Theme: Means of chemical detection and monitoring

Chemical detection is a type of measures for the early detection of the presence of toxic chemical agents in the air, on the terrain, in materiel, and in food and water supplies.

The purpose of chemical detection is to delineate contaminated sectors, determine the type and extent of contamination, notify troops about contamination, determine the direction of movement of a contaminated cloud, locate and mark the safest axes (routes) through or around a contaminated area, and establish regions of stagnation of toxic chemical agents.

Chemical detection is carried out by detection subunits of the chemical troops, from which observation posts and patrols are detailed. In the subunits of combat arms and special forces, special crews and details are trained for chemical detection. The detection is implemented on specially equipped vehicles or on foot using special devices. Unlike a radiological survey that determines the extent and intensity of the hazard, a chemical survey can only determine the extent, not the intensity, of the hazard.

Timely detection and warning are critical to the protection of forces—especially since chemical agents act very quickly.

In conducting a chemical survey answers on the following points should be obtained:

- Are chemical agents present?
- If there is an agent present, what type is it?
- Where/when was the chemical agent first detected?
- What are the agent's boundaries?
- Are there any clean routes through the contamination?

Requirements for chemical detection:

- Timeliness
- Continuity
- Accuracy
- Succession

- Effectiveness

Possible indicators of Chemical agents

- Mass deaths animals or birds or fish
- Lack of insect life
- Unidentified smoke or mist.
- Unexplained odors
- Low-lying clouds
- Unusual liquid droplets
- Physical symptoms
- Mass casualties

There are two methods for the detection and identification of chemical agents: subjective and objective. The objective is more reliable.

a. Subjective. Detection by one of your five physical senses: sight, hearing, taste, touch, and smell. Use this method of detection only as a warning of the presence of an agent, to be followed by immediate masking.

b. Objective. Detection and identification by an external physical or chemical aid such as M8 paper and M9 tape, M256A1, and the CAM. hese items sample the molecular structure of air or indicate a chemical agent's presence when the agent chemically reacts with these treated papers or test reagents.

Objective method of detection is preferred over the other!

Characteristic odor of some chemical agents

Agent Names	Characteristic odor
Sarin	None or ether
Mustard gas	Garlic
Lewisite	Geraniums
Phosgene Diphosgene	Rotting hay or rotting fruits
Hydrogen cyanide	Bitter almonds
Chloroacetophenone (CN)	Bird-cherry tree

Recognizing health effects of chemical agents

Agent Type	Agent Names	Any Unique Characteristics	Signs and Symptoms
Nerve	- Cyclohexyl sarin (GF) - Sarin (GB) - Soman (GD) - Tabun (GA) - VX - Some insecticides (cholinesterase inhibitors) - Novichok agents/ Soviet V	- Miosis (pinpoint pupils) - Copious secretions/sweating - Muscle twitching/ fasciculations	- Miosis (pinpoint pupils) - Blurred/dim vision - Headache - Nausea, vomiting, diarrhea - Copious secretions/sweating - Muscle twitching/ fasciculations - Breathing difficulty - Seizures - Loss of consciousness
Asphyxiant/Blood	- Arsine - Cyanogen chloride - Hydrogen cyanide	- Possible skin color changes: cherry-red (cyanide or cyanogens chloride); yellow or bronze (arsine) - Possible cyanosis - Possible frostbite*	- Confusion - Nausea - Gasping for air, similar to asphyxiation but more abrupt onset
Choking/ Pulmonarydamaging	- Chlorine - Hydrogen chloride - Nitrogen oxides - Phosgene	- Seizures - Chlorine is a greenish-yellow gas with pungent odor - Phosgene gas may smell like newly-mown hay or grass - Possible frostbite*	- Eye and skin irritation - Airway irritation - Dyspnea, cough - Sore throat - Chest tightness
Blistering/ Vesicant	Mustard/Sulfur mustard (HD,H) - Nitrogen mustard (HN-1,HN-2,HN-3) - Lewisite (L) - Phosgene	- Mustard (HD) may have an odor like mustard, garlic or horseradish - Lewisite (L) may have an odor like geranium - Phosgene oxime	- Redness and blisters of the skin - Tearing, conjunctivitis, corneal damage - Mild respiratory distress to marked airway damage

	oxime (CX)	(CX) may have a pepper-like or pungent odor	
Incapacitating/ Behavior-altering	- Agent 15/BZ	- May appear as mass drug intoxication with erratic behaviors, shared realistic and distinct hallucinations, disrobing and confusion - Hyperthermia - Mydriasis (dilated pupils)	- Dry mouth and skin - Initial tachycardia - Altered consciousness, delusions, denial of illness, belligerence - Hyperthermia - Ataxia (lack of coordination) - Hallucinations - Mydriasis (dilated pupils)
*Frostbite may occur from skin contact with liquid arsine, cyanogen chloride or phosgene.			

