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# Developing a nuclear material control and accounting system in Russia

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## Introduction

When considering the requirements for a global nuclear material accounting system, Russia's experience in developing its domestic system deserves special attention for four reasons: First, Russia's nuclear complex includes all of the types of nuclear facilities and nuclear material handling procedures that would be subject to a global system. Second, Russia has significant experience transitioning from an outdated system to a modern one. Third, Russia has operated its nuclear complex in a financially constrained environment and has relied in part on international assistance. Finally, the Russian nuclear complex is managed by many agencies with their own agendas, priorities, and visions of nuclear material accounting. This experience with an interagency environment may be a model for other countries.

As a major nuclear power—in both military and civilian applications—Russia possesses all possible types of nuclear facilities, including all types of nuclear reactors, a complete range of fuel cycle facilities, storage sites, and several types of nuclear ships.[1] Russia also possesses a wide variety of nuclear materials, including all types of uranium and various isotopic compositions of plutonium. These materials exist in both items and bulk accounting forms, as well is in a number of physical forms including metals, oxides, solutions, and salts. These materials are subject to a broad range of operations–at both the industrial scale and in smaller quantities for research purposes. Russia is also heavily involved in the domestic and international trade of nuclear materials. This results in a significant volume of nuclear materials transport—to include changes in ownership and in control and accounting requirements and systems.

Russia began transitioning from its Soviet-era nuclear material accounting systems in the early 1990s. The Soviet Union was home to a comprehensive nuclear industry and nuclear materials accounting system. Thus, a modern system based on new standards had to be introduced into an operating nuclear complex. This process has confronted many challenges, in part because of the major cultural change that it required. After nearly 20 years of evolving the Russian system, some important issues remain unresolved.

## A broad range of stakeholders with diverse interests

While the State Atomic Energy Corporation (Rosatom) controls the majority of the inventory of nuclear materials and facilities in Russia, at least four other agencies are involved in the handling of weapons-usable nuclear materials. In addition, the regulatory body, Rostechnadzor, and several agencies working with lower category nuclear materials are

[1]This last group is distinguished from other nuclear reactors due to the existence of certain characteristics related to accounting and control of nuclear materials at this type of facilities.

directly involved in nuclear material control and accounting (MC&A) activities. The interests of all these agencies, as well as the Ministry of Justice, which does not work with nuclear materials but manages the development of regulations, need to be reconciled when defining requirements for nuclear materials control and accounting.

It is mainly because of this interagency arrangement that a long-awaited revision of the key Russian regulation that defines requirements for nuclear materials control and accounting was enacted only in November 2012—two and a half years after a well-developed draft was published for public review. The key reason for this delay was a misunderstanding between the developers and the Ministry of Justice. While the developers did not appreciate the regulatory requirements and practices imposed by the Ministry of Justice, the Ministry of Justice was unwilling to take into account nuclear security specifics and unique challenges distinguishing it from other areas of regulation.

An analysis of Russian interagency relations in the area of nuclear materials control and accounting could provide insights that would be useful when trying to facilitate negotiations between stakeholders attempting to develop a global nuclear materials control and accounting system. For example, most Russian agencies handling nuclear materials, with the exception of Rosatom, work with nuclear materials in the form of items (primarily fuel assemblies) that they receive from Rosatom facilities. These types of materials are subject to different control and accounting requirements than materials in bulk form. Meanwhile, Rosatom plays the primary role in developing MC&A regulations and does not always take into account the specific conditions and types of materials used by other agencies and entities when developing its recommendations. The future global distribution of nuclear materials could resemble this arrangement, where most participants only have materials in the form of items and will not operate fuel cycle facilities with bulk-form materials.

**IAEA safeguards and Soviet material accounting practices**

A good system of nuclear materials control and accounting needs to include measures aimed at ensuring that nuclear material is not diverted for unauthorized use. These measures were articulated in “The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons” (Model IAEA Safeguards Agreement, INFCIRC/153) adopted in June 1972.

