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Measures Against-Illicit Trafficking of Nuclear Materials and Other Radioactive Sources

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ABSTRACT

Since the early nineties, illicit trafficking (IT) of nuclear materials and radioactive sources appeared as a new trend which raised the concern of the international community due to the grave consequences that would merge if these materials or radioactive sources fell into the hands of terrorist groups.

However, by the end of the last century illicit trafficking of nuclear materials and radioactive sources lost its considerable salience, in spite of seizure of considerable amounts of ^{235}U (76% enrichment) in Bulgaria (May 1999) and also ^{235}U (30% enrichment) in Georgia (April 2000). Nevertheless, IT should be always considered as a continued and viable threat to the international community. Awareness of the problem should be developed and maintained among concerned circles as the first step towards combating illicit trafficking of nuclear materials and radioactive sources.

Illicit trafficking of nuclear and radioactive materials needs serious consideration and proper attention by the governmental law enforcement authorities. Measures to combat with IT of nuclear material or radioactive sources should be effective in recovery, of stolen, removed or lost nuclear materials or radioactive sources due to the failure of the physical protection system or the State System Accounting and Control (SSAC) system which are normally applied for protecting these materials against illegal actions.

Measures such as use of modern and efficient radiation monitoring equipment at the borders inspection points, is an important step in preventing the illicit trafficking of nuclear and radioactive materials across the borders. Also providing radiological training to specific personnel and workers in this field will minimize the consequences of a radiological attack in case of its occurrence.

There is a real need to start to enter into cooperative agreements to strengthen borders security under the umbrella of IAEA to faster as an international cooperation in the illicit trafficking of nuclear material and radioactive sources.

Keywords: illicit Trafficking, Combating with IT, Threat Analysis of IT.

INTRODUCTION

The threat of terrorist activities involving nuclear materials is increasingly raising the concern of the international community. On one hand crude-or sophisticated-nuclear explosive devices prepared by terrorist groups involving the elaborate use of fissionable nuclear materials obtained through illicit trafficking represent a major threat to peace and security world-wide. On the other hand recent threats of nuclear terrorism involve the production and use of dirty bombs which is recently the most plausible act of nuclear terrorism. The dirty bomb is made of a conventional explosive packed with radioactive material from medical or industrial sources. The possibility of the dispersion of such materials over urban areas which may result in widespread panic and contamination leading, in turn, to their introduction into the food chain or drinking water systems constitutes an important currerrtly perceived risk to our modern societies [1,2]. Cleaning up procedures after an attack on a major city would take many months and would cost a

huge amount of money although the number of serious causalities could be limited to those who were injured or killed by the initial blast.

A prerequisite for the use of primitive nuclear devices or dirty bombs by terrorist groups is the acquisition of the proper and sufficient amounts of nuclear material or radioactive sources respectively. The acquisition of such materials normally goes through illicit trafficking which is defined as the illegal import, export, acquisition, sale, delivery, movement or transfere of nuclear materials and other radioactive sources from or across the territory of one state party to that of another state party [3].

The illicit trafficking of nuclear material is a new threat, which requires new efforts, new approaches, and coordination of services and institutions and even new legislation. In the early 1990's. a sharp rise in the number of illicit trafficking cases which has been a serious concern of the international organizations involved in fostering peace and security all over the world i.e. U.N, IAEA……etc.

Radioactive materials are used throughout the world for a wide variety of beneficial purposes in industry, medicine, research, defense, and education. There have been instances in which loss of security over radioactive materials has led to serious, even fatal consequences to the public [4].

Concern about a "nuclear black market" has increased, remarkably in the last decade. In addition to the threat of nuclear weapons getting into wrong hands, radioactive materials, widely used in industry or medicine, are more easily accessible for criminals than nuclear materials, which are generally kept under strict physical protection measures [5].

Nature of the threat

The risk of fostering a rather limited attack using a small or medium nuclear device and/or the risk of widespread contamination by spreading radioactive materials contained in explosive devices to which states at different parts of the world are vulnerable is considered to be actual.

a- Nuclear Weapons Threat

After the fall of Soviet Union (US) the global arsenal of nuclear heads has drastically shrunk. The break up of the SU put a vast array of nuclear weapons and materials at risk of theft or clandestine sale to non-state actors-either terrorist groups or criminal networks. The soviets did not keep good records, so it is not known how much of nuclear material is still there unaccounted for. Small quantities are known to have been bought or sold illegally [6].

