# CHAPTER 41

# REFERENCES (Technical)

# Launch on Warning

Prior to the introduction of intercontinental ballistic missiles (ICBMs), the Strategic Air Command, and probably its Soviet counterpart, had multiple bombers flying at any given time. In the event of a nuclear strike upon one of the nations, the other nation would order their bombers to fly to the other country and drop their nuclear payload on predetermined targets. In the United States, these bombers were typically either B-47 Stratojets or B-52 Stratofortresses, and there were three major flight routes. With bombers already in the air, there was an assurance that a retaliatory strike would be feasible, even if the country that was attacked could do very little otherwise. At the height of the Cold War, the United States had special Boeing E-4B airplanes equipped as control centers for the nuclear arsenal. This airplane included a military official who was authorized to order a retaliatory strike in the event that the President could not be contacted.

‘Launch on warning’ has its roots in U.S. President Dwight Eisenhower's ‘Positive Control’ strategy, but really took shape with the introduction of the Minuteman missile. Since many ICBMs (including the Minuteman) were launched from underground silos, the concern arose that a first strike by one nation could destroy the ground launch facilities of the retaliating nation.

Once an ICBM is launched, it cannot be recalled by the launching party, so a different strategy had to be created by both the U.S. and U.S.S.R. This led to two primary options. One option, ‘retaliation after ride-out’ would require the second-strike nation to wait until after they were attacked to launch their missiles. Some portion of the nuclear arsenal would inevitably be destroyed in such an attack. This led to both superpowers investing heavily in survivable basing modes for their nuclear forces, including hardened underground missile silos for ICBMs, and submarine-launched ballistic missiles.

Launch on warning is launching nuclear missiles before the other side's missiles could destroy them. With the invention of the Ballistic Missile Early Warning System in the early 1960s, the possibility of America detecting launches of Soviet missiles became real. In the 1970's, this technology came to fruition after the deployment of space-based launch detection technology on both sides.

Once both countries had the ability to detect ballistic missile launches, both countries could at least theoretically implement a ‘launch on warning’ strategy. It is a popular misconception that either or both superpowers actually adopted this as a standing policy. While neither country would publicly confirm or deny that they had a launch on warning policy in effect, it is likely that they did not. There are practical reasons why this policy was not feasible. The primary concern was that a false warning could easily lead to a global nuclear war. There were several false alarms on each side during the Cold War, and none of them led to a nuclear exchange.

Even if the false alarm problem were to be set aside, a practical launch on warning policy would still be too difficult to implement. Although it takes about 30 minutes for a wave of ICBMs to reach their targets, that does not mean the President of the targeted country has 30 minutes to decide what to do about the attack, for the following reasons.

The side that launches a well-coordinated first strike can pin down the retaliatory forces of the other country by launching a barrage of submarine based missiles from close range, in a fast ‘depressed trajectory’ mode, and exploding the warheads every minute or so at high altitudes over the ICBM fields of the targeted country, using a technique called X-ray pin-down. This makes it impossible to launch the ICBMs without damaging their navigation systems for as long as the high-altitude detonations continue. This buys extra time for the wave of first strike ICBMs to complete their flights and hit their targets, which are the ICBMs that have been pinned down in their silos.

This greatly shortens the effective warning time for the President to make his decision to launch a retaliatory strike while still under attack. It takes a few minutes to confirm launch detection from early warning systems, and another few minutes for ICBMs to complete their launch procedures, and then a bit more for them to clear the region of X-ray pin-down, and that squeezes the decision time from both ends of the schedule. It means that even if all of the command and control systems are working perfectly in the targeted country, the President of that country still has only about five minutes after being shaken awake in the middle of the night to decide what to do. Five minutes to decide whether to launch thousands of nuclear warheads.

This means that launch on warning was regarded as an extremely dangerous policy with enormous practical problems to implement. That's why both superpowers deployed their nuclear forces in suvivable basing modes, to maintain a credible deterrent of residual retaliatory forces that would survive a first strike. This gives military leaders the more realistic option of riding out the attack, assessing which forces remain operational, and deciding what range of retaliatory options are available.

There are nuclear strategies that fall short of massive retaliation. One of these is the proportional response. If one country launches one missile (accidentally or otherwise), a proportional response of one missile may be chosen. While this proportional response approach might have worked on paper, a real-world limited nuclear exchange would have likely climbed the escalation ladder to an all-out nuclear war.

# Game Theory

The principle behind ‘launch on warning’ is an element of game theory and has been studied extensively by game theorists. The nuclear arms race would best be described as a non-zero-sum game. As long as neither side launches, both countries survive. If one country launches a first strike, the other country launches a retaliatory strike (second strike), and both sides lose. The only way for either side to win is for neither side to launch a first strike. This is also known as [nuclear deterrence](http://en.wikipedia.org/wiki/Nuclear_deterrence).

# MAD (Doctrine)

The Mutual Assured Destruction (MAD) doctrine between the Soviet Union and the United States throughout the Cold War represents a Nash equilibrium, where neither side is willing to escalate the confrontation due to fear of all-out nuclear war. Anti-ballistic missile systems have been criticized by some as having the potential to upset this balance of power. If one nation develops technology capable of destroying incoming missiles, that country then has the ability to launch a first-strike without having to endure a retaliatory strike. Thus, the deployment of anti-ballistic missiles by either side is likely to destabilize the Nash Equilibrium for the conflict, with unknown results. While it seems to work well for symmetrical conflicts such as the Cold War, this strategy would not be useful against an asymmetric threat such as terrorism.

MAD is a doctrine of military strategy in which a full-scale use of nuclear weapons by one of two opposing sides would effectively result in the destruction of both the attacker and the defender. It is based on the theory of deterrence according to which the deployment of strong weapons is essential to threaten the enemy in order to prevent the use of the very same weapons. The strategy is effectively a form of Nash Equilibrium, in which both sides are attempting to avoid their worst possible outcome — Nuclear Annihilation.

