

Conveyor Belt Flammability Tests

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Acknowledgements

- PRL personnel that contributed to the Flammability of Mine Materials Project
- MSHA personnel from the Approval and Certification Center
- Conveyor belt manufacturers

Outline

- Conveyor Belt Fires
- Current Federal Flame Test for Conveyor Belting, 30 CFR 18.65
- Large-Scale Gallery Fire Test
- Laboratory-Scale Fire Test – BELT
- Outcomes
- Other related studies

Conveyor Belt Entry Fires 1980-2006

Underground Coal Mines

MSHA Data

65 Fires

- Frictional heating
- Flame cutting and welding
- Electrical malfunctions

Conveyor Belt Fires



Conveyor Belt Fires

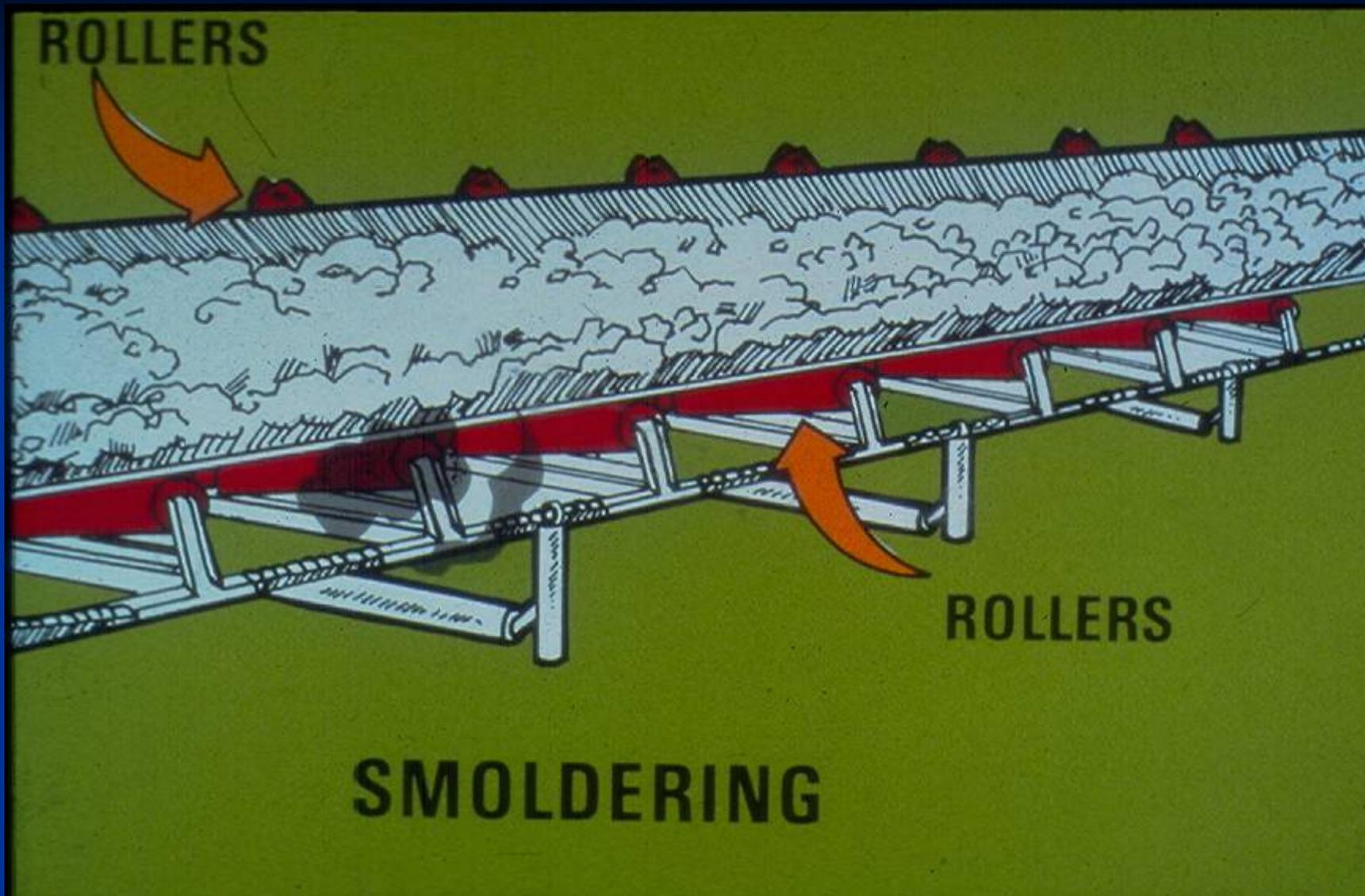
| Year | Mine | State |
|------|-----------------|------------|
| 1986 | Florence No. 1 | PA 1 fatal |
| 1987 | Beckley | WV |
| 1988 | Marianna No. 58 | PA |
| 1994 | Bullitt | VA |



Conveyor Belt Fires

| Year | Mine | State |
|------|-------------------|-----------------|
| 2002 | Blacksville No. 2 | WV |
| 2003 | VP No. 8 | VA |
| 2003 | Mine 84 | PA |
| 2005 | Buchanan | VA |
| 2005 | Powhatan No. 6 | OH |
| 2006 | Aracoma | WV 2 fatalities |
| 2006 | Oak Grove | AL |





Bullitt Mine Fire

- Conveyor belt ignited by contact with trolley line
- 31 miners walked about 2 miles out of the mine
- 4 miners treated for smoke inhalation

CFR Title 30 – Parts 1 to 199

- Suppression systems in drive areas
 - automatic sprinkler
 - water deluge
 - dry chemical powder
 - fire-fighting foam
- Slippage and sequence switches