> Fortunately up till now, no non-state actor has managed to aquire the minimum mass of material necessary to make a first-generation atomic bomb. Nevertheless, efforts in that direction are undoubtedly continuing. The first step in that direction is to collect gradually small pieces of fissile material aiming at collecting an amount sufficient to produce a nuclear device.

Moreover, new nations continue to seek nuclear explosive device e.g. India, Pakistan, North Korea and others declared their acquisition of nuclear weapons. Some 20 other nations possess the technology to build a nuclear weapon. Consequently, continued devoted attempts to smuggle fissile materials across borders suggest that terrorists are there in the market.

Using the IAEA data base on the illicit trafficking of nuclear materials, a concise compilation and categorization of nuclear materials that have been seized in various illicit trafficking operations during the period from 1993 to 2004. are given in table 1 [7]. Table 2

shows some specific reported smuggling incidents of sizable amounts of nuclear materials that could be useful in producing nuclear explosives [8].

Examination of these tables is greatly useful in order to set authoritative information that would be helpful in determining what are the materials or sources most vulnerable to illicit trafficking and consequently what actions may be needed to be undertaken with respect to particular events and also in order to raise the ability of the competent authority in a country in formulating the internal policy for combating illicit trafficking of such materials. From the data given in table 1, it could be observed that only abut 12% of reported incidents involve HEU and Pu. Only three incidents occurred involving >1 kg - < 3 kg, two incidents involving >20-1 kg and 6 incidents involving <20g of HEU. This shows that out of eleven incidents there are only three incidents involving considerable amounts of HEU. In case of Pu only very limited amounts of Pu are subject to IL.

Table (2) shows that although smuggling events of nuclear materials, particularly HEU and Pu, are rather less frequent, however these events involve rather greater amounts of these materials. This probably indicates that highly enriched uranium (HEU) and Pu are more acceptable when offered in greater amounts. The rather low frequency of IT events involving HEU and Pu could probably be due to the fact that they are guarded more strictly in different countries than low enriched uranium (LEU) and depleted uranium (DU). In should be noted that the prices of these materials in the black market are extremely high. For example it has been reported in 1994 that the nominal black market prices per kg of nuclear and radioactive commodities in Germany amounted to: 100.000 to 1 million $ per kg for enriched Uranium and for highly enriched U the price was in the range 1 million to 60 million $, whereas for Pu the price was in the range 700.000 – 1 million $ per kg [9]. It is obvious that the defeat of safeguards and physical protection systems used to effect the safety and security of these materials could lead to grave results. Acquisition by terrorists of several small amounts of weapons grade nuclear materials can constitute a real threat to non proliferation.

b- Non-Nuclear devices threat

Non-nuclear radioactive materials could not be used to create a nuclear explosion. However, these materials do have the potential to be used as weapons either in the form of radiological dispersal device (RDD) or a radiation emission device (RED). The use of a RDD or a RED is considered by many observers to be the most likely terrorist scenario in the near future because many radioisotopes are widely used in medicine industry and science, and therefore are readily accessible to be exploited in criminal actions [10].

A dirty bomb, that could be used as a radiological dispersal device (RDD), consists of a conventional explosive, such as dynamite or C-4, packaged with radioactive material(s) or source(s) that scatters into the atmosphere and the surrounding environment when the bomb detonates. The airborne radiation and contamination is a leftover residue that has long-term health effects on the local population dependent upon the type of radioactive material used. Such bombs could be miniature devices or as big as a truck bomb commensurate with the amount of explosive and nature of the radioactive material to be dispersed. A dirty bomb is a device that a group or an individual may choose to build if unable to create, afford or obtain a real nuclear material.

Depending on the sophistication of the bomb, wind conditions, and the speed with which the area of the attack could be evacuated, the number of deaths and injuries from a dirty bomb explosion might not be substantially greater than from a conventional bomb explosion. It leaves areas in a gridlock of hysteria. Moreover, the area struck would be off-limits for at least several months during cleanup efforts, which could paralyze local or even national economy and reinforce public fears about being near a radioactive area.

