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DRAFT REGULATORY GUIDE AND VALUE/IMPACT STATEMENT

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GENERAL GUIDANCE FOR DESIGNING, TESTING, OPERATING, AND MAINTAINING EMISSION CONTROL DEVICES AT URANIUM MILLS

A. INTRODUCTION

Regulations applicable to uranium milling are contained in 10 CFR Part 20, "Standards for Protection Against Radiation," and in 10 CFR Part 40, "Domestic Licensing of Source Material."

Paragraph 20.1(c) of 10 CFR Part 20 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. Paragraph 20.105(c) of 10 CFR Part 20 requires that licensees engaged in uranium fuel cycle operations subject to the provisions of 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," comply with that part. Part 190 of Title 40 requires that the maximum annual radiation dose to individual members of the public resulting from fuel cycle operations be limited to 25 millirems to the whole body and to all organs except the thyroid, which must be limited to 75 millirems. Criterion 8 of Appendix A to 10 CFR Part 40 requires that milling operations be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable.

Air in the immediate vicinity of such uranium milling operations as ore crushing, ore grinding, and yellowcake drying and packaging frequently contains radioactive materials in excess of that permissible for release to unrestricted areas. Emission control devices are installed in ventilation systems of uranium mills to limit releases of these radioactive materials to the environment.

This regulatory guide and the associated value/impact statement are being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. They have not received complete staff review and do not represent an official NRC staff position.

Public comments are being solicited on both drafts, the guide (including any implementation schedule) and the value/impact statement. Comments on the value/impact statement should be accompanied by supporting data. Comments on both drafts should be sent to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch, by July 8, 1985.

Requests for single copies of draft guides (which may be reproduced) or for placement on an automatic distribution list for single copies of future draft guides in specific divisions should be made in writing to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Division of Technical Information and Document Control.

General guidance for filing an application for an NRC source material license authorizing uranium milling operations is provided in § 40.31 of 10 CFR Part 40. An applicant for a new license or renewal of an existing license for a uranium mill is required by § 40.31 to provide detailed information on the proposed equipment, facilities, and procedures at the installation. This information is used by the NRC to determine whether the applicant's proposed equipment, facilities, and procedures are adequate to protect the health and safety of the public and to determine if they will significantly affect the quality of the environment. Calculations by the NRC of the environmental impact from the proposed uranium milling operations are based on the estimated rate of production of radioactive airborne particulates adjusted to reflect the removal efficiency of the emission control devices installed in the plant ventilation systems. This requires reliable information on the efficiency of these devices. It also requires reliable information on the production of airborne radioactive particulates during the proposed operations.

Section 40.65 of 10 CFR Part 40 requires mill operators to submit semi-annual reports to the NRC specifying the quantity of each of the principal radionuclides released to unrestricted areas in gaseous effluents. This information may be used by the NRC to estimate maximum potential annual radiation doses to the public resulting from effluent releases and thereby determine compliance with paragraphs 20.1(c) and 20.105(c) of 10 CFR Part 20. The quantity of radionuclides released is based on scheduled sampling of effluents discharged into exhaust stacks. The reliability of this data for estimating radiation exposures depends on maintaining uniform operation of the emission control devices during the reporting time interval because these effluents are not continuously sampled.

All emission control devices used in uranium mill ventilation systems need to perform reliably under expected operating conditions to meet the objectives discussed above. This guide describes procedures acceptable to the NRC staff for designing, testing, operating, and maintaining these emission control devices to ensure the reliability of their performance.

Any information collection activities mentioned in this draft regulatory guide are contained as requirements in 10 CFR Parts 20 or 40, which provide the regulatory basis for this guide. The information collection requirements in 10 CFR Parts 20 and 40 have been cleared under OMB Clearance Nos. 3150-0014 and 3150-0020, respectively.

B. DISCUSSION

The milling of uranium ores results in the production of airborne particulates containing uranium and its daughters in several areas of 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 such as maintenance shops, laboratories, and general laundries. Milling operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable (ALARA). The primary means of accomplishing this is the control of emissions at the source.

