

Coal Mine Dust Sample Processing

by

Lewis D. Raymond

Informational Report Number 1249

Mine Safety and Health Administration

United States Department of Labor

May 1998

CONTENTS

| | |
|---|----|
| Abstract. | 1 |
| Introduction. | 2 |
| Operator Dust Sampling Program. | 2 |
| Filter Cassette | 4 |
| Transmittal of Samples. | 7 |
| Laboratory Facility | 7 |
| Sample Processing Procedure | 9 |
| Weighing of Samples | 13 |
| Abnormal Samples. | 18 |
| Data Processing | 19 |
| Quality Control Programs. | 19 |
| Epilogue. | 23 |

ILLUSTRATIONS

| | |
|--|----|
| 1. MSA Respirable Dust Cassette. | 5 |
| 2. Dust Data Card. | 6 |
| 3. Balance for Manual Weighing and Environmental Recorders | 8 |
| 4. Removing Sealing Tape From Cassette | 11 |
| 5. Loading of Robotic Weighing Tray. | 12 |
| 6. Robotic Weighing System | 14 |
| 7. Robotic Arm Grasping a Sample | 15 |
| 8. Turntable with Robotic Weighing Trays | 16 |
| 9. Quality Control Chart for Weight Difference | 20 |
| 10. Quality Control Chart for Standard Deviation. | 21 |

TABLES

| | |
|--|----|
| 1. Void Codes for Respirable Dust Samples. | 10 |
|--|----|

COAL MINE DUST SAMPLE PROCESSING

by

Lewis D. Raymond¹

ABSTRACT

Mandatory dust standards for coal mines were established with the enactment of the Federal Coal Mine Health and Safety Act of 1969 and were continued under the Federal Mine Safety and Health Act of 1977. Regulatory requirements for complying with the Act are published in Title 30 of the Code of Federal Regulations, Parts 70, 71 and 90. These standards and sampling requirements, along with a description of the laboratory which was established to process respirable coal mine dust samples, were described in a 1976 publication, MESA Informational Report 1045². After significant changes to these regulations were made in 1980, another report, MSHA Informational Report 1156³, was issued describing the regulatory changes and describing the updated equipment used to automate the sample processing facility. This paper describes further changes in the equipment and procedures used by MSHA to maintain a state-of-the-art facility for processing respirable coal mine dust samples in accordance with regulatory requirements.

¹Chief, Weighing Branch, Dust Division, Pittsburgh Safety and Health Technology Center.

²Parobeck, Paul S. Respirable Mine Dust Sample Processing Laboratory. MESA IR 1045, 1976, 13 pp.

³Raymond, Lewis D., Tomb, T. F. and Parobeck, P. S. Respirable Coal Mine Dust Sample Processing. MSHA IR 1156, 1987, 23 pp.

INTRODUCTION

Each operator of a coal mine is required to take accurate samples of the amount of respirable dust in the mine atmosphere as specified in Section 202(a) of Title II of the Federal Coal Mine Health and Safety Act of 1969⁴ (later amended to the Federal Mine Safety and Health Act of 1977). To enable the operator to fulfill his obligation, detailed instructions pertaining to dust sampling procedures are prescribed in three parts of Title 30 of the Code of Federal Regulations⁵. Part 70 of these regulations gives Mandatory Health Standards for Underground Coal Mines, Part 71 gives Mandatory Health Standards for Surface Work Areas of Underground Coal Mines and Surface Coal Mines and Part 90 gives Mandatory Health Standards for Coal Miners who have evidence of the Development of Coal Workers' Pneumoconiosis.

Section 202(b) of Title II of the Act established the standard for the dust exposures in coal mines. This set the allowable limit for the average concentration of respirable dust in the mine atmosphere. Effective December 30, 1972, the allowable limit became 2.0 milligrams of dust per cubic meter of air, provided that the quartz content of the respirable dust does not exceed five percent. If the quartz concentration exceeds five percent, the allowable dust level is reduced to a value determined by dividing the number 10 by the percent quartz.

OPERATOR DUST SAMPLING PROGRAM

Under present regulations, mine operators may be required to collect the following different types of samples:

1. Designated Occupation samples (underground)
2. Designated Area samples (underground)
3. Designated Work Position samples (surface)
4. Part 90 Miner samples (underground or surface)
5. Citation or Abatement samples (underground or surface)

A Designated Occupation (DO) sample is collected on that occupation on a mechanized mining unit (MMU) that has been determined, by results of respirable dust samples, to have the highest respirable dust exposure. Five valid respirable dust samples are required to be collected from the DO in each MMU during each bimonthly period. Collection of the five samples may begin at any time during the period, however once sampling has started the samples must be collected on consecutive normal

⁴U. S. Congress. Federal Coal Mine Health and Safety Act of 1969. Public Law 91-173. December 30, 1969, 83 Stat. 742.

⁵U. S. Code of Federal Regulations. Title 30--Mineral Resources; Chapter I--Mine Safety and Health Administration, Department of Labor.

production shifts or normal production shifts each of which is worked on consecutive days. The bimonthly periods in which DO samples are required to be collected are:

January 1 - February 28 (29)
 March 1 - April 30
 May 1 - June 30
 July 1 - August 31
 September 1 - October 31
 November 1 - December 31

The average respirable dust concentration determined from these samples is used to determine compliance with the applicable standard.

A Designated Area (DA) sample is a respirable dust sample collected in an area of a mine that has been identified by the operator in the mine's Ventilation Plan and approved by the District Manager. The District Manager may also designate that samples be collected in other areas. These are also DA samples. One sample is required to be collected from each DA on a production shift during each bimonthly period. The bimonthly periods during which DA samples are collected are:

February 1 - March 31
 April 1 - May 31
 June 1 - July 31
 August 1 - September 30
 October 1 - November 30
 December 1 - January 31

If a bimonthly DA sample exceeds the applicable standard, five additional samples are required to be collected on consecutive production shifts or on production shifts on consecutive days. The average respirable dust concentration determined from these five samples is used to determine compliance with the applicable standard.

A Designated Work Position (DWP) sample is a respirable dust sample collected at a surface mining operation or at a surface facility of an underground mine. The District Manager is responsible for designating the work positions to be sampled by the operator. One valid respirable dust sample is required to be collected from each DWP. The bimonthly periods during which these samples are collected are the same as for DAs. If a bimonthly DWP sample exceeds the applicable standard, five additional samples are required to be collected on consecutive production shifts or on production shifts on consecutive days. The average concentration of these five samples is used to determine compliance with the applicable standard.

Part 90 Miner samples are those respirable dust samples collected

on individuals who, based on medical examination, show evidence of the development of pneumoconiosis and who have exercised their right to work in an area of a mine where the average concentration of respirable dust is at or below 1.0 milligram per cubic meter of air. Part 90 Miners are required to be sampled (one sample) bimonthly. The bimonthly sampling periods for Part 90 Miners are the same as for DAs. If a bimonthly Part 90 Miner sample exceeds the applicable standard, five additional samples are required to be collected on consecutive production shifts or on production shifts on consecutive days. The average concentration of the five samples is used to determine compliance with the applicable standard.

