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AIR RAID PRECAUTIONS

HANDBOOK No. 4

(1st Edition)

DECONTAMINATION OF MATERIALS

ON
STATIONERY OFFICE

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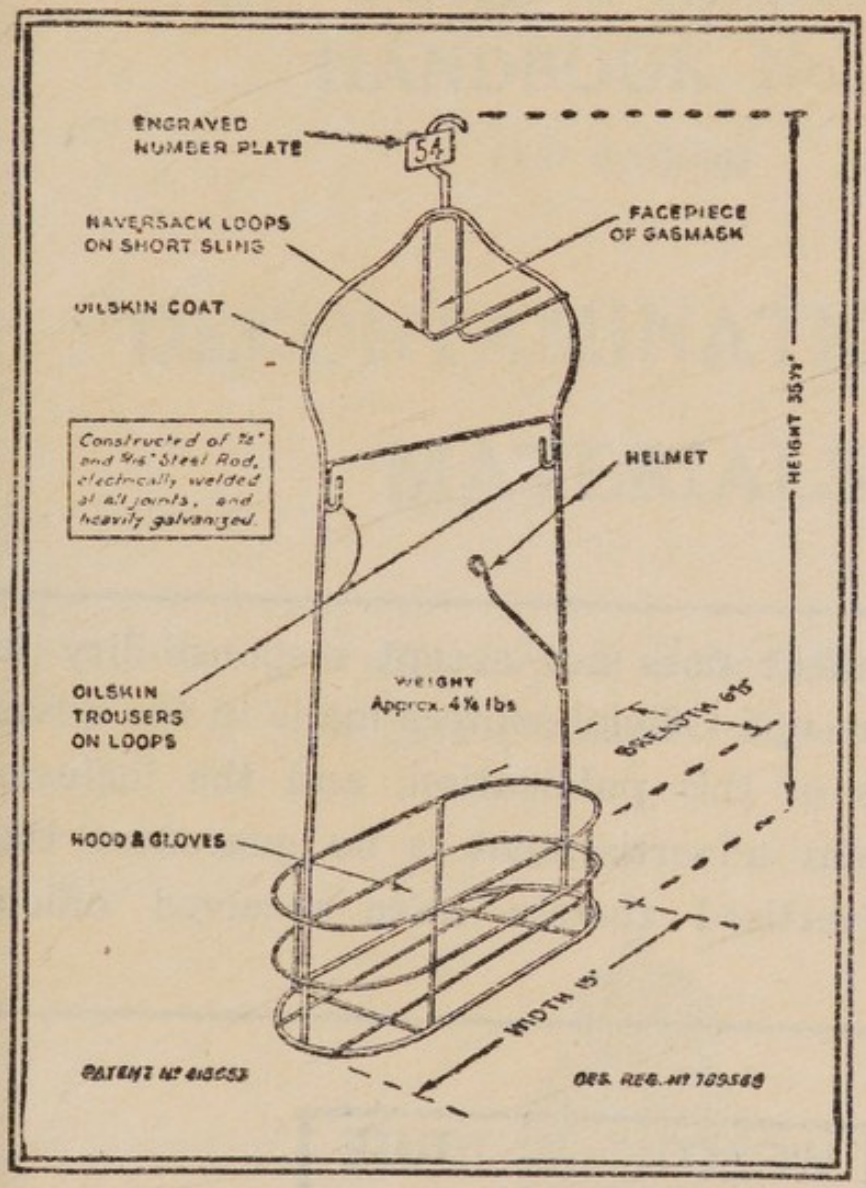

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AIR RAID PRECAUTIONS
HANDBOOK No. 4

(*1st Edition*)

DECONTAMINATION OF MATERIALS

Issued by the Home Office
(*Air Raid Precautions Department*)

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List of Air Raid Precautions Handbooks

(issued and projected)

No. 1.—Personal Protection against Gas (*1st edition*) (price 6*d.*: 8*d.* post free).
(A handbook primarily for members of air raid precautions services.)

No. 2.—First Aid for Gas Casualties (*2nd edition*) (price 4*d.* : 5*d.* post free).
(A handbook designed primarily for services giving first aid to air raid casualties.)

No. 3.—Medical Treatment of Gas Casualties (*in preparation*).
(A handbook for hospitals, doctors and nurses.)

No. 4.—Decontamination of Materials (*1st edition*) (price 6*d.* : 7*d.* post free).
(Decontamination of streets, buildings and their contents, vehicles and plant.)

No. 5.—Structural Precautions against Bombs and Gas (*in preparation*).
(Structural protection against bombs and gas in buildings ; air raid shelters, either separate or in buildings. This handbook will be designed for use by architects, builders and others directly responsible for the construction or maintenance of buildings.)

No. 6.—Air Raid Precautions in Factories and Business Premises (price 6*d.* : 7*d.* post free).
(A handbook designed primarily for the guidance of occupiers of such premises.)

No. 7.—Anti-Gas Precautions for Merchant Shipping (*2nd edition*) (price 3*d.* : 4*d.* post free).
(Includes certain recommendations to Port Authorities.)

A special Handbook is also being prepared for Householders.

In addition to these Handbooks, there is published a series of A.R.P. Memoranda dealing with various aspects of the organisation to be provided by local authorities for public air raid precautions services.

GENERAL PREFACE.

The series of Air Raid Precautions Handbooks (of which a list is given on the opposite page) is produced, under the authority of the Secretary of State, by the Air Raid Precautions Department of the Home Office with the assistance of other Government Departments concerned.

The measures for safeguarding the civil population against the effects of air attack which these Handbooks describe have become a necessary part of the defensive organisation of any country which is open to air attack. The need for them is not related to any belief that war is imminent. It arises from the fact that the risk of attack from the air, however remote it may be, is a risk that cannot be ignored, and because preparations to minimise the consequences of attack from the air cannot be improvised on the spur of the moment but must be made, if they are to be effective, in time of peace.

For the purpose of the measures now to be taken, it must be assumed that the scale of attack would greatly exceed anything which was experienced in the last war, and would involve the use of high explosive and incendiary bombs.

The use of poison gas in war is forbidden by the Geneva Gas Protocol of 1925, to which this country and all the most important countries of western Europe are parties, and the Government would use every endeavour on an outbreak of war to secure an undertaking from the enemy not to use poison gas. Nevertheless, the risk of poison gas being used remains a possibility and cannot be disregarded.

The Handbooks are designed to describe a scheme of precautions which it is hoped would prove effective in preventing avoidable injury and loss of life, or widespread dislocation of national activities. The Handbooks will aim at giving the best available information on methods of passive defence against air attack, and will be revised from time to time in the light of future developments

CONTENTS.

GLOSSARY OF TECHNICAL TERMS.

Bleaching Powder	...	Chloride of lime.
Concentration ...	...	The proportion of gas in a given volume of air.
Container ...	...	The part of the respirator containing the filter and the gas absorbent.
Contamination	...	The liquid or vapour remaining on an object or person as a result of exposure to gas (usually a persistent gas).
Decontamination	...	A process intended to remove the contaminating gas or to render it harmless.
Facepiece ...	...	The part of a respirator which covers the face.
Gas	...	Includes any chemical substance, solid, liquid or gas, used in war for its poisonous or irritant effects on the human body.
Non-persistent gas	...	A gas which forms a cloud (not necessarily visible) immediately it is released and leaves no liquid contamination on the ground.
Persistent gas ...	...	A gas in liquid form which evaporates slowly and so continues to give off dangerous vapour for a long period.

INTRODUCTION.

This handbook is intended to serve two purposes —to explain the general principles of governing the methods of counteracting contamination arising from war gases; and to form a text-book for the training of the members of the decontamination services, whether the public services to be provided by local authorities or the decontamination squads organised by public utility undertakings or in factories, etc.

The general principles will be important to the higher officials of local authorities and to all who need to have an appreciation of the behaviour of war gases. Methods of decontamination do not in fact lend themselves to precise definition. They cannot be applied by rule of thumb. The gas used, the exact position of the contaminated area, its nature and its importance, the weather, the degree of urgency, all are factors which must be taken into account if decontamination is to be achieved with success and without waste of effort. The choice of method depends on a knowledge of the principles involved as much as on following any set of rules.

This handbook does not repeat the general description of war gases, their characteristics and effects, which is contained in A.R.P. Handbook No. 1. That handbook is therefore needed by every reader of this book, to give him the basic knowledge of war gases.

The actual methods of decontamination described in the later part of this handbook must be learned by the personnel who would actually have to carry them out. The work itself would necessarily expose these men to danger from the gas, and it is essential that before they start to learn about decontamination they should first learn how to protect themselves from injury. A.R.P. Handbook No. 1—" Personal Protection against Gas " will give them the required information, which is not repeated in this handbook.

The Organisation of Decontamination Services is described in A.R.P. Memorandum No. 3.

It is impossible to over-emphasise the importance of decontamination if certain forms of war gases had to be encountered. Where the proper steps were not taken, areas and buildings would remain derelict when they might have been taken back into use, and avoidable casualties would occur through neglect to remove a continuing source of danger.

The short glossary of technical terms included at the beginning of this book should be studied before the book itself is read.

CHAPTER I.

HOW CONTAMINATION ARISES.

1. What Contamination Means.

The term contamination is used to signify the presence on the ground, or on any object or person, of a chemical substance, either liquid or vapour, which is capable of giving off what is known as a poison gas.

Many war gases are discharged in the form of a liquid, which vaporises on being freed from its container. Some of these liquids vaporise immediately, and these gases belong to the category known as non-persistent. From other liquids the vapour is given off slowly, sometimes over a period of days and even weeks, and these are known as persistent gases.

Contamination arises mainly from the persistent gases, and is caused by splashes of the liquid, or wind-borne spray. Temporary contamination may also be present in the disturbed earth of the crater of a bomb containing a non-persistent gas.

The persistent gases with which this book is mainly concerned are:—

Tear Gases—
Ethyl iodoacetate (K.S.K.).
Bromobenzyl cyanide (B.B.C.).

Blister Gases—
Mustard gas.
Lewisite.

The blister gases* are by far the most dangerous, and give rise to the major decontamination problem.

2. Types of Contamination.

Three sources of contamination may be encountered as a result of air attack:—

(1) Fine spray from aircraft.
(2) Gross spray from low-flying aircraft.
(3) Heavy local contamination from gas bombs.

* For their characteristics, effects, and methods of use, see A.R.P. Handbook No. 1.

The liquid splashes which constitute the main source of contamination will have different effects according to the nature of the surface on which they fall.

