

OSCI 12
Ohio Safety Congress & Expo

WELL AT HOME. SAFE AT WORK.

373 Blasting Safety in Ohio's Quarries and Surface Coal Mines

Mike Mann

Wednesday, March 28, 11 a.m. to Noon

Ohio Bureau of Workers' Compensation



Blasting Safety Series

The Safe Explosives Act – A Quick Reminder for Mine Employees and Mine Managers

The Safe Explosives Act

Overview of the SEA 

- Congress enacted the Safe Explosives Act ("SEA") on November 25, 2002 as part of the Homeland Security Act.
- The purpose of the SEA is to prevent terrorists and criminals from obtaining explosives.
- The SEA imposes a **permitting, licensing and background clearance requirement on all users, manufacturers, dealers and importers of explosives.**
- ATF is the agency responsible for enforcement of the SEA.

The Safe Explosives Act

Who is prohibited? 

Effective January 24, 2003: The SEA expanded the categories of persons prohibited from using explosives to include:

-  Illegal aliens
-  Nonimmigrant aliens (with exceptions)
-  Persons dishonorably discharged from the U.S. armed forces
-  Persons who have renounced their U.S. citizenship

The Safe Explosives Act

Others prohibited from possessing explosives: 

- persons convicted of, or under indictment for, a felony
- fugitives from justice
- unlawful users or addicts of any controlled substance
- persons adjudicated as mentally defective or committed to a mental institution

The Safe Explosives Act

Theft Reporting Requirements 

- Licensee/permittee who discovers that explosive materials have been stolen must report theft to the ATF and local authorities within 24 hours of discovery
- Penalties for failure to report: fine of up to \$250K and imprisonment for up to 5 yrs

The Safe Explosives Act

Users of Explosives Must Have Permits

- Permit authorizes use, transporting and shipping of explosives
- Intrastate users of explosives no longer exempt from permitting requirements
- Limited permit available for users who infrequently purchase explosives
 - allows user to make no more than 6 purchases within 12-month period from in-state seller
- Must post permit at mine

The Safe Explosives Act

Independent Contractors? 

- If you use an IC to handle ALL blasting at your mine site, you DO NOT need an ATF permit and your employees will not be subject to background checks - **BUT:**
 - you are only exempt from the SEA if you or your employees have NO contact with or control over explosives.

The Safe Explosives Act

Use of IC: Key Questions 

- Do mine employees have access to explosives or keys to an **explosives magazine/storage facility** used by an IC?
- Do they receive or unload explosives delivered to your mine site?
- Do they inventory explosives?

–IF YES (to any), YOU NEED A PERMIT FROM ATF.

The Safe Explosives Act

Penalties:



- It is a **FELONY** to manufacture or use explosive materials without a license or permit.
- It is also a **FELONY** to **knowingly allow** a prohibited person to possess or use explosive materials.

