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HEALTH PHYSICS SURVEYS DURING ENRICHED URANIUM-235 PROCESSING AND FUEL FABRICATION

A. INTRODUCTION

This regulatory guide specifies the types and frequencies of surveys that the U.S. Nuclear Regulatory Commission (NRC) staff consider acceptable for the protection of workers in plants licensed by the NRC to process enriched uranium and fabricate uranium fuel. This revision includes changes to fuel cycle facility surveys based on updated industry guidance, including the American National Standards Institute (ANSI) standards and National Council on Radiation Protection and Measurements (NCRP) guidance.

Title 10 of the *Code of Federal Regulations* (10 CFR) 20.1501(a) requires each licensee to make or cause to be made surveys that may be necessary for compliance with the regulations in 10 CFR Part 20, "Standards for Protection Against Radiation," (Ref. 1). The NRC regulation 10 CFR 20.1003, "Definitions," defines the term "survey" as "an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation." Section 20.1003 further provides that this evaluation, when appropriate, "includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation or concentrations or quantities of radioactive material present."

This guide does not relate to the processing of uranium-233, nor does it deal specifically with the following aspects of an acceptable occupational health physics program that are closely related to surveys: (1) the number and qualification of the health physics staff, (2) instrumentation, including types, numbers of instruments, limitations of use, accuracy, and calibration, (3) personnel dosimetry, and (4) bioassays.

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This guide was issued after consideration of comments received from the public. The public comments and NRC staff response to them may be found in ADAMS under Accession No. ML110400315.

This regulatory guide contains information collection requirements covered by 10 CFR Part 20 that the Office of Management and Budget (OMB) approved under OMB control number 3150-0014. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. This regulatory guide is a rule as designated in the Congressional Review Act (5 U.S.C. 801-808). However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

B. DISCUSSION

The NRC considers surveys part of a comprehensive radiation protection program established by the licensee, according to the philosophy and principles of Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable," (Ref. 2). Principles, methods, and instrumentation for carrying out radiation and contamination surveys were developed early in the atomic energy program and have been discussed in reports published by the NCRP, the International Atomic Energy Agency (IAEA), and the International Commission on Radiological Protection (ICRP). More recent standards, such as ANSI/Health Physics Society (HPS) N13.49-2001, "Performance and Documentation of Radiological Surveys," (Ref. 3), contain additional information for use in establishing radiation survey programs and selecting methods and equipment for their implementation. Surveys are necessary supplements to personnel monitoring in which devices worn by the workers measure individual external radiation exposures and to various forms of bioassay to determine the intake of radioactive material by the workers.

Some enriched uranium processing and fuel fabrication plants conduct operations with Clearance Class D (transportable, rapid clearance from the lung) uranium compounds, for which considerations of chemical toxicity to the kidney are limiting. This guide does not address other chemical hazards, such as hydrogen fluoride. Other plants conduct operations with Clearance Class W or Y (nontransportable, with a longer (50- or 500-day) biological half-life in the lung) compounds. In the latter case, consistent with ICRP Publication 30, "Limits for the Intake of Radionuclides by Workers" (Ref. 4**),** dose equivalent to the lung is limiting. The staff considered such differences in plant operation when it developed this guide.

The NRC has a goal of harmonizing its guidance with international standards. The IAEA has established a series of safety guides and standards constituting a high level of safety for protecting people and the environment. IAEA safety guides present international good practices and increasingly reflects best practices to help users striving to achieve high levels of safety. Pertinent to this regulatory guide, IAEA Safety Guide RS-G-1.1, "Operational Radiation Exposure," issued October 1999, (Ref. 5), contains general guidance on radiation protection surveys. In addition, various ICRP publications provide users with guidance on methods and instrumentation for carrying out radiation and contamination surveys. This regulatory guide provides survey methods similar to those recommended by these international guidelines.

C. STAFF REGULATORY GUIDANCE

This guide is intended to assist those preparing license applications and to provide guidance to licensees in establishing acceptable survey programs in accordance with the "as low as is reasonably achievable" (ALARA) philosophy.

1. Types of Surveys

1.1. General Description

a. The regulation 10 CFR 20.1502, "Conditions Requiring Individual Monitoring of External and Internal Occupational Dose," specifies that surveys be performed to demonstrate compliance with the other radiation safety requirements of 10 CFR Part 20. Some of these surveys are necessary to evaluate external exposure to personnel and concentrations of airborne uranium in the facility and in effluents from the facility. Effluent monitoring is beyond the scope of this guide although radiological monitoring programs should include surveys and records that indicate control of the quantities of radioactive material released in air and water to unrestricted areas are in accordance with 10 CFR Part 20. Applicable regulatory guides in Division 4 should be consulted for such guidance.

b. Occupational radiation protection programs at enriched uranium processing and fuel fabrication plants should include the types of surveys discussed below. Regulatory Position C.2 discusses acceptable survey frequencies.

