ISIS Estimates of Unirradiated Fissile Material in De Facto Nuclear Weapon States, Produced in Nuclear Weapon Programs

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Central Estimates for current and former de facto nuclear weapon states' inventories of unirradiated plutonium and highly enriched uranium (HEU) produced in nuclear weapon programs, end of 2003(a)

Country	Category	Plutonium (kg)		HEU (kg)	
		Median	*5^{th}-95^{th} Percentiles*	*Median*	*5^{th}-95^{th} Percentiles*
Israel (b)	De Facto	580	510-650	?	-
India (c)	De Facto	425	345-510	150-300 (d)	-
Pakistan (c)	De Facto	40	20-60	1,100	1,000-1,250
DPRK (e)	Ambiguous	15-40	-	?	-
South Africa	Dismantled	0	-	430-580(f)	-

Notes and Comments

(a) The medians and the 5^{th} and 95 percentiles in the table are calculated using the forecasting software Crystal Ball®. This software allows a more systematic and defensible uncertainty analysis. For North Korea (DPRK) and South Africa, ranges are given with no central estimate.

(b) Israel's plutonium and HEU stocks remain difficult to estimate. The plutonium estimate is based on the Dimona reactor having a power of about 40 megawatts-thermal initially that increased to about 70 megawatts-thermal in the mid-1970s. Although significantly higher reactor powers are discussed publicly, the underlying reactor-based rationale for the higher reactor powers has proven hard to confirm or recreate. For a more detailed discussion, see D. Albright, Frans Berkhout, and William Walker *Plutonium and Highly Enriched Uranium 1996* (Oxford: SIPRI and Oxford University Press, 1997). If the reactor power remained about 40 megawatts-thermal, total plutonium production would have been about 400 kilograms through the end of 2003. Although the reactor is about 40 years old, it is expected to operate for many more years. Public information suggests that Israel has had a gas centrifuge enrichment program, but this information is too spotty to determine whether Israel has a stock of HEU or, if so, its magnitude.

(c) The estimates for India's stock at the end of 2003 are greater than estimates made by the author in 2004. The median of the distribution for the net amount of plutonium at the end of 2003 in this study is about 45 kilograms greater than last year's median for this amount. The reason for the increase is because this year's estimate assigns higher capacity factors to the Cirus reactor throughout its lifetime and to the Dhruva reactor after 1998. For more information, see *India's Military Plutonium Inventory*, May 7, 2005.

(d) India has been working on building a gas centrifuge plant for many years. The status of the project is rarely discussed in public, although progress has been made. The plant is believed to have produced HEU, although most of it is believed to have an enrichment of 20-40 percent. India may have produced a few tens of kilograms of

weapon-grade uranium. For a description of this program and the basis for this estimate, see *India's Gas Centrifuge Enrichment Program*, June 30, 2005.

(e) Because of the difficulty of estimating North Korea's plutonium stock, only a range is provided. North Korea has separated plutonium during two periods. It may have separated up to about 10 kilograms of plutonium prior to 1993. North Korea has stated that during the first half of 2003 it separated all the plutonium in a stock of fuel irradiated prior to mid-1994. Most experts accept that North Korea has separated a significant amount of plutonium from this irradiated fuel, but questions remain about whether North Korea separated all or the bulk of the plutonium in this fuel. The amount separated from this spent fuel is therefore estimated to be between 15 and 30 kilograms of plutonium. In total, North Korea has an estimated 15-40 kilograms of separated plutonium. North Korea may have used gas centrifuges to enrich uranium. Available information suggests that little, if any HEU has been produced in this program, but a great deal of uncertainty surrounds this issue.

(f) South Africa dismantled all its nuclear weapons and associated programs in the early 1990s. In 1991, after the bulk of the dismantling occurred, South Africa had over 800 kilograms of HEU (average roughly 70% uranium 235), the vast bulk of which was unirradiated. Of this amount, South Africa used or irradiated about 200 kilograms of HEU in the Safari reactor as fuel (90% and 45% enriched) and targets (45% enriched). South Africa may recover the HEU used in the targets, about one-quarter of the 200 kilograms of HEU used in the reactor. Since the early 1990s, it may have blended down up to 150 kilograms of HEU in this stock of 800 kilograms to low enriched uranium. Thus, the unirradiated HEU stock at the end of 2002 was about 450-600 kilograms. This stock is estimated to have decreased in 2003 by roughly 20 kilograms of HEU that was used in the Safari reactor, giving it an end of 2003 stock of 430-580 kilograms. South Africa's total HEU stock was roughly 600-750 kilograms as of the end of 2003.