MINISTRY OF FOOD

FOOD AND ITS PROTECTION AGAINST POISON GAS

(2ND EDITION)

The Conservation of Food is Second only to the Preservation of Life

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INTRODUCTION

BE REASSURED BUT BE PREPARED

This booklet has been compiled with a view to giving a concise account of the dangers of gas contamination, of simple protective measures and of the procedure that will be followed to protect the public against dangers arising from food which may have been in contact with poison gas.

Aerial attacks in which poison gas is used are less likely to be a menace to our food supply than may popularly be imagined. Gross contamination in the immediate vicinity of an exploded gas-bomb or resulting from successful spraying by low-flying aircraft can render foods unfit for consumption, but clouds of gas or vapour in concentrations sufficient to incapacitate an unprotected person would in a number of cases have comparatively little effect on food.

At a time when no effort should be spared to conserve the food supplies of the country it is very important that the greatest care should be taken to give as much protection as possible to food stores, whether they are the relatively small supplies in the ordinary home or the great reserves in our warehouses.

READ THIS BOOKLET CAREFULLY AND HAVE CONFIDENCE

[*This edition supersedes the first edition of the same pamphlet and also the A.R.P. Publication "The Protection of Foodstuffs against Poison Gas" (2d.) which appeared in 1937*].

CONTENTS

Part I

General Considerations

1. *Poison Gases and Gas Attacks*

Although we commonly speak of the various substances employed in chemical warfare as poison gases, they are not all true gases, the majority being in fact liquids or solids which can be spread by the bursting of a bomb or by a suitable spraying device attached to an aeroplane.

It is important to distinguish between the two main types of war gases (*a*) non-persistent, (*b*) persistent.

The non-persistent gases, when liberated by the burst of a bomb, form highly concentrated clouds of gas or particles which are usually rapidly dispersed. Generally, the effect is therefore a local one, although it must be borne in mind that a bomb of this type can produce a dangerous concentration persisting for some time in a place such as a narrow passage, a cellar or other confined space where ventilation is defective.

The group of non-persistent gases includes:—

Asphyxiant or choking gases like phosgene and chlorine which cause irritation of the lungs.

Sneezing gases or arsenical smokes which cause irritation of the nose and throat.

Certain tear gases which cause irritation of the eyes.

Other miscellaneous gases such as arsine and hydro-cyanic acid.

The *persistent gases* are usually liquids which vaporise slowly and will therefore contaminate for some time any area over which they are distributed. The burst of a bomb containing a persistent gas not only produces a considerable cloud of vapour but also distributes splashes and spray over a wide area. The liquid so dispersed will continue to give off poisonous vapour which will travel downwind until the appropriate decontamination measures have been carried out. Persistent gases may also be sprayed from aircraft giving rise to a more widespread but less heavy contamination by liquid droplets.

The persistent gases comprise:—

Certain tear gases such as B.B.C.

Blister gases such as mustard gas and lewisite.

The vapour of the blister gases in quite low concentrations will produce inflammation of the eyes, respiratory passages and skin, while even small drops of the liquid on the skin will give rise to severe burns.

In the case of those gases which contain arsenic, e.g., lewisite, the additional hazard of arsenical poisoning is introduced.

The effect of atmospheric conditions is very important in considering the behaviour of poison gases. Free circulation of air, wind, warmth and rain all accelerate the rate of dispersal of both types of gas, but the rate at which the persistent blister gases disappear as a result of favourable atmospheric conditions is naturally much lower than in the case of the non-persistent gases. The most persistent contamination by poison gas prevails when the air is still and the temperature low.

It should never be forgotten that the dispersal of gas by wind or by an air-current may be a source of danger downwind.

In general, high concentrations of non-persistent gases are unlikely to be present for long enough to affect foodstuffs to an extent that cannot be made good by airing. The persistent gases, on the other hand, offer a greater danger, and it is therefore with this type of gas that this pamphlet is chiefly concerned.

2. *Danger of Contamination of Foodstuffs by Poison Gas*

It is important to remember that—

POISON GASES ARE PENETRATIVE

SOME FOODSTUFFS ARE HIGHLY ABSORBENT

MANY WRAPPINGS AND PACKING MATERIALS ARE PERMEABLE AND PERMIT THE PASSAGE OF GAS

If poison gas comes in contact with a foodstuff either by direct exposure or as the result of gradual penetration through the packing material, it may result in that foodstuff being condemned by the authorised officer of the Local Authority either as dangerous or unsuitable for human consumption. However, it should be remembered that it may often be possible to salve a large part, if not the whole, of the foodstuff by taking appropriate decontamination measures as described in Part III.

PART II

Protective Measures

3. The most important points with regard to protection are first, to prevent foodstuffs from becoming directly contaminated by liquid gas, and secondly, to reduce vapour contamination to the lowest possible degree. The fact that foods are normally stored in warehouses, shops, etc., is the first and best line of protection against direct and heavy liquid contamination.