If they fall on an absorbent surface, they will penetrate it and take correspondingly longer to evaporate naturally, or to be removed or neutralised artificially.

They will penetrate into earth, and into wood, or textiles, or foodstuffs, if not protected by impervious coverings. The blister gases especially are of an oily nature, and are readily absorbed by other oils (e.g. lubricating oil on machinery), by fats (e.g. in the human skin) and by tar-products (e.g. road surfaces). Liquid splashes will also be absorbed by brick, stone and concrete.

The degree of penetration will depend on the nature of the particular surface and the length of time it is allowed to remain untreated. Danger and damage may thus be reduced or almost prevented if action can be taken promptly.

Water dissolves only very little mustard gas, and by long contact slowly destroys it by chemical action (hydrolysis). Large volumes of water such as reservoirs will not become contaminated to any significant extent, and no danger to filtered water supplies need be feared.

The possibility of contamination by lewisite raises a different problem. Lewisite is fairly rapidly destroyed by water, and so any treatment by means of water is effective for purposes of decontamination. On the other hand lewisite leaves poisonous arsenical compounds in the water, so that while water affected by lewisite would have no blistering effect it might contain a dangerous quantity of arsenic. Reservoirs supplying large water undertakings should be too large to be appreciably affected, and no danger need be anticipated; but in the event of a large lewisite bomb falling in a small reservoir (say less than three million gallons) the water should be tested for arsenic before being supplied for drinking.

If water in small vessels has received splashes of *liquid* blister gas, it should be thrown away.

This handbook is not concerned with the means of getting rid of contamination on the human body, which is dealt with in A.R.P. Handbook No. 1, or with foodstuffs, about which a further handbook is projected. At the same time the general principles of decontamination apply equally to all types of contaminated surface. The differences lie in the most appropriate method of treatment.

3. Effect of Weather.

The effectiveness of a gas is considerably influenced by the weather.

Wind.—A high wind rapidly blows away non-persistent gas, or vapour arising from an area contaminated by persistent gas, but it does not remove the danger arising from the liquid of a persistent gas which remains as "contamination."

Temperature.—This is of particular importance in relation to persistent gases. The liquid itself will evaporate more quickly in warm weather, therefore the danger from the vapour will be greater, but the length of time for which the liquid persists will be less.

In hot climates a persistent gas may evaporate so rapidly as to nearly resemble a non-persistent gas.

On the other hand in very cold weather a liquid such as mustard gas may freeze, and there will be little danger from vapour, though direct contact with contaminated objects will still produce skin burns. When the temperature rises increased vapour will be given off.

Besides the direct effect on the gas itself, temperature has an important effect on the surfaces contaminated and thus indirectly on the contamination resulting.

In a hot climate a road surface or pavement of stone or concrete may be so heated by the sun that blister gas will evaporate quickly and leave no contamination which requires treatment. Tarred or bituminous surfaces may become soft and easily absorb any liquid gas, thus rendering the decontamination process much more difficult.

Light rain has little effect upon gases of either class, but heavy rain tends to wash gas out of the air and also helps to wash away and destroy any liquid upon the ground. Absence of wind means that the rate of mixing of the gas with air will be slow, and therefore the gas will drift about in dangerous concentrations for a long time. Under these conditions gas may tend slowly to penetrate into houses and rooms through small inlets which have been overlooked.

CHAPTER II.

GENERAL PRINCIPLES OF DECONTAMINATION.

4. What Decontamination Involves.

Decontamination means the treatment of the contaminated ground or object in such a way that danger from direct contact has been eliminated and dangerous vapour can no longer be given off. For practical purposes decontamination of materials must be regarded as complete when this result has been secured, even if the contaminating substance has only been buried or sealed and not destroyed.

Broadly speaking, decontamination may be achieved in three ways: by chemical destruction of the gas, by its physical removal (e.g. washing it away), or by covering it with a seal through which the vapour cannot emerge.

Alternative methods of decontamination are described, in general terms, in later Sections of this Chapter, but their practical application must depend to a great extent on three factors:—

(*a*) the identification of the gas;
(*b*) the severity of the contamination;
(*c*) the urgency of decontaminating the particular area or object.

Of these three factors the first two demand accurate knowledge on the part of the person in charge, who should be familiar with the relevant chapters of A.R.P. Handbook No. 1. In case of doubt the nearest available expert advice should be sought without delay.

The question whether the particular situation demands rapid and drastic processes, or can be left to the slower methods of weathering, etc., might be of great importance. Work on a number of contaminated sites might have to be arranged in an order of priority because there were not sufficient men to work on all at the same time. Some sites might have to be left

after only superficial attention. Another point of importance is that the supply of chloride of lime, the most practical chemical neutraliser of mustard gas, would be strictly limited, and its use could not be justified on sites of no real importance.

The problem will vary considerably in countries with dissimilar climatic conditions because the properties, and in particular the persistence, of the gas is determined by these conditions. The methods of decontamination described in this handbook are suitable for dealing with gases in a temperate climate, but may require some modification under tropical conditions.

5. How to Deal with Non-persistent Gases.

In exposed areas non-persistent gases will rapidly diffuse into the air and drift down wind. No decontamination treatment is necessary, but if the crater is covered with fresh earth it will reduce the continued evolution of gas from the soil saturated by the bomb.

In cases where the gas has entered confined spaces or buildings, the first step is to ascertain that the outside air is free from gas and, if so, to ventilate the building freely by opening doors, windows, etc. Fanning with newspapers or the lighting of a fire will help to produce the necessary circulation of air and may be of special value in dealing with areas or basements where normal ventilation is poor.

6. Methods of Decontamination for Persistent Tear Gases.

Three methods of decontamination are applicable to persistent tear gases:—

(1) To cover over the liquid with fresh earth.

(2) To hose down the area so as to wash away any gas unabsorbed.

(3) To treat the contaminated material with suitable chemicals to destroy the substance which causes watering of the eyes.

The method to be employed must depend on the nature of the surface which has been contaminated. Hard surfaces, roads, etc., can best be dealt with by hosing, whereas in soft ground or vegetation the craters should be filled in and covered with a layer of fresh earth.

The débris of buildings which have been demolished by high explosive and splashed with liquid tear gas should be piled up and railed off, and adequately marked with the recognised "Danger" sign (see Section 12).

Chemical treatment will only be necessary in the case of a building which has been grossly contaminated by the liquid of a tear gas. All the contaminated walls, floors, etc., should be sprayed with a mixture containing equal parts of glycerine and 50 per cent. solution of caustic soda. This solution will destroy paint-work but this in in fact necessary, otherwise the paint will continue to harbour the contamination. It will probably be necessary to repeat this treatment at least twice with an interval of two hours.

7. Contamination by Blister Gases.

Every object which has been contaminated by a persistent blister gas is a source of danger. So long as the liquid has not been removed, neutralized or sealed, it will produce dangerous effects by direct contact and will also give off dangerous vapour. Any blister gas liquid which may have been liberated must therefore be treated to render it harmless, and it is very important to remember that, as a general rule, the treatment should be applied as quickly as possible,- especially if the contamination is gross. Delay means that a greater quantity of gas will evaporate into the air, and also that the liquid will penetrate further into the material contaminated, thus rendering the subsequent decontamination more difficult.

Before any treatment can be applied it will be necessary to examine the site upon which gas is believed to have been liberated. The sense of smell will in most cases be a sufficiently sure guide to indicate that gas is present and what type it is, but the vapour may drift some distance down wind from the point of contamination, so that careful investigation will be required to locate and define the actual area of danger and the objects which need treatment.

This examination should be carried out as soon as possible after the gas has been reported, because the drops of liquid scattered over the ground, whether from aircraft spray or from a burst bomb, will rapidly be absorbed and disappear from sight. On this account it may often be unsafe to rely simply on visual evidence of splashing, which may remain over a limited area only—e.g., close to the crater caused by the bomb. An estimate must be made of the wider area which may have been contaminated, and the whole of it may have to be treated. It is probable that if persistent gases are used they will leave some stain upon objects which are splashed, but reliance must not be placed on the presence or absence of this stain. Blister gas may leave a brown oily stain which will facilitate the location of heavy contamination, but it is possible to use a purer form which is almost colourless.

The use of chemical indicators will also be of assistance in defining areas which are contaminated by blister gases. The indicator will take the form of a specially prepared yellow paint which turns red on contact with *liquid* blister gas. Pieces of metal or wood painted with this paint can be set out before an air raid at intervals over an area, and the stains on the paint will then indicate where the blister gas has fallen. Papers similarly painted may be pressed on to grass or herbage where contamination is suspected, and the stains will define the area in which liquid contamination persists.

8. Principles of Decontamination for Blister Gases.

Decontamination may be effected in four different ways:—

(1) The gas may be neutralised with some suitable chemical substance.

(2) The bulk of the liquid may be removed from the object contaminated by the use of water or by a solvent.

(3) The gas may be covered with a suitable layer of protecting material so that it is no longer able to produce harmful effects.

(4) The natural effects of weathering may be allowed to remove and destroy the blister gas if the area can be isolated.

The first method is only possible when the gas is present in such a way that the neutralising chemical can come into contact with it. If the blister gas has been allowed to penetrate deeply into a piece of wood this chemical action is almost impossible, but if the treatment can be applied whilst the liquid is still on the surface of the wood very satisfactory results may be obtained.

The second method of physical removal of the blister gas may be adopted in a large number of cases when it would be wasteful to use chemical methods, or when the use of the latter would not be practicable. Light contamination may be removed by adequate airing during which the liquid gradually evaporates.

In the case of heavy contamination of road surfaces, a great deal of the blister gas may be removed by washing down with water. On the other hand a wooden floor which is soaked with liquid may have to be taken up and burned (see paragraph (6) in Section 9).

Certain instances may arise where neither of these methods is satisfactory and where it may be simpler to adopt some means of covering up the source of contamination. The object in this case is to seal up the

liquid and prevent any vapour from being evolved. If in the process the blister gas remains in contact with water or damp material for a considerable time, the gas will be gradually destroyed by chemical action with the water.

Finally there are many occasions when careful marking and roping off of the contaminated area may be sufficient. Where bombs have fallen into parks or open country, and there is no necessity for anyone to approach the contaminated sites, a great economy of labour and material will result from this method of isolation. It will be found applicable to many kinds of material and is quite efficient where time is not important.

There are likely to be so many occasions when immediate decontamination by one of the previous methods is essential, to safeguard life and property, that it will be important to avoid dissipating the resources of trained men and material in decontaminating ground or objects which can be left untouched without detriment to public safety.

