Protection against Gas and Air Raids

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Passive Air Defence

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(Provisional)

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CHAPTER I.

INTRODUCTORY

1. Necessity for and objects of passive air defence

Attack from the air may take the form of bombing, gas-spraying, machine gun fire or a combination of any of these. Bombs may be high explosive, incendiary or gas. The most effective form of attack against towns, and therefore the most probable, is the use of high explosive and incendiary bombs.

The psychological effects of an air raid are often out of all proportion to the material results. Noise, ignorance, surprise, suspense and false rumours all contribute to produce panic, a factor which may enable the enemy to effect great damage to morale.

Some hostile aircraft must always be expected to penetrate active air defences, no matter how powerful the latter may be. Further, the range of modern aircraft is such that no place can be considered to be immune from attack.

Everything possible must accordingly be done by discipline and by careful training and organization to minimize the effect of a hostile air attack when it comes. Knowledge of the proper course to adopt and the provision of mental and manual occupation will go far to counteract any tendency to panic.

The measures adopted with these objects in view are known as "Passive Air Defence".

Arrangements for P.A.D. are designed to minimize the possible effects of air attack as follows:

i. The prevention of panic by prior education, training and organization.

   ii. The protection of personnel against high explosive by dispersion, by the provision of trenches and shelters and arrangements for their orderly occupation, and by improvements to the protection offered by buildings.

   iii. The prevention or localization of fires by the training of individuals in the immediate steps to be taken to deal with incendiary bombs, by the provision and proper distribution of fire fighting appliances, by ensuring that an adequate water supply is always available at all essential places, and by the organization of a proper fire fighting service.
iv. The protection of personnel against gas by educating them with regard to its characteristics, by arrangements for individual and collective protection, by training in the treatment of gas casualties and by providing an organization to deal with them. (See Chapter V.)

v. The maintenance of vital services (water, food, transport, communications, etc.) by material protection, where practicable, and an organization providing for emergency services, the repair of damage and for decontamination.

vi. The provision of an adequate warning system to ensure that personnel are prepared when the attack is delivered and to give them confidence at other times to continue their normal occupations. In order to avoid unnecessary disturbance of normal conditions, warning signals will be given only to those districts which appear likely to be affected by a forthcoming raid. (See Sec. 11.)

vii. The provision of a medical organization for the collection of casualties and their treatment. (See Chapter VI.)

CHAPTER II.

ORGANIZATION OF P.A.D.

7. Air raid wardens

1. Appointment.—Any organization of personnel which is to work efficiently and without panic in times of crisis requires subordinate leaders and commanders. It is essential for these leaders that they should be well trained, should have a thorough knowledge of the plan of their superiors and that they should be well acquainted with those under their command.

Air raid wardens should be of good character, level headed and free from physical or temperamental disability. They should have a keen sense of responsibility and be of a type to inspire confidence among others. In the case of military units, the duties of air raid wardens automatically devolve on officers and N.C.Os. and special appointments will usually be unnecessary as far as military personnel are concerned, but, where there are married families, special wardens will be required and the training and appointment of senior and reliable women should be considered.

A woman who has personal care of children should not, as a rule, be considered for this duty.

In semi-military and civilian establishments, special appointments will be necessary. The question of appointing women to such posts where there are a large number of women employees must be decided locally, but such personnel as superintendent typists, welfare superintendents, forewomen, etc., would be suitable for controlling female staff.

The area with which one warden can deal with varies widely according to local conditions.

As a rough guide, one warden will be required for each building or group of buildings and one for each refuge. In many cases one warden can function in both capacities.

In large W.D. establishments the appointment of head wardens, and in some cases of a chief warden, may be necessary.

Reserves should be trained.
2. Duties.—The duties of wardens will normally include the following:—

   At all times

i. To have a thorough knowledge of the P.A.D. scheme, their duties under the scheme and the personnel for whom they are responsible.

   In peace time

ii. To train personnel in the action to be taken during a raid. All personnel not detailed for duties outside must take cover in the shelters allotted to them.

iii. To fit personnel in their charge with respirators and to keep a roll of names and sizes required.

iv. To train personnel in the use of the respirator and other means of individual protection against gas.

