# PROTECTION OF CIVILIANS AGAINST GAS ATTACKS

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During the week after Pearl Harbor a number of chemists, biologists and physicists of the faculty of the California Institute met with the Pasadena Health Officer, Mr. Charles Arthur, and with Dr. Alvin G. Foord to organize a special technical committee to be associated with the Pasadena Office of Civilian Defense. Some of the aims of this committee were as follows:

1) To give advice, if possible, to the local authorities and to the public on questions concerning the defense against attacks with high explosive bombs, incendiary bombs and chemical and bacterial agents.

2) To give lectures and seminars on the various problems involved in Civilian Defense, and to train a number of students at the Institute in the handling of practical means of defense.

3) To help in the efficient adaptation to local conditions of defense equipment furnished by the U.S. Federal Government.

4) To experiment with new devices for the civilian defense in instances where the government did not or could not provide for any equipment, and to put into operation any of these devices which would be found most effective.

Unfortunately this ambitious program could not be carried through in its entirety because of various reasons. First, many members of the original committee were drafted into projects important to the conduct of actual warfare. Secondly, since neither financial aid nor any priorities could be secured from the central office of the O.C.D., it was necessary to mobilize the needed funds, materials and labor locally and to work with a very limited number of basic materials, engines and gadgets of various kinds. Thirdly, great, and in the face of past disasters, incomprehensible inertia was often encountered, which apparently sprang from a lack of vision to take the possibility of an enemy attack on this coast seriously.

On the other hand all of the City departments, as well as a great number of individuals and industrial and commercial concerns, have lent us their moral and material aid unstintingly and generously; and hearty thanks are herewith expressed to them on behalf of our committee. A whole book might be filled by mentioning all of the names of the contributors and the work done by them. But I must confine myself to a short description of the equipment, the design and construction, or supervision of construction of which I have been personally responsible. I hope that such a discussion may pave the way in this and other communities towards the realization of some of the other projects which our committee had originally envisaged.

The following discussion will be essentially restricted to the problem of the defense of the City of Pasadena against war gas attacks. This problem has naturally two aspects, dealing with collective protection and with individual protection respectively.

Those concerned with means of collective protection should before all else keep in mind that an attack is most likely to be delivered from the air, and that with modern methods of dispersal of persistent war gases, large areas and large volumes of

