# COMPREHENSIVE REVIEW OF NUCLEAR MATERIALS OF THE FORMER SOVIET UNION, INCLUDING ILLICIT DIVERSIONS

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**Abstract**

During the past four years the United States (US) has worked with the Russian to assess the diversion vulnerability of nuclear material at Ministry of Defense (MOD) and Minatom sites. The US is also providing funding to prevent such nuclear diversion. Many US and other international programs are interrelated and one picks up where the others leave off. All US/Russian collaborations overlap with respect to institutes, materials, facilities and objectives. Using internal funds we have been developing a database named Russia Integrated Nuclear Complex (R-INC) to provide a comprehensive view of the overall Russian nuclear complex and to better understand US/Russian cooperative projects. The R-INC system is designed to evaluate any country's information or the relationship between countries. We chose Russia for evaluation based upon the large number of US/Russian programs currently in existence. The R-INC database tool could be used to plan and to prioritize these US/Russian programs. Information in R-INC is integrated to show the relationships between material locations, transfers, and processing on a site-by-site basis. By integrating this information in such a systematic and visual fashion, we are creating a tool that can address many programmatic issues, including nuclear nonproliferation. Thus, R-INC can be used to analyze illicit nuclear diversions. R-INC also provides a way to reports of illicit diversions involving nuclear material from the Former Soviet Union (FSU). Data from these reports is cross-correlated with other data in R-INC pertaining to existing and location of Russian nuclear facilities. This correlated data promotes identification of significant trends associated with illicit nuclear trafficking.

## Introduction

In the summer of 1998, a small team at Los Alamos began evaluating the Russian nuclear complex in order to understand how the overall complex works, where nuclear material is located and which U.S. projects exist at each institute. A tool was needed to cross-correlate information on material production, storage, transfers, institutes, regional information, maps, images, and many other relevant data. Therefore the Russian Integrated Nuclear Complex (R-INC) database was designed and is being developed to:

1. provide a better understanding of the nuclear complex of the Former Soviet Union,
2. aid the understanding of what had occurred, and
3. better understand the future complex.

This tool, populated with information on the joint U.S. and Russian programs, can help both secure and prevent the illicit proliferation of FSU special nuclear material

Geographical Information Systems (GIS) software ArcView, from Environmental Systems Research Institute, is used to show the vast amounts of information in a concise format. We have used the mapping capability to graphically show the relationship between sites containing nuclear material, Russian customs offices, and proposed sites for equipment installation. Using this

information and structure we have begun to review regions of nuclear material transfers as an aid in addressing programmatic questions.

**Programmatic Benefits**

R-INC supports the analysis of information in an integrated format to provide assistance to programs dealing with nonproliferation and arms control. It allows information to be collated to provide a more comprehensive understanding about topics of interest. The following are a few examples:

- locations of commercial development and economic health,
- locations of nuclear material storage by safeguard category and gross quantities, and
- transfer of nuclear materials.

Based upon collating the above information we can support the establishment of priorities for funding of nuclear material safeguards and locations of radiation detection at border crossings. Many of the US projects can benefit from general information on the Russian complex to support and establish prioritization of funding and equipment. Information that supports these programs include:

- watching the political stability of regions where nuclear material is located,
- following disease or epidemics occurring in a particular region that could hinder the implementation of safeguards or verification plans?
- following the overall health of support structures within the Former Soviet Union (FSU) including railways, roads, food supply, power infrastructure, and medical support.

Political stability, population health, and infrastructure adequacy are all important to the successful implementation of nonproliferation programs and to the safeguarding of nuclear material. It requires a consistent effort to answer the questions required to effectively prioritize and address the major issues. R-INC provides a useful tool to address these issues and subsequently will promote effective decision-making by program policymakers.

Material safeguard programs can benefit from R-INC by utilizing its profiles of regions surrounding sites containing special nuclear material. In addition to providing information about material types, forms, and approximate quantities at a particular site, important regional socioeconomic factors are included to aid in the evaluation of the materials' security. Political stability, guard and personnel morale, wages, and other issues are vital information to aid the material safeguarding programs.

