CHAPTER 4

Simulated U.S. and Chinese Nuclear Strikes

The analysis of the numbers, characteristics and deployment of the strategic nuclear forces of China and the United States presented in this study raises the question of what would be the consequences if these forces were ever used. A nuclear exchange between the United States and China is clearly a remote possibility – a situation would have to arise that exceeded any crisis of the Cold War. Ironically, success of a nuclear deterrent strategy is measured by the fact that weapons are never used in the first place. Nevertheless, the nuclear capabilities of China and the United States are assessed by their respective political and military leadership in part by the measures of targeting and how effectively targets are destroyed. This chapter explores the consequences of two nuclear strike scenarios: An attack by U.S. submarine-launched ballistic missiles on China's long-range ICBMs (DF-5A/CSS-4 Mod 2), and a strike by Chinese forces on cities in the continental United States.

Even a rough comparison of the nuclear forces of China and the United States raises basic questions about their deterrent relationship, as the United States currently possesses overwhelming nuclear superiority. The United States has in excess of 2,000 warheads capable of hitting China on short notice. A small percentage of the U.S. arsenal could be targeted against all Chinese strategic nuclear systems, Command and Control (C2) sites and major conventional military assets. Although not thought to be part of the current U.S. war plans, an even smaller percentage of the U.S. strategic nuclear arsenal could be targeted against Chinese cities to cause massive civilian and industrial damage.

China deploys an estimated 20 ICBMs capable of targeting U.S. cities. In the future, the U.S. National Missile Defense system may undermine China's nuclear deterrent against the United States. Given the imbalance of forces, how effective would a first strike be against China's long-range ICBMs, and what would be the effects on Chinese civilians and the environment? Some have argued that "the United States [today] stands on the verge of attaining nuclear primacy" and "could conceivably disarm the long-range nuclear arsenals of Russia or China with a nuclear first strike."[486] But our realistic calculations of what effects would occur if only a few Chinese ICBM warheads survived indicate that the United States would need to have complete confidence that a preemptive strike had managed to destroy all of China's long-range missiles.

Calculating the Effects of Nuclear Weapons

In order to quantitatively explore these scenarios in greater depth, we utilized a combination of Geographical Information System (GIS) software, including GoogleEarth and the U.S. government computer code, Hazard Prediction Assessment Capability (HPAC versions 3.2.1 and 4.04).[487] Scenarios that can be simulated using HPAC include the use of a radiological, biological, chemical or nuclear weapon, accidents involving such weapons, and accidental releases at WMD facilities. For this study we utilized the component models of HPAC that calculate the effects of nuclear explosions and are based on legacy code developed during the Cold War. Casualties are calculated in HPAC using the LandScan world population database developed by the U.S. Oak Ridge National Laboratory.[488]

HPAC version 4.04, the Nuclear Weapons Special Edition (NWPNSE) model calculates the effects of a single nuclear explosion, for example, terrorists using a nuclear device in an urban setting. Interestingly, at least one previous version of HPAC (version 3.2.1) had a nuclear weapons model that was compatible with DOD nuclear targeting software. The parameters of a nuclear strike – including the latitude and longitude of the ground zero, weapon yield, height-of-burst and fission fraction – could be read from a "strike file" to calculate the combined effects of as many as 8,000 nuclear detonations. Figure 86 displays an example of a STRATCOM-formatted strike file provided as a sample file in the HPAC help documentation. The coordinates of the ground zeros are listed in the first column – actual ICBM silos in Russia.[489]

Figure 86:
STRATCOM-Formatted Nuclear Strike File For HPAC

```
RS562340N0373900E1000.0  600  400 99                W1   V01      20000UN01S0101
RS561740N0373400E 900.0  500  400 99                W1   V21      20000UN21S2121
RS561840N0374700E 800.0  400  300 99                W1   V01      20000UN01S0101
RS561240N0374100E 700.0  300  300 99                W1   V21      20000UN21S2121
RS561420N0382030E 600.0  200  200 99                W1   V01      20000UN01S0101
RS561420N0382630E 500.0  100  200 99                W1   V01      20000UN01S0101
RS561420N0383400E 400.0  200  200 99                W1   V01      20000UN01S0101
RS561420N0383830E 300.0  300  300 99                W1   V01      20000UN01S0101
```

A STRATCOM-formatted nuclear strike file for input to HPAC. The columns of numbers refer to the coordinates of the target, nuclear explosive yield, height-of-burst and other weapon and target parameters.

We created sets of such strike files for the scenarios modeled in this chapter to more efficiently track various parameters. For example, one key variable for fall-out calculations are the prevailing winds at elevations from ground level to the top of the initial "mushroom cloud." HPAC provides both historical weather data and the capability to access real-time meteorological data and forecasts from both classified and unclassified DOD servers.

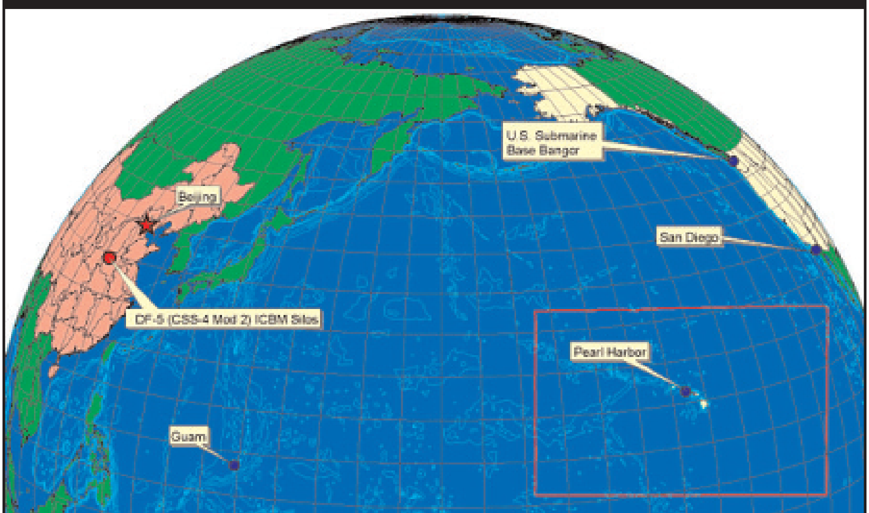
Scenario One: U.S. Nuclear Strike Against Chinese Long-Range ICBMs

In the first hypothetical nuclear attack scenario, U.S. ballistic missile submarines stationed in the Pacific Ocean fire Trident II D5 submarine launched ballistic missiles (SLBMs) at Chinese DF-5A missile silos. As discussed above the U.S. Trident force has evolved to become the main element in U.S. nuclear war plans against China. U.S. long-range bombers based in the Pacific region or flown from the United States would require a relatively long time to reach their targets and would have to penetrate China's airspace. The U.S. ICBM force, based in silos in the upper Midwest, would have to over-fly Russia and risk triggering the remnants of the Soviet early-warning system, or worse. Since the end of the Cold War, U.S. nuclear forces have been shifted to the Pacific in the form of additional Trident SSBNs based at the Submarine Base at Bangor, Washington. For these reasons we developed a scenario involving a Trident strike against the DF-5A, the sole Chinese nuclear weapon system capable of hitting the continental United States (CONUS) and China's primary deterrent against the United States.

