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Technical Bulletin

July 2025

#155 - 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)**	**Minimum Test Time (min)**	**TLV® [1] / IDLH [2] (mg/m^3)**	**Maximum Use Concentration [3] (mg/m^3)**
Ammonia (NH_3) [4]	697	50	34.8	25	17 / 210	210
Carbon Tetrachloride (Organic Vapors) [4]	6290	50	31.5	25	31 / 1258	1258
Chlorine (Cl_2) [4]	1450	50	14.5	17.5	0.29 / 29	29
Chlorine Dioxide (ClO_2) [4]	1380	50	0.28	30	0.28C / 13.8	13.8
Chloropicrin (PS) [5, 6]	5000	80	5	27	0.67 / 13.4	13.4
Cyanogen Chloride (CK) [5, 7]	2000	80	2.5	25	0.75C / 62.2 [8]	62.2
DMMP [5, 9, 10]	3000	Dry	0.04	59	NA	NA
Formaldehyde (CH_2O) [4]	123	50	1.2	50	0.12 / 24.6	24.6
Hydrogen Chloride (HCl) [4]	746	50	7.5	25	2.98C / 74.5	74.5
Hydrogen Cyanide (AC) [7]	2000	80	1 [11]	25	5C / 55	55

Challenge Agent	Challenge Concentration (mg/m^3)	Testing Relative Humidity (%)	Maximum Allowed Breakthrough (mg/m^3)	Minimum Test Time (min)	TLV® [1] / IDLH [2] (mg/m^3)	Maximum Use Concentration [3] (mg/m^3)
Hydrogen Fluoride (HF) [4]	57.3	50	2.5	30	0.41 / 24.6	24.6
Methylamine (CH_3NH_2) [4]	1270	50	12.7	25	6.4 / 127	127
Particulates (High Efficiency) [4]	100	NA	<0.03%	NA[12]	10 I [13] / ND 3 R [14] / ND	10000 3000
Phosgene (CG) [5, 6]	20000	80	8	9.4[15]	0.4 / 8.1	8.1
Sarin (GB) [5, 9]	4000	50	0.04	83	0.0001STEL [16] / 0.1 [16]	0.1
Sulfur Dioxide (SO_2) [4]	1310	50	13.1	15	0.65C / 262	262

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

NOTE

NIOSH approvals for a-Chloroacetophenone (CN), o-Chlorobenzylidene-malononitrile (CS), and Phosphine (PH) are only for tight fitting, air purifying respirators.

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1. TLV = Threshold Limit Value from ACGIH®, 2019 TLVs® and BEIs® Book. Copyright 2019. Reprinted with permission.
2. 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
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. Testing criteria from NIOSH testing methods tables, 42 Code of Federal Regulations, Part 84.
5. 3M respirators are not NIOSH approved for these agents. There are no NIOSH approval schedules for GB, DMMP, CK, AC, CG or PS.
6. 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).
7. 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).
8. There is no actual IDLH value for CK. The NIOSH IDLH value for “Cyanides as (CN)” is 25 mg/m^3, so multiply 25 by the MW of CK (61.47) and divide by the MW of CN (26.02).
9. Performance Specification, Canisters Chemical-Biological Mask: C2A1 MIL-PRF-51560A(EA) conducted at the operating powered airflow rate (57 LPM).
10. 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.
11. Calculated as $(CN)_2$.
12. Instantaneous penetration test using 0.3µm MMAD DOP particles.
13. I = Inhalable, Particles (Insoluble) Not Otherwise Specified (PNOS).
14. R = Respirable, Particles (Insoluble) Not Otherwise Specified (PNOS).
15. 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.

16. TLV and IDLH limit values have not been established for GB. The values listed for GB are from the US Army Public Health Command, Chemical Agent Health-Based Standards and Guidelines Summary Table 1: Criteria for Airborne Exposures as of July 2011.

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