Article 32 of this agreement requires that “the State's system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement shall be based on a structure of material balance areas, and shall make provision as appropriate and specified in the Subsidiary Arrangements for the establishment of such measures as:

> (a) A measurement system for the determination of the quantities of *nuclear material* received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory;

(b) The evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty;
(c) Procedures for identifying, reviewing and evaluating differences in shipper/receiver measurements;
(d) Procedures for taking a *physical inventory;*
(e) Procedures for the evaluation of accumulations of unmeasured inventory and unmeasured losses;
(f) A system of records and reports showing, for each *material balance area*, the inventory of *nuclear material* and the changes in that inventory including receipts into and transfers out of the *material balance area;* and
(g) Provisions to ensure that the accounting procedures and arrangements are being operated correctly."

Safeguards agreements developed on the basis of this "model" agreement are mandatory for non-nuclear weapon parties to the Nuclear Non-Proliferation Treaty (NPT). As long as the Soviet Union/Russia maintains a nuclear weapons arsenal, it is unlikely to sign such an agreement. So while, the Soviet Union did contribute to negotiating and approving INFCIRC/153, its system of nuclear materials accounting and control is quite different than that specified under the model agreement.

The Soviet system of nuclear material control and accounting was primarily concerned with financial accounting and the control of technology and industrial operations that included nuclear material. [2] The foundation of this type of control involved assigning continuous, *personal* responsibility for nuclear material to individuals at facilities. Once nuclear material arrived at a facility, it was placed under the personal responsibility of a specific employee. After that employee conducted an assigned technological operation, responsibility for the material was transferred to another employee who conducted the next operation. The nuclear material "path" through a facility was determined by documents that guided technology operations. To ensure accurate nuclear materials accounting throughout this process, every technology operation was assigned a standard level of irretrievable losses. Such a system does not require the measurement of materials or the evaluation of *actual* losses. It works as long as losses are within limits established for specific technology operations.

To put this system in terms familiar to those who work with more traditional material accounting and control systems, a standard level of irretrievable losses was the only criteria for evaluating inventory differences. Under the Soviet/Russian system, inventory differences were simply the difference between nuclear material inputs and nuclear material outputs from a specific technology process. If the difference was less than the sum of standard levels of irretrievable losses for all technology steps involved, then the difference was not investigated. In other words, actual losses were not measured. Under more traditional MC&A

[2]This description of nuclear materials accounting and control is largely based on the following article: Alexander Rumyantsev, "State System for Accounting and Control of Nuclear Materials and Radioactive Substances in Russia," *Yaderny Kontol (Nuclear Control) #15*, March 1996.

requirements, losses must be either measured or evaluated using experiment-based methods, and the specific values of losses must be taken into account when calculating inventory differences. The criteria for inventory difference acceptability in traditional MC&A are driven by the need to prevent the loss of a significant quantity of nuclear material. The Soviet Union's arrangements were somewhat mitigated by the fact that the system of personal responsibility was supplemented by tight control over all nuclear personnel by state security services.

The control of technology operations with nuclear materials was supplemented by the financial accounting of nuclear materials. The key parameters in this type of accounting were the monetary value of materials and the changes in material value through technology operations. Parameters that are typically critical for material accounting and control, such as mass and isotopic composition, were considered secondary and controlled only to ensure that a final product complied with established specifications. Financial accounting, contrary to accounting based on measurements, does not take into account potential measurement errors. This approach is sufficient when accounting for items, such as fuel assemblies, that can be counted with high confidence, where the lack of tampering can be verified via use of tamper indication devices, or where an item has unique characteristics, e.g. surface microstructure. This approach is unacceptable, however, when accounting for bulk nuclear materials, e.g. pellets, powder, solutions, etc.

Under this system, nuclear facilities had to provide financial accounting reports and take financial accounting inventories. The scopes and frequencies of these reports and inventories depended on the types of nuclear materials handled at each facility. These processes also didn't involve physical inventories based on measurements but rather relied on documentation accompanying specific products, such as fuel assemblies.

