APPENDIX-A

Dust Control Systems (Chapter 5, 6)

Half–Curtain System-System 1

A three-dimensional view of the standard Kloppersbos spray configuration for the half-curtain system is shown in Figures A1 to A3 respectively. The system consists of a total of 34 sprays including three air movers. The main feature of the system is that it has a curtain just behind the scrubber inlet in order to contain the escaped dust travelling towards the return or influence re-circulation. The half-curtain covers an area from the scrubber on the left-hand side of the machine to the middle of the machine over the flight conveyor. This curtain is made up of a conveyor belt, and closes a height of ± 1.0 m (3.28 ft) on top of the on-board scrubber.

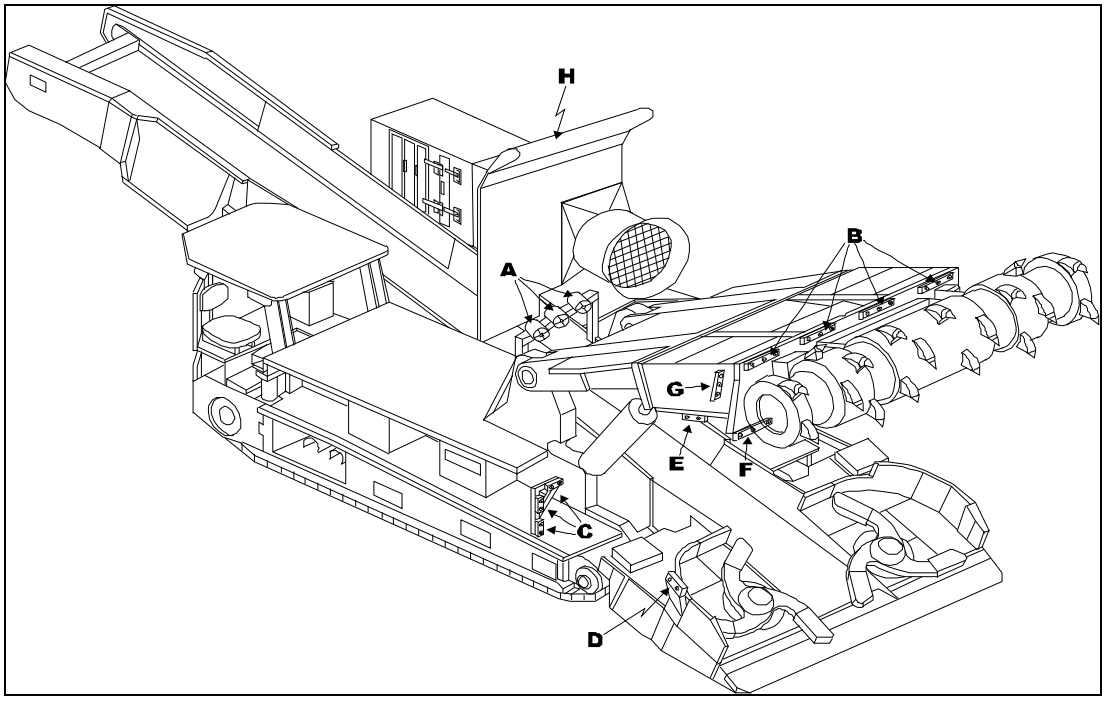


Figure A1: Three-dimensional view of half-curtain system with standard Kloppersbos spray configuration

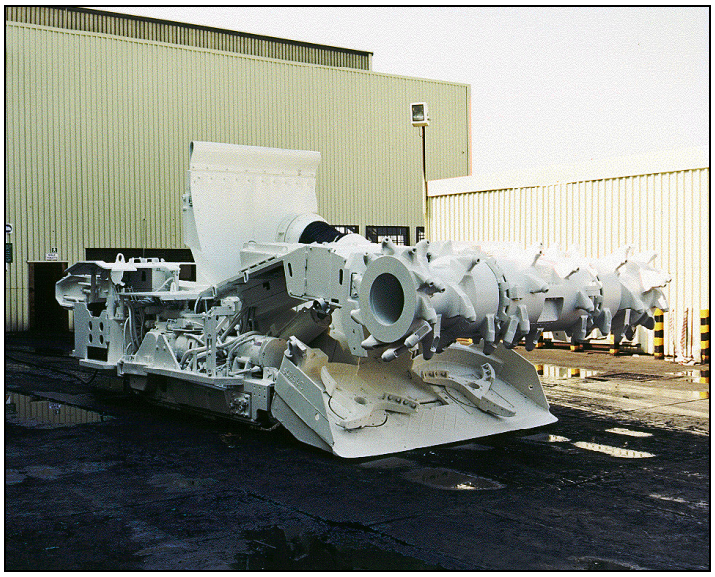


Figure A2. Photographic view of half-curtain system with standard Kloppersbos spray configuration

Figure A3. Photographic view of half-curtain system with standard Kloppersbos spray configuration

The half-curtain system consists of:

- ✓ A wet fan on-board scrubber with a capacity of 10 m³/s -12 m³/s, fitted with an inlet cone.
- ✓ Maintains water pressure of 2000 kPa (20 bar) and a water flow rate of 110 L/min.
- ✓ Hollow-cone nozzles with a single inlet diameter of 1.6 mm and an outlet diameter of 2.0 mm.
- ✓ Three air movers spraying downwards at an angle > 45° from the horizontal onto the conveyor to prevent dust rollback and to wet the coal (A).
- ✓ Four top spray blocks (total 12 sprays) situated above the cutter drum to move air across the face from right to left towards the scrubber intake (B).
- ✓ An L-shaped spray block (three spray blocks, each consisting of two sprays) installed on the right-hand side of the machine, ensuring air movement to the front of the machine (C).
- ✓ One spray block consisting of two water sprays installed on the spade, directing air to the left of the machine underneath the boom (D).
- ✓ One spray block consisting of two water sprays connected to the bottom of the cutter boom, directing air towards left of the machine under the boom (E).
- ✓ Two bottom directional spray blocks, each consisting of three sprays installed underneath the cutting head on the left and right sides of the head to ventilate under the cutting drum (F).
- ✓ One spray block consisting of three water sprays installed on right hand side of the cutting drum to ventilate the right hand side corner of the face (G).
- ✓ A half-curtain on top of the machine (H).

Retrofitted Hood System-System 2

The retrofitted hood system (Figures A4 to A7) is fitted with the Kloppersbos spray configuration on CM HM 9 with the addition and removal of spray blocks on the machine. Also, an exhaust hood is fitted on the top of the boom, which in turn is connected to the scrubber inlet (a wet fan on-board scrubber with a capacity of 10 m³/s -12 m³/s), by means of flexible spiral ducting. The hood draws the dusty air from four different positions underneath the boom towards the scrubber inlet. The spray configuration on the machine is designed to ensure that the dust and methane-laden air will be directed towards the four intake ports of the hood.

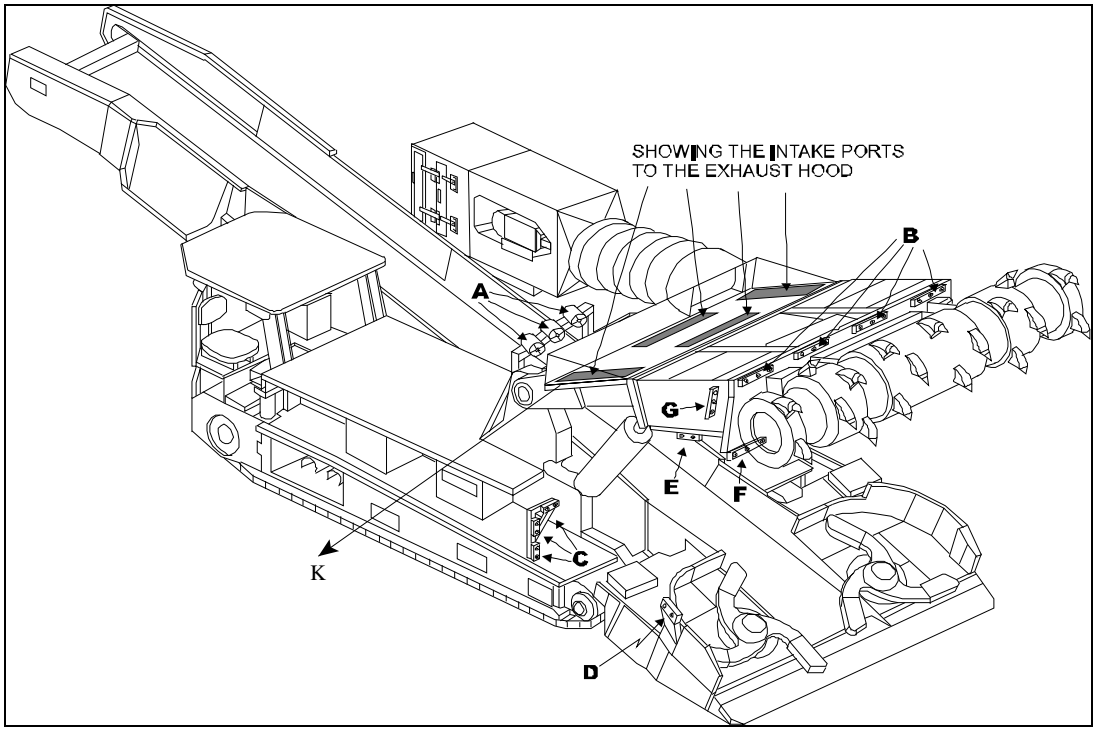


Figure A4: Three-dimensional view of retrofitted hood system

The retrofitted hood system consists of:

- ✓ Water supply line and a booster pump maintaining water pressures between 1500 and 2000 kPa (15 and 20 bars) and water flow rate of 100 and 120 L/min to the spray system.
- ✓ Three air movers spraying downwards directed at an angle of 60 to 70 degrees from the horizontal onto the conveyor to prevent dust rollback and to wet the coal (A).
- ✓ Four top spray blocks (total 12 sprays) situated above the cutter drum to move air across the face from right to left towards the scrubber intake (B).
- ✓ An L-shaped spray block (three spray blocks, each consisting of two sprays) installed on the right-hand side of the machine, ensuring air movement to the front of the machine (C).
- ✓ One spray block consisting of two water sprays installed on the spade, directing air to the left of the machine underneath the boom (D).
- ✓ One spray block consisting of two water sprays connected to the bottom of the cutter boom, directing air towards left of the machine underneath the boom (45 ° to horizontal) (E).
- ✓ Two bottom directional spray blocks, each consisting of three sprays installed underneath the cutting head on the left and right sides of the head to ventilate under the cutting drum (F). These were shut-off for the retrofitted hood tests.
- ✓ One spray block consisting of three water sprays installed on right hand side of the cutting drum to ventilate the right hand side corner of the face (G).
- ✓ One spray block consisting of two sprays was positioned before the left-hand side of the inlet to the hood, directing downwards to prevent rollback (position K).
- ✓ An additional two spray blocks (four sprays) was placed on the right-hand side of the machine and on the bottom front of the scrubber. The bottom two spray blocks (six sprays) were shut off. The system consists of a total of 34 sprays including three air movers.

FigureA5: Photographic view of the hood from the front side showing sprays

FigureA6: Photographic view of the hood from the mouth from the front side of the CM

FigureA7: Photographic view of the hood from the operator's cabin position and suggested alterations

Double Scrubber System: System 3

A photographic view of the Double Scrubber system is shown in Figure A8 below. The system contained the same Klopeprsbos standard spray configuration as described for retrofitted hood system and half-curtain systems. As the name suggests, the system consists of two on-board scrubbers. An additional small scrubber was positioned just above the flight conveyor, replacing air movers. The small scrubber prevents dust rollback towards the operator through the exhaust action. The use of the small scrubber enhances the airflow in the face area and in effect controls the airborne dust. The system consists of a total of 31 sprays.

Figure A8: Three-dimensional view of integrated hood system

The details of the double scrubber system as shown on the drawing are summarized below:

- On-board scrubber: A wet fan scrubber capable of handling an air quantity of 10 m³/s - 12 m³/s, fitted with an inlet cone in parallel with the small scrubber inlet.
- Small on-board scrubber: .An additional scrubber capable of handling an air quantity of 3.5 m³/s to 4.0m³/s, to control dust rollback from the conveyor.
- Water supply to the machine: Maintains water pressure of 15 bars and a water flow rate of 140 L/min, of which 40-50 L/min is to the on-board scrubbers.
- Type of nozzles: Standard hollow-cone nozzles with a single inlet diameter of 1.6 mm and an outlet diameter of 2.0 mm.
- Standard Kloppersbos spray configuration.

Integrated Hood System – System 4

The top view of the integrated hood system with the spray configuration on the larger HM31 CM is shown in Figure A9.

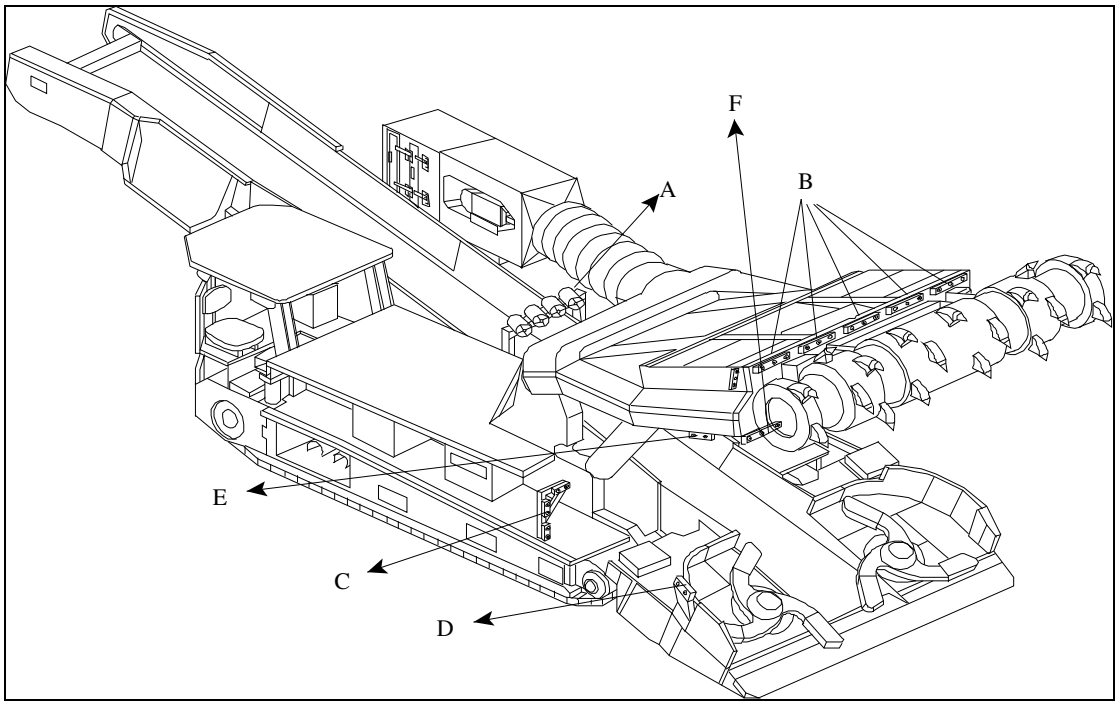


Figure A9: Three-dimensional view of integrated hood system

The system consists of a total of 41 sprays and four air movers. The details of the individual design specifications that are different from the retrofitted hood system as shown on the drawings are as follows:

- ✓ On-board wet fan scrubber:

- Handling air quantities between 6.0 and 8.0 m^3/s (referred to as the small scrubber).
- Handling air quantities between 10 m^3/s and 12 m^3/s (referred to as the large scrubber).

✓ Four air movers spraying downwards (> 45° from vertical) onto the conveyor to wet the coal and to prevent dust rollback through the flight conveyor (A).

✓ Five top spray blocks (15 sprays) situated above the cutter drum to move air across the face from right to left (B)

✓ One spray block consisting of two water sprays connected to the bottom of the cutter boom, directing air towards the left of the machine underneath the boom (45 ° to horizontal) (E).

✓ One spray block consisting of two sprays was positioned before the left-hand side of the inlet to the hood, directing downwards to prevent rollback (position K). These were shut-off for the integrated hood system.

BANK 2000 RH DUST CONTROL SYSTEM

The dust control system on the RH that was developed underground as part of an extensive research project (Belle et al., 2000) referred to as the "Bank 2000 Road Header (RH) Dust Control System." The name was chosen to distinguish this dust-control system from the various dust-control systems currently employed in South African mines. The final configuration of the sprays (Figure A10) as installed on the AM 80 RH machine consists of a number of water spray blocks, air movers and an on-board scrubber. The system consisted of a total of 38 sprays, including seven air movers (three air movers on the flight conveyor and four-tube air movers on the LHS computer box).

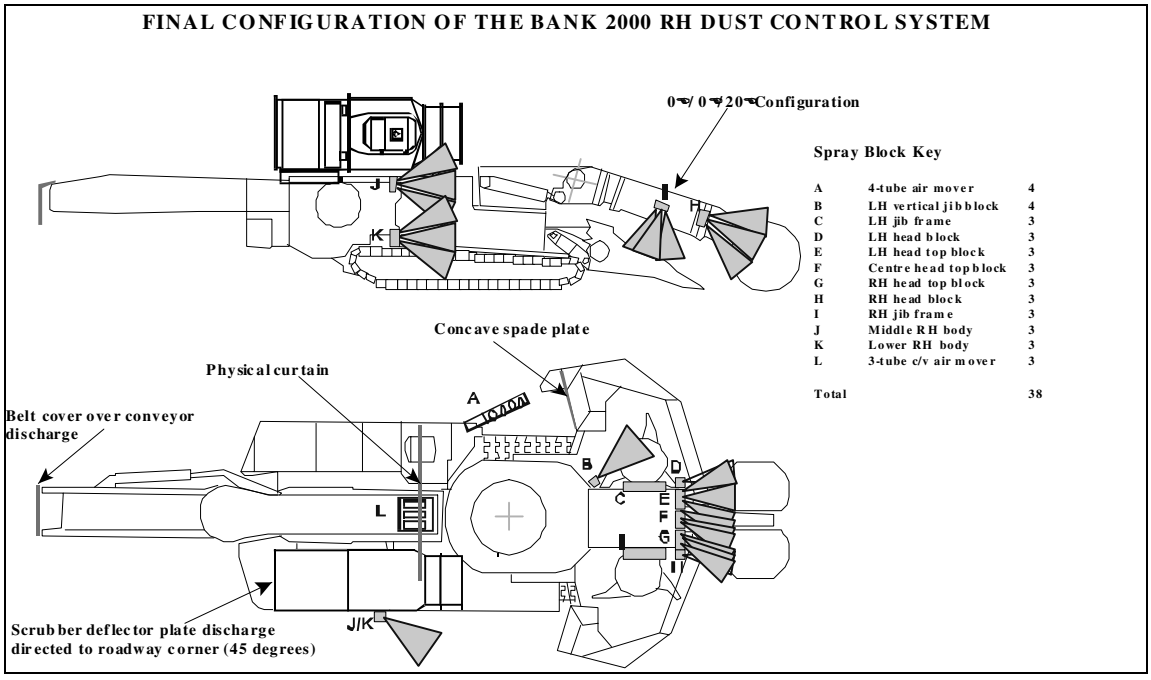


Figure A10: Final configuration of the Bank 2000 RH dust control system

The detailed descriptions of the individual components as shown on the drawings are as follows:

- ✓ On-board scrubber: A wet fan scrubber (capacity of 17 m³/s) fitted with an inlet cone and a scrubber outlet deflector plate discharge directed to a roadway corner at 45°.
- ✓ Water to the spray system: Water pressure in the range of 1 500 kPa (15 bar) to 2 000 kPa (20 bar) and a water flow rate of 120 L/min (maxi-mum flow made available in the section).
- ✓ Type of nozzles: Hollow-cone nozzles with a single-inlet diameter of 1.6 mm and an outlet diameter of 2.0 mm.
- ✓ Position A: Single four-tube air mover positioned on the left-hand-side (LHS) spade of the machine opposite the scrubber, spraying towards the LHS corner of the face in order to contain and sup-press falling total dust.
- ✓ Position B (jib spray): A spray block with four sprays positioned at the jib at an angle of 45° from the vertical plane, acting as a water curtain as the boom moved across the face, sweeping and clearing the dust underneath the boom.
- ✓ · Position E, F and G: A total of nine directional water sprays in three spray blocks located on the upper surface of the jib frame (behind the cutter head) arranged in a ‘spray-fan’ pattern. These sprays are angled to one side to promote the ventilation of the face by other components of the dust system and to wet the face around the cut-ting head.
- ✓ · Positions D and H: Two spray blocks each consisting of three water sprays installed on the LHS and RHS of the cutting head, directing the sprays covering the corners of the cutting drum.
- ✓ · Positions C and I: Jib spray blocks with three sprays were positioned on the LHS and RHS of the jib frame with a spray nozzle configuration of 0°/0°/20°. The intended function of the down-ward-facing spray blocks on the jib, is to

ensure proper ventilation of the area beneath the jib, particularly the loading zone.

- ✓ · Positions J and K: Two spray blocks, each consisting of three sprays installed on the RHS of the machine. One spray block positioned on the side of the scrubber and the other spray block was positioned on the bottom of the machine. The purpose of the spray blocks located on the RHS body of the machine is to oppose the outflow of any air past the scrubber inlet to the right of the machine and to contain the dust cloud and improve effective scrubber capture with no force ventilation.
- ✓ · Air movers: The three air movers positioned on the flight conveyor spraying downwards at an angle grater than 45 degree from the horizontal onto the conveyor was to prevent dust rollback and to wet the coal on the flight conveyor.
- ✓ · Physical half-curtain: The half-curtain covers an area from the scrubber on the LHS of the ma-chine to the middle of the machine over the flight conveyor. This curtain consists of a conveyor belt positioned approximately 1 m from the scrubber inlet.
- ✓ · Concave spade plate: Visual observations during the trials indicated that the RH operator's position was exposed to frequent very high dust- concentration levels. A concave spade plate was then added on the LHS of the RH at the spade position. In high seam coal mining headings, the control of total dust is difficult as the water sprays or air movers alone will not be able to contain the rollback of dust towards the operator. The principle of operation of the concave spade plate, as shown in Figure A11, is as follows: The spade plate is approximately 30 inches high and 22 inches wide and is positioned at the spade.

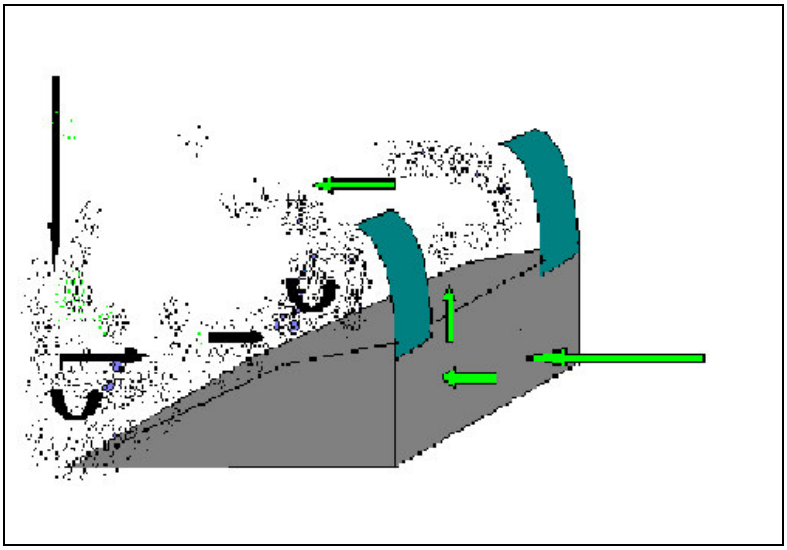


Figure A11: Operation of concave spade plate

The concave shape of the plate prevents or slows down the momentum of the rollback dust, prevents further travel towards the operator's position and acts as a physical shield. As the falling dust rolls to-wards the concave spade plate, due to its concave shape, the dust travels backwards towards the face. On the other hand, when auxiliary ventilation such as a jet fan and column are used, the concave shape of the spade plate does not act as a shield and prevent the fresh air from reaching the face area.

Figures A12 and A13 show the Bank 2000 Road Header Dust Control System operating underground and the spray configuration on the cutting head respectively.

Figure A12: Operation of concave spade plate

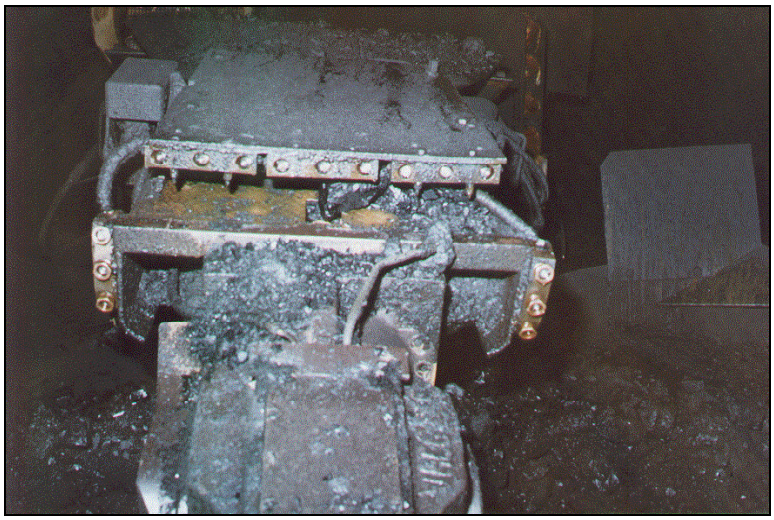


Figure A13: Operation of concave spade plate

APPENDIX-B1

CM Operator and Section Return Real-Time Dust Profiles-Mine A1 (Chapter 6, 8)

