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Influence of Civil Defense On Strategic Countervalue Fatalities

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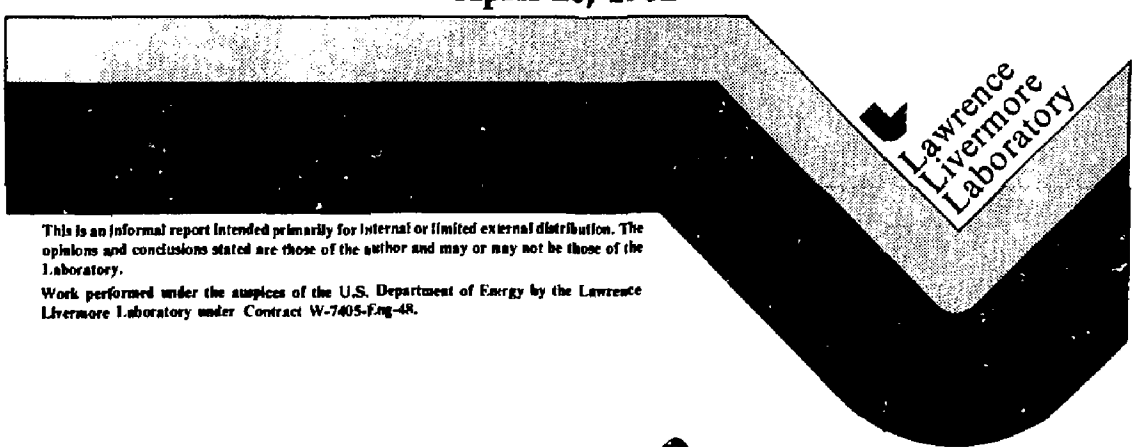

Influence of Civil Defense On Strategic Countervalue Fatalities

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Abstract

We conducted two modeling studies to simulate the effect of fallout shelters on the outcome of a massive countervalue nuclear exchange between the Soviet Union and the United States. One was to determine the number of nuclear weapons required to mount an effective fallout attack against a country with dispersed population; the other was to determine the number of expected U.S. fatalities resulting from a countervalue attack against U.S. urban population centers. The results of these studies indicate that the number of weapons required to mount such an attack depends on the adequacy of the shelter system and that evacuation of urban populations can substantially reduce expected fatality levels.

Introduction

Early fallout can pose a lethal threat to a large portion of the population that survives the blast effects of a massive nuclear exchange between the Soviet Union and the United States. At least an order-of-magnitude reduction in fatality levels caused directly by blast and fallout appears feasible if the population of urban areas can be evacuated to adequate fallout shelters before this exchange begins. Thus, a great apparent assymetry in population at risk will result if the Soviet Union, in an extreme nuclear crisis, evacuates its urban population to adequate fallout shelters and the United States does not do likewise.

Fallout Shelter Studies

To determine how various fallout shelter systems could affect the outcome of a massive countervalue nuclear strike, we conducted two studies. The results of these studies show how different fallout shelter systems influence

- The number of weapons required to mount an effective area fallout attack against a country with dispersed population (Study A).
- The number of expected U.S. fatalities in a massive countervalue attack against U.S. urban population centers (Study B).

The fallout shelter systems used in the two studies are shown in Table 1. Each was designed to simulate a different level of civil preparedness. FS1 represents a population attempting to leave an extensive fallout area. FS2 simulates an informed population, with food stores for one month, for whom only a spontaneous fallout shelter program has been implemented. After one month, the FS2 population has to evacuate or decontaminate the area, either of which will require about one week. FS3 and FS4 are the same population postures as FS2, but with better prepared fallout shelters. Since studies indicate that the human body can repair itself to some extent when dose is accumulated over substantially long periods, we have used 500 rads as a lethal dose for the FS1 population and 1000 rads for the FS2, FS3, and FS4 populations.

TABLE 1. Fallout shelter systems used in Studies A and B.

