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AIR RAID PRECAUTIONS

HANDBOOK No. 7

(2nd Edition)

ANTI-GAS PRECAUTIONS FOR MERCHANT SHIPPING



LONDON

HIS MAJESTY'S STATIONERY OFFICE

Price 3*d.* net



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MERCHANT SHIPPING**

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PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

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List of Air Raid Precautions Handbooks issued and projected

No. 1.—Personal Protection against Gas (price 6d., 8d. post free.)

(A handbook primarily for members of air raid precautions services.)

No. 2.—First Aid for Gas Casualties (*2nd edition*) (price 4d., 5d. post free.)

(A handbook designed primarily for services giving first aid to air raid casualties.)

No. 4.—Decontamination of Material (*1st edition*) (price 6d., 7d. post free.)

(Decontamination of streets, buildings and their contents, vehicles and plant.)

No. 5.—Structural Precautions against Bombs and Gas (*in preparation*).

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(Includes certain recommendations to Port Authorities.)

No. 8.—The Duties of Air Raid Wardens (*2nd edition*) (price 2d., 2½d. post free).

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 (see list on inside back cover).

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.

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INTRODUCTION.

This Handbook outlines the precautions needed in merchant ships in the event of their being subjected to gas attack from the air. It includes no reference to the dangers of attack by high explosive or incendiary bombs from aircraft, nor to attack by enemy ships.

It is not to be anticipated that gas attacks on merchant ships at sea would be frequent, but if they should occur the ship would be entirely dependent on its own resources. In ports within range of hostile aircraft the risk of gas attack would be greater and (unless the ship was laid up) the main responsibility for dealing with their effects would still rest with the Master.

Anti-gas measures in merchant ships cannot be complete without precautions to prevent the loading of cargo which is already contaminated with gas, and it is similarly necessary to deal on shore with cargo which is discharged in a contaminated condition from a ship which has been attacked with gas.

The aim should be that no outward-bound ship should sail without a certificate to the effect that the ship and her cargo were free from gas contamination, and that inward-bound ships which had been attacked with gas at sea, or had contaminated cargo on board, should remain at an examination anchorage without unloading pending proper instructions from the Port Authority. The necessary organisation to be provided by Port Authorities is described in Chapter II.

So far as possible the Handbook has been arranged so as to separate the duties of Port Authorities, Shipowners and Masters, but in respect of ships in port the arrangements require concerted action by all parties, and it is desirable that everyone concerned should be familiar with the whole Handbook. It is therefore essential that Masters of ships should ascertain and fall in with the anti-gas organisation in force in any port in which the ship may happen to be.

CHAPTER I.

EFFECTS OF GAS ATTACK ON SHIPPING.

1. Explanation of Terms.

The following terms are used in connection with gas warfare:—

Gas.—This includes any chemical substance, solid, liquid or gas, employed for its poisonous or irritant effects on the human body.

Persistent Gas.—A gas (in liquid form) which evaporates slowly and so continues to produce effects for a long period.

Non-persistent Gas.—A gas which forms a cloud (not necessarily visible) immediately it is released, and has no further effect when the cloud drifts away.

Concentration.—A term used to indicate the amount of gas present in the air; a high or low concentration means that there is much or little gas present.

Contamination.—The liquid or vapour remaining on a person or object as a result of exposure to a persistent gas.

Decontamination.—A treatment designed to render the contamination harmless.

It is considered that merchant ships will be more likely to be attacked by mustard gas or similar persistent gas than by a non-persistent gas, owing to the special characteristics of the former (see Section 2 below). Full protection against non-persistent gases is afforded by the respirator alone, and they leave no contamination on material objects.

2. Characteristics of Mustard Gas.

Mustard gas is an oily liquid and in the form likely to be used in war is brown in colour, with a smell

resembling mustard or garlic. Its presence is usually first detected by smell, but it may also be seen by the stains it leaves on objects.

As described in Sections 3 and 4 below, the two methods by which mustard gas might be used from aircraft are in the form of spray, when the liquid would come down like rain, or in gas bombs, when large splashes of liquid may be expected, possibly between decks.

Effect on personnel.

Mustard gas attacks any portion of the body with which it comes in contact. On the skin it will cause intense irritation and may cause deep and extensive blisters. No pain is felt on contact with the liquid or vapour, and the effects may not appear until several hours have elapsed—sometimes in the case of vapour up to 24 hours—except when drops of liquid enter the eyes, when an immediate irritation is produced.

Mustard gas vapour in low concentrations attacks the eyes, and long exposure to low concentrations or short exposure to high concentrations will cause damage to the lungs and skin, especially where the latter is moist.

The respirator will give complete protection to the lungs and eyes but, since the vapour attacks the skin, men working in a concentration of vapour must wear protective clothing as well. (See Appendix I.)

Persistence.

Liquid mustard gas evaporates very slowly at ordinary temperatures and so is very persistent; the rate of evaporation depends on the temperature. In hot weather vapour is given off freely, and the concentration is strong. In cold weather, below 45°F., mustard gas will freeze and give off practically no vapour, but when the temperature rises again gas in dangerous

concentrations will be given off. Its presence in cold weather may not be detected and contamination is likely to take place unawares.

Penetration.

(i) Liquid.

Liquid mustard gas has great powers of penetration and soaks into porous materials in a manner similar to oil and also penetrates paintwork.

Metals, glass, glazed bricks and glazed earthenware are not penetrated.

Ordinary clothing materials are readily penetrated, leather is penetrated slowly and rubber garments still more slowly.

The most resistant of clothing material which is readily available is oilskin.