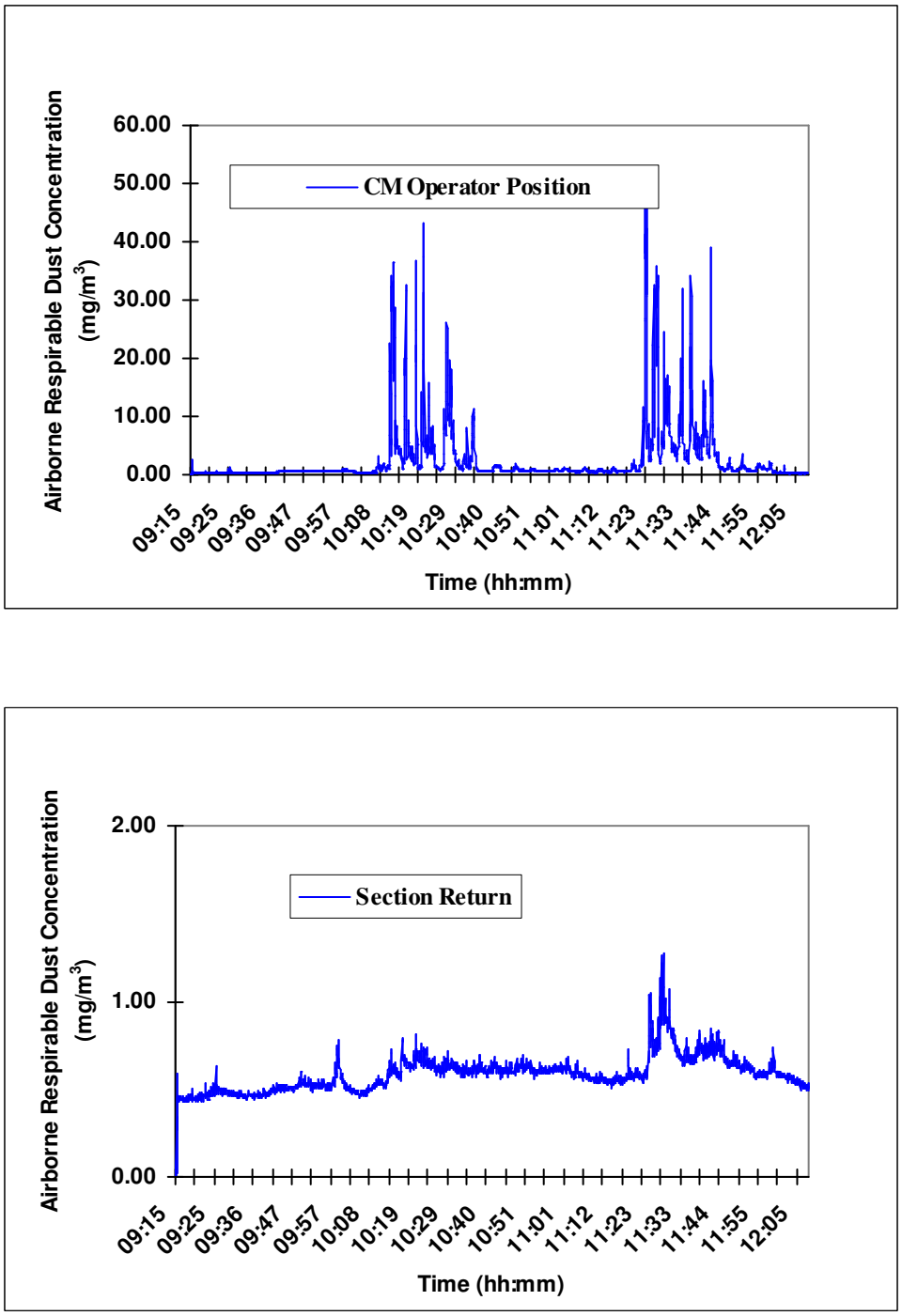


Figure 1: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 1

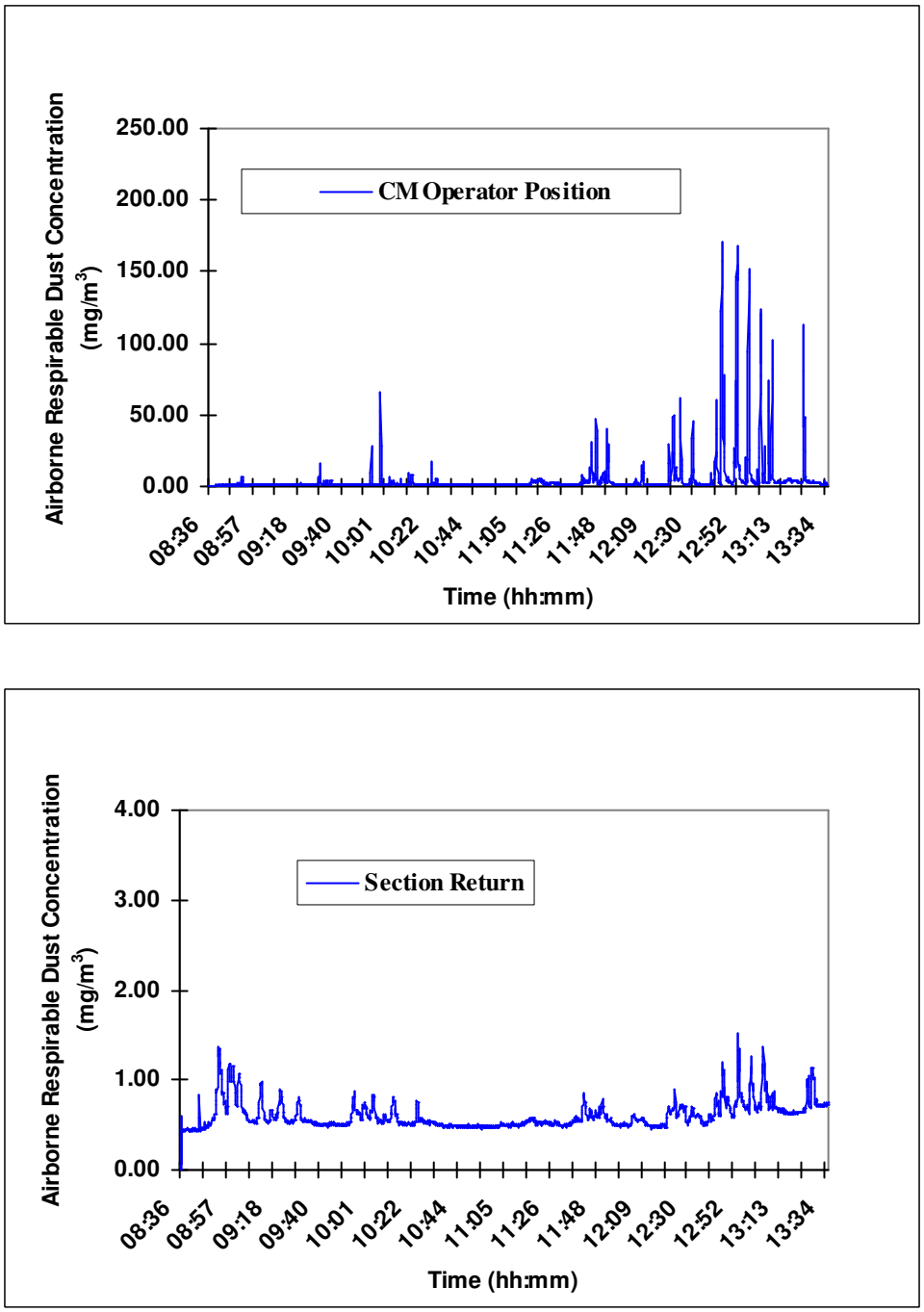


Figure 2: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 2

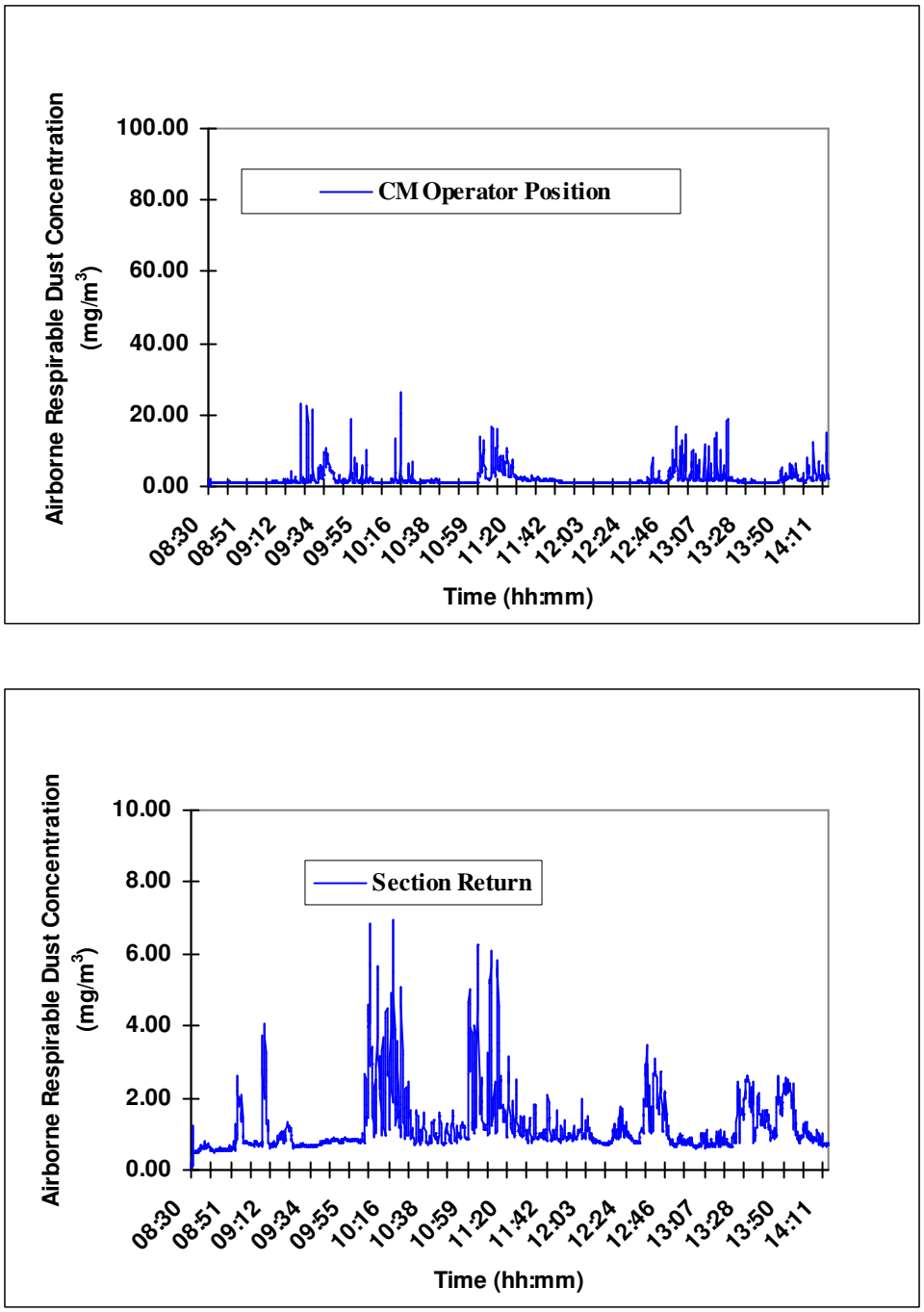


Figure 3: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 3

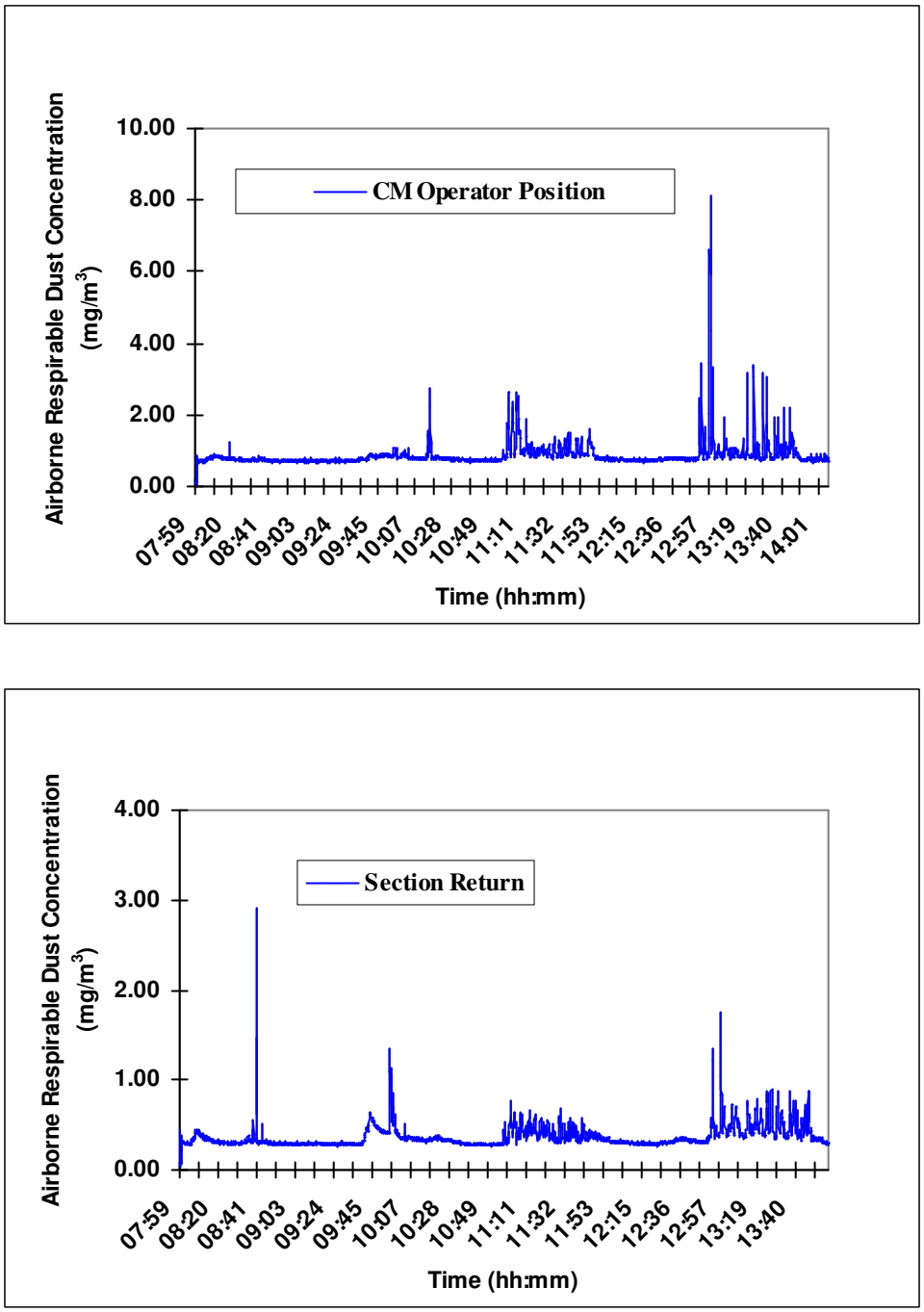


Figure 4: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 4

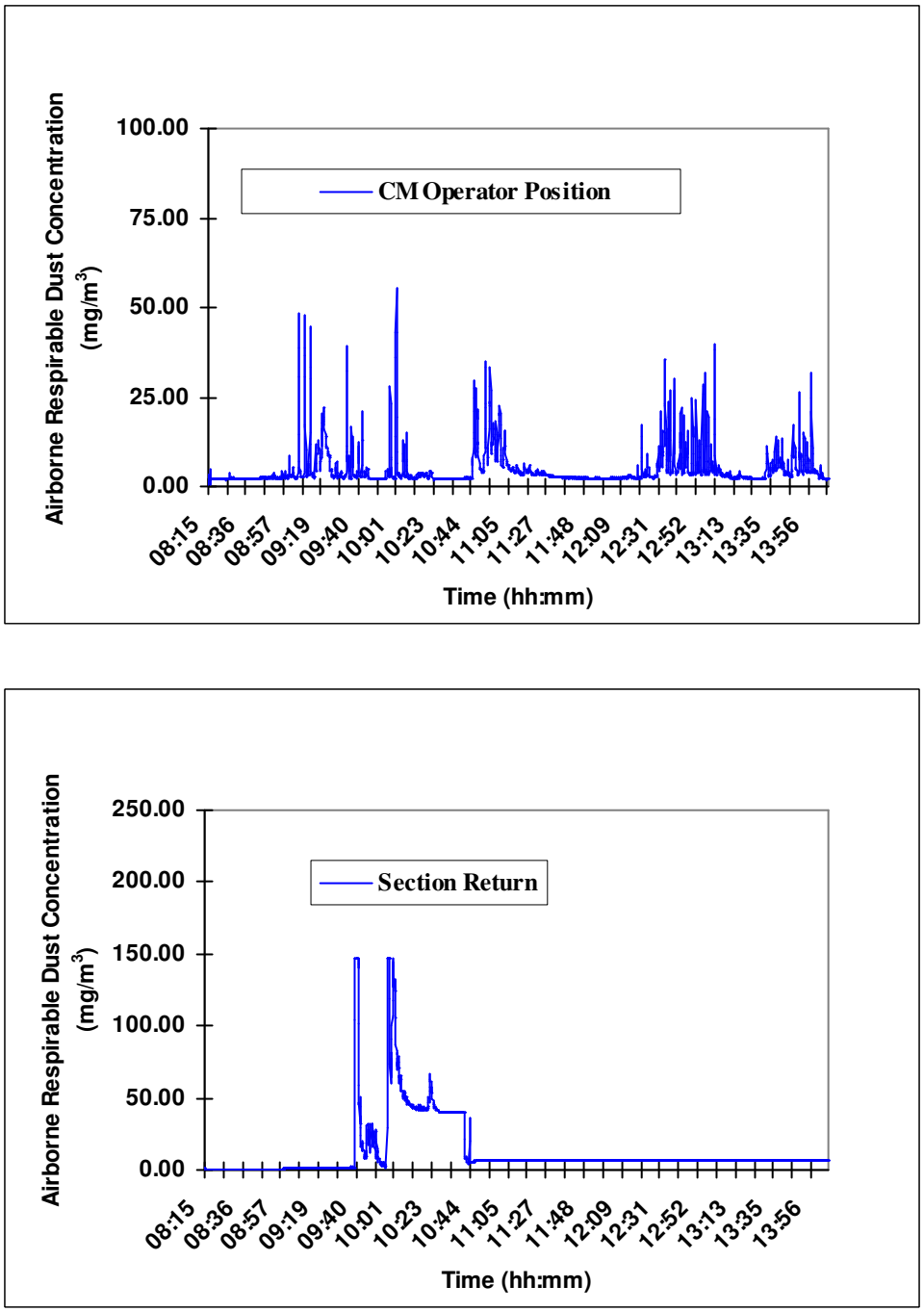


Figure 5: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 5

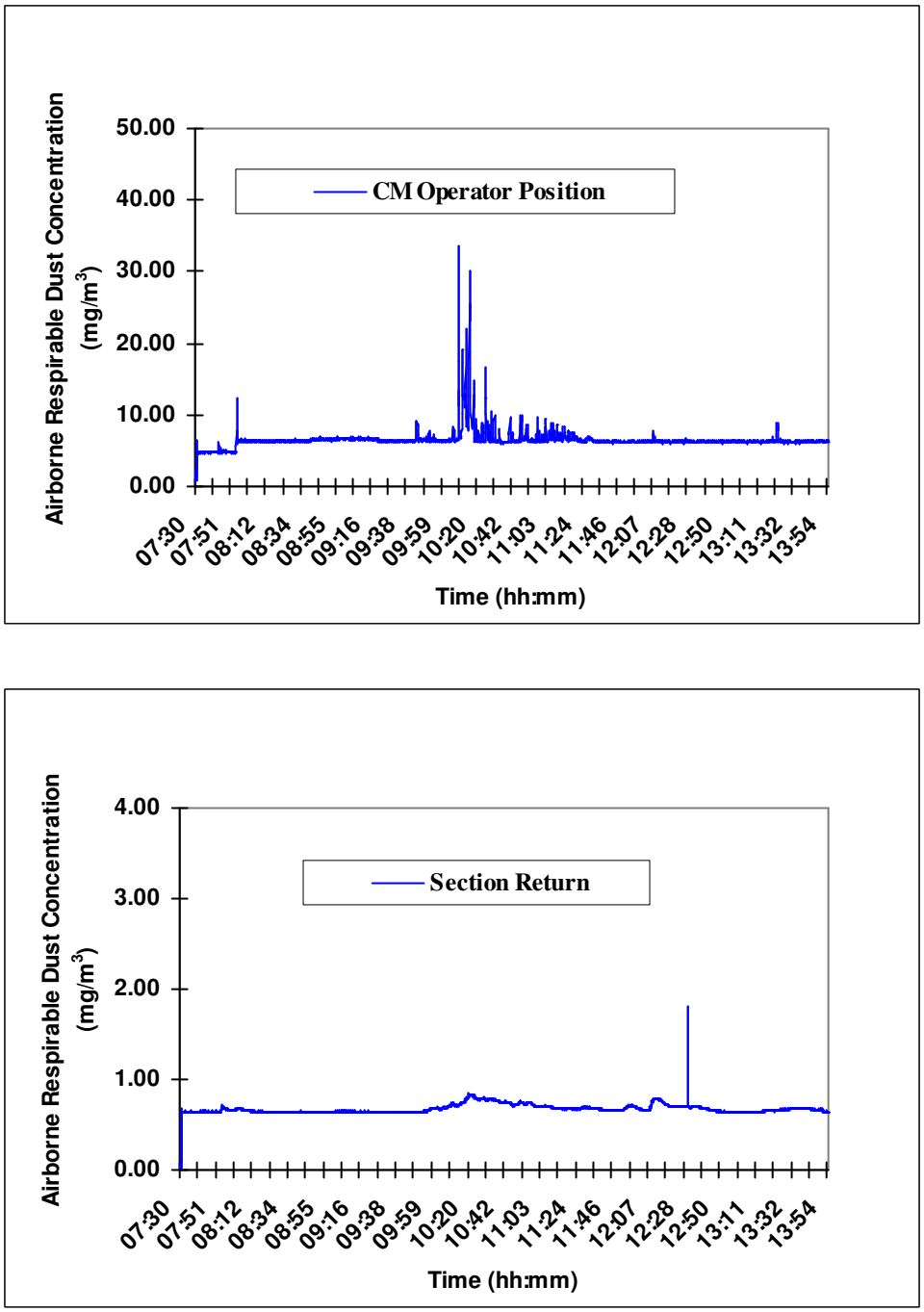


Figure 6: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 6

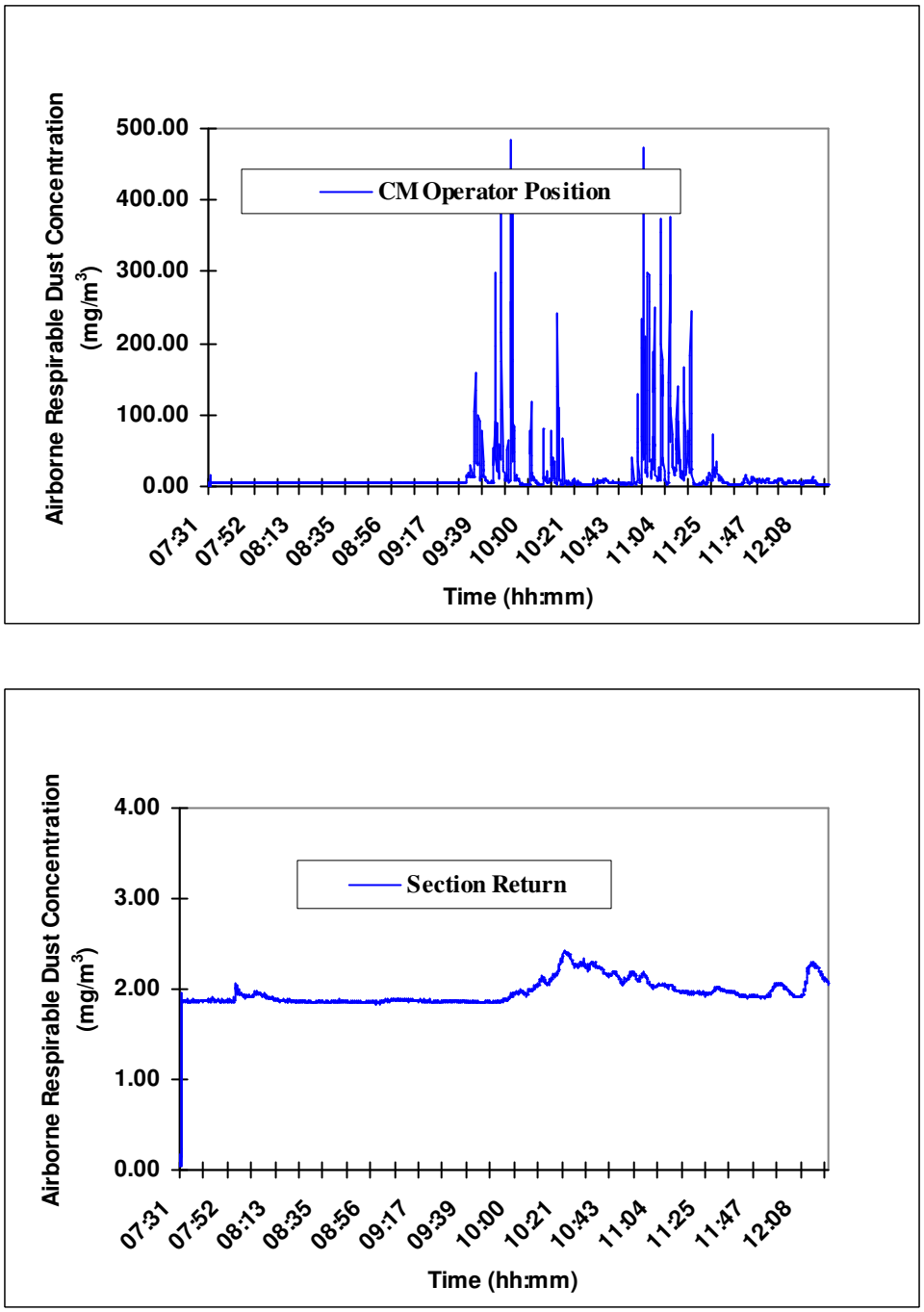


Figure 7: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 7

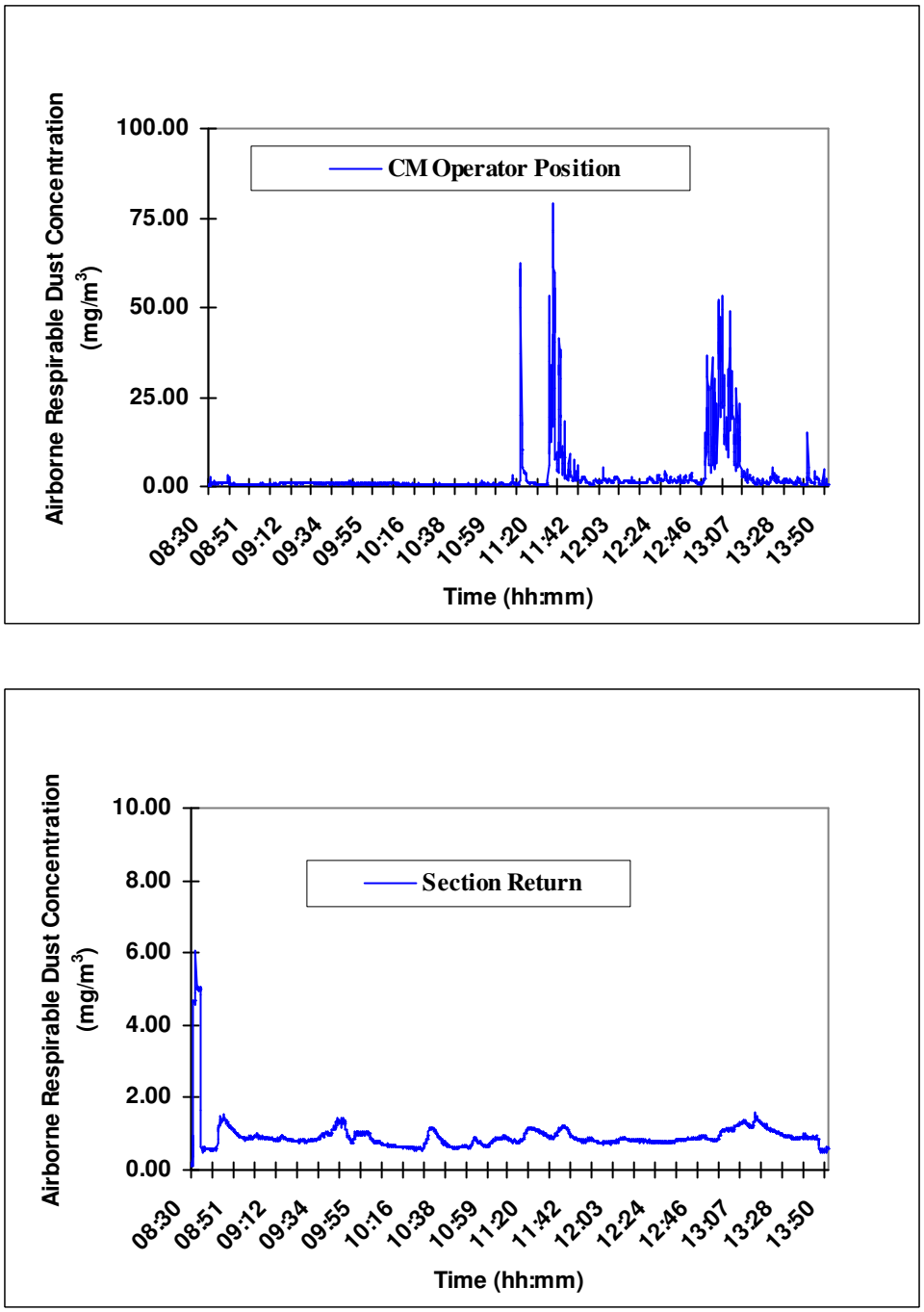


Figure 8: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 8

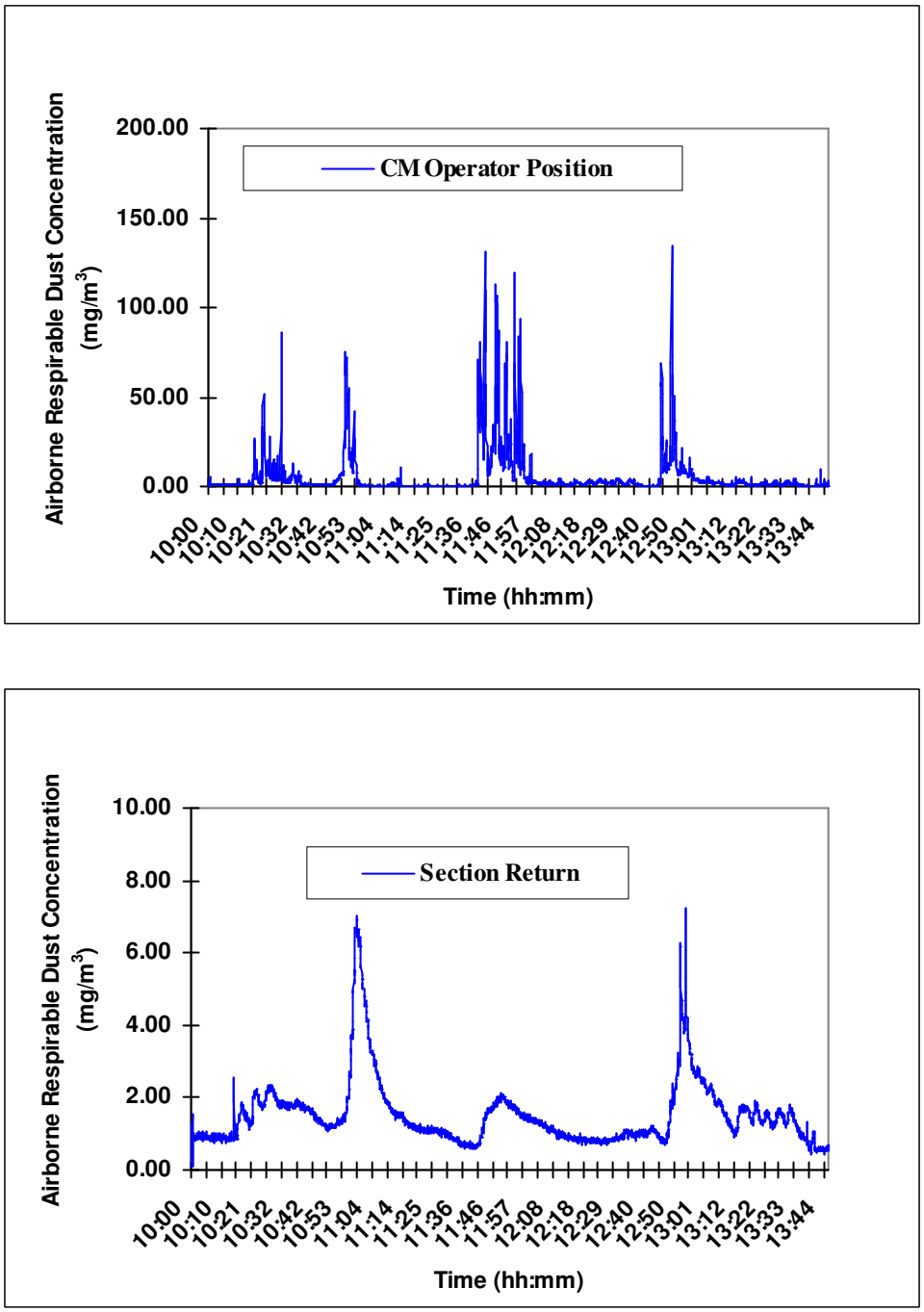


Figure 9: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 9

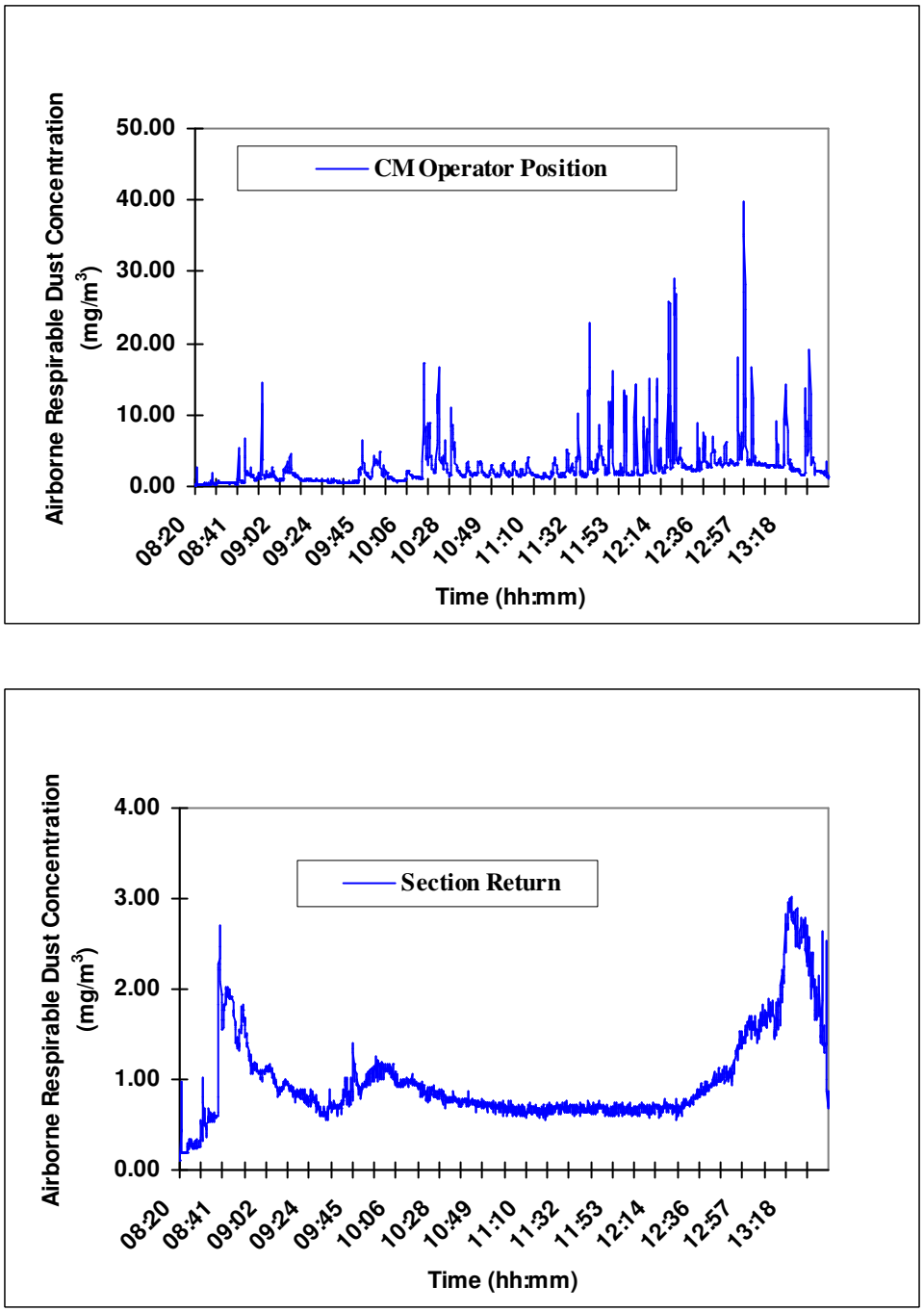


Figure 10: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 10

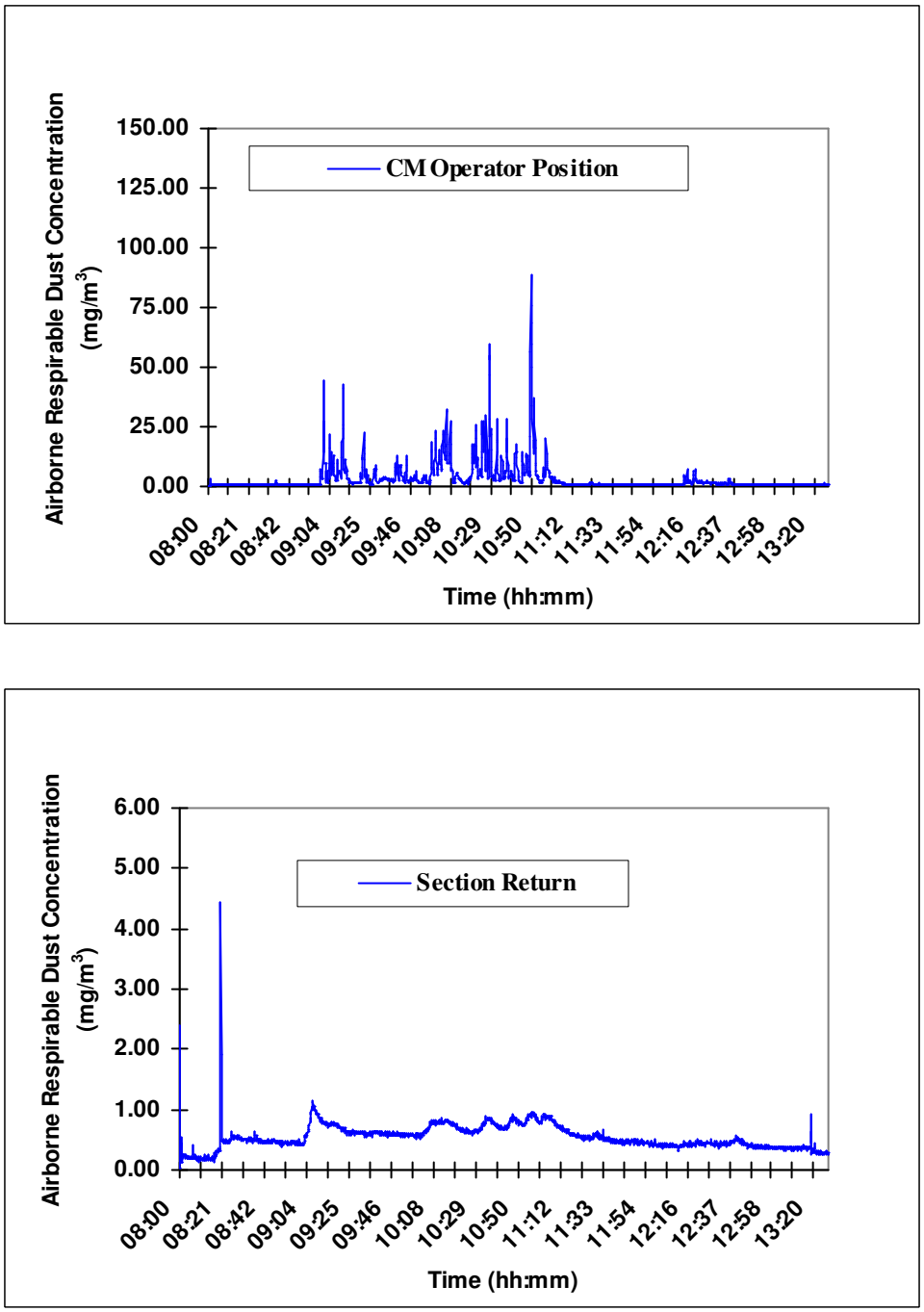


Figure 11: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 11

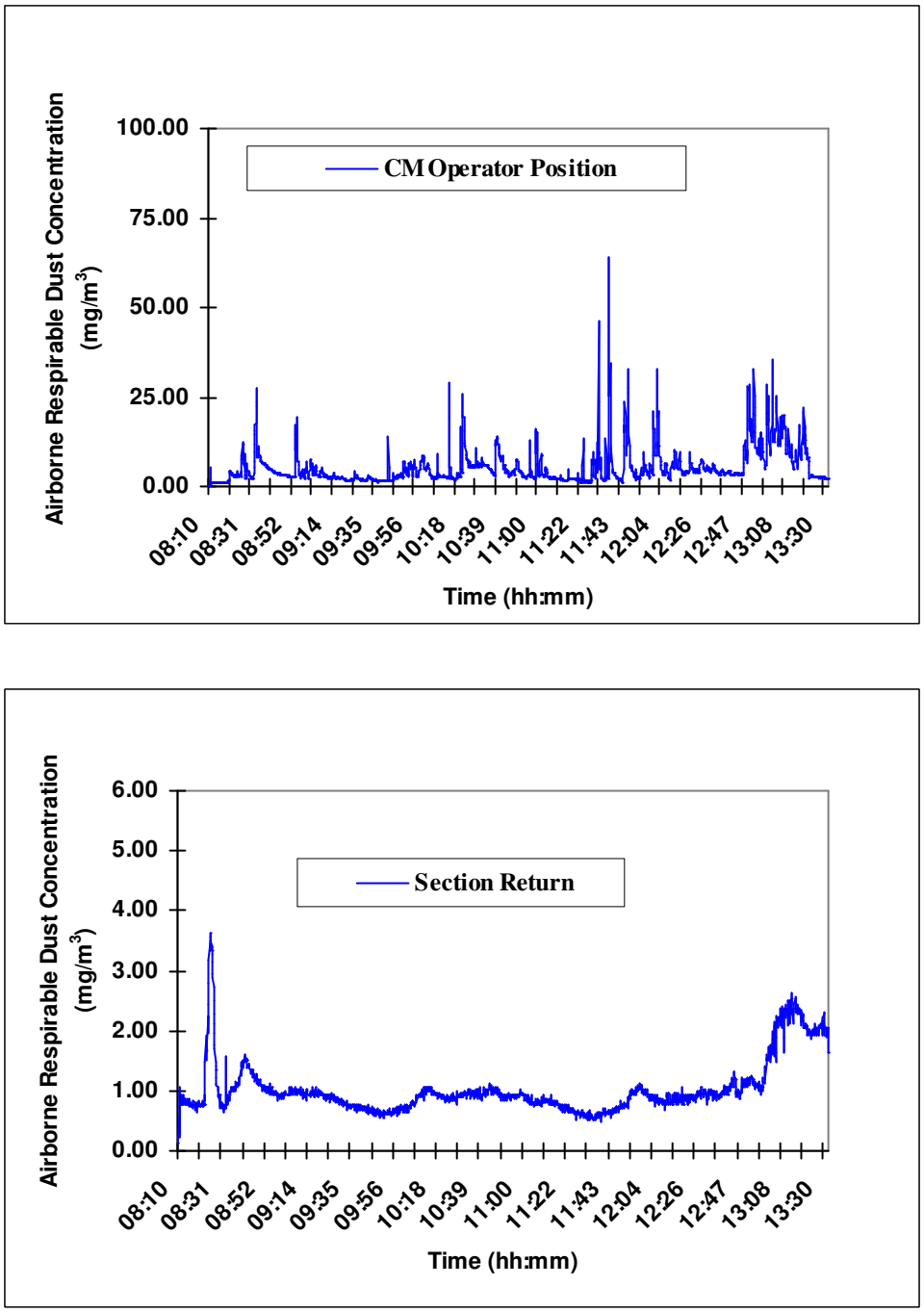


Figure 12: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 12

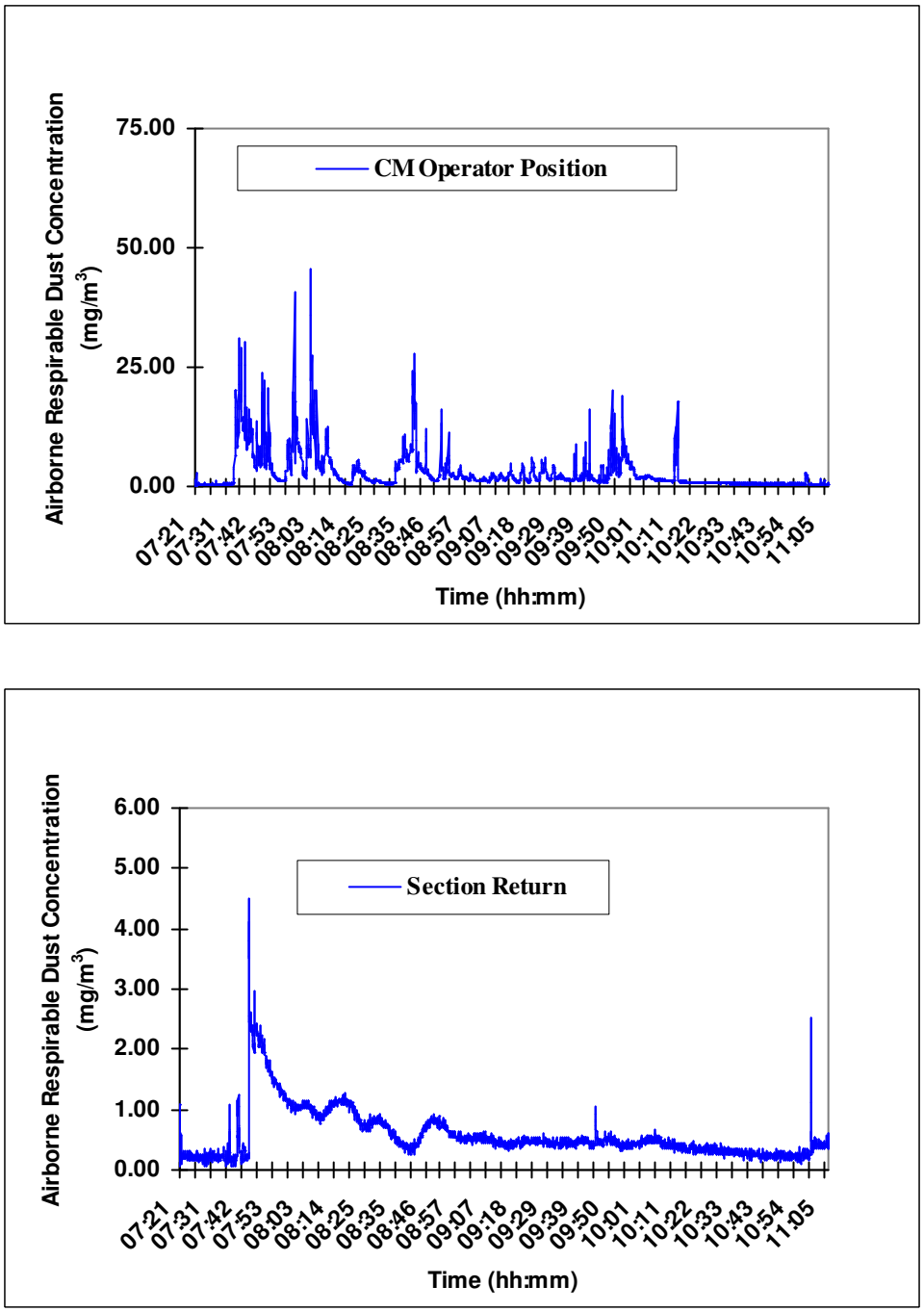


Figure 13: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 13

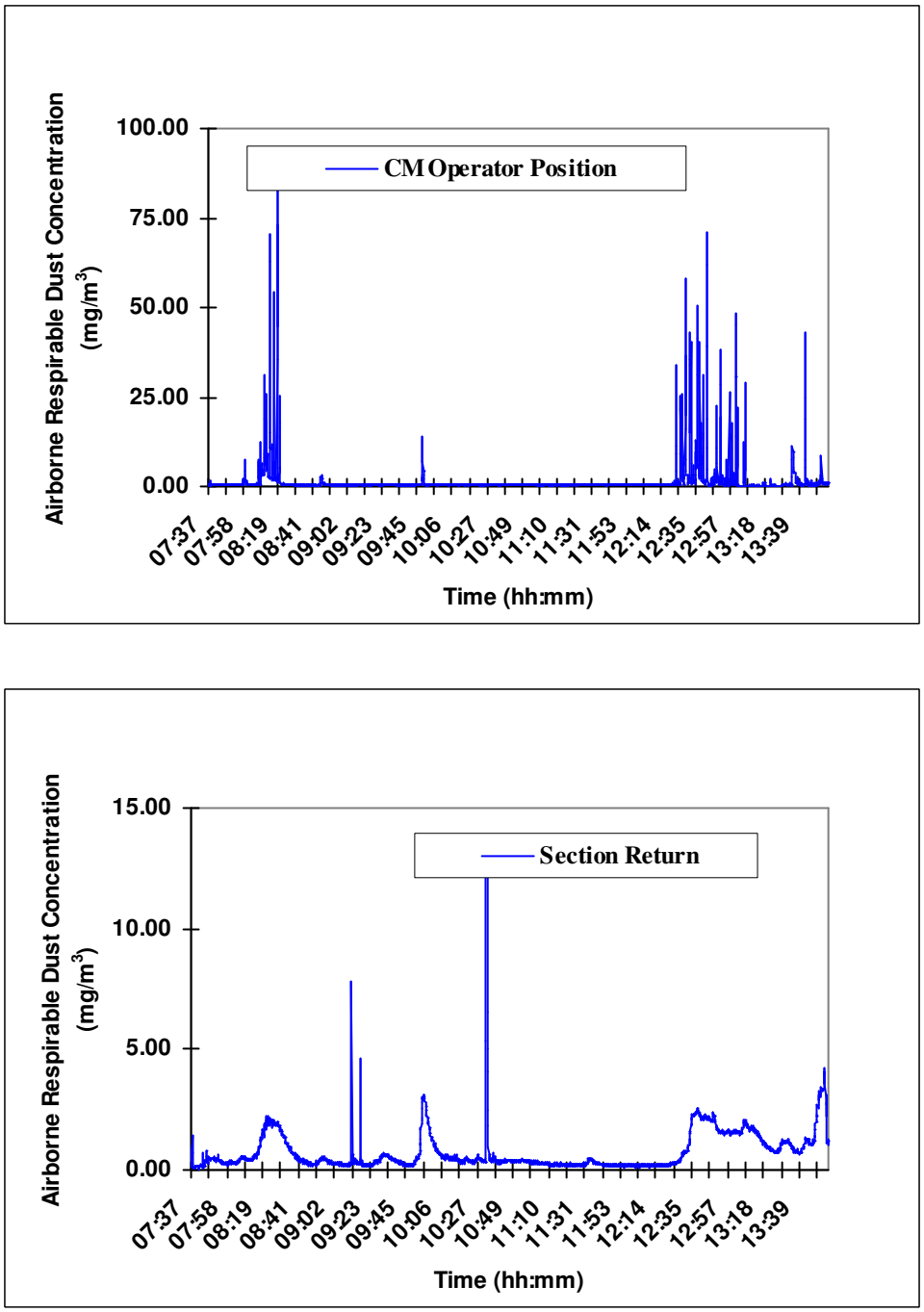


Figure 14: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 14

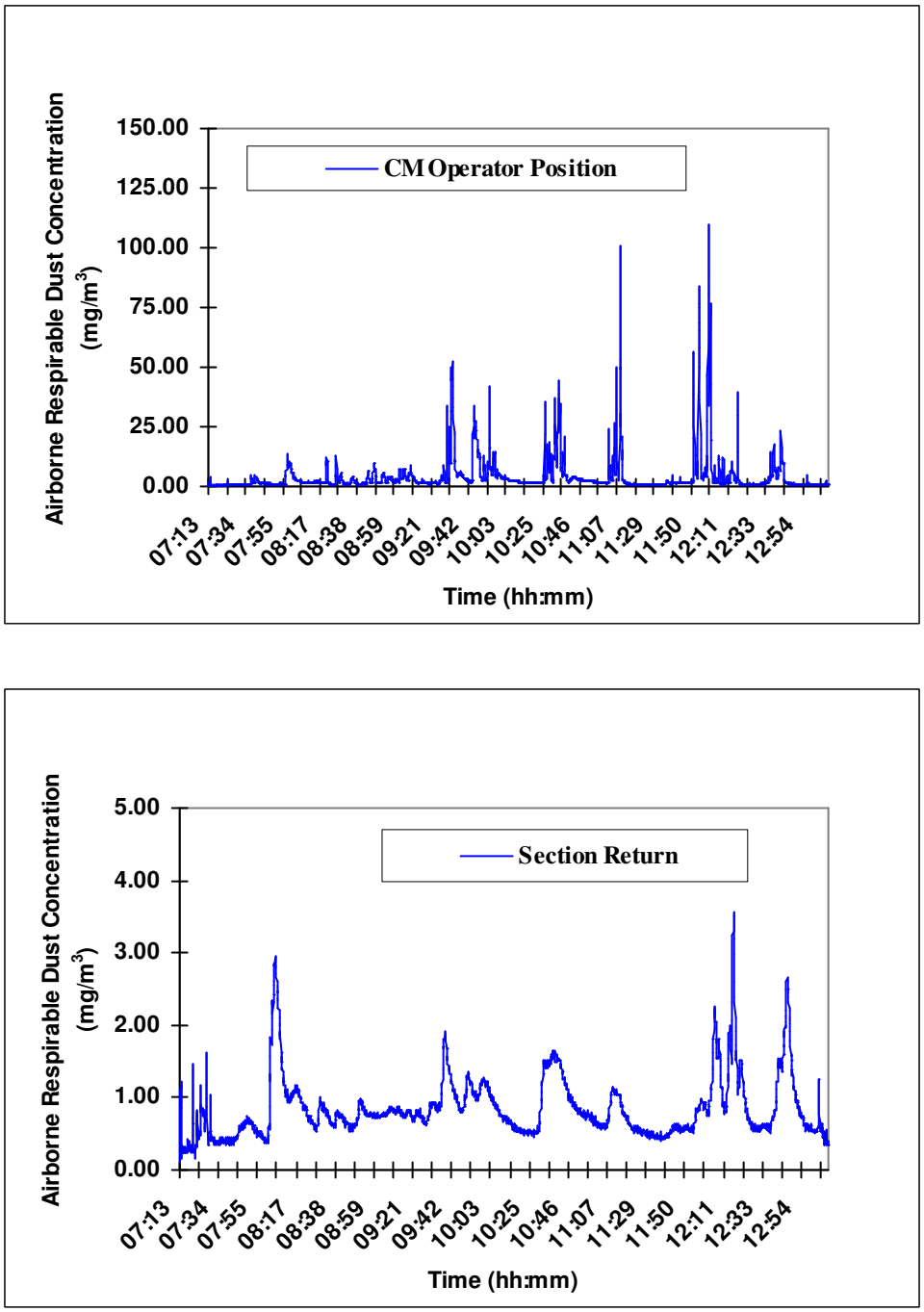


Figure 15: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 15

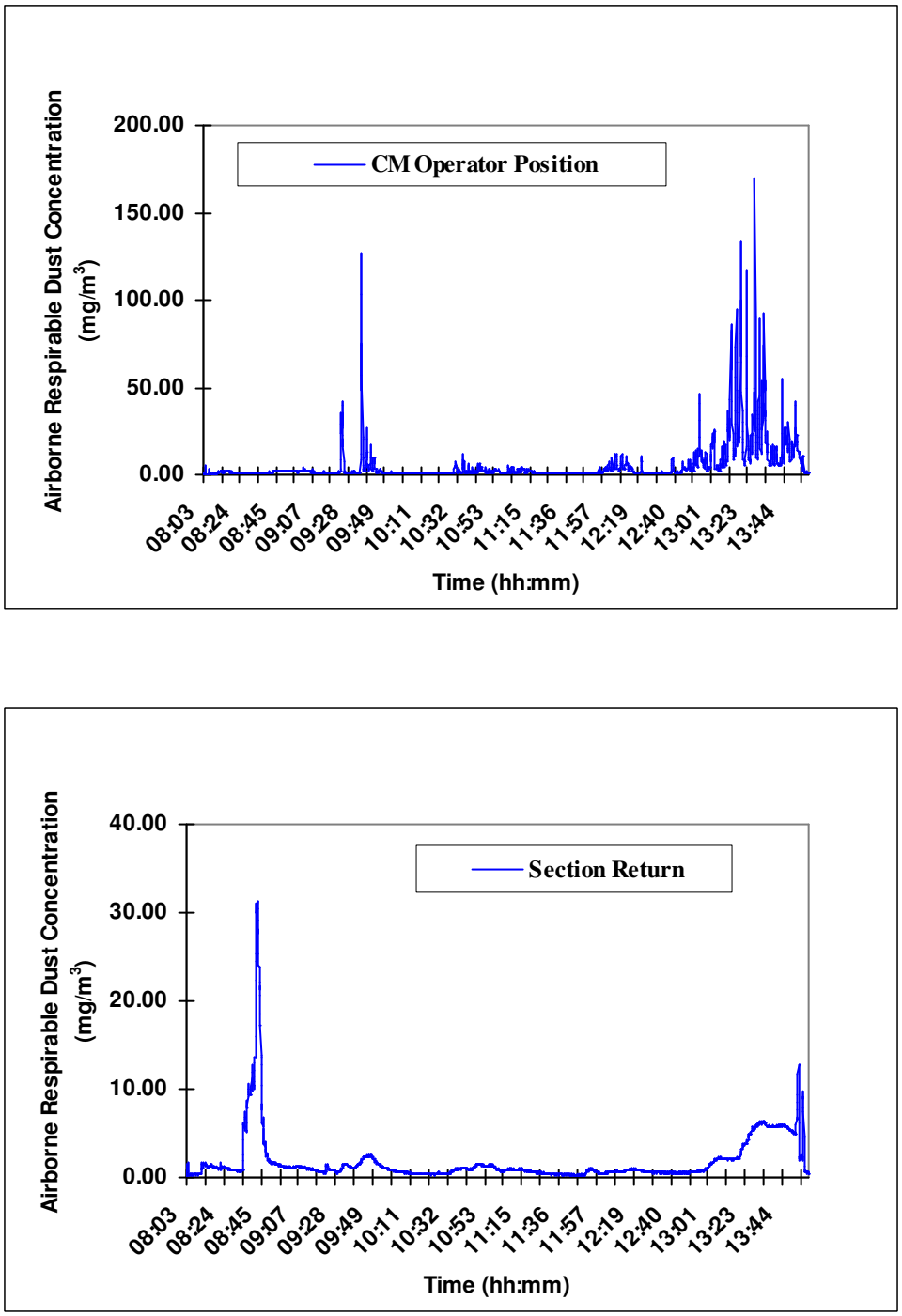


Figure 16: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 16

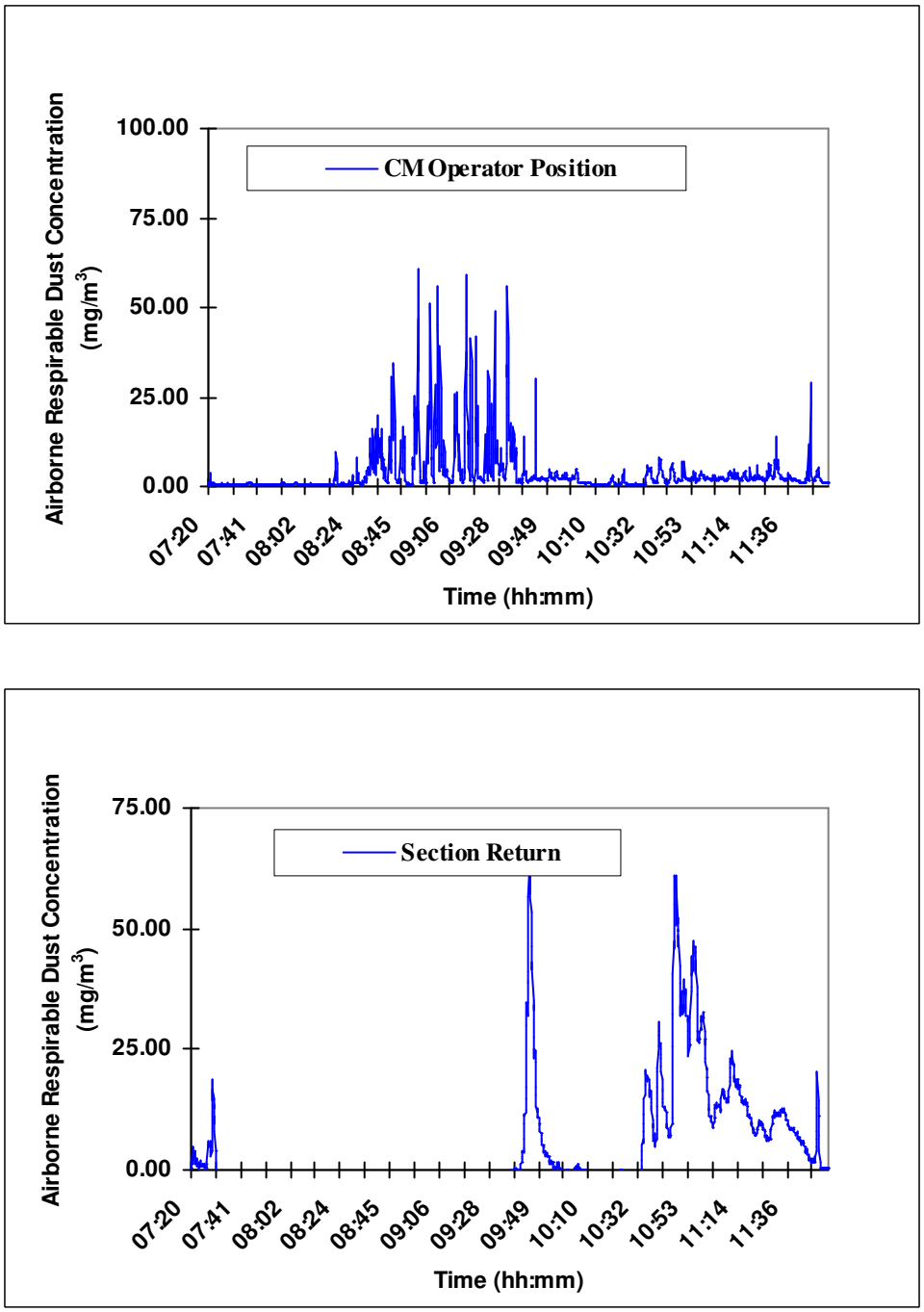


Figure 17: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 17

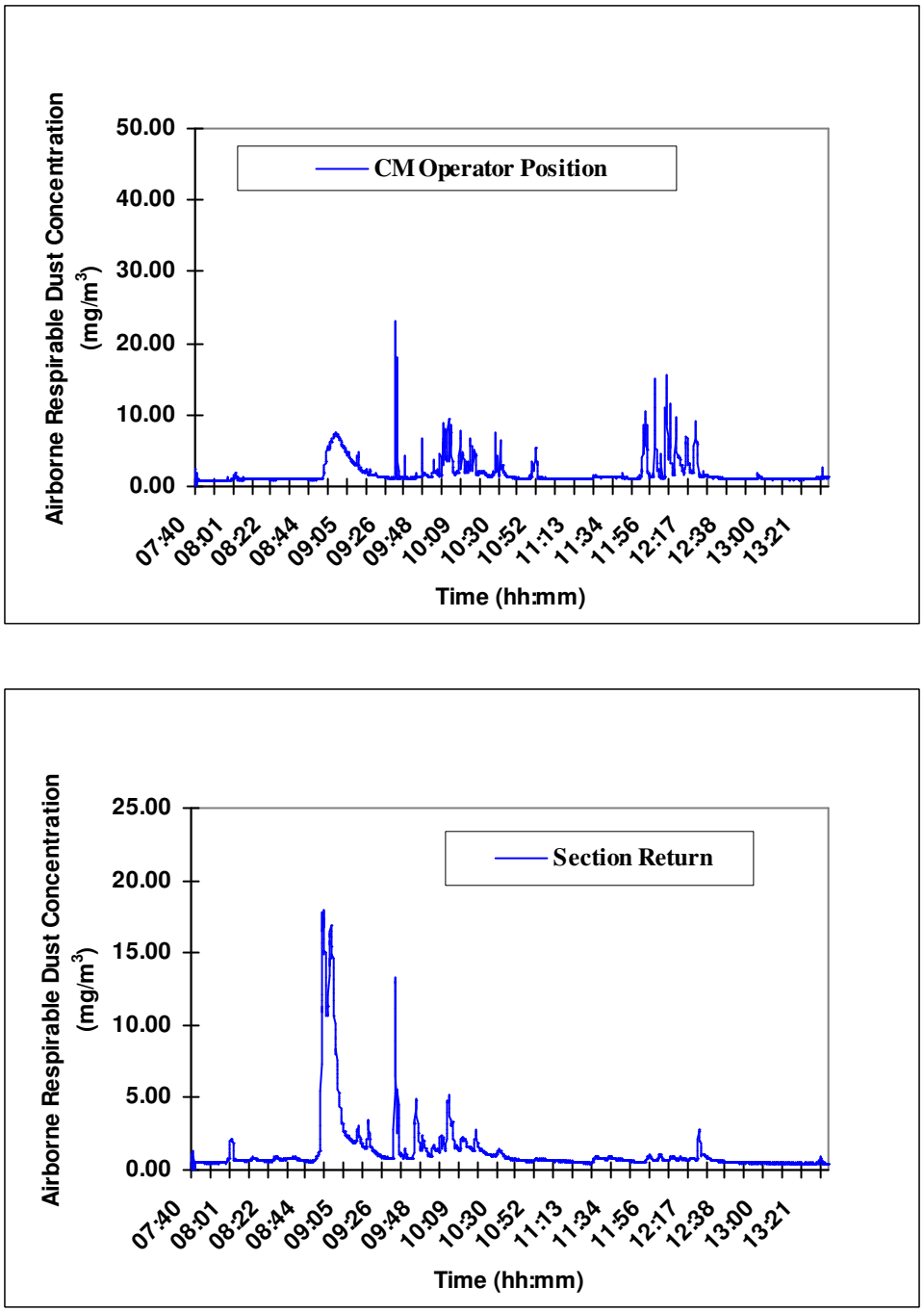


Figure 18: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 18

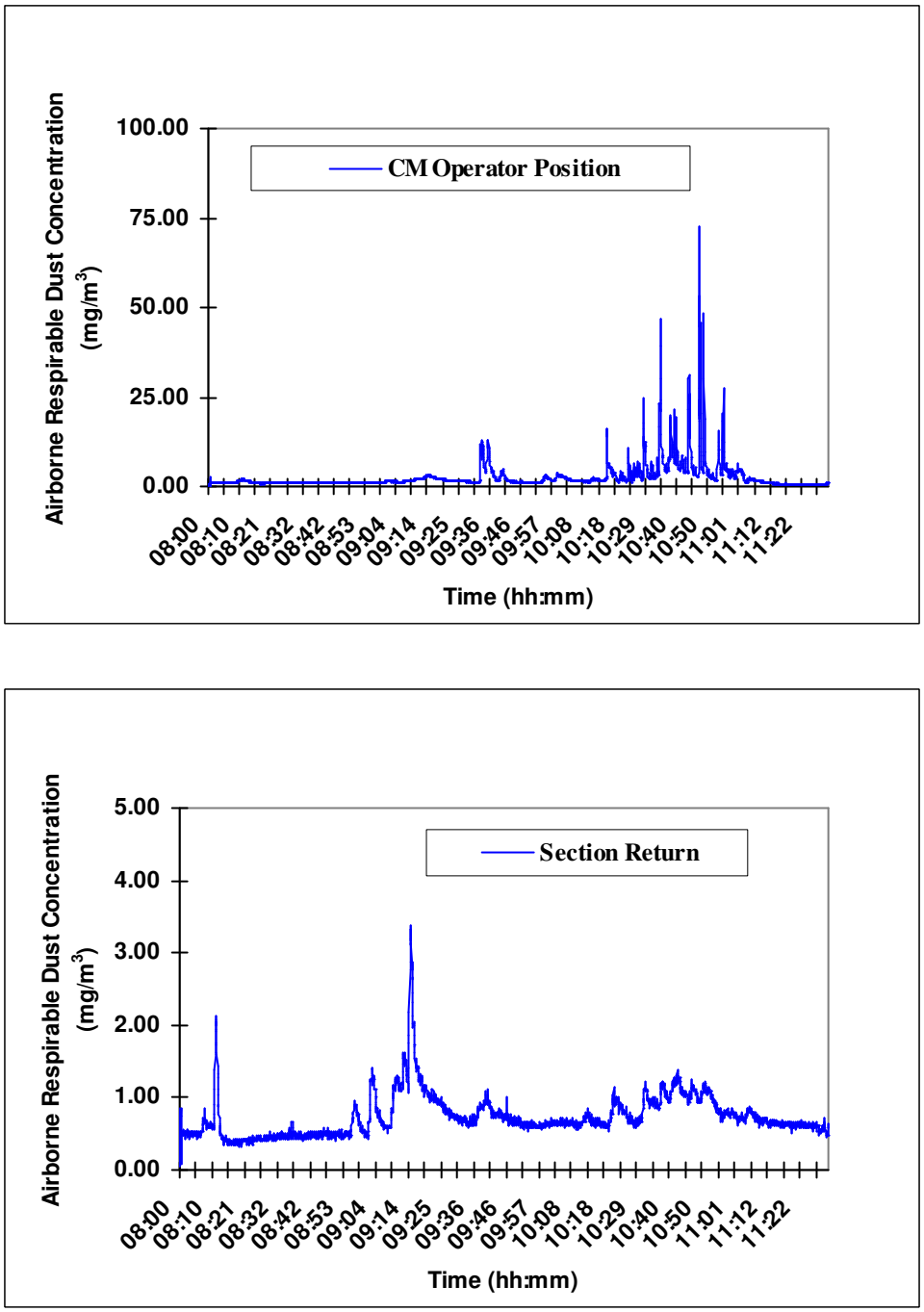


Figure 19: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 19

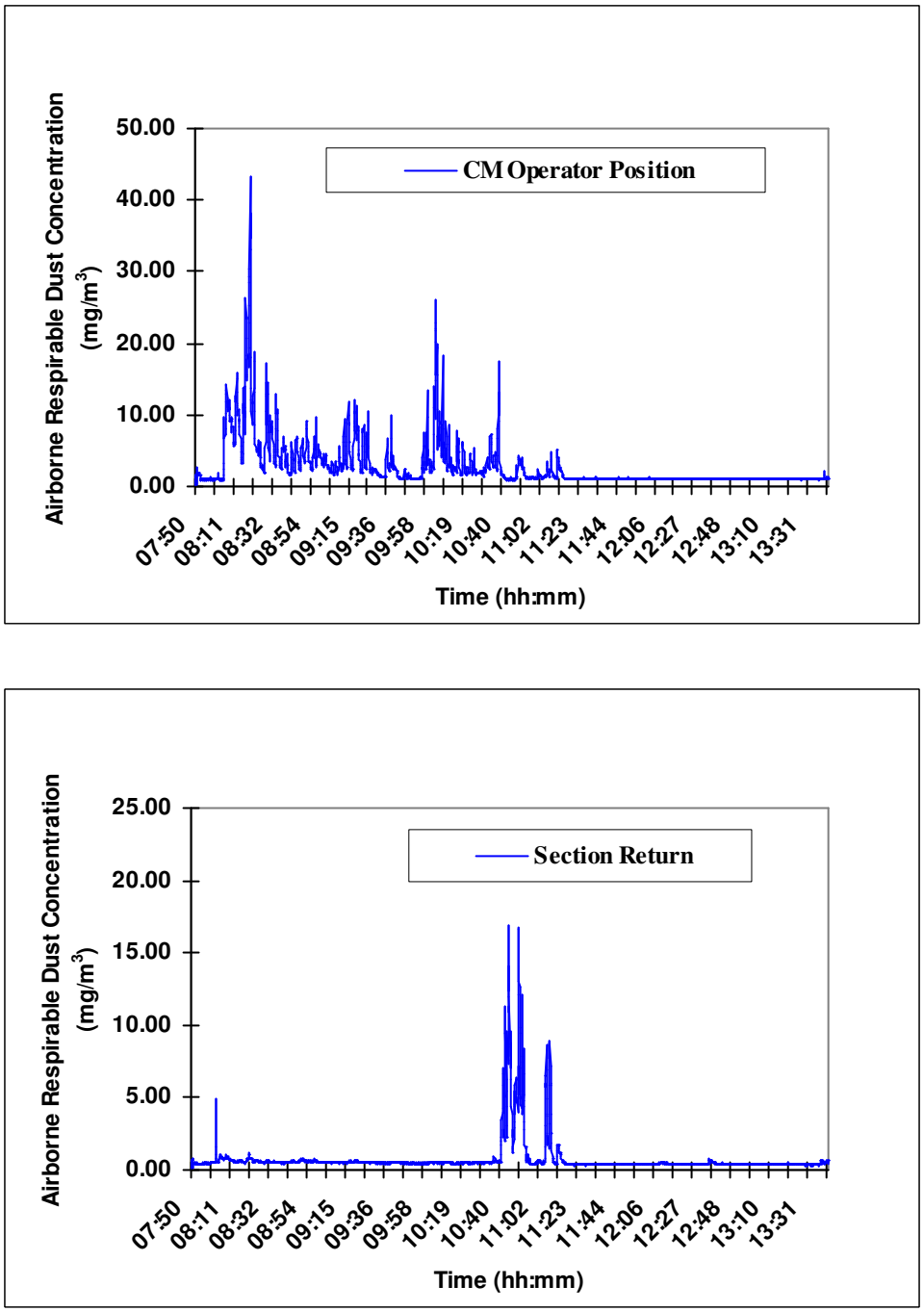


Figure 20: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 20

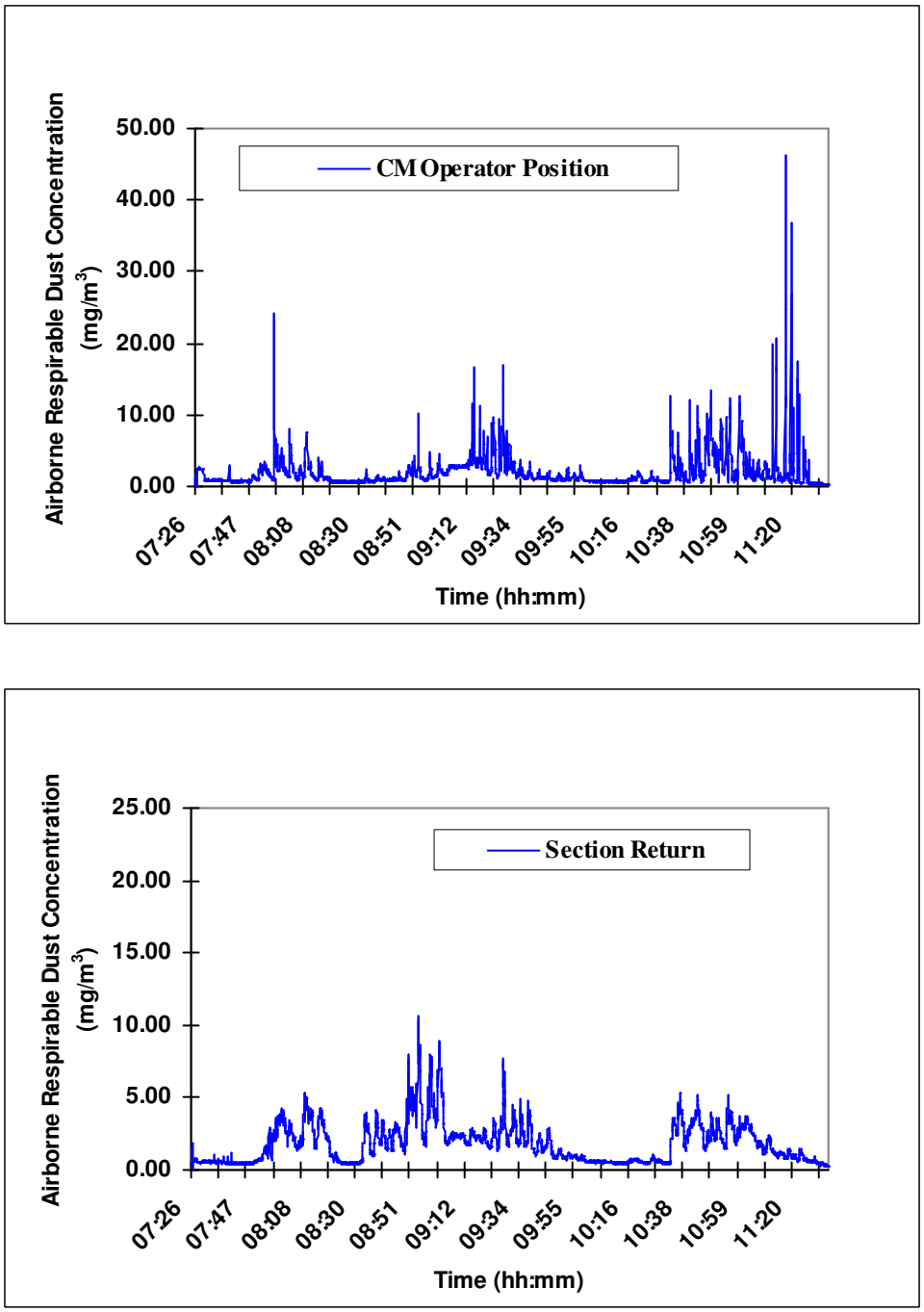


Figure 21: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 21

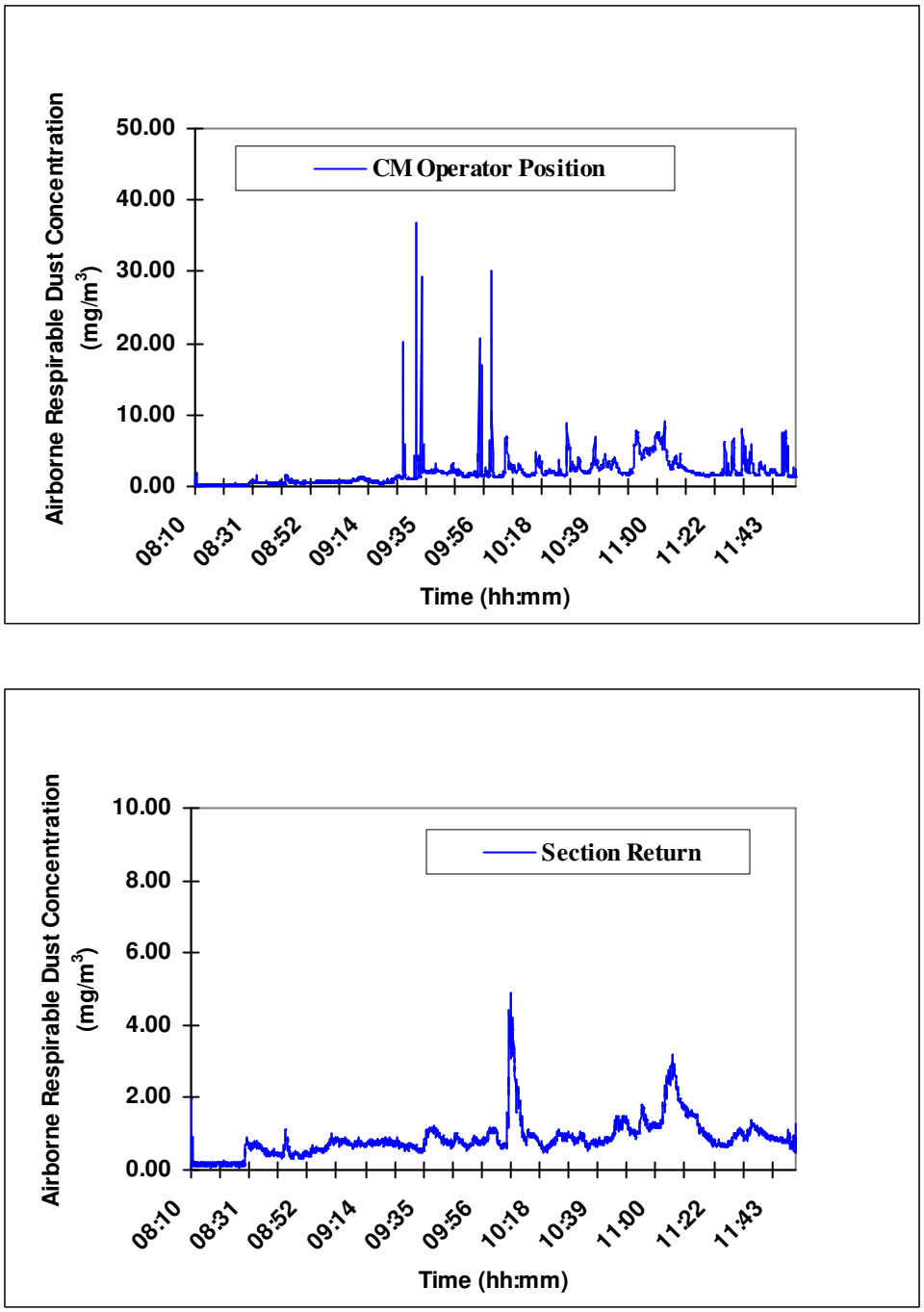


Figure 22: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 22

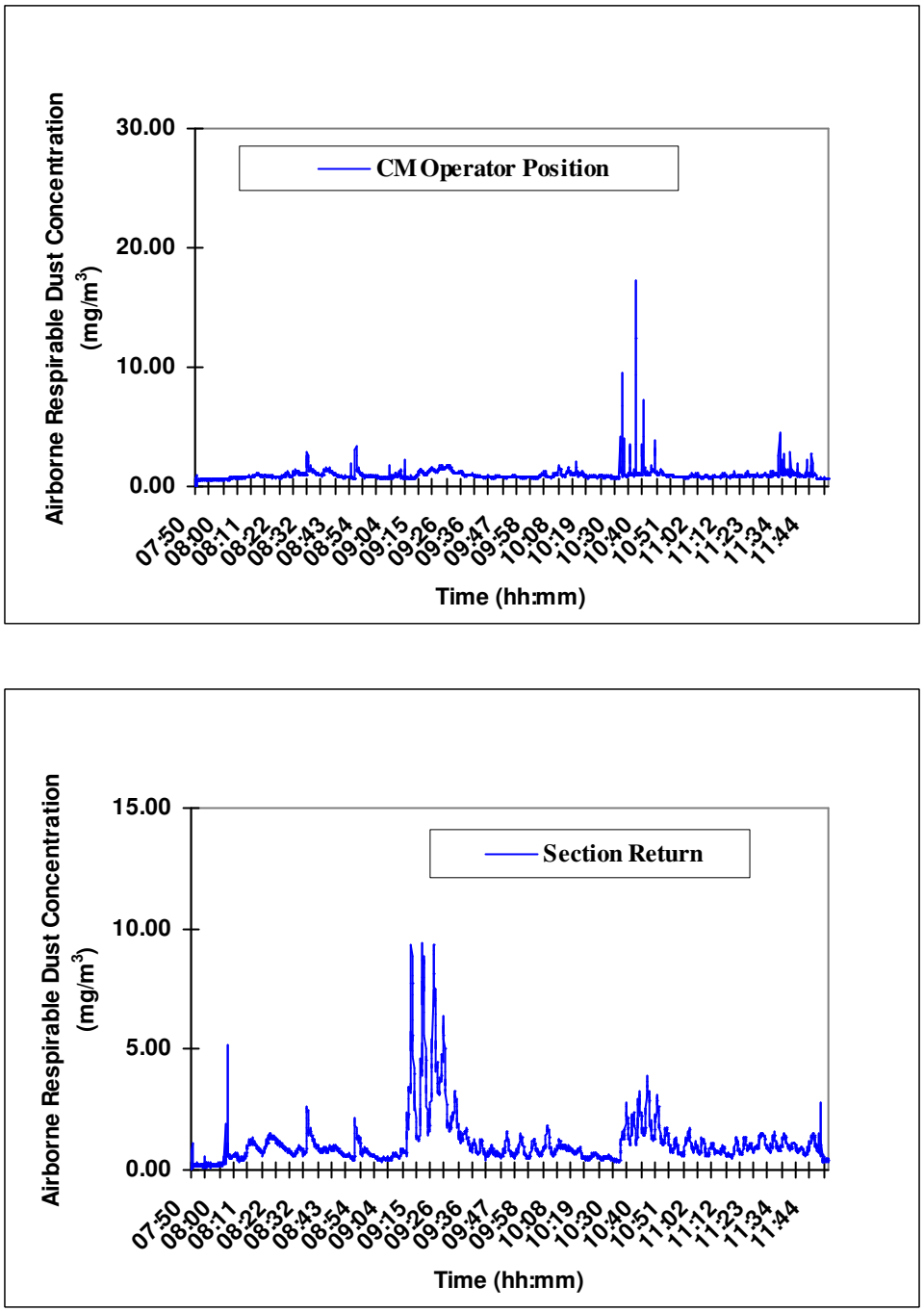


Figure 23: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 23

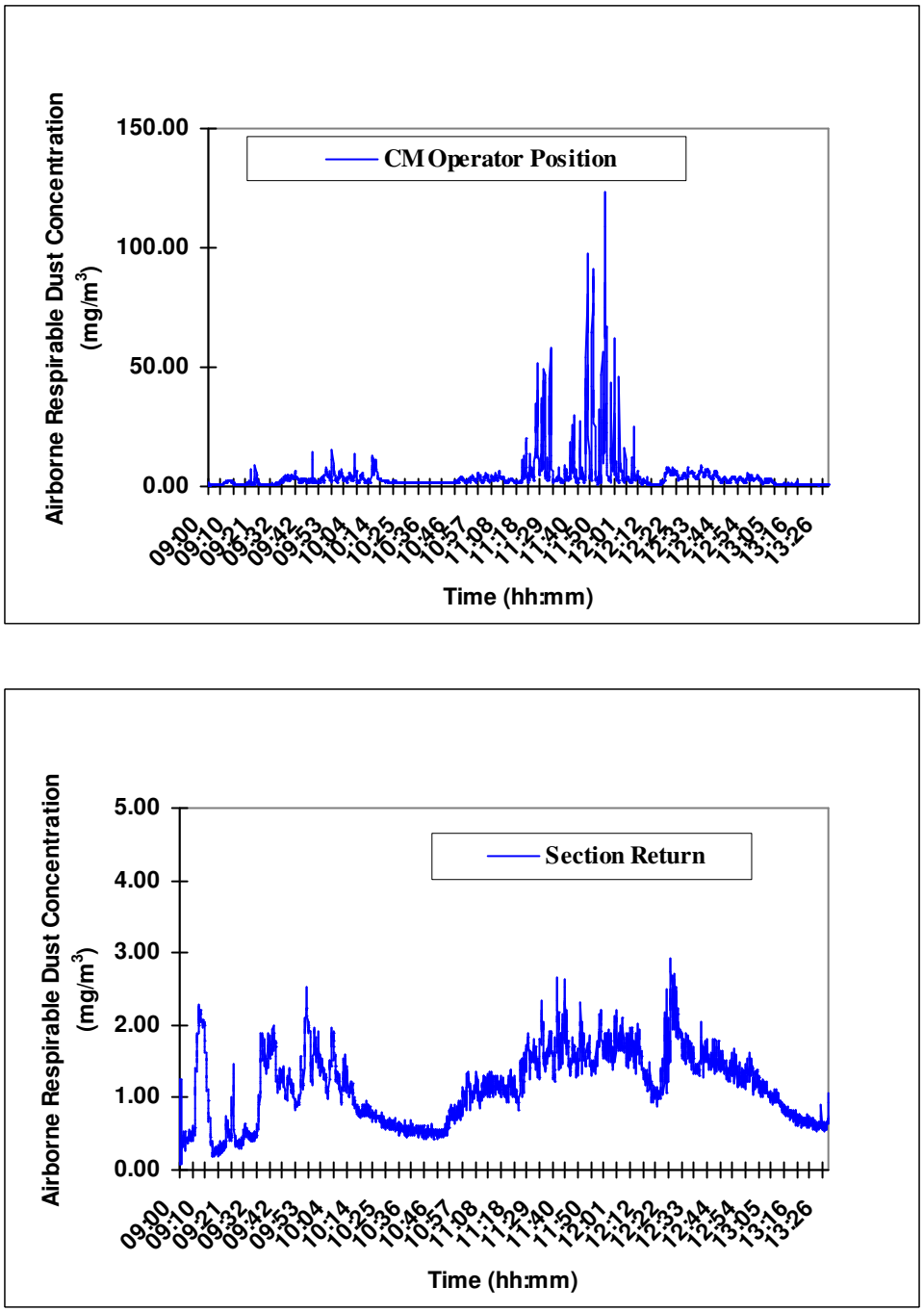


Figure 24: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 24

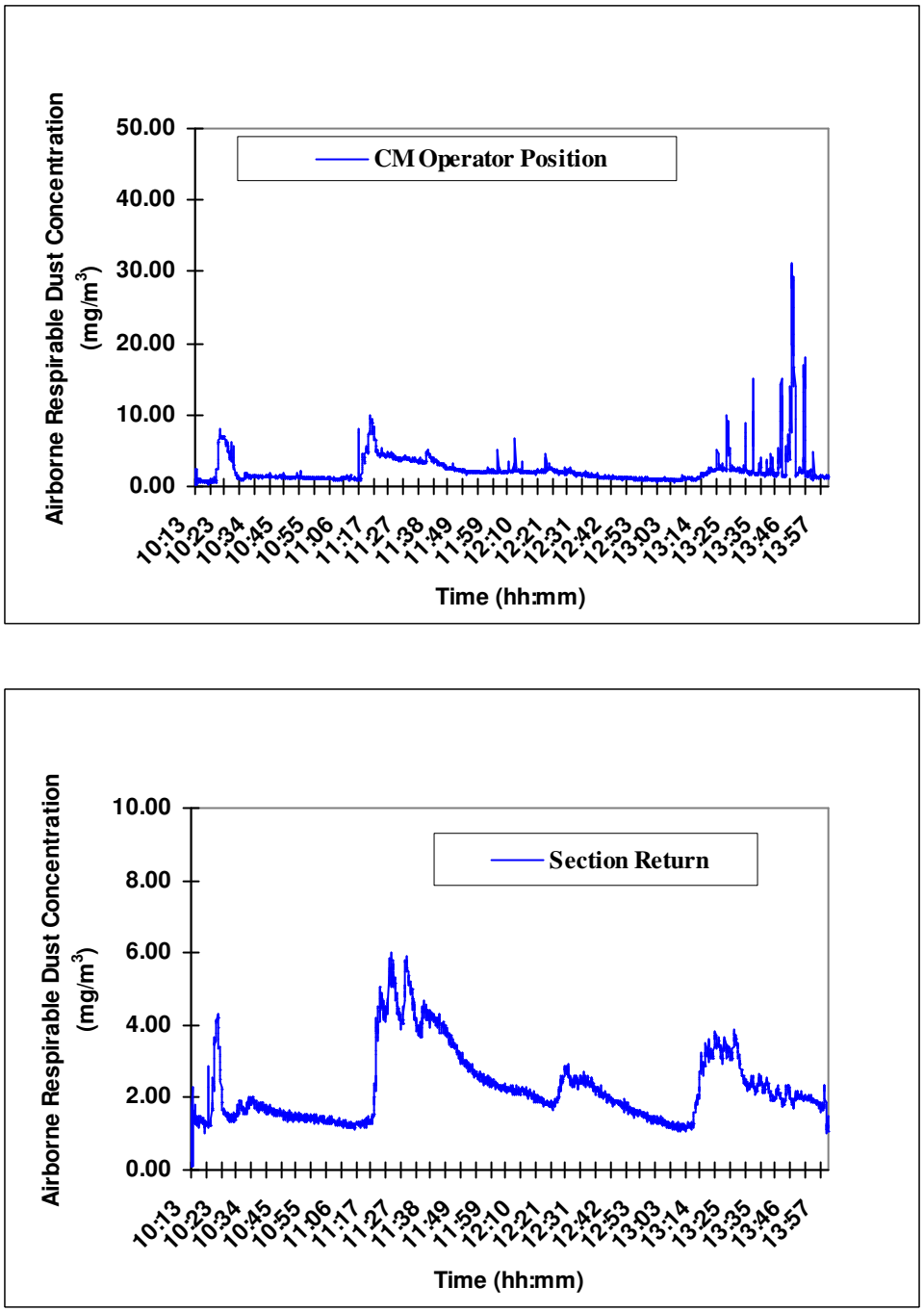


Figure 25: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 25

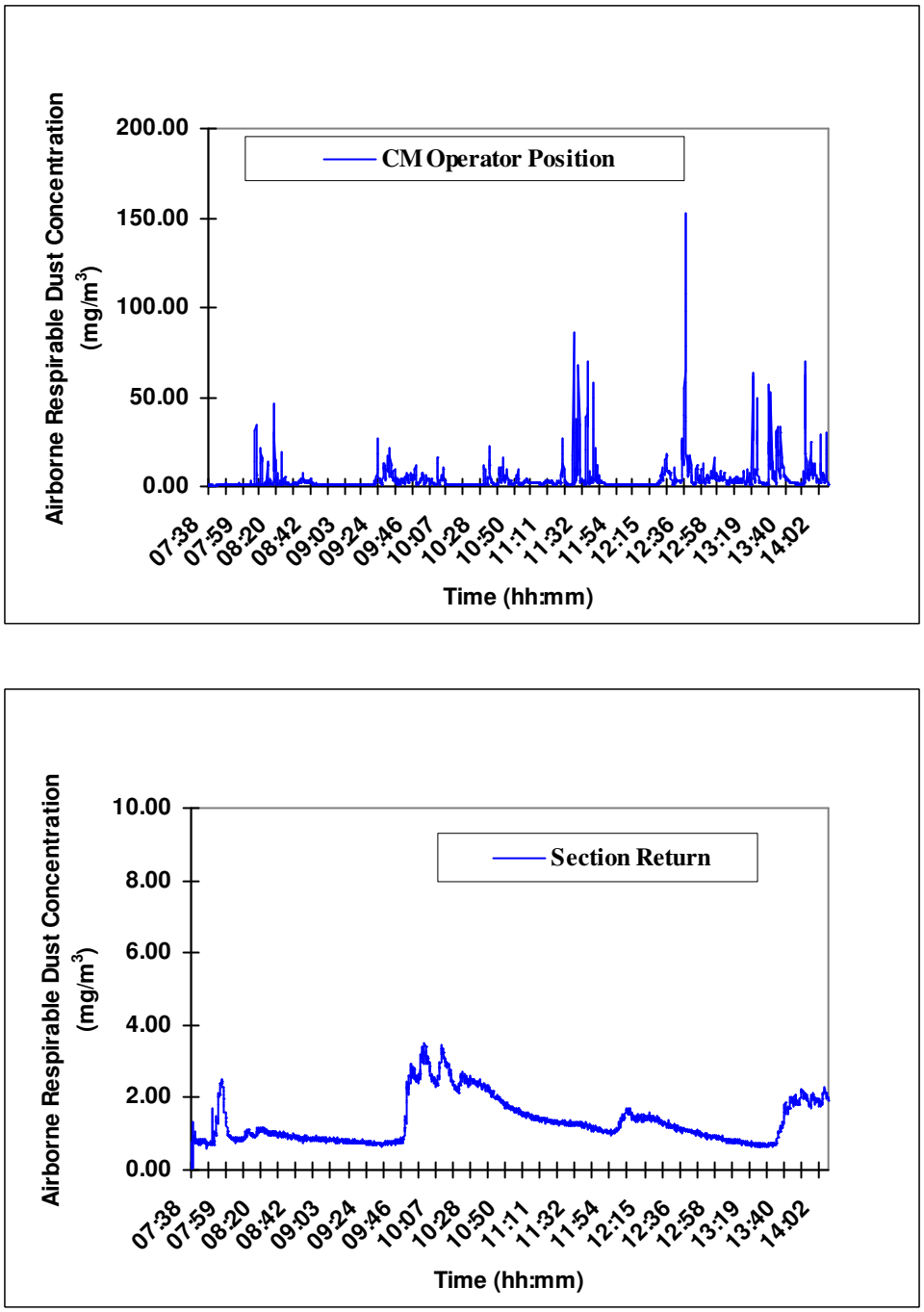


Figure 26: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A1-Test # 26

APPENDIX-B2

CM Operator and Section Return Real-Time Dust Profiles-Mine A2 (Chapter 6, 8)

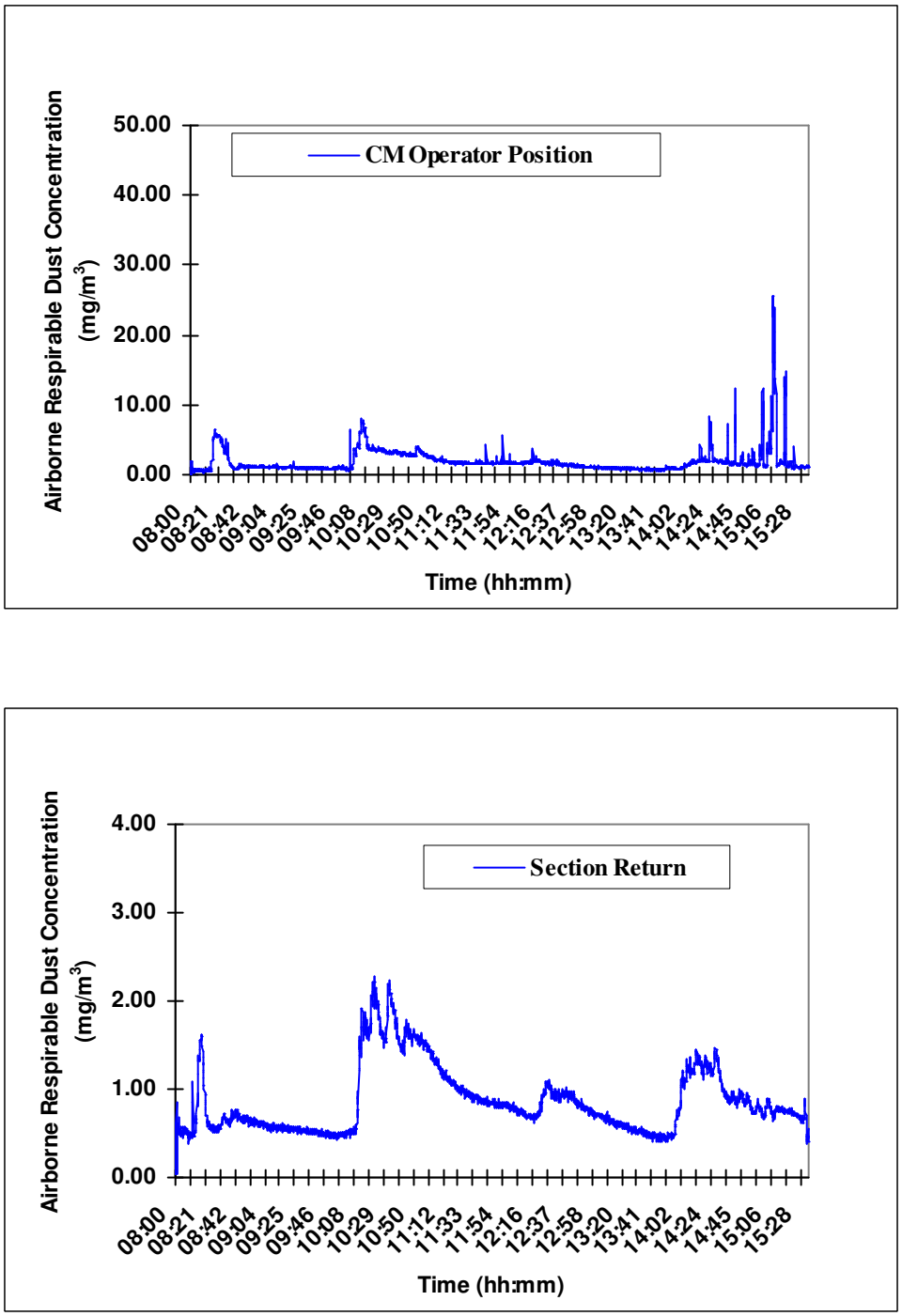


Figure 1: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A2-Test # 1

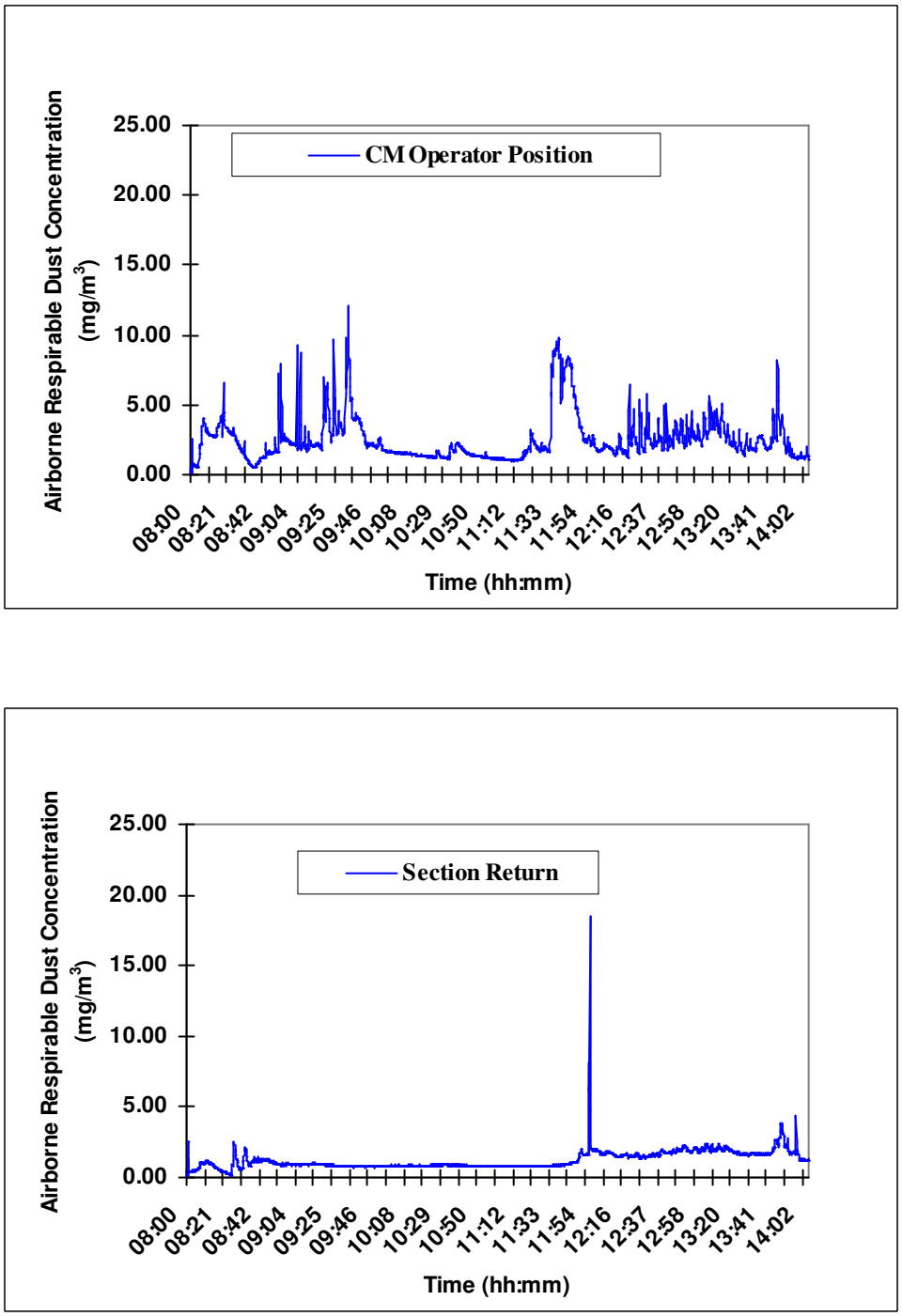


Figure 2: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A2-Test # 2

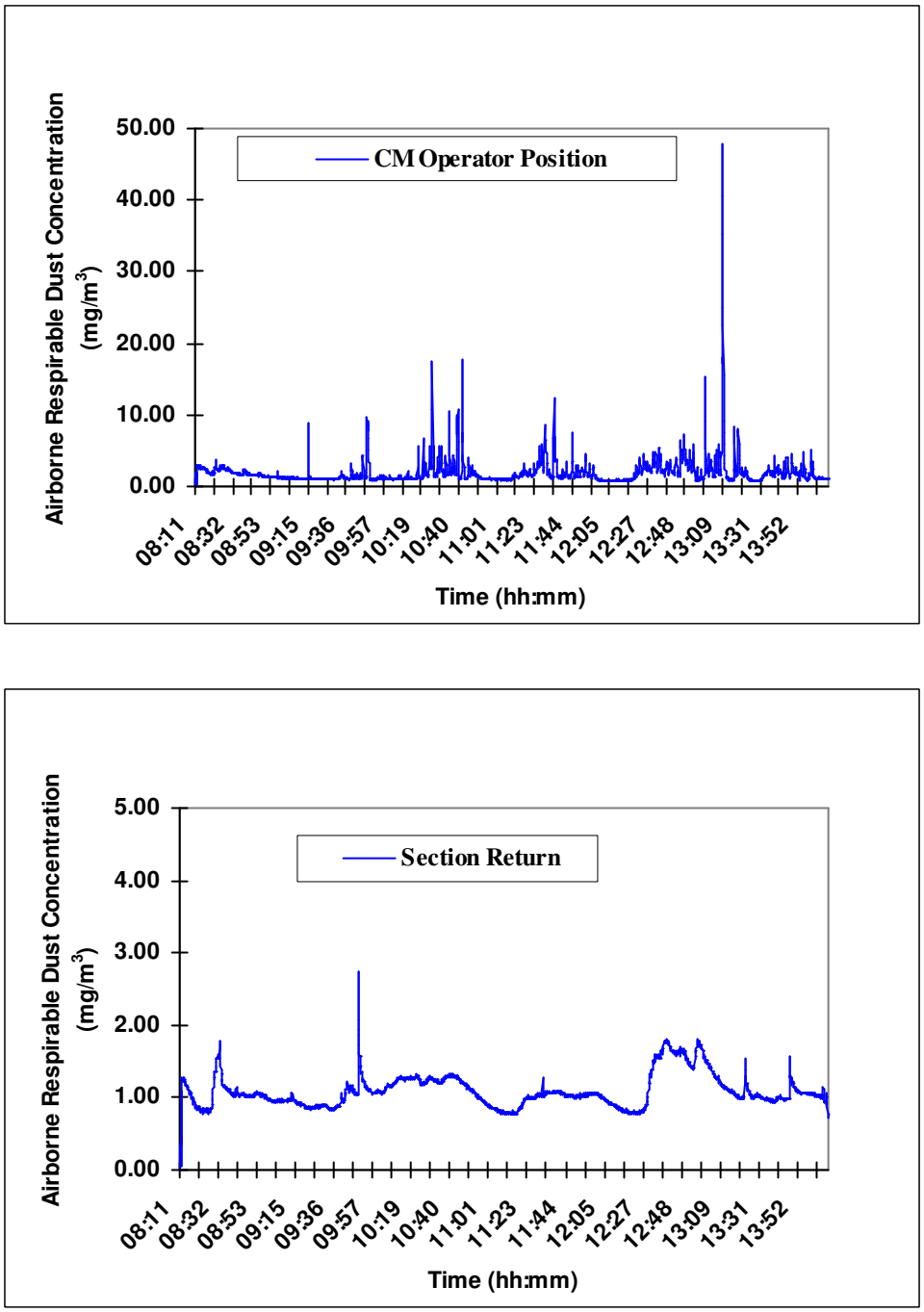


Figure 3: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A2-Test # 3

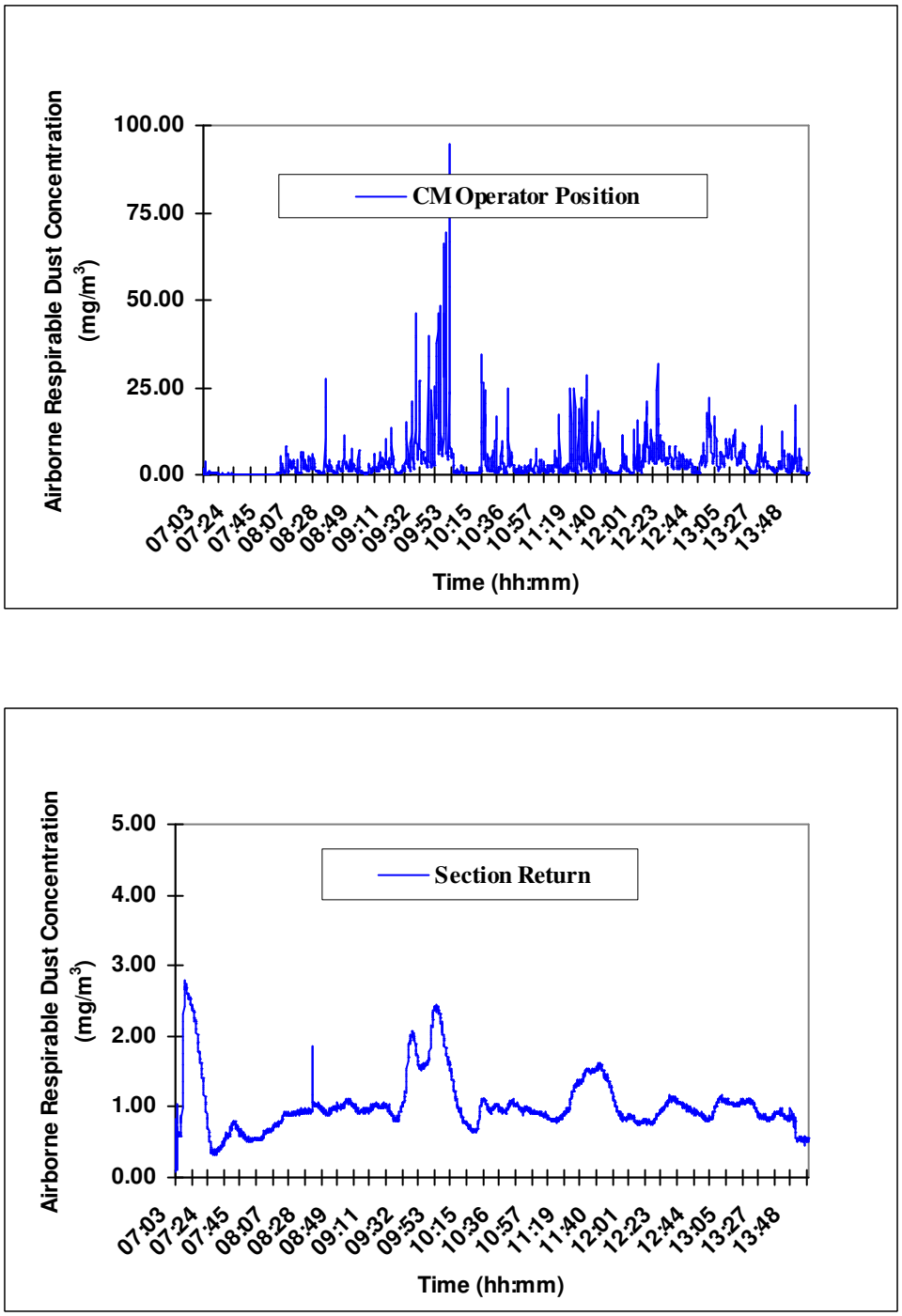


Figure 4: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A2-Test # 4

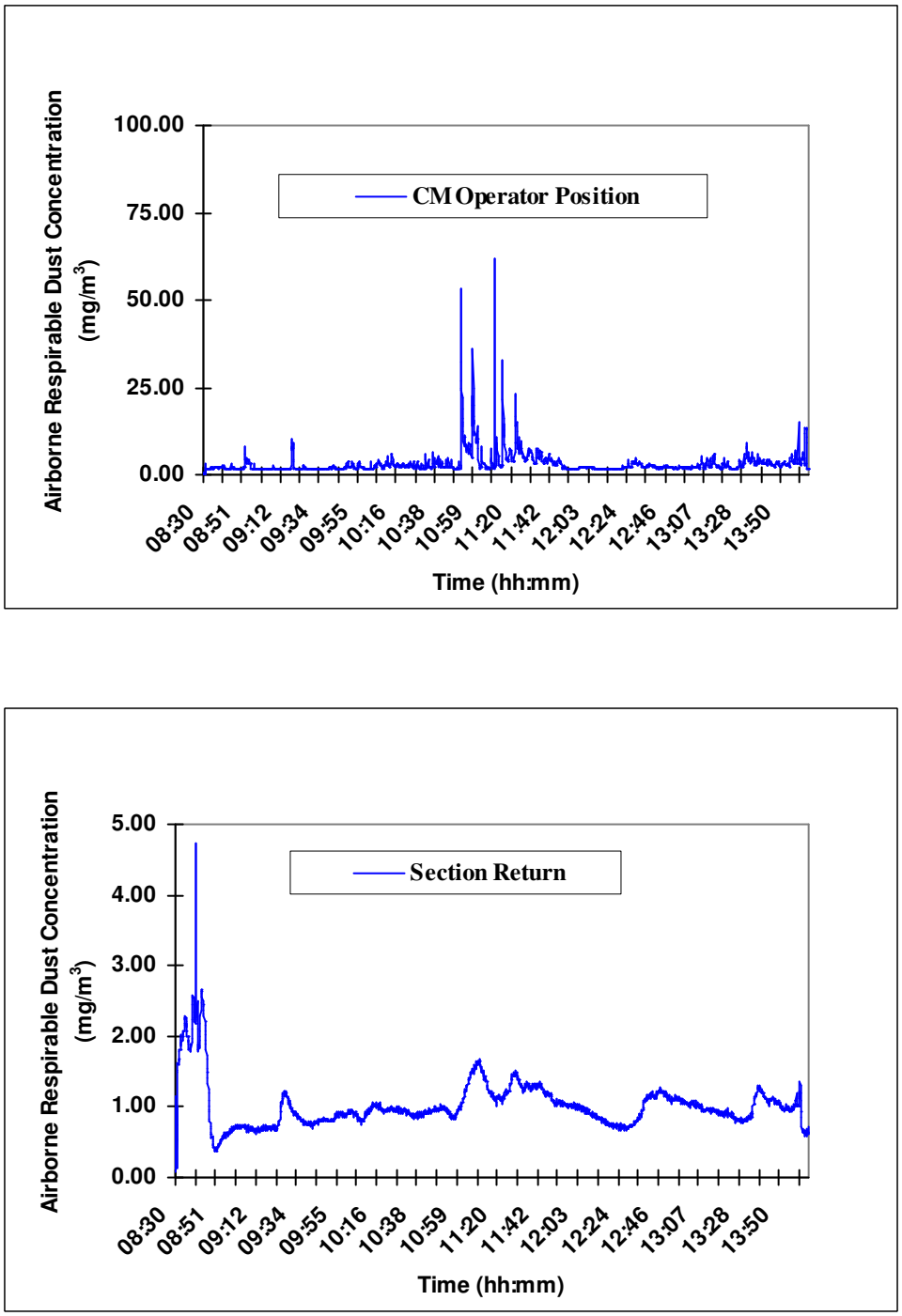


Figure 5: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A2-Test # 5

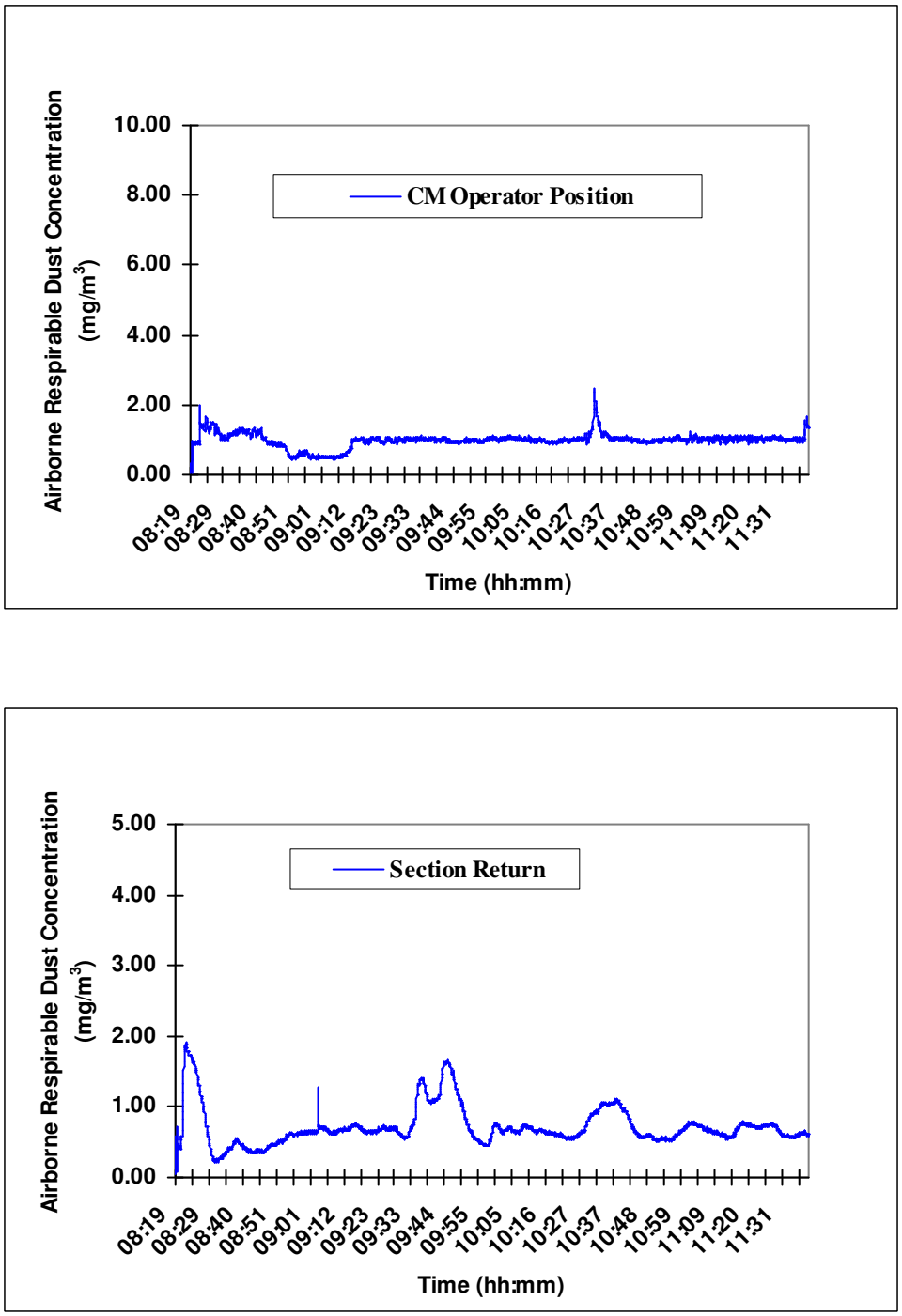


Figure 6: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A2-Test # 6

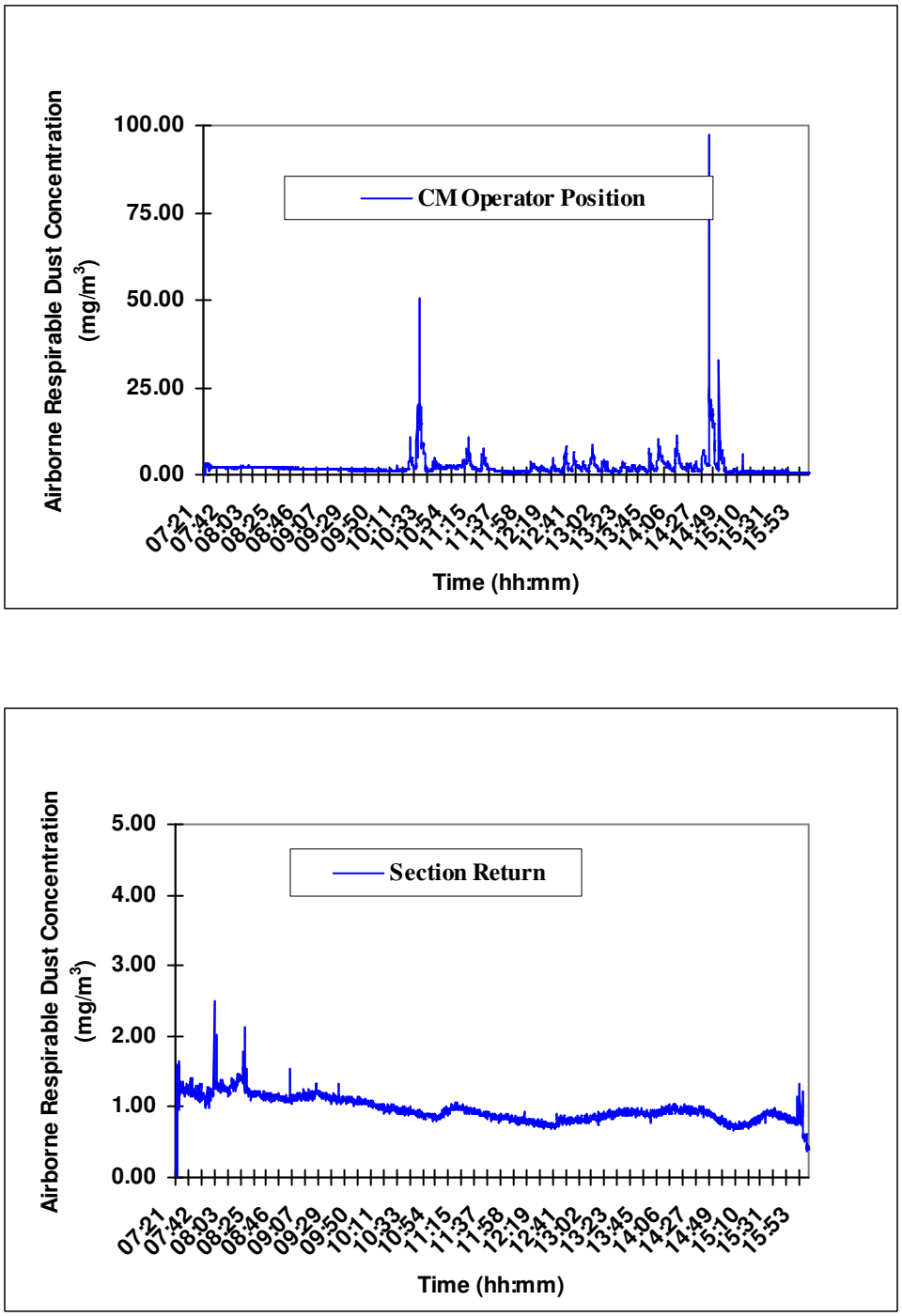


Figure 7: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A2-Test # 7

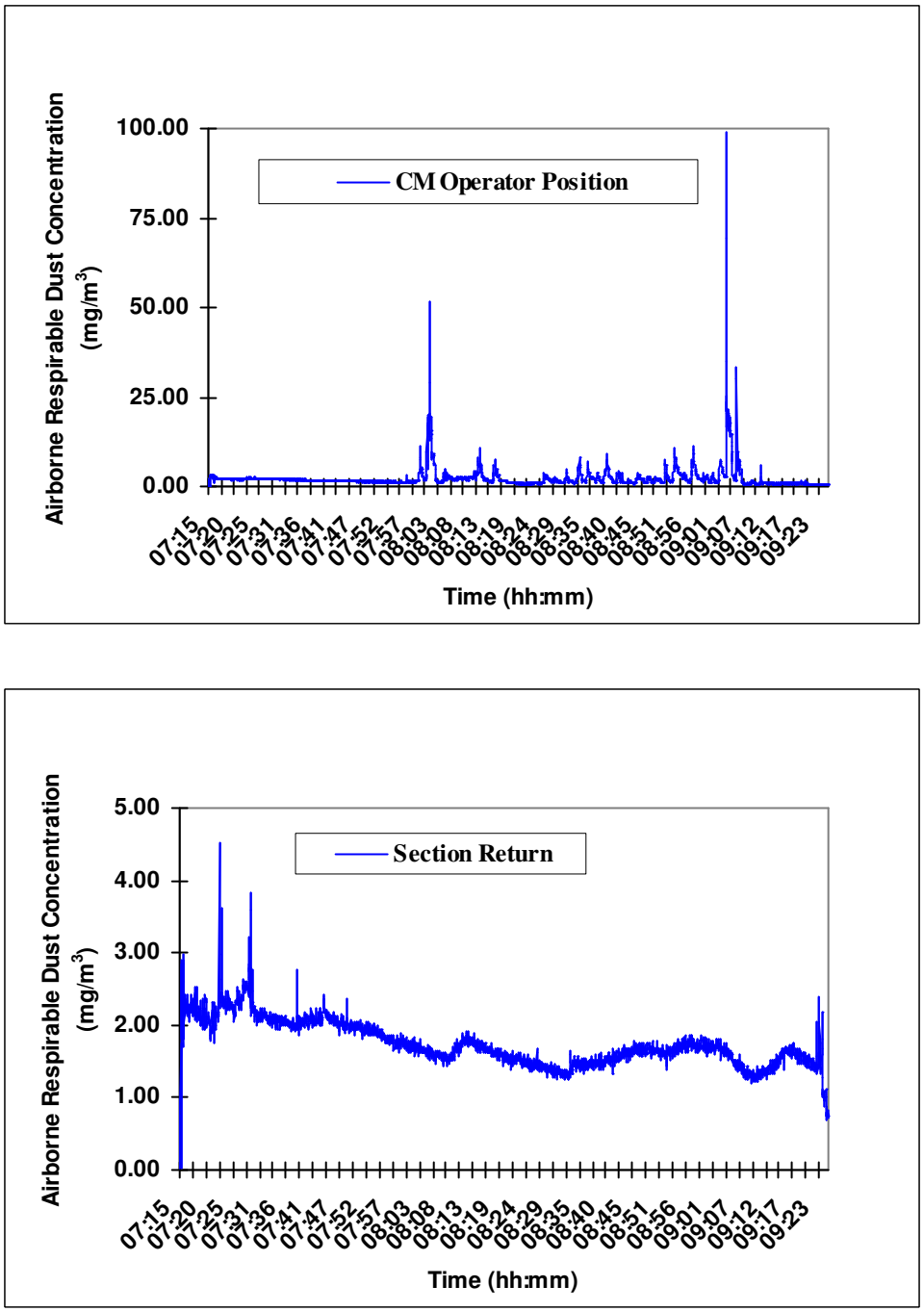


Figure 8: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A2-Test # 8

APPENDIX-B3

CM Operator and Section Return Real-Time Dust Profiles-Mine A3 (Chapter 6, 8)

