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

A. INTRODUCTION

Paragraph 20.201(b) of 10 CFR Part 20, "Standards for Protection Against Radiation," requires that each licensee make or cause to be made such surveys as may be necessary for him to comply with the regulations in that part. As used in Part 20, the term "survey" is defined as an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. This guide specifies the types and frequencies of surveys that are acceptable to the NRC staff for the protection of workers in plants licensed by the NRC for processing enriched uranium and for the fabrication of uranium fuel.

This guide does not relate to the processing of uranium-233. Further, this guide does not specifically deal with a number of 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) bioassay. Guidance on bioassay for uranium appears in Regulatory Guide 8.11, "Applications of Bioassay for Uranium."

B. DISCUSSION

Surveys are considered to be part of a comprehensive 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." 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 of the National Council on Radiation Protection and Measurements (NCRP) (Refs. 1-3), the International Atomic Energy Agency (IAEA) (Refs. 4-7), and the International Commission on Radiological Protection (ICRP) (Ref. 8). More recent reports (Refs. 9-10) 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 intake of radioactive material by the workers.

Some enriched uranium processing and fuel fabrication plants conduct operations with Class D (transportable, with rapid clearance from the lung) uranium compounds for which considerations of chemical toxicity to the kidney are limiting. (There are other chemical hazards such as HF that are not addressed in this guide.) Other plants conduct operations with Class W or Y (nontransportable, with 50- or 500-day biological half-life in the lung) compounds only. In the latter case, considerations of dose equivalent to the lung are limiting. Such differences in plant operation were considered in the development of this guide.

C. REGULATORY POSITION

Methods, procedures, and criteria in this guide are acceptable to the NRC staff and may be incorporated into appropriate sections of a license application. This guide is intended to assist applicants in preparing license applications and to assist 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

Section 20.201 of 10 CFR Part 20 specifies that surveys be performed to demonstrate compliance with the other radiation safety requirements of that part. Certain 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. Monitoring of effluents is beyond the scope of this guide.[1] Applicable guides of Divisions 4 and 10 should be consulted for such guidance.

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

1.2 Surveys of External Radiation Dose Rates

NRC licensees are required by § 20.202 of 10CFR Part 20 to supply appropriate personnel monitoring equipment to each individual who enters a restricted area under such circumstances that he is likely to receive a dose in any calendar quarter in excess of 25% of values specified in paragraph 20.101(a) and to require the individual to use the equipment. Health physics personnel should conduct initial surveys to identify all areas and operations where personnel monitoring may be required and periodic surveys to detect any changes. The survey instruments used should be operable and capable of measuring, at or below the required level, the types of radiation that will be encountered. Note that if workers will occupy the area essentially full time (520 hours per quarter), periodic surveys should be made for beta-gamma radiation at levels as low as 0.24 mrem/hr. Such levels may exist in a large fraction of the area of an enriched uranium processing or fuel fabrication plant unless considerable care is taken to minimize exposures. Beta-gamma radiation levels of 1 to 2 mrem/hr usually exist at a distance of one foot or more from the surfaces of UO_2 pellet trays or boats and fuel rods or bundles and in areas where fuel bundles are stored. Radiation levels of 5 to 10 mrem/hr may be found at the surfaces of fuel rods and bundles, and levels of 50 to 100 mrem/hr may be found near the surface of pellet trays and boats. 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). Much higher levels of gamma radiation may exist at such points as multiply used UF_6 cylinders or where operations involving melting or reduction to uranium metal are conducted and the thorium and protactinium daughters of uranium become separated as "bottoms," scale, or residue. The radiation levels near such sources should be surveyed. Although most of the radiation levels in operating areas are low, a reasonable effort should be made to minimize individual and collective (man-rem) doses.

Preoperational, routine, and special radiation surveys of the plant areas should be performed by the health physics staff as described in Regulatory Position C.2. Results of these surveys should be recorded as described in Regulatory Position C.3.