(ii) Vapour.

Mustard gas vapour readily passes through ordinary clothing materials.

High concentrations of mustard gas vapour may contaminate food, which should therefore be kept protected.

3. Attack by Mustard Gas Spray.

A ship can be attacked by an aircraft with mustard gas spray and the liquid may, or more probably may not, be observed falling.

When the liquid arrives it is seen in the form of brown drops on the decks and paintwork, and a smell of mustard or garlic is noticed.

If the liquid falls on any man who is not provided with protection that man will be a casualty unless immediate steps are taken to counteract the effect of the mustard gas. The steps to be taken are given in Appendix II.

Every drop of the liquid that has fallen on board is dangerous.

Any man who touches any contaminated bulkhead, rail, deck, screen, rope, navigational instruments, such

as engine-room telegraphs, or anything else, with his bare hands, will be a casualty unless some form of treatment is applied to his hands immediately.

If he brushes against a recently contaminated bulk-head in any clothing other than oilskin, the mustard gas will be transferred to his clothing, and a burn will eventually result if he continues to wear the clothing.

If he walks across a freshly contaminated deck, he will pick up the mustard gas on his boots, and may carry it elsewhere and contaminate other portions of the deck.

If he is wearing protective clothing which is contaminated, attempts to undress himself will probably result in his becoming a casualty.

If mustard gas is taken on the boots into a closed compartment, which is used for living or working purposes, in the space of a few hours sufficient mustard gas vapour may be given off to cause other persons in the room to become casualties.

If the temperature is low the mustard gas may arrive frozen, and as such will not penetrate anywhere at once. If the mustard gas is in the form of a mush on the surface it is more liable to be removed by contact, *i.e.*, on being trodden on.

Paintwork is penetrated easily by mustard gas, and is very difficult to decontaminate rapidly. Owing to the large areas involved it must in most cases be allowed to weather, but it must be remembered that it will still be dangerous for at least a week if the bare hand is kept in contact with it for more than a few minutes.

Any portion of the ship on which the spray has fallen and in which there is no circulation of air will be dangerous from mustard gas vapour.

The decks will remain dangerous for lying on for several weeks unless decontaminated.

If ventilating fans are started up and air drawn down below from contaminated decks, eye casualties may result.

Action to be taken.

(i) After a spray has fallen men on exposed decks should wear respirators until the extent of the contamination is known and safe areas defined.

(ii) Decontamination should commence as soon as possible, as described in Chapter III. Any man affected should be dealt with as described in Appendix II. The methods of decontaminating materials are described in Appendix III.

4. Attack by Gas Bombs.

Should the attack be by mustard gas bomb, the immediate effects will be localised, but the dangers in the affected spots will be much greater than in the case of attack by spray.

Action to be taken.

(i) Should the bomb penetrate the deck and burst in a confined space, the vapour concentration will be such that no person should approach the space unless he is wearing a respirator and full protective clothing.

(ii) Steps should be taken to effect a preliminary decontamination by covering with bleach paste all objects on which mustard gas can be seen; this will prevent the vapour from being given off to any great extent.

(iii) If any place of vital importance has been contaminated, complete decontamination must be carried out as described in Chapter III. If the space can be isolated and left unused, it should be sealed after the preliminary decontamination, and arrangements made for free ventilation of surrounding spaces.

CHAPTER II.

PORT ANTI-GAS ORGANISATION.

5. Port Anti-gas Officer.

It will be necessary for each Port Authority to appoint a Port Anti-gas Officer, with the necessary staff, to perform the duties described in this chapter.

The arrangements for instructing Port Anti-gas Officers in the necessary precautions will be notified separately to Port Authorities.

The Port Authority will be responsible for providing a launch for the Port Anti-gas Officer. This launch must be suitable for the conveyance of decontamination parties and stores.

The Port Authority should also provide at each dock area a suitable site on shore, with the necessary examining staff, for any contaminated or suspect goods landed from ships or received for shipment.

6. Certificates for Outward-Bound Ships.

With a view to re-assuring the crew and passengers, as well as for the avoidance of possible difficulties at the port of discharge, it is proposed that, if this country were being subjected to air attack, no ship should leave a United Kingdom port without a certificate that the ship and her cargo were free from gas contamination.

The certificate would require endorsement at every United Kingdom port at which the ship called before finally clearing for her destination.

It is assumed that the Port Authority would have kept records of any contamination which had occurred to goods in their own warehouses or premises. As regards cargo delivered by land, it is intended that every consignment of goods sent to the port should be accompanied by a certificate that the goods were not contaminated at the outset. If the consignment had passed through a gassed area *en route* to the port, the railway company or other carrier would, at the time of giving delivery of the goods to the Port Authorities, furnish a statement to that effect.

The Port Anti-gas Officer (or, in ports where no Anti-gas Officer was available, the Master) would be entitled to give a gas-free certificate in respect of all cargo not recorded in these ways as being contaminated or suspect.

It would be the responsibility of the Port Authority to take proper steps with regard to contaminated or suspect goods in their charge before allowing the goods to be shipped.

7. Gas Clearance of Inward-Bound Ships.

It would be the duty of the Master of any inward-bound ship which was free from gas, and had no gas contaminated cargo, to furnish the Port Anti-gas Officer with a certificate to that effect. He would make out this certificate himself.

On the other hand, as described in Section 14 below, any inward-bound ship which was contaminated, or which had been attacked with gas on the voyage (even if it had since been decontaminated), would be required to fly the signal " Gas " on entering a port, and to remain in an examination anchorage, at a safe distance from the shore and from other shipping, until the Port Anti-gas Officer had visited it and made suitable arrangements.