1.2. Surveys of External Radiation Dose Rates

a. Health physics or radiological control personnel should conduct initial surveys to identify all areas and operations in which personnel monitoring would be required, consistent with the provisions of 10 CFR 20.1502(a)(1) and in which periodic surveys might be needed to identify significant changes in the radiation fields. The survey instruments used should be operable and capable of measuring, at or below applicable action levels, the types of radiation that personnel could encounter. Generally, at fuel facilities, licensees should conduct surveys of beta-gamma exposure fields to ensure that any personnel dose is adequately monitored and controlled, although surveys of neutron exposure fields may also be necessary (e.g., α, n reactions with ^{19}F may produce a relevant radiation hazard in some cases). Radiation levels, in a large part of an enriched uranium processing or fuel fabrication plant, could be excessive unless licensees take care to minimize exposures. Pellet trays, fuel rods, fuel rod bundles, and storage areas are all sources of external exposure and must be evaluated, taking into consideration enrichment, daughter products, contaminants, and cladding. Care should be taken to survey and assess doses to hands and lenses of eyes received by workers handling process materials (with gloves or short tools). Levels of gamma radiation may be much higher around used uranium hexafluoride cylinders because of thorium and protactinium daughters of uranium in heels, scale, or residue. The radiation levels near such sources should be surveyed. Although most of the radiation levels in operating areas are low, licensees should make a reasonable effort to minimize individual and collective (person-rem) doses.

b. The health physics staff should perform preoperational, routine, and special radiation surveys of the plant areas, as described in Regulatory Position C.2. The staff should record the results of these surveys, as described below in Regulatory Position C.3.

c. In areas in which operating personnel can potentially receive more than 10 percent of the dose limits, the NRC does not normally accept surveys for compliance with the personnel monitoring requirements of 10 CFR 20.1502(a)(1). However, in the absence of personnel dosimetry data (e.g., because of loss of the dosimeter or chemical or physical damage to it), an alternative means of estimating the exposure can be to use survey data in conjunction with appropriate occupancy factors. In such a case, the estimate, including the survey data used, must be documented and retained until the NRC terminates the pertinent license requiring the record, along with personnel

monitoring records, pursuant to 10 CFR 20.2103(b)(1). The health physics staff should promptly review survey results in conjunction with personnel monitoring records (1) to identify potentially hazardous situations and unfavorable trends, and (2) to ensure that all personnel are adequately monitored and that exposures are maintained ALARA. Licensees should conduct surveys for alpha radiation in enriched uranium processing and fuel fabrication areas primarily to assess the extent of contamination of personnel, equipment, and premises and to detect the loss of confinement. The following sections discuss such surveys in more detail.

1.3. Measurements of Uranium Concentrations in Air

a. It is essential to establish a comprehensive program for assessing concentrations of uranium in air, at frequencies specified in Regulatory Position C.2, for each area in which operations could expose workers to the intake of quantities of uranium exceeding those specified in 10 CFR 20.1201(e). The NRC may also make special requirements for such assessments a license condition. Air samples should be collected in such a way that the concentrations of uranium are representative of the air to which workers are exposed. Additional guidance on air sampling may be obtained from Regulatory Guide 8.25, "Air Sampling in the Workplace," (Ref. 6).

b. Air sampling may be accomplished using fixed-location samplers for basic evaluation of the exposure of workers, personal (lapel) samplers for supportive measurements and special studies, and air monitors for early warning of unexpected releases. In general, the NRC considers use of lapel samplers to be an effective way to provide a basic evaluation of a worker's environment. The use of fixed or lapel samplers should be evaluated to ensure that the sampling program is commensurate with the risk involved.

c. When licensees take radiometric measurements of the quantity of uranium deposited on or in an air sample filter, appropriate corrections should be included for geometry and alpha (or beta) absorption by the filter media and by material collected on the filter. The filter media used should retain collected material on the filter surface, and corrections should be made for filter efficiency, considering the particle sizes and flow rates involved. Licensees should avoid overestimates of the volume of air that has passed through the filter by accurately calibrating the flow rate and by preventing, or correcting for, the loss of flow rate resulting from the accumulation of material on the filter. A means for measuring flow rate at air sampling heads should be available. Licensees should also address the management of uncertainties and accuracy.

d. Any air samples suspected of representing high concentration releases, such as those taken during glovebox glove changes, should be counted promptly to identify any quantities of uranium greater than that expected for the sampling location and volume. The procedures used should ensure prompt evaluation and correction of the circumstances or operation that led to the release and the high sample. Air samples should be counted again for record purposes after a routine period of time (e.g., licensees often use 24 hours) for decay of the "background" radon and thoron progeny.

e. As mentioned above, consideration of radon and thoron in the facility when performing air sampling is usually necessary. Licensees can choose from several methods available for excluding radon and thoron progeny contributions to the sampling or analysis, including those that use an impactor designed to discriminate against collection of radon and thoron progeny in the sample. Analytical methods using alpha spectroscopy typically have radon or thoron rejection algorithms available. Most destructive analytical methods isolate uranium in the analysis preparation, which would eliminate radon or thoron progeny. The most economical method for radon and thoron progeny compensation, when time permits, simply involves allowing for decay

of the radon or thoron progeny before analysis of the sample. The typical decay time for radon progeny is 24 hours after sample collection, while thoron progeny may need 3 days to 4 days to decay.

