ARTICLES

The Risks from Nuclear Weapons after the Cold War

WKH Panofsky

Physics and Society will publish a series of essays on the risks of nuclear weapons remaining after the end of the Cold War. Those risks have by no means disappeared and, in fact, may have grown. In an unfortunate and misleading categorization, nuclear weapons have been grouped together with biological and chemical weapons as *weapons of mass destruction.* However, each of these weapon types has its own distinctive character. Nuclear weapons have increased the amount of destructive power which can be carried by a delivery vehicle of given size and weight by a factor of a million or even somewhat more as compared with conventional explosive weapons. Delivery of nuclear weapons is very difficult to prevent in an effective manner, and the destructive effects – blast, heat, prompt radiation, and delayed radiation are difficult to mitigate. Chemical weapons, however horrendous their perceived effects, have not increased the lethality of munitions of given size and weight relative to conventional explosives by a significant amount. Biological weapons have fortunately not been used in warfare to any significant extent, but their lethality could become comparable to that of nuclear weapons. Their means of delivery remains to some extent unreliable and unpredictable, and defenses ranging from public health measures to protective gear can be effective. Note that the effects of biological weapons are delayed while most of those by nuclear weapons are prompt.

We consider remaining nuclear risks in the following five scenarios:

1. The Risk of Revival of Hostility with Russia.

While the United States is striving for partnership with Russia and while there are no longer ideological conflicts with Russia, it is at least conceivable that the relationship might turn hostile again at some future time. Since the inventory of nuclear weapons in Russia is still near the 20000 mark, the use of only a small fraction of their inventory could endanger the survival of the United States as a civilization.

2. Accidental Release of Nuclear Weapons, through error or failure of command and control.

With the end of the Cold War the early warning systems of Russia have become much less capable than those of the former Soviet Union, and the discipline inherent in Russian command and control systems has slackened. While such systems are considerably more robust in the case of the United States there have been instances of "near misses" on both sides where some, but happily not all, of the various safeguards against accidental delivery were breached.

3. Proliferation of Nuclear weapons to "states of concern"

The current regime to limit proliferation of nuclear weapons is centered on the Non- Proliferation Treaty of 1970 and has been remarkably successful. All states in the world other than India, Pakistan, Israel and now, North Korea are parties to the NPT. That treaty divides its signatories into nuclear weapon states and non-nuclear weapon states. The peaceful nuclear energy facilities of non nuclear weapon states are subject to an inspection regime negotiated with the International Atomic Agency (IAA). However, the non proliferation regime is under stress due

to the failure of the nuclear weapon states, and in particular the US, to reduce their reliance on nuclear weapons in international relations and due to the clandestine nuclear weapons programs which may be pursued by non nuclear weapons states which are parties to the NPT.

4. Acquisition of Nuclear Weapons by Terrorists

A new threatening possibility is that sub-state actors may acquire nuclear weapons. September 11th has reminded us that the destructive power which terrorists will wield is only limited by the tools at their disposal. Nuclear weapons require the availability of highly enriched uranium or plutonium. Highly enriched uranium (HEU) might be the material of choice for terrorists since bomb manufacture using HEU is well understood and does not require elaborate technology. It is noteworthy that the stockpiles of HEU and plutonium now in the hands of Russia, and to a lesser extent of the United States, are well in excess of the amounts required to fashion 100000 weapons. Thus safeguarding and reducing these inventories is a matter of paramount importance. While progress along these lines has been made a great deal more remains to be done, and obstacles to further progress have arisen.

5. Regional Conflict Using Nuclear Weapons

Nuclear weapons have not been used in war since two weapons were detonated in 1945 by the United States over Hiroshima and Nagasaki. This tradition of non-use has persisted for 58 years despite the fact that the US and the USSR collectively accumulated over 70000 nuclear weapons during the Cold War. The US and the SU, in fact, avoided direct hostile engagements during this entire period. However, the situation may become different in respect to countries in conflict, such as India and Pakistan, which share a common border.

Risk is a product of the probability of an adverse event times its consequences. While the maximum consequences of a nuclear weapons release have diminished since the end of the Cold War, the probability that one of the five disastrous scenarios listed above could occur has probably increased. In the interest of human civilization, therefore, efforts must be intensified to decrease these risks. The newsletter of the Forum on Physics and Society will dedicate a series of articles outlining the promises on the one hand and difficulties on the other of these efforts.

Wolfgang K.H. Panofsky
Stanford Linear Accelerator Center
SLAC, PO Box 20450, Stanford CA 94309
650/926-3988; fax: 926-239
pief@slac.stanford.edu

An Alternative Nuclear Posture

Michael May

President Bush's 2002 nuclear posture differs sharply from its predecessors and is relevant to the President's recently repeated assertion that he will strike first against any country that might pose a threat of using weapons of mass destruction.

The main new trend in the posture is that the US will be prepared to use nuclear weapons in a much wider range of circumstances than before. Such an emphasis has not been seen since the days of "flexible response" forty or so years ago, when tactical nuclear weapons were deployed in Europe and elsewhere.

Yet, nuclear weapons don't help much with the kinds of missions the US prepares for, including the ones noted in the posture, such as digging out deep underground facilities that might contain bio-warfare agents. Deep underground facilities are difficult or impossible to destroy without large nuclear explosions that create large amounts of fallout. Nuclear weapons are more suited for use against shallow-buried facilities (of the order of ten meters deep) but even in those cases, Hiroshima-type yields are needed, and complete destruction of the bio-agents cannot be guaranteed. Other uses mentioned to justify the posture are even more marginal in their feasibility.

Given the overwhelming US conventional advantage and the relative invulnerability of the US to all but nuclear weapons, the US nuclear posture should aim at minimizing the chances of nuclear weapons spread rather than seeking marginal gains with tactical nuclear weapons. Nuclear weapons are equalizers. Why bring them back into the forefront of regional problems, whether in the Middle East or anywhere else?

Increasing the US nuclear threat will increase the motivation of adversaries, big or small, to improve and extend their own nuclear force, or to get one if they don't already have one. The US cannot subsequently be confident that it will be the only power to use or threaten to use nuclear weapons. There are now several demonstrations of the relative ease with which states can acquire nuclear weapons. North Korea, a poor nation of 17 million people, made and separated with little help enough plutonium for perhaps one or more weapons. South Africa made at least six weapons with essentially no help. Other cases tell the same tale.

