A Fissile Material (Cutoff) Treaty and its Verification

Progress Report from the International Panel on Fissile Materials

IPFM
INTERNATIONAL PANEL
ON FISSILE MATERIALS

Geneva, May 2, 2008

Revision 7

About the IPFM

Established in January 2006 with MacArthur Foundation 5-year grant

MISSION

to help inform international policy on methods to

achieve irreversible nuclear-warhead reductions, strengthen the nonproliferation regime, and reduce dangers of nuclear terrorism

MEMBERS

from Brazil, China, France, Germany, India, South Korea, Japan, Mexico, the Netherlands, Norway, Pakistan, Russia, South Africa, Sweden, the United Kingdom and the United States

(9 non-weapon & 7 weapon states)

Completed Reports

(available at www.fissilematerials.org)

Global Fissile Material Reports 2006 and 2007

Research Reports

#1 Fissile Materials in South Asia: The Implications of the US-India Nuclear Deal
by Zia Mian, A.H. Nayyar, R. Rajaraman, M.V. Ramana (July 2006)

#2 Japan's Spent Fuel and Plutonium Management Challenges
by Tadahiro Katsuta and Tatsujiro Suzuki (September 2006)

#3 Managing Spent Fuel in the United States: The Illogic of Reprocessing
by Frank von Hippel (January 2007)

#4 Spent Nuclear Fuel Reprocessing in France
by Mycle Schneider and Yves Marignac (April 2008)

Forthcoming Reports

Global Fissile Material Report 2008 *(mostly about the FMCT and its verification)*

National perspectives relating to the design of an FMCT

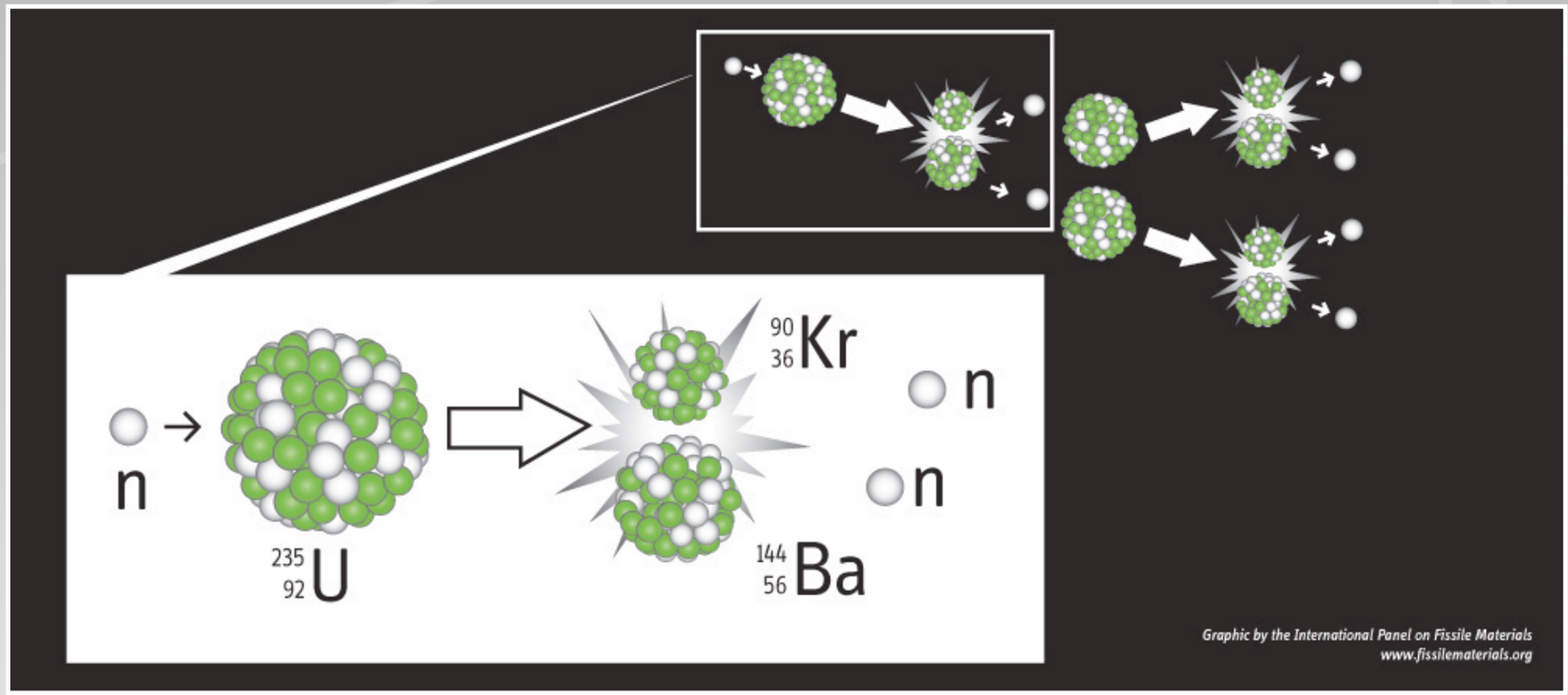
The Legacy of Reprocessing in the U.K., *by Martin Forwood*

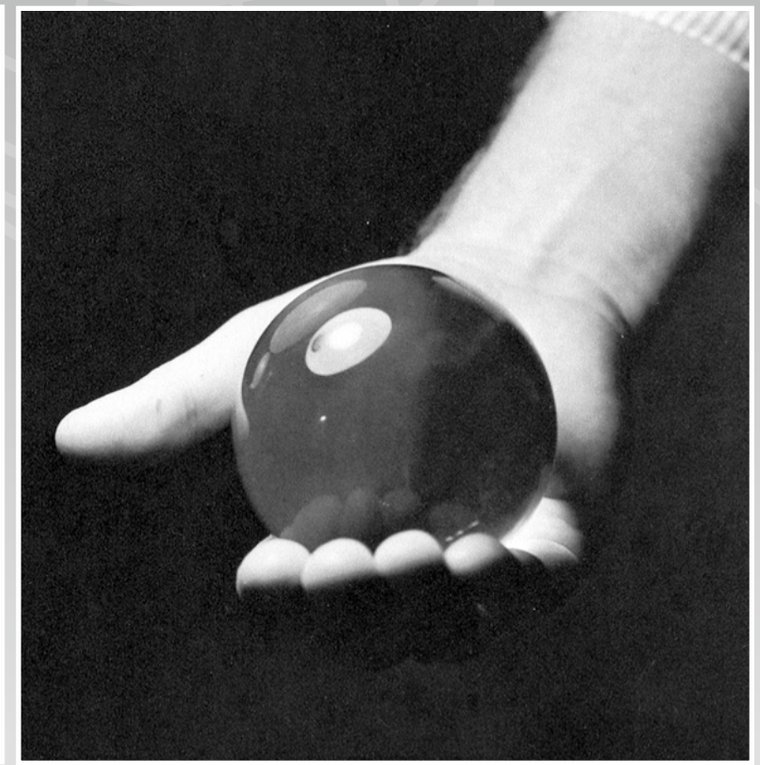
Toward elimination of HEU as a Reactor Fuel, *by Ole Reistad, S. Hustveit*

Consolidation of Nuclear Materials in Russia, *by Pavel Podvig*

The History of Fast Breeder Reactors, *by Tom Cochran, Gennadi Pshakin, M.V. Ramana, Mycle Schneider, and Tatsujiro Suzuki*

What Are Fissile Materials?