Where it was necessary to discharge contaminated cargo before decontamination was complete, care would have to be taken to protect the men who handled it and to prevent the contamination being spread to other goods.

CHAPTER III.

DECONTAMINATION OF MERCHANT SHIPS.

8. Organisation for Decontamination on Board Ship.

Decontamination is a matter affecting the whole ship.

Stewards and other personnel available on board must be utilised for inclusion in decontamination squads if necessary, since the actual deck hands will not be sufficient in many cases to deal with decontamination.

The final organisation of the decontamination squads rests with the Master of the ship. In the table given on the next page an attempt has been made to estimate the number of squads which would be required to deal with contamination from mustard gas spray in different types of ships.

The number of squads recommended should be able to cope with the essential work in order of precedence given in Section 9 below, although complete decontamination of the whole structure might not be possible.

Decontamination squads should each consist of six men, one of whom should act as foreman. The men comprising the squads will each require two suits of full protective clothing (*see* Appendix I).

The gear required for each decontamination squad is :—

- 1 shallow tray for bleach for treatment of boots.
- 2 long-handled scrubbers.
- 2 buckets for mixing bleach paste.
- 2 whitewash brushes for applying bleach paste.
- 1 gallon of paraffin and swabs.

Table of Decontamination Arrangements on Typical Ships.

Type of ship.	Gross tonnage.	Decontamination squads and sets of equipment number.	Number of personnel in parties.	Protective clothing sets, including spares.	Bleach powder.
Foreign-going passenger ship	30,000 and above.	10	60	140	3 tons.
Foreign-going passenger ship	20,000	8	48	110	2½-3 tons.
Foreign-going passenger ship	30,000	5	30	70	1½-2 tons.
Troopship ...	12,000	4	24	60	1 ton.
Passenger and cargo ship	20,000	3	18	45	1 ton.
Cross Channel passenger ship	9,500	2	12	30	5 cwt.
Tanker (oil in bulk) ...	10,000	2	12	30	½ ton.
Foreign-going cargo ship	7,500	2	12	30	½ ton.
Coasting cargo ship ...	5,000	1	6	15	2 cwt.
	800				

9. Procedure for Decontaminating a Ship.

It cannot be too strongly emphasised that the successful neutralisation of the effects of mustard gas depends upon the rapidity with which decontamination is carried out. In the first instance all ladders, gangways and deck areas which have been contaminated and which need not necessarily be used by passengers and crew should be roped off as out of bounds. The decontamination of the ship's structure and equipment should be carried out in the following order of precedence:—

(a) All appliances necessary for safe navigation, *i.e.*, steering wheels, engine-room telegraphs, sounding apparatus, signal halliards, &c.

(b) Handrails to ladders and gangways, also treads of ladders and decks, wood and steel, needed for gangways.

NOTE.—The roped-off portions referred to above may be dealt with later.

(c) Lifeboats and equipment, boats' winches and falls, davits and turning-out gear.

(d) All exposed canvas gear throughout the ship.

NOTE.—Canvas covers should be removed as soon as possible.

(e) Mooring arrangements, windlass and capstans, hawsers and hawser reels, fairleads, bollards, &c.

(f) Bulwarks, rails, wood decks and casings.

(g) Superstructure bulkheads and all exposed painted surfaces, ship's side, &c.

It is considered that as an additional precaution special gangways should be arranged, preferably on the side of the ship which was to leeward during the attack, until the open decks have been well "weathered"; also that the superstructure bulkheads

should be railed off to prevent persons leaning against or coming into contact with painted surfaces which may have absorbed mustard gas.

In certain circumstances (e.g. weathering under humid conditions) hemp cordage, etc., which has been contaminated with mustard gas may become rotted. Where appreciable contamination has occurred, it is therefore recommended that hemp boats' falls or any other cordage on which the safety of life depends, also signal halliards, should be replaced as soon as the opportunity permits. The rotting effect, however, takes place comparatively slowly, so that if an emergency occurred shortly after contamination had taken place, the existing cordage could be used, as its strength would not at that time have been materially affected. (See also page 35.)

The best methods of decontaminating materials, &c., are given in Appendix III. It is recognised that complete decontamination cannot be carried out in all cases owing to limited facilities, but if the recommendations are followed the principal dangers will be counteracted.

CHAPTER IV.

PRECAUTIONS IN MERCHANT SHIPS IN
TIME OF WAR.

10. Preparation at the Outbreak of War.

At the outbreak of any war in which ships might be exposed to gas attack, it is particularly recommended that each ship be provided with the following:—

(a) Canvas covers to protect such fittings as winches, etc., as set forth in Section 11 below, paragraph (a).

(b) Suitable means for closing cowl ventilators and similar openings.

(c) Adequate supplies of bleaching powder, paraffin, brushes (whitewash pattern), and long-handled scrubbers, for carrying out decontamination.

(d) Respirators for crew.

(e) Protective clothing for crew, e.g., gloves, hoods, southwesters, oil-skins, and rubber sea boots.

(f) Washing facilities for crew, e.g. showers.

(g) Steam connection for providing boiling facilities for decontaminating clothing.

The organisation of decontamination parties and instruction in their work must be carried out so that there is no delay in dealing with a gas attack.

The number of parties and their composition for various types of ships is given in Section 8 above.

11. Preparation prior to entering a Danger Zone.

(a) As far as possible, all equipment requiring handling by the crew, such as boats, falls, winches, mooring hawser reels, fire hoses, and general deck equipment, should be protected by means of canvas covers. It is anticipated that the lifeboats will be in readiness for lowering, but boats' covers should be laid loosely inside the boats to protect the equipment.

