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BEST PRACTICES IN EFFECTIVE VENTILATION OF UNDERGROUND COAL MINES

U.S. PRACTICES AND REGULATIONS

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Mining & Civil Engineers & Geologists

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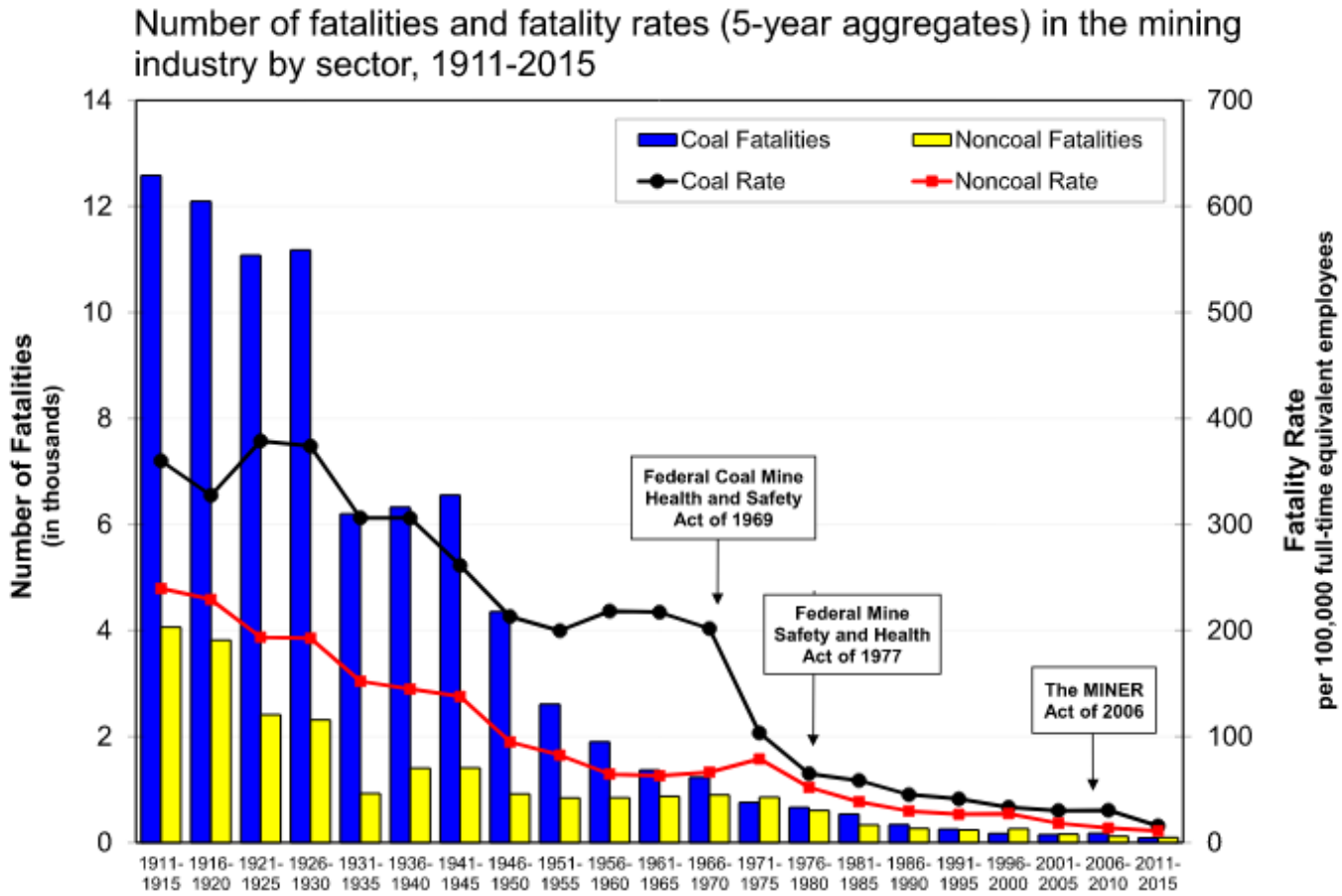
U.S. Mine Fatality History



NOTE: Excludes office employees. Noncoal includes metal, nonmetal, stone, and sand & gravel operations. Sand & gravel miners included starting in 1958. Hours for 1911-1923 computed on assumption that weighted average length of workday was 9.36 hours. Full-time equivalent employees (2,000 hours = 1 FTE employee). Data source: USBM and MSHA