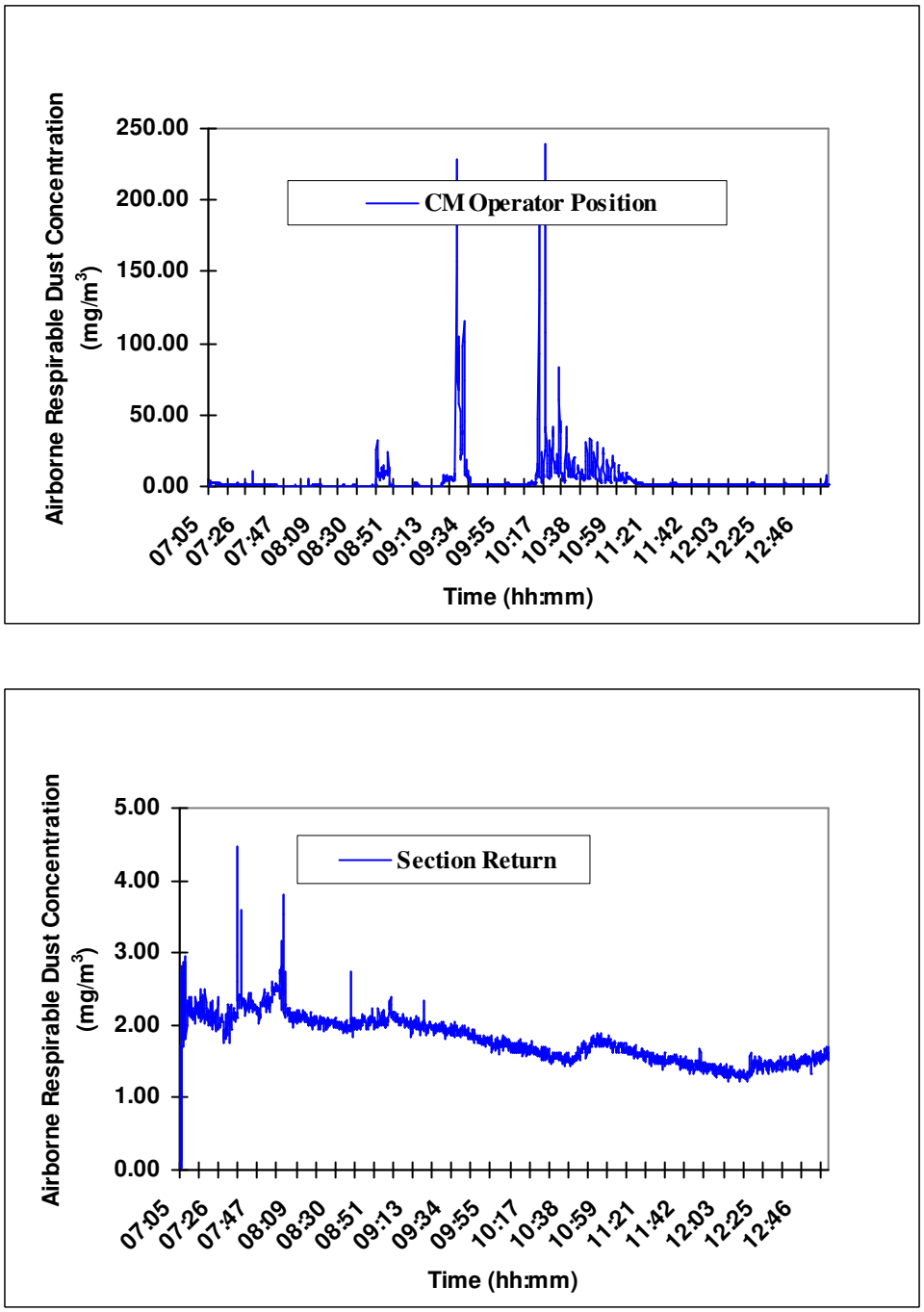


Figure 1: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 1

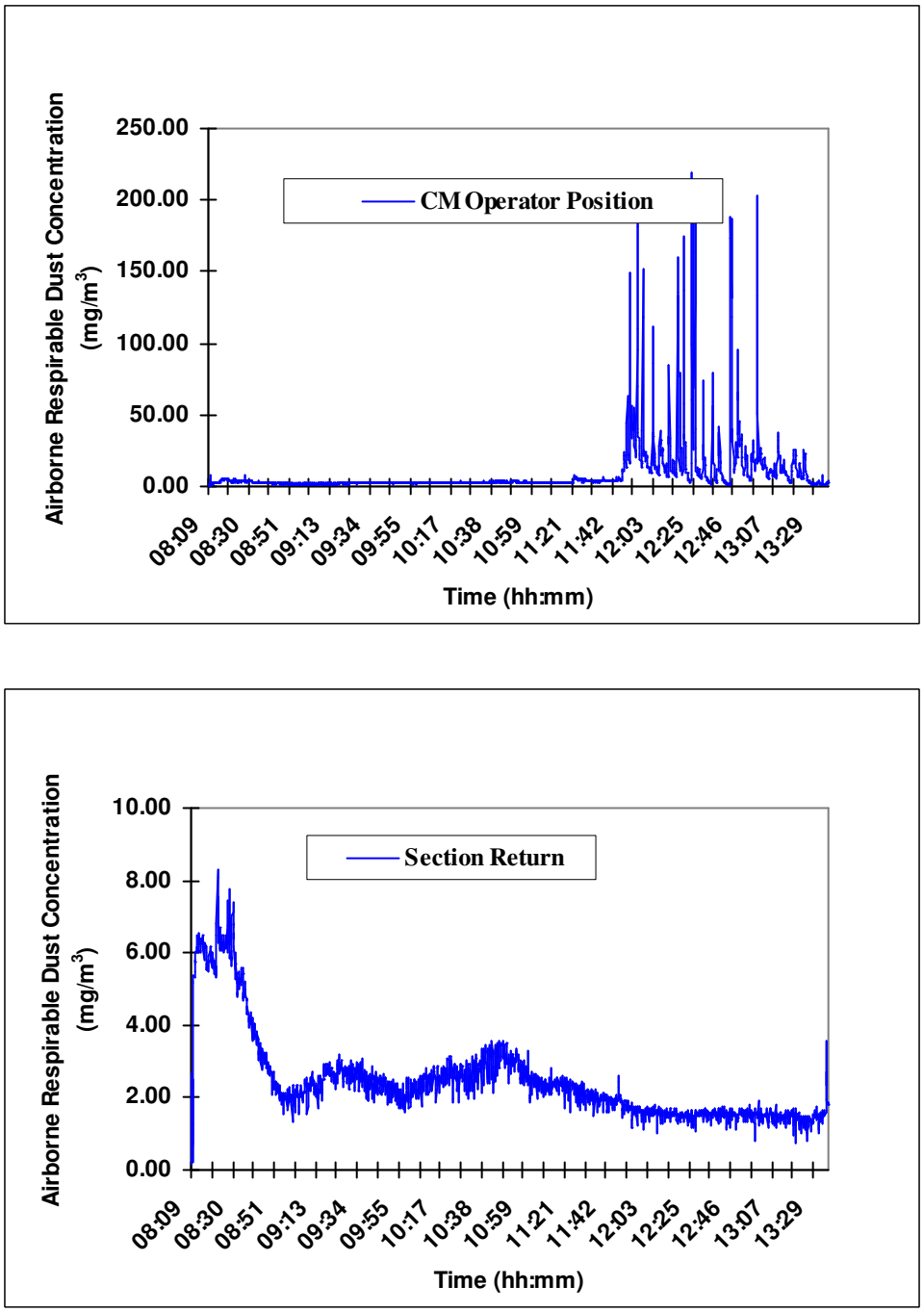


Figure 2: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 2

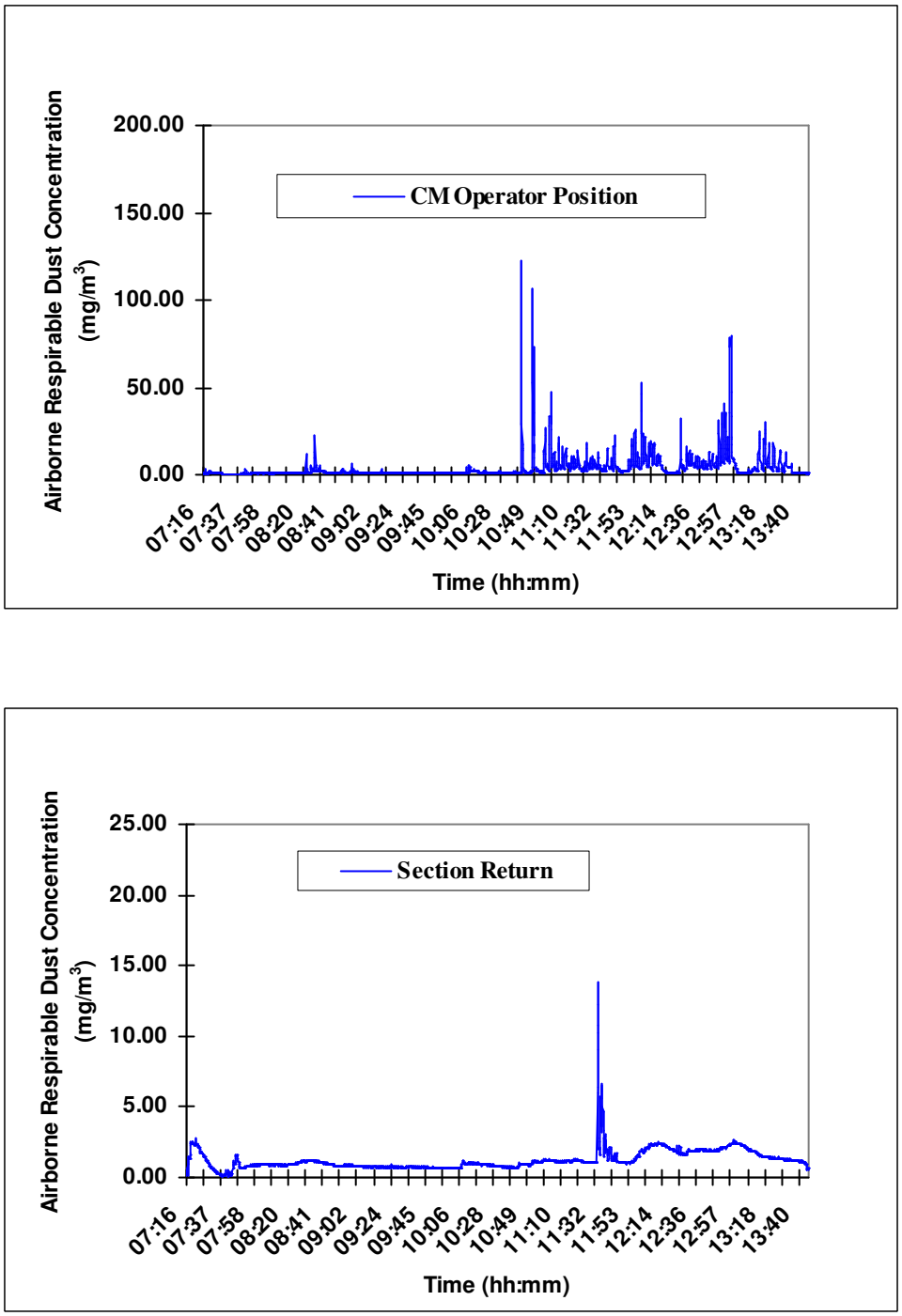


Figure 3: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 3

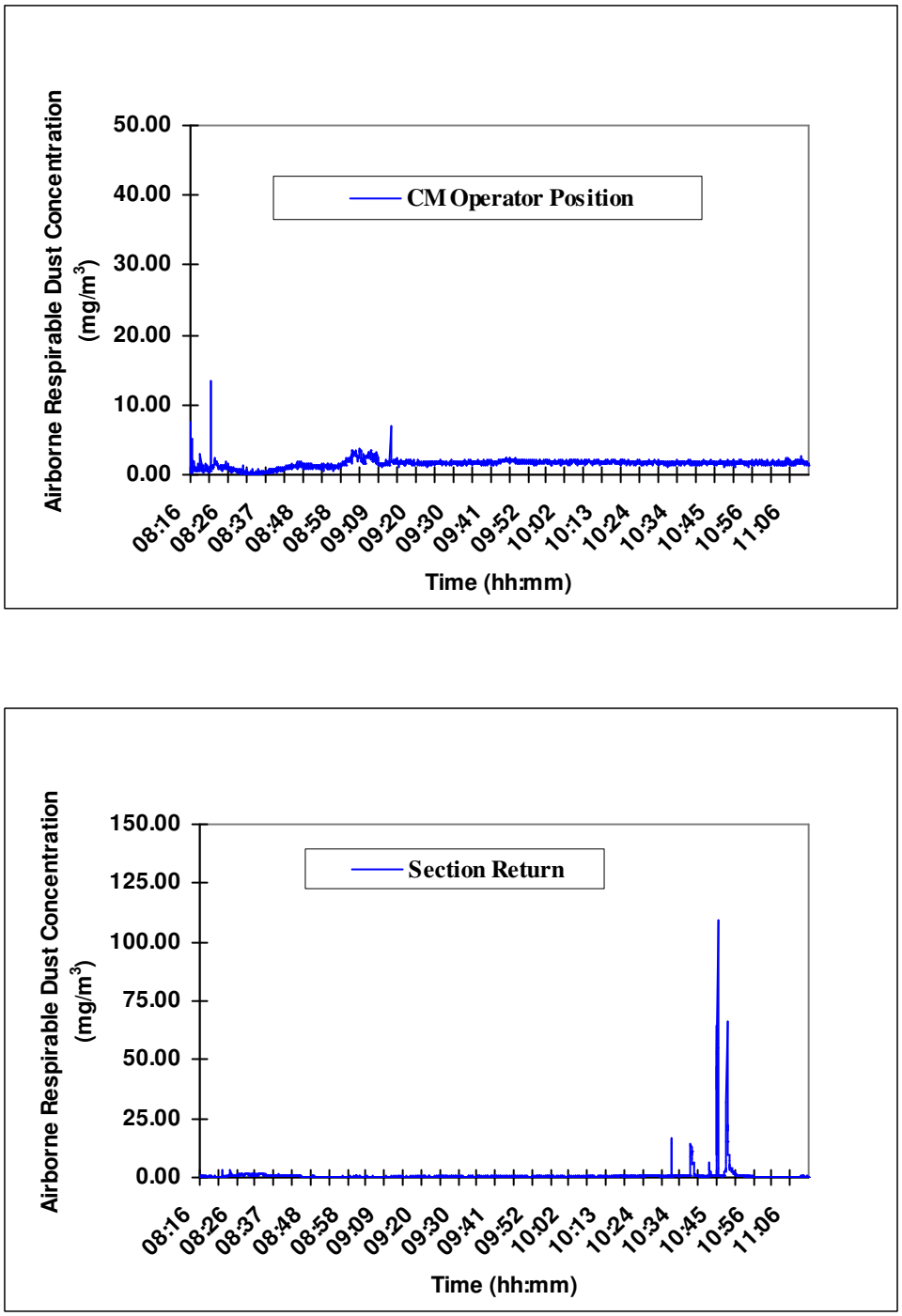


Figure 4: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 4

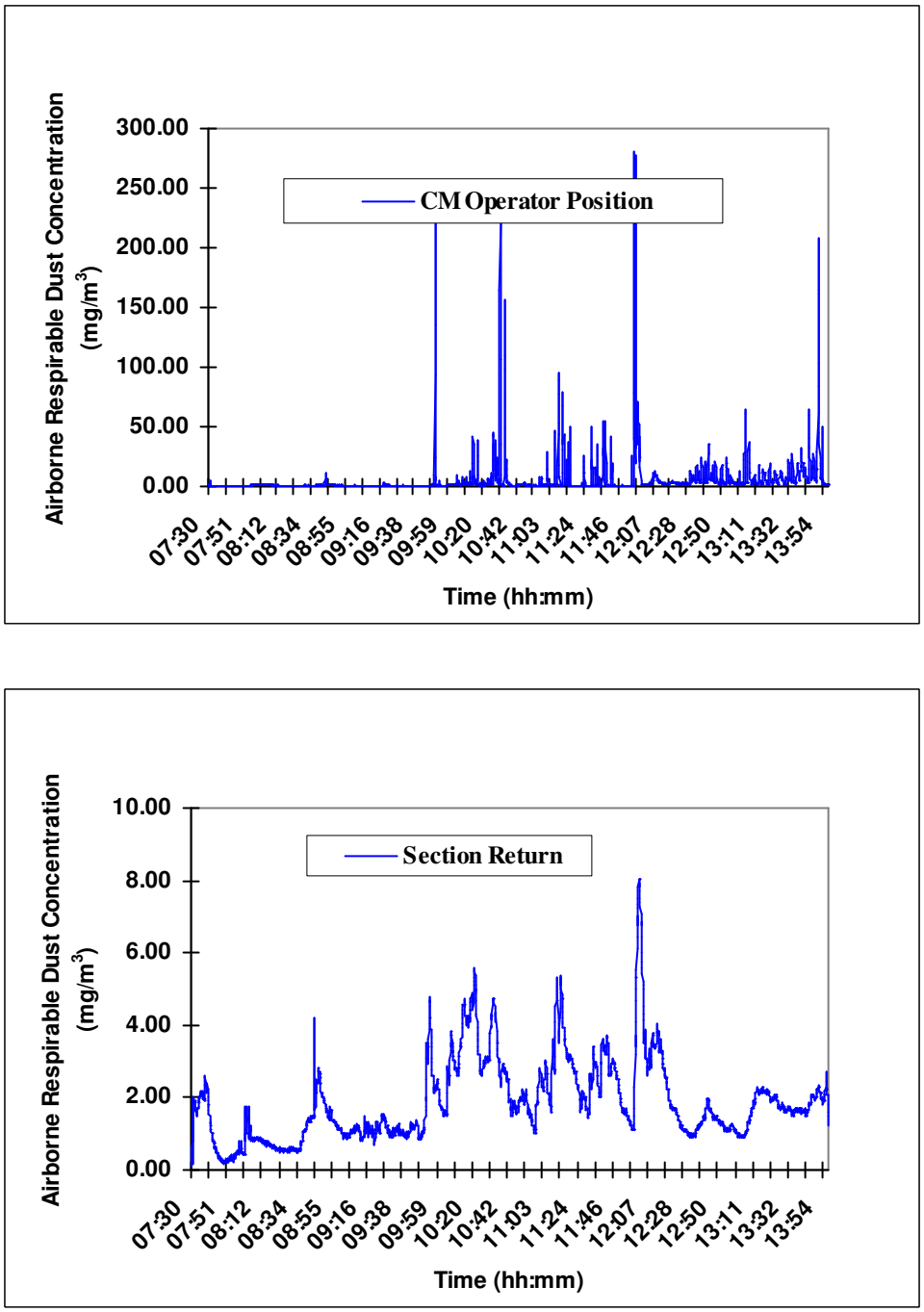


Figure 5: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 5

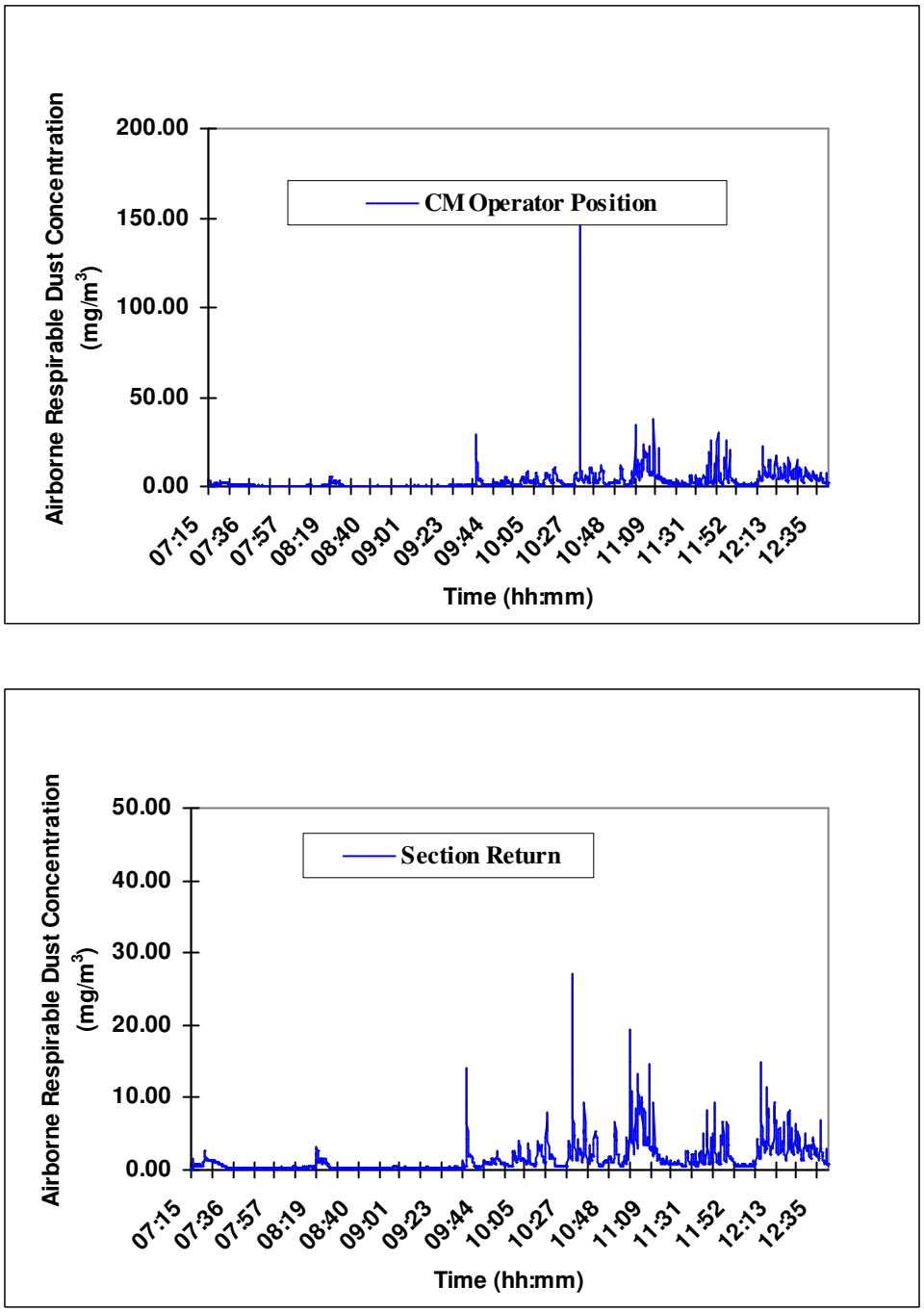


Figure 6: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 6

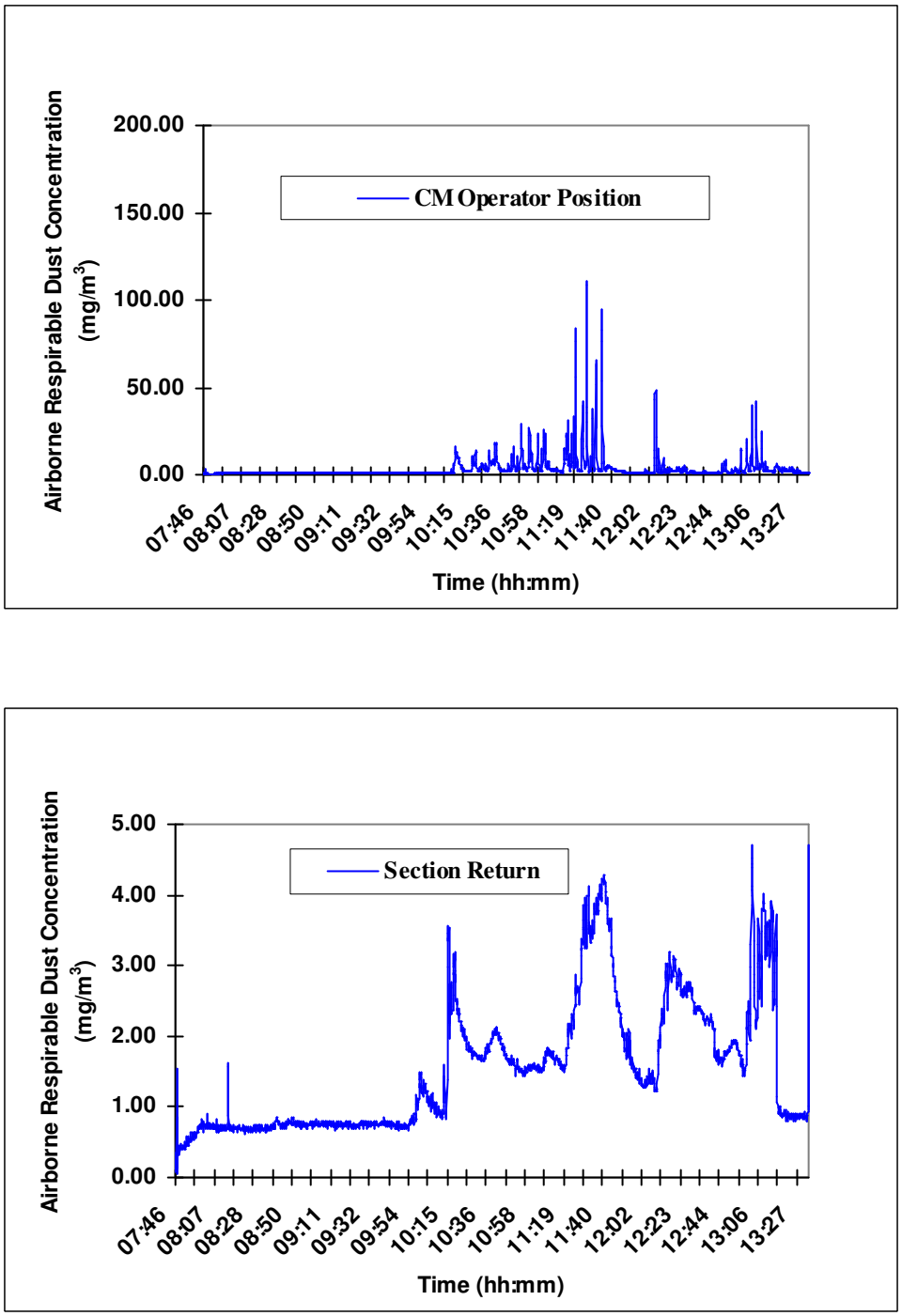


Figure 7: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 7

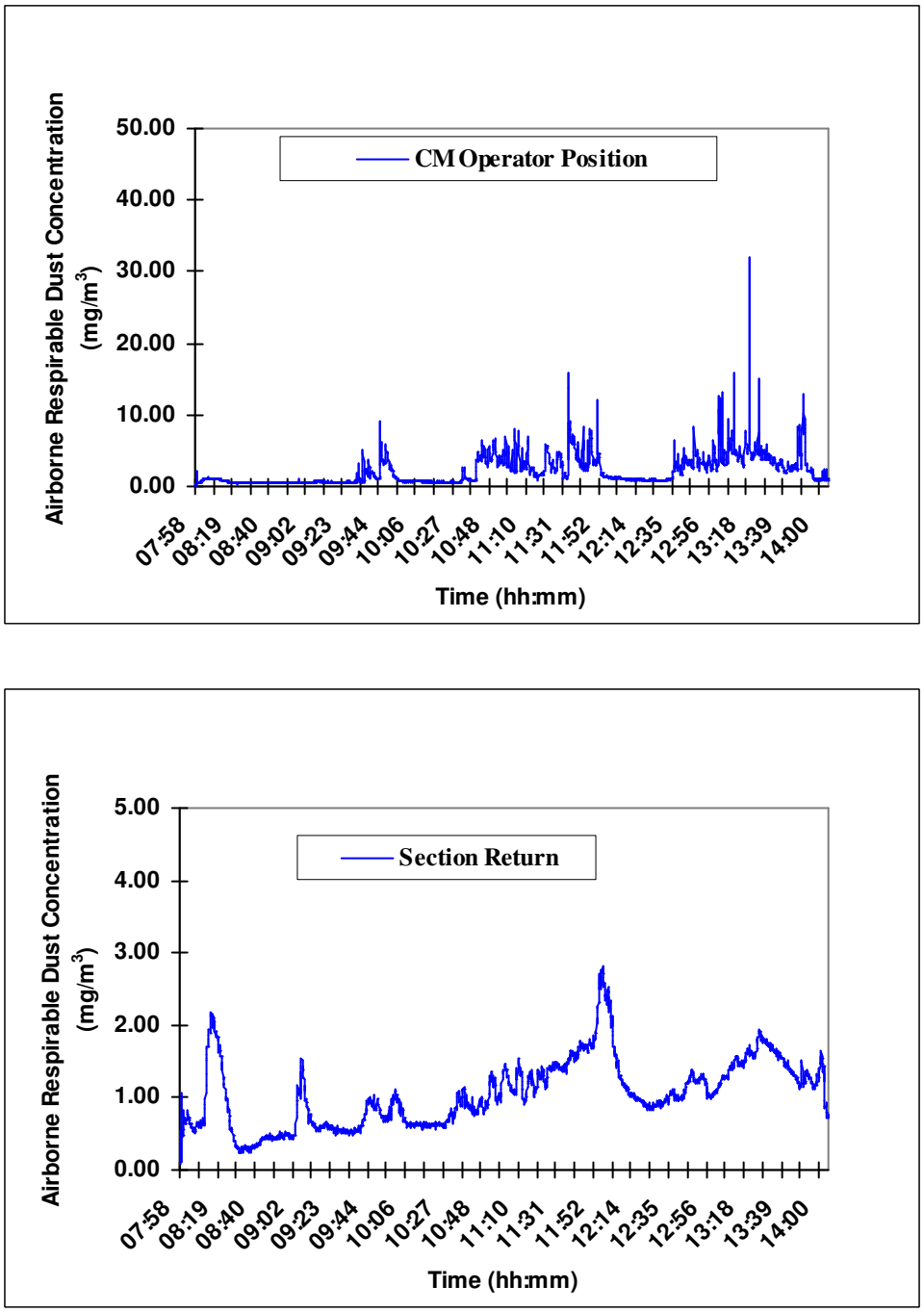


Figure 8: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 8

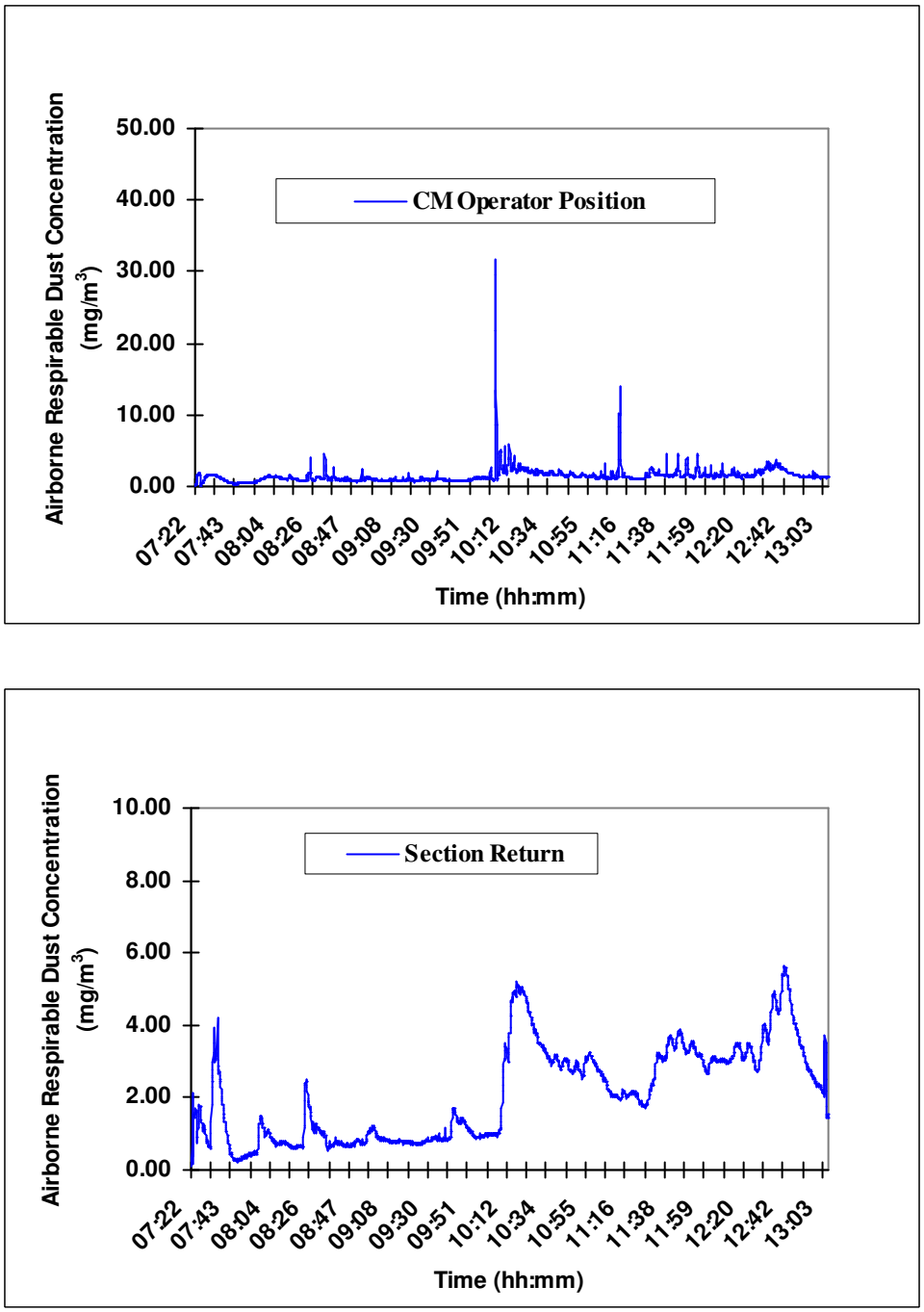


Figure 9: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 9

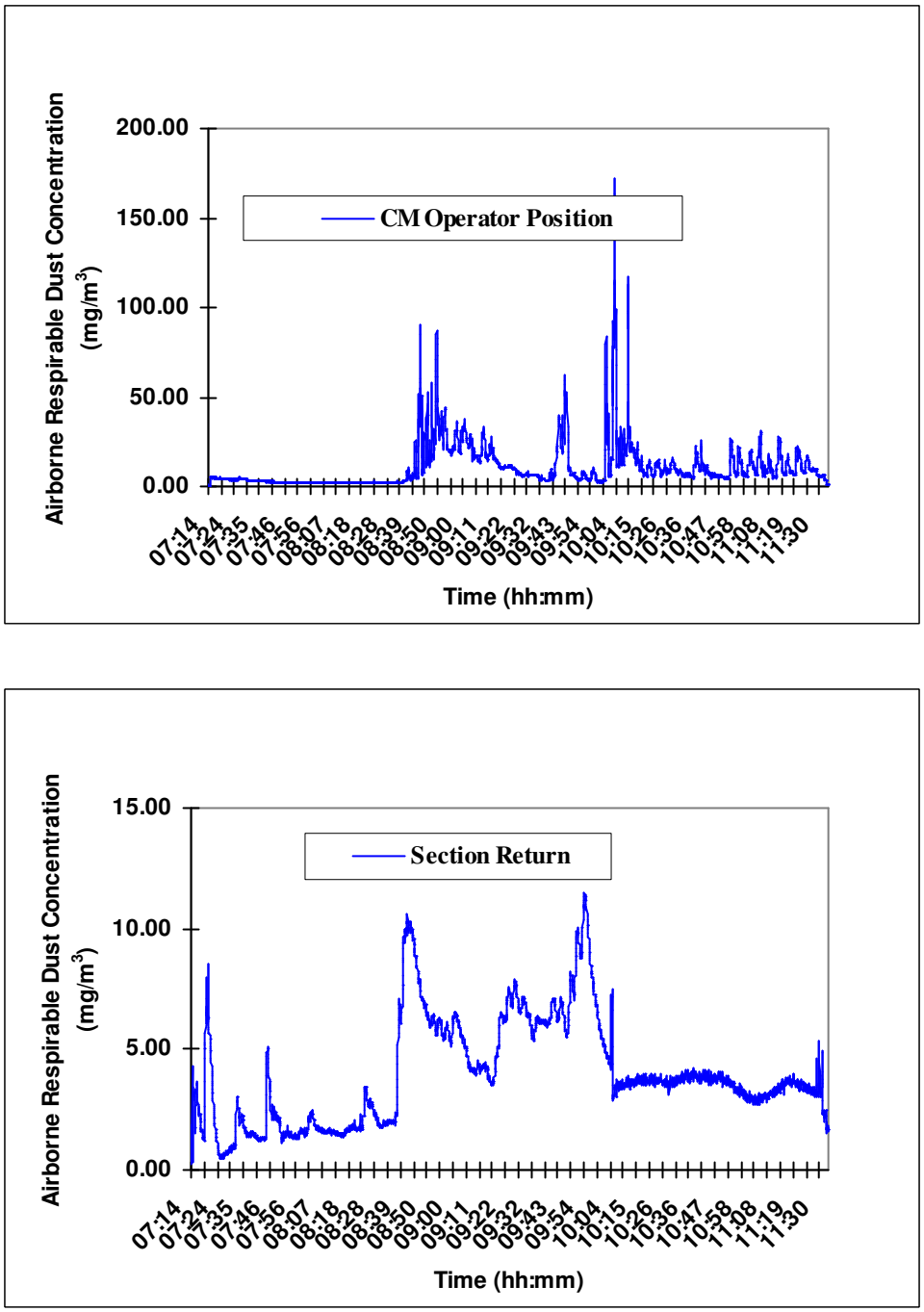
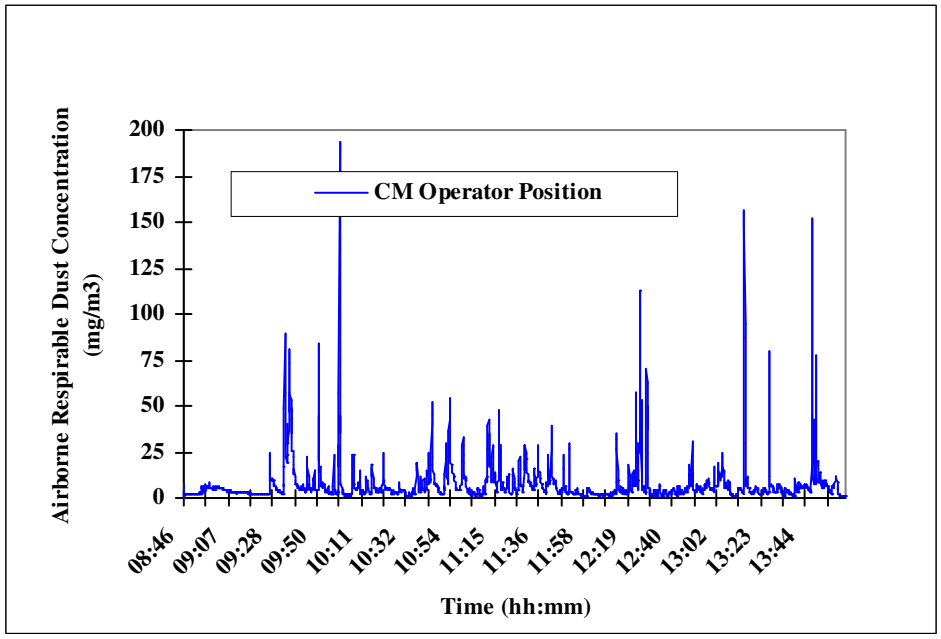


Figure 10: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A3-Test # 10

APPENDIX-B4

CM Operator and Section Return Real-Time Dust Profiles-Mine A4 (Chapter 6, 8)



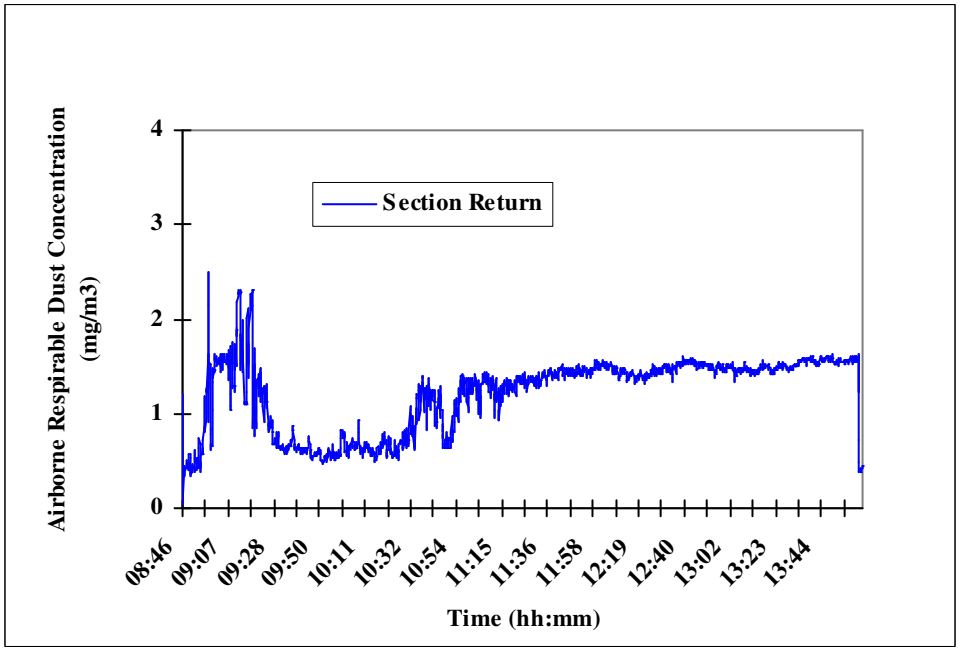


Figure 1: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A4-Test # 1

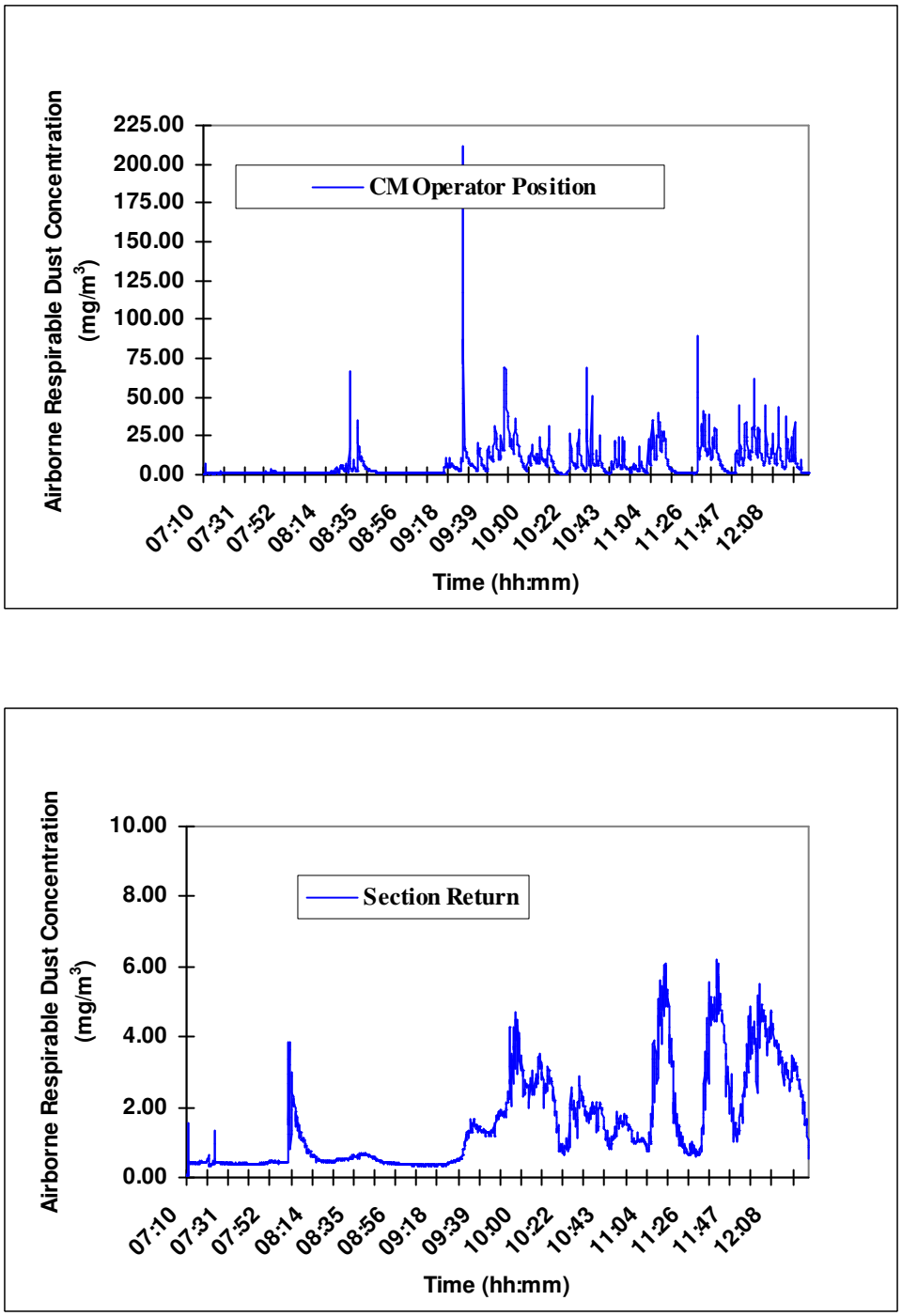


Figure 2: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A4-Test # 2

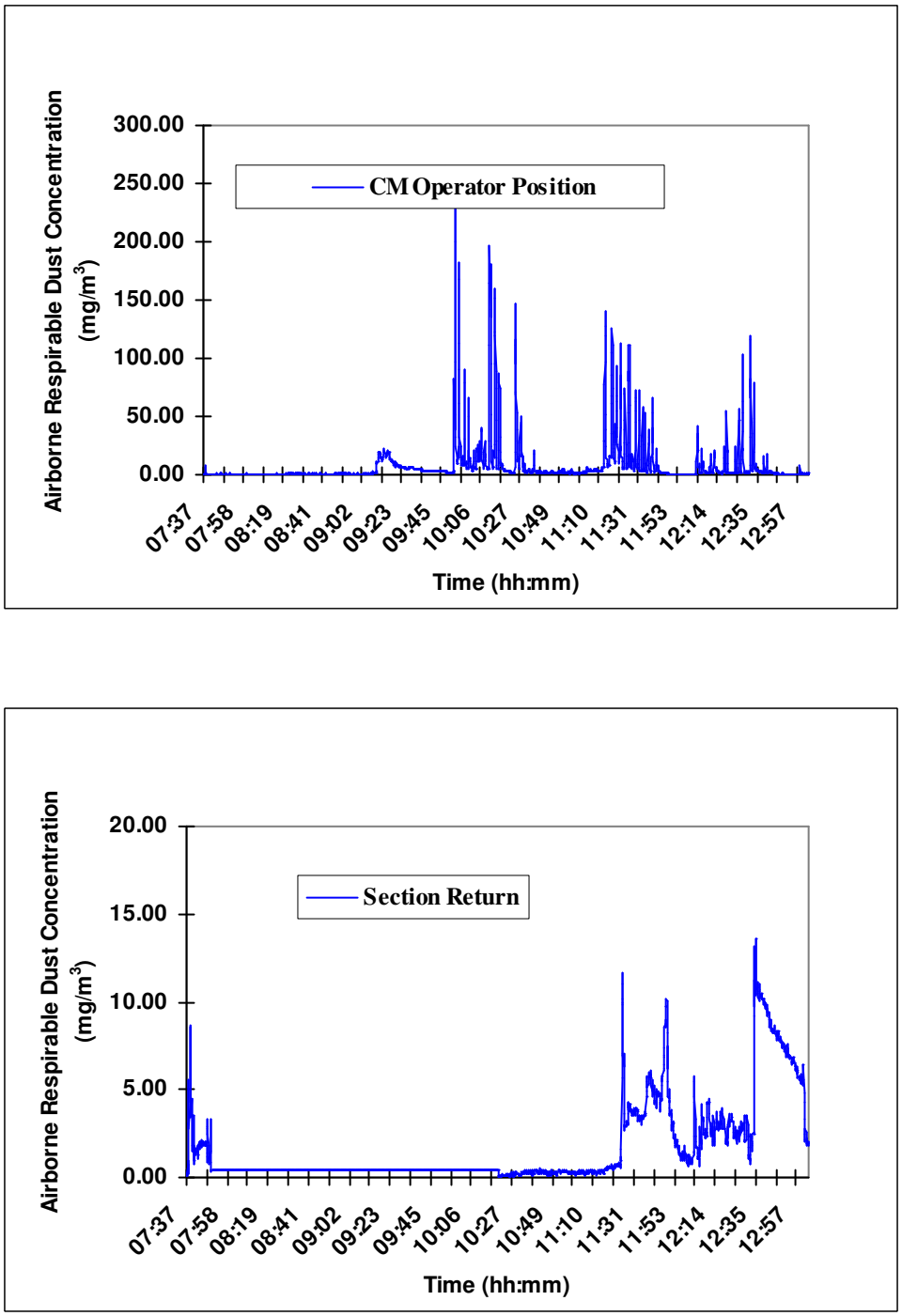


Figure 3: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A4-Test # 3

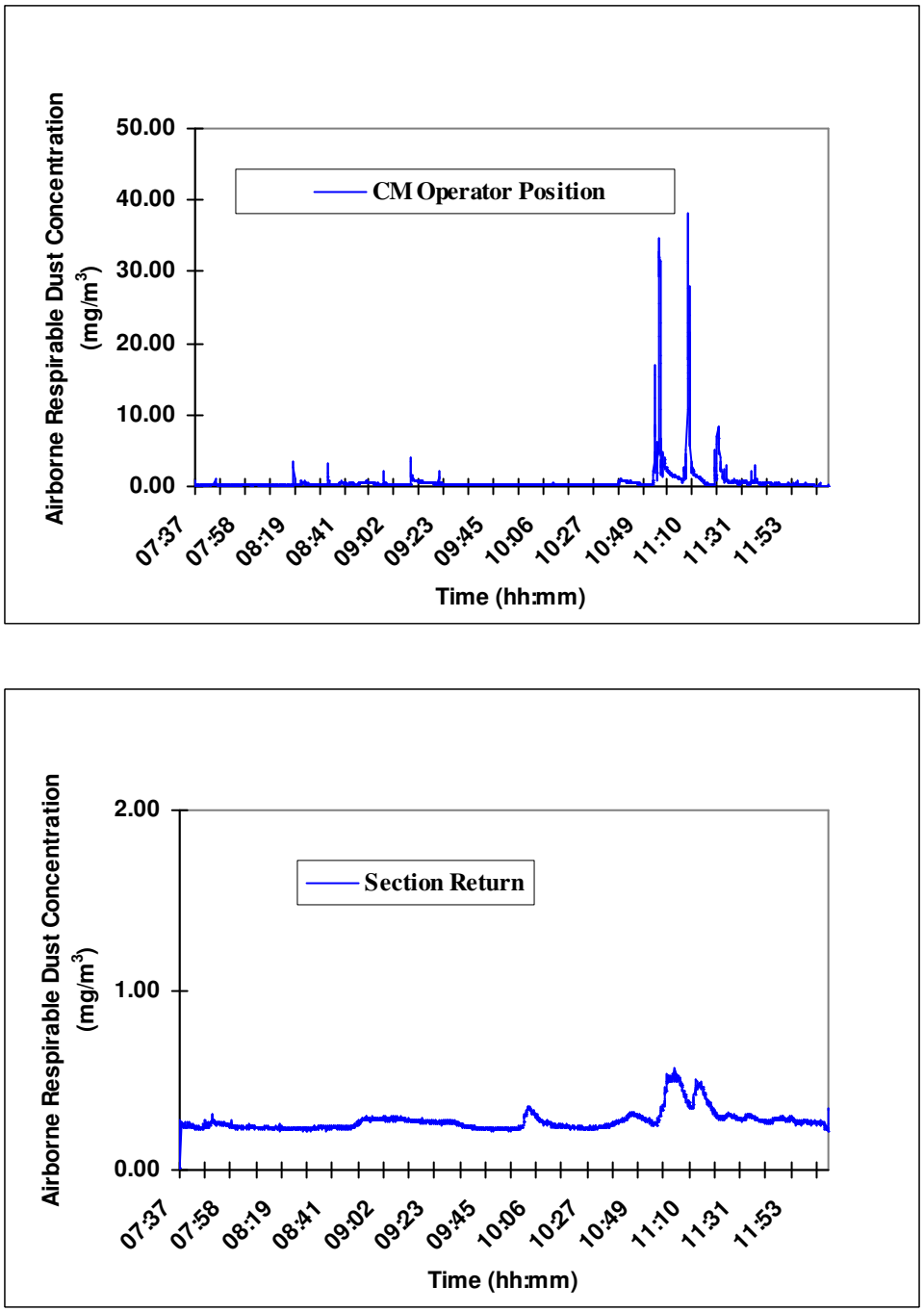


Figure 4: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for dust control system A4-Test # 4

APPENDIX-B5

CM Operator and Section Return Real-Time Dust Profiles-Mine B (Chapter 6, 8)

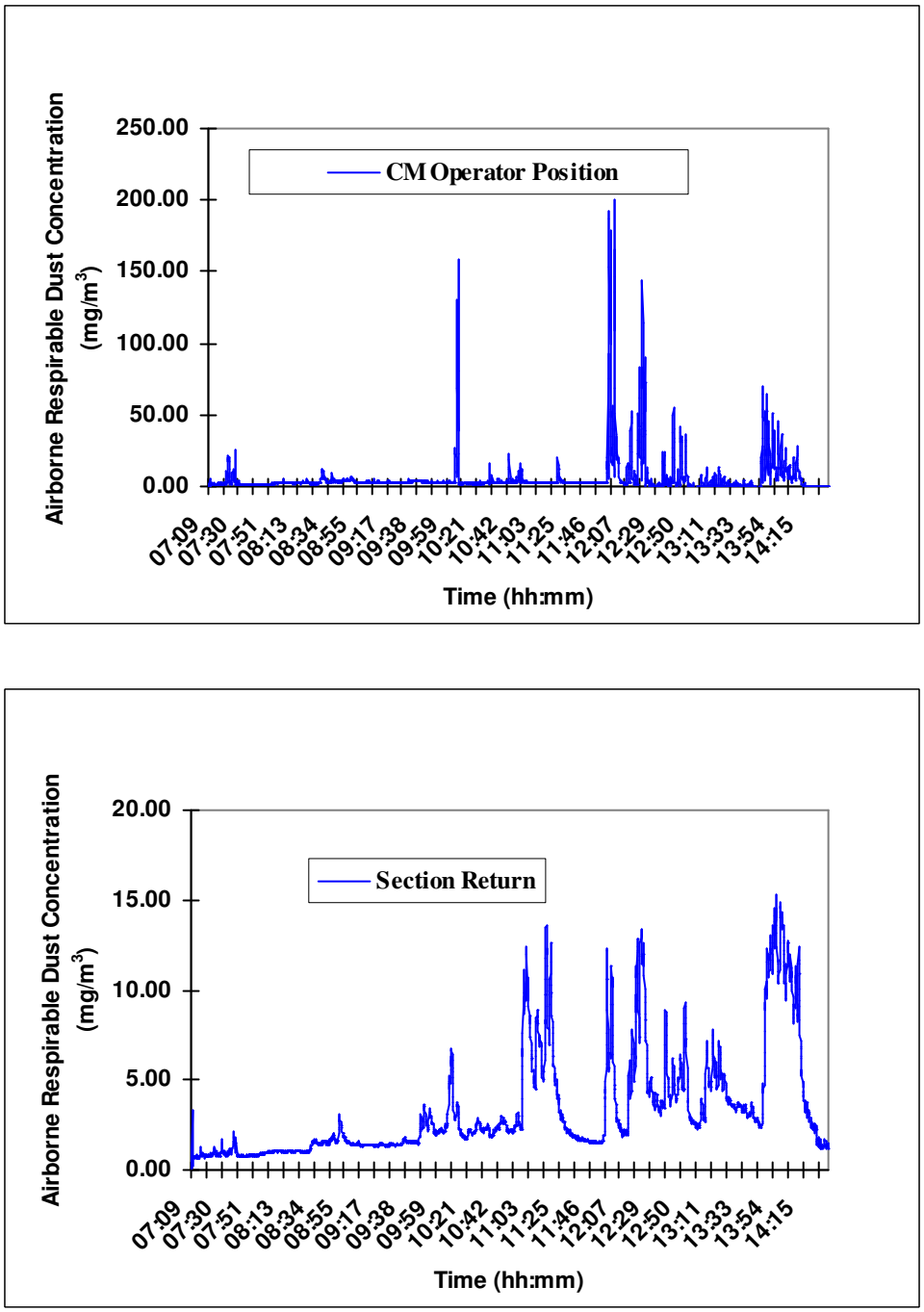


Figure 1: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 1

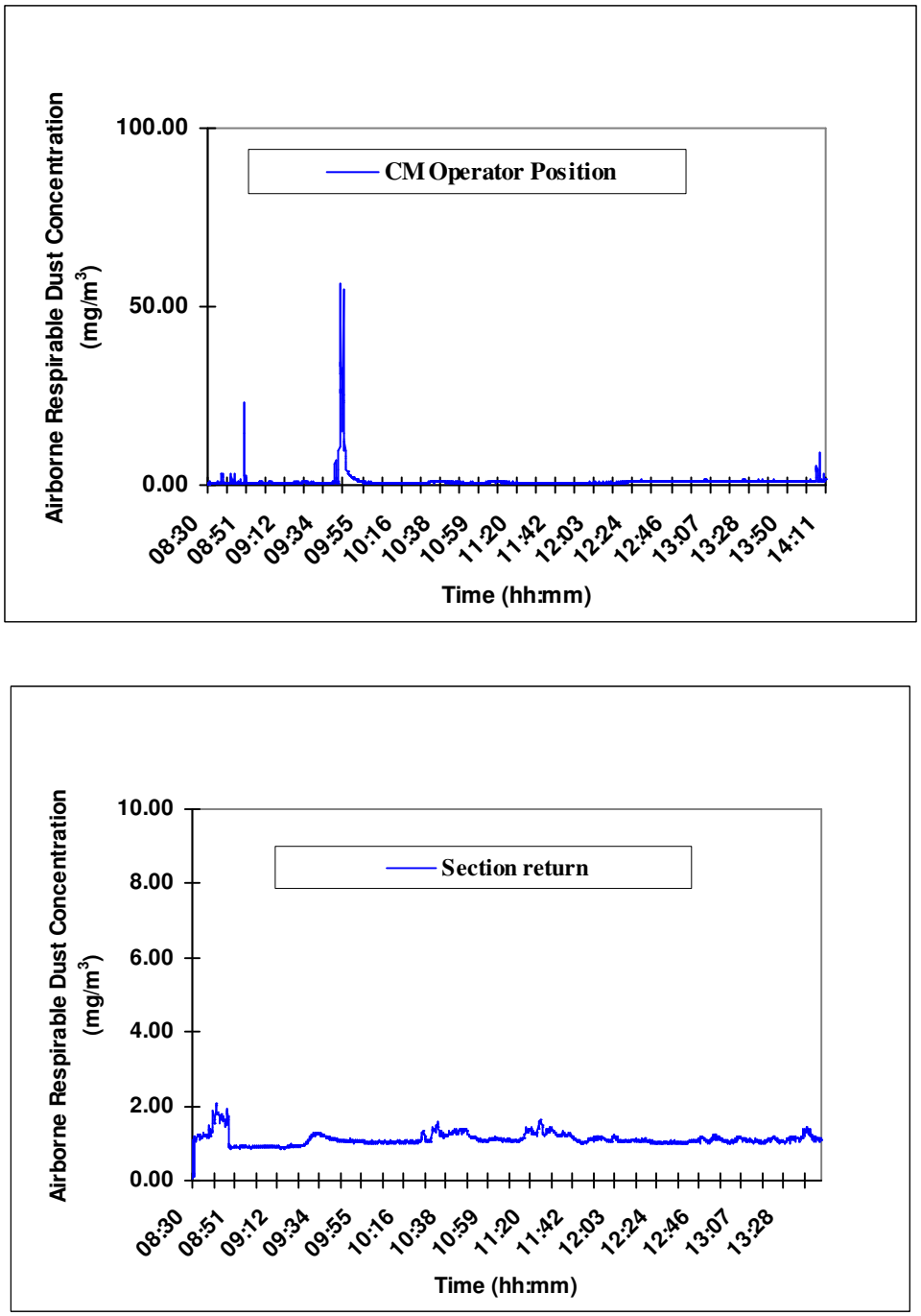


Figure 2: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 2

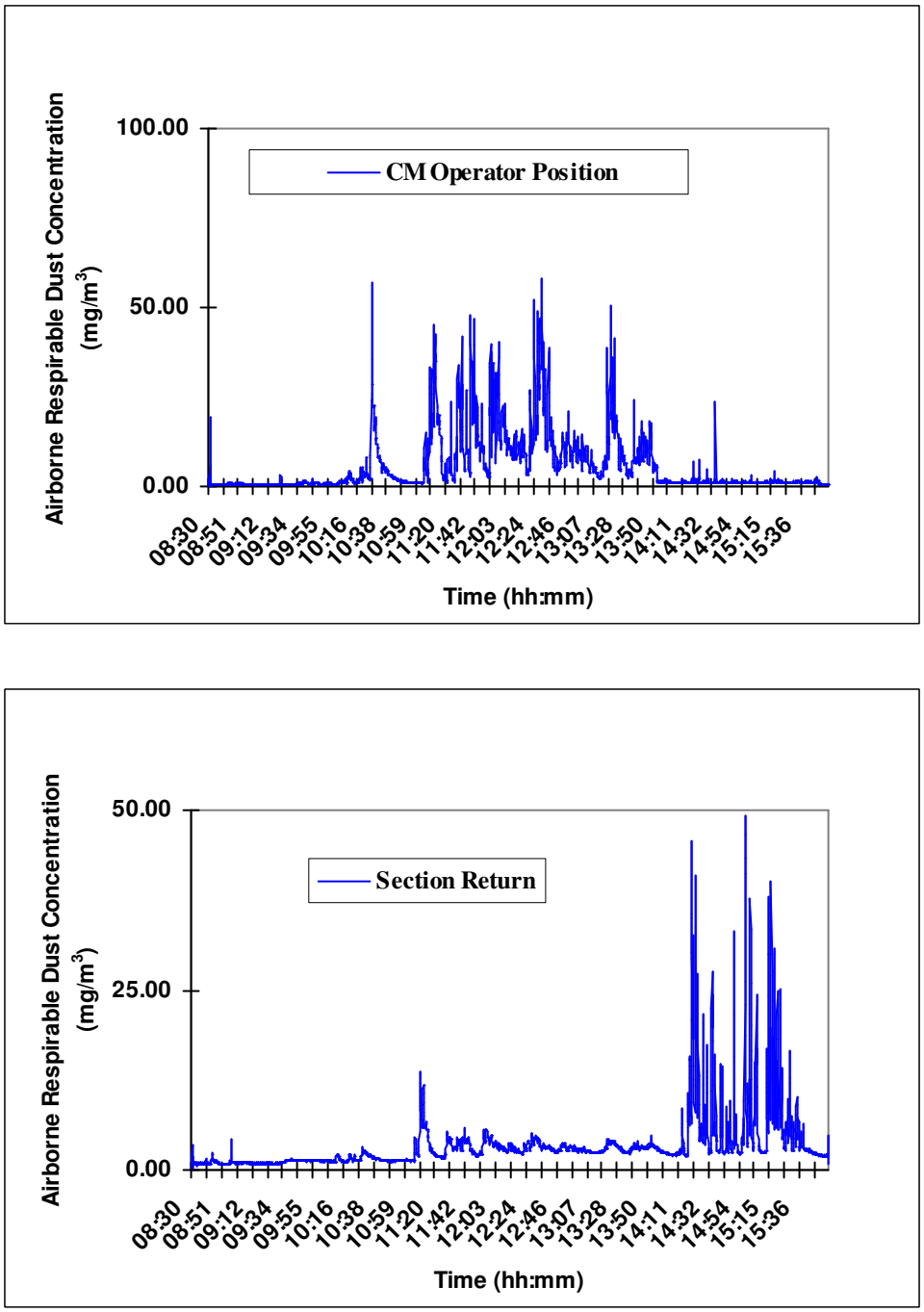


Figure 3: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 3

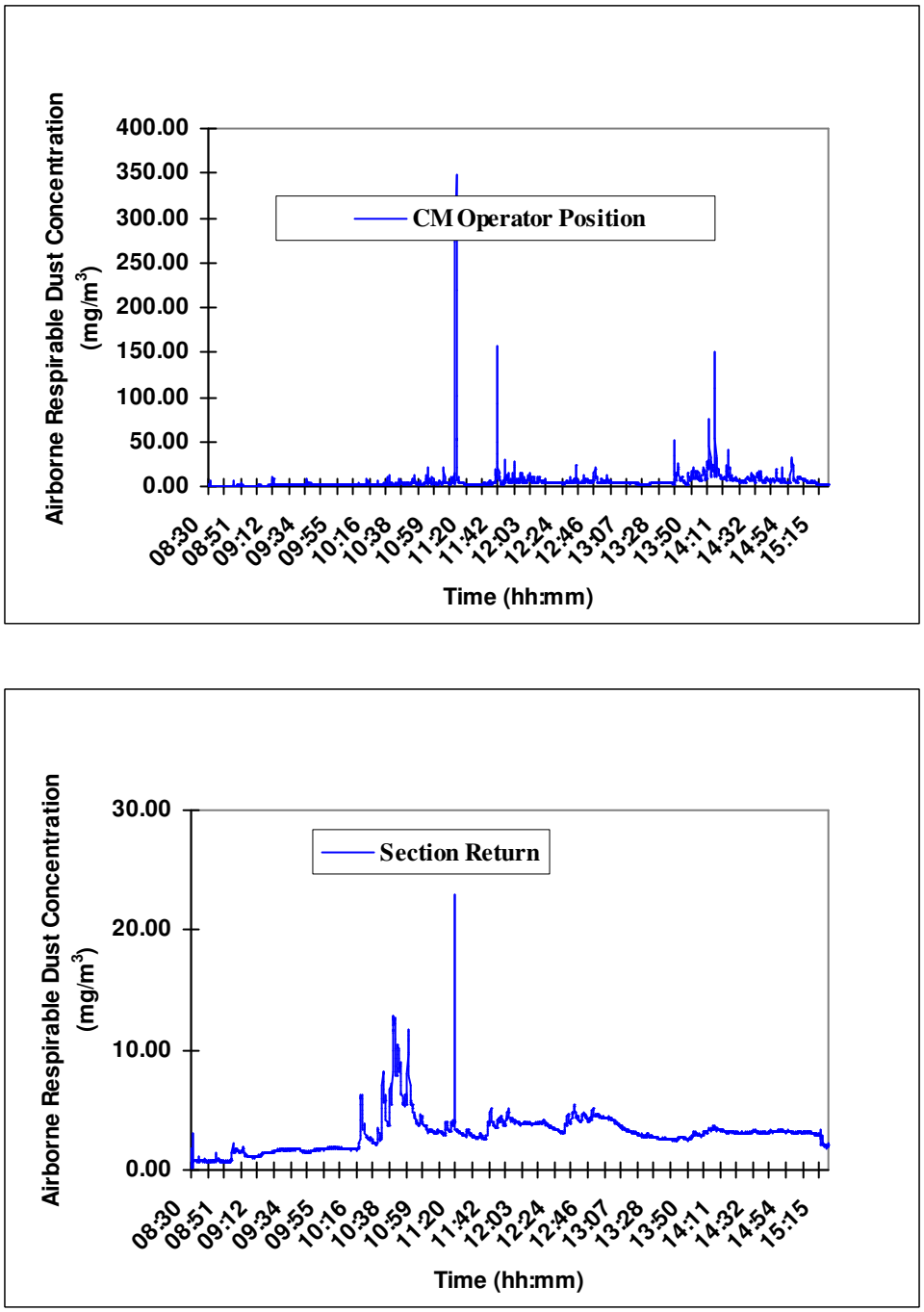
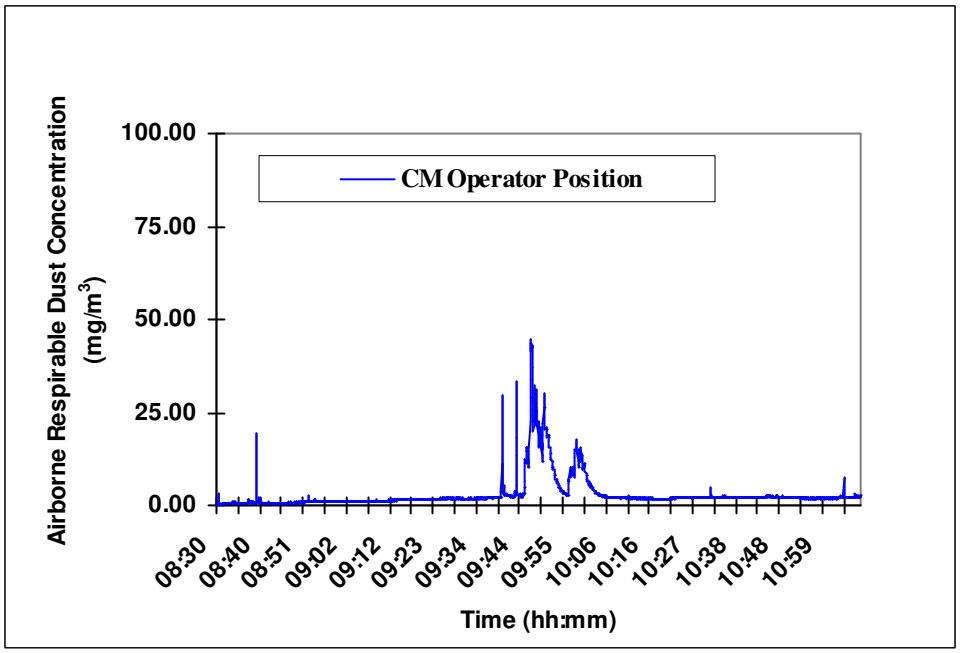


