Unified Mine Rescue Training (Advanced)
Underground Coal and Metal/Nonmetal Mines

U.S. Department of Labor
Mine Safety and Health Administration
National Mine Health and Safety Academy

Instruction Guide
IG 115 Appendix (Visuals Only)

2021

Sample Mine Emergency Notification Plan

SAMPLE MINE EMERGENCY NOTIFICATION PLAN				
Contact	**Name**	**Address**	**Telephone (Home)**	**Telephone (Office)**
1. Mine Rescue Team Trainer				
2. Mine Rescue Team Members				
3. Mine Superintendent and Responsible Persons				
4. Mine Foreman				
5. Safety Director				
6. General Mine Manager				
7. General Mine Superintendent				
8. District Inspector (State and Federal)				
9. Chief, State Department of Mines				
10. District MSHA Office				
11. Miners' Representative				
12. Law Enforcement Agencies				
13. Medical personnel, ambulances, and other emergency vehicles				
14. Hospital to be alerted				

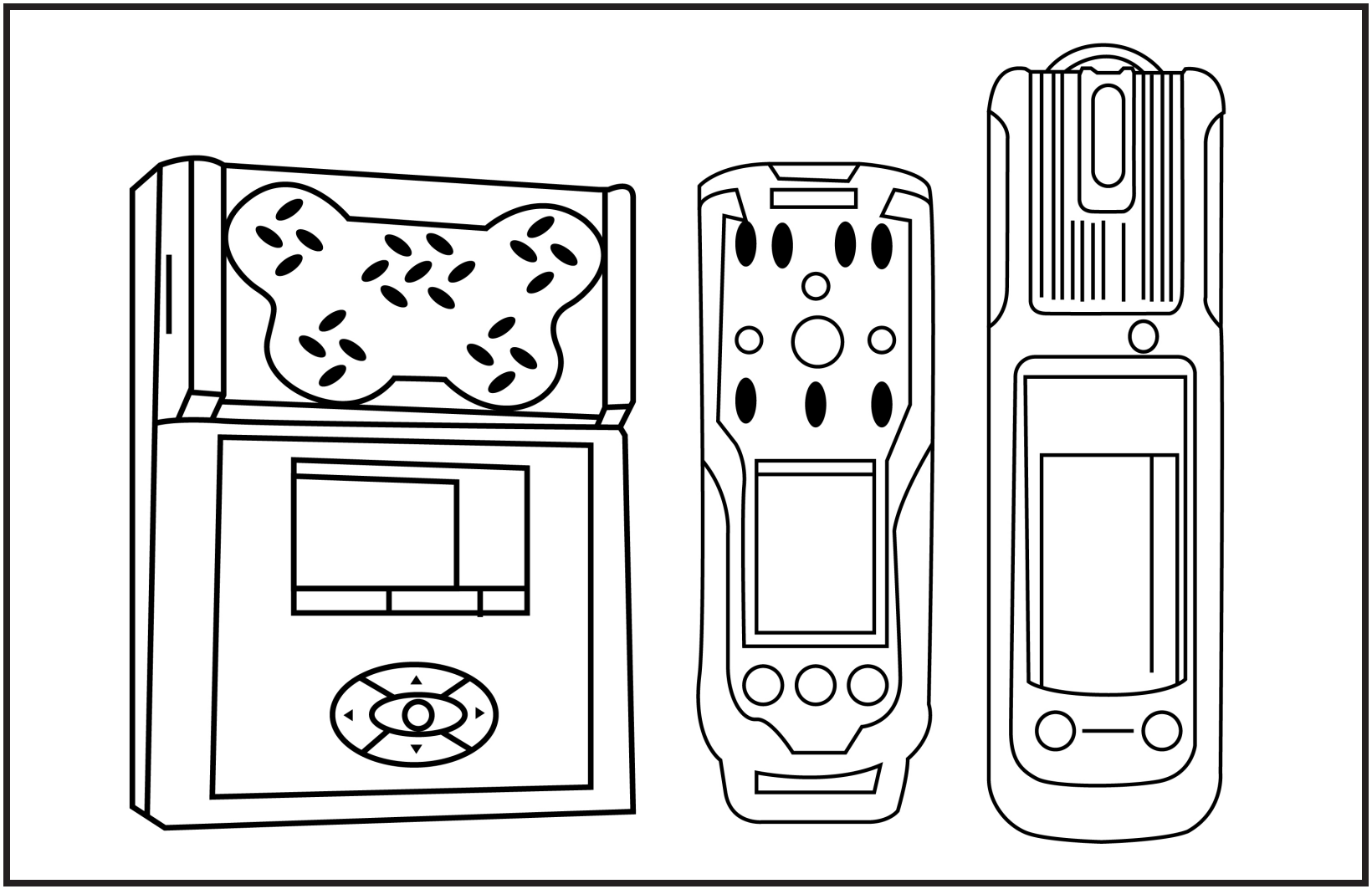
Sample Six-Team Rotation Schedule

SAMPLE SIX-TEAM ROTATION SCHEDULE (24-Hour Period)												
Team No. and Captain	**Two-Hour Time Periods**											
1	Work	R	R	Standby	Standby	Backup at FAB	Work	R	R	Standby	Standby	Backup at FAB
2	Backup at FAB	Work	R	R	Standby	Standby	Backup at FAB	Work	R	R	Standby	Standby
3	Standby	Backup at FAB	Work	R	R	Standby	Standby	Backup at FAB	Work	R	R	Standby
4	Standby	Standby	Backup at FAB	Work	R	R	Standby	Standby	Backup at FAB	Work	R	R
5	R	Standby	Standby	Backup at FAB	Work	R	R	Standby	Standby	Backup at FAB	Work	R
6	R	R	Standby	Standby	Backup at FAB	Work	R	R	Standby	Standby	Backup at FAB	Work

NOTE: This schedule is a sample of how six teams could be rotated during a 24-hour period. If a larger number of teams are available, the schedule of rotation would, of course, be different.

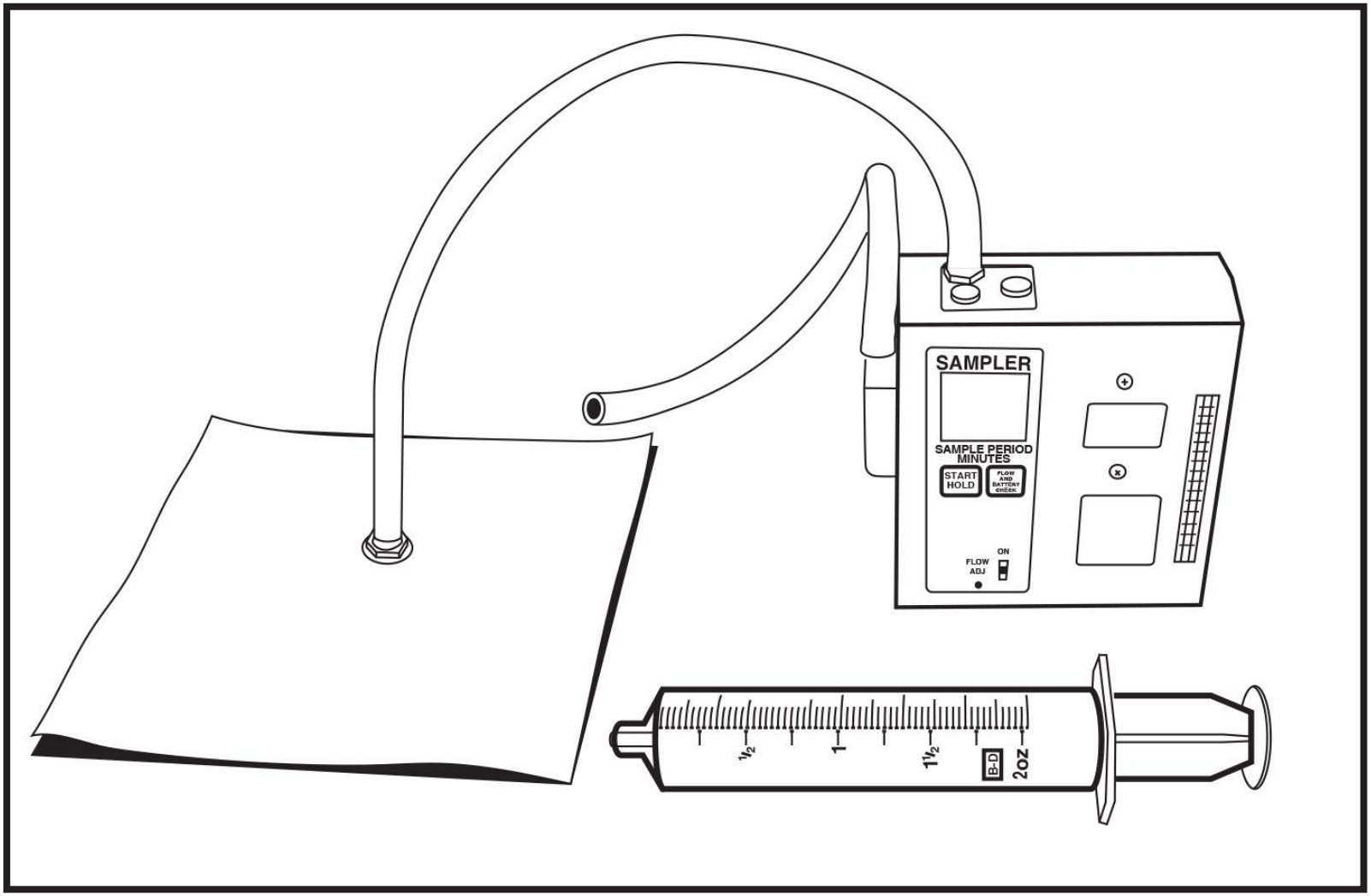
R = Reserve FAB = Fresh Air Base

Gas Detectors



Module 2 - Visual 1

SKC Sample Bag, Sampler Pump and 60mm Syringe



Module 2 - Visual 2

Effects of Temperature and Pressure on Gas

Effects of Temperature and Pressure

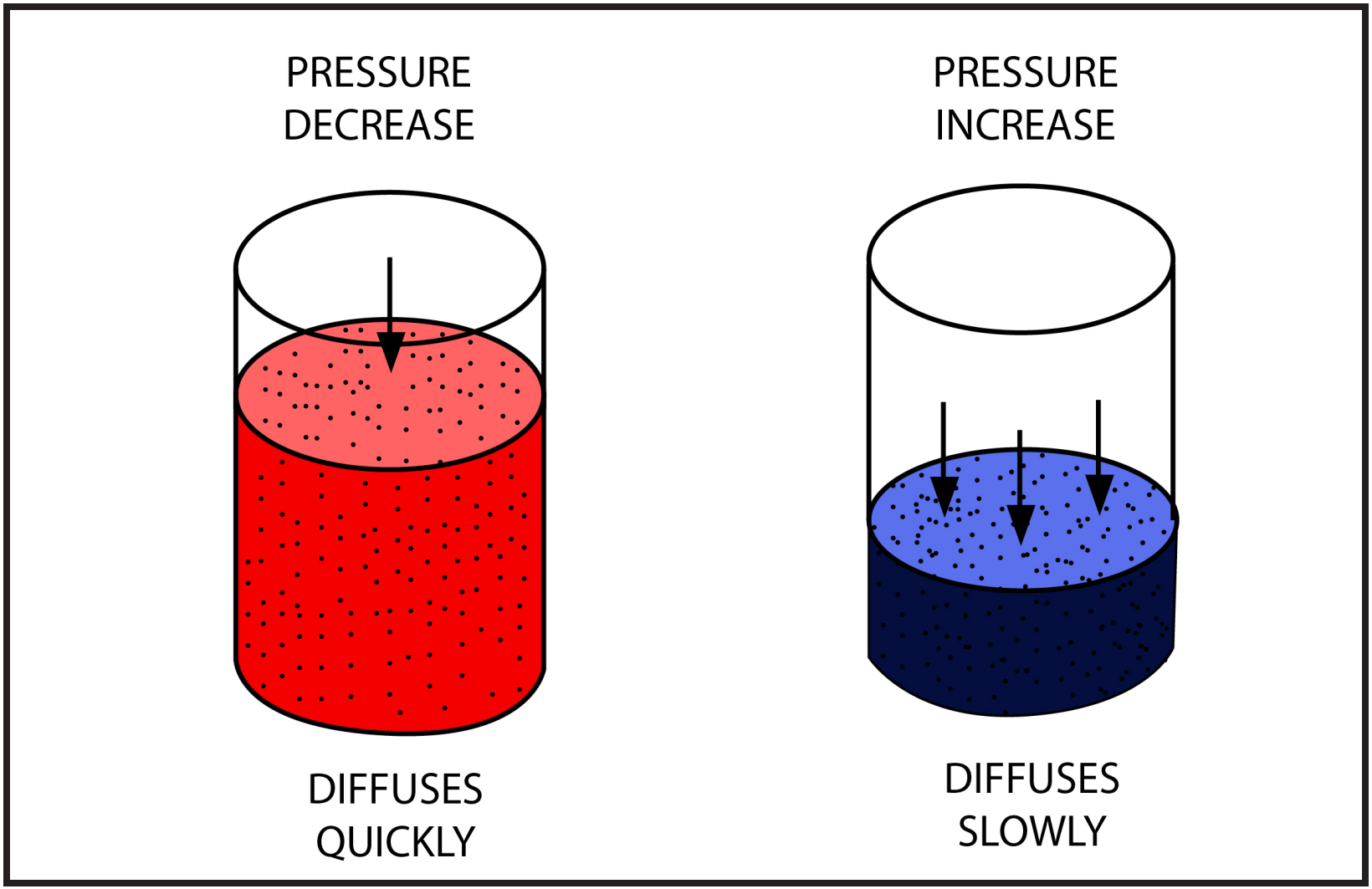
pressure increases – gas contracts

pressure decreases – gas expands

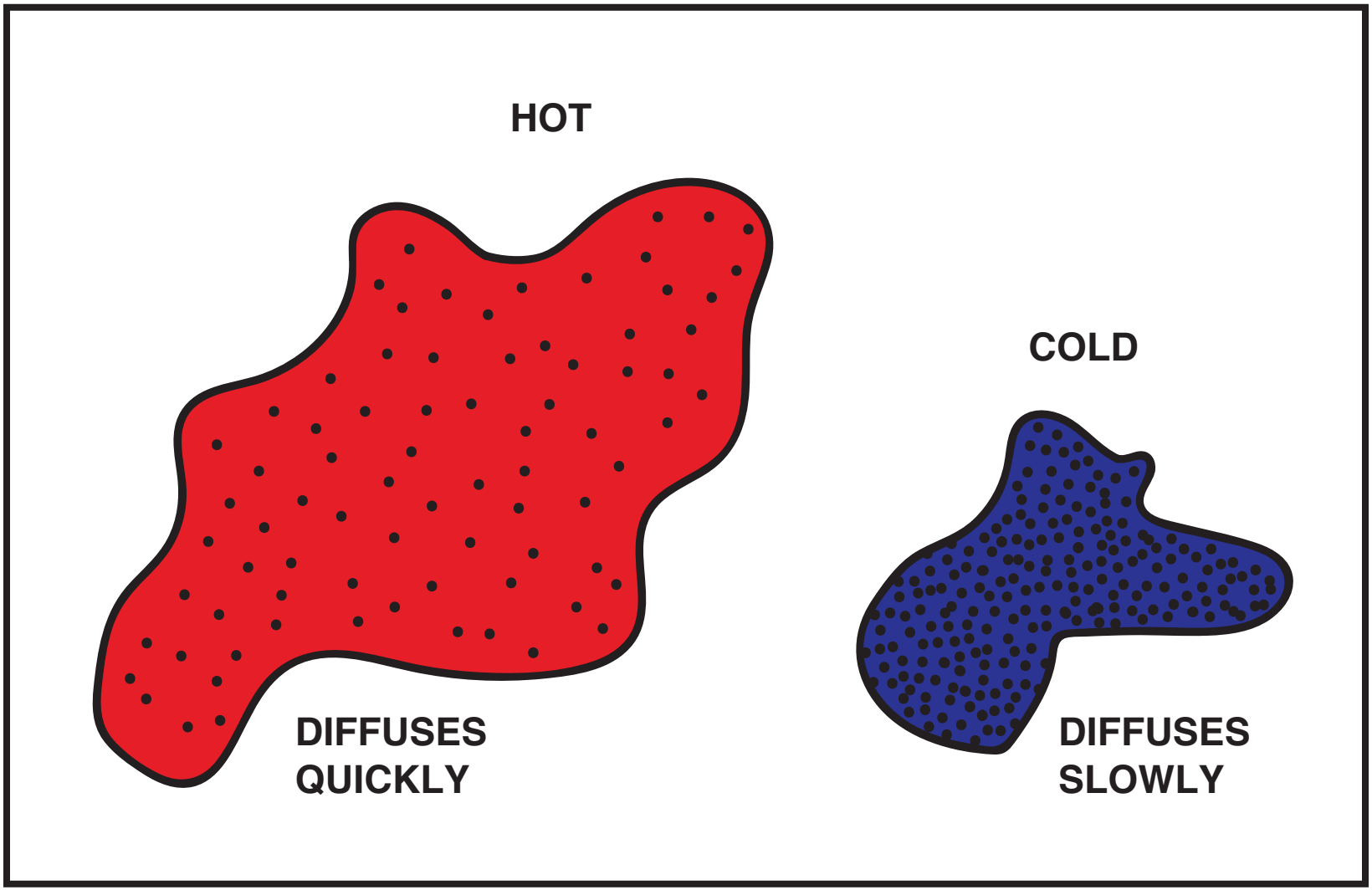
temperature increases – gas expands

temperature decreases – gas contracts

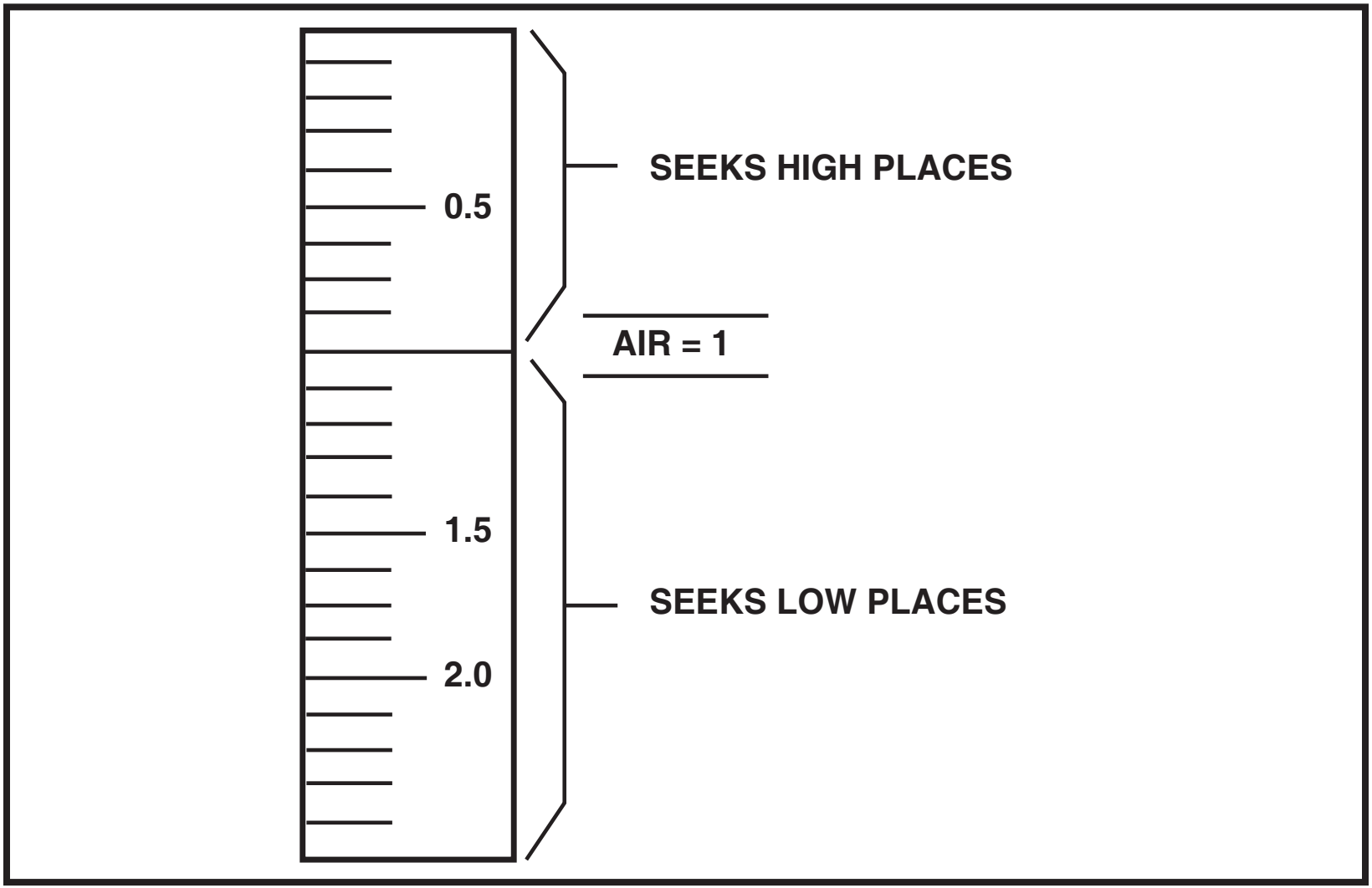
Effects of Pressure on Gas



Effects of Temperature on Gas



Specific Gravity (relative weight)

