Testimony of
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Hearing on
A Review of U.S. International Efforts to Secure Radiological Materials

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Introduction

Mr. Chairman, I appreciate the opportunity to offer comments on the subject of international safety and security of radioactive sources. In 1961, I accepted a Commission in the U.S. Public Health Service (USPHS) and began a career as a health physicist. Later, I joined the Pennsylvania radiation control program becoming chief of the Division of Radiation Control. Following another tour of duty with the USPHS, I joined the Atomic Energy Commission. For many years I managed the Nuclear Regulatory Commission's (NRC) Agreement State Program. Beginning in 1992, I served as a Technical Assistant to Nuclear Regulatory Commission Commissioner E. Gail de Planque and later as Senior Assistant to Chairman Greta Joy Dicus retiring from government service in 1999. Presently, I am a consultant.

Since 1984 when the Mexican contaminated steel incident occurred, I have been involved in safety issues caused by orphan sources. In 1995 and 1998 James Yusko and I wrote review articles for the *Health Physics* journal on orphan sources in metal scrap destined for recycling (1,2). In 1998, I presented an historical overview of radioactive source accountability and control to the International Atomic Energy Agency (IAEA) international conference on safety and security of radioactive source held in Dijon, France, later published in the *IAEA Bulletin* (3). Two months after 9/11, Dr. Brian Dodd asked if I was willing to take on the task of updating the IAEA draft safety guide on safety and security of radioactive sources to reflect the new concerns about security. Early in 2002, I was pleased to assist Dr. Peter Zimmerman, then Senior Scientist on the staff of the Senate Foreign Relations Committee, in the preparations for the committee's 2002 hearing on nuclear and radiological terrorism. In August 2002, *Health Physics* published a paper by Dr. Daniel Strom and me, "Safety and Security of Radioactive Sources in the Aftermath of 11 September 2001" (4). In 2003, Dr. Ferguson and I collaborated on an article, "Securing U.S. Radioactive Sources," published in *Issues in Science and Technology* (5).

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I am pleased to note that the Health Physics Society has issued several position papers and reports advocating improvements in safety, accountability, and security of radioactive sources (6-9). The Conference of Radiation Control Directors and Organization of Agreement States have advocated improvements *since 1981* (10).

Historical Overview

Mr. Chairman, losses and thefts of radioactive sources and injuries and damages that result are not new news. In 1913, only 15 years after the discovery of radium, a radium source was reported lost (3). In a 1968 study of NY Times reports, the USPHS identified 286 news reports of lost and stolen radium sources between 1913 and 1964 (3). Given that there were no regulatory requirements at the time for such reports, the actual number was undoubtedly larger. In the 1940s, a 5 gram radium source used for industrial radiography was stolen from a Pennsylvania foundry (11). Police later found it in a bureau drawer in a residence. Orphan source incidents causing injuries of members of the public occurred. In 1979, a 28 Ci iridium-192 radiography source was mishandled and lost at a job site at a U.S. plant (12). The source was found and picked up by a plant worker who then pocketed it. He later showed it to other curious workers. Several received serious radiation burns. NRC Commissioner Dicus noted in 1999 that between 1992 and 1999, unshielded radioactive sources were found in the public domain in the U.S. 13 times, one of them a 40 Ci iridium-192 source that had been stolen (13). In 9 of the cases, the sources were found in metal scrap yards and steel mills.

Orphan sources have been a recurring problem for the U.S. metal scrap and steel industries. In our 1998 review paper, Mr. Yusko and I reported that between 1983 and 1997 NRC regulated radioactive material was found in U.S. and Canadian metal scrap on 119 occasions. Since 1983, US steel mills have accidentally melted radioactive sources that were mixed with scrap metal on 24 occasions.[2] Many occurred despite installation of radiation detectors to monitor scrap. Collectively, these 24 events cost US steel mill operators *over a quarter billion* dollars in clean up and mill shutdown costs, a cost incurred because of the negligence of others and ineffective regulatory requirements for control and accountability of radioactive sources.

