DEPARTMENT OF THE ARMY
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
EDGEWOOD CHEMICAL BIOLOGICAL CENTER
5183 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MD 21010-5424

REPLY TO
ATTENTION OF

RDCB-DSR-S

DEC 1 2 2017

MEMORANDUM THRU Director, Edgewood Chemical Biological Center, (RDCB-D/ ELM
Dr. Eric L. Moore), 5183 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5424

FOR Defense Technical Information Center (DTIC), 8725 John J. Kingman Road, Ft. Belvoir, VA 22060

SUBJECT: Internal Request for Change in Distribution

1. This action is in response to an Edgewood Chemical Biological Center (ECBC) internal request for a Change in Distribution for the below listed documents, which are currently authorized for release to DoD Components Only:

a. ADB954958 - Report No. EAMRD 17; Project No., A3.2-3; Toxicity of Chlorine on Dogs-10 minute exposure; Authors: G. C. Armstrong, W. A. Eldridge, J. A. Baldwin, dated 1 September 1923.

b. ADB958296 – Report No. EACD 328; Project No. C-4; Important Constants of Fourteen Common Chemical Warfare Agents; Author: C. H. Beebe; dated 1 December 1924.

c. ADB955268 – Report No. EATR 351; Project No. A 10.4; Chlorine. Median Lethal Concentration for Mice; Authors: S. D. Silver, F. P. McGrath; dated 9 May 1942.

d. ADB955266 – Report No. EATR 373; Project No. A 10.4; Chlorine. Median Lethal Concentration for Mice; Authors: S. D. Silver, F. P. McGrath, R. L. Ferguson; dated 17 July 1942.

2. The above listed documents have been reviewed by subject matter experts within ECBC and have been deemed suitable for the change in distribution to read "Approved for Public Release; Distribution Unlimited".

3. The point of contact is the undersigned at (410) 436-1999, ronald.l.stafford.civ@mail.mil.

for RONALD L. STAFFORD
Security Manager

UNANNOUNCED

UNCLASSIFIED

Edgewood Arsenal, Md.
January 13, 1925.

C. E. T. LULL,
Major, C.W.S.,
Commanding.

WAR DEPARTMENT
CHEMICAL WARFARE SERVICE
EDGEWOOD ARSENAL, EDGEWOOD, MD.
COLONEL C. W. EXTON, COMMANDING.

Chas a. T. Lull

C. E. T. LULL, TECHNICAL DIRECTOR.

J. E. MILLS, CHIEF, CHEMICAL DIVISION.

REPORT NO. E.A.C.D. 328, COPY NO. 1.
PROJECT NO. C-4.

SUBJECT: Important Constants of Fourteen Common Chemical Warfare Agents.

BY: C. H. Beebe.

DATE: December 1, 1924.

[redacted]

CONFIDENTIAL

IMPORTANT CONSTANTS OF POLYTENE

COMMON CHEMICAL WARFARE AGENTS.

December 1, 1924.

By

C.H. Beebe.

ARSINE
(AsH_3)

December 1, 1924.

Factor - P.P.M. to Mg./L. 0.00348) 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 287.4)

Molecular Weight	77.98
Melting Point[1]	-113°C.
Boiling Point[1]	-54.8°C.
Decomposition Temperature[2]	230°C.
Specific Heat	
Heat Vaporization[2]	55-58 cal./g.
Heat Formation[2]	-39060 cal.
Estimated Cost[2]	$1.00 per lb.
Critical Temp.[2]	> 30°C.
Critical Pressure	> 18 atmos.

Temperature °C.	Vapor Pressure[2] Mm. Hg.		Volatility Mg./l. at Saturation	Density[2] (Liquid)
-59.4	715		2558	-
-30.6	2521		10280	-
-12.2	4745		20790	-
0	6755		30000	1.439
5	7690		34600	1.423
10	8712		38500	1.408
15	9829		42700	1.392
20	11044		47100	1.376
25	12360		51800	1.361
30	13780		56900	1.345
40	16960	Extrapolated	67700	-
50	20600	"	79700	-
60	26090	"	99800	-

Lethal Concentration[3] (Dogs)

Time of Exposure Min.	Lg./l.
3.5	2.50
7.5	1.33
15.0	0.78
30.0	0.40
60.0	0.30
120.0	0.17
240.0	0.08

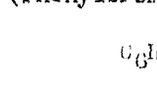
Protection[4] - 1919 Canister

1.6 mg./l., 80% humidity, 32 l./min.

