Lecture 1.4  Fissile materials and associated risks. Transport safety and security

Dr. Alexey Ubeev

Dual Master’s Degree Program in Nonproliferation Studies
Moscow, Fall 2019
Fissile materials and associated risks

“Cut-off” treaty as a possible solution for safe and secure management of fissile materials

HEU-LEU Agreement and PMDA Agreement

Multilateral approaches to the NFC as a possible deterrent for nuclear proliferation

Transport safety and security of radioactive materials
Fissile materials stockpile

As of January 2015, the global stockpile of highly enriched uranium (HEU) is estimated to be about 1370 ± 125 tons. The global stockpile of separated plutonium is about 500 tons, of which about 270 tons is the material in civilian custody.

<table>
<thead>
<tr>
<th>Country</th>
<th>HEU, tons</th>
<th>Military Pu, tons</th>
<th>Civilian Pu, tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>679</td>
<td>128</td>
<td>52.8</td>
</tr>
<tr>
<td>United States</td>
<td>599</td>
<td>87.6</td>
<td>0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>21.2</td>
<td>3.2</td>
<td>103.3</td>
</tr>
<tr>
<td>France</td>
<td>30.6</td>
<td>6</td>
<td>61.9</td>
</tr>
<tr>
<td>China</td>
<td>18</td>
<td>1.8</td>
<td>0.025</td>
</tr>
<tr>
<td>Pakistan</td>
<td>3.1</td>
<td>0.19</td>
<td>0</td>
</tr>
<tr>
<td>India</td>
<td>3.2</td>
<td>5.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Israel</td>
<td>0.3</td>
<td>0.86</td>
<td>-</td>
</tr>
<tr>
<td>North Korea</td>
<td>0</td>
<td>0.03</td>
<td>-</td>
</tr>
<tr>
<td>Others</td>
<td>15</td>
<td>-</td>
<td>52.8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1369</td>
<td>234</td>
<td>271</td>
</tr>
</tbody>
</table>

(International Panel of Fissile Materials, IPFM data)
Fissile materials overview

- France, Russia, the United Kingdom, Japan, and India operate civilian reprocessing facilities that separate plutonium from spent fuel of power reactors. China is operating a pilot civilian reprocessing facility.

- Twelve countries - Russia, the United States, France, the United Kingdom, Germany, the Netherlands (all three are in the URENCO consortium), Japan, Argentina, Brazil, India, Pakistan, and Iran - operate uranium enrichment facilities. North Korea is also believed to have an operational uranium enrichment plant.

- Production of military fissile materials continues in India, which is producing plutonium and HEU for naval propulsion, Pakistan, which produces plutonium and HEU for weapons, Israel, which is believed to produce plutonium. North Korea has the capability to produce weapon-grade plutonium and highly-enriched uranium. (IPFM)
Fissile material “Cut-off” Treaty: reality or dreams?

“Cut-off” treaty pertaining to fissile material could obligate states to halt the production of nuclear weapons grade material and could also lead to the management or even reduction of existing stocks.

Such a treaty would have four general benefits:

➢ Assist in efforts to curb nuclear proliferation by preventing the production of new stocks for nuclear warheads; thereby limiting the potential for future nuclear arms races.
➢ Aid the global disarmament agenda, especially if a treaty were to address existing stocks.
➢ Reduce the likelihood of terrorists acquiring fissile material by improving controls, and limiting and diminishing availability.
➢ Strengthen non-proliferation norms, and reinforce reliance on using legal structures to manage international insecurities.
In 1993 the U.N. General Assembly agreed Resolution 48/75L and formally defined an FM(C)T as the “Prohibition of the production of fissile material for nuclear weapons or other nuclear explosive devices.” It also recommended: “The negotiation in the most appropriate international forum of a non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices”.

Responsibility for expediting the General Assembly’s resolution was given to the U.N. Conference on Disarmament (CD), the United Nations’ negotiating body on disarmament matters, which requires consensus among its members on both procedure and substance.

**Substantive issues for possible agreement:**
- Definitions of fissile material and production
- Scope of obligations
- Verification of compliance
- Methods of funding activities
HEU-LEU Agreement

- Rus-US Gov to Gov Agreement Signed in Washington on February 18, 1993 for 20 years
- Dismantled ~ 20,000 nuclear warheads
- Processed ~ 500 tons of HEU enriched to not less than 90% U235
- Downblended with feed component into LEU and supplied to the US with the U235 of 3.2-4.95%; ~ 14,000 tons of LEU
- Since 2000, the deliveries of Russian LEU fulfilled ~50% of the annual needs of US NPPs
- Electricity annually generated by US NPPs with the nuclear fuel produced from Russian LEU has been ~10% of the US total electricity
- This amount would be enough to keep illuminated Washington for ~185 years
The aggregate revenue of the Russian side has reached USD 17 billion

Source: TENEX
US-Russia PMDA Agreement

- Signed in 2000, stipulated that most of both countries’ excess plutonium (34 metric tons) would be used to fabricate MOX fuel, which would be irradiated in existing light-water reactors.
- In 2010, the agreement was amended to change the agreed disposition methods. Russia abandoned the option of using MOX in light-water reactors, which it never liked, and would now irradiate plutonium in its fast-neutron reactors, BN-600 and BN-800. The reactors are part of Russia’s ambitious plan to expand the use of plutonium in its nuclear power industry. The United States decided not to pursue the immobilization option, fully committing itself to the MOX route.
- 3 October 2016 Russia suspended PMDA implementation
- IAEA-US-Russia Trilateral Initiative for verification of excess military—origin fissile materials wasn’t implemented, but created a technical options.
Why multilateral approaches to the NFC?