9. Methods and Materials used in Decontamination for Blister Gases.

The methods of decontamination are described in this Section in order of simplicity.

(1) *Ventilation or thorough Airing.*

Since blister gas slowly evaporates into the air, it is possible to decontaminate an object which has been wetted or splashed with blister gas by allowing it to remain exposed to a current of air for a considerable time. The blister gas will be removed more quickly if the air is warm.

(2) *Hosing with Water.*

This method of dealing with blister gas contamination is dependent on two different actions; the physical

washing away of the blister gas from the objects contaminated, and its gradual destruction by chemical action with the water.

The first hosing down should be done with a gentle stream of water, so as not to cause splashing. Subsequently a more powerful jet should be employed, and the water should be allowed to flow over the area for some minutes to ensure as complete removal as possible of the contaminating substance.

Care must be taken to ensure that the water can drain away satisfactorily to a place where it will not become a source of danger. It should not be allowed to flow into streams or ditches where the contamination might be carried to some place where it would be dangerous. If it flows into pools or ditches near at hand where it is considered that it can be allowed to remain, those pools or ditches should be marked as contaminated. Where there is nowhere for the water to flow away safely, the method of decontamination by hosing cannot be used, and alternative methods must be employed.

The blister gas removed by the water will dissolve very slowly and will then undergo chemical action and be destroyed. If a considerable quantity of liquid were washed into a gutter by a steady stream of water it might collect in the joints between the stones and remain unaffected for a long period. If this is suspected, the gutters should be specially treated with a sprinkling of bleaching powder, which should be well brushed backwards and forwards.

It must also be appreciated that hosing will only deal effectively with blister gas which is on the surface and has not been soaked up by the material contaminated. In nearly every case of contamination a certain proportion of the blister gas will be absorbed by the substance on which it falls, before decontamination is carried out, so that usually hosing with water will not completely remove all the contamination. Its

effectiveness depends on the quickness with which it can be applied, and on the nature of the surface which is contaminated.

Where hosing with water is carried out its effectiveness for purposes of decontamination will be increased if the surface is vigorously brushed with long-handled stiff brushes.

(3) *Removal by Solvents (Paraffin, Petrol, etc.).*

Where the nature of the surface is such that it cannot be washed with water, and the blister gas cannot readily soak into it (e.g. pieces of machinery), the article may be swabbed over with paraffin or petrol. This physically removes the blister gas and does so the more effectively because the gas dissolves in the paraffin or petrol. This method is particularly applicable to metal surfaces and to objects of a greasy nature. Protective gloves must be worn, and the rags and paraffin burned after use (under the precautions given in paragraph (6) of Section 9), as the blister gas will remain in them. The wiping should be repeated several times, using fresh rags. The continued use of the same rag merely serves to spread the contamination.

(4) *Destruction of Blister Gas by Chemical Means.*

Blister gas is readily acted upon by free chlorine or by substances from which chlorine is easily liberated. The most convenient source of chlorine for the purpose is bleaching powder (chloride of lime), which has therefore come to be regarded in one form or another as the most general decontaminating agent.

(i) *Mixtures of dry bleaching powder with earth or sand.*

The action between liquid blister gas and pure bleaching powder is so violent that the heat produced would vaporise a good deal of the blister gas, and it might even cause a fire. For this reason the bleaching powder should usually be mixed with some other substance which will retard the action. Two or three

times as much earth or sand may be mixed with the dry bleaching powder to form a suitable material for decontaminating purposes. A layer of this mixture one inch thick is sufficient to prevent any harmful vapour coming off a contaminated surface, but to ensure thorough decontamination it is advisable to leave the bleach mixture in contact with the surface for as long as possible.

(ii) *Bleaching powder and water.*

Bleaching powder may also be applied in the form of a cream consisting of 2 lbs. of powder to a gallon of water. For some purposes (e.g. vertical surfaces) a stiff paste is required and this should be formed by using 4 lbs. of bleach in one gallon of water.

Bleaching powder quickly loses its active chlorine in the presence of moisture, so it should be stored in a sealed tin, and the cream or paste should be made up freshly when required.

To prepare the paste, which is often referred to in the following paragraphs, the requisite quantity of bleaching powder should be placed in a bucket, a little water added, and the mixture stirred to a smooth paste; more water is then added until the required consistency is obtained as indicated above. It is then ready for use. It will only remain effective for one or two days after being made up.

Where a floor or other horizontal surface is being dealt with, the cream should be brushed backwards and forwards so as to ensure that the blister gas is being continuously subjected to the action of fresh bleach.

On surfaces which are not horizontal it will in many instances be found difficult to apply bleach paste with a brush. In such cases it may be applied with a sprayer (e.g. such as used by gardeners), but before the paste is used in this way it should be forced through a fine sieve, otherwise small lumps may block the nozzle.

(iii) *Bleaching powder and vaseline.*

Some surfaces of an oily or greasy nature may be decontaminated by treatment with a mixture containing equal parts by weight of bleaching powder and vaseline. The most satisfactory method is to swab the surface first with paraffin as described under heading (3) of this Section, and then to smear it with bleach-vaseline ointment, which should be left in contact for a short period. It may then be wiped off, leaving a thin film on the surface.

(iv) *Immersion in boiling water.*

Blister gas is destroyed by boiling water, so articles which will not be injured by such treatment can be decontaminated by being boiled. The time for which they must be boiled is dependent upon the nature of the material, but is usually from one to two hours.

Leather should not be boiled.

Detailed instructions for the decontamination of clothing are described in A.R.P. Handbook No. 1.

(5) *Covering with an Earth Seal.*

It is important that the chemical methods which involve the use of bleaching powder (the supplies of which will be strictly limited) should be applied only in cases where the immediate destruction of the blister gas is essential. Many instances are likely to occur of gas bombs dropping into gardens or open spaces which need not be used, and where it will be sufficient if the contaminating material is so covered up that no dangerous vapour is emitted. This sealing up of the gas can be satisfactorily accomplished by covering it with a layer of earth or sand not less than three inches in thickness. Dry earth will absorb the blister gas most readily, but a slightly thicker layer of moist earth will suffice and the moisture will cause gradual destruction of the blister gas. The earth seal should be left undisturbed for as long as possible and the area should accordingly be roped off or suitably marked.

(6) *Destruction by Burning.*

Blister gas contamination may also be destroyed by burning. When contaminated objects have to be burned, the following precautions must be observed:—

(*a*) The burning should be carried out on a site in the open air, away from occupied buildings, in a place where no danger will be caused by the vapour given off.

(*b*) The men concerned must wear protective clothing, and work on the windward side of the fire.

(*c*) The fire should be kept burning briskly so that the blister gas will be destroyed, and not merely evaporated by gentle heating.

CHAPTER III.

DUTIES OF DECONTAMINATION SERVICES.

10. Organisation and Training of Decontamination Personnel.

The services of men trained in decontamination work would be required whenever blister gas, or some other contaminating gas, had been used. These men will consequently need to be organised in a distinct service (see A.R.P. Memorandum No. 3) ready to be summoned to the scene of contamination in much the same way that the fire brigade is called to fires. In times of air attack, a sufficient number should always be standing by, and the men on duty should not be used for other work which would prevent their being immediately available.

The men engaged on decontamination work will necessarily be exposed to blister gases in both liquid and vapour form. They would therefore have to wear protective clothing and respirators, and this heavy equipment will impose limits on the possible period of work. If work had to be carried on in a confined space with heavy vapour contamination present, necessitating the wearing of full protective clothing with hood, it is probable that only three spells of from half an hour to an hour could be performed during each 24 hours. This depends on the temperature. In cold weather, or in less severe concentrations which did not necessitate the wearing of the hood, men might be able to work for six spells of one hour, or for three spells of two hours.

The public decontamination personnel should be organised in squads of six men, including a foreman. The equipment required by each squad would be of the kind shown in Appendix A. A vehicle would be needed to carry this equipment.

It should also be the aim of every occupier of large industrial or commercial premises, and every operator of large fleets of vehicles, to have a certain number of suitably trained men available among his employees.

The general procedure should be to call the decontamination workers as soon as contamination was located. No other persons should be allowed in the area of contamination, except for the saving of life or the rescue of injured, until the decontamination service had pronounced it free from danger.

This responsibility would rest on the foreman of the squad, as well as the higher officials in charge of decontamination work, all of whom should have a sound practical knowledge of the characteristics and behaviour of war gases, and the general principles of decontamination described in the previous chapter.

All decontamination workers must have a thorough training in personal precautions against gas, as described in A.R.P. Handbook No. 1, and would require respirators and protective clothing for their work. At their depot or base they would require the cleansing facilities described in Appendix D to Handbook No. 1.

On account of the strenuous nature of most decontamination work, and especially the strain of work in protective clothing, only fit men accustomed to manual labour are suitable for the decontamination services.

11. Precautions when entering a Gas-contaminated Area.

These precautions are of special importance to decontamination workers, both to maintain the efficiency of the decontamination service and to avoid casualties.

Whenever the presence of gas can be detected by the sense of smell, or by the effect on the eyes or throat, and whenever it is necessary to approach craters which have been marked as dangerous, the respirator must always be worn. When carrying out decontamination

duties, the full protective clothing should normally be worn, but some latitude in this matter must be left to the foreman in charge of the work. Where it is possible to keep to windward of the gassed area, and where the treatment required is such that personnel need not approach closely to the contamination, as in the case of a road which is being hosed down, it may be safe to dispense with the jacket and hood.

The oilskin clothing gives adequate protection against blister gas. After it has been in contact with liquid, however, it must be boiled to remove contamination, and this reduces its protective qualities when used again.

The respirators of the squad must not be removed until the foreman has assured himself that no gas is present. This can be done by inserting the fingers between the facepiece and the cheek and sniffing gently.

12. Marking of Areas contaminated by Blister Gas.

A contaminated area may be of very considerable dimensions. In the case of gas spray released from a comparatively low height some drops which reach the ground may be quite large, but beyond the zone of gross contamination there will be a much larger zone in which only fine drops occur. In this latter zone the fine spray will quickly evaporate or be absorbed, so that decontamination treatment will not be necessary. Only the zone in which there is considerable wetting by the spray should be roped off for treatment. The same instruction should apply to the area contaminated by a bomb. Around the crater there will be a zone in which heavy liquid splashing is clearly visible. Beyond this will be an area over which a fine spray has been scattered and further away still there will be a wider area through which the vapour has drifted. The treatment should be confined to the definite liquid contamination, though not necessarily to the area in which liquid is still visible some time after the bomb bursts.

