



UNIVERSITY OF
KENTUCKY[®]
College of Engineering

Health and Safety – Keeping Pace with Technology

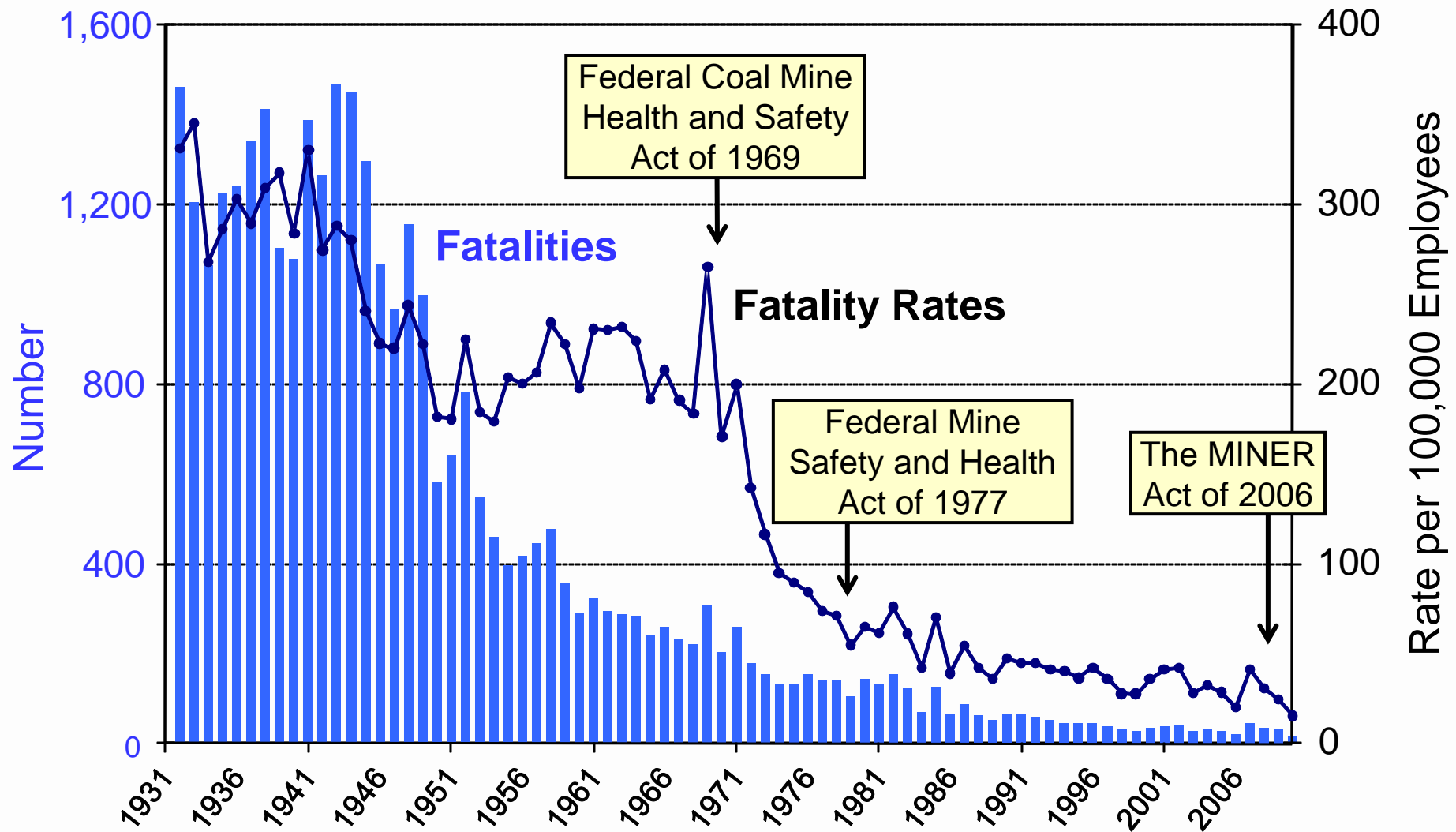
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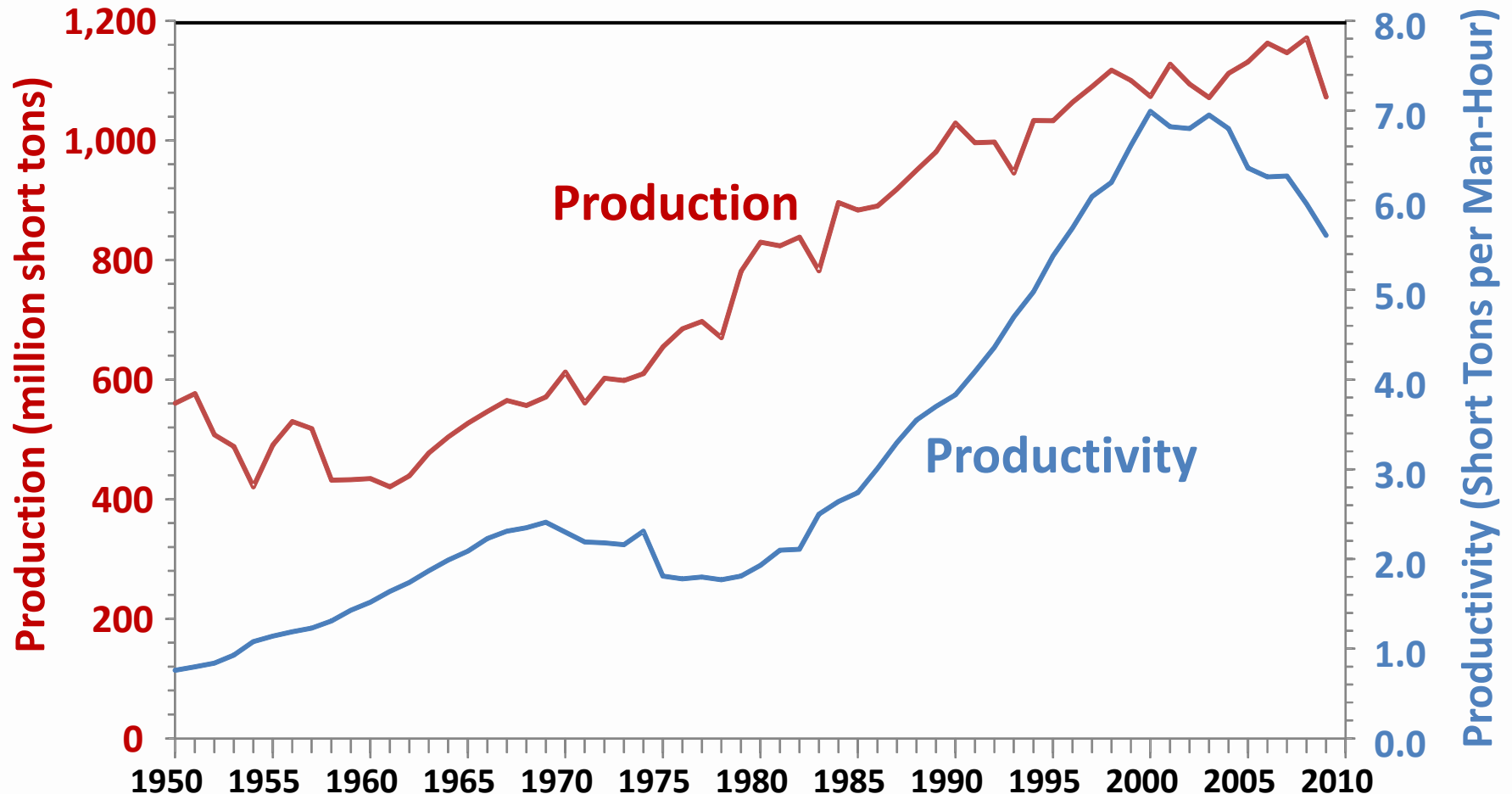
Outline

