

“Last Chance Rescue Filter” Live Burn Test CyFair Vol. Fire Department 6/30/08

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One of the main goals in protection of firefighters is providing safe breathable air. Prior to the invention of self contained breathing apparatus (SCBA) respiratory injury to firefighters was of great concern. SCBA provides a safe environment allowing firefighters to spend longer periods of time and “go deeper” into hostile environments. SCBA is one of the tools that we have in the firefighter personal protective equipment.

With this improvement came benefits of increased rescue of trapped victims but also increased the potential for firefighters to become victims themselves. The environment of a structure fire is full of poisonous and carcinogenic vapors. NFPA 1404 has outlined air management training so that the firefighter exits this environment prior to the “low air” alarm. This training should improve the life span of the firefighter and is an important tool for all departments. As with all training and planning comes the unexpected.

When we started to review the “Last Chance Rescue filter”, it was reviewed as another potential safety item for our firefighters. Being a large combination volunteer/career department we look at all items with budget in mind but will sacrifice other items to protect our firefighters since safety is our highest priority and they are also our neighbors. We also were joined in the testing from a broad cross section of neighboring departments. Participating departments were the Houston Fire Department, Jersey Village Emergency Services, Cypress Creek Vol. Fire Department, Brenham Fire Department, The Village Fire Department, Conroe Fire Department, Westlake Vol. Fire Department, Harris County Fire Marshals Office, and CyFair Vol. Fire Department including our EMS division which supplied personnel for medical testing and monitoring.

Product Description

The “Last Chance Rescue filter” currently is the only product of its kind on the market. Previous to this filter was another product, similar in nature but has appreciable differences. Review of the technical data on this product can be found at www.lastchancefilter.com . The manufacturer describes the function of the filter as follows. *Once the moisture resistant barrier pouch has been torn open and installed into the SCBA mask, contaminated air is drawn through the open end of the Last Chance Rescue Filter by the fire fighter breathing. The first stage of the filter is comprised of an N95 pleated filter. This fibre filter captures the visible (particulate) products of smoke and will trap 95% of all particles .5 microns and larger. Autopsies show soot can carry toxins deep into the lungs and cause lower respiratory injuries – this component of the filter works to mitigate this. Particulates having been removed, toxic gases now enter the next stage of filtration, which is an activated carbon bed that, through the process of adsorption and reaction, removes most of the harmful gases except for carbon monoxide (CO), which cannot be filtered.*

CO is dealt with through a granular bed that converts this highly toxic gas to non-toxic carbon dioxide (CO²). This is accomplished by passing the air through a granular bed of Manganese Dioxide/ Copper Oxide (hopkalite). The filtered and catalyzed air is then pulled up through the

intake valve and into the face piece of the SCBA. Exhalation is accomplished by the user exhaling through the exhalation valves of the SCBA mask where applicable or back through the upper section of the emergency respirator and out of its exhaust valves. The Last Chance Rescue Filter functioning as described here, provides at least 15 minutes of respiratory protection against typical fire gases, as described in established standards respiratory protective escape devices. The device has a service life of five years when maintained in its moisture resistant barrier pouch.

Our main focus in the testing was carbon monoxide levels and comfort in the hot environment. Performance of the filter in variable conditions and different personnel was also an important factor.

Testing procedure

Class A materials (wood and hay) were burned in a 4 story burn building. All testing was done on the first story in an area approximately 25 ft by 25 ft. The area was blocked off to help maintain the smoke filled environment and limited visibility. All test subjects were monitored during the testing by a buddy firefighter and overall by an internal safety officer. Prior to testing each test subject was monitored for blood pressure, oxygen saturation, and carbon monoxide levels. The Masimo® Rad-57 monitor was used to monitor all test subjects carbon monoxide levels. Conventional pulse oximeter was used to detect the PO2 levels of each of the test subjects. Selected test subjects also had blood tests specifically for carbon monoxide to verify non-invasive testing.

Each test subject attended a training session on the filter and practiced proper application prior to entering the testing area. This training was done by representatives of the product and was done in full gear (PPE) with and without blackout masks. One of the concerns was the ability of the firefighter to remove the product from its protective pouch and remove the unit from the protective water proof vacuum sealed outer wrap.

