracted from the enclosure must be returned to it after passing through the DataRAM.

b) Duct/stack sampling.

In general, in this case, a probe should be used (inside the duct) whose inlet faces the direction of the air flow. If the particles in the stream are larger than 1 μm (approx.) sampling should be under isokinetic conditions, i.e. the sampling inlet velocity equals the air velocity in the duct or stack. This can be achieved using the MIE Isokinetic Sampling Nozzle set model RAM-ISN which in combination with the DataRAM covers the range of 3.8 to 25 m/s (750 to 5000 ft/min.).

As in the case of enclosure sampling, it is advisable to return the DataRAM exhaust air stream to the duct/stack in order to ensure proper internal flow conditions within the instrument.

3.5 Accessories

3.5.1 Standard Accessories

The DataRAM is provided with the following standard accessories:

- Battery charger/power supply (MIE model DR-UCP)
- Analytical filter holder/adaptor (MIE model DR-AFH)
- Digital output cable (MIE model DR-DOC)
- Carrying case (MIE part no. RAM-2-197-1)
- Instruction manual

3.5.2 Optional Accessories

A line of optional accessories is available from MIE to DataRAM users. This line is expected to grow in time as new applications for this instrument are identified. We encourage the DataRAM user to contact MIE periodically to obtain updated information on the most recent additions to this line. Presently, the following optional accessories are available:

- Omnidirectional Sampling Inlet for ambient monitoring (MIE model DR-OSI).
- Temperature Conditioning Heater for monitoring in high humidity or water fog conditions (MIE model DR-TCH).
- PM-10/PM-2.5 Inlet Head, a modular impactor for use in combination with the above accessories (MIE model PM-10/2.5).
- Respirable Cyclone Precollector incorporates a 10-mm nylon cyclone (MIE model DR-RCP10) (inquire at MIE for the availability of other cyclones).
- Sampling Dilution Unit for monitoring at very high concentrations and/or elevated temperatures (MIE model DR-SDU).

- Portable Digital Color Printer operates with either battery or line (MIE model DR-PPR).
- Serial-to-Parallel Converter Kit, provided with DR-PPR, and used to interface DataRAM with parallel printers (MIE model DR-S/P).
- External D.C. Power Cable required if an external battery is to be used to power the DataRAM (MIE model DR-DCS).

4.0 INSTRUMENT LAYOUT

The user should become familiar with the location and function of all externally accessible controls, connectors and other features of the DataRAM. Refer to figures 1, 2 and 3.

All user related functions are externally accessible. All repair and maintenance should be performed by qualified MIE personnel. Please contact the factory if any problems should arise. Do not attempt to disassemble the DataRAM.

4.1 Back Panel

All user related components are labeled. Refer to Figure 1.

- Charger/Ext. Bat. receptacle to connect either the MIE supplied battery charger, or an auxiliary user supplied external battery as an alternative to the internal battery.

- Exhaust is the small barbed tubing fitting through which the sampled air exits the DataRAM. To be used for extractive sampling (see Section 3.4.3 of this Manual).

- Span Check knob is used to insert and retract the reference scatterer element to check the DataRAM calibration. To insert (for span check), rotate knob counterclockwise (as viewed from back of DataRAM). To retract (for normal operation), rotate knob clockwise.

- Alarm Output provides a switched output voltage whenever the user selected alarm level concentration is exceeded (see Sections 8.2.8 and 8.2.9 of this Manual).

- Analog Output provides an analog voltage linearly related to the real-time concentration.

- RS-232 provides a digital output of either the real-time concentration, or of the data logged by the DataRAM, after completion of a run.

- Fast Fuse requires a fast blowing fuse of 1 ampere to protect the DataRAM circuitry.

- Int. Bat./Charger, OFF, Ext. Bat. is a 3-position locking switch to select either: a) operation with internal battery (normal position), with switch handle in the up position, b) complete shut off of DataRAM (for transport and/or longer term storage), with switch handle in its mid-position, and c) operation with external battery (to supplement internal battery) connection to the Charger/Ext. Bat. receptacle, with switch handle it its down position.

  To change locking switch position, pull handle outwards while moving it to its desired position, and then release handle.