Figure 4: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 4



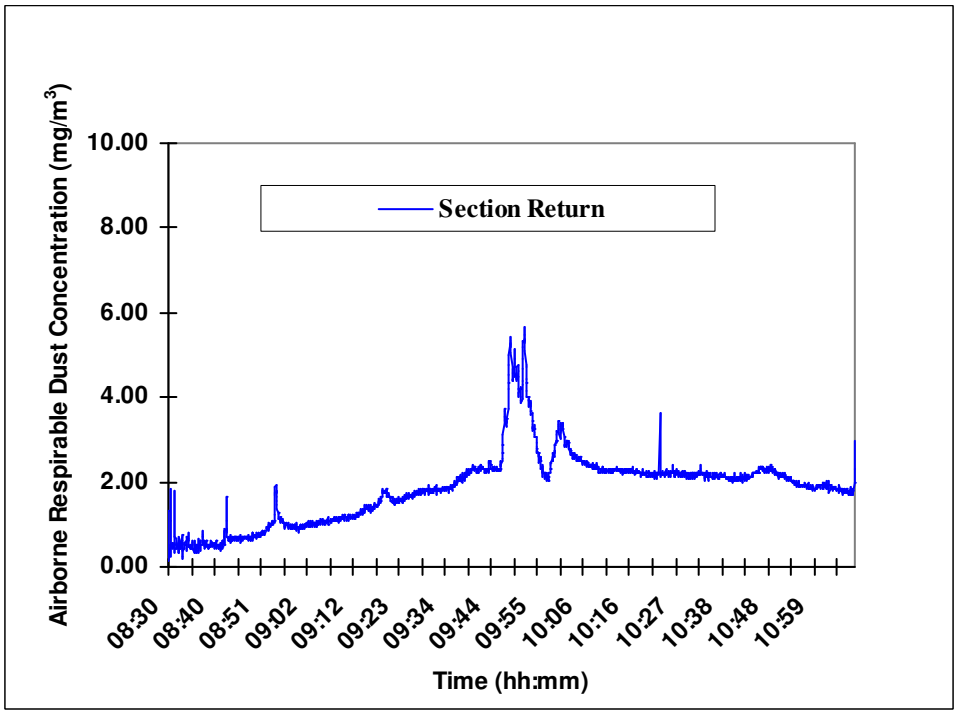


Figure 5: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 5

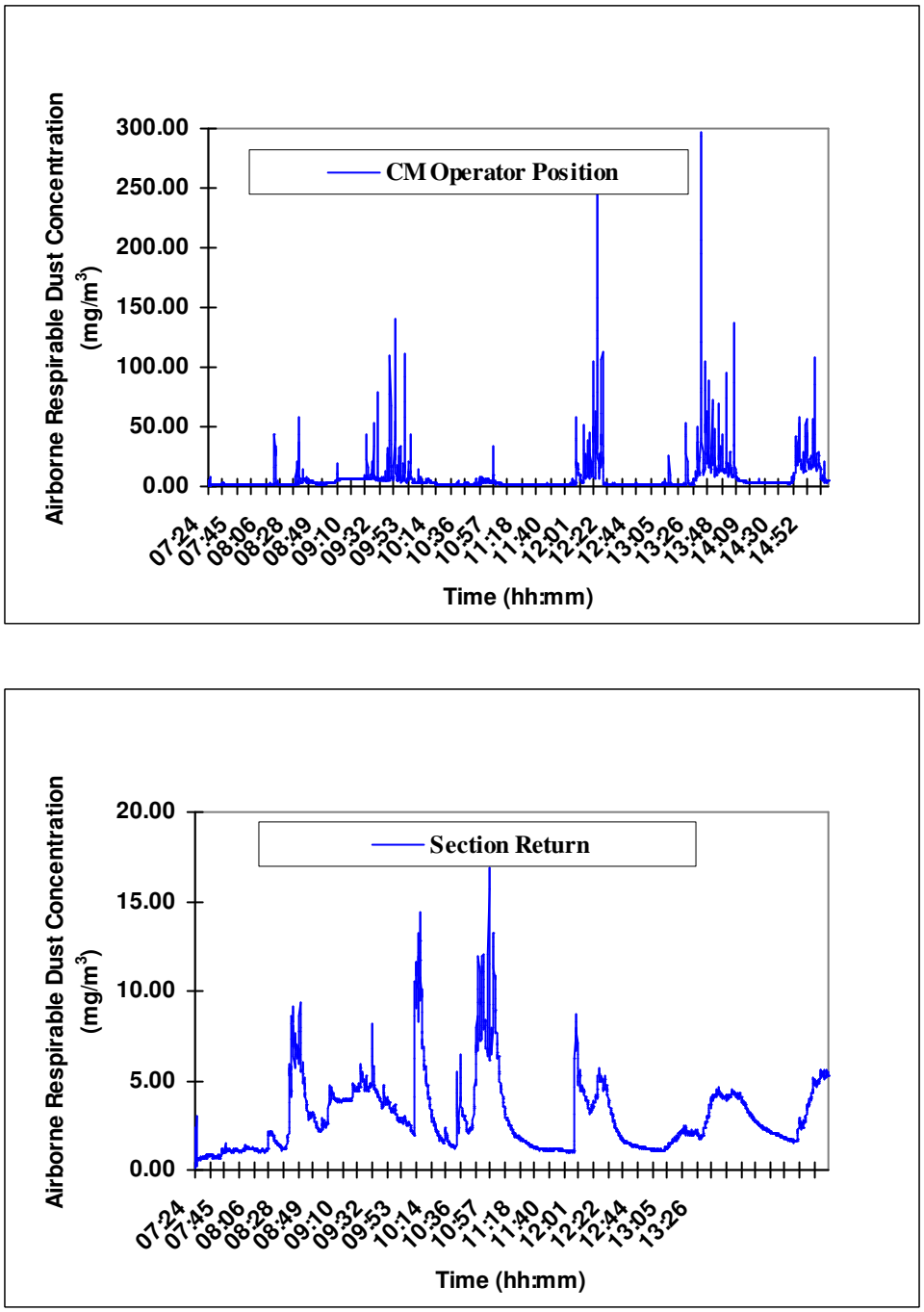


Figure 6: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 6

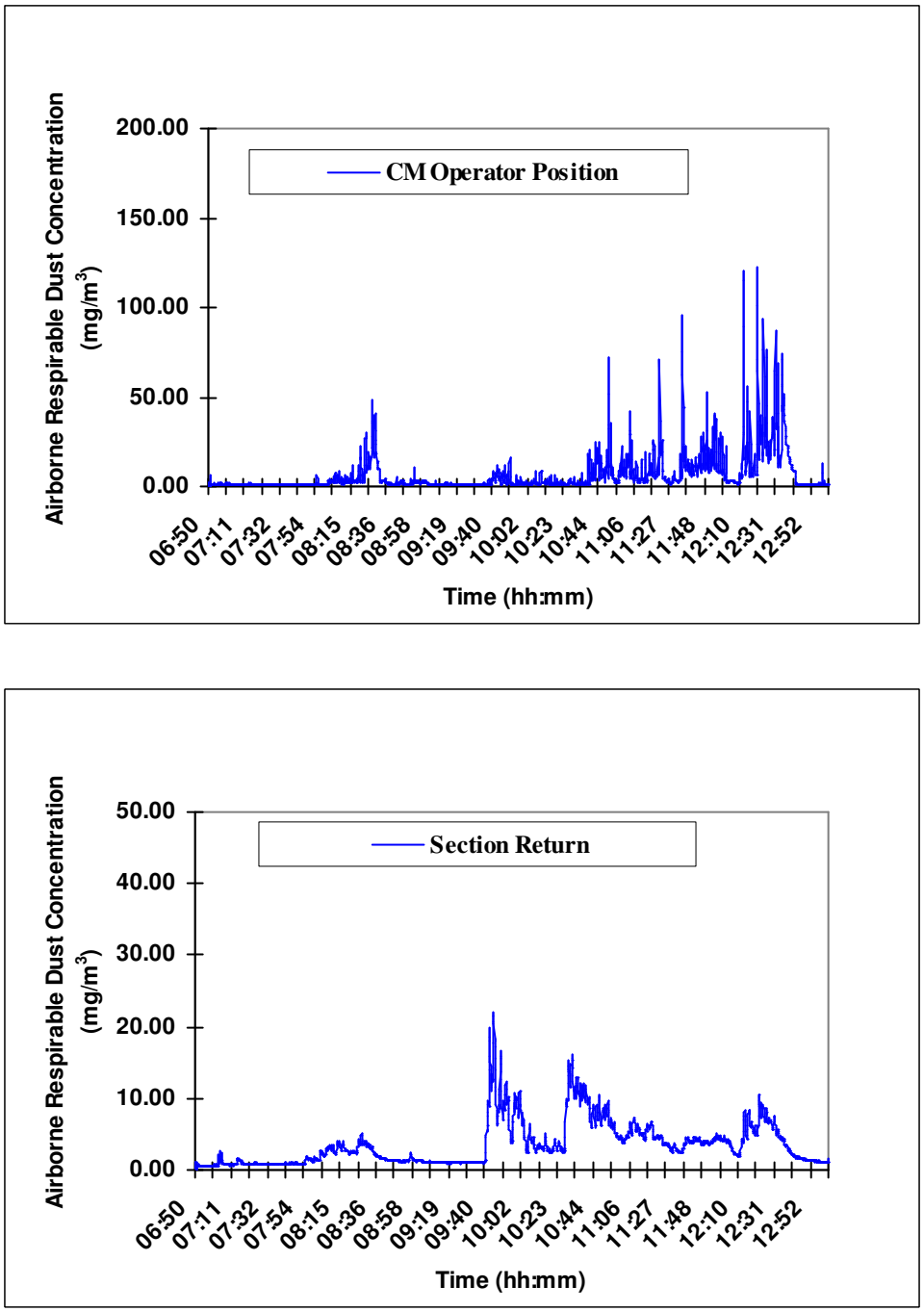


Figure 7: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 7

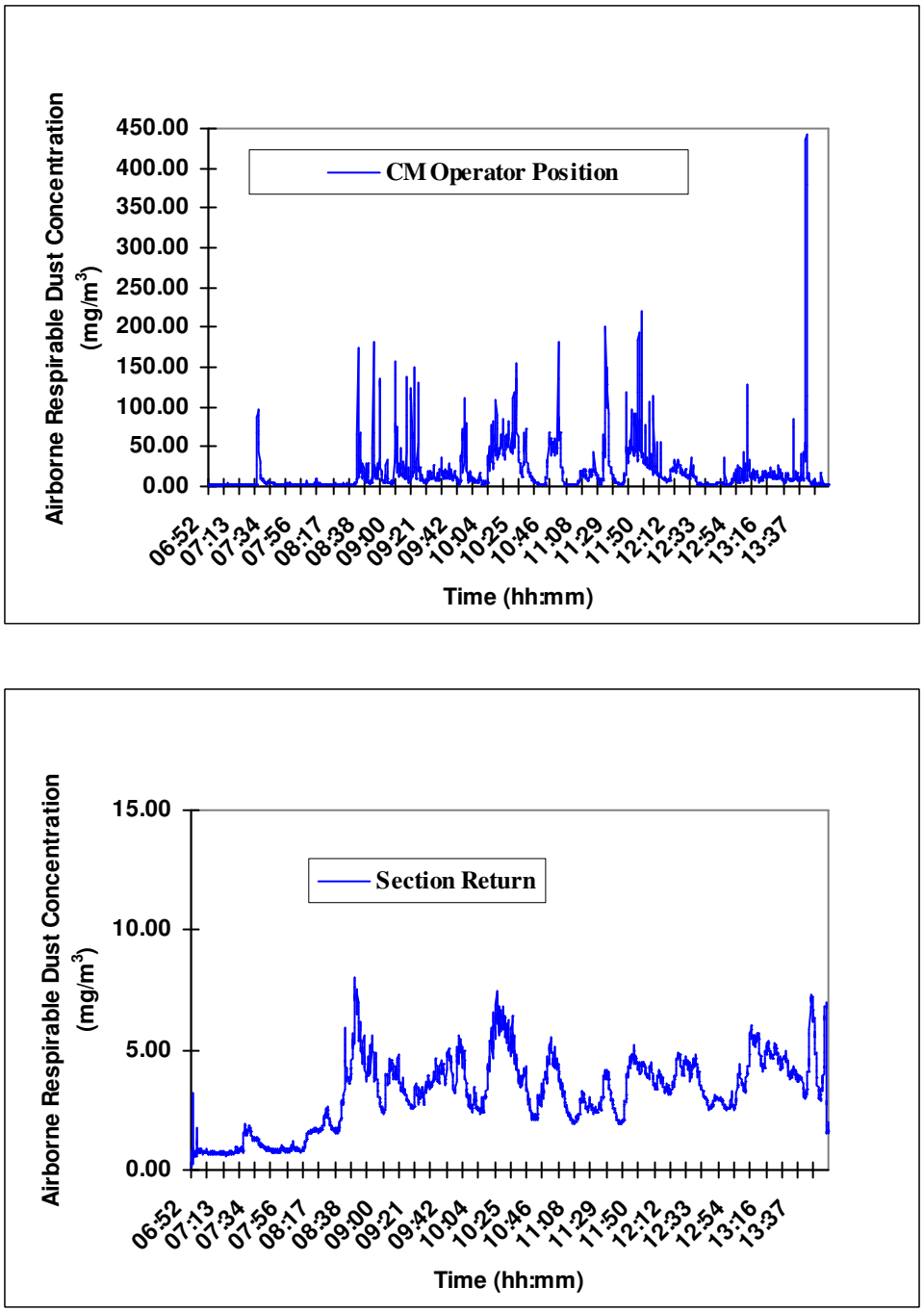


Figure 8: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 8

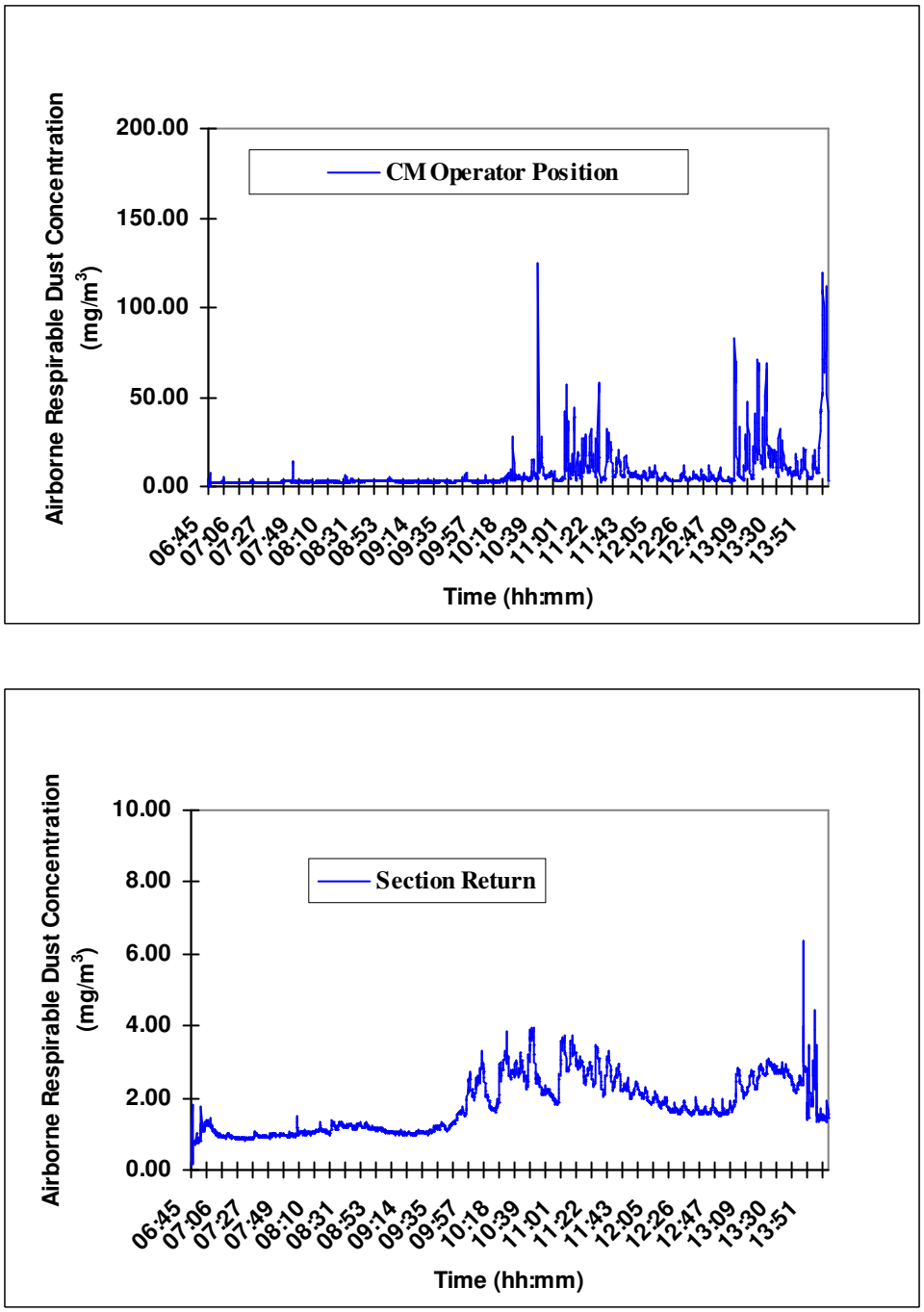


Figure 9: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 9

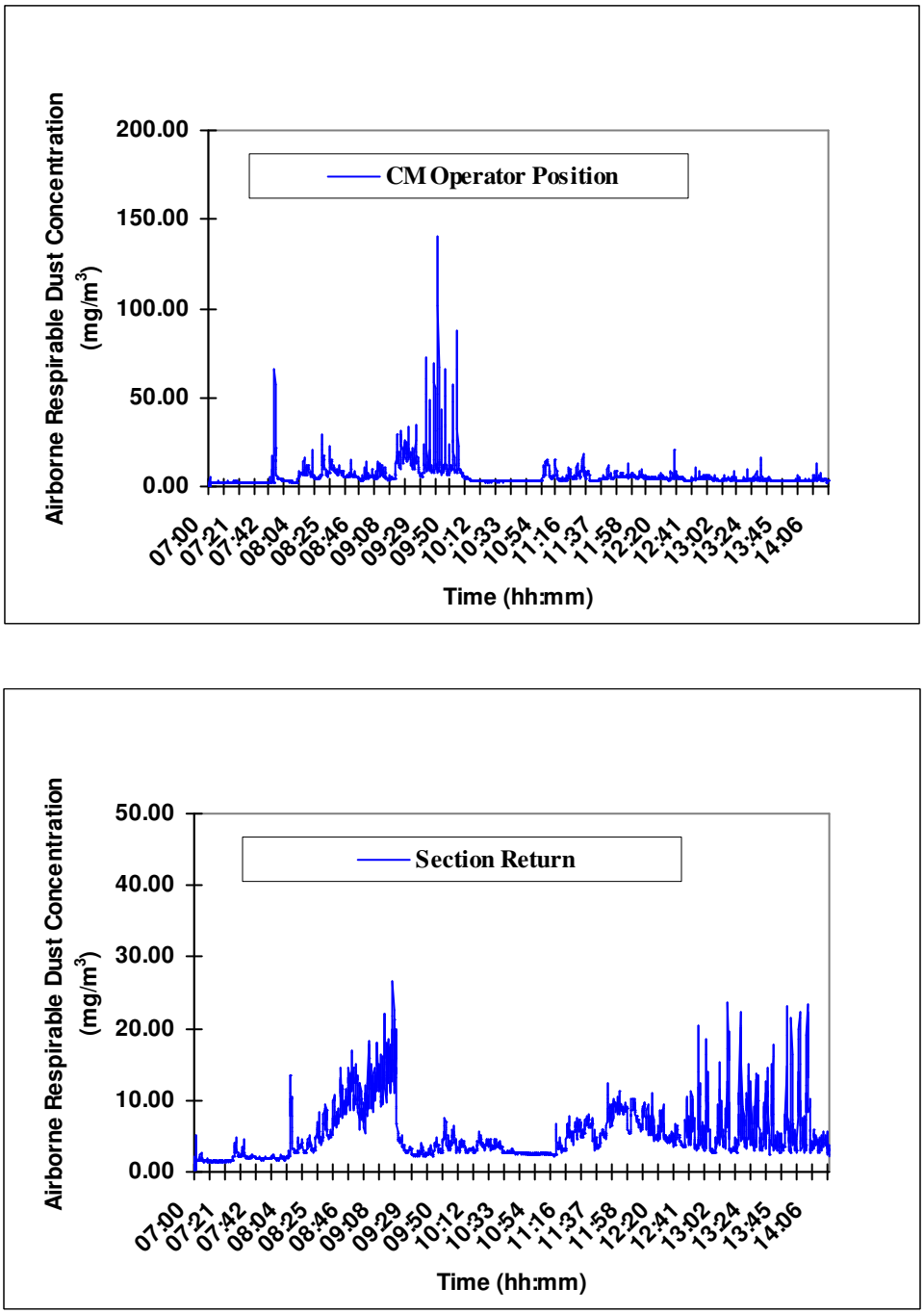


Figure 10: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 10

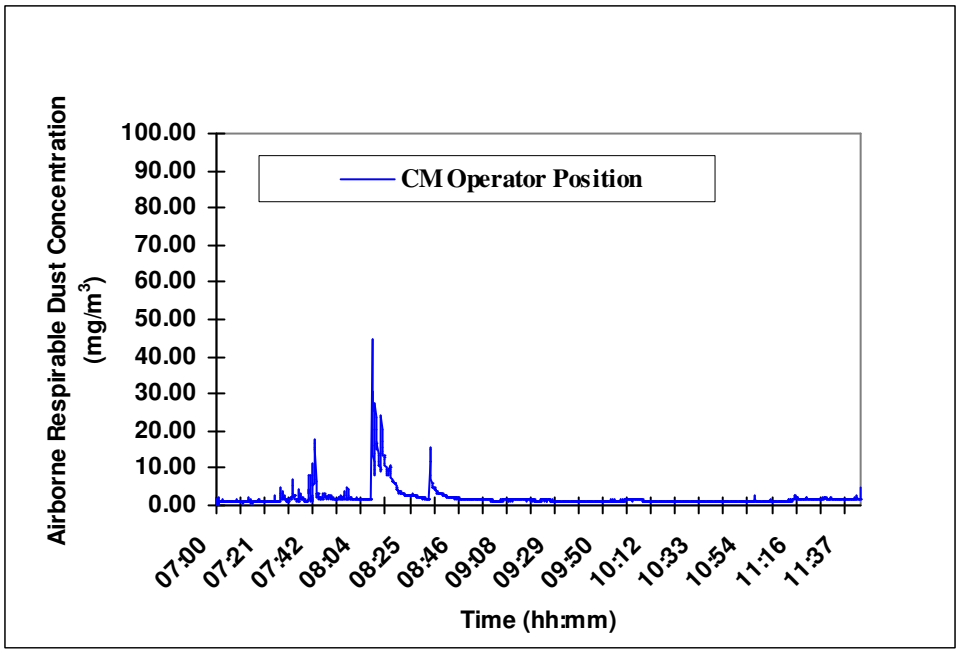


Figure 11: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine B-Test # 11

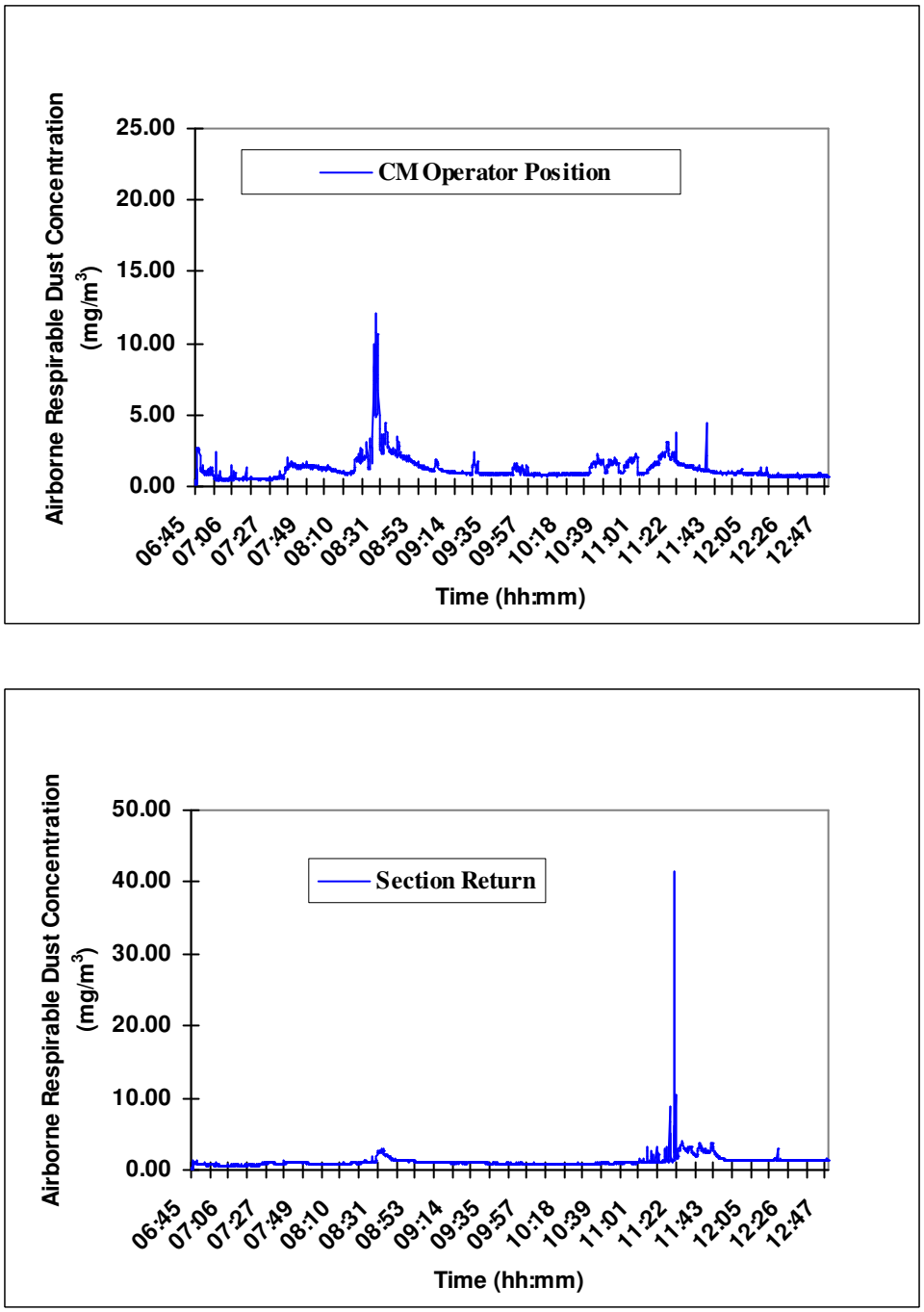


Figure 12: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 12

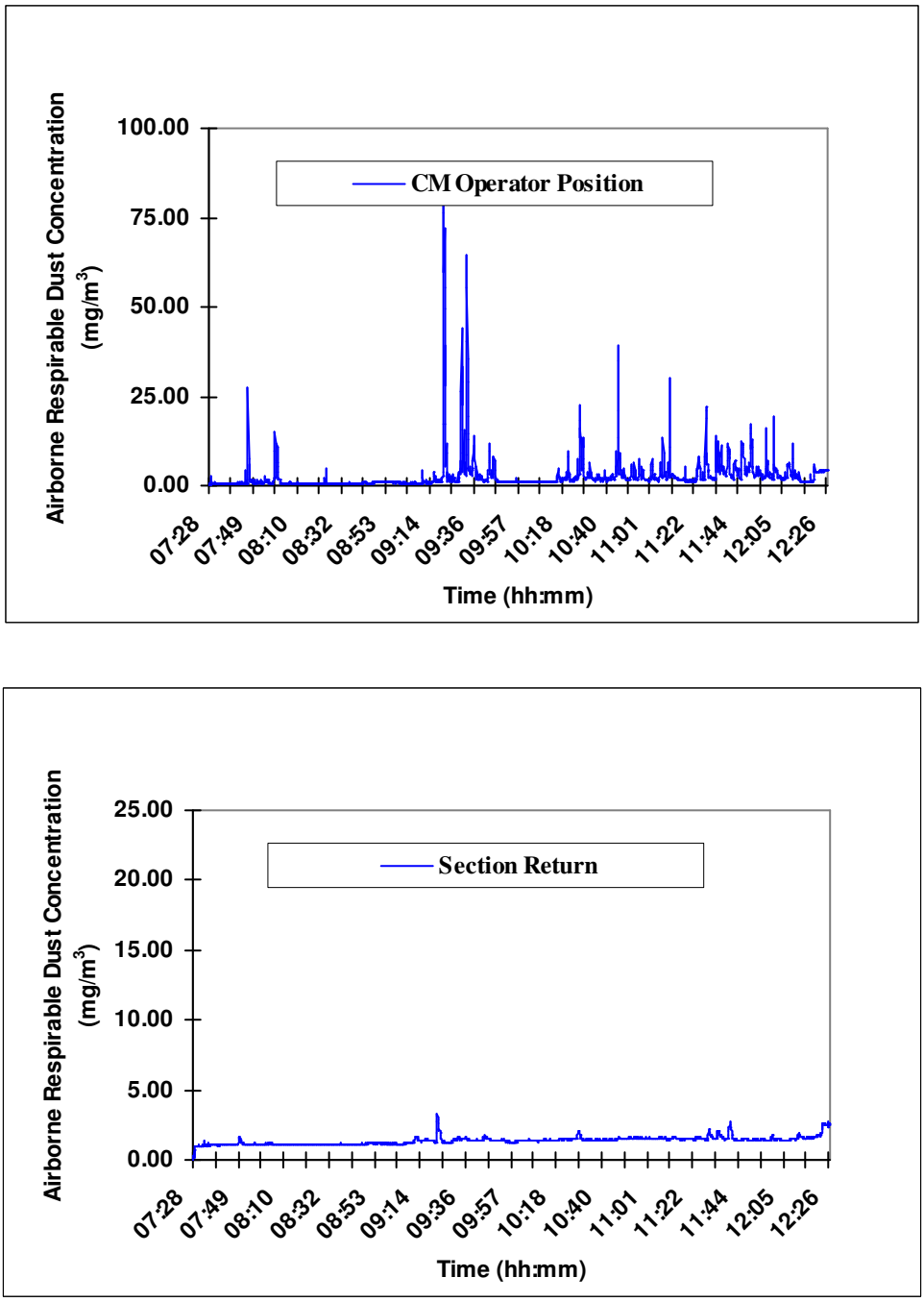


Figure 13: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 13

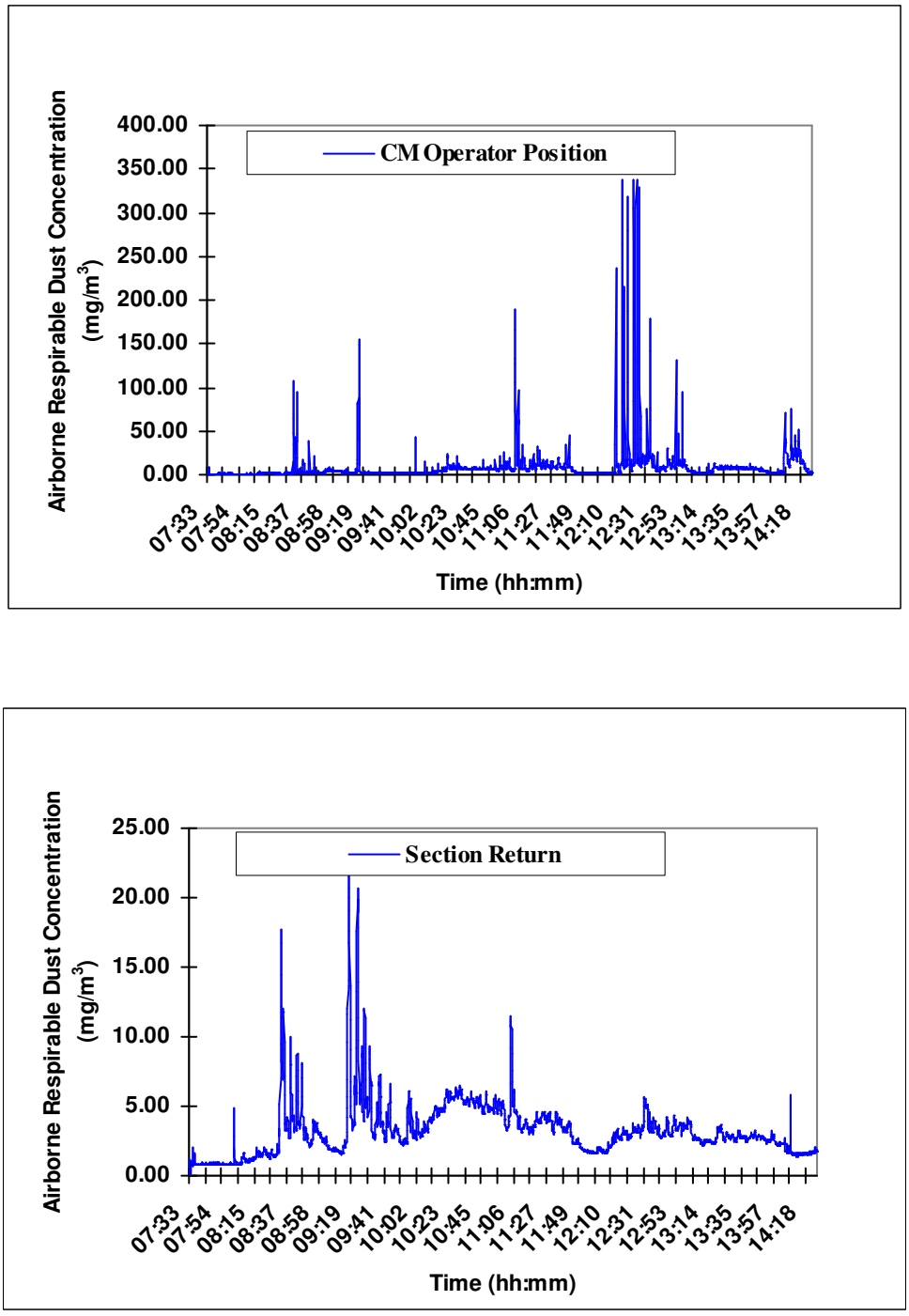


Figure 14: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 14

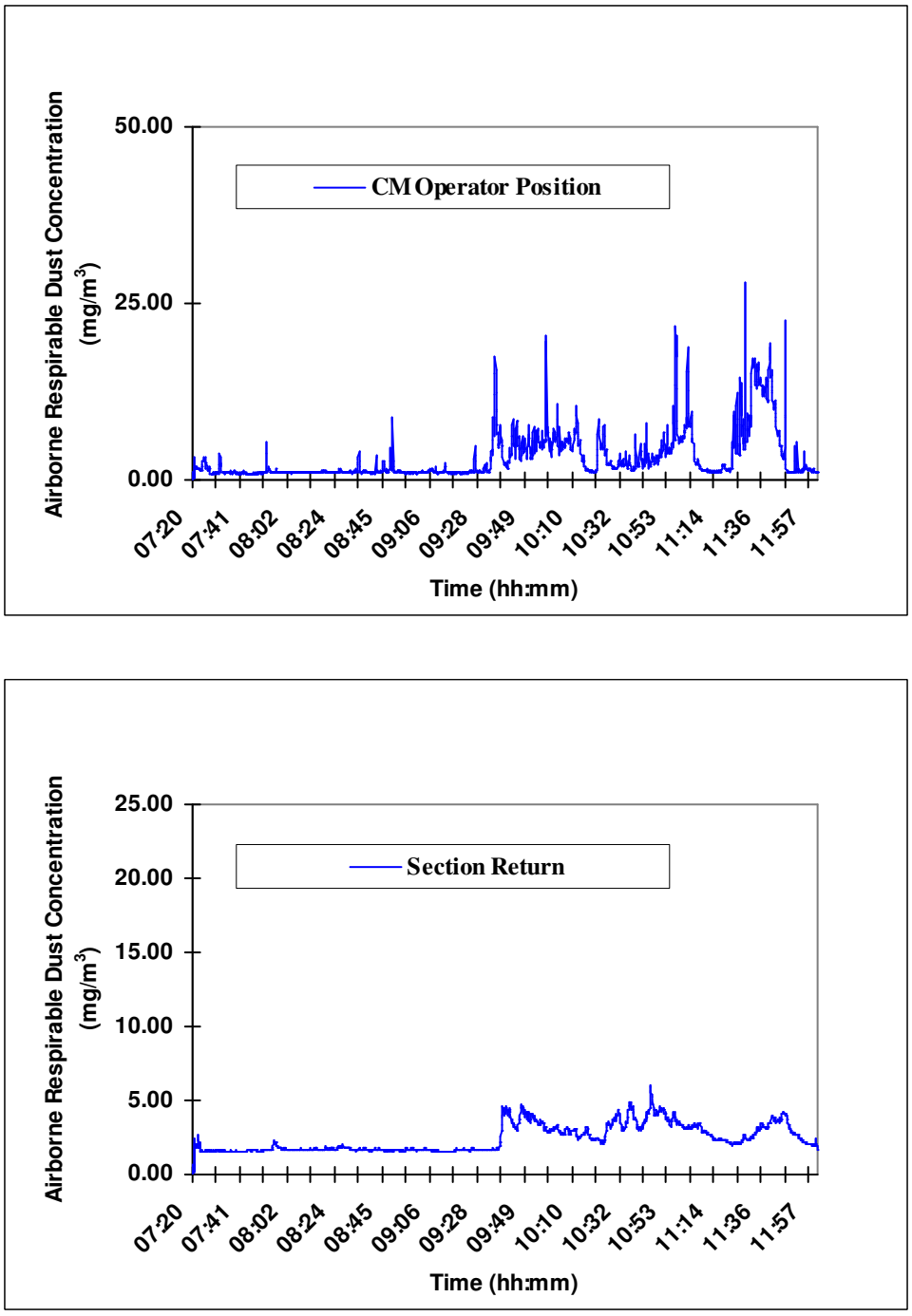


Figure 15: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine B-Test # 15

APPENDIX-B6

CM Operator and Section Return Real-Time Dust Profiles-Mine C (Chapter 6, 8)

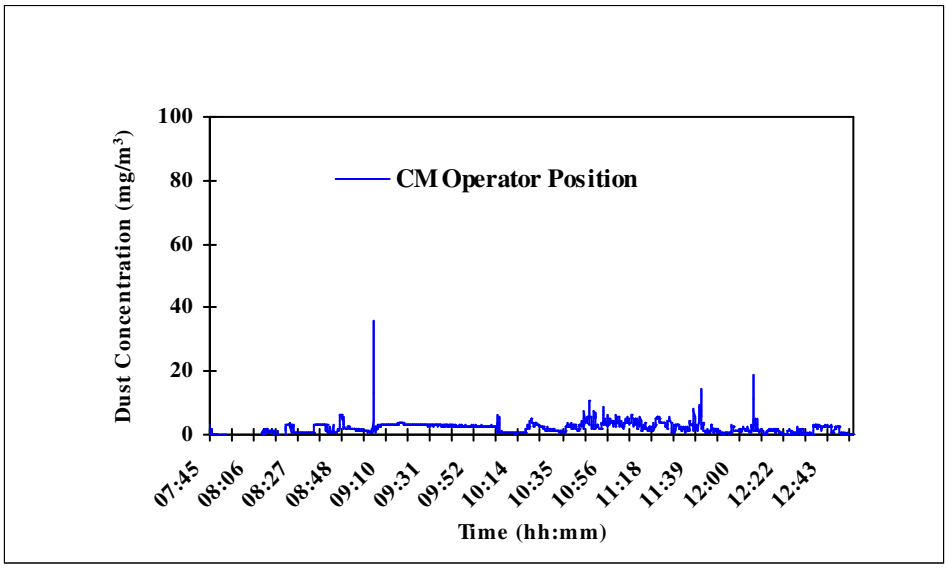


Figure 1: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine C-Test # 1

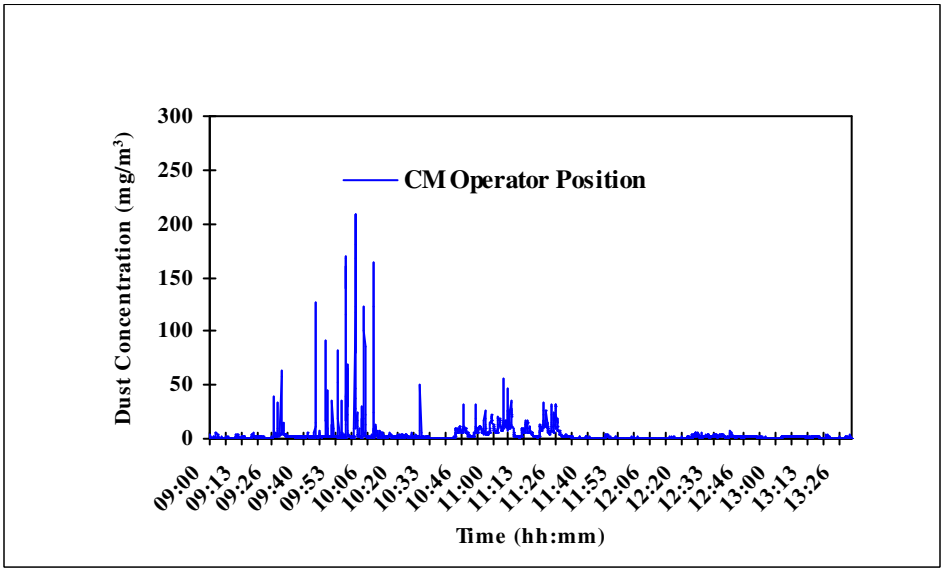


Figure 2: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine C-Test # 2

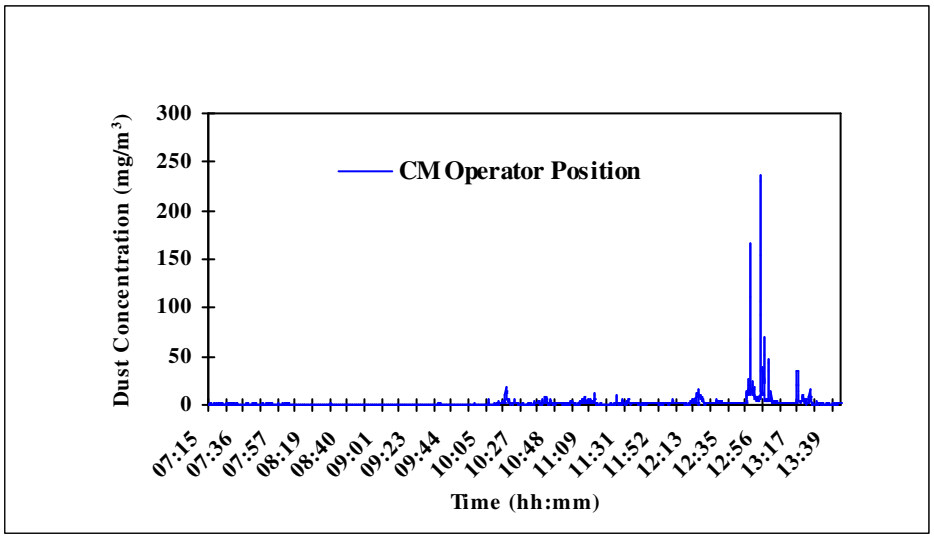


Figure 3: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine C-Test # 3

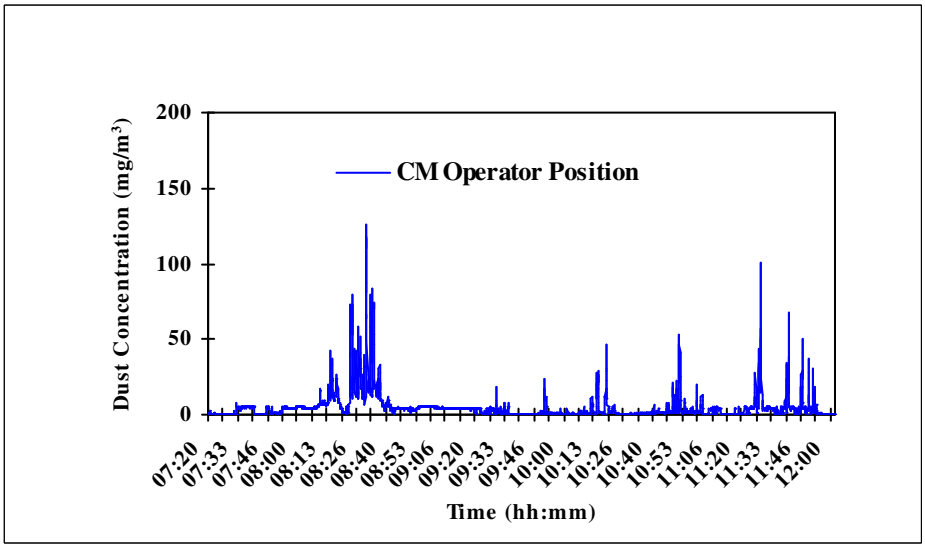


Figure 4: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine C-Test # 4

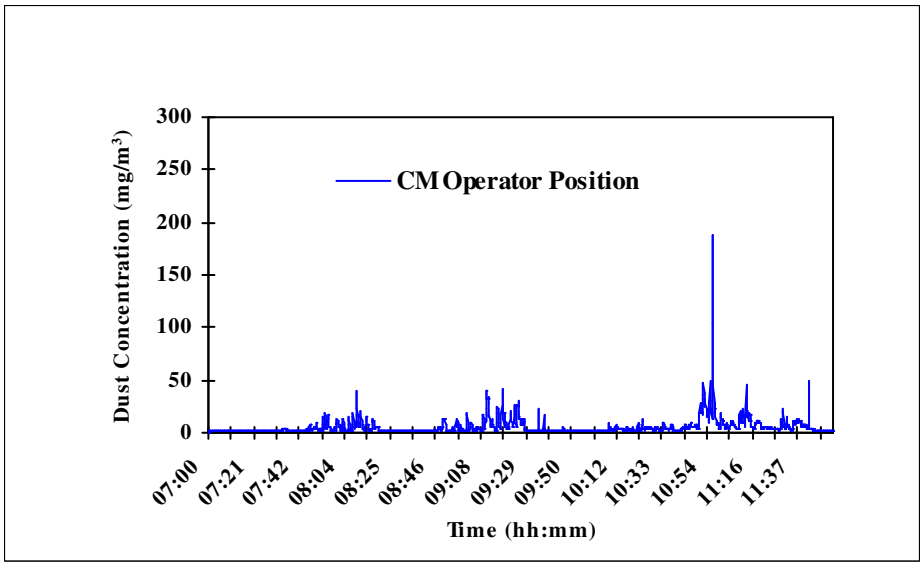


Figure 5: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine C-Test # 5

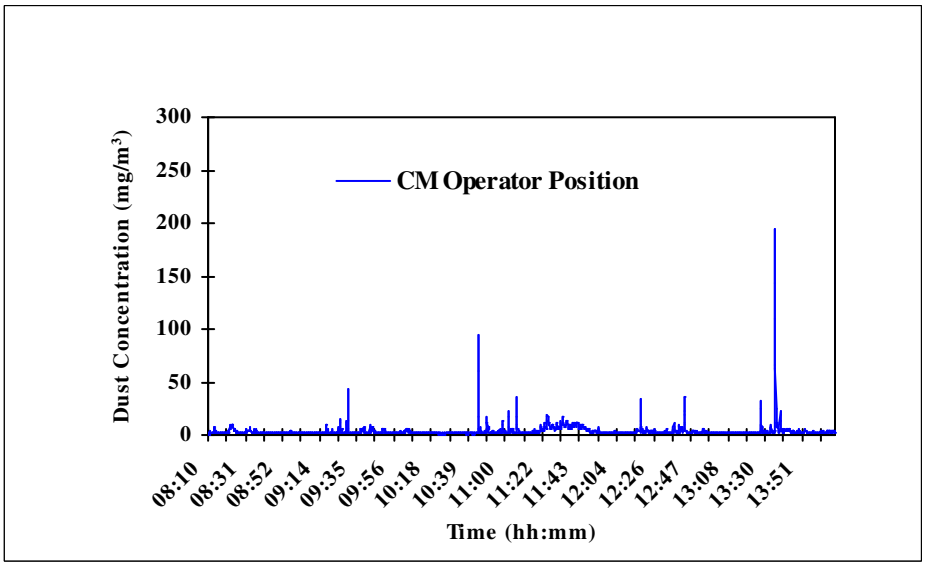


Figure 6: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine C-Test # 6

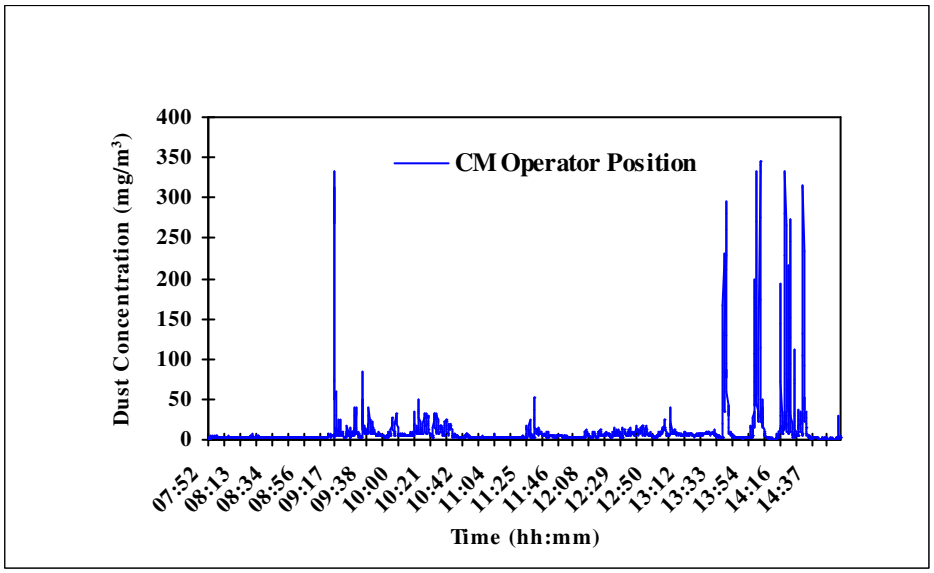


Figure 7: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine C-Test # 7

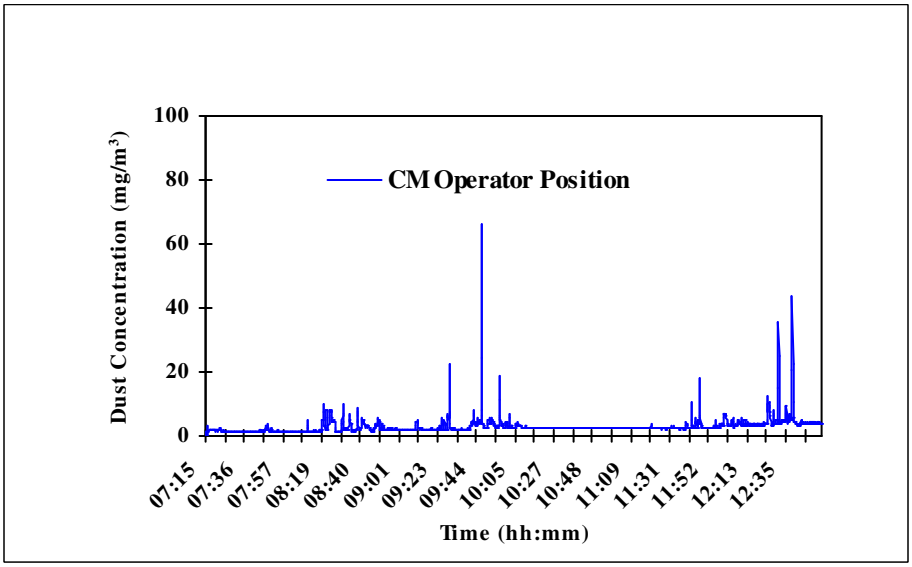


Figure 8: ARD profile recorded by the real-time dust monitor at the CM operator position for Mine C-Test # 8

APPENDIX-B7

CM Operator and Section Return Real-Time Dust Profiles-Mine D (Chapter 6, 8)

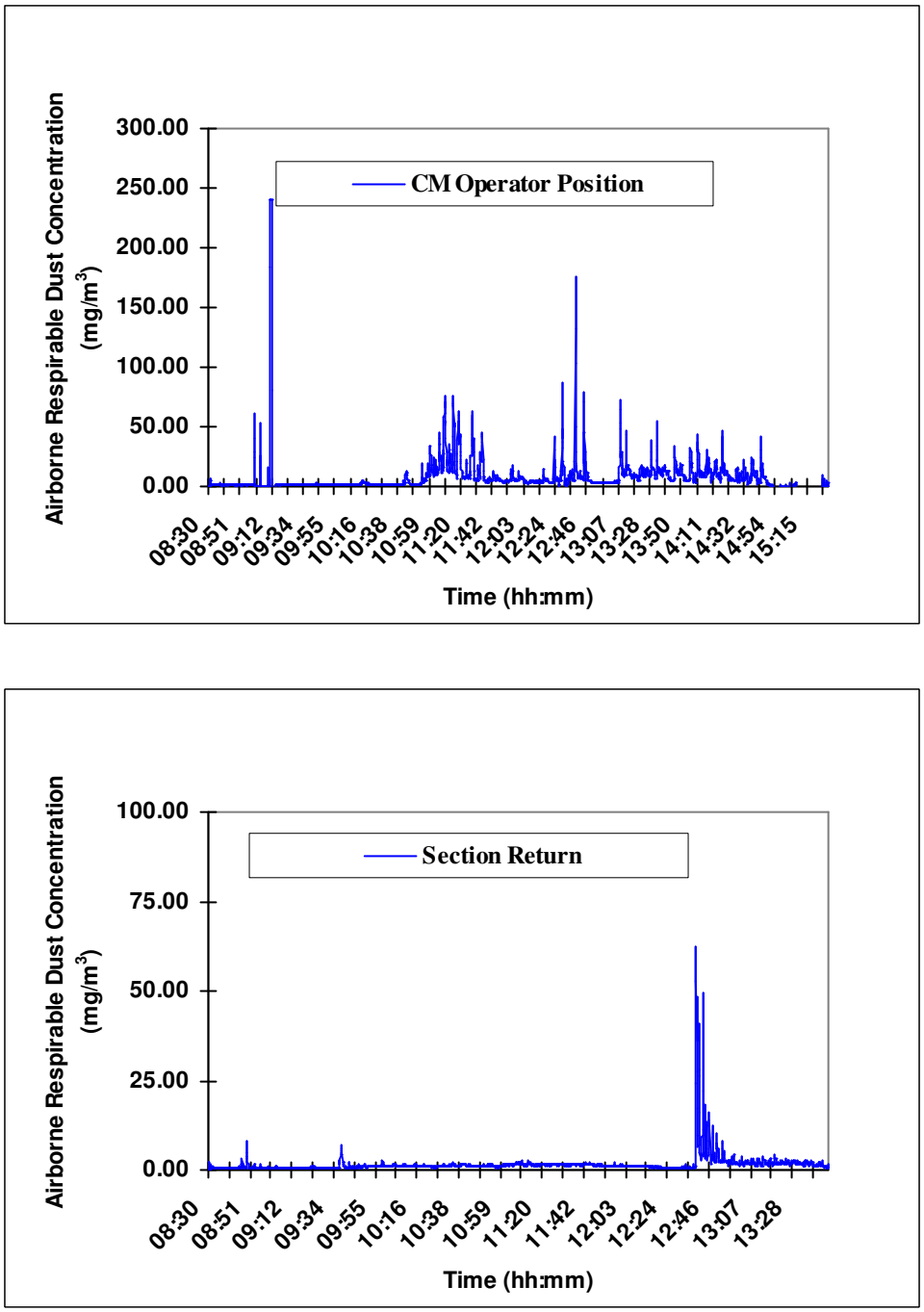


Figure 1: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine D-Test # 1

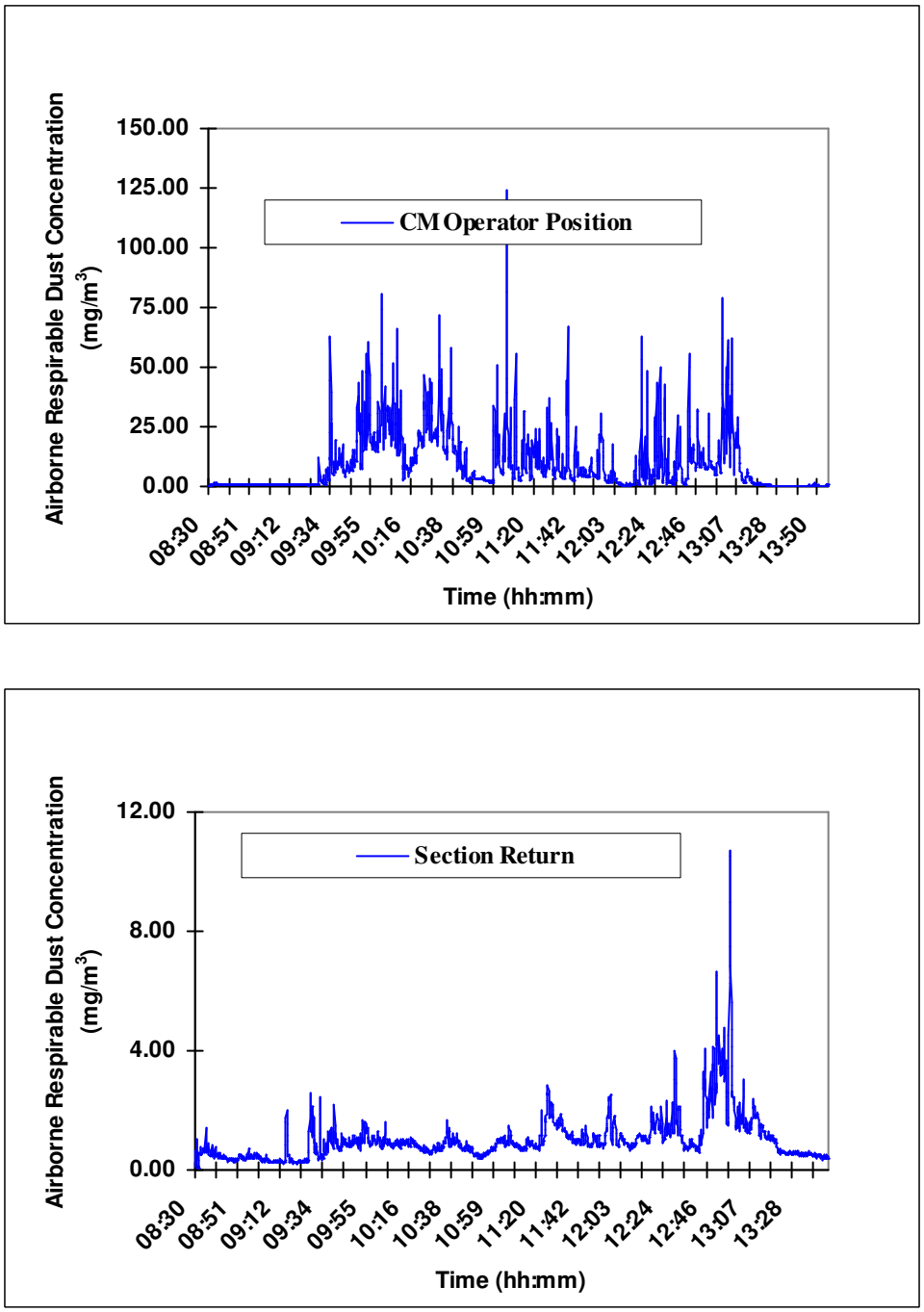


Figure 2: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine D-Test # 2

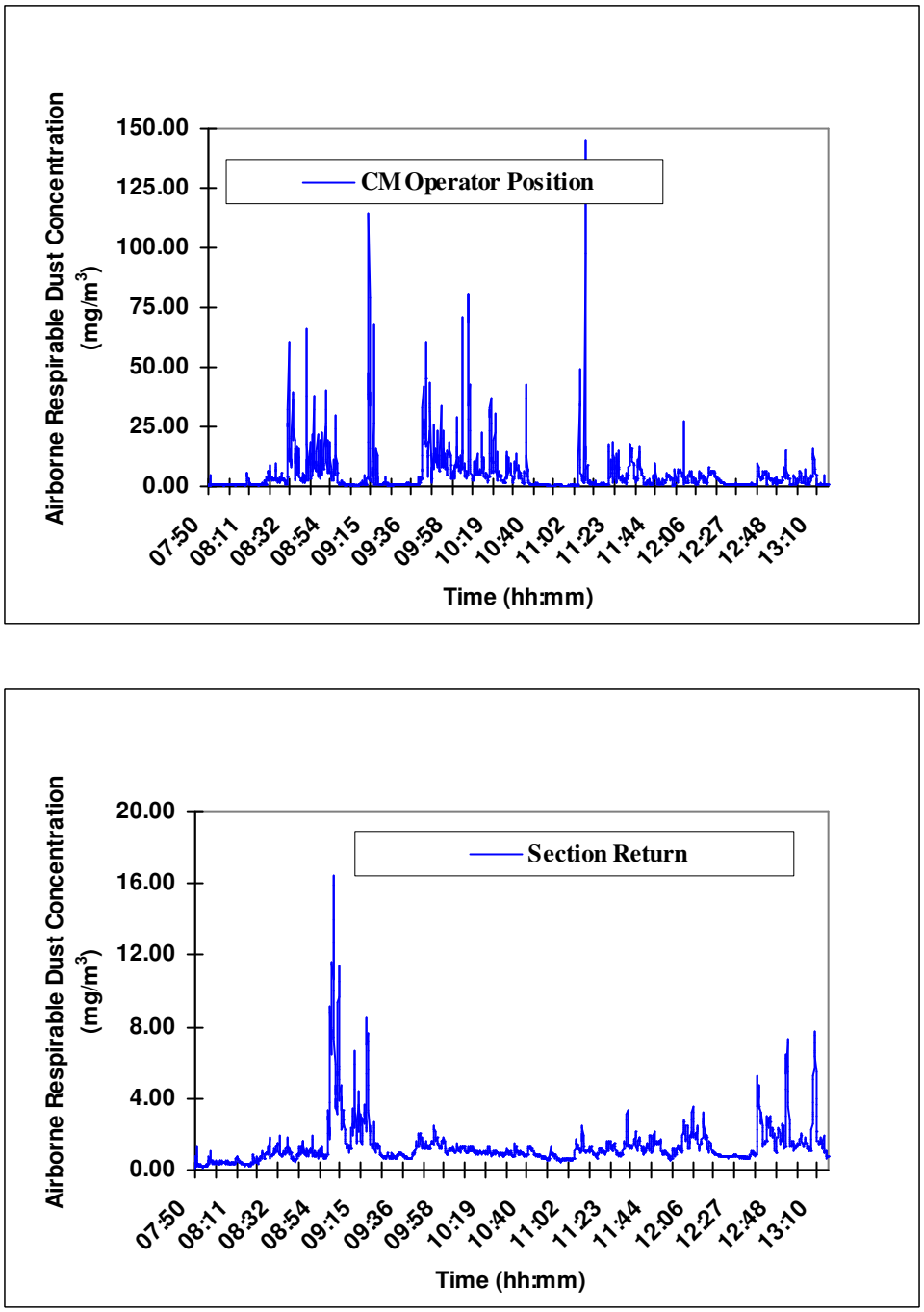


Figure 3: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine D-Test # 3

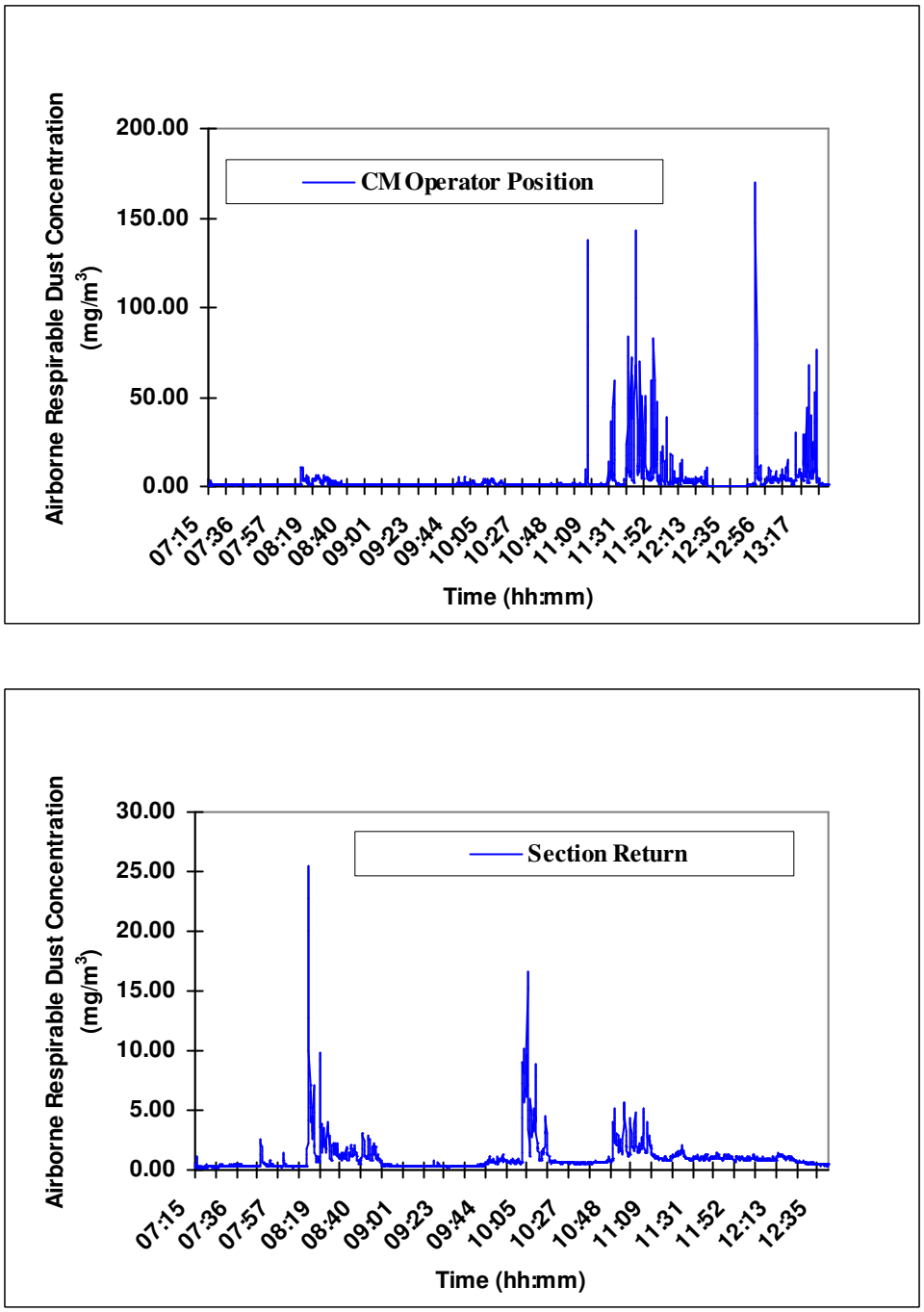
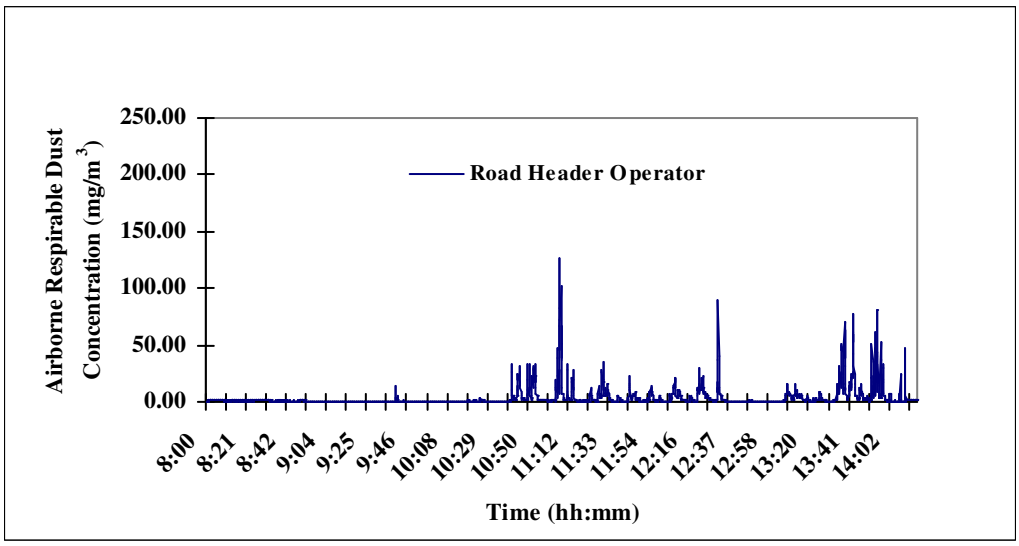


Figure 4: ARD profile recorded by the real-time dust monitor at the CM operator and section return positions for Mine D-Test # 4

APPENDIX-B8

CM Operator and Section Return Real-Time Dust Profiles-Mine E (Chapter 6, 8)



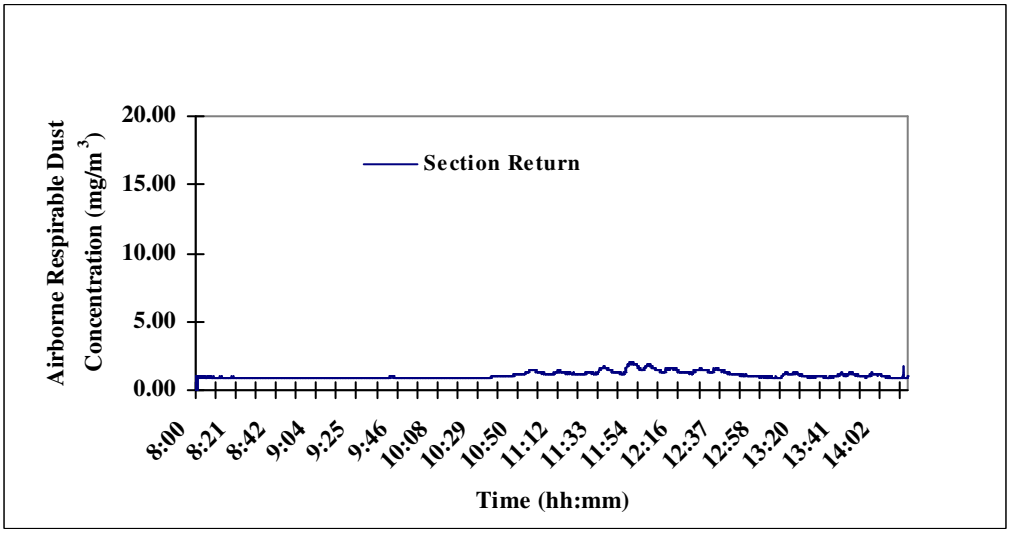
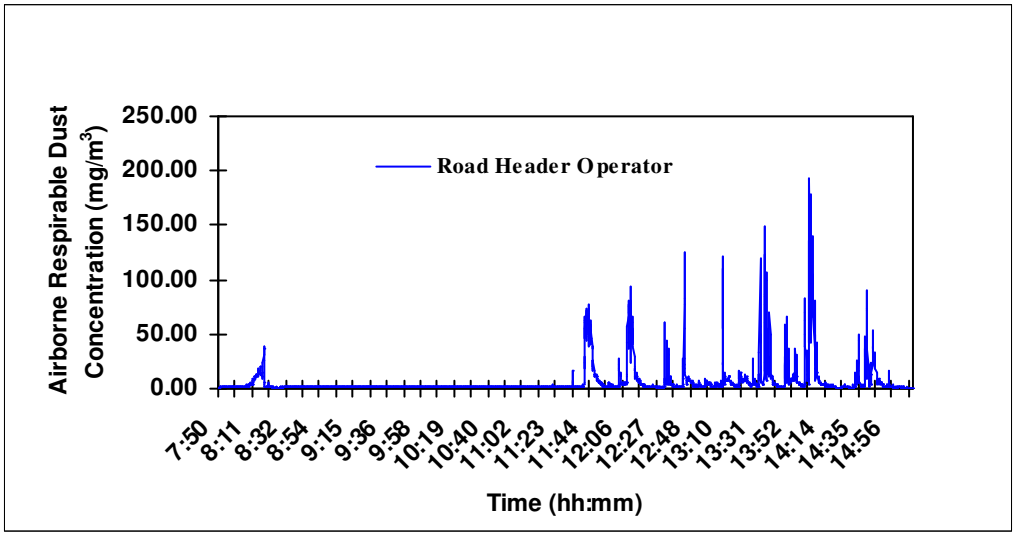