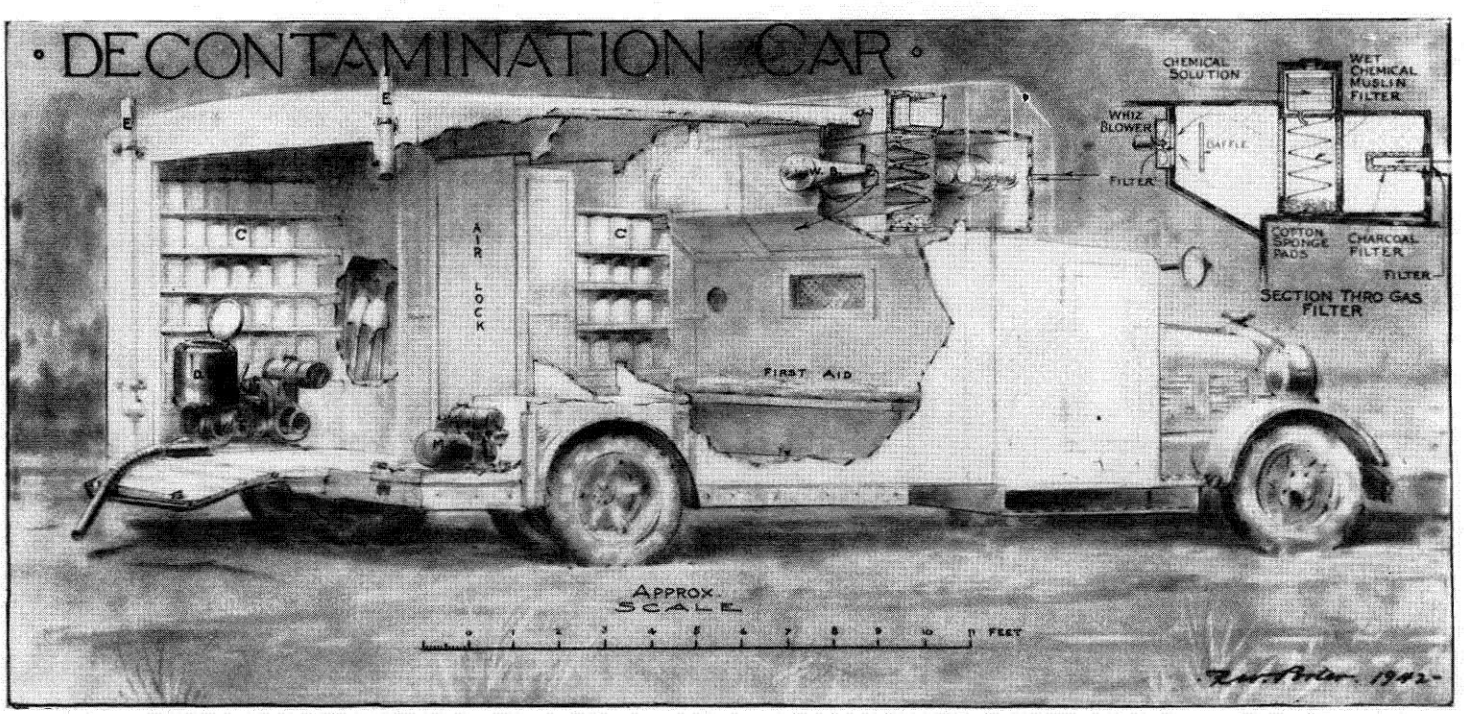




Fig. 1

air may be infested in a short time. A highly *mobile defense* is therefore needed. We cannot hope that only a few gas bombs will be dropped here and there and that we shall be allowed to conveniently ignore their contents until the next day and then to proceed leisurely to decontaminate a few localized spots.

In the design and construction of mobile decontamination units for the City of Pasadena the following points were therefore constantly kept in mind:

A) To build units which, if necessary, could counterspray air and ground with chemical and physical neutralizing agents if the enemy should succeed in dispersing war gases over extended areas and through large volumes of air;

B) To meet, if possible, an attack of a combination of gas and incendiaries;

C) To provide for a mobile first aid station to be carried along with the decontamination trucks in order to safeguard as far as possible the highly exposed members of the mobile decontamination squad and to render first aid to civilian victims, at least in some of the most severe instances.

To meet the stated requirements, the use of small planes and of automobiles equipped with dust blowers comes to mind immediately. Autogyros or helicopters from which neutralizing chemicals in the form of either dust or liquid droplets could be blown into the poison gas clouds would obviously provide an ideal means of defense. Nevertheless, because of the impracticability of carrying large amounts of liquids, such aerial counterspraying would have to be coordinated with ground crews operating fire hoses with voluminous water sprays for the purpose of precipitating the whole mixture of poison gases and neutralizing agents out of the air. Needless to say, the benefactor who will furnish us with the desired aerial vehicles is still around the corner. It might, however, be suggested that a district like the County of Los Angeles seriously consider the introduction of some such vehicles as the autogyro or the helicopter equipped with gadgets similiar to those to be mentioned in the following discussion of the decontamination truck No. 1 of the City of Pasadena. The use of small planes for first aid purposes and communications would have its additional advantages, provided that the necessary permission from the Army could be obtained.

Since no flying machines were available for our use, we set out to construct a fleet of three decontamination trucks with whose help the following operations could be carried out:

a) Decontamination of hydrants to which hoses have to be attached either by the firemen or the gas decontamination squads;

b) Dispersal in the air and over the ground of large volumes of suitable mixtures of chemicals which neutralize the poison gases;

c) Precipitation of the gas clouds out of the air and hosing down the ground with water sprays from the hydrants;

d) A thorough, final check up of contaminated spots outdoors and inside of buildings.