f. Licensees should count filters from personal (lapel) samplers, and the data related to the wearer's uranium intake, by applying factors for sampling time, breathing rate, wearing time, and total working time. Filter exchange frequency should be evaluated to address the buildup of material on the filter media, which reduces the airflow. Consideration may be given to running samplers over weekends when no work is in progress or to changing part of the samplers on each day of a weekend.

g. The regulation 10 CFR 20.1003 defines "airborne radioactivity area," and 10 CFR 20.1902(d) prescribes posting requirements. In presenting the standards for limiting the intake of uranium and other radioactive materials, 10 CFR 20.1701, "Use of Process or Other Engineering Controls," requires licensees to use process and other engineering controls, to the extent practicable, to limit concentrations of radioactive material in air to levels below those that delimit an airborne radioactivity area. The regulation 10 CFR 20.1702, "Use of Other Controls," allows the use of other precautionary procedures such as increased surveillance, limitation of exposure times, or provision of respiratory protective equipment to maintain the intake of radioactive material ALARA in the absence of adequate process or engineering controls. Licensees can use health physics surveys of airborne radioactivity concentration to evaluate process and engineering controls, conduct increased surveillance, determine exposure time limitations for workers, and support a program for the use of respiratory protective equipment. Licensees can also use an air monitor[1] for increased surveillance, which will provide a warning signal when the concentration of airborne uranium has become unexpectedly high. Use of an air monitor should be considered if conditions make it likely that an intake of uranium exceeding the limits in 10 CFR 20.1201(e) may occur.

h. The principal function of an air monitor is to alert workers to take immediate action to protect themselves from unexpected airborne uranium. Inhalation exposures occur during the time between the release of the uranium and the sounding of the alarm; therefore, every reasonable effort should be taken to reduce this time period. In particular, the air inlet of the monitor should be located near the potential source of airborne uranium, preferably between the source and the workers. Licensees should avoid using excessively long tubing or piping leading to the inlet because of the high probability of alarm delay because of uranium deposition on the interior walls of the tube or pipe. The intake by personnel should be reduced by the choice of setpoint. However, the setpoint should not cause false alarms that weaken the workers' confidence in the air monitor. Provision of a high flow rate of air through the filter may also reduce the intake by personnel. It is important to optimize this flow rate, thereby reducing the time of exposure before the alarm is activated.

1.4. Surface Contamination Surveys

a. For contamination control inside the restricted area of a plant, there are controlled areas where workers handle uncontained uranium and uncontrolled areas where workers handle uranium in the form of sealed sources, cladded fuel, or where uranium is not handled at all. Routine monitoring for uranium contamination that could be present on surfaces of floors, walls, plant equipment, or furniture in controlled areas is a necessary part of the survey program. The failure

[1] The term "air monitor," as used here, refers to a device that provides a particle collection system, a radiometric measurement system, a continuous recorder, a meter with preset alarm capability, and an audible alarm.

to control surface contamination may result in unnecessary external or internal exposure of personnel to radiation. Although surface contamination contributes to the external radiation dose of workers, the primary concern is to avoid internal deposition that results from the intake of loose uranium by inhalation, ingestion, or penetration through the skin.

b. Removable contamination refers to uranium contamination present on a surface that can be transferred to a dry smear test paper or fabric smear by rubbing the surface with moderate pressure. Methods and instruments used in surveys of removable surface contamination should be capable of detecting the alpha radiation from uranium at and below the levels specified in the table in Appendix A of this regulatory guide. For example, smear counting may be performed with proportional counters, alpha scintillation counters, or thin-window Geiger-Mueller tubes.

c. Uniform methods for collecting and analyzing smear samples should be used. These standardized methods should be employed over extended periods of time to aid in a cross-comparison of contamination at different times and places and to evaluate trends. A dry smear taken from an area of about 100 square centimeters (cm^2) is acceptable to indicate levels of removable contamination. A diagram of each routinely surveyed area should be used for recording survey results. This procedure will provide radiation safety personnel with a record to assist them in identifying trends and to assist in decontamination efforts. The surveyor should identify the smear-tested locations on the survey diagram.

d. Quantitative measuring instruments used to monitor the adequacy of confinement and contamination control, such as those used to measure air samples and to evaluate uranium contamination of personnel (friskers or monitors), work areas (smear tests), and equipment should be within calibration and checked before use each day.

e. Each applicant may propose and justify surface contamination limits allowable before decontamination is required in each work area. These limits should be based on the need to avoid transfer of contamination to uncontrolled areas and to maintain exposures ALARA. Appendix A of this regulatory guide presents the contamination limits for controlled areas that the NRC staff considers acceptable and that the applicant does not need to justify.