   During a state of emergency

v. To issue anti-gas equipment, and to test and inspect it from time to time.

vi. To ensure that any shelters for which they are responsible are fit for immediate occupation in all respects.

   During an air raid

vii. To prevent panic by personal example and the issue of orders.

viii. On the air raid warning being sounded, to direct personnel to their shelters and ensure they remain there until the All Clear signal is given.

ix. To check from a previously prepared list that all persons who should be in a shelter are present or satisfactorily accounted for, and that shelters are not overcrowded by persons who should be sheltering elsewhere.

x. In the absence of look-outs, to report to headquarters the fall of bombs in their vicinity, which necessitate immediate action.

xi. To ensure that the gas protective measures of the shelter are adequate and properly adjusted.

xii. If gas is in their immediate locality to sound the gas alarm.

xiii. To assist in dealing with casualties or damage after bombs have fallen.

xiv. To ensure that the situation is safe before personnel are allowed to leave the shelter.

3. Equipment.—Air raid wardens will be equipped with anti-gas clothing, steel helmets and service respirators. They will wear a distinguishing badge and should be in possession of an electric torch. Detailed scales of equipment are given in Appendix V.
CHAPTER III
PROTECTION AGAINST HIGH EXPLOSIVE BOMBS

15. Description

There are three main types of high explosive (H.E.) bomb.

1. The armour piercing or semi armour piercing bomb.— This is designed for the destruction of specially protected or deep targets and requires a strengthened case to give it the necessary penetration and a delay action fuze to ensure that explosion does not take place until penetration has been effected. Bombs of this type can only obtain their full effect by a direct hit and, if they fall on open ground, produce a large crater but cause only local damage. The heavier bombs (over 500 lb.) are generally of this type, and by reason of their weight, the number which can be carried by an aeroplane is small in comparison to other types.

2. The anti-personnel bomb.—This is designed primarily for attacks on personnel and produces its effect by blast and splinters over a wide area. As cratering would reduce this effect, penetration is not required; in consequence bombs of this type have a lighter case and are normally fitted with instantaneous fuses. Such bombs have only slight powers of penetration and little cover is necessary to give protection against them. They are intended for attacks against troops and personnel in the open, and will generally be light in weight (up to 50 lb.) but used in large quantities.

3. The general purpose bomb.—This is a compromise between the two types described above and may be of any weight and with or without some element of delay in the action of the fuze. Such bombs are ineffective against specially protected or deep targets and are designed to produce effect mainly by blast. They will penetrate the upper floors of buildings and explode inside, or may demolish buildings by their blast effect should they explode on the ground outside. For this purpose, bombs of intermediate weight (50 to 500 lb.) are most probable.
2. Trenches.—The following principles apply to the construction of trenches:

i. Where trenches have not already been constructed, any intended site should be kept clear or in a state in which the trenches can be very quickly prepared. The necessary tools should be readily available.

ii. When siting the trenches the problem of drainage should be considered. Soft or wet ground or ground liable to flooding should be avoided. Entrances to trench systems should be carried below the level of the floor of the trench to prevent flooding, and arrangements made for emptying the sump thus formed. Drainage should also be provided in the trenches themselves by sloping the bottom towards sumps situated at intervals. Floor boards should be provided.

iii. In order to localize the effects of an explosion, trenches should not be straight. They should be either zig-zag or traversed, with not more than 10 yards between angles or traverses. Lines of trenches should be not less than 15 yards apart. Typical traces of trenches are shown in Fig. 2.

iv. Trenches should have a total depth of 6 ft. 6 in. from floor to the top of the parapet, if open, or at least 6 ft. headroom if covered, a width of not more than 3 ft. at the bottom, and a seat along one side only. Sides of trenches should have a batter of 5/1 and be revetted by one of the methods described in the Manual of Field Engineering, Vol. 1 (All Arms). A suitable form of support for the revetment is a large A frame 6 ft. 6 in. high, strutted across the top, for every 2 ft. run of trench. Corrugated iron for subsequent overhead cover can be laid on top of these struts. If more permanent construction is required the work should be carried out by Royal Engineer or Works Services.

