# Shuttle Car Canopy Air Curtain Field Test Results


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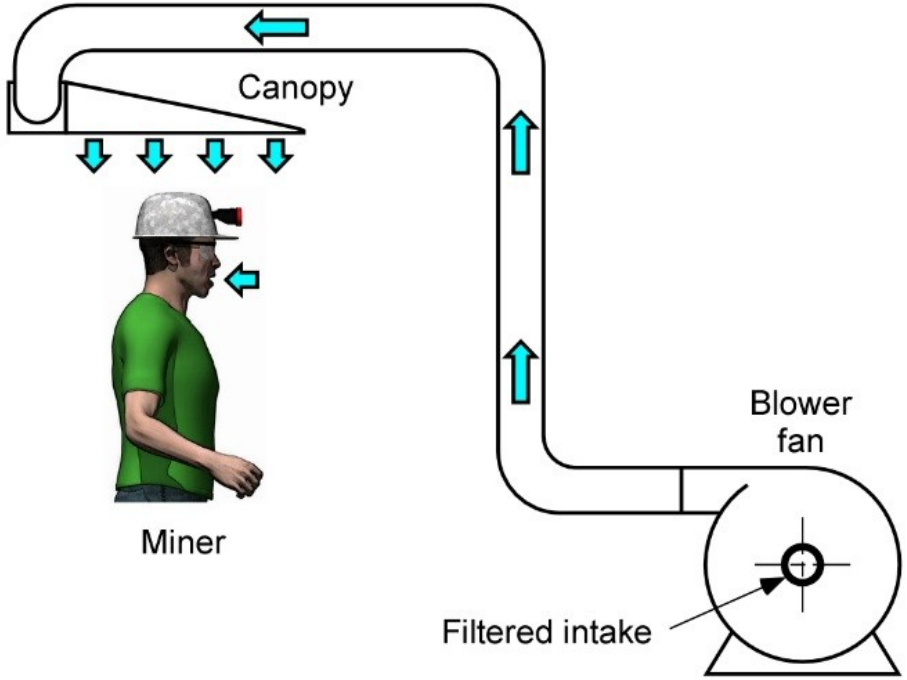
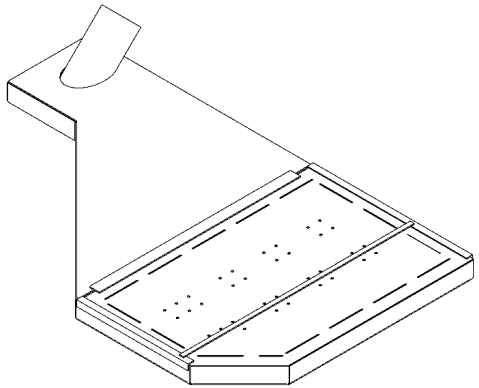
# Canopy Air Curtain (CAC)

- Continuous miner (CM) canopy

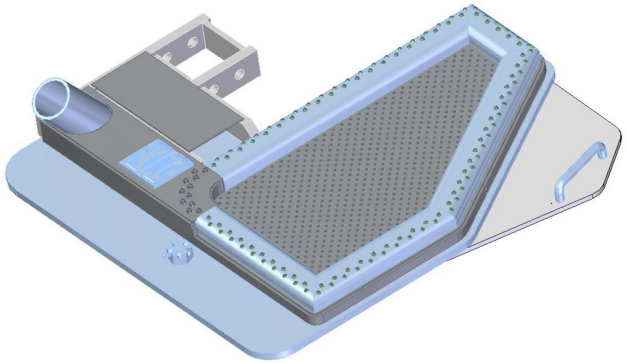
  30% to 70% reductions in respirable coal dust