Chemical Detection Equipment

M8 Chemical Agent Detection Paper

M8 chemical detector paper (figs 4-2 through 4-4) is a blotter-like paper, impregnated with chemicals used to detect liquid contamination, specifically to indicate the possible presence of liquid blister and nerve agents (these agents are disseminated as a liquid). There are three sensitive indicator dyes suspended in the paper matrix. The paper is blotted on a suspected liquid agent and observed for a color change, which will occur within 30 seconds: VX turns the paper dark green, the G series of agents turn the paper yellow and blister agent turns it red.

Instructions for Using M8 Paper

1. Remove and open M8 paper from kit or mask carrier, discard plastic bag.
2. Test the liquid.
   - Tear out a sheet of M8 paper (sheets are perforated; use one segment).
   - Expose M8 paper to suspected liquid agent.

3. Compare any color changes on the paper with the colors shown inside the cover of the book of M8 paper. Use color readings to determine the type of chemical agent present.

Note: Ensure that you hold the M8 paper in the down position to prevent liquid contaminates from running onto your protective glove. Blot, do not rub, the M8 on suspected contamination.

M9 Chemical Agent Detection Paper

M9 Chemical Agent Detection Paper is a portable, single roll of paper that comes with a Mylar adhesive-backed and -coated tape. It contains a suspension of an agent-sensitive dye in a green-colored paper matrix. The agent-sensitive dye will turn pink, red, reddish brown, or red-purple when exposed to agent but does not identify the specific agent. M9 paper is more sensitive to nerve and blister agents and reacts more rapidly than M8 paper, although it also reacts to a wide range of interferents such as petroleum products, brake fluid, aircraft cleaning compounds, DS2, insect repellent, defoliant, and antifreeze**.**

M9 paper, which is similar to masking tape, is used by attaching strips to the individual overgarment and to equipment such as vehicle controls. The strips are then inspected routinely for color change. The paper should not be attached to hot surfaces, as this will discolor the tape and lead to a false positive reaction.

Instructions for Using M9 Tape

1. Open package of M9 tape.
2. Unroll small portion of detector tape.
3. Blot, do not rub, the M9 tape on the suspected liquid.
4. Observe for color change.

Like M8 paper, M9 tape changes colors when in contact with a chemical agent. However, when in contact with contamination, it can appear as a light pink color to a reddish brown or violet color, signifying a chemical agent is present. It will not identify specific chemical agents.

Chemical Agent Monitor and Improved Chemical Agent Monitor

The chemical agent monitor (CAM) and improved chemical agent monitor (ICAM) are handheld, soldier-operated devices designed for monitoring chemical agent contamination on personnel, equipment, and surfaces. They use ion mobility spectrometry technology to detect and discriminate between mustard and nerve agent vapor. The concentrations of agents detected by the CAM and ICAM areas are as follows: for sarin (GB), 0.03 mg/m3; for VX, 0.1 mg/m3; and for mustard (HD), 0.1 mg/m3.

The units are simple to operate, can be held in either hand while the user is wearing chemical protective equipment, and operate day or night.

Relative vapor hazard and malfunction information is displayed by bars on a liquid crystal display. As an example, the bar readings for concentrations of the nerve agent sarin. The CAM and ICAM are point monitors only and cannot give an assessment of an area vapor hazard.

The two may give false readings when used in enclosed spaces or when sampling near strong vapor sources such a dense smoke, aromatic vapors, cleaning compounds, exhausts from some rocket motors, and fumes from some munitions. Because of the technology employed, the CAM and ICAM are subject to saturation; they must be cleared to function properly.

Chemical Agent Detector Kit

The M256A1 Chemical Agent Detector Kit is a portable, expendable item capable of detecting and identifying hazardous concentrations of nerve and blister agents and cyanide.The kit is used after a chemical attack to determine if it is safe for personnel to unmask. Each kit consists of 12 disposable plastic sampler-detectors (ticket or card), one booklet of M8 paper, and a set of instruction cards. Each ticket (card) contains laboratory filter paper test spots for the various agents. The technology used is wet chemistry, enzymatic substrate– based reactions, where the presence of agents is in dicated by a specific color change. Response time is about 15 minutes. Some smokes, DS2, petroleum products, and high temperatures may produce false readings.

The detection limits for the M256A1 are as follows: for the G series of nerve agents, 0.005 mg/m3; for VX, 0.02 mg/m3; for the vesicants mustard (HD) and Lewisite, above threshold concentrations of 3.0 mg/m3 and 14 mg/m3, respectively; and for hydrogen cyanide (AC), 11 mg/m3, and cyanogens chloride (CK), 10 mg/m3.