(b) All doors and openings on weather decks, side scuttles and ports, ventilators to holds, passenger and crew accommodation should be closed. Where inlet and exhaust fans are installed, they should be stopped, and circulating fans only kept running.

(c) Arrangements should be made for a distinctive alarm in the event of a gas attack, either by means of the existing fire and collision alarms or other equally effective arrangements.

(d) Suitable clothing, as indicated in Section 10, paragraph (e), should be worn by officers and crew whilst on duty in the danger zone.

(e) The bleaching powder, paraffin, long-handled scrubbers and brushes for decontamination purposes should be stowed in readily accessible positions on the decks.

(f) As mustard gas penetrates dry decks and other surfaces more readily than wet ones, steps should be taken to keep all exposed surfaces wet when in the danger zone. This may be done by hoses coupled up to the wash deck service.

12. Precautions in a Danger Zone.

Attention is directed to the necessity of maintaining a special watch for aircraft, particularly to windward.

All passengers should, as far as possible, be kept under cover and, on the alarm being sounded, should be assembled in one or more of the main compartments, such as the Dining Saloons, and remain there until decontamination has been completed to the satisfaction of the Master.

CHAPTER V.

MERCHANT SHIPS IN PORT IN TIME OF WAR.

13. Outgoing Ships.

As described in Section 6 above, outgoing ships would require a certificate to the effect that the ship and her cargo were free from gas contamination.

The procedure for issuing these certificates is described in Section 6.

14. Ships entering Port.

Ships arriving at a port may be classified under two categories—safe and unsafe from gas contamination.

After the Master has furnished the Port Anti-gas Officer with a certificate to the effect that the ship and her cargo had not been exposed to any gas contamination (*see* Section 7 above), "Safe" ships would proceed as directed by the Examination Service; or, where no Examination Service exists, according to the normal custom of the port.

"Unsafe" ships may be placed in the following categories:—

(a) ships which have been contaminated and in which no decontamination measures have been taken;

(b) ships which have been contaminated and in which decontamination measures have been carried out.

Masters of "Unsafe" ships on entering port or proceeding to an examination anchorage will be responsible for making a signal by flags in the international code "Gas," to indicate that the ship has been chemically contaminated.

This signal will convey the warning "ship cannot be boarded unless protective clothing is worn," and is to be kept flying until the ship has been passed by the Port Anti-gas Officer as safe for handling.

If decontamination measures have been taken before entering the port or examination anchorage which, in the opinion of the Master, render the ship safe for handling, the additional signal "cleared up" should be hoisted.

Ships in category (a) will be required to anchor in accordance with instructions issued by the Examination Service, or by the Port Anti-gas Officer where no Examination Service exists. They will remain at anchor until they have been decontaminated either by the ships' own resources, or by a decontamination party supplied by the Port Authority. No members of the crew, or passengers, should be allowed to land, and no cargo should be unloaded, without the authority of the Port Anti-gas Officer, who will finally be responsible for passing the ship as fit for service.

The Master of any contaminated ship arriving in port will be responsible for asking for assistance for decontamination work if his own resources are inadequate for any reason; such assistance will be provided by the Port Authority as and when available.

Ships in category (b) will be inspected by the Port Anti-gas Officer, and if certified "clear" will await further instructions as to their future movements.

15. Warning and Protective Arrangements for Ships in Harbour.

The Port Authority will be responsible for warning the Masters of ships entering a port if there is any likelihood of air attack, in order that the Master may take such precautions as are possible. The Port Authority will also be responsible for issuing any further warnings that may be necessary from time to time while the ship is in dock. On receipt of such a warning from the Port Authority, the Master, or other person in charge of the ship, will be responsible for taking protective measures in accordance with instructions issued.

The following are the general precautions which can be taken in a ship to minimise the effects of gas attack:—

The weather deck openings of all ships should be kept closed as far as is possible, and only such hatchways and companionways should be opened as are essential for the loading or discharging of cargo, or for access and egress of the crew and workmen.

When hatchways are opened the web beams, fore and afters, hatch covers and tarpaulins should be stowed in such a manner as to be capable of being replaced as quickly as possible in the event of an alarm being given.

All cargo of a nature liable to be easily impregnated by gas, such as wooden crates, bagged commodities, etc., should be placed under cover as soon as received at the wharves and quays; where this is not possible the merchandise should be covered with tarpaulins until it can be safely removed.

Before a ship is laid up the owners will be responsible for taking such protective measures as may be possible in case of gas attack. The action to be taken will conform generally with the instructions given in the preceding paragraphs.

16. Decontamination of Ships in Harbour.

If the docks area is subject to attack by gas, the steps to be taken to deal with any ships contaminated will depend to some extent on the situation of the ship—that is to say, whether sufficient personnel are available on the ship itself to deal with the situation, or whether help from outside will be required.

The conditions in regard to individual ships, which must differ in accordance with the circumstances, may be summarised as follows:—

(i) *Ships with full crews on board.*

A ship with a full crew on board would be expected to proceed as soon as possible with decontamination, and should normally be able to do so without

assistance. If assistance should be required, either in personnel or material, it is the responsibility of the Master to inform the Port Authority.

(ii) *Ships with depleted or maintenance crews only.*

Ships with a depleted crew will probably require assistance from the Port Authority and should indicate, if necessary with the advice of the Port Anti-gas Officer, what assistance is required.