Where operating personnel are subject to receiving more than 25% of the dose limits, surveys are not normally acceptable for compliance with the personnel monitoring requirements of § 20.202 of 10 CFR Part 20. However, in the absence of personnel dosimetry data, due, for example, to loss of chemical or physical damage to the dosimeter, an alternative means of estimating the exposure is 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 indefinitely along with personnel monitoring records pursuant to paragraph 20.401 (c)(2)(ii). Survey results should be reviewed promptly by the health physics staff 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 as low as is reasonably achievable. Surveys for alpha radiation in enriched uranium processing and fuel fabrication areas are conducted primarily to assess the extent of contamination of personnel, equipment, and premises and to detect the loss of confinement. Such surveys are discussed in more detail in following sections.

1.3 Measurements of Uranium Concentrations in Air

It is essential to establish a comprehensive program for assessing concentrations of uranium in air, at frequencies specified in Regulatory Position C.2 below, for each area where operations could expose workers to the intake of quantities of uranium exceeding those specified in § 20.103. Special requirements for such assessments may also be made a condition of the NRC license. Air samples should be collected in such a way that the concentrations of uranium are representative of the air in which workers are exposed.

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.

When radiometric measurements of the quantity of uranium deposited on or in an air sample filter are being performed, appropriate corrections should be included for geometry and alpha (or beta) absorption by the filter media and by material collected on the filter. Filter media used should retain collected material on the filter surface, and correction should be made for filter efficiency considering the particle sizes and flow rates involved. Overestimates of the volume of air that has passed through the filter should be avoided by accurate calibration of the flow rate and by

[1] However, the radiation safety program should include surveys or records that indicate control of the quantities of radioactive material released in air and water to unrestricted areas as required by 10 CFR Part 20.

prevention of or correction for loss of flow rate due to the accumulation of material on the filter. A means for measuring flow rate at air sampling heads should be available.

Any air samples that are suspected of reflecting releases and high concentrations, such as samples taken during glovebox glove changes, should be counted at once to identify any samples with quantities of uranium greater than expected for the sampling location and volume. Procedures used should ensure prompt correction of the faulty control or operation that led to the release and high sample. Air samples should be counted again for record purposes after a routine period of time (24 hours is frequently used) for decay of the "background" radon and thoron. The samples should be counted for a sufficiently long period of time or until a sufficiently large number of counts has been observed to establish the sample counting rate error within $\pm 30\%$.

Filters from personal (lapel) samplers should be counted and the data related to the uranium intake of the wearer by application of factors for sampling time, breathing rate, wearing time, and total working time. Filters from general air samplers should be changed each working shift or more often in the event of rapid buildup of material on the filter media, which reduces the air flow. Consideration may be given to running samplers over weekends when no work is in progress or to changing part of the samplers each day of a weekend.

Paragraph 20.203(d) of 10 CFR Part 20 defines "airborne radioactivity area" and prescribes posting requirements. In setting forth the standards for limiting intake of uranium, Section 20.103 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 which delimit an airborne radioactivity area. That section also provides for the use of other precautionary procedures such as increased surveillance, limitation of working times, or provision of respiratory protective equipment to maintain intake of radioactive material as low as is reasonably achievable. Health physics surveys of air concentration are essential in evaluating the changes obtained under process and engineering controls, in conducting increased surveillance and limiting working times, and in support of a program for the use of respiratory protective equipment. An air monitor[2] may be used to provide a warning signal that the concentration of airborne uranium has become unexpectedly high. An air monitor should be considered if conditions make it likely that an intake of uranium exceeding the limits in § 20.103 may occur.

The principal function of the air monitor is to alert personnel to take immediate action to protect themselves from unexpected airborne uranium. Inhalation exposures are in progress during the time between the release of the uranium and the sounding of the alarm. Thus 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. The use of excessively long tubing or piping leading to the inlet should be avoided because of the high probability of alarm delay due to 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. The intake by personnel may also be reduced by providing a high flow rate of air through the filter. It is important to maximize this flow rate, thus reducing the time of exposure before the alarm.

