NON- PROLIFERATION PROBLEMS IN CENTRAL ASIA: PREVENTING NUCLEAR AND RADIOACTIVE MATERIAL TRAFFICKING

by

BEKHZOD YULDASHEV [*)]

International Atomic Energy Agency, Vienna, Austria

ABSTRACT

Based on practical experience obtained in Uzbekistan we propose to create a joint regional system in preventing nuclear and radioactive material illicit trafficking in five Central Asian countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

[*)] On leave of absence from Institute of Nuclear Physics, Tashkent, Uzbekistan

E-mail: b.yuldashev@iaea.org or yuldbekh@gmail.com

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1. INTRODUCTION.

1.1 Historical Background

Central Asia consists of the five former Soviet republics and now independent countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. The Central Asian region lies between the strategically important countries of Russia, China, Afghanistan, Iran, Azerbaijan, Armenia, and Georgia. This geographic location lies at the cross-roads of many political, cultural, and technological events in human history. For instance, the archeological evidence suggests that the Central Asian region established close trade and cultural relations with China and Mesopotamia more than three thousand years ago. Moreover, due to its rich mineral and human resources, favorable climate and irrigation system, the Central Asian region represented vital commercial and communications link between the East and the West known as "The Silk Road". The Central Asian region exemplified how diverse cultures as well as religions (Zoroastrianism, Buddhism, Islam and early Christianity) could develop and co-exist peacefully. Central Asia, however, due to its rich endowments also suffered many invasions among which the invasions of Cyrus the Great, Alexander the Great, the Arabian and Mongolian invasions led by Al-Qutayba and Jenghis Khan, respectively.

1.2 Importance in Modern Times

Central Asia still remains a very important geopolitical region nowadays. In addition to its strategic geographical location, the Central Asian region possesses vast reserves of oil, gas, gold, non-ferrous metals (including such strategic mineral as uranium) and intellectual resources, almost 100% literacy. All these continue to make Central Asia very attractive for investors and political activity.

There are two major concerns crucial for the whole region: political stability and security. The last one requires consideration of such important issues as economic development, regional relations, trade, environmental, energy and water problems, climate change, communications, demography, terrorism, and others.

Since the collapse of the Soviet Union in 1990's, the Central Asian states have signed several regional and intergovernmental treaties and agreements that should promote and support security of the region. However, the neighborhood with instable countries like Afghanistan and Pakistan, the rise of Muslim extremism and Islamic radicalism supported by some neighboring countries, the nuclear ambitions of countries like India, Pakistan and Iran as well as the struggle for oil and gas pipelines, make the stability of Central Asia very fragile.

1.3 The Potential Nuclear Threat

Three factors place Central Asia in a key global nonproliferation position: the proximity of nuclear neighbors, the proximity of states and other groups seeking nuclear/radioactive material and know-how, and indigenous sources of nuclear/radioactive material. The nuclear threat is of special concern because of the proximity of major nuclear states such as Russia and China, states with nuclear ambitions such as Iran, and sub-state groups potentially seeking nuclear and/or radioactive materials. In addition, Central Asia possesses currently functioning nuclear facilities widely using powerful radioactive sources from Soviet times and active uranium mines; e.g. Kazakhstan is the number three producer of mined uranium in the world, whereas Uzbekistan is the eighth largest producer. The abovementioned factors altogether oblige Central Asian

countries to take serious actions in order to prevent nuclear and radioactive material theft, smuggling, transit and illicit trafficking as well as a leakage of nuclear technologies.

1.4 Central Asian Nuclear Weapon Free Zone

It should be emphasized that the first important step has been already taken by countries of this region. On 8 September 2006, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan signed a treaty (first suggested by Uzbekistan in 1993) establishing a Central Asian Nuclear Weapon Free Zone (CANWFZ). This treaty, de facto, creates a logical basis for further actions that should be taken by Central Asian countries in order to prevent illicit trafficking of nuclear and radioactive materials.

1.5 Proposal Concept

In this proposal we formulate basic principles of the project that are aimed at creating a regional system to prevent nuclear and radioactive material illicit trafficking in Central Asia. In principle, this system is reliable, simple, fast responding, effective and relatively non-expensive. For the first time, this system has been successfully implemented in Uzbekistan.

