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Respirable Mine Dust Sample-Processing Laboratory

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ILLUSTRATIONS

RESPIRABLE MINE DUST SAMPLE-PROCESSING LABORATORY

by

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ABSTRACT

The Federal Coal Mine Health and Safety Act of 1969 established mandatory dust standards for coal mines. Sampling procedures prescribed in the Mandatory Health Standards, Title 30, Code of Federal Regulations, Part 70 and Part 71, were published in the Federal Register on April 3, 1970, and March 28, 1972, respectively. A laboratory was established in the then Pittsburgh Field Health Group of the Bureau of Mines to process the coal mine dust samples collected by the mine operators. This paper describes the laboratory, located at the Mining Enforcement and Safety Administration's (MESA) Pittsburgh Technical Support Center, and the equipment and procedures used by MESA's Dust Branch in processing these samples.

INTRODUCTION

As specified in section 202(a) of Title II of the Federal Coal Mine Health and Safety Act of 1969, each operator of a coal mine shall take accurate samples of the amount of respirable dust in the mine atmosphere. To enable the operator to fulfill his obligation, detailed instructions pertaining to dust sampling procedures are prescribed in the Mandatory Health Standards--Underground Coal Mines, and in the Mandatory Health Standards--Surface Work Areas of Underground Coal Mines and Surface Coal Mines, Title 30, Code of Federal Regulations, Parts 70 and 71, respectively.

Section 202(b) of Title II establishes allowable limits of dustiness. Dustiness means the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of the mine is exposed. Effective December 30, 1972, the standard became 2.0 milligrams of dust per cubic meter of air, except where an operator had obtained a permit for noncompliance. The limit of dustiness allowable under a noncompliance permit was not to exceed 3.0 milligrams of dust per cubic meter of air. Permits for noncompliance terminated December 30, 1975.

As stated in the regulations, samples of respirable dust shall be taken from each working section of an underground coal mine. The requirements as to

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the number of samples and the frequency and the location of sampling are given in the relevant sections of the mandatory health standards (30 CFR, Part 70).

In addition to the samples of respirable dust from each working section, the mine operators are required to sample as follows:

1. Every 120 days, or three times a year, for each miner employed in coal-producing sections.

MINE DATA CARD

CASSETTE NO. 40249991

INITIAL WT. _____

MINE ID NO. _____

FINAL WT. _____

SECTION ID NO. _____

SAMPLING TIME (MIN.) _____

MINER'S SSA NO. _____

OCCUPATION _____ **TONS THIS SHIFT** _____

TYPE OF SAMPLE

HIGH RISK _____ **INTAKE AIR** _____

NON-HIGH RISK:

FACE _____ **NON-FACE** _____ **203(B)(1)** _____

FACE VENTILATION

EXHAUST _____ **BLOWING** _____

AUXILIARY _____ **BRATTICE** _____

TYPE OF MINING

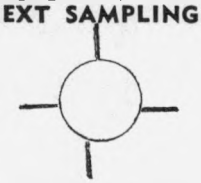
DEVELOPMENT _____ **RETREAT** _____

METHOD OF MINING

CONTINUOUS _____ **CONVENTIONAL** _____

LONGWALL _____ **OTHER** _____

_____ **CHECK IF SECTION WILL CLOSE BEFORE NEXT SAMPLING CYCLE.**



SIGNATURE:

(MINER SAMPLED) _____

(MINE OFFICIAL) _____

DATE _____ 995836

FIGURE 1. - Mine data card.

2. Every 180 days, or twice a year, for each miner employed in non-coal-producing areas.

3. Every 90 days, or four times a year, for each miner who has exercised his option of transfer under Section 203(b) of the Act; that is, transferring to a less dusty area of the mine because of evidence of the development of pneumoconiosis.

Mandatory health standards (30 CFR, Part 71), pertaining to surface work areas of underground coal mines and surface coal mines, became effective June 26, 1972. These regulations require samples to be collected on each miner employed in a surface installation or at a surface worksite on an annual or semiannual basis. The sampling cycle is dependent on the dust concentration measured; at or below 1.0 mg/m^3 the cycle is annually, greater than 1 but less than or equal to 2.0 mg/m^3 it is semiannually.