- Coal Mining and Accident Statistics in the U.S.
- Coal Workers Pneumoconiosis (CWP)
- Current and Proposed Respiratory Dust Regulations
- Proximity Detection
- Communications/Tracking Systems

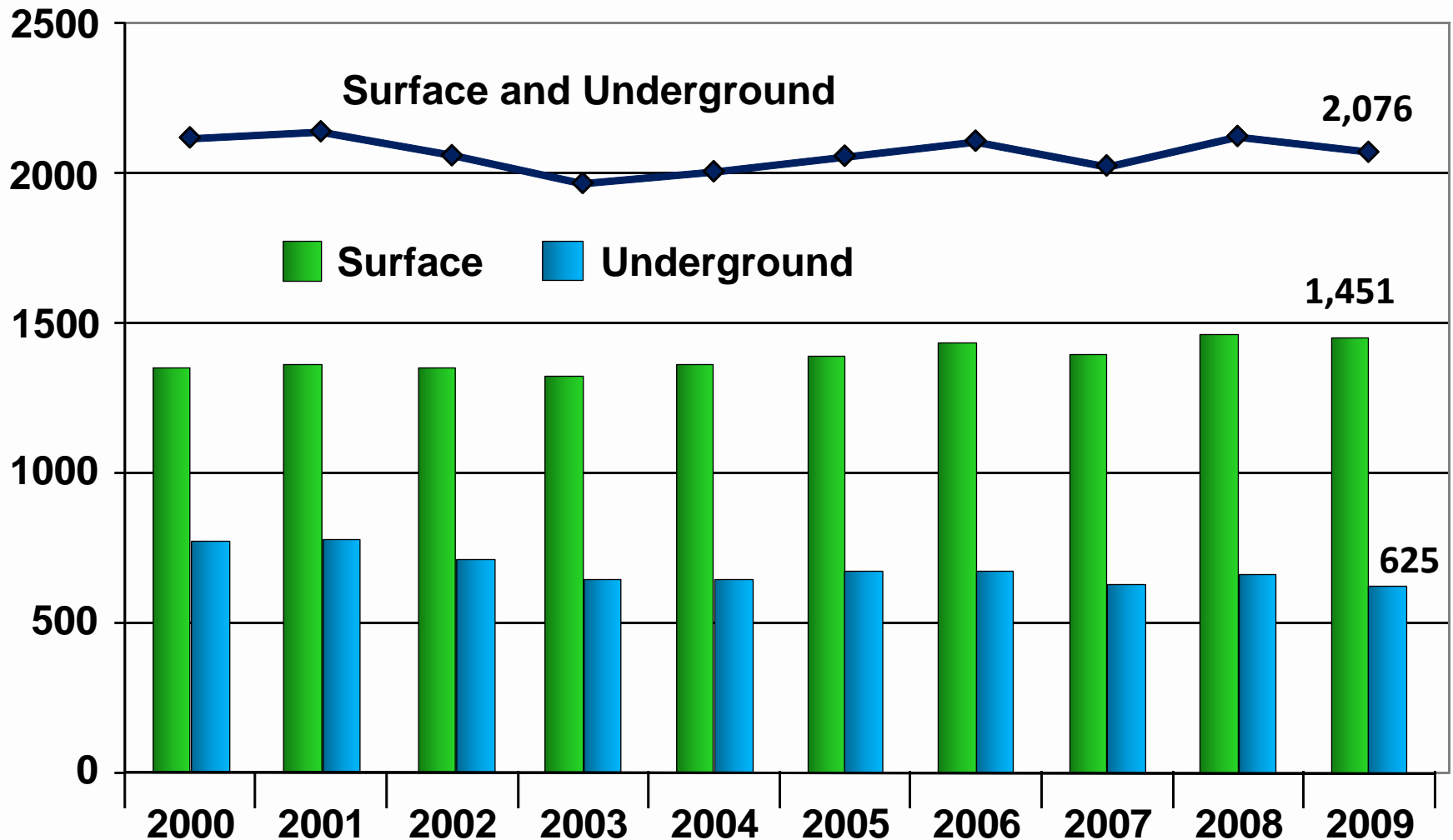
Historical Perspective of Fatalities in U.S.



U.S. Coal Production and Productivity

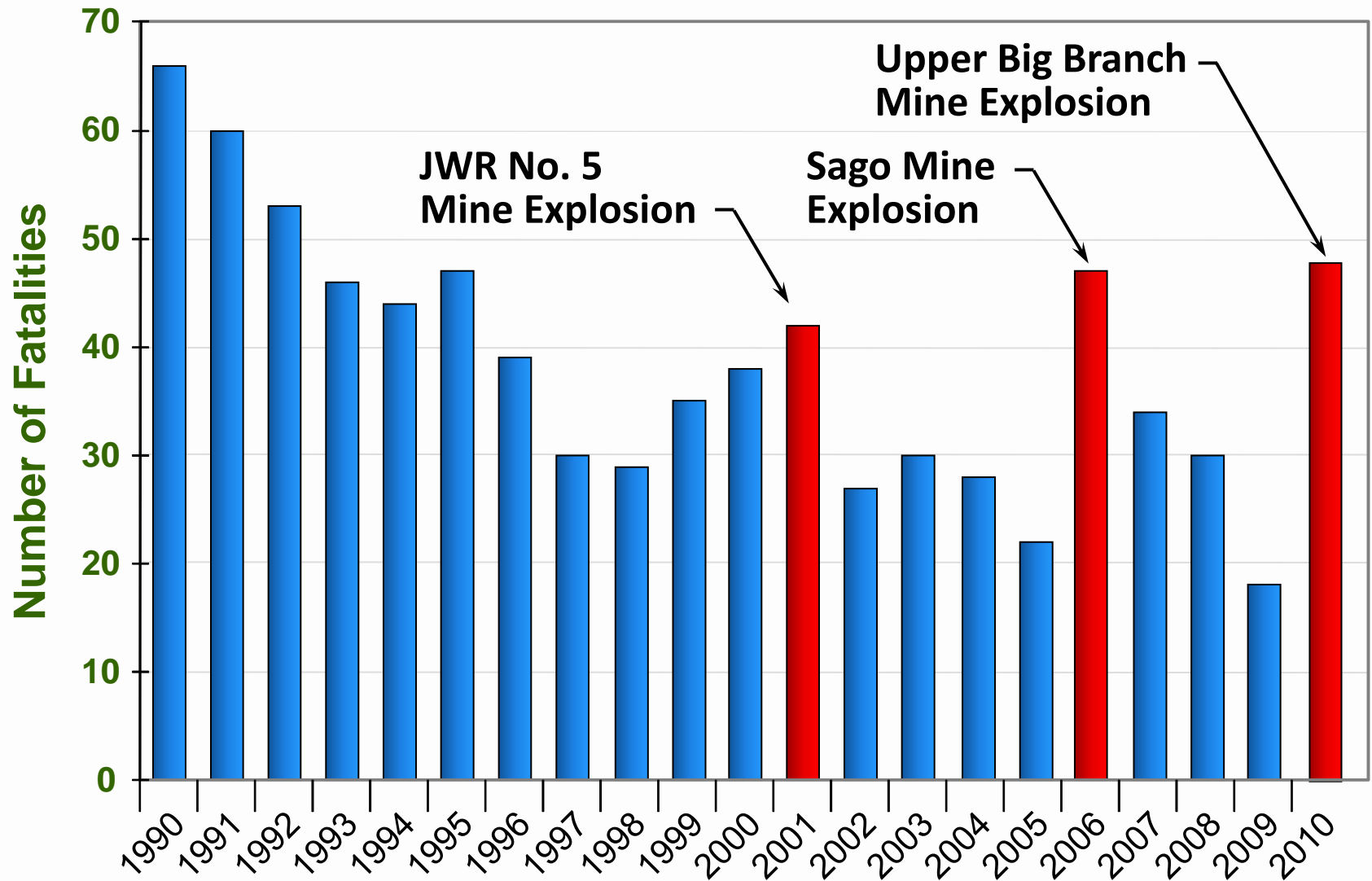


Number of Coal Mines in the U.S.

