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DEPARTMENT OF DEFENSE
DEFENSE ATOMIC SUPPORT AGENCY
WASHINGTON 25, D.C.

ADDRESS REPLY TO:
THE CHIEF, DEFENSE ATOMIC
SUPPORT AGENCY
DASARZ 930

29 OCT 1962

MEMORANDUM FOR: ASSISTANT TO THE SECRETARY OF DEFENSE (ATOMIC ENERGY)

SUBJECT: Special Vulnerability Analysis (U)

1. Reference is made to your memorandum, subject: "Special Vulnerability Analysis Portion of the AEC/DOD Ecological Study on Effects of Nuclear War," dated 25 September 1962.

2. In accordance with your request, the Department of Defense Damage Assessment Center (DODDAC) has completed a special vulnerability analysis of three hypothetical nuclear attacks against the USSR. The analysis addressed the effects of the adverse wind (east-to-west) upon the USSR, the Soviet Satellites in Europe, and the Allied countries of Western Europe, and the results show the following:

a. From a series of normal weapon attacks, the Soviet Satellite countries of Europe would suffer widespread fatalities (as much as 47 percent of the total population) while the Allied nations of Western Europe would suffer a markedly smaller percentage (3 percent).

c. The number of fatalities suffered in the USSR does not vary significantly from that of the mean wind condition (west-to-east).

d. Adverse wind conditions (east-to-west) have been shown historically to be sustained for periods of 36 hours or more; accordingly, such wind conditions are amenable to forecast by trained meteorologists.

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3. A complete analysis is attached as Inclosure 1.

Robert H. Booth

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Major General, USA
Chief

1 Incl
An Analysis of Fallout Effects from Weapons Detonated in the USSR Under Adverse Wind Conditions, SECRET, copy 2A, w/32 Incls

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AN ANALYSIS OF FALLOUT EFFECTS FROM WEAPONS DETONATED IN THE USSR UNDER ADVERSE WIND CONDITIONS (U)

I. GENERAL

1. A special vulnerability analysis has previously been submitted to the Assistant to the Secretary of Defense (Atomic Energy) on the fallout effects of several levels of nuclear weapon attacks on targets in the USSR. Parameters for this previous analysis included mean spring wind conditions, eight different weapon types, and both air and surface burst. Since the mean spring winds in the attacked area blow in a generally west-to-east direction, it was found that fallout effects in Red Satellite and West European areas from the mean conditions were inconsequential.

2. In considering the maximum fallout effects that might occur in the Satellite and Western European areas under adverse wind conditions, a detailed examination was made of meteorological records of the past ten years pertaining to the western USSR target area, seeking wind situations that might generally blow from the east for a duration of at least 12 hours. Half a dozen or so very adverse situations were found, and the wind situation of 3 February 1956 was chosen for effects analysis. This particular meteorological situation, shown on Figure 1, lasted for several days with little change and with winds of moderate to somewhat high velocity blowing from the northeast across the northern half of the target area in western USSR. This wind potentially carries fallout debris over Finland, Poland, East and West Germany, Czechoslovakia, Austria, Hungary, Rumania, Yugoslavia, and extending as far as Switzerland, southern France, and northern Italy. The low pressure area extended in a southwest-northeast region, and the winds on its southern side blew generally from the west, thus sparing southern Italy, Albania, Greece, Bulgaria, and Turkey in this instance.

3. Having selected an adverse wind situation, computations were made of the fallout effects upon the populations in the Satellite and Western European areas for the six levels of attack upon the USSR, employing in turn each of the eight different weapon types. Shelter availability and utilization, both urban and rural, were assumed to be about the same as the Russian situation.

4. Results and conclusions of the analysis are given below and are followed by a brief discussion of meteorological factors relating to the problem (Section IV) and a more detailed examination of the effects of targeting military and non-military centers (Section V).