Citation or abatement samples are respirable dust samples collected by the operator whenever the operator is cited for a violation of the applicable standard, based on either operator or MSHA sampling. When abatement samples are required, corrective action is first taken by the operator to lower the dust concentration and then samples are collected until five valid respirable dust samples are taken. If the mine operator fails to achieve compliance with the applicable standard within the abatement time in the citation, MSHA may extend the abatement period or may issue an order halting production until the condition causing the violation has been corrected.

Federal regulations require that all sampling devices used to collect respirable dust samples in coal mines be approved by MSHA and the National Institute for Occupational Safety and Health (NIOSH) in accordance with part 74 of 30 CFR. The sampling device consists of a pump unit and a sampling head assembly. A battery charger is also part of the sampling device if rechargeable batteries are used. The sampling head assembly consists of a cyclone and a filter cassette assembly. After completing sampling, the operator is required to transmit the filter cassette(s) to MSHA within 24 hours after the end of the sampling shift.

FILTER CASSETTE

Mine operators use commercially available, plastic, filter cassettes to collect respirable dust samples. The filter capsule contained inside each filter cassette (Figure 1) is preweighed by the manufacturer to the nearest 0.01 milligram (mg). Currently, the only manufacturer of the filter cassette is the Mine Safety Appliances Company (MSA)⁶. The cassette currently manufactured has several tamper-resistant design features which prevent reverse airflow through the cassette and prevent dust from falling through the inlet opening during an impact. The cassette

⁶ Reference to specific equipment, trade names or manufacturers does not imply endorsement by MSHA.

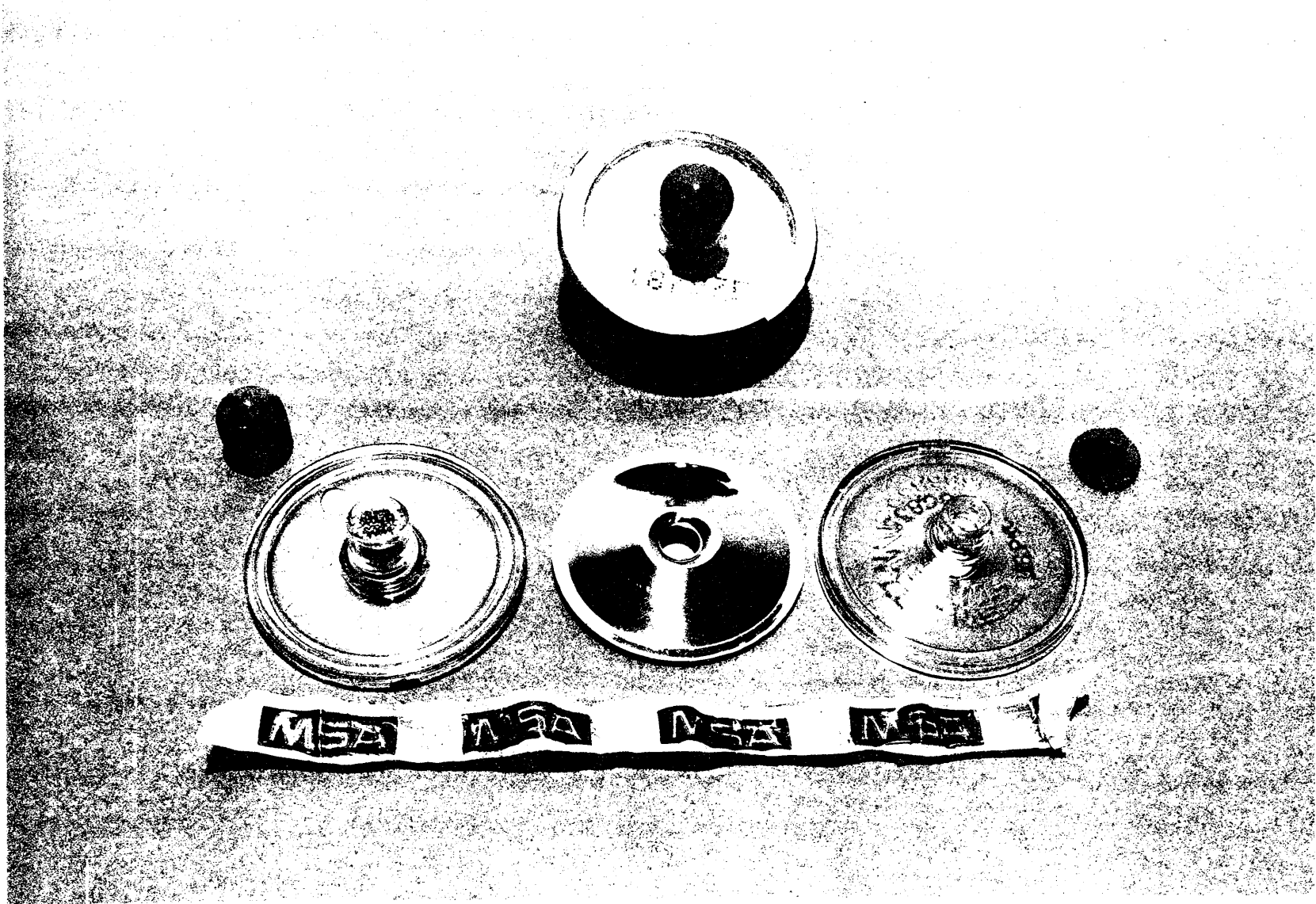


Figure 1. MSA Respirable Dust Sampling Cassette

Dust Data Card

1. Cassette Number

50 218617

2. Mine ID Number

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| | | | | | | | |
|--|--|--|--|--|--|--|--|

3. Contractor Code

| | | |
|--|--|--|
| | | |
|--|--|--|

4. Mine Name

5. Company Name

6. Date Sampled

| | | | | | |
|--|--|--|--|--|--|
| | | | | | |
|--|--|--|--|--|--|

Mo. Da. Yr.

7. Sampling Time

| | | |
|--|--|--|
| | | |
|--|--|--|

(min)

8. Tons This Shift

| | | | | | |
|--|--|--|--|--|--|
| | | | | | |
|--|--|--|--|--|--|

9. Type of Sample (select one)

- (1) designated occ (ug)
- (2) nondesignated occ (ug)
- (3) designated area (ug)
- (4) designated work position (sur)
- (5) part 90 miner

10. MMU DA/SA

| | | | |
|--|--|--|--|
| | | | |
|--|--|--|--|

11. Occ Code

| | | |
|--|--|--|
| | | |
|--|--|--|

12. Part 90 Miner Sampled

SSN

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| | | | | | | | |
|--|--|--|--|--|--|--|--|

13. Certified Person: NOTICE – Knowingly making any false statement, representation, or certification on this document is a violation of the federal criminal code which may be punished by a fine or by imprisonment or both.