The nuclear genie is long out of the bottle and the relative stability that characterized the Cold War is also gone. Instead, the US has been pursuing an aggressive strategy of military expansion around the world and ever closer to other states' vital interests. Quite apart from the wisdom of that strategy, is it wise to couple it with an increased nuclear threat to possible adversaries, as the posture does?

In the past, the existence of a real or putative nuclear threat has been a serious motivation for states to improve and extend their own nuclear force, or to get one if they didn’t already have it. That was true of the US, USSR, China, and others. The US, as the world's strongest and least vulnerable major power, should pursue a strategy that minimizes the most serious risk rather than increase it for marginal, and questionable, benefits. The posture implies a strategy that does the opposite.

A nuclear posture better suited to our times would recognize these changes. It would lay the policy basis for the following difficult, long-term, but necessary steps:

1. *Minimizing the demand for nuclear weapons, focusing on Asia.* Asia contains most of the world's population and might, in a few decades, have most of its wealth. Three states there (four if Israel is included) have nuclear weapons; several more could readily have them. The US nuclear posture should provide US initiatives toward a more stable security order there, one in which peaceful states will not be threatened by nuclear or potentially nuclear rivals. The Non-Proliferation Treaty provides a basis -the only existing basis- for such an order, but it needs to be updated with more inducements in the way of technical cooperation and reassurance, and more clearly defined internationally agreed sanctions if the treaty is disregarded. The US nuclear posture in essence forswears the lead in this endeavor.

2. *A pattern for nuclear arms reductions that would include eventually limitations on all arsenals.* Openness here is as important as numbers. The US and Russia have most of the weapons but, after the first hundred or so survivable weapons, it matters less and less how many a state has. An internationally recognized framework is needed that can be applied to the regions of the world where nuclear rivalries threaten. Instead, the US has gone the other way, with a sketchy US-Russia agreement that delays the time scale for reductions and does not provide any precedent for international agreements on inspections.

3. *A strategy for addressing the problem of nuclear terrorism.* The most serious dimension of that problem - the possibility of a terrorist nuclear weapon - is closely related to the proliferation of nuclear weapons and capabilities. Any strategy to avoid that has an important international dimension. Hundreds of tons of weapons-grade uranium and plutonium, most of it surplus in the US and former Soviet Union from the Cold War, need to be better secured and accounted for. A solution to the problem of keeping nuclear weapons and materials out of the tens of millions of shipping containers that crisscross the world requires international cooperation on standards, procedures, cost sharing, and inspections. A good start has been made toward these goals, mainly through the Nunn-Lugar programs, but more money and agreements are needed. A modern nuclear posture should establish the policy basis for securing those resources and agreements. There is at present no comprehensive global strategy for securing such vital agreements and establishing the institutions to enforce them. Consistent, high-priority US participation is vital to secure other countries' participation.

4. *A strategy for reducing the risks of accidental nuclear launch while at the same time maintaining invulnerability of the reduced deployments.* The nuclear posture briefly mentions the "rigorous safeguards" on US weapons systems and proposes to deal with the problem of accidental or unauthorized launch of "certain foreign forces" via nuclear missile defense. That is at best a partial and certainly a distant remedy. Maintaining the human and financial infrastructure for nuclear weapons system will become more difficult in the US as well as elsewhere. Given the relationship among nuclear deterrent forces, the problem cannot be solved unilaterally. A program that would use US technical leadership to improve warning and control for *all* states threatened by nuclear weapons is also needed. It is needed now in South Asia. Later, it could help limit crises with or among Russia and China, and help prevent proliferation in the Middle East. President Reagan, with a portion of Star Wars, and, before him, President Eisenhower, with Open Skies, had something of the kind in mind. It is time to begin thinking about how this would look in modern form.

In summary, a nuclear posture for a world with more dispersed power centers and more widely available nuclear technology should have more, not less, emphasis on international agreements. President Eisenhower stated fifty years ago that "Only chaos will result from our abandonment of collective international security." That is even truer in today's world than it was then. The present administration seems to have a bias against such agreements, which are slow to bear fruit and do not win votes. That is shown in the posture itself, which states that arms control measures will not stand in the way of nuclear weapons development.

Yet these and other agreements are essential to deal with the dangers of proliferation to unstable states, with the possible use of international trade for terrorism, and with the risk of accidents and unauthorized launch. Nuclear deterrence continues to be needed, but the last thing a modern posture should do is to bring nuclear weapons back into the forefront of regional deterrence.

Ironically, when it has committed itself to the task, the US has used international agreements more effectively than any other nation. The Cold War - better called a Cold Peace perhaps, since the military lines of demarcation never changed while the safeguarding of Western values and collapse of the Soviet Union were brought about mainly by economic and political instruments - saw a rise in US power and influence in good part through the use of US-led international agreements in the areas of trade and security, areas that are necessarily related. Now is not the time to give up that approach, especially not in matters relating to nuclear weapons.

Michael May is Professor Emeritus (Research) in the Stanford University School of Engineering and a Senior Fellow with the Institute for International Studies at Stanford University. He is the former Co-Director of Stanford University's Center for International Security and Cooperation. He worked at Lawrence Livermore National Laboratory from 1952-1988 and was Director there from 1965-1971. He was a member of the US delegation to the Strategic Arms Limitation Talks (SALT) and held other positions dealing with nuclear weapons and arms control.

Mmay@stanford.edu

Weapons of Mass Destruction in Iraq, North Korea and Iran: Hype, Hope or Hysteria?

Philip E. Coyle, III

Since Sept. 11, 2001, public debate in the United States and at the United Nations has combined and often confused the notions of fighting terrorism with the pursuit and production of weapons designated as weapons of mass destruction (WMD). The actions of al Qaeda on Sept. 11 and the subsequent, unsolved anthrax infections and deaths after October 2001 lead to a reactive lumping of biological, chemical and other conventional weapons into the WMD category, which was previously limited to nuclear weapons.

