

It is 5 minutes

We stand at the brink of a second nuclear age. Not since the first atomic bombs were dropped on Hiroshima and Nagasaki has the world faced such perilous choices. North Korea's recent test of a nuclear weapon, Iran's nuclear ambitions, a renewed U.S. emphasis on the military utility of nuclear weapons, the failure to adequately secure nuclear materials, and the continued presence of some 26,000 nuclear weapons in the United States and Russia are symptomatic of a larger failure to solve the problems posed by the most destructive technology on Earth.

As in past deliberations, we have examined other human-made threats to civilization. We have concluded that the dangers posed by climate change are nearly as dire as those posed by nuclear weapons. The effects may be less dramatic in the short term than the destruction that could be wrought by nuclear explosions, but over the next three to four decades climate change could cause drastic harm to the habitats upon which human societies depend for survival.

This deteriorating state of global affairs leads the Board of Directors of the Bulletin of the Atomic Scientists—in consultation with a Board of Sponsors that includes 18 Nobel laureates—to move the minute hand of the “Doomsday Clock” from seven to five minutes to midnight.



to midnight.

NUCLEAR WEAPONS PRESENT THE MOST grave challenge to humanity, enabling genocide with the press of a button. In 1945, scientists warned the world about the nearly unimaginable destructive power of the atomic bombs they had created. As Eugene Rabinowitch, one of the cofounders of the *Bulletin*, wrote, “The *Bulletin*’s Clock is not a gauge to register the ups and downs of the international power struggle; it is intended to reflect basic changes in the level of continuous danger in which mankind lives in the nuclear age, and will continue living, until society adjusts its basic attitudes and institutions.” As inheritors and trustees of the Clock, we seek to warn the world that this level of danger has escalated precipitously.

The second nuclear era, unlike the dawn of the first nuclear age in 1945, is characterized by a world of porous national borders, rapid communications that facilitate the spread of technical knowledge, and expanded commerce in potentially dangerous dual-use technologies and materials. The Pakistan-based network that provided nuclear technologies to Libya, North Korea, and Iran is an example of the new challenges confronting the international community.

The current period of globalization coincides with an erosion of the global agreements and norms that have constrained the spread of nuclear weapons since 1970 when the Nuclear Non-Proliferation Treaty (NPT) came into force. The NPT provided standards, set up protocols for inspections and regulation through the International Atomic Energy Agency (IAEA), and held out a promise of disarmament

by the nuclear powers in exchange for restraint by those countries that did not have nuclear weapons. Compliance has always been voluntary, and until the last five years, nearly all governments felt that their interests were served by adhering to the NPT provisions. The 2005 NPT Review Conference, however, ended in failure, without any consensus on the core issues of verification of safeguards on national nuclear programs, the peaceful use of nuclear power, and disarmament.

Iran, which is a signatory state of the NPT, has violated its IAEA obligations and obstructed efforts to determine the extent of its activities. North Korea, which withdrew from the NPT in 2003, followed through on its declared intention to test a nuclear weapon three years later. Although this test prompted stern global condemnation, the international community essentially acquiesced. The dominant concern was that North Korea might sell its nuclear weapons abroad. In effect, the message from the international community was “don’t proliferate” rather than “don’t become a nuclear power.” In this regard, the North Korean test was doubly dangerous and sets an unfortunate example for other would-be nuclear powers.

The five NPT-recognized nuclear weapon

states have failed in their obligation to make serious strides toward disarmament—most notably, the United States and Russia, which still possess 26,000 of the 27,000 nuclear warheads in the world. By far the greatest potential for calamity lies in the readiness of forces in the United States and Russia to fight an all-out nuclear war. Whether by accident or by unauthorized launch, these two countries are able to initiate major strikes in a matter of minutes. Each warhead has the potential destructive force of 8 to 40 times that of the atomic bomb dropped on Hiroshima,

Japan, on August 6, 1945. In that relatively small nuclear explosion, 100,000 people were killed and a city destroyed; 50 of today’s nuclear weapons could kill 200 million people.