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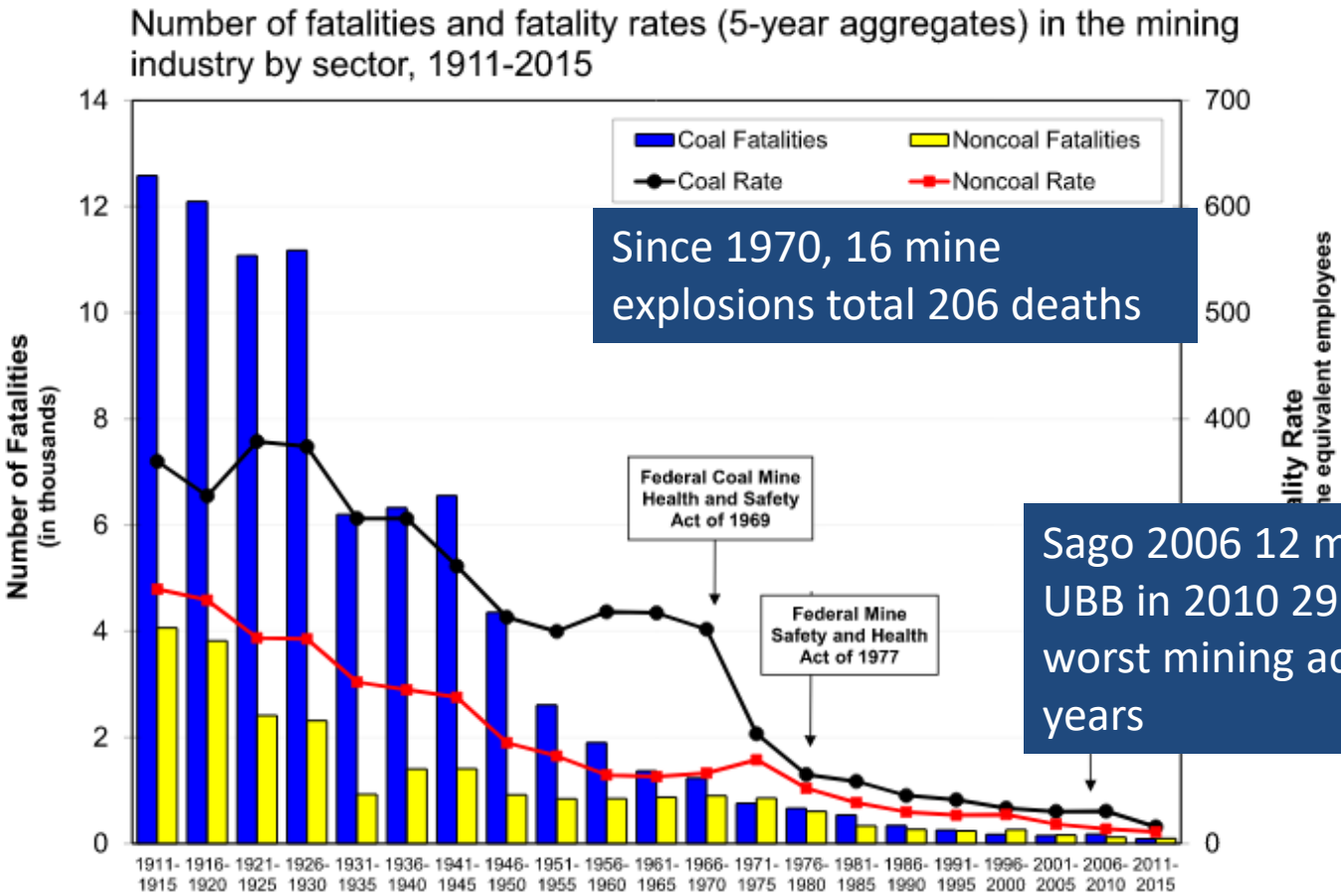
U.S. Mine Fatality History



Since 1970, 16 mine explosions total 206 deaths

Sago 2006 12 miners lost
UBB in 2010 29 lives lost
worst mining accident 40 years

NOTE: Excludes o
miners included sta
9.36 hours. Full-tim

2010 MSHA reported 33 face “ignition or explosion of gas and dust”; 34 reported in 2011.

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History of Regulation of Coal Industry

U.S. Public demand for health and safety after disasters

- US Bureau of Mines
- Federal Coal Mine Health and Safety Act 1969-"Coal Act" followed No. 9 Mine, WV 78 of 99 miners underground were killed in gas and dust explosion
  - Mine Enforcement Safety Administration (MESA)
  - Inspections
  - No smoking or flame sources
  - Ventilation plans
  - Training of miners
  - Separate splits of air
  - Air changes essential personnel only
  - Permissible equipment