(iii) *Ships at moorings with watchmen only on board.*

Ships at moorings in this condition must be dealt with by the Port Authority as opportunity occurs, and in accordance with a priority list which the Port Authority will draw up.

(iv) *Ships discharging and/or loading cargoes.*

Such ships should be dealt with immediately in accordance with the arrangements proposed in (i) and (ii) above.

(v) *Ships laid up with no crew on board.*

Ships laid up with no crew on board will be dealt with by the Port Authority as and when required.

In order that the Port Authorities may know whether a ship entering a port can be responsible for its own decontamination arrangements while in port, the Master, owner or agent, is responsible for informing the Port Authority whether, in the event of the ship becoming contaminated, any assistance will be required in either personnel or material. In the event of a report being rendered that any decontamination requirements can be met from personnel and material on board, and subsequent modifications are found to be necessary owing to personnel being paid off, or for other reasons, assistance from the Port Authority may be required, in which case an amended report should be forwarded, together with the date from which the change will take effect.

17. Tugs and Harbour Craft.

The primary responsibility for the protection and decontamination of tugs, barges and other craft employed in docks and harbours, rests with the owners of the vessels, who should request such assistance as may be necessary from the Port Anti-gas Officer.

Owners should, however, issue instructions to the crew of these craft to take any immediate decontamination measures that are possible, basing their instructions on the lines laid down in Appendices I, II and III.

The attention of owners is drawn to the advisability of the crews of these craft being in possession of a complete set of spare clothes.

The precautions to be observed during loading and discharging stores are as outlined in Section 18 below.

CHAPTER VI.

CONTAMINATED CARGO.

18. Methods for dealing with certain descriptions of Contaminated Cargo.

A table has been prepared and is attached as Appendix IV which sets forth various methods of dealing with contaminated cargo.

It is most important to try to prevent cargoes becoming contaminated, since in some cases, particularly cargoes in bulk, decontamination may be impossible and considerable loss may ensue.

It is obviously better to prevent contamination if possible, and with this object exposed cargo should be covered up with tarpaulins and all hatches kept closed.

In the cases where weathering has been recommended it has been necessary to suggest times which are adequate in any type of weather. A week's exposure of the contaminated article in hot weather is much more effective than a month's exposure in cold, frosty weather. Thus under certain climatic conditions the periods mentioned in Appendix IV may be considered to have erred on the safe side.

APPENDIX I.

PROTECTIVE CLOTHING.

Persons whose duties expose them to the risk of contamination by mustard gas in liquid or vapour form, such as decontamination parties and those who cannot take cover during an attack by mustard gas spray from the air, require special protective clothing.

Respirators are needed to give protection to the face and lungs. The facepiece of a respirator is penetrated by liquid mustard in about four hours. The container will give protection against mustard gas vapour for many hours.

Heavy pattern oilskins give protection for at least two hours, and the lighter oilskin fabric for at least one hour against liquid mustard gas spilled on them.

The head, hands and the greater part of the body can thus be protected for a certain period, although the protective clothing is being penetrated gradually. Oilskin clothing which has been contaminated must be decontaminated before being worn again.

Rubber sea-boots give good protection against liquid mustard gas, the uppers for about 18 hours, and the soles for 2 or 3 days.

A complete set of protective clothing consists of :—

Respirator.

Oilskin jacket.

Oilskin trousers.

Oilskin hood or sou'wester.

Oilskin gloves.

Rubber sea-boots.

A long oilskin coat, which is an alternative to the jacket and trousers, will protect against the mustard gas spray, but is not adequate against vapour, which will penetrate from below.

The oilskin suit (i.e., jacket and trousers) protects completely against liquid mustard gas. The jacket should be worn outside the trousers, a belt being drawn tightly over the jacket to prevent vapour entering.

The trousers should be worn inside the boots, with a fold over the top of them or outside the boots and tied round. The gauntlets of the gloves should be firmly tied round the sleeves of the jacket.

Work in protective clothing is very arduous, owing to the clothing being non-porous. Work in protective clothing is still more exhausting if it has to be performed in a confined space, in a warm climate, or when wearing a hood in addition.

Only light underclothing should be worn under protective clothing. Hard manual work can be performed, but must be carried out with frequent pauses and periods of rest.

In cool conditions, under circumstances which do not render the wearing of the hood essential, spells of work up to a maximum of four hours can safely be performed.

The protection against mustard gas vapour afforded by the full protective suit is of limited duration, owing to the suction effect produced by movement. The inside of such suits should therefore be ventilated at regular intervals by opening the coat and letting down the trousers in an atmosphere free from mustard gas vapour.

APPENDIX II.

CLEANSING OF CONTAMINATED PERSONNEL.

General Precautions.

Since the facilities for dealing with contaminated persons vary so much the following instructions must be modified to suit each ship, but certain essential measures have to be taken in all cases where protective clothing is not being worn. These are:—

(a) Remove the outer clothing within five minutes.

(b) Wash off all liquid mustard gas from the skin as quickly as possible. If this is done within five minutes serious blistering may be prevented. (Application of bleach ointment within two minutes will neutralise the effect of the mustard gas.)

The arrangements advised for the carrying out of the above are:—

(a) *Undressing.*

Undressing should take place on the upper deck in an uncontaminated and well ventilated place adjacent to the bathroom or place selected for washing.

Men wearing ordinary clothing who have become contaminated will probably have to undress themselves, but assistance from an undresser in protective clothing for the actual removal of garments is advisable. Men wearing contaminated protective clothing should invariably be undressed by others.

The routes and passages of men to the undressing station and bath place must be organised so that there is no contact between men who are contaminated and those who have washed.

