

Section M

SEQUENTIAL AND TAPE SAMPLERS

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SEQUENTIAL AND TAPE SAMPLERS

William H. Perry¹

I. INTRODUCTION

In many determinations it is necessary to isolate an air sample or concentrate an air contaminant before the contaminant can be identified and measured quantitatively. Gaseous substances are often collected by grab sampling, absorption into a liquid, or by adsorption on a solid. Cryogenic sampling or collection by condensation or freezing is less commonly used. Particulates are collected by filtration, impaction, impingement and deposition. Less frequently they are collected by thermal precipitation or electrostatic precipitation.

Procedures and instrumentation have been developed so that a series of samples may be collected by these methods with a minimum of operator involvement.

II. A SEQUENTIAL GRAB SAMPLER

Griffith, Drivas and Shair (9) describe a remote sequential grab sampler. Spring-loaded syringes are held in a 5 inch wide aluminum channel. A rotary mechanical timer releases the springs so that the plungers are pulled back across the channel. Field tests indicate that the device can take accurate sequential air samples automatically and can contain each sample without leakage for at least 18 hours in an outdoor environment. The sampler described uses four 200 cc plastic syringes, weighs less than 3 pounds and requires no batteries or external power.

III. ELECTRICALLY TIMED SAMPLING PERIODS

Electrical timers are used to operate high Volume Air Samplers to collect from midnight to midnight. Two samplers are alternated so that all filter changes can be made at times convenient to the operator (2).

Electronic timers capable of ON/OFF control of three high current circuits are available (6).

Sometimes a timer for ON/OFF control is an integral part of what is otherwise a non-automated sampling system (26).

IV. MULTIPLE BRANCH SEQUENTIAL SAMPLERS

A diagram of a typical arrangement of the components of a multiple branch sequential sampler is shown in Figure M-1. In many respects this sampler is similar to a multiple branch simultaneous sampler. The distinctive feature of the sequential sampler is the set of automatically

operated ON/OFF valves. In some samplers the ON/OFF action is obtained by a rotary multiple port valve. Valve action is controlled by switches which are opened and closed by a timer or programmer.

The design shown in Figure M-1 uses an exhaust manifold to connect the parallel collecting branches to the source of vacuum. Samplers with a rotary multiple port valve do not require an exhaust manifold. Provision for flow control and metering are often located between the exhaust manifold or rotary valve and the source of vacuum. An intake manifold is often included in samplers that use a probe. Filters and other devices for pretreatment may be located in either the individual branches or ahead of the intake manifold.

Multiple branch sequential samplers have been most frequently used to obtain samples by absorption into liquid media using impingers or bubblers as collectors. Traps or demisters are used to prevent entrained droplets or mist from reaching valves and other downstream sampling train members. Some wet collectors have an expansion bulb in their inlet. Air entrapped between the collector and valve expands and contracts on warming and cooling. Loss of liquid from the inlet side is prevented by the expansion bulb. Loss of liquid would not only invalidate the sample but could also contaminate upstream parts of the sampler.

Inclusion of a heater and thermostat in the sampler may be necessary if the unit is to be lo-

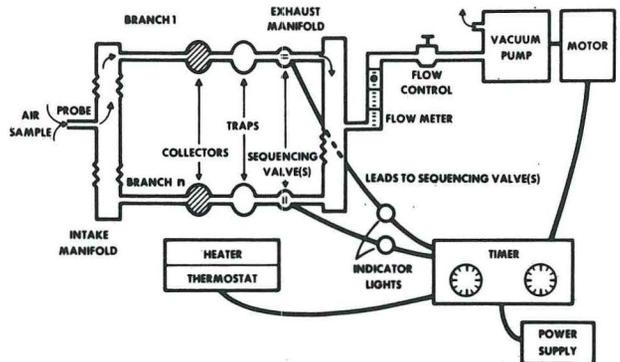


Fig. M-1. Generalized Representation of a Sequential Sampler.

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cated in unheated shelters during colder weather. Use of a setting slightly above the normal ambient range promotes a degree of temperature uniformity. Adequate labeling of branches and collectors is necessary to prevent confusion in identity of samples and the times they represent.

The principle of multiple branch sequential sampling has been adapted for use with collectors other than wet scrubbers. Individually mounted filters and tubes packed with solid adsorbents have also been used.

V. AN AUTOMATIC COLLECTOR CHANGER

Rahn, Beke and Windels (28) have built an automatic filter changer. A pre-cut filter is enclosed in an individual plastic holder. The sampler will change up to 24 filters unattended. It draws air at about 30 m³ per hour through a 11 cm filter. A set of filters or a particular filter can be resampled in such a way as to obtain integrated composite samples for detailed analysis. This approach can be used to follow average diurnal variations.

VI. AUTOMATIC SUBSTRATE ADVANCE

The use of automatically changed individual collectors is somewhat unusual. More frequently the substrate is continuous and is advanced by linear or rotary motion. Tape samplers usually collect by filtration or chemical reaction.

Moving slide samplers collect by impaction or thermal precipitation and usually use glass microscope slides. Rotary drum and disc samplers collect by impaction on lateral and circular surfaces respectively. Coatings are often applied to improve collection efficiency and sample retention.

The GCA Model RDM-101 uses a polyester impaction disc to collect respirable particulates. The disc is coated with a thin layer of petroleum jelly to minimize re-entrainment.

Drums may be wrapped or covered with tapes to facilitate removal and elevation.

A. Continuous and Intermittent Advance

Substrates can be advanced by a continuous motion to produce a sample trace of gradually changing composition. Intermittent or periodic advance produces a series of separate spots or bands.

B. Built-In Evaluation

Tape samplers and rotary disc samplers often contain built-in instrumentation for evaluation. This evaluation may be simultaneous with collection so that the device gives continuous and instantaneous results. In samplers with continuous advance there is a direct relationship between concentration and observed value. In samplers with intermittent advance the instantaneous concentration is related to the rate of change rather than to absolute value.

C. Delayed Evaluation

Even with samplers with built-in evaluation the measurement is sometimes delayed to allow suf-

ficient accumulation of sample or optimal development of reactions that produce color change.

In these samplers the evaluator may be adjacent to the collector and the evaluation may be delayed for as long as 15 minutes.

Many samplers do not include an evaluator and the samples must be evaluated in a separate operation. Delays of weeks or months may be involved.

D. Portable Samplers and Personal Monitors

Denenberg and Kriesel (4) describe a tape sampler that is designed for personal monitoring. Portable monitors for determining respirable dust are available (7). These use a polyester impaction disc for sample collection. The disc is rotated to expose the respective sampling areas.

VII. TAPE SAMPLERS

Tape samplers use a combination of linear and rotary motion for advancement of the sampling substrate. The tape is usually pulled from a feed spool by the rotation of a motor-driven takeup spool. Sampling takes place on a portion of the tape which moves linearly between these two spools. This sampling area is shrouded by a holder which has an inlet and outlet for connection in the air sampling train. Cassette models have been developed to simplify operation and to protect the tapes during storage and handling. Some tape samplers use the clean sampled air from the vacuum pump exhaust to maintain a slight positive pressure in the compartment surrounding the spools and holder.

Heard and Wiffen (11) describe a sampler in which a Millipore membrane filter is moved by a driving roller. Exposed tape is stored as an open spiral in a grooved receiver compartment. This prevents damage to the surface deposit which is evaluated by electron microscopy.

A. Sampling Tapes

Papertapes and chemically impregnated paper-tapes are the substrates most commonly used in tape sampling. Glass fiber, porous membrane filters and cotton tapes are also used. Use of a "Pallflex Filter Tape" consisting of a glass fiber filter with thin cellulose backing has been described by Macias and Husar (22) and by Husar et al. (15)

B. Impregnating Agents

Tapes impregnated with lead acetate have been used to sample for hydrogen sulfide. Formation of lead sulfide results in a darkening of the exposed area of the tape. Tapes impregnated with mercuric chloride are also used for determination of hydrogen sulfide. Darkening results from formation of mercuric sulfide. Determination of hydrogen sulfide by tape sampling has been the subject of articles by Wellinger and Giever (35) and by Siu, Levaggi, Potter, Martin and Feldstein (31).

Atmospheric fluoride has been monitored by Israel (16). A dual paper tape sampler with a citric acid-treated prefilter tape and an alkali-treated

tape were used to distinguish between particulate and gaseous florides.

The use of impregnated tapes in personal and area monitors has been summarized by Denenberg and Kriesel (4). Tapes are available for determination of phosgene, TDI, chlorine, sulfur dioxide, hydrogen sulfide, nitrogen dioxide and vinyl chloride monomer.

VIII. METHODS OF ANALYSIS AND EVALUATION

Samples collected by sequential and tape samplers are subjected to a wide variety of analyses and measurements consistent with their stability and the characteristics of the media.

A. Visual Comparisons

In those procedures in which a sampling media darkens or otherwise changes color it is possible to make visual comparisons. This requires standardization of sampling conditions and some degree of operator experience and judgment. Comparisons can be made between samples and standards obtained by sampling controlled test atmospheres.

B. Measurement of Transmitted or Reflected Light

Color changes in either sampling liquids or on sampling tapes can be evaluated by measurement of either transmitted or reflected light. Color changes in liquids are usually measured using a colorimeter or spectrophotometer. Reagents are often added subsequent to sample collection so that colors are developed by chemical reactions. Measurements can be made in the near UV range as well as in the visible portion of the spectrum.

Changes in light transmission through sampling tapes are made in a manner analogous to that used with liquid reagents. The instrument in this case is called a densitometer or transmissometer. It usually does not have provision for selecting narrow bands of light and often consists of little more than a tungsten lamp and a light meter separated by the tape.

Tapes can also be evaluated by measurement of reflected light. In this case the lamp and light meter are both on the same side of the tape. The instrument is called a reflectometer.

Selectivity or specificity are sometimes achieved through sample pretreatment, choice of sampling rates, and use of carefully selected reagents.

Tape samplers are often used to obtain only a very general indication of the type and quantity of particulate contaminants. The COH index or Coefficient of Haze is obtained through transmission measurements. Determination of RUDS (Reflectance Units of Dirt Shade) is made through measurements of reflected light. Measurements of these indices have been used to estimate the general level of particulate contamination in community atmospheres. These measurements have been taken as indicators of soiling potential and of reduction in visibility.

The relationship between transmittance and reflectance measurements of soiling index has been

studied by Saucier and Sansone (30). Their article prompted Linsky (20) to comment on some of the limitations of RUDS and COH measurements.

Lee, Caldwell and Morgan (18) conducted an in-depth comparative study of commonly used methods for estimating suspended particulate matter. Various relationships between COH values and results from High Volume Samplers, British Smokeshade Samplers, membrane filter samplers and cascade impactors were studied.

Relationships between COH values and visibility and humidity have been studied by Paterson (24). Reigel and Gruber (29) have used reflectance measurements to estimate the soiling potential of emissions from fossil fuel combustion. Yocom, Clink and Cote (36) have used COH values to compare indoor and outdoor pollution levels. Hirt and Shaw (13) used COH determinations to study pollution levels associated with the advance and retreat of a lake-breeze front in Toronto. Tilley and McBean (33) investigated the relationships between COH values, wind speeds and vertical temperature differences. Stebbings, Fogelman, McClain, and Townsend (32) used COH values to estimate relative particulate levels at monitoring stations in and near Pittsburgh during an air pollution episode in November 1975. Ott and Thom (23) have reviewed air pollution index systems used in the U.S. and Canada. Some of these indices use COH values in arriving at an overall estimate.

1. Determination of COHS

In 1953 Hemeon, Haines and Ide (12) described a procedure for obtaining an index of the degree of soiling caused by atmospheric particulates. They defined a COH as that quantity of light scattering solids that produces an optical density of 0.01 when collected on a filter tape. The term COH is a contraction of the phrase "Coefficient of Haze". Rather than express results in COHS per volume of air sample they chose to express them in COHS per 1000 lineal feet of air. The particulates are imagined as having been contained in a cylinder of air having the same cross sectional area as the spot produced on the tape. The length of this imaginary cylinder is such that its volume is equal to the volume of air sample.

The optical density of the spot is measured with a transmissometer. Darker spots transmit less light and produce higher optical densities or COH values.

In a sample calculation it was shown that a two-hour sampling at 0.22 cubic feet per minute is representative of a sample volume of 26.4 cubic feet. The area of a circular spot one inch in diameter is 5.45×10^{-3} square feet. A cylinder with this base would have to be 4,850 feet long in order to contain 26.4 cubic feet of air. A spot whose light transmission is 50% would have an optical density of 0.301.

$$\log \frac{100}{50} = \log 2 = 0.301$$

This is equivalent to 30.1 COHS. The results would then be expressed as

$\frac{30.1}{4.85}$ or 6.2 COHS/1,000 ft.

2. Determination of RUDS

Gruber and Alpaugh (10) developed a method of tape sample evaluation based upon measurement of reflected rather than of transmitted light. The term, RUDS, was introduced as a contraction of Reflectance Units of Dirt Shade. The term, "dirt shade" was defined by the equation:

Dirt Shade =

$$\text{Log}_{10} \frac{\% \text{reflectance clean filter paper}}{\% \text{reflectance soiled filter paper}} \times 100$$

A dirt shade of zero corresponds to a spot which undergoes no detectable soiling over the exposure interval. During a two-year sampling program, the darkest spot evaluated by Gruber and Alpaugh had a reflectance value of 11%. A slightly darker spot having a reflectance value of 10% would have corresponded to a dirt shade of 100.

