

TAKING STOCK VERIFIED DECLARATIONS OF FISSILE MATERIAL STOCKS

Alexander Glaser

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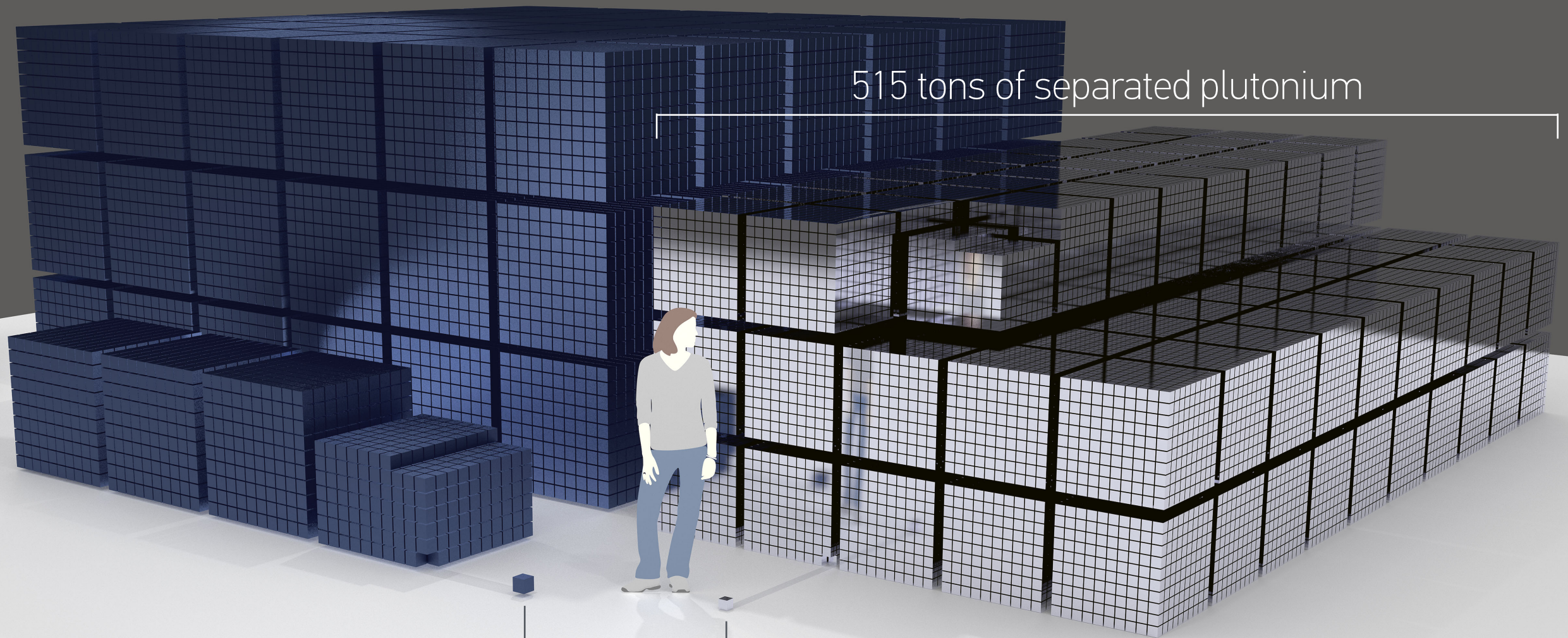
United Nations Institute for Disarmament Research (UNIDIR)

United Nations, New York, October 9, 2017

WORLD STOCKPILE OF FISSILE MATERIALS

1340 tons of highly enriched uranium (HEU)

