URANIUM MILLING ACTIVITIES
AT SEQUOYAH FUELS CORPORATION

1. INTRODUCTION

Sequoyah Fuels Corporation (SFC) describes previous operations at its Gore, Oklahoma, uranium conversion facility as: (1) the recovery of uranium by concentration and purification processes; and (2) the conversion of concentrated and purified uranium ore into uranium hexafluoride (UF_6), or the reduction of depleted uranium tetrafluoride (UF_4) to UF_6. SFC contends that these operations occurred in separate areas within the processing buildings or, in some cases, within separate buildings, and created separate and distinct waste streams.

The staff has previously considered the issue of classifying the waste from the front-end processes of SFC's facility as 11e.(2) byproduct material. In a July 1993 memorandum to the Commission, the Executive Director for Operations (EDO), supported by the Office of General Counsel (OGC), concluded that the waste was not 11e.(2) byproduct material. This conclusion was based on the historical view that UF_6 conversion plants had not been considered as uranium mills and were not contemplated as such by the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. Consequently, these wastes were considered source material, along with the wastes generated later in the conversion process, because of their concentration and where they were processed.

OGC has reconsidered this position, since the regulatory definitions of uranium milling and 11e.(2) byproduct material are process-related definitions and not restricted to a particular location of activity nor the physical characteristics of a material. Although the tailings and wastes from the front-end of SFC's facility can continue to be classified as source material (physical characteristic of the material), OGC believes that this material can also be classified as 11e.(2) byproduct material if the processes that took place at the front-end of SFC's facility can be considered a continuation of uranium milling. As a result, the front-end wastes from SFC could fall under the legislative and regulatory definitions of two different licensed materials. This would allow the use of the decision-making framework in Attachment 6. As detailed below, OGC's view of wastes at SFC is supported by the staff's understanding of what constitutes uranium milling.

2. WHAT CONSTITUTES URANIUM MILLING

Title 10, Code of Federal Regulations (10 CFR) 40.4 provides the following definitions of uranium milling and byproduct material:

> *Uranium milling* means any activity that results in the production of byproduct material, as defined in 10 CFR 40.4.
>
> *Byproduct material* means the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by such solution extraction operations do not constitute "byproduct material," within this definition.

> With the exception of "byproduct material," as defined in section 11e. of the [Atomic Energy] Act, all other terms defined in section 11 of the Act shall have the same meaning when used in the regulations in this part.

A fundamental, plain-language, working definition of uranium milling can be constructed from the somewhat circular references contained in the above regulatory definitions:

> *Uranium milling* is an activity or series of processes that extracts or concentrates uranium or thorium from any ore primarily for its source material content, and the resulting tailings or wastes are 11e.(2) byproduct material.[1]

The regulatory and working definitions of uranium milling and byproduct material are definitions based on a process rather than the location of an activity or the characteristics of a material. The regulations do not address when milling is completed. Once the fuel cycle is beyond natural uranium oxide, and conversion processes is initiated, the milling process is clearly completed.

Source material is clearly defined by its characteristics in 10 CFR 40.4 as:

> "*Source material* means: (1) Uranium or thorium, or any combination thereof, in any physical or chemical form or (2) ores which contain by weight one-twentieth of one percent (0.05%) or more of: (i) Uranium, (ii) thorium or (iii) any combination thereof. Source material does not include special nuclear material."

Ore is not defined in the uranium milling regulations nor its enabling legislation. The common-use definitions of ore, as defined in Webster's Ninth New Collegiate Dictionary, are: (1) a mineral containing valuable constituent (as metal) for which it is mined and worked; (2) a source from which valuable matter is extracted. For the purposes of alternate feed at licensed conventional uranium mills, the staff developed the following working definition of ore (NRC, 2000):

> "*Ore* is a natural or native material that may be mined and treated for the extraction of any of its constituents or any other matter for which source material is extracted in a licensed uranium or thorium mill."

