Scope and Verification of a Fissile Material (Cutoff) Treaty

IPFM
INTERNATIONAL PANEL ON FISSILE MATERIALS

Zia Mian, Arend Meerburg and Frank von Hippel

Conference on Disarmament, Geneva, 21 August 2009

Revision 1

Outline

About the IPFM

Global stocks of fissile material -- Zia Mian

FM(C)T design choices -- Arend Meerburg

Verification issues -- Frank von Hippel

About IPFM

Established in January 2006 with MacArthur Foundation 5-year grant

MISSION

To provide the technical basis for policy initiatives to consolidate, and reduce stockpiles of HEU and plutonium and thereby help:

- Achieve irreversible nuclear-warhead reductions,
- Strengthen the nonproliferation regime, and
- Reduce dangers of nuclear terrorism

24 Members from 17 States

7 Weapon States

- James Acton (UK)
- Anatoli Diakov (Moscow, Russia)
- Pervez Hoodbhoy (Islamabad, Pakistan)
- Li Bin (Beijing, China)
- Yves Marignac (Paris, France)
- Abdul H. Nayyar (Islamabad, Pakistan)
- Pavel Podvig (Russia)
- R. Rajaraman (Co-Chair, New Delhi, India)
- M. V. Ramana (Bangalore, India)
- Mycle Schneider (Paris, France)
- Shen Dingli (Shanghai, China)
- Frank von Hippel (Co-Chair, Princeton, USA)
- William Walker (St. Andrews, UK)

10 Non-weapon States

- Jean DuPreez (South Africa)
- José Goldemberg (São Paolo, Brazil)
- Martin B. Kalinowski (Hamburg, Germany)
- Jungmin Kang (Seoul, South Korea)
- Patricia Lewis (Ireland)
- Miguel Marín-Bosch (Mexico City, Mexico)
- Arend Meerburg (Den Haag, Netherlands)
- Henrik Salander (Stockholm, Sweden)
- Ole Reistad (Olso, Norway)
- Annette Schaper (Frankfurt, Germany)
- Tatsujiro Suzuki (Tokyo, Japan)

Princeton University Researchers

Harold Feiveson

Zia Mian

Alexander Glaser

Completed IPFM Reports

(available at www.fissilematerials.org)

Global Fissile Material Reports 2006, 2007, and 2008 (incl. Companion Volume)

Research Reports

Publications Focused on the Fissile Material (Cutoff) Treaty

Global Fissile Material Report 2008: *Scope and Verification of an FM(C)T*

Banning the Production of Fissile Materials for Nuclear Weapons: Country Perspectives on the Challenges to a Fissile Material (Cutoff) Treaty

A Draft Fissile Material (Cutoff) Treaty with Article-by-Article Explanation

"Complete Cutoff: Designing a Comprehensive Fissile Material Treaty"
by Arend Meerburg and Frank von Hippel, *Arms Control Today*, March 2009.