All mine operator samples are processed in a central laboratory. At present the average number of samples processed per day

is 2,500 or approximately 500,000 samples per year. In accordance with the requirements of 30 CFR, Part 70 and Part 71, the mine operator, at the conclusion of each production shift, transmits the collected sample (or samples) along with a mine data card to the central processing laboratory at the following address:

Pittsburgh Technical Support Center
Dust Branch
MESA
4800 Forbes Avenue
Pittsburgh, Pa. 15213

The mine data card (fig. 1) is supplied by the manufacturer of the samplers. A cassette number and the initial weight of the filter capsule are premarked on the data card. Specific data noted on the card shall be inserted by the representative of the mining company responsible for the dust sampling procedure.

Upon receipt of respirable dust samples by MESA, each sample is processed and the specific data on the card is recorded. The data are then transmitted to an automatic data processing center, and computed results are returned to the operator through MESA's Coal Mine Health and Safety District or Subdistrict Offices. A flowchart of the mine dust monitoring system is shown in figure 2.

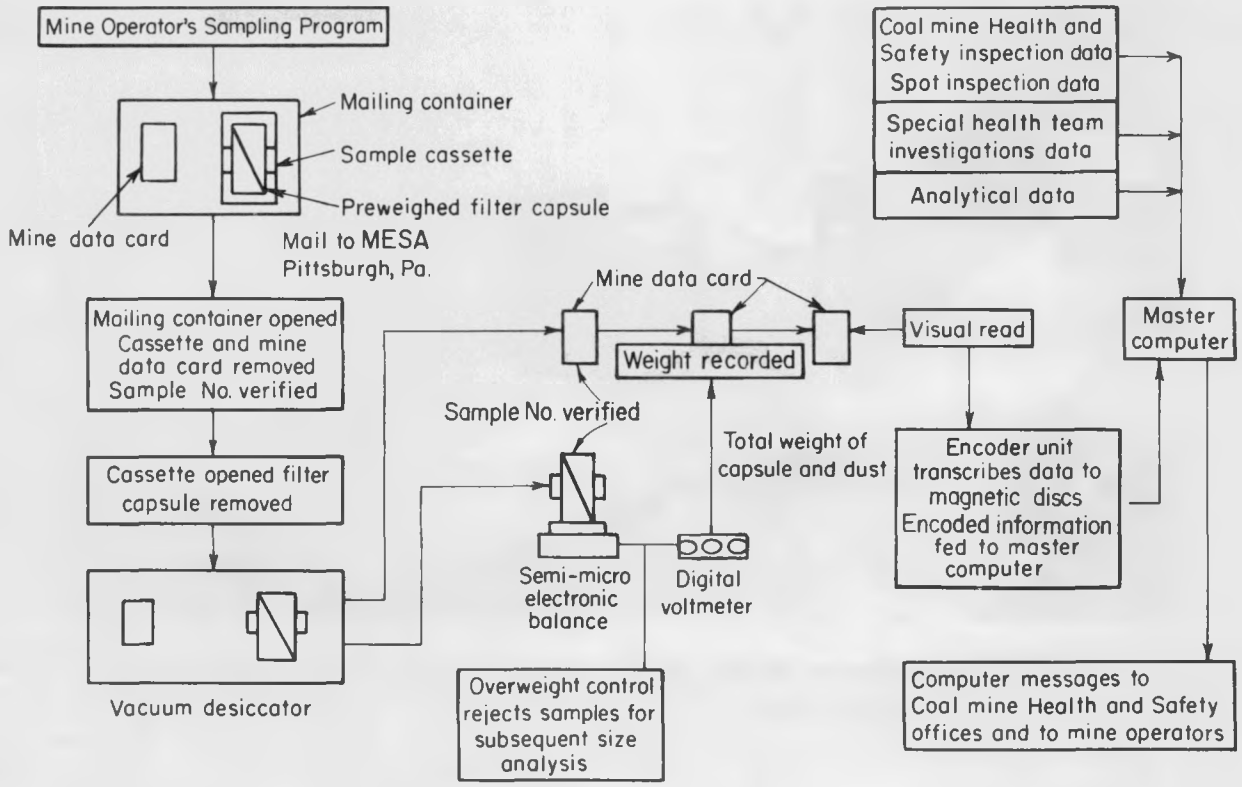


FIGURE 2. - Mine dust monitoring system.

SAMPLE PROCESSING LABORATORY

All coal mine operator dust samples are processed in a "clean room" environment. The laboratory is a restricted area, off limits to other than authorized personnel working therein.