With regard to vapour contamination, two simple facts should be borne in mind:—

(*a*) Wherever air can penetrate, poison gas can enter, unless intercepted as in a gas mask.

(*b*) Ventilation is helpful when the flow of air leads to dispersal of vapour but dangerous if its direction draws vapour into a food store.

The commonsense application of these general principles together with a knowledge of the protective powers of various type of material and containers are all that is required to decide upon the protective measures to be used in any particular case.

4. The protective values of a number of materials commonly employed for packing foodstuffs are detailed in Appendix I. To summarise the position briefly, the non-persistent gases will go anywhere air can go and the protection offered by any container or material depends on its air-tightness or lack of porosity. The liquid gases behave like other oils and will penetrate or soak into any type of porous material.

5. *Protection of Foodstuffs in Transit*

(i) Foodstuffs in transit are clearly in their most unprotected condition, since they are without the protection of a building and may even be stored in the open for some time.

(ii) The main point to be borne in mind is the importance of cover *at all times*. Material which is being moved in open wagons or trucks should be covered by *tarpaulins of the oil-dressed or cuprammonium-bitumen (C.A.B.) type*. Unloading and breaking of bulk should be carried on as far as possible under cover and exposure of the foodstuff to the sky should be reduced to a minimum.

(iii) Particular attention should be paid to the protection of food while it is being unloaded from ships and while it is on the quayside. Where it is known that a gas-raid is in progress, then the hatches should be battened down and covered with tarpaulins.

(iv) When foodstuffs has to be stored in the open, then it should be protected by tarpaulin covers. Maximum protection is obtained by using two layers of tarpaulins, one placed closely over the dump of foodstuff and the other

arranged tent-fashion so that there is an air space between the tarpaulins. Where one layer of tarpaulin or of some permeable material (canvas, roof felting, etc.) is all that is available, then it should if possible be arranged over the food in tent-fashion so that liquid gas, if it falls on the cover, will not come in direct contact with the foodstuff. Using this principle, some protection can be obtained even from sacking.

(v) It must be remembered at all times that any cover is better than none. The important point is to keep liquid gas from coming in direct contact with any food or food containers.

6. *Protection of Foodstuffs in Warehouses and Bulk Stores*

(i) The most vulnerable parts of a building during a gas attack will be the top floor, the basement, and the ground floor in that order. Foods which are packed in sacks, hessian, open crates, etc., should be stored elsewhere than on those floors, which should be reserved for the storage of food in gas-proof containers. The top floor is best left empty.

(ii) On any floor, positions of particular danger such as the space near windows or doorways should be occupied by impermeable packages, such as cans or drums. This precaution also helps to protect against the contamination of food by broken glass.

(iii) Goods in sacks, crates, etc., should be piled in the largest possible stack, since such an arrangement gives protection to the greatest number of containers.

(iv) Goods in sacks or open crates can be given further protection, particularly against vapour, by covering the stacks with suitable gas-proof tarpaulins. Where free circulation of air is desirable as in fruit storage, then the protecting material should be arranged as screens or curtains on hooks or frames.

(v) Canvas or sacking can be used to provide coverings or screens if tarpaulins or oilskins are not available. They give no protection against vapour but they reduce the extent of liquid contamination by soaking up the oily drops. Anything that helps to protect the actual food containers from becoming splashed is of value.

(vi) Food in chambers such as refrigerator stores, cold rooms, gas chambers, etc., requires no additional protection, providing the doors are reasonably gas tight and that precautions have been taken against contaminated air entering by a ventilation system. Even should this last eventuality come about there is no serious danger since at the low temperature which prevails inside such chambers, no appreciable amount of blister gas vapour can exist.

(vii) All arrangements should be made for rendering warehouses, etc., as gas-tight as possible in the event of a gas alarm being received. High concentrations of vapour will only enter a building if doors, windows, etc., are open or the building has been directly hit and damaged. Arrangements that will ensure the prompt closing of windows and doors, the stoppage of intake fans and the covering of other air inlets will probably be effective in preventing the entry of dangerous quantities of vapour.

7. *Protection of Foodstuffs in Retail Shops, Hotels, Institutions, etc.*

(i) The exposure of food in display windows or on open shelves, where a liability to contamination is greatest, should be reduced to a minimum. This should be regarded as a public duty.

(ii) Food on open shelves should be protected wherever possible by screens or coverings, preferably of impermeable tarpaulin or oilskin. Remember, however, that any additional cover helps to protect against direct liquid contamination.

(iii) Supplies of packed foods should be left in their original packings as long as possible. Avoid breaking bulk unnecessarily.

(iv) Rooms which are used for the storage of foodstuffs should be gas-proofed. Instructions how to do this are given in the pamphlet entitled " The Protection of your Home against Air-Raids " which was distributed to every householder.

(v) Refrigerators should be carefully examined to ascertain whether the doors are fitting properly and the locking devices are in good working condition. In good condition such chambers will give complete protection against gas.