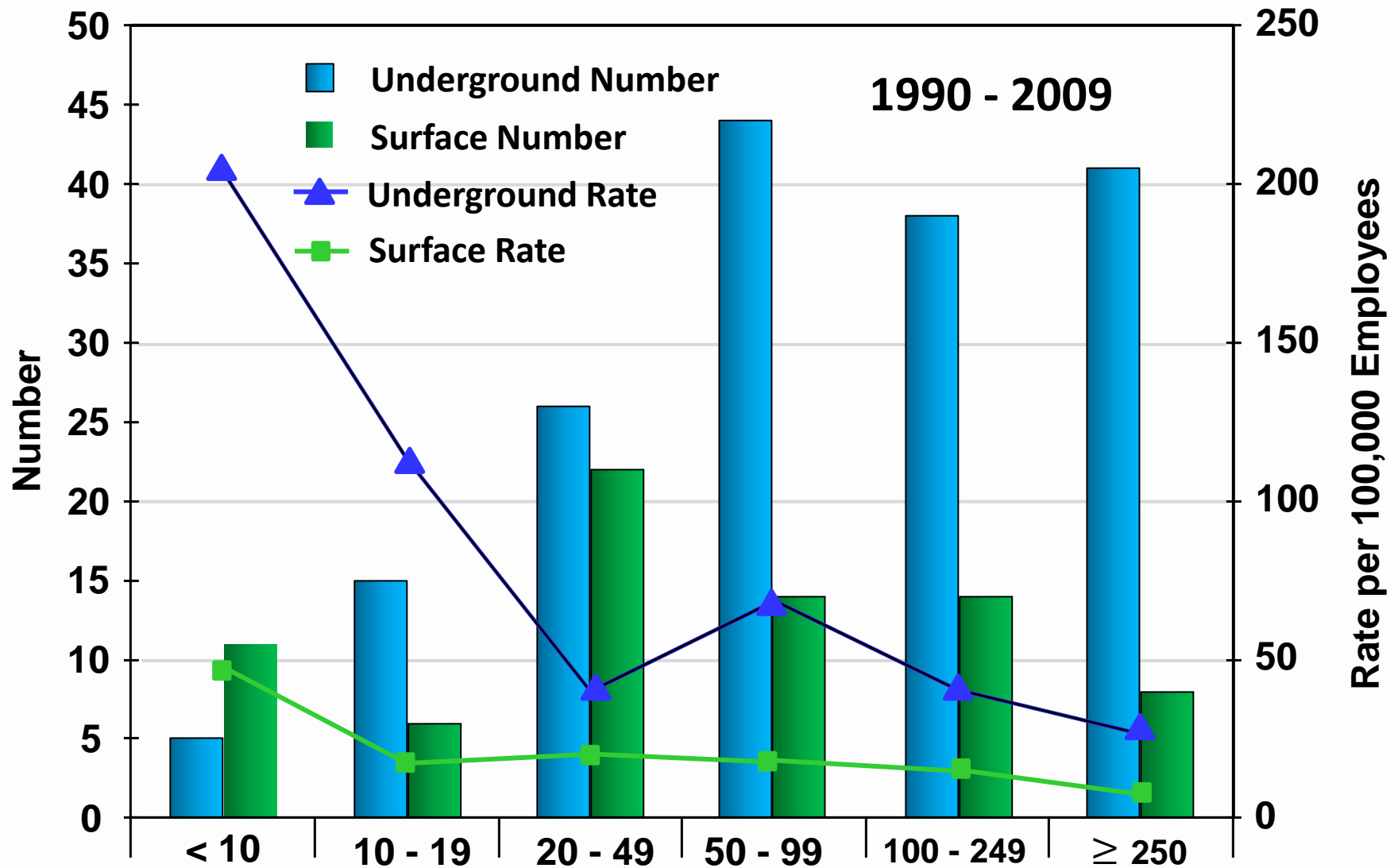


Source: National Institute for Occupational Safety and Health

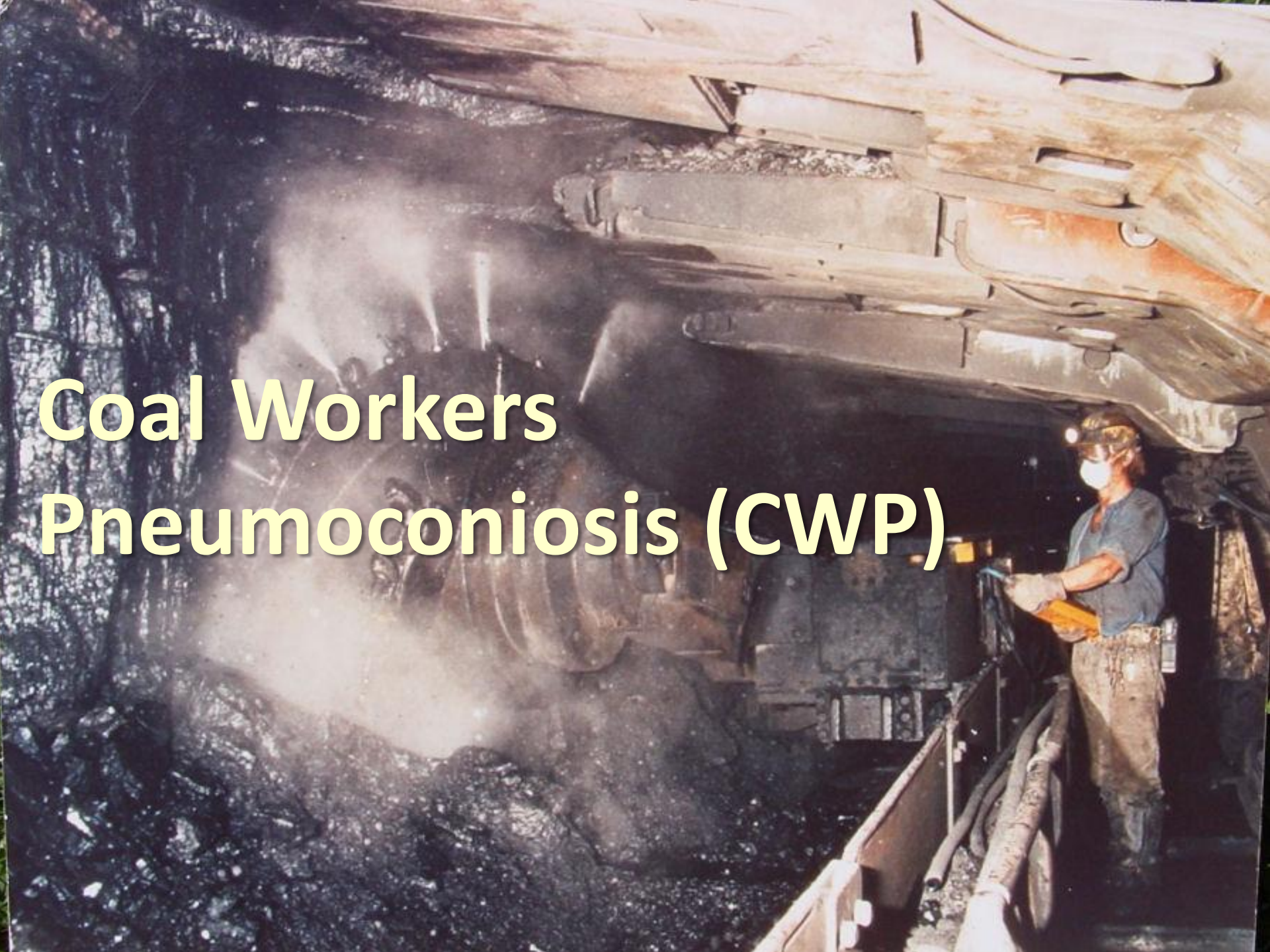
More Recent Fatalities in U.S.



