# Unmaking the Bomb: A Fissile Material Approach to Nuclear Disarmament and Nonproliferation

Harold A. Feiveson, , Alexander Glaser, Zia Mian, Frank N. von Hippel, Cambridge, Massachusetts: The MIT Press, 2014, 296 Pages.

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"The development of nuclear power is fraught with infinitely greater dangers than were all the inventions of the past." This warning was voiced to the US government by a group of Manhattan Project scientists led by James Franck in June 1945, one month before the first ever nuclear weapon was detonated at the Trinity test site in New Mexico's Alamogordo desert. Two months later the world saw firsthand the unprecedented destruction that could be wrought by the military application of such weapons as two first generation nuclear devices were dropped on the Japanese cities of Hiroshima and Nagasaki. The key fissile materials, namely plutonium and highly enriched uranium (HEU), used in the assembly of these bombs are the same as those used in more modern designs of nuclear weapons today and are not necessary ingredients of fuel that is used to generate peaceful nuclear energy. This distinction between weapon-usable fissile materials that are the products of extensive enrichment or costly reprocessing of spent nuclear reactor fuel on the one hand and material that can be used as a fuel for the generation of peaceful nuclear energy without being immediately ready for incorporation into a nuclear weapon on the other, constitutes the foundational truth behind *Unmaking the Bomb: A Fissile Material Approach to Nuclear Disarmament and Nonproliferation.* The authors, all physicists, begin the book by providing a history of the discovery, application, and spread of fissile materials and the technology required for their production. They later go on to introduce a variety of ways in which the imbedded link between nuclear energy and nuclear weapons can be broken

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before finally presenting policy options that can facilitate the reduction and elimination of fissile material stockpiles worldwide.

Seeing the prevalence of the (mis)perception that nuclear energy and nuclear weapons go hand in hand, or more precisely because of the ease with which weapon-usable HEU can be produced by utilizing the same technology that creates the more benign low enriched uranium (LEU) that is used for fuel in nuclear power generators, the authors first engage in a discussion on the rudimentary science behind nuclear fission and isotope separation. Here, it is important to note that the enrichment of natural uranium strives to separate uranium isotopes 235 and 238, the former of which only constitutes about .7% of the weight of natural uranium. Uranium that is enriched to a level in which uranium-235 constitutes more than 20% of its total weight is considered highly enriched and weapon-usable and it becomes weapon-grade upon being enriched to 90% uranium-235. Alternately, uranium that is enriched to levels between 2-4% (or LEU) is primarily used for energy generation purposes. Additionally, plutonium, the other core ingredient of nuclear weapons, is a product of fission reactions that occur in nuclear reactors. Therefore, plutonium is created as a result of civilian nuclear power generation activities, yet it takes extensive reprocessing technology to purify and separate the material for use in an explosive device. By providing the reader this groundwork on the basics of fissile material production, the authors then expand their discussion to the broader implications of the existence of such materials across the globe.

There are currently nine states that possess nuclear weapons. In the order of their first detonations of a nuclear device they are the United States, Russia, the United Kingdom, France, China, Israel, India, Pakistan, and North Korea. Within the book, each state's methods of obtaining a nuclear device are explained in brief. Additionally, and of particular importance to the technical and verification aspects of physical nuclear disarmament, the authors also present the case of South Africa, which is the only state to have developed a nuclear weapon only to have later chosen to renounce the capability and disarm. Interestingly enough, it is also pointed out that the spread of nuclear technologies and know-how, which ultimately facilitated some states' acquisition of a nuclear weapon, was made largely possible by way of the US and Soviet Atoms for Peace Program that was initiated in 1953 to assist countries in developing peaceful nuclear energy programs.

