GHQ/SCAP Records (RG 331, National Archives and Records Service)

Description of contents

(1) Box no. 9088

(2) Folder title/number: (25)
Report on Scientific Intelligence Survey in Japan
September to October 1945 - Volume IV

(3) Date: Nov. 1945

(4) Subject:

Classification	Type of record
850	d

(5) Item description and comment:
Chemical Warfare

(6) Reproduction: (Yes) No

(7) Film no. Sheet no.

(Compiled by *National Diet Library*)

CONFIDENTIAL

22

GENERAL HEADQUARTERS
UNITED STATES ARMY FORCES, PACIFIC
Scientific and Technical Advisory Section

25

REPORT

ON

SCIENTIFIC INTELLIGENCE SURVEY IN JAPAN

September and October 1945

VOLUME IV

CHEMICAL WARFARE

1 November 1945

CONFIDENTIAL

TABLE OF CONTENTS

ABSTRACT

A PRELIMINARY SURVEY OF JAPANESE CHEMICAL WARFARE RESEARCH AND DEVELOPMENT

Objective:

The purpose of the survey on chemical warfare was to investigate quickly Japanese chemical warfare research and development and to pass on information obtained to technical intelligence teams for further investigation and corroboration as required.

Summary of Results:

1. Japanese laboratories had synthesized and examined better than 1000 compounds as possible new poison gases, but they claim to have found none superior to the gases used in World War I.

2. Japanese chemical warfare munitions were on the whole poorly designed and inefficient.

3. Tactical experimentation by the Japanese on the use of gas in the field though far behind the United States at present, was probably ahead of the United States at the outbreak of the war.

4. The Japanese are evidently unaware of the poor protection of their gas mask canister, against CK and the United States' intention of taking advantage of this fact in the event of chemical warfare.

5. The Japanese freely admit their lack of a wearable protective clothing for hot weather and the catastrophic effect this fact could have had on their island defense system if gas had been used.

6. The Japanese claim that no information on new gases was received by them from the Germans or Italians.

7. Though the Japanese stated that they obtained no assistance from the Germans in Chemical Warfare, several apparently new German spray tanks were found in one of their warehouses. When confronted with the tanks the Japanese Officer "remembered" arrival of the tanks by boat in 1936 or 1937, subsequent tests and copy by the Japanese Navy. (The Type 99 tank is the Japanese copy of the German tank).

GENERAL HEADQUARTERS
UNITED STATES ARMY FORCES, PACIFIC
Scientific and Technical Advisory Section

PRELIMINARY SURVEY OF JAPANESE CHEMICAL WARFARE RESEARCH AND DEVELOPMENT

I. INTRODUCTION

The purpose of this survey was to investigate quickly Japanese Chemical Warfare research and development and to pass on information obtained to technical intelligence teams for further investigation and corroboration as required.

In order that interested agencies might make use of information obtained with as little delay as possible, conference notes* were distributed after each interview. These conference notes were unedited and contained no attempt at analysis. The present report is a preliminary compilation of the information contained in the conference notes with certain impressions gained by interviewers. Certain data on chemical warfare subjects other than Research and Development which were obtained incidental to the principal aim of the survey are included herein as per request of the chemical officer, 6th Army.

It should be made clear the data contained herein are for the most part the word of the Japanese Army, Navy, Air Force and Civilian scientists. Corroboration of the reports given by them is needed as well as an intensive search for any important information which might have been withheld.

It is also emphasized that this is not a completed survey. Omissions are apparent as are failures to pursue certain leads. It is hoped, however, that this information will be of assistance to technical intelligence teams who are charged with the overall survey of the Japanese chemical warfare effort.

---

*Copies of conference notes on Chemical Warfare were distributed as follows:

Scientific Intelligence Survey, GHQ, AFPAC (Forwarded to Chief C/S)
Economic and Scientific Section, GHQ, AFPAC
Commanding General, CIC
A-2, Far East Air Forces
Office of Chief Chemical Officer, AFPAC
Lt. Gordon T. Wallis, Chemical Officer, Advance Echelon, Far East Air Forces

II. ORGANIZATION AND PERSONNEL

A. General

1. Nowhere in the Japanese military organization is there a clearly discernible Chemical Warfare Service which can be traced as such through all echelons of command. Only in chemical warfare research and training were men found who could be identified solely with chemical warfare. The highest ranking Japanese officer found who had chemical warfare as his primary duty was Major General Kinsei Akiyama, Chief of the 6th Military Laboratory, chemical warfare research center of the Japanese Army. In higher headquarters, chemical warfare duties were said to be always additional duties of men who either had little or no knowledge of the subject, little or no interest in it, or both. This appeared also to be the case in the Navy and the Air Force. Therefore, there is much about chemical warfare organization which it has not been possible specifically to define, and which must undergo further detailed checking and investigation before the exact pattern will emerge. The organization of chemical warfare research and training has been obtainable in fairly complete detail, but supply, plans and policy organization and personnel have been obtainable only in general outline.

2. In chemical warfare, as in other fields investigated, a Japanese liaison organization between the Army and the Navy was totally lacking. This situation seemed to stem from the personal feelings of one service for the other, which ranged from mere coolness, as in the case of chemical warfare, to almost open hostility. The result was that there was relatively little interchange of information between the two services.

B. Army (Charts 1, 2 and 3*)

1. Research (Chart 2). The largest, and without doubt the most progressive research organization was the Japanese Army's 6th Military Laboratory. The most worthwhile and complete information obtained on chemical warfare was received from personnel of this organization. Housed in more than twenty buildings, equipped with modern laboratory facilities, employing some 700 people (of whom 90 were scientists), and with an average yearly budget (for the last several years) of approximately 3,000,000 yen, this organization has done a great amount of extensive research in chemical warfare. Major General Akiyama, its head, was felt by the authors to be the outstanding individual in Japanese

---

* All organizational charts are included at the end of this section.

chemical warfare encountered during the entire survey. He possessed an apparent and ready grasp of all phases of Japanese chemical warfare in his particular service that was found in none of the other personnel interrogated. His manner was straight-forward and unhesitant, his answers complete and to the point. Two other men in this organization are thought to be worthy of specific reference - Military Engineer Shigeru Hayashi, Chief of the Chemical Research Section, and Major J. Sakagami, Micrometeorologist.

2. Training (Chart 3). The only Army chemical warfare training center was the Narashino School (Chiba Prefecture) whose director is Major General Takeshi Yamazaki. There was no opportunity to visit this school and obtain detailed information about it, but this has been done by technical intelligence groups of the 8th Army.

3. Supply - Chemical warfare supply was integrated with other types of supply, and as nearly as could be determined, follows the same channels. The specific organization of chemical warfare supply should be the subject of further inquiry.

4. Plans and Policy - Formulated in the General Staff Office, chemical warfare plans and policy were not the sole concern of any one or several officers, and during the course of the survey, no specific personnel was located which was charged with these duties.

C. Navy (Charts 4, 5 and 6)

1. Research (Chart 5). In chemical warfare, unlike other fields investigated, the Navy research organization was behind that of the Army, not only in equipment, but also in the quality of the personnel*. The Sagami Naval Research Department was housed in twelve buildings, and employed some 300 people, of whom 30 were scientists and the remainder predominantly laboratory technicians. It did all chemical warfare research work for the entire Navy, including the naval air force. Its work was neither as extensive nor as intensive as that of the 6th Military Laboratory, but in many instances was very ably done. The most noteworthy officer interrogated was Captain Kizo Miretsuka, who, though currently "retired", was in charge of synthesis and testing of new agents, and who appeared to be a very capable chemist. Captain S. Tauruo, presently in charge of the laboratory, is relatively new in that position (about a year) and so not as familiar with all phases of the work as he might be. However, he was found to be very cooperative.

---

* This might easily be explained by the apparent fact that the Navy put much less emphasis on chemical warfare than did the Army.

2. Training (Chart 6). Detailed investigation of the organization and personnel of the two naval schools where chemical warfare training was accomplished was not possible during the course of the survey.

3. Supply - As in the Army, naval chemical warfare supply was integrated with other types of supply as far as organization and personnel are concerned, but this phase was not a subject of specific investigation, so a detailed account is not possible.

4. Plans and Policy - The only identifiable plans and policy organization was embodied in the Chemical Warfare Section (Committee), recently initiated (1 April 1945) for the purpose of advising the highest headquarters on chemical warfare matters. Detailed information regarding the exact functioning of this committee and the names of the persons serving on it could not be obtained, since its existence was not brought to light until the end of the survey, and then only in general outline.

D. Air Force (Charts 8, 9, 10 and 11)

1. Research (Chart 9) - The 3rd Military Laboratory for the Air Force was relatively small organization as regards chemical warfare work. Housed in seven buildings, and employing some 300 people (of whom 30 were scientists), only one building, two officers and seventeen men were devoted to chemical warfare. With an average yearly budget for the past several years of approximately 1,000,000 yen, only 30,000 yen were allocated for chemical warfare research and development. Major General I. Masaki, Chief of the laboratory, proved to be the most fruitful source of information concerning it, even though he is not himself a chemist. Of the two officers in direct charge of the chemical warfare section, only one, Capt. Kamei, remains, the other having committed suicide some time ago. Captain Kamei did not impress the interrogators as being a very keen man.

2. Training (Chart 10) - The Nikatagahara School of Gas Defense is the only air force chemical warfare training organization. Located near Hamamatsu, it had a staff of approximately 50 officers, of whom 13 were instructors, and 37 were administrators. It was a relatively new school, having only been established in June 1944. Before that time, there was no separate chemical warfare school for the air force, but chemical warfare training was accomplished on a very small scale at the School of Aviation (Army Airplane School) at Hamamatsu.

3. Supply (Chart 11)- A detailed explanation of the workings of the integrated chemical warfare supply channels within the air force was made in the course of the interrogation and incorporated into the attached chart, which is self-explanatory. Due, however, to the great confusion of terms in naming precisely the various headquarters and

bureaus involved, a further check will have to be made to verify the various echelons as listed.

4. Plans and Policy - Air Force organization was split into two halves - one consisting of the supply and training phases, the other of the strategic and tactical phases. At the head of the latter division was the Imperial Headquarters (or General Headquarters) from which plans and policies were handed down, but chemical warfare again lost its identity there and no specific organizational material or names of personnel could be obtained.

E. Civilian.

Throughout the survey this question was asked repeatedly: "What use was made of outstanding scientists outside of Military laboratories?". The answers varied from "None" to "Academic men were consulted on occasion and requested to carry out research on special chemical warfare projects". The Japanese 6th Military Laboratory furnished the following list of scientists consulted by them and projects on which the respective men were asked to work:

Hokkaido Imperial University

Professor Jiro Horiuchi (Artificial method for synthesis of arsenic acid)

Professor Zenichi Shibata (The study of extraction of arsenecus acid from iron manufacturing plant)

Tohoku Imperial University

Professor Rienzaburo Hara (The study of artificial method of arsenic acid)

Tokyo Imperial University

Professor Tanesoburo Samejima (The study concerning smoke)

Professor Morizo Ishitate (The study concerning poisonous mechanism of poisonous substances)

Osaka Imperial University

Professor Tashizo Chitani (The study of arsenic acid, artificial)

Nagoya High Technical School

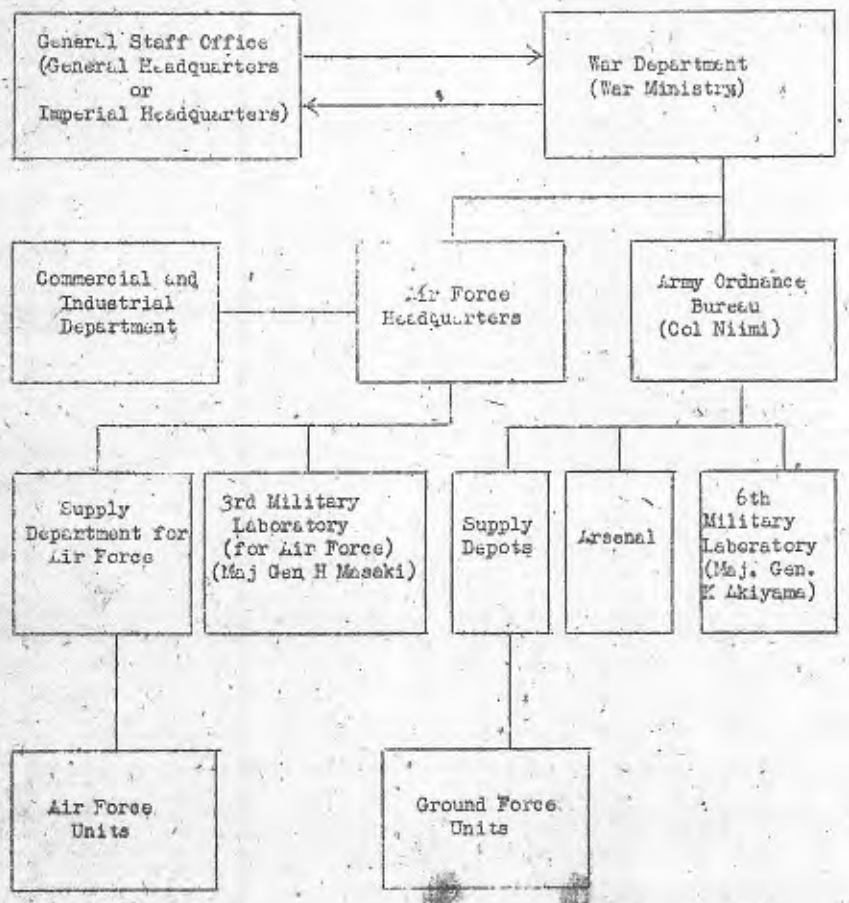
Professor Yoshiaki Nastunaga (The study concerning smoke)

Lt. Col. Ninomiya of the Japanese Army Medical School stated that permission could not be obtained from the top to go out and ask outstanding civilian scientists to help on the study of treatment of gas casualties. (C1-15)

Chemists of the Physical and Chemical Research Institute Tokyo, stated that they had not been approached by the Army or Navy concerning chemical warfare problems, and added that in their opinion the scientists in the Military services were not of the highest calibre.

All persons questioned agreed that there was no organized civilian group concerned with chemical warfare research and development.

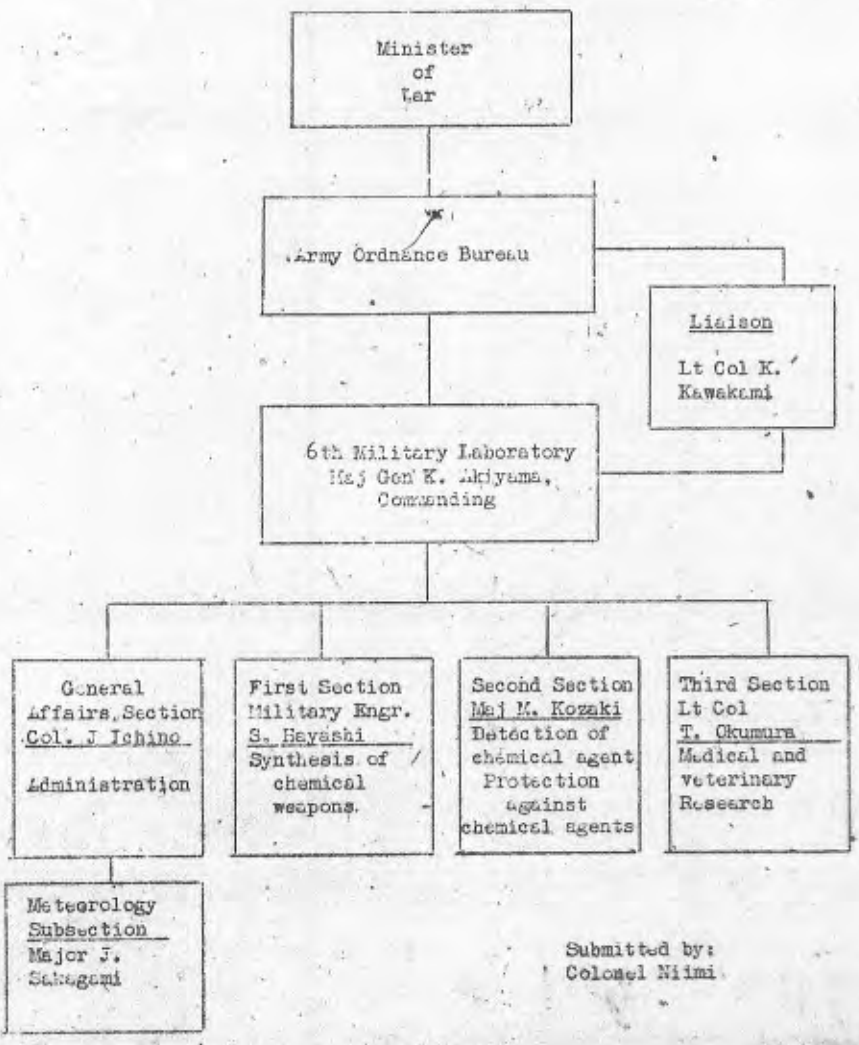
CHEMICAL WARFARE ORGANIZATION - JAPANESE ARMY Chart 1



Submitted by:
Col Niimi

ORGANIZATION - 6TH MILITARY LABORATORY
(100 Nincho 4 Chome, Yodobashi-Ku, Tokyo)

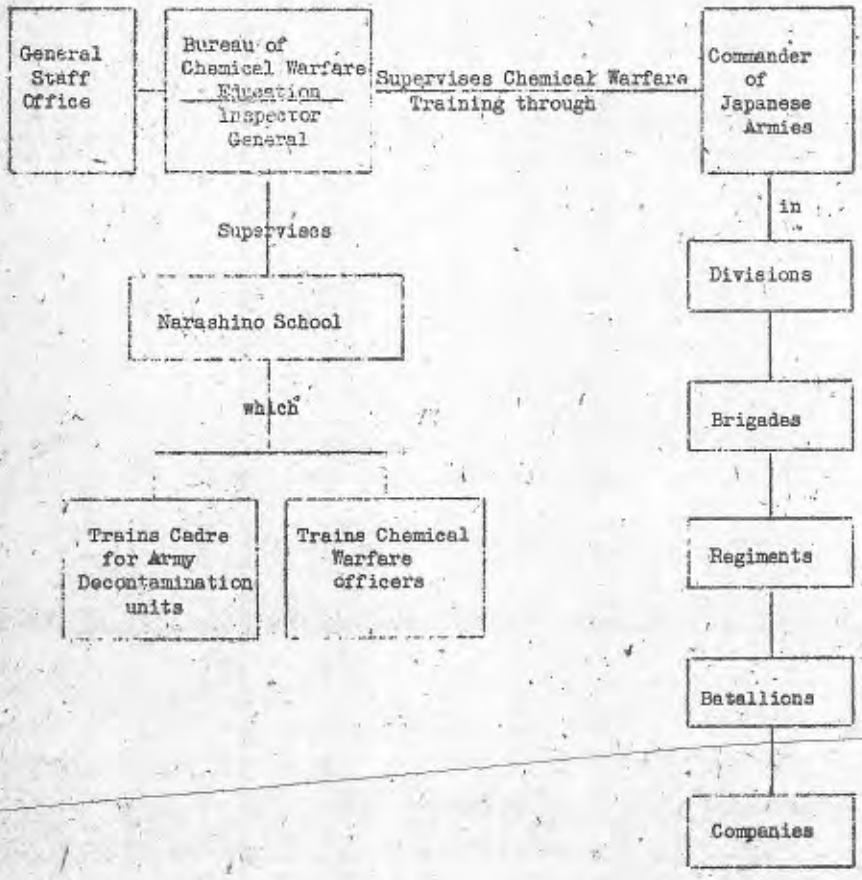
Chart 2



Submitted by:
Colonel Niimi

ORGANIZATION - JAPANESE ARMY CHEMICAL WARFARE TRAINING

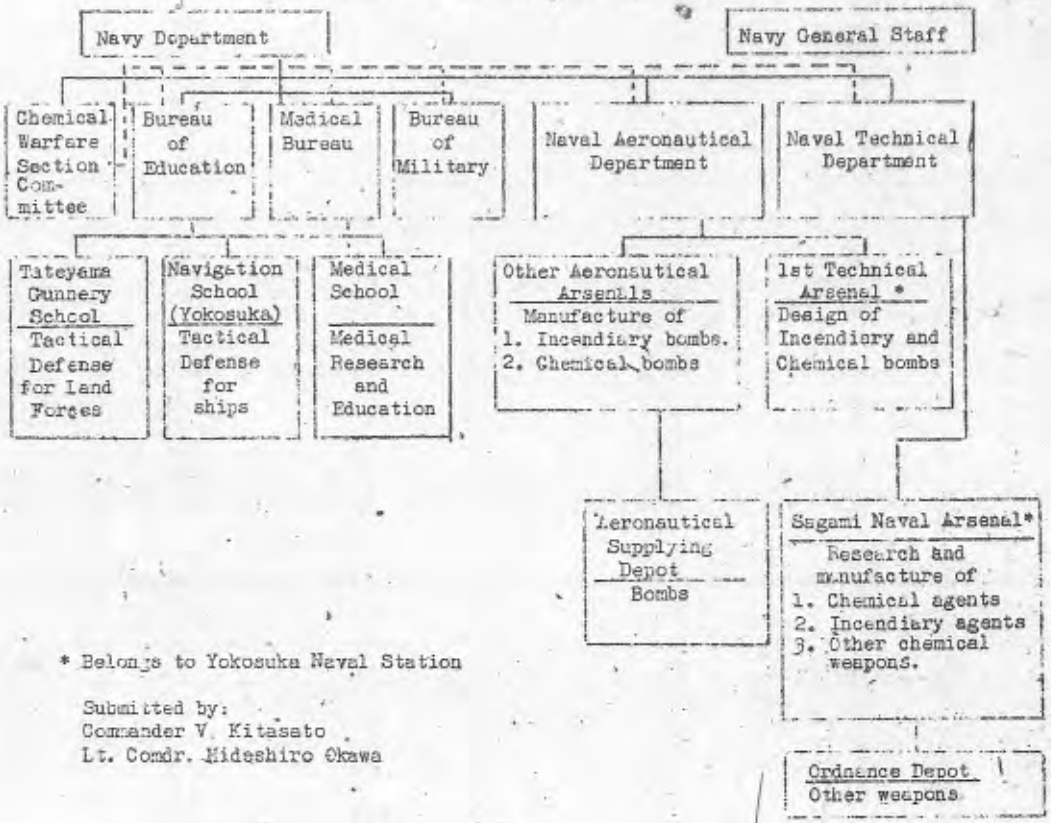
Chart 3



Submitted by:
Maj. K. Nagao

CHEMICAL WARFARE ORGANIZATION - JAPANESE NAVY

Chart 4



* Belongs to Yokosuka Naval Station

Submitted by:
Commander V. Kitasato
Lt. Comdr. Hideshiro Okawa

CONFIDENTIAL

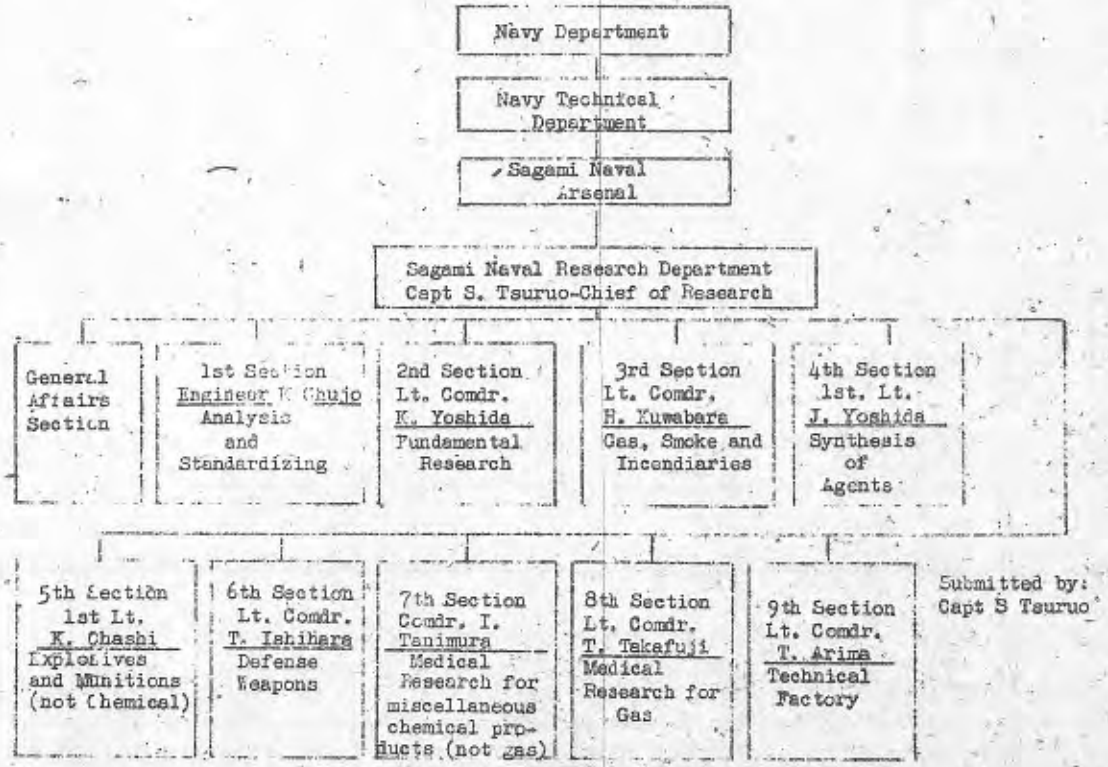
CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

ORGANIZATION - SAGAMI NAVAL RESEARCH DEPARTMENT
(Hiratsuka - Kanagawa Prefecture)

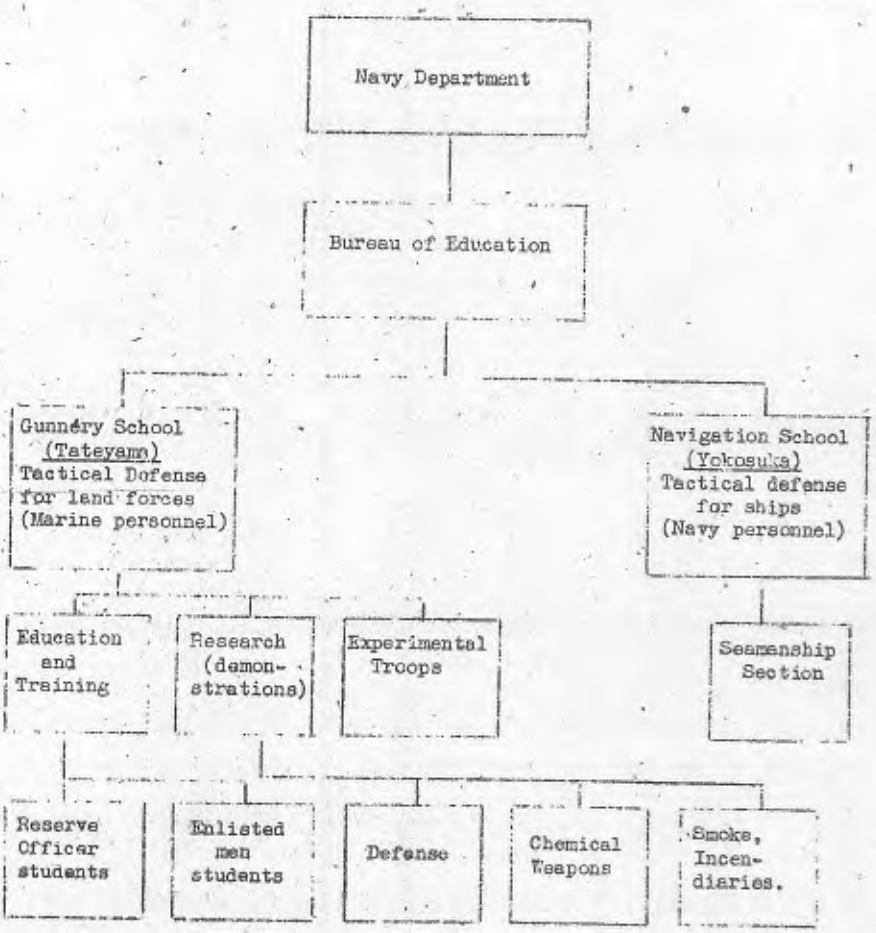
Chart 5



Submitted by:
Capt S Tsuruo

ORGANIZATION - JAPANESE NAVY CHEMICAL WARFARE TRAINING

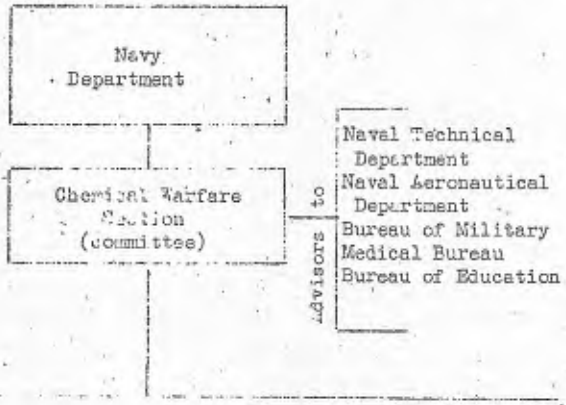
Chart 6



Submitted by:
Lt Comdr. H Okawa

ORGANIZATION - JAPANESE NAVY CHEMICAL WARFARE SECTION COMMITTEE

Chart 7



Serving full time

Captain H. Mayuzumi
One (1) Medical Officer
One (1) Technical Officer

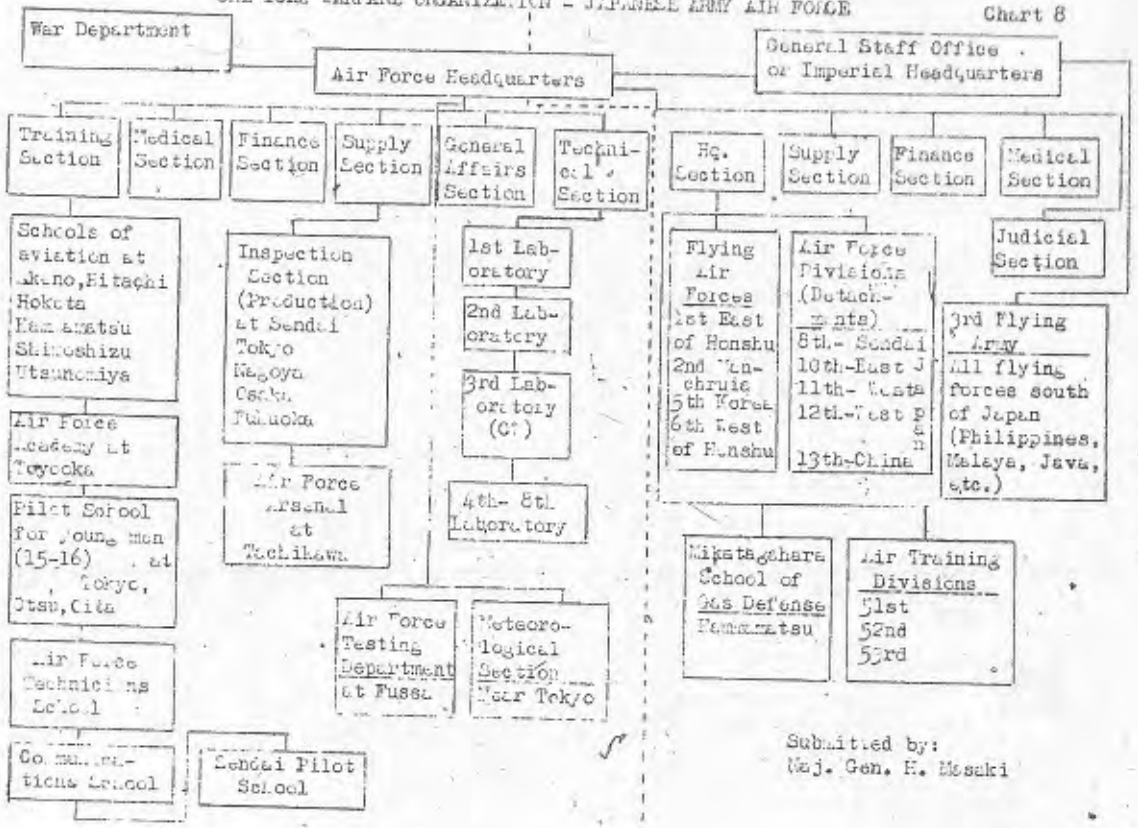
Representatives From:

Navy General Staff
Bureau of Military
Bureau of Education
Technical Department
Aeronautical Department
Sagami Arsenal
Navigation School
Tateyama Gunnery School
Medical School
Yokosuka Air Corps

Submitted by:

Commander Y. Kitasato
Lt Comdr. Hideshiro Okawa

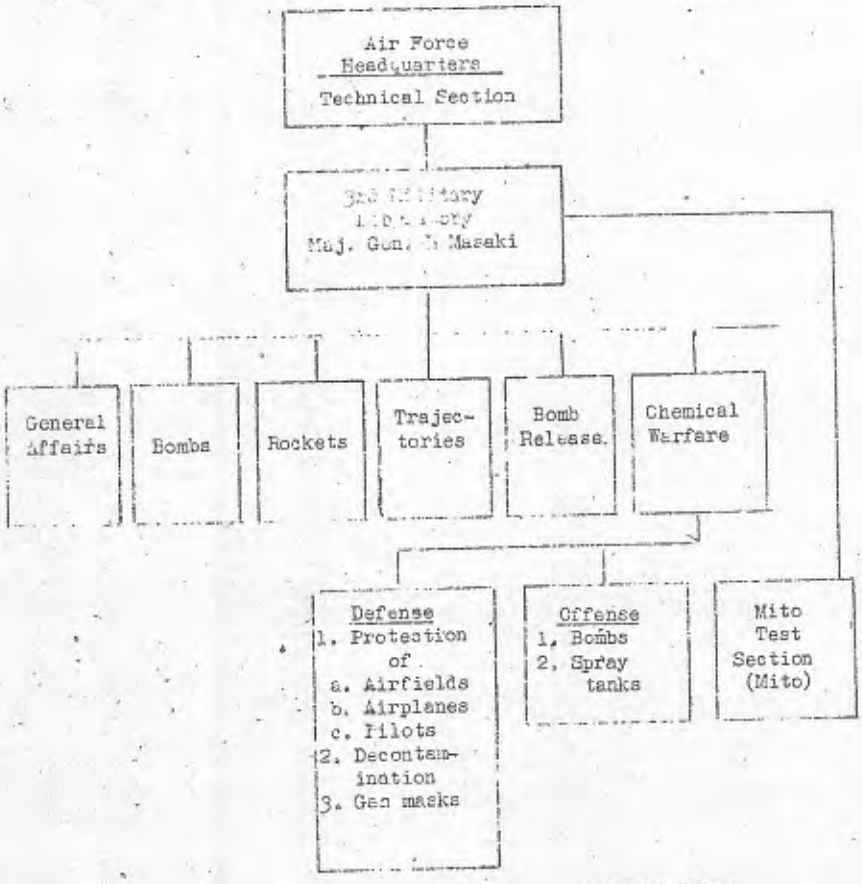
CHEMICAL WARFARE ORGANIZATION - JAPANESE ARMY AIR FORCE Chart 8



Submitted by:
Maj. Gen. H. Masaki

ORGANIZATION - 3RD MILITARY LABORATORY
(Tachikawa Air Base)

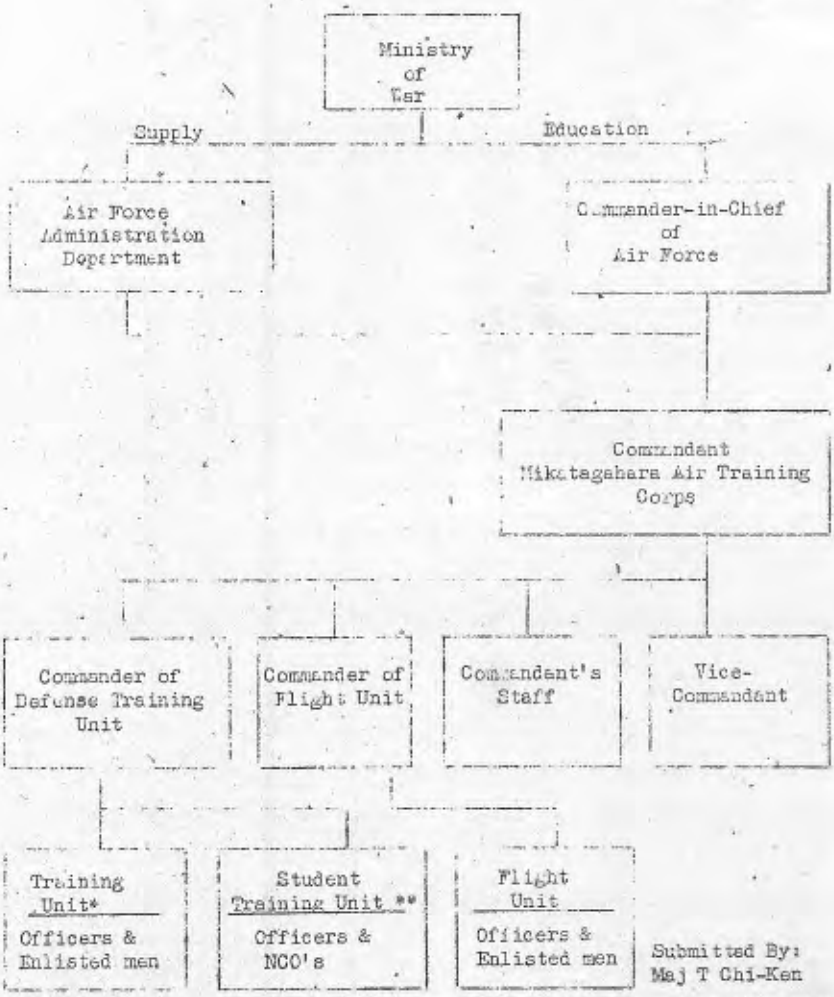
Chart 9



Submitted by:
Maj. Gen. H. Masaki

ORGANIZATION - JAPANESE ARMY AIR FORCES
CHEMICAL WARFARE TRAINING

Chart 10



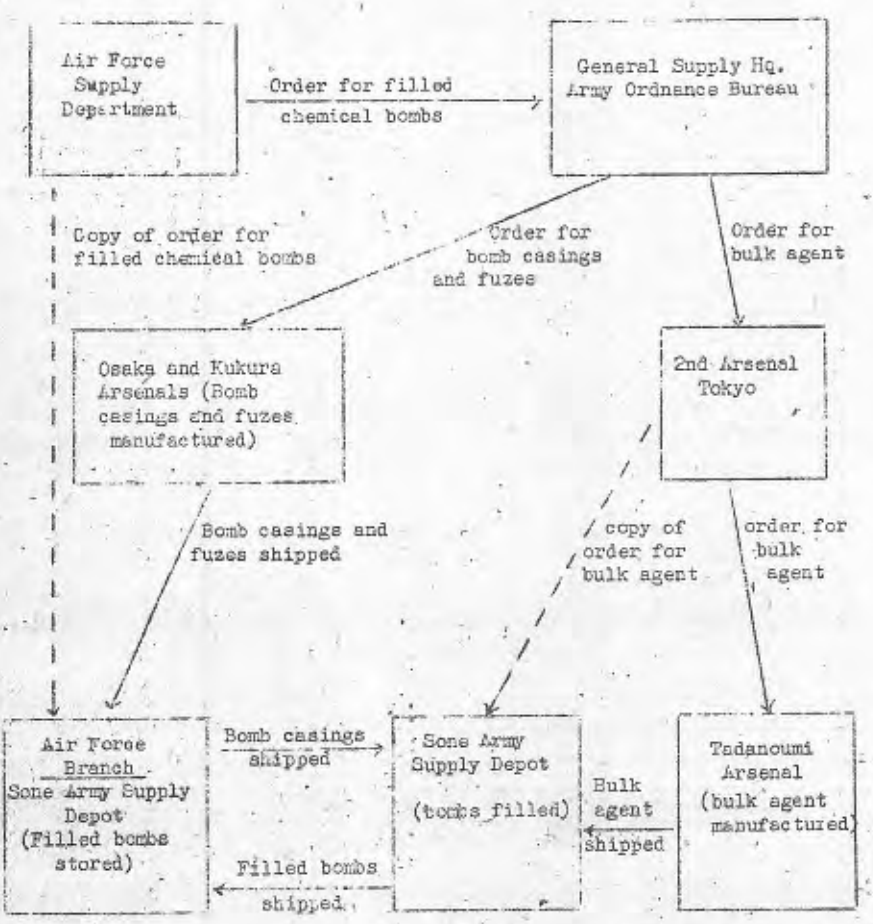
Submitted By:
Maj T Chi-Ken

* Composed of men newly called up for military Service. They were given regular combat training and used as demonstration troops in training students.

** Drawn from non flying personnel of Air Force Units.

AIR FORCE CHEMICAL WARFARE MUNITIONS SUPPLY

chart 11



Submitted by:
Maj. K. Kora

III. RESEARCH TRENDS

A. Army.

Japan, having had no experience in chemical warfare in the First World War had to start with research on production of the standard agents, mustard, lewisite, phosgene, diphenylcyanarsine and chloracetophenone (CN-10). A Dr. Mezzner (German)came to Japan about 20 years ago and helped establish Japanese chemical warfare (CN-2). Studies on production of the principal poison gases were begunin earnest in 1926 and were completed in 1932-1933. Studies on non-freezing mustard and HCN were completed about 1936. Search for new poison gases was begun in 1930 and was going "with all our might" in 1936. In 1941 emphasis was changed from the search for new agents to better methods of producing and using the well known ones (CN-10).

It was brought out in the questioning that Japan had expended large quantities of money and material for chemical warfare defensive research and equipment considering the resources of Japan (CN-13).

B. Navy.

Before the war Japanese chemical warfare research and training was limited to problems concerned with sea fighting, hence the emphasis on sternutator and lacrimator high explosive shell (CN-3). Persistent and non-persistent gas shells and bombs were not believed to be effective against ships and as a result little research was carried out on these weapons (CN-14).

Chemical warfare research in the Japanese Navy changed from the offensive to the defensive in 1943 and 1944 principally because of the concurrent change in Naval tactics (use of large numbers of aircraft and rare battles between ships (CN-3)) and the danger of aerial gas attack against advance Japanese Naval units on land

A history of Japanese Naval Chemical Warfare written by Japanese Navy officers is appended (CW-3). This paper includes information with reference to Naval policy, manufacture, weapons, supply, research and treatment of gas casualties.

C. Air Forces.

Chemical warfare research as it pertains to the Army Air Forces dealt in the main with defense against chemical attack. The offensive research was limited to several types of incendiary bombs, one type of chemical bomb and two types of spray tanks. Chemical warfare research by the Army Air Forces stopped about two years ago because it was felt to be complete (CW-5). The Chemical Section of the 3rd Military Laboratory for the Air Forces was nothing but a munitions design section. All basic research was done by the 6th Military Laboratory.

IV OFFENSIVE RESEARCH AND DEVELOPMENT

Although the Japanese repeatedly disavow any offensive intentions as far as chemical warfare is concerned and continually emphasize the defensive character of their research, it can be seen from a breakdown of the 1945 budget of the 6th Military Research Laboratory that more money was allocated to the 1st Section (Searching for new chemical warfare agents and developing new or better ways of manufacturing present agents) than to any other section of the laboratory (CW-8). Also their effort to determine munition requirements data and effects of meteorological conditions thereon belies more than an exclusively defensive research program.

A. The Japanese Search for New Poison Gases.

Synthesis of new compounds and the testing thereof as possible new chemical warfare agents was carried out by the 6th Military Laboratory for the Army and the Sagami Naval Research Department for the Navy.

1. 6th Military Laboratory

The search for new agents was under the direction of Military Engineer S. Hayashi, a capable organic chemist who had been at the laboratory for over 21 years. About 1000 compounds had been examined*. (CW-10)

---

* Early in the survey Engineer Hayashi stated that all information concerning new agents had been burned, later he said he was searching for and might be able to find the list and finally the list of compounds studied was found, reproduced and turned over to Scientific Intelligence Survey.

The first list of new compounds synthesized and tested (prepared from memory by Engineer Hayashi) is contained in appended conference notes (CK-10). It includes:

1. Inorganic compounds
2. Organic Halogens
3. Nitrils
4. Isonitrils
5. Isocyanates
6. Phosgenes
7. Mercaptans
8. Ketones
9. Organic sulphides
10. Amines
11. Nitro compounds
12. Nitroso compounds
13. Organic fluoro-compounds
14. Organic metallic compounds
15. Organic Se-compounds
16. Organic As-compounds
17. Phosphines
18. Alkaloids
19. Proteins
20. Oximes

It appeared from questioning that the Japanese had carried out no work on cadmium compounds, nor high vapor pressure sulphides.

Both ricin and aconitine had been studied as possible agents for poison darts (mouse LD 50 for these agents had been set at 0.1 mg/kg).

Fluorophosphates, fluoroacetates, and phospine oxides were not listed as having been worked on. When casually questioned on phosphates and phospine oxides the reply was that nothing of interest had been studied along these lines.

Meta nitrophenyl dichlorarsine was found to be of interest, but was not believed to be as good as lewisite.

The nitogen mustard, tris (B chloroethyl) amine, was studied in the leboratory and found to be less effective than mustard (CK-10).

In a short conversation on the relationship of certain molecular groupings to physiological activity of agents, Engineer Hayashi stated that he was very much interested in this subject and had studied it for a long time; however he had been able to come to few if any, consistent trends (CK-10). The Chart of 1000 compounds mentioned above was prepared originally in January 1944 and is titled, General list of Studied Poisons.

Because of the magnitude of the task of translating and reproducing this mass of information it was decided in agreement with the Economic and Scientific Section, General Headquarters and the Office of the Chief Chemical Officer, AFPAC that these data should be safe-handed back to Washington by members of the Scientific Intelligence Survey. There is another copy of these data in the hands of Japanese 6th Military Laboratory.

A peremptory survey of this General List of Studied Poisons which includes structural formula, state, boiling point, freezing point, class of agent and toxicological data, revealed that:

a. Toxicological studies were carried out on CNCl.

b. A study of the "Theory of Toxicity" must have been one of their principal objectives.

c. HN_3 and its hydrochloride was studied but neither HN1 or HN2 is listed.

d. Nitroso methyl and ethyl urethane were studied, but no interesting variations thereof.

e. Much emphasis was put on study of cyenides and HCN.

f. Sesqui mustard was tested by the Japanese as were many other H analogues. They were thought to be inferior to mustard.

g. An intensive study of the toxicity of arsenicals was made.

h. No phosphine oxides or fluorophosphates appear to have been studied.

i. The Japanese appear to have missed other interesting fluoro compounds in their search for possible new agents.

Engineer Hayashi stated that of the toxic compounds studied none proved to be better than the standard or well known agents (H, L, CG, HCN, CN) except the paracresol lacrimators (CN-10). General Akiyama also stated flatly that no new agents had been developed in Japan.

General Akiyama said on several occasions that no information on new agents had been received from the Germans (CW-2). The following questions and answers on this subject are listed:

Q. Do you know of any new agents worthy of production providing raw materials were available to you?

A. None could be found which could be considered superior to H, HCN,

DC (except -- chloroacetyl derivatives of paracresol -- a lacrimator) (CT-10).

Q. Are you willing to go on record as saying you received no information on new German agents during or before the war?

A. None was received. The Germans informed us that the Russians had nitrogen mustard and phosgene oxime but would tell nothing of German developments, either offensive or defensive (CT-10).