# MAD (Theory)

The doctrine assumes that each side has enough weaponry to destroy the other side and that either side, if attacked for any reason by the other, would retaliate with equal or greater force. The expected result is an immediate escalation resulting in both combatants' total and [assured destruction](http://en.wikipedia.org/wiki/Assured_destruction). It is now generally assumed that the nuclear fallout or nuclear winter would bring about worldwide devastation, though this was not a critical assumption to the theory of MAD.

The doctrine further assumes that neither side will dare to launch a first strike because the other side will launch on warning (also called fail-deadly) or with secondary forces (second strike) resulting in the destruction of both parties. The payoff of this doctrine is expected to be a tense but stable peace.

The primary application of this doctrine started during the Cold War (1950s to 1990s) in which MAD was seen as helping to prevent any direct full-scale conflicts between the two power blocs while they engaged in smaller proxy wars around the world. It was also responsible for the arms race, as both nations struggled to keep nuclear parity, or at least retain second-strike capability. Although the Cold War ended in the early 1990's and today (2006) the US and Russia (former USSR) are on relatively friendly terms, the doctrine of Mutually Assured Destruction certainly continues to be in force although it has receded from public discourse.

Proponents of MAD as part of U.S. and USSR strategic doctrine believed that nuclear war could best be prevented if neither side could expect to survive (as a functioning state) a full scale nuclear exchange. Since the credibility of the threat is critical to such assurance, each side had to invest substantial capital in their nuclear arsenals even if they were not intended for use. In addition, neither side could be expected or allowed to adequately defend itself against the other's nuclear missiles. This led both to the hardening and diversification of nuclear delivery systems (such as nuclear missile bunkers, ballistic missile submarines and nuclear bombers kept at fail-safe points) and to the Anti-Ballistic Missile Treaty.

First Alert to Missile Launch

From the time that satellites first detect a possible nuclear attack, authorities have only ten minutes to decide whether to launch a counterattack. This following timeline outlines the sequence of events leading to such a launch.

Step 1 of 12

Time elapsed since alert: 00:00:01 - 00:00:59

Time to respond: 00:09:59 - 00:09:01

Within the first minute of a launch, satellites detect missiles in flight. This information is analyzed by a ground-based early warning system, which is programmed to look for characteristics specific to nuclear-warhead-carrying missiles. Operators at the main early-warning center check the initial validity of the indicators and then relay the information to the Missile Command Center.  
  
Step 2 of 12

Time elapsed since alert: 00:01:00 - 00:01:59

Time to respond: 00:09:00 - 00:08:01

Personnel at the center check on the reliability of the report. If they decide it is valid, they send out an alert to the nuclear briefcases ‘Football’. One briefcase is with the president, one is with the defense minister, and one is with the chief of the Missile Command Center. They also send out an alert to the Strategic Missile Forces command center.

The briefcase looks similar to a laptop computer when opened. It is designed to receive and display the early-warning information, which is relayed through the Missile Command Center. The briefcase also allows the president to transmit an order to launch missiles. To make such an order, the president must transmit the permission code, which is contained within the briefcase. The permission code prompts the leaders at the Command Center to send out the launch authorization codes, the unblocking codes, and a war plan to missile sites and land- and sea-based mobile launchers. In addition to the briefcase, other equipment is always near the president. This equipment allows him to communicate with the other leaders.

Step 3 of 12

Time elapsed since alert: 00:02:00 - 00:02:59

Time to respond: 00:08:00 - 00:07:01

The Missile Command Center turns on a special communications circuit, which connects the post to all missile sites and mobile launchers. The mobile launchers include trucks, trains, and submarines. The crews make preparations to launch.

Step 4 of 12

Time elapsed since alert: 00:03:00 - 00:03:59

Time to respond: 00:07:00 - 00:06:01

The three individuals carrying the briefcases confer with one another by phone. They also communicate with the early-warning centers to confirm that missiles are incoming.

Step 5 of 12

Time elapsed since alert: 00:04:00 - 00:04:59

Time to respond: 00:06:00 - 00:05:01

The incoming missiles are now within range of ground-based radar centers. The centers validate the satellite reports.

Step 6 of 12

Time elapsed since alert: 00:05:00 - 00:05:59

Time to respond: 00:05:00 - 00:04:01

To successfully launch a counterattack, the president must make a decision now. If he decides to strike, he'll transmit the permission codes that are contained within the briefcase to the Missile Command Center, to air force and navy command posts, and to the Strategic Missile Forces command post. Over the next few minutes, he can rescind his order to launch.

Step 7 of 12

Time elapsed since alert: 00:06:00 - 00:06:59

Time to respond: 00:04:00 - 00:03:01

The Missile Command Center transmits the authorization codes, the war plan (which includes targets and the time to launch missiles), and the unblocking codes. Without the unblocking codes, it is theoretically impossible to launch any missiles. (Deterioration of the control systems, however, has made unauthorized launch a remote but real possibility.)

Step 8 of 12

Time elapsed since alert: 00:07:00 - 00:07:59

Time to respond: 00:03:00 - 00:02:01

The strategic launchers are prepared for launch. Safety procedures require that the commanding officers at each missile site confirm that the orders are genuine. They do this by comparing the final authorization codes they received against codes that are kept in a safe.

The officers begin to implement launch procedures.

Step 9 of 12

Time elapsed since alert: 00:08:00 - 00:08:59

Time to respond: 00:02:00 - 00:01:01

The commanding officer at each missile site activates the site's missile system with a safety key. The unblocking codes are then entered.

Step 10 of 12

Time elapsed since alert: 00:09:00 - 00:09:59

Time to respond: 00:01:00 - 00:00:01

The commanding officers are completing final launch procedures.

Step 11 of 12

Time elapsed since alert: 00:09:00 - 00:09:59

Time to respond: 00:01:00 - 00:00:01

Unless they receive an order that rescinds (cancel) the previous order (as with simulation tests), the commanding officers launch the missiles.