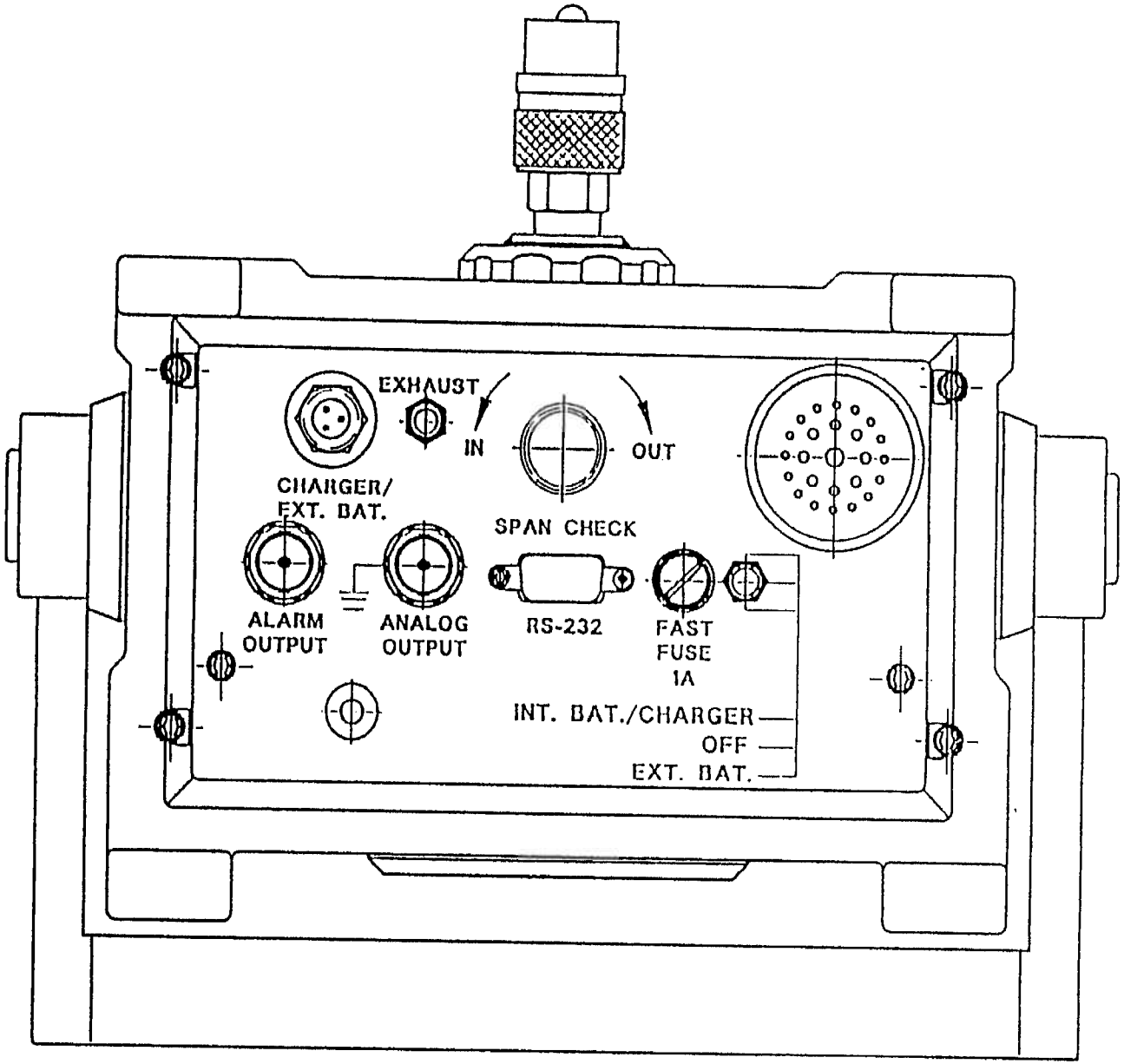


Figure 1. Back-panel view of DataRAM

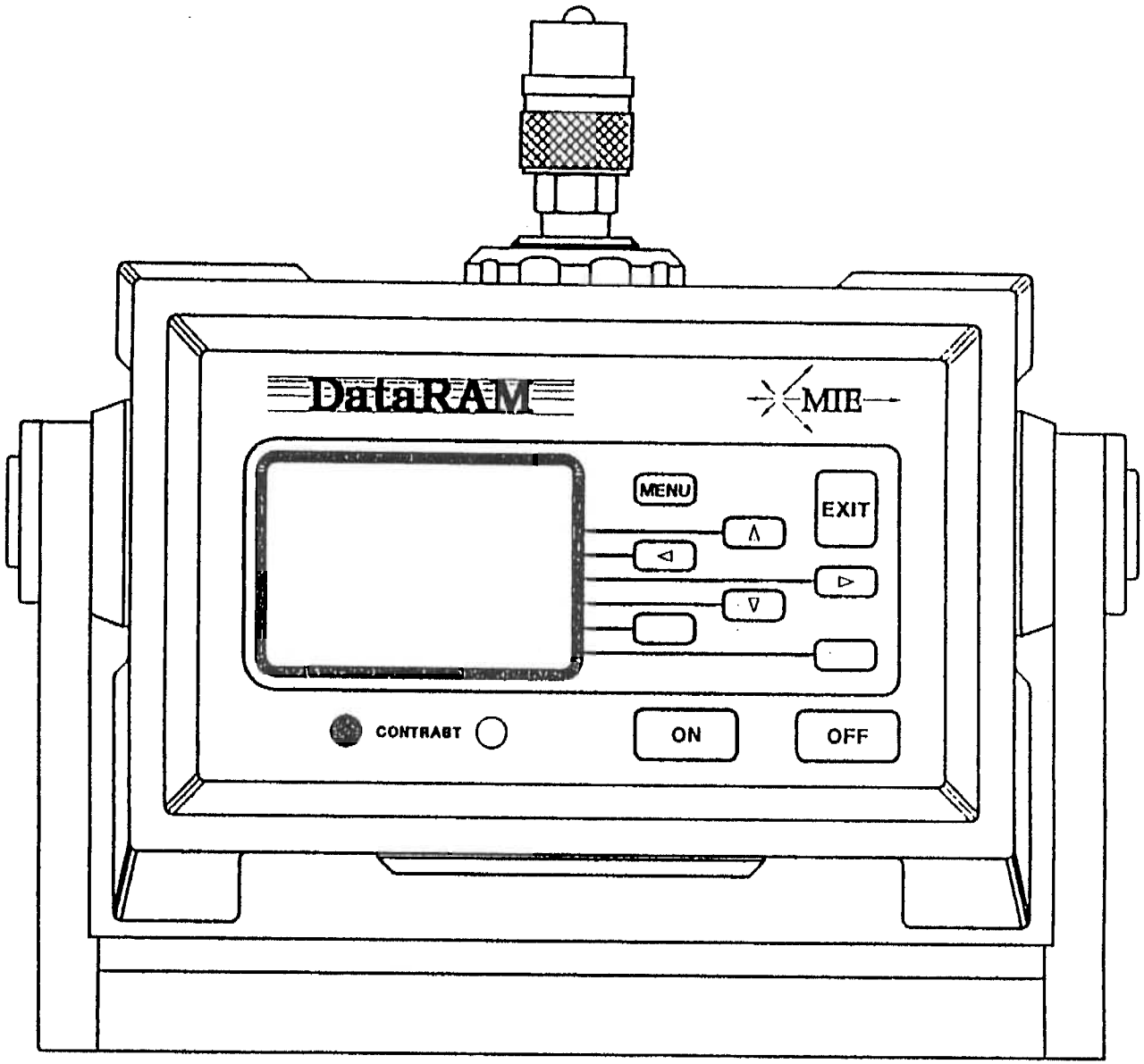
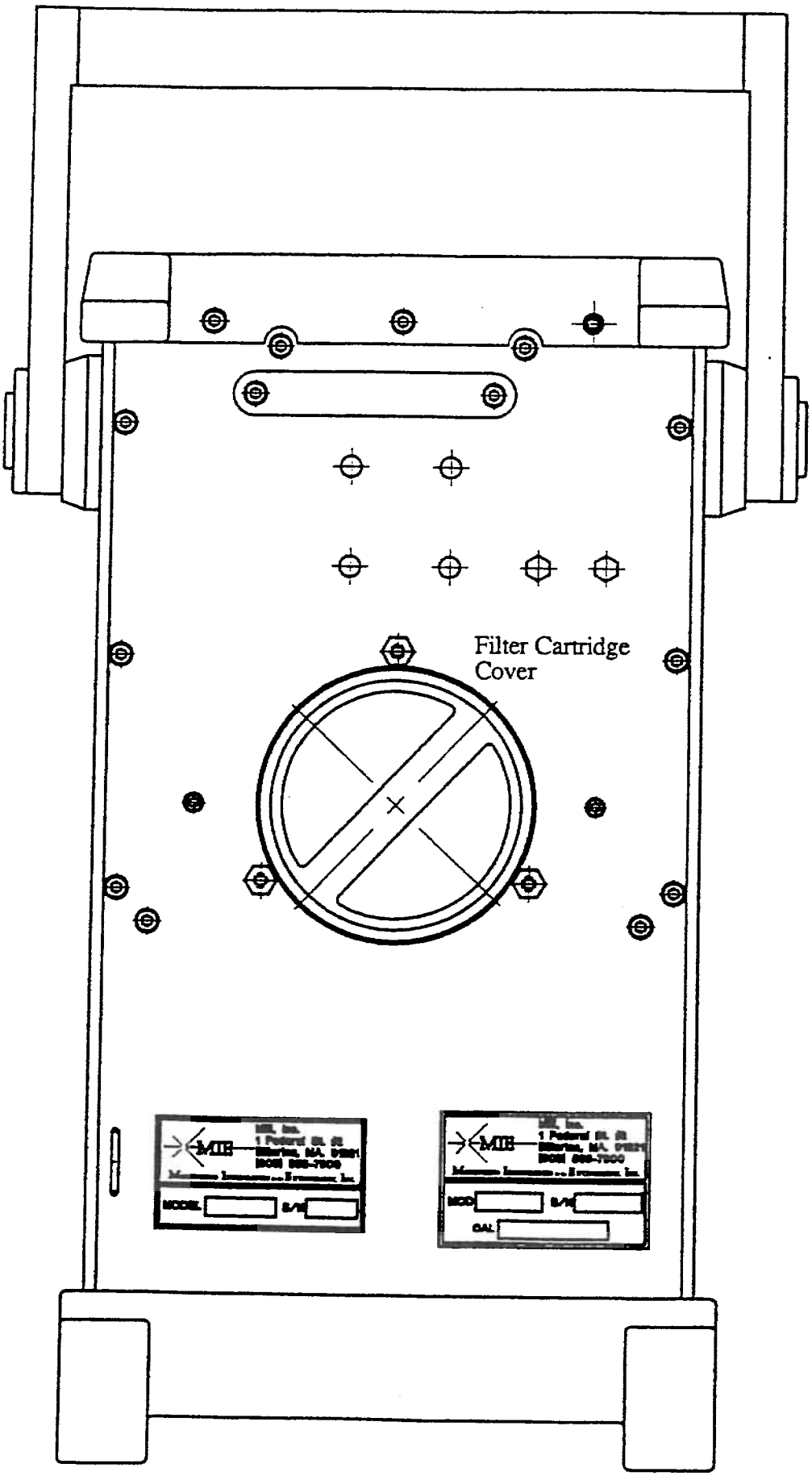


Figure 2. Front-panel view of DataRAM

Figure 3. Bottom View of DataRAM



- A pod (located below the two output connectors) is provided to store the quick-connect inlet stem cap while sampling air.

4.2 Front Panel

The front panel contains all touch switches and the LCD screen required for the operation of the DataRAM. The touch switches provide tactile "popping" feedback when properly actuated. Refer to Figure 2.

Specific commands or selections listed on the LCD with a > arrow symbol on the right side of the screen can be actuated/selected by pressing the corresponding key (one of 6 such keys) whose line points to that arrow.

The [MENU] key is in operation only when the DataRAM is in the run mode.