Fatalities vs Mine Size



Source: National Institute for Occupational Safety and Health



Coal Workers Pneumoconiosis (CWP)

Coal Workers Pneumoconiosis - CWP

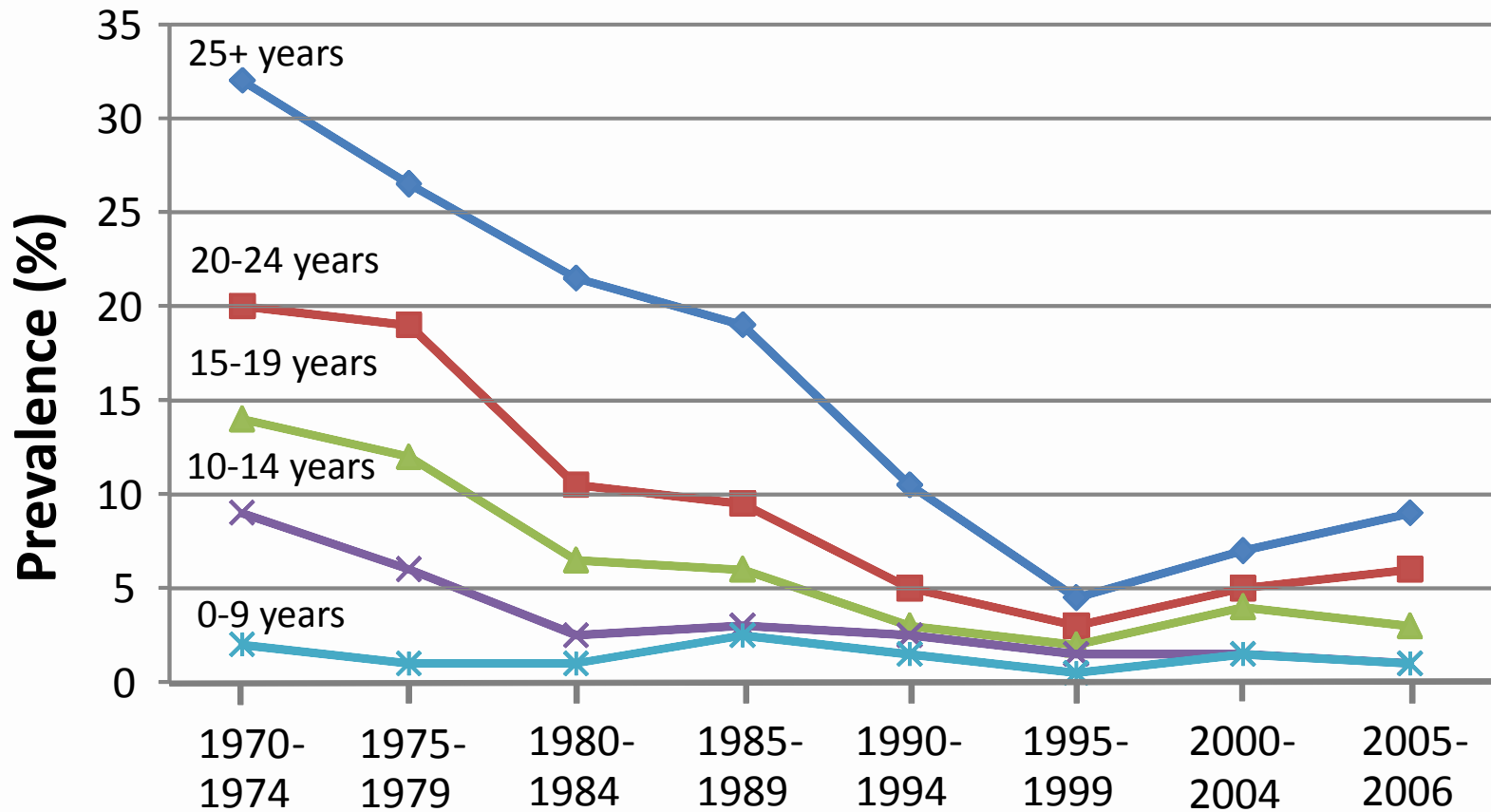
- Black Lung – Incurable chronic lung disease.
- Advanced stages – Progressive Massive Fibrosis (PMF).
- PMF – Lungs become rigid and lose their ability to expand fully.
- Medical Complications:
 - Airflow obstruction,
 - Respiratory infection,
 - Low blood oxygen levels,
 - Respiratory failure,
 - Enlargement of the heart, and
 - Abnormal heart rhythm.

Coal Workers Pneumoconiosis - CWP

According to NIOSH:

- 1970 to 2004 – CWP caused or contributed to 69,377 deaths.
- 1980 to 2005 – over \$39 billion in CWP benefits were paid to coal miners and their families.

Prevalence of CWP



(Source: NIOSH Coal Workers' X-ray Surveillance Program)

CWP – Black Lung Disease

According to NIOSH:

- For miners with 25 or more years of experience, the occurrence rate of black lung has nearly doubled since its low point.
- The disease is occurring in younger miners.
- CWP's progression rate from beginning stages to more advanced stages has accelerated.

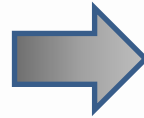
CWP – Black Lung Disease

- Mine Safety and Health Administration (MSHA) instituted a Comprehensive Initiative to “End Black Lung – Act Now.”
- The initiative includes rulemaking, enhanced enforcement, collaborative outreach, and education and training.

Dust Samplers



Coal Mine Dust Personal Sampler Unit (CMDPSU)



Continuous Personal Dust Monitor (CPDM)

MSHA's proposed rule totally phases-out the use of the CMDPSU in favor of the CPDM.

Continuous Personal Dust Monitor

- NIOSH funded its development.
- Designed to operate continuously for 12 hours, and displays three values:
 - Respirable-dust concentration for the most recent 30-minute period,
 - Average respirable-dust exposure from the beginning of the shift, and
 - Current percentage of the exposure limit.