**The development of Russia's modern state system of accounting and control**

The Soviet Union began to introduce material accounting practices based on measured material balances in the mid-1980s, when it agreed to implement IAEA safeguards at a limited number of Russian nuclear facilities. The Soviet Union signed a safeguards agreement with the IAEA on February 21, 1985, and the agreement entered into force on June 10, 1985.[3] One VVER-1000 reactor at the Novovoronezh nuclear power plant and one research reactor at the Kurchatov Institute in Moscow were the only facilities subject to IAEA safeguards. As a result of these activities, site-level MC&A systems that met IAEA standards were established at each of these facilities. A set of regulatory documents were also developed to govern safeguard activities at these sites.

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[3]Agreement of 21 February 1985 Between the Union of Soviet Socialist Republics and the Agency for the Application of Safeguards in the Union of Soviet Socialist Republics - INFCIRC/327

Not until the collapse of the Soviet Union did efforts to further improve MC&A in Russia receive additional impetus. The Soviet system was adequate for the social, economic, and political environment of a state with tightly controlled borders. This environment changed drastically after the Soviet Union collapsed, increasing the need for new approaches to MC&A. Russian political leadership recognized this, but significant changes in MC&A practices at Russian nuclear facilities only became possible after U.S. financial support commenced.

On September 15, 1994, Russian President Boris Yeltsin issued Decree #1923 “On Immediate Measures to Improve the System of Nuclear Materials Accounting and Safeguards.” This decree ordered the government to:

- establish an interagency commission to review the status of accounting and physical security practices for nuclear materials;
- initiate the development and implementation of a State System of Accounting and Control of Nuclear Materials that included the development of federal regulations, the creation of a federal information system, the enhancement of state oversight inspections, the development of modern MC&A equipment, and compliance with international nuclear nonproliferation obligations;
- identify additional funding to support the development and implementation of an SSAC; and
- consider funding MC&A activities as a priority when developing the federal budget.

On November 21, 1995, the President enacted the federal law “On the Use of Atomic Energy,” which was intended to govern civilian nuclear energy applications. The law identified nuclear material control and accounting as a key part of atomic energy use and defined all nuclear materials, regardless of ownership rights, as subject to MC&A. The goal of MC&A is to determine the actual quantity of nuclear materials, substances, and waste at each location, and to prevent the loss, unauthorized use, or theft of material. The law also provided Russian authorities, nuclear managers, and nuclear regulatory agencies with information on the availability and movements of nuclear materials. Perhaps most significantly, the law established MC&A as the responsibility of nuclear facility operators.

**Russian MC&A regulatory documents**

Russian industry officials and experts have created a set of regulations establishing MC&A requirements for the state and facility levels. This regulatory framework is made up of three key documents. The first, the above-mentioned federal law “On Atomic Energy Use,” established the fundamental requirement that nuclear facilities have MC&A systems. The second, Government Decree #352, was issued on May 6, 2008. This decree, known as “Regulation on the State System for Nuclear Material Accounting and Control,” established the structure of the state system and the key responsibilities of all stakeholders, including government authorities, operators, and supporting organizations. This decree superseded a similar decree that was issued in late 1990s.

The third key regulatory document is the "Basic Rules of Nuclear Materials Accounting and Control," which is known in U.S. and Russian MC&A communities by its Russian acronym: OPUK. This document, which is similar to the U.S. Code of Federal Regulations, established mandatory MC&A requirements for all entities operating nuclear facilities and handling nuclear materials. This document defines the necessary components of site-level MC&A systems and the requirements of these components. This document was initially issued in 2001 and was revised in 2005 and 2012. Finally, government agencies have created dozens of regulations and standards that establish requirements for specific MC&A components, including material balance areas, physical inventories, systems of measurements, nuclear materials transfers, accounting and reporting documentation, tamper indicating devices (seals), personnel training, etc.

OPUK is the most important regulation in this set, as it defines the comprehensive set of mandatory MC&A requirements for nuclear materials in civilian use. This document is used as a basis for issuing operating licenses to facilities, as well as for inspections conducted by Rostechnadzor, the Russian nuclear regulatory body. Violations of OPUK requirements can result in sanctions, including the withdrawal of a site's operating license.