	Efficiency 100%	99%	96%	90%
Life (in mins.)	10	11	14	24

1 - Landolt Börnstein Tables, 5 Ed.
2 - C.W., 23, Pt. 1
3 - Based on data in Bur. of M. I. 276
4 - U.S. 1377,225-6

BROMBENZYLCYANIDE C.A.
(Phenylbromacetonitrile)



December 1, 1924.

Factor - P.P.M. to Mg./L. 0.00875) 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 114.3)

Molecular Weight	196.02	Heat Vaporization[1]	75.2 cal./g. (above 24.8 C.); ~~78.7~~ cal./g. (calculated at theoretical boiling point)
Melting Point[1]	24.8°C.		
Boiling Point[1]	247°C. (calculated)		
Decomposition Temperature[2]	>150°C.	Heat Fusion	
Specific Heat		Heat of Formation	
		Estimated Cost[3]	$1.30 per lb.

Temperature °C.	Vapor Pressure[1] mm. Hg.	Volatility Mg./L. at Saturation	Density[4] (Solid and Liquid)
0	0.00191	0.0220	1.4965
5	0.00312	0.0353	1.4893
10	0.00500	0.0555	1.4844
15	0.00787	0.0858	1.4787
20	0.01224	0.1313	1.4733
25	0.01867	0.1963	1.4676
30	0.02813	0.2919	1.4622
40	0.06149	0.6172	1.4511
50	0.12800	1.2450	1.4400
60	0.25470	2.4030	1.4290
65	0.35400	3.2900	1.4233
100	2.77	23.35	
150	28.98	215.6	
200	185.	1230.0	

Threshold Concentration[5]
Irritation - 0.00015 mg./l.

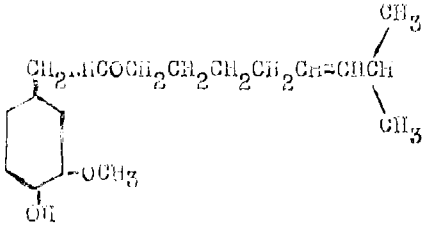
Lachrymation[6]
0.0003 mg./l.

Intolerable Concentration[5]		Lethal Concentration[5]	
Exposure	Conc./mg./l.	Time (min.)	Mg./L.
51 sec.	0.1	10	0.36 mice
5 min.	0.00045	30	0.9 dogs

1 - MPF 142.22-1 (MACH 70)
2 - MPF 142.2-1 (MACH 64)
3 - CH 22.9
4 - MPF 142.21-1 (MACH 210)
5 - MPF 142.3-1 (MACH 142)

CAPSAICIN D.C.

(8 methyl-nonen-6 oyl-vanillyl-amide[1])



December 1, 1924.

Factor - P.P.M. to Mg./L. 0.0136 } 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 73.41 }

Molecular weight 305.31 Decomposition Temperature[4] - between 230°C. and 270°C.
Melting Point[2] 65°C.
Boiling Point[3] 340°C. (Calculated) Heat Vaporization[3] 42.2 cal./g.

Temperature °C.	Vapor Pressure[5] mm. Hg.	Volatility Mg./L. at Saturation	Density
10	9.38×10^{-12}	1.62×10^{-10}	
20	7.45×10^{-11}	1.24×10^{-9}	
30	4.75×10^{-10}	7.66×10^{-9}	
40	1.40×10^{-9}	2.32×10^{-8}	
60	1.6×10^{-7}	2.2×10^{-6}	
70	3.1×10^{-7}	4.4×10^{-6}	
80	1.2×10^{-6}	1.7×10^{-5}	
90	4.6×10^{-6}	6.2×10^{-5}	
100	1.6×10^{-5}	2.1×10^{-4}	
110	5.2×10^{-5}	6.6×10^{-4}	
130	4.6×10^{-4}	0.0057	
140	0.0015	0.0155	
150	0.0033	0.0381	
160	0.0053	0.0938	
180	0.046	0.4967	
200	0.221	2.286	
250	6.62	61.91	
300	110.0	939.0	

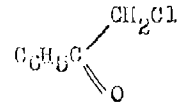
Threshold Concentration[6]
Odor 0.0000014
Irrit. of Nose 0.000007 Mg./L.
Irrit. of Throat - 0.000008 Mg./L.
Coughing - 0.000027 Mg./L.