2. NON-PROLIFERATION ACTIONS IN CENTRAL ASIA

2.1 The Material and Knowledge-Based Resource

For decades in former Soviet Union, all five Central Asian countries widely used proliferation-sensitive nuclear techniques and methods for military, scientific, industrial and medical needs. In addition, Central Asia played an important role in providing a large amount of raw uranium and heavy water for nuclear needs. For example, the first Soviet nuclear bomb in 1949 was produced using uranium mined in Tajikistan and heavy water produced at chemical plants of Chirchik city near Tashkent, Uzbekistan. Moreover, Central Asia possesses several research nuclear reactors (including a breeder reactor) and accelerators, installed and operated during the former Soviet Union and widely used for research, material sciences, materials' radiation modification, radioisotope production, radiochemistry, elemental analysis, industry, biology and medicine. Correspondingly several thousands nuclear experts, scientists, engineers, and technicians were involved in these activities and their infrastructure and remain a knowledge-based resource.

2.2 Nonproliferation Actions

After gaining independence all five Central Asian countries took measures in providing nuclear and radiation security and safety. For example, all five joined the Non Proliferation Treaty (NPT) and signed the Additional Protocol (AP). Consequently, all nuclear materials in Central Asia (mainly from Kazakhstan and Uzbekistan) are under IAEA safeguards. Moreover, Kazakhstan removed from its territory nuclear warheads and highly enriched weapon grade uranium. It addition, Kazakhstan has decided to decommission a breeder reactor in Aktau city. Significant measures to improve the physical protection of nuclear facilities and sites containing reactors and powerful radioactive sources were implemented in Uzbekistan and Kazakhstan.

Some attempts to inventory radioactive sources, although not quite efficient, have been implemented in some countries of the region as the national legislature concerning the nuclear and radiation safety, inventory, safeguards and control was accepted in different forms.

In April 2006, for the first time in last fifteen years, a project to return highly enriched spent fuel from research reactors back to Russia was performed. Uzbekistan is the first country (among other 15 countries-users of Russian-origin reactor fuel) that returned 252 spent reactor fuel elements with 90% and 36% enrichment. A similar project is under preparations in Kazakhstan.

Also notable are the actions taken to prevent smuggling of nuclear and radioactive material across Central Asian borders. Uzbekistan, Kazakhstan and partly Tajikistan are equipping their borders' customs-controlled exit-entry points with radiation detecting equipment. The recent works in Uzbekistan employed advanced radiation monitoring devices in more than 30 major points-of-entry to reduce any illicit trafficking and transit of nuclear and radioactive materials. Most of these projects have been performed with the assistance of the U.S. Departments of Energy and Defense, IAEA, and other international and national organizations.

3. THE SOURCES OF CONCERN AND PROBLEMS

Despite some of the abovementioned positive results, there are serious problems that should be resolved in order to prevent potential proliferation of nuclear and highly radioactive materials, including raw uranium (in form of yellow cake), from Central Asia. Among main concerns are the theft and smuggling of materials from domestic and foreign sources to neighboring countries and others, the persistent threat from terrorist and extremist groups that are trying to possess such materials and the interest of neighboring countries in nuclear technologies and materials. Also, internal sabotage cannot be excluded. There are some immediate measures that must be taken in order to prevent such actions.

3.1 Radioactive Sources

No complete and reliable inventory of radioactive sources has been ever done in all five Central Asian countries after the collapse of the Soviet Union. Despite the accepting of good laws and regulations, such inventories, if any, have been done only partially and do not give a full and transparent picture of the distribution of radioactive sources on the territory of each country. Taking into account that the thousands of powerful (with total activities of tens and hundreds curies and more) sources were used in past, one must formally inspect for the presence (or absence) of sources, establish the history of its origin and usage, as well as check the physical condition (in order to prevent possible leakage and to make a decision about future disposition) and create database at national level.

Checking the physical integrity of containers is a very serious task and can be done only in a well-equipped and radiation protected laboratory. Such work has been done recently at the Institute of Nuclear Physics in Uzbekistan, where more than 1,600 unused, powerful radioactive sources were inspected. To our knowledge, no similar job has been done in other regional countries. The lack of accounting and quality control of such sources is a direct way to begin to control the bulk of "orphan" sources, which could be attractive targets for extremist groups as well as for smugglers.

Another concern is environmental since each source has fixed time of exploitation after which it should be either demolished or buried. However, expired sources can leak and pollute the environment with radioactivity. Rough estimates show that almost 80% of all radioactive

sources ever used in Central Asia have aged by more than two half-life which increases the probability of leakage.

Due to the abovementioned reasons, the first step that each country must do is to create a national database for all long-lived radioactive sources having activities of tens and more Curies, which are potential materials for creating so-called “dirty” bombs and causing severe environmental degradation.