Many types of radioactive materials with military, industrial, or medical applications like Cobalt-60, Stronium-90, and Cesium-137 could be used in dirty bombs although they generally would be less dangerous.

Tables 3 and 4 show the illicit trafficking incidents that were reported during the period from 1993 to 2004 as adapted from IAEA data base [7]. Again most of the illicit trafficking incidents occurred in Germany or in the republics of the former Soviet Union and some of the former Soviet Union allies. Again, The nominal black market price for Cs-137 was within the range 100.000 – 1 million $ while that for Os-187 it was 70 million $ and for Zn-68 it ranged between 50-100 million $ per kg [9].

After a radiological attack, radioactive materials would be physically lodged in crevices on the surfaces of buildings, sidewalks, and streets, making decontamination and the free release of material difficult to be made.

Combating with illicit trafficking

Illicit trafficking of nuclear materials and radioactive sources appeared in the early 1990's as a new phenomenon that has an international dimension and therefore requires international cooperation in order to increase the capability of preventing or responding to illicit trafficking events.

It is generally agreed that the first step in combating illicit trafficking of nuclear materials and radioactive sources should be prevention based on the defense in depth principle. This includes application of measures for safety, security, physical protection, accountancy, and strict control of nuclear materials and radioactive sources especially in transborder movements [11, 12]. Consequently, coordination between the licensing authority, the safeguards accounting system, the states physical protection system and the import-export authority, is highly recommended. Collaboration and coordination with other relevant authorities e.g. customs, border and coast guards can be fostered through appropriate agreements and material training of personnel and establishing border control procedures.

Defense in depth systems are based on design and enforcement of control measures that assure the continuity of knowledge about the possession, use and movements of nuclear materials as a primary element for the prevention of its illicit use. In fact the existence of a regulatory authority empowered to establish effective physical protection on one hand and accountancy and control measures on the other hand enhances the states capability to prevent, intercept and respond to illicit use of nuclear materials.

Design and implementation of a system of physical protection is the responsibility of the state. That system is entrusted to take the necessary steps to:-

a- minimize the possibilities of unauthorized removal of nuclear material or sabotage.

b- Undertake the necessary measures to locate and recover missing materials as rapidly as possible.

c- Minimize the effect of sabotage.

Accountancy and control are complementary measures contributing to the prevention of illicit uses of nuclear materials [13]. This is realized through the establishment of a state system for accountancy and material control which should comprise a set of requirements and procedures applicable to all nuclear materials to ensure, with a reasonable degree of certainty that such material is not diverted to unauthorized uses and that they are in full compliance with the country's non-

proliferation commitments. The SSAC shall have the jurisdiction to:-

a- Ensure that the nuclear materials are imported, exported, produced, transferred stored, used or disposed of only by an authorized party.

b- Ensure that the licensee and the relevant organizations are well aware of their responsibilities and applicable procedures and requirements

c- Keep an updated data base system of all nuclear materials present in the country.

In case of radioactive sources, it is a usual practice to apply adequate security measures, using the graded approach, to assure that the radioactive sources are under adequate and effective control. This could be achieved by applying entry control systems together with other systems for intrusion detection as well as applying appropriate and effective barriers to deter intruders.

Accountancy measures are also complementary to the effective control over radioactive sources. This could be achieved by applying registration systems and log books control for following the status of the radioactive sources-open or closed.

In order to discover illicit trafficking or inadvertent movement of radioactive materials, the following steps are required: detection of any abnormal radiation level, verification of such detection, localization of the origin of the radiation, radiation safety measurement, and identification of the radioactive material. Specialized equipments are required for performing one or more of the steps indicated above, which can be divided into three categories: pocket type instruments, used to detect the presence of radioactive materials and inform the investigator about the radiation level; hand-held mobile instruments, required to detect, locate and identify radioactive material and fixed installed, automatic instruments, designed to be placed at roads railways border crossings, airports, and seaports, etc [14]. All such systems and detection points can effectively interfere with any attempt to smuggle or traffic any amount of nuclear material or radioactive sources.