- J.H Fletcher roof bolter canopy air curtains



1st generation

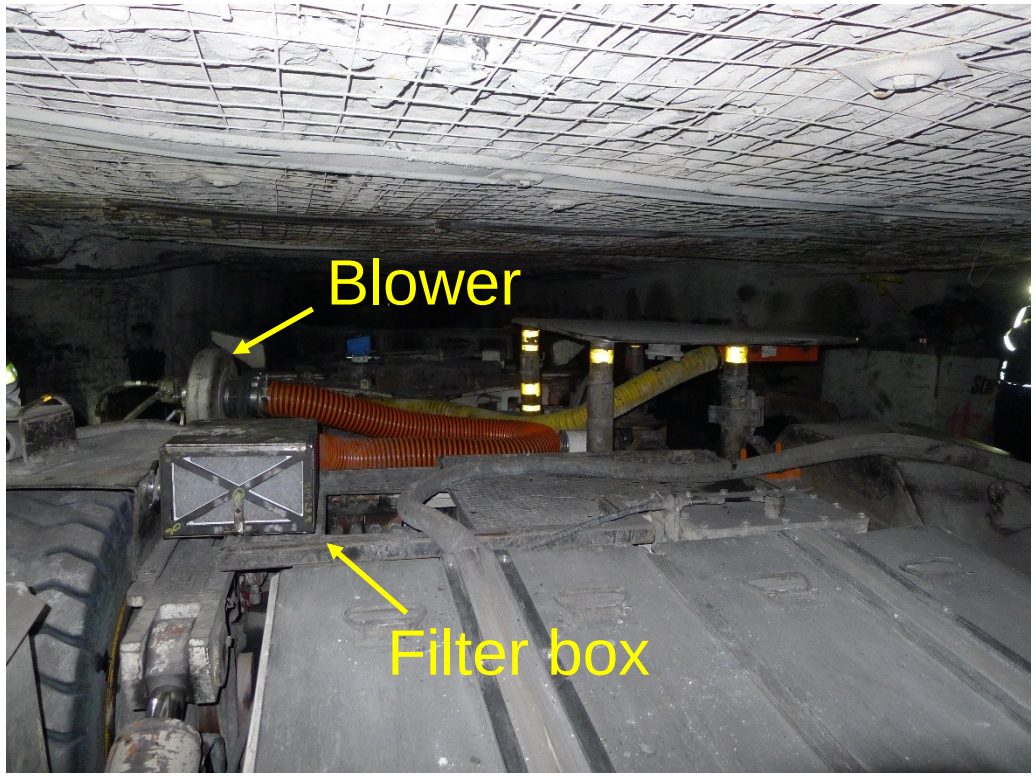


2nd generation

3rd generation

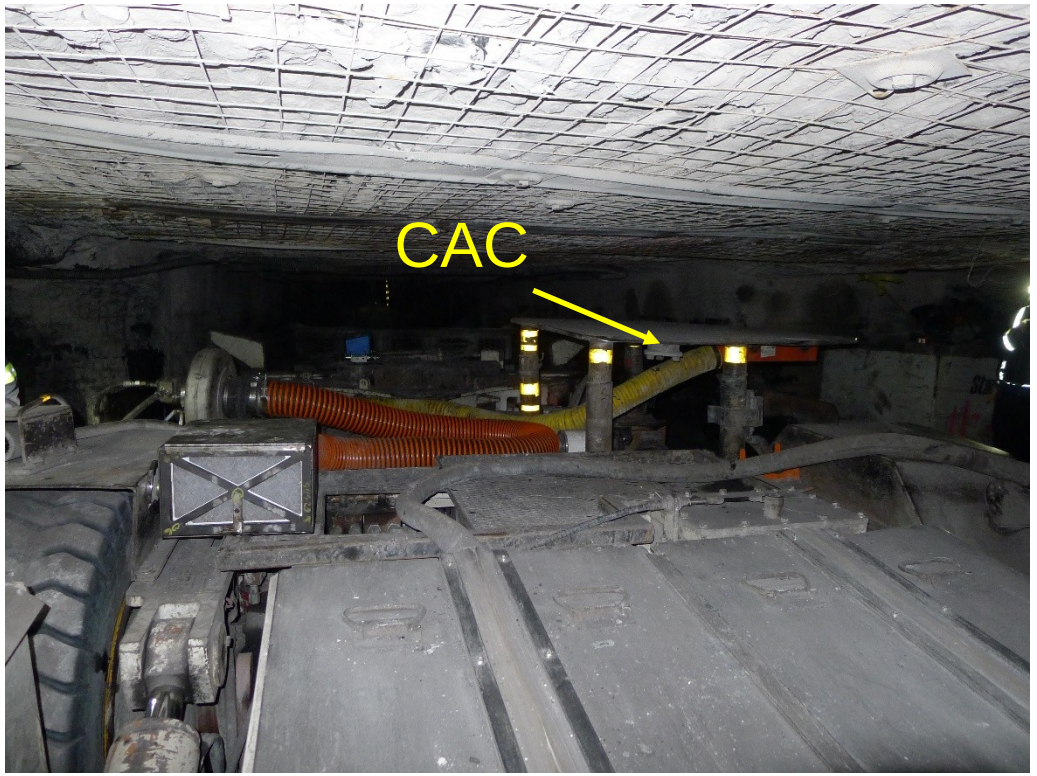
# Canopy air curtain installation on RamCar #1