3.2 Nuclear Materials

Nuclear materials in form of uranium with different enrichment fractions are possessed by Kazakhstan and Uzbekistan at their nuclear research facilities (in form of reactor fuel) and at the Ulba nuclear fuel fabrication plant (Kazakhstan). All of these materials are under national and IAEA safeguards and have relatively good physical protection. However, it is still theoretically possible that cases of internal sabotage resulting in theft could occur. In addition, attacks by terrorist groups cannot be excluded. Therefore, permanent control of materials and personnel are required along with special guard protection.

3.3 The Spent Nuclear Fuel

Another subject of concern is highly enriched spent fuel from research reactors and its physical protection. Due to recent initiatives of the United States and Russia, it has been agreed to return to Russia the spent fuel from research facilities that are using Russian-origin fuel. This program has been started in Uzbekistan. Currently, fourteen other countries, including Kazakhstan, expressed their willing to participate in this program. It should be reminded that highly enriched spent fuel from research reactors contains almost 50% of non-burned uranium that, in principle, can be extracted and used again. Although this type of fuel is considered as “self-protected” (due to a very high radiation), one can not guarantee that, after being stored for relatively long periods of time, such materials also could be a subject of interest for extremist and fanatic groups.

3.4 Raw Uranium

Another serious subject for control is the uranium that is processed from ore extracted at mines in Kazakhstan, Uzbekistan as well as in small amounts in Kyrgyzstan and Tajikistan.

The final product of these mines is the uranium in the form of U_3O_8 (yellow cake), which is subject of legal export. Although all five Central Asian countries are participants of NPT and signed the AP, there is a possibility of illegal proliferation of products of those factories, as it has been proved by several detected cases. Therefore, adequate actions must be taken in order to prevent theft (internal control, anti-sabotage measures, accountancy and physical protection, guards) and illicit trafficking of raw uranium.

4. REGIONAL APPROACH AND PREVENTING NUCLEAR SMUGGLING

As it was mentioned above all five Central Asian countries have signed the CANWFZ, claiming the region as a zone free of nuclear weapon. This treaty de-facto has and should have very serious consequences.

Firstly, it means that each country that signed the treaty should create legislation that completely excludes any possibility of creation of materials or technology potentially promoting or leading to production of nuclear weapons or similar devices.

Secondly, the treaty increases the responsibility of each party to provide corresponding control and accountancy of related materials and technologies at the national level.

Thirdly, the parties should agree on measures that should be taken at the regional level in order to prevent any possibility of sabotage, theft, smuggling and illicit transit of related materials including the dual purpose ones.

The fourth, and very important, each party must have corresponding technical provision in order to perform such control at national level including detection and fast response systems, as well as a capability for prompt identification of intercepted material and identification of its origin.

The integral part of such an approach should be a united network and database that collects relevant information from all control points into one whole system. Finally, there should be a possibility for each party to exchange promptly necessary information for mutual use and to make a common decision on actions to be taken remotely through corresponding networks.

5. PROPOSED ACTIONS

In order to increase regional nuclear security, to improve the control and accountancy and to prevent nuclear and radioactive material illicit trafficking in Central Asia the following actions may be proposed:

a) All five countries should update their national legislature in order to provide better protection, control and accountancy of radioactive and nuclear materials, including prevention of the sale of raw uranium to countries with nuclear weapons ambitions.
b) All five countries should take measures on internal inventory and accountancy of radioactive and nuclear materials for inspection of their physical condition and the creation of national database.
c) All five countries should create a database of micro-elemental composition of final products (yellow cake) of uranium mines. This action would allow the origin of intercepted material to be determined. The data should be available for mutual exchange.
d) The general regional treaty (agreement) on cooperation in preventing nuclear and radioactive materials' illicit trafficking should be signed. This agreement should include an agenda for creating united network, using comparable technical capabilities for detection and prompt identification of materials.
e) All five countries should equip main border entry-exit points and other sensitive areas by modern equipment which allows detecting and identifying nuclear and radioactive materials' smuggling.

The technical possibilities of the implementation of this proposal are discussed below in Section 6.

6. TECHNICAL POSSIBILITIES IN PREVENTING NUCLEAR TRAFFICKING

6.1. Introduction

Technical provisions for preventing nuclear and radioactive materials' trafficking should include such elements as:

- 24-hour operations
- highly sensitive detection systems
- prompt identification (express analysis) of intercepted suspicious materials
- good communication capabilities
- a regional integrated network system with local and remote control of customs points
- data analysis
- database creation
- prompt response

The checking apparatus can be deployed in the areas of customs points in airports, railways stations, seaports and border crossing points.