U.S. Trident SSBNs based at the Naval Submarine Base Bangor in Washington deterrent patrols in the Pacific Ocean, and cover targets in China and in the Russian Siberian and Far East regions. The missiles on two submarines on Hard Alert are within range of their targets and ready for launch with short notice (on 15-minute launch readiness). Each submarine is loaded with 24 missiles with up to six warheads each for a total of as many as 288 warheads on patrol at a given time. Additional deployed submarines could be placed on Hard Alert within relatively short time.

For this scenario we have chosen a hypothetical deployment area for U.S. ballistic missile submarines, as the actual deployment areas of these boats are classified. We chose the hypothetical deployment area to surround the island of Hawaii. Figure 87 shows a map of the bathymetry of the Pacific Ocean (light blue lines) overlaid with the hypothetical deterrent patrol area shown in red. This hypothetical deterrent patrol area measures 386,100 square miles (1 million square km) and the center of the patrol area is approximately 1,860 miles (3,000 km) from the vessels' homeport at Naval Submarine Base Bangor.

Figure 87:
Hypothetical U.S. SSBN Deterrent Patrol Area in Pacific



Hypothetical U.S. ballistic missile submarine deterrent patrol area (in red) avoids overflying Russian with Trident II D5 SLBMs in a potential strike on China's DF-5 ICBMs. U.S. SSBNs regularly make port calls to Hawaii, sometimes San Diego, and occasionally Guam, as part of the Strategic Continuity of Operations (SCOOP) exercise program that practices forward refit of the submarines in case their main base at Bangor is destroyed.

The targets for these nuclear submarines include the DF-5A ICBM silo launch area at Lunoning (in China's Henan Province). The Luoning DF-5A launch group is reportedly "buried deep in the mountains 150 miles (240 km) east of Xian … near the town of Luoning."[490] These targets are approximately 4,350 miles (7,000 km) from the hypothetical U.S. SSBN deployment area and Trident II D5 launch site. The time-of-flight of the U.S. Trident SLBMs to the Chinese targets would be therefore be about 30 minutes.[491]

Unfortunately we have not yet positively identified Chinese silo locations based on the available GoogleEarth high-resolution imagery or additional QuickBird imagery purchased from DigitalGlobe for this project. Above-ground structures associated with an ICBM silo may not be readily apparent even at the resolution offered by the QuickBird satellite. For example, Figure 88 shows a GoogleEarth-hosted QuickBird image of a U.S. and Russian ICBM silo, where the location was previously published in the START data exchange.

In order to construct specific silo target locations for a U.S. hypothetical nuclear attack scenario against the Chinese DF-5 force, we used satellite imagery data from GoogleEarth combined with map data from the Operational Navigation Chart (ONC) map series published by the U.S. Geological Survey (USGS) National Imagery and Mapping Agency (NIMA). Figure 89 displays a map of 20 hypothetical silo target locations overlaid on a GoogleEarth background, consisting of NaturalVue (a 49-foot (15-meter) resolution LandSat composite) and a swath of QuickBird imagery 2.3-foot (0.7-meter) resolution). The hypothetical Chinese silo targets at Luoning were selected with a separation distance of approximately 6.2 miles (10 km), consistent with the separation distance of U.S. and Soviet-built ICBM silos presumably to preclude the possibility of one attacking warhead damaging more than one target silo.

A fundamental parameter of a nuclear strike scenario is the height-of-burst (HOB) of the attacking warheads. The HOB, along with the nuclear warhead yield and accuracy, determines the probability of achieving a certain level of damage to a target, referred to as the "kill probability" or "PK." It is known that the ICBM silos in the United States and Russia have been engineered to withstand a certain amount of damage from nuclear attacks. Indeed, for the most modern, hardened Russian ICBM silos the target must effectively lie in the crater created by the nuclear explosion to achieve a high kill probability. In general, to destroy a hardened silo it is necessary to attack with an accurate, high-yield nuclear weapon detonated on the ground.

Figure 88:
Satellite Images of U.S. and Russian ICBM Silos

U.S. and Russian ICBM silos as seen in QuickBird high-resolution satellite imagery provided by GoogleEarth. The upper figure Minuteman III ICBM Silo #E-11 in McLean County, North Dakota associated with 91st Space Wing at Minot. The lower figure is SS-19 Launch Group #4, Silo #8 at the Kosel'sk missile field located approximately 155 miles (250 km) south-west of Moscow. The United States and Russia provided each other ICBM silo coordinates and other data as part of START I.

Images: GoogleEarth/DigitalGlobe

Figure 89:
Hypothetical DF-5A Silo Targets

Hypothetical Chinese DF-5A (CSS-4 Mod 2) missile silo targets near the city of Luoning. Image from GoogleEarth (note the swath of high-resolution QuickBird imagery covering the city of Luoning and extending south-east). This image is centered at 34.35 North, 111.49 East. The headquarters of the second artillery corps group which mans the ICBMs is reportedly located at Luoyang.

Image: GoogleEarth/DigitalGlobe

In a 2001 report, NRDC used the Pentagon's own methodology to calculate the probability of achieving severe damage to Russian ICBM silos in strikes by U.S. attacking warheads.[492] The report found that both ground bursts and multiple strikes were necessary to achieve a high probability of destroying the newest hardened Russian silos with W88 or W76 warheads. We do not know the hardness of Chinese DF-5A silos, but given their design and construction in the late 1970s and 1980s, we assume that Chinese silos are hardened to at least the extent of first or second generation Russian ICBM silos.

The HOB of a nuclear detonation also is an important factor determining the intensity and extent of fallout. If a nuclear explosion occurs above a certain altitude – and the resulting fireball is well above the surface of the Earth – then the radioactive debris from the explosion is in the form of very light particles that are lofted high into the atmosphere, circulate around the hemisphere in which the explosion takes place, and return to the Earth days or weeks later much weaker and diluted. If the nuclear fireball touches the Earth's surface then the radioactive debris from the explosion mixes with material gouged from the ground and the resulting heavier radioactive particles are deposited in the region of the explosion.[493] For a

455 kt nuclear explosion (the yield of the U.S. W88 warhead) the threshold for fallout is a HOB of 2,116 feet (645 meters), and for a 100 kiloton nuclear explosion (the yield of the U.S. W76 warhead) the threshold for fallout is 1,135 feet (346 meters).[494] These HOB thresholds are much higher than required to severely damage known ICBM silos, so our scenario assumes ground bursts in the nuclear strikes.