The Safe Explosives Act

Resources

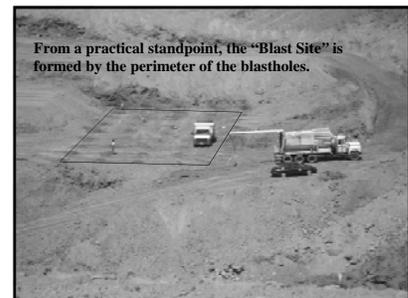
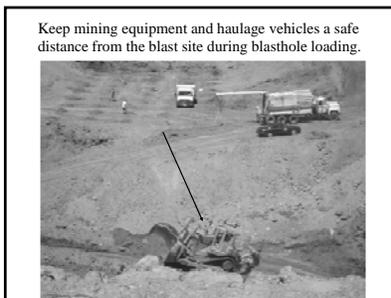
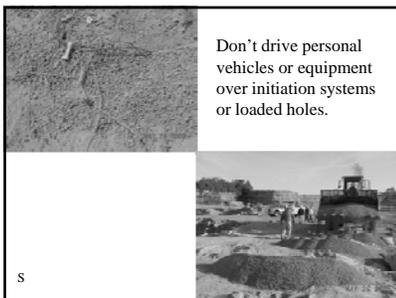
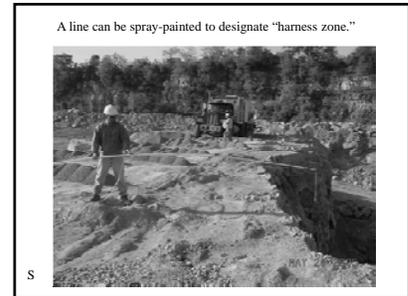
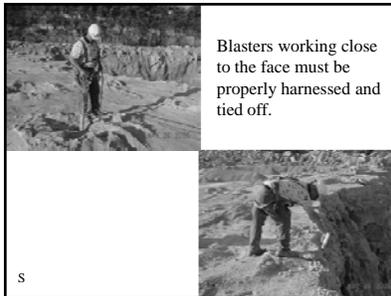
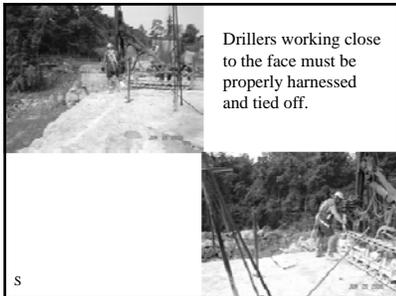


- For Forms:
 - Download forms at www.atf.gov.
- For Questions:
 - Consult:
 - ATF
 - Your lawyer



Blasting Safety Series

Blast Bench Safety for Mine Managers and Employees





Per MSHA:

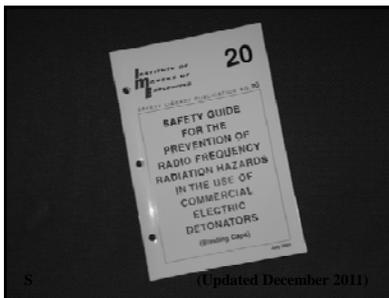
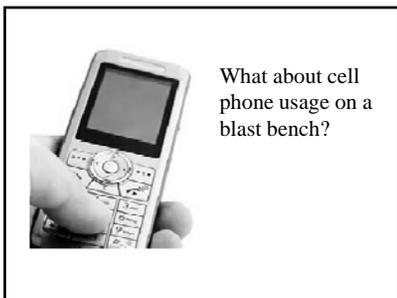
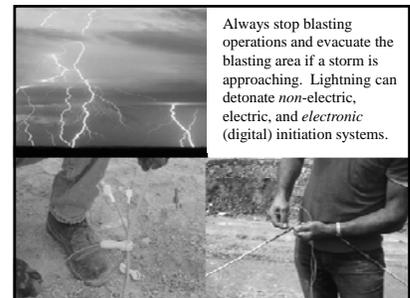
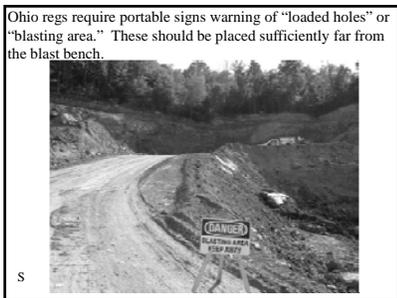
- "Once loading begins, the only activities permitted within the blast site shall be those activities *directly related* to the blasting operation..." (emphasis added)
- "Haulage activity is permitted near the base of a highwall being loaded or awaiting firing, provided no other haulage access exists."

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Per MSHA, the Blast **Site** shall be:

- Attended (as when the blast crew is there);
- Barricaded and posted with warning signs, such as, "Danger," "Explosives," or "Keep Out;"
- Or flagged against unauthorized entry.

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IME's recommended minimum distances from *electric* blasting circuits and detonators (caps):

- Cell phone (3 watts or less): 13 feet
- Hand-held CB (4 watts): 5 feet
- Mobile CB (4 watts): 65 feet
- Hand-held CB (12 watts): 20 feet
- Mobile CB (12 watts): 110 feet
- Mobile 2-way (160 MHz; ≤ 100 watts): 120 feet
- Consult SLP 20 for other sources/configurations

Best Policy:

KEEP MOBILE
TRANSMITTERS AWAY FROM
BLAST SITES WHERE
ELECTRIC DETONATORS ARE
USED



Blasting Safety Series

Blasting Area, Access Control and
Warning and All-clear Signals

Per NIOSH:

“Between 1978 and 2000, 106 miners were killed and 1,050 were injured by explosives and breaking agents.”