The most significant sources of radioactive airborne particulates occur in ore handling and crushing areas and in yellowcake drying and packaging areas. These sources are generally controlled by separate ventilation systems in each area that remove these airborne particulates through local hoods, hooded conveyor belts, etc., into emission control devices where they are removed from the air streams. The cleaned air is then discharged by fans into the atmosphere through local exhaust stacks.

Emission control devices are available in a wide range of designs to meet variations in air cleaning requirements. Degree of removal required, quantity and characteristics of the contaminant to be removed, and conditions of the air stream all have a bearing on the device selected for any given application. Emission control devices used at ore crushing and grinding operations include bag or fiber filters (baghouses), orifice or baffle scrubbers, and wet impingement scrubbers. Water spray systems are also used at these operations to minimize the generation of dust. Wet impingement scrubbers or venturi scrubbers are generally employed at yellowcake drying and packaging areas.

All emission control devices used in a uranium mill ventilation system need to be designed for reliable performance under the expected operating conditions. Initial testing and proper maintenance are primary factors in ensuring the reliability of these components. Periodic testing during operation to verify the efficiency of these components is another important means of ensuring reliability. Built-in features that will facilitate convenient in-place testing of these devices are important in ventilation system design.

Emission control devices used in a uranium mill ventilation system need to be sufficiently instrumented to measure and monitor their operating characteristics. Frequent checks of all significant operating parameters are necessary to determine whether or not conditions are within a range prescribed to ensure that this equipment is operating consistently near peak efficiency. When checks indicate that the equipment is not operating within this range, it is necessary to take action to restore parameters to the prescribed range. To ensure that timely actions are taken, instrumentation is often supplemented by audible alarms that are preset to signal when prescribed operating range limits are exceeded. When the required actions cannot be taken without shutdown and repair of this equipment, it will be necessary to suspend milling operations that are the source of the emissions that are being controlled until corrective actions have been implemented. Suspension of yellowcake drying and packaging operations as soon as practicable under these circumstances is required by Criterion 8 of Appendix A to 10 CFR Part 40. The installation of automatic shutdown instrumentation on processes and systems where operating parameters on emission control devices may exceed acceptable limits could prevent excessive releases that may result from continuous operations under these circumstances, e.g., those associated with the production of yellowcake.

A preventive maintenance program is important for emission control devices used in uranium mill ventilation systems. A program designed to identify deficiencies in operation of these devices so that corrective action can be taken to reduce the frequency of off-normal operation can provide a measure of confidence in the operating characteristics of these devices. This program may require periodic updating to reflect actual in-plant experience, equipment manufacturer's guidelines, and NRC guidance. For example, a preventive maintenance program can consist of the equipment supplier's recommendations supplemented by provisions derived from the licensee's own routine inspection and maintenance records.

The key to proper maintenance of emission control devices is frequent inspection. It is important that a regular program of inspection be established and followed and records kept of all inspections and the resulting maintenance. Inspection intervals will depend on the type of emission control device, the manufacturer's recommendation, and the process area where the unit is installed. These inspections need to be performed as frequently as experience shows to be necessary but not less than annually.

Considerable maintenance time can be expended on trouble shooting and correction of malfunctions of emission control devices. The ability to locate and correct malfunctioning components of these devices requires a thorough understanding of the system.

Throughout the manufacturing industry, there are many models for each type of emission control device used at uranium mills. These models range in size in order to meet the different air capacity needs at the mills. In addition, some design features of each manufacturer are unique. Accordingly, the specific design and the testing, operating, and maintenance procedures for each model are beyond the scope of this guide. General guidance is presented, however, for each type of emission control device based on typical models in present-day use. Background information for this guidance can be found in References 1-8. The licensee may substitute procedures based on specific operating parameters of the model in use at the facility for those described in this guide.