The laboratory is maintained at a slight positive pressure to limit the entry of extraneous dust from the surrounding work areas. The environment in the weighing room is maintained at 74°±1° F and 50 percent ±5 percent relative humidity. Ventilation in the weighing room is controlled to prevent air currents from passing over the weighing balances, thereby affecting their operation. Under these conditions optimum performance of the electronic weighing system is achieved and maintained.

Equipment

The equipment used in the laboratory for processing the coal mine operators' respirable dust samples is as follows.

FIGURE 3. - Electronic semiautomatic balance with digital voltmeter readout (Mettler HE20).

Balance System

Mettler HE20 balances[2] as depicted in figure 3 are used for weighing the filter capsules. These are semimicro electronic analytical balances with electronic digital readout displays which provide a direct visual weight indication. The balances have a weighing precision of ±0.05 mg. Balances are checked daily with Class M[3] certified calibrated weights. To isolate the balances from vibrations, they are positioned on marble tables weighing approximately 700 pounds.

Each balance chamber contains a Nuclear Products Co. model 2-U-500 radioactive ionizing unit. This unit will dissipate any static charges which might have accumulated on the filter capsules. Static charges can cause erroneous weight determinations.

Data Encoders

There are six IBM series 3700 data entry stations in the data recording room. Data are recorded onto diskettes, which are flexible magnetic disk cartridges, via the equipment. One station (fig. 4) has "intelligence" for

FIGURE 4. - Data entry station with editing capability.

[2]Reference to specific trade names is made for identification only and does not imply endorsement by the Mining Enforcement and Safety Administration.

[3]Class M certified calibrated weights possess the lowest tolerance allowances under National Bureau of Standards specifications.

editing processed data for completeness and accuracy, and also has the capacity to compile or accumulate data from any number of diskettes onto one diskette. Another station has communication capability whereby information compiled on a diskette is transferred via a data phone access arrangement to MESA's Division of ADP in Denver, Colo.

Vacuum Chambers

Two Webber model F-3-AV vacuum chambers (fig. 5) are used in the laboratory for desiccating (moisture removal) the filter capsules. These units each hold two trays of filter capsules, each tray containing 100 units. After loading, the internal pressure of the chamber is reduced to and maintained at 5 mm of mercury for 15 minutes. This is sufficient to evaporate any moisture adsorbed on the dust layer within the filter capsule.

Trays

Two types of trays are used for holding, transporting, and storing the samples. One type is a flat tray on which the cassettes and data cards are