PRECAUTIONS TO BE TAKEN IN THE EVENT OF A GAS ALARM OR ON LEAVING THE SHOP AT NIGHT

(vi) All windows, doors, shutters, etc., should be closed and any other precautions taken which time permits to shut off food supplies from contact with the outside air.

(vii) Extractor fans or other artificial ventilating systems that draw outside air into a food store or chamber should be shut off.

8. *Protection of Foodstuffs in the Home*

(i) Foods contained in air-tight containers (e.g. sealed cans and bottles) are completely protected against any form of gas.

(ii) Any sorts of foods, such as flour, rice, bread, butter, etc., which are sold in paper wrapping or without any covering should be stored in tins or bottles with well-fitting lids. It is important to remember that opened jars or bottles of preserves or sauces will possibly absorb blister gas where some of the contents are smeared round the opening. Such jars or bottles should also be stored in a tin.

(iii) Jam jars with paper covers can be given extra protection by covering with a piece of moisture-proof cellulose film secured by an elastic band. Moisture-proof cellulose film can always be used for giving additional protection to containers since it is impervious to both liquid and vapour forms of gas.

(iv) Do not forget that it is important to protect the outside of your containers from contamination by splashes of liquid gas. Therefore, place your cans, bottles, and tins inside cupboards or under the stairs and do not store them near to an exposed window.

(v) Perishable foods such as meat, fish, milk, butter will be quite safe if kept in one of the ordinary domestic refrigerators, provided the door closes properly. In other cases, protect these foods by making use of tins and bottles. Remember, however, that eggs are unaffected by vapour and need only be protected from liquid contamination which would make them dangerous to handle.

(vi) A special store-cupboard or store-room can be rendered gas-proof with a little effort, and this is a precaution well worth taking. Local A.R.P. Wardens are in a position to give householders advice on this matter.

Part III

Effect of War Gases on Foodstuffs and Methods for Decontamination

9. *General Considerations*

In this section it is proposed to consider the effect of war gases on foodstuffs that are completely exposed or inadequately protected by their wrappings, and the methods which should be applied to foodstuffs so contaminated in order to make them safe for consumption when this is possible.

The possibility of decontaminating foodstuffs will depend on

(i) The nature of the gases used and the degree of contamination.

(ii) The extent to which the foodstuffs have been protected by packages, covers, methods of stacking, etc.

(iii) The nature of the foodstuffs.

In deciding on the measures which would have to be applied in any particular case, all these factors have to be taken into consideration before a decision is reached.

The nature of the gases which have been used in an attack and the probable extent of contamination will be problems on which the Gas Identification Service will be able to give expert advice.

The various factors involved in (ii) have already been discussed and it is the object of the following paragraphs to give some idea of the effect of the different types of gases on various foodstuffs and to explain the steps to be taken in various cases of contamination.

10. *Lung Irritant Gases*

In view of the intense irritation produced in the respiratory system by this group of gases, it might be thought that it would be dangerous to consume foods which had been exposed to one of these gases. It is comforting to learn that it is very unlikely that exposure of foodstuffs to these gases will result in their edibility being affected to an extent which cannot be made good by airing.

Experiments in which every kind of food was exposed to high concentrations of phosgene for periods of one hour showed that the foods were only slightly affected, if at all, and were fit to eat after 24-48 hours' airing. It has never been found possible to demonstrate any poisonous action in foods even immediately after exposure to phosgene (see Appendix II).

The same facts hold good for chloropicrin and diphosgene which are to some extent persistent gases. They have equally little effect on foodstuffs, and airing will always largely restore the material.

Methods of Airing Foodstuffs

To air foodstuffs effectively, the packages should be spread out on a covered site where free circulation of air will carry away residual gas as rapidly as possible. Increasing the movement of air by artificial means such as the use of fans will be helpful in accelerating decontamination. Airing should be continued until there is no trace of the smell of the gas, and in most cases a period of 24 hours will suffice. Generally speaking, it will not be necessary to empty foodstuffs from containers in order to facilitate the dispersal of the gas. Foodstuffs in sacks or other permeable containers are soon decontaminated if air is allowed to circulate freely round the exterior. A pile of sacks containing flour, grain, potatoes, or similar foods only requires to be taken down and stacked so that air circulates freely between each sack.

If after 24-48 hours airing, food that has been contaminated by one of these gases is still unpalatable, then two courses are possible. The foodstuff can be blended with a large bulk of uncontaminated foodstuff, if the taste has not been badly affected. Failing this, it will have to be marked as unfit for human beings and disposed of for other purposes.

Even where taste is badly affected, the foodstuff will still be perfectly safe for consumption. Taste is the only criterion in this case.

11. *Tear Gases*

(*a*) *Non-persistent.* It is unlikely that foodstuffs will be affected by these gases, apart from slight tainting, which can be removed by suitable airing.