Our base case for this hypothetical scenario examines the consequences of 20 W88 warheads (each W88 warhead has a yield of 455 kt) striking the hypothetical DF-5A silo targets as ground bursts. We examined additional cases that looked at variations in the number of attacking W88 warheads and the use of lower-yield (100 kt) W76 warheads.

We begin to examine the results of the HPAC calculations with the first case: 20 Trident W88 warheads attacking 20 DF-5A silos. As noted above, the selection of ground bursts maximizes the extent of fallout. We sampled historical weather data for the region around Luoning for each month of the year, and found that the prevailing winds blow the fallout east-south-east of the silo target locations. It should be noted we did not include elevation data in these calculations. For lower-yield weapons this approximation would have a significant effect on the fallout pattern in a mountainous region (the radioactivity could be contained by mountains in the path of the drifting fallout cloud). However, for a warhead yield of 455 kt the height of the “mushroom cloud” reaches approximately 39,370 feet (12,000 meters), and for a warhead yield of 100 kt the cloud height is calculated to be 29,530 feet (9,000 meters).[495] According to GoogleEarth’s elevation data the height of the mountains flanking the city of Luoning only reaches approximately 5,900 feet (1,800 meters).

The effects of a nuclear explosion are commonly divided into “prompt” effects and fallout. The prompt effects are the blast wave (including high winds), thermal (heat) radiation, and the initial radiation, which is a burst of neutrons and gamma rays occurring within the first minute after the nuclear explosion. Fallout may continue as long as 24 hours after the nuclear explosion and potentially cover a much larger area than impacted by the prompt effects. In HPAC, casualties are calculated separately for prompt nuclear weapons effects and for fallout, and under separate input assumptions that people exposed to the nuclear weapons effects are either inside building structures (sheltered) or out in the open. In general, casualty estimates from prompt nuclear effects are slightly higher for people in structures and casualty estimates from fallout are much higher for people out in the open. These trends are reflected in the current calculation.

Roughly 100,000 casualties from prompt nuclear effects are estimated for nearby populations – 6.2 to 12.4 miles (10 to 20 km) from the target silos. For people out in the open at the time of the attack, and estimated 75 percent of the casualties would be fatalities, while for people in building structures at the time of the attack, 40 percent of casualties would be fatalities. HPAC's estimate of prompt casualties clearly relies on the rough assessment of the region's population in LandScan – the zone within 6.2 to 12.4 miles (10-20 km) of the hypothetical silo locations does not include any major towns as viewed in GoogleEarth.

However, the most widespread result of the attack would be fallout. The extent of the fallout pattern is determined by the quantity of radioactive material produced in the explosion and the prevailing wind speed and direction for elevations reached by the initial fallout cloud. For all HPAC cases run, we found that the historical data on prevailing winds in the region blew fallout in an easterly-south-easterly direction. For the months of March and February, we found that higher-speed winds created a longer, narrower fallout pattern, and for other months crosswinds widened and shortened the fallout pattern. Given that a crisis leading to a nuclear strike on these Chinese targets could occur in principle at any time, either fallout pattern could be relevant to a casualty analysis.

With respect to the accuracy of the fallout calculation, the zones of more intense fallout are more accurately reproduced with fallout codes by comparing them with measured fallout patterns from the U.S. and British above-ground nuclear testing program. This is in part because the zones of more intense fallout occur closer to the ground zero sooner after the nuclear explosion – involving less spatial and temporal variations in the prevailing winds and modeling the behavior of relatively heavier fallout particles.

Table 18 lists the health effects for a given radiation exposure (REM). The output of the HPAC calculations used in the study integrated the dose to people over the first 48 hours after the strike. Much of the radiation dose to survivors would occur in this time period, as the intensity of the fallout radiation drops to one percent of its initial value after two days (of course for the most intense zones of fallout – more than 100 times the threshold for health effects – continued exposure would be dangerous). Long-term effects of fallout include contamination of the environment and agriculture, displacement of refugees – many of whom would require medical attention and access to uncontaminated food and water, and the concentration of fallout in "hot spots" over time from precipitation, as occurred in the Chernobyl accident.

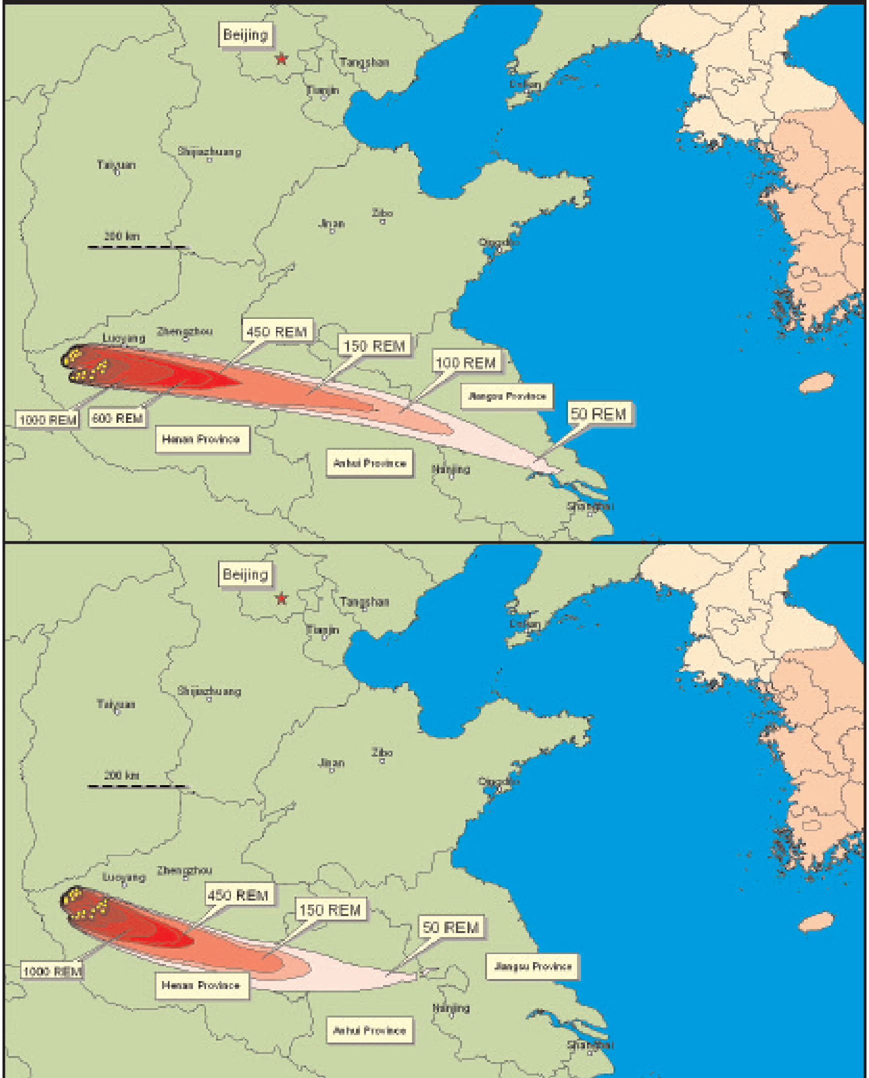
Table 18:
Effects of Radiation[496]

