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REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

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INFORMATION RELEVANT TO ENSURING THAT OCCUPATIONAL RADIATION EXPOSURES AT URANIUM MILLS WILL BE AS LOW AS IS REASONABLY ACHIEVABLE

A. INTRODUCTION

Paragraph 20.1(c) of 10 CFR Part 20, "Standards for Protection Against Radiation," states that licensees should make every reasonable effort to keep radiation exposures, as well as releases of radioactive material to unrestricted areas, as far below the limits specified in Part 20 as is reasonably achievable. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," sets forth the philosophy and general management policies and programs that licensees should follow to achieve this objective.

This guide recommends design criteria and administrative practices acceptable to the NRC staff for maintaining occupational exposures as low as is reasonably achievable (ALARA) in uranium mills. However, some of the basic processes at other types of uranium recovery facilities have a similar potential for exposing workers to uranium and its daughters. Therefore, the guidance provided in this guide can be applied, as appropriate, to those facilities as well.

An existing NRC report, NUREG-0706, "Final Generic Environmental Impact Statement on Uranium Milling" (Ref. 1), also provides detailed information for controlling the radiation hazard and chemical toxicity of airborne uranium and its daughter products in uranium mills.

This guide is directed toward occupational health protection from radiologic and toxic hazards from airborne particulates of uranium and its daughters. However, it is also recognized that uranium mill workers will be exposed to external radiation in addition to inhaled particulates. Therefore, ensuring protection of mill workers from external radiation hazards is also addressed.

Specific guidance regarding protection of the public from radiologic and toxic hazards caused by materials in effluents to unrestricted areas is beyond the scope of this guide. This topic is mentioned only in connection with actions that influence both occupational exposure and effluent control. Some of the same controls that have been shown to keep occupational exposures to airborne uranium and its daughters ALARA also tend to keep releases of these materials from the mill ALARA (see Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring At Uranium Mills").

Any guidance in this document related to information collection activities has been cleared under OMB Clearance No. 3150-0014.

B. DISCUSSION

The principle of maintaining occupational radiation exposures as low as is reasonably achievable is an extension of an original recommendation of the National Committee on Radiation Protection (NCRP) (now the National Council on Radiation Protection and Measurements) in its Report No. 17 (Ref. 2). In this early report, the NCRP introduced the philosophy of assuming that any radiation exposure may carry some risk and recommended that radiation exposure be kept at a level "as low as practicable" below the recommended maximum permissible dose equivalent. This philosophy is currently referred to as "as low as is reasonably achievable" (ALARA). Similar recommendations to keep exposures ALARA have been included in NCRP reports up to the present time (Ref. 3), as well as in recommendations of the National Academy of Sciences–National Research Council (Ref. 4), the Federal Radiation Council (Ref. 5), and other independent scientific and professional organizations (Ref. 6). Therefore, NRC has incorporated this basic radiation protection philosophy from these recommendations into its regulations and guides.

This guide provides a detailed supplement for uranium mill licensees of the basic philosophy of Regulatory Guide 8.10, which lists for all specific licensees the types of

management commitments and radiation protection programs that would help to achieve the objective of maintaining occupational exposures ALARA.

Regulatory Guide 3.5, "Standard Format and Content of License Applications for Uranium Mills," outlines the information that applicants should include in an application for a uranium mill license. This regulatory guide describes the details of an acceptable radiation protection and ALARA program that an applicant should describe as recommended in Section C.5, "Operations," of Regulatory Guide 3.5.

C. REGULATORY POSITION

The principles and practices presented in this guide should be used as guidance in developing the radiation protection and ALARA program for a uranium mill for appropriate sections of an application* for a new or renewal license. The recommendations of this guide are intended to assist applicants in preparing license applications that are acceptable to the NRC licensing staff and are consistent with the philosophy of ALARA. Unique features not addressed here will be specifically reviewed by the NRC licensing staff.

A licensee's program for occupational protection against uranium and its daughters will be considered consistent with the ALARA philosophy if the uranium mill's operating policies and programs satisfy the following major principles and practices.

1. ALARA PHILOSOPHY

A major purpose of the occupational radiation protection program at a uranium mill is to maintain radiation exposure ALARA for all employees, contractors, and visitors.