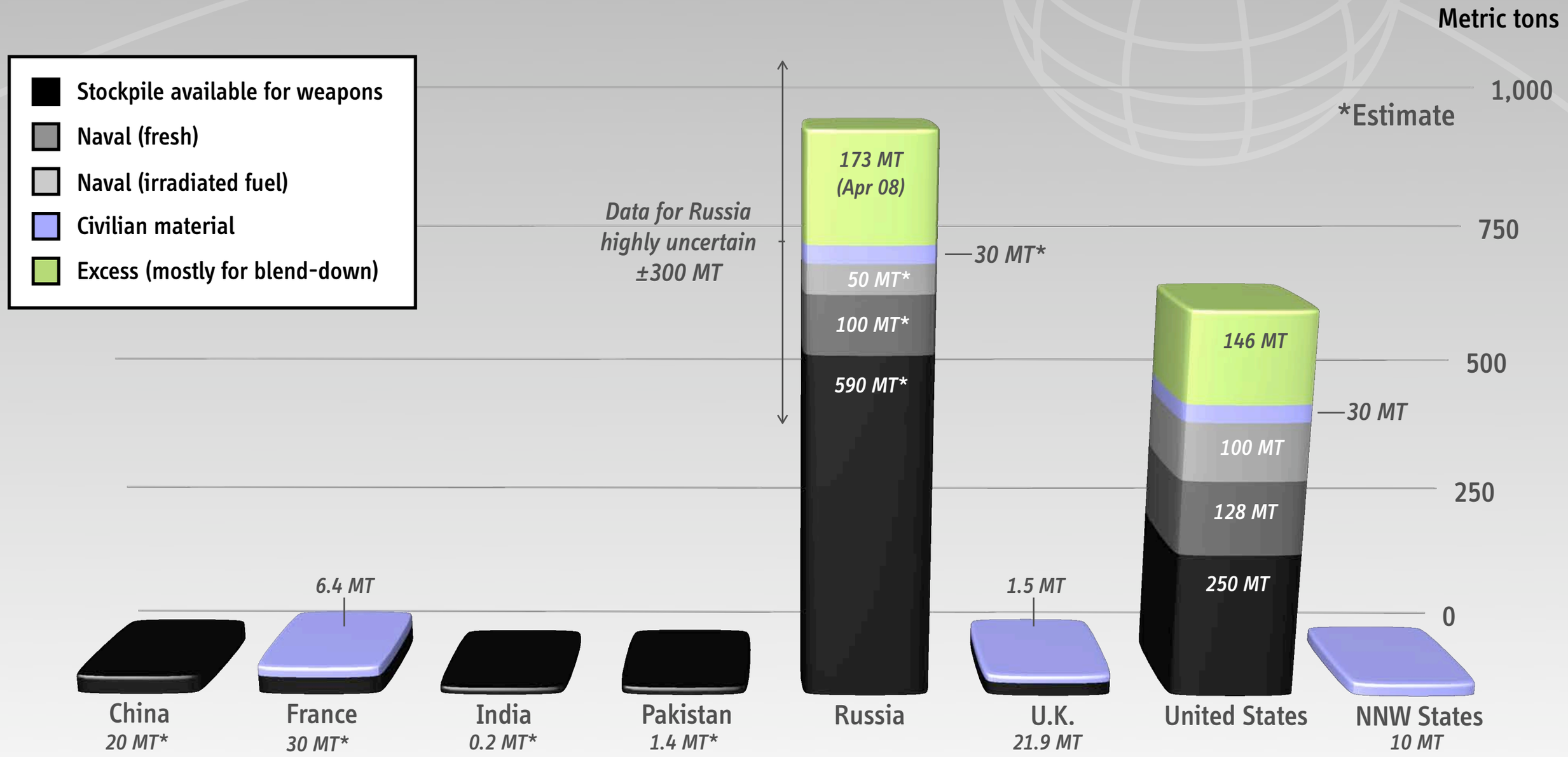
Material that can sustain an explosive fission chain reaction
notably highly enriched uranium (> 20% U-235) or plutonium (of almost any isotopic composition)

Already some controversy

Russia has proposed to limit FMCT to "weapon-grade" rather than "weapon-usable" uranium and plutonium

Plutonium containing more than 95% plutonium-239 *(but India tested with reactor-grade plutonium)*
Uranium containing more than 90% uranium-235 *(but Hiroshima bomb contained 80% uranium-235)*

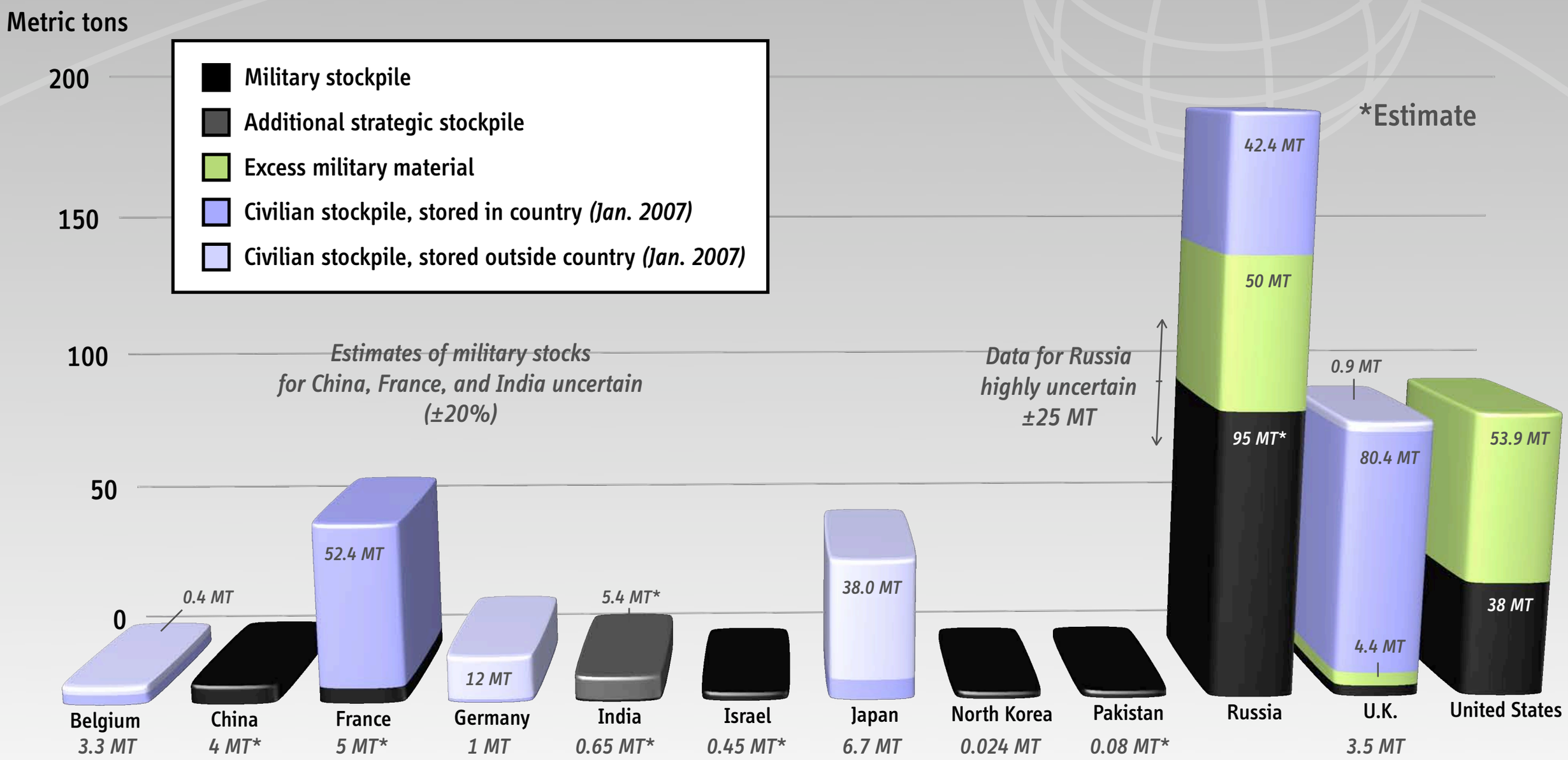
Highly Enriched Uranium Stockpiles



(250 MT of HEU are equivalent to 10,000 nuclear weapons)