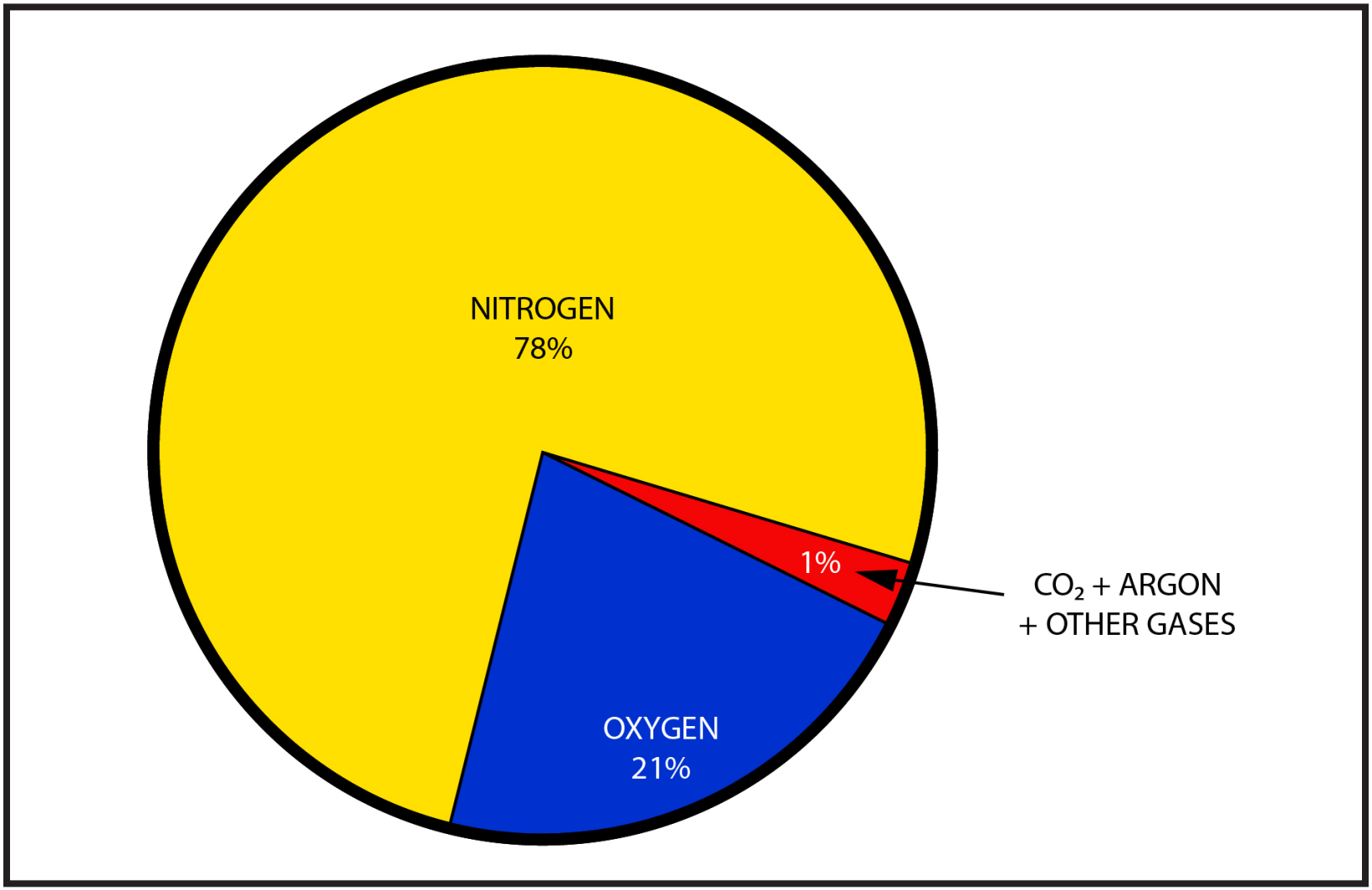


Effects of Toxic Gas

Effects of Toxic Gas Depend on:

1. Concentration
2. Toxicity
3. Length of Exposure

Contents of Normal Air



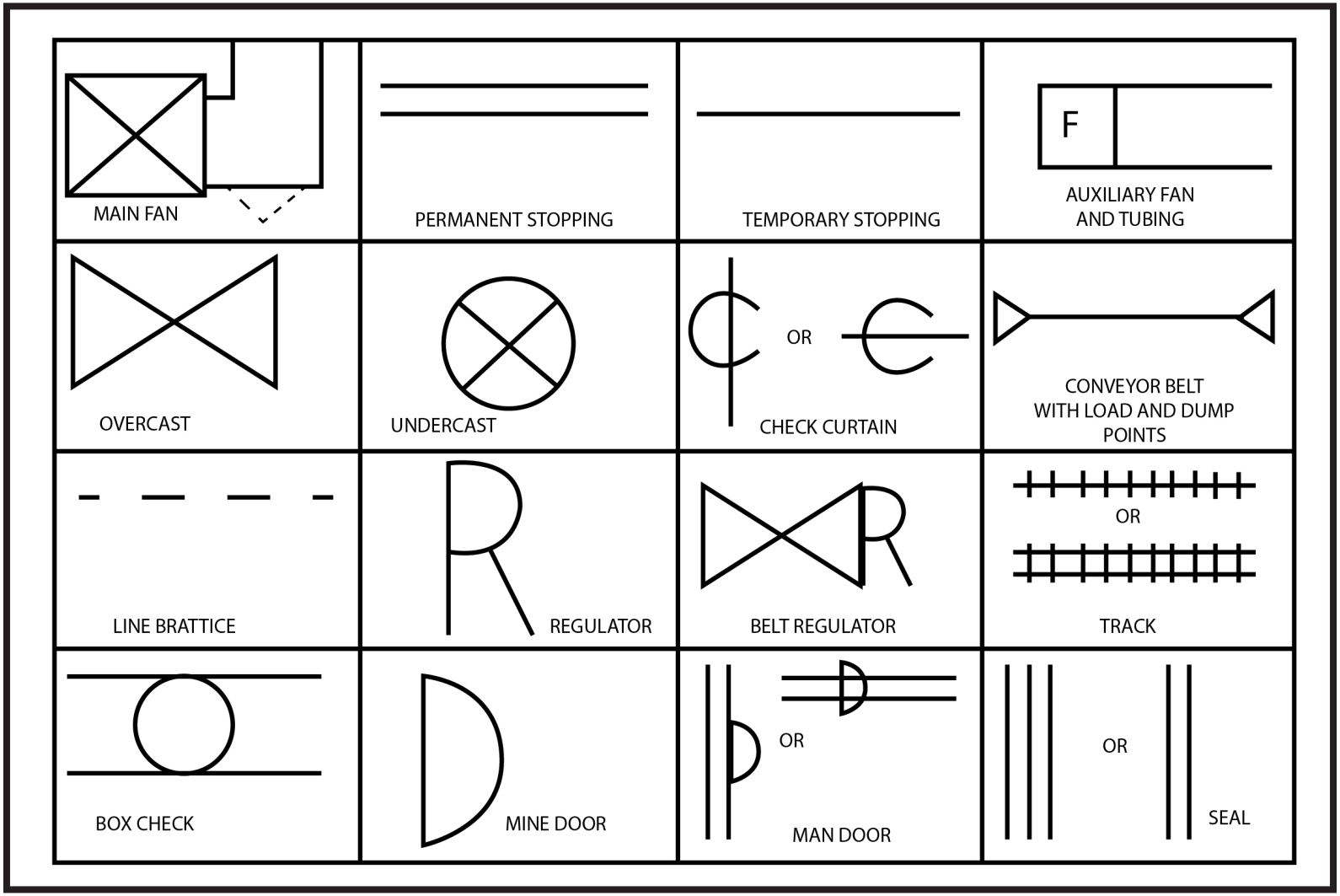
Mine Gases Chart

Gas	Chemical Symbol	Specific Gravity	Explosive Range	Solubility	Color/Odor/ Taste	Health Hazards	IDLH	Test Location
Normal Air	– –	1.0	– –	– –	– –	– –	– –	– –
Oxygen	O_2	1.1054	Supports combustion	Moderate	– –	Respiratory/cardiovascular in oxygen deficient atmosphere	8 - 10%	All areas of opening
Carbon Dioxide	CO_2	1.5291	– –	Soluble	Acid taste - high concentrations	Respiratory/cardiovascular in high concentrations	40,000 ppm	Low areas near floor
Methane	CH_4	0.5545	5 to 15%	Slight	– –	– –	– –	High areas near roof
Carbon Monoxide	CO	0.9672	12.5 to 74.2%	Slight	– –	Highly toxic to cardiovascular system even in low concentrations	1,200 ppm	Near center of openings
Nitrogen	N_2	0.9674	– –	Slight	– –	Asphyxiant in higher concentrations due to oxygen displacement	– –	Near face areas
Nitrogen Dioxide	NO_2	1.5894	– –	Very Slight	Reddish brown color- high concentrations, odor/taste of blasting powder	Highly toxic to respiratory system even in low concentrations	20 ppm	Low areas near floor
Hydrogen	H_2	0.0695	4.0 - 74.2%	– –	– –	Asphyxiant in higher concentrations due to oxygen displacement	– –	High areas - especially near battery charge stations
Hydrogen Sulfide	H_2S	1.1906	4.3 - 45.5%	Soluble	Rotten egg odor/ slightly sweet taste	Highly poisonous to respiratory system and eyes even in low concentrations	100 ppm	Low areas - especially near water accumulation
Sulfur Dioxide	SO_2	2.2638	– –	High	Sulfur odor/ acidic taste	Highly toxic to respiratory system and eyes even in very low concentrations	100 ppm	Low areas near floor
Ethane	C_2H_6	1.0493	3.0 to 12.5%	Slight	– –	Asphyxiant in higher concentrations due to oxygen displacement	– –	Low areas - especially near gas and oil wells
Propane	C_3H_8	1.5625	2.12 to 9.35%	Slight	– –	Asphyxiant in higher concentrations due to oxygen displacement	– –	Low areas - especially near gas and oil wells
Butane	C_4H_{10}	2.0100	1.86 to 8.41%	Slight	– –	Asphyxiant in higher concentrations due to oxygen displacement	– –	Low areas - especially near gas and oil wells
Acetylene	C_2H_2	0.9107	2.5 to 80%	Very Slight	Slight garlic odor	Asphyxiant in higher concentrations due to oxygen displacement	– –	All areas after methane explosion
Radon	Rn	7.526	– –	High	– –	Continuous exposure linked to lung cancer	– –	Most prevalent in uranium mines

Gas Detection Chart

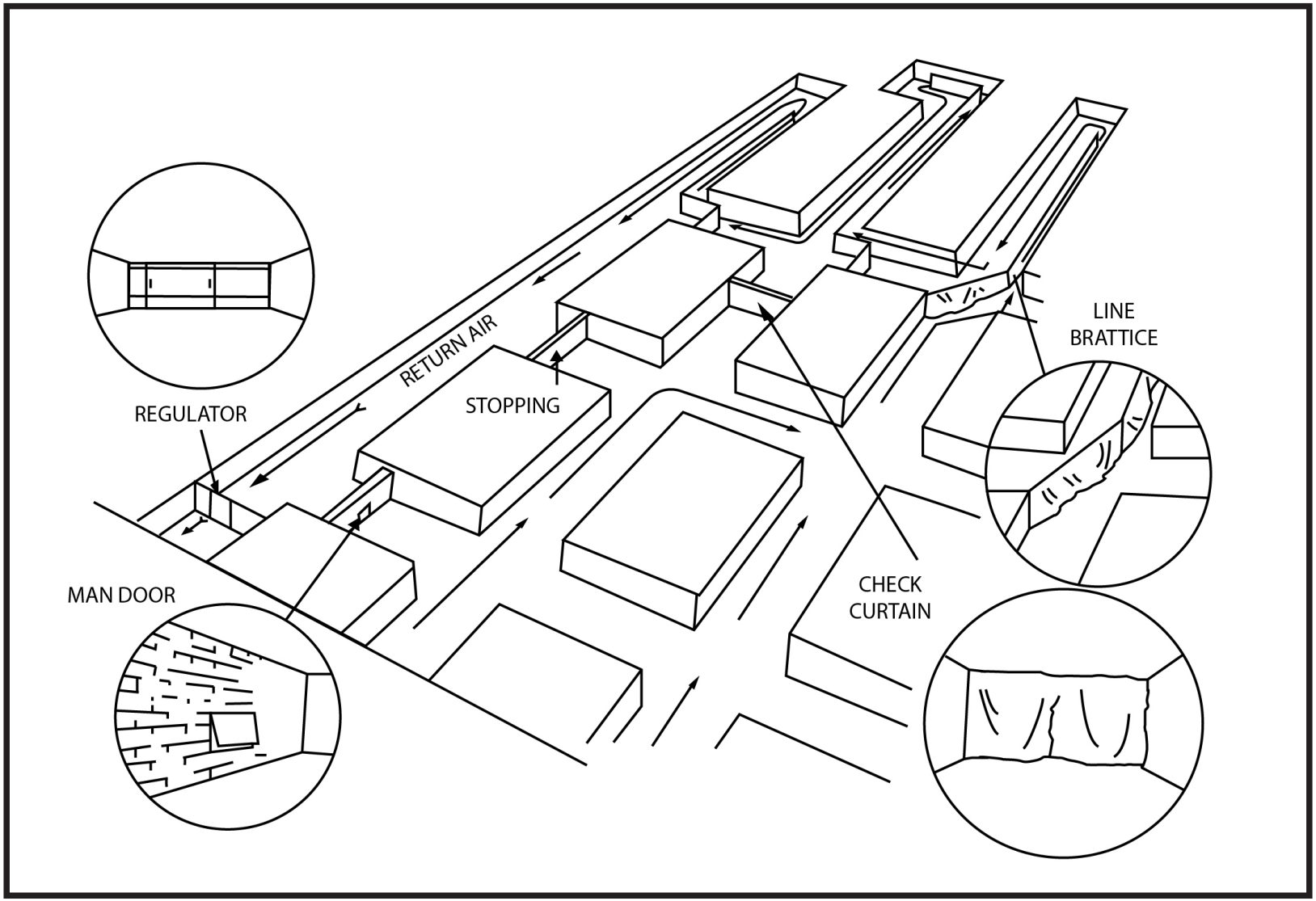
GAS	DETECTION METHODS	WHEN TO TEST
Oxygen (O_2)	Oxygen indicator. Chemical analysis.	During any team exploration.
Nitrogen (N_2)	Chemical analysis.	When an oxygen deficient atmosphere is suspected. In mines where nitrogen issues from rock strata. In inactive areas where ventilation has been inadequate.
Carbon Dioxide (CO_2)	Carbon dioxide detector. Multi-gas detector. Chemical analysis.	After a fire or explosion. When entering abandoned areas. When reopening sealed areas.
Carbon Monoxide (CO)	Carbon monoxide detector. Multi-gas detector. Chemical analysis.	During any team exploration, especially when fire is suspected.
Nitrogen Dioxide (NO_2)	Nitrogen dioxide detector. Multi-gas detector. Chemical analysis. Color.	After mine fires or explosions. When diesel equipment is used. After detonation of explosives.
Hydrogen (H_2)	Multi-gas detector. Chemical analysis.	After mine fire or explosion. Near battery- charging stations. When steam is produced by water, mist, or foam in fire-fighting.
Hydrogen Sulfide (H_2S)	Hydrogen sulfide detector. Multi-gas detector. Chemical analysis. Eye irritation.	In poorly ventilated areas. During unsealing operations. Following mine fires.
Sulfur Dioxide (SO_2)	Multi-gas detector. Chemical analysis. Odor, taste, and respiratory tract irritation.	When standing water is disturbed. After mine fires or explosions and when reopening sealed areas of the mine after mine fires.
Methane (CH_4)	Methane detector. Chemical analysis.	During any team exploration. When normal ventilation is disrupted. When entering abandoned workings.
Heavy Hydrocarbons Ethane (C_2H_6) Propane (C_3H_8) Butane (C_4H_{10})	Multi-gas detector. Chemical analysis.	Following fires or explosions when methane is present. Following accidental entry into adjacent oil or gas well casings.
Acetylene (C_2H_2)	Multi-gas detector. Chemical analysis. Odor.	Following a methane explosion in air which is low in oxygen.
Radon (Rn)	Survey meter.	When normal ventilation is disrupted and during unsealing operations.