✓ Significant increase of nuclear material and facilities worldwide

✓ High initial capital costs for construction of nuclear facility can be difficult to finance by individual company or State

✓ Instability in some regions has resulted in rise of political security risks

✓ Possibility of “break out” from the NPT by non-nuclear-weapon States (NNWS) with advanced nuclear fuel cycle technology and/or stocks of enriched uranium or separated plutonium – intentions cannot be verified

✓ Increased threat of nuclear and/or radiological terrorism

✓ Rise of clandestine nuclear supply networks – individuals and entities in nearly 40 countries
Two factors dominate all assessments of MNA:

- Assurance of supply and services – measured by the associated incentives (e.g. supplier guarantees); the economic benefits that would be gained by participating countries; and better political and public acceptance for such projects

- Assurance of non-proliferation – measured by the various proliferation risks associated with a nuclear facility, whether national or multilateral

Activities and facilities of NFC involving significant proliferation risks:

- Uranium enrichment
- Spent fuel reprocessing
- Spent fuel repositories (final disposal)
- Spent fuel storage (intermediate)
✓ Multinational ownership of enrichment and reprocessing facilities is already happening in some respects, led by reactor vendors and generating utilities. Urenco and Eurodif are government-owned (not essentially private) multinational enterprises.

✓ GNEP envisages the development of comprehensive fuel services, including such options as fuel leasing, to address the challenges of assuring reliable fuel supply while minimizing the need for enrichment plants in new countries. (2006)

✓ The International Uranium Enrichment Centre at Angarsk (Russia) is already a Russian-Kazakh – Armenian- Ukrainian enterprise with equity interest from other countries (2007)

✓ Six countries with commercial uranium enrichment activities – France, Germany, Netherlands, Russian Federation, UK and US tabled a proposal to offer ‘reliable access’ to nuclear fuel to States opting to rely on the international market for nuclear fuel and not to have domestic enrichment activities (2006)

✓ IAEA LEU-Bank in Kazakhstan (2015), opening in August 2017
Transport (of radioactive material) is the deliberate physical movement by a conveyance of radioactive material (other than that forming part of the means of propulsion) from one place to another, outside of a controlled facility; and shall include temporary, in-transit stops and storage.

Safety is the achievement of proper operating conditions, prevention of accidents or mitigation of accident-related consequences for radioactive materials in transport.

Security is the prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, radioactive sources, and other radioactive substances for radioactive materials in transport.
Safety is first achieved by requiring that the consignor properly:

- classifies the material to be transported (radionuclides, activity, etc.)
- selects the appropriate package type and design for the material
- prepares the package for transport including marking, labelling, shipping documentation, etc.

Safety is then achieved during transport through simple but effective operational controls performed by the carrier.
**Why transport security is treated separately?**

- A dedicated and unique approach to security during transport of nuclear and other radioactive material during transport is needed.
- The security challenges during transport are unique.

**The approach is different from activities in facilities**

- Security during transport and temporary storage is one of the most complex aspects of radioactive material control:
  - occurs in the public domain
  - may involve multiple national authorities
  - may involve multiple operators
  - involves multiple security interfaces that must function seamlessly to ensure continuous and adequate security.
Transport Background

Nuclear Material
- CPPNM
- Amendment to CPPNM
- NSS-13
- NSS-14

Radioactive Sources
- Code of Conduct
- Guidance Import/Export
- NSS-09
- NSS-14

Radioactive Material
- NSS-09
- NSS-14
- UN Model Regulations
Transport Background

Consignment = \(\sum\) packages

Shipment = Consignment’s Movement

Consignor / Shipper  +  RADIOACTIVE CONTENT  =  Carrier  +  Consignee / Receiver

Departure  In transit  Arrival
Annex I specifies appropriate protection levels during international transport following a graded approach.

- **For Category II and III materials**, transport under special precautions including:
  - prior arrangements among sender, receiver, and carrier
  - prior agreement between natural or legal persons specifying time, place and procedures for transferring transport responsibility

- **For Category I materials**, transport under special precautions for Category II and III materials, and in addition:
  - under constant surveillance by escorts
  - under conditions which assure close communication with appropriate response forces

For natural uranium other than in the form of ore or ore-residue, for quantities exceeding 500 kg uranium, protection shall include:

- advance notification of shipment specifying (mode of transport; expected time of arrival; confirmation of receipt of shipment)
A Regulatory framework for Transport Security

Class 7 Radioactive Material

Mode specific

All 9 Classes
All modes

NSS-13
(through CPPNM)

NSS-14
(NSS-09, NSS-11)

All modes

All 9 Classes
One mode (Land; Air; Sea)

National Law

National Law
Summary:

✓ Significant quantities of HEU and separated Pu create relevant proliferation risks
✓ Conclusion of FM “Cut-off” Treaty might be an essential input to curb nuclear proliferation
✓ RUS-USA HEU-LEU and PMDA Agreements are/were (?) real efforts to nuclear nonproliferation and disarmament
✓ Multilateral Nuclear Approaches to NFC assist in achieving the nonproliferation goals
✓ The security challenges during transport of radioactive materials are unique and merit appropriate measures and regulation
Thank you for your attention!
Questions?