v. Trenches should be dug so as to balance "cut" and "fill", the parapet being not less than 2 ft. 6 in. thick at the top of the A frame, and allowing for overhead covering of between 9 in. and 12 in. of earth on top of the corrugated iron. In level ground this will mean digging to a depth of about 5 ft. 3 in. A typical section of a revetted and covered trench is shown in Fig. 3 (page 26).

vi. Trench systems should have entrances sited with reference to exits from the buildings they serve. Access should be provided by steps or ramps and entrances to covered trenches gas-proofed as described in Sec. 34. In long systems gas-locks at intervals will be required so that damage to one portion of the system will not render the whole untenable.

vii. Accommodation can be provided either by seats along one side of the trench or in chambers leading off it. The size of such chambers in relation to the number of people who have to be accommodated is calculated in Sec. 35. Chambers will require revetting and roofing in a manner similar to that described above, the roof framework being designed to suit the size of the chamber.

Fig. 2.—Trench shelter system.
21. Protection of buildings against H.E. bombs

i. Performance of bombs.

i. Angle of descent.—A properly designed bomb falls at an angle to the vertical depending on the speed and height of the aircraft at the time of release. The angle may be as much as 40 degrees from the vertical in the case of release from a low height, and consequently the walls of the building may be struck as well as the roof. Overhead protection would therefore have to project beyond the walls to give security.

ii. Penetration.—The penetration of a bomb depends on its weight, design and the height from which it is released.

iii. Splinter effect.—On detonation splinters are violently projected in all directions. The majority fly at right angles to the axis of the bomb and may cover a zone from the horizontal up to an angle of about 60 degrees. The splinter effect of bombs which penetrate into the ground before detonation is reduced considerably by the surrounding earth; it follows that the softer the ground round a building, the better it is for the purpose of defence.

Assuming well-designed bombs with similar proportions of explosive to weight, the velocity of the splinters is, for all practical purposes, independent of the size of the bomb, as also is their maximum penetrative power.

iv. Nature of blast.—The explosion of a bomb produces a very intense pressure wave in the air which is of extremely short duration and travels very rapidly; this is generally followed immediately by a suction wave. The object struck by the pressure wave, if not strongly constructed and well supported, may be shattered or pushed over, or it may be pulled towards the source by the succeeding suction wave. Buildings are constructed to withstand outside pressure from wind, but internal pressure which would have effects similar to the suction wave are not as a rule considered. For this reason it is often the suction wave which causes the greater damage.

This blast effect is widespread but also variable according to the surroundings; in an enclosed space the effect is greater than in the open with few obstructions. The pressure wave is more or less evenly distributed about the point of detonation and generally has a somewhat upward tendency. A structure that can withstand or absorb the pressure wave will give a degree of protection to one in rear of it, though it will not necessarily give protection against the succeeding suction wave. Well constructed buildings, such as are provided in permanent barracks, will give very fair protection against the blast from bombs up to 500 lb. detonating 50 ft. or more from the building.

v. Earth pressure.—The earth pressures produced by bombs after penetration into the ground are similar to those produced by small mined charges. They may damage buried water mains, drains, cables, etc., in the immediate vicinity, but little damage should be caused except in the case of the heaviest bombs. Similarly the effect on the stability and structure of buildings at 50 ft. would be very small.
CHAPTER IV.
INCENDIARY BOMBS AND FIRE FIGHTING.

24. Incendiary bombs

1. Description.—Incendiary bombs may be designed for single or multiple effect. The single effect bomb produces one fire centre; the multiple effect bomb on explosion throws out a number of fire producing units, which are similar in action to the single effect bomb.

The type of incendiary bomb most commonly produced is the small electron bomb consisting of a thick-walled magnesium tube filled with an ignition composition, which is usually "Thermite" though other substances may be used.

When the bomb strikes, this composition is fired and burns fiercely at a high temperature for about one minute, melting and setting fire to the magnesium casing. The molten magnesium, which is the real danger, burns less fiercely than the Thermite, but will continue to do so for about 15 minutes.