The [EXIT] key can be used to either return to the "MAIN MENU 1" in the standby mode, to cancel any ongoing special operation (e.g. purging), to return to the main "RUN DATA" screen, or to initiate run termination.

Pressing the [OFF] key initiates a programmed instrument shut off with automatic purging.

The CONTRAST keys can be pressed (repetitively) to either lighten (white key) or darken (black key) the display for maximum legibility.

4.3 Bottom Filter Cap

A large threaded plastic cap that covers and seals the internal filter cassette (either large capacity HEPA or membrane type) can be accessed on the DataRAM bottom panel. Refer to Figure 3. To replace the filter cassette, this cap should be rotated counterclockwise (as viewed from bottom side). Do not leave this access opening uncovered for any extended period of time: dust may, otherwise, settle on the internal optical surfaces. Hand tighten cap firmly after filter cassette replacement.

4.4 Carrying Handle

The swivel-type carrying handle can be locked in various positions, 30° apart. To unlock, press inwards the large buttons on both hinges, while rotating the handle. Allow these buttons to lock (by springing outwards) at any desired handle angle. At a 90° downward position the handle will provide an upward tilted position for the DataRAM, facilitating access and viewing of the front panel.

4.5 Sampling Inlet

The sampling inlet of the DataRAM is a quick-connect 1/4-inch stem compatible with all inlet accessories available from MIE. When the DataRAM is not in use, the inlet should be closed by means of the stem cap provided with the instrument. During use this cap should be stored on its pod on the back panel. This stem cap serves to prevent accidental entry of any objects, debris, or other forms of solid or liquid contamination into the sensing stage of the DataRAM, as well as to protect the inlet stem from any gouging or scratching.

To remove the stem cap slide spring-loaded knurled sleeve back, and pull cap away from inlet. To insert cap slide spring-loaded knurled sleeve back, push cap down on stem until it bottoms, and release knurled sleeve. The same procedures apply for removing cap from and inserting it into the storage pod on the back panel of the DataRAM.

Do not loosen the large notched aluminum nut that secures the inlet to the case.

5.0 PREPARATION FOR START-UP

5.1 Battery Charging

When shipped from the factory, the DataRAM internal battery has been fully charged allowing immediate operation of the instrument as received by the user.

If the DataRAM has not been used for more than about 3 months, the battery should be recharged to full capacity before operating without a charger. Otherwise, the instrument can be operated immediately using the charger.

A fully discharged battery requires at least 12 hours of charging using the MIE supplied charger to achieve full operating capacity.

A new and fully charged battery at temperatures above 15°C (60°F), approx., is expected to allow at least 20 hours of continuous operation of the DataRAM before recharging is required.

During battery charging the DataRAM can be placed in any of its operating positions but not resting on its front.

The DataRAM can be operated continuously and for an indefinite time using its universal charger/power supply. This charger accepts any line voltage between 100 and 240 VAC, 50 to 60 Hz.

5.2 Inlet Uncapping

Before operating the DataRAM, the protective stem cap must be removed from the inlet and stored on the pod provided on the back panel (see Section 4.5 of this Manual). The DataRAM should never be operated with the stem cap covering the inlet.

5.3 Power Selector Switch

The 3-position power selector switch on the rear panel will typically be in its OFF position (mid-position) when the DataRAM is received from the factory. To enable operation with either its internal battery or the charger supplied with the DataRAM, this switch must be placed in its INT. BAT/CHARGER position (handle upwards). Refer to Section 4.1 to operate this locking-type switch.

5.4 External Electrical Connections

If the DataRAM is to be electrically connected to any external equipment (recorder, printer, PC, alarm circuitry, etc.) during sampling/monitoring, such connection must be made only after both the DataRAM and the external equipment are shut off in order to prevent damage or interference due to transient electrical effects.

5.5 External D.C. Power Operation

In order to extend the operating time of the DataRAM (in the absence of a.c. line power) beyond the nominal 20 hours provided by its internal rechargeable battery, an external battery or other d.c. source can be used. The required specifications for an external d.c. source are:

- Voltage: 6.0 to 9.0 VDC
- Instantaneous current capability: >3A
- Continuous average current requirement: 300 mA
- Ripple-free output (if external d.c. source is not a battery)

To calculate ampere-hour capacity of an external battery, use the following formula:

ampere-hours = 0.3 x number of hours of operation

For example, if the DataRAM is to run without interruption for one week using an external battery, the actual capacity (at its operating temperature) of that battery should be at least:

0.3 x 24 x 7 = 50 ampere-hours

To connect external d.c. source to DataRAM use special cable assembly (MIE model DR-DCS). Insert its 3-terminal connector into CHARGER/EXT.BAT. receptacle on DataRAM back panel (see section 4.1 and Figure 1). Connect positive (+) side of external battery to the lead marked (+) and the negative (-) to lead marked (-) (DataRAM common ground). Before inserting connector into receptacle place 3 position locking switch on DataRAM back panel in its mid position (OFF) (see section 4.1 and Figure 1). After inserting and securing connector, place 3-position switch in its down position (EXT.BAT.). DataRAM can now be operated using the external d.c. source (as per sections 7.0 or 8.0). Before disconnecting external d.c. power source place 3-position switch in its mid-position (OFF).

6.0 OPERATIONAL CHARACTERISTICS AND PROCEDURES

6.1 Operating Modes

With exception of the Span Check, all operations and commands are performed by means of the front panel touch keys.

There are five different modes of operation:

a) Standby mode (before a run has been initiated or after it has been terminated).

b) Run mode (during which sampling/monitoring proceeds with or without data logging).

c) Purging mode (during which the DataRAM purges itself with internal filtered air).

d) Zeroing mode (during which the DataRAM purges itself and registers it own background level).

e) Span Check mode (during which the DataRAM purges itself, and the user inserts and then retracts the internal reference calibrator).

6.1.1 Standby Mode

In this mode all normal functions are activated (i.e. pump running) except the measurement and/or logging function. Only in this mode can any operational parameters be selected/changed. During the run mode none of these parameters can be changed (e.g. display update time, alarm activation/level, data logging enabling/parameters, etc.).

6.1.2 Run Mode

During the run mode the DataRAM performs concentration measurements which can be displayed and logged in that mode. If automatic zeroing has been enabled (as selected in the standby mode) the instrument interrupts the normal sampling operation on a timed basis (e.g. every 2 hours) for approximately 30 seconds during which the DataRAM purges itself and registers its optical background which is then automatically subtracted from the sensed signal.

The DataRAM will remain in the run mode until the run is terminated (by manual command), or automatically, if the battery charge falls below an acceptable level.

The MENU key responds only when the DataRAM is in run mode.

6.1.3 Zeroing Mode

This mode can be activated either manually, or automatically (at preprogrammed time intervals). No concentration readings are provided during the zeroing mode. The DataRAM remains in this mode for a period of about 20 to 30 seconds after which it returns to whatever mode it had been in initially (standby or run).

6.1.4 Purging Mode

This mode can only be activated manually. Concentration readings for clean air are indicated. Manual command is required to cancel this mode. This mode is provided principally for instrument check out and testing purposes, including span check.

6.1.5 Span Check Mode

This mode requires manual insertion of the reference calibrator (reference scattering element) into the sensing chamber, by rotating a knob on the back panel of the DataRAM. Once the span reading has been completed (as indicated on the LCD screen), the user retracts the calibrator to its normal position. During the span check the DataRAM operates in the purging mode.