In a sample calculation it was shown that sampling at an average flow rate of 0.21 cfm for six hours would correspond to a sample volume of 75.6 cubic feet of air. A cylinder having a circular base with a diameter of one inch would have to be 14,000 feet in length to contain this air sample. They chose to standardize on a length of 10,000 feet for expressing their results. In this sample calculation they showed that a spot having a dirt shade of 7 could be reported as corresponding to a "Soiling Index of 5 RUDS/10,000 linear ft." By referring to a value of 10,000 feet, rather than of 1,000 feet, the soiling index can be adequately expressed in whole numbers ranging from zero to about 100, rather than from zero to about 10.

C. Measurement of Beta Attenuation

An estimate of the mass of particulate deposited on a sampling tape can be obtained by measurement of the amount of beta-radiation that passes through the tape. This approach is superior to either the measurement of transmitted or reflected light for estimating the mass of suspended particulate.

Husar (14) and Macias and Husar (22) describe the use of beta attenuation in monitoring for atmospheric particulates. Dresia and Mucha (5) describe a sampler that is capable of measuring both the mass and the radioactivity of particulates collected in emissions testing.

Beta attenuation has also been used to evaluate samples obtained on Mylar discs (7).

D. Radioactive Contaminants

Radioactivity may be the subject of measurement rather than as a means to other determinations. Alpha, beta and gamma counters are used to determine radioactive contaminants collected on tapes.

Glowiak and Pacyna (8) have used a tape sampler to investigate Sr 90 and Cs 137 levels in Wroclaw Poland. Ping and Piatkowski (25) have used a

tape sampler for measurement of long-lived airborne radioactivity concentrations.

E. Pressure Drop

The pressure drop across a filter tape increases with increasing particulate loading and can be readily measured. This is the basis for the Fleming Air Pollution Monitors (1).

F. Microscopic Examination

Heard and Wiffen (11) describe a sampler that uses a tape of AA Millipore membrane to collect samples for evaluation by electron microscopy.

G. Chemical Analysis

Samples collected by absorption into liquids using multiple branch sequential samplers are usually evaluated by chemical analysis. Sulfur dioxide, nitrogen dioxide, ammonia and other gases have been determined in this way. Samples collected with tape samplers are sometimes subjected to chemical analysis where the quality of the collecting media and sample size permit. MacLeod and Lee (21) and den Tonkelaar (34) have collected particulates on Whatman No. 4 tapes. MacLeod and Lee analyzed for lead, cadmium and copper by anodic stripping voltammetry. Lead was determined by den Tonkelaar by atomic absorption spectroscopy.

IX. NETWORK OPERATION

Costs can often be minimized by centralization of laboratory support and delegation of most routine work to personnel with less extensive technical training. Use of less expensive samplers without built-in evaluation partially offsets the cost of larger numbers of sampling units. In some applications sampling supplies and collected samples are sufficiently stable to be transferred between the laboratory and sampling location by mail or messenger. This permits the use of on-site personnel who may collect samples as an incidental activity. This approach does delay the obtaining and reporting of results and limits the overall automation of the procedure.

X. MULTIPLE POINT SEQUENCED SAMPLING

Multiple locations can be monitored from a central location. Sensors can be placed at each location or samples can be drawn through a probe system to be central analyzer. In either case the locations may be scanned in some type of sequence.

Multiple point sequencing manifolds have been designed for use with gas chromatographs, dispersive infrared monitors, non-dispersive infrared monitors, flame ionization detectors, photoionization detectors, and an "IR Fourier Multiplex Spectrometer". Although these multiple point sampling systems are designed to be used with a particular analytical device they are often compatible with many other instruments.

XI. AUTOMATED REPETITIVE ANALYSIS

Gas chromatography has been adapted to repetitive analysis by extensive automation of sample introduction, analysis and data reduction. Lieb-

man, Ahlstrom, and Sanders (19) describe a system which is capable of repeating determinations of hydrogen cyanide and sulfur dioxide every 2.2 minutes.

Coloff, Cooke, Drago and Sleva (3) reviewed methods of monitoring gaseous pollutants. A semi-continuous method with a 5 minute cycle is described. Total hydrocarbons, methane, and carbon monoxide are determined by a gas chromatograph fitted with a flame ionization detector.

XII. CHOICE OF SAMPLING INSTRUMENTATION

Laitenen (17) has commented on the current trend in which sampling, sample pretreatment, adjustment of conditions, separation, measurement and data processing are consolidated into integrated systems.

Multiple branch sequential samplers do not lead themselves to a high degree of integration with the measurement operation. They complete on the basis of their adaptability for use with a wide variety of collectors and procedures and on their relatively low initial cost. In many of their former applications they have been displaced by improved portable direct reading instruments and by area monitors equipped with recorders. New applications of multiple branch sequential samplers have been made possible by improvements in sampling and analytical methodology. This method of collection should be very useful with adsorption tubes filled with activated carbon or other physical adsorbants. It should also be useful with direct reading detector tubes developed for time-weighted sampling.

Tape samplers do lend themselves to incorporation into integrated systems. A wide range of applications has been developed for monitoring both particulates and gases. Tape samplers are being used for personal monitoring, area monitoring, emissions monitoring and process control. The more sophisticated tape sampling systems include such features as built-in tape evaluation, automatic standardization, constant flow control, automatic indexing, alarms, and interfaces for recording and telemetering (27).

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DRUM-PULSED SEQUENTIAL AEROSOL SAMPLER (Metronics Associates Inc.)

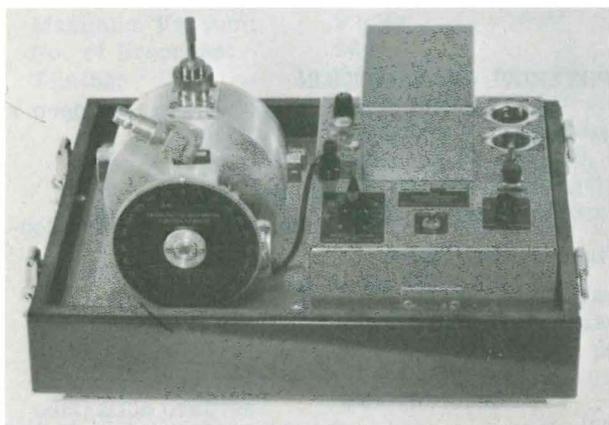


Fig. M-2: Metronics Drum - Pulsed Sequential Aerosol Sampler, showing inlet nozzle, vacuum fitting and index position dial. The Control Unit is on the right side. Access to housing is through the lid on the far side of the sampler.

DESCRIPTION

The Drum-Pulsed Sampler (DPS), from Metronics Associates, Inc., uses a single sampling path rather than multiple branches. In this respect, it is more closely related to the various tape samplers than to other sequential samplers.

This sampler is an impaction device. The collection surface consists of Scotch vinyl electrical tape wrapped evenly around a 4 7/8" diameter aluminum drum. The adhesive side of the tape is in contact with the drum. A specially formulated rubber cement is applied to the outer surface of the tape.

At the pre-selected intervals the drum is rotated through a 30° angle and a fresh collection area is brought to face the flow of air sample.

An impactor nozzle is in perpendicular alignment to the collection area and serves to direct the flow of air and also acts as a limiting orifice.

APPLICATIONS

The DPS is specifically designed for sampling fluorescent particles used in tracer studies. These particles are typically in the 1 to 10 micron range. The particles are collected in narrow bands along the tape and are identified and counted using an indexing microscope. This method can also be adapted to sampling for other airborne particulates.

In one application the sampling head of a DPS has been attached under the wing of an aircraft. The weight of this unit is less than 15 pounds. Pulsing can be controlled either manually or automatically from within the aircraft. The vacuum source is also located inside the aircraft.

SPECIFICATIONS

Vacuum Source: A vacuum pump is provided in a separate case. It is connected to the impactor by means of flexible tubing and by an electrical cord. This pump maintains a vacuum of 1/2 atmosphere or better at 40-50 1/min.

Number of Samples: Up to 120 samples can be obtained over time intervals ranging from 1-8 hours.

Timing: A selector switch provides for drum pulse intervals of 1/2, 1, 2, or 4 min. A second timer permits delayed turn-on of up to 12 hours.

Electrical Requirements: 115 V/60 Hz; a 28 V DC output from the control unit drives the pulsing mechanism.

Weight: The combined weight of sampling unit and pump is about 100 pounds.

SOURCE

Metronics Associates, Inc., 3201 Porter Drive, Stanford Industrial Park, Palo Alto, California 94304

SEQUENTIAL PESTICIDE SAMPLER
(Microchemical Specialties Co.)



Fig. M-3. Misco Model 88 Sequential Pesticide Sampler.

USES

The Sequential Pesticide Sampler, Model 88, was primarily designed to collect samples for the measurement of pesticide levels in the atmosphere. The unit may also be used to collect samples for determining levels of other atmospheric contaminants by the proper choice of pre-filter, absorbent packing, and absorbent liquid for the impinger.

OPERATING PRINCIPLE

Four sampling trains are supplied, each consisting of a pre-filter section, impinger, and absorption tube with a fitted rubber stopper. The unit is supplied with an oilless positive displacement pump, rated for continuous duty, which is connected through a manifold to separate solenoid valves for switching the input. The input is controlled by means of a timer and cam arrangement which can be set for any desired 24-hour sequence.

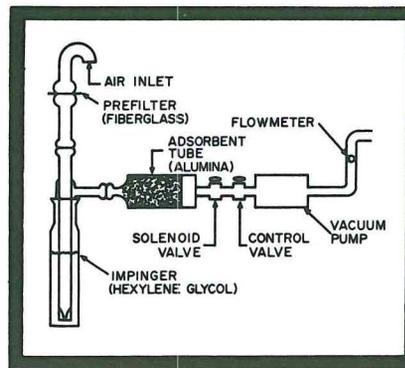


Fig. M-4. Schematic of Sampling Train.

PHYSICAL DESCRIPTION

Physical Dimensions: 22" wide x 22" deep x 34" high

Weight: 87 Pounds

Power: 115 VAC 60 Hz, 8 amp

Air Mover: Self-Lubricating 1/4 HP Continuous Duty Motor

2.7 CFM Free Air

1 CFM at 21" Hg.

Flow Meter:

Range—0.1 to 1.5 CFM

Accuracy—5%

All glassware used in the gas stream prior to the absorption tubes is manufactured from borosilicate glass and connections are made with glass ball and socket o-ring joints.

Case: Weatherproof Fiberglass

Sampling Cartridge: Impingers are held by foam rubber in cartridge, which is shock mounted to case. The cartridge is readily removable in the field.

Blower: 90 CFM fan cools sampling train.

APPLICATIONS

This unit is being used to measure airborne pesticides using glass cloth as a pre-filter. Hexylene glycol is used in the impinger, and alumina is used in the absorbent tube. The pesticides are extracted from the filter, alumina, and hexylene glycol, passed through a Florisil column clean-up step, at which time the chlorinated pesticides are separated from the organophosphate pesticides. Both pesticide samples are analyzed using gas chromatograph techniques.

SOURCE

Microchemical Specialties Co., 1825 E. Shore Highway, Berkeley, California 94710.

24-PORT SEQUENTIAL AIR SAMPLER
(National Environmental Instruments, Inc.)

OPERATING PRINCIPLES

The SQ 24 is an air mover with 24-port rotary sequencing valves to direct the air flow through the respective sampling branches. A dual timing system permits selection of cycles of 15, 30, 60, or 120 minutes and sampling times of 5-120 minutes. The sampler can be programmed to collect 6, 12, 18, or 24 samples over periods up to 48 hours.

PHYSICAL DESCRIPTION

Dimensions:	18" x 12" x 12-1/2"
Net Weight:	39 lbs.
Air Flow Control:	Valve
Air Flow Metering:	Dual Float Rotameter 0-10 & 5-35 LPM
Maximum Vacuum:	9" Hg
No. of Branches:	24
Timing:	Dual times; interval between beginning of successive samples can be set at 15, 30, 60, or 120 min.; sampling time can be set at 5-120 min.

APPLICATION

Typical application of the sequential air sampler includes use in periodic hazard area sampling, study of industrial or community air pollution sources, and obtaining stack emission concentration profiles.

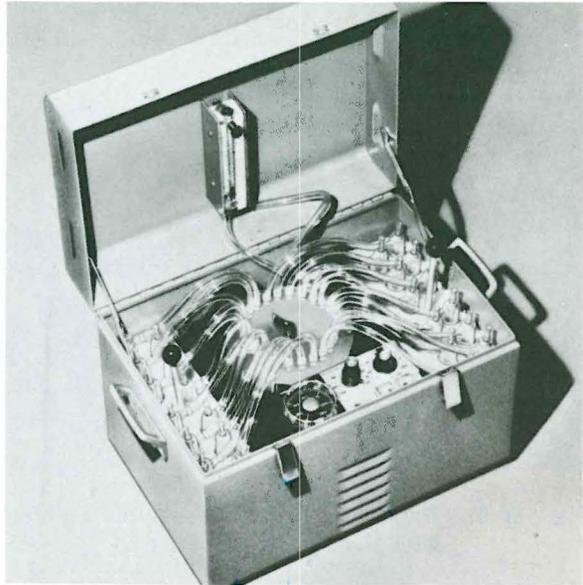


Fig. M-5. NEI 24-Port Sequential Air Sampler.