Dose range (REM free air)	Onset & duration of initial symptoms	Medical care & disposition
0 – 70	6 - 12 hr; none to slight transient headache, nausea; vomiting in 5% at upper end of dose range.	No medical care, return to duty.
70 – 150	2 - 20 hr; transient mild nausea and vomiting in 5 - 30%.	No medical care, return to duty.
150 – 300	2 hr - 3 days: transient to moderate nausea and vomiting in 20-70%; mild to moderate fatigability and weakness in 25 - 60%.	3 - 5 wk: medical care for 10 - 50%. High end of range death in > 10%. Survivors return to duty.
300 - 530	2 hr - 3 days: transient nausea & vomiting in 50 - 90%; moderate fatigability in 50 - 90%.	2 - 5 wk: medical care for 10 - 80%. Low end of range < 10% deaths; high end death > 50%. Survivors return to duty.
530 - 830	2 hr - 2 days: moderate to severe nausea & vomiting in 80 - 100%. 2 hr - 6 wk: moderate to severe fatigability and weakness in 90 - 100%.	10 days - 5 wk: medical care for 50 - 100%. Low end of range death > 50% at 6 wk. High end death for 99%.
830 - 3000	30 min - 2 days: severe nausea, vomiting, fatigability, weakness, dizziness, disorientation; moderate to severe fluid imbalance, headache.	1000 REM: 4 - 6 days medical care for 100%; 100% deaths at 2 - 3 wk. 3000 REM: 3 - 4 days medical care for 100%; 100% death at 5 - 10 days.
3000 – 8000	30 min - 5 days: severe nausea, vomiting, fatigability, weakness, dizziness, disorientation, fluid imbalance, headache.	4500 REM: 6hr to 1 - 2 days; medical care for 100%; 100% deaths at 2 - 3 days.
over 8000	30 min - 1 day: severe prolonged nausea, vomiting, fatigability, weakness, dizziness, disorientation, fluid imbalance, headache.	8000 REM: medical care immediate - 1 day; 100% deaths at 1 day.

In the case of 20 W88 warheads detonating on the Luoning ICBM silos, we found that the combined fallout patterns would create hazardous conditions reaching over 620 miles (1,000 km) from ground zero. Fallout zones where the 48-hour dose to exposed people exceeds 150 REM would cover 12,360 to 21,620 square miles (32,000 to 56,000 km^2). In those zones, survivors would experience severe radiation sickness from hours to days after the explosion, or death. This land mass exceeds the area of the states of Massachusetts and Connecticut. The fallout zone for a 48-hour exposure exceeding 450 REM (death 50 percent likely) cover 6,950 to 14,670 square miles (18,000 to 38,000 km^2), and the most intense zone of fallout exceeding 600 REM (death likely) would cover an area of 4,633 to 5,405 square miles (12,000 to 14,000 km^2). The two types of fallout patterns (June and December or all other months of the year) calculated for the 20 W88 are shown in Figure 90.

The calculated numbers of casualties depends strongly on whether people down-wind of the nuclear explosions are sheltered for the first 48 hours after the attack

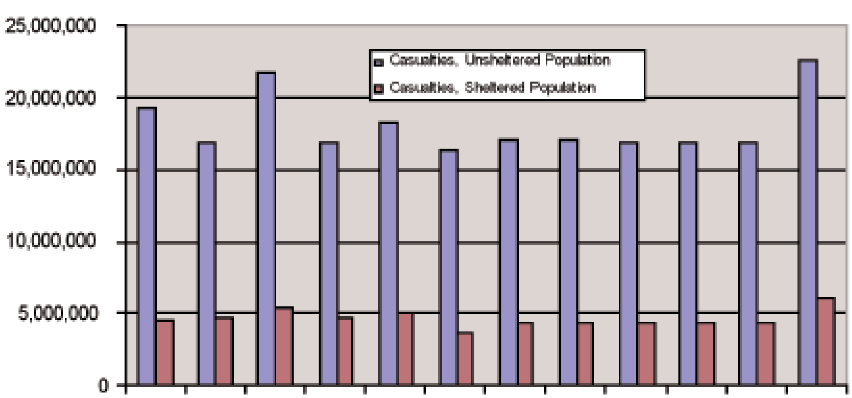
Figure 90:
Fallout Patters For Hypothetical U.S. Strike On Chinese DF-5A Silos



Calculated fallout patterns from the 20 W88 warhead strike on the DF-5A (CSS-4 Mod 2) silos at Luoning for winds typical of December (above) and June (below). Note: The precise locations of Chinese DF-5A silos are not known.

or are out in the open. The average dose received is likely to be some averaging of the two estimates, as survivors move to other areas. A smaller variation in the number of calculated casualties results from monthly changes in the average prevailing winds. We found that winds typical of the months of March and December more efficiently dispersed the fallout from the nuclear strike. Figure 91 plots the calculated casualties as a function of month of the year and sheltering. The average number of casualties under the assumption of no sheltering would be 18 million, and the average number of casualties – assuming all people were sheltered in structures – would be 4.7 million. Thus because the strike occurs in a sparsely populated area, more than 98 percent of expected casualties would arise from fallout instead of the prompt nuclear effects of blast, thermal radiation and initial radiation. For unsheltered people, we found that two-thirds of the casualties would be fatalities, while in the calculation assuming sheltering, only 20 percent of the casualties would be fatalities.

Figure 91:
Casualties From U.S. Strike Against Chinese DF-5A Silos



Casualty calculations from a hypothetical U.S. strike with 20 W88 warheads against 20 DF-5A Luoning silos.

If we assume that the net result of the strike is an average of the two assumptions regarding sheltering, then the expected fatalities from the strike on the Luoning silo field by 20 U.S. W88 warheads would be 3.5 million, and the number of injuries (predominantly radiation sickness) would be 7.7 million.

The base case for the strike on the Luoning DF-5A silos involved a total yield of 9.5 Mt. We also considered the use of two or three times as many W88 warheads and the use of the W76 warhead instead of the W88. Therefore, these other cases looked at total nuclear explosive yields of 2 Mt through almost 30 Mt. Table 19 illustrates the casualty calculation given these other cases.

