UCRL-JC-127638
PREPRINT

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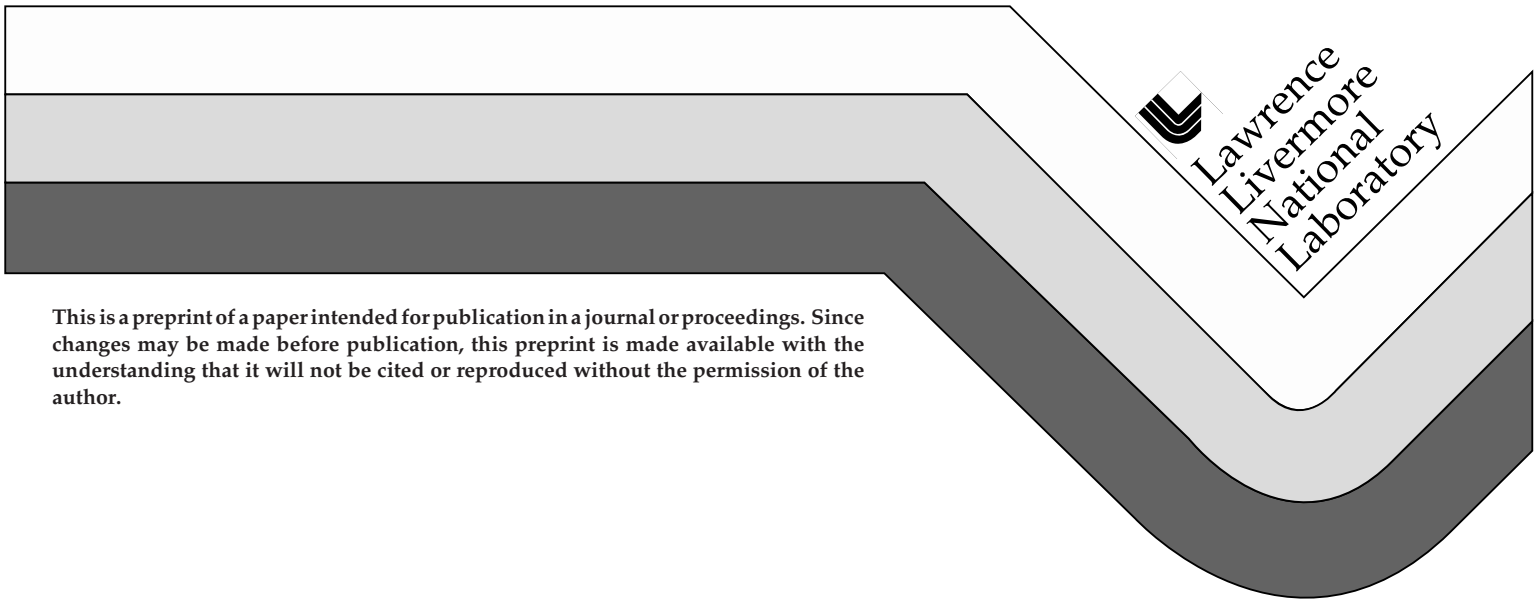
This paper was prepared for submittal to the
NATO Advanced Research Workshop and
Nuclear Materials Safety Management
Amarillo, TX
March 17-21, 1997

June 1, 1997



An Integrated Approach to Nuclear Materials Safety Management in the U.S. and Russia*

by
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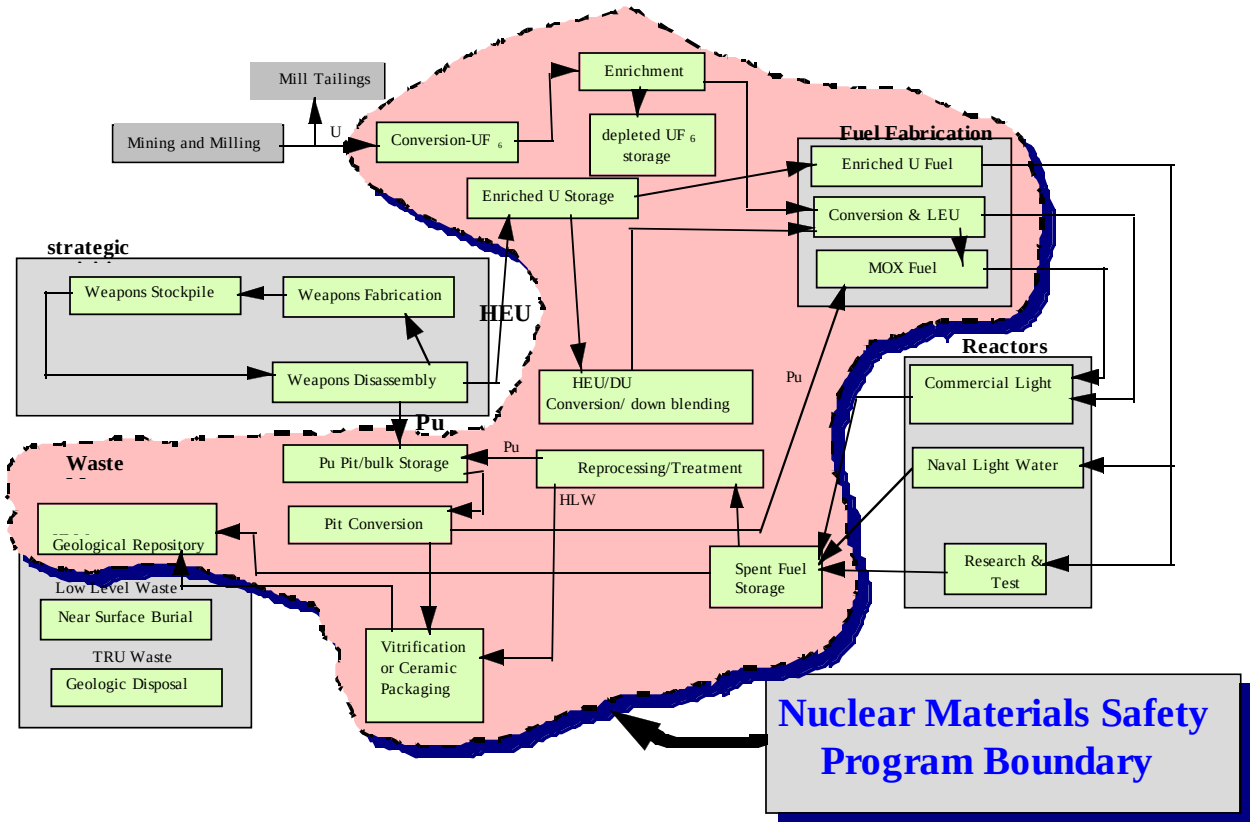
Abstract

The United States and Russia are dismantling nuclear weapons and generating hundreds of tons of excess plutonium and high enriched uranium fissile nuclear materials that require disposition. The U.S. Department of Energy and the Ministry of the Russian Federation for Atomic Energy (Minatom) organizations are planning and implementing safe, secure storage and disposition operations for these materials in numerous facilities. This provides a new opportunity for technical exchanges between Russian and Western scientists that can establish an integrated and improved common safety culture for handling these materials. The development and use of personal relationships and joint projects among Russian and Western participants involved in fissile nuclear materials safety management contributes to improving nuclear materials nonproliferation and to making a safer world. Technical exchanges and workshops are being used to systematically identify opportunities in the nuclear fissile materials facilities to improve and ensure the safety of workers, the public, and the environment.

With the ending of the Cold War and the implementation of various nuclear arms reduction agreements, the United States and Russia have been actively dismantling tens of thousands of nuclear weapons. As a result, large quantities of fissile materials, including more than 100 tons of weapons-grade plutonium and significantly more high-enriched uranium (HEU), have become excess to both countries' military needs. To meet nonproliferation goals and to ensure the irreversibility of nuclear arms reductions, these excess fissile materials must be placed and maintained in secure storage prior to being dispositioned.

To disposition HEU in the United States or in Russia, the HEU components must be converted to UO_2, then to UF_6, and finally blended down to nonweapons-useable low-enriched uranium (LEU) to make feed material for use in conventional, commercial light-water reactor (LWR) fuel fabrication. Excess plutonium in weapons components must be converted to oxides suitable either for use in existing reactors as mixed-oxide (MOX) fuel or permanently discarded as a stable glass or ceramic form in a geologic repository. The United States is considering the use of both approaches to plutonium disposition. Russia will use the MOX fuel approach in existing reactors, which will include light water reactors and possibly fast reactors, followed by reprocessing and plutonium recycle. Figure 1 illustrates these unit operations as they would be integrated into a nuclear fuel cycle.

"Simplified" Nuclear Materials Flowsheet



All treatment and disposition of excess weapons-grade plutonium and HEU in the United States or Russia must be accomplished in a safe, secure manner and as quickly as practical. Storage of excess fissile materials is a prerequisite to any disposition process, but the length of storage time is unknown. Disposition of large quantities of plutonium and HEU will require decades. Thus, safe, secure storage for excess fissile materials is mandated for decades—and perhaps longer, if disposition operations encounter delays. Should operational accidents occur in either country, delays are certain in both countries, thus increasing even further the length of time these materials will be in storage. This would increase costs to the U.S. Department of Energy and result in a corresponding delay in implementing nonproliferation goals by disallowing closure of storage and disposition operations as originally budgeted and scheduled.

Both the DOE and the Russian Minatom organizations have embarked on the required operations for safe, secure storage and disposition of excess plutonium and HEU. Because the "end products" for disposition of the excess HEU and weapons-grade plutonium are different from those associated with the production of weapons components, many of these operations will involve handling and processing new forms of fissile nuclear materials. Storage and disposition of fissile materials requires new operations in existing, upgraded facilities and, in some cases, new facilities and must be accomplished in a timely and safe manner.

A major opportunity now exists to reduce implementation risks associated with these new and different individual storage and disposition nuclear material activities. Both the United States and Russia have extensive experience handling fissile materials, experience that can be pooled and

integrated to ensure that storage and disposition operations are performed safely. By sharing, coordinating, integrating, and redirecting the combined U.S. and Russian nuclear materials technical knowledge and experience base formally developed for nuclear weapons production, a strategy can be established to mutually understand, improve, and sustain the "safety cultures" required by fissile nuclear materials facilities in both countries.

By creating a joint U.S.–Russian program of technical exchanges and projects on nuclear materials safety management, the United States and Russia can establish an improved and sustained common safety culture for handling these fissile materials over the next several decades.

This process has already begun. In June 1993, a U.S. team of scientists visited the site of a runaway chemical reaction that had occurred at the Russian radiochemical separations plant at Tomsk-7 in Siberia. That fall, a joint U.S.–Russian follow-up meeting was held in Hanford, Washington, to review the accident and the analyses of the event done by each country. At that meeting, it was agreed to continue such technical exchanges on radiochemical operational safety for other nuclear materials. Thus began a sequence of technical exchanges, as follows:

- November 1994—Second joint U.S.-Russian workshop on radiochemical operational safety (St. Petersburg and Krasnoyarsk-26, Russia)
- August 1995—Third U.S.-Russian workshop on nonreactor nuclear safety (Los Alamos, NM)
- August 1996—Program review and planning meeting for future technical exchanges (Seattle, WA)
- March 1997—Fourth U.S.–Russian workshop and NATO advanced research workshop on nuclear materials safety management initiative (Amarillo, TX)
- Fall 1997—Planned fifth U.S.–Russian workshop and second nuclear safety management NATO workshop (St. Petersburg, Russia).

A U.S.–Russian Nuclear Materials Safety Management Program is limited to those issues related to the storage and disposition of excess fissile materials. As illustrated in Figure 1, it does not deal with nuclear reactor issues, except for fuel fabrication and spent-fuel storage, and is not involved in strategic activities associated with nuclear weapons stockpiles, except for disposition of the nuclear materials resulting from weapons dismantling and excess "in-process" materials. The low-level wastes and uranium mining and milling operations are also not explicitly considered. The boundary of the nuclear materials safety program and its included and excluded activities is illustrated in Figure 1.

The following approaches are recommended for implementation of a U.S.–Russian Nuclear Materials Safety Management Program:

- Provide technical exchange visits and workshops of U.S. and Russian experts
- Identify and conduct joint projects in nuclear materials safety in both countries
  - Training: computer codes, simulators, operational practices and procedures
  - Experiments: source terms, failure modes, monitoring methods
  - Assessments: safety analysis reports, methods, consequences, initiating events

- Identify and conduct joint university activities and exchanges
  - Course work and curriculum development on radiation protection, health physics, and materials safety management
  - Faculty, student, and curriculum exchanges

Some projects involving joint U.S.–Russian technical exchanges have already begun, including the following for FY 96–97:

- Assessment of accident consequences with release of radionuclides into atmosphere by using the MACCS[1]
- Safety assurance problems in using exchange resins for plutonium purification
- Radioactive-aerosol monitoring to meet most recent standards for stack-sampling and other aerosol measurements

The nuclear materials safety program develops and uses personal relationships among DOE national laboratory and Minatom Institute participants in the United States and Russia because of a common involvement with fissile nuclear material processes and a common desire to contribute to nuclear nonproliferation and to ensure a safer world. The establishment, by DOE and Minatom, of a joint U.S.–Russian program that focuses on nuclear materials safety would add another major national security element to the ongoing, successful intergovernmental programs (e.g., the Material Protection Control and Accounting Program [MPC&A] of DOE's Office of Nonproliferation, National Security and the International Reactor Safety Program of DOE's Office of Nuclear Energy and the Joint U.S.-Russian Disposition Program of DOE's Office of Fissile Materials Disposition) and involves another completely different group of nuclear technology specialists in both countries. These direct interactions and collaborations of U.S. and Russian scientists are establishing a common improved safety culture that will contribute to the successful, safe, secure, and timely implementation of the storage and disposition of excess HEU and plutonium in both countries.

In summary, the proposed nuclear materials safety program offers the following major benefits to the U.S.and Russian nonproliferation activities:

- Establishes a common technical culture in which safety is the primary focus in storage and disposition nuclear facilities for HEU and plutonium
- Contributes further to the nonproliferation goals using past nuclear weapons production and safety experience with fissile materials
- Allows an exchange of past operational experiences for nuclear materials safety in nuclear facilities handling HEU and plutonium associated with past weapons production in the United States and Russia that can now be applied to the new operations required for HEU and plutonium storage and disposition

[1] Code Systems for Calculation of Reactor-Accident Consequences

- Avoids the potential loss of capital expenses invested in the United States and Russia to implement the safe, secure storage and disposition of excess HEU and plutonium by reducing the likelihood of major operational accidents

- Ensures that future implementation schedules can be achieved by avoiding accidents; this allows storage and disposition missions to be completed according to original schedules, thus not extending recurring operational and maintenance costs, and planned shutdowns and decontamination and decommissioning operations to be carried out, thus ending recurring costs

- Allows fissile nuclear-materials-production technical work forces to be retrained in the nuclear safety of HEU and plutonium disposition operations while reducing the threats of proliferation

- Promotes U.S.–Russian sharing of actual accident data, particularly those resulting in inadvertent criticality incidents and significant off-site radionuclide releases, to ensure the safer operations of all future nuclear operations, including those of nuclear stockpiling

The results of this program include an increased understanding of nuclear materials safety approaches, improved safety practices in nuclear facilities, inculcation of a nuclear materials safety culture, and realization of national and international goals incorporating safety into all aspects of nuclear materials safety management and disposition. At this juncture, a key contribution of the activities of this program is to assist in sustaining a viable human resource in the field of nuclear safety during a period of budgeting constraint in the United States and economic uncertainty in Russia.

References

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2. Storage and Disposition of Weapons-Usable Fissile Materials, Final Programmatic Environmental Impact Statement, DOE/EIS-0229, December 1996.

*Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

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