Whether for military or civilian purposes, individual states' efforts to produce large amounts of plutonium and HEU over the last seven decades have resulted in a combined global fissile material stockpile of around 1,900 tons - enough for 100,000 nuclear weapons. At this point, the authors are

eager to mention that this number represents only an estimate, as the exact amount of fissile materials produced and currently held by each country has often been shrouded in secrecy. In this way, a key argument of the book is that transparency of each country's past and current production of fissile materials should be expanded. As noted by the UK government in 2006, "increased transparency by all weapon states will be required to provide essential background information for the negotiation and verification of deep reductions in the nuclear arsenals and the eventual elimination of nuclear weapons." Moreover, aside from a state's ability to use these stockpiles to create new weapons, the authors also contend that the mere existence of these materials pose a significant short-term risk as they are susceptible to theft. The authors point to the 1993 theft of HEU meant for submarine fuel in Russia and the 2001 security breach of antinuclear activists at the Oakridge nuclear weapons complex in Tennessee as just a few examples of the reasons why fissile stockpiles should be reduced and ultimately eliminated. Nonetheless, considering that fissile materials are not only used for military purposes poses a difficulty in their elimination.

Aside from being used in the construction of weapons, HEU is also used by some countries as fuel for naval propulsion reactors as well as for research. In this regard, the authors take an in-depth look into the ways in which certain countries have sought to convert either their research facilities and/or naval vessels to function with LEU, therewith taking a step to forgoing the need to produce greater amounts of HEU. For example, both Russia and the US have set out to convert their domestic research reactors to run on LEU while also enacting stricter controls on the export of HEU for research purposes. Additionally, France serves as the strongest example of a country that has been able to shift to LEU for naval propulsion purposes. When it comes to the US, however, the book emphasizes the unfavorable view held the US Department of Energy when it comes to adopting LEU fuel for naval propulsion, as was expressed in its 1995 report on the feasibility of such a conversion. However, as of 2014, results of a new report by the same department, released subsequent to the publishing of the book, provide strong reason for the US to reconsider its seemingly rigid stance on the issue.

Plutonium, like HEU, also has a civilian use, namely, it can be used as fuel in nuclear energy generation. Nonetheless, the process of obtaining plutonium requires costly plants designed specifically for the reprocessing of spent nuclear fuel. In this sense, "from the earliest days of the nuclear era, interest in civilian reprocessing was driven by the dream of breeder reactors that would produce more chain-reacting material than they consumed." Yet,

as the authors argue, this hope for breeder reactors, and therewith the use of plutonium fuel in nuclear energy generation, has largely been discredited based on extensive failures at their commercialization.

In the end, *Unmaking the Bomb: A Fissile Material Approach to Nuclear Disarmament and Nonproliferation* is supremely successful in displaying the extreme superfluity of fissile materials in today's nuclear world order. Moreover, backed by an extensive bibliography and well-cited arguments, the authors make their obvious expertise in the realm of nuclear physics accessible to a general audience. Whether the reader be a student of international relations, a policy-maker, or simply somebody interested in nuclear disarmament and non-proliferation, they need not possess a deep understanding of the technicalities involved in the production and elimination of fissile materials before opening this book, as the authors clearly convey such information in laymen's terms. Yet for all its successes in presenting how technically unnecessary these materials are, the application of this information to the pursuit of concrete policy change seems to have been afforded too little space. For example, for all that the authors' heavy focus on the Fissile Materials Cutoff Treaty informs readers on the possible ways in which plutonium and HEU might be phased out and eliminated, the deeper reasons why such a treaty has yet to be negotiated in the international arena remain skimmed over. While it would definitely go beyond the scope of the work to address each detail of each relevant country's unwillingness to take the necessary steps to reduce global fissile material stockpiles, a more extensive discussion on the reasons behind such dispositions may have proven fruitful. Moreover, it would have been interesting to read how the authors perceive of their approach's role in relation to other initiatives working for nuclear disarmament and nonproliferation such as the Humanitarian Initiative and the movements to establish LEU banks and nuclear-weapon-free zones. Ultimately, however, these may just be the subjects of works meant for another time.