Since the Cold War and until 9/11, WMD meant only nuclear weapons: something that could produce truly mass destruction, that is, hundreds of thousands or even millions of deaths. Since 9/11, WMD has been redefined as something that could cause a few thousand deaths, or even a few hundred, or less. Last September, the State of California passed a law that would define an ordinary school bus as a weapon of mass destruction if used for terrorism. These revisions to the definition have added additional layers of complexity to determining when or how to deal with issues of global terrorism.

Defining WMD

Among the general populace, a weapon of mass destruction is thought to be either a nuclear bomb, or chemical, biological or radioactive materials dispersed by a bomb or by some other apparatus. In the following section, I evaluate each kind of weapon and whether the label "WMD" is applicable.

When radioactive materials are dispersed it's called a "dirty bomb," - a bomb that scatters radioactive materials but without producing any nuclear explosive force. Let's examine the meaning of the term "dirty bomb" Some people think a "dirty bomb" is worse than a full scale nuclear explosion, just somehow "dirtier." Let us deconstruct the dirty bomb's impact and its potential as a WMD by discussing the following example:

Suppose some aberrant person stole a radiation source from a hospital, a radiation source that is used to save lives, not take them, such as radioactive isotopes used to treat cancer or used in x-ray machines. Suppose that same person wraps the radioactive source in dynamite, or just throws it into a fire, to create a "dirty bomb." Such a bomb might kill no one, or at least no more than might have been killed by the dynamite alone, but because of the hype of WMD such an incident would scare everyone to death. The cleanup afterwards would likely close an area the size of downtown Washington, D.C., but the detonation wouldn't produce **mass** destruction. The cleanup would certainly be expensive, and would disrupt and distract people living and working nearby, but it would not produce mass destruction, only mass disruption and mass distraction.

Like the dirty bomb, chemical and biological weapons do not fit the Cold War definition of WMD either. Both toxic chemicals and biological agents can certainly produce horrible deaths, but they make lousy weapons of mass destruction. Wind, rain and temperature can weaken the effects of chemical agents. It is difficult to disperse chemicals in lethal doses over a large population and the effects are so immediate that everyone who could would flee. Anyone who has ever whiffed a chlorine spill or industrial chemical spill knows how quickly our senses tell us to move.

As with chemical weapons, biological weapons do not distinguish friend from foe. Biological weapons also take too long to act on the battlefield. Some biological agents, such as anthrax, can be treated successfully with antibiotics, and others can be treated with anti-toxins or vaccines. The anthrax attacks in the mail in October 2001 did not kill many people, as tragic as those few deaths were. There are worries that tomorrow's biotechnology might be able to invent 'superbugs' that would act with more speed and virulence. It is certainly true that we have already been able to take genetic information from a database and translate it into DNA and then an actual polio virus. This kind of technology is still at the cutting edge and, while we can reconstitute existing organisms, enhancing their performance, for good or ill, is a fundamental research question. Furthermore, 'weaponizing' any biological system is not easy. Finally, it is also the case that modern biology is proving equally adept at countering biological threats. For example, within a month of the first SARS break out, scientists in Canada, and soon thereafter at the U.S. Centers for Disease Control, had succeeded in deciphering the DNA of the virus that causes SARS.

Why is it that the United States, Russia, and other countries willingly gave up chemical and biological weapons decades ago, but still cling to nuclear weapons? It's because it is difficult to make an effective chemical or biological weapon that doesn't end up killing your own troops or allies. Saddam Hussein learned this in his war with Iran. Nuclear weapons, on the other hand, can create destruction on a scale of no other weapon known to mankind.

So, for all practical purposes, there are no weapons - plural - of mass destruction that can be effectively delivered by terrorists; there's still only one: a nuclear weapon. Does that mean that someone couldn't make a horrible mess and kill many people with hazardous chemicals or with anthrax, of course they could. With this information in mind, we can be less hysterical about these threats.

This fear of WMD is what is causing the security perimeter around the White House, around the U.S. Capitol, and around airports to be expanded, even though - and think about this - the number of international terrorist attacks in the mid 1980s was about 600 a year; whereas in 2001, the year of 9/11, it was just 350. And here's another comparison: at the height of World War II, a time of high alert in the United States when enemy ships and planes were being sighted off U.S. shores, people ate their lunches on the lawn between the Treasury building and the White House. Today, security is tight around the White House perimeter and tours are suspended.

Defining WMD: Impact on the Current Developments in Iraq

This expanded notion of WMD is driving us to distraction and disrupting our daily lives. The fear of WMD was used to market the war in Iraq. Many people, who otherwise would have been against war in Iraq, supported it because they genuinely feared the WMD that Iraq was said to have, and believed those weapons could reach the United States.

We knew for certain that Saddam Hussein, as leader of Iraq, was pursuing nuclear technology until UN inspectors stopped him a few years ago. We also knew that he had used chemical agents on both his Iranian foes and his own Kurdish people, and we suspected that he was developing biological weapons. As either an enemy to his neighbors or as a sponsor of state terrorism, his ruthless pursuit of any weapons forbidden by international conventions has been a deep concern for the last decade and more.

Before the war with Iraq, the UN inspectors told us that Saddam Hussein did not have a nuclear weapons capability and had never used biological weapons - if he ever had them - either in his war with Iran or against his own Kurdish people, as he had with chemical weapons. Before the war with Iraq, the UN inspectors had not found any WMD and proposed tripling or quadrupling the number of inspectors from 250 to 1,000. The administration of President George W. Bush mocked that proposal, saying that more inspectors would not help.

Now, after the war in Iraq, recent documents indicate Saddam Hussein may not have nuclear or biological weapons capability and effective or deployable chemical weapons. This does not mean that we may not find caches of chemicals or other evidence of his attempts to develop such weapons, but the reality of Saddam Hussein's WMD has not lived up to the pre-war claims. Now, after the war, the administration is building a team of 1,000 or even 1,500 U.S. inspectors to go into Iraq in defiance of the United Nations, and is actively opposing letting UN inspectors back in.

During the fighting in Iraq, television news reporters repeatedly stated that they ***hoped*** we would find WMDs in Iraq, as otherwise the justification for the war would be questionable. Why one would <u>hope</u> for such a thing, other than to justify the government's decision, is puzzling. From the administration's repeated assertions it is clear that WMD will be found in Iraq.