Figure 1: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 1



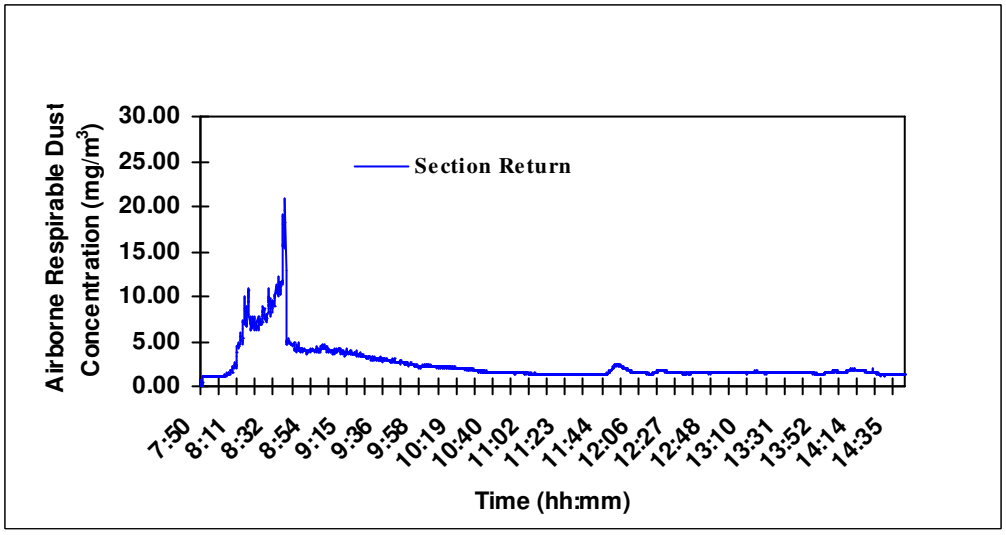
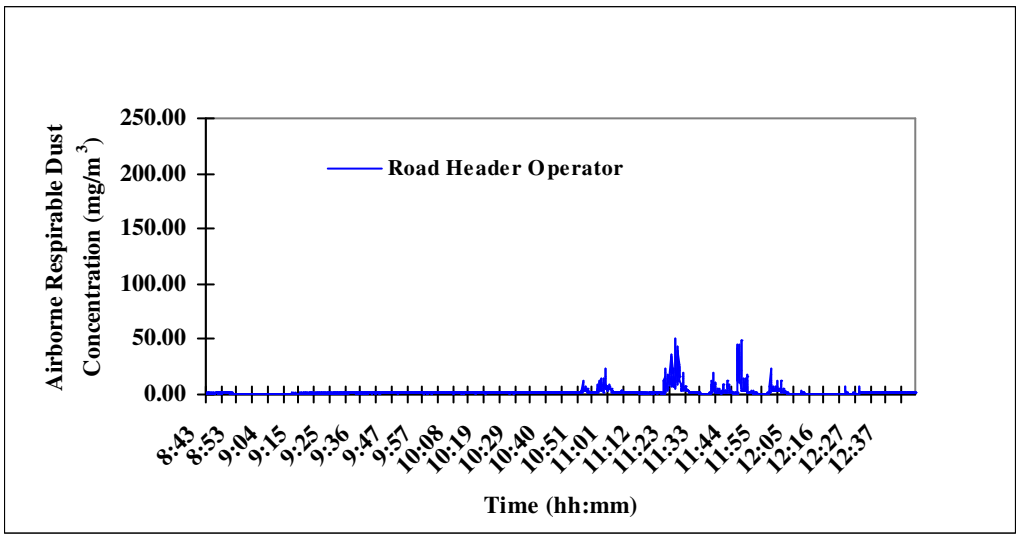


Figure 2: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 2



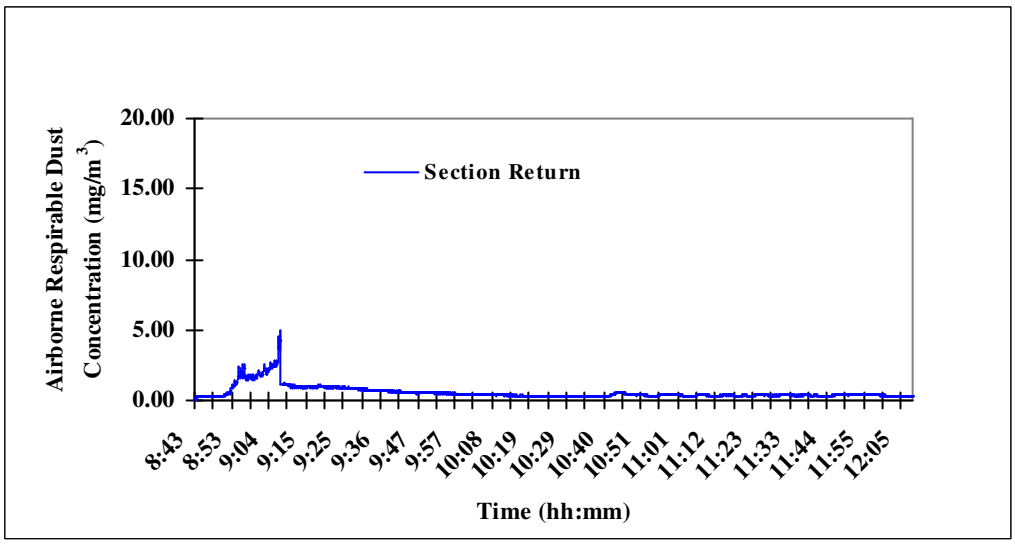
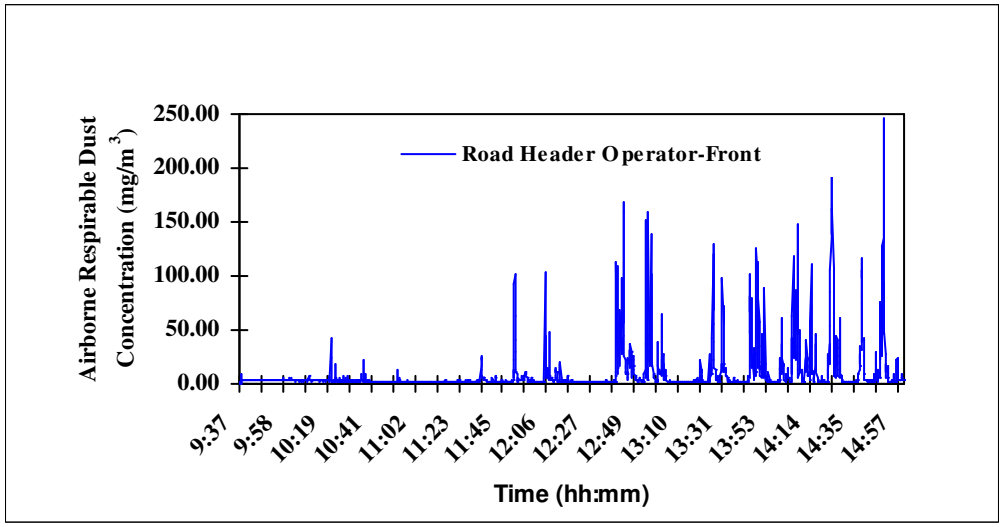


Figure 3: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 3



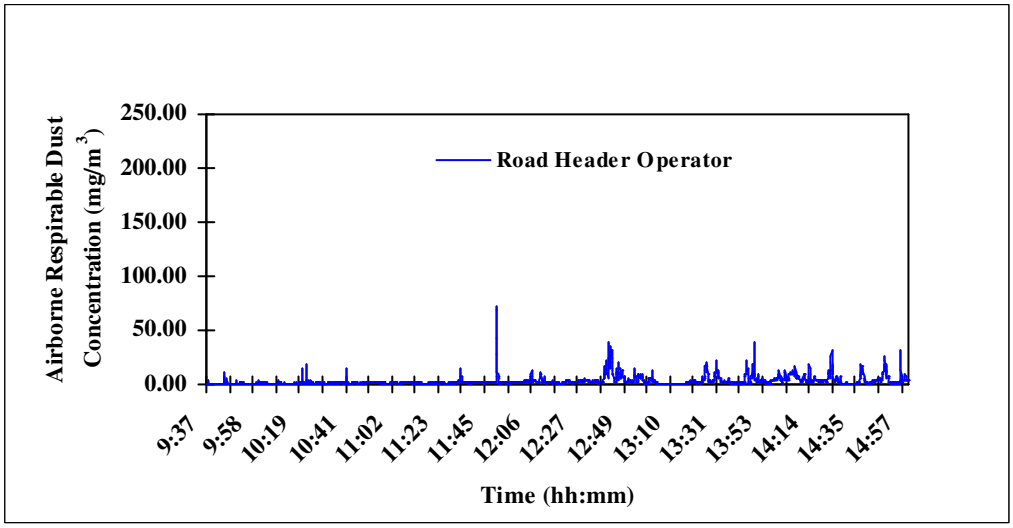
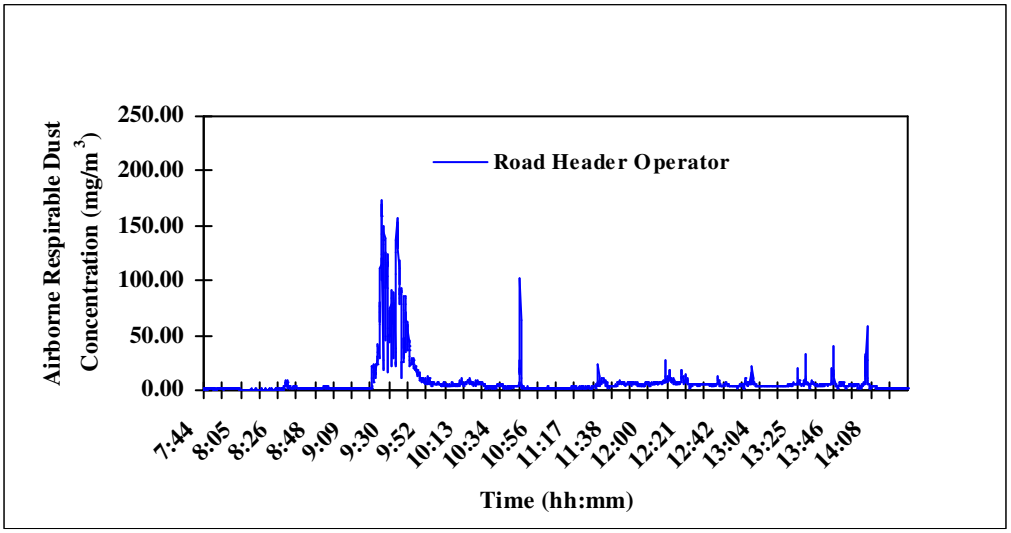


Figure 4: ARD profile recorded by the real-time dust monitor at the road header operator positions for Mine E-Test # 4



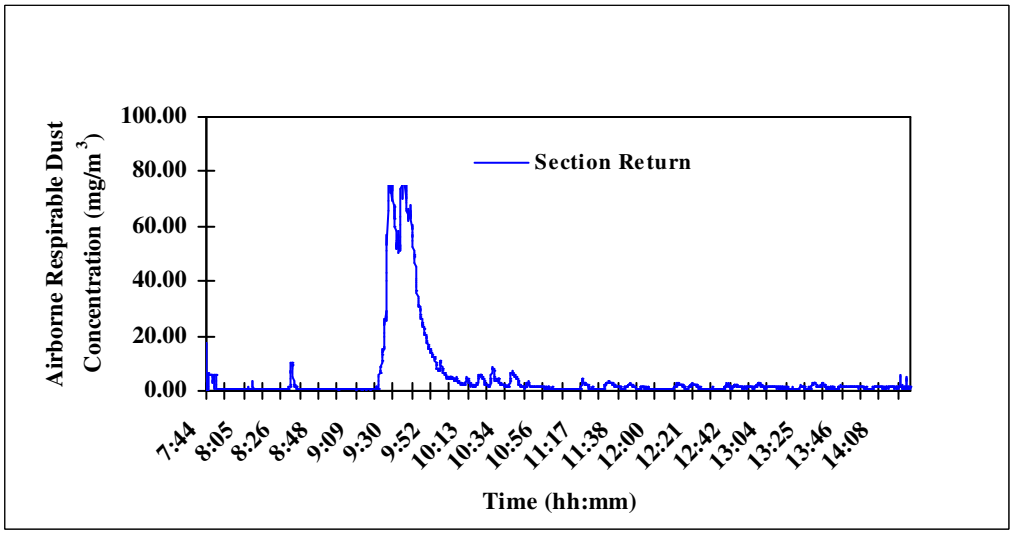
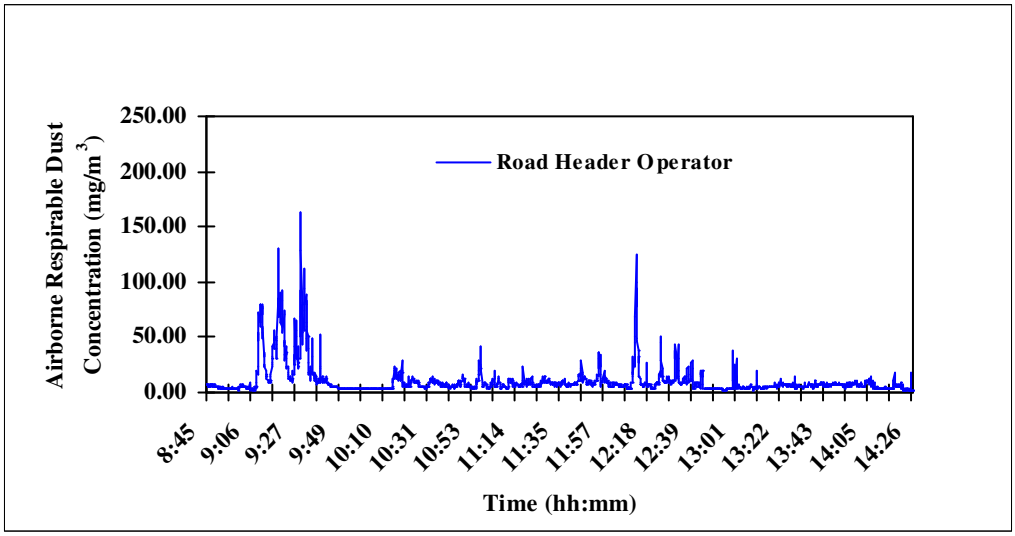


Figure 5: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 5



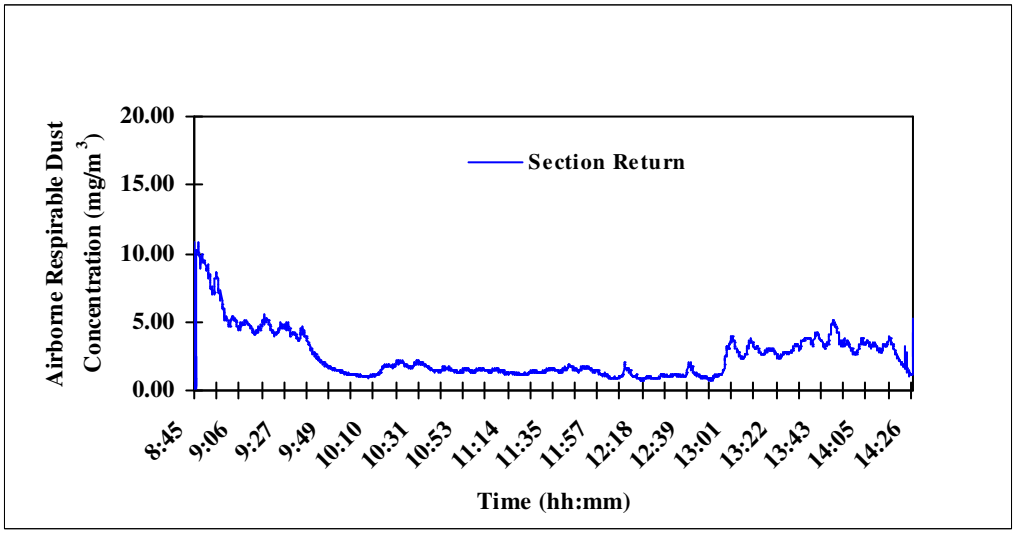
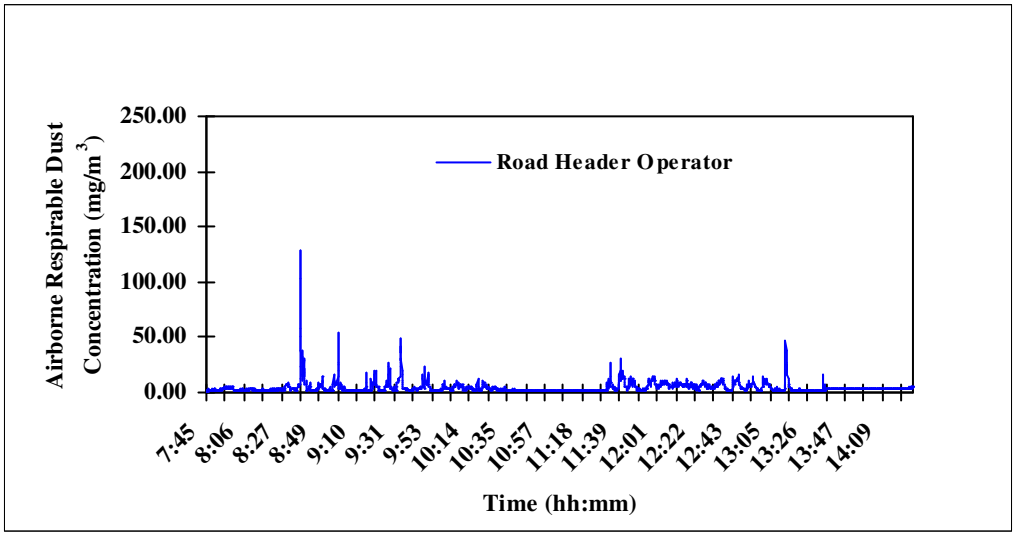


Figure 6: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 6



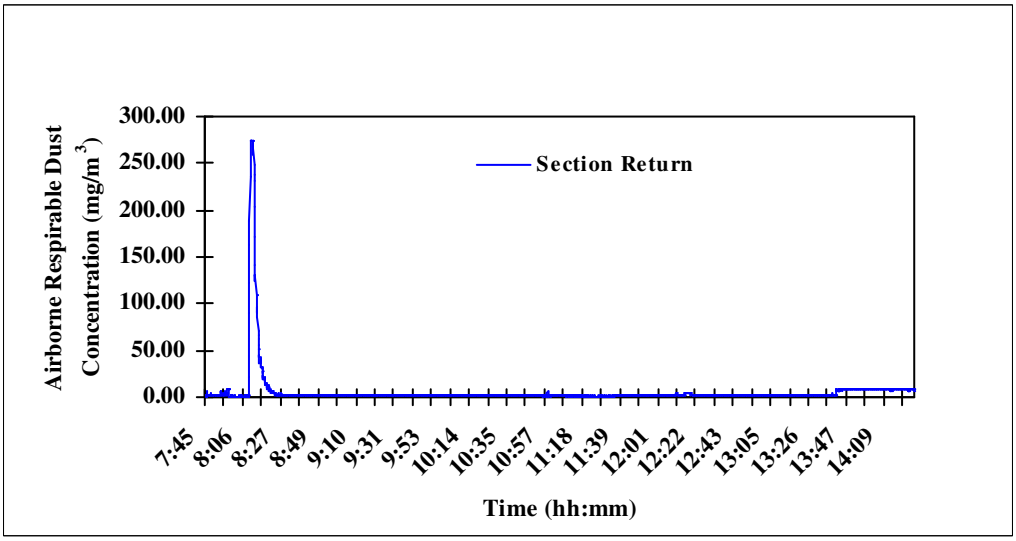
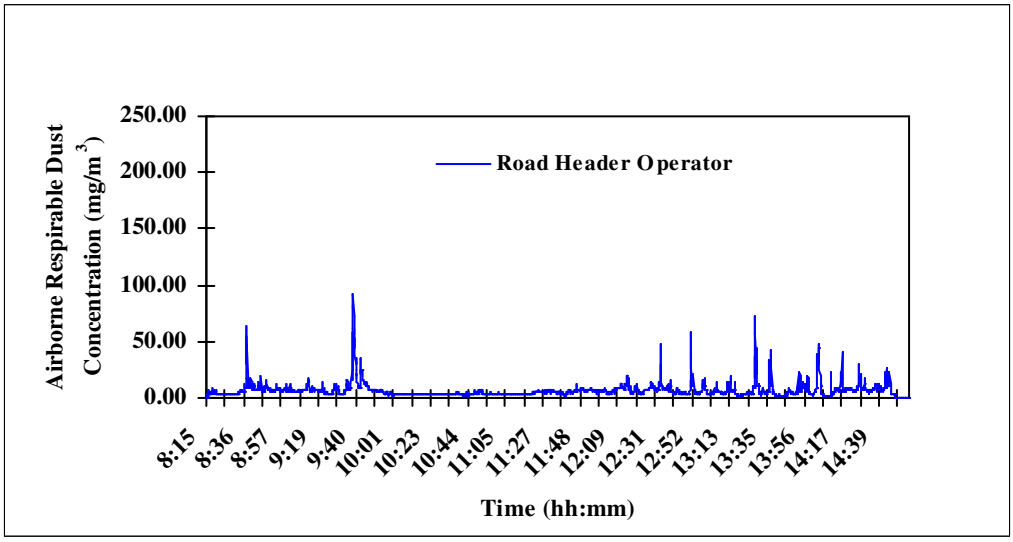


Figure 7: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 7



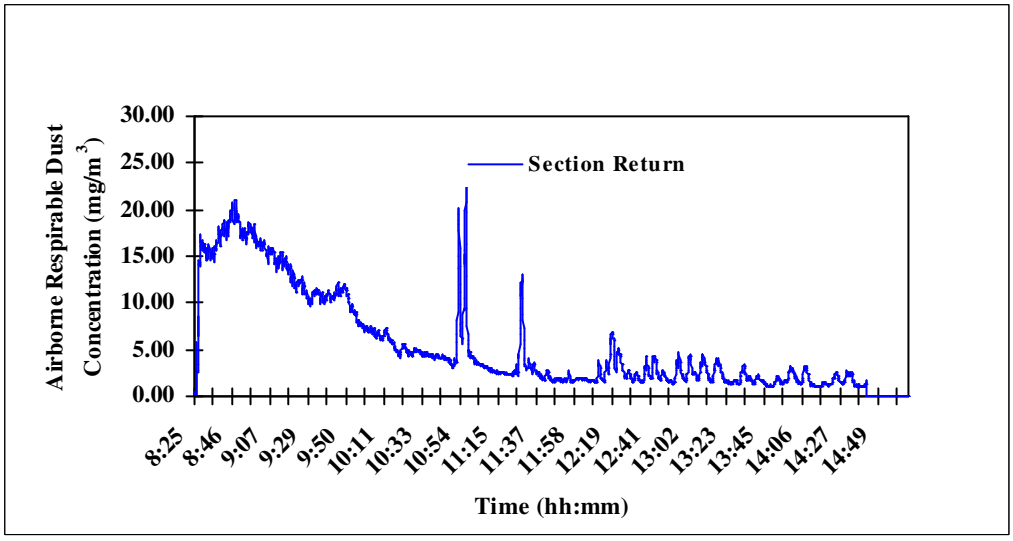
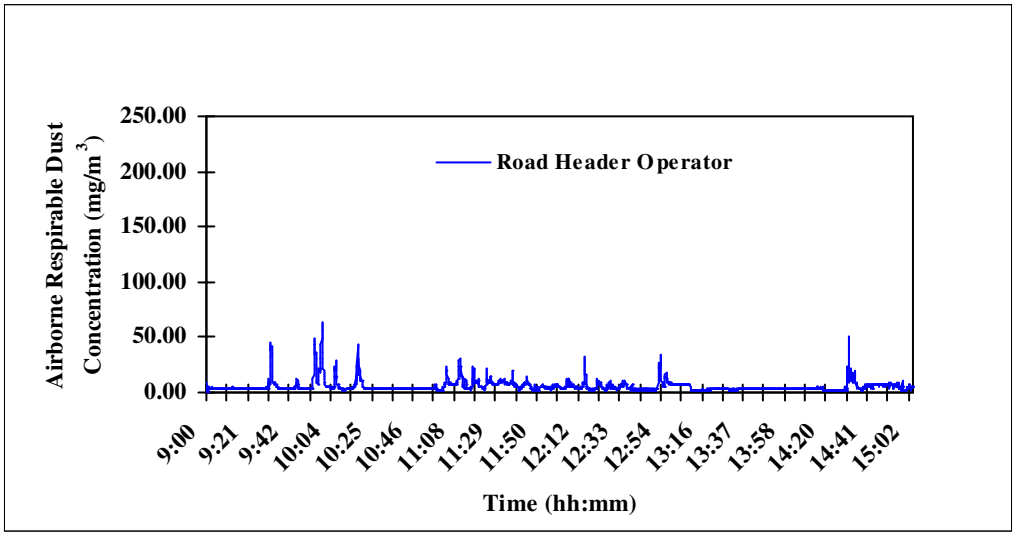


Figure 8: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 8



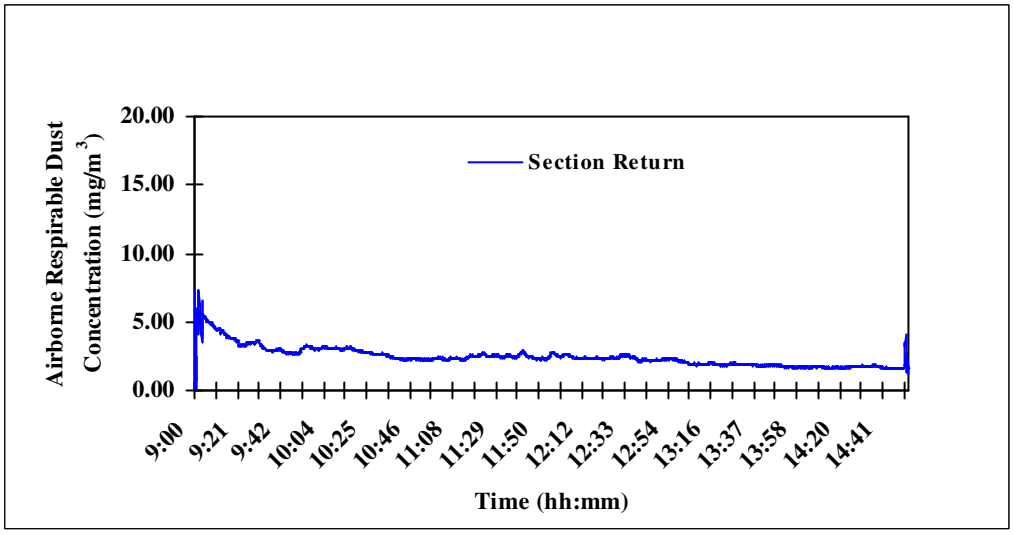
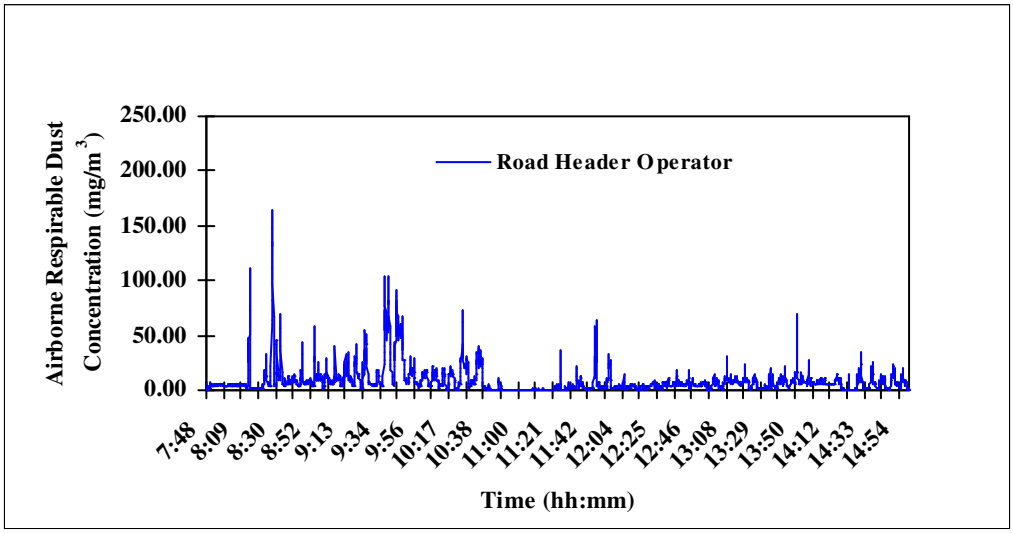


Figure 9: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 9



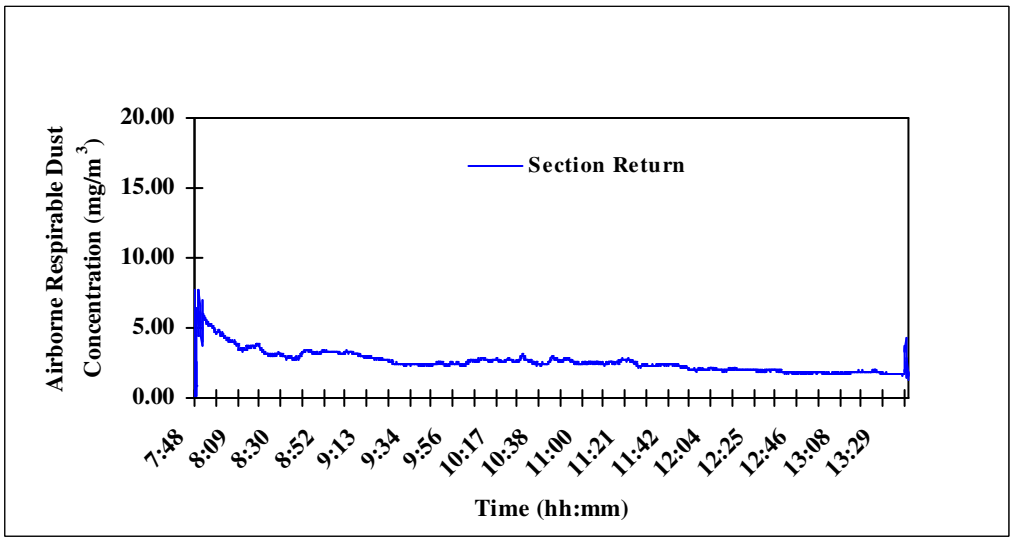
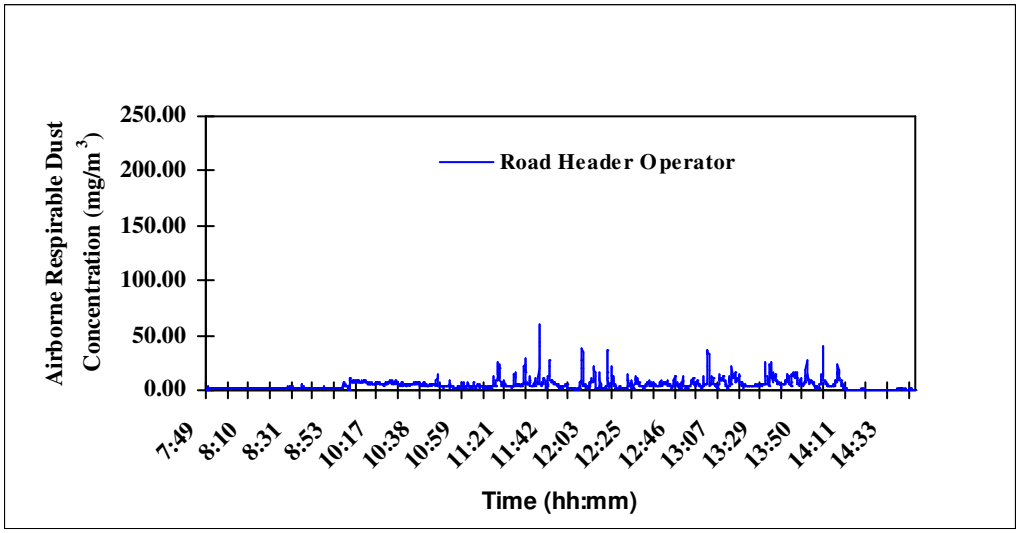


Figure 10: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 10



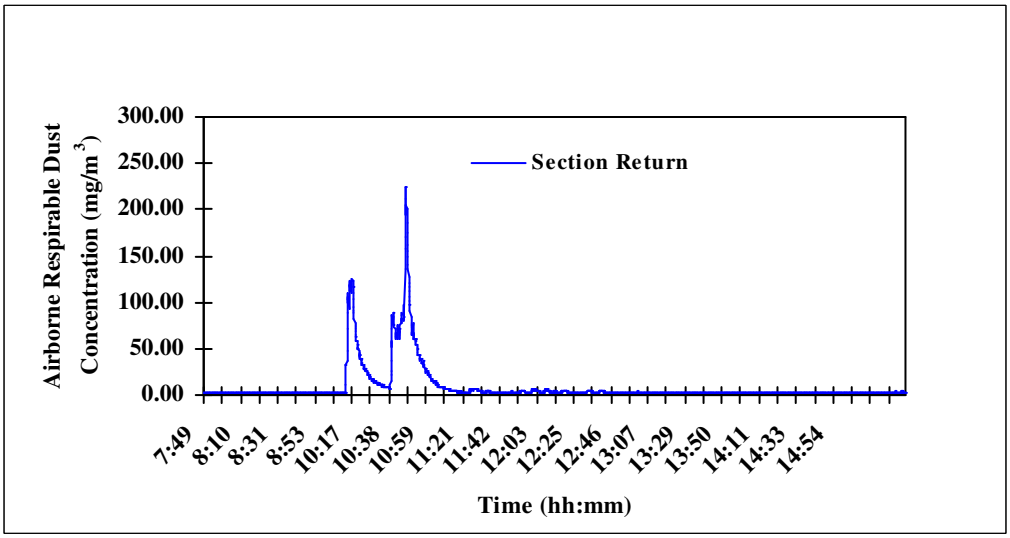
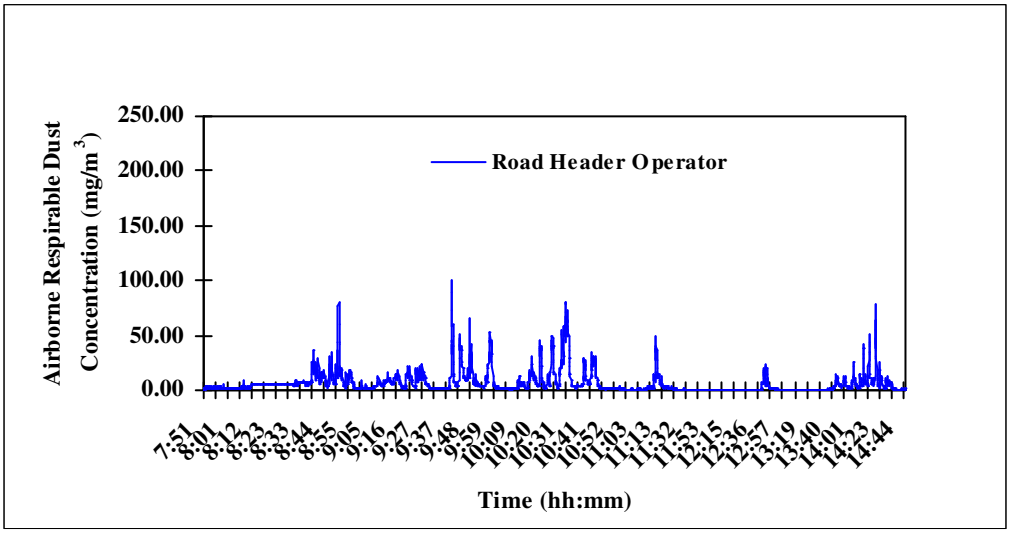


Figure 11: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 11



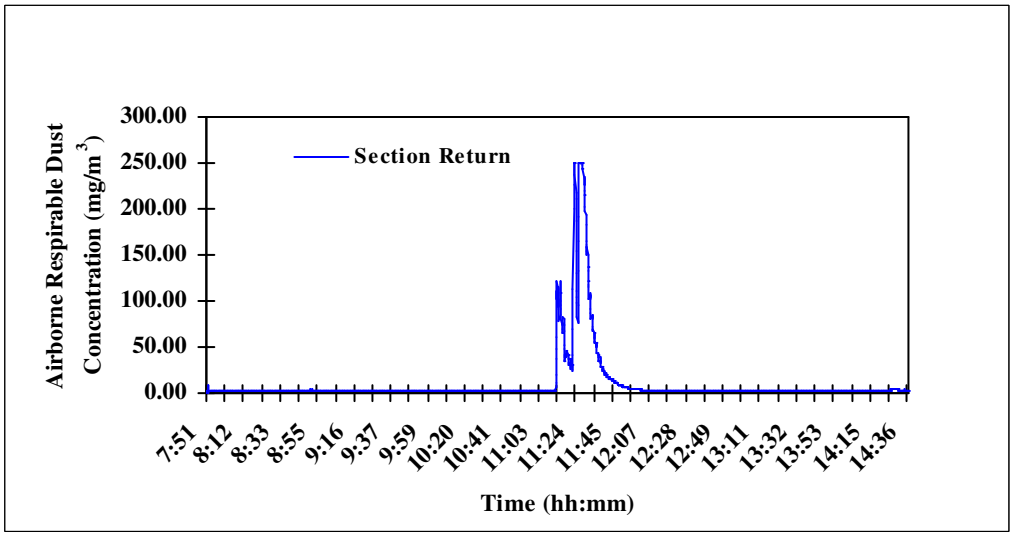
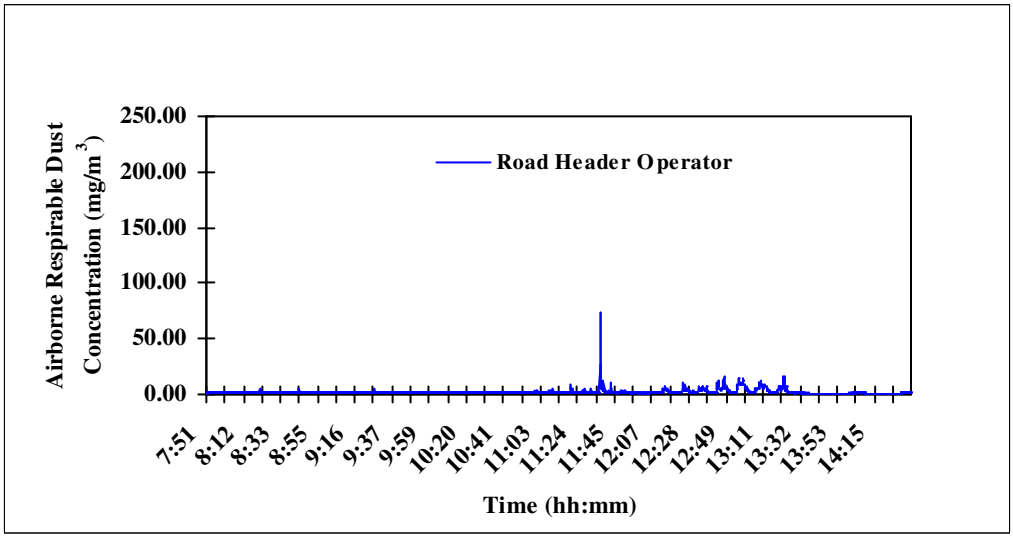


Figure 12: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 12



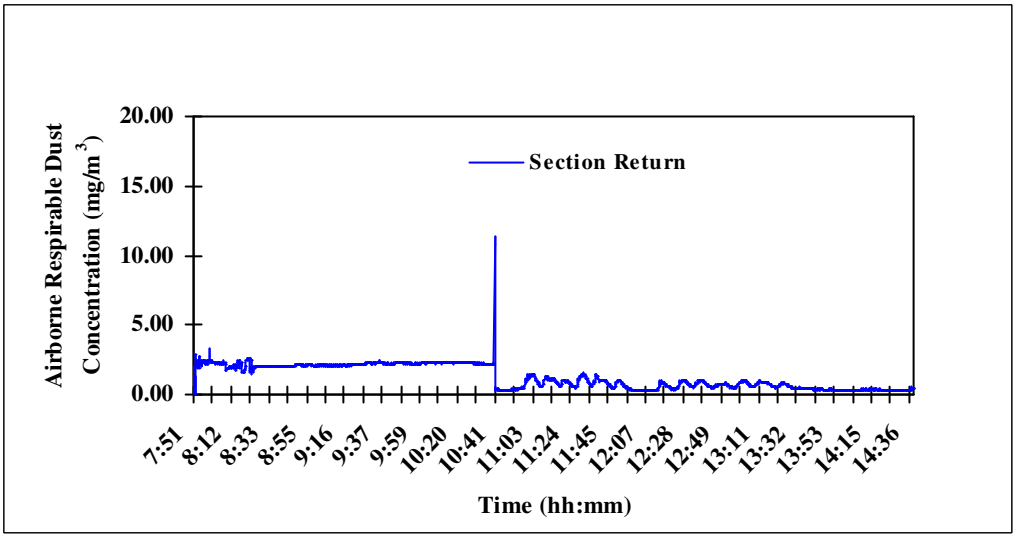
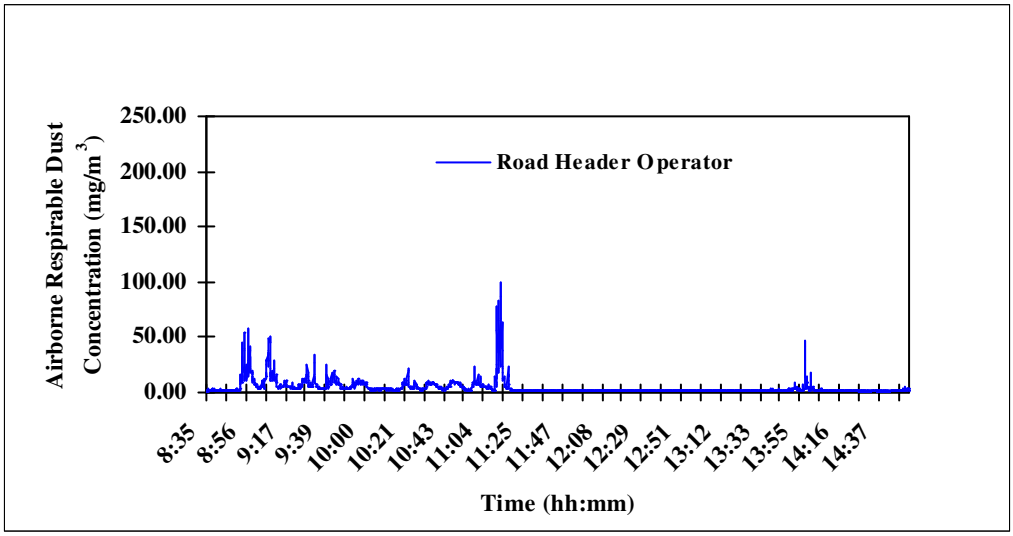


Figure 13: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 13



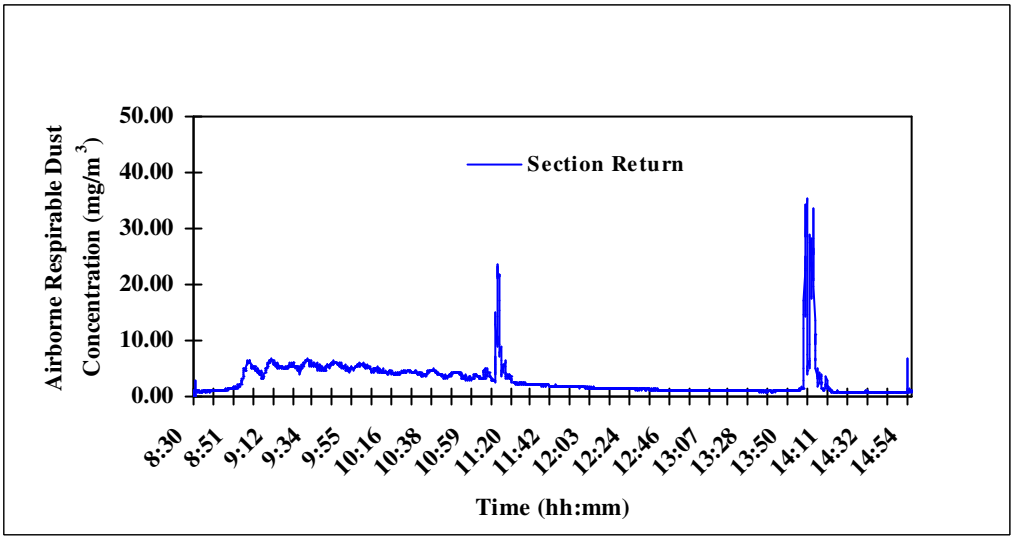
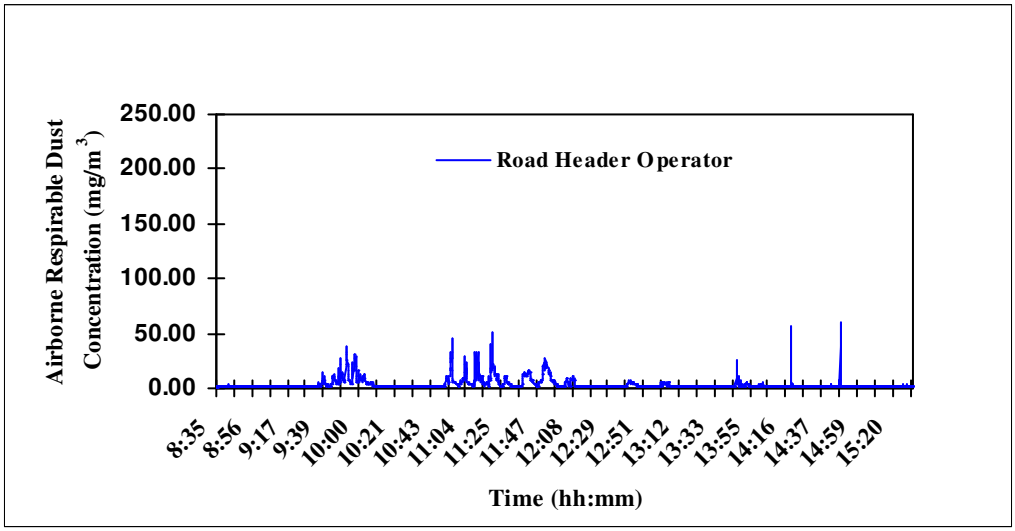


Figure 14: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 14



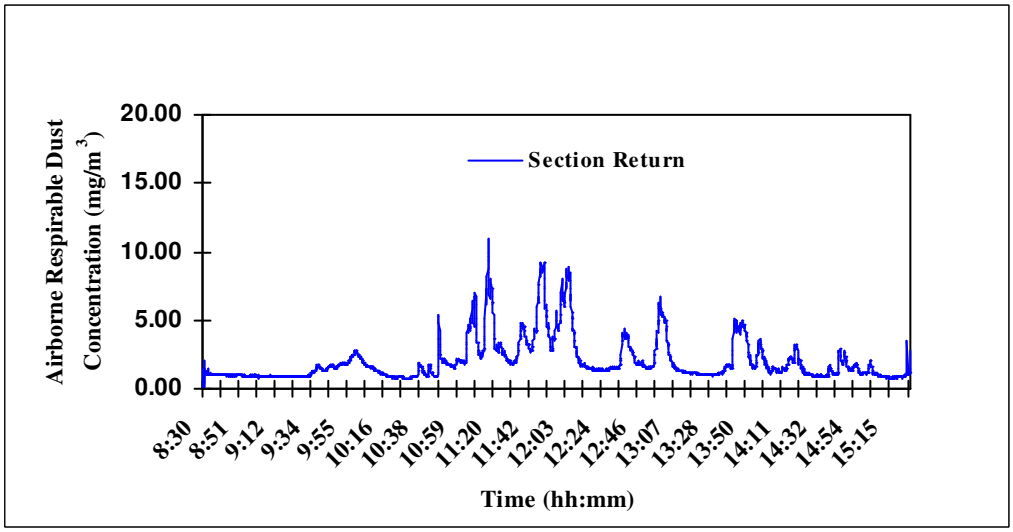
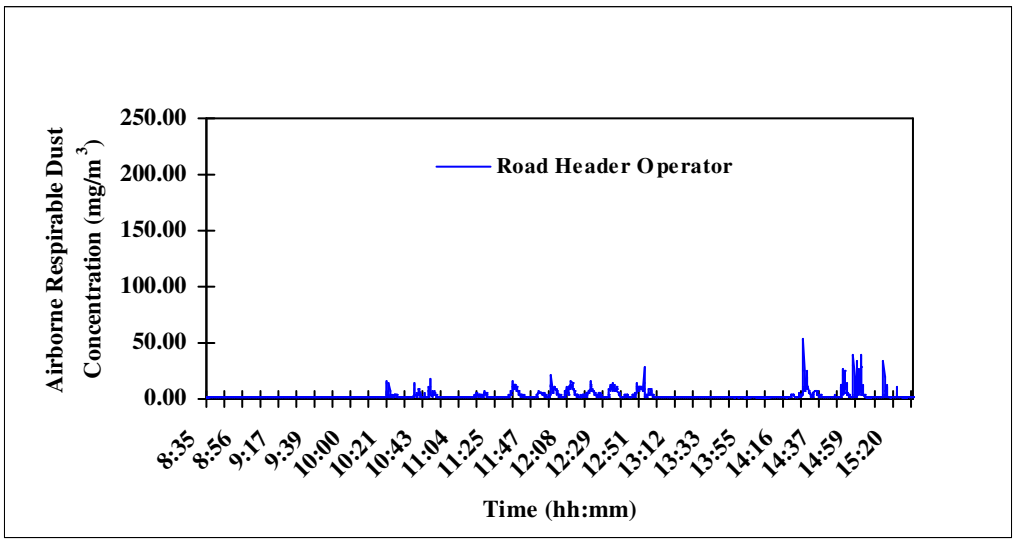


Figure 15: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 15



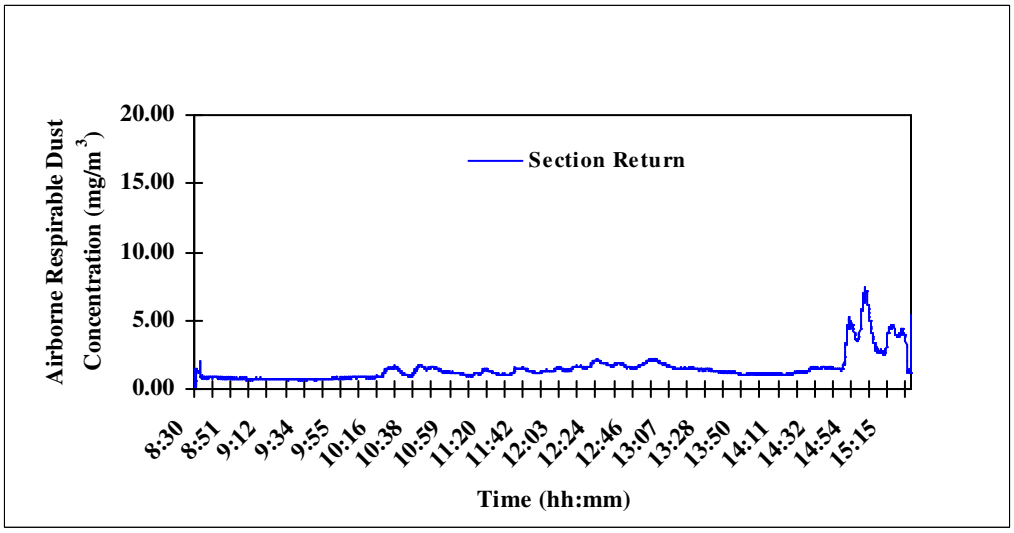
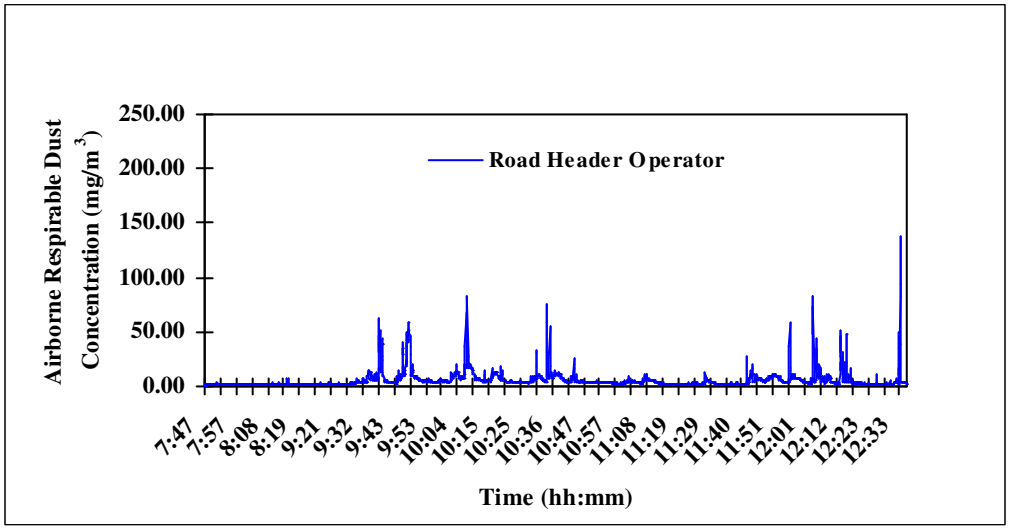


Figure 16: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 16



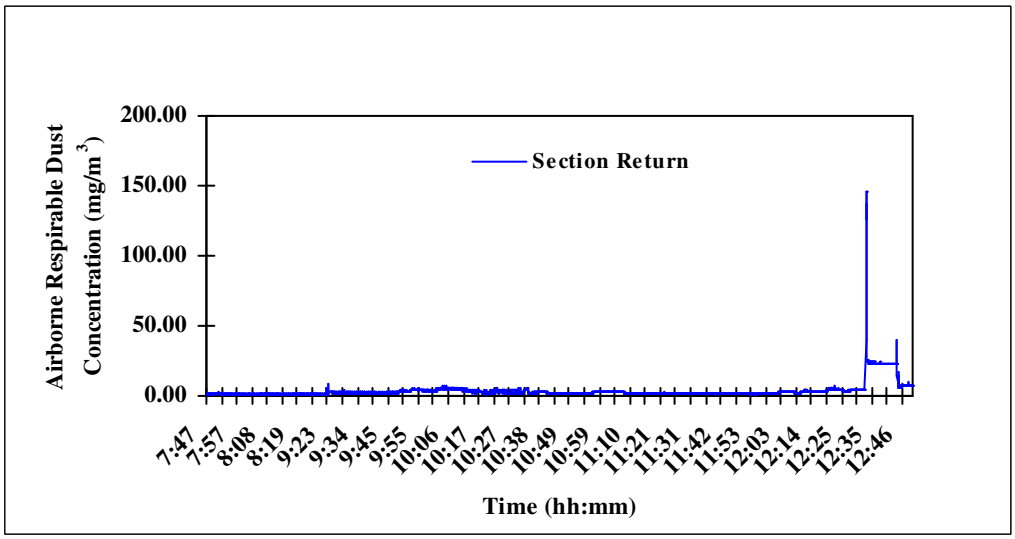
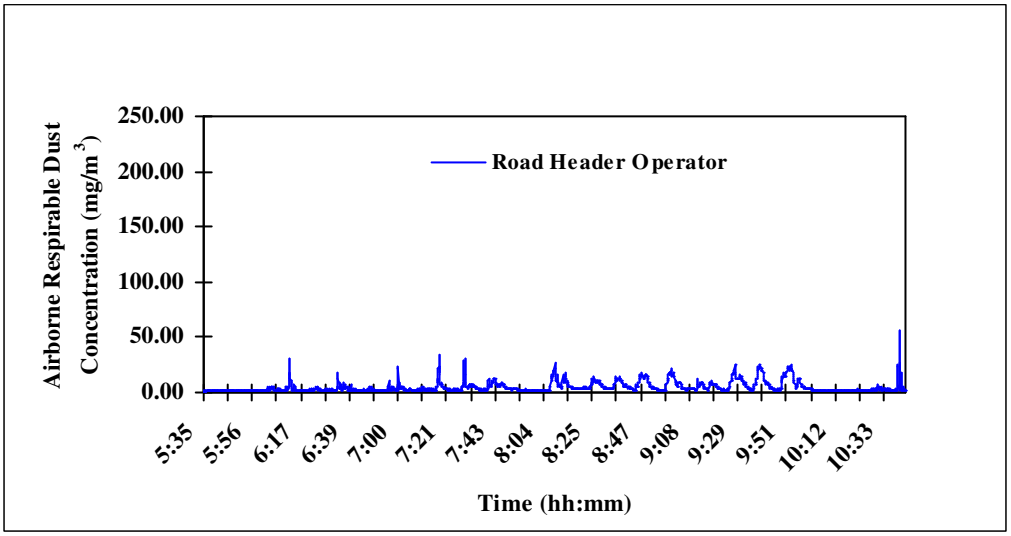


Figure 17: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 17



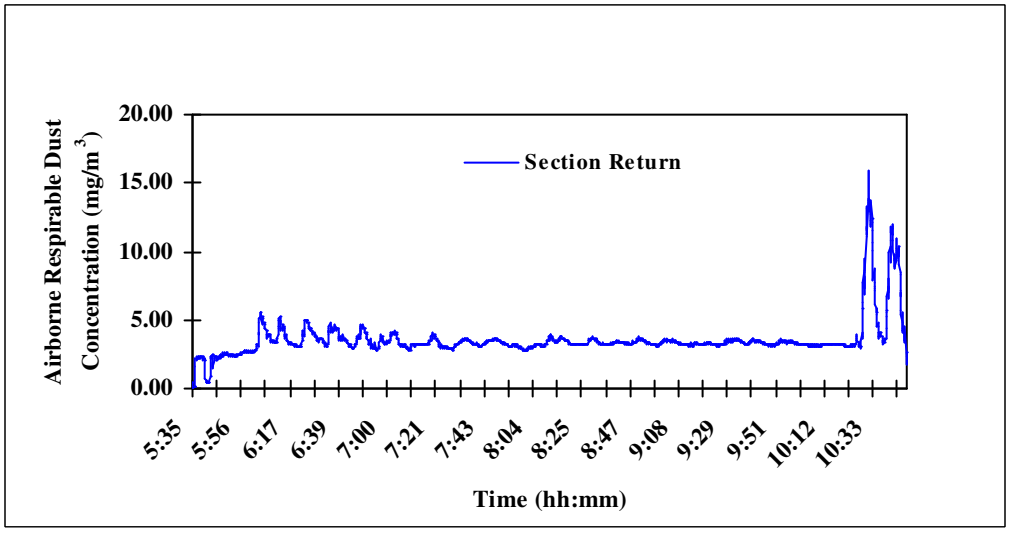
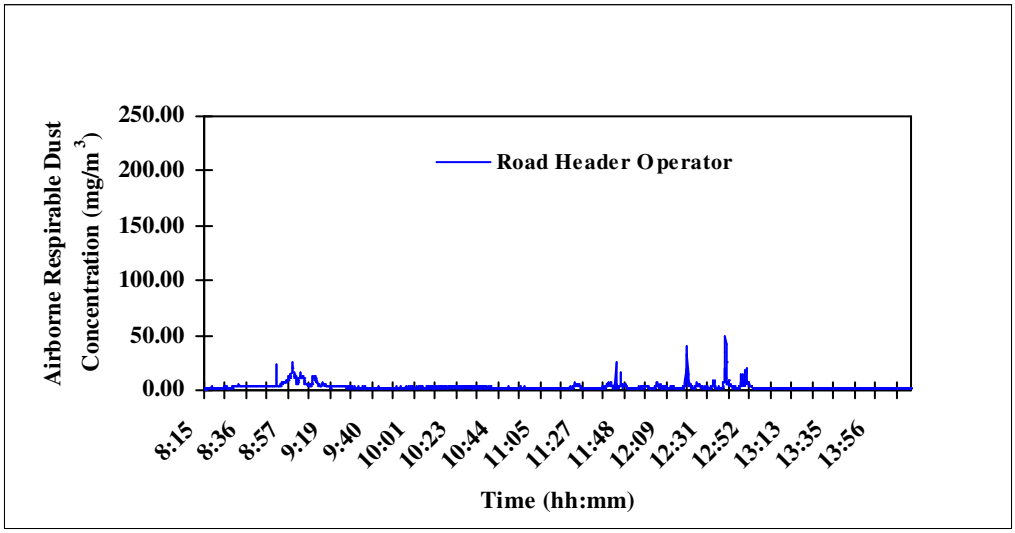


Figure 18: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 18



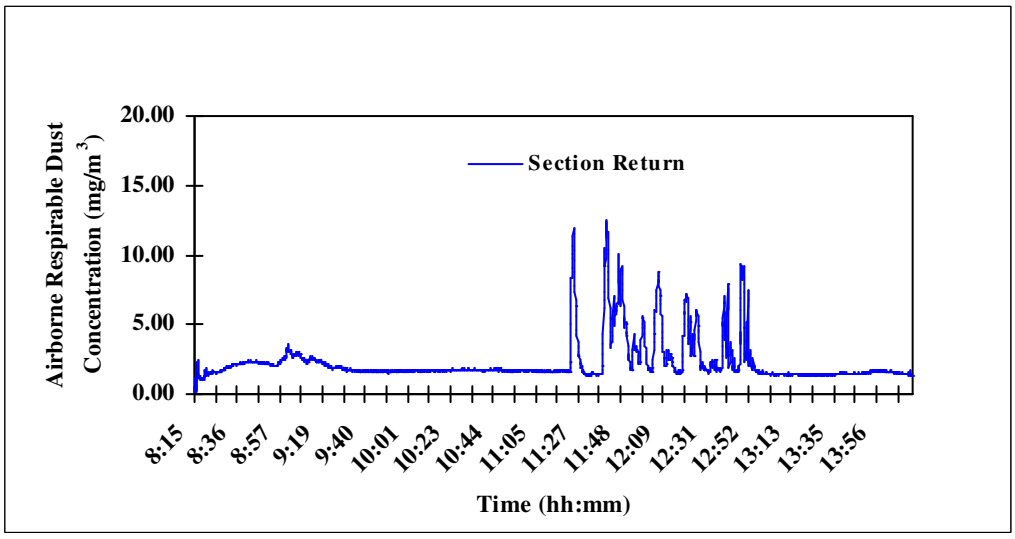
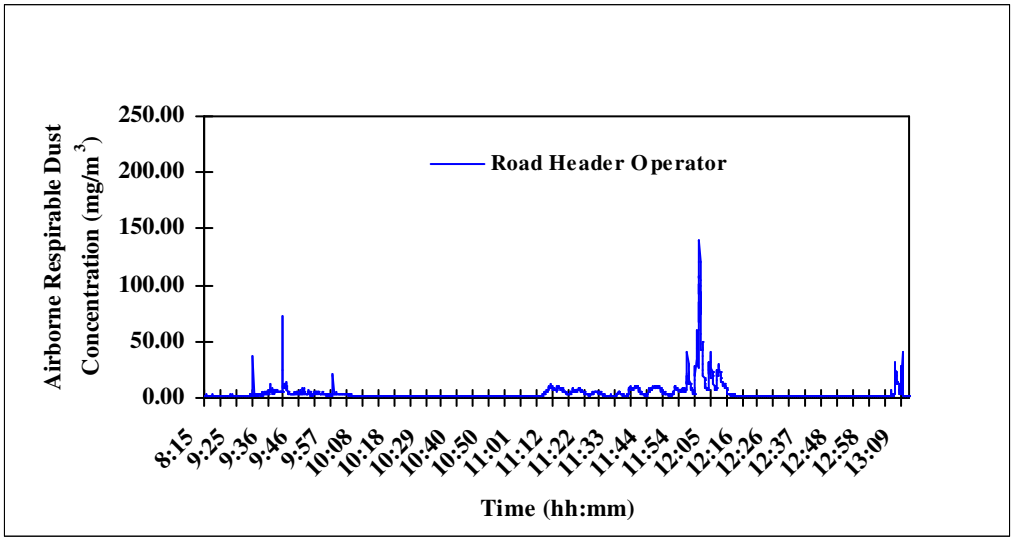


Figure 19: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 19



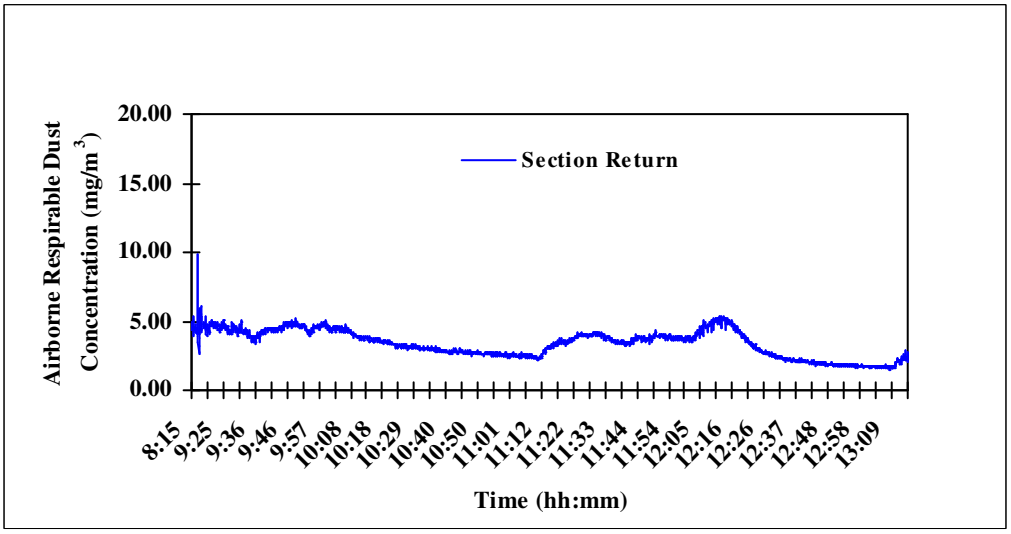
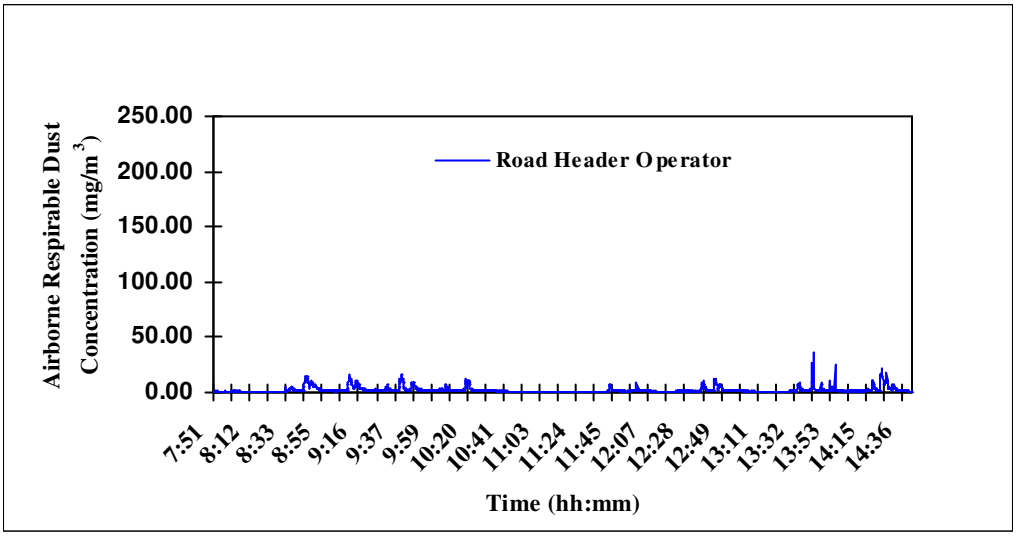


Figure 20: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 20



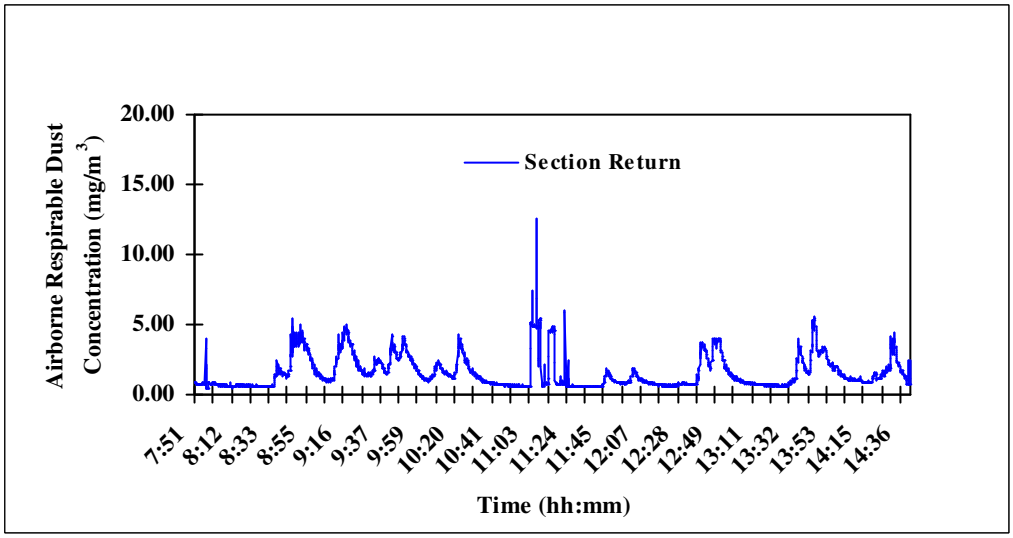
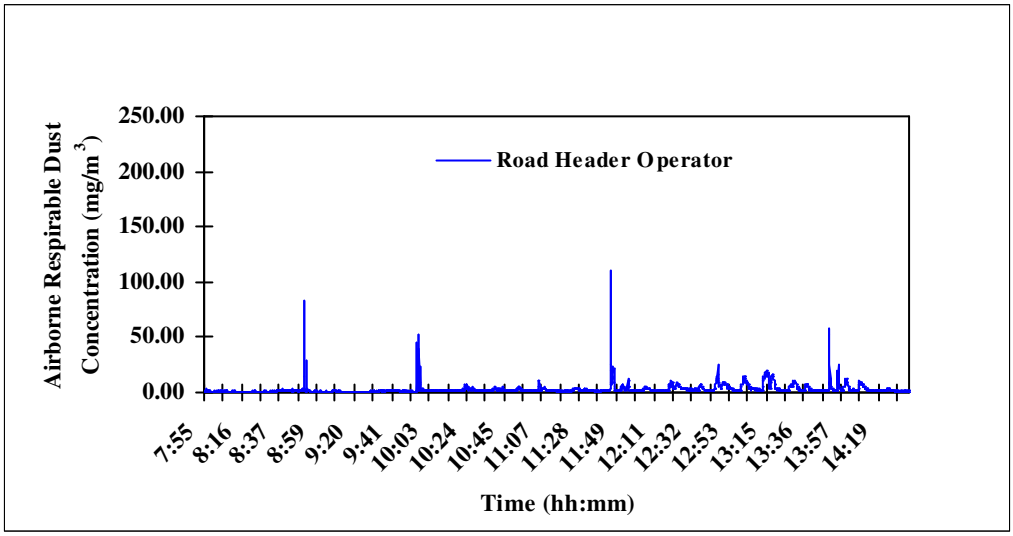


Figure 21: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 21



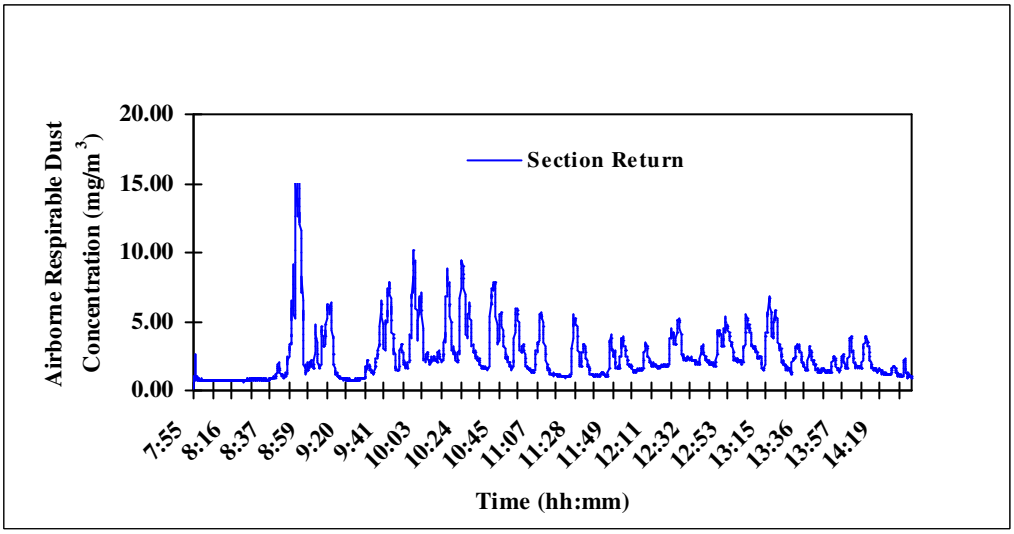
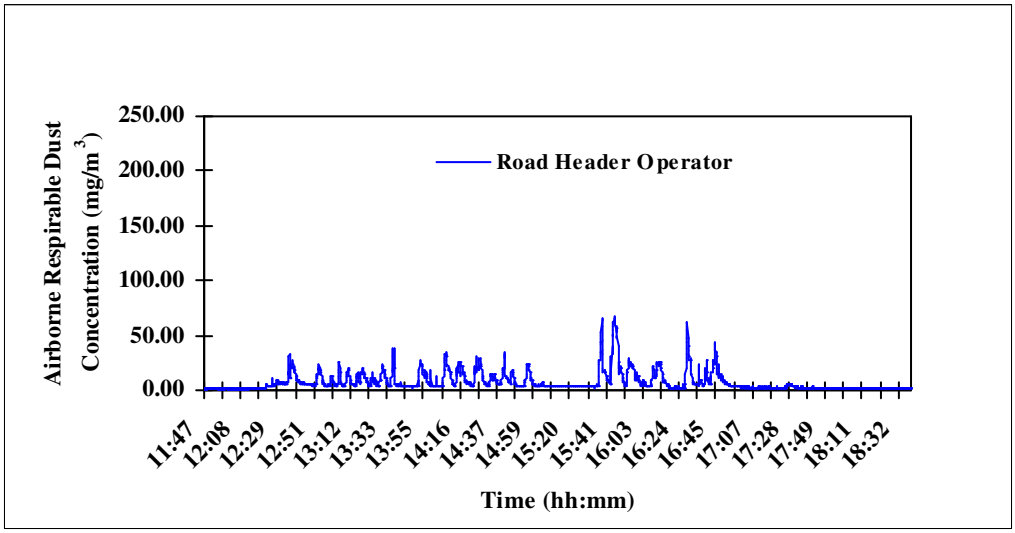