Metal scrap is an internationally traded commodity. In 1998, a Spanish steel mill unknowingly melted a cesium-137 source, initially estimated to be between 8 and 80 Ci, that was in recycled metal scrap (14). Its presence in the scrap used by the mill had not been detected by radiation monitors installed for this purpose. Some of the cesium escaped through the plant stack. Environmental radiation monitors operated in France detected the airborne radioactivity. The discovery initially raised concerns that there had been an unknown nuclear power plant accident. It cost the Spanish mill operator US$ 26 million to clean up the mill. Most of the mill's metal scrap is imported.

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[2] Data on these and other incidents involving mills accidentally melting radioactive sources are in a database maintained by James G. Yusko, Pennsylvania Bureau of Radiation Protection, Southwest Regional Office, 400 Waterfront Drive, Pittsburgh, PA 15222-4745, U.S. In addition to the 24 U.S. steel mill cases, the database includes 12 U.S. incidents involving other metals (aluminum, gold, lead, zinc) and 60 foreign cases.

The first known incident of a steel mill accidentally melting a source was reported in 1983 (15). A New York steel mill melted a 25 Ci cobalt-60 source contaminating the steel mill and the mill product. The metal scrap used by the mill was a mix of domestic and imported scrap, the latter from Canada. The origin of the source was never determined.

The following year, U.S. and Mexican authorities discovered that Mexican steel mills and foundries melted metal scrap accidentally contaminated by 400 Ci of cobalt-60 (16). Some of their contaminated products, rebar and cast iron furniture, were exported to the U.S. The cobalt came from a teletherapy unit that had been legally exported from the U.S. to a Mexican clinic that then stored it. However, Mexican authorities were uninformed that the source was in Mexico. The stored teletherapy unit was stolen, broken apart and sold for scrap. The source capsule that contained 6000 pellets of Co-60 was breached releasing the pellets in the scrap yard. A number of Mexican nationals received serious overexposures. The contaminated ferrous products that had been exported to the U.S. were, for the most part, recovered and returned to Mexico.

Three years later in Goiânia, Brazil, another incident involving the destruction of an unused teletherapy unit for scrap occurred (17, 18). Again, the source capsule was breached. At least four people died and several more were seriously injured. Radioactive contamination was widespread. The social impact was enormous; because of public fears of being exposed to contamination carried by Goiânians, they were ostracized when they traveled to other parts of Brazil.

In both these cases, and some later ones, a contributing factor was that persons who gained access to the devices containing the sources, either did not recognize the radiation caution propeller symbol on the device label as a warning or were confronted with warning labels in a language other than their own.

Worldwide, more incidents involving the loss or theft of large radioactive sources resulting in deaths and injuries occurred leading to growing concerns in the international community (19-22). Thefts of radioactive sources from inadequately secured waste repositories have occurred (19). Recognizing this trend, the IAEA in 1998 convened the first-ever international conference on safety and security of radiation sources in Dijon, France. This conference led to an IAEA action plan approved by the 1999 IAEA General Conference to improve radioactive source safety and security. The plan incorporated a variety of approaches including developing a source categorization system, drafting a Code of Conduct for member countries, and taking steps to improve regulatory infrastructures of member countries.

All of this was accomplished before 9/11.

The aftermath of 9/11 elevated concerns about security of radioactive sources that might be used in a radiological dispersion device (RDD). Security has always been part and parcel of radiation protection but, as Dr. Abel Gonzalez of the IAEA frequently noted, security requirements on account of safety have not been as stringent as those to prevent malicious use. Because of their inherent hazard, radioactive sources were considered self-protecting, a paradigm that changed given the prospect of persons accessing and using radioactive sources for malicious purposes without regard to their personal safety.

Though rare, deliberate malicious use of radioactive material was not unknown. In Texas, a radioactive source was deliberately used to injure a boy (4). In the U.S., there have been several incidents where radioactive material was used to deliberately contaminate persons and property.[3] More recently, Chechen rebels demonstrated their capability to make a RDD when they left a RDD device in a Moscow park to be discovered (4). The recent Litvenenko case represents another kind of malicious – and deadly – use of radioactive material. That case is notable for the international movement of the polonium-210 used for the assassination and subsequent spread of contamination. Also notable is the public anxiety over possible exposure to the contamination, an effect seen earlier in the Goiânia, Brazil accident.