History of Regulation of Coal Industry

U.S. Public demand for health and safety after disasters

- Federal Mine Safety and Health Act 1977
  - Coal, metal and non metal mines under single legislation
  - Separate health and safety standards for coal mining
  - MESA becomes MSHA
  - Mandating of miner training
  - Mine rescue teams for all underground mines
  - Increased involvement of miners
- Miner Act of 2006
  - Communications and tracking
  - Civil penalties

U.S. Regulations
Mine Safety Health Administration (MSHA)

- 30 CFR Part 75 Mandatory Safety Standards for Underground Coal
  - Separate split of air to each section exhaust to return §75.332
  - Main fan on surface, explosion proof installation NO BOOSTER
  - Face ventilation installation §75.330
  - Minimum quantities §75.325
  - Methane limits and actions §75.323
  - Intrinsically safe
  - All face equipment built and maintained to be permissible
  - Atmospheric monitoring certified personnel, monitors
  - Fire suppression, combustible materials
  - Seals

U.S. Regulations
Mine Safety Health Administration (MSHA)

- 30 CFR Part 75 Mandatory Safety Standards for Underground Coal
  - Ventilation plan approved by district manager §75.370
  - Escapeways
  - Nearby mines
  - Combustible materials
  - Communications and tracking

U.S. Regulations
Mine Safety Health Administration (MSHA)

§75.325 prescribes the required minimum air quantity for different coal types and mine locations. This information is summarized in Table 1. It should be noted that, in order to meet the mandatory methane and dust control standards, it is usually necessary to maintain higher airflow quantities than these minimum values. In addition to the required minimum air quantities, §75.326 mandates that a mean entry air velocity of at least 60 feet per minute must reach each working face where coal is being cut.

Type of Coal Mine	Bituminous/Lignite Mines	Anthracite Mines
Location within the Mine	Minimum Air Quantity (cubic feet per minute)	Minimum Air Quantity (cubic feet per minute)
Working face where coal is being cut	3,000	1,500
Last open crosscut or end of pillar line	9,000	5,000
Longwall or Shortwall mining systems	30,000*	30,000*

Causes of Methane Explosions
(from Kissell and Goodman 1991)

- Human Factors
  - Ventilation duct at face not close enough
  - Use of scavenger system with inadequate overlap
  - Fan turned off
  - Ductwork leaky or pinched
  - Smoking
  - Methane monitor calibration
  - Equipment permissibility not maintained explosion proof
  - Gas checks not made prior to and during welding

Causes of Methane Explosions
(from Kissell and Goodman 1991)

- Combination of Human Factors and Engineering Specifications
  - Methane monitoring off or not present
  - No other warning system for excess gas
  - Engineering Specifications
  - Ductwork undersized
  - Equipment not explosion-proof by design
- Neither engineering or human factors
  - Cutter pick sparks

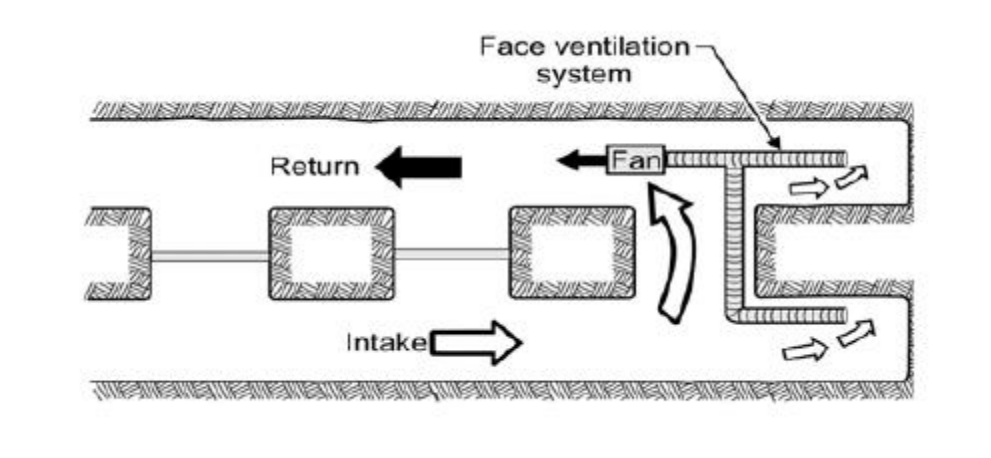
Prevention of Explosions—Three Basic Elements