515 tons of separated plutonium

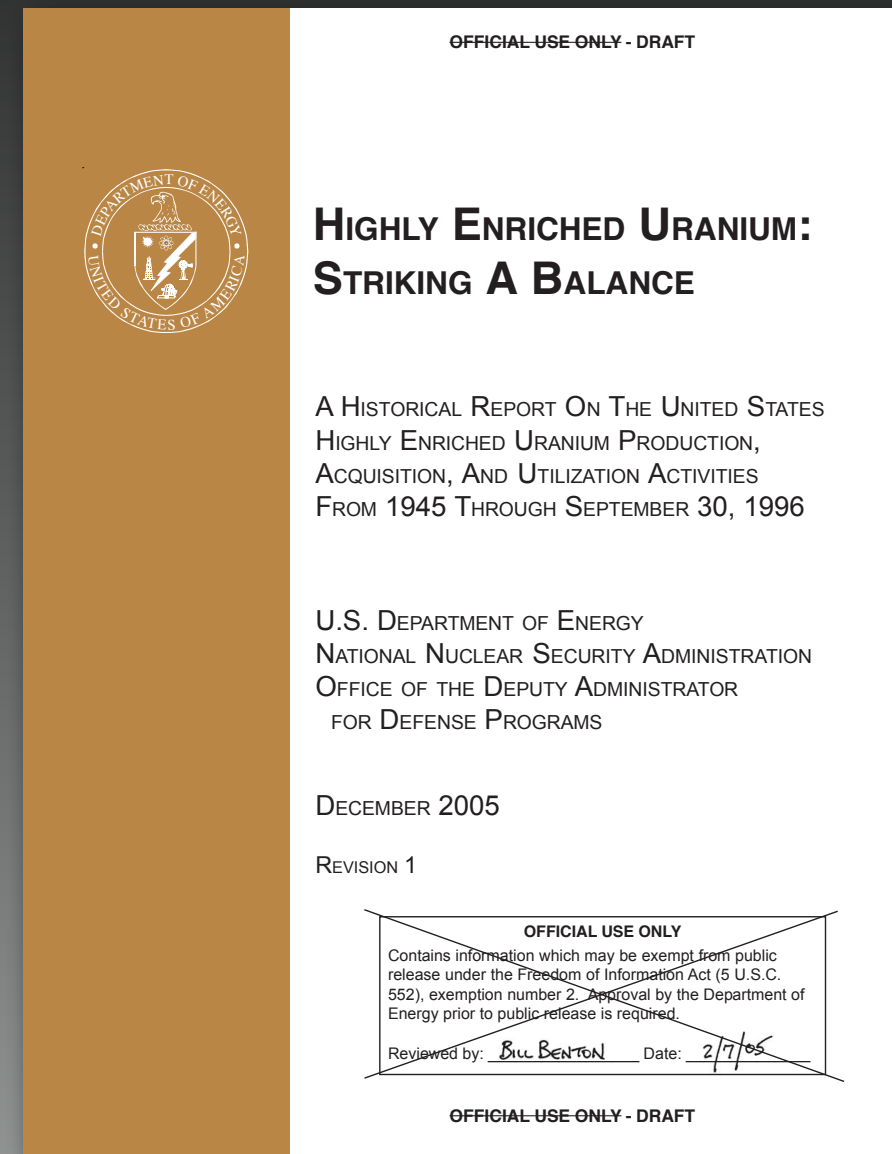
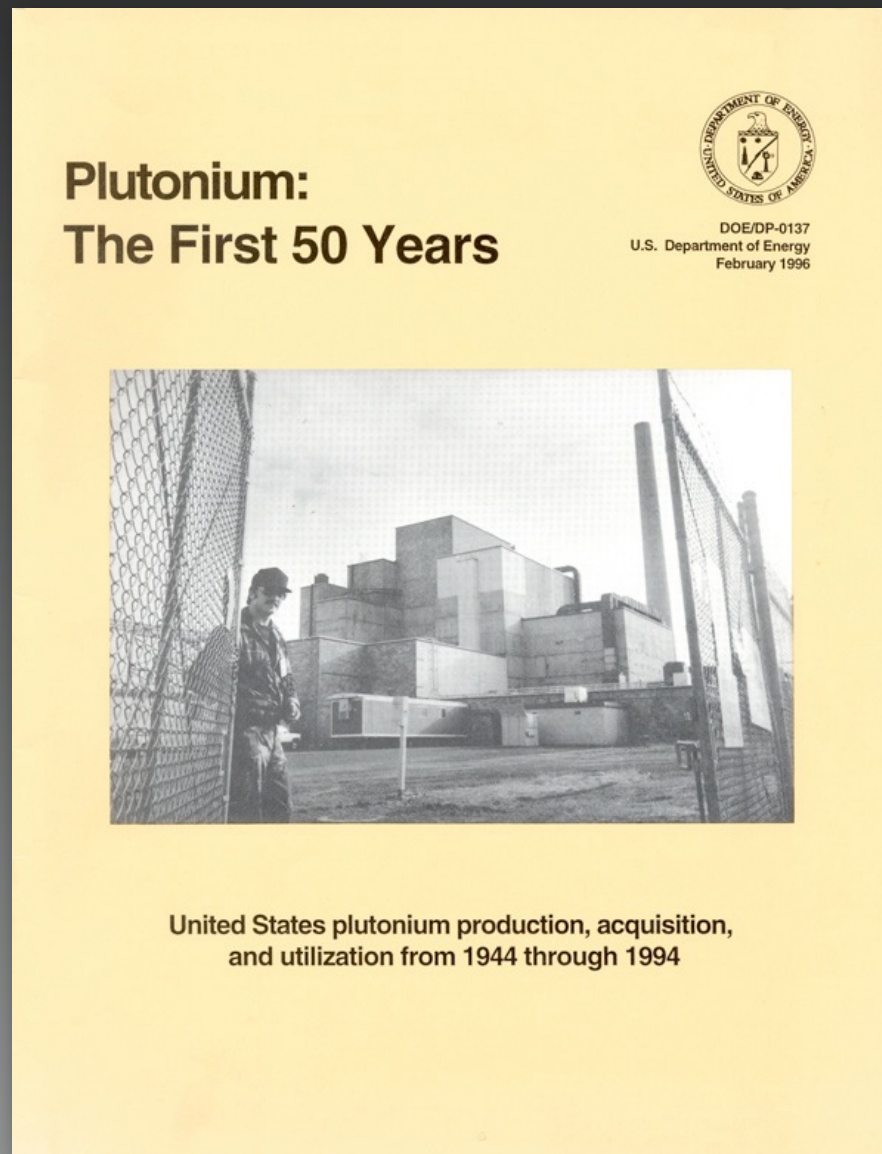