7.0 ABBREVIATED OPERATING INSTRUCTIONS

	KEYSTROKES	DISPLAY
A.	To monitor without logging data:	
1.	[ON]	"MAIN MENU 1"
2.	"ZERO" line	"ZERO ING" until "ZERO COMPLETE"
3.	[EXIT]	"MAIN MENU 1"
4.	"Run" Line	"RUN DATA"
B.	To monitor and log data clearing all previously stored data follow steps 1,2 and 3 as above, followed by:	
5.	"Parameters" line	"PARAMETERS 1":"Clear Data"

KEYSTROKES	DISPLAY
6. "Clear Data": line	:"No: EXIT Clear:"
7. "Clear" line	:"Clear Data"
8. "Log Data" line	:"LogData: ON"
9. Arrows to select logging period	:"Period: xx xx xx"
10. [EXIT]	"MAIN MENU 1"
11. "Run" line	"RUN DATA"
C. To end run:	
1. [EXIT] from "RUN DATA" screen	"Terminate RUN"
2. "Terminate RUN" line	"MAIN MENU 1"
D. To shut down:	
1. [OFF] and wait until DataRAM shuts itself off	"POWER OFF": "Purging"

8.0 DETAILED OPERATING PROCEDURES

8.1 Operating Instructions Codes

The following codes are applied in this Manual to identify keys and display information:

a) Specifically labeled keys (e.g. ON, OFF, etc.) are identified in the Manual text as follows: [ON], [OFF], [MENU], [EXIT].

b) Text displayed on the LCD screen is identified by quotation marks: e.g. "MAIN MENU 1", or "RUN DATA".

c) Commands or selections displayed on the LCD screen are identified by quotation marks: e.g. "Parameters". The key in line with that displayed command or selection will activate it.

d) Blinking messages on the LCD screen are identified with a dashed line under the flashing word: e.g. "Purging", "Clear Data".

e) Arrow (i.e. directional) keys are used either as line command keys (see c) above) or to select numbers. Left and right arrow keys (◁ , ▷) select significant digits, and up and down arrow keys (Δ , ∇) increase or decrease the digits.

8.2 Operating Parameters Selection

Before starting a run the user should select the desired operating parameters. Table A lists these selectable parameters and their default conditions/values (i.e. the conditions/values that the DataRAM will select automatically when turned on unless the user changes them).

TABLE A. Parameter Selections and Default Conditions

PARAMETER	SELECTABLE CONDITIONS/RANGE	DEFAULTS
1. Concentration averaging/updating time	1 or 10 seconds	Last setting
2. Automatic zeroing activation	OFF or ON	OFF
3. Automatic zeroing time interval	1 to 20 hours	1 hour
4. Alarm activation/integration time	OFF, INST* , STEL**	Last setting
5. Alarm level range	0.1 ug/m^3 to 399.9 mg/m^3	Last setting
6. Data logging activation	OFF or ON	OFF
7. Data logging averaging period	1 second to 10 hours 59 min. 59 sec	Last setting
8. Data logging tag	0 to 9	1
9. Digital output (Selection to be performed after run completion)	• Selected tag summary • Selected tag data • All data in memory	No default condition (requires specific user selection)
10. Flow rate	1.7 to 2.3 lpm	Last setting

To select the desired operating parameters prior to a run proceed as follows:

Press [ON]. The internal pump should be heard.

The following screen will appear (time and date shown below are examples):

1	4	:	3	7	:	1	8		1	3		A	p	r
		M	A	I	N		M	E	N	U		1		
R	u	n	(	z	e	r	o	e	d	?	)			>
S	y	s	t	e	m		D	i	a	g	n	o	s	>
P	a	r	a	m	e	t	e	r	s					>
P	u	r	g	e										>
Z	e	r	o											>
N	e	x	t		S	c	r	e	e	n				>

8.2.1 Concentration Display Averaging Time Selection (from MAIN MENU 1)

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Ave Time":	"PARAMETERS 1"	Toggles between 1 and 10 seconds

* When INST is selected the alarm integration time equals the selected concentration averaging/updating time (1 or 10 seconds).

** 15-minute averaging time.

KEYSTROKES	DISPLAY	NOTES
3. EXIT	"MAIN MENU 1"	Pressing EXIT returns to "MAIN MENU 1"

8.2.2 Data Logging Activation (from (MAIN MENU 1)

Whenever the "PARAMETERS 1" screen is presented the first time after the DataRAM has been turned on, Tag # 1 (default tag number) will be displayed on that screen. If data (previously logged) remains in that tag the "Clear Data" will be flashing and "(Used)" will appear after "Tag #". To enable logging either the stored data must be erased (see section 8.2.4 below), or another (unused) Tag # must be selected (see Section 8.2.5 below). If the "Clear Data" is keyed all stored data (in all tag numbers) is erased, i.e. the DataRAM logging memory is cleared.

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	If "Clear Data" is flashing proceed to section 8.2.4 or 8.2.5 below.
2. "Log Data"	"PARAMETERS 1"	Toggles between "OFF" and "ON"
3. EXIT	"MAIN MENU 1"	

8.2.3 Data Logging Averaging Period (from MAIN MENU 1)

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Log Data"	"PARAMETERS 1"	Select "ON"
3. "Every"	"PARAMETERS 1"	Select hours, minutes and seconds Using ▷◁ ΔV keys
4. EXIT	"PARAMETERS 1"	Pressing EXIT enters the selected period
5. EXIT	"MAIN MENU 1"	

Example: Assuming that a previously programmed period of 30 seconds is to be changed to 5 minutes, proceed as follows (after pressing "Every"):

- Press ▷ 3 times
- Press Δ 5 times
- Press ▷ once
- Press V 3 times
- Press EXIT to enter the selected 5-minute period
- Press EXIT again to return to "MAIN MENU 1"

8.2.4 Clear All Logged Data (from MAIN MENU 1) (see section 8.2.2 above)

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Clear Data"	"PARAMETERS 1" "No:EXIT Clear:"	To prevent accidental loss of stored data you must confirm the clear command by keying "Clear" (otherwise key [EXIT]).
3. "Clear"		Keying the "Clear" line will erase all stored data
4. [EXIT]	"MAIN MENU 1"	

8.2.5 Tag # Selection (from MAIN MENU 1)

To select or change the tag number under which the data is to be logged, proceed as follows:

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Tag #"	"PARAMETERS 1"	Select flashing tag # Δ or ∇ keys
3. [EXIT]	"PARAMETERS 1"	Enters selected tag #
4. [EXIT]	"MAIN MENU 1"	

8.2.6 Automatic Zeroing Activation (from MAIN MENU 1)

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Next Screen"	"PARAMETERS 2"	
3. "Auto Zero"	"PARAMETERS 2"	Toggles between "OFF" and "ON"
4. [EXIT] [EXIT]	"MAIN MENU 1"	

8.2.7 Automatic Zeroing Period Selection (from MAIN MENU 1)

The user can select any time interval between successive automatic zeroing operations, in steps of one hour, over the range of 1 to 20 hours. It should be noted that this is an optional function required only if large temperature

variations are expected during a run and/or for high precision low concentration measurements.

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Next Screen"	"PARAMETERS 2"	
3. "Auto Zero"	"PARAMETERS 2"	Select "ON"
4. "Every"	"PARAMETERS 2"	Select the number of hours using ▷◁ Δ∇ keys
5. EXIT	"PARAMETERS 2"	Pressing EXIT enters the selected period
6. EXIT EXIT	"MAIN MENU 1"	

8.2.8 Alarm Activation (from MAIN MENU 1)

Three different alarm conditions can be selected: a) alarm disabled (indicated by "Alarm OFF"), b) alarm activated by real-time concentration as shown on the display (indicated by "Alarm INST"), and c) alarm activated by a STEL exceedance (i.e. running 15-minute average). If "Alarm INST" is selected and the set alarm level (see section 8.2.9) is exceeded during a run, the audible alarm will be heard and the alarm output will switch. The user can reset both the sound and the output by pressing EXIT. This will disable the alarm function for 10 minutes after which the alarm function is enabled again ready to respond to an exceedance of the set level. If "Alarm STEL" is selected and the set alarm level is exceeded during a run, the alarm will be activated as in the case of "INST", but will not be enabled again after keying EXIT, i.e. the "STEL" alarm will operate only once during a given run.