The fear of WMD also is driving the administration's justification for preemptive action and confrontation against Iran, North Korea, and now Syria. At home the fear of WMD is driving our planning for Homeland Security.

Kahlil Gibran said that the fear of need is greater than the need itself. This is equally applicable to WMD: the fear that weapons of mass destruction will destroy our country is driving U.S. taxpayers to spend unheard of sums for national defense and for Homeland Security and has been used to justify continuing assaults on our civil liberties. Unfortunately, the perceived threat from WMD is distracting our citizens and overworked local officials from the <u>real</u> threats.

We have heard amazingly inconsistent messages from Washington. One day, the administration tells us that the war in Iraq will not spawn hundreds of Osama bin Ladens, as some predict; the next day Homeland Security Secretary Tom Ridge is on television telling us that because of the war there **<u>is</u>** a heightened threat from terrorism. The threat level was lowered back to yellow with the explanation that the war in Iraq was now over - as if that would matter to someone like bin Laden who is bent on hurting the United States sooner or later, no matter what.

As far as Homeland Security is concerned, I'm much more concerned about homely threats such as someone setting fire in the Washington, D.C. public transit system, the Metro. It might not kill anyone, but it would tie up the city in the same way that a farmer who drove his tractor

into the reflecting pool on the Mall tied up the city for several days. As a new resident of Los Angeles, my personal sense of risk is much higher than it ever was when we lived in Washington, D.C., but not from WMD, just from traffic accidents on the freeways and surface streets of L.A.

With regard to WMD, the administration's inconsistent policies and fear-mongering rhetoric are not only driving the U.S. public crazy, they also threaten to increase the threat to the United States from the one true WMD threat that remains in today's world.

When asked why the administration's policy of invading Iraq for regime change would not be applied to North Korea, Secretary of Defense Donald Rumsfeld said that it was because North Korea already had nuclear weapons and Iraq didn't. Of course, that sent a message to other non-nuclear countries – and any subnational enemies of the United States - that that they'd better get them while they still can. This is exactly what India and Pakistan have already done.

The United States is doing it, too! According to the *Oakland Tribune*, "The Pentagon is drawing up its first formal demand for a new or modified U.S. nuclear weapon since the mid-1990s. On March 19, 2003, Assistant Defense Secretary Dale Klein confirmed that he is seeking 'sign-off' inside the Pentagon for a new, nuclear 'bunker buster' ". The *San Jose Mercury News* has reported this as well.

Think about what we are saying. If the United States of America - the most powerful country in the world, a nation with unmatched conventional weapons that we have seen work so effectively in Iraq - if <u>we</u> need nuclear weapons to counter non-nuclear threats and blow up bunkers, then why don't weaker countries have even more need for nuclear weapons, particularly countries facing far more immediate security threats?

Defining WMD: Impact on Future Developments in North Korea and Iran

Accordingly, the recent developments in North Korea and Iran should be of great concern.

In October 2002, North Korea admitted to having a program to enrich uranium for nuclear weapons. The United States saw this as a violation of the 1994 Geneva accord known as the Agreed Framework. North Korea said the 1994 accord halted only plutonium processing, not uranium.

Through a series of diplomatic missteps on both sides, the United States and North Korea have been escalating ever since. In recent months, to try to get the Bush administration to take it seriously, North Korea has taken a half dozen actions - any one of which would have been cause for great alarm were they not obscured by the situation in Iraq.

In November, the United States and its allies agreed to suspend fuel oil shipments to North Korea promised under the Agreed Framework.

In December, North Korea removed the seals and monitoring cameras from a nuclear reactor shut down under the 1994 pact, and expelled inspectors from the United Nation's International Atomic Energy Agency (IAEA). Seals were also removed from some 8,000 spent nuclear fuel rods that could be used to make weapons-grade plutonium.

In early January 203, North Korea first threatened to withdraw and then withdrew from the Nuclear Non-Proliferation Treaty, designed to prevent the spread of nuclear weapons.

In February, the IAEA declared North Korea to be in violation of non-proliferation accords and referred the crisis to the UN Security Council. Also in February, North Korea restarted its five-megawatt nuclear reactor that could produce plutonium for nuclear weapons, and began to move nuclear fuel rods that could signal the start of reprocessing that fuel into nuclear weapons.

In March, the United States and South Korea began a month-long war game described by North Korea as a prelude to invasion. You may think North Korea was being paranoid to view

those war games as a prelude to attack, but war games in Kuwait preceded the attack of Iraq on March 19, 2003.

In early April, North Korea said it had begun reprocessing those 8,000 spent fuel rods into weapons-grade plutonium - but South Korea asserted the statement is ambiguous and should not be taken literally.

For its part, the United States has refused to negotiate directly with North Korea, refused to consider a non-aggression pact with North Korea, and in February put 12 B-52 and 12 B-1 bombers on alert for deployment to Guam to be closer to North Korean territory.

The situation in Iran is not without stress either. In the summer of 2002, two secret nuclear sites were revealed by an Iranian opposition group. The first is a gas centrifuge uranium enrichment plant currently under construction in Natanz. Overhead imagery suggests it could house 50,000 centrifuges (enough to produce highly enriched uranium for scores of bombs/year). After an interim period of official silence, the Iranian government has since said that this facility will be used to produce low-enriched uranium for its Bushehr reactor, and several other reactors planned for construction by 2020. Such a large facility could, however, be rapidly converted to produce highly enriched uranium for nuclear weapons. Iran continues to insist that it has only peaceful intentions for these plants. The IAEA's Mohammed Al Baradai recently commented that this was a "very sophisticated" centrifuge project, putting Iran in the company of only about 10 other countries around the world with such capabilities. While this plant may indeed be used only to process reactor fuel for peaceful civil power, there will be little, if any, safeguards in place to prevent the transfer of centrifuge technology for nuclear weapons.

The second site identified by the Iranian opposition was at Arak, and is a heavy water production plant. While heavy water may be an essential component for the reactors Iran currently has on the drawing board, its one, declared reactor in Bushehr does not require heavy water for operation. This has raised concern that a second, secret reactor may already be in operation or that Iran has other nuclear weapons purposes in mind.

In December 2002, Iran canceled a scheduled IAEA inspection visit, following the revelations concerning these two sites.