The IAEA, because of its prior work to improve radioactive source safety and security, was well positioned to respond quickly to the post-9/11 security concerns. The source categorization system issued in 2000 readily served as the basis for a revised version (23). Similarly, work began that led to revision of the Code of Conduct in 2004 (24). Concurrently, existing initiatives to improve member country regulatory infrastructures were expanded and accelerated.

Setting Priorities

In the U.S. the Department of Energy's (DOE) Off-site Source Recovery Program (OSRP) recovers and places into secure storage orphan and unwanted sources. To date, the program has recovered 14,000 sources.[4] By 2021, projections are that another 31,000 sources will need to be recovered. In 2003, the Government Accountability Office (GAO) found that the program suffered from budgetary shortfalls (25). The program was moved to National Nuclear Security Administration (NNSA) and incorporated into the Global Radiological Threat Reduction Initiative. It's responsibilities were expanded to recover U.S. origin sources outside the country. However, in 2007, the program's domestic goal for source recovery was reduced because of reprogramming of program funds for security upgrades at DOE facilities. NNSA plans call for significant budget increases for 2008 and beyond. Future competing, non-predictable priorities within the DOE, however, cannot be ruled out. They should not be allowed to adversely affect the program again.

Regardless of cause – accidental or malicious intent – radiation safety and the avoidance of deterministic effects is the first and foremost concern following a radiological incident.

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[3] See, for example, NRC SECY-97-023 and SECY-97-045, both available at the NRC web site, http://www.nrc.gov/reading-rm/doc-collections/commission/combined/.

[4] NNSA Fact Sheet, "NNSA: Working to Prevent Nuclear Terrorism," January 2007.

Categorization of radioactive sources by the IAEA is based on this premise (23).[5] Non-radiological effects – economic damage and social anxiety – also result and, in many scenarios, will be the major consequence (26). The consequences, albeit on a smaller scale, extend to lower priority sources. For this reason, steps to improve accountability and security of radioactive sources should not be limited to Category 1 and 2 sources. The IAEA has published for comment interim guidance to improve security for categories utilizing a graded approach (27). In 2006, NRC directed staff to take steps towards enhancing controls over lower priority sources.[6]

Prioritization of radioactive sources for recovery and actions to enhance security should into account additional factors that include their accessibility, mobility, physical and chemical form, vulnerability, threat assessments, and proximity to and consideration of impacts upon critical infrastructures. Taking into account these factors, the radioisotope thermal generators (RTGs) in the Former Soviet Union (FSU) that are no longer in use, have been abandoned, or are unsecured should receive high priority. Another group of large sources deserving priority attention are Russian made seed irradiators, *Gamma Kolos* units (18, 28). These are *mobile* units containing several kilocuries of cesium-137 or more.[7] The exact number made is unknown; estimates range from 100 to 1,000. They were widely distributed to various countries in the FSU. Many are unaccounted for.

Long-term Measures

The lack of viable, affordable disposal paths for unused and unwanted sources has led to unplanned storage that increases their vulnerability to loss whether accidentally or purposefully. This is also an issue in the U.S. It is entirely possible that in some cases sources have been "dumped" to avoid disposal costs and storage. In the short-term, programs such as the DOE Off-site Source Recovery Program are needed to recover and securely store unwanted and orphan sources, both domestically and internationally. In the long-term, better solutions to low-level radioactive waste disposal must be found.

Reviews of international accidents indicated another matter needed international attention. Because of language barriers or lack of literacy, standard warning labels on radioactive devices intended to alert individuals to the radiation hazard are not always understood. Also, the radiation warning propeller is not as well recognized as other internationally used symbols. Recognizing this, the IAEA initiated work to address this. The result, recently announced by the NRC in a public notice, is approval of an

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[5] Economic and social consequences were recognized by the IAEA in its original (2000) and revised (2005) source categorization systems but the IAEA noted that they are difficult to quantify.
[6] See NRC SECY-06-0094, "Tracking or Providing Enhanced Controls for Category 3 Sources," the accompanying Staff Requirements Memorandum, and the Commissioners' voting record, available at the NRC web site, http://www.nrc.gov/reading-rm/doc-collections/commission.
[7] *Gamma Kolos* irradiators were intended to be transported, usually by trucks. Transportation of radioactive sources is, itself, a vulnerable activity.

internationally proved sign to supplement the current standard warnings[8]. Its use needs to be required for higher risk sources.