MSHA's Proposed Rule:

Lowering the Respirable-Dust Standard

- Reduces the exposure limit from 2.0 mg/m³ to 1.0 mg/m³ at the working face.
- Reduces the 1.0-mg/m³ requirement in the intake air within 200 ft of the working faces to 0.5 mg/m³.

MSHA's Proposed Rule:

Single-Shift Sampling for Compliance

- **Compliance with the existing standard –**
Determined by calculating the average dust concentration for the designated occupation (and other occupations) from five valid samples taken during five consecutive, *normal-production shifts*.
- **Compliance with the proposed standard –**
Determined from single-shift dust measurement during a *normal-production* shift.

MSHA's Proposed Rule:

Redefine *Normal Production Shift*

The term *normal production shift* is redefined from 50% or higher of the average coal production for the 30 most-recent production shifts to 100% or higher of the average coal production for the 30 most-recent production shifts.

MSHA's Proposed Rule:

Increased Sampling Frequency

- **Existing Rule** – *Designated occupations* (DO) and other occupations are sampled on a bimonthly basis.
- **Proposed Rule** – *Designated occupations* (DO) must be sampled during each production shift, seven days per week, 52 weeks per year. Other designated occupations (ODO), must be sampled during each production shift for 14 consecutive days during each quarterly period.

MSHA's Proposed Rule:

Full-Shift Sampling

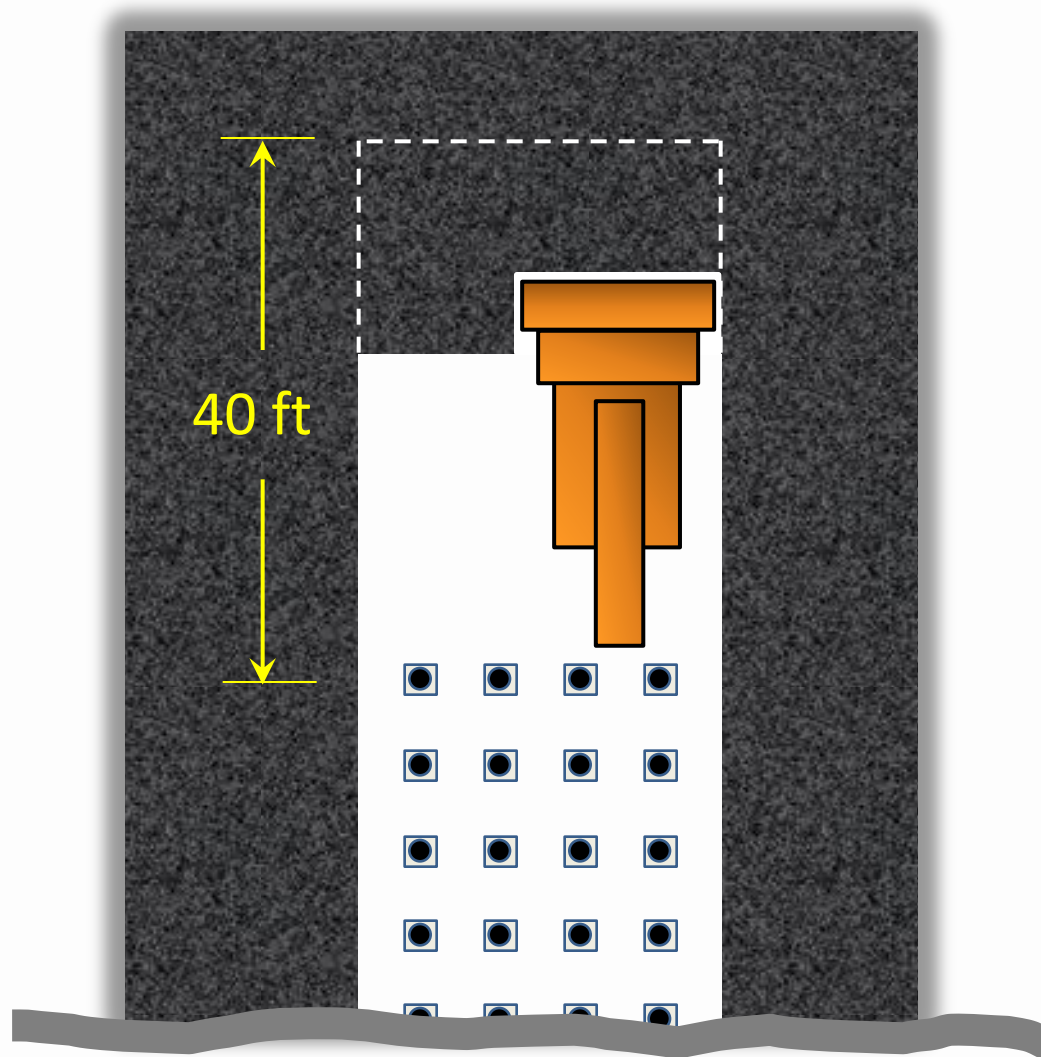
- **Existing Rule** – Requires the respirable dust concentration to be measured for an 8-hr shift. (If an operator works a shift longer than 8 hrs, the sampler is turned off after 8 hrs.)
- **Proposed Rule** – If a work shift is longer than 8 hrs, the concentration must be converted to an 8-hr equivalency.