Fissile Material (Cutoff) Treaty

Global Stocks of Fissile Materials, 2008

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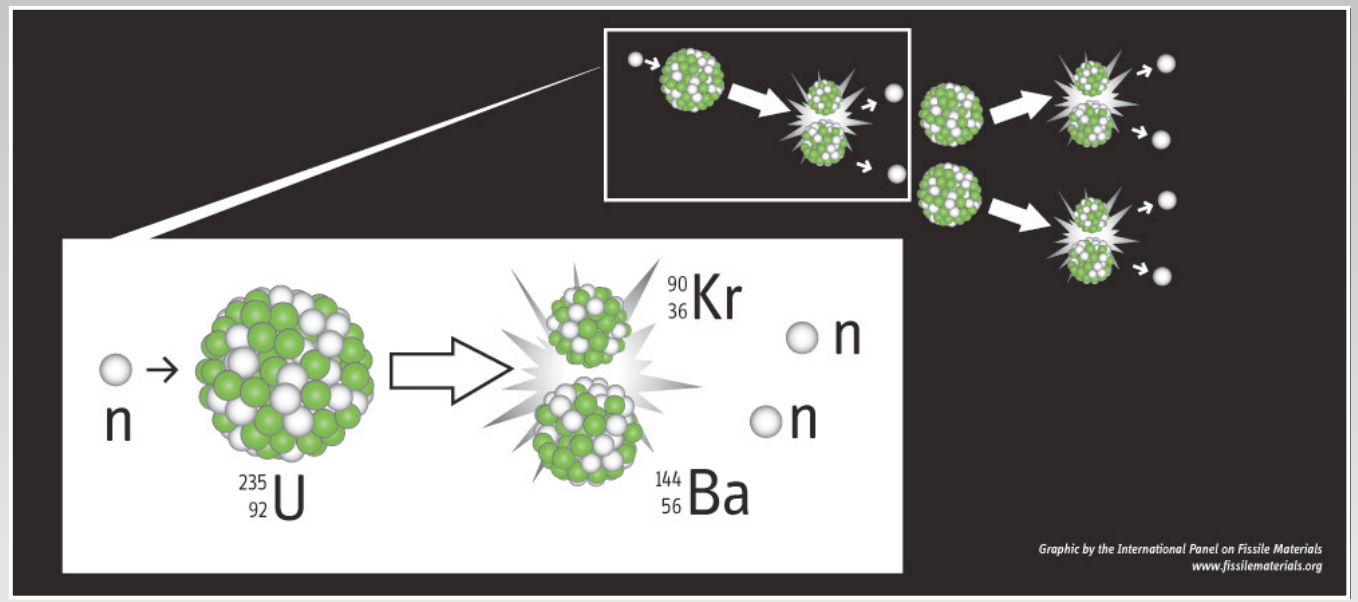
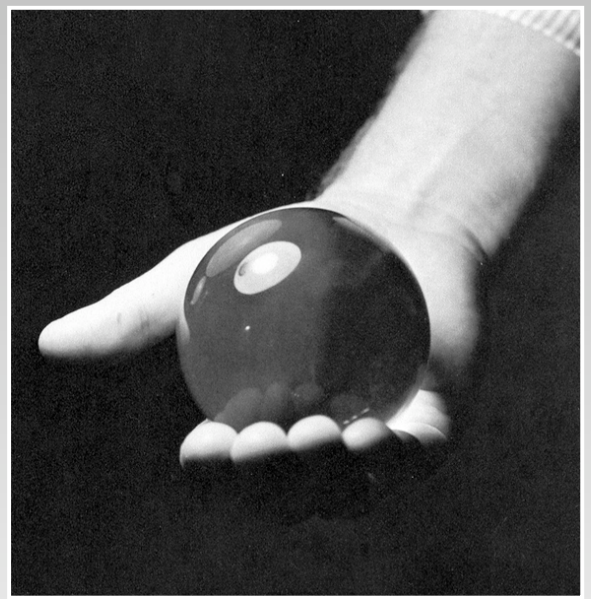
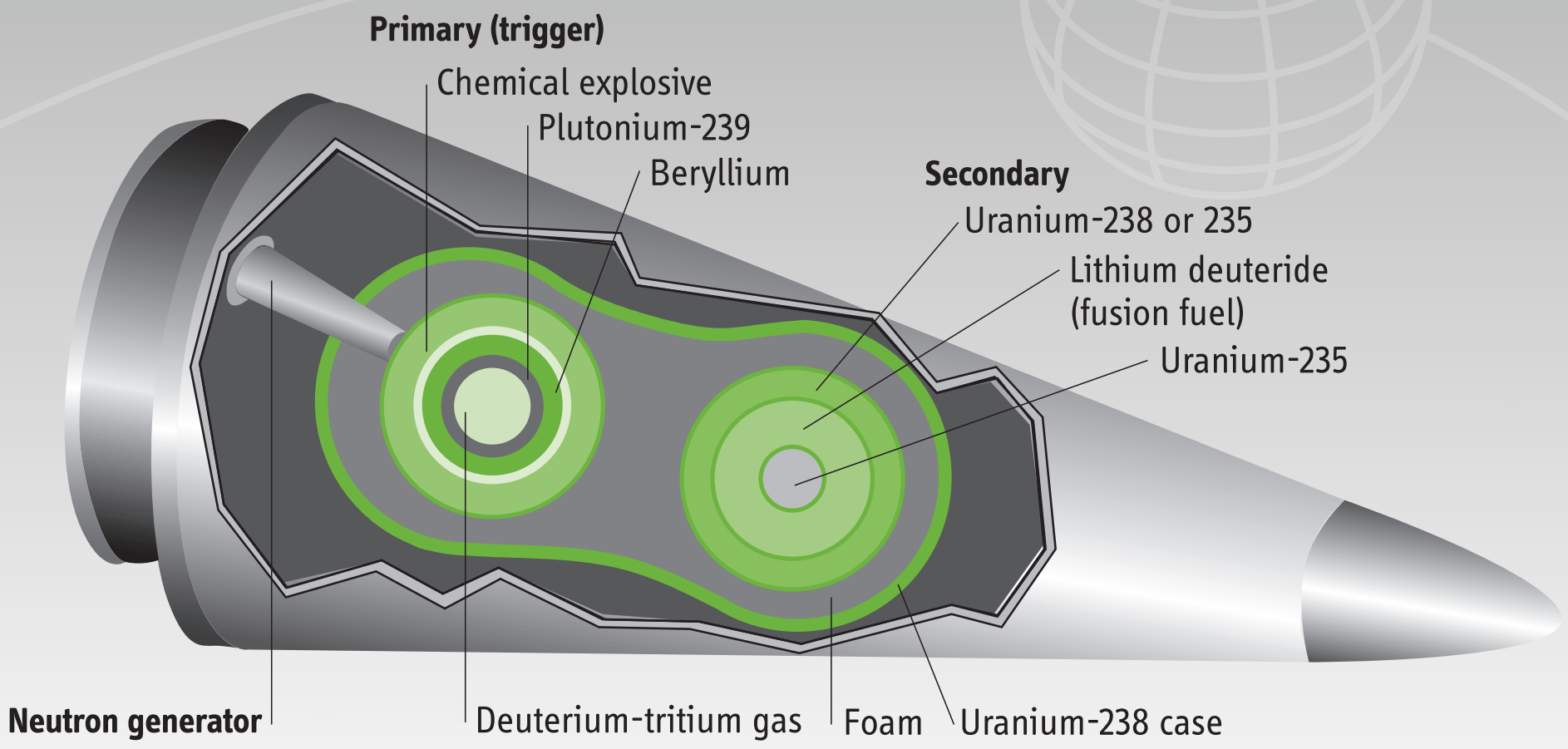
Fissile Materials and Nuclear Weapons





Material that can sustain an explosive fission chain reaction
notably highly enriched uranium or plutonium (of almost any isotopic composition)

Modern Thermonuclear Warhead



A modern thermonuclear warhead may contain *both* plutonium and highly enriched uranium

(Average estimated values are 4 kg and 25 kg of plutonium and HEU, respectively)