Revised:28 April 2008

Global Stocks of Plutonium



(50 MT of plutonium are equivalent to more than 10,000 nuclear weapons)

Revised:28 April 2008

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FISSBAN SANS "C"

A SOUTH AFRICAN PERSPECTIVE

by Jean du Preez
Director, International Organizations and Nonproliferation Program
James Martin Center for Nonproliferation Studies
Monterey Institute of International Studies

UNDERSTANDING PRETORIA'S POSITION: FMCT vs. FMT

- Unique practical experience
  - Built & dismantled NW program
  - IAEA verified completeness of stocks declaration
  - Largest (former) military stockpile of weapons grade HEU outside the weapon states

- Role in "Shannon Mandate"
  - "negotiate a non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices."
  - SA argued that FMT should not only cap production but should also cover existing stockpiles
  - 1995 Shannon Report did not preclude any delegation from raising the issues of scope and verification within the Committee
  - Necessary to get consensus in time for '95 NPT RevExtCon

SECURING AN INDEFINATE DEAL

- U.S. promise linked to NPT indefinite extension
- Central element of 1995 package of integral decisions:
  - P&O disarmament action plan called for "immediate commencement and early conclusion of negotiations" of a fissile material treaty in accordance with the Shannon Report and "the mandate contained therein"
- At 2000 RevCon SA argued:
  - to be an effective disarmament measure, treaty should have both nuclear nonproliferation and nuclear disarmament objectives
  - "cut-off" treaty would only freeze status quo of nuclear capable countries, not reduce nuclear weapons over time
- Key among 13 practical steps adopted in 2000:
  - Step 3: Conclusion within 5yrs of negotiations "in accordance with the statement of the Special Coordinator in 1995 and the mandate contained therein, taking into consideration both nuclear disarmament and nuclear non-proliferation objectives."
  - Also related to principle of irreversibility (step 5); unequivocal undertaking (step 6); IAEA Trilateral Initiative (step 8) & transparency (step 9b)

ROLE IN CD/NPT

- One of the 1st to put forward concrete proposals (2002 working paper):
  - Merits of a verifiable treaty that should cover both past and future production of weapons usable fissile material
  - Emphasized that since declaration of weapons materials stocks by all nuclear-capable states would not be feasible, materials declared as excess should be included as a starting point
  - Stressed that a fissile material ban should not undermine commercial nuclear energy programs

- More recent statements show that South Africa has not moved away from this position
  - US draft treaty seems to have further fueled SA arguments in favour of a verifiable nonproliferation & disarmament mechanism.

- "South Africa continues to support the placing by all the nuclear-weapon States of fissile material no longer required for military purposes under international verification by the IAEA." – *Amb. Abdul S. Minty at the 2007 PrepCom*

AN OLD POLICY WITH A TWIST

- Linkage to efforts to reduce eliminate HEU for peaceful civilian purposes
  - Commercial value of 400+kg former weapons grade HEU (isotope production, fuel for partially converted research reactor, etc)
  - Strategic value given nature of HEU removed from warheads and relevance to excess military material stocks
- At 2006 Oslo International Symposium on HEU a clear linkage was made between the need to minimise/eliminate civilian HEU & material declared as excess in military stockpiles:
  - "we cannot exclusively focus on HEU without similar attention being given to other materials used in the production of nuclear weapons, including plutonium, tritium and other transuranic elements that have a proliferation potential"
  - "for any (FMT) to be considered as a disarmament measure, it would need to address, at the very least, the issue of excess stocks – that is, weapons material declared as excess, as part of an ongoing and irreversible process of the verified elimination of all fissile material for nuclear weapons or other nuclear explosive devices"
  - "Such a Treaty can also prevent altogether or regulate the further production of weapons-grade materials for legitimate and non-proscribed uses, including for the fueling of research reactors and naval reactors"

- Amb. Abdul S. Minty

FMT OBJECTIVES: A SOUTH AFRICAN PERSPECTIVE

Nonproliferation:

- Prevent altogether or regulate further production of weapons-grade materials for legitimate (non-proscribed) uses such as fuel for research reactors, naval reactors, etc.
- Prohibit the transfer of previously-produced fissile material between weapon states for weapon purposes.

Disarmament:

- Capture irreversibly weapons material declared as excess in ongoing process.
- Prohibit use in weapons of previously-produced fissile materials in use for non-military purposes; in a weapon-production complex but declared to be excess to military needs, and in a reserve for future use as fuel in military (e.g. naval-propulsion) reactors.

Safety& Security:

- International monitoring of civilian fissile materials and weapons material declared as excess in all countries would aid in securing these materials against diversion to non-state actors.

Verification:

- Must provide verified assurances that fissile material for weapons purposes is no longer produced

CAPTURING FISSILE MATERIAL STOCKS

- Ceasing production of weapons fissile material will quantitatively cap # of weapons & lay foundation for eventual elimination
- All nuclear materials in NNWS already subject to CSAs - NWS & *de facto* possessors will be affected by the inclusion of existing stocks, making it a disarmament mechanism
  - If not, stockpiles material originating from dismantled weapons could potentially be reversed into new weapon systems
  - Reductions will only be irreversible if (re)use of fissile material transferred from military use to civilian nuclear activities (declared as excess) is prohibited
- Political & practical reasons why full/complete declaration of all past produced weapons grade material as a Fissban requirement would be problematic
  - Inability to verify the declaration of nuclear material in weapons will not contribute to confidence building

A NONPROLIFERATION & DISARMANT FISSBAN

A treaty that covers existing stocks would:

- Meet the objectives of Art VI, particularly in terms of transparency, accountability, and irreversibility
- Further enhance nonproliferation objectives by preventing transfers from NWS or *de facto* nuclear weapons possessors to any NNWS
- Be "non-discriminatory" & equalize safeguards burden
- Avoid a potential loophole for declaring military fissile material produced after treaty's entry into force as past stocks
- Would help prevent diversion of materials to non-state actors

A PRACTICAL & PRAGMATIC APPROACH

- Material declared as excess should be included in a starting inventory of a state upon E.I.F. and be subject to verification - add. excess material would be added to the starting inventory in an irreversible way
  - without obligation to declare "completeness and correctness" of historical production
- Some excess material in sensitive geometrical or compositional forms would rule out direct verification
  - IAEA Trilateral Initiative provides a model
- Declared excess materials reworked into insensitive forms can be introduced into the verification system as new material
  - Downgrade HEU or used for production of MOX fuel as the need arises
  - Pu could be mixed with high-level radioactive waste for direct disposal.
  - Rest of material stored under normal verification conditions
- Lack of agreement on scope should not stall negotiations until such time as agreement is reached
  - Should be addressed during negotiations, in the same manner as other aspects of the treaty

TREATY VERIFICATION

Position based on 3 basic principles:

- Notion that effective FMT verification cannot be achieved implies that the NPT is not verifiable

- Success & future credibility of an FMT would require verified assurances that fissile material is no longer being produced for weapons purposes

- Subjecting NWS & 3 *de-facto* possessors to international monitoring of at least their civilian nuclear activities would redress long-standing concern that nuclear industries in NNWS are disadvantaged

VERIFICATION SYSTEM

- Set of legally binding agreements between each party and the designated verification entity
  - identical for all parties, but modified to reflect restrictions required by NWS
  - limited to fissile material subject to the treaty rather than all nuclear material
- Declarations within a specific timeframe of all material covered under the treaty upon E.I.F.
- Declarations should trigger inspections of decommissioned. production and (if appropriate) storage facilities
  - Should require some form of verifiable declaration that naval fuel is not diverted to nuclear-weapon purposes
- Material declared as excess, but still in sensitive geometrical & compositional forms should be subject to appropriate verification measures
  - Materials re-worked into non-sensitive forms, should be placed under appropriate IAEA safeguards

VERIFICATION SYSTEM (cont.)