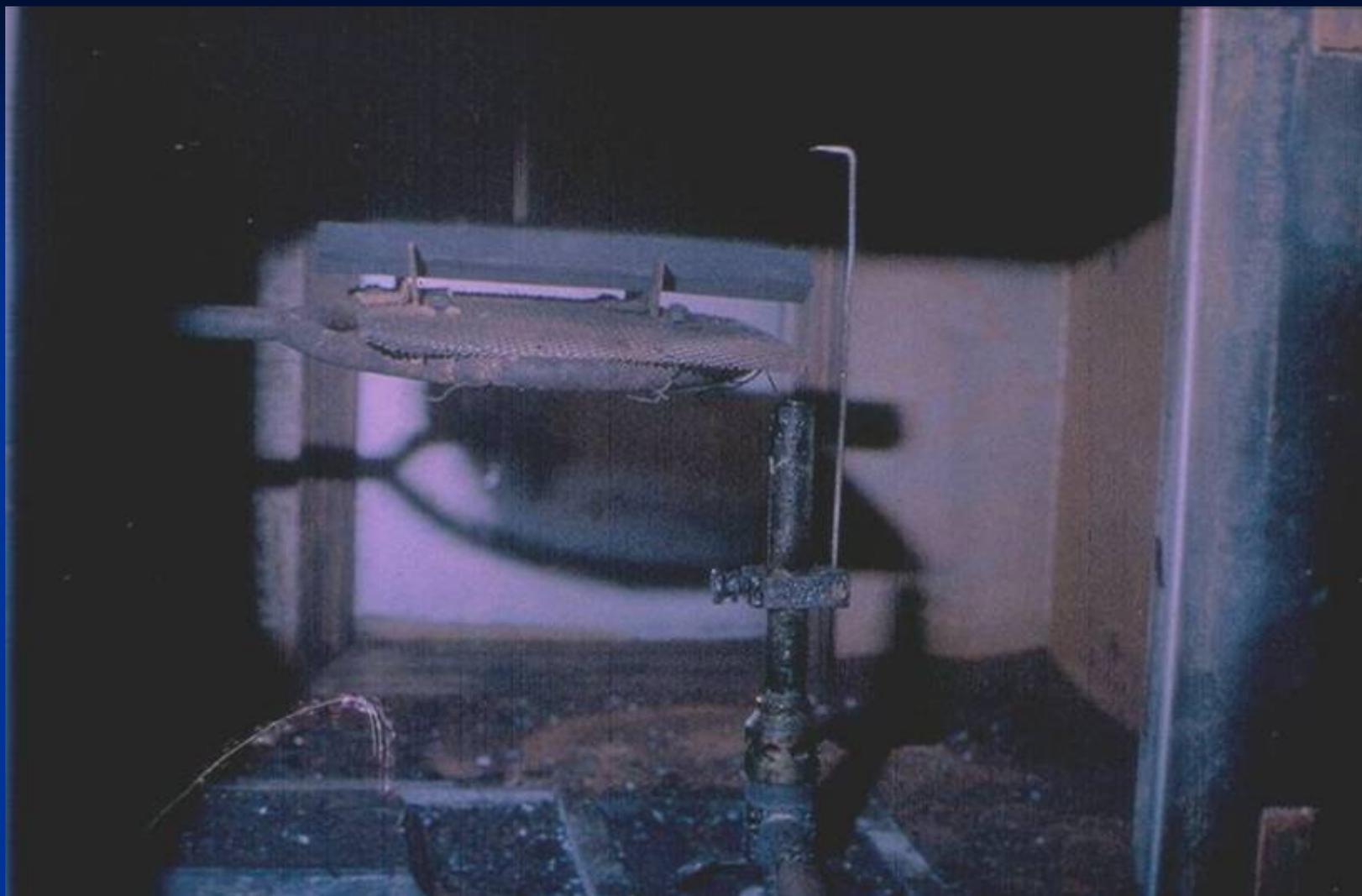
CFR Title 30 – Parts 1 to 199

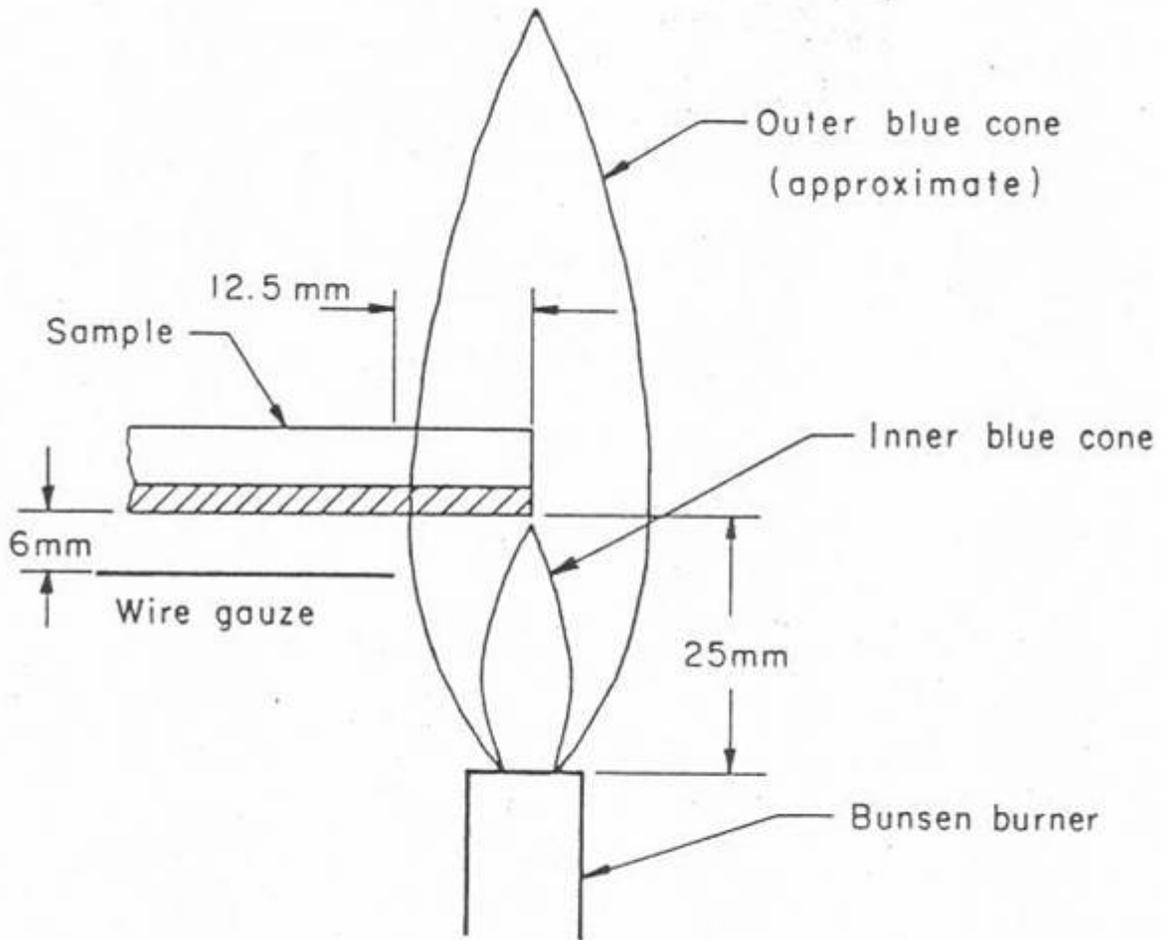
- Fire detectors along beltlines
 - point type heat sensors
 - CO sensors
 - smoke sensors
- Fire hydrants (300-ft intervals) and fire-fighting equipment
- *Flame-Resistant Conveyor Belting*

