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A Memorandum Report

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CYANOGEN CHLORIDE
EYE-IRRITANT AND LACRIMATORY ACTION

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By

R. G. Horton

S. D. Silver

and

L. J. Wallen

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A Memorandum Report

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CYANOGEN CHLORIDE
Eye-irritant and Lacrimatory Action

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By:

R. G. Horton
S. D. Silver
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Forwarded to the Chief, Chemical Warfare Service

MAR 29 1943

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CYANOGEN CHLORIDE
Eye-irritant and Lacrimatory Action

Project A 10.3 T.D.M.R. 603

ABSTRACT

OBJECT

The object of project A 10.3 is to determine the physiological action of non-lethal doses of chemical compounds submitted for test as war agents.

The object of the work described in this report was to determine the eye-irritant and lacrimatory action of cyanogen chloride on human subjects. Interest was not so much in its eye-action alone but more in the amounts detectable by irritation of the eyes since this compound is known to penetrate present gas mask canisters.

RESULTS

Results obtained are summarized as follows:

No. of Subjects	Concn. mg/l	Eye Irritation Time for reaction (sec) Average	Eye Irritation Time for reaction (sec) Median	Tear Formation Time for reaction (sec) Average	Tear Formation Time for reaction (sec) Median	Tear Overflow Time for reaction (sec) Average	Tear Overflow Time for reaction (sec) Median
7	0.0061	71	72	>137	135	>187	---
5	0.0122	35	27	> 85	65	>171	---
5	0.0244	14	15	32	25	>107	80
5	0.0488	6.3	7	22	15	42	44
5	0.0976	4.8	5	15	15	66	64

The following are the minimal concentrations detected by various reactions within 3 minutes by 100% of the subjects:

Eye Irritation	0.0122 mg./l.
Tear Formation	0.0244 mg./l.
Tear Overflow	0.0488 mg./l.

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CONCLUSIONS

Concentrations of cyanogen chloride much less than those considered lethal for man were detectable by irritation of the eyes within 3 minutes.

RECOMMENDATIONS

1. That this data be used in the study of canister penetration by cyanogen chloride now being made.

2. That the proper personnel be informed that canister penetration of lacrimatory concentrations of cyanogen chloride although not immediately lethal should be considered a warning of immediately impending danger from a progressive and finally a lethal break.

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CYANOGEN CHLORIDE
Eye-Irritant and Lacrimatory Action

Project A 10.3 T.D.M.R. 603

GLOSSARY OF TERMS

Point of Irritation - The time in seconds at which the subject noticed a definite irritation of the eyes.

Point of Tear Formation - the time in seconds at which the subject noted the beginning of tear formation.

Point of Tear Overflow - the time in seconds at which the subject felt tears running out from the eyes.

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CYANOGEN CHLORIDE
Eye-irritant and Lacrimatory Action

Project A 10.3 T.D.M.R. 603

I. INTRODUCTION

A. Object.

The object of project A 10.3 is to determine the physiological action of non-lethal doses of chemical compounds submitted for test as war agents.

The object of the work described in this report was to determine the eye-irritant and lacrimatory action of cyanogen chloride on human subjects. Interest was not so much in its eye-action alone but more in the amounts detectable by irritation of the eyes since this compound is known to penetrate present gas mask canisters.

B. Authority.

Work was done by authority of C, CWS under project A 10.3.

II. HISTORICAL.

Although previous work has been done upon this compound's action upon the eye, little data applicable to the object of the present work can be found. Work done during World War I determined the concentration necessary to produce eye-irritation and lacrimation in the majority of subjects within 3 minutes (C.W.W. LVI). Cyanogen chloride has been used as a detecting agent in fumigation with HCN following preliminary work at Edgewood Arsenal (U.S. Public Health Service, Reprint #800, 1922).

III. EXPERIMENTAL

A. Materials and Equipment.

Cyanogen chloride (of high purity, supplied by Canister Section, Protective Development Division).

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1 ml. graduated pipette
absolute ethyl alcohol
50 ml. volumetric flask
Dewar flask
ice
5 ml. graduated pipette
300 l. chamber (similar to that described in E.A.T.R. 327) containing:
fan
hot plate
evaporating dish

B. Procedure.

A solution of cyanogen chloride containing 3.66 g./l. was made up in cold (0°C) absolute ethyl alcohol in a 50 ml. volumetric flask which was placed in a Dewar flask and packed wit ice Various amounts of this solution were pipetted through the glass side tube of the chamber into the evaporating dish on the hot plate and then washed down with a few mls. of absolute ethyl alcohol. One ml. of this solution evaporated would give a concentration of 0.0122 mg. per liter of air in the 300 liter chamber.

Subjects were exposed up to 3 minutes and asked to note the point of eye-irritation, of tear formation and of tear overflow. These points were timed by an observer. If the subject showed tear overflow before 3 minutes, exposure was ended. The fan was turned on for short periods of time to maintain a more nearly even distribution of the agent.

Subjects were examined both before and after exposure by a medical officer.