(*b*) *Persistent.* Owing to the unpleasant smell of the vapours of the persistent tear gases (K.S.K. and B.B.C.) foodstuffs which have been in contact with their vapour for a long period are rendered unpalatable. If contamination is slight, airing for 24 hours will often remove the smell and unpleasant taste and the food will be fit to eat. B.B.C. may leave an unpalatable flavour even after prolonged airing, but even in such cases the food is in no way dangerous.

Where there has actually been direct contamination by liquid tear gases, the taste of the food will usually be so badly affected as to render it completely uneatable.

The only guide which need be employed in deciding whether foodstuffs, which have been exposed to tear gases, are fit for human consumption or not, is that of palatibility.

It is quite possible that these gases will be used mixed with a more dangerous gas, e.g., mustard gas, in which case the latter will naturally present the more serious problem.

12. *Blister-Gases* (*non-arsenical*), *e.g., Mustard Gas*

It is not until we come to the liquid blister gases that the danger of contamination becomes in any way serious. While the results of eating food contaminated by mustard gas vapour would probably not be fatal, they might be unpleasant if the degree of vapour contamination was high; nausea and vomiting, accompanied by gastric pains, are the usual symptoms. The consumption of food contaminated by liquid gas might have fatal results in view of the extensive inflammation and hæmorrhage that would result. The vapour of mustard gas, or of any other blister gas which does not contain arsenic, may be harmful to foods when the concentration of vapour in the atmosphere is high and the period of exposure is prolonged. Since mustard gas is an oily liquid, it is natural to expect that both in liquid and vapour forms it will be more readily absorbed by fatty foods such as butter, margarine, cooking fats, meat, cheese, cream and fatty fish, than by the non-fatty foods such as bread, white fish, vegetables, tea, coffee, cereals, sugar, rice, dried fruits, etc., on which the vapour has very little effect.

Unfortunately there is no simple method of deciding whether foodstuffs have been contaminated by mustard gas vapour. In some cases, there may be slight discolouration but this cannot be relied upon. In practically all cases of vapour contamination which are at all dangerous, there will be a perceptible smell of the gas, but here again it is not possible to make a hard and fast rule. In cases where foods are known to have been seriously exposed to mustard gas vapour it may be necessary to submit them to an analyst after the appropriate treatment has been carried out.

(*a*) *Vapour*

We have seen already that mustard gas vapour is not likely to contaminate seriously foods of the non-fatty type. Only when the liquid gas has been in close proximity to the food stuffs will they have been exposed to a high enough concentration of vapour to affect them at all seriously. On the other hand, exposed fatty foods are likely to have become dangerous after relatively short periods of contact with the vapour of mustard gas.

(i) Non-fatty foodstuffs, which are either completely unprotected or are packed in containers which are not air-tight, should be aired as effectively as possible along the lines laid down in the preceding section. This treatment will render them perfectly safe for consumption.

(ii) Fresh white fish, fresh fruit and vegetables should be hosed down with plenty of water in order to remove any taint.

(iii) Remember that eggs are completely unaffected by vapour contamination.

(iv) Fatty foodstuffs such as butter, margarine, cooking fats, bacon, fat meat, etc., will all tend to absorb and retain mustard gas vapour, but since the rate of penetration is low (2 mm. in 24 hours) the food can be rendered perfectly safe by removing the outer surface. Butter, margarine, fats, cheese, bacon, etc., should be trimmed to a depth of about ½ inch, when they will be perfectly safe. A carcase which has been slightly contaminated by vapour may be treated by airing, but if exposed to a heavy concentration for a considerable time, it should be treated as for liquid contamination.

(v) If small quantities of milk have been exposed to mustard gas vapour, they may have become dangerous and should be condemned. The contents of sealed milk bottles will be safe unless the cardboard discs themselves have been splashed. Where larger quantities are concerned, it would be essential to have an analyst's opinion; the milk may possibly be safe after treatment by some manufacturing process.

(vi) Fatty fish which has been seriously exposed to vapour should be destroyed.

(vii) Air tight containers which have been exposed to vapour will be perfectly safe and will require no treatment whatsoever,

(b) Liquid

Contamination by liquid mustard gas should be a relatively infrequent occurrence in the case of foodstuffs. While it clearly presents difficult problems, it does not necessarily mean that the food must be destroyed. As is the case with vapour contamination, the fatty foodstuffs are more difficult to deal with than the non-fatty type. However, once again the rate of penetration is not rapid even in the case of fatty foods such as butter and would always be less than ½ inch in 24 hours, except, of course, in the case of liquid foods.

Whenever possible, the particular area or part in contact with the liquid mustard gas should be removed and the remainder then treated as for vapour contamination. Bear in mind that where the liquid has actually been in contact, then there will also have been a high vapour concentration.

Some articles of food are naturally protected against even liquid gas by their outer coverings. Eggs, after prolonged contact with liquid mustard gas, are perfectly safe to eat after they have been rinsed and cooked, always provided the shells are intact. Oranges and old potatoes are also not seriously affected by fine droplet contamination and can be decontaminated by hosing with water.