There were four testing phases and each phase offered different procedures to help focus on the effectiveness of the filter. Each testing group performed work in the hostile environment for the period of time of the testing phase.

Phase 1 is the control with full SCBA in use by the test subject. This phase allowed us to see if there were any problems with face piece seals and revealed any potential variables from typical firefighting incidents.

Phase 2 has the firefighter entering the building with the filter in place and 2 different lengths of time in the building were tested. They performed light work duties and were instructed to stay close to the floor where the oxygen levels would be highest and crawl around the area. The first test groups were only allowed to be in the building for 7 minutes to insure there were no problems with the product. The second test group was allowed in the building the full 15 minutes. The short period was to put the test subjects at ease with the product.

Phase 3 test had the firefighter enter the building with SCBA and has the RIT team change to the filter. This was intended to simulate finding a downed firefighter out of air and placing a filter on the subject. The buddy had to remove the filter from the pouch and opening the protective cover and placing the filter while in PPE.

Phase 4 test had the firefighter enter the building with SCBA and change the filter themselves while in the hostile environment. This was intended to simulate running out of air and having to place the filter themselves. They continued to move throughout the test area for the 15 minute period. It required the firefighter to remove the item from the pouch and protective cover and place the filter while in PPE.

The testing was done in typical Houston weather 80% humidity and temperatures between 87 and 95 degree F. Test subjects did no pre-hydration or special procedures prior to participation so it simulated normal response activities. The SCBA in use was a Scott AP50 integrated pass and heads-up display with AV2000 face piece. There are several factors that we could not simulate such as the panic of running out of air and being trapped in an unfamiliar place. Our intention is to test the capabilities of the product and see how fast our firefighters adapted to using the product.

Air Quality Testing

Table 1 contains the air quality testing done throughout the testing. Testing was done using various monitors (see Table 2) checking levels of carbon monoxide, oxygen, hydrogen cyanide, benzene and hydrogen sulfide.

Our intention was to keep the carbon monoxide levels greater than 250ppm and only during one test did it fall below the desired test levels.

	CARBON MONOXIDE	OXYGEN	HYDROGEN CYANIDE	BENZENE	HYDROGEN SULFIDE
	PPM	%	PPM	PPM	PPM
PREBURN/BASELINE	0.00	20.90	0.00	0.00	0.00
TEST NUMBER 1	525.00	20.30	70.30	26.00	7.00
TEST NUMBER 2	768.00	20.30	79.20	62.00	7.20
TEST NUMBER 3	185.00	20.40	24.10	33.20	4.30
TEST NUMBER 4	322.00	20.10	28.60	18.00	9.20
TEST NUMBER 5	312.00	20.40	37.30	22.00	9.10
TEST NUMBER 6	375.00	20.30	37.30	22.00	9.50
TEST NUMBER 7	300.00	20.30	55.30	20.10	9.10
TEST NUMBER 8	259.00	20.90	27.80	30.00	9.00
NIOSH REL LIMITS (see appendix)	TWA 35 ppm (40 mg/m ³) C 200 ppm (229 mg/m ³)	19.5 TO 23.0	4.7	1.0	C 10.0

Table 1 air quality testing

Monitor Brand or Manufacturer	Model # & Type	Qty Used	Gas Sensors & Detailed Monitoring					
			O2	LEL	CO	H2S	HCN	PID
B W Technologies	Micro 5/PID	2	Yes	Yes	Yes	Yes	No	Yes – Calibrated w/ Isobutylene with Correction factor set for Benzene
B W Technologies	GAXT-M-DL	8	No	No	Yes	No	No	No
Scott Health & Safety	Mini-S/A-CO	4	No	No	Yes	No	No	No
Scott Health & Safety	Mini-S/A-HCN	4	No	No	No	No	Yes	No
Scott Health & Safety	Mini-S/A-H2S	1	No	No	No	Yes	No	No

Table 2 Air quality monitors

Test Subject data

Each firefighter that entered the test building were required to have their blood pressure, oxygen saturation, and carbon monoxide levels done prior to entering and upon exiting the building. Table 3 shows the results of the testing. Blood work was also drawn during the testing both before testing and after use of the filter. This gives a much more accurate result and gives validity to the non-invasive testing meters. Results of the blood work appears in Table 4.