SOURCE

National Environmental Instruments, Inc. P. O.
Box 590, Warwick, Rhode Island 02888.

AERON SEQUENTIAL SAMPLER (Precision Scientific Company)

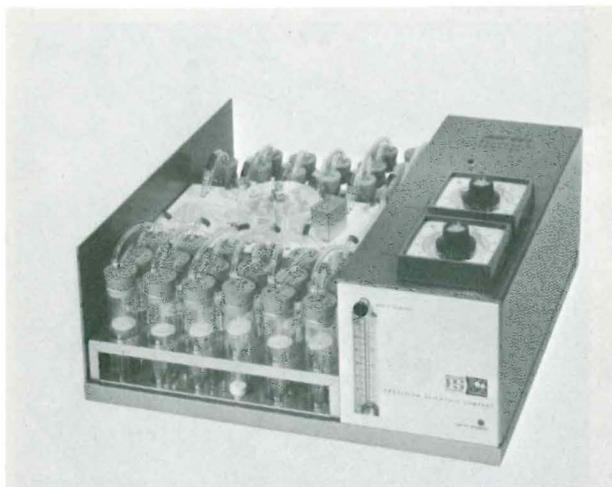


Fig. M-6. Precision Aeron Sequential Sampler, with dust cover removed.

DESCRIPTION

The Precision Scientific Sequential Sampler (Aeron) consists of 12 sampling branches connected to a rotary sequencing valve. Separate timers control sampling time and interval time. With each timer at its maximum setting the sampler will operate unattended for four days and then shut itself off automatically.

Two removable racks are positioned within the sampler. Each rack will accommodate 3 rows of 6 midget impingers. This arrangement permits the use of 3 tubes in series in each sampling branch.

The following are available as accessories:

- Impinger tube
- Diffuser tube
- Sulfur-free 2-hole rubber stopper
- Splash shield
- Glass connecting link
- Tube rack
- Rack for conventional midget impinger glassware

APPLICATIONS

This sampler is particularly suited to those sampling methods which use several tubes in series such as the joint determination of nitrogen dioxide and nitric oxide.

SPECIFICATIONS

Dimensions: 18"L x 19"W x 10"H

Net Weight: 43 lbs.

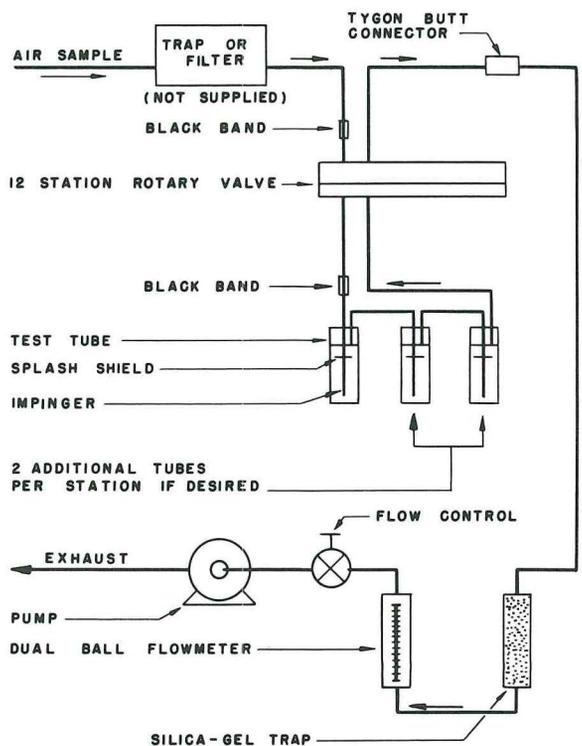


Fig. M-7. Schematic diagram of Precision Aeron Sequential Sampler.

Air Flow Control: Valve

Air Flow Metering: Rotameter, 0.2-11 l/min.

Vacuum Source: Oil-less diaphragm pump, 12 l/min free air capacity

Number of Branches: 12 (3 positions per branch)

Timing: Sampling time, 2 minutes to 4 hours, repeatable to $\pm 0.2\%$ of full range

Interval time, 2 minutes to 4 hours, repeatable to $\pm 0.2\%$ of full range

Electrical Requirements:

Cat. No. 63063—120 V/60 Hz, 2 amps

Cat. No. 63064—230 V/60 Hz, 1 amp

Other Features: A see-through bronze-tinted acrylic cover protects light sensitive solutions.

Each timer has a pilot light to indicate when it is in operation.

SOURCE

Precision Scientific Company, 3737 W. Cortland Street, Chicago, Illinois 60647

RAC SEQUENTIAL SAMPLER
(Research Appliance Co.)



Fig. M-8. Research Appliance Co. Sequential Sampler, Model PV 2340.

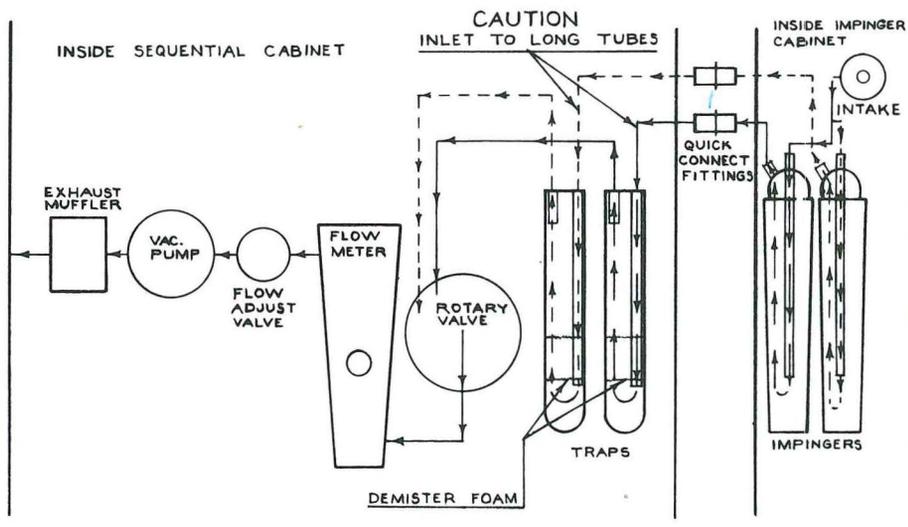


Fig. M-9. Schematic diagram of Research Appliance Co. Sequential Sampler.

DESCRIPTION

The Research Appliance Company Sequential Sampler Model PV 2340 consists of two separate modules housed in separate steel carrying cases.

The "Sequential Cabinet" contains the vacuum pump, flow control valve, meter, multipoint rotary sequencing valve, programmer timer and 12 traps. The "Impinger Cabinet with Manifold" has rack

space for 12 midget impingers and is equipped with a glass intake manifold and a thermostatically controlled heater. Sections of rubber tubing are used to connect the sampling impingers to the respective traps in the sequential cabinet.

APPLICATIONS

The Model PV 2340 is suitable for use in sampling for gases such as sulfur dioxide, nitric oxide, nitrogen dioxide, ammonia and carbon monoxide; sampling for particulates; stack sampling, industrial sampling and ambient air sampling.

SPECIFICATIONS

Dimensions:

Impinger Cabinet: 14"L x 15 1/4"W x 12"H
Sequential Cabinet: 17 1/4"L x 12"W x 12"H

Weight:

Impinger Cabinet: 16 1/2 lbs.
Sequential Cabinet: 30 1/2 lbs.

Air Flow Control: Valve

Air Flow Metering: 2-10 CFH rotameter

Vacuum Source: Diaphragm vacuum pump, 0-30 free flow

Number of Branches: 12

Timing: Programmer Timer can be set for 1/2 to 23 3/4 hrs. per sample and for 1/4 to 23 3/4 hrs. between samples

Electrical Requirements: Operates on 115 V/60 Hz, 1.5 amps without heater, 3.5 amps with heater; other voltages and frequencies can be supplied.

SOURCE

Research Appliance Company, Route 8, Gibsonia, Pennsylvania 15044.

MODEL 4620 MULTI-DAY IMPACTOR (Sierra Instruments)

DESCRIPTION

Air is drawn through a shielded inlet which prevents entry of rain or particles carried by drafts or winds. Particles are collected in fractions by two impactors in series and by an after filter. Each impactor uses a rotating collection drum with a collection surface of 5/8 x 8 inches. Nozzles and drums are constructed of anodized aluminum. Each drum may be covered with a suitable substrate, such as mylar or teflon film, to facilitate particle analysis. The drums rotate at one revolution per eight days.

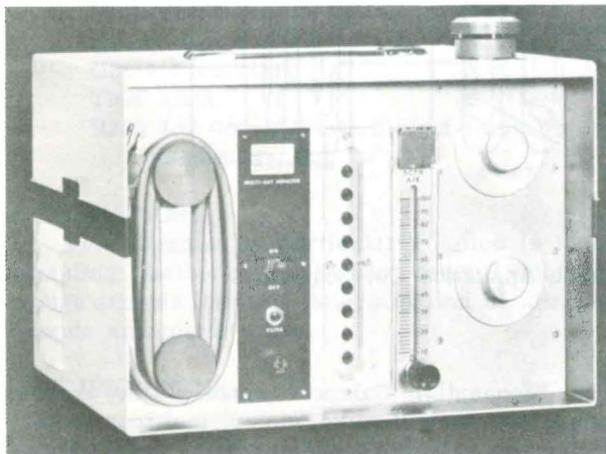


Fig. M-10. Sierra Model 4620 Multi-Day Impactor.

Smaller particles are collected on a sequential after filter which contains up to eight 47 mm filter holders. Flow is sequenced through the filters so that each represents one day of sampling.

A 1/10 h.p. rotary vane pump draws the air sample through the collecting system. Flow is regulated by a valve and monitored by a rotameter. Pressure taps allow precise flow calibration. The Model 4620C has an automatic flow controller for operation at any selected flow from 0.5 to 1.0 SCFM.

At 1 SCFM the 50% cut-points for unit density particles are 5 micrometers for stage 1 and 0.5 micrometers for stage 2.

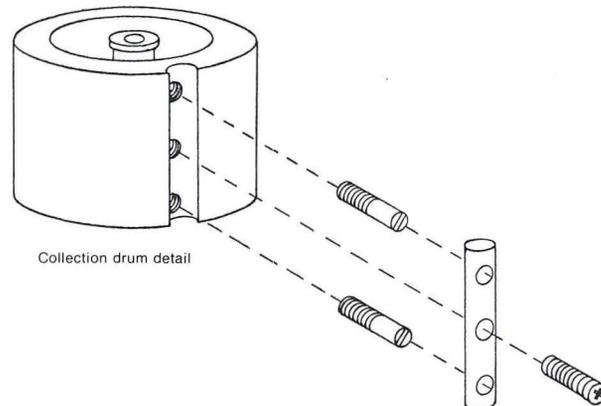


Fig. M-11. Collection Drum Detail from Sierra Model 4620 Multi-Day Impactor.

SPECIFICATIONS

Dimensions: 11-1/2 x 16 x 13-1/2"
 Weight: 25 lbs.

APPLICATIONS

The aerosol collection procedures are compatible with analytical techniques such as atomic

absorption, neutron activation, and x-ray fluorescence.

SOURCE

Sierra Instruments, Inc., P.O. Box 909 Village Square, Carmel Valley, California 03024.

THETADYNE AIR SAMPLERS
 (Enviro-Guards, Inc.)

DESCRIPTION

There are two models. They are similar in appearance to the automatic monitor shown in Figure M-12.

Cat. No.	Model
2001	F-12 Particle
2003	F-12 H ₂ S

The H₂S Model is designed for determination of hydrogen sulfide. An external spot evaluator, Cat. No. 3001, can be used as a transmissometer.

APPLICATIONS

These samplers are used in determination of COH values and hydrogen sulfide concentrations.

FEATURES

A by-pass flowmeter and flow adjustment valve are provided. The timer allows settings of 10 minutes to 5 hours in 10 minute increments.

SOURCE

Enviro-Guards Inc., 510 Superior Street, Carnegie, Pennsylvania 15106.

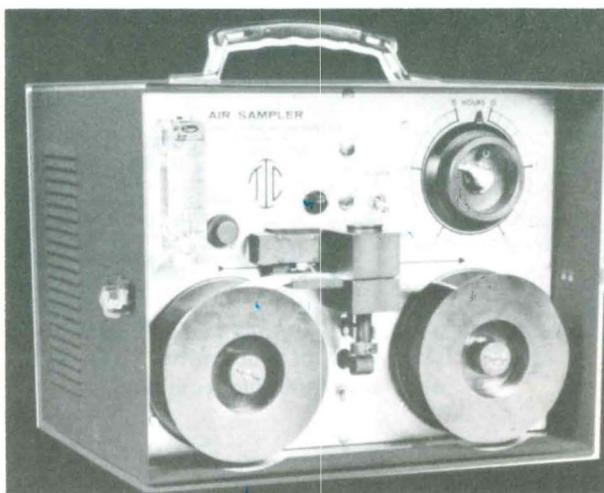


Fig. M-12. Enviro-Guards Thetadyne Air Sampler.