1.5. Protective Equipment and Clothing Contamination Surveys

a. When it is impracticable to apply process or other engineering controls to limit concentrations of uranium in the air below those defined in 10 CFR 20.1201(e), other precautionary procedures, such as increased surveillance, limitation of exposure times, or provision of respiratory protective equipment, must be used to keep the intake of uranium by any individual within regulatory limits. When respiratory protective equipment is used to limit the inhalation of airborne uranium, pursuant to 10 CFR 20.1702, the licensee may allow for such use in estimating exposures of individuals to uranium, provided that the use of such equipment follows the guidance in Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," (Ref. 7).

b. Individuals working in areas in which a potential for skin or clothing contamination exists should wear suitable protective clothing. Radioactive material on contaminated protective clothing may become airborne when the clothing is removed. Monitors should be available in areas where workers change clothing to survey their bodies (particularly their heads, hands, and other exposed portions) after they remove the protective clothing and before they leave the controlled area. Potentially contaminated clothing should not be sent to a laundry that is not specifically authorized to process contaminated clothing. Clothing surveyed and found to have less than

200 disintegrations per minute (dpm) per 100 cm^2 ($9x10^{-7}$ picocuries per square centimeter (pCi/cm^2)) of uranium contamination is acceptable outside restricted areas.

c. Individual workers' surveys of themselves need not be recorded unless the values exceed those in the table in Appendix A of this regulatory guide. However, the health physics staff and radiological control personnel should maintain regular surveillance to ensure that the workers continue their own personal contamination surveys. Observations during radiation safety surveillance should be recorded.

d. Any personal clothing worn beneath protective clothing should be surveyed before a person leaves the controlled area. If the contamination levels of personal clothing exceed preselected limits,[2] the health physics office should be contacted to provide direction for the survey and to supervise any necessary decontamination or clothing disposal. The licensee may propose and justify personal clothing contamination limits; the NRC considers the level of 200 dpm/100 cm^2 ($9x10^{-7}$ pCi/cm^2) acceptable, and the licensee does not need to justify this level. Licensees should maintain records in accordance with 10 CFR 20.2103, "Records of Surveys," 10 CFR 20.2106, "Records of Individual Monitoring Results," and 10 CFR 20.2110, "Form of records."

e. For individuals whose work is conducted in controlled areas with a potential for high surface contamination levels, complete clothing changes are normally provided. In this case, workers should store their personal clothing outside of the controlled area. Surveys of personal clothing are not necessary in this case if the area in which the clothing is stored is surveyed in accordance with Regulatory Position C.1.4 and if the survey results are below the limits adopted for in-plant uncontrolled areas. After workers remove protective clothing and before they don personal clothing and leave the change areas, particular attention should be paid to surveying workers' hair, bottoms of their shoes or feet, and their hands.

1.6. Personal Surveys

a. Individuals whose duties involve work in controlled areas in which a potential exists for uranium contamination of body surfaces should survey all exposed areas of the body after washing and before donning personal clothing and leaving the controlled area. Workers should be required to report to the health physics office if, following attempts to remove any contamination by washing with soap and water, contamination that exceeds preselected levels remains on the body. Decontamination attempts under the direction of the radiation safety staff or the licensee's medical consultant should be repeated until (1) such attempts cease to achieve significant reductions or (2) such attempts threaten to damage the skin.[3] If the residual contamination does not exceed preselected levels when the decontamination attempts are terminated, there should be no further concern because the contamination would not then present a significant ingestion or inhalation hazard. If residual contamination exceeds the preselected levels, the affected individual should be released, but periodic surveys should be made until the levels of activity have sufficiently decreased. There are no restrictions of personnel in this situation. However, the health physics staff should be consulted as needed. NCRP Report No. 65, "Management of Persons Accidentally Contaminated with Radionuclides" (Ref. 8), offers additional guidance on

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[2] "Preselected limits" or "selected limits" mean the limits set forth in paragraph 1.5.b. and Appendix A of this regulatory guide or more stringent administrative limits adopted by the licensee.

[3] Decontamination attempts without a medical consultant present should be restricted to approved decontamination procedures agreed upon by the licensee and its medical consultant. If such attempts do not reduce the contamination levels, sites should obtain the aid of a physician.

this topic. The licensee should maintain complete records of each incident of this nature in accordance with 10 CFR 20.2103, 10 CFR 20.2106, and 10 CFR 20.2110.

b. Because of the potential for the intake of uranium in various chemical and physical forms, screening by means of nasal swabs and bioassay by means of urinalysis, fecal analysis, and in vivo counting should be performed if there is reason to believe that an individual might have an intake of uranium, based on air sampling data or on such events as an accident or equipment failure. Broad direction exists for such programs such as ANSI/HPS N13.39-2001, "Design of Internal Dosimetry Programs" (Ref. 9). This provides guidance on the initiation, selection, frequency, and interpretation of results.