Current Flame Test for Conveyor Belting and Hose

30 CFR 18.65 (Schedule 28, 2G)





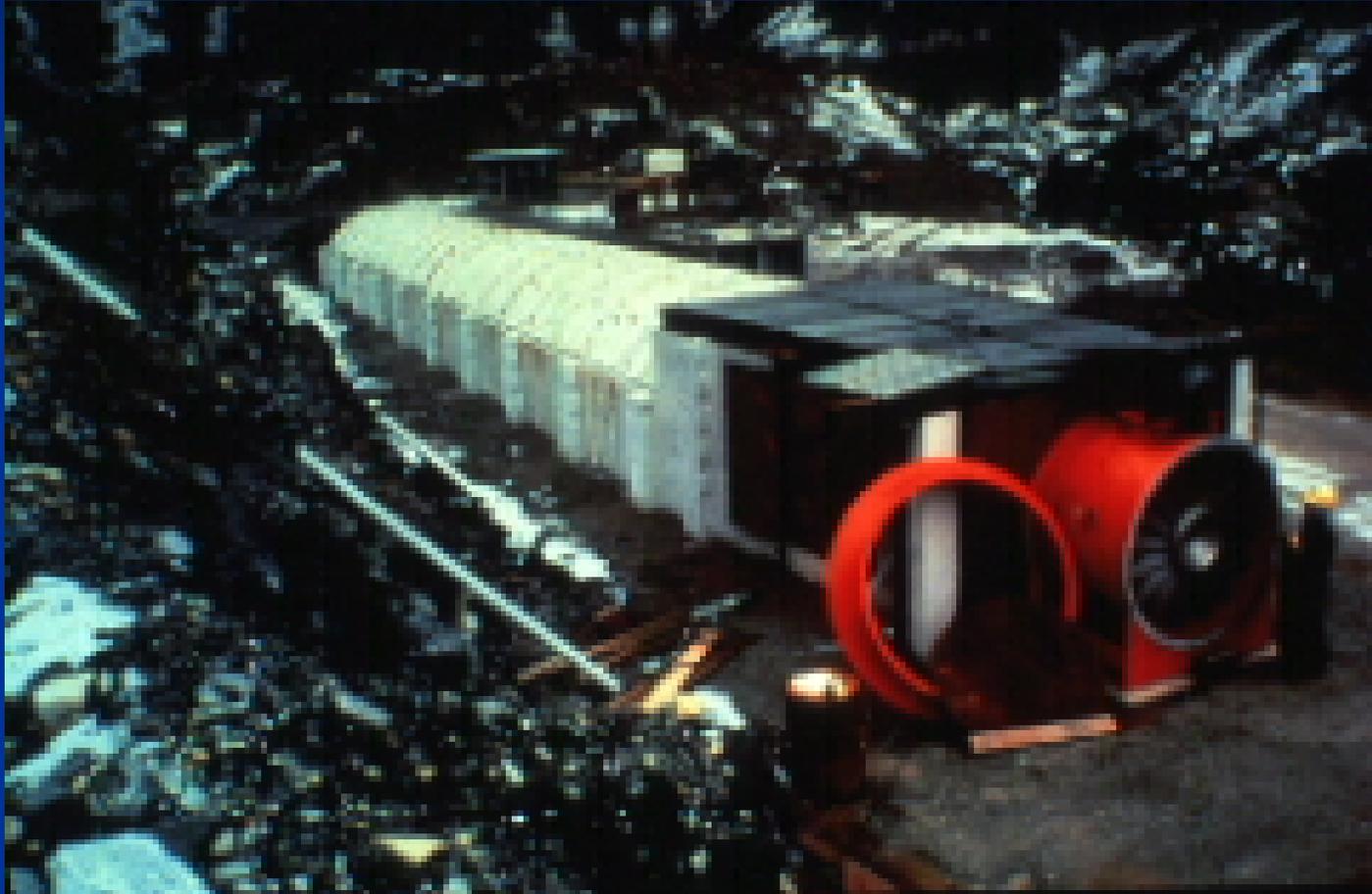


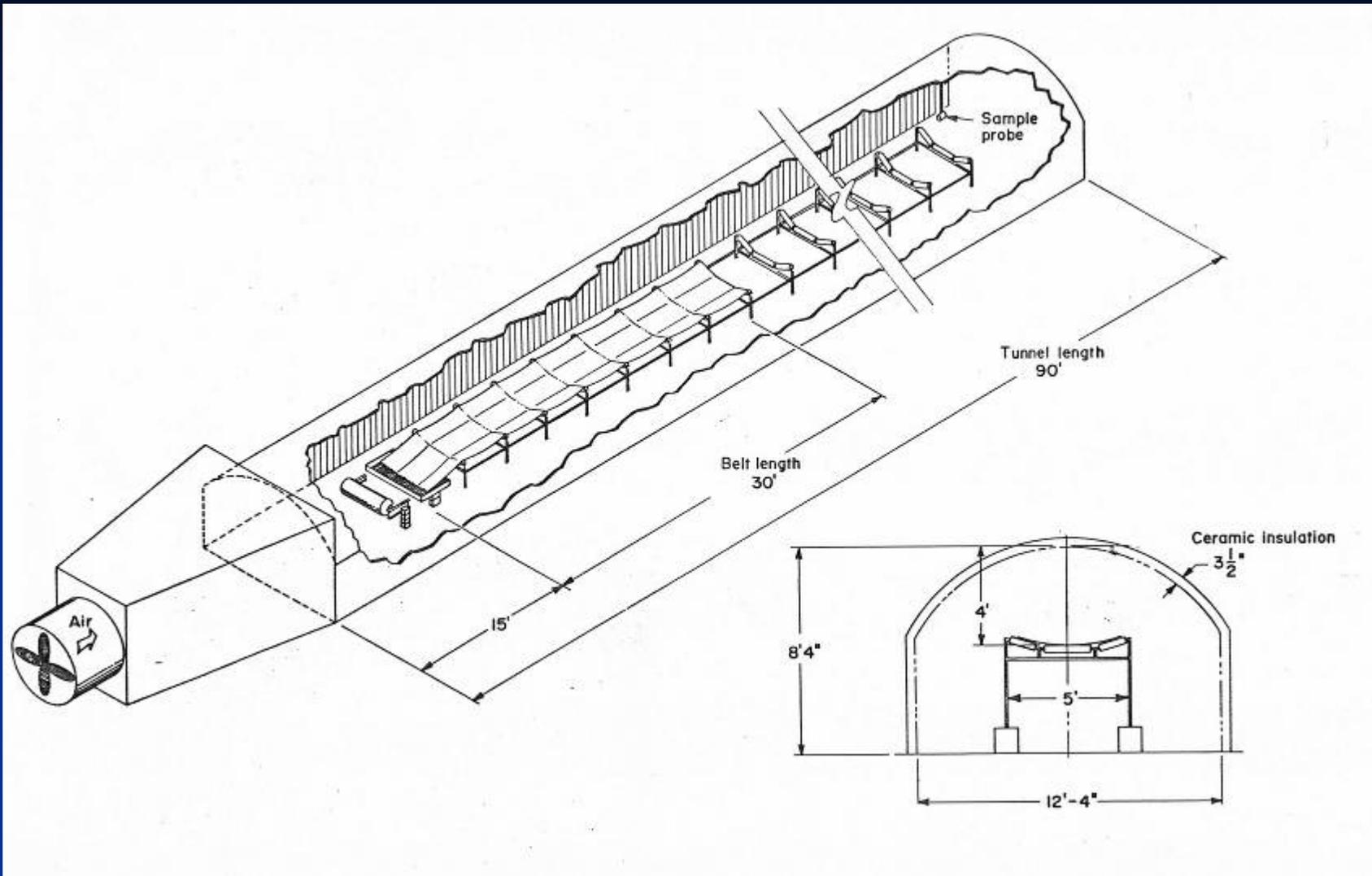
Side view

Flame Test for Conveyor Belting

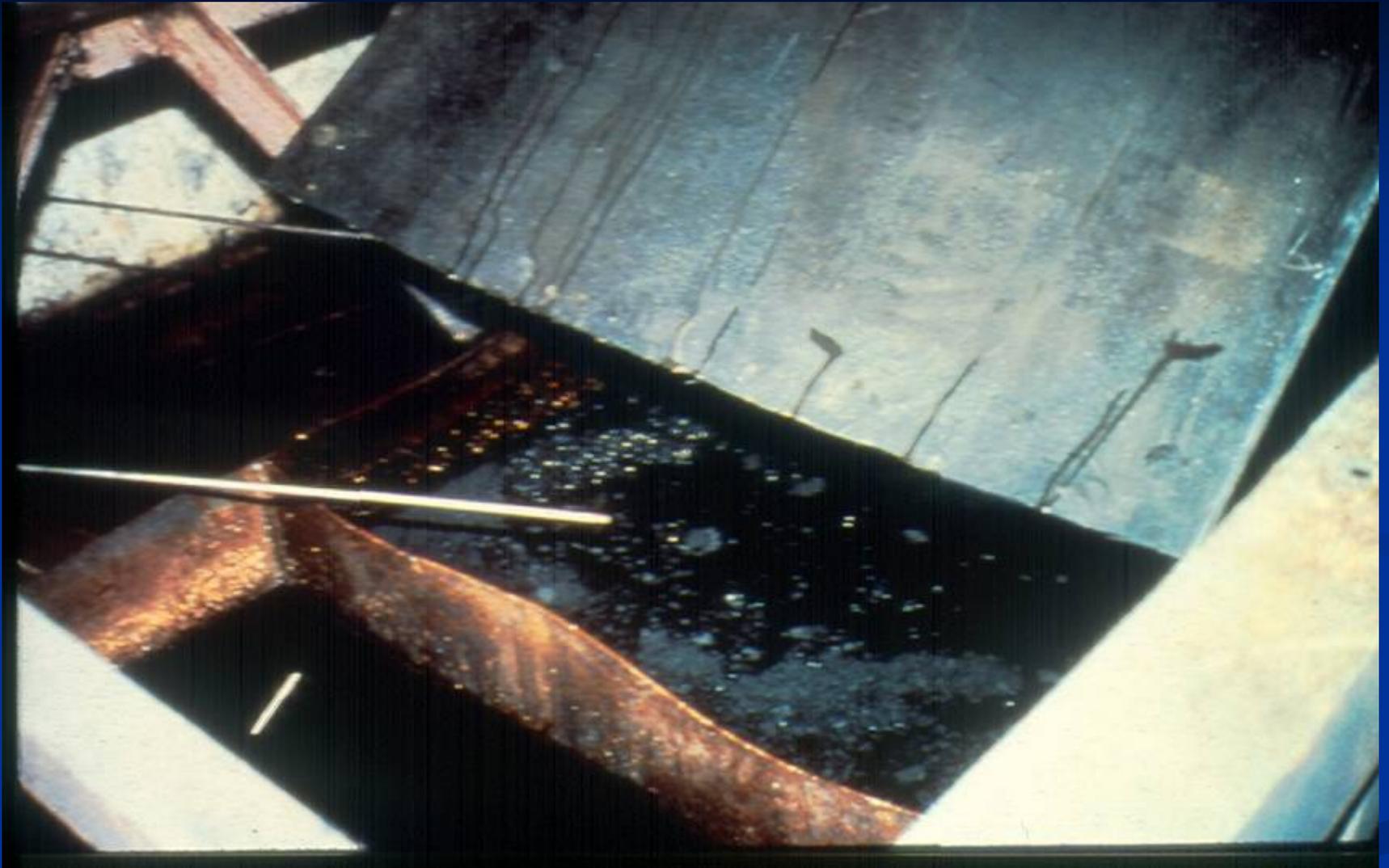
- Belt passes if average flame duration is less than 1 minute or average afterglow is less than 3 minutes
- Labeled: Fire-Resistant USMSHA
No. 28/xx/xx