	FF1 Test Pre test	Phase 1 SCBA only	Phase 2 LCF only	Phase 3 RIT Chg Filter	Phase 4 Self chg Filter
PO2	97	98	97	96	97
CO	1	4	2	1	2
BP	126/82	147/90	120/88	167/88	134/86

	FF2 Test Pre test	Phase 1 SCBA only	Phase 2 LCF only	Phase 3 RIT Chg Filter	Phase 4 Self chg Filter
PO2	96	97	98	96	98
CO	2	1	1	1	1
BP	138/98	144/84	135/85	151/83	151/82

	FF3 Test Pre test	Phase 1 SCBA only	Phase 2 LCF only	Phase 3 RIT Chg Filter	Phase 4 Self chg Filter
PO2	96	97	96	96	96
CO	3	1	1	1	1
BP	119/81	124/91	148/87	dnc	122/77

	FF4 Test Pre test	Phase 1 SCBA only	Phase 2 LCF only	Phase 3 RIT Chg Filter	Phase 4 Self chg Filter
PO2	97	97	98	96	96
CO	1	3	1	1	1
BP	126/82	147/90	120/88	167/88	134/86

	FF5 Test Pre test	Phase 1 SCBA only	Phase 2 LCF only	Phase 3 RIT Chg Filter	Phase 4 Self chg Filter
PO2	96	nc	95	nc	nc
CO	1	nc	4	nc	nc
BP	138/89	nc	143/90	nc	nc

	FF6 Test Pre test	Phase 1 SCBA only	Phase 2 LCF only	Phase 3 RIT Chg Filter	Phase 4 Self chg Filter
PO2	96	nc	96	nc	nc
CO	1	nc	1	nc	nc
BP	117/78	nc	118/81	nc	nc

	FF7 Test Pre test	Phase 1 SCBA only	Phase 2 LCF only	Phase 3 RIT Chg Filter	Phase 4 Self chg Filter
PO2	97	nc	95	nc	nc
CO	1	nc	1	nc	nc
BP	123/84	nc	nc	nc	nc

Table 3 Test subjects Non-invasive testing

Blood Work vs Meter Reading	Results Blood(meter)	Comments
FF1 Phase 1- 9:36am	1.2 (2)	pre-test
FF1 Phase 2- 10:05am	1.5 (1)	post LCF use
FF2 Phase 1- 9:30am	1.3 (1)	pre-test
FF2 Phase 2- 9:50am	1.7 (2)	post LCF use
FF3 Phase 1- 9:38am	1.1 (1)	pre-test
FF3 Phase 2- 1:07pm	1.8 (2)	post LCF use
FF4 Phase 1- 9:28am	1.2 (1)	pre-test
FF4 Phase 2- 1:08pm	1.9 (2)	post LCF use

Table 4 Blood sample CO levels

Testing Conclusion

All firefighters were tested and showed no ill effects from the testing. None of the firefighters had to remove themselves from the testing due to adverse events. Selected test subjects also had blood samples taken. The Masimo® CO monitor only registers in whole numbers and blood work was done to insure accuracy. Phase 1 testing was with SCBA only and Phase 2 testing was with LCF use only. FF5, FF6, FF7 were test subjects that were testing the filter only. FF7 was a special control that used the filter only and exercised at a high level (running stairs, doing chin ups, and running inside the burn tower to simulate extreme work requirements) and stayed in the smoke filled environment for 32 minutes with the filter in use. All filter test results revealed no appreciable changes in oxygen saturation or increase in carbon monoxide levels. In one of our tests the filter had less carbon monoxide absorption than that of standard SCBA use. We attributed that result to potentially a poor seal of the face piece because it was not repeated in any of the data. Prolonged use (in excess of manufacturers' recommendations) only showed a 2

percent reduction in oxygen saturation and no change in carbon monoxide saturation. We do not recommend or promote the extended use of this product longer than the recommended 15 minutes but the results are encouraging in case of a catastrophic event. The manufacturer also used a breath analyzer and tested the participants (see Table 5). The levels were much higher but none exceeded 10 percent. The issue with using the breath analyzer is that it does not measure absorbed carbon monoxide only recently inhaled gases. Exiting the building and removing the face piece and canister may cause a higher percentage to be in the exhalation test sample. We did not base our report on these findings since there are more variables that we could not control. The results are found in table 5 but our interests were in absorbed carbon monoxide not exhalation levels.

