US Nuclear Cooperation and Nonproliferation

A briefing for the Senate Foreign Relations Committee

By Henry Sokolski
The Nonproliferation Policy Education Center

www.npolicy.org

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123 basics

1. 123 agreements refers to Section 123 of the Atomic Energy Act (AEA) that authorizes US civilian nuclear cooperative agreements with other states.

2. There are two kinds of agreements:
   a) Those that meet all 9 of the key nonproliferation criteria
   b) Those that do not
9 nonproliferation criteria required by section 123 agreements

1. Safeguards on transferred nuclear material and equipment continue in perpetuity.
2. IAEA comprehensive safeguards are applied in nonnuclear weapon states (NWS).
3. Nothing transferred is used for any nuclear explosive devise or other military purpose.
4. If a NWS partner detonates a nuclear explosive device using produced nuclear material or violates an IAEA safeguards agreement, the US has a right to demand the return of transfers.
5. US consent for all re-transfers of material or classified data.
6. Physical security on nuclear material is maintained.
7. Prior approval by the US for enriching or reprocessing material received in or produced from the transfer.
8. Storage for transferred plutonium and HEU is approved in advance by the US.
9. Any material or facility produced or constructed through use of special nuclear technology transferred under the agreement is subject to all the above requirements.
Additional criteria that have been proposed

- Recipient maintains all safeguards on their nuclear program in perpetuity (former IAEA safeguards DDG).
- Agreement requires Congressional reauthorization.
- Agreement contains pledge from non-weapons partner not to reprocess or enrich in domestic law, not to acquire the means to produce heavy water, and to ratify the Additional Protocol (H.R. 3766).
- Contains consent rights over the reprocessing of any nuclear material generated from a reactor containing any US nuclear trigger list components either made in the US or containing US-embedded technology. Also contains consent rights over the retransfer of such components.
123 agreement process limits Congressional role severely for compliant agreements

1 Diplomatic negotiation (law requires Congress to be kept informed at some level)
2 Initialing of the agreement
3 President’s signature
4 President submits text of proposed agreement & required support docs, including unclassified NPAS, to HFAC and SFRC.
   President consults with committees for no less than **30 days** (continuous session).
5 President submits agreement to Congress (along with classified annex to the NPAS, statement of approval with national security determination, & letters of support from Sec. of State & NRC).
60-day Congressional review period begins.
Timeline for making a 123 Agreement (cont.)

Non-exempted agreement:
Agreement enters into force at the end of the 60-day period, unless Congress adopts a joint resolution disapproving the agreement and the resolution becomes law.

Exempted agreements:
Congress must adopt a joint resolution of approval and it must become law before the end of the 60-day period or the agreement may not enter into force.

Non-exempted (in compliance):
The agreement meets all 9 AEA requirements.

Exempted (not in compliance):
The President may exempt an agreement from any of the 9 AEA requirements if he determines the export or exemption is not “inimical to the common defense and security.”
Questions

1. Do US 123 nuclear cooperative agreements deserve Congressional attention? If so, why?

2. What, if anything, does civil nuclear cooperation and the history of proliferation suggest Congress should focus on?

3. What's coming relating to civil nuclear cooperation that Congress will have to address?
Industry claims tighter US export rules weaken US leverage over nonproliferation standards

- US declining nuclear export market share reduces ability to influence world nonproliferation rules.

- Tighter Hill nonproliferation review & conditions on US nuclear exports will ward off customers and jeopardize US-based nuclear firms share of up to $740 B in exports at 5-10 K jobs/$B.

- Industry conclusion: “Don’t mess with 123 agreements.”