- IAEA most logical verification entity - would require more inspectors & larger budget
- Non-compliance should be dealt with in timeframe consistent with threat
  - A promptly convened Conference of State parties would offer opportunities to consider allegations and response of the suspected noncompliant party (or parties)
  - Conference should have plenipotentiary powers to:
    - refer allegations to the UNSC
    - recommend other measures as appropriate
    - require a report from the verification entity on progress made towards compliance by a noncompliant State.

CONCLUSION

- Willing to start negotiations without preconditions.
  - BUT Pretoria may consider that a treaty that does not effectively address irreversible nuclear disarmament is not worth pursuing.
  - Likely to become more critical of attempts to restrict civilian fuel cycle; uses of fissile material, including HEU; and to make the AP a mandatory condition of supply
- Crucial to keep all negotiating options open
  - Attempts to preempt inclusions of stocks or to create a “partial FMT” will likely result in further deadlock
- Focus of future FMT should remain military use fissile material and not civilian material in any way or form - if not it is likely to come under fire by one of its strongest supporters:
  - Increased global interest in nuclear fuel as a sustainable energy source
  - Pretoria may be highly sensitive to any obligations which would imply restrictions on civilian fissile production facilities or stocks of fissile material
  - Judging by projected energy needs, it is estimated that by 2015 to 2020, SA plans to have more than half of its electric-power needs satisfied by nuclear energy.

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The FM(C)T and the South Asian Nuclear Buildup: India

M. V. Ramana

Centre for Interdisciplinary Studies in Environment and Development

India

Historical support for FMCT

- Co-sponsored United Nations General Assembly resolution 48/75L in 1993
- Support reiterated after Conference on Disarmament (CD) adopted negotiating mandate in 1995
- And in 1998 following establishment of negotiating committee

Requirements

- No moratorium on production of fissile material
- Non discriminatory, multilaterally negotiated and internationally verifiable FMCT
- Security interests have to be fully addressed
- No inclusion of stockpiles

Indo-US Nuclear Agreement

- Lays the ground for resumption of international nuclear trade with India in return for India putting some of its reactors under IAEA safeguards
- Waiting for Indian government and IAEA to agree on safeguards, NSG approval, and US Congress vote

Separation Plan

- Nine reactors outside of safeguards, some that will only be commissioned by 2010
- Reprocessing plants outside of safeguards
- Large plutonium stockpile kept outside of safeguards, can be used in unsafeguarded breeder reactor to produce weapon grade plutonium
- Policy makers seem to be keen on maintaining large fissile production capacity for weapons purposes for many years

Unsafeguarded Production Capacity

- Prototype Fast Breeder (scheduled operating date 2010) ~ 140 kg/y
- Heavy Water Reactors ~ 200 kg/y

- Capacity of plutonium production reactors at 70 % efficiency ~ 30 kg/y

  - Zia Mian, A.H. Nayyar, R. Rajaraman and M.V. Ramana, "Fissile Materials in South Asia and the Implications of the US-India Nuclear Deal," http://www.fissilematerials.org/ipfm/site_down/ipfmresearchreport01.pdf

At the same time…

- Nuclear doctrine claims "India shall pursue a doctrine of credible *minimum* nuclear deterrence"
- Suggests that government is not interested in pursuing a major buildup of nuclear weapons
- Problem: never defined minimum, which is qualified as a dynamic concept => arsenal size can't be fixed

Estimates and Projections

- Sufficient weapon grade plutonium for ~ 110 weapons (5 kg/weapon)
- Not clear how much of this is in the form of nuclear weapon pits
- "Credible minimum deterrence" requirement – analysts have come up with figures as low as a dozen to several hundreds (300 – 400)
- Might need 5-10 years at least

Prognosis

- India's fissile material buildup will probably continue for a while
- Stockpile size is a site of conflict – different groups/analysts argue for different sizes
- Global stockpile (weapons and fissile material) reductions would help those arguing for smaller arsenal and earlier cessation of fissile production

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The FM(C)T and the South Asian Nuclear Buildup - Pakistan

A. H. Nayyar
Sustainable Development Policy Institute,
Islamabad, Pakistan

Scope: *production - past, present and future*

- Pakistan wants an FMT, not FMCT

  Treaty should cover stocks, not just ban production

- "A cut-off in the manufacturing of fissile material must be accompanied by a *mandatory programme for the elimination of asymmetries* in the possession of fissile material stockpiles by various states. Such transfer of fissile material to safeguards should be made *first by states with huge stockpiles*, both in the global and regional context."

- "A fissile material treaty must provide a *schedule for a progressive transfer of existing stockpiles to civilian use* and placing these *stockpiles under safeguards* so that the *unsafeguarded stocks are equalized at the lowest level possible*."

Verifiable, Non-intrusive and Non-discriminatory

- Pakistan wants verifiable treaty

Verification should cover declarations and stocks

Not too intrusive

Non-discriminatory - all subject to same standard of verification

How can this be done while keeping secret the size of fissile material stock and the number of weapons

"We will cross the bridge when we come to it"

Tagged to India

- Position on FMT is dependent on India's nuclear capabilities:

  How many weapons, what kind, size/quality of stocks.

- "Pakistan cannot allow India to once again destabilize the balance of deterrence in future through *asymmetry in the level of stockpiles*",

  Significant asymmetry only if include India's un-safeguarded power reactor plutonium stocks

- Pakistan is not likely to sign or ratify an FMCT unless India does so at the same time

- If stocks not addressed, Pakistan may not sign or ratify.

Response to the US-India Nuclear Deal

- August 2007 National [Nuclear] Command Authority

  "the [US-India] agreement would have implications on strategic stability as it would enable India to produce significant quantities of fissile material and nuclear weapons from un-safeguarded nuclear reactors… and expressed firm resolve to meet the requirements of future credible minimum deterrence."

- Pakistan expanding its production capacity

  More efficient centrifuges

  Two additional production reactors,

  New reprocessing plant

A growing and costly nuclear complex

We have spent more in the past three years on the nuclear program than in the previous thirty -- Pervez Musharraf, 2006

Pakistan may have fissile material for 60-80 weapons and is making more

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Draft Elements of a Fissile Material (Cut-off) Treaty FM(C)T

The International Panel on Fissile Materials is developing draft elements for an FM(C)T.

We plan to present these in more detail early 2009

Presentation by Arend J. Meerburg, The Netherlands
Comments are welcome: arendmeerburg@xs4all.nl

Design Recommendations for an FM(C)T

- **Should be verified** (1993 General Assembly/ 2000 NPT Review Conf.)
- **By the IAEA** (already trained and equipped to do the task)
- Unlike the CWC and CTBT, but like the NPT, no detailed verification provisions in the Treaty itself since the IAEA has the mechanisms to develop the special verification measures and safeguards needed for an FM(C)T

Scope

- The Treaty should, of course, **prohibit the production of all fissile materials** (plutonium Pu, highly enriched uranium HEU) for use in nuclear weapons
- **Production facilities should be closed and dismantled** or only be used for civilian or non-explosive purposes. This should be verified. Production facilities are reprocessing plants (separating Pu from spent radioactive fuel) and uranium enrichment facilities.
- The FM(C)T should require that **all civilian stocks** of fissile materials and stocks declared excess for weapons purposes not be used for weapons and therefore be safeguarded**.** Verifying only non-production would not be enough!
- Could include **verified commitments that fissile material to be used for non-weapon military purposes (e.g. naval fuel) not be used for weapons.**

A Conference of States Parties (CSP)

- Since the IAEA Board of Governors **must** report to the Security Council in the case of a safeguards-violation and a State with veto power in the Security Council could be involved, a CSP may be needed to handle such a case (see also CWC and CTBT)

- The CSP may have its own Executive Committee, consisting of members of the Board that are FM(C)T parties as well as a few other parties.

Entry into Force (EiF)

- An FM(C)T is particularly relevant for those 8 or 9 States active in the nuclear field that do not have a safeguards agreement covering all their nuclear materials.

- In view of the great differences between these States it would not be wise to demand ratification by all those States before EiF is possible. Better to start with the Treaty quickly and get experience with the application of the extended safeguards, and have a serious review after, say, ten years.