COB Readings from Cy-Fair Last Chance Rescue Filter Live Burn Test

30-Jun-08

***Readings are in ppm (parts per million)**

Subject Name	Base Line Reading	After going in w/ SCBA	Walked in w/ LCRF donned	Partner did Switch over for them. Head over burn barrel	Subject did his own change over 10+ min with very high exersion	30+ Minutes with high exersion
FF1	02	01	03	04	04	
FF2	01	01	02	02	03	
FF3	01	missed	02	02	05	
FF4	02	missed	04	04	09	
FF7	02					10

Table 5 Breath analyzer results

Firefighters Comments

Each firefighter was questioned upon exit about their overall impressions of the filter and function. Most firefighters commented about the difficulty in inspiration at first but that they quickly adapted to the restriction. Going from a positive pressure environment to a negative pressure environment took some getting use to but was not a serious problem. Due to the exhalation in a negative pressure environment and that the Scott face piece exhalation valve is designed to be used with a regulator, the face piece may loses its seal. It is recommended that the firefighter wear a sock hood or Reed hood to help prevent the seal loss from allowing toxic gases to enter the face piece. They also commented that at first they could smell the smoke but it also went away after a few breaths. The heat from the environment was also noticeable but was less than they had first anticipated. No one complained of adverse issues or medical problems. The one firefighter that stayed in the environment for an extended period (32 minutes) using nothing but the filter had no elevation in carbon monoxide and oxygen saturation was not diminished. He commented that he could feel the filter start to require a stronger inhalation pressure and become more difficult to use. Some additional requests from the participants were a change in the pouch to include a clip on attachment instead of a slide on strap for the SCBA unit. Also some bright strip or reflective material on the external part of the pouch for improved visibility in a low visibility environment. Opening of the internal pouch appears to be easy with gloves but wet

gloves may be an issue and the attachments should be made with a rough exterior for easier grip. The dogs on the filter need to be extended so that they can line the filter up in poor visibility and may want to design them to lock into the face piece.

Conclusions

The “Last Chance Rescue filter” performed within the companies specifications and actually out performed their claims. This product is going to be included in our personal protective equipment where we will continue to review and monitor the use and lifespan of the product. Use of this product is expected to be limited and is one of the reasons we wanted to review it’s performance under live fire training exercises. Training in the use of the product is extremely important and continuous reinforcement in the proper donning of the product is of paramount importance. Panic during a real life situation may cause failure if training is not continuous. The product is not inexpensive and departments contemplating using this item should review their budgeting with saving lives in mind. While we do not diminish the importance of NFPA 1404 Air Management this should be viewed as a life saving item and not as a way to circumvent a good Air Management program.

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Chris vonWiesenthal HazMat Coordinator reviewing gas readings



2 test subjects exit the burn building after “Last Chance Rescue Filter” use



8 area departments prepare for testing of the “Last Chance Rescue Filter”

Excerpts from NIOSH Pocket Guide to Chemical Hazards (September 2005)

Appendix

- A **Short Term Exposure Limit (STEL)** is defined by ACGIH as the concentration to which workers can be exposed continuously for a **short** period of time without suffering from:
 1. irritation
 2. chronic or irreversible tissue damage
 3. narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.

Additional Info

STEL's are generally used only when toxic effects have been reported from high acute (short-term) exposures in either humans or animals. An STEL is not a separate independent exposure limit, but supplements time-weighted average limits where there are recognized acute effects from a substance whose toxic effects generally chronic (long-term) in nature.