This working definition is consistent with the common-use definition and was constructed with a limitation on where the activity occurred (i.e., a uranium mill), to allow the use of non-typical feed stocks in conventional uranium mills. It eliminates the creation, by definition, of large quantities of mixed waste (commingled Atomic Energy Act (AEA) and non-AEA waste materials) in uranium mill tailings impoundments by classifying all the material as 11e.(2) byproduct material. Side-stream process circuits at mineral processing facilities, which are licensed because they

[1] As stated in NRC's December 13, 2000, Director's Decision, although pre-UMTRCA mill tailings may be chemically, physically, and radiologically similar to 11e.(2) byproduct material, it is not material over which NRC has jurisdiction.

extract uranium for its source material content, are not affected by this working definition.[2] The small volume of wastes from these side-stream circuits is normally commingled with the wastes from the other mineral circuits and are managed as non-AEA material.

Uranium milling, as an activity or set of processes, is described in NUREG-0706, the "Final Generic Environmental Impact Statement on uranium milling" (NRC, 1980) as conventional and non-conventional recovery processes. NUREG-0706 examined both conventional and non-conventional uranium recovery processes as licensed activities, in the context of evaluating the

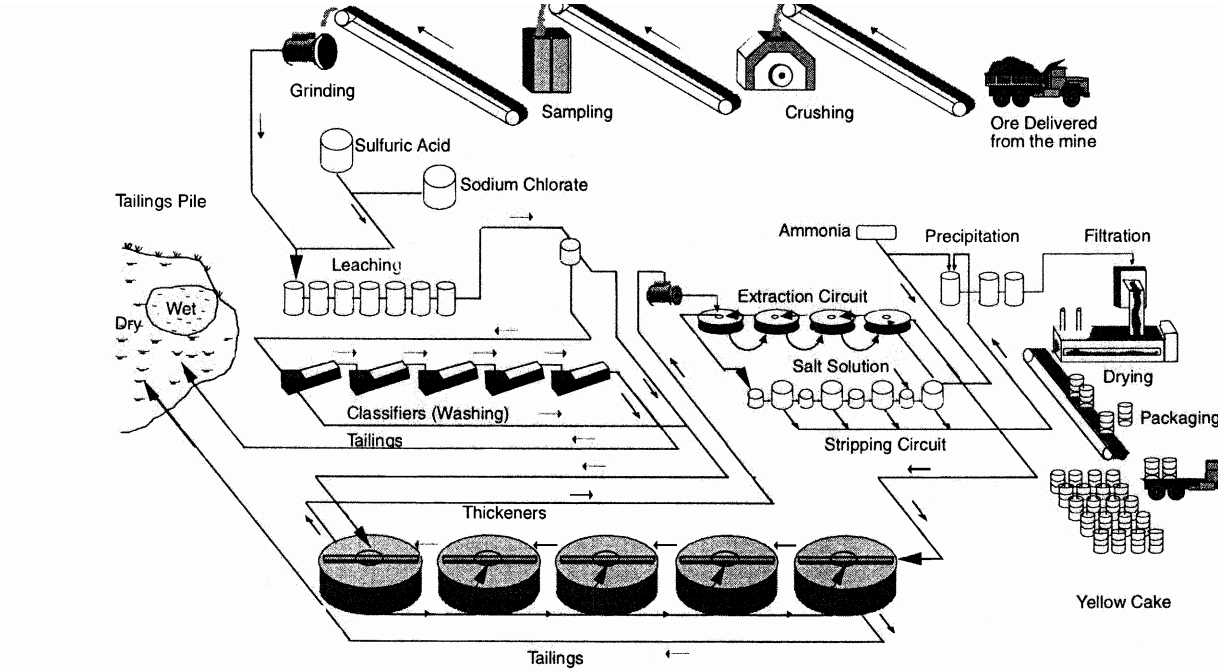

Figure 1 Conventional Uranium Milling

environmental impacts associated with those activities. Several process stages are involved in conventional milling: the crushing, grinding, and leaching of the ore; followed by chemical separation, concentration, and drying of the uranium, as shown in Figure 1. As illustrated, all process stages for conventional milling, from accepting ore; extracting, concentrating, and purifying source material; to disposing tailings are conducted in a continuum at one location. In