The decline in the overall number of IT incidents observed at the end of the nineties probably could be attributed to the possibility that amateur smugglers have been deterred from involvement and that the professionals have become more skilful and adept at avoiding detection [15].

Combating any possible illicit trafficking of nuclear materials and sources in Egypt

Egypt is located in a highly sensitive region in the middle east. Egypt shares borders with Palestine, Israel in the east, Sudan in the south, Libya in the west. Frequently, some terrorist groups undertake some sporadic attacks on tourist sites as well as many other crowded places. Some of these attacks resulted in some serious causalities. Measures should be undertaken to rupture any possible links between any terrorist group and nuclear material or radioactive sources.

a- Nuclear materials

So far terrorist groups, due to their low education levels and/or their limited

proficiency are using ordinary explosives. However, escalation of their activities both on the local as well as on the international levels, should be expected. Involvement of more knowledgeable parties in the terrorist groups would lead to more sophistication in the activities of the terrorist groups, particularly if local terrorist groups coordinate their activities with international terrorist groups. That phase of coordination and cooperation could probably lead to the inclination to use nuclear materials or dirty bombs. Consequently it is necessary to deter any actions that involve illicit trafficking of nuclear materials and radioactive sources into or out of the country.

In Egypt rather small amounts of nuclear materials are inside the Atomic Energy Authority for use either as reactor fuel for the two research reactors or in the fuel fabrication workshops. Moreover, there are some nuclear material in the chemistry department in which they are used in some research activities inside the atomic energy authority. Very small amount of U, Th salts may be scattered in research laboratories in Egyptian universities or in different scientific research centers. In addition there are some DU which is imported as a part of radioisotope generators used in medical diagnosis and therapy in the country. All these materials are either recorded or to be recorded in the state system of safeguards of Egypt. They are either locally controlled and subjected to safeguards measures by the regulatory body of Egypt and their use is subjected to control and verification through regular visits of the IAEA safeguards experts to the Egyptians facilities or in the way to be fully recorded and controlled by SSAC of Egypt..

Moreover, physical protection measures and practices are strictly applied for protecting the nuclear materials in ETRR-l and ETRR-2 reactors as well as in the nuclear fuel production facility.

b- Radioactive sources.

Radioactive sources that could be used in dirty bombs are the subject of general concern in Egypt.

In Egypt many types of radioactive isotopes in reasonable amounts either in the form of sealed or open sources are in general use. Sources with high radioactivity and toxicity are normally placed in sealed enclosures – sealed sources.

These isotopes are normally distributed through intermediaries to end users all over the country.

There are around one hundred radioisotopes used in medical diagnosis, therapy or investigations in nuclear medicine. Industrial uses of radioisotopes include instrumentation and measuring devices. Both fixed and portable analyzers of all kinds, smoke detectors irradiation and sterilization processors (food and different materials) radioactive tracers, non destructive testing and gamma radiographic equipments. In agriculture isotopes are used to investigate chemical and biological processes in plants and to sterilize pests such as med flies.

Once these isotopes used in different applications are exhausted they have to be disposed off safely in specialized facilities. Opportunities of loss or theft may occur at any point in this cycle especially as these radioactive sources are not closely monitored and controlled in the same way as nuclear materials such as uranium and plutonium.

Open sources used in many applications are regulated and licensed by the Atomic Energy Authority. Sealed sources which are applied in medicine and industry are regulated and licensed by the Ministry of health (MOH). The conduct of regulatory activities involve licensing of workplaces as well as of workers. The licensing process involve the submission of reports by the operators on the security of sources (open or closed) – as a part of the requirements – regulatory inspections by the regulatory body inspectors to be sure of the safe and secure use of sources in medical, industrial, agricultural and biological practices.

The existence of suitable measures to enhance the security of radioactive sources is always a prerequisite for licensing. For larger sources, elaborate security measures are applied. Prior to September 11, the emphasis on the security of radioactive sources was primarily based on limiting the use of such sources by unqualified staff or general public and securing sources from being proliferated by persons seeking scrap metal for resale or similar [16, 17].

Therefore the greater amount of radioactive sources that would be suitable for use in dirty bombs are particularly and effectively supervised and controlled by the regulatory activities sponsored by AEA or MOH.