Operations a) and b) are to be carried out by the crew of the decontamination unit I, while the operations c) and d) are to be taken care of by the units II and III respectively. These latter units, as well as the equipment carried by them, are more or less of conventional design, so we shall mention them only briefly. We propose to discuss the decontamination unit I in more detail. A drawing of this unit, which I owe to the kindness and skill of Russell W. Porter, is reproduced in Fig. 1.

Decontamination unit No. 1 is a large truck with three compartments, the driver's cabin, a *first-aid cabin* and a semi-enclosed rear platform. One of the older service trucks of the Light and Power Department of the City of Pasadena was generously turned over to us by its director, Mr. Benjamin De Lanty. The truck was stripped of its unnecessary trimmings. Most of the subsequent construction work was done in the shops of the Light and Power Department, to whose engineers and workmen I am indebted for many pleasant days of work together on this construction. Much of the work was

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**Fig. 2**

**Unit No. 1 with the blower in action**

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done by Mr. F. R. Huddy in the yard at California Street and Broadway, under the supervision of Mr. L. S. Caswell.

It was attempted to render the driver's compartment and the first aid cabin gas-free under all circumstances. Mobile gas-free cabins of this type have several advantages. Inside these cabins the driver and a physician or first aider are not encumbered with masks or gas proof suits, and victims can be given aid on the spot. Also the men of the squad may change dress leisurely while the car is starting on its mission so that no time is lost in putting in the gas proof suit, shoes, masks, etc., before starting. The air is drawn into the interior by a whizz blower (marked W.B.) with a 200 watt motor and fan creating a pressure of 20 inches water lift. The air first passes through a thin felt filter and a large double cylinder activated charcoal canister kindly lent to us by Professor F. Went of the Institute. This is followed by a chemical muslin filter, which is kept wet by a solution of appropriate chemicals dissolved in water and some glycerin trickling through their orifices from eight five gallon tanks mounted on top. Finally, having surplus pressure left, we decided to install behind the whizz blower a tank air bubbling filter, not shown in the drawing. The power for the whizz blower and for the lamps in the first aid cabin and the rear platform is furnished by a small 500-watt motor generator set (M.G.), which is mounted on the rear platform. Two wet blanket doors form an airlock which closes the two cabins off against the rear platform. The surplus air pressure created in the two cabins by the whizz blower prevents any poison gas or carbon monoxide from the exhausts of the three gasoline engines from penetrating the two closed cabins in any dangerous amounts.

On the rear platform a *dual duster* (D.D.) is mounted. For the loan of this blower I am greatly indebted to the generosity of the Los Angeles office of the Food Machinery Corporation. Dual aluminum fans enclosed in aluminum blower cases are driven by a 1½ H.P. Cushman Husky Air-Cooled Engine. Powdered chemicals may be dumped into a 50-pound capacity hopper with independent feed control, and blown out with great force into the air through one or two semi-flexible hoses about three inches in diameter. While the truck is driving along, a dust cloud about fifteen yards high and a hundred yards in width may thus be generated. Very fine dry silt and powdered chemicals such as chloride of lime may be carried along in three hundred single friction top 5-pound cans (C). While one member of the crew is dumping the contents of these cans into the hopper, another member is handling the hose and generating the dust cloud. The neutralizing chemical cloud might under certain circumstances react all too violently with the poison gases, such as vesicants for instance. Decontamination truck No. 1 is therefore followed by truck No. II which carries some 450 feet of fire hose, to be attached to several already decontaminated hydrants. Powerful water jets then precipitate to the ground and wash down into the sewers the poison gases and the neutralizing agents. To speed up the neutralization of the poison gases, the fine silt dust is used. This dust, together with some additions of powdered detergents such as Dreft, acts to emulsify the whole precipitate into fine globules giving the chemicals and the water a maximum chance to oxydize, chlorinate or hydrolize the poison gases and thus render them ineffective. Dr. R. W. Hummer at our Institute was kind enough, at my suggestion, to carry out some experiments on the emulsification and destruction of mustard gas.