1.7. Surveys of Equipment, Premises, or Scrap before Release for Uncontrolled Use

Licensees should conduct surface contamination surveys for both removable and total contamination before the release of potentially contaminated premises, equipment, or scrap from controlled to uncontrolled areas and use. If contamination is detected or is known to have been covered, licensees should make reasonable efforts to eliminate the contamination (i.e., decontamination procedures should be repeated until additional efforts do not significantly reduce contamination levels). The limits in Appendix A of this regulatory guide apply. If the value of the items involved do not justify this level of effort, the items should be disposed of as radioactive waste, in accordance with 10 CFR 20.2001, "General Requirements," or limited to use inside the controlled area. The applicant may propose and justify, in the form of a license amendment request, total and removable contamination levels higher than those specified in the license for uncontrolled use. Such proposals should ensure that reasonable efforts will be made to eliminate the residual contamination.

1.8. Surveys of Packages Received and Packages Prepared for Shipment

Licensees should ensure that external radiation surveys and smear tests of external surfaces of packages are performed at the packaging point before the packages are sent to the shipping point and at the receiving point to avoid unwarranted radiation exposure and inadvertent contamination of personnel or the facility. Surveys and labeling must comply with the regulatory requirements in 10 CFR 20.1904, "Labeling Containers," 10 CFR 20.1906, "Procedures for Receiving and Opening Packages," the requirements of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," (see 10 CFR 71.5, "Transportation of Licensed Material"), (Ref. 10) and any specific license conditions. Packages transported within the plant should also be surveyed and labeled. When practicable, materials should be transferred by carts, conveyors, or other mechanical equipment rather than by hand. Appropriate controls should be exercised in opening packages. Workers should not open packages (particularly pails or other containers containing powder or other finely divided material) until the packages have been placed in an appropriately exhausted facility, such as a hood or glovebox.

1.9. Checks on the Posting of Caution Signs, Labels, Signals, Controls, and Notices to Employees

The health physics staff should ensure that signs, labels, signals, other access controls, required notices to employees, copies of licenses, and other items are properly posted, legible, and operative, as required by 10 CFR Part 19, "Notices, Instructions, and Reports to Workers: Inspection and Investigations," and 10 CFR Part 20 or specific license conditions. Air monitor alarms should be tested monthly unless the licensee provides justification for testing at less frequent intervals. The licensee should promptly correct any failure of such devices to perform as intended.

1.10. Leak Tests of Sources

Leak testing of sealed sources of uranium, such as those used in instrument calibration and quality control procedures, must be carried out in accordance with the terms and conditions of the applicable specific license. (See Appendix C of this regulatory guide).

1.11. Calibration of Radiation Safety Instruments

a. Portable survey instruments should be placed on a routine maintenance and calibration program that will ensure that properly calibrated and operable survey instruments are available at all times for use by the health physics staff. Guidance on calibrating and managing instrumentation is available in ANSI N323A-1997, "Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments" (Ref. 11) and NCRP Report No. 112, "Calibration of Survey Instruments Used in Radiation Protection for the Assessment of Ionizing Radiation Fields and Radioactive Surface Contamination (Ref. 12).

b. An adequate calibration of survey instruments cannot be performed solely with built-in check sources. Electronic calibrations should be evaluated to ensure the proper functioning and response of all components of an instrument. However, the NRC considers an initial calibration with a radiation source and periodic tests using electronic input signals to be adequate for high ranges that are not used routinely.

c. Daily or other frequent checks of survey instruments should be supplemented annually with a calibration of each instrument at two points, 20 percent and 80 percent, of each linear scale that is used routinely or with a calibration at one point near the midpoint of each decade on logarithmic scales that are used routinely. Digital readout instruments with either manual or automatic scale switching should be calibrated in the same manner as that used for linear readout instruments. Digital readout instruments without scale switching should be calibrated in the same manner as that used for logarithmic readout instruments. Survey instruments should also be calibrated following repair. A survey instrument may be considered properly calibrated when the instrument readings are within ±10 percent of the calculated or known values for each point checked. The NRC considers readings within ±20 percent acceptable if a calibration chart or graph is prepared and attached to the instrument.

d. The accuracy of the calibration standard should be maintained at ±3–20 percent of the stated value for field activities and should be traceable to a primary standard, such as that maintained by the National Institute of Standards and Technology.

1.12. Ventilation Surveys

a. Ventilation design guidance can be found from such sources as the American Conference of Governmental Industrial Hygienists (ACGIH), "Industrial Ventilation: A manual of Recommended Practice for Design" (Ref. 13) and the American Society of Mechanical Engineers (ASME), ASME AG-1, "Code on Nuclear Air and Gas Treatment" (Ref. 14). Health physics personnel should conduct surveys monthly to determine that the velocity of airflow at the entrance of all hoods or other exhausted enclosures and close-capture points is adequate to preclude the escape of airborne uranium (considering the density and particle size of the materials present) and to minimize the potential for intake by workers. Such measurements should be made using a properly calibrated thermoanemometer or velometer to determine whether the airflow has been reduced to unacceptable levels by filter loading, malfunction of exhaust fans, or some other

factor. The average face velocity for a hood used for special nuclear material with the sash in the operating position and an opening in a special enclosure should be 45 meters per minute (m/min) (150 feet per minute (ft/min)), as determined from at least five different measurement points. In addition to these surveys, each enclosure should be equipped with manometers or other indicators of the pressure drop across filters to provide an early indication of a reduction in airflow; the readings of such devices should be checked during each shift or more frequently for operations during which high loading rates may occur. Corrective action should be taken as soon as possible when the airflow is found to be deficient. Licensees should terminate work if the average face velocity falls below 30 m/min (100 ft/min).