Step 12 of 12

Time elapsed since alert: 00:10:00 - 00:15:59

Time to respond: 00:00:00 - 00:00:00

At this time the missiles are five minutes into their 25-minute flight to the destination. If the hostile attack is real, its missiles begin to hit their targets.

Consequences of Nuclear Conflicts

The Natural Resources Defense Council (NRDC) has nuclear experts evaluate the unthinkable, using state-of-the-art nuclear war simulation software for assessing crisis in case of nuclear attack and fallout. The following scenario is derived from such a simulation.

The months-long military standoff between India and Pakistan intensified several weeks ago when suspected Islamic militants killed more than 30 people at an Indian base in the disputed territory of Kashmir. As U.S. diplomatic pressure to avert war intensifies, Secretary of Defense Donald Rumsfeld is going to India and Pakistan this week to discuss with his South Asian counterparts the results of a classified Pentagon study that concludes that a nuclear war between these countries could result in 12 million deaths.

Prior to this recent crisis two nuclear scenarios were calculated. The first assumes 10 Hiroshima-sized explosions with no fallout; the second assumes 24 nuclear explosions with significant radioactive fallout. Below is the account of the two scenarios in detail and an exploration of several additional issues regarding nuclear war in South Asia.

**Indian and Pakistani Nuclear Forces**

It is difficult to determine the actual size and composition of India's and Pakistan's nuclear arsenals, but NRDC estimates that both countries have a total of 50 to 75 weapons. Contrary to the conventional wisdom, we believe India has about 30 to 35 nuclear warheads, slightly fewer than Pakistan, which may have as many as 48.

Both countries have fission weapons, similar to the early designs developed by the United States in the late 1940s and early 1950s. NRDC estimates their explosive yields are 5 to 25 kilotons (1 kiloton is equivalent to 1,000 tons of TNT). By comparison, the yield of the weapon the United States exploded over Hiroshima was 15 kilotons, while the bomb exploded over Nagasaki was 21 kilotons. According to a recent NRDC discussion with a senior Pakistani military official, Pakistan's main nuclear weapons are mounted on missiles. India's nuclear weapons are reportedly gravity bombs deployed on fighter aircraft.

NRDC's Nuclear Program initially developed the software used to calculate the consequences of a South Asian nuclear war to examine and analyze the U.S. nuclear war planning process. We combined Department of Energy and Department of Defense computer codes with meteorological and demographic data to model what would happen in various kinds of attacks using different types of weapons. The June 2001 report, ‘The U.S. Nuclear War Plan: A Time for Change,’ is available at http://www.nrdc.org/nuclear/warplan/index.asp.

**Scenario 1: 10 Bombs on 10 South Asian Cities**

The first scenario uses casualty data from the Hiroshima bomb to estimate what would happen if bombs exploded over 10 large South Asian cities: five in India and five in Pakistan. (The results were published in ‘The Risks and Consequences of Nuclear War in South Asia,’ by NRDC physicist Matthew McKinzie and Princeton scientists Zia Mian, A. H. Nayyar and M. V. Ramana, a chapter in Smitu Kothari and Zia Mian (editors), ‘Out of the Nuclear Shadow’ (Dehli: Lokayan and Rainbow Publishers, 2001).)

The 15-kiloton yield of the Hiroshima weapon is approximately the size of the weapons now in the Indian and Pakistani nuclear arsenals. The deaths and severe injuries experienced at Hiroshima were mainly a function of how far people were from ground zero. Other factors included whether people were in buildings or outdoors, the structural characteristics of the buildings themselves, and the age and health of the victims at the time of the attack; the closer to ground zero, the higher fatality rate. Further away there were fewer fatalities and larger numbers of injuries. The table below summarizes the first nuclear war scenario by superimposing the Hiroshima data onto five Indian and five Pakistan cities with densely concentrated populations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Estimated nuclear casualties for attacks on 10 large Indian and Pakistani cities | | | | |
| City Name | Total Population Within 5 Kilometers of Ground Zero | Number of Persons Killed | Number of Persons Severely Injured | Number of Persons Slightly Injured |
| India | | | | |
| Bangalore | 3,077,937 | 314,978 | 175,136 | 411,336 |
| Bombay | 3,143,284 | 477,713 | 228,648 | 476,633 |
| Calcutta | 3,520,344 | 357,202 | 198,218 | 466,336 |
| Madras | 3,252,628 | 364,291 | 196,226 | 448,948 |
| New Delhi | 1,638,744 | 176,518 | 94,231 | 217,853 |
| Total India | 14,632,937 | 1,690,702 | 892,459 | 2,021,106 |
| Pakistan | | | | |
| Faisalabad | 2,376,478 | 336,239 | 174,351 | 373,967 |
| Islamabad | 798,583 | 154,067 | 66,744 | 129,935 |
| Karachi | 1,962,458 | 239,643 | 126,810 | 283,290 |
| Lahore | 2,682,092 | 258,139 | 149,649 | 354,095 |
| Rawalpindi | 1,589,828 | 183,791 | 96,846 | 220,585 |
| Total Pakistan | 9,409,439 | 1,171,879 | 614,400 | 1,361,872 |
| India and Pakistan | | | | |
| Total | 24,042,376 | 2,862,581 | 1,506,859 | 3,382,978 |

As in the case of bombs dropped on Hiroshima and Nagasaki, in this scenario the 10 bombs over Indian and Pakistani cities would be exploded in the air, which maximized blast damage and fire but creates no fallout. On August 6, 1945, the United States exploded an untested uranium-235 gun-assembly bomb, nicknamed ‘Little Boy,’ 1,900 feet above Hiroshima. The city was home to an estimated 350,000 people; about 140,000 died by the end of the year. Three days later, at 11:02 am, the United States exploded a plutonium implosion bomb nicknamed ‘Fat Man’ 1,650 feet above Nagasaki. About 70,000 of the estimated 270,000 residents died by the end of the year.