1. DESIGN AND OPERATION

1.1 Bag or Fabric Filters (Baghouses)

Bag or fabric filters, usually in the form of baghouses, remove particulates from a gas stream by filtering the airborne particulates (by impaction or diffusion) through a porous flexible fabric made of a woven or felted material. These collected particles form a structure of their own, supported by the filter, and have the ability to intercept and retain other particles. The increase in retention efficiency is accompanied by an increase in pressure drop through the filter. The baghouses are equipped with one of several automatic cleaning mechanisms for periodically dislodging collected material from filter components to prevent excessive resistance to the gas flow (i.e., excessive pressure drop) that would otherwise develop. The dislodged material settles in storage hoppers before the filter components are placed back on stream. The automatic cleaning cycle can be initiated by either a differential pressure switch or a timer, which may be interlocked with the main fan motor for the baghouse.

The cleaning mechanisms employed in baghouses are based on either mechanical shaking of the filter components or pneumatic vibration of these components

by high-pressure air applied in reverse flow, reverse jet, or reverse pulse modes. The effectiveness of these compressed air systems depends on maintaining a sufficient reservoir of compressed air at the pressure specified by the baghouse manufacturer. Higher pressures than specified could cause failure of the filter fabric, while lower pressures can result in poor filter cleaning. These problems are minimized by pressure regulating devices used in these compressed air systems.

The most critical parameter to be observed during baghouse operation is the pressure drop. Proper operation of the baghouse requires, at a minimum, maintaining the differential pressure of this device in the correct range specified by the manufacturer. A manometer or a differential pressure gauge and transmitter are usually provided for this purpose. This instrumentation is often supplemented by an audible alarm system designed to signal and alert mill operators when prescribed pressure differential ranges are exceeded. Lower differential pressures indicate potential deficiencies such as damaged filters or other air bypass channels that should be corrected. Higher differential pressures indicate that cleaning operations are inadequate. This can be corrected by increasing the frequency of the automatic cleaning cycle through adjustment of the differential pressure switch or timer of the baghouse installation.

1.2 Wet Scrubbers

Wet scrubbers remove particulates from a gas stream by effecting intimate contact between the gas stream and a scrubbing liquor, usually water. The basic operations that take place within a wet scrubber are (1) saturation of the incoming gas, (2) contacting and capture of the particulates in the scrubbing liquor, and (3) separating the entrained particulate-laden liquid from the gas stream. The basic types of wet scrubbers are distinguished by the mechanisms used for transfer of particulates from the gas stream to the liquid stream. Most scrubber systems require some type of treatment and disposal of the particulate-laden scrubbing liquor.

Several water spray systems may be used in wet scrubber operations. Water from the main water spray system is directed either into a screen or throat to contact the particulate-laden gas stream. In applications where inlet gas temperatures are inordinately high, preconditioning of the incoming gas to the

scrubber may be necessary to provide adequate humidity and thereby maintain particulate collection efficiency. This may be accomplished by use of an auxiliary water spray system upstream of the scrubber particulate scavenging area. Where particulate buildup is likely to occur in the entrainment separator, a wash system may be necessary to avoid this condition. The wash system is usually composed of low-pressure spray nozzles using recycled scrubbing liquor or fresh water for cleansing.

Orifice, wet impingement, or venturi wet scrubbers are generally used in uranium mill ventilation systems. In orifice-type wet scrubbers, the gas stream is made to impinge upon a surface of scrubbing water and is then passed through various constrictions where its velocity may be increased and where greater liquid-particulate interaction may occur. The gas stream finally discharges through a chamber section where entrained droplets are disengaged. In wet impingement scrubbers, the gas stream is wetted with water from low-pressure spray nozzles in the scrubber inlet and then passed through perforated plates at high velocity to impinge on baffle plates or vanes where liquid droplets containing particulate matter coalesce and drain to a sump. Solid particles are washed to the sump by either intermittent or continuous sprays. Prior to exiting from the scrubber, the gas stream passes through an entrainment separator to remove entrained liquid droplets. In a venturi scrubber, the gas stream flows through a throatlike passage where the gas is accelerated in velocity. The scrubbing liquor is added at or ahead of the venturi throat and is sheared into fine droplets by the high-velocity gas stream, resulting in liquid-particulate interaction. The gas and liquor droplets then pass through a cyclone separator where entrained droplets containing particulate matter are removed from the gas stream.

