APPENDIX D–SUMMARY OF REPORT ON EXECUTIVE BRANCH CALCULATIONS

[Note: The full report, classified SECRET, is available separately to qualified requesters.]

PURPOSE

This appendix summarizes and analyzes studies of the direct effects of nuclear attacks that have been performed by and for various agencies of the executive branch of the U.S. Government in recent years. This review ineludes those studies whose results are currently viewed by the sponsoring agency as being valid and applicable to the current through mid-1980's time period, with the U.S. and Scviet forces projected under a SALT I I agreement.

SCOPE

The estimates of the direct effects of nuclear attacks presented in this paper represent analyses performed by or for the Department of the Defense (DOD), the Arms control and Disarmament Agency (ACDA), and the intelligence community. Although these analyses describe the direct effects of nuclear attacks in terms of population fatalities and attack damage objectives against military, leadership, and economic target systems, it is recognized that a more meaningful basis for assessing the direct effects of nuclear attacks would be to analyze the effects of such attacks in terms of postwar national survival and recovery To date, however, analytical capabilities have not permitted such analyses, I n fact, the complex issues concerning national recovery should nuclear war occur, or the postwar power and recovery capabilities of the belligerents, have as yet not even been properly formulated for analysis. Until that is accomplished, analyses of the direct effects of nuclear attacks will continue to focus, as have the studies used for this analysis, on one-dimensional first-order direct effects

Furthermore, all analyses examined in this study assume a “two-shot” nuclear war — the Soviets strike first against all targets included under a particular scenario and the U S. retaliates against a similar set of Soviet targets. More protracted (and more likely) attack scenarios are not examined. Hence, such factors as the feasibility of sustaining population in a “ protected or evacuated” posture over a protracted duration, either i n a continuing crisis with no nuclear attacks or one with attacks repeated every few days or so, are not reflected i n the damage estimates available from these studies and included in this report

Five questions provided the focus for the analytical results exam in this study:

1. How many people would be killed by:
   – Prompt effects of nuclear explosions?
   – Fallout radiation?
2. What number of nonfatal but disubling injuries could be expected?
3. What areas would possibly receive damaging levels of overpressure and how many people live o r work i n those areas?
4. What areas **would** receive what levels of fallout contamination ?
5. What would be the possible extent of fire damage, and what mechanisms would create it?

Answers to these questions, as provided in the various studies used in this analysis, are given i n the following section.

SUMMARY OF RESULTS

In viewing the estimated direct effects of nuclear attacks, particularly population casualties, it is important to focus on the *relative* numbers for the various nuclear attack scenarios examined, as opposed to the absolute. The analyses on which these estimates are based do not take into account the many imponderable associated with such a cataclysmic event, the majority of which would cause higher levels of human devastation than are indicated by the analyses of hypothetical attacks. A significant imponderable is the uncertainty of human behavior. Would people really react as planned and as assumed in the computer models? Also, our ability to simulate even the immediate direct effects from thousands of nuclear detonations based on data extrapolateions from single bursts is suspect because of its inherent uncertainties. And, finally, the inability to assess the longer term prospects for the immediate survivors, which would depend not only on the availability of subsistence levels of food, medical supplies, etc., but also on how quickly they could adapt to a radically unfamiliar environment and social structure, further limits the validity of these estimates as a net assessment of the damage to be expected as a result of nuclear war.

Population Damage

Table D-1 summarizes in terms of total national population high- and low-range fatality estimates derived from the various analyses used for this report. In view of the many uncertain factors involved in such estimates, it is not possible to synthesize a "best estimate" range from the results of the studies used for this analyses.

Differences within and between the low and high ranges listed in the table are due primarily to differences in force alert status, weapons laydown, population protection level, population data base, and/or evacuation scheme assumed.