Table 19: Casualties For Variations of U.S. Hypothetical Strike Against Chinese DF-5A Silos

Targets	Number and Type of Attacking U.S.Warheads	Total Yield of Nuclear Strike	Average Casualties	Average Fatalities	Average Injuries (radiation sickness)
20 DF-5A silos	20 W76 Warheads	2.0 Megatons	1.58 million	460,000	1.12 million
20 DF-5A silos and 20 decoy silos - or multiple strikes on silos	40 W76 Warheads	4.0 Megatons	2.85 million	900,000	1.95 million
20 DF-5A silos and 20 decoy silos - or multiple strikes on silos	W76 Warheads	6.0 Megatons	4.0 million	1.3 million	2.6 million
20 DF-5A silos – Base Case	20 W88	9.5 Megatons	11.2 million	3.5 million	7.7 million
20 DF-5A silos and 20 decoy silos - or multiple strikes on silos	40 W88	19 Megatons	20.3 million	7.7 million	12.5 million
20 DF-5A silos and 20 decoy silos - or multiple strikes on silos	60 W88	28.5 Megatons	26.2 million	11 million	15.2 million

As would be expected, the numbers of casualties from a nuclear strike on the missile silos at Luoning increases with larger weapon yield because more fallout would be produced. Most of the casualties are predicted to occur in three Chinese provinces: Henan (where the silo targets are located), Anhui and Jiangsu. For the largest-yield case considered – 60 W88 warheads – the 50 REM contour would extend to the city of Nanjing.

Depending on the U.S. estimate of the hardness of the Chinese DF-5A silos, more than one attacking warhead could be allocated to each target. Furthermore, the Chinese may employ "decoy" silos that do not contain missiles but may nonetheless be targeted by U.S. forces. Assuming 14 percent (2/14) of all 400 W88 in the U.S. arsenal are on the two SSBNs on Hard Alert patrol in the Pacific, then approximately 60 W88s are available on short notice (the last case considered in Table 19). A larger number of W76s would be available, and these are being retrofitted with a ground-burst capability to enhance their effectiveness against a wider spectrum of targets (see Chapter 3).

The overall effect of these calculations is that a highly accurate, counterforce strike against the 20 Chinese ICBMs capable of attacking the U.S. homeland would cause millions of casualties and radioactive contamination over a very large area. Other basic questions about a U.S. strike against Chinese DF-5A ICBMs that are not answered in this study include: How does the flight time of U.S. SLBMs compare with Chinese early warning and launch preparedness? How far apart are the DF-5A targets spaced – are the distances between targets greater than the "footprint" of the MIRVed warheads from one U.S. SLBM? Could some of the Chinese targets be on the "wrong side of the mountain" with respect to U.S. targeting (i.e., the mountains obstruct a direct hit)? Could the Chinese forces ride out a strike and successfully launch missiles weeks or months later?

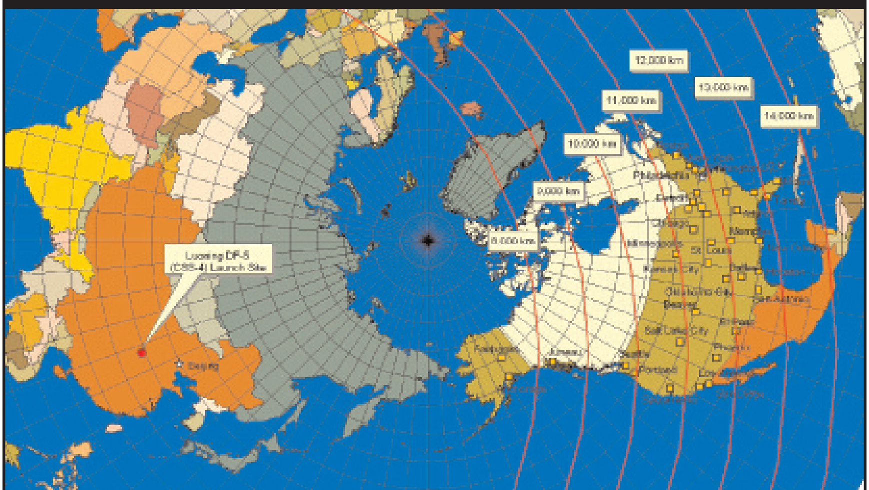
Scenario Two: Chinese Nuclear Strikes Against U.S. Cities

China's main nuclear deterrent against the United States has been described as a retaliatory minimum deterrent against countervalue targets with forces on very low or no alert. "Retaliatory" and "countervalue" refer to the fact that the Chinese nuclear doctrine is one of no-first-use, and consistent with that stated policy, the Chinese nuclear weapons capable of attacking the continental United States are not of a quantity or an accuracy that could threaten U.S. nuclear forces, but instead would be capable of targeting population centers.

We calculated the effects of a Chinese strike against U.S. cities with warheads from the 20 DF-5A ICBMs that were hypothetical targets in the scenario discussed above. We did this analysis to better quantify China's current deterrent against the U.S. homeland and examine different potential future Chinese nuclear force postures against the United States. We also explored parameters of the calculation, such as missile range, warhead yield, and warhead height-of-burst and targeting.

In Chapter 2 we quoted a range for China's DF-5A ICBM of at least 8,000 miles (13,000 km). Assuming a circumpolar trajectory for the missile, Figure 92 illustrates which areas of the United States are within range assuming the DF-5A is launched from silos near the city of Luoning in China's Henan Province. A range of at least 6.835 miles (11,000 km) is required to put cities at risk on the West Coast and in the north-central region of the United States. A range of 7,456 miles (12,000 km) puts cities on the East Coast at risk, including New York City and Washington, D.C. If the range of the DF-5A exceeds 8,000 miles (13,000 km) then all of the continental United States could be targeted. Note that a near-polar intercontinental ballistic missile trajectory toward the United States from Luoning is the shortest distance but would necessitate an overflight of Russia and possibly activate Russia's early warning system. Missile trajectories from China to the continental United States which do not overfly Russia would require a range exceeding 10,560 miles (17,000 km).

Figure 92:
DF-5A Ranges to U.S. Cities



DF-5A (CSS-4 Mod 2) ranges to major U.S. cities assuming an ICBM trajectory that traverses the North Pole.

The yield of the warhead mounted on the DF-5A is believed to be from 3 Mt to 5 Mt – a substantially higher-yield warhead than the U.S. W88 or W76. In HPAC, the effects of a nuclear explosion in the 3 Mt to 5 Mt range on a city are estimated from an extrapolation of the effects seen at Hiroshima and Nagasaki, but the damage due to fire storms from such a high-yield nuclear explosion may be more pervasive.[497]