The M256A1 kit cannot be used to detect agent in water. It can, however, be used to check an area before a military unit moves in or to define clean areas or routes. Some chemical ingredients in the kit are considered possible carcinogens and should be handled as such. The emissions produced by this kit are also toxic; a mask and gloves must be worn while the kit is being used.

M272 Chemical Agent Water Testing Kit

The M272 Chemical Agent Water Testing Kit is designed to detect and identify, via colorimetric reactions, hazardous levels of nerve agents, mustard, Lewisite, and cyanide in treated or untreated water. A full kit contains enough supplies to perform 25 tests for each agent, and simulants are included for training use. About 20 minutes is required to perform all four tests. All bodily contact should be avoided with the kit chemicals, as some can be very harmful and should only be handled while wearing protective gloves and equipment. Detection limits are as follows: for the G-series nerve agents and VX: 0.02 mg/L; for the vesicants Lewisite (L) and mustard (H and HD): 2.0 mg/L; and for the cyanides (AC and CK), 20 mg/L.

Automatic Chemical Agent Alarm

The M8A1 Automatic Chemical Agent Alarm is an automatic chemical agent detection and warning system designed to provide real-time detection of the presence of nerve agent vapors or inhalable aerosols. The M8A1 consists of the M43A1 detector and up to five M42 alarms, which will provide both an audible and a visible warning. The M43A1 is an ionization product diffusion/ion mobility type detector; it will sound a false alarm in the presence of heavy concentrations of rocket propellant smoke, screening smoke, signaling smoke, engine exhausts, and whenever a nuclear blast occurs. The M8A1 can be located within a hospital

complex, with alarm units placed to cover all criticalcare, treatment, and support areas. The M43A1 detects nerve agent vapors at concentrations of 0.2 mg/m3 for sarin (GB) and 0.4 mg/m3 for VX.

Chemical detection device (VPKhR)

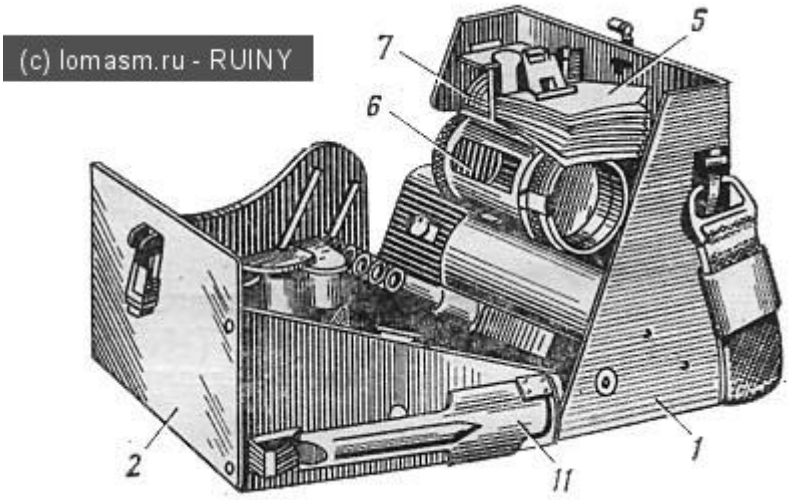
Troop Chemical detection device is used to determine the air, on the ground and on the technique of chemical agents - sarin, mustard gas, phosgene, diphosgene, hydrogen cyanide, cyanogen chloride in the air, on the ground and on vehicle and Vx vapor in the air.

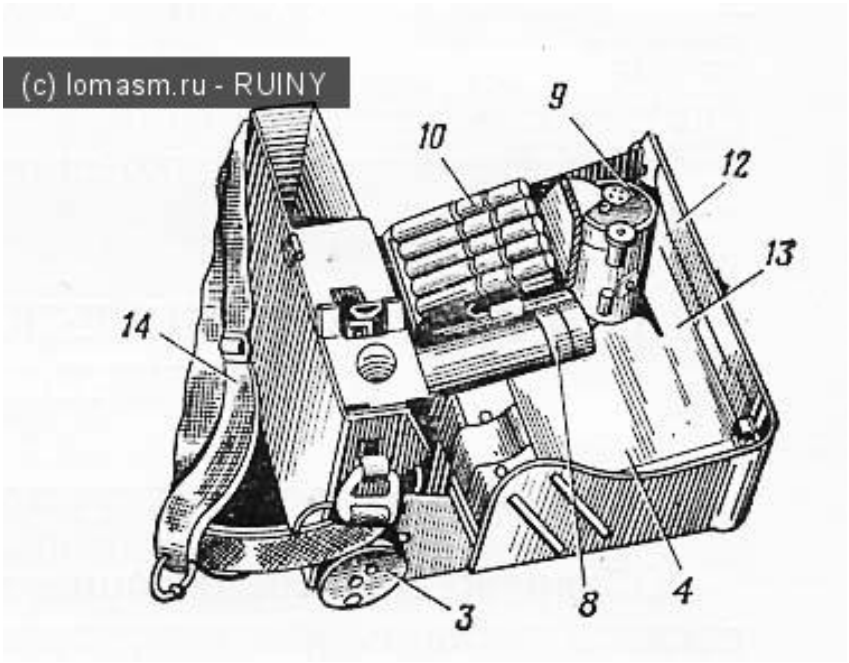
Chemical detection consist of a frame with a cover and placed in which are placed a hand pump, paper cases with indicated tubes, antismoke filters, an attachment to a hand pump, protective caps, an electric light, a chemical heater and catridges for it, a shovel, an instructions on operating with device and an instruction on detection of chemical agents.