By February 2003, the Iranian government was more forthcoming. President Khatami explained that Iran was operating or building uranium mines, uranium concentration and conversion facilities, and fuel fabrication plants for civil purposes. However, Iran has refused to sign the IAEA "Model Additional Protocol" that would allow for further assurances concerning these two sites.

The point of these grim recent histories, for Iran and for North Korea, is that the United States needs sophisticated and artful diplomacy to deal with such issues - and that blunt, muscular diplomacy, coupled with U.S. pursuit of new nuclear weapons, has so far only succeeded in driving us farther away from peace.

By contrast, the high technology of U.S. conventional weapons has permitted unprecedented judgement and restraint to be exercised in the midst of battle. There has never been a war where the nation on the offensive went to such lengths to avoid civilian targets - mosques, schools and hospitals. In Iraq (and Afghanistan), the U.S. military has made extraordinary efforts to avoid both military and civilian casualties with precision satellite-guided bombs and laser-guided weapons.

No adversary will master anytime soon the combination of technologies the United States has for modern warfare as it was practiced in Iraq and Afghanistan. A number of countries could develop nuclear weapons to attack their neighbors or potentially a large U.S. city.

So, what should we be doing about this? I'll give you five first steps:

- First, the United States needs to temper its rhetoric and get down to the business of building peace. Just as it has not been productive with Iran and North Korea, threatening military action and calling for regime change will not be a productive approach.
- Second, we need to not lose sight of the dangers from nuclear weapons while we are worrying about chemical or biological weapons, or "dirty bombs." We need to sustain our focus on the real dangers from nuclear weapons. The United States does not need to go to war again because of hyped-up fear of these sorts of weapons, as we have just done in Iraq.
- Third, we need to recognize that the U.S. government needs the United Nations' support and assistance. Most immediately we need to get the UN Inspectors back into Iraq. We know inspectors can find weapons with a certainty and level of control that is impossible in war. Between 1991 and 1998, UN weapons inspectors methodically destroyed more weapons than were destroyed during the whole of the Persian Gulf War, including 40,000 chemical munitions, 690 tons of chemical warfare agents, 3,000 tons of precursor chemicals, 48 Scud missiles, a "super gun," and biological warfare-related factories and equipment. The IAEA found and dismantled a developing Iraqi nuclear weapons program. This is exactly what we want the UN and IAEA inspectors to do again now.

  By contrast, in March 1991 during Operation Desert Storm, when U.S. troops blew up a cache of chemical weapons containing sarin gas at the Khamisiyah site in Iraq, they set off a decade long inquiry into what actually happened. It took the Department of Defense five years to officially recognize that chemical weapons were present at that site and that U.S. soldiers had destroyed them. The blast also exposed large numbers of U.S. troops to chemical agents, one of the leading theories for the cause of Gulf War Syndrome - a debate that, to this day, 12 years later, is still unresolved.

  This is exactly what we don't want to happen again.

  Now that U.S. and coalition forces have cleared the way, UN inspectors can resume the work they started before the war but without interference from Saddam Hussein's guards and "minders." The United States can help to populate these teams, but shouldn't monopolize the job. UN inspectors are trained and equipped for this work, and have a proven track record of success.
- Fourth, we also need to get the UN inspectors back into Iran and North Korea.
- Fifth, we need to realize that we need the United Nations more broadly than for just its inspectors, or its highly competent food, health, education, and economic development bureaus. We need the United Nations, not to do our bidding, but to hold us accountable from an international perspective. Some people have said the United Nations has become irrelevant because it didn't call for military action against Iraq. That is nonsense. For the United States, the relevancy of the United Nations is a mirror in which we can see how we are viewed by other nations. For the United States, the United Nations is a way to "touch the wall" - to reach out and learn and respond to the views of others.

In summary, we must work hard at restoring clarity to our discussions about fighting terrorism, the weapons of terrorism, and the real weapons of mass destruction. We must carry this clarity into sustained involvement in the United Nations, especially for rebuilding Iraq and - through diplomacy - halting nuclear weapons and nuclear weapons technology in North Korea and Iran.

Philip E. Coyle, III
Center for Defense Information
Sunday, April 27, 2003
All Saints Church

Peace and Justice Ministry
Pasadena, California,
pcoyle@cdi.org

Ballistic Missile Defense Revisited

W. K. H. Panofsky

The American Physical Society has issued a report entitled "Boost Phase Intercept Systems for National Missile Defense, Scientific and Technical Issues." This is an independent study of one of the 'layers' of ballistic missile defense now pursued by the Missile Defense Agency.

The report itself is a sobering identification of the scientific and technical factors involved in just one component of the larger problem – preventing the hostile detonation of nuclear weapons on U.S. soil. Such a catastrophe could be produced not only by short- or long-range ballistic missiles, but also by cruise missiles, aircraft of all kinds, detonation of nuclear explosives in U.S. harbors or smuggled across U.S. land boundaries. Moreover, the essential components to fashion a nuclear weapon can be introduced clandestinely and assembled in small buildings. Should terrorists acquire a nuclear weapon, delivery by ballistic missile is the least likely means by which they would introduce such an explosive into the United States.

Intercontinental Ballistic Missiles can be attacked during three phases: the 'boost phase' during powered flight as the missile ascends, 'mid-course' in the vacuum of outer space, and 'terminal defense' after re-entry of the missile into the atmosphere. The Administration projects a 'layered system' including all these phases. The largest fraction of today's approximately 10 billion dollar budget for missile defense is for mid-course intercept, but substantial increases for boost phase defense are planned. Note that thus far about 100 billion dollars has been spent on overall BMD with little to show for it.

Each of the three phases of an enemy missile's trajectory offers advantages and disadvantages to a defense. During the boost phase, the rocket plume emits very intense radiation that can only be decoyed by another rocket. In contrast, in mid-course all objects follow the same trajectory, be they heavy or light; therefore discriminating decoys from the target is a serious issue. During re-entry the atmosphere screens out light objects but a defense at that point can only protect a small area. Because of the large and distinct technical difficulties each layer imposes, the Administration has adopted what it terms a 'capabilities-based' approach, which translates to: do what you can, irrespective of a careful evaluation comparing effectiveness against projected threats in relation to costs and effort.