Q. Did Japan request information on new German agents?

A. Yes, Japanese Imperial Army requested this information through the Japanese Embassy in Berlin but got no information (CT-10)

Toxicological studies were made on compounds of interest. Toxicological methods used by the Japanese were crude in comparison with methods used at Edgewood Arsenal and the University of Chicago Toxicity Laboratory. Chambers were made of glass plate and were of the static type.

Two rather large explosion chambers of concrete and steel plate were used to test the stability of agents to explosion.

An "antifreeze" mustard, the thio alcohols of which were produced from coal gas, was developed by the Japanese (CT-10). It was thought to consist of:

$$S\begin{cases}CH_2\ CH\ Cl\ CH_3\\ CH_2\ CH\ Cl\ CH_3\end{cases} \quad (15\%)$$

$$S\begin{cases}CH_2\ CH_2\ CH_3\\ CH_2\ CH_2\ Cl\end{cases} \quad (35\%)$$

$$S\begin{cases}CH_2\ CH_2\ Cl\\ CH_2\ CH_2\ Cl\end{cases} \quad (50\%)$$

This mixture is reported to freeze at -35°C and to retain 75% of the physiological effectiveness of pure Bis (B Chlorethyl) sulfide.

2. Japanese Sagami Naval Research Department

The work on new agents carried out by the Navy was on a very small scale. Only about 100 new compounds were synthesized some of which were tested biologically. Since all the data was reputedly burned, members were requested to remember as many as possible of the agents tested and to list same, see (CT-14). Capt. K. Hiratsuka the chemist who synthesized the 100 compounds for the Navy was familiar with each one.

On request he prepared his "Conclusions about new agents produced at the Sagami Naval Arsenal" (CW-14). None of the compounds listed appear to be of unusual interest.

None of the toxicological work of the Navy is available. Methods used in testing as well as criterion for judging new agents are included in conference notes (CW-14, 16).

Captain Miratsuka states that, "We could not find new agents superior to Yperit, Lewisite, Chloracetophenone and HCN".

B. Munitions (See drawings - appendix CW-25)

1. Army Ground Forces.

a. Candles. The Japanese candles were of two types - concealing smoke and irritant smoke. There were two types of concealing smoke candles (94 type A and B), the former containing Berger mixture, the latter HC mixture. There were six models which ranged in size from 0.8 kg. to 20 kg and in burning time from 2 minutes to 10 minutes. Among them were two floating candles. The irritant candles consisted of one variety of lacrimatory candle for training and four models of sneezing smoke (DC) candles for operational use. These range in size from 1 to 12 kg. and in time of function from 30 seconds to 2 minutes. There was one projecting irritant candle with a range of 200 meters.

b. Rockets: Experiments were carried out with four types of gas-filled rockets, ranging in capacity from 4 to 10 liters, and in range from 2000 - 3000 meters. In total weight they ranged from 35 to 80 kg. The propellant charge was Gl powder, which was composed of:

Nitroglycerine	30%
Nitrocellulose	65%
Centralite (ethylphenylurea)	3%
Graphite	2%

The rockets were launched from two simple guide rails. Research was never completed on them. Begun in 1941, it was necessary to stop in June 1945 because of lack of powder and other materials.

c. Gas Shells - All gas shells used the same casings as HE shells. Gas-filled shells were authorized for four types of artillery: the 7.5 cm cannon, the 10 cm cannon howitzer, the 15 cm. howitzer and the 9 cm. morter. Four fillings were standard: B-L mixture (50% - 50%) (yellow shell), phosgene (blue and white shell), diphenylcyanarsine (red

shell) and hydrocyanic acid (brown shell). The chemical efficiency of these shells was low.

d. Flame thrower Tank - Research was begun in 1942 on a flame thrower tank and by 1944 one had been developed, but material shortages prevented manufacture. One test model was produced. The flame thrower unit could be installed only in the Type 97 (15-ton) medium tank. It worked by compressed air and had a range of approximately 70 meters.

e. Gas Fog Emitter (HCN) - In the period 1942-1944 the Japanese developed a trailer-mounted 900 liter capacity HCN sprayer. Using a vortex type nozzle and compressed air system, the 900 liter tank of HCN was discharged in 2 minutes. The range of this weapon was said to be about 500-1000 meters (depending on meteorological conditions) with large quantities of agent. One test model was produced, but again material shortages prevented mass production.

f. Grenades - The only chemical grenade discussed was the so-called "Chibi" Glass Ball HCN grenade. It is an anti-tank weapon, a glass flask weighing approximately 500 grams and containing about 200 grams of HCN and 50 grams of methyl formate as anti-freeze. They were carried, two per man, and thrown at the side of a medium tank. This grenade also had a $TiCl_4$-50% &Sn Cl_4-50% filling for blinding tank drivers until other destructive steps against the tank could be taken

g. Non-explosive shell (Masuku-Dan) - For greater range (200 meters) and for use against larger tanks, the Japanese developed an 8 cm. recoil-less gun (weighing approximately 80 kg.) to fire a 4 kg. finned shell filled with approximately 400 grams of HCN or 1000 grams of Ti Cl_4. The shell contained no explosive. The body was made of soft steel and the nose of cast iron so that fracturing of the shell would occur upon impact with the tank. The gun was not rifled. The barrel was an open tube closed at the breech end by a metal resisting plate and a sand bag, both of which were inserted within the breech end of the barrel before firing and both of which were thrown about 100 meters to the rear when the gun was fired. This base ejection principle provided the recoil-less feature. This weapon was still in the experimental stage. Work was started on it in September 1944 and its inventor (Major Sato) estimated that six more months would have completed the research. At the present stage of development, the gun was mounted on rails for the purpose of testing its recoil, but it was designed to be mounted on a tripod and carried by hand. There was to be only the one caliber.

h. 9 cm. Mortar Smoke Shell - This shell was designed to detonate at a height of 30-60 meters above the ground, eject from its base and ignite 6 smoke candles which fell to the ground in an area roughly 10 meters in diameter and functioned for a period of 2 minutes. The length of the screen developed was said to be 100 meters. The range

of the shell was 1700 meters. The smoke was a hexachloroethane smoke.

i. Mustard Sprinkler (Sansha) - For gross contamination of fields and roads, the Japanese developed a trailer-mounted 300 liter tank with a pressure nozzle attachment which sprayed mustard gas in a band about 7 meters wide. It was never mass-produced, and was felt to have grown obsolete some time before the war ended.

j. Incendiary shells - There were three types of incendiary shells, a hand projecting shell, a 7.5 cm. field artillery shell and a 9.5 cm. mortar shell. The hand projecting shell weighed 1 kg., burned for 1 minute, had an area of coverage of 40 meters in diameter, and was filled 50% with phosphorus and 50% with carbon disulfide soaked into 25 rubber pellets (10 mm in diameter and 20 mm in length). It had a stick handle and was thrown like a hand grenade. The 7.5 cm. and 9 cm. shells are the same shells as their equivalent gas shells except for the filling. The filling, with the exception of the number of rubber pellets is the same as the hand projecting incendiary shell.

k. Chemical land mines - The Japanese had no chemical land mine. When questioned concerning it, General Akiyama stated that chemical mines are not as effective as high explosive mines, and that chemical mines required more agent to cover adequately a target such as a beach-head than would be required in chemical shells (CE-13).

2. Army Air Forces.

a. Chemical bomb - The air force had only one type of chemical bomb, the type 97 - 50 kg. bomb. It was a thin case (3mm steel) welded bomb. It carried an explosive charge in the nose (as well as through the center) with a steel plate behind it which was supposed to reduce crater loss. Upon impact, the nose charge forced the plate to the rear like a piston at the same time that the case itself was being ruptured by the center charge. The backward force of the steel plate was said to provide a rearward thrust to the agent and thus to prevent it from pooling in the crater. The Japanese said it did so effectively. There were five fillings for the bomb as follows:

Agent	Capacity (kg)	Area of Effectiveness (meters)
Mustard-Lewisite mixture (50-50) (yellow bomb)	ca 17.0	ca 30 (liquid)
Phosgene (blue bomb)	ca 15.4	50-70 (vapor)
HCN (brown bomb)	ca 8.0	50-70 "
CN (green bomb)	ca 14.0	50-70 "
DC (red bomb)	ca 0.350	50-70 "

b. Incendiary bombs - The most extensively used incendiary bomb was contained in the same case as was used for the chemical bomb. The filling consisted of 3 kg. of rubber pellets (20 mm diameter and 20 mm length) soaked in 6 kg. of yellow phosphorus and 6 kg. of carbon disulfide. The area of burst was 50-80 meters. There was also one other 50 kg. type incendiary bomb in the process of development which was filled with 14 kg. of a mixture of heavy oil, light oil, gasoline, KNO_3, and sawdust or rags. Ignition of this bomb was said to be very unsatisfactory, so it was never used operationally. There were three midget incendiary bombs, one magnesium, one thermite, and one oil, each weighing 1-2 kg. also in the process of development. They were not considered to be very effective. And there was also one 12.5 kg. (Type 97) magnesium incendiary bomb about which little is known. It should be further investigated.

c. Smoke Bombs - The Japanese had three smoke bombs - one a 50 kg. type, using the same case as the chemical bomb and filled with $ClHSO_3$, $TiCl_4$ and $SnCl_4$, a 20 kg. bomb containing Berger mixture and a 1 kg. Berger mixture midget type similar to the midget incendiary bombs. The 20 kg. type contained ten individual candles. The time fuze in the bomb was set so that the bomb burst above the ground, ignited all of the candles and ejected them out thru the base. When ejected from a height of 500-1000 meters these candles were said to land at approximately 20 meter intervals and burn for 3 - 4 minutes.

d. Spray tanks - The Japanese air force has had two known types of spray tanks. The earliest was a 28-liter brass non-pressure type wing tank with a mechanical release, a discharge time of 5-7 seconds and an alleged coverage of 35-50 meters in width and 350-400 meters in length at an airspeed of approximately 250 kmph and a height of approximately 100 meters. The Japanese admitted that it was absurdly small but they did nothing about it until July 1942 when they captured what they thought to be an American tank at Singapore (it might well have been an E6R2). This tank (which has since been destroyed and so is unavailable for inspection) was immediately copied and 6 test models made. They were tested at Mito (north east of Tokyo) and found to need modification. When modified, the present type Japanese tank emerged. It is an 85-liter non-pressure type wing tank with a mechanical release, a discharge time of 6 seconds, and a coverage of 30-50 meters in width and 500 meters in length at an airspeed of 70 m/s and a height of 100-300 meters. The Japanese at first pretended no knowledge of this tank, but eighty of them were found at Tachikawa and when the Japanese were confronted with one, they recalled the details. Since the earlier type tank was made of brass, they have all been destroyed and the metal used for other purposes.

3. Navy.

a. General - Although the Japanese Navy had an assortment of smoke candles, shells and bombs, and various incendiary munitions, none was unusually effective nor showed any significant departure from types already known. Therefore, a detailed description of each Navy munition encountered of those types mentioned will not be given here. Noteworthy, however, were their spray tanks, chemical bombs, and chemical "cans" for naval artillery shells.

b. Chemical cans for naval shells - Instead of filling shell casings themselves with chemical agent, the Navy developed small brass cans which were filled with agent and then inserted into either the nose or the base of the projectile depending upon the fuzing. For base-fuzed armor-piercing projectiles, a conical shaped can was made and filled with DC. In addition, a smaller flat can was made and filled with CN. By removing a certain amount of the explosive charge in the casing of the standard HE shell, both of these cans could be inserted in the nose and a chemical shell resulted. For nose-fuzed demolition shell, the can was merely a closed cylinder filled with CN. This was inserted in the base of the shell in place of a portion of the explosive charge. CN and DC were the only fillings for these cans. Vesicants and CG were ruled out because their effect is not immediate. The Japanese felt the battle would be over before the effect of these agents would become evident. DC was ruled out in the nose-fuzed demolition shells because the hole in the side of the ship would be so large that the smoke would quickly dissipate from within the ship. The hole made by the armor-piercing shell, being much smaller, would allow the DC to persist within the ship for an effective length of time. These cans were not loaded in the shells aboard ship, but at Navy arsenals ashore.

c. Chemical bombs - The Navy had only one chemical bomb. It consisted merely of the standard 120-lb HE bomb casing with the majority of the explosive charge replaced by the agent. It was unlike the Army air force's in two respects: it was not a special thin cased bomb as was the air force's and the agent was not filled directly into the bomb body cavity but into cans which were then themselves inserted into the bomb. There were two cans, one for the cylindrical part of the body cavity and one for the conical base. The bomb held 17-18 kg. of mustard thickened with metha crylates and polyvinyl alcohols and operated on the same nose plate rearward thrust principle for reduction of crater loss as did the air force bomb. The cans of agent were held in place within the bomb by paraffin. When the shortage of steel became serious, a wooden bodied mustard bomb was developed which used only 30% as much steel as the standard casing. It contained 23 kg. of mustard, and in tests proved to be on the same level of effectiveness as the standard bombs. Its principle of function was the same as that of the standard bomb. It was never produced in quantity.

d. Spray tanks - The Japanese Navy had two known types of spray tanks. The type 97 was developed about 16 or 17 years ago. It was a pressure type tank designed to be carried in the belly of navy bombers and torpedo planes and flown at 100 knots. It was approximately 3 meters long and 400 mm in diameter. Fastened to its underside were four pressure cylinders approximately 2 meters long and 60-80mm in diameter. The tail pipe was joined to the rear end of the tank, ran along the entire underside of the fuselage and extended out behind the tail of the fuselage. The tank held 300-400 kg. of chlorsulfonic acid smoke and discharged in about one-half to one minute. Once begun, the discharge could not be checked due to the shattering of a thin lead plate in the tail pipe by the initial discharge pressure. The pressure in the tank for discharge was 3-4 kg. cm^2 and was controlled by a gate valve within the airplane. The smoke screen produced was said to be 2,000 meters long from an altitude of 100 meters. The newer type tank, the Type 99, was, in the main, merely a modification of the older type tank. The most important difference was the modification of the tail pipe. It was removed from the rear of the tank, joined to the forward end and shortened to a few feet in length. The body of the tank remained the same otherwise. The operating pressure within the tank was increased to 6-8 kg./cm^2, the discharge time thus reduced to 20 seconds and the length of the screen to 1200 meters. This tank was designed in 1939 for planes to carry and operate at speeds of 140 knots; over this speed the tank does not operate satisfactorily, so with the increase in airplane speeds it has become obsolete. Up until March of 1945 only 60 had been produced. The type 97 were all converted into type 99's. A close examination of this tank was not possible and since some of the information given by the Japanese verbally and in writing conflicted, a further, more detailed investigation of these tanks should be made.

C. Field Trails - It was apparent from the amount of field sampling equipment in use (as many as 200 bellows machines and over 1000 bubblers in a single test (CW-8), that the Japanese 6th Military Laboratory expended considerable effort on field experimentation. A description of the sampling equipment and the analytical methods used have been covered in conference notes (CW-12)

Field trials were carried out at Gotemba (near Tokyo), Ojoji, Formosa and other maneuver areas. Field layouts and interpretation of data obtained are surprisingly similar to United States and British techniques. Gridded sampling positions over one or two 100 x 100 meter areas, with total dosage as well as integral dosage sampling, were generally used (CW-8). Dosages are expressed as Cts (mg/mins/M3) and dosage isolines are constructed from the sampling data. Animals were used extensively to check and supplement chemical sampling.

An arithmetic mean of the Ct's obtained over the target areas as well as the percent of the area covered by a dosage greater

than the "effective dosage" was calculated in each field experiment (CW-8).

Field experiments were fairly well standardized, usually using 1 or 2 hectares as the sampling areas. Tests were repeated under varying meteorological conditions (CW-8). Trials were carried out under tropical as well as temperate conditions (CW-8).

The Japanese appear to have been using both the direct and the theoretical approach to the problem of munitions requirements. They too had their formula! Their approach to the question of horizontal and vertical gustiness appears of interest and needs careful study.

No one was in direct charge of planning and carrying out field testing. Each time tests were to be conducted General Akiyama designated an officer to be in charge (CW-2)

Chemical warfare experiments were carried out in Formosa first about 15 years ago at Koko, near Shinchiku. More recent tests were run six years ago on maneuver grounds near Heito. All records of these and other field tests were destroyed on August 15th and 16th per Japanese War Department order (CW-2). Colonel Saeki, who took part in the Formosa experiments, was requested to reproduce the procedure used, results obtained and conclusions drawn from each trial. This information is appended (CW-20).

A rather large scale trial was carried out by Major General (then Colonel) Akiyama in Manchuria (July 1943) on the effectiveness of HCN aircraft bombs (CW-8). Conclusions drawn from these trials as given by memory were:

1. If you do not have a sufficient number of planes HCN is not effective.

2. Climatic (meteorological) conditions must be ideal for the use of HCN.

3. The number of bombs would have to be double the expenditure used in this trial (80 bombs per 40,000 sq. meters) to be effective.

4. Because of the small number of planes in the Japanese Air Forces it would not be feasible to use HCN in attack.

5. Although high concentrations could be obtained near the earth the agent will not penetrate trenches and

pillboxes unless excessively large numbers of bombs are used* (For details on this trial see data appended (CW-8,20).

There have been many field trials using 100 x 100 meter plots. In a group of three trials on an area of 1 hectare where 15 bombs charged HCN were dropped per trial, it was found that the results very greatly depending on meteorological conditions, especially wind velocity. If the wind velocity is less than 1 M/Sec the results are good; if the wind velocity is 2 M/Sec or greater there is quite a drop in effectiveness, and if the wind speed is 3 M/Sec or greater HCN is practically no good (CW-8). On request, Colonel Ichino wrote up the details of the test described above as well as could be remembered (CW-12). He concluded that, "then it will be thrown down 15 bombs for one hector at the best condition of meteorology, the men and horses who are stay in this area are killed instantaneously".

When questioned concerning field experiments using phosgene, it was learned that trials had been carried out 10 years ago in Japan and 6 years ago in Formosa. Conclusions were:

1. Because the specific gravity of phosgene is greater than HCN and because more can be put into a bomb it is easier to attain the desired Ct of 2000 using phosgene in the field.

2. Phosgene has a distinctive smell and is easily protected against.

3. Since the Japanese soldier has an adequate mask the principal danger is to civilians.

4. The gauze mask is satisfactory against phosgene (CW-8).

Most of the field trials were said to have been carried out using HCN. More information on Japanese H trials is definitely required.

In reply to a question as to whether or not the Japanese had ever studied the effect of gas on cities, General Akiyama answered that tests had been run in Tokyo with smoke candles to determine penetration of gas into houses. Penetration was found to be good, but the General thought incendiary bombs were more effective in a city.

* This conclusion was drawn by observing smoke, not from HCN studies.

D. Micrometeorology

The Japanese appear to have intelligently approached the study of gas cloud travel, but analysis of this phase of the survey will require further translation of notes and the aid of a specialist in this field. Their study of G_y and G_z by means of a grid of samplers and a tower (using HCN as the indicator of "wind turning") is of interest.

Reference (CW-19) contains information on chemical warfare micrometeorology prepared by Major J. Sakagami of the 6th Military Laboratory.

E. Plant Processes

1. Army - Mustard has been made by two processes in Japan, the French process (sulfurmonochlorids, ethylene), and the German process (thiodiglycol) (CW-6). All French process mustard was redistilled. The final product was 95% pure. The re-distillation (vacuum) started about ten years ago (CW-9).

The production of "antifreeze" mustard using the hydrocarbons from coal gas is of interest (CW-10).

The Japanese were still chlorinating thiodiglycol by the batch process. A continuous chlorination process had been developed and was in the pilot plant stage (CW-10).

The use of an aluminum oxide catalyzer in place of an acid earth catalyzer in production of ethylene from ethyl alcohol was considered by the Japanese to be quite an improvement. The aluminum oxide was produced in a special way (CW-10).

The Japanese were searching for some new way to produce HCN because of the acute sodium and nickle shortage (CW-10).

2. Navy - Mustard was produced principally by the thiodiglycol process in the Navy. Manufacture by the sulfur monochloride method was on a very small scale and to use their own words, "we have a many unknown problems" concerning this synthesis.

V. DEFENSIVE RESEARCH AND DEVELOPMENT

The Japanese consider their research on Defensive equipment as good as that of any country, yet General Akiyama freely admitted that Japanese troops would have been helpless to combat the large scale use of gas by the United States, especially against their island defences. He felt that repeated bombings with gas would have been disastrous for the Japanese on Iwo, the Bonins etc.

A. Gas Mask - Army

The Japanese absorber for HCN (Katzuryu) contained: (% in grams)

Copper oxide -30) Manganese Oxide - 7)	Best ratio	70
Calcium Hydroxide		20
Caustic Soda		5
Binding Material (magnesia cement)		5

Composition (% by volume) of canister

Katzuryu 30%
Active carbon 70%

Breaking time for indicated agents are given as follows:

	Concentration %	Breaking time (min.)
CCl_3NO_2	0.5	20-26
$CO\ Cl_2$	0.5	18-23
HCN	0.2	12-16*

Conditions of Test:

Speed of flow	- 30 L/min (continuous)
Temperature	- 20°C
Humidity	- 50%
Height of layer of absorber	- 40 mm

Pertinent questions on gas mask research are listed with answers given by Colonel Hashimoto and other members of his staff:

Q. Have you carried out tests on captured United States canisters?
A. Yes. As concerns HCN, the United States canister is 2 to 3 times as good as the Japanese canister.

Q. Did you determine why?
A. No, not exactly. It was largely because of its size. In tube tests there is little difference between American and Japanese charcoal.

Q. Did you ever use pyridine in canisters?
A. No, it is too irritating to the nose to be used in testing canisters.

* This is to a break of HCN - Oxidation products prior to this break don't count. Chlorine containing agents were checked for break with starch iodide indicator. Could not find out what was used for HCN (Technician who did this work not available).

Q. What of the use of the mask in high humidities such as are found in New Guinea? Does it effect your canister's protection against HCN?
A. Not too greatly, since the oxidizing agent in the charcoal is still effective.

Q. Do you think it is possible, without exorbitant expenditures of munitions, to break the gas mask canister in the field?
A. General Akiyama and others present did not believe this feasible.

Q. Have you ever tested your canister with other agents such as ethyl bromide?
A. No our standard test agents are HCN, H, PS, CG, and DC.

Q. How about cyanogen?
A. No.

Other information reference the Japanese army gas mask is appended (CT-11). More information than is contained in the present report is required on this subject.

Gas mask Navy

It is interesting to note that the Navy absorbent consists of two components, active carbon and soda lime and nothing else. No impregnites were used. This was the answer to several direct questions on charcoal. Captain Tsuruo stated that they had heard of the Japanese Army work on zinc oxide and were thinking of putting this compound into the navy mask. Work was in progress on this subject.

Information on the Japanese Navy canister is contained in conference notes (CT-14,21).

B. Protective Clothing.

Most of the Japanese troops had been issued a rubberized impermeable suit consisting of trousers, boots and gloves (only decontaminating units had complete suits). The complete suit could be worn about 20 minutes under tropical conditions. The Japanese had no solution to the problem of protection against mustard vapor in the tropics other than ventilated gasproof shelters (CT-11). The gas proof shelter would consist simply of gasproof curtains over cave and pill box entrances (CT-11). It was hoped that the initial high Ct's could be protected against this way, but it was realized to be impractical and that repeated bombings would in the words of General Akiyama "almost completely annihilate" troops in areas such as Iwo Jima (CT-22).

The Japanese captured a secret document at Cavite, Philippine Islands, telling of United States' impregnated clothing. This document

did not say that the active ingredient was but the Japanese assumed it to be chloramine T. Hence American protective clothing was referred to as "Chloramine T clothing". None of this clothing had been captured or seen by the Japanese.

Both the Japanese Army and Navy had been concerned with abortive attempts to produce "chloramine T protective clothing". The Army's method included quite an array of garments: There was (1) an undershirt waterproofed with an Al soap and paraffine to protect the skin from chloramine T; (2) a gauze shirt soaked in chloramine T and donned wet; (3) a cotton coat with hood, waterproofed to spread drops of liquid mustard for purpose of increasing rate of evaporation; (4) the regular rubber pants, boots etc.

Authors' Comment: This idea hardly seems practical.

General Akiyama estimated that chloramine T clothing (or the constituents to make the clothing as described above) could have been produced in about a year (if adequate quantities of toluene could have been taken from high explosive production and the factories weren't bombed out). However, the General added if it had been produced there were no ships to carry it to the fronts. He thought the ships that did get through would have done better to carry food. The General didn't think the clothing much good anyhow as it lost its effectiveness when it dried out. It was at this point that General Akiyama again stated, "There is no doubt the Japanese would have been in bad straits had gas been used. That is why we were so afraid of gas" (CM-11).

The Japanese Navy possessed a heavy rubber suit for protection against gas which would appear to be very impractical. The Navy also had a protective half-suit made of rubberized silk.

The Japanese Navy attempt at "chloramine T" clothing was along the same lines as the Army, and equally as unsuccessful (CM-21).

The Japanese Air Force possessed a protective "gum apron" for pilots. The body of this apron was made of "thick gum sheet". The arms (sleeves) and legs (like hip boots) made of "thin gum sheet" could be detached by unfastening snaps in case the pilot became too warm in flight (CM-18).

The use of charcoal-impregnated clothing had been studied in Manchuria by General Akiyama who believed it to be very good, but no one else in Japan had done work on this idea. It was not determined why this idea was not followed-up in Japan.

C. Treatment of gas casualties.

The most interesting claim the Japanese make on treatment of

gas casualties is concerning use of anthranilic acid (methyl ester) for decontamination of mustard on the skin. They believe the methyl ester of anthranilic acid is significantly better than chloramine T with respect to decontamination after 5 - 10 minutes. The reason given was "because it (methyl ester of anthranilic acid) not only decontaminates, but also washes unreacted mustard from the skin (even down in the skin) like kerosene" (CT-15).

The study of the mechanism of action of H in the body was carried out by Lt. Col. Minomiya of the Japanese Army Medical School. Lt. Col. Minomiya believes that the action of mustard in the body is due to its reaction with SH groups, principally glutathione. He agreed that there was no way (known to him) to reverse the reaction once mustard was fixed or had combined with the tissue.

Conclusions on treatment of HCN casualties were that "for the therapeutic effects 1 medicaments among them are methylen blue, natrium thiosulfate, and natrium subnitride, but the most effectual one is the artificial respiration". They found that artificial respiration at the rate of at least 100 times/minute was most effective (CT-12).

It was concluded by the Japanese doctors that "thiosulphuric" salts have antitoxic action against the poisonous function of mustard gas and CO (CT-12). Lewisite (systemic effects) were also treated by means of thiosulphates. For treatment of phosgene poisoning calcium thiosulphate was found to be ineffective. Venesection and oxygen therapy were recommended in cases of phosgene poisoning.

No work on thio alcohols for treatment of lewisite action had been carried out (CT-15).

D. Decontamination

The Japanese were found to have developed nothing new in either decontamination methods or equipment. They had no mechanical equipment for decontamination except for an experimental model of a vehicle drawn slurry-spreader which consisted simply of a funnel type container (with a 1 cubic meter capacity) into which ready mixed slurry was poured from containers carried in the bed of the towing vehicle. This development belonged to the Army Air Force. Except for it, all decontamination was done by hand, using either water, dirt or bleaching powder for the most part.

E. Detection

The use by the Japanese of sealed glass tubes containing compounds which would otherwise be too unstable on storage to use in detector kits smells of German assistance. Details obtained on the

Japanese Army and Navy gas detection equipment are contained in conference notes (CWC-11,21).

The Japanese appear not to have used DB3 in their detection work.

VI. OTHER INFORMATION

A. Production of chemical warfare munitions.

1. Army production of agents - Last stage production of chemical agents for the Army, both for ground forces and for the air force, was accomplished only at the Tandanoumi Plant of the 2nd Tokyo Military Arsenal, located at Tandanoumi-Machi, Toyoda-gun, Hiroshima-ken, about 40 miles from the area where the atomic bomb fell. Intermediate materials were manufactured by many outside commercial plants and shipped to Tandonoumi, where final processing occurred. Manufacture of poison gases was stopped in September 1944 and the plant facilities converted to the manufacture of dinitro naphthaline and the tetranitrate of pentaerythritol. The monthly capacity of the Tandanoumi Plant was as follows:

Mustard	200 tons
Diphenylcyanarsine	60 tons
Lewisite	50 tons
Hydrocyanic acid	50 tons
Chloracetophenone	2.5 tons

The following chart shows the total production figures for the period 1938-1945:

Name of gas	Quantity produced (in tons)	Remarks
Kii No. 1 (Koo)	978	Ethyl alcohol chlorohydrin mustard gas
Kii No. 1 (Otsu)	780	Antifreeze mustard gas
Kii No. 1 (Hei)	978	Ethylalcohol-S_2Cl_2 mustard gas
Kii No. 2	1,290	Lewisite
Ohi No. 1	270	Hydrocyanic acid
Aka No. 1	1,444	Diphenylcyanarsine
Midori No. 1	20	Chloracetophenone
	5,760	

Below are the figures showing quantities of agent presently stored at Tandanoumi:

Aka No. 1 (Diphenylcyanarsine)	1000 tons
Kii No. 1 (Mustard gas)	913
Kii No. 2 (Lewisite)	314
Cha No. 1 (Hydrocyanic acid)	20
Midori No. 1 (Chloracetophenone)	7

2. Navy production of agents (CW-3) Last stage production of chemical agents for the Navy was also contained in one arsenal, the Sagami Naval Arsenal, located at Somekawa, Kanagawa Pref. (near Chigasaki), to which were shipped the majority of the intermediate materials for final processing. Some intermediate materials were produced at Sagami Arsenal, however. The following chart shows the actual production figures:

Name of Gas	Monthly Prod. Capacity (tons)	Total Amt. Produced	Manufacture of Intermediate Material at Sagami
Mustard	80	ca. 600	Manufacturing capacity was 20 tons monthly. Converted to ethylene-diglycol prod. in 1945
Lewisite	Small pilot plant	ca. 10	None (used only for experiments)
Diphenylcyanarsine	20	ca. 120	Ca. 10 tons monthly
Chloracetophenone	30	ca. 120	Converted to production of styrol resin in 1945

3. Army production other than agents

a. Since production of chemical warfare weapons other than bulk agents was not a primary concern of the survey, little information was obtained on that subject. Since chemical - filled shells used the same casing as HE shells, production of both would be accomplished at the same locations. The exact number of shells produced for chemical fillings is not known, but the following figures were obtained on the number of gas shells in storage at the Hiroshima Supply Depot:

Type of Shell	Rounds classified by branch depots: Hachikan Matsu	Omine	Total
Type 91 (10 cm. Howitzer)	2214	5820	8034
Type 38 (Field gun)		20000	20000
Type 4 (15 cm. Howitzer)		8000	8000
Type 94 (mortar)		54098	54098
			90132

In addition to these shells there are many more in Manchuria and Hokkaido, but no reports were received on them.

b. 50 kg chemical bomb casings were produced at Osaka and Fukuro Arsenals. The only production figures received were for the following three years.

1941 - 37,500

1942 - 20,000

1943 - 9,800

67,300

These casings were also used for incendiary bombs, so the exact number either originally allocated for toxic agents or actually filled was said by the Japanese questioned to be unknown. All that were filled and stored at the Sone Supply Depot (Air Force Branch), were destroyed at sea previously to the end of the war. These were said to be made up as follows:

50 kg.	CG filled bombs	3,000
50 kg.	H filled bombs	955
50 kg.	CN filled bombs	448

c. Airplane spray tanks of the 85-liter type were produced by only one known manufacturer: The Asano Aerial Industry Co., Ltd. - 106, 4-chome, Higashishinagawa, Shinagawa-ku, Tokyo (called, until 1944, the Kondo Mfg. Co.). 3,000 were originally ordered in 1943, but up until 1945 only 1200 had been produced. The only known storage place for these tanks is Tachikawa Airfield, where approximately 80 were found.

c. No information was received on the production of the remainder of Army chemical warfare Munitions-such as smoke and irritant candles, glass grenades, etc.

4. Navy production of other chemical warfare munitions - The only Naval chemical warfare weapons whose production figures were touched upon were chemical bombs, naval gun shell chemical "cans" and spray tanks. The only chemical filling for the standard Naval bomb was mustard. In 1944, the production goal for 60 kg mustard bombs was at first set at 100,000 and later reduced to 60,000. It was stated that 43,000 were produced and then production ceased. About 30,000 "cans" for Naval gun shells were produced in total, and then due to the change in Naval tactics their use was no longer seen as a possibility, so production was discontinued. There were only 60 of the Type 99 spray tanks completed when production ceased last March. (It was more a conversion problem than a manufacturing problem since the Type 99 was merely a made over Type 97). The extremely small number produced was due, it was said, to the fact that they had long since been made obsolescent by the increased speed of Naval operational aircraft. Production figures on smoke weapons, incendiary weapons, etc. though obtained in part, were not completely assembled for this report.

B. Training.

1. Army Ground Forces - The Narashino School, located near Tokyo, was the only Army ground force training organization where chemical warfare training was carried out. It was formerly a Cavalry school, but was converted into a chemical warfare school a number of years ago. It has accomodations for 1000 students, and its three weeks course was given both to officers and non-commissioned officers. It ceased to function on 15 July 1945. The exact nature of its course outline is not known, but the school has been the subject of investigation by 8th Army technical intelligence units and a detailed report written of its organization and mission. Nothing isknown of the exact nature of the chemical warfare training given to the average soldier in basic or combat training.

2. Army Air Force (CWS-24) - The air force chemical warfare school, the Mikatagahara School, is located near Hammamatsu. It was started in June 1944 to train unit gas officer personnel. Non-commissioned officers were first accepted for training in April 1945. Prior to June 1944, chemical warfare training was given at the Army Airplane School at Hammamatsu, where the course of training was the same as the Mikatagahara School, but the students numbered only 4 to 8 per class. The staff of the school numbered approximately 50 officers, 13 of which were instructors and 37 administrative officers. Student personnel was selected from ground units of the air force on a quota system determined

by Air Force Headquarters. Officer' classes were fixed at 80 students, NCO classes at 50. Unit commanders were thought by the school staff to send their worst men. Upon reporting to the school, prospective students were subjected to a physical examination whose chief demands were good eyes and nose and strong lungs. Failing these, the student was refused admittance to the school. This resulted in the average class numbering some 70 officers and 45 NCO's. A total of approximately 200 officers (3 classes) and 45 NCO's (1 class) was trained. The course of instruction for officers lasted for 4 months and for NCO's 3 months. The following subjects were covered:

1. Individual protection
2. Group protection
3. Protection of equipment
4. Meteorology
5. Treatment of Gas Casualties
6. Decontamination of Ground
7. Gas warning
8. Gas reconnaissance

At the completion of the course, the students were returned to their units. They were not expected to carry out chemical warfare training within their own units, but were merely to be available as chemical warfare specialist, should a need for them arise. The Mikatagahare School had no connection with the Narashino School, nor with any other schools, Army or Navy. Chemical warfare training for the average air force soldier was accomplished as part of his regular basic training. It was not very complete. The main subject was gas mask drill. First aid for gas was tried using water as simulated H, but the men, it was said, thought it ridiculous, so the training wasn't felt to be very effective.

3. Navy (CW-23) The Navy had two schools where chemical warfare training was carried out, but only one of these gave a very comprehensive unit gas personnel type course of instruction. That was the Tateyama Gunnery School. With a staff of approximately 40 officers and 100 enlisted men, it gave a course in defensive chemical warfare of from 3 to 6 months covering the following subjects:

		% of Total Time
1.	Chain of Command in Control of Protection	20
2.	History of Chemical Warfare	5
3.	Individual Protection	10
4.	Collective Protection	8
5.	Decontamination	10
	a. Gas sprayed from airplane	10
	b. Gas sprayed on ground	10
6.	Weapons training	20

7. Meteorology	2
8. Chemical weapons (other than gas)	5

The following recapitulation of personnel trained was also given:

No. Officers Trained	Length of Time Trained (Mo's.)
50	3
100	5½
100	4
100	In process (4 mos.)
Total 350	Average time of training- 4 mos.

No. of Enlisted Men Trained	Length of Time Trained (Mos.)
100	3
100	3
200	2
Total 400	Average time of training- 3 mos.

C. Chemical Warfare Policy

1. Army - As was mentioned earlier in this paper it has been impossible to determine who governed chemical warfare policy in the Japanese Army. It has been indicated on several occasions that no one in GHQ knew the fundamentals of Chemical Warfare (CW-22). This may be professional jealousy or even an attempt to cover up what might be considered a war criminal case -- the use of gas against the Chinese (see CW-22 appended).

Lt. Col. Kawakami of the Army Ordnance Bureau was asked early in the survey who in the Japanese Army was responsible for the chemical warfare tactical doctrine. The only answer he would give was that this was the responsibility of the General Staff, but who specifically he didn't know (CW-7). General Akiyama, when asked from what source impetus for chemical warfare research and development came, answered from two sources, from the laboratory itself for ons. A new agent or some other new development would be written up and sent from the laboratory to GHQ* through the Army Ordnance Bureau. Desired action would be returned through the same channels. Or, a project would be initiated in GHQ and sent through Ordnance Bureau to the laboratory for completion. General Akiyama stated that there was no chemical warfare planning board as such, however, nor anything similar to it.

---

* Someone must have been on the other end of this chain of command. Investigation of higher echelons reference Chemical Warfare must be made.

An interesting question and answer concerning the working of Japanese chemical warfare was:

Q. What is the Japanese intelligence organization as it pertains to chemical warfare?

A. No one is in charge of chemical warfare intelligence exclusively at any point in the Army. Intelligence on chemical warfare is passed from operational areas through GHQ to Army Ordnance Bureau which (Lt. Col. Kawakami) passes it to the 6th Military Laboratory for study (CW-2).

Another indication of policy (or what they would like for the United States to believe was their policy) is included in a Japanese Army write-up of manufacture of poison gases (for the Scientific Intelligence Survey), "Manufacture of poison gases was taken charge of by the Tandaloumi plant of Tokyo Second Military Arsenal and filling was the Sone Plant of the same arsenal respectively, but by no intention of offensive use, poison gases were keeping on manufacture at the minimum capacity in order to maintain the technical skill (CW-6)".

2. Navy - "Regarding chemical warfare the Japanese navy has attached importance to gas defense and observed following provisions".

1. "Chemical warfare shall be averted as far as it is possible in the cause of humanity and of prevention of terrific influence to our nation. So even though Allies use poisonous gas in limited bounds in small scale, we ignore it and retaliate with no gas whatsoever.

2. "If Allies begin to use chemicals publicly and extensively, then we shall inevitably have to retaliate with gas, but it should be commenced by special order of the General Head-Quarters".

3. "Organization, equipment, and training of warships and land forces for gas defense shall be in better condition as far as we can".

4. "So far as offensive weapons, considering if by any chance the chemical warfare should occur, we provide some amount of them, but not supplied to troops though retained at the naval ordnance depots or naval air force supply depots neighboring Yokosuka".

"NOTE: Stored mustard bombs, nevertheless, were distributed to the naval airforce supplying depot at Kure, Sasebo, Maizuru, Cominato, and Ooita in June and July this year, being afraid of the dangerous disaster caused by such an accumulation of bombs at air raids".

D. Supply

With the exception of the organization charts included earlier in this report under Section II, no information was obtained on supply and distribution systems within the Army, the Army Air Force, and the Navy. Chemical Warfare supply was said to follow the same lines as other types of supply, but no further details were sought since such investigation was outside the scope of what could be covered within the time allotted.

I. Japanese Intelligence

It was quite surprising to find that a percentage of the Japanese Army and Navy believed that the United States had already begun using poison gas in mopping up operations. Major General Akiyama was frank to state that he believed the United States used gas in the latter stages of battles after radio communications had been knocked out. He said this was the opinion of many in the Army including high-ranking officers (CB-13). In the Navy it was said that the majority of non-technical officers believed the United States to be using gas in mopping up operations. The reasons given were the unexplained sudden collapse of resistance in several island battles and the campaign for use of gas in American newspapers. The Japanese Army and Navy claim to know little or nothing of United States, British, Russian or German research and development along chemical warfare lines. The Japanese all seem to have feared the use of gas by the United States and almost universally believed it would be used on a large scale.

General Akiyama thought that the large scale use of gas by the United States would have hastened the end of the war. He was most afraid of the use of toxics on Japan's rice fields, however, and stated that this would have been as effective as the atomic bomb (CB-22).

VII. INTERVIEWERS' COMMENTS

Generally speaking few real inconsistencies in fact have appeared during the numerous interviews. Almost all persons questioned gave or attempted to give the impression of "a willingness to tell all". However, they almost always preferred to bring back the information (written out) at a later date. This might be construed in either of two ways: (1) a desire to obtain accurate and complete information on a subject about which they did not know the details or (2) an order from superiors to get information, which was going to be given out, checked by a central Japanese agency whenever possible so that stories would agree.

The impression gained by the interpreters and interviewers was that General Akiyama was answering all questions honestly and completely holding back nothing. Other Japanese officers of lesser rank were very reticent to discuss any but their own particular field.

There is considerable doubt in the minds of the interviewers as to the burning of all chemical warfare documents. No direct evidence to the contrary has been found, but this impression has persisted throughout the Survey and is mentioned for that reason.

It must be pointed out again that this entire Survey is based on the word of the Japanese. There has been little opportunity to check the veracity of their statements, and more important, to determine whether or not they were with-holding their most important data. This is a very important task which still remains to be accomplished.

At the end of this Survey an inconsistency appeared which may be indicative of the attitude or policy of a portion of the Japanese questioned. On numerous occasions the Japanese Navy had been asked concerning any and all information obtained from the Germans on matters pertaining to chemical warfare. The answer had always been "nothing". However, on searching a warehouse in one of the Navy Yards several beautifully finished and packed spray tanks were uncovered which contained German markings and German instructions. The Japanese officer in charge of spray tanks immediately remembered when they were received from Germany, tested, and copied by the Japanese. This same Officer had been questioned about spray tank design, development, etc. a week earlier, but he claims to have forgotten to mention this fact. This appears to be an obvious lie though the purpose of such evasion is obscure. Another type Japanese spray tank, not mentioned in earlier questioning was also found. This was said to be a test model, never put into production and not remembered at the time of the conference.

It may be that the Japanese are, in certain instances, adopting a policy of not mentioning articles of interest unless directly questioned on them, and completely withholding information on new or worthwhile developments of which we know nothing.

Conference Notes

The original conference notes of the interviewers were written up and distributed as quickly as possible. Copies were sent to:

Economic and Scientific Section, GHQ
A-2 FEAF
CG, CIC
Office of Chief Chemical Officer, AFPAC
Lt Gordon T Wallis, Chem. Off. Adv. Ech. FEAF
Office of the Chief CWS, Gravelly Point, Va.

For the most part these conference notes have been reproduced and are appended herewith, however because of the short time and limited personnel, reproduction in their entirety has been impossible. In a few instances in the body of the report reference is made to original conference notes which are available in the files of the above mentioned organizations.

Index to Appendices

Appendix No.	Subject	Date of Interview
CW-1	Japanese Army and Navy Chemical Warfare Organization.	9/19/45
CW-2	Chemical Warfare, (6th Military Laboratory, Organization)	9/26/45
CW-3	Navy Chemical Warfare	9/26/45
CW-4	Sagami Naval Arsenal Research Department	9/28/45
CW-5	CW, Japanese Airforce Research	9/30/45
CW-6	Manufacture of Poison Gas	10/1/ 45
CW-7	Japanese Army CW, Storage of Agents	10/2/45
CW-8	CW, Japanese Army Research, 6th Military Laboratory	10/2/45
CW-9	Chemical Warfare, Special Weapons	10/3/45
CW-10	CW Production and Plant Chemistry	10/3-4/45
CW-11	CW (Protection)	10/5/45
CW-12	CW 6th Laboratory Research Papers	10/19/45
CW-13	CW Intelligence	10/16/45
CW-14	Japanese Navy CW Research	10/10/45
CW-15	Chemical Warfare Medical Aspects	10/17/45
CW-16	Japanese Navy CW	10/12/45
CW-17	Flame Thrower	
CW-18	The 3rd Military Laboratory	10/5/45
CW-19	CW Meteorology	
CW-20	Field Testing in Manchuria and Formosa	10/18 /45
CW-21	Japanese Navy Protective Equipment	
CW-22	CW, Japanese Intelligence and Views	10/20/45
CW-23	Navy CW Intelligence and Training	10/19/45
CW-24	CW, 3rd Military Laboratory	10/11/45
CW-25	CW Munitions	

SUBJECT: Japanese Army and Navy Chemical Warfare Organization

INTERVIEWED: Col NIIMI, Member of Ord Bureau, Head 1st Sec., CW; Lt Col KUNITAKE, Balloons and CW; Capt YASUI, Navy CW; Lt Comdr KITAYATO, Navy CW.

INTERVIEWERS: Major SKIPPER, Lt Col SANDERS, Tec 4 Yagi

The Army and Navy CW representatives were requested to draw up organizational charts of their respective groups with detailed breakdown of research laboratories' functions.

Q Were scientists brought into Army for technical jobs?

A Yes, graduates of the University were offered to the military as technical officers.

Q What agents were manufactured for the Army?

A Mustard, Lewisite, diphenylcyanoarsine, HCN, chloroacetophenone.

Q Were any new agents obtained from the Germans?

A No.

Q Did you know of new German agents thru intelligence channels?

A We never heard of any.

Q Why did you mix H and L?

A To lower the freezing point.

Q What processes were used to produce H?

A Two processes were used: the German and the French process.

NOTE: None of the "so-called" technical officers present could write the reactions.

Q What quantities of agents were produced? (Note: this was given by Army CW Ord man and may not include Army air force figures)

A

A

H	913 tons
L	314 tons
Diphenylcyanoarsine	1000 tons
HCN	20 tons
Phosgene	All used for field tests
CN	7 tons

Stored at Tandanoumi storage plant.

Q Did your HCN ever explode?

A Sometimes exploded in shell, used powdered Cu stabilizer.

Q Did you use toxic chemicals against the Chinese?

A Haven't heard of use of poison gases against the Chinese: however, mistakes were made in laying smoke screens (toxic smoke or sternutators used)

NAVY - (questions answered by Lt Comdr Kitazato)

Q What agents did you produce?

A Bombs filled H* 43,000
Bombs filled L none
Bombs filled CO none

*60 kg bombs containing 17 kg of H

Q Did you manufacture chemical spray tanks for the Navy?

A None for toxic chemicals.

Q Were any produced for smoke?

A Yes, they were tested once with mustard but they were too small. Also "naval officers no like to fly low to spray toxic chemicals." "Naval officers claim naval tactics not in CW hence no work was carried out."

Q What protection against gas was taken by the Navy?

A Ships carried gas masks and detectors and an attempt was made to make ships air tight.

Q What protective clothing was available to the Navy?

A A sandwich cloth of the following layers:

_____rubber
_____celatin
_____silk
_____rubber

Q Did you expect to have CW used against you?

A Yes, the Navy thought you must use gas.

Q Why?

A Information from your war prisoners, your newspapers, and radio broadcasts. Also our intelligence told us you were going to use gas.

Q Colonel Niimi, did the Army expect the U.S. to use gas?

A Yes, we were afraid gas would be used by the U.S.

Q Why were you afraid?

A Our protective means not completed.

Q Where are your files on CW research?

A We burned them (Col Niimi).

Q Why?

A This has been explained to General MacArthur.

The conference was terminated at 1730.