The contaminated clothes should be removed to a safe place until they can be dealt with by weathering or other means of decontamination. If they have to be taken below for decontamination they should be stowed and carried in closed bins or boxes.

All handling of contaminated clothing must be done by men wearing protective clothing and respirators.

(b) *Washing.*

Washing facilities consist of a spray of either salt or fresh water with nailbrushes and soap. If no spray is available two changes of water are desirable.

Symptoms of contamination and methods of dealing with casualties.

The eyes are the most sensitive part of the body, the lungs and breathing passages come next, and lastly the skin. Moist and greasy skin is more readily affected than parts which are dry.

The effect of a drop of mustard gas in the eye is to cause irritation which may pass off in a few minutes. Within an hour, however, the eye becomes red and swollen. The inflammation progresses until the eye is greatly swollen, and in the case of contamination by anything larger than a very small drop of mustard gas, severe ulceration will result with partial or complete loss of vision.

The treatment should consist of *immediate* and thorough irrigation with water, repeated at frequent intervals.

In view of the serious effects of contamination of the eye, the importance of protecting the eyes by means of the respirator or goggles cannot be over stressed.

If the mustard gas has fallen on the skin and has not been removed, reddening of the skin followed by severe blistering will take place within a few hours. If the liquid falls on porous clothing the effect will be the same, but slightly delayed.

Within about 6 hours of exposure to vapour a man will begin to feel soreness of the eyes, accompanied by much watering. The nose is also affected as in the case of a severe cold. At a later stage the eyes become very inflamed, swollen and painful and the man will be unable to see. By this time

soreness of the throat and a dry cough will have developed—stomach pains and vomiting may also occur. At the next stage skin injuries begin to appear. At first these show themselves by reddening, accompanied by intolerable itching. In a mild case nothing more may happen, but in a severe case blisters commence to form and may become large.

In the severest cases the skin becomes a bluish colour, and the bluish areas later break down to form ulcerated surfaces, which are very slow in healing.

It should be noted, however, that mustard gas patients almost invariably recover completely with proper treatment, and the death rate is extremely low except when severe secondary infection of the lung injuries occurs.

Treatment.

First aid treatment may be considered under two headings:—

(a) Preventive.

(b) Curative.

(a) *Preventive.*

To prevent burns developing it is essential to get rid of contamination without delay. Clothing which has been exposed to vapour or contamination by liquid mustard gas should be removed at once and until it can be decontaminated so disposed of that it does not become a source of danger to others.

Contamination of the skin, whether by liquid or vapour, should be dealt with as follows:—

(i) The contaminated areas should be thoroughly washed with soap and water, a nailbrush being used on the less tender parts of the skin. Two or more changes of water should be used, according to the degree of contamination, and care should be taken to avoid spreading the contamination by the nailbrush, which should be rinsed frequently.

(ii) Bleaching powder can also be used to neutralise contamination. It should be smeared over the affected parts in the form of a stiff paste or, better still, as an ointment made of equal parts of bleaching powder and vaseline. The paste or ointment should not be left in contact with the skin for more than 5 minutes. In some persons repeated prolonged application will give rise to an inflammatory condition of the skin.

If these methods of treatment can be applied immediately after contamination, within one minute, they will completely prevent burns; but, even if unavoidable delay has occurred, their application will materially mitigate subsequent injury by removing any mustard gas which has not penetrated the skin.

All persons who have been exposed to the vapour of mustard gas should have their eyes washed with a solution of one teaspoonful of salt to one pint of water or, if this is not available, with plain water.

(b) *Curative Treatment.*

If injuries have developed, the patient should be brought to a medical officer without delay, but the following first-aid measures may be adopted in addition to removing contaminated clothing and bathing as described above:—

After washing the eyes a drop or two of liquid paraffin or castor oil should be instilled between the eyelids to prevent their sticking. Great care should be taken not to rub the surface of the eye.

If blisters have developed, they should be covered with clean dressings and an endeavour should be made to prevent them from bursting until they can be treated by proper surgical means.

APPENDIX III.

DECONTAMINATION OF MATERIALS.

Removal and destruction of mustard gas.

Materials contaminated by liquid mustard gas may be dealt with in the following ways:—

(1) By weathering.—If the contaminated area or material is left alone, the effects of sun, air and rain will eventually remove the mustard gas.

(2) By washing.—Mustard gas may be removed from the surfaces of contaminated objects by hosing them with water or by swabbing them with paraffin.

(3) By burning.—Mustard gas may be destroyed by burning, but care must be taken as the vapour which is given off is dangerous.

(4) By evaporation.—This may be assisted by heat, as in a disinfecter.

(5) By hydrolysis.—This is generally effected by boiling in water or by exposure to steam, but cold water will decompose mustard gas slowly.

(6) By chlorination and oxidation.—This is effected by chemicals, of which the most common is bleaching powder or chloride of lime.

Bleaching Powder.

This is a white powder, which must be kept dry and preferably in light-tight, air-tight containers. It must also be stowed in a cool place. The powder can be used either as it is, or mixed with water to the consistency of paste or cream. The paste should be used within a few hours of mixing, as it does not keep well.

Bleaching powder reacts strongly with liquid mustard gas and, if directly applied, sufficient heat will be generated to drive off dangerous vapour. For this reason, bleaching powder is always mixed with sand or earth or diluted with water before it is applied to liquid mustard gas.

Men working with bleaching powder should wear respirators, owing to the irritating effect of the powder on the eyes and nose.