**Table 1. Specific MC&A activities and components included in current Russian regulations**

| | |
|---|---|
| A measurement system able to determine quantities of *nuclear material* received, produced, shipped, lost, or otherwise removed from inventory, and the quantities in inventory. | ✓ |
| A system to evaluate the precision and accuracy of materials measurements and estimates of measurement uncertainty. | ± |
| Procedures for identifying, reviewing, and evaluating differences in shipper/receiver measurements. | ✓ |
| Procedures for taking a *physical inventory.* | ✓ |
| Procedures for evaluating accumulations of unmeasured inventories and unmeasured losses. | ± |
| A system of records and reports that show the inventory of nuclear material and the changes in that inventory for each material balance area, including receipts into and transfers out of the balance area. | ✓ |
| Provisions to ensure that the accounting procedures and arrangements are being operated correctly. | ± |

While existing regulations cover most necessary elements of an MC&A system (see Table 1), industry officials and experts continue to work to improve the regulatory basis for MC&A. They are developing new regulations required to close existing gaps, and reviewing and revising existing regulations to reflect changes and feedback from operations under current requirements. For example, industry officials and experts recently completed the third revision of OPUK. Specific improvements in the regulations that are worth noting, include: requiring that each site establish a designated MC&A organization; requiring that the book inventory be adjusted on the basis of a physical inventory taking; requiring the application of seals with unique identifiers to the most attractive categories of nuclear materials; and requiring the adoption of a two-person rule when accessing and working with nuclear material in certain situations.

This latest version of OPUK addresses deficiencies in previous versions of the regulation and reflects the accumulation of MC&A experience at Russian nuclear sites. OPUK is not perfect, however, and future revisions will be necessary to close additional gaps (e.g., the need for trending analysis of inventory differences during consecutive physical inventories to detect potential protracted thefts of nuclear materials) that exist in part because some Russian facilities don't have the capacity to meet current requirements. Three areas in particular require significant additional regulatory development: measurement methodologies, statistical analysis of physical inventories, and the evaluation of MC&A systems at the agency and site levels.

Measuring materials and reconciling records for accounting purposes requires the use of methods certified at the industry level. Developing these types of methods also involves testing measurement processes to confirm that they are appropriate for specific measurement tasks and that they are sufficiently accurate. While some measurement protocols can be applied at multiple facilities, some are unique to certain facilities due to the specific technology that is used, equipment design, and the parameters of handled materials. While some methodologies have been developed toward this end, dozens more are likely still needed.

The latest version of OPUK does establish the general requirement that statistical analysis be used at the completion of each physical inventory-taking. However, it does not establish specific requirements, goals, or criteria. Several Russian facilities are developing relevant analytical methods, but it will take several years for these methods to be fully developed and tested, for personnel to be trained in using them, and for facilities to acquire the necessary technological capabilities to conduct them.

Government Decree #352 and OPUK establish the high-level requirement for the Russian government to maintain control over the State System of Accounting and Control and the importance of site-level self-evaluations. The regulatory documents that will provide details on implementing this requirement are under development with U.S. support.

It is important to highlight two features of the institutional framework for MC&A activities in Russia. First, all nuclear materials in Russia are owned directly by the State or by State-owned legal entities; weapons usable nuclear materials are owned *only* by the State. (A complete list of nuclear materials owned exclusively by the State is provided in Appendix A.)

These materials are subject to tighter accounting requirements than are non-weapon-usable materials. Second, civilian and defense nuclear materials have separate accounting systems. Available regulatory documents provide general information for how these two systems interact, however, detailed procedures are not available.

There are three key stakeholders for MC&A regulation in Russia: Rostechnadzor, the agency responsible for establishing key requirements for MC&A and ensuring compliance through licensing and oversight inspections; Rosatom, the agency that manages SSACs, including the Federal Information System for Nuclear Materials Accounting and Control (FIS); and the nuclear sites themselves, which handle nuclear materials, develops site specific MC&A systems, and report changes in material inventories to the FIS.
Other organizations with minor roles include federal agencies overseeing certain non-Rosatom nuclear facilities and specialized organizations providing support in the areas of measurements, personnel training, and other areas related to development of site-specific MC&A systems.

