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THE NUCLEAR REGULATORY COMMISSION AND ITS ROLE IN MINING OVERSIGHT

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Abstract

The Nuclear Regulatory Commission through the authority of the Atomic Energy Act of 1954, as amended, authorizes the holder of a materials license to receive, acquire, possess and transfer byproduct, source and special nuclear materials. The licensing process involves the preparation of an application which consists of a process description, a demonstration of geohydrologic control and a restoration methodology. These materials undergo a concurrent Federal and State review, ultimately resulting in the issuance of a materials license. The holder of the license is authorized to operate the facility for a period of 5 to 7 years, under the agreements and conditions contained in the application and license. Following this period of time, the materials license is subject to renewal.

The renewal effort involves a quantative and qualitative overview of the licensed activities performed over the period of record. A compliance history is maintained of licensed activities through regular inspections conducted by the Nuclear Regulatory Commission, as well as environmental and radiological reporting requirements. The inspections and reporting requirements address well-field control of injected fluids, handling and disposal methods of waste streams and airborne radiological effluent levels within the process facility, as well as in the environment. Additional data on radionuclide concentrations are collected and compiled to determine employee doses. These data serve as the basis to determine if the health and safety of workers associated with licensed activities as well as the general public are being protected.

All uranium recovery licensing and enforcement actions are conducted through the Uranium Recovery Field Office located in Denver, Colorado. This office was established in October of 1982, due to a congressional request which had its origin with western uranium producers. Since the establishment of the office, inspection visits have been more frequent; however, regulatory costs have diminished, while rapport with licensees has increased.

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The Nuclear Regulatory Commission (NRC) was established by the Energy Reorganization Act of 1974. This act abolished the Atomic Energy Commission and subsequently transferred to the NRC all the licensing and related regulatory functions assigned to the Atomic Energy Commission by the Atomic Energy Act of 1954, as amended. With this conversion, the NRC established offices throughout the United States.

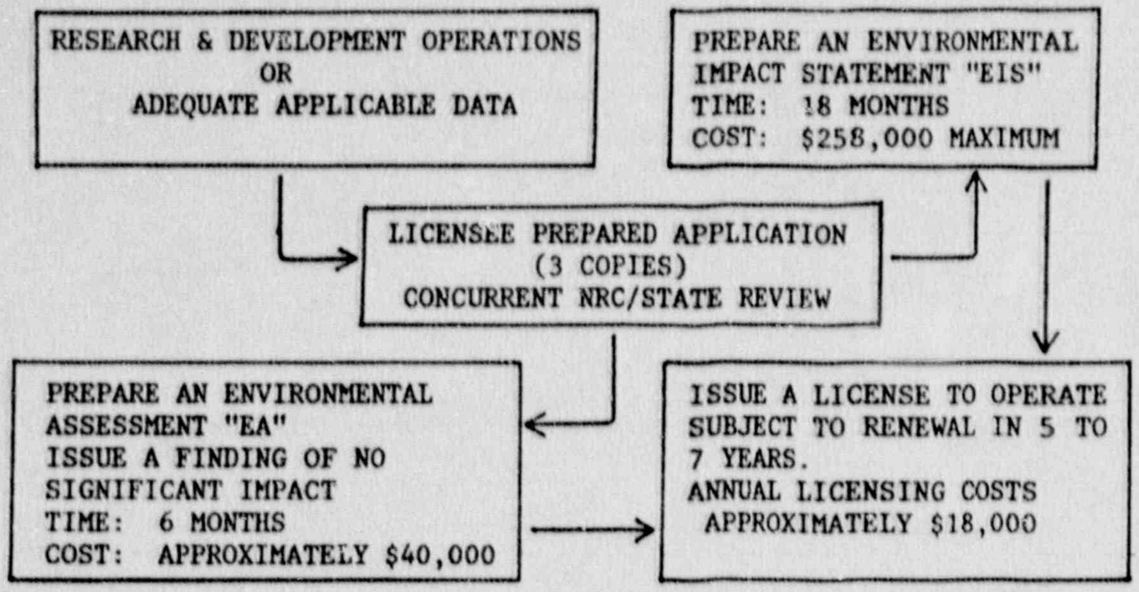
The principal NRC offices are located in Washington, D.C., with regional offices located in Pennsylvania, Georgia, Illinois, Texas and California. Additionally, there is one field office in Colorado. The Washington, D.C. office provides overall coordination, administrative support and technical assistance for the five regional offices. The primary responsibility of the regional office is to ensure that the health and safety of workers associated with licensed activities as well as the general public are being protected. A great deal of the workload in the regional offices evolves around licensing and inspection of power reactors.

The NRC field office, of which there is only one in Denver, Colorado, has as its primary function licensing and inspection of conventional milling and solution mining uranium recovery operations. Over the past several years, the NRC has seen a decrease in uranium production associated with conventional milling. Indeed, of all the once active uranium mills in the western United States, three are currently producing uranium. However, the inverse situation exists for solution mining activities. Currently, the NRC licenses two commercial solution mining sites and six research and development operations. Additionally, the agreement state of Texas licenses numerous commercial operations, as well as maintaining an ongoing research and development program.