- Main mine system of intake and return and sweep of working face with fresh air by line brattices or ventilation duct with fan
- Regular monitoring of methane gas concentrations with action levels including equipment shut down
- Ignition sources eliminated

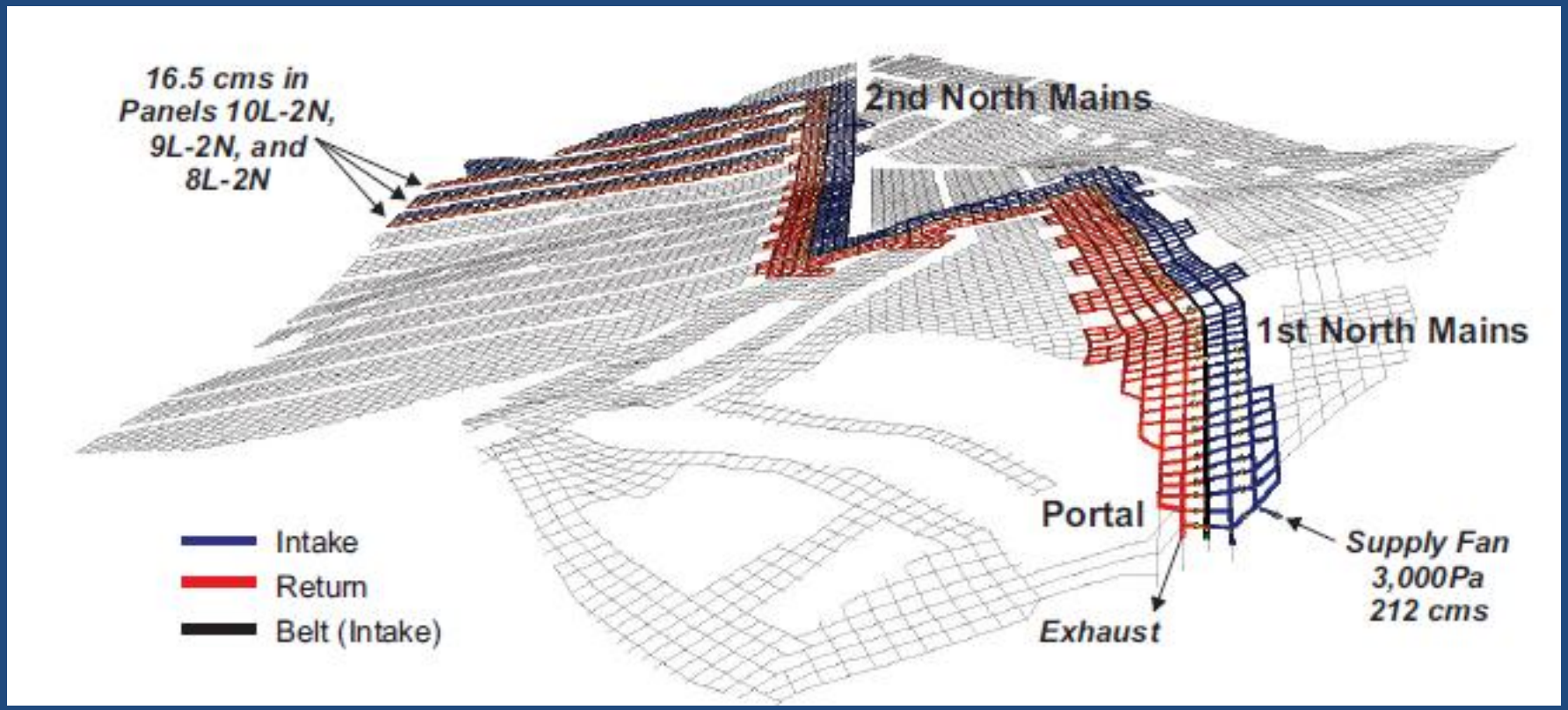
Ventilation Design

- Ventilation adequate if
  - Ample dilution to safe levels. Methane emitted at high concentrations reduce to as far below LEL as soon as possible
  - Main ventilation system circulate air from the portal to sections. Main entries to circulate air at least one for intake and one for return. No duct work or booster fans in mains. Large quantities long distances.
  - Face Ventilation system last hundred meters to face where coal is broken and removed.