- But biggest “US nuclear exporters” are American in name only
Westinghouse: US-headquartered but entirely foreign-owned

- **87%**
  - Toshiba
  - Kazatomprom
  - Ishikawajima-Harima Heavy Industries

- **3%**

- **10%**
Proceeds of 80% US "GE" Exports Go to Japan

US "GE" domestic sales

- GE: 60%
- Hitachi: 40%

US "GE" Export sales

- Hitachi: 80%
- GE: 20%
Foreign entities own URENCO USA*

*Louisiana Energy Services operates the American plant in New Mexico for URENCO. URENCO USA is a marketing subsidiary of URENCO.
Moreover, 123-controlled US nuclear exports are few

- Last US reactor export was over 7 years ago
- US share global n. fuel market declined from 33% in '94 to less than 10% today (NEI). Fuel >80% of US n. exports (GAO).
- Coolant pump & n. valve exports to world's largest market – PRC – are now under PRC assault (Dow Jones, Dec. 16, 2014)
- All US nuclear exports <4% of US nuclear revenues, reactor exports<1% (NRC license info, NEI, GAO)
- Westinghouse business plan suggests future PRC, Korea interest in transfers of technology rather than equipment, as is the case with sales to France and Japan
Why, then, are US-headquartered n. firms so opposed to the Hill conditioning 123s?

- Reason has far less to do with gain or loss of "US" jobs or exports

- More with reducing uncertainties concerning the:
  1. Transfer of US-origin nuclear reactor design information critical to other countries' (e.g., Japan, Korea, PRC) manufacture and retransfer of nuclear components to 3rd to other states, (e.g., Vietnam, UAE, Turkey, etc)
  2. Transfer of US-origin nuclear materials (e.g., yellowcake and LEU fuels) and their subsequent enrichment or reprocessing overseas (e.g., in China, RoK, Japan, etc.)
Recipients of n. components embedded with US tech must have US consent to reexport

Toshiba-built reactor using parts with US-imbedded nuclear technology

Vietnam

Toshiba-made reactor items of US design

Japan

US reactor design info

USA
US 123 cooperation recipients also need US consent to reprocess or enrich US-origin n. materials or n. materials made in "US" reactors

- US uranium fuel products (yellowcake, UF6, U08, LEU in any form) used as feed for uranium fuel production overseas

- US uranium fuel products (yellowcake, UF6, U08, LEU in any form) irradiated in any foreign reactor for subsequent reprocessing

- Plutonium generated in US-exported reactors, in reactors that have licensed US components in them, or in reactors that components that have "embedded" US technology in them
Example: China

- CAP-1400
- AP 1000 reactors, US coolant pumps
- Reprocessing, enrichment plants

AP 1000 reactors, design info, coolant pumps, U yellowcake, LEU fuel
Takeaway: The US still has leverage

- PRC can't complete AP 1000 without more US cooperation, reprocess any plutonium generated in AP 1000 reactors (CAP 1400s ?) without US consent
- Japan, PRC and RoK can't reexport any reactor items embedded with US tech without US consent
- Russian and French nuclear exports may not do well without PRC, RoK and Japanese help
What does history suggest the US should do with the leverage it still has?

- **1946**: *Atomic Energy Act of 1946 (McMahan Act)* Congress all but blocks "civilian" nuclear sharing reflecting the Baruch Plan.

- **1954**: *Atomic Energy Act of 1954*, Congress delegates its power over commerce to the executive branch to expedite small research reactor exports in support of Ike's Atoms for Peace Program

- **1957**: *International Atomic Energy Agency (IAEA)* created US begins nuclear cooperation related to power reactors, particularly with India, Japan, and Europe

- **1974-78**: *India test "peaceful" bomb*; RoK, Pakistan, Taiwan try to make bombs from "peaceful" programs as well but are blocked

Key nonproliferation legislation & developments (continued)

- **1985:** Congress conditions US-PRC deal, delaying it 13 years
- **1991-97:** *Revelations Iraq broke IAEA rules & was within 1-2 years of acquiring a bomb lead to Additional Protocol*
- **1992:** NSG adopts US NNPA controls over dual use nuclear items
- **1992-2006:** *DPRK violates safeguards, then the Agreed Framework, US LWR aid ended as "too risky," DPRK tests first nuclear weapon*
- **2003-2007:** Libya caught violating NPT, Syrian covert reactor bombed
- **2002-Present:** *Iran asserts right to enrich*, LWR is allowed, Iran gets within 2 months of getting fissile material for 1st bomb
- **2008:** *House & Senate affirm US India nuclear deal*
- **2009-14:** *US-UAE nuclear deal* sets new nonproliferation "gold standard" for 123s, Taiwan follows; Vietnam does not
Takeaway: Congress has both authority & cause to increase its review of 123s