When contamination by liquid gas has taken place, it will usually be possible to see dark spots and stains unless the surface is a dark one, e.g., red meat, or the contamination is very fine.

The area which is heavily contaminated as a result of the burst of a gas-bomb will always be small by comparison with the area which is lightly contaminated. Moreover, from spray attacks, only light contamination can result. Consequently, even the most permeable forms of covering material will protect foodstuffs in so far that they will soak up some of the liquid droplets.

(i) The rapid removal of all contaminated, permeable containers (cardboard or wooden boxes, sacks, etc.) should always be the first step, since the material inside may not actually have been in contact with the

liquid gas. Contaminated containers which have been removed should then be destroyed. Their contents can be treated as for vapour contamination, and a sample then sent for analysis.

(ii) Watertight wooden casks and tea-chests will resist light liquid contamination and they could be decontaminated by hosing and airing. If more heavily contaminated, it may be possible in some cases to decontaminate the exterior roughly, and transfer the contents to clean containers.

(iii) Droplet contamination of exposed foods such as vegetables, eggs, and fruits should be treated by hosing down and airing. Eggs will certainly be safe after such treatment and the others will often be saved.

(iv) Where fatty foodstuffs such as cheese, butter, margarine, fats, etc., have been contaminated by liquid gas, then they can be treated by trimming the contaminated surface to a depth of about one inch. Such trimming will have to be done very cautiously and great care taken to ensure that liquid contamination is not spread by the act of cutting. When the liquid contaminated parts have been removed, it must be remembered that the remainder has all been exposed to vapour, and the other surfaces should be trimmed to a depth of half an inch.

(v) Sacks of flour that have been lightly contaminated by liquid mustard gas should be treated as described under (1). If the contamination is at all heavy, then the sacks should be soaked in water for an hour, taken out and allowed to dry. This treatment will form a hard, outer case of flour paste and the flour can be tipped out from the inside quite easily. It can then be treated for vapour contamination. Other sacked commodities, e.g., sugar or rice, may have to be condemned if badly contaminated; but the possibility of decontamination by refinement or other treatment should be borne in mind.

(vi.) Carcases of meat which have been splashed by liquid gas will be very difficult to deal with. If possible, they should be treated as under (iv) but in many cases will probably have to be condemned altogether.

(vii) Cans, drums, glass jars, or bottles and glazed earthenware containers are impermeable, and if they become contaminated by liquid gas the contents will be perfectly safe provided the container is air-tight. Decontamination should be effected by wiping off any liquid gas followed by treatment with bleach paste and hosing. This method is preferable to continued wiping with cotton-waste or rag moistened with petrol or other solvent.

13. *Blister Gases* (*Arsenical, e.g., Lewisite*)

Foodstuffs are effected by arsenical blister gases such as lewisite in exactly the same way as they are by mustard gas, e.g., they are absorbed in the vapour form by fatty foodstuffs to a much greater extent than by non-fatty foodstuffs. The treatment of foods contaminated by lewisite or other arsenical vesicants should follow the principles laid down for mustard gas. *Foodstuffs which have come in contact with an arsenical blister gas in liquid or vapour form must be regarded with the greatest suspicion. They will always have to be held for examination by an analyst where they are not condemned outright.*

14. *Nose Irritant Gases*

The arsenical compounds employed as nose irritants are liberated in the form of smokes, i.e., clouds of exceedingly small particles of solid matter, which are rather readily dispelled. There is no tendency on the part of foodstuffs

to absorb these smokes, and it is improbable that such a cloud would significantly affect foods with which it came in contact. However, there is always the danger that the fine particles will contaminate any exposed foodstuff, and in view of the arsenic content, such danger must be borne in mind.

Any foodstuff which has been exposed to a strong concentration of these gases or is suspected of having been exposed must be held until it has been analysed.

15. *Arsine.*

This gas is not absorbed by foodstuffs to any greater extent than phosgene but it contains such a high proportion of arsenic that, if there has been any possibility of contamination, the food must be regarded with suspicion and not released for consumption until passed by an analyst.

16. *Hydrocyanic Acid*

It is unlikely that danger will arise by absorption of this gas by foodstuffs. Although highly poisonous, it is frequently used for the fumigation of large amounts of foodstuffs, and yet does not produce contamination.

Part IV

Contamination of Water Supplies

17. In the case of large reservoirs, the danger of contamination as a result of the use of poison gases is remote, but a problem may arise in the case of a small storage reservoir. In no case will the non-persistent gases have a deleterious action.

Mustard gas is very unlikely to present a problem even in the case of small reservoirs since it is heavier than, and insoluble in, water. Hence if a bomb bursts in a reservoir, the liquid gas will sink to the bottom and it will remain there until completely decomposed into harmless products. Since water is almost invariably drawn at some height above the floor of the reservoir or tank, there is no danger of mustard gas being drawn out, except in the few cases where the drainage is by way of the floor.