Signature SSN

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| | | | | | | | |
|--|--|--|--|--|--|--|--|

X
Laboratory Analysis

Final Weight

Initial Weight

.39254 gram

| | | | | | |
|------------|----------------|--|--|--|--|
| Weighed By | OSP Checked By | Void Code | | | |
| | | <table border="1"><tr><td></td><td></td><td></td></tr></table> | | | |
| | | | | | |

Date Processed

AFTER SAMPLING, PLACE THIS COPY AND THE USED CASSETTE INTO THE SECURITY BAG PROVIDED.

Figure 2. Dust Data Card

is supplied with a security bag that can be used to provide added security for the sample subsequent to its collection and during shipment to MSHA.

A Dust Data Card (Figure 2) is supplied with each filter cassette. The card contains an identification number (cassette number) and the initial weight, in grams, of the filter capsule. Information relative to the specific mining operation at the time of sampling is filled in by a representative of the mining company who is certified by MSHA and is responsible for the dust sampling. The card includes a notice informing the user of the consequences of making false statements, representations and certifications on the card.

TRANSMITTAL OF SAMPLES

In accordance with the requirements of 30 CFR, Parts 70, 71 and 90, the mine operator, within 24 hours after the end of the sampling shift, transmits all samples along with the dust data cards to a central processing laboratory located at the following address:

Respirable Dust Processing Laboratory
Pittsburgh Safety and Health Technology Center
PO Box 18179
Cochran's Mill Road
Pittsburgh, Pennsylvania, 15236-0179

or to any other address designated by the District Manager.

Upon receipt at the central processing laboratory, each sample is analyzed gravimetrically and the specific data provided on the dust data card are recorded. The weight of dust collected on a filter is equal to the difference between the "final weight" of the filter capsule, as determined by MSHA in the laboratory, and the "initial weight" of the capsule, at the time of manufacture. Each day, the data are transmitted electronically to the Information Resource Center in Denver, Colorado, for overnight processing and determination of the dust concentration. The computed dust concentration of each sample is then sent to the mine operator and to the District/Subdistrict Office on a computerized "data mailer".

The following sections of this paper describe the central processing laboratory facility and the procedures used to process respirable dust samples and associated data.

LABORATORY FACILITY

The laboratory is divided into two main areas. One area is used to receive mail and prepare samples for weighing and also to transcribe and process data. The other area is reserved for

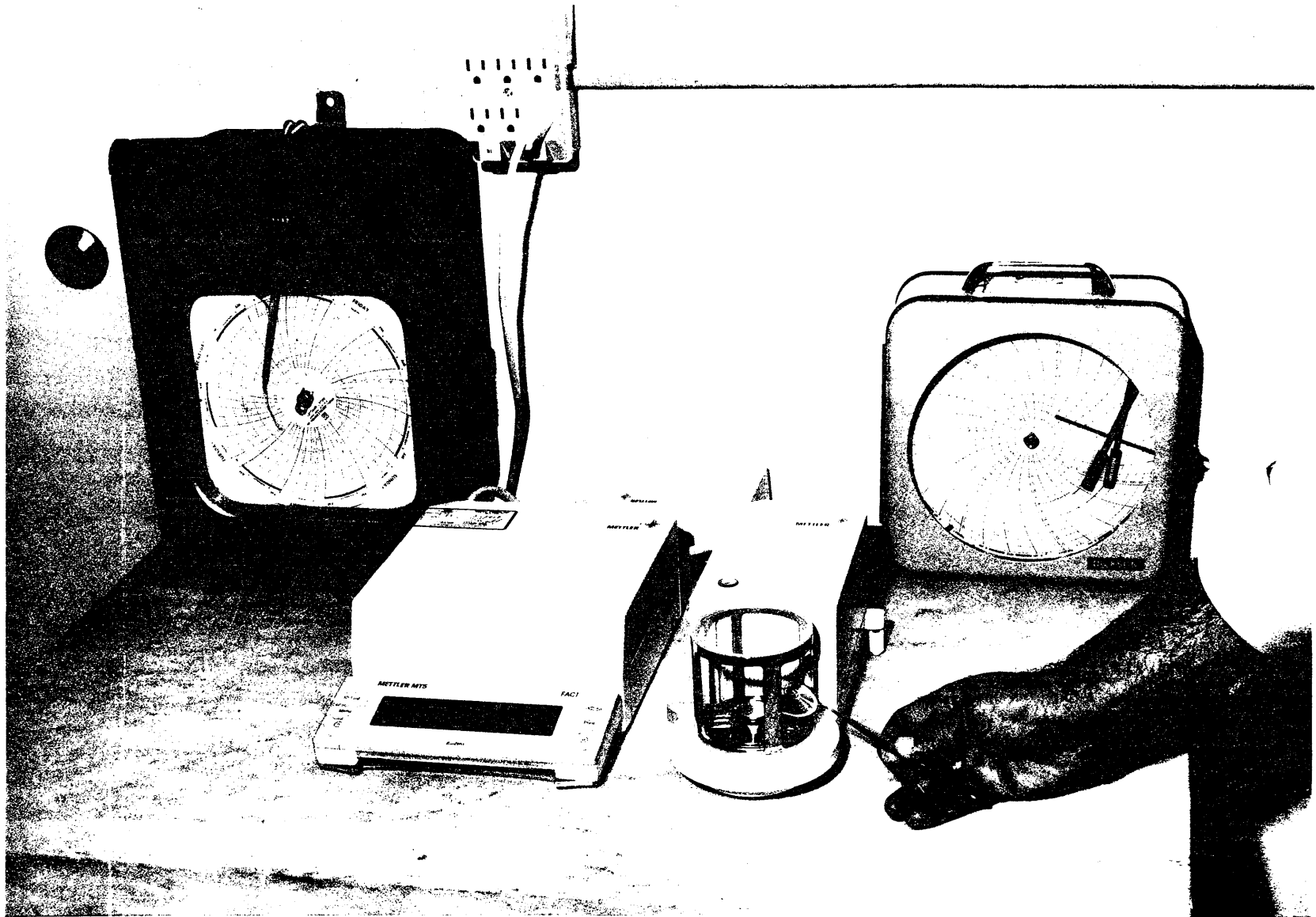


Figure 3. Balance for Manual Weighing and Environmental Recorders

weighing of dust samples. The weighing area is maintained at a temperature of $74^{\circ}\pm 2^{\circ}\text{F}$ and $50\%\pm 5\%$ relative humidity. The relative humidity, temperature and barometric pressure in the weighing area are continuously recorded on chart recorders (Figure 3). Ventilation in the weighing area is controlled to prevent the existence of strong air currents.