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The Verification Challenge

"'Effective verification' of an FMCT cannot be achieved ... even with ... verification mechanisms and provisions ... so extensive that they could compromise the core national security interests of key signatories, and so costly that many countries will be hesitant to accept them."

Bush Administration at Conference on Disarmament, May 17, 2006

But the FMCT would require of the weapon states the same thing that the IAEA is supposed to verify in NPT non-weapon states

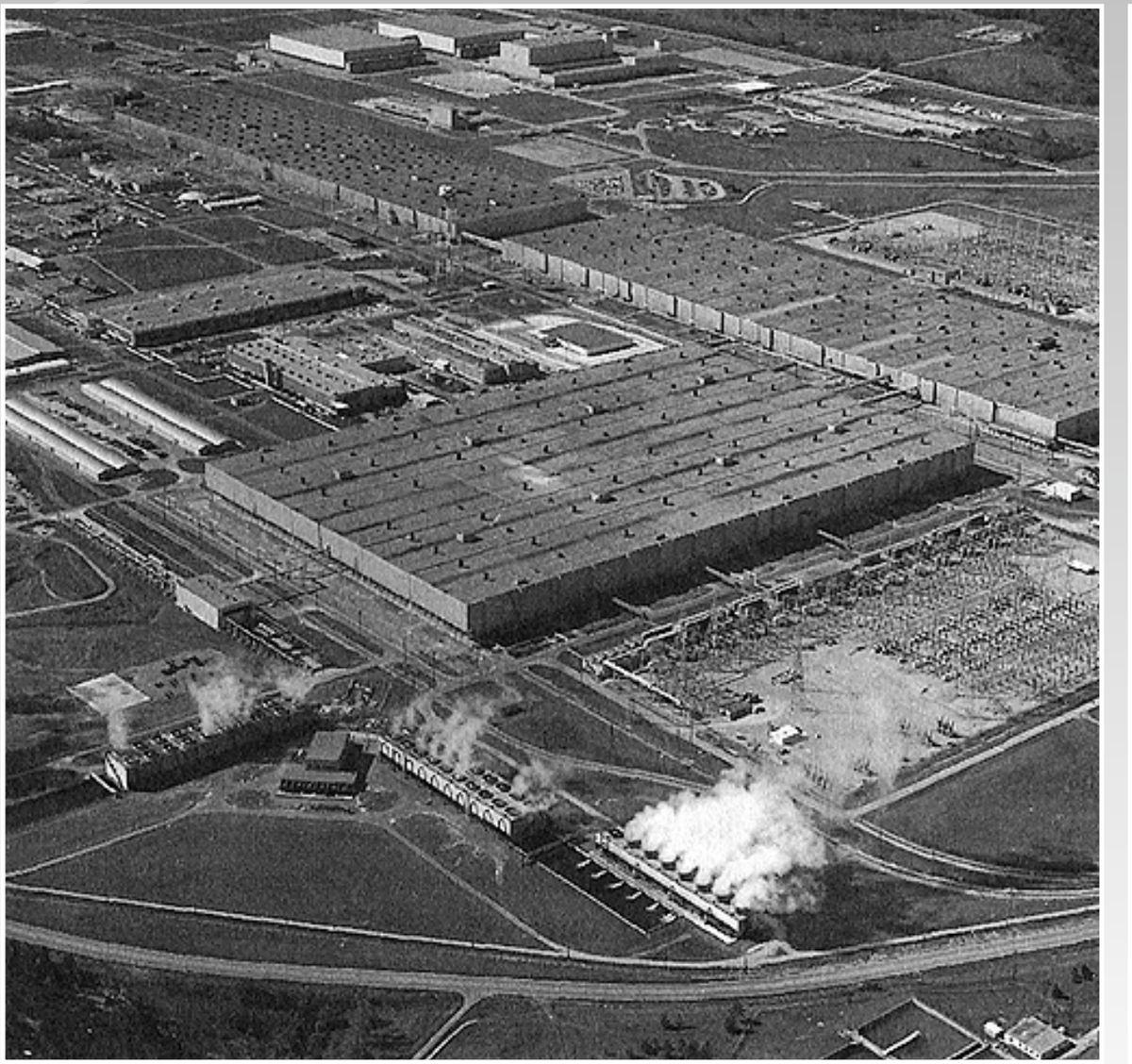
Five Verification Challenges in Nuclear Weapon States

1. Shutdown status of enrichment & reprocessing plants
2. No undeclared enrichment or reprocessing in military nuclear facilities
3. Non-diversion of plutonium at previously operating reprocessing plants
   (not designed for safeguards and without verified design information)
4. Non-production of HEU at previously operating enrichment plants
5. Non-diversion of material declared excess for weapons purposes
   (plutonium and HEU in classified form, and HEU to be used as naval fuel)

Minimizing additional IAEA Safeguards costs

Challenge #1

Verifying Shutdown of Enrichment and Reprocessing Plants



The U.S. Portsmouth gaseous-diffusion uranium-enrichment plant stopped operating in 2001, but has not yet been decommissioned

- Satellite monitoring
- Remotely monitored video cameras and sensors and seals on key equipment
- Short-notice random inspections

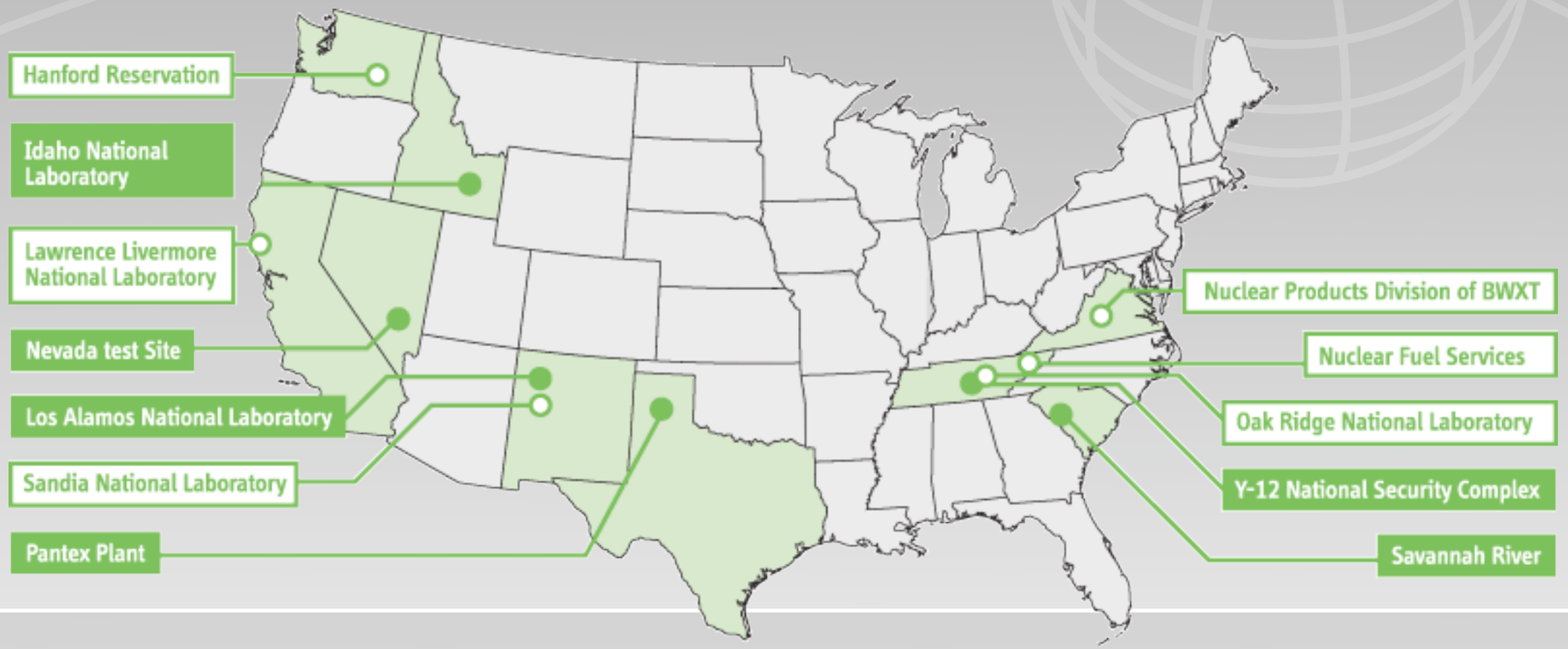
Cost would not be high

Potential sensitivities about qualitative indicators of past production *(e.g. HEU and plutonium isotopics)*