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Next Screen"	"PARAMETERS 2"	
3. "Alarm"	"PARAMETERS 2"	Select between "OFF", "INST" and "STEL" by keying the "Alarm" line
4. EXIT EXIT	"MAIN MENU 1"	

8.2.9 Alarm Level Selection (from MAIN MENU 1)

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Next Screen"	"PARAMETERS 2"	
3. "Alarm"	"PARAMETERS 2"	Select "ON"
4. "Conc"	"PARAMETERS 2"	Select alarm concentration level using ▷◁ Δ∇ keys

KEYSTROKES	DISPLAY	NOTES
5. EXIT	"PARAMETERS 2"	Pressing EXIT enters the selected concentration
6. EXIT EXIT	"MAIN MENU 1"	

8.2.10 Calibration Factor Adjustment (from MAIN MENU 1)

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Next Screen"	"PARAMETERS 2"	
3. "CalFactor"	"PARAMETERS 2"	Select desired calibration factor (in %) using ▷◁ Δ∇ keys
5. EXIT	"PARAMETERS 2"	Pressing EXIT enters the selected calibration factor
6. EXIT EXIT	"MAIN MENU 1"	

8.2.11 Setting Clock (from MAIN MENU 1)

To set the time and date of the internal clock proceed as follows:

KEYSTROKES	DISPLAY	NOTES
1. "Next Screen"	"MAIN MENU 2"	
2. "Set Date, Time"	"MAIN MENU 2"	Select hours, minutes, day of month, and year* using ▷◁ Δ∇ keys
3. EXIT	"MAIN MENU 2"	When EXIT is keyed the clock is reset to 00 seconds and time keeping is initiated
4. EXIT	"MAIN MENU 1"	

8.2.12 Flow Rate Adjustment (from MAIN MENU 1)

To set the desired sampling flow rate over the range of 1.7 to 2.3 liters per minute (lpm), in 0.1 lpm steps, proceed as follows:

KEYSTROKES	DISPLAY	NOTES
1. "Parameters"	"PARAMETERS 1"	
2. "Next Screen"	"PARAMETERS 2"	

* The year is not displayed except while setting clock when keying ▷ after the month selection.

KEYSTROKES	DISPLAY	NOTES
3. "Flowrate"	"PARAMETERS 2"	Select desired flow rate by toggling "Flowrate" key. Each keystroke increments flow rate by 0.1 lpm.
4. EXIT EXIT	"MAIN MENU 1"	

8.3 Pre-run Procedure

Prior to initiating a measurement run the instrument should be zeroed and the diagnostics should be checked. If any of the internally monitored functions is faulty a flashing message "System Fault" will appear on "MAIN MENU 1".

8.3.1 System Diagnostics (from MAIN MENU 1)

KEYSTROKES	DISPLAY	NOTES
1. "System Diagnos"	"SYSTEM DIAGNOST"	Screen shown below displays normal operating conditions:

1	4	:	3	7	:	1	8		1	3		A	p	r
S	Y	S	T	E	M		D	I	A	G	N	O	S	T
F	i	l	t	e	r				N	o	r	m	a	l
B	a	t	t	e	r	y			N	o	r	m	a	l
B	a	c	k	g	r	n	d		N	o	r	m	a	l
F	l	o	w						N	o	r	m	a	l
B	a	t	C	h	r	g			1	2	3	4	5	
F	l	o	w	r	a	t	e	2	.	0	L	P	M	

Fault conditions for any of the 4 functions that otherwise are identified as "NORMAL" are then indicated (by flashing) as:

"Change Filter"
"Battery Low"
"Background High"
"Flow Problem"

If the calibrator has been left in the inserted position (e.g. after completion of the span check, see section 8.3.2), the screen title ("SYSTEM DIAGNOST") will flash "RETRACT CALIBR". Rotate fully clockwise span check knob on rear panel until the above flashing message disappears.

The battery charge status ("BatChrg") is indicated by 5 ascending numbers. A fully charged battery is indicated by 1 2 3 4 5, a partially charged battery by fewer digits, such as 1 2 3 _ _, a nearly completely discharged battery by 1 _ _ _ _.

The sampling flow rate in liters/minute displayed on the last line. Normally the indicated flow rate equals the programmed flowrate (section 8.2.12). If either or both the "Filter" and/or "Flow" functions are flagged as faulty (see above), the indicated flow rate may deviate from the programmed value.

KEYSTROKES	DISPLAY	NOTES
2. EXIT	"MAIN MENU 1"	

8.3.2 Zeroing and Span Check (from MAIN MENU 1)

Important: Zeroing should be performed routinely before starting a run. *Do not interrupt zeroing: wait until* "ZERO COMPLETE". Span Check need only be performed occasionally or if a DataRAM malfunction is suspected.

KEYSTROKES	DISPLAY	NOTES
1."Zero"	"ZEROING"	This message will be shown for several seconds after which it switches automatically to:
	"ZERO COMPLETE"	
	"Span Check"	If only zeroing is desired key EXIT to return to "MAIN MENU 1". If the span check is to be performed proceed as follows:
2."Span Check"	"insert calibrator"	
		At this point rotate counterclockwise span check knob on rear panel until it reaches end of rotation, and the display indicates:
	"wait"	and then immediately:
	"retract calibrator"	
	"Calibr Diff = xxx%"	The percentage displayed represents the difference (%) between the present span check value and the value recorded at the factory. For example: -003% indicates that the span check is at 97% of the factory value (see explanatory notes in section 9.6).

8.3.3 Purging (from MAIN MENU 1)

This function is normally not required in preparation for a run. It is provided principally as a means to check the clean air purging and zeroing functions, as well as the long term stability and precision of the DataRAM.

KEYSTROKES	DISPLAY	NOTES
1. "Purge"	"PURGING" "Conc xxx.x µg/m3" "TWA xxx.x µg/m3" "Wait"	This screen will remain for several seconds, after which it switches to:
	"PURGE COMPLETE" "Conc xxx.x µg/m3" "TWA xxx.x µg/m3"	This screen will remain until

KEYSTROKES	DISPLAY	NOTES
	"Span Check"	EXIT or "Span Check" are keyed (for "Span Check" see section 8.3.2).
2. EXIT	"MAIN MENU 1"	

8.4 Measurement Run Procedure

8.4.1 Run Initiation

Starting from the "MAIN MENU 1" screen, proceed as follows:

KEYSTROKES	DISPLAY	NOTES
1. "Run (zeroed?)"	"RUN DATA"	The question "zeroed?" serves to remind the user to perform that function before starting a run.

A typical "RUN DATA" screen is shown below:

1	5	:	4	5	:	3	6		1	3		A	p	r
u			R	U	N		D	A	T	A				
C	o	n	c		0	3	4	.	6	u	g	/	m	3
T	W	A			0	3	2	.	7	u	g	/	m	3
E	T			0	0	:	0	1	:	0	8	:	1	8
M	e	m	o	r	y	F	r	e	e		9	6	%	
C	a	l	F	a	c	t	o	r	:		1	0	0	%
S	y	s	t	e	m		D	i	a	g	n	o	s	>

The information displayed on this screen is as follows:

Line 1: time and date
Line 2: symbol on left identifies the concentration range of the analog output:
- u for 0 to 4 mg/m^3
- m for 4 to 40 mg/m^3
- M for 40 to 400 mg/m^3

Line 3: "Conc" is the instantaneous (1 or 10 sec. average) concentration
Line 4: "TWA" is the time-weighted-average concentration from run start
Line 5: "ET" is the elapsed run time in days, hours, minutes and seconds
Line 6: "MemoryFree" is the percentage of unused or available logging memory
If data is currently being logged (i.e. if activated before start of current run) a letter L will be flashing on this line.
Line 7: "CalFactor" is the calibration response slope value with respect to the factory value, in percent (user adjustable)

Line 8: "System Diagnos" can be selected for viewing (see section 8.3.1)

Once the DataRAM is in the run mode it will continue in that mode until: a) run is manually terminated (see section 8.4.2) or b) the battery charge is exhausted (if operated without the charger/power supply or other external source of power).

8.4.2 Run Termination

A run can be terminated at any time by the user, starting from the "RUN DATA" screen (if the DataRAM is displaying any other screen the "RUN DATA" can always be reached by keying EXIT once or twice).

	KEYSTROKES	DISPLAY	NOTES
1.	[EXIT]	"Terminate RUN" "to continue RUN key 'EXIT'"	
2.	"Terminate RUN"	"MAIN MENU 1"	

After this point the user can change the programming parameters, display or download logged data, or start new run. If data logging is to be resumed, reactivation of that function is required (see sections 8.2.2 through 8.2.5).

8.4.3 Run Menu

When the DataRAM is in the run mode, keying [MENU] provides the following screen:

1	4	:	3	7	:	1	8		1	3		A	p	r
			R	U	N			M	E	N	U			
S	y	s	t	e	m		D	i	a	g	n	o	s	>
P	a	r	a	m	e	t	e	r	s					>
S	c	r	o	l	l		D	a	t	a	l	o	g	>
Z	e	r	o											>
P	u	r	g	e										>

The [MENU] key is enabled only in the run mode.