If one of the liquid gases containing arsenic is used, then it is possible that if several bombs were dropped into a small reservoir, sufficient arsenic would dissolve in the water to render it dangerous. Where analysis shows that the amount of soluble arsenical products exceeds the permissible limits, the arsenic can be removed by precipitation as basic ferric arsenate. The arsenite is first oxidised to the arsenate by the addition of a slight excess of bleaching powder and after standing for some time the arsenate is precipitated by the addition of the requisite amount of iron alum.

The careful control that is exercised over public water supplies makes it unlikely that such contamination would escape detection.

Part V

Responsibility for Dealing with Contaminated Foodstuffs

18. *Local Authorities' Responsibility*

The responsibility for dealing with all foodstuffs contaminated by war gases rests with the Local Authority which has powers under Regulation 25 (2) of the Defence Regulations, 1939 (Statutory Rules and Orders, No. 927), to seize, hold and condemn, food which has become contaminated by poison gas. These authorities will examine all such food and decide whether it can be

released after appropriate treatment for use as human food, whether it shall be diverted after treatment for other use, or whether it shall be destroyed. They will also decide upon the methods of treatment and of destruction.

19. *Organisation*

In order to ensure both the protection of the public and the salvage of as much food as possible, Local Authorities have appointed officers, known as Gas Contamination Officers, who are usually members of the staffs of the Medical Officers of Health. Each officer has under his control in his locality a Food Treatment Squad which is trained and equipped to deal with contaminated foodstuffs.

20. *Action to be Taken with Contaminated Foodstuff*

(i) *In no circumstances should an attempt be made to decontaminate affected premises or to touch their contents. Everything should be left to the Local Authority and to the skilled personnel. Decontamination is an undertaking which requires skilled attention.*

(ii) Normally, the Local Authority will be in possession of full details of all cases of contamination and will deal with them as rapidly as possible, but if a shopkeeper or warehouse manager is in any doubt, he should get in touch with an air-raid warden or the police.

(iii) Private householders must remember that the first consideration of the expert officers will be the inspection of large and important stores of food. Consequently, they must not except that these officers will be able to come and inspect private houses immediately. If food has been protected in the manner described in the foregoing section, then it will be perfectly safe. If food has been exposed and doubt is felt, then the proper course is to notify the police or an air-raid warden.

Part VI

Growing Crops and Foodstuffs on the Farm

21. *Growing Crops*

It is not considered likely that the enemy will attempt to harm growing crops by aerial attacks in view of the fact that the results would not be worth the effort required. Nevertheless, chance contamination resulting from a bomb or spray intended for other objectives may occur.

The explosion of a gas bomb of any type would probably cause scorching and bleaching of the vegetation in the immediate vicinity and, to some extent, down-wind.

22. *Effect of Non-Persistent Gases*

Air bombs containing this group of gases would probably be large and would produce a high local concentration of gas which would destroy or severely injure vegetation in the immediate vicinity of the bomb burst. There should be no difficulty in delineating the area affected; all the vegetation would be turned a yellowish colour and would appear scorched. Green vegetables would be bleached by the lung irritant gases.

In areas seriously affected, growing crops would probably not recover, but grass and trees would not be permanently damaged unless the concentration of gas was exceptionally high. When the non-persistent cloud has dispersed, the material effect of weathering would soon render the crops safe from the

point of view of any toxic effects. In some cases, however, the crops may be affected from the point of view of palatability, but the area so affected is not likely to be large.

In the case of pasture, once the gas cloud has dispersed, animals grazing are unlikely to sustain any injury if they find the pasture sufficiently palatable to eat.

23. *Effect of Persistent (Blister) Gases*

Immediately around the point at which the bomb burst, the ground would be grossly contaminated by liquid gas. Any crop or pasture would be completely destroyed and there would be no question of saving anything. Outside the area immediately around the bomb burst, the contamination would be similar to that produced by spray from low flying aircraft, and these two types of contamination will be considered together. The damage to crops will differ for mustard gas and lewisite, being much more serious in the case of the latter, since arsenic is a powerful plant poison.

With mustard gas the effects on pasture or crops would probably be transient. Exposure to the weather will in time remove all traces of the gas and in due course the vegetation will recover. The time required for this weathering will naturally be dependent on the character and extent of the contamination and on the atmospheric conditions, but, in general, it can be expected that crops would probably begin to recover from the effects of the non-arsenical gases after about a week.

Contamination by mustard gas is very often difficult to detect by smell, the smell not usually persisting in the crops for more than one day. With standing crops mustard gas causes some slight discolouration, usually brownish, but frequently it is insufficient to enable sprayed and unsprayed parts of the crop to be distinguished at a distance. With leaves and stems, only the parts in contact with the mustard gas are injured, brown spots being produced. The unaffected areas remain green. The presence of dead patches of tissue caused by mustard spray reduces the palatability and feeding value to animals of leafy green crops such as kale, sugar beet tops and especially grass.