This preliminary examination and definition of the contaminated area is very important, both from the point of view of preventing persons from unwittingly entering these zones, and also to enable the decontamination squads to carry out the necessary treatment where it is most required.

It may often be impossible for the squads to deal with all contaminated sites as soon as they are reported, but if the areas are carefully marked, and warning notices placed in position, the public will be able to avoid the danger and the authorities can give priority to those places which present the gravest menace.

The warning notices should be yellow boards bearing, in black letters, the words—

DANGER

GAS

The boards should preferably be about 30 inches by 15 inches in size.

CHAPTER IV.

DECONTAMINATION OF ROADS, OPEN SPACES, ETC.

Before deciding on the decontamination measures to be applied to the road surfaces in towns it is essential to know the degree and extent of the contamination which has occurred. No general method of decontamination can be specified to cover all circumstances, because it is probable that the degree of contamination which is tolerable in one place may be highly dangerous in another. Elaborate methods of decontamination may be essential in an important and congested centre, whereas they might be entirely unnecessary and wasteful on an open highway.

13. Treatment for Light and Medium Contamination.

The three sources of contamination should be remembered:—

(1) Fine spray from aircraft.

(2) Gross spray from low-flying aircraft.

(3) Local contamination from gas bombs, consisting of a small zone of heavy contamination and a larger zone of less severe contamination.

Of these all except the heavy local contamination near the point of burst of a gas bomb are dealt with in this Section.

Treatment for fine spray.

Fine spray would produce relatively little contamination of roads. The surfaces of most pavements and roads are fairly absorbent to blister gas, and the spray would be quickly absorbed. The actual time during which it would be dangerous to traverse the area is largely dependent on the climatic conditions, particularly the temperature. In warm or mild weather it is

unlikely that any danger will persist after one hour. Under these circumstances it will be appreciated that very little good will be achieved by attempting decontamination measures unless they can be undertaken very shortly after the spray has been detected. If it is possible to hose the streets down within a few minutes of the droplets being noticed, it will help to prevent the formation of vapour and will wash away any contaminated dust which might otherwise be dangerous; but if this procedure cannot be carried out within less than half an hour it will generally be too late to be effective.

If the streets can be kept clear for an hour after the spray has fallen, there will be little danger.

The *treatment for fine spray* may therefore be summarised as (*a*) hosing down important thoroughfares, if possible within 30 minutes, and (*b*) in all other circumstances, weathering.

Treatment for gross spray and outer zone of splashes from bomb bursts.

The contamination caused by the gross spray and by the outer zone of drops thrown out when a bomb bursts is of the same order, and should usually be treated by hosing down with water. The area affected will generally be too great for wholesale treatment with bleaching powder, but the footways in constant use should be brushed over with a thin cream of bleaching powder and water after a preliminary hosing to remove any superficial blister gas. It is important that the hosing down should be carried out as quickly as possible after the contamination has occurred, and it should be continued for at least 10 minutes. If the size of the affected area precludes any further chemical treatment, warning notices should be put up and vehicular traffic and foot passengers kept off the streets for at least three hours. Repeated hosing down at intervals of one hour would hasten decontamination.

14. Heavy Contamination of Road Surfaces.

It is next necessary to consider the more heavily contaminated areas in the vicinity of a burst gas bomb. Surrounding the crater will be a limited area which is soaked with the liquid contents of the bomb and there will be a further zone which is thoroughly wetted by large splashes. The treatment recommended for dealing with this type of contamination on each of the different kinds of surface is set out below.

It is calculated that a squad of six men could decontaminate in two hours the area directly contaminated by a 50 lb. gas bomb (consisting partly of street and partly of the fronts of buildings, or of forecourts or gardens).

The squad should always, if possible, work from the windward side of the contaminated area, to avoid exposure to vapour. This may make it unnecessary to wear the protective hood.

The various treatments recommended in the following paragraphs for different types of road surfaces are summarised in Appendix B.

Stone-paving, stone setts, concrete, etc.

Liquid blister gas is readily soaked up by the stone or slabs used for pavements, and also by concrete. Stone setts are relatively impervious, but there are porous joints surrounding the setts into which most of the blister gas will disappear.

When any of these surfaces are wetted with blister gas two processes commence. One is the absorption of the liquid into the surface and the other is the evaporation of it from the surface. If the stone or concrete is hot, as may be the case in sunny weather or in a tropical climate, a good deal of the liquid will be vaporised in a short time and the remainder, though quickly absorbed, will be given off again later as vapour. This means that the danger from vapour in the streets will be great, though the problem of

decontamination will be less. Once the gas has been thoroughly absorbed, no quick process of decontamination will render such a surface safe for prolonged contact.

As in nearly every other case, the efficiency of any treatment is largely dependent upon the speed with which it can be applied. Owing to their irregular surface the stone setts present a rather separate problem if they occur in the centre of an important town. Preliminary hosing down with water would carry the blister gas into all the joints between the stones over a wide area. In such a situation it may be important to confine the contamination as much as possible, and so immediate treatment with a thin bleach cream will be necessary. This should be well brushed into all the joints between the setts and allowed to remain in contact with the surface for at least 15 minutes. After this treatment, thorough hosing down of the whole area should be carried out and this will render the roadway quite safe for general traffic. In hot weather a small amount of vapour may still be detected above the roadway, but it is not likely to be any source of danger.

Pavements and concrete surfaces being smooth should be subjected to a steady flow of water to wash away as much blister gas as possible before any other treatment is applied. It is important not to direct a powerful stream of water on the area until the bulk of the liquid blister gas has been removed, otherwise splashing and contamination of objects in the vicinity might occur.

A steady jet of water is required, and it should be allowed to flow over the whole area for 10 minutes. A light sprinkling of dry bleaching powder should then be distributed over the area and thoroughly brushed into the surface for five minutes, care being taken not to omit the gutters through which the first washing water drained away. The hosing down should then be repeated with a more powerful stream.

Wood paving.

Wood paving blocks are usually impregnated with creosote and are set in tar or bitumen compounds. A good deal of any surface dressing may have been worn off by traffic, and regular treatment with sand and grit may have rendered the surface hard and smooth.

Blister gas will dissolve readily in tar and bitumen, especially in warm weather, so that new wood paving would form a particularly absorbent surface and would be very difficult to decontaminate. Fortunately when the road has been in use some time, and if it has not recently been re-dressed, the surface is harder and less absorbent. This difference is, however, only relative, and once the blister gas has penetrated below the surface no superficial treatment will eradicate it. Tar or bitumen in which blister gas has been dissolved is made softer and of a consistency more easily picked up on the tyres of vehicles and on the soles of boots.

Hosing down with water as quickly as possible after the contamination has occurred is the most satisfactory method of decontaminating wood paving, and the water should be allowed to flow over the area for a quarter of an hour. If there is any tendency for the surface dressing or jointing material to become soft and treacly, a liberal covering with sand will prevent the contamination being spread. If the decontamination squad is able to arrive on the scene of the contamination while liquid blister gas is present on the surface a liberal sprinkling of dry bleaching powder and sand may be applied and brushed over the surface for some minutes before hosing down.

If the road is not required for immediate use, the bleach-sand mixture should be left in contact with the surface for an hour or two before washing down. The addition of sand in these cases is necessary to overcome the difficulty of getting intimate contact between the bleach and the tarry surface.

A wood pavement treated by either of the above methods will not emit any quantity of dangerous

vapour and will be safe to walk over provided that, before entering a house, the soles of the shoes are rubbed with bleach so as to remove any possible tarry contamination.

Tarred macadam, bituminous and asphalt surfaces.

Much of what has been said in the preceding paragraphs will apply to roads made from these materials. When well ironed down, however, these roads, particularly asphalt, tend to be somewhat harder than wood pavement, and thus it is possible to remove a greater proportion of blister gas contamination by hosing down. Bleach treatment if used at all should be restricted to the grossest contamination, and in this case it may be preferable to apply the dry bleaching powder without dilution with earth or sand. The heat generated by the interaction between the blister gas and the bleaching powder will tend to cause a fire or at any rate drive off the vapour, and the decontamination squad should be careful to wear protective clothing and to work to windward of the fumes. The procedure will result in the removal of as much blister gas as possible.

If important thoroughfares paved with these materials have been grossly contaminated and for some reason it has not been possible to treat them until all the blister gas has been completely absorbed, a more drastic method of decontamination is to heat up the road surface with the type of machine used for re-surfacing asphalt. The heat is sufficient to melt and set fire to the bitumen if the cowl is held in contact with the road surface for a few minutes. If the heat is applied to a contaminated surface for a limited time the blister gas will be driven off as vapour and very effectual decontamination will result. This process is, however, slow and therefore of limited application. Damage is also caused to the road surface, which requires to be made good afterwards.

Water-bound macadam surfaces.

This type of surface is very similar to stone setts and concrete so far as the absorption of blister gases is concerned. The minor roughnesses of the surface make it difficult to remove much blister gas by hosing with water, but on the other hand they prevent much contamination being picked up on the feet or by vehicle tyres. Hard brushing with bleach cream would disturb the surface and be unnecessarily wasteful of material. This type of surface is no longer common in the chief centres of population or on main traffic routes, and when contaminated may generally be left to weather. If some form of treatment is essential, a light sprinkling with dry bleaching powder, followed after 10 minutes by gentle hosing for a further 10 minutes, will be most effective.

15. Craters produced by Gas Bombs.

The size of the crater produced and the amount of road material thrown out will depend upon the size and nature of the bomb. The more high explosive the bomb contains, the less localized will be the contamination. If an instantaneous fuze is used very little penetration may occur and the crater will be shallow; on the other hand a time fuze may be fitted to the bomb and a deep crater may result.

A crater in a roadway can be temporarily repaired by packing back the contaminated spoil, a small quantity of dry bleaching powder being mixed with the top layer.

An ordinary gas bomb is not likely to cause more than superficial damage to a road laid on a reinforced concrete foundation. The paving or surface will, however, be broken. As it will not generally be possible for water to drain out of a shallow crater such as this, the broken surface should be sprinkled with bleaching powder and then made good with the material which has been thrown out. The surrounding area

should be thoroughly hosed down after the crater has been filled up.

A more difficult problem arises in the case of a large crater caused by the penetration of a bomb with a delay action fuze. Such a bomb might damage service mains under the road. If this crater is heavily contaminated with blister gas it must be decontaminated before the mains can be repaired.

A burst gas main might be fired by the explosion of the bomb and if so the burning gas would almost certainly destroy or drive off much of the blister gas in the crater.