See section 8.3.2 for "System Diagnos".
See section 8.2 for "Parameters". Note that in the run mode the operating parameters can be viewed but not changed. Parameter selection can only be performed in the standby mode (starting from MAIN MENU 1).
To return to "RUN MENU" from PARAMETERS or SYSTEM DIAGNOST key [MENU]
If "Zero" is keyed from the "RUN MENU", DataRAM will switch to the zeroing mode, identified by "Z" in the upper right of the screen. After a few seconds, the DataRAM returns automatically to the normal sampling mode.

If "Purge" is keyed from the "RUN MENU", the DataRAM will switch to the purging mode, identified by "P Z" in the upper right of the screen. After a few seconds, the DataRAM will return automatically to normal sampling mode. If either "Zero" or "Purge" are keyed from the "RUN MENU" the displayed TWA computation will include the zero concentrations sensed during those periods.
For the description of "Scroll DataLog" refer to section 8.6.1

To terminate a run proceed as follows (starting from RUN DATA screen):

KEYSTROKES	DISPLAY	NOTES
1. [EXIT]	"Terminate RUN"	
	"to continue RUN key 'EXIT'"	
2. "Terminate RUN"	"MAIN MENU 1"	Alternatively if the run is not to be terminated key [EXIT]

8.5 Data Retrieval Output and Downloading

Either during a run, after its termination, or after shutting instrument off and turning it on again, any data that has been logged can be displayed on the DataRAM. The real-time concentration level (1 or 10-second) is outputted continuously at the RS-232 port, as well as at the analog output connector, during the run. After run termination, i.e. in the standby mode, the logged data can be downloaded through the RS-232 port to a printer, computer, etc.

8.5.1 Display and Scrolling of Logged Data

Either during or after a run the logged data can be viewed on the DataRAM display.

To display the logged data during standby (after run termination), proceed as follows (starting from "MAIN MENU 1"):

KEYSTROKES	DISPLAY	NOTES
1. "Next Screen"	"MAIN MENU"	
2. "Scroll DataLog"	"SCROLL DATA LOG"	

To display the logged data during a run, proceed as follows (starting from "RUN DATA"):

KEYSTROKES	DISPLAY	NOTES
1. [MENU]	"RUN MENU"	
2. "Scroll DataLog"	"SCROLL DATA LOG"	

A typical "SCROLL DATA LOG" screen is shown below:

S	C	R	O	L	L		D	A	T	A		L	O	G
A	v	g	C	:	0	2	8	.	6	u	g	/	m	3
M	a	x	C	:	0	4	5	.	8	u	g	/	m	3
M	i	n	C	:	0	2	1	.	1	u	g	/	m	3
X	X	:	X	X	:	X	X		1	3		A	p	r
T	a	g	#	:									1	>
P	o	i	n	t	#	:				0	0	0	1	>
S	u	m	m	a	r	y	1	D	i	s	p	1		>

This screen contains the following information:

Line 2 ("AvgC"): average concentration for displayed point
Line 3 ("MaxC"): maximum concentration for displayed point
Line 4 ("MinC"): minimum concentration for displayed point
Line 5: Start time and date of logging for displayed point
Line 6 ("Tag #"): displayed data tag number
Line 7 ("Point #"): displayed data point number
Line 8 ("Summary Displ"): can be commanded to display data summary for each tag number (see below)

To scroll the data for each tag number used proceed as follows:

KEYSTROKES	DISPLAY	NOTES
1. "Point #"	"SCROLL DATA LOG"	The most significant digit of the "Point #" will be flashing
2. ▷ ◁	"SCROLL DATA LOG"	Use these keys to select significant digit
3. Δ ∇	"SCROLL DATA LOG"	Use these keys to select desired data point to display corresponding average, maximum, and minimum

To select tag number proceed as follows (if the point number is flashing, first key [EXIT]):

KEYSTROKES	DISPLAY	NOTES
1. "Tag #"	"SCROLL DATA LOG"	The tag number will be flashing
2. Δ ∇	"SCROLL DATA LOG"	Use these keys to select desired tag number to be displayed. Only tag numbers with logged data can be selected here
3. [EXIT]	"SCROLL DATA LOG"	At this point the data within the selected tag number can be scrolled as described above, or the summary display for that tag can be displayed.

8.5.2 Summary of Logged Data

For each tag number, the user can display a data summary as follows (starting from "SCROLL DATA LOG"):

KEYSTROKES	DISPLAY	NOTES
1. "Summary 1 Displ"	"Data Summary 1"	The first line of this screen shows the run tag number, followed by the corresponding start time of that logged run and the duration (elapsed time) for that run.
2. "Next Display"	"Data Summary 2"	The first line of this screen shows again the run tag number, followed by the overall run average concentration (TWA), the STEL* value for that run, and the time and date at which the STEL occurred.
3. "Next Display"	"Data Display 3"	The first line of this screen shows again the run tag number, followed by the overall minimum concentration for the run, and the time and date at which this minimum concentration for the run occurred, followed by the overall maximum concentration for the run and the time and date at which this maximum occured.

If "Next Display" is keyed again the screen returns to "SCROLL DATA LOG".

8.5.3 Downloading of Logged Data

Downloading of logged data can only be performed in the standby mode, as follows (starting from MAIN MENU 1):

KEYSTROKES	DISPLAY	NOTES
1. "Next Screen"	"MAIN MENU 2"	
2. "Dump Data RS232"	"DUMP DATA LOG"	
3. "Tags Used?"	"DUMP DATA LOG"	When this line is keyed the used tag numbers will be displayed
4. "Select Tag #"	"DUMP DATA LOG"	The displayed number will flash indicating that this number can be selected
5. Δ ∇	"DUMP DATA LOG"	Use these keys to select desired tag number
6. EXIT	"DUMP DATA LOG"	Enters the selected tag number

* STEL value is the highest concentration averaged over any 15-minute period during the run.

To download only the summary data for the selected tag numbers:

KEYSTROKES	DISPLAY	NOTES
7. "Dump Tag Summary"	"DUMP DATA LOG"	When keying this line there will be momentary blinking of that line

To download all data for the selected tag number:

8. "Dump Tag Data"	"DUMP DATA LOG"	This line will flash until all data for the selected tag has been downloaded

To download all data for all tag numbers:

9. "Dump All Data"	"DUMP DATA LOG"	This line will flash until all data logged has been downloaded. The tag # being downloaded is indicated on that line

To clear all data logged:

10. "Clear Data"	"DUMP DATA LOG"	This line will blink off once confirming that all logged data has been erased from memory

Procedures for printing out data, transferring data to a PC, and generation of spreadsheets are provided in section 11.0 and 12.0.

8.6 Shut Off

To shut off the DataRAM, key [OFF], then for several seconds the screen will display the following before automatic shut off:

"Power OFF"

"Purging"

"Wait"

9.0 MAINTENANCE AND TROUBLESHOOTING

No user serviceable components are inside the metal case of the DataRAM with the exception of the filter cartridge (see section 9.4 for filter replacement procedure).

Normal maintenance procedures and precautions to be followed are described below.

9.1 Battery Charging and Cycling

The battery of the DataRAM should be fully charged before initiating a run. The DataRAM battery charger/power supply can be connected continuously to the instrument whether the DataRAM is on or off. If charger is not connected, the battery will discharge very slowly depending on storage temperature. Low storage temperature reduces battery capacity after a given time. In general, higher overall temperatures reduce the battery life which is of the order of 8 years at 20°C (68°F), and only 2 years at 40°C (104°F).

In general, the user should maintain the battery charge as high as possible to extend its charge/discharge cycling capacity (this characteristic differs from that of nickel-cadmium batteries).

9.2 Instrument Storage

If the DataRAM is to be stored for an extended period of time (i.e. more than 3 months), place the 3-position latching switch of the back panel in its OFF position (mid-position), in order to minimize gradual battery discharge by internal electrical leakage. This will have no effect on data retention or clock function.