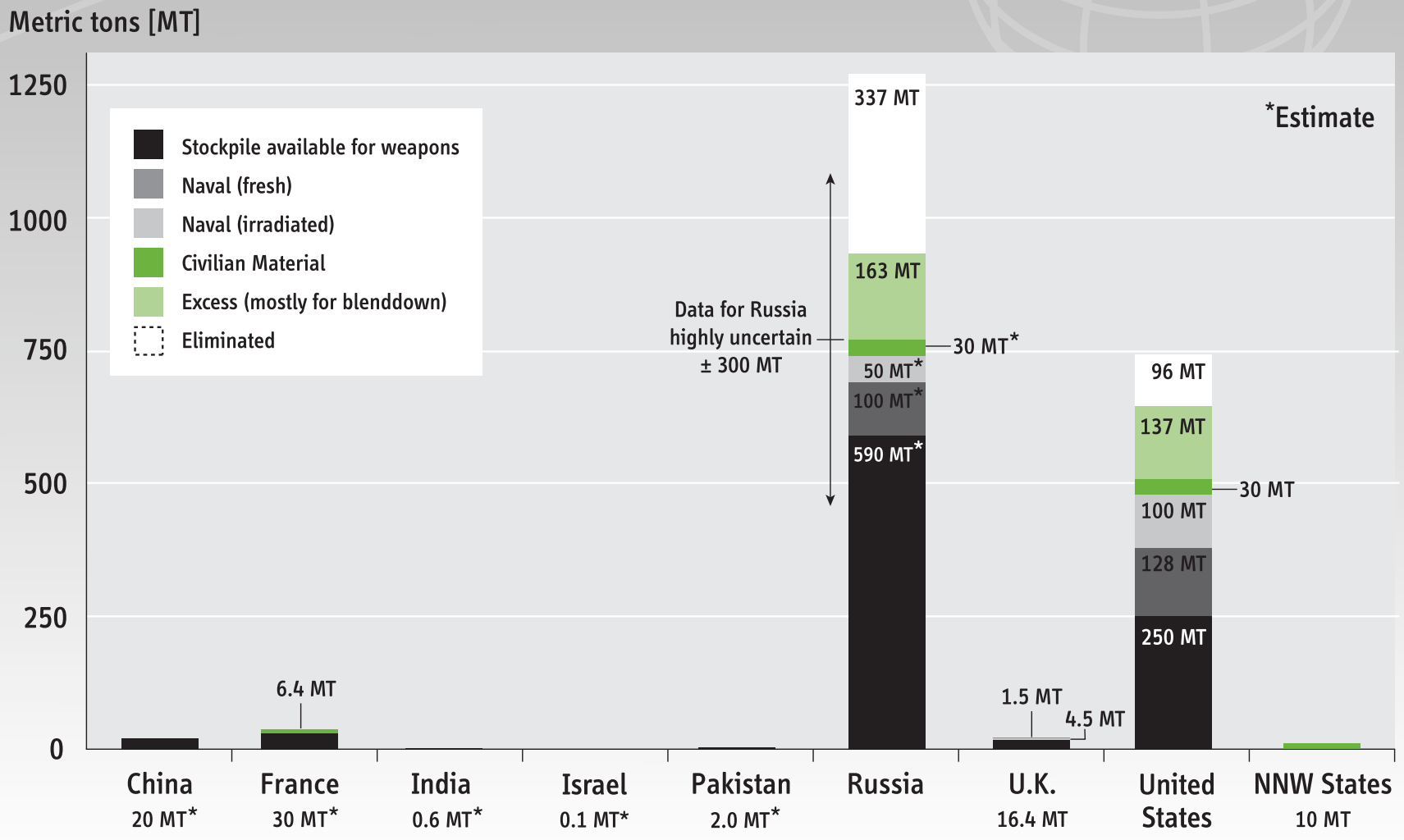
Nuclear Arsenals, 2009

(based on estimates by NRDC/FAS)

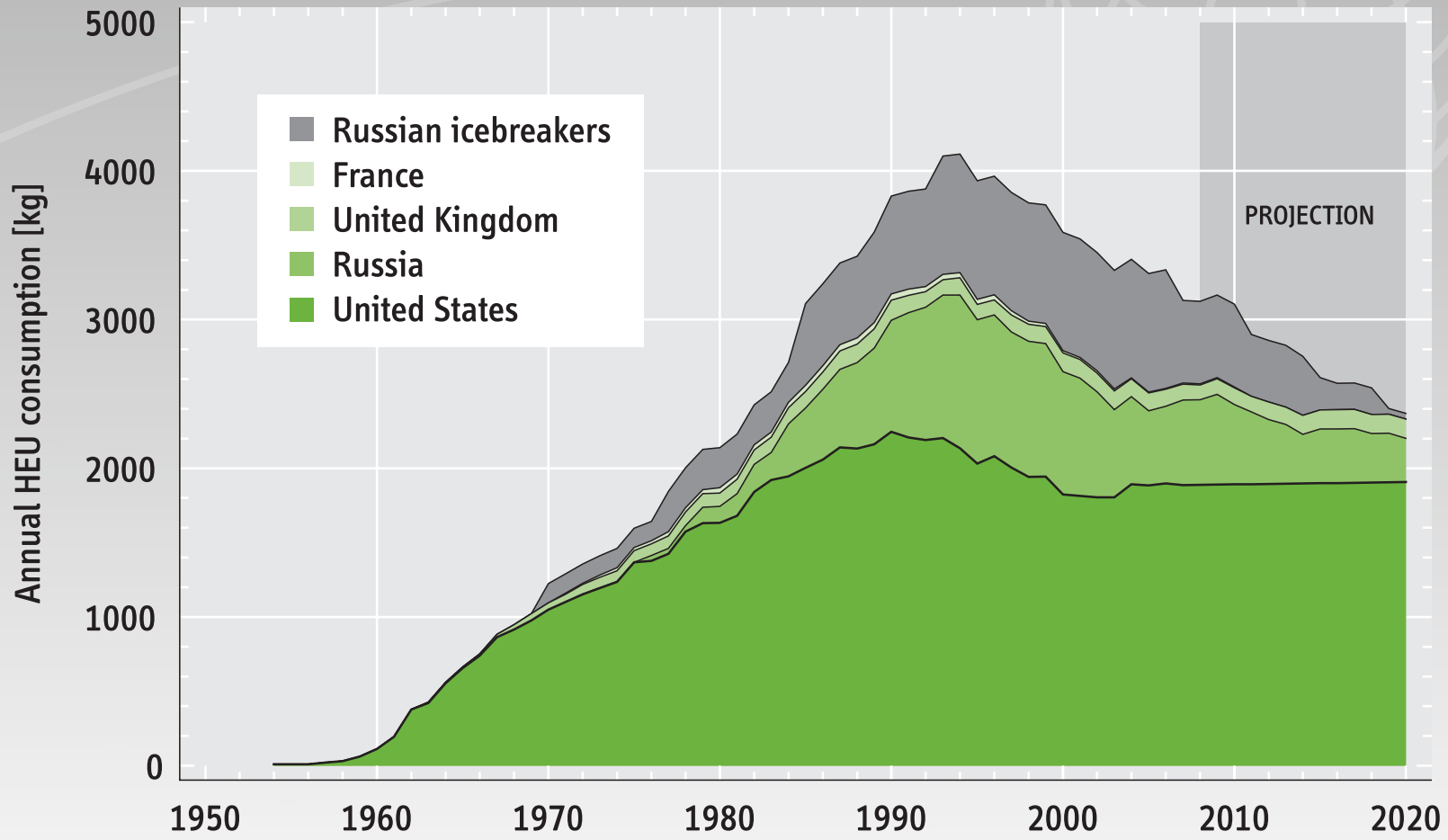
Country	Nuclear Warheads
United States	about 10,000 *(5000 deployed + 5000 awaiting dismantlement)*
Russia	about 10,000 *(large uncertainty as to number awaiting dismantlement)*
France	fewer than 300
United Kingdom	185
China	about 240
Israel	100-200
Pakistan	about 60
India	about 60
North Korea	fewer than 5