2. Powers of penetration.—Incendiary bombs may be of any weight from 2 lb. to 50 lb., or even more. An indication of their powers of penetration is given in Sec. 21, 2, i. A small bomb (2-lb.) falling from 5,000 feet will penetrate normal roofing materials and a plaster ceiling below, unless it falls immediately above a joist, but is unlikely to penetrate a boarded floor.

If not extinguished or removed, an incendiary bomb may burn through a wooden floor and possibly through further surfaces, causing a succession of fires.
26. Methods of dealing with small electron incendiary bombs

1. Action of the bomb.—The mechanism of a normal incendiary bomb has been explained in Sec. 24.

For about one minute after impact the composition used for igniting the magnesium case will be burning inside the bomb.

This action cannot be arrested since the composition is protected by the casing and burns so fiercely, producing its own oxygen, that neither sand nor water will extinguish it.

Although the bomb may appear active, hissing violently and throwing off small fragments of molten metal, little damage is done to surrounding material at this stage.

It is not until the ignition composition has burnt itself out and the magnesium case itself starts burning that the bomb attains its full capacity as a fire producing agent.

During the second stage it can be extinguished by either of the approved methods described in paras. 3 and 4 of this section.

Though the glare, heat and danger from spluttering of the normal incendiary bomb have been generally exaggerated, fire-fighting may be complicated by acrid fumes and smoke given off by the bomb and by burning materials, which are unpleasant in a confined space though not usually dangerous.

2. Methods of fighting.—There are two methods of dealing with an incendiary bomb. The first is to smother it with sand and then remove it to a safe place (The "sand" method); the second is to play a fine spray of water on it, causing it to react more violently and burn itself out in a comparatively short time. (The "water" method.)

Whichever method is employed it is vitally important that the bomb should be neutralised before the fire has spread.

The "sand" method is more suitable—

i. if the bomb can be reached before surrounding materials have caught fire; and

ii. if the bomb falls in close proximity to stores which might be damaged by the spluttering caused by the "water" method.

The "water" method is more suitable if the fire has spread and if there is no danger to stores from spluttering.

Facilities for using both methods must be available.

3. The sand method.

i. The operator, wearing anti-gas eye-shields and carrying a G.S. shovel and bucket filled with sand, approaches the burning bomb.

ii. He tips 1/2 of the sand on to the floor about two yards from the bomb, retaining 1/2 of the sand in the bucket.

iii. Using the shovel, the operator places the sand from the floor round and on top of the bomb. (The bomb can be approached to within one yard without difficulty and the sand should not be thrown on to the bomb from a distance.)

iv. The operator shovels up the bomb and places it in the bucket (the sand retained in the bucket prevents the bomb from burning through the bottom, though the sides of the bucket may be slightly damaged).

v. By placing the shovel under the handle of the bucket the operator carries it away to a safe place.

4. The water method.—A fine spray of water played on the bomb causes it to react violently and burn itself out in a comparatively short time.

For this method two operators are required to handle the equipment which is a hand stirrup pump and hose fitted with an immediate change-over nozzle for spray and jet.

The first operator directs the water and the second works the pump.

The first operator, wearing a pair of anti-gas eye-shields, approaches the bomb and first extinguishes any surrounding fire by playing a jet of water on it. This jet should not be used on the bomb itself which must be extinguished with the spray as soon as the material fire has been put out.
Considerable spluttering takes place but this is invariably in a direction away from the operator and the resulting molten fragments do very little damage to surrounding material.

Anti-gas eye-shields give complete protection to the wearer's eyes against these fragments.

It is quite unnecessary to equip the operators in either of these methods with dark glasses or any form of shield from heat.

Hedging gloves and anti-gas eye-shields should however be worn to give confidence to the operator.

27. Individual fire fighting

1. For individual fire fighting "fire points" will be organized. At these fire points small fire fighting equipment will be stored.

2. An ordinary fire can be put out with water, which should be applied with force to the seat of the fire. A fire resulting from an incendiary bomb is an ordinary fire. It is only the bomb itself which requires special treatment.