During storage always place quick-connect cap over the inlet to protect the sensing optics from gradual dust contamination.

9.3 Diagnostic Fault Conditions

Fault messages displayed on the "SYSTEM DIAGNOST" screen (see section 8.3.1) should be handled as described in the subsequent sections. If "Change Filter" is indicated check for any inlet or exhaust blockages. If the pump appears to run (but perhaps at a higher-than-normal speed), replace the filter cartridge (see section 9.4).

If "Battery Low" is displayed and "BatChrg" reads 12 or less, plug in the DataRAM charger/power supply as soon as possible.

If "Background High" is indicated, the sensing chamber optics are most likely contaminated with dust, or condensation is occurring due to a combination of low temperatures and high relative humidity. If the latter cause is likely (see section 3.1) allow DataRAM to warm up and run it in the Purging mode from standby (i.e. from MAIN MENU 1). If dust has deposited on the optical surfaces (as seen when removing filter cartridge, see section 9.4), gently and carefully clean the interior surfaces of the exposed sensing chamber making sure not to rub the black antireflectant coating. An air jet can be used at low pressure to blow off the deposited dust.

If "Flow Problem" is displayed, a blockage at the inlet, exhaust, or a pump failure can be the cause. In any of these cases, the "Flowrate" reading will also be outside its normal value. If an internal failure is suspected (e.g. pump), the DataRAM should be returned to the factory for repair.

9.4 Filter Cartridge Replacement

To replace the filter cartridge place the DataRAM with its front panel facing upwards. On the bottom surface of the instrument (refer to Figure 3), locate the large threaded filter cover and rotate it, counterclockwise, using the cross bar of that cover. Remove cover and then the filter cartridge. Clean the internal black rubber gasket against which the filter cartridge rests if it appears dusty. Install new large capacity HEPA-type cartridge (MIE model DR-SFC) by inserting its wider ridged end first. Reposition threaded cover engaging threads carefully; rotate clockwise, hand tightening firmly. Properly dispose of used filter to prevent inadvertent re-use.

Alternatively, the analytical filter holder/adaptor (MIE model DR-AFH) can be installed in lieu of the large capacity filter cartridge (see section 10.0).

9.5 Electronic Malfunction

In case of electronic lock up, i.e. when the DataRAM ceases to respond to keystroke commands (including OFF), place the 3-position latching switch on the back panel in its OFF position (mid-position), and then return it to its INT.BAT./CHARGER position. Key [ON] to ascertain that the DataRAM lock up has been cleared.

9.6 Span Check Indication

The span check (section 8.3.2) is intended to provided an indication of the overall condition of the DataRAM sensing system. It is not intended as a rigorous calibration reference determination.

The "Calibr Diff" value indicated when performing the "SpanCheck" procedure (section 8.3.2) may be in the range of -010% to 010% (equivalent to ± 10%) without implying that the DataRAM is out of calibration. These deviations are caused by variations in mechanical positioning of the insertable scattering element, and by temperature dependent variations of this element and of the near-infrared source. This latter device is not regulated when the scattering element is inserted in the sensing volume. During normal particle monitoring operation (run mode), the DataRAM sensing system is temperature compensated and the actual deviations of its calibration are negligible. The DataRAM temperature coefficient in the run mode is less than 0.02%/°C.

If a "Calibr Diff" value outside the ±10% range is obtained, repeat the check (all steps of section 8.3.2 must be performed) several times to confirm the reading. If this value remains consistently outside the ±10% range, consult MIE, Inc.

10.0 FIELD GRAVIMETRIC CALIBRATION

If desired, the DataRAM can be field calibrated for a particular aerosol (dust, smoke, mist, etc.) using its own "analytical" filter. Proceed as follows:

1. Remove large-capacity metal filter cartridge as described in section 9.4.
2. Weigh (using analytical balance) 37mm diameter membrane (0.8 μm) filter to be used for gravimetric calibration, and install in transparent plastic filter holder provided with the DataRAM. Ensure proper sealing between the two parts of this holder. Insert adapter ring (grey plastic) into inlet (open face) side of transparent plastic filter holder (make sure that this adapter is fully inserted into filter holder).
3. Install filter holder with its adapter into DataRAM filter well (adapter end first). Reposition threaded cover engaging threads carefully; rotate clockwise, hand tightening firmly.
4. Key [ON] and immediately "Zero" (from MAIN MENU 1).
5. When ready to sample, key [EXIT] and immediately "Run".
6. Run for a period of time sufficient to collect a mass of at least 1 mg on the analytical filter (in order to permit accurate weighing of collected particles). To estimate the required sampling time ET (elapsed time) in minutes, read the TWA value on the

RUN DATA screen, after an elapsed time of one minute or more, and apply the following relationship:

$$ET > 500/TWA$$

For example, it TWA = 2.5 mg/m^3, then ET> 200 minutes (approximately 3 hours). If the TWA changes significantly as the run proceeds, recalculate the required ET accordingly.

7. At end of run (after time ET has elapsed) record TWA, ET and flow rate values, and key [OFF].

8. Remove analytical filter holder as described in section 9.4, and carefully disassemble holder, removing filter. Weigh filter on analytical balance and obtain Δm, the mass increment due to the collected particles.

9. Calculate average gravimetric concentration C_g as follows:

$$C_g = \frac{\Delta m}{ET \times Q} \times 1000$$

Where Q is the DataRAM flow rate in lpm, Δm is the collected mass in milligrams, and C_g is the gravimetric concentration in milligrams per cubic meter.

10. Compare the recorded value of TWA and C_g and calculate the calibration factor

$$R = \frac{C_g}{TWA} \times 100$$

For example, if C_g is 3.2 mg/m^3 and TWA is 2.4 mg/m^3, R = 133%.

11. Reinstall large-capacity metal filter cartridge as described in section 9.4, and key [ON].

12. Proceed to adjust calibration factor R as described in section 8.2.10. Select the required value of R as obtained above (for example 133%). This completes the gravimetric calibration of the DataRAM for a specific aerosol.

11.0 COMMUNICATIONS TO PRINTER

11.1 Hardware Required

The following components are required: MIE DataRAM, MIE model DR-PPR Printer (Hewlett Packard Deskjet 310 portable color printer) or other IBM/PC Centronics compatible parallel printer, MIE model DR-S/P Serial-to-Parallel Converter Kit. Instructions below are based on the MIE model DR-PPR printer.

11.2 Hardware Connection

The 36-pin connector of the DR-S/P Kit should be plugged into the DR-PPR (or equivalent) printer input. The 9-pin connector of the DR-S/P Kit should be plugged into the DataRAM RS-232 output.

The MIE model DR-S/P Kit is specifically configured at MIE for compatibility with the DataRAM. However, if the printer fails to print, the DR-S/P may be opened to check the jumpers are set as follows:

Large switch: **DCE** (Data Communications Equipment)
Baud Rate: **9.6** (Kbps)
7/8 BITS: **8**
EN/DS PTY: **DS** (Disable Parity)
O/E/: **E** (either can be used)

11.3 Real-Time Data Printing

Real-time concentration values can be printed out every second, or every 10 seconds (depending on selected averaging/updating time, see section 8.2.1). Whenever the DataRAM is in the run mode data will be sent to the printer automatically.

After interconnecting DataRAM with the DR-PPR printer (see section 11.2) proceed as follows:

1. Load sufficient paper on the DR-PPR printer
2. Key [ON] on DataRAM
3. Press Power button on DR-PPR (green light on that button should then appear as well as on the Online button).
4. Start Run on DataRAM. Printer should be printing out concentration values every second (or 10-seconds).

If the printer paper runs out during a printing run, paper can be reloaded without interrupting the run, and the Online button on the printer should be keyed on again.

If printer paper runs out during a run, the data that is not being printed out is stored in the DR-PPR printer buffer. When paper has been reloaded, all these accumulated values will be printed out rapidly until the printer "catches up" with the real-time data from the DataRAM.

Caution: Do not shut off printer during a run as this may cause DataRAM microprocessor lock up. To stop printing key off the Online button of the printer. Printer power should be shut off only after termination of DataRAM run or after shutting off DataRAM. If DataRAM lock up occurs key [OFF].