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II. RESULTS

5. The adverse wind case, when compared to the mean wind case, does not alter the casualty assessments made for air burst weapons. This applies to the USSR as well as to all other areas.

6. USSR - The adverse wind situation under the condition of surface bursts has little overall influence on the fatality rates in the USSR as computed for the mean wind case, the rates dropping by 1 to 4% as shown by comparing Tables A-1 (mean winds) and 1 (adverse). The 2-7 million population thus spared are rural inhabitants.

[redacted] The 16-19% rates in East Germany and Rumania drop to 2% with the clean weapons. Most of the fatalities result from weapons directed against military targets near the Soviet western border. This aspect of the problem is discussed further in Section V, below.

8. Western Europe - The adverse winds cause some fatalities in Western Europe (Table 3) but by no means as many as in the Satellites because of the increased distance from the weapon burst areas.

[redacted]

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III. CONCLUSION

[redacted]

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Western European fatalities could be as high as ten million.

10. The use of clean weapons would reduce Satellite fatalities by more than two-thirds, and would cause almost no fatalities in Western Europe, as shown in Graphs 1 and 2.

11. If the burst area included a large number of enemy targets in the Satellites, adverse winds would have a much more significant effect upon Western Europe than indicated above, depending upon location and number of targets. Clean weapons would be proportionately sparing of population, at about the same ratios shown above for the Satellites.

12. It is unlikely that all weapons, either in the USSR or Satellites, would be surface burst; hence, the situation summarized above represents a weapon application philosophy which is perhaps the most unfavorable to be expected in regard to Western Europe; however, even a limited number of surface bursts in an unfavorable wind can produce significant casualties as shown in Section V, below.

13. The probability of recurrence of the given adverse wind situation in all its details is exceedingly unlikely; however, the probability of a wind situation resulting in a fallout hazard in Satellite areas can be significant as shown on attached maps, Figures 2 to 13. Figure 2 shows, for example, that the probability of a spring wind carrying fallout from the central target area into or through eastern Poland is about 13% ranging down to about 1% in France. Greece, which was spared in the situation described above, has a fallout hazard probability of 1% or 2%.

IV. METEOROLOGICAL FACTORS

14. The weather situation chosen for the adverse wind study was that prevailing on 3 February 1956 (see Figure 1). The winds entering into the fallout computations were those existing at the 500 millibar level (approximately 18,000 ft.). Although the winds selected are not strictly identical with integrated effective winds applicable to the detonation yields used in the study, they are considered to be reasonable approximations. Some slight modifications of the wind field were made to compensate for the characteristics of the fallout model application used in computations. Specifically, the computational routine holds the wind direction and velocity prevailing at the detonation point constant throughout the entire course of the fallout deposition; therefore, relatively small-scaled details in local wind structure, which occur in any real situation, are applied over a period of many hours and over a distance of many hundreds of miles. The errors introduced may in any

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one specific incident be appreciable in respect to an area remote from the point of detonation. This effect was alleviated somewhat by estimating trajectories between various burst points and general terminal areas of interest, and then selecting wind bearings and average course velocities which, when entered into the model, gave approximately correct results. It must be noted that inaccuracies, or unresolved small-scale variations inherent in meteorological observations, make even the most detailed trajectory computations subject to considerable error. Tests have shown that variations equivalent to 20% or more of total calculated displacements are common.