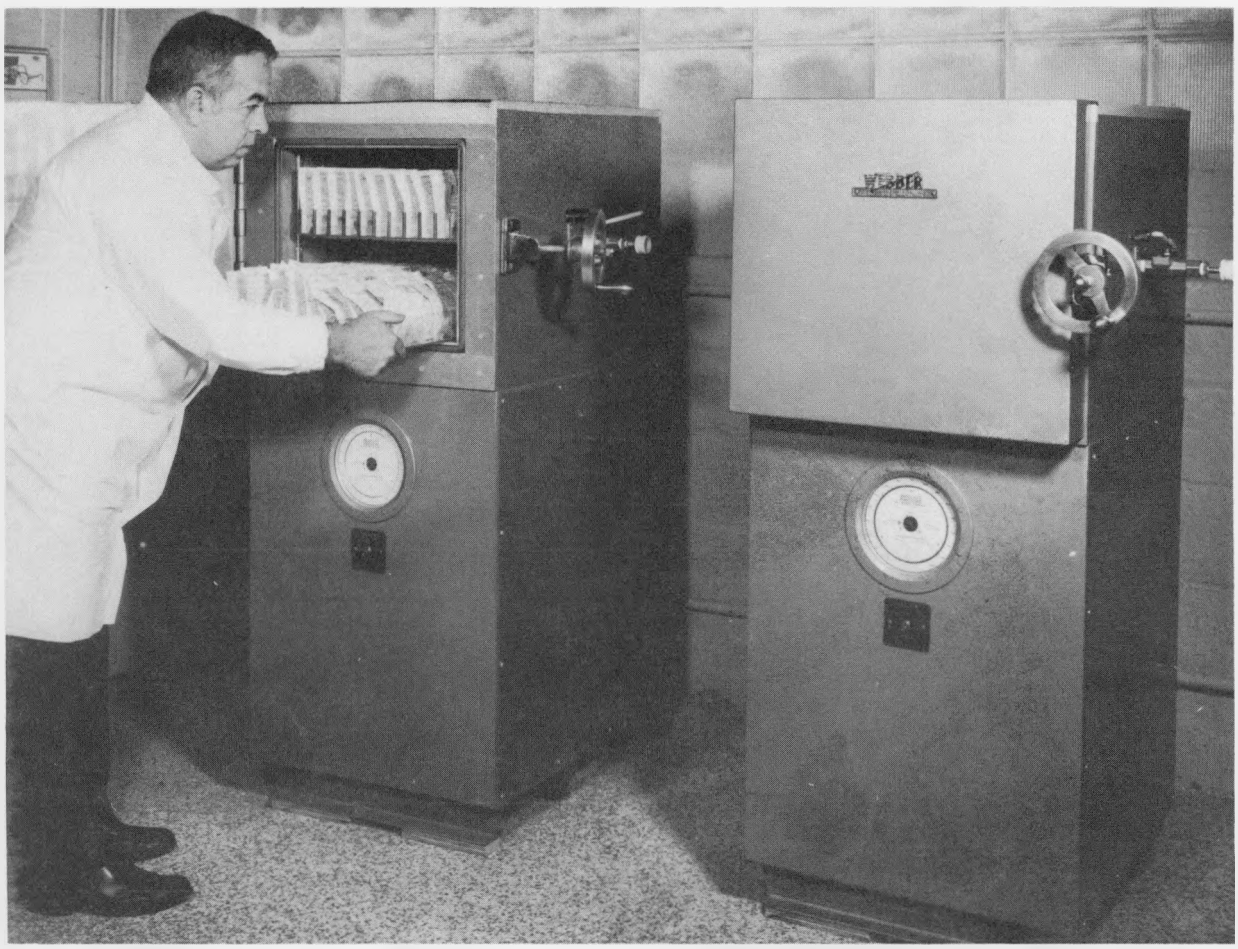


FIGURE 5. - Vacuum desiccation chambers.

placed; the other is a tray having 100 compartments with slots to hold the mine data cards. This tray is used to hold the data cards and the filter capsules after they are removed from their protective cassettes.

Forceps

Filter capsules are never touched with the hands. Once the cassette is opened, the capsules are handled only with forceps to prevent contamination. The forceps used in the laboratory have hard plastic tips to prevent slipping or scraping which could occur with metal-tipped forceps.

Processing of Samples

Samples are processed in four stages: receiving, preparation, weighing, and data recording.

Receiving

Each morning, mail bags containing respirable mine dust samples submitted by the coal mine operators are received at the laboratory. After the individual mailers containing the samples are opened and the cassettes and accompanying data cards are removed, the identification number on the cassette and on the data card are visually verified to insure that they are identical. Since the manufacturer's designated initial weight is specific for each cassette, mismatched units cannot be processed. After each unit has been removed from the mailer and verified, the back of the mine data card is stamped with the receiving date. The units are then placed with their corresponding data cards on flat trays as shown in figure 6. These are then taken to the preparation area of the laboratory.

Preparation

In the preparation room, the filter capsules containing the dust are removed from their cassettes in the following manner:

1. The filter capsules used with approved Bendix personal samplers are removed from their cassettes by breaking the two sealing lugs, removing the cover, and gently prying the capsule from the base.

2. The capsules used with the approved Mine Safety Appliances Co. personal samplers are removed from their cassettes by stripping off the plastic sealing band and prying open the cassette.

3. The capsules used with the Willson/Casella approved personal sampler are removed from their cassettes by stripping off the plastic sealing band, removing the inlet portal plug, and popping open the cassette.

4. The capsules used with the MRE samplers are removed from their cassettes by prying open the cassettes.

FIGURE 6. - Initial processing and marking of respirable coal mine dust samples.

After the capsules are removed, they are placed along with their data cards in compartment trays as shown in figure 7. The mine data card is placed in the slot on the tray behind each capsule compartment, and the identification numbers on the sample and data card are again visually verified for correlation. When the trays are filled, they are desiccated and then transferred to the weighing room.