*Each block corresponds to 12 kg of HEU,
the amount necessary to make a fission bomb;
about 111,670 bombs-worth total*

*Each block corresponds to 4 kg of plutonium,
the amount necessary to make a fission bomb;
about 128,750 bombs-worth total*

DECLARATIONS OF FISSILE MATERIAL STOCKPILES

THE UNITED STATES HAS ALREADY MADE BASELINE DECLARATIONS (BUT COULD UPDATE THEM MORE FREQUENTLY)



1996 and 2001 U.S. Declarations on Plutonium and HEU

POSSIBLE REPORTING FORM

FOR A FISSILE MATERIAL (BASELINE) DECLARATION

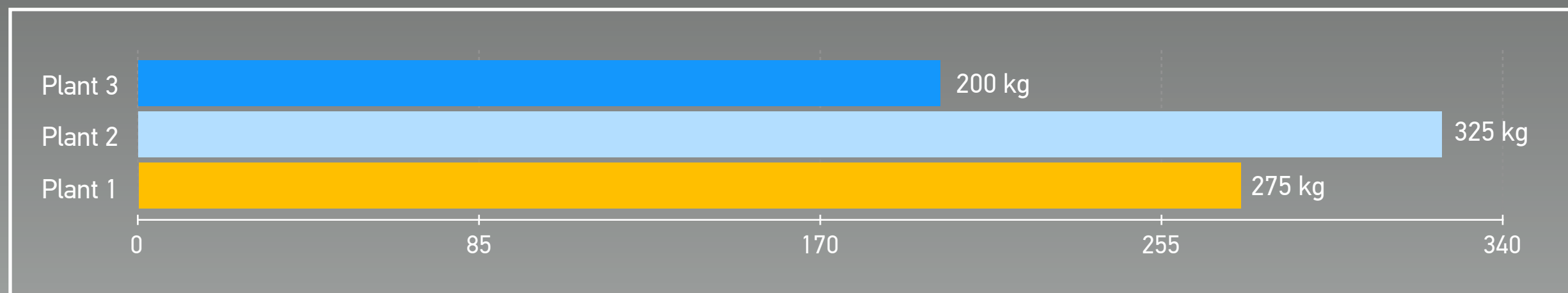
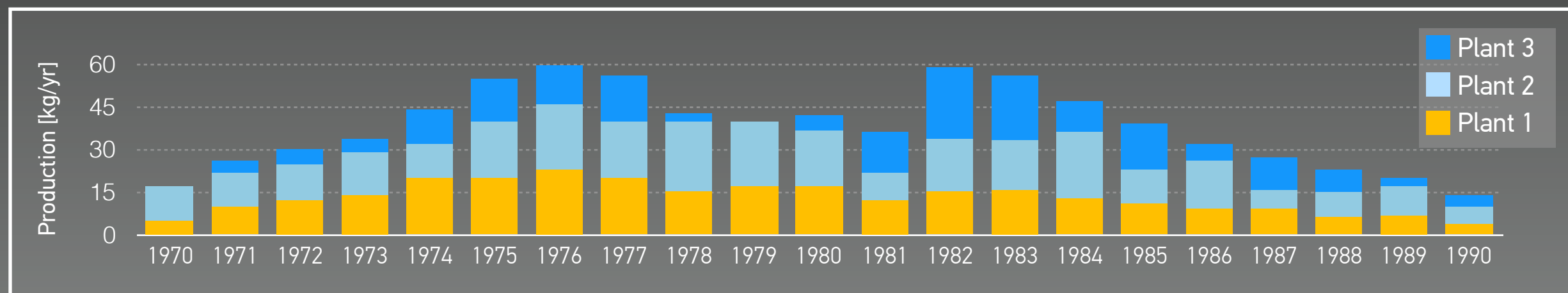
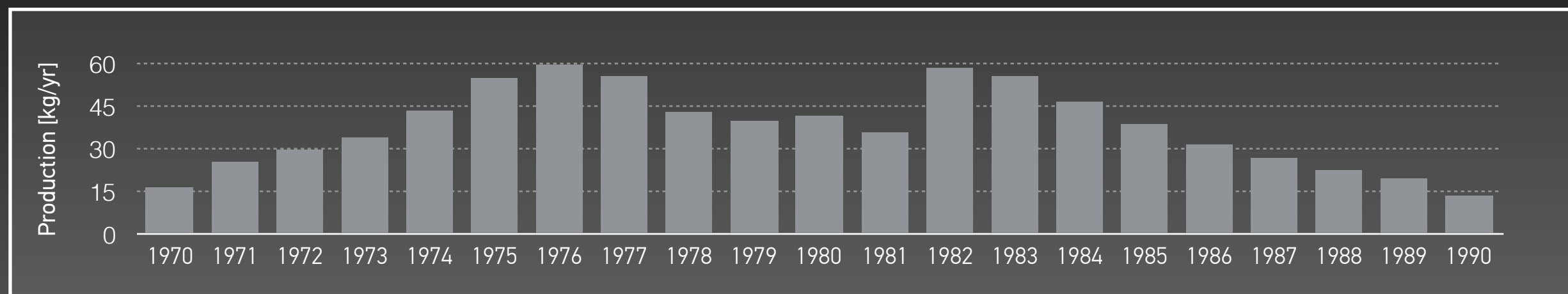
	HEU	Plutonium
Inventory as of (DATE)	-----	-----
Military, available for weapons	-----	-----
Military, reserved for non-weapon purposes	-----	-----
Military, in irradiated fuel	-----	-----
Excess military, not available for IAEA safeguards	-----	-----
Civilian, not available for IAEA safeguards	-----	-----
Civilian, available for IAEA safeguards	-----	-----
Excess military, available for IAEA safeguards	-----	-----