Figure 22: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 22



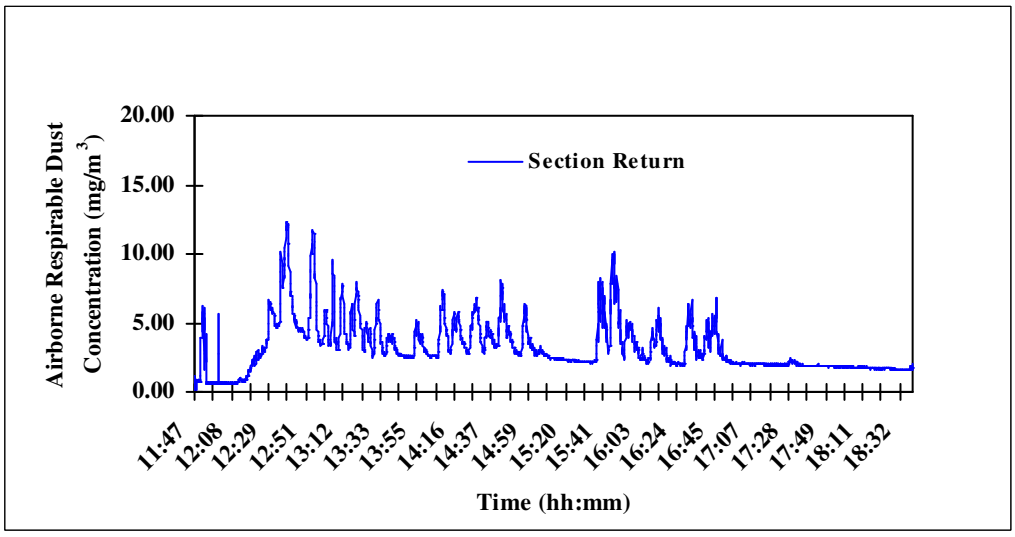
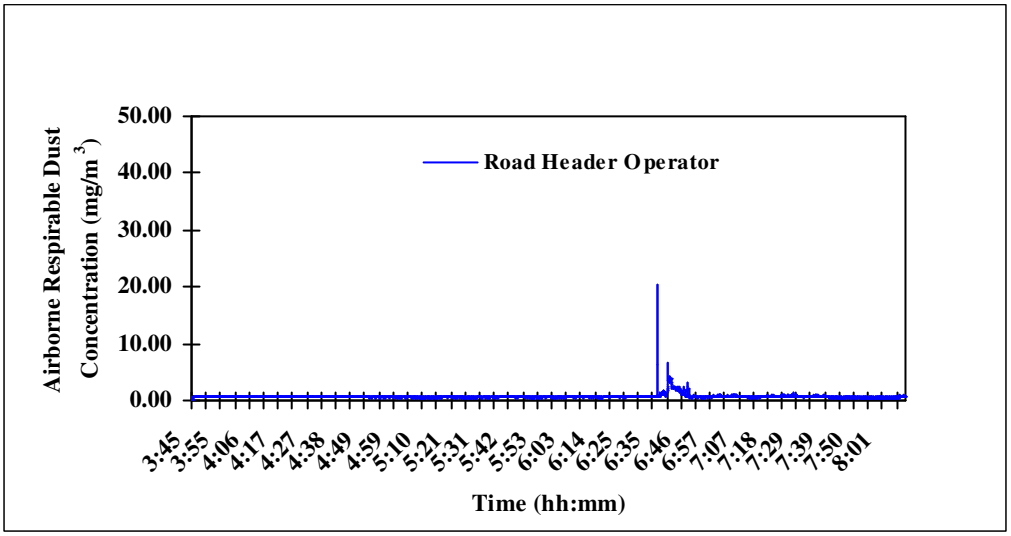


Figure 23: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 23



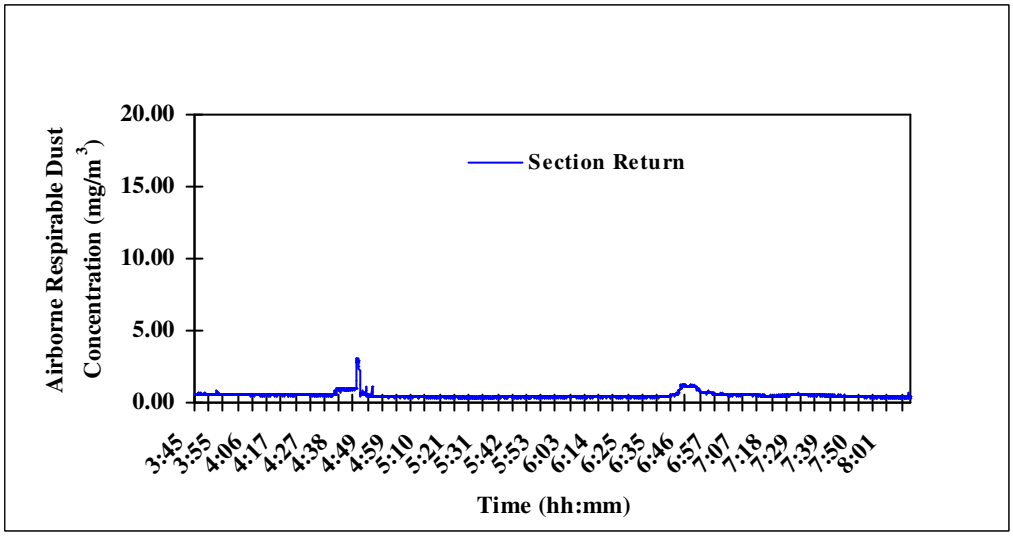
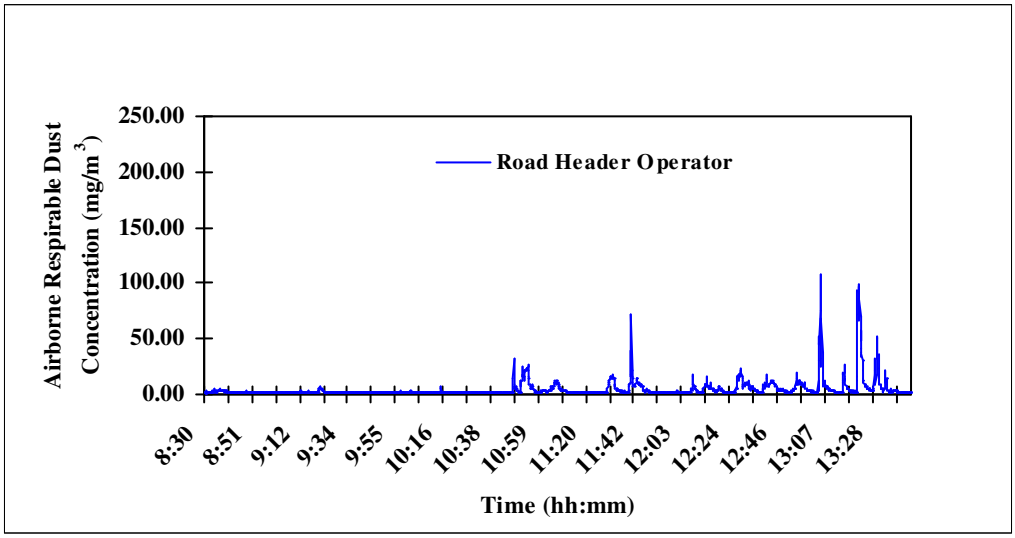


Figure 24: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 24



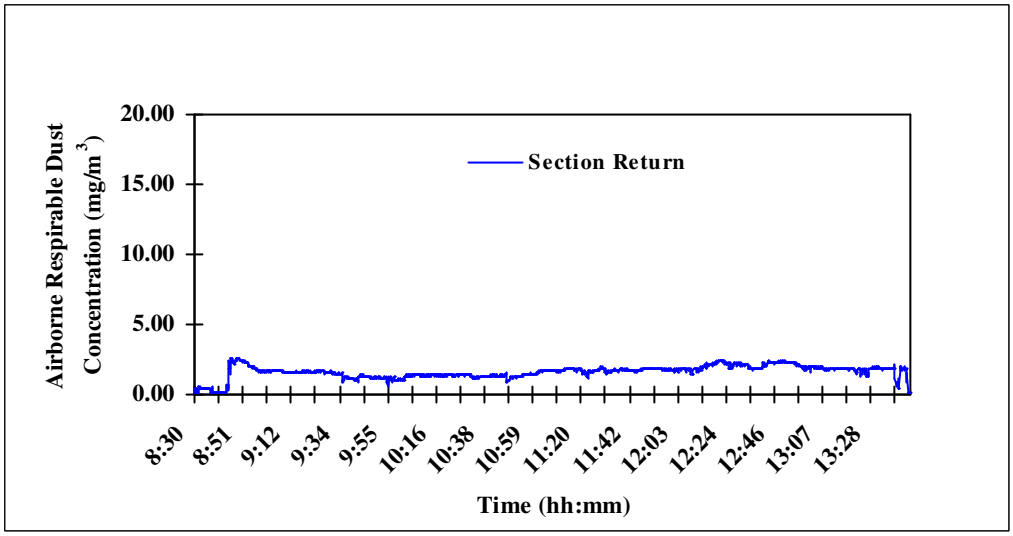


Figure 25: ARD profile recorded by the real-time dust monitor at the road header operator and section return positions for Mine E-Test # 25

APPENDIX-B9

Real-Time Dust Profiles in a Longwall Mine-F

(Chapter 6, 8)

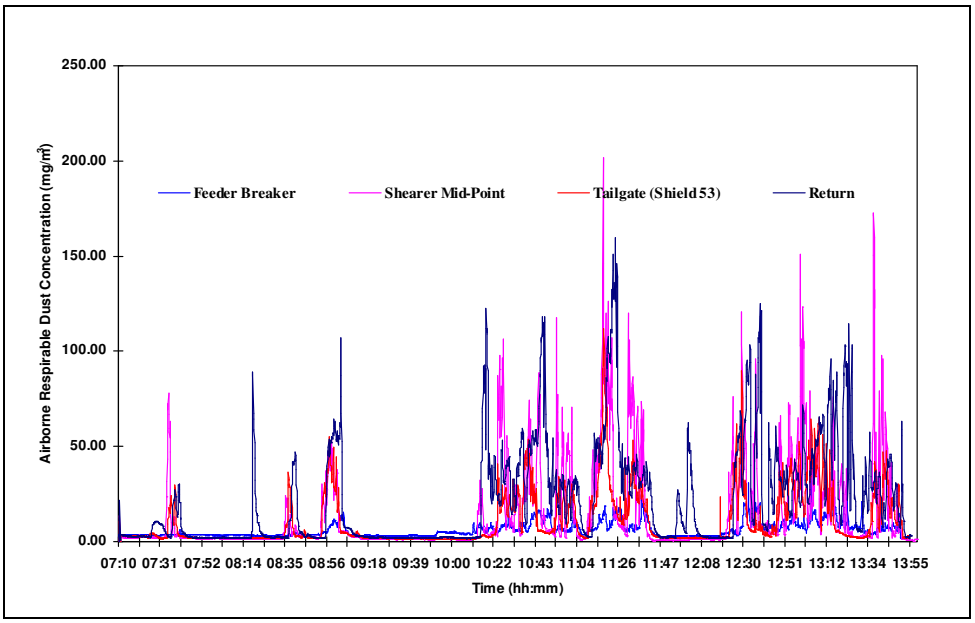


Figure 1: ARD profile recorded by the real-time dust monitor in the longwall section for Mine F-Test # 1

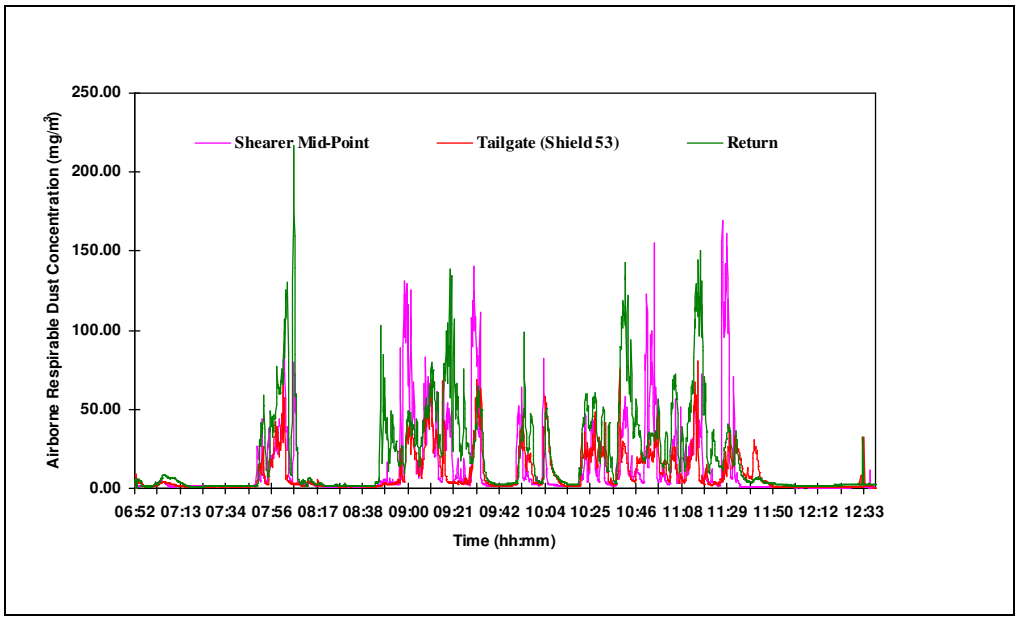


Figure 2: ARD profile recorded by the real-time dust monitor in the longwall section for Mine F-Test # 2

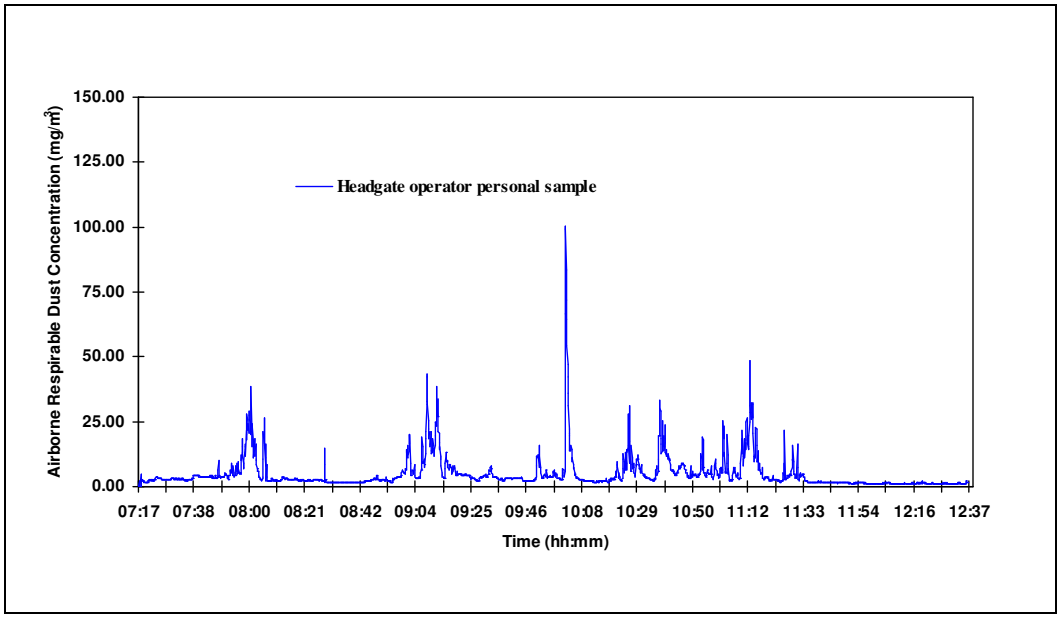


Figure 3: ARD profile recorded by the real-time dust monitor in the longwall section for Mine F-Test # 3

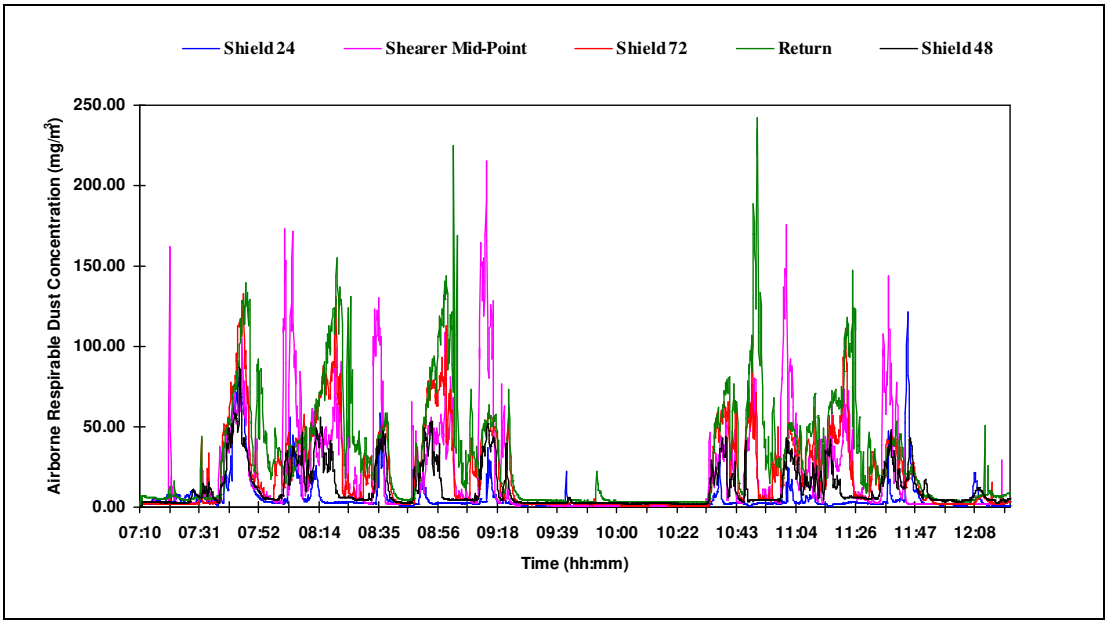


Figure 4: ARD concentration profile recorded by the real-time dust monitor in the longwall section for Mine F-Test # 4

APPENDIX-C

Section Intake Real-Time Dust Profiles for Various Mines (Chapter 7)