Although each type of scrubber discussed above has unique design features, their collection efficiences are influenced in similar ways by incremental changes in certain common operating parameters, principally gas and liquid flow as well as pressure drop. A decrease in either the gas or liquid flow rate could result in insufficient gas cleaning. Collection efficiency can also diminish if the liquid-to-gas flow rate ratio falls below design values. An increase in pressure drop across the scrubber will enhance the collection efficiency for the same size distribution and concentration of particulates in the gas stream. Proper operation of these wet scrubbers requires monitoring of these parameters to determine that they are within ranges prescribed to

ensure equipment performance consistently near optimum collection efficiency. Instrumentation used to monitor these parameters is often supplemented by audible alarm systems designed to signal and alert mill operators of the need for corrective action when prescribed operating ranges are exceeded. In some cases automatic control systems with interlocks may be necessary. For example, the scrubber fan could be interlocked to shut down in the event of an indication of water flow failure. These circumstances would require suspending particulate-producing processes in the ventilation zone serviced by the scrubber until corrective action could be taken or switching to a redundant scrubber unit.

Daily operational data summaries on baghouse and wet scrubber performance are useful in providing a continuous record of performance of these devices. Other formats that contain equivalent information such as recorder charts can also be used for this purpose. Criterion 8 of Appendix A to 10 CFR Part 40 requires that checks of all parameters that determine the efficiency of yellowcake stack emission control equipment operation be made and logged hourly. In addition, data from checks made of all operating parameters necessary to enable timely identification of malfunctions can be of value in ensuring proper operation of baghouses and wet scrubbers and in updating preventive maintenance programs for these devices to reflect actual operating experience.

2. MAINTENANCE

2.1 Bag or Fabric Filters (Baghouses)

The frequency of needed maintenance for baghouses can be determined from manufacturer's recommendations and operating experience. In order of decreasing frequency, the principal baghouse components requiring maintenance are (1) filter bags, (2) flow controls, (3) hoppers, and (4) cleaning mechanisms. Symptoms of potential operating problems requiring corrective maintenance are almost always one of the following: (1) excessive emissions, (2) short filter bag life, and (3) high pressure drop. These symptoms may indicate malfunctioning in more than one component. For example, high pressure drop may be attributable to difficulties with the filter bag cleaning mechanism, low compressed air pressure, high humidity, weak shaking action, loose filter bag tension or excessive reentrainment of dust. Many other factors can cause

excessive pressure drop, and several options are usually available for appropriate corrective action.

2.2 Wet Scrubbers

The major problems with wet scrubbers from a maintenance standpoint are (1) excessive buildup of solids in the wet/dry zones and entrainment separator, (2) plugged water spray nozzles, (3) abrasion in areas of high velocity such as throats and orifices, and (4) corrosion on scrubber vessel internal surfaces. A buildup of solids often occurs around the wet/dry interfaces of ducts where the gas stream contacts the wetted scrubber housing. Instrumentation such as liquid and gas pressure indicators can exhibit rapid solids buildup and therefore require regular cleaning to ensure proper system operation and performance. Increased pressure drop, reduced gas flow, and subsequent system malfunction are all possible consequences of a buildup of solids in the entrainment separator. Water spray nozzles frequently wear or clog, which produces an uneven liquid pattern and requires their replacement. Venturi and impingement scrubbers tend to show signs of abrasion in areas downstream of gas and liquid acceleration. Corrosion can occur from the high moisture and airborne liquid incident on components, in particular where protective liners may have deteriorated.

A regular schedule of routine inspection of key components and operating parameters is an essential ingredient of a maintenance program for ensuring the reliability of performance of typical baghouses and wet scrubbers. Examples of some typical maintenance activities for baghouses and wet scrubbers used at uranium mills are presented in Appendices A and B, respectively. These activities are in addition to those procedures recommended by manufacturers for routine lubrication, inspection, and replacement of component parts.