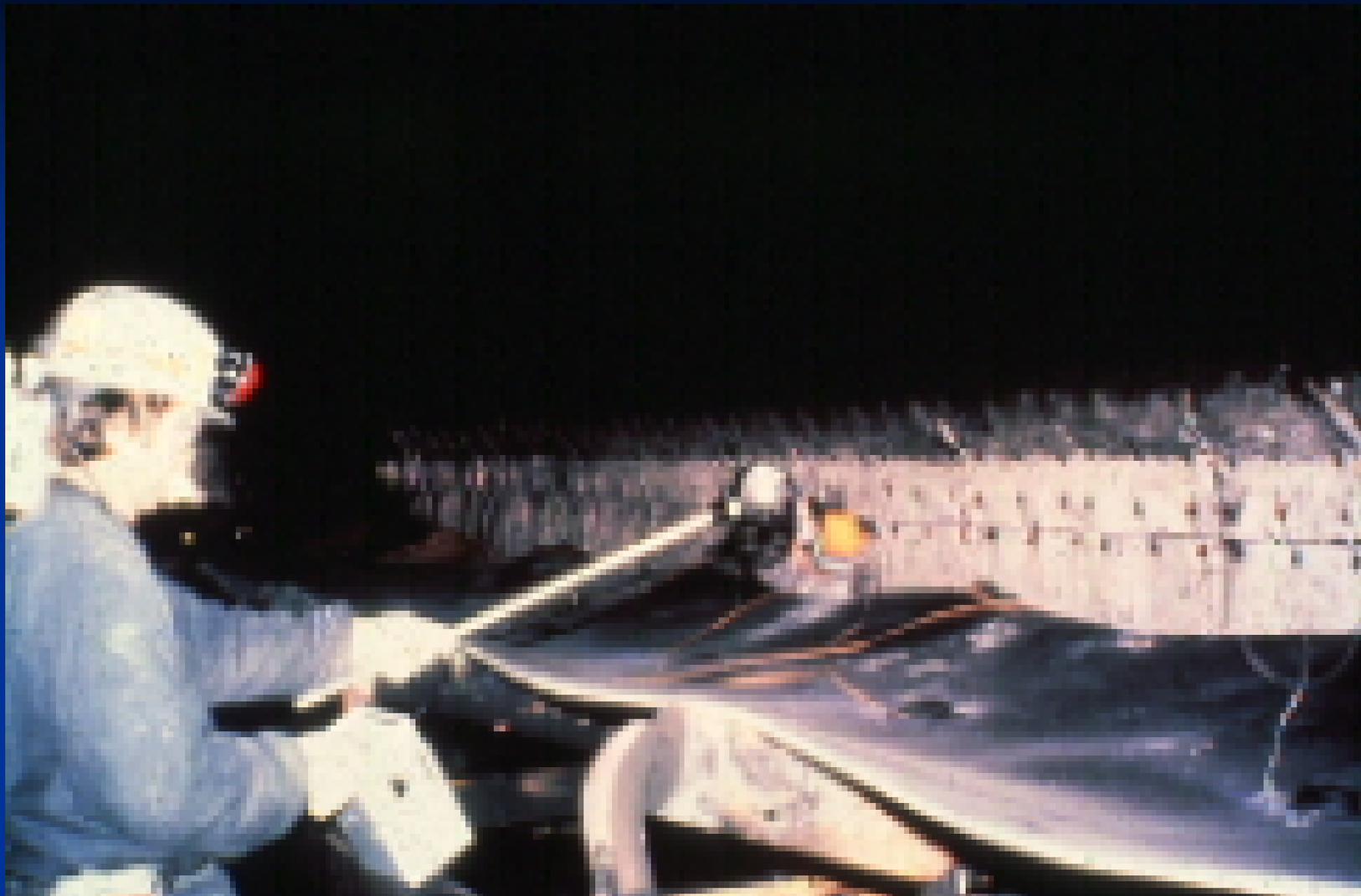
Large-Scale Gallery Fire Test







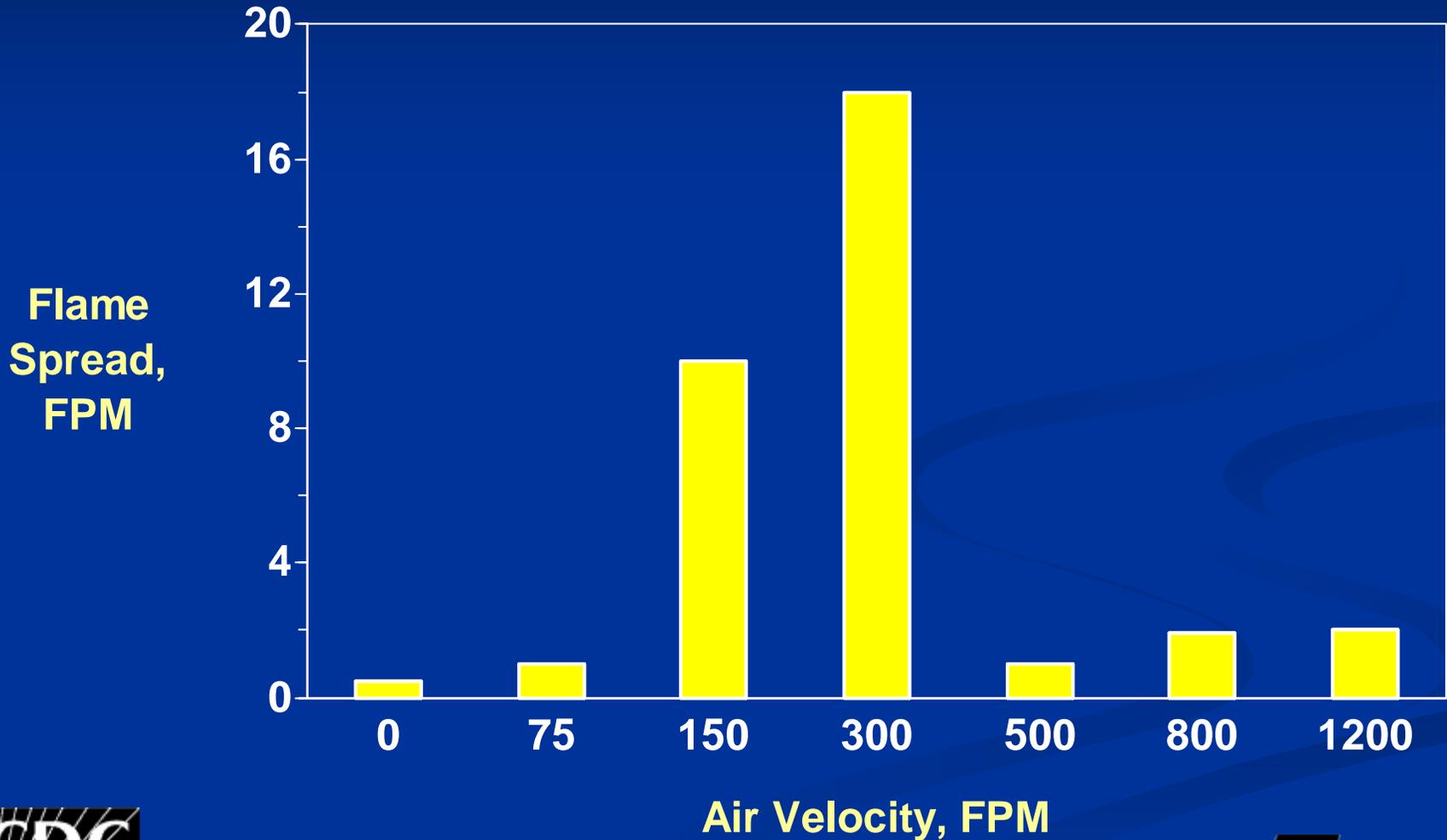




Large-Scale Gallery Fire Test

- Sample: 42-in-wide by belt thickness by 30-ft-long
- Sample to roof distance: 4 ft
- Airflow: 300 FPM (24,200 CFM)
- Igniter: 2 gallons of liquid fuel in a 2-ft by 3-ft tray