Challenge #2

Managed Access

(to confirm no undeclared enrichment or reprocessing in military nuclear facilities)

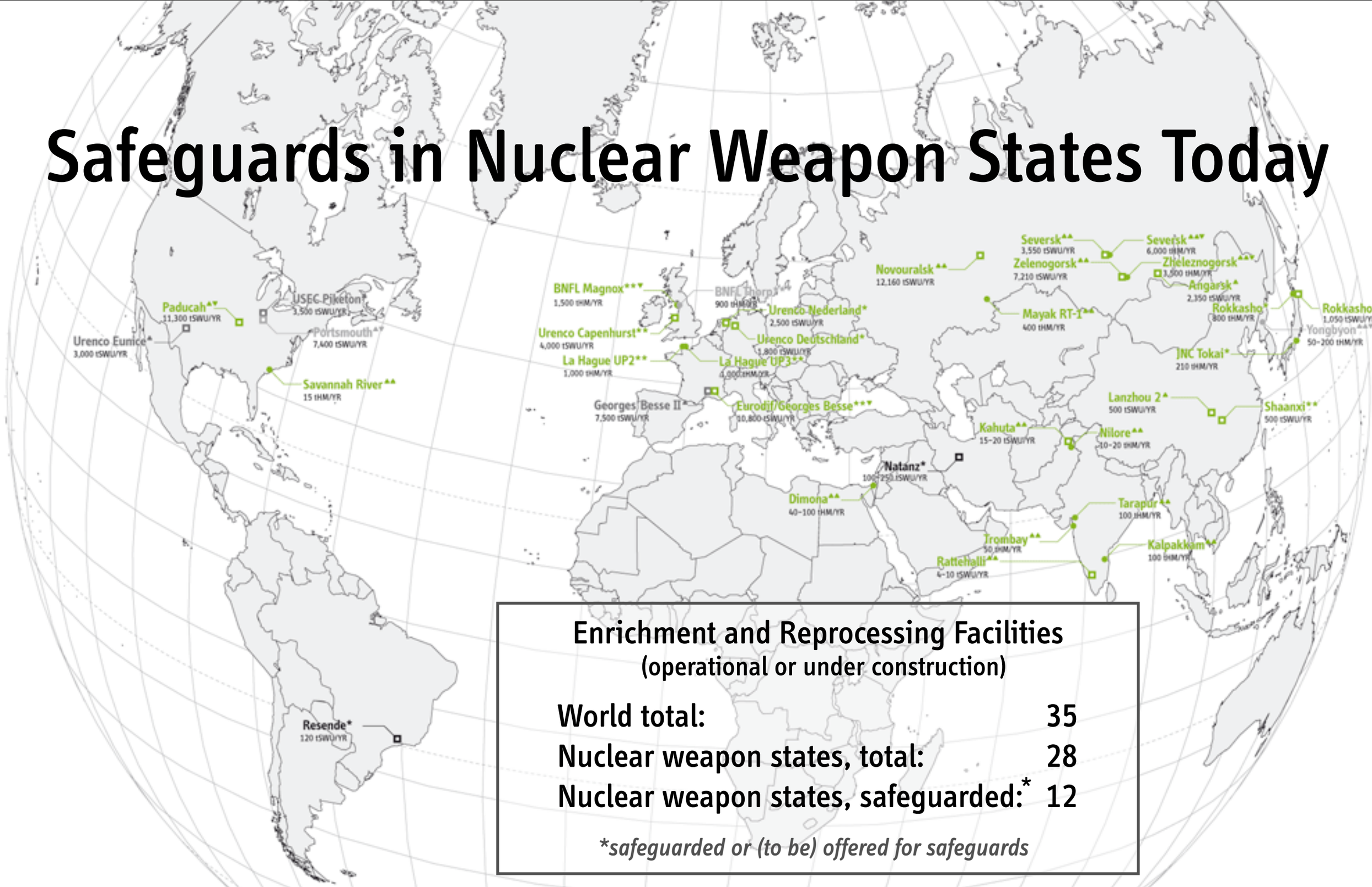


Managed-access procedures have been developed for OPCW inspections

U.S. DOE has instructed its facilities and U.S. NRC has instructed its licensees to prepare for managed access in connection with possible IAEA questions about the completeness and accuracy of U.S. Additional Protocol declarations

IPFM has been examining how managed access could be used to verify FM(C)T

Safeguards in Nuclear Weapon States Today



Enrichment and Reprocessing Facilities
(operational or under construction)

World total:	35
Nuclear weapon states, total:	28
Nuclear weapon states, safeguarded:*	12

**safeguarded or (to be) offered for safeguards*

Many reprocessing and enrichment plants in the nuclear weapon states already are subject to international safeguards (Global Fissile Material Report 2007)

Challenge #3

Non-Diversion at Operating Reprocessing Plants

Design information cannot be verified for operating unsafeguarded facilities
By far, most costly facilities to safeguard

Country	Facility	Safeguards Status	Capacity [tons/yr]
France	UP2/UP3	Yes (Euratom)	1000/1000
India	Trombay/Tarapur/Kalpakkam	No	50/100/100
Japan	Tokai/Rokkasho	Yes	210/800
Russia	Mayak	No	400
United Kingdom	B205/Thorp	Yes (Euratom)	1500/900
United States	Savannah River	No	15

Measure plutonium flow at strategic points and random short-notice inspections

Annual cleanout and inventory

$20 million investment and $1 million/plant-year. Much less costly than Rokkasho safeguards because no resident inspectors and no on-site safeguards laboratory