In the case of the boost phase intercept, the APS study provides little comfort. The burn time of the booster averages three to four minutes, severely constraining placement of potential interceptors and limiting the decision time to launch such an interceptor to a minute or less. Thus the decision has to be automated or pre-delegated to local commanders – a prescription for attacks on hostile missiles or peaceful launchers alike! Launches from certain small countries, such as North Korea, could be intercepted from land, sea or air, and even this becomes impossible if more rapid burning solid fuel boosters are employed. Launches, accidental or deliberate, from larger continental countries such as Russia, China, or Iran become inaccessible. To intercept launches from space, even one launch from a single location, would require over 1,000 satellites carrying heavy interceptors – several times the total launch capacity of the United States! Thus boost phase intercept systems add little to the already unpromising technical capability of the mid-course BMD system now under test by the Defense Department.

This test program has been much in the public spotlight. Opponents of BMD decry each test failure as evidence that "BMD does not work," while each successful test is ballyhooed by proponents as proof that BMD can offer comprehensive protection. In fact, these developmental

tests have been carried out under far from realistic conditions: intercepts have occurred at speeds well below those realistically expected and the launchers knew the target trajectory in advance. Unfortunately, discussion of Ballistic Missile Defense (BMD) is now so highly politicized that basic scientific factors controlling a BMD's performance have been largely overridden by policy arguments. BMD has become a political litmus test for support of the Administration. The Defense Department has now thinned out the test program and imposed increased secrecy over test performance.

But the fundamental question remains: Is the nation taking the necessary steps to minimize the risk of a nuclear explosion on United States soil, considering *all* available means of hostile delivery? Technical and scientific realities cannot be coerced by policy. In my view the political prominence of BMD has resulted in a costly and dangerous distortion of priorities among the efforts designed to reduce the real nuclear risk to this Nation.

W. K. H. Panofsky is Director Emeritus of the Stanford Linear Accelerator Center. He is a member of the National Academy of Sciences and recipient of the National Medal of Science. He served on the President's Science Advisory Committee and headed its Strategic Military Panel.

Pief@slac.stanford.edu

Protecting Nuclear Material and Facilities: A Standards-Based Approach

Charles D. Ferguson

Without access to fissile material, radioactive sources, or nuclear facilities, terrorists cannot successfully carry out nuclear or radiological terrorism. While other prerequisites, such as highly motivated and technologically skilled terrorists, are needed before such attacks can occur, arguably the most effective way of preventing nuclear and radiological terrorism is to block access to the nuclear materials.

What is the level of physical protection of nuclear material and facilities after September 11, 2001?[i] Answering this question requires comparison to the agreed standards of physical protection. Unfortunately, no international binding standards or requirements exist for the

protection of nuclear material or facilities within a state. Physical protection measures vary from state to state.

This paper offers five physical protection standards for consideration. It also discusses some impediments to achieving universal application of the standards. Before introducing the standards, the paper defines the four threats of nuclear and radiological terrorism. Throughout this paper, the word "terrorists" refers in shorthand to those terrorists who are highly motivated to unleash nuclear or radiological terrorism. A forthcoming Center for Nonproliferation Studies report will examine in depth the motivational issue as well as other issues briefly covered here.

First, terrorists might seek to acquire enough highly enriched uranium (HEU) or plutonium to build an improvised nuclear device (IND), or crude nuclear weapon. Second, terrorists might try to seize an intact nuclear weapon. Third, terrorists might launch an attack against a commercial nuclear power plant or other nuclear facility. Fourth, terrorists might construct a radiological dispersal device (RDD) – one type of which is popularly known as a "dirty bomb" – to spread radioactive material.

Physical protection standards should strive for maximizing the risk reduction of nuclear or radiological terrorism. Although these standards will not entirely eliminate the risk of nuclear and radiological terrorism, the closer they approach universal application the more the risk will be reduced.[ii] The first two standards below are not new and were articulated by the National Academy of Sciences almost ten years ago, as documented in the references, while the other three standards arise from national and international efforts to address the security of radioactive sources, nuclear power plants, and the large stockpiles of HEU.

Proposed Physical Protection Standards

Spent-Fuel Standard: Make weapons plutonium "roughly as inaccessible for weapons use as the much larger and growing stock of plutonium in civilian spent fuel."[iii] The highly radioactive fission products (especially the prevalent cesium-137 with a half-life of 30 years) in spent fuel provide a lethal barrier against theft.

Non-weapon-usable plutonium contains 80% or more of plutonium-238, which has the highest rate of spontaneous neutron emission as compared to other plutonium isotopes. The higher the spontaneous neutron emission rate the more probable a mixture of plutonium isotopes would result in a dud or "fizzle" nuclear bomb because of pre-initiation of the chain reaction. All other mixtures of plutonium isotopes are, in principle, weapon-usable. Weapon-grade plutonium typically has 93% or more of plutonium-239 (the most desirable plutonium isotope from a weapon design standpoint mainly because of its relatively low rate of spontaneous neutron emission) and from 3 to 7% of plutonium-240. Depending on the burn up of the nuclear fuel, reactor-grade plutonium usually has about 65% of plutonium-239 and from 18 to 30% of plutonium-240. Although there is some controversy[iv] about whether any state has actually built or tested a nuclear weapon using reactor-grade plutonium, there is no physical reason why it cannot be used in a nuclear explosion.[v]

Stored Weapons Standard: Weapon-usable nuclear materials should be guarded as securely as stored nuclear weapons.[vi] In 1997, the Department of Energy officially adopted this standard. Although all the details of the implementation of this standard in the United States are not openly published, by analyzing open source U.S. government documents, George Bunn has pieced together a definition of the stored weapons standard.[vii] First, the standard defines the "design basis threat," or DBT, which is a credible threat that authorities must design their storage sites to withstand. The DBT for stored nuclear weapons or weapon-usable material would in rough terms posit "a violent external assault by a group using weapons and vehicles, possibly with inside

assistance." To try to defeat this DBT, the stored weapons standard would require, among other safeguarded details, "a strong, secure storage vault with a single entry surrounded by two layers of strong fences and an open, lighted area where no one could hide. Access to the vault should be limited to personnel with a need for access, who are cleared through full-field background investigations and accompanied by another such person (the 'two-person' rule). Such access limitations should be enforced by both armed guards and electronic monitoring devices, supported in case of need by nearby armed backup forces. All of these personnel should be trained to deal with design basis threats, and their competence checked periodically in exercises like war games."[viii] In a subsequent study, George Bunn and his colleagues at Stanford University showed in a survey that many states do not meet this standard.[ix]