The implementation and effectiveness of a successful ALARA program is the responsibility of everyone involved in the processing of uranium ores. Responsibilities for conducting a radiation protection and ALARA program are shared by licensee management,** the radiation safety officer (RSO),*** and all mill workers.

1.1 Licensee Management

Licensee management is responsible for developing, implementing, and enforcing the rules, policies, and procedures necessary for an effective radiation protection and ALARA program to ensure the health and safety of workers.

Licensee management should provide the following:

1. A strong commitment to and continuing support for the development and implementation of the radiation protection and ALARA program;

2. Information and policy statements to employees, contractors, and visitors;

3. A periodic management audit program that reviews procedural and operational efforts to maintain exposures ALARA;

4. Continuing management evaluation of the health physics program, its staff, and its allocation of adequate space and money;

5. Appropriate briefings and training in radiation safety, including ALARA concepts for all uranium mill employees and, when appropriate, for contractors and visitors.

1.2 Radiation Safety Officer

The radiation safety officer (RSO) has primary responsibility for the technical adequacy and correctness of the radiation protection and ALARA program and has continuing responsibility for surveillance and supervisory action in the enforcement of the program.

The radiation safety officer should be assigned the following:

1. Major responsibility for the development and administration of the radiation protection and ALARA program;

2. Sufficient authority to enforce regulations and administrative policies that affect any aspect of the radiological safety program;

3. Responsibility to review and approve plans for new equipment, process changes, or changes in operating procedures to ensure that the plans do not adversely affect the protection program against uranium and its daughters;

4. Adequate equipment and laboratory facilities to monitor relative attainment of the ALARA objective.

1.3 Mill Workers

Because a radiation protection and ALARA program is only as effective as the workers' adherence to the program, all workers at the mill should be responsible for the following:

1. Adhering to all rules, notices, and operating procedures for radiation safety established by licensee management and the RSO;

*An application and a suggested format for its completion may be obtained from the licensing staff of the Division of Waste Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

**"Management" is defined here as those persons authorized by the licensee of record to make policies and to direct activities of the recovery facility.

***The title "radiation safety officer" is used synonymously with "radiation protection manager" by many licensees and will be used in this guide to designate the qualified individual who is responsible for developing and supervising the radiation safety program; other titles are equally acceptable.

2. Reporting promptly to the RSO and licensee management equipment malfunctions or violations of standard practices or procedures that could result in increased radiological hazard to any individual;

3. Suggesting improvements for the radiation protection and ALARA program.

2. HEALTH PHYSICS ORGANIZATION AND ADMINISTRATIVE PROCEDURES

2.1 Health Physics Authorities and Responsibilities

The radiation safety officer at the mill site should be responsible for conducting the health physics program and for assisting the resident manager in ensuring compliance with NRC's regulations and the license conditions applicable to worker health protection.

Generally, the RSO should report directly to the resident manager on matters of radiation safety. The RSO should be directly responsible for supervising the health physics technicians, for overseeing the day-to-day operation of the health physics program, and for ensuring that records required by the NRC are maintained. The RSO should have both the responsibility and the authority, through appropriate line management, to suspend, postpone, or modify any work activity that is unsafe or potentially a violation of the Commission's regulations or license conditions, including the ALARA program. It is recommended that management delegate this responsibility and authority directly to the RSO. The RSO may have other safety-related duties, such as responsibility for programs of industrial hygiene and fire safety, but should have no direct production-related responsibility.

2.2 Operating Procedures

Written standard operating procedures should be established for all activities that involve handling, processing, or storing radioactive materials. All such procedures should include consideration of pertinent radiation safety practices. Written procedures should also be established for such activities as health physics monitoring, sampling, analysis, and instrument calibration. An up-to-date copy of each written procedure, including accident response and radiological fire protection plans, should be kept accessible to all employees. All written procedures involving radioactive material control should be compiled in a manual that allows documentation of each revision and its date.

To ensure that proper radiation protection principles are being applied, written procedures for all activities should be reviewed and approved in writing by the RSO before being implemented and whenever a change in a procedure is proposed. In addition, the RSO should review all existing operating procedures at least annually to ensure the procedures do not violate any newly established radiation protection practices.