VENTILATION



Room and Pillar Mine with Pillar Recovery



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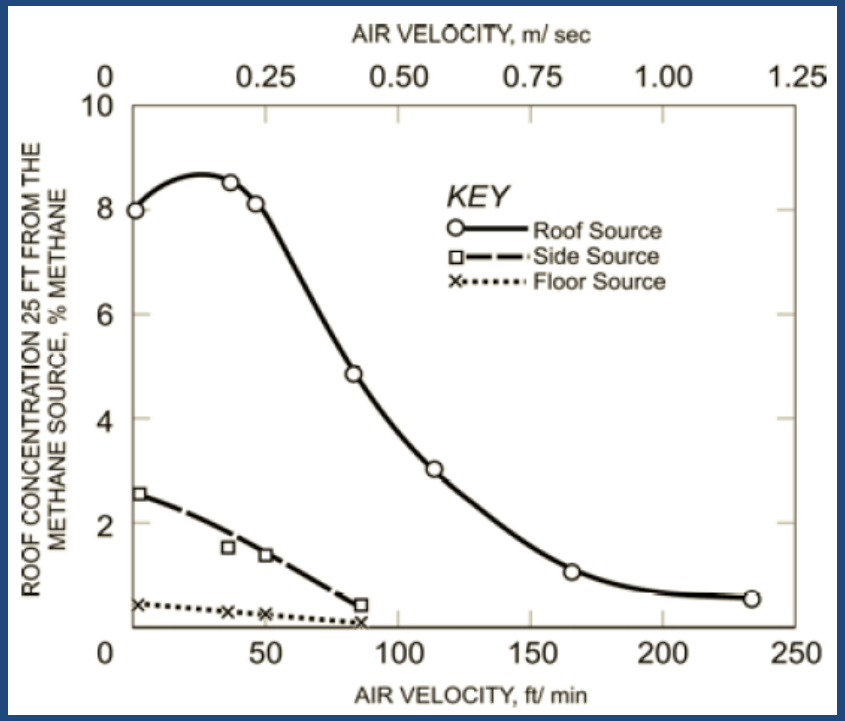
Main Ventilation System

- At least one intake and one return
- Large quantities
- Air velocity greater than 100 fpm



Methane layering with roof, side, and floor sources
(from Bakke and Leach [1962]

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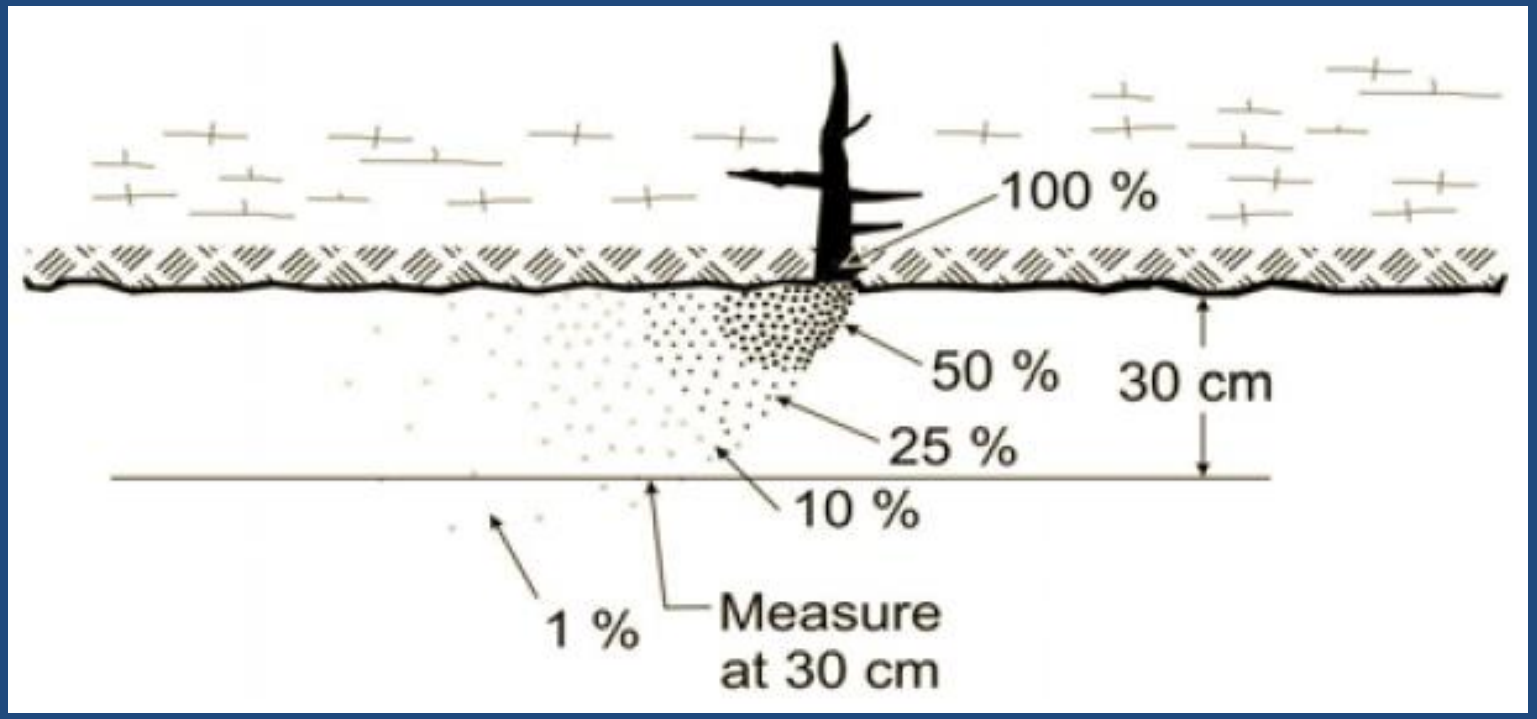
MONITORING



