Verification challenges of a Fissile Material (Cutoff) Treaty

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Consortium for Verification Technology Kickoff Workshop
Campus Inn, University of Michigan, Ann Arbor
16 October 2014, 10:25 AM

National Nuclear Security Administration

Fissile Material (Cutoff) Treaty [FM(C)T]

The next multilateral nuclear arms control treaty.

Scope. FMCT would ban the production of HEU, separated plutonium, separated U-233 (Np-237 and Am-241/243…) *for weapons*.

An FM( )T would also place under safeguards some pre-existing fissile materials that have been declared excess for weapons use.

Negotiations were supposed to start at Conference on Disarmament in Geneva after completion of Comprehensive Test Ban Treaty in 1996.

But the 65 countries in CD have not been able to agree on an agenda. In recent years Pakistan has blocked a consensus because it wants:

i) To force India to reduce its stock of separated plutonium to the same level as Pakistan and

ii) The Nuclear Suppliers Group to treat Pakistan like India.

Currently, only substantive discussion of an FM(C)T is among a Group of Government Experts established by UN General Assembly under chairmanship of Canada (US has a member).

Commonalities and differences between the FM(C)T for weapon states and NPT for non-weapon states

Commonalities

- Safeguards on reprocessing facilities and any new separated plutonium, etc that they produce.
- Monitoring of enrichment facilities to assure either that they don't produce HEU or that any new HEU is safeguarded with special arrangements for HEU used for naval fuel.
- Surveillance for clandestine enrichment and reprocessing facilities.

Differences

- Weapon states have pre-existing fissile material outside the Treaty scope and in nuclear-weapon/naval-fuel-related facilities.
- Weapon states have pre-existing reprocessing and enrichment facilities not designed for safeguards – although most now shut down.

1. Nuclear-weapon-related facilities

Can we verify nonintrusively that e.g. Los Alamos' plutonium-pit-prod. facility does not contain a uranium-enrichment facility? Stand-off laser-induced breakdown spectroscopy to detect UF_2O_2 deposits?

LANL, Technical Area 55

J.E. Barefield II, S. M. Clegg, Loan A. Le, and Leon Lopez, "Development of Laser Induced Breakdown Spectroscopy Instrumentation for Safeguards Applications," LA-UR 10-05978

2. Nuclear-powered ships and submarines

Four nuclear-weapon states are known to use HEU fuel for naval propulsion.

Country	Nuclear ships	Naval fuel enrichment*
U.S.	11 aircraft carriers, 72 submarines	>90%
U.K.	10 submarines	Same as U.S.
Russia	4 cruisers, 29 submarines (+7 icebreakers)	21-90+%
India	1 submarine	30-45%?
China	14 submarines	< 20%?
France	1 aircraft carrier, 10 submarines	< 10% going down to 5%
Brazil	submarines under development	<20%
Total	**12 aircraft carriers, 136 submarines**	

U.S., U.K. and Russia will not need to produce additional HEU for naval reactor use for many decades but will eventually if they don't convert to LEU.