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Also Per NIOSH:

“For the past two decades, most explosives-related injuries and fatalities in surface mines occurred when workers were *struck by rock*, either because they were **too close to the blast or rock was thrown much farther than expected.**”

What is the **BLASTING AREA**?



What is the “**Blasting Area**”?

It is the area around a blast where there is a danger from:

- Flyrock (rocks, mud or debris projected by the force of the blast);
- Toxic Gases - primarily NO_2 (nitrogen dioxide) and CO (carbon monoxide); and
- Concussion (sub-audible air pressure wave)

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The Blasting Area **WILL CHANGE**
for each blast based on:

- Blast site conditions (e.g., mud seams, weak or insufficient burden in front of face holes, misfires, etc.)
- Blast design (e.g., hole diameter, burden, bench height, stemming, delay pattern, etc.)
- Face orientation
- Wind conditions
- Other factors

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In Ohio Mines, Who **Defines** the
BLASTING AREA for Each Blast?

The **CERTIFIED BLASTER** defines the blast area for each blast and communicates that area to the mine foreman.



In Ohio Mines, Who **Controls Access** to the **BLASTING AREA**?

The **Mine Foreman** must control access to the blasting area before the blast, and until the certified blaster detonates the blast and determines that the area is safe to re-enter.



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REMEMBER:

- The *certified blaster* must define and explain the blasting area to the mine foreman
- The *mine foreman* must *take charge* of controlling access until the all-clear is sounded
- Failure of the mine foreman to take charge of controlling access is a direct violation of the Ohio Administrative Code, and may result in enforcement actions and fines against the mining company and/or foreman.

And, per MSHA:

“All access routes to the blast area shall be guarded or barricaded to prevent passage of persons or vehicles.”

In **ALL** Ohio Mines, What are the Warning and All-clear Signals?



Pre-Blast Warning Signal

- **3 long sounds** (each at least 5 seconds in length) on siren or airhorn...
- **At least one minute**, but not more than two minutes, before the blast
- Audible **within ½ mile of a coal overburden blast** (per OSM)
- Audible **within 1,000 ft. of a quarry blast**
- Must be repeated if the blast is delayed more than two minutes

All-Clear Signal

- **1 long sound** (at least 5 seconds) on siren or airhorn
- Sounded only after certified blaster determines the blasting area is safe to re-enter, meaning that:
 - Toxic gases have dissipated
 - All charges have detonated
 - There are no imminent slides

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Warning! Explosives in Use Signs Must Be Posted at EACH Entrance to the Mine Permit Area from *Any* Road.



Blasting Area Signs Must be Posted Along Access and Haul Roads *Within* the Mine Area, and where the blasting area will be within 100' of a Public Road.



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Additional Precautions

- Inform all visitors (e.g., contractors, mechanics, welders, regulators) of daily blast locations and approximate times
- Inform all visitors of the meaning of the warning and all-clear signals



Thought question:
How do you keep these “visitors” out of the blasting area?

Additional Precautions (cont.)

- If you must be at the fringes of the designated blasting area during a blast:
 - **don’t sit in cabs** of vehicles or machinery, and be prepared to duck *under* “heavy metal”
 - allow at least 15 seconds for any flyrock to drop

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Let’s Review Blasting Area Access Control...



After holes are loaded, blaster hooks up holes and checks connections.



Certified blaster defines/explains blasting area to mine foreman.



Mine foreman controls access to blasting area, maintaining 2-way communications with the blaster and all posted guards.



Mine foreman tells certified blaster when the entire blasting area is secure.



Certified blaster sounds pre-blast warning signal.

Click on photo for Video



After one minute (but not more than two minutes), blast is detonated and fumes are allowed to dissipate.

Click on photo for Video



Certified blaster conducts post-blast inspection.