This type of information system analysis capability can provide program planners and implementers a better understanding of the broad picture at hand, thus enabling them to make more informed decisions. This information system is in its infancy and improvements are added continuously. However, even with the small amount of information that presently populates R-INC, it is possible to make more informed decisions. For example, it is possible to derive which sites have what type of nuclear material and their approximate quantities.

**Sites Containing Special Nuclear Material**

Table I provides a summary of the Russian sites with special nuclear material but does not include sources such as americium. Nor are sites included where nuclear weapons are located. Some of the sites are counted multiple times due to the different types of material contained on-site. Most of the material is involved in various processes such as enrichment, down-blending, chemical separation and nuclear weapon assembly and disassembly.

Table I Estimated Number of Sites Containing Special Nuclear Material Within Russia

| Material Type | | Estimated Number of Sites Containing: | |
|---|---|---|---|
| | Less than 500kg | 500kg-10MT | Greater than 10 MT |
| Fresh Fuel High Enriched Uranium | 9 | 8 | 0 |
| Fuel in Decommissioned Naval Cores | 0 | 14 | 0 |
| High Enriched Uranium | 13 | 13 | 1 |
| Neptunium | 2 | 1 | 0 |
| Reactor-Grade Plutonium | 1 | 0 | 1 |
| Spent Fuel High Enriched Uranium | 1 | 3 | 5 |
| Weapons-Grade Plutonium | 5 | 7 | 2 |
| Weapons-Grade Uranium | 2 | 7 | 0 |

After such information is collected and displayed, material safeguards and nonproliferation programs can use this information to make programmatic decisions about how to prevent nuclear material diversions and how to keep the special nuclear material safely under storage.

**Sites Involved with Nuclear Material Diversions**

Reports of illicit trafficking of nuclear materials from the Former Soviet Union are compiled from numerous foreign and domestic wire services, newspapers, periodicals, testimony of experts, and government reports. Events include: seizures of diverted nuclear material; reports of missing or stolen nuclear materials; reports of unauthorized shipment of nuclear inventory; arrests made by law enforcement agencies of suspected nuclear traffickers; and press releases of laboratory analysis of recovered special nuclear material. Data and summaries of almost all cases of illicit nuclear diversion recorded in R-INC are derived from the open literature, and many of the events were reported by several different sources. R-INC has the capacity to record reports available from open literature, with confidence levels attached to indicate the veracity of the articles or the summaries. The confidence levels assigned to the reports are subjective; they reflect the analyst's ability to confirm the information by finding other reports or sources with similar facts. Cases assigned a "high" confidence level typically have multiple sources of literature containing identical or very similar details describing several important categories of information. These categories may include material quantities, isotopic data, perpetrator-to-site relationships, seizure and/or theft locations, and modes of transportation. While cases assigned a "high" confidence level reflect a number of corroborating sources, the level is still assigned subjectively and reflects the analyst's personal interpretation of the available information. All data sources are submitted and maintained with each diversion case and are available for evaluation by others. The confidence levels serve as a guideline to aid other analysts or policymakers in making programmatic decisions. One analyst has assigned a high confidence level to 40 cases of illicit diversion in R-INC.

There are 184 cases with varying confidence levels of illicit nuclear diversion recorded in R-INC (as of June 1, 1999), starting from the demise of the Soviet Union in 1991. The most recent case includes reports of a seizure of enriched uranium ore in the Ukraine in May 1999. The cases in R-

INC are added on a continual basis and the data from new reports is automatically correlated with the existing data in the database. Information from each case is stored and categorized in appropriate fields within the database. This data is linked with corresponding data from other cases and any potential matching characteristics with Russian nuclear facilities profiled in R-INC. Storage of the facts in this manner allows one to view many or all of the cases comprehensively or from a variety of perspectives. The identification of significant trends or patterns associated with illicit diversions is often a difficult and inconclusive process. R-INC affords the analyst a convenient and effective tool for evaluation based on a highly visual format with maps, photographs, images, and tables included with the data in many of the cases.

