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# Integrated Global Nuclear Materials Management Preliminary Concepts

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June 20, 2006

Institute of Nuclear Materials Management, 47th Annual  
Meeting  
Nashville, TN, United States  
July 16, 2006 through July 20, 2006

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# **INTEGRATED GLOBAL NUCLEAR MATERIALS MANAGEMENT PRELIMINARY CONCEPTS**

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## **ABSTRACT**

The world is at a turning point, moving away from the Cold War nuclear legacy towards a future global nuclear enterprise; and this presents a transformational challenge for nuclear materials management. Achieving safety and security during this transition is complicated by the diversified spectrum of threat “players” that has greatly impacted nonproliferation, counterterrorism, and homeland security requirements. Rogue states and non-state actors no longer need self-contained national nuclear expertise, materials, and equipment due to availability from various sources in the nuclear market, thereby reducing the time, effort and cost for acquiring a nuclear weapon (i.e., manifestations of latency). The terrorist threat has changed the nature of military and national security requirements to protect these materials. An Integrated Global Nuclear Materials Management (IGNMM) approach would address the existing legacy nuclear materials and the evolution towards a nuclear energy future, while strengthening a regime to prevent nuclear weapon proliferation.

In this paper, some preliminary concepts and studies of IGNMM will be presented. A systematic analysis of nuclear materials, activities, and controls can lead to a tractable, integrated global nuclear materials management architecture that can help remediate the past and manage the future. A systems approach is best suited to achieve multi-dimensional and interdependent solutions, including comprehensive, end-to-end capabilities; coordinated diverse elements for enhanced functionality with economy; and translation of goals/objectives or standards into locally optimized solutions. A risk-informed basis is excellent for evaluating system alternatives and performances, and it is especially appropriate for the security arena. Risk management strategies – such as defense-in-depth, diversity, and control quality – help to weave together various technologies and practices into a strong and robust security fabric. Effective policy, science/technology, and intelligence elements are all crucial and must be harmonized. It is envisioned that integrated solutions will include reducing and securing nuclear/radiological materials at their source; improved monitoring and tracking; and enhancing detection, interdiction, and response. An active architecture, artfully combined of many synergistic elements, would support national actions and international collaboration in nuclear materials management, and it would help navigate a transition toward global nuclear sustainability.

## **INTRODUCTION**

The nuclear era is at a key transition point, moving from an initial 50 years dominated by the development of nuclear weapons and nuclear power, moderated by the bipolar Cold War dynamic, to today’s emerging global nuclear enterprise seeking nuclear materials, equipment, and technology for peaceful purposes while containing the threat of proliferating weapons of mass destruction. Regardless of the future of nuclear weapons or nuclear energy, managing the generation, flow, and use of nuclear materials is essential to international security and is a fundamental, compelling, and enduring mission. For more than a decade, existing programs have been working towards this goal. To uphold the President’s nonproliferation and security objectives a global unified approach is needed. In addition, it is essential if there is to be a safe, secure, and reliable future nuclear energy regime.

An Integrated Global Nuclear Materials Management (IGNMM) approach would address the existing legacy nuclear and radiological materials and the transition towards a nuclear energy future while

strengthening a regime to prevent nuclear weapon proliferation. Achieving safety and security during this transition is complicated by the diversified spectrum of threat “players” that has greatly impacted nonproliferation, counterterrorism, and homeland security requirements. Rogue states and non-state actors no longer need self-contained national nuclear expertise, materials, and equipment due to availability from various sources in the nuclear market, thereby reducing the time, effort and cost to acquiring a nuclear weapon (i.e. manifestations of latency). In addition, the worldwide expanding peaceful use of radioactivity has left more radiological materials at risk. The terrorist threat has changed the nature of military and national security requirements to protect these materials. Countries cannot create impenetrable borders, so an integrated defense-in-depth approach to securing material worldwide is essential.

### **Scope and Situation Analysis**

Integrating systems and situational analysis provide the important functions in building a progressive architecture for defining the problem domain, reconciling its boundary conditions and contingencies, and identifying the key technical and institutional factors and functions. These then can be translated into requirements, components, and attributes of a system or framework approach to IGNMM that serves current needs and supports a pro-active approach to shortcomings and future demands. The first step in designing the path forward would be to compile existing information on the inventory of worldwide nuclear materials and activities and the control functions exercised over them (e.g., monitoring and proliferation detection) into a representation of the global nuclear material management landscape. This would include materials and activity pathways; their links to proliferation, latency, military threats, and/or terrorism and hence classes of risks associated with material and technology capabilities; and security or disposition strategic maps. Today’s GIS software can greatly enhance the working link between databases, assessments and visualization.