1.4 Surface Contamination Surveys

For contamination control inside the restricted area of a plant, there are controlled areas where uncontained uranium is handled and uncontrolled areas where uranium is in the form of sealed sources or 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 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 resulting from the intake of loose uranium by inhalation, ingestion, or penetration of the skin.

For the purposes of this guide, removable contamination is that uranium contamination present on a surface that can be transferred to a dry smear test paper by rubbing with moderate pressure. Methods and instruments used in surveys of removable surface contamination should be capable of detecting the alpha radiations from uranium at and below the levels specified in Table 2. For example, smear counting may be performed with proportional counters, alpha scintillation counters, or thin-window Geiger-Mueller (GM) tubes.

Uniform methods for collecting and analyzing smear samples should be employed. These standardized methods should be employed over extended periods of time to aid

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

in cross-comparison of contamination at different times and places and in order to evaluate trends. A dry smear taken from an area of about 100 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 that will assist in the identification of trends. The surveyor will find it helpful to identify on the survey diagram the locations that are smear-tested.

Quantitative measuring instruments used to monitor the adequacy of confinement and contamination control, such as those used for measuring air samples, and measurements to evaluate uranium contamination of personnel (bioassays), work areas (smear tests), and equipment should be calibrated and checked prior to use each day. The accuracy of the calibration source should be, as a minimum, $\pm 5\%$ of the stated value and traceable to a primary standard such as that maintained by the National Bureau of Standards.

The regulations in 10 CFR Part 20 do not specify limits for surface contamination. 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 as low as is reasonably achievable. The contamination limits for controlled areas presented in Table 2 are acceptable to the NRC staff and need not be justified by the applicant.

1.5 Protective Equipment and Clothing Contamination Surveys

When it is impracticable to apply process or other engineering controls to limit concentrations of uranium in air below those defined in paragraph 20.203(d)(1)(ii), other precautionary procedures such as increased surveillance, limitation of working times, or provision of respiratory protective equipment must be used to maintain intake of uranium by any individual within the limits. When respiratory protective equipment is used to limit the inhalation of airborne uranium pursuant to paragraph 20.103(b)(2), the licensee may make allowance for such use in estimating exposures of individuals to uranium provided such equipment is used as stipulated in Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection." Licensees are required to notify in writing the director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in Appendix D to 10 CFR Part 20 at least 30 days before the date that respiratory protective equipment is first used under the provisions of paragraph 20.103(b)(2).

Individuals working in areas where a potential for skin or clothing contamination exists should wear suitable protective clothing. Because it is likely that the radioactive material on contaminated protective clothing will again become airborne while the clothing is being removed, monitors should be available in clothing change areas for workers to survey their clothing before removal and their bodies (particularly their heads, hands, and other exposed portions) after removal of the protective clothing and before leaving the controlled area. Potentially contaminated clothing should not be sent to a laundry that is not specifically authorized to process clothing contaminated with uranium unless the clothing has been surveyed and found to have less than 200 disintegrations per minute per 100 cm^2 (9×10^{-7} $\mu Ci/cm^2$) of uranium contamination.

Individual workers' surveys of themselves need not be recorded unless the values in Table 2 are exceeded. However, the health physics staff should maintain daily surveillance to ensure that the workers continue their own personal contamination surveys. Observations during radiation safety surveillance should be recorded.

Any personal clothing worn beneath protective clothing should be surveyed before leaving the controlled area. In the event that personal clothing contamination levels exceed preselected limits, workers should be instructed to report the situation to the health physics office. A member of the health physics staff should then survey and supervise any necessary decontamination or clothing disposal. The applicant may propose and justify personal clothing contamination limits; the level 200 disintegrations per minute per 100 cm^2 (9×10^{-7} $\mu Ci/cm^2$) is acceptable to the NRC staff and need not be justified by the applicant. Records should be maintained in the manner described above for instances of protective clothing contamination.