Tolerance Data[6]

Exposure	Concentration (mg./L.)	Exposure	Concentration (mg./L.)
30 sec.	.0186?	5 min.	.0018
1 min.	.0093?	7½ min.	.00125
2 min.	.0046	10 min.	.00093
3 min.	.0031	30 min.	.00031?
4 min.	.0023	60 min.	.00015?

1 - M.C.D. 284. 2 - M.P. 123.6-7 (M.C.D. 188) 3 - M.P. 123.22-3 (M.C.D. 79)
4 - M.P. 123.22-3 (M.C.D. 138) 5 - M.P. 123.2-3 (M.C.D. 89) 6 - Report of A.E. Hill on Toxicities. Note: Tolerance data on D.C. not highly reliable, especially for exposures less than 1 minute and more than 7½ minutes. It is possible that for exposures less than 1 minute the concentration may be less than that given above, and for exposures longer than 7½ minutes the concentrations may be greater than those given.

CHLORACETOPHENONE C.N.



December 1, 1924.

Factor - P.P.M. to Mg./L. 0.0069 } 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 145.0 }

Molecular Weight	154.56	Heat Vaporization[1]	92 cal./g.
Melting Point[1]	59°C.	Heat Fusion[1]	10 cal./g.
Boiling Point[1]	247°C.	Heat Sublimation	102 cal./g.
Decomposition Temperature[1]	< 247°C.	Heat of Formation[1]	4630 cal. (calculated)
Specific Heat[1]	0.264 cal./g. - Calculated (Solid)	Estimated Cost[2]	$1.50 per lb.

Temperature °C.	Vapor Pressure[1] mm. Hg.	Volatility Mg./L. at Saturation	Density[1] (Solid or Liquid)
0	0.00170	0.0154	1.334
5	0.00288	0.0257	1.3465
10	0.00478	0.0418	1.3382
15	0.00781	0.0672	1.3297
20	0.01253	0.1059	1.321
25	0.01980	0.1646	1.3130
30	0.03082	0.2519	1.3047
40	0.07158	0.5663	1.2880
50	0.1676	1.2084	1.2713
60	0.3174	2.3605	Liquid at 58°C. 1.189
65	0.4367	3.1996	
100	3.26	21.65	
150	32.2	188.6	
200	195.0	1020.	

Threshold Concentration[3]
Irritation - 0.00015 Mg./L. (3 min.)

Lachrymation[3]
0.00031 Mg./L. (3 min.)

Intolerable Concentration[3] Exp. In Min.	Conc. Mg./L.
1	0.0350
2	0.0175
3	0.0117
4	0.0088
5	0.0070
10	0.0035
15	0.0023
17	0.0020

Lethal Concentration (Dogs)[4]
30 min. exp. 0.54 mg./l.

1 - ECF 141.2-1 (BACD 59)
2 - CD 22.9
3 - ECF 141.3-1 (BACD 108)
4 - B.U. XXVI-01

CHLORINE
(Cl_2)

December 1, 1924.

Factor - P.P.M. to Mg./L. 0.00316 } 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 316.1 }

Molecular Weight	70.92	Heat Fusion[1]	23.0 cal./g.
Melting Point[1]	-102°C.	Estimated Cost[2]	$.075 per lb.
Boiling Point[1]	-33.6°C.	Critical Temp.[1]	144.0°C.
Specific Heat[1]	0.124 (13-202°C.) cal./gm.	Critical Pressure[1]	76.1 atmos.
Heat Vaporization[1]	67.4 cal./gm. at ~~-33.6°C.~~	See ref. LB 5th.	

Temperature °C.	Vapor Pressure[3] Mm. Hg.	Volatility Mg./L. at Saturation	Density[3] (Liquid)
-40	595	2903	1.574
-20	1570	6154.6	1.524
-10	1975	8535.0	1.496
0	2766	11516	1.468
5	3235	13227	1.453
10	3770	15142	1.438
15	4324	17066	1.423
20	4993	19369	1.408
25	5692	21710	1.393
30	6536	24518	1.377
35	7479	27600	1.361
40	8467	30747	1.344
50	10746	37815	1.310
65	14812	49810	1.257

Threshold Concentration[4]
Odor 0.0096 mg./L.

Irritation of Throat[4] (3 min.) 0.048 mg./L.
Treatment for colds[7] 0.013 - .015 mg./L.

Lethal Concentration (Dogs)

Time (mins.)	Mg./L.
10	5.58 (5)
30	2.5 (4)

Protection[8] - 1919 Canister
15.8 mg./L., 50% humidity 32 L./min.