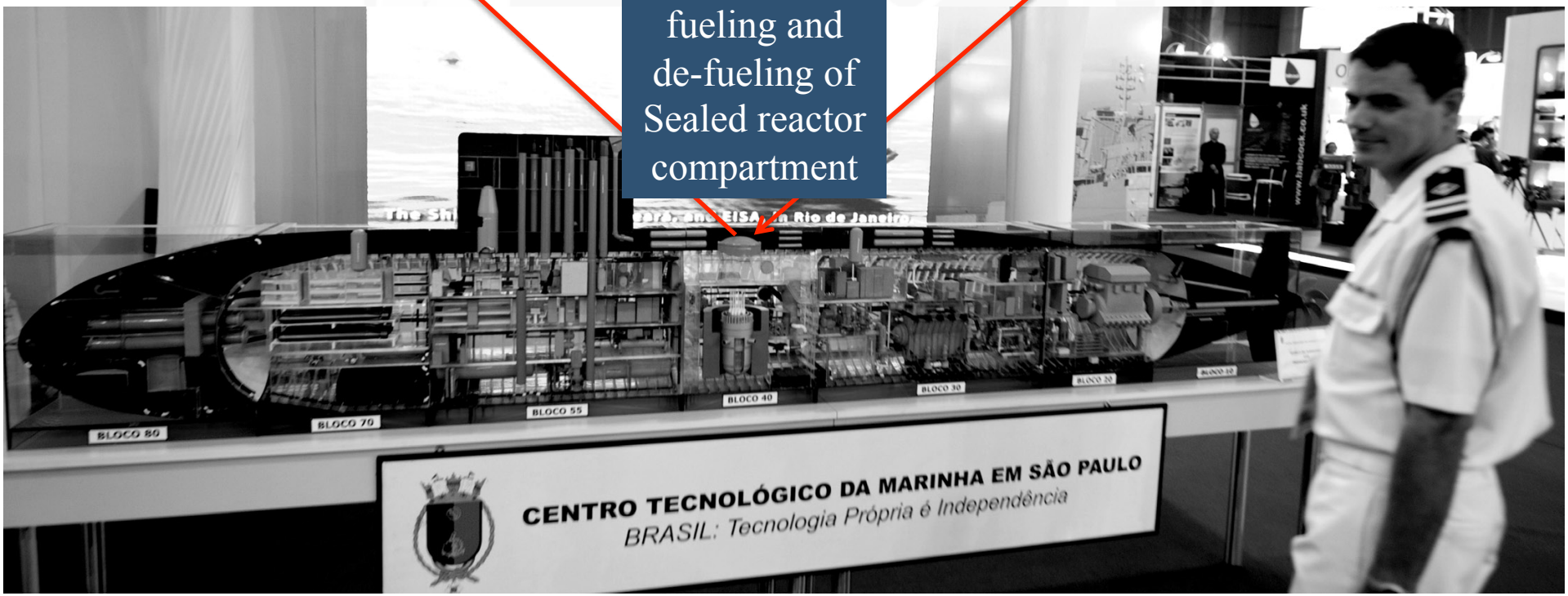
VERIFICATION TECHNOLOGY QUESTIONS

Naval fuel cycle: will need cooperation of nuclear navies to devise minimally intrusive approaches to international monitoring.

Enrichment plant (monitored) → HEU → HEU storage (monitored) → Fuel fabrication plant Surveillance & containment → Fuel storage (sealed containers)

Spent fuel storage (sealed containers) ← Check contents with information barrier? → Fuel storage (sealed containers)