b. Licensees should ensure that surveys are made of the negative pressure maintained inside gloveboxes or other closed systems. Additional surveys for airborne uranium, contamination of personnel and equipment, and other sources should be made during and after glove changes and any other operations during which the integrity of the system may be lost. In addition to these surveys, each enclosure should be equipped with a device that indicates operability. Workers should be instructed to check these devices before using the closed system and to notify the health physics staff promptly if the device is not operating at the predetermined specifications. Licensees should remove a malfunctioning device from service until repairs can be made.

1.13. Surveys of In-Plant Uncontrolled Areas

Uncontrolled areas inside a plant should be surveyed periodically to ensure that uranium is adequately confined in the controlled areas. Procedures should be established for moving uranium (in any form capable of contaminating surfaces or of dispersing in air) through corridors or other uncontrolled areas of a plant. Regulatory Position C.2 discusses acceptable survey frequencies; Regulatory Position C.3 describes how the results should be recorded. The NRC considers random smear testing of floors alone adequate for most uncontrolled areas, with the exception of lunchrooms, cafeterias, snack bars, and vending machine areas. In these areas, furniture, vending equipment and floors should be surveyed. If such surveys reveal that contamination has been transferred out of the controlled areas, immediate corrective action should be taken to eliminate such transfers and to decontaminate the uncontrolled areas. In addition, the uncontrolled areas should be surveyed more frequently (e.g., daily or weekly) after contamination has been found, until a trend of negative results is again established. The applicant may propose and justify permissible contamination levels for in-plant uncontrolled areas. Appendix A of this regulatory guide provides limits that the NRC considers acceptable and that the applicant does not need to justify.

1.14. Surveillance

This guide uses the term "surveillance" to refer to observations of working conditions in and around a plant made by the health physics staff performing routine radiation and contamination surveys. The NRC considers such surveillance to be one of the most important aspects of a protection program. Licensees should have a surveillance plan to allow health physics personnel to acquire and maintain detailed knowledge of each operation, as necessary, to permit (1) the identification of ways to prevent or minimize occupational exposures, (2) the selection of appropriate times for making health physics measurements, and (3) adequate preparation for action to be taken in the event of process equipment breakdown or other emergency conditions. Health physics personnel responsible for performing surveys should be sufficiently familiar with each activity in order to recognize potential hazards so that precautions can be taken to minimize exposures. Knowledge of procedures within each activity is essential to the selection of appropriate times for performing measurements.

2. Frequency of Surveys

a. The frequency of routine surveys should be commensurate with the nature of the work being conducted, the quantities of material being processed, and the specific protective facilities, equipment, and procedures used to protect workers from external radiation and the intake of uranium. For example, the nature and frequency of surveys appropriate for a plant in which all or a large portion of the work is conducted entirely within closed systems are quite different from those conducted in plants having only hoods, exhausted enclosures, or close-capture exhaust systems.

b. Generally, surveys should be performed before the plant begins operation to establish a baseline of background radiation levels and radioactivity from natural sources. These baseline surveys should be performed under various conditions expected during routine plant operation. Surveys should be conducted during the test operation of any new process or protective equipment, during significant changes in input materials or workload, and during routine plant operations with all potentially involved persons present and carrying out their functions. Routine and repetitive surveys are necessary to control the location of material within process equipment and handling systems and to ensure the continued integrity of protective equipment and the adequacy of procedures. The survey program should be capable of monitoring the continuing adequacy of containment and control of the materials involved in the entire plant operation. Although the frequency of routine surveys depends on many factors and should be designed for the specific operations and facilities involved, Appendix B of this regulatory guide presents minimum acceptable frequencies for meeting the requirements of 10 CFR 20.1501, "General."

3. Records of Surveys

a. General recordkeeping requirements for all records required by 10 CFR Part 20 are set forth in 10 CFR 20.2101, "General Provisions." Section 20.2101 lists permissible units of measurement. Thus, the licensee should record (1) external exposure rates in estimated maximum dose equivalent units, rem or millirem, to relevant organs or tissues as specified in 10 CFR 20.1201, (2) air concentrations in terms of disintegrations per unit time per milliliter or microcuries per milliliter, (3) surface contamination measurement results in disintegrations per unit time per 100 cm^2 or in microcuries per cm^2, and (4) uptakes of radioactive material in terms of microcuries (micrograms may be used for uranium-234, -235, and -238) and percentage of the applicable limit. The exposed individual's record should specifically reference or document the methods used to calculate intake quantities from bioassay data. If specific information on the uranium

compounds involved and their behavior in an individual is known, the licensee may use such information and should document it in the exposed individual's record.