Specifying average isotopics (uranium-235 content in HEU and plutonium-239 in plutonium)
would enable further consistency checks of the declarations

Global Fissile Material Report 2013, International Panel on Fissile Materials, Princeton, October 2013, www.ipfmlibrary.org/gfmr13.pdf

NOTIONAL PRODUCTION SCENARIO

(AND ALTERNATIVE WAYS OF DECLARING HISTORIC FISSILE MATERIAL PRODUCTION)



2010 NPT REVIEW CONFERENCE

SELECTED ACTION ITEMS FROM FINAL DOCUMENT

Action 19: Transparency and Verification for Nuclear Disarmament

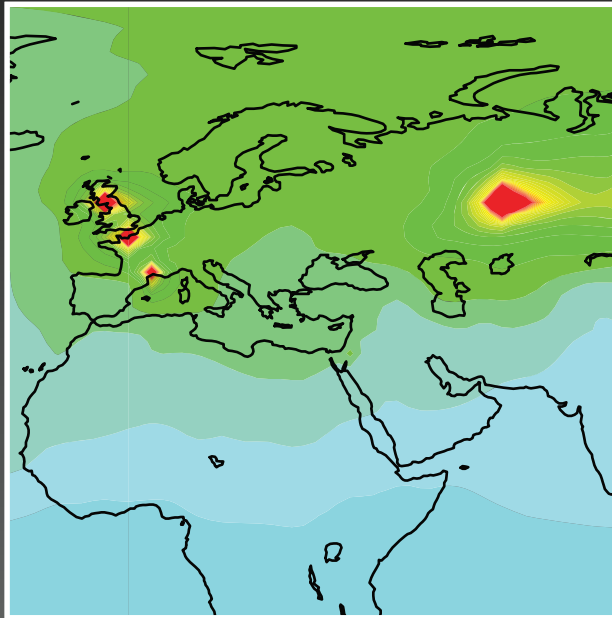
“All States agree on the importance of supporting cooperation among Governments, the United Nations, other international and regional organizations and civil society aimed at increasing confidence, improving transparency and developing efficient verification capabilities related to nuclear disarmament.”

Action 21: Standard Reporting Form

“As a confidence-building measure, all the nuclear-weapon States are encouraged to agree as soon as possible on a standard reporting form and to determine appropriate reporting intervals for the purpose of voluntarily providing standard information ...”

VERIFICATION OF BASELINE DECLARATIONS AND THE CASE FOR NUCLEAR ARCHAEOLOGY

WILL WE EVER KNOW HOW MUCH FISSILE MATERIAL EXISTS WORLDWIDE?