While the possibility of launching these powerful weapons may seem remote, experts in Russia and the United States are concerned about command and control systems that depend on complex electronic communications and information. Past incidents suggest that technical failures, misperception, and miscommunication happen in even the best-maintained systems. Such errors could lead to an accidental launch already programmed in the event of attack.

The *Bulletin*’s Board of Directors and Sponsors, in consultation with other scientists, engineers, experts, and citizens’ groups, will continue to monitor progress on reducing dangers from nuclear weapons and fissile material. We also will follow climate change, including efforts to reduce carbon emissions and plans to mitigate its consequences. Our website will provide information about global trends with charts that track indicators, reports of major scientific studies, proposed solutions to the problems we face, and analysis and commentary from experts. Visit the *Bulletin* online at www.bulletin.org.

Experts have documented four nuclear false alarms—in 1979, 1980, 1983, and 1995—where either the United States or Soviet/Russian forces were placed on the highest alert and missile launch crews were given preliminary launch warnings.

Sixteen years after the end of the Cold War, following substantial reductions in nuclear weapons by the United States and Russia, the two major powers have now stalled in their progress

toward deeper reductions in their arsenals. Equally worrisome, the United States, in its 2002 Nuclear Posture Review, declared that nuclear weapons “provide credible military options to deter a wide range of threats,” including chemical and biological weapons, as well as “surprising military developments.” In early 2004, this new concept, which espouses the quick use of even nuclear weapons to destroy “time urgent targets,” was put into

operation. That the United States—a nation with unmatched superiority in conventional weapons—would place renewed emphasis on the need for nuclear weapons suggests to other nations that such arsenals are necessary to their security.

In the face of the major powers’ continued reliance on nuclear weapons, other nations are following suit. Since the end of the Cold War, three countries have announced the

The Clock since 1947



7 MINUTES TO MIDNIGHT

2002: The United States rejects a series of arms control treaties and announces it will withdraw from the Anti-Ballistic Missile Treaty. Terrorists seek to acquire and use nuclear weapons.



9 MINUTES TO MIDNIGHT

1998: India and Pakistan go public with nuclear tests. The United States and Russia disagree on further reductions in their nuclear stockpiles.



14 MINUTES TO MIDNIGHT

1995: Arms reductions stall. Risks of nuclear “leakage” from poorly guarded former Soviet facilities increase.



17 MINUTES TO MIDNIGHT

1991: The United States and Soviet Union sign the Strategic Arms Reduction Treaty and announce further unilateral cuts in tactical and strategic nuclear weapons.



10 MINUTES TO MIDNIGHT

1990: Democratic movements in Eastern Europe shatter the myth of monolithic communism, and the Cold War ends.



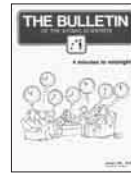
6 MINUTES TO MIDNIGHT

1988: The United States and Soviet Union vow to eliminate intermediate-range nuclear forces. More nations actively oppose nuclear weapons.



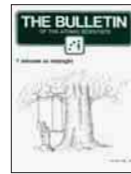
3 MINUTES TO MIDNIGHT

1984: The arms race accelerates. The blunt simplicities of force threaten to displace any other form of discourse between the superpowers.



4 MINUTES TO MIDNIGHT

1981: Both superpowers develop more weapons for fighting a nuclear war. Terrorist actions, repression of human rights, and regional conflicts add to world tension.



7 MINUTES TO MIDNIGHT

1980: The deadlock in U.S.-Soviet arms talks continues, while nationalistic wars and terrorist actions increase.



9 MINUTES TO MIDNIGHT

1974: Strategic Arms Limitation Treaty talks reach an impasse. India develops a nuclear weapon.



12 MINUTES TO MIDNIGHT

1972: The United States and Soviet Union sign the first Strategic Arms Limitation Treaty and the Anti-Ballistic Missile Treaty.



