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CIVIL DEFENCE COMMITTEE

CIVIL DEFENCE AND THERMO-NUCLEAR WEAPONS

THE PROBLEM OF FALL-OUT

Memorandum by the Experts

INTRODUCTION

1. In document AC/23(CD)D/98 the broad problems caused by thermo-nuclear weapons were considered in their relation to Civil Defence planning. It was stated, however, in paragraph 5(a) that information in regard to fall-out was incomplete and, in consequence only a passing reference was made to its effects.

2. Since this paper was written, further information on this subject has been released by the United States Atomic Energy Commission (CD/JH/55/286), and although the data is not yet complete there is enough to enable the broad effects of this phenomenon to be assessed.

3. It is the object of this memorandum, which should be regarded as supplementary to paper AC/23(CD)D/98, to state briefly the problem created by fall-out and to examine its impact on Civil Defence and other kindred measures.

PART I - THE THREAT

THE EFFECTS OF FALL-OUT RADIATION

(a) General

4. As stated in the Atomic Energy Commission's latest statement "a nuclear detonation produces four major characteristics - blast, heat, immediate nuclear radiation and residual radioactivity. Of these, the first three are essentially instantaneous, while the fourth has a more protracted effect."

5. It is with the fourth of these characteristics that this paper is concerned. It is of great importance that this residual radioactivity is not confused with immediate nuclear radiation. They present two distinct problems. "Immediate nuclear radiation" (i.e. the neutrons and gamma rays) "does not present a serious hazard beyond the area where heat and blast are of great concern", to quote the AEC report again; whereas "particles with residual radioactivity produced by a detonation may fall out over an area much larger than that affected by blast and heat, and over a longer period of time."

6. This residual radioactivity or fall-out radiation will not be a hazard where the detonation of the bomb takes place at such a height that the fireball does not touch the ground.

7. It will be a hazard where the detonation takes place:

- (a) sufficiently low down, so that the fireball touches the surface of the ground; the closer the burst to the surface the greater the contamination;

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- (b) sufficiently low down so that the fireball touches the surface of water (sea or fresh);
- (c) under water.

8. It is dangerous to generalise, because the effects and the areas affected under (a), (b) and (c) will not be the same; and even the nature of the earth on which the detonation takes place will influence the results. It may be said, however, that broadly there will be an area of extreme radio-active contamination and a much larger area of some hazard.

9. Information in regard to the special effects created by detonations under (b) and (c) has not yet been made available in any detail. But it may be said that the main significance of the sea is that it quenches the heat of the explosion so that the fall-out is not lifted to the same altitude and comes down in an intensive fashion around the point of burst. The total area affected will probably not, therefore, be so large as with that of a ground burst, with which this paper must, for the reasons just stated, be more concerned.

(b) The Fall-Out Pattern

10. "In general terms, the region of severe fall-out contamination of a thermo-nuclear weapon fired on or near the surface can be described as an elongated, cigar-shaped area extending down-wind from the point of burst." (A.E.C. statement).

11. On the basis of the experience of the 1954 Bikini test, this cigar-shaped area extended for approximately 220 statute miles down-wind and varying in width up to 40 miles. In addition, there was a contaminated area up-wind extending possibly 20 miles from the point of detonation. It is, however, pointed out in the A.E.C.'s report that, due to a change of wind, this estimated contour of the fall-out pattern is based partly on actual measurements and partly on extrapolation.

12. A rough diagram of the fall-out pattern is attached as an appendix.

THE EFFECT ON PERSONNEL

13. The following deductions have been drawn by the A.E.C. as to the effects on persons taking no protective measures at all, i.e. the worst case:-

- (i) All persons in the down-wind belt approximately 140 miles long and of varying width up to 20 miles would have their lives seriously threatened.
- (ii) At a distance of about 160 miles and along the axis of the ellipse the amount of radio-activity would have seriously threatened the lives of about 50% of the persons in that area.
- (iii) Near the outer edge of the cigar-shaped area, or approximately 190 miles down-wind, the level of radio-activity would have seriously threatened the lives of 5 to 10% of the persons in that area;
- (iv) At a distance of 220 miles or more down-wind, it is unlikely that any deaths would have occurred.

14. In other words, an area of about 7,000 square miles of territory down-wind from the point of burst would become so contaminated that survival of persons might have depended upon prompt evacuation of the area or upon taking shelter and other

protective measures.