Once the data is organized and correlated, analysts have a powerful resource to aid in the identification of significant trends in illicit nuclear diversion activity. These trends can be integrated into the decision making process for funding the protection and accountability of special nuclear materials. A few statistics can be quickly generated from special comparisons of the diversion case data. The following analysis is based upon the 40 cases that have been evaluated to have "high confidence" regarding reliability of information:

- Special nuclear material (plutonium and various forms of uranium metals, oxides, and ceramics) contraband outnumbered natural uranium, radioactive sources (special isotopes), and dual-use material combined 25 to 18. (Several cases involved the diversion of both special nuclear material and dual-use material).
- Less than 90% enriched U-235 was involved in fifteen of these cases. The most recent case involving weapons-grade enriched U-235 occurred in 1995.
- Thirteen cases involve contraband suspected or confirmed as originating from institutes under Minatom authority. Eight of the thirteen involve special nuclear material; six of these were identified as weapons-grade uranium or plutonium. Conversely, none of the three illicit diversions suspected of leaking from Ministry of Defense institutes involved any weapons-grade contraband, although they all involved special nuclear material.
- While eight of thirteen "high confidence" cases originating from sites not yet identified involve special nuclear material, only one has been confirmed to involve weapons-grade contraband.

Useful information and trends can also be derived about the parties involved with the thefts and the modes of transportation used in attempts to get the nuclear materials out of Russia and the former Soviet Union. The perpetrators reported responsible for nuclear diversion attempts have been identified as working for or with the institute or organization safeguarding the materials in sixteen of the 40 cases with a high confidence level. Fourteen of these sixteen indicate identification or suspicion of involvement by authorized facility personnel or "insiders." Six of the fourteen "insider" cases involve authorized personnel from Minatom sites while two involve "insiders" from the Russian Ministry of Defense. The remaining six of the fourteen "insiders" involve Russian commercial and non-Russian organization personnel. The final two cases of the sixteen with identified ties to sites of material origin implicate individuals with responsibility for oversight or with high-level authority at the organizational level.

By correlating the data among the nineteen cases with known primary mode of transport (among the 40 assigned high confidence), some basic trends have been identified:

- Nuclear material was carried over borders covertly by airplane in six of the nineteen cases of identified mode of transport. While three of these flights involved special nuclear material, only one shipment was seized before it crossed an international border.
- Only two of six cases identifying vehicle as the primary transport mode indicated a successful international border crossing.
- Among four cases involving rail transport shipments, three crossed an international border prior to seizure.

In addition to generating trends and statistics, profiles can be created describing activity in geographic regions of Europe and Asia by utilizing R-INC's maps and tables. (See Table 2 and Figure 2).

**Table 2: Regions of Initiation of Illicit Diversion in the Former Soviet Union**

| Suspected Region where Material Initiated | Number of "High Confidence" Cases Involving: | | | |
|---|---|---|---|---|
| | Special Nuclear Material | Natural Uranium | Radioactive Sources | Dual Use Material |
| Azov/Caspian Sea (Caucasus) | 1 | 0 | 2 | 1 |
| Chelyabinsk/Ural Mountains | 3 | 1 | 1 | 1 |
| FSU/CIS - Asia | 4 | 0 | 2 | 0 |
| FSU/CIS - Europe | 2 | 0 | 1 | 1 |
| Kola Peninsula/Northwest | 3 | 0 | 1 | 0 |
| Krasnoyarsk/Siberia | 1 | 0 | 0 | 0 |
| Moscow/Arzamas/Western Russia | 4 | 2 | 0 | 1 |
| Russian Far East | 1 | 0 | 0 | 0 |
| St. Petersburg/Kaliningrad | 0 | 0 | 0 | 0 |
| | | | | |
| Undetermined | 6 | 1 | 4 | 0 |

R-INC successfully integrates these cases with the information describing existing quantities of special nuclear material at Russian nuclear sites to aid scientists, policy makers, and other government officials in assessing the proliferation risks involved with any part of the Russian integrated nuclear complex. In addition, evaluating past illicit diversion activity in conjunction with existing nuclear material inventory can assist experts in determining chances of success for nations or organizations to acquire or build weapons of mass destruction.