Table 0-1 .–OTA Attack Cases–Executive Branch Fatality Estimates

Case	OTA attack cases	Population posture	Percent of national fatalities	
			Low range	High range
2	Small attack on U.S.		(not available)	
	Small attack on U.S.S.R.		(not available)	
3	Attack on U.S. ICBMs	In-place	1-3	8-10
	Attack on Soviet ICBMs	In-place	< 1	1-4
	Attack on U.S. CF	In-place	< 1-5	7-11
		Evac.	–	5-7
	Attack on Soviet CF	In-place	1	1-5
		Evac.	1-2	
4	Attack on U.S. CF, OMT, & ECON	In-place	35-50	59-77
		Evac.	10-26	32-43
	Attack on Soviet CF, OMT, & ECON	In-place	20-32	26-40
		Evac.	9-14	
3 (excursion)	Attack on U.S. CF and OMT	In-place	14-23	26-27
		Evac.	–	18-25
	Attack on Soviet CF and OMT	In-place	5-17	22-24
		Evac.	6-9	
4 (excursion)	Attack on U.S. CF, OMT, ECON, and population	In-place	–	60-88
		Evac.	28-40	47-51
	Attack on Soviet CF, OMT, ECON, and population	In-place	–	40-50
		Evac.	22-46	

NOTE: CF = counterforce targets. OMT = other military targets. ECON = economic targets.

For Soviet First-Strike Attacks on the United States, Against:

ICBM Targets Only (Case 3). – The 1- to 3-percent spread in the low range results from assureing two 550-kiloton (kt) optimum height-of-burst (OPT HOB) weapons per silo (1-percent national fatalities) versus assureing one 550-kt OPT HOB and one surface burst 550-kt weapon per silo (3-percent national fatalities). The 8- to 10-percent spread in the high range results from assuming one 3-megaton (Mt) OPT HOB and one surface-burst 3-Mt weapon per silo (8 percent) versus assureing two 3-Mt surface bursts per silo (1 O percent). The difference between the ranges is due to the difference in the yield of the assumed weapons.

All Counterforce Targets (Case 3).–The less than 1-to 3-percent low range for *in-p/ace U.S. population* fatalities results from the difference in fallout protection levels assumed by DOD and AC DA. The less than l-percent value assumes an enhanced U.S. in-place fallout protection program that would provide a fallout protection factor (PF) of at least 25 for the entire population. The 3-percent value assumes in-place fallout shelters providing PFs of 10 to 1,000 and that 90 percent of the population would use the shelters. The unprotected portion of the population is assumed to be equally divided between a PF of 3 and 6. The 7- to 11-percent high range also results from differences in fallout protection levels assumed by DOD and AC DA. In this case, the 7-percent value assumes the current U.S. in-place fallout protection program. PFs as low as 5 are assumed for about one-half of the U.S. rural population, and PFs as low as 15 for one-quarter of U.S. urban population. The 1 l-percent value assumes essentially no U.S. civil defense program and a PF of 3 for the entire U.S. population. The difference between the ranges reflects the differences in the assumed fallout protection levels.

All Counterforce Targets (Case 3).– The 5- to 7-percent high range for *evacuated U.S. population* fatalities reflects ACDA's assumptions concerning the amount of fallout protection available for the combined rural and evacuated urban population. The 5-percent value assumes 66 percent of the total exurban population would be able to obtain fallout protection of 10 to 40 PF. Those persons not protected were assumed to be equally divided between between a PF of 3 and of 6. The 7-percent value assumes only **33** percent of the total exurban population would be able to obtain fallout protection of 10 to 40 PF. The rest were assumed to be equally divided between a PF of **3** and 6. This range of values is listed as "high" because it results from assuming that no expedient fallout protection upgrading could be achieved by the evacuated population.