Ten Hiroshima-size explosions over 10 major cities in India and Pakistan would kill as many as three to four times more people per bomb than in Japan because of the higher urban densities in Indian and Pakistani cities.

**Scenario 2: 24 Ground Bursts**

In January, NRDC calculated the consequences of a much more severe nuclear exchange between India and Pakistan. This scenario calculated the consequences of 24 nuclear explosions detonated on the ground -- unlike the Hiroshima airburst -- resulting in significant amounts of lethal radioactive fallout.

Exploding a nuclear bomb above the ground does not produce fallout. For example, the United States detonated ‘Little Boy’ weapon above Hiroshima at an altitude of 1,900 feet. At this height, the radioactive particles produced in the explosion were small and light enough to rise into the upper atmosphere, where they were carried by the prevailing winds. Days to weeks later, after the radioactive bomb debris became less ‘hot,’ these tiny particles descended to earth as a measurable radioactive residue, but not at levels of contamination that would cause immediate radiation sickness or death.

Unfortunately, it is easier to fuse a nuclear weapon to detonate on impact than it is to detonate it in the air -- and that means fallout. If the nuclear explosion takes place at or near the surface of the earth, the nuclear fireball would gouge out material and mix it with the radioactive bomb debris, producing heavier radioactive particles. These heavier particles would begin to drift back to earth within minutes or hours after the explosion, producing potentially lethal levels of nuclear fallout out to tens or hundreds of kilometers from ground zero. The precise levels depend on the explosive yield of the weapon and the prevailing winds.

For the second scenario, the fallout patterns and casualties were calculated for a hypothetical nuclear exchange between India and Pakistan in which each country targeted major cities. Targets chosen were cities throughout Pakistan and in northwestern India to take into account the limited range of Pakistani missiles or aircraft. The target cities, listed in the table below, include the capitals of Islamabad and New Delhi, and large cities, such as Karachi and Bombay. In this scenario, we assumed that a dozen, 25-kiloton warheads would be detonated as ground bursts in Pakistan and another dozen in India, producing substantial fallout.

The devastation resulting from fallout would exceed that of blast and fire. NRDC's second scenario would produce far more horrific results than the first scenario because there would be more weapons, higher yields, and extensive fallout. In some large cities, we assumed more than one bomb would be used.

|  |  |  |  |
| --- | --- | --- | --- |
| 15 Indian and Pakistani cities attacked with 24 nuclear warheads | | | |
| Country | City | City Population | Number of Attacking Bombs |
| Pakistan | Islamabad (national capital) | 100-250 thousand | 1 |
| Pakistan | Karachi (provincial capital) | > 5 million | 3 |
| Pakistan | Lahore (provincial capital) | 1-5 million | 2 |
| Pakistan | Peshawar (provincial capital) | 0.5-1 million | 1 |
| Pakistan | Quetta (provincial capital) | 250-500 thousand | 1 |
| Pakistan | Faisalabad | 1-5 million | 2 |
| Pakistan | Hyderabad | 0.5-1 million | 1 |
| Pakistan | Rawalpindi | 0.5-1 million | 1 |
| India | New Dehli (national capital) | 250-500 thousand | 1 |
| India | Bombay (provincial capital) | > 5 million | 3 |
| India | Delhi (provincial capital) | > 5 million | 3 |
| India | Jaipur (provincial capital) | 1-5 million | 2 |
| India | Bhopal (provincial capital) | 1-5 million | 1 |
| India | Ahmadabad | 1-5 million | 1 |
| India | Pune | 1-5 million | 1 |

NRDC calculated that 22.1 million people in India and Pakistan would be exposed to lethal radiation doses of 600 rem or more in the first two days after the attack. Another 8 million people would receive a radiation dose of 100 to 600 rem, causing severe radiation sickness and potentially death, especially for the very young, old or infirm. NRDC calculates that as many as 30 million people would be threatened by the fallout from the attack, roughly divided between the two countries.

Besides fallout, blast and fire would cause substantial destruction within roughly a mile-and-a-half of the bomb craters. NRDC estimates that 8.1 million people live within this radius of destruction.

Most Indians (99 percent of the population) and Pakistanis (93 percent of the population) would survive the second scenario. Their respective military forces would still be intact to continue and even escalate the conflict.

**Thinking the Unthinkable**

After India and Pakistan held nuclear tests in 1998, experts have debated whether their nuclear weapons contribute to stability in South Asia. Experts who argue that the nuclear standoff promotes stability have pointed to the U.S. - Soviet Union Cold War as an example of how deterrence ensures military restraint.

NRDC disagrees. There are major differences between the Cold War and the current South Asian crisis. Unlike the U.S.-Soviet experience, these two countries have a deep-seated hatred of one another and have fought three wars since both countries became independent. At least part of the current crisis may be seen as Hindu nationalism versus Muslim fundamentalism.

A second difference is India and Pakistan's nuclear arsenals are much smaller than those of the United States and Russia. The U.S. and Russian arsenals truly represent the capability to destroy each other's society beyond recovery. While the two South Asia scenarios we have described produce unimaginable loss of life and destruction, they do not reach the level of ‘mutual assured destruction’ that stood as the ultimate deterrent during the Cold War.

The two South Asian scenarios assume nuclear attacks against cities. During the early Cold War period this was the deterrent strategy of the United States and the Soviet Union. But as both countries introduced technological improvements into their arsenals, they pursued other strategies, targeting each other's nuclear forces, conventional military forces, industry and leadership. India and Pakistan may include these types of targets in their current military planning. For example, attacking large dams with nuclear weapons could result in massive disruption, economic consequences and casualties. Concentrations of military forces and facilities may provide tempting targets as well.

# The facts about the Chernobyl aftermath

The disaster at Chernobyl on April 26, 1986, contaminated an area of about 100,000 square miles. This area encompassed about 20 percent of the territory of Belarus; about 8 percent of Ukraine; and about .5 to 1 percent of the Russian Federation. Altogether the area is approximately the size of the state of Kentucky, or of Scotland and Northern Ireland combined. The most serious radioactive elements to be disseminated by the accident were iodine-131, cesium-137 and strontium-90.