AUTOMATIC TAPE SAMPLER
 (Precision Scientific Company)

DESCRIPTION

The Precision Automatic Tape Sampler is similar to the Automatic Tape Sampler/Recorder, but does not include provision for tape evaluation. Consult the description of the automatic tape sampler/recorder for details related to sample collection.

APPLICATIONS

The automatic tape sampler is less expensive than the sampler/recorder. It is sometimes more economical to use several samplers in conjunction with one tape spot evaluator rather than to use sampler/recorder units at multiple sampling locations.

Use of the sampler which does not include a built-in evaluator allows transmittance to be determined only for the total sampling interval. Rate of darkening during an individual collection period can be obtained only by continuous measurement.

SPECIFICATIONS

Dimensions: 15"W, 11"D, 12"H
 Weight: 32 lbs.
 Electrical Requirements:

Cat. No. 63092	120 V, 60 Hz, 2.0 Amps
Cat. No. 63093	230 V, 50 Hz, 1.0 Amps

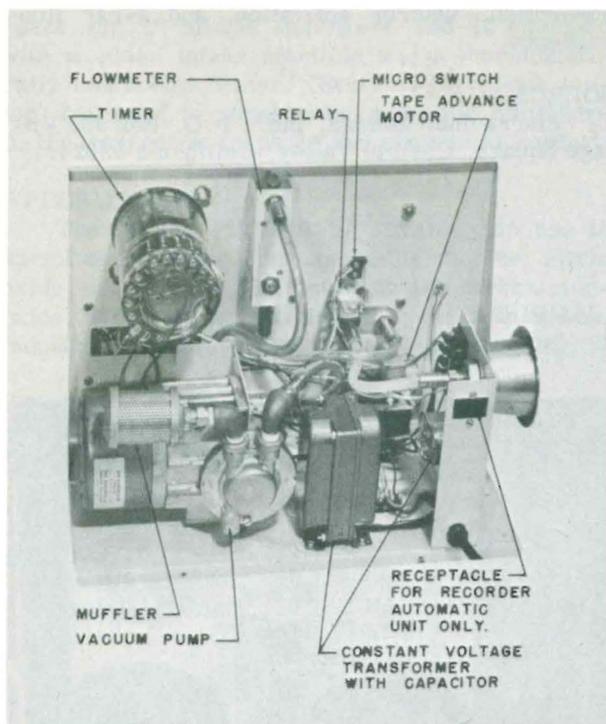


Fig. M-13. Rear view of Automatic Tape Sampler, with housing removed.

SOURCE

Precision Scientific Company, 3737 W. Courtland Street, Chicago, Illinois 60647

NOTE:

A Precision Tape Spot Evaluator is available for use in conjunction with the Automatic Tape Sampler. A light-adjust control establishes the base reading of a clean area of the tape. The tape can be advanced at the rate of 12 spots per minute so that the operator can note and record the transmission readings.

Although designed to accommodate the Precision 1 1/2-inch wide tape, other sizes may be used with suitable spacers.

Repeatability of readings is 2% of full scale.

Dimensions: 15"W, 10"D, 6"H

Weight: 11 lbs.

Electrical Requirements:

Cat. No. 63096 120 V, 60 hz, 0.60 Amps

Cat. No. 63097 230 V, 50 Hz, 0.30 Amps

G SERIES TAPE SAMPLERS (Research Appliance Co.)

DESCRIPTION

The G Series of Samplers has evolved from the F Series described in the 4th edition of Air Sampling Instruments. The simplest and least expensive model within the series is the G1 Particulate Sampler. It has a pump rated at 30 scfh free flow and a G1 timer that permits sampling cycles of 1/2, 1, 2 and 4 hours. It does not have a flowmeter or capability for tape evaluation. The G2 Particulate Sampler differs from the G1 in that it has a flowmeter (5-20 cfh) and the G2 timer. It permits sampling periods ranging from 10 minutes to 3-1/2 hours in 10-minute increments. It is similar in appearance to the G Series Tape Monitor shown in Figure M-29.

APPLICATIONS

G Series Models can be adapted to sample either particulate or hydrogen sulfide by installing or remove particulate, a humidifier and a soda lime tube. The soda lime removes residual hydrogen sulfide before the cleaned sampled air is directed into the sealed filter tape sampling compartment.

The following tapes are available:

#4 Particulate Tape - This tape is most commonly used and has a pore size of 3.4 micrometers. Retention of particles as small or smaller than 1.0 micrometers can be achieved due to filter loading.

#41 Particulate Tape - This tape has considerably higher chemical purity than the #4 tape. It is very soft and requires care in handling.

Lead Acetate Tape - This tape is the tape commonly used to sample for hydrogen sulfide in the range of 0.02 to 20 ppm.

Mercuric Chloride Tape - After sampling this tape is developed by exposure to ammonium hydroxide. Sample spots on undeveloped tapes have been found to be stable for a period of three days in a clean atmosphere. Its range is 0-15 ppb.

SAMPLE EVALUATION

A manual spot evaluator, Model 2296, and two semiautomatic spot evaluators, Models 2332 and 2348 are available for use with samplers that have no evaluation capability of their own. For spots that represent 30 cu ft. of sampled air (2 hrs. at 0.25 cfm) the meter can be read directly in COHS/

1000 LF. Values for other air volumes can be obtained from conversion tables or can be obtained by simple calculations. The meter is also calibrated in units of percent transmission.

Calibration curves are used for correlating the degree of staining of lead acetate tapes with concentrations of hydrogen sulfide.

SPECIFICATIONS

Models within the G Series are supplied with a 3-wire power cord and plug and operate at 110/115 V and 60 Hz. Export models operating on 220 V and 50 Hz are also available.

The dimensions and weight of the various models are listed in the accompanying table.

RAC Series G Samplers

Cat. No.	Model	Dimensions, (inches)			Wt., lbs.
		W	H	D	
2301	G1	14-1/2	11-1/4	12	34
2303	G2	14-1/2	11-1/4	12	34



Fig. M-14. RAC Semiautomatic Spot Evaluator.

SOURCE

Research Appliance Company, Route 8, Gibsonia, Pennsylvania 15044.

FLUORIDE SAMPLER - DUAL TAPE
(Research Appliance Co.)

DESCRIPTION

The RAC Model 2356 Fluoride Sampler uses a dual filter tape system for simultaneous sampling of particulate and gaseous fluorides. Each tape has its own motor drive and indexing control switch.

Gaseous Fluoride Tape is impregnated with sodium hydroxide. Particulate Fluoride Tape is impregnated with citric acid. The two tapes are fed simultaneously through the sampling head. The exhaust from the vacuum pump is used to pre-saturize the front compartment.

The amount of fluoride on each of the sample spots is determined by chemical analysis.

The Fluoride Sampler is equipped with an oil-less rotary carbon vane pump rated at 1.1 cfm free flow. The flowmeter reads in the range 0.1-1.0 cfm. It can be supplied with either the G1 or G2 timer.

APPLICATIONS

HF has been determined in the range of 2-75 $\mu\text{g}/\text{m}^3$. Particulate concentrations up to 57 $\mu\text{g}/\text{m}^3$ have been tested.

SPECIFICATIONS

Dimensions: 20-3/4" W x 23-3/4" H x 12" D

Weight: 45 lbs.

Electrical Requirements: 110 V, 60 Hz; 220 V, 50 Hz

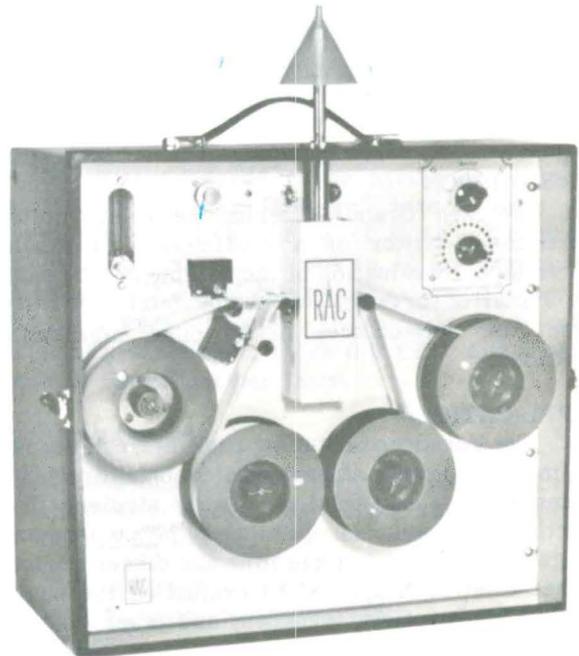


Fig. M-15. RAC Model G2DT Dual Tape Fluoride Sampler.

SOURCE

Research Appliance Company, Route 8, Gibsonia, Pennsylvania 15044.

FILTERING RECORDERS
(Von Brand Filtering Recorders)

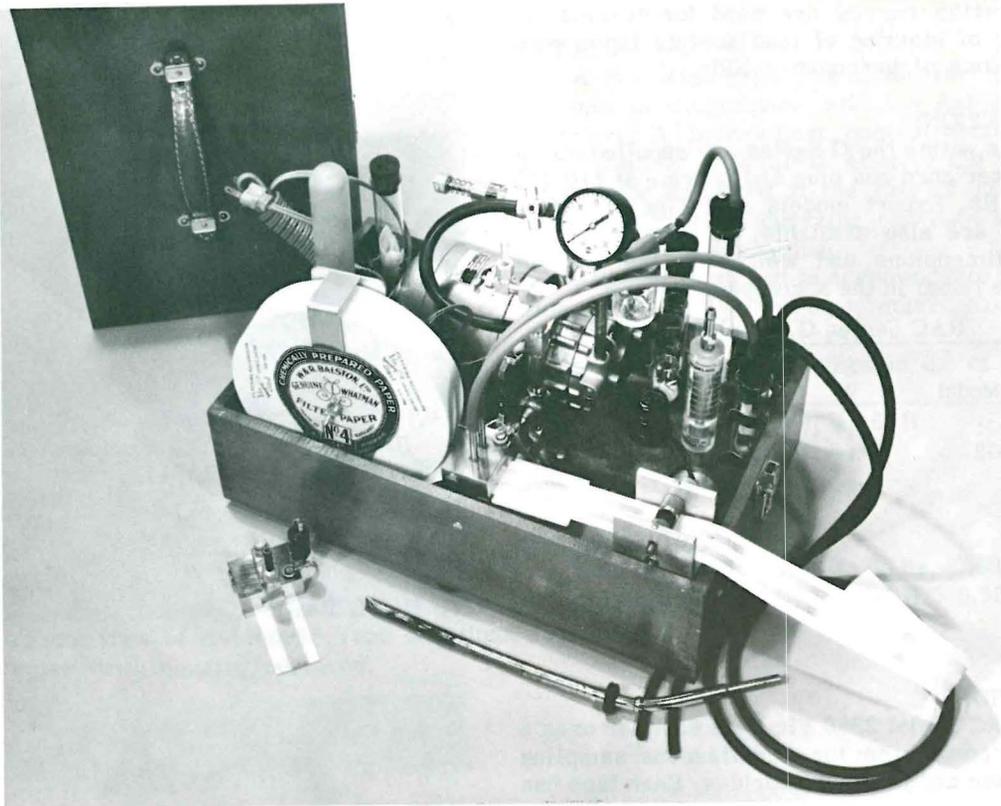


Fig. M-16. Von Brand Heavy Duty Portable Filtering Recorder.

DESCRIPTION

The Von Brand Filtering Recorders collect particulate matter on a continuously advancing filter tape. Evaluation of the sample can be made by visual observation, by photoelectric measurement of reflectance, or by other appropriate methods.

APPLICATIONS

The Von Brand filtering recorder can be used to monitor levels of particulate contamination in community of industrial air quality studies. It is particularly useful in optimizing the performance of gas turbines and of gasoline and diesel engines. It has also been applied to evaluating the operation of incinerators, furnaces, and other combustion devices.

DESCRIPTION OF COMPONENTS

Air Flow System

Several types of pumps and orifices are available for sampling rates up to 3 CFM. The heavy duty portable model normally samples at rates up to 1 CFM. Three interchangeable sam-

pling heads are available. These heads will produce single, dual, or triple traces for simultaneous sampling and comparison from as many as three different sources. A heater in the sampling head prevents condensation and has a conditioning effect on the tape. The heater is easily disconnected if there is no need for it.

Tape System

Standard tape is No. 4 Whatman filter paper with a width of 1 3/8 inches. Tape speed can be varied over a wide range by changing the synchronous gear motor of the tape drive. Rates as fast as 4 inches per second can be used in sampling for very high concentrations of particulate. Rates as slow as 1 inch per hour can be used for such applications as the monitoring of clean rooms.

The sampler can be equipped with a repeat cycle timer and used as a sequential rather than as a continuous sampler.