A third decontamination truck is being equipped by the senior gas officer, Mr. Ted V. Ackerman, with the officially recommended equipment of shovels, brushes, pails to mix slurry of chloride of lime, stirrup pumps, portable tanks with hand pumps, etc. This unit is designed to take care of the decontamination of local spots on the streets or in buildings, which cannot be reached with the blower on truck No. 1. Contaminated machinery in industrial establishments will be particularly difficult to decontaminate, since many of the poison gases are highly soluble in machine oils and greases. Special chemical decontamination agents which do not corrode any of the exposed metal parts will be needed. Unfortunately no good agents of this type are available to us. It is to be expected that the chemical warfare services will in an emergency release the non-corrosive agents developed by them.

A crew of fifteen men of the Pasadena Street Department is being trained in the operation of the equipment. In an emergency it is intended to call on the services of some of the students of the California Institute. The direction of operation of the chemical defense lies in the hands of the senior gas officer and his assistant at the main control center of the city. Associated with them is a group of four technical advisors from the Institute: Doctors F. W. Went, D. H. Campbell, A. L. LeRosen and the author of this article. On every yellow alert

one member of this group is called directly by the senior gas officer to take up his station in the auxiliary control center. The remaining three members may be called upon to assist in the gas reconnaissance service or to go out with the decontamination fleet to direct operations in the field.

The decontamination fleet and the control officers keep also in touch with two groups of men which were organized at the California Institute. The first group, under the direction of Prof. Haagen-Smit, is a self-contained decontamination unit with all of the necessary equipment for local operations around the campus. The second group consists of about one dozen reconnaissance officers recruited among the faculty and the students at the Institute. These men have *gas identification kits* at their disposal, and on their reports as well as on the information to be obtained from the air wardens the whole gas defense service depends. Doctors Dan H. Campbell and A. L. LeRosen are responsible for the design and construction of a set of the identification kits used.

The individual equipment furnished by the government includes army training masks, steel helmets and a number of gas proof suits. To familiarize the men on our squads with the use of the gas masks, one or more practical tests were given to most of them in a room filled with tear gas (C.N.) to a concentration of 150 milligrams per cubic meter. The transit house on the roof of the Astrophysics Building proved to be very convenient for use as a gas chamber.

Several simple devices were developed to protect the gas masks from any possible damage. All of our men were advised to close up the canisters of their masks at both ends with double seals of cellophane and dental dam in order to prevent the activated charcoal from being saturated prematurely with gasoline fumes, steam and other easily absorbable vapors. Also there is danger that men operating stirrup pumps, fire hoses and other water spraying devices will get their canisters wet and thus render them useless. To prevent such accidents as far as possible, a light and partially stiffened muslin bag was developed, which protects the canisters from getting wet too quickly and which does not interfere with breathing.

So far the Office of Civilian Defense has not released any gas proof boots, socks or gloves. We therefore set out to develop some makeshifts. For shoes a type of *sandal* with wax-impregnated heavy wooden soles was made, modelled after the so-called *"Zoccoli"* worn in the Italian speaking parts of Switzerland. The wooden soles are fitted with hinges in the proper place, which sufficiently facilitate walking. I am indebted to Mr. Walden Shaw for the construction of forty pairs of these sandals, which were turned over to the Institute squads. The squads of the City were furnished similar sandals.

To take the place of impermeable socks a sort of *mukluk* was designed, which consists of five layers of cellophane being sewed between two layers of heavy muslin, the outer of which may be impregnated with some wax, oil or gelatine to be hardened subsequently. Unfortunately sewing of the cellophane presents considerable difficulties. Anybody who intends to ask any of his lady friends to fabricate such a pair of mukluks, therefore, had better be prepared for the worst. A large amount of excellent double thickness cellophane to be used for the mukluks was made available to us through the generosity of the Zellerbach Paper Co. of Los Angeles.