Ten years after the event, Chernobyl remains shrouded in controversy as to its immediate and long-term effects. The initial explosion and graphite fire killed 31 operators, firemen and first-aid workers, and saw several thousand hospitalized. Over the summer of 1986 and in the period 1986-1990 it also caused high casualties among clean-up workers. According to recent statistics from the Ukrainian government, over 5,700 ‘liquidators’ have died - the majority young men in their 20s. A figure of 125,000 deaths issued by Ukraine's Ministry of Health appears to include all subsequent deaths, natural or otherwise, of those living in the contaminated zone of Ukraine.

According to specialists from the World Health Organization, the only discernible health impact of the high levels of radiation in the affected territories has been the dramatic rise in thyroid gland cancer among children. The comment appears unwarranted in light of regional research. In Belarus, for example, a study of 1994 noted that congenital defects in the areas with a cesium content of the soil of 1-5 curies per square kilometer have doubled since 1986, while in areas with over 15 curies, the rise has been more than eightfold.

Among liquidators, and especially among evacuees, studies have demonstrated a discernible and alarming rise in morbidity since Chernobyl when compared to the general level among the population. This applies particularly to circulatory and digestive diseases, and to respiratory problems. Less certain is the concept referred to as ‘Chernobyl AIDS,’ the rise of which may reflect more attention to medical problems, better access to health care, or psychological fears and tension among the population living in contaminated zones. Increases in the incidence of children's diabetes and anemia are evident, and again appear much higher in irradiated zones. The connection between these problems and the rise in radiation content of the soil has yet to be determined.

To date, the rates of leukemia and lymphoma - though they have risen since the accident - remain within the European average, though in the upper 75th percentile. One difficulty here is the unreliability or sheer lack of reporting in the 1970s. The induction period for leukemia is four to 15 years, thus it appears premature to state, as have some authorities that Chernobyl will not result in higher rates of leukemia.

As for thyroid cancer, its development has been sudden and rapid. Today about 1,000 children in Belarus and Ukraine have contracted the disease, and it has yet to reach its peak. One WHO specialist has estimated that the illness may affect one child in 10 living in the irradiated zones in the summer of 1986; hence ultimate totals could reach as high as 10,000. Though the mortality rate from this form of cancer among children is only about 10 percent, this still indicates a further 1,000 deaths in the future. Moreover, this form of cancer is highly aggressive and metastasizes rapidly if not operated upon. The correlation between thyroid gland cancer and radioactive fallout appears clear and is not negated by any medical authority today.

Turning to the question of the Chernobyl reactor itself, it continues to pose enormous problems for newly independent Ukraine and for the nuclear industry in general. In the spring of 1994, eight years after Chernobyl disaster, the IAEA belatedly declared the reactor unsafe. Pressure from the Group of Seven has forced Ukraine to agree to the closure of the station by the year 2000, but Ukraine's price tag-some $4.4 million to shut down Chernobyl and to construct a new thermal power station in the vicinity - has been offset by only about 50 percent from G-7 subsidies and loans.

Both the current director of the Chernobyl plant, Serhiy Parashyn, and former director Mykhail Umanets have vocalized their view that the station's lifespan is only 50 percent complete and that Chernobyl today is safer than other Soviet-made RBMK (graphite-moderated) reactors at Ignalina, Lithuania (an RBMK-1500); and the Russian stations of Sosnovyi Bor (near St. Petersburg), Kursk and Smolensk.

Both Ukraine and Belarus face significant energy crises and have been reliant on expensive imports of oil and gas from Russia and Turkmenistan. Both have turned back to the nuclear option. Yet the industry remains short of skilled personnel, adequate and well-paid safety regulators, and reliable reactor units. Several potentially serious mishaps have occurred in Ukraine, including two recent accidents that involved leakages of radiation at Zaporizhzhia-4 (April 1995) and Chornobyl-1 (November 1995, now acknowledged to have been a more serious Class 3 accident on the international scale rather than Class 1 as initially reported).

In addition to such a serious dilemma, the funding of a new sarcophagus over the destroyed reactor has not been determined. The current structure, which covers some 20 tons of radioactive fuel and dust, is cracking and is not anticipated to last more than a further 10 to15 years. Though plans have been formulated to re-cover the original concrete shell, the financial backing for such a structure is problematic. Moreover, the present plan will likely entail the permanent closure of Chornobyl-3 and as such is regarded with skepticism by those of Ukraine's energy sphere who wish to continue reliance upon nuclear power.

It is fair to say that the dangers presented by former Soviet nuclear power stations today exceed those of one decade ago. In the meantime, some 3.5 million people live in contaminated zones. Even evacuees are known to be dissatisfied with their new homes. From a necessary panacea, evacuation of those living in zones with high soil contamination, today has become an unpopular and slow-moving process.

Finally, the lack of consensus on the effects of the Chernobyl disaster helps no one. It does not help the economically floundering governments of Ukraine and Belarus; and it places a serious impediment on the work of charitable and humanitarian organizations. And, the one-sided statements to the effect that morbidity and diseases may have causes other than Chernobyl, or that they are caused by ‘radio phobia,’ detract from the prime need, which is to provide aid for a population facing an acute health crisis with inadequate resources.

Ultimately, it will be seen that Chernobyl has compounded a health crisis of extraordinary dimensions. Thyroid gland cancer is proof of the relationship between the 1986 nuclear disaster and dilemmas faced today by Belarus and Ukraine according to David R. Marples, PhD, University of Sheffield, MA Department of History and Classics.

**China's Nuclear Weapons (Present Capabilities)**

Given the People's Republic of China's size in terms of geography (third in the world, only slightly behind Canada), population (number one), and economy (second largest in the world by 1999 CIA equivalent purchasing power estimates, with current growth rates in the high single digits), it seems inevitable that China (also called the PRC) will become the dominant power in the world within a few decades. China's leaders are acutely aware of this fact, and are also acutely aware that except for the last few centuries, China has consistently been the most powerful and advanced society in the world for 3500 years. They undoubtedly intend that China will have military capabilities commensurate with this once and future status.