HEU Stockpiles, 2008

Global stockpile is almost 1700 tons, over 99% is in weapon states

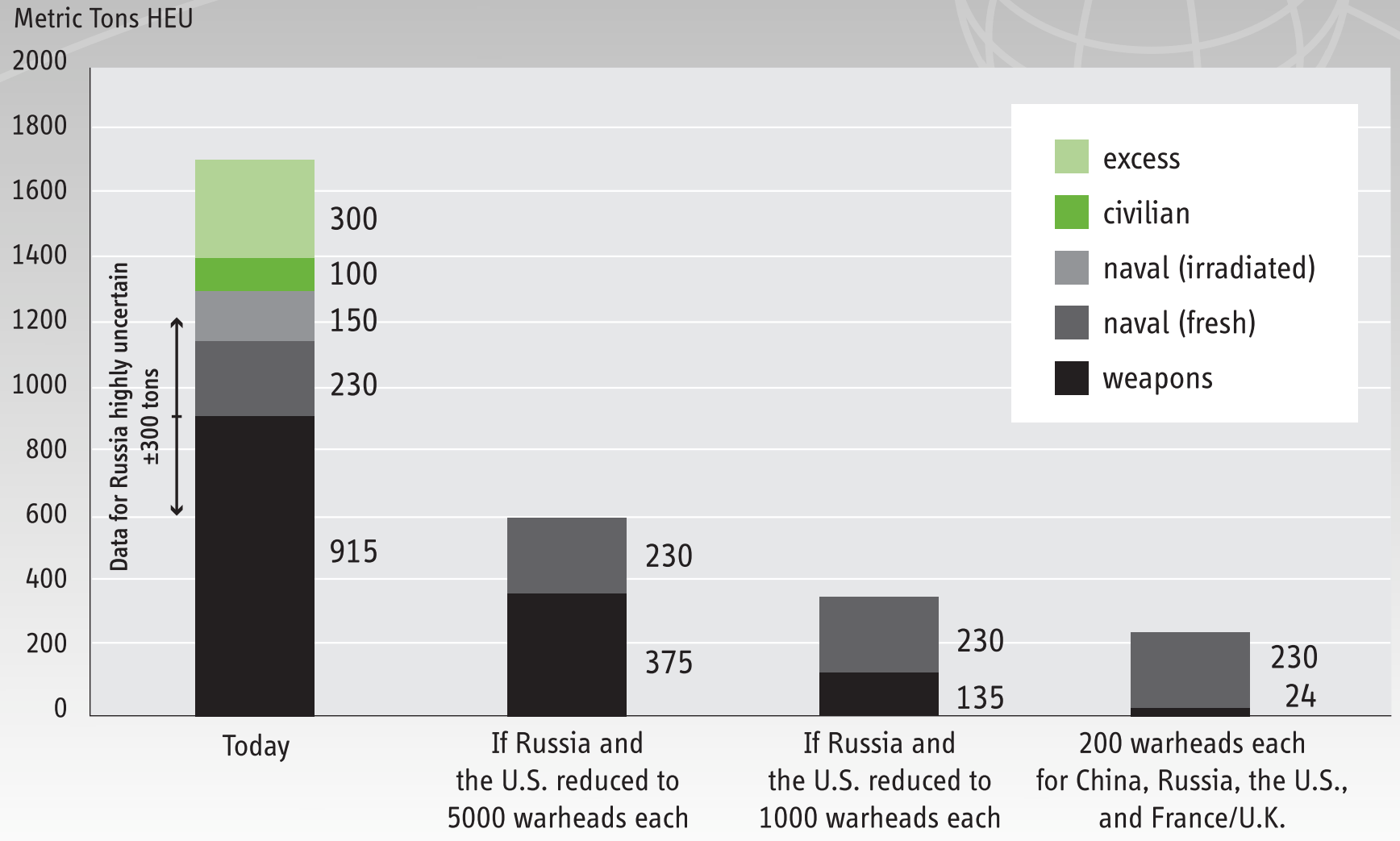


HEU Consumption in Naval Vessels*



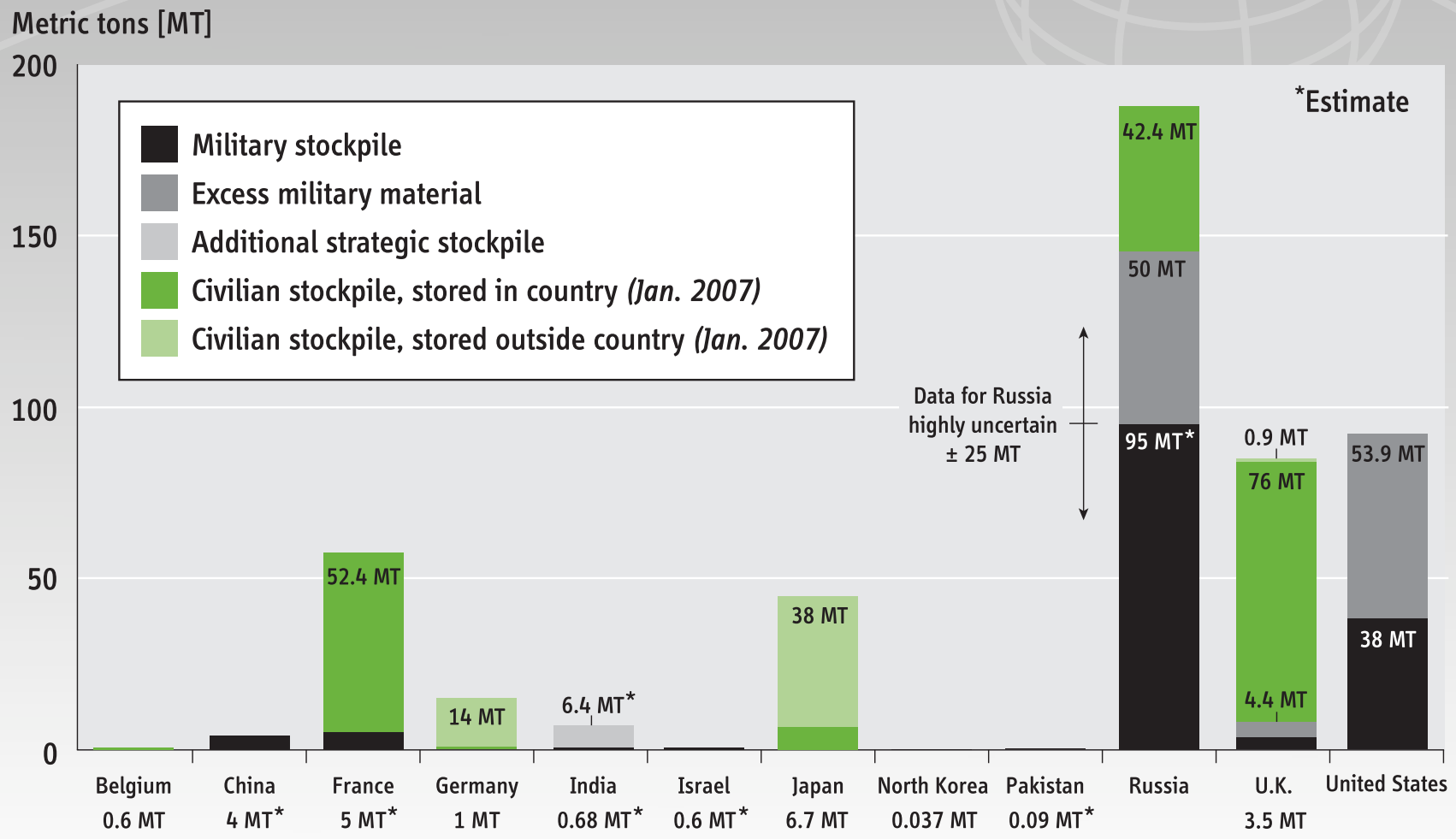
*"HEU Fuel Cycle Inventories and Progress on Global Minimization,"
Ole Reistad and Styrkaar Hustveit,Nonproliferation Review, 15:2, (2008) p. 265.