b. Specific recordkeeping requirements for surveys are set forth in 10 CFR 20.2103, "Records of Surveys." The regulation 10 CFR 20.2103(a) requires that records of surveys conducted in accordance with 10 CFR 20.1501 and 20.1906(b) be retained for 3 years after a record is made. The NRC regulation 10 CFR 20.2103(b) requires that licensees retain the following records until the NRC terminates the pertinent license requiring the record: (1) records showing the results of air sampling sufficient to identify the potential hazard, permit the selection of proper respiratory protection equipment, and estimate doses, (2) records showing the results of surveys and bioassays (by urinalysis, fecal analysis, whole body, or in vivo counting) to evaluate actual intakes, (3) records of the results of surveys to determine the dose from external sources and used in the assessment of individual dose equivalents (in the absence of or in combination with individual monitoring data), (4) records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose, and (5) records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment (not treated in this regulatory guide). Note that additional information, such as occupancy time, may be essential to the estimation of dose from survey data or the estimation of intake from data on air concentrations.

c. Records may be maintained in logbooks or on special forms if they are clear, legible, understandable, and authenticated by authorized personnel and if they contain all of the information required. The signature of the person making the record and the data should appear on the same page immediately following each record entry. Either the original or a reproduced copy or microform (duly authenticated) may be maintained to meet the storage requirements in 10 CFR 20.2110, "Form of Records." Each licensee shall maintain adequate safeguards against tampering with and loss of records.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC's plans for using this regulatory guide. The NRC neither intends nor approves any imposition or backfit in connection with issuance of this regulatory guide.

In some cases, applicants or licensees may propose an alternative or use a previously established acceptable alternative method for complying with specified portions of the NRC's regulations. Otherwise, the methods described in this guide will be used in evaluating compliance with the applicable regulations.

REFERENCES[4]

1. 10 CFR Part 20, "Standards for Protection against Radiation," U.S. Nuclear Regulatory Commission, Washington, DC.

2. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable," U.S. Nuclear Regulatory Commission, Washington, DC, May, 1977.

3. American National Standards Institute (ANSI)/Health Physics Society (HPS) N13.49-2001, "Performance and Documentation of Radiological Surveys," Health Physics Society, McLean, VA, August 6, 2001. [5]

4. International Commission on Radiological Protection (ICRP), Publication 30, "Limits for the Intake of Radionuclides by Workers," ICRP, Ottawa, Canada, 1982. [6]

5. IAEA Safety Guide RS-G-1.1, "Operational Radiation Exposure," October 1999. [7]

6. Regulatory Guide 8.25, "Air Sampling in the Workplace," U.S. Nuclear Regulatory Commission, Washington, DC, June 1992.

7. Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," U.S. Nuclear Regulatory Commission, Washington, DC, October, 1999.

8. National Council on Radiation Protection and Measurements (NCRP) Report No. 65, "Management of Persons Accidentally Contaminated with Radionuclides," National Council on Radiation Protection and Measurements, Bethesda, MD, 1980. [8]

9. American National Standards Institute (ANSI)/Health Physics Society (HPS) N13.39-2001, "Design of Internal Dosimetry Programs," Health Physics Society, McLean, VA, May 24, 2001.

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[4] Publicly available documents from the U.S. Nuclear Regulatory Commission (NRC) are available electronically through the NRC Library on the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/. The documents can also be viewed on-line for free or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415 3548; and e mail pdr.resource@nrc.gov.

[5] Copies of American National Standards Institute (ANSI) standards may be purchased from ANSI, 1819 L Street, NW, Washington, DC 20036, on their Web site at http://webstore.ansi.org/; telephone (202) 293-8020; fax (202) 293-9287; or e-mail storemanager@ansi.org.

[6] Copies of the International Commission on Radiological Protection (ICRP) may be obtained through their Web site: http://www.icrp.org/; 280 Slater Street, Ottawa, Ontario K1P 5S9, CANADA; Tel: +1(613) 947-9750 Fax: +1(613) 944-1920.

[7] Copies of International Atomic Energy Agency (IAEA) documents may be obtained through their Web site: WWW.IAEA.Org/ or by writing the International Atomic Energy Agency P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria. Telephone (+431) 2600-0, Fax (+431) 2600-7, or E-Mail at Official.Mail@IAEA.Org

[8] Copies of The National Council on Radiation Protection and Measurements (NCRP) may be obtained through their Web site: http://www.ncrponline.org/Publications/Publications.html] or by writing to the NCRP at 7910 Woodmont Avenue, Suite 400, Bethesda, Maryland 20814-3095, Ph: 301-657-2652, fax: 301-907-8768.

10. 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," U.S. Nuclear Regulatory Commission, Washington, DC.

11. ANSI N323A-1997, "Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments," Institute of Electrical and Electronic Engineers, New York, NY, 1997.