Over the years China has certainly invested a much smaller amount of resources (although not necessarily a much smaller proportion of its resources) to developing and deploying nuclear weapons than either of the two superpowers. The exact size and composition of its nuclear forces is very difficult to determine however due to strict secrecy. Force structure estimates consequently are rather uncertain, and published estimates are even a bit mysterious. It is hard to assess the ultimate source or reliability of the data provided.

Since the cut-off of aid to its nuclear weapons program in 1960 by the Soviet Union, most of the technology used on the program has been developed indigenously. There has been (and continues to be) considerable concern in the West about the export of this technology to non-nuclear powers interested in acquiring these weapons. China is known to have given Pakistan considerable assistance, possibly including actual warhead designs. Recent concern has focused on Chinese deals with Iran. With the collapse of the Soviet Union, China has turned its interest to obtaining more advanced nuclear technology from the successor to its old mentor. Nihon Keizai Shimbun has reported that China bought computer simulation technology for nuclear warheads from Russia during the mid-90s.

To date China has conducted many fewer nuclear tests than the United States or the Soviet Union/Russia (less than 5% as many as either) and this discrepancy accounts for China's initial reluctance to sign on to a permanent ban of all nuclear tests at the CTBT negotiations, although these reservations have now been overcome since the conclusion of China's final test series. The final test series concluded in the spring and summer of 1996. According to Japanese government sources (reported in Nihon Keizai Shimbun), the penultimate underground Chinese nuclear test on 8 June 1996 (calculated at 20 to 80 kilotons) was actually a simultaneous detonation of multiple warheads (a common practice by both the U.S. and USSR). It was said to be part of a program to produce smaller warheads for submarine-launched and multiple-targeted missiles. Overall, the yields since 1990 have suggested that two warheads have been in development: one in the 100-300 Kt range, and one in the 600-700 Kt range.

China's last nuclear test was detonated at 0149 GMT (9:49 p.m. EDT) on 29 July 1996. According to the Australia Geological Survey Organization in Canberra its yield was 1 to 5 kilotons, with a seismic magnitude of Mb 4.3. This was China's 45th test, and its 22nd underground one.

It is believed that with the conclusion of this series, China has completed development of a range of warheads similar to the state of the art weapons developed by the other major nuclear powers. These would be miniaturized hardened thermonuclear warheads with yields in the tens to hundreds of kilotons, as well as warheads with variable yield options, and enhanced radiation ‘neutron bomb’ warheads.

The subject of China's neutron bomb capability has been the subject of considerable public attention over the last several years. China reportedly conducted a successful test of a neutron bomb on 29 September 1988; in March 2000 a Chinese military newspaper threatened to use neutron bombs to capture Taiwan if it declared independence. But most of the attention has centered on alleged connections with the theft of nuclear secrets from the United States. Allegations have circulated for over 20 years that U.S. nuclear weapon technology has been leaked to China. CIA Director George Tenet reported in the 1999 ‘Intelligence Community Damage Assessment’ on Chinese spying, that China ‘obtained information on a variety of U.S. weapon design concepts and weaponization features, including those of the neutron bomb.’ As was reported by Dan Stober in the 13 April 2000 San Jose Mercury News, in 1981 Gwo-Bao Min, a nuclear weapons engineer in the D-Division at the Lawrence Livermore National Laboratory, was forced to resign form the laboratory due to suspicions about having provided China with information about U.S. neutron bomb technology from the W-70 warhead.

According to Stober:

Exactly how the government discovered the loss of neutron bomb secrets to China and what led investigators to Min remain a secret. Sources outside the FBI say the agency is protecting its source, which could be a spy or the clandestine interception of an electronic communication. Min continued to be investigated after his resignation by an FBI operation known as ‘Tiger Trap.’

Stober interviewed a number of officials familiar with the case:

‘We did not design nuclear warheads (in D-Division), but we had access to all that stuff,’ said one of Min's co-workers. ‘They're classified documents and you go down and check them out. There's a classified library and you sign your name to show what you checked out.’

’If the information was compromised, (the damage) could have been quite severe,’ said Houston T. Hawkins, an expert on Chinese nuclear weapons who is the top intelligence official at Los Alamos. Hawkins directs the group that wrote the ‘damage assessment’ in the wake of the Tiger Trap case’. Although no prosecution ever developed from Tiger Trap, a December 1982 phone call between Min and Los Alamos scientist Wen Ho Lee emerged as an important piece in the infamous case against Lee two decades later.

Walter Pincus and Vernon Loeb reported in stories published in the Washington Post on 8 April and 9 May 1999 that in 1997 another Chinese-American scientist named Peter H. Lee had been arrested and pled guilty to verbally passing classified nuclear weapons information to Chinese scientists while he was employed as a physicist at Los Alamos. Like Wen Ho Lee (who is unrelated), Peter Lee is a naturalized citizen born in Taiwan. The 1985 incident for which he was convicted involved a briefing Lee gave seven or more top Chinese nuclear scientists for two hours in a small conference room at another Beijing hotel.

According to Pincus and Loeb;

‘He talked about laser fusion and even discussed problems the United States was having in its nuclear weapons simulation program. He drew diagrams and supplied specifications. He explained test data. And he described at least one portion of a classified paper he had written, knowing that his disclosures violated the law.’

’In December 1997 -- more than 12 years after the events, and after a six-year FBI investigation that included agents tapping his phones for months, reading his e-mail and his personal diaries, trailing him to China and conducting a polygraph -- Lee finally confessed and pleaded guilty. He was not paid by the Chinese for information, receiving only some travel expenses in 1997, and there was no evidence he disclosed classified information other than what he, himself, had described.’