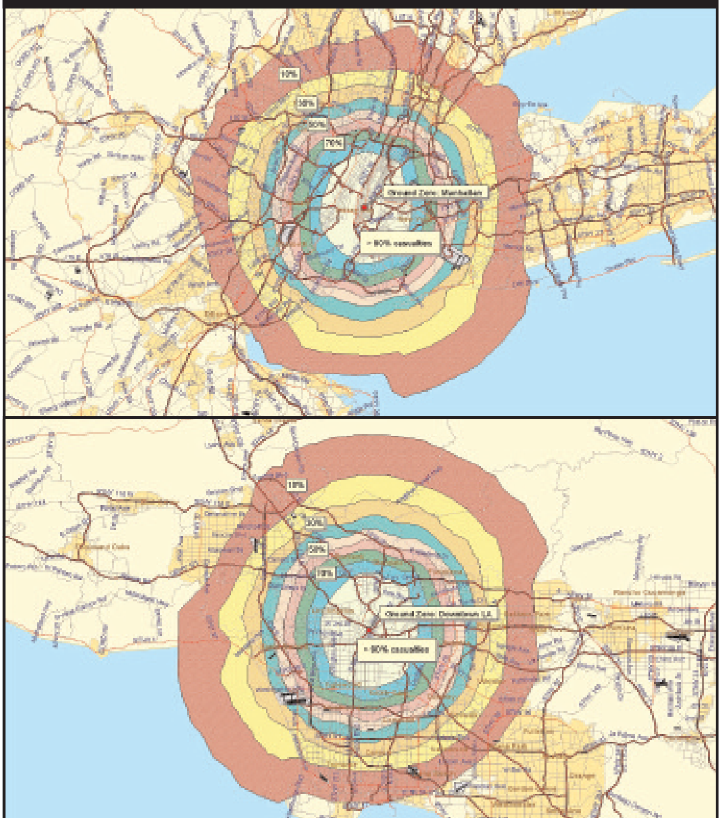
It is unknown whether the Chinese warheads on the DF-5A can be fuzed to detonate as a ground burst. The U.S. nuclear weapons dropped on Hiroshima and Nagasaki at the end of World War II were fuzed to detonate at an altitude of approximately 1,640 feet (500 meters) to maximize the area exposed to the blast wave produced in the nuclear explosion. The DOD defines the "optimum height of burst" as: "For nuclear weapons and for a particular target (or area), the height at which it is estimated a weapon of a specified energy yield will produce a certain desired effect over the maximum possible area."[498] In the case of the "Fat Man" and "Little Boy" nuclear weapons dropped on Japan, a height of burst of 1,640 feet (500 meters) maximized the area exposed to 10 pounds-per-square inch (psi) for nuclear explosive yields of about 15 kilotons, and the radius of a circle exposed to 10 psi or greater from these nuclear explosion is calculated to be about 0.62 miles (1 km). In the case of a 4 Mt weapon, the optimum height of burst to maximize an area exposed to 10 psi or greater is 9,840 feet (3,000 meters), and the radius to which 10 psi extends is 3.9 miles (6.2 km). Table 20 contrasts the effects of a Hiroshima nuclear bomb with that of the 4 Mt warhead on the Chinese DF-5A.

Table 20:
DF-5 Warhead and Hiroshima Bomb Parameters

	Chinese DF-5A (CSS-4 Mod 2)	U.S. "Little Boy" as at Hiroshima	Ratio: DF-5A Warhead/Little Boy
Yield	4 Megatons (4,000 kilotons)	15 kilotons	320 times greater yield
Optimum Height of Burst (to maximize area subject to 10 psi or greater blast)	3,000 meters	500 meters	6 times higher altitude for optimum height of burst
Area subject to 10 psi or greater blast overpressure	121 square km (6.2 km radius)	3 square km (980 meter radius)	40 times the area exposed to high blast
Area subject to > 25 cal/cm2 thermal flux	3.1 square km (1 km radius)	707 square km (15 km radius)	228 times the area exposed to very high thermal flux
Area subject to > 10 cal/cm2 thermal flux	2,000 square km (25 km radius)	9 square km (1.7 km radius)	218 times the area exposed to high thermal flux
Area subject to 50 rads initial radiation	9 square km (1.7 km radius)	11.3 square km (1.9 km radius)	About equal areas exposed to initial radiation
Calculated Fatalities: Los Angeles, CA	2.8 – 3.0 million	33,000 - 58,000	About 65 times the total fatalities in LA
Calculated Casualties: Los Angeles, CA	4.6 – 4.8 million	94,000 - 115,000	About 50 times the total casualties in LA
Calculated Fatalities: New York, NY	2.9 – 5.0 million	175,000 - 240,000	About 19 times the total fatalities in NYC
Calculated Casualties: New York, NY	7.7 – 7.8 million	322,000 – 366,000	About 22 times the total casualties in NYC

The calculated effects of a single 4 Mt nuclear airburst over a major U.S. city are staggering. Figure 93 illustrates the combined nuclear explosive effects of blast, thermal radiation and initial radiation in the form of an overall probability of being killed or injured while inside a building structure at the time of the explosion in New York City (top) or Los Angeles (bottom). An inner zone of near complete destruction (more than 90 percent casualties) would extend 16.2 miles (10 km) from ground zero, and blast and fire damage would extend as far as 21.8 miles (35 km) or more from the ground zero. A blast wave as strong or stronger than that directly under the Hiroshima explosion (35 psi) would cross the island of Manhattan. A firestorm could potentially engulf all of New York City or Los Angeles.

Figure 93:
Nuclear Explosive Effects of DF-5 Strikes Against New York and Los Angeles

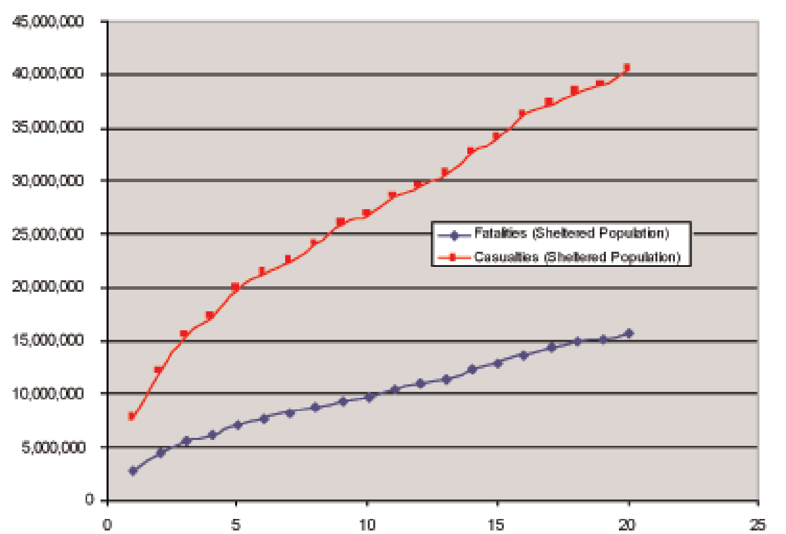


The output from an HPAC calculation showing the combined nuclear explosive effects of blast, thermal radiation and initial radiation created by a hypothetical detonation of a 4 Mt Chinese nuclear warhead on New York City (top) and Los Angeles (bottom).

Using HPAC, we calculated the combined effects of 4 Mt nuclear detonations on 20 populous U.S. cities, including Washington, D.C. From 15.8 million to 26.1 million fatalities and 40.6 million to 41.3 million casualties would result. We found that varying the yield of the Chinese DF-5A nuclear weapon from 3 Mt to 5 Mt only changed the predicted casualties by 10 percent – any multi-megaton weapon threatens a large urban area. The results also were relatively insensitive to varying the commonly-estimated accuracy (Circular Error Probable, or CEP) of these weapons.