- After a series of proliferation events, Hill tightened conditions in 1978 over what 123s require joint resolution
- NSG followed US lead, adopted n. referral list controls in '92
- Iraq's, Iran's, Syria's, North Korea's, and Libya's pursuit of bomb options with reprocessing & enrichment despite IAEA safeguards suggests the need to tighten nuclear rules further
- More needs to be done to get nuclear supplier states to discourage customers from reprocessing and enriching
Joinder: We don't need more protections; IAEA safeguards are good enough

- No bombs yet made from light water power reactors
- We have learned from past failures
- Additional Protocol allows for more intrusive inspections
- And yet...
IAEA estimates of significant quantities (SQ) of fissile materials are egregiously generous

<table>
<thead>
<tr>
<th>Kilo grams (kg)</th>
<th>HEU</th>
<th>Pu</th>
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<tbody>
<tr>
<td>IAEA</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>DOE</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>NRDC, IPFM</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>(low tech, 20 kt)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(med. tech, 20 kt)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(high tech, 1 kt)</td>
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IAEA conversion times: Too often, far shorter than IAEA detection goals.
Power reactor fuel, a worry
(Hubbard)

![Bar chart showing estimated yield in kilotons (kt) for different technologies: 1945 Tech, 1950 Tech, 1970 Tech. The chart compares weapons grade fuel (6% 240 Pu content) and one-cycle LWR Pu (14% Pu 240 content).]
2015-16: What's coming?

- Iran deal: How verifiable will it be? How safeguardable?
- US-RoK deal: Will it support or undermine US efforts to repress the global spread of enrichment and reprocessing?
- PRC deal: Will China be able to reprocess plutonium from "US" reactors; will it follow other n. powers & allow IAEA safeguards on civil plants; what US tech may China replicated or retransfer without US consent?
- Will Japan start up Rokkasho; will the US stay silent?
- Will Saudis push for a 123 that differs from UAE's 123?
Kirk-Menendez Iran Bill on verification

- Current bill asks if IC can find covert facilities

- Possible draft amendment also asks IC how well it thinks IAEA can detect and safeguard against military diversions from declared facilities
ROK wants to breed and recycle Pu-based fuels using US-origin materials and tech.
If China recycles plutonium, it could amass a large stockpile of weapons-useable plutonium.
How much plutonium could American reactors generate in China per year?

- 4 kg Pu assumed per bomb based on DOE estimate.
- 250 kg reactor-grade Pu conservatively assumed per reactor year.
- 150 kg weapons-grade Pu conservatively assumed per reactor year (see page 64, http://fsi.stanford.edu/sites/default/files/VAF-June.pdf)
Proposed EnR legislation

- H.R. 3766 would require
  1. Joint res. approval of EnR of US-origin materials that were generated in "US" plants for states that don't already enjoy programmatic approvals for subsequent arrangements
  2. This would capture PRC unless renegotiated deal clearly gave generic approval. If so, the 123 could be noncompliant

- Corker amendment of Summer 2014 and H.R. 3766 would:
  1. Effectively add 10th requirement in AEA that any 123 with a non-weapons state that failed to forswear enrichment and reprocessing would require a joint res. of approval
  2. Would not preclude noncompliant agreements but push State to drop case-by-case approach to promoting Gold Standard with both customers and, more important, other nuclear supplier states
1985 objections to original US-PRC deal

- Included concerns that language on subsequent arrangements was inadequate.
- Concerns also raised that agreement lacked language obligating PRC to allow IAEA safeguards over its civilian program as other nuclear weapons states have allowed.
- These concerns may be worth reviewing again.
Will Rokkasho open in 2016?

Figure 2. Japan’s stockpile of separated plutonium grew in the 1990s due primarily to separation in Europe and the failure of the fast breeder reactor and MOX programs in Japan. In the late 2000s, test separation began at the RRP but then halted because of an inability to solidify the liquid high-level waste. The current plan is to start commercial operations in 2014. If this plan is carried out and MOX use is delayed, Japan’s total stockpile could rise to 100 tons by 2022.
Additional issues

- Congressional reauthorization of 123s
- Legal possibility of states receiving US nuclear cooperation to take other non-US facilities out of IAEA safeguards
- Lack of clarity over consent rights regarding US-origin nuclear materials being reprocessed or enriched because of confusion as to what a "US" reactor or nuclear facility consists of
123 Agreements that do not require Congressional reauthorization