SAMPLE PROCESSING PROCEDURE

Samples are transmitted mainly through the U. S. Postal Service to the processing laboratory. A few companies submit samples through the many express parcel delivery services which are available. Samples are normally packaged and mailed in the mailing boxes supplied by the cassette manufacturer, however a few companies package multiple samples (from multiple MMUs or mine areas) in larger cardboard cartons or other containers. Upon receipt, packages are taken to the sample preparation area where the samples are removed from their mailing containers. After the samples are removed, the mailer is folded and passed through a slot in the cover of a trash receptacle to ensure that cassettes are not accidentally discarded. When a sample is shipped in a security bag, the cassette and data card are removed and the bag discarded. Once separated, the cassette and data card are then attached together by pushing the smaller red sealing plug into the hole provided on the data card.

As samples are being prepared for weighing, the identification number on the cassette and data card are checked to ensure that they match. If they do not match, the data card is marked with the void code "MIM" which indicates that a matching cassette was not received. In addition to verifying that the cassette number on the dust data card agrees with that on the cassette, samples and data cards are examined for other irregularities. Table 1 shows a list of void codes which may be used to void a sample because of an irregularity. The operator who submits the sample may make notations on the data card to indicate irregularities with the sample. These comments are reviewed and the samples are voided when appropriate.

After opening the mail, the cassettes and attached data cards are placed in a holding basket. The basket of samples is further prepared by removing the sealing tape from around the perimeter of the cassette (Figure 4). If the cassette seal has been damaged in any way, the sample is voided as contaminated (CON).

The filter capsule, contained inside the cassette shell, is the only part of the cassette that is weighed. The capsule is kept free of contamination and is never touched with the hands until after the weighing process is completed. To gain access to the filter capsule, the two halves of the cassette shell are pried apart using a knife or other sharp object. The capsule is then removed from the shell using forceps and placed in strict order

Table I. VOID CODES FOR RESPIRABLE DUST SAMPLES

| | |
|-----|--------------------------------------|
| ADB | Status is Abandoned |
| ANP | DA Not in Producing Status |
| ATR | Abnormal Tamper Resistant Cassette |
| AWC | Abnormal White Center |
| BRK | Broken |
| CNR | Cassette Not Received |
| CON | Contaminated |
| DBN | Dated Before Citation |
| DIS | Discarded Sample (too old) |
| DNP | DWP Not in Producing Status |
| DNR | Dust Data Card Not Received |
| DTE | Invalid or Missing Date |
| EXC | Excess Sample |
| HLD | Hold |
| IDO | Insufficient Dust Observed |
| IMI | Invalid Part 90 Miner |
| INW | Invalid Initial Weight |
| IVR | Inspector Void - Rain |
| IWG | Insufficient Weight Gain for Quartz |
| IWS | Invalid Work Shift |
| MFP | Malfunctioning Pump |
| MIM | Cassette Did Not Match Card |
| MMO | Mining Method-Occupation Mismatch |
| MNP | Mine Not in Producing Status |
| NDO | Nondesignated Occupation |
| NON | Nonapproved Equipment |
| NSS | Part 90 Miner Not in Sampling Status |
| OCC | Invalid Occupation Code |
| OSP | Oversize Particles |
| OVE | Operator Void - Equipment |
| OVL | Operator Void - Location |
| OVM | Operator Void - Miscellaneous |
| OVP | Operator Void - Production |
| OVR | Operator Void - Rain |
| OVT | Operator Void - Time |
| OVM | Operator Void - Miscellaneous |
| PDT | Predated |
| PRO | Invalid Production |
| QIT | Quartz Sample Improperly Taken |
| QLV | Quartz Lab Void |
| QNT | Unacceptable Time Frame |
| QPN | Invalid Certified Person Number |
| SAM | Invalid Sample Type |
| TME | Invalid or Missing Time |
| UNP | MMU Not in Producing Status |
| UWP | Unauthorized Work Position |
| WPE | Invalid Work Position |