1. Clothing.

Clothing contaminated by mustard gas vapour may be decontaminated by airing in the open for 12 to 24 hours, or by the methods below (or by treatment in the steam disinfecter for 10 to 15 minutes in ships where this is fitted).

All clothing contaminated by liquid mustard gas may be decontaminated by boiling. Cotton and linen fabrics may be boiled for half an hour, oilskins for half an hour, rubber boots for two hours. Since respirators have to be dismantled for decontamination by boiling, it is recommended that they should be left until reaching port.

As woollens and leather goods are liable to shrink when boiled they should be either weathered or destroyed if the amount of mustard gas liquid on them is large.

Leather boots if treated with bleach paste will be practically safe so far as the soles are concerned, but if the uppers have had liquid mustard gas on them they must be considered dangerous after half an hour. Leather boots can be decontaminated by baking, but as this treatment will completely ruin the boots unless carried out under special precautions, it is recommended that they should be left for decontamination on arrival in port.

Oilskin suits, if treated with care, may be boiled about six times without injury to their protective qualities.

Oilskins should be boiled as soon as possible after they have been contaminated. Before boiling, any liquid mustard gas or bleaching powder on the surface of a contaminated oilskin should be removed by hosing with water.

Where possible the tank or bath used for boiling should be placed on deck in the open air, preferably

in the after part of the ship, as the fumes from boiling contaminated clothing are dangerous, and precautions should be taken to protect persons who may come in contact with them.

2. Other Materials.

Weathering.

Many materials can be decontaminated by sufficient exposure to sun, air and rain, but the time required to complete this process depends upon the atmospheric conditions and upon the nature of the material. Weathering is quicker in hot weather than cold. In warm, temperate weather, exposed areas will generally become safe, for all practical purposes, within one week. In cold weather it will be twice as long. Enclosed spaces must be completely decontaminated before it is safe to use them again. In enclosed spaces, such as cabins, with normal ventilation, vapour ceases to be given off from contaminated paintwork after three weeks of warm weather.

Wooden decks.

Mustard gas penetrates a dry deck more readily than a wet one, and if water can be kept running over a deck, it tends to wash off the gas before it can penetrate. If mustard gas has penetrated a wooden deck, the following method of decontamination will render the decks reasonably safe and should be followed as far as possible with the resources available:—

(1) First swill the contaminated area with water, in order to remove the unabsorbed liquid mustard gas.

(2) Cover the area with a mixture of two parts of bleaching powder to one of sand, with enough water to make a thin cream, and scrub this vigorously into the deck with long-handled scrubbers, every part of the deck receiving this treatment for about fifteen minutes. Spread the

mixture as evenly as possible over the surface, adding more, if this appears necessary, and leave it in position for at least two hours, but for twenty-four hours if possible.

(3) Hose off the mixture after twenty-four hours and the deck will be decontaminated for all practical purposes except for lying on and walking on with bare feet.

(4) Complete decontamination will necessitate scraping out the pitch from the seams and application of bleach paste for forty-eight hours before renewal of pitch.

As soon as a deck is covered with decontaminating mixture, it ceases to give off vapour and can safely be used as a gangway.

Steel Decks.

Steel decks should be hosed down and then scrubbed with bleach and sand, as for wooden decks. The mixture should be left in place for at least two hours and preferably for twenty-four hours, before it is hosed off. Rusty areas should be scrubbed repeatedly with bleach paste and sand.

Unpainted metal work and machinery.

This may be decontaminated in the following ways:—

The mustard gas (and any oil or grease into which it may have penetrated) may be swabbed off with rags or cotton waste soaked in paraffin. Swabs should be thrown overboard after use.

Internal paintwork.

A thick paste of bleaching powder and water should be applied to the surface of the paintwork. This prevents vapour from being given off while the paste is in place. It can be best applied to vertical and overhead surfaces by pasting newspaper over them with bleach mixture, so as to form a bleach seal, which should be left in place for at least seven days.

Wooden fittings.

Wooden fittings should be scrubbed with bleach paste and sand and other precautions taken as for wooden decks.

Canvas, unpainted and painted.

Unpainted canvas covers should be boiled for half an hour in water, to which a little washing soda ($\frac{1}{2}$ oz. to one gallon) should be added to prevent the canvas rotting. This will render them safe to handle. Unpainted canvas should be safe to handle after being weathered for a week in hot weather, but it should not be stowed in a confined space until a much longer period has elapsed. Painted canvas will take longer to weather.

Rope, Hemp and Coir.

If rope has been heavily contaminated, it should be destroyed, as the mustard gas will remain in the core of the rope and will rot it. If rope has only been lightly sprinkled with mustard gas, it may be left to weather for a week in hot weather, which will not appreciably reduce its strength. Small rope may be decontaminated by boiling. It is preferable in cases of doubt to destroy and replace rope which has been contaminated.

Wire Rope.

Wire rope should be thoroughly wiped over, two or three times, with waste soaked in paraffin and may then be handled after twenty-four hours.

APPENDIX IV.

ACTION RECOMMENDED IN CASES OF CONTAMINATION OF DIFFERENT KINDS OF CARGO BY MUSTARD GAS

NOTE "A."—For the purpose of this table goods may be considered as "grossly contaminated" when there are definite signs of liquid drops on the surface of the article.

NOTE "B."—In view of the importance of most cargoes, especially grain, and the difficulty of separating contaminated grain from the remainder when in bulk stowage, special precautions should be taken when loading or discharging to obviate contamination. Only the minimum number of hatch covers necessary for working the cargo should be removed and arrangements made so that both hatch covers and tarpaulins can be replaced as quickly as possible in the event of a warning being given.