Counterforce, Other Military Targets, and Economic Targets (Case 4). — The 35- to 50-percent low range for *in-p/ace U.S. population* fatalities results from assuming day-to-day alert (35-percent fatalities) versus generated forces (50-percent fatalities), and that 90 percent of the U.S. population are sheltered in available civil defense shelters. The 59- to 77-percent high range reflects differences in weapons laydown and population protection level. The 59-percent value assumes a generated forces Soviet attack with about 60 percent of the weapons air burst and that only 66 percent of the U.S. population are sheltered in available civil defense shelters. The 77-percent value also assumed a generated forces attack, but with all weapons ground burst and no civil defense sheltering of the population. The reasons for the differences between the ranges are the differences in assumed population protection levels and weapons laydown.

Counterforce, Other Military Targets, and Economic Targets (Case 4). — The 10- to 26-percent low range for *evacuated U.S. population* fatalities results from differences in assumed weapons laydown. The 10-percent value assumes about half the attacking weapons are air burst. The 26-percent value assumes all weapons are ground burst. Both values in the low range assume expedient upgrading of fallout protection could be achieved by the evacuated population, that is, a fallout PF of at least 25 for the entire U.S. population. The 32- to 43-percent high range reflects ACDA's assumptions as to the fallout protection that could be achieved by the evacuated population. The 32-percent

value assumes 66 percent of the total exurban population would be able to obtain fallout protection of 10 to 40 PF. The 43-percent value assumes only 33 percent could obtain such protection. Those persons not protected in each case were assumed to be equally divided between a PF of 3 and of 6. The difference between the ranges can be attributed to: 1) The differences in the levels of fallout protection assumed. The low range assumes expedient upgrading. 2) The less extensive evacuation scheme used by ACDA. The low range (DOD results) assumes 80 percent of all U.S. risk area population is evacuated. The high range (ACDA results) assumes only cities of more than 25,000 population are evacuated. 3) The larger, about 1,000 more equivalent megatons (EMT), attack laydown used by ACDA.

Counterforce and Other Military Targets (Case 3 excursion).—Within the low range, the spread in values, for *U.S. population in-place,* results from day-to-day alert versus generated forces attacks. Within the high range, the spread reflects day-to-day alert versus generated forces plus low protection levels (no civil defense assumed) versus an assumed in-place civil defense population posture. The difference between ranges is primarily due to the difference in assumed population protection levels.

Counterforce and Other Military Targets (Case 3 excursion).—The 18- to 25-percent range for *U.S. population evacuated* is based on ACDA analysis and reflects ACDA's assumptions as to the percent of exurban population that would have sheltering available in host areas. The 18 percent corresponds to 66 percent having available shelters and the 25 percent corresponds to 33 percent having available such shelters. This range probably represents high estimates because of the evacuation scheme assumed by ACDA. The 47-percent value assumes degraded protection levels based on DOD's sensitivity analysis, and evacuation of 80 percent of all risk area population. The 51-percent value also reflects degraded protection levels, only 33 percent of the total exurban population are able to obtain protection in rural shelters, and ACDA's less extensive relocation scheme. Once again, the range also retlects the effect of ground bursting all weapons versus air bursting about half the weapens The difference between the ranges is due to differences in assumed population protection levels,

Counterforce, Other Military Targets, Economic, and Population (Case 4 excursion).— In this case the 60- to 80-percent fatality range for U.S. population in-place reflects the impact of the protection levels assumed. The 60-percent value corresponds to the high protection levels used by DC PA. The 88-percent value corresponds to the more modest levels assumed by OSD analysts. This range is listed as "high" because of the severity (all ground bursts and all but 10- to 15-percent of Soviet weapons) of the attack used.