Flame Spread, Belt R11



21 Conveyor Belts Tested

- 13 synthetic rubber
- 8 polyvinyl chloride
- 2 of the belts were slightly worn
- 19 of the 21 belts passed the current Federal flame test for conveyor belting



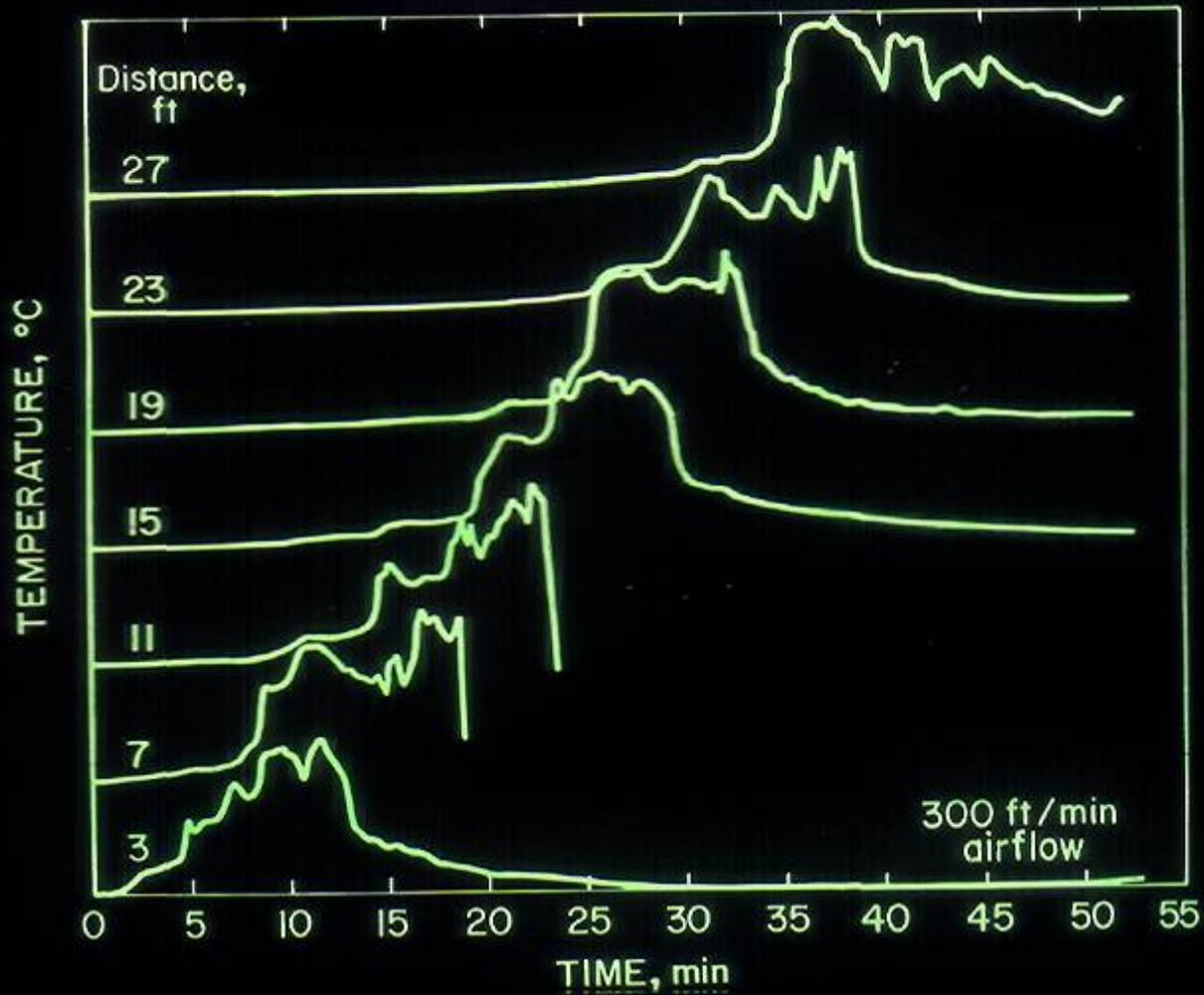


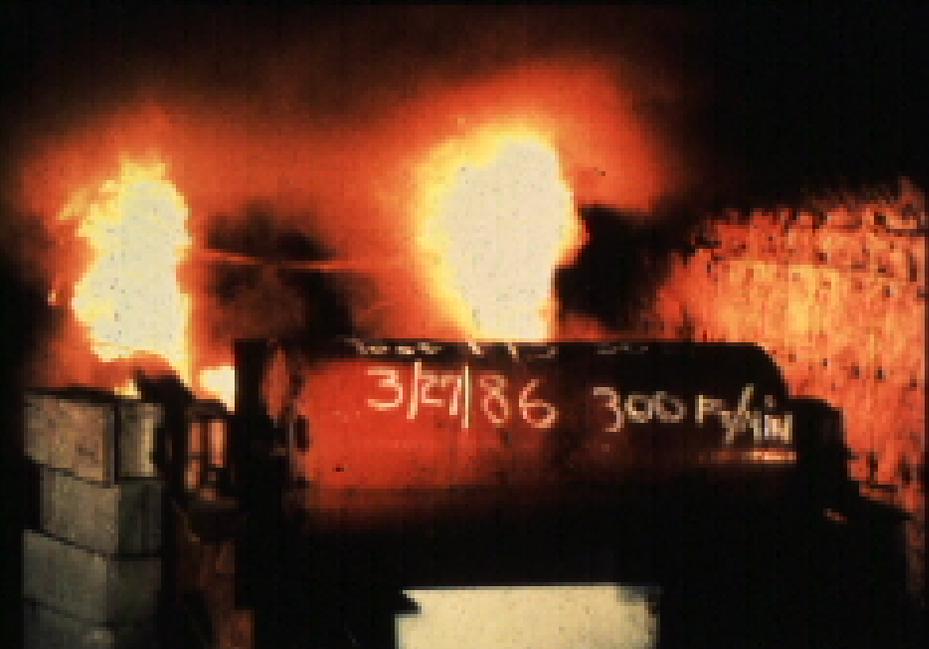






RUBBER BELTING



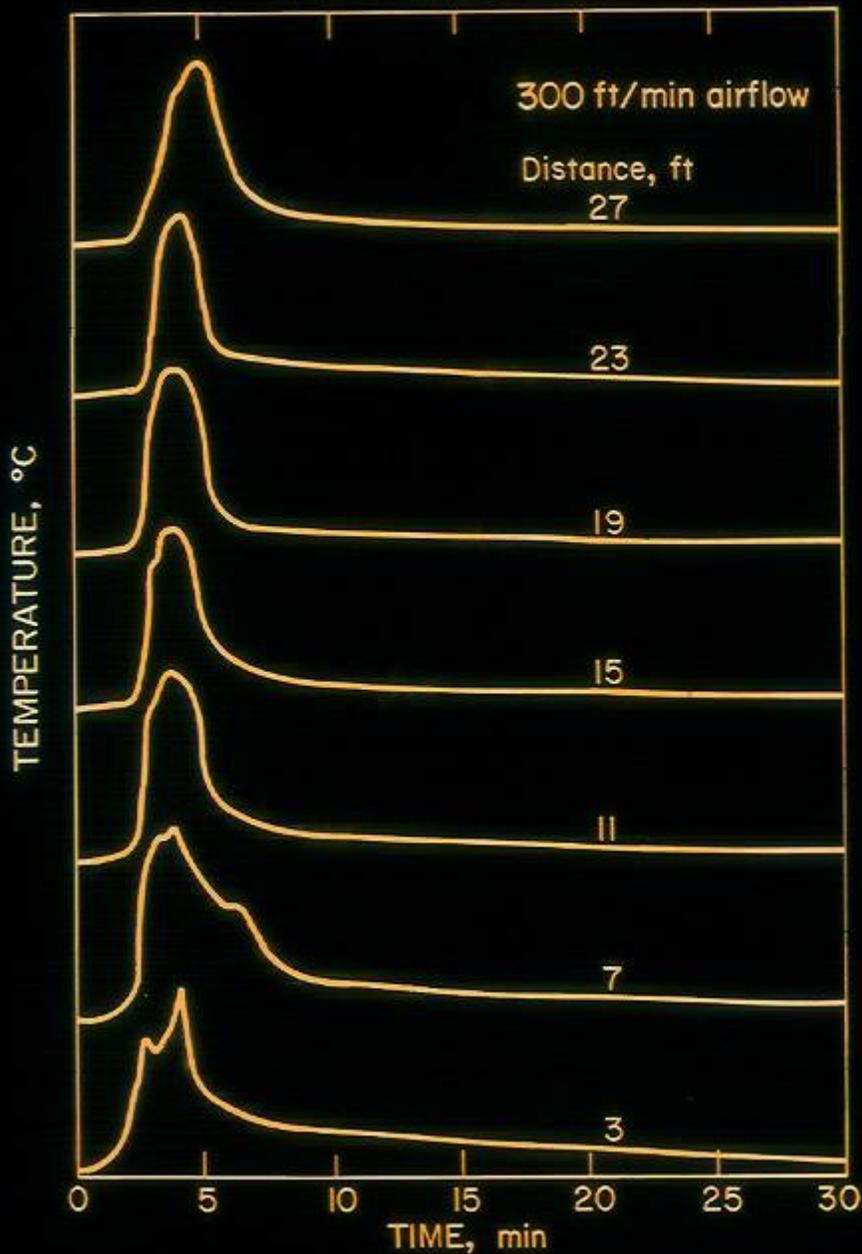




CDC

NIOSH

PVC BELTING





Rubber Belt Test Results

300 FPM Airflow

| Belt | Flame Spread, FPM | Maximum Temp., °C | Maximum Fire Size, Mwatt |
|------|-------------------|-------------------|--------------------------|
| R7 | 15 | 448 | 6.3 |
| R9 | 4 | 287 | 2.7 |
| R10 | NP | 130 | 1.3 |
| R11 | 18 | 391 | 5.4 |

PVC Belt Test Results

300 FPM Airflow

| Belt | Flame Spread, FPM | Maximum Temp., °C | Maximum Fire Size, Mwatt |
|------|-------------------|-------------------|--------------------------|