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, personal clothing should be stored outside 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 of this guide and if survey results are below the limits adopted for in-plant uncontrolled areas. After removal of protective clothing and washing and before donning personal clothing and leaving the change areas, particular attention should be paid to surveying the hair, bottoms of the shoes or feet, and the hands.

1.6 Personal Surveys

Individuals whose duties involve work in controlled areas where uranium contamination of body surfaces is probable should survey all exposed areas of the body after washing and before donning personal clothing and leaving the con-

trolled area. Skin contamination levels may be proposed and justified by the applicant. Workers should be required to report to the health physics office if there is contamination on the body that exceeds the preselected levels following attempts to remove the contamination by soap and water washing. 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 effect 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 selected limits, the affected individual should be released, but periodic surveys should be made until the limits are no longer exceeded. Complete records should be maintained of each incident of this nature.

Because of the potential for 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, on the basis of air sampling data, accident, equipment failure, etc., there is reason to believe that an individual might have taken uranium into his or her body. Minimum acceptable criteria, including numerical guidance on the initiation, selection, frequency, and interpretation of results for such programs, are provided in Regulatory Guide 8.11, "Application of Bioassay for Uranium."

1.7 Surveys of Equipment, Premises, or Scrap Prior to Release for Uncontrolled Use

Surface contamination surveys should be conducted for both removable and total contamination prior to 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, reasonable efforts should be made to eliminate the contamination, i.e., decontamination procedures should be repeated until additional efforts do not significantly reduce contamination levels. If the value of the items involved does not justify this level of effort, the items should be disposed of as radioactive waste or limited to use inside the controlled area. The applicant may propose and justify 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

External radiation surveys and smear tests of external surfaces of packages should be carried out both at the packaging point before being 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 regulatory requirements in §§ 20.203 and 20.205 of 10 CFR Part 20 and any specific license conditions. Packages transported within the plant should also be surveyed and labeled. When practicable, materials should be transferred by carts, conveyers, or other mechanical equipment rather than by hand-carrying. Packages (particularly pails or other containers containing powder or other finely divided material) should not be opened until the packages have been placed in an appropriately exhausted facility such as a hood or glove box. Packages should not be released for shipment or transfer unless external radiation and contamination levels are within the limits of the Department of Transportation regulations.

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

The health physics staff should survey to 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 Parts 19 and 20 or specific license conditions. Criticality and air monitor alarms should be tested monthly unless the licensee provides justification for testing at less frequent intervals. Any failure of such devices to perform as intended should be promptly corrected.

1.10 Leak-Tests of Sources

Leak-testing of sources 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.

1.11 Calibration of Radiation Safety Instruments

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.

An adequate calibration of survey instruments cannot be performed solely with built-in check sources. Electronic cali-

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

brations that do not involve a source of radiation also will not determine the proper functioning and response of all components of an instrument. However, an initial calibration with a radiation source and periodic tests using electronic input signals may be considered adequate for high ranges that are not used routinely.

Daily or other frequent checks of survey instruments should be supplemented every six months with a calibration of each instrument at two points separated by at least 50 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 are linear readout instruments. Digital readout instruments without scale switching should be calibrated in the same manner as are 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 $\pm$ 10 percent of the calculated or known values for each point checked. Readings within $\pm$ 20 percent are considered acceptable if a calibration chart or graph is prepared and attached to the instrument.

1.12 Ventilation Surveys

Health physics personnel should conduct surveys monthly to determine that the velocity of air flow at the entrance of all hoods or other exhausted enclosures and close-capture points is adequate to preclude escape of airborne uranium (considering 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 or not the air flow has been reduced to unacceptable levels by filter loading, malfunction of exhaust fans, etc. 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 150 ft/min (45 m/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 early indication of a reduction in air flow; the readings of such devices should be checked during each shift or more frequently for operations where high loading rates may occur. Corrective action should be taken as soon as possible when the air flow is found to be deficient. Work should be terminated if the average face velocity falls below 100 ft/min (30 m/min).