	Efficiency 100%	99%	95%	90%
Life (mins.)	25	30	36	42

1 - Landolt Bornstein Tables, 5 Ed.
2 - CD 22.9
3 - J. de Chimie Phys. 13, 449 (1915)
4 - C.W.S. Pt. II, 243
5 - GTF 132.312-1 (22760 17)
7 - GTF 132.595-1(22760 21)
8 - CD 197-22-6

CHLORPICRIN P.S.
(CCl_3NO_2)

December 1, 1934.

Factor - P.P.M. to Mg./L. 0.00734) 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 136.3)

Molecular Weight	164.39	Heat Vaporization[1]	55.5 cal./gm. (0-112°C.
Melting Point[1]	-69.2°C.		
Boiling Point[1]	112°C.	Heat Formation[1]	46.7 cal.
Decomposition Temperature[1]	150°C.	Coeff. Expansion[1]	1.16×10^{-3} (0-70°C.)
Specific Heat[1]	0.225 (0-20°C.) cal./gm.	Estimated Cost[2]	$.40 per lb.

Temperature °C.	Vapor Pressure[3] Mm. Hg.	Volatility[3] Mg./L. at Saturation	Density[1] (Liquid)
0	5.768	55.64	1.6930
5	7.817	74.06	1.6843
10	10.47	97.26	1.6755
15	13.90	127.15	1.6666
20	18.28	164.4	1.6577
25	23.82	210.6	1.6489
30	30.76	267.5	1.6400
35	39.56	336.6	1.6309
40	50.00	420.9	1.6219
50	73.98	644.2	1.6037
60	121.3	969.7	1.5853
65	149.0	1161.4	1.5756
100	554.7	3920.	

Threshold Concentration[4]
- Odor - 0.0073 mg./L.
- Irritation of eyes - 0.009 mg./L.
- Irritation of throat - 0.076 mg./L.
- Coughing - 0.114 mg./L.
- Lachrymation (3 min.) - 0.0190 mg./L.

Intolerable Concentration[4]
0.1467 mg./L. (2 min.)

Lethal Concentration (Dogs)[5]

Exposure (min.)	Conc. mg./L.
5	3.67
7½	2.64
10	2.07
15	1.46
30	.74
60	.51

Protection - 1919 Canister[6]
16 mg./L., 50% humidity, 32 L./min.

	Efficiency			
	100%	95%	95%	90%
Life (min.)	67	68	80	86

1 - MTF 143.2-1 (WAD 61)
2 - CD 22.9
3 - MTF 143-1 (based on formula given in EGD 61)
4 - MTF 143.3-1 (WARD 3)
5 - J.H. Mills, Summary of Toxicity Data
6 - CD 197.22-6

CYANOGEN CHLORIDE CC

(CNCl)

December 1, 1924.

Factor - P.P.M. to Mg./L. 0.00274) 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 364.6)

Molecular Weight	61.47	Heat Vaporization	
Melting Point[1]	-6°C.	Heat Fusion	
Boiling Point[1]	12.8°C.	Heat Formation[2] (Liquid)	-26.8 Cal.
Decomposition Temperature		Estimated Cost[3]	$.60 per lb.
Specific Heat			

Temperature °C.	Vapor Pressure[4] Mg. Hg.	Volatility Mg./L. at Saturation	Density[5] (Liquid)
-30	68.3	276	-
-20	148.2	577	-
-10	270.5	1011	-
0	444	1601	1.2270
5	554	1961	1.2170
10	682	2376	1.2068
15	830	2830	1.1967
20	1002	3370	1.1866
25	1200	3960	1.1765
30	1427	4635	1.1665
40	1987	6250	1.1464
50	2719	8280	1.1262
65	4231	12300	1.0959

Threshold Concentration[6-7]

Detection	0.0005 mg./l.
Odor	0.0075 mg./l.
Irritation of eyes	0.0125 mg./l.
Lachrymation	0.015 mg./l.

Lethal Concentration (Dogs)[4]

Time (min.)	Mg./l.
2.5	0.92
7.5	0.66
15.0	0.29
30.0	0.20
60.0	0.14
90.0	0.14
240.0	0.12

Protection[5] - 1919 Canister
1.26 mg./l., 50% humidity, 32 l./min.