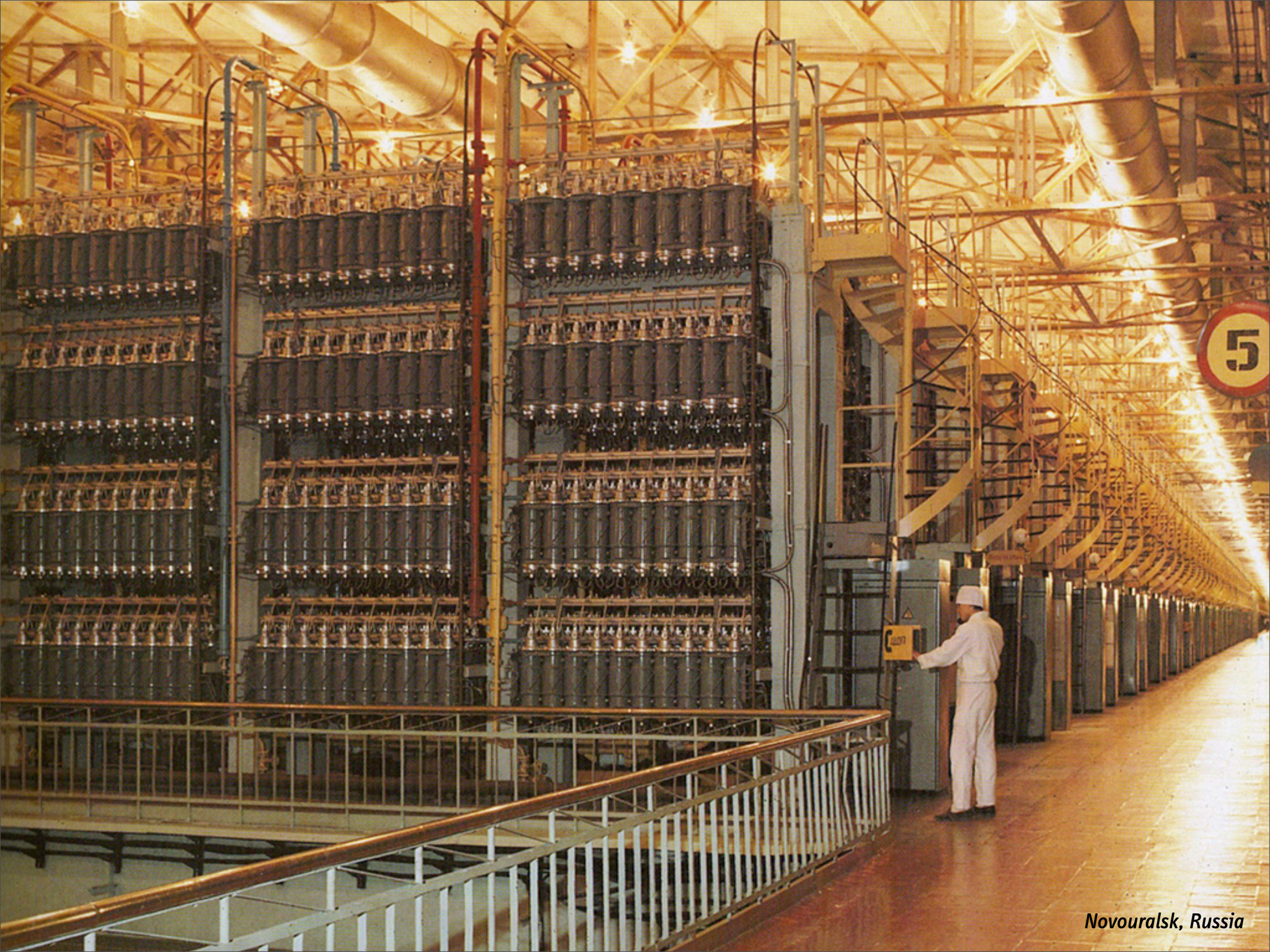
Challenge #4

Centrifuge Enrichment Facilities

(as currently expected for the year 2015)

	Country	Facility	Safeguards Status	Capacity [tSWU/yr]
Non-weapon states	Brazil	Resende	Yes	120
	Germany	Gronau	Yes (IAEA/Euratom)	4,500
	Iran	Natanz	Yes	250*
	Japan	Rokkasho	Yes	1,050
	The Netherlands	Almelo	Yes (IAEA/Euratom)	3,500
Weapon states	France	George Besse II	Yes (IAEA/Euratom)	7,500
	U.K.	Capenhurst	Yes (IAEA/Euratom)	4,000
	United States	Piketon, Ohio	Likely	3,500
		Eunice, NM	Possible	3,000
		TBD (Areva)	Possible	3,000
	China	Shaanxi	Yes (IAEA)	500
		Lanzhou II	Offered?	500
	Russia	Angarsk II	Offered?	5,000*
		4 others	No	30,000*
	India	Rattehalli	No	4-10
	Pakistan	Kahuta	No	15-20

**uncertain values*



Novouralsk, Russia

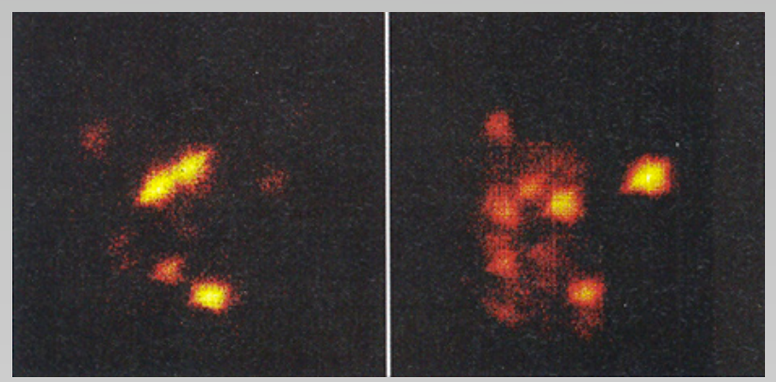
Challenge #4

Verifying Non-Production of HEU in Previously Operating Enrichment Facilities

Installation/use of continuous (or portable) enrichment monitors

Already added to centrifuge facilities in the United Kingdom and in China

Swipe sampling techniques to detect HEU particles



Images of micron-sized uranium particles made with a Secondary Ion Mass Spectrometer

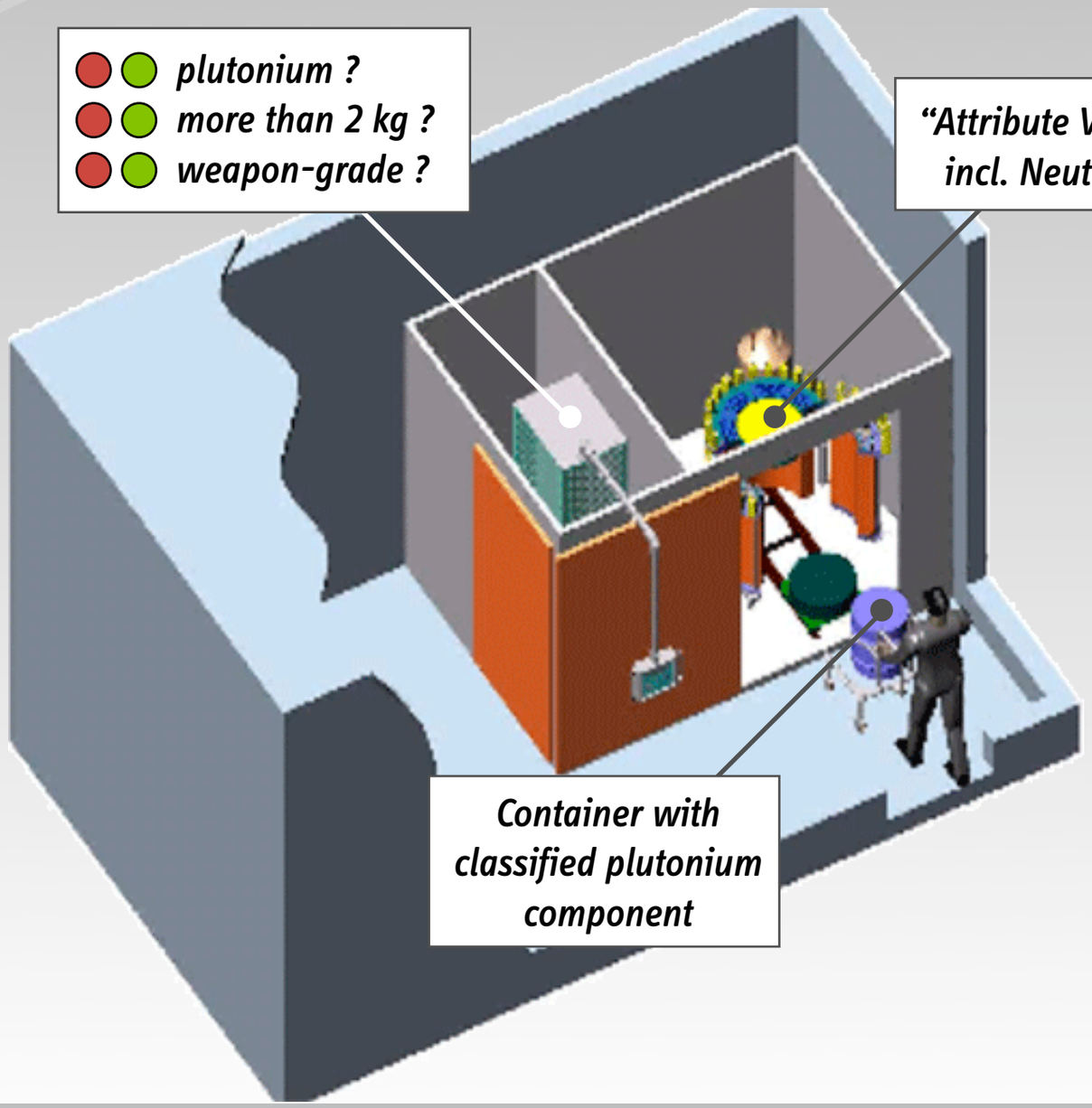
Left: U-235 Concentration
Right: U-238 Concentration