Interest in solution mining activities due to the unfavorable economics of open pit or underground mining is dramatically increasing. Currently, the NRC has under review or is providing prelicensing guidance on two locations in New Mexico, one location in Nebraska, and two locations in Wyoming. Each of these locations represents a commercial scale solution mining operation which is expected to be producing by 1990. The typical licensing process at a solution mining site involves the preparation of an application which has as its basis a process description, a demonstration of geohydrologic control and a restoration methodology.

The license application is the document that compiles the information necessary to make a regualtory decision. Commonly, a concurrent Federal and State review takes place; thus minimizing future reporting requirements. During the review process, an Environmental Assessment of the project is performed by the NRC. This effort generally takes about 6 months, at which time a Federal Register Notice is filed informing the public of impacts, or lack of impacts, associated with the proposal. Should significant impacts be identified, an Environmental Impact Statement must be written. If significant impacts are not identified, the Environmental Assessment maintains itself as a decision document and a license may be granted. The general steps in the licensing process as well as time requirements and costs are shown below.

STEPS IN THE LICENSING PROCESS



The license application gathers its data from research and development operations and associated operational data, as well as data gathered from similar operations in similar stratigraphy. Originally, actual construction of a research and development scale operation accompanied by mining and restoration was all but required to support a commercial license application. This was due to the lack of production and restoration data associated with solution mining. This lack of operational data led to numerous uncertainties in the licensing process. However, with operational data becoming more prolific, laboratory leach and restoration tests coupled with field verification of hydraulic properties may serve as the basis for a commercial license application. Considering this approach, a reduced well field flow rate is often utilized during the initial months of operation, to verify the laboratory generated data.

The typical uranium recovery process involves sequential circulation of the well field, accompanied by lixiviant injection. The enriched mining solutions are passed through ion exchange columns causing initial uranium concentration. At this point, the regulatory process begins to have some meaning. Radionuclide concentrations in the process solutions begin to rise as uranium and its daughter products are concentrated. In response to this, radionuclide concentrations in the form of gamma radiation and radon gas within the plant have the potential to increase. Additionally, surface contamination consisting of removable alpha particles begins to be a health concern. Due to the mobilization of radionuclides and their subsequent concentration, the potential exists for workers or the general public to receive elevated levels of the various radionuclides through inhalation or ingestion. An additional pathway for radionuclide uptake is by way of stack emissions associated with product drying. Because of this situation, the licensee measures the individual radionuclides and determines individual doses.

Also of regualtory interest is the geohydrologic control of the lixiviant. Typically, the hydraulic conductivities of the production zone as well as the confining layers are verified by the use of multiple well aquifer tests. These tests are conducted on a production zone basis. The production zone is stressed by pumping for 24 to 36 hours. During this time and the following recovery period, responses are measured in the first overlying and underlying aquifer to verify the characteristics of the confining layers. Generally speaking, a difference of two orders of magnitude in hydraulic conductivity between the production zone and the confining layers is considered adequate to present a physical barrier to vertical lixiviant movement. This data is essential not only for production zone planning, but also to gain regulatory approval for mining. Closely associated with aquifer testing are well completion details and integrity testing of all wells utilized at the site. Well completion details are of particular interest to determine the vertical portion of the production zone that is being monitored. Often the aquifer has vertically separated zones which are not mineralized. In such cases, only the mineralized zones have screens installed. It is important in these instances to obtain baseline water quality data that is representative of the mining zones.

Experience gained from numerous integrity tests indicates that 120 percent of operating pressure maintained for 10 minutes with not more than a 10-percent pressure loss adequately characterizes the integrity of the well. These tests are performed on injection, production and monitor wells prior to their being placed into service. They are also performed following well servicing and workovers which may result in damage to the casing.

Water quality data is collected from numerous wells at the site to determine baseline concentrations of various parameters. During the infancy of solution mining, several wells per acre were utilized to characterize baseline water quality. These same wells were subsequently utilized to determine restoration success on a well-by-well basis. However, now that more information has been collected on the concentrations of constituents in uranium mineralized formations, approximately one well per acre of production unit is utilized for baselining purposes. Similarly, the data from these wells is combined, resulting in average baseline water quality conditions over the entire production unit.

Water quality characterization involves sampling for numerous cations and anions as well as selected heavy metals and radionuclides. Sufficient anions and cations are analyzed to allow for calculating a meaningful ion balance. The heavy metals of interest depend on the trace metals associated with the uranium mineralization. A common suite would include arsenic, barium, chromium, lead, mercury, molybdenum, selenium and vanadium. Additionally, the metal list is often expanded to include more hazardous metals. The radionuclides of interest are generally radium-226 and uranium. These data serve as the basis to determine the degree of lixiviant control, based upon upper control limits. Additionally, these data are utilized to determine restoration success.

