726662

THIS DOCUMENT CONSISTS OF 8 PAGES
NO. 6 SERIES a

[redacted]

AN ESTIMATION OF THE FEASIBILITY OF RADIOLOGICAL WARFARE

Paul C. Aebersold, William S. Hutchinson, Jr.,
Karl Z. Morgan, Merlin D. Peterson

1. This report has been written at the request of the Division of Military Application of the Atomic Energy Commission to provide a rough indication as to whether further study of radiological warfare would be wise as an investment against the contingency that radioactive materials might be used against us in a future war. Are radioactive materials, in themselves, potential military weapons? A fundamental estimation of the answer to this question based on existing information is offered. Such an estimate should indicate whether further serious study of radiological warfare is advisable.

2. The entire field of radiological warfare is very broad. It is inseparably related to the military application of nuclear detonation, since low air bursts and subsurface water bursts of atomic bombs are both, in part, means of dispersing radioactive materials over a target area. This report makes no attempt to be comprehensive. We only try to estimate whether certain pile-produced radioactive materials not dispersed by means of nuclear detonation are potentially dangerous weapons. Our approach to this problem was to consider the known characteristics of a few radioactive materials and to estimate whether those materials could be manufactured, separated, delivered to a target area, and dispersed throughout a target area in such a way as to achieve a dangerous military effect. We have chosen for illustrative purposes three very hazardous radiomaterials each typical of a specific type of emitted radiation: polonium for alpha radiation, radiostrontium for beta radiation, and [redacted] radiobarium-radiolanthanum for gamma radiation.

8 PAGES ONLY

STATUS VERIFIED UNCLASSIFIED
Dennis W. Murphy
Declass Auth Ltr 4/28/95
5/18/95
DATE

1183894

NND 931121 1941 D

[redacted]

3. Since the possible tactical applications of radioactive weapons appears to be a somewhat complex subject because of the inherent delay in the manifestation of the effects of exposure, we did not attempt any analysis of the use of these materials in actual battle between armed forces. This, of itself, does not mean that there are no such uses. It only means that we have not attempted to analyze them.

4. Analysis of the possible strategic uses against the civilian society and economy appeared more promising of results in such a non-exhaustive study. Therefore, we have emphasized this specific phase of the problem.

5. The first specific material considered was polonium 210. The following characteristics were considered:

A. Type of emissions.--Alpha rays with about one gamma ray for every 10^5 alpha emissions.

B. Energy.--5.298 M.E.V. for the alpha rays.

C. Half life.--140 days.

D. Production feasibility.--Manufactured by neutron bombardment of bismuth 209. Could be produced in large quantities by irradiation in a pile.

E. Separation feasibility.--Since bismuth 209 has no isotopes there are no inherent contaminants in the polonium 210. Separation of pure polonium is not a problem.

F. Chemical and physical processing to final product. Investigation would be necessary to determine what compound of polonium or what mixture of polonium in a suitable carrier would have the characteristics

[redacted]

1183895

NND 931121 124 E

required to contaminate an area after being scattered over the ground, streets, roofs and outside walls of buildings, etc. Such a compound or mixture should have a vapor density heavier than air, a relatively high vapor pressure, a fine particle size (thus a large surface area), be non-hydrolysable, etc. Generally it should have the physical and chemical characteristics of a dangerous chemical warfare agent. This committee did not consider this problem seriously, since any form of polonium scattered within an area would be most insidious in contaminating the shoes, clothing, and the person of any individuals therein. Even a perfectly efficient gas mask would only protect the wearer while the mask was worn. When the mask is removed, the hands would be dangerous sources of infection. Washing is most difficult. Our conclusion was that any form of polonium would be an effective contaminant. Therefore, the chemical and physical processing of polonium 210 to a dangerous radiological warfare agent would be no problem. The material could thus be used for strategic attack of populated areas.

G. Biological effectiveness.--.01 x 10^{-6} curies is the tolerance of the kidney to this material. 1 x 10^{-6} curies or approximately 0.002 micrograms absorbed in the body would very probably be fatal to most individuals a long time after exposure. Larger quantities of infection would undoubtedly have very dangerous effects much more quickly. Thus a very small amount of the material taken into the body would be very dangerous. There is no known method for promoting significant biological elimination of the material from the body once it has been absorbed, nor is there any known antidote.

H. Packaging problems.--The alpha rays are stopped by any practical container. The gamma rays are so few that no special protection

1183896

NND 021121 194 F

would be required. It might be necessary to cool the containers or to keep the individual packages small because of the heat generated by the activity of the polonium. These problems are entirely soluble so that handling, storing, containing present no real obstacles to use of the material.

I. Delivery.--As indicated in F and H above, delivery of polonium to a suitable target area is entirely feasible with existing means of military air attack. It would probably be necessary to develop a compound or mixture suitable for loading into aerial bombs or spray tanks but such development seems entirely possible since practically any means of contamination of an area would be dangerous.

J. Dispersal feasibility within the target area.--With development of a compound or mixture of polonium which has the characteristics of a dangerous chemical warfare agent practically any form of dispersion within a target area should be possible. The contaminant could be relatively evenly distributed so that a large area is made dangerous, or intense centers of contamination could be placed at vital points and defiles such as commuters stations, etc.