**Conclusion**

All of the above sections have been the result of collating large numbers of documents from a wide range of sources. Having comprehensive information about finances, salaries, material amounts, and transportation routes enables a better understanding of how material is transported, its

destination, and its most likely path of travel. Numerous conclusions can be drawn using R-INC regarding transfers, locations, diversions and approximate quantities of nuclear material in the Former Soviet Union and in the funding and training of personnel involved with these processes. Information regarding basic health, poverty, crime, and other socioeconomic issues can be cross-referenced with this information to provide a comprehensive view about the "health" of a region containing nuclear material and the best way to protect the material and prevent "brain drain" or loss of intellectual knowledge by scientists leaving the country due to unpaid salaries. The collated information can aid in various U.S. programmatic issues and in making more informed decisions regarding the monitoring and protection of material. This information system is versatile and can be applied to countries outside the Former Soviet Union and to other weapon complexes, such as biological or chemical weapon complexes.

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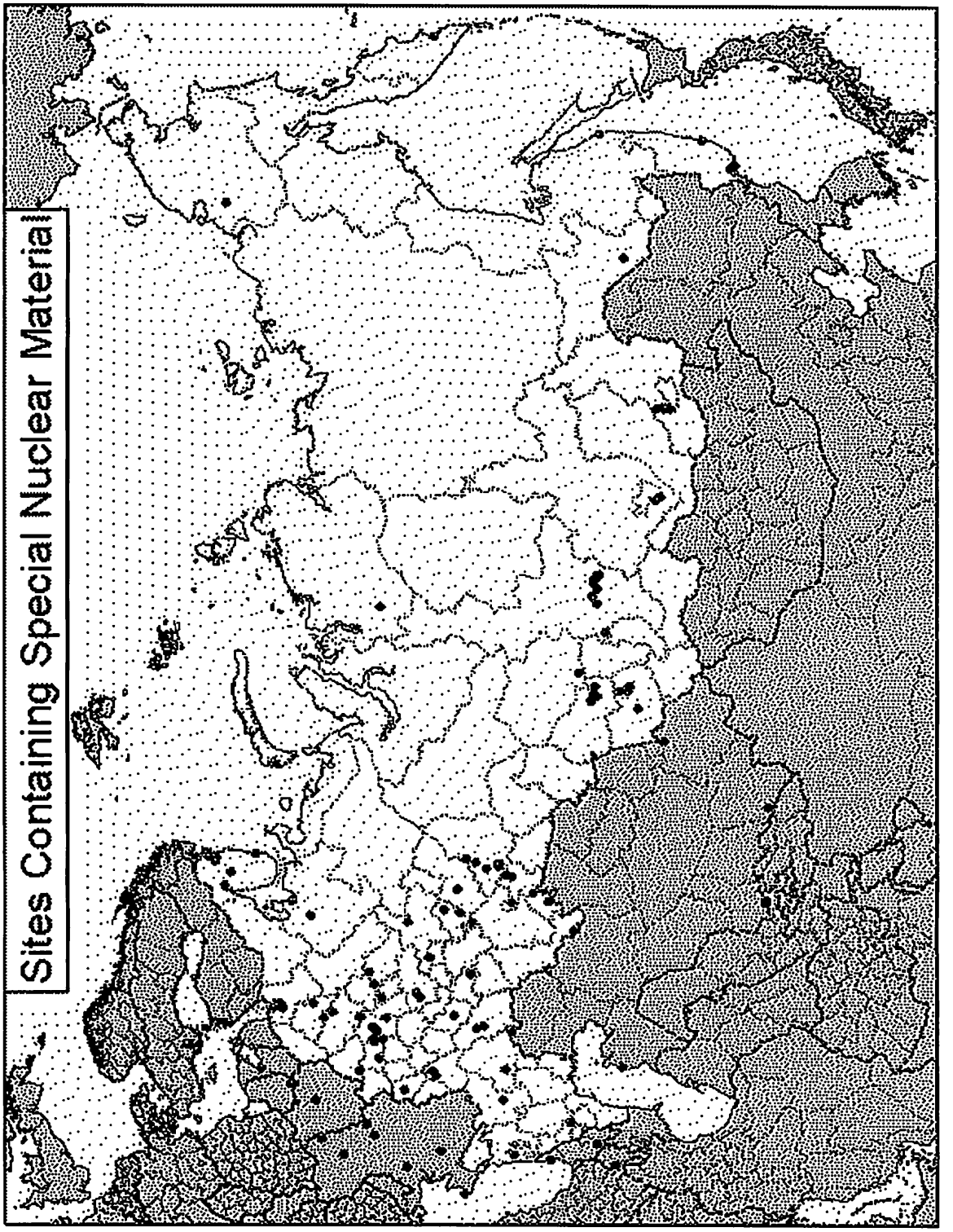


Figure 1: Map of the Former Soviet Union showing sites containing special nuclear materials in different forms and types.