No special treatment beyond weathering is required for cereals or potato crops contaminated by liquid mustard gas. Some loss of yield ensues, but the produce is normal and not toxic. With sugar-beet crops in the seedling stage, the effect is disastrous and the only course to be followed is that of ploughing in. At later stages of growth contaminated sugar-beet crops could probably be utilised for sugar extraction.

With lewisite the effects are much different and much more serious. To some extent, however, this gas provides its own safeguard in that the greater part of the affected crop will wither and die. The standing crop is bleached to a straw yellow colour and is very conspicuous; in dry weather the crop is brittle and in wet conditions becomes infected with moulds and rots. With the broad leaved plants, kale, sugar-beet, etc., the whole plant is usually killed.

In cereal crops, grass and potatoes sprayed with lewisite at an early age, many of the plants survive and produce new shoots. In the early stages of growth of barley and wheat, the injury is localised and does not spread and is scarcely distinguishable from mustard injury.

Crops severely affected can either be burned or ploughed in, for it is unlikely that the arsenic liberated into the soil after they have decomposed would constitute a danger to any subsequent crop.

The germinating capacity of wheat and barley is only slightly reduced by spraying the crop at maturity with lewisite. This suggests that such grain could be kept, after weathering, for seed. This also applies to crops sprayed at a similar stage by mustard gas.

If spraying with lewisite or mustard occurs at an early stage of growth, the treatment of the crop must depend on whether a sufficient yield can be expected at harvest to justify leaving the crop to grow to maturity, as well as on the question of toxicity. Inspection of the damage after spraying should indicate the course to be followed.

Similar considerations apply to fruit crops. Fruit crops which are contaminated during ripening will probably be unsafe, but if the contamination takes place during the earlier stages of growth, then they should be allowed to ripen and should then be examined. Contamination by lewisite will mean that in all probability the fruit will be completely useless. In the nearly mature fruit, there would be the danger from arsenic and during the earlier stages of growth the fruit would probably die.

On no account should any part of the fruit crop which is suspected of having been in contact with arsenic be used as foodstuff or fodder unless it has been approved by an analyst.

Further information on these problems is available in a publication of the Ministry of Agriculture and Fisheries: Grow-more Leaflet No. 38—War Gases and Crops.

24. *Foodstuffs on the Farm*

With the exception of the arsenical gases, none of the poison gases likely to be used will probably affect stacks of hay, unthreshed grain, or the usual farm stocks to an extent which cannot be remedied by natural weathering or airing. If it is desired to give such stocks of food additional protection this can best be provided by the intelligent use of impervious tarpaulins, oilskins or other coverings. Even canvas or sacking may provide useful protection by soaking up drops of liquids and, thereby, reduce direct contamination of foods which they cover. If foodstuffs in barns or granaries become contaminated by liquid gas, they should be left for the skilled personnel to deal with.

If a gas bomb falls where there are growing crops or if it is suspected that crops have become contaminated by gas spray, notification should be sent without delay to the Police or an Air Raid Warden.

It is very dangerous to walk over ground contaminated by blister gases unless fully protected by special clothing.

There is a grave risk of serious personal injury if salvage is attempted by unprotected or inexperienced individuals. Everything should be left to the skilled personnel who will advise as to any further action which may have to be taken.

Part VII

Livestock

25. *General*

Tear gases have little or no effect on animals, nor have the arsenical smokes except in very high concentrations when they produce some sneezing, watery discharge from the nose and some restlessness. Horses can be worked immediately after exposure to the nose irritants on removal to a clean atmosphere.

Otherwise the danger to animals from war gases is for all practical purposes precisely similar to the danger to human beings, and animals should be evacuated as far as possible from the large industrial centres. For such animals as have to be kept in vulnerable areas, there should be adequate protection against blast, splinters, fire and poison gas.

Nevertheless, it is inevitable that, in the event of gas raiding, animals will fall victims to the war gases and this fact raises the question of the edibility of the carcases of such animals.

It must be borne in mind that the following instructions refer to animals that have died as a result of exposure to poison gas or have been so badly affected as to render their slaughter a matter of necessity. Clearly the responsibility of deciding whether or not an animal, which has been exposed to gas, should be slaughtered will rest with a veterinary surgeon.

26. *Animal Exposed to Poison Gas Vapour*

If an animal is known to have been badly gassed by a lung irritant gas or blister gas vapour it should be slaughtered at once. The offals should be discarded, but in the absence of any symptoms of congestion or fevered condition of the meat, the remainder of the flesh will be edible. *Speed is essential in order to obtain flesh in which congealment of the blood has not set in.*

27. *Animals Exposed to Liquid Mustard Gas*

Contamination of the skin by liquid mustard gas leads to ulceration which is deep seated in the case of heavy contamination. The skin of animals is, however, much tougher than that of humans and it is also covered by numerous hairs which prevent any significant amount of fine or moderate contamination from reaching the skin.

