The National Mining Association's and the Fuel Cycle Facilities Forum's White Paper on *Direct Disposal* of *Non*-11e.(2) Byproduct Materials in Uranium Mill Tailings Impoundments

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I. INTRODUCTION

Although radioactive elements have many beneficial uses including medical diagnosis and treatment, energy generation, and academic research, radioactive wastes generated from these activities require proper disposal. Radioactive waste disposal has been and remains a politically explosive issue that has proved to be a "thorn" in the side of those who attempt to use radioactive elements for beneficial purposes. Disposal of high level waste ("HLW") from energy-producing nuclear reactors currently is a major national political "football." Disposal of low level radioactive waste ("LLRW"), while not quite as politically charged, nevertheless has proved to be almost as difficult to address as HLW. In the past, Congress has attempted, through legislation (i.e., the Low Level Waste Policy Act ("LLWPA"), as amended)) to facilitate the development and operation of new LLRW disposal facilities based on a comprehensive system of interstate Compacts. As of this date, this so-called "Compact system" has failed to create even one new LLRW disposal site. Indeed, this nation's existing licensed LLRW disposal capacity has steadily eroded and will continue to do so in the future. Although the cost of LLRW disposal has actually led to lower volumes of waste generated for disposal, substantial volumes of waste materials remain that must be addressed. Additionally, the advent of new Nuclear Regulatory Commission ("NRC") decommissioning and decontamination ("D&D") regulations will generate new volumes of such wastes for disposal.

In light of these developments, the National Mining Association ("NMA") and the Fuel Cycle Facilities Forum ("FCFF") are hereby undertaking a joint effort to propose

active regulatory, political, and economic consideration of using Atomic Energy Act (AEA) licensed uranium mill tailings facilities for *direct disposal* of some of these LLRW waste materials that are *similar* to uranium recovery ("UR") wastes designated as 11e.(2) *byproduct material*.

Beginning in 1992, NRC considered and developed a policy for the *direct disposal* of *non*-11e.(2) *byproduct material* in such facilities. In 1998, NMA, in a White Paper entitled *Recommendations for a Coordinated Approach to Regulating the Uranium Recovery Industry* ("1998 White Paper"), proposed that NRC relax its waste acceptance criteria for determining what types of *non*-11e.(2) materials could be disposed of appropriately in licensed uranium mill tailings impoundments by developing *generic waste acceptance criteria* for such materials. This joint NMA/FCFF White Paper (Non-11e.(2) White Paper) attempts to build on the record developed by NRC and on NMA's proposals in its 1998 White Paper to further refine the debate on this issue. To understand how these issues have developed in the past and where they stand currently, this White Paper will review the history of LLRW disposal and the history of the proposed use of UR mill tailings impoundments for direct disposal of *non*-11e.(2) materials. Then, this White Paper will attempt to propose regulatory, political, and economic bases for *generic waste acceptance criteria* that can be actively debated in the regulatory marketplace among all relevant stakeholders.

A. <u>An Overview of Relevant Low-Level Radioactive Waste Disposal Facts and Issues</u>

There are different definitions of LLRW ranging from that of the International Atomic Energy Agency ("IAEA") to that of the United States government, individual states, and interstate Compacts. In NRC's 10 CFR Part 61 regulations, waste is defined

as, "those low-level radioactive wastes containing source, special nuclear or *byproduct material* that are acceptable for disposal in a land disposal facility." Part 61 waste (LLRW) is defined negatively as "radioactive waste not classified as high-level radioactive waste, transuranic waste , spent nuclear fuel, or *byproduct material* (as defined in section 11e.(2) of the Atomic Energy Act (uranium or thorium mill tailings)." For the purposes of the Non-11e.(2) White Paper, low-level waste has the same meaning as in the LLWPA, that is, radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or *byproduct material* as defined in section 11e.(2) of the Atomic Energy Act (uranium or thorium tailings and waste)."[1]

LLRW can be solid, liquid or gaseous and can be generated by industries such as hospitals, medical, educational or research institutions; private or government laboratories; or nuclear fuel cycle facilities (e.g., nuclear power plants, fuel fabrication facilities). NRC has estimated that, in the 1980s, approximately 85,000 cubic meters of LLRW was generated and disposed of at commercial disposal sites on an annual basis, with most of the LLRW generated by fewer than 100 licensees.[2]

Disposal capacity for LLRW has slowly diminished over the last three decades. In the early 1970s, there were six operating LLRW disposal sites across the United States.[3] Between 1975 and 1979, three (3) of those sites closed leaving only three (3) sites to receive and dispose of the nation's LLRW; (1) the Barnwell site in South Carolina, (2) the Beatty site in Nevada, and (3) the Hanford site in Washington. The Sheffield site closed when it was filled to capacity and the Maxey Flats, KY and West

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[1] 10 CFR 61.7
[2] *Id.*
[3] The six (6) original sites included sites located in; (1) Beatty, NV; (2) Hanford, WA, (3) Barnwell, SC; (4) Maxey Flats, KY, (5) Sheffield, IL, and (6) West Valley, NY.

Valley, NY sites were closed due to a variety of problems including complex hydrogeology, surface cap collapse, and water infiltration and collection in disposal trenches. Thus, at that point in time, the nation's LLRW disposal capability was limited to three geographic locations whose disposal capacity was diminishing.[4] As a result, the cost of *direct disposal* of LLRW at the three remaining sites increased significantly and, because of the decreased disposal capacity, high volume/low activity wastes were less favored for *direct disposal* due to the priority placed on disposing of low volume/high activity wastes first.

In 1981, NRC released a Draft Environmental Impact Statement ("DEIS") stating that long-term permissible releases from shallow burial of LLRW would be minimal and the threat to public health and safety from such burial would be trivial. NRC determined that shallow burial of LLRW at closely-monitored sites would be appropriate because, based on LLRW's relatively low level of radioactivity as compared to HLW, such wastes required only "marginal shielding."[5]

B. <u>The Evolution of the Regional Compact System: A Failed Experiment</u>

Believing that they were shouldering an unfair and disproportionate burden for the disposal of the nation's LLRW, the governors of the States of Washington and Nevada closed down their disposal sites because of transport and packaging violations and South Carolina decided to strictly limit the amounts and types of wastes eligible for

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[4] It is also worth noting that two of these three remaining LLRW disposal sites were located in the Western United States thereby severely limiting the ability of Eastern and Central United States LLRW producers to dispose of their LLRW without expending considerable financial resources transporting such wastes.

[5] The levels of radioactivity present in Class B & C wastes are comparable to the levels of long-lived radium and airborne radon exposures present in uranium mill tailings. UR facilities already possess active air and groundwater quality monitoring and occupational health and safety programs designed to protect members of the public and mill workers from the radiological or *non*-radiological hazards associated with uranium mill railings.

disposal at its site. But, the most significant event occurred in 1980 when Washington's citizens overwhelmingly approved Initiative 383 prohibiting the importation of non-medical radioactive waste after an effective date of July 1, 1981. This measure was struck down as unconstitutional with the Supreme Court finding that Initiative 383 violated both the Supremacy Clause and the Interstate Commerce Clause of the United States Constitution.[6]

The actions taken by both Washington and Nevada to temporarily close down their disposal sites, the restrictions placed on waste disposal in South Carolina, and Washington's failed attempts to prohibit out-of-state waste made LLRW disposal issues matters for national policy debate. In response, in December of 1980, Congress passed the LLRWPA which required that each state take responsibility for providing disposal capacity for LLRW generated within its boundaries. Implementation of this policy included a recommendation that states join together and form regional LLRW Compacts to allow for the siting, characterization, and establishment of regional LLRW disposal facilities.[7] Further, the LLRWPA established an exclusion date of January 1, 1986 after which Compact members could exclude LLRW generated in out-of-Compact states from their regional Compact's LLRW disposal site. This deadline was created to encourage states to form regional Compacts quickly so that the nation's three remaining LLRW disposal sites would no longer bear the burden of receiving all of the nation's LLRW and so that states could avoid having to create their own individual LLRW disposal sites.

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[6] *See* United States Constitution, Article VI, cl. 2; Article I, Sec. 8, cl.3.
[7] Based on potential Constitutional problems regarding the Supremacy and Interstate Commerce Clauses, Congress must enact regional Compacts into law.

Failure to act raised the possibility of rejection of LLRW at out-of-state LLRW disposal sites.[8]

After the LLRWPA's passage, various states began to discuss the formation of regional Compacts and, as a result, six (6) regional Compacts composed of between five (5) and eleven (11) states were created. The Northwest, Southeast, and Rocky Mountain regions could readily propose their Compacts for Congressional approval, because they already possessed sited and characterized LLRW disposal facilities. By obtaining Congressional approval by the January 1, 1986 exclusionary date, these Compacts could exclude out-of-state generated LLRW and effectively transfer the burden of accepting large future amounts of LLRW to the other Compact regions.

Despite the states' efforts, however, including the submission of seven (7) regional Compact proposals for Congressional ratification, no Compacts were ratified prior to the January 1, 1986 exclusionary date. The possibility of new LLRW disposal facilities generated strong political opposition. Further, while the exclusionary date was designed to force Congressional ratification of LLRW Compacts before January 1, 1986, the exact opposite occurred when many legislators refused to ratify the proposed regional Compacts due to concerns that LLRW producers in their states, which did not have licensed sites, would be prohibited from sending their waste materials to other states with licensed sites for disposal. Legislators also were loath to approve regional Compacts that eventually could lead to the siting of a LLRW disposal facility in their state or near their

[8] The LLRWPA's legislative history suggests that Congress' primary intent was to create more LLRW disposal sites based on the fact that South Carolina, Nevada, and Washington, did not wish to continue accepting LLRW for disposal unless progress was made, "in creating new sites, and in more evenly distributing the burden of the low-level waste disposal." Also, the legislative history showed that Congress supported a "regional approach" and regarded states as best suited to manage these regional sites because they are "better capable of the planning and monitoring functions relevant to low-level waste."

constituents. In addition, many states decided to postpone or abandon efforts to gain approval of a regional Compact to force the existing sites to remain open and accept out-of-state LLRW.

In response to this apparent lack of "national progress," Congress passed the Low-Level Waste Policy Act Amendments Act of 1985 ("LLWPAA"), which was signed into law on January 15, 1986. This legislation was seen as a "deal" of sorts, because states could rely on the three existing LLRW disposal sites for a seven (7) year transitional period during which they could ship wastes to the existing sites, and the existing sites were given assurances that new sites would be developed.

The LLRWPAA also alleviated confusion stemming from inconsistent definitions of LLRW by instituting a single definition of LLRW, which is consistent with the definition of LLRW in the AEA.[9] The LLRWPAA also divided responsibility for disposal of different LLRW streams based on the entity that generated the waste. LLRW generated by commercial generators, state entities or federal agencies pursuing private objectives would be the responsibility of states and the federal government would be responsible for the disposal of LLRW generated for national security purposes or defense programs. More specifically, States would be responsible for Class A, B, and C wastes generated within their boundaries, because the LLRWPAA maintained that such waste materials could be managed most effectively by Regional Interstate Compacts. The federal government would manage DOE-created or owned waste or waste generated by the U.S. Navy during vessel decommissioning or as a result of federal atomic research

[9] The legislation defined LLRW as any radioactive material that is not high-level waste, spent nuclear fuel or *byproduct material* and whatever NRC classifies as LLRW. However, though this simple definition helps to alleviate some confusion, defining LLRW as what "it is not" will always has the potential to cause some uncertainty as to the classification of different materials.

programs. Wastes outside this scope generated by the federal government would still be the states' responsibility, but the federal government would manage LLRW with concentrations of radionuclides above NRC Class C parameters. The maximum total LLRW that could be disposed of at the three existing sites was limited to 19.6 million cubic feet ("mcf") or 2.8 mcf per year with a proposed breakdown of this total by site.[10] NRC also was given an "emergency" power of sorts which allowed it to order additional access for LLRW if an "immediate and serious threat to the public health and safety or the common defense and security" was created.

Unfortunately, however, the Compact system created by the LLRWPA and LLRWPAA has failed. Many of the problems associated with the failure to site and characterize new regional LLRW disposal sites are inherent in the political nature of the issue. State politicians ignored the LLRWPAA's interim period and deadline for implementation of out-of-Compact waste prohibitions and put site characterization on hold for extended periods of time so that their state might receive better terms for Compact management. States that already had LLRW disposal sites (i.e., Washington, South Carolina, and Nevada) were the only states willing to accept host state status for site development and some other states that generated minimal levels of LLRW wastes decided to handle their own waste and not accept other States' waste. Internally, states were forced to consult with local political groups to determine where a site could be located that would be both politically and environmentally sound and that process failed.

While a number of regional Compacts were formed, the process of siting disposal sites failed to yield even one new regional Compact site. Many citizens in areas where

[10] The proposed breakdown of the yearly 2.8 mcf limit was 0.2 mcf for the Beatty site, 1.4 mcf for the Hanford site, and 1.2 mcf for the Barnwell site.

disposal sites could be located did not have adequate knowledge of the differences between LLRW and HLW and, due to the closures of the West Valley, Sheffield, and Maxey Flats sites, the environmental community came to believe that shallow-land burial was not an appropriate method for LLRW disposal. They feared that, although 10 CFR Part 61 lists shallow-land burial as the approach of choice, disposal sites would follow the cheapest route to managing a site unless stricter provisions were enacted into law. All these problems have led to the expenditure of over 600 million dollars on the Compact system without so much as one shovel of dirt being turned to begin construction of a single new site.

C. <u>The Development of Disposal Standards for LLRW: 10 CFR Part 61</u>

NRC promulgated 10 CFR Part 61 to address regulation of LLRW that may be suitable for direct disposal in a land-disposal facility. Part 61 "contains specific requirements for near-surface disposal of radioactive waste which involves disposal in the uppermost portion of the earth, at a depth of approximately thirty (30) meters" and for "site characteristics [which] should be considered in terms of the indefinite future and evaluated for at least a 500 year time frame."[11] Part 61 LLRW is divided into three distinct categories; Class A, B, and C wastes. Class A waste is defined as waste that "does not contain sufficient amounts of radionuclides to be of great concern"[12] with respect to long-term active maintenance, migration of its radionuclide content or potential exposures to trespassers. This material tends to be similar to ordinary trash materials and tend[s] to be stable. Class B and C wastes are determined by evaluating the radionuclide content and measuring that content against limitations listed in two tables discussing long

[11] *See generally* 10 CFR Part 61.
[12] 10 CFR § 61.7(b)(2).

and short-lived waste materials. If the radionuclide content exceeds the highest measurements delineated in these tables, then they are "not generally acceptable for near-surface disposal."[13]

D. The Uranium Mill Tailings Radiation Control Act of 1978 and Its Relationship to *Direct Disposal* of *Non*-11e.(2) Materials

Even before the initial efforts to develop a regulatory scheme addressing *direct disposal* of *non*-11e.(2) materials in uranium mill tailings impoundments, the enactment of the Uranium Mill Tailings Radiation Control Act of 1978 ("UMTRCA"), as an amendment to the AEA, provided a basis for supporting an expansion of wastes eligible for *direct disposal* at such facilities. UMTRCA created a new definition of "byproduct material" to address long-term control of uranium recovery wastes, including specifically tailings from uranium recovery operations. This newly defined category of byproduct material was called "11e.(2) byproduct material" which is defined as "the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content."[14]

UMTRCA's provisions and its legislative history dictate that EPA and NRC regulate the potential radiological hazards associated with 11e.(2) *byproduct material*. However, even though the most serious potential hazards associated with 11e.(2)

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[13] As shown in 10 CFR § 61.55, Class A waste is, "waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in § 61.56(a). If Class A waste also meets the stability requirements set forth in § 61.56(b), it is not necessary to segregate the waste for disposal."

Class B waste is "waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in § 61.56."

Class C waste is "waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in § 61.56."

[14] 42 U.S.C. § 2014(e)(2).

byproduct material were deemed to be radiological in nature, both UMTRCA and its legislative history address the need to protect against the potential *non*-radiological hazards of such material as well. Section 206 of UMTRCA, which added section 275 to the AEA, directs EPA to promulgate *generally applicable standards* to protect public health and the environment from *both* potential radiological and *non*-radiological hazards associated with 11e.(2) byproduct material. With respect to such potential *non*-radiological hazards, EPA's *generally applicable standards* are directed to be consistent with requirements established under the Resource Conservation and Recovery Act ("RCRA") which is applicable to materials posing *similar* potential hazards.

In addition, section 205 of UMTRCA requires the NRC to regulate 11e.(2) *byproduct material* in a manner that:

> "the Commission deems appropriate to protect the public health and safety and the environment from radiological and *non*-radiological hazards associated with the processing and with the possession and transfer of [11e.(2)] material."[15]

The Commission is also directed to establish general requirements that are:

> "*comparable to* requirements applicable to the possession, transfer and disposal of similar hazardous material regulated by the Administrator [of EPA] under the Solid Waste Disposal Act, as amended."

Thus, the plain language of UMTRCA reflects Congress' intent to vest in EPA and NRC the authority to regulate *non*-radiological hazards associated with 11e.(2) *byproduct material*.

Similar indications of Congressional intent are found in the legislative history of UMTRCA as well. For example, the House Interior and Insular Affairs Committee, in reporting on the bill that would eventually be enacted as UMTRCA, stated as follows:

[15] 42 U.S.C § 2114(a)(1).

> "In establishing requirements or promulgating regulations for licensing or for oversight of the Department's remedial activities, the Commission must set all standards and requirements relating to management concepts, specific technology, engineering methods, and procedures to be employed to achieve desired levels of control for limiting public exposure and for protecting the general environment…The NRC is also responsible for implementing general standards and criteria promulgated by the Administrator of the Environmental Protection Agency. NRC must assure that the technology, engineering methods, operational controls, surveillance requirements and institutional arrangements employed at the sites provide the necessary barriers and levels of control to limit public exposure, and protect the environment from radiological *and toxic non-radiological substances associated with uranium mill tailings materials,* as specified by EPA standards and criteria."

Consequently, both the language of UMTRCA and its legislative history demonstrate that the statute focuses on both the radiological and *non*-radiological hazards of 11e.(2) byproduct material. In accordance with UMTRCA, EPA developed regulations in 40 CFR Part 192 and NRC developed regulations in 10 CFR Part 40, Appendix A, which conforms to 40 CFR Part 192, to fulfill these legislative directives.

E. <u>10 CFR Part 61 Versus 10 CFR Part 40, Appendix A Long-Term Safety Criteria</u>

It is worth noting here that a comparison between the provisions of 10 CFR Part 61 and 10 CFR Part 40, Appendix A Criteria demonstrates that both are intended to provide *long-term* protection against potential adverse impacts on public health, safety or the environment from radioactive waste materials. The long-term stabilization Criteria under 10 CFR Part 40, Appendix A require that all mill tailings must be protected for a minimum of 200 years and, to the extent reasonably achievable, 1,000 years with only *passive* controls and *no active maintenance* along with mandatory transfer to a long-term custodian while Part 61 allows for 100 years of active institutional controls and for Class C wastes protection for 500 years.

10 CFR Part 61 requirements for doses to members of the public are limited to 25 mrem/y while 10 CFR Part 40, Appendix A incorporates 40 CFR Part 190 prescribes a 25 mrem/y dose limit for non-radon releases at an *operating* UR facility and a 20 pCi/m²/s limit on radon flux from tailings which, according to EPA's hazardous air pollutant regulations developed under Section 112 of the Clean Air Act ("CAA") as amended, in 40 C.F.R. Part 61, Subpart W, provides an *ample margin of safety* for members of the public.[16] Groundwater protection Criteria under Appendix A require that each mill tailings impoundment have a liner sufficient to prevent leakage and migration of any mill tailings constituents into the surrounding subsurface soils or groundwater.[17] These criteria also prescribe that concentrations of mill tailings constituents in site groundwater may not exceed background, a maximum contaminant level ("MCL"), if applicable, or an NRC-approved alternate concentration limit ("ACL").[18] Under UMTRCA, *all* wastes, including hazardous constituents, resulting from traditional uranium or thorium milling processes are classified as 11e.(2) *byproduct material* and are disposed of in mill tailings impoundments subject to 10 CFR Part 40 requirements and Appendix A Criteria. In addition, 11e.(2) byproduct material is explicitly exempt from EPA regulation under RCRA, even if it contains hazardous constituents.[19] Part 61 has no such requirements for hazardous constituents, since they are not, except in the case of 11e.(2) byproduct material, AEA waste materials.

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[16] 40 C.F.R. Part 61, Subpart T, which was rescinded after settlement negotiations and amendments to 10 C.F.R. Part 40, Appendix A by NRC, previously provided the same conclusion regarding the 20 pCi/M2/S standard at reclaimed tailings piles.
[17] *See* 10 CFR Part 40, Appendix A, Criterion 5.
[18] *Id.*
[19] *See* 40 CFR § 261.4.

Further, Title II of UMTRCA mandates that all mill tailings sites and the property on which they lie must be transferred to the state in which it is located or to the federal government (i.e., DOE) at no cost to the government for long-term surveillance and monitoring under a perpetual license from NRC.[20] This statutory provision guarantees, as effectively as possible, that a licensed entity will exist to maintain, as necessary, finally reclaimed mill tailings disposal facilities in perpetuity. Part 40, Appendix A Criterion 10 mandate payments by Title II UMTRCA licensees to cover the cost of long-term surveillance and monitoring and, if necessary, any active maintenance.[21] Part 61 also requires a federal or state long-term custodian, but UMTRCA mandates not only a federal or state long-term custodian but also NRC licensing of the long-term custodian.

F. <u>The Uranium Recovery Industry: A New Direct Disposal Initiative</u>

For the past several years, the domestic UR industry has suffered the ramifications of a severely depressed world uranium market. Low spot-market prices for uranium coupled with the lack of long-term contracts for domestic UR operations have caused the entire domestic UR industry to experience significant economic downturns. Prior to 2004, the spot-market price of uranium dipped below eight dollars per pound based on poor demand for, and an oversupply of, marketable uranium. As a result, most if not all domestic UR companies have seen their financial stability undermined to the point that their continued existence is threatened.

Despite recent increases in spot-market uranium prices, current and projected future uranium prices potentially may not sustain traditional conventional domestic UR capacity. Cotter Corporation (Cotter) has survived by operating their conventional mills

[20] *See* 10 CFR § 40.28.
[21] *See* 10 CFR Part 40, Appendix A, Criterion 10.

to process alternate feeds for which they receive recycling/disposal fees, in addition to the value of recovered uranium. Kennecott Uranium Company (Kennecott) has placed its Sweetwater Uranium Project on *standby* status while evaluating its future. These two mills (Cotter & Kennecott) presently have enough existing licensed disposal capacity (20 to 40 million tons) to take large volumes of *similar* "other than 11e.(2) waste" for *direct disposal*. The Rio Algom Ambrosia Lake facility and the U.S. Energy Shootaring Canyon facility also have the potential to make even more disposal capacity available although neither currently is positioned to do so.

A fundamental concern associated with the potential direct disposal of *non*-11e.(2) *byproduct material* in uranium mill tailings impoundments is that, if such material contains RCRA hazardous wastes, it could then make the entire impoundment subject to regulation by EPA or delegated States under RCRA. A similar type of jurisdictional overlap might occur if any *non*-11e.(2) *byproduct material* containing NORM subject to State regulation is disposed of in a mill tailings impoundment.

This potential for dual or overlapping jurisdiction raises questions about the eventual transfer of custody of mill tailings to the long-term custodian (i.e., DOE). UMTRCA *requires* Title II licensees to transfer custody of their mill tailings facilities to DOE upon license termination, and DOE is required by section 83 of the AEA, as amended, to take the mill tailings impoundment(s) and other property necessary for the proper disposal of 11e.(2) *byproduct material*. Since UMTRCA contains no provision *requiring* that DOE take custody of, or title to, materials *other than* 11e.(2) *byproduct material*, disposal of *non*-11e.(2) *byproduct material* in mill tailings impoundments potentially could pose an impediment to license termination and transfer of custody to

DOE, as the NRC licensed long-term custodian. This is NRC's fundamental concern with *direct disposal* of *non*-11e.(2) materials. For example, currently, major questions exist as to whether DOE will take title to any LLRW disposal sites, even at no cost to the government. for purposes of long-term surveillance and monitoring which is *permissible* but not *mandatory* under section 151 (b) of the Nuclear Waste Policy Act ("NWPA").[22] Currently, DOE appears to be trying to avoid long-term surveillance and monitoring responsibilities rather than embracing them.

DOE has several different concerns that weigh against taking title to a site and waste which it is not mandated to take. First, even if a statute states a site must be transferred at no cost to the government, DOE apparently believes that, as a practical matter, it will have to obtain appropriations from Congress to maintain the integrity of any disposal site. Appropriated funds are necessary for conducting routine maintenance and possibly to address unforeseen and/or catastrophic problems that may occur at a disposal site. While DOE is mandated to take title to a uranium mill tailings site, extra *permissible* sites would pose additional funding problems such as requiring an increase in DOE's budget and further justification to Congress demonstrating the need for additional funding. As of this time, it appears that DOE is reluctant to increase this burden.

Second, after license termination, there is the potential for states to cause additional expenses through regulation of any hazardous substances in the waste material. Under the Federal Facilities Compliance Act ("FFCA"), the United States waived sovereign immunity with respect to state regulation of hazardous wastes at federal facilities.[23] Although 11e.(2) *byproduct material* is preemptively regulated by NRC

[22] 42 U.S.C. § 10101 et seq.
[23] Public Law 102-386, 106 Stat. 1505.

under its AEA power to exercise jurisdiction over both its potential radiological and *non*-radiological hazards, states may still exercise authority over the *non*-radiological (hazardous) components in LLRW.

In the past, NRC has received requests to allow disposal of various categories of *non*-11e.(2) *byproduct material* in uranium mill tailings impoundments. Factors such as their similarity to uranium mill tailings in volume, radioactivity, and toxicity and the high costs associated with their disposal in LLRW facilities prompted generators of these wastes to view uranium mill tailings piles as an attractive alternative for disposal.

One category of *non*-11e.(2) waste materials that has been proposed for disposal in uranium mill tailings impoundments consists of the secondary process wastes generated during the capture of uranium in *side-stream* recovery operations. Since natural *ores* that are processed for rare earths or other metals (i.e., copper, zirconium, vanadium) can have significant concentrations of uranium, these *ores* sometimes are processed through a *secondary side-stream* recovery operation to capture uranium either before or after the recovery of the rare earth or other metals. Even if the tailings from such processing operations contain *source material* in concentrations above the 0.05 percent *licensable* threshold listed in 10 CFR 40.13 and, thus, would be subject to NRC licensing, the Commission does not regard the tailings or related wastes from such *secondary side-stream* operations to be 11e.(2) *byproduct material*, because such *ores* are not processed *primarily* for their *source material* content, but rather *primarily* for their rare earth or other metal content.[24]

[24] Such materials likely are prime candidates for alternate feed processing assuming uranium can be recovered by such processing.

Another category of *non*-11e.(2) *byproduct material* frequently considered for disposal in uranium mill tailings piles consists of sludges or residues generated during treatment of mine water containing suspended or dissolved *source material*. Finally, some facilities have requested permission for the disposal of NORM and TENORM, such as contaminated resins from IX restoration operations[25] and construction scrap that ordinarily is subject to State regulation.[26] There are other potential sources of TENORM such as radium-bearing oil and gas production, geothermal power production, and industrial water treatment wastes.

To address these and other issues raised by the disposal of *non*-11e.(2) *byproduct material* in uranium mill tailings impoundments, NRC Staff and the Commission began its inquiry into this matter almost a decade ago.

II. NRC and the Development of a Policy on *Direct Disposal* of *Non*-11e.(2) Materials Pre-1995 *Direct Disposal* Policies

A. Pre-1995 Direct Disposal Policies

On August 7, 1991, NRC Staff released SECY-91-243 which informed the Commission that it had developed guidance regarding responses to applicants' requests to dispose of material *other than* AEA 11e.(2) *byproduct material* (i.e., *non*-11e.(2) *byproduct material*) in licensed 11e.(2) mill tailings impoundments. In response, the Commission issued a Staff Requirements Memorandum ("SRM") dated September 20, 1991 raising some concerns about the proposed guidance.

In another SRM dated December 3, 1991, the Commission directed NRC Staff to publish a Federal Register notice for public comment regarding NRC Staff's proposed

[25] In SECY 99-11, the Commission decided that ISL *restoration* wastes are 11e.(2) *byproduct material* so such wastes can now be disposed of directly in 11e.(2) disposal facilities.
[26] The volume of this type of material which will need disposal may increase greatly due to the passage of the EPA's new drinking water MCLs for radium and uranium.

guidance on *direct disposal* of *non*-11e.(2) *byproduct material* with its then-proposed alternate feed guidance ("AFG"). On April 30, 1992, the Commission approved a Federal Register notice combining both the proposed *direct disposal* guidance and the AFG which was published on May 13, 1992. Review and comments were sought from the public including specifically DOE, EPA, Agreement States, and LLRW Compacts.[27]

From the public comments received, NRC Staff identified six (6) subject areas specifically dealing with *direct disposal* and one (1) subject area dealing with both *direct disposal* and the proposed AFG. The following discussion reviews NRC Staff's proposed *direct disposal* guidance, the subject areas upon which comments were received, the commenter and their comments on those subject areas to provide a framework for consideration of the concept in today's regulatory marketplace.

Licensees have proposed to directly dispose of wastes in tailings impoundments from a wide range of processing activities that did not, for various reasons, yield wastes classified as 11e.(2) *byproduct material*. First, some licensees wanted to dispose of wastes from de-watering underground mine areas where *source material* had originally been extracted. The water from de-watering such mine areas frequently contained suspended or dissolved constituents that included *source material*. After being processed to meet Clean Water Act ("CWA") National Pollutant Discharge Elimination Standards ("NPDES") release requirements, which included removal of uranium, according to NRC Staff, the post-treatment wastes did not meet the definition of 11e.(2) *byproduct material*. NRC Staff reasoned that the resulting water-treatment "filtercake" or sludge residues did

[27] On October 28, 1992, an Advance Notice of Public Rulemaking ("ANPRM") on 10 CFR Part 40 was published in the Federal Register a proposed AFG and *direct disposal* of *non*-11e.(2) guidance were two of the issues included for comment. The *direct disposal* guidance identified in this ANPRM was identical to that in the May 13, 1992 Federal Register notice.

not directly result from the extraction or concentration of uranium or thorium from *ore processed primarily* for its *source material* content and, therefore, would not qualify as 11e.(2) *byproduct material*.[28]

Second, as noted above, some licensees requested that they be able to dispose of wastes created by secondary or *side-stream* recovery of rare earths or other metals (i.e., copper, zirconium, vanadium). NRC Staff noted that although the extraction of uranium from pregnant solutions containing these rare earths or other metals must be licensed by NRC (i.e., secondary circuit at a multiple circuit mill), the resulting wastes would not be 11e.(2) *byproduct material* because the processing was not *primarily* to extract the *ore*'s *source material* content but rather primarily to extract its rare earth content.[29]

Third, licensees requested that they be able to dispose of waste materials from the Formerly Utilized Site Remedial Action Program (FUSRAP) that originally processed materials like monazite sands for their thorium content.[30] Though many of the processing activities involved processing materials for their *source material* content (i.e., thorium), it was unclear to NRC Staff whether *all* the residual FUSRAP materials were the result of that particular activity and, therefore, 11e.(2) *byproduct material*.[31]

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[28] The obvious conflict between this apparently logical conclusion and the Commission's current policy determination that restoration fluids and wastes at *in situ leach* (ISL) facilities (which similarly are not derived by processing primarily to remove *source material* content, but which are derived from cleaning up a barren ore body which itself is not classified as 11(e).2 *byproduct material*) are 11e.(2) *byproduct material* is striking.
[29] *Id*.
[30] *Id*.
[31] DOE, which formerly had responsibility for FUSRAP sites, identified a variety of waste materials at such sites, including some specifically identified as 11e.(2) *byproduct material*. NRC's more recent interpretation regarding the status of pre-1978 wastes generated pursuant to AEC contracts and/or licenses where materials were processed *primarily* for their source material content as not being 11e.(2) *byproduct material* currently is inconsistent with DOE's conclusions.

Fourth, naturally occurring and accelerator-produced radioactive material ("NARM") wastes were considered as potential candidates for *direct disposal*. NRC Staff determined that most NARM wastes are the result of activities not regulated under the AEA as are NORM[32] wastes such as contaminated resins from IX well-water purifying operations, construction scrap, and radioactively contaminated soil from various commercial operations such as oil and gas production and geothermal power production.[33] Individual states normally have regulatory responsibility over NARM, but several federal agencies including EPA, the Department of Health and Human Services, and the Department of Labor have jurisdictional responsibilities. The definition of LLRW in several Compacts includes NORM and Envirocare, Inc. already has a licensed NORM disposal facility in Clive, Utah.

Analyses of *direct disposal* requests suggested that two common elements were shared by most such requests; (1) the material is low specific activity ("LSA"), radioactive material and (2) the material is physically *similar* to 11e.(2) *byproduct material*. In assessing these requests, the two familiar policy concerns regarding *direct disposal* of such wastes in mill tailings piles noted above were identified and discussed in some detail. First, the requested *direct disposal* activities might result in, what NRC Staff called, "complicated, dual, or even multiple regulation of the tailings pile."[34] Second, as a result, the requested *direct disposal* might complicate the eventual transfer of the tailings piles to DOE for perpetual, long-term surveillance and monitoring.[35]

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[32] Naturally Occurring Radioactive Materials ("NORM") has been defined as a subset of materials known as NARM (i.e., materials made radioactive in nuclear accelerators). NARM includes NORM, but NORM does not include the accelerator-produced portion of NARM.
[33] 57 Fed. Reg. at 20527.
[34] *Id.* at 20526.
[35] 57 Fed. Reg. at 20526.

Several other issues were addressed by public commenters. The first such issue was waste type(s) that could be viable candidates for *direct disposal*. A uniform trend among commenters was opposition to guidance that would "either exclude or severely restrict other types of waste for disposal."[36] The States of Wyoming and Utah concurred with NRC Staff's conclusion that NARM wastes should not be allowed in tailings impoundments while Colorado, Washington, Rio Algom, and the American Mining Congress (AMC) asserted that NARM and mine wastes should be permitted for *direct disposal*. Wyoming agreed with NRC Staff's guidance on 11e.(1) byproduct and *special nuclear material* that only *compelling circumstances* should warrant the *direct disposal* of such materials in tailings impoundments. Rio Algom, Envirocare, and AMC requested that NRC Staff more clearly define which materials may be candidates for *direct disposal* by separating NARM wastes from mine and other radioactive wastes.

NRC Staff decided that, instead of more clearly defining NARM, it would change the guidance to allow only "radioactive material regulated by NRC under the AEA."[37] Also, NRC Staff noted that, while it could conceive of relatively few instances where it would approve of the disposal of 11e.(1) *byproduct material* or *special nuclear material* for *direct disposal*, it nonetheless wished to maintain flexibility if special circumstances should arise.

The second public comment issue was the relation of *non*-11e.(2) *byproduct material* to LLRW. Wyoming and Utah agreed with NRC Staff guidance requiring Compact approval in both the state where the waste originated and the state where it is to

[36] See U.S. Nuclear Regulatory Commission Staff Response to Public Comments on "Revised Guidance on Disposal of Non-Atomic Energy Act of 1954, Section 11e.(2) *Byproduct material* in Tailings Impoundments" at A1.2.
[37] *See id.* at A1.3.

be transported and disposed. The FCFF opined that several categories of waste that are *similar* to 11e.(2) *byproduct material* should not require Compact approval. Rio Algom commented that Compact approval should not be required when the *non*-11e.(2) *byproduct material* and the tailings impoundment are owned by the same company. Rhone-Poulenc stated that Compact approval was unnecessary and too restrictive, because Compacts would have economic incentives to disapprove of such proposals for their own gain.

Envirocare, Inc. raised several legal issues related to the LLRWPAA stating that NRC Staff should have included language explicitly requiring Compact approval by law and approval by the Governor of the State where the disposal site is located. It also stated that the Compact or State where the tailings impoundment is located should be authorized to charge fees related to LLRW waste disposal for the *direct disposal* of such wastes. UMETCO, Rio Algom, and the FCFF stated that an exemption to the requirements of 10 CFR Part 61 would be appropriate and the AMC stated that a joint Part 40 and Part 61 license would be redundant. Envirocare argued that the guidance should provide for a hearing to address the possibility of a Part 61 exemption.

NRC Staff reiterated its position that regional Compact approval was required because *non*-11e.(2) *byproduct material* is likely to be classified as LLRW (i.e., the waste material does not meet the definition of 11e.(2) *byproduct material*, then such material likely will be LLRW). Despite the economic incentives a regional Compact may have to disapprove of a *direct disposal* request, NRC Staff maintained that regional Compact approval should be required based solely on the wastes being classified as LLRW. With regard to LLRWPAA issues, NRC Staff agreed that the requirement for regional

Compact approval comes from the LLRWPAA. However, NRC Staff disagreed with the need for gubernatorial approval of *direct disposal* proposals and have found the numerous requests it received for gubernatorial approval to be unnecessary and not supported by Congress. An exemption to Part 61 requirements, in NRC Staff's opinion, would prevent the redundancy of joint Part 40 and 61 licenses as mentioned by AMC. Envirocare's request for a mandatory hearing on a Part 61 exemption was rejected but, since a *direct disposal* request would necessitate an amendment to a uranium mill's license, a hearing in accordance with NRC's 10 CFR Part 2 procedures for "informal hearings" would be an option for a potential intervenor with standing.

The next public comment issue was *mixed waste*. Envirocare and the State of Utah indicated that demonstrating that there are no CERCLA issues involved in a *direct disposal* proposal could be nearly impossible. Cabot Corporation requested clarification on this issue. AMC, the state of Colorado, and Cabot Corporation also requested that NRC and EPA work together to form non-overlapping, *mixed waste* regulations and to cooperate to allow for the *direct disposal* of *mixed waste*. Envirocare stated that EPA should be allowed to comment on the viability of *direct disposal* and regulation under 10 CFR Part 40, Appendix A. Texas requested a list of constituents and limiting concentrations so RCRA waste could be separated from byproduct wastes. Utah asked that a sampling protocol be developed for incoming shipments of wastes for *direct disposal*, and DOE expressed concern that tailings impoundments should not be subjected to active EPA regulation.

NRC Staff stated that limiting acceptance to only radioactive material regulated under the AEA will help provide reasonable assurance that CERCLA remedial action will

not be warranted at a later date. It was also agreed that more inter-agency cooperation should be sought to resolve *mixed waste* issues. NRC Staff made clear that it would not approve *direct disposal* of materials that would bring the tailings impoundment under the purview of RCRA. In order that the tailings impoundment may have further safeguards against RCRA's applicability, NRC Staff added a requirement to its guidance that an 11e.(2) licensee must demonstrate that the waste for *direct disposal* does not contain material classified as hazardous waste under 40 CFR Part 261 or polychlorinated biphenyl under 40 CFR Part 761. To make such determinations, testing procedures were required to follow existing EPA regulations.

Another public comment issue involved questions about transfer of title and custody of tailings impoundments. Envirocare and Utah noted that NRC Staff guidance suggested that DOE has authority to take title under the AEA but that the AEA only addresses DOE's obligation to take 11e.(2) *byproduct material*. Two states asked for an explanation or analysis of the technical requirements for DOE to take title to a tailings impoundment containing *non*-11e.(2) *byproduct material*. Washington asked whether the requirements that there be no groundwater restoration issues applied only to *non*-11e.(2) material guidance or also to previously existing 11e.(2) guidance as well. Wyoming proposed that the requirement that DOE agree, in advance, to take title to the tailings impoundment site remain in the new guidance and that a licensee post a surety similar to that of a LLRW disposal facility. AMC stated that requiring DOE approval of each specific license amendment proposal was unnecessary and that obtaining *generic* DOE approval would be far less cumbersome if NRC, working with DOE, could agree on a set

of *generic waste acceptance criteria*. DOE asked for one-hundred and twenty (120) days rather than thirty (30) days to comment on proposed *direct disposal* guidance.

NRC Staff stated that though it agreed that UMTRCA does not address *directly* the issue of DOE taking title to tailings impoundments containing *non*-11e.(2) *byproduct material*, UMTRCA does not preclude DOE from taking title to such a site, if DOE has agreed to take title to such site provided NRC makes certain findings regarding the disposed materials. Also, NRC Staff cited section 151(b) of the NWPA that authorizes DOE to assume title and custody of AEA LLRW and the land on which it is disposed if certain defined criteria are satisfied. Since *non*-11e.(2) *byproduct material* would likely be classified as AEA LLRW, NRC Staff concluded that DOE could take title to tailings impoundments containing *non*-11e.(2) *byproduct material*. NRC Staff also noted that the guidance was not intended to provide assistance on the technical criteria required for DOE to take title to these sites. Rather, the criteria would be part of the licensing process when a *direct disposal* request is submitted. Also, the statements pertaining to the resolution of groundwater contamination issues at these sites would, in effect, apply to 11e.(2) byproduct material sites as well because of the Appendix A Criteria for groundwater restoration.[38] NRC Staff also revised its guidance to include a commitment by DOE to take title to a tailings impoundment site within 120 days of a request for *direct disposal*.

The next set of public comments addressed the technical aspects of *direct disposal*. Congressman Wayne Owens of Utah commented that mill tailings impoundments were never designed for, nor are they suitable for, *direct disposal* of materials other than 11e.(2) *byproduct material*. AMC disagreed stating that tailings

[38] *See* 10 CFR Part 40, Appendix A, Criterion 5.

impoundments are among the most eligible places for *direct disposal* as long as the materials are *similar* to uranium mill tailings, and Cabot Corporation recommended that a study be conducted on the *characteristic*s of 11e.(2) byproduct material and see what similarities exist between 11e.(2) byproduct material and *mixed wastes*. If they share similar *characteristic*s warranting *direct disposal*, Cabot Corporation argued that NRC and EPA should confer on legislative changes to allow *direct disposal* without any overlapping jurisdictional problems.

Envirocare stated that a licensee should demonstrate that it can dispose of all its existing 11e.(2) *byproduct material* before accepting any materials for *direct disposal*. Also, Envirocare stated that the licensee must show that the entire impoundment is in compliance with 10 CFR Part 40, Appendix A Criteria, because some older impoundments do not comply with current requirements or NRC has interpreted and applied the standards differently to different licensees. Congressman Owens also stated that the House of Representatives had incorporated a provision in H.R. 776 to prohibit such *direct disposal* without gubernatorial approval from the sponsoring state. Utah asked if the guidance would apply to uranium mills in "*standby*" status and stated that *direct disposal* would be subject to potentially stricter facility-siting and land-disposal requirements than those in standard uranium mill tailings regulations.

NRC Staff flatly disagreed with any statements that mill tailings impoundments are not suitable for *direct disposal* of *non*-11e.(2) materials, because such materials have *similar* radiological, chemical, and physical characteristics to 11e.(2) byproduct materials but do not satisfy the technical definition of 11e.(2) *byproduct material*. NRC Staff concurred with Cabot Corporation and stated that materials exhibiting radiological or

non-radiological (hazardous) *characteristic*s may be *similar* to 11e.(2) byproduct material and even some *mixed wastes* would meet this criteria and be potential candidates for *direct disposal*. Since the 10 CFR Part 40, Appendix A Criteria were written to address 11e.(2) byproduct materials and the guidance allows *direct disposal* of *non*-11e.(2) materials that are *similar* to 11e.(2) byproduct material, technically, *direct disposal* is feasible from a regulatory standpoint. However, though some *mixed waste* may be a potential candidate for *direct disposal*, EPA and NRC have not yet overcome the regulatory/political hurdles to its disposal which still exist. NRC Staff noted that both NRC and EPA would continue to work toward resolving that situation.

Though NRC Staff agreed with Envirocare's statements that a licensee must demonstrate that mill tailings impoundments have met the 10 CFR Part 40, Appendix A criteria for reclamation and closure, it disagreed with the request that NRC essentially reassess past determinations on the suitability of a licensee's tailings impoundment. NRC Staff stated that the Commission had determined that unless a significant risk to public health, safety or the environment exists, there would be no need to reassess previously-approved reclamation plans.[39] Also, NRC Staff's revised guidance would not be a reversal of any long-standing NRC policies since the prior guidance had been in effect since 1988.

A requirement for gubernatorial approval of *direct disposal* proposal would, in NRC Staff's view, be inappropriate as it would discourage the development of national policies for radioactive waste disposal. Obtaining approval from regional Compacts, rather than from States, should ensure that no LLRW programs would be compromised. Congressman Owens' statement about a Congressional provision preventing *direct*

[39]*See* SECY-95-155, *Review of Previously Approved Reclamation Plans*, (June 14, 1995).

disposal without gubernatorial approval was moot because it did not survive legislative scrutiny. NRC Staff stated that UR facilities on "*standby*" status would be prime candidates for *direct disposal* since they could, at any time, resume *ore* processing. These mills would, however, have to submit a license amendment showing that their tailings impoundments could handle *direct disposal* of *non*-11e.(2) materials and that such activities would pose *no significant potential risk* to public health, safety, or the environment. NRC Staff also noted that NRC would not enforce state regulations on land-disposal or siting at an NRC-licensed site.

Finally, NRC Staff received comments on various other *direct disposal* issues. Cabot Corporation asked for clarification on the type and amount of documentation required for a licensee to obtain approval of a *direct disposal* request. Envirocare stated that the guidance did not require adequate documentation for approval of a *direct disposal* proposal, that a detailed environmental analysis should be required for transportation of *non*-11e.(2) materials, and that a new EIS should be required for the entire site. Another commenter argued that the guidance might result in a proliferation of Part 61 LLRW disposal sites and an increase in the number of transportation corridors. DOE recommended that the guidance preclude the *direct disposal* of any materials that might jeopardize the long-term stability of a Title II site and that it not be applied to Title I sites.

NRC Staff specifically stated again that the guidance was not intended to provide technical assistance on any aspects of *direct disposal* and that guidance on documentation matters could be found in other NRC NUREGS or other regulatory guides. NRC Staff did agree that a license amendment would be subject to review under 10 CFR Part 51,

including an environmental report, that would assess different aspects of the proposed *direct disposal* activity, such as transportation, unless the proposed license amendment would qualify for a exemption under 10 CFR 51.22.[40] Additionally, NRC Staff found that, while Envirocare was correct in saying that more sites would contain LLRW, no new sites would be created because existing tailings impoundments would be used and/or available licensed disposal capacity or even new disposal capacity would be utilized[41] without creating additional sites. Also, DOE's concern about long-term surveillance would be addressed by NRC Staff's requirements that *direct disposal* meet the closure and reclamation criteria under 10 CFR Part 40, Appendix A and that the guidance would not apply to Title I sites.

To summarize, based on the 1992 Draft Guidance and prior to the issuance of the 1995 Final Guidance, a licensee had to meet four specific requirements to receive NRC approval of *non*-11e.(2) *byproduct material* disposal: (1) the disposal could not have "significant additional effects on public health and safety and the environment;" (2) the disposal had to comply with the reclamation and closure criteria set forth in 10 CFR Part 40, Appendix A; (3) the disposal could not result in the tailings pile becoming subject to RCRA or CERCLA; and (4) DOE or the State had to agree to take title to the site upon completion of reclamation.

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[40] The exemption criteria are listed under 10 CFR Part 51.22(c) entitled *Criterion for Categorical Exclusion; Identification of Licensing and Regulatory Actions Eligible for Categorical Exclusion or Otherwise Not Requiring Environmental Review*. Such criteria include all exemptions in subsection (c) or if "the proposed action belongs to a category of actions which the Commission, by rule or regulation, has declared to be a categorical exclusion, after first finding that the category of actions does not individually or cumulatively have a significant effect on the human environment." See 10 CFR 51.22(a).

[41] Even if additional disposal capacity would have to be licensed, it will still not create a *new site*—just more capacity at the *same site*.

B. <u>The 1995 Final Guidance and NMA's Response</u>

With the public's comments in mind, on August 15, 1995, NRC Staff issued its *Final Revised Guidance on Disposal of Non-Atomic Energy Act of 1954, Section 11e.(2) Byproduct Material in Tailings Impoundments* as follows:

(1) Since mill tailings impoundments are already regulated under 10 CFR Part 40, licensing of the receipt and disposal of such material should also be under Part 40.

(2) Radioactive material not regulated under the AEA shall not be authorized for disposal in an 11e.(2) *byproduct material* impoundment.

(3) *Special nuclear material* and Section 11e.(1) *byproduct material* waste should not be considered as candidates for disposal in a tailings impoundment, *without compelling reasons to the contrary*. If staff believes that such material should be disposed of in a tailings impoundment in a specific instance, a request for approval by the Commission should be prepared.

(4) The 11e.(2) licensee must demonstrate that the material is not subject to applicable RCRA regulations or other EPA standards for hazardous or toxic wastes prior to disposal. To further ensure that RCRA hazardous waste is not inadvertently disposed of in mill tailings impoundments, the 11e.(2) licensee also must demonstrate, for waste containing *source material*, as defined under the AEA, that the waste does not also contain material classified as hazardous waste according to 40 CFR Part 261. In addition, the licensee must demonstrate that the *non*-11e.(2) material does not contain material regulated under other Federal statutes, such as the Toxic Substances Control Act. Thus, *source material* physically mixed with other material, would require evaluation in accordance with 40 CFR Part 261 or 40 CFR Part 761. (These provisions would cover material such as: *characteristic* hazardous waste; *listed* hazardous waste; and polychlorinated biphenyls). The demonstration and testing should follow accepted EPA regulations and protocols.

(5) The 11e.(2) licensee must demonstrate that there are no CERCLA issues related to the disposal of the *non*-11e.(2) *byproduct material*.

(6) The 11e.(2) licensee must demonstrate that there will be no significant environmental impact from disposing of this material.

(7) The 11e.(2) licensee must demonstrate that the proposed disposal will not compromise the reclamation of the tailings impoundment by demonstrating compliance with the reclamation and closure criteria of Appendix A of 10 CFR Part 40.

(8) The 11e.(2) licensee must provide documentation showing approval by the Regional Low-Level Waste Compact in whose jurisdiction the waste originates as well as approval by the Compact in whose jurisdiction the disposal site is located.

(9) The DOE and the State in which the tailings impoundment is located, should be informed of the NRC findings and proposed action, with a request to concur within 120 days. A concurrence and commitment from either DOE or the State to take title to the tailings impoundment after closure must be received before granting the license amendment to the 11e.(2) licensee.

(10) The mechanism to authorize the disposal of *non*-11e.(2) *byproduct material* in a tailings impoundment is an amendment to the mill license under 10 CFR Part 40, authorizing the receipt of the material and its disposal. Additionally, an exemption to the requirements of 10 CFR Part 61.6, must be granted. (If the tailings impoundment is located in an Agreement State with low-level waste licensing authority, the State must take appropriate action to exempt the *non*-11e.(2) *byproduct material* from regulation as low-level waste). The license amendment and the § 61.6 exemption should be supported with a staff analysis addressing the issues discussed in this guidance.[42]

Thus, in the 1995 Final Guidance, NRC Staff retained all four (4) of the criteria from the 1992 Draft Guidance, but also added several new requirements resulting in a total of ten (10) criteria for the *direct disposal* of *non*-11e.(2) *byproduct material*. In its White Paper, NMA argued that the 1995 Final Guidance would impose so many burdensome requirements on licensees that it would be extremely difficult, if not impossible, to dispose of *non*-11e.(2) *byproduct material* in tailings impoundments.

[42] U.S. Nuclear Regulatory Commission, Final Revised Guidance on Disposal of Non-Atomic Energy Act of 1954, Section 11e.(2) *Byproduct Material* in Tailings Impoundments (August 15, 1995). (emphasis added).

NMA asserted that this guidance was inconsistent with the goal of optimizing protection of public health, safety, and the environment by encouraging disposal rather than storage of wastes and generally not in accordance with sound public policy, given the many advantages to making *direct disposal* a viable option.

For example, NMA argued that disposal of *non*-11e.(2) *byproduct material* in tailings impoundments would promote maximum utilization of available disposal capacity for radioactive waste given the shortage of options in the marketplace for disposal of high volume, low activity LLRW that is *similar* to uranium mill tailings (i.e., contaminated soils, sludges, rubble, etc.). Developing new waste disposal capacity, particularly for radioactive waste, has become extremely difficult and increasingly expensive and likely will remain so into the foreseeable future. Existing uranium mill tailings impoundments offer large amounts of disposal capacity for LLRW materials that are *similar* to mill tailings.

In particular, NMA noted that waste materials that are likely eligible for disposal, such as *side-stream* process wastes, construction scrap, and mine-water sludges are high volume, low activity wastes that are physically, chemically, and radiologically *similar*, and, in some cases, virtually identical, to 11e.(2) *byproduct material*. In many cases, the only difference between the two types of waste is their process history and, thus, their regulatory status. Consequently, commingling of these types of wastes with 11e.(2) byproduct material in mill tailings impoundments would not pose any potential hazards beyond those evaluated for an 11e.(2) byproduct material disposal license. NMA pointed out that NRC Staff has agreed with the position in the preamble to the Draft Guidance on *direct disposal* issues:

> "In most of the proposals the staff has seen, *disposal of these materials in tailings impoundments would not significantly increase the effect on the public health, safety, and environment*…These wastes are *similar* to the tailings in volume, radioactivity, and toxicity."[43]

Indeed, in some cases, *non*-11e.(2) materials likely will pose even fewer potential radiological and *non*-radiological hazards than existing uranium mill tailings.

Under UMTRCA regulations, *non*-11e.(2) *byproduct materials* disposed of in mill tailings impoundments would be subject to *stringent, ongoing*, and *long-term* oversight by NRC and DOE with regard to both potential radiological and *non*-radiological hazards, making uranium mill tailings impoundments particularly appropriate disposal sites. Moreover, this superior degree of protection would be achieved without the creation of new disposal sites.[44] NRC addressed this potential benefit as follows:

> "[N]o new disposal sites would be created as a result of the proposed guidance, since existing tailings impoundments would be used for disposal. In fact, the proposed guidance may result in *fewer* radioactive waste disposal sites, since material that might have been disposed of in a new site or that would take up valuable space in a LL[R]W disposal facility could be disposed of in an existing tailings impoundment."[45]

The use of existing mill tailings impoundments to dispose of *non*-11e.(2) *byproduct material* also is philosophically consistent with Criterion 2 of Appendix A which requires NRC "to avoid proliferation of small waste disposal sites and thereby reduce perpetual surveillance obligations" and would be consistent with NRC's long-standing policy favoring disposal over storage of LLRW wastes.[46]

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[43] 57 Fed. Reg. at 20527 (emphasis added).
[44] *See* 10 CFR Part 40, Appendix A, Criterion 2.
[45] Memorandum from James M. Taylor, Executive Director for Operations, U.S. Nuclear Regulatory Commission, to the Commission, U.S. Nuclear Regulatory Commission, Attachment 3, 13 (August 15, 1995)
[46] *See e.g.*, 58 Fed. Reg. 6730, 6731 (February 2, 1993), where the Commission explained that:

> "Although LL[R]W can be safely stored, NRC believes that the protection of the public health and safety and the environment is enhanced by disposal, rather than

Moreover, in its Strategic Assessment Rebaselining Initiative ("SARI"), in which the Commission examined in detail all aspects of its regulatory program, the Commission expressed its willingness to consider broader uses for uranium mill tailings facilities. The Commission specifically reviewed the option of expanding the use of uranium tailings impoundments to allow the disposal of waste generated during decommissioning of nuclear facilities along with 11e.(2) *byproduct material* by noting:

> "Because several…sites [currently undergoing decommissioning] have large quantities of uranium-and thorium-contaminated waste with *characteristic*s *similar* to those of mill tailings, it may be cost-effective to dispose of decommissioning waste at existing mill sites..."[47]

Based on these arguments, NMA made recommendations for revisions to the 1995 Final Guidance that would make that policy less restrictive and more workable using a creative approach to disposal of *non*-11e.(2) *byproduct material*. First, DOE has indicated to NRC that it would have no objections to *direct disposal* if the following conditions are met: (1) no adverse environmental impact would result from the disposal; and (2) there are no outstanding environmental compliance issues under RCRA or CERCLA.[48] The first condition, NMA stated, was incorporated into the 1995 Final Guidance, and should be easily satisfied by wastes that are physically, chemically, and radiologically *similar* to 11e.(2) *byproduct material*.[49] As to the second condition, NMA argued that DOE's concerns about any inconsistencies caused by dual EPA/NRC

> by long-term, indefinite storage of waste. Disposal of waste in a limited number of facilities licensed under 40 CFR Part 61 or compatible Agreement State regulations, will provide better protection of the public health and safety and the environment than long-term storage at hundreds or thousands of sites around the country."

[47] U.S. Nuclear Regulatory Commission, *Strategic Planning Framework*, 9-11 (September 16, 1996) (emphasis added).

[48] 57 Fed. Reg. at 20528.

[49] Naturally, the term *similar* would encompass wastes that are not as high volume, have *less* potentially hazardous constituents, and that have *less* radiological constituents (e.g., lower radon, radium-226, thorium-232 concentrations) than conventional uranium mill tailings.

regulatory oversight over RCRA/CERCLA wastes should be resolvable, since 11e.(2) byproduct material disposal sites are already subject to a regulatory regime under Appendix A which incorporates EPA radiological and long-term control requirements as well as EPA RCRA standards for potential *non*-radiological hazards.

Further, although DOE is only mandated to take title to and custody of 11e.(2) *byproduct material* under UMTRCA, DOE has the authority to accept custody of AEA wastes other than 11e.(2) byproduct material under the NWPA.[50] Section 151(b) provides DOE with the authority to accept custody of AEA wastes, including *non*-11e.(2) *byproduct material*, provided that (i) NRC requirements for site closure are satisfied; (ii) the transfer of title and custody to DOE is *without cost to the federal government*; and (iii) federal ownership and management of the site is necessary or desirable to protect public health and safety and the environment.[51] Since a mill tailings impoundment will not be allowed to close until NRC determines that all its site reclamation and closure requirements have been satisfied and section 83 of the AEA mandates that mill tailings disposal facilities must be transferred to the government at no cost, UMTRCA regulatory requirements applying to the closure and long-term control of uranium mill tailings disposal sites *by definition* satisfy the criteria set forth in section 151(b) of NWPA.

To the extent that state concurrence is deemed necessary or appropriate, considering the relatively insignificant incremental environmental impact of commingling *similar* 11e.(2) and *non*-11e.(2) waste, NMA asserted it may be possible to convince states where 11e.(2) byproduct material facilities are located of the benefits of such disposal practices based on certain well-understood *generic waste acceptance*

[50] 42 USC §§ 10101 *et seq.*
[51] 42 USC § 10171(b).

criteria. Even if a state did object, DOE could take title to the mill tailings impoundment(s) upon closure if the *non*-11e.(2) materials disposed do not raise any RCRA issues, since the AEA would preempt any state requirements pertaining solely to radiological health and safety issues. Pursuant to section 151(b) of the NWPA, NRC should, in NMA's view, explore revising the 1995 Final Guidance to require only formal notification of DOE and the state in which the mill tailings impoundment(s) is located of the Commission's decision to permit *direct disposal* instead of requiring the concurrence of DOE and the State.

Second, NMA stated that seeking a case-by-case exemption to the requirements of 10 CFR Part 61, as required under the Final Guidance, is also unnecessary given the similarity of the Part 40 and Part 61 requirements and goals. Mill tailings impoundments that satisfy the requirements of 10 CFR Part 40 for groundwater protection from potential *non*-radiological hazards and long-term isolation of tailings for 200-1,000 years would more than satisfy the less conservative Part 61 isolation requirements (which are *primarily* directed at radiological hazards) of 100 years for active oversight and 500 years for Class C wastes. On this subject, NMA quoted NRC stating:

> "The basic objectives of Parts 40 and 61 are the same; protection of public health and safety and the environment by disposal that controls and isolates the wastes for long periods of time."[52]

Accordingly, NMA requested that NRC consider issuing a *blanket exemption* from Part 61 requirements for Part 40 licensees seeking to directly dispose of *non*-11e.(2) *byproduct material*.

Third, NMA recommended that NRC should consider lifting its ban on the disposal of NORM in tailings impoundments or should seek legislative authorization to

[52] 57 Fed. Reg. at 20530 (1992).

do so. NMA focused on NORM because, generally, *direct disposal* requests do not involve NARM. NRC's primary concern in enforcing such a ban now is to avoid dual or overlapping NRC/state regulation of mill tailings impoundment, since the individual states typically exercise primary regulatory authority over NORM. This should not be a concern in Agreement States if DOE will accept title to the mill tailings pile.

In *non*-Agreement States, NRC should consider the feasibility of entering into agreements or a Memorandum of Understanding ("MOU") with relevant State agencies to satisfy concerns about dual regulation. *Non*-Agreement States should be receptive to this type of approach, since most such states apparently want no part of long-term surveillance and monitoring of mill tailings or any other type of LLRW and most states find the development of new LLRW disposal capacity next to impossible to achieve. Moreover, NMA asserted that model state regulations for control of NORM (Part N) developed by the Conference of Radiation Control Program Directors ("CRCPD") suggest that such wastes should be placed in facilities equivalent to uranium tailings impoundments so that there can be few, if any, technical bases for State recalcitrance.[53] In any case, NMA stated NORM is already present in 11e.(2) *byproduct material* (i.e., radium, K-40) and is adequately controlled under the current regulatory framework established under UMTRCA, thus demonstrating that disposal of NORM in tailings impoundments will not raise any serious concerns about public health and safety.

[53] In EPA's comments on SECY-99-012 regarding direct disposal in mill tailings impoundments, EPA stated, "TENORM wastes (particularly from conventional uranium mining overburden spoils) that are '*physically, chemically, and radiologically similar to material already in uranium/thorium tailings impoundments*' may be appropriate for disposal at such sites, provided that the volume of the radioactive materials placed in the tailings impoundments do not result in an exceedance of the National Emission Standards for Hazardous Air Pollutants ("NESHAPs") radon standard as embodied in 40 CFR 192.31, as amended."

Fourth, NMA requested that NRC, EPA and, where relevant, state agencies discuss the prohibition on disposal of *mixed waste* (part radioactive waste/part RCRA or TSCA waste) in tailings impoundments. NMA noted the Commission's concern that, because the AEA explicitly excludes 11e.(2) *byproduct material* from RCRA permitting, disposal of *mixed waste* in tailings piles would subject some facilities to overlapping NRC/EPA/State regulation. Yet, this concern, in NMA's view, should be mitigated for all parties by the fact that UMTRCA created a dual EPA/NRC regulatory program for tailings impoundments that requires the protection of public health, safety, and the environment from both potential radiological and *non*-radiological hazards posed by 11e.(2) wastes. NRC regulations governing the management of tailings impoundments, 10 CFR Part 40, Appendix A, already conform to the appropriate portions of EPA's RCRA regulations (i.e., groundwater protection standards) for "hazardous" as opposed to radiological constituents.[54] In other words, NMA stated that NRC should be able to make the case for *direct disposal* of mixed wastes as long as the *mixed waste* proposed for disposal is *similar* to 11e.(2) byproduct material in radiological and hazardous constituent *characteristic*s that, but for the definition of 11e.(2) *byproduct material*, would make it a classic *mixed waste*. NMA, quoting NRC Staff, stated:

> "11e.(2) *byproduct material* in tailings impoundments are both radioactive and exhibit hazardous *characteristic*s…Further, at least some material currently classified as "*mixed waste*" is similar in physical and chemical *characteristic*s to 11e.(2) *byproduct material* and therefore would appear, from a technical standpoint, to be candidate material for disposal in tailings impoundments."[55]

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[54] NMA also noted here that the regulatory regime governing management and disposal of 11e.(2) *byproduct material* under UMTRCA is comprehensive and in some respects provides public health protection far beyond that offered by RCRA—for example, by specifying a regulatory horizon of 200 to 1,000 years with *passive* controls (as opposed to 30 years under RCRA) and a statutorily mandated NRC-licensed governmental custodian..

[55] 1995 Final Guidance, Attachment 3, 10.

Thus, NRC should be able to enter into agreements or MOUs with EPA, DOE, and relevant states, to resolve any lingering concerns the Commission might have regarding dual or overlapping jurisdiction as a result of the disposal of *mixed wastes* in uranium mill tailings impoundments.[56]

Finally, NMA asked that NRC reconsider the presumption against *direct disposal* of low activity, high volume *special nuclear material* that is *similar* to 11e.(2) tailings. Due to the failure of the regional Compact scheme of the LLRWPAA to provide additional necessary disposal capacity for *special nuclear material* (and other AEA wastes) at an economically feasible cost and the low probability of construction of new nuclear waste disposal facilities, there is now, and likely will continue to be, a shortage of space for cost-effective disposal of such *similar special nuclear material*. Given the stringent regulatory oversight of 11e.(2) byproduct material disposal facilities and the fact that DOE must take custody of all 11e.(2) byproduct material upon license termination in perpetuity, NRC's concerns about "material control and accountability, and site security"[57] could be readily addressed.

Moreover, appropriate *generic waste acceptance criteria* could be developed to assure that *similar non*-11e.(2) waste materials containing *special nuclear material* proposed for *direct disposal* will not pose any significant potential hazards in addition to those considered in NRC's Part 40 licensing processes. These *generic waste acceptance criteria* could include: (1) only disposal of *special nuclear material* below criticality

[56] EPA has recently issued decisions which will allow for the storage of mixed waste and, perhaps, the future disposal of such waste at LLRW disposal facilities The willingness of EPA to allow for the storage of mixed waste under AEA requirements lends credibility to the fact that mill tailings impoundments are suitable for disposing of such wastes. *See e.g.*, 67 Fed. Reg. 54124 (August 21, 2002).
[57] 57 Fed. Reg. at 20529 (1992).

levels of concern; (2) radon emission criteria; (3) waste form and/or solubility criteria such as prohibiting disposal of wet or soluble *special nuclear material* wastes to minimize potential moderator and groundwater contamination concerns; (4) the familiar limitations on RCRA hazardous wastes; and (5) DOE's commitment to taking such wastes in accordance with section 151(b) of the NWPA. A *blanket waiver policy* that permits *special nuclear material* disposal if the *generic* acceptance criteria were met would offer considerably more flexibility than case-by-case review by the Commission.

NMA also noted that NRC's 1981 Branch Technical Position, which discussed five permitted options for disposal or on-site storage of thorium and uranium, indicated that, under 10 CFR § 20.302, licensees could bury enriched uranium for disposal so long as use of a given burial area was appropriately *restricted*.[58] The Commission required a covenant running with the land that restricted excavation and that also prohibited certain residential or industrial structures and agricultural uses. If these conditions were met, the average concentration of enriched uranium that could be buried under this option was as high as 1,000 pCi/gm, if the enriched uranium was soluble, and 2,500 pCi/gm, if the enriched uranium was insoluble. Uranium mill tailings impoundments would easily satisfy these requirements since they are subject to a statutory mandate that restricts their future use in perpetuity and they are designed to manage wet, soluble wastes.[59] Moreover, enriched uranium does not emit any significant quantities of radon so its disposal will comply with applicable radon (the primary radiological threat from uranium mill tailings) emission limits of 20 pCi/m²/s specified in Criterion 6 of Appendix A, which EPA has determined provides an *ample margin of safety* for public health.

[58] 46 Fed. Reg. 52061, 52062 (1981).
[59] 42 USC § 2113.

C. SECY-99-012: NRC Staff's Response

On April 8, 1999, NRC Staff issued SECY-99-012 for the purpose of obtaining Commission approval for its guidance on *direct disposal*.[60] Citing NMA's position on behalf of the UR industry, NRC Staff considered the argument that: (1) the prohibition of *non*-AEA, RCRA, TSCA, and CERCLA materials is overly restrictive and effectively precludes any significant use of uranium mill tailings facilities for *direct disposal*; (2) that UR facilities should be permitted to receive *non*-AEA materials for disposal, such as TENORM, as well as including some *similar special nuclear material*; and (3) requiring Compact approval would be overly burdensome.[61]

NRC Staff stated that the primary purpose behind the 1995 Final Guidance was to prevent any occurrences of dual or overlapping jurisdiction.[62] *Non*-AEA materials were not included in the list of permitted candidate-materials for *direct disposal* because of the potential jurisdictional and regulatory problems associated with them. The main concern was allowing states the opportunity to impose regulatory oversight over NRC-approved final tailings stabilization and remediation plans.[63] Again, NRC Staff feared that, like *non*-radiological components of 11e.(2) byproduct material which, *at that time*,[64] were

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[60] SECY-99-012, Use of Uranium Mill Tailings Impoundments for the Disposal of Waste Other than 11e.(2) *Byproduct Material* and Reviews of Applications to Process Material Other than Natural Uranium Ores, April 8, 1999.
[61] *Id*.
[62] *Id*.
[63] SECY-99-012, Use of Uranium Mill Tailings Impoundments for the Disposal of Waste Other than 11e.(2) *Byproduct Material* and Reviews of Applications to Process Material Other than Natural Uranium Ores, April 8, 1999.
[64] It should be noted that the Commission reversed the long-standing policy of the Office of the Executive Legal Director (OELD) on concurrent jurisdiction of the *non*-radiological component of 11e.(2) byproduct material. Now, the Commission has sole regulatory authority over both the radiological and *non*-radiological components of 11e.(2) byproduct material. *See* SECY-99-277

subject to concurrent NRC and non-Agreement State jurisdiction, dual jurisdiction would cause unwanted confusion in the regulatory scheme.[65]

NRC Staff argued that, based on Congress' legislative intent in UMTRCA to prevent dual regulation of mill tailings sites, *direct disposal* would cause tailings impoundments containing materials otherwise eligible for regulation under the Solid Waste Disposal Act ("SWDA") to fall under dual NRC/EPA jurisdiction. Concerns expressed by DOE in its comments to the Final Guidance motivated NRC Staff to conclude that allowing this type of *direct disposal* could complicate the eventual transfer of title to a site and its mill tailings impoundments to DOE. For that reason, NRC Staff expressly stated that the Final Guidance had been developed in "extensive consultation with DOE in its capacity as the anticipated long-term custodian" of reclaimed mill tailings impoundments after license termination.[66] NRC Staff concluded that the requirement of obtaining DOE approval as long-term custodian of any *direct disposal* of materials causing potential dual regulation problems should remain in the guidance despite any other revisions.[67] If DOE were to take sites with waste materials other than 11e.(2) *byproduct material*, then it would do so under section 151(b) of the NWPA and,

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[65] *Id*.

[66] NRC noted that DOE had, in the past, allowed disposal of TSCA waste in a tailings impoundment. The waste was a combination of 11e.(2) *byproduct material* and transformer oil containing polychlorinated biphenyls ("PCB"). With EPA's concurrence, DOE allowed the licensee to construct a second tailings cell on top of its original so that the material could be disposed. However, Staff Stated that DOE "took the lead" on the disposal issue and NRC had very little involvement. *Id*. If the PCBs had been from the Mill and, therefore, 11e.(2) *byproduct material* there would not have been the need for EPA concurrence or a second dedicated PCB cell.

[67] *Id*.

as long as they agree to do so, NRC Staff found that there would be no procedural problems with the transfer of the site and its mill tailings impoundments.[68]

NRC Staff proposed three potential courses of action for the Commission's consideration; (1) retain the guidance in its current form; (2) revise the guidance to allow for more flexibility in using the disposal capacity of mill tailings impoundments or; (3) seek legislative changes with regard to the type of materials to be placed in a mill tailings impoundment under the long-term care of DOE.[69]

In response, the Commission issued an SRM approving the second course of action, allowing more flexibility in the disposal capacity for mill tailings impoundments, and expressly disapproving NRC Staff's third option.[70] The Commission stated that "the disposal of material other than 11e.(2) *byproduct material*, which may include *listed* hazardous wastes, in mill tailings impoundments should be allowed if: (1) there is adequate protection of the public health, safety, and the environment; (2) the long-term custodian of the site has indicated its willingness to accept responsibility for maintenance of the site prior to NRC approving the disposal; and (3) necessary approvals of other affected regulators (e.g., States, EPA) have been obtained.[71] The Commission also stated that consideration should be given to obtaining written approval of the long-term custodian (i.e., DOE) before approving a *direct disposal* request.[72]

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[68] *Id.*
[69] *See* FN 62 *supra*.
[70] Staff Requirements Memorandum ("SRM"), SECY-99-0012, Use of Uranium Mill Tailings Impoundments for the Disposal of Waste Other Than 11e.(2) *Byproduct Material* and Reviews of Applications to Process Material Other Than Natural Uranium Ores, July 26, 2000.
[71] *Id*. Presumably, the "necessary approvals" language refers to EPA or delegated States regarding RCRA issues involving *characteristic* or *listed* constituents and, possibly CWA permit issues, if any. Such approvals may no longer be necessary for alternate feeds that qualify as *source material ore*.
[72] *Id.*

The Commission ordered that the new revisions to the Final Guidance should be codified in a final rule after proper interaction with important stakeholders such as DOE, EPA, States, and the UR industry.[73] The *direct disposal* of *non*-11e.(2) materials, the Commission stated, should be allowed if the above-mentioned criteria are met and the materials are "radiologically, physically, and chemically *similar* to, and compatible with, materials already being disposed of in mill tailings impoundments."[74] Also, NRC Staff should pursue a generic exemption to Part 61 requirements so that individual exemptions from those requirements for each disposal request can be avoided.[75]

D. Commissioner's Statements on *Direct Disposal*

The Commissioners offered individual statements reflecting their viewpoints on the *direct disposal* of *non*-11e.(2) materials at licensed uranium mills.[76] Chairman Meserve agreed with the NRC Staff in that mill tailings sites may be used for the direct disposal of *non*-11e.(2) materials and stated that:

> "Mill tailings sites can clearly provide appropriate disposal locations for materials that are physically, radiologically, and chemically *similar* to section 11e.(2) *byproduct material*. This might include non-AEA material (e.g., NORM/TENORM), as well as AEA material (i.e., *source*, 11e.(1) *byproduct material*, and *special nuclear material*). Moreover, in light of the fact that tailings impoundments must comply with requirements that are consistent with standards for the disposal of similar hazardous chemical wastes, *see* 42 USC §§ 2022(b)(2), 2114(a)(3), such impoundments offer the opportunity for safe disposal of certain materials that are regulated under RCRA, TSCA, and CERCLA. Thus, consistent with Commission policy of lowering the [cost of] decommissioning waste

[73] *Id*.
[74] SRM, SECY-99-0012, Use of Uranium Mill Tailings Impoundments for the Disposal of Waste Other Than 11e.(2) *Byproduct material* and Reviews of Applications to Process Material Other Than Natural Uranium Ores, July 26, 2000. (emphasis added).
[75] *Id*.
[76] Commission Voting Record, SECY-99-0012: Use of Uranium Mill Tailings Impoundments for the Disposal of Waste Other than 11e.(2) *Byproduct material* and Reviews of Applications to Process Material Other than Natural Uranium Ores, July 26, 2000.

> disposal and using existing mill tailings impoundments to dispose of materials in circumstances in which there is adequate protection of the public health and safety and the environment, I conclude that the Commission should allow for the disposal of material other than 11e.(2) *byproduct material* in tailings impoundments."

While supporting the notion of directly disposing *non*-11e.(2) materials in mill tailings impoundments, Chairman Meserve noted that, "such action may result in the impoundment being subject to regulation by both NRC and other regulators." Nevertheless, he concluded that, "because of the value of using impoundments in appropriate cases for disposal, I nonetheless believe the staff should proceed to allow disposal of *non*-11e.(2) *byproduct material* in tailings impoundments in circumstances where the licensee is prepared to accept consequences of dual regulation."[77]

Commissioner Diaz agreed with Chairman Meserve's perspective and recommended that the proposed changes be incorporated into the new Part 41 rulemaking plan, if and when that avenue is pursued. The need for adequate DOE or state agency input into applications involving potential dual or overlapping regulatory issues was re-emphasized and allowing LLRW Compacts to provide input would also be allowed.[78] Commissioner McGaffigan argued that NRC Staff should proceed with the Part 41

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[77] To address the consequences of dual regulation, Chairman Meserve stated that, "in order to avoid the needless expenditure of staff resources on the review of applications for disposal of *non*-11e.(2) *byproduct material*, the consent of the long-term custodian (a state or, more likely, DOE) to accept the site should be obtained before review is undertaken." Further, Chairman Meserve reiterated that, "approval of other regulators (e.g., EPA, a state regulatory agency, and/or affected LLW Compacts) should be received before disposal begins." Chairman Meserve did support limited efforts to pursue an amendment to UMTRCA eliminating dual jurisdiction concerns but, at the same time, recognized that it would not be given high priority in Congress. Commissioner Merrifield also noted that DOE should be given the lead in pursuing any such legislative change that would eventually place an increased burden on DOE during its term as long-term custodian and NRC's role should be merely supportive.

[78] *See* Commission Voting Record on SECY-99-0012. Chairman McGaffigan also noted that DOE possesses large quantities of materials that could safely be disposed of in tailings impoundments without significant threat to public health and safety or the environment which would make DOE, as the long-term custodian, potentially, more supportive of Chairman Meserve's position.

rulemaking plan to codify many of the positions taken by Chairman Meserve. He stated that, "the disposal of material other than 11e.(2) *byproduct material* in tailings impoundments is safe," and that "NRC-licensed disposal facilities including mill tailings impoundments are adequately protective of workers, public health and safety, and the environment."[79] Further, Commissioner McGaffigan recommended that interaction with stakeholders such as DOE, related state regulatory agencies, and EPA should occur with the end result being a codified rule allowing for the disposal of *non*-11e.(2) materials such as NORM, TENORM, TSCA, and RCRA materials.[80] Commissioner Merrifield took a more restrictive approach stating that "if waste material exists which is physically, chemically, and radiologically identical to 11e.(2) *byproduct material* and if there are no statutory impediments to the type of disposal action," then the disposal application should be allowed.

Finally, Commissioner McGaffigan stated that "it may be possible to relax the NRC criterion that a mill licensee obtain concurrence from the appropriate regional Compact since placement of non-11e.(2) materials in the tailings impoundment will ultimately require consent from the long-term custodian…"[81] Commissioner Merrifield

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[79] Commissioner McGaffigan also stated that, "[s]tate-of-the-art tailings impoundments, like RCRA disposal cells, rely in part on a system of liners and leachate detection and collection systems to prevent and detect releases of hazardous and radioactive materials to the environment. Also, long-term stability, government ownership, and enduring or perpetual controls are measures used by NRC and EPA to ensure safety." These factors contributed to Commissioner McGaffigan's conclusion that, "materials other than mill tailings may be safely disposed of in the tailings impoundments."

[80] While this cooperation may allow for the codification of a rule on *direct disposal*, Commissioner McGaffigan recognized that "consideration should be given to requiring written confirmation from DOE or the State that it would accept responsibility for the maintenance of the site prior to NRC approving the disposal of non-11e.(2) material."

[81] Commissioner McGaffigan further stated that, "while I recognize that LLW Compact approval was not originally proposed by the staff…but was added to the guidance at the direction of the then sitting Commission, I believe that, based on the fact that the Compacts have made virtually

disagreed and argued that the implementation of NRC Staff guidance requiring the approval of the appropriate LLRW Compact where the proposed *direct disposal* waste originates and the LLRW Compact where disposal will occur should be pursued and codified in any Part 41 rulemaking.

III. ***Direct Disposal*** **Preliminary Considerations**

Two basic premises that that must be addressed prior to evaluating the viability of *generic waste acceptance criteria* for direct disposal of *non*-11e.(2) waste materials in license mill tailings impoundments are the level of assessments available regarding such impoundments and the types of candidate materials eligible for direct disposal. With respect to the level of available assessments, both EPA and NRC have conducted extensive generic assessments for uranium milling which include detailed analyses of factors such as impoundment design requirements, potential impacts from radiological and *non*-radiological constituents, and surface stabilization for site closure. Further, pursuant to UMTRCA's mandate, EPA and NRC have promulgated a strict, robust regulatory program for the management and control of 11e.(2) byproduct material and its radiological and *non*-radiological constituents.[82] Additionally, many, if not all, uranium recovery licensees have conducted site-specific environmental assessments and submitted environmental reports to NRC in conjunction with their Part 40 licenses. These environmental reports also should provide useful bases for evaluating *generic waste acceptance criteria*.[83]

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no progress in siting additional LLW sites coupled with the need for increased disposal options, the issue of Compact approval warrants discussion with appropriate stakeholders."

[82] *See* 40 CFR Part 192 & 10 CFR Part 40, Appendix A.

[83] It is worth noting that, while EPA's and NRC's generic assessments address a wide variety of issues associated with uranium milling, these agencies did not intend for such assessments to replace site-specific assessments, if necessary. Factors such as site-specific impoundment

With respect to the types of *non*-11e.(2) waste materials eligible for direct disposal, the basic premise is that such materials should be physically, chemically, and radiologically *similar* to 11e.(2) byproduct material. Physical similarities potentially could include the particular waste form (i.e., soil, sand, metals, rubble, sludges, resins, etc.), moisture content, and solubility. Given the size of licensed 11e.(2) tailings impoundments and the variety of potential waste forms which have been disposed, physical similarity should not be a problematic issue.

Chemical similarities potentially could include hazardous constituents (i.e., presence of *listed* or *characteristic* RCRA hazardous wastes), including, specifically, concentrations and chemical form(s) thereof in candidate *non*-11e.(2) waste materials. Generally, 11e.(2) byproduct material contains varying levels of acids and other chemicals used in uranium milling that are disposed of in mill tailings impoundments.[84] In addition, as noted by EPA and NRC, natural uranium ores contain wide ranges of heavy metals and other *non*-radiological constituents which are not removed during the uranium recovery process and are disposed in mill tailings impoundments as 11e.(2) byproduct material. Unless a candidate *non*-11e.(2) waste material contains some unusual chemical or mineral constituent or unusually high concentration thereof which has not been assessed either generically or specifically, there should be no problem demonstrating that most candidate materials can be safely disposed in licensed 11e.(2) tailings impoundments.

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construction (i.e., liner and leachate collection system), facility construction, site geography, site geology and hydrogeology, and financial assurance may be considered in such site-specific assessments.

[84] *See generally* GEIS.

Radiological similarities potentially could include radionuclide content (i.e., the radionuclides uranium, thorium, radium/radon, their form and concentrations). To the extent to which such naturally occurring radionuclides are not in natural equilibrium, there could be a relevant issue. For example, potential candidate materials containing *special nuclear material* in the form of low-enriched uranium (LEU) may contain little or no radium and, thus, generate little or no radon. EPA determined that the single greatest threat to public health and safety from 11e.(2) byproduct material is radon emissions and that all other health risks "can be ignored compared to that from breathing short-lived radon decay products."[85] Thus, such materials may represent less of a potential radiological hazard than traditional 11e.(2) materials or other materials like TENORM, which can contain substantial radium and. Depending on its form, can emit substantial quantities of radon. Material containing long-lived radionuclides which have been assessed in EPA's and NRC's generic assessments, in licensee-specific environmental reports or which will behave similarly are *non*-11e.(2) waste materials which should be eligible for direct disposal in licensed mill tailings impoundments.

IV. <u>NMA/FCFF Proposal(s)</u>

Considering the potentially significant public health, safety, and environmental benefits of allowing *non*-11e.(2) waste materials to be disposed in licensed mill tailings impoundments and the recognized ability of such impoundments to safely contain various types of *non*-11e.(2) waste materials, NMA and FCFF hereby recommend that NRC revise its current guidance on *direct disposal* of *non*-11e.(2) *byproduct material* to make

[85] *See* FEIS at 6-11; *see also* GEIS at 4. "With respect to overall health impacts, the critical mill-released radionuclides and their primary sources are, in descending order of importance: Rn (radon)-222 from the tailings pile; Ra (radium)-226 and Pb (lead)-210 from the tailings pile; and U(uranium)-238 and U-234 from yellowcake operations."

the policy less restrictive and more workable. From a political perspective, NRC should relax the restrictions on *direct disposal* so that various forms of LLRW will no longer be "stored" at DOE-owned/operated or private, licensed facilities and will be directly disposed at private sites that eventually will return to the government at no cost to the government. From a regulatory perspective, NRC should fully evaluate the constituents in materials proposed for *direct disposal*, including all physical, chemical, and radiological characteristics when deciding whether *non*-11e.(2) materials are appropriate for disposal in mill tailings impoundments. Further, implementation of *generic waste acceptance criteria* will provide a valuable threshold test that licensees and NRC may use when evaluating *direct disposal* proposals. Assuming such *generic waste acceptance criteria* are acceptable to DOE, EPA/States, and other relevant stakeholders, *direct disposal* should be an acceptable option for *similar* wastes containing source material, special nuclear material, NORM/TENORM or mixed wastes.

In its Strategic Assessment Rebaselining Initiative (SARI), the Commission examined all aspects of its regulatory program in great detail. While expressing its willingness to consider broader uses for UR facilities, the Commission specifically reviewed the option of expanding the use of uranium tailings impoundments to allow the disposal of waste generated during decommissioning of nuclear facilities along with 11e.(2) *byproduct material*. The SARI noted:

> "Because several…sites [currently undergoing decommissioning] have large quantities of uranium-and thorium-contaminated waste with *characteristic*s *similar* to those of mill tailings, it may be cost-effective to dispose of decommissioning waste at existing mill sites..."[86]

[86] U.S. Nuclear Regulatory Commission, *Strategic Planning Framework*, 9-11 (September 16, 1996) (emphasis added).

Further, as assumed in 10 CFR Part 40, Appendix A, Criteria 2, allowing broader disposal uses for uranium mill tailings impoundments will prevent the proliferation of small or large numbers of new, small disposal or storage sites that make little sense if the wastes involved likely will contain significant concentrations of long-lived radionuclides. New sites have proven to be very difficult to characterize and license while there are several licensed uranium mill tailings impoundments that already have been extensively characterized and which are subject to stringent operating and post-closure controls.

Disposal of wastes containing source material, special nuclear material, NORM/TENORM, mixed waste or other *similar non*-11e.(2) materials in uranium mill tailings impoundments would assure that these materials are "disposed" in secure tailings impoundments rather than merely being "stored" at a facility. Storing such materials provides no guarantee that they will have consistent and adequately protective long-term oversight and also forces either DOE or private facilities to incur significant costs to insure that whatever materials are stored and the impoundments or containers in which they are stored (e.g., ponds, drums, casks) are monitored and maintained for extended periods of time. Theoretically, these materials eventually must be transported for final disposal at an *existing* LLRW facility. Given limited existing disposal capacity, the large existing amounts of LLRW, potential increases due to NRC's site closure regulations, potential increases in domestic nuclear power capacity, and the failure of the LLRW Compact system, new disposal capacity *must* be created or existing UR capacity should be used. Given the questionable prospects for the former, the latter should be seriously considered.

Another factor to consider is that, in the case of DOE LLRW currently stored at facilities under its control, *direct disposal* of these materials in uranium mill tailings impoundments will not present any fundamental changes in title to such materials because they eventually will return to DOE when it takes title to these UR facilities as required by UMTRCA. The materials will be removed from DOE's custody for *direct disposal* and returned to it at no cost after license termination. These materials will be safely stored in mill tailings impoundments under strict Appendix A Criteria, and DOE will act as an NRC licensee in perpetuity.

V. NMA and FCFF Recommendations: *Generic Waste Acceptance Criteria* for NRC Approval

In an effort to promote efficient and effective *non*-11e.(2) *direct disposal* guidance, NMA/FCFF recommend that NRC adopt *generic waste acceptance criteria* to use in evaluating individual licensee proposals for accepting and disposing of *non*-11e.(2) materials.

First, obtaining DOE approval for any *direct disposal* proposal is crucial to insuring that DOE will eventually take title to the site and manage it as an NRC licensee in perpetuity. By obtaining DOE approval and the concurrence of other relevant entities such as EPA and/or States on *generic waste acceptance criteria*, NRC will have created a cohesive, publicly enunciated framework under which all *direct disposal* proposals may be evaluated without fear of alienating DOE and jeopardizing future long-term stewardship. DOE approval could be based on NRC's *non*-11e.(2) guidance and/or through an MOU for sites under Section 151(b) of the NWPA.

Similarly, EPA approval should be obtained so that no dual or overlapping jurisdiction concerns arise at the federal level from *direct disposal* of *non*-11e.(2)

materials containing *characteristic* or *listed* hazardous wastes under RCRA. Consultation with EPA Regional offices and headquarters may be required depending on the type of materials and the hazardous constituents they contain. Approval of State regulators if they are Agreement States under the AEA will be required so that no regulatory inconsistencies arise with respect to AEA materials accepted for *direct disposal*. State regulatory approval in both Agreement and *non*-Agreement States will also be necessary for licensees to directly dispose of mixed AEA and hazardous or TENORM *non*-11e.(2) materials to avoid concerns that, at some later date, the State would intervene and attempt to force implementation of additional regulatory controls. In particular, approval from the State will help prevent any post-license termination dual or overlapping jurisdictional problems under RCRA, which is a major concern of DOE as the long-term steward. EPA or State approval will be *the* pivotal factor in the acceptance of *non*-11e.*(2)* materials for direct disposal that contain *characteristic* or *listed* hazardous wastes that is actively regulated.

Compact approval should also be sought so that no objections will be raised during the transport of *non*-11e.(2) materials from generators in one Compact jurisdiction to a licensee in another Compact jurisdiction. Finally, NMA and FCFF suggest that the views of LLRW generators without access to cost-effective disposal capacity be solicited so that the issues raised by *non*-11e.(2) disposal may be addressed by as many affected parties as possible.

A. <u>Proposed Generic Waste Acceptance Criteria</u>

NMA and FCFF recommend that NRC create new *generic waste acceptance criteria* to assist licensees, NRC, and other interested or affected entities in determining

whether a given candidate *non*-11e.(2) material is suitable for *direct disposal* in uranium mill tailings impoundments. Potential candidate materials encompass a wide variety of waste streams with differing characteristics and constituents, but NMA and FCFF propose to address four (4) categories: (1) *source material* which the current guidance finds acceptable if the ten (10) above-mentioned criteria are satisfied; (2) *special nuclear material*; (3) NORM/TENORM; and (4) mixed waste (i.e., materials with radiological and hazardous components). NMA and FCFF recommend that consideration be given to developing *generic waste acceptance criteria* for each of these four categories of potential *non*-11e.(2) wastes which will reflect both their similarities to 11e.(2) wastes and any of the unique characteristics of such waste streams with respect to their potential incremental impacts on public health and safety and the environment. NMA and FCFF believe that, in many cases, *non*-11e.(2) waste materials may pose essentially the same, or even less, potential radiological and/or *non*-radiological hazards as 11e.(2) byproduct material. Since many *non*-11e.(2) waste streams will be high volume, low-activity wastes, uranium mill tailings impoundments should be well-suited for *direct disposal* of these materials.

The "upper bound"[87] assumption for this White Paper is based on the activity set forth in NRC's GEIS for uranium milling of a "high quality" 1% uranium ore at secular equilibrium, uranium recovery (extraction efficiency) at the mill of 93%,[88] and the design

[87] The bounding criteria proposed here is "generic," because licensees potentially could submit a license amendment request with appropriate site-specific dose modeling and other evidence to NRC Staff demonstrating that materials exceeding the proposed "upper bound" assumption could be disposed of in a mill tailings impoundment.
[88] GEIS at 5-4.

capacity of the mill's tailings impoundment.[89] Thus, for purposes of the foregoing candidate materials, the primary bounding criteria will be based on the activity levels set out in the GEIS for uranium ores containing 1% U3O8 at secular equilibrium.[90]

In addition, the appendices to this White Paper use the 93% uranium mill recovery assumption used in the GEIS and assume a loss of radon (and its subsequent progeny) of 35% based on the default emanation co-efficient of 0.35 stated in *Regulatory Guide 3.64* entitled *Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers*. The NMA/FCFF proposal means that uranium mill tailings impoundments as described and defined in the GEIS can be considered capable of safely containing materials in a given decay chain with a total activity from all radionuclides present in the given chain of 2.22E-08 curies per gram with no single radionuclide present in an activity greater than 2812 pCi/g in quantities equal to the design capacity of the mill tailings impoundment. Materials of this type could be accepted without any site-specific dose modeling or other evidence except, possibly, for modeling and analyses related to changes in the tailings impoundment cover design to satisfy the cover design requirements in 10 CFR Part 40, Appendix A, Criterion 6(1)(ii) for containment of higher than usual radon releases.

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[89] One percent U3O8 was arbitrarily chosen as an *upper-bound* "high quality" uranium ore concentration assumption which NRC chose to use to illustrate sources of radioactivity in the U-238 decay series in the GEIS. A higher *upper-bound* ore concentration assumption could have been chosen, but U.S. reserves did not and do not appear to contain large volumes of such "high quality" ores and any such ores likely would be blended routinely with lower grade ores during production operations. Indeed NRC's assumed *average* ore grade was initially 0.15% but that was revised downward to reflect estimates of lower ore grades likely to be processed from 1980 to the year 2000. GEIS at A-12-13. *Please see* Appendix 2, *Total Activity from 1% Uranium Ore at Secular Equilibrium* for the total estimated activity in uranium mill tailings derived from ore containing 1% uranium at secular equilibrium.

[90] *Please see* Appendix 1, *Bounding Limits Table* for a list of proposed bounding criteria based on 1% percent ore.

NMA/FCFF suggest that licensees seeking to accept materials with a total decay chain activity in excess of the 2.22E-08 curies per gram assumption and/or a single isotope in such materials with an activity level in excess of 2812 pCi/g would perform site-specific dose assessments and/or modeling demonstrating that the dose from such materials after disposal would not cause the facility to exceed the operational dose limits in 40 CFR Part 190, 10 CFR Part 20, and post-operational limits in 40 CFR Part 192 and 10 CFR Part 40, Appendix A. However, licensees also may resort to specialized disposal techniques involving the even distribution of higher activity material in existing tailings which contain lower radionuclide content or isolation and/or encapsulation of the higher activity materials. Such specialized disposal techniques could involve dissolution of waste materials in acidic solution following by pumping such materials into the tailings impoundment to mix with existing tailings solutions, physical mixing of waste materials and existing tailings, and placement of waste materials in an isolated area of the tailings impoundment specially constructed to encapsulate such waste materials, including cover thickness adjustments to prevent the escape of unusual concentrations of radon.[91] The candidate materials discussed in the following sections should be eligible for *direct disposal* at licensed 11e.(2) disposal facilities.

[91] The total activity of the tailings impoundment immediately prior to reclamation (point in time when the impoundment is filled) could not exceed the design capacity of the impoundment in tons times 0.020 curies per ton. This value of 0.020 curies per ton times the design capacity of the tailings impoundment in tons shall be defined as the *radiological design capacity* of the impoundment. (i.e., 2.22E-8 curies per gram * 454 grams per pound * 2,000 pounds per ton= 0.020 curies per ton).

B. Candidate Materials: Source Material

1. Waste Material Contaminated with Natural Source Material

The first candidate material that should be addressed under NRC's *generic waste acceptance criteria* is *source material*. Currently, NRC's *non*-11e.(2) direct disposal guidance specifically allows disposal of wastes containing *source material* if the ten (10) criteria are satisfied. *Generic waste acceptance criteria* approved by relevant entities could obviate the necessity for the current ponderous guidance.

A proposed NRC rule provides that some *ores* containing *source material* uranium below *licensable* levels, which are not viable alternate feeds because either it is too difficult or too expensive to extract the uranium content, would still be considered part of a licensee's licensed AEA material inventory at an AEA-licensed site.[92] As such, it would have to be properly disposed of in a licensed or permitted facility. Such material frequently would be *similar* to uranium mill tailings and would be an obvious candidate for *direct disposal*.

EPA's 40 CFR Part 192 regulations for the regulation of uranium *and thorium* mill tailings apply the same control requirements to 11e.(2) byproduct material which was generated from processing *source material* primarily for its *thorium* content as those used for controlling 11e.(2) byproduct material from processing *source material* for its *uranium* content. 40 CFR § 192.41 states, "[p]rovisions applicable to the element uranium shall also apply to the element thorium." NRC's GEIS states that, "the radiological parameters associated with the Th-232 [thorium] series are such that the impact of these isotopes is *relatively inconsequential*, even when they are present in

[92] *See* 67 Fed. Reg. 55175 (August 28, 2002).

amounts comparable to the natural uranium concentration in *ore*."[93] In addition, EPA's FEIS states, "the radiological impact of the thorium decay products would be *negligible* due to the short half-lives of the decay products."[94]

For waste contaminated with natural thorium, thorium-232 "in-grows" quickly (i.e., 67 years or ten times the half-life of radium-228) and, hence, there is no difference in activity in a 1,000 closure period between waste contaminated solely with thorium-232 and wastes contaminated with thorium-232 in equilibrium with its progeny. Thus, using the "upper bound" assumption noted above, waste materials contaminated with up to 2.5% thorium-232 should be acceptable for *direct disposal* without any additional site-specific assessment. With respect to waste material contaminated with thorium but without significant concentrations of its decay products, materials containing 1% thorium-232 attain secular equilibrium quickly with a maximum activity for the entire decay chain of 7.65E-9 curies per gram. Since the total activity for wastes from the processing of 1% U3O8 ores at secular equilibrium is estimated to be 2.22E-8 curies per gram, material contaminated with up to 2.5% thorium-232 could be placed in a mill tailings impoundment and remain within the "upper bound" assumption proposed by NMA/FCFF.[95]

Waste materials falling within the ambit of thorium processing wastes as "pre-1978" byproduct material also should be eligible for *direct disposal* in mill tailings impoundments. Thorium processing wastes may include thorium-232 decay products as well as any residual thorium remaining after processing. These wastes are at their peak

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[93] NRC GEIS 6-21.
[94] EPA FEIS at G-12.
[95] *Please see* Appendix 3, *Total Activity from a Waste Containing 1% Thorium-232*, for activity levels associated with wastes containing thorium-232 source material.

activity at the time of creation and such activity drops rapidly due to decay resulting from the short half-life of radium-228 (i.e., 6.7 years).[96] The activity of tailings from the processing of material containing 1% thorium-232 is estimated to be 8.008E-9 curies per gram. The total activity for tailings from 1% uranium ore at secular equilibrium is estimated to be 2.22E-8 curies per gram, thus, wastes from the processing of materials containing up to 2.5% thorium-232 would fall within the "upper bound" assumption proposed by NMA/FCFF.

Wastes contaminated with concentrations of natural thorium in excess of the "upper bound" parameters could be accepted for disposal in mill tailings impoundments following appropriate dose modeling and/or the implementation of specific safeguards to prevent potential undue worker exposure to direct gamma radiation.

Because both EPA and NRC already have anticipated the presence of natural thorium in 11e.(2) byproduct material, wastes containing source material thorium either above or below *licensable* levels which are *similar* to uranium mill tailings would appear to be the prime candidate for *non*-11e.(2) direct disposal. This is particularly true for any such materials that do not contain any "RCRA-activating" hazardous constituents, because DOE AEA authority would preempt any potential dual regulation by EPA or States. At the present time, such materials cannot be processed as an alternate feed since there is no viable market for the thorium equivalent of yellowcake. Therefore, generators should be encouraged to dispose of waste materials contaminated with natural thorium at NRC-licensed 11e.(2) disposal facilities.

[96] *See* Appendix 4, *Total Activity from a Waste Derived from Processing Material Containing 1% Thorium-232*.

2. **Waste Material Contaminated with Depleted Uranium**

Wastes contaminated with *source material* in the form of *depleted uranium* are appropriate candidate materials for *direct disposal* at licensed 11e.(2) disposal facilities. 10 CFR Part 40.4 defines *depleted uranium* as, "the *source material* uranium in which the isotope uranium-235 is less than 0.711 weight percent of the total uranium present."[97] Since *depleted uranium* is, by definition, *source material* and, since NRC's direct disposal policy currently permits the direct disposal of source material in mill tailings impoundments, materials contaminated with *depleted uranium* are eligible for *direct disposal* in mill tailings impoundments.

Wastes contaminated with depleted uranium possess less activity, by definition, than wastes contaminated with natural uranium. Depending on the level of depletion (concentration of U-235), wastes with higher concentrations of depleted uranium potentially could be placed in a mill tailings impoundment as a "buffer" to minimize radon emissions.[98] For example, wastes containing only the uranium-238 isotope (100% depleted uranium) would have an in-grown activity (at a 1,000 year closure period) of 1.32E-8 curies per gram. Using the total activity of tailings from 1% uranium ore at secular equilibrium of 2.22E-8 curies per gram, a waste with a concentration of 1.68% of fully depleted uranium would remain within the "upper bound" assumption proposed by NMA/FCFF.

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[97] *See* 10 CFR § 40.4.

[98] A table showing the total activity of wastes containing only uranium-238 is included as Appendix 2 of this White Paper. *See* Appendix 2, *Total Activity from a Waste Containing 1% Uranium-238.*

3. **Waste Materials Containing Special Nuclear Material**

The next candidate material to be addressed under NRC's *generic waste acceptance criteria* is waste material containing *special nuclear material*. 10 CFR Part 40.4 defines *special nuclear material* as "(1) plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material; or (2) any material artificially enriched by any of the foregoing." Currently, NRC's policy on the *direct disposal* of *special nuclear material* is that such material may be considered for *direct disposal* on a case-by-case basis if there is a "*compelling reason*" to do so. NRC presumably would evaluate each waste stream containing *special nuclear material* to determine whether such waste stream would pose a significant, potential incremental threat to public health and safety or the environment.

Generic waste acceptance criteria for waste streams containing *special nuclear material* would replace the *compelling reason* criteria (whatever that phrase means), and would focus on issues which relate to potential hazards from disposing such materials. The primary radiological issue for the *direct disposal* of *similar* wastes containing *special nuclear material* is the potential for criticality associated with enriched uranium, uranium-233 or plutonium.

As noted hereafter, no wastes containing any *significant concentrations* of uranium-233 or plutonium likely would be *non*-11e.(2) candidate material since neither is common in commercial or industrial waste streams. Thus, the primary radionuclide of concern for *non*-11e.(2) disposal of materials containing *special nuclear material* is LEU. The possibility of *criticality* during transport or storage of *special nuclear material* at a

licensed uranium mill appears to be the pivotal concern. Each waste stream containing varying concentrations of *special nuclear material* needs to be assessed in a manner which demonstrates that *criticality* is not, *and cannot be*, a realistic concern. While there may be a hypothetical possibility that a nuclear criticality event may occur as a result of the *direct disposal* of *special nuclear material* in a mill tailings impoundment, there is no reason that appropriate constraints on the *direct disposal* of such materials cannot obviate any realistic concerns. Indeed, support for this proposition can be found in many past technical analyses performed by NRC as well as from the chemical nature of *special nuclear material*. To provide some background in relation to which proposed generic waste acceptance criteria can be evaluated, this White Paper will provide a brief discussion of the available analyses within the scope of the following categories: (1) transportation; (2) emplacement; and (3) long-term disposal.

i. <u>Special Nuclear Material Issues: Transportation</u>

The safe and effective transportation of materials containing *special nuclear material* (fissile or fissionable material) can be accomplished in a relatively simple and straight-forward manner. Beginning with NRC's NUREG/CR-5342 entitled *Assessment and Recommendations for Fissile-Material Package Exemptions and General Licenses Within 10 CFR Part 71* and continuing through several recent changes to transportation packaging requirements from DOT, NRC, and the International Atomic Energy Agency ("IAEA"), it is possible to develop criteria that will prevent any possibility of a nuclear criticality event during transport to a uranium mill tailings facility.

In NUREG/CR-5342, NRC and its contractor, Oak Ridge National Laboratory, found that the prevention of a nuclear criticality event during transport can be

accomplished effectively if two factors are monitored; (1) the type, mass, and form of the fissile material and (2) the moderator-to-fissile ratio or the "degree of moderation" in the transport packages.[99] For NRC, the type, form, and mass of fissile material are crucial to an analysis of transportation safety requirements because,

> "[t]he type (uranium-235, plutonium-239, etc.), mass, and form (homogeneous, heterogeneous, metal, oxide, etc.) of the fissile material will affect the neutron production in a system because each has different energy-dependent probabilities for the absorption of neutrons…."

NUREG/CR-5342 at 3.

In addition, NRC found that the presence of moderators in a given ratio to fissile material is important because, "[t]he optimum ratio of moderator-to-fissile nuclei defines the minimum critical mass of a fissile material that can be made critical in a finite system…." *Id*. at 4. Based on these observations, NRC determined that a fissile material exemption or a general license specification could be created relying "on the form and/or concentration of the [fissile] material…" and that any such exemption or specification "must ensure that there is no practical means to alter the form and/or concentration [of the fissile material] in a manner adverse to maintaining subcriticality."[100]

Based on this analysis, NRC has allowed licensees to develop concentration-based limits for the transport of *special nuclear material* to a licensed disposal site. However, as will be described below, limitations on the concentrations of *special nuclear material* have varied depending on the particular radionuclide evaluated in the limitation. This proposition finds support in the Envirocare of Utah waste acceptance criteria for

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[99] NRC and Oak Ridge stated that the exemptions and general license requirements in 10 CFR Part 71 provided no requirements for transport packages relative to criticality safety and that water was selected as the best reflector for such transport packages. Therefore, the only remaining factors to be used to evaluate criticality safety were those mentioned above.
[100] *Id.* at 5

special nuclear material. Envirocare's waste acceptance criteria for uranium-233 and plutonium isotopes which, as noted above, are not likely to be found in candidate *non-*11e.(2) waste materials, are based on radiological considerations and not on nuclear criticality safety. The mass concentrations equivalent to the activity concentrations in the Envirocare acceptance criteria are so low as to represent an acceptable margin for nuclear criticality safety.

Recent final changes to the NRC and DOT transportation regulations defining fissile exempt material further validate the concept of the concentration criteria as an acceptable basis for demonstrating nuclear criticality safety for transport and disposal. The concentrations allowed for fissile exempt materials are more restrictive for enriched uranium than allowed by the Envirocare waste acceptance criteria and, thus, would effectively establish the upper limit (without exemption) for transport concentration criteria because of the necessity to economically transport the waste material to the disposal site.

ii. <u>Special Nuclear Material: Emplacement and Long-Term Disposal</u>

After waste streams containing *special nuclear material* are transported to a UR facility, such materials must be placed in the licensee's tailings impoundments in a manner which will assume that there is no likelihood of a nuclear criticality event. The main goal of proper emplacement is to prevent the accumulation of *special nuclear material* in sufficient quantities to cause a nuclear criticality event. For purposes of emplacement of materials containing *special nuclear material* in disposal areas, NRC and Oak Ridge National Laboratory first issued its NUREG/CR-6626 entitled *Emplacement*

Guidance for Criticality Safety in Low-Level Waste Disposal.[101] According to NRC, "[t]he purpose of this guidance is to provide a way that LL[R]W disposal facility licensees could demonstrate that SNM [special nuclear material] waste at emplacement will not cause a nuclear criticality accident." NUREG/CR-6626 analyzed waste streams with a broad range of *special nuclear material* concentrations. Most importantly, this analysis adequately demonstrated that land disposal of certain concentrations of *special nuclear material* will remain sub-critical, under optimal conditions, with a large margin of safety.

The isotopic and enrichment levels of *special nuclear material* are also waste stream-specific. Depending on the generator that produces each given waste stream, isotopic and enrichment levels of its *special nuclear material* content may vary greatly. Thus, NRC evaluated waste streams for disposal containing 10 percent by weight and 100 percent by weight enriched uranium.[102] Since the derivation of the above-discussed Envirocare acceptance criteria is based on soil under optimum moderation conditions, these criteria can be used for a mill tailings impoundment.

Non-radiological contaminants present in a waste stream containing *special nuclear material* may need to be analyzed for any potential incompatibility with a specific site's tailings impoundments. The characteristics of the particular waste stream may play a role in whether the material will be compatible with a given uranium mill's tailings impoundments. Waste streams may be present in several different forms (e.g.,

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[101] *See also* NUREG-6505, Vol. 1, *The Potential for Criticality Following Disposal of Uranium at Low-Level Waste Facilities* (June 1997) and Vol. 2, *The Potential for Criticality Following Disposal of Uranium at Low-Level Waste Facilities* (August 1998), which form the basis of the Envirocare Exemption from Licensing Requirements in 10 CFR Part 70 (May 24, 1999).
[102] NRC does not consider plutonium or uranium-233 in its analysis because, "[s]ignificant quantities of plutonium and uranium-233 are not common in commercial or industrial waste streams."

soils, rubble, sludges) with varying moisture content, but, given the scope of Appendix A Criteria, additional safety measures may not be necessary.

For purposes of long-term disposal, comparisons of the waste streams likely will be made with the constituents currently present in the licensee's mill tailings impoundments, EPA's and NRC's generic assessments of uranium milling as reflected in 40 CFR Part 192 and 10 CFR Part 40, Appendix A, (including Criterion 13 for non-radiological constituents) which address constituents typically found in natural ores and after UR processing in uranium mill tailings. Constituents unique to the licensee's mill tailings impoundments and EPA's and NRC's generic assessments that will behave similarly or identically to constituents regularly present in such impoundments should be suitable for *direct disposal* as appropriate surrogates are frequently used to model potential behavior of constituents of concern in the environment. Certainly, constituents which pose less potential radiological or chemical hazards should be considered suitable as well.

The lack of radon emissions from waste contaminated with *special nuclear material*, in the form of LEU, would suggest that such a waste stream would pose substantially less potential radiation hazards because radon is *the* primary health and safety threat associated with uranium mill tailings by orders of magnitude. To the extent that hazardous constituent levels are low or essentially non-existent and the LEU component is in an insoluble form, the *non*-11e.(2) waste material would pose similar or less potential hazards than typical 11e.(2) byproduct materials (e.g., radium in 11e.(2) byproduct materials is relatively insoluble).

Although Appendix A Criteria specifically contemplate liquids (i.e., tailings slurry) in uranium mill tailings impoundments, the *non*-11e.(2) waste material being added to the mill tailings must be evaluated to assure compatibility. NRC's GEIS and, in some cases, a specific uranium mill's previously accepted waste streams, for either alternate feed processing or *direct disposal*, should provide a useful reference to determine the nature of solutions in the tailings currently in a licensee's impoundments and the potential (if any) for migration of *special nuclear material* under such conditions. Site-specific factors such as geological and hydrological conditions should also be considered when determining the potential for off-site migration of *special nuclear material* and the threat such migration may pose to local communities beyond the site's boundaries. Many uranium mill tailings facilities were sited at particular locations because the geological and hydrological conditions were favorable to storage of mill tailings. This factor should be taken into account when evaluating the solubility of *special nuclear material* in waste material being considered for *direct disposal*.

As noted above, the hazardous constituent(s) (if any) present in waste streams containing *special nuclear material* are a concern, not only for their potential environmental impacts, if any, but also for the possibility of dual jurisdiction questions involving RCRA. *Direct disposal* of materials containing RCRA hazardous waste should not raise a significant health and safety issue and, in theory, should be acceptable to NRC, DOE and/or EPA/States. As previously stated, NRC's GEIS on uranium milling, EPA's FEIS on the impacts of uranium mill tailings, and 10 CFR Part 40, Appendix A, Criterion 13 demonstrate that NRC and EPA have anticipated that a wide variety of hazardous constituents would be disposed of in a uranium mill tailings impoundment

over time. Indeed, Appendix I of 40 CFR Part 192, which contains the full suite of RCRA hazardous constituents, was incorporated into Appendix A, Criterion 13 prior to its promulgation. Thus, when composing a set of waste acceptance criteria, NRC should take notice that the placement of many, if not all, RCRA hazardous constituents in uranium mill tailings impoundments was anticipated in its GEIS and by EPA in its FEIS over twenty (20) years ago.

Additionally, NRC should consider using certain "limiting factors," similar in form to the Criteria in its Alternate Feed Guidance, to provide a licensee with guidance in determining whether a given waste stream is eligible for disposal in a mill tailings impoundment. For example, NRC could allow the *direct disposal* of waste containing *special nuclear material* if it is below specific levels of concern and/or could prohibit the *direct disposal* of *wet* special nuclear material to minimize potential moderator concerns. A *blanket waiver policy* that permits disposal of waste containing special nuclear material if the *generic waste acceptance criteria* are satisfied is much more practical than case-by-case review by the Commission. NMA and FCFF believe that materials containing *special nuclear material* below certain concentrations should be eligible for *direct disposal* barring some other potentially significant impact on public health and safety or the environment. The existing approved waste disposal criteria (i.e., Envirocare, Waste Control Specialists, Barnwell, South Carolina, etc.) provide realistic bases for consideration.

4. <u>Candidate Materials: NORM/TENORM</u>

The next candidate material for *direct disposal* in uranium mill tailings impoundments is naturally occurring radioactive material or NORM. NORM is defined

as a subset of materials known as NARM (naturally occurring and accelerator-produced radioactive materials (i.e., materials made radioactive in nuclear accelerators)). NARM includes NORM, but NORM does not include the accelerator-produced portion of NARM. The most relevant type of NORM waste material is now defined as TENORM which is NORM containing materials produced when human activity, such as uranium mining or sewage treatment, concentrates or exposes to the environment radionuclides that occur naturally in *ores*, soils, water or other natural materials, and can include a wide variety of media such as soils, sludges, rubble, construction metals, and equipment.

With respect to NORM/TENORM materials, the primary radionuclide of concern in NORM/TENORM waste streams which would be *similar* to 11e.(2) byproduct material is radium. Radium, in and of itself, is not particularly mobile through groundwater pathways but can pose a threat in the form of direct gamma exposure to workers in close proximity to materials containing higher concentrations of radium than typically are found in mill tailings impoundments. However, any such direct gamma exposure requires ongoing proximity to the gamma source and, as such, does not represent an acute threat in mill tailings impoundments.[103] Its daughter product radon and its daughter products present the primary potential radiological threat[104] in the form of a lung dose, while the latter can grow-in over time, and As noted above, these wastes are perhaps most *similar* to 11e.(2) byproduct material, since radium is the primary source of potential radiological hazards in 11e.(2) byproduct material.

In some cases, NORM/TENORM will present less of a threat to public health and safety and the environment than 11e.(2) byproduct material because it contains lower

[103] *See id.*.
[104] *See* GEIS at 4-5.

concentrations of the same radionuclides in 11e.(2) byproduct material. Some NORM/TENORM wastes (e.g. radium contaminated scales) may contain considerably higher concentrations of such radionculides, but still may be similar to 11e.(2) byproduct material because the volume of materials with higher concentrations likely will be small relative to tailings volumes, thus not causing any potentially significant, incremental impacts on a site's NRC-approved radium inventory.

In *non*-Agreement States, NRC should consider the feasibility of addressing dual jurisdiction questions regarding hazardous constituents in NORM by entering into MOU's with relevant State agencies. *Non*-Agreement States should be receptive to this approach since most such States apparently want no part of the long-term care and custody of mill tailings or, for that matter, any other type of LLRW. Even if willing to accept responsibility for long-term care and control of radioactive wastes, most States would find the development of future disposal capacity unlikely. As noted above, the CRCPD's Part N draft State TENORM regulations address such wastes including those *similar* to uranium mill tailings. These draft regulations note that most TENORM, in the form of scales or sludges, have a lower radon emanation fraction than uranium mill tailings and that:

> "TENORM disposal within impoundments meeting the requirements for disposal of byproduct materials is consistent with Part N and *should be acceptable to state regulatory agencies*."[105]

Additionally, EPA's comments on NRC's *non*-11e.(2) direct disposal policy state, "TENORM wastes (particularly from conventional uranium mining overburden spoils) that are '*physically, chemically, and radiologically similar to material already in*

[105] Implementation Guidance for Regulation and Licensing of Technologically Enhanced Naturally Occurring Radioactive Material, Part N of the Suggested State Regulations for Control of Radiation. (July 2001) (emphasis added).

uranium/thorium tailings impoundments' may be appropriate for disposal at such sites, provided that the volume of the radioactive materials placed in the tailings impoundments do not result in an exceedance of the National Emission Standards for Hazardous Air Pollutants ("NESHAPs") radon standard as embodied in 40 CFR 192.31, as amended." Further, NORM/TENORM is already present in some 11e.(2) byproduct material (i.e., K-40) and is adequately controlled under the UMTRCA's and NRC's current regulatory framework, thus demonstrating that disposal of NORM/TENORM in tailings impoundments should not raise any serious public health and safety concerns.

Using NMA/FCFF's "upper bound" assumption of uranium-bearing ores with 1% U3O8 in secular equilibrium, such ores would contain approximately 2812 pCi/g of radium-226[106] which provides an acceptable "upper bound" for radium concentrations in NORM/TENORM which can be *directly disposed* in mill tailings impoundments. Materials with higher concentrations of radium-226 also could be appropriate candidate materials for mill tailings impoundments either by providing appropriate site-specific dose modeling to demonstrate compliance with 40 CFR Part 192 requirements and 10 CFR Part 40, Appendix A Criteria or through the use of the above-mentioned specialized disposal techniques to minimize or eliminate radon emissions. To the extent that NORM/TENORM is *similar* to 11e.(2) byproduct material, NRC should have little difficulty approving its *direct disposal* in mill tailings impoundments, including lower volume/higher activity scales and sludges, as well as *similar* high volume, low activity materials.

[106] *See Regulatory Guide 3.64—Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers*.

5. Candidate Materials: Mixed Waste

The final candidate material for *direct disposal* in mill tailings impoundments is mixed waste. Mixed waste is traditionally defined as waste which contains both hazardous (as defined by RCRA) and radioactive constituents (as defined by the AEA). Generally, mixed waste is regulated jointly by NRC and EPA or delegated States, and, in the past, such materials have not been disposed of in mill tailings impoundments. However, given the recent Advanced Notice of Public Rulemaking (ANPR) issued by EPA to determine a proper disposition pathway for low activity mixed wastes (LAMW), mill tailings impoundments could serve as a disposition pathway for generators. As described in the ANPR, potential options for LAMW include RCRA Subtitle C facilities or other permitted locations and mill tailings impoundments. When comparing these disposition pathways, mill tailings impoundments offer an alternative for disposal that, in some respects, is more protective of public health and safety.

RCRA facilities are specifically designed for the disposal of hazardous waste and RCRA design criteria do not account for the presence of elevated concentrations of long-lived radionuclides. RCRA regulations do not require permitted facilities to establish strict radionuclide-based design criteria for their disposal cells, do not require dose assessments for scenarios such as air emissions, worker exposure, and do not require a site-specific radionuclide inventory. Further, RCRA disposal cells are designed with a regulatory oversight horizon of approximately 30 years and do not have a comprehensive statutory and regulatory program for long-term surveillance and control of the facility with a mandated governmental long-term custodian after the site's permit is terminated.

Uranium mill tailings facilities are specifically designed to address both radiological and *non*-radiological (hazardous) components in waste materials. Traditionally, uranium ores are processed at conventional uranium mills using a conglomerate of acids and other chemicals to solubilize and remove uranium from other components in the ore, including heavy metals, to create yellowcake. Thus, mill tailings created from uranium ore processing contain various components that could be deemed hazardous waste and, hence, uranium mill tailings would be a "classic" mixed waste if it were not 11e.(2) byproduct material.

When creating the regulatory regime for uranium mill tailings impoundments, EPA and NRC anticipated that uranium mill tailings would contain various heavy metals and chemicals that the impoundments would have to contain safely over a 1,000 year closure period. As a result, as shown in 10 CFR Part 40, Appendix A, Criterion 13, uranium mill tailings impoundments are designed to safely contain a wide variety of heavy metals and other hazardous chemicals over a 1,000 year closure period. In addition, NRC specifically states that the list of hazardous elements in Criterion 13 is not exhaustive, thus, demonstrating that mill tailings impoundments can be considered for newly designated hazardous materials. Further, as stated above, mill tailings impoundments have a statutorily mandated governmental custodian that is tasked to maintain the integrity of all mill tailings for the required closure period. Therefore, using the conservative assumptions set out above for radionuclide concentrations,[107] mill tailings impoundments represent a viable, cost-efficient disposal pathway for generators of mixed waste.

[107] Licensees also may provide assessments of heavy metal or chemical concentrations in a mill tailings impoundment to demonstrate that no potential threat to public health and safety or the environment exists from disposal of a given lot of waste materials.

VI. NMA and FCFF Recommendations: Performance-Based License Conditions

In addition to considering the viability of *generic waste acceptance criteria* for direct disposal of *non*-11e.(2) waste materials in licensed mill tailings impoundments, NMA/FCFF recommend that NRC actively consider the viability of performance-based license conditions for specific licensees based on the proposed *generic waste acceptance criteria.* While Envirocare has a PBLC for 11e.(2) *byproduct material* at its Clive, Utah site, a PBLC for materials other than 11e.(2) *byproduct material* has not yet been implemented for any direct disposal site. At this point, the issue has not been actively considered by the Commission and only if the *direct disposal* guidance incorporates accepted *generic material acceptance criteria* for different types of *non*-11e.(2) materials, which are accepted by other critical regulatory players (i.e., DOE, EPA, States), will PBLCs for *direct disposal* ever be likely.

The implementation of PBLCs for licensees to accept wide ranges of *non*-11e.(2) materials within a given set of assumptions would require several events to occur. First, it is likely that a licensee would have to submit a request for a license amendment allowing a PBLC or an organization (e.g., NMA) would have to submit a White Paper or a petition requesting that NRC revise its current guidance on *direct disposal* to allow for a PBLC. In either case, NRC Staff and the Commission could formulate revisions to the guidance including the possibility of licensees obtaining PBLCs for *direct disposal* based on *generic waste acceptance criteria* which are acceptable to DOE, EPA, and relevant States.

PBLCs would alleviate the need for a licensee to obtain a license amendment for each *direct disposal* candidate material. PBLCs would permit a licensee to accept

different types of *non*-11e.(2) waste materials which will not result in changes to any fundamental license conditions and that will be within either generic or site-specific environmental assessments. A licensee would have to demonstrate to its Safety and Environmental Review Panel ("SERP") that specific *direct disposal* proposals fall within the parameters of the PBLC and, if so, the licensee would not be required to pursue a license amendment. This would allow a licensee to avoid engaging in multiple licensing actions which could force the unnecessary expenditure of valuable financial resources. PBLCs for *direct disposal* may not yet be imminent, but their addition to the licensing process would be extremely valuable to licensees. First, as stated before, PBLCs provide a cost-effective way for licensees to avoid multiple formal licensing actions without fundamentally changing license conditions or preparing costly environmental statements. The regulatory process, including potential Subpart L or Agreement State-administered hearings for intervenors, which force a licensee to expend considerable financial resources, could be avoided with a PBLC. Second, a licensee would be able to proceed with a *direct disposal* proposal without experiencing regulatory delay that could, perhaps, put the viability of its proposal in jeopardy and cause a generator to question the viability of *direct disposal* of its materials by a particular licensee. This would allow the licensee to proceed with a *direct disposal* proposal and focus primarily on the economic aspects of obtaining a contract for a shipment of materials for *direct disposal*. With PBLCs, licensees may still find that the public is somewhat alienated from the licensing process which, in turn, may require the licensee to engage in some additional community and governmental outreach programs to assure that the citizenry and the local, city, and state authorities are meaningfully included in the licensee's SERP decision-making process.

VII. NMA and FCFF Recommendations: Licensee Commitments

Where candidate materials do not fit comfortably within existing generic or site-specific assessments, NRC should evaluate whether the *direct disposal* of a *non*-11e.(2) waste stream is viable for a given site based on licensee submissions (e.g., dose assessments, etc.). However, licensees still may be required to commit to the implementation of certain additional measures to insure that protection of the public health and safety and the environment is realized.

For example, a licensee could consult with NRC to develop modifications to its site Occupational Protection Program when high concentrations of radionuclides such as thorium-232 or radium-226 may require additional worker protection from direct exposure to gamma radiation during disposal operations.

The licensee could commit to implementing increments to its existing environmental monitoring program to further alleviate any concerns associated with potential contamination to air, ground and surface water, and soils associated with any atypical radionuclides or hazardous constituents in *non*-11e.(2) wastes. Air quality may be assessed through consultation with the State and NRC on the proper requirements for each potential airborne contaminant that may result from the *direct disposal* of a given material in the tailings impoundment. Surface and ground water protection may addressed through existing monitoring systems designed to detect leakage from the tailings impoundment into groundwater formations below unless a particularly mobile constituent requires additional safeguards. In such cases, additional monitoring wells may be installed as the need arises. Soil monitoring, along with surface water protection controls (i.e., berms, concrete ore storage pads, covers over waste, site grading, etc.), may

be necessary depending on the waste form or solubility of radionuclides or hazardous constituents in a given waste stream.

Finally, factors associated with final license termination and the events occurring after the site closes could be the subject of some additional licensee commitments. A crucial public health and safety factor would be surface stabilization of all tailings impoundments and the related property necessary for control of constituents of concern to which DOE would take title after license termination. While 10 CFR Part 40, Appendix A provides that a site be stabilized *without active maintenance* for a period of 200 years and, to the extent practicable, 1,000 years, NMA and FCFF believe that, to the extent that it has not already part of an existing license commitment, it would appropriate for licensees accepting various types of *non*-11e.(2) materials for *direct disposal* to agree to eliminate consideration of anything less than final stabilization in accordance with the 1,000 year stabilization period design criteria and to provide the requisite financial assurance. Even sites with double-lined tailings impoundments and sophisticated leak detection systems will require extensive surface reclamation to satisfy the requirement for only "*passive*" controls for the 1,000 year stabilization period. The additional assurance provided by such a commitment may help to alleviate any political and regulatory concerns that some interested and/or affected parties may have about *non*-11e.(2) *direct disposal* as well as highlighting an important difference in the level of long-term protection offered by RCRA Subtitle C facilities.

After license termination, the mandatory long-term custodian, DOE or the resident State, takes title to the site pursuant to statute and with the added assurance of any regulations, MOUs or other agreements between DOE, EPA, NRC, and relevant

State agencies. DOE would then conduct long-term surveillance and monitoring activities as a licensee of NRC in perpetuity as delineated in UMTRCA. Funding from the uranium recovery licensee is required for post-site closure long-term surveillance and monitoring activities as necessary. However, to the extent that there is some particularized concern that DOE still will have to seek appropriations for potential unanticipated remediation or maintenance activities, a trust could be used as an additional durable, non-commercial mechanism to insure that DOE has the proper funding for long-term surveillance and monitoring and may prevent the need for "counting on Congress" to provide adequate funding in a timely fashion in the future. By keeping a trust fully funded for long-term oversight, a selected trustee would be subject to a strict fiduciary duty to perform all activities outlined in the trust for the benefit of DOE or a State as the beneficiary of the trust. DOE or the resident State would oversee the activities of the trust and the trustee with complementary regulation from NRC to insure that public health and safety are protected and the integrity of the site remains intact. Further, using trusts may induce States to be more receptive to long-term stewardship because it can assure that necessary funds are available for routine or emergency maintenance over the long-term. In such circumstances, States may then be more willing to "get involved" in long-term stewardship activities or, at the very least, provide active assistance so that the site is properly maintained.

(NMAnon11e.(2)submission.doc)

Appendix 1 Bounding Limits Table

Total Activity of Ore and Tailings
One (1) Percent U3O8

Element	Isotope	Decay Chain Split Factor	Half Life	Half Life U	Specific Activity (Curies per gram)	Fraction in Natural Ore	Fraction Uranium in U3O8	Specific Activity per Gram of Natural U3O8 (Curies per gram)	Activity in One (1) Percent Ore at Equilibrium Corrected for Chain Split (Curies per gram)	Mill Recovery	Emanation Coefficient Correction (1-Emanation Coefficient)	Activity in Tailings from One (1) Percent Ore (Curies per gram)
Uranium-238 Decay Chain												
Uranium	238	1	4.5100E+09	Years	3.400E-07	0.9928	0.848	2.863E-07	2.86253E-09	0.93	1	2.00377E-10
Thorium	234	1	24.1	Days	2.300E+04				2.81E-09	0.93	1	1.96452E-10
Protactiniu	234	1	1.17	Minutes	6.867E+08				2.81E-09	0.93	1	1.96452E-10
Protactiniu	234	0.0013	6.75	Hours	1.984E+06				3.65E-12	0.93	1	2.55387E-13
Uranium	234	1	2.4700E+05	Years	6.200E-03				2.81E-09	0.93	1	1.96452E-10
Thorium	230	1	8.00E+04	Years	2.100E-02				2.81E-09	0	1	2.80645E-09
Radium	226	1	1602	Years	9.883E-01				2.81E-09	0	1	2.80645E-09
Radon	222	1	3.823	days	1.500E+05				2.81E-09	0	0.65	1.82419E-09
Polonium	218	1	3.05	minutes	2.827E+08				2.81E-09	0	0.65	1.82419E-09
Lead	214	0.9998	26.8	minutes	3.278E+07				2.81E-09	0	0.65	1.82383E-09
Astatine	218	0.0002	2	seconds	2.587E+10				5.61E-13	0	0.65	3.64839E-13
Bismuth	214	1	19.7	minutes	4.459E+07				2.81E-09	0	0.65	1.82419E-09
Polonium	214	0.9998	1.64E-04	seconds	3.214E+14				2.81E-09	0	0.65	1.82383E-09
Thallium	210	0.0002	1.32	minutes	6.782E+08				5.61E-13	0	0.65	3.64839E-13
Lead	210	1	21	years	7.600E+01				2.81E-09	0	0.65	1.82419E-09
Bismuth	210	1	5.013	days	1.241E+05				2.81E-09	0	0.65	1.82419E-09
Polonium	210	0.999999	138.4	days	4.494E+03				2.81E-09	0	0.65	1.82419E-09
Thallium	206	1.3E-06	4.19	minutes	2.178E+08				3.65E-15	0	0.65	2.37145E-15
Lead	206	STABLE										
Subtotal Activity:												2.09964E-08
Uranium-235 Decay Chain												
Uranium	235	1	7.1000E+08	Years	2.200E-06	0.0071	0.848	1.326E-08	1.32644E-10	0.93	1	9.28509E-12
Thorium	231	1	25.5	Hours	5.300E+05				1.29E-10	0.93	1	9.05058E-12
Protactiniu	231	1	3.25E+04	Years	4.700E-02				1.29E-10	0	1	1.29294E-10
Actinium	227	1	21.6	Years	7.200E+01				1.29E-10	0	1	1.29294E-10
Francium	223	0.014	22	Minutes	3.832E+07				1.29E-10	0	1	1.29294E-10
Thorium	227	0.986	18.2	Days	3.100E+04				1.29E-10	0	1	1.29294E-10
Radium	223	1	11.43	Days	5.100E+04				1.29E-10	0	1	1.29294E-10
Radon	219	1	4	seconds	1.288E+10				1.29E-10	0	0.65	8.40411E-11

Polonium	215	1	1.78E-03	seconds	2.947E+13	1.29E-10	0	0.65	8.40411E-11
Lead	211	0.999998	36.1	minutes	2.468E+07	1.29E-10	0	0.65	8.40411E-11
Astatine	215	2.3E-06	1.00E-04	seconds	5.247E+14	1.29E-10	0	0.65	8.40411E-11
Bismuth	211	1	2.15	minutes	4.144E+08	1.29E-10	0	0.65	8.40411E-11
Polonium	211	0.0028	0.52	seconds	1.028E+11	1.29E-10	0	0.65	8.40411E-11
Thallium	207	0.9972	4.79	minutes	1.896E+08	1.29E-10	0	0.65	8.40411E-11
Lead	207	STABLE							
									1.25E-09
Subtotal Activity:									
Total Activity:									2.22E-08

Notes: The Regulatory Guide 3.64 default emanation coeficient of 0.35 (35%) radon released was used.
This was applied to radon in each decay chain plus all radon progeny.
Measured emanation coeficients are often less resulting in larger activities retained by the tailings.
A 93% recovery rate for the mill was used as per the FGEIS.
This 93% recovery was applied to all uranium isotopes
This 93% recovery was also applied to all short half life near term uranium daughters.
Decay chain splits were considered.
Radium-226 calculates 2.806E-9 Curies per gram which is close to the 2812 picoCuries per gram used in Regulatory Guide 3.64
This is one cross check on the calculation.
Radiometric equilibrium for both the Uranium-238 and Uranium-235 decay chains in the ore was assumed as per the FGEIS.
Splits in the decay chain with split fractions.

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Appendix 2 **Total Activity of Waste**

One (1) Percent Uranium-238

Time	**(Years)**											0	500	1000
Element	**Isotope**	**Decay Chain Split Factor**	**Half Life**	**Half Life Unit**	**Specific Activity** (Curies per gram)	**Fraction in Waste**	**Fraction Uranium in Uranium**	**Specific Activity per Gram of Uranium-238** (Curies per gram)	**Activity in One (1) Percent Waste Corrected for Chain Split** (Curies per gram)	**Mill Recovery (Assume None)**	**Emanation Coefficient Correction (1-Emanation Coefficient)**	**Activity in Waste Containing One (1) Percent Uranium-238** (Curies per gram)	(Curies per gram)	(Curies per gram)
Uranium-238 Decay Chain														
Uranium	238	1	4.5100E+09	Years	3.400E-07	1.0000	1	3.400E-07	3.4E-09	0	1	3.4E-09	3.4000E-09	3.4000E-09
Thorium	234	1	24.1	Days	2.300E+04				0.00E+00	0	1	0	3.4000E-09	3.4000E-09
Protactiniu	234	1	1.17	Minutes	6.867E+08				0.00E+00	0	1	0	3.4000E-09	3.4000E-09
Protactiniu	234	0.0013	6.75	Hours	1.984E+06				0.00E+00	0	1	0	4.4200E-12	4.4200E-12
Uranium	234	1	2.4700E+05	Years	6.200E-03				0.00E+00	0	1	0	1.2525E-09	1.2543E-09
Thorium	230	1	8.00E+04	Years	2.100E-02				0.00E+00	0	1	0	4.6278E-10	4.6543E-10
Radium	226	1	1602	Years	9.883E-01				0.00E+00	0	1	0	2.0680E-10	2.4326E-10
Radon	222	1	3.823	days	1.500E+05				0.00E+00	0	0.65	0	1.3442E-10	1.5812E-10
Polonium	218	1	3.05	minutes	2.827E+08				0.00E+00	0	0.65	0	1.3442E-10	1.5812E-10
Lead	214	0.9998	26.8	minutes	3.278E+07				0.00E+00	0	0.65	0	1.3442E-10	1.5812E-10
Astatine	218	0.0002	2	seconds	2.587E+10				0.00E+00	0	0.65	0	2.6884E-14	3.1624E-14
Bismuth	214	1	19.7	minutes	4.459E+07				0.00E+00	0	0.65	0	1.3442E-10	1.5812E-10
Polonium	214	0.9998	1.64E-04	seconds	3.214E+14				0.00E+00	0	0.65	0	1.3439E-10	1.5809E-10
Thallium	210	0.0002	1.32	minutes	6.782E+08				0.00E+00	0	0.65	0	2.6884E-14	3.1624E-14
Lead	210	1	21	years	7.600E+01				0.00E+00	0	0.65	0	1.3439E-10	1.5809E-10
Bismuth	210	1	5.013	days	1.241E+05				0.00E+00	0	0.65	0	1.3439E-10	1.5809E-10
Polonium	210	0.9999987	138.4	days	4.500E+03				0.00E+00	0	0.65	0	1.3439E-10	1.5809E-10
Thallium	206	0.0000013	4.19	minutes	2.178E+08				0.00E+00	0	0.65	0	1.7471E-16	2.0551E-16
Lead	206	STABLE												

Subtotal Activity Uranium-238 Series:	3.4E-09	1.32019E-08	1.34323E-08

Notes:

1 The Regulatory Guide 3.64 default emanation coeficient of 0.35 (35%) radon released was used.

Measured emanation coeficients are often less resulting in larger activities retained by the tailings.

2 Decay chain splits were considered.

All decay chain splits in both uranium chains are heavily biased/assymmetric splits.

Progeny activities in splits are only calculated from the dominant isotope in the split.

. 1. Assuming pure Uranium-238 at Time = 0 full ingrowth occurrs at 2.47 million years

At this time the waste reaches maximum activity.

2. In the real world no waste would contain pure Uranium-238. The waste would most likely be contaminated with depleted uranium which would contain approximately 0.2% Uranium-235.

3. This spreadsheet would have to be used in conjunction with the Uranium-235 spreadsheet.

Splits in the decay chain with split fractions.

Appendix 3 Total Activity of Tailings

Assumes Thorium Ore Containing One (1) Percent Thorium-232 as Metal

Element	Isotope	Decay Chain Split Factor	Half Life	Half Life Unit	Specific Acti	Specific Activity per Gram of Natural Thorium	Activity in One (1) Percent Thorium-232 Ore at Equilibrium Corrected for Chain Split	Mill Recovery	Emanation Coefficient Correction (1-Emanation Coefficient)	Activity in Tailings from One (1) Percent Ore
					(Curies per g	(Curies per gram)	(Curies per gram)			(Curies per gram)
Thorium-232 Decay Chain										
Thorium	232	1	1.4100E+10	Years	1.100E-07	1.100E-07	1.1E-09	0.93	1	7.7E-11
Radium	228	1	6.7	Years	2.700E+02		1.10E-09	0	1	1.1E-09
Actinium	228	1	6.13	Hours	2.200E+06		1.10E-09	0	1	1.1E-09
Thorium	228	1	1.91	Years	8.200E+02		1.10E-09	0	1	1.1E-09
Radium	224	1	3.6400E+00	Days	1.600E+05		1.10E-09	0	1	1.1E-09
Radon	220	1	5.50E+01	Seconds	9.322E+08		1.10E-09	0	0.65	7.15E-10
Polonium	216	1	0.15	Seconds	3.481E+11		1.10E-09	0	0.65	7.15E-10
Lead	212	1	10.64	Hours	1.400E+06		1.10E-09	0	0.65	7.15E-10
Bismuth	212	1	60.6	minutes	1.500E+07		1.10E-09	0	0.65	7.15E-10
Polonium	212	0.64	3.04E-07	seconds	1.750E+17		7.04E-10	0	0.65	4.576E-10
Thallium	208	0.36	3.1	Minutes	2.916E+08		3.96E-10	0	0.65	2.574E-10
Lead	208	STABLE								
Subtotal Activity:										8.052E-09

Notes:

1 The Regulatory Guide 3.64 default emanation coeficient of 0.35 (35%) radon released was used.
This was applied to radon in each decay chain plus all radon progeny.
Measured emanation coeficients are often less resulting in larger activities retained by the tailings.

2 A 93% recovery rate of thorium-232 for the mill was assumed based on the uranium recovery in the FGEIS.
This 93% recovery was applied to the thorium-232 isotope only.

3 Decay chain splits were considered.

4 Peak activity for this chain is at time of tailings creation.

Splits in the decay chain with split fractions.

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Appendix 4 Total Activity of Thorium-232 Contaminated Material
One (1) Percent Thorium - 232

Time	**(Years)**											0	200	500
Element	**Isotope**	**Decay Chain Split Factor**	**Half Life**	**Half Life Unit**	**Specific Activity**	**Fraction in Natural Ore**	**Fraction Uranium in Natural Thorium-232**	**Specific Activity per Gram of Natural Thorium-232**	**Activity in One (1) Percent Ore at Equilibrium Corrected for Chain Split**	**Mill Recovery**	**Emanation Coefficient Correction (1-Emanation Coefficient)**	**Activity in Tailings from One (1) Percent Ore**		
					(Curies per gram)			**(Curies per gram)**	**(Curies per gram)**			**(Curies per gram)**	**(Curies per gram)**	**(Curies per gram)**
Thorium-232 Decay Chain														
Thorium	232	1	1.4100E+10	Years	1.100E-07	1.0000	1	1.100E-07	1.1E-09	0	1	1.1E-09	1.1000E-09	1.1000E-09
Radium	228	1	6.7	Years	2.700E+02					0	1	0	1.1000E-09	1.1000E-09
Actinium	228	1	6.13	Hours	2.200E+06					0	1	0	1.1000E-09	1.1000E-09
Thorium	228	1	1.91	Years	8.200E+02					0	1	0	1.1000E-09	1.1000E-09
Radium	224	1	3.6400E+00	Days	1.600E+05					0	1	0	1.1000E-09	1.1000E-09
Radon	220	1	5.50E+01	Seconds	9.322E+08					0	0.65	0	6.5972E-10	7.1369E-10
Polonium	216	1	0.15	Seconds	3.481E+11					0	0.65	0	6.5972E-10	7.1369E-10
Lead	212	1	10.64	Hours	1.400E+06					0	0.65	0	6.5972E-10	7.1369E-10
Bismuth	212	1	60.6	minutes	1.500E+07					0	0.65	0	6.5972E-10	7.1369E-10
Polonium	212	0.64	3.04E-07	seconds	1.750E+17					0	0.65	0	4.2222E-10	4.5676E-10
Thallium	208	0.36	3.1	Minutes	2.916E+08					0	0.65	0	2.3750E-10	2.5693E-10
Lead	208	STABLE												
Subtotal Activity:									1.10E-09			1.10E-09	8.80E-09	9.07E-09

Notes:

1 The Regulatory Guide 3.64 default emanation coeficient of 0.35 (35%) radon released was used.
This was applied to radon only in each decay chain since all radon progeny activities are calculated from radon-220 and not independently as in the Total Activity Ore and Tailings sheet.
Measured emanation coeficients are often less resulting in larger activities retained by the tailings.

2 Decay chain splits were considered.
Only a single decay chain split exists in the Thorium-232 chain.
Progeny activities were not calculated since the product of the split is Lead-208, which is stable.

Splits in the decay chain with split fractions.

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5 Radiometric equilibrium for both the chain in the ore was assumed.

Splits in the decay chain with split fractions.

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Table 1 Uranium-238 Decay Chain

Element	Atomic Mass	Fraction of Isotope Present	Half Life		Specific Activity (Curies per gram)
Uranium	238	1	4.5100E+09	Years	3.400E-07
Thorium	234	1	24.1	Days	2.300E+04
Protactiniu	234	1	1.17	Minutes	6.867E+08
Protactiniu	234	0.0013	6.75	Hours	1.984E+06
Uranium	234	1	2.4700E+05	Years	6.200E-03
Thorium	230	1	8.00E+04	Years	2.100E-02
Radium	226	1	1602	Years	9.883E-01
Radon	222	1	3.823	days	1.500E+05
Polonium	218	1	3.05	minutes	2.827E+08
Lead	214	0.9998	26.8	minutes	3.278E+07
Astatine	218	0.0002	2	seconds	2.587E+10
Bismuth	214	1	19.7	minutes	4.459E+07
Polonium	214	0.9998	1.64E-04	seconds	3.214E+14
Thallium	210	0.0002	1.32	minutes	6.782E+08
Lead	210	1	21	years	7.600E+01
Bismuth	210	1	5.013	days	1.241E+05
Polonium	210	0.999999	138.4	days	4.494E+03
Thallium	206	1.3E-06	4.19	minutes	2.178E+08
Lead	206	STABLE			

Notes: Splits in the decay chain with split fractions.
Most widely used half life used. Some isotopes have multiple half

Uranium-235 Decay Chain

Element	Atomic Mass	Fraction of Isotope Present	Half Life		Specific Activity (Curies per gram)
Uranium	235	1	7.1000E+08	Years	2.200E-06
Thorium	231	1	25.5	Hours	5.300E+05
Protactiniu	231	1	3.25E+04	Years	4.700E-02
Actinium	227	1	21.6	Years	7.200E+01
Francium	223	0.014	22	Minutes	3.832E+07
Thorium	227	0.986	18.2	Days	3.161E+04
Radium	223	1	11.43	Days	5.100E+04
Radon	219	1	4	seconds	1.288E+10
Polonium	215	1	1.78E-03	seconds	2.947E+13
Lead	211	0.999998	36.1	minutes	2.468E+07
Astatine	215	2.3E-06	1.00E-04	seconds	5.247E+14
Bismuth	211	1	2.15	minutes	4.144E+08
Polonium	211	0.0028	0.52	seconds	1.028E+11
Thallium	207	0.9972	4.79	minutes	1.896E+08
Lead	207	STABLE			

Notes: Splits in the decay chain with split fractions.
Most widely used half life used. Some isotopes have multiple half lives