Alternatively, to stop printing, remove the 9-pin connector from the RS-232 DataRAM output on its rear panel, and then shut off printer power.

11.4 Logged Data Printing

To print out data that had been previously logged by the DataRAM proceed as indicated in the section 11.1 and 11.2 above, followed by steps 1, 2 and 3 of section 11.3 above. Then proceed as in section 8.5.3.

12.0 COMMUNICATION TO COMPUTER

12.1 Required Hardware and Software

This procedure describes how to collect and save DataRAM data in an IBM PC compatible computer with the standard setup of Microsoft "Windows", version 3.1. No other software is required.

The following components are required: DataRAM, IBM PC compatible computer system with the standard setup of Microsoft "Windows", version 3.1, DataRAM Digital Output Cable MIE model DR-DOC.

To download DataRAM data to a Macintosh computer an adapter is required to interface the 25-pin female cable connector provided with the DataRAM with the computer serial input. A software package (e.g. White Knight) is required before a spreadsheet (e.g. EXCEL, LOTUS, etc.) can be used.

12.2 Hardware Connection

Connect the DataRAM to a serial communications port of the IBM PC compatible computer with the DataRAM Digital Output Cable. The Digital Output Cable, MIE model DR-DOC, is normally connected from the 9 pin subminiature-D connector on the rear of the instrument to a serial communications port (COM1, COM2, etc.) of an IBM PC compatible computer system. If the only available serial port of the IBM PC compatible computer is a 9 pin subminiature-D instead of a 25 pin, then a 9 pin male to 25 pin female subminiature-D adapter is required.

Note: The DataRAM Digital Output Cable, MIE model DR-DOC is a customized null modem cable, so that it is important that no substitutions for this cable be made. However, adapters between the DR-DOC and the computer serial port may be used if needed.

12.3 Computer Set up

Proceed with the following steps:

1. If it hasn't been done already, it is a good idea to create a directory in which to store the DataRAM data: from "Program Manager", select "Windows", "Main", "File Manager", "File", "Create Directory..." and type in an appropriate pathname such as "c:\dataram". Select "OK" and then "File", "Exit" to get back the "Program Manager".

2. From the "Program Manager", select "Windows", "Accessories" ,"Terminal".

3. When the application "Terminal" comes up, select "Settings", "Communications..." and select the proper settings in the popup screen:

- Connections: **select the port connected to the DataRAM**
- Baud Rate: **9600 bps**
- Data Bits: **8**
- Stop Bits:**1**
- Parity: **none**
- Flow Control: **Xon/Xoff**

Then select "OK".

4. Select "Transfers", "Receive Text File...". Decide on an appropriate filename ("tag001" for example) and type it in using the correct drive, pathname and the file extension "txt" (for example: "c:\dataram\tag001.txt").

12.4 DataRAM Commands

Proceed as in described in section 8.5.3 to transfer logged data from the DataRAM. Whenever a "Dump..." command is keyed on the DataRAM (steps 7, 8 or 9 of section 8.5.3) the keyed "DUMP DATA LOG" display should blink indicating that data is being transferred to the computer.

12.5 Completion of Data Transfer

Once the data transfer has been completed, select "Transfers", "Stop". The data file at this time is saved and this application may be terminated, if desired, by selecting "File", "Exit". At this time you may receive a popup screen inquiring if the "terminal settings" are to be saved. It is not necessary, but recommended to save the settings for later use by selecting "Yes", then entering the filename "dataram.trm", and selecting "OK". If saved, the terminal settings for the DataRAM can be restored while running "Terminal" by selecting "File", "Open", and selecting the file "dataram.trm".

12.6 DataRAM Spreadsheet Applications

Spreadsheet applications with DataRAM generated output files are provided in this section. Specific procedures are given on importing or opening DataRAM file in Microsoft "EXCEL 4.0", "LOTUS 1-2-3, release 4", and Borland "QUATTRO PRO" (all applications for IBM PC compatible systems running Microsoft "Windows").

12.6.1 Lotus 1-2-3

Proceed as follows:

1. Open "Lotus 1-2-3, release 4"
2. Select "File", "Open"
3. Select "Drives:" and indicate the drive to which the DataRAM generated text (".txt") file has been saved.
4. Select "File type:" and select "Text [txt, prn]"
5. Select "Directories:" and select the directory to which the DataRAM generated text (".txt") file has been saved.
6. Select "File name:" and simply highlight (don't select yet) the DataRAM generated text file desired.
7. Select "Combine", "Formatted text", "OK"

The current "Lotus 1-2-3" spreadsheet should display the DataRAM data with the header in the first column and the time history separated into four columns ready to be plotted.

12.6.2 Microsoft Excel 4.0

Proceed as follows:

1. Before opening the DataRAM generated file in Microsoft "Excel 4.0", it is necessary to perform an edit in Microsoft "MS-DOS Editor", an editor which is standard with Microsoft DOS.

    - If available inside of "Windows", select "MS-DOS Editor" from "Applications". Otherwise, exit "Windows" to "DOS" and type "**edit**".

    - When the "Welcome to the MS-DOS Editor" screen appears, press <ESC>.

    - Select "File", "Open" and type in the drive number, the path, and the name of the DataRAM generated text file (e.g. File Name: **c:\dataram\tag001.txt**) and select "OK". If a listing of files in the directory is required, use the wildcard "*" (e.g. File Name: **c:\dataram*.txt**), and a list will appear.

    - The correct text file should appear on the screen.

    - Save it as a "CSV" file: Select "File", "Save As" and in the pop-up screen, <BACKSPACE> to change "**TXT**" to "**CSV**" and select "OK". Select "File", "Exit", and return to "Windows".

2. Open Microsoft "Excel 4.0".

3. Select "File", "Open".

4. Select "Drives:" and indicate the drive in which the generated "CSV" file has been saved.

5. Select "Directories:" and indicate the directory in which the generated "CSV" file has been saved.

6. Select "List Files of Type:" and select "Text Files (*.TXT;*.CSV)"

7. Select "File Name:" and select the desired "CSV" file, and select "OK".

The Microsoft "Excel 4.0" spreadsheet should now display the DataRAM data with the header, two lines per cell in the first column, and the time history separated into four columns, ready to be plotted.

12.6.3 Borland Quattro Pro

1. Open Borland "Quattro Pro for Windows, version 5.00"

2. Select "Tools", "Import".

3. Select "Drives:" and indicate the drive in which the DataRAM generated text file has been saved.

4. Select "Directories:" and indicate the directory in which the DataRAM generated text file has been saved.

5. Select "File Type:" and select "*.TXT".
6. Select "File Name" and highlight (don't select yet) the DataRAM generated text file.
7. Select under "Option" the box for 'Comma and " Delimited File'.
8. Select "OK"

The Borland "Quattro Pro" spreadsheet should now display the DataRAM generated data with the header in the first column, and the time history separated into four columns ready to be plotted.

13.0 DataRAM RS-232 OUTPUT

13.1 Connector Pin-out Information

PIN #	NAME	FUNCTION
2	Receive data	Receives software commands in serial form from a computer or device prompting the DataRAM when to stop or resume sending data.
3	Transmit data	Sends serial data to a computer's serial port or to a serial device as selected in the menu "DUMP DATA LOG".
5	Ground	Ground reference for all communication signals and is also chassis ground.
6	Data load	Non-standard input which is used to program the DataRAM. This pin is not connected in either of the two cables provided by MIE (DR-DOC or DR-S/P) and should not be used.
9	Vss	Non-standard power supply output (+12V). This pin is not connected by MIE DR-DOC cable but is connected by the DR-S/P adapter cable to power the serial/parallel adapter to convert the serial output of the DataRAM for compatibility with a standard parallel printer.

13.2 Miscellaneous Notes

1. Because pins 6 and 9 have non-standard functions, standard interface cables and null modem adapters should not be used.
2. Using standard straight (not null modem) 25/9 pin adapters (PC or MACINTOSH) or straight extension cables to adapt or extend the MIE provided cables is allowable.
3. Following is a chart for custom building the DataRAM to PC serial interface cables:

from:	to:	
DataRAM RS-232	25-pin communication port	9-pin communication port
pin 2	pin 2	pin 3
pin 3	pin 3	pin 2
pin 5	pin 7	pin 5