[2]Licensing source material recovery from side-stream processes at facilities other than uranium mills was explicitly addressed in the legislative history. UMTRCA does not include the wastes from side-stream production, such as uranium extraction from phosphate processing, because the ore was not "processed primarily for its source material content." Conversely, staff has considered other minerals, such as vanadium, extracted as a side-stream of a uranium mill, as not licensed material; however, the wastes from that side-stream are 11e.(2) byproduct material because the original ore is processed primarily for its source material content. Rare-earth processing and other facilities, along with the resulting wastes, can be licensed as source material, if the extraction results in a concentration of uranium or thorium above 0.05 weight percent.

the context of regulatory oversight, the licensed processes that comprise milling occur at one location, a mill.

Non-conventional processing, also identified in NUREG-0706, comprise other technologies, such as *in-situ* extraction of natural ore bodies, leaching uranium-rich tailings piles or low-grade ores (often called heap leaching), and uranium extraction from mine water and wet-process phosphoric acid. Non-conventional processing usually encompasses one or several of the processing stages (depending upon the application) that are performed at a conventional milling facility. The distinction among non-conventional milling activities is that these activities often occur at locations other than a uranium mill.

As an example, the extraction circuit, precipitation circuit, drying and packaging at an *in-situ* extraction operation are conducted in a centralized processing plant; whereas the leaching "circuit" is performed underground, often at a location different than where the other process circuits occur. The depleted ore body is not considered 11e.(2) byproduct material; however, discrete wastes generated at the surface are managed as 11e.(2) byproduct material and disposed of at a licensed uranium mill tailings facility. Often times, the leaching occurs at distant wellfields. The extraction circuits, using an ion-exchange resin technology, are located at small decentralized satellite facilities near the distant wellfields. The partially processed source material is then transported by truck to the central processing plant for final concentration, purification, and packaging. In this example, the source material extraction occurs at one location and the concentration / purification occur at another.

As another example, when heap leaching was performed in the past, the low-grade ore was leached above-ground with acid on a constructed leaching pad at a remote location. The diluted source material solution was trucked to a uranium mill or partially concentrated at the remote location and then shipped. The depleted ore heap was then managed as 11e.(2) byproduct material in a manner similar to conventional uranium mill tailings. For these activities, the extraction occurred at a different location than the remainder of the processing.

The dispersed milling operations typified by non-conventional uranium processing resemble the milling operations in the early days of the uranium industry during the 1950s and 1960s. Many of the early mills licensed by the Atomic Energy Commission (now the UMTRCA Title I mills) were often existing metal extraction mills refitted to process uranium ore or were constructed to perform only one or a few of the milling processes at one location. For example, the mill in Lowman, Idaho, processed dredge material from other locations by mechanical separation and sent produced solid material to other mills for chemical extraction, concentration, and purification. Other mills, such as the one in Green River, Utah, were built as ore-upgrading mills, which performed ore grinding and separation. The up-graded ore concentrate was shipped by rail to another mill located in Rifle, Colorado, where it was processed into uranium oxide (DOE, 2002). Each of these mills and several others accomplished only a portion of the milling process at dispersed locations, but were all licensed operations at one time.

Regardless of the characteristics, wastes from uranium milling are classified as 11e.(2) byproduct material. The characteristics of the wastes from non-conventional milling can vary according to the composition and characteristics of the incoming feed material. Heap leach wastes resemble the coarser fractions of conventional uranium mill tailings, and may be devoid of the finer fractions, because the aggressive ore grinding has not occurred. *In-situ* extraction

wastes resemble the finer fractions of conventional uranium mill tailings, since the leaching occurs underground and the ore grinding does not occur at all. Similarly, the characteristics from each process step within a conventional uranium mill will vary among themselves.