However, even with a perfect system to detect attempts to smuggle radioactive and nuclear materials (RNM), the lack of control, accountancy, efficient physical protection of RNM and inventory at given facility will significantly reduce the efficiency of preventing illicit trafficking. Moreover, possible internal sabotage can not be excluded. Therefore serious measures in these areas should be taken into account.

One should note that the existence of diverse natural features (mountains, glaciers, steppes, deserts, plains, forests, lakes, Caspian sea, etc.), wide variety of meteorological conditions along the borders of the Central Asian countries and other features mentioned in the first chapter of this document are creating an excellent and unique possibility in challenging modern methods and systems to be developed and tested in preventing illicit trafficking. The obtained experience and knowledge then can be easily adapted in other regions.

6.2. Inventory and Protection of RNM

Continuous monitoring of nuclear materials' and radioactive sources' inventory is the major priority of each country. There should be a database for each RNM, which includes data like:

- origin of the material
- present status and disposal
- its parameters and properties
- data about radiation protection
- its history, the site, forms
- purposes and methods of utilization
- ownership data
- certificates and other documents from the governmental authority allowing to use it
- time of utilization, including expiration date
- data about last inspection of physical conditions
- data about disposal at given depository (after full use)

Having such data allows one to control RNM and quickly identify in case of theft or illegal use.

There are no standard prescriptions or internationally accepted regulations on physical protection of RNM and each country has its own laws and regulations. However, one general rule is that any type of physical protection must maximally exclude the possibility of theft and illegal use of RNM and provide enough time for proper response even in case of armed intrusion to area containing RMN.

Also all facilities containing RNM must have locally deployed radiation detection and surveillance systems in order to detect any non-sanctioned moves of RNM.

6.3 General Requirements for Detection Systems

Among many possible actions in preventing RNM illicit trafficking, despite well-organized control, accountancy and physical protection systems, the first and obligatory requirement is to have in related areas and at border crossing points the tools for the detection of RNM in case of theft with following-up possible illegal export or import. The general requirements to those tools are the following:

a) high efficiency in detecting radioactive and nuclear materials (normally these systems should reveal the presence of, for example, about 10 grams of ^{239}Pu ,about 30 grams of ^{235}U or a radioactive source activity of about 20 microCuries under the standard 4-cm thickness lead shielding - the thickness of commonly used containers- at distance at least of 50 cm);
b) very small “dead time” (i.e. the minimal time interval between detection of signals from two different in time sources) of detectors;
c) very low probability (normally not more than 1 per 1000) of false signals and alarms;
d) capability to work properly and independently under meteorological conditions;
e) ability for permanent 24-hour monitoring and collecting (storage) data for possible follow-up analysis;
f) relatively easy and simple in deploying, operation and maintaining;
g) an emergency power source that could be used in case power supply shortage (or sabotage);
h) low cost and long operational time;
i) video-surveillance system and image indexing and storage database.

A critical and very special criterion for detection systems is their capability for fast and simple operation and subsequent recognition of suspicion carrier of RNM during standard in-site customs procedures. Some modern detecting systems use fast spectrometry, which allows RNM identification within a short period of time. However, the cost of such apparatus is very high.

Stolen RNM can be transported by airplane, train, car, or ship. A well-designed detection system manned by trained and motivated customs officers can be effective in intercepting smuggled RNM in many cases where these vehicles are used. However, such systems are impractical along remote coastlines or mountain passes in regions of great interest, such as Central Asia. Central Asia lies between potential illicit RNM sources in Russia and China and potential users to the south and west. It includes a major international waterway (the Caspian Sea) and an abundance of rugged and remote mountainous terrain, such as the Pamir and Tian Shan mountains that are shared by countries of the region. Such animals as horses, donkeys, camels and mules are commonly used for transporting commercial material along trials in the Central Asian Mountains. Placement and effective operation of fixed detectors even on the most commonly used trails would require an enormous financial and manpower commitment. At best, hand-held

detectors could be employed to intercept illicit nuclear and radioactive materials in these situations but it remains a difficult challenge.

