# Technical Data Bulletin

OH&ESD

**#162 (March 2004)**

## Recommended use of the 3M™ Canister FR-15-CBRN Against Various Military and Industrial Chemical Agents

3M's FR-15-CBRN canister has been tested against military and NIOSH protocol and found to be effective against a number of different chemical warfare agents and industrial chemicals (see table and footnotes below). The canister contains a P100 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.

Air purifying respirators (APR) 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 an APR can be utilized is the product of the assigned protection factor (APF = 50 for a quantitatively fit tested full facepiece respirator) multiplied by the airborne exposure limit (such as TLV®). This number must be lower than the IDLH, otherwise the IDLH becomes the MUC (see columns 6 and 7). Because it has a canister approval, the FR-15-CBRN may also be used to escape from IDLH environments 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 canister 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 canister will depend upon the activity of the wearer (breathing rate); 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. However, it should be noted that in most cases, the test concentration was higher than the MUC allowed for a negative pressure full facepiece APR. Service life at lower concentrations may be longer. The minimum test times listed in the table are only the minimum required duration under the test conditions; the canister may last longer.

3M™ Service Life Software may also be helpful in determining a change schedule (please see the 3M OH&ESD web site http://www.mmm.com/occsafety/). The software includes data for many industrial chemicals, and users may calculate service life for other organic vapors (such as warfare agents) if the chemical properties of these contaminants are known. The 3M™ Cartridge FR-64 is similar to the FR-15-CBRN, and may be selected to estimate service life.

As part of the NIOSH CBRN approval, the canister is attached to a full facepiece 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 canister must be replaced if increased breathing resistance is noticed. If used in environments containing oily aerosols, it must be replaced after 40 hours of use or 30 days, whichever is first.

| Challenge Agent | Challenge Concentration (ppm) | Testing Relative Humidity (%) | Maximum Allowed Breakthrough (ppm) | Minimum Test Time (min) | TLV®[1] / IDLH[2] (ppm) | Maximum Use Concentration[3] (ppm) |
|---|---|---|---|---|---|---|
| Ammonia ($NH_3$) [4] | 1000 | 50 | 50 | > 25 | 25 / 500 | 500 |
| Ammonia ($NH_3$) [5] | 2500 | 25 / 80 | 12.5 | > 15 | 25 / 500 | 500 |
| Chlorine Dioxide ($ClO_2$) [4] | 500 | 50 | 0.1 | > 30 | 0.1 / 10 | 10 |
| Carbon Tetrachloride (Organic Vapors) [4] | 1000 | 50 | 5 | > 25 | 5 / 300 | 250 |
| Chlorine ($Cl_2$) [4] | 500 | 50 | 5 | > 17.5 | 0.5 / 30 | 25 |
| α-Chloroacetophenone (CN) [4, 6] | 16 | 50 | 0.05 | > 480 | 0.05 / 16 | 2.5 |
| o-Chlorobenzylidene-malononitrile (CS) [4, 6] | 3 | 50 | 0.05 | > 480 | 0.05C [7] / 0.25 | 0.25 |
| Chloropicrin (PS) [8] | 744 | 80 | 0.74 | > 27 | 0.1 / 4.0 | 4.0 |
| Cyanogen Chloride (CK) [5] | 300 | 25 / 80 | 2 | > 15 | 0.3C[7] / ND (46.9)[9] | 15.0 |
| Cyanogen Chloride (CK) [10] | 1591 | 80 | 3.2 | > 30 | 0.3C[7] / ND (46.9)[9] | 15.0 |
| Cyclohexane (Organic Vapors) [5] | 2600 | 25 / 80 | 10 | > 15 | 100 / 10000 | 5000 |
| DMMP [10, 11] | 591 | Dry | 0.008 | > 59 | NA | NA |
| Formaldehyde ($CH_2O$) [4] | 100 | 50 | 1.0 | > 50 | 0.3C [7] / 30 | 7.5 [12] |
| Formaldehyde ($CH_2O$) [5] | 500 | 25 / 80 | 1 | > 15 | 0.3C [7] / 30 | 7.5 [12] |
| Hydrogen Chloride (HCl) [4] | 500 | 50 | 5 | > 25 | 2C [7] / 100 | 100 |
| Hydrogen Cyanide (AC) [13] | 3618 | 80 | 4.5 [14] | > 28 | 4.7C [7] / 50.0 | 50.0 |
| Hydrogen Cyanide (AC) [5] | 940 | 25 / 80 | 4.7 [15] | > 15 | 4.7C [7] / 50.0 | 50.0 |
| Hydrogen Fluoride (HF) [4] | 70 | 50 | 3.0 | > 30 | 3C[7] / 30 | 30 |
| Hydrogen Sulfide, Escape ($H_2S$) [4] | 1000 | 50 | 10 | > 30 | 10 / 300 | 300 |
| Hydrogen Sulfide, Escape ($H_2S$) [5] | 1000 | 25 / 80 | 5 | > 15 | 10 / 300 | 300 |
| Methylamine ($CH_3NH_2$) [4] | 1000 | 50 | 10 | > 12.5 | 5 / 100 | 100 |
| Nitrogen Dioxide ($NO_2$) [5] | 200 | 25 / 80 | 1 ppm $NO_2$ or 25 ppm NO | > 15 | 3 / 50 | 50 |
| Particulates (P100) [4] | 200 mg total loading w/ 0.3µm MMAD DOP particles | NA | <0.03% | 2400 [16] | 10 $mg/m^3$ I[17] / ND<br>3 $mg/m^3$ R[18] / ND | 500 $mg/m^3$<br>150 $mg/m^3$ |
| Phosgene (CG) [13] | 4943 | 50 | 2.0 | > 25 | 0.1 / 2.0 | 2.0 |