Surveys should be made of the negative pressure maintained inside glove boxes or other closed systems. Additional surveys for airborne uranium, contamination of personnel and equipment, etc., 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 the flow rate, pressure drop, or negative pressure in the enclosure. Workers should be instructed to check on these devices and to notify the health physics staff promptly upon indication of flow rates below preset levels.

1.13 Surveys of In-Plant Uncontrolled Areas

Uncontrolled areas inside the plant should be surveyed periodically to ensure that uranium is adequately confined in the controlled areas. Procedures should be established for the movement through corridors or other uncontrolled areas of the plant of uranium in any form that is capable of contaminating surfaces or of dispersal in air. Acceptable survey frequencies are discussed in Regulatory Position C.2; results should be recorded as described in Regulatory Position C.3. With the exception of lunch rooms, cafeterias, snack bars, and vending machine areas, random smear testing of floors alone is adequate for most uncontrolled areas. In lunch rooms, cafeterias, snack bars, and vending machine areas, furniture and vending equipment as well as 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. Also, 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. The limits given in Table 2 are acceptable to the NRC staff and need not be justified by the applicant.

1.14 Surveillance

The term "surveillance" as used in this guide, refers to observations of working conditions in and around the plant made by the health physics staff who perform the routine radiation and contamination surveys. Such surveillance is considered by the NRC staff to be one of the most important aspects of a protection program. There should be a preconceived surveillance plan through which health physics personnel 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 breakdown of process equipment or other emergency conditions. Health physics personnel

who are responsible for performing surveys should be sufficiently familiar with each activity 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 health physics measurements.

2. FREQUENCY OF SURVEYS

The frequency of routine surveys depends on the nature of the work being conducted, the quantities of material being processed, and the specific protective facilities, equipment, and procedures used to protect the 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.

Generally, surveys should be performed prior to the operation of the plant in order to establish a baseline of background radiation levels and radioactivity from natural sources. These baseline surveys should be performed under various conditions to be expected during routine plant operation. Surveys should be conducted during test operation of any new process or protective equipment, during significant changes in input materials or work load, 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 frequencies of routine surveys depend on many factors and should be designed for the specific operations and facilities involved, minimum frequencies acceptable to the NRC staff as meeting the requirements of § 20.201 of 10 CFR Part 20 are given in Table 1.

3. RECORDS OF SURVEYS

Reference should be made to § 20.401 of 10 CFR Part 20, § 40.61 of 10 CFR Part 40, and paragraph 70.32(b)(5) of 10 CFR Part 70 for recordkeeping requirements regarding surveys. Section 20.401 requires that the licensee maintain records in the same units used in 10 CFR Part 20. Thus external exposure rates should be recorded in estimated maximum dose equivalent units, rem or millirem, to relevant parts of the body as specified in § 20.101 of 10 CFR Part 20. Air concentrations should be recorded in terms of disintegrations per unit time per milliliter or microcuries per milliliter. Surface contamination measurement results should be recorded in disintegrations per unit time per 100 square centimeters or in microcuries per square centimeter. The intake of radioactive material should be recorded in terms of microcuries (micrograms may be used for U-234, U-235, and U-238) and percentage of the applicable limit. Methods used to calculate intake quantities from bioassay data should be specifically referenced or documented in the exposed individual's record. If specific information on the uranium compounds involved and their behavior in an individual is known, such information may be used and documented in the exposed individual's record.