Click on photo for Video



After finding no undetonated charges or imminent slides, blaster sounds all-clear signal.

Click on photo for Video



How are things done at your mine?



Blasting Safety Series

Toxic Gases from Blasting

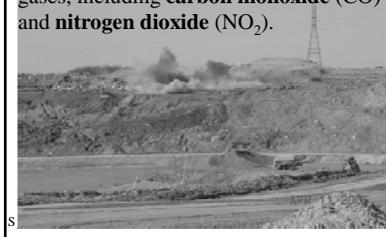


When a blast detonates...

...the gases produced are mostly water vapor, carbon dioxide, and nitrogen – all harmless.



However, ALL blasts produce some *toxic* gases, including **carbon monoxide (CO)** and **nitrogen dioxide (NO₂)**.



Carbon Monoxide Facts

- ALL blasts produce some CO (1% to 3% of gases)
- It is colorless, odorless, and tasteless
- Its density is about the same as air
- 35 ppm TWA is considered safe over 8 hours per NIOSH
- 1,200 ppm is Immediately Dangerous to Life and Health (IDLH) per NIOSH
- Effects: headache; nausea; dizziness; fatigue; death from asphyxiation (at prolonged high concentrations)

Primary Causes of Excessive CO

- Overfueled ANFO-based explosives (too much carbon; too little nitrate)
- Use of molecular explosives, such as pelletized TNT, that are “heavy” on the fuel side of the oxygen/carbon equation (not a likely choice of explosives for surface mine blasts, but sometimes used for construction blasts)

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To Prevent CO Poisoning from Surface Mine Blasts:

- Wait several minutes for fumes to clear pit and surrounding area
- Wait even longer on still days with no wind
- (And never re-enter blasting area before the all-clear signal has been sounded)
- If in doubt about CO level in the pit, use a hand-held CO meter to measure it, or allow even more time before re-entering

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Example of meter for measuring gas concentrations:



Nitrogen Dioxide Facts

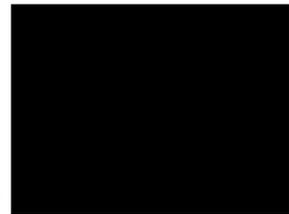
- ALL blasts produce some NO₂
- It has a pungent, acrid odor
- In large concentrations, it is orange, red, or rust-colored
- Its density is about 1.58 (denser than air)
- 5 ppm is recommended limit per OSHA and ACGIH
- 20 ppm is Immediately Dangerous to Life and Health (IDLH) per NIOSH
- Effects: irritation of eyes, nose, throat; cough; dizziness; headache; sweating; labored breathing; pulmonary edema (from acidity); death (at high concentrations)

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Effects from inhalation of NO₂ may be delayed for a few hours, and lung damage is irreversible !



NO₂ From Coal Overburden Blast



Click on black box for Video

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Primary Causes of NO₂

- Poor blasting mixtures (underfueled)
- Degradation of blasting agents during storage
- Degradation of non-water-resistant products in wet blastholes
- Inefficient detonation due to loss of confinement (in cracks and voids)
- Disruption of powder column due to too much time between rows (in large casting shots)

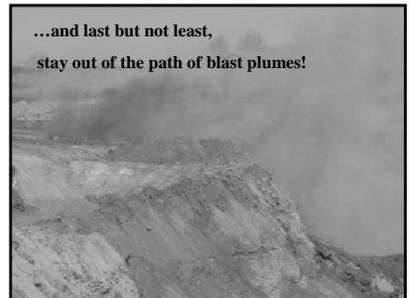
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NO₂ Mitigation Measures (any or all of the following)

- Pump water from very wet blastholes
- Select field-appropriate water-resistant (and oxygen balanced) explosives and loading methods
- Communicate with driller to locate significant cracks and voids, then stem through or seal off those zones
- Detonate when wind will not carry the plume to an occupied dwelling or public road
- Vacate occupants of close dwellings where feasible; block traffic on public roads

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...and last but not least, stay out of the path of blast plumes!