3. The following simple rules apply to fire fighting generally:
   i. Any person discovering a fire should endeavour to put it out personally. If this is impossible help should be summoned from the nearest police post, look-out, air raid warden, fire party or by telephone. Where assistance is summoned by telephone a guide should meet the fire party.
   ii. Gas in the house should be turned off at the main.
   iii. Doors and windows should be kept closed. If room doors are left open, the staircase will act as a flue and the fire will quickly spread.
   iv. If it is necessary to open a door leading to the seat of the fire care should be taken to prevent it from flying open.
   v. By keeping close to the wall, it is often possible to move in safety in rooms and passages and on staircases which have been weakened by fire.
   vi. When approaching the fire centre a stooping posture or even a crawl should be adopted if necessary, as the smoke and fumes will be less thick near the floor.

4. Any occupants of the building, if in danger, who are not required to assist fire fighting should be evacuated. This evacuation will be superintended by the air raid warden who will see that all have their respirators with them and will conduct them to the nearest available shelter.
34. Methods of gas proofing.

1. General.—When an air attack is imminent, shutters, where provided, will be fixed in window frames. Complete protection against the entry of any type of gas can be obtained by the gas proofing methods described below. Should a gas proof room be holed by blast or splinters, it may be possible to preserve the gas proofing by the use of extra material held in readiness inside the building. Should this be impossible respirators should be used to give protection.

2. Windows.—As windows should be opened the provision of inside gas proofing is necessary.

Fig. 4 (page 51) shows one method. Gas proofing material (cloth, union, anti-gas; blankets; closely woven carpets; cotton or linen sheets backed with strong brown paper, etc.) of a size to overlap the whole window should be held in place at the top by a wooden batten. When not in use the curtain may be rolled up to this batten and held in place by strings. Spare battens cut to size with the necessary screws or nails should be available for holding the bottom and sides of this curtain against the window frame.

In the case of iron framed windows, the bottom and sides of the curtain when in use should be fixed to the wall with adhesive tape 2 in. to 4 in. wide.

Treatment of the gas proofing material with heavy oil will increase the protection, water should not be used for this purpose as it is only temporarily effective and increases the humidity in the shelter.

Improved protection against both gas and glass splinters is given by a frame of iron or wood which will fit accurately on the inside of the window. Over this frame may be placed galvanized iron sheeting, ply wood, or blanket material supported on both sides by small mesh wire netting. The frame should be provided with strips of felt or other material to ensure close contact with the window frame. Wedges or bolts with butterfly nuts should be available for fixing this frame quickly in position.

3. Doors.—Doors may be rendered gas proof by fixing strips of suitable material (felt, rubber, baize, blanket) all round the edge of the door or door frame: a wooden strip may be necessary in addition at the bottom of the door.

Alternatively doors may be treated in a way similar to that recommended for windows, with the following modifications:—The gas proof curtain should be outside the door;
the batten on the handle side of the door should end about 5 feet from floor level to allow the blanket to be raised by a person using the door; about 1 foot of blanket should be left trailing on the floor and a weight should be fixed to bring the blanket back into place after the door has been used. In cases where the door opens outwards, the material forming the curtain should be increased to allow for this (see Fig 5).

4. Air locks.—In all gas proofed shelters entrances which may have to be used during an air raid should be fitted with "air locks." These are compartments with two gas proof doors or curtains through which a person entering or leaving the shelter must pass. By having one or other of these doors closed the direct passage of air from outside into the shelter can be prevented. Gas entering the air lock will be diluted to such an extent that when the inside door is opened, any gas entering the shelter will be so weak as to be harmless. For this reason, the larger the space inside the air lock the greater the protection it will give.

Fig. 6 shows one method of construction, by setting up two blanket curtains across the entrance passage. The curtains should be at least 4 feet apart; 10 feet should be aimed at to give greater protection and to allow for a stretcher case with bearers to enter. The best arrangement is for the blankets to rest on inclined frames to ensure a close fit.

Fig. 5.—Gas protected door.

Fig. 6.—Air lock.

Note.—Frame 4 in. by 1 in. timber covered with anti-gas material sloping at 20 degrees from the vertical.

Laths on the underside 1 ft. shorter than those on the front. Lowest laths 4 in. from the ground.

Any wires or pipes to pass through the frame and made gas tight.