For work on nonroutine maintenance jobs where the potential for exposure to radioactive material exists and for which no standard written operating procedure already exists, a radiation work permit (RWP)* should be used. Such permits should describe the following:

1. The details of the job to be performed,

2. Any precautions necessary to reduce exposure to uranium and its daughters,

3. The radiological monitoring and sampling necessary before, during, and following completion of the job.

The RSO should indicate by signature the review of each RWP prior to the initiation of work, and the work should be carried out in strict adherence to the conditions of the RWP. The RSO should designate a member of the radiation safety office staff or a supervisory member of the production staff who has received specialized radiation protection training to review and sign RWPs when the RSO is not available, e.g., during off shifts.

2.3 Surveillance: Audits and Inspections

It has been observed repeatedly that, if sufficient management interest exists, exposure to hazardous materials is reduced. Frequent management audit and inspection of worker health protection practices at a uranium mill can serve to provide management with the information necessary to conduct an appropriate ALARA program.

2.3.1 Daily and Weekly Inspections

The RSO and the mill foreman should conduct a weekly inspection of all mill areas to observe general radiation control practices and review required changes in procedures and equipment. The RSO or designated health physics technician should conduct a daily walk-through (visual) inspection of all work and storage areas of the mill to ensure proper implementation of good radiation safety procedures, including good housekeeping and cleanup practices that would minimize unnecessary contamination. Problems observed during all inspections should be noted in writing in an inspection logbook. The entries should be dated, signed, and maintained on file for at least 1 year. The RSO should review all violations of radiation safety procedures or other potentially hazardous problems with the resident manager or other mill employees who have authority to correct the problem. Also, the RSO should review the daily work-order and shift logs on a regular basis to determine that all jobs and operations having a potential for exposing personnel to uranium, especially those RWP jobs that would require a radiation survey and monitoring, were approved in writing by the RSO, his staff, or designee prior to initiation of work.

*The term "radiation work permit" is used by many licensees and will be used throughout this guide; other terms such as "special work permit" are equally acceptable.

2.3.2 Monthly Reviews

At least monthly, the RSO should review the results of daily and weekly inspections, including a review of all monitoring and exposure data for the month. The RSO should provide to the resident manager and all department heads for their review a written summary of the month's significant worker protection activities containing (1) a summary of the most recent personnel exposure data, including bioassays and time-weighted calculations, and (2) a summary of all pertinent radiation survey records.

In addition, the monthly summary report should specifically address any trends or deviations from the radiation protection and ALARA program, including an evaluation of the adequacy of the implementation of license conditions regarding radiation protection and ALARA. The summary should provide a description of unresolved problems and the proposed corrective measures. Monthly summary reports should be maintained on file and readily accessible for at least 5 years.

2.3.3 Radiation Protection and ALARA Program Audit

Licensee management should have annual audits of the radiation protection and ALARA program performed and written reports on the audits submitted to corporate management. All members of the audit team should be knowledgeable concerning the radiation protection program at the mill. In addition, one member of the team should be experienced in the operational aspects of specialized uranium mill radiation protection practices. The RSO should accompany the audit team but should not be a member.

The audit report should summarize the following data:

1. Employee exposure records (external and time-weighted calculations),

2. Bioassay results,

3. Inspection log entries and summary reports of daily, weekly, and monthly inspections,

4. Documented training program activities,

5. Radiation safety meeting reports,

6. Radiological survey and sampling data,

7. Reports on overexposure of workers submitted to NRC, Mine Safety and Health Administration (MSHA), or States,

8. Operating procedures that were reviewed during this time period.

The report on the annual radiation protection and ALARA audit should specifically discuss the following:

1. Trends in personnel exposures for identifiable categories of workers and types of operational activities,

2. Whether equipment for exposure control is being properly used, maintained, and inspected,

3. Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

2.4 Technical Qualifications of Health Physics Staff

2.4.1 Radiation Safety Officer

The RSO should have the following education, training, and experience:

1. Education: A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in uranium mill radiation protection. Two years of relevant experience are generally considered equivalent to 1 year of academic study.

2. Health physics experience: At least 1 year of work experience relevant to uranium mill operation in applied health physics, radiation protection, industrial hygiene, or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.