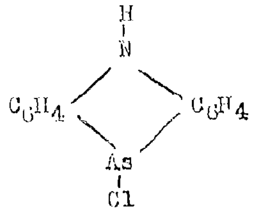
	Efficiency			
	100%	99%	95%	90%
Life (min.)	13	14	18	22

Public Health Service Canister[8]

Protection approximately 6 hours against mixture of 1.02 mg./l. CNCl and .47 mg./l. HCN (32 l./min. and 50% humidity)

1 - C.W. XXIV - I - 39
2 - Landolt Börnstein Tables, 5 Ed.
3 - Estimated from data in C.W. XXIV
4 - C.W. XXIV
5 - C.D. 197.22-6
6 - C.W. XVIII-62
7 - Pic-1
8 - S.G.F. 611.565 M.A.C.D. 273

DIPHENYLAMINECHLORARSINE, D.M.



December 1, 1924.

Factor – P.P.M. to Mg./L. 0.0124) 0°C. and 760 mm.
Factor – Mg./L. to P.P.M. 80.74)

Molecular Weight	277.56	Heat Vaporization[1] (250°–195°C.)	80.1 cal./g.
Melting Point[1]	195°C.		
Boiling Point[1]	410°C. (Calculated)	Heat Fusion[1]	79.3 cal./g.
Decomposition Temperature[1]	195°C.	Heat Sublimation[1]	159.4 cal./g.
Specific Heat[1]	0.268 cal./g.,(Solid)	Estimated Cost[2]	$2.25 per lb.

Temperature °C.	Vapor Pressure[3] Mm. Hg.	Volatility Mg./L. at Saturation	Density[4] (solid)
0	5×10^{-16}	8.15×10^{-15}	1.672
20	2×10^{-13}	3.0×10^{-12}	1.648
40	3×10^{-11}	4.3×10^{-10}	–
60	2×10^{-9}	2.6×10^{-8}	–
80	8×10^{-8}	1.0×10^{-6}	density of
100	2×10^{-6}	2.4×10^{-5}	powdered
120	5×10^{-5}	5.6×10^{-4}	D.M. at 20°C.
140	0.0008	0.00862	= 1.073[6]
160	0.009	0.09261	
180	0.0[illegible]	0.8744	
195	0.43	2.089	
200	0.54	5.081	
220	1.38	12.42	
240	3.39	29.41	

Threshold Concentration[5]

0.0001 mg./l., lowest detectable concentration (1 minute)
0.00038 mg./l. (1 minute) Irritation of Throat
0.0005 mg./l. (1 minute) Irritation of Lower respiratory tract

Intolerable Concentration[5]

Exp.	Conc. Mg./L.
45 sec.	0.0490
1 min.	0.0225
2 "	0.0058
3 "	0.0022
4 "	0.0010
[illegible] "	0.00072
10 "	0.00030
30 "	0.00017
60 "	0.00014

Lethal Concentration (Dogs)[5]

Time	Mg./L.
30 min.	0.65

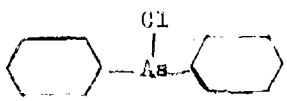
Protection[6] (Mark III Canister type 1919)
Penetration against a cloud of 1 mg./l.– less than 0.000066 mg./l. at 15 l./min.

1 – ETF 121.2-1 (EACD 58)
2 – CD 22.9
3 – ETF 121.22-1 (EACD 46)
4 – [illegible] XXVIII-44
5 – ETF 121.3-2 (EACD 135)
6 – Table (Gas Def., Edgewood Arsenal, average results on production canisters over a period of 2 years)

DIPHENYLCHLORARSINE, D.A.

$(C_6H_5)_2AsCl$

December 1, 1924.



Factor - P.P.M. to Mg./L. 0.0118) 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 84.71)

Molecular Weight	264.56	Heat Vaporization[1]	56.6 cal./g. (44°-188°C.)
Melting Point[1]	44.0°C.*		
Boiling Point[1]	383°C. (calculated)	Heat Fusion	
Decomposition Temperature[1]	> 300°C.	Heat Formation[1]	14 Cal.
Specific Heat[1]	0.217 cal./g. (solid)	Estimated Cost[2]	$2.25 per lb.