6.4. The Minimal Technical Package

There is a range of equipment that can be used for detecting smuggled RNM. The most sophisticated is fixed-placement apparatus, with high sensitivity and high resolution radiation detectors. These can be equipped with spectrometry or linear electron accelerator based gamma-screening devices that are able to recognize tiny objects and even provide 3D-images. But these are overwhelmingly expensive for large scale application under challenging conditions. One should have reasonable and pragmatic alternatives for providing the minimal but sufficient set of related apparatus for checking points. From our experience in Uzbekistan, each checking border (customs) point should have enough capability to rapidly and confidently detect, and identify RNM. (RBK: more detail needed here)

The detection system should include pedestrian, automobile, and, in case of necessity, train monitors. Airports should possess mobile and stationary radiation detectors for checking passengers, their luggage as well as cargo and mail coming or transiting by planes. The preliminary rapid spectrometry (or identification) of RNM can be executed by portable devices that currently exist in many types and varieties (for instance, detectors based on crystals of NaJ- or Ge-Li).

For more sophisticated cases one should have so-called mobile laboratory, which is the vehicle equipped with spectrometers and chromatography equipment and software that allows identification of not only RNM but also suspicious materials like explosives or narcotics. Such mobile laboratory can play the role of the fast response regional centre that provides operative analysis of seized materials. That is especially important in case of dangerous and harmful chemicals or exploding chemicals and compounds. The range of service of mobile laboratory could be at least 150-200 km. Having such mobile laboratories is especially important for the remote areas where a fast decision about the disposition of intercepted materials and the people transporting them are needed. For example, our estimates show that in case of Uzbekistan (an area of about 448,000 km^2); 5-6 such mobile laboratories would be enough in order to provide the needs of all checking (customs) points. The attractiveness of such laboratories is relatively low cost of hardware (about $300,000 including vehicle, portable power generator and detection and analyzing apparatus), mobility and relative simplicity in operation. The team of two trained experts per vehicle, as it is demonstrated again in Uzbekistan case, could provide all the necessary service. Those could be, for example, the part-time hired qualified persons from local universities.

Also one should mention that in case of Kazakhstan, Uzbekistan and Turkmenistan the similar mobile laboratories mounted on the fast boats could be very effective in case of preventing illegal RNM trafficking on the Caspian and Aral seas as well as along the basins of the two main rivers Syr-Darya and Amu-Darya.

6.5. Analysis Capabilities

As we mentioned above, the capability of fast and reliable analysis of samples is very important in case of suspicious materials' seizure. The portable radiation spectrometers in case of proper calibration could, in principle, help to identify radioactive (but hardly nuclear) materials (although the cases of misidentification can not be excluded) and control measurements, as it has been shown by our experience, are always required. Moreover, to determine the origin of nuclear

material there should be a capability for micro-elemental analysis which, as it was mentioned above, can help to determine possible origin especially in case of possessing database for RNM. In the Central Asian region there are two facilities, Kazakhstan Institute of Nuclear Physics and Uzbekistan Institute of Nuclear Physics, where the methods of multi-elemental analysis are well developed (for example, the presence of trace elements with concentrations up to 10^{-10}% can be determined by means of neutron activation analysis) and those centers could play the role of regional facilities for that purpose. That would be especially important in case of smuggling of uranium or its products from local mines or processing facilities.

6.6. The Cost Estimates

The estimation of costs in equipping the border control points with related apparatus is rather complicated task because it depends on the type of apparatus, its producer, warranty obligations, requested parameters, mounting conditions, local labor and construction materials costs, transportation, taxes, training, maintenance works and others.

The example of Uzbekistan, where in more than 30 border control points such systems have been installed and operated, suggests that the most cost-efficient, operative and sensitive detection systems to be employed in the Central Asian region are those produced by "Aspect" company (Dubna, Russia). The "Aspect" company, in addition to warranty time obligations, also provides training of personnel and spare parts.

6.7. Regional Network

In ideal case all monitoring systems in each of five Central Asian countries should be integrated in country network which could be in turn, a part of the regional network system between all regional countries. The creation of such system would be quite efficient in preventing RNM illegal trafficking, identification and finding the origin of RNM, accepting operative decision and assessment, database exchange as well as tracking the approved transit of RNM. The prototype of similar system has been developed recently in Uzbekistan and the experience of its exploitation could be useful for future projects.

7. CONCLUSION

In this project we have formulated the basic principles for the creation of the regional system for preventing nuclear and radioactive materials' illicit trafficking in Central Asia. This proposal is on the front burner due to geopolitical importance of this region and recent signature of treaty announcing the region as a zone free of nuclear weapon (CANWFZ treaty) by all five countries of Central Asia. Furthermore, recent experience of Uzbekistan demonstrated in practice the reality and efficiency of similar projects.

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