Sample Mine Map Symbols



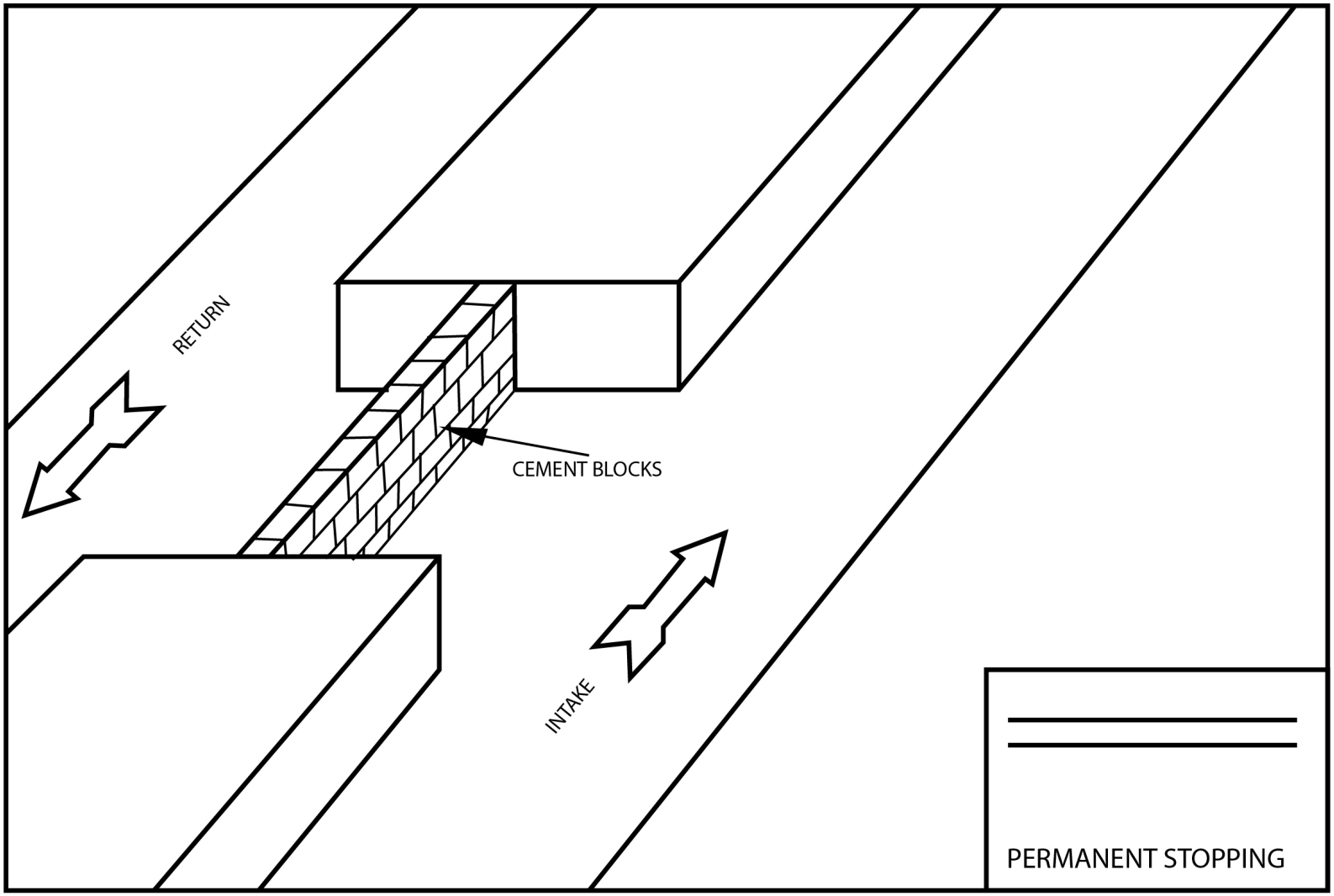
Module 3 - Visual 1

Ventilation Controls



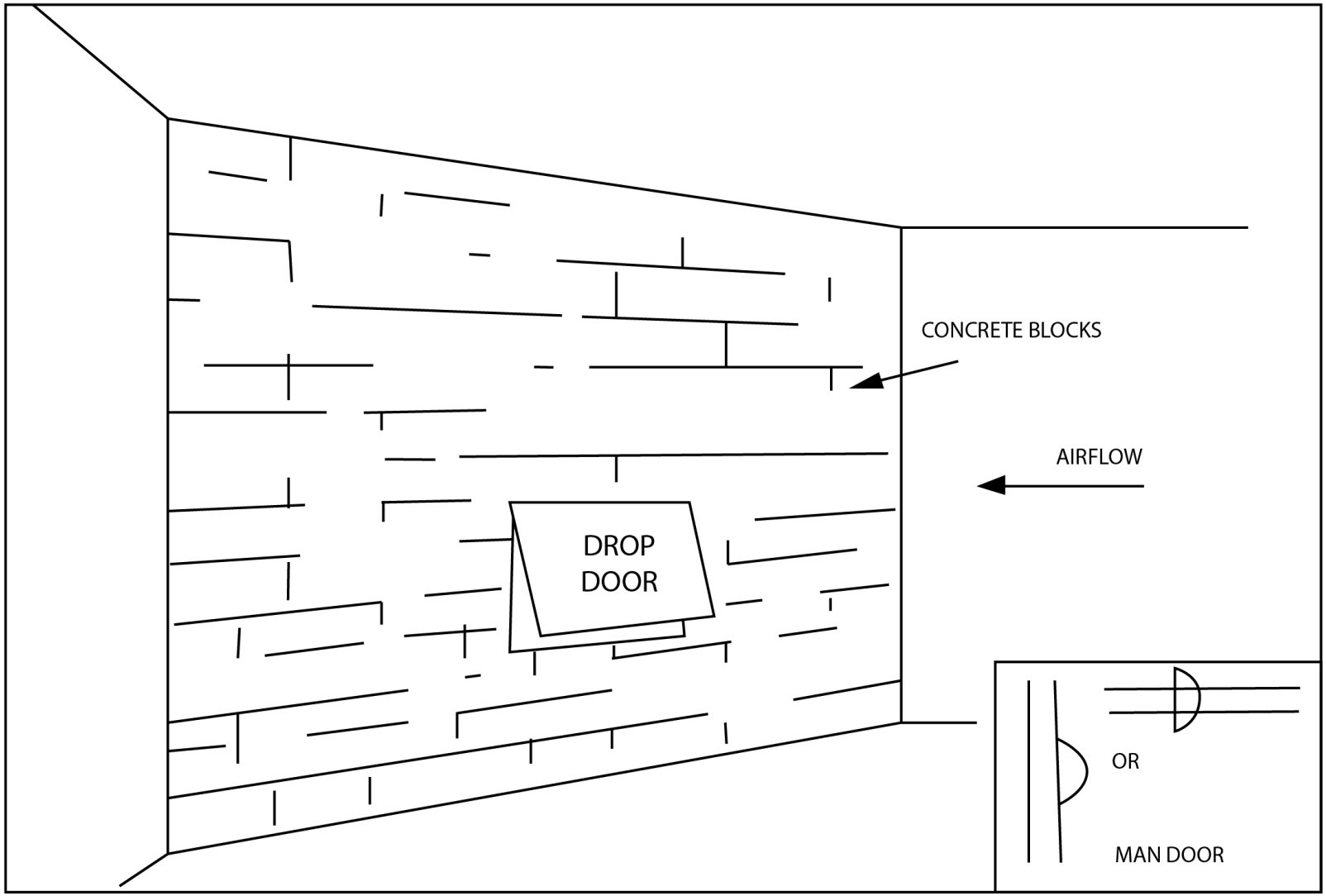
Module 3 - Visual 2

Permanent Stopping



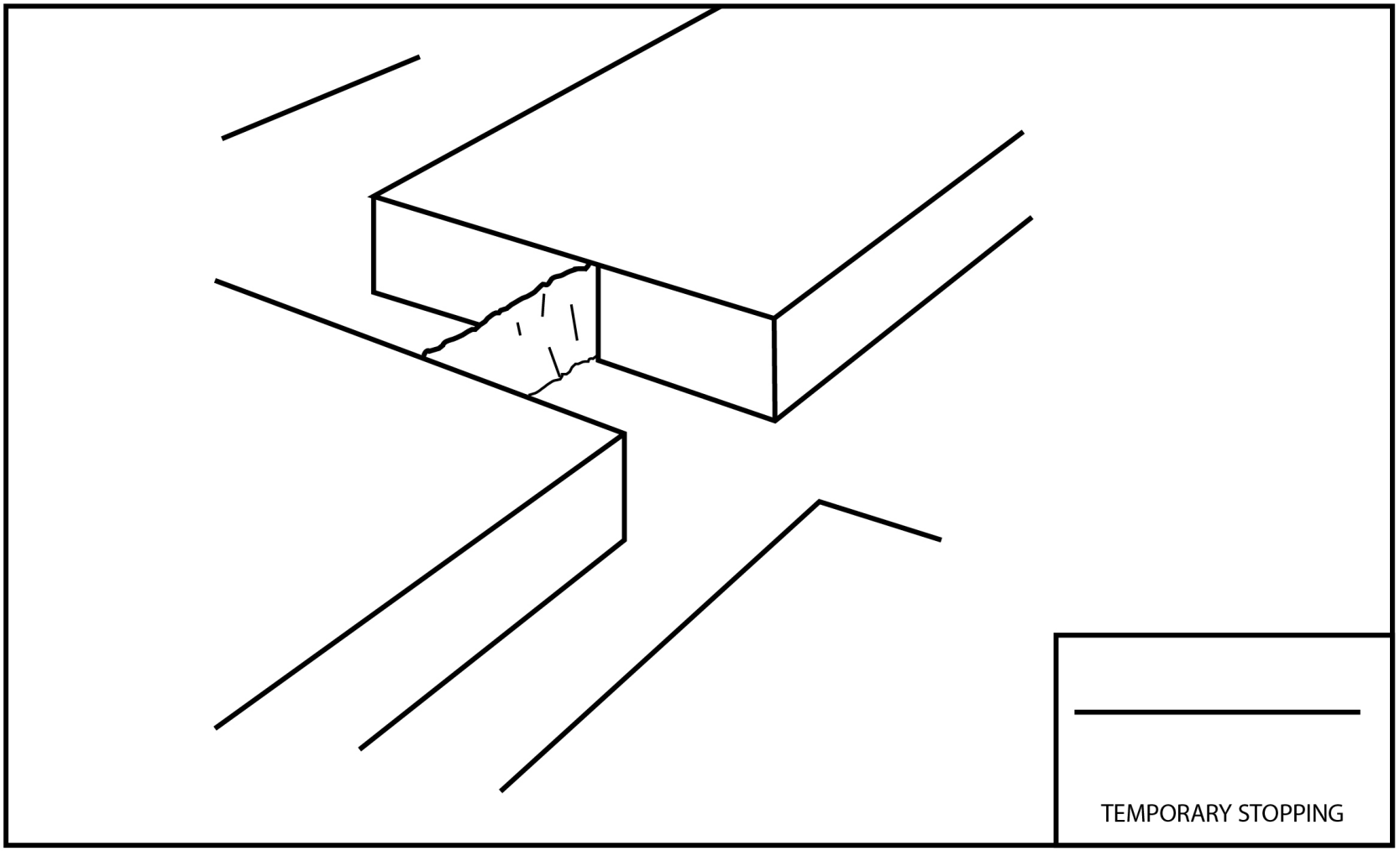
Module 3 - Visual 3

Permanent Stopping with Man Door (or Drop Door)