| P1 | 22 | 394 | 3.0 |
| P2 | 21 | 275 | 2.3 |
| P3 | NP | 164 | 0.7 |

Flammability Performance

- Rapid flame spread >12 FPM; complete destruction (7 belts)
- Rapid flame spread; top surface charred, bottom surface undamaged (4 belts)
- Slow flame spread; complete destruction (4 belts)
- Non-propagating fire; limited damage (6 belts)

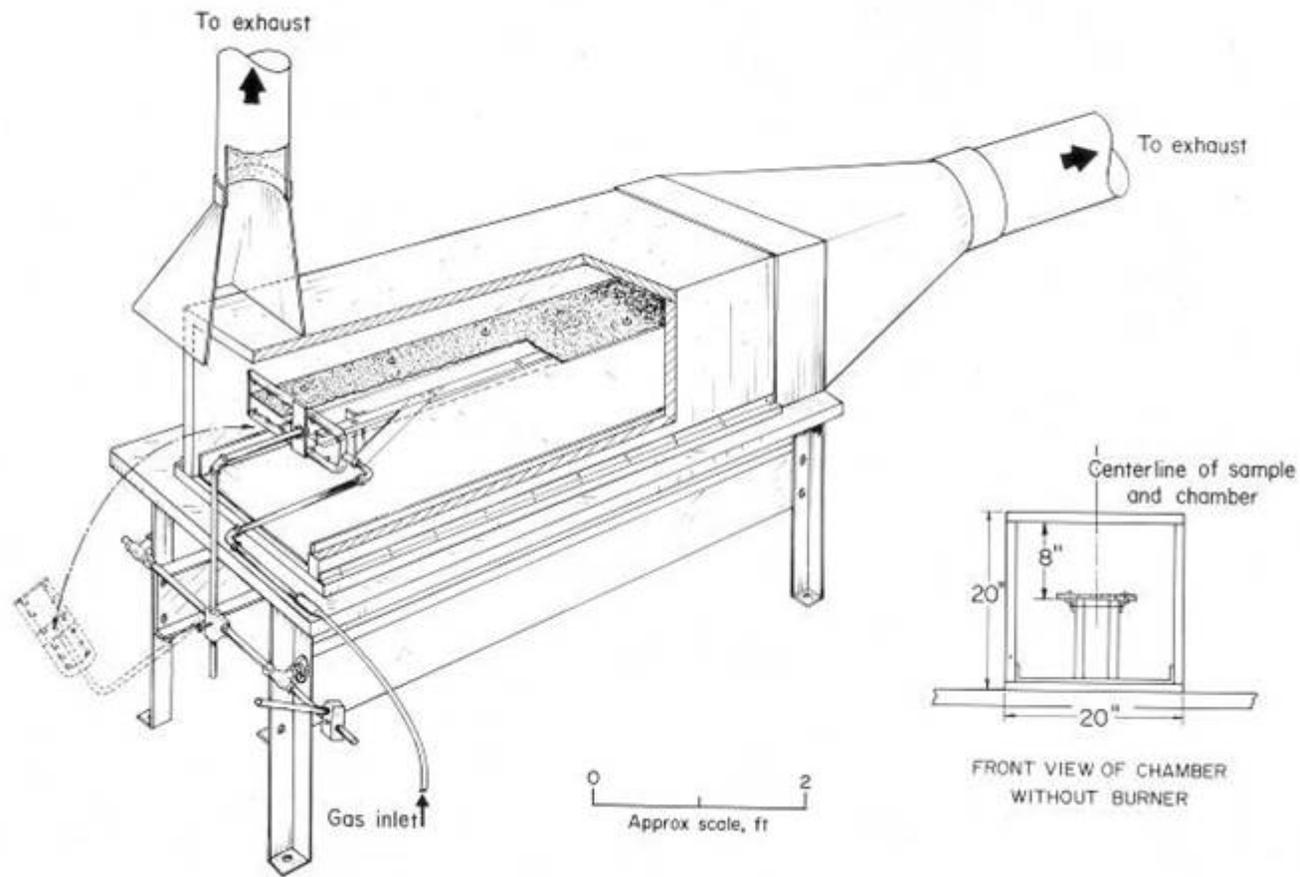
Large-Scale Gallery Test

Belt passed if fire damage did not extend to the end of the 30-ft-long sample

- Rubber belts
 - 11 failed
 - 2 passed
- Polyvinyl chloride belts
 - 4 failed
 - 4 passed

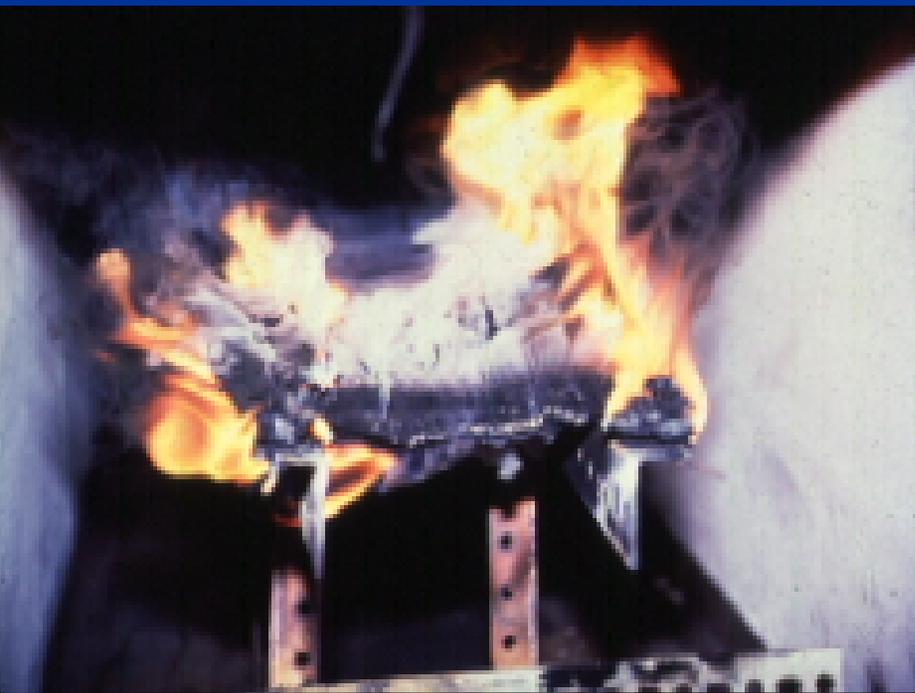
Laboratory-Scale Tunnel Test BELT





Laboratory-Scale Tunnel Test BELT

- Sample: 3 pieces, 9-in-wide by belt thickness by 5-ft-long
- Sample rack to roof distance: 8 inches
- Airflow: 200 FPM
- Igniter: 12 jet gas burner for 5 minutes, 1.2 SCFM gas flow