If the beast has been badly splashed with liquid mustard gas, it should be rapidly decontaminated by swabbing off the excess liquid, rubbing down with a mixture of bleaching powder and water, and this hosed off immediately (irritation will result if the bleach paste is allowed to remain for more than a brief period). The animal should then be slaughtered immediately, the flesh underlying any lesions cut away and the offals discarded. The remaining meat will be safe for consumption.

If the animal has died as a result of mustard gas burns, it will not be fit for consumption, but this is an extreme case.

In the case of animals having eaten fodder which has become contaminated by mustard gas, it will be possible to use the meat after discarding the offals, if no serious necrosis and haemorrhage have taken place in the alimentary tract.

The examination and judging of the flesh of slaughtered animals, which have been exposed to poison gases, is based on the general rules for meat inspection, except in the following cases:

28. *Animals Exposed to Liquid Arsenical Gases*

If an animal becomes ill as a result of consuming fodder contaminated by a liquid arsenical gas, the carcase should be regarded as unfit for consumption.

In the event of the skin of the animal becoming badly contaminated by an arsenical gas, it should be slaughtered immediately, the hide decontaminated, and all discoloured flesh removed at the time of skinning, and rejected. The rest of the animal should be submitted for analysis before being released for consumption.

APPENDIX I.

PROTECTIVE VALUES OF MATERIALS USED FOR HOLDING OR COVERING FOODSTUFFS.

The relative protective value of a number of materials commonly employed for packing foodstuffs are given below:—

Nature of Covering.	*Protection against Poison Gas Vapour.*	*Protection against Liquid Poison Gas.*
Sealed metal drums	Complete	Complete.
Sealed metal-lined cases or casks	Complete	Complete.
Sealed tins	Complete	Complete.
Tins with well-fitting lids but not sealed	Fairly Good	Good.
Glass bottles, glazed earthenware vessels with well-fitting stoppers or lids of glass, metal, bakelite or similar impervious materials ...	Complete	Complete.
Bottles or glazed vessels with ordinary cork stoppers ...	Fairly Good	Good.
Sealed wooden barrels such as are used for transporting and holding liquids ...	Complete	Complete, except in cases of heavy and prolonged contamination which may lead to the wood becoming impregnated to a significant depth.
Bottles and jars covered by grease-proof paper... ...	Fairly Good	Moderate, but additional protection can be provided by an outside covering of a transparent cellulose wrapping.
Waxed Cartons	Good if well sealed ...	Good if all joints are waxed or covered by a layer of a transparent cellulose wrapping.
Papier mache cartons ...	Good if well sealed ...	Fairly good. A transparent cellulose wrapping gives additional protection.
Moisture-Proof Cellulose Film*	Good	Good.
Bags lined with moisture-proof cellulose film	Good	Good.
Metal foil wrappings... ...	Good if no pinholes ...	Good if no pinholes.
Oilskins, tarpaulins	Fairly good	Good
Greaseproof paper†	Good	Fairly good if contamination slight.
2- or 3-ply bitumen or tar-lined paper	Good	Fairly good if contamination slight.
Wooden boxes	Good if all joints tight ...	Poor. Soft woods are very absorbent.
Thick cardboard boxes ...	Good if all joints tight...	Poor, very absorbent.
Paper containers	Poor	None.
Sacks, canvas, hessian and other textiles	None	None (except when used as screens).

* Many types of transparent wrapping films are on the market. Those prepared from cellulose, cellulose acetate and nitrocellulose are, in general, good as protective wrappings against gas. Those based on benzyl cellulose are less satisfactory. With all these wrappings, the protection offered when the wrappings are wet is not so good as when dry.

† Creasing these papers greatly diminishes their protective value.

APPENDIX II.

EFFECTS OF HIGH CONCENTRATIONS OF PHOSGENE ON FOODS.

Food.	*Effect.*	*Treatment.*
Flour	May become sour and slightly unpalatable and make a poor loaf.	48 hours airing. Can then be blended with five parts of undamaged flour and will bake normally.
Bread	Outer layers may become unpalatable.	Cut away outer layers and air remainder.
Cereals	Negligible	48 hours airing.
Meat and Fish ...	May become slightly discoloured on the surface.	Condition improved by airing and cooking.
Milk	May slightly affect taste ...	Bring to boil.
Eggs	None	—
Cheese, Butter, Margarine and Fats.	May bleach slightly on surface	If bleached, cut away affected part, which may be used for cooking. Remainder is edible.
Fresh Fruit... ...	Almost none	Air and peel off skin or outer layer.
Dried Fruits ...	Slight loss of palatability ...	Air and cook.
Fresh Vegetables ...	Green vegetables may be slightly bleached.	Air and cook.
Tea, Coffee	May become bitter and unpalatable.	None is effective, but such material might be used for blending.

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