3. Specialized training: At least 4 weeks of specialized classroom training in health physics specifically applicable to uranium milling. In addition, the RSO should attend refresher training on uranium mill health physics every 2 years.

4. Specialized knowledge: A thorough knowledge of the proper application and use of all health physics equipment used in the mill, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of the uranium milling process and equipment used in the mill and how the hazards are generated and controlled during the milling process.

2.4.2 Health Physics Technicians

In addition to the RSO, there should be a minimum of one full-time health physics technician at any full-scale operating uranium mill. The health physics technician should have one of the following combinations of education, training, and experience:

1. Education: An associate degree or 2 or more years of study in the physical sciences, engineering, or a health-related field,

Training: At least a total of 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to uranium mills,

Experience: One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium mill; or

2. Education: A high school diploma,

Training: A total of at least 3 months of specialized training (up to 1 month may be on-the-job training) in radiation health protection relevant to uranium mills,

Experience: Two years of relevant work experience in applied radiation protection.

The health physics technician should demonstrate a working knowledge of the proper operation of health physics instruments used in the mill, surveying and sampling techniques, and personnel dosimetry requirements.

2.5 Radiation Safety Training

All new employees should be instructed by means of an established course in the inherent risks of exposure to radiation and the fundamentals of protection against exposure to uranium and its daughters before beginning their jobs. Other guidance pertinent to this course is found in Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure," and Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure." This course of instruction should include the following topics:

1. Fundamentals of Health Protection
   a. The radiologic and toxic hazards of exposure to uranium and its daughters,
   b. How uranium and its daughters enter the body (inhalation, ingestion, and skin penetration),
   c. Why exposures to uranium and its daughters should be kept as low as is reasonably achievable (ALARA).
2. Personal Hygiene at Uranium Mills
   a. Wearing protective clothing,
   b. Using respirators correctly,
   c. Eating, drinking, and smoking only in designated areas,
   d. Using proper methods for decontamination (i.e., showers).
3. Facility-Provided Protection
   a. Ventilation systems and effluent controls,
   b. Cleanliness of the work place,
   c. Features designed for radiation safety for process equipment,
   d. Standard operating procedures,
   e. Security and access control to designated areas.
4. Health Protection Measurements
   a. Measurement of airborne radioactive materials,
   b. Bioassays to detect uranium (urinalysis and in vivo counting),
   c. Surveys to detect contamination of personnel and equipment,
   d. Personnel dosimetry.
5. Radiation Protection Regulations
   a. Regulatory authority of NRC, MSHA, and State,
   b. Employee rights in 10 CFR Part 19,
   c. Radiation protection requirements in 10 CFR Part 20.
6. Mill Emergency Procedures.

A written or oral test with questions directly relevant to the principles of radiation safety and health protection in uranium milling covered in the training course should be given to each worker. The instructor should review the test results with each worker. The instructor should discuss any wrong answers to test questions with the worker until the worker understands the correct answer. Workers who fail the test should be retested after receiving additional training. These tests and results should be maintained on file.

Each permanent worker should be provided an abbreviated retraining course annually. Documented successful completion of the retraining course should also be maintained on file. Retraining should include relevant information that has become available during the past year, a review of safety problems that have arisen during the year, changes in regulations and license conditions, exposure trends, and other current topics.

In addition, all new workers, including supervisors, should be given specialized instruction on the health and radiation safety aspects of the specific jobs they will perform. This instruction should be in the form of individualized on-the-job training. Supervisors should be provided additional specialized training on their supervisory responsibilities in the area of worker radiation protection. Retraining should be conducted annually and documented. All employees should sign a statement that they received job-specific radiation safety training. The statement should indicate the dates the training was received and it should be cosigned by the instructor. Radiation safety matters of concern that arise during plant operation should be discussed

with all workers during regular monthly or bimonthly safety meetings.

All visitors who have not received training should be escorted by someone properly trained and knowledgeable about the hazards of the mill. At a minimum, visitors should be instructed specifically on what they should do to avoid possible hazards in the areas of the mill they will be visiting.