Depiction of methane being diluted into a moving air stream. Methane explosive range 5-15% in greater than 12% oxygen.

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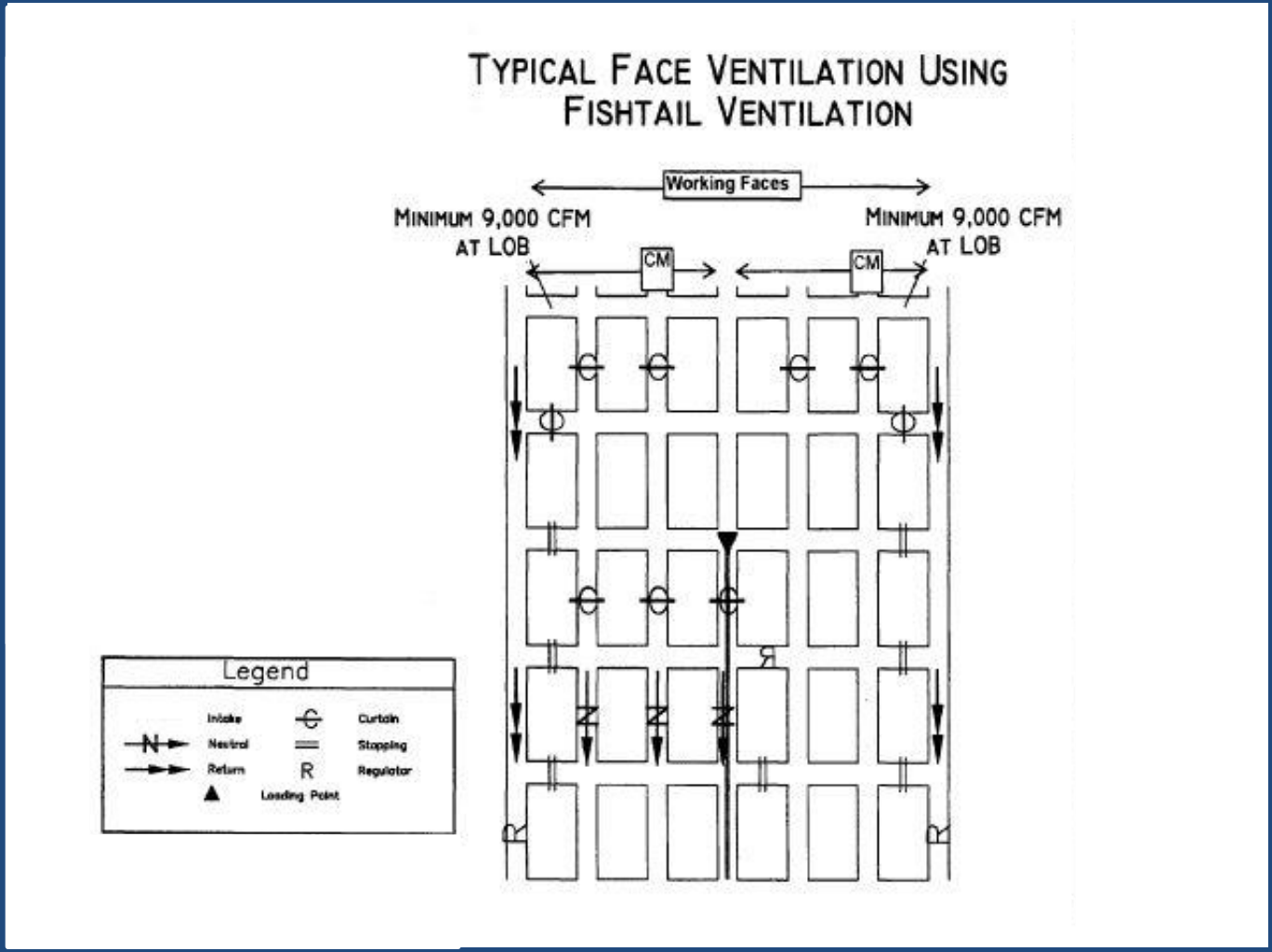
Velocity