Figure 94 plots the numbers of casualties and fatalities from a Chinese strike as a function of the number of U.S. cities attacked. Using HPAC, we found that the average number fatalities per attacking weapon is about 800,000, and the average number of casualties per weapon is about two million for these nuclear airbursts. It is evident from this analysis that the threat of even a few weapons reaching the United States should serve as a robust deterrent. U.S. war planners would have to have complete confidence in the success of both a counterforce strike against the DF-5A launchers and the capabilities of a National Missile Defense (NMD) system, otherwise a huge toll would be exacted on the United States.

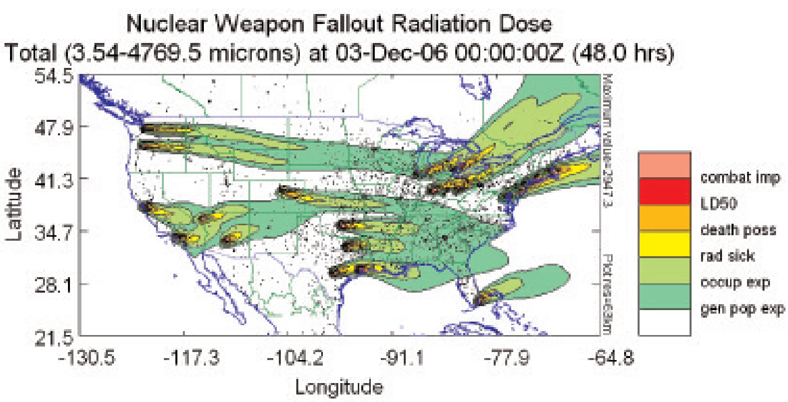
Figure 94:
Casualties and Fatalities From 20 DF-5A Airburst Attacks on US Cities



A plot of the number of casualties (red) and fatalities (blue) as a function of the increasing number of U.S. cities (x axis) attacked by 4 Mt warheads delivered by Chinese DF-5A (CSS-4 Mod 2) ICBMs, assuming a sheltered population at the time of the airburst strikes. The calculated numbers of casualties would be a factor of two to four times higher if the attacks were ground burst and cause very widespread fallout contamination throughout the United States and in Canada (Figure 95).

We also explored the effects of fallout, should the Chinese warheads be detonated as ground bursts. Because ground burst significantly increases radioactive fallout, they represent worst-case scenarios. Figure 95 illustrates the pervasive reach of the fallout clouds from such a scenario: The total yield of this attack is 80 Mt – about 10 times more powerful than the U.S. strike considered above. The calculated numbers of casualties are two to four times higher than for the air burst scenario (Figure 94), and very widespread fallout contamination would occur across the United States and Eastern Canada.

Figure 95:
Fallout From Attack On 20 US Cities With 20 DF-5A 4-Mt Ground Burst Warheads



Effects of fallout from attacking 20 U.S. cities with 20 Chinese DF-5A missiles with 4 Mt warheads as ground bursts. The figure was created using the HPAC plotting routine, where the color scale at right refers to the health effects of exposure to a given level of fallout over the first 48 hours after the strike. Winds typical of the month of December were used in this calculation.

As mentioned in Chapter 2, China is developing a new ICBM, the DF-31A, that the DOD projects will become operational sometime before the end of the decade. At first the mobile DF-31A is expected to supplement the silo-based DF-5As, but may eventually replace the older missiles altogether. As a solid-fueled missile, the DF-31A will have less throwweight than the DF-5A and therefore be forced to carry a smaller warhead to reach targets throughout the United States. The yield of the DF-31A warhead is not known but 200 kt to 300 kt is probably a reasonable guess.

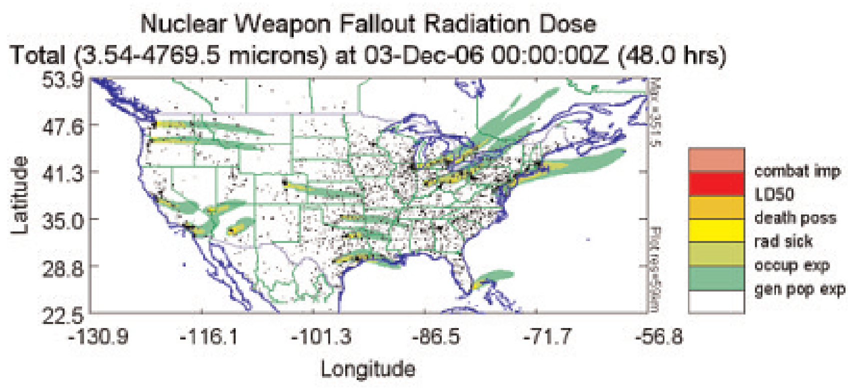
The U.S. intelligence community estimates that by 2015 China will deploy 75 to 100 warheads "primarily targeted" against the United States. As described in Chapter 2, the lower end of this estimate envisions a mix of 20 4-Mt warheads on DF-5As and 55 250-kt (our yield assumption) warheads on DF-31As (see Table 4 in Chapter 2). By adding 55 250-kt warheads to the existing 20 4-Mt warheads in its arsenal, China can potentially use the 250-kt warheads to hold at risk an additional 55 U.S. cities with populations ranging from 250,000 to 750,000 (Austin, Memphis, Tucson, Atlanta, etc.) while continuing to hold at risk the largest U.S. metropolitan areas with the 4-Mt warheads (New York, Los Angeles, Chicago, etc. – cities with a population in the range of 750,000 to several million). The casualties from a countervalue strike with these 75 warheads (93.75 Mt total yield, air burst) would cause a total number of casualties in excess of 50 million, or over 16 percent of the current U.S. population.[499]

Although such an increase in China's countervalue deterrent capability (above the current 20 4-Mt warheads, 80 Mt total yield) would put many more U.S. cities at risk, it would not significantly increase the number of casualties in the strikes calculated in Figure 94. The reason is that there are only a limited number of very large metropolitan areas and that – once they have been destroyed by the 4-Mt warheads – the additional 250-kt warheads would have to be targeted on smaller cities causing comparatively fewer additional casualties. Of course launching more missiles also would mean more warheads reaching their targets, assuming each missile has comparable vulnerability of pre-emptive destruction, probability of technical failure or interception by the U.S. National Missile Defense system.[500]

Another option is that China decides to deploy multiple warheads on its DF-5A missiles, a possibility frequently highlighted by news media and private analysts. This scenario also is the basis for the high-end of the U.S. intelligence community's estimate of 100 Chinese warheads primarily targeted against the United States by 2015. With such a force consisting of 20 DF-5As and 40 DF-31As (all with 250-kt warheads for a total yield of 25 Mt), a quantitatively lower yet qualitatively similar countervalue deterrent capability (20 million to 30 million casualties) could be achieved by targeting the additional 25 250-kt warheads on the current target set of the largest U.S. metropolitan areas and hold medium-sized cities at risk with the other 55 warheads. Interestingly, this high-end projection for China's deterrent would cause the least total casualties of the three potential future scenarios for China's nuclear forces structure considered here, yet potentially damage a larger set of urban areas and so still pose a robust deterrent to U.S. nuclear use.