Ironically even though Peter Lee pled to passing classified defense information to unauthorized recipients (for which he was sentenced in March 1998 to a five-year prison term, suspended in favor of 12 months in a halfway house, a $20,000 fine and 3,000 hours of community service), by the time of his arrest much of the information on laser fusion had been declassified (in 1993). But a DOE impact analysis of Lee's disclosures completed in February 1998 held that the information ‘was of significant material assistance to the PRC in their nuclear weapons development program, ... This analysis indicates that Dr. Lee's activities have directly enhanced the PRC nuclear weapons program to the detriment of U.S. national security.’ Lee had also revealed current classified information to Chinese scientists in 1997 about his work at TRW involving space radar imaging of submarines.

By far the most celebrated case of actual and alleged Chinese-American nuclear espionage involved the case against Los Alamos nuclear scientist Wen Ho Lee. This saga grew out of a strange incident in 1995, in which a Chinese intelligence agent walked in to a U.S. diplomatic office unannounced and handed over a collection of highly classified Chinese documents, which included a 1988 Chinese document that made reference to design features of America's miniaturized nuclear warheads. The CIA later concluded that, for unknown reasons, this ‘walk-in’ had acted at the direction of Chinese intelligence.

Of particular interest were some design details of the W-88 warhead, America's most sophisticated design. The details fell far short of evidence that China had obtained anything close to a complete design however, a fact that was often ignored in the later controversy, and it transpired could have been obtained from documents about the warhead distributed at many sites around the country and accessible to thousands of people. Nonetheless, because the warhead design had originated at Los Alamos, an FBI investigation focused there, and because Wen Ho Lee was the only Chinese-American employed in the X-Division, he quickly became the focus of the investigation. Lee's early appearance in Tiger Trap essentially clenched him as the prime (and sole) suspect in the eyes of Department of Energy investigator Notra Trulock.

The Wen Ho Lee investigation was kicked into hyper drive when the Cox Committee, organized to investigate the transmission of space and missile technology to China, got wind of it and hastily added a sensationalized section on nuclear weapon espionage to the committee’s final report in December 1998. Virtually no attention was paid to Chinese nuclear spying allegations until a front-page 6 March 1999 New York Times story about the investigation. DOE Secretary Richardson fired Wen Ho Lee two days later. During the next 18 months circumspection was rarely seen in pronouncements made politicians, pundits, and officials.

The extravagant claims made about Lee and supposed intelligence compromises led to Lee's arrest, extended imprisonment in solitary confinement, threats of capital punishment, and sworn testimony by government witnesses later admitted to be false. In the end the espionage case utterly collapsed with no evidence of spying by Lee ever having been found. Finally a plea agreement was reached on 13 September 2000 in which Lee pleaded guilty to one count of improperly handling classified information and was released.

As far as can be determined from publicly available information, there appears to be no real evidence of China obtaining actual nuclear warhead designs from the U.S. At most the information seems to have been information about warhead design and technology, possibly quite sketchy that would help guide Chinese research and development down the most productive tracks. Without detailed designs of warheads (‘blueprints’), Chinese weapons would necessarily be based on indigenous designs even if they incorporated design features and concepts derived from U.S. systems.

China's nuclear delivery system programs have traditionally proceeded very slowly. This has resulted in the deployment of forces that have been one to two decades behind the other nuclear powers in technology (although cause and effect may be reversed, lack of advanced technology may have been the cause of such tardy deployments). It is believed that fewer than 250 ballistic missiles have ever been deployed (with only the first cryogenic liquid fuel missile having been retired). The vast majority of China's arsenal is not capable of reaching the United States, and thus seems geared towards deterring (or threatening) its immediate neighbors.

The oldest weapon in China's missile arsenal, the single stage liquid fueled DF-3 deployed in 1971, is gradually being retired. The DF-3 has a range of 2800 km. The DF-4 missile has a range of 4750 km, making it capable of reaching any part of Russia. Current estimates assert that only about 20 ICBMs are in service - the Dong Feng (East Wind)-5A. This figure is surprising in light of China's ability to produce the same basic booster in larger numbers as the Long March 2 satellite launcher. The U.S. government has stated that in 1981 there were DF-5As deployed in hardened silos at two sites. It is thought to carry the largest warhead ever tested by China (4-5 Mt).

China has placed little emphasis on aircraft as a strategic weapon carrier. The Hong-6 and Qian-5 are short-medium range, light payload aircraft suitable more for tactical or regional-strategic operations. The main bomber, the Hong-6, is based on the Tu-16 Badger which entered Soviet service in 1955 and first flew in China on 27 September 1959. This plane was used to drop two live nuclear weapons in tests: a fission bomb in May 1965 and a megaton-range thermonuclear bomb in June 1967.

The Xian Aircraft Company has been developing the Hong-7 (FB-7), a supersonic fighter-bomber, for over 10 years, but no date has been given for its deployment. The most attractive possibility for modernization of the air arm is simply to purchase advanced fighter bombers from Russia (where they are readily available on easy terms) and modify them to carry Chinese nuclear weapons. China has already purchased 24 Su-27SK and 2 Su-27UBK Flankers (in 1992). Russia has also sold production rights for the Su-27 to China, and an assembly plant has been set up at Shenyang. The first two Chinese-made SU-27s flew in December 1998. China plans to build at least 200 SU-27s over the next 15 years. There is no information available to indicate that they have been assigned a nuclear role however.

China has had a rather unsuccessful ballistic missile submarine program. China has only one operational ballistic missile submarine, the Xia (No. 406). This 6500 ton nuclear-powered boat was laid down in 1978 and launched in April 1981 from the Huludao Shipyard and Naval Base on the northern Bohai Gulf but achieved operational status only with great difficulty. The first attempt to fire a missile from the Xia failed in 1985, and it entered service only after a successful test launch was conducted on 27 September 1988. It was deployed to the Jianggezhuang Submarine Base, where the nuclear warheads for the missiles are believed to be stored, in January 1989.