- Blower
  - Yellow hose connects from blower to plenum
- Hydraulics
  - motors/pumps plumbed into shuttle car hydraulic systems
- Filter box
  - Orange hose connects from filter box to blower inlet

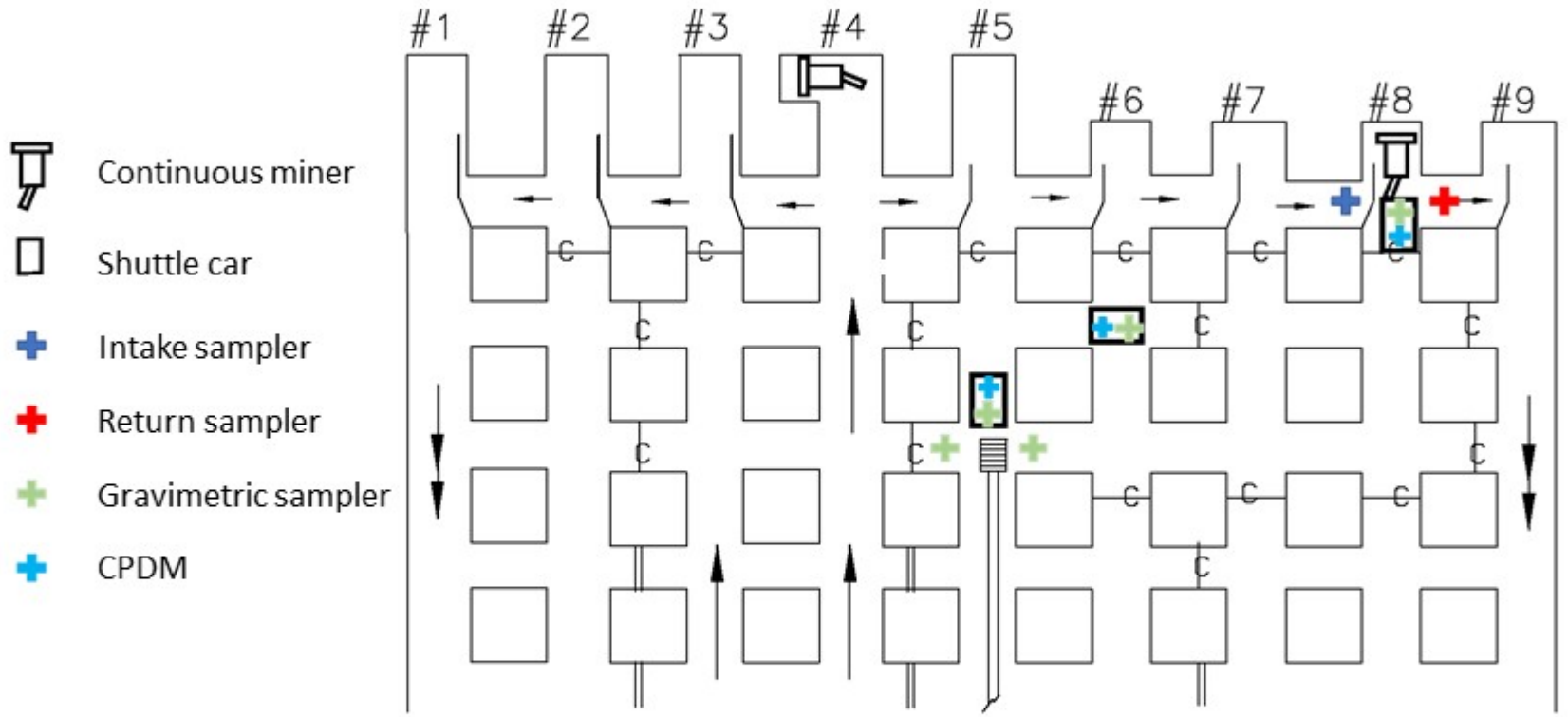



# Canopy air curtain installation on RamCar #1

- Plenum
  - Welded to underside of shuttle car canopy

# Mine Layout with sampling locations



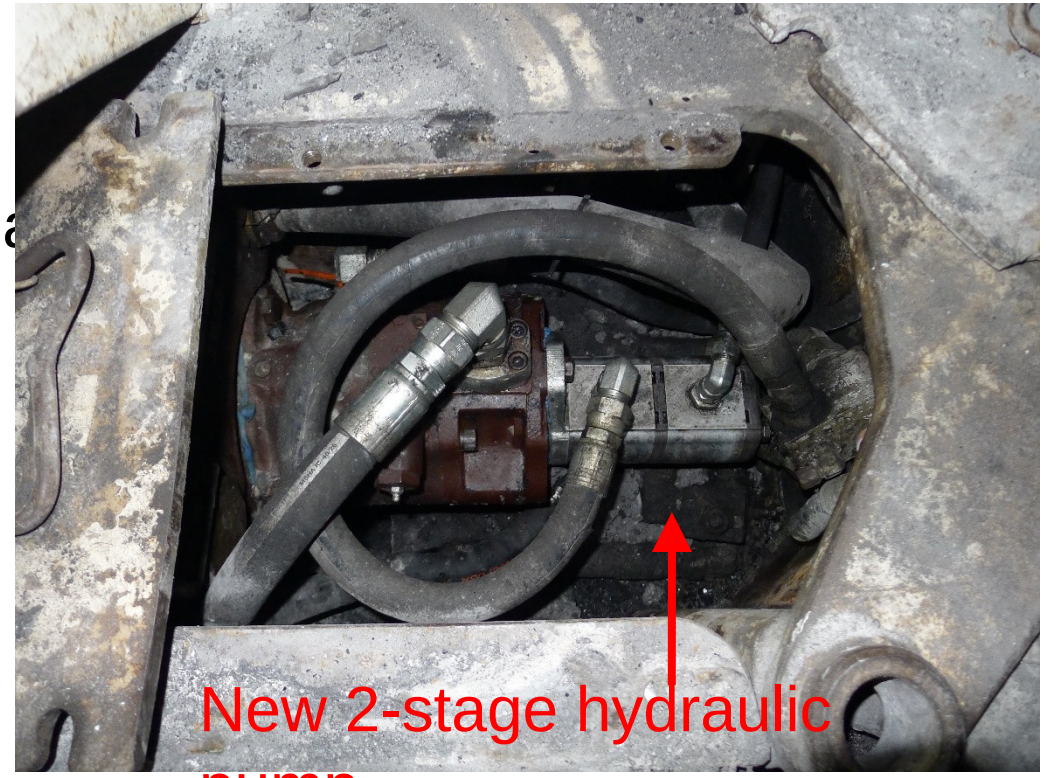
# NIOSH Dust Survey

- At operator underneath canopy
  - Personal Data Ram (pDR-1000)
  - Continuous Personal Dust Monitor (CPDM)
- On RamCar outside canopy
  - NIOSH sampling rack
    - pDR-1000
    - 2 gravimetrics
- At Feeder locations
  - NIOSH sampling rack
- At Continuous Miner
  - NIOSH sampling rack
    - Intake
    - Return


# Test results

- March 2019 testing
  - Canopy air curtain hydraulics plumbed into existing RamCar hydraulic system
    - Canopy blower slowed or shutdown when existing RamCar hydraulic systems in operation
      - Moving Ram during loading/unloading
      - Steering during tramming
  - Required additional pump installed on RamCa

- September 2019 testing
  - Canopy air curtain hydraulics "piggybacked" onto existing RamCar hydraulic system using additional 2-stage hydraulic pump



## Face ventilation quantities

| Date | Entry | Curtain Width (in) | Entry Height (in) | Velocity (fpm) | Quantity (cfm) |
|---|---|---|---|---|---|
| 10-Sep | #9 | 216 | 77 | 275 | 31763 |
| 10-Sep | #6 | 219 | 85 | 165 | 21330 |
| 11-Sep | #6 | 222 | 82 | 110 | 13906 |
| 11-Sep | #8 | 215 | 80 | 269 | 32131 |
| 12-Sep | #9 | 210 | 96 | 202 | 28280 |
| 12-Sep | #6 | 204 | 80 | 117 | 13260 |

## Canopy air curtain airflows

| Date | Canopy airflow (fpm) |
|---|---|
| 10-Sep | 361 |
| 11-Sep | 315 |
| 12-Sep | 185 - 220 |