Proximity Detection

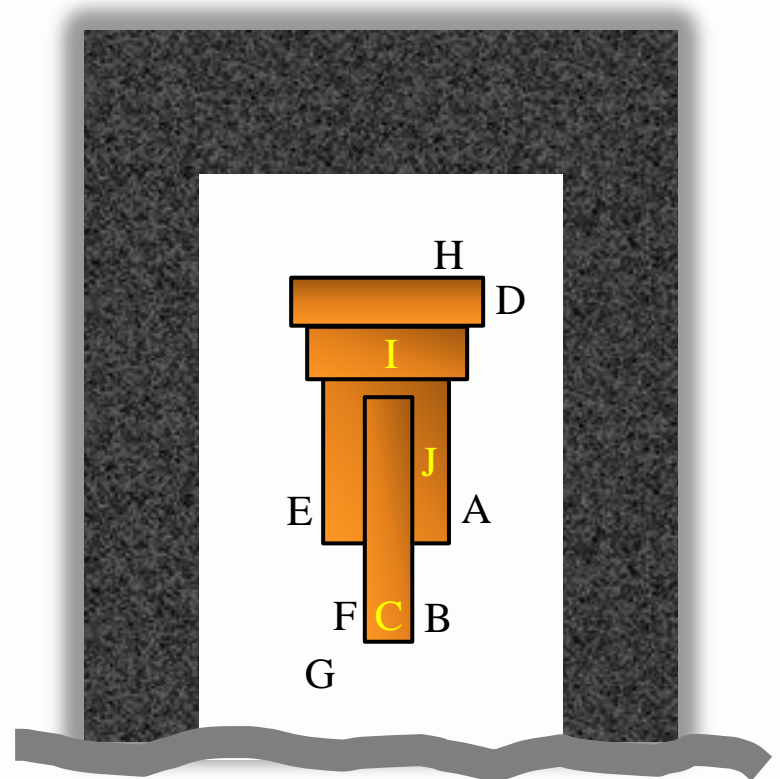


Remote Control – Deep Cuts

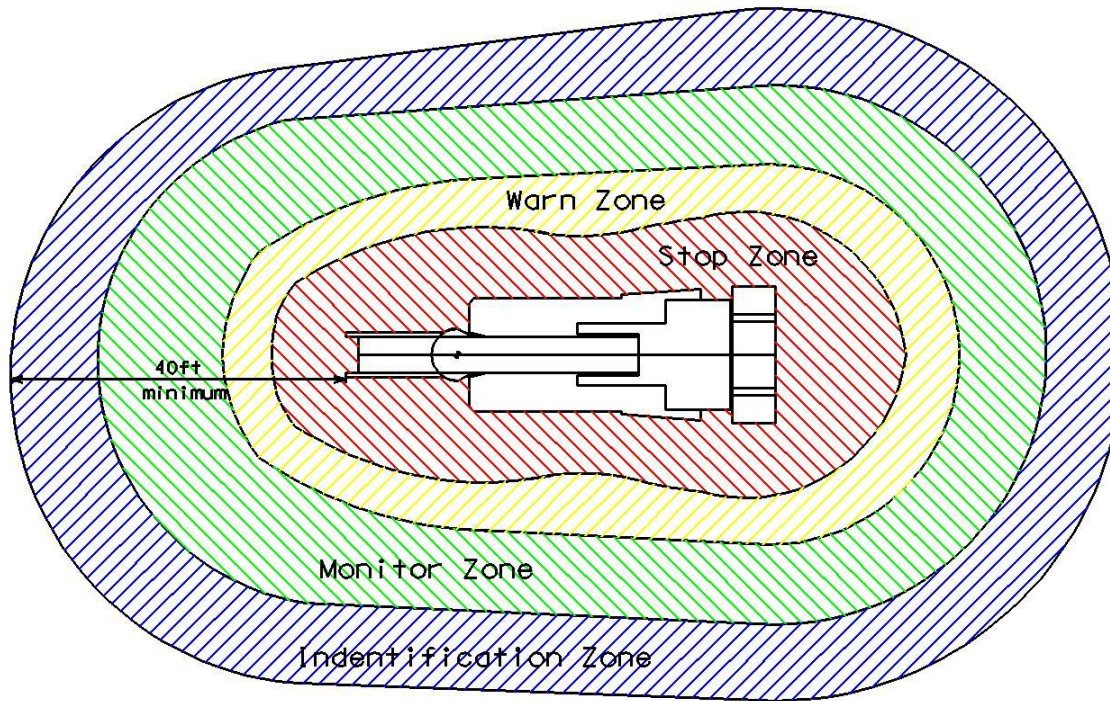


Remote-Control Crushing Accidents

- 14 Fatalities since 2000
- 31 Fatalities since 1984
- Fatalities by location
 - Location A: 9 Fatalities
 - Location B: 7 Fatalities
 - Location C: 4 Fatalities
 - Location D: 4 Fatalities
 - Location E: 2 Fatalities
 - Locations F, G, H, I, and J: 1 Fatality



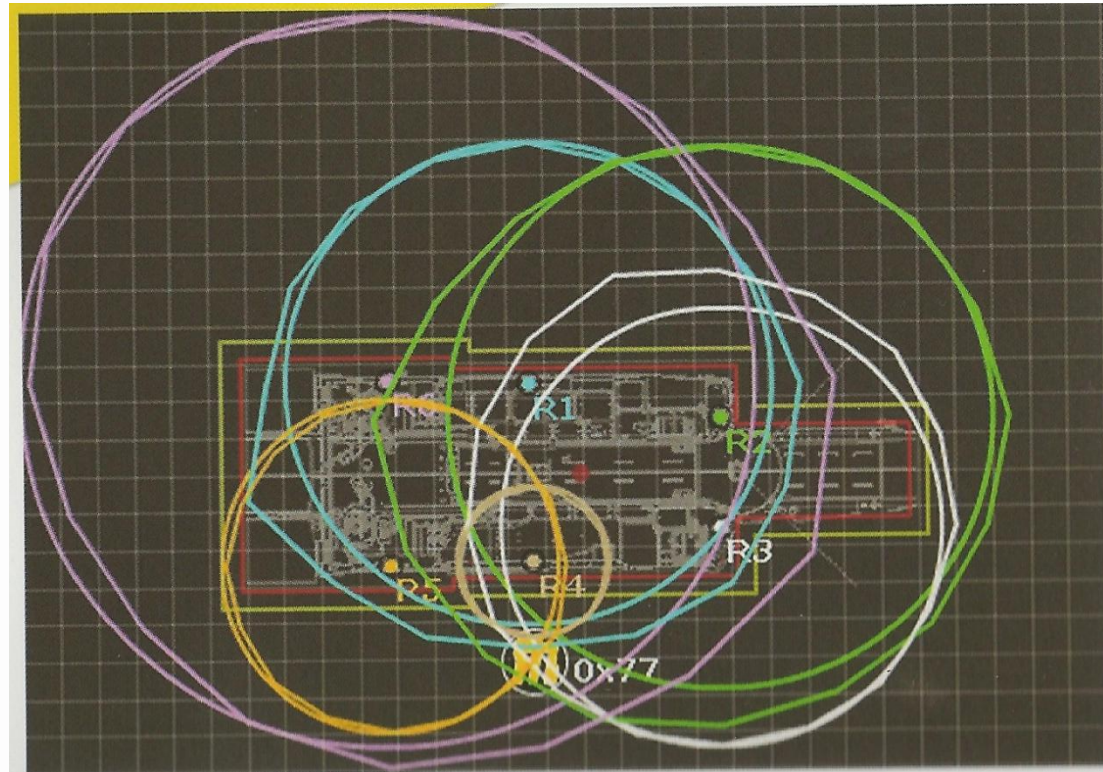
Safety-Zone Approach



Not effective for the operator of a remote-controlled continuous miner during the mining cycle.