Low air velocities can lead to poor mixing between methane and air. Poor mixing leads to fluctuations in the methane concentration that makes ignition more likely.

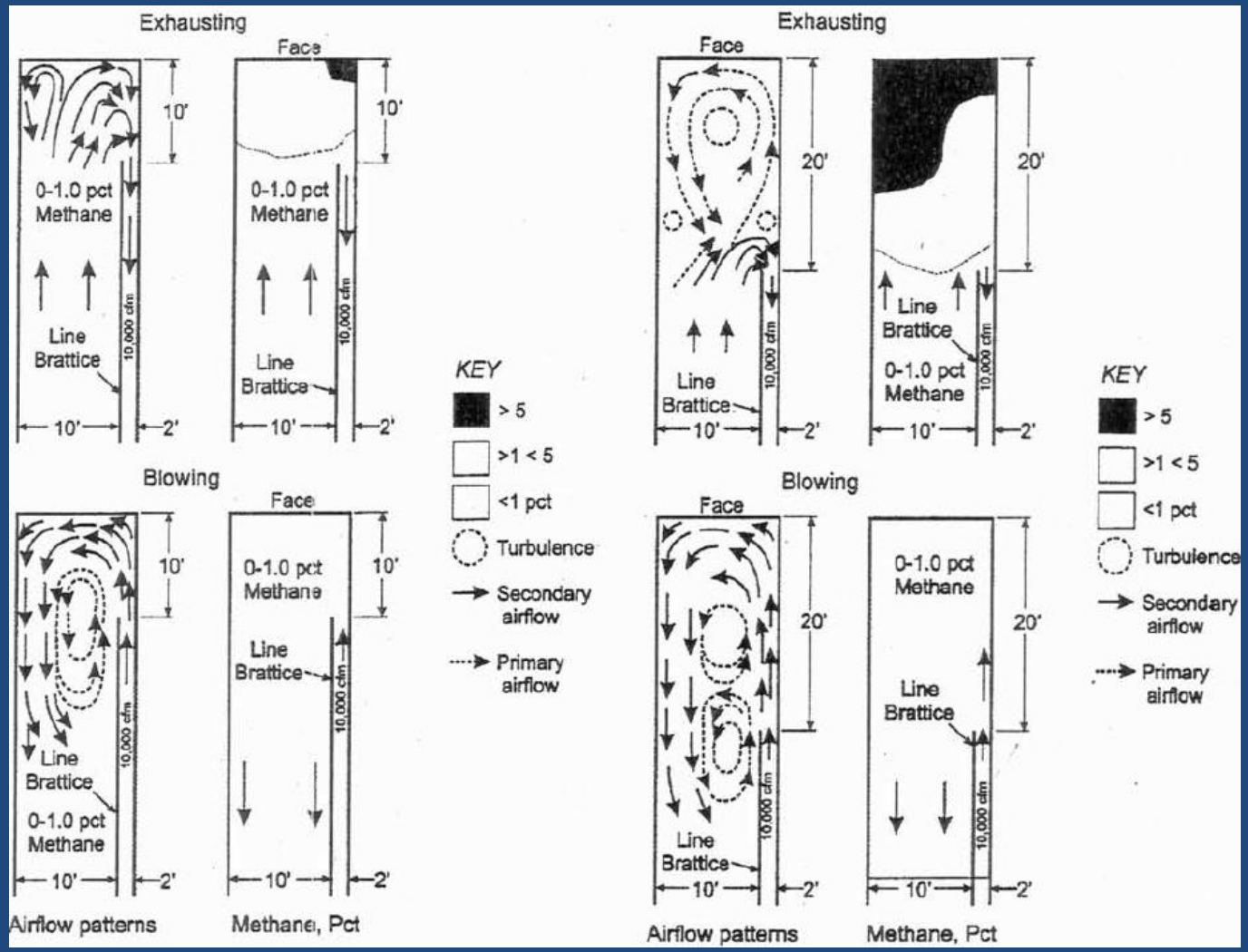
Face Ventilation

- Liberation of methane varies considerably by location
- Blowing fan and tubing (dust generation)
- Exhaust fan and tubing (close to face)
- Line brattice if properly constructed