- FS1 – The surviving population is in an extensive radiation field for one week with essentially no shelter. A lethal dose is 500 rads.
- FS2 – The surviving population is in a fallout shelter with a protection factor of 10 for one month then leaves the shelter and is in the radiation field with essentially no protection for one week. A lethal dose is 1000 rads.
- FS3 – The population posture is the same as that for FS2, but the fallout shelter protection factor is 100.
- FS4 – The population posture is the same as that for FS2 and FS3, but the fallout shelter protection factor is 1000.

Study A. Number of Nuclear Weapons Required to Cover the Continental U.S. And European Russia with Lethal Radiation

A realistic fallout model was used in this study to predict lethal fallout areas for 30 surface-detonated nuclear weapons. The target scheme used is shown in Fig. 1. Since the detonation pattern shown does not maximize the lethal fallout area for given fallout shelter systems, the numbers should be considered rough upper bounds to the number of weapons needed to defeat fallout shelters in an area fallout attack.

Computer-drawn fallout isodose contours were used to calculate the model lethal radiation area. The number of nuclear weapons required to cover the U.S. or European Russia (west of the Ural Mountains) with lethal dose levels was taken as 30 times the ratio of each country's area to the model lethal radiation area. The results of these calculations are shown in Table 2.

TABLE 2. Number of nuclear weapons required to defeat fallout shelter systems.

Country	Fallout shelter system			
	FS1	FS2	FS3	FS4
Continental U.S.	5×10^3	10^5	5×10^5	10^6
European Russia	5×10^3	3×10^5	10^6	3×10^6

On the basis of the above results, we can make a number of definitive statements:

- The number of nuclear weapons required to mount a fallout attack against an unprepared but evacuated population (FS1) makes a fallout attack against an evacuated population plausible.
- The number of nuclear weapons required for such an attack is strongly dependent on the fallout shelter system.
- If both countries have similar shelter systems, similar numbers of attacking weapons will be required to defeat both systems.
- Diminishing returns are obtained by increasing the protection factor above 100 since the dose received in the last week of the month becomes dominant for higher protection factors.