The Naval HEU Problem in a Disarming World

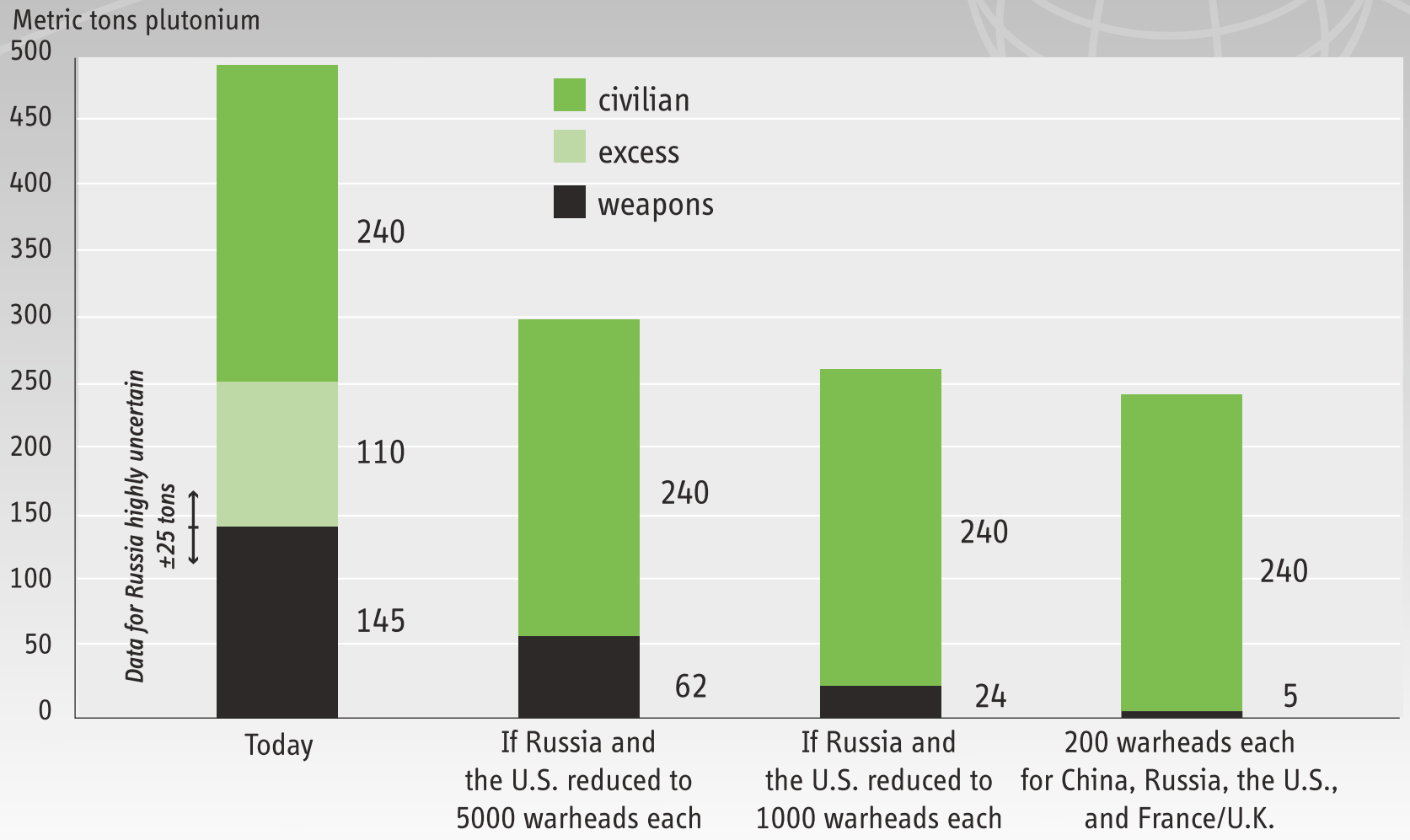


Plutonium Stockpiles, 2008

Global stockpile is 500 tons, half is civilian and this stock is growing



The Civilian Plutonium Problem in a Disarming World



Fissile Material (Cutoff) Treaty

Design Choices

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Arend Meerburg

Conference on Disarmament, Geneva, 21 August 2009

Design Recommendations for an FM(C)T

Should be verified: essential in a disarming world

By the IAEA (already trained and equipped to do the task)
Like the NPT, no detailed verification provisions in the Treaty since IAEA has the mechanisms to develop appropriate verification measures

Treaty should **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 used for civilian or non-explosive military purposes.
Production facilities are reprocessing plants (separating Pu from spent radioactive fuel) and uranium enrichment facilities.

Four categories of stocks of fissile materials

1. Fissile materials in or for weapons
2. Fissile materials for civilian purposes
3. Fissile materials declared as excess for military/explosive purposes
4. Fissile materials in or for military reactors (naval propulsion, tritium production)

Category 1 is directly related to nuclear disarmament agreements.

FM(C)T should cover categories 2-4 which should never be used for weapons : a one-way street to safeguards

Coverage

All production and use of civilian fissile materials after entry into force should be safeguarded.

All existing civilian fissile material also should be safeguarded

All material declared as excess for weapons should be brought under safeguards (if necessary after conversion to unclassified form)

Military non-explosive materials (e.g. naval HEU) should not be used for weapons

Verification Protocols

Non-nuclear-weapon States with a comprehensive safeguards agreement and an Additional Protocol have no further obligations (but must make special arrangements for use of fissile materials in naval propulsion and when producing or using neptunium and/or americium)

Other (weapon) states need to make special agreements with the IAEA

This approach would bring convergence between the basic safeguards obligations of nuclear-weapon states and non-weapon states

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 SC could be involved, a CSP is needed to handle such a case (see also CWC and CTBT)

However: what about the relation with the IAEA?