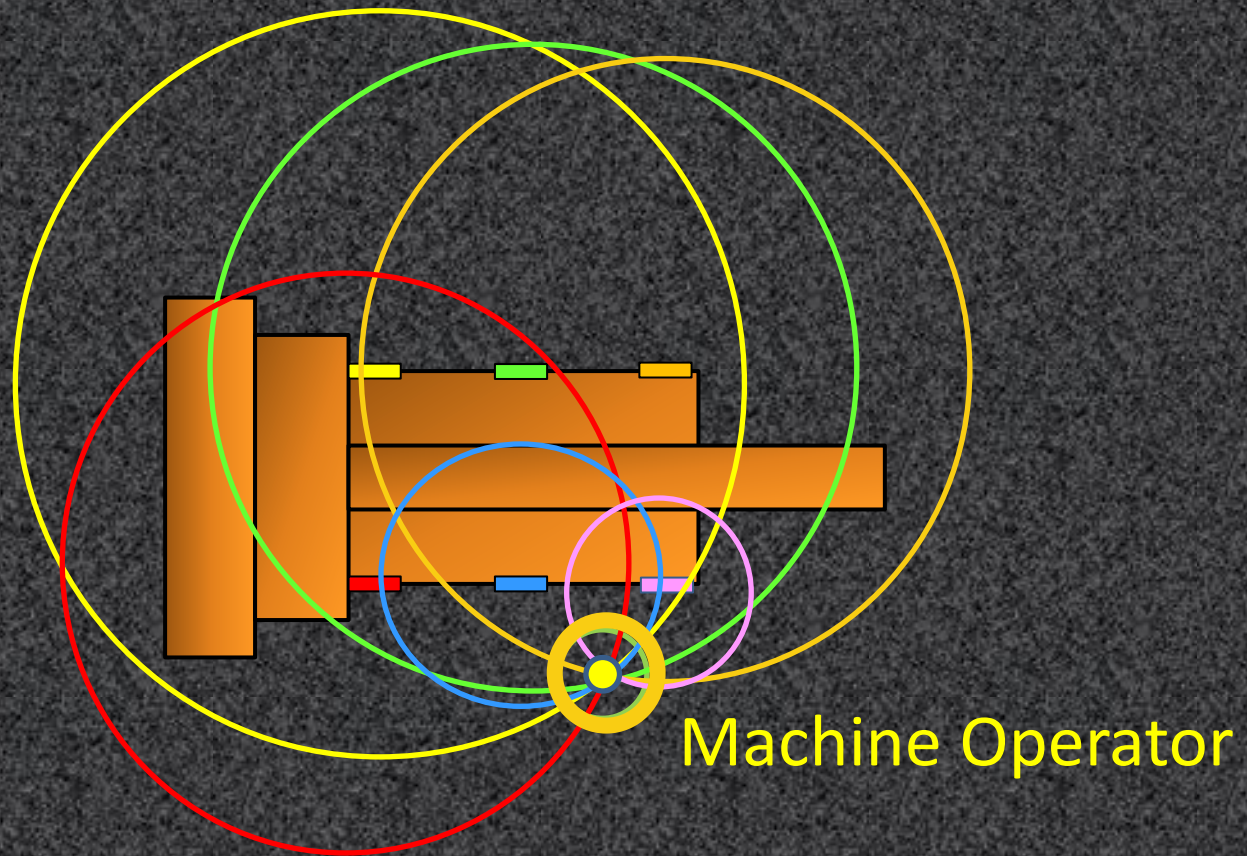
Actual Operator Location

- Arrangement of six RF receivers on machine.
- RF Transmitter located on operator.
- Field strength is used to estimate distances between the transmitter and the receivers.
- Operator's location is based on the estimated distances.



Source: Matrix Development / Joy Mining Machinery

Triangulation

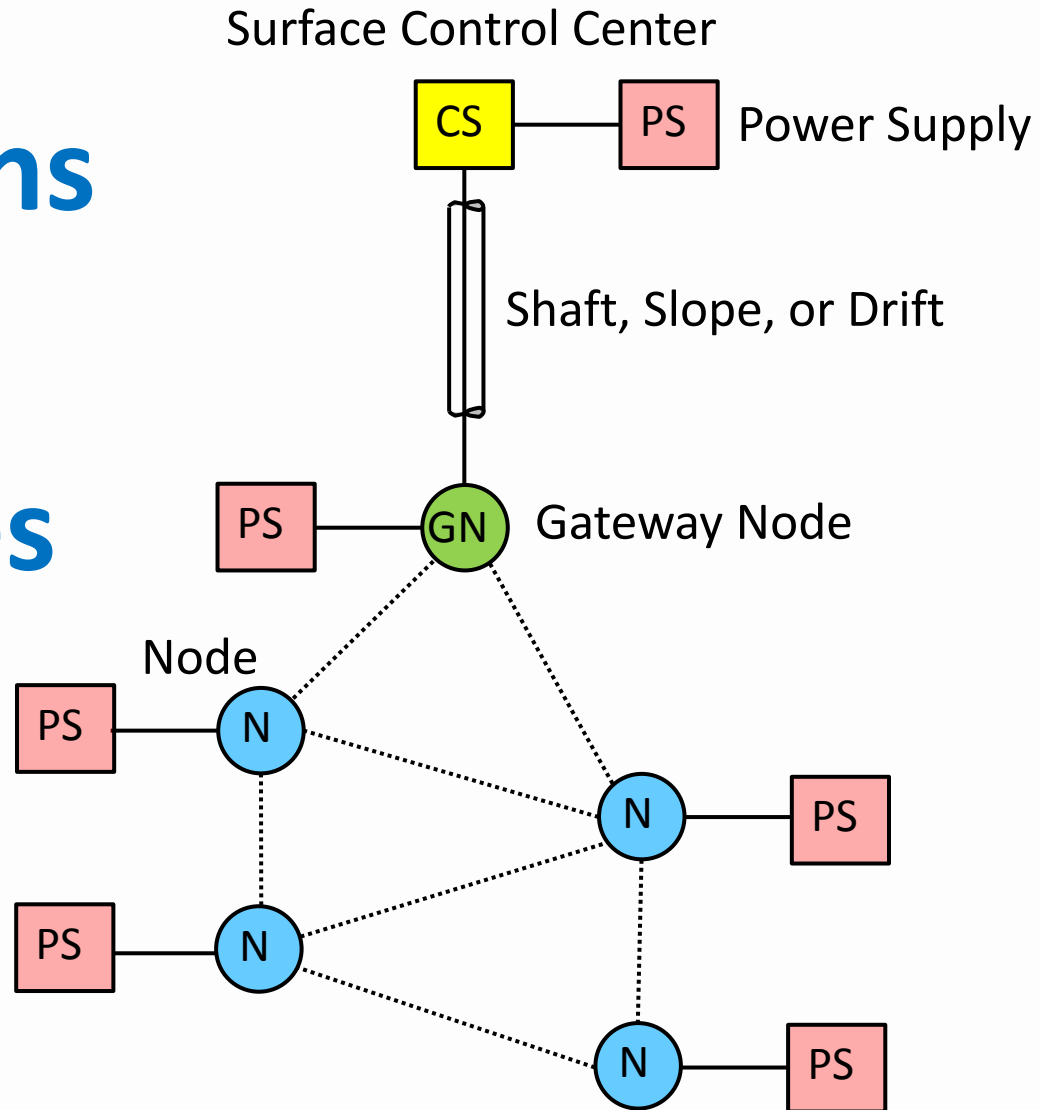


Proximity Detection Challenges

To design a system that

- Enables the operator to work anywhere around the machine.
- Knows precisely where the operator, and other miners in proximity of the machine, are located.
- Allows only specific movements of the machine to be constrained so that the operator can not be injured.

