

Remarks on Nuclear Disarmament

by

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[Note added after the event: These are resource notes I prepared before the discussion, which was more interactive than I expected. I covered much of this territory in my oral remarks, and exhibited more of the text, including the quotes from Sidney D. Drell, on the screen toward the end of the session.]

Q1: If the world magically arrived at a status with not a single nuclear weapon left, what would that world be like? Is a world free of nuclear weapons what we really want? Why or why not?

A1: I start with two general, brief comments. First, science has two roles—discovering novel and potentially important phenomena, such as the existence of radio waves, or nuclear fission; further, science and its practitioners can help to do things with the tools of science and technology. But limiting the threat of nuclear weapons has more to do with people than with weapons.

Second, in addition to my own responses to these questions, I will quote from a tightly reasoned presentation by my colleague, Sidney D. Drell of Stanford University¹, “IS IT ILLOGICAL TO WORK TOWARD A WORLD WITHOUT NUCLEAR WEAPONS?” For the most part, I will show excerpts without reading the text, as it applies to the individual questions.

If there are no nuclear weapons because nuclear weapons are a physical impossibility, that is a one matter. Whether or not life on Earth is compatible with a universe in which nuclear weapons are impossible is another question, but assume it is. Then we would be back in an era without an “ultimate weapon” in which conflicts between groups and nations could find expression in war and destruction without the possibility of total devastation. In such a world, biological and chemical weapons would assume greater importance and might break free of the limits most nations have agreed to place on them. The nuclear-weapon-free world (NWFw) would free us from the hazard and the threat of terrorist use of nuclear weapons against one or more cities, and of the total devastation that could be caused by the exchange of the

¹ September 28, 2013, for the Freeman Dyson celebration at the Institute for Advanced Studies in Princeton.
11/19/2013 Panel on Nuclear Disarmament.doc

many thousands of nuclear weapons now in existence. But a world temporarily free of nuclear weapons, without very different structure of international governments and enforcement would very likely lead to a competitive race to acquire a modest number of nuclear weapons, and perhaps even to use them as a threat to keep other states disarmed or actually to employ them for that purpose—perhaps in the name of national survival. The massive destruction of World Wars I and II, with tens of millions of people dead, and many wounded, has been avoided in the nuclear age.

Here is what Sid Drell says on behalf of his colleagues in the “Gang of Four,” Henry A. Kissinger, Sam Nunn, William J. Perry, and George P. Shultz,

“For more than 50 years America’s vast arsenal of nuclear weapons has been, and still is, widely viewed to be essential to our national security. To many of the mandarins of nuclear policy in this country, and around the world, an initiative to create a world without nuclear weapons is considered to be dangerous as well as a misguided fantasy.

Why? As best I can understand it, they fear disturbing what they see as a relative calm and smooth sailing with our current condition of nuclear deterrence based on mutual assured destruction, or MAD as it is appropriately called. But in order to

arrive at this conclusion, it is necessary to minimize, if not totally ignore, a growing danger. With the broad spread of nuclear technology and material, we are now facing an increasingly serious hazard that these weapons may be acquired, and used, by dangerous leaders and terrorists willing to resort to suicidal actions to achieve their goals.

Is it really logical to accept such risks, and to put our survival in the hands of rogue leaders or terrorists should they acquire nuclear weapons by whatever means – theft, bribery, or more simply just acquiring the nuclear fuel itself, that is Pu²³⁹ and U²³⁵? Acquiring that material is by far the most difficult step in building a relatively primitive, but deadly effective, nuclear weapon. And the world today is awash with nuclear material. How long can we count on continuing to bat 100% in keeping that fuel, or these deadly weapons, out of the hands of such people, and preventing their use?

Against such dangers, nuclear weapons are no longer much of a deterrent. I am unable to think of any scenario in which the use of nuclear weapons would be appropriate or effective in dissuading their being used on suicidal missions, or in regional crises. On the other hand I have no trouble thinking of one or two primitive bombs, like those that obliterated Hiroshima and Nagasaki, being detonated in New York, London, Paris, Moscow, Beijing. And what do you think would be its global impact on the morning after, especially in large urban areas?

Caution! The details of a NFW are not trivial, and usually include active weapon laboratories ready to make nuclear weapons anew. Is this preferable to preserving a few nuclear weapons aboard strategic submarines maintained in de-alerted status?

Q2: How do we get there? Is the world free of nuclear weapons achievable? And if not, what is achievable?

A2: In principle a world free of nuclear weapons is achievable, requiring only the agreement of those who have nuclear weapons to eliminate them and of those who don't have, not to acquire them. To this end we have the major tool of the 1970 Non-Proliferation Treaty, under which states having nuclear weapons agree not to provide them or help others to acquire them, and states without nuclear weapons, party to the NPT, agree not to acquire them. But the NPT does not limit the holding of nuclear weapons by the five formal nuclear weapon states—those that had conducted a nuclear explosion by 1964, and it does not limit nuclear weapons in states not party to the Treaty. Nuclear weapon states party to the NPT have a commitment to elimination of their nuclear weapons, together with general and

complete disarmament, which, to my mind, brings a large degree of unreality to what would otherwise be a reasonable goal. An alternative to a world free of nuclear weapons would be one in which national holdings are limited to 100, and in which positive and negative security guarantees are extended to non-nuclear-weapon states by those states or groupings of states that have nuclear weapons. Another possibility would be a small number of nuclear weapons under the control of United Nations or a U.N. organization, maintained and if necessary rebuilt by a relatively small cadre of nuclear weapon adepts. This would need to be buttressed by a substantial U.N. conventional force and commitments of member states to protect the U.N. nuclear weapon force and to ensure its penetrability and effectiveness.