Pre-FM(C)T HEU particles may be identified with age-dating techniques (and isotopic analysis)

Challenge #5

Verifying Non-Diversion of Material Declared Excess for Weapon Purposes

(while in classified form)



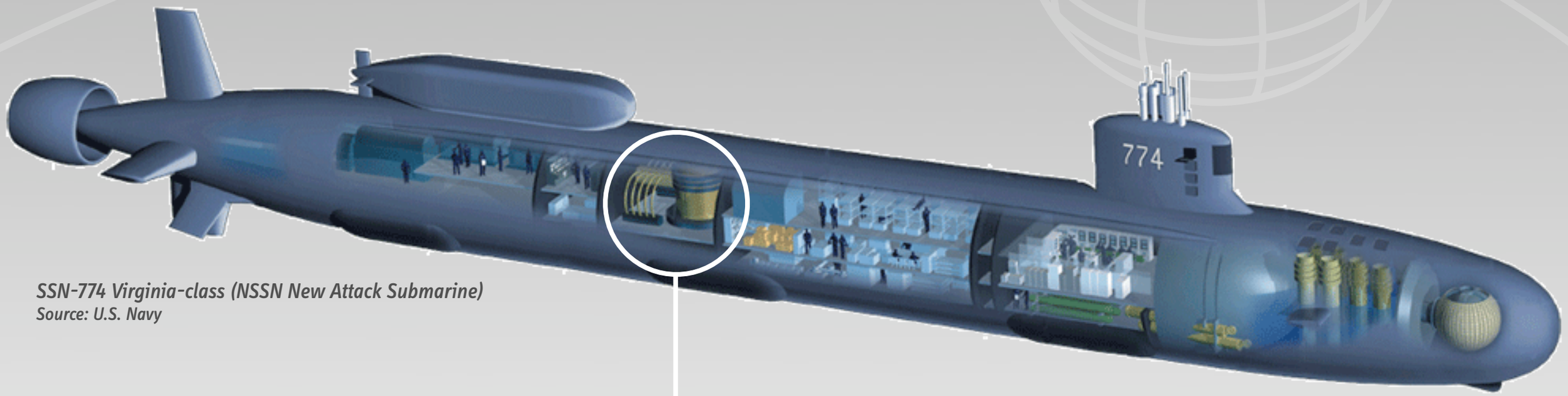
1996-2002 Trilateral Initiative developed approach to determine that a container holds more than a threshold amount of weapon-grade plutonium

Results communicated by red or green lights through information barrier

IPFM is working on corresponding approach for HEU components

Challenge #5

HEU Stockpiles for Naval Fuel



SSN-774 Virginia-class (NSSN New Attack Submarine)
Source: U.S. Navy

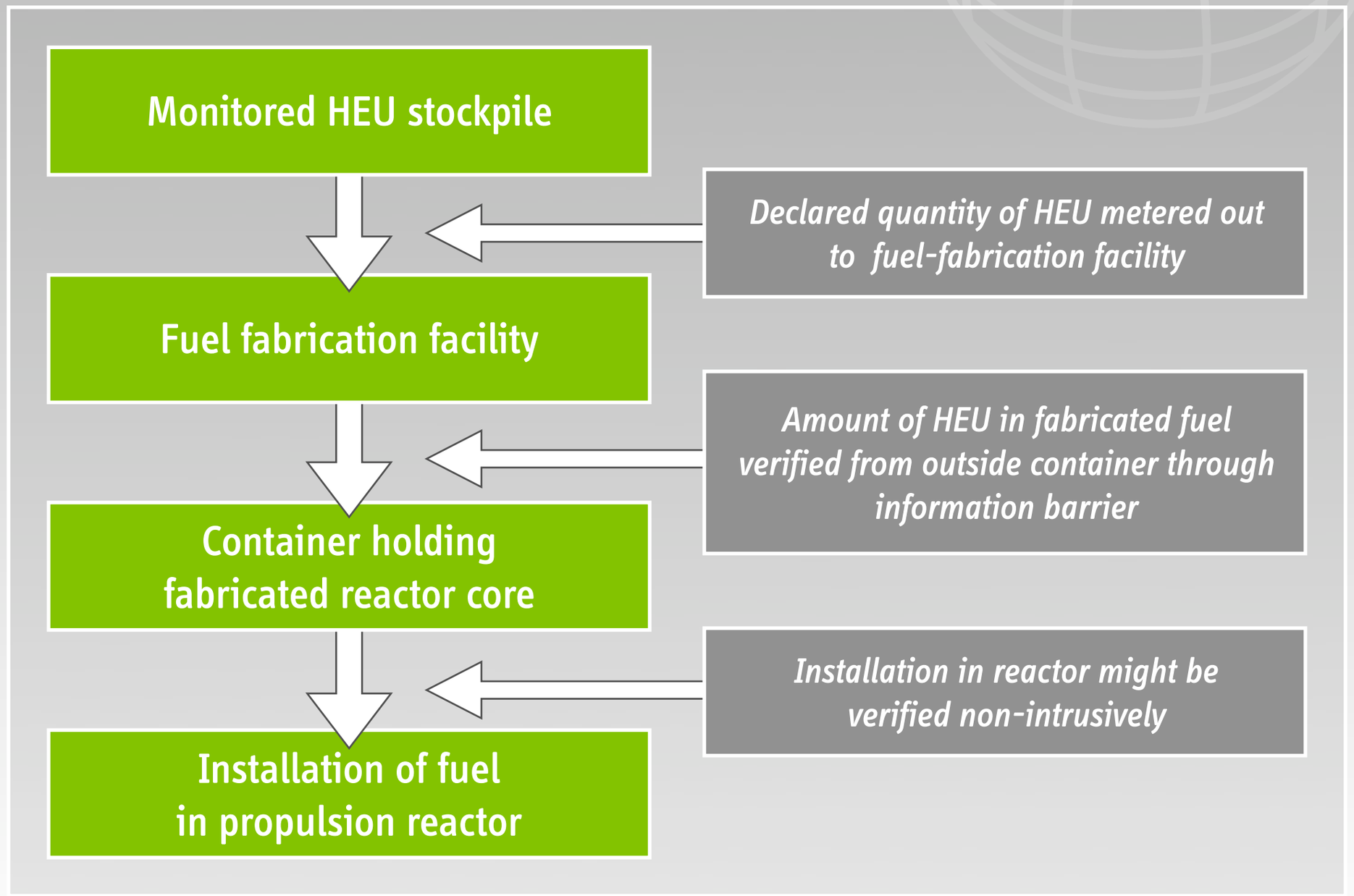
The United States, Russia, and the United Kingdom use HEU to fuel naval vessels
(mostly submarines; the U.S. and U.K. vessels are fueled with weapon-grade uranium)

The U.S. fleet currently requires about 2000 kg of weapon-grade uranium per year

The United States has reserved 128 tons of excess weapon-grade uranium (enough for 5,000 nuclear weapons) for future use in naval reactors

Challenge #5

Non-Diversion of HEU Set Aside For Naval (and Tritium Production) Reactors



Conclusion

The technical challenges of FM(C)T verification are significant
but probably not as significant as
the political challenges of FM(C)T negotiation

The costs of FM(C)T verification could be
less than the current IAEA safeguards budget

The technical challenges and costs will come down
as former military production facilities are
shut down and dismantled

A Fissile Material (Cutoff) Treaty and its Verification

Progress Report from the International Panel on Fissile Materials

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