RECONSTRUCTING HISTORIC FISSILE MATERIAL PRODUCTION

Many aspects of declared production histories can be reviewed for consistency even without dedicated verification efforts

(for example, by comparison with historic krypton emissions)

PUBLIC HISTORIC DOCUMENTS CAN OFTEN HELP RECONSTRUCT PRODUCTION HISTORIES

(MUCH BETTER WOULD BE FORMAL DATA EXCHANGES OF HISTORIC PRODUCTION RECORDS)

La Hague et de la Cogema a été de minimiser les faits et leurs conséquences possibles, afin de rassurer l'opinion publique française et la clientèle étrangère, faisant prendre ainsi

chaque année en séparant le combustible venant de G3 (taux de combustion compris entre 700 et 1200 MWJ/t) et le combustible EDF (taux de combustion atteignant 5000 MWJ/t.)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Tonnage G2, G3	190	130	320	620	640	760	850	820	960	730	890
Tx de combustion	100	100	100	200	200	300	300	300	400	400	450
Tonnage EDF	—	—	—	—	—	—	—	—	—	—	—
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Tonnage G2 G3	530	570	460	480	240	280	260	170	non connu	non connu	190
Tx de combustion	450	450	500	600	700	800	1000	1200			1200
Tonnage EDF					113	8	25	120	245	280	310

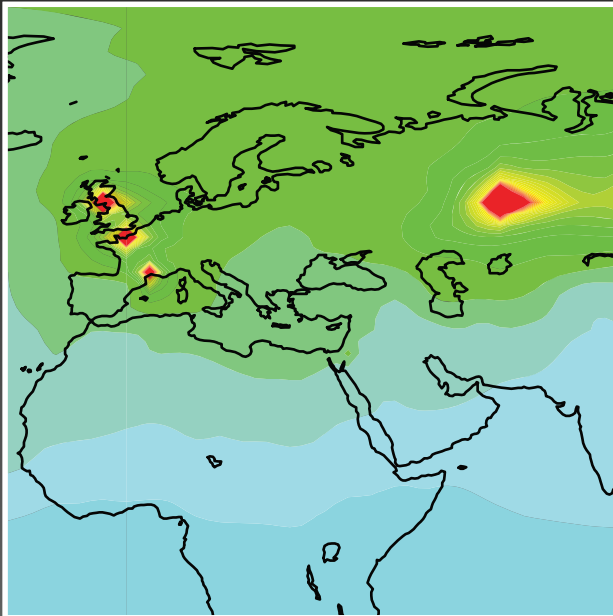
Si jusqu'aux années 1972-73 les tonnages retraités sont très élevés, une des raisons essentielles en est le faible taux de combustion des combustibles.
Le tonnage retraité diminue ensuite sensiblement en

ne. Il est également inférieur aux prévisions faites par la Cogéma au début de l'année 1980 puisque 310 tonnes ont été retraitées alors que les prévisions étaient 365 tonnes.

LES CONDITIONS DE

Le retraitement des combustibles irradiés: La situation de la Hague et Marcoule, Analyses et positions de la CFDT
Rayonnement, Syndicat National du Personnel de l'Energie Atomique, No. 92, Février 1981

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DATA EXCHANGE AND NUCLEAR ARCHAEOLOGY

Verification could begin with data exchanges (e.g. sharing of available operating records) and, eventually, envision onsite inspections

Nuclear archaeology is based on nuclear forensic analysis of samples taken at former production facilities

Source: Ole Ross and www.francetnp2010.fr

Nuclear Archaeology: Verifying Declarations of Fissile-Material Production

Steve Fetter^a

Controlling the production of fissile material is an essential element of nonproliferation policy. Similarly, accounting for the past production of fissile material should be an important component of nuclear disarmament. This paper describes two promising techniques that make use of physical evidence at reactors and enrichment facilities to verify the past production of plutonium and highly enriched uranium. In the first technique, the concentrations of long-lived radionuclides in permanent components of the reactor core are used to estimate the neutron fluence in various regions of the reactor and thereby verify declarations of plutonium production in the reactor. In the second technique, the ratio of the concentrations of U-235 to that of U-234 in the tails is used to determine whether a given sample is enriched uranium, which can be used in "nuclear archaeology," and thereby lay a

INTRODUCTION

For the first time, the world's nuclear proliferation—reduce their combined nuclear arsenals by more than 10,000 by the year 2025. South Africa, Iran, and North Korea are nuclear thresholds. It is important to understand their capabilities and intentions.

^a. School of

Science & Global Security, 22:27-49, 2014
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ISSN: 0892-9882 print / 1547-7800 online
DOI: 10.1080/08929882.2014.871881

Nuclear Archaeology for Gaseous Diffusion Enrichment Plants

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Princeton University, Princeton, NJ, USA

Gaseous diffusion was historically the most widely used technology for military production of highly enriched uranium. Since June 2013, all gaseous diffusion enrichment plants worldwide are permanently shut down. The experience with decommissioning some of these plants has shown that they contain large amounts of uranium particles deposited in the cascade equipment. This article evaluates the potential for uranium particle deposition to understand the past production of highly enriched uranium.