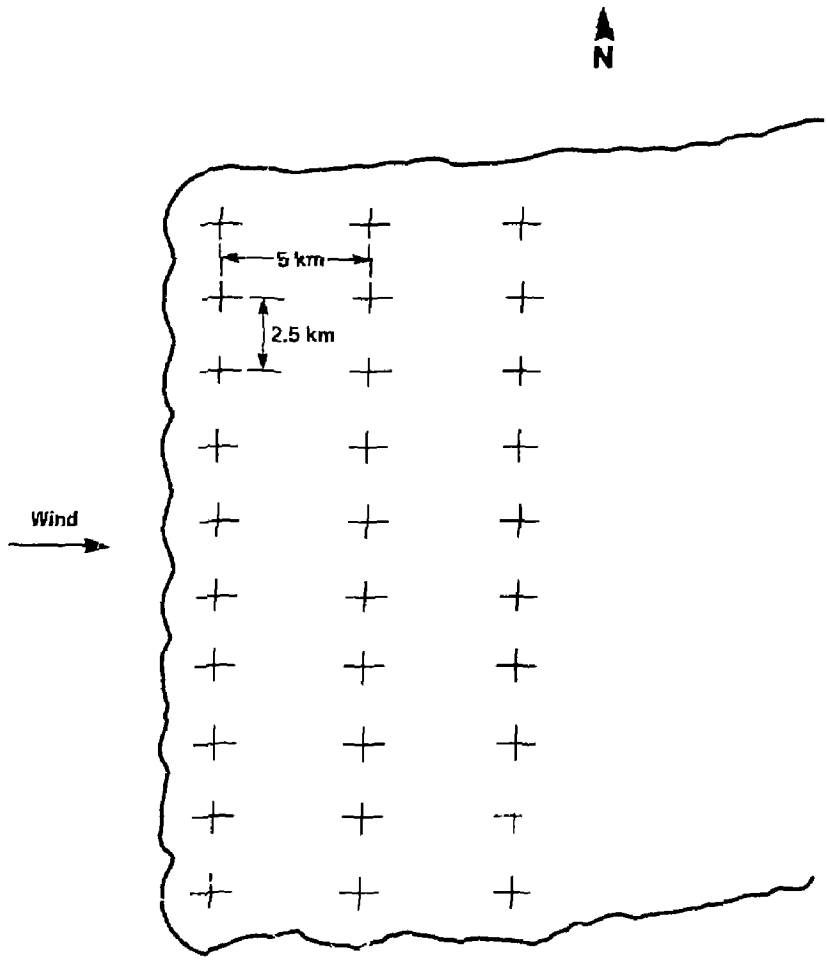

Figure 1. Weapon burst point pattern used in Study A. The wind sounding used for Studies A and B was chosen from U.S. Weather Bureau data for a day on which the wind was nearly the same over the whole continental U.S. Computer-drawn fallout isodose contours resulting from this target array and wind were used to calculate the lethal radiation area coverage for the 30 weapons shown in the array. In Study A, the Soviet nuclear weapons used against the continental U.S. (area 3 million mi^2) were assumed to be 1-Mt, 50% fission weapons. The U.S. nuclear weapons attacking Russia (area 2 million mi^2) were 100-kt, all-fission weapons.

Study B. U.S. Fatalities Incurred From Soviet Countervalue Attack on U.S. Population Centers

In Study B, we looked at two population scenarios: an unevacuated urban population, and an evacuated urban population. The fatalities for the shelter systems shown in Table 1 and for varying Soviet nuclear force levels were calculated for both scenarios.

The urban population data base contained nearly 1000 target population centers, which account for about 70% of the total population of the continental United States. Varying Soviet nuclear force levels of one, three, and six 1-Mt, 50% fission weapons were used against each urban population center. Everyone within four nautical miles of ground zero was counted as a fatality of either prompt or fallout effects. Figure 2 shows a typical fallout pattern, as well as the target array. The isodose contour outlines the lethal dose areas for an urban population with fallout shelter system FS1.

In the first scenario of a Soviet Union countervalue attack against U.S. population centers, the population is assumed to be unevacuated. Of the fatalities, 144 million are urban population fatalities due to prompt and fallout effects. The 10%-like variations in Table 3 are the result of fallout fatalities in the rural population.

TABLE 3. Unevacuated case fatalities (millions).

Approx. number of 1-Mt, 50% fission weapons	Fallout shelter system			
	FS1	FS2	FS3	FS4
1000	160	145	144	144
3000	165	150	145	144
6000	175	160	150	150

Although better resolution regional studies are needed before definitive statements can be made about these results, some general observations are:

- The number of fallout fatalities for an unevacuated population is only a fraction of the number of prompt fatalities.
- Regional studies of urban fallout fatality sensitivities become appropriate in this case if adequate blast shelters are available to the unevacuated urban population.
- Urban fallout shelters that are not also blast shelters appear to have an insignificant effect on reducing urban fatalities.
- A Soviet expenditure of more than 1000 weapons is unlikely for any of the shelter systems studied.

In the second scenario, the urban population is evacuated to rural areas. The results are shown in Table 4. The eastern and western populations are assumed to be dispersed in a uniform population density over the eastern and western grids, respectively. Other more realistic, evacuated population distributions that show positive correlation with the targeted population centers would result in larger fatality levels. Ground-zero weapons effects are included, as in the unevacuated case.

TABLE 4. Evacuated case fatalities (millions).