MILITARY RESEARCH LABORATORIES
(Only concerned with ground force)

First	Guns, rigles, ammunition
Second	Observation facilities (including balloons)
Third	Engineering
Fourth	Tanks and tractors
Fifth	Communication facilities (Lt Gen KONO)
Sixth	Chemical Warfare
Seventh	Physics Research
Eighth	Materials (Kokubanji Tokyo, Maj Gen TAKEO NAGAO, Head)
Ninth	Materials for Special Raiding Party Materials for Military Police (including balloons sent over to U.S.)
Tenth	Barges, landing crafts

SIXTH MILITARY LABORATORY
ORGANIZATION & PROGRAM

SUBJECT: Chemical Warfare
DATE: 26 September 1945
INTERVIEWED: Maj Gen Kinsei AKIYAMA, Commanding, 6th Mil Lab
Mil Engr Shigeru HAYASHI, Chief, 1st Section
Col Shinji ICHINO, Chief, General Affairs Sec
Lt Col Tatsuo OKUMURA, Chief, 3d Section
Lt Col Kujoyasu KAWAKAMI, Member, Army Ord Bureau
Maj Masatake KOZAKI, Chief, 2nd Section
Maj Kokuru NAGAO, Member, General Affairs Section
INTERVIEWERS: Maj Howard Skipper, 1st Lt Gordon Wallis (FEAF), Tec 4 Yagi

The representatives of the different sections were requested to draw up organizational charts of their respective sections to show breakdown of functions and personnel.

Q Where is the 6th Military Laboratory located, and what of it remains?
A At 100 Nincho 4 chome, Yodobashi - Ku, Tokyo. Part of the Laboratory was burned; part remains intact. From that part destroyed, personnel were evacuated to Takaoka, Toyama Ken.

Q How many and what type personnel worked in the Laboratory?
A There were approximately 700 persons employed in the Laboratory, 200 of whom were evacuated to Takaoka. There are approximately 90 "scientists", of whom 50 are Army officers and the actual scientists, and 40 are civilian laboratory assistants. The remaining personnel are laborers.

Q Where were field tests carried out?
A At Gotemba, Ojoji, Formosa, and various maneuver areas. Generally in whatever vacant areas were available.

Q Who was in charge of field testing?
A No one specifically. Each time tests were to be conducted, General Akiyama designated someone to be in charge.

Q Are you familiar with the tests carried out on Formosa concerning use of gas under tropical conditions?

A Yes. (Gen Akiyama). These experiments were conducted first 15 years ago at Koko, near Shinchiku. More recent tests were run six years ago on maneuver grounds near Heito. All records of these tests were destroyed together with all other records on August 15, per WD order.

Q Is the 6th Military Laboratory the only organization in the Army for Chemical Warfare research?

A No. In addition to the 6th, there was the Air Force Chemical Laboratory No. 3, located at Tachikawa airfield, where work on airplane spray and bombs was carried out. This was a very small installation (one lab - two floors of wooden building) and was entirely destroyed in an incendiary raid. It is not known to where the personnel was evacuated. In overall charge was Maj Gen Hiroshi Masaki, though chemical warfare was only a minor part of his duties. Under him was Col Mizutani, who committed suicide, and in direct charge was Capt Kamei. There are no other air force chemical laboratories; further information can best be obtained from Air Force Headquarters.

Q Are there any other Army research organizations on chemical warfare?

A Yes; the 8th Military Laboratory. This laboratory is not exclusively a chemical warfare laboratory, as is the 6th, but rather a metals and chemicals laboratory. However, research has been carried out on smoke, flame thrower fuels and activated charcoal here. This laboratory is located at Fokubunji, Tokyo, and is under the command of Maj Gen Takeo Nagao. It has not been burned.

Q What arsenals produced chemical agents?

A Tandanoumi and Hiroshima-Ken. We haven't been making gas shells recently; we converted them to HE.

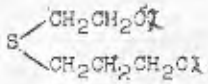
Q From what source did the impetus for chemical warfare research and development come?

A From two sources. From the laboratory itself, for one. A new agent or some other new development would be written up and sent forward from the laboratory to GHQ through the Army Ordnance Bureau. Desired action would be returned through same channels. Or, a project would be initiated in GHQ and sent through Ordnance Bureau to laboratory for completion. There was no chemical warfare planning board as such, however, nor anything similar to it.

Q What is the most significant development to come out of each section of the 6th Military Laboratory?

A The Laboratory has been in existence for 22 years. There has been much important work done but not much that is worthwhile has been accomplished recently. (However, the following important developments were cited and some without reference as to time):

1st Section: HCN stabilization. First started five years ago, it was steadily improved and completed last year. Mustard which would not freeze was also made about ten years ago with propylene as a basis. The formula was given as:



This will be checked.

2nd Section: New gas detectors developed. Made Hopkolite for HCN.

3rd Section: Studies on first aid treatment of mustard and HCN. Methyl ester of anthranilic acid. Thio sulphate for injection for HCN and also methylene blue.

Q What use has been made of leading civilian scientists?
A Civilian scientists were approached but were never taken into complete confidence of Army.

Q Was there any civilian scientific organization carrying out research on chemical warfare?
A No organizations but individuals. Each one approached was given a particular job.

Q Were the best organic chemists asked to synthesize poison gases for test?
A Some of them.

Q Did you receive any information from the Germans on chemical warfare?
A Not recently. After World War I, Dr Mezzner came over and helped establish Japanese chemical warfare, but since that time (20 years ago), or at least recently, no information from German sources has been received. Most recent reference used has been Prentiss. Most widely-used reference has been Floury.

Q What is the Japanese intelligence organization as it pertains to chemical warfare?

A No one is in charge of chemical warfare intelligence exclusively at any point in the Army. Intelligence on chemical warfare is passed from operational areas through GHQ to Army Ordnance Bureau who, (through It Col Kawakami), passes it to the 6th Military Laboratory for study.

It was requested that each section chief prepare a recapitulation of all research and developmental work carried out by his section during the time of his services with the Laboratory. These reports will be in English and will be completed at the time set for individual interviews with section chiefs next week.

Prepared by
Jap. personnel

NAVY CHEMICAL WARFARE RESEARCH LABORATORY
Sagami Naval Arsenal, Hiratsuka

SUBJECT: Navy Chemical Warfare
DATE: 26 September 1945
REQUESTED BY: Maj H E Skipper; Lt Gordon T Wallis

GENERAL REPORT ON CHEMICAL WARFARE OF NAVY

1. INTRODUCTION

The first Naval laboratory of chemical munitions was established in Tokyo, in 1923, as a section of the Naval Technical Research. This laboratory changed its attachment to the Scientific Research Dept of that research in 1925, and was transferred after the great earthquake within the bounds of the Naval powder factory in Hiratsuka, in 1931, and then it became independent as the Chemical Study Dept in 1934.

In the early stages at this laboratory, we chiefly studied the characteristics of chemicals, and subsequently manufacture too.

After the outbreak of this war, with the sudden increase of the amount of manufacture, this laboratory was developed and named "Sagami Naval Arsenal" in May, 1943.

Study and training about tactical gas defense, before this war, was taken charge of by the Naval Navigation School as a section of seamanship, but there was nothing worth mentioning.

In these stages, in brief, our efforts were concentrated to get possession of the knowledge about chemical munitions, to technical gas protection on board ship, and to the avoidance of injuries from carbon monoxide. Regarding to the retaliative weapons, we designed a small can which contains the lachrymator or sternutator to be put into medium calibre shell.

Before the outbreak of this war study and training about the chemical warfare had been entirely limited to sea battle, and concerning land battle we had cared little.

At the beginning of this war, the operation was quite satisfactory, so there came a very optimistic atmosphere for the future of the war, and for a while chemical warfare was entirely passed out of mind.

While the operation at the Guadalcanal Island, with the increasing intensity of action, many informations about the preparation for chemical warfare in American forces, and application of lachrimator by american trench mortar, awoke much attention. Especially, it was evidently forcast that these small islands floating on the Pacific would be fallen into serious danger if once attacked with a mass of poisonous gas. Then we intended to improve the defensive efficiency of the Naval forces occupying these important bases.

On the other hand, as to the study and education on the tactical defence on land, the Tateyama Naval Gunnery School has become charge of them from 1943 and promoted training and study.

Thereafter, incited by quick depression of the situation, by opinions on the application of poisonous gas spread in United States whenever landing operations took place, and by many advices from European fronts about chemical warfare, we took strict precaution against gas at the end of the war.

2. FUNDAMENTAL POLICY OF NAVY ABOUT CHEMICAL WARFARE

Regarding chemical warfare the Japanese navy has attached importance to gas defense and observed following provisions.

a. Chemical warfare shall be averted as far as it is possible in the cause of humanity and of prevention of terrible influence to our nation. So even though Allies use poisonous gas in limited bounds in small scale, we ignore it and retaliate with no gas whatever.

b. If Allies begin to use chemicals publicly and extensively, then we shall inevitably have to retaliate with gas, but it should be commenced by special order of the General Headquarters.

c. Organization, equipment, and training of warships and land forces for gas defense shall be in better condition as far as we can.

d. So far as offensive weapons, considering if by any chance the chemical warfare should occur, we provide some amount of them, but not supplied to troops though retained at the naval ordnance depots or naval air force supply depots neighboring Yokosuka.

NOTE: Stored mustard bombs, nevertheless, were distributed to the naval air force supplying depot at Kure, Sasebo, Omizura, Oominato, and Ooita in June and July this year, being afraid of the dangerous disaster caused by such an accumulation of bombs at air raids.

3. THE FUNDAMENTAL SCHEME OF MANUFACTURE AND EQUIPMENT OF CHEMICAL MUNITIONS

After the fundamental policy, in manufacture and equipment of chemical munitions, much importance was attached to the defensive weapons to keep the equipment of the forces, especially of the expeditionary forces, in better condition.

About the offensive weapons, we intended to be able to retaliate effectively in case of need though in a limited scale.

a. Defensive weapons. Efforts were made to manufacture the defensive weapons aiming to equip military men and troops after a standard with naval service weapons. (see chapter V)

Following the descending situation of the war, the anxiety against gas warfare increased, then it was planned to equip the civilians in navy employment with naval service weapons, but accomplished only partially for the expeditionary forces.

b. Offensive weapons. Before the war, in navy, the battle between fleets was concerned the most important matter, and then our plan on the retaliative weapons was only to prepare the small can packing lachrymator or sternutator for medium calibre gun, but the manufacture was suspended after about 30,000 cans were made, because the chance applying them would scarcely occur, nothing was packed in shell.

Following the progression of the war, the style of the battle was changed, and became as if a battle between air bases, then as the retaliative weapons, we desired to manufacture 100,000 H bombs, but actual manufacture was ceased because of lack of raw materials and others and of depression of air forces.

4. PRODUCTION OF THE CHEMICAL MUNITIONS

In manufacturing chemical weapons, the most part is occupied by defensive weapons and the other part incendiary weapons, smoke weapons and the least part gas weapons.

a. Defensive weapons. Masks, protective covers, protective suits, decontaminating materials, chemical detectors and apparatus for training etc., were contained and the most part of them were manufactured in 1944 (4-1944 - 3-1945). At the beginning of 1944 the importance of manufacturing these weapons was urged by the Naval Headquarters and then the amplification of their manufacturing capacity was planned and somewhat advanced but in 1945 because of frequent air raids, damages of factories and lack of raw materials canceled it. The maximum output of masks was about 100,000 monthly. Then to increase their outputs, other abundant substitute materials were used and methods of manufacturing were simplified.

On decontaminating materials. Bleaching powder (60% effective Cl_2) was the most important and its output in 1944 was 1,600 tons but in 1945 its production was restricted because of the lack of storing capacity of the naval ordnance depots.

b. Incendiary weapons. Phosphorus and special rubber thermate were the main incendiary materials used in this war.

On weapons. The 3 type incendiary shrapnels of large and medium calibre, 250 kg incendiary shrapnel bomb, 60 kg incendiary bomb containing pieces of special rubber thermate and the 4 type incendiary shrapenl and 30 kg incendiary shrapnel bomb containing steel pipe pieces filled with phosphorus were produced.

At the end of the war, their outputs were decreasing because of the lack of starting materials such as barium nitrate, magnesium, phosphorus, etc.

c. Smoke weapons. At the beginning of the war, about 1,500 tons of Oleum (or Oleum Chlorosulfonic acid mexture) was stocked for ship and airplane use, but it was scarcely used and its production since was almost zero. In 1945, as air raids became frequent and violent, Oleum had become used in large quantities for smoke screens against airplanes and then its production had been desired but the corrosion, aging of equipment and damages by air raids made its production almost impossible.

Other weapons such as smoke shells on land and sea, smoke floats, etc., were produced but also they were not used and estimated their values.

5. GAS WEAPONS. As war gases, lacrimators, sternutators and vesicants were manufactured to some extent but not to the full capacity. The manufacturing capacity and total amount produced was as follows:

WAR GAS	CAPACITY	TOTAL AMOUNT PRODUCED
Lacrimator (Chloracetophenon)	30 ton monthly	About 120 tons. The manufacturing equipment was turned into production of styrol resin in 1945.
Sternutator (Diphenylcyanarsine)	20 ton monthly	About 120 tons. Manufacturing capacity of intermediate material was about 10 tons.

Vesicants (mustard)	80 ton monthly from intermediate material	About 600 tons. Manufacturing capacity of intermediate material was 20 T monthly and was turned into ethylene-diglycol production in 1945.
Levisite	A small pilot plant	About 10 tons. For experiment

These irritants were filled in cans for shells and for bombs but shells and bombs were not accomplished and the manufacturing was almost stopped in 1944 and turned into production of styrol resin (material for electric detector)

Mustard bomb was manufactured in compliance with the request of Naval Headquarters at the beginning of 1944, but stopped at the end of 1944. The request was 100,000 bombs at first but changed to 60,000 later and 43,000 were produced and production was stopped.

The production capacity of intermediate material was insufficient and its amplification was difficult owing to the lack of necessary materials. At the end of 1944 by the order of naval General Staff, the equipment of intermediate material was turned into the production of ethylen diglycol (material for smokeless powder).

6. STANDARD OF EQUIPMENTS AND GENERAL SITUATION OF SUPPLY

At first we had the standard of equipment only for warships, and land forces were equipped after the example of warships. Warships and expeditionary forces were comparatively well-equipped though there were some exceptions.

STANDARD OF EQUIPMENT OF DEFENSIVE WEAPONS TO WARSHIP

Gas mask	Protective suits	Oxygen breathing apparatus	Detector	Decontaminating Agent No III Bleaching Powder	Decontaminating Agent No III CoL_4 + Cl_2
110%	3/100	3/100	3/100	1 Kg per person	About 80% of crew

Since it entered into the latter half of the war, enforcement of the gas protection for the land forces became very important problem and they were to be provided with protective suits, gas-proof cape and so on. These weapons had been supplied in proportion to the amount of store, at the organization of a new troop or at the departure for the front.

Following the situation of the war, it became necessary to provide defensive weapons to the internal forces like the expeditionary forces, so the standard of equipment was planned as the next table at the end of the war, and on the whole about 60% of them would be realized at the end of August. The amount of defensive weapons kept in the country are uncertain because of the errors and omissions of the reports, frequent changes of the organizations, detection by air raids and so on.

STANDARD OF EQUIPMENT OF DEFENSIVE WEAPONS TO LAND FORCES

Weapons	Gas Mask	Protective suits	Light suits Protective	Protective capes	No III Bleaching Powder	Detector
Line force & corresponding force	100%		50%	75%	2 kg per person	1 to ea Co
Rear-service force & corresponding force	100%		30%	50%	1 kg per person	Do
Auxiliary service (concluding force & civilian gas civilian mask) in Navy employment	100%			15%	Do	Indefinite

Concerning the offensive weapons, they were never supplied to the forces, and then no standard of equipment existed. Every weapons have been merely stored at the ordnance depots and the present amount is as follows.

STOCK-LIST OF GASES AND GAS WEAPONS

Place	Mustard Bomb	Canned gas for Med Cal Shell 4.7 to 6"	Gases			
			Mustard	Lewisite	Diphenyl Chlo. Arsine	Cyanarsinetophetone
Sagami Naval Arsenal (Samukawa)	314		42.5 T		23.85	1.00
Sagami Naval Arsenal (Hiratsuka)	17	1035	0.1	6.53	72.80	
Sagami Naval Arsenal (Nishiki)						39.00

Ominato	About	3,000
Kure	"	15,000
Oita (Yabakei)	"	5,000
Sasebo	"	5,000
Maizuru	"	5,000
Yokosuka (Ikego and Seya)	"	10,000 about 30,000

7. OUTLINE OF RESEARCH FOR CHEMICAL MUNITIONS

The research for chemical munitions in the Japanese Navy was commenced in 1923 at the Scientific Study Dept of Naval Technical Institute in Tsukiji, Tokyo. But the Great Earth Quake at Tokyo, Sept 1923, it was interrupted and then recovered slowly.

After then this research was transferred to Hiratsuka City, and in 1931 a part of the chemical laboratory was established, but there was not a valuable report, because of few estimate and personnel.

Since the Manchurian Affair in 1932, the estimate and personnel of the research was gradually increased, and in 1934 it was completed and named "Naval Chemical Study Department".

In May 1943 it was developed and named "Sagami Naval Arsenal".

During that period, at first the research was aimed chiefly for the gas protective equipments and next it came to the smoke weapons, also fundamental experiments of manufacture of poisonous gas and gas shells or bombs. After the China Affair the incendiary agents were researched. As the result of the research, the following chemical munitions are completed.

1. 2 type gas mask. 1927
2. 94 type anti-gas suit. 1934
3. Chemical Detector 1st type and 2nd type 1933
4. 93 type gas mask. 1933
5. 91 type smoke generator. 1931
6. Smoke candle. 1935
7. Smoke box. 1942

8. Gas can in the shell for medium gun.....1935

9. 60 kg gas bomb (17 kg of mustard gas is packed in it).....1937

10. Sea smoke shell.....1938

11. Ground smoke shell.....1939

12. Hand smoke bottle.....1943

13. Polysulfide rubber type incendiary agent for 3 type shell and incendiary bomb.....1942

14. Special red phosphor.....1943

15. Oxygen gas mask.....1937

16. Anti-gas cape.....1943

17. Illuminating shell and barrage shell for 8 cm dia trench mortar..1944

18. Igniter.....1944

19. Decontamination agent No. 1, 2, 3, 4.....1936
No. 5, 6.....1943

20. Chemical detector 3 type (for advanced base).....1943
4 type (test paper).....1944

21. Filtering protector (screening box).....1941

22. Fire extinguish agent.....1943

Other researching problems are as follows:

1. Research for new gases. Nothing was superior to the known gases.

2. New synthetic methods of producing poison gases and chemical agents.

a. Hydrogenation of acetylene.
b. Direct oxidation of ethylene.
c. Productive method of ethylene diglycol.
d. Productive method of stylene.
e. Fundamental experiments of these problems are completed.

3. Medical treatments for gas casualties are almost completed about known gases.

In the research following results are comparatively good and are applied for use:

1. Elevation of the filtering efficiency in gas mask.

2. Test paper for mustard gas is completed by the use of a dyeing material and dinaronine.

3. By the use of rubber and polysulfide rubber, plastic incendiary and smoke agent are completed.

4. Viscosity and persistency of mustard gas are increased by adding some synthetic resins.

REFERENCE: At the Chemical Experimental Department of Sagami Naval Arsenal, the following problems were researched besides the study of the chemical munitions above-mentioned.

1. Explosives and ammunitions for marine.
2. Anti-air balloon.
3. Rubber weapons.

9. CHEMICAL TREATMENT FOR GAS AND PHYSICAL SERVICE.

a. Method of treatment.

1. The outline of the investigation about the treatment. The investigation about the treatment for gas was commenced at 1922 with the beginning of investigation of the chemical munitions at the Naval Technical Research. At that time the investigations were so insignificant as the grade of making collection of the literature about the gas at the time of the First European War.

This investigation was interrupted by the Great Earthquake in Tokyo but was revived gradually later and the investigation institute was removed to Hiratsuka to continue the work.

Since 1930 a part of this investigation was the pathology and treatment of the gas disease at that time, and general treatment was found about 1936, and the set of the medicine and materials for the gas treatment had been made.

The investigation was still continued for the purpose of the improvement of the treatment and the materials up to the present.

b. The treatment of gas disease at present.

The several medical materials for every gas were selected as shown in the following table. In the table * symbol shows that materials added to the set of the medicine for gas treatment in 1944 and the usage of these materials stated in the booklet named "The instruction of treatment at the front" for the education of the gas treatment.

TABLE NO. 1. MEDICINE FOR THE GAS TREATMENT

(1) For Lachrymatory

1. 2% natrium bicarbonicum
2. 2% boracic acid
3. 1% chloramine T
4. Eye lotion (2% cocain-adrenaline)
5. Alcalic eye ointment

borax	1.0
nat. bicarbo	2.0
lanolin	10.0
aq. dest.	10.0
vaseline	80.0

6. Zinc sulphate
7. Ungentum hydrargyri flavum
8. Atropin
9. Argentum proteinicum

(2) For respiratory irritant

1. Spray (alcohol) 40.0
   chloroform 40.0
   aether 15.0
   ammonia 15.0
2. Inhalation tube of chlorine
   (Active carbon and chlorine)
3. Medicine A.
   (bleaching powder 1.
   talc) 9.
4. Zinc oil
5. Cod-liver oil

(3) For Lung irritant

1. Strophantin
2. Camphor
3. Coffeinum natrium benzoicum
4. Drugs of digitalis
5. Atmuratin (lobelinum hydrochloricum)
6. Codeinum phosphoricum
7. Carmotin (bromvalerylurea)
8. Gleran (mixture of aminopyrin and barbitar)
9. Insulin
10. Bursanol (choline preparation)
11. Paisiologic solution of NaCl.
12. Ringer-Locks solution

(4) For vesicant.

1. Medicine A. (bleaching powder 1
   talc 9
*2. New Medicine A. (CCl_4 97
   Cl_2 3
3. Medicine B (4% NaOH)
*4. New Medicine B (2% $AgNO_3$)
5. Medicine C. (glycerole paste of $FeOH_3$)
6. Medicine D. (a preventive; mastic gum and water glass)
*7. Medicine E. (chloramine T.)
8. $KMnO_4$
9. Rivanol
10. Cod-liver oil
11. A preventive for infection

mentholum	2.5
chloroform	8.0
oleum eucalypti	8.0
creosote	8.0
spiritus jodi	4.0
add alcohol	60.0

12. Solution of glucose
13. Vitamine B1
14. 5% natrium thiosulphate

(5) For systemic.

1. Lobelinum hydrochloricum
2. Camphor
3. Strophantin
4. Coffeinum-natrium benzoicum
5. Solution of methylenblue (1%)
6. Solution of Natrium thlosulphate (5%)

2. The Articles of treatment for Poison Gas.

a. The stock in Hospitals for supply (1945-6)

List of articles	No or quantity	No of men to be treated
Medical Pannier No. 1	883	44400
Medical Pannier No. 2	1292	32300

REMARKS: No. 1 contains the articles of treatment for ro men at one time, No. 2 contains that for 25 men.

b. Contents of Medical Pannier for Gas

	List of articles	Number or quantity No. 1	No. 2
	Cutter for phial	2	1
	cistern	2	
Fixtures	box	1	1
	can	5	2
	cylinder for medicines		1
	gauze-parcel	20	10
Supplies	blotting paper	10	5
	eye cup	4	2
	bandage	6	2
	kalium soap	10	2
	nat. bicarbo	16	1
	inhalation tube of chlorine	10	
	Medicine a.	5	2
Medicines	New Medicine A	5	2
	Medicine B	15	10
	New Medicine B	15	10
	Medicine C	6	4
	Medicine D	8	4
	Medicine E	6	3

c. Supplied articles of treatment for Fleet and Troops.

Details are not clear. Round number: for 100,000 men at one time.

10. COOPERATION BETWEEN NAVY AND ARMY

At the beginning of the investigation of the chemical munitions, navy and army cooperated very closely as to reach the european leavel. Afterward, when navy enforced the study in sea battle, the relation between Navy and Army became cool by and by.

Exchanging informations, however, was continued up to the present.

In the latter half of the war, most of our Naval forces fought on land, and then we were coordinated to Department of Army Education (Bureau of Chemical Warfare Education) and Kinashino Army School, and we studied much concerning the technical and tactical gas defense from Army. As to the tactical defense we take up "Annual of the Gas Defense" of Army, though unofficial.

APPENDIX CW 4

SUBJECT: Chemical Warfare

ORGANIZATION: Sagami Naval Arsenal Research Department

PERSONS QUESTIONED: Capt. Tsuruo - Chief of Research
Comdr. Kitazato - Naval Technical Department
Med. Lt Comdr. T. Takafuji - Treatment of gas casualties. Animal tests with new gases
Tech. Lt Comdr. Torigata - Defensive chemical warfare. Did research until July 1945 - then production.
Tech. Lt Comdr. T. Ishihara - General affairs, chemical analysis and defensive weapons.
Tech. Lt Comdr. H. Kuwabara - Development of gas, smoke and incendiary weapons.
Tech. Lt Comdr. K. Yoshida - Fundamental research, synthesis of new agents.

INTERVIEW: 28 Sept. 1945

MEMBERS OF SIS PRESENT: Major Howard E. Skipper.
1st Lt Gordon T. Wellis (FEAF)
T/4 Yagi

INTERROGATION

Q. How many and what type personnel were employed in the laboratory?
A. There were approximately 300 persons working in the laboratory, of whom 30 were scientists. Of those 30, 26 were Naval officers and 4 were civilian engineers, of the 26 Naval officers, 6 were Medical officers and 20 were technical officers.

Q. Where is the laboratory located?
A. Next to the Naval powder factory at Hiratsuka, Kanagawa-Ken (some 60 km distance from GHQ).

Q. How much of the laboratory installation was destroyed?
A. Two out of twelve buildings were burned.

Q. Are there any other Navy organizations engaged in chemical warfare research?
A. No. There are none. All Naval air force research is done by the Air Technical Department. (Dai ichi Koku Gijitsu Sho). Chemical warfare research for the naval air force is done for the Air Technical

Department by the Sagami Research Laboratory. Among the work has been research on and design of chemical and white phosphorus bombs.

Q. What channels were followed in instigating chemical warfare research for the air forces?
A. Original desire would initiate from the Air Technical Department, go to Navy Technical Department for approval and thence to the Sagami Research Laboratory for action.

Q. What research has been done on chemical bombs?
A. 7 or 8 years ago some bomb research was done (unspecified) and completed. Since then no work has been done on chemical bombs. Most recent research has been with portable smoke generators (30-40 kg) for large area screening both on land and at sea (Inspired by bombing of industrial districts). These generators dispense Oleum chlorsulfonic acid smoke.

Q. Who handled the field tests?
A. Lt Comdr. Kuwabara

Q. Have there been any static bomb tests made?
A. Three years ago some tests were run to determine ability to decontaminate area contaminated by bomb bursts.

Q. Has any work been done on determination of munition requirements for chemical bombs?
A. Yes. Before the tests were run, background material was obtained from Prentiss and German authors. Then 10 pure mustard bombs, each weighing 60 kg or 130 lbs., were dropped in an area 100 meters by 100 meters. The effectiveness of the vapor concentrations within the area was determined by the use of animals, detector paper, gas absorbers and vacuum bottle samplers. Such tests were run once or twice and from them it was concluded that 10 Mustard bombs per 100 meter square will produce an effective vapor concentration - for 2 or 3 days at 15° - 20° C and for 1/2 day at 30° C. Note: These tests were with pure mustard. Standard mustard filled bombs do not contain pure mustard, but mustard thickened with a synthetic resin. (Polyvinyl alcohol type)

Q. Where are mustard bombs stored?
A. At Seiya, Kanagawa - Ken. No other type but H stored here.

Q. What chemical artillery shells were produced for Navy?
A. Only shells of medium caliber (4½"-6") were made for chemical use. These shells contained only a small can of either sneezing or tear gas. No lethal agents were used. Cans of colored smoke were also used in shells for signaling purposes and identification of ack ack. (Note: These "cans" are actually small cans filled with agent, which are in-

serted in the hollow center of the shell in the position farthermost forward toward the nose. Behind it is inserted the bursting charge.

Q. What research was carried out on white phosphorus bombs and who did it?
A. Three or four years ago Navy Capt. Kizo Hiratsuka (now retired) developed the WP bomb, to be used solely for plane to plane bombing. The experiments were made at Hiratsuka. Field test, at which Capt. Hiratsuka was present, were carried out by and at the Air Technical Department (Isogu-Ku, Yokahama) (Note: The Air Technical Department was not destroyed in the bombing of Yokahama).

Q. What arsenals produced poison gas for the Navy?
A. Only the Sagami Naval Arsenal.

Q. How many new agents have been synthesized by the laboratory?
A. Roughly about 100. Capt. Hiratsuka worked on this 3 - 4 years ago and lt Comdr. Yoshida since then.

Q. For what purpose did the Navy use chloramine T?
A. Solely for personal decontamination.

Q. Was it ever tried for impregnation of clothing?
A. Yes, but it was found to be unsatisfactory with light, thin materials and the Navy had no heavy clothing. Lt Comdr. Torigata did the research.

Q. Were navy men trained to impregnate their own clothing with the chloramine T given them for personal decontamination?
A. No. Not enough chloramine T could be produced for that purpose.

Q. Who produced chloramine T for the Navy?
A. Mitsui Chemical Co. (Mitsui Kagaku Kaisha) located at Omuta, Fukuoaka, Kyushu.

Q. What disposition was made of the records of the laboratory?
A. They were burned at the order of the Navy Department on 15 August. Personal files were scattered all over when American infantry troops looted the laboratory on 15 September. These scattered personal files were then just gathered and burned. Some records were also destroyed when the two buildings were burned in incendiary bombing raids.

Q. What types of agents were used in testing canisters?
A. All types.

Q. Where is H produced?
A. Last stage production at Sagami Naval Arsenal. Thiodiglycol produced elsewhere.

It was requested that all data available be compiled on the following subjects in preparation for survey of laboratory to begin on Tuesday 6 Oct. 1945.

1. All toxicity data on agents synthesized.
2. Procedures of gas chamber testing and diagrams of chamber installations.
3. Complete data on chloramine T or chloramide protective clothing and protective ointment.
4. Complete data on field testing - procedures, results, conclusions.
5. Plans and diagrams of all offensive chemical weapons.
6. Complete data on treatment of gas casualties and research on which data are based.
7. Complete data on canister testing.
8. Procedures used in synthesis of agents.

APPENDIX CM-5

SUBJECT: Chemical Warfare, Japanese Airforce Research

ORGANIZATION: The 3rd Military Laboratory

PERSONS QUESTIONED: Major General H. Masaki - Chief, 3rd Military Laboratory
Major S. Kishimoto - Member, research staff 3rd Military Laboratory.

INTERVIEW: 30 September 1945

MEMBERS OF SIS PRESENT: Major Howard E. Skipper
1st Lt. Gordon T. Wallis (FEAF)
T/4 Yagi

General Masaki was asked to check for accuracy of the organizational chart of the Japanese Army previously drawn up by members of the 6th Military Laboratory for SIS. He verified its accuracy. He was then asked to prepare an organizational breakdown of the 3rd Military Laboratory.

INTERROGATION

Q. Where is the 3rd Military Laboratory located?
A. At Tachikawa, but it was burned in an air raid on the 1st or 2nd of April 1945. Destruction was complete.

Q. After the destruction, did the laboratory move elsewhere?
A. Yes, but the chemical warfare section was at that time no longer functioning.

Q. What, again, is the manner in which the 3rd Military Laboratory fits into the chemical warfare organization of the Army?
A. The 3rd Military Laboratory is the research laboratory for the Army Air force. Chemical warfare research as it pertains to the air force is part of it, but a very small part, and that part deals in the main with chemical warfare defense for the air force. The offensive research was limited to several types of incendiary bombs, one type of chemical bomb and one type of spray tank.

Q. When did chemical warfare research for the air force stop?
A. About two years ago. Research was felt to be complete.

Q. Did you expect the U.S. to use gas?
A. No, not really. There was a possibility, of course, but the Japanese air force thought it was ready in case it should come - ready from the standpoint of defense, not offense. The air force never intended, nor was it ready, to use chemical warfare offensively.

Q. How many types of chemical bombs do you have?
A. One type (50 kg type) with four fillings: H, CB, PS, & DC. HCN was tried as a filling but it flashed upon detonation so was discarded.

Q. Were chemical bombs filled with agents and stored ready for use?
A. For research and experimental purposes a few were filled, but whether or not any considerable quantities were filled for use is a question only the supply people can answer.

Q. Was the agent filled directly into the bomb casing or first into "cans" such as the Navy used for its shells?
A. It was filled directly into the bombs.

Q. Was H which was filled in bombs pure H or thickened H?
A. It was a mixture of H and L so it wouldn't freeze, but was not thickened. The 6th Military Laboratory did all the work with the agents themselves. The 3rd Military Laboratory merely took the agents and filled them into the chemical bombs in the way calculated to give the best possible results.

Q. Was the 50 kg type chemical bomb casing the same as the HE casing for that size bomb?
A. No, it was thinner (but didn't know exactly how thin). The chemical bomb casing was the same as that used for incendiary bombs.

Q. What types incendiary bombs did you have?
A. First, 50 kg yellow phosphorus bombs, which consisted of yellow phosphorus dissolved in carbon disulfide and that mixture soaked into pellets of crude rubber 5 cm in height and 2 cm in diameter. Also, 50 kg flame thrower fuel filled bombs. These contained scraps of cloth to improve the burning, and ignition was provided by yellow phosphorus. Also, 1 kg elektron (magnesium) bombs. There were no thermate bombs. Capt. Kamei will know more about incendiaries.

Q. Was the fuze used for chemical and incendiary bombs the same as that used for HE bombs?
A. Yes. We only had an instantaneous fuze, no delay fuzes.

Q. Did you have any spray tanks?

A. Yes, one, called the 50 kg type tank. It holds 20 - 30 liters of agent, and is a wing type tank. It's discharge line is opened by electricity. There is no air inlet, for we found that to be unnecessary. Further details we will have to gather together for a later date.

Q. Were there any special protective devices developed particularly for the air force?

A. Yes. There was an impermeable protective suit (pure rubber) developed for pilots from which the arms (and perhaps other parts) could be removed by the pilot in flight, when the need for protection had passed. This feature was developed because of the great discomfort of this suit when worn for any length of time at all. Another special piece of equipment was an extremely light weight gas mask for pilots. The canister was merely fastened to the front of their flying clothes. Then there was developed a gas resistant airplane covering, consisting of rubber covered hemp? This material was made in sections 5 meters square which could be fastened together to make a covering of any desired size. In addition to these, there were also a rubber apron to be worn by decontamination personnel, detector paper, and detector cloth. (General Masaki said that the detector paper and cloth were used very sparingly by the ground forces. Instead, they were for the especial use of the air force. He was not clear on why that was, will be questioned on it later).

Q. What protective equipment was issued to air force personnel in general?

A. Same as that issued to ground forces.

Q. What work was done on decontamination?

A. Nothing special which applied to air forces alone in the way of research. For airplane decontamination, plain water would be used. Runway contamination would be allowed to weather off if light. If heavy, a vehicle drawn slurry dispenser would be used. This consists of nothing more (as near as could be determined) than a funnel into which ready mixed slurry (carried in containers in the bed of the towing vehicle) would be poured and which would issue forth from a spray nozzle just above the ground. The capacity of this funnel is 1 cubic meter.

Request was made for submission by General Masaki of all information, specifications, and drawings relative to all CW weapons and munitions developed for the air force. Publications and other instructional material will be also furnished at a later date, and at this time further, more specific questioning will be undertaken.

APPENDIX CW-6

SUBJECT: Manufacture of Poison Gas

PREPARED BY JAPANESE ARMY CW PERSONNEL

DATE: 1 October 1945

PREPARED FOR: Scientific Intelligence Survey, GHQ, Adv Ech, APO 500

REQUESTED BY: Major H. E. Skipper and Lt Gordon T. Wallis

1. Manufacture of poison gases.

a. General Description. Manufacture of poison gases was taken charge of by the Tadanoumi Plant of Tokyo Second Military Arsenal and filling was the Sone Plant of the same arsenal respectively, but by no intention of offensive use, poison gases were keeping on manufacture at the minimum capacity in order to maintain the technical skill.

And since September of 1944, the manufacture was ceased and then the plants and filling equipment were gradually converted into explosive manufacturing and forming establishments. In current situation, as poison gas manufacturing equipments are taken to pieces or under desolution, they are not in perfect condition.

b. Manufacturing plants of poison gases.

Name	Service		Location
	Before Sept of 1944	Since Sept 1944	
Tadanoumi Plant Hiroshima Pref (40 mi fr Atomic Bomb)	Manufacture of poison gases	Manufacture of dinitro naphthalene and tetranitrate of penta erythritol.	Tadanoumi-machi Toyoda-gun, Hiroshima-ken
Sone Plant	Filling of poison gases	Forming of mixture of ammonium nitrate and T.N.T.	Kokura-shi, Fukuoka-ken. Northern part of Kyushu neer Moji

c. Capacity of poison gases manufacture and their formula before 1944.

(1) Tadanoumi Plant.

Name of Gases	Plant Capacity in t/month (not operated in full capacity)	Formula
Kii No. 1 (mustard gas)	200	French Process $S_2Cl_2 \rightarrow SCl_2$ $C_2H_5OH \rightarrow CH_2{:}CH_2$ $\rightarrow (Cl{\cdot}CH_2CH_2)_2S$ Meyer Process $CH_2OH{\cdot}CH_2$ $CH_2OH{\cdot}CH_2$ > S $\xrightarrow{HCl}$ $(Cl{\cdot}CH_2{\cdot}CH_2)_2S$
Kii No. 2 (Lewisite)	50	$+ H_2SO_4$ $+ NaCl$ $+C_2H_2$ $As_2O_3 \rightarrow AsCl_3 \rightarrow ClCH{\cdot}CHAsCl_2$
Aka No. 1 (Diphenyl cyanoarsine)	80	$+ NaHSO_3$ $+NaCN$ $C_6H_5AsC_6H_5 \xrightarrow{+HCl} C_6H_5AsC_6H_5 \rightarrow$ $\rightarrow (C_6H_5)_2AsCN$
Cha No. 1 (Hydrocyanic acid)	50	$NaCN \xrightarrow{H_2SO_4} HCN$
Midori No. 1 (Chlorcaceto-phenone)	2.5	$CH_2Cl{\cdot}COOH \rightarrow CH_2ClCOCl \xrightarrow[AlCl_3]{C_6H_6}$ $CH_2ClCOC_6H_5$ as Catalyser

Only one plant for manufacture of poison gas. HCN munitions for Army ground forces consisted only of glass grenades.

2. Supply of poison gases.

a. Quantity of poison gases in storage at Tadanoumi Plant.

(At present)

Name of Agent		Quantity in tons
Aka No. 1	(Diphenycyanoarsine)	1,000
Kii No. 1	(Mustard gas)	913
Kii No. 2	(Lewisite)	314
Cha No. 1	(HCN)	20
Midori No. 1	(Chloroacetophenone)	7

b. Quantity of gas shells in storage at Hiroshima Supply Depot.

Kind of Shell	Rounds classified by branch depots.		Total
	Hachihon matsu	Omine	
Type 91 10 cm. Howitzer	2214	5820	8034
Type 38 Field gun		20000	20000
Type 4 15 cm. Howitzer		8000	8000
Type 94 Morter		54098	54098
GRAND TOTAL	-	-	90132

Remarks:

1. There are many shells in Manchuria and Hokkaido, but not received detailed reports.

2. Percentage of shells is blister 70% to sneezing 30%.

3. All documents and reports were burned, so details are not clear.

c. Gas protective materials.

Materials	Supplied Number, classed by districts			
	Troops in			
	Mainland	Manchuria	China	South Seas
Decontaminating box (7 kg.) (Bleaching powder container) (hypochlorite)	200,000	60,000	10,000	100,000
Detector	12,000	6,000	1,000	10,000

Remarks: This indicates rough number.

APPENDIX C.-7

SUBJECT: Japanese Army Chemical Warfare, Storage of Agents

DATE: 1 October 1945

PERSONS INTERVIEWED: Lt Col Kamakami
Maj Satoshi Sasaki (of the 2d Military Arsenal, Tokyo; in charge of planning of manufacture of gas in Tokyo)
Maj Nagao

MEMBERS OF THIS SECTION PRESENT: Maj Skipper, Lt Wallis (FEAF
T/4 Yagi

Lt Col Kamakami was asked who in the Japanese Army was responsible for CW tactical doctrine. The only answer he would give was that this was the responsibility of the General Staff but who specifically he did not know. He was asked to inquire and give that information at a later date.

It was learned that there is only Army CW school. It is located at Narashino, Chiba Prefecture. This school is directed by Maj Gen TAKESHI YAMAZAKI. A small amount of field research is carried out at this school. The size of the school could not be given by the Japanese officers present. It was reported, however, not to have burned in the air raids.

Questions on storage of gas in the Tokyo area were answered as follows: There are no large quantities of CW agents stored in the Tokyo area. Some gas may be found at Narashino, and empty cases exist at the 6th Army Laboratory as well as some bulk agents. Information with reference to bombs must come from air force.

Concerning production and storage of agents at Tendaroumi, it was stated by Maj SASAKI that production was carried out at Tendaroumi (east of Mitsui). The agents were then shipped in bulk (25-30 gal. drums) to Some (east of Kokura) where they were filled into shells which were stored at Omani and Kacoikon matsu (northeast of Yamaguchi City). Col TAYAMA is head of the Hiroshima Supply Depot.

When asked if they know of a Japanese M7 bomb, the answer was no. They remarked, however, that this was a navy marking system.

A list of questions and requests for further information on numbers, types, fillings, location, and condition of chemical munitions was given Maj NAGAO at the request of Col KELLOG, 8th Army, for answer at a later date.

Request for history of flame thrower research and development was also made at this time.

CHEMICAL WARFARE, JAPANESE ARMY RESEARCH
6th Military Laboratory

DATE: 2 October 1945
INTERVIEWED: Maj Gen Kinsei AKIYAMA, Col Shinji ICHINO, Maj Kokuru HAGAO
INTERVIEWER: Maj H E Skipper

Maj General Akiyama, in answer to a question as to his military history, stated that in 1926 as a 1st Lt he had been sent to the 6th Military Laboratory. In 1933, he was posted to France where he studied CW in the French Army school (near Paris) until 1935. From 1935 to 1940 he was in charge of the Narashina Chemical Warfare School and at the same time concerned with research at the 6th Laboratory. In 1940 he took charge of the Chemical Dept of the Kwantung Army at Chichiharu in Manchuria. This is a subsidiary of the 6th Laboratory which acts as a school and a research laboratory.

General Akiyama has done nothing but work in Chemical Warfare throughout his career in the Army. When asked if there were other senior officers like himself who had devoted their whole time to CW, he replied that this was the case with Colonel Ichino (now Chief of General Affairs Section, 6th Lab), also Military Engineer Hayashi had been in this work for many years (21½ years).

When asked about his tour of duty in Manchuria, General Akiyama described the school at Chichiharu as consisting of about 300 persons, about 25 of whom were officers. The research program while he was there consisted of attempting to devise some simple methods of defense against chemical attack. It was necessary to improvise since very little was to be had in the way of equipment or materials.

A gauze-type mask was worked on which consisted of a thick piece of cloth impregnated with chemicals and with powdered, activated charcoal. This mask would protect against phosgene or mustard, and with zinc oxide added would protect against HCN. If used as protection against mustard, close-fitting glasses were also used. These glasses were made of paper cloth and exposed X-ray film or scrap glass.

When questioned on offensive studies carried out in Manchuria, General Akiyama said that trials with HCN dropped from planes resulted in most of the agent "dissipating upward" and led him to the conclusion that it was a difficult gas to handle. Questions and answers concerning this interesting subject are given below:

Q What bombs were used in the HCN trials?
A Type 100 fifty (50) kilogram bombs were used.

Q Did any of the bombs flash on explosion?
A General Akiyama did not remember any of them flashing. He stated that when HCN bombs are fired statically they usually flash, but when dropped from aircraft they don't flash. He could not explain why.

Q Could you describe the procedure and results of this HCN trial?
A An area 200 meters square was used, 80 bombs were dropped, the meteorological conditions were:

wind speed - 1/2 meter/sec
temperature gradient - (50 cm to 3 m) plus 0.3 °C inversion
air temperature - 15° C
area - open terrain

Q What CT's were obtained?
A CT 1,000 average over area was obtained (C_z concn. in mg/m^3; T_z time in minutes). It was pointed out that there were about 8 kilograms of agent in each bomb, but 30% of this was methyl-formate added as an antifreeze.

Q What do you consider the lethal CT for HCN?
A CT of 2,000 or greater.

Q What do you consider the lowest effective concentration for HCN?
A About 300 mg/m^3. This was determined on guinea pigs and is not really adequate evidence. It is used in calculations.

Q What are the lethal CT's for H, CG, and L? (LCt_{50})
A Mustard about 2,000, phosgene 2,000. Lewisite we don't know but guess about 2,000. It should be about 1,000 but is greater than that because of hydrolysis. The medical officers can help with this data.

Q What conclusions did you draw from the HCN trial in Manchuria?
A Conclusions were:

1. If you do not have a sufficient number of planes the HCN gas is not effective.

2. Climactic conditions must be ideal for use of HCN.

3. The number of bombs would have to be more than double the expenditure used in this trial to be effective (80 bombs per 40,000 sq meters).

4. Because of the small number of planes in the Japanese Air Forces it would not be feasible to use HCN in attack.

5. Although they could get high concentrations near the earth, the agent will not penetrate trenches and pillboxes unless excessively large numbers are used.*

Q Do you know of other trials with HCN?
A There have been many other experiments using 100 x 100 meter plots.

Q Could you describe some of these trials?
A In a group of three trials on an area of 1 hectare where 15 bombs were dropped per trial, it was found that the results vary greatly depending on meteorological conditions, especially wind velocity. If the wind velocity is less than 1M/sec the results are good; if the wind velocity is 2M/sec or greater there is quite a drop in effectiveness and if the wind speed is 3M/sec or greater, HCN is practically no good.

Fifteen bombs dropped on one hectare with a wind speed of less than 1M/sec resulted in an "average CT"** of 2,000 or greater.

Q How many samplers and animals were used?
A Thirty samplers of the accordion type.. 50 rabbits, 50 guinea pigs, and 50 doves.

Q What were the other meteorological conditions?
A Air temperature 10° C, inversion.

* This conclusion was based on HC smoke trials - not the HCN trials. Smoke source was considerable distance upwind so thermal effect could be ignored (so says Gen A).

** Japanese use grid system of sampling with 15-20 yds between samples. Extra samplers are sometimes put in the middle and outside the periphery of area.

Q Altitude of drop?
A 1,000 M (on different days). VOLUNTEERED: An arithmetic mean is calculated over the whole area. Contour lines for concentration-time dosages are drawn.

Q Do you also calculate percent of area covered by dosage greater than effective dosages (i.e. 2,000)?
A Yes, this is also done. VOLUNTEERED: It is believed that 100 kg of agent (HCN) will give a CT of 2,000 or greater for one hectare with a wind speed of less than 1M/sec. If the wind speed is 1½M/sec the munitions requirement is twice as much and a wind velocity of 2M/sec or greater is prohibitive. Gen Akiyama pointed out that there is disagreement on this point.

Q What have you noted to be the rate of action of HCN on animals?
A From 30-60 seconds.

Q Have experiments been carried out on CG?
A Yes, more than ten years ago in Japan proper. Six years ago in Formosa.

Q What is your opinion of CG as a war gas?
A Very low; it is too easy to protect against by use of the gas mask.

Q What were the conclusions on your CG experiments?
A 1. Because the specific Gr. is greater and more can be put into a bomb it is easier to attain the desired CT 2,000 in the field.