Science and Global Security, 19:223-233, 2011
Copyright © Taylor & Francis Group, LLC
ISSN: 0892-9882 print / 1547-7800 online
DOI: 10.1080/08929882.2011.616124

 **Routledge**
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Nuclear Archaeology for Heavy-Water-Moderated Plutonium Production Reactors

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There is growing interest in a set of methods and tools that can be used to characterize past fissile material production activities, using measurements and sampling at production and storage sites. This paper describes two promising techniques that have been dubbed "nuclear archaeology." The first technique, the Gaseous Diffusion Method (GDM), determines the cumulative plutonium production of this particular method is that it can determine only one class of re-enriched plutonium production. In this article, we present results of neutronics calculations for support structures and other core components of heavy-water moderated reactors by analyzing the results of neutronics calculations. We present results of neutronics calculations for support structures and other core components of heavy-water moderated reactors by analyzing the results of neutronics calculations. We present results of neutronics calculations for support structures and other core components of heavy-water moderated reactors by analyzing the results of neutronics calculations.

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presented at the 51st INMM Annual Meeting, Baltimore, MD, July 11-15, 2010.
Department of Geosciences, for advice and support.
Matos from Argonne National Laboratory, for advice and support.

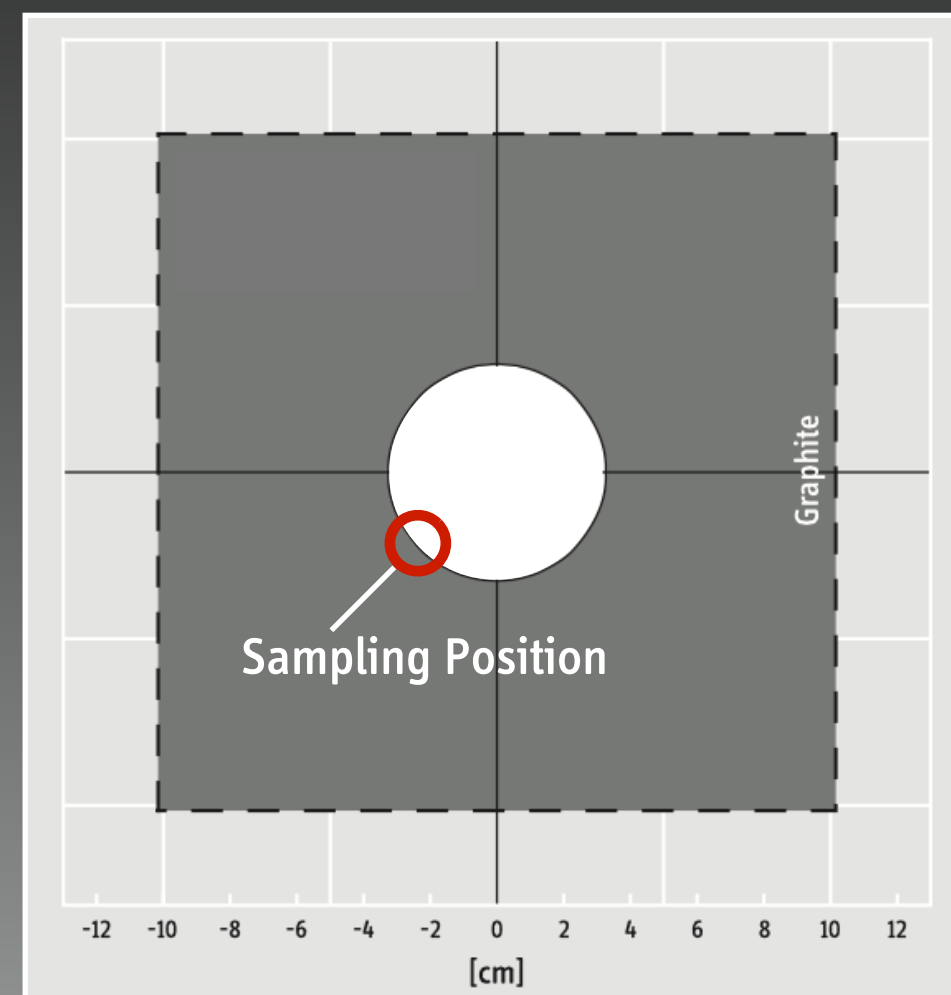
NUCLEAR ARCHAEOLOGY WOULD HAVE BEEN USED TO VERIFY NORTH KOREA'S PLUTONIUM DECLARATION

FORENSIC ANALYSIS OF GRAPHITE SAMPLES COULD CONFIRM TOTAL PLUTONIUM PRODUCTION IN NORTH KOREA WITHIN AN UNCERTAINTY OF ± 2 KG



The banner reads: "Let's protect Dear General Kim Jong Il desperately!"