Figure 4. Removing Sealing Tape From Cassette

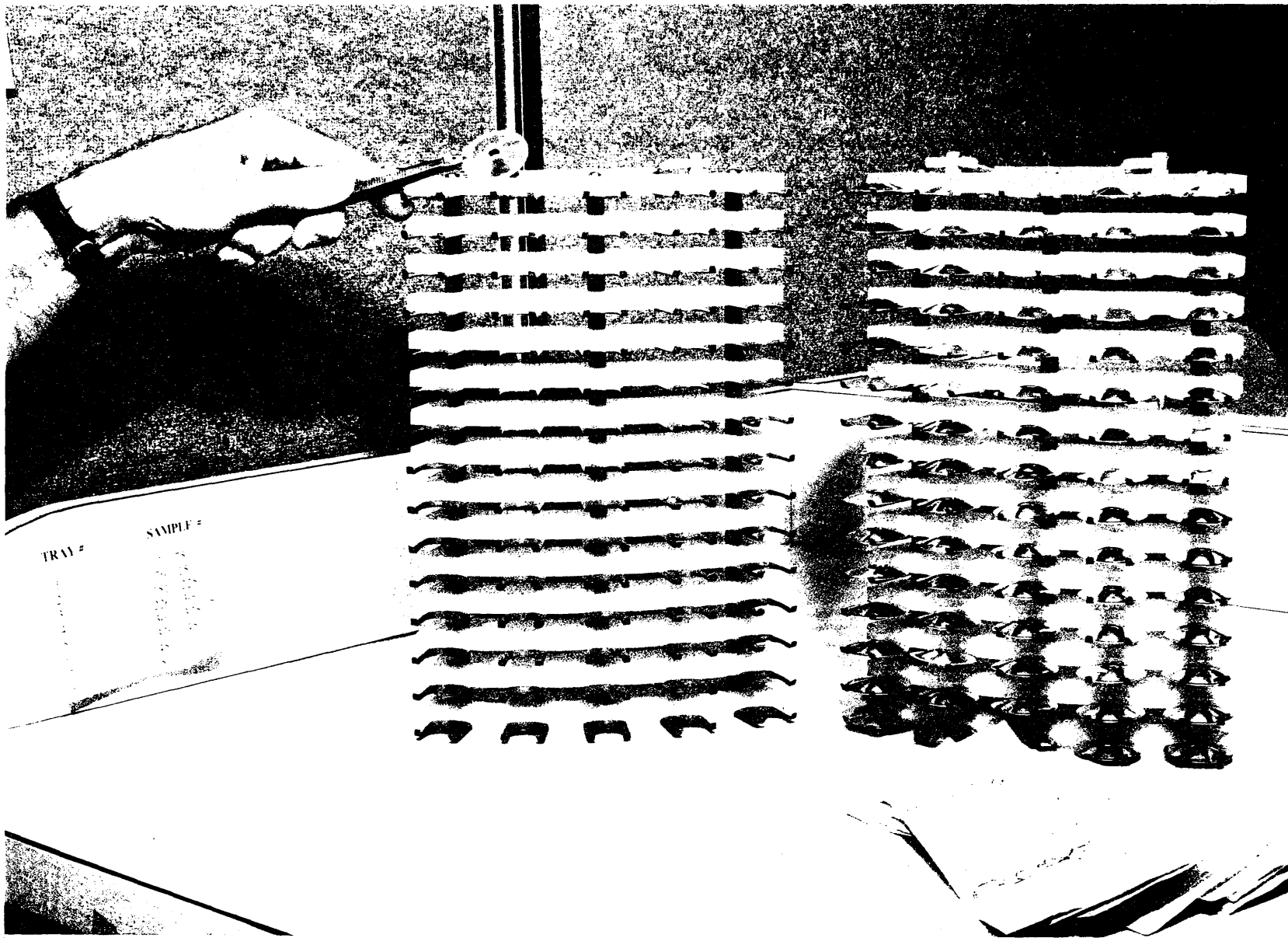


Figure 5. Loading of Robotic Weighing Tray

onto a weighing tray specially designed for use with an automated weighing system. The specially designed tray is shown on Figure 5. Each weighing tray holds up to 75 capsules. The data cards are sequentially maintained in the exact order in which the samples are placed on the weighing trays. The data cards are stamped with the processing date and are sequentially numbered automatically using a Rapidprint, Model ADN-E, electronic stamping machine. The number stamped on the data card corresponds to the position of that sample on the robotic weighing system.

Prior to weighing, the samples are desiccated to remove moisture which may be present on the samples. The samples are desiccated in a Webber, Model F-3-AV, vacuum chamber. Up to five trays holding a total of 375 samples can be placed in the chamber and desiccated at the same time. To desiccate the samples, the samples are placed inside the chamber, the door is closed and the absolute internal pressure is reduced to approximately 5 mm Hg and held at that pressure for 15 minutes. After 15 minutes, the pressure inside the chamber is slowly increased by bleeding air through a filtered vent in the chamber wall. When the inside pressure is equal to atmospheric pressure, the door is opened, the sample trays are removed, secured in a wheeled cart and taken into the weighing room where they are allowed to equilibrate to the controlled laboratory conditions before weighing.

WEIGHING OF SAMPLES

The final weight of each sample being processed is determined to the nearest 0.001 milligram using an Automated Weighing System (AWS). The AWS is composed of a Zymark, Zymate System, laboratory robot with a System V Controller, a sample turntable, two Mettler, Model MT5, microbalances, a printer and an IBM, Model AT, computer with a monitor. The system is self-calibrating and is capable of automatically weighing 600 filter capsules without manual intervention. An overview of the AWS is shown on Figure 6. The robotic arm which moves the filter capsules from the weighing tray to the balance is shown on Figure 7 and the turntable loaded with weighing trays is shown on Figure 8.

Two radioactive deionizing units, Polonium 210, 500 microcuries each, are placed in the weighing chamber of the laboratory balances to eliminate the presence of any static charges which may be present on a filter capsule. To isolate the balances from vibration, they are positioned on marble balance tables, each weighing approximately 300 kilograms.

The weighing system is programmed and controlled through a personal computer which is connected to the System V Controller. The System V Controller regulates movement of the central robotic arm, communicates with the balances and controls the rotation of



