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Technical Bulletin

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#177–Recommended use of the 3M™ Cartridge RBE-57 CBRN against Various Military and Industrial Chemical Agents

3M's RBE-57-CBRN cartridge has been tested against NIOSH CBRN protocol and found to be effective against a number of different chemical warfare agents and industrial chemicals (see table and footnotes on the following page). The cartridge contains a high efficiency (HE) filter to remove solid and liquid aerosols including biological and radiological particles. It also contains activated and impregnated carbon to absorb or react with gases and liquid vapors.

Loose fitting powered air purifying respirators (PAPR) can only be used when sufficient oxygen is present and when the contaminant and concentration are known and below Immediately Dangerous to Life or Health (IDLH) limits. The maximum use concentration (MUC) in which a loose fitting PAPR can be utilized is the product of the assigned protection factor (APF = 1000) multiplied by the airborne exposure limit (such as TLV®). This number must be lower than the IDLH, otherwise the IDLH becomes the MUC (see far right columns in the table). Because it has a cartridge approval, the RBE-57-CBRN may only be used in environments up to IDLH as long as adequate oxygen is present. In the US, OSHA states in their standard for Hazardous Waste Operations and Emergency Response (HAZWOPER), 29 CFR 1910.120, that Level C personal protective equipment (including air purifying respirators) may only be used in areas where lesser levels of skin and respiratory protection are required. Respirators help reduce exposure to certain airborne contaminants, but do not eliminate exposure of the risk of contracting disease or infection.

The cartridge must be replaced in accordance with an established change schedule or earlier if smell, taste or irritation from contaminants is detected. If a change schedule cannot be developed, atmosphere supplying respirators are required. The actual service life of the cartridge will depend upon the specific type, volatility and concentration of the contaminants; and environmental conditions such as humidity and temperature. Data in the table below may serve as a starting point for determining a change schedule. The minimum test times listed in the table are only the minimum required duration under the test conditions; the cartridge may last longer or shorter.

As part of the NIOSH CBRN approval, the cartridge is attached to a PAPR with a loose fitting hood and the entire respirator is tested against warfare agent permeation. The assembled system must have a test life of at least 8 hours against 50 mg/m^3 (7.55 ppm) distilled sulfur mustard (HD) vapor or 210 mg/m^3 (36 ppm) Sarin (GB) vapor. It must also have a test life of at least 2 hours against 0.43 ml of HD liquid.

In the U.S., OSHA does not require change schedules for particulate filters. The cartridge must be replaced if it is damaged or the PAPR fails minimum flow of 6 cfm.

Challenge Agent[1]	Challenge Concentration (ppm)	Testing Relative Humidity (%)	Maximum Allowed Breakthrough (ppm)	Minimum Test Time (min)	TLV® [2] / IDLH [3] (ppm)	Maximum Use Concentration [4] (ppm)
Ammonia (NH_3)	1250	25 / 80	12.5	> 15	25 / 300	300
Cyanogen Chloride (CK)	150	25 / 80	2	> 15	0.3C / 24.7 [5]	24.7
Cyclohexane (Organic Vapors)	1300	25 / 80	10	> 15	100 / 1300	1300
Formaldehyde (CH_2O)	250	25 / 80	1.0	> 15	0.1 / 20	20
Hydrogen Cyanide (AC)	470	25 / 80	4.7[6]	> 15	4.7C / 50	50
Hydrogen Sulfide	500	25 / 80	5.0	> 15	1 / 100	100
Nitrogen Dioxide (NO_2)	100	25 / 80	1 ppm NO_2 or 25 ppm NO [7]	> 15	0.2 / 13	13
Particulates (HE)	200 mg total loading w/0.3µm MMAD DOP particles	25 / 80	<0.03%	2,400	10 mg/m^3 I [8] / ND 3 mg/m^3 R [9] / ND	10000 mg/m^3 3000 mg/m^3
Phosgene (CG)	125	25 / 80	1.25	> 15	0.1 / 2	2
Phosphine (PH)	150	25 / 80	0.3	> 15	0.05 / 50	50
Sulfur Dioxide (SO_2)	750	25 / 80	5	> 15	0.25C / 100	100

NA = Not applicable	ND = Not Determined	ppm = parts per million	mg/m^3 = milligrams per cubic meter of air	STEL = Short Term Exposure Limit	C = Ceiling Limit

1. Testing criteria from NIOSH Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Powered Air-Purifying Respirators (PAPR), October 6, 2006. Flow rate is 170 lpm divided by the number of cartridges (3).
2. TLV = Threshold Limit Value from ACGIH®, 2019 TLVs® and BEIs® Book. Copyright 2019. Reprinted with permission.
3. IDLH = Immediately Dangerous to Life or Health limit. IDLH values published by the US National Institute for Occupational Safety and Health (NIOSH). https://www.cdc.gov/niosh/idlh/default.html
4. Assuming a Powered Air Purifying Respirator (PAPR) with a loose-fitting hood and OSHA assigned Protection Factor of 1000. These values are 1000 times the TLV, or the IDLH limit, whichever is lower.
5. There is no actual IDLH value for CK. The NIOSH IDLH value for “Cyanides as (CN)” is 25 mg/m^3, so multiply 25 ppm by the MW of CK (61.47 g/mole) and divide by the MW of CN (26.02 g/mole).
6. Sum of HCN and C_2N_2.
7. Nitrogen dioxide breakthrough is monitored for both NO_2 and NO. The breakthrough is determined by which quantity, NO_2 or NO, reaches breakthrough first.
8. I = Inhalable particles, insoluble, low toxicity, not otherwise specified. See exposure limits for specific substances.
9. R = Respirable particles, insoluble, low toxicity, not otherwise specified. See exposure limits for specific substance.

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