

North Korea's Stockpiles of Fissile Material

*Siegfried S. Hecker**

*Chaim Braun***

*Chris Lawrence****

North Korea has conducted five nuclear tests and is believed to be rapidly increasing the size and sophistication of its nuclear arsenal. Increased sophistication, particularly the ability to miniaturize nuclear devices, requires more nuclear tests. The size of the arsenal is limited primarily by the stockpile of fissile material — plutonium and highly enriched uranium (HEU). Current plutonium inventories are estimated with moderate confidence to be in the range of 20 to 40 kg, sufficient for the manufacture of 4 to 8 plutonium bombs. HEU inventories are estimated with much greater uncertainty to be in the range of 200 to 450 kg, sufficient for 10 to 25 HEU bombs. Annual production rates are estimated to be less than 6 kg of plutonium and ~150 kg HEU.

Key Words: North Korea, fissile material, nuclear weapons, plutonium, highly enriched uranium (HEU), tritium, fuel cycle

* Siegfried Hecker is research professor and senior fellow at Center of International Security and Cooperation, Stanford University and emeritus director of the Los Alamos National Laboratory. He has visited North Korea seven times between 2004 and 2010. Email: shecker@stanford.edu

** Chaim Braun is an affiliate at the Center of International Security and Cooperation, Stanford University. He has more than forty years experience in nuclear energy and fuel-cycle issues in research, industrial and academic institutions.

*** Chris Lawrence is a research fellow with the Program on Science, Technology and Society in Harvard's Kennedy School of Government. He is a nuclear scientist by training, and is generally interested in questions of knowledge as they pertain to arms control and disarmament.

I. Introduction

On September 9, 2016, seismic stations around the world picked up the unmistakable signals of a North Korean underground nuclear test in the vicinity of Punggye-ri. It was the second successful nuclear test in 2016 and believed to be the fifth nuclear test since the initial test on October 9, 2006. These tests suggest an increasingly sophisticated North Korean nuclear arsenal. The size of the arsenal is likely constrained by the stockpile of fissile materials, namely plutonium and highly enriched uranium (HEU), for bomb fuel. Accurately estimating the size of North Korea's fissile materials stockpile is essential to understanding the status of its nuclear weapon program and the threat it poses.

Plutonium is produced in nuclear reactors. The quantity and quality of plutonium depends on reactor design and operations. Estimates of North Korea's plutonium stockpile can be made reasonably accurately because much is known about the North Korean reactors and operation of the reactors is readily discernable from satellite imagery. Natural uranium contains only 0.72 percent of the fissile isotope Uranium-235, the rest is Uranium-238. Hence, natural uranium must be enriched, or concentrated in U-235. Of the numerous technologies available, North Korea has chosen centrifuge enrichment, which has also become the method of choice for established nuclear weapons and nuclear energy states. HEU estimates have great uncertainties because centrifuge enrichment facilities have a small physical footprint and are easy to conceal. In this article, we provide estimates of North Korea's stockpiles of plutonium and HEU by examining in detail North Korea's means of production of these materials. We explain the methodology we used to make the stockpile estimates. We also briefly examine North Korea's potential for tritium production because on January 6, 2016, Pyongyang claimed to have tested a hydrogen bomb, which requires tritium for fusion.¹

1. Hecker concluded that this test was unlikely a test of a modern, two-stage thermonuclear device, typically called a hydrogen bomb. See Siegfried S. Hecker,