**The Federal Information System**

To efficiently operate its SSAC, in 1996 Rosatom established the Federal Information System for Accounting and Control of Nuclear Materials (FIS). According to Government Decree #352: "Rosatom is required to ensure the development, establishment, and operation of the federal automated information system for accounting and control of nuclear materials, establish information analysis organizations and (or) centers for information collection and processing."

The FIS is used to accumulate and analyze data on available nuclear material inventories and inventory changes at operating nuclear facilities. This data is then provided to federal authorities. The FIS consists of an Information Analysis Center, a Data Communication System, and site-level components that are used to generate information submitted to the Information Analysis Center. The key element of the FIS's federal-level infrastructure is the Information Analysis Center, which is run by Rosatom.

Despite these positive developments in Russia's capacity to account for nuclear materials on the national level, two significant reporting issues remain. First, while most sites provide their reports in electronic form, paper-based reporting is still allowed. Second, information is provided to the FIS not from the level of a single material balance area, but from so-called "reporting areas," which represent aggregates of several material balance areas. This structure simplifies reporting for complex facilities with multiple material balance areas, but it means that detailed data is not reported to the federal level. This type of data is maintained at the facility level and is available for review in case of inspections or requests for details. As a consequence of this set up, the quality of the raw, facility level data is not routinely checked.

## The impact of international nuclear security assistance on Russian MC&A standards

Russian international cooperation, primarily with the United States, has been one of the most critical factors affecting the development of modern MC&A systems at Russian nuclear facilities. This cooperation has helped to resolve many of the cultural, technical, and funding obstacles to developing MC&A in Russia.

The collapse of the Soviet Union instigated U.S. support for a range of Russian nuclear-related programs, including some aimed at material control and accounting. A March 1996 Government Accounting Office (GAO) Report referred to the U.S. belief that the Soviet MC&A system accounted for nuclear material, but was "not complete, timely, or accurate." The collapse of the Soviet Union eliminated some of the controls that had been effective under the old system and significantly increased the risk of nuclear materials theft.

The U.S. Department of Defense sponsored the Cooperative Threat Reduction (also known as "Nunn-Lugar") Program in 1993. And the Department of Energy launched its laboratory-to-laboratory program in 1994. Both of these efforts included improvements related to MC&A: raising awareness of and training in MC&A best practices, developing Russian nuclear security culture, developing updated MC&A regulations, supplying Russian facilities with MC&A equipment, developing the Federal Information System, developing Rostechnadzor and Rosatom inspection capabilities, and conducting initial physical inventory takings at certain facilities. These cooperative programs remain active, but there have been changes in the way they are implemented.

*Education and Training*. Personnel training has been perhaps the most important component of the cooperative programs. If MC&A personnel do not know how to do their jobs, other components of the system are useless. This is why the development of indigenous Russian training capabilities was a priority of the U.S.-Russian cooperative framework from the very beginning. In March 1994, U.S. and Russian officials decided to establish the Russian Methodological and Training Center (RMTC), which now spearheads Russian MC&A training efforts.[4] After its establishment, the center conducted a training needs assessment that involved U.S. experts and representatives from Russian nuclear facilities. This assessment was then used to develop a training course and to inform decisions about facilities' infrastructure needs. Today, the center features curriculum for more than 30 training courses that cover the complete scope of MC&A activities, including fundamentals, nuclear material control, non-destructive assay, statistical methods, development and use of MC&A software, and monitoring status of MC&A. These courses target a range of personnel categories–facility management, MBA managers, nuclear material custodians, members of

[4]U.S.-RUSSIAN COLLABORATION IN THE DEVELOPMENT OF THE RUSSIAN METHODOLOGICAL AND TRAINING CENTER. Alan M. Bieber, Brookhaven National Laboratory, Greg Sheppard, Los Alamos National Laboratory, G. Pshakin, Institute of Physics and Power Engineering, Kate Bricker, Pacific Northwest National Laboratory, R. Cross, PNNL, D. Dickman, PNNL, D. Ek, SNL,C. Key, ORNL, B. Ryazanov,, Institute of Physics and Power Engineering, G. Sanord, LLNL, D. Liles, DOE/HQ. Presentation to the Institute of Nuclear Materials Management Annual Meeting, 1996

physical inventory taking committees, and inspectors. Several hundred students attend these training courses annually. New training courses are developed on an as-needed basis.