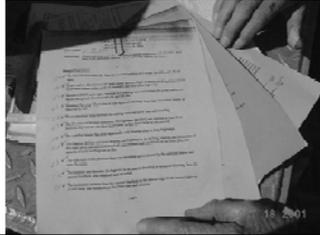




Blasting Safety Series

Blast Design to Prevent Flyrock – What Mine Managers and Employees Need to Know

Check mining plan for site-specific blasting measures to prevent flyrock.



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Discuss the flyrock plan with the mine foreman, driller, and blasters before the project begins.



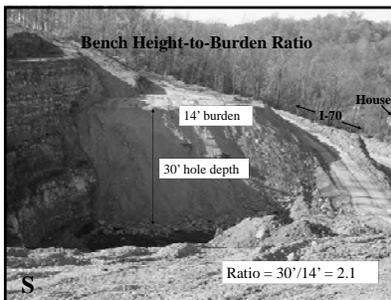
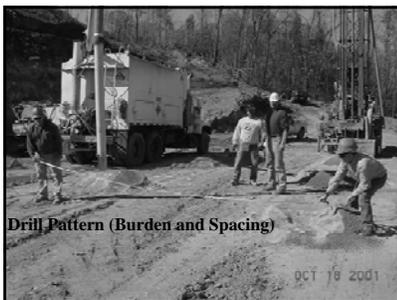
Fully support the certified blaster's efforts to follow blast plan and prevent flyrock.



At critical distances from houses and highways, defer all blast design decisions to the certified blaster, including...



Hole Diameter



Why is the Bench Height-to-Burden Ratio Important?

- To prevent premature stemming release and violent cratering from the top of blast bench
- To prevent excessive flyrock and airblast caused by the above
- Note: it is even more critical with shallow limestone blasts and coal parting blasts

FROM: *Explosives and Blasting Procedures* (USBM's IC 8925)

- Recommends *minimum* hole-depth-to-burden ratio of 1.5

FROM: *Surface Blast Design* (Cal Konya, 1990)

Potential for Flyrock Problem related to Bench Height-to-Burden Ratio (L/B):

- 1.0 = severe (high probability)
- 2.0 = fair control
- 3.0 = good control
- 4.0 = excellent control
- Cap rock blast: $L/B = 4'/13' = 0.3 !!!$

Shallow Limestone Blast in NW Ohio

Click on Black Box for Video

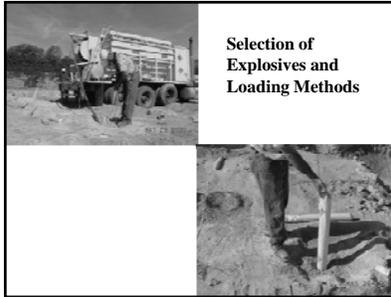


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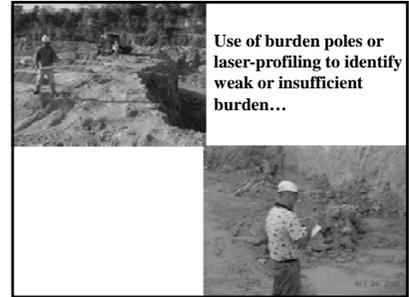
Additional blast design decisions that should be deferred to the certified blaster at critical distances:



Selection of Explosives and Loading Methods

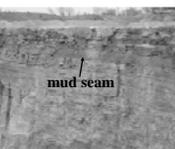


Use of burden poles or laser-profiling to identify weak or insufficient burden...



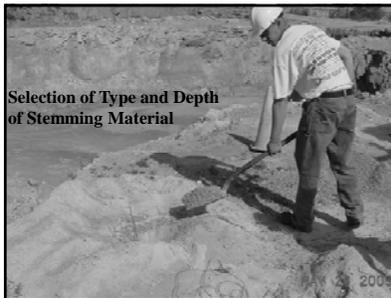
...and custom loading face holes to compensate for areas of weak or insufficient burden.

void

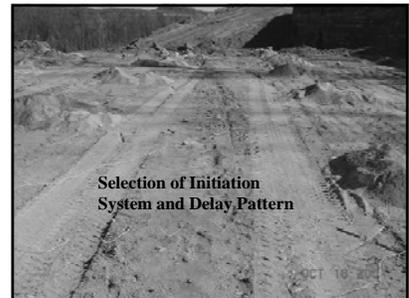


mud seam

Selection of Type and Depth of Stemming Material



Selection of Initiation System and Delay Pattern



How can the *driller* help prevent flyrock?