High-Risk Radioactive Source Security Standard: Prioritize enhanced security efforts on those radioactive sources that have the potential to cause serious human health effects or radioactive contamination if used in an RDD.[x] In May, the U.S. Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE) published the findings of an Interagency Working Group that used a radiological basis to determine what radioisotopes and radioactive sources would pose the greatest RDD risk.[xi] The threshold radioactivity levels (curie content) that would trigger a federal response if the radioactive material were used in an RDD were not published in the NRC/DOE report. However, based on some NRC and International Atomic Energy Agency (IAEA) presentations at the International Conference on Security of Radioactive Sources in Vienna in March, these threshold levels would depend on the type of radiation emitted (whether alpha, beta, or gamma) and would not be less than about ten curies. These levels imply that only a small fraction of the millions of radioactive sources used or stored globally would pose an inherently high risk of causing significant harm if used in an RDD. Nonetheless, in absolute numbers, perhaps tens of thousands of sources would belong to the high-risk category.

Prioritizing security enhancements on this group of sources would achieve the greatest RDD risk reduction in the shortest period of time. The IAEA is working with member states to try to reach consensus on the prioritization standard. As part of this process, the IAEA is revising the Code of Conduct on the Safety and Security of Radioactive Sources and the Categorization of Radiation Sources in order to place more emphasis on enhanced security.

Hardened Nuclear Facility Standard: Ensure that all nuclear fuel bearing elements including reactor cores and spent fuel are protected inside hardened structures such as containment buildings, dry storage casks, and spent fuel pools that are fortified against attack by explosives or high kinetic energy projectiles, such as crashing airplanes. Although such hardening would not prevent terrorist attack against these facilities and would not obviate the need for a well-trained and well-armed guard force, implementing this standard would greatly diminish the likelihood of an off-site radiological release if an attack occurred.

In general, U.S. nuclear power plants (NPPs) and other U.S. nuclear facilities tend to meet this standard. For instance, all U.S. NPPs protect their reactors with containment structures. Notably, however, a recent study has pointed out that terrorist attacks on some spent fuel pools may cause release of radiological materials.[xii] Outside the U.S., some dozen Chernobyl-type, or RBMK, reactors continue to operate in Russia and Lithuania. Lacking containment structures, these reactors would not meet the hardened nuclear facility standard. The world witnessed in April 1986 the massive release of radioactivity resulting from the Chernobyl accident.

HEU Elimination Standard: Because of the relative ease by which HEU, especially weapon-grade HEU, can be used in a simple IND, there should be a global effort to eliminate HEU by phasing out civil commerce of HEU, by down blending existing stocks, and by agreeing to stop

enrichment of LEU into HEU. Weapon-grade HEU typically contains 90% or more uranium-235 (the uranium isotope which is desirable for nuclear weapons).

Down blending weapon-grade HEU to the 3 to 5% LEU enrichment level for use in commercial light-water reactor fuel would certainly eliminate the possibility of that material being used to fuel a nuclear weapon. The Megatons-to-Megawatts deal between the U.S. and Russia has been applying this process to 500 tons of Russian weapon-grade HEU. However, after several years of effort, much less than half of this HEU has been down blended; the current rate is about 30 tons per year. Considering the urgency of the terrorist threat, this deal is progressing at too slow of a rate to make rapid headway. Recent proposals have sought to accelerate the blend down of Russian weapon-grade HEU by only going to the 19% enrichment level.[xiii] Although the dividing line between LEU and HEU was set at 20% enrichment in uranium-235, LEU that is enriched to 19% uranium-235 can be used in nuclear weapons. However, the bare critical mass would be greater than 800 kg, an amount unlikely to be acquired by terrorists.

Even increasing the blend down of Russian weapon-grade HEU to its maximum rate will still mean that several years will be required to complete the process. In parallel, the U.S. and Russia need to step up their efforts to ensure that all weapon-usable HEU meets the stored weapons standard.

Some Impediments to Universal Compliance of Physical Protection Standards

These or comparable standards are not universally applied. In general, a global strategic plan to prevent nuclear and radiological terrorism is needed to guide U.S. and international security work. Such a strategic plan would seek to meet the types of physical protection standards outlined above. Importantly, the plan would have to specify what steps are necessary to achieve the standards. Last year's G8 Global Partnership meeting made some progress toward developing a plan by putting the G8 leaders on record as to the urgency of stopping nuclear terrorism.

However, only continued high level political effort will lift barriers to reaching effective standards and will lead to a workable strategic plan. Impediments to establishing such standards include the potentially high costs to implementing the standards, political resistance, culture of secrecy, varied national practices, and some commercial interests at odds with one or more of the standards. Due to space limitations, only a few impediments will be discussed below.

Many countries lack adequate regulatory systems to control radioactive sources. Near term efforts, such as the Department of Energy's plan to secure the most highly radioactive sources in the most vulnerable locations, can make rapid progress in enhancing security. Nevertheless, a long term, sustainable plan requires addressing the systemic weaknesses in the world's regulatory controls of radioactive materials. Additional political and monetary support of the IAEA's efforts to assist states' regulatory organizations is needed.

In Russia, numerous security upgrades are still required in order to meet the stored weapons standard for tons of weapon-usable fissile material, according to a recent General Accounting Office report.[xiv] The GAO report pointed out that the major stumbling block is lack of access to several Russian facilities. U.S. policy guidance in January 2003 between DOE and DOD prohibits U.S. security assistance to operational sites because it might enhance Russia's military capabilities. However, due to the concerns about the security of many Russian tactical nuclear weapons, this policy should be revisited. In parallel, a presidential level initiative is needed to eliminate tactical nuclear weapons under a verified agreement.