A burst water main will also tend to decontaminate the crater, because the rush of water will wash some of the blister gas down the sewers.

The water, gas, and electricity services might have to be cut off before decontamination work could begin.

When this action has been taken the decontamination squad will have to remove as much of the contaminated material (mud, etc.) from the crater as possible with large iron scoops into a suitable receptacle. Dry bleaching powder should then be scattered round the sides and bottom of the crater, and bleach paste applied to the fractured edges of any pipes or cables which may be projecting into the crater. The complete decontamination of these pipes or cables should normally be left to the staffs of the services concerned when they undertake repair. The work of the decontamination squad is completed when they have rendered the crater safe to work in, and decontaminated the roadway so that it can be re-opened to traffic.

16. Damaged Pipes and Cables.

The repair staffs of the water, gas and electricity undertakings will require special training in the decontamination of their own material.

Gas and water are carried in metal pipes and where these have been broken by a bomb explosion it will

usually mean cutting out a section and replacing it with a new pipe. The decontamination squad will have treated any part projecting into the crater, but the explosion may have forced persistent gas inside the pipe or into the earth surrounding it. This means that the pipe will be dangerous to handle when in process of removal. The men concerned should wear protective gloves, and possibly respirators and a limited amount of protective clothing. As soon as the section has been freed from the surrounding soil it should be washed over with paraffin or petrol, or brushed over with bleach paste, inside and outside, if there is any indication of contamination.

Drain pipes for sewage are usually made of stoneware or concrete, and they may be treated with bleach paste.

Electric cables which have been soaked in liquid mustard gas may present difficulty. The exterior surface of the cable may be of lead, which presents little difficulty. In other cases (and also in damaged lead-covered cables) there may be material saturated in bitumen. This readily dissolves blister gas. Inside the bitumen layer there is rubber insulation and this again will absorb blister gas. Finally there are the copper strands which are readily corroded by hydrochloric acid which is formed when mustard gas breaks down. If the cable is damaged by the explosion it will be advisable to smear the outer surface with bleach paste and then cut out and replace the contaminated section.

If, however, the cable is undamaged it is obviously undesirable to do more work than is absolutely necessary, and the question will arise as to how far the blister gas has penetrated through the layers of insulation. The time during which the cable has been exposed to the liquid will generally be the surest guide, and if it is more than a few minutes it will be safest to treat the surface with bleach paste and then remove

the bitumen layer. If this outer layer is sound it is unlikely that the blister gas will have penetrated the rubber to any extent, and a new covering of the bitumen-treated material is all that is required. If there is evidence that the rubber has been heavily contaminated by liquid blister gas for several hours, the urgency of the situation must dictate the course of action. The most satisfactory way would be to replace this section of the cable. On the other hand if may be possible to remove and replace another layer of insulation. Before deciding on either of these courses it must be remembered that the corrosive action of the gas in this insulating material will be slow and no immediate ill effects will result from leaving the partially contaminated cable in position as a temporary measure. The service will not be interrupted until the insulation breaks down.

Underground telephone wires are usually encased in stoneware ducts and these should be washed with paraffin or petrol.

Overhead telephone wires are unlikely to be heavily contaminated unless they are blown down by an explosion. In that case the contaminated section should be replaced by new wire. If they are not broken or are wetted with spray without being blown down, they may be left to be decontaminated by the action of the weather, though if the contamination has been heavy it is possible that corrosion will develop later.

17. Débris from Damaged Buildings, etc.

Contaminated débris may result from a direct hit on a building by a gas bomb, or by spray contamination after a building has been damaged by a high explosive bomb. In the former case the contamination is likely to be heavy, whilst in the latter it will probably be light.

The ruling consideration in the case of the heavy contamination must be the situation of the débris, and

the danger to the occupants of adjacent premises from the vapour, such as might arise in the case of a direct hit on a large public building which could not be evacuated. In such a case the débris would have to be carted away by men wearing the full protective suit and dumped on a piece of vacant land where it could be left to the action of the weather. The dump would have to be marked with a warning sign.

If the premises which have been hit are so badly damaged that evacuation is essential and no other buildings closely adjoin, it will be simplest to pile the débris on to the site and leave it to weather.

Débris which has been contaminated by spray should be left to the action of the weather whenever possible but if it must be removed from a roadway or other public place it should be piled back on to the site from which it fell, or on to any open land adjoining. It need only be carted away if its removal is necessary on grounds of obstruction.

Contaminated material from road surfaces which have been directly hit by a gas bomb may have been wetted with liquid blister gas, and if it cannot be buried in the crater, as recommended in Section 15, may also be removed to a marked dump in an open space.

The passage of contaminated débris along the street is not likely to be dangerous to passers-by if open lorries are used, and care is taken so to load the vehicle and fasten the back-board that nothing is spilt during transit.

As a matter of routine, lorries used for the removal of contaminated débris should be swept out each day but, as it will not be possible to decontaminate them thoroughly, men should be specially warned against sitting or riding inside them. It would be useful if a loose flooring of sheet iron or corrugated iron could be put into vehicles before they are loaded with contaminated débris.

18. Open Spaces, Gardens, etc., in Built up Areas.

The craters caused by bombs which fall into soft ground of this nature will generally be the last to receive treatment from the decontamination squads because they are not likely to cause interference with traffic. The natural effects resulting from the explosion of a bomb in soft ground also tend to self-decontamination, and thus minimise the danger. A large part of the liquid contents of the bomb will be forced into the earth on the bottom and sides of the crater. Of the liquid thrown out, a considerable proportion will be mixed with earth from the crater; and the remaining drops which fall on earth or gravel will be rapidly soaked up, and evaporation will be slower than from a hard road surface.

The necessity for speedy decontamination measures will only arise when the crater is quite close to an occupied building. In this case there will be a vapour danger as long as the ground remains untreated, and this will be greater or less according to the temperature and direction of the wind.

The measures required are of a very simple nature; the crater should be filled in with the spoil thrown out and covered over to a depth of three inches with fresh earth or ashes, and a similar layer of earth or ashes scattered over the grossly contaminated ground in the immediate vicinity of the crater.

Only in cases where the contamination is heavy and very close to houses, or where the ground has to be constantly traversed, should it be necessary to employ any bleaching powder. In these special instances, the ground, after rough levelling, should be covered with three inches of earth, and this in turn should be covered with a top layer, one inch thick, composed of three parts of earth to one part of bleaching powder. Hosing with water should not be employed because it will form contaminated mud which is easily picked up on the boots and clothing.

Concrete paths or paving stones which may have been splashed with blister gas should be hosed down and then left to weather.

If the area has been sprayed no special decontamination treatment will be necessary other than hosing of the pavements. So long as the smell of blister gas can be detected, notices should be displayed warning the public to avoid the area.

19. Natural Earth Surfaces and Grassland.

Where contamination of earth or vegetation has occurred in places remote from occupied premises and it is possible to rail off the whole site and leave it to weather, this should be done. If there is any fear of the vapour being a danger to adjacent occupied buildings, the contaminated ground should be covered with fresh earth to a depth of two or three inches according to the nature of the contamination.

Grassland should be treated in exactly the same way as natural earth but rather more caution is required in ascertaining the extent of the contamination.

It is difficult to lay down any hard and fast time in regard to the evaporation of blister gas from grassland, because so much depends on the temperature. In cold winter weather there may be danger by contact for days, but in mild or summer weather it should be safe to walk over short grass after about 2 hours.

The vegetation on pasture land is considerably longer and coarser than mown grass and therefore it will require longer weathering to render it safe for traversing. In mild weather, however, an area which has received fine spray should be safe for men and animals to walk over after 6 hours. It is not safe to turn animals out to graze on pasture land which has received gas spray until at least 48 hours after the contamination took place.

CHAPTER V.

DECONTAMINATION OF BUILDINGS AND THEIR CONTENTS.

20. General Considerations.

The treatment of buildings will have to depend very largely on the structural damage caused by the bombs. If any part of a dwelling house has been actually struck by a blister gas bomb, it should be evacuated without delay, but in the case of large public buildings, blocks of offices, etc., it may be possible to seal off the contaminated portion and continue to use the remainder of the building.

The various parts of the fabric of a building will require special treatment according to the nature of the structural material. They are dealt with in detail in this chapter. A summary of methods is given in Appendix C.

Before commencing any decontamination work in the interiors of buildings, the doors and windows should all be opened to remove dangerous concentrations of vapour, which will very quickly accumulate in enclosed places.

After the prescribed methods of treatment have been carried out, it is essential that the premises should be examined by a specially qualified official and certified as safe before they are re-occupied.

21. Exterior Walls.

External walls will not require any treatment for light spray, which can safely be left to the action of the weather. Heavy contamination, such as would occur from the bursting of a bomb in the close vicinity, may be of such a serious nature as to render satisfactory decontamination impossible. A great deal will depend upon the construction of the house and the speed with which decontamination can be begun.

Stonework and exterior concrete is generally so thick that penetration by blister gas is immaterial. It is not likely to pass right through from one face to the other, so that a prolonged application of bleach paste to the exterior surface will suffice to render these materials safe except against prolonged contact.

A preliminary hosing down with water is only recommended when it can be carried out before the liquid has had time to soak into the wall and there is still the possibility of removing superficial blister gas in the water stream.

Most brick houses are constructed with 9 inch exterior walls or two $4\frac{1}{2}$ inch courses with a cavity between. In either of these constructions there should be no danger of penetration unless the pointing is faulty. On the other hand it is *possible* for splashes of liquid mustard gas to penetrate through a $4\frac{1}{2}$ inch wall sufficiently to cause burns *by contact* with the other side. Contaminated brickwork should therefore be sprayed or brushed with a cream of bleaching powder and water, which should be left in contact with the bricks for 24 hours.

A second treatment with bleach cream should be applied in the case of all these surfaces, but it must not be anticipated that complete decontamination will result. The bleach cream will only deal with the blister gas very near to the surface, and a large proportion of the gas will have been absorbed into the interior of the bricks. This will only be decontaminated by long exposure to the weather (up to three weeks), but the vapour emitted during the process will not be a source of danger, though danger may still arise from prolonged contact with the material.

22. Concrete Floors and Tiles.

Blister gas will penetrate freely into concrete or unglazed tile surfaces. The best method of decontamination is to hose them down very thoroughly and then to apply bleach cream and brush it well over

the surface. The bleaching powder and water should be left in contact with the floor for at least six hours, after which it should be swilled off with more water. This procedure will render the floor perfectly safe to walk over, but it will not get rid of all the blister gas which has been absorbed, and the surface would be dangerous to sit on.