What about the financing for the extra safeguards?

Entry into Force (EiF)

An FM(C)T is relevant primarily for those 8 or 9 States with significant quantities of fissile materials not subject to international safeguards.

It would not be wise to demand ratification by all those States for EiF. Better to start with the Treaty quickly and get experience with the application of the safeguards, and have a serious review after, say, ten years.

Fissile Material (Cutoff) Treaty

Verification Challenges

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Princeton University

Conference on Disarmament, Geneva, 21 August 2009

Verification Challenges

1. Shutdown facilities
2. Enrichment plants
3. Reprocessing plants
4. Managed access to military nuclear sites
5. Weapon-origin fissile material
6. HEU in Naval-reactor fuel cycle

Precedents for verification exist in NPT safeguards in non-weapon states but some important difference.

1: Shutdown Facilities

Largest HEU and plutonium production facilities have been shut down or converted to non-weapons purposes for at least a decade.

Easy to verify that they have been disabled: Put seals on key equipment, remotely monitor key areas, and make periodic short onsite checks.

	End of Weapons Pu Prod	End of Military HEU Prod
China	1991	1987-89
France	1994	1996
India	*continuing*	*continuing*
Israel	*continuing?*	*?*
North Korea	*continuing*	*?*
Pakistan	*continuing*	*continuing*
Russia	1995	1987-88
United Kingdom	1989	1963
United States	1988	1992*

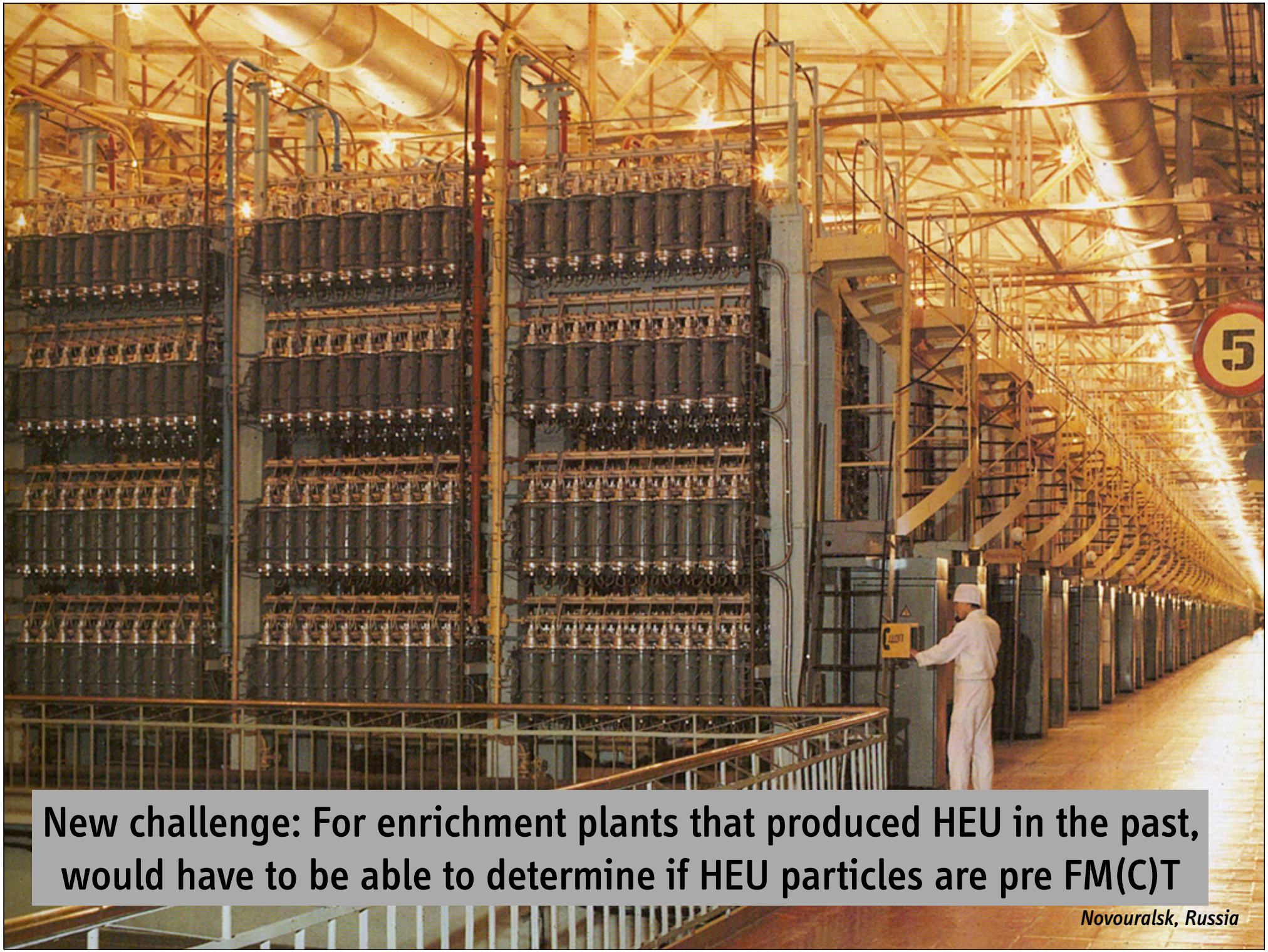
*1964 for weapons

2: Enrichment Plants

Many centrifuge enrichment facilities in weapon states already under or offered for international safeguards.

	Country	Facility	Safeguards Status	Capacity [tSWU/yr]
Non-weapon states	Brazil	Resende	Yes	120
	Germany	Gronau	Yes	4,500
	Iran	Natanz	Yes	250
	Japan	Rokkasho	Yes	1,050
	The Netherlands	Almelo	Yes	3,500
Weapon states	France	George Besse II	(Yes)	under construction
	U.K.	Capenhurst	Yes	4,000
	United States	Piketon, Ohio	offered	under construction
		Eunice, NM	offered	under construction
		Areva, Idaho	(offered)	under construction
	China	Shaanxi	(Yes)	1,000
		Lanzhou II	offered	500
	Russia	Angarsk II	(offered)	proposed
		Angarsk I Novouralsk Seversk Zelenogorsk	No	about 30,000
	India	Rattehalli	No	4-10
	Pakistan	Kahuta	No	15-20

*after planned expansions are complete



New challenge: For enrichment plants that produced HEU in the past, would have to be able to determine if HEU particles are pre FM(C)T