The single trace head produces a trace 1/2 or 1/4 inch wide. A 7/8-inch diameter circular spot is procured when the system is modified to obtain sequential samples.

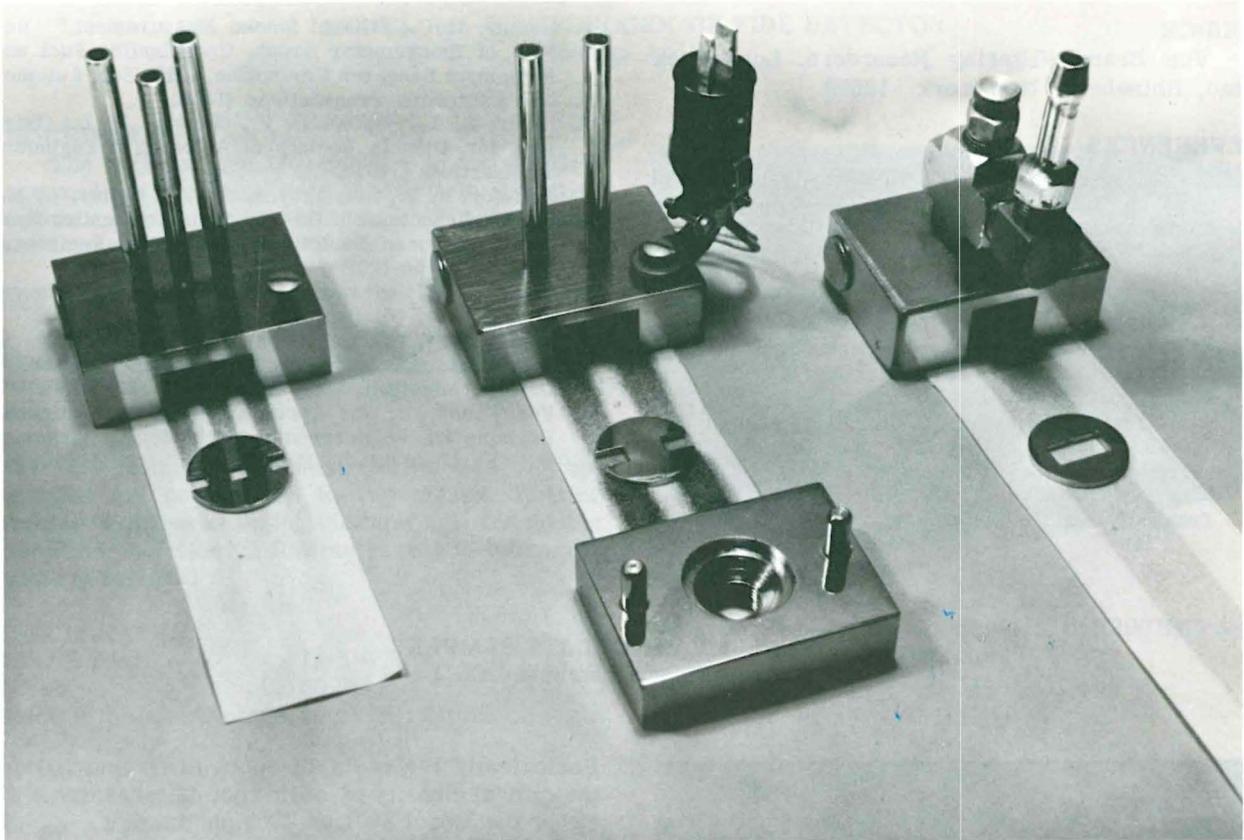


Fig. M-17. Sampling Heads for Single, Dual, and Triple Filter Traces. The Heater Shown on Dual Head is Supplied on All Heads.

Use of the dual head produces two traces each 1/4 inch wide. Three traces each 3/16 inch wide are produced with the triple head.

Tape Evaluation

For applications such as the testing and adjusting of fuel-burning equipment, it is often sufficient to evaluate the sampling tape by simple visual comparison.

The filtering recorder can also be obtained with a reflectometer built into the collecting head. Darkening of the tape is photoelectrically measured using fully transistorized circuitry. Readings are observed on a meter.

For applications not requiring instantaneous evaluation, an evaluating head without gas passages and heater is available. This evaluator is positioned adjacent to the sampling head and is useful for evaluating previously sampled tapes. Both types of evaluators are equipped with solid state detector, constant voltage supply, amplifier, and meter with 4-inch scale.

Filtering recorders obtained previous to the development of this instantaneous readout device can be converted to include this feature.

Sensitivity

Sensitivity depends on the nature of the particulate, rate of air flow, and rate of tape advancement. In one series of tests particulate concentrations varied from 1 to 14 mg per cubic meter and produced darkening ranging from a very light gray to black. These tests were conducted at a sampling rate of 0.5 CFM and a tape speed of 12 inches per hour.

SPECIFICATIONS

Dimensions and Weight: Different models of this filtering recorder range from about 25 to 40 pounds in weight.

Typically the dimensions are about 17-21 inches length, 10 inches width, and 12 inches height.

Electrical Requirements: Most models operate on 115 V, 60 Hz, but other voltages and cycles are available. A 12 V model with built-in reflectometer and Rustrak recorder is available for road testing of automobiles.

SOURCE

Von Brand Filtering Recorders, Long Dock Road, Rhinebeck, New York 12572

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MODEL 2701 PARTICULATE SAMPLER
(Wallace Fisher Instrument Co.)

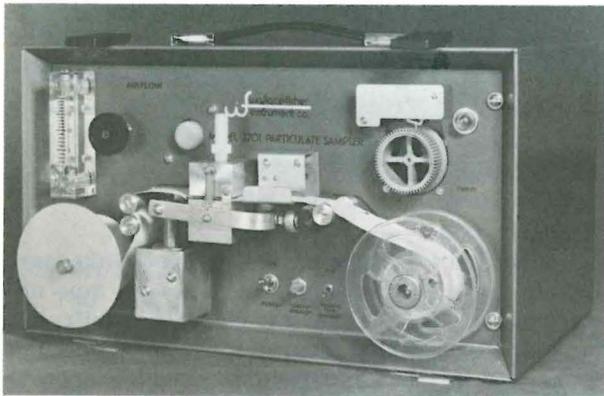


Fig. M-18. Wallace Fisher Model 2701 Particulate Sampler.

DESCRIPTION

The Model 2701 tape sampler collects samples of particulate for later photometric evaluation.

Periodically the reels of spots are removed and the optical density of each spot is measured with either the Model 2801 or 2802 photometer.

The Model 2701 is equipped with a motorless pump giving a minimum air flow of 40 CFH. A model 2702 which does not include a pump and a Model 2703 with a pump giving a minimum air flow of 15 CFH are also available.

The timer is a synchronous non-reset type. Cams permit selection of intervals of 2 hrs, 1 hr, 40 min, 30 min or 20 min. A push-to-test flowmeter is also included.

SPECIFICATIONS

Dimensions: 17" W x 10" H x 11" D
Weight: 35 lbs. approximately

SOURCE

Wallace Fisher Instrument Company, Ocean Grove Station, Swansea, Massachusetts 02777.

MODEL H₂S 200 HYDROGEN SULFIDE DETECTOR
(Ecology Audits)

DESCRIPTION

The detector can be operated in a stationary tape mode or a moving tape mode. A dual optical system measures the discoloration of the lead acetate impregnated tape.

APPLICATIONS

Hydrogen sulfide is measured in the 0.01 to 10 ppm range. Minor modifications allow determination above 10 ppm.

FEATURES

This instrument is designed to operate unattended for periods up to two weeks. Routine service includes changing the tape roll and adding humidifier solution. A flowmeter with 0-450 cc/min range is included.

SPECIFICATIONS

Dimensions: 14-1/4"H x 22"W x 12"D
Weight: 60 lbs.
Electrical Requirements: 100 VAC, 60 Hz

OPTIONS

Rustrak Recorder
Range: 0.01-20 ppm
0.01-100 ppm
External Alarms



Fig. M-19. Ecology Audits Model H₂S 200 Hydrogen Sulfide Detector.

SOURCE

Ecology Audits Inc., 9995 Monroe Drive, Suite 107, Dallas, Texas 75220.

THETADYNE AIR SAMPLER/MONITOR
(Enviro-Guards, Inc.)

DESCRIPTION

There are two models:
Cat. No. Model
2002 F-12, SE Particle
2204 F-12, SEH2S
They include built-in transmissometers. The H₂S Model is designed for determination of hydrogen sulfide.

APPLICATIONS

These samplers are used in determination of COH values and hydrogen sulfide concentrations.

FEATURES

A by-pass flowmeter and flow adjustment valve are provided. The timer allows settings of 10 minutes to 5 hours in 10 minute increments.

SOURCE

Enviro-Guards Inc., 510 Superior Street, Carnegie, Pennsylvania 15106.

SERIES 4801 HYDROGEN SULFIDE ANALYZER
(Honeywell)

DESCRIPTION

The analyzer automatically measures and records H_2S concentrations in streams of gases and air. It uses cotton tape impregnated with lead acetate as the sampling medium. Reference and measuring cells continuously compare the amount of light reflected from exposed and unexposed areas of the tape. Results are produced as a saw-toothed trace on a circular chart recorder with one revolution for each 24 hours. Peak heights are measures of the amount of H_2S reaching the tape during corresponding test periods.

The standard analyzer has a full-scale reading of 0.5 grains H_2S per 100 SCF for a 15 minute sample time. Other ranges are available from 0.05 to 25 grains H_2S per 100 SCF full scale.

When H_2S concentration is below a preset amount the sample time is extended to 60 minutes to conserve tape.

APPLICATIONS

The analyzer is primarily used in the natural gas industry but is suited to other applications where low concentrations of H_2S must be measured.

FEATURES

The analyzer is enclosed in a free-standing cabinet. Thermostatic control prevents freezing and moisture condensation. Tape can be replaced, humidifier reservoir refilled, calibration performed, charts changed, ink supply replenished, and adjustments made through front access doors. The system is fully automatic except for this routine service.

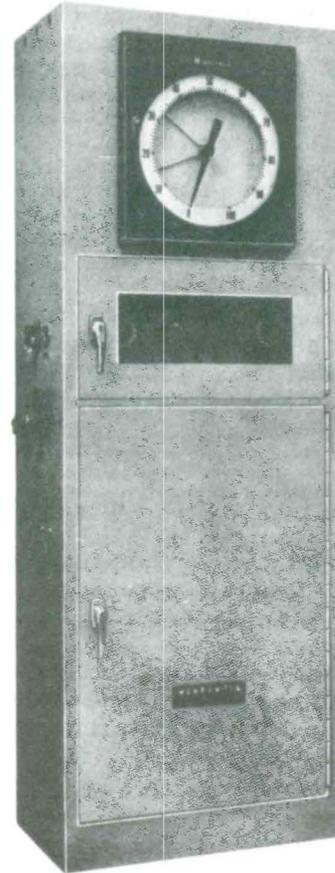


Fig. M-20 Honeywell Model 4801-0 H_2S Analyzer.

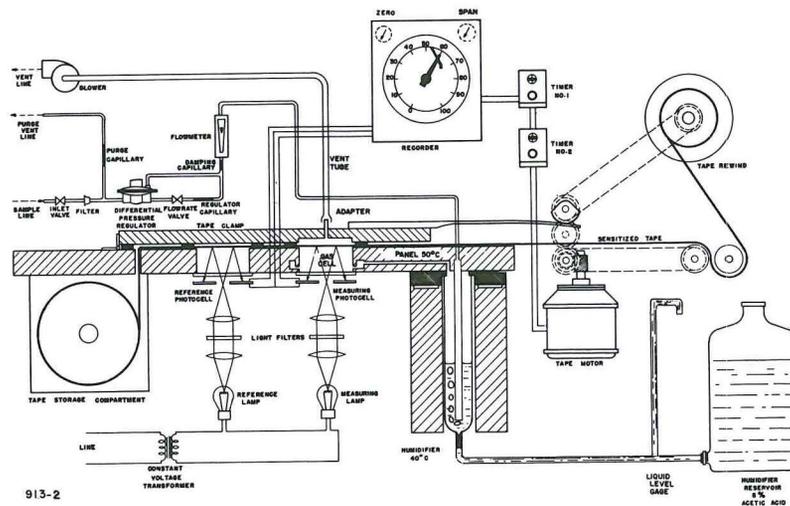


Fig. M-21. Schematic Diagram of Honeywell Model 4801-0 H_2S Analyzer.

SPECIFICATIONS

Dimensions: 73" H x 16" D x 26" W
 Weight: 500 lbs.
 Electrical Requirements: 115 VAC, 60 Hz, 500 W

SOURCE

Honeywell, Process Control Division, 1100 Virginia Drive, Fort Washington, Pennsylvania 19034.

**PORTABLE HYDROGEN SULFIDE GAS ANALYZER MODEL 825
 (Houston Atlas, Inc.)**



Fig. M-22. Houston Atlas Model 825 Portable Hydrogen Sulfide Gas Analyzer.

in contact with hydrogen sulfide. A photoelectric cell measures the change. A meter deflection proportional to concentration is obtained. An adjustable alarm and a 2-1/2" strip chart recorder are included.