15. The AEC comment on these figures that "the estimates do not apply universally throughout the contaminated area inasmuch as the intensity of radio-activity within a region of heavy fall-out will vary from point to point due to such factors as air currents, rain, snow and other atmospheric conditions." Because of this and because most persons, if given sufficient warning, would probably evacuate the area or take shelter and other precautionary measures, the actual percentage of deaths might be smaller than these extreme estimates, though a reduction in one area might mean a larger dose somewhere else.

16. It is important to remember that the area which may be affected will be subject to considerable variation, especially since the radio-active cloud will rise with great rapidity to heights of 80,000 feet and over. And also, as has already been stated, the fall-out will be governed by the type of soil and other factors, some of them atmospheric.

17. Given a knowledge of wind directions and velocities up to high levels and meteorological conditions at the time, it will usually be possible to predict the fall-out region with considerable accuracy. The actual pattern and the degrees of contamination in the different areas can, however, only be determined precisely by ground observers equipped with the appropriate radiac instruments.

PART II - THE CIVIL DEFENCE PROBLEM AND ITS IMPLICATIONS

INTRODUCTION

18. It is clear from what has been said in Part I that the addition of fall-out to the other hazards of thermo-nuclear warfare has created some fresh problems for Civil Defence and, indeed, in the fields of civil emergency planning. In this part of the memorandum, therefore, an attempt is made to assess broadly the most important of these effects and their general implications in relation to the problems in hand.

WARNING ARRANGEMENTS

(a) General

19. The first and, perhaps, most important need is to provide warning to the areas which may be affected by the fall-out. Because of the considerable distances which the radio-active cloud can travel, and from which dangerous deposits can be experienced, there is a clear necessity not only for a national warning, but at times also for an international one.

(b) National Warnings

20. The arrangements for the issue of national warnings must be a matter for each member of the alliance to settle for itself, but it is assumed that the normal practice will be for the responsibility to rest with the Civil Defence authorities.

21. In order to accomplish this mission successfully, it will be essential for the Civil Defence authorities to.

- (i) study carefully beforehand, in conjunction with the national meteorological service, the travel and behaviour of the upper winds, particularly between 50,000 to 100,000 feet;
- (ii) arrange with the meteorological service so that immediately the point of burst is known information

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can be received from them as to the probable travel of the radio-active cloud;

- (iii) arrange to issue a warning, which must obviously allow considerable margin, to the areas in which a dangerous fall-out can be expected, coupled if possible with a forecast of the times when the fall-out is likely to affect these areas;

"(iii)<sup>BIS</sup> arrange, in the most appropriate way, an organization for collecting information in which warnings can be issued. Such an organization will probably need to include static, mobile and air agencies."

- (iv) ensure that, on receipt of this general warning, local arrangements are adequate to disseminate the warning to all those in the particular areas concerned; and that responsible Civil Defence officials in those areas know exactly what action to take;

- (v) as part of the normal Civil Defence services, to organize and train the necessary reconnaissance teams, and equip them with the appropriate radiac equipment, so that they can be directed to take up their allotted stations, or be given warning if they are already in post, so that they can record accurately the degrees of contamination experienced and the area covered; and on this information becoming available, to issue further supplementary warning orders in regard to the length of time people must remain under cover and so on.

(c) International Warnings

22. If a national authority, on receipt of the information from the meteorological service, anticipates that the fall-out is likely to affect another country or countries, (e.g., a thermo-nuclear explosion close to the Canadian border might affect areas in the United States or vice versa; or similarly, in Europe an explosion might very easily affect more than one country) it should take immediate steps to pass the necessary information on to the designated authorities in those countries over which the fall-out might be experienced.

23. It is clear that international agreements as to the proper procedure are required, especially in regard to the means by which the information is passed and the authorities to be alerted. It may well happen that in certain cases - certainly in Europe - the fall-out warning may have to be sent in the reverse direction to warnings of the presence of hostile aircraft, and it is most important to ensure that there is no interference and that the arrangements can work independently and reliably. This is a matter which may also affect military forces and will, it is suggested, require consideration jointly by the NATO Civil Defence Committee, SHAPE and Channel Command.