Face Ventilation



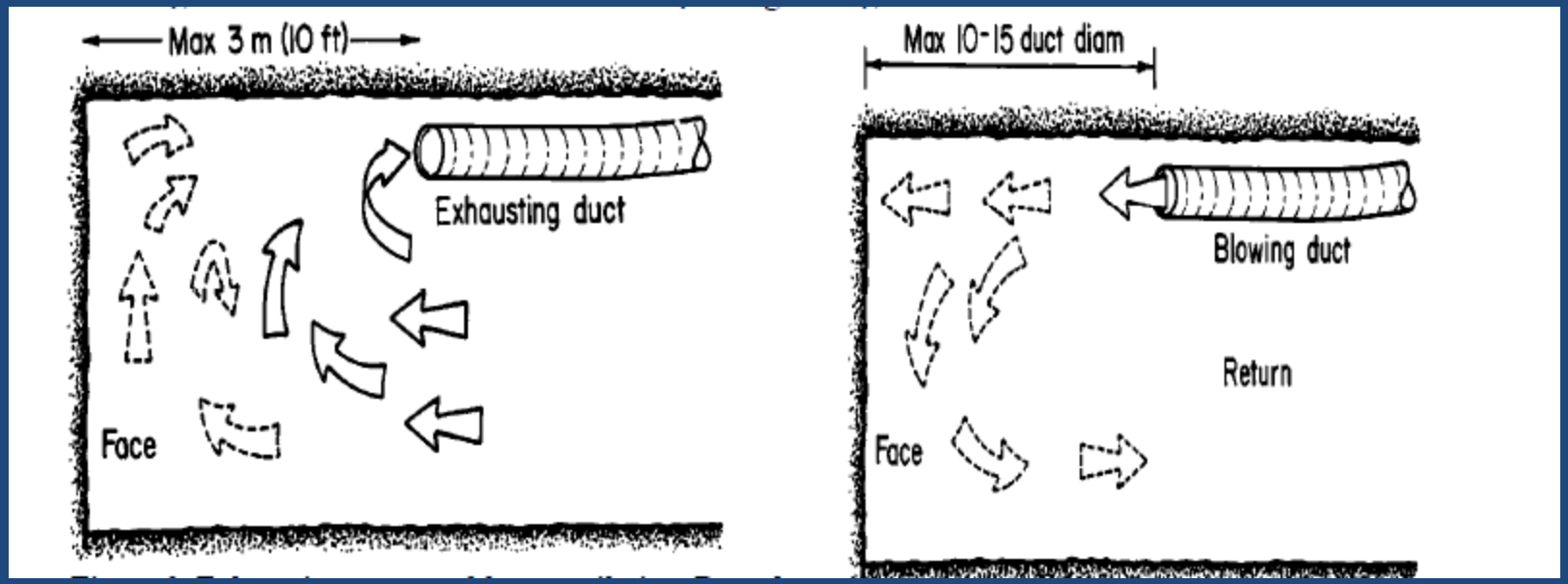
Face Ventilation



Face Ventilation

Very important to keep the tubing at the face regardless of cost or inconvenience

- Blowing
- Exhausting



Face Ventilation

"If 100 cms goes into the portal but only 1 cms reaches the cutting face where most methane is released then as far as methane control at the working face is concerned, the mine is being ventilated with 1 cms" (from Kissell and Goodman 1991)

Best Practices for Prevention of Mine Explosions

- Maximum 1% methane
- Single pass ventilation
- Prevention of face ignitions
- Bleeder systems
- Mine atmospheric and ventilation system monitoring including gobs for spontaneous combustion.
- Dedicated ventilation officer

Sources

- Kissell, F.N., Jerry CJ Tien and Edward D. Thimons, “Methods for Controlling Explosion Risk at Coal Mine Working Faces”
- CFR Part 75: Title 30 Code of Federal Regulations, U.S. Printing Office, Washington DC
- MSHA.gov