September 12, 2019 –the hydraulic flow regulator was turned off for night shift

- Regulator knob adjusted prior to the shift to obtain flow
- During the first ¼ of the shift, airflow was approximately 185 fpm
- Regulator adjusted until knob broke off (no more adjustment possible)
- During the last ¾ of the shift, airflow was approximately 229 fpm

# Time (minutes) underneath the canopy air curtain for September 2019 study –RamCar #1

| - | 9/10/2019 | 9/11/2019 | 9/12/2019 |
|---|---|---|---|
| **Time at CM** | 33 | 31 | 20 |
| **Time at Feeder** | 22 | 24 | 15 |
| **Time tramming Feeder to CM** | 55 | 106 | 87 |
| **Time tramming CM to Feeder** | 47 | 65 | 46 |
| **Time underneath** | 157 | 226 | 168 |
| **Total Time** | 379 | 340 | 345 |
| **%of time under** | 41.4 | 66.5 | 48.7 |
| | | | |
| **Time weight average % reduction** | 34% | 31% | NA |

NA -not applicable, dust reductions during tram time statistically insignificant

# RamCar results for respirable dust sampling

| Date | Outside MRE concentration (mg/m3) | Underneath MRE PDM concentration (mg/m³) | %reduction inside /outside comparison of MRE | Total sampling time (min) |
|---|---|---|---|---|
| **10-Sep-19** | 1.118 | 0.873 | 14.81 | 379 |
| | 0.930 | | | |
| **11-Sep-19** | 0.864 | 0.693 | 23.23 | 340 |
| | 0.941 | | | |
| **12-Sep-19** | 1.124 | 1.074 | 8.05 | 345 |
| | 1.213 | | | |

# Average concentration of instantaneous data measured by pDR-1000 at each location encountered for RamCar #1 (w/ CAC)

| Date | Location | Outside CAC Average Concentration (mg/m³) | Confidence Interval @ 95% | Underneath CAC Average Concentration (mg/m³) | Confidence Interval @ 95% | Percent reduction (%) | |
|---|---|---|---|---|---|---|---|
| 10-Sep | @ CM | 2.821 | ± 0.872 | 0.996 | ± 0.433 | 65% | High CAC Airflow |
| | @ Feeder | 0.433 | ± 0.084 | 0.277 | ± 0.078 | 36% | |
| | Tramming Feeder to CM | 0.581 | ± 0.081 | 0.425 | ± 0.071 | 27% | |
| | Tramming from CM to Feeder | 0.658 | ± 0.135 | 0.523 | ± 0.105 | 21% | |
| 11-Sep | @ CM | 2.829 | ± 0.725 | 1.009 | ± 0.400 | 64% | |
| | @ Feeder | 0.223 | ± 0.033 | 0.144 | ± 0.015 | 35% | |
| | Tramming Feeder to CM | 0.630 | ± 0.085 | 0.503 | ± 0.080 | 20% | |
| | Tramming from CM to Feeder | 0.975 | ± 0.166 | 0.824 | ± 0.163 | 15% | |
| 12-Sep | @ CM | 4.524 | ± 2.089 | 1.952 | ± 1.208 | 57% | Low CAC Airflow |
| | @ Feeder | 0.601 | ± 0.343 | 0.329 | ± 0.094 | 45% | |
| | Tramming Feeder to CM | 1.540 | ± 0.797 | 1.483 | ± 0.715 | 4% | |
| | Tramming from CM to Feeder | 1.799 | ± 0.612 | 1.981 | ± 0.779 | -10% | |

# Conclusions

- **The CAC can provide improved protection for operator in blowing face ventilation.**
- **57% - 65% reduction** of respirable dust concentrations while CM loading RamCar
- **35% - 45% reduction** of respirable dust concentrations while unloading RamCar
- **20% - 27% reduction** of respirable dust concentrations while tramming

- Time underneath canopy ranged from 41% - 66% total time
- Relationship of higher plenum air velocities providing higher protection

# Methods to improve performance

- Maintain high airflow through plenum
- Change filter when needed.
  - Filter was the filter from March testing (used 3 days)
  - Filter was not changed throughout testing
- Add 2-3” lip around perimeter of plenum
- Effective for protection when operator is underneath the canopy

# For answers to questions, contact

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NIOSH Mining Program