10 MINUTES TO MIDNIGHT

1969: The U.S. Senate ratifies the Nuclear Non-Proliferation Treaty.

possession of nuclear weapons—India, Pakistan, and North Korea. Israel possesses weapons but chooses not to declare them. The director of the IAEA, Mohamed ElBaradei, believes up to 30 countries have the capacity, and increasingly the motivation, to develop nuclear weapons in a very short time span.

Such developments have prompted some to declare the NPT a “failure.” Yet this assessment ignores the decades-

long success of the treaty in stemming nuclear proliferation. In 1963, President John F. Kennedy warned of the possibility of the United States facing a world “in which 15 or 20 or 25 nations” would have nuclear weapons. In the decades following the entry into force of the NPT, only six countries have embarked on nuclear weapons programs and many others have shut down their programs, including Argentina, Brazil, Libya, and South Africa.

Even at the height of the Cold War, President Kennedy worried about U.S. allies’ acquisition of nuclear weapons technology. In recent years, however, the United States appears focused on denying nuclear weapons only to its adversaries, while accommodating its friends. Yet, as history demonstrates, countries that are deemed allies can quickly become adversaries. And the success of the illicit, Pakistan-based nuclear procurement network, which extended into Europe, shows how even friendly governments can fail to guard against the theft and smuggling of sensitive nuclear technology.

Reducing global nuclear arsenals is a key to keeping such weapons out of the hands of terrorists. Through the Cooperative Threat Reduction program, the United States and Russia have succeeded in finding, consolidating, and securing about half of Russia’s nuclear bombs and

fissile material in just over a decade. European countries have also pledged to aid this effort to ensure that existing nuclear materials are kept out of the hands of terrorist groups. But bureaucratic and legal disputes, as well as inadequate funding, have frequently slowed the process.

The problem of unsecured fissile material is not confined to Russia, however. More than 1,400 metric tons of highly enriched uranium and approximately 500 tons of plutonium are distributed worldwide at some 140 sites, in unguarded civilian power plants and university research reactors, as well as in military facilities. The first report of the International Panel on Fissile Materials in September 2006 focused on the ease with which unauthorized groups, including terrorist groups, could obtain sufficient highly enriched uranium to make nuclear or radiological bombs.

The prospect of civilian nuclear power development in countries around the world raises further concerns about the availability of nuclear materials. Growth in nuclear power is anticipated to be especially high in Asia, where Japan is planning to bring on line five new plants by 2010, and China intends to build 30 nuclear reactors by 2020. Over the next five years, some two-dozen nuclear power plants are scheduled to be refurbished or rebuilt worldwide, and countries as diverse as Nigeria, Poland, and Vietnam have expressed interest in nuclear energy. In November 2006, the IAEA announced that four Mideast nations—Algeria, Egypt, Morocco, and Saudi Arabia—had declared their intentions to embark on nuclear energy programs.

Several factors are driving the turn to nuclear power—aging nuclear reactors, rising energy demands, a desire to diversify energy portfolios and reduce reliance on fossil fuels, and the need to reduce carbon emissions that cause climate change. Yet expansion of nuclear power increases the risks of nuclear proliferation. Enrichment facilities that produce low-enriched uranium for reactor fuel can be easily modified to produce weapons-usable, highly



7 MINUTES TO MIDNIGHT

1968: France and China acquire nuclear weapons. Wars rage in the Middle East, the Indian subcontinent, and Vietnam.



12 MINUTES TO MIDNIGHT

1963: The United States and Soviet Union sign the Partial Test Ban Treaty.



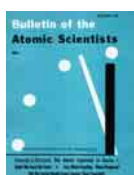
7 MINUTES TO MIDNIGHT

1960: The public better understands that nuclear weapons make war between the major powers irrational.



2 MINUTES TO MIDNIGHT

1953: The United States and Soviet Union test hydrogen bombs within nine months of each other.



3 MINUTES TO MIDNIGHT

1949: The Soviet Union detonates its first atomic bomb.