APPLICATIONS

Typical applications include well logging, pipeline monitoring, process control, and product monitoring.

FEATURES

Ranges of 0-1 ppm and 0-100 ppm H₂S are available.

SPECIFICATIONS

Dimensions: 9" H x 19-1/2" W x 18" D
 Weight: Approximately 45 lbs.
 Electrical Requirements: 115 VAC, 60 Hz, 50 W

SOURCE

Houston Atlas Inc., 9441 Baythorne Drive, Houston, Texas 77041.

DESCRIPTION

The sampler uses a lead acetate impregnated tape which turns from white to dark brown when

**HYDROGEN SULFIDE GAS ANALYZER MODEL 860
 (Houston Atlas, Inc.)**

DESCRIPTION

Hydrogen sulfide reacts with lead acetate impregnated on the sampling tape forming a light brown stain. Light reflection from the test spot is measured continuously. The rate of change is proportional to hydrogen sulfide concentration. The rate can be measured without waiting for equilibrium, providing rapid readout with no zero error. At the end of the preset time interval a new section of tape is advanced into sampling position. The rate of reaction is monitored and stored in an analog unit. The analog storage unit is updated every 240 seconds. The continuous readout is linear and a direct measure of hydrogen sulfide concentration. Both a digital display and a trace on a 4" strip chart recorder are provided.

APPLICATIONS

Determination of H₂S in air or other gases in the range of 1-100 ppb.



Fig. M-23. Houston Atlas Model 860 Hydrogen Sulfide Gas Analyzer.

SPECIFICATIONS

Dimensions: 9" H x 19-1/2" W x 18" D
 Weight: 45 lbs.
 Electrical Requirements: 15 VAC, 60 Hz, 50 W

SOURCE

Houston Atlas, Inc., 9441 Baythorne Drive,
 Houston, Texas 77041.

SERIES 4000 MINIATURE CONTINUOUS MONITORS
 (MDA Scientific, Inc.)

DESCRIPTION

The Miniature Continuous Monitor (MCM) is worn near the breathing zone or is located at the work station. A sampling pump pulls air through the moving paper tape. The tape is chemically impregnated for the determination of a specific gaseous contaminant. Systems are available for the determination of TDI and phosgene. Other systems are being developed for H₂S, NO₂, Cl₂, SO₂, and vinyl chloride monomer (VCM).

Air is sampled at 100 cc/min and the tape moves at 2 cm/hr. The sampler is powered by a rechargeable battery pack with a running time of 10 hours per battery charge. The battery pack is designed to be worn on the belt.

At the end of the shift the tape is read on the corresponding MCM Integrating Reader/Recorder. Tape speed is 1 cm/sec and the eight hour exposure is read within 30 sec. A "Datagram" is produced on a printed form. It shows a profile of the variation of concentration with time. A linearizing integrating circuit computes the exposure integral in ppm-hrs. and this appears on the datagram as a bar graph.

APPLICATIONS

The Model 4000 MCM is the first in a series of personal continuous monitors. It can be used with either TDI sensitive tapes or phosgene sensitive tapes. The Model 4100 Integrating Reader/Recorder is calibrated for only TDI sensitive tapes.

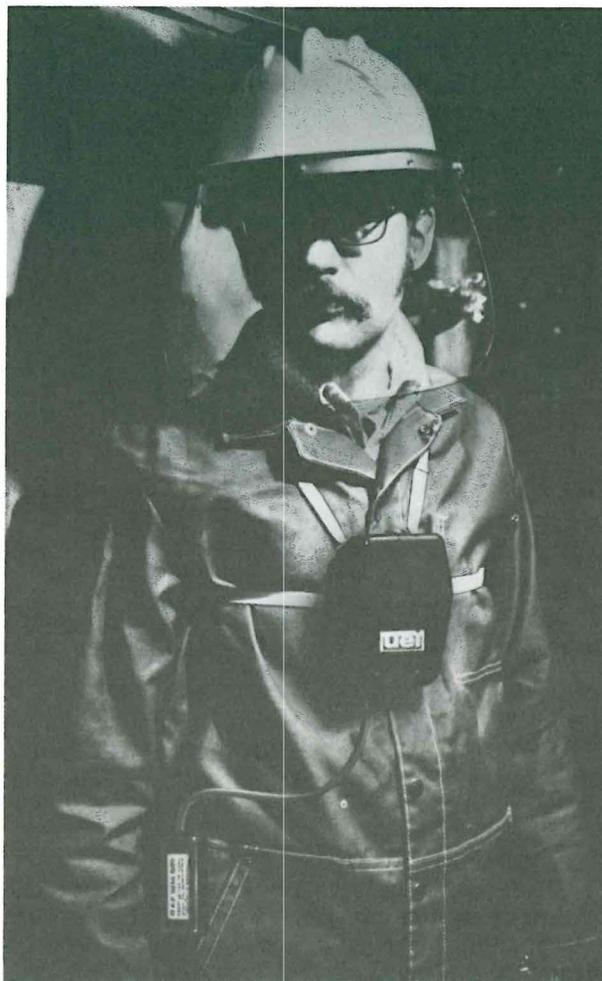


Fig. M-24. MDA (UEI) Series 4000 Miniature Continuous Monitor and Battery Pack.



Fig. M-25. MDA Model 4100 Integrating/Recorder (evaluating exposed tape).

Substance	Upper Limit of Conc., ppm	Model Numbers	
		Sampler	Reader
TDI	0.08	4000*	4100*
Phosgene	0.4	4020*	4120*
H ₂ S	20	4010	4110
NO ₂	20	4030	4130
Cl ₂	4	4040	4140
SO ₂	0.5	4050	4150
VCM	8	4070	4170
Hydrazine	1	4080	4180

*Only these models were available at the time this listing was prepared, the other models are being developed.

SEPECIFICATIONS FOR THE SAMPLER

Dimensions: 6" x 2-1/4" x 4"
 Weight: 1-1/2 lbs. (excluding battery pack)

SPECIFICATIONS FOR THE READER/RECORDER

Dimensions: 10" x 11" x 12"
 Weight: 20 lbs.

Electrical Requirements: 115 VAC, 60 Hz or 220 VAC, 50 Hz

SOURCE

MDA Scientific, Inc., 808 Busse Highway, Park Ridge, Illinois 60069. (The MCM system is jointly developed with the UEI Division of J.S. Sieger, Ltd.)

SERIES 7000 CONTINUOUS MONITORS
 (MDA Scientific, Inc.)

DESCRIPTION

Models in the 7000 series are line operated, semi-portable tape cassette samplers. Sensitivity and specificity are obtained by use of chemically impregnated paper tapes. The tape is advanced at a constant rate. The top half of the tape is exposed to the sampled air while the bottom half remains unexposed. The reference and measurement photometric detectors sense the reflected light and produce a differential electronic output signal. Concentration is displayed in ppm as a needle position on the front panel meter. Self-contained audio and visual alarms are activated if a preset concentration is exceeded.

The sampler can be used with a conventional time-stamped strip chart recorder or with the Series 7500 Integrator/Recorder. In addition to the conventional strip chart record the Series 7500 Integrator/Recorder presents:

- a) an elapsed time and a time weighted average (TWA) at present intervals, normally every 20 minutes;
- b) an eight-hour TWA;
- c) a total exposure print-out the moment a preset limit is reached.

A Four Point Parallel Sampling System (MDA Data Sheet UA 86) is available for use with the Series 7000 Continuous Monitors. A composite sample is presented to the monitor. Normally the flow controls are set so that equal flow is contributed by each of the four points. The majority of total flow is directly exhausted through a tee-piece. The monitor samples at its correct rate through a flow smoother. The observed concentration is an average of the four contributing concentrations.

Enclosure systems (MDA Data Sheet UA 92) are available for the Series 7000 Continuous Monitors. These are designed for corrosive atmospheres, combustible atmospheres or outdoor installations.



Fig. M-26 MDA (UEI) Series 7000 Continuous Monitor.

APPLICATIONS

Substance	Upper Limit of Conc., ppm	Sampler Model	Integrator/Recorder Model
H ₂ S	20	7010	7510
Phosgene	0.4	7020	7520
NO ₂	20	7030	7530
Cl ₂	4	7040	7540
SO ₂	0.5	7050	7550
VCM	8	7070	7570
Hydrazine	1	7080	7580

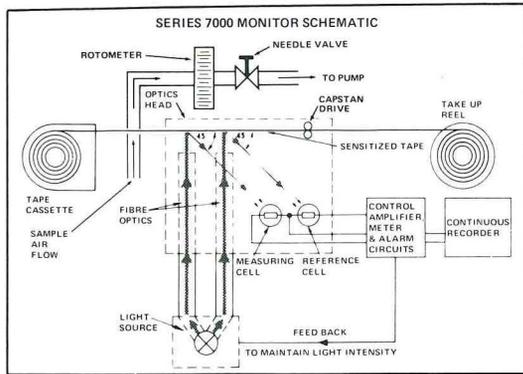


Fig. M-27. Schematic Diagram of MDA (UEI) Series 7000 Continuous Monitor.

SPECIFICATIONS FOR SERIES 7000 MONITORS
 Dimensions: 9" H x 16" W x 10" D
 Weight: 22 lbs.

Electrical Requirements: 115 VAC, 60 Hz

SPECIFICATIONS FOR SERIES 7000 MONITORS USED WITH FOUR POINT PARALLEL SAMPLING SYSTEM

Dimensions: 24" W x 18" H x 18" D
 Weight: 75 lbs. with Series 7000 Continuous Monitor and Recorder

Electrical Requirements: 115 VAC, 60 Hz

SPECIFICATIONS FOR SERIES 7500 INTEGRATOR/RECORDERS

Dimensions: 11" W x 9-1/2" L x 6" H
 Weight: 12 lbs.

Electrical Requirements: 115 VAC, 60 Hz

SOURCE

MDA Scientific, Inc., 808 Busse Highway, Park Ridge, Illinois 60068. (The system is jointly developed with the UEI Division of J. S. Sieger, Ltd.)

AUTOMATIC TAPE SAMPLER/RECORDER (Precision Scientific Company)



Fig. M-28. Precision Scientific Co. Automatic Tape Sampler/Recorder.

DESCRIPTION

The Precision Automatic Tape Sampler/Recorder automates the acquisition of data on the concentration of particulate in the atmosphere. A prepunched sampling tape is continuously monitored for light-transmission as particulate is deposited on a circular collection area.

An external strip-chart recorder having a 0-100% transmission scale provides a detailed time-transmission record.

SUGGESTED APPLICATIONS

This sampler can be used to monitor community air quality and for other applications in which the concentration of particulate matter in

air is of concern. Results are readily convertible to COH units.

DESCRIPTION OF COMPONENTS

Air Flow System

The sampler is normally operated at 15 CFH but other rates in the 2-20 CFH may be used for sampling. A push-to-test flowmeter permits precise setting of air flow and minimizes wear on the float and the inner surface of the rotameter tube.

Tape System

Tape is supplied in rolls of 40 feet of 1 1/2-inch width with indexing holes on 2-inch centers. The diameter of the circular spot is 1 inch.

Most sampling is done for a standard 2-hour period, but the timer is adjustable for intervals up to 240 minutes. For tape reel loading and for rapid manual advance or rewind of the tape, the tape positioning arm is disengaged from the holes in the tape by pressing the "tape release" switch.

Evaluation System

A constant voltage light source is controlled by an adjustable rheostat. This permits setting of the transmission reading at 100%. Light passing through the filter is detected by a photovoltaic cell. As the filter darkens during the sampling interval less light reaches the detector and the light transmission value decreases from its initial

setting of 100%. Transmission readings can readily be converted to COH valves.

Other Features

Bronze-tinted acrylic doors permit observation of sampler during operation and are secured by a tumbler lock to discourage tampering.

SPECIFICATIONS

Dimensions: Sampler—15" W, 11" D, 12" H
Recorder—4" W, 5" D, 6" H

Weight: 37 lbs. (with recorder)

Electrical Requirements:

Cat. No. 63094 120 V, 60 Hz, 2.2 Amps
Cat. No. 63095 230 V, 50 Hz, 1.1 Amps

SOURCE

Precision Scientific Company, 3737 W. Courtland Street, Chicago, Illinois 60647

G SERIES TAPE MONITORS (Research Appliance Co.)

The G Series of Samplers and Monitors has evolved from the F Series described in the 4th Edition of Air Sampling Instruments. Many models include an integral densitometer that reads the percent of light transmitted through the sample spot as the air sample is being taken. Some models are equipped for measurement of reflected light rather than transmitted light. Other models include capability for dual transmission and reflectance measurements.

Models G1 SE and G2 SE Monitors are equipped with a densitometer which permits "self-evaluation" of the sample spot as it is being collected. Models G1 SER and G2 SER have an inkless strip-chart recorder as well as the densitometer. Models G1 SESR and G2 SESR have the added feature of automatic standardization. A value of 100% transmission is preset at the beginning of each sampling cycle.

Models G2-R-100, G2-R-600, G2-T-100, G2-T-600, G2-RT-100 and G2-RT-600 are designed for telemetering applications. The G2-R Models measure reflectance after sampling has been completed. G2-T Models measure transmission throughout the sampling period. G2-RT Models measure transmission throughout the sampling period and reflectance at the completion. All three types can be supplied in either a model to accommodate the usual 100 ft. roll of filter tape or a model for a 600 ft. roll. The 600 ft. roll permits longer periods of unattended operation and is recommended for remote locations.