Contractors having work assignments in the mill should also be given appropriate training and safety instruction. Contract workers who will perform work on heavily contaminated equipment should receive the same training and radiation safety instruction normally required of all permanent workers. Only job-specific radiation safety instruction is necessary for contract workers who have previously received full training on prior work assignments at the mill or have evidence of recent and relevant radiation safety training elsewhere.

2.6 Surveys

The RSO and radiation safety office staff are responsible for performing all routine and special radiation surveys as required by license conditions and by 10 CFR Part 20. Acceptable survey methods are specified in Section C.1 of Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills."

2.7 Respiratory Protection

The RSO and the radiation safety office staff are responsible for the implementation of a respiratory protection program, if one is needed. There should be adequate supplies of respiratory devices to enable issuing a device to each individual who enters an airborne radioactivity area. Additional respiratory protection devices should be located near access points of airborne radioactivity areas. All airborne radioactivity areas should have controlled access. Routine physical (medical) evaluation should be required of those individuals who will use respirators. If the licensee elects to take credit for protection factors the respiratory protection program must meet, at a minimum, the requirements of § 20.103 of 10 CFR and should follow the recommendations in Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," which are supported in NUREG-0041, "Manual of Respiratory Protection Against Airborne Radioactive Materials" (Ref. 7).

2.8 Bioassay Procedures

The RSO is responsible for implementing a bioassay program. The frequency adopted and the type of analysis should meet the recommendations in Regulatory Guide 8.22, "Bioassay at Uranium Mills."

3. FACILITY AND EQUIPMENT DESIGN

General considerations for the design of uranium mills and uranium ore processing equipment should not be based solely on chemical process efficiency, but should also be based on the relative potential for radiologic and toxic hazards resulting from exposure of personnel to uranium and its daughters. Major aspects of planning and design that should be considered are discussed below.

3.1 Space Layout

Facility layout should be designed to maintain employee exposures ALARA while at the same time ensuring that exposure to other persons is not thereby increased. The mill layout should provide for:

1. Safe access to process equipment and for routine maintenance;

2. Adequate ventilation in all mill areas in which radioactive materials might be spilled, suspended, or volatilized;

3. Isolation of yellowcake drying, packaging, and shipping areas from other accessible mill areas;

4. Controlling access to the uranium mill proper and the ability to secure or restrict entry to any airborne radioactivity area;

5. Change rooms and shower facilities so that all workers can remove any possible radioactive contamination before leaving the site;

6. Dispersion control on radioactive materials moving from contamination areas (e.g., crushers) to relatively contamination-free areas (e.g., crusher control room);

7. Isolation of mill areas where there is a high potential for the dispersal of uranium as the result of a fire.

3.2 Access Control

Access to airborne radioactivity areas should be controlled or restricted by the use of caution signs and operational procedures, or security locks when permitted by fire protection regulations.

3.3 Ventilation Systems

To the extent practicable, the facility ventilation systems should accomplish the following:

1. As a minimum design objective, provide local exhaust ventilation (such as chemical hoods) or general area ventilation where concentrations of natural uranium and its daughters may be present in excess of 25% of the values given in Table 1 of Appendix B to 10 CFR Part 20.* The design ventilation rate (air exchange rate) should be sufficient to maintain airborne concentrations of natural uranium and its daughters to less than 25% of the maximum permissible concentration (MPC) given in Table 1 of Appendix B to 10 CFR Part 20.

*The figure 25% is used here to encourage the use of ventilation systems and other process controls in an effort to prevent the existence of airborne radioactivity areas as defined in § 20.203(d), and according to § 20.103(b)(1), "The licensee shall, as a precautionary procedure, use process or other engineering controls, to the extent practicable, to limit concentrations of radioactive materials in air to below those which delimit an airborne radioactivity area...."

2. In addition, establish a facility-specific, operational ALARA goal for concentrations of natural uranium and its daughters at less than 25% of the values given in Table 1 of Appendix B to 10 CFR Part 20.

3. Design exhaust stacks so that exhausted air will not enter air intakes that service any other mill areas.

4. Locate exhaust vents in a way that ensures compliance with the requirements of § 20.106, "Radioactivity in effluents to unrestricted areas," of 10 CFR Part 20, and 40 CFR, "Protection of Environment," Part 190, "Environmental Radiation Standards for Nuclear Power Operations," for effluents to unrestricted areas, as well as ALARA exposure considerations for the worker.