Laboratory-Scale Tunnel (BELT) versus Large-Scale Gallery

- Pass/fail results agreed for all 13 of the rubber belts tested
- Pass/fail results agreed for 6 of the 8 PVC belts tested
- Overall pass/fail results agreed for 19 of the 21 belts tested

CONCLUSIONS

- The majority of currently accepted fire-resistant belts tested failed the large-scale gallery test (13 of 19 belts)
- Laboratory-scale fire test results were in good agreement with large-scale gallery test results
- Belts that pass the laboratory-scale test, BELT, have improved fire resistance

Outcomes

- Another BELT apparatus was constructed and tested by PRL for MSHA
- Public meeting on January 19, 1989, to describe BELT and initiate voluntary evaluation test program
- BELT apparatus fabricated by several belt manufacturers and CANMET



Outcomes

- Favorable evaluation of BELT by CANMET
- Petitions for modification to use belt entry air to ventilate working spaces required improved fire resistant belting as soon as the materials were identified by MSHA and became commercially available
- Notice of proposed rule making; Requirements for Approval of Flame-Resistant Conveyor Belts; December 24, 1992; 57 FR 61254

MSHA Belt Entry Ventilation Review; Report of Findings and Recommendations - 1989

“The primary hazard associated with the belt entry today is the existence of conveyor belting which can be ignited and propagate flame along its length. Belt fires when they reach the propagation stage produce more fire gases and spread faster than the surrounding coal surfaces. The committee believes that the elimination of this major fire source through the introduction of improved belting materials is the single greatest achievement that can be made in reducing the hazards associated with belt entries.” pg. 11



MSHA Belt Entry Ventilation Review; Report of Findings and Recommendations - 1989

“Use of conveyor belts meeting the new and more stringent flammability test developed by the Bureau of Mines would significantly reduce the hazards to miners from conveyor belt fires.” pg. 32



Final Report of the Dept. of Labor's Belt Air Advisory Committee, 1992

Recommendation Number 10, pg. 74

“It is the consensus of the Belt Air Advisory Committee that MSHA proceed rapidly to develop regulations for improved fire resistant belting, including new testing and approval schedules.

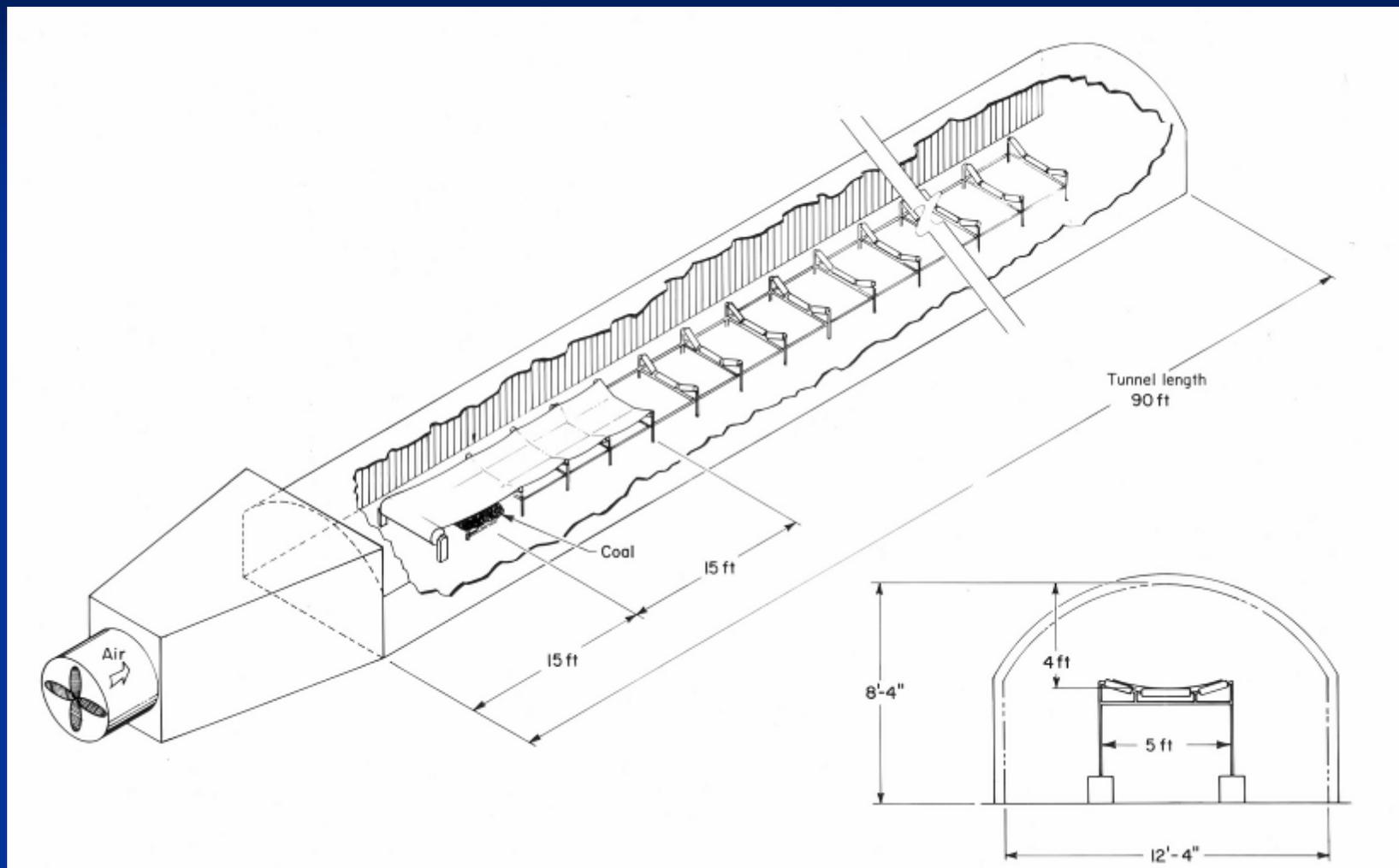
Notwithstanding the scope of the committee charter, the committee recommends that once available, the improved fire resistant belting material should be used in all underground coal mines.”