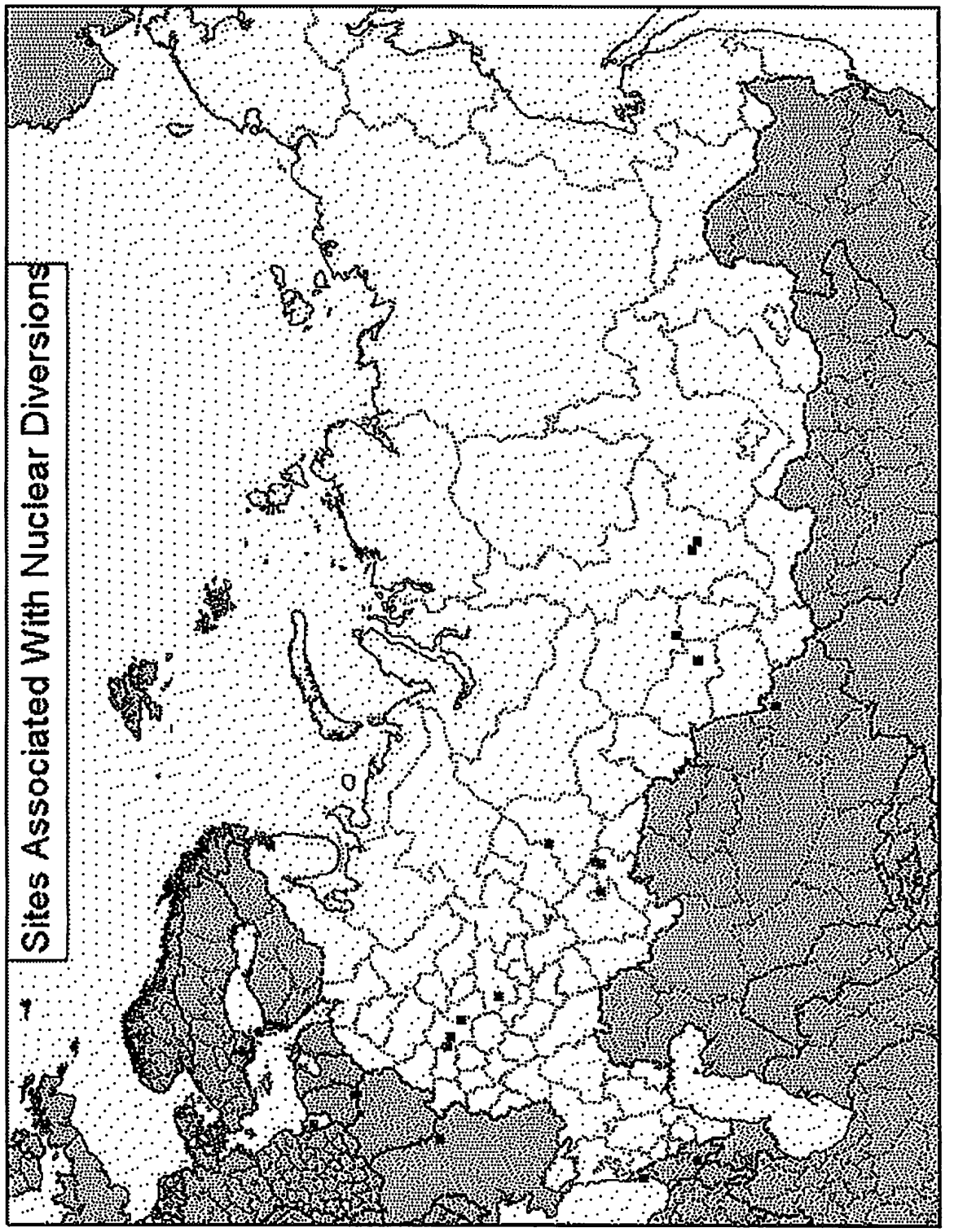


Figure 2: Sites in the Former Soviet Union which are associated with nuclear material diversions.