BLASTING GASES AND SAFETY

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Blasting Gases

- Carbon Dioxide
- Water Vapor
- Nitrogen
- Oxygen

- Carbon Monoxide
- Nitrogen Oxides
- Hydrogen Sulfide
- Ammonia
Ambient Gases

- Work place
- Home
- Agencies that address gases
  - Recommendations
  - Regulations
What is a confined space?

- Mines
- Basements
- Trench
- Wells
- Pits
- Well houses
- Crawl spaces
Confined Spaces

OSHA:

• Large enough and so configured that and employee can bodily enter and perform work
• Has limited or restricted means for entry or exit
• Not designed for continuous employee occupancy

MSHA:

• Any space or structure which by design has limited openings for entry and exit, and which is not intended for continuous employee occupancy

ME: Any place big enough to stick my head into
Consider Spatial Relationships

House

Source

Work Area

Pit

House

House
Physical Properties

Clean Dry Air

- Nitrogen: 78.08%
- Oxygen: 20.95%
- Argon: 0.93%
- Carbon Dioxide: 0.03%
- Other Gases: 0.01%

The chart also shows a table with percentage and PPM values:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>10,000</td>
</tr>
<tr>
<td>0.1</td>
<td>1,000</td>
</tr>
<tr>
<td>0.01</td>
<td>100</td>
</tr>
<tr>
<td>0.001</td>
<td>10</td>
</tr>
<tr>
<td>0.0001</td>
<td>1</td>
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</tbody>
</table>

Carbon Dioxide: 0.03% or 300 ppm

Clean Dry Air
Parts per million

4 drops of ink mixed into a 55 gallon drum is equivalent to 1ppm
Specific Gravity / Relative Density

The weight of a ratio of a specific gas compared to the same ratio of air. (Air = 1.00)
Left alone, gas molecules introduced into an environment will spread throughout the volume of that environment over time.
As temperature drops the volume of a gas compresses and its ability to diffuse into the air is lowered.

As temperature rises, the volume of a gas expands and its ability to diffuse into the air is elevated.
High Pressure

As pressure increases, the volume of a gas is compressed and its ability to diffuse into the air is less.
Low Pressure

As Pressure decreases, the volume of a gas is expanded and its ability to diffuse into the air is greater.
Physiological Impacts

A Clear and Present Danger
Dangers

 Explosive
  - Flying debris
  - Concussion Wave
  - Heat

Asphyxia
  - No oxygen in the blood

Toxic
  - Chemical cellular disruption
  - externally
  - internally
Combustible gases are explosive or flammable at different concentrations depending on volatility of the gas and amount of oxygen.
Asphyxia or asphyxiation (from Greek α-"without" and σφύξις sphyxis, "heartbeat") is a condition of severely deficient oxygen in the blood.

Suffocate – to kill by preventing the access of air to the blood; impede respiration
Asphyxiation from gases can be produced by:

- Displacement of the normal volume of Oxygen in air (20.9%)
- Through chemical processes that may affect the lungs.
Cyanosis

Blue or purple coloration of the skin or mucous membranes due to the tissues near the skin surface being low on oxygen

"the blue disease" or "the blue condition"
Carboxyhemoglobin

Carbon monoxide molecule replaces the oxygen molecule on hemoglobin

Classic cherry red skin is rare

"When you're cherry red, you're dead"
Toxic is defined as having some adverse effect under some defined condition of exposure.

Generally classified as poisonous.

May affect the human respiratory, circulatory, nervous systems.

May irritate the skin or be carcinogenic.

May produce immediate affects or accumulate over time.
Toxic levels are defined by **Threshold Limit Value (TLV)** of a chemical substance to which a **healthy worker** can be exposed day after day for a working lifetime **without adverse health effects**.

**TLV–TWA**, time weighted average, 8-hours

**TLV- STEL**, Short Term Exposure Level, 15 min

**IDLH**, Immediately Dangerous to Life and Health
Gas Detection Equipment

- Stain Tubes
- Single Gas Detectors
- Multi Gas Detectors
- Specialty gas detectors:
  - Photo Ionization Detector
  - Flame Ionization Meters
  - Radiation Dosimeters
Single Gas Meter or Alarm

$300

< $60
Multi-Gas Meters

$1,500 – $3,000
Carbon Dioxide

- Chemical Formula: CO$_2$
- **Specific Gravity**: 1.5291
- Molecular Weight: 44 g/mol
- **Physical Characteristics:**
  - Color: None
  - Odor: Slight acid smell
  - Taste: Slight acid taste at high concentrations
Carbon Dioxide

Physiological Characteristics

– Explosive – No
– Asphyxiant - Displaces Oxygen
– Toxicity
  • TLV-TWA = 5000 ppm (0.5% by volume)
  • TLV-STEL = 30,000 ppm (3% by volume)
  • IDLH = 40,000 ppm (4% by volume)
– Rapid breathing, Dizziness, Headaches, Confusion, Blackout, Death
Carbon Monoxide