The last traces of gas may be prevented from working out by applying to the surface a solution of sodium silicate (one part of water glass to four parts of water) which forms an effective seal against the emission of vapour.

The treatment outlined above will deal with all but heavy liquid contamination. Where, however, a quantity of liquid blister gas has been in contact with a concrete or tiled floor for a prolonged period, the liquid will have soaked in for a considerable distance and no satisfactory method of decontamination can be recommended. If it is essential that the room be used for occupation it is advisable to break up the top surface and re-lay it.

Concrete which has been treated with sodium silicate solution is much more resistant to penetration by blister gas than untreated concrete.

Glazed tiles will not readily absorb blister gas and may be rendered safe by hosing down followed by one treatment with bleach cream. Most attention in this case should be paid to the pointing.

23. Interior Walls (papered or distempered).

If the distempered walls of a room have been splashed with blister gas they should be painted over thickly with a paste made with bleaching powder and water. This may be conveniently sprayed on with a suitable pump which has two separate jets so arranged as to give a fine spray of water and another of dry bleaching powder which meet on the wall surface. Alternatively the paste can be applied with a long-handled brush.

To prevent the paste running down the walls, the treated area should be covered with sheets of newspaper. The paste is fairly adhesive, and the paper applied to it will remain in place for days. One or two alternate layers of bleach paste and paper make an effective seal against the escape of mustard vapour. This seal should be left in position for at least 24 hours and if possible for 48 hours. It should then be washed off, after which the danger from mustard gas will have disappeared except in cases of particularly gross contamination.

In the case of papered walls, the paper should be stripped off before decontamination is started. The same treatment should then be applied as for the distempered surface. It is not advisable to re-occupy the room until the walls have been coated with washable distemper or a solution of water glass.

24. Painted Surfaces (Plaster or Woodwork).

Ordinary paint, in which linseed oil is the foundation readily dissolves blister gas.

Certain hard drying enamels and varnishes are more resistant to penetration by blister gas than paint but they are relatively difficult to decontaminate once the liquid has been absorbed. It is difficult for the active chlorine in the bleaching powder to get into contact with the dissolved blister gas and, if the paint is thick and the contamination has been of some duration, it will probably be necessary to remove the paint by a blow-lamp or other means. Great care must be used during such a process because of the vapour danger.

Should early treatment of a painted surface be possible, bleach paste should be applied as in the case of distempered walls. The seal should be left on for 48 hours and the surface repainted before the room is occupied.

25. Wooden Floors and Unpainted Woodwork.

The rate of penetration of blister gas into wood depends on the nature of the wood. Soft wood soaks it up more quickly than hard wood. If any liquid is visible on the floor it should be absorbed by a liberal sprinkling with earth. This contaminated earth should then be removed and burned or buried. If no liquid is visible, or if it has been removed as indicated above, the surface should be well scrubbed with a thin paste of bleaching powder and water. If sand is available, a small quantity may with advantage be added to the bleach paste, as it will aid the scrubbing action and render the surface less slippery. If the boards are not well fitting, care must be taken not to make the paste too thin, because surplus water containing very little bleaching powder may wash un-neutralised liquid blister gas between the boards, and this may later be a source of danger. The bleach paste should be left in contact with the floor for at least 24 hours, and should then be brushed off and the surface re-washed. To remove all traces of blister gas it may be necessary to repeat the treatment two or three times. If the wood has been heavily contaminated and the blister gas has soaked into it, it may have to be removed and burned, under the precautions given in paragraph (6) of Section 9.

Hard wood articles and mouldings, etc., which have irregular surfaces may be decontaminated by swabbing them first with paraffin or petrol, and then applying a mixture consisting of equal parts of bleaching powder and vaseline. Care must be taken to wear protective gloves when using the paraffin or petrol, and the contaminated rags must be burnt. A succession of fresh rags must be used to avoid spreading the contamination. The bleach-vaseline mixture should be left in contact with the surface for several days, according to the degree of contamination and the time which has elapsed before the treatment is applied.

26. Furniture and Household Goods.

In most cases where a blister gas bomb drops into a dwelling house the structural damage will render the house unfit for use, and if the furniture is contaminated by blister gas it is also likely to be damaged by the explosion. If it is badly damaged, it should be destroyed by burning under the precautions given in paragraph (6) of Section 9. There may, however, be instances in which furniture is contaminated with blister gas but otherwise undamaged, and in these cases it will require treatment under expert supervision because specially thorough decontamination is necessary. The danger from prolonged contact, such as sitting on a slightly contaminated chair, is so great that hasty methods of decontamination should not be attempted.

Wooden and upholstered furniture.

Most articles of furniture consist of wood together with cane, leather and textiles, horse hair and the like. Hard woods such as oak, walnut and mahogany are not easily penetrated by blister gas. They will, however, require swabbing with paraffin or petrol, followed by prolonged treatment with bleach-vaseline mixture, of at least 48 hours' duration. Because of the contact danger it will be necessary to repeat the treatment at least twice. Leather and fabric upholstery will have to be stripped from the wooden frames, and it will usually be necessary to replace it by new material.

To render textile fabrics safe they must be immersed in boiling water as specified for clothing (see A.R.P. Handbook No. 1). The leather will require lengthy exposure in a current of hot air.

Bedding.

Bedding can be decontaminated by immersion in boiling water for the stipulated time (two hours), but if this is not practicable it should be destroyed by burning, under the precautions given in paragraph (6) of Section 9.

Mattresses can be decontaminated in a steam disinfector.

Carpets, rugs, etc.

If carpets are lightly contaminated they should be removed and hung over a line in the open air to weather. Under mild conditions they will be safe for use after a week's airing. In cold weather a fortnight may be required.

If the contamination is more than light, but not such as can be described as heavy, it will be advisable to spray the carpet with a solution of washing soda (1½ lb. per gall.) before putting it in the open air. Weathering alone would cause tendering of the fabric.

Should the contamination be heavy the carpets should be destroyed by burning (under the precautions given in paragraph (6) of Section 9) unless they can be immersed in boiling water for two hours.

Linoleum.

If the contamination is on the upper surface only, the same treatment should be applied as in the case of paint-work, but if the linoleum is old or worn and the contamination has reached the underfabric, it will generally have to be burned, under the precautions given in paragraph (6) of Section 9.

Metal fittings.

These may be iron, brass, copper or aluminium, and they will not present any difficulty in decontamination. They should be swabbed several times with paraffin or petrol and then rubbed dry, the usual precautions being taken with regard to protective gloves and the disposal of the contaminated rags.

Glass, china and earthenware.

Articles made of glass or china or glazed earthenware can be decontaminated by boiling in water or prolonged immersion in a strong solution of bleaching powder, or by swabbing with paraffin or petrol.

The first two methods may also be applied to unglazed earthenware, but if this is not possible the article should be destroyed. Swabbing with paraffin or petrol is not suitable for such porous material.

Domestic food supplies.

To avoid unnecessary wastage of food it is desirable that every household should make arrangements to store its food in air-tight receptacles, if possible. Failing this, it should be well wrapped in grease-proof paper. Ordinary biscuit tins or boxes which are in sound condition with close-fitting lids will serve as storage receptacles. The general articles of daily diet, bread, meat, butter, bacon, sugar, etc., can easily be stored in one of these ways so that, if phosgene or blister gas vapour should gain entrance to the house, and the house were not completely clear for an hour or two, the food would still be quite wholesome.

If liquid contamination in any way occurred, the food and the containers affected must be destroyed.

These recommendations do not of course apply to tinned or bottled foods. If the containers of these foods are still intact, they can be decontaminated by being swabbed with paraffin or petrol, and then washed with water, and the food inside will be unharmed.

Water which has been exposed to vapour only can be rendered perfectly safe for drinking by a few minutes boiling. If, however, it has been contaminated by liquid blister gas it must not be used for any purpose.

A summary of the methods of decontamination for household articles is given in Appendix D.

CHAPTER VI.

DECONTAMINATION OF VEHICLES.

27. General Instructions.

All types of vehicles such as trains, buses, trams, motor cars, lorries and carts may be in a contaminated zone, and may be splashed with liquid blister gas from bombs or spattered with fine spray from aircraft. The materials exposed to exterior contamination will be metal, wood, fabric and glass. A good deal of the metal and all the wood and fabric are likely to be painted or varnished and, as this will readily absorb mustard gas, the vehicles will not be easy to decontaminate completely. A further complication which may arise may be the time elapsing between contamination and treatment. In most cases, however, only the outside will have been contaminated and the danger of contact will be small. It should be a general instruction to all transport personnel that after air attack direct contact with the outside of vehicles should be avoided so far as possible, since they may be contaminated.

Vehicles which have been exposed only to the vapour of blister gas will require no special treatment and can be retained in use.

With regard to vehicles which have received liquid contamination a few broad principles may be laid down.

(1) The first general treatment in all cases is to hose the vehicle down very thoroughly.

(2) The next step is to give special treatment to such parts of the vehicle as are likely to be a source of contact danger; the engine bonnet, driver's seat, hand rails, etc.; leaving the larger part of the body-work to the action of the weather.

When deciding on the special treatment required the following is a useful guide:—

(*a*) Bright and oily metal parts and painted metal work, are best treated with paraffin or petrol.

(*b*) Fabric and painted woodwork should be treated with a cream made from bleaching powder and water.

(3) If liquid blister gas has contaminated the interior of vehicles and the upholstering is affected the latter will have to be taken out and reserved for appropriate treatment.

(4) Rubber tyres will absorb liquid blister gas and cannot be satisfactorily decontaminated for handling. The contaminated surface should be hosed down and left to weather, but it will be advisable to put a distinguishing mark on these tyres so that special precautions can be adopted when removal becomes necessary.

A summary of methods of decontamination for vehicles, with notes on the materials and labour involved, is given in Appendix E.

28. Buses and Tramcars.

These vehicles present a large surface area for exterior contamination, but they can be totally enclosed except for the driver's platform and the rear stairway. Provided that the windows are kept shut no contamination should enter the vehicles unless the glass is shattered. Contamination of the handrails would be the only source of danger to passengers. As the conductor and driver would be the most exposed to contact danger, it is desirable that they should be provided with protective gloves and the means of decontaminating the hand rails (paraffin and rag).

A bus that has been contaminated on the outside can safely proceed on its journey and will not be a source of danger to pedestrians provided no contact is made with the exterior surface. It must however be remembered that decontamination will be simplified if the vehicle can be treated before the blister gas has had time to soak into the paint work.