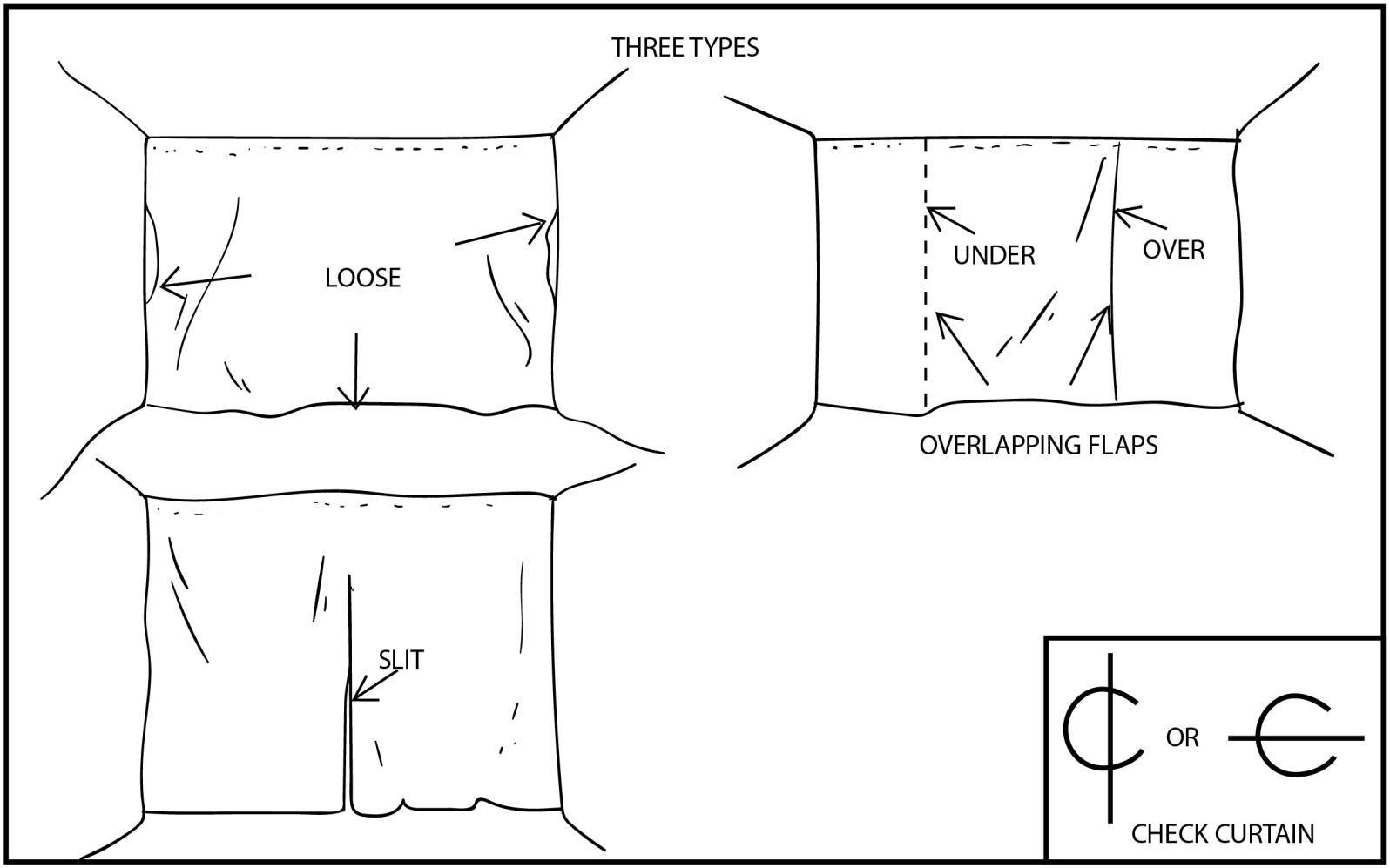
Module 3 - Visual 4

Temporary Stopping

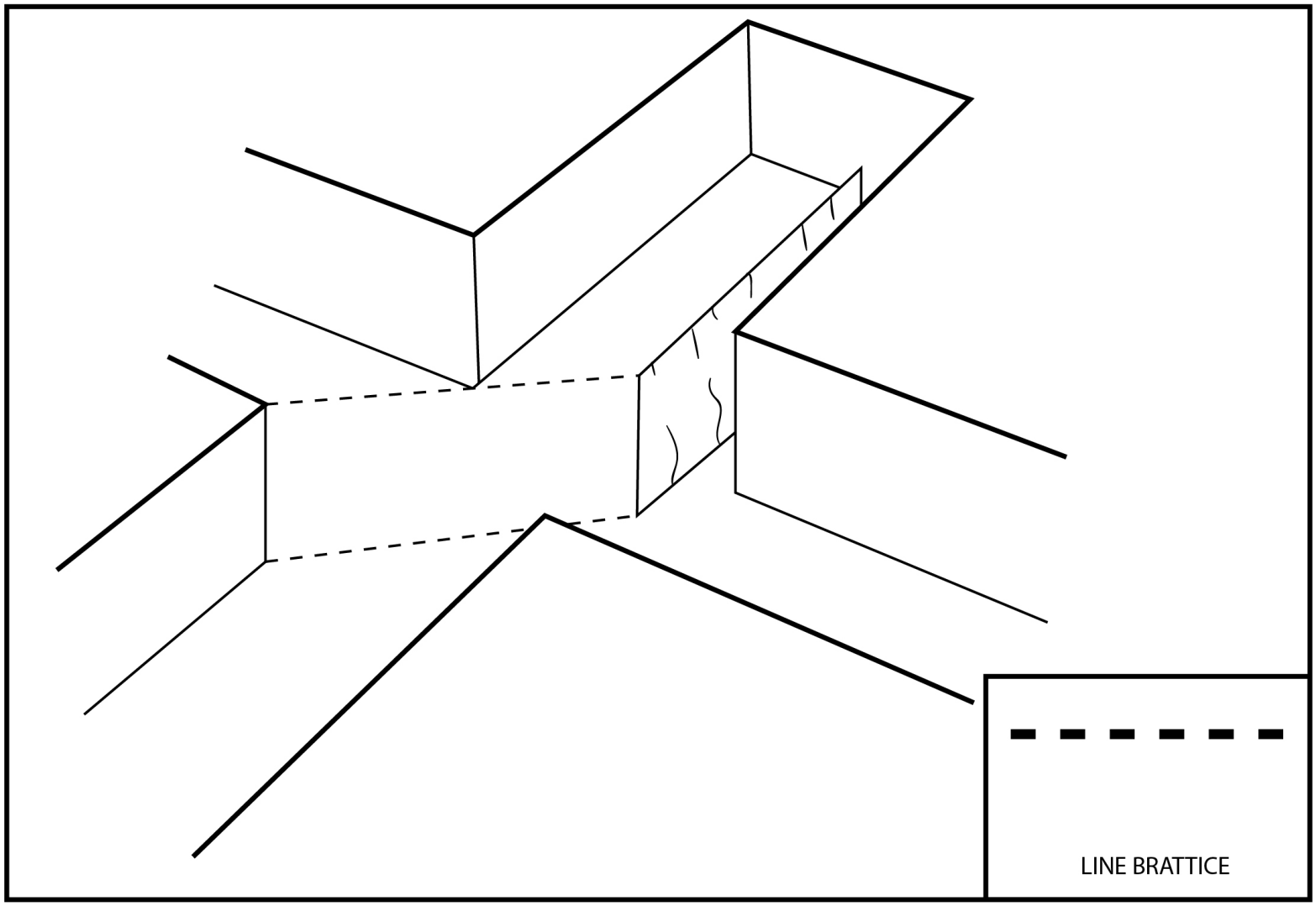


Module 3 - Visual 5

Check Curtains or Run-Through Checks

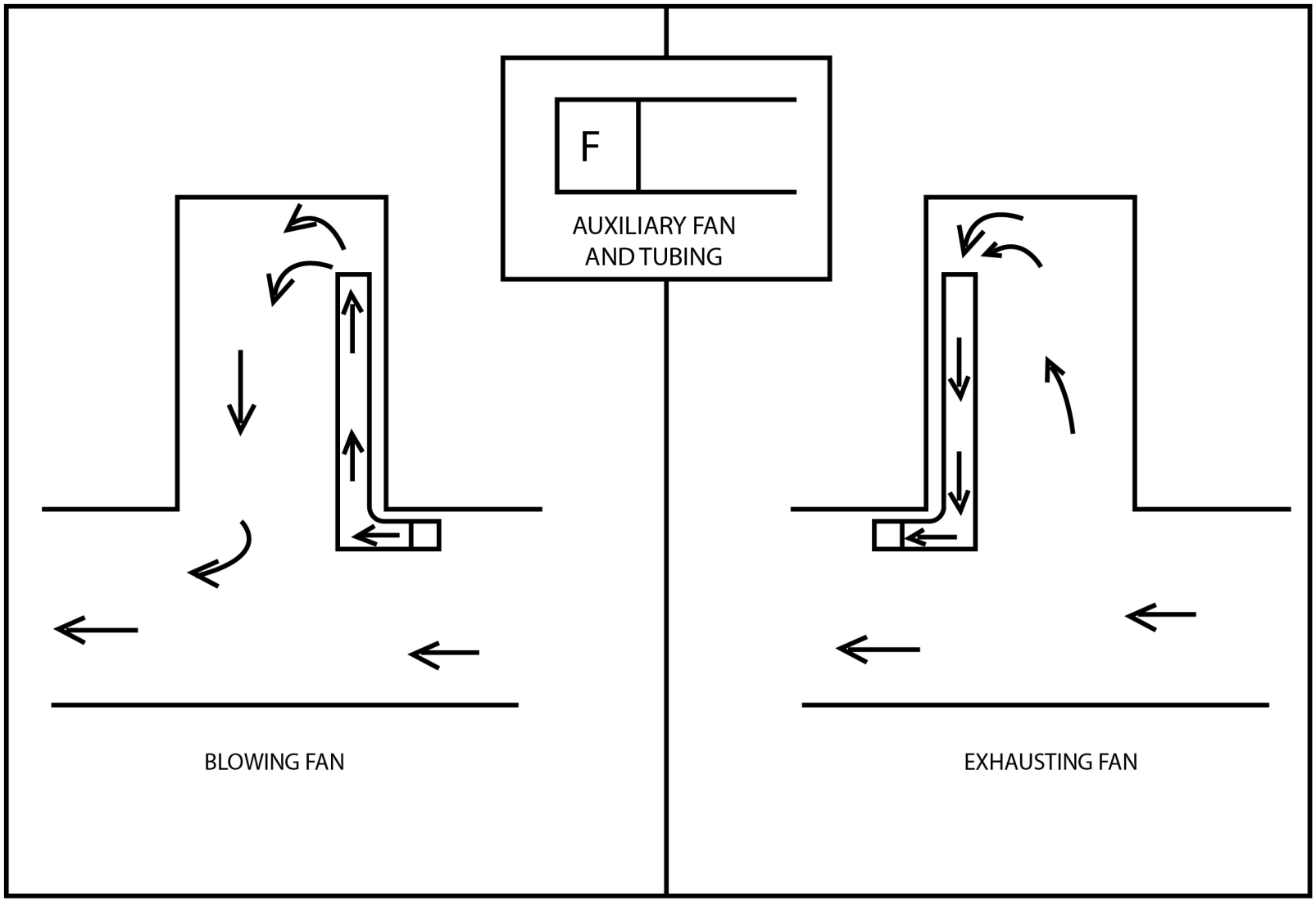


Line Brattice / Line Curtain



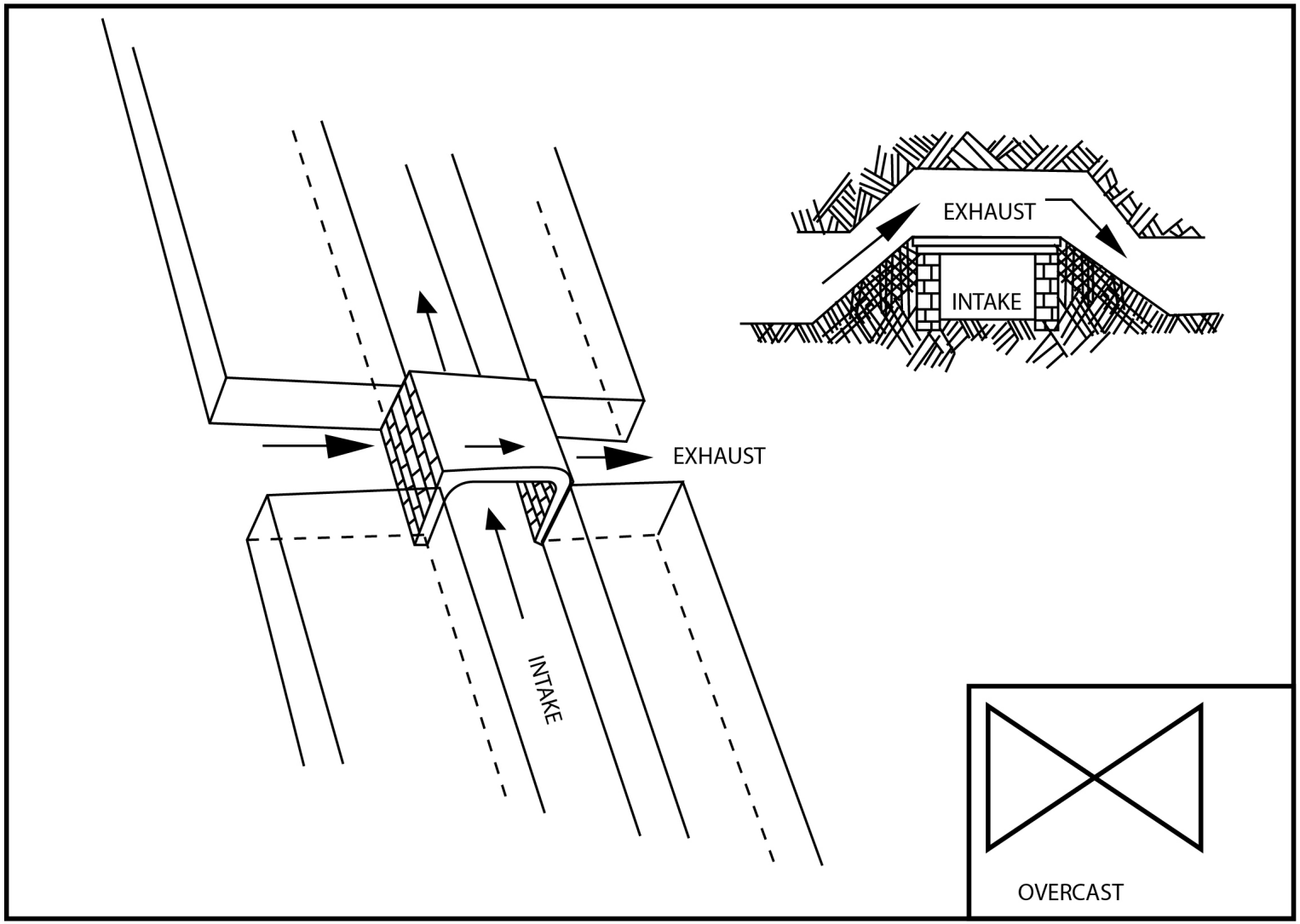
Module 3 - Visual 7

Auxiliary Fan and Tubing



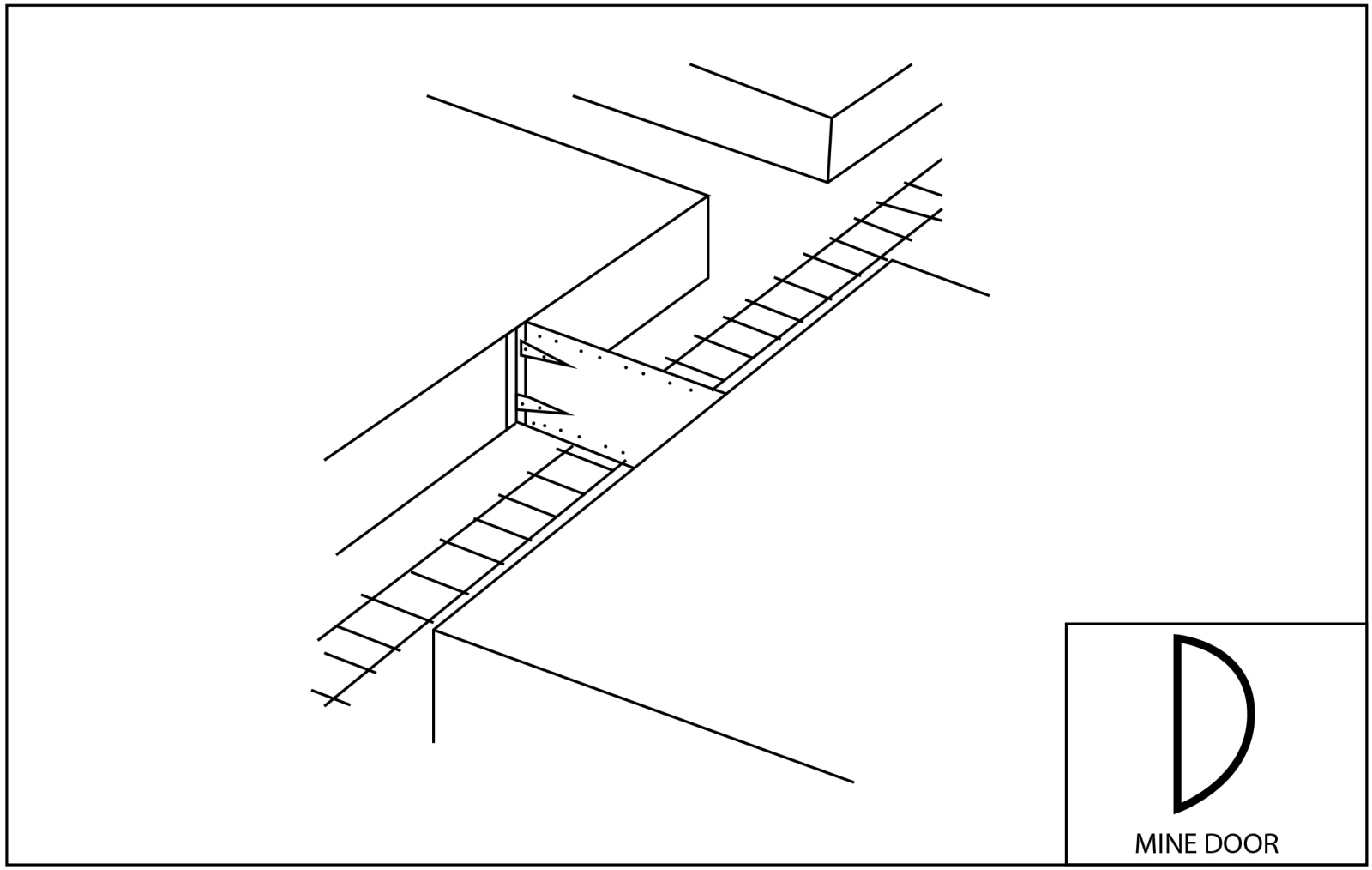
Module 3 - Visual 8

Overcast

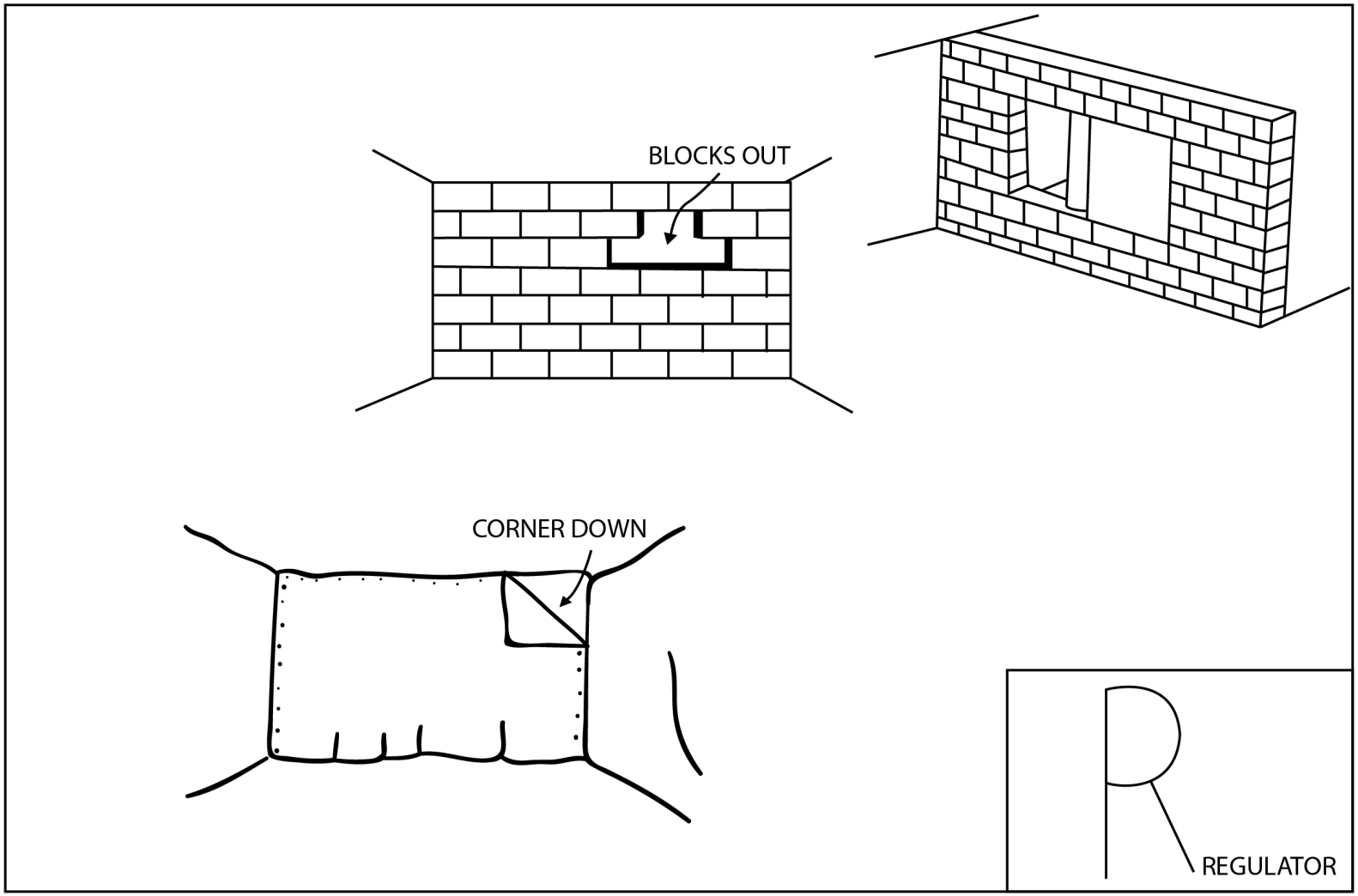


Module 3 - Visual 9

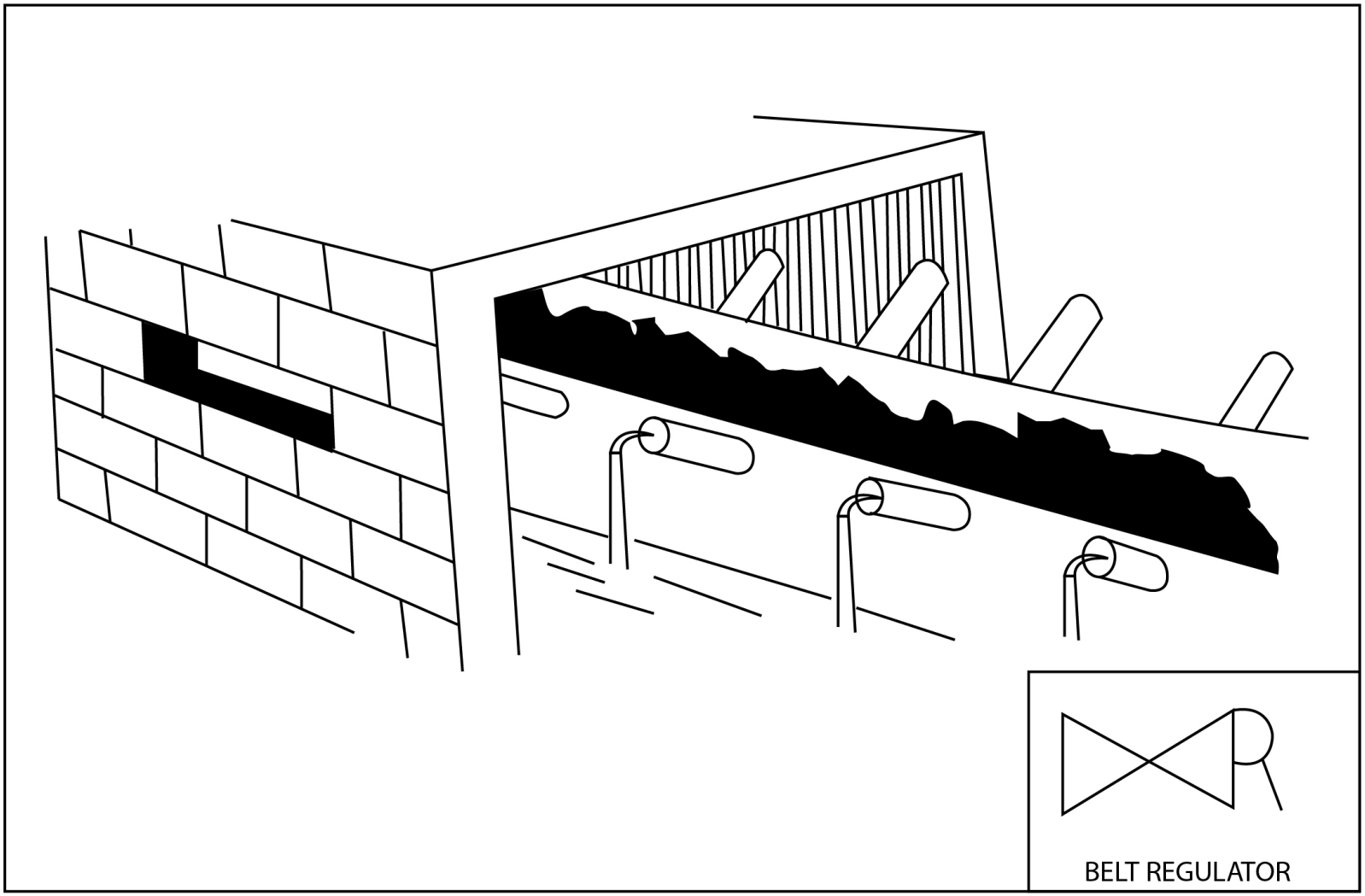
Mine Door



Types of Regulators

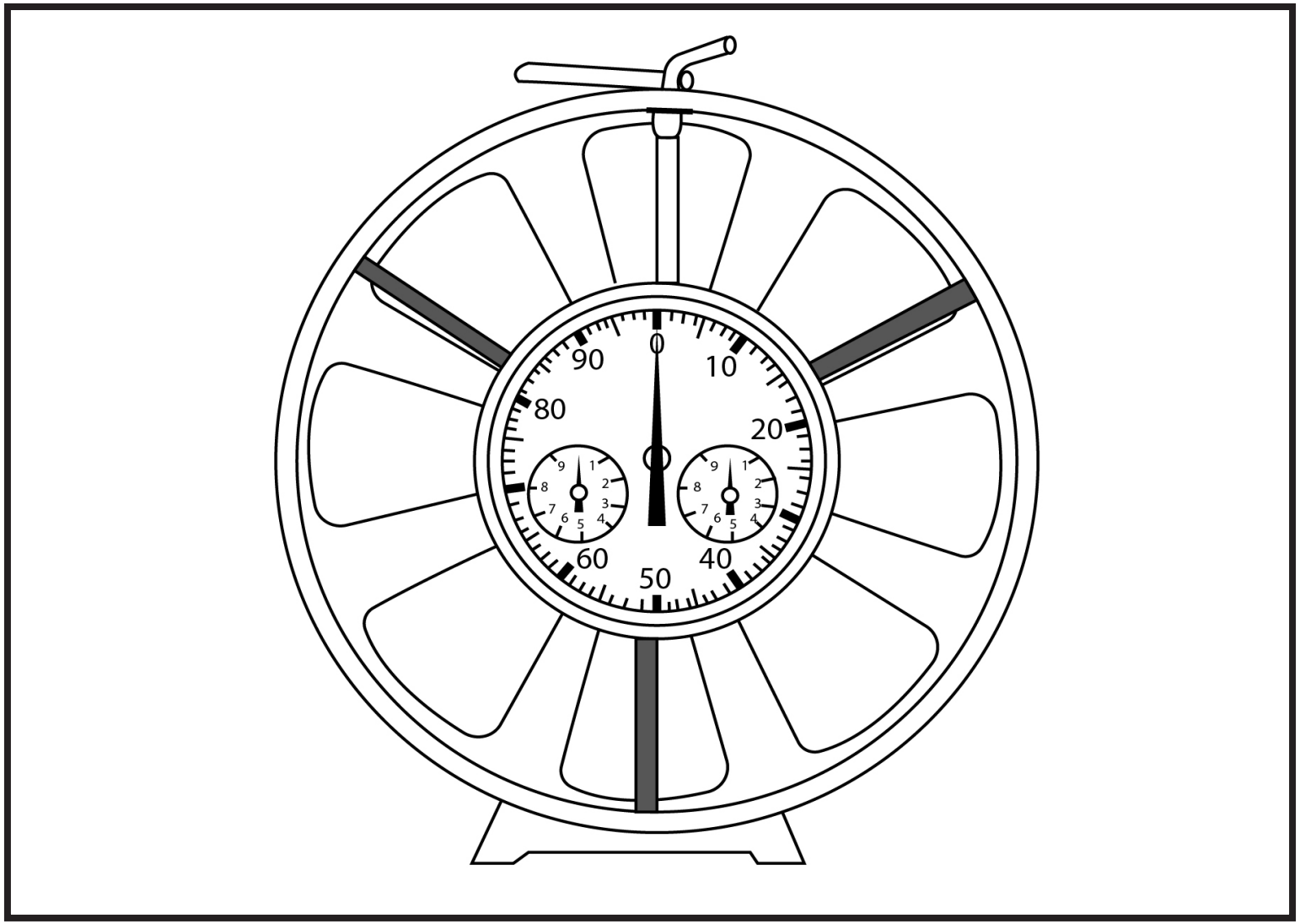