Communications and Tracking Power Supplies



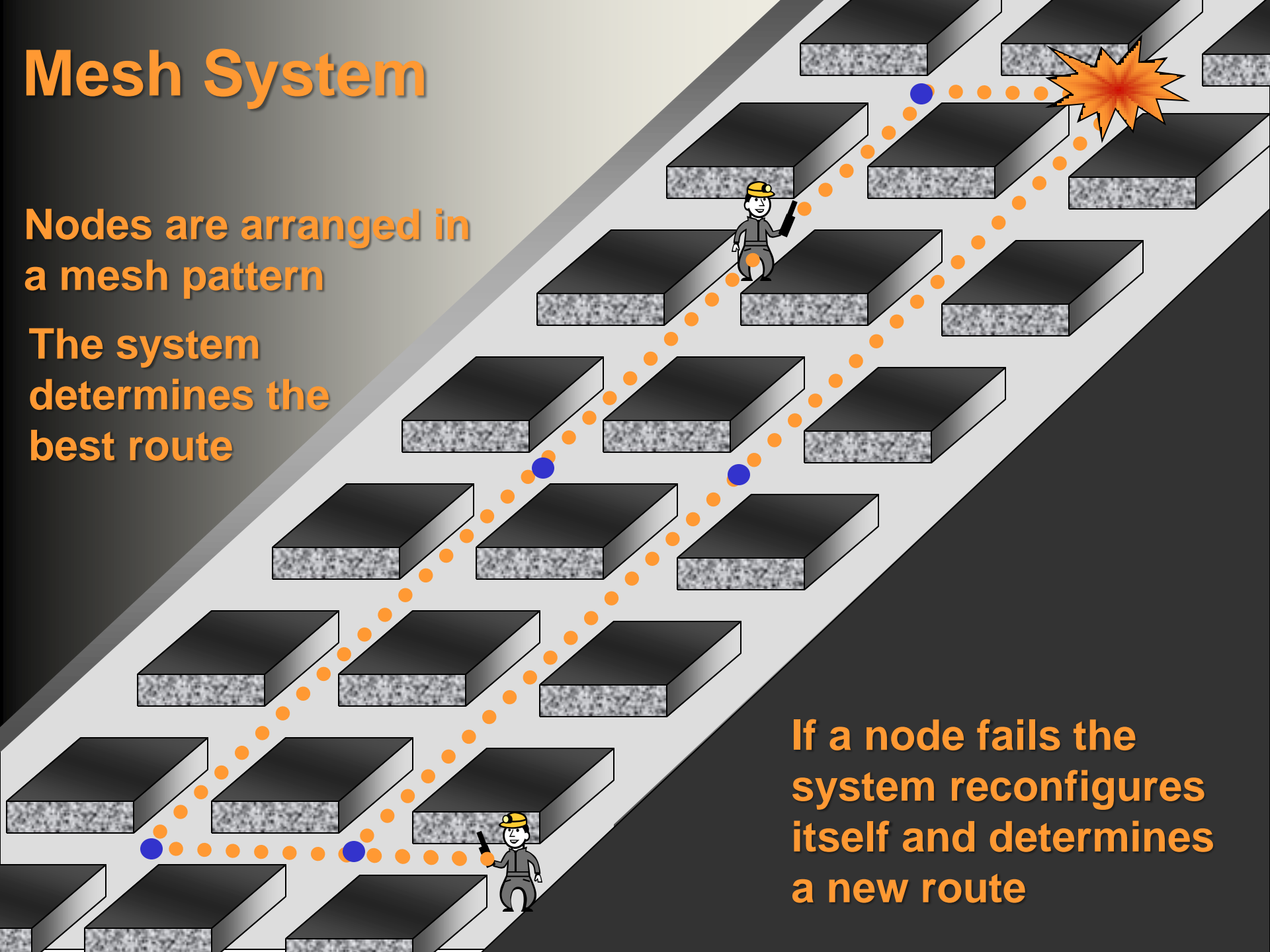
Communications and Tracking

- Required by the Mine Improvement and New Emergency Response Act (MINER Act)
- Systems must be designed and installed to maximize their survivability after a mine disaster, such as an explosion or fire.
- Therefore must have a permissible battery backup power supply.

Mesh System

Nodes are arranged in a mesh pattern

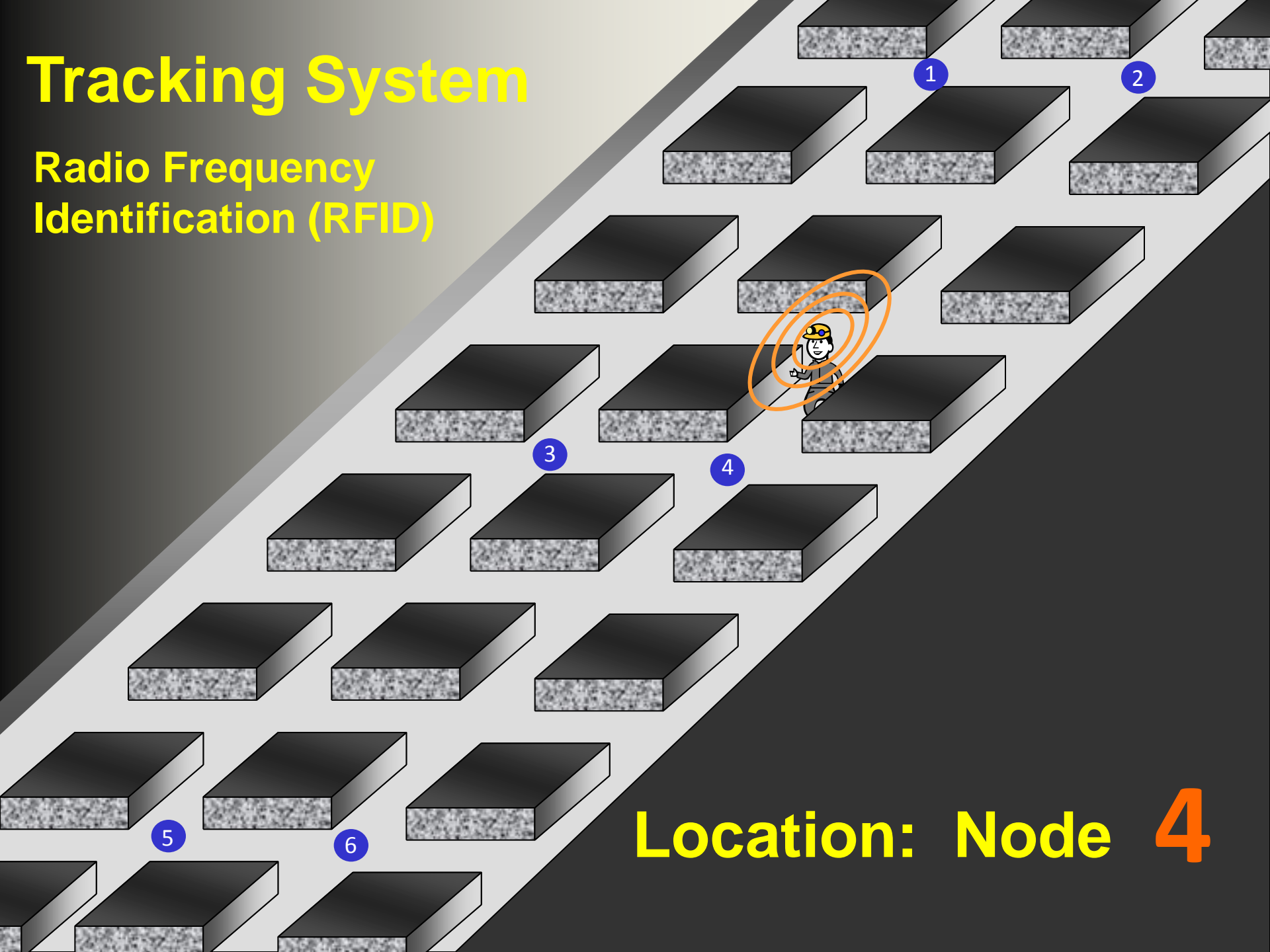
The system determines the best route



If a node fails the system reconfigures itself and determines a new route

Tracking System

Radio Frequency
Identification (RFID)



Location: Node **4**

Lithium-Ion Batteries

- Lithium-ion batteries are being used by some communications and tracking systems as the backup power supply.
- Advantages:
 - Lightweight,
 - High energy density,
 - Wide variety of shapes and sizes,
 - No memory effect, and
 - Low self-discharge rate.

Safety Issues:

Some Types of Lithium-Ion Batteries

- Overheating or overcharging can result in thermal runaway and cell rupture.
- Also, during the manufacturing process, tiny pieces of metal may unintentionally be deposited in the electrolyte.
- The metal particles may puncture the separator and cause a short circuit.
- The flammable electrolyte may ignite, causing a fire.
- A temperature increase results in a pressure increase, and the battery may explode.

Possibility of Lithium-Ion Battery Fires



Conclusions

- As technology progresses, we must always consider the associated consequences from a health and safety perspective.
- As we introduce new safety technology into mines, we must be sure that we are not inadvertently creating other safety problems.

Thank You!