Reports issued by the IAEA, the National Academy of Sciences, the National Council on Radiation Protection and Measurements, the Health Physics Society and many experts have recommended development and wider utilization of alternative chemical and physical forms of radioactive material in sources and of alternative technologies to replace radioactive sources (28, 29). Alternative technologies are being utilized by the U.S. steel industry (5). Private-public partnerships may provide a mechanism for advancing the measures.

Conclusions

Dr. Ferguson has pointed out the production, fabrication and utilization of radioactive sources *is an international enterprise* (30).

The historical record of past incidents shows that the consequences of radiological incidents *do not respect boundaries.*

The historical record shows that while radiation injuries and deaths may occur, the severity of the economic damage and social anxiety that result from incidents *often exceeds the health effects*.

The historical record shows that the IAEA, the states and numerous radiation safety experts identified source safety and security as a concern *prior to 9/11*.

Developing solutions radioactive source safety and security issues will require approaches that

- are international in scope,
- retain an appropriate level of attention to domestic needs,
- consider all of the impacts of accidental and malicious use of radioactive material, and
- incorporate both long-term and short-term solutions.

Recommendations

Given this background, the following recommendations are offered:

1. The radioisotope thermal generators (RTGs) in the FSU are a concern because of the very large quantities of radioactive material in the devices. RTGs that are disused, have been abandoned or are unsecured *need priority attention*. Priority attention should also be given to locating and securing mobile seed irradiators in the FSU.

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[8] U.S. Nuclear Regulatory Commission, "NRC Regulatory Issue Summary 2007-03 Ionizing Radiation Warning Symbol," ML070600495 (March 1, 2007).

2. Improving security at radioactive waste repositories should receive priority attention: *The transfer of recovered radioactive sources that are at risk to an unsecured waste repository simply continues the risk*.
3. The DOE's program to recover *domestic* radioactive sources posing safety and security risks *is greatly needed*. Over 14,000 sources have been recovered in the U.S. to date and another 31,000 are projected to need recovery between now and 2021. The program has been expanded to recover U.S. origin sources outside the country. Future competing, non-predictable priorities within the DOE *should not be allowed to adversely affect the program*.
4. A key to success of international radiological security efforts to development of national regulatory infrastructures is finding reliable funding sources *to sustain them.* The NRC's experience (and that of the Agreement States) in developing and sustaining regulatory programs is a resource that should be utilized. To this end, neither NRC licensee fees nor interagency fund transfers should be utilized. Instead, *Congress should directly fund NRC work in this area using general revenues*.
5. Long-term measures must become an integral part of a program to improve radioactive source security:
   - The lack of viable, affordable disposal paths for unused and unwanted sources has led to unplanned storage that increased their vulnerability to loss and theft. In the short-term, programs such as the DOE Off-site Source Recovery Program help address this. *In the long-term, better solutions to low-level radioactive waste disposal must be found*.
   - The IAEA, the National Academy of Sciences, the National Council on Radiation Protection and Measurements, the Health Physics Society and numerous experts have recommended *development and wider utilization of alternative chemical and physical forms of radioactive material in sources and of alternative technologies to replace radioactive sources*. This should be vigorously pursued. Private-public partnerships should be explored as a mechanism for advancing these measures.
   - Because of language barriers or lack of literacy, warning labels on radioactive devices intended to alert individuals to the radiation hazard are not always understood. The use of internationally approved supplementary signage for this purpose *should be required for higher risk sources*.

Mr. Chairman, again thank you for the opportunity to provide testimony on this important subject. I will be glad to answer any questions that you and committee members may have.

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