To expand training opportunities, Russia has also established facility-level training centers at major facilities with U.S. support. Instructors at facility-level training centers are typically trained at the RMTC, receive support from RMTC officials in developing training courses tailored to the needs of specific facilities, and transfer their knowledge to facility personnel.

In 2009, Russian officials issued a new regulatory document, “Methodological Instructions for Organizing and Conducting Initial and Advanced Training in the Area of Nuclear Material Protection, Control, and Accounting for Personnel at Joint Stock Companies, Institutions, and Federal Government Enterprises Under the Jurisdiction of the Government Corporation Rosatom,” to support the development and continuous updating of MC&A training programs at Rosatom nuclear facilities. This document established training program requirements and recommended the use of a systemic approach to training that is shared by U.S. experts. This approach involves five key stages of the training lifecycle: analysis, design, development, implementation, and evaluation. Such an approach allows officials to continuously improve training programs based on needs analyses and feedback from facility-level operators. Similar regulations were developed for several other agencies.

In addition to professional training for industry personnel, U.S.-Russian cooperative efforts led to the creation of two university-level programs—at the Moscow Engineering Physics Institute and the Tomsk Polytechnic Institute—aimed at preparing graduates in the area of MC&A. These programs graduated their first classes in 1999, and they continue to prepare several dozen specialists annually. In contrast to the training center programs, the university programs cover a broad range of issues, including some MC&A topics. Graduates from these typically do not work as technicians or operators, but rather as system managers. (The author of this paper graduated from the program at the Moscow Engineering Physics Institute in 2000. One of his classmates now holds one of the most senior positions in charge of MC&A oversight at Rostechnadzor.)

*Development of MC&A regulations*. As shown in Table 1, most MC&A issues are currently being addressed by new and revised Russian regulations. Most of these regulations have been developed with expert, organizational, and funding support provided under the U.S. MPC&A program. Officials have developed dozens of regulations aimed at different levels of the Russian nuclear complex, from Federal-level general requirements to detailed agency-level regulations and standards. Russian organizations have taken the lead in developing these regulations, while U.S. experts share their expertise when feasible. Despite the close cooperation between U.S. and Russian officials, certain Russian regulations differ significantly from their U.S. analogues, and use different approaches that reflect specific Russian requirements.

Some regulations have been repeatedly revised since the late 90s. These revisions have attempted to incorporate feedback from the implementation of previous versions; they also reflect changing requirements on Russian nuclear facilities whose capabilities have grown.

*Supplies of MC&A equipment*. Equipment used to measure nuclear materials and determine their isotopic compositions are the most essential pieces of hardware for the operation of MC&A systems. Other important equipment includes tamper indicating devices (TIDs), used to detect access to nuclear materials; bar-coding equipment; and other auxiliary equipment, such as information used for the automation of MC&A operations and for reporting accounting information to the FIS.

An analysis conducted by the joint U.S.-Russian working group supporting the development of MC&A in Russia shows that as of December 2011, 1,188 items of measurement and bar-coding equipment were available at Russian nuclear sites.[5] This equipment includes scales, gamma-spectrometers, active-well coincidence counters, etc. Most of this equipment was purchased as part of U.S.–Russian cooperation efforts and was paid for by the U.S. Department of Energy.[6]

The same analysis shows that an additional 143 pieces of equipment are currently needed and does not take into account equipment that will need to be replaced in the coming years. Ideally, Russian nuclear sites are supposed to have the capability to sustain their material accounting capabilities and purchase needed equipment using their own funding or funding provided from the Russia federal budget. However, most Russian nuclear sites expect that the United States will continue supporting new equipment purchases and the maintenance of available equipment.

*Development of the Federal Information System*. U.S. support was critical to the development of the Federal Information System. While nuclear facilities are currently required to report to the FIS and pay for their site-level infrastructure from their own funds, most of the progress in this area has been achieved with U.S. funding.