Temperature °C.	Vapor Pressure[1] Mm. Hg.	Volatility[1] Mg./L. at Saturation	Density[1]
20	0.0005	0.0068	-
25	0.0007	0.0102	-
30	0.0011	.0154	-
35	0.0017	.227	-
40	0.0024	0.0331	1.583 (solid)
43	-	-	1.478 (liquid)
45	0.0036	0.0477	-
50	0.0052	0.0678	-
55	0.0074	0.0955	1.467 (liquid)
60	0.0105	0.133	-
65	0.0146	0.183	-
80	0.0576	0.4520	-
100	0.1189	1.352	-
120	0.3460	3.754	-
150	1.3050	13.07	-
200	8.740	78.37	-

Threshold Concentration[3]
Odor 0.0003 mg./l. (3 minute exposure)
Irritation of Nose 0.0015 mg./L. (3 minute exposure)
Irritation of Throat 0.0026 mg./l. (3 minute exposure)

Intolerable Concentration[3]

Exposure	Conc. Mg./l.
30 sec.	0.060
1 min.	0.026
2 "	0.0100
3 "	0.0069
4 "	0.0048
5 "	0.0035
10 "	0.0007
60 "	0.0006

*In unstable form of D_2A_2 melts at 18.2-18.4°C. (J. Chem. Soc. 125, 909 (1924)

1 - GEF 122.2-1 (SAGO 87) 2 - GO 22.9 3 - GEF 122.5-1 (SAGO 127)

HYDROCYANIC ACID A.C.

HCN

December 1, 1924.

Factor - P.P.M. to mg./L. 0.00121) 0°C. and 760 mm.
Factor - mg./L. to P.P.M. 829.2)

Molecular Weight	27.02	Heat Vaporization[3]	211 cal./g.
Melting Point[1]	-14°C.	Heat Fusion	
Boiling Point[1]	26°C.	Heat Combustion[1]	158620 cal.
Decomposition Temperature[2]	100°C.	Heat Formation[3]	- 24.8 Cal. (Liquid)
Specific Heat		Estimated Cost[1]	$.75 per lb.

Temperature °C.	Vapor Pressure[2] Mm. Hg.	Volatility[2] Mg./L. at Saturation	Density[5] (Liquid)
0	283	449	0.7190
5	347	541	.7136
10	422	646	.7068
15	510	767	.6988
20	613	906	.6918
25	732	1060	.6844
30	868	1240	.6770
35	1030	1440	.6692
40	1200	1660	.6614
45	1400	1910	.6534
50	1630	2190	.6454
55	1890	2490	.6374
60	2180	2830	.6290
65	2500	3200	.6210

Threshold Concentration

Lethal Concentration Mg./L.[6]

Time	Dogs	Monkeys	Mice	Guinea Pigs	Rabbits
30 sec.	1.49	1.68	0.77	2.65	1.48
1 min.	0.67	0.77	0.567	1.64	0.785
3 "	0.34	0.58	0.367	0.812	0.464
7.5 "	0.208	0.30	0.242	0.35	0.25
10 "			0.190		
30 "	0.1				

Protection[7] - 1919 Canister

.55 mg./L., 50% humidity, 32 L./min.

	Efficiency			
	100%	99%	95%	90%
Lbs. (in min.)	30	32	45	56

Public Health Service Canister[8]

Protection approximately 6 hours against mixture of 1.02 mg./L. CNCl and .47 mg./L. HCN (32 L./min. and 50% humidity)

1 - CWS - XXIII
2 - Bolsteln TE-56
3 - Chem. Kal. 1923
4 - WW 303-4
5 - CS 54
6 - WW 165.5-1 (March 30)
7 - CO 197.22-46
8 - WW 611.563-1 (March 27)

LEWISITE M-1
(β Chlorvinyl dichlorarsine)

December 1, 1924.

$$\begin{matrix} & & H \\ H\diagdown & & | \\ & C = & C-AsCl_2 \\ Cl\diagup & & \end{matrix}$$

Factor - P.P.M. to Mg./L. 0.00925) 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 108.1)

Molecular Weight	207.37	Specific Heat	
Melting Point[1]	-18.2°C.	Heat Vaporization[2]	57.9 cal./g.
Boiling Point[2]	190°C.	Coefficient of Expansion[2] (0°-50°C.)	9.4×10^{-4}
Decomposition Temperature[3]	Very slight at 100°C.	Estimated Cost	

Temperature °C.	Vapor Pressure[2] Mm. Hg.	Volatility[2] Mg./l. at Saturation	Density[2] (Liquid)
0	0.087	1.06	1.9200
5	0.15[illegible]	1.55	1.9113
10	0.196	2.30	1.9027
15	0.275	3.18	1.8940
20	0.395	4.47	1.8855
25	0.556	6.20	1.8768
30	0.769	8.44	1.8682
40	1.47	15.6	1.8513
50	2.68	27.5	1.8338
60	4.68	46.7	1.8164
65	6.12	60.1	1.8077
70	7.83	75.8	
75	9.86	94.3	
80	13.00	1[illegible]2.3	
90	20.60	189.0	
100	35.58	317.	
150	175.0	1485.	