- Australia
- Canada
- Euratom
- Japan
- India
- Morocco
- Switzerland
- Taiwan
- Turkey
- Vietnam
Additional Slides
E. Asian U Enrichment Capacity

Operational and Planned Enrichment Capacity (Thousand SWU/year)

- **China**: 8 million SWU (2020) and 1.5 million SWU (2014)
- **Japan**: 1.05 million SWU (2020)
- **North Korea**: 8,000 SWU (2020)

- 232 SWU required to make 1 kg HEU
- 120,000 SWU required to refuel 1-GWe reactor with LEU annually
World enrichment capacity: Supply vs. Demand

US NRC Part 110 nuclear trigger list items require an NRC export license and a 123

a. Reactor items especially significant for nuclear explosive purposes:

1) Reactor pressure vessels, i.e., metal vessels, as complete units or major shop-fabricated parts, especially designed or prepared to contain the core of a nuclear reactor and capable of withstanding the operating pressure of the primary coolant.

2) On-line (e.g., CANDU) reactor fuel charging and discharging machines, i.e., manipulative equipment especially designed for inserting or removing fuel in an operating nuclear reactor.

3) Complete reactor control rod system, i.e., rods especially designed or prepared for the control of the reaction rate in a nuclear reactor, including the neutron absorbing part and the support or suspension structures therefor.

4) Reactor primary coolant pumps or circulators, i.e., pumps or circulators especially designed or prepared for circulating the primary coolant in a nuclear reactor.

5) Reactor pressure tubes, i.e., tubes especially designed or prepared to contain fuel elements and the primary coolant in a nuclear reactor.

6) Zirconium tubes, i.e., zirconium metal and alloys in the form of tubes or assemblies of tubes especially designed or prepared for use as fuel cladding in a nuclear reactor.

7) Reactor internals, e.g., core support structures, control and rod guide tubes, fuel channels, calandria tubes, thermal shields, baffles, core grid plates, and diffuser plates especially designed or prepared for use in a nuclear reactor.

8) Reactor control rod drive mechanisms, including detection and measuring equipment to determine neutron flux levels within the core of a nuclear reactor.

9) Heat exchangers, e.g., steam generators especially designed or prepared for the primary, or intermediate, coolant circuit of a nuclear reactor or heat exchangers especially designed or prepared for use in the primary coolant circuit of a nuclear reactor.

10) External thermal shields especially designed or prepared for use in a nuclear reactor for reduction of heat loss and also for containment vessel protection.

11) Any other components especially designed or prepared for use in a nuclear reactor or in any of the components described in the appendix.

b. Other n. materials and Items especially "significant" on trigger list:

- Nuclear fuels and feed stocks,
- Nuclear enrichment, reprocessing and fabrication and heavy water production plants and related components
### Recommended timeliness detection goals

<table>
<thead>
<tr>
<th>Material</th>
<th>IAEA Conversion Time</th>
<th>NRDC/NPEC Commissioned Estimate</th>
<th>Official IAEA Timeliness Detection Goal</th>
<th>NPEC Conclusions and Recommended Timeliness Detection Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu, HEU, $^{233}$U in metal form</td>
<td>Order of days (7-10)</td>
<td>Order of days (7-10)</td>
<td>1 month</td>
<td>Timely detection is not possible</td>
</tr>
<tr>
<td>In fresh MOX</td>
<td>Order of weeks (1-3)</td>
<td>Order of days (7-10)</td>
<td>1 month</td>
<td>Timely detection is not possible</td>
</tr>
<tr>
<td>In irradiated spent fuel</td>
<td>Order of months (1-3)</td>
<td>Order of months (1-3), if reprocessing - enrichment plant on tap (7-10 days)</td>
<td>3 months</td>
<td>For countries with covert or declared nuclear fuel making plants, timely detection is not possible</td>
</tr>
<tr>
<td>Low enriched uranium</td>
<td>Order of months (3-12)</td>
<td>Order of weeks to months</td>
<td>1 year</td>
<td>For countries with covert or declared enrichment plants, timely detection is not possible</td>
</tr>
</tbody>
</table>