Cooperation between the U.S. and Russia on the FIS started in 1996; on the U.S. side, Lawrence Livermore National Laboratory played the most active role. [7] During the first stage of cooperation, from 1996 to 1999, officials created a conceptual design for the system; a prototype of the Information Analysis Center was developed, as was the infrastructure necessary to support FIS operation; and several nuclear facilities started a trial operation of the system.

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[5]http://www.vniia.ru/rgamo/rg/plan/doc/planrus.pdf. Page 23.
[6] The working group doesn't explicitly report which pieces of equipment were purchased by U.S. funds, yet facility operators routinely report purchases of equipment, spare parts, and technical maintenance as a key part of their contracts with the U.S. national laboratories.
[7]The Russian Federal Information System for Nuclear Material Control and Accounting: Yesterday, Today and Tomorrow**.** V. P. Berchik, MinAtom's Situation and Crisis Center, L. A. Kasumova, MinAtom's Situation and Crisis Center, R. A. Babcock, Lawrence Livermore National Laboratory, C. L. Heinberg, Pacific Northwest National Laboratory, W. Kilmartin, U.S. Department of Energy, A.A. Martyanov, Minatom of Russia, V.A. Pitel, Minatom of Russia. Presentation to the Institute of Nuclear Materials Management Annual Meeting, 2002

The second stage, which started in 2000, involved the full-scale implementation of the FIS at all civilian nuclear facilities. The first stage of the project revealed how difficult financially it would be for most Russian nuclear facilities to report nuclear materials inventory at the level of detail originally proposed for the FIS. As a consequence, both U.S. and Russian officials worked to revise reporting approaches for facilities with limited resources, while still providing authorities with a sufficient level of detail.

The third stage of cooperation started in 2005, when the Joint Coordinating Committee—the main governing body of cooperation between U.S. and Russian officials—decided to emphasize the importance of the FIS's long-term sustainability.[8] The committee set the end of 2012 as the date at which the system's transition to sustainable operation should be complete. However, it remains unclear to what degree Russia is currently capable of supporting the system. While the federal-level infrastructure is available, the capabilities of individual facilities vary. Large, wealthy facilities can afford information systems that allow proper reporting in electronic form; small less-resourced facilities cannot.

*Initial physical inventory takings*. Assembling complete, measurement-based initial physical inventories of nuclear materials is a key element of conducting MC&A. Yet, only a handful of Russian nuclear sites have conducted actual initial physical inventory takings that would meet international standards. Sites where initial physical inventories have been conducted include individual material balance areas at research facilities, where relatively insignificant amounts of nuclear material are handled. Major production sites, where dozens of tons of nuclear material are located, have not been subject to this type of inventory taking. This shortcoming is in part due to resource constraints. Complete, measurement-based physical inventory taking is extremely time consuming and requires significant human resources.

At some point during the development of the FIS, Russian authorities concluded that the records of materials inherited from the old, Soviet system were sufficient to serve as a baseline for the new accounting system. More recently, some Russian facilities have expressed interest in completing measurement-based physical inventories; they've noted the need for initial physical inventory taking as part of their effort to consolidate legacy nuclear material in passive storage.

*Expert support and best practice exchanges*. Expert support and best-practice exchanges within U.S.-Russian cooperation efforts have made important contributions to Russian nuclear security, including MC&A. By engaging directly with U.S. scientists and officials, Russian participants learned about U.S. best practices, used them in practice, and prepared to adopt tougher regulatory requirements. While benefits of these interactions to U.S. officials are not obvious, the exchanges allowed U.S. participants to familiarize themselves with and gain an appreciation for Russian approaches.

[8]Ensuring the Sustainability of Russian Federation National Nuclear Material Accounting System. Victor Pitel, Russian Federal Atomic Energy Agency, R. A. Babcock, Lawrence Livermore National Laboratory, L. A. Kasumova, TsNIIATOMINFORM, M. S. Kushnaryov, Situation and Crisis Center of Rosatom. Presentation to the Institute of Nuclear Materials Management Annual Meeting, 2006

Expert support and best practice exchanges have taken on different forms, including: high-level meetings to brief management on the issue at hand and to secure their commitment and support for best practices; formal workshops involving subject-matter experts and nuclear-site personnel who share detailed technical information on particular issues; U.S. experts' comments on Russian deliverables, including draft regulations, training materials, and elements of the system design; and translations from English into Russian of U.S. regulations, standards, books, and other materials covering issues of interest.