Weighing

In the weighing room, a tray containing samples is placed on a table adjacent to each balance system. The capsules are weighed on the previously described balances. A radioactive ionizing unit located in the balance chamber eliminates any static charges which might be present on the capsule. The balance systems, which are checked daily with calibrated weights, give a visual display of the determined weight. The zero of the balance is checked by the operator after every five weighings or less to insure the required precision in weighing. The weighing operation is shown in figure 8. Using forceps, the operator places the capsule on the weighing pan after passing it over the ionizing unit. When the balance reaches a steady-state condition, the weight (to a tenth of a milligram [0.1]) shown on the digital display is recorded on the data card in the position designated "final weight." The

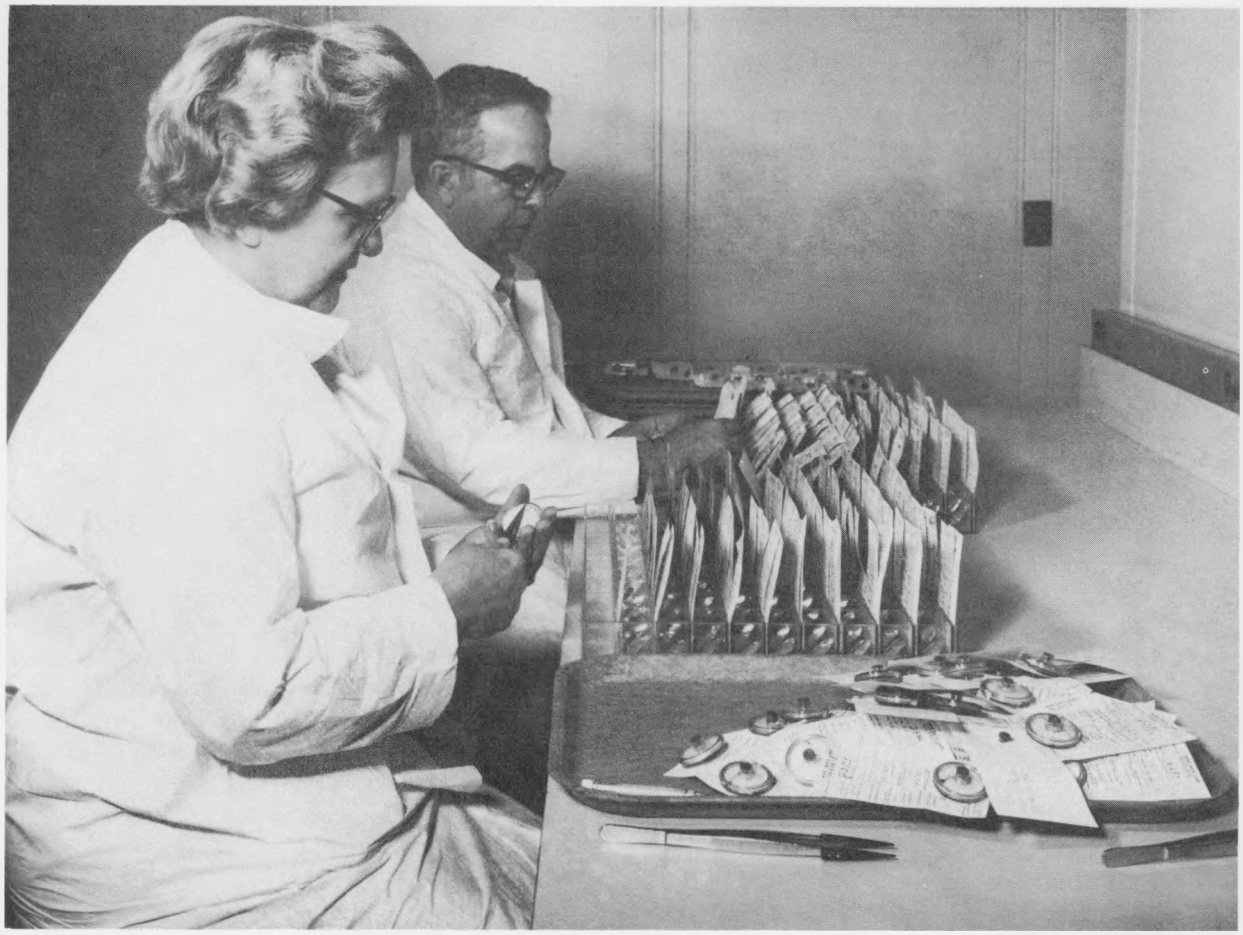


FIGURE 7. - Removal of filter capsules and filling of compartment trays.

weigher initials the card and replaces the capsules in the tray, for a later weight verification.