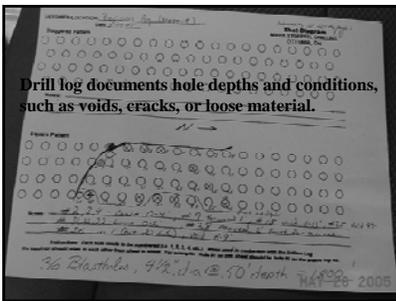
Strive for accurate drilling.



Keep a detailed drill log.



Drill log documents hole depths and conditions, such as voids, cracks, or loose material.

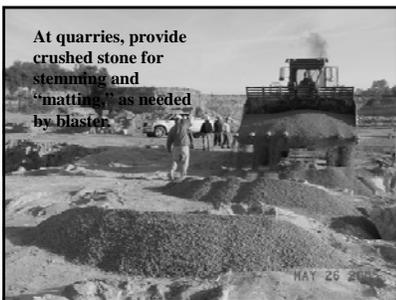


Communicate hole conditions to blaster before hole loading begins.

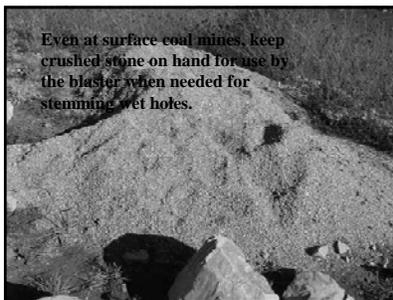


How can the *mine foreman* help prevent flyrock?

At quarries, provide crushed stone for stemming and "matting," as needed by blaster.



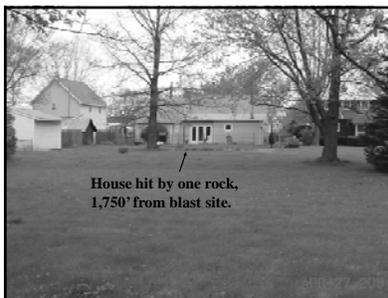
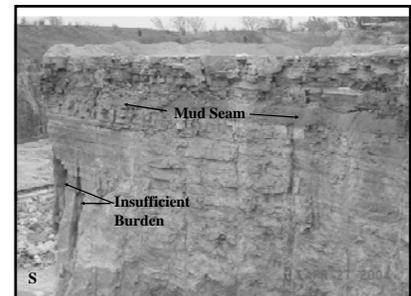
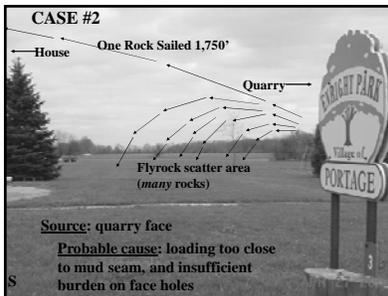
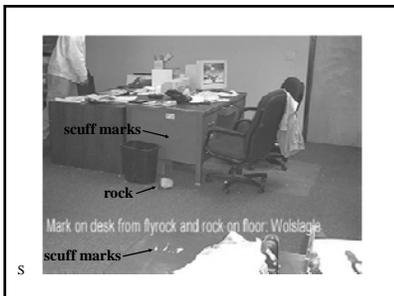
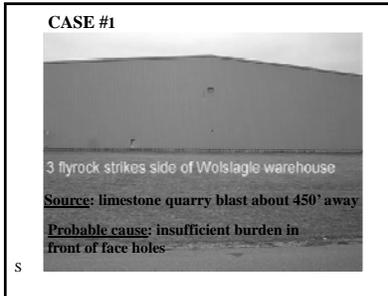
Even at surface coal mines, keep crushed stone on hand for use by the blaster when needed for stemming wet holes.