7 MINUTES TO MIDNIGHT

1947: The Clock first appears on the *Bulletin's* cover as a symbol of nuclear danger.

enriched uranium. Moreover, spent plutonium fuel from reactors is weapons-usable after reprocessing. It does not require much nuclear material to construct a fissile weapon: 1 to 3 kilograms of plutonium or 5 to 10 kilograms of highly enriched uranium is all

spread into new habitats, carrying diseases and destroying flora and fauna in zones that have no evolutionary protection. Through flooding or desertification, climate change threatens the habitats and agricultural resources that societies depend upon for

States is well positioned to reduce its carbon emissions.

Such reductions do not necessarily depend upon nuclear power as a panacea. Carbon emissions can be cut by implementing auto emissions limits, reducing subsidies for oil and coal production, supporting carbon-trading regimes, increasing taxes on gasoline, increasing energy efficiency by establishing manufacturing standards for appliances and lightbulbs, subsidizing solar and wind power development, and planting more trees, among others. Government funding and private investments are required to develop innovative technologies, such as fuel cells, biomass, and carbon sequestration. If we do not take measures in the next several years to reduce carbon emissions, the costs of disruption from climate change could be as high as 5 percent of global gross domestic product (GDP) each year, according to the October 2006 report authored by British economist Nicholas Stern. By contrast, the costs of mitigating climate change could be limited to about 1 percent of global GDP each year.

We ask scientists, in the words of Eugene Rabinowitch, not to “retire in resignation and despair to their laboratories” but to publicly engage these issues and make their voices heard. And we implore governments to actively engage the scientific community for sound, nonpartisan technical advice.

that is needed for a single bomb.

The international community faces a dilemma: How to mitigate climate change without increasing the dangers of nuclear materials proliferation.

Global warming poses a dire threat to human civilization that is second only to nuclear weapons. The most authoritative scientific group on these issues, the Intergovernmental Panel on Climate Change (IPCC), has concluded, “Most of the warming observed over the last 50 years is attributable to human activities.” Carbon dioxide, principally from fossil fuel burning, has been accumulating in the atmosphere, where it acts like a blanket keeping Earth warm and heating up its surface, ocean, and atmosphere. As a result, current levels of carbon dioxide in the atmosphere are higher than at any time during the last 650,000 years.

Observations of changes in the atmosphere, on land, in the oceans, in glaciers, and in polar ice cores have led to worldwide scientific consensus about the causes of climate change. The most distinguished scientific bodies in the United States, including the National Academy of Sciences, the American Meteorological Society, and the American Association for the Advancement of Science have come to conclusions similar to those of the IPCC.

Disruptions in climate already appear to be happening faster in some regions than earlier predicted. In some areas warming has interrupted normal patterns, allowing insects to

survival. Coral reefs will disappear, forest fires will be more intense and more frequent, and heat waves and storms more damaging. In coming years, coastal cities will bear the brunt of sea-level rise, as we have already witnessed in New Orleans, compelling major shifts in human settlement patterns. As such, climate change is also likely to contribute to mass migrations and even to wars over arable land, water, and other natural resources.

Indeed, a “business as usual” scenario—wherein we take no further measures to reduce greenhouse gas emissions—would raise the global temperature 2.8 degrees Celsius (5 degrees Fahrenheit) by the end of the century, causing a sea-level rise of about 80 feet. The United States would lose most of its cities on the East Coast: Boston, New York, Philadelphia, Washington, and Miami, and nearly the whole state of Florida. China would have 250 million displaced people; India, 150 million.