Once a tray of capsules has been weighed, the tray and the associated data cards are checked by a person responsible for a quality control program. Eight of the 100 capsules are randomly selected and their recorded weights are verified. If any one of the eight units deviates by more than ±0.1 mg from the weight recorded on the data card, the entire tray of 100 capsules is reweighed by the person who originally weighed the capsules. The cards of the samples verified are initialed and the notation "checked" is placed in the lower area of the card.

Personnel conducting the weighing operation set aside all samples containing 6 milligrams or more of dust and any questionable samples. These samples are transported to a location in the laboratory where they are opened for examination in accordance with the procedure given in Standard Method A4, Dust Group, Pittsburgh Technical Support Center (fig. 9). This involves scanning

FIGURE 8. - Weighing operation in controlled atmosphere room of laboratory.

FIGURE 9. - Microscopic examination of filter capsules.

the filter surface for evidence of particles having diameters greater than 10 microns, or for evidence of other contamination.

Contaminated samples have filters whose collection surface contains deposits of dust particles of nonrespirable size. This may be produced in the mine operator's sampling program by the dumping of the cyclone grit pot, faulty sampler operation, or deliberate contamination.

Briefly, the procedure used to determine whether oversized particles are present is as follows:

1. Open capsule to expose dust-laden filter surface.

2. Observe filter surface under illumination with the light source at an angle of 45° to the specimen; large dust particles will generally show shiny surfaces. If large particles are present the data card is marked with a void code.

3. If visual inspection is not conclusive, the sample is placed on the stage of a stereomicroscope having a magnification of 100X. The microscope eyepiece contains a Whipple disk which has been calibrated with a stage micrometer. After focusing on the dust, the filter is traversed and observed for particles having sizes greater than 10 microns. If 30 or more oversize particles are evident in 10 fields of 0.25 mm^2 each, the sample is invalid and the data card is marked with a void code.

Data Recording

Data recording comprises the last stage in processing the coal mine operators' respirable dust samples (fig. 10). In this stage, the information on the data card is transcribed onto magnetic disks using data encoder units. The information on each card encompasses 58 entries and is transcribed in numeric notation. All data entered onto the magnetic disks are verified. To verify, the data is retranscribed onto the disk by another operator who checks what has been entered. All disks generated during the day are then machine-edited for completeness and accuracy and the data is accumulated onto one diskette. Every evening the day's work is telecommunicated to MESA's Automatic Data Processing Center in Denver, Colo., by means of a data-telecommunications system. The source data cards are then mailed to Denver, where they are then microfilmed for recall when needed.

FIGURE 10. - Data recording operation.

DENVER AUTOMATIC DATA PROCESSING (ADP) CENTER

The information telecommunicated to MESA's ADP Center in Denver, Colo., is put on a Burroughs 5500 computer. The computer stores the data and calculates the dust concentration from the telecommunicated information. For a sample collected with a personal sampler the equation is as follows:

$$\text{Dust concentration } (mg/m^3) = \frac{\text{final weight (mg)} - \text{initial weight (mg)}}{\text{sampling time (min)} \times \text{rate of sampling } (m^3/min)} \times 1.38,$$

where 1.38 is the conversion factor necessary to convert the dust concentration obtained with a personal sampler equipped with a pulsation damper to an equivalent MRE concentration.

When a particular mine section data file has been updated, a paper tape is generated by the computer and then forwarded to the Communications Section of the Division of Automatic Data Processing. The paper tape is read into a teletype ASR-35 machine, and messages of noncompliance or abatement of a violation are transmitted to the respective MESA Coal Mine Health and Safety District or Subdistrict Offices. These messages can be sent at any time, day or night, to the respective field offices. They are then distributed to the mine operator. Other messages of information, such as compliance notices and

void sample notification, are printed directly on data mailers by the computer and are forwarded to both the mine operator and the appropriate MESA office.

QUALITY CONTROL

Title 30, Code of Federal Regulations, Part 74.3(b)(2)(ii), states that the filter capsule shall be preweighed by the manufacturer with a precision of ±0.1 milligram. To insure maintenance of this precision in weighing, the Dust Branch check-weighs 10 randomly chosen cassettes from each production shift on which cassettes are produced by the manufacturer. Prior to check-weighing the capsules are heated at an elevated temperature of 120° F for 16 hours. Following this heat treatment, the capsules are allowed to stabilize in the weighing room's controlled environment for 4 hours before weighing. If the weight of any one unit falls outside the specified limits, that is, greater than ±0.1 mg, the manufacturer is notified to reweigh all cassettes produced during that production shift.

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