Monitored fueling and de-fueling of Sealed reactor compartment

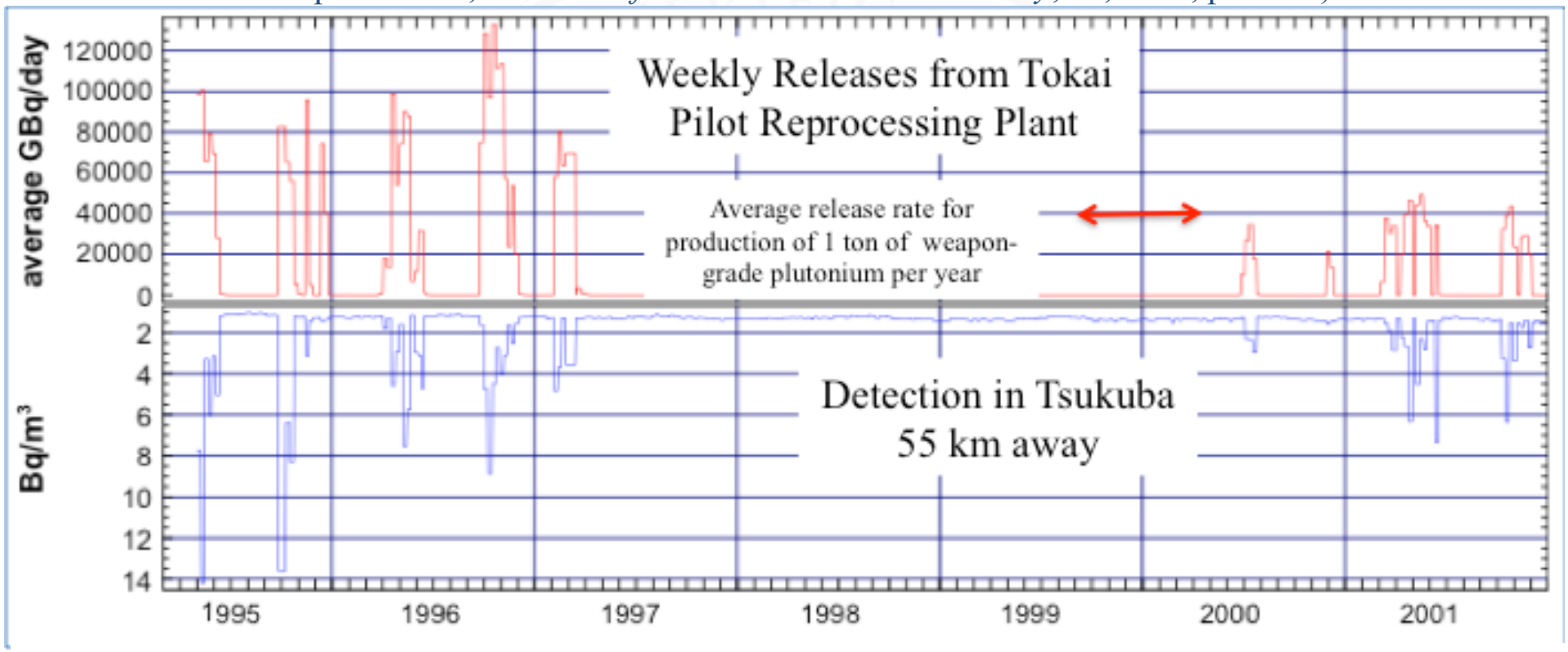


VERIFICATION TECHNOLOGY QUESTIONS

3. Detection of clandestine reprocessing through ^{85}Kr?

(~20-400 kg [5-100 warheads/yr] detection threshold for 20% best-worst days)

(R. Scott Kemp, "A performance estimate for the detection of undeclared nuclear-fuel reprocessing by atmospheric ^{85}Kr," *Journal of Environmental Radioactivity*, 99, 2008, p. 1341.)



But ^{85}Kr could be removed from the released gases. Also accumulation of other released radioisotopes in environment around reprocessing plant: ^{14}C, ^{3}H, ^{129}I, ^{106}Ru.

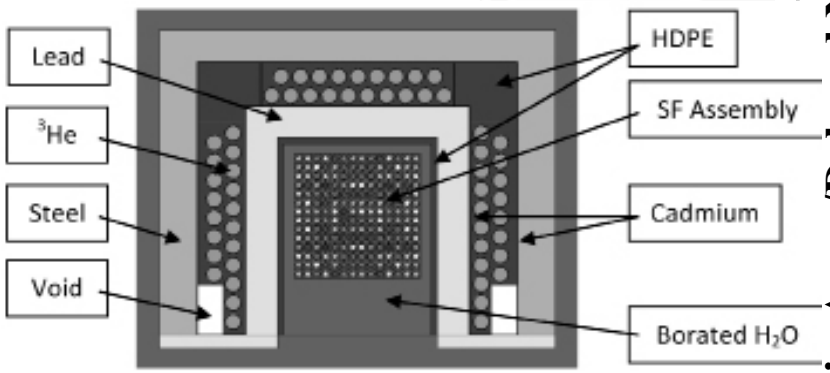
4. ***How to detect clandestine uranium enrichment?***