Figure 6. Robotic Weighing System

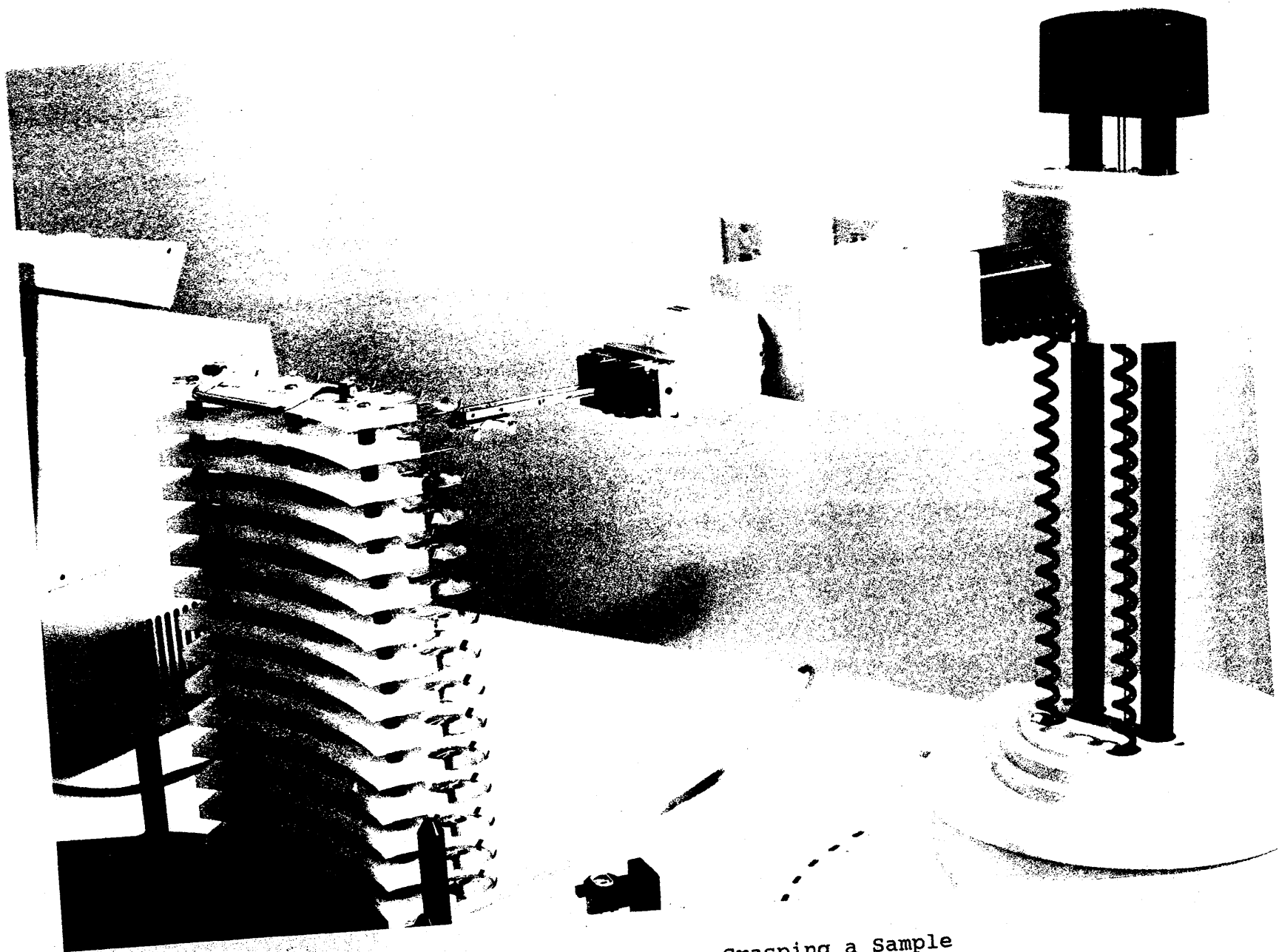


Figure 7. Robotic Arm Grasping a Sample

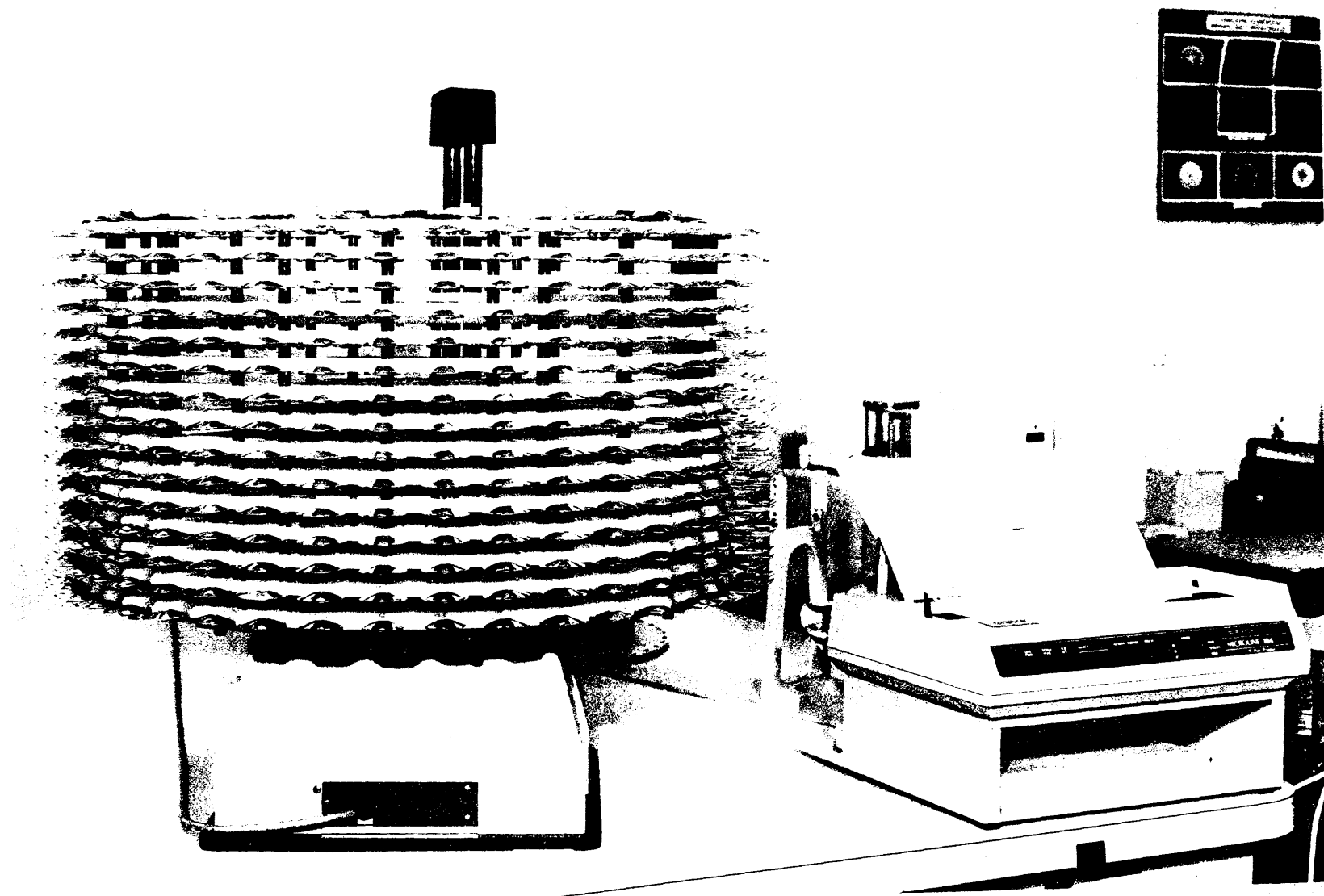


Figure 8. Turntable with Robotic Weighing Trays

the turntable. The system automatically checks the calibration status of the balance before weighing each capsule and initiates the balance calibration procedure if necessary. Each time the system recalibrates a balance, a computer file is updated to record the date, time, sequence number and file name for the capsule being weighed.

The automated weighing process is performed as follows. Weighing trays, previously loaded with desiccated samples, are placed onto positioning pegs around the sample turntable. The weighing program is selected on the computer screen and executed. As the weighing process continues, the sequence number and weight of each sample are stored on a floppy diskette.

For each batch of filter capsules to be weighed, the operator is prompted to enter program variables such as the date, starting position for the capsules on the turntable, and number of capsules to be weighed. After the variables are entered, the turntable rotates to bring the tray holding the first capsule in front of the robotic arm. Capsules are selected by the robotic arm in sequence from top to bottom of each column of 15 capsules. After a column of filter capsules is completed, the controller rotates the turntable to bring the next column of capsules into position.

In order to grasp the filter capsule to be weighed, two "fingers" on the hand of the robotic arm, are opened and lowered over the capsule. The fingers are closed to grip the capsule. The capsule is then lifted from the tray and placed over a reflecting light sensor to confirm that the capsule has been successfully removed from the weighing tray. If the sensor indicates that a capsule is not present in the hand, the arm will try once again to grasp the capsule. If the second attempt is not successful, the system will go on to the next capsule and write a message on the printer indicating the time, file name and sequence number of the capsule that was not weighed.

After the robot has retrieved a capsule from the weighing tray, the calibration of the balance is checked and the balance is calibrated if necessary. The arm then moves the capsule to a position in front of the balance and the balance is set to zero. The balance door is opened and the capsule is placed on the weighing pan. The balance door is then closed and the capsule is allowed to stabilize until a constant weight reading is obtained.

The length of time that the weight must remain stable is dependant on the balance configuration. The balances are configured with the maximum seven second stability time and minimal damping of the signal which is appropriate for a balance on a stable surface. The capsule weight and sequence number are recorded onto a floppy diskette. The filter capsule is removed from the balance and placed back onto the weighing tray. The

process is then repeated until all capsules are weighed. As a quality control check of the weights being obtained with the AWS, every twelfth capsule is weighed twice. The quality control check is performed by the AWS on a second Mettler, Model MT5, microbalance. This check weighing is done automatically as part of the weighing process. If the check weight of every twelfth capsule is not within ± 0.010 mg, the system recalibrates both balances and reweighs the previous 11 capsules. If a second check weighing of the twelfth capsule is still outside the ± 0.010 milligram limits, a message is printed to notify the AWS operator of the QC failure, and any problem with the system or the capsule being weighed is investigated and corrected.

After weighing of all capsules is completed, the controller signals the operator by sounding a buzzer. Any capsules listed on the printer as not being weighed are weighed manually and the weights are entered into the data file on the floppy disk using a text file editor. For manual weighing of capsules and for other quality control work, a third Mettler, Model MT5, balance is available in the weighing room. This third balance is configured for maximum precision in the same way as the two balances on the AWS. The microbalance used for manual weighing is shown on Figure 3.