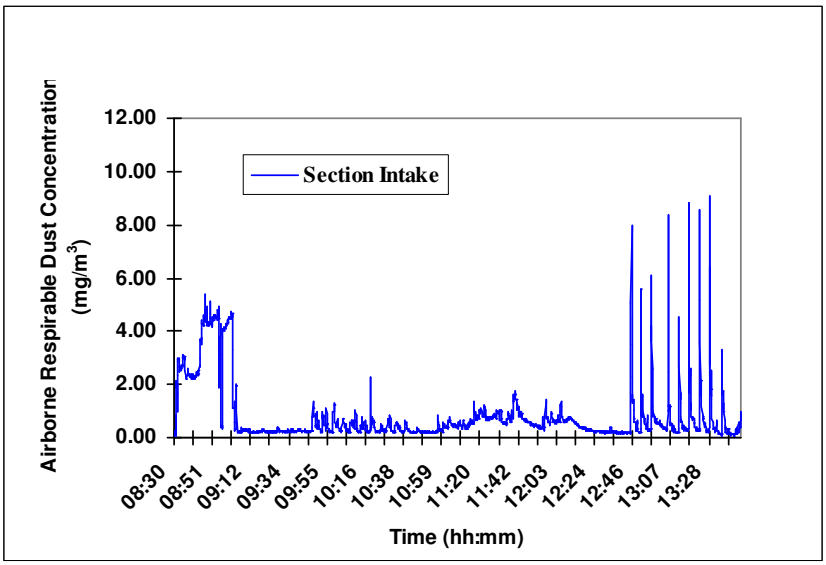


Figure 1: ARD profile recorded at the section intake position for Test # 1

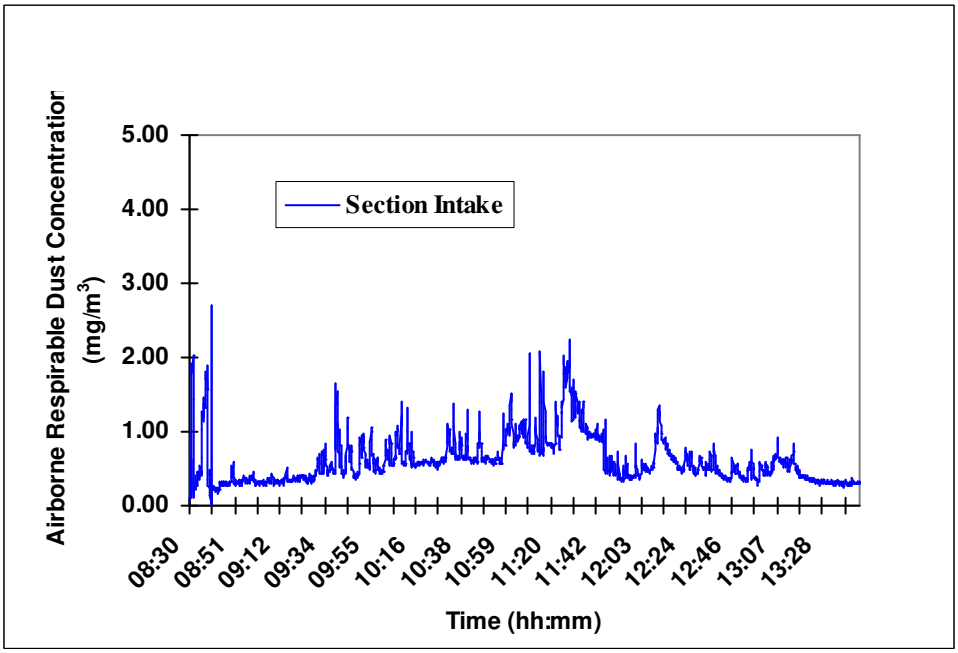


Figure 2: ARD profile recorded at the section intake position for Test # 2

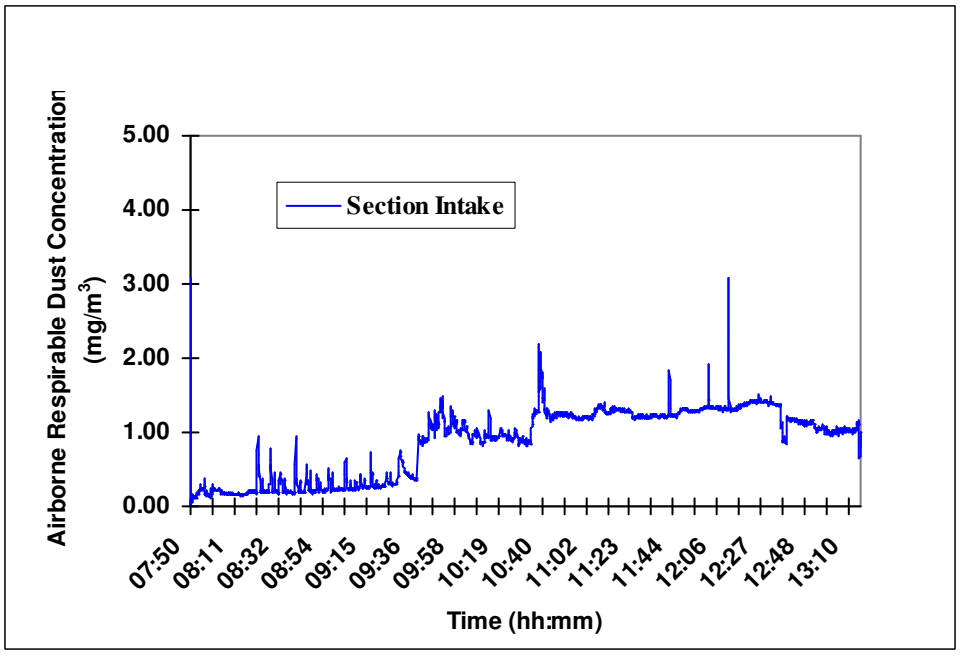


Figure 3: ARD profile recorded at the section intake position for Test # 3

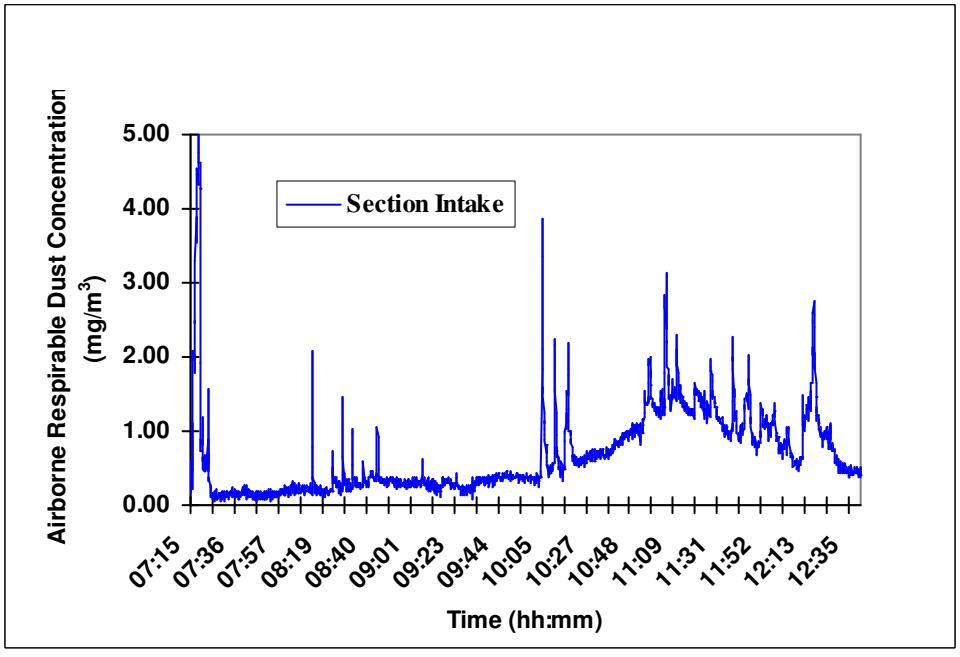


Figure 4: ARD profile recorded at the section intake position for Test # 4

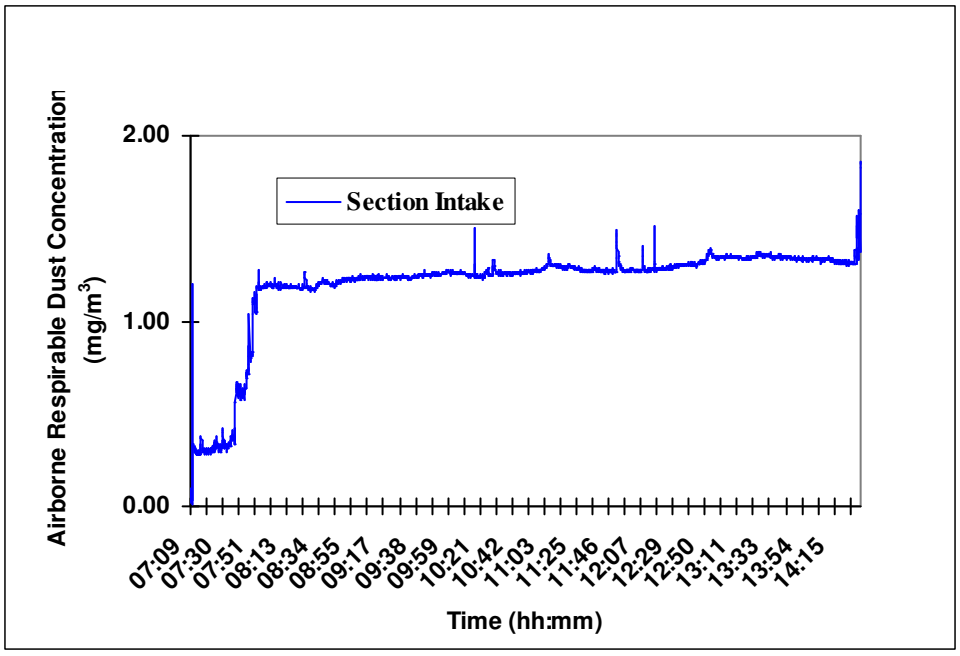


Figure 5: ARD profile recorded at the section intake position for Test # 5

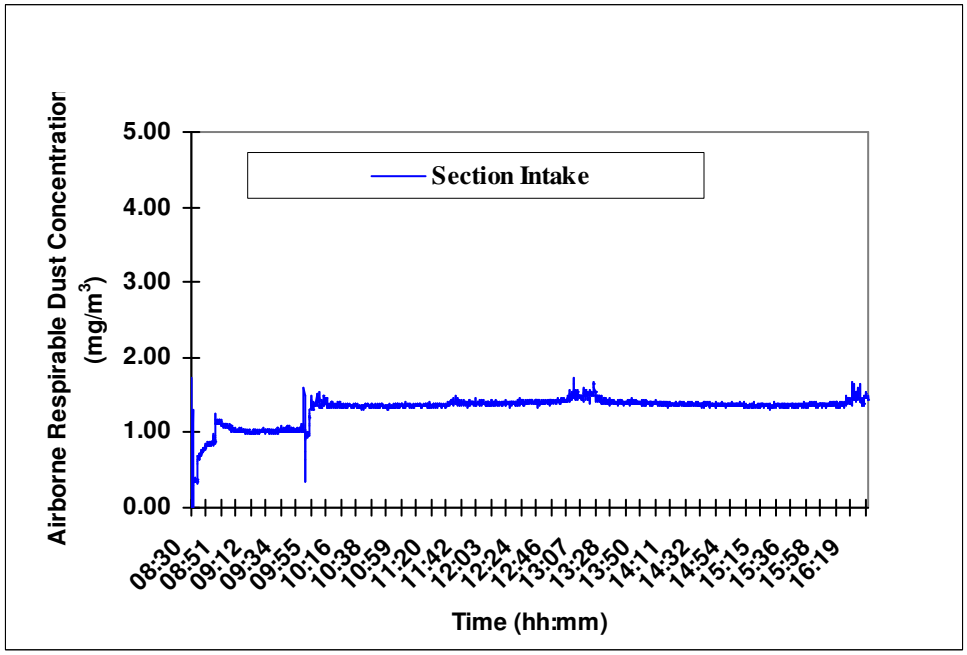


Figure 6: ARD profile recorded at the section intake position for Test # 6

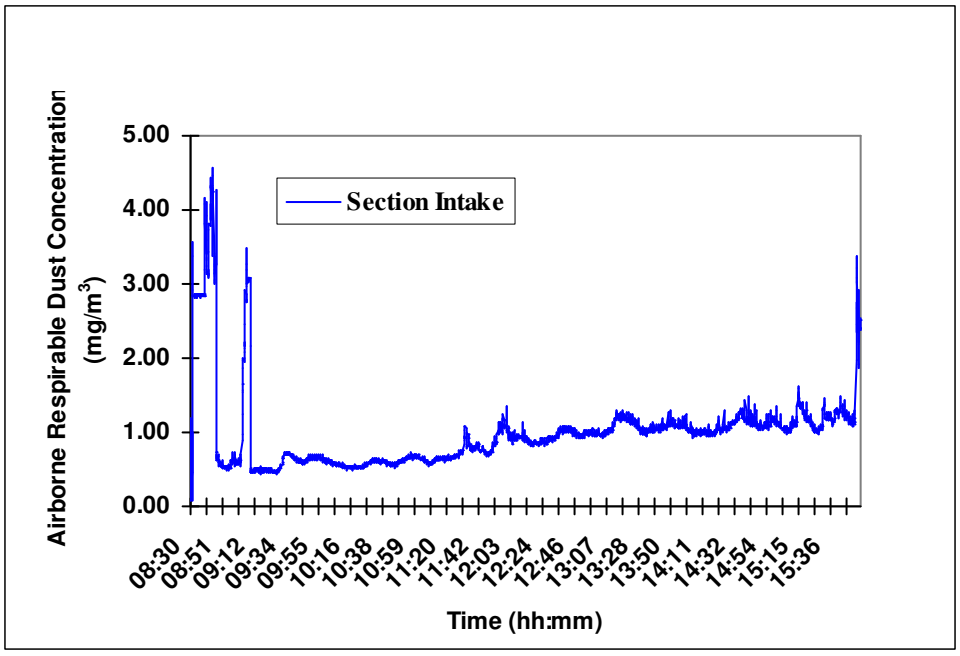


Figure 7: ARD profile recorded at the section intake position for Test # 7

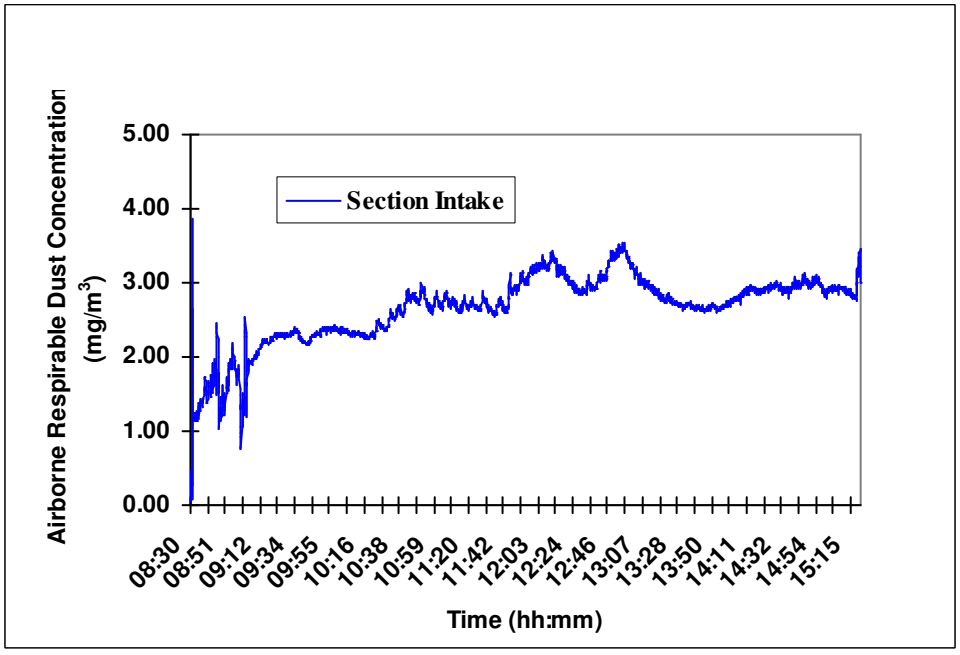


Figure 8: ARD profile recorded at the section intake position for Test # 8

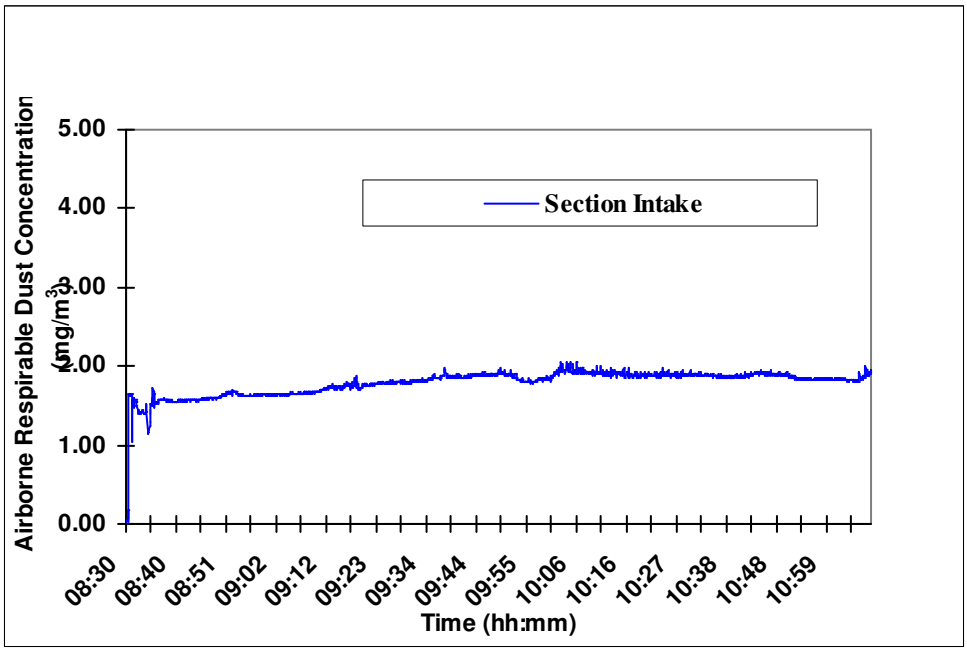


Figure 9: ARD profile recorded at the section intake position for Test # 9

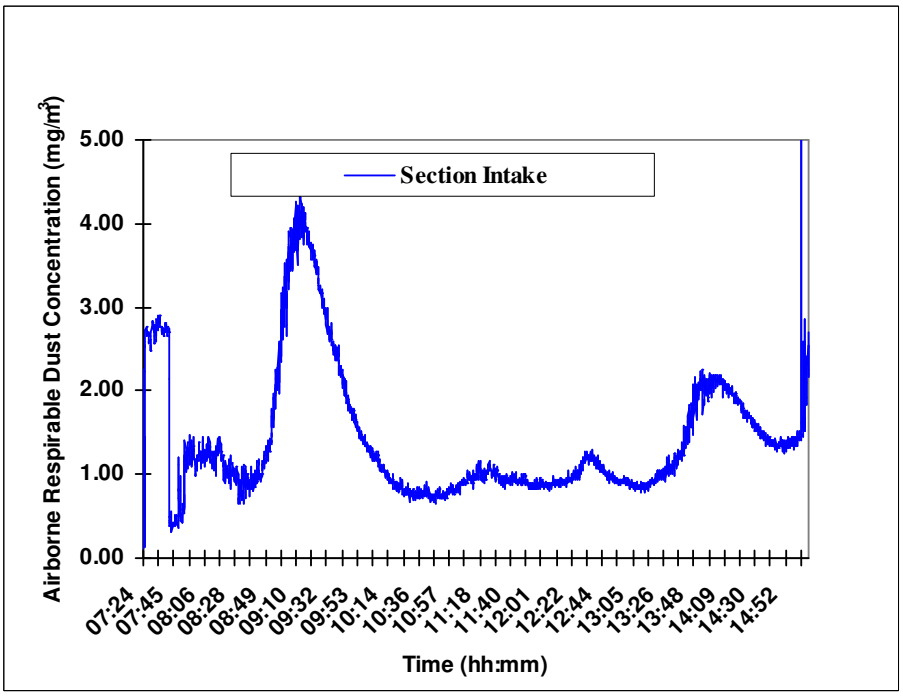


Figure 10: ARD profile recorded at the section intake position for Test #10

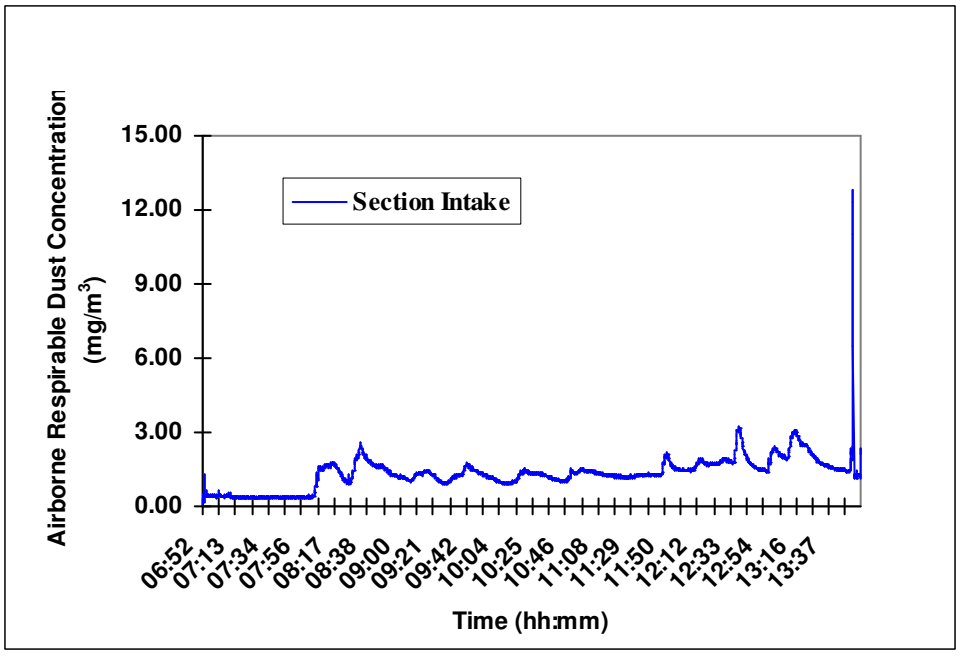


Figure 11: ARD profile recorded at the section intake position for Test # 11

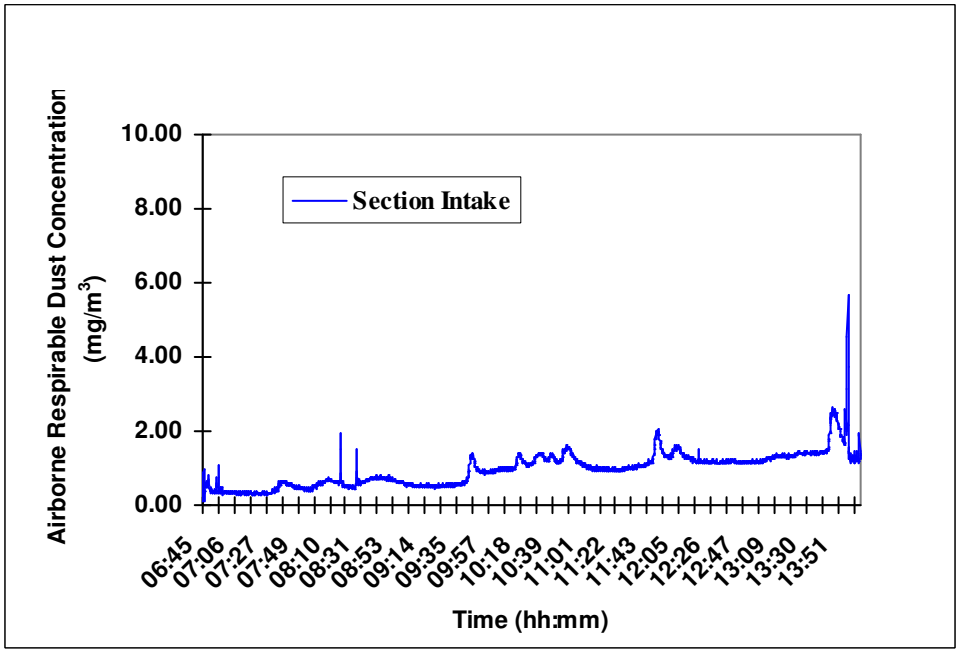


Figure 12: ARD profile recorded at the section intake position for Test # 12

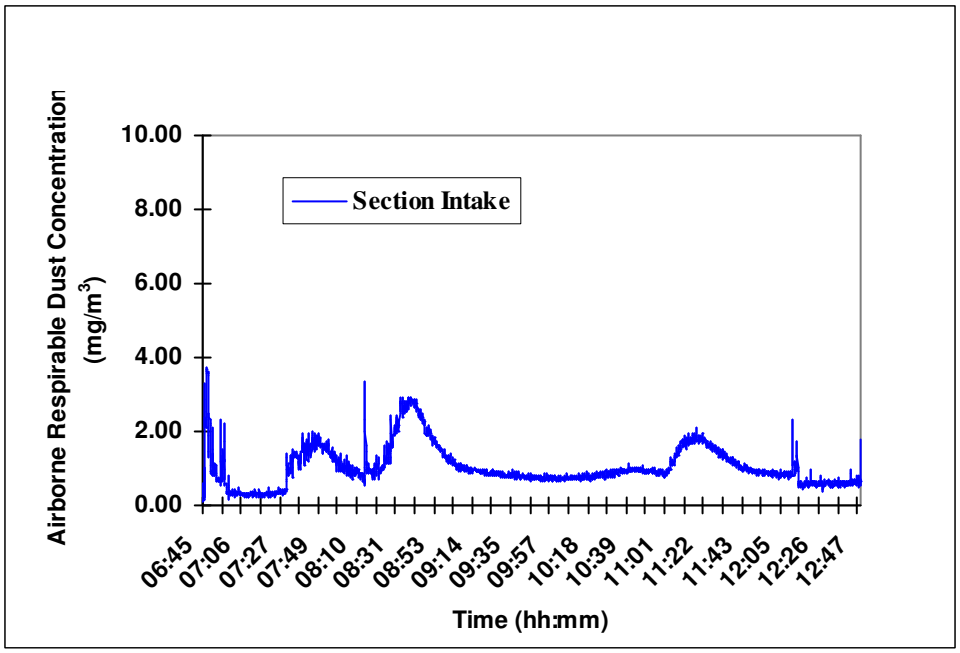


Figure 13: ARD profile recorded at the section intake position for Test # 13

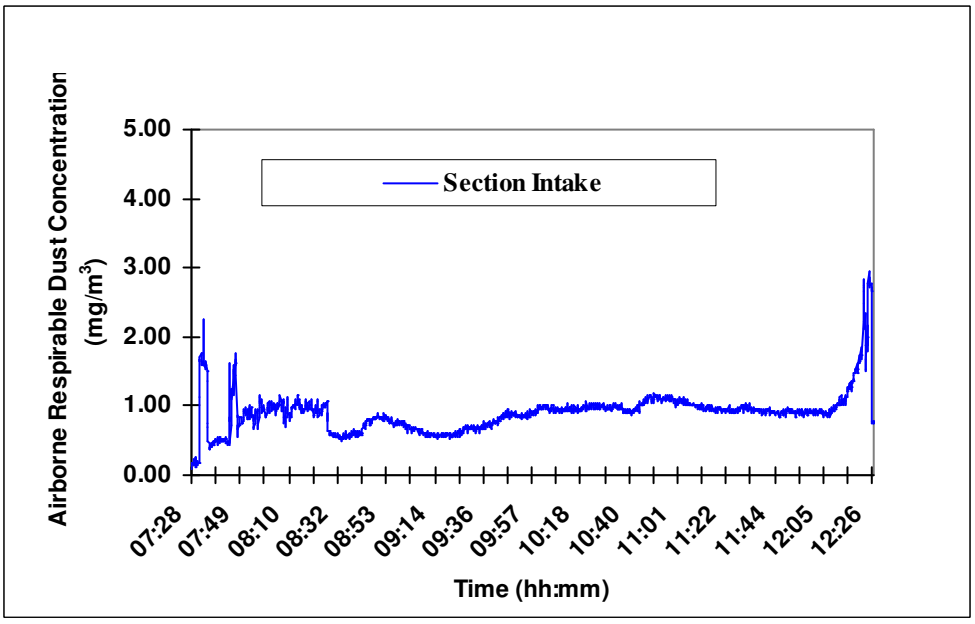


Figure 14: ARD profile recorded at the section intake position for Test # 14

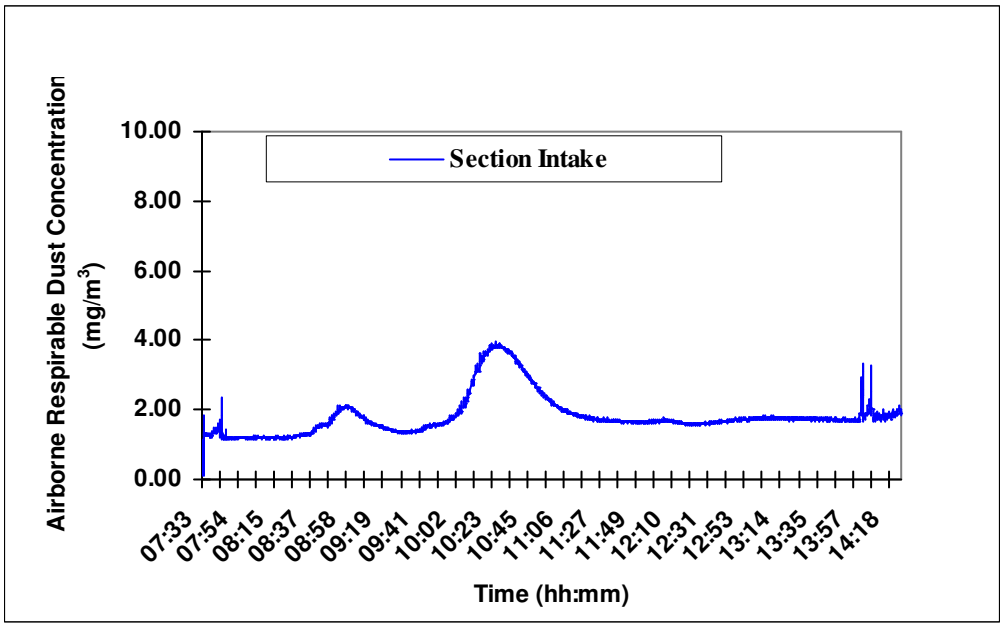


Figure 15: ARD profile recorded at the section intake position for Test # 15

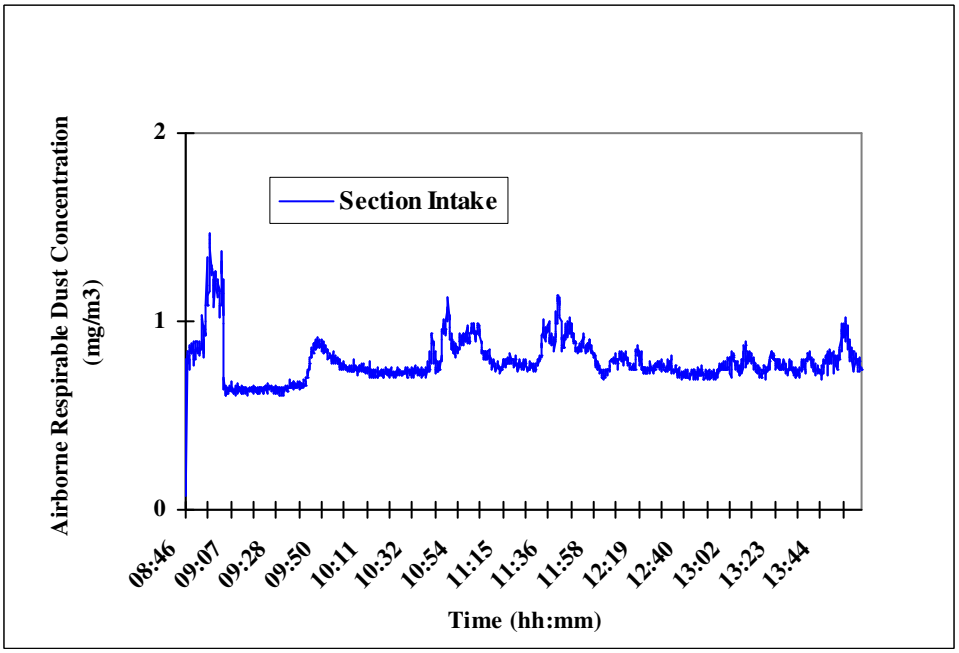


Figure 16: ARD profile recorded at the section intake position for Test # 16

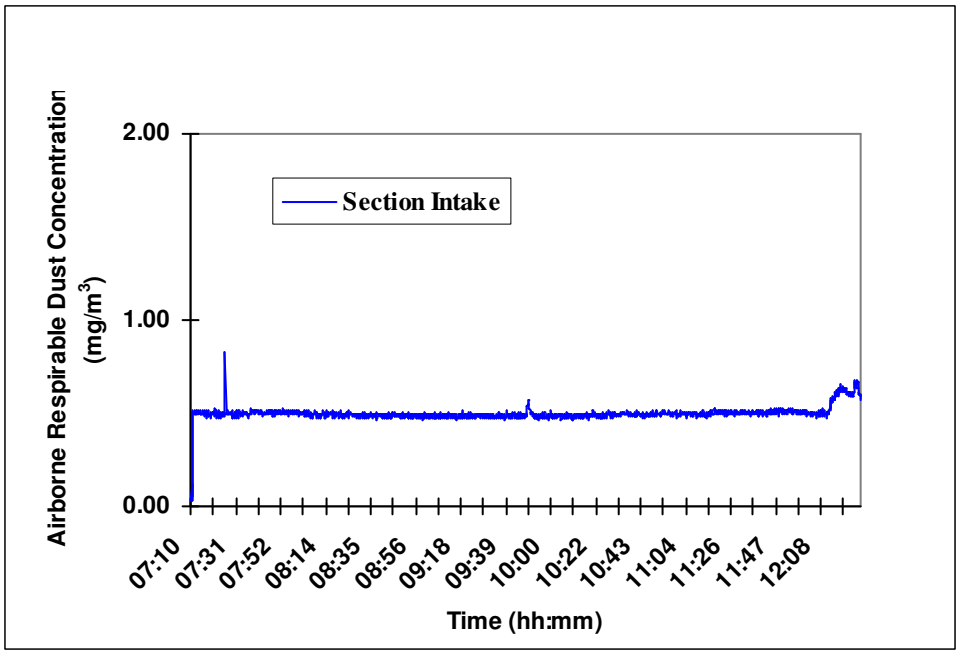


Figure 17: ARD profile recorded at the section intake position for Test # 17

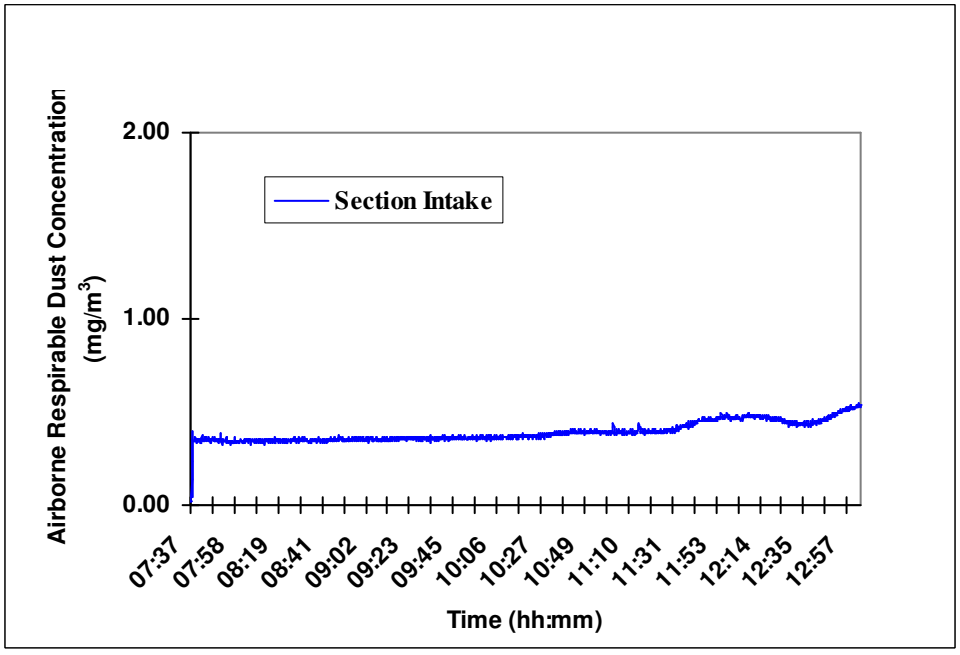


Figure 18: ARD profile recorded at the section intake position for Test # 18

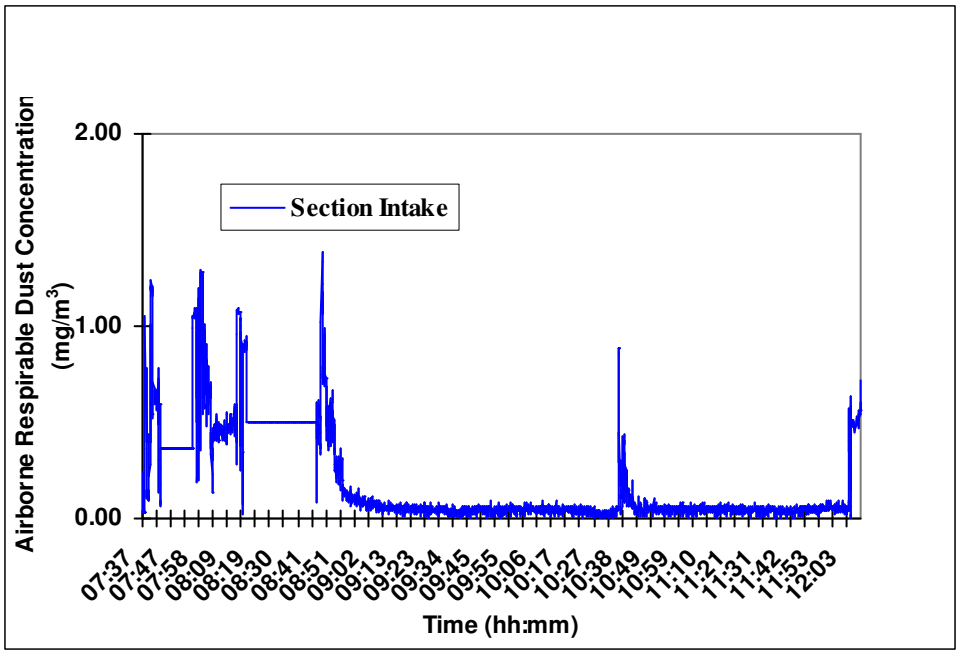


Figure 19: ARD profile recorded at the section intake position for Test # 19

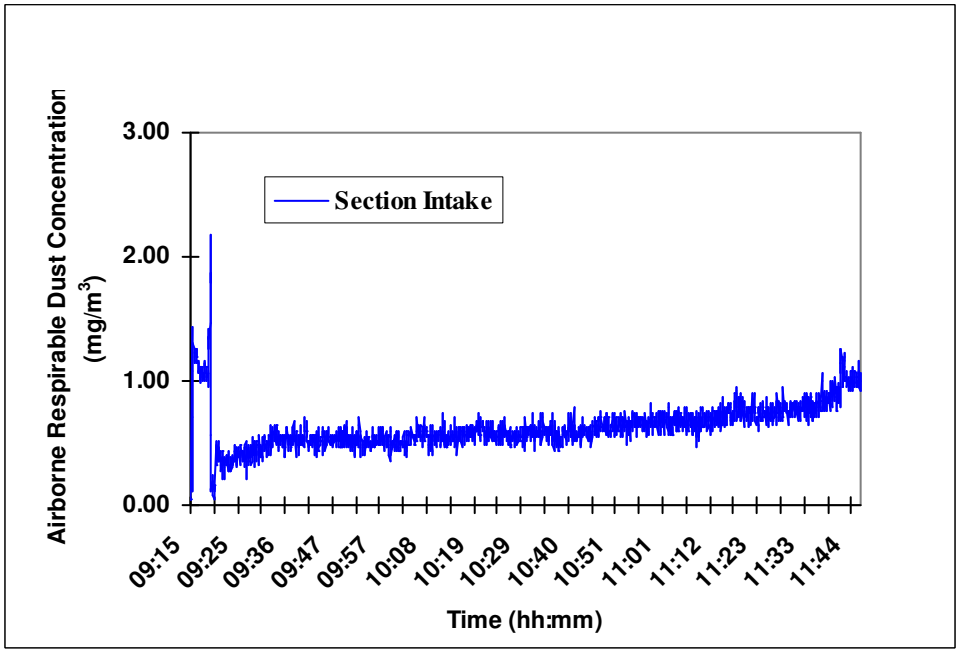


Figure 20: ARD profile recorded at the section intake position for Test # 20

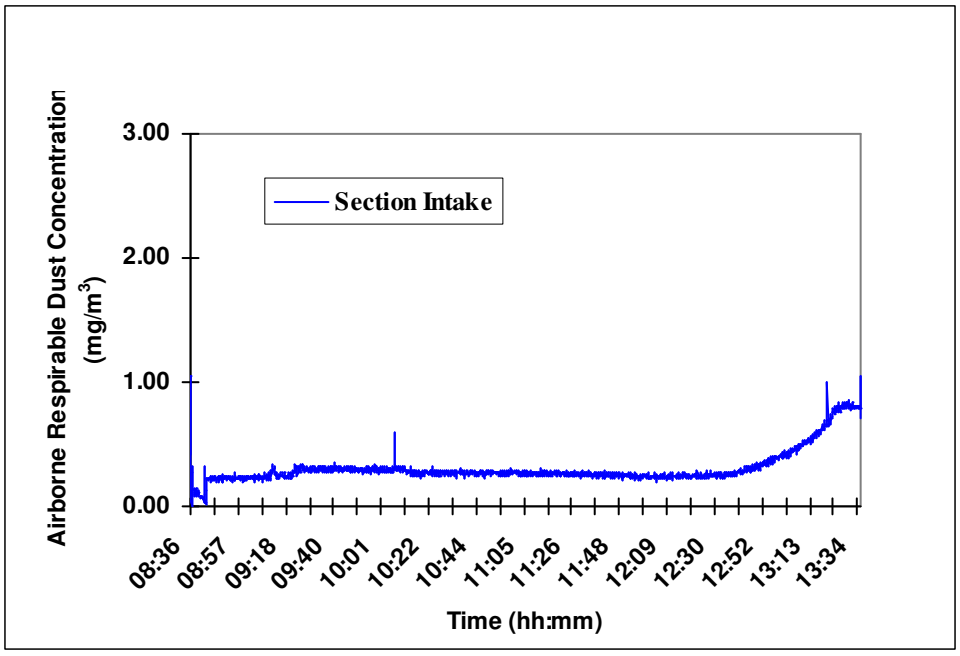


Figure 21: ARD profile recorded at the section intake position for Test # 21

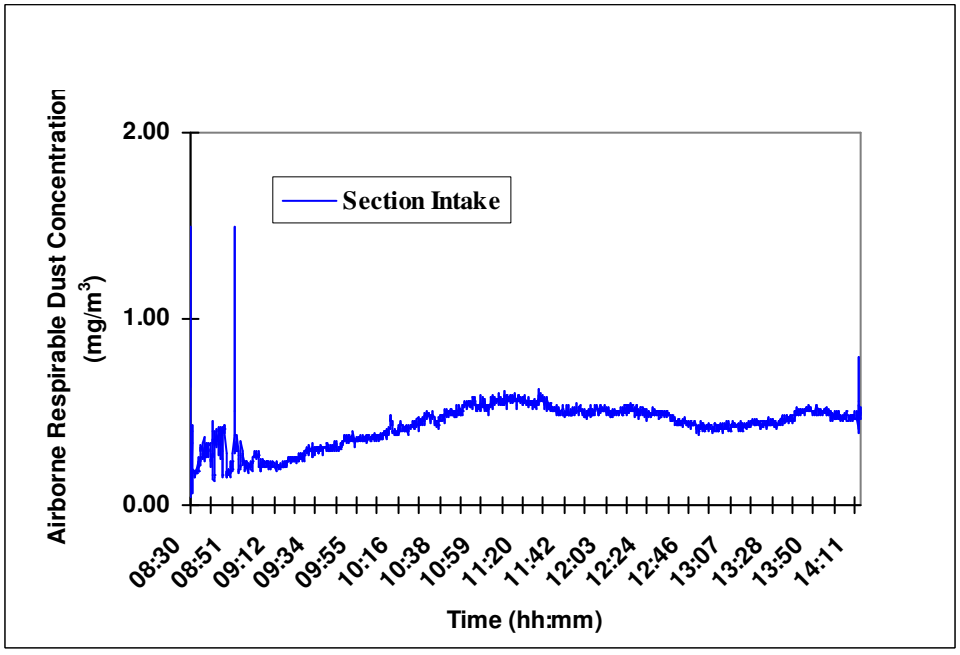


Figure 22: ARD profile recorded at the section intake position for Test # 22

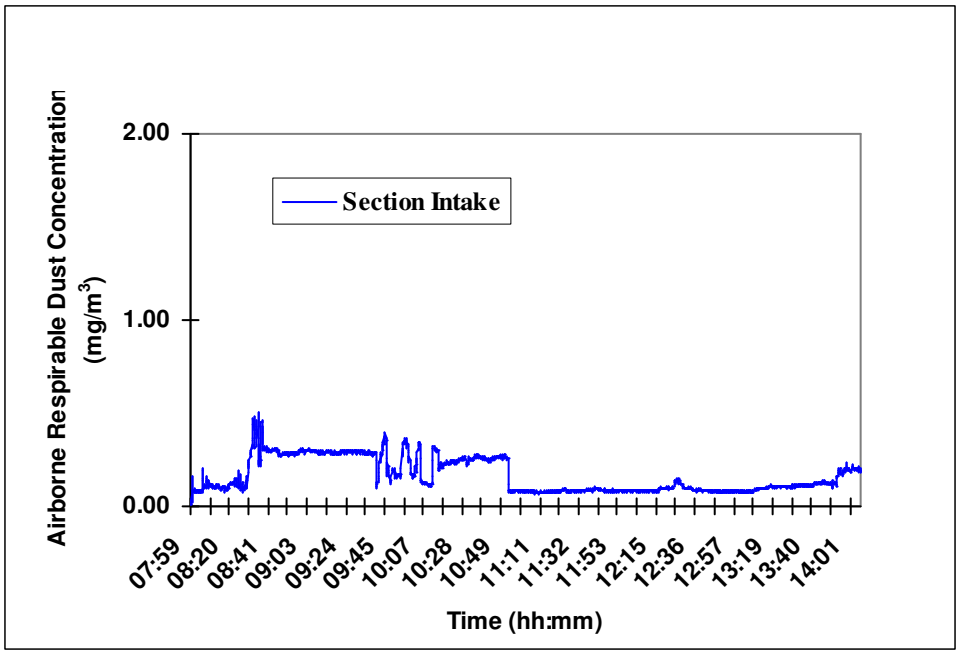


Figure 23: ARD profile recorded at the section intake position for Test # 23

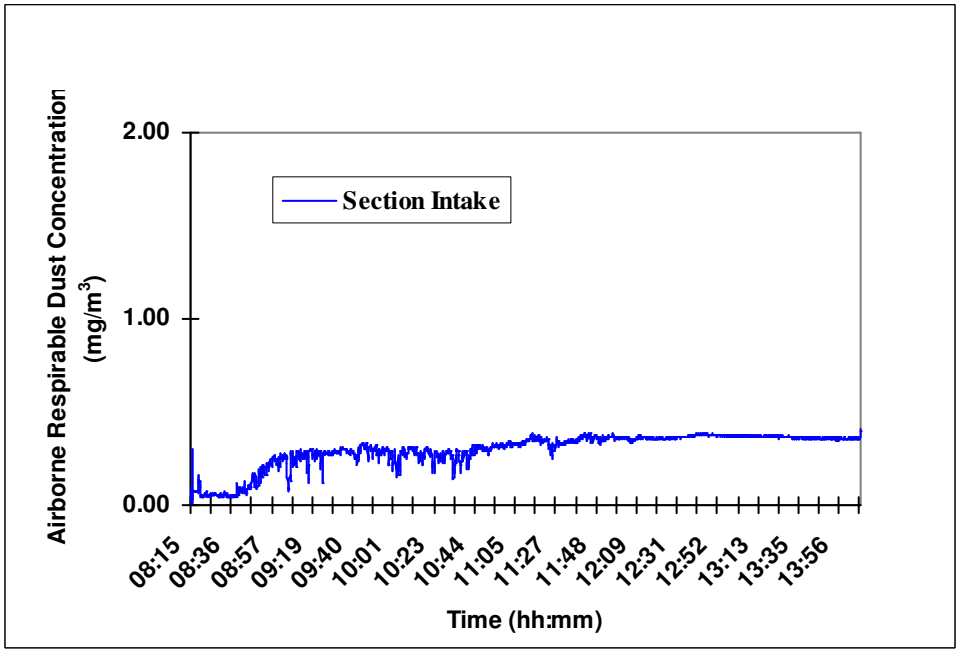


Figure 24: ARD profile recorded at the section intake position for Test # 24

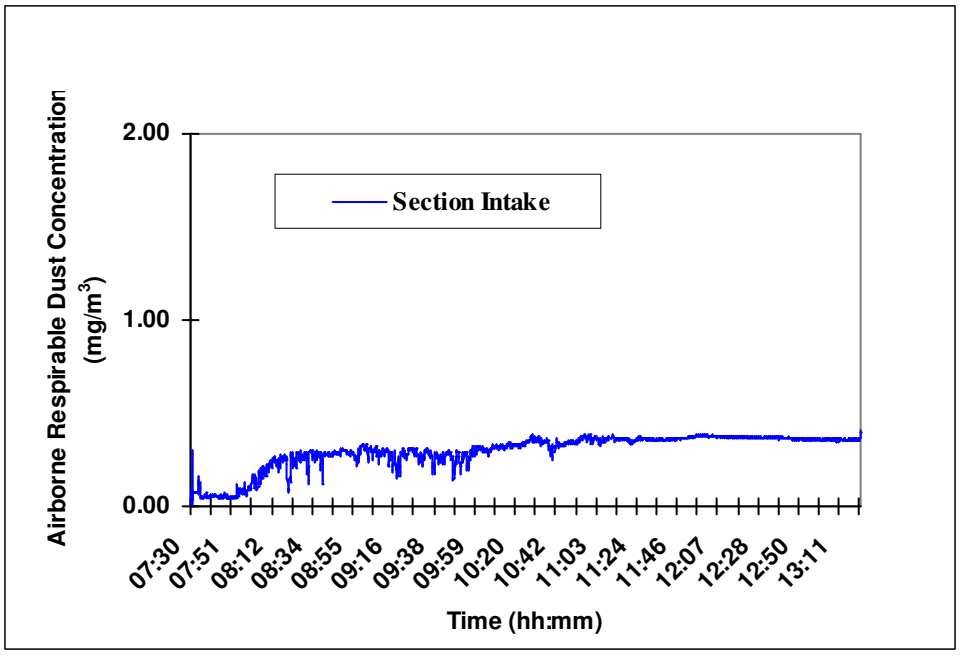


Figure 25: ARD profile recorded at the section intake position for Test # 25

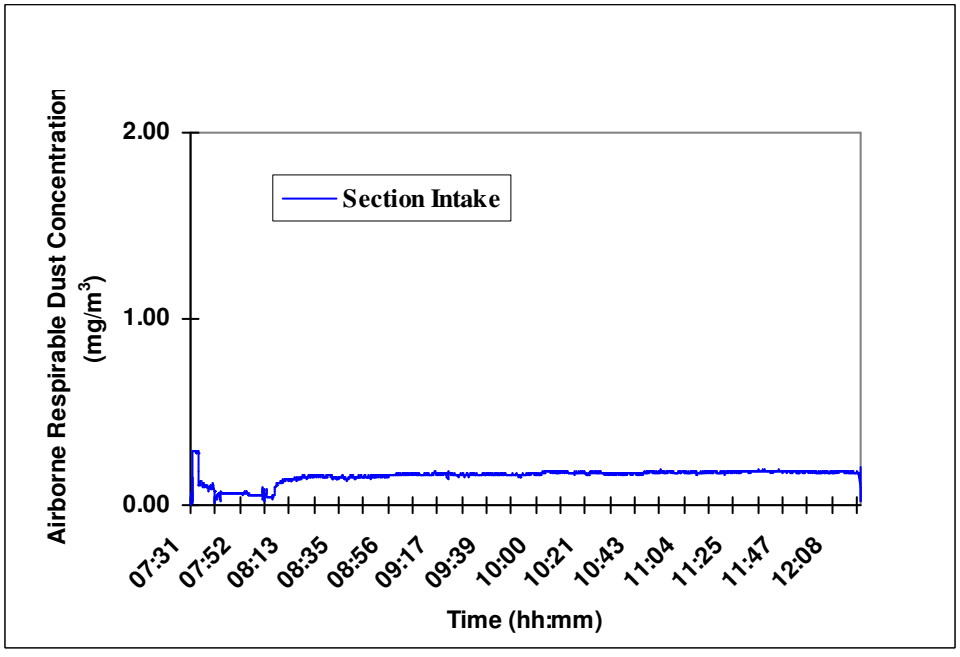


Figure 26: ARD profile recorded at the section intake position for Test # 26

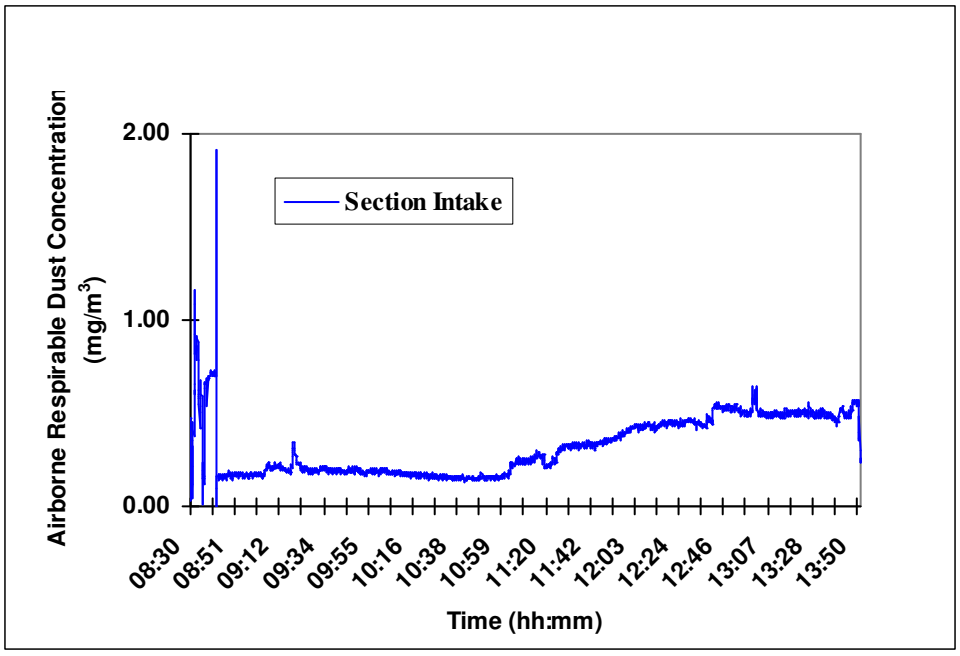


Figure 27: ARD profile recorded at the section intake position for Test # 27

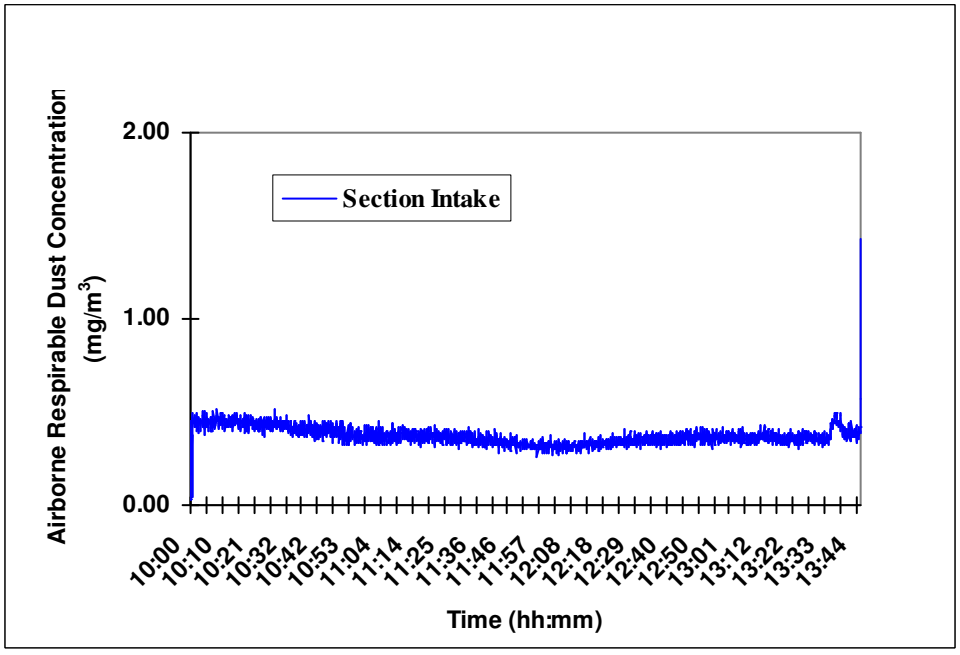


Figure 27: ARD profile recorded at the section intake position for Test # 27

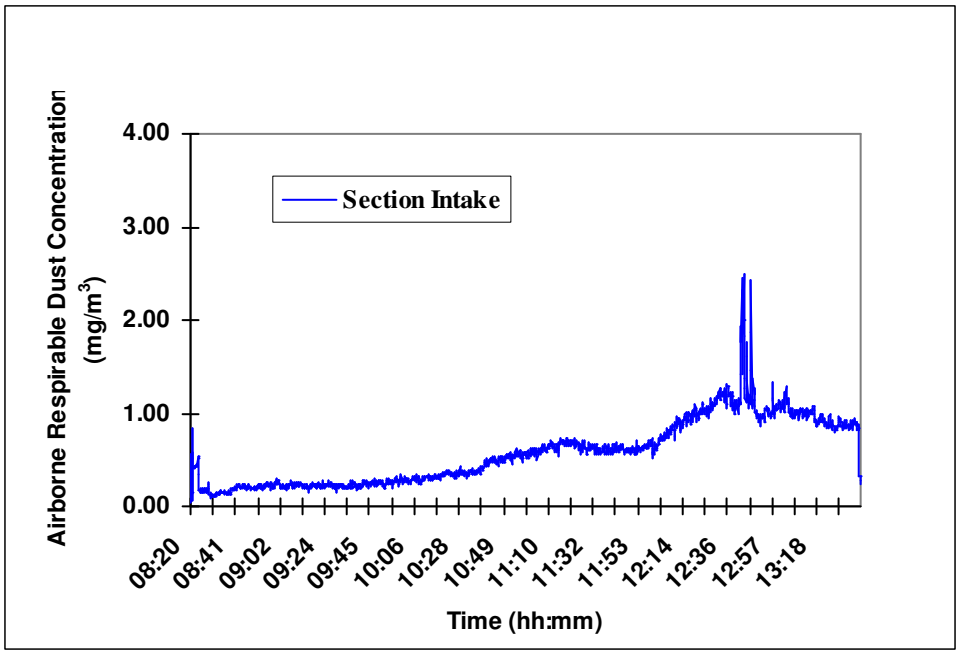


Figure 28: ARD profile recorded at the section intake position for Test # 28

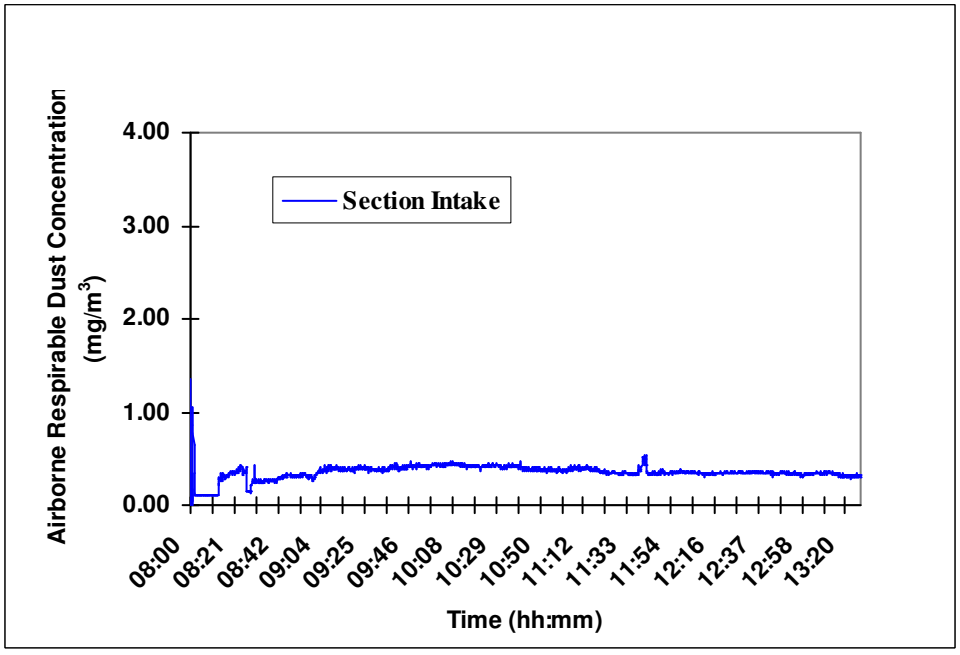


Figure 29: ARD profile recorded at the section intake position for Test # 29

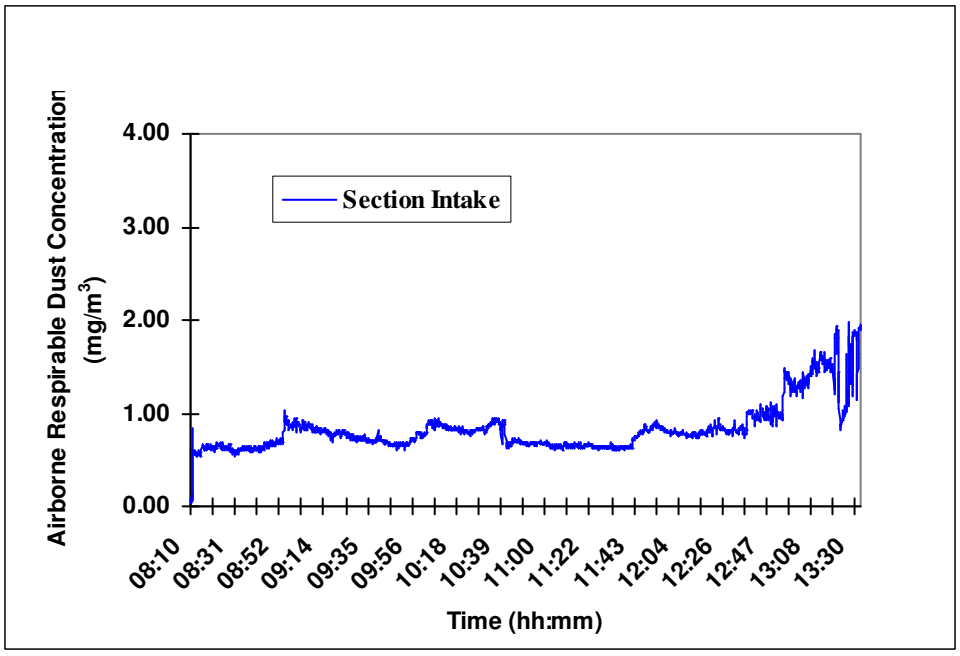


Figure 20: ARD profile recorded at the section intake position for Test # 30

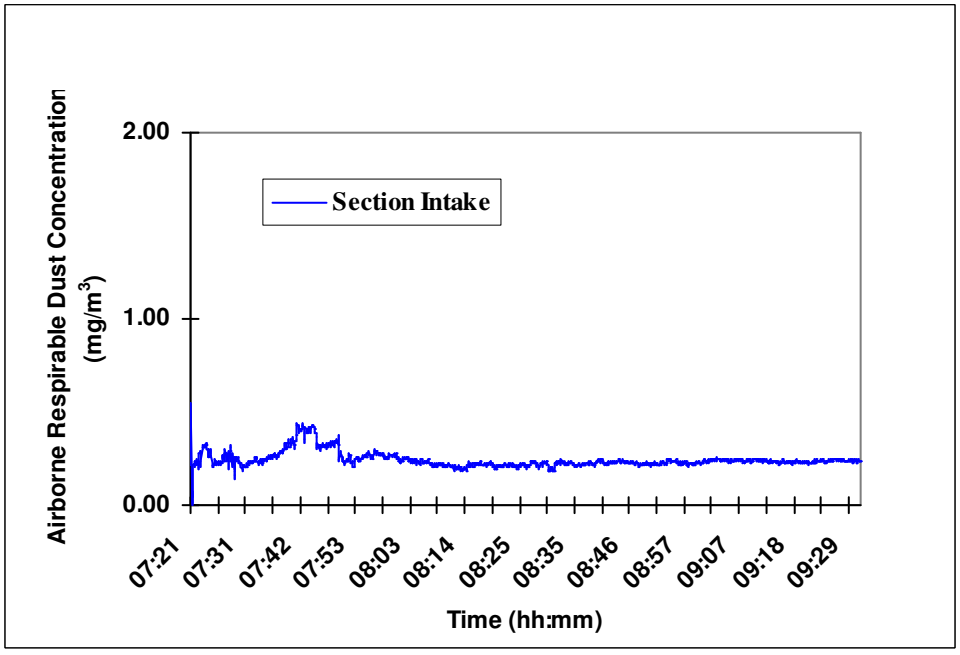


Figure 31: ARD profile recorded at the section intake position for Test # 31

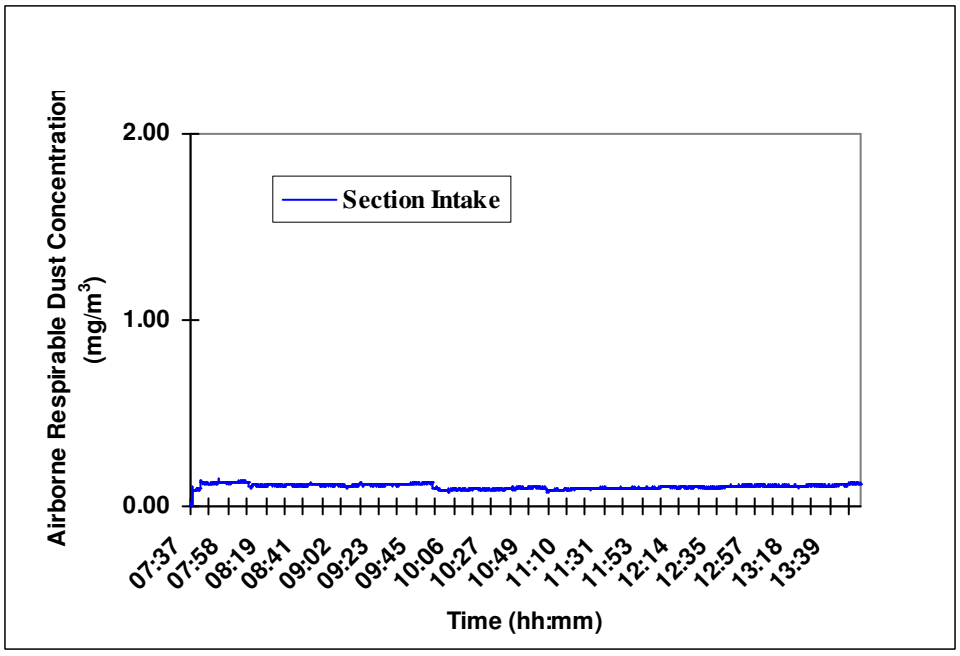


Figure 32: ARD profile recorded at the section intake position for Test # 32

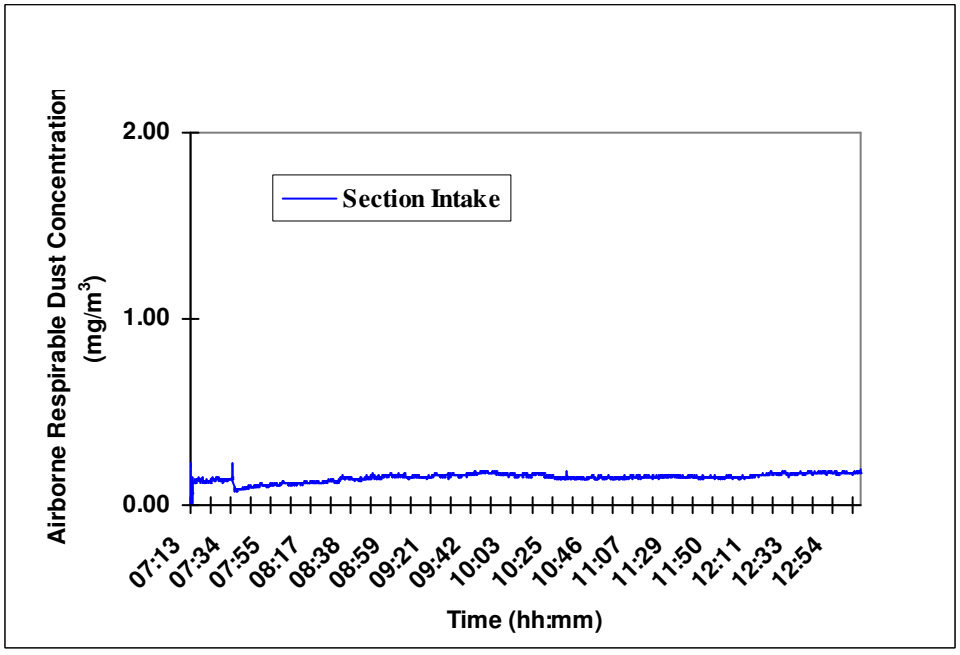


Figure 33: ARD profile recorded at the section intake position for Test # 33

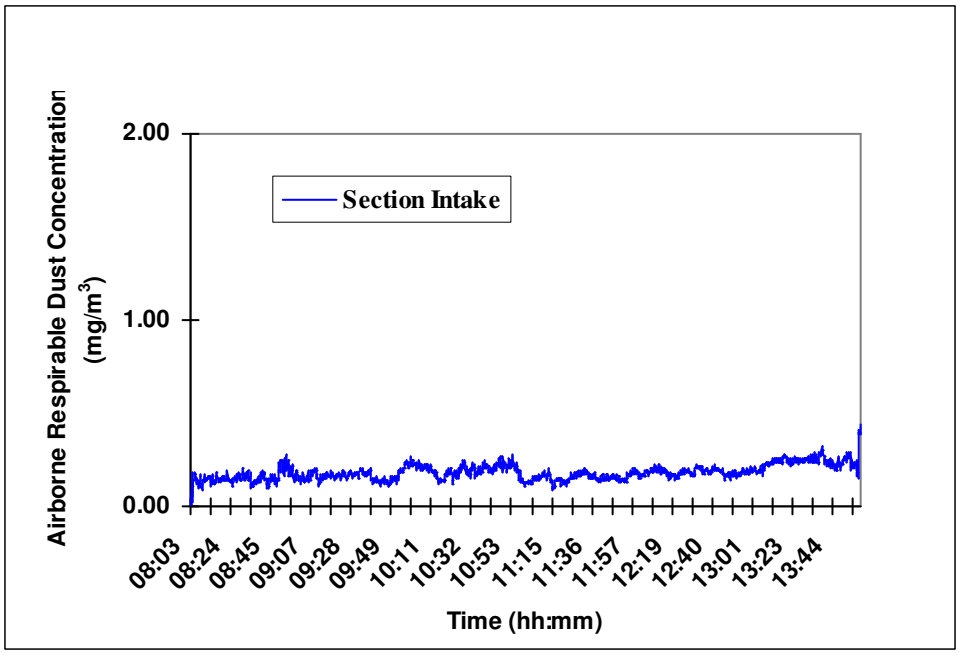


Figure 34: ARD profile recorded at the section intake position for Test # 34

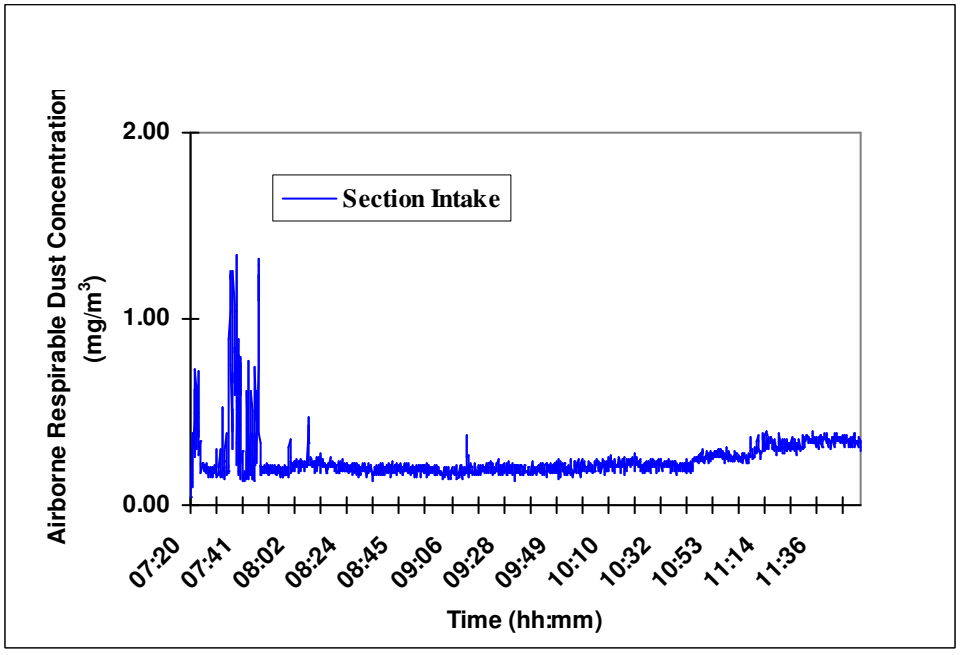


Figure 35: ARD profile recorded at the section intake position for Test # 35

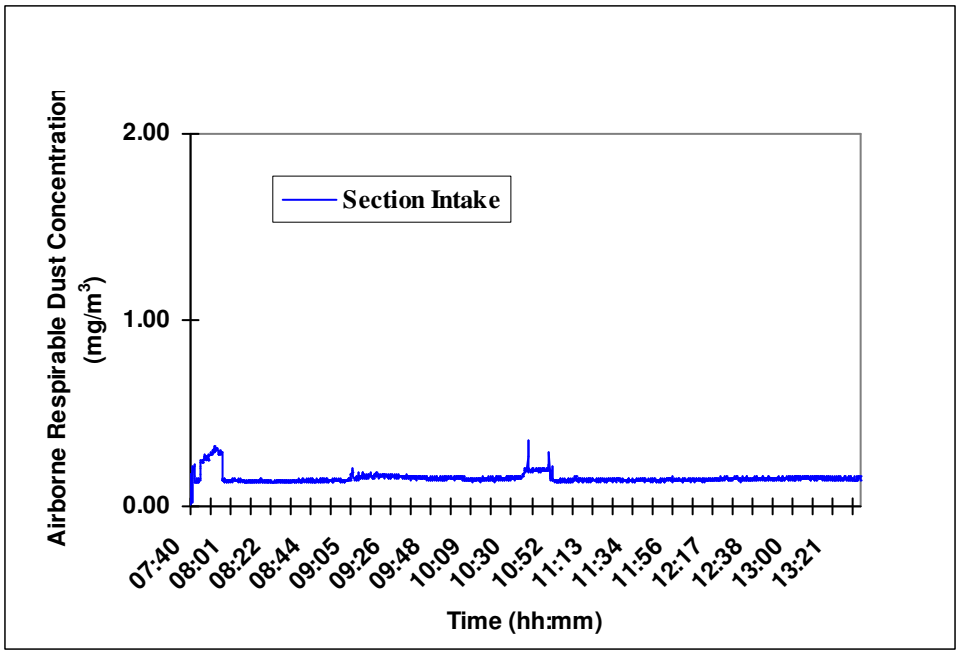


Figure 36: ARD profile recorded at the section intake position for Test # 36

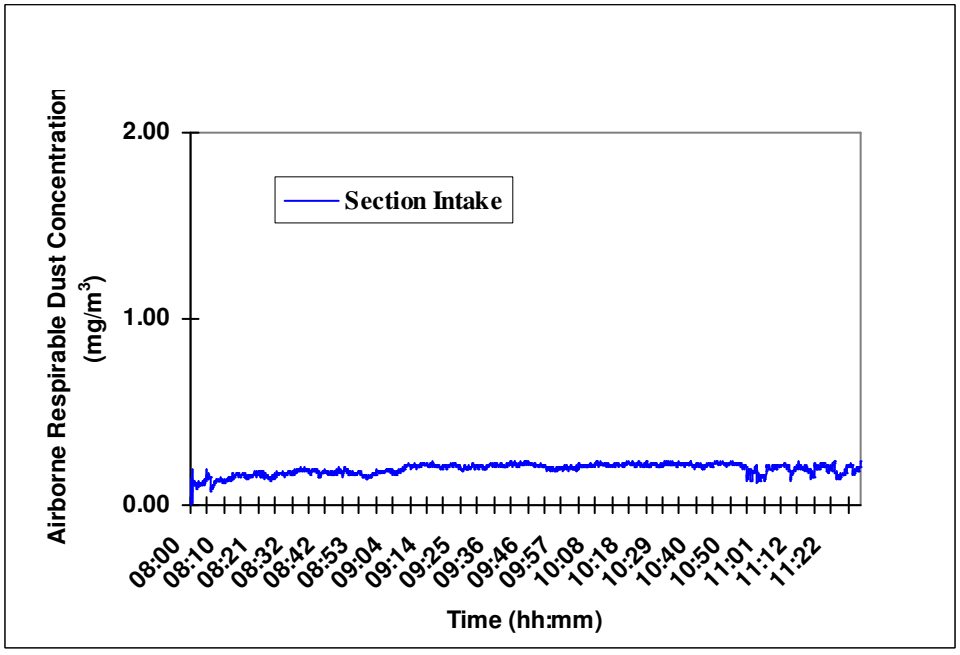


Figure 37: ARD profile recorded at the section intake position for Test # 37

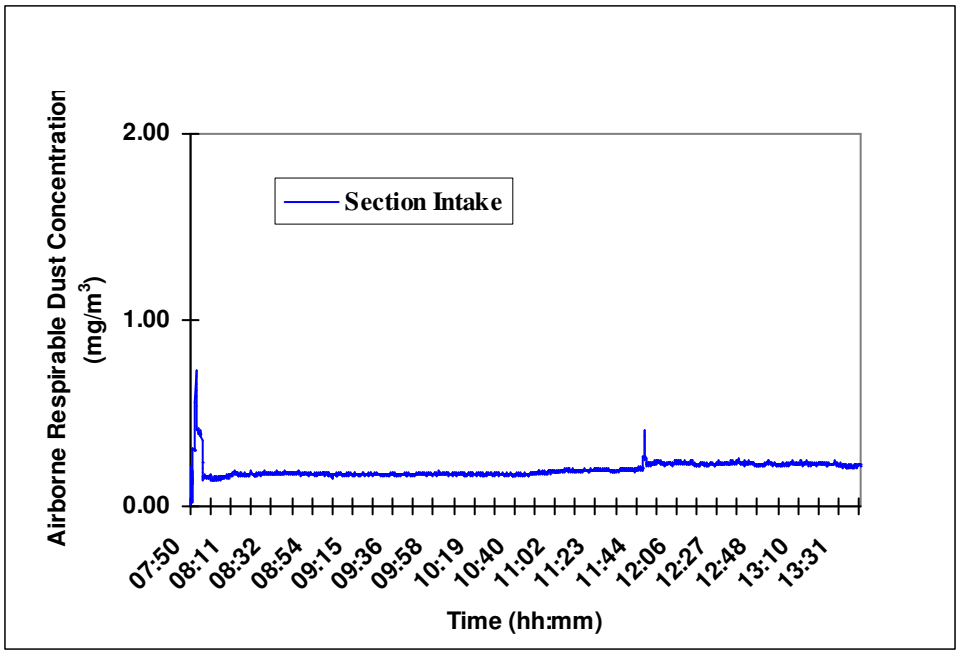


Figure 38: ARD profile recorded at the section intake position for Test # 38

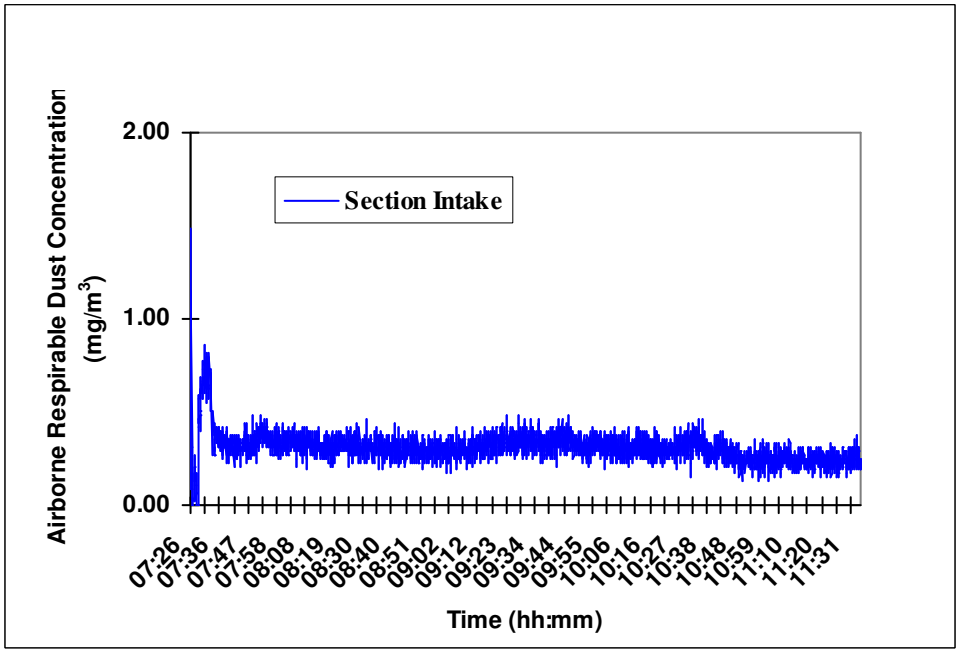


Figure 39: ARD profile recorded at the section intake position for Test # 39

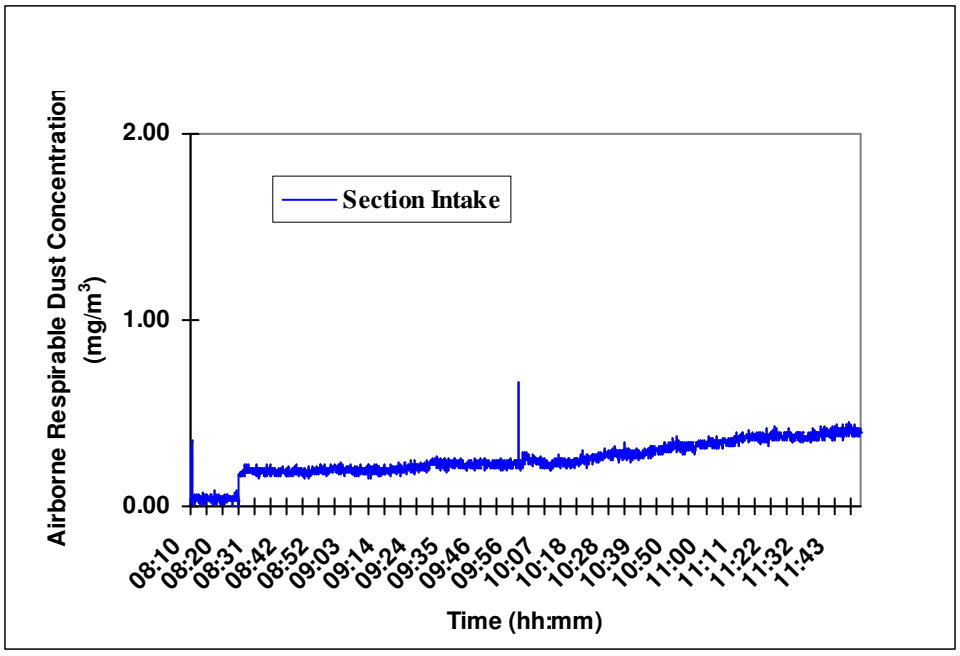


Figure 40: ARD profile recorded at the section intake position for Test # 40

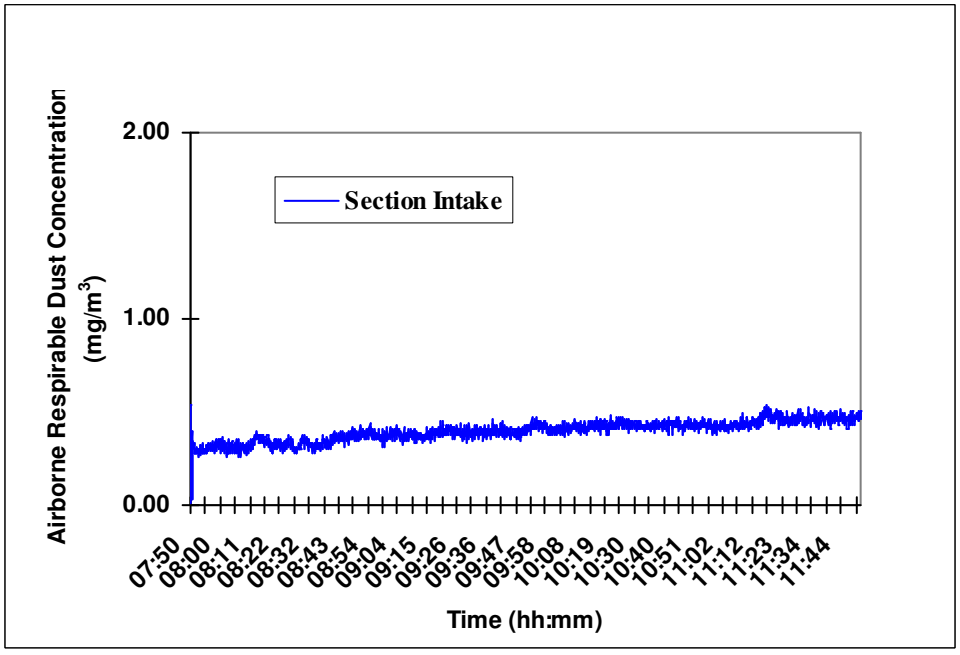


Figure 41: ARD profile recorded at the section intake position for Test # 41

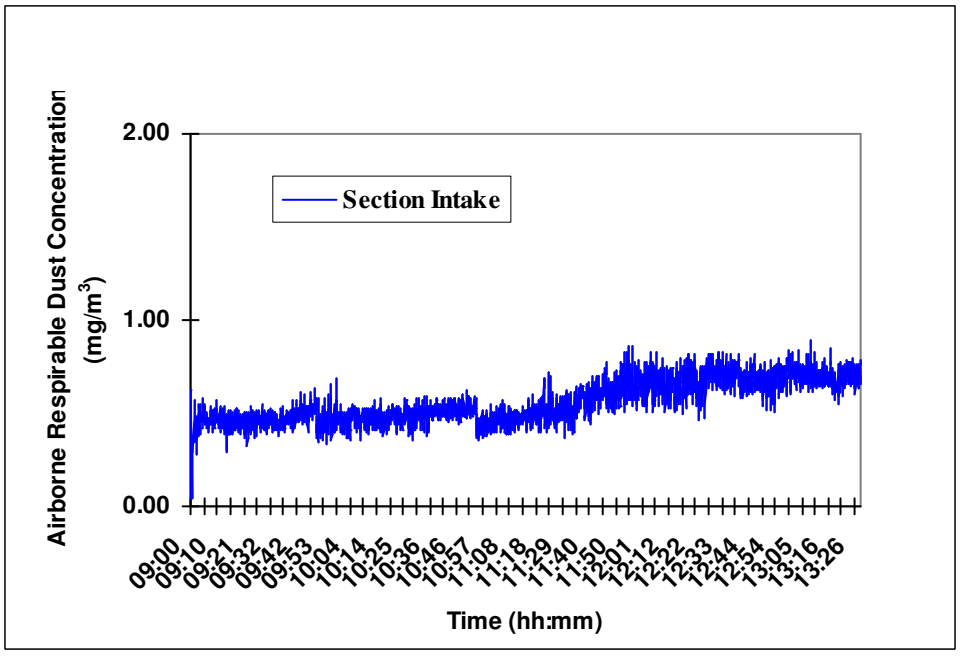


Figure 42: ARD profile recorded at the section intake position for Test # 42

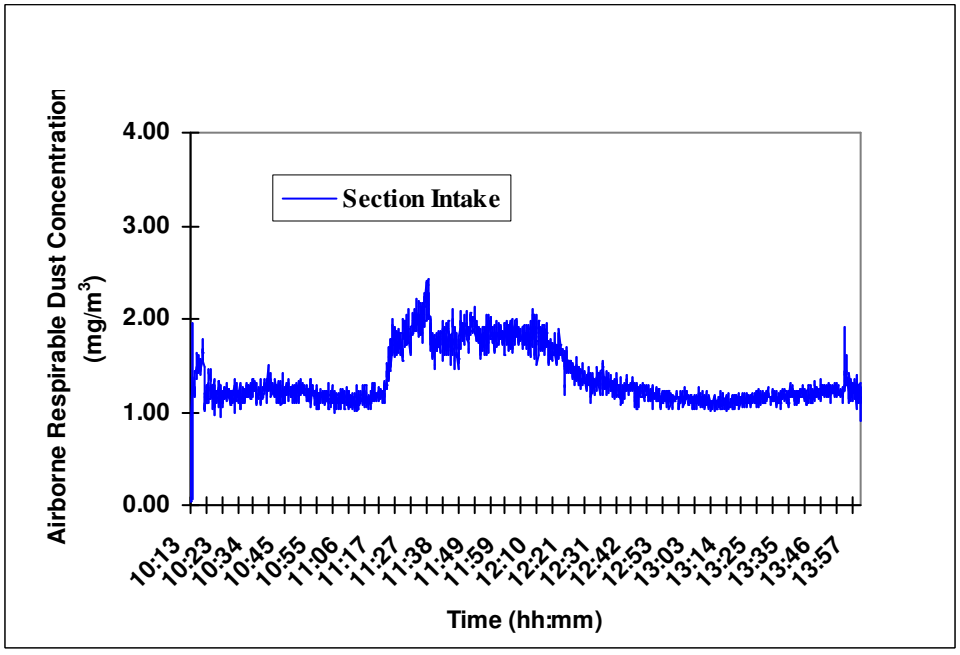


Figure 43: ARD profile recorded at the section intake position for Test # 43

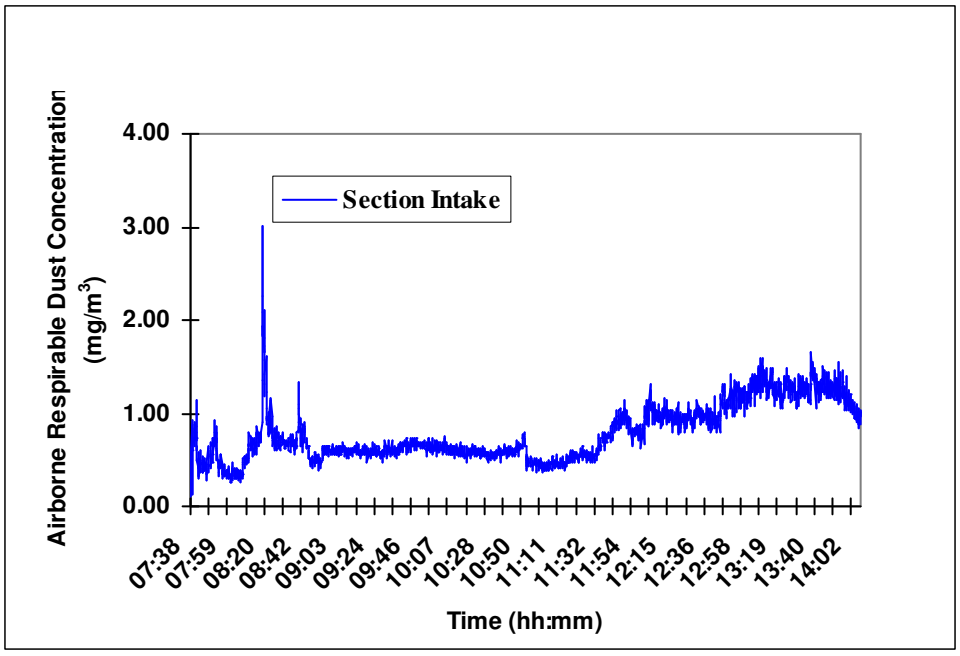


Figure 44: ARD profile recorded at the section intake position for Test # 44

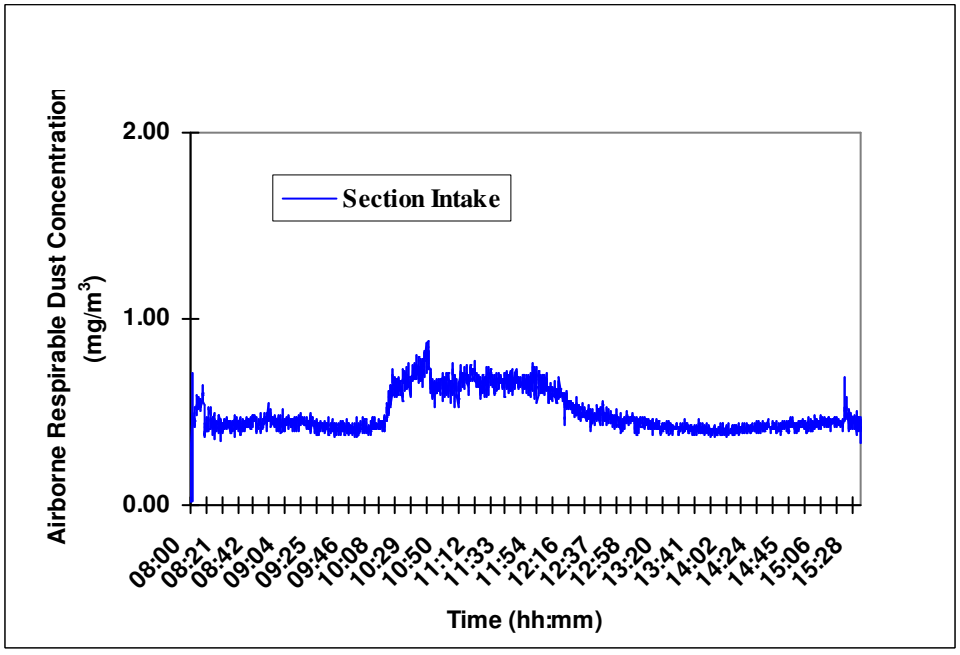


Figure 45: ARD profile recorded at the section intake position for Test # 45

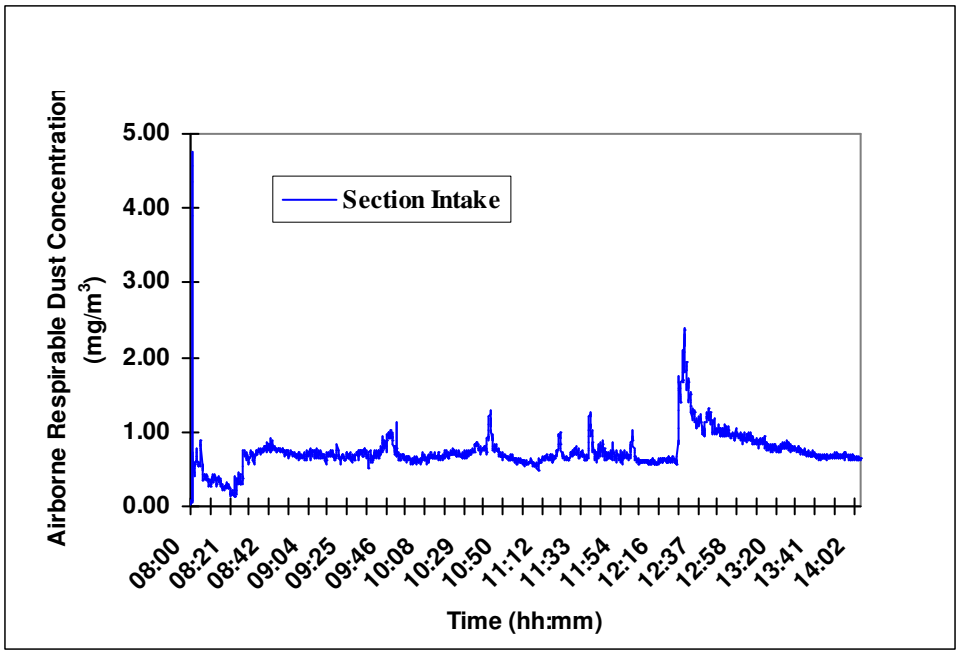


Figure 46: ARD profile recorded at the section intake position for Test # 46

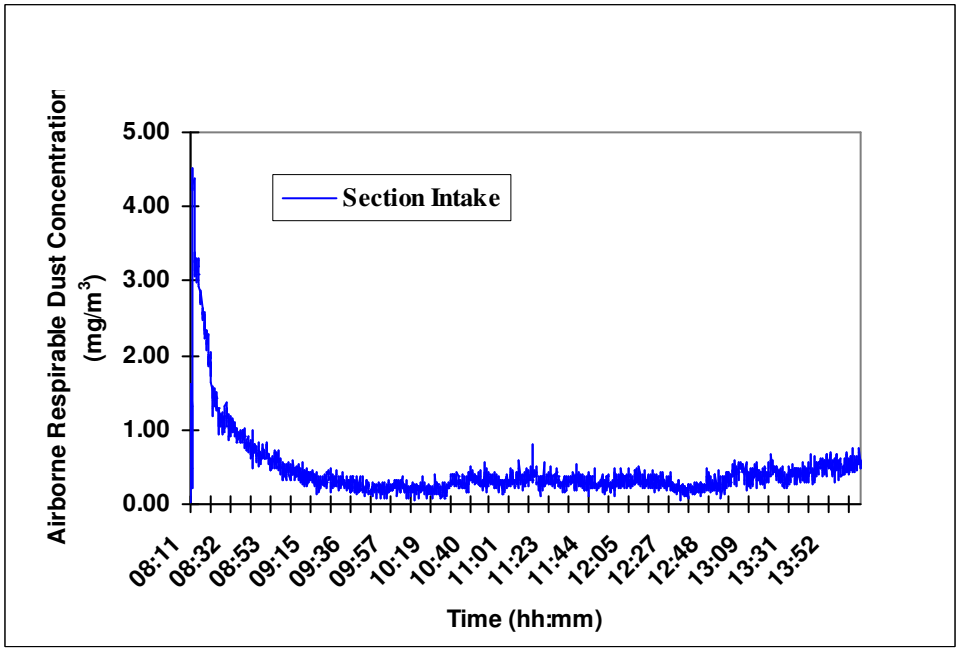


Figure 47: ARD profile recorded at the section intake position for Test # 47

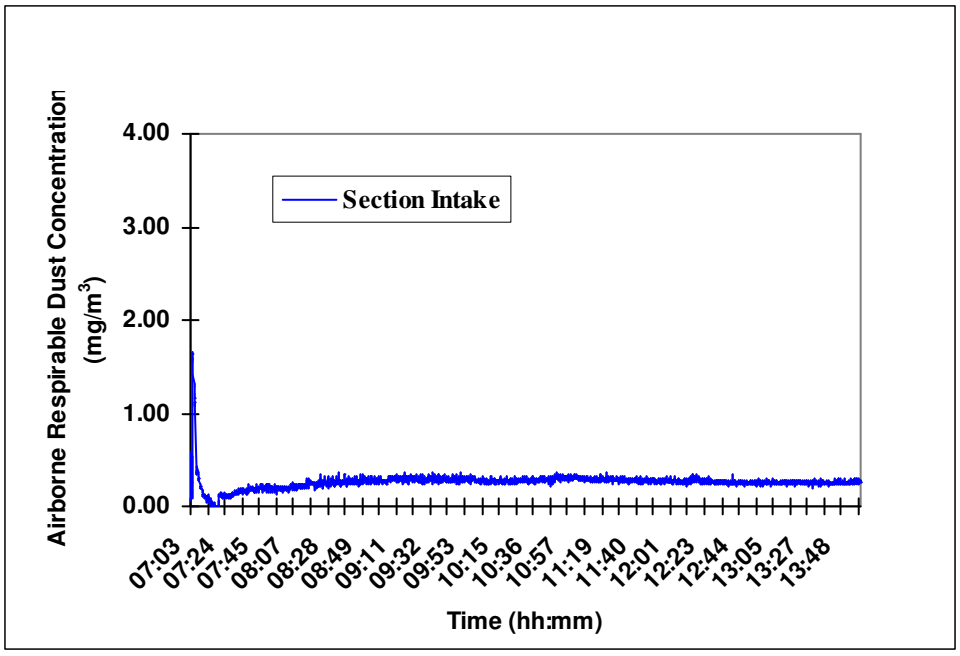


Figure 48: ARD profile recorded at the section intake position for Test # 48

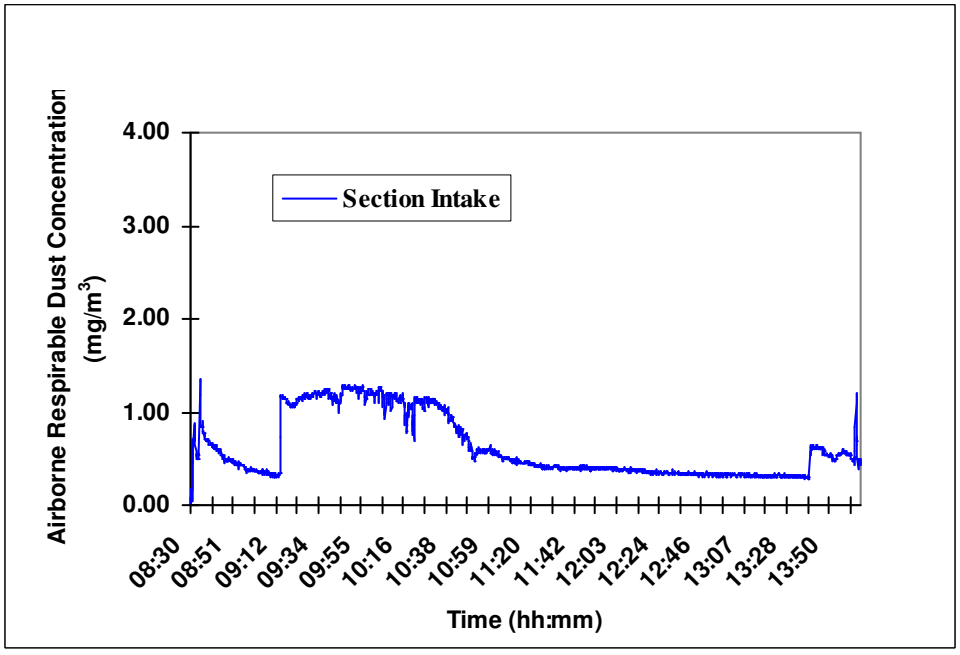


Figure 49: ARD profile recorded at the section intake position for Test # 49

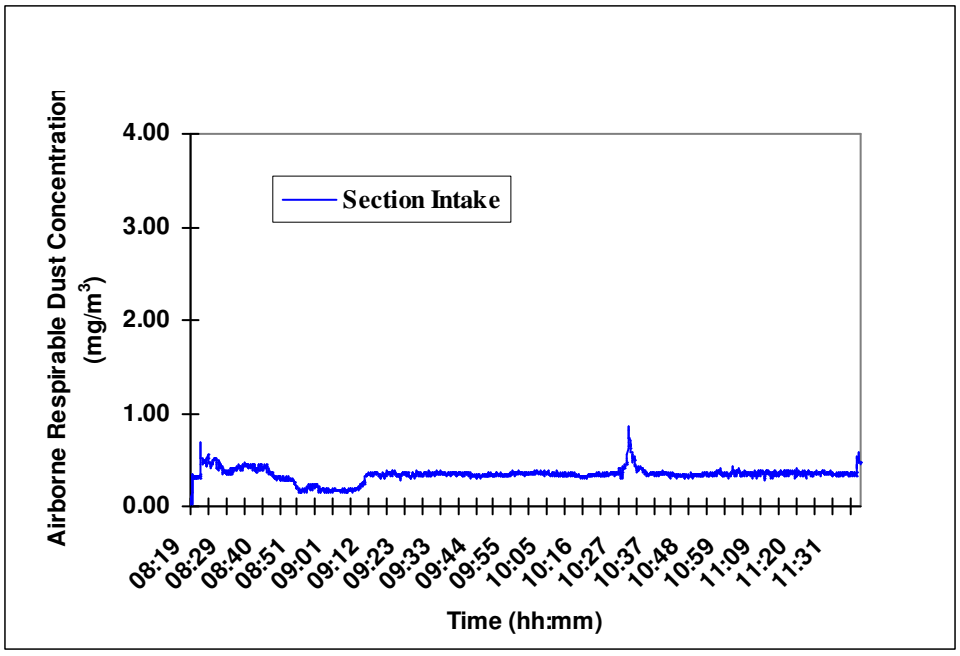


Figure 50: ARD profile recorded at the section intake position for Test # 50

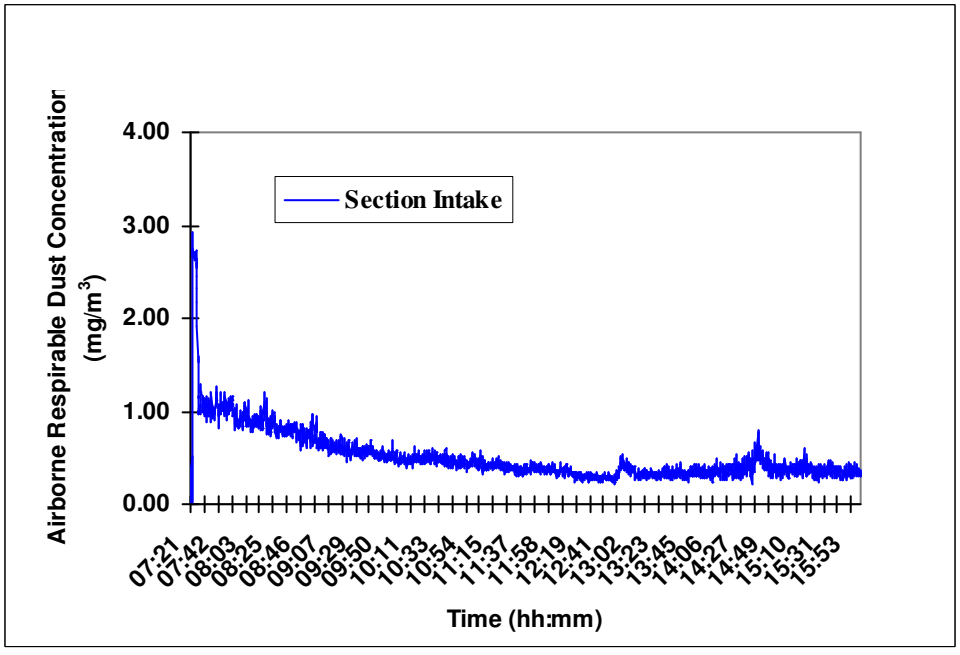


Figure 51: ARD profile recorded at the section intake position for Test # 51

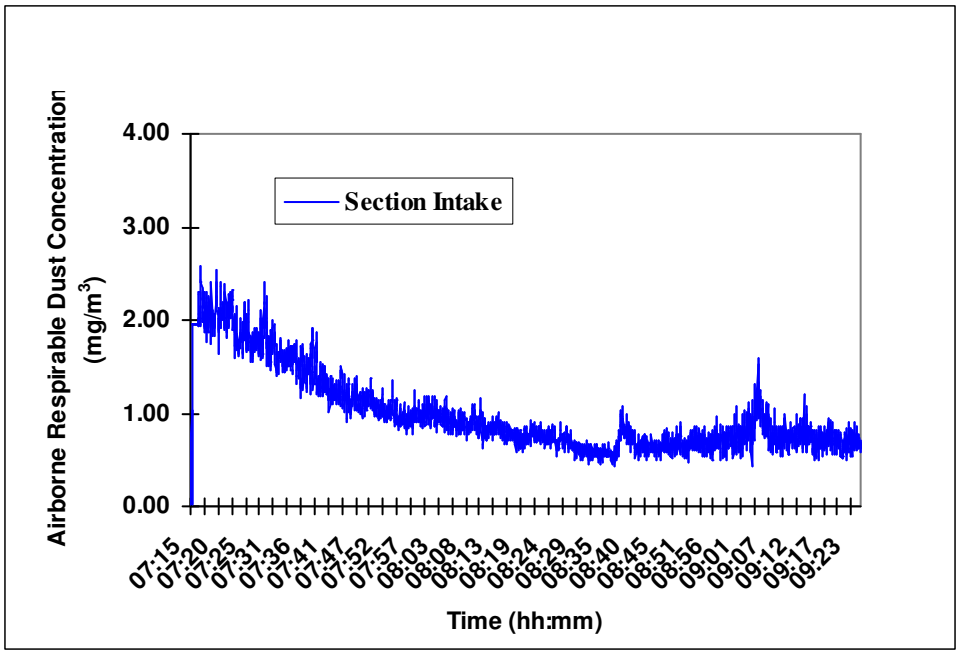


Figure 52: ARD profile recorded at the section intake position for Test # 52

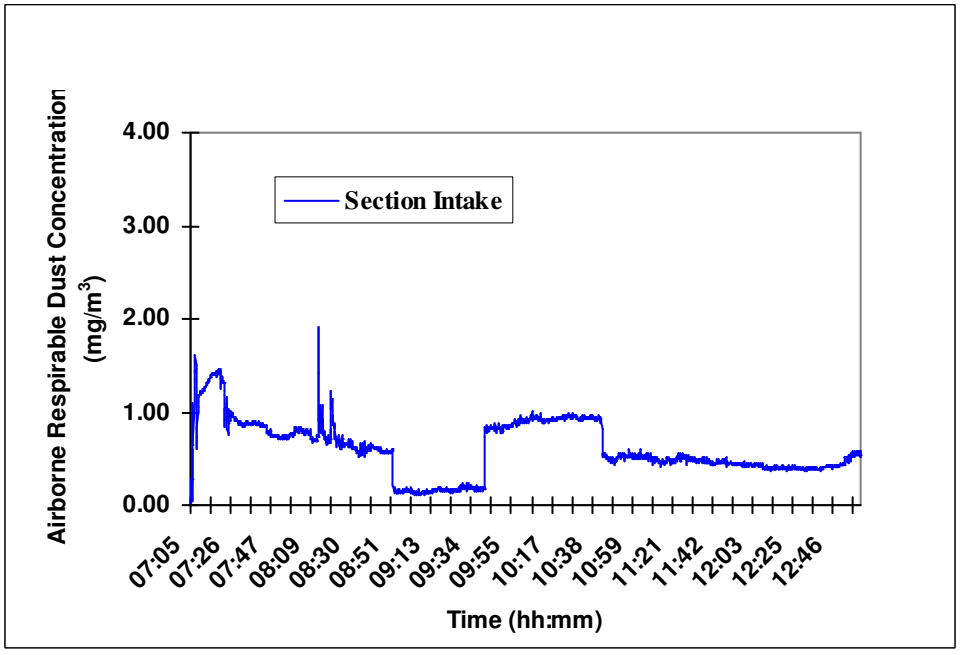


Figure 53: ARD profile recorded at the section intake position for Test # 53

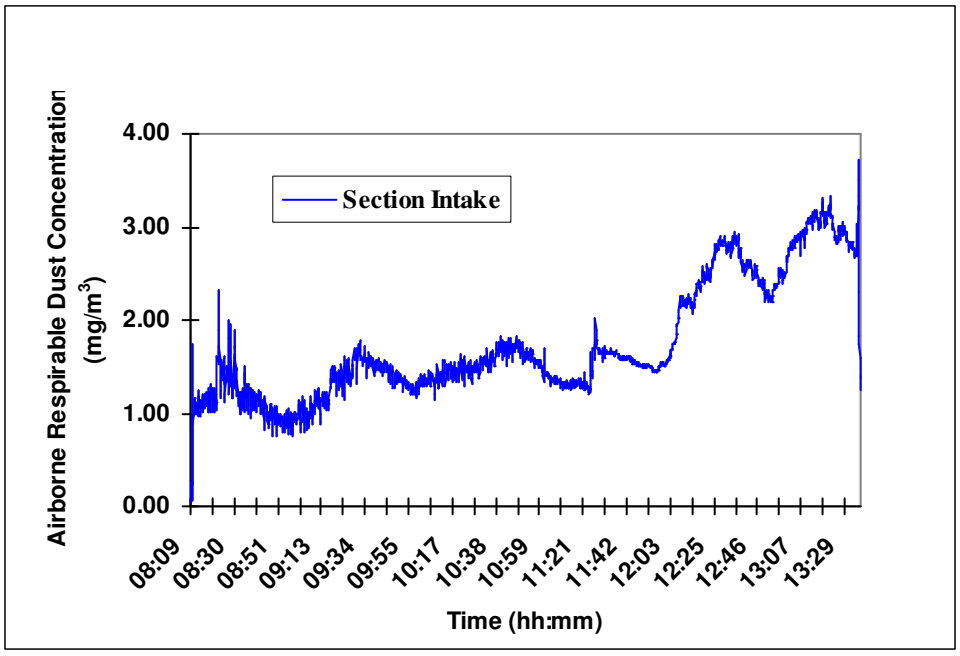


Figure 54: ARD profile recorded at the section intake position for Test # 54

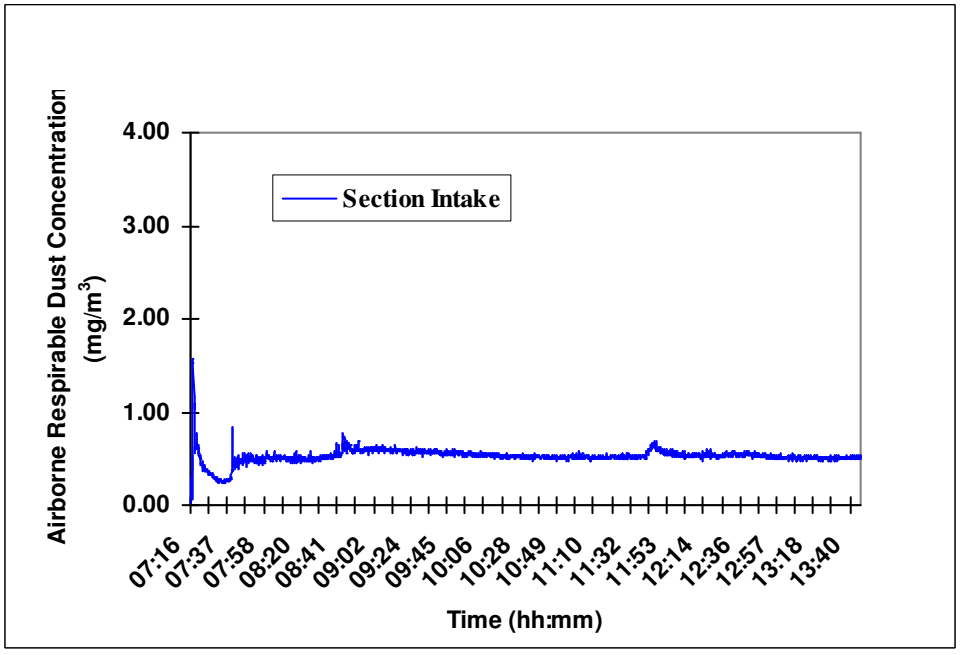


Figure 55: ARD profile recorded at the section intake position for Test # 55

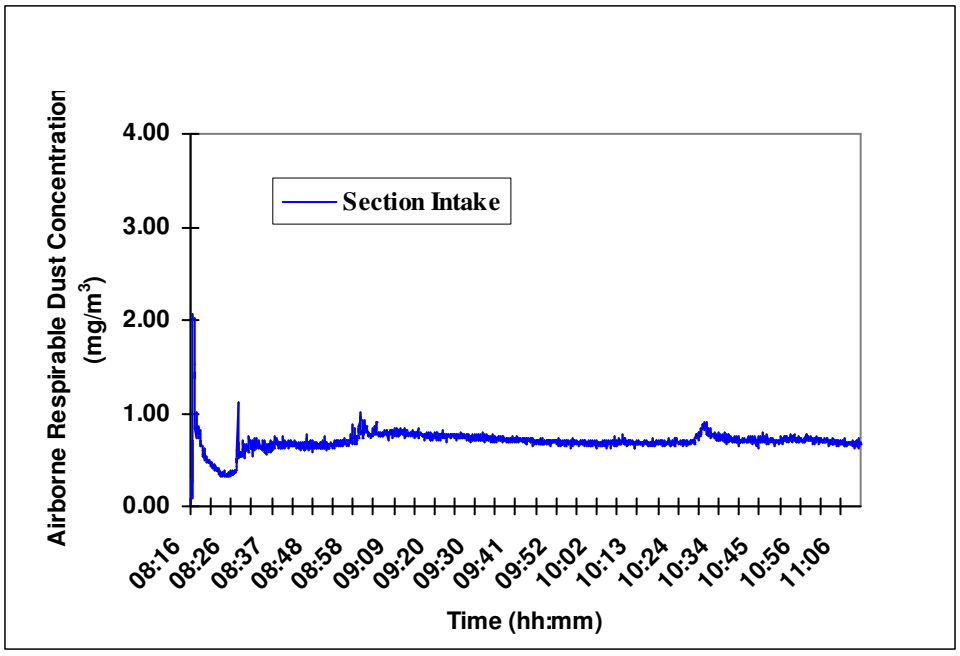


Figure 56: ARD profile recorded at the section intake position for Test # 56

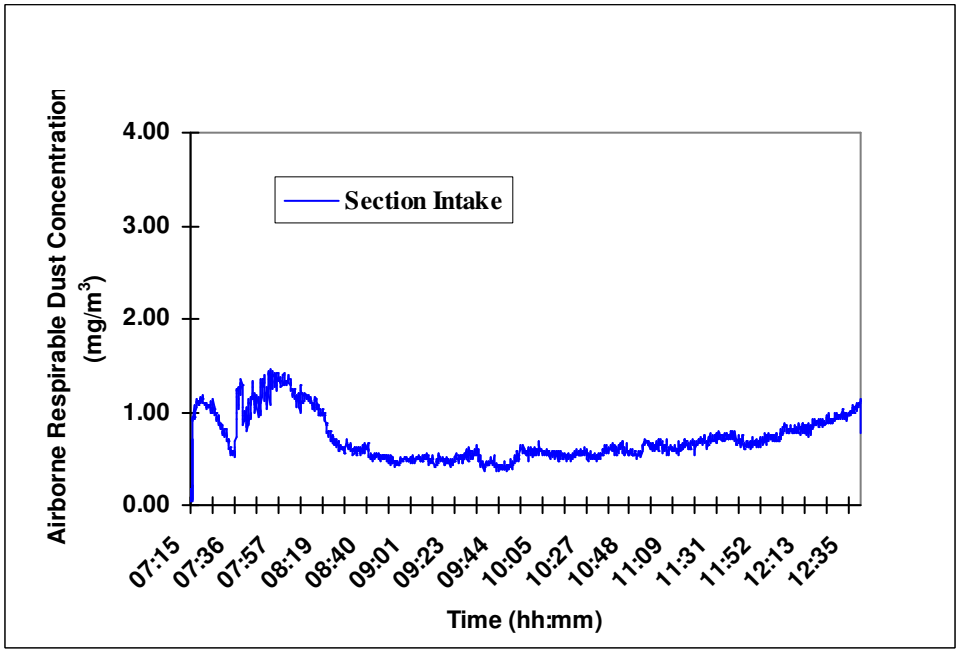


Figure 57: ARD profile recorded at the section intake position for Test # 57

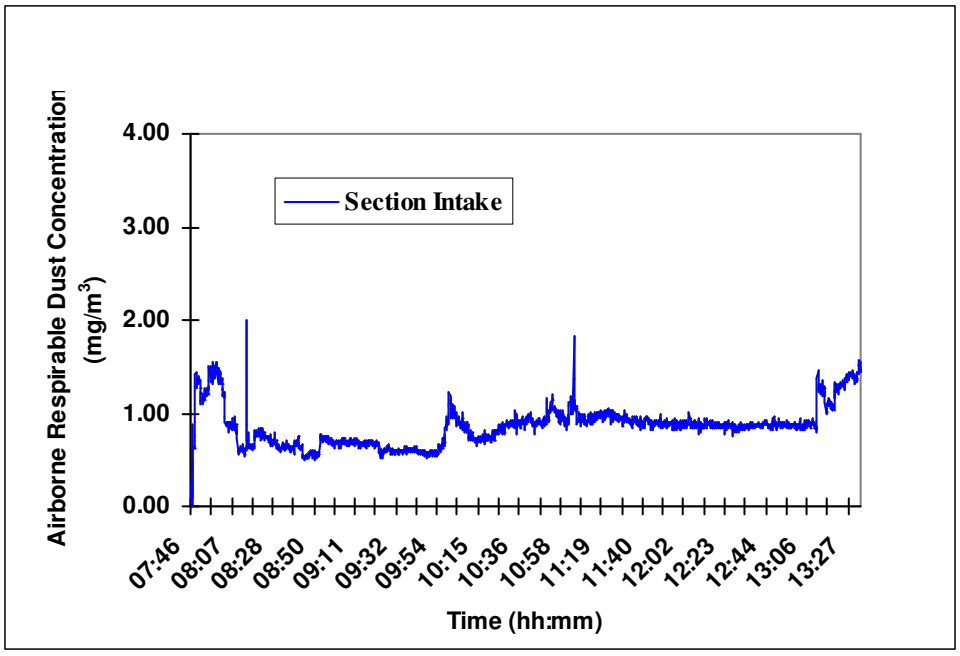


Figure 58: ARD profile recorded at the section intake position for Test # 58

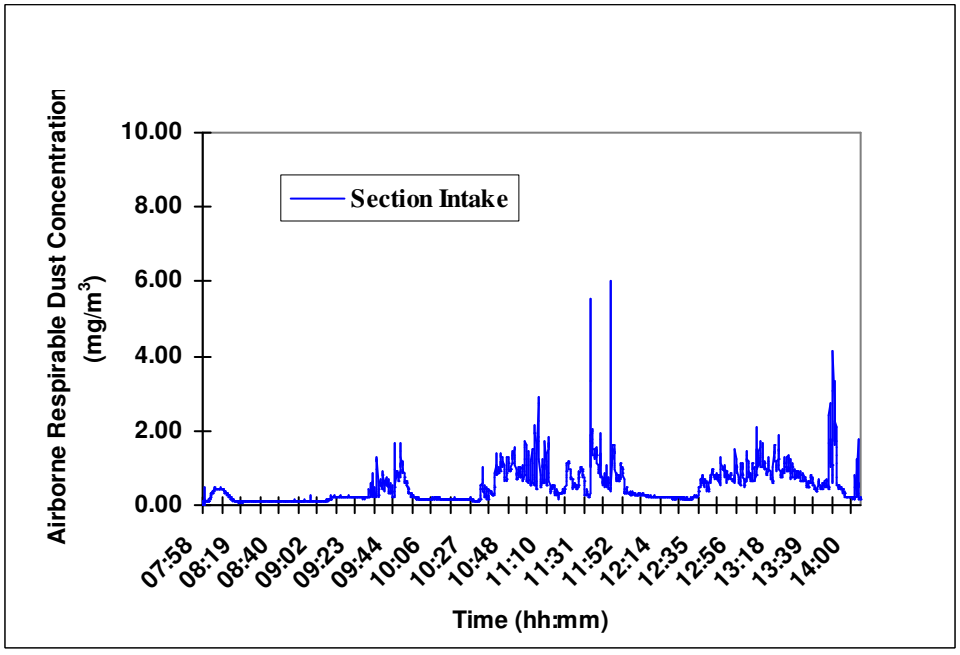


Figure 59: ARD profile recorded at the section intake position for Test # 59

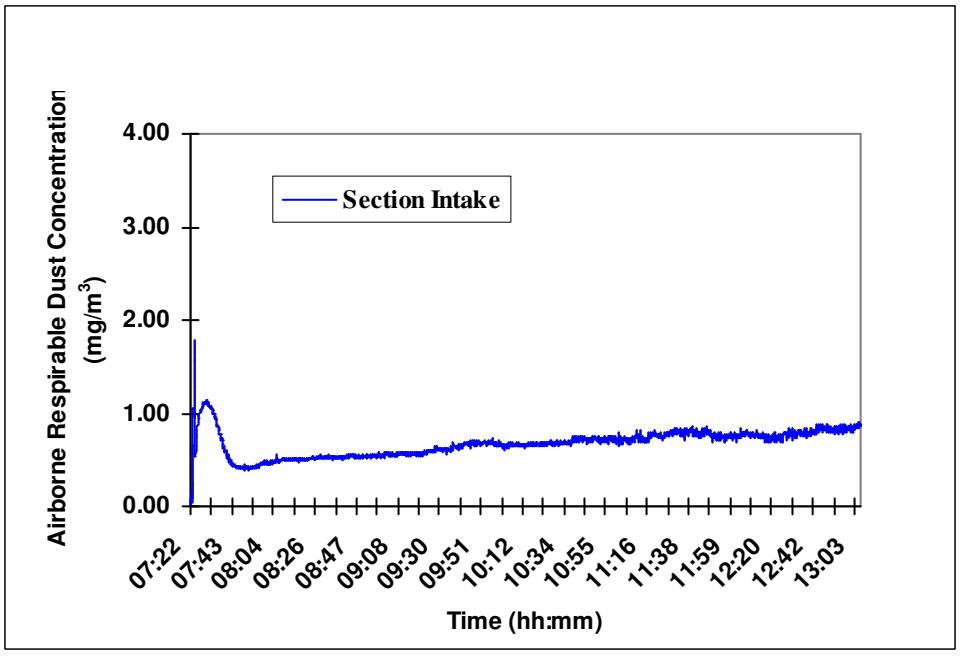


Figure 60: ARD profile recorded at the section intake position for Test # 60

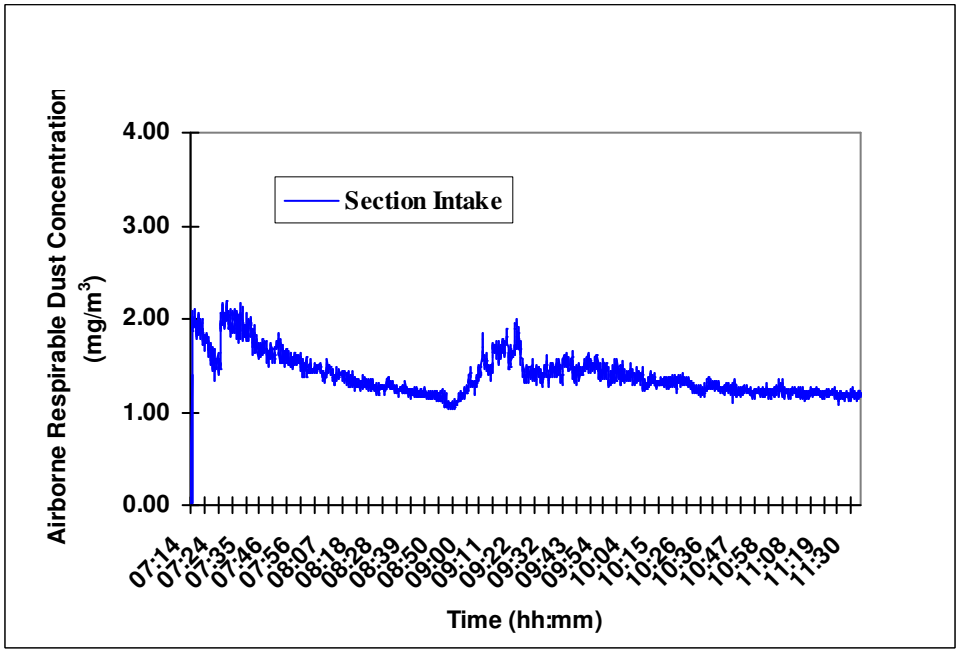


Figure 61: ARD profile recorded at the section intake position for Test # 61

APPENDIX-D

Size Analyses Data of Underground Coal Samples

(Chapter 9)

Table D1: Relationship between particle size, number and dust concentration

Sample dust concentration in mg/m^3	2.37	3.89	5.62	5.56
Sample dust mass in mg	1.75	2.35	2.99	2.96
Sample number #	1	2	3	4
Particle size in microns				
0.16	1.2E+13	1.9E+13	1.1E+13	1.2E+13
0.20	5.1E+12	7.6E+12	4.4E+12	5.0E+12
0.31	8.4E+11	1.2E+12	6.8E+11	8.1E+11
0.42	3.9E+11	5.2E+11	3.0E+11	3.9E+11
0.51	2.9E+11	4.0E+11	2.3E+11	3.0E+11
0.63	2.1E+11	2.9E+11	1.7E+11	2.2E+11
0.70	1.7E+11	2.5E+11	1.4E+11	1.8E+11
0.86	1.2E+11	1.8E+11	9.5E+10	1.2E+11
0.96	9.8E+10	1.5E+11	8.0E+10	1.1E+11
1.06	8.3E+10	1.3E+11	6.9E+10	9.1E+10
1.45	4.9E+10	7.5E+10	4.6E+10	6.0E+10
1.97	2.3E+10	3.8E+10	2.6E+10	3.2E+10
2.19	1.6E+10	2.8E+10	2.0E+10	2.4E+10
3.31	3.0E+09	5.5E+09	4.9E+09	4.8E+09
4.07	1.0E+09	1.7E+09	2.0E+09	1.6E+09
4.52	5.8E+08	9.0E+08	1.2E+09	9.1E+08
5.01	3.2E+08	4.3E+08	7.6E+08	4.9E+08
6.16	9.3E+07	7.5E+07	3.0E+08	1.4E+08
7.58	2.8E+07	3.0E+06	1.3E+08	4.0E+07
8.40	1.7E+07	0.0E+00	9.6E+07	2.4E+07
9.32	1.2E+07	0.0E+00	7.3E+07	1.5E+07
10.33	1.1E+07	0.0E+00	5.9E+07	1.1E+07
11.46	1.1E+07	0.0E+00	5.1E+07	1.1E+07
12.71	1.3E+07	0.0E+00	4.6E+07	1.3E+07
14.09	1.5E+07	0.0E+00	4.3E+07	1.8E+07
15.62	1.5E+07	0.0E+00	3.9E+07	2.4E+07
19.21	1.0E+07	0.0E+00	3.0E+07	3.0E+07
21.31	6.9E+06	0.0E+00	2.4E+07	2.7E+07
29.06	4.2E+05	0.0E+00	6.8E+06	8.5E+06
35.74	0.0E+00	0.0E+00	1.7E+06	1.6E+06
48.74	0.0E+00	0.0E+00	1.6E+05	1.1E+05
59.93	0.0E+00	0.0E+00	1.1E+05	7.1E+04
66.46	0.0E+00	0.0E+00	9.6E+04	5.4E+04
73.70	0.0E+00	0.0E+00	7.9E+04	3.8E+04
81.73	0.0E+00	0.0E+00	5.7E+04	2.2E+04
90.64	0.0E+00	0.0E+00	3.6E+04	7.6E+03

Table D2: Relationship between particle size, surface area and dust concentration