To determine the success of overproduction in containing mining solutions, monitor wells are generally required at the non-mineralized periphery of the production zone. Spacing on these wells varies, dependent upon ground-water gradients and, to a lesser extent, upon such variables as land ownership and topography. However, they generally encircle the well field at 300 to 600 foot intervals. Additional monitor wells are also installed above and below the confining layers to verify the adequacy of previously tested confining characteristics as well as to determine if vertical excursions are occurring.

Should an excursion be noted, modifications to the injection and production sequence are almost always successful in returning the solutions to the production zone.

After the production zone has been mined, the ground water must be restored. Restoration has as its primary goal to return all water quality parameters to baseline concentrations. Alternately, restoration goals may be to return ground waters to their class-of-use standards. Initially, many operators based their restoration demonstration solely on the results of solution mining of a small well field associated with a research and development project. However, as additional insight is gained, restoration demonstrations are now being based upon the experience previously gained in the field as well as laboratory leaching and associated laboratory restoration. To a large extent, laboratory verification of restoration is limited to sodium carbonate/bicarbonate lixiviants with oxygen or carbondioxide oxidants. The field application of alternate forms of lixiviants is so limited that it does not support laboratory verification without a research and development scale operation.

Typical restoration methods include ground-water sweep, reverse osmosis treatment with permeate reinjection and reductant utilization. For the most part, ground-water sweep and reverse osmosis treatment of the well-field waters have been relatively successful in reducing anions and cations as well as non-hazardous metals to baseline concentrations. Quite often, the concentrations of arsenic, selenium, vanadium and molybdenum, as well as radionuclides respond poorly to these methods. The lack of response is primarily due to the oxidized environment that has been created in the production zone. Due to this, the injection of reducing compounds into the production zone has gained regulatory approval as a means to re-establish reducing conditions. It is often necessary to follow reductant utilization with some form of well-field circulation. This not only allows for the reductant to contact the majority of the formation, but also evenly distributes the ionic carrier associated with the reductant.

Verification of restoration results is followed by a stability monitoring period. During this period of time, the well field is encouraged to approach equilibrium. This is accomplished by suspending all production unit circulation activities other than monthly monitoring. The stability period generally lasts 6 to 12 months, with 12 months being the most common time period. During this time, an evaluation of the restoration success is made based upon the baseline water quality values that were initially established. The results gathered during this period of time serve as the basis to determine the success of the project. Experience has proven that uranium can be recovered by solution mining; however, restoration efforts are not always as encouraging. In cases where restoration is unsuccessful in reaching the target values, additional efforts may be required.

The regulatory significance of a license application is that it serves as the "blueprint" for issuance of a Source and Byproduct Material License authorizing uranium recovery. Each portion of the operation; process description, geohydrologic control and restoration methodology, if not adequately discussed in the application, will be covered by license conditions.

License conditions generally cover three areas. Those conditions which deal with health and safety of the workers as specified in 10 CFR Part 20 generally deal with exposure determinations, contamination surveys, instrument calibrations and associated reporting requirements. Additional license conditions are developed which deal specifically with environmental monitoring of air, water, soil and vegetation. Finally, license conditions are written which speak to operational monitoring of the well field, waste disposal stream and restoration efforts.

The issuance of a Source and Byproduct Material License allows operation of the site for 5 to 7 years. During this time period, the NRC will on at least an annual basis visit the site and perform an inspection of the facilty's compliance with license conditions, as well as commitments in the licensee application. Based upon the facility's performance over the period of record as well as the inspection history, a regulatory climate is established.

The purpose of regulation of solution mining activities is to verify compliance with the legal requirements of a Source and Byproduct Material License. Since the establishment of the Denver field office, the NRC has become more involved in licensed activities. Due to this, the average number of license conditions in most licenses has decreased. Similarly, State and Federal requirements covering the ground water have, for the most part, had any inconsistencies eliminated. Furthermore, the NRC, to a certain extent, maintains a uniform level of licensing authority and inspection throughout the solution mining community.

The Denver field office is striving to allow the recovery of the uranium resource by way of solution mining. In accomplishing this, a licensee prepared application, which characterizes the proposed project, is required. Upon filing of the application, a concurrent Federal and State review is conducted. The review draws not only on the application materials but also on previous mining experience and results in the issuance of a Source and Byproduct Material License.

Biographical Sketch

Gary R. Konwinski is a project manager with the U.S. Nuclear Regulatory Commission (Uranium Recovery Field Office, P.O. Box 25325, Denver, Colorado 80225). His responsibilities include technical coordination of the agency's ground water program as well as licensing and inspection of uranium recovery operations. Prior to employment with the Nuclear Regulatory Commission, he worked for the Bureau of Land Management and the Soil Conservation Service. Educated at the University of Wisconsin, Western Michigan University, Michigan State University and Colorado School of Mines, his specialties include soil science, geology and geohydrology.