Novouralsk, Russia

3. Reprocessing Plants -- by far the most costly facilities to safeguard

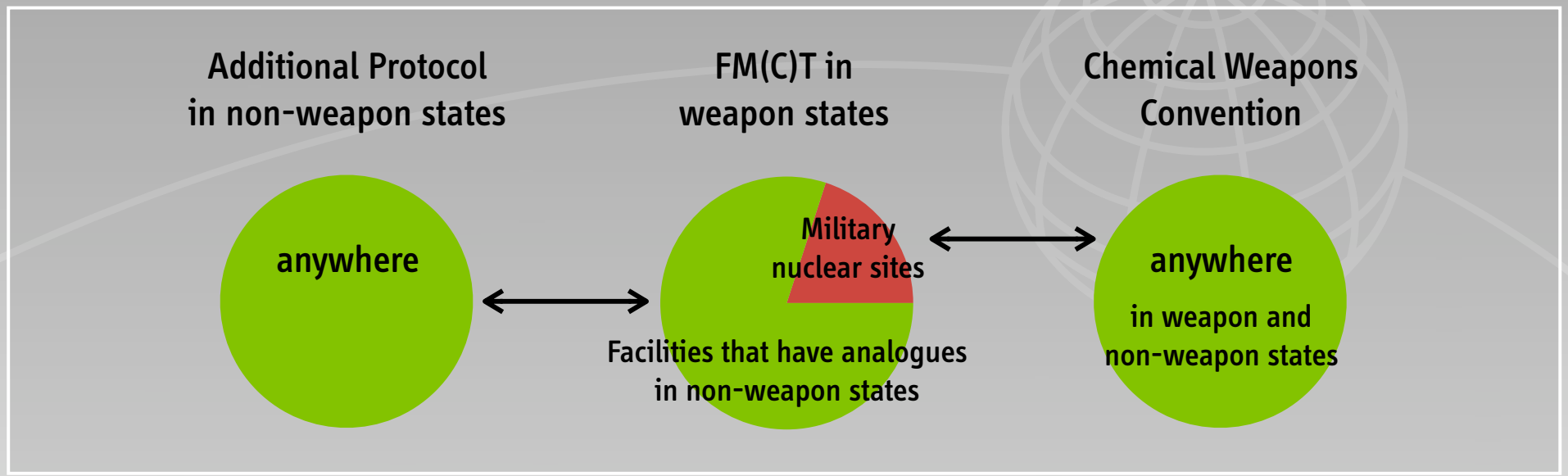
(Rokkasho, only full-scale reprocessing plant in a non-weapon state, under IAEA Safeguards)

Major producer of fissile material: 1000 weapon equivalents of plutonium will be separated each year.

Costly safeguards: Japan's two reprocessing plants absorb about 20% of the IAEA safeguards budget.

A modernized lower-cost approach for already operating plants in weapon states: Former IAEA expert who supervised the safeguards for Rokkasho has designed a system that would cost about 1/6 as much.

4. Challenge Inspections at Military Nuclear Sites: Managed Access Precedents



Issue is nuclear activities at nuclear sites.

Select sensors to reveal enrichment or reprocessing but not sensitive weapon or fuel-related information

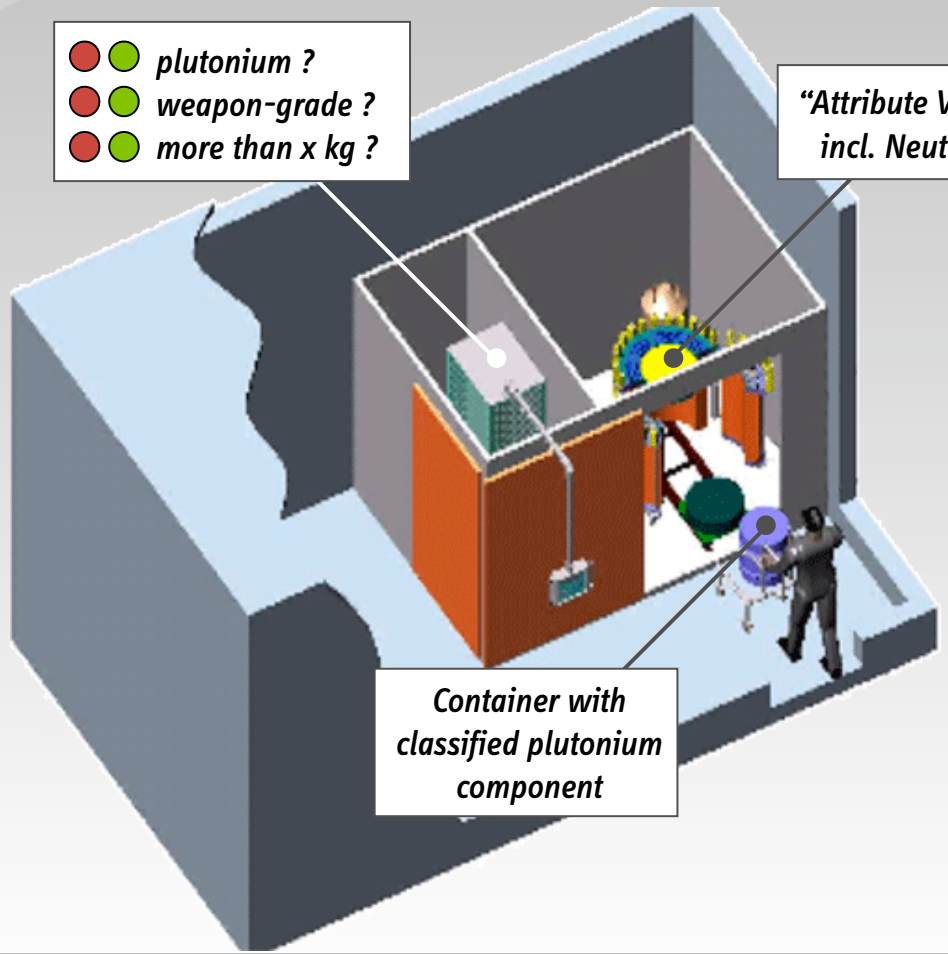
Managed access under the U.S.-IAEA Additional Protocol

Limited by a national-security exclusion but only Department of Defense invoked blanket exemption. U.S. Nuclear Regulatory Commission has required its licensees and Department of Energy many of its facilities to plan for IAEA managed access (list was published)

5. Non-Diversion of Material Declared Excess for Weapon Purposes

(while in classified form)