As mentioned in Chapter 2, there is of course also a possibility that the U.S. intelligence community's projection of 75 to 100 Chinese warheads "primarily targeted" against the United States by 2015 turns out to be wrong, and that China instead decides to replace the DF-5A with the DF-31A on a one-by-one basis. To examine such a scenario and its effect on China's deterrent, we ran the HPAC code using the same U.S. city targets as in the DF-5A countervalue strike scenario above. The optimum height of burst for a 250 kt warhead (16 times smaller than the 4 Mt warhead on the DF-5A) to maximize the area exposed to 10 psi or greater overpressure is 4,593 feet (1,400 meters). For airbursts, we found that about 12 million casualties would result from the use of 20 250-kt warheads on 20 U.S. cities, including 3 million to 6 million fatalities. If these 250 kt warheads were detonated as ground bursts, the fallout patterns shown in Figure 96 combined with the prompt nuclear effects would produce from 6 million to 8 million casualties.

Figure 96:
Fallout From Attack On 20 US Cities With DF-31A Ground Bursts Warheads



Effects of fallout from attacking 20 U.S. cities with 20 Chinese DF-31A missiles with 250 kt warheads as ground bursts. The figure was created using the HPAC plotting routine, where the color scale at right refers to the health effects of exposure to a given level of fallout over the first 48 hours after the strike. Winds typical of the month of December were used in this calculation. A total of 6 million to 8 million casualties would result.

Discussion of Nuclear Strike Simulations

The nuclear strike scenarios presented in this chapter using the HPAC computer code provide insight into what is certainly the most significant and problematic aspect of the current nuclear deterrent relationship between the United States and China.

From the perspective of Chinese nuclear war planners, the destruction inflicted by just a few DF-5A ICBMs delivering their warheads to their intended city targets ought to represent a robust deterrent. From these calculations, which Chinese war planners can easily do themselves, it becomes apparent why China determined that its relatively small number of ICBMs is an adequate deterrent against the United States and anyone else. The Chinese deterrent may be called "minimum," but there's nothing minimum about the destruction it can inflict, and a no-first-use policy could naturally evolve from a quantitative assessment of the nuclear weapons effects.

The forthcoming modernization of the Chinese ballistic missile force with the introduction of the DF-31, DF-31A and JL-2 will significantly affect the deterrent against the United States. But not in ways normally assumed in the public debate. A "several-fold" increase in the number of warheads "primarily targeted" against the United States would not also result in a "several-fold" increase in the number of casualties that China could inflict in the United States. Our calculations described above show that if China decided to deploy the maximum number of warheads envisioned by the U.S. intelligence community (100) due to the replacement of large-yield warheads with smaller-yield warheads, the results would be a nearly 70 percent *reduction* of the total megatonnage on the force and a 25 percent to 50 percent reduction in the number of potential casualties resulting from a countervalue strike against the continental United States. Although this ought to be more than adequate to deter the United States (or anyone else) from using nuclear weapons against China, it suggests that the objective of the current Chinese modernization may not be so much to increase the threat as to ensure the continued effectiveness of the force.

From the point of U.S. nuclear planners, it may not matter much whether China can hit the United States with 94 Mt or 25 Mt. Their job is to implement White House guidance and hold Chinese nuclear forces at risk. Yet the hypothetical Chinese strike scenarios described above underscore that even a pre-emptive U.S. first strike against China's DF-5A ICBMs would need to disable all of the missile silos (and in the future all of the DF-31As as well) or risk a retaliatory Chinese attack on U.S. cities resulting in millions of casualties. The fallout from such a U.S. strike – even against purely military targets in a remote area – would cause millions of civilian casualties and widespread radioactive contamination across three large Chinese provinces. As if such a level of destruction would not be sufficient to deter the Chinese leadership, the 1997 Presidential Decision Directive (PDD-60) ordered the U.S. military to broaden nuclear targeting against Chinese facilities, and the U.S. Navy has since moved several strategic submarines from the Atlantic into the Pacific, upgraded the submarines to carry the more accurate Trident II D5 missile, and begun equipping W76 warheads with a new fuze to enable the weapon to strike a wider range of targets. The effects from a wider U.S. attack against China's entire nuclear force structure and political leadership would be significantly greater than the scenario described in this report and also result in fallout on allied countries in the region.

Other potential scenarios, that are not examined in this report, include a U.S. strike on all of China's offensive nuclear forces and leadership, a U.S. limited regional strike on Chinese forces off Taiwan, a Chinese strike against U.S. bases in the region as part of a retaliatory strike against the continental United States, and a Chinese limited strike against U.S. bases in the region in a conflict over Taiwan. Below such levels are potential uses of nuclear weapons in limited tactical strikes under the assumption that the other side will not be prepared to escalate to strategic nuclear use.

The U.S. counterforce strategy is based on the deployment of advanced weapons and planning capabilities that make it possible to target military facilities rather than cities as the Chinese are believed to target with their countervalue strategy. STRATCOM reportedly has concluded that countervalue targeting violates the Law of Armed Conflict (LOAC):

> Many operational law attorneys do not believe "countervalue" targeting [against selected enemy military and military-related activities, such as industries, resources, and/or institutions that contribute to the enemy's ability to wage war]…is a lawful justification for employment of force, much less nuclear force. Countervalue philosophy makes no distinction between purely civilian activities and military related activities and could be used to justify deliberate attacks on civilians and non-military portions of a nation's economy. It therefore cannot meet the "military necessity" prong of the Law of Armed Conflict (LOAC). Countervalue targeting also undermines one of the values that underlies LOAC – the reduction of civilian suffering and to foster the ability to maintain the peace after the conflict ends. For example, under the countervalue target philosophy, the attack on the World Trade Center Towers on 9/11 could be justified.[501]

Whether STRATCOM rejects countervalue targeting or not, the calculations cited above about the effects of the nuclear strikes do not even begin to describe what would actually occur if nuclear weapons were employed. The EMP produced by just two 4 Mt high-altitude atmospheric explosions, for example, would disable communications and electronic equipment across the entire United States. Several million Chinese expatriates also would die in a Chinese countervalue attack against U.S. cities. Even if the United States conducted a first strike on China's long-range ICBMs, and there was no immediate retaliation, there would still be massive suffering for refugees. And when this unprecedented humanitarian crisis was broadcast back to the United States, the social and economic chaos that would follow from Americans fleeing cities in fear of an eventual Chinese retaliatory strike would deepen the suffering.

Regardless of intentions and moral values, however, the simulations underscore that both a Chinese countervalue strike and a U.S. counterforce strike (even more so the expanded targeting directed by PDD-60) would inflict millions of civilian casualties and fatalities. If this is not sufficient to deter either side, it is hard to imagine what would.