2. Has distinctive smell and is easily protected against.

3. Since Japanese soldier had masks, the principal danger was to civilians.

4. The gauze mask satisfactory for this purpose.

Q How good was your intelligence on Allied CW?
A Very poor; will tell you about Russian CW.

1. There was talk that the Russians were well prepared.

2. The CW Headquarters were in Moscow and a man named Fishman had been in charge.

3. 10,000 tons of agents per month probably produced.

4. Russians probably do not have any new agents.

5. It has been reported that the Russians have phosgene oxime.

6. Gen Akiyama had heard that the Russians were working on fluorine but was skeptical.

Q Had the Japs ever carried out field trials of HN compound?
A No, only vials full were made for animal tests.

INTERROGATION OF GENERAL AFFAIRS SECTION - Col ICHINO

Q What was the budget for the 5th Military Laboratory for 1945?
A For fiscal year of 1945, budget was ¥2,900,000, broken down as follows:

¥1,500,000 - salaries (civilian employees)
300,000 - General Affairs Section
450,000 - 1st Section (development of new gases)
350,000 - Takaoka sub-station of 5th Mil Lab
100,000 - 2nd Section
200,000 - 3rd Section

Q What has been the budget in past years?
A In 1926, the budget was¥250,000. It reached the million mark about 1935, was ¥1,500,000 for 1938, and grew to ¥3,000,000 in 1944.

INTERROGATION ON SPECIAL PROJECTS

NOTE: The officers in this group, by reason of the Army demobilization, no longer are assigned to the laboratory, but during the war they worked there on certain special projects. They were brought together to be interrogated on that work. Each wrote a report on his work in advance of interrogation. These reports are attached as inclosures to this report.

Smoke Candles - Lt Col Yoneichiro Iraoka (Sec. incl 1)

Q At what intervals were the screening smoke candles spaced?
A With a wind velocity of 2-3 meters/sec, the interval was 50 meters when wind was parallel to the line of candles, 20-30 meters when wind was perpendicular to the line of candles. Under ideal meteorological conditions, the interval could be increased to as much as 100 meters in the first instance and to 50 meters in the second. These candles were used at Okinawa, but supply was not adequate.

Q What was the size of the smoke particles from these candles (toxic smoke)?
A Mean size was 1 micron in diameter. Particles ranged from 1/3 to 2 or 3 microns in diameter.

Q Will the Japanese gas mask filter out these particles?
A Yes.

Q What work was done on irritant smoke?
A Work was done on it, but we were unable to penetrate the gas mask canister, so research was stopped.

Q Could you vary the smoke particle size?
A Not very successfully.

Q Was the irritant smoke candle thought to be an effective offensive weapon?
A Only when the victims were unmasked.

Q Was smoke candle ever made using DM?
A Yes. Ten years ago research with DM was carried out, but the smoke particles were too large and so too easily protected against. It was discarded.

Q For what was celluloid used in the irritant candle--a binder?
A It was used for producing heat with which to vaporize the smoke agent.

Q In screening smoke candles, using an HC smoke mixture, did you ever use elements other than zinc, such as lead, mercury, cadmium, aluminum, etc?
A No, only zinc was used.

Q Was the large sneezing candle the only one with the projecting feature?
A No; the screening smoke candle was also thus equipped.

Rocket-Gas Shell - Maj Yoshio Onisha and Maj Jirozaemon Takakuko

Q What is the composition of the G-1 powder which was used as the propellant charge?
A It was as follows:

Nitroglycerine -	30%	
Nitrocellulose -	65%	
Centralite -	3%	(ethyl phenyl urea)
Graphite -	2%	

Q What type of launcher was used for this shell?
A It consisted merely of two guide rails, weighing about 80 kg total. These guide rails were approximately 2 meters long and the distance between them was 15 cms. This whole project only reached experimental stage, so none was ever produced for operational use.

Q What type of fuze was used?
A Instantaneous.

Q Were there any other rockets developed for carrying gas?
A No. This was the only one.

Q When did this research begin?
A It ran from April, 1941, until June, 1945. It was stopped because of lack of powder and other materials.

Q Where was research done on Army HE rockets, and where were they produced?
A Research was done by the 7th Military Laboratory, production of shell body by 1st Military Arsenal, Tokyo; and explosive by 2nd Military Arsenal, Tokyo.

Q Did you ever obtain any information from the Germans on rockets?
A No.

Q Did you ever consider the use of hydrogen peroxide fuels in rockets?
A No.

Q Was this rocket to be fired singly or from multiple launchers?
A From multiple launchers of six sets of guides each. This, however, was only in the planning stage.

Flame Thrower Tank - Maj Setsunosuke Tanak (See incl 3)

Q How close to completion was the research on this project?
A The research was completed and one unit was made, but it was never used in combat.

Q What was used as a fuel?
A The fuel was diesel oil thickened with crude rubber. It had a specific viscosity of 30-60 (using water (1) as comparison).

Q Did you ever use aluminum soaps to thicken fuel?
A No.

Q Was thickened fuel used in portable flame throwers?
A Yes. It was the same fuel as used in this flame thrower unit.

Q Have you had any reports on American flame thrower tanks (as used on Okinawa and Guam)?
A Yes. At first they were very effective, but later a defense against them was developed. It was actually developed a long time ago and consists merely of using as a barrier anything that will deflect the flame away from direct contact with the body. So long as the flame does not come in direct contact with the body, everything is all right (meaning not quite clear, but Japanese appeared quite confident in his assertion).

Q When was work on this project (flame tank) begun?
A Three years ago. Lack of materials prevented manufacture. Research was completed at the end of 1944.

Q Could this unit be installed in any type tank other than the Type 97?
A No.

Q Did you ever use any soap thickeners?
A Household soap was used as a lubricator in flame thrower fuels, but not as a thickener.

Gas Fog Emitter - Maj Tanaka

Q What agent was used in this weapon?
A HCN.

Q How was the unit transported?
A On a 2-ton four-wheel trailer.

Q Were any of these units manufactured?
A Yes; one.

Q When was the research begun?
A About three years ago. It was completed at the end of last year. Lack of materials prevented mass production.

Q Were any field tests carried out?
A Yes; one. I will write it up (upon Maj Skipper's request).

Q Was the fog emitter considered to be an effective weapon?
A Yes; if it could have been produced in the desired quantities.

Q Was thickened fuel used in portable flame throwers?
A Yes. It was the same fuel as used in this flame thrower unit.

Q Have you had any reports on American flame thrower tanks (as used on Okinawa and Guam)?
A Yes. At first they were very effective, but later a defense against them was developed. It was actually developed a long time ago and consists merely of using as a barrier anything that will deflect the flame away from direct contact with the body. So long as the flame does not come in direct contact with the body, everything is all right (meaning not quite clear, but Japanese appeared quite confident in his assertion).

Q When was work on this project (flame tank) begun?
A Three years ago. Lack of materials prevented manufacture. Research was completed at the end of 1944.

Q Could this unit be installed in any type tank other than the Type 97?
A No.

Q Did you ever use any soap thickeners?
A Household soap was used as a lubricator in flame thrower fuels, but not as a thickener.

Gas Fog Emitter - Maj Tanaka

Q What agent was used in this weapon?
A HC".

Q How was the unit transported?
A On a 2-ton four-wheel trailer.

Q Were any of these units manufactured?
A Yes; one.

Q When was the research begun?
A About three years ago. It was completed at the end of last year. Lack of materials prevented mass production.

Q Were any field tests carried out?
A Yes; one. I will write it up (upon Maj Skipper's request).

Q Was the fog emitter considered to be an effective weapon?
A Yes; if it could have been produced in the desired quantities.

Q What was the range of this weapon?
A About 500-1,000 meters with large quantities of agent. Requirements were figured at 100 kg of agent per 100 meter^2. To cover a frontage of 1,000 meters in length, it is estimated that 10-20 tons of agent would be necessary at a range of 500-1,000 meters. This would mean from 20 to 40 fog emitters. The depth of coverage on the 1,000-meter frontage is not known--would depend upon the meteorological conditions. Frontal coverage is the only coverage we figured upon.

Q How did you determine the particle size which emerged from the nozzle?
A By using water in tests.

Q Could apparatus be used below the freezing temperature of WCM?
A We never did, but we could by using methyl formate as an anti-freeze.

Gas Sampling Equipment - Maj J Sakagami and Maj Shinji Iwata

Q What is the rate of flow through the bubbler?
A Three liters per minute.

Q How is it regulated?
A By the size of the mouthpiece on top of the bellows mechanism.

Q How long does the bellows apparatus operate?
A Thirty minutes.

Q What is the smallest quantity of agent which can be analyzed by the I Cl_2 method? (At this point Maj Hotta and Capt Muto, who worked on analysis of agents, entered the conference).
A 0.2 milligrams.

Q Did you ever use chloro platinate method for analysis?
A No; but we did for detection. We were trying to use it.

Q Have you ever used bromine?
A No.

Q Did you ever use bubblers for H instead of silica gel and absorb it in acetic acid?
A Yes; we used bubblers for H, but we absorbed it in alcohol. Silica gel tubes were used to absorb H in the field, because they are so easy to handle. But alcohol was much more convenient for laboratory work.

Q How many aspirators did you use in field tests?
A As many as 200 bellows mechanisms and over 1,000 bubblers. This many would be used in an area 200 meters x 200 meters. Interval between them would be 15-20 meters. Many such tests have been carried out.*

Q What was the purpose of these tests?
A To gather numerical data on diffusion constants. To test meteorological conditions, topography, etc., as they affect the use of gas.*

Q What was the rate of flow through the electrolytic sampler?
A Four liters per minute.

Q On what agents was your diffusion work based?
A On CG and HCN, and mostly on the latter.

* At these points regrets were expressed on the loss of all the data occasioned by burning of records, 15 August 1945.

SUBJECT: Chemical Warfare.
PLACE: The 6th Military Laboratory, Special Weapons.
DATE: 3 October 1945.
INTERVIEWED: Maj. AKIO SATO) Anti-Tank Weapons
Lt. TOMOKUNI MITSUISHI)

Col. SHINJI ICHIKO) Chief, General Affairs Section
INTERVIEWERS: Maj. Howard E. Skipper, 1st Lt. Gordon T. Wallis (FEAF)
T/4 Yagi.

INTERROGATION

1. "Chibi" Glass Ball - HCN. Maj. SATO and Lt. MITSUISHI.

a. This anti-tank weapon, a glass flask weighing about 500 grams and containing 200 grams of HCN is designed to be thrown by hand at a tank from a distance of not more than 5 meters (for accuracy). It is aimed high up on the turret, and when it hits, it shatters and the agent runs down the side of the tank, vaporizes and enters the tank through gun ports and vision ports.

b. It is designed for a 15 ton tank, because the concentration which can be built up within a tank is not sufficiently high for a larger tank. As a matter of fact, Maj. Sato said, the concentration built up within a 15 ton tank is often not sufficient. He spoke in terms of a ct. of 2000 being possible and as being the desired ct., but he indicated that this was often not achieved. Ct. 3000 was considered very good, the usual ct. possible was less than 2000.

c. Fifty grams of methyl formate is used in these grenades as anti-freeze. Powdered copper was used as a stabilizer originally and later arsenic trichloride, which they found to be better because it mixes more homogeneously.

d. The grenades are carried, two per man, in cardboard containers filled with sawdust and slung over their shoulder with a strap.

e. Maj. Sato said that the Japanese also had worked on a smoke filling for these grenades - 250 grams of Ti Cl_4 - 50%. The Sn Cl_4 - 50%
purpose of these grenades is to blind the driver and allow other weapons to come into play.

2. Maguku Dan - Non-explosive shell. Maj. SATO and Lt. MITSUISHI.

a. For greater range (200 meters) and for use against larger tanks, there was developed an ' cm. recoilless gun (weighing approximately 80 kg) to fire a 4 kg. finned, non-explosive shell filled either with HCN or smoke. This shell contained no explosive. The body was made of soft steel which fractured upon impact with the tank.

b. The gun was not rifled. The breech end of the barrel was closed by a metal resisting plate and a sand bag, both of which were

placed inside the barrel tube and both of which were thrown about 100 meters to the rear when the gun was fired. This base ejection provided the recoilless feature.

c. The gun was still in the experimental stage. Work was started on it in Sept. 1944 and Major Sato figured it would have taken six more months to complete the research. At the present stage in its development, it was mounted on rails to test the recoil, but it was designed to be carried by soldiers and mounted on a tripod. There was to be only the one caliber.

d. This weapon was field tested against stationary tanks with their motors running. When good hits were obtained, ct's of 5000 to 6000 were obtained inside the tanks. They were well satisfied with results and felt that the weapon would have been a very effective one when finished.

3. Gas shells and bombs. Col. ICHINO.

Q. Were any of the agents thickened which were filled in shells and bombs?
A. No. Mustard was mixed 50% - 50% with Lewisite, however.

Q. Was the construction of gas shells different from that of high explosive shells?
A. No. It was the same casing.

Q. Did H ever flash when shells detonated?
A. No, but I have seen it burn experimentally when a bulk container was exploded.

Q. How did you store H?
A. In 100 kg steel containers (similar in appearance to our 55 gal. drums). There is one large container (50 tons) at Tadanoumi, but that is not portable.

Q. Did you ever notice precipitation of S in shell and effect on ballistics?
A. Used thiodiglycol Mustard, hence no precipitation.

Q. Was all Mustard made by the thiodiglycol process
A. No, some made by French process, but it was re-distilled.

Q. In field trials you have carried out, have you ever noticed tree bursts?
A. Yes, in trials we carried out in Formosa, we had tree bursts. To correct this, time fuzes were used.

Q. Did you ever have any decomposition of Mustard-Lewisite in shells?
A. No.

Q. Is French process mustard re-distilled after it has been produced?
A. Yes. The re-distilling process was started about ten years ago. Before re-distillation, Mustard is 70-75% pure, afterwards 95% pure.

All of our Mustard now in existence has been re-distilled or is thiodiglycol Mustard.

Q. Will you give me as many particulars as you can on these Formosa tests?

A. There were some 12 - 13 officers, 100 NCO'S, 2 batteries of mountain artillery and 2 or 3 airplanes. Both shell and spray trials were conducted. As regards spray, in answer to detailed questions, Col. Ichino gave the following information. The spray tanks (50 kg type) carried 30 kg. of agent (pure H). They were trying to determine the best altitude from which to lay vesicant spray, so the airplanes flew at various heights. The lowest altitude was approximately 80 meters, but they decided that best results could be obtained at 100 - 200 meters. Col Ichino said they really hadn't done enough work to say for certain just what the best altitude for spray is, but he would place it at 100 meters - no lower, certainly. 5 gms/m^2 was considered to be an effective liquid concentration in these tests. He didn't know what figure for effective vapor concentrations. Both vapor (bubblers) and liquid (paper) samplers were used. Japanese soldiers volunteered to walk through contaminated area to test protective clothing.

It was requested that a detailed report of these tests be drawn up. Colonel Saeki will do this.

RESEARCH OF GAS SHELL

Research period: 1923 to 1940

Research men: Major Idogaki (1923 - 1935)
Col. Ichino (1926 - 1940)

Kind of and data on gas shell

Kind of shell		Amount of filling kg	Amount of burster	bursting charge	Total weight kg
7.5cm cannon	Yellow	0.800	70	picric acid	5
	Blue & white	0.800	70	picric acid	5
	Red	0.150	250 ?	TNT 80% naphthalene 20%	5
10 cm cannon howitzer	Yellow	2.0	140	picric acid	10
	Blue & white	2.0	140	" "	10
	Red	0.4	700	TNT 80% naphthalene 20%	10
15 cm howitzer	Yellow	5.0	350	picric acid	32
	Blue & white	5.0	350	" "	32
	Red	1.0	1,500 ?	TNT 80% naphthalene 20%	32
	B Brown	2.5	350	picric acid	30
9 cm mortar	Yellow	0.9	160	picric acid	6
	Brown	0.4	160	" "	6
	Red	0.2	400	TNT 85% naphthalene 20%	5.5

Notice:

1. This data is remembering number and not accurate.

2. Symbols of gas shell.
   Yellow shell ---- yeperite 50% - Lewisite 50%, no thickeners
   Blue & white shell --- Phosgene 90% - trichlorarsine 10%
   Red shell ---- diphenylcyanarsine
   Brown shell ---- hydrocyanic acid.

STRUCTURE

For the blue and white, yellow and brown shells, indentical bodies filled with different gases were used. Its structure is as shown in Fig. 1, made especially so as the use of identical shells may be possible. The Red shell has a special structure as shown in the Fig. 2, and the amount of bursting charge are very large. Consequently it is something like a gas shell, which preparation being not easy. An instant bursting fuze is used. Bakerite varnish is painted inside the shell but we think it useless. The most important problem is whether it is "gas tight" or not, and for thread lead packing is used but is not perfect. Elastic materials or taper screw shows better result.

So as not to be filled up by the ascension of the temperature they hold the following portion of empty space.

Yellow	8%
Blue & white	12%
Brown	15%
Red	5%

This space is sufficient even when the temperature rises to 60° C.

FUNCTION

The object of the yellow shell is the infection of the field area and the poisoning of human beings and animals. For the latter purpose the quantity spread as liquid drops are 30% of the total yperite and 50% are scattered as mist or gas, and 20% deposits inside of the shot hole. The more charged powder used the gaseous portion increases and the less charged powder used the quantity deposited in the soil increases. 7% of the lethal material is the most effective quantity of the charged powder. The blue and white, brown which are suitable for gaseous material are used for the purpose of attaining intensitive effective mortality but in order to make it similar with the yellow shell the scale of the shell and the bursting powder are considered with them. The addition of trichlorarsine to the blue and white shell is to make the observation easy. 2% of copper dust are added to the brown shell as stabilizer of the prussic acid, but while preservation, explosion took place sometime, the reason being unknown. Previously we had an idea of breaking of the mask by the red shell but found it impossible due to the improvement of the technique of filtration of smoke.

The gas decomposes and becomed uneffective when T.N.T. or picric acid are used in the charged powder, because when explosion velocity is high the degree of decomposition becomes large. Naphthalin is added to prevent decomposition for the purpose of reducing the explosion velocity, but decomposition still goes on. There are about 10% of diphenylcyanarsine in the generated gas, 90% being decomposed. The reason of decomposition is unknown.

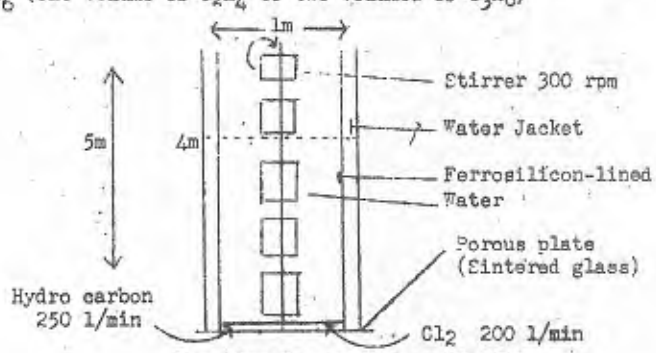
APPENDIX CW 10

SUBJECT: Chemical Warfare, Production and Plant Chemistry
DATE: 3-4 October 1945
INTERVIEWED: Maj Gen K AKIYAMA, Military Engr S HAYASHI, Military Engr M TAKEUCHI, Maj K NAGAO
INTERVIEWERS: Maj H Skipper, Lt Gordon Wallis (FEAF), Tec 4 Yagi

Engr Takeuchi was asked to describe the procedure used in manufacture of "anti-freeze" mustard.
The method was given as follows:

Coal gas —liquification→ H_2 (40-50%)
Hydrocarbon (2-4%)

Of the hydrocarbons produced, approximately 50% consisted of C_2H_4 and C_3H_6 (one volume of C_2H_4 to two volumes of C_3H_6)



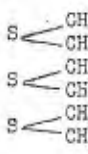
Reacting temperature: 20-25°C
Reacting time: 10 hours
Concentration of chlorohydrin produced: 7-8%
Volume of reactor: 4 cu meters
F.P. -35°C
Effectiveness of H 75%

The excess HCl is neutralized with sodium carbonate.

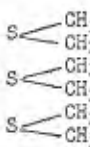
ClC_2H_4OH and ClC_3H_6OH-(7-8%)
HCl (3.5%)
Cl_2 Trace
ClC_2H_4Cl Trace
$+ Na_2CO_3 \rightarrow$

NaCl and impurities which settle to botton of reactor.

Chlorohydrin from ethyl alcohol and from coal gas is mixed in equal portions and reacted with Na_2S (5% excess used) giving:



Chloronation of the above is accomplished using 36% HCl (1 part of the thio alcohols to 4 parts of HCl by volume). The final mixture consists of:



On further questioning it was found that:

a. The purpose of the porous plate shown above is to produce small bubbles of gas for quick reaction.

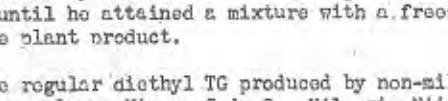
b. The reactor discussed is used in the Mitsui Chemical Industry Co., Omuda Fukuoka Pref., Kyushu, where there are about five such reactors. The plant is set up to produce about one ton of propylene thio-alcohols per day. It is the only one producing the thio-alcohols for propylene mustard.

c. It was estimated that 10 tons of agent a day could be produced by the coal gas process if raw materials were made available.

d. There are more than 50 bbls of this agent at the Tandanoumi plant.

When asked how he had been able to determine analytically the presence of the different constituents in propylene H, Engr Hayashi stated that he had not been able to fractionate the mixture and had to be content with synthesis of the three agents and variation in reconstitution until he attained a mixture with a freezing point equal to that of the plant product.

Q Is the regular diethyl TG produced by non-military industry?
A Yes, one place--Nippon Soda Co, Nilongi, Niigata Pref.



Research was carried out in an attempt to obtain a method of production which would minimize the yield of (b) and (c) above. First, an additional step was used:

$$(ClCH{:}CH)_2\,AsCl + AsCl_3 \xrightarrow[cat.]{Reduce\ Fe} 2ClCH{:}CHAsCl_2$$

It was found later that the secondary step could be eliminated if a Cu_2Cl_2 catalyst were substituted.

STABILIZATION OF HCN. Cu powder was used at first (cu gauze or wire equally as good); however, this was not entirely satisfactory because it settled out.

Q Would you explain the chemistry involved in stabilization of HCN with Cu?

A This was studied but no satisfactory answer obtained. They simply tried many materials and Cu seemed best. He supposed HCN "spoiled" by polymerization. Alkali materials "spoil" HCN. Magnesium cement MgO + $MgCl_2$ mixture or phenol resin produced by alkali process both "spoil" HCN.

Q SO_2 has been mentioned as your present stabilizer for HCN. How is it added?

A NaCN (saturated) + H_2SO_4 (50%) ---> HCN
$NaHSO_3$ (5%) ---> SO_2(2%)

It was noted that HCN containing 2% SO_2 did not polymerize in the condenser as had previous runs of HCN.

Q Did bombs or shell filled with SO_2 stabilized HCN sometimes explode?

A Yes.

THICKENING OF H. It was stated that the Japanese Army had done nothing on thickening H.* When they were told that the Navy CW laboratory had developed a thickener for H bombs they appeared surprised and then began to laugh. They said the Navy had asked about that problem of them one time, but never mentioned having developed a thickener. Gen Akiyama stated that the Navy Laboratory were "students" in CW research. The Army lab had carried out experiments 6-7 yrs ago on mixing H with different oils in an attempt to make it more persistent. This had been unsuccessful. This work was done by Maj Gen Hiramatsu (now in Manchuria).

*They were curious as to why other countries were interested in this problem.

Q Did you attempt to float H on water?

A Yes, 1st Lt Kitahara worked on this problem last year but did not get very far. It was just in the beaker stage.

ANTI-FREEZE HCN

A How was the methyl formate added?
A It is added directly after synthesis of the HCN.

Q What amount?
A 30%; this lowers the freezing point to 25°C.

Q Is this the eutectic?
A Yes.

Q Were many munitions filled with antifreeze HCN?
A At first they planned to put antifreeze in all shells, but later decided it was not worth while unless the agent was to be used in cold climate (30% wasted volume).

Q How about production of the formate-HCN shell?
A All early shells are so filled. Stopped such filling 3 years ago. Will find both types of shells in depots.

Q How about HCN bomb?
A The General did not believe many bombs had been filled with HCN.

Q Was methyl formate used in "Chibi" (glass ball) bombs?
A Yes, in all produced.

Q Do you consider HCN shell more effective than bombs? (Gen Akiyama)
A About the same. Vapor from airplane bombs probably rises higher, hence we would probably have to use more airplane bombs on a weight agent basis. Because the Japanese had few airplanes and cannons, most emphasis was put in production of Chibi bomb carried by the soldier. This had the advantage of requiring no steel.

Q How many were produced?
A Slightly greater than 100,000.

Q How did you attempt to set up low vapor pressure agents in the field?
A (Gen Akiyama) By means of candles and the shattering effect of bursters in shell.

The list of new agents synthesized and tested biologically is listed below with comments of Engr Hayashi*:

*This list had been requested at an earlier meeting.

1. INORGANIC COMPOUNDS: BrF_3, BrF_5, H_3As. $HSiCl_3$, $Fe(CO)_5$, $Ni(CO)_4$. The fluoro-bromides had the interesting characteristic of setting fire to organic materials with which they came into contact, but the 6th Lab. could visualize no military use for the compounds. Arsine was not considered worth while because it requires a high CT to be effective.

It does penetrate the mask to some extent. The Japanese were very interested in Arsine because they had large quantities of Arsenic.

Q Were field trials carried out on arsine?
A No.

Q Were trials carried out in attempt to set up arsine by dropping magnesium arsenide in wet places?
A Yes, this was tried with calcium arsenide but it was not feasible because of the large quantities required to set up an effective CT.

Q Did you carry out experiments on the metallic carbonyls for purpose of mask penetration?
A Yes, but decided that it required so much that might as well use some better agent.

2. ORGANIC HALOGENS: CH_3Br, $ClCOOCCl_3$

$(COCl)_2$

None of these agents was thought to be of military value.

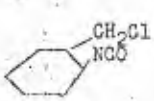
3. NITRILS: CH_3CN, C_3H_7CN - no value

Q Were any other cyanides tested?
A Not to his (Hayashi) knowledge.

Q Was any work carried out on CNBr, CNF, CNCl or CNI?
A No.

4. ISONITRILS: C_2H_5NC

5. ISOCYANATES:

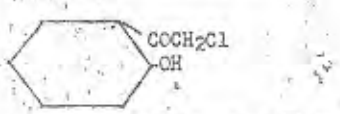


6. PHOSGENES: $COCl_2$, $CO(CN)_2$, $CSCl_2$

Dicyano carbonyl was very unstable. $CSCl_2$ had an LCT_{50} almost twice that of phosgene. It was remembered as about 5,000 mg mins per m^3.

7. MERCAPTANS: HSC_2H_5, $ClSCH_3$

8. Ketones: $BrCH_2COCH_2Br$,



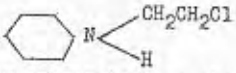
The chloroacetyl methyl hydroxy benzene was found to be twice as effective as CN as a lacrymator, but raw materials are too difficult to get in Japan.

9. ORGANIC SULPHIDES: $S(CH_2CHClCH_2Cl)_2$, $S(CH_2CHClCH_3)_2$

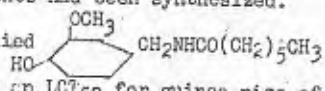
These compounds were produced several years ago by a Col Seitaro Yamaguchi who is now a Lt General. Yamaguchi is a pharmacist

and an MD and is now somewhere in Java. He was down south working on quinine.

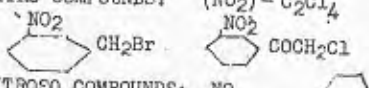
When the above compounds were first produced, Yamaguchi got some on his clothing and was burned rather badly and the agents were believed to be very vesicant. It was later found that they were not as effective as H.

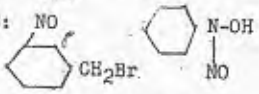
10. AMINES. $Cl_2NC_2H_5Cl$, $N(CH_2CH_2Cl)_3$, 

The nitrogen mustards (of which they appear to have studied only HN3) were found to be less effective than H and discarded. In answer to a question on field work with these agents, they replied that only small vials of the agents had been synthesized.

They had also studied 

This agent, they claim, had an LCT_{50} for guinea pigs of less than 50 (it is a lung irritant). When asked its toxicity to other species they replied it was not so great.

11. NITRO COMPOUNDS: $(NO_2)-C_2Cl_4$ 

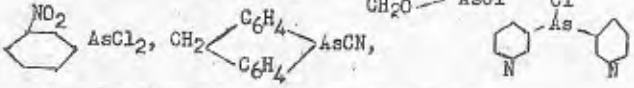
12. NITROSO COMPOUNDS: 

13. ORGANIC FLUORO-COMPOUNDS: $S(CH_2CH_2F)_2$

This compound was found to be unstable and to be no more effective than H.

14. ORGANIC METALLIC COMPOUNDS: $(C_2H_5)_3PbCl$, C_6H_5HgCl, $(C_2H_5)_2SbCl(C_2H_5)_3SnCl$. These agents were said to be of no value.

15. ORGANIC Se-COMPOUNDS: $Se(CH_2CH_2Cl)_2$
This was said to be less toxic than H and to have a very bad odor.

16. ORGANIC As-COMPOUNDS: 

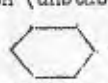
17. PHOSPHINES: $(C_6H_5)_2PCl$, $C_6H_5PCl_2$
These agents were said to be weak.

18. ALKALOIDS: Aconitin
mouse LD_{50} 0.1 mg/kg

19. PROTEINS: RICIN*. Mouse LD_{50} 0.1 mg/kg. Methods of extraction from castor bean had been studied.

*Both aconitin and ricin were studied for the purpose of poisoning darts; hence, the toxicity data by injection. When questioned on experiments with poison darts, they stated none had been carried out. When asked if small darts for airplane dispersal had been designed, the answer was no. They did say, however, that the civilian army along the coast and in Manchuria had prepared spears and darts of bamboo because they had no other arms. There had been no poison prepared for such weapons, said General Akiyama. Toxicity of these agents by inhalation had not been studied. When asked if research on poisoned bullets had been carried out, the answer was no.

20. OXIMS: $Cl_2C{=}NOH$ (unstable)



(ineffective)

Q Were there many other agents studied during the past 20 years?
A Yes, but these were the most interesting; hence, Engr Hayashi had been able to remember.

In a short conversation on the relation of certain molecular groupings to physiological action, Engr Hayashi stated that he was very much interested in this subject and had studied it for a long time; however, he had been able to come to few, if any, consistent trends. He mentioned a chart on this subject he had prepared and which was burned. he added that he was trying to find another copy.

Q Was any work carried out on Pb, Hg, Cd, or Pt compounds?
A None except that mentioned.

Q Were any high vapor pressure sulphides investigated?
A None.

Engr Hayashi next outlined what he considered improvements in plant processes with reference to chemistry.

a. Production of ethylene from ethyl alcohol. Use of Al_2O_3 instead of acid earth. Aluminum oxide has 20 times the life.

$$C_2H_5OH \xrightarrow[Al_2O_3]{Cat.} C_2H_4$$

The aluminum oxide (called alumina earth) is produced in a special way:

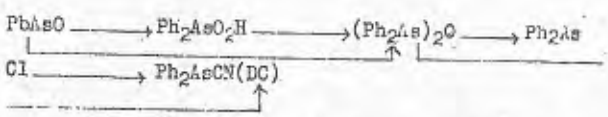
$$Al(OH)_3 \xrightarrow{H_2SO_4(50\%)} Al_2(SO_4)_3 \xrightarrow[50^{oo}]{NH_4OH}$$

$$Al(OH)_3 \xrightarrow{300^oC} Al_2O_3$$

The most important features in this process are said to be the use of 50% sulphuric acid and maintaining temperature of 50°C in the NH_4OH step. This method which was said to be a Japanese patent was in use in the production of thio diglycol.

b. A continuous chloronation process for converting thio diglycol to mustard was developed. Coils of glass tubing were used into which were fed HCl and TDG. This process was still in pilot plant stage--not used in production.

c. Production of diphenyl cyano arsine. The usual process is:



The Japanese, by a secret patent of the Jap. Army, were able to leave out two steps in the synthesis as indicated by above arrows. The principle was:

$$PhAsO \xrightarrow[PhAsO_3H_2]{H_2SO_4} (Ph_2As)_2O \xrightarrow[HCN]{\text{liquid}} DC$$

Reaction temperature for above is 180°C; reaction time 10 hours.

This method was said to work for other compounds of this type. It was still in pilot plant stage at the end of the war.

d. Production of HCN. The usual method:

$$NaCN \xrightarrow[H_2SO_4]{} HCN$$ Yield about 90%.

But due to lack of Na and Ni in Japan, other methods were studied.

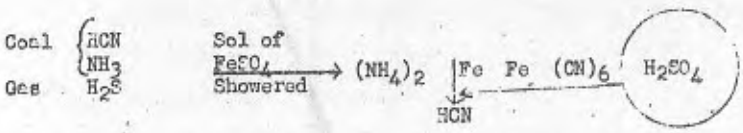
(1) $CH_4 + NH_3 \xrightarrow[ThO_2,\ 1{,}000°C]{Al_2O_3} HCN$ Yield 80% to NH_3.

(2) $CO + NH_3 \xrightarrow[600°C]{} HCN$

Al_2O_3 catalyst gave yield of 40% $(NH_4)_2SO_4$. $Al_2(SO_4)_3$ cat. gave yield of 70%.

(3) $C + NH_3 \xrightarrow{1000°C} HCN$. C= ordinary charcoal. yield 35% to NH_3; no catalyst used.

(4) Coal gas ——→ HCN. Recovery about 1 gram/cubic meter.



This ended the interview with Section 1. Engr Hayashi has been with the 6th Army Lab (CW research) for 21½ years.

Enclosure 1 to this report is Engr Hayashi's summary of the work carried out by the 1st Section and is titled: "Studies on the Synthesis of Poison Gases and Fundamental Studies of These Production."

STUDIES ON THE SYNTHESIS OF POISON GASES AND FUNDAMENTAL STUDIES OF THIS PRODUCTION

By Engr. Hayashi, 6th Mil. Lab.

Chapter I - Outline of the Development of Studies.

As Japan, having no experience of the chemical warfare in the First World War, had to develop quickly its chemical equipment to the level of the Great Countries and then had to complete his equipment fully, we had the purpose of studies as follows.

In the first step, we began to study about the production of phosgene mustard gas, chloracetophenone, benzylchloride, Lewisite and diphenylcyanarsine, which were regarded as principal poison gases in the end of the Great War. After the completion of these studies, we began to find new poison gases gradually, but estimating the shortage of these materials along with the expansion of Chinese Accident, we began to study the rational produce of above mentioned gases.

And the studies on production of the principal poison gases were begun seriously in the 15th Year of Taisho (1926), and were completed in the 7th and 8th Year of Showa (1932-1933); but the studies on non-freezing mustard gas and hydrocyanic acid were begun in the 7th Year of Showa (1932) and were perfected in the 11th Year of Showa (1936).

Studies of new poison gases were begun gradually in the 5th Year of Showa (1930) and done with all our might in the 10th Year of Showa (1935), but after the 16th Year of Showa (1941) changed our might to the studies on rational produce of gases.

The important results of these studies until late are as follows:

(1) Fundamental Study on Production.

Studies on the production of phosgene, mustard gas, chloracetophenone, benzylchloride, Lewisite, diphenylcyanarsine, non-freeze mustard gas and hydrocyanic acid have been perfected. We must mention specially in these studies that, the production of ethylenechlorhydrine which is the material of mustard gas, was done to react water with ethylene and chlorine, in the production of Lewisite used Cu_2Cl_2 as catalyst, in the production of diphenylcyanarsine used sodiumbisulphide instead of SO_2 in the reduction of diphenylarsenic acid, and the material of non-freezing mustard gas was non-pure ethylene in coal gas and it does not freeze at -35°C.

(2) Studies on New Gases.

The purpose of these studies as follows:-

(a) Strengthening the force of important known poison gases.

(b) Experimental studies of poisonous substances in data.

(c) Experimental studies of substances which may be poisonous on chemical composition.

We treated already about 1,000 substances, in which we found no superiority to above mentioned gases in results of poisonous test, but only the chloracetyl derivative of paracresol had twice stimulus effect in mucous membrane more than chloracetophenone.

(3) Studies on Rational Producing Process.

(a) In the case of preparing of ethylene from dehydration of ethyl alcohol in the producing process of mustard gas, we used catalyser made of active fuller earth but its activity was only about 50 hours. But we gained new catalyst of aluminum oxide of which length of life was about 1,000 hours.

The operation of changing to poisonous mustard gas from thiodiglycol was used in acid proof china or porcelain in the past, but we invented to operate continuously using with glass and wood which were easily made of and supplied.

(b) The second condensation process producing diphenylcyanarsine is very complex and bad yield, but we invented new producing method by thermal decomposition of phenylarseneous acid.

(c) Hydrocyanic acid was produced by sodium cyanide in the past, but we tried to study the synthesis of it perspecting of hard to supply sodium cyanide.

In the first place, we succeeded in the fundamental study which hydrocarbon and ammonia were reacted by new effective catalyst Al_2O_3-ThO_2 to hydrocyanic acid, and its yield was 80% against to ammonia.

Next, we succeeded almost in the fundamental study of preparing hydrocyanic acid with CO and NH_3 by the catalyst of aluminum oxide, of which hield was 40% against to NH_3.

(d) We cannot make light of hydrocyanic acid contained little in coal gas, so we tried to catch it out experimentally, but the end of the war came before the perfect fundamental study.

(4) Studies on Properties of Poison Gases.

(a) Hydrocyanic acid occurred to explosion occasionally by its chemical change in preservation, so we used copper as stabilizer to protect it, but we found SO_2 which superior to copper.

(b) Analytic photochemical study was not adopted as one method to detect poison gases.

APPENDIX C.-11

CHEMICAL WARFARE (PROTECTION)

INTERVIEWED: Maj Gen Akiyama, Col Hashimoto, and others of 2d Section

PRESENT : Maj H E Skipper, Lt Gordon Wallis, Tech 4 Yagi

DATE : 5 October 1945.

SECOND SECTION. Col. Hashimoto, head of work on protection, had been at the laboratory for 23 years (longer than anyone else in the organization). (See Inclosure 2 for the Second Section Report on Protective Equipment; Inclosure 3 for data on absorber for 99-type charcoal; and Inclosure 4 for information on Japanese gas detectors.

Q What type of protective clothing was issued to troops?
A Type 96, lightweight impermeable.

Q What sort of rubber was used in this suit?
A Natural rubber.

Q How long can it be worn under tropical conditions?
A About 20 minutes with coat; longer without coat.

Q If this is the limit of wearibility of your clothing, how had you planned to protect troops against H vapor?
A We had no solution to this problem other than ventilated gas-proofed shelters. Hoped by use of curtains to make shelters that would be gas-proof for an hour or so, after which time most of the gas would be dissipated. General Akiyama stated that the gas-proof shelters were all theoretical; no actual steps had been taken to assure adequate protection.

Q What would such shelters consist of?
A Simply gas-proof curtains over cave and pill box entrances.

Q What troops were provided with protective clothing?
A Most troops had trousers, boots, and gloves; however, only decontaminating units had complete suits.

Q. What work was carried out with impregnated clothing?
A. (See inclosure 2) Research on chloramine T was completed 2-3 years ago. Several score of suits were made for test purposes. Cloth, as well as chloramine, was scarce at that time; hence, none was ever produced.

Q. What dosage would the chloramine T clothing protect against?
A. As high as 2,000 mg mins./m3 resulted in no burns except at places of poor fit. They provided very effective protection. Penetration was noted after an hour's wear in high concentrations.

Q. Was it irritating to the skin if worn for considerable periods?
A. No, because an unimpregnated garment was worn next to the skin.

NOTE: There is (1) undershirt waterproofed with an Al soap and paraffine to protect skin from chloramine T; (2) gauze shirt soaked in chloramine T; (3) coat with hood; khaki cotton waterproofed to spread drops of liquid H for purpose of increasing rate of evaporation.

Q. Is the clothing impregnated immediately before use?
A. Yes, clothing is worn damp. The clothing loses its effectiveness when the clothing dries out.

Q. Could chloramine T be produced in quantities large enough to supply troop?
A. No.

Q. How long would it have taken to produce chloramine T clothing sets for the fighting troops?
A. About a year, if adequate quantities of toluene could have been obtained and the production hadn't been bombed out. However, if it had been produced there were no ships to carry it to the fronts. The ships that did get through had better carry food. There is no doubt the Japanese would have been in bad straits had gas been used, that is why we were so afraid of gas. (Gen Akiyama)

Q. How did you protect the foot from vesicant agents?
A. By use of a dubbin made of carnauba wax, beeswax, castor oil mixture. It was not adequate and was replaced by use of rubber boots when possible.

Q. Had you considered impregnation of clothing with activated charcoal?

A. Yes, Gen. Akiyama had been connected with considerable work on this problem in Manchuria. He believed it to be superior to chloramine T clothing and had recommended that a plant (in Manchuria) be improved so as to increase production to the point where charcoal could be used to make impregnated clothing. Only 80 gms of charcoal per suit of clothing was required. The General did not remember the details too well but stated that some sort of silk undershirt was impregnated with charcoal at 70-80° C (at this temperature, fibers melt and charcoal adheres to knots). Trousers used with this suit were rubber, impermeable or silk, charcoal impregnated. The work on this problem was carried out about 10 years ago. It proved to be a very effective clothing.*

Q. Have you ever captured the U.S. impregnated clothing?
A. No, have only seen pictures of it.

Q. Do you know what it contains?
A. No.

**The exact method used in preparation of the material is among the Japanese patents. The charcoal cloth doesn't irritate the body; it does, however, get it very dirty. General Akiyama said complete protection was provided for CTs of 2,000-3,000.

GAS MASK. (See Inclosure 3 for detailed filling and test data). It was stated that research on the present mask was completed about six years ago. It had been in production five years. The only change during this period was substitution of zinc and aluminum oxide for CuO which ran out. The new oxides were found to be much inferior.

Q. Have you carried out tests on captured U.S. canisters?
A. Yes. As concerns HCN, it is 2 to 3 times as good as the Jap.

Q. Did you determine why?
A. No, not exactly; it was largely because of its size. In tube tests there was little difference between American and Japanese charcoal.

Q. Tests on Russian masks?
A. Yes, it is still larger than the U.S. mask but its HCN protection is about the same.

Q. Did you ever use pyridine in canisters?
A. No, it is too irritant to the nose to be used in testing canisters.

Q. What effect does wearing of the mask have on the efficiency of the Jap soldier?
A. All depends on training; imperceptible if training adequate.

Q ere you able to produce as many gas masks as would have been needed in case of gas warfare?
A No; recently it had been impossible to equip all troops with masks.

Q as there only one type of mask in the field?
A No, there were two, namely: model 99 and model 01. There were many more of the former type. The 01 model was developed to conserve metal.

Q hat was the effect of equilibration of your canister to a high relative humidity?
A Short exposures to high humidity had little effect.

Q hat of use of the mask in high humidities such as are found in New Guinea? How does this affect protection against HCN.
A Not too greatly, since the oxidizing agent in the charcoal is still effective.

Q Do you think it is possible, without exorbitant expenditures of munitions, to break the gas mask canister under field conditions?
A General Kiyomi and others did not believe it possible.

Q ouldn't your fog emitter accomplish this objective?
A No. This weapon was developed for surprise.

Q Have you ever tested your canister against other agents such as ethyl bromide?
A No, our standard tests were with HCN, H, PS, CG, DC.

Q How about cyanogen?
A No.

Q Do you impregnate your particulate filter with anything to make it more effective?
A Talcum, zinc oxide, and congo red. This was copied from the Germans. It (congo red) does improve the filter a small amount.

Q How, and why, does congo red improve filter?
A Don't know how but it results in a filter which will take out more smoke and smaller particles.

Q Do you have any other protective devices?
A None, save the gas detector kit.

NOTE: See inclosure 2 for list of protective equipment.

Q What work was done on protective ointments?
A About ten years ago ointments were tested for protection of skin and legs of horses. Composition of ointment was chloramine T, zinc oxide, and a fatty oil base.

Q Did you find it irritating?
A Didn't test at high temperatures. Mostly on horses and they didn't complain. (It was said to be very irritating to the skin of man also) It was found to be of little use in protecting against mustard vapor; hence, no further work was carried out on ointments.

Q Did you ever capture U. S. M4 ointment with the mask?
A No. (apparently didn't know about it). (Had captured only the old style service mask--no light weight service had been investigated in the 6th Lab. They hadn't heard of this U. S. mask).

HORSE GAS MASK. This mask was of the "feed bag" type--very light, consisting of cloth bag with a rubber seal. It was soaked in a hexamethylenetetramine sodium carbonate mixture just before use. There were also horse leggings and a horse cape made of rubberized cotton.

Q Had you much horse protective equipment?
A Yes, horses at the front were provided with protective equipment.

GENERAL QUESTIONS.

Q What did the Japanese Army think of the U. S. 4.2 mortar?
A Never captured any so don't know anything about it. (Gen. Akiyama) hadn't heard any reports from the front on it.

Q What was the Japanese Army opinion of the flame thrower tank?
A It was extremely effective. Both officers and men were very afraid of this weapon. It did much against the morale of our troops.

Q What of the U. S. portable flame thrower?
A Gen Akiyama had never seen one but reports from the front indicated that it had a longer range than did the Jap flame thrower, and it was generally feared by the troops.

GAS DETECTOR FOR THE HEAD QUARTER

PURPOSE:

The purpose of this detector is to analyze chemical warfares, used or planned to use by the enemy, about captured samples.

CONSTITUTION:

This detector consist of several sorts of chemical reagents, a solid alcohol burner, test tubes and their stands, a canvas bucket, filter papers, gauze and so on. They are contained in a wooden carrying box.

Name of Chemical Warfares	Reagents (Principal)
Chlorine	KBr & Fluorescene (test paper)
Phosgene (mono, di, tri)	p-Dimethylaminobenzaldehyde, Dimethylaniline
Hydrogen arsenide	$AgNO_3$ (test paper)
Hydrosulphuric Acid	Pb-Acetate (test paper)
Phosgenoxime	Diacethylmonoxime (Dimethylglyoxime)
Chloropirine	Na-Ethylate (NO. This is detected by Griess-Ilosway's reagent)
Chloroacetophenone	$(NH_4)_2Sx$, HCL, p-Dimethylaminobenzaldehyde
Brombenzyl	Lachrymal character; Br detection by Fluorexene
Bromcyanbenzyl	$(NH_4)_2Sx$, (CN-CNS); Fluorescene (Br)
Adamsite	Guzeit's method (AS)
Diphenylcyanarsine	$(NH_4)_2Sx$, (CN-CNS); Guzeit's method (AS)
Diphenylchlorarsine	Guzeit's method (AS)
Yperite	Au-Chloride; KJ + $CuSO_4$ + Arabian Gum
Lewisite	NaOH ($CH_2$is produced, which is changed to Ag- or Cu- acethylide by ammonical soln. of AgNO, or Cu_2 CL_2
Hydrocyanic acid	$CuSO_4$ + Guaiac resin (test paper); Hopcalite
Ketone halide	
Ether halide	Alkali hydrolysis (HCHO, this is formed into red coloured C_6H_5 CHO with C_6H_5OH)

When we analyze practically a given sample, at first we must guess the name of the sample before chemical detection by comparing the sample with the above-mentioned chemical warfares about their some physical properties (for example colour, odour and so on) or knowing its other circumstances.

Then we analyze the sample chemically as the following order:

I. Test paper test about gaseous samples.
II. As detection by Guzeit's method.
III. Br detection by fluorescene.

We can guess more surely by the operation of II and III. Furthermore we must perform the detection individually about the guessed chemicals.