(d) Nature of the national warning and method of dissemination

24. The nature of the local warnings to be used and the actual method of dissemination must be a matter for each member country to decide. The problem is whether to use some form of audible signal, where practical; or whether the warning will be passed verbally. Speed will be of importance and also reliability of transmission. It would seem, therefore, that even if the telephone is regarded as the normal method of transmission, wireless should be available as an alternative. The possibility of using national or local broadcasting systems is worth consideration. If an audible warning is to be used, the question must be settled as to whether it would be the same as the hostile aircraft warning.

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25. In view of the international aspect of this problem, it may be worth discussing the possibility of getting an agreed procedure amongst member countries so far as initial warnings, at least, are concerned. There would be obvious advantages in this idea and a possible source of confusion and error eliminated.

ACTION ON RECEIPT OF WARNING

26. On receipt of a warning that a dangerous fall-out is anticipated, which in a small country may have to be nation-wide, the most important action to be taken is to get people and livestock under cover or shelter of some kind. It is not proposed to go into technical details of the amount of shelter necessary in this paper, but it can be remarked that the problem is not so difficult as that of getting shelter against the main effects, i.e. blast etc. of thermo-nuclear or indeed other kinds of attack.

27. An important factor is the length of time for which people, animals, etc. must remain in shelter or under cover, so as to allow a sufficient period to elapse for the radiological effects to decay to such an extent that they no longer endanger human or animal life. So far as present information goes, this may be a period ranging from hours to days, but information is still lacking. The advice to be given must be dependent on the information supplied by the reconnaissance teams, and the arrangements must obviously include measures by which everybody concerned in the area understands that they must remain under cover until they are told it is safe to come out, and have made preparations accordingly as regards food, water, etc.

"This implies, in fact, the selection and preparation of a refuge room."

This presents a difficult problem, since many of the areas concerned may well be of an agricultural nature with a very scattered population, though this nature may have been somewhat changed if the area has been filled up by persons evacuated or dispersed from target areas. The arrangements must be a matter to be worked out nationally, but there might be advantage in exchanging views on the best methods by which this can be accomplished.

ACTION IF CONTAMINATED

28. It will be most important to issue definite instructions to persons who may have become contaminated as to the action that they should take, and the more this action can be taken locally in their own homes the better. The most important recommendation is immediate cleansing.

29. It can well happen that materials may become contaminated which are urgently needed, and again instructions must be issued as to the action to be taken. There is quite a lot more information required before complete guidance can be given, but immediate cleansing or hosing down is a rough and ready method of operation.

EFFECT ON FOOD SUPPLIES

30. Crops, grazing land and so on will obviously be affected, and here again information is not at all complete and further instructions will have to be issued as to the length of time the ground must be left, any action such as ploughing which could be safely taken and might help to reduce the period of neutralisation, the effect on food supplies and so on, including drinking water, especially small quantities which might be set out for use of cattle.

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31. It is emphasised that radio-activity caused by fall-out has very low powers of penetration and that supplies in air-tight containers should, normally speaking, be immune from contamination. The importance of having such supplies available, both for human beings and animals, is therefore very high. Similarly, reserve stocks should be protected so far as possible in this way, i.e., they should be kept under cover.

32. It is important also to remember that, particularly in a smaller country, there are probably no parts which would be immune from the risk of fall-out if thermo-nuclear weapons were used against it or its neighbours, and preparations would therefore need to be on a nation-wide scale.

33. Attention is also drawn to the fact that in any case, especially where the fall-out has been heavy, areas must expect to be neutralised over a period of at least some days, and that movement generally will have to be prohibited or severely restricted in them. All this may have a considerable bearing on the national economy during the period of a war of survival, and emphasises the great importance of studying this problem beforehand with the meteorological authorities, with a view to determining, in relation to probable main target areas, those areas where the fall-out is most likely to be experienced; in this way, reserve supplies and stocks and things of this kind can, so far as practicable, be located in the areas least likely to be affected by the fall-out. Dispersal and evacuation plans could be affected and will need studying also.

SURFACE OR UNDER-WATER BURST

34. It has already been stated that information in regard to the effects of burst of this character is limited. Attention is, however, drawn to the fact that in a port area affected by a surface or under-water burst, it is certain that this area will be so heavily contaminated as to be out of action for some very considerable period which could last up to months. On the other hand, under normal circumstances and especially where tidal conditions are experienced, the water itself will probably cease to be dangerous in a very much shorter space of time, and even though the port facilities might be unusable, the port itself might still be available as an anchorage, if it was so desired.