15. To assist in the evaluation and analysis of the case study results, twelve diagrams portraying the extent of the variability of 36-hour wind trajectories have been prepared (Figure 2-13). The diagrams represent the expected variance in trajectories originating approximately at Murmansk, Pinsk, and Tbilsi, for each of the four seasons. Basic information utilized included the mean seasonal effective winds (300 kiloton-10 megaton yield) and their standard vector deviations. In performing the calculations, the trajectories were assumed to be straight lines, constant in time and space. Although this assumption is not precisely correct, probability distributions calculated on this basis have been found to compare favorably with those based on a highly sophisticated wind trajectory model considering the full variance of the trajectories in time and space (Inclosure B to 2nd. Supplement to WSEG SS#46, A Monte Carlo Method of Wind Transport Based on Wind Correlations.) Percentage probabilities that a 36-hour trajectory would terminate or pass over specified areas were computed as follows:

a. The trajectory of the mean effective wind from the hypothetical burst point was constructed.

b. The radii of circles about the terminal point of the mean trajectory were computed to portray the limits of 99%, 90%, 80%, etc., probability of containment of vector in accordance with circular normal distribution within the standard vector deviation.

c. Radial lines were constructed from burst points through the extremities of each area in question. The total probability of vector termination within this envelope and in or beyond the area was entered as the probability of a 36-hour wind trajectory terminating in or passing over the area.

16. The percentage values so computed are not additive, and cannot be summed to provide total probability for various combinations of areas; however, any additional computations for specified areas or combinations of areas may be readily made through application of procedures described above to basic data provided.

17. Obviously, this purely meteorological analysis must be applied to the radiological effects of the test case with extreme caution, as the extent of casualty-producing doses does not spread linearly with increasing wind speed and may not necessarily be distributed in a symmetrical pattern with other wind directions. In a very general sense, the relative probability of a trajectory passing over an area is related to the relative probability of fallout hazard to the area. The diagrams indicate that the risk of winds specifically identical to those used in the case study are relatively low. Nevertheless, the risk of other abnormal winds extending across parts of the areas influenced, or across other areas of concern, may be seen to be significant.

V. TARGETING CONSIDERATIONS

18. In examining the tables of results, it appeared incongruous at first that there were not greater differences in fatalities between the military and combined target attacks since the latter had about two-thirds more weapons and megatonnage than the military. Table 2 shows, for example, that there are substantial increases in Satellite fatalities in expanding from the low to the medium and high level attacks for both the combined and military targets cases.

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19. In attempting to resolve this apparent inconsistency it was at first considered that perhaps the computer programming or processing had gone awry, but this consideration was ruled out since the effects tables always show fatalities to be as high or higher when megatonnage is increased.

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20. It was tentatively concluded, therefore, that the lack of additional combined-target fatalities must be due to the relative locations of the military and non-military targets in the combination. The target maps were examined and a megatonnage count for the high attack was made for the weapons targeted within about 500 miles of the Soviet border. It was found that of the combined total in the area about 85% were directed against military targets whereas the national average was 60% (6037/10,000). This tended to prove that the lack of significant

difference in fatalities between the military and combined target attacks stemmed from a preponderance of military targets in the western regions of the USSR where surface bursts would be most hazardous to the Satellites and Western Europe.

21. In seeking more conclusive proof of this hypothesis, the total non-military weapons (combined minus military) were run separately in the computer followed by a separate run of those non-military weapons directed against those targets in the critical region of western USSR north of 47° latitude and west of 35°E longitude.

22. The results are shown in Table 4, together with the military and combined target totals previously computed. The low fatality rate caused by the total non-military weapons shown in the table confirms that the weapons directed against non-military targets do indeed add very little to the total fatalities caused by the military target weapons alone. Furthermore, the fact that 48 weapons of the total 331 non-military weapons would produce almost equivalent fatalities proves that most non-military targets are too remote to have much effect upon the Satellites.

23. It is to be noted in Table 4 that the non-military weapons would produce 6.6 million fatalities in Poland and the military weapons would produce 23 million if each attack occurred alone, but both attacks combined would produce only 23.5 million. The reason is that the fatality rate (81%) is so high that the only survivors have excellent fallout protection and considerable additional fallout dosage is required to increase the fatality rate even by a small amount. By similar reasoning, the combined fallout in areas of low fatality rate is more effective than the simple summation of the two contributors because the combined dosage is approaching a critical level for those individuals in poor shelters.

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