In most cases a preliminary hosing down followed by treatment of the handled metal parts with paraffin

will suffice. In the event of very heavy splashing, however, thorough decontamination might be necessary and in that case the following procedure is recommended:—

(1) Hose down the whole exterior surface with a steady stream of water, being careful to remove all mud and grease.

(2) Brush over the fabric top, and all woodwork, with bleach cream and leave this in contact with the surface for half an hour. Then wash off.

(3) Swab all the metal parts including main panels, doors, mudguards, wheels, handrails, bonnet, front axle, number plates, etc., with paraffin, taking due precautions as to the wearing of protective gloves and the destruction of the decontaminating materials. If any parts of the engine are contaminated swab over with a rag soaked in paraffin and remove superficial oil. Then re-oil. The heat of the engine will rapidly drive off any mustard gas which dissolves in the engine oil.

(4) Finally allow the vehicle to stand exposed to the weather for 24 hours.

Any contamination which may reach the engine will be largely dispersed by heat. If however it should be necessary to carry out repairs to an engine which is still contaminated, any parts affected should be swabbed over with paraffin or petrol. They should then be wiped dry and re-oiled.

29. Commercial Vehicles and Carts.

It is difficult to lay down rules for commercial vehicles and carts, because of the diversity of their construction. Closed vans of all types can be dealt with on the same lines as motor buses. Lorries of the open and covered types, and the different kinds of trucks, trailers and wagons, are usually fitted with

wooden bodies and in many cases a good deal of the surface is unpainted or the paint worn off. If this woodwork is heavily contaminated it will not be possible to render it completely safe for contact. Before any decontamination measures are taken, therefore, consideration should be given to the purpose for which the vehicle is intended. The sides of the vehicle and the parts likely to be touched will require treatment as recommended for buses. If the floor and sides of the interior have only been subjected to light or medium spray, hosing with water and brushing with sand will remove any chance of contamination being imparted to heavy goods such as building material, iron work or wooden cases, but there would still be danger from direct contact.

If it is desired to make this woodwork as safe as possible it should be well scrubbed with a cream of bleaching powder and water, to which sand has been added, and the bleach cream should be left on the surface for 2 hours. Even this treatment will not however make the floor safe to sit upon, if it has been heavily contaminated.

30. Private Cars.

The special point requiring consideration in connection with private cars is the liability to contamination of the fabric bodies and the leather upholstery. Private cars are often driven with the windows lowered, and sections of the roof or windscreen open, and there will accordingly be danger of contamination in the interior. It is most important that all vehicles should be kept closed if there is danger from gas spray.

Where cars with fabric bodies or hoods have been heavily contaminated, it will be necessary to rip the fabric off and burn it, because, in the case of closed cars, danger will arise from vapour given off by the interior surface.

Light contamination of the exterior surface can be dealt with by hosing down and one application of bleach paste.

Other contaminated parts should be dealt with as described in Section 27.

31. Railway Rolling Stock.

If the windows of railway carriages are kept closed there should be little danger of contamination to passengers except by contact with the door handles and exterior surface. If a train has been sprayed or otherwise contaminated by blister gas the driver and fireman will need to take special precautions in handling the exposed parts of the engine and tender, because the presence of oil or grease will increase the persistency of the gas. From the heated parts of the locomotive the blister gas will quickly evaporate, but there are many parts which have to be handled where blister gas would remain dissolved in the oil. As this is all metal work it should be swabbed over with paraffin or petrol as soon as possible, and re-oiled. The coal in the tender should not be handled with the bare hands.

The passenger coaches which have been contaminated will require hosing down, and the door handles and other metal fittings should be swabbed with paraffin or petrol. No attempt need be made at specialized treatment of the exterior surface because exposure to wind and weather will rapidly produce satisfactory decontamination.

Should any compartment be contaminated inside, the upholstery will have to be removed and the coach work treated as described in Section 24 (Painted Surfaces).

Hermetically sealed wagons such as tank wagons, refrigerator vans, etc., should be specially decontaminated before being opened to prevent the contents becoming contaminated when they are opened.

If open goods trucks should be lightly contaminated they can safely be left to weather so long as any metal handles and couplings are wiped over with paraffin or petrol. Care should however be taken to avoid contamination by keeping such trucks and their contents covered over with tarpaulins, and if these are contaminated they will require hosing down and 48 hours' airing. If the surface of the tarpaulin has been much wetted with liquid blister gas it may be treated with bleach paste.

When trucks or their contents have been contaminated the trucks should not be unloaded, or left standing, in a covered shed, because of the vapour danger. They should be shunted to an open siding and dealt with under expert directions.

If heavy splashing of the woodwork has occurred it may require treatment as recommended for the wooden parts of motor vehicles, but the necessity for this will depend upon the position of the contamination and the possibility or otherwise of danger arising through contact.

CHAPTER VII.

PARTICULAR DECONTAMINATION PROBLEMS IN FACTORIES, &c.

This chapter refers to some of the special problems which might arise in industrial premises. It does not pretend to deal with them exhaustively, but merely indicates typical ways in which the problem should be tackled. The information in the previous chapters about buildings and their contents, and about paved and unpaved out-door surfaces, will apply equally to industrial premises, and the decontamination of particular types of plant and materials must be worked out according to the general principles enunciated in this book.

32. Special Items of Factory Plant, etc.

The methods of decontamination recommended for certain types of factory plant and equipment are given in this Section.

Machinery, plant, conveyors, etc.

The principal materials involved in these units are metals, but there is also a quantity of leather or fibre composition in the form of belting.

The moving metal parts will be oily and can be decontaminated by wiping over with paraffin or petrol. The parts should then be wiped dry and re-oiled.

The leather and composition belting cannot easily be decontaminated. It is usually important that they should be kept free from grease, so the application of bleach vaseline is not recommended unless it can be applied on the outer surface where it will be out of contact with the pulley wheels.

Any obvious liquid contamination should be wiped off with paraffin or petrol. As there is little contact danger this will be satisfactory treatment if the con-

tamination is light, but if it is gross the belts after this treatment should be handled with care, avoiding prolonged contact with the bare hands.

Electrical equipment.

The electrical equipment which is liable to contamination in a factory consists principally of switch gear, motors and starters, electric fans, cables, and possibly generators.

Vapour contamination would not constitute any danger, so the only question that arises is liquid contamination resulting from a direct hit on some part of the factory.

The immediate danger to the operation of the equipment is negligible, but there will be danger through direct contact with the various switches and starters, and as a good deal of the gear becomes warm when running there is a possibility of vapour arising from the contaminated parts.

Furthermore, some of the insulation in this electrical equipment is of rubber, which readily absorbs blister gas.

It must also be remembered that when, through the action of moisture, mustard gas breaks down, a good deal of hydrochloric acid is formed, and this is highly corrosive.

There is very little oil or grease about electrical equipment so that, except in the case of rubber insulation, it is not likely that liquid blister gas would be rapidly absorbed. The actual drops of liquid may therefore be expected to remain on the insulating material of the switch board and metal motor casings for some little time, until they are removed by evaporation or gradual absorption. These drops should be removed from the vulcanite or other insulating material by wiping the parts with an oily rag and then rubbing off any oil with a dry cloth. The metal parts are best treated with a rag containing a little paraffin or petrol. If the moving parts of motors, armatures, etc.,

are contaminated, the liquid drops are best removed by wiping with a dry rag and then allowing warmth and exposure to the air to complete the decontamination.

Rubber will absorb the blister gas, but any residual liquid on the surface can be dealt with by coating it with bleach-vaseline mixture and leaving this in contact with the rubber for at least an hour.

The successful decontamination of this electrical equipment is chiefly dependent on the early application of the various treatments.

Pipe lines.

Pipe lines for the conveyance of water, steam, vacuum, etc., may be contaminated in the same way as other permanent fixtures. Steam pipes will usually be lagged and the lagging is very absorbent to blister gas, but as they are warm any liquid contamination would quickly evaporate. Water and vacuum pipes can be hosed down and left to air exposure. Where this is undesirable on account of the proximity of steam pipes, or for any other reason, they should be wiped over with a rag moistened with paraffin or petrol.

Fuel dumps.

The coal and coke used for boiler furnaces are nearly always stacked in the open and they may therefore be contaminated by gas spray or by a bomb. The only danger that will arise will occur in transferring the fuel from the dump to the furnace.

If the fuel has been contaminated by spray no danger need be anticipated so long as the stoker wears a respirator and such protective clothing as will prevent contact danger. It is the coal dust rather than the vapour which has to be guarded against, and it is therefore advisable to leave contaminated fuel to weather for a few days instead of trying to use it immediately.

If the fuel has been heavily splashed with liquid it should always be left exposed to the weather for at least a week before being used for hand-fired boilers. If the furnaces are fed by mechanical stokers there is no reason for any delay in using contaminated fuel, but precautions should be taken to avoid contamination by touching the stoking machinery.

33. Decontamination of Garages, Bus Depots, etc.

The problem of decontamination in a large garage or bus depot is considered in detail in this Section because it affords a good illustration of the somewhat elaborate decontamination arrangements which would be necessary where there were considerable covered areas with surfaces impregnated with oil. Resort to weathering would be impossible and there would be danger of blister gas evaporating in the warm atmosphere and causing eye casualties among the workers.

If a large bomb containing liquid blister gas exploded inside a garage or bus depot two problems would arise, (i) the decontamination of the vehicles it contained, and (ii) the decontamination of the fabric of the building and the equipment in general use.

The first problem has been covered in Chapter VI, except in so far as it will be necessary to man-handle or drive the vehicles out of the depot while they are still in a contaminated condition. This will obviously be essential because the greasy floor and general equipment will all be contaminated in addition to the vehicles. In the confined space a high concentration of vapour would soon be built up unless as much as possible of the contaminated surface was removed to the open air. The vehicles will have to be moved by men wearing the full protective suit. They should then be treated as laid down in Chapter VI. It should be noted that there is some likelihood of the interiors

and the engines having become contaminated in the contaminated garage, because many of the engines may have been open for attention, and fine spray may be blown or drift inside the vehicles on account of the confined space in which the bomb burst.

The decontamination of the garage and permanent equipment will require a considerable staff and a large quantity of material compared with the treatment of an exterior bomb crater.

The floor of the garage will usually be concrete with a quantity of oil and grease on the surface. In various places there will be working pits which are covered with timber in a more or less greasy condition. The workshop will contain machinery and tools coated with oil and there may be equipment for the washing of the vehicles.