Type of Cargo.	Possibility of Decontamination by Weathering.	Method of Decontamination Advocated.	Action Recommended.
Bulk Cargo— Timber ...	No ...	No satisfactory treatment	The upper layers, which have been wetted by mustard gas, should be marked and set aside in the open for use in exposed situations where danger from contact will not arise. Failing this, the upper layers should be burnt. In the case of bulk timber it may be

Wood pulp ...	No	...	...	Ditto ...	...	Lightly contaminated pulp can be handled under precautions and utilised in paper-making. The process of pulping in solution will effect adequate decontamination. Grossly contaminated layers should be destroyed by burning.
Coal and Coke	No	...	...	None ...	...	Coal and coke should be put on one side and used for selected purposes, boiler furnaces, &c., where it will be stored in the open and loaded into closed fire boxes.
Locomotives and large machinery	No	...	...	Swabbing down with rags soaked in paraffin.		Set aside until satisfactory decontamination measures have been taken, then put into normal use.
Steel plate sections, girders and pig-iron	Yes	...	...	Thoroughly hose down and allow one month's weathering		Put into normal use after decontamination, as described.
Meat and fruit cargoes	No	...	...	No satisfactory treatment		Any meat or fruit which has been definitely contaminated with mustard gas must be considered as unsafe for consumption, and should be destroyed. Obviously such action is only necessary in the case of exposed layers.
Grain ...	No	...	...	No satisfactory treatment		Contaminated grain will have to be destroyed.

Type of Cargo.	Possibility of Decontamination by Weathering.	Method of Decontamination Advocated.	Action Recommended.
Bulk Cargo— <i>cont.</i> Stone, sand and shingle	Yes; very gradually	No treatment necessary	Provided this material is intended for use in buildings or exposed surfaces, no treatment is necessary unless the contamination has been very gross. In the latter case the contaminated layer should be unloaded under precautions and placed in an isolated position, where it can be thoroughly hosed down. It should then be left to weather for at least a month.
Salt cargoes...	No ...	No satisfactory treatment	Remove and destroy the top layer which has been contaminated.
Nitrates ...	No ...	Ditto ...	Ditto.
Cargo in bales— Jute, hemp, cotton and wool	No ...	Ditto ...	Remove and destroy wrapping and outer layer of contents.
Wood pulp ...	No ...	Ditto ...	Remove and destroy wrapping and treat pulp as indicated on p. 37 above.

Canvas	...	Yes; in considerable time	Boiling in water for 30 minutes	Remove and destroy wrapping and immerse contents for 30 minutes in boiling water containing 1 lb. of washing soda per 30 gallons, or, in the absence of such facilities, hang up in the open air for two weeks.
Cork	...	Not readily	No satisfactory treatment	Remove and destroy wrapping, and put aside contents of exposed bales in a place where they can be allowed to weather for one month. This material should be used for selected purposes, but not food-stuffs.
Hides	...	No	No satisfactory treatment for gross contamination	Grossly contaminated hides should be destroyed. Lightly contaminated hides can be submitted to tanning treatment under precautions and such treatment will result in adequate decontamination. (See note "A" above).
Bagged Cargo— Grain	...	No	No satisfactory treatment	Any bags of grain which have been contaminated by liquid mustard gas, or have been in contact with bags so contaminated, will have to be destroyed.
Sugar, flour, coffee beans, cocoa beans	...	No	No satisfactory treatment for gross contamination	If there is evidence that bags of these food-stuffs have been contaminated with mustard gas, those bags and their contents will have to be destroyed.

Type of Cargo.	Possibility of Decontamination by Weathering.	Method of Decontamination Advocated.	Action Recommended.
Crated Cargo— Small pieces of machinery and manufactured articles	No 	Swab down the articles with rag soaked in paraffin	The crates will need to be destroyed, and if there is any indication that the machinery or manufactured articles have become contaminated, they will require decontamination by paraffin as indicated.
Food - stuffs, Fruit and chemicals	No 	No satisfactory treatment	If the containers are watertight and the contents can be removed immediately after contamination, the contents should not be affected ; if this is impossible then they should be destroyed. Immediate removal of the contents is essential and the crates or casks will need to be destroyed.
China and glass	Yes ; slowly ...	Thorough washing under precautions	The crates will require to be destroyed, but obviously the contents will not be affected.
Matches ...	No 	No satisfactory treatment	The containers should be removed and destroyed and if the mustard gas has penetrated the contents will also have to be destroyed. If the mustard gas has not penetrated into the containers the matches can be utilised in the normal way

Remove and destroy outer crates.
Treat drums as indicated.

This depends upon the degree and time of contamination. If the contamination is quite recent, the casks will not have been penetrated and the contents can be removed to new containers and will not be affected. If the contamination has been gross and is of some duration, the contents will not be fit for consumption. In this case the casks will be put aside so that the contents can be distilled for the preservation of the spirit.

The outer crates should be removed and destroyed. Where there is evidence that the mustard gas has penetrated the inner containers the contents will have to be destroyed. It is usual, however, for tea to be packed in wooden boxes containing a solid inner lead lining. In the event of the wooden cases being lightly contaminated by spray, it is unlikely that the contents of the inner lead lining will be affected.

The outer coverings should be removed and destroyed, and, where there is evidence that the mustard gas has penetrated the packing, the contents should be destroyed.

Paint	...	Yes; if contained in iron drums	Wash drums and allow to weather for one week
Beer, wines, and spirits	...	No	No satisfactory treatment
Tea	...	No	No satisfactory treatment
Tobacco	...	No	No satisfactory treatment



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