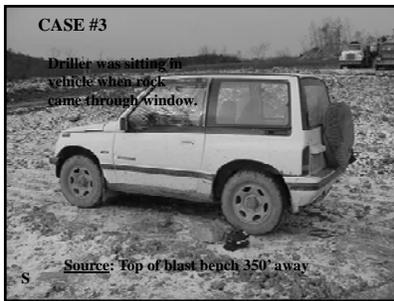


And Finally...
Don't Expect Miracles of the Blaster!

- Blasting SAFELY near houses and highways often requires smaller-scale, precision blasting, and will probably cost more
- Placing conveyors and crushing facilities close to blast faces requires precision (more expensive) blasting, or the acceptance of greater risk of property damage

And now, some examples of “close calls” during the past few years...





Contributing Flyrock Factors

- Broken drill bit replaced by smaller bit after drilling only front third of pattern, but pattern dimensions were not reduced to compensate, creating backpressure in back rows
- Back row, near crop edge, had greater depth of softer material on top, but stemming was not increased to compensate
- At 350' to the side of the blast bench, the driller was certainly at "fringe" of blasting area, and should have had "heavy metal" to duck under

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How are things done at your mine?



Blasting Safety Series

Underground Migration of Carbon Monoxide into Houses

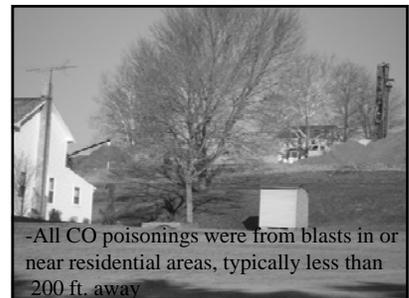
Since 1988, 17 cases have been reported where blast-generated CO moved through the earth into basements or other enclosed spaces.

- 39 suspected or medically verified poisonings
- One fatality (victim entered manhole close to where a construction blast was detonated)
- (How many have gone unreported?)

Carbon Monoxide Facts

- ALL blasts produce some CO (1% to 3% of gases)
- It is colorless, odorless, and tasteless
- Its density is about the same as air
- 35 ppm TWA is considered safe over 8 hours per NIOSH
- 1,200 ppm is Immediately Dangerous to Life and Health (IDLH) per NIOSH
- Effects: headache; nausea; dizziness; fatigue; death from asphyxiation (prolonged high concentrations)
- Range for CO migration incidents: 400 – 2,600 ppm

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Major Factors Affecting Degree of Confinement

- No free faces (except ground surface)
- Large stemming depth and/or thick overburden left in place over rock being blasted
- Little or no lateral movement (just upward heave)

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Heavily Confined Construction Blast Near Businesses



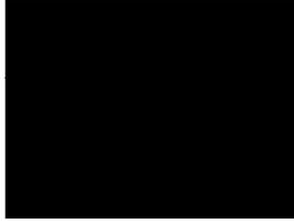
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Construction Blast in Urban Area



Click on photo for Video
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Heavily Confined Coal Overburden Blast Near I-70



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Quarry Blast With Good Lateral Movement



Click on photo for Video
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- Most CO poisonings were from construction blasts < 150' from houses or a manhole, **but...**

**Kittaning, PA Incident
April 2000**

- Surface coal mine – Upper Freeport coal
- CO migrated about 450' into house
- Three people suffered from CO poisoning



Lewis House

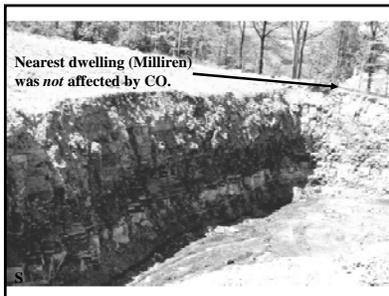
Dug well with concrete cap; deep and 3' wide

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CO Poisoning – Kittaning, PA