Belt Regulator

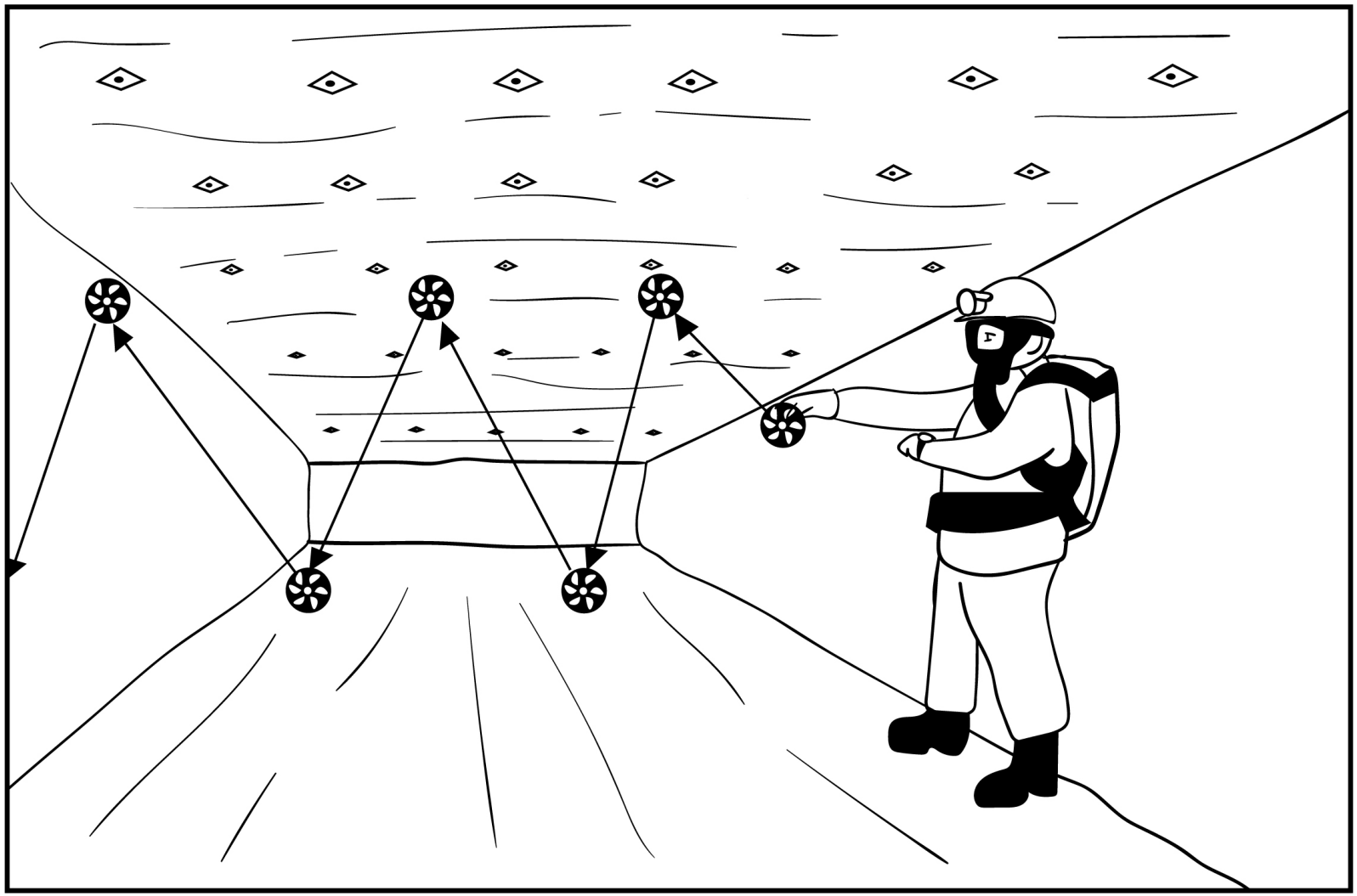


Module 3 - Visual 12

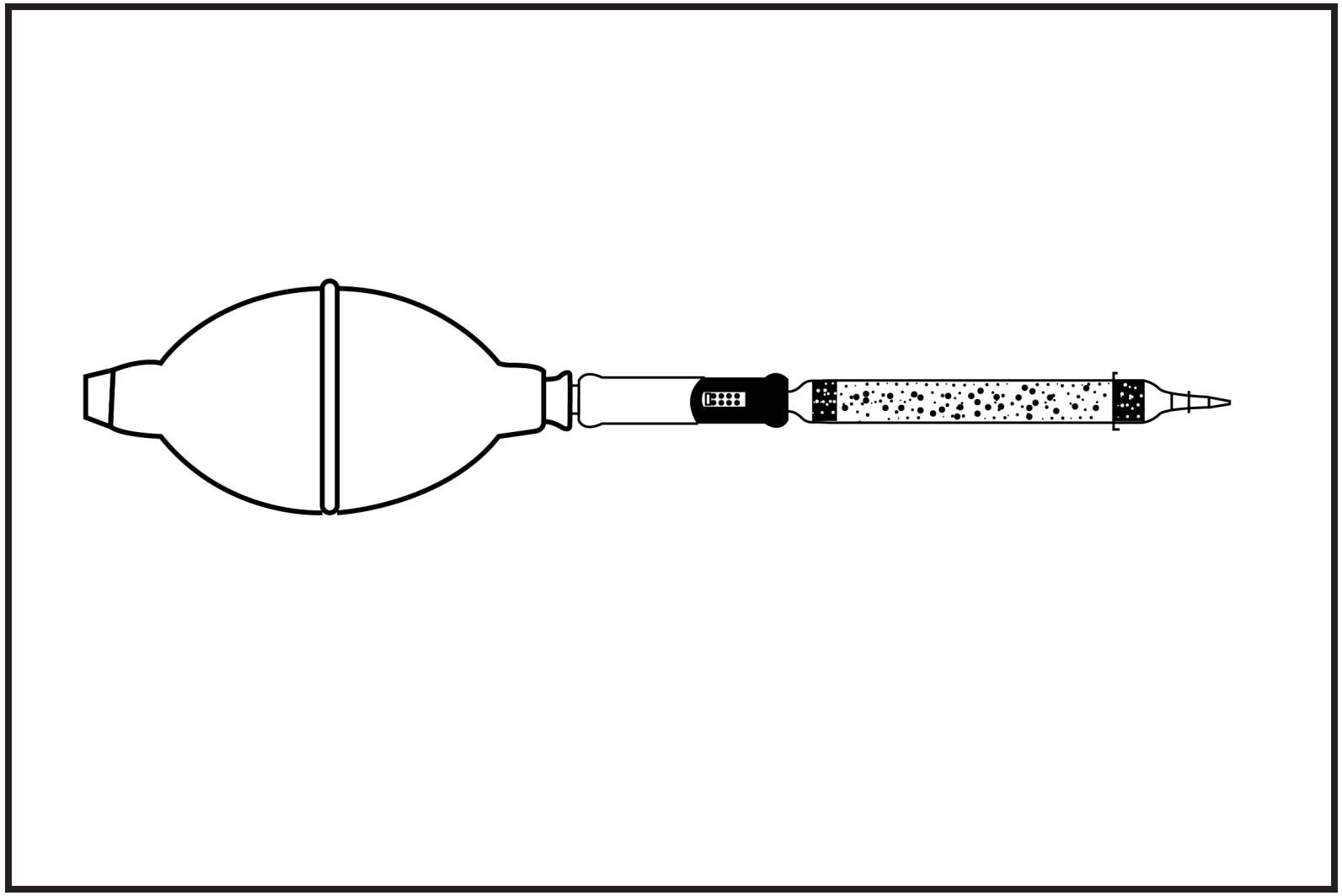
Anemometer



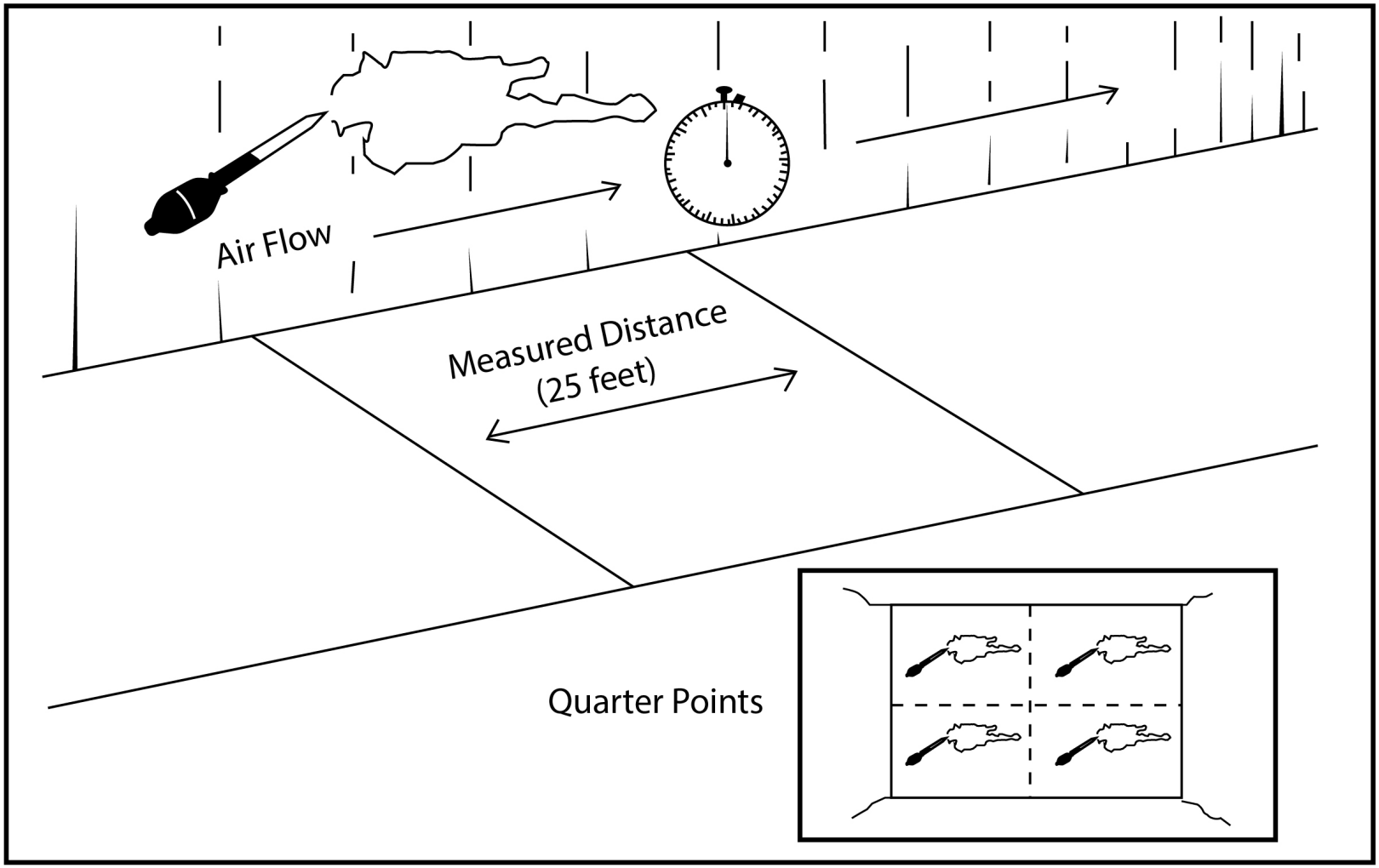
Anemometer Reading Using Traverse Method



Smoke Tube



Taking a Smoke Tube Reading



Requirements for a Fresh Air Base

Requirements for a Fresh Air Base:

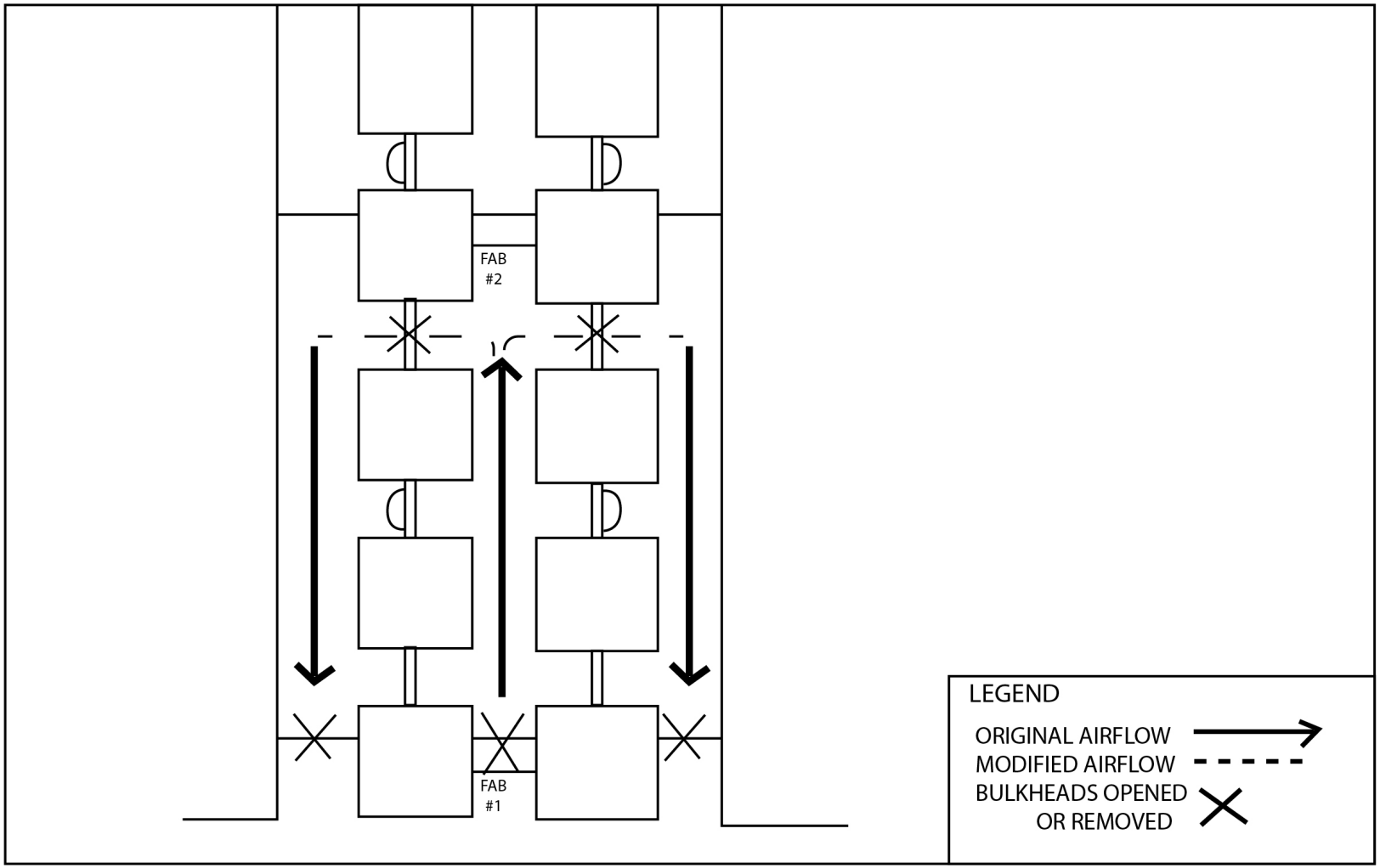
1. Positive ventilation and fresh air
2. Travelway for people and supplies
3. Communication with Command Center
4. Communication with team

Fresh Air Base Coordinator's Responsibilities

Coordinator's Responsibilities:

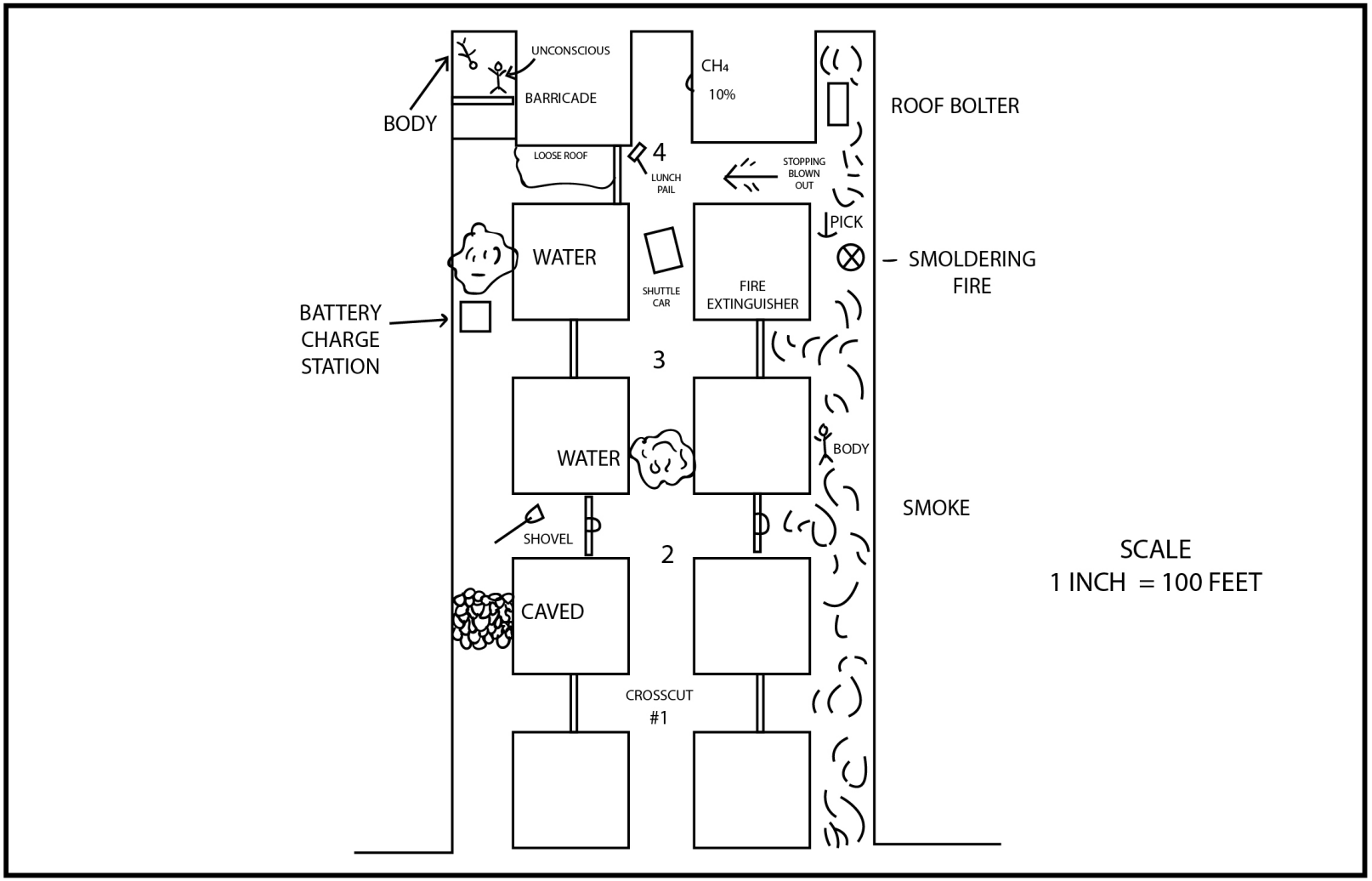
1. Communication with team and Command Center
2. Follow and mark team's progress on map
3. Coordinate and oversee all activities

Advancing the Fresh Air Base



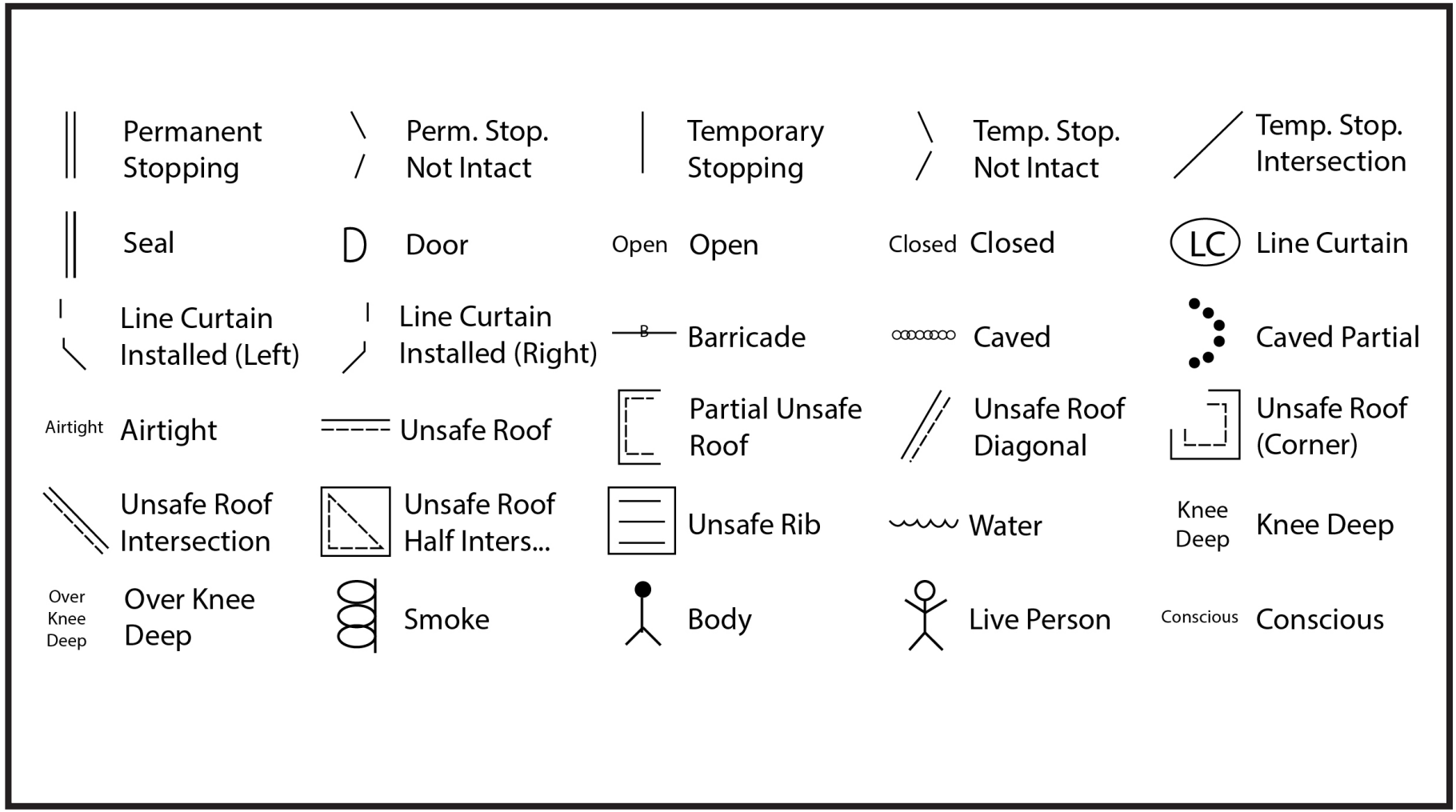
Module 4 - Visual 3

Marking the Mine Map

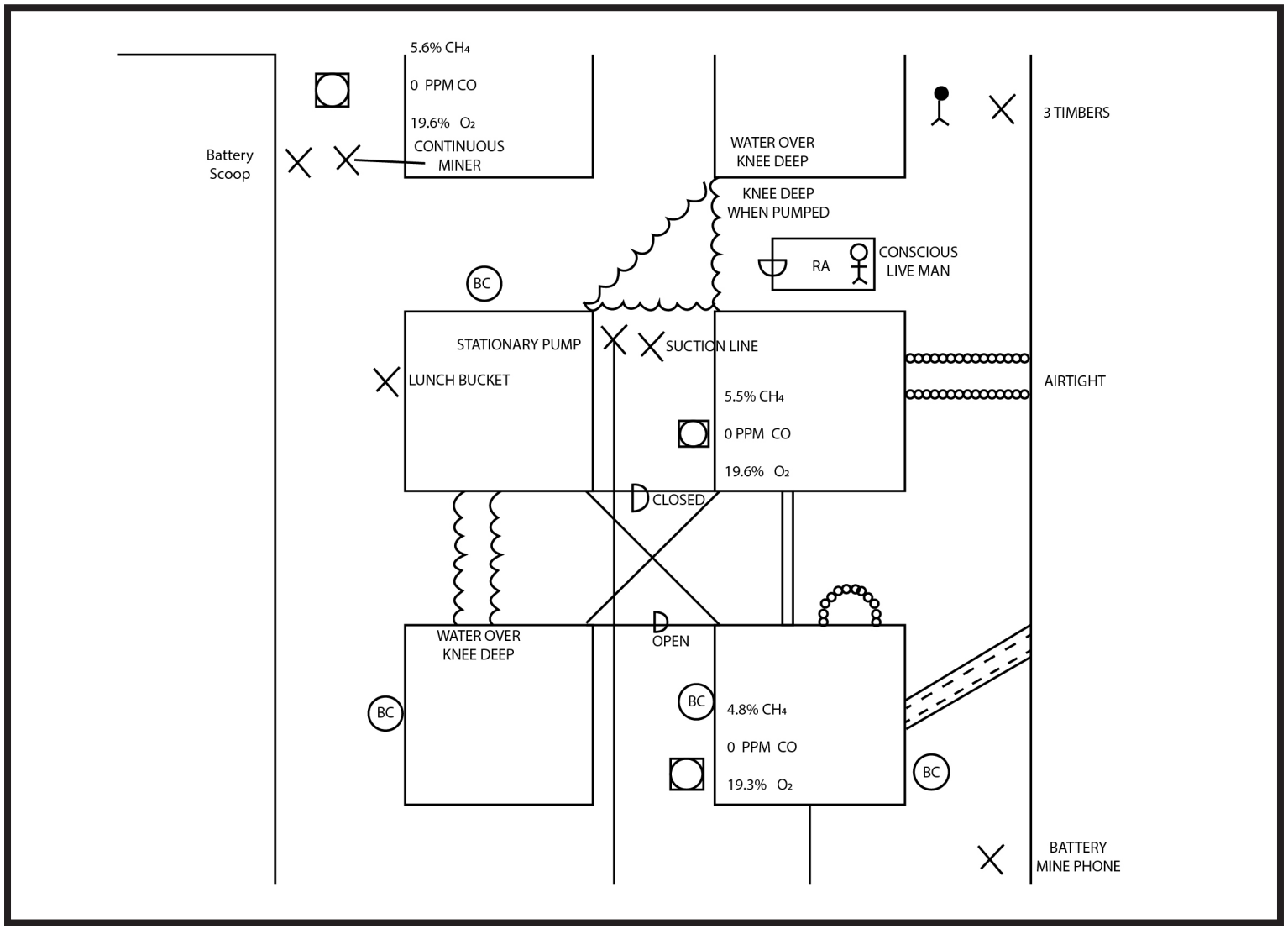


Module 4 - Visual 4

Click/Drag Mapping Software Symbols



Sample Map Using the Mapping Software Symbols



Module 4 - Visual 6

Mine Rescue Team Signals

Mine Rescue Team Signals:

One – Stop

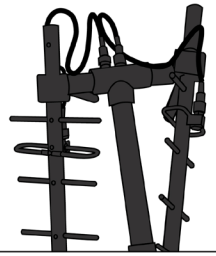
Two – Advance

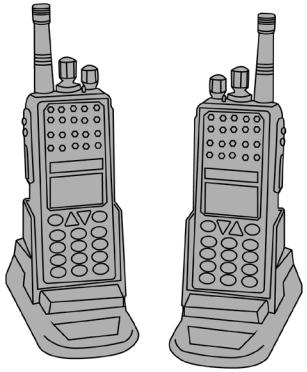
Three – Retreat

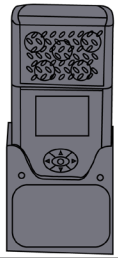
Four – Distress / Emergency

Communication System Components

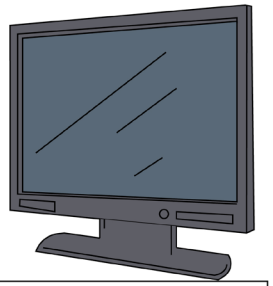
RF is used inby the Fresh Air Base and is Permissible with these...

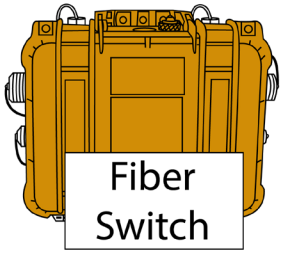

Antennas

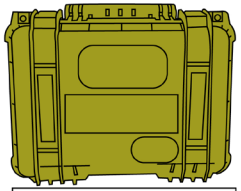

Radio

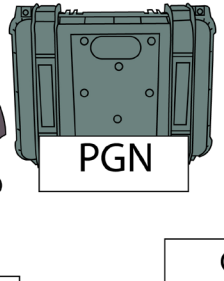

MX6

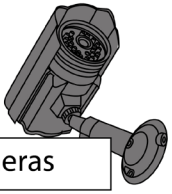
RF/Fiber is used Outby the Fresh Air Base and is Non-Permissible with these...