12. NCRP Report No. 112, "Calibration of Survey Instruments Used in Radiation Protection for the Assessment of Ionizing Radiation Fields and Radioactive Surface Contamination," National Council on Radiation Protection and Measurements, Bethesda, MD, 1991.

13. American Conference of Governmental Industrial Hygienists (ACGIH), *Industrial Ventilation: A Manual of Recommended Practice for Design*, 26th Edition, American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation, Cincinnati, OH, ISBN 978-1-882417-71, 2007. [9]

14. American Society of Mechanical Engineers (ASME), ASME AG-1, "Code on Nuclear Air and Gas Treatment," ISBN: 079182764X, New York, NY, 2003. [10]

[9] Copies of the American Conference of Governmental Industrial Hygienists (ACGIH) , Committee on Industrial Ventilation, may be obtain at 1330 Kemper Meadow Drive, Cincinnati, Ohio 45240, USA, Customers/Members Phone: 513-742-2020, Administrative Phone: 513-742-6163, Fax: 513-742-3355, E-mail: mail@acgih.org.

[10] Copies of American Society of Mechanical Engineers (ASME) standards may be purchased from ASME, Three Park Avenue, New York, New York 10016-5990; Telephone (800) 843-2763. Purchase information is available through the ASME Web site store at http://www.asme.org/Codes/Publications/.

APPENDIX A

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES [a]	AVERAGE [b, c, e, f]	MAXIMUM [b, d, e, f]	REMOVABLE [b, c, e, f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, and I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, and I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma (βγ) emitters (nuclides with decay modes other than alpha (α) emission or spontaneous fission) except Sr-90 and others noted above	5,000 dpm βγ/100 cm^2	15,000 dpm βγ/100 cm^2	1,000 dpm βγ/100 cm^2

a Where surface contamination by both α- and βγ-emitting nuclides exists, the limits established for α- and βγ-emitting nuclides should apply independently.

b As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c Measurements of average contaminant should not be averaged over more than 1 square meter. For objects with less surface area, the average should be derived for each such object.

d The maximum contamination level applies to an area of not more than 100 square centimeter (cm^2).

e The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with a dry filter, soft absorbent paper, or fabric smear; applying moderate pressure; and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally, and the entire surface should be wiped.

f The average and maximum radiation levels associated with surface contamination resulting from βγ emitters should not exceed 0.2 millirad per hour (mrad/h) at 1 centimeter (cm) and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per cm^2 of total absorber.

APPENDIX B

SURVEY FREQUENCIES

PLANT AREAS	EXTERNAL RADIATION SURVEYS	AIR SAMPLING	REMOVABLE SURFACE CONTAMINATION SURVEYS
Uranium receiving, warehousing, and shipping	Monthly	Continuous air sampling; samples changed weekly and following any indication of release leading to airborne concentrations of uranium	Monthly and following any indication of release
Operational processing areas UF_6 vaporization, UF_6-UO_2 conversion, chemical processing, scrap recovery, powder processing, rod loading, decontamination, waste processing, and change rooms	Monthly	Continuous air sampling;* samples changed each shift, following any change in equipment or process control, and following detection of any event that may have released uranium (i.e., leakage from valves, pipes, tanks, or trays; spillage; or blockage of process equipment, such as conveyors, elevators, or hoppers)	Weekly and following any indication of release
Chemical-metallurgical laboratory	Monthly	Continuous air sampling; samples changed each shift	Weekly
Fuel assembly, inspection, and storage	Monthly	Continuous sampling; samples changed weekly	Monthly
Lunchrooms, cafeterias, snack bars, and vending machine areas	Quarterly	-	Daily

* See Regulatory Position C.1.3.

APPENDIX C

LEAK TEST REQUIREMENTS

A. Each source shall be tested for leakage at intervals not to exceed 6 months. In the absence of a certificate from a transferor indicating that a test has been made within 6 months before transfer, the sealed source shall not be put into use until tested.

B. The test shall be capable of detecting the presence of 0.005 microcuries of contamination on the test sample. The test sample shall be taken from the source or from appropriate accessible surfaces of the device in which the sealed source is permanently or semipermanently mounted or stored. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Commission.

C. If the test reveals the presence of 0.005 microcuries or more of removable contamination, the licensee shall immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired by a person appropriately licensed to make such repairs or to be disposed of in accordance with the Commission's regulations. Within 5 days after determining that any source has leaked, the licensee shall file a report with the Director, Division of Fuel Cycle Safety and Safeguards, U.S. Nuclear Regulatory Commission (NRC), Washington, DC 20555. This report shall describe the source, test results, extent of contamination, apparent or suspected cause of source failure, and corrective action taken. A copy of the report shall be sent to the administrator of the nearest NRC regional office listed in Appendix D, "United States Nuclear Regulatory Commission Regional Offices," to 10 CFR Part 20, "Standards for Protection Against Radiation."

D. The periodic leak test required by this condition does not apply to sealed sources that are stored and not being used. The sources excepted from this test shall be tested for leakage before any use or transfer to another person unless they have been tested for leaks within 6 months before the date of use or transfer.