C. Results.

The results of experiments run to determine minimum times of exposure (up to 3 minutes) to various concentrations of cyanogen chloride in order to produce eye effects are shown in table 1.

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Table 1.

Minimum Exposures to Cyanogen Chloride Necessary to Produce Irritation, Tear Formation and Tear Overflow in Human Eyes.

Subject	Concn. (Nominal)	Irritation Individual	Irritation Av.	Tear Formation Individual	Tear Formation Av.	Tear Overflow Individual	Tear Overflow Av.
	mg./l.	sec.	sec	sec.	sec	sec.	sec
C.M.H.	0.0061	60		0 at 3 min		---	
W.A.L.		48		180		0 at 3 min	
R.H.H.		72		105		0 at 3 min	
D.L.W.		180 *		0 at 4 min		---	
O.B.		30		55		0 at 3 min	
E.L.B.		95		135		170	
M.E.T.		15	71	65	137+	180	187+
H.E.S.	0.0122	25		50		0 at 3 min	
J.L.S.		55		95		135	
D.M.		55		0 at 3 min		---	
S.D.S.		12		35		0 at 3 min	
L.J.W.		27	35	65	85+	0 at 3 min	171+
J.W.L.	0.0244	10		20		35	
D.L.W.		17		42		0 at 3 min	
C.C.C.		15		50		0 at 3 min	
R.H.H.		8		25		60	
C.M.H.		18	14	25	32	80	107+
G.E.Lc	0.0488	9		15		45	
T.A.H.		7		32		67	
A.M.G.		33 **		40		44	
R.C.F.		6		15		35	
R.G.H.		3	6.3	10	22	20	42
S.D.S.	0.0976	5		15		80	
J.L.S.		4		14		80	
D.M.W.		5		16		46	
A.M.K.		3		14		64	
D.M.		7	4.8	16	15	60	56

* Subject was uncertain whether the feeling could be described as definite irritation.

** This value is not in line with times for other subjects nor does it correlate well with the times for tear formation and overflow. The value has been omitted from the average for the group.

Note: In cases of zero responses the time of exposure in seconds followed by a plus(+) has been used in computing the averages.

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Subjects experienced almost complete relief within 2 minutes of the end of exposure and showed slight congestion of the bulbar conjunctiva for about 10 minutes.

IV. DISCUSSION

Since cyanogen chloride is known to penetrate certain canisters, it is necessary to know what concentrations can be detected.

Considering the small number of subjects in each run, the data obtained appear to be fairly reliable. The results show that the averages and the medians for minimal times both for eye-irritation and for tear formation are in quite close agreement. These figures can be plotted to form a fairly consistent set of curves, (Chart 1, appended). The point of tear overflow showed more variability.

Although chloroacetophenone is considered to be the standard for lacrimatory agents, there exists no very complete series of experiments from which one may obtain data for comparison. Cyanogen chloride is probably between 1/12 and 1/30 as effective as chloroacetophenone as shown in table 2.

Table 2.

Comparison of Eye Effects
Cyanogen Chloride and Chloroacetophenone

Effect	Time sec.	Chloroacetophenone concn. mg./l.	Cyanogen chloride concn. mg./l.	concn CN[d] / concn CC =
Irritation	42(med)	0.0004 [a]	0.009	1/25
	150 ave	0.0001 [b]	0.003(extrapolated)	1/30
Tear	187	0.0004 [a]	0.005(extrapolated)	1/12
Formation	180	0.00031 [c]	0.005(extrapolated)	1/18

a. E.A.T.R. 15
b. E.A.C.D. 456
c. E.A.C.D. 108
d. CN = chloroacetophenone
CC = cyanogen chloride

Cyanogen chloride in concentrations of 0.12 mg./l. does not produce convulsions in dogs up to a 4-hour exposure (P.R. 222) or in concentrations of 0.14 mg./l. in monkeys up to a

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60 minute exposure (Ph 1 XLVI - 1). The present work shows that concentrations much lower than this are detectable by eye effects in man. The following concentrations were just detectable by 100% of the subjects within 3 minutes in the present work and in British work (P.R. 205):

	Irritation	Tear Formation	Tear Overflow
(Present work)	-concn. mg./l. 0.0122	0.0244	0.0488
(P.R. 205)	-concn. mg./l. 0.0150	>0.0150 *	------

* 88% of the subjects lacrimated within 3 minutes at this concentration.

V. CONCLUSIONS

Concentrations of cyanogen chloride much less than those considered lethal for man were detectable by irritation of the eyes within 3 minutes.

VI. RECOMMENDATIONS

1. That this data be used in the study of canister penetration by cyanogen chloride now being made.

2. That the proper personnel be informed that canister penetration of lacrimating concentrations of cyanogen chloride although not immediately lethal should be considered a warning of immediately impending danger from a progressive and finally a lethal break.