Credit: CNN/Brian Rokus, 2008



Unit cell of the DPRK Yongbyon reactor

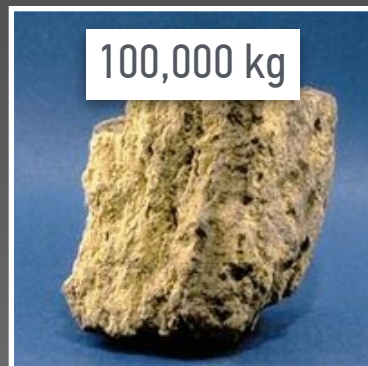


A U.S. delegation led by State Department official Sung Kim crosses the military demarcation line between North and South Korea on May 10, 2008. North Korea shared 18,000 pages of operating records to confirm the correctness of its declared plutonium stockpile. Credit: Chung Sung-Jun

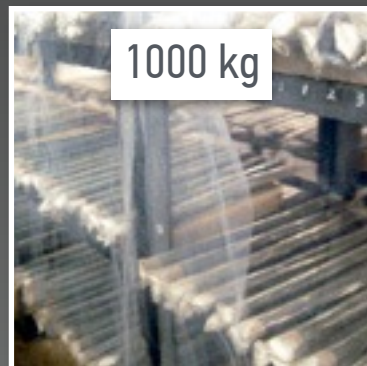
PREPARING FOR FUTURE VERIFICATION

MANY DIFFERENT MATERIALS, PROCESSES, AND SITES HAVE BEEN INVOLVED IN FISSILE MATERIAL PRODUCTION

THE CASE OF PLUTONIUM



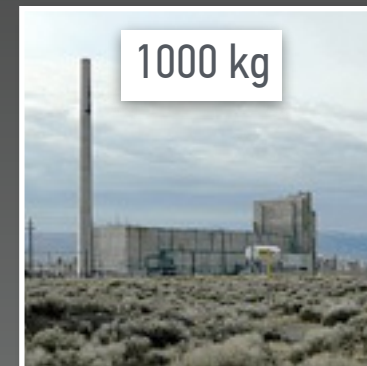
Source material
(Uranium ore)