3.4 Fire Control

Because of the potential for loss of control of radioactive material in the event of a fire, a facility should have adequate firefighting equipment and workers should be trained in its proper use.

Provisions should be made for fire alarms, fire extinguishers, sprinkler systems, fire hydrants, water tanks, and other general firefighting equipment. Emergency procedures and training should include immediate fire control as a priority item. Design features should include automatic fire detection and suppression equipment in high fire-potential areas (e.g., solvent extraction area). In the event of fire, there should be provision for drainage of solvent to sumps or to outside lined ponds. Appropriate caution signs should be posted in areas of fire hazard. Fire detection systems should be checked weekly. Fire drills should be performed at least semiannually.

3.5 Laboratory Design Features

Consideration should be given to providing different laboratory facilities for metallurgical and bioassay analyses, if they are both performed at the mill site. Owing to the sensitivity required in performing bioassay analyses, provisions should be made to ensure against cross-contamination of uranium from mill ore samples. Laboratory equipment and surfaces should be constructed of materials that are easily decontaminated. Laboratory surfaces used for the preparation of bioassay samples should be decontaminated daily to less than 200 dpm $\alpha/100$ cm^2 of total surface contamination. All mill laboratories should provide adequate general ventilation and exhaust fume hoods. Special attention should be directed to the design of air exhaust systems that service ore sample pulverizing and grinding equipment. The design of the laboratory should provide for the safe handling, storage, and disposal of radioactive wastes resulting from sample analyses.

3.6 Ore and Product Storage

Uranium mill plans should include the following:

1. Provisions for raw ore storage, fine ore bins, and yellowcake storage in areas so that the material does not cause unnecessary exposure to mill personnel and so that material is not dispersed by wind and rain;

2. Adequate space in the yellowcake storage and packaging areas to conduct initial surveys and spot smear tests of yellowcake packages and to enable decontamination of drums to avoid transporting a contaminated package through other mill areas;

3. Locations for yellowcake storage and shipping areas that minimize the handling time required prior to shipment.

3.7 General Equipment Considerations

General features applicable to equipment that will be used for handling, containing, or contacting uranium and its daughters are as follows:

1. Equipment that contains large volumes of uranium bearing liquids should be designed with sumps or dikes to contain the liquids in the event of leaks or spills;

2. Equipment should be designed for optimum ease of carrying out procedures, especially routine maintenance, to minimize working time where personnel are exposed to radiation or radioactive material, and to maximize distances of personnel from the source of radiation with which they are working;

3. Appropriate caution signs and symbols should be provided to meet the requirements of § 20.203 of 10 CFR Part 20, as discussed in more detail in Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills";

4. The use of semiautogenous methods for grinding ore is recommended because of the significantly reduced generation of airborne dusts.

4. CONTROL OF AIRBORNE URANIUM AND ITS DAUGHTERS

One of the major inhalation hazards associated with uranium milling facilities results from the resuspension in air of uranium and its daughters. Therefore, properly designed ventilation and dust control systems are needed to ensure that exposure of workers is maintained ALARA. There are, in general, four areas that present radiologic and toxic hazards caused by airborne materials at a typical uranium mill. These areas encompass (1) ore storage, handling, and crushing; (2) ore grinding, leaching, and concentrating processes; (3) yellowcake precipitation, drying, and packaging; and (4) miscellaneous mill locations as specified in Section 4.4. Appropriate design objectives for ventilation and dust control systems recommended for each of these generalized mill areas are given below.

4.1 Ore Storage, Handling, and Crushing Areas

Where ore is handled in the open, the objective should be to minimize blowing of dust. Water sprinkling systems

are recommended for use on ore piles when the ore moisture content is less than 10%. If ore is crushed and transported in the dry state (i.e., moisture content less than 25%), the use of ventilation systems and dust collectors is recommended. As ore travels along convevor belts to the grinder, all drop points should have either hooded dust collectors or dust suppressant systems, such as sprinklers or foam ejectors. When crushers are used prior to grinding, it is recommended that a hooded ventilation system be installed over all external openings to the crusher. The use of wet scrubbers or dust collectors is recommended for ventilation systems that service ore storage, handling, and crushing areas of the mill to prevent recirculation of contaminated air.