PROTECTIVE EQUIPMENT

1. GAS MASK. Type 99

a. Total weight: ca 1,300 gr

b. Absorbing capacity: ca 60 hrs for war gases (concentration 100 mg/m^3 $COCl_2$)

c. Use at cold climate.

(1) At below 0° C; applied antifreezing liquid (ethylene glycol and glycerine) and anti-clouding plates for eye glasses.

(2) At below -25° C; added to the above, the nose cover is used.

d. Use jointly the observing eyeglass for one who uses spectacles.

2. WATERPROOF ATTACHMENT FOR CANISTER. For landing operations use jointly on canister.

3. GAS MASK FOR CO. The canister contains Hopcalite and moisture absorbing agents besides ordinary absorbents. When the moisture absorbent became unavailable, the agent is to be changed. Hopcalite has the absorbing capacity to be able to renew 25 times of moisture absorbent, and absorbing capacity of each time is about 4 hrs; namely, the total absorbing capacity of CO is about 100 hrs.

4. GAS PROTECTIVE CLOTHING. Type 96, light.

a. Total weight: ca 1,200 gr.

b. Structure of stuff.

adhesive material { rubber / silk cloth / cellophane

c. Penetrating hours. (mustard gas, at 30°C) more than 24 hrs.

d. Consists of following four parts: trousers, pair of gloves, pair of overshoes; breast cover.

e. Protection of the chief part of body against mustard gas.

5. GAS PROTECTIVE CLOTHING: Type 96, heavy.

a. Total weight: ca 2,000 gr

b. Consists of following three parts: gas protective clothing, type 96, light; gas protective coat with a hood; a wrapping cloth.

c. Protection of every part of body against mustard gas.

6. GAS PROTECTIVE CAPE. Paper cape used for protection against blister gas sprayed from airplane. The material is made of paper coated with water-proofing agent such as cellulose.

7. HORSE MASK. Before using, soak into the following solution of absorbing agent. When the temperature is below -15°C, solvent is ethylene glycol instead of water.

Hexamethylene tetramine	80 gr
$NA_2 CO_3$	5 gr
Zinc acetate	10 gr
Salt	5 gr
Water (solvent)	1,000 lit

Absorbing capacity - it must be soaked in the solution at each use.

8. HORSE BOOTS. Protection of horse legs, the capacity is about 30 minutes.

9. HORSE CAPE. Protection against sprayed gas, the capacity is probably 30 minutes.

10. GAS PROTECTIVE CLOTHING FOR TROPICAL ZONE. a. Consists of the following six parts:

(1) A gas protective clothing - type 96, light.
(2) An undershirt - no sleeves
(3) Gauze shirt, with sleeves
(4) Coat with hood
(5) Wrapping cloth (carrier)
(6) Chloramine T box (chloramine T corresponding quantity to 100 persons)

b. Explanation of details.

(1) Gas protective clothing T-96, light - explained already in ordinary protective clothing, type 96, light.

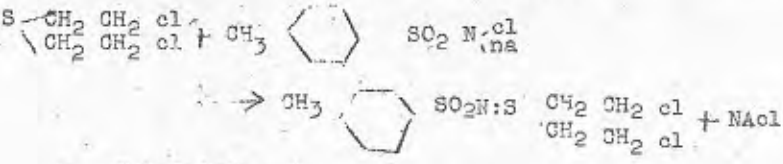
(2) Undershirt - khaki cotton cloth, water-proofed with Al-soap and paraffine. Use for protection of skin against the stimulus of chloramine T solution.

(3) Gauze shirt: gauze (3 layers) soaked into chloramine T water solution when it will be used. Use for protection from the vaporized mustard gas and Lewsite.

(4) Coat with a hood: khaki cotton cloth, water-proof, use for spreading drops of liquid of mustard and Lewsite in order to vaporize quickly.

(5) Wrapping cloth - same as the wrapping cloth of gas protective clothing type 96, heavy.

(6) Chloramine T box - same as box of bleaching powder type 95. Reaction of chloramine T and mustard gas is following:



c. Chief data.

(1) Total weight: 2 kg (take off chloramine T)
(2) Protecting ability: over 3 hrs
(3) Possible time of continuous wearing: over 3 hrs.

CW-11-10

ABSORBER OF 99-TYPE CANISTER

1. KATZURYU (ABSORBER FOR HCN)

Composition: (% in grams)

Copper oxide - 30) best ratio 70
Mangan dioxide - 7)
Calcium hydroxide - 20
Caustic soda - 5
Binding material (magnesia cement) - 5

2. ABSORBING POWER (breaking time) (tube tests)

	Concentration (%)	Breaking time (min)
CCl_3NO_2	0.5	3
$COCl_2$	0.5	35
HCN	0.5	600

3. ACTIVE CARBON

	Concentration (%)	Breaking time (min)
CCl_3NO_2	0.5	80-130
$COCl_2$	0.5	26-32
HCN	0.5	10

Conditions: Speed of flow - 1570 cc/min continuous
Temperature - 20° C
Humidity - 50%
Height of layer of absorber - 100 mm
Sectional area of absorber - 3.14 cm^{-2}

4. ABSORBING POWER OF CANISTER

a. Composition (% in volume)

(Katsuryu - 30%
(Active carbon - 70%

b. Absorbing power (breaking power)

	Concentration (%)	Breaking time (min)
CCl_3NO_2	0.5	20-26
$COCl_2$	0.5	18-23
HCN	0.2	12-16

cw-11-11

Incl 3
CWS-11-12

Conditions: Speed of flow - 30 L/min
Temperature - 20° C
Humidity - 50%
Height of layer of absorber - 40 mm

5. FILTERING POWER OF SMOKE FILTER

a. Composition

Egypt cotton - 62
Pulp (for artificial silk) - 3
Asbestos - 35

b. Filtering power

Talcum and ZnO

CONFIDENTIAL

Prepare this 6th Army Test

GAS DETECTOR

USE: 1. Finding of a chance to get off gas mask.
2. Identification of main poison gases.

CONSTITUTION:

Carring container	1
Rubber bulb	1
Detecting tube	Several
Detecting paper	Several

Contents and its functions.
Showed on the following table.

Names of Parts	Use, sensibility, change of color.	Constitution and reagents
#1 Detecting Tube	Used to get off mask for gases having no odour. $COCl_2$ 30 mg/m³ w. ⟶ y.	Glass tube. Test Paper ($(CH_3)_2N$⬭CHO ($(C_2H_5)_2NH$ (alcohol Sealed tube 5%$HgCl_2$ in alc. sol.
#4	H_3As 50 mg/m³ w. ⟶ y. - b.	Glass tube SiO_2 gel 2g 5% $HgCl_2$ in alc. sol.
#3	HCN 50 mg/m³ y.b. ⟶ d.bl.	Glass tube O-Tolidin) Alc. sol. $CuAc_2$) Sealed tube CH_3OH) C_2H_5OH) 0.15 cc.
#2	CCl_3NO_2 50 mg/m³ w. ⟶ v.	Glass tube Silica gel 2g ⬭(N)–OH 0.05g CH Sealed tube $(CH_3)_2N$⬭ 0.01 g Toluol 0.1 cc.

cw-11-13

CWS-11-14

Detecting Tube #5	$COCl_2$ 50 mg/m³ y ⟶ bl.v. - g.	Glass tube SiO_2 gel 2g $(CH_3)_2N$⟨⟩CHO 0.02 g Sealed tube $(CH_3)_2N$⟨⟩ 0.001 g Toluol 0.1 cc.
#6	Lewisite ? y. ⟶ r.	Glass tube SiO_2 gel. 2 g Cu_2Cl_2 < 0.1 g NH_2OH Sealed tube NaOH 15% aq. sol. 0.15 cc.
#7	N - yperite y. ⟶ r.	Glass tube SiO_2 gel 2 g Sealed tube NH_4BiJ_4 aq. sol. 0.15 cc.
Detecting Paper	Yperite, Lewisite, etc. (persistent gas) Red spot on yellowish green surface of detecting paper.	(Dithizon 1-2 g (ZnO 30 g (Yellow pigment 30 g (Talc 30 g gelatin water
Note	1. y: yellow, b: brown, bl: blue, r: red, v: violet, g: green. 2. alc. sol.: alcolic solution aq. sol.: aqueous solution	

OPERATION:

1. Finding of a chance to get off gas mask. To find a chance to get off gas mask, No. 1 detecting tube is used and operated as follows:

i) Colloidion film of the tube is broken and the sealed glass tube is snapped at neck (see fig. 3).
ii) The detecting paper in the glass tube is moistened with the reagents in the sealed glass tube.
iii) The right end (see fig. 1) of the detecting tube is inserted in a rubber stopper of a rubber bulb.

iv) The rubber bulb is operated by hand ten times and color change of the detecting tube is compared with the standard paper and the chance to get off gas mask is judged.

2. Identification of main poison gases.

i) For temporary gases (phosgene, chlorpicrine, hydrocyanic acid and hydrogen arsenide) To identify of main poison gases, we operate as follows:

No. 2, No. 3 and No. 4 detecting tube are fitted altogether to the rubber stopper as described above and operate rubber bulb. Kinds of gases are identified by colors produced.

ii) For persistent gases (except yperite) No. 6 and No. 7 detecting tubes are used. Two tubes are fitted to rubber stopper at right hand side of the rubber bulb (see fig. 2). Lewisite and N-yperite are identified by color changes.

CW-11-15

APPENDIX CW 12

SUBJECT: Chemical Warfare, 6th Lab Research Papers
DaTE: 19 October 1945
INTERVIEWED: Members of the Japanese 6th Military Laboratory, Tokyo.
INTERVIEWERS: Major Skipper(Sc & Tech Adv Sec) and Lt Wallis (FEAF).

Inclosed are several papers prepared by the Japanese 6th Military Laboratory for the Scientific Intelligence Survey Group.

Gas Effect Testing in Field of 50 kg HCN Bomb
(Colonel Ichino)

(This is not correct data, because the report was burned)

Objective:

Objectives of this experiment are to judge the value of use and to search the necessary number of bombs per one hectar (100 m x 100 m) to kill the man.

Date: June, 1938

Procedure of Experiment:

Number of bombers ----------	3
Number of bombs ----------	15 (each experiment)
Air area ----------	100m x 100m
Flying height ----------	1000m
Throw down distance----------	20 m
Beside distance of bombers --	30 m
Kind of bomb ----------	92 type 50 kg HCN bomb
Amount of fillings ----------	9 kg
Equipment for gas effect testing ---	Gas catch instrument and small animals (, rabbit, pigeon)
Times of experiments -------	3 times

Results:

Results of the experiments are shown as figures I, II, & III.

Conclusion:

1. When it will be thrown down 15 bombs for one hectar at the best condition of meteorology, the man and horses who are stay in this area are killed instantaneously.

2. The gas effect changes by the meteorological condition, especially it changes remarkably by the wind velocity.

View

It is difficult to use the 50 kg HCN bombs always, because the gas effect changes by the meteorological condition remarkably.

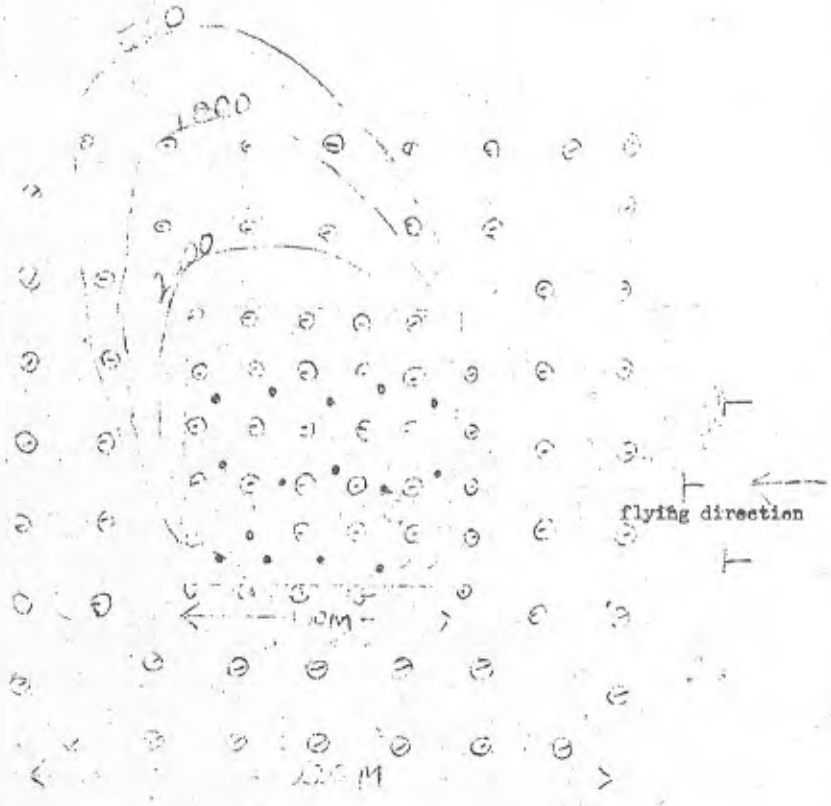


FIG. 1

Fig. 2.

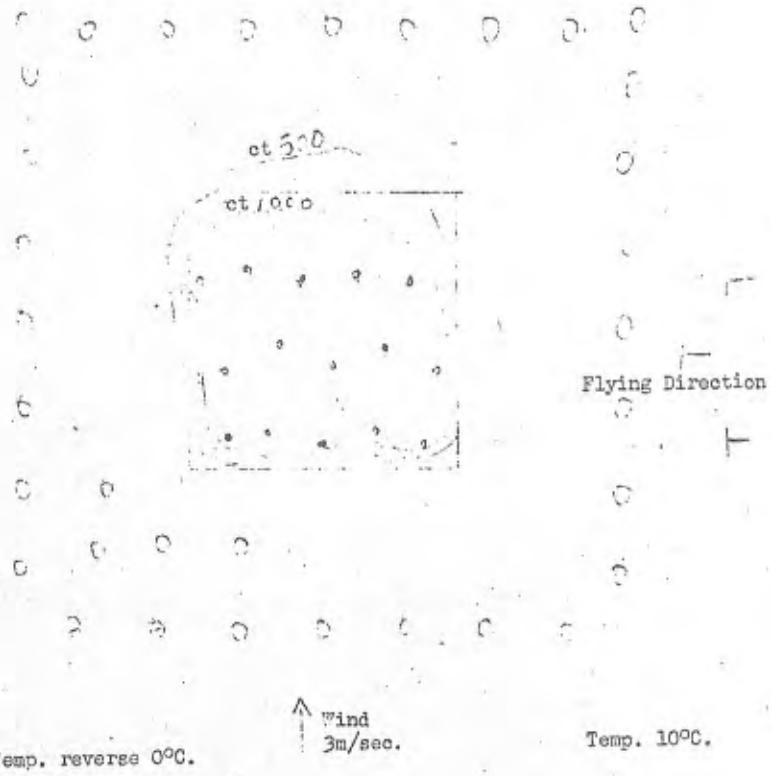


Fig 3.

ANALYTICAL METHODS

Maj. Katsuichi Hotta
Capt. Guichi Muto

A. Prussic Acid.

By Denigès' method: HCN is absorbed in 4% ammoniak and then the solution is titrated with $\frac{N}{10}$~$\frac{N}{50}$ $AgNO_3$ with 10% KI as an indicator until permanent yellow turbidity of AgI produces.

By Volhardts' method: HCN is converted into KCN by alkali and after adding an excess of $\frac{N}{10}$~$\frac{N}{50}$ $AgNO_3$, the solution is titrated back with $\frac{N}{10}$~$\frac{N}{50}$ NH_4 NCS with iron alum as an indicator until permanent red color produces.

B. Phosgene

CO Cl_2 is converted into Na Cl by 5% alcoholic alkali and then Na Cl is titrated with $AgNO_3$ by Volhardts' method.

C. Yperit (in gas state)

Yperit absorbed on silica gel is decomposed by alkali on heating and their Na Cl produced is titrated with $\frac{N}{50}$ $HgNO_3$ with diphenyl carbazone as an indicator until permanent pink color produces.

D. Yperit (in liquid state)

Yperit is extracted in C Cl_4 and then 2% I Cl - C Cl_4 solution is added to the extract. After standing for awhile, a little of concentrated H Cl is added to the mixture, and after shaking, purple red color of I_2 produced is compared with the standard colors which are prepared from known samples.

E. Diphenylarsine cyanide (in state of aerosol)

$(C_6H_5)_2$ AsCN filtered on a special paper is decomposed and oxidized by concentrated H_2SO_4 and 30% H_2O_2, and after 10% KI is added to the mixture, As_2O_3 produced is reduced to AsH_3 by H_2SO_4 and Zn. Hg Cl_2-paper is used for the determination of AsH_3.

FIELD ABSORBING MEDIUMS

H-Silica gel - alcohol (80%) Decomposed by Na No_3 neutralization tetration (phenoph ind.)

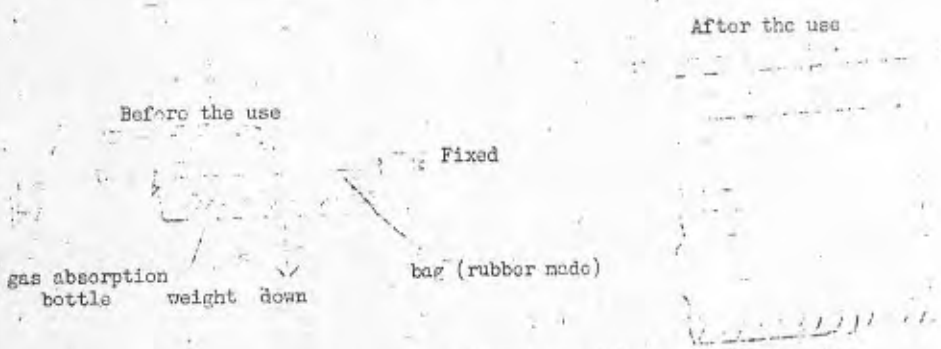
HCN - 4% NH_4oH ordinarily
2% Na oH in summer

Phosgene 2% Na oH sometines 40% C_2 H_5 oH

GAS SAMPLING EQUIPMENT
Maj. Shinji Iwata

1. Measurement of gas concentration in the field, total poisoning degree (ct)

Gas which flows at one point in the field, is caught by gas aspirator. Construction is shown below.



Gas aspirator consists of a rubber bag and iron weight. The bag is folded and the mouthpiece of the bag is connected to absorption bottle.

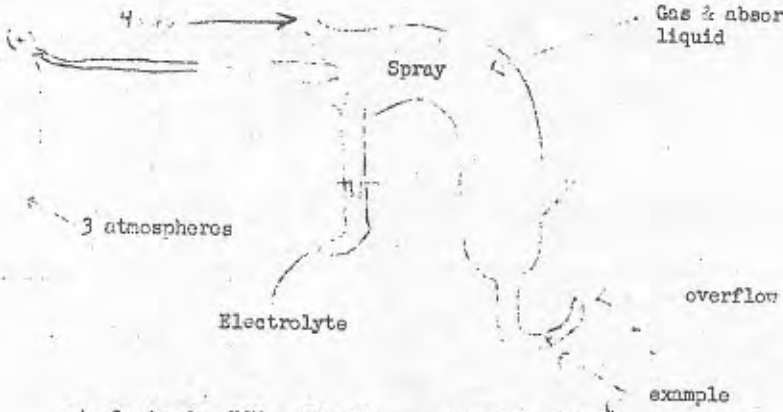
When the bag is stretched gradually, it produces a vacuum. Then gas is led from air. Gas is absorbed in the absorption bottle. Flow rate is 3 L per minute and it runs approximately 30 minutes.

2. Continuous gas-catching Apparatus Using Washing Bottles.

This apparatus is used to measure ct in every short time intervals. A cock with 12 outside mouthpieces and 1 inside hole is used, and, internal cock with one hole is moved from one position to the next intermittently. The time interval is regulated by a clock, several seconds to a few minutes.

Outer mouthpieces are connected to 12 washing bottles and one hole of the inside rotor is connected to gas catching apparatus.

3. Measurement of gas concentration of every instant, by utilizing of electric conductivity.



example

pt-electrode $\frac{HCN}{gas} + \frac{NH_4OH}{\text{Absorption liquid}} = \frac{NH_4CN}{\text{Measurement of elec. cond.}} + H_2O$

↓

A.C. bridge (balance method)

↓

unbalanced current

↓

amplifier

↓

milliammeter (self recorder with time)

↓

Calibration curve (before the use)

↓

Gas concentration

4L/Min

200 instruments in experiment. 200 x 200 meters (interval on grid 15-20m)

4. Absorption agent of gas in the field examination.
   (1) Yperit
       Silica gel
   (2) Diphenyl cyanarsine
       filter paper
   (3) Hydrocyanic acid
       ammonia in the absorption bottle
   (4) Phosgene
       alcoalic alkali liquid in the absorption bottle.

5. Measurement of sized of Yperit drops.

   Zinc oxide) mixture
   nigrocyne)

   Mixture is painted on a paper. If the drop of yperit falls on this paper, the black spot is produced. Size of the spot corresponds to the volume of yperit.

CONFIDENTIAL

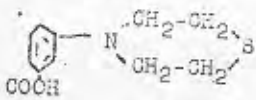
(The chemical reaction of the anthranillic acid-methyl-ester with dichlordiethylsulphide.)

I think the mechanism of the acute remedy for the skin of the ester is becaused by the under reaction.

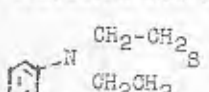
An alcohol solution of the ester reacts with dichlordiethylsulphide on the water-bath about 7 hours and the next non-poisoned compoun s are reduced.

F.p. 193°

As the same, from m-amino-benzoic acid ester and p-amino-benzoic acid-ester the next non-poisoned compounds are reduced.



F.p. 272°



F.p. - 252°

But these m- and p-benzoic acid ester could not react so rapidly as the anthranillic acid ester.

We analysed already these 3 products.

TOXICOLOGICAL DATA

Name	Formula	Ct (50% Mortality) Rabbit	Guinea-Pig	Pigeon	t= 10'
Chlorine	Cl_2	30000	10000	20000	
Mustard Gas	$S(CH_2CH_2Cl)_2$	5500	2300	1500	
lewisite	$ClCH{=}CHAsCl_2$	5000	2000	1000	
phosgene	$COCl_2$	10000	2200	20000	
diphosgene	$CO(OCCl_2)_2$	12000	2500	24000	
prussic acid	HCN	700 t=2'	1500 t=2'	200-250 t=2'	
N-yperite	$N(CH_2CH_2Cl)_3$	6000	2500	1800	
non erfrearte mustard gas	$(S(CH_2CH_2Cl)_2$ $(S(CH_2CH\ Cl\ CH_3$ $(S(CH_2CH_2Cl$ $(S(CH_2CH\ Cl\ CH_3)_2$	7000	3000	2000	

Exposure period, 10 min.; observation period, 7 da.; ca. 5 animals per exposure.

CW:(3-9.

CONFIDENTIAL

THERAPEUTICS AND PROPHYLACTICS OF THE EXPERIMENTAL POISONING OF HYDROCYANIC ACID

This study was made for to obtain the foundamental materials to the therapeutics and prophylactics of HCN poisoning in the field.

For this purpose about 60 medicaments were used, and principals of them were as follows, for antidotes methylen blue natrium subnitride (which changes haemoglobin into methaemoglobin) natrium thiosulfate colloidal sulphur (which make HCNS from HCN), morphin atropin strichnin (symptomatic), for heart drugs caushor digitalis and their derivates, strophantin, for respiration center stimings coramin and loberin, etc.

Further then blood transfusion, and as physical therapeutics, artificial respiration were made. These medicaments were mainly intravenously applied, and we wanted to apply them per os or per subcutan after ascertained their effect, for only by simple application and with long continuous effectiveness, they will be applied in the field. But this study was interrupted in the middle by other circumstances only after ascertained their effect by intravenous application.

Animals which were used in this study were chiefly rabbits. They were brought into the gas chamber, and a certain HCN was taken into a evaporating dish on the electric heater in the chamber, and then HCN was heated and vaporized, and during a certain time rabbits were exposed to the vapor.

The stadium which we began the therapeutics was corrected at just after exposure, a stadium of apnoea, arhythmic, just before and after the stop of the heart, although the poisoning symptoms rapidly appeared and arrived at the last, death.

The conlusion of this study was that, for the therapeutics effectual medicaments among them are methylen blue, natrium thiosulfate, and natrium subnitride, but the most effectual one is the artificial respiration. The artificial respiration which is seen in a textbook to make it agree with the normal respiration that is 16 to 20 times a minute by a man, 30 to 60 times by a rabbit, was completely effectless, but the one which is made rapidly as soon as possible, at least 100 times a minute, has the most valuable effectiveness. Instead of times of respiration but volume of it will be increased with success. For this purpose a pump for artificial respiration which is moved with hands or foot was used.

The stadium which we began the therapeutics were earlier the better to succeed. But by the poisoning of very high concentration of HCN (above 1000 mg/m³HCN), any therapeutics in every stadium of poisoning was completely effectless.

The medicament which had the therapeutical effect upon poisoning were also applied for the prophylactics, but had no so much good effectiveness.

The reason that the general artificial respiration has no therapeutical effect is that, the respiratory organs has a certain dead room which has no effect upon the gas exchange of the blood (larynx, pharynx, trachea, bronchus and bronchiolus, by rabbit 0.5 - 0.7 cc.), and in the condition of paralysis of respiration tonus of muscles are lost, and for that only smaller volume of air is inspired and used by the artificial respiration than that of the normal ones. For instance rabbit inspires 5 cc. volume of air by one respiration, and 50 times a minute, so the effectual volume of air upon the gas exchange of the blood is (5-0.5) x 50 = 225 cc. In the condition of paralysis, about 1/3 volume of air to the normal respiration is inspired by the artificial ones, so that (5/3 - 0.5) = 1.1 cc. is effectual, and at least 225/1.1 = 200 times of respiration is necessary.

Chief datas of therapeutics are as follows:

I.

1) Control; 46 rabbits were used.

HCN Concentration in mg/m³	Time of exposure in minutes	Rate of recovery in %
700	2	25
800	2	22
900	2	16
1000	2	6

2) Heart Drugs:

Medicament	HCN Concentration in mg/m³	Rate of Recovery in %	
Vitacampher	750	44	
Strophantin	650 - 750	29	Time of
Nat. Caff. Benz.	800 - 1000	35	Exposure
Cardiasol	850 - 900	20	2 Min.
Adrenalin	1000	37	
Strichnin	750 - 800	27	

Cw-12-10

3) Antidote:

Medicament	Dosis	HCN Concentration in mg/m³	Rate of Recovery in %
3% nat. thiosulf.	1 cc/kg	750-800	11
5% nat. thiosulf.	1 cc/kg	"	32
con. colloidal sulphur	2 cc/kg	"	20
5% nat. subnitride	0.5 cc/kg	"	63
	1.0 cc/kg	"	33
1% methylen blue	1 cc/kg	800	56
Glucose		750-800	29

4) Respiratory Center Stimulants:

Medicament	Dosis	HCN Concentration in mg/m³	Rate of Recovery in %
Coramin	12.5 mg/kg	750-800	25
	20 mg/kg	"	46
Loberin	0.8 mg/kg	"	23

II. With mixture:

	Therapeutics	Rate of Recovery in %
1	(Art. Resp. (Coramin (Methylenblue	70
2	(Coramin (Methylen blue	65
3	(Coramin (Methylen blue (Nat. Subnit.	65
4	(Art. Resp. (Coramin (Methylen blue (Nat. Subnit.	57
5	(Art. Resp. (Vitacampher (Methylen blue	57
6	(Vitacampher (Methylen blue	52

	Therapeutics	Rate of Recovery in %
7	(Vitacampher (Nat. Submit.	60
8	(Art. Resp. (Methylen blue	57
9	(Art. Resp. (Nat. Submit.	52

III. Stadium which we began the therapeutics:

1)

Therap.	Stadium	HCN Concent. in mg/m³	Time of Exposure in Min.	Rate of Recovery in %
Art. Resp. with foot pump.	Apnoea	850	2	100
		1500	1	100
		850-900	2	71
	Arhythmia	1000	2	91
	just before heart stop	800-850	2	83
	just after heart stop	850	2	40
		1000	2	13
Art. Resp. with hand pump	apoea	850	2	100
		850	2	95
	Arhythmia	1000	2	58
	just after heart stop	850	2	15
	just after heart stop with trachiotomia	850	2	45

2) Rate of Recovery in %:

Stadium	Art. Resp. with foot pump methylen blue coramin	Art. Resp. Methylen blue Coramin	Methylen blue Coramin
Apnoea	91	65	60
Arhythmia	80	33	0
Just before heart stop	44		
Just after heart stop	14	0	

Chu-12-12

Cw-12-43

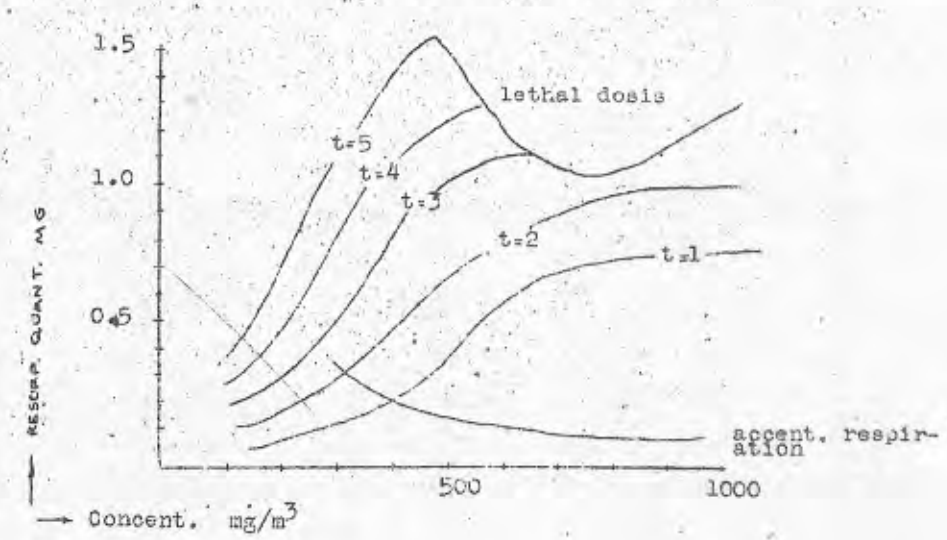
CONFIDENTIAL

LETHAL DOSIS OF HCN BY RABBIT

I had researched the resorptions quantities and the lethal dosis of HCN by rabbit by inhalation, and wanted to make the detail criticism to the Herber's form it which is seemed to be fundamental to research the effect of chemicals.

The HCN vapor in the chamber formed was previously analysed for several times exactly, and then the chamber was connected to the trachial kanule which has the entrance and out way valves of rabbit with gummi tube. The trachiatomized rabbit inspired the HCN vapor in the chamber through the gummi tube and the kanule, and expired air was collected and measured the volume and analyzed its concentration of HCN vapor, and then calculated the resorptions quantities of HCN.

The conclusion of this study was that, the resorptions quantities and lethal dosis of HCN by rabbit have a certain relation to the C and t (see under fig.), but concerned the lethal dosis of the Herber's form ct = constant dose not come into existence in every concentration of HCN.



CONFIDENTIAL

CONFIDENTIAL

THE THIRD SECTION

The Staple Studies

Surgeons and veterinary surgeons have made medical and veterinary studies about every kind of poisons and physiological experiment for "masks" and other protecting instruments since the establishment of this laboratory.

Mustard gas, phosgen and hydrocyanic acid, etc. was studied, and other many poisons was compared with these ordinary gasses.

In the last few years the critical treatment for hydrocyanic acid and mustard gas poisoning was studied earnestly. By origin about these studies was performed at the army medical and veterinary school, and at the laboratory only the fundamental affairs was handled.

During this war we have studied on the real nature of hydrocyanic acid poisoning, phosgen and mustard gas intoxication to discover more suitable and exact critical treatment than ever since.

The head title studied in last few years as follows:

1) Methods of critical treatments.

   a) The protection from the cutaneous injury of mustard gas poisoning.
   b) The medical treatment for mustard gas poisoning.
   c) The critical treatment for the intoxication of hydrocyanic acid.

2) Studies on the nature of intoxication.

   a) Mustard gas.
   b) Hydrocyanic acid.
   c) Phosgen.
   d) $N\begin{cases} CH_2CH_2Cl \\ CH_2CH_2Cl \\ CH_2CH_2Cl \end{cases}$, H_3As, etc.

Result:

1) a) Anthranylic acid methyl ester is effectable against the cutaneous injury of mustard gas poisoning.
   b) Sulfonamide, $K\,MnO_3$, Gultazion, etc. was tried for rabbits and guinea pigs that inhaled the mustard gas, but was not suitable enough.

cw-12-14

CW-12-45

CONFIDENTIAL

ON THE N-YPERITE

$$N\begin{cases}CH_2CH_2Cl\\CH_2CH_2Cl\end{cases}$$

I experimented a few animals test as following idea to make clear the therapeutics, preventives method of N-YPerite as compared with mustard gas, to determine the method of protect and therapeutics, preventives.

Experiment Record:

1) The toxity of N-YPerite almost equals to YPerite, but to investigate it finely: as follows.

   a) It falls about below to YPerite: Mortalitat ct= 6000
   b) The injury of the skin lights to compares with TPerite injury; heals up early to compare with it.
   c) The injury of eyes equals to that.
   d) The affection of internal organs to absorb its toxin in the body, seems to equal the injury of YPerite; rather intenses of it.
   e) Therapeutics, preventives method of it almost equals to YPerite, but for the sterilize of the skin is better effective to permanganic acid than chloramine.

Experiment method:

As a few healthy Rabbits, Morumottos is one group, it puts in the gas chamber ($1m^3$), and make the gas in it by the evaporations method; they absorb the gas in the certain times (10 minutes); afterwards I am observed the progress of their injuries and mortalities.

THE STUDY ON AN EFFECTABLE PREVENTION WITH ANTHRANYLLIC ACID METHYL ESTER AGAINST THE CUTANEOUS INJURY OWING TO MUSTARD GAS POISONING

An interesting fact, that the anthranyllic acid methyl ester reacts with mustard gas easily and rapidly, had been discovered, when we began to study. We made some experiments with the skin of animals and then ourselves, resulting a remarkable effect against the cutaneous injury owing to mustard gas poisoning.

The Method of Experiments:

1) by animals: On the shearing backs of albino rabbits we dropped 5 mg of mustard gas and each 3', 5', 10', 15', 20' 30' and 1° after rubbed with wool saturated the anthranyllic acid methyl ester, watching closely the symptoms.

2) with human skin: The surgeons and their cooperaters participated in the test voluntarily. At first 0.3 mg and next 3 mg of mustard gas was dropped upon the insides of their forearms, and 10' later rubbed with the same method as by animals.

The result:

Due to the individual different of animals the each result in the same group could not always prove the agreement. Generalizing into a table, it is as follows.

(5 rabbits)		Swelling Degree of the Skin						
Group	Time Rubbed	1°	3°	6°	10°	24°	48°	Effect
I	3' after	-	-	-	-	-	-	++
II	5' "	-	-	-	-	-	-	++
III	10' "	-	-	±	+	+	+	++
IV	15' "	-	+	+	++	++	++	+
V	20' "	-	+	++	++	++	++	±
VI	30' "	+	+	++	++	++	++	±
VII	1° "	(+)	+	++	++	+++	+++	-
Control	(No rubbing)	-	-	-	-	-	-	

After 24 hours or 48 hours:
and 0.3 mg with the human skin:

The Whole No.	Effect 1-2 mm		2 cm
	No wound or very slight oedema	rubella and oedema	small blister or remarkable rubella and oedema	big blister
10	5	1	3	1
(3 mg with the human skin:			1-2 mm (many)	2 cm)
30	20	3	6	1

Eco-12-1/6

CW-124

Conclusion:

By rubbing anthranyllic acid methyl ester at the suitable time on the skin adhered with mustard gas, we can prevent the skin of animals from the cutaneous injury, and then prove remarkable effect against the human skin, when the measure is taken at least within 10 minutes.

THE LETHAL DOSIS OF "RICIN"

Method of Determination of the lethal dosis.

The powder of "Ricin" was diluted in the physiological salt solution so fixed that about 0.1 cc. of the toxic reagent is injected subcutaneously. For albino rabbits the powder itself was also enclosed under the skin.

Result.

Species of Animal	Dosis 7. mg/kg	1 mg/kg	0.7 mg/kg	0.5 mg/kg	0.1 mg/kg	0.05 mg/kg
Mouse	3/3	5/5	3/5	3/5	0/5	0/5
Albino rat	3/3	5/5	4/5	3/5	0/5	0/5
Guinea pig	3/3	5/5	5/5	5/5	3/5	0/5
Albino rabbit	3/3	5/5	4/5	4/5	0/5	0/5
Cat	-	0/1	-	-	-	-
Dog	-	1/1	-	-	-	-

Note: lethal/injected

The powder itself for albino-rabbit: 1 mg/kg - 5/5,
0.5 mg/kg - 3/5

The interval to death: 7 mg/kg - within several hours.
1 mg/kg-0.5 mg/kg - within several days.

Conclusion: The absolute lethal dosis is seemed to be in 0.5-1 mg/kg.

CONFIDENTIAL

AN EXPERIMENT OF TOXICATION OF AsH_3

1. Production of AsH_3.

AsH_3, produced by adding water to $AsNa_3$ were put into a chamber of $3.5m^3$, and the condensation was attained. Analyst was based on the method of Gutzeit.

2. The condition of toxication; speaking mainly of dog, is as following:

Gas Condensation (mg/m^3)	Time of Reaction (min)	Animal Tested	Termination
1538	10	(Dog	Dead
		(Dog	Alive
1531	10	Dog	Alive
1510	10	(Dog	Dead
		(Dog	Alive
		(Rabbit	Dead
		(Guinea-pig	Dead
		(Pigeon	Dead
		(Cat	Dead
1510	10	Dog	Dead
(76-110 (5 days running)	10	(Dog	Alive
(2 days after		(Rabbit	Dead
(133-219 (5 days running)	10	(Guinea-pig	Dead
133-219 (5 days running)	10	(Dog	Alive
		(Rabbit	Dead
		(Guinea pig	Dead
		(Pigeon	Alive
83	120	Dog	Alive
76-110	15	Dog	Alive

From the list above we had the following results.

1. The ct (Gas condensation mg/m^3 x time of reaction) of dogs were more than 20,000.

2. The ct of rabbits, pigeon and guinea pigs were more than 5,000.

CW-12478

CONFIDENTIAL

TH 4KM /
A5

THE RESEARCH FOR THE ANTITOXIC ACTION OF THIOSULPHURIC SALTS AGAINST THE POISON GASES

The following fact is well known that, to make the various kind of poison gas reveal their poisonous effect, the taking place of the combination between poison gas and chemical compounds in the living body, which have -SH, especially glutathion. It is moreover proved theoretically and experimentally, that the thiosulphric salt is to be used as the substitute of glutathion.

Conclusion: The thiosulphric salts have the evidents antitoxic action against the poisonous function of mustard gas and CO.

Result: 1. Lewisite

(1) (Daikoku-nezumi) weighting Ca 150 gram is used for experiment 2% calcium thiosulphat is injected in the rate of 1.0 cc. per 100 gram of weight (A - group). The contrast the saline solution is used, (B-group). In one hour after injection, they are exposed in a gas chamber (volume 100 liters). With the 10 mg/m³ concentration of Lewisite one hour long. Mortality of A-group is 0, that of B-group is 40% (2/5).

(2)

	Preliminary injection (one hour and 24 hours)	Exposure in the 200 mg/m³ concentrating of Lewisite 40 minutes long. Two times with the interval of 24 hours.	No. of death / No. of Experimental
Experimental Group	Calcium thiosulfat		5/20
Contrast	Saline solution		13/20

(3)

Group	of calcium thiosulphat (per kilogram of weight	No. of death	No. of animals
A	0.19 subcutaneously		9/10
B	0.29 "		7/20
C	0.59 "		10/20
Contrast			12/20

Cw-12-19

Cau-12-28

CONFIDENTIAL

2. Diphenilarsincyamid.

(1)

	Preliminary injection 0.1 cc. per kg. wt. subcutaneously (one hour and 24 hours)	Exposure in 100 liter gas chamber of diphenylarsincyamid (30 mg of which is evaporated). Two times with interval of 24 hours.	No. of death / no. of animals
Experimental Group	3% Calcium thiosulfat		3/10
Contrast	Saline solution		5/10

(2)

	Preliminary injection 0.1 cc. per kg. wt. subcutaneously (one hour and 24 hours)	Same condition with the last table, but the concentration of second exposure is 1000 mg/m³	No. of death / No. of Animals
Experimental Group	2% Calcium thiosulfat		6/18
Contrast	Saline solution		10/16

3. HCN.

	Preliminary injection (0.1 cc. per 100 gr. wt. subcutaneously)	One hour after preliminary injection to be exposed in gas chamber of 0.004% HCl one hour long	No. of death / No. of Animals
Experimental Group	2% Calcium thiosulfat		1/5
Contrast	Salvine solution		4/5

CONFIDENTIAL

4. Mustard Gas.

A. The research on the mortality of rat (Daikoku-nezumi).

(1)

	Preliminary injection (1.0 cc. per 100 gr. wt. subcutaneously)	One hour after preliminary injection to be exposed in 100 mg/m³ Mustard gas 30 minutes long.	No. of death / No. of Animals
Experimental Group	2% Calcium thiosulfat		0/5
Contrast	Salvine solution		1/5

(2)

	Preliminary injection (1.0 cc. per 100 gr. wt. subcutaneously)	One hour preliminary injection to be exposed first in 100 mg/m³, Mustard gas 40 minutes long, next in 200 mg/m³ Mustard gas 40 minutes, next in 200 mg/m³ Mustard gas 40 minutes long	No. of death / No. of Animals
Experimental Group	2% Calcium thiosulfat		5/10
Contrast	Salvine solution		6/10

(3)

	Preliminary injection 1.0 cc. per 100 gr. wt. subcutaneously (one hour and 15 hours)	The same condition with upper table	No. of death / No. of Animals
Experimental Group	2% Calcium thiosulfat		3/10
Contrast	Salvine solution		5/10

Cw-12-24

Cw-12-22

(4) 10% calcium thiosulphat per as in the rate of 0.5 gr. per kilogram, mortality of the experimental group 7/10, 3/10 in contrast.

B. The Research on the Symptom of Skin

(1) The experimental animal (rabbits, after the skin is shaved) 3.0 mg of mustard applied. Injection of 10% calcium thiosulphat 0.5 gr. per kilogram, in one hour, 4 hours, 7 Hours, and 10 hours.

Rugar and infiltration is to be examined after 3 hours, 24 hours, and 48 hours.

Result: The symptom is milder in the experimental animal the contrast.

C. The research on the quantitative analysis of residue - N in blood.

Method of quantitative analysis: Dumazert's method. 22.0 mg of mustard is applied on the shaved skin of rabbit. Next, 10% calcium thiosulphat is injected subcutaneously, is repeated 3 times. And food (100 gr. of the carrot) is given daily.

Result: The residue - N of to be experimental group is increased in 26.06%, and that of contrast is increased in 46.83%.

5. The research on Co-poisoning.

(1) The judgment by means of mortality . Is used rat (Daikoku nezumi) , 2% calcium thiosulphat is injected subcutaneously in the rate of 0.2 cc. per 100 gr. of body weight. Exposed in 0.1 % CO 2'30" long once a day, two days continued, no mortality in 10 cases. In contrast, 4 mortality in 10 cases.

(2). The judgment by means of the measuring of the blood sugar.

The experimental group (rabbit) are exposed one hour in 0.8% CO after subcutaneous injection of 10% calcium thiosulphat in the rate of 0.2 cc. per kilo gram of weight, daily one time, 3 days continued.

Result: Is increase on the experimental group is less than contrast group.

6. The research on phosgen poisoning.

	Preliminary injection 0.2 cc. per kilogram weight (one hour and 24 hours)	Exposure in 25 mg/m³ phosgen half and hour long	No. of death / No. of Animals
Experimental Group	10% Calcium thiosulfat		7/10
Contrast Group	Salvine solution		3/10

Result: Calcim thiosulphat has no effect.

The treatment of the mustard-wound by means of cystin-compress.

Comparing the effects by the compress of Natriumthiosulphat, cystin and thiophenol and by application of the same elements.

The compress of 0.5% cystin (PH 7.2 in 0.45% salvine solution) twice a day continuously applied works best.

The experimental result on the treatment of HCN. (Ten rabbits are used as one group and five rabbits as contrast.)

Treatment	Recovery
Artificial respiration	45.4%
Natrium subnitricum	62.8%
Natrium thiosulphat	Theoretic harmless, but clinical effect doubt.
Methylen blau	56.2%
Coramin	45.8%
Vita campher	43.5%

For prevention of HCN the intravenous injection of natrium subnitricum with glukosis, as well as methylen-blue with natrium subnitricum is effective.

The internal application of natrium thiosulphat for prevention. Rat (Daikoku-nezumi) is used for experiment. Natrium thiosulphat 0.05 gr (per os) per kilogram weight no noticeable injection with 350 mg/m³ HCN, with 900 mg/m³ no mortality in the experimental group and 60% in contrast.

CCV-12-23

APPENDIX CW-13

SUBJECT: Chemical Warfare, Intelligence.
DATE: 16 October 1945.
INTERVIEWED: Maj Gen K AKIYAMA, Maj SAKAGAMI, Maj NAGAO, Engr HAYASHI.
INTERVIEWERS: Maj H Skipper, Lt Yamada.

The first hour of this conference was concerned with Japanese CW intelligence, policy, and other general questions of interest on Chemical Warfare. General Akiyama answered most of the questions in his frank, matter-of-fact way, with little hesitation.

General Akiyama opened with a reference to the high expenditures in money and materials for defensive research and equipment, considering the resources of Japan. He indicated that he thought the U.S. might have suspected Japan of offensive ideas because of this fact.

Q Do you know of any new agents worthy of production providing raw materials are available to you?
A None were found which could be considered superior to H, HCN, and DC (except the chloroacetyl derivatives of para cresol mentioned in an earlier conference).

Q Are you willing to go on record as saying you received no information on new German agents before or during the war?
A None was received. The Germans informed us that the Russians had nitrogen H and phosgene oxime, but would tell nothing of German developments, either offensive or defensive.

Q Did Japan request information on new German agents?
A Yes, Japanese Imperial Army requested this information through the Japanese Embassy in Berlin*, but got no information. The General (Akiyama) heard of H gas being left by the Germans in retreat from Konigsberg and Danzig and capture of this gas by the Russians. He also heard about Russian and U.S. CW from Germany, but information about the Germans was hardest to get.

General Akiyama personally thought there would be no new gases in this war.

Q What agents have you heard of in the U.S.?
A Nitrogen H and other standard agents.

Q How much had you heard that the U.S. was producing?
A Didn't know, but believed U.S. capable of producing tremendous amounts. They were well aware of the U.S. potential production.

* He stated that Japan had no chemical warfare specialist in Germany during the war.

Q Do you know where in the U.S. gases were being produced?
A Edgewood Arsenal and some other arsenals larger than E.A. We tried to find out where it was from an Army and Navy Journal (1941 issue), but couldn't place it.

Q Do you know where the Research Stations on CW were located in the U.S.?
A No, we never heard of them.

Q Did you hear of any use of gas in this theater?
A We heard of chemical spray drills in New Guinea and tear gas operations in New Britain. The newest information was that there might be HCN or sneezing gas in Okinawa, but they were not certain. Some unexplained deaths at Okinawa might have been from CO, however.