In late 2012, Russian authorities stated that they did not intend to extend the CTR Umbrella Agreement that expired in June 2013, which served as the foundation for nuclear security cooperation. Three reasons are commonly provided for this decision: first, Russia has sufficient resources to take care of its nuclear security; second, liability indemnification provisions in the existing agreement no longer satisfy Russian interests; and third, U.S. access to Russian nuclear sites within the framework of cooperation reveals sensitive information about the Russian nuclear complex. This last reason is typically not voiced by official sources.

On June 14, 2013, the United States and Russian signed a new bilateral framework on threat reduction. According the U.S. announcement about the framework, it "authorizes the United States and the Russian Federation to work in several areas of nonproliferation collaboration, including protecting, controlling, and accounting for nuclear materials."

**Lessons learned for a global nuclear material accounting system**

Russia's experience developing a modern MC&A system can provide several lessons for the implementation of a global nuclear material accounting system. For starters, all parties involved in such a system—from national authorities to individual nuclear site employees—need to understand and acknowledge its potential value. If any of these parties fail to see the value in such a system, then the whole system will fail. Also, if a government doesn't establish adequate MC&A requirements and properly enforce them, then nuclear sites will lack incentives to implement adequate MC&A measures.

Second, advocates of a global nuclear material accounting system need to plan ahead, yet be prepared to adjust their plans as the development of such a system proceeds. Negotiation and implementation of the system will be time consuming due to sensitivities around this issue; and sustainability planning needs to be considered as an initial part of any multi-state negotiation. The key to sustainability is ensuring the financial commitment of participating countries. Some system participants will need support during the implementation of a global system, yet they need to be committed to supporting the system domestically over the long run. Without this type of support, the system would be supported by only a handful of advocates with sufficient expertise and resources.

Third, all stakeholders need to be involved, including governments, regulators, and industry. Involving all parties at the outset will help to avoid developing a system that would be hard to implement at the facility level.

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**Author bio**

Dmitry Kovchegin works as an independent consultant. Prior to 2013, Dmitry was the Lead Associate in the Booz Allen Hamilton office in Moscow, Russia. In these capacities, Dmitry has been providing support to the U.S. Department of Energy and its national laboratories in implementing nuclear security cooperation programs with Russia, Ukraine and Belarus. Dmitry has been involved in multiple efforts aimed at developing national infrastructure supporting nuclear security operations at nuclear sites. Before joining Booz Allen Hamilton in 2004 Dmitry worked as visiting researcher at Harvard University's Belfer Center for Science and International Affairs and research associate at PIR Center for Policy Studies in Russia (Moscow, Russia). Dmitry holds BS in nuclear engineering and MS in nuclear materials security and nonproliferation from Moscow Engineering Physics Institute.

**APPENDIX A: List of Nuclear Materials That Can Be Owned Exclusively by the Federal Government**[9]

1. Uranium enriched to 20% and higher of U-235 excluding uranium:
a) contained in the nuclear fuel of nuclear power plants, transportation power units and research reactors;
b) contained in detectors of ionized radiation, targets of elementary particle accelerators and sealed radiation sources.
2. Plutonium, excluding plutonium:
a) contained in irradiated nuclear fuel or reactor fuel consisting of uranium and plutonium chemical compounds [cover MOX];
b) contained in sealed radiation sources;
c) contained in detectors of ionized radiation;
d) contained in targets of elementary particle accelerators;
e) containing 80% or more of Pu-238.
3. Nuclides: U-233, Np-237, excluding nuclides:
a) contained in irradiated nuclear fuel;
b) contained in sealed radiation sources;;
c) contained in detectors of ionized radiation;
d) intended for use in industry, science or medicine in the amount not exceeding minimum quantity established by federal norms and rules in the area of nuclear materials accounting and control

[9] In accordance with the President of Russia Decree #556 of April 27, 2007 "On Restructuring Nuclear Power Industry Complex of the Russian Federation"