The procedure should be to scatter first earth and then dry bleaching powder over that area of the floor which is grossly contaminated with liquid, so as to absorb and destroy as much as possible of the blister gas. This will also prevent the spreading of the contamination by the subsequent hosing down. If the bomb has burst in such a position as to contaminate heavily any of the side walls or roof supports, the contaminated section should be brushed down with bleach paste and a further quantity left on the wall or pillar to soak in. Greasy wooden benches and boards covering the pits, if only lightly contaminated, may be dealt with by swabbing with paraffin or petrol, which will remove both grease and blister gas, and then scraping to give a clean surface. If they are heavily contaminated no quick treatment will render them safe, and they should be removed to a place outside the garage for subsequent destruction.

Most of this preliminary work will have involved the washing on to the concrete floor of water and bleach paste which will have mixed with the earth and bleaching powder first put down. It will now

be necessary to brush this mixture over the whole of the contaminated area with stiff brooms for at least half an hour. While this is being done the crater should be cleaned out with shovels, and any broken brick or concrete removed outside. The interior of the crater and the area immediately surrounding it should be given a fairly thick layer of bleach paste and then railed off for 24 hours. The remainder of the contaminated floor should then be given a second scrubbing with fresh bleach and water and finally washed down. The garage will then be safe for re-occupation, though additional treatment will still be required for the machinery and metal equipment, which may have been contaminated. These will need swabbing with paraffin or petrol, and this treatment should be carried out in such a way that contaminated liquid is not allowed to run down on to the benches or the floor. Two treatments with paraffin or petrol will be required, and a final drying and re-oiling.

If any electrical equipment has been heavily contaminated it should be removed for special treatment.

Where the contamination is of a light order such as may be caused by fine spray, it will usually be sufficient to rub the equipment over with an oily rag and then remove the oil with a dry cloth.

APPENDIX A. [§ 10

EQUIPMENT FOR A DECONTAMINATION SQUAD.

The suggested equipment for a decontamination squad of six men is as follows :—

3 spades.
3 picks.
2 buckets.
2 mops or hard, long-handled brushes.
Hose (2 lengths of 60 to 100 feet).
2 standpipes (with adaptors if necessary).
Apparatus for spraying bleach on walls (such as horticultural lime sprayers).
Supply of bleaching powder (say, 2 cwts.).
Paraffin (5 gallon drum).
Bleach-vaseline ointment (say, 7 lbs.).
Cotton waste.
12 pickets and rope (say, 120 ft.) for enclosing contaminated areas.
6 danger boards.
14 suits (being two suits per man and 2 spare) of protective clothing, namely,

Black oilskin jackets.
Black oilskin trousers.
Oilskin hood.
Oilskin gloves.
Rubber gum boots.

As gloves soon wear out, 4 or 6 *additional* pairs of gloves should be provided.

14 suits of underclothing (to be worn, in place of the man's own, under protective clothing).
Cleansing outfit, consisting of basin, soap, nail brush and cotton wool.
2 bins for contaminated clothing (e.g., galvanized iron sanitary bins).
1 bleach tray (about 30 in. by 18 in. by 3 in. deep) (for the treatment of boots or tools contaminated during work).
1 bin for contaminated tools.
1 bin for mixing bleach paste (e.g., a galvanized iron sanitary bin).

§13 & 14] **APPENDIX B.**

METHODS OF DECONTAMINATION FOR ROAD SURFACES.

Surface.	Method of Treatment.
Treatment for Fine Spray.	
All surfaces.	In busy thoroughfares hose down with water if this can be done within 30 minutes. In all other circumstances leave to weather.
Treatment for Gross Spray and Outer Zone of Bomb Contamination.	
All surfaces.	Hose down with water as quickly as possible for 10 minutes. Repeat treatment. Pavements for immediate use can be brushed with thin cream of bleaching powder and water.
Treatment for Gross Contamination round Bomb Craters.	
Stone setts.	Cream of bleaching powder and water. Brush well into joints. Leave in contact for 15 minutes Finally hose down with water.
Stone paving and concrete.	Hose with water for 10 minutes. Sprinkle with dry bleaching powder. Brush well into surface for 5 minutes. Also treat gutters. Finally hose down with water.

Appendix B—*continued.*

Surface.	Method of Treatment.
Wood paving.	Hose with water for 15 minutes. If jointing material is soft, cover with sand. (If heavy liquid splashes visible, treat with bleaching powder and sand before hosing: brush well over surface and leave in contact for 1 or 2 hours.)
Tarred macadam, bitumen or asphalt.	Hose with water for 15 minutes. Use dry bleaching powder treatment for grossly contaminated areas. In certain cases road heating machines may be used.
Water-bound macadam.	When possible leave to weather. If treatment essential, sprinkle with bleaching powder and leave for 10 minutes. Then hose gently with water for 10 minutes.
Natural earth, grass, etc.	Cover with 2 to 3 inches of fresh earth and leave to weather. If contamination very gross and near to occupied premises, add top layer of earth and bleaching powder 3 : 1.

§ 20] **APPENDIX C.**

METHODS OF DECONTAMINATION FOR THE STRUCTURE OF BUILDINGS.

NOTE.—No special treatment required for vapour contamination.

Material.	Treatment for liquid contamination.
Stone or brickwork ...	Hose down with water if this can be done before the liquid has had time to soak in, but *not otherwise*. Spray or brush surface with cream of bleaching powder and water. Leave in contact as long as possible (not less than 24 hours). Repeat treatment.
Concrete floors and tiles	Hose with water. Apply bleaching powder and water cream and brush thoroughly over surface. Leave in contact for 6 hours. Hose with water. Apply sodium silicate solution, when available. Prolonged exposure to gross contamination may necessitate breaking up and re-laying floors in rooms which have to be inhabited.
Glazed tiles	Hose with water and treat with cream of bleaching powder and water. Give special attention to the joints.
Distempered walls ...	Paint or spray with paste of bleaching powder and water. Apply alternate layers of bleach paste and paper, and leave in position for at least 48 hours. Finally wash off and treat wall with fresh distemper or sodium silicate solution.

Appendix C—*continued.*

Material.	Treatment for liquid contamination.
Papered walls... ...	Strip off paper and then treat as for distempered walls.
Painted walls (wood or plaster).	If immediate treatment can be applied, treat as for distempered walls and finally repaint. If the contamination has been prolonged, remove the paint completely.
Wooden floors... ...	Absorb visible liquid with fresh earth which should be burnt or buried. Scrub the surface with cream of bleaching powder and water, and sand. Leave bleaching powder in contact for 24 hours, then brush off and wash with water. Repeat treatment two or three times when necessary. Boards soaked in blister gas should be removed and burnt.
Unpainted woodwork	General treatment as for wooden floors. Hard wood articles and mouldings should first be swabbed with paraffin, and then treated with paste of bleaching powder and vaseline, which should be left in contact for a short period, and then wiped off, leaving a thin film on the surface.

§ 26] **APPENDIX D.**

METHODS OF DECONTAMINATION FOR HOUSEHOLD ARTICLES.

Article.	Treatment.
Furniture (hard woods)*	Swab thoroughly with paraffin, then give prolonged treatment (not less than 48 hours) with mixture of bleaching powder and vaseline.
Upholstery	All upholstery must be stripped from the wooden framework. In many cases it will probably be quicker and easier to destroy it by burning and replace with new material. When it is necessary to undertake decontamination, use the following methods :— *Woollen fabrics.*—Immerse in boiling water for 1 hour. *Cotton fabrics.*—Treat as for cotton garments. *Leather.*—Expose for prolonged period in a current of hot air, but if heavily contaminated, it is safer to destroy by burning. *Padding.*—Hot air treatment may occasionally be applicable, but in general it will be safer to burn.
Bedding	Treat as for clothing according to whether textile is wool or cotton. Mattresses may be treated in a steam disinfector.

* *Note.*—Owing to possible danger from personal contact with furniture hasty decontamination should not be attempted.

Appendix D—*continued.*

Article.	Treatment.
Carpets, rugs, etc. ...	If lightly contaminated hang in open air to weather for 7 days in mild weather, and 14 days in colder weather. If wetted with blister gas, spray with soda solution before hanging out to air to prevent tendering of the fabric. If carpets are heavily contaminated they should be destroyed by burning unless arrangements can be made to immerse them in boiling water for 2 hours.
Linoleum	If in good condition and only the upper surface is contaminated, treat with bleach and water cream. If it is worn and the basic fabric is contaminated, it is safer to destroy by burning.
Metal fittings	Swab well with paraffin or petrol, and rub dry with clean cloths.
China, glass and earthenware.	Treat in boiling water or strong bleaching powder solution, or swab with paraffin or petrol (swabbing not suitable for unglazed articles).

APPENDIX E.

METHODS OF DECONTAMINATION FOR VEHICLES.

Vehicle.	Treatment.	Labour and time.	Materials required.
Buses or trams, and closed commercial vans.	*For Spray Contamination.*—Hose down exterior thoroughly with water. Treat handrails and other metal parts, which have to be touched, with paraffin or petrol.	2 men, 2 hours.	1 quart paraffin or petrol.
	For Gross Liquid Contamination.—Hose down with steady stream of water. Brush over fabric top and all woodwork, including back and front steps with thin bleach cream. Leave in contact for ½ hour, then wash off. Treat all metal parts by swabbing with paraffin. Finally, leave to weather for 24 hours.	*Exterior.* 2 men, 3 hours.	7 lbs. bleaching powder. 1 gallon paraffin or petrol.
	If the interior has been contaminated, this will have to be decontaminated carefully before the vehicle can be taken into use again. Contaminated upholstery will probably have to be removed	*Interior.* No estimate possible.	—

Open vans and lorries.	General treatment as for buses will meet normal requirements. Where there is contact danger, the inside should be scrubbed with bleach cream and sand, and left for 2 hours, after which it should be washed off. Even then the floor will not be safe to sit on, if it has been heavily contaminated.	2 men, 2 hours (working time).	7 lbs. bleaching powder. 1 pint paraffin or petrol.
Private cars (coach built).	Hose down thoroughly. Swab with paraffin or petrol parts liable to be touched. If contaminated inside upholstery will have to be removed.	1 man, 3 hours.	1 gallon paraffin or petrol.
Private cars (fabric bodies).	For light contamination hose down thoroughly then treat with bleach paste. For gross contamination the fabric will have to be removed and destroyed by burning. Treat all metal parts by swabbing with paraffin or petrol.	1 man, 3 hours.	4 lbs. bleaching powder. 1 pint paraffin or petrol.

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