Q Where in New Guinea were the reported spray drills?
A Didn't know; perhaps Port Moresby. At Iwo the U.S. had used yellow phosphorous shells and in some instances had poured phosphorous into caves.

Q Did you expect the U.S. to initiate gas warfare?
A We believe they did use it. (Gen Akiyama)

Q What led you to that conclusion?
A Because of the sudden and rapid collapse of certain small island operations. (Iwo, Bonins, etc) We believed that in the later stages of battles after radio communications had been knocked out, gas was used to mop up.

Q Is this just the opinion of Gen. Akiyama or was it shared by other officers?
A It was the opinion of many, including high-ranking officers.

Q Does your Imperial General Headquarters believe gas was used?
A Gen Akiyama thought Imperial Gen Hq might have some suspicions. (Maj Nagao, the interpreter, said he believed gas had been used by the U.S.)

Q Did you get any actual information on this subject? (By radio or by persons who had seen gas used?)
A No, just believed it from the way operations went.

Q What agent or agents do you think were used?
A Don't know, but any would have been feasible because the soldiers were tired, without masks, and were living in caves.

Q Did you believe the British used gas?
A The Allies used gas in Burma.

Q What kind?
A Doesn't know.

Q How do you know this to be a fact?
A Information came by radio, but no details.

Q What intelligence information did you get on U.S. equipment?
A We captured the mask and found it to be good protection against HCN.

Q Have you captured any U.S. protective clothing or any information concerning it?
A No, we have only seen pictures of it. At this point Gen. Akiyama emphasized the fact that the Japanese were very proud of their protective equipment and believed it to compare favorably with any.

When questioned as to the lack of a good airplane spray tank, Gen Akiyama simply replied: "We had so few planes, it wasn't worth working on further."

Q Did you have a chemical land mine?
A No, gas mines were not thought to be as effective as H.E. mines.

Q Did you hear of Jap mining beaches of the Philippines with gas?
A Don't know anything about this. If gas were going to be used against a landing it would be better to use shell. Mining with gas would require too much agent.

Q What did you think of the probability of gas warfare in the invasion of Japan?
A Believed the U.S. would use gas, but Japan would most certainly not start it.

Q Why?
A Japan has no quantity and if started, the U.S. will retaliate with gigantic quantities.

General Akiyama stated that he was afraid the U.S. would use gas against Japan's food supplies.

Q What agents would be most effective against rice crops?
A $AsCl_3$ or L.

Engr Hayashi brought with him the list of 1,000 compounds synthesized for possible toxic agents for which he had been searching. This list includes physical and chemical constants and toxicologic data, and is being translated. He will complete work on list and give it to SIS in about ten days.

The next hour was spent in a rather disjointed discussion of micrometeorology as it applies to CW. Maj Sakagami produced several papers (which will be translated and reproduced at a later date).

Maj Sakagami has produced, as a result of diffusion experiments, an interesting mathematical approach to gas-cloud behavior which ignores vertical temperature gradient (uses "wind-turning" instead).

SUBJECT: Japanese Navy Chemical Warfare Research
INTERVIEWED: SADAO TSURUO, Capt
ICHIRO TANIMURA, Medical Commander
KANJI YOSHIDA, Tech Ord Lt Comdr
TAKAO KUWABARA, Tech Ord Lt Comdr
TOSHIO ISHIHARA, Tech Ord Lt Comdr
HIROTOSHI TORIGAI, Tech Ord Lt Comdr
HARUO ISHII, Tech Lt
MASAYA SOBU, Tech Lt
TATSUSO YUASA, Medical Capt
INTERVIEWERS: Maj HOWARD E. SKIPPER, Lt Gordon T. WALLIS (MC), Lt USNR

A tour of the laboratories of the Chemical Research Dept., of Sagami Naval Arsenal at Hiratsuka revealed first a fair job of disposing of any literature or apparatus which might have indicated the nature or extent of the work carried out (this was accomplished by the Japs) and second very poor judgment on the part of American officers and men now quartered in neighboring buildings who by entering the laboratories and unnecessarily disturbing papers and equipment have completed the job of ruining this target.

In a four-hour discussion with Japanese naval officers, Capt Tsuruo emphasized several points with reference to CW thinking which are listed as follows:

a. Tests at Kure 7-8 years ago lead the Navy to the conclusion that gas shells (demolition and A.P. shells with small amounts of diphenylcyanoarsine and chloracetophenone) are very effective. These tests were carried out in explosion chambers and on useless ships. For details of the Kure tests see Incl 1, prepared by Capt Tsuruo.

b. Persistent gas shells or bombs were not considered of value against ships because they are not immediately effective (sea battles are of short duration, so says Capt Tsuruo).

c. Non-persistent gas shell or bombs were not considered of value against ships because of the difficulty of keeping a gas cloud on a ship long enough to attain an effective ct.

d. Persistent gas sprays were not considered feasible against ships because "they must be released at an altitude of less than 50 meters" (plane easily shot down) and they are delayed in their physiological action.

e. The extreme difficulty of hitting a ship with gas bombs was emphasized. Capt Tsuruo stated that CW research

in the Navy had been changed from offensive to defensive in 1943 and 1944, principally because of the concurrent change in naval tactics (use of large numbers of aircraft and rare battles between ships). Also chemical projects, not CW, took up considerable of their effort after 1944. These problems consisted of ship bottom paints, bubblers to fake the position of submarines, carbon monoxide protection, signal flares, pyrotechnics and miscellaneous explosive weapons.

However, it seems that work proceeded in filling H bombs, development of a wooden H gas bomb and the testing of a few compounds as possible new agents. Other questioning is summarized below:

Q Have you studied the corrosiveness of CG against ships?
A This was studied 15-20 years ago but the delayed action of phosgene and the difficulty of attaining an effective ct on a moving ship would rule out this agent.

Q Were cyanides tested against ships?
A Explosive shells containing potassium cyanide were tested but were found to be ineffective. HCN came off too slowly even in contact with water.

Ishihara - Protective Clothing and Ointment.

Tests were carried out on an experimental protective suit made up as follows:

An absorbent underwear was dipped into a 2-3% water solution of chloramine T and put on while wet. This was covered with a cotton coat (not impregnated) and the usual impervious pants and boots.

When this so-called dipping protective suit was tested on men for wearing comfort as compared to the complete impervious suit, it was found much superior, but when this clothing was later tested for its protective value against rabbits, it was found little better than regular unimpregnated clothing.

Japanese decontaminating ointment No. 5 contained:

Chloramine T	16%
Bentonite	81%
Sea water soap	3%

150,000 boxes of No. 5 produced in 1944.
100,000 boxes of No. 5 produced in 1945.

A number 6 was under investigation which contained barium peroxide, calcium hypochlorite, ferric sulphate and powdered activated charcoal. It was for arsenic compound as well as H.

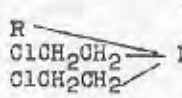
For details of chloramine T work, see Incl 2, prepared by Navy Laboratory.

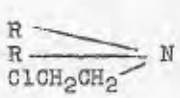
Canisters were discussed next with special reference to additives to the charcoal. The man in charge of this work, Comdr Ishihara, stated that all canisters in the field had no additions to the straight activated charcoal. They had been studying ZnO just before the end of the war. See Incl 3 for method of canister testing and break test data as given by the Japanese Navy Laboratory.

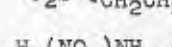
Synthesis of new agents:

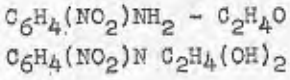
Q Do you have toxicity data on agents listed?

A No, they were carried out 5-6 years ago. It is possible that Capt Hiratsuka might know some of this data. He did some of these experiments along with Rear-Admiral Kotatsu (now in Singapore). These experiments were carried out in 1935-1936. They were recently working on N mustard compounds of the following types:





also 



For list of new compounds synthesized as possible new agents, see Incl 4.

Methods used in toxicity determinations are described briefly in Incl 5, written by Med Capt Yuasa who appeared to the interviewers to be uncommonly stupid. This character states that they were unable to confirm the Army's results on anthanilic acid, but they used only one or two rabbits in their tests.

Sketches of all Navy CW weapons were provided by Capt Tsurno. These will be reproduced and circulated as soon as

possible. All weapons were discussed and a number which were on hand examined.

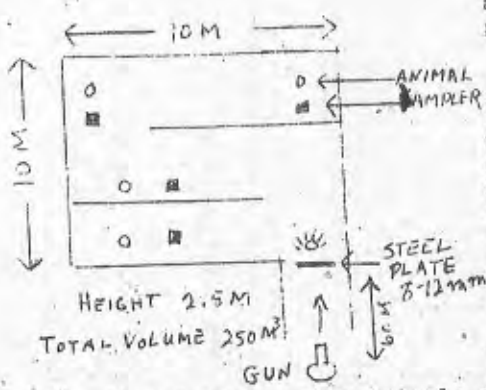
The remainder of the afternoon was spent in a quick tour through the plants and at the bomb dump about 5 miles from the laboratory.

The method used in production of H in the Japanese Navy is described in Incl No. 6 prepared by the Navy Laboratory

Incl 1

KURE EXPLOSION CHAMBER WORK

I. Procedure.



The explosion chamber is such as the figure, and the testing gas is fired from the gun.

After explosion of the shell, we take the sample gas from 8 places of the chamber, using wash bottle or vacuum can for analysis and put in animals at 4 places for 5 or 30 minutes, and some human test people enter with masks taking off now and then for the test of the gas concentration.

These tests are done immediately after the explosion and after 3 hours. The animals are marmot, rabbit, dove and love bird.

The decontamination is done after ventilation, at first using the solution of bleaching powder or K Mn O_4 and NaCH, and then washing with sea water two or three times.

Data	12 cm	CN 300 g	14 cm	CN	20 g	D. Cyanarsin	300 g
	12.7 cm	" 500 g	15 cm	"	30 g	"	500 g

II. Result.

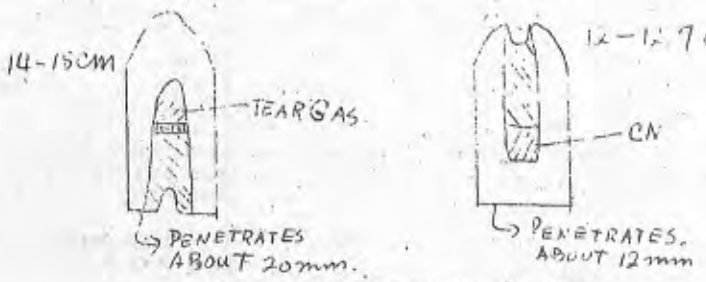
12 cm, 12.7 cm (CN)
Animal test, dove. Love bird is suffering, shut eyes, and twinkles. Human test, without masks people cannot bear, and even if with masks the bare skin such as neck feels burning. After 3 hours the result of the test is almost the same. The result of the analysis of gas is not sufficiently sure because of the little of sampling and analyzing method.

14 cm, 15 cm.
Some marmots die. Human test: Of course, without mask man cannot bear, and even if with mask. Diphenyloyanarsin sometimes breaks the canister of the mask and the effect of the tear gas is also large. The decontamination is very difficult.

III. Discussion and Conclusion.

The effect of the fragment of the gas shell does not differ so much as the demolition shell, and the gas effect is additional to the demolition shell, but the explosion pressure effect of the gas shell is a little smaller (And in the ship, especially at the insufficiently ventilating room, the tear gas effect is very persistent), so at the total effect of the gas shell is better than the demolition shell.

So we divide the bursting explosive of the shell to two part, and when we need we substitute the adverse part of the explosive for fuze to gas containing can, and we can change the demolition shell to gas shell.

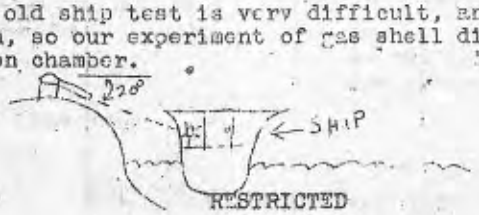


THE EXPERIMENT OF OLD SHIP

1. Procedure. We fire the gas shell from the gun at high place. The gas shell explode at a room of the old ship. The test of the gas is almost same as the explosion chamber test.

2. The result and conclusion is also almost same as the explosion chamber test.

The old ship test is very difficult, and we cannot repeat so often, so our experiment of gas shell did chiefly at the explosion chamber.



Incl 2

APPLICATION OF CHLORAMINE T AND ITS DERIVATIVES ON DECONTAMINATING AGENTS AND PROTECTIVE SUITS.

It is famous fact as described in "Flury" that Chloramine T and its derivatives form nonpoisonous addition compounds with mustard or lewisite.

1. Application on decontaminating agents. It has been known that bleaching powder was the most powerful decontaminating agent for vesicants. However, if using bleaching powder for decontamination of body. the skin is damaged according to its bleaching power, and so the purpose of decontamination cannot be attained sufficiently. And if using it for decontamination of fibrous manufacturer, fibre is oxidized and becomes almost damaged state. As a complete bodily decontaminating agent which any soldier can easily carry such a state. Study of decontaminating agent using mainly chloramine T and its derivatives has been completed and it was standarized as decontaminating agent No. 5 and passed mass production.

(1) Summary of investigation. It is possible on the base of our countries' source, that full of chloramine T are provided for each soldiers. We have been investigated for the purpose that uses a minimum chloramine T and yet makes effective. This is to gain a dilution agent which does not lower an effect of chloramine T and given a better effect than chloramine T.

The necessary conditions of dilution agent is to be gained a large quantities and to be cheapness, and so, we proposed bentonite, acid clay, calcium carbonate and sodium carbonate, etc.

Dilution agents were selected by measuring its effectiveness by means of triangular coordinate of water, chloramine T and dilution agent, and the mixing ratio of the best dilution agent, "bentonite" and chloramine T was determined. While proceeding the investigation, it became clear that the agent containing about 3% of sea water soap was very effective and was more excellent than chloramine T.

The mixing ratio, the most effective is as follows.

Chloramine T	16%
Bentonite	81%
Sea water soap	3%

Method of effect judgment:

One drop of mustard, about 0.2 cc. was dropped on a piece of uniform material. This material was on a flat glass plate and was covered by diadem with hole. And test paper was placed on a diadem and the degree of changing colour was observed. When the effect of decontamination was sufficient, test paper was placed directly on a contaminated uniform material and the effect was tested by the degree of colour change.

Test paper is prepared by dipping filter paper colored by chrysophenine dye in CCl_4 solution of dichloramine T.

Reaction mechanism: As described below, mustard is chlorinated by dichloramine T and eliminate hydrochloric acid at the same time.

$$S(CH_2CH_2Cl)_2 + C_6H_5SO_2NCl_2 \rightarrow S(CHClCH_2Cl)_2 + 2HCl\ C_6H_5SO_2NH_2$$

Chrysophenine dye as pH-indicator changes colour from orange to brown owing to the eliminated hydrochloric acid.

3. Decontamination of human body.

For decontamination of body, a creamy one added about twice water to decontaminating agent No. 5 was used.

(a) Animal test. Mustard was dropped on the naked back of rabbit. After leaving three minutes it was wiped off, and decontaminated by either bleaching powder solution or creamy solution of decontaminating agent. o. 5, and the effect was compared with untreated blank test. As the results, when employing No. 5, there almost remained no harm.

(b) Human test. Experiments were carried out by the staff of this laboratory proposed human test. One drop of mustard was dropped on skin, and after three minutes, it was rubbed off with the cloth and was decontaminated by rubbing with 10-20 g creamy No. 5. As the results, there remained no harm.

4. Decontamination of clothes. It has been said that there were no suitable means besides either decontamination by boiling or drying in air. When bleaching powder was used, fibre was used to grow very weak and became unutilized state. Contaminated uniforms were decontaminated by dipping into an aqueous solution of No. 5 and taking the same process as usual washing. Decontamination process was carried out at short time and yet effect was almost complete.

Confirmation of effect. A piece of decontaminated cloth by No. 5 by boiling and not decontaminated cloth was stuck on rabbit back, and the effect was compared each other.

5. Decontamination of weapons and other munitions. Movable munitions were decontaminated in an aqueous solution of No. 5 (1:3) by means of brush, etc. Fixed munitions were carried out decontamination by rubbing with creamy No. 5.

II. Application on the protective suits.

The idea which dipped clothes with decontaminating agent and used to protective clothes has been occurred since old years ago, but did not attach great importance owing to be absent suitable agent.

Recently, as the application for protective suits, so called "dipping protective suits" has been investigated.

1. Dipping protective suits. This consists of two parts, underwear and coat. Underwear is made of material having an aptitude to dampen such as a gauze, and dipped in a 2-3% solution of chloramine T. Moreover, coat are weared in order to protect an evaporation of containing solutions. Under such a condition, masked men divided three groups, that is, protective suits unwearer (no prot. suit), regular protective suit (rubber) wearer and dipping protective suit wearer, are walked 2.000 meters and their feels of wear and increase proportion of pulse are determined. This result is that dipping protective suits are best. However, when observed a state of rabbits that are covered by dipping protective suits and placed in poisoned chamber, there is expected no more effective than today's protective suits, though effect is recognized.

Accordingly, if the service protective suits are necessary as in the past, adoption of dipping protective suits corresponded to "spring coat" are inadequate for our countries owing to difficulties of preparations.

2. Protective suits without dipping. It is impossible to protect gas unless it is always wetting state, because it has not any membrane producer in dipping agent. For this reason, it is necessary to form coat and underwear specially for protective suits by painting directly agent as paint, membrane producer (high molecular compounds such as polyvinyl alcohol or alum root) must be added into No. 5 or chloramine T. The war ended as soon as the study was scarcely started.

3. Application of chloramine T for medicine. Chloramine T is provided for medicines, and its 1% aqueous solution is used for medical treatment of casualty of lachrymatory or vesicants.

4. Study of chloramine T and its derivatives. Source of chloramine T is very poor in our countries, and yet competes with explosive factory and other organic synthetic industry. Therefore, we have been to study manufacture of chloramine M, Chloramine E, etc., in which do not contain benzene ring, but war ended at the degree of examination.

The End

Encl 3

INFORMATION OF TESTING OF CANISTERS
(Method, etc.)

Testing methods for canister are as follows:

1. Leakage test for canister.

Specification. Necessary to be completely airtight for 200 mm of pressure of water.

Method. Either entrance or outlet of canister (A) is sealed tightly and flow of air adjusted over 200 mm of an air pressure of water is passed through canister. Valve (H) is closed and it is examined whether water level of manometer (M) is lowering or not.

2. Breathing resistance test for canister.

Specification. Necessary to be under 17 mm of pressure of water.

Method. Flow of air is passed through either entrance or outlet of canister at the rate of 30 liters per minute through flowmeter. Breathing resistance is determined by reading a height of water column in manometer.

3. Filtering efficiency test for canister.

Specification. Necessary to be not recognized leakage of smoke with naked eye.

Method. The twenty of standard joss sticks are smoked in the vessel, through which a flow of air, 30 liters per minute, is passed through an entrance of canister. And then, flow from the canister is led into dark cell and leak of smoke is tested by means of condenser and light source.

4. Compressed air test for canister. Necessary to be not recognized leak of carbon powder.

Method. After a canister is carried out shock test during thirty minutes, compressed air, 100 liters per minute, is passed into the entrance of this canister in a moment. Gauze wetted with water, is placed on outlet of canister, and it is examined that carbon powder is adhered on gauze or not.

5. Leakage test for facepiece.

Specification. Necessary to be completely airtight at 150 mm of pressure of water.

Method. Tested facepiece of mask is worn in model face, flow of air saturated with ammonia gas is passed through the end of hose and pressure of the inside of facepiece is regulated as kept over 150 mm of pressure of water. And then surface of facepiece, eyepiece, mouthpiece, etc., are covered with test cloth with alcoholic solution of phenolphthalein. Leakage test is carried by examining colour of test cloth. If leaked, cloth is coloured red by ammonia.

6. Gas test of canister

Model 93 No. 2 70 min for Cl_2 gas
Model 93 No. 3 40 min for Cl_2 gas

Method. This test is carried out in accordance with method of testing absorbents against chlorine.

Method of testing absorbents against chlorine.

1. Conditions of test. Refer to an annexed table.

2. Apparatus. Refer to an annexed figure.

3. Method.

(a) Method of filling tubes. The absorption tube (inner diameter 2.0 cm) is supported in a vertical position with the funnel and the entire sample which is placed on the paper is poured through the funnel to a given height. The tube should not be tapped at any time.

(b) Procedure of break time determination. Flow of chlorine gas from cylinder is entered into mixing chamber through a flowmeter, At the rate of 7.85 cc per minute. At the other hand, flow of air (humidity is regulated 50%) enter into chamber from the entrance and is mixed with chlorine gas there. And then this mixed flow is regulated, 1,570 cc per minute and is passed through absorption tube and temperature regulator into detecting bottle. Water (20°C) goes around the temperature regulator and circumstance of absorbent tube from a thermostat in order to regulate the temperature.

When the whole condition of test is provided, test flow is passed through absorbents in a tube. Time is determined until the colour of solution of detecting bottle changes blue and this time is decided as absorptive capacity for absorbents.

(c) Method of detection. By means of changing 2% solution of KI solution added a few of starch blue.

ABSORPTIVE CAPACITY FOR VARIOUS ABSORBENTS

	Cocoanut Shell Charcoal	Granulated Charcoal	Cocoanut Shell Charcoal No. 2	Granulated Charcoal No. 2	Soda Lima	Soda Lima No. 2
Chlorine	over 85	75-90	75-90	65-80	over 40	50
Chloropicrine	over 100	95-110	100-120	85-95	0	0
Phosgene	50	-	-	-	-	-
Hydrocyanic Acid	9-10	6-7	70-90	60-70	-	-
Arsine	10	9	over 70	over 60	-	-

(Above figures refer to minutes)

ABSORPTIVE CAPACITY FOR VARIOUS CANISTERS

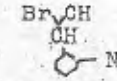
	Model 93 No. 2 Canister	Model 93 No. 3 Canister	Sub-Canister Type II	Sub-Canister Type IV	Direct System Cocoanut Coal #1	Canister Cocoanut Coal No. 2
Chlorine	over 70	over 40	-	-	25	20
Chloropicrine	90-110	60-70	-	-	30	25
Phosgene	30-35	20-25	-	-	-	-
Hydrocyanic Acid	11-13	7-8	-	-	3-5	over 18
Carbon Monoxide	-	-	over 90	over 30	-	

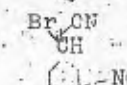
(Above figures refer to minutes)

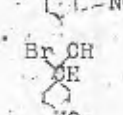
CONDITIONS FOR GAS ABSORPTIVE TEST

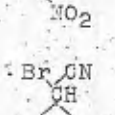
	Testing Gas	Gas Flow	Gas Concentration	Depth of Absorbent Layer	Temperature	Humidity	Method Detecting Break Point
Charcoal	(Chlorine)* (Chloropicrine)**	500 cc/min/cm_2	0.5%	10 cm	20°C	50%	By changing colour of pot. iodide starch solution blue.*
							By changing colour of pot. iodide starch sol. blue after decomposition.**
Soda Lime	Chlorine	500 "	0.5%	10 cm	20°C	50%	Same with the case of charcoa
Hopcalite	Carbon Monoxide	500 "	1%	5 cm	15°C	100%	By changing colour of palladium chloride test p per dark brown
Chief Canister	Chlorine	30 l/min	0.5%	-	20°C	50%	Same with the case of charcoa
Sub Canister	Carbon Monoxide	30 l/min	0.5%	-	15°C	100%	Same with the case of hopcal

1

1. 
o-Nitrobromobenzylcyanide

2. 
m-Nitrobromobenzylcyanide

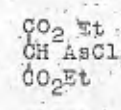
3. 
p-Nitrobromobenzylcyanide

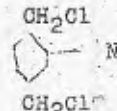
4. 
Bromobenzylcyanide

5. $CN.CH_2COO\ Et$

6. $CN.CO_2CH_3$

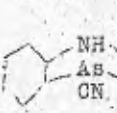
7. $ICH_2.CO_2Et$

8. 

9. 

10. 

11. BrCN

12. 

13. $H_4Fe(CN)_6$

14. Diphenylarsinebromide.

15. Diphenylarsine fluoride (difficult)

16. Tetrochlorodinitroethane $NO_2-\overset{Cl}{\underset{Cl}{C}}-\overset{Cl}{\underset{Cl}{C}}-NO_2$

17. Chloropicrin Cl_3C-NO_2

18. Hexachlorodimethyloxalate $\begin{matrix} COOC.Cl_3 \\ COOC.Cl_3 \end{matrix}$

19. Diphosgene $CO\begin{matrix} O.C.Cl_3 \\ Cl \end{matrix}$

20. Hexachlorodiamethylcarbonate $CO\begin{matrix} OCCl_3 \\ OCCl_3 \end{matrix}$

21. $ClCH{:}CH\ AsCl_2$ - NOCl composition unknown

22. Bromolewisite

23. Fluorolewsite (HF) Very good

24. AsF_3

25. Fluorolewisite + NOCl

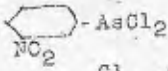
26. Bromolewisite + NOCl

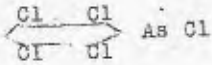
27. Diphenylchloroarsine

28. Diphenylbromoarsine

29. Diphenyliodoarsine

30. Diphenylcyanoarsine

31. m-Nitrophenyldichloroarsine 

32. Tetrachlorophenyldichloroarsine 

33. $S\begin{matrix} C_2H_4AsCl_2 \\ C_2H_4AsCl_2 \end{matrix}$

34. $S\begin{matrix} C_2H_4AsCl_2 \\ C_2H_4Cl \end{matrix}$

35. o-Toluyldichloroarsine

36. m-Toluyldichloroarsine

37. p-Toluyldichloroarsine

38. o-Chlorophenyldichloroarsine

39. m-Chlorophenyldichloroarsine

40. p-Chlorophenyldichloroarsine

41. o-Bromophenyldichloroarsine
42. m- "
43. p- "
44. x-Naphthyldichloroarsine
45. B- "
46. S $(CH_2CH_2Cl)_2$
47. S $(CH_2CH_2F)_2$
48. S $(CH_2CH_2Br)_2$
49. S $(CH_2CH_2I)_2$
50. Chloroacetophenone
51. o-Nitrochloroacetophenone
52. m- "
53. p- "
54. Dichlorodimethylether
55. Dibromodimethylether
56. Diiododimethylether (negative)
57. Methylaminedichloride $CH_3.N.Cl_2$
58. Perchloromethylmercaptan
59. $CH_2.CH.CHO$ Acrolein
60. Phenylcarbaminechloride
61. Methyldichloroarsine
62. Ethyldichloroarsine
63. Propyldichloroarsine
64. Butyldichloroarsine
65. Amyldichloroarsine
66. Hydrozinehydrate
67. Chloroacetone
68. Bromoacetone
69. Iodoacetone
70. Chloromethylmercaptan
71. Dichlorodipropylsulphide
72. Dichlorodiethylselenide (bad odor)
73. Chloroethylmercaptan

74. Ethylchlorsulphate
75. Methylchlorosulphate
76. ClCH:CH AsS (Ship paint)
77. $ClCH_2$: CH AsO
78. Diphenylarsinesulphide (Ship Paint)
79. Diphenylarsine organic acid derivatives (Ship Paint)
80. Diphenylarsine ferrocyanide (Ship Paint)
81. Diphenylarsine ferricyanide (Ship Paint)
82. Phenylphosphorousdichloride (didn't come out)
83. Dichlordiethylsulfone and its derivatives
84. Trichlorotriethylarsine, HCl, HBr $AsCl_3$ salts, and its derivatives
85. Bromopicrin $Br_3.C.NO_2$
86. Chloral-pds.
87. Dichlorvinylarsinchloride (cyanide)
88. Phosgene oxime
89. Hydrocyarsine
90. Tetramethylenedichloroethane

The production method of mustard gas in Japanese navy divides two stages.

That is:

(1) Synthesis of thiodiglycol.
(2) Chlorination of thiodiglycol.

The first stage or synthesis of this diglycol carries on at certain factories of people, and the navy has only a small scale factory such as pilot plant with object of establishing the production method of thiodiglycol.

The second stage or chlorination of thiodiglycol are carried on by this Sagami naval arsenal.

We had directly synthesized the mustard gas with monochlorosulphide and ethylene, but not were successful in establishing the synthetic procedure.

Synthesis of this diglycol. This diglycol is synthesized by following chemicle equation.

(1) $C_2H_5OH = C_2H_4 + H_2O$
(2) $Cl_2 + H_2O = HOCl$, $HOCl + C_2H_5 = ClC_2H_5OH$
(3) $2ClC_2H_5OH + Ca(OH)_2 = C_2H_4O + CaCl_2 + 2H_2O$
(4) $NA_2S + H_2SO_4 = H_2S + NA_2SO_4$
(5) $H_2S + 2C_2H_4O = S \begin{matrix} C_2H_4OH \\ C_2H_4OH \end{matrix}$

That is:

(1) Generation of ethylene by decomposing and dehydrating of alcohol.
(2) Synthesis of ethylenchlorohydrine with ethylene, chlorine and water.
(3) Generation of ethylene oxide by decomposing the ethylene chlorohydrine with milk of lime or caustic soda.
(4) Generation of hydrosulphide with sulphuric acid and sodium sulphide.
(5) Syntheis of thiodiglycol by bubbling a ethylene oxide and hydrosulphide into water.

We explain the every process.

Generation of ethylene. $C_2H_5OH = C_2H_4 + H_2O$

This, generating plant, consists of flowmeter, evaporator of alcohol, generating pipe, water condenser, vacuum pump and gas meter. Generating pipe is charged by 30 kg of forming acid clay as catalyst and heated in furnace at at 350-600°.

When alcohol is passed into the catalyst as vapour which is vapourized in the evaporator, alcohol is dehydrated and decomposed into ethylene and water. Ethylene gas is taken out of furnace directly by pump and cooled by condenser, so a moisture which mixes in the ethylene which has no moisture passes through in the flowmeter and is sent into the gas holder.

Synthesis of ethylenechlorohydrine. $H_2O + Cl_2 = HOCl + HCl$
$HOCL + C_2H_4 = ClC_2H_4OH$

Synthesis plant consists of synthetic tower, circulating pump and gas condensor, and main plant is synthetic tower. Tower is made by porcelain which inner volume is about 800 l.

Previously, water is charged in this tower and agitated and circulated by the pump. Then, chlorine and ethylene injected into the tower, so ethylene, water and chlorine react with each other and ethylene chlorohydrine is synthesized. When the concentration of ethylene chlorohydrine reached at 5%, we inject a water continuously into the tower, so ethylene chlorohydrine overflows the tower continously and flows into tank of hydrine.

Generation of ethyleneoxide.

$$2ClC_2H_4OH + Ca(OH)_2 = 2C_2H_4O + CaCl_2 + 2H_2O \quad \text{or}$$

$$ClC_2H_4OH + NaOH = C_2H_4O + NaCl + H_2O$$

Plant consists of decomposing vessel, condenser of moisture and reserver of milk of lime.

About 300 kg of ethylenechlorohydrine solution is charged in the decomposing vessel and heated up to 80-90°C. Pressure of the vessel is reduced to 500-600 m.m. Hg. by the vacuum pump. Then, we drop down the milk of lime on the surface of the hot ethylenechlorohydrine solution. So the ethylenechlorohydrine is decomposed and generate the ethyleneoxide. After the moisture which is mixed in the gas is condensed and separated from the gas by the condenser, the ethyleneoxide is sent into the next synthetic vessel.

(4) Generation of hydrogenesulphide.

$$Na_2S + H_2SO_4 = Na_2SO_4 + H_2S$$

When we drop down a 20% solution of sodium sulphide into a 50% solution of sulphuric acid, the hydrogenesulphide gas is generated and reserved in the gas holder.

(5) Synthesis of this diglycol.

$$H_2S + 2C_2H_4O = S(C_2H_4OH)_2$$

The synthetic plant is a ironic vessel which inner surface is lead lining and has a stirrer. Previously, water solution of caustic soda

which concentration is 0.5% is charged in this vessel. We maintain at temperature of the liquid at 50° C and agitate the liquid by stirrer then we send the ethylene oxide and hydrogenesulphide into this reagution agent. Gas volume ratio of ethyleneoxide and hydrogenesulphide is 3.5 to 1. Ethyleneoxide is reacted with hydrogenesulphide which is absorped in the caustic solution and thiodiglycol is synthesized.

When concentration of thiodiglycol reached at 30-50%, the reaction is stopped.

After all reaction matter is neutralized by dilute sulphuric acid, this is sent in distillation still. We dirtilate this solution at pressure of 50-60 mm. Hg. and separate out the water. Finally, we take the thiodiglycol out of the still.

Summary.

We used this plant to try an experiment of solution of problem which carried into the process of production. The factories of people are such as our factory except which capacity is large scale. Capacity of all factories is aimed at 1000 tons per year but a construction of plants proceeded not smooth. And then we were converting the factories of thiodiglycol into that of glycol, diglycol, and styrol.

Chlorination of thiodiglycol.

$$S(C_2H_4OH)_2 + 2HCl = S(C_2H_4Cl)_2 + 2H_2O$$

We charge a 200 kg of thiodiglycol and a 700 kg of hydrochloric acid which concentration is 37% in reaction vessel and heat at 80° and agitate the liquid with stirrer.

When reaction is completed after ten hours, mustard gas is settled at the bottom of the vessel. We absorp up the gas in the settling tank. After we settle the gas about ten hours, we neutralize the hydrochloric acid which is mixed in the gas with caustic soda. Finary, we purficate the gas with method of vacuum distilation.

We have a plant in this arsenal which capacity is 1000 tons per year, but do not use full plants, because of unsuccessful of production of thiodiglycol.

Manufacturing Method of Mustard Gas from Monoclorosulphide

This reaction depends upon following chemical equation

$$S_2Cl_2 + 2C_2H_4 = S(C_2H_4Cl)_2 + S$$

Manufacturing Process.

At first, we charge 100 kg S_2Cl_2 in porcelain vessel and babble

ethylene into it continuously with stirring. Volume of the gas is 15-30 liter per a minute. The temperature in vessel is gradually used by reaction heat and when it reached at 45-50°C., it is hold in the temperature by outside cooling. This babbling is intersepted when ethylene gas was used about 70m.

During this reaction, free sulfor deposit and sinks at the bottom of the vessel. After reaction is completed, the upper part of the liquid, that is mustard gas, is put out and mixed with a great deal of water. Excess S_2Cl_2 is decomposed and settled for some time and at last mustard gas is separated from water.

In this reaction, most noticeable factor is water, on account of slight water, mustard gas turns the brownish black paste. So the water which is, of course, in the vessel and gas in the ethylene, is eliminated.

In this arsenal, this manufacture is very small scale and we have a many unknown problems.

TOXICITY DETERMINATIONS
By Capt T. Yuasa

1. All agents synthesized for animal test (toxicity test). About the toxicity of agents synthesized, we set the standard upon mustard and Lewisite, and tried the animal test, comparing with these. We found, however, that there was nothing more effective than these two. We tried the animal test for toxicity about the effect by inhalations and the grade of skin injuries. This method is shown in following clauses.

2. All toxicity data on above gases. Methods and drawing of chambers. The records about the toxicity data are not clear because of burning, but the method for the determination of gas toxicity is as follows:

a. The coefficient of toxicity. (The effect of inhalation.) We take the certain quantity of an agent into the chamber, change it to vapor if it is solid or fluid, put test animals into the chamber when the vapor concentration is settled, then take out them after thirty minutes (but five or ten minutes in the case of systemic gases), and feed them ordinarily in the room. And, when fifty per cent of these test animals are dead by the inhalation of the toxic air within forty-eight hours after the experiment (but seven days in the case of vesicant gases), we use the product of that concentration and the test time as the coefficient of toxicity.

Remark: At the experiment, we record the temperature and the humidity in the chamber and the temperature in the open air.

As we have no apparatus that keeps the temperature and the humidity in the chamber always constant, we tried the experiment above-stated in a short period of comfortable weather.

As test animals, we use mainly birds (uroloncha domestica), mice, guinea pigs, and rabbits; but sometimes cats, dogs and monkeys.

b. The effect of skin injuries. We use as test animals usually healthy rabbits, remove the hairs of the abdomens or the backs, wash with water and dry in the sun. Then we apply here a few drops of the certain chemicals, and observe the grade of skin injuries caused by these chemicals.

The method of decision:

Symptoms	Mark for the grade of injuries
Erythema	+
Erythema and swelling	++
Erythema, swelling and induration	+++
Erythema, swelling, induration and necrosis or ulcer	++++

Remarks: We observe and record the result of the experiment after 1, 3, 6, 24 and 48 hours. We have always a standard on the skin of the same animal.

Information on treatment of gas casualties. Research on which that is based.

The effect of these medicines is decided by animal tests.

The practical and clinical application of these medicines are tried about the patients of gas casualties which are occasionally injured in our factory.

The medicines which we may use at the medical treatment of gas casualties are tested mostly according to the literatures published at the previous European War.

APPENDIX C -15

SUBJECT: Chemical Warfare (Medical Aspects)

DATE : 17 October 1945

INTERVIEWED: Lt. Col. Minomiya, Japanese Army Medical School
Lt. Col. Okumura, 6th Army Laboratory

INTERVIEWERS: Maj. H. Skipper, Maj. Jake Nolen (CWS), Lt. Yamada

When questioned as to the division of work between the medical section of the 6th Army Laboratory and the Army Medical School it was explained that the Medical School studied Mechanism of action and treatment of gas casualties while the Medical Section of the 6th Army Laboratory worked on defensive equipment, offensive toxicology, first aid, and carried out some work on mechanism of action.

In a discussion of mechanism of action of mustard in the body Col. Minomiya explained that he believed mustard acts on glutathione (combining with it). His reasons were twofold: (1) H reacts with SH group in test tube (2) when H was injected into the body of rabbits (10 mg injected subcutaneously) he found that the quantity of glutathione in the blood (as determined by Goddard's method) decreased. Col. Minomiya added that he believed some of the toxic action of H due to action on Glutathione and perhaps this was the mode of combination with epithelial cells.

RNH_2 + H (in test tube) reaction slow
NaSH + H (in test tube) fairly rapid action
R - S - H + Cl - C - C - S - C - C - Cl - proposed action in body.

He also suggested the reaction with the amino acid methionine as above.

Q. Can this reaction between Glutathione and H be reversed?
A. No, if that were possible treatment would be very simple.

Q. Did you find any compound which would reverse this reaction in vitro?
A. No.

Q. Were the above mentioned two tests the only proof of the reaction of H with SH?
A. Yes.

Q. Was any tissue respiration or Radio active tracer work done?
A. We wanted to do this kind of work but didn't have a chance.

Lewisite

The two medical officers thought that the mechanism of Lewisite action was the same as that of H. It was studied in the test tube. No animal experiments were carried out.

Q Did you ever treat L with sulfhydral compounds?
A We tested thio sulphate.

Q No, we mean thio alcohols?
A No work on thio alcohols. We do not know much about the biochemistry since only NDS worked on this problem.

Q If no chemists were concerned with this problem on what basis did you choose compounds for test as therapeutic possibilities?
A By reading the literature. In the 6th Army Laboratory chemists were consulted, but in Japan any work dealing with animals is usually the concern of Medical Officers.

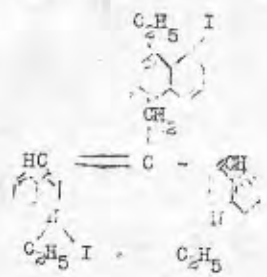
Q Did the Army go out and ask outstanding chemists to help on study of treatment of gas casualties?
A Most of the University workers did not care to take up work on chemical warfare. The Army kept all chemical warfare agents.

Q Don't you think you could have made more progress with help of best chemists?
A The people in the Laboratories thought so but could not obtain permission from the top. Top did not like the idea, thought it too dangerous.

Q Could you bring in chemists to help at the Army Medical School?
A No, this was not allowed at Army Medical School. The 6th Army Lab had discussions with University workers.

Q Did you study compounds which might speed up healing time of H burns?
A Thought that as soon as decontamination was completed they had to let nature take care of the rest. Nothing they knew of would speed up healing of burns.

Q What about "Ko Ha-?" ("Ko Ha" used to sensitize infra-red filters - is reported by the 9th Jap Army Lab as good for frost bite, thermal burns and leprosy.)



One drop of 10% H in alcohol was placed on the ear of guinea pigs (rabbits had run out) and two methods tried, (1) "Ko Ha" in saline solution was injected (subcu) (0.02 mg of compd/day); and though the experiments were incomplete it appeared that a rather high per cent of the animals were dying. (2) "Ko Ha" was administered in tablet form per os (0.02 mg/day) for 4 days and it appeared that if the quantity was too great no beneficial effect was noticed. The 0.02 mg/day dose appeared to lessen the damage as compared to the control. This was judged by casual observation of the degree of injury to the guinea pig's ear.

Control	Ko Ha
8/10 Burns	5/10 Burns
	These burns less severe

The above was the best results from the desired quantity.

The Colonel stated that more tests were required before any definite statements could be made. He thought also as a result of casual observation that the "Ko Ha" animals required a shorter healing time than did the controls (watched for 15 days)

Q What do you think was the physiologic action of Ko Ha?
A Don't know.

Q Had tests been carried out where "Ko Ha" was placed on burned area?
A No, planned to start that work. Had begun work on "Ko Ha" in April.

Q How was it applied for thermal burns by 7th Lab?
A Don't know.

Q The 7th Lab did considerable work on this subject didn't they give you their report?
A Sent to 7th Lab for sample, they told him it was good for thermal burns so he decided to try H burns.

Mustard Vapor Effects

Q What do you consider the lethal ct for H vapor in temperate climate (mask worn, no protective clothing)?
A Don't know exactly, but would estimate greater than 20,000 to 30,000 to kill.

Q What do you think about the relative effectiveness of H vapor on the skin in summer or winter (temperate and tropical)?
A It was their supposition that when the pores are open more gas is absorbed. Workers get more and worse burn in the summer.

Q Did you use human volunteers for chamber work on H?
A No, some work was carried out a number of years ago using a continuous flow vapor cup.

Q What did you do in your large gas chamber?
A Just work on non-dangerous compounds, DC and CN.

Q Did you study protective clothing in large chamber?
A Not to knowledge of Col. Okumura. (Col. Okumura has been at 6th Army Lab since last March, before this was with Gen. Akiyama in Manchuria).

Q Were there field tests using human volunteers in Manchuria?
A Yes, but principally for other purposes in which clothing was exposed to H vapor.

Q What is your lethal CT for mustard vapor without the mask?
A Rabbits 5500, guinea pigs 2300, man may be less than these figures.

Q What is the dose for incapacitation of man with the mask; no protective clothing?
A Estimated at 8000. Genitals hit first followed by axillae, neck and tender tissues.

Q Again the difference between summer was brought up.
A They thought that perhaps there was a difference of 1000CT, but had no experimental data on this point.

Q What CT is required to incapacitate without the mask?
A Eyes are affected very rapidly; they judged about 1000 $mg/mins/m^3$. They did not believe it to be a constant value. They suggested that there was more damage from a high concentration for a short time than from a low concentration for a long time (CT same in both cases). This too was just a surmise since they had no data to back up their belief.

Treatment of H contamination with anthranilic acid

Q How late after H has been put on the skin can you expect good results from anthranilic acid?
A About 10 minutes.

Q Would it reduce the size of the burned area if applied 1 hour after contamination?
A Yes a little. This was done on rabbits. It was proved that the LD_{50} by absorption of liquid H through the skin could be increased by use of anthranilic acid as long as 30 minutes after applying H.

Q Did you carry out in vitro experiments with anthranilic acid?
A Yes, at the Army Medical School the rapidity of action of H + Glutathione and H + Anthranilic acid were compared, the former was the faster.

Q Did the Army Medical School teach the use of anthranilic acid?
A They notified the Medical Officers about the effectiveness of this compound, but there had been no distribution of the agent yet.

Q Do you think anthranilic acid is significantly better than Chloramine T?
A Yes, but it costs much more.

Q Why do you think it is better?
A Because it not only decontaminates, but also washes H from the skin (even down in skin) like kerosine.

Q Can you treat H contamination later with anthranilic acid and expect beneficial results?
A Yes.

Q How late can you use anthranilic acid?
A On border line case: chloramine T - 5 mins.; anthranilic acid - 20 mins.

Q Which is the better compound if used within the first 2 mins?
A No difference.

Atropine

Q For what is the atropine in your medical chest for treatment of gas casualties?
A For dilation of the pupil

Q What agent causes constriction of the pupil?
A Mustard.

Q What do you use to counteract spasm of the ciliary muscle?
A (After quite a discussion it was decided they didn't know any agent that would cause spasm of the ciliary muscle, nor any compound to counteract it).

The Medical Officer of the 6th Army Lab was requested to get data on the incapacitating and lethal CT (estimated for man with and without the mask) for H, L, CG, HCN. He was not certain of this data since he had been at the Lab but 1½ years and little work had been carried out on this subject during that time.

APPENDIX C -16

SUBJECT: Japanese Navy Chemical Warfare

INTERVIEWED: Capt K Hiratsuka, Capt S Tsuruo

INTERVIEWER: Maj H B Skipper

DATE: 12 October 1945

Capt Tsuruo went over the paper on the Kure experiments that he had prepared (covered in previous conference notes). He stressed the point that CN was very persistent and effective inside ships because ventilating systems were not good enough to take care of it. The small cans filled with DC (which were inserted in the H. E. Shells) could be used from indicated guns on following ships:

a. Small destroyer and torpedo boats (12 cm guns)
b. Large destroyers (12.7 cm guns)
c. Cruisers and new type battle ships carrying 14 cm guns.
d. Old type battleships (Kongo class) 15 cm guns.

Mixtures of CN and DC were found better than either alone. DC could be used only with base fuze type, because nose fuze type shell made a large hole in steel plate and effectiveness of DC was lost too quickly.

WOODEN AIRCRAFT BOMB (CHARGED H). (See Incl 1 prepared by Sagami Naval Research Lab). The research on this weapon was made necessary by steel shortage in 1943. It was never produced, but dropping trials were carried out on it. The performance of the wooden bomb was good; an area of about 900 to 1,000 square meters was contaminated to the extent of 5 gms/m^2.*

When questioned on method of vapor assessment, they replied that this was done with animals, since they had not been successful in field vapor sampling. The Sagami Naval Arsenal possessed 8-10 accordion-type samplers but didn't use them much.

Were the meteorological aspects of gas cloud travel studied at Navy Lab?

A. No, simply observed wind speed temperature and cloud cover in field work (very limited).

* They considered contamination of >5 gms s/m^2 effective liquid contamination

CAPT HIRATSUKA. Organic chemist. Tokyo Imperial U. 3 yrs, graduated in 1925, then went directly into Navy. At first worked at Sukiji (Naval Technical Institute), Tokyo. He was in Germany, France, and U. S., 1931-32 visiting chemical factories etc.

NOTE: This man is a very capable chemist and was very frank and cooperative--the most impressive seen at Sagami Naval Lab. When asked the criterion used for judging a possible CW agent, the reply was:

1. Stability
2. Effect on animals
3. Difficulty of synthesis
4. Availability of raw materials
5. Vapor pressure
6. Odor
7. Mask Penetration

Capt Hiratsuka was asked to write comments on compounds he synthesized while at Sagami Naval Research Lab (15-year period). These comments are appended as Inclosure No. 2.

Work on floating H (in petroleum) was attempted about 14 years ago; it was considered unsuccessful. On small ponds it was all right but in the sea it is not persistent (washes onto shore, etc).

Gas ageinst ships was not considered effective. Too hard to get high concentration, too hard to hit, and planes must fly too low in order to spray. Petroleum added to H was believed to increase its effectiveness from airplane spray (wetting action).