Fuel fabrication



Plutonium production



Reprocessing
of irradiated fuel



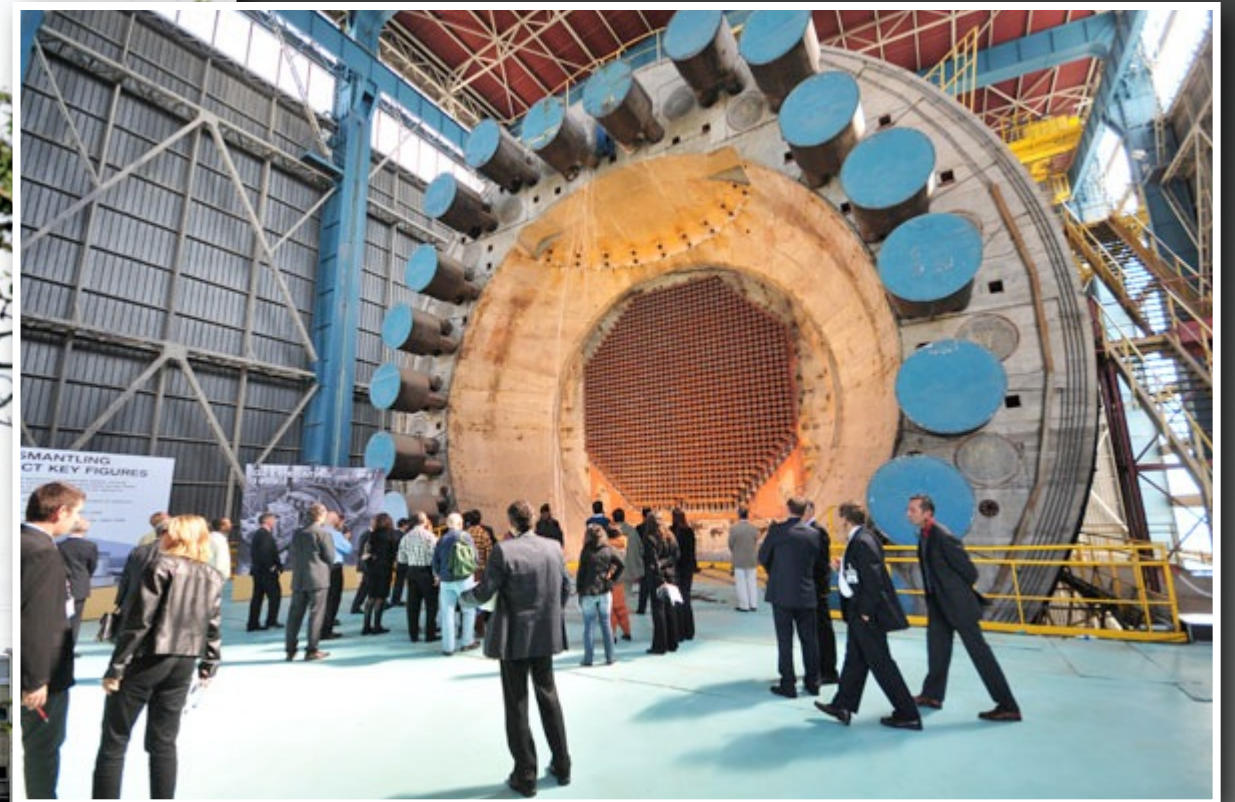
Waste storage

TO ALLOW FOR FUTURE VERIFICATION, STATES COULD:

1. Agree on the most important types of operating records to be preserved
2. Catalogue, characterize, and preserve relevant waste materials

TEST BEDS FOR NUCLEAR ARCHAEOLOGY

To begin countries could offer single sites or facilities as test beds and invite partners with similar production facilities to engage in “site-to-site exercises” to jointly demonstrate verification approaches and measurement techniques



Left: Windscale Piles, www.sellafieldsites.com
Right: G2/G3, Marcoule, www.francetnp.fr

MANY NON-NUCLEAR WEAPON STATES HAVE CANDIDATE FACILITIES THAT COULD BE USED TO DEMONSTRATE METHODS REQUIRED FOR NUCLEAR ARCHAEOLOGY



NRX, Canada



Ågesta Reactor (105 MWt), near Stockholm, Sweden

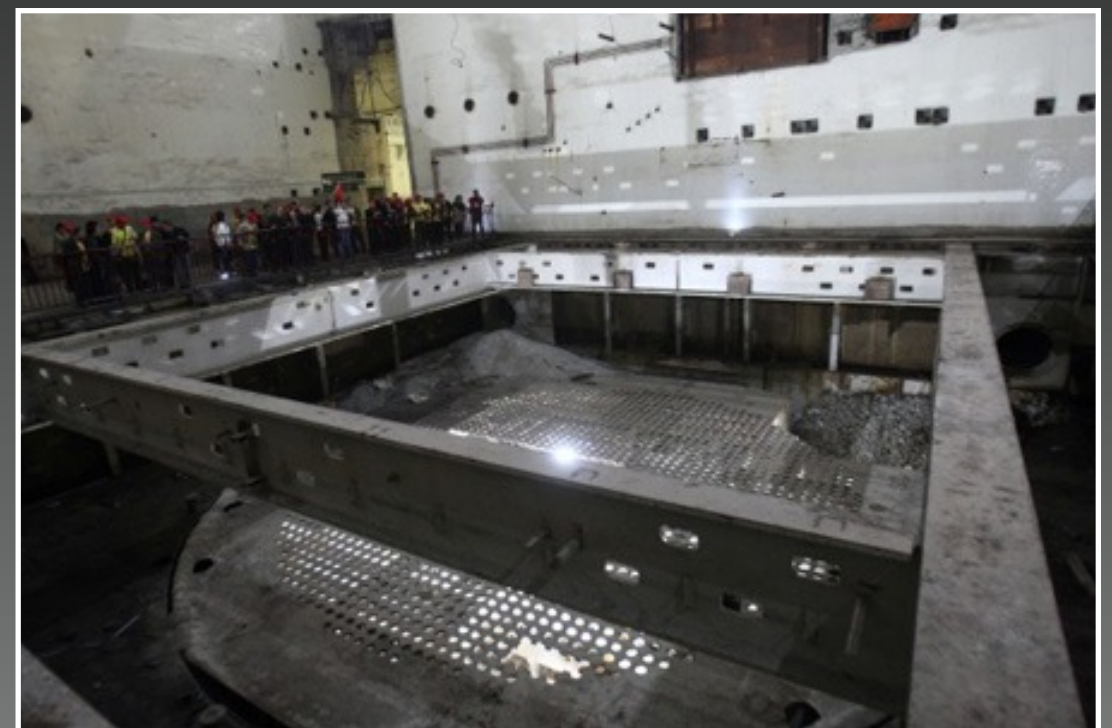
“THE CLOCK IS TICKING”

SHUTDOWN ENRICHMENT PLANTS AND PRODUCTION REACTORS
ARE BEING DECOMMISSIONED OR DEMOLISHED



Demolition of the K-25 uranium enrichment plant began in December 2008 and has been completed in 2012

Source: Bechtel Jacobs



China's unfinished underground plutonium production complex (Project 816), near Chongqing

Source: CQTV