35. The importance of selecting alternative facilities, quite apart from the destruction of the port if directly attacked, is obviously therefore of very high importance.

SUMMARY OF CONCLUSIONS - PART II

36. The provisional conclusions and recommendations set out in Part II of this memorandum (paragraphs 18 to 35) may be summarised as follows:

Warning Arrangements

(a) General

- (i) that the provision of adequate warning arrangements of the probability of radio-active fall-out over any area is of first importance;
- (ii) that such a warning will be required, both on a national and an international basis;

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(b) National warnings

- (iii) that a study of the travel and behaviour of the upper winds (50,000 to 100,000 feet) is of importance; as also what parts of the cloud or column actually give rise to the fall-out.
- (iv) that very close collaboration between the national meteorological service and the civil defence authorities is required;
- (v) that once the point of burst is determined, a forecast of the probable direction of the fall-out and the time of its arrival is required;
- (vi) that on receipt of this information, immediate warning must be sent to the areas likely to be affected with anticipated times of arrival;
- (vii) that local arrangements must be made to ensure the rapid dissemination of this warning when received;

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(viii) "that the national warning arrangements will probably have to be based on a static organization supplemented by mobile ground and air reconnaissance teams."

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(ix) "that on receipt of information gathered by the agencies described in conclusion (viii) above, arrangements must be made for supplementary warnings to be issued in regard to the length of time persons, animals, etc., must remain in shelter or under cover, unless standing instructions have been issued that everyone must remain in shelter until notified that it is safe for them to come out."

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(c) International Warnings

- (x) that national authorities, anticipating, on the information they receive, that the fall-out from any thermo-nuclear explosion may affect a neighbouring NATO country or countries, should take immediate steps to warn that country or countries;
- (xi) that international agreements will be required to settle the procedure regarding such warnings, which may be of concern to the military as well as the civilian authorities;

(d) Nature of the national warning and method of dissemination

- (xii) that the local warning might be an audible signal, or might have to be passed verbally or by some other means; but that speed and reliability of transmission are both essential;
- (xiii) that alternative methods of transmission should be arranged to safeguard against any breakdown, e.g., telephone, wireless, national or local broadcasting systems;
- (xiv) that because this problem has an international aspect, it is for consideration as to whether an agreed international signal for the initial warning might not be desirable;

Action on Receipt of Warning

- (xv) "that the most important action on receipt of a warning is to get persons, animals, etc., into the best possible protection available."
- (xvi) that since in some areas, persons, etc., may have to remain under cover for periods up to 48 hours - even longer - it is essential that they have been warned to prepare for such a contingency and given guidance as to the minimum preparations and precautions they should make, e.g., provision of food, drinking water, etc;
- (xvii) that there are a number of problems in regard to the arrangements suggested under (xvi) above, especially in scattered communities, and that an exchange of ideas might be helpful;

Action if contaminated

- (xviii) that instructions will have to be issued as to the action to be taken if persons, animals or materials become contaminated; and that the more the doctrine of self-help can be applied, the better;

Effect on Food Supplies

- (xix) that crops, grazing land, etc., will be affected by the fall-out, but that further information is required, both in relation to the time factors and also as to any useful decontamination action that can be taken. There will be need to prevent entry into contaminated areas for certain periods in any event;
- (xx) that, since the penetrative powers of radio-active fall-out are small, the importance of having food and other supplies in air-tight containers or protected in other ways is high;
- (xxi) that the need to stockpile supplies of food and other commodities essential to maintain life and existence during any "survival period" is of the highest importance; and that a study of the most likely areas to experience fall-out, in relation to probable target areas, should be studied in peacetime with a view to selecting stockpiling sites where they are least likely to be affected; also in regard to dispersal and evacuation plans.

Surface or Under-water Burst

- (xxii) that a surface or under-water burst in a port area is likely to neutralise that area for a much longer period than an area affected by fall-out from an explosion overland, especially if the water is salt. But that information is still lacking on this problem;
- (xxiii) that the importance of selecting alternatives to main ports is high, even though ports affected by contamination might still be used as anchorages after a fairly short interval has elapsed;

37. This memorandum has only attempted to outline some of the problems likely to be caused by radio-active fall-out from thermo-nuclear explosions. All figures quoted must be regarded as provisional at this stage. In view of the importance of the problems and the need to study carefully their implications, it was felt that a broad survey would be useful at the present time. As further detailed information becomes available, then the arrangements can be finalised.

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