Polyvinyl chloride 7%, methylmethacrolate 2% mixture was used in H bombs. It was believed to increase persistence of H 2-3 days, "even in rainy weather".

Capt Hiratsuka was originator of HNO_3, ethyl alcohol rocket fuel using dimethyl or diethylamine ignitor. He was working on this at end of war.

Incl 3 is Capt Tsuruo's summary of Naval CW Research Policy. Incl 4 is the Japanese version of a tear gas field test.

Encl 1 - Prepared by Japanese Navy

THE FIELD TEST ON DESIGN
OF THE WOODEN BODY MUSTARD BOMB

1. OBJECT. In this field test we study the practical usefulness of the wooden body mustard bomb which we designed to save iron material.

2. PROCEDURE. In this field test we studied only poisonous effect. We test the mustard poisonous effect by the method that we collect the constant volume of infected soils and sands from the constant points and analyze quantitatively it. The collection points are 91 points; that is, the explosion point and the interesting points of concentric circles, which center is the explosion points and radius are 5m, 10m, 15m, 20m, and 25m, and 16 radial straight lines from the explosion point. The collection volume of soils and sands is 20 centimeters square and 2 centimeters thick.

Quantitive analysis is that after man has added 200 cc alcohol to the collected soils and sands and stirred well to extract mustard with alcohol, man filters it, neutralizes the filtrate with $\frac{N}{10}$ KOH, heat to hydrolysis it in 90° C for an hour and ti- $\frac{N}{10}$ trates it by $\frac{N}{10}$ KOH with phenolphthalein as the indicator. And then by $\frac{N}{10}$ calculation man can know the mustard quantity per one square meter ground in the all points. Accordingly we can draw iso-mustard quantity lines. However, we draw only the iso-mustard quantity lines for 5 grm/m^2 and we discuss the mustard effect by the area which its line encircles. However, for the standard of "5grm/m^2" we have no special experimental base and it is based on our presumption that this extent will be certainly effect. And yet the surgeon performed the animal test to make sure this discussion. (The detailed record was lost)

a. The 1st test. May, 1944, at Heisaura. One wooden body mustard bomb and one service type were standed at intervals of about 100 meters and were explored electrically. There was not a wide difference between the two and the area of 5 grm/m^2 was about 800 m^2 and after 24 hours about 100 m^2.

b. The 2nd test. May, 1944, at Heisaura. One wooden body mustard bomb and one service type were dropped from height 500 m at intervals of about 100 meters. They were both lower result compared with it of the 1st test and tend to bring a large quantity of mustard to the bomb hole.

c. The 3rd test. June, 1944, at Yashiro. The wooden body mustard bombs in the 1st and 2nd test had 600 grm of explosive in the center and 600 grm in the head and their head iron plate had a thickness of 3 mm. We think, the more the quantity of the head explosive and the thickness of the head iron plate the less the quantity of mustard into the bomb hole and the more the infection area. Therefore, in the bomb

we decreased the center explosive to 400 grm, increased the head explosive to 900 grm and thickness of the head iron plate to 25 mm. This two bombs were standed and explosived electrically. A drop of mustard was greater and was slaver like of an ox and therefore their persistents were greater than it of the 1st and 2nd test, but their dispersion were ununiform.

d. The 4th test. July, 1944, at Kashima. This two bombs were dropped from height 2,000 m. The quantity of mustard into the bomb holes were greater than it of the 2nd test and the areas of 5grm/m^2 were smaller.

e. The 5th test., August, 1944, at Kashima. As a result of the above four tests this bomb must have more quantity of explosive in the center and in the head. In this test we tested on the bomb which had 600 grm of explosive in the center and 1 kg in the head. 1 kg is the maximum filled quantity in the head. This two new bombs were dropped from height 2,000 m. The areas of 5 grm/m^2 were about 1,000 m^2 and good spreaded.

3. Conclusion.

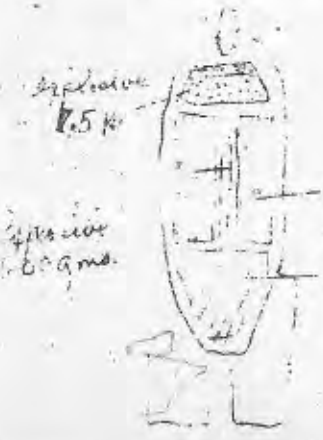
a. The wooden body mustard bomb needs 600 grm of explosive in the center and 1 kg in the head.

b. In this bomb we cannot expect fragment effect, but its poisonous effect is better than the service type.

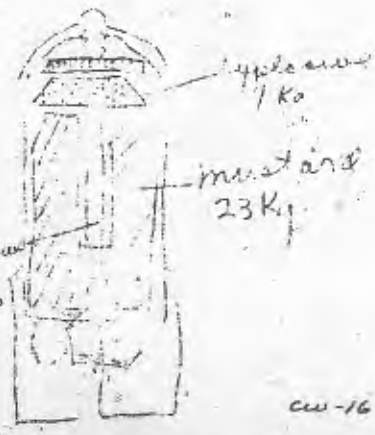
c. The needed iron material for the wooden body mustard bomb is about 30% of it of the service type.

Reference:

The service type



The wooden body bomb



cw-16-4

Ind 2

(Japanese translation) CONFIDENTIAL

CONCLUSIONS ABOUT NEW AGENTS PREPARED AT THE SAGAMI NAVAL RESEARCH LABORATORY (CW)

By Capt K Hiratsuka

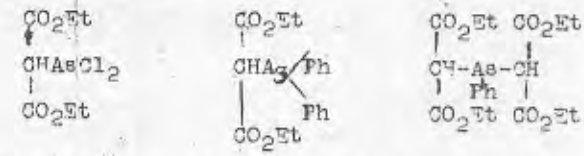
for

Scientific Intelligence Survey

1. Nitro-derivatives of bromo-benzyl-cyanide increase scarcely any lachrymatory effect. They all show some tendency of skin-irritating action. The disadvantage of decomposition in contact with metals (except lead) is not eliminated. The field of synthesis was in general poor. In conclusion, we need not prefer nitro-compds to mother subs.

2. In CN compds, the toxsity depends only on the contents of CN-groups, derivatives of which increasing the M.W. lowers the vapor pressure, and rapid attacking properties of it decreased or vanished. HCN, BrCN, ClCN exploded sometimes spontaneously. Explosion starts at the vapor phase, and very small amount of SO_2 dissolved in liquid phase, partially in present in gas phase prevents the explosion efficientlly. ICN was not tried, as the source of Iodium in Japan is scanty.

3. Halogeno-acetic acid esters (Bromo. Iodo) showed some lachrimatory action, but nothing new was found more than described in literature.

4. 

and their allied arsenical substances showed decreased toxcityes from their mother arsenicals. Some of them easily suffer hydrolysis by atmospheric moisture.

5. In nitro derivatives of benzyl chloride, o-compd showed some skin-irritating action, and others not. But the former tends to decompose in contact with ordinary metals. Their lachrymatory effect was not improved.

6. Cyan-adamsite suffers hydrolysis very easily and decompose well in the flash of explosives.

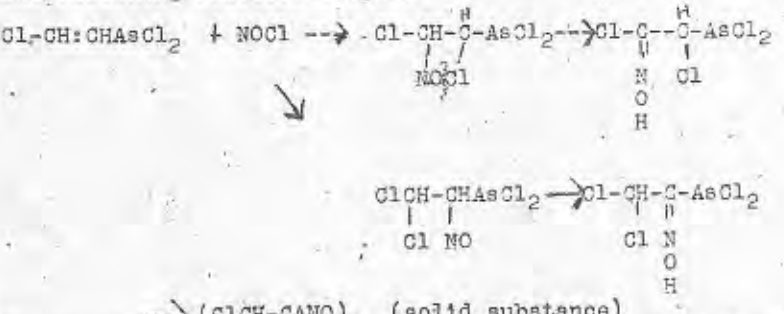
7. $H_4Fe(CN)_6$, when heated slowly, produces theoretical amount of HCN, but carbonises when rapidly heated.

8. In dichenyl-arsine series, fluoride was difficult to synthesize, while others showed no peculiarity from chlor- or cyan- comnds. Toxic-smoke-formating property remained the same, or even diminished.

9. In chlor-nitro-methane series lachrimatory and lung-irritant effect increases with their chlor-contents, chlor-picrin being the most active, trinitro monochlor methane the least and their properties approache to nitric acid plus hydrochloric acid. Likewise, in chloro-nitro ethane series tetranitro-dichloro ethane being the least effective resembling trinitro-chloro-methane, while dinitro-tetrachloro ethane is excellent tear and lung irritant gas even superior to chloropicrin. But the latter has a serious defect of decomposing in the flash of fire (explosion fire).

10. In phosgen series the lung irritant action depends only on the contents of phosgen produced, but diphosgen is somewhat inferior to the former. Hexachloro-dimethyl-oxalate proved to be the most desirable as it is easy to work with (solid, low-vapor pressure) liable to produce 3 $COCl_2$ and CO on the burst of shell by explosives, and fairly stable. Hexachlordimethyl carbonate also decomposes to 3 $COCl_2$, but not completely. Yet undecomposed substance act as an irritant agent to far less degree. Phosgene Homologues increases, their odor with M.W. increase.

11. Lewisite (primary) $ClCH{:}CHAsCl_2$ and its homologus were mixed with NOCl gas in the cool place. We obtained an liquid devoid of Lewisite odor and some crystalline solid precipitated, the latter containing no arsenic. The liquid had very strong vecicant on skin twice as strong as ordinary Lewisite (animal test), but decomposed gradually to less active agent. It suffered hydrolysis very easily. We imagine the following reaction stages:



$\longrightarrow (ClCH\text{-}CANO)_n$ (solid substance)

The vapor had an intolerable action to mucous membrane ofnose and eyes, after a little time delay.

Cw-16-L

12. M Halogen substitutes of Lewisite, the fluor compds ClCH:CH-AsF_2 was the most active with regards to toxicity stability to humidity, etc. We abandoned it because of our scanty source of Fluorine.

13. Ary-arsine dichloridss were prepared but none of them exceeded phenylarsine dichloride in tactic point of view. M-nitro phenyl arsine dichloride was somewhat interesting as it acts also vesicantly. Except by nitro compd all benzen nucleons substituted phenyl arsine dichlorides decreased their toxic (skin irritant) action with M.W. increase.

14. In halogenated acetone bromo and Iodo-acetone were the better tear agent than chloro-compound. But their effectiveness was far less than that of chloro acetophenone series.

15. Nitration of chloro acetophenone adds to it some tendency for skin-irritant action, the ortho comp. the most. The lachrimatory effect decreases to some extent in general. But when heated to produce a tear smoke it is apt to decompose more easily than the mother compound.

16. Halogenated methyl ether is very sensitive to atmospheric humidity, while halogenated ethyl either has little or no labrinthic property. In conclusion they have no value in chemical warfare except in the case of using them as solvents.

17. Methyl aminedichloride was expected to decompose by heat by the formula $CH_3NCl_2 \rightarrow 2HCl+HCN$, but we found that it reacted the other way, producing unknown substance, probably polymerise HCN products. Moreover it took fire to serious explosions.

18. Phonylcarbamine chloride and Perchlormethyl mercaptane were prepared as intermediate of other chemicals.

19. Aeroleine, crotonylaldehyde were not good lachrimators.

20. Methyl and ethyl arsine dichloride are good agents, perhaps better than Lewisite in its proper vapor tension, stability against humidity, etc. But as we found very easy method of manufacturing Lewisite, and we were not provided with numbers of autoclave to produce Methyl or Ethyl arsenic acid, Lewisite was prefered. Bromo-compds have too low vapor pressure. Iodocompds liable to decompose. Propyl-Amyl arsine dichlorides are less active agent, and have too low vapor pressure.

21. Hydrazine-hydrate is stronger than NH_3 in its toxicity, but easily oxidisable.

22. None was found useful (67) (68) (69).

23. Dichlorodipropyl sulphide has low vapor pressure, and proves to be good persistent agent, its vesicant toxicity being ½-1/3 of Yperite. It is mixed with Yperit to lower F.P. of the latter.

24. In Yperit series, we could not find any agent superior to Yperit. Bromo and Fluoro comds showed the same effectiveness as chloro-compd. Higher homologues (long chain Cl R-S-R-O-R-S Cl) were rather weaker vesicant agents.

25. Dichlorodiethyl selenide has bad odor, but not so effective as Dichlorodiethyl sulphide.

26. Chloro ethyl mercaptane, ethylchlorosulphate, methylchlorosulphate were prepared as intermediate of other chemicals

27. Some arsenicals (76) (77) (78) (79) (80) were prepared for the purpose of ship-bottom paint composition. Therei chlorovinylarsenious sulphide ClCH:CHAsS and Phenylarsenious oxide PhAsO proved to be very efficient.

28. The preparation of Ph-P-Cl_2 and its homologues were not successful.

29. Dichloro diethylsulfore and its derivatives were somewhat more stable against bleaching powder than Yperit, but their toxicity were smaller. Moreover, they were all solid, and lost the characteristic action of liquid Yperit.

30. Trichloro-triethylamine, and its salt ($HClAsCl_3$, $ClCH:CHAsCl_2$) was thought better than Yperit, notwithstanding its smaller toxicity, because of its stability against humidity or water, lack of its odor, difficulness of its decontamination, etc.

31. Chloral was prepared for insectide object.

32. Dichlorodivinyl arsine chloride and cyanide were prepared, but found less effective than Diphenyl-arsine compounds.

33. Phosgen-oxim suffers hydrolysis very easily. Its vesicant action being not so great, we abandoned further research.

In conclusion, we could not find new agent superior to Yperit Lewisite, chloroacetophenone, and hydrocyanic acid.

Incl 3 -(Prepared by Jap. Navy - By Capt TSUKUO

As above mentioned our chemical warfare research was chiefly its defensive and offensive method when chemical weapon was used at sea battle, but it became clear that since several years ago the attack of chemical weapon for the naval vessels is not so effective as considered and especially after the beginning of this war, the decisive battle between mutual vessels hardly occurred. So our chemical warfare research was limited to deffensive method only except gas bomb attack for base ground, we laid our importance to other research where we can use our chemical knowledge such as follows:

a. Fire extinguisher.

b. Paint for ship's bottom.

c. Military explosive and ammunition.

d. Incendiary agent combined with rubber.

e. Thrusting agent.

f. Bubble generator tube for submarine imitation.

g. Smoke weapon.

h. Utilizing of the manufacturing plant of gas to other chemical reagent such as dinlycol, styren.

i. Disinfectant of reverse soap such as arsen compound.

Incl 4 - Prepared by Jap. Navy

FIELD TEST OF TEAR GAS SHELL
at Matsaura, April, 1943

1. OBJECT. To examine the practical value of the tear gas shell in woods and open field.

2. PROGRESS OF THIS EXPERIMENT. We discharged in volley 100 shell per minute with 3 trench motors to the field 100 m length, 50 m width. For examination of gas effect, we put the gas catcher in the field in 10 m. interval. When the first shell exploded in the field this gas catcher is opened and after one minute it is closed and then we analyize the gas in it. When the discharge was finished, the experimenter went into the field and examined the gas effect by his senses.

a. In open field.

Weather - very fine
Atm temp - 20° C
Field surface temp - 22° C
Wind vel - 5 m

Concentration of gas in gas catcher - trace
Just after discharge there are some tear gas effect.
One hour after discharge no gas effect.

b. In the wood.

Weather - very fine
Atm temp - 20° C
Field surface temp - 22° C
Wind vel - 3 m

Concentration of gas in gas catcher - 30 mg/m^3.
Just after discharge we must wear gas mask.
One hour after discharge there are some tear gas effects.

3. CONCLUSION. This shell has a moderate gas effect at above-mentioned condition in wood, but in open field, tear gas effect cannot be expected.

CW-16-10

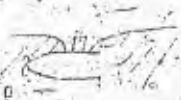
Incl 4 (cont'd)

FIELD TEST OF THE DISPOSITION OF THE BLIND BOMB
At Kashima, July, 1943

1. OBJECT. To examine the practicality of the disposition of the blind bomb by incendiary agent.

2. PROGRESS OF THIS EXPERIMENT.

a. The disposition ended about 30 min, not explosive. (fig 1)



b. This time is complete explosion. (fig 2)

c. The disposition ended about 30 min, not explosion. (fig 3)

d. The disposition ended about 20 min, but with incomplete explosion. (fig 4)

3. CONCLUSION. We can almost disrose the blind bomb using one package of incendiary agent for 60 kg bomb and 3 package for 250 Kg bomb. Even in worse condition there is not complete explosion but incendiary agent must be settled as far as possible from the fuse of the bomb.

FIELD TEST
1938, Kure

1943 - Disposition of blind or time bomb at Kashima.

1944 - On design of the wooden body mustard bomb. At Hewaura and Yashima.

1945 - On summary effect of lachrymatory shell for 2 centimeters trench motor, at Hetsaura.

Cw-16-11

APPENDIX CW 17

SUBJECT : Flame Throwers
DATE : 6 October 1945
PREPARED BY : Japanese Army Ordnance Bureau
REQUESTED BY: Scientific Intelligence Survey

The inclosed information was prepared by the Japanese Army Ordnance Bureau in response to a request for a summary of their research and development on flame throwers.

ON THE FLAME EJECTOR

October 6, 1945
Army Ordnance Bureau

A HISTORICAL SURVEY OF THE RESEARCHES ON THE FLAME EJECTOR

1. The outcomes of the First World War rendering prominent the necessity of this weapon, studies were started in 1918.

2. Two kinds, larger and smaller, were selected as the subjects of the studies.

a. The larger was contemplated as a stationary one in trenches, and the smaller, as portable for individuals. Both kinds having approached their perfection in 1926, engineer corps were supplied with them. But many defects being disclosed, from the practical point of view, they were modified and in 1933 M. 93 smaller, flame ejector was brought to light, while the larger one was given up, the difficulties in handling standing as chief obstacles.

3. M. 93 smaller, flame ejector was distributed to almost all troops and made use of on a large scale in the Sino-Japanese conflict. Many flaws, however, being found, it was further improved, and in 1940 M. 100 smaller, flame ejector was accomplished. During the Great Eastern Asiatic War, infantry and engineer troops were all equipped with flame ejectors of this kind (4-8 to each regiment). Both M 93 and M100 eject flames by means of the compressed air in the tank filled by a small air-compressor.

4. As for the flame ejector mounted on the vehicle, its studies were commenced about 1934, its accomplishment being brought forth in 1934. It was mounted on a caterpillared vehicle for researches' sake, but there being found defects, it was again modified. Though the researches had arrived at a successful conclusion in 1939, its production for practical use was not realized.

5. In order to make the supply easy, the flame agent was standardized as follows:

a. M.93 smaller flame ejector.....heavy oil 50%, gasoline 50%

b. Flame ejector for vehicle.....gasoline only

6. In regard to increasing its range, a brilliant idea was formed*, but could not be adopted on account of the difficulty of obtaining materials.

* Thickened fuels

DATA OF FLAME EJECTORS

1. Small type flame ejector.

Item	Data	Main Improvement
Small type	range.....20 m width of flame..... 3 m dia. of nozzle..... 7 mm time of ejecting..... 8 sec gasoline 1 flame agent light oil 5 heavy oil 2 quantityof flame agent.....10 l ejecting method - compressed nitrogen (25 A.P.) ignition method - percussion type weight, equipped.....25 kg use.....for individual	
M 93 small type Flame ejector	range.....25 m width of flame..... 3 m dia. of nozzle..... 7 mm time of ejecting.....10 sec gasoline 1 flame agent light oil 5 heavy oil 2 quantity of flame agent.....11 l. ejecting method - compressed nitrogen (at 25 A.P.) ignition method - percussion type weight, equipped.....23 kg use.....for individual	1. Increase of range (flame length) 2. Increasing of ejecting time. These improvements were done on the above-mentioned small type flame ejector

M 100 small type Flame ejector	range.....20 25 m width of flame..... 3 m	Adjustable ejecting time by using 5 mm and 7 mm nozzle. 2. Reliable function of ignition. 3. Adoption of compressed air instead of nitrogen. 4. Shortening of ejecting pipe in order to facilitate carrying. These improvements were done on the above-mentioned M 93 small type flame ejector.
2. Large type flame ejector.		
Item	Data	Main Improvement
Large type Flame ejector	range.....40 m width of flame..... 5 m dia. of nozzle.....14mm time of ejecting.....7sec flame agent gasoline 1 light oil 5 heavy oil 2 quantity of flame agent..40 l ejecting method - compressed nitrogen (at 25 A.P.) ignition method - percussion type use - for stationary in the trench	
Improved flame ejecter for vehicle	range.....43 m width of flame..... 5 m dia. of nozzle.....12mm time of ejecting.....100sec flame agent - light oil quantity of flame agent 750 l ejecting method - turbine pump ignition method - heating wire	1. Increase of range. (flame length) 2. Improvement of ignition method. 3. Improvement of ejecting method. These improvements were done on the above-mentioned flame ejector for vehicle

APPENDIX CW 18

SUBJECT: Chemical Warfare

ORGANIZATION: The 3rd Military Laboratory

PERSONS QUESTIONED: Major S. Kishimoto - Member, Research Staff of 3rd Military Laboratory.
Capt H. Kamei - In direct charge of Chemical Section of 3rd Military Laboratory.

DATE: 5 October 1945

MEMBERS OF SIS PRESENT: Major Howard E. Skipper
1st Lt Gordon T. Wallis (FEAF)

1. Major Kishimoto, upon request, furnished the following chart of the chemical section of the 3rd Military Laboratory.

Subsection 7.

Incendiary Bombs	Protection	Smoke Bombs
1. To determine regular type	1. Protection of planes	1. Improvement of regular type
2. Improvement of regular type	2. " " ground crews	2. Investigation of foreign type.
3. Investigation of foreign types	3. Protection of pilots	
	4. Decontamination of airfields.	

Personnel: 2 officers
15 civilians (none of whom were college graduates)

2. Capt. Kamei brought with him a part of the information requested at a previous conference, and the remainder he promised within a few days. The part he had finished was gone over in detail and the following notes made:

a. Page 1 - Munitions requirements in column 4 obtained by calculation from area of smoke bomb bursts (by assuming the size of the gas cloud to be the same as the size of the smoke cloud). This procedure followed except for Mustard, which they assumed to be smaller.

b. Page 2 - The explosive charge in the nose of the shell was placed there both to reduce the depth of the crater and to blow the agent back out of the crater to reduce crater loss. The type 12 instantaneous fuze was used with this bomb. Capt. Kamei knows nothing about the use of time fuzes. The welded bomb case leaked at the welds in the case of liquid incendiary fillings, so Capt. Kamei supposed, though he didn't know, it would in the case of Mustard, also. He had never seen an H bomb burst, nor had he exploded one statically, so he couldn't say whether H would flash upon detonation of the bomb.

c. Page 3 - The 1 kg bombs are clustered, 16 bombs to a cluster the size of a 50 kg. bomb. Capt. Kamei will prepare a diagram of the cluster.

d. Page 4 - The time fuze on this bomb is set so that the bomb will burst above the ground. The case does not fracture, but the individual smoke candles within the bomb are ignited by the train of black powder through the center of the bomb and then are ejected from the rear of the bomb to fall individually to the ground. When the bomb detonates at a distance of 500-1000 meters from the ground, the candles land at approximately 20 meter intervals.

e. Page 5 - In the Oil Incendiary bomb, rags were inserted once or twice for the purpose of absorbing oil, but the usual filler was sawdust. Research was not completed on this bomb. Ignition of it was very unsatisfactory. Nor was research completed on the Midget bomb, which was not yet very effective.

f. Page 8 - Trials have been carried out on spray tanks. Capt. Kamei will write them up. This spray tank was the only type made. No research was done on any other (this will be checked). In use, this spray tank sometimes contaminates the wing, but never the tail.

g. Page 10- The arms and legs were joined to the body with metal snaps.

3. Capt Kamei and Maj. Kishimoto were questioned regarding air-force chemical warfare training. The only school of which they were aware was the Mikatagahara Decontaminating Corps (near Hamamatsu). At this school a small percentage of a regular unit (they said that it was for bombardment groups only) was trained in chemical warfare. More detailed information will be made available on this school.

4. In answer to a question regarding auxiliary gas tank incendiaries, neither Major Kishimoto nor Capt. Kamei had ever heard of the Japanese using gas tanks as flame bombs, nor had they ever heard of ours.

5. The airforce had no supply of bulk toxic agents. Tadanoumi was the only source and they would have obtained it there if it became necessary to fill air force chemical warfare munitions with toxic agents.

6. Neither officer seemed to have any concertion of air force chemical warfare tactics or munitions requirements for air force chemical warfare weapons. This subject will be further pursued.

NOTE: The inclosure to which the above information refers will be found in the original conference notes.

SUBJECT: CW Meteorology.

PREPARED BY: Major J. Sakagami

REQUESTED BY: Major Howard Skipper
Lieutenant Gordon T. Wallis (FEAF).

DATE: 18 October 1945.

The following papers on diffusion of gas clouds and physiological effectiveness of gas are two from several papers prepared by Major Sakagami.

Fundamental Studies on the Effectiveness of Gas

There are few literatures about the effectiveness of gas, we have researched chiefly theoretically and independently.

We have endevoured chiefly to clear the original nature of the effectiveness rather than the details of it.

We can consider the effectiveness separately, i. e. the physical effectiveness and the physio logical effectiveness.

1. Physical Effectiveness: The research about this is finally the research about the diffusion phenomena in the atmosphere. We have researched theoretically and experimentally that how the concentration of gas varies according to the lapse of time, in a place and in a sort of the employment.

Differential equation of the diffusion phenomena is:

$$\frac{\partial \chi}{\partial t} = a\left(\frac{\partial^2 \chi}{\partial x^2} + \frac{\partial^2 \chi}{\partial y^2}\right) + \frac{\partial}{\partial z}\left(bz\,\frac{\partial \chi}{\partial z}\right).$$

As a solution of this equation for a instantaneous point source we get:

$$\chi = M\,\frac{e^{-\frac{(x-ut)^2}{4at} - \frac{h+z}{bt}}}{4at\,bt}\,J_0\left(i\,\frac{2\sqrt{hz}}{bt}\right)$$

We have obtained the solutions in other cases, e. g. the case of cloud attack, sprinkling of gas, firing of gas-shells, and bombing of gas bombs, etc., but we will abbreviate about them.

If we assume that $4a = 1.5u$, $b = 0.025u$ (u is wind velocity) these solutions agree with the data of experiment in the main.

We have studied relations between $4a$, b and meteorological elements.

2. Physiological Effectiveness: We have studied that what we must consider, when we judge the physiological effectiveness. If we consider the effectiveness using the conception of it, we cannot obtain adequate conclusions when an animal inhales noxious air, whose variation of concentration refer to time is very complicated as it occurs in open air. We consider next differential equation.

$$\frac{d^2x}{dt^2} = \phi(C - C_s).$$

x is a quantity which express degree of symptom and we interprete that the animal is indisposed when x reaches the value M. Os ϕ and M are constants according to sorts of poison and animals.

We get

$$\chi = -\frac{\phi}{2} C_s t^2 + \phi \int_0^t \int_0^\eta C \, d\xi \, dy \quad \text{(during inhalation of noxious air)}$$

$$= -\frac{\phi}{2} C_s t^2 + \phi \int_0^t \int_0^\eta C \, d\xi \, dy + \phi(t-T) \int_0^T C \, d\zeta \quad \text{(after inhalation of noxious air)}$$

If we assume in the animal experiment a mode of C(t) (o≤t≤T) results 50%, say, mortality, so maximum x is M and

$$\chi_{max} = \phi \int_0^T \int_0^\eta C \, d\xi \, dy + \frac{\phi \left(\int_0^T C \, d\xi \right)^2}{2 C_s} - \phi T \int_0^T C \, d\zeta$$

From the results of a set of C(t), we can obtain values of M, ϕ and C for 50% mortality.

This equation is available practically.

Detailed values cannot be mentioned.

Area of Effectiveness of Gas Bombs

(Maj. Sakagami)

Remark:

When we want to calculate the effectiveness of gas is insignificant if given condition are not established exactly, because the fundamental phenomenon of it - the diffusion phenomenon - is a natural phenomenon. In case of explosive shells from the conclusion that is is necessary n-shells in one hectar we can deduce that it is necessary 8n-shells, say 8 hectars namely the effectiveness of explosive shells is arithmetically additive and we can consider it as to be proportionate.

However, the effectiveness of gas is complicated and its area is not additive when N-gas shells are dropped uniformly in an area A - the area of effectiveness does not extend so far windward as leeward. If we assume that the area of effectiveness is 1 hectar we can not deduce that it is necessary 2N shells for 2 hectars.

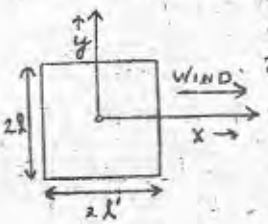
If another area A' is dropped bombs similar the synthesized effectiveness is 2 hectars when A' is close to A.

In my case as the given conditions are not clear, simplified it as follows - N shells are dropped uniformly in 3 sorts of area (1,4,9, hectars simultaneously.

Effectiveness is the mortal effectiveness
ct=2000 Both case (HCN and mustard gas)

$$Ct = \frac{1}{60}\frac{M}{2l\,2l'\mu}\,\frac{e^{-\frac{z}{\gamma+\beta_0'}}}{\gamma+\beta_0'}\,\frac{\Phi\left(\frac{y+l}{\sqrt{A_0'}}\right)-\Phi\left(\frac{y-l}{\sqrt{A_0'}}\right)}{2}\cdot\begin{cases}2l' & x \geqq l'\\ l'+x & x \leqq l'\end{cases}$$

M= Total gas quantity (mg)



$2l = \begin{matrix}(100)\\(200)\\(300)\end{matrix}$ = side length of area (m)

μ : Wind velocity (m/s)

x,y,z : coordinates of the point at where we calculate the concentration (m)

γ = A constant which represents the state of initial concentration at initial instant (from our present experiment = 2)

$$\beta_0' = \beta\mu\left(\sqrt{(x-l)^2+(4\alpha)^2}-4\alpha\right)$$

$$A_0' = 4\alpha\mu\left(\sqrt{(x-l)^2+(4\alpha)^2}-4\alpha\right)$$

$M = 8\ Kg \times N$ for HCN

$M = 16\ Kg \times N$ for H

$4\alpha = 1.5 \quad \beta = 0.02$

$$\Phi(\beta) = \frac{2}{\sqrt{\pi}}\int_0^{\beta} l^{-\xi^2}\,d\xi$$

We assume that the vaporizing efficiency is 100%. The effect of verificial temperature gradient is omitted. That effect on the diffusion of gas has been too much misunderstood. The most effective facts is turnings, of wind direction and the effect of inversion is related indirectly through this fact but in above case the turning of wind direction are also neglected

Results:

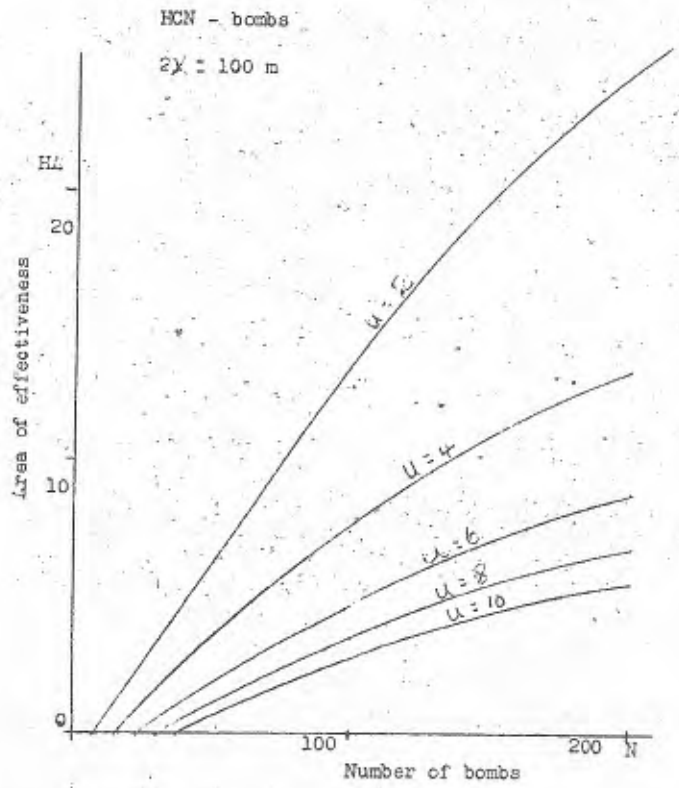
Fig. 1, 2, and 3. Total area of effectiveness number of bombs

In the case 2β = 100,200, and 300 area of effectiveness is greater as 2β increases, but minimum necessary number of shells are greater.

Notice: The states of initial gas cloud of the usual 50 kg HCN bomb are not good and the values of σ show usually 10 to 20. So when we refer the above results, we must consider the numbers of bombs as 1/5 to 1/10 N.

We are intending to improve the structure of 50 kg HCN bomb for getting better states of initial gas cloud.

Figure I



In case of Mustard gas-bombs its area of effectiveness is almost as large as the area of HCN bombs, though filling quantity of mustard gas is twice that of HCN, vaporizing efficiency is usually 50%.

U = (Wind speed meters per second).

Figure 2

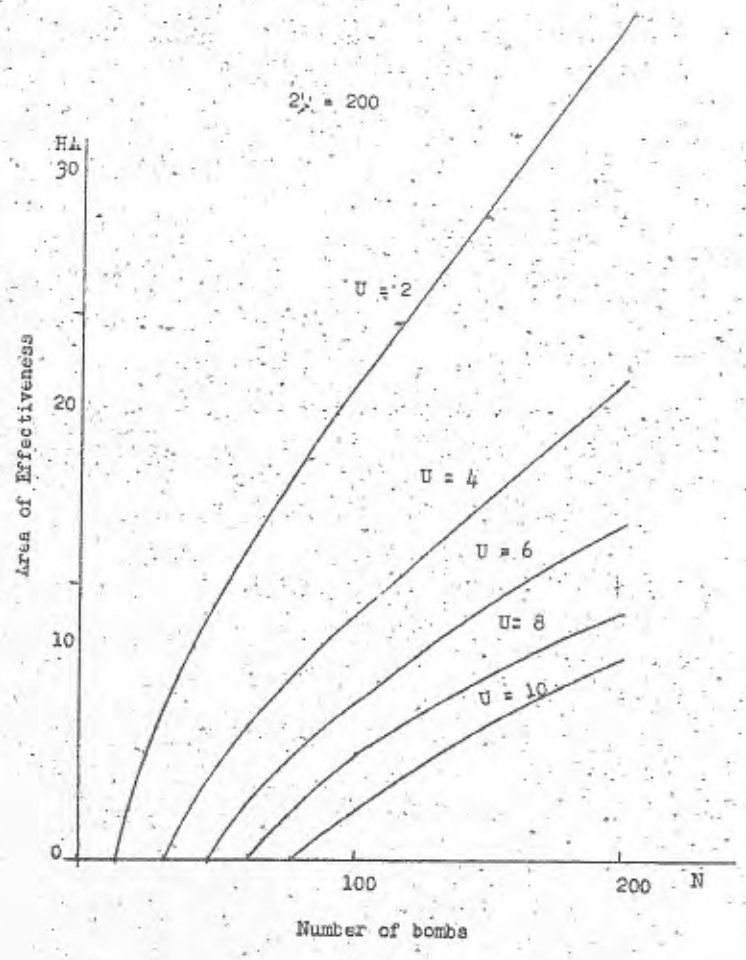
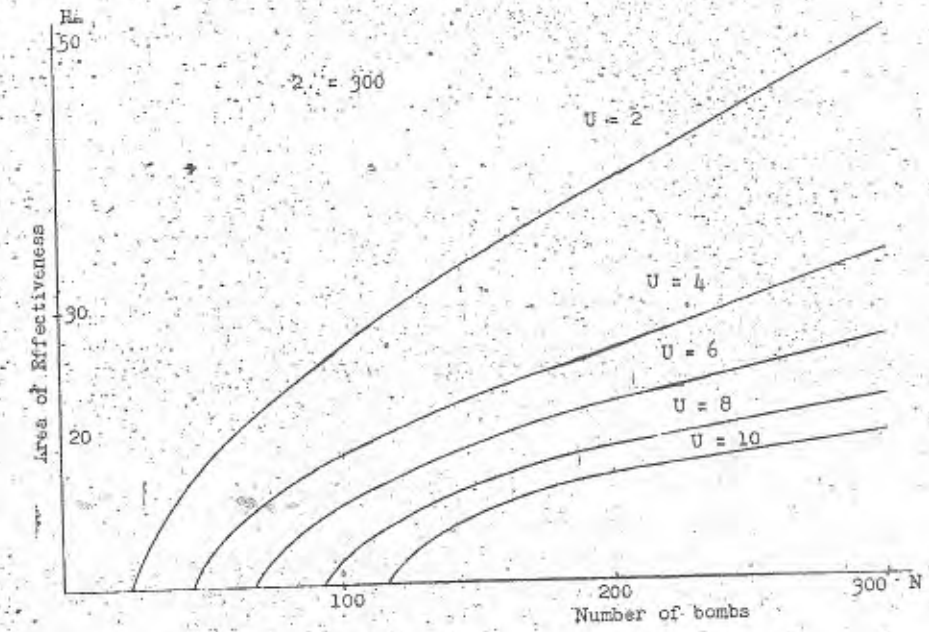


Figure 3



APPENDIX CW 20

SUBJECT: Field Testing in Manchuria and Formosa.
PREPARED BY: Maj Gen K. AKIYAMA and Col SAEKI.
DATE: 23 October, 1945.
REQUESTED BY: Maj Howard Skipper, SIS, Lt Gordon Tallis FEAF.

The inclosed papers have been reproduced as written by General Akiyama and Col Saeki. They are stated to cover the major Chemical Warfare field testing carried on outside Japan proper.

The Field Experiment of The HCN Bombs (Manchuria)
Written by Maj Gen K. Akiyama

Time: July 1943
Place: Heidai (near Hakujoshi) Manchuria
Chief of the testing troop: Colonel K. Akiyama
Organization of the testing troop:
Commissioned officers.....8.
Non-commissioned officers and soldiers.....100 ca.
Object of the experiment: To obtain the effectiveness of the 100 type HCN bombs in field.
Munitions and other materials used:

a. 100 type 50 kg HCN bombs ---- 80 ca.
(Each bomb contains 6 kg ca of HCN liquid and 2 kg ca of methyl formic acid)
Total quantity of HCN ---- 480 kg ca.

b. Aircraft ---- 97 type heavy bombers.....7

c. Gas catching apparatus (Lantern type).....49
Rabbits.....100 ca
Pigeons.....200 ca

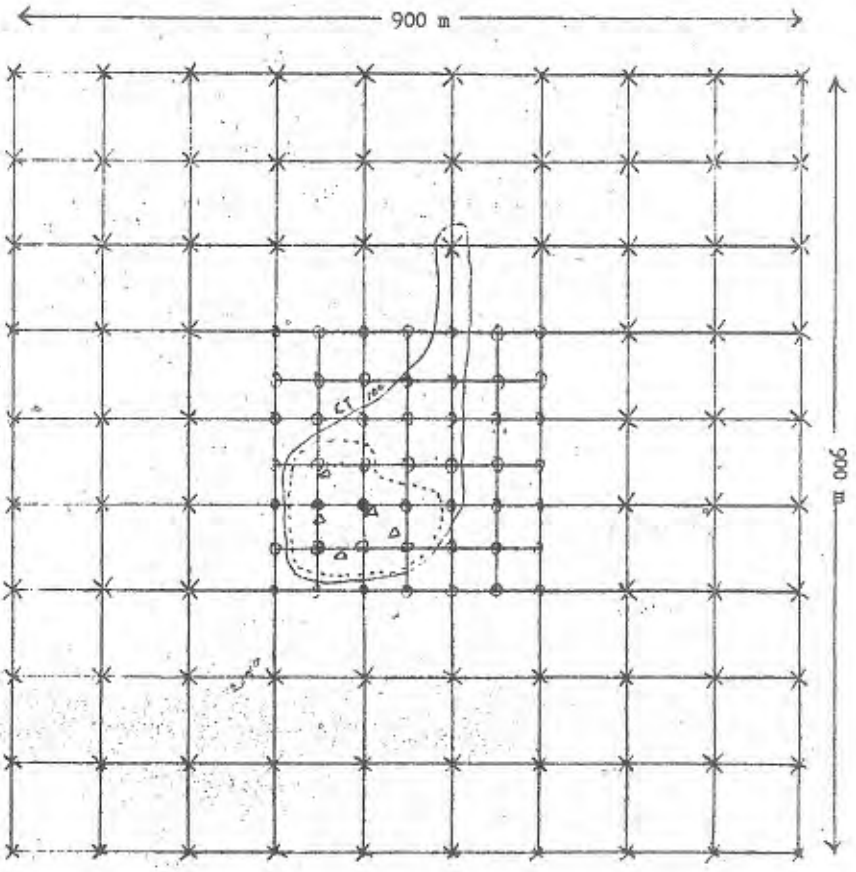
Procedures:

a. Bombing method
Formation of heavy bombers ---- close order
Height ---- 1500 m
Simultaneous bombing
Time ---- immediate after the sun rise

b. Gas catching period ---- more than 15 minutes
Height of gas catching position ---- 50 cm ca above the ground

c. Meteorological observation
Fair (There were few clouds)
Calm (1.5 m/sec)
Temperature 15°C
Inversion of temperature (between 0.5 m and 3 m above ground)
plus 0.3 to 0.5°C

Results Fig. 1.



○ Gas catching apparatuses, rabbits and pigeons

× Testing papers and pigeons

● Positions where the gas catching apparatuses were ruined,

—— Range of CT 1000

---- Range where bombs dropped

△ Sections where bombs dropped densely

d. Geographical features:
Flat and open
grass-height----30 to 40 cm
quality of ground----medium hardness

Results

The result is shown in Fig. 1. In the range where bombs dropped, there are few points at which the value of Ct show more than 2000 but generally it was concluded that the area of Ct more than 1000 was about 4 hectares.

Discussions

We expected that when 30 HCN bombs (400 kg ea of HCN) are dropped in 4 hectares, the area of Ct more than 2000 would be more than 4 hectares. But in the experiment, the result was a half of this expectation.

This result was considered mainly affected by meteorological conditions:-specially the wind-velocity of 1.5 m/sec.

If the wind velocity were less than 1 m/sec and there was the inversion of temperature, the area of Ct more than 2000 would have been more than 4 hecteres.

When the bombs exploded, the height of the explosion clouds was 25 to 30 m. This was concluded as a cause of diminishing the value of Ct near the ground.

Conclusions

HCN bombs can be available in good meteorological conditions for the purpose of killing men and animals in the narrow area by heavy bombers.

It is necessary 20 ea HCN bombs for each hectare when the wind-velocity is less than 1 m/sec, 40 ea HCN bombs when the wind-velocity is 1 to 2 m/sec. As a heavy bomber has 15 HCN bombs, a company of heavy bombers (9) is ought to aim 3 to 6 hectares. When the wind-velocity is more than 2 m/sec, this bomb is considered as unavailable. As when formic acid methylester is mixed as anti-freezing agent the quantity of HCN diminishes, it is superior to use HCN only than to use this mixture. Therefore, it is considered not to use HCN bomb in cold season.

Hot-zone Experiments in Formosa

By Colonel Saeki

Place: Katoh army drill ground in Formosa.
Time: May 1941.
Chairman: Colonel Murenaka.
Main items and general conclusions.

a. Effectiveness of yperit-shells by mountain-guns, trench-mortars and aircraft.
Effectiveness of yperit-shells were judged not so great, because the meteorological conditions were not good. But in the woods, the effectiveness was considerably great, it was to be investigated again.

b. Effectiveness of phosgene-shells by trench-mortars.
As the meteorological conditions were good, the effectiveness of phosgene-shells was concluded as considerably great.

c. Scattering of yperit by aircraft.
Scattering of yperit by aircraft was considerably effective, when it was operated from low altitude.

d. Scattering of lachrymatory gas by aircraft.
We scattered lachrymatory gas absorbed in granules, but it was not effective.

e. Assembling effectiveness of projecting noxious smoke candles.
It was not different as that in the warm zone.

f. Effect of gas-protecting dress in hot-zone on the ability of battle. The ability of battle of the soldiers cannot be maintained for a long period, when he was dressed completely by gas-protecting dress.

g. Meteorological investigations concerning the effectiveness of gas.
Some specialties in hot-zone were obtained, but it was concluded that this subject ought to be investigated for a long period.

Questions:

Q. Persistance of liquid hazard under tropical conditions?
A. About 30 minutes.

Q. Persistance of vapor hazard under tropical conditions?
A. Several hours.

APPENDIX CW 21

Japanese Navy
Gas Protective Equipments

Contents

I. Gas Mask

1. Model 93 No. 2 type II gas mask.

Purpose.....In general
Structure...This consists of face-piece, chief canister, sub-canister and carrier, belonging to antidimmer and training plug, is received into hanger.
Character of canister

	Chief canister	Sub-canister
weight	980 g	530 g
breathing resistance	14~16mm	3~5mm
absorptive capacity (for 0.5% Cl_1)	70~80min	———
filtering efficiency	99.85%	———
power protecting CO(0.5%)	———	30~40min

Total weight.....3.420 g
Wearing weight.....1850 g (not containing sub-canister)

2. Model 93 No. 3 & Model 93 No. 4 gas mask.

Purpose.....No. 3 for land battle in general
.....No. 4 for ship in general
Structure.....This consists of face-piece, chief canister, sub-canister carrier, antidimmer and hanger. Form of face-piece is like Model 93 No. 2 type II.

	Chief canister	Sub-canister
weight	660 g	630 g
breathing resistance	13~15mm	5~7mm
absorptive capacity (for 0.5% Cl_1)	40~50min	———
filtering efficiency	99.85%	———
power protecting CO(0.5%)	———	90~120min

	No. 3	No. 4
Total weight	1430 g	3020 g
Wearing weight	1430 g	2040 g

3. Model 97 gas mask.

Purpose.....Either No. 3 or No. 4 is diaphragm gas mask for commander and messenger owing to propagate voice very clearly.
Structure...Besides it has a diaphragm, it is the same with Model 93 No. 3 and No. 4.
Propagation degree of voice at distance of 10m for naked voice:
Model 93 Ca. 70%
Model 97 Ca. 90%

4. Model III gas mask (provisional name).

Purpose.....Used for operation of treatments of breaked battery in

submarine battery room etc. It may chiefly protect chlorine gas.
Structure...This consists of mouthpiece, canister and carrier, and is provided four of canisters for supplement.