K. Feasibility of decontamination.--The first tendency is to decide that no decontamination is feasible and that no protection for individuals within the contaminated area is possible because of the insidious nature of the material. Detection of alpha radiation is more difficult than detection of beta or gamma radiation. The only reasonable procedure seems to be evacuation of the area until the natural decay of the activity has dissipated the danger. However, under very carefully controlled conditions working teams might be able to operate in the presence of the contamination if they were protected by impervious clothing and gas masks. There is a very great hazard of contamination when the clothing and the

1183897

NND 931121 RHC

mask are removed. The clothing could only be used once during any one period of contamination. Possibly the garments could be worn again after the lapse of six months or so. Such working teams could be very useful to operate vital contaminated utilities, take samples of the contaminant, clean up and monitor the area, evacuate casualities, etc. However, there seems to be very little that such teams could do to hasten the day when re-entry of the area by unprotected individuals would be possible.

L. Possible peacetime application.--We cannot now foresee any peacetime application for large quantities of polonium.

6. The second specific material considered was a mixture of strontium 89 and strontium 90:

A. Types of emissions: Beta rays.

B. Energy: 89 - 1.52 Mev; 90 - 0.65 Mev.

C. Half life: 89 - 55 days; 90 - 30 years.

D. Production feasibility: Now produced as a fission product in the Hanford piles: 89, 1.2 grams per mol. of plutonium or 31000 curies per mol. Of plutonium: 90, 4.5 grams or 630 curies per mol. of plutonium.

E. Separation feasibility: Readily separable as a mixture of Sr 88, 89, and 90. The 88 is stable and would occur as an inactive ingredient in the ratio of 3.1 parts of 88 to 1.2 parts of 89 and 4.5 parts of 90 by weight. Chemical extraction could easily be increased to separate very large quantities.

F. Chemical and physical processing feasibility to suitable end product: Development of a strontium compound or a mixture of strontium in a suitable carrier having the chemical and physical properties of a dangerous chemical warfare agent is more important for strontium than for

1183898

NND 931121 /88 H

polonium. However, serious investigation of this problem is quite promising. The resultant material would be suitable for strategic attack of populated areas and also possible for attack of the agricultural productiveness of rural areas.

G. Biological effectiveness: 90×10^{-6} curies is the tolerance of the bone for strontium. Larger quantities deposited internally would be dangerous. Delay of effects would vary inversely with the amount ingested.

H. Packaging: Since the mixture emits beta rays only, handling, storing and packaging would be entirely feasible.

I. Delivery: Similarly, delivery would be feasible. The 55 day half life of Sr 89 would permit placing the contaminant on the target area well before the activity was seriously depleted. However, stockpiling would not be possible. However, production from a plutonium pile is continuous so there would be a steady supply.

J. Dispersal feasibility: This depends on development of a compound or mixture having the necessary chemical warfare properties.

K. Decontamination: There is no readily apparent means of decontamination. On all but extremely smooth surfaces such as enamel or stainless steel, chemical or washing action would not be very effective in removing the radioactivity. The material itself would probably not be as insidious as the polonium since detection and decontamination may be less difficult in the case of strontium. Detection of the radiation is readily accomplished with proper field instruments. Otherwise, our comments on the decontamination of polonium apply here as well.

1183899

NND 931122 184 I

L. Possible peacetime application: None foreseen at present.

7. The third specific material considered was barium 140:

A. Types of emissions: Beta and gamma rays.

B. Energy: Beta rays, 1.05 Mev; gamma rays, 0.529 Mev.

C. Half life: 12.5 days decaying to lanthanum 140 which has a forty hour half life and which emits one beta and two gamma rays per decay; energy of lanthanum beta ray, 1.45 Mev, of gamma rays, 1.65 and 2.3 Mev.

D. Production feasibility: Now manufactured at Clinton Laboratories and delivered to Y. Manufacture of really large quantities would be limited by the small fission yield of 0.056 grams per mol. of plutonium. However, military significant amounts could be obtained if all of the barium 140 produced in all of the domestic piles were recovered. There is no technical reason why this could not be done.

E. Separation feasibility: The present process is adequate.

F. Chemical and physical processing feasibility to end product: Again development of a compound or a mixture suitable for chemical warfare would be very desirable so that the most dangerous method of contamination (either uniform dispersion or intense infection of critical points) could be used at will. Such development appears to be entirely possible. However, intense infection of specific defiles such as Grand Central Terminal in New York City is entirely possible with the barium-lanthanum mixture now being produced. Therefore, the material could be used for contamination of vital points within populated areas.

G. Biological effectiveness: The lanthanum daughter is a strong gamma emmitter. Rough calculation indicates that two grams of lanthanum 140 evenly distributed over a circular area one mile in diameter would set up a contamination three feet above the ground at the

NND 931121 184 J

center approximately equal to 100 R/hr. If we accept 100 R as the incapacitating dosage for humans, any individual who remains for one hour near the center of such a contaminated area would very probably be incapacitated. More intense contaminations would naturally be more dangerous.

H. Packaging: A feasible solution to this problem would be to deliver the material to the target area within the 12.5 day half life of the barium 140. The packaging problems are thereby much more simple than they would be for the lanthanum daughter.

I. Dispersal feasibility: See F above.

J. Decontamination: As with strontium detection is more feasible than with polonium. However, decontamination is hardly promising in view of the short half life.

K. Peacetime application: None foreseen at present.

8. Summary:

A. Polonium seems to be entirely feasible as a radiological warfare agent. It is difficult to detect, insidious in its contamination, practically impossible to decontaminate or defend against, and it can be manufactured by pile irradiation in considerable quantities. It is very probably suitable for strategic attack of populated areas.

B. A mixture of strontium isotopes is probably suitable for strategic attack of vital points in populated areas and possible for attack of rural areas.

C. A barium-lanthanum mixture is probably suitable for strategic attack of vital points in populated areas.

D. On the basis of this very elementary estimate it is the opinion of the group that the use of radioactive materials as weapons for radiological warfare is feasible.

1183901

NND 931121, 194 K