MARTIN MARIETTA

**An Initial Survey of Nuclear Material
Safeguards Requirements Applicable to the
Civilian Waste Management Program**

B. W. Moran
Safeguards Studies Department
International Technology Programs Division

September 1988

MASTER

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
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CIVILIAN WASTE MANAGEMENT PROGRAM**

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EXECUTIVE SUMMARY

The waste management systems to be developed and implemented by the U.S. Department of Energy's (DOE's) Office of Civilian Radioactive Waste Management (OCRWM) include the transportation, storage, packaging, and final disposal in a geologic repository of spent nuclear fuel (SNF) and high-level radioactive wastes (HLW). The HLW will come predominantly from defense programs; the SNF will come from commercial power reactors. The SNF will be received primarily as intact fuel bundles but also will include fuel that has been consolidated, reconstituted, or damaged. The DOE will take title to the SNF at the commercial power reactor.

The waste management systems and facilities will be operated by DOE, licensed by the U.S. Nuclear Regulatory Commission (NRC), and eligible for International Atomic Energy Agency (IAEA) safeguards. It is expected that these systems and facilities will be required to meet the safeguards requirements of all three safeguards authorities. Existing DOE and NRC safeguards requirements are designed to protect nuclear material from theft and radiological sabotage and appear to have been developed for a closed nuclear fuel cycle. These requirements may not adequately address all the safeguards concerns of the back end of an open fuel cycle, especially those concerns associated with SNF repackaging, long-term storage, and final disposal of SNF and HLW.

The DOE, NRC, and IAEA requirements applicable to the safeguarding of irradiated or highly radioactive materials were reviewed to determine those requirements that may impact the physical design and operating procedures of the waste management systems. The only safeguards requirements determined to have a significant impact on these designs and procedures are those associated with containment and surveillance of the SNF by the IAEA and the measurement of the special nuclear material (SNM) content of material in transfers and in inventory. (Other safeguards requirements also will have significant impacts on the overall costs of the facilities and systems.) The most significant measurement requirements are those that may be required to permit the IAEA to implement effective safeguards.

If effective safeguards systems for the measurement and verification of the nuclear material content in the SNF and HLW are to be implemented, measurement as well as containment and surveillance (C/S) systems need to be identified and developed concurrent with the development of the SNF storage and transportation casks and of the other waste management systems. If appropriate safeguards systems are not available early in the waste management program, effective domestic and international safeguarding of SNF and HLW within the OCRWM Program may be difficult to achieve without costly backfitting. Delays in the development of the safeguards system may also eliminate the opportunity for OCRWM to provide input into the development of the IAEA safeguards regime for waste management facilities.

This report provides an initial survey of the domestic and international safeguards requirements and provides a general framework on which future studies may be based. Additional studies are needed to evaluate the activities required to implement effective safeguards within the civilian waste management system and to ensure compliance with all safeguards requirements.

1. INTRODUCTION

The waste management systems developed and implemented by the U.S. Department of Energy's (DOE's) Office of Civilian Radioactive Waste Management (OCRWM) include the transportation, storage, packaging, and final disposal in a mined geologic repository of spent nuclear fuel (SNF) and high-level radioactive wastes (HLW). The HLW will come predominantly from defense programs; the SNF will come from commercial power reactors. The SNF will be received primarily as intact fuel bundles but also will include fuel that has been consolidated, reconstituted, or damaged. The DOE will take title to the SNF at the commercial power reactor.

The waste management systems and facilities will be operated by DOE, licensed by the U.S. Nuclear Regulatory Commission (NRC), and eligible for International Atomic Energy Agency (IAEA) safeguards. It is expected, therefore, that the proposed waste management systems will be required to meet (1) the safeguards requirements developed by DOE and approved by the NRC and (2) the IAEA safeguards requirements. This report surveys the requirements of these three safeguards authorities to determine the applicable safeguards requirements and the potential impacts of these requirements on the waste management systems being developed.

The DOE, NRC, and IAEA nuclear material safeguards requirements are based on the principles of nuclear material accounting and of containment and surveillance (C/S). The DOE and NRC regulations are additionally based on the principles of access control, personnel security, and protective force response. The IAEA uses C/S as a complementary procedure to material accounting to detect undeclared flows of nuclear material and to improve the effectiveness of nuclear material accounting techniques. The DOE and the NRC use C/S as components of their material control and physical protection procedures. The DOE regulations are specified in the DOE Order Series 1270 and 5630;¹⁻⁵ the NRC regulations are specified in Title 10 of the Code of Federal Regulations (10 CFR) Parts 60, 70, 72, 73, 74, and 75.⁶⁻¹¹ The IAEA requirements for countries signatory to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) are stated in IAEA Information Circular (INFCIRC)/153 (Corrected).¹² These requirements are modified for, and implemented in, the United States through the "Agreement with the International Atomic Energy Agency for the Application of Safeguards in the United States of America,"¹³ "Subsidiary Arrangements to the Agreement between the Government of the United States of America and the International Atomic Energy Agency for the Application of Safeguards in the United States of America,"¹⁴ and the facility attachment document negotiated for each facility selected for IAEA safeguards. The regulations and requirements are composed of (as applicable to the safeguards authority) safeguards procedures, safeguards personnel requirements (numbers, qualifications, and training), reports and record keeping (including notification requirements), inspection frequencies, safeguards equipment (design and installation), and safeguards systems designs (protection and access areas).

This report will focus on only those safeguards components that might impact the physical design and operating procedures of waste management systems for SNF and HLW. Additional studies are needed to evaluate the activities required to implement effective safeguards within the civilian waste management system and to ensure compliance with all safeguards requirements.

1.1 SAFEGUARDS OBJECTIVES

The DOE and NRC have implemented regulations to safeguard nuclear material. These regulations are intended (1) to protect nuclear material at fixed sites and in transit from theft and radiological sabotage acts by individuals, criminals, or subnational

groups that may adversely impact national security or the health and safety of the public, and (2) to account for the nuclear material to verify that the protection provided has been successful. The safeguards regulations can be divided into three major components: physical protection, material control, and material accountability.

In support of its nuclear nonproliferation objectives, the United States voluntarily offered to permit the IAEA to apply its safeguards at selected nuclear facilities within the United States in 1966 and ratified the NPT in 1970. The offer to permit IAEA safeguards within the United States was made to demonstrate the United States' willingness to accept a burden on its nuclear industries equal to that placed on the nuclear industries of the non-nuclear weapon nations. Although diversion is not a credible international concern in the case of the United States and the other nations possessing nuclear weapons, it is inevitable that the IAEA safeguards approach used at a U.S. facility would become a reference point for IAEA safeguards at similar facilities in other nations. Therefore, it is essential that any IAEA safeguards approach developed for a U.S. activity be designed in such a way that it would provide an adequately high degree of effectiveness to detect diversion if the approach was used in a similar activity within the borders of the most proliferation sensitive nation.¹⁵

The list of U.S. facilities eligible for IAEA safeguards filed by the Secretary of State excludes (1) those facilities with activities having direct national security significance and (2) mining and ore processing facilities. All other facilities, unless specifically excluded, are eligible for IAEA safeguards. Those U.S. facilities of advanced design incorporating new technology and those that are sensitive in terms of international competition are most likely to be selected for IAEA safeguards.

The IAEA safeguards system is designed to verify that nations have not diverted nuclear material and nuclear equipment and facilities from peaceful uses to the manufacturing of a nuclear explosive device or to the furthering of any military purpose. The stated objective for IAEA safeguards in the United States is "the timely detection of withdrawal, other than in accordance with [the] Agreement, of significant quantities of nuclear material from activities in facilities while such material is being safeguarded under [the] Agreement." To achieve this objective, the IAEA uses material accountancy "as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures....The technical conclusion of the [IAEA's] verification activities [is] a statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period, giving the limits of accuracy of the amounts stated."¹³

1.2 GENERAL SAFEGUARDS REQUIREMENTS APPLICABLE TO SPENT NUCLEAR FUEL

The safeguards requirements for a facility are determined by the form and quantity of special nuclear material (SNM) present at the facility. (SNM is generally defined to be plutonium, ²³³U, and uranium enriched in the isotope ²³⁵U or ²³³U.) For the OCRWM waste management systems, it is expected that the safeguards requirements will be defined by the plutonium content of the SNF contained in the storage and transportation casks (greater than 2 kg Pu). The safeguards requirements for the uranium component of the SNF would be much less stringent than those for the plutonium component because the uranium is enriched to less than 20% ²³⁵U. The containers of HLW are expected to contain small, economically unrecoverable quantities of uranium and plutonium and would be subject to less stringent safeguards requirements than would the SNF. An evaluation of the safeguards requirements for only the plutonium content of the SNF should adequately define the safeguards requirements for the overall waste management system.

When the SNF is transferred from the NRC-licensed reactor to DOE, the SNF assemblies will have been accumulated into transportation casks for shipment. The quantity of plutonium contained in a cask should exceed 2 kg Pu. This contained quantity is defined by the NRC to be a formula quantity of strategic SNM. The safeguards requirements specify that the contained quantity of plutonium receive the highest level of protection defined by the regulations. The applicable IAEA requirements are based on those safeguards procedures necessary to verify that a significant quantity of plutonium (8 kg) or of uranium enriched to less than 20% ^{235}U (75 kg ^{235}U) has not been diverted. (A significant quantity is defined by the IAEA to be the approximate quantity of nuclear material for which, when conversion processes are considered, the possibility of the manufacture of a nuclear explosive device cannot be excluded.) Because of the highly radioactive nature of the SNF, less stringent safeguards procedures than those applied to equal quantities of nonirradiated materials are permitted. The DOE defines all highly radioactive SNM to be a Category IV quantity of SNM for which the minimum level of safeguards requirements are specified and for which the specific requirements are established by the cognizant DOE operations office.

The current safeguards requirements have been developed for the SNM at existing nuclear fuel cycle facilities. Many of these requirements are generally applicable to all nuclear material handling facilities; however, some are applicable specifically to the existing fuel cycle systems and may not define an appropriate safeguards system for SNF and HLW that will be repackaged and buried in a mined geologic repository.

2. PHYSICAL PROTECTION REQUIREMENTS

Spent nuclear fuel and HLW are considered by the NRC and DOE to be unattractive to theft or diversion because of their high radiation emission levels and because they are not practical for use in the construction of an improvised nuclear device. The NRC's and DOE's principal safeguards concern for this material is the prevention of radiological sabotage. The DOE physical protection requirements for these materials are not specified but are those procedures developed and approved by the cognizant DOE operations office.³ The NRC specifies the level of physical protection that must be provided to irradiated reactor fuel in transit and to highly radioactive formula quantities of strategic SNM at fixed sites (other than licensed nuclear reactor facilities).⁹ The NRC-specified level of protection approximates, but is less stringent than, the level of protection required by DOE for the protection of Category I quantities of SNM.

For the disposal of HLW in geologic repositories, the NRC states that DOE must certify that it will "provide at the geologic repository operations area such safeguards as it requires at comparable surface facilities (of DOE) to promote the common defense and security."⁶ This certification is rebuttable by the NRC. Therefore, the level of protection needed at a geologic repository must be determined by DOE and ultimately approved by the NRC (who can impose additional safeguards requirements before approving the license application).

The IAEA has no physical protection requirements because this function is not a part of its mandate. (The levels of physical protection recommended by the IAEA for the protection of nuclear material are stated in INFCIRC/225 and are generally less stringent than the levels specified by DOE and the NRC.¹⁶)

The following physical protection requirements are those specified by the NRC regulations for irradiated reactor fuel and highly radioactive formula quantities of strategic SNM.

2.1 FIXED SITE

The NRC physical protection requirements for a formula quantity of strategic SNM contained in SNF (hereafter referred to as SNF) state that the SNF be contained within a vital area because of the radiological sabotage threat and within a material access area (MAA) because of the SNM theft threat. The vital area and/or MAA is required to be contained within a protected area such that access into the vital area or MAA requires passage through at least two barriers. The maintenance of an isolation zone around the perimeter barrier of the protected area is also required. The perimeter barrier should be separated from any other barrier within the protected area and the intervening space monitored to detect suspicious activity or the breaching of any physical barrier. Isolation zones and clear zones between barriers should be illuminated to permit 24-h monitoring.

2.1.1 Security Areas

2.1.1.1 Vital area

A vital area is an area that contains vital equipment (equipment, systems, devices, or materials — the failure, destruction, or release of which would directly or indirectly endanger the public health and safety by exposure to radiation). Vital equipment also includes equipment or systems that would be required to function to protect public health and safety following the failure or destruction of other vital equipment (e.g., alarm systems). Unoccupied vital areas are required to be monitored by intrusion detection systems.

2.1.1.2 Material access area

An MAA is defined by the NRC to be any location that contains SNM within a vault or a building and for which the roof, walls, and floor each constitutes a physical barrier. Unoccupied MAAs are required to be monitored by intrusion detection systems.

2.1.1.3 Protected area

A protected area is a controlled-access area encompassed by physical barriers. The physical barrier at the perimeter of a protected area is usually one or more alarmed 8-ft-high steel mesh fences topped with barbed wire selvage, barbed ribbon, or concertina wire.

2.1.1.4 Isolation zone

An isolation zone is an area adjacent to a physical barrier that has been cleared of all objects that could conceal or shield an individual. Monitoring of the isolation zone is required to detect the presence of individuals or vehicles within the zone and thereby allow the security organization to respond when the perimeter barrier into the protected area is penetrated. The isolation zone is often located between a steel mesh fence and the perimeter barrier.

2.1.2 Security Organization

The SNF facility would be required to have a security organization for protection against theft and sabotage. The security organization should consist of properly trained,

equipped, and qualified security force personnel, 24-h supervision of the security force personnel, security procedures, and contingency plans. The size of the security force and the response time to alarms is not specified by the NRC and would be dependent on the waste management systems implemented.

2.1.3 Access Controls

The security organization of the SNF facility would be required to control all points of personnel and vehicle access into protected areas, vital areas, and MAAs. Access to vital areas and MAAs should be limited to personnel who are authorized access to vital equipment or SNM, respectively, and who require such access to perform their duties. No vehicles used for the conveyance of people should be permitted within a protected area. Picture badges are to be used by personnel authorized into a protected area without escort. Personnel authorized admittance to vital areas or MAAs should have specially coded numbered badges. Personnel, vehicles, and packages are subject to search before entry or exit from a protected area, vital area, or MAA. Access control procedures should include personnel security procedures that may include a two-person rule for nuclear-material handling operations.

2.1.4 Detection Systems

All alarm systems would be required to be "self-checking and tamper-indicating" and to indicate the type of alarm and location at a continuously manned central alarm station within the protected area and at another continuously manned station. All emergency exits in each protected area, vital area, and MAA should activate alarms when opened. All unoccupied vital areas and MAAs should be monitored by intrusion alarms. Functional testing for operability and required performance should be performed weekly for all intrusion alarms.

2.1.5 Communication Systems

Each guard on duty should be capable of maintaining continuous communication with an individual at the central alarm station. The alarm stations should be equipped with conventional telephone service and two-way radio voice communications that permit communication with the local law enforcement authorities. All fixed-location communications equipment must remain operable from independent power sources in the event of the loss of primary power. Communications equipment should be tested for operability and performance at the beginning of each security shift.

2.2 SPENT NUCLEAR FUEL IN TRANSIT

Spent nuclear fuel in transit is required to be protected to minimize the possibilities for theft or radiological sabotage and to facilitate the location and recovery of shipments that have come under the control of unauthorized individuals. Advance notification of shipments must be made to the NRC and to states through which the shipment will pass, and advance approval must be obtained from the NRC of the planned routes. Arrangements must be made with local law enforcement agencies along the planned route for emergency response. Shipments are required to be escorted and the escort(s) are to be capable of maintaining communications with a fixed-site continuously manned communications center, local law enforcement agencies, and other escorts. The communications center monitors the progress of the shipment and notifies appropriate agencies in the event of a safeguards emergency. Escorts in heavily populated areas

must be armed. Spent nuclear fuel transport road vehicles must be equipped with NRC-approved vehicle immobilization features.

3. MATERIAL CONTROL AND ACCOUNTABILITY REQUIREMENTS

All facilities under DOE, NRC, and IAEA safeguards are required to establish, maintain, and follow written nuclear material control and accountability (NMC&A) procedures (except DOE waste disposal sites containing nuclear materials determined by DOE to require safeguards no longer and NRC-licensed low-level waste disposal sites containing very small quantities of SNM). These procedures specify that the facility maintain a system of records that shows the receipt, acquisition, disposal, transfer, removal, and inventory of nuclear material. Facilities are also required to conduct periodic physical inventories of all nuclear material at the facility.

The DOE, NRC, and IAEA also require submittal of material status reports (material balance reports and physical inventory listings), nuclear material transfer reports, and other reports (as required) containing safeguards accountability information. This information is submitted on the appropriate DOE/NRC forms (740M, 741, 742, and 742C) to DOE (and the NRC if an NRC licensee) and on DOE Data Processing (DP) forms (DOE facilities only) to the Nuclear Material Management and Safeguards System (NMMSS) for entry into the national database. For those facilities under IAEA safeguards, material status reports and nuclear material transfer (inventory change) reports required by the IAEA will be generated by NMMSS in the IAEA format and submitted to the IAEA.

3.1 RECEIPTS AND SHIPMENTS

The NRC regulations for SNF facilities not selected for IAEA safeguards do not specify that accountability or confirmatory measurements need to be made when SNF is shipped or received. The DOE Orders classify any quantity of highly irradiated SNM as a Category IV quantity. For these materials, the safeguards requirements are established by the cognizant DOE operations office and are not required to include material confirmation or accountability measurements to verify shipper's values [a check to verify the item count, tamper-indicating device (TID) integrity, and identification numbers is required]. Similarly, limits of error for the shipper's and receiver's values are not required for these shipments.

For facilities selected for IAEA safeguards, the NRC regulations require that the facility should establish, as appropriate, a measurement system for determining the quantities of nuclear material shipped and received and should evaluate the precision and accuracy of the measurements for estimating measurement uncertainties. The facility should also have the capability to identify, review, and evaluate shipper/receiver differences. Similar requirements are specified by the IAEA.

3.2 PHYSICAL INVENTORY

The DOE, NRC, and IAEA require that SNF shall be inventoried at least annually. For facilities selected for IAEA safeguards, the NRC and IAEA require, as appropriate, a measurement system for the determination of quantities of nuclear material in inventory. The facility is to submit to the IAEA a statement of the physical inventory that lists all batches separately. During routine inspections, the IAEA inspectors may verify the location, identity, quantity, and composition of all nuclear material subject to safeguards. This includes the making of independent measurements on the nuclear material present to detect gross, partial, and bias defects.

3.3 CONTAINMENT AND SURVEILLANCE

Containment and surveillance establishes a physical boundary around nuclear material (e.g., building walls or storage containers) and provides a means to determine if the material in the containment has been accessed (e.g., intrusion alarm, altered TID, or surveillance camera film record). The DOE requires that facilities shall, to the maximum extent practical and possible, use TIDs to monitor the containment (exceptions may be granted for irradiated items). The NRC specifies no requirements for the use of TIDs with SNF. The IAEA often employs combinations of C/S methods and techniques (e.g., TIDs on material containers and video or film cameras at strategic points) to help ensure the completeness of flow and inventory measurements.

3.4 MEASUREMENTS

The objective of the measurement system is to provide and verify quantitative values of the quantity of nuclear material in inventories and transactions. For facilities selected for IAEA safeguards, the NRC and IAEA require, as appropriate, a measurement system for the determination of quantities of nuclear material received, produced, shipped, lost or otherwise removed from inventory, and the quantities in inventory. These facilities are also required to evaluate the precision and accuracy of measurements and to estimate the measurement uncertainty. No measurement requirements are stated for SNF at NRC-licensed or DOE facilities not selected for IAEA safeguards.

3.5 SAFEGUARDS AUTHORITY INSPECTIONS

Inspections (surveys) of safeguarded facilities are conducted by the NRC and DOE to evaluate compliance with their requirements and are conducted by the IAEA to verify that a significant quantity of SNM has not been diverted from a facility. The NRC and IAEA require that rent-free office space be provided for their inspection personnel. Inspectors are not to be impeded or delayed in the exercise of their functions. The IAEA inspectors typically are escorted by DOE or NRC personnel and a designated person from the facility when they perform their inspection functions. These functions routinely include auditing the facility's nuclear material accountability books and records, taking measurements, verifying quantities of safeguarded nuclear material, and verifying the stated facility measurement systems and operations.

4. POTENTIAL IMPACTS

Three significant potential impacts on the waste management systems from the safeguards regulations are apparent: (1) containment of the SNF within an MAA, (2) C/S of the SNF by the IAEA, and (3) the measurement of SNM content of SNF receipts, shipments, and inventories. The extent of these impacts cannot be determined because the safeguards requirements are subject to revision. These revisions are required because (1) NRC and DOE safeguards regulations were developed before the development of waste management programs that include the reconstitution of fuel, consolidation of SNF, and final disposition of the SNF in geologic repositories; and (2) the IAEA does not have experience in safeguarding these waste management activities.

4.1 CONTAINMENT WITHIN A MATERIAL ACCESS AREA

Containment of the SNF in an MAA would require that the SNF casks at any storage facility be stored inside a controlled-access building. It is possible that an

exception to this requirement could be obtained or the regulations revised because the SNF elements are contained in shipping and/or storage casks. If the design of the casks provides protection to the SNF at least equivalent to that of a controlled-access building, and if intrusion detection is provided around the casks, physical protection at least equivalent to that specified in the regulations could be provided to the SNF. The independent spent fuel storage installation licensed by the NRC that uses dry-storage casks has not been required by the NRC to enclose the casks within an alarmed building.

4.2 CONTAINMENT AND SURVEILLANCE

To maintain assurance of item integrity, the IAEA will rely on containment measures (e.g., TIDs) on SNF packages and surveillance of packages (e.g., film cameras) in storage areas. For effective implementation of these measures, C/S systems would have to be factored into facility and package designs. In addition, effective surveillance systems would need to be implemented during all repackaging and fuel assembly consolidation activities. The C/S procedures may impact designs throughout the civilian waste management system.

4.3 MEASUREMENTS

A requirement to measure SNF in storage casks could significantly impact the waste management systems. The measurement requirements are imposed to permit the IAEA to implement effective safeguards; the NRC and DOE measurement requirements for SNF (irradiated nuclear material) not selected for IAEA safeguards are minimal. To meet their safeguards accountability goals, the DOE and NRC need to evaluate, and may need to establish, measurement requirements for SNF to be placed in a final repository and for SNF that was reconstituted or consolidated. Currently, the nuclear material content value assigned to SNF is determined by the power reactor operator from fuel burn-up calculations. In a closed fuel cycle, the quantity of SNM in the SNF would be determined at a reprocessing plant following dissolution of the SNF. With disposal of the SNF in a final repository, a measurement of the nuclear material content might be necessary to verify that the calculated SNM quantities are accurate. For reconstituted fuel and consolidated SNF, measurements may be needed to verify the nuclear material content of the new fuel assembly or fuel package respectively.

If effective safeguards systems for the measurement and verification of the nuclear material content of the SNF received from the reactor facilities and of the HLW are to be implemented, appropriate measurement systems and procedures need to be identified and developed concurrent with the development of the waste management systems. If appropriate safeguards systems are not available early in the waste management program, effective domestic and IAEA safeguarding of SNF and HLW in the OCRWM Program may be difficult to achieve. For example, measurement methods and C/S techniques and methods for international safeguards verification of light water reactor SNF in storage pools have been under study for many years. After more than a decade of applying safeguards to power reactors, the level of IAEA safeguards verification achieved can still be substantially improved. Fully effective safeguards verification of SNM present in the SNF storage pools is restricted by storage pool procedural constraints and the intrusiveness of the safeguards measurements on facility operations.

REFERENCES

1. "Safeguards Agreement with the International Atomic Energy Agency," DOE Manual, DOE Order 1270.2, U.S. DOE, July 29, 1983.
2. "Safeguards and Security Program," DOE Manual, DOE Order 5630.11, U.S. DOE, Jan. 22, 1988.
3. "Physical Protection of Special Nuclear Material and Vital Equipment," DOE Manual, DOE Order 5632.2A, U.S. DOE, Feb. 9, 1988.
4. "Control and Accountability of Nuclear Materials," DOE Manual, DOE Order 5633.3, U.S. DOE, May 24, 1989.
5. "Nuclear Material Transactions: Documentation and Reporting," DOE Manual, DOE Order 5633.4, U.S. DOE, Apr. 28, 1988.
6. "Disposal of High-Level Radioactive Wastes in Geological Repositories," 10 CFR Pt. 60 (1987).
7. "Domestic Licensing of Special Nuclear Material," 10 CFR Pt. 70 (1987).
8. "Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation," 10 CFR Pt. 72 (1987).
9. "Physical Protection of Plants and Materials," 10 CFR Pt. 73 (1987).
10. "Material Control and Accounting of Special Nuclear Material," 10 CFR Pt. 74, (1987).
11. "Safeguards on Nuclear Material -- Implementation of US/IAEA Agreement," 10 CFR Pt. 75 (1987).
12. The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFIRC/153 (Corrected), International Atomic Energy Agency, Vienna, June 1972.
13. Agreement with the International Atomic Energy Agency for the Application of Safeguards in the United States of America, with Protocol, U.S. Government Printing Office, Washington, D.C., 1978.
14. Subsidiary Arrangements to the Agreement Between the Government of the United States of America and the International Atomic Energy Agency for the Application of Safeguards in the United States of America, U.S. Mission to IAEA, Vienna, June 28, 1978.
15. L. M. Brenner, "Salient International Safeguards Issues Facing OCRWM Program Activities," ESP87-144 (Amended), Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., June 30, 1987.
16. The Physical Protection of Nuclear Material, INFIRC/225, International Atomic Energy Agency, Vienna, September 1975.

ACRONYMS

10 CFR	Title 10 of the U.S. Code of Federal Regulations
C/S	containment and surveillance
DOE	U.S. Department of Energy
DP	data processing
HLW	high-level radioactive waste
IAEA	International Atomic Energy Agency
INFCIRC	IAEA Information Circular
MAA	material access area
NDA	nondestructive assay
NMC&A	nuclear material control and accountability
NMMSS	Nuclear Material Management and Safeguards System
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRC	U.S. Nuclear Regulatory Commission
OCRWM	DOE Office of Civilian Radioactive Waste Management
SNM	special nuclear material
SNF	spent nuclear fuel
TID	tamper-indicating device

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