| Challenge Agent | Challenge Concentration (ppm) | Testing Relative Humidity (%) | Maximum Allowed Breakthrough (ppm) | Minimum Test Time (min) | TLV®[1] / IDLH[2] (ppm) | Maximum Use Concentration[3] (ppm) |
|---|---|---|---|---|---|---|
| Phosgene (CG) [5] | 250 | 25 / 80 | 1.25 | > 15 | 0.1 / 2.0 | 2.0 |
| Phosphine (PH) [4] | 1500 | 50 | 0.3 | > 12 | 0.3 / 200 | 15 |
| Phosphine (PH) [5] | 300 | 25 / 80 | 0.3 | > 15 | 0.3 / 200 | 15 |
| Sulfur Dioxide ($SO_2$) [4] | 500 | 50 | 5 | > 15 | 2 / 100 | 100 |
| Sulfur Dioxide ($SO_2$) [5] | 1500 | 25 / 80 | 5 | > 15 | 2 / 100 | 100 |

NA = Not applicable ND = Not Determined ppm = parts per million $mg/m^3$ = milligrams per cubic meter of air

1. TLV = Threshold Limit Value from the American Conference of Governmental Industrial Hygienists. ACGIH Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices, 2003.
2. IDLH = Immediately Dangerous to Life or Health limit. NIOSH Pocket Guide to Chemical Hazards, DHHS (NIOSH) Publication No. 90-177, 1990. Although newer IDLH values have been published, OSHA stated in a May 21, 1996 Memorandum that OSHA will use the older IDLH valves while NIOSH conducts further study.
3. Assuming a tight fitting full facepiece respirator that has been quantitatively fit tested and has an assigned protection factor of 50. These values are 50 times the TLV or the IDLH limit, whichever is lower.
4. Testing criteria from NIOSH testing methods tables, 42 Code of Federal Regulations, Part 84. Flow rate is 64 liters/minute.
5. Testing criteria from NIOSH Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Full Facepiece Air Purifying Respirator (APR), April 4, 2003. Flow rate is 64 liters/minute. The canister must also demonstrate a minimum test life of at least 5 minutes when tested at a flow rate of 100 liters/minute.
6. CS and CN have very low vapor pressure and therefore will exist mainly as particles.
7. C = Ceiling Limit refers to the concentration that should not be exceeded during any part of the working exposure without respiratory protection.
8. American British Canadian Australian Armies Standardization Program. Standards for General Service Respirators/Masks for the Timeframe 1985-2005, QSTAG 695 Second Draft.
9. There is no actual IDLH value for CK. The NIOSH Pocket Guide to Chemical Hazards lists the value for "Cyanides as (CN)" as 50 $mg/m^3$, so multiply 50 by the MW of CK (61.47) and divide by the MW of CN (26.02).
10. MIL-PRF-51560A(EA) for C2A1 Canister.
11. DMMP is a common surrogate or simulant test agent for the nerve agent sarin (GB). TLV and IDLH limit values have not been established for DMMP. NIOSH does not have an approval schedule for DMMP.
12. The OSHA formaldehyde standard, 29CFR1910.1048, allows a full facepiece respirator with cartridges to be used up to 7.5 ppm.
13. MIL-DTL-32101 for ASZM-TEDA Carbon; 22 Jan 99, applied to full canister.
14. Calculated as $(CN)_2$.
15. Sum of HCN and $C_2N_2$.
16. If used in oil aerosol environment, dispose of respirator after 40 hours (2400 minutes) or 30 days, whichever is first.
17. I = Inhalable particles, insoluble, low toxicity, not otherwise specified. See exposure limits for specific substances.
18. R = Respirable particles, insoluble, low toxicity, not otherwise specified. See exposure limits for specific substances.



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