In Russia, Lithuania, and the United Kingdom, many nuclear power reactors continue to operate without containment structures that would reduce the likelihood of an off-site

radiological release in the event of an accident or devastating terrorist attack. Since the G7 meeting in Lisbon in 1992, the U.S. and the other G7 states have emphasized the nuclear safety hazard posed by the continued operation of many Soviet-designed nuclear power plants, especially the RBMK Chernobyl-type plant without containment structures. How willing is the U.S. to push the shut down of these plants? Cost estimates for the energy replacement are as high as several billion dollars. Do these plants pose a big enough safety and terrorist sabotage risk to justify spending money to shut down these plants? A compromise position between demanding near term shutdown of these plants and acquiescing in their indefinite operation could be for the G7 to strive for Russian commitment to phase out the operation of the RBMKs over the next decade and to promise to not build any more reactors without containment structures and other vital safety features. Reaching agreement on this position would be difficult mainly because Russia does not consider the RBMKs to be unsafe. Encouragingly, Lithuania appears likely to shut down its RBMK plant as a condition of European Union membership. The UK also is working toward closure of its NPPs that do not have containments.

Although civil commerce in HEU has substantially reduced over the past 25 years that the Reduced Enrichment for Research and Test Reactors (RERTR) program has promoted the conversion of these reactors from HEU to LEU use, some commerce in bomb-grade HEU continues. Two proposed amendments in Congress (the Burr Amendment in the House of Representatives and the Bond Amendment in the Senate) could reverse this progress toward phasing out HEU commerce by repealing the 1992 Schumer Amendment. The Schumer Amendment bars U.S. export of HEU to reactor facilities unless the owners of these facilities commit to converting from HEU to LEU use. Supporters of the Burr and Bond Amendments claim that removing the Schumer Amendment is necessary to ensure an uninterrupted supply of medical isotopes from commercial radioisotope production reactors. However, this legislation is unneeded because the Canadian company MDS Nordion, the world's largest producer of these isotopes and the largest importer of U.S. HEU, has stockpiled four years supply of HEU targets for its new production facility. Also, Nordion would not be denied HEU exports under the Schumer Amendment as long as this company makes progress toward conversion. Even if the flow of medical isotopes from Nordion were interrupted, the U.S. could make up the difference by turning toward producers in Belgium, the Netherlands, and South Africa. Furthermore, the Burr and Bond legislation is misguided because, if enacted, it would have the unintended consequence of undermining U.S. nonproliferation interests and increasing the risk that terrorists could seize HEU that is suitable for an IND.[xv]

Conclusion and Recommendations

The United States should work with other nations and the IAEA to ensure that nuclear materials and facilities meet the highest physical protection standards. Such standards support the goal of decreasing the likelihood that terrorists could gain access to nuclear and radiological materials by securing and accounting for the materials (e.g., meeting the stored weapons standard), eliminating materials (e.g., blending down HEU to LEU), converting the materials to unusable or undesirable forms (e.g., transforming weapon-grade plutonium or combining separated plutonium with highly radioactive waste to meet the spent fuel standard), stopping production of materials (e.g., stopping the separation of plutonium from spent fuel and stopping the manufacture of weapon-grade plutonium in Russian production reactors), and fortifying nuclear power plants and other nuclear facilities against attack (e.g., ensuring fuel bearing components are protected by hardened structures).

Charles D. Ferguson
Center for Nonproliferation Studies
Monterey Institute of International Studies
11 Dupont Circle, 9th Floor
Washington, DC 20036
Tel: 202-478-3426; Fax: 202-238-9603
charles.ferguson@miis.edu

---

[i] This paper stems from trying to answer that question for a presentation given at the panel discussion "Physical Protection of Nuclear Material and Facilities Post 9/11" at the American Nuclear Society's Annual Meeting on June 3, 2003.

[ii] Matthew Bunn, Anthony Wier, John P. Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, Harvard University and the Nuclear Threat Initiative, March 2003, examine in detail the issues of standards and performance metrics as these pertain to the security of fissile material.

[iii] National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium*, National Academy Press, Washington, DC, 1994, p. 34.

[iv] Bruno Pellaud, "Proliferation Aspects of Plutonium Recycling," *Journal of Nuclear Materials Management*, Fall 2002, pp. 30-38.

[v] J. Carson Mark, "Explosive Properties of Reactor-Grade Plutonium," *Science and Global Security*, Volume 4, 1993, pp. 111-128.

[vi] National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium*, National Academy Press, Washington, DC, 1994, p. 31.

[vii] George Bunn, "U.S. Standards for Protecting Weapons-Usable Fissile Material Compared to International Standards," *The Nonproliferation Review*, Fall 1998, pp. 137-143.

[viii] Ibid, p. 138.

[ix] George Bunn, "Raising International Standards for Protecting Nuclear Materials from Theft and Sabotage," *The Nonproliferation Review*, Summer 2000, pp. 146-156.

[x] Charles D. Ferguson, Tahseen Kazi, and Judith Perera, *Commercial Radioactive Sources: Surveying the Security Risks*, Occasional Paper No. 11, Center for Nonproliferation Studies, January 2003.

[xi] DOE/NRC Interagency Working Group on Radiological Dispersal Devices, "Radiological Dispersal Devices: An Initial Study to Identify Radioactive Materials of Greatest Concern and Approaches to Their Tracking, Tagging, and Disposition," Report to the Nuclear Regulatory Commission and the Secretary of Energy, May 2003.

[xii] Robert Alvarez et al., "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States," *Science and Global Security*, Vol. 11, 2003, pp. 1-51.

[xiii] See for example, Matthew Bunn, John P. Holdren, and Anthony Wier, Securing Nuclear Weapons and Materials: Seven Steps for Immediate Action, Managing the Atom Project, Harvard University, May 2002, pp. 65-72; and Robert Civiak, *Reducing Stockpiles of Weapons-Usable Highly Enriched Uranium in Russia and Other Nations*, Federation of American Scientists, May 2002. Both reports discuss in detail how to structure a rapid down blending deal.

[xiv] U.S. General Accounting Office, "Weapons of Mass Destruction: Additional Russian Cooperation Needed to Facilitate U.S. Efforts to Improve Security at Russian Sites," GAO-03-482, March 2003.

[xv] Alan J. Kuperman, "Loose Nukes of the West," *The Washington Post*, May 7, 2003, p. A31; and Kuperman et al. letter to Senator Pete Domenici, Chairman, Committee on Energy and Natural Resources, May 28, 2003.