DRELL: “We remain caught in the Cold War trap of nuclear deterrence more than two decades after the demise of the Soviet Union.

A growing concern that the world seemed to be inexorably approaching a tipping point with nuclear proliferation getting out of control moved George Shultz and me at Stanford to action eight years ago. We enlisted three distinguished former senior U.S. government leaders with impeccable records, like George, as Cold War hawks – Sam Nunn, Henry Kissinger, Bill Perry, to join us, and organized a conference on the

20th anniversary of Reykjavik, October 10-11, 2006. Our three goals were: 1) to see what we could learn from that experience; 2) to figure out what conditions would be required to convince ourselves and others that a more stable and peaceful world can be established without nuclear weapons, instead of trying to preserve a two tier system, as it is today, with some nations with nuclear arms and others without, a world that a growing number of nations are rejecting; and 3) to build a global constituency, a coalition of the willing, to work together to pave a practical path toward achieving such a goal as both desirable and realistic.”

Q3: To arrive at your goal (zero nuclear weapons or some non-zero number) what role and policies should the U.S. be implementing? What about the international community in general?

A3: As for the United States, it is generally agreed that the 10,000 nuclear weapons that it has (of which about 5000 are usable) are far more than is desirable for U.S. security, and the same goes for a similar or perhaps slightly larger number in Russia. Standing in the way of great reductions in these nuclear weapon stockpiles are

primitive concerns about equality in the face of unequal situations of the two states, the cost of elimination, and the difficult decision of which nuclear weapons and weapon carriers to reduce or eliminate.

Further inhibiting the elimination process is the question as to whether with a goal of 1000 or 100 total weapons (including weapon-usable material—Pu-239 and U-235) some lesser power with a few hundred nuclear weapons (Britain, France, China, Israel, India, and Pakistan) would insist on maintaining or building to a comparable number. Under those circumstances, the spectre of alliances carries with it the possibility of substantially larger numbers on one side or the other in a future confrontation or conflict.

That said, I have long been on record and still support essentially immediate reductions of the U.S. and the Russian stockpile to 1000 nuclear weapons on each side, including all potentially usable NW and weapon-usable materials.

Achieving this goal in the face of cost and schedules of dismantling of NWs would be aided by imaginative approaches on the two sides to NW demilitarization—means for ensuring that an NW could not soon (perhaps a year for the thousands of NWs disabled) be returned to usable form.

One specific example for U.S. weapons is to crush the hollow plutonium shell within in its stainless steel or other metal containment that constitutes the “pit” of the primary of every U.S. nuclear weapon.

Russia, being familiar with the structure of its own nuclear weapons, could propose a comparable process.

In practice, such almost immediate reductions to a level of 1000 NW in Russian and U.S. inventories would be feasible only if there are commitments from the other NWS (and those holding NWs outside the NPT) not to build further and to join in reductions as the U.S. and Russia disarm below the level of 1000 NWs.

Certainly the United States should promptly ratify the CTBT and move to support the NPT by encouraging states to implement the Additional Protocol to the NPT; there has been no U.S. nuclear explosion test since 1992, and the nuclear weapons laboratories are not requesting or planning any nuclear explosion test, so ratification of the CTBT will provide non-proliferation benefits without restraining the United States.

In maintaining a reduced stockpile of nuclear weapons, the weapon component of the US Department of Energy—NNSA, that National Nuclear Security Administration—should stick closely to pure maintenance and remanufacture, resisting the siren song of “modernization” or “consolidation.” Why spend more than necessary, especially when the government is trying to eliminate the nuclear weapons?

Q4: Specific role and policies on Iran and North Korea?

A4: I am highly encouraged by the change of leadership in Iran with President Rouhani and Foreign Minister Zarif taking an active role in negotiations to eliminate any program to provide a capability for the development and use of NWS. All domestic factions in Iran, however, are committed to the development and deployment of civil nuclear power plants, and, as such, maintain the equivalent of a “sacred value” in developing and operating uranium enrichment facilities in Iran. This despite the fact that many countries with substantial fraction of their electrical power from nuclear plants have no domestic enrichment capability; South Korea is a case in point.

In fact, the NPT, of which Iran is a member, guarantees its non-NWS parties access to civil uses of nuclear energy and so it is a matter of Iran showing that its enrichment capability is warranted for application in the civil sector.