ABNORMAL SAMPLES

Normal respirable coal mine dust samples contain very few particles which are greater than 10 micrometers in diameter. A sample may be considered invalid due to the presence of a sufficient number of particles greater than 10 micrometers in size. These large particles may come from accidental mishandling of the sampling head or from deliberate contamination. Samples having a weight gain greater than 1.4 milligrams are opened and examined visually for the presence of large dust particles, signs of water or other contamination. If necessary, a stereomicroscope is used to examine the filter surface. The samples are voided as contaminated (CON), when appropriate.

Samples not voided as CON which have a weight gain of 6.0 milligrams or more are examined for oversize particles (OSP) using a stereomicroscope at 100X. If 30 or more particles larger than 10 micrometers are found in ten 0.25 mm^2 fields, the sample is voided as OSP.

Samples weighing less than 0.100 milligram are opened and examined for evidence of sampling using a stereomicroscope at 100X. If fewer than 20 particles are found in four 1 mm^2 fields, the sample is voided as IDO (Insufficient Dust Observed).

All samples are opened and examined for other irregularities such as abnormal deposition patterns. When deemed necessary, samples

are voided with an appropriate void code, including AWC (Abnormal White Center) for older cassettes and ATR (Abnormal Tamper Resistant) for the newer tamper-resistant cassettes.

DATA PROCESSING

Each respirable dust sample is accompanied by a mine data card (Figure 2). The data on each card is manually transcribed into a computer file using a personal computer. The laboratory has four computers for data entry work which are connected by a local area network. These computers have custom designed data entry programs, created with Entrypoint 90 software, which are used in transcribing the data from the cards. Data transcription is verified by a second operator using a double entry system. The Entrypoint 90 program allows for edit checks to be made on the data as it is entered. Each day, after data entry for the entire batch of samples is completed, the data from the card is merged with the weight data obtained by the AWS. The data for the samples are then transmitted to a Honeywell, Model 66/80, main-frame computer at the Information Resource Center in Denver, Colorado. Each evening the Information Resource Center runs updates of the dust data files and generates messages for mine operators which are sent via the U. S. Postal Service on Data-Mailers. Computer messages concerning the sample results are also sent to MSHA District personnel.

QUALITY CONTROL PROGRAMS

In order to assure that the weighing process continues to produce reliable results with the passage of time, a program is maintained to provide information about the quality of the weighing operation on a continuing basis. This program⁷ was developed jointly by MSHA and the National Bureau of Standards (now called the National Institute of Standards). In brief, the program consists of weighing 10 filter capsules on two different days, by two different people (or the AWS), using two different balances. The statistical evaluation consists of calculating the average weight difference, "d", between the two weighings of each sample and calculating the standard deviation, "s", of these weight differences. Each week ten different samples are weighed by the AWS on one day and weighed again on another day by a laboratory technician using a manual balance. The ongoing results of the program are tabulated quarterly and are used to calculate quality control limits for the weighing process. If the "d" or "s" values for the current week are outside either of these limits, the weighing process is examined and results are

⁷P. Parobeck, T. Tomb, H. Ku, and J. Cameron. Measurement Assurance Program for Weighings of Respirable Coal Mine Dust Samples. Journal of Quality Technology, V. 13, No. 3, July 1981, pp. 157-165.