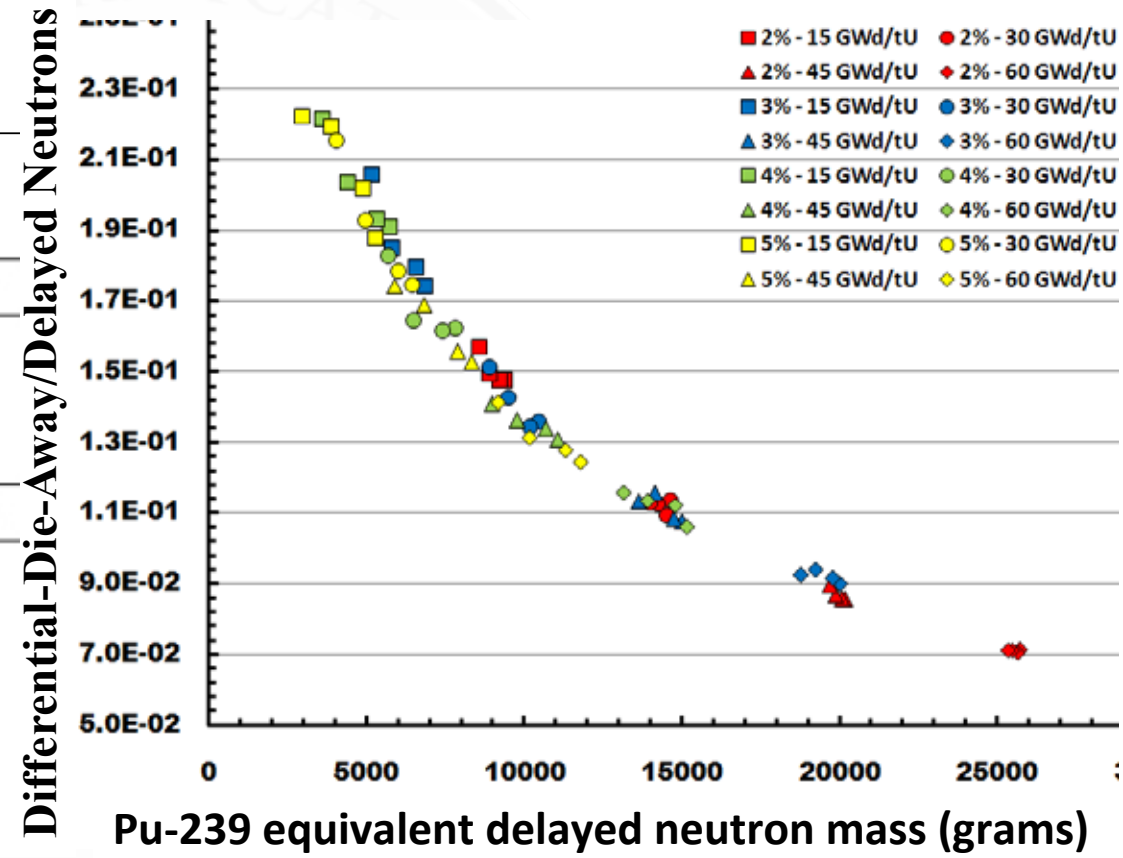
VERIFICATION TECHNOLOGY QUESTIONS

5. Balancing Pu input and output of reprocessing plant

Input is spent fuel. NNSA Next Generation Safeguards Initiative's Spent Fuel Nondestructive Assay Project (2009-2014)

ure 3. Cross-sectional view of the new DDSI design





Anthony Belian, Howard O. Menlove, Martyn T. Swinhoe, and Stephen J. Tobin, "New Design of the Differential Die-away Self-interrogation Instrument for Spent Fuel Assay" *Journal of Nuclear Materials Management*, Spring 2012; Marc Humphrey, NNSA, "Nondestructive Assay of Spent Fuel for International Safeguards," 16 January 2013.

Summary

FM(C)T verification offers opportunities for research in a number of technical areas, including:

- Laser-induced breakdown spectroscopy for non-intrusive confirmation that sensitive nuclear facilities do not contain enrichment plants (test at Los Alamos?);
- Non-intrusive arrangements for monitoring HEU use in naval fuel cycles (work with Office of Naval Reactors?);
- Atmospheric detection of gases and aerosols released by enrichment (tests at Piketon enrichment cascade?) and reprocessing plants (tests at Savannah River H canyon?); and
- Improved safeguards for reprocessing plants.