CONCLUSION

1- Although Illicit Trafficking of nuclear materials and radioactive sources does not represent a serious threat at present in Egypt, serious efforts should always be directed to apply more stringent measures to safeguard any nuclear material as well as to protect all radioactive sources against sabotage, theft or unlawful acquisition in all facilities in which radioactive materials or sources are used.

2- Exit portals of all facilities in which radioactive sources or nuclear materials are handled or used or stored should be provided with suitable radioactive monitors to detect any unlawful acquisition, or theft of any amount of radioactive materials or any radioactive source on the spot. The mere presence of such equipments at the exit portals would effectively deter any unlawful trials in this respect.

3- It is necessary to raise the degree of awareness of the border guards personnel, customs officials as well as all security officials in all facilities in, which nuclear materials or radioactive sources are regularly handled about the threat to which these materials and sources are vulnerable. Regular visits, meetings and on-the job training could be also implemented to that effect. Dissemination of security culture among facility workers and the public would be very useful.

4- It is vital to install at the border exit points as well as at air ports and sea ports of the country highly efficient radiation detecting devices to enable the customs officials as well as the border guards to detect and stop successfully any unlawful movement of nuclear materials or radioactive sources across the borders.

5- The radioactivity detection devices placed at the border points should be highly sensitive to different types of radiations and should always be updated. The operating personnel-either from the border guards or customs officials-should

be well trained to use these equipments effectively and with great proficiency in order to be able to get, interpret and understand the out going signals correctly.

6- Measures for physical protection of nuclear materials, security of radioactive sources and various accountancy systems should be coordinated effectively to deter and detect any unlawful manipulation of nuclear materials or radioactive sucrose.

7- Close regulatory control of all practices applied in combating IT should be undertaken and maintained carefully.

Table (1): Illicit trafficking incidents involving nuclear material confirmed by States from 1993 to 2004 (adapted from IAEA data base on illicit trafficking incidents [7].

Country	Nuclear Material																	Total No. of Incidents
	DU				NU				LEU				HEU			Pu		
	No. of Incidents																	
	H	I	K	B	D	H	J	L	E	H	K	L	C	F	G	A	B	
Germany	-	-	-	5	11	3	-	-	9	2	-	-	2	-	-	2	1	**35**
Russia	2	-	1	-	1	7	3	-	-	5	-	-	-	-	2	-	-	**21**
Lithuania	1	1	-	-	-	1	1	-	3	3	1	1	-	-	-	-	-	**12**
Turkey	-	1	-	-	1	1	-	-	6	1	-	-	-	-	-	-	-	**10**
Poland	1	1	-	-	-	4	-	-	1	-	-	-	-	-	-	-	-	**7**
Romania	-	1	-	-	4	-	-	1	-	1	-	-	-	-	-	-	-	**7**
Austria	2	-	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	**6**
Czech Republic	-	-	1	-	1	-	-	-	1	-	-	-	2	-	1	-	-	**6**
Slovakia	-	1	-	-	-	1	-	-	2	2	-	-	-	-	-	-	-	**6**
Switzerland	-	-	1	-	3	2	1	-	2	-	-	-	-	-	-	-	-	**9**
Hungary	-	1	-	-	-	1	-	-	1	1	-	-	-	-	-	-	-	**4**
Georgia	-	-	-	-	-	-		-	-	-	-	-	-	2	-	1	-	**3**
Belonia	1	--	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	**2**
Estonia	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	**2**
Bulgaria	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	**1**
France	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	**1**
Greece	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	**1**
India	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	**1**
Italy	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	**1**
Kazakhstan	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	**1**
Latvia	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	**1**
UK	-	-	-	-	-	-	-	* 1	-	-	-	-	-	-	-	-	-	**1**

A- > 0.001g - <1g. B- > 1g - <10g. C- > 0.1g - <20g. D- > 0.1g -<1g.
E- > 1g - <1kg. F- > 20g - <1kg. G- > 1kg - <3kg. H- >1kg -<10kg.
I- > 10kg - <20kg. J- > 10kg - <50kg. K- > 20kg - <50kg. L- Higher Amounts
* Unspecified Amount.