Complicating this is the enormous disparity between the enrichment capability required for investing and refuelling even a single large power reactor such as that built by the Germans and completed by the Russians at Bushehr, which consumes about 1000 kg per year of U-235, as low-enriched uranium (LEU) of about 4% U-235 content. To be technical, each kg of U-235 consumed by Bushehr requires the investment of 151 separative work units (SWU), whereas a kg of U-235 as 90% U-235, and thus ideal for making nuclear weapons, requires the investment of 231 SWU. Thus the nominal 20 kg of 90% U-235 required for a nuclear weapon consumes about 4000 SWU, whereas the annual refuelling of a single power reactor like Bushehr requires 150,000 SWU.

The enrichment facility that produces LEU differs only very slightly from that yielding HEU, so the problem is that to feed even a single power reactor involves an enrichment plant that would be capable of providing HEU for $150,000/4,000 = 37$ nuclear weapons per year.

Resolving this problem and the lesser one of the heavy water reactor being built at Arak in Iran is the nub of the negotiations among foreign ministers taking place in Geneva. I am optimistic that a solution can be reached that satisfies the needs of Iran for the production of medical isotopes, its desires for the operation of some enrichment facility, and the security concerns of the United States, Israel, and the Arab states of the Middle East.

North Korea is a different matter. The long-term resolution of that problem will probably be solved by unification of the two states on the Korean Peninsula.

Q5: The world is very different from 20 years ago. What do you expect the world to look like 20 years from now?

A5: I tend to agree that the best way to know what the world will look like is to invent it, but invention is unpredictable. I think that we will probably have seen the detonation of a terrorist nuclear explosive in a city, and by “terrorist nuclear

explosive” I don’t mean a little bit of radioactivity but the ground burst of either a stolen nuclear weapons or an improvised nuclear weapon that will yield the equivalent of the output of the Hiroshima bomb—10,000 tons of high explosive with the resulting death of perhaps 500,000 people.

The evolution of technology will continue apace, thus lowering the barrier to the acquisition of nuclear weapons by a state or a sub-national group. Furthermore, the availability of weapon-usable materials or the potential availability will increase because of the spread of enrichment capability to supply an expanding nuclear power sector. Adding to the hazard of improvised nuclear weapons is the transport of many tons of plutonium, which, if not “weapon grade” is still eminently usable in making high-performance nuclear weapons. As a benchmark, the UK at its Sellafield site has accumulated 112 tons of reactor-grade plutonium, enough for 10,000 nuclear weapons.

In 2012 President Obama committed the United States to lead a world-wide program to bring all weapon-usable materials under rigid control within four years, and that should be a priority effort for the world.

Q6: What message for the student in the audience? What should a concerned young citizen do, in your opinion?

A6: Despite the dread hazards of loss of a city to terrorist nuclear explosion and the possibility of the destruction of civilization by the exchange of the current stocks of weapons, I am optimistic that we will be able to reduce these threats. What it takes is increased recognition on the part of the citizenry demanding transparency on the part of the government, putting resources behind the programs to control these major threats.

DRELL: *"In view of the decreasing value and increasing hazards of the current condition of nuclear deterrence, achieving the vision of a world without nuclear*

weapons is an urgent challenge. ... Furthermore it is a fundamental moral challenge when you consider the consequences of failure.”

There is plenty of information available on the Internet and, if we care, opportunities to join together, some of us in full-time work and some as knowledgeable, impassioned, and reasoned amateurs, to ameliorate this threat. In fact, there are several organizations to provide information and to enable the public to demand and to support legislation to reduce the threat of nuclear weapons. Among these are the Union of Concerned Scientists, www.ucsusa.org, the Federation of American Scientists, www.fas.org, and the Natural Resources Defense Council www.nrdc.org.

I can't hold out the hope of influencing your representative in the House or your senator by letter or email, because for the most part these are counted or weighed and not read. But visits to the individual either in Washington or in their home office can be valuable. And jump at that chance for a White House internship, perhaps in the Office of Science and Technology Policy—OSTP—or to be a AAAS

Congressional Science Policy Fellow for a year, or a similar Fellow of other professional societies.

Demanding “value for money” in our nuclear weapon and national security sectors, with a demand for explicit statement of options and values is a potentially powerful lever for change.

A final word: Put in any Google search box,

[this is just to show the utility of the “site:” qualifier; try also {site:mil “nuclear matters”}]

site:fas.org/RLG/ nuclear weapons abolition

to find 11 “hits,”

1. [\[PDF\] The Reykjavik-2 Initiative and the Essential Role of the CTBT](#)
www.fas.org/rlg/082208R2ICa2.pdf
Eliminating short-range *nuclear weapons* designed to be the urgent international security interest of the world to *abolish nuclear weapons*, and although that ...
2. [\[PDF\] The Scientific Roots and Prospects for the CTBTO and the IMS](#)
www.fas.org/rlg/CTBT4%20Vienna%20June%202011.pdf
Jun 8, 2011 - Many scientists around the world had been arguing for the internationalization, control, or *abolition* of *nuclear weapons*, and the acquisition of.
3. [Enrico Fermi and Ethical Problems in Scientific Research](#)
www.fas.org/rlg/011019-fermi.htm
As von Hippel notes "Thus, the relative priority of the importance of *abolishing nuclear weapons* and using them to deter war (was) being debated before the rest ...