Counterforce, Other Military Targets, Economic, and Population **(Case** 4 excursion). — The 28- to 40- percent low range for *U.S. population evacuated* reflects the d inferences between DOD's and ACDA's assumptions concerning levels of fallout protection, evacuation scheme, and weapons laydown. The 28-percent value assumes expedient upgraded protection levels as specified by DCPA and evacuation of 80 percent of all risk area population. The 40-percent value reflects ACDA's less extensive evacuation scheme (only cities with population greater than 25,000 are evacuated) and no expedient upgrading of protection levels. In addition, the 28-percent value results from an attack with all weapons ground burst and the 40- percent value assumes about half the values are air burst. The 47- to 51-percent high range also results from differences in fallout protection, evacuation scheme, and weapons laydown. In this case the 47-percent value assumes degraded protection levels based on DOD's sensitivity analysis, and evacuation of 80 percent of all risk area population. The 51-percent value also reflects degraded protection levels, only 33 percent of the total exurban population are able to obtain protection in rural shelters, and AC DA's less-extensive relocation scheme. Once again, the range also reflects the effect of ground bursting all weapons versus air bursting about half the weapons. The difference between the ranges is

clue to differences in assumed population protection levels.

For U.S. Retaliatory Attacks on the U. S. S. R., Against:

ICBM Targets Only (Case 3).– The low, less than l-percent, value assumes one OPT HOB weapon per silo In this case fatalities are less than 1 percent for attacks using only 40-kt, only 200-kt, or only 1-Mt weapons The high range of 1 to 4 percent results from assuming one ground-burst weapon per silo. In this case the 1-percent value assumes only 200-kt weapons and the 4-percent value assumes only 1-Mt weapons are used. The differences between the range reflects the effect of OPT HOB weapons versus ground bursting al I weapons.

All Counterforce Targets (Case 3).– The less than 1-percent low value for *in-p/ace Soviet population* assumes relatively good fallout protection for the entire Soviet population and, in the case of ACDA's analysis, a U.S. attack based on a preplanned laydown using in part U.S. ICBMs that do not survive the Soviet first strike. The high range reflects differences in weapons laydown, population protection levels, and data bases used by ACDA and DOD. The less than l-percent value reflects ACDA's preplanned attack laydown, relatively good fat lout protection assumptions, and use of a coarser Soviet population data base. The 5-percent value reflects DOD's attack lay down, which does not attrite U.S. weapons due to a Soviet first strike, lower fallout protection assumptions, and use of a finer Soviet population data base The difference between the ranges results from all these differences i n dassumptions.

All Counterforce Targets (Case 3).– The less than 1- to 2-percent variation results from differences in population protection levels assumed by ACDA for *evacuated Soviet population.* The less than 1 -percent value assumes 66 percent of the exurban population use available sheltering. Those not using such sheltering are assigned protection levels of 3 and 6 in equal shares. It is difficult to judge whether this represents a low or high range On one hand the range could be considered on the low side because of the coarseness of the Soviet data base used by ACDA. Conversely, the evacuation scheme assumed by ACDA would suggest that it be considered a high range.

Counterforce, Other Military Targets, and Economic Targets (Case 4). — l-he 20- to 32-percent low range for *in-place Soviet population* fatalit results from d inferences i n force alert status and weapons laydown assumed T he 20-percent value reflects day-to-day alert forces and an attack using only 40-kt air-burst weapons against economic targets. The 32-percent value reflects generated forces and an attack using d mixture of weapens against economic targets. The 26- to 40-percent high range reflects differences between ACDA and DOD assumptions. The 26-percent value from ACDA analysis assumes relatively good population protection levels and a lower amount of EMT used against economic tar-gets than assumed i n the DOD analysis. The W-percent value from DOD analysis reflect lower population protection levels, a finer population data base, and a larger attack against economic targets than used i n the ACDA analysis. The difference i n assumptions made by DOD, AC DA, and the interagency intelligence group.

Counterforce, Other Military Targets, and Economic Targets (Case 4). — The 9- to **14-percent** range reflects the difference in poplation protection levels used by ACDA for evacuated *Soviet population.* The 9-percent value assumes 66 percent use available shelters The 14 percent assumes only 33 percent use available shelters It is difficult to judge whether this reflects a low or high range. The coarseness of the Soviet data base used by AC DA would suggest it be treated as a low range Conversely, the ACDA evacuation scheme would suggest it be considered a high range.