Table (2): Some of the reported smuggling events of significant nuclear material (adapted from R. Rhodes report [8]).

Country	Area	Subject	Case	Amount
Greece (2001)	Asvestochori	245 small metal plets	Found in berried cache	00.3 kg
Georgia (2000)	Batumi	Highly Enriched Uranium (HEU)	People selling	0.77 kg
Bulgaria (1999)	Ruse	HEU	Caught by customs	0.01 kg
Russia (1998)	Chelyabinsk Region	(HEU)	Stealing, caught by security agencies	18.5 kg
Georgia (1997)	Sokhomi	HEU	Missing, revealed after Russian inspection	2.0 kg
Czech Republic (1995)	Cake Budejovice	HEU	Police seized	0.016 kg
Russia (1995)	Moscow	HEU	Man arrested, stolen from nuclear facility	1.7 kg
Czech Republic (1994)	Prague	HEU	Police seized	2.7 kg
Germany (1994)	Munich	Pu	Seized by airport authority	0.363 kg
Germany (1994)	Tengen-wiechs	Pu	Police detected in building search	0.006 kg
Russia (1994)	St. Petersbourg	HEU	Stolen from nuclear facility (person arrested)	3 kg
Lithuania (1993)	Vilnius	HEU	Found in storage area of a bank	0.15 kg
Russia (1993)	Ardreyeva Bay	HEU	Thief arrested	1.8 kg
Russia (1993)	Murmansk	HEU	Stolen by Naval officer	1.3 kg
Russia (1992)	Podolsk	HEU	Stolen by Worker	1.5 kg

HEU: Highly Enriched Uranium
LEU: Low Enriched Uranium

Table (3) :Illicit trafficking incidents involving radioactive sources confirmed by IAEA member States from 1993 to 2004 (adapted from IAEA data base on illicit trafficking incidents [7].

Country	Radioactive sources							Total No. of Incidents
	Cs-137 No. of incidents	Co-60 No. of incidents	Sr-90/Y-90 No. of incidents	Ra-226 No. of incidents	Am-241 No. of incidents	Ba No. of incidents	Ir-192 No. of incidents	
Germany	10	8	2	5	2	-	-	**27**
Russia	23	-	1	-	-	-	1	**25**
Estonia	8	2	-	1	-	-	-	**11**
Poland	2	-	3	-	-	-	-	**5**
Bulgaria	2	-	1	-	1	1	-	**5**
Ukraine	3	1	-	-	-	-	-	**4**
Latvia	2	-	1	-	1	-	-	**4**
Slovakia	-	3	1	-	-	-	-	**4**
Belarus	3	-	-	-	-	-	-	**3**
Spain	3	-	-	-	-	-	-	**3**
Iran	2	-	1	-	-	-	-	**3**
Colombia	1	-	-	-	1	-	1	**3**
UK	1	-	-	-	1	1	-	**3**
Canada	1	-	-	-	1	-	-	**2**
Newzeland	1	-	-	-	-	-	-	**1**
Greece	1	-	-	-	-	-	-	**1**
Turkey	-	1	-	-	-	-	-	**1**
Romania	-	-	1	-	-	-	-	**1**
Czech Republic	-	-	1	-	-	-	-	**1**
Hungary	-	-	1	-	-	-	-	**1**
Switzerland	-	-	-	1	-	-	-	**1**
Lithuania	-	-	-	-	-	1	-	**1**

Table (4) :Illicit trafficking incidents involving other radioactive sources confirmed by States from 1993 to 2004 (adapted from IAEA data base on illicit trafficking incidents [7].

Country	Radioactive sources	No. of incidents	Country	Radioactive sources	No. of incidents
Germany	Kr-85	1	**Bulgaria**	Pu-239	1
Germany	Cd-109	1	**Bulgaria**	NU	1
Germany	Pb-210	1	**Bulgaria**	T1-204	1
Germany	Cs-134	1	**Bulgaria**	Neutron Sources Po/Be	1
Poland	I-131	1	**Ukraine**	Eu-155	1
Poland	Al metal scrap	1	**Ukraine**	Sb-125	1
Turkey	Mixed Alpha crimtters	1	**Ecuador**	Tc-99	2

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