The weight of the device is 2,3 kg. The pumping of the analyzed air with a hand pump through the indicated tubes is the principle of using the device.

The hand pump is placed in a metal tube, mounted in the frame of the device**.** Apertures for break of ampoules in indicated tubes (IT) are placed in the handle of the pump.

A knife to cut the ends of indicated tubes, socket for installation of the indicated tube and two apertures the breaking end of the tube are placed in the head of the pump.





1 – frame

2 – cover

3 – hand pump

4 – paper cases with indicated tubes

5 – antismoke filters

6 – attachment to a hand pump

7 – protective caps

8 – electric light

9 – chemical heater

10 – catridges for heater

11 – shovel

12 – instructions on operating with device

13 – instruction on detection of chemical agents

14 – shoulder strap

Indicated tubes are placed in the paper cases. Indicated tubes are sealed glass tubes with filler and one or two glass ampoules with reagents (indicated tubes with a yellow ring have no ampoules). Each indicated tube has special marking:

- Indicated tubes with red ring and red point – for detection of sarin, soman, VX;
- Indicated tubes with three green rings for detection of phosgene and diphosgene, hydrogen cyanide, cyanogen chloride;
- Indicated tubes with yellow ring for detection of mustard gas.

There are colorimetric color standard, instructions on the procedure of work with indicated tube on the paper cases.

Antismoke filters are used for detection chemical agents in the air with smoke. Antismoke filter consists of one layer of filtering material and several layers of nylon fabric. Antismoke filters are fixed to attachment by fixing ring.

Electric light is used for monitoring of the color changes of indicated tubes in the dark time.

Chemical heater is intended for heating of indicated tubes when detection chemical agents at low air temperature (from -40^0C to $+10^0$C). Heater consists of a frame, catridges for heater and a metal spike for breaking of ampoules with a solution at the point of use of the cartridge.

Chemical detection devices have a manual piston pump is used to pump air through the test tube indicator. At 50 swings per minute pump through the indicator tube are 1.8 - 2 liters of air itra.

A pump which has VPHR device consists of a head, cylinder, piston, rod handle. It is placed in a metal tube mounted in the housing. Inside the tube there is a spring designed to push the pump when the latch is opened. VPKhR pump embedded in the pipe handle rod out. At the pump head has a knife to cut the ends

of test tubes and card slot for the display tube. At the end of the head there are two blind holes for breaking off the ends of the tubes.

Instructions of detection of a chemical agent by Chemical detection device

To detect a chemical agent in the air you should:

- Make an incision and break off the ends of the indicated tubes.
- Insert the indicated tube in the central aperture of the head of the pump with untagged point.
- Run the air through the pump.
- Break the ampoules of indicated tube if it necessary.
- Compare the color of filler of indicated tube with the colorimetric color standard.

To detect a chemical agent in the smoke air you should use the attachment and the antismoke filter.

To detect a chemical agent on the ground you should use the attachment and the protective cap.

Detection of phosgen

For detection of phosgen you should:

- Open the indicated tube with three green rings, break the ampoule in it.
- Insert the indicated tube in the central aperture of the head of the pump with untagged point.
- Run the air through the pump from 10 to 15 times.
- Compare the color change of the upper layer of filler of the indicated tube with the colorimetric color standard. (The lower layer of filler of the indicated tube changes the color when in the air there are hydrogen cyanide or cyanogen chloride)

Detection of mustard gas

For detection of mustard gas you should:

- Open the indicated tube with yellow ring.

- Insert the indicated tube in the central aperture of the head of the pump with untagged point.
- Run the air through the pump from 6 to 10 times.
- Compare the color change of filler of the indicated tube with the colorimetric color standard in a minute.

Detection of sarin

For detection of sarin you should:

- Open the indicated tube with red ring and red point, break the upper ampoule and shake it.
- Insert the indicated tube in the central aperture of the head of the pump with untagged point.
- Run the air through the pump from 5 to 6 times.
- Break the upper ampoule of indicated tube and shake it.
- Compare the color of filler of the indicated tube with the colorimetric color standard.