S.O.P. #: TACTICAL OPERATIONS MANUAL #11

SUBJECT: AIR MONITORING ON THE INCIDENT SCENE

DIVISION: EMERGENCY OPERATIONS

Objective: To reduce personnel exposure to hazardous and toxic materials while operating on an incident scene. Establish guidelines for monitoring Carbon Monoxide (CO), Hydrogen Cyanide (HCN), Oxygen (O2) and Hydrogen Sulfide (H2S) levels to determine when respiratory protection is no longer needed for the protection of personnel.

Section 1: Definition and effects of toxic and hazardous materials affecting our personnel.

A. Carbon Monoxide - CO

1. A colorless, odorless and tasteless gas that is slightly less dense than air.
2. It is toxic to humans in higher concentrations.
3. It combines with Hemoglobin to produce Carboxyhemoglobin, which blocks the space in Hemoglobin that normally carries Oxygen, but is ineffective for delivering Oxygen to bodily tissues.
4. Within short time scales, (multiple exposure) Carbon Monoxide is cumulative, since the half-life is about five hours in fresh air.
5. Symptoms of poisoning include headache, nausea, vomiting, dizziness and a feeling of weakness.
6. Neurological signs include confusion, disorientation, visual disturbance, syncope and seizures.
7. Exposures to CO may cause significant damage to the heart and central nervous system, often with long-term pathological conditions.
8. Exposure to 800 PPM of CO over forty-five minutes = Death within two to three hours.
9. Exposure to 400 PPM of CO over one to two hours = Life threatening after three hours.
10. Exposure to 200 PPM of CO over two to three hours = Headache, fatigue, nausea and dizziness.

B. Hydrogen Cyanide – HCN

1. Is a by-product of the combustion of material used in products of everyday life.
2. The real offender is the combustion of manmade plastics and resins containing nitrogen, especially if the fire is hot and in an enclosed space.
3. Common manmade material that generate cyanide gas during combustion include nylon, polyurethane, melamine and acrylonitrile which are used extensively in building furnishings, vehicles, foam insulation, carpets, draperies, appliances, many plastics and articles of clothing.
4. High temperatures and low-oxygen concentration favor the formation of cyanide gas.
5. Firefighters exposed to smoke from burning materials will not likely be able to smell the HCN.
6. HCN can enter the body by inhalation, absorption or ingestion and targets the heart and brain. Humans retained 58% of HCN in the lungs after inhaling the gas through normal breathing.
7. HCN is 35 times more toxic than Carbon Monoxide and has a half-life of one hour in the blood.
8. HCN is highly flammable, and thankfully, most of it will burn away during combustion.
9. HCN causes rapid death by metabolic asphyxiation.
10. Firefighters inhaling HCN associated with smoke often experience cognitive dysfunction and drowsiness that can impair the ability to escape or perform rescue operations.
11. Symptoms of low concentration exposure to HCN may include stupor, confusion, flushing, anxiety, sweating, headache, drowsiness and increased respiratory rate.
12. Exposure to higher concentrations of HCN result in cardiac arrhythmia (which can be delayed 2-3 weeks after the fire exposure), coma, respiratory depression, respiratory arrest and cardiovascular collapse.
13. Exposure to 135 PPM over thirty minutes = FATAL.
14. Exposure to 181 over 10 minutes = FATAL.

15. Exposure to 270 PPM over 6 minutes = FATAL.
16. Exposure to 3400 PPM over 1 minute = FATAL.

C. Hydrogen Sulfide – H2S

1. H2S is a highly toxic and flammable gas that is heavier than air so it tends to accumulate at the bottom of poorly ventilated spaces.
2. H2S is a colorless liquid at extremely low temperatures or under very high pressure.
3. The gas is a product of decaying plant and animal material under low Oxygen conditions.
4. It is commonly encountered in sewage treatment plants, waste disposal, pulp and paper manufacturing, manure stockpiles and petroleum/natural gas extraction and refining.
5. H2S has a rotten egg odor at low concentrations (less than 50 PPM); the ability to smell H2S can dull and be completely lost at levels over 50 PPM.
6. It is a broad-spectrum poison that affects the respiratory and nervous system; the toxicity is comparable with HCN.
7. Symptoms of exposure (1-5 PPM) are nausea, headaches and moderately offensive odor.
8. Symptoms of exposure (20-50 PPM) are nose, throat and lung irritation with digestive upset and loss of appetite.
9. Symptoms of exposure (100-200 PPM) are severe nose, throat and lung irritation.
10. Symptoms of exposure (250-500 PPM) are the potentially fatal build-up of fluid in the lungs (pulmonary edema).
11. Symptoms of exposure (above 500 PPM) are sudden unconsciousness, respiratory paralysis.