Records retention requirements are given in the regulations cited above. Paragraph 20.401(c)(2) requires that survey records be preserved for two years, except that (1) records of air monitoring, bioassay by urinalysis, fecal analysis, whole body or in vivo counting, etc., used to determine the intake of an individual in compliance with § 20.103, (2) in the absence of personnel monitoring data, records of surveys to determine external radiation dose, and (3) results of surveys used to evaluate the release of radioactive effluents to the environment (not treated in this regulatory guide) are to be maintained until the NRC authorizes their disposition. 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.

Records may be maintained in logbooks or on special forms if they are clear, legible, understandable, authenticated by authorized personnel, and contain all of the information required. The signature of the person making the record and the data should be 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 of § 20.401.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plan for using this regulatory guide. This guide reflects practices currently acceptable to the NRC staff. Except in those cases in which the applicant or licensee proposes alternative practices or methods for complying with specified portions of the Commission's regulations, the practices or methods described herein will be used as a basis for evaluating applications for specific licenses for enriched uranium processing and fabrication of uranium fuel or (in conjunction with inspection of performance) for evaluating survey programs established by licensees.

TABLE 1

SURVEY FREQUENCIES

Plant Areas	External Radiation Surveys	Air Sampling	Removable Surface Contamination Surveys
Uranium receiving, warehousing, 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
Active processing areas UF_6 vaporization, UF_6-UO_2 conversion, chemical processing, scrap recovery, powder processing, rod loading, decontamination, waste processing, 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 (valves, pipes, tanks, trays), spillage, or blockage of process equipment (conveyors, elevators, hoppers).	Weekly and following any indication of release
Chemical-metallurgical laboratory	Monthly	Continuous air sampling; samples changed each shift.	Weekly
Fuel assembly, inspection, storage	Monthly	Continuous sampling; samples changed weekly.	Monthly
Lunch rooms, cafeterias, snack bars, vending machine areas	Quarterly	–	Daily

*See Regulatory Position C.1.3.

TABLE 2

LIMITS FOR REMOVABLE SURFACE CONTAMINATION (Alpha Activity) IN ENRICHED URANIUM PROCESSING AND LWR FUEL FABRICATION PLANTS

Item	Limit	
	DPM/100 cm^2	$\mu Ci/cm^2$
Controlled areas	5,000	2.3×10^{-5}
*Protective clothing worn only in controlled areas	1,000	4.5×10^{-6}
Uncontrolled areas onsite	200	9×10^{-7}
*Personal clothing worn outside restricted areas	200	9×10^{-7}
Skin	0**	0**

*Determined by direct measurement.

**See Regulatory Position C.1.6 and footnote 3.

REFERENCES*

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2. NCRP Report No. 57, "Instrumentation and Monitoring Methods for Radiation Protection," May 1, 1978.

3. NCRP Report No. 58, "A Handbook of Radioactivity Measurements Procedures," November 1, 1978.

4. International Atomic Energy Agency (IAEA) Technical Report Series No. 120, "Monitoring of Radioactive Contamination on Surfaces," 1970.

5. IAEA Safety Series No. 38, "Radiation Protection Procedures," 1973.

6. IAEA Safety Series No. 1, "Safe Handling of Radionuclides," 1973 Edition, Code of Practice Sponsored by the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO), 1973.

7. IAEA Technical Report Series No. 133, "Handbook on Calibration of Radiation Protection Monitoring Instruments," 1971.

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9. Diegl, H., "Guidelines for Determining Frequency of Wipe Samples," *Health Physics Operational Monitoring, Vol. 1,* C. A. Willis and J. S. Handloser, Eds., Gordon and Breach, New York, 1972.

10. Sommers, J. F., "Sensitivity of G-M and Ion Chamber Beta-Gamma Survey Instruments," *Health Physics* 28, 755, 1975.

*IAEA Reports may be obtained from UNIPUB, Inc., P.O. Box 433, New York, N.Y. 10016. NCRP Reports may be obtained from NCRP Publications, P.O. Box 4867, Washington, D.C. 20014. ICRP Reