DESCRIPTION OF ABLATION MINING TECHNOLOGY APPLIED TO URANIUM DEPOSITS

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SUBMITTED TO THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT, RADIATION CONTROL DIVISION – URANIUM PROGRAM

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I. INTRODUCTION

Ablation Mining Technology (AMT) is a method of mining mineral deposits from host rock. AMT is able to disassociate, or mine, mineral coatings from sand grains in sandstone hosted uranium mineral deposits. After this disassociation is complete, the coarse sand grands can be screened from the mineral fines, producing cleaned sand grains and uranium mineral ore fines. The cleaned sands can then be used as mine backfill and the uranium ore fines transported to a Nuclear Regulatory Commission (NRC) or Agreement State-licensed uranium mill to isolate the uranium from other minerals found in the ore, creating U_3O_8 (Yellowcake). AMT does not recover uranium primarily for its source material content, does not occur at a uranium mill, and does not produce 11e.(2) byproduct material.In Colorado, the Mineral Rules and Regulations of the Colorado Mined Land Reclamation Board (MLRB), which are administered by the Department of Reclamation and Mine Safety (DRMS), regulate and permit uranium prospecting and mining operations. Additionally, other Colorado State agencies regulate uranium mining operations including the Colorado Department of Public Health and Environment (CDPHE) - Water Quality Control Division (WQCC) and the CDPHE - Air Pollution Control Division (APCD).

Colorado is an Agreement State with the NRC for licensing of uranium milling and 11e.(2) byproduct material under the Atomic Energy Act (AEA). As an NRC Agreement State, the Colorado Radiation Control Act (RCA) under Title 25 Article 11 of Colorado

Statues conforms with and complies with NRC regulations as authorized by the AEA. The CDPHE Radiation Control Program (RCP) administers RCA rules and regulations. AMT does not meet the regulatory definitions for source material processing or for uranium milling due to its substantial similarity to previously accepted mining techniques such a blasting and "high-grading" ore at mine sites.

The following items will be addressed in this White Paper: (1) technological overview of the AMT process; (2) review and applicability of AEA statutory and NRC regulatory provisions and their implications for AMT;[1] (3) legal conclusions. This White Paper is being submitted so that CDPHE-RCP Staff can consider what, if any, regulatory requirements may apply to the AMT process.

II. OVERVIEW OF AMT

AMT is a mining method that facilitates the disassociation of constituent fractions of a composite material from each other. In doing so it becomes possible to use physical characteristics that are unique to particular fractions, to separate particular fractions from other fractions of post-AMT material.

The inherent nature of the deposition of mineralization in sandstone-hosted uranium deposits allows practical application of the AMT as a mining method to this type of mineral deposit. One of the key reasons why AMT can be applied successfully to sandstone-hosted uranium deposits arises from the location of uranium mineralization, on a granular scale, within most sandstone host rocks. In these deposits, uranium lies within a mineralized crust which coats, and is located between, individual sand grains that make up the majority of the host rock (as opposed to the mineralization being present *within* the individual sand grains themselves).

[1] NRC regulations are referenced here because CDPHE's Agreement State regulations are substantially similar, if not identical, to NRC regulations.

The processes that formed sandstone-hosted uranium deposits determine the location of the uranium mineralization within the host rock. A model for the formation of these deposits involves the migration of mineral bearing solutions through permeable surface and subsurface channels in the host rock, until conditions change due to natural lateral and/or vertical variations in the chemistry of the host rock. Although the host rock as a whole is relatively porous and permeable, the individual sand grains (commonly quartz and feldspar grains) themselves are not permeable. As such mineral-bearing solutions flow predominantly around and between the impermeable sand grains. When the fluids encounter a reducing agent such as carbon, or a reduction in overall permeability, dissolved minerals precipitate out of solution to form a fine coating of stable minerals over individual sand grains within the host sandstone. When substantial quantities of minerals precipitate and are concentrated within a small volume of the host formation, a mineral deposit is formed.

AMT Explained

AMT can be used effectively to separate the precipitated minerals from the sand grains. It involves the application of a two stage mechanical process that (i) disassociates the minerals that form the crust on the sand grains from the sand grains themselves, and then (ii) separates the finer-grained minerals from the coarser sand grains. In this section we describe these two stages in more detail.

(i) Disassociation

Within the context of applying AMT as a mining process to a typical sandstone-hosted uranium deposit, the first step is to disassociate the mineralized crust from the underlying individual grains of the sandstone host rock. To do this, a sandstone host rock is typically crushed to minus 6.35 millimeters and then mixed with water to form a slurry comprising approximately twenty (20) percent solids. The slurry is pumped through opposing nozzles, creating two high-velocity slurry streams that directly collide with each other (Figure 1). The collision of these high-velocity slurry streams creates a high energy impact zone where individual particle-to-particle (i.e. mineral-crusted sand grain to mineral-crusted sand grain) collisions impart energy that disassociates the mineral crust (ore) from the underlying sand grains (waste rock). The energy in the impact zone is carefully controlled to prevent destruction of the underlying sand grains themselves. Once the bond between the ore and the waste rock is broken, AMT is complete.

Figure 1. Nozzle array within the semi-commercial scale AMT unit that is under construction (the front set of nozzles is deliberately uncovered and slightly offset for illustrative purposes).

The residence time in the AMT system is important, as is the energy imparted in the collision zone, both of which can be controlled during mining operations. Disassociation is more efficient when greater energy is available in the collision zone. However once AMT has removed the mineral crust from the underlying sand grain, continuation of AMT may result in the gradual size reduction of individual sand grains as they collide with each other in the impact zone. There is no chemical or physical change of the component sand grains or mineral crust; the components are simply disassociated from each other. Because ore is recovered by grain-size separation (see below), it is highly preferable that AMT continues no longer than is necessary to disassociate the mineral crust from the sand grains. As such the optimal residence time in the AMT system will differ for ores from different deposits. It will be dependent on the energy imparted in the collision zone (higher energy = more effective AMT = lower required residence time) as well as the nature and degree of cementation of the sand particles in the host rock (better cemented = AMT is less efficient = longer required residence time). This dynamic is the same as blasting at underground and open pit mining operations. Harder more well cemented formations require more energy (closer blast hole spacing) than softer formations to break rock.

(ii) Separation

After disassociation, the post-impact slurry stream comprises a mixture of coarse-grained waste rock (sand grains), finer-grained disassociated ore, and water. This slurry can be subjected to separation by physical screening,[2] based on grain size, where the finer ore minerals are separated from the coarser waste rock. Screening of this material is the same as split-shot blasting in underground mines. A split-shot refers to first shooting and removing high grade ore from a mine face then, shooting and removing waste rock to advance the mine face.

Screening could be undertaken to separate any size fraction(s). Experimentally, it has been determined that in many cases defining and separating "ore," as all material finer than approximately 400 mesh (0.037 mm) yields high mineral concentrations, with the added advantage that the over-sized material comprises a clean (very low mineral content) coarse-grained waste product. This preferred size classification is however based on limited testwork and will vary depending on the deposit. In some cases, utilization of other screen sizes may optimize ore to waste dissociations and the resultant properties of the segregated fractions.

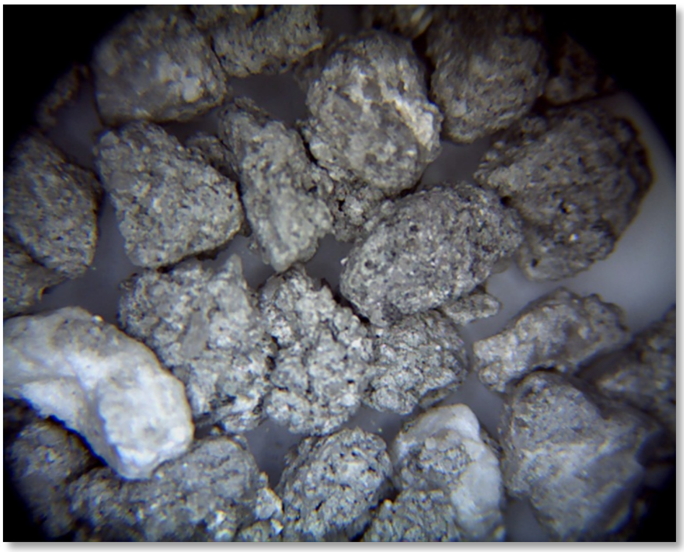
[2] It is important to note that NRC's new general license rule states that screening is not considered to be a "processing" operation.

Upon separation, the waste rock stream typically comprises approximately ninety (90) percent of the mass but contains only about five (5) percent of the uranium (and any other minerals) that was present in the pre-AMT material. Logically, the ore stream comprises the balance of the mass (~10%), and contains the balance of the uranium and other minerals that coated and cemented between individual sand grains prior to AMT (~95%).

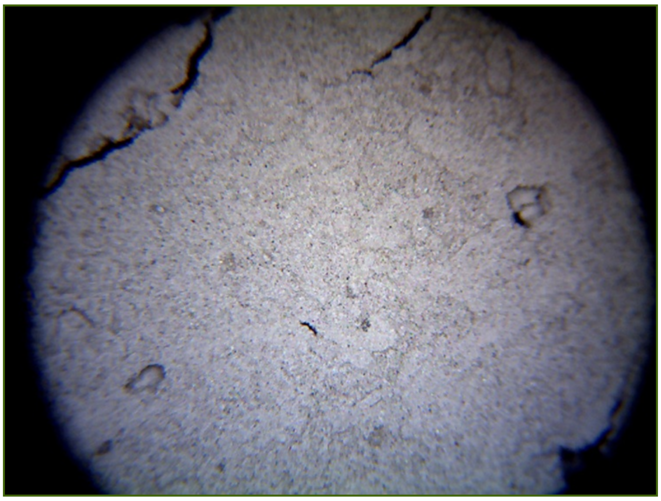
After separation, each fraction is dewatered to the extent practical, leaving three post-AMT products: a dewatered fine-grained ore fraction, a dewatered coarser-grained waste rock fraction, and a water stream which typically will be recycled through the AMT system.

The ore fraction is a collection of very fine-grained mineral grains and other material that predominantly comprised the cement between and the mineral coating on the pre-AMT sandstone grains. Micrograph 2 shows the fine-grained ore product, following AMT, under magnification.

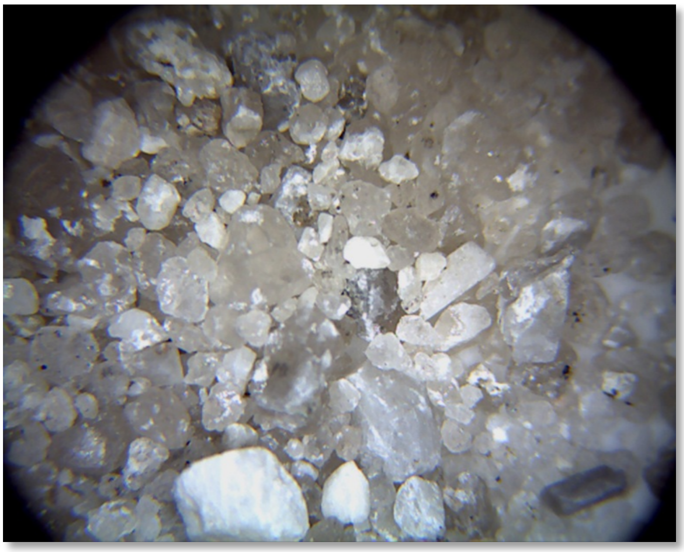
The waste rock fraction is comprised of the grains around which the mineralized crust (ore) forms during deposition in the host rock; typically quartz and feldspar grains. Physically and chemically, the waste rock reports as clean (low concentrations of minerals) sand grains. Micrograph 3 shows representative clean sand grains post AMT. In comparison, mineralized pre-AMT sandstone is shown in Micrograph 1, showing the mineralized crust coating individual sand grains, before it has been disassociated.



Micrograph 1 – Mineralized sandstone prior to AMT, with an outer coating of mineralization evident on most of the individual sand grains.



Micrograph 2 – Very fine-grained mineral grains of the ore fraction following AMT and screening.



Micrograph 3 – “Clean sand” or “coarse-grained waste rock” grains post-AMT and screening.

In addition to the highly reduced concentrations of uranium, the waste rock fraction also contains reduced concentrations of any other associated minerals that were present in pre-AMT sandstone’s mineralized crust and cement. For example, in various tests, the waste rock fraction exhibited reductions in arsenic by more than 88 percent, mercury by 93 percent, molybdenum by 90 percent, and tin by 80 percent. Importantly, limited studies to date on materials subject to AMT show that all other radiometric elements respond similarly to uranium (i.e. they too predominantly report to the fine-grained ore fraction). In Colorado’s Paradox Valley vanadium minerals are typically 4 to 10 times the amount of uranium in vanadium-uranium deposits. This dynamic can produce ores that are more valuable for the vanadium and thereby essentially make uranium an economic secondary product.

From a mineral composition perspective, the individual mineral grains recovered in the fine-grained ore fraction are identical to the minerals present in the mineralized crust that surrounded the sand grains in the pre-AMT sandstone (i.e. there is no change in mineralogy as a result of AMT). If uranium minerals such as uraninite (UO_2), coffinite ($U(SiO_4)_{1-x}(OH)_{4x}$) and brannerite ($U_{0.5}Ca_{0.3}Ce_{0.2}Ti_{1.5}Fe^{2+}_{0.5}O_6$) were present in the pre-AMT sandstone, these same minerals will be present in the fine-grained ore (while essentially absent from the coarser-grained waste product). AMT does not alter the composition of uranium minerals; most certainly not to U_3O_8 ("yellowcake"), as occurs during "milling". AMT simply disassociates these minerals from the underlying sand grains. In addition, there is no change to the amount of individual minerals in the dissociated materials, as if they were recombined, the relative amounts of these minerals would be identical.

A key characteristic of AMT is that it is a purely mechanical process. The sandstone material in AMT is simply mixed with water. No chemicals or reagents are added to the system. As a result, there is no chemical change to the materials in AMT, and no new chemical compounds are created. Within the context of AMT of sandstone-hosted uranium deposits, this means that the sandstone host rock is not chemically altered during AMT. Without chemical change, the elemental, mineral and physical properties of the host rock remain constant throughout AMT. AMT results in the disassociation of minerals from the host rock, producing coarse-grained waste whose composition is virtually identical to the sand grains that were present in the host rock prior to the deposition of minerals. Barring the potential for slight grain size decrease due to impacts in the collision zone, the quartz and feldspar grains of the host rock remain intact and are in the same physical form before and after AMT.

Worker Health and Safety, AMT, and Environmental Protection

AMT itself comprises a closed system of primarily rigid steel tanks and pipes. As such there is a very low risk that ore can escape the system during operations. Despite this, a precautionary secondary spill-containment system has been incorporated into the modules constructed to date, in the form of steel sumps at the base of all modules. Figure 2 shows the Pilot-scale AMT unit. The Semi-commercial scale AMT unit is shown in Figure 3. On a commercial scale it is anticipated that the AMT modules will be located within a tertiary spill-containment system, which could comprise concrete pads surrounded by impermeable barricades.

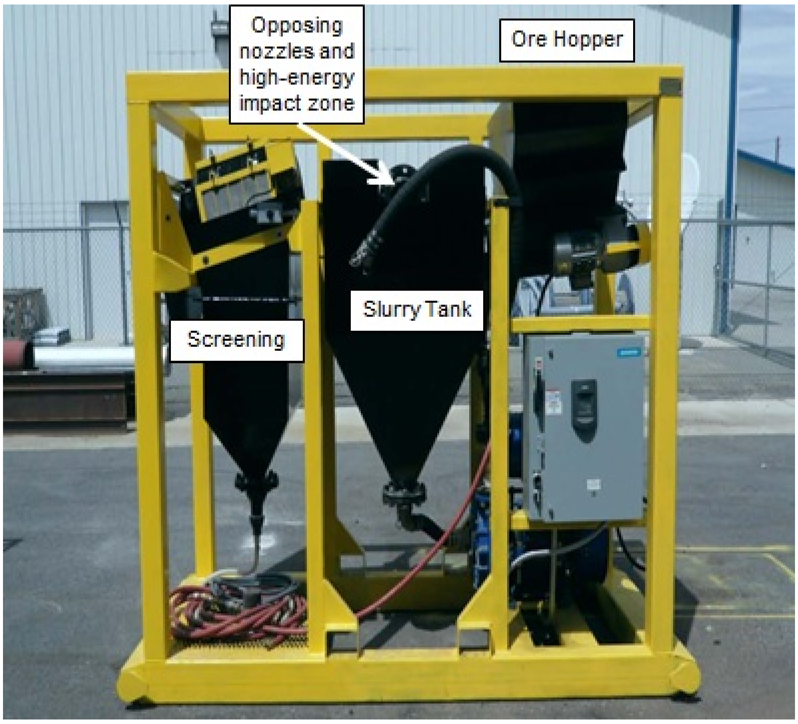


Figure 2. Pilot-scale AMT unit.

Figure 3. The semi-commercial scale AMT unit under construction. A slurry mix tank, being fed by a conveyor, is in the foreground. Three interconnected AMT modules are positioned immediately behind the mix tank.

AMT typically takes place in a "wet" environment, hence ore dust is minimal to essentially non-existent. A wet mineral-slurry enters the AMT system and, on completion of AMT, a wet slurry product is transferred either to tanks or directly to wet-screens for grain-size separation.

The steel tanks, pipes and water act as shields that offer workers protection from the very low level of radiation present in the host rock as it passes through the AMT system. Thus, there is little to no concern for occupational health and safety outside the ambit of typical mining regulations on the federal and State levels that would require increased regulatory oversight such as an AEA-based license.

Limited evaluation to date indicates that, during screening, not only uranium but also other alpha-, beta- and gamma emitters report to the finest size fractions. As such these are removed from the remnant coarse-grained waste, leaving a "clean" waste product that can be emplaced and stored for the long term either on the surface or returned underground as mine backfill.

It is anticipated that water that is used during screening will be re-circulated through the AMT system. If however, at a particular mine site, it becomes necessary to dispose of excess water, it is considered it will be both economically beneficial as well as environmentally preferable to treat the water to recover any uranium and remove any other potential constituents of concern (COC) that may be present in solution prior to disposal. Suitable commercial-scale water treatment systems are readily available.

The fine-grained ore product will comprise a moist paste. It is anticipated that this will be enclosed in appropriate containers prior to transportation to an AEA-licensed conventional uranium recovery facility.[3] The moisture, coupled with the containing barrier(s) will attenuate radioactive emissions, thereby minimizing any potential radiological hazard.

Day-to-day operations will be run in compliance with Mine Safety and Health Administration (MSHA) standards. MSHA requires that all workers are properly trained and follow written procedures to work safely at mine sites. Safety procedures are required to eliminate potential hazards, and mining equipment is required to be certified to meet certain standards. At uranium mines, MSHA requires that radon and gamma surveys be conducted to identify possible exposures to workers. Mitigation activities such as dust suppression, ventilation, use of respirator protection, and reduction in work assignment time will be utilized as necessary reduce workers' exposure to potential hazards. Engineered controls for the crushing, screening, and material handling systems will afford workers protection as required by MSHA. Workers conducting operations in areas of possible exposure are required to wear dosimeters to monitor individual exposure levels. Strict record keeping and reporting of worker exposure is required by MSHA.

Benefits of AMT

AMT units will operate at mining sites, as the process is a mining technology designed to remove valuable ore from host rock consistent with previously identified and approved mining procedures. Following AMT, it will be necessary to process the fine grained ore product at a conventional uranium recovery facility ("mill"). Because AMT significantly reduces the ore mass (by ~90% or more) and creates a moist slurry material to go into a container, not only the traffic between mine and mill, but the potential impacts of a process upset or spill, will be greatly reduced. As such the potential impact on both the environment and local communities will be reduced dramatically.

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[3] These facilities are referred to as AEA-licensed due to the potential for such material to be transported to uranium recovery facilities licensed under the AEA by NRC Agreement States.

The low-mass, fine-grained AMT ore will be considerably more valuable than non-AMT material. As such it will be economically viable to transport the fine-grained ore greater distances than non-AMT material. Hence AMT will improve the economic viability of building new or maintaining existing uranium processing facilities; thereby, potentially helping to achieve and maintain an optimum number of active uranium processing facilities.

Furthermore, if a uranium processing facility were to take delivery of only fine-grained AMT ore, it will have a smaller surface footprint, hence a lower environmental impact than under current operating assumptions. This is because (i) crushing and grinding circuits will not be required at the mill site; and (ii) it will be necessary to deliver considerably less (approximately 90% less) material to the facility to recover a comparable quantity of yellowcake, hence the number and size of leach tanks at a mill will be reduced considerably.

Importantly, energy consumption at the mill will be reduced significantly because (i) there will be no need to operate energy-intensive crushing and grinding circuits; and (ii) by delivering a higher-grade material to the mill, less energy will be required to handle materials throughout the processing circuit to produce a comparable amount of yellowcake.

It is anticipated that some processes within the mill will utilize significantly less reagent than are consumed with non-AMT ore. For example, consumption of sulfuric acid is expected to be substantially reduced because the uranium minerals will be in higher concentrations, present within a finer grained medium, and include less gangue material than an non-AMT ore.

Notably, AMT is applied prior to milling, the amount of 11e.(2) material that will need to be managed and stabilized at a licensed mill facility will be reduced dramatically (by ~90% or more to produce a comparable quantity of yellowcake without AMT). As such substantially smaller impoundment facilities will be required, considerably reducing both short- and long-term environmental impacts. Indeed, given the dramatically reduced quantity of 11e.(2) material, it may be viable to dry-stack the material rather than impound a slurry, thereby reducing the long term impact as well as the time and cost of final reclamation.

III. REVIEW AND APPLICABILITY OF NRC REGULATIONS AND IMPLICATIONS FOR AMT

From a regulatory perspective, the application of AMT on uranium-bearing material is nothing more than utilizing a modern mining technology to remove valuable uranium minerals from a host rock. AMT is a purely mechanical process. No chemicals or reagents are utilized. The chemical characteristics of uranium ores are not altered during AMT. Nor does the mineralogy of the ore change. AMT is a technologically advanced, systematic method of recovering uranium minerals from host rock. As such, AMT is "mining" and not "processing" or "milling". Accordingly, AMT should not fall under the statutory/regulatory jurisdiction of the AEA, NRC or Agreement States, although the product will when it is transported to a licensed uranium recovery facility.

Following is our reasoning on this, particularly in consideration of AEA's regulatory jurisdiction and its historical distinction between "mining", "source material processing" and "uranium milling."

A. AEA Jurisdiction Overview

The AEA, as enacted in 1954 and amended by UMTRCA in 1978 provides the bases for the development of NRC's and all Agreement State regulatory programs for "source material" and "source material recovery." With respect to *source material*, Congress used the AEA to establish a system by which the identification, extraction, possession and transfer of uranium or thorium would be regulated using licenses containing requirements or conditions. In Chapter 7 of the AEA, Congress created a program under which entities seeking to engage in the production of *source material* could be required to obtain licenses from the Atomic Energy Commission (AEC now NRC or Agreement States) so that such *source material* could be used for a variety of purposes such as research and development and the creation of special nuclear material.[4] It is extremely important to note that, under the AEA's statutory framework, NRC is now solely an *independent* regulatory agency and, as such, "has no authority to encourage and promote the development of atomic energy for peaceful purposes. Nor does it bear any responsibility for the development or regulation of other energy sources."[5] Thus, a private entity (e.g., source material recovery company) or governmental entity (e.g., United States Department of the Army) is required to voluntarily submit license or license amendment applications to the Commission in order to possess, use, and transfer AEA materials to which NRC reacts.[6] "[T]he Commission has no power to compel an applicant to come forward or to require an applicant, once having come forward, to prepare and submit a totally different proposal."[7] When reviewing a license or license amendment application, "the available alternatives [to NRC] are to grant the application, grant the application subject to certain conditions, or deny the application, either with or without prejudice."[8] Ultimately, under this scheme, the licensee, and not the Commission, is *primarily* responsible for the safe management of AEA materials.

Prior to implementing a licensing program for *source material*, Congress needed to define the point at which the AEC's jurisdictional authority over *source material* would be triggered. Given that there are delineations between *source material* (i.e., uranium or thorium) as it resides in nature, the extraction of *source material ore*s by mining, and the

[4] 42 U.S.C. § 2093(a)(1-4) (hereinafter "Exhibit 5").
[5] 49 Fed. Reg. 9352, 9353 (March 12, 1984) (hereinafter "Exhibit 6").
[6] In the event of a potential imminent hazard such as national security concerns, NRC can issue orders without waiting for a licensee to propose an action (e.g., "compensatory measures" or "immediately effective orders").
[7] *Id.*
[8] *Id.*

processing of such *ore*s to recover their *source material* content, Congress determined that the AEC's jurisdiction should be invoked only *after removal of source material from its place in nature*. As stated in Section 62 of the AEA:

> "[u]nless authorized by a general or specific license issued by the Commission…no person may transfer or receive in interstate commerce,
> transfer, deliver, receive possession of or title to, or import into or export from the United States any *source material after removal from its place in nature*…."[9]

AEC's/NRC's 10 CFR Part 40 regulations define a class of *source material ore*s that have been removed from their place in nature but, nevertheless, are not subject to Commission regulation regardless of the source material concentration – termed *unrefined and unprocessed ores*. Such ore is defined as "*ore* in its natural form *prior to any processing,* such as grinding, roasting or beneficiating, or refining."[10] Thus, *source material ore* that has not undergone *processing* activities such as those that take place at a conventional uranium *mill* (e.g., grinding, and beneficiating) is not subject to NRC's jurisdiction.

The meaning of the phrase "after removal from its place in nature" was further clarified in NRC's 1980 Generic Environmental Impact Statement on uranium milling (GEIS or "NUREG-0706"), which explains that this phrase refers to *source material* "associated with processing" (i.e., at a licensed uranium mill):

> "Section 205(a) of the UMTRCA [Uranium Mill Tailings Radiation Control Act of 1978]
> amends the Atomic Energy Act of 1954 by adding a new Section 84 which states inpart that 'the Commission shall insure that the management of any *byproduct material*, as
> defined in section 11e.(2) , is carried out in such a manner as…the Commission deems appropriate to protect public health and safety and the environment from radiological and nonradiological hazards *associated with the processing* [of source material ore] and with the possession and transfer of such material…"[11]

[9] 42 U.S.C. § 2092 (emphasis added) (hereinafter "Exhibit 7").
[10] *See* 10 CFR § 40.4 (hereinafter "Exhibit 8").
[11] GEIS at A-89 (emphasis added) (hereinafter "Exhibit 9").

Similarly, the Atomic Safety and Licensing Appeal Board in *In the Matter of Rochester Gas and Electric* states:

> "The Atomic Energy Commission's jurisdiction in this area was transferred to the NRC on January 19, 1975, by the Energy Reorganization Act of 1974, 42 U.S.C. § 5841(f). As the quoted observation indicates, the Commission's authority over uranium *ore* and other '*source material*' attaches only '*after* removal from its place of deposit in nature,' and *not when the ore is mined*."[12]

Congress' motives for enacting UMTRCA in the manner interpreted by NRC was to consolidate the disposal and control of 11e.(2) byproduct material at limited geographic locations throughout the United States. This is consistent with the provisions of 10 CFR Part 40, Appendix A, Criterion 2 which is designed to prevent the proliferation of small 11e.(2) byproduct material disposal sites. Thus, *mining* processes that occur at mine sites typically do not result in the exercise of AEA-based jurisdiction and typically are left to the appropriate federal (e.g., MSHA) and State authorities to enforce appropriate requirements for the protection of both public and occupational health and safety. Congress also did not want to create any "disincentive" to miners' efforts to find and recover uranium ore by subjecting it to federal regulation under the AEA. Therefore, based on these well-understood statutory provisions and regulatory interpretations, *source material* in uranium *ore* at a uranium *mill* is subject to AEC/NRC jurisdiction, `while *source material* in an unrefined and unprocessed uranium *ore* at or by a uranium *mine* or during transport from a mine to an uranium *mill* prior to *processing* is not subject to AEC/NRC jurisdiction, regardless of its *source material* concentration percentage.

Section 62 of the AEA requires that entities seeking to transfer or receive in interstate commerce or to transfer, deliver, receive possession of or title to or to import into or export

[12] 8 NRC 551, *6 (November 17, 1978), *citing* 42 U.S.C. § 2092 (2005) (emphasis added) (hereinafter "Exhibit 10").

from the United States *source material* obtain a license from the Commission.[13] Section 62 also addresses *unimportant quantities* of *source material* (which Congress empowered the AEC to define) by stating that "licenses *shall not be required* for quantities of *source material* which, in the opinion of the Commission, are unimportant.[14] By regulation, the AEC/NRC defined "unimportant quantities" of *source material* to mean, "[a]ny person is exempt from the regulations in this part and from the requirements for a license set forth in section 62 of the Act to the extent that such person receives, possesses, uses, transfers or delivers *source material* in any chemical mixture, compound, solution, or alloy in which the *source material* is by weight less than one-twentieth of 1 percent (0.05 percent) of the mixture, compound, solution or alloy."[15] Quantities of *source material* exceeding the 0.05% or 500 parts per million (ppm), by weight, threshold often are referred to as *licensable source material unless it is in unrefined and unprocessed ore*. Unrefined and unprocessed ore is explicitly exempt from regulation under the AEA by the Commission's 10 CFR Part 40 regulations. *See* 10 CFR § 40.13(b). The AEC General Counsel's evaluation of Section 62 of the AEA determined that its provisions are *mandatory.*[16]

In 1978, Congress enacted UMTRCA to provide express statutory authority to regulate the production, containment, and monitoring of uranium and thorium mill tailings during and *after* active recovery operations. UMTRCA was based upon a finding that uranium and thorium mill tailings located at *active* (i.e. licensed) and *inactive* (i.e. abandoned) mill sites may pose a significant, potential radiation health hazard to members of

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[13] *See* Exhibit 7.
[14] *Id.*
[15] 10 CFR § 40.13(a).
[16] *See* Letter to H. L. Price, Director, Division of Licensing and Regulation from Neil D. Maiden, Acting General Counsel, Atomic Energy Commission, *Re: Mill Tailings* (December 7, 1960). It is critical to reiterate that *unrefined and unprocessed ore* that exceeds 0.05%, by weight, source material is still not subject to AEA jurisdiction (e.g., ores in transport to a uranium mill prior to milling activities are not subject to AEA licensing). This is typically the case in mining operations, where well-understood processes such as blasting create *ore* that may contain greater than 0.05% by weight source material but still are not subject to AEA licensing.

the public.[17] In explaining the need for UMTRCA, the House Report accompanying the legislation relied upon the description of the potential public health hazard of mill tailings in the testimony of then-NRC Chairman, Dr. Joseph Hendrie:

> "The NRC believes that long-term release from tailings piles may pose a radiation health hazard if the piles are not effectively stabilized to minimize radon releases and prevent unauthorized use of the tailings."

The centerpiece of this new grant of direct authority to regulate uranium mill tailings was the creation of a new category of AEA-regulated materials. Specifically, the definition of "byproduct" material was modified when Congress created "11e.(2) *byproduct material*," which is defined to mean:

> "the tailings or wastes produced by the extraction or concentration of uranium and thorium from any *ore* processed *primarily* for its source material content."[18]

This class of material was (and is) unique among the materials regulated under the AEA, because it is not defined solely in terms of its radiological characteristics, but instead is defined broadly enough to encompass "all wastes"— both radioactive and *non*-radioactive— resulting from uranium *ore* processing primarily for its source material content at licensed uranium recovery facilities.[19] Since this new definition of "*byproduct material*" is intended to be expansive and to cover the broad range of wastes associated with uranium milling, the tailings and *all* other wastes associated with uranium recovery produced at AEA-licensed uranium milling facilities are referred to as "11e.(2) *byproduct material*." *The relationship between source material and 11e.(2) byproduct material is the fundamental driving force*

[17] Pub L. No. 95-604, at 2(a), 92 Stat. 3021-22.
[18] AEA Section 11e.(2) (42 U.S.C. § 2014(e)(2)) (emphasis added). Previously, "*byproduct material*" had been defined to mean "any radioactive material (except special nuclear material) yielded or made radioactive by exposure to radiation incident to the process of producing or utilizing special nuclear material." *See* 42. U.S.C. § 2014(e)(1). This definition is currently located at Section 11e.(1) of the AEA.
[19] *See* 57 Fed. Reg. 20,525, 20,526 (1992).

behind NRC's uranium recovery regulations, relevant guidance and policies, and licenses/permits from 1978 to the present.

With the enactment of UMTRCA came the need for NRC to determine where its jurisdictional line should be drawn with respect to the activities and materials that it could regulate under the UMTRCA- amended AEA. As time passed and based on the intent-based provisions of the AEA definition of 11e.(2) byproduct material, NRC's regulatory jurisdiction can be defined to include two different activities: (1) "source material processing" and (2) uranium milling.

The latter "uranium milling" is easily defined using the intent-based provisions of the 11e.(2) byproduct material. Typically, it is assumed that ores are processed *primarily for their source material content* at an NRC or Agreement State-licensed uranium milling/recovery facility such as conventional uranium mills, heap leach facilities or ISR sites. This assumption is logical, because a company would not apply for and expend resources to obtain a combined source and 11e.(2) byproduct materials license if it were not processing uranium ores *primarily for their source material content.* In the case of ISR facilities (which typically are referred to as mining facilities, due to the subsurface process of injecting lixiviant into an underground ore body to dissolve the uranium into solution, the entirety of subsurface and surface activities at such sites are deemed to be "uranium milling" and thus fall under NRC's exclusive, federal preemptive jurisdiction over source and 11e.(2) byproduct material. However, for conventional uranium mills and heap leach facilities, the process of obtaining the ore from a mine, making it suitable for transportation to the mill facility, and the act of transporting such ore to the mill facility have been considered to be part of the "mining" process and, thus typically, have not fallen under NRC's AEA jurisdiction, even after the enactment of UMTRCA.

The former "source material processing" is intended to address Sections 11(z) and 62 of the AEA requiring that generators of source material obtain either *general* (source material in excess of 0.05% by weight but under general license limits) or *specific* (source material in excess of general license limits) licenses. However, while this class of licensees generates *licensable source material*, they are not processing materials *primarily for their source material content* and, thus, do not generate 11e.(2) byproduct material. As a result, while it is possible that NRC could require such a generator to obtain an NRC specific license pursuant to 10 CFR § 40.22 for possession and use of *source material*, it would not require a specific license for *uranium milling* (i.e., possession and use of source material and 11e.(2) byproduct material).

In the Final Rule released by NRC on new *general* source material license requirements, NRC appears to have further defined the jurisdictional line for "source material processing" based on the answer to the question of whether there is a physical or chemical change to the source material during the process operation. The Final Rule specifically states that, "[i]f a licensee does physically or chemically alter the solid source material, that altered source material must fall within…the new § 40.22(a)(1)." 78 Fed. Reg. 32310, 32317 (May 29, 2013).. Previous discussions with NRC have described physical changes of source material during a processing operation to include uranium put into solution by lixiviant at an ISR facility and then transferred onto IX resin at ISR central processing facilities,[20] while chemical changes have been described to include the use of sulfuric acid or other leach solutions at conventional uranium mills and heap leach facilities. The Final Rule also specifically recognizes that "sieving" is "considered to be a simple mechanical technique for separating particles of different size in an ore where the actual physical particles themselves

[20] This example of a physical change involving source material is representative based on the fact that water treatment systems such as those used by Water Remediation Technology (WRT) required a specific exemption from the new general license limits in the Final Rule. *See* 10 CFR § 40.22(a)(3)..

are not modified (e.g., separating rocks from sand)." *Id.* at 32319. The critical conclusion is that the pre-AMT crushing and post-AMT screening constitutes "processing" (not "milling") that does not and should not implicate NRC AEA jurisdiction given the limited potential health and safety concerns for miners handling the moist, AMT high-grade ore.

Due to questions regarding the AEA/UMTRCA line of jurisdiction between *mining*, *source material processing*, and *uranium milling*, NRC Staff determined that it should create a policy to allow mining and milling companies to better understand that jurisdictional line between mining, which is outside of NRC's AEA jurisdiction, and post-mining activities (e.g., source material processing and milling), which are within NRC's AEA jurisdiction. On July 13, 1977, NRC Staff responded to a letter of inquiry from Atlas Minerals, then a possessor of a source material license from NRC (at the time of the letter, 11e.(2) byproduct material as an AEA material did not yet exist) challenging a citation/violation from NRC inspectors claiming that crushed ore run through their mill site's crusher was located outside of a fenced restricted area and unsecured in two other areas in violation of its license. Atlas Minerals challenged this citation/violation by claiming that crushed ore is not "licensed material" within the scope of NRC's AEA jurisdiction. NRC Staff requested a legal opinion from the then-Office of the Executive Legal Director (OELD "now OGC") asking whether or not NRC could exercise jurisdiction over crushed ore within the scope of its AEA regulatory authority. On March 1, 1977, OELD rendered its legal opinion stating that 10 CFR Part 40.13(b)'s exemption of unrefined and unprocessed ore represents a *waiver* or *exemption* for NRC regulatory authority over such ore and identified such ore as a product of a post-mining activity. More specifically, OELD stated, "the Act does permit regulation by licensing at *any* stage after mining. 10 [sic] CFR 40.13(b), by exempting the transportation and handling of unprocessed ore, implicitly recognizes this authority to regulate." OELD further stated that, "by drawing the exemption line at unprocessed and unrefined ore, that is, *ore whose gross* *appearance and chemical state has not yet been altered from the point of mining, there is recognition of underlying health and safety considerations.* The assumption is that any processing or refining may alter the radiological environment associated with the source material enough so that the health and safety of workers and others becomes a matter of legitimate regulatory concern." The OELD opinion concludes with a health and safety threshold for determining its regulatory authority, "If the handling of the ore (for example in sorting) exposes workers to an increase in exposure to radioactive material…it may be viewed as a licensable situation." In summary, the OELD opinion concludes that an activity that changes the physical and chemical state of the ore and increases the potential for worker exposure to radioactive materials could qualify as an AEA-licensable activity.

B. AMT Does Not Constitute Uranium Milling

AMT is not "uranium milling" as defined in 10 CFR Part 40.4. In order for AMT to constitute "uranium milling," it must be demonstrated that the AMT process either *extracts* or *concentrates* uranium *primarily for its source material content*. Indeed, NRC's fact sheet on uranium recovery entitled *What We Regulate* states "[t]he distinction between these regulatory responsibilities [mining versus milling] is that the NRC becomes involved in uranium recovery operations when the ore is processed and chemically altered. This happens either in a uranium mill (the next step in processing ore from a conventional mine) or during in situ recovery (ISR)."[21] AMT does neither of these. In fact, AMT is a process designed to conduct high-grade vanadium/uranium mining or separating valuable unrefined and unprocessed ore from waste material, thereby reducing significantly the future waste material generated by licensed processing or extraction activities or "uranium milling." "High-grading" uranium is typically done to economically justify the transportation of such ores to

[21] *See* www.nrc.gov/materials/uranium-recovery.html. This fact sheet also states that NRC regulates ISR "where the uranium ore is *chemically altered underground* before being pumped to the surface for further processing." (emphasis added).

a uranium mill for uranium recovery pursuant to existing economic circumstances and is recognized as a "mining" activity. This also demonstrates that AMT does not present a process that would result in the generation of 11e.(2) byproduct material.

With respect to *extraction of source material primarily for its source material content*, the United States Department of the Interior's Dictionary of Mining, Mineral, and Other Terms defines "extraction" as: "[u]sed in relation to all processes that are used in *obtaining metals from their ores. Broadly, these processes involve the breaking down of the ore both mechanically (crushing) and chemically (decomposition), and the separation of the metal from the associated gangue.*" In the "uranium milling" context typically regulated by NRC and deemed to produce 11e.(2) byproduct material, "extraction" has been used at conventional, heap leach, and ISR facilities to include the use of processes to change the chemical form or composition of uranium in a solution. For example, at ISR facilities, the Commission's "milling underground" decision (SRM-SECY-99-0013) [22] rests its determination that underground processes at ISR facilities result in a change in the chemical status of the uranium when it is dissolved into solution and pumped to the surface for further milling (i.e., ion-exchange, elution, drying, and packaging). Further, while there have been instances of NRC regulation of activities such as crushing of ore at conventional uranium mills, these determinations were designed to confine the generation of 11e.(2) byproduct material to a 10 CFR Part 40 or Agreement State-licensed uranium mill, so that there are not multiple 11e.(2) disposal sites located around the country.[23] Thus, NRC's current regulatory scope with respect to "uranium milling" appears to focus on a narrow set of activities that

[22] *See* United States Nuclear Regulatory Commission, SRM-SECY-99-0013, *Staff Requirements-SECY-99-0013-Recommendations on Ways to Improve the Efficiency of NRC Regulation at In Situ Leach Uranium Recovery Facilities* (July 26, 2000).

[23] *Compare* 10 CFR Part 40, Appendix A, Criterion 2 which expresses the Commission's regulatory determination that there should not be a proliferation of 11e.(2) disposal sites which resulted in a Commission policy that 11e.(2) byproduct material generated at ISR sites be transported to licensed 11e.(2) disposal sites and not be disposed of on-site.

include those associated with *both* physical and chemical changes to an ore at a mill or, in the case of ISR in an ore body, and, to the extent that activities typically called "processing" are done at a 10 CFR Part 40 or Agreement State-licensed site, they are considered to be generating 11e.(2) byproduct material, which AMT does not. AMT is not an activity conducted primarily for recovery of source material content from an ore; but rather, it is an activity designed to sort ore for the purpose of sending such sorted ore to a uranium mill for actual "processing" or "milling." Therefore, AMT, conducted at a mine site, does not generate 11e.(2) byproduct material.

After a review of NRC's typical regulatory scope of authority for "uranium milling," it appears that AMT does not fall with the scope of "extraction" activities that are part of recovery processes at conventional uranium mills. The core process associated with AMT of ore that is extracted from host rock by blasting in a conventional uranium mine is to *disassociate* the mineralized "crust" on sand grains that make up a host rock without fracturing or changing the physical composition or appearance or the chemical nature of the ore itself. At the end of the AMT, the mining company is left with exactly the same ore it possessed after it was removed from the mine itself, only the mineralized "crust" is *disassociated* from what becomes the waste rock sand grain. The resulting fractions created by AMT comprise the "waste rock" fraction being the underlying materials such as quartz and feldspar grains around and between which the mineralized "crust" formed, and the resulting *disassociated* ore fraction that contains the mineralized crust that typically amounts to approximately 10 percent of the host rock mass and contains approximately 95 percent of the uranium that was in the host rock. But, as stated above, the mining company is left with exactly the same ore components as it possessed prior to the introduction of the material into the AMT. Thus, after the use of AMT, a mining company has not *extracted or concentrated* any uranium or vanadium from any ore primarily for its source material content; but rather, it has disassociated the mineralized crust containing uranium *and other minerals* from the host sand grains and further separated the minerals from the non-mineralized host rock just as blasting separates the valuable ore from the host (waste) rock source. Therefore, AMT does not meet the "uranium milling" classification as it is not *extraction of source material primarily for its source material content* but dissociating mineral components to "high-grade" the uranium ore.

With respect to *concentration of source material primarily for its source material content*, the DOI's Dictionary defines "concentrate" as "separat[ing] ore or metal from its containing rock or earth. *The concentration of ores always proceeds by steps or stages. Thus, the ore must be crushed before the mineral can be separated, and certain preliminary steps, such as sizing and classifying, must precede the final operations, which produce the finished concentrates.*" Based on this definition, AMT falls within the initial steps of the mining process or those steps that are identified as "preliminary" prior to engaging in "final operations" that produce a finished concentrate, such as uranium yellowcake. Again, AMT is not designed to *concentrate* or isolate uranium into a final product for introduction into the nuclear fuel cycle by changes to the uranium mineral composition, but rather is to *disassociate* the mineralized "crust" from an underlying sand grain using a purely mechanical process without the use of chemicals such as acid leach solutions or a lixiviant. Typically, in the context of uranium milling, NRC regulatory authority has focused the term *concentration* on the use of techniques at conventional mills, heap leach or ISR facilities such as elution of IX uranium-loaded resins that create a final uranium product that may be sent for conversion (i.e. U_3O_8). Further, the term *concentration* was further defined to include the removal of trace impurities in U_3O_8 product at the Sequoyah Fuels facility's front-end process. In these instances, unlike AMT, these processes are used at a 10 CFR Part 40-licensed uranium milling or conversion facility for the sole purpose of *concentrating* uranium in ore by changing its chemical composition into a final uranium yellowcake product. On the other hand, AMT is designed only to *disassociate* a mineralized "crust" from an underlying sand grain so that the uranium/mineral-bearing material may be separated and transported to a mill for concentration into a yellowcake product.

C. AMT Does Not Constitute Source Material Processing

While AMT does not constitute "uranium milling" under current NRC regulations, also AMT does not fall within the scope of "source material processing." As discussed above, NRC regulatory authority over source material processing relies on a physical or chemical change to the source material before NRC determines it falls within the scope of its AEA regulatory authority. With regard to the latter, chemical changes, AMT does not involve the use of any chemicals at any stage of the process. At no time during AMT is the ore or the source material uranium exposed to any form of reagent or other chemical such as an ISR-type lixiviant or an acidic or alkaline solution. Thus, as a purely mechanical process, AMT does not implicate any chemical changes that would result in it being classified as "source material processing."

With regard to physical changes, the AMT process itself does not physically alter the source material uranium at any time. The process of *disassociating* the mineralized "crust" from the underlying waste rock sand grain does not alter the physical structure of either material, but merely separates them from each other so that the mining company can properly identify *ore* that should be processed and/or milled and *host rock* that does not merit processing. This process is analogous to conventional blasting where a mining company identifies a portion of an ore body where concentrations of uranium are high enough to be ore, and strategically blasts that part of the deposit to remove the uranium ore from the host rock for processing. AMT is similar in that it removes the mineralized "crust" from the underlying host sand grain allowing a mining company to process the mineralized crust and reduce the amount of future tailings by eliminating the underlying host sand grain from the processing stream. In essence, AMT is not even ore sorting, which conceivably could be deemed to be "processing" in some cases, because AMT does not involve separating different ores from a single lot of mined material; but rather like mining, AMT identifies a particular portion of an ore and separates that ore portion from the underlying host rock. During the AMT, the physical characteristics of the mineralized "crust" and the underlying sand grain do not change and the mining company is left with exactly the same constituents, both radiological and non-radiological, that were in the ore prior to introduction into the AMT system. Thus, there is no physical change to a given ore during and after AMT and none of the process' aspects resembles those of IX processes which draw uranium out of solution into a solid form on a resin or grinding/crushing at a conventional mill where the physical make-up of the ore is changed from rock to much smaller rock-like components for reduction to sand-like material that can be treated with an acid or base solution to solubilize the uranium. The latter represents a physical change to the source material uranium portion of the ore after it has arrived at and been introduced at the front-end of the grinding and chemical processing circuits at a conventional mill facility. The crushing at a mine site pre-AMT does nothing more than lead to a separation of a fraction of that ore from an underlying sand grain.[24] Crushers at mine sites and blasting to achieve sizing that creates ore that is appropriate for milling typically have not been regulated by NRC. Thus, pre-AMT crushing at a surface or underground mine sites does nothing more than ore sizing to prepare such ore for transport to a mill facility.

[24] This is consistent with NRC's Fact Sheet on Uranium Recovery which states "[t]he NRC becomes involved in uranium recovery operations when the ore is processed and physically or chemically altered." *See* www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-uranium-recovery.html.

The 1977 OELD opinion (which in essence states that any activity associated with source material uranium once removed from the mine *could* be regulated) raises the critical question regarding an assertion of jurisdiction over AMT as source material processing. AMT involves minerals (mineral crust on sand grains) that unquestionably have been removed from their place in nature. AMT simply produces ore for transport to an AEA licensed facility and waste rock for storage at the mine

Ore that has been blasted from its host rock in a conventional surface or underground uranium mine technically can be said to have been extracted and removed from its place in nature, yet typically NRC, has not extended its regulatory reach to or into the mine itself. As noted above, ore in underground mines is frequently crushed to fit through *grizzlies* that effectively size ore prior to removal to the surface. NRC has not asserted jurisdiction over these activities. During the late 1960s-1980s when considerable conventional mining was taking place in the US, underground mines routinely had large ore stockpiles on the ore pads at the surface at the mine. Ores from these stockpiles were routinely *blended* at the mine site for transport to the mill to maximize uranium recovery from milling operations pursuant to existing economic conditions. To our knowledge, NRC did not assert jurisdiction over such activities. Accordingly, and particularly where AMT takes place at the mine site, NRC should not involve itself in activities that differ only technically from ore sizing and blending at conventional mining operations. There is no more potential radiological exposure to workers (probably less than in underground uranium mines) involved in AMT and essentially zero potential exposure to the general public.

Thus, even if NRC theoretically could regulate source material ore immediately after blasting in a mine, or during crushing and ore sorting in or at a mine, or during ore blending on the surface *at a mine site*, it has chosen not to do so in the past. Presumably, the reason is that mining has many facets depending on the characteristics of the deposit at the mine and the operations tailored thereto that take place after the ore's actual extraction /removal from its place in nature.

State and federal agencies (e.g., MSHA) rather than AEA authorities directly regulate mining operations at mine sites, including occupational radiation protection, directly through the exercise of their State powers. There are no increased potential radiological hazards and the volume of 11e.(2) byproduct material generated when uranium milling ultimately occurs will be reduced dramatically. Thus AMT affords the uranium industry and public considerable environmental and health and safety benefits.

CONCLUSIONS

The statutory mission of NRC and its Agreement States is the protection of public health and safety from potential radiological impacts of AEA materials and processes. Based on the information and analysis offered above, AMT does not constitute the AEA processes of "uranium milling" or "source material processing." AMT is an example of one of the latest technological developments in mining with respect to the operational, environmental, and public health and safety scenarios. Based on the analysis set forth in this White Paper, it is our position that the AMT process does not meet the regulatory definitions for source material processing or for uranium milling due to its substantial similarity to previously accepted mining techniques such a blasting and "high-grading" ore at mine sites. Further, the AMT process does not recover uranium primarily for its source material content, does not occur at a uranium mill, and does not produce 11e.(2) byproduct material. Additionally, AMT does not result in an increase in potential risk to public or occupational health and safety in a manner that would differentiate it from a typically recognized mining process. Thus, AMT is "mining" and, outside the scope of NRC's statutory/regulatory authority.