A second submarine was reportedly launched in 1982, but is not now in service. Unsubstantiated reports claim it was lost in a 1985 accident. The Xia underwent a modernization refit beginning in 1995. It has never sailed beyond China's regional waters and is believed incapable of deployment to distant areas. The submarine is armed with the Julang-1 (Giant Wave, or Tsunami) two-stage solid fuel missile, which was first test fired 30 April 1982. The Julang-1 was adapted to land service as the DF-21 (CSS-5). There will very probably be no more submarines of this class. A new design (Type 094) submarine, to be equipped with the longer range three stage Julang-2, a variant of the DF-31, is been under development for several years but probably won't see deployment for several more.

Much less is known about Chinese tactical nuclear weapons, which are believed to comprise a large part of the Chinese nuclear arsenal. The neutron bomb claimed by China is strictly a tactical weapon (designed for use against armored vehicles). China has conducted a number of low yield tests that may have been tactical weapons, and a large military exercise incorporating simulated nuclear weapons was held in June 1982. China's M-family of tactical ballistic missiles, the M-9, M-11 and M-18, are believed to be nuclear capable. Taiwanese officials have said that over the last four years the number of M-family missiles in China's three southern provinces nearby, have increased from 30-50 to 160-200 today. Estimates of Chinese tactical warheads range from 100 to 200, with yields from a few kilotons to hundreds of kilotons.

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| Chinese Tactical Forces: End of 2000 | | | | | | |
| Delivery Systems | Entry into Service | Range (km) | Payload (kg) | Accuracy (CEP, m) | Warhead Number and Type | Launcher Number |
| M-9 | 1988 | 600 | 500 | 300 | Single HE or nuclear | unknown |
| M-11 | 1988 | 300 | 500 | < 300 | < or HE> | unknown |
| M-18 | 1990s |  |  |  | Single HE or nuclear | unknown |
| Grand Total | | | | | | 120 |
| Notes | | | | | | |
| 1. Nuclear armed. | | | | | | |

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| Chinese Strategic Forces: End of 2000 | | | | | | | | |
| Weapon Designations | | Launcher Number | Warhead Loading (Number x Mt) | Warhead Number | Total Yield (Gross Mt) | | Total Yield (Equiv Mt) | |
| Land Based Missiles | | | | | | | | |
| Dong Feng-3A (DF-3A) CSS-2 (NATO) | 40 | | 1 x 2-3.3, or 3 MRV 50-100 Kt | 40 | 6-132 | | 16.3-88.7 | |
| Dong Feng-4 (DF-4) CSS-3 (NATO) | 20 | | 1 x 2-3.3 | 20 | 40-66 | | 31.7-44.3 | |
| Dong Feng-5A (DF-5A) CSS-4 (NATO) | 20 | | 1 x 4-5 | 20 | 80-100 | | 50.4-58.4 | |
| Dong Feng-21A (DF-21A) CSS-5 (NATO) | 48 | | 1 x 0.20-0.50 | 48 | 9.6-24 | | 16.4-30.2 | |
| Dong Feng-31 (DF-31) | 0 | | MIRV | 0 | 0 | | 0 | |
| SLBMs/Submarines | | | | | | | | |
| Julang (JL)-1 CSS-N-3 (NATO) | 12 | | 1 x 0.20-0.50 | 12 | | 2.4-6 | | 4.1-7.6 |
| Xia Class Submarine | 1 | | 12 x JL-1 |  | |  | |  |
| Aircraft | | | | | | | | |
| Hong-6 (H-6); B-6 (NATO) | 120 | | 1-3 x bomb | 120 | | Kt to Mt (120 [2]) | | 120 [2] |
| Qian-5 (Q-5); A-5 (NATO) | 30 | | 1 x bomb | 30 | | Kt to Mt (30 [2]) | | 30 [2] |
| Grand Total |  | |  |  | | 288-478 | | 269-379 |
| Notes | | | | | | | | |
| 1. Equivalent mega tonnage (EMT) is based on the relative blast effect and is calculated by Y2/3 where Y is the yield in megatons. 2. Assumes 1 Mt nominal average yield (both gross and EMT). | | | | | | | | |

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| Chinese Delivery Systems and Characteristics | | | | | | |
| Delivery Systems | Entry into Service | Range (km) | | Payload (kg) | Accuracy (CEP, m) | Warhead Number and Type |
| Land-Based Missiles | | | | | | |
| Dong Feng-3A (DF-3A) CSS-2 (NATO) | 1971 | | 2800 | 2150 | 1000 | 1 x 2-3.3 Mt, or 3 MRV 50-100 Kt |
| Dong Feng-4 (DF-4) CSS-3 (NATO) | 1980 | | 4750 | 2200 |  | 1 x 2-3.3 Mt |
| Dong Feng-5A (DF-5A) CSS-4 (NATO) | 1981 | | 13000 | 3200 | 500 | 1 x 4-5 Mt |
| Dong Feng-21A (DF-21A) CSS-5 (NATO) | 1985 | | 1800 | 600 |  | 1 x 0.20-0.50 Mt |
| Dong Feng-31 (DF-31) | 2001? | | 8000 |  |  | MIRV |
| New ICBM | 2010? | | 12-13000 |  |  | MIRV |
| SLBMs/Submarines | | | | | | |
| Julang (JL)-1 CSS-N-3 (NATO) | 1987 | | 1700 | 600 |  | 1 x 0.20-0.50 Mt |
| Xia Class Submarine | 1987 | |  |  |  | 12 x JL-1 |
| Julang (JL)-2 CSS-NX-4 (NATO) | 2010? | | 8000 | 600 |  | 1 x 0.20-0.50 Mt |
| Aircraft | | | | | | |
| Hong-6 (H-6); B-6 (NATO) | 1965 | | 3100 | 4500 |  | 1-3 x bomb (Kt to Mt) |
| Qian-5 (Q-5); A-5 (NATO) | 1970 | | 400 | 1500 |  | 1 x bomb (Kt to Mt) |

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