Counter-force and Other Military Targets (Case 3 excursion) .—The differences within both ranges for *Soviet population in-p/ace* reflects the variation in protection levels assumed by AC DA. The difference between the ranges is due to the alert status of U.S. forces used.

Counterforce and Other Military Targets (Case 3 excursion).–The 6- to 9-percent range

reflects the variation in protection levels assumed by ACDA for *evacuated Soviet population, 66* percent use available shelters versus **33 percent. As** in the previous cases, with Soviet population evacuated, it is difficult to judge if this is a low or high range of fatalities.

Counterforce, Other Military Targets, Economic, and Population (Case 4 excursion). — Fatality estimates range from 40 to 50 percent for Soviet *population in-p/ace* based on DOD analysis. The variation is primarily due to differences in assumed population protection levels. Given the rather low protection levels assumed by DOD, the range probably represents the high level of Soviet fatalities.

Counterforce, Other Military Targets, Economic, and Population (Case 4 excursion). — Fatality estimates range from 22 to 26 percent for Soviet *population evacuated* based on ACDA analysis. The variation reflects differences in assumed population protection levels; 66 percent use available shelters versus 33 percent. Once again it is difficult to judge whether this is a high or low range. The coarse data base used by ACDA suggests their estimates are low, but the evacuation scheme suggests they might be high.

In examining the fatality ranges listed in table D-1 it should be noted that the differences between U.S. and Soviet fatality levels for comparable attacks and population postures can be primarily attributed to:

- The nature of the nuclear attacks assumed in the various studies; that is, the assumption that the Soviets attack first and the United States retaliates in the various attack scenarios examined,
- The higher yields of Soviet weapons, which result in significantly higher levels of nuclear yield detonating in the United States than the U.S.S.R. for comparable attack cases.

Although the data on nonfatal injuries available from the studies used in this analysis are quite limited, the results suggest that:

- For attacks against ICBMs or counterforce target sets, nonfatal injuries would about equal fatalities.
- For attacks that include economic targets, but not population per se, nonfatal injuries would vary from about 20 to 40 percent of total casualties.
- For attacks including population, nonfatal injuries vary from about 8 to 25 percent of total casualties.

Military and Economic Damage

Unlike population damage levels, which (except for excursions to Case 4) result only collaterally from attacks on other target sets, damage levels against military and economic target sets are input objectives used in structuring the attack laydowns examined in the various analyses on which this report is based. Damage levels attained against these target systems in the studies examined in this analysis were:

For Soviet First-Strike Attacks Against the United States:

Counterforce Targets (Percent Total Damaged).— ICBMs (42 to 90 percent), SAC bomber bases (90 to 99 percent), and submarine support facilities (90 to 99 percent).

Other Military Targets (Percent Installations Damaged). –Major military leadership facilities (90 to 95 percent), State capitals (95 percent), DCPA and FPA emergency operating centers (95 percent), and other military installations (77 to 90 percent).

Economic Targets. – 70- to 90-percent damage of the national manufacturing value of the economic targets attacked.

For U.S. Retaliatory Attacks Against the U. S. S. R.:

Counterforce Targets (Percent Total Damaged).— Bomber bases (70 to 90 percent).

Other Military Targets (Percent Installations Damaged).– Major military leadership facil-

ities (70 to 90 percent), major political leadership facilities **(7o to 90 percent), and other miliitary install at** ions **(20 to 50 percent).**

Economic Targets. – 70- to 90-percent damage of the national manufacturing value added plus capital replacement cost of the economic targets attacked.

As in the case of population fatalities, the **differences between U.S. and Soviet damage** levels against strategic forces, other military **targets, and economic targets can be attrib-**uted to the assumption that the Soviets strike first and to the larger yields of Soviet weapons.