QUALITY CONTROL CHART

WEIGHING LABORATORY

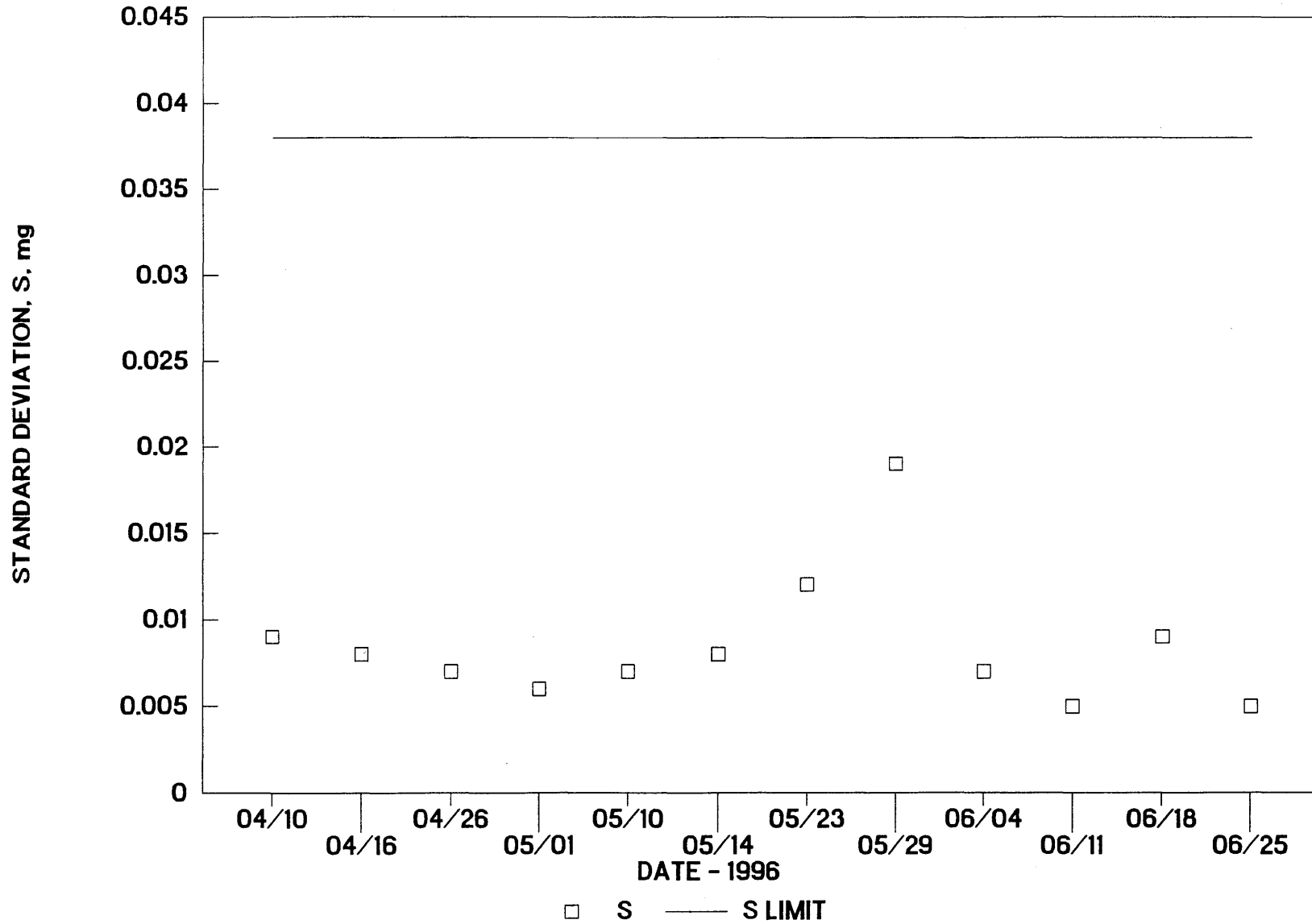


Figure 10. Quality Control Chart for Standard Deviation

QUALITY CONTROL CHART

WEIGHING LABORATORY

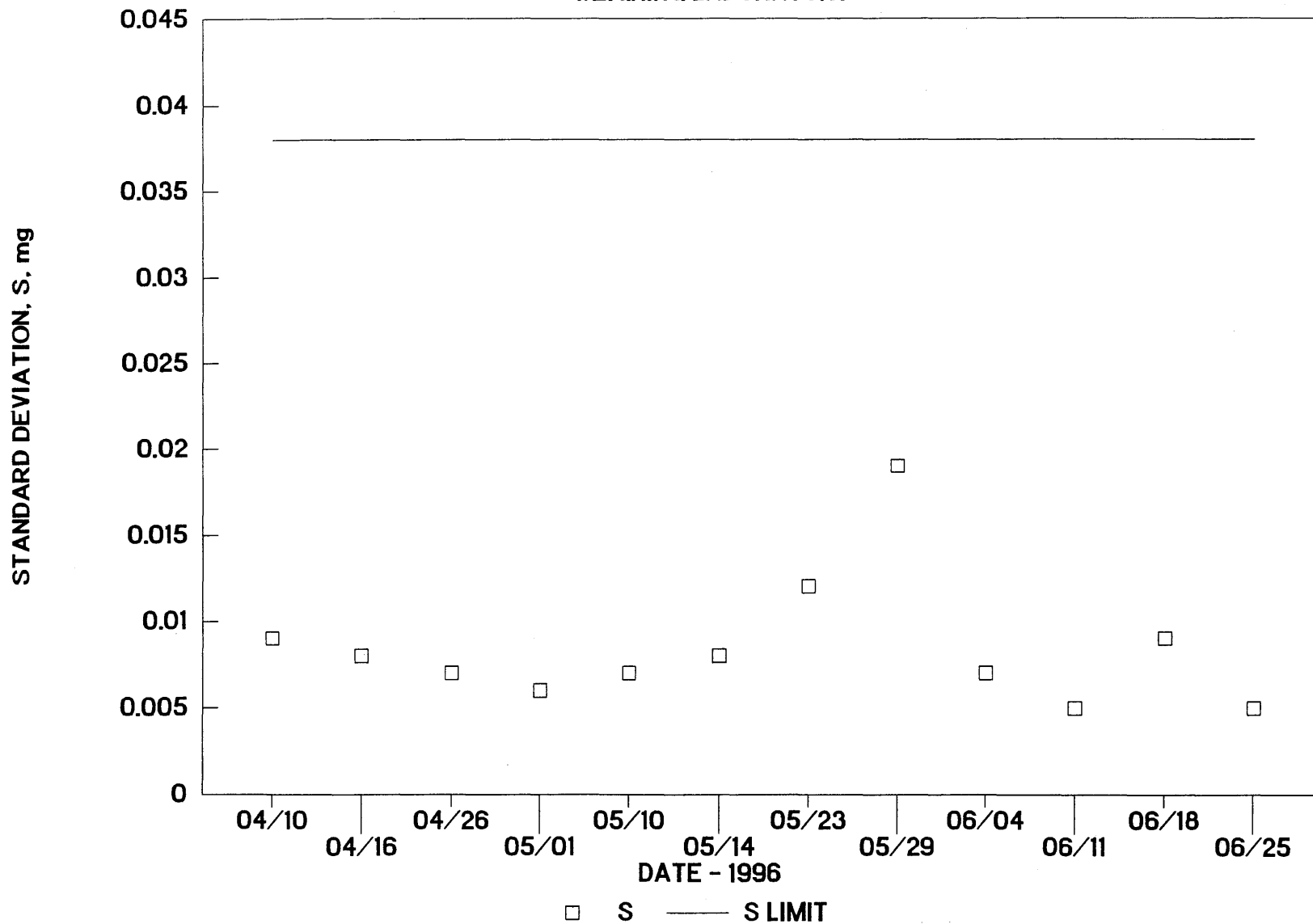


Figure 10. Quality Control Chart for Standard Deviation

not accepted until any problems are corrected and comparative weighings meet the established quality control criteria. The data are plotted as quarterly quality control charts. Figure 9 shows the quality control chart for the weight difference parameter, "d", which shows the current upper and lower control limits and the 12 weekly "d" values for a recent quarter. Figure 10 shows the quality control chart of the standard deviation parameter, "s", which shows the upper control limit and the weekly "s" values for the same quarter.

A statistical study to determine the precision of MSHA's AWS for weighing respirable coal mine dust samples to the nearest microgram was initiated in October, 1994.⁸ This study involved weighing the same 55 unused filter capsules 139 times over a 218-day period. The study showed that the precision (one standard deviation) of the weighing process was ± 0.0065 mg.

Quality Control of Newly Manufactured Dust Cassettes

Present Federal Regulations (Title 30, Code of Federal Regulations, Part 74.3 (b)(2)(ii) require that newly manufactured filter capsules be preweighed by the manufacturer to a precision of ± 0.1 mg. To ensure maintenance of the precision of the initial weights as recorded on the data card by MSA, a program is in place whereby MSA randomly selects 10 samples from each production shift and sends them to MSHA for evaluation. MSHA checks the initial weight of the filter capsules and also tests the integrity of a valve that is designed to prevent reverse flow of air through the cassette. Currently, MSA is weighing the filter capsules used in the operators' dust sampling program to the nearest 0.01 mg using a Mettler, Model AE-163, semi-microbalance. Prior to check weighing, the filter capsules are heated to 120°F for 16 hours and then allowed to stabilize in the controlled atmosphere of the weighing room for four hours. The weight of all capsules must be within ± 0.1 mg (truncated) of the weight obtained by MSHA. Before heating, the valves are checked by subjecting them to a static pressure of 8 psi. To be acceptable, the airflow leakage across the valve must be less than 150 cc per minute. If any cassette fails either the check weighing or valve test, then all cassettes in the production run must be reweighed or have the back-flush valves rechecked. A shift production is not approved for distribution to the mining industry until all 10 cassettes meet specified requirements.

⁸T. Tomb, L. Raymond and P. Parobeck. Investigation To Determine the Precision of MSHA's Automatic Weighing System for Weighing Respirable Coal Mine Dust Samples. USDOL-MSHA-PSHTC-DUST Laboratory Report, February 1996, 43 pp.

EPILOGUE

This publication has described current (August, 1996) laboratory equipment and procedures used by MSHA in processing respirable dust samples submitted in accordance with Title 30 of the Code of Federal Regulations, Parts 70,71 and 90. Future updates of this publication will be prepared as warranted by equipment and procedural changes in the laboratory.