Other Related Studies

- RI 9380 “Fire Detection for Conveyor Belt Entries” 1991
- RI 9570 “Hazards of Conveyor Belt Fires” 1995

RI 9380





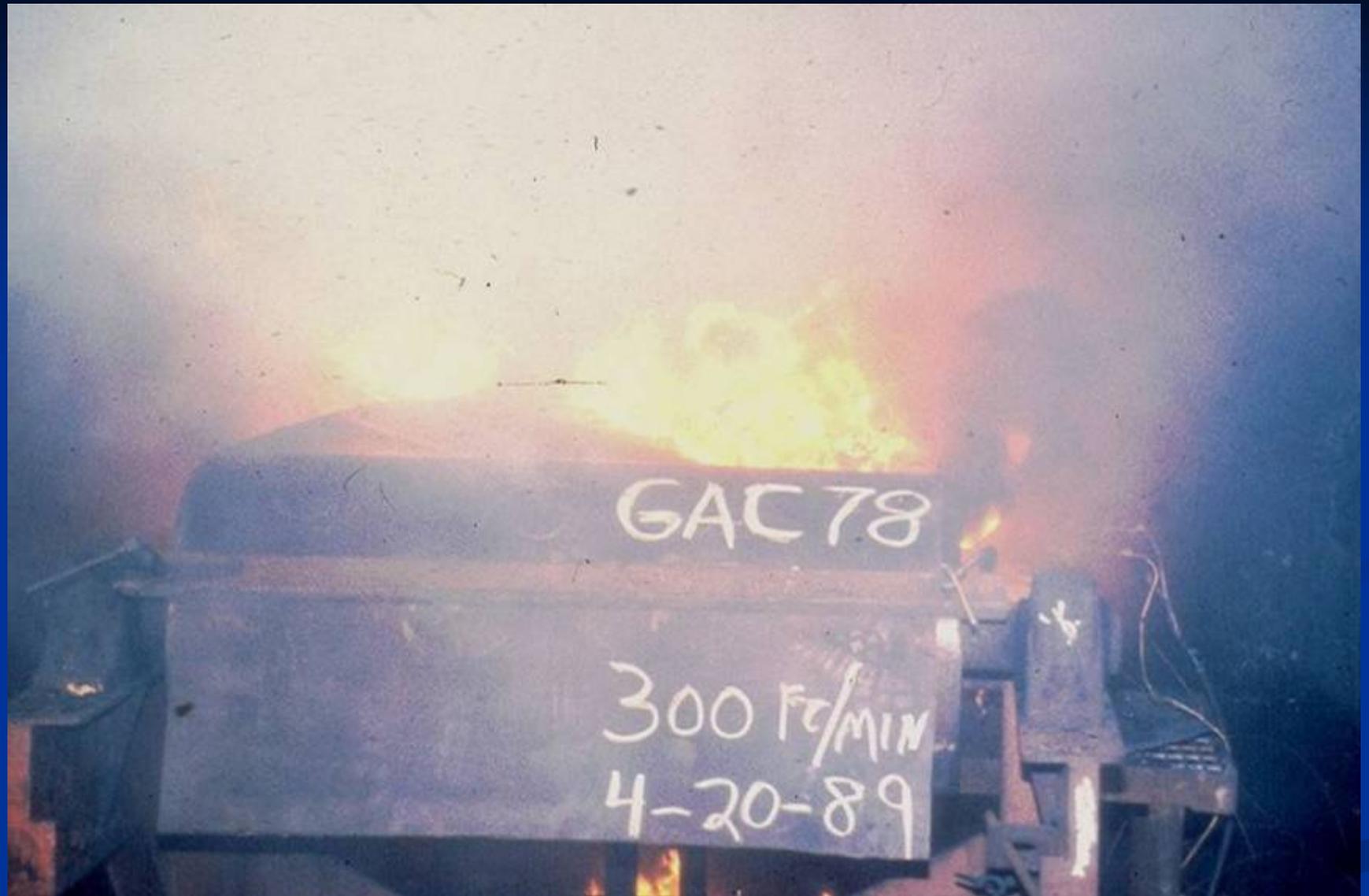








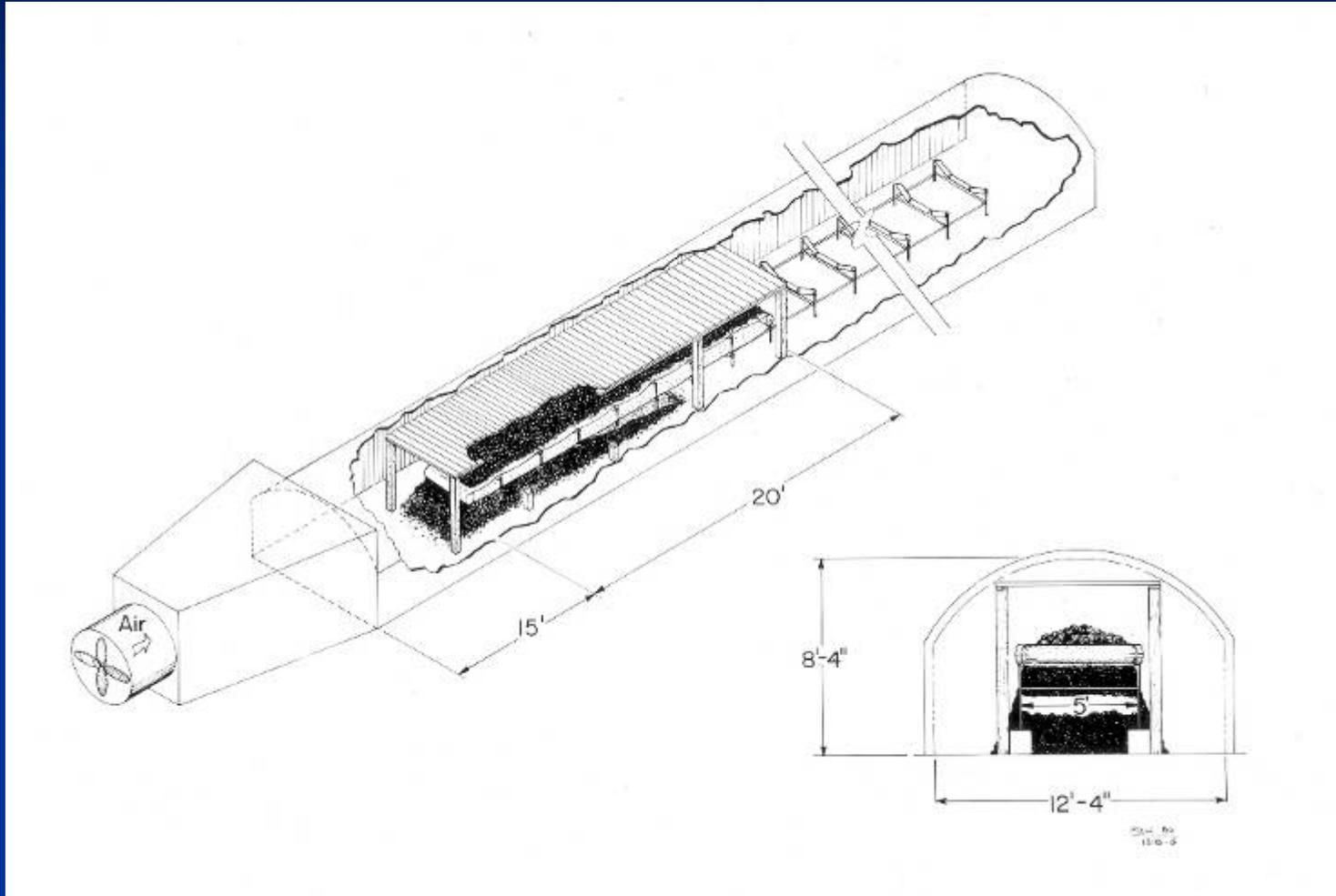




RI 9380 – Belt R11 Ignition Data

| Airflow, FPM | T_{BI} , min | Q_{coal} , kW | $T_{BFS} - T_{BI}$, min |
|-----------------|-------------------|--------------------|-----------------------------|
| 150 | 8.5 | 20 | 15.5 |
| 300 | 26 | 60 | 18.5 |
| 800 | 20 | 95 | 15.5 |

RI 9570



















RI 9570 – Belt R11 Ignition Data

| Avg. Airflow, FPM | Avg. T_{BI} , min | Avg. Q_{coal} , kW | Avg. T_{BFS} , min |
|----------------------|------------------------|-------------------------|-------------------------|
| 150 | 149 ± 10 | 28 ± 11 | 217 ± 28 |
| 315 | 167 ± 5 | 46 ± 14 | 209 ± 35 |
| 807 | 157 ± 78 | 47 ± 29 | 180 ± 31 |

RI 9380 and RI 9570 Findings

- Under these large-scale experimental conditions, a small coal fire (less than 100 kW) ignited a rubber belt that passed the current small-scale flame test
- The belt fire then spread over the belt sample and to nearby combustible materials

A photograph of a tunnel interior, likely a mine or underground passage. The scene is dimly lit with a warm, orange glow from a light source in the distance. Several workers in dark clothing and hard hats are visible, some standing and others near a stretcher or gurney. The tunnel walls are rough and textured. The text "Thank You" is overlaid in the center of the image.

Thank You