D. Oxygen – O2

1. O2 is a clear, colorless, odorless and tasteless gas that is a primary component of Earth's atmosphere.
2. O2 supports combustion and is necessary for plant and animal life.
3. The hazard to responders regarding oxygen is most commonly an atmosphere that is deficient in the percentage of oxygen.
4. Symptoms of exposure to an oxygen deficient atmosphere (19.5% or less) are impaired attention/coordination, increased pulmonary/cardio output, emotional upset and tunnel vision.
5. Symptoms of exposure to an oxygen enriched atmosphere (21% or greater) are seizures, pulmonary edema and the potential for permanent pulmonary fibrosis.
6. An oxygen enriched atmosphere is more a combustion hazard for responders as the burning characteristics of material can change/increase dramatically.

Section 2: Incident Procedures

A. Air monitoring will be required on any incident scene where SCBA is used. Examples include but are not limited to structure, vehicle, dumpster, appliance fires along with confined space and hazardous material incidents.

B. The Incident Commander shall require air monitoring before any member is allowed to remove their SCBA. This will typically be done after the fire has been extinguished and ventilation has been conducted to the point that visibility is no longer impaired.

C. Air monitoring will typically fall under the direct responsibility of the incident Safety Officer.

D. The meter used will measure Carbon Monoxide, Hydrogen Cyanide, Hydrogen Sulfide, LEL and Oxygen.

E. The area monitored will include the primary incident scene as well as any area that our members will be staged/located.

F. All air monitoring readings shall be documented on the Air Monitoring Checklist Form 367B (See Appendix A) by the Safety Officer, IC or designee. The checklist info will be documented on the Safety Officers Incident Report Form 367.

G. The Incident Commander or Safety Officer may continue to require members to continue to wear SCBA despite the air quality levels obtained.

Section 3: Parameters for Determining if SCBA is required

A. For SCBA to be removed by personnel, **all** of the criteria below must be met.

a. Carbon Monoxide must be below 35ppm (NIOSH REL 35PPM)

b. Hydrogen Cyanide must be below 4.5ppm (NIOSH REL 4.7PPM)

c. Hydrogen Sulfide must be below 10 ppm. (NIOSH REL 10PPM)

d. Oxygen must be greater than 19.5%, (IDLH), but less than 23.5% (Enriched)

e. LEL must be below 10.

B. These are the minimum action levels for the consideration of SCBA removal by the IC.

APPENDIX A

INCIDENT SCENE AIR MONITORING

Form 367B

Date: _____ Time: _____

Location: _____

Incident Number: _____

Meter Used: _____

Name and Rank of Member Conducting Air Monitoring: _____

Signature of Member Conducting Air Monitoring: _____

Carbon Monoxide Level: _____ ppm (below 25 ppm for SCBA removal)

Hydrogen Cyanide Level: _____ ppm (0 ppm for SCBA removal)

Hydrogen Sulfide Level: _____ ppm (below 10 ppm for SCBA removal)

Oxygen Level: _____ % (greater than 19.5% but less than 21.5% for SCBA removal)

TIME of Second Air Monitoring (if needed): _____

Carbon Monoxide Level: _____ ppm (below 25 ppm for SCBA removal)

Hydrogen Cyanide Level: _____ ppm (0 ppm for SCBA removal)

Hydrogen Sulfide Level: _____ ppm (below 10 ppm for SCBA removal)

Oxygen Level: _____ % (greater than 19.5% but less than 21.5% for SCBA removal)

TIME of Third Air Monitoring (if needed): _____

Carbon Monoxide Level: _____ ppm (below 25 ppm for SCBA removal)

Hydrogen Cyanide Level: _____ ppm (0 ppm for SCBA removal)

Hydrogen Sulfide Level: _____ ppm (below 10 ppm for SCBA removal)

Oxygen Level: _____ % (greater than 19.5% but less than 21.5% for SCBA removal)

Form 367B (1/2015)

Air Monitoring Checklist		
Time:		
Gas	Safe Level	Readings
Oxygen	19.5-23%	
LEL	<10	
CO	<35ppm	
H2S	<10ppm	
HCN	<4.5ppm	
Notes:		
Time:		
Gas	Safe Level	Readings
Oxygen	19.5-23%	
LEL	<10	
CO	<35ppm	
H2S	<10ppm	
HCN	<4.5ppm	
Notes:		
All Levels Must Be Met To Consider Removal of SCBA by IC		
Form 367B (5/2016)		