The Model G2A H₂S Alert Monitor is designed for use with lead acetate treated tape. The standard timer allows sampling times in the range of 1-60 minutes in one minute intervals. Each spot is automatically adjusted for 100% transmission before sampling begins. An alarm circuit is triggered if a preset limit is exceeded. A totally enclosed model designed to be purged with an inert gas is



Fig. M-29. RAC Series G Samplers and Monitors.

also available as the Purged Model G2A H₂S Monitor.

OPTIONS

The Models within the G Series can be modified by choosing from a series of options. These include higher air flow systems (A or B), computer interface (C), automatic standardization (D), rack mount adapter (E), rack mount (F), H₂S adapter kit (G), export models with 220 V and 50 Hz (H) and telemetering (I).

APPLICATIONS

G Series Models can be adapted to sample either particulate or hydrogen sulfide by installing or removing an H₂S Adapter Kit. The Kit consists of a prefilter to remove particulate, a humidifier and a soda lime tube. The soda lime removes residual hydrogen sulfide before the cleaned sampled air is directed into the sealed filter tape sampling compartment.

The following tapes are available:

#4 Particulate Tape - This tape is most commonly used and has a pore size of 3.4 micrometers. Retention of particles as small or smaller than 1.0 micrometers can be achieved due to filter loading.

#41 Particulate Tape - This tape has considerably higher chemical purity than the #4 tape. It is very soft and requires care in handling.

Lead Acetate Tape - This tape is the tape commonly used to sample for hydrogen sulfide in the range of 0.02 to 20 ppm.

Mercuric Chloride Tape - After sampling this tape is developed by exposure to ammonium hydroxide. Sample spots on undeveloped tapes have been found to be stable for a period of three days in a clean atmosphere. Its range is 0-15 ppb.

SPECIFICATIONS

Model within the G Series are supplied with a 3-wire power cord and plug and operate at 110/115 V and 60 Hz. Export models operating on 220 V and 50 Hz are also available.

The dimensions and weight of the various models are listed in the accompanying table.

SOURCE

Research Appliance Company, Route 8, Gibsonia, Pennsylvania 15044.

RAC SERIES G TAPE MONITORS

Cat. No.	Model	Dimensions, (inches)			Wt., lbs.
		W	H	D	
<u>Particulate Monitors</u>					
2302 SE	G1 SE	14-1/2	11-1/4	12	39
2301 SER	G1 SER	20-3/4	11-1/4	12	46
2301 SESR	G1 SESR	20-3/4	11-1/4	12	46
2303 SE	G2 SE	14-1/2	11-1/4	12	39
2303 SER	G2 SER	20-3/4	11-1/4	12	46
2303 SESR	G2 SESR	20-3/4	11-1/4	12	46
<u>Air Monitors for Telemetering</u>					
2370-R-100	G2-R-100	20-3/4	11-1/2	12	47*
2370-R-600	G2-R-600	20-3/4	18-3/4	12	55*
2370-T-100	G2-T-100	20-3/4	11-1/2	12	47*
2370-T-600	G2-T-600	20-3/4	18-3/4	12	55*
2370-RT-100	G2-RT-100	20-3/4	11-1/2	12	47*
2370-RT-600	G2-RT-600	20-3/4	18-3/4	12	55*
<u>H₂S Alert/Alarm Monitors</u>					
2307-C	G2 A H ₂ S	12-1/2	22-1/2	12	57-1/2
2324	Purged G2 A H ₂ S	19	15-1/2	12-7/8	68*

*These models do not include a built-in sampling pump.

AISI TAPE SAMPLER—MODEL 5000 (Research Appliance Company)



Fig. M-30. Research Appliance Co. Model 5000 Tape Sampler.

DESCRIPTION

Many of the features found in the various samplers of the Model G Series are found in an upgraded and modernized form in the RAC Model 5000 filter tape sampler. The modular design of the Model 5000 allows its basic system to be readily adapted for use in a variety of more highly developed systems.

The Model 5000 includes provision for tape sampling and evaluation and allows several options for the telemetering, recording, and further handling of data.

APPLICATIONS

The RAC Model 5000 is a deluxe filter tape sampler for determining COH levels and for estimating concentrations of hydrogen sulfide. It is particularly suited for use with telemetering and computerized data handling.

DESCRIPTION OF COMPONENTS

Air Flow System

Sampling rate is adjusted to 0.25 CFM by a flow adjust valve. A flow-meter and a push to check valve are included in the sampler.

Tape System

The sampling tape is 1.5 inches wide and is supplied in 100-foot rolls for particulate and in 60-foot rolls for hydrogen sulfide. It is pre-punched for positive indexing of spots. One roll of tape will be sufficient for 1,350 spots with 1-inch diameters. Tape is automatically indexed at the end of each sampling period.

Sampling period can be regulated from 5 minutes to 3 hours and 20 minutes. Tape remains fixed in position during each discrete sampling period.

Evaluation System

A standardization module automatically adjusts to 100% transmission on clean spot before sampling begins. The transmission meter is equipped with a set point. An alarm can be activated when this point is exceeded. Transmission readings can be observed throughout the sampling period. The light source and photocell are separated from the flow stream by glass windows.

A telemetering module is available as an option and can transmit the signal to the desired monitoring center.

A computer interfacing module is also available as an option and can amplify the signal to match computer input requirements.

Other Features

Air is taken into the system through an intake at the rear of the cabinet. A prefilter humidifier jar is mounted in the front section of the sampler and is included in the sampling train when hydrogen sulfide is determined. Components of glass or stainless steel are used in the portion of the sampling train upstream of the filter tape. Air exhausted from the vacuum pump is passed through soda lime and is used to pressurize the front section of the cabinet. The locations of the soda lime tube and of the prefilter humidifier make them readily accessible for inspection and maintenance.

SPECIFICATIONS

Dimensions: 20 1/4" L x 23" H and 15" D

Weight: 60 lbs.

Electrical Requirements:

115 V, 60 Hz, other voltages available

SOURCE

Research Appliance Company, Route 8, Gibsonia, Pennsylvania 15044.

MODEL 2500 PARTICULATE TAPE SAMPLER
(Wallace Fisher Instrument Co.)

DESCRIPTION

The Model 2500 is a particulate tape sampler designed for direct measurement of COH values. It can be supplied to use 1" or 1-1/2" wide paper tapes. The diameters of the corresponding spots are 5/8" and 1". The sampling head is self-aligning. Air leakage does not exceed 2% of sample flow rate (up to 25 l/min) with 10" water vacuum at the inlet.

A dual-acting piston pump is used. It contains no rotating parts and can draw a minimum of 20 l/min through a 5/6" diameter spot. A push-to-test flowmeter and a flow control valve are included.

The photometer uses two phototransistors located in the sampling head to supply reference and measuring inputs to the log-of-ratio amplifier. The amplifier output is substantially independent of lamp brightness. This output is linear with the optical density of the spot and the corresponding COH value. An auto-zero circuit eliminates errors caused by variations in optical density of the clean paper tape.

The Model 2500 can be supplied with either a reset type of timer (max. interval of 120 min.) or

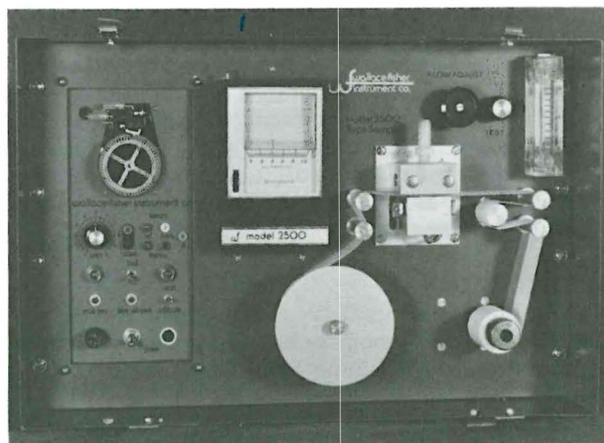


Fig. M-31. Wallace Fisher Model 2500 Tape Sampler.

a synchronous cam timer (specify max. interval of 1 or 2 hours). It can also be supplied with either a panel meter or a built-in recorder. A protective circuit prevents transmission of erroneous data in the event of exhaustion or breakage of the tape.

SPECIFICATIONS

Dimensions: 19" W x 13" D x 13" H
 Weight: 50 lbs., with pump, recorder and case
 Electrical Requirements: 115 VAC, 60 Hz

SOURCE

Wallace Fisher Instrument Company, Ocean Grove Station, Swansea, Massachusetts 02777.

APM AMBIENT PARTICULATE MASS MONITOR
 (GCA/Technology Division)

DESCRIPTION

The inlet incorporates a novel design. The configuration and flow rate are similar to that of a standard high volume sampler. Ambient air enters at 28 l/sec or 60 cfm. A secondary flow system extracts an isokinetic sample at 150 cm³/sec or 9 l/min. This permits use of a standard 1/2 inch cyclone for respirable particulates measurements. Models are available with either one or two parallel collection - detection systems, depending on whether one or two size fractions (e.g., total and respirable) are to be monitored simultaneously.

Each measurement cycle begins with a reference determination of the beta transmission through a clean area of the tape. The tape is advanced to the collection head. Particulates are collected on the high-efficiency glass fiber filter tape. Sampling times can be selected from 1 to 999 min. To eliminate "dead-time" the design incorporates two independent beta-source-detector pairs. Final beta counting occurs on one area, particle collection on another and beta reference counting on a third filter spot.

Transmission of low-energy beta radiation depends almost exclusively on mass per unit area. The concentration of airborne particulate is determined from the mass collected on the filter and the volume of air from which it was obtained.

The entire measurement and computation sequence is performed automatically. Real time and data are printed out as well as displayed digitally, together with each mass concentration measurement.

APPLICATIONS

Ambient air quality monitoring; Respirable dust continuous monitoring; Auto and aircraft emission testing; Occupational dust monitoring.

FEATURES

The instrument can determine mass concentrations from a maximum of about 300 mg/m³ to a minimum of less than 1 mg/m³.

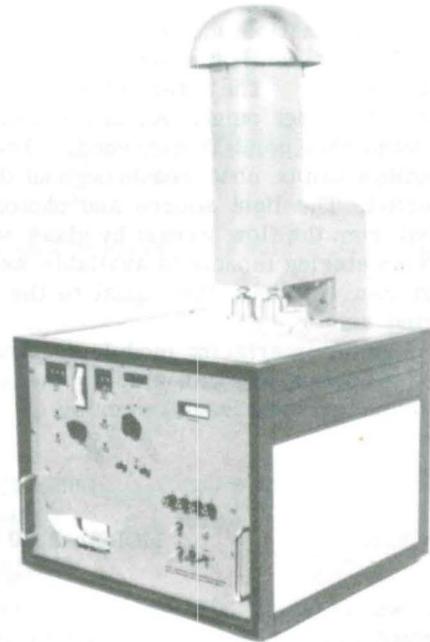


Fig. M-32. GCA Model APM Ambient Particulate Mass Monitor.

SPECIFICATIONS

Dimensions: 52 cm W x 40 cm H x 36 cm D (20" x 16" x 14")
 Weight: 50 Kg (110 lbs.), including separate pump
 Electrical Requirements: 115 VAC, 60 Hz, 400 W

SOURCE

GCA/Technology Division; Burlington Road, Bedford, Massachusetts 01730.

PMM-1 AIRBORNE PARTICULATE MASS MONITOR
(GCA/Technology Division)

DESCRIPTION

Each cycle begins with a measurement of beta transmission through a clean area of the glass fiber filter tape. Air is sampled at a rate in the range of 20-100 l/min for durations between 1-999 min. Beta transmission is measured at the end of the collection period. Counting time can be varied between 1-99 min. The entire measurement and computation sequence is performed automatically.

Particle mass, air volume and mass concentration are displayed digitally at the completion of each measurement cycle. The instrument can be obtained with either a digital display using light emitting diodes or a version with a digital printer-indicator.

APPLICATIONS

Ambient air quality monitoring; Stationary or mobile source monitoring; Aerosol research.

FEATURES

Measurement ranges are automatically switched as a function of sampled volume:

- 0.001 to 9.999 mg/m³ for volumes 10 m³
- 0.01 to 99.99 mg/m³ for volumes of 1 to 9.999 m³
- 0.1 to 999.9 mg/m³ for volumes 0.001 to 0.9999 m³

SPECIFICATIONS

- Dimensions: 53 cm W x 53 cm D x 90 cm H (21" x 21" x 36")
- Weight: 45 Kg (100 lbs.) including pump
- Electrical Requirements: 115 VAC, 60 Hz, 500 W

SOURCE

GCA/Technology Division, Burlington Road, Bedford, Massachusetts 01730.