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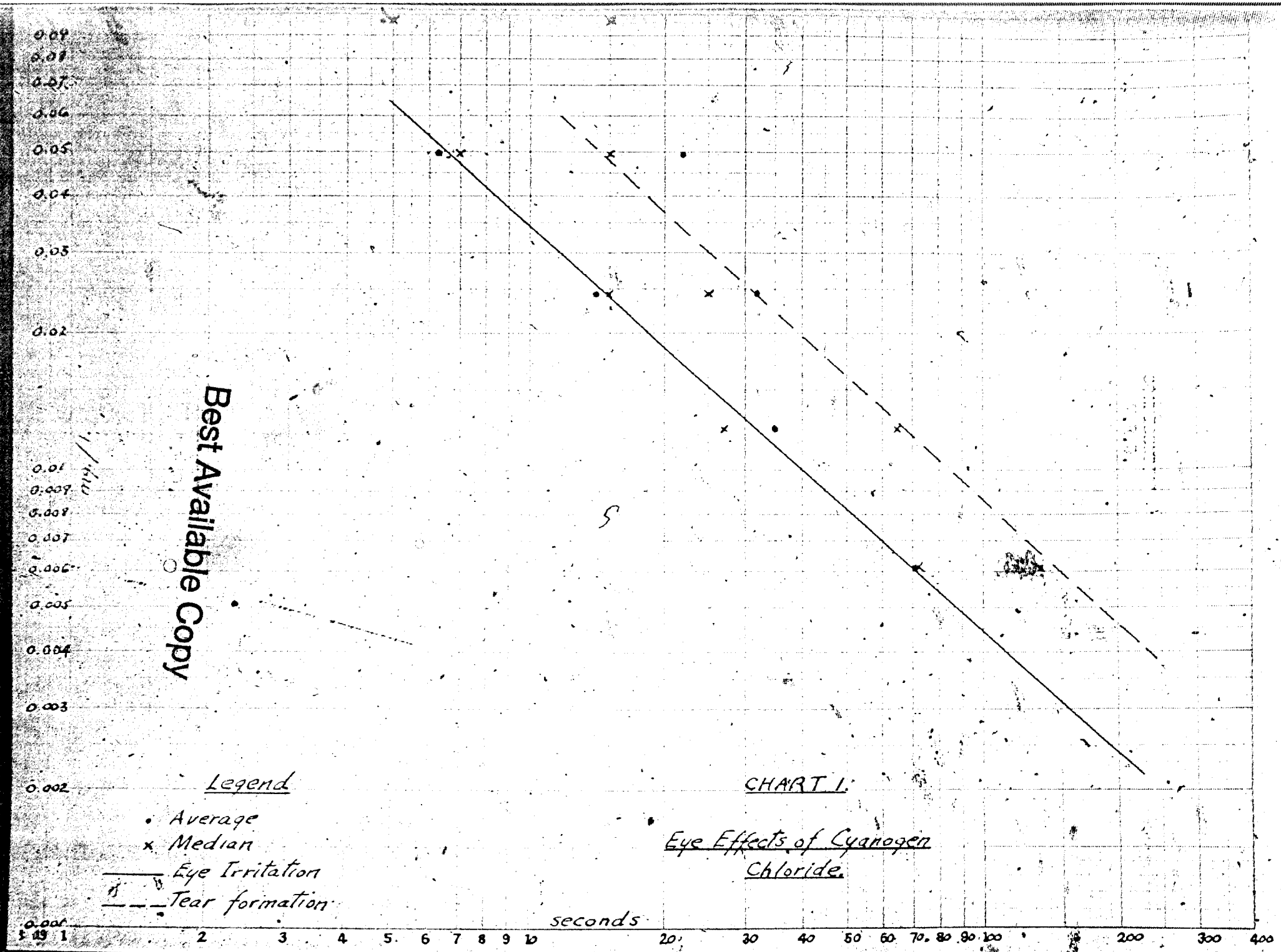

CHART I.

Eye Effects of Cyanogen Chloride.

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CYANOGEN CHLORIDE;
Eye-irritation and
Lacrimatory Action

Project A 10.3

Experimental Work:

March 11 and 12, 1943

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Typed - March 24, 1943 - mt

Submitted by:

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

RDCB-DPC-RS

MEMORANDUM FOR Defense Technical Information Center (DTIC), 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218.

SUBJECT: Change in Limitation (Public Release of Information)

1. The purpose of this memorandum is to recommend the Release of Information to the General Public regarding Memorandum Report on Cyanogen Chloride Eye-Irritant and Lacrimatory Action, dated March 29, 1943. This information was downgraded from Confidential to Restricted and then to Unclassified previously. The DTIC Number is AD-B960 422.

2. This document has been reviewed by Subject Matter Experts from the Edgewood Chemical Biological Center (ECBC) on Aberdeen Proving Ground, Maryland and deemed releasable to the General Public. This is a WWII Era document with documented test data. Release of this document would enable the EPA to further explore and develop Acute Exposure Guideline Levels (AEGL) for the general public for protection against CK.

3. As the Security Manager for the documents in question, I concur with the recommendations made by the ECBC Review Team. Request that this document be properly identified and appropriately marked.

4. Point of contact for this action is the Information Security Officer, Ronald Stafford at 410-436-6810 or the undersigned at 410-436-7232.

Encl

JUNE K. SELLERS
ECBC Security and Surety Manager

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