3. TESTING

To ensure proper selection of emission control devices, it is necessary for potential users to supply manufacturers with a list of specifications for the given application, including gas flow rates, liquid flow rates (where scrubbers are under consideration), temperature, pressure, pressure drop, concentration of particulates, particle size distribution, emission levels, and collection efficiency. The manufacturers, in turn, should design and supply

these devices based on test data already available for prototype equipment used under similar circumstances. If relevant test data are not available, it is generally advisable for the manufacturer and potential user to run mutually agreed-upon pilot plant or prototype tests with a gas stream typical of the gas stream to be cleansed to ensure that proper equipment is supplied to meet the desired collection efficiency. After installation of the device, it may be tested in place to confirm its particulate removal efficiency. Periodic in-place testing will ensure continued effectiveness of the device. In this way, reliable data will be available to the licensee for estimating the environmental impact of uranium milling operations before and after the commencement of operations.

Collection efficiency for baghouses and wet scrubbers used in uranium mills is usually based on inlet and outlet particulate concentrations in a dry gas corrected to standard temperature and pressure. Inlet and outlet particulate concentrations are preferably sampled simultaneously if practicable. The procedure of choice for determination of particulate concentrations is described in Method 5, "Determination of Particulate Emissions From Stationary Sources," of Appendix A to 40 CFR Part 60, "Standards of Performance for New Stationary Sources." In this procedure, particulate matter is withdrawn isokinetically from the gas stream and collected on a glass fiber filter maintained in a prescribed elevated temperature range. The particulate mass, which includes any material that condenses at or above the filtration temperature, is determined gravimetrically after removal of uncombined water. If a preoperational in-place determination of collection efficiency is desired, a procedure mutually acceptable to the user and manufacturer may be used.

4. QUALITY ASSURANCE

Components of uranium mills do not require a formal quality assurance program; however, particular quality assurance requirements may be imposed by the NRC as license conditions if deemed necessary to protect health. A quality assurance program for emission control devices need only be an extension of the overall quality assurance program usually submitted by an applicant for a license to ensure that the emission control devices are designed and the testing, operating, and maintenance procedures are implemented to maintain uniform operation of these devices within prescribed ranges under expected operating conditions.

C. REGULATORY POSITION

Emissions from milling operations must be controlled so that all airborne effluent releases are reduced to levels as low as is reasonably achievable. An important means of accomplishing this is by means of emission control devices in mill ventilation systems. The design and the testing, operating, and maintenance procedures for these emission control devices should ensure that these devices are operating consistently near peak operational efficiency.

1. DESIGN AND OPERATION

In addition to the requirement in Criterion 8 of Appendix A to 10 CFR Part 40 that requires checks to be made and logged hourly of all parameters that determine the efficiency of yellowcake stack emission control equipment operation, other emission control devices should be sufficiently instrumented to monitor all operating parameters necessary to enable timely identification of malfunctions. Consideration should be given to centralizing equipment instrumentation and controls, where feasible, to facilitate ease of changing and evaluating operating parameters.

Instrumentation may be supplemented by audible alarms that are preset to signal when prescribed operating range limits are exceeded.

Consideration should be given to installation of automatic shutdown instrumentation on processes and systems so that, when operating parameters on emission control devices exceed preset limits, operations would cease.

Equipment used in the emission control system should be clearly marked to allow easy identification. System drawings should be available to identify the location of valves and instruments.

Consideration should be given to keeping records of operating data in order to evaluate system performance and to provide a basis for establishing or modifying a preventive maintenance program.

Written procedures should be available for equipment operation and for operator actions if malfunctions occur. Checkoff lists should be considered for complex or infrequent modes of operation. Some operational procedures that may be considered for typical baghouses and wet scrubbers used at uranium mills are presented in Appendix C.

Equipment operators should be instructed in the function of each device and its operating characteristics. They should also be made aware of consequences of malfunctions and misoperation as well as of corrective measures that may be taken by the operator.

Equipment operators should be made aware of modifications to the equipment, changes in procedures, and problems encountered during system operation.

2. MAINTENANCE

A preventive maintenance program should be developed and implemented to sustain proper equipment performance and to reduce unscheduled repairs. Inspections should be performed at least annually, more frequently if necessary, on all components.