• Chemical Formula: CO
• **Specific Gravity:** 0.9672
• Molecular Weight: 28.01 g/mol
• Physical Characteristics:
  – **Color:** None
  – **Odor:** None
  – **Taste:** None
Carbon Monoxide

Physiological Characteristics

– Explosive with > 6% Oxygen
  • 12.5% to 74%

– Asphyxiate - Displaces oxygen in blood

– Toxicity
  • TLV-TWA = 35 ppm (OSHA’s TWA = 50ppm)
  • TLV-STELE = 200 ppm
  • IDLH = 1200 ppm
Oxides of Nitrogen

• Chemical Formula: NO$_x$
  – NO (Nitric Oxide),
  – N$_2$O (Nitrous Oxide),
  – NO$_2$ (Nitrogen Dioxide)

• Production
  – *Produced during combustion*
  – Cycles between forms in air
    • NO + CH$_3$O$_2$ → NO$_2$ + CH$_3$O
    • NO$_2$ + sunlight → NO + O
Nitrogen Dioxide

- Chemical Formula: NO₂
- **Specific Gravity:** 1.5894
- Molecular Weight: 28.975 g/mol
- **Physical Characteristics:**
  - Color: Reddish Brown
  - Odor: Acidic smell
  - Taste: Acidic taste
Nitrogen Dioxide

- Explosive – No
- Asphyxiating – No
- Toxicity
  - TLV-TWA = None
  - TLV-STEL = 5 ppm
  - IDLH = 20 ppm
- Very Toxic when inhaled – caustic to human organs and tissues
Pathways – Surface, NOx

Atmospheric

– Inversions
– Wind
– Gravity
– Concentration
– Gradient/Pressure
– Temperature
– Gas type
– Topography
– Distance
### Pathways – Underground, CO

<table>
<thead>
<tr>
<th>Man-made</th>
<th>Natural</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Mines</td>
<td>- Rocks</td>
</tr>
<tr>
<td>- Water wells</td>
<td>- Caves</td>
</tr>
<tr>
<td>- Gas Wells</td>
<td>- Joints</td>
</tr>
<tr>
<td>- Boreholes</td>
<td>- Faults</td>
</tr>
<tr>
<td>- Subsidence cracks</td>
<td>- Bedding</td>
</tr>
<tr>
<td>- Utilities</td>
<td>- Unconsolidated soils</td>
</tr>
<tr>
<td>- Spoil</td>
<td></td>
</tr>
<tr>
<td>- Sewers</td>
<td></td>
</tr>
</tbody>
</table>
CO Migration

Atmospheric Pressure Differentials

Sump

CO Migration
Mitigation Concepts

Eliminate the source

Stop Blasting????
Mitigation Concepts
Structure Entry Points?

Caulk Cracks

Vapor Barriers

Seal Walls

Fill Blocks

The contractor is applying the coat of primer/sealer to the basement wall. This is east
wall.
Mitigation Concepts
Intercept the Pathways?

Barriers, CO
- Cut-off Walls: trenches backfilled with compacted natural soils, clay, concrete, synthetic materials
- Drill & Grout: penetration grouting, backfilling open voids & mine entries, pressure grouting fractures

Atmosphere, NOx
- Consider wind direction
- Secure the blast area
Mitigation Concepts
Source Elimination, NOx

• **ALWAYS** remain in a position away from the blast area until post-blast fumes, dusts, or mists have subsided. i.e. keep the blast area secure.
• Avoid moisture with ANFO or use plastic sleeves
• In wet holes use water resistant products
• Ensure proper confinement
• Ensure adequate stemming
• Prime the holes adequately
Mitigation Concepts
Source Elimination, CO

IME Recommendations

WARNINGS AND INSTRUCTIONS
for
CONSUMERS
IN TRANSPORTING, STORING,
HANDLING, AND USING
EXPLOSIVE MATERIALS

March 2000
Incorporates all changes through May 2004
ALWAYS - assume toxic concentrations of carbon monoxide gas from heavily confined shots such as those used in trenching can migrate through the earth and accumulate in nearby underground enclosed spaces such as basements or manholes.

ALWAYS - monitor nearby enclosed spaces for toxic gasses such as carbon monoxide after blasting.
• **ALWAYS** - ventilate nearby enclosed spaces and continue to monitor them if any carbon monoxide gas is detected in the enclosed space after blasting.

• **ALWAYS** - excavate blasted material from heavily confined shots as **soon as possible**. Blasted material may harbor dangerous concentrations of carbon monoxide gas for days if not excavated.

• **NEVER** - enter a recently blasted trench or an enclosed space **without checking for toxic gasses such as** carbon monoxide.
http://www.osmre.gov/resources/blasting.shtm
(ARblast.osmre.gov)

Questions?
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