Sample dust concentration in mg/m^3	2.37	3.89	5.62	5.56
Sample dust mass in mg	1.75	2.35	2.99	2.96
Total surface area of dust in m^2	1	2	3	4
Particle size in microns				
0.16	0.25	0.40	0.22	0.25
0.20	0.16	0.25	0.14	0.16
0.31	0.06	0.09	0.05	0.06
0.42	0.05	0.07	0.04	0.05
0.51	0.06	0.08	0.05	0.06
0.63	0.07	0.09	0.05	0.07
0.70	0.07	0.10	0.05	0.07
0.86	0.07	0.10	0.06	0.07
0.96	0.07	0.11	0.06	0.08
1.06	0.07	0.11	0.06	0.08
1.45	0.08	0.12	0.08	0.10
1.97	0.07	0.12	0.08	0.10
2.19	0.06	0.11	0.07	0.09
3.31	0.03	0.05	0.04	0.04
4.07	0.01	0.02	0.03	0.02
4.52	0.01	0.01	0.02	0.01
5.01	0.01	0.01	0.02	0.01
6.16	0.00	0.00	0.01	0.00
7.58	0.00	0.00	0.01	0.00
8.40	0.00	0.00	0.01	0.00
9.32	0.00	0.00	0.00	0.00
10.33	0.00	0.00	0.00	0.00
11.46	0.00	0.00	0.01	0.00
12.71	0.00	0.00	0.01	0.00
14.09	0.00	0.00	0.01	0.00
15.62	0.00	0.00	0.01	0.00
19.21	0.00	0.00	0.01	0.01
21.31	0.00	0.00	0.01	0.01
29.06	0.00	0.00	0.00	0.01
35.74	0.00	0.00	0.00	0.00
48.74	0.00	0.00	0.00	0.00
59.93	0.00	0.00	0.00	0.00
66.46	0.00	0.00	0.00	0.00
73.70	0.00	0.00	0.00	0.00
81.73	0.00	0.00	0.00	0.00
90.64	0.00	0.00	0.00	0.00

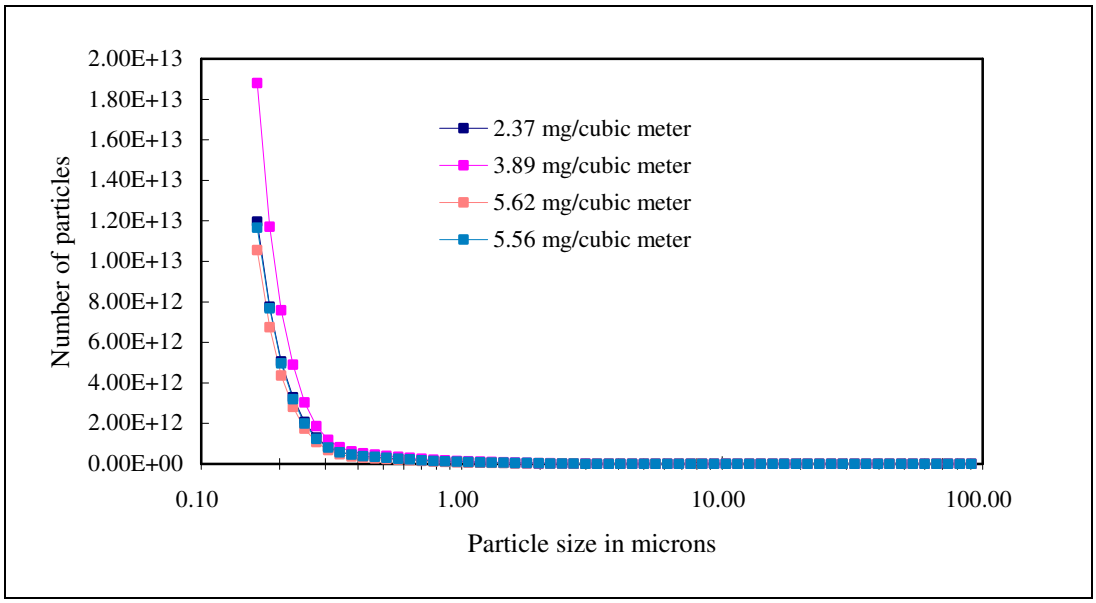


Figure D1: Relationship between particle size, number and dust concentration

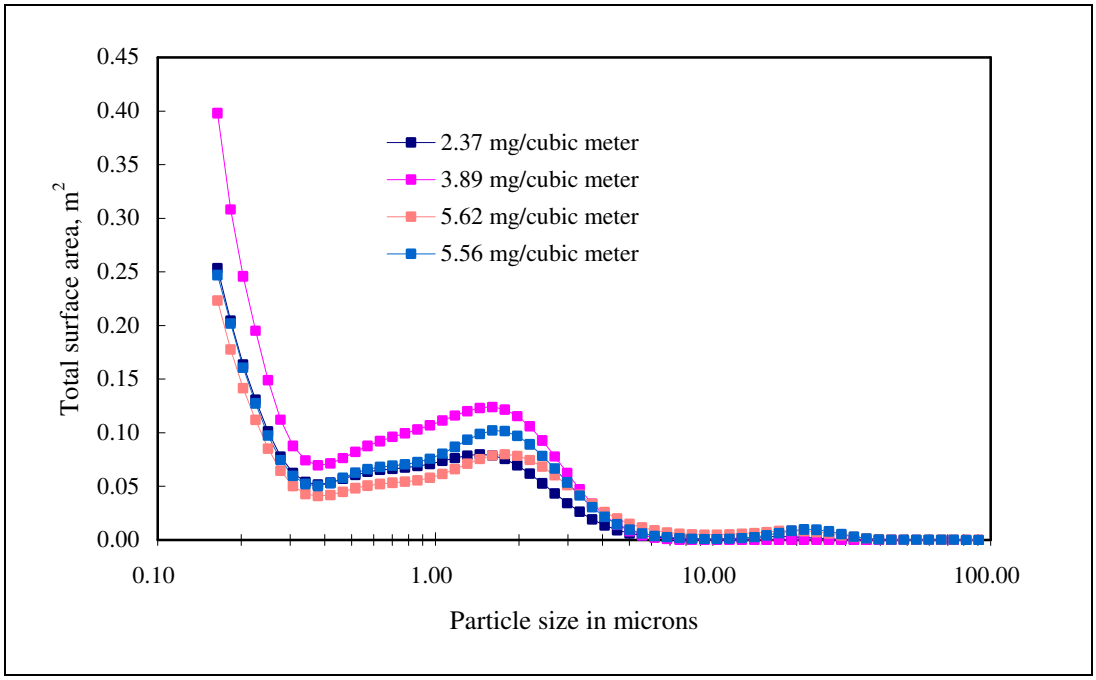


Figure D2: Relationship between particle size, surface area and dust concentration

APPENDIX-E

Inherent Respirable Dust Generation Potential (IRDGP) Real-Time Data (Chapter 11)

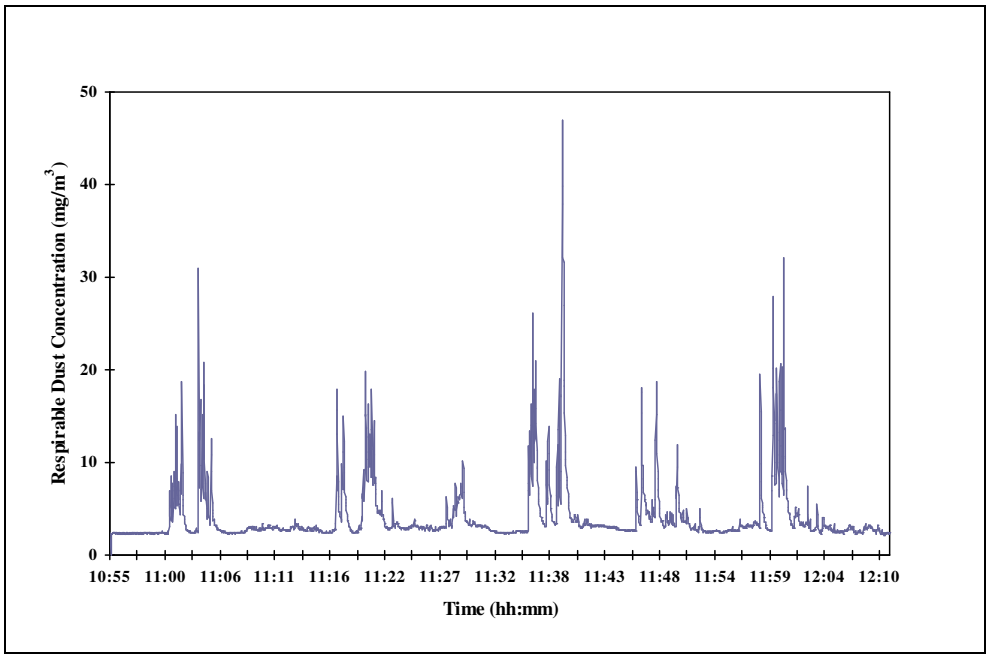


Figure A1: ARD profile recorded by the real-time monitor for Middleburg coal

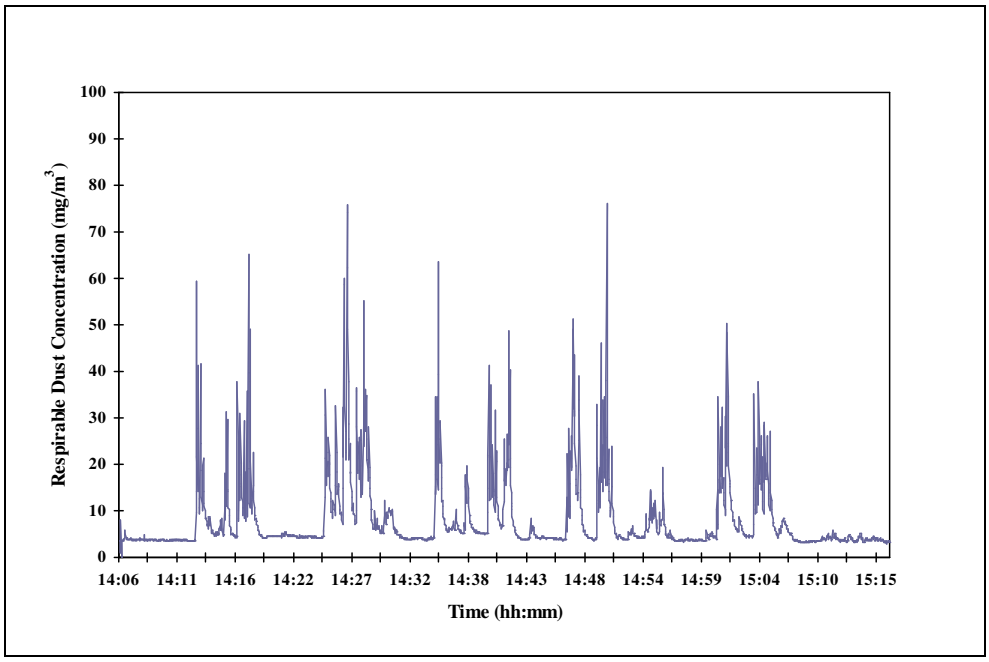


Figure A2: ARD profile recorded by the real-time monitor for Middleburg coal

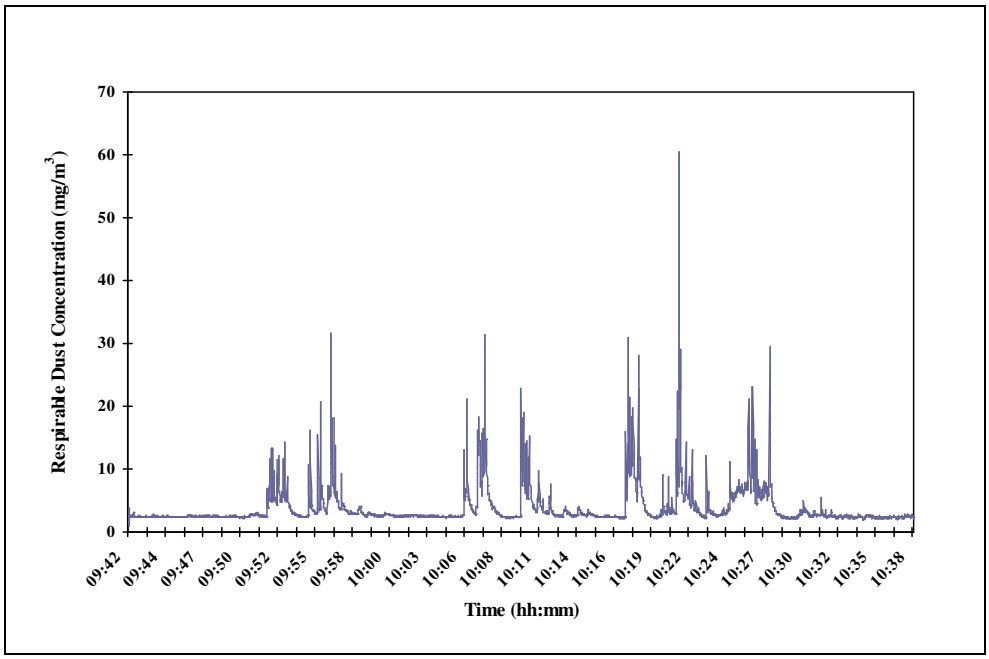


Figure A3: ARD profile recorded by the real-time monitor for Koornfontein coal

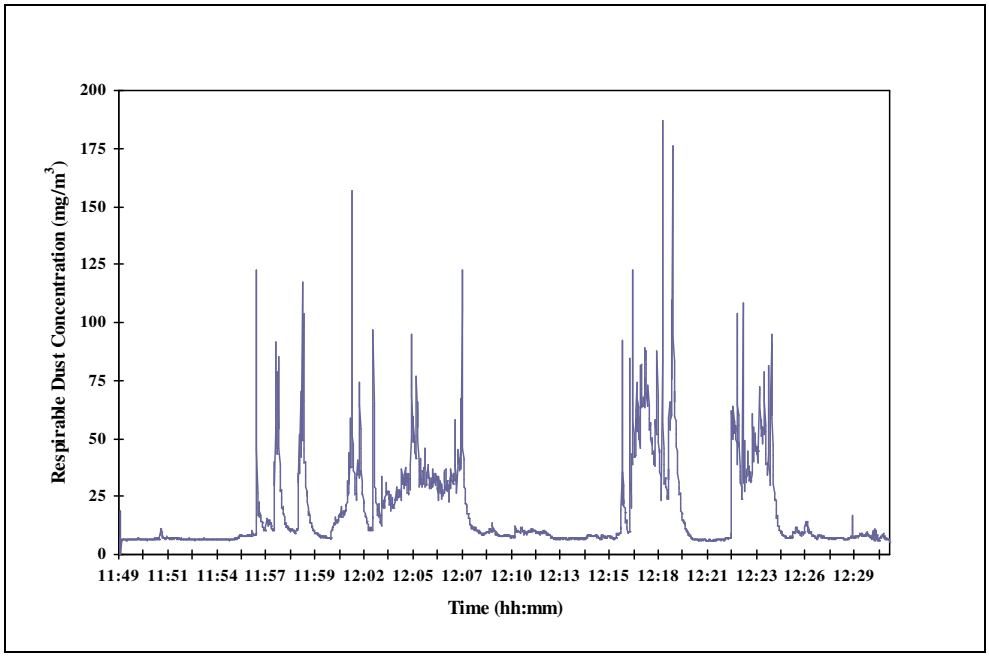


Figure A4: ARD profile recorded by the real-time monitor for Kwa Zulu Natal coal

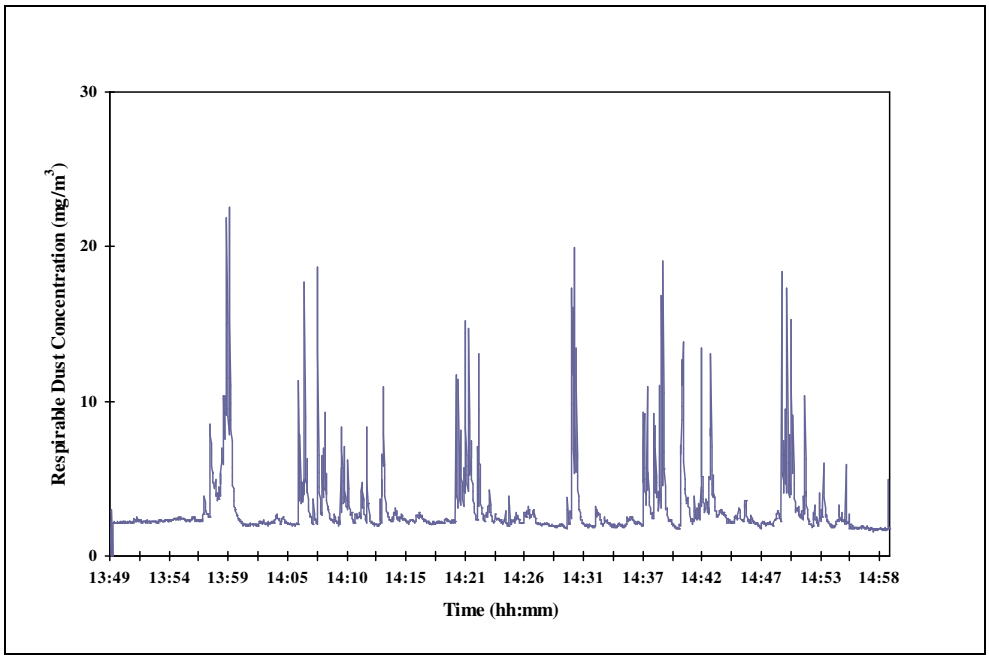


Figure A5: ARD profile recorded by the real-time monitor for Douglas coal

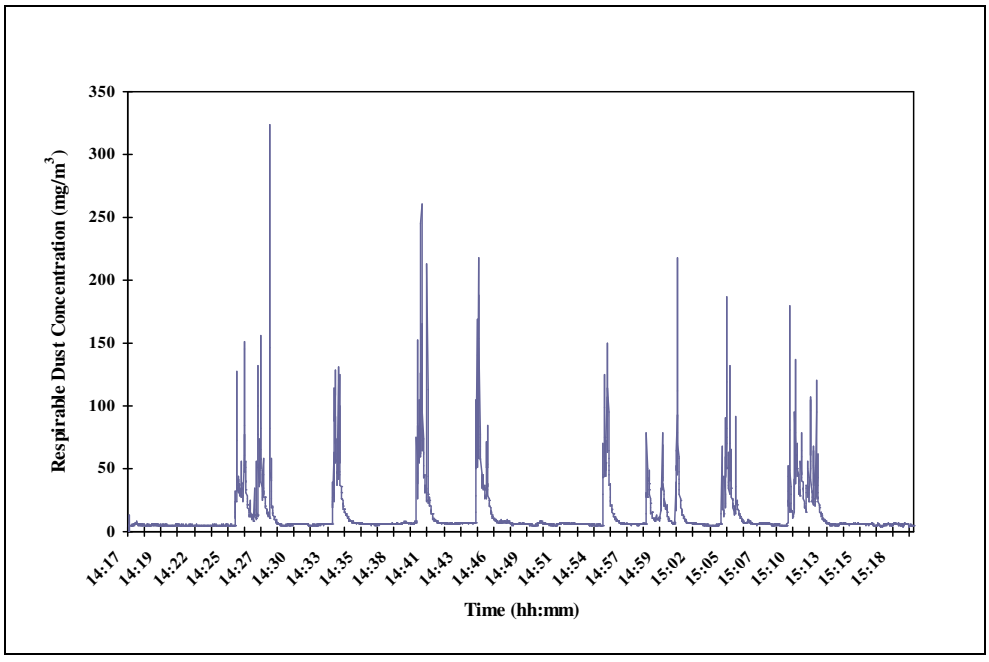


Figure A6: ARD profile recorded by the real-time monitor for Bank coal

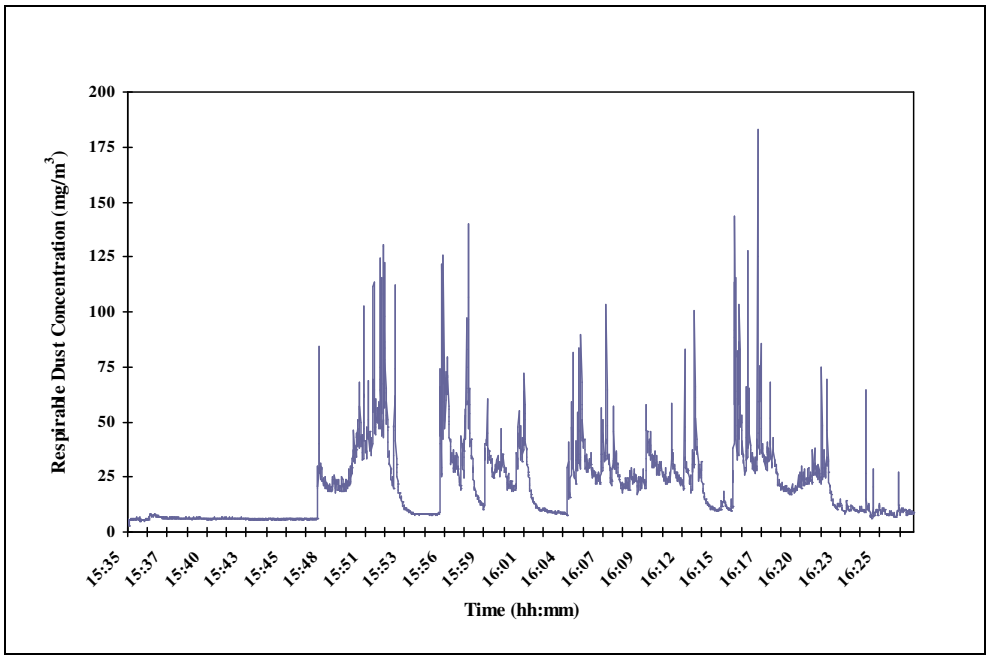


Figure A7: ARD profile recorded by the real-time monitor for Bank coal

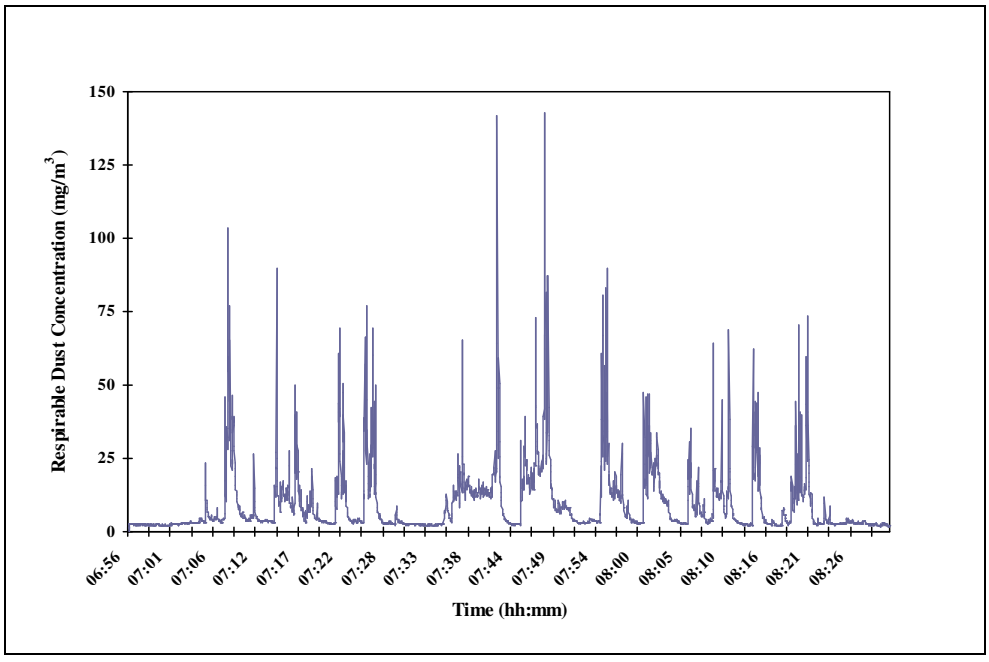


Figure A8: ARD profile recorded by the real-time monitor for Bank coal

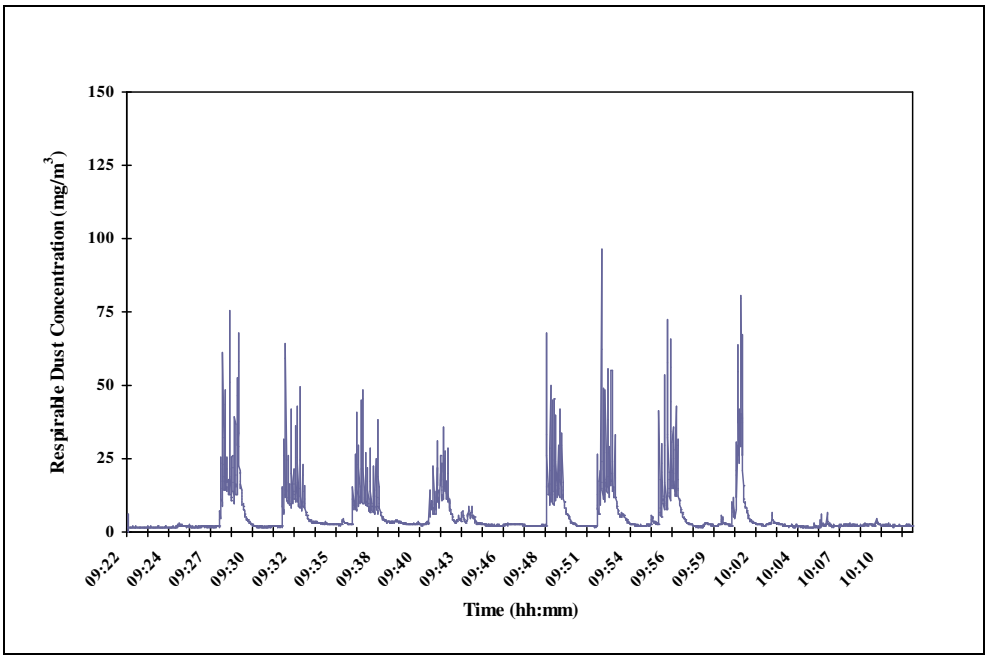


Figure A9: ARD profile recorded by the real-time monitor for Bank coal

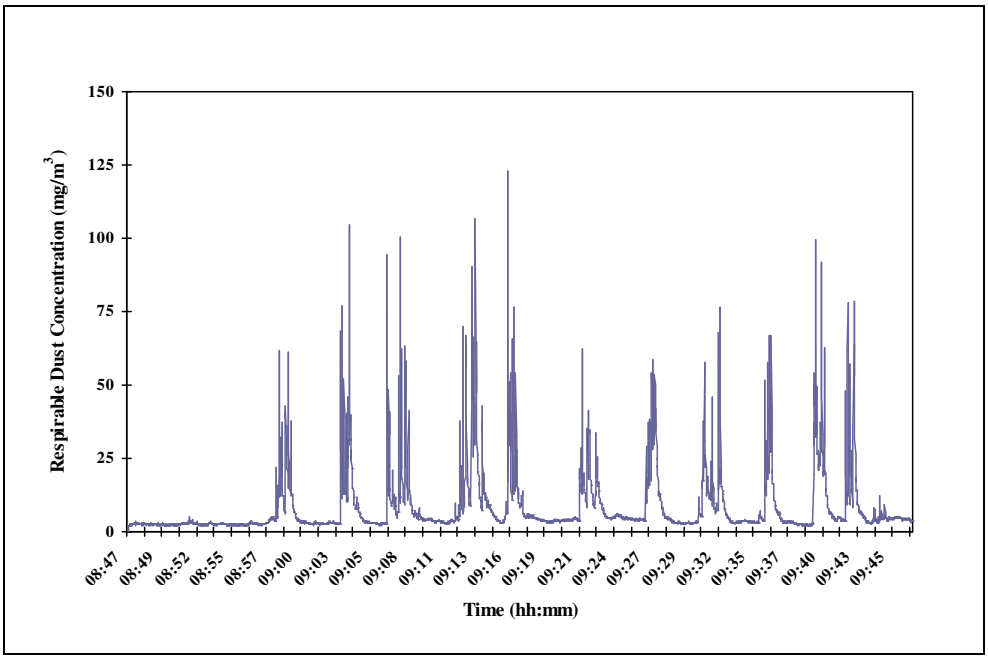


Figure A10: ARD profile recorded by the real-time monitor for Middleburg coal

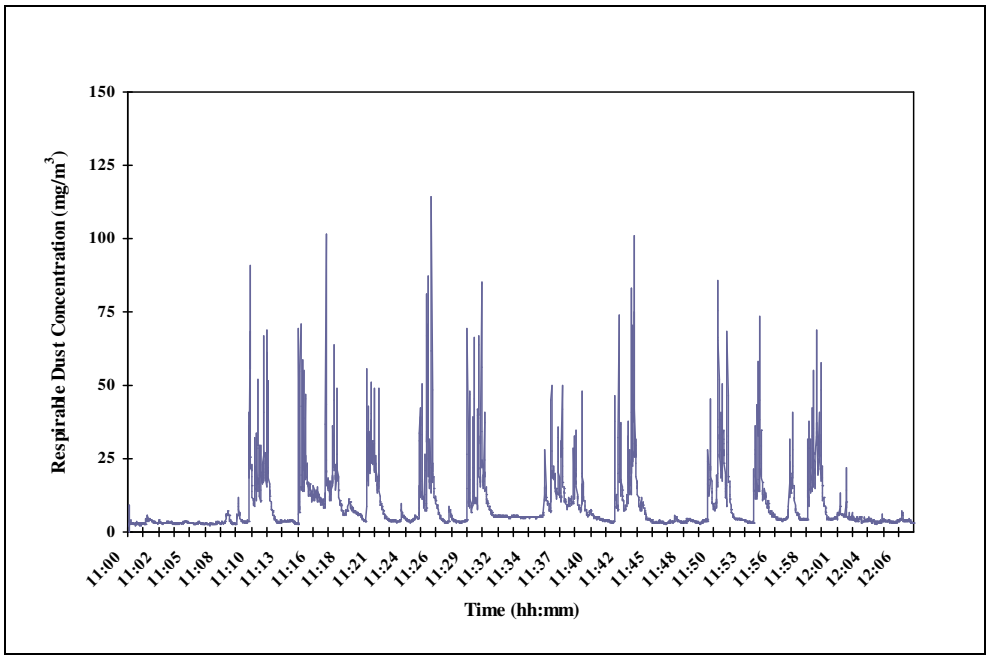


Figure A11: ARD profile recorded by the real-time monitor for Middleburg coal

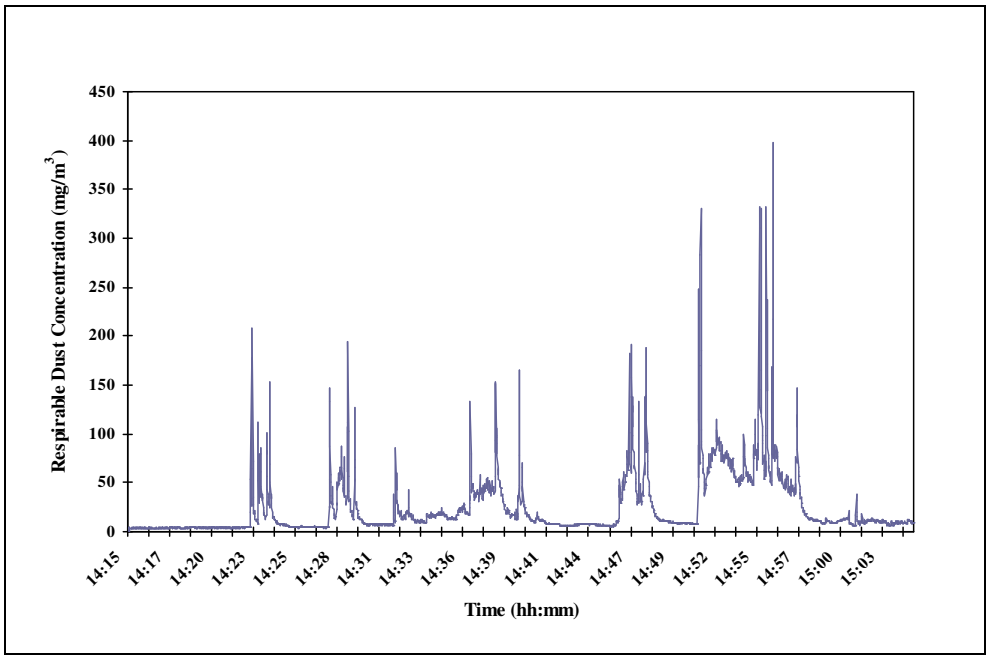


Figure A12: ARD profile recorded by the real-time monitor for Kwa Zulu Natal coal

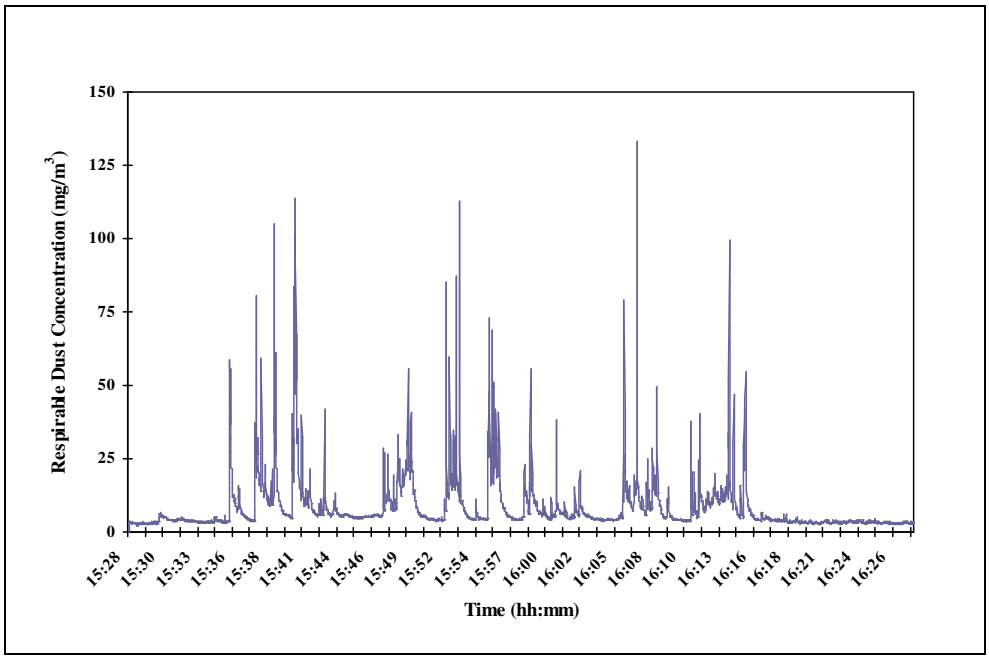


Figure A13: ARD profile recorded by the real-time monitor for Optimum and Rietspruit coal

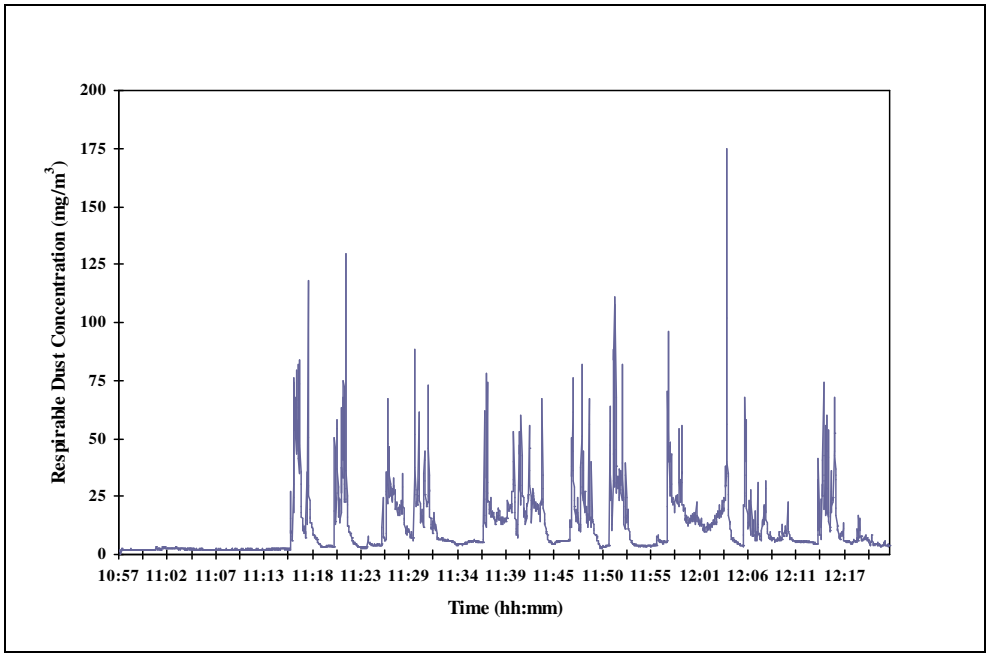


Figure A14: ARD profile recorded by the real-time monitor for Goedhope coal

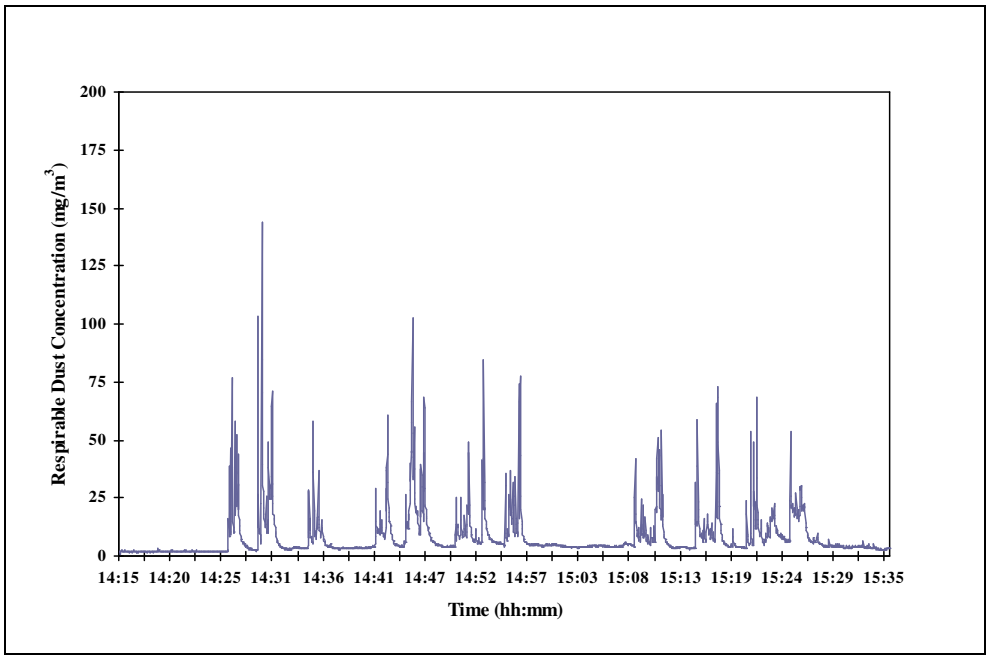


Figure A15: ARD profile recorded by the real-time monitor for Rietspruit coal

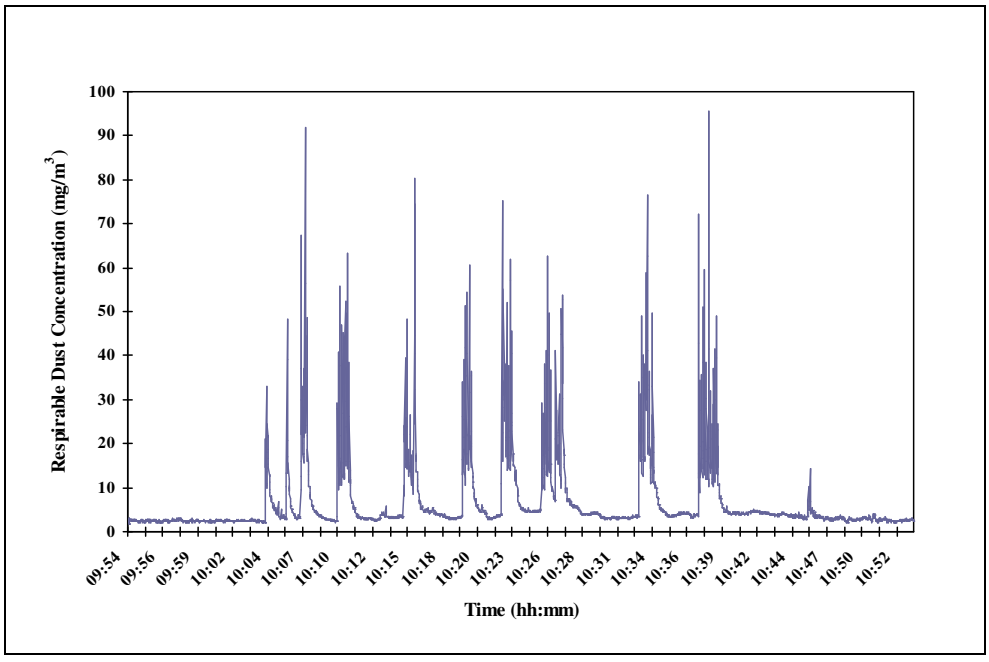


Figure A16: ARD profile recorded by the real-time monitor for NDC coal

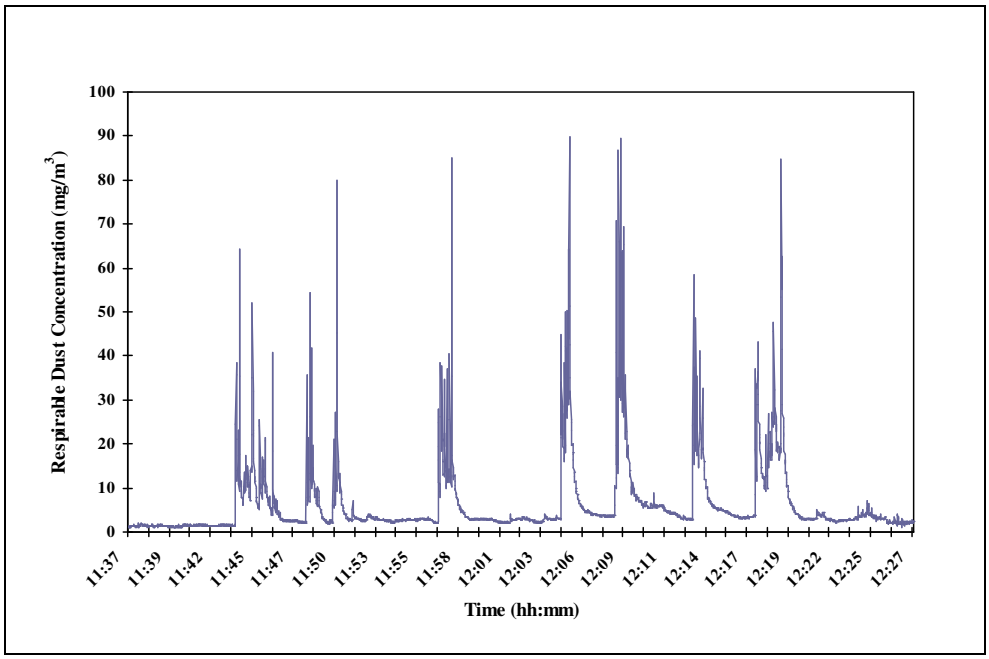


Figure A17: ARD profile recorded by the real-time monitor for Bosspruit, Twistdraai West, Syferfontein coal

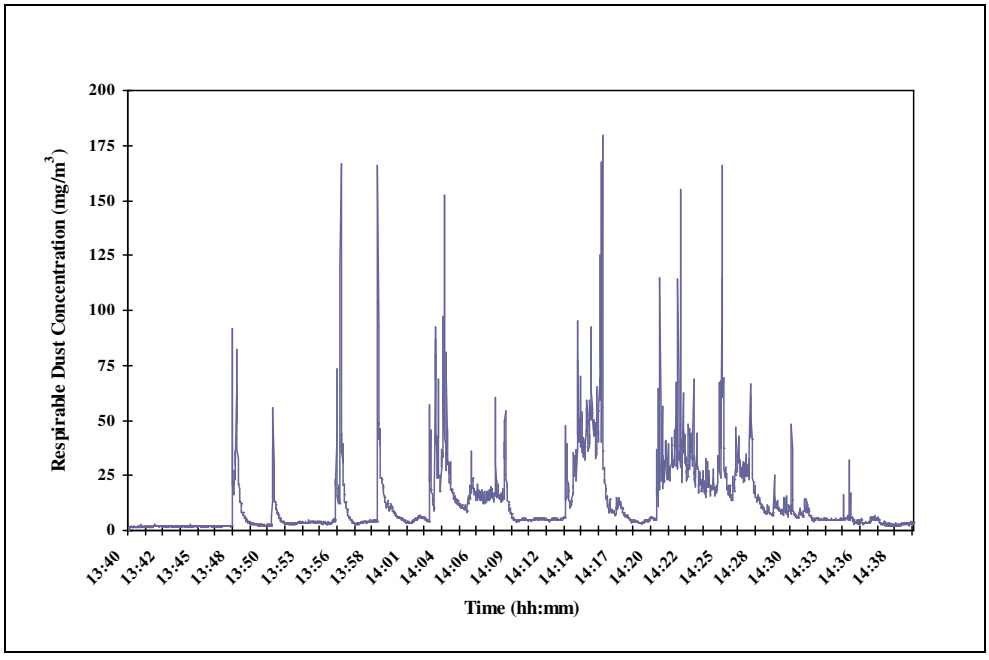


Figure A18: ARD profile recorded by the real-time monitor for Duiker, Middlebult, Boosjespruit coal

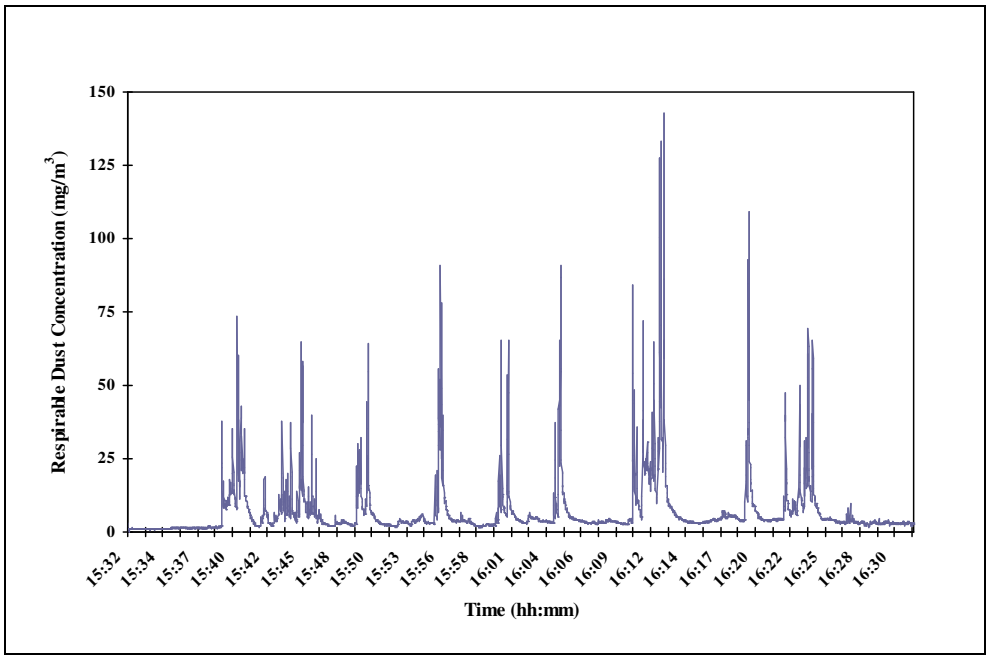


Figure A19: ARD profile recorded by the real-time monitor for Twistdraai East, Sigma and Brandspruit coal

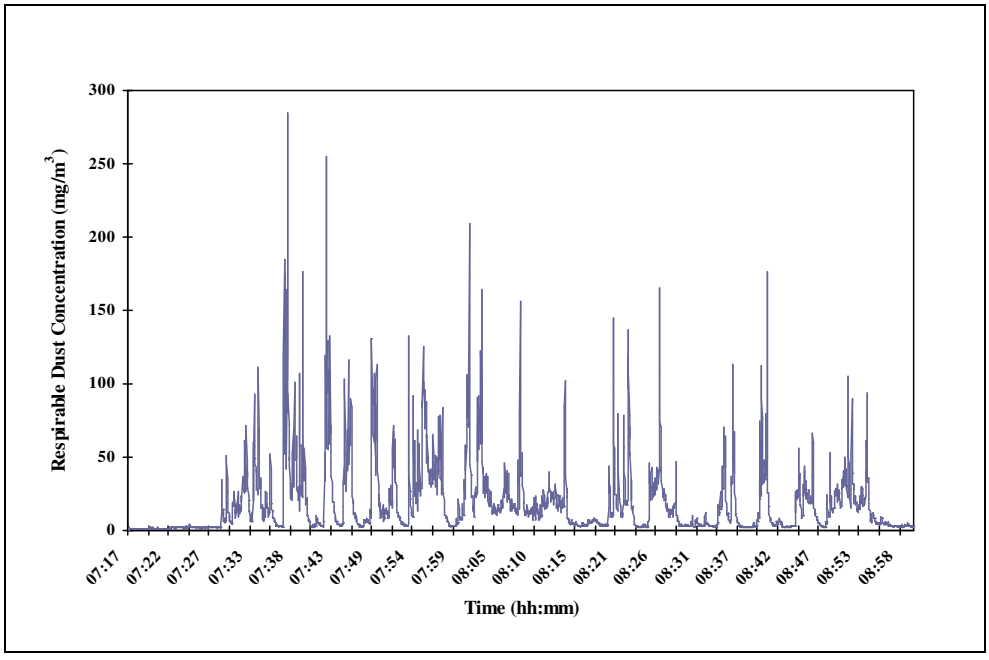


Figure A20: ARD profile recorded by the real-time monitor for Elisras and Twistdraai Central coal

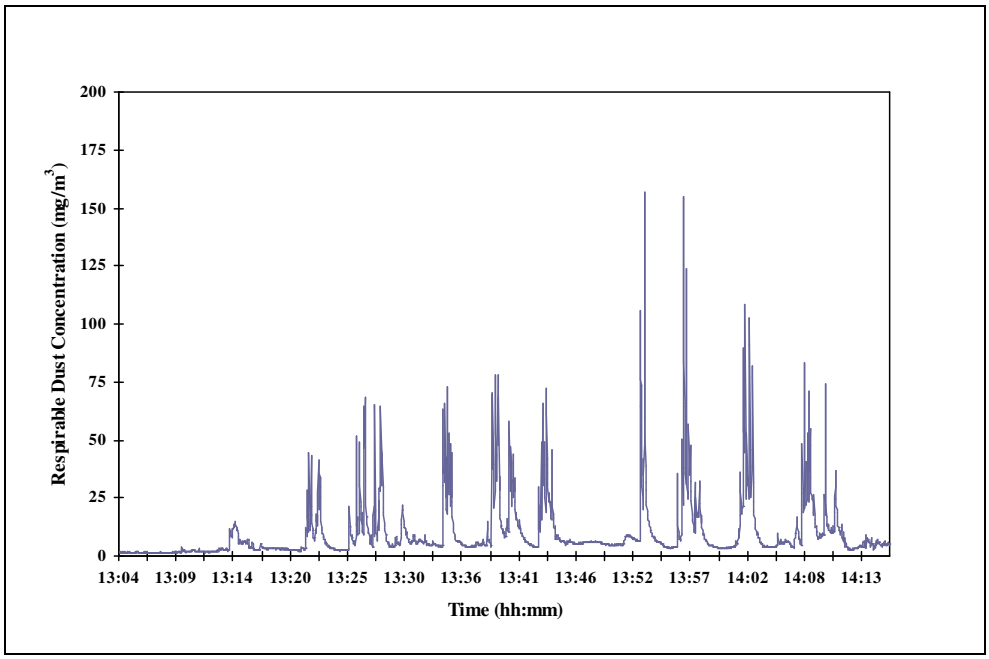


Figure A21: ARD profile recorded by the real-time monitor for Twistdraai East, Brandspruit, and Goedhope coal

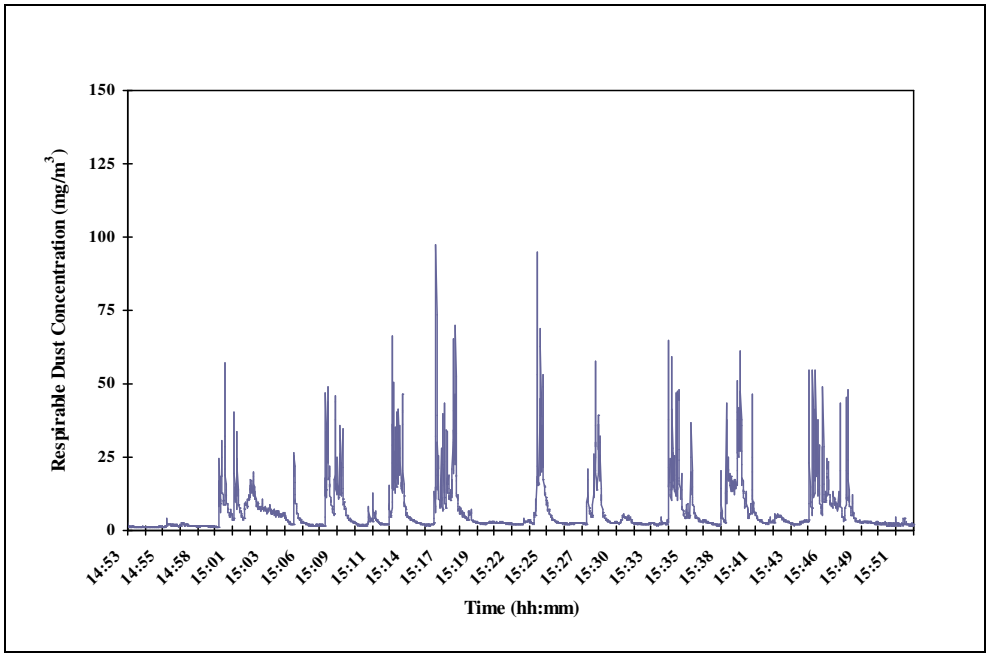


Figure A22: ARD profile recorded by the real-time monitor for Goedhope and Elisras coal

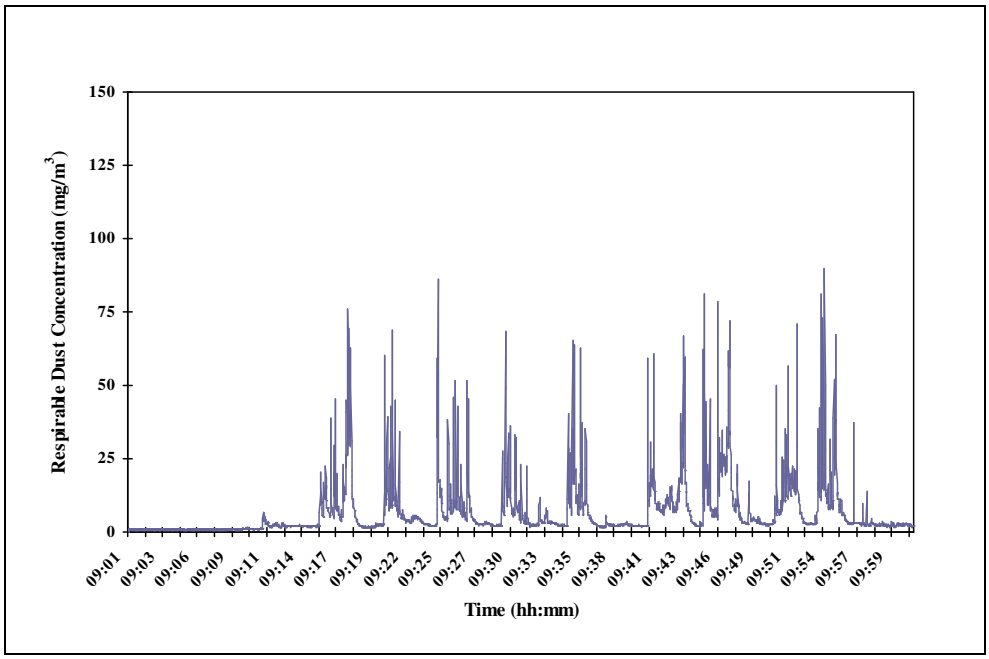


Figure A23: ARD profile recorded by the real-time monitor for Goedhope and Elisras coal

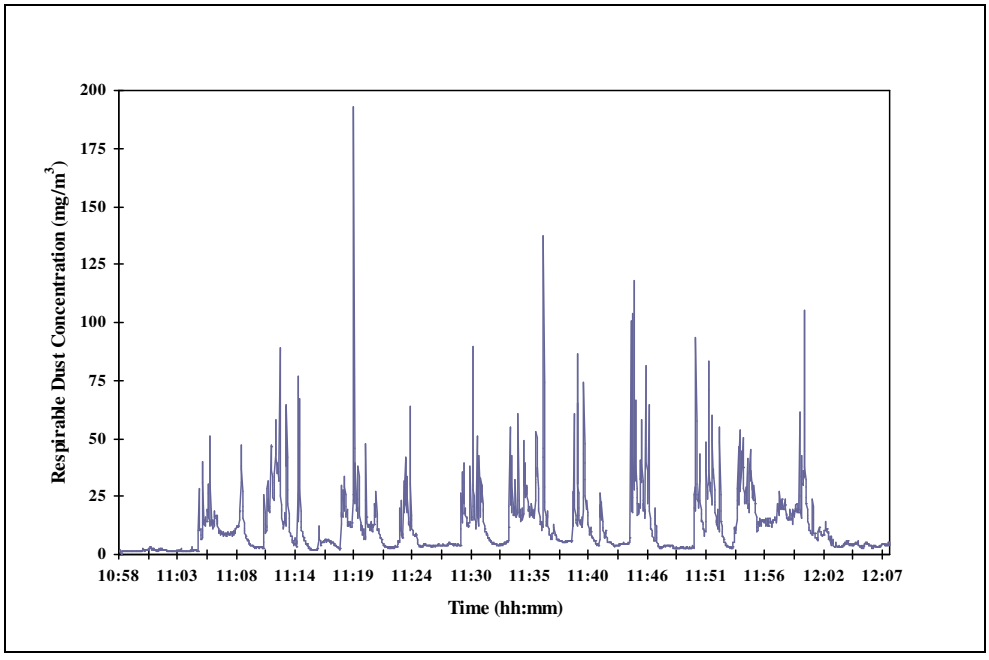


Figure A24: ARD profile recorded by the real-time monitor for Elisras coal

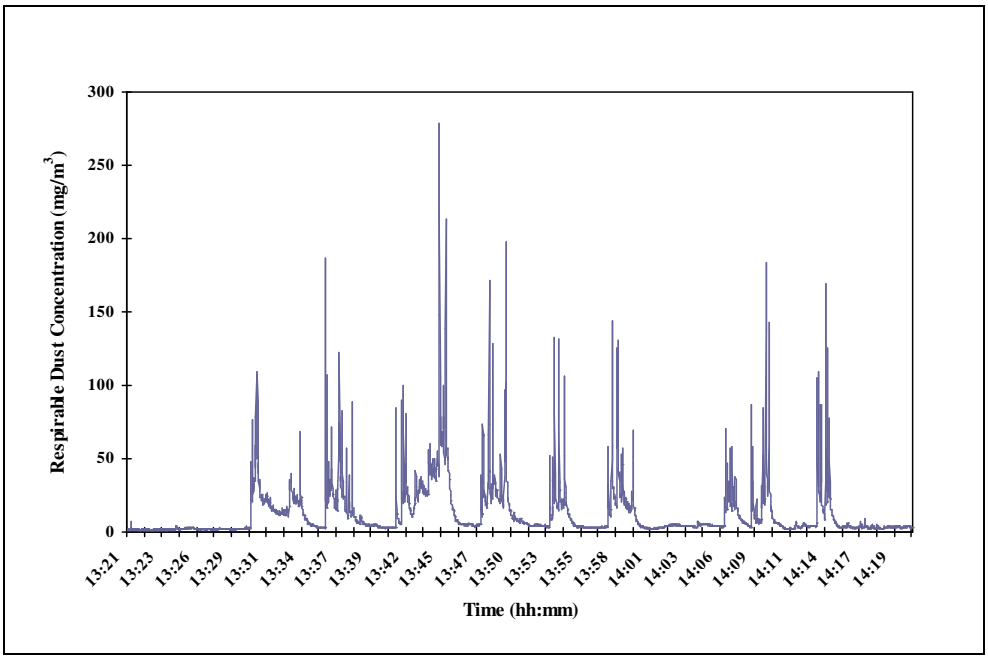


Figure A25: ARD profile recorded by the real-time monitor for Elisras coal

APPENDIX-F

Examples of Application of DELI Model for Coal Mines (Chapter 12)

Section 13 at Bank Colliery, South Shaft

The dust measurement was carried out in a bord-and-pillar road header (AM 85) section # 25 operating in seam number two. The seam height was 5.5 m with a bord width of 6.5 m, with pillar dimensions of 13.5 m × 13.5 m. Figure F1 shows the typical deployment of the dust-monitoring instruments in the section. The respirable dust-concentration levels in the headings were determined by placing gravimetric respirable dust samplers along with the Hund tyndallometers. The samplers were positioned in the section intake, in the operator's cabin and in the section return. The personal dust level was measured in the breathing zone of the remote road header operator.

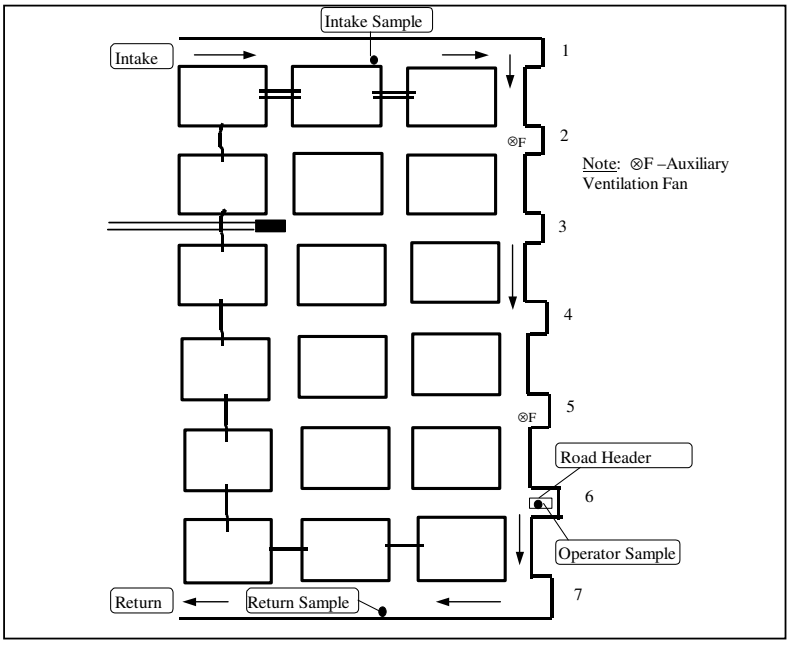


Figure F1: General layout of Test Section 13 at Bank Colliery, South Shaft

The measured dust levels at the section intake, road header operator (engineering sample), section return and remote road header operator personal dust levels were 0.625 mg/m^3, 8.585 mg/m^{3}and 2.592 mg/m^3 and 3.756 mg/m^3 respectively. The production for the measured shift was 1680 tons. The average production for the section was 600 tons. During the measured shift, the road header was cutting in the direction of "heading" in road numbers 6 and 4 for a distance of 15 m and 25 m respectively. The DELI input and Output sheet are shown in Figures F2 and F3 respectively.

Air Quality index (AQI)

AQI Input Sheet			**Gravimetric Sampler Description**					
Organization/Company			**Type of Sampler**	**SA cyclone**				
University of Witwatersrand			**Sampling Rate (L/min)**	**2.20**				
Prepared By B.K. Belle@2003			**Respirable Curve**	**ISO/CEN/ACGIH**				
University of Witwatersrand			**D50 of the sampling curve**	**4.00**				
User:			Sample date					
Bank South Shaft			**Feb-8-2000**					
Data Analysis By:			Data Analysis Date:					
B.K. Belle			**Feb-9-2000**					
Shift Production, Tons			Type of Mining (CM/RH/Wall)			Coal Type		
1680.00			**Continuous Miner**			**Bituminous**		
Cutting Direction			Cutting Distance			Peak Dust Frequency		
Heading			**25.00**					
Lab Filter Correction factor (mg)			Quartz Analysis Lab Name					
-0.00241								
Filter Number #	**Sampling Location**	**Filter Pre-Weight (mg)**	**Filter Post-Weight (mg)**	**Corrected Mass (mg)**	**Sampling Time (minutes)**	**Dust Level (mg/m3)**	**Quartz Content %**	**Quartz Level (mg/m^3)**
1	Section Intake	**59.340**	**59.870**	0.532	387.00	**0.625**	**3.50**	**0.022**
2	Section Return	**59.341**	**61.779**	2.440	428.00	**2.592**	**3.50**	**0.091**
3	Operator-Engineering	**59.330**	**67.487**	8.159	432.00	**8.585**	**3.50**	**0.300**
4	Operator-Personal	**59.345**	**62.896**	3.553	430.00	**3.756**	**3.50**	**0.131**
AQI Coal Dust	**1.88**							
AQI Quartz Dust	**3.00**		All other cells are protected.					
To use spreadsheet, fill in yellow cells:			All values are automatically calculated.					

Figure F2: DELI Input sheet for Road Header Section, Bank Colliery

DELI-DUST EXPOSURE LEVEL INDEX

		DELI POINTS	Good	Average	Unsatisfactory	Unhealthy and Unsafe
Section Intake Dust	0.62	7.5	10	7.5	5	2.5
Section Return Dust	2.59	2.5	10	7.5	5	2.5
CM Engineering Dust Level	8.59	2.5	10	7.5	5	2.5
Personal CM Operator Dust	3.76	2.5	10	7.5	5	2.5
CM Cutting Direction	Heading	5	10	7.5	5	2.5
CM Cutting Distance	25.00	2.5	10	7.5	5	2.5
Average Shift Production	1680.00		10	7.5	5	2.5
Peak Dust Levels	6	10	10	7.5	5	2.5
Coal Dust Type	Bituminous	5	10	7.5	5	2.5
Inherent or Airborne Silica, %	3.50	10	10	7.5	5	2.5
Dust Exposure Level Index		47.5	100	75	50	25

DELI COLOUR INDEX

UNSATISFACTORY
BORDER LINE
SATISFACTORY

DELI POINT INDEX

100-75	Good
74-50	Average
49-25	Unsatisfactory
24-0	Unhealthy and Unsafe

Figure F3: DELI Index for Road header Section, Bank Colliery, South Shaft

From the DELI output, it is noted that Section # 13 was operating in an "Unsatisfactory" conditions. The measured dust levels at various places of the section were higher than the regulatory limits. This indicates the failure of both the engineering and administrative dust control systems. Lack of administrative control can be recognised with the high production rates indicating production takes precedence over the environmental conditions or engineering and administrative controls. From the model output, it was noted that the peak dust levels was not a critical parameter for high dust levels. In summary, the "Red' DELI colour index showed that much to be done for reducing the worker exposures.

Section # 2 of Gloria Colliery (Wilmansrust Shaft)

The dust measurement was carried out in a bord-and-pillar continuous miner (CM) Joy HM 17 at Section # 2 of Gloria Colliery (Wilmansrust Shaft) using Hydra wet head dust control system. The seam (Four seam) height was 4.1 m with a bord width of 6.5 m, with pillar dimension of 20.0 m $\times$ 20.0 m.

The respirable dust levels in the headings were determined by placing gravimetric respirable dust samplers along with the Hund tyndallometers. The samplers were positioned in the section intake, in the operator's cabin and in the section return. The personal samples were also measured where the author followed the CM operator during the shift.

The measured dust levels at the section intake, CM operator (engineering sample), section return and operator personal dust levels were 1.386 mg/m^3, 6.761 mg/m^3, 3.038 mg/m^{3}and 7.541 mg/m^3 respectively. The production for the shift was 940 tons. The average production for the section was 1200 tons. The CM was cutting in the direction of "split" between road numbers 6 and 7 and 5 and 4 for a distance of 12 m and 10 m respectively. The DELI input and output sheet are shown in Figures F4 and F5 respectively.

Air Quality index (AQI)

AQI Input Sheet	**Gravimetric Sampler Description**		
Organization/Company	**Type of Sampler**	**SA cyclone**	
University of Witwatersrand	**Sampling Rate (L/min)**	**2.20**	
Prepared By B.K. Belle@2003	**Respirable Curve**	**ISO/CEN/ACGIH**	
University of Witwatersrand	**D50 of the sampling curve**	**4.00**	
User:	Sample date		
Gloria-Wilmansrust Shaft-Section 2	**18-Jan-01**		
Data Analysis By:	Data Analysis Date:		
B.K. Belle	**18-Jan-01**		
Shift Production, Tons	Type of Mining (CM/RH/Wall)	Coal Type	
940.00	**Continuous Miner**	**Bituminous**	
Cutting Direction	Cutting Distance	Peak Dust Frequency	
Split	**12.00**		
Lab Filter Correction factor (mg)	Quartz Analysis Lab Name		
-0.00005			

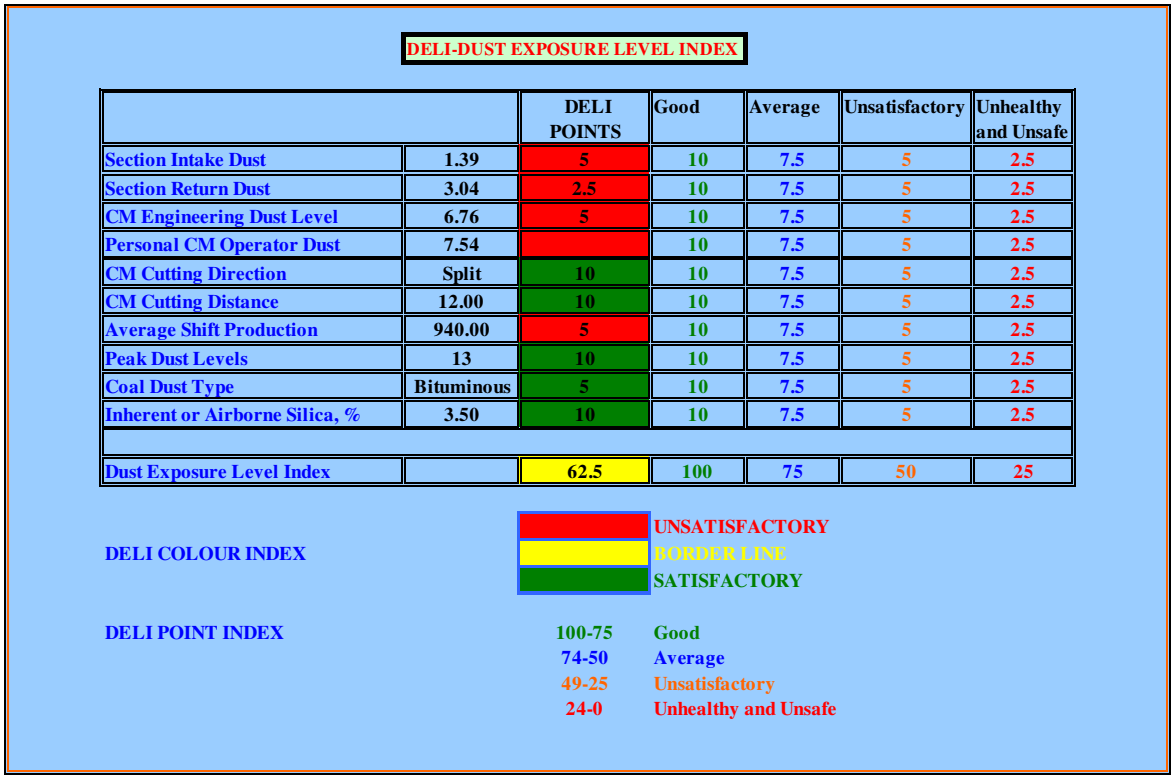
Filter Number #	Sampling Location	Filter Pre-Weight (mg)	Filter Post-Weight (mg)	Corrected Mass (mg)	Sampling Time (minutes)	Dust Level (mg/m3)	Quartz Content %	Quartz Level (mg/m^3)
1	Section Intake	**54.730**	**55.822**	1.092	358.00	**1.386**	**3.50**	**0.049**
2	Section Return	**54.683**	**57.056**	2.373	355.00	**3.038**	**3.50**	**0.106**
3	Operator-Engineering	**54.683**	**59.949**	5.266	354.00	**6.761**	**3.50**	**0.237**
4	Operator-Personal	**54.887**	**60.727**	5.840	352.00	**7.541**	**3.50**	**0.264**

AQI Coal Dust	**3.77**
AQI Quartz Dust	**2.64**

All other cells are protected.

To use spreadsheet, fill in yellow cells: All values are automatically calculated.

Figure F4: DELI Input sheet for Continuous Miner Section, Gloria Colliery, Wilmansrust Shaft



DELI-DUST EXPOSURE LEVEL INDEX

		DELI POINTS	Good	Average	Unsatisfactory	Unhealthy and Unsafe
Section Intake Dust	1.39	5	10	7.5	5	2.5
Section Return Dust	3.04	2.5	10	7.5	5	2.5
CM Engineering Dust Level	6.76	5	10	7.5	5	2.5
Personal CM Operator Dust	7.54		10	7.5	5	2.5
CM Cutting Direction	Split	10	10	7.5	5	2.5
CM Cutting Distance	12.00	10	10	7.5	5	2.5
Average Shift Production	940.00	5	10	7.5	5	2.5
Peak Dust Levels	13	10	10	7.5	5	2.5
Coal Dust Type	Bituminous	5	10	7.5	5	2.5
Inherent or Airborne Silica, %	3.50	10	10	7.5	5	2.5
Dust Exposure Level Index		62.5	100	75	50	25

DELI COLOUR INDEX

UNSATISFACTORY
BORDER LINE
SATISFACTORY

DELI POINT INDEX

100-75 Good
74-50 Average
49-25 Unsatisfactory
24-0 Unhealthy and Unsafe

Figure F5: DELI Index sheet for Continuous Miner Section, Gloria Colliery, Wilmansrust Shaft

Unlike the previous example, from the DELI output it was noted that Section # 2 was operating in an “Borderline” conditions based on output of DELI index. The measured dust levels at various places of the section were higher than the regulatory limits. Same as before, lack of administrative control can be recognised with the high production rates indicating production takes precedence over the environmental conditions or engineering and administrative controls. Frequency of the peak dust levels was higher than the previous example but was not a critical parameter for high exposures. In summary, the “Yellow’ DELI colour parameters indicate that dust control requires administrative and engineering controls for reducing the worker exposures.