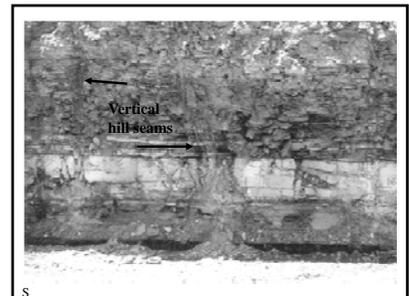
- Husband, wife and infant were treated at hospital
- Infant was placed in hyperbaric chamber
- Husband – 28% carboxyhemoglobin level
- Wife – 17%
- Infant (11 days old) – 31%
- All were released later that day

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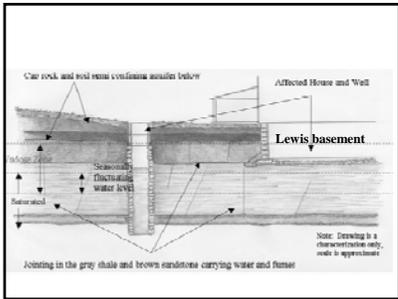
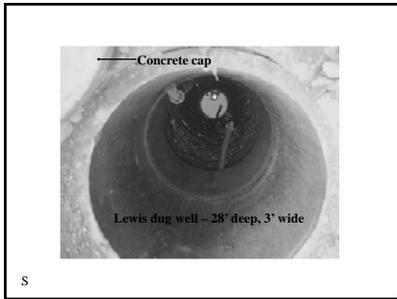
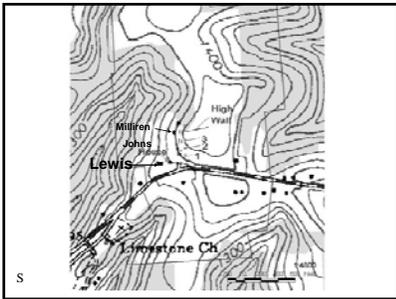
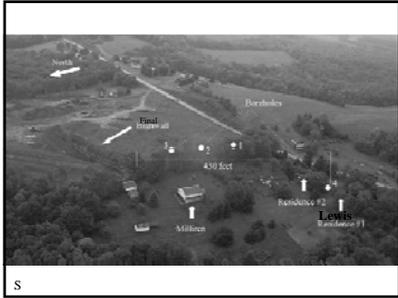
Nearest dwelling (Milliren) was not affected by CO.

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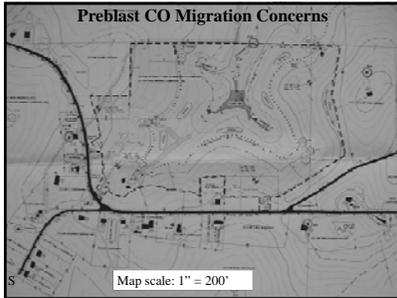
Vertical hill seams

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Major Factors Conducive to Underground CO Migration

- Heavily confined blast
- Leaving muck pile sit
- Geologic conduit from blast to house: vertical fractures ("hill seams") or horizontal bedding planes
- Man-made conduits: buried waterlines, old wells, basement sumps and drains, wall and floor cracks
- Distances generally 500' or less



Preblast Measures to Prevent CO Migration/Poisoning

- Locate houses with basements w/in 500' of final highwall, that are in or just above the rock strata to be blasted
- Conduct preblast inspection for possible entry points in those basements
- Install commercial-type CO detectors before blasting w/in 500' of those basements

Measures *During Mining* to Prevent CO Migration/Poisoning

- Apply to blasts within 500' of houses in or above strata being blasted
- Maintain at least one open face
- Use delay patterns that promote lateral movement
- *Immediately* begin removal of muck pile
- Continue mucking until the new rock face is completely exposed

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**CO Mitigation Measures
(what to do if CO is detected)**

- Immediately vacate persons and pets
- Notify proper authorities and seek assistance
- Ventilate house and basement with windows and exhaust fans
- Install exhaust fans over drains, sumps, and wells with high CO levels
- Drill and ventilate closely spaced holes between blast site and house

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Reasons/Justification for Preventing CO Migration

- “Blasting shall be conducted in a manner to **prevent injury to persons**, damage to public or private property....”
- Liability protection

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And remember:

Check Blast Plan for CO Prevention Measures!

(But if you don't find any, use good judgment and apply prevention and mitigation measures when appropriate.)

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