In the development of the maintenance program, consideration should be given to the type of emission control device, the manufacturer's recommendations, and the process at which the unit is installed. This program may require periodic updating to reflect onsite maintenance experience.

Schedules and written procedures should be available for maintenance work. Maintenance personnel should be trained in the implementation of maintenance procedures. They should be trained to recognize the symptoms that indicate potential problems, to determine the cause of the difficulty, and to remedy it with the help, if necessary, of the manufacturer or other outside resource.

3. TESTING

Emission control devices should be tested in place at least annually to verify collection efficiency. Collection efficiency for baghouses and wet scrubbers used in uranium mills should be based on inlet and outlet radioactive particulate concentrations in a dry gas corrected to standard temperature and pressure. Inlet and outlet (radioactive or uranium) particulate concentrations should be sampled simultaneously, if practicable.

The test should be performed in accordance with Method 5 of Appendix A to 40 CFR Part 60 or an acceptable equivalent.

If a preoperational in-place determination of collection efficiency is desired, a procedure mutually acceptable to the user and manufacturer may be used.

4. QUALITY ASSURANCE

The overall quality assurance program submitted by an applicant for a license should include provisions for (1) documentation, review, and evaluation of design, testing, operating, and maintenance data for emission control devices and (2) timely initiation of corrective actions necessary to maintain uniform operation of these devices within prescribed ranges under expected operating conditions.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This draft guide has been released to encourage public participation in its development. Except in those cases in which an applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the methods to be described in the active guide reflecting public comments will be used by the NRC staff in evaluating procedures for designing, testing, operating, and maintaining emission control devices used at uranium mills.

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APPENDIX A

TYPICAL MAINTENANCE ACTIVITIES FOR BAGHOUSES

COMPONENT	ACTIVITIES
Baghouse Housing	• Inspect exhaust from filters for visible dust. • Inspect gasketing on filter housing to ensure against leakage.
Compressed Air System	• Inspect for air leakage (low pressure) and check valves.* • Check alignment of air pulse holes with center of bag filters.*
Dust Collection Hopper	• Inspect for dust and debris buildup in ducting to hopper. • Rod out dust buildup on all accessible hopper surfaces. • Check operation of the discharge mechanism.
Manometer	• Inspect for blockage.
Filter Bags	• Inspect individual filter bags and attachment hardware.

*Activities applicable to pulse or jet baghouses. The remainder are applicable to all baghouses.

APPENDIX B

TYPICAL MAINTENANCE ACTIVITIES FOR WET SCRUBBERS

COMPONENT	ACTIVITIES
Scrubber Body	• Inspect for wear, particularly in areas downstream of gas and liquid acceleration. • Inspect for corrosion on all scrubber internal surfaces. • Inspect for excessive buildup, in particular in the wet/dry zone.
Nozzles	• Inspect for buildup and damage.
Entrainment Separator	• Check operation. • Inspect structural supports for integrity.
Pumps	• Inspect pumps for wear, seal water, packing, and smooth operation.
Instruments	• Inspect the condition of all instruments with regard to solids buildup.

APPENDIX C

TYPICAL OPERATIONAL SURVEILLANCE PROGRAM FOR EMISSION CONTROL DEVICES

EMISSION CONTROL DEVICE	SURVEILLANCE ACTIVITY
Baghouses	• Monitoring differential pressure. Adjusting timer or differential pressure switch to adjust frequency of automatic cleaning cycle as needed.
	• Monitoring differential pressure alarm lights in control area.
	• Monitoring compressed air pressure gauge on high-pressure air system.
	• Monitoring air flow instrumentation in control area.
Wet Scrubbers	• Monitoring differential pressure.
	• Monitoring differential pressure alarm lights in control area.
	• Monitoring air flow instrumentation and alarm lights in control area.
	• Monitoring water flowmeters.
	• Monitoring water pressure alarm lights in control area.
	• Monitoring control area process control indicator lights for possible process shutdown in the event of water flow failures at preconditioning sprays or at the scrubber.