Because climate change is a global problem, it will require global action. As China and India develop their economies, for example, they will need to find ways to reduce or neutralize their contributions of carbon dioxide to the atmosphere. Currently, however, the United States is the single largest producer of carbon dioxide emissions in the world. Efforts in this one country would have disproportionately large effects on world climate. As a wealthy and technologically advanced country, the United

TURNING BACK THE CLOCK WILL DEPEND on humanity’s ability to think in new ways about how to cooperate to achieve common goals. We ask scientists, in the words of Eugene Rabinowitch, not to “retire in resignation and despair to their laboratories” but to publicly engage these issues and make their voices heard. And we implore governments to actively engage the scientific community for sound, nonpartisan technical advice. We urge immediate attention to climate change and caution those who believe nuclear energy is a problem-free solution. Finally, and most importantly, we call upon policy and opinion leaders, business and civic leaders, and the public to place the dangers of nuclear weapons at the top of their agendas for action.

More specifically, major progress toward a safer world would include:

● Reducing the launch readiness of U.S. and Russian nuclear forces, and

completely removing nuclear weapons from the day-to-day operations of their militaries;

- Reducing the number of nuclear weapons by dismantling, storing, and destroying more than 20,000 warheads over the next 10 years;

- Greatly increasing efforts to locate, store, and secure nuclear materials in Russia, the United States, and elsewhere. The Cooperative Threat Reduction program has provided an example of how even former adversaries can cooperate to reduce the dangers of nuclear weapons. Extending the principles of that program, including working side by side with other countries, establishing transparency, and initiating partnerships between government and the private sector to downblend highly enriched uranium, would be constructive;

- Disavowing the development of new nuclear weapons and ratifying the Comprehensive Test Ban Treaty (CTBT). To date, the CTBT has been ratified by 137 nations, but notable holdouts include the United States, China, India, Pakistan, North Korea, and Israel;

- Stopping production of nuclear weapons material, including highly enriched uranium and plutonium—whether in military or civilian facilities. The proposed Fissile Material Cutoff Treaty should be taken up by the nuclear powers as a major step toward achieving this goal;

- Engaging in serious and candid discussion about the potential expansion of nuclear power worldwide. As a means of addressing the threats from climate change, nuclear power should be considered as an alternative energy source. While nuclear energy production does not produce carbon dioxide, it does raise other significant concerns, such as the health and environmental hazards of nuclear waste, the production of nuclear materials that can be diverted to the production of weapons, and the safety and security of the plants themselves. As such, any contemplation of the expansion of nuclear power must be predicated upon a thorough assessment of the technolog-

ical and legislative safeguards required to curb these risks;

- Providing nuclear fuel for energy production in ways that drastically reduce the risk of spreading nuclear weapons. A number of arrangements have been proposed, beginning with the Acheson-Lilienthal Plan of 1946. More recent plans have called for international consortia that would oversee the production, distribution, storage, and disposal of nuclear materials;

- Implementing stricter controls over trade in and shipment of nuclear technologies and materials. Harmonizing domestic laws across countries and enforcing these uniformly, as required under U.N. Security Council Resolution 1540, would be a step in the right direction;

- Building on the strengths and successes of the IAEA by giving more authority to the agency to monitor and inspect nuclear facilities worldwide and by providing more financial and staff resources. The agency already has shown that it can effectively dismantle nuclear weapons programs and monitor internal developments over a period of years, as it did in Iraq from 1991 to 2001. It has proven its capacity and should be rewarded and its programs expanded;

- Providing meaningful international fora to spur innovative solutions that halt nuclear proliferation and provide blueprints for radical reductions in nuclear weapons worldwide. The NPT Review Conferences could provide such an ongoing forum, if nuclear weapon countries would recognize the benefits of this institution for impeding the spread of lethal technologies.

The terrible and still unprecedented destructive power of nuclear weapons led Albert Einstein to observe, “With nuclear weapons, everything has changed, save our way of thinking.” As we stand at the brink of a second nuclear age and at the onset of an era of unprecedented climate change, our way of thinking about the uses and control of technologies must change to prevent unspeakable destruction and future human suffering.

The Clock is ticking. ❄

With our thanks

We acknowledge and thank the many scientists and global security specialists who have helped us assess developments in nuclear weapons, in climate change, and in emerging technologies.

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