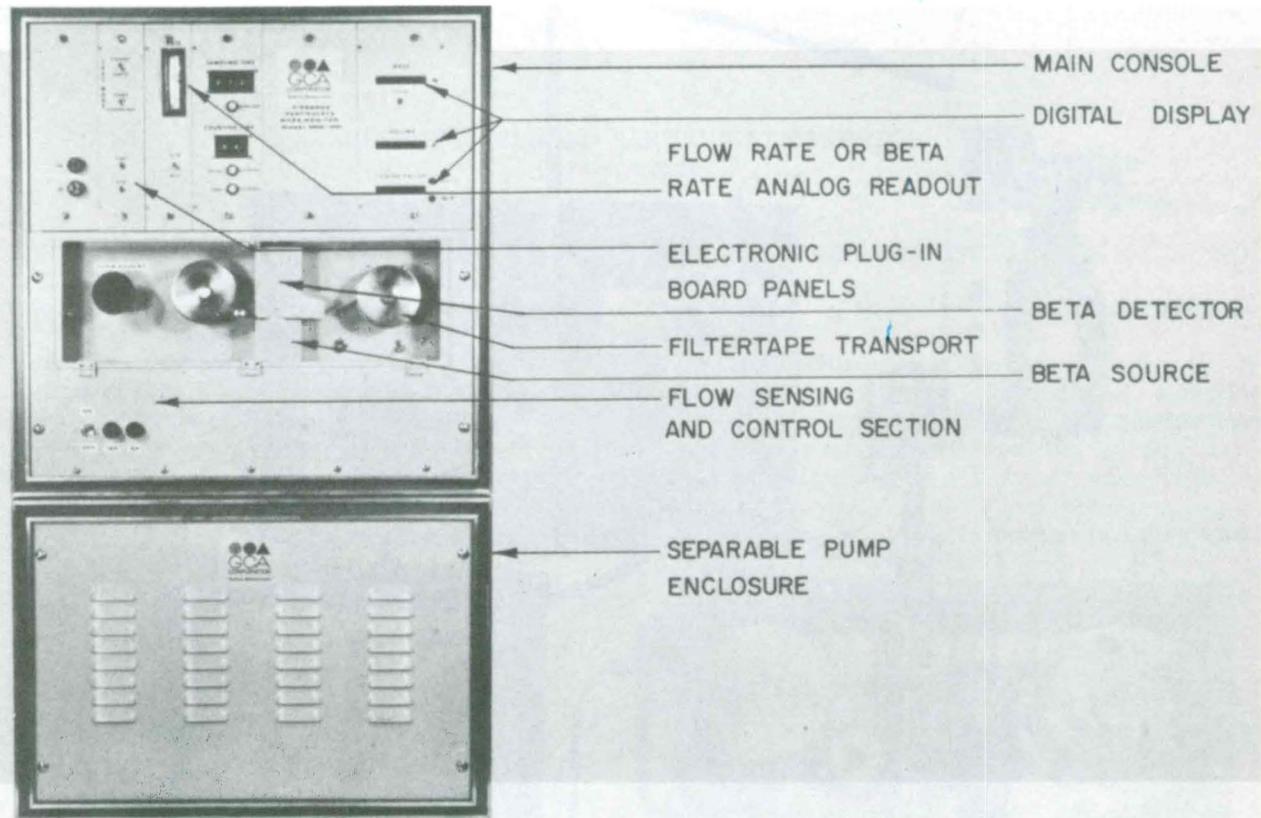


Fig. M-33. GCA Model PMM-1 Airborne Particulate Mass Monitor.

ARGOS I STACK MONITOR
(Lear-Siegler)

DESCRIPTION

The Argos I is available in a stationary and a transportable version. A complete system includes: 1) motor driven stack sampling probe; 2) particulate measurement unit; 3) gas flow measurement unit; 4) computer and control unit; 5) sampling pump and control unit.

The transportable system is designed for installation in a mobile van.

The Argos I has a continuously traversing sampling probe designed to obtain a representative sample of the stack gas. The stack sample is either heated or allowed to cool to a temperature above the dew point.

Particulates are collected on a reinforced fiberglass tape. After a preset period the pump

is turned off and the filter sample is positioned in a radiometric measuring device. A C14 beta emitter (less than 100 microcuries) is the radioactive source. A geiger-Mueller tube is the detector.

The beta transmission through the tape before and after sampling is compared. The log of the ratio of the two count rates is proportional to the mass of the collected particulate.

The computer and control unit processes the count rates and determines particulate mass concentrations from flow rate, pressure and temperature measurements.

APPLICATIONS

Coal-fired boilers; Cement and lime kilns; Carbon black furnaces; Detergent spray drying;

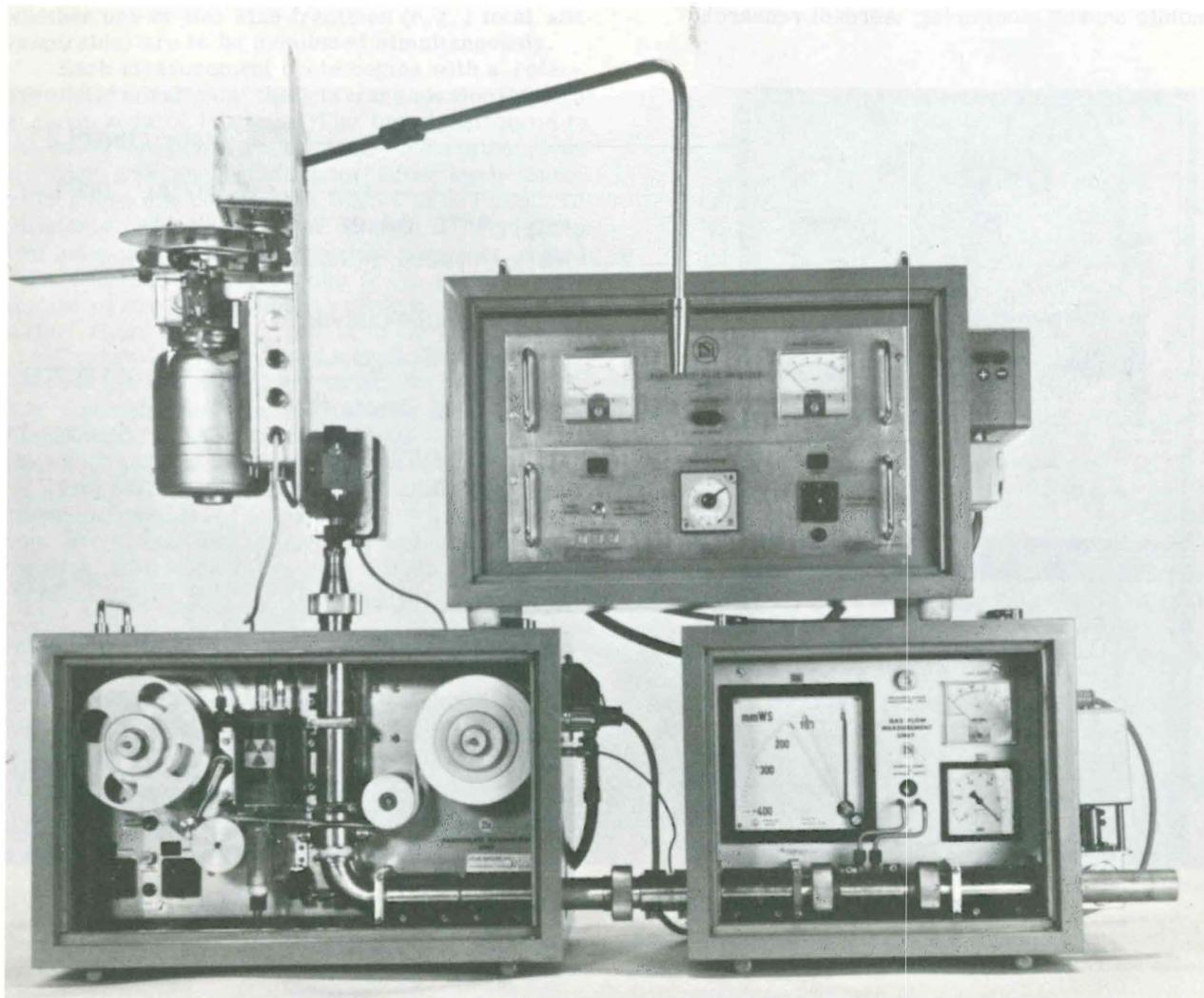


Fig. M-34 Lear Siegler Argos I Stack Monitor, Transportable Version.

Fertilizer spray drying; Foundry cupolas; Iron ore sintering; Ferro-alloy furnaces; Coke oven gas; Blast furnace gas.

FEATURES

The Argos I can be applied reliably after wet scrubbers. Sampling volume and time are adjustable. Full scale is factory adjustable from 10 to 1000 mg/m³. The sample spot size is 9 cm². The tape samples can be subjected to chemical analysis by non-dispersive x-ray or neutron activation analysis. The transportable version may be used on a large number of stacks.

SPECIFICATIONS FOR STATIONARY SYSTEM

Particulate and Gas Flow Measurement Unit
 Dimensions: 600 mm W x 1000 mm H x
 x 350 mm D (24" W x
 40" H x 14" D)
 Weight: 100 lbs.

Computer and Control Unit

Dimensions: 600 mm W x 340 mm H x
 350 mm D (24" W x 13"
 H x 14" D)
 Weight: 75 lbs.

Electrical Requirements: 115 VAC, 60 Hz

The Computer and Control Unit may be located at a maximum of 300 feet from the Particulate and Gas Flow Measurement Unit.

SPECIFICATIONS FOR TRANSPORTABLE SYSTEM

Particulate Measurement Unit
 Dimensions: 600 mm W x 340 mm H x
 350 mm D (24" x W x
 14" D)
 Weight: 60 lbs.

Gas Flow Measurement Unit

Dimensions: 450 mm W x 340 mm H x
 300 mm D (18" W x 13"
 W x 12" D)
 Weight: 70 lbs.

Computer and Control Unit are as described for stationary system.

SOURCE

Lear Siegler, Inc., 74 Inverness Drive East, Engelwood, Colorado 80110.

ARGOS II SUSPENDED PARTICULATE MONITOR
 (Lear-Siegler)

DESCRIPTION

This instrument uses the same measurement technique as the Argos I Stack Monitor.

APPLICATIONS

The Argos II is well-adapted to monitoring ambient air in the vicinity of industrial plants. The Argos II can be set up to provide adjustable full-scale measurement from 100 µg/m³ to 100 mg/m³.

SPECIFICATIONS FOR PARTICULATE AND GAS FLOW MEASUREMENT UNIT

Dimensions: 28" W x 16" H x 17" D
 Weight: 70 lbs.

SPECIFICATIONS FOR COMPUTER AND CONTROL UNIT

Dimensions: 28" W x 16" H x 17" D
 Weight: 65 lbs.
 Electrical Requirements: 220 VAC, 60 Hz, 300 W
 (excluding sampling pump and sample line heaters)

SOURCE

Lear Siegler, Inc., 74 Inverness Drive East, Engelwood, Colorado 80110.

PW 9790 DUST MONITOR
(Philips Electronics Instruments)

DESCRIPTION

Particulates are collected on a filter tape over sampling periods ranging from 10 seconds to 14 hours. The mass of the dust deposited on the tape is determined by comparing the beta-radiation absorption of the sampled area with that of the clean tape.

The basic monitor consists of a measurement unit, a control unit and a pump. Particle separators PW 9737/00 and PW 9738/00 are available as options, and remove non-respirable particles before they reach the filter.

APPLICATIONS

The Dust Monitor is designed to measure ambient concentrations of atmospheric dust.

SOURCE

Philips Electronic Instruments, 750 S. Fulton Avenue, Mt. Vernon, New York 10550.

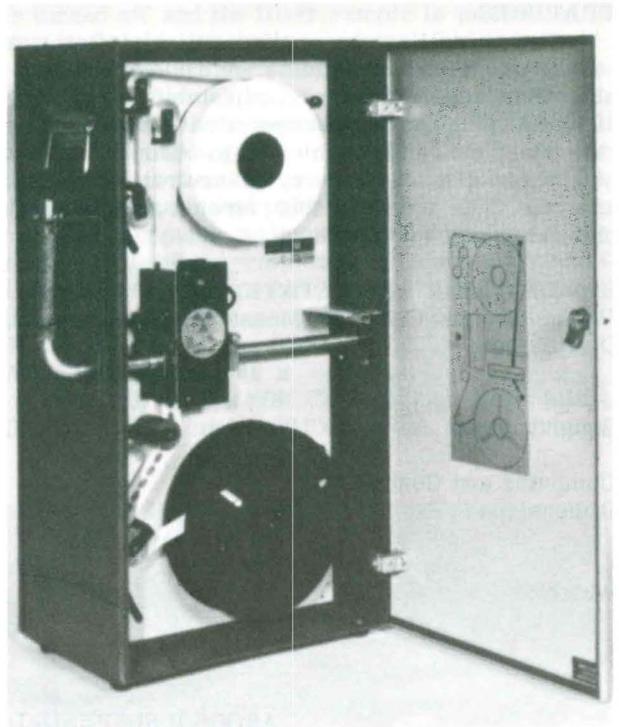


Fig. M-35. Philips PW 9790 Dust Monitor.

AIR SAMPLING INSTRUMENTS

For Evaluation of Atmospheric Contaminants

Fifth Edition



AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

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