Approx. number of 1-Mt, 50% fission weapons	Fallout shelter system			
	FS1	FS2	FS3	FS4
1000	45	10	4	4
3000	70	25	10	5
6000	100	45	15	10

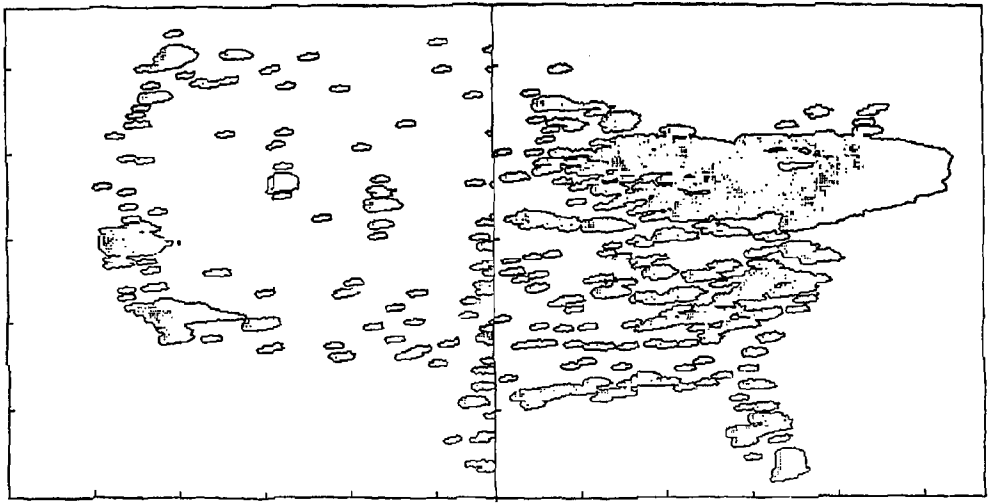

Figure 2. Lethal radiation isodose contours to defeat fallout shelter system FS1 and population centers (dots) targeted with a single 1-Mt, 50% fission weapon. To improve resolution of the fallout patterns, the continental U.S. is divided into two parts, with the center passing through Manhattan, Kansas. Although the calculation does not include radioactivity originating in the western part of the United States that would accumulate on the eastern grid, the approximation should not affect the results substantially. The wind was from west to east and, on the day chosen, nearly constant; thus a "single-wind" approximation appears appropriate. In the 3000-weapon case, three weapons were employed against each population center shown; a similar procedure was used for the 6000-weapon scenario. To calculate fatalities, the rural populations in the East and West were assumed to be at uniform density.

From Table 4, we can draw several conclusions:

- Fallout is of primary concern for an evacuated population and, thus, could conceivably be used as a weapon against it.
- For a 1000-weapon attack, evacuation to a uniform population density with no fallout shelter system (FS1) reduces the number of fatalities by 72%, compared with the unevacuated case.
- Unlike the unevacuated case, the evacuated case shows that factors of several reduction in fatalities will occur for even the most modest (FS2) of the fallout shelter systems considered.
- For all Soviet force levels, more than 90% of the population will survive through the most critical episode of high radioactivity if FS3 shelter systems or better are available.

Our estimates in Study B show that civil defense, including both evacuation and fallout shelters, can reduce U.S. fallout fatalities from more than 160,000 for each 1-Mt Soviet weapon to less than 4,000 per weapon. Similar reductions in the fatality levels from a nuclear exchange are expected for European Russia if its population is successfully evacuated from target areas to adequate fallout shelters.

Recommendations for Future Studies

Refinements and extensions of the strategic fallout model could lead to insightful results for strategic and civil defense planners. Suggested future projects that might be useful to such planners include

- Refinement of Study A by optimizing the target array to give lethal dose, maximum area coverage for each shelter system.
- Extension of Study B to include a comparison attack by the United States on European Russia countervalue targets.
- Inclusion in Study B of (a) actual weapons systems, (b) counterforce targets, and (c) more realistic rural and dispersed population densities.
- Broadening the study to particular regions with precise target locations and actual weapon characteristics, such as CEPs. Tradeoffs could be made between blast shelters, fallout shelters, evacuation, and duration of sheltering.