So far, official gas masks have been issued only to a relatively few men. On a large scale gas attack it would be imperative to have many more gas masks available immediately. Also, if gases, fires and perhaps phosphorous sprays had to be fought simultaneously, the official rubber face mask might prove to be a truly hot affair. For these reasons we experimented with a complete hood of multiple muslin and cheese cloth, kept as wet as possible with water, glycerin and some surface tension-lowering detergents. The hoods are provided with horizontal channels into which various chemicals such as sodium bicarbonate, urotroprine, sodium sulfite, chloramine-T, etc., can be inserted; the chemicals to be chosen appropriately, depending on the gases to be neutralized. These hoods, which we call *scram masks,* are equipped with exhaust valves of various designs and are considerably more convenient and effective than the wet towels occasionally recommended for emergency protection. With Drs. F. Went and R. W. Dodson, the author tested these scram masks on numerous occasions against tear gases, phosgene, chlorpicrin, mustard gas and smokes. It was found that the scram mask may well be used to decisive advantage to scram out of gas infested areas as long as nothing better is available. For suitable models of scram masks and mukluks made after his designs, the author is indebted to Mrs. Winchester Jones, Miss A. Stryke and Mrs. M. L. Cross. Subsequently Mrs. F. B. Badgley and Mrs. B. Gutenberg organized a circle of ladies who made about two hundred scram masks available to the Health Department of the City of Pasadena, which provided

most of the needed materials. A considerable number of persons also produced similar masks for their own private use. On breathing in through the scram mask the outside air passes through the films of liquid lamellae which are suspended between the threads of the various layers of cloth. A difference in pressure of only a few inches of water column is necessary to make the air pass. This transfusion of gases through thin liquid films, as well as the various physical and chemical processes which accompany it, present some rather interesting scientific and technical problems which justify a more detailed study.

The problem also was studied of making large buildings gas tight by filtering the air at the intakes and by creating a positive pressue of about one half of an inch water head in the interior of the buildings. With all of the windows closed the doors could then be used freely for entrance and exit without danger of poison gas entering. An air intake of this kind was installed for the control center of the City of Pasadena. The air intakes must be located as high as possible. The most suitable building to be rendered gas tight on the campus is the biology building, but no practical action has as yet been taken. The protection of factory buildings and the machinery which they contain presents some of the most interesting problems of gas defense, and it is to be hoped that adequate studies in this direction are being made. Even if we never should be forced to make practical use of the results of such studies, they might be of value to our friends overseas who are more likely to be exposed to enemy gas attacks.

In conclusion we wish to express our gratitude to the great number of persons who have cooperated in our efforts. Lack of space makes it impossible to mention them individually. I wish, however, to express my most sincere thanks to Mr. Charles Arthur, Director of the Health Department of Pasadena, who most clearly recognized his responsibility in working for the protection of the civil population; without his untiring assistance and support our efforts would have been futile. The effective cooperation of the senior gas officer, Mr. Ted V. Ackerman, as well as that of many of my colleagues at the Institute likewise is highly appreciated.

# POST WAR AIRCRAFT MANUFACTURING

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Military airplanes will probably continue to occupy a prominent place in our industry, especially among those who have the most flexible design and manufacturing facilities. World and national political factors will largely govern here.

Commercial cargo and passenger transportation will provide a large demand, especially for the bigger airplanes, but this field will be dominated by those companies with the highest degree of engineering skill. Airline operators will greatly expand their potential volume of traffic, especially as design changes permit further declines in operating costs. However, in the field of bulk cargo there will be plenty of business for the railroads and our ships—at least as far as we can see ahead. New merchandising methods may develop, as air transportation makes it possible to reduce the need for carrying large inventories of the higher cost goods. But cost of transportation will still be a governing factor, even though the small town merchant may have the goods of the world within a few hours reach. The general level of prosperity in this country, following the war, will be the big question mark. Also our world-wide tariff policy. The means of trading with all the peoples of the earth and easy access to them will certainly be at our disposal through the use of the airplane. Will our political leaders see the light?

However, let me emphasize the fact that none of this can come true for us if we lose the war. That is why post-war planning seems to me to be decidedly secondary at this time. Our engineers are developing many things for war which can be used in peace. Let's not take our minds from the big task at hand today. The development of the airplane is *evolutionary* rather than *revolutionary*. *If we* make the world a safe place to live in—post-war aviation will follow as a matter of course and on an unprecedented scale. The war has accelerated its development—let's not throw away these benefits by dissipating our energies in fighting with our Allies for future air commerce now while our enemies strive to drive us from the skies.