In parallel, an overall compilation and analysis of current USG and international nuclear nonproliferation and arms control regimes, as embodied in the complex of multi-party agreements, treaties, agreements, and standards, would be conducted. Material control and accounting, physical protection, pledged material dispositions, expansion of nuclear energy, continued/future deployment of enrichment and reprocessing technology, expanded radioactive and by-product material use, and waste disposal will be among the key programs linked in one overall framework.

The desired outcome is to identify strengths and any new priorities in the current nuclear materials management regime, in order to help reduce uncertainties and increase latency times. Examples of application areas that might be distilled from this situation analysis include the future of plutonium, spent nuclear fuel and high-level waste disposition, and nuclear security. Most of the world’s plutonium is in the geometrically expanding spent nuclear fuel, not in legacy nuclear weapon stockpiles, with limited, security-challenged disposition options of disposal, re-use, or transmutation. Within the context of IGNMM and the Global Nuclear Energy Partnership, the issues of safe storage, reprocessing, and disposal would be addressed.

### **System or Framework Approach**

IGNMM can be made coherent and functional by an operational architecture. The basic system approach depends on constant iteration and appropriate feedback among three key operations: 1) detection, measurement/monitoring, understanding, and bounding of situations; 2) assessing the risk landscape associated with an issue including its connection to other management issues or aspects; and 3) developing system strategies for present and future actions and investments. These three elements would work together to connect global objectives and principles to guide international, national and/or local implementation of solution strategies.

In addition to situation awareness, bounding the issue entails a geographic, political, and conceptual articulation of the desired results, operational constraints, and other considerations in view of U.S. and international program and agreements to control risks, while accommodating legitimate uses of nuclear materials. It would include a realistic assessment of available management options, resources, and influences, taking into account the range of tolerable risks to enable evaluation of priorities and tradeoffs (e.g., cost-benefit) among options. The risk-based assessment would include:

- threat and vulnerability assessment and potential remediation;
- determination of potential consequences of likely or hypothetical actions; and
- communication and representation of the risk landscape to other analysts and decision makers.

It is envisioned that integrated solutions will include reducing and securing nuclear/radiological materials at their source, monitoring and tracking (in-place or during transportation), and enhancing detection, interdiction, and response. Such strategies and capabilities can also be assimilated to provide an operational system for warning and incident characterization in a near-real-time environment to achieve situational awareness and decision support. An active architecture, artfully combined of detection, system models, methods, technologies, and international cooperation will allow the testing, discovery, and performance monitoring of robust and evolving strategies through measures to indicate degrees of success and to attribute credit to a strategy.

This assessment characterizes and categorizes risks to support a graded approach to risk reduction and continuous improvement, and it is especially well suited to informing the control of undesired material use while permitting (with appropriate controls) desirable use. Risk management options are formulated through a coherent mix of barriers, controls and actions such as detection, monitoring, prevention, protection, mitigation and response. This is important for including an uncertainty reduction loop in the system feedback process, as well as pointing to additional program, science, assessment, and technology needs. Insights from the risk analysis feedback to enhance and refine the understanding of the global nuclear material management problem, and they feed forward to solution development.

In sum, an overall system framework feature would a three-pronged approach to nuclear material security, safety, and reliability:

- Defense-in-depth entails barriers in different material management domains to realization of the same threat (for example, securing, tracking, and interdicting a material).
- Diversity in a multiplicity of protection approaches, such as technological controls, institutional controls, and cooperation for building global and regional security.
- Control quality relates to the design, implementation, and operation of controls or disincentives such as safeguards and security, standards, and treaty requirements. It ensures controls work as intended and that best practices are implemented.

By harmonizing a web of national and international assessments, activities, programs, and capabilities with the flexibility of local options and incorporating risk management strategies of defense-in-depth, diversity, and quality control, a path forward can be developed to help direct future programs, and can provide a basis for understanding and addressing nuclear weapon latency. A risk-informed predictive knowledge framework can enable prioritizations and tradeoffs among local solution options to meet cost and other performance measures, and it would support national decision-making and effective international collaboration. Such a framework commonly used among international partners will facilitate effective cooperation with foreign entities. The drivers are global but the solutions must be national and in many cases local.

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This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.