For example, one can not be exposed to an STEL concentration if the TLV-TWA (time weighted average for an 8 hour shift; see Permissible Exposure Limit (PEL)) would be exceeded. Workers can be exposed to a maximum of four STEL periods per 8 hour shift, with at least 60 minutes between exposure periods

Benzene	CAS
	71-43-2
C₆H₆	RTECS
	<u>CY1400000</u>
Synonyms & Trade Names	DOT ID & Guide
Benzol, Phenyl hydride	1114 <u>130</u>

Exposure Limits	NIOSH REL: Ca TWA 0.1 ppm ST 1 ppm <u>See Appendix A</u>
	OSHA PEL: [1910.1028] TWA 1 ppm ST 5 ppm <u>See Appendix F</u>
IDLH	Conversion
Ca [500 ppm] See: <u>71432</u>	1 ppm = 3.19 mg/m ³

Physical Description			
Colorless to light-yellow liquid with an aromatic odor. [Note: A solid below 42°F.]			
MW: 78.1	BP: 176°F	FRZ: 42°F	Sol: 0.07%
VP: 75 mmHg	IP: 9.24 eV		Sp.Gr: 0.88
Fl.P: 12°F	UEL: 7.8%	LEL: 1.2%	
Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.			
Incompatibilities & Reactivities			
Strong oxidizers, many fluorides & perchlorates, nitric acid			

Measurement Methods

NIOSH [1500](#), [1501](#), [3700](#), [3800](#); OSHA [12](#), [1005](#)
See: [NMAM](#) or [OSHA Methods](#)

Personal Protection & Sanitation

(See [protection](#))

Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid

(See [procedures](#))

Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations

(See [Appendix E](#)) NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus

[Important additional information about respirator selection](#)

Exposure Routes

inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms

Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]

Target Organs

Eyes, skin, respiratory system, blood, central nervous system, bone marrow

Cancer Site

[leukemia]

Hydrogen cyanide

CAS

74-90-8

HCN	RTECS MW6825000
Synonyms & Trade Names Formonitrile, Hydrocyanic acid, Prussic acid	DOT ID & Guide 1051 117 (>20% solution) 1051 117 (anhydrous) 1613 154 (< or =20% solution)

Exposure Limits	NIOSH REL: ST 4.7 ppm (5 mg/m ³) [skin]
	OSHA PEL†: TWA 10 ppm (11 mg/m ³) [skin]
IDLH 50 ppm See: 74908	Conversion 1 ppm = 1.10 mg/m ³

Physical Description			
Colorless or pale-blue liquid or gas (above 78°F) with a bitter, almond-like odor. [Note: Often used as a 96% solution in water.]			
MW: 27.0	BP: 78°F (96%)	FRZ: 7°F (96%)	Sol: Miscible
VP: 630 mmHg	IP: 13.60 eV		Sp.Gr: 0.69
Fl.P: 0°F (96%)	UEL: 40.0%	LEL: 5.6%	
Class IA Flammable Liquid Flammable Gas			
Incompatibilities & Reactivities			
Amines, oxidizers, acids, sodium hydroxide, calcium hydroxide, sodium carbonate, caustics, ammonia [Note: Can polymerize at 122-140°F.]			

Measurement Methods

NIOSH [6010](#), [6017](#)
See: [NMAM](#) or [OSHA Methods](#)

Personal Protection & Sanitation

(See [protection](#))
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid

(See [procedures](#))
Eye: Irrigate immediately
Skin: Water flush immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations

NIOSH
Up to 47 ppm:
(APF = 10) Any supplied-air respirator
Up to 50 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus
[Important additional information about respirator selection](#)

Exposure Routes

inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms

Asphyxia; lassitude (weakness, exhaustion), headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes

Target Organs

central nervous system, cardiovascular system, thyroid, blood

Carbon monoxide	CAS
	630-08-0
CO	RTECS
	FG3500000
Synonyms & Trade Names	DOT ID & Guide
Carbon oxide, Flue gas, Monoxide	1016 119 9202 168 (cryogenic liquid)

Exposure Limits	NIOSH REL: TWA 35 ppm (40 mg/m ³) C 200 ppm (229 mg/m ³)
	OSHA PEL†: TWA 50 ppm (55 mg/m ³)
IDLH	Conversion
1200 ppm See: 630080	1 ppm = 1.15 mg/m ³