Wastes generated during the later concentration and purification stages at a conventional mill (e.g., the solvent extraction processes) will have little or no radium composition in the waste stream, since the radium-bearing fractions are typically removed in the early stages. The distinctiveness of these later-stage wastes is lost when they are ultimately blended with other waste streams in the tailings impoundment. If, for some reason, these wastes had been segregated and handled differently at a conventional uranium mill, they would still have been managed as 11e.(2) byproduct material, even though their characteristics would be dissimilar to other wastes from earlier process stages.[3]

3. SFC INITIAL PROCESSING AS URANIUM MILLING

A reasonable argument can be made, from a technical perspective, that the initial processing conducted at the SFC facility in Gore, Oklahoma, is merely the completion of the milling process started at other locations. Uranium milling entails many processing steps, which, as previously discussed, are not required to occur at a single location, but often do. The later stages at a conventional mill involve concentrating and purifying the source material, using solvent extraction, precipitation, and drying processing circuits. These same processes were performed at the front-end of the SFC facility for the same reason they are conducted in the later stages of the milling process at a conventional mill.

The source material that is processed at a conventional uranium mill and was processed at the front-end of the SFC facility are the same chemical form, natural uranium oxide. The later stages at the SFC facility converted the natural uranium oxide (typically U_3O_8) into UF_6 for subsequent processing into special nuclear material at an enrichment facility. The conversion to a new chemical form, which occurred midway through the processing at SFC, represents a clear demarcation between uranium milling and uranium conversion. The other licensed commercial conversion facility, in Metropolis, Illinois, currently does not include the source material purification stage before conversion to UF_6.[4] The processes at that facility are entirely geared toward converting U_3O_8 to UF_6. Conventional uranium mills are able to concentrate and purify the U_3O_8 to such a degree that the Metropolis conversion facility can process it without the risk of impurities compromising the conversion processes. Other mills, whether antiquated or because of differences in the incoming ore composition, had not achieved that level of purification. The SFC facility accepted the U_3O_8 from those facilities and further processed it to remove those impurities and it produced an acceptable grade of U_3O_8 for conversion.

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[3] The classification and management of wastes as 11e.(2) byproduct material are uniquely limited to uranium milling. Other fuel-cycle processes that concentrate or purify uranium, such as during conversion, enrichment, or fuel manufacturing, would not meet the legislative constraints of milling and the resulting wastes would not meet the classification of 11e.(2) byproduct material.

[4] Although uranium milling was not performed at Honeywell in the recent past, the staff is determining whether uranium milling was ever performed at the facility. If so, some wastes could be potentially classified as 11e.(2) byproduct material. Honeywell has not indicated that it would pursue this classification with NRC.

Whether the incoming source material to SFC meets the definition of "ore" is not relevant to the argument of waste classification. Declaring an incoming feed for individual milling-process stages as "ore," throughout the continuum of milling, is an artificial and unnecessary distinction. When milling is done at one site, the feed for each stage is not considered when making 11e.(2) byproduct material determinations for the classification of wastes for each stage. Similarly, uranium milling has, and does, occur at different locations under regulatory oversight without the construct of individual processing feeds meeting the definition of "ore." Thus, there is no need to consider the feed at SFC as ore, because the front-end process at SFC was simply the last step in the milling activity, which occurred away from a uranium mill, before the material was suitable for conversion to UF_6.

SFC, with the front-end purification process, had been licensed as a conversion facility under 10 CFR Part 40 at the time UMTRCA was enacted. In retrospect, a pure licensing separation between the front-end purification processes and the remaining conversion processes could have been made at that time. However, such a distinction would have probably been viewed as unnecessarily burdensome for the time, given that protection of public safety, the environment, and the common defense were maintained under the existing license.

4. **REFERENCES**

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