4.2 Grinding, Leaching, and Concentrating Process Areas

General ventilation systems are recommended to service mill areas where any grinding method is performed to ensure against the buildup of radon-222 and its daughters and ore dust normally released in the grinding process. The ventilation rate should be adequate to maintain the concentrations of radon-222 or its daughters and natural uranium from ore dust to less than 25% of the value specified in Table 1 of Appendix B to 10 CFR Part 20 as modified by the note to Appendix B. It is recommended that all leaching and thickening tanks located in enclosed structures be covered and vented directly to the outside atmosphere. General ventilation systems for mill areas where leaching and thickening tanks are located should be designed to maintain natural uranium ore dust concentrations in air at less than 19.0 $\mu g/m^3$ of uranium. If the mill is so designed that the solvent extraction (SX) concentration process equipment is in enclosed structures, a general ventilation system is recommended and should be designed to maintain the airborne natural uranium concentration in air to less than 50 $\mu g/m^3$ of uranium or 2.5×10^{-11} $\mu Ci/cm^3$ (i.e., 25% of the MPC for natural uranium). The use of wet scrubbers on general ventilation systems that service areas of the mill where grinding and leaching equipment are located is recommended. Scrubbers are not necessary on ventilation systems that service areas of the mill where the clarification or solvent extraction equipment is located.

4.3 Precipitation, Drying, and Packaging Areas

General ventilation systems are required and should be designed to maintain the concentration in air of yellowcake near precipitation tanks, yellowcake thickeners, yellowcake filters, and yellowcake repulp equipment to less than 50 $\mu g/m^3$ of uranium in air or 2.5×10^{-11} $\mu Ci/cm^3$ (i.e., 25% of the maximum permissible concentration). The next step of the recovery process involves the drying and packaging of yellowcake. Since the potential for the release of airborne yellowcake is much greater in dry form, it is recommended that drying and packaging of yellowcake should be performed in an enclosure that is separated from other areas of the mill. Also, the drying and packaging enclosure should be maintained under negative pressure. A separate air suction ring system should also be used at each yellowcake drumming station. Individual suction ring systems need only be operated during periods when the drum at that location is being filled. The exhausts for the drying and packaging enclosure and the suction ring should be vented through a wet scrubber. To ensure proper operation, the scrubber system on the concentrate drying and packaging area should be checked every shift and documented, or automatic malfunction alarm or interlock systems installed. Manometer readings or operational and instrument checks should be recorded once per shift and subsequently documented.

4.4 Miscellaneous Locations

Other important areas of the mill that have the potential for containing hazardous levels of uranium and its daughters in air include maintenance shops, rubber shops, metallurgical and bioassay laboratories, and general laundries, if they exist. Each of the above mill areas should be serviced by ventilation systems designed to maintain air concentration of natural uranium and its daughters to less than 50 $\mu g/m^3$ or 2.5×10^{-11} $\mu Ci/cm^3$ of uranium. Wet scrubbers are not necessary on these systems, however, bag filters are recommended.

D. IMPLEMENTATION

Except in those cases in which an applicant or licensee proposes an acceptable alternative method, this guide and Regulatory Guide 3.5, "Standard Format and Content of License Applications for Uranium Mills"; Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection"; Regulatory Guide 8.22, "Bioassay at Uranium Mills"; and Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills," will be used as the basis for evaluating license applications and radiation safety and ALARA programs of NRC-licensed uranium mills.

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Final Generic Environmental Impact Statement on Uranium Milling," USNRC Report NUREG-0706, September 1980.*

2. National Bureau of Standards, "Permissible Dose from External Sources of Ionizing Radiation," *Handbook 59, Recommendations of the National Council on Radiation Protection* (NCRP Report No. 17), Washington, D.C., September 24, 1954.

3. National Council on Radiation Protection and Measurements, "Review of the Current State of Radiation Protection Philosophy," Report No. 43, Washington, D.C., January 15, 1975.

4. National Academy of Sciences – National Research Council, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Washington, D.C., 1972.

