Technical Data Bulletin

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Test Criteria for the 3M™ Cartridge FR-57 Against Various Military and Industrial Chemical Agents

3M's FR-57 cartridge 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 testing footnotes below).

The FR-57 cartridge contains a high efficiency filter to remove solid and liquid aerosols. 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 = 1000 for a powered air purifying respirator with a hood or full facepiece) 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).

Challenge Agent	Challenge Concentration (mg/m^3)	Testing Relative Humidity (%)	Maximum Allowed Breakthrough (mg/m^3)	Meets Minimum Service Time of: (min)	TLV®[1] / IDLH[2] (mg/m^3)	Allowable Maximum Use Concentration (mg/m^3)[3]
Sarin (GB)[4,5]	4000	50	0.04	83	0.0001[6] / >0.2[6]	0.1
DMMP[4,5,7]	3,000	Dry	0.04	59	NA	NA
Cyanogen Chloride (CK)[4,10]	2,000	80	2.5	25	0.75C[8] / ND(118)[9]	118
Hydrogen Cyanide (AC)[4,10]	2,000	80	1.0[11]	25	5.2C[8] / 55.3	55.3
Phosgene (CG)[4,12]	20,000	80	8.0	9.4[13]	0.40 / 8.1	8.1
Chloropicrin (PS)[4,12]	5,000	80	5.0	27	0.67 / 26.9	26.9
Chlorine (Cl_2)[14]	1450	50	14.5	17.5	1.5 / 87.0	87
Sulfur Dioxide (SO_2)[14]	1310	50	13.1	15	5.2 / 262	262
Hydrogen Chloride (HCl)[14]	746	50	7.5	25	7.5C[8] / 149	149
Carbon Tetrachloride (OV)[14]	6290	50	31.5	25	31.5 / 1888	1888
Ammonia (NH_3)[14]	697	50	34.8	25	17.4 / 348	348
Formaldehyde (CH_2O)[14]	123	50	1.2	50	0.37C[8] / 36.9	36.9
Hydrogen Fluoride (HF)[14]	57.3	50	2.5	30	2.5C[8] / 24.6	24.6

Challenge Agent	Challenge Concentration (mg/m^3)	Testing Relative Humidity (%)	Maximum Allowed Breakthrough (mg/m^3)	Meets Minimum Service Time of: (min)	TLV®[1] / IDLH[2] (mg/m^3)	Allowable Maximum Use Concentration (mg/m^3)[3]
Methylamine (CH_3NH_2)[14]	1270	50	12.7	25	6.4 / 127	127
Chlorine Dioxide (ClO_2)[14]	1380	50	0.28	30	0.28 / 27.6	27.6
Particulates (High Efficiency)[14]	100	NA	<0.03%	NA[15]	10 I[16] / ND 3 R[17] / ND	10,000 3,000

NA = Not applicable ND = Not Determined ppm = parts per million mg/m^3 = milligrams per cubic meter of air
Note: NIOSH approvals for α-Chloroacetophenone (CN), o-Chlorobenzylidene-malononitrile (CS), and Phosphine (PH) are only for tight fitting, air purifying respirators.

1. TLV = Threshold Limit Value from the American Conference of Governmental Industrial Hygienists. ACGIH Threshold Limit Values and Biological Exposure Indices, 2001.
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 powered air purifying respirator with a hood or full facepiece that has an assigned protection factor of 1000. These values are 1000 times the TLV or the IDLH limit, whichever is lower.
4. 3M respirators are not NIOSH approved for these agents. There are no NIOSH approval schedules for GB,DMMP,CK,AC,CG or PS.
5. Performance Specification, Canisters Chemical-Biological Mask: C2A1 MIL-PRF-51560A(EA) conducted at the operating powered airflow rate (57 LPM).
6. TLV and IDLH limit values have not been established for GB. The values listed for GB are the airborne exposure limit and the limit for which a SCBA is the only acceptable respiratory protection. The Office of the US Army Surgeon General (OASG) established these values.
7. 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.
8. C = Ceiling Limit refers to the concentration that should not be exceeded during any part of the working exposure without respiratory protection.
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. Combined Operational Characteristics, Technical Specifications and Evaluation Criteria for the Protective Mask (Triptych) AC/225 Panel (VII) D/103 - UNCLASSIFIED VERSION 1977 conducted at the operating powered airflow rate (57 LPM)
11. Calculated as $(CN)_2$.
12. American British Canadian Australian Armies Standardization Program Standards for General Service Respirators/Masks for the Timeframe 1985-2005 – Second Draft QSTAG 695 conducted at the operating powered airflow rate (57 LPM).
13. The minimum service time for this chemical is listed as a "time x concentration" function. For this test, 188,000 min x mg/m^3 is divided by the concentration of interest (in mg/m^3) to calculate the amount of service time for the cartridge.
14. Testing criteria from NIOSH testing methods tables, 42 Code of Federal Regulations, Part 84.
15. Instantaneous penetration test using 0.3µm MMAD DOP particles.
16. I = Inhalable, Particles (Insoluble) Not Otherwise Specified (PNOS)
17. R = Respirable, Particles (Insoluble) Not Otherwise Specified (PNOS)

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Occupational Health and Environmental Safety Division