Threshold Concentration[4]
Odor - 0.0137 Mg./L.
Irritation of Nose[5] 0.0008

Lethal Concentration[6]
when applied to skin - 0.015 cc. per sq. cm. per Kg. body weight - (100% material)

Blister Curve[6]

Exp. in Min.	Conc. Mg./L.
5	2.09
10	1.04
30	0.334
60	0.[illegible]5
120	0.063
180	0.0262

Lethal Concentration (Dogs)[5]

Time (Min.)	Mg./L.
7.5	0.176
15.	0.096
30	0.048
60	0.0252
120	0.0125
240	0.00624

1 - ETF 119.12-1 (EACD 170)
2 - ETF 112.2-1 (EACD 62)
3 - ETF 112.6-2 (EACD 239)
4 - Gas L, p. 585
5 - ETF 100-3 (EAMRD 14)
6 - ETF 112.3-2 (EAMRD 8)

METHYLDICHLORARSINE MD

CH_3AsCl_2

December 1, 1924.

Factor - P.P.M. to Mg./L. 0.00718) 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 129.3)

Molecular Weight	160.91	Specific Heat[3]	0.176 cal./g. (14°-98°C.)
Melting Point[1]	-54.8°C.		
Boiling Point[1]	132.6°C.	Heat Vaporization[2]	65.2 cal./g. (at 0°C.); 55.6 cal./g. (at 130°C.)
Decomposition Temperature[2]	> 135°C.		
		Heat Formation[4]	71 Cal.
		Estimated Cost[5]	$.92 per lb.

Temperature °C.	Vapor Pressure[2] Mm. Hg.	Volatility Mg./L. at Saturation	Density[6] (Liquid)
0	2.063	19.49	1.8750
5	2.916	27.05	1.8663
10	4.064	37.03	1.9575
15	5.591	50.06	1.8485
20	7.593	66.82	1.8394
25	10.19	88.18	1.8299
30	13.53	115.2	1.8204
35	17.76	148.7	1.8108
40	23.08	190.2	1.8010
50	37.87	302.3	1.7812
60	60.01	464.7	1.7618
65	74.61	569.2	1.7522
100	282.4	1950.	

Threshold Concentration[7]
Irritation of nose - 0.009 Mg./L.
Barely detectable[8] (nose) .0008

"Lowest effective concentration of methyldichlorarsine dissolved in absolute alcohol on skin of man is slightly more than 0.1%"[9]

Lethal Concentration (Dogs)[10]

Time (Min.)	Mg./L.
7.5	0.815
15	0.303
30	0.125
60	0.047
120	0.031

1 - NTF 119.12-1 (EACD 170)
2 - NTF 113.22-1 (EACD-176)
3 - Landolt Bernstein Tables
4 - Thomsen - Thermochemistry
5 - EACD 319
6 - NTF 113.2-1 (EACD 63)
7 - CWS XXI, Pt. I, 59
8 - Ph 1.
9 - PT 251, 300
10 - NTF 113.3-1 (EACRD 4)

MUSTARD GAS H.S.
(Bis beta Chloroethyl Sulfide)

December 1, 1924.

$$ClCH_2CH_2 \diagdown S$$
$$ClCH_2CH_2 \diagup$$

Factor - V.P.M. to Mg./L. 0.0071) 0°C. and 760 mm.
Factor - Mg./L. to V.P.M. 140.9)

Molecular Weight	159.06	Heat Vaporization[1]	94.2 cal./g. (at 13.9°) 83.4 cal./g.(at100°)
Melting Point[1]	13.99°C.		
Boiling Point[1]	228°C(calculated)	Heat Fusion[1]	26.2 cal./g.
Decomposition Temperature[2]	150°C.	Coeff. of Expansion[2]	(16°-75°C.) 8.95 x 10^{-4}
Specific Heat[2]	0.360 cal./g.(Liquid) 0.275 cal./g. (solid)	Estimated Cost[3]	$0.25 per lb.

Temperature °C.	Vapor Pressure[1] Mm. Hg.	Mg./L.	Volatility[1] at Saturation	Density[2]
0	0.0068		0.0635	1.371
5	0.0129		0.117	1.3444
10	0.0237		0.213	1.3190
15	0.0417		0.369	1.2702
20	0.0650		0.5655	1.2736
25	0.0996		0.858	1.2682
30	0.150		1.262	1.2628
40	0.525		2.647	1.2516
50	0.662		5.224	1.2408
65	1.757		13.251	1.2250
80	3.203		39.6	-
100	11.75		80.5	-
120	28.78		186.2	-
140	63.41		392.0	-
160	125.6		745.0	-

Threshold Concentration[4]
Odor - 0.0015 Mg./L.