5. Federal Radiation Council, "Background Material for the Development of Radiation Protection Standards," Report No. 1, Washington, D.C., 1960.

6. International Commission on Radiological Protection, "Implications of Commission Recommendations That Doses Be Kept As Low As Readily Achievable," Report No. 22, Pergamon Press, Elmsford, New York, 1974.

7. U.S. Nuclear Regulatory Commission, "Manual of Respiratory Protection Against Airborne Radioactive Materials," USNRC Report NUREG-0041, October 1976.*

*Copies are available from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

VALUE/IMPACT STATEMENT

1. PROPOSED ACTION

1.1 Description

Applicants for a uranium milling license must submit a license application containing the information specified in Regulatory Guide 3.5, "Standard Format and Content of License Applications for Uranium Mills." The purpose of this action is to describe both administrative health physics programs and methods to achieve ALARA occupational exposure to workers that are acceptable to the NRC staff. Health physics programs are covered in Section C.5, "Operations," in Regulatory Guide 3.5.

1.2 Need for the Proposed Action

Currently, licensees are uncertain what the NRC staff will accept in the way of a health physics and ALARA program or procedures and design features needed to achieve ALARA exposures in a uranium mill. As a consequence, a wide variety of programs are submitted. To meet minimum standards, much correspondence between the applicant and NRC is required. A guide will reduce the amount of correspondence needed, save personnel resources for both NRC and the applicant, show clearly how NRC regulations apply to uranium mills, and establish a uniform standard for an acceptable health physics and ALARA program for worker protection.

1.3 Value/Impact of the Action

1.3.1 NRC

The impact of the guidance will be primarily to reduce licensing staff effort in reviewing applications and in corresponding with applicants about areas where the application does not meet current NRC licensing requirements. An estimated 0.75 staff-year is required to develop the guide.

1.3.2 Other Government Agencies

The guidance will impact on the Mine Safety and Health Administration (MSHA) because they also regulate occupational health protection at uranium mills and on Agreement State regulatory agencies that regulate mills, primarily New Mexico, Colorado, Texas, Washington, and Florida. A Memorandum of Understanding (MOU) signed by NRC and MSHA states that each agency will coordinate the development of standards with the other agency. The MOU was published in the *Federal Register* (45 FR 1315) on January 4, 1980.

1.3.3 Industry

Industry will benefit from having clear guidance on what constitutes NRC licensing policy. Some minor expense may be involved, however, in upgrading current health physics programs and in establishing an effective ALARA program where one does not currently exist to meet the recommendations in the guidance.

1.3.4 Workers

Workers' protection should improve from having clearly stated and consistent standards for health physics and ALARA programs. Workers and their representatives will now have access to a clearly defined standard ALARA program for uranium mills. This will help them understand whether their employer has an adequate program and why some things are done as they are.

1.3.5 Public

The guidance pertains to worker protection programs. It will not directly affect the public.

1.4 Decision

The NRC should publish guidance on a standard administrative health physics and ALARA program for worker protection that is acceptable to the NRC licensing staff.

2. TECHNICAL APPROACH

The technical approach in the guidance is based on (1) NRC licensing policy as expressed in Safety Evaluation Reports (SER) written by the NRC licensing staff, especially the recent SER for Minerals Exploration Company Sweetwater Uranium Project, and (2) other references to be cited in the guidance.

3. PROCEDURAL APPROACH

3.1 Procedural Alternatives

The three reasonable procedural alternatives are as follows:

a. Regulation,

b. Regulatory guide,

c. Continue to handle each licensing application on a case-by-case basis.

3.2 Value/Impact of Procedural Alternatives

A regulation is not suitable for the type of guidance envisioned because some of the program must be tailored to the design and needs of the individual mill.

A regulatory guide is recommended since it provides the best mix of flexibility and clear statement of a uniform and consistent licensing policy.

3.3 Decision on Procedural Approach

The staff concludes that a regulatory guide should be published.

4. STATUTORY CONSIDERATIONS

Authority for this guide is derived from the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended, through the Commission's regulations.

5. CONCLUSION

In summary, it is proposed that a regulatory guide should be published concerning radiation protection and ALARA programs in uranium mills for worker protection.

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