1996-2002 **Trilateral** (IAEA-Russia-US) **Initiative** developed approach to check that a container holds more than a threshold amount of **weapon-grade plutonium**

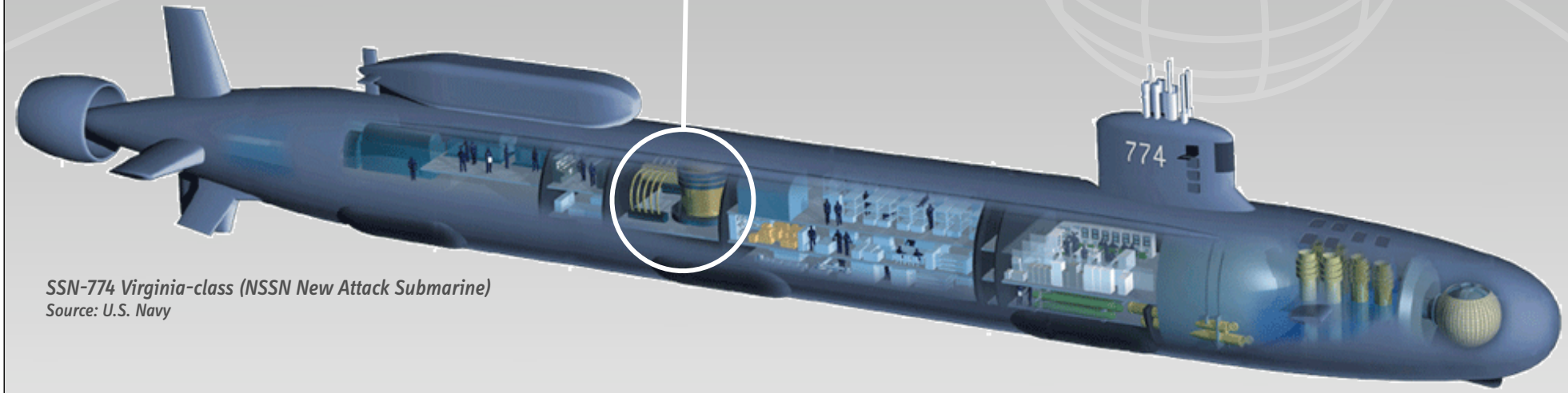


Results communicated by red or green lights through information barrier

IPFM is working on corresponding approach for HEU components

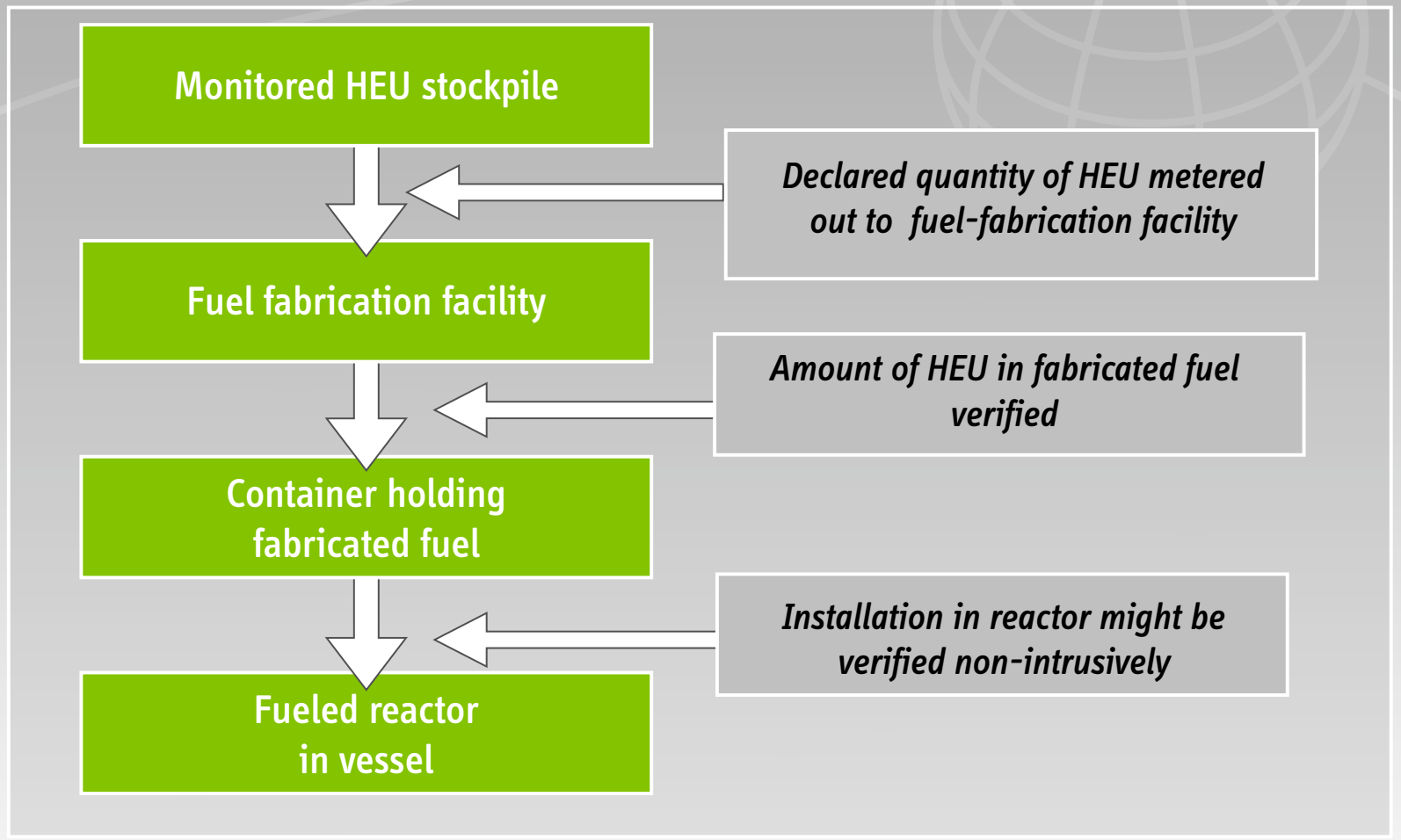
6. Non-diversion of **HEU in the Naval Fuel Cycle**

United States, Russia, United Kingdom and India all use HEU to fuel naval vessels
(mostly submarines; the U.S. and U.K. vessels are fueled with weapon-grade uranium)
France has switched to LEU (China unknown)



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

Tracking HEU in the naval-reactor fuel cycle



Overall Conclusions

1. The technical challenges of verifying an FM(C)T are significant
but probably not as difficult as
the political challenges of negotiating it

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

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