Minimum Conc. to produce casualties[9]
0.001 Mg./L. in 2 to 4 hours

Blister Curve[5]

Time (Min.)	Conc.Mg./L. Winter	Conc.Mg./L. Summer	Reduces (5) Conc. Mg./L.	Lethal Concentration (Dogs) Time (Min.)	Mg./L.
				1	0.509 (6)
5	0.66		< 0.16	3	0.337 (6)
10	0.45	0.43	< 0.21	7.5	0.22 (7)
30	0.26		< 0.09	30	0.07 (8)
60	0.18	0.14	< 0.09	60	0.033 (8)
120	0.125	0.064	< 0.057	120	0.020 (8)
180	0.061	0.020	< 0.016	240	0.015 (8)
				480	0.01 (7)
				720	0.008 (7)
				960	0.0062 (7)

1 - MTF 111.22-1 (EACD 242)
2 - MTF 111.2-1 (EACD 56) 5 - CD. 22.9
4 - C&E 30, p. 227 5 - MTF 111.32-1 (EACD 9)
6 - MTF 111.3-3 (EACD 22) 7 - MTF 111.3-3 (EACD 98)
8 - MTF 111.3-3 (EACD 18) 9 - [illegible] - 104 (2)

PHOSGENE C.G.

$COCl_2$

December 1, 1924.

Factor - P.P.M. to Mg./L. 0.00441 } 0°C. and 760 mm.
Factor - Mg./L. to P.P.M. 226 }

Molecular Weight	98.92	Specific Heat[2] - Vapor	0.085 cal./g. at 8.2°C.
Melting Point[1]	-118°C.		
Boiling Point[1]	8.2°C.	Heat Vaporization[2]	60.1 cal./g.
Decomposition Temperature[2]	0.8% dissociated at 200°C.	Heat Formation[2]	55 Cal. (C. amorp.)
		Coeff. Expansion[2]	0.001602 (-40° to + 50°)
Specific Heat[2] - Liquid	0.243 cal./g. (-10 to + 23°C.)	Estimated Cost[8]	3.25 per lb.
Critical Temp.[3]	182°C.	Critical Pressure[3]	56 atmospheres

Temperature °C.	Vapor Pressure[4] Mm. Hg.	Volatility[4] Mg./L. at Saturation	Density[2] (Liquid)
-20	232	1460	1.4615
-10	365	2200	1.4411
0	555	3220	1.4203
5	677	3860	1.4100
10	819	4690	1.3987
15	985	5420	1.3878
20	1180	6370	1.3760
25	1400	7440	1.3647
30	1650	8640	1.3518
35	1900	9760	1.3400
40	2270	11500	1.3262
45	2640	13100	1.3131
50	3050	15000	1.3000
55	3520	17000	1.2868
60	3990	19000	1.2754
65	4610	21600	1.2600

Threshold Concentration[5]
Odor - 0.0044 Mg./L.
Detection by nose and throat 0.015 mg./l.
Irritation of eyes, nose and throat 0.044

Lethal Concentration (Dogs)

Time	Mg./L.
30 sec.	16.19 (6)
1 min.	8.41 (6)
3 "	1.61 (6)
5 "	0.95 (6)
7.5 "	0.62 (6)
10. "	0.46 (6)
30 "	0.29 (6)
120 "	0.14 (6)

Protection[7] - 1919 Canister
20.25 mg./l. 50% humidity, 32 l./min.

Efficiency	100%	99%	95%	90%
Life (min.)	26	30	36	40

1 - Landolt Bornstein, 5 Ed.
2 - MIT 131.2-1 (1920) 55)
3 - Science 60, 319
4 - MIT 100 1
5 - MIT 131.2-1 (1920) 55)
6 - MIT 131.2-2 (1920) 55)
7 - CO MIT.22 6
8 - CO 32.9

Submitted by

C. H. Roebe

Checked by

T. E. Knapp

F. W. Pralatowski

Approved by

J. E. Mills,
Chief, Chemical Division.

Important Constants of Fourteen Common Chemical Warfare Agents.

N.A.C.D. #328

10 copies made)
Copied by hon)