Physical Description			
Colorless, odorless gas. [Note: Shipped as a nonliquefied or liquefied compressed gas.]			
MW: 28.0	BP: -313°F	MLT: -337°F	Sol: 2%
VP: >35 atm	IP: 14.01 eV	RGasD: 0.97	
Fl.P: NA (Gas)	UEL: 74%	LEL: 12.5%	
Flammable Gas			
Incompatibilities & Reactivities			
Strong oxidizers, bromine trifluoride, chlorine trifluoride, lithium			

Measurement Methods
NIOSH 6604 ; OSHA ID209 , ID210 See: NMAM or OSHA Methods

<p>Personal Protection & Sanitation</p> <p>(See protection) Skin: Frostbite Eyes: Frostbite Wash skin: No recommendation Remove: When wet (flammable) Change: No recommendation Provide: Frostbite wash</p>	<p>First Aid</p> <p>(See procedures) Eye: Frostbite Skin: Frostbite Breathing: Respiratory support</p>
<p>Respirator Recommendations</p> <p>NIOSH</p> <p>Up to 350 ppm: (APF = 10) Any supplied-air respirator</p> <p>Up to 875 ppm: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode</p> <p>Up to 1200 ppm: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern† (APF = 50) Any self-contained breathing apparatus with a full facepiece (APF = 50) Any supplied-air respirator with a full facepiece</p> <p>Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus</p> <p>Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern†/Any appropriate escape-type, self-contained breathing apparatus</p> <p>Important additional information about respirator selection</p>	
<p>Exposure Routes</p> <p>inhalation, skin and/or eye contact (liquid)</p>	
<p>Symptoms</p> <p>Headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S-T segment of electrocardiogram, angina, syncope</p>	
<p>Target Organs</p> <p>cardiovascular system, lungs, blood, central nervous system</p>	

Hydrogen sulfide	CAS
H₂S	7783-06-4
Synonyms & Trade Names	RTECS
Hydrosulfuric acid, Sewer gas, Sulfuretted hydrogen	<u>MX1225000</u>
	DOT ID & Guide
	1053 <u>117</u>

Exposure Limits	NIOSH REL: C 10 ppm (15 mg/m ³) [10-minute]
	OSHA PEL†: C 20 ppm 50 ppm [10-minute maximum peak]
IDLH	Conversion
100 ppm See: <u>7783064</u>	1 ppm = 1.40 mg/m ³

Physical Description			
Colorless gas with a strong odor of rotten eggs. [Note: Sense of smell becomes rapidly fatigued & can NOT be relied upon to warn of the continuous presence of H ₂ S. Shipped as a liquefied compressed gas.]			
MW: 34.1	BP: -77°F	FRZ: -122°F	Sol: 0.4%
VP: 17.6 atm	IP: 10.46 eV	RGasD: 1.19	
Fl.P: NA (Gas)	UEL: 44.0%	LEL: 4.0%	
Flammable Gas			
Incompatibilities & Reactivities			
Strong oxidizers, strong nitric acid, metals			

Measurement Methods
NIOSH <u>6013</u> ; OSHA <u>ID141</u> See: <u>NMAM</u> or <u>OSHA Methods</u>

<p>Personal Protection & Sanitation</p> <p>(See protection) Skin: Frostbite Eyes: Frostbite Wash skin: No recommendation Remove: When wet (flammable) Change: No recommendation Provide: Frostbite wash</p>	<p>First Aid</p> <p>(See procedures) Eye: Frostbite Skin: Frostbite Breathing: Respiratory support</p>
<p>Respirator Recommendations</p> <p>NIOSH Up to 100 ppm: (APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern (APF = 10) Any supplied-air respirator* (APF = 50) Any self-contained breathing apparatus with a full facepiece Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection</p>	
<p>Exposure Routes</p> <p>inhalation, skin and/or eye contact</p>	
<p>Symptoms</p> <p>Irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite</p>	
<p>Target Organs</p> <p>Eyes, respiratory system, central nervous system</p>	