5. Model V gas mask.

Purpose.....Service gas mask for land battle.
Structure...This consists of face-piece, canister and carrier.
Canister is the same with Model 93 No. 3.
Character...This mask is planned with consideration of saving of lack material and so suits mass production.

inspiration resistance	18~20 mm
expiration resistance	4~6 mm
filtering efficiency	over 99.85%
wearing weight	about 1.2 kg
absorptive capacity for Cl_2 0.5%	40~45 min
absorptive capacity for CCl_4, NO_2	50~55 min
absorptive capacity for field gas conc. (200 mg/m^3)	about 60 hours

NOTE: 1. Face-piece is made by cutting out gum plate (thickness 1.6 mm) suturing. A mould is not necessary.
2. Absorbents (active carbon 8) (soda lime 2) 250g
3. Filtering material (cocoon 2) (moxa 1)

6. Direct system gas mask.

Purpose....In general for land battle.
Structure...This consists of face-piece, canister (cylindrical) and carrier. Face-piece is the same with Model V gas mask.
Capacity

inspiration resistance	20~23 mm
expiration resistance	4~6 mm
filtering efficiency	over 99%
wearing weight	about 0.8 kg
Absorptive capacity for Cl_2 (0.5%)	15~20 min
Absorptive capacity for CCl_4NO_2 (0.5%)	20~25 min
Absorptive capacity for HCN	10~15 min
Absorptive capacity for field gas conc.	Ca. 25 hours

NOTE: 1. Absorbents (active carbon 8) (soda lime 2) 150 g
2. Filtering material (cocoon 2) (moxa 1

7. Oxygen breathing mask.

Purpose.....Used for operation in room lacked of oxygen in air or in such high concentration that is difficult to protect with general

gas mask.
Structure...This consists of face-piece, frame of oxygen producing can, air bag and four of oxygen producing can, box, accessories, and supplements.
Capacity

Total weight	about 17.4 kg
Wearing weight	about 4.3 kg
Time capable for use (for an oxygen producing can)	60 90 min

8. Model V Oxygen breathing mask.

Purpose.....Independent use for antifire, fire extinguishing or antigas on ship etc.
Structure...This consists of face-piece, air bag, frame of oxygen producing can and Co_2 absorbing can, oxygen producing can, Co_2 absorbing can and box.
Capacity....Oxygen producing can is packed with pot. chlorate which produces oxygen by combustion. Co_2 absorbing can eliminates Co_2 in expiration.

Time for use	30 min
Wearing weight	5 kg

9. Filtering protectors (Type III and Type V).

Purpose.....Used to filter contaminated air and provide pure air on collective protection.
Structure...Filtering protectors have such a structure as enlarge a canister of gas mask.
Capacity

	Type III	Type V
capacity	about 30 men	about 100 men
ventilation volume	3 m^3/min	5 m^3/min
weight	65 kg	90 kg
air resistance	under 60 mm	under 60 mm
absorptive capacity (for o.5%Cl_2)	about 25 min	about 25 min
filtering efficiency (for 200mg/m^3)	10 min	10 min

II. Protective Suits

1. Model 98 protective suits.

Purpose.....Used for operation in place contaminated by vesicants and protect the whole body taking it with gas mask.
Structure...This consists of coat, trousers, gloves, boots and carrier. Materials made of coat, trousers and gloves are gas-proof cloth coated rubber.
Gas penetrating degree of gas-proof cloth.
for vesicants when drying.....over 10 hours
when wetting.....60 80 min.
Total weight.....about 4.5 kg

2. Protective half suits.

Purpose.....Used for protect half a body for vesicants. Most case on ship and land wear only mask and protective half suits.
Structure...This consists of trousers, gloves, shoes covers and carrier. Material made of trousers gloves and of shoes covers is gas-proof cloth coated silk with rubber.
Gas penetrating degree of gas-proof cloth for vesicants when drying....over 3 hours
when wetting.....20 40 min
Total weight.....,about 1.6 kg.

3. Model III gas-proof cape (Type I and Type II).

Purpose.....Protecting of body and equipments against raining of vesicants and spray from vesicants shell.
Structure...This consists of cape, bag, and talc powder. Color of cape is deep yellowish green.
Capacity

		Type I	Type II
material		painting linseed oil both sides of silk and drying	Coating with gum(gum content 15%) on both sides of silk
gas penetrating degree	mustard	10 min	3 min
	lewisite	1 min	0.5 min
cold resistance	hardening not when leaving during 2 days at 20° C		
heat resistance	cohering " " " " " " " " 70° C		

4. Model V gas-proof cape (provisional name).

Purpose.....The same with Model III gas-proof cape.
Structure...This consists of cape and bag. Color of cape is deep yellowish green and shape is as follows:
Material. Japanese paper stuck with a paste of arum root.

III. Gas Detector

1. Type II detector.

Purpose.....Detection of poisonous gas on ship.
Structure...(weight...1.5 kg).

gum squirt	1
gas detecting tube("yellow" "black" and "blue" tube are 20 each	60
supplements (soda lime, active carbon etc.)	1
small ebonite tube containing water	1
color comparison table	1

Components of detecting agents.

	Components
"yellow" tube	Se O_2, SO_3, silicagel
"blue " tube	test paper wet with p-dimethylamino-benzaldehyde, an diphinylamin solution
"black" tube	I_2O_5 , SO_3 silicagel

	detecting gas	changing color	sensibility	obstacle
"yellow" tube	vesicants	reddy orange	30 mg	expl. smoke HCN
"blue" tube	phosgene	yellow	20 mg	Cl_2, HCN, smoke agent
"black" tube	carbon monoxide	grey-green	0.01g	

Principle of detecting reaction

yellow	$SeO_2 + (C_2H_4Cl)_2S \rightarrow Se + (C_2H_4Cl)_2O_2$
blue	unknown
black	$I_2O_5 + 5CO \rightarrow I_2 + 5CO_2$, deposited iodine combines with SO_3 and color changes to grevish green.

2. Model III gas detecting instruments (provisional).

Purpose.....Detecting for vesicants on lands, especially aviation base,
Components..(weight....15kg)

gas detecting paint	4 cans
brush	5 cans
Standard table of gas concentration on contamination	1 cans
gas detecting plate (Sample painted detecting paint on thick paper)	10 cans
"yellow" test paper (yellow filter paper)	500 cans
color comparison table	2 cans
frame of test paper	200 cans
carrier(made of cellophane)	30 cans
filter paper	15 cans
gas detecting agent	20 cans
gas detecting stick	50 cans

Character
a. Detecting paint
(1) Components

Sudan III	0.4%	37%
blue	2.0	
Cadmium yellow	34.6	
Ethyl cellulose	4.6	46%
Ethyl alcohol	41.4	
Hexahydrophenol	17.0	17%

(2) Color change.....Original color yellowish green
changing red by mustard (only liquid state)
" blue by Lewisite(" " ")

(3) Obstacle.....Diphosgene, chloropicrine, bromobenzylcyanide changing slightly color by benzene, petroleum or gasoline.

(4) Weather resistance.....painted surface is available during about one month on exposure in sunlight and rain.

b. Test paper

(1) Component.....Original paper is treated filter paper with 0.5% alcoholic solution (1:1) of chrysophenin. Detecting agent in 2% CCl_4 solution of chloramine T.

(2) Sensibility.....25 mg/m^3 for gaseous vesicants. Color changes from yellowish orange to brownish black.

(3) Obstacle.....Acidic smoke agents etc.

(4) Feather resistance.....This test paper is non-resistant for sunlight and rain and, when treated with reagent of chloramine T once, can be scarcely available during 2 or 3 days.

3. Model IV gas detector.

Purpose.....Used to detect vesicants, phosgene, hydrocyanic acid and carbon monoxide, instead of Type II detector.

Components

test paper	200	(pairs with "yellow", "blue" and "brown" are 40 apiece, and black is 80)
detecting agent	200	("yellow", "blue", and "black" is 40 apiece. "black" is 80)
test paper clipper	2	(made of bamboo)
color comparison table	1	
drop detecting plate	1	(binding paper painted with gas detecting paint)
sand glass	2	

Character

test paper		Components
yellow	original paper reagent	colored paper with chrysophenin and drying 2% CCl_4 solution of dichloramineT
blue	original paper reagent	filter paper as it is p-dimethylamino benzaldehyae 5 gr dimethylaniline 5 gr alcohol 100 cc
brown	original paper reagent	colored paper with 1% picric acid and drying 10% Na_2CO_3 solution added 10cc of N-NaoH
black	original paper reagent	dipped with 5% Sod. acetate and drying 1% Acetone solution of Padladiumchloride (75:25)

Test paper	Color change		Sensibility	Obstacle	Preservation
	original	changed			
yellow	yellowish orange	greyish black	25mg/m^3	acidic smoke agent	2 3 days
blue	white	blue-purple	20 "	special	1 week
brown	brown	yellowish brown	50 "	special	30 50 min
black	light orange	greyish brown	0.0%	NH_3H_2S, reducing gas	

IV Decontaminating agent

1. Decontaminating agent No. 1.

Purpose.....Used for decontamination of adhering gas by using this agent with decontaminating agent No. 2 together.
Component...Potasium permanganate 150 g
Capacity....By using No. 2 at the same time (No. 1--150 g and No. 2--1,000 g, water 30 l), it may be chiefly decontaminate adhering lachrymatory or sneezing agents.

2. Decontaminating agent No. 2.

Purpose.....Used for decontamination of adhering gas by using No. 1 at the same time.
Component...Scaly sodium hydroxide 1 kg
Capacity ...cf. Decontaminating agent No. 1.

3. Decontaminating agent No. 3.

Purpose.....Used for decontamination of vesicants scattered with liquid state.
Component...Higher bleaching powder (available chlorine over 68%) or common bleaching powder (available chlorine over 33%)
Capacity...It has a special mixture for adhering vesicants and reacts effective for sneezing agents too. Metal and fibrics etc. are damaged. It is necessary to take care because of deteriorating a decontaminating effect by lowering available chlorine by moisture and promoting decomoosition by high temperature.

4. Decontaminating agent No. 4.

Purpose.....Used for decontamination of vesicants and sneezing gas in space.
Component...Chlorine gas absorbed in CCl_4
Capacity....About 50 g of agents (quantity of chlorine is 10 g) is sealed by melting into an ampoule. If broken this glass ampoule by throwing, dissolving chlorine gas in solution is freed in a moment and decontaminating effect is exhibited.
Standard to use is in the proportion of one of ampoule per 30 cubic meters.

5. Decontaminating agent No. 5.

Purpose.....Used for decontamination of vesicants adhered to clothes and body.
Components.....
Chloramine T.....16%
Bentonite.....81%
Sea water soap.....3%
Direction for use.....
For body, reagent in creamy state prepared by adding twice weight of water.
For clothes, reagent in solution prepared by adding three times weight of water.

6. Decontaminating agent No. 6.

Purpose.....Used for decontamination of drinking water contaminated with arsenic compounds.

Components

Decontaminating agent (containing in vessel made of bakelite)	10
Filtering bag (folding part made of rubber)	1
Filtering cloth. (white cloth)	2
Detecting tube for arsine	25
Test paper	
Test tube	1
Pincette (made of bamboo)	1
Color comparison table	

Accessories

Decontaminating agent

1st reagent	higher bleaching powder	1 g
	barium peroxide	8 g
	ferric sulphate	9 g
2nd reagent	calcium carbonate	8 g
	active carbon	4 g

In use, stir water with the 1st reagent during 10 minutes, and with 2nd reagent during 5 minutes, and then, filter with filtering bag. Arsenic compounds precipitate by producing addition compounds with ferric ion or coprecipitate with colloidal ferric hydroxide.

Detecting tube for arsine.....This consists of sodium-lead alloy and $HgCl_2$-test paper. Arsenic compounds in water produce AsH_3 by sodium lead alloy, and change color of test paper brown.

V Material for Protective Equipments

1. Active carbon.

Purpose.....Canister, collective filtering protector

Component...Carbonized, activated and granulated coconut shell.

Capacity....It absorbs physically various kinds of gaseous poisonous gas. However, it is less effective for carbon monoxide, hydrocyanic acid and ammonia etc.

2. Soda lime.

Purpose.....Canister, collective filtering protector.

Components

slaked lime	67%
cement	21%
diatomaceous earth	9%
sod. hydroxide	3%

Capacity....Soda lime absorbs acidic gas chemically and setting acidic gas absorbed by active carbon by chemical absorption.

3. Hopcalite.

Purpose.....Sub-canister

Components..Active manganese dioxide 70% This is prepared by
Copper oxide 30% a special method.

Capacity...Hopcalite can remove toxicity of CO, HCN, and NH_3 gas etc. However, oxidizing ability for CO is influenced with moisture and its ability is damaged if its water content degree attain over 3%.

4. Active carbon No. 2 (Trying when war ended.)

Purpose.....Canister, (especially, for HCN.)
Preparation.After treated common active carbon dipped with $CuSO_4$ solution with Na_2CO_3 solution at 70°C, products are washed for 40 hrs and then drying during 24 hours.
Capacity...Absorptive capacity for Cl_2(0.5%).....70 min
CoI_3 NO_2 (0,5%)....90 min
HCN (0.5%).....60 min

5. Soda lime No. 2.

Purpose.....Canister
Components...Slaked lime, slaked lime, acid clay, diatomaceous earth, copper sulphate, sodium hydroxide.

6. Drying agent No.1.

Purpose.....Drying in general
Component...Silica gel.
Capacity....Absorptive capacity of moisture is over 50% at 20°C.

7. Drying agent No. 3.

Purpose.....Drying (especially for sub-canister)
Components..This is prepared by adding 40% of $CaCl_2$ to silica gel.
Capacity....Absorptive capacity is over 90% at 20°C.

8. Antidimmer.

Purpose.....Antidimness for glass, especially eye-piece.
Component...This is prepared by adding glycerine and Sod. hydroxide to sulphonated rape-seed oil, sapinificating and kneading.
Capacity. This can protect dimness of glass when painted on eye-piece of mask. Effect is maintained about 1~2 hours.

9. Oxygen producing agent.

Purpose.....Oxygen breathing apparatus.
Component...Mainly, Sodium peroxide (about 800 g)
Capacity....This reagent reacts with expiration absorbing CO_2 and H_2O and produces oxygen.

10. Oxygen producing agent. (for Model V oxygen breathing gas mask)

Purpose.....Producing oxygen on firing and used for Model V oxygen breathing gas mask.

Component	I	II	
$KClO_3$	80.0	67.77	Components described above used by moulded in shape of cylinder diameter 60mm, height 205mm.
Fer-powder	13.0	9.21	
$FerO_3$		4.78	
MnO_2	3.0	0.78	
Na_2CO_3		13.55	
Asbestos	4.0	3.82	
Total Weight	185 g	965 g	
	Used for the first half of agent	Used for the latter half of agent	

Capacity....Time of combustion over 40 min. Total oxygen volume, about 150 l.

VI Training Munitions

1. Gas tent.

Purpose.....Every gas training on ship and other places.
Structure...This consists of folding tent made of gum coating cloth supports made of steel and box.

	great type	small type
width	4 m	3 m
Size, length	3.5	2.5
height	2	2
total weight	135 kg	85 kg

2. Imitation gas for training.

Purpose.....Used for training for detection and decontamination of vesicants.
Structure and Components.....Sealed into glass ampoule. When in use, throw this ampoule and scatter the reagent in it.

Trichloroethylene	50 cc	120 cc
Glycol	30	
Alcohol	32	
Thioether	5	
Ethylacetate	10	
Hydrochloric acid (5%)	6	

Character...It has an odor like mustard and presents as same reaction as the decontaminating reagent No. 3, and yet non-poisonous.

RESTRICTED
APPENDIX 2 - CW 22 CW-22-1

SUBJECT: Chemical Warfare, Japanese Intelligence and Views
6th Mil Lab
DATE: 20 October 1945
INTERVIEWED: Maj Gen Kirsei Akiyawa, Col Shinji Ichino,
Maj Kokuru Nagao
INTERVIEWERS: Maj H E Skipper, Maj J Nolen (GHQ), 1st Lt
G T Wallis (FEAF), Tec 4 F Yagi

1. Gen Akiyama was first questioned on Japanese CW intelligence. In answer to individual questions, Gen Akiyama reported as follows: No documents on CW were captured by Japanese at beginning of war in the Philippines. They captured some protective clothing made of oilcloth, but not much else. Much British CW equipment was captured in Malay, however. Protective capes, boots, ointment, etc., they found no chloramine T clothing. They did not know of a "Secret" document on U.S. protective clothing reported to be captured by the Japanese Navy at Cavite. He (Gen Akiyawa) had heard that Navy had captured a great amount of equipment, but he never saw any of it. When asked to give the date of the cml spray trials he had previously spoken of (interview of 15 October 1945) as having taken place in New Guinea, the General answered that they were to have taken place in the summer of 1943. It was just hearsay; there was no conclusive evidence of it. It was to have been just an experiment. He had not heard of any spray trials in Australia, but he received reports that U.S. was sending CW agents and munitions into Guadalcanal and New Guinea. Those reports, he said, came from front-line troops in those sectors. He also heard that U.S. had a chemical dump in Casablanca for use in the Italian campaign. The best source of information regarding U.S. CW, he said, was from front-line troops. Reports were also received from Germany.

2. About Italian CW, the General knew only that the Italians were supposed to have a 1# manufacturing plant near Rome with a 5-ton per day capacity. The General did not think Italy was ready for offensive CW, but was for defensive CW. The Japanese had no liaison with the Italians. Gen Akiyawa visited Italy about ten years ago and was shown their setup. The Japanese exchanged no information with the Italians during the war. Of the use of gas by Italy in the Ethiopian campaign, the General had had reports that it was very effective and caused the early capitulation of the Ethiopians. He also saw pictures of the use of gas which were obtained from the League of Nations. He said that he had heard that the Italians were prepared to use phosgene bombs against Ethiopia, but he doesn't know whether or not they were ever actually used.

3. When asked whether or not he had heard anything about the Russians using gas against Finland, the General said that he had heard something about it. He said he didn't remember the details, but it was mustard which was supposed to have been used. The Russians were said to have a mustard which would not freeze at low temperatures. About 1939, a German medical officer, a Colonel or Brigadier Munch came to Japan and reported that the Russians had used gas against the Finns. When asked his opinion of Munch, the General said he thought that as a doctor, Munch knew quite a bit about toxicity. He visited the medical school, but never the 6th Military Lab. He was not very free with information concerning German CW. He offered to stay in Japan for from 6-12 months to teach CW to the Japanese, but General Akiyawa figured it wouldn't be worth-while.

4. When requested to give his opinion as to who is the leading CW authority in the various countries, the General said that as regards Germany, Britain, and France, he didn't know who was considered to be the leading authority. Ten years ago he thought Kling, the head of the Paris Municipal Research Laboratory was the leader in France. Of the Americans he said he knew of Prentiss and Gilchrist. He said he knew of Sutton (British) and of Sartori (Italy).

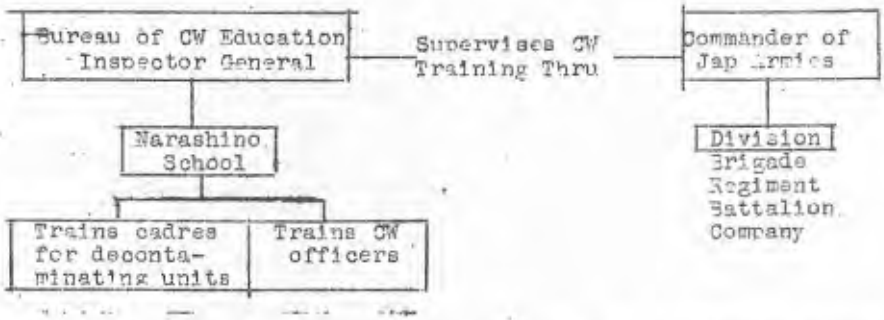
5. At this point, several specific, unrelated questions were asked, as follows:

Q For what purpose was your mustard sprayer designed?
A For gross contamination of fields and other areas. It was decided to be impractical so was abandoned while still in the experimental stage.

Q What was the "brilliant idea" someone had for increasing the range of the flame thrower? (Mentioned in Ord Dept write-up for SIS)
A I don't know. That report was made by someone in another lab, but presumably it was done by including in the fuel, rubber, or something else which will melt.

Q Where does the Bureau of CW Education fit into Japanese Army organization?

A It can best be likened to American Inspector General. The bureau is on a level with the General Staff (Maj Nagao - and should be checked) and is merely a supervisory body to see that CW training is carried out in all echelons of command. Its organization is as follows:



Q Will you review once again the role of the Takaoka branch of the 6th Military Laboratory?

A At Takaoka, there were some 200 people, evacuated there after part of the 6th Military Laboratory buildings there had been burned. The research done there consisted of studying the process of making HCN from hydrocarbons and ammonia. The manufacture of H (by continuous process) without using steel was also studied. They used the building formerly occupied by a paper mill, and now the mill has gone back to the owner and the laboratory personnel have been demobilized.

6. Gen Akiyawa was asked to summarize once again what Intelligence he had been able to obtain on U.S. CW preparedness. He answered that he knew that the U.S. had great chemical productive power and that scientifically it was very progressive, but he doubts whether CW progress in the U.S. was very much greater than in Japan.

7. He was also asked to review again what he knew about the suspected use of gas by the U.S. in island mopping-up operations. The Japanese had no conclusive evidence of it, but inferred it from the fact that island fighting would continue protractedly and then suddenly cease. They felt that this could mean nothing but the use of gas. The islands he referred to were Iwo Jima, Makin, Tarawa, and Kwajalein. The public never knew anything about this suspected use of gas by the U.S. He said, that after the war, United Press came out with the statement that the use of gas by the U.S. would have reduced the number of our casualties. The General thinks it probably would have. When asked whether or not he thought large-sacle use of gas by the U.S. would have been an effective weapon, Gen Akiyawa said that he thought it would have been.

8. In reply to the question of whether or not the Japanese had ever studied the effect of gas in large cities, the General answered that tests were run in Tokyo with smoke candles to determine penetration of gas into houses, and it was found to be good through the cracks in the houses. But, he said, he thinks incendiary bombs are more effective in a city than gas.

9. In connection with the possible use of gas by the U.S., the General said that had we used as much H in bombing Iwo Jima as we did HE, it would have been far more effective. The Japanese were very worried about our spraying their rice fields with H or L, or worst of all, arsenic trichloride. The General said that this would have been as effective as the atomic bomb. He said he thought that large-scale use of gas by the U.S. would have brought about an early capitulation.

10. General Akiyama was next questioned about the use of gas by the Japanese in China. He said that two years ago there were rumors that the U.S. was going to use gas so the Japanese sent CW munitions to their various theaters of operations, and that might have been the circumstance leading up to the possible use of gas. There might have been some gas munitions in China before that, but if there were, the General didn't know about it. If there had been any official order to use gas, it would have issued from GHQ, and the 6th Military Laboratory would have received a reference copy of the order. When asked if there were someone in GHQ whom we might question on CW, all of the Japanese present laughed, indicating, as they have before, that there is no one in GHQ who knows anything about CW. The General said that gas might have been used either on the sole initiative of a field commander or by a mistake. He said he knew that sneezing gas had been used in China, but no lethal agent to his knowledge. He said that the Japanese were afraid to use gas for fear the U.S. would retaliate.

11. In reply to question of just what would have happened in the Japanese Army if we had used gas, the General stated that the Army was prepared to protect itself. The civilian population, however, was not, and also recent inductees may not have had masks. When asked if Japanese troops were adequately protected against gas on Iwo Jima, etc., the General replied that if gas had been used for ten days on Iwo, almost complete annihilation would have resulted. Casualties, of course, would occur and increase up until that time.

12. On the question of H ct's, Gen Akiyawa stated that with mask on, the ct necessary to cause H casualty on exposed skin surfaces is over 4,000; that is, in a hot climate. In a cold climate, he said that a higher ct would be necessary--he guessed may be double that of a hot climate. Without a mask, he said a ct of 2,000 would cause death, about 200 would cause blindness. No tests were ever carried out with human volunteers to test ct's necessary for damage to genitals, but they found out it was very low by accidents in connection with other tests on protective clothing.

13. Gen Akiyawa in closing stated that he did not believe that advances in CW reference new agents had been made during this war, and that he thought that in spite of the atomic bombs, chemicals would be used in any future wars.

14. Gen Akiyawa said that the opportunity for effective use of gas came in a war between a strong nation and a weak nation, that in the case where the warring countries are evenly matched, the country which initiates CW is likely to have it used effectively against himself.

APPENDIX CW-23

SUBJECT: Navy Chemical Warfare Intelligence and Training

PERSONS INTERVIEWED: Commander Y. Kitasato
Lt. Comdr. Hideshiro Okawa

DATE : 19 October, 1945

MEMBERS OF SIS PRESENT: Maj. Howard E. Skipper
T/4 Yagi

Commander Kitasato brought in a written report (inclosure #1) in answer to a previous request for:

1. Summary of Japanese Navy Intelligence with reference to United States and other Allied preparation for chemical warfare covering (a) agents (b) protective equipment (c) likelyhood of initiation of chemical warfare.

2. Information on experiments carried out with the 10 tons of Lewisite reported to have been produced.

3. Outline of Japanese Navy chemical warfare training organization and methods.

4. An official answer to question, what information was received from the Germans on chemical warfare?

The results of verbal questioning on Navy chemical warfare intelligence are given as follows: (Most questions answered by Commander Kitasato)

Q. What agents did you think the United States was producing?
A. Tear gas, sneezing gas, H, L, (HL), stickstofflost, phosgene, and HCN.

Q. What had you heard concerning Russian Chemical Warfare?
A. Nothing except we heard that they spray HCN from aircraft.

When pressed again for any information from German sources the Commander remembered receiving a bottle of decontaminating agent (yellow in color) by submarine from Germany. This was received toward the end of 1942. Analytical methods failed to indicate exactly

that was contained in the bottle. When asked why they didn't simply ask the Germans what was in it, Kitasato replied that they didn't consider it of great importance at the time. The Japanese attache who sent the bottle also sent an anti-gas (protection) manual at the same time. It wasn't clear whether the two items had come through proper channels or had been "snitched".

Q. Were there any Japanese Navy chemical warfare experts in Germany?
A. No. There are only about 6 well rounded chemical warfare officers in the Japanese Navy and none could be spared.

Q. Does the Japanese Navy think the United States used poison gas in the latter stages of the war?
A. Definitely they could not say, but they believe it might have been used. Commander Kitasato did not think it had been used. There were 3 or 4 reports that United States had used HCN in Okinawa. Later investigation led them (Japanese Navy) to believe deaths in tunnels, which caused reports of use of poison gas by United States, had been due to CO instead of HCN (CO resulting from HE and small arms fire)

Q. Did the Japanese Navy General Staff believe United States was using gas in mopping up operations?
A. Among non-chemical warfare officers the majority believed gas was being used by the United States. Among Navy chemical warfare officers a minority believed the United States was using gas.

Lt. Commander Okawa stated at this point that he believed that the United States has used poison gas. When asked to give his reasons for believing this he replied that:

(1) He had heard from the Japanese Army that United States troops had orders to use poison gas whenever it was to their advantage. This he admitted was just heresay.

(2) Japanese newspapers reported that public opinion in the United States favored the use of gas in mopping up stages. This the paper stated was according to broadcasts from San Francisco, and had been verified in reports from Spain and Switzerland.

Commander Okawa said he had no information about the British or Australians.

Q. What information were you able to obtain concerning United States production of poison gas?
A. The Japanese Navy received no definite information but learned about amounts of money spent for United States war effort and calculated that at least 100,000 tons of gas must have been produced by the United States. Kitasato went on to say that at the time of the first world war the United States had a well organized Chemical Warfare Service with good research and that dufing this war the United States was probably far ahead of Japan with reference to chemical warfare.

Q. Do you think any new agents were produced during this war?
A. No he didn't believe any new agents had been produced even though much work had been done with this objective. Commander Kitasato thought the progress in chemical warfare in this war and in the future would be, not in New agents, but in finding new uses to which gas can be put.

Q. Did the Japanese Navy believe that the United States had poison gas in this theatre of war?
A. No definite information, but because of the United States Army organization (chemical warfare officers and units with each section of the Army) he was sure that if Japan should have used gas in a certain spot the United States had gas near enough to retaliate.

Q. Where were the big United States gas dumps?
A. This information was from the Army (two years ago) and was indefinite but they thought:

New Guinea, Port Moresby
Dutch Harbor
Guadalcanal
Australia, Sydney

Q. What information did you get when the Japanese invaded the Philippines?
A. The army took over Philippines except for Cavite where Navy found three types of manuals on chemical warfare.

(1) Training manual against gas attack.
(2) Use of chloromine T* for protective clothing.
(3) Manual for Marines for both offensive and defensive use of gas.

In the Philippines or Guam, the Japanese captured United States Airplane spray tanks.

In Burma a United States chart which explained how far away (correction) from target aircraft bombs should be released, a 100 lb mustard bomb was mentioned.

---

* The manual did not mention chloramine T but they surmised that it was chloramine T from reading manual. Manuel was marked Secret. It said clothing was to be soaked, and hung up to dry in a dark place. Also said clothing would protect against vapor and small droplets but not large droplets.

Q. Did you hear anything of research being carried on in United States or Australia?
A. No.

Commander Kitasato stated that if gas had been used he would have been the man in the Navy responsible for advising on use of it.

An addition to the initial Navy organization chart (prepared by Commander Kitasato) was submitted at this time. It consisted of a Navy chemical warfare section committee which was initiated 1 April, 1945 and began to operate in May, 1945. The committee was to advise the Navy Bureau of Education, Navy Medical Bureau, Navy Bureau of Military, Navy Technical Department and the Navy Aeronautical Department, on chemical warfare matters. It had made the following recommendations:

1. Advised necessity of putting utmost effort for producing great quantities of defensive weapons because of great increase in number of Navy men.

2. Advised on protection against CO in caves and dugouts.

3. Studied distribution of equipment for protection against poison gas and recommended a more equitable disposition of existing equipment.

4. Recommended disposition of equipment to be produced in future.

Prepared by Commander Y. Kitasato of the Japanese Navy

1. Japanese Navy had not the special intelligence organization, and we got information with reference preparation for chemical warfare of United States and other allied nations by radio broadcasting and news-telegram, by the captured weapons and papers at the beginning of the war, and from Army side.

Therefore we have received no report with concerned chemical agents and protective equipments.

On the problem of likelyhood of initiation of chemical warfare, we supposed that United States forces would be well equipped both in offence and defence, and clearly presumed that opinion to use Gas against Japanese Force spreaded all over United States.

Remark: We received some reports, that our forces were attacked with Tear-gas, from Cape Marcus, Finschhafen, Leyte and Luzon. Army - Navy believes.

2. Lewisite

(a) Purpose: To compare effectiveness of Mustard, Mustard and Lewisite mixture and Lewisite when applied to the chemical bomb.

(b) Procedure: Charged in small scaled bombs (10 kg) and 60 kg bombs, and exploded on the ground (Kashima air training field).

(c) Results: Lewisite or Lewisite mixture has comparing with Mustard, such characteristics as follows:

(1) It effects very quickly
(2) Poor persistency (especially in moist weather or on wet ground).
(3) Gives warning to enemy by its high irritation.
(4) Lethal effect seems to be weaker than Mustard by animal tests.
(5) Decomposition of the agents itself by aging is rather quick than of Mustard.

(d) Conclusion: At that time (about 10 years ago) our stand point was that to attach much importence to persistency of liquid gas and direct lethal effect, so we decided that Mustard-gas was superior to other gases for bombs. Furthermore, it is convenient in handling and producing chemical bombs to limit only one kind.

Thus, Lewisite was not adopted by Navy as a service chemical agent.

Produced Lewisite has been consumed by this experiment, other miscellaneous researches (mainly concerning with protection), and training at schools and troops, remaining 6.5 T at present.

3. So far as we remember, Navy had not received no report from the Germens with reference chemical warfare.

We merely received from our naval attache to Germany following reports, as to be given by German official:

(a) "German has no will to use chemicals to the extreme end of the war" (December 1944 - - ?)

(b) "British navy are thinking that chemical warfare is not effective in sea battle." (June 1944 - - ?)

APPENDIX CM-24

SUBJECT: Chemical Warfare

ORGANIZATION: The 3rd Military Laboratory

PERSONS INTERVIEWED: Maj. Gen. Masaki - Chief, 3rd Military Laboratory
Col. T. Okada - Principal, Military School of Defense Against Gas (Located at Mikatagahara - near Hamamatsu)
Maj. T Chi-Ken - Chief, Gas Defense Unit of above school.
Maj. K. Kora - Supply Department, Air Force Administrative Center, Ministry of war (In charge of supply of all types ammunition for air force)
Capt. H Kamei - Member, 3rd Military Laboratory.
T. Matsuzaki - Official Interpreter attached to Military Affairs Section.

MEMBERS OF SIS PRESENT: Major Howard E. Skipper
1st Lt. Gordon T. Wallis (FEAF)
T/4 Yagi

1. Two reports (attached as Report #1 and Report #2) were submitted in compliance with requests earlier made for certain information. These reports were discussed as follows:

a. Report #1: -

1. Page 3 - Bomb thrower remains attached either to wing or in bomb bay, merely allowing the bombs contained within it to drop one by one. This was never used operationally, was on an entirely experimental basis.

2. Page 4 & 5 - Large numbers of these bombs were made and are still on hand because they were found to be quite unsatisfactory. When asked whether there were also substantial quantities of H bombs on hand, the answer was that the H bombs had been destroyed, being dumped into the sea towards the close of the war. The Sone Supply Depot carried out the destruction and disposed of an estimated 4,000 - 5,000 bombs. Major Kora is going to investigate the matter thoroughly and submit a report on his findings.

---

* Report #2 concerned Chemical Warfare training, but as submitted was unintelligible. Its content was clarified in conference and included as part of the afternoon conference notes.

3. Pages 10-18 - Paper prepared by Major Sakagami of the 6th Military Laboratory upon request by 3rd Military Laboratory subsequent to our request for the information. This material was not in the possession of the 3rd Military Laboratory prior to that time.

4. Page 19 - This data was obtained incidentally to two or three exercises given at the Mikagatahara School in 1944-1945 to train students in defense against air chemical spray. Students were equipped with protective clothing and 6 airplanes sprayed H from twelve 26-liter tanks from an altitude of 50 meters. It was felt that less than 50 meters altitude was best for laying spray, but the type airplane they used could not be flown any lower than 50 meters.

2. Rubber-nosed Bombs - Sometime during 1943-1944, approximately 30 or 40 50kg rubber-nosed bombs were produced with which to carry out tests on the problem of ground penetration. These bombs were to be incendiary-filled but for testing purposes were filled with sand. The tests were carried out by Capt. Kamei at Tachikawa. The idea was that the resiliency of the rubber would absorb the force of the impact of the bomb and prevent or effectively reduce penetration. This did not occur. The nose was found to split apart and penetration to follow as usual when the bombs were dropped from 2,000 meters. The project was eventually discontinued.

3. a. In the afternoon a resume was given of Chemical Warfare training within the air force and Report #2 thus clarified. The Mikatagahara School is the only air force chemical warfare school in existence. It was started in June 1944 for officer training. Non-commissioned officers were accepted for the first time in April 1945. Before June 1944, chemical warfare training was given at the Army Airplane School at Hamamatsu, where course of training was the same as at Mikatagahara but the students numbered only 4-8 per class. The staff of the Mikatagahara School totaled approximately 50 officers, 13 of them were instructors and 37 administrative officers.

b. Personnel for the school was selected from ground units of the air force on a quota system determined by Air Force Headquarters. Officers' classes were fixed at 80 students, NCO classes at 50. Both Col. O Kade and Maj. Chi-Kon complained that the personnel which attended the school was of the poorest quality. Unit commanders sent their worst men, they thought.

c. Upon reporting to the school, the prospective students were subjected to a physical examination whose chief demands were good eyes and nose, and strong lungs. Failing these, the student was refused admittance to the school. Therefore, the actual classes usually totaled 70 officers and 45 NCO's.

d. A total of approximately 200 officers (3 classes) were trained and only 45 NCO's (1 class).

c. The course of instruction for officers lasted for 4 months and for NCO's 3 months. The subjects covered were given as follows:

SUBJECTS:

1. Individual Protection.
2. Group Protection
3. Protection of Equipment (airplanes, motors, machine guns etc)
4. Meteorology
5. Treatment of Gas Casualties.
6. Decontamination of Ground.
7. Gas warning.
8. Gas reconnaissance.

At the completion of the course, the students returned to their units. They were not expected to carry out chemical warfare training within their own units, but were merely to be available as chemical warfare experts should a need for them arise.

f. The Hiratagahara School had no connection with the Narashino school, nor with any other schools, Army or Navy.

g. No research was carried out as such at Hiratagahara. There was not time for it. Some was accomplished incidentally to training, however. (airplane spray coverage data).

h. Chemical warfare training for the average air force soldier was accomplished as part of his regular combat (basic) training. It was not very complete. He was taught how to use gas mask. First aid for gas was tried using water for H, but men thought it ridiculous so it wasn't very effective.

5. Decontamination -

a. Reference was made to the slurry sprinkler discussed at the conference of 1 Oct 1945, and reply was given that there were only two produced in Japan - and those for experimental purposes. General Masaki said that the Japanese air force possessed no mechanical equipment for decontamination, that decontamination methods were all manual. He said that the air force chemical warfare manual made reference to mechanical equipment for decontamination, but emphasized that that was theory, not fact. Much of the manual, he continued, was theoretical and did not represent the actual state of Japanese chemical warfare which was well behind the manual.

6. Tactics - a. The question of offensive chemical warfare was again referred to, and the response was as vehement a denial as always. General Masaki reiterated that the Japanese had no intention of waging chemical warfare, so that their work on Offensive chemical warfare was purely superficial. Due to the fact they regard chemical warfare as "unfair", they really didn't expect us to use it. He further stated that the pressing need for other types of shells and bombs prevented the production of chemical munitions.

7. Special Chemical Warfare Air Force Units. a. General Masaki stated that there were no special chemical warfare units within the air force. He said that there was some discussion of it in the manual, but that again it was theory. They had no "time" for it actually.

NOTE: Inclosure #1, to which part of the above information refers, will be found in the original conference notes.

Appendix CE-25

Chemical Warfare Munitions

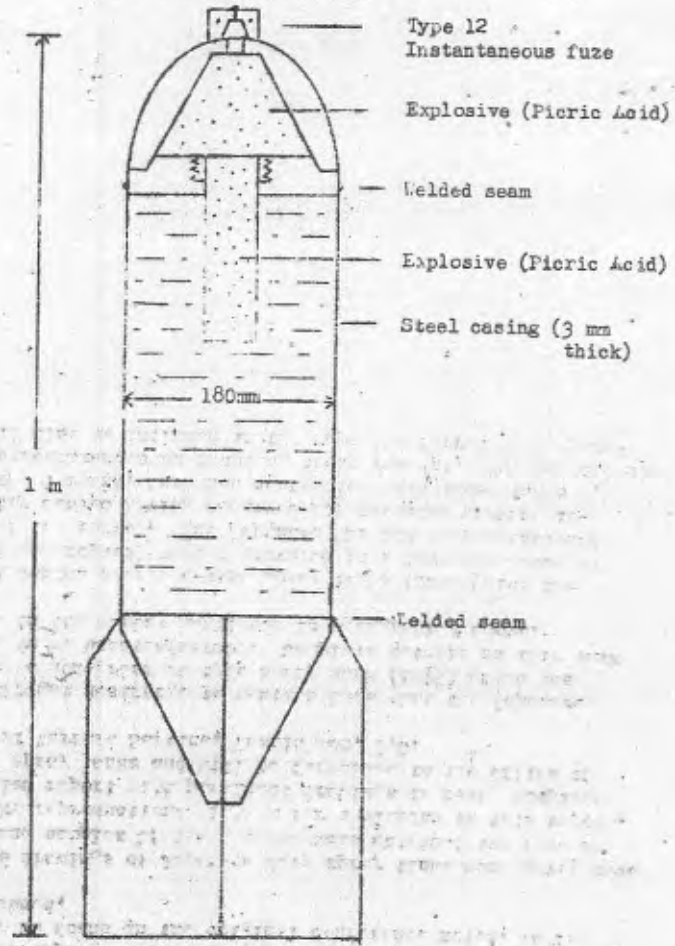
1. There was neither time nor personnel to reproduce in drawings all of the chemical warfare munitions encountered in the survey. Therefore only the more important ones are included here. The majority of the remainder may be found in the original conference notes. A few were never reproduced.

2. Accurate drawings of Japanese Navy spray tanks were never made by the Japanese and samples of these tanks were obtained too late in the survey to make reproductions of them for inclusion in this report. However, a detailed report with pertinent drawings is being compiled on Japanese Navy spray tanks and will be forwarded to the Office of the Chief, Chemical Warfare Service, Washington, D.C.

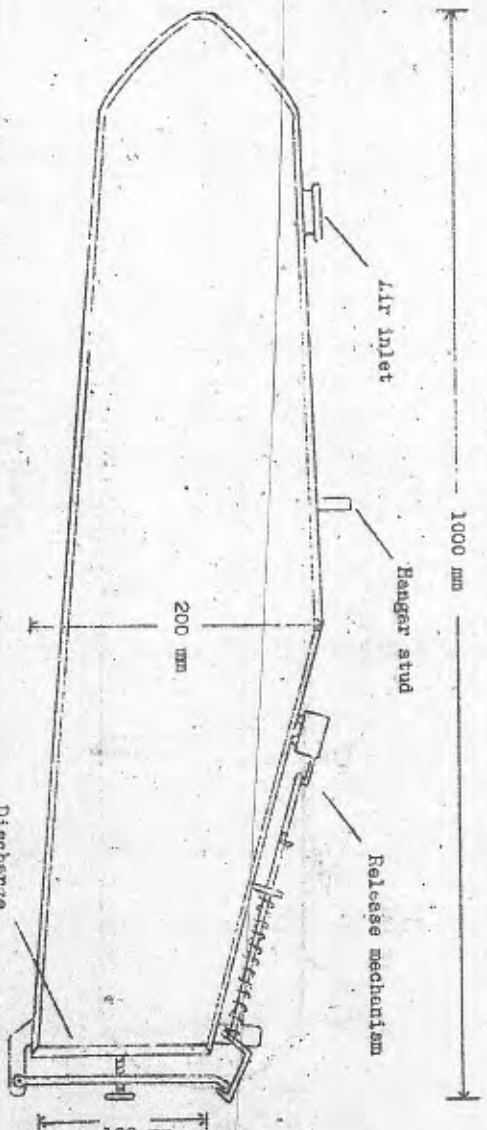
3. It is thought desirable to mention here that the Japanese Navy did develop a non-pressure type spray tank (1935) which was tested and found to be unsatisfactory. Complete details on this tank will be included in the report mentioned in paragraph 2 above.

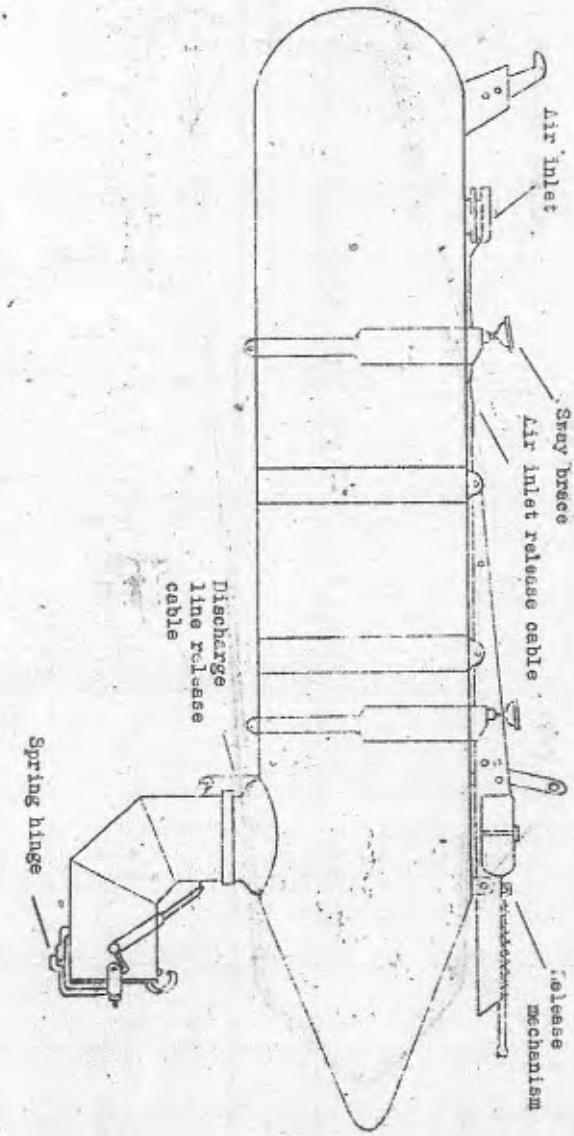
4. Several German pressure-type spray tanks (from which the Japanese Type 99 was copied) were discovered in a navy warehouse at the conclusion of the survey. The Japanese who had been questioned earlier vehemently denied having received any chemical warfare information from the Germans, but when confronted with these tanks remembered the circumstances surrounding their receipt. Further details on this tank will also be included in the report referred to in paragraph 2 above.

50 Kg. TYPE CHEMICAL BOMB
Japanese Army Air Force



28 LITER WING TANK
Japanese Army Air Force

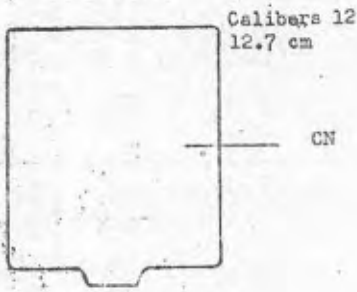




85 LITER GAS TANK
Japanese Army Air Force

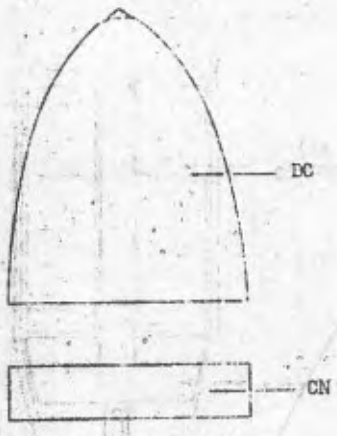
CHEMICAL "CANS" FOR NAVAL ARTILLERY SHELLS

Japanese Navy



For nose - fuzed shell

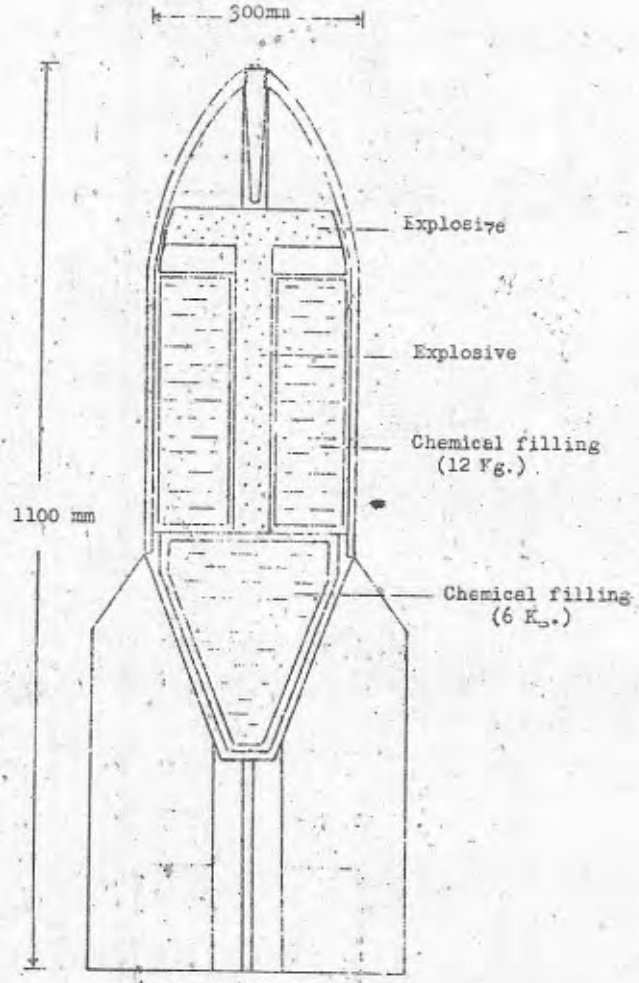
Calibers 14 cm and 15 cm



For tail - fuzed shell

60 KG. TYPE CHEMICAL BOMB

Japanese Navy Air Force



EXPERIMENTAL TYPE WOODEN-BODY MUSTARD BOMB

Japanese Navy Air Force