Computers



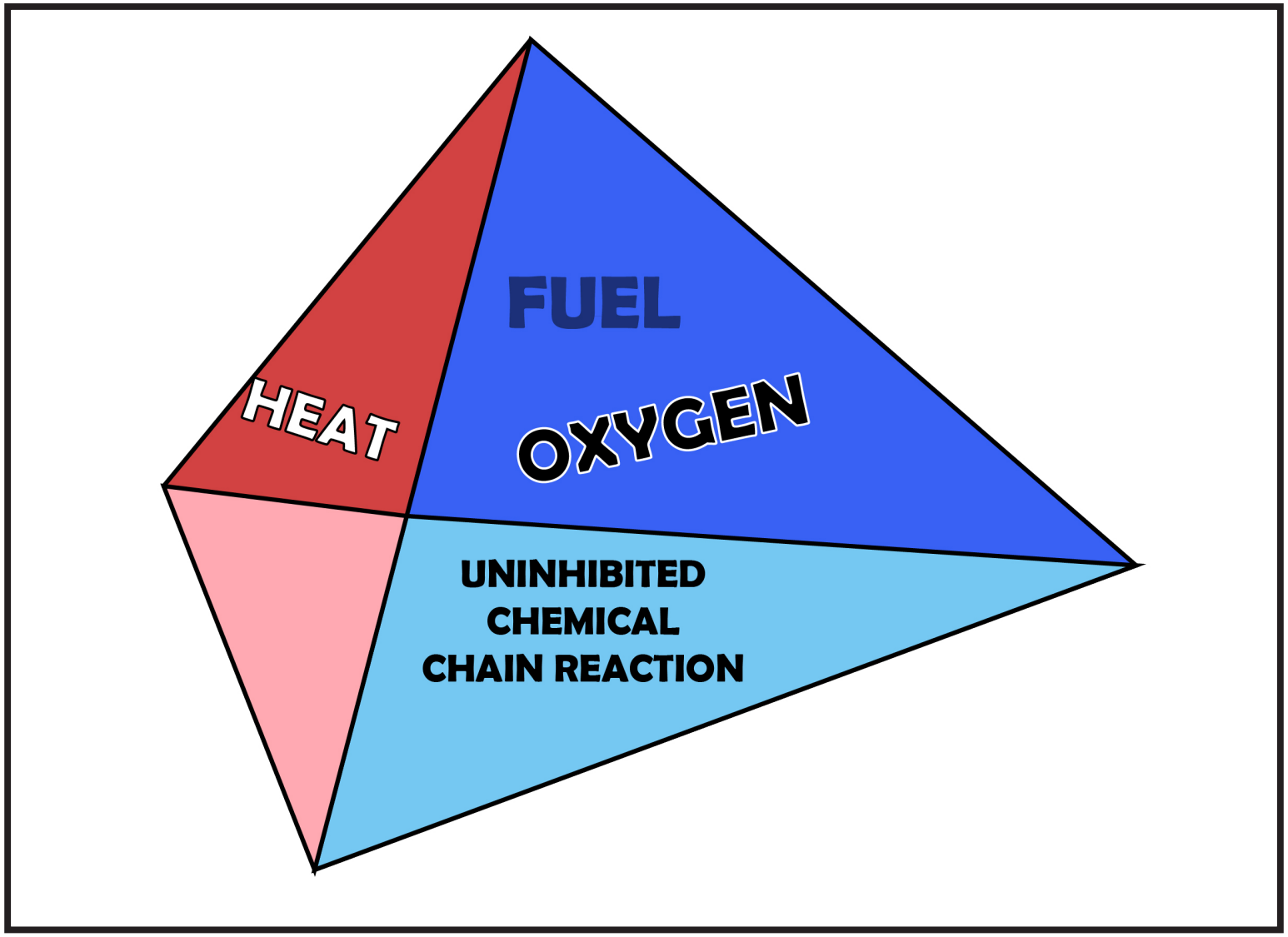

Smart Battery


Cables


Cameras

United States Department of Labor
MSHA
Mine Safety and Health Administration

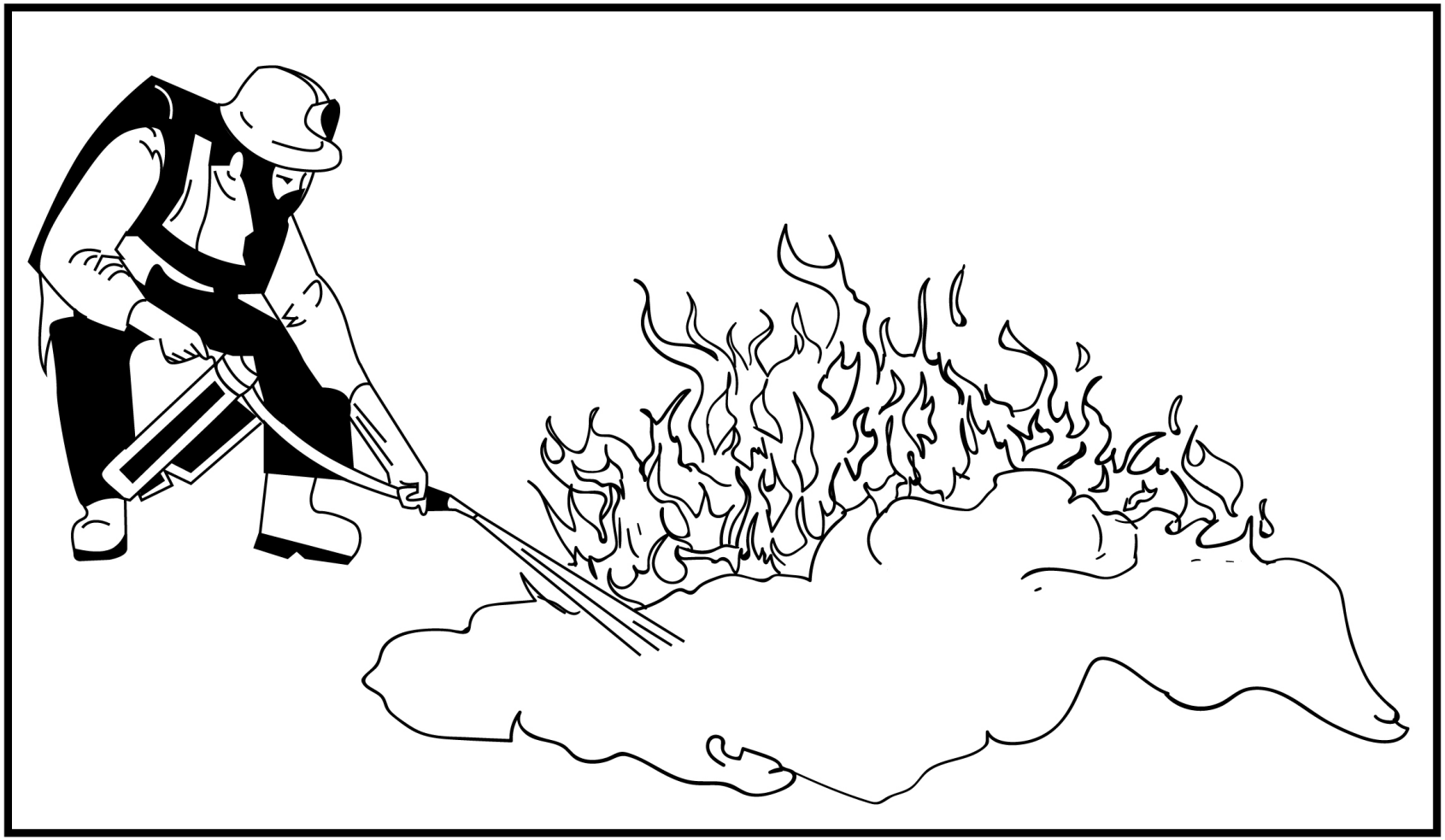
Fire Tetrahedron



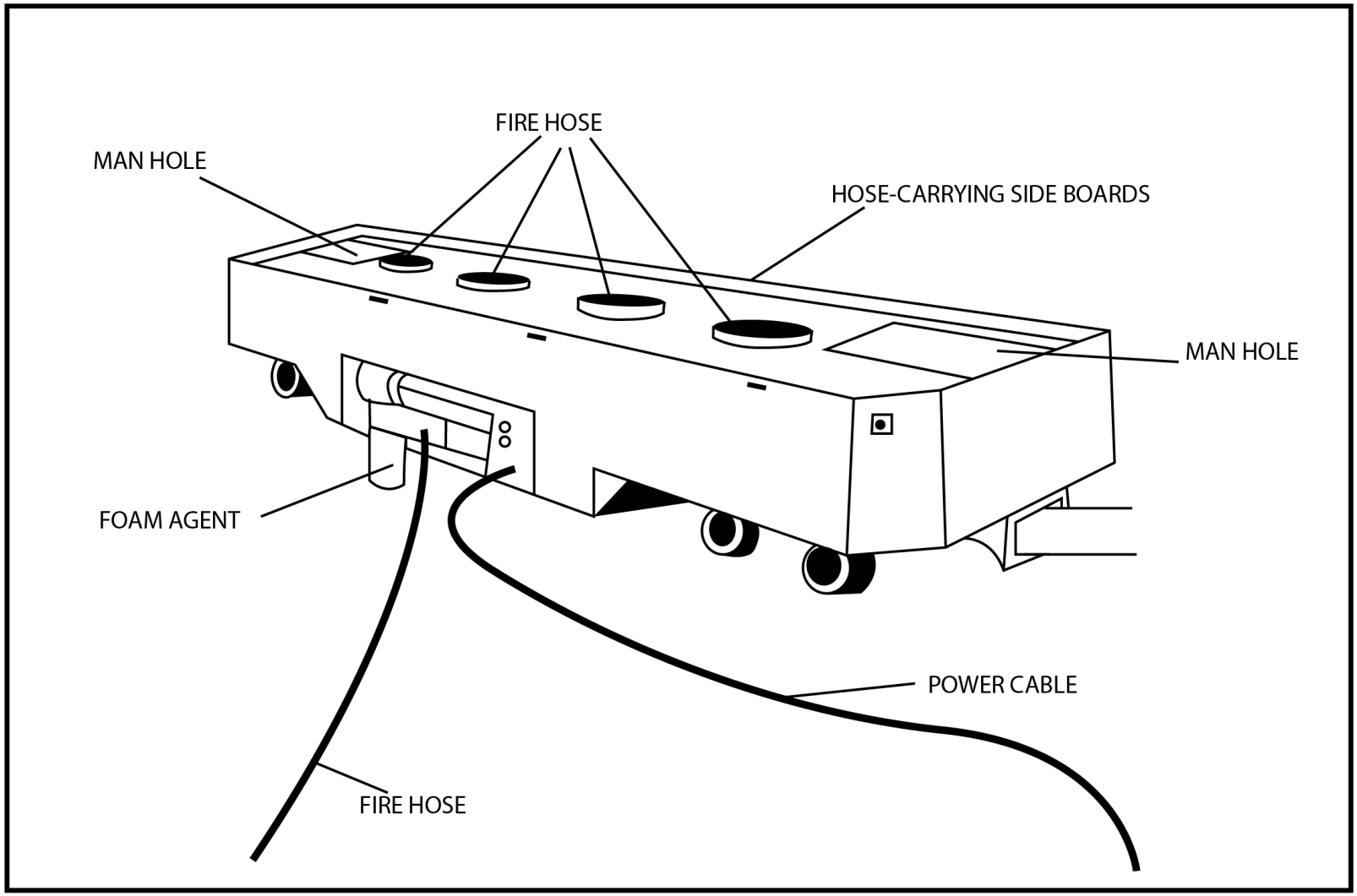
The Five Classes of Fires

A		Common Combustibles	Wood, Paper, Cloth, etc.
B		Flammable Liquids and gases	Gasoline, Propane and Solvents
C		Live Electrical Equipment	Computers, Fax Machines
D		Combustible Metals	Magnesium, Lithium, Titanium
K		Cooking Media	Cooking oils and Fats

Using Hand-held Fire Extinguishers

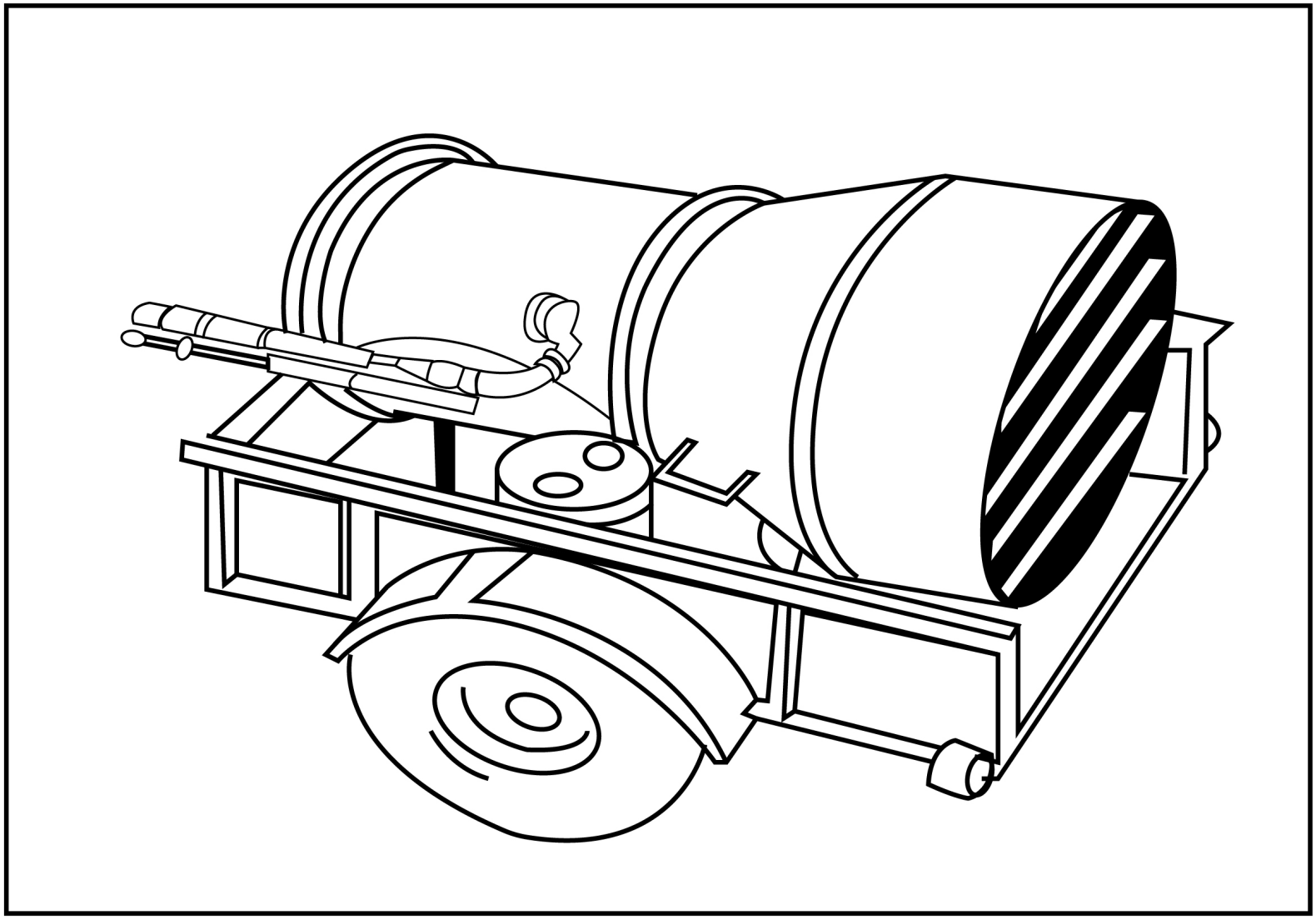


Fire Car

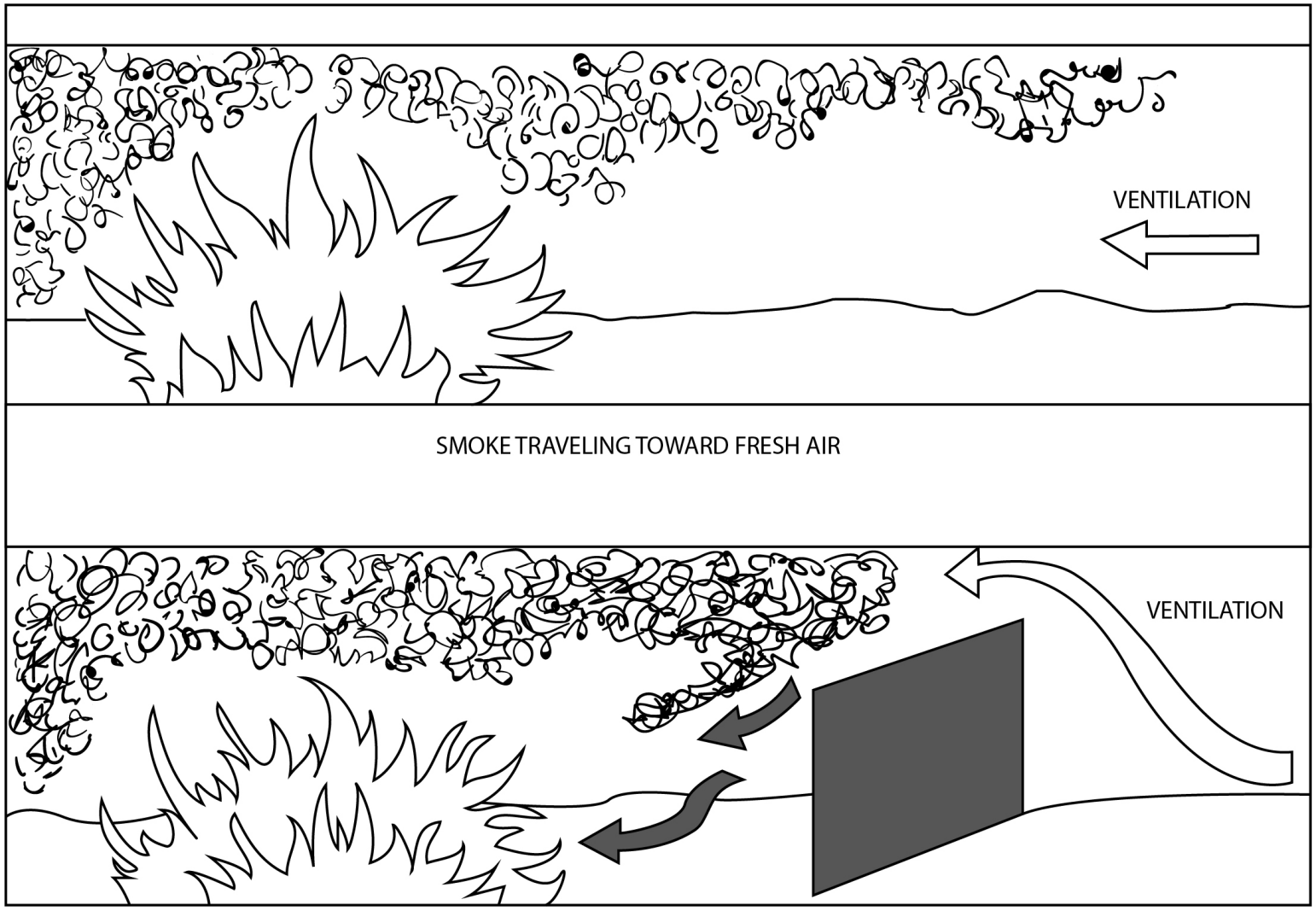


Module 5 - Visual 4

Foam Generator



Transverse Brattice



Hazards of Direct Firefighting

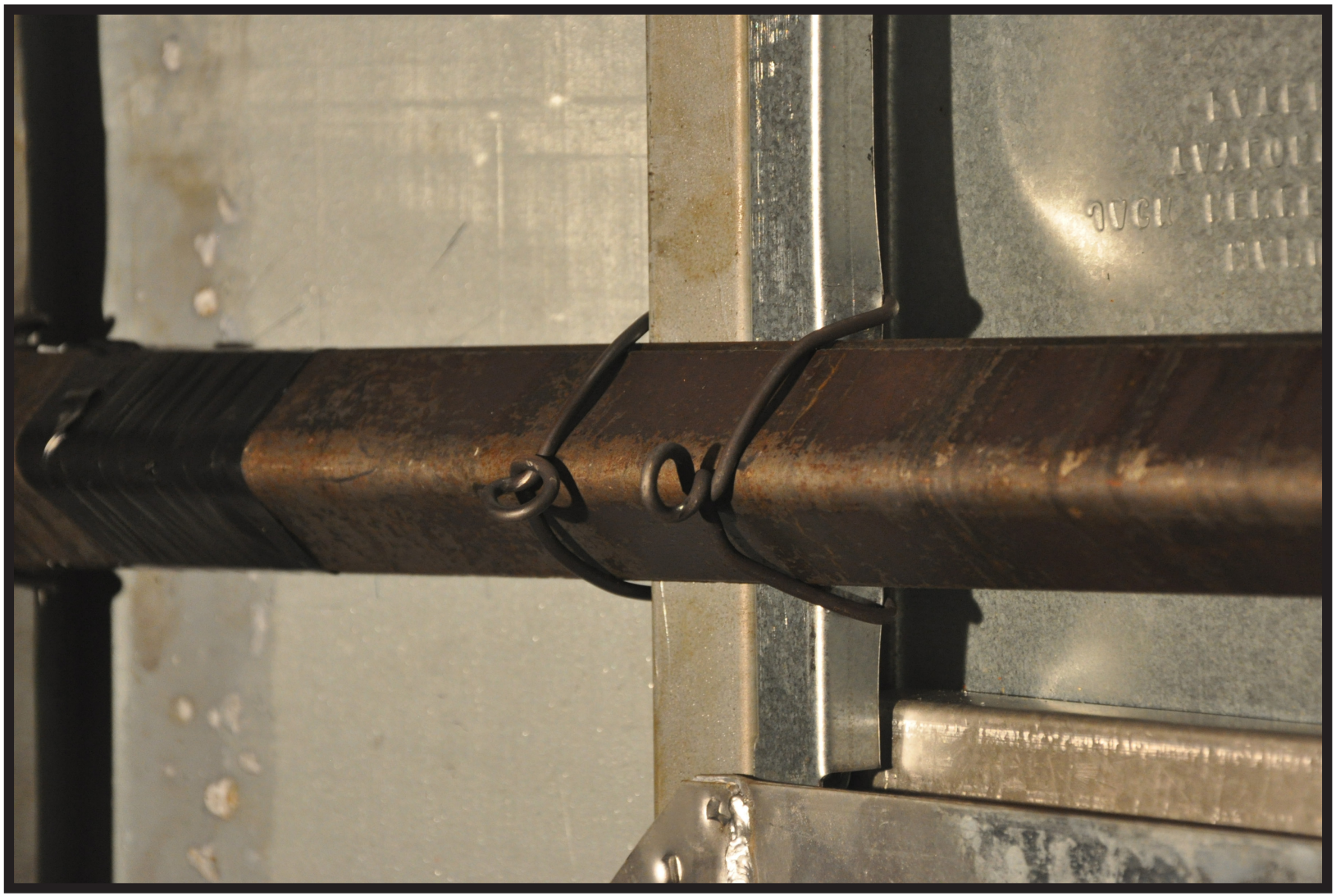
Hazards of Direct Firefighting:

- Electrocution
- Toxic and Asphyxiating Gases
- Oxygen Deficiency
- Explosive Gases
- Heat, Smoke, and Steam

Front of Stopping with a Jack

Module 5 - Visual 8

Hooks on Rails



Module 5 - Visual 8-1

Stopping with Sealant

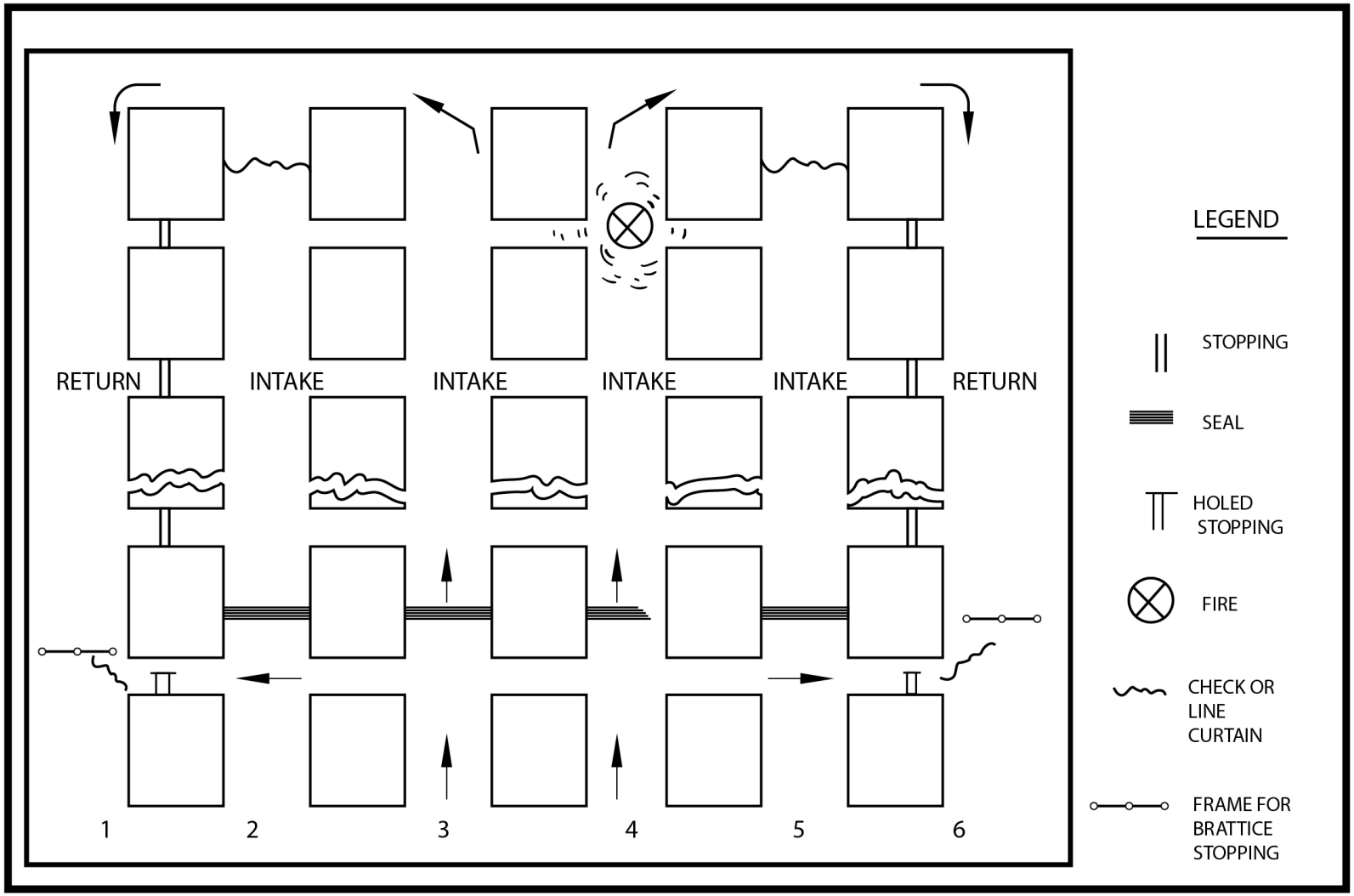
Module 5 - Visual 8-2

Toxic Gases

Gases Produced by Burning Rubber, Neoprene, and PVC	Maximum Allowable PPM	Percent
Carbon Monoxide	50	.005
Chlorine	1	.0001
Hydrogen Chloride	5	.0005
*Phosgene	0.1	.00001
Sulphur Dioxide	5	.0005
Hydrogen Sulfide	10	.001
Nitrogen Dioxide	5	.0005
Ammonia	50	.005
Hydrogen Cyanide	10	.001
*Arsine+	0.05	.000005
*Phosphine+	0.3	.00003

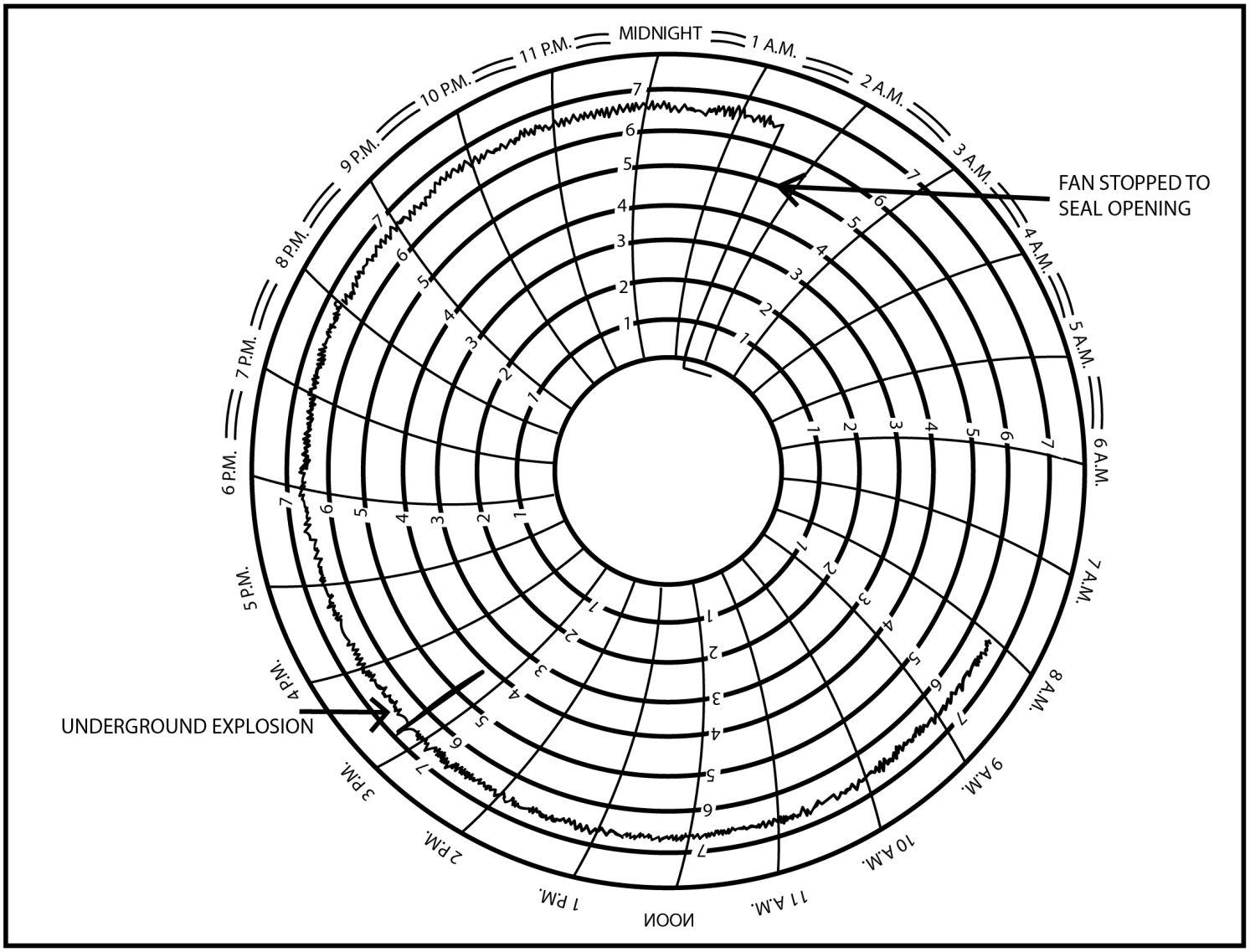
*Note the deadliness of these gases as compared to Carbon Monoxide.
+These gases will be found only if the carcass (foundation) is impregnated with certain fungicidal or fire-retardant compositions.
Source: “Investigations into Underground Fires.” Safety in Mines Research Establishment, Buxton, England.

Sealing Procedures



Module 5 - Visual 10

Fan Chart



Module 5 - Visual 11

When to Unseal

Factors Governing When to Unseal:

1. Extent and intensity of fire
2. Characteristics of burning material and surrounding area
3. Tightness of seals
4. Effect of barometric pressure
5. Effect of temperature
6. Location of fire area
7. Gas conditions

Preconditions for Unsealing a Fire Area

Preconditions for Unsealing:

1. The oxygen content of the atmosphere in the sealed area is low enough to make it inert

2. Carbon monoxide not present behind seal

3. Area behind seal has had sufficient cooling time

Preparations for Opening a Sealed Fire Area

Preparations for Opening a Sealed Fire Area:

1. Adjust ventilation so toxic and/or explosive gases released from the sealed area are directed into main returns.

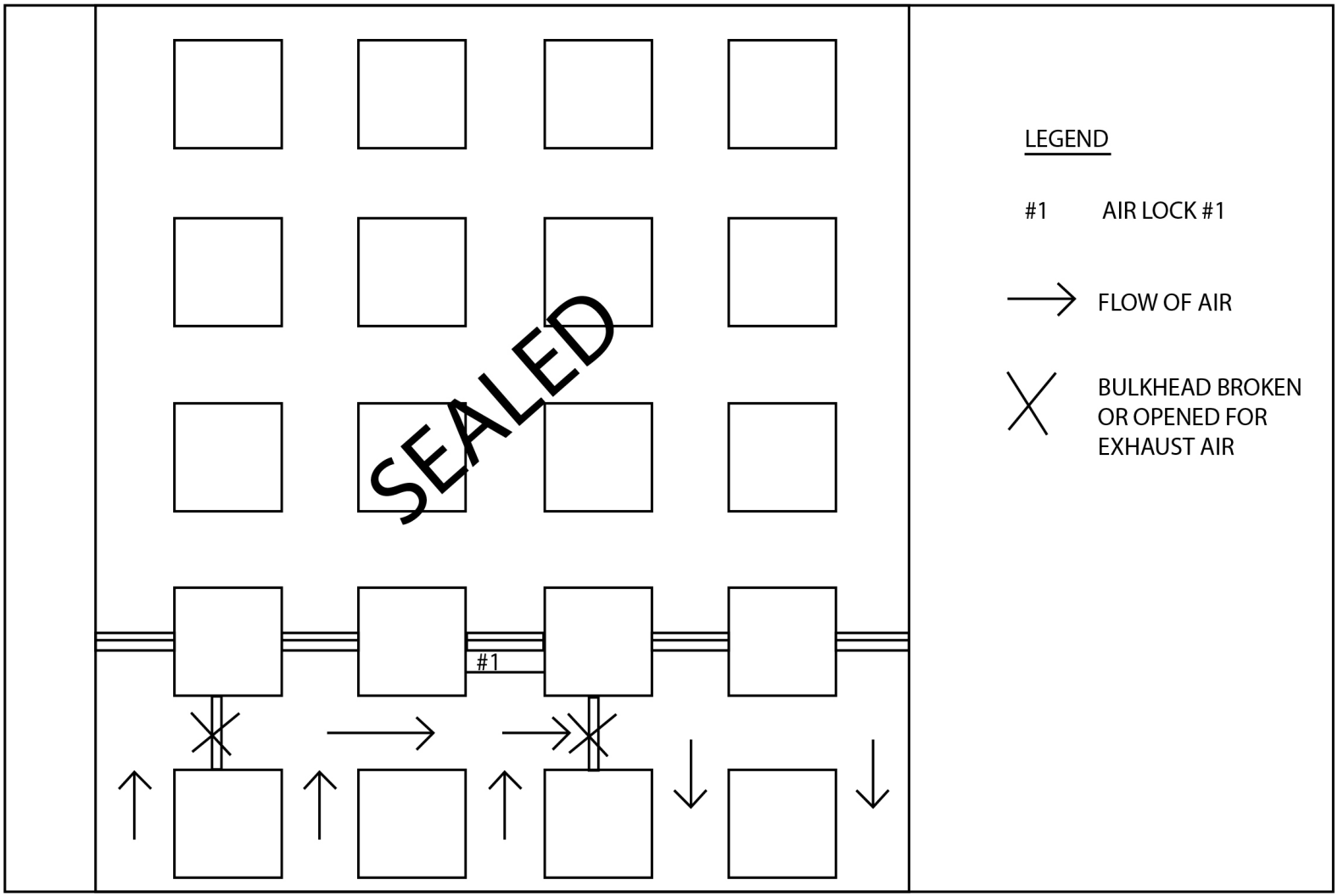
2. An observer should be stationed at the main fan to warn the rescue team of any fan malfunctions. Also, someone should be stationed in the main exhausts to monitor gas levels.

3. Cut off all electrical power to the sealed area.

4. In bituminous mines, heavily rock dust all entries and cross cuts leading to and from the sealed area.

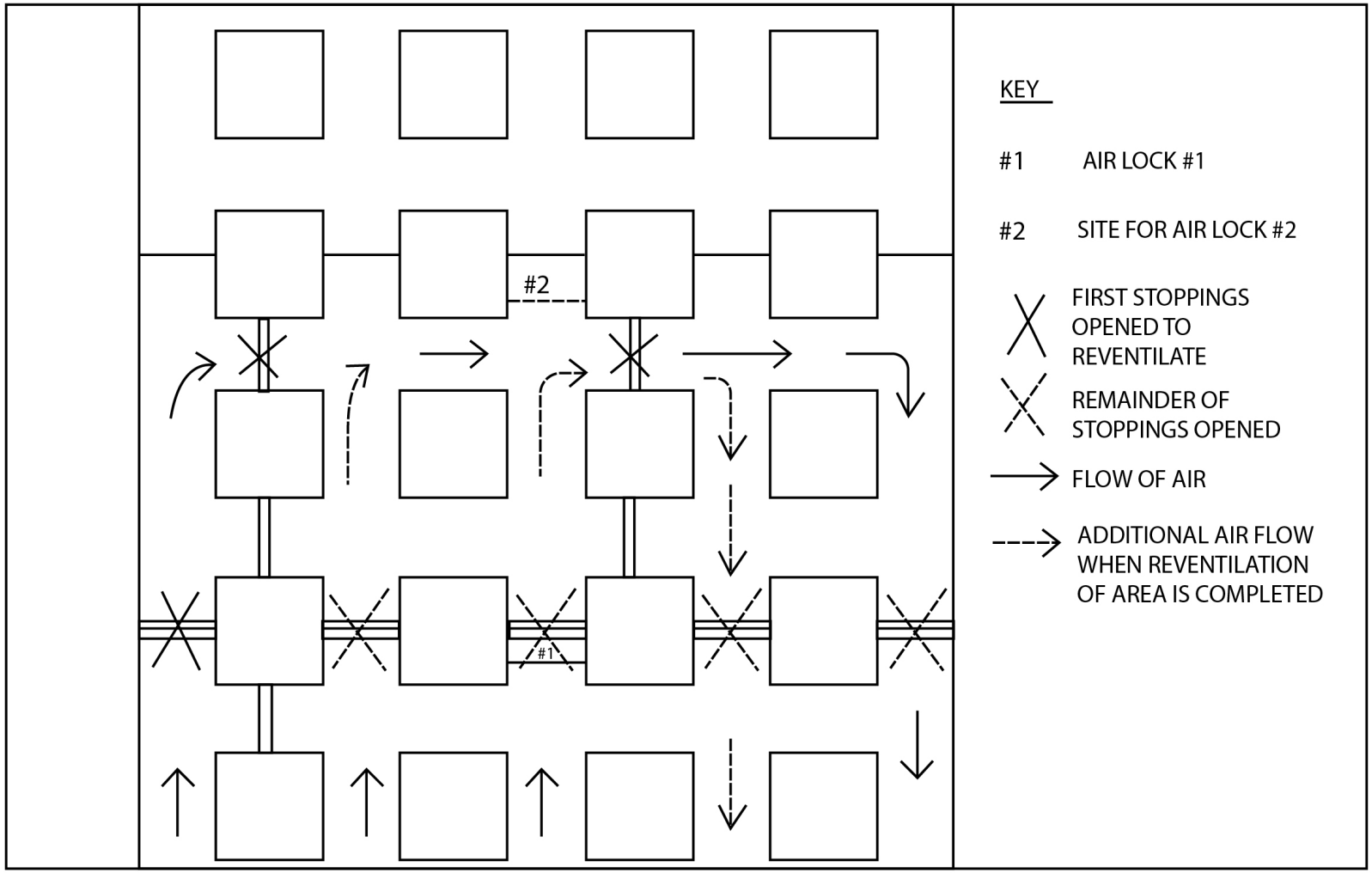
5. Withdraw all unnecessary personnel from the mine.

Sealed Area and First Air Lock



Module 7 - Visual 4

Re-ventilation of an Area



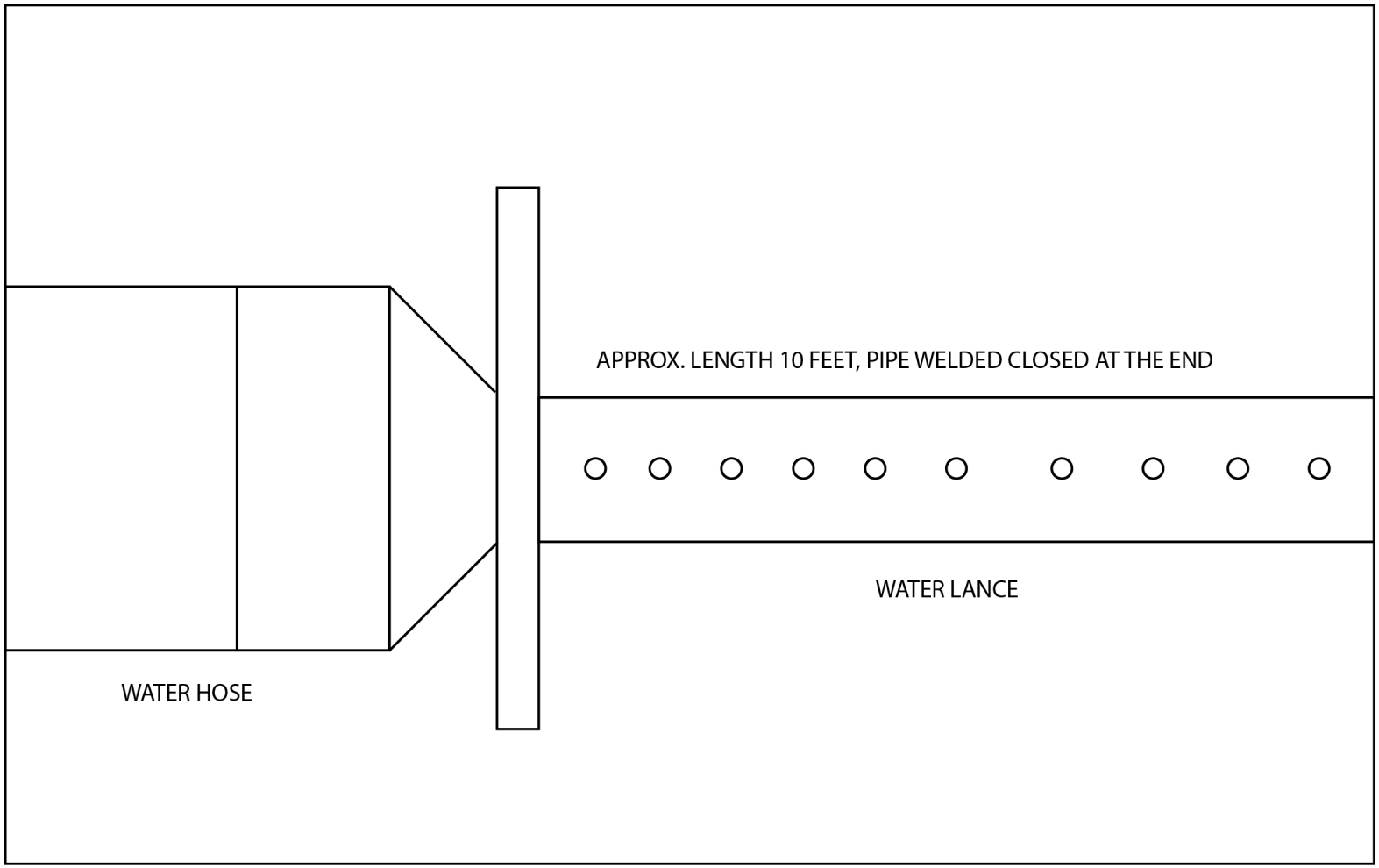
Module 7 - Visual 5

Re-ventilation After an Explosion

Considerations When Re-ventilating After an Explosion:

1. Concentrations of explosive gases
2. Percent of oxygen present
3. Sources of ignition

Water Lance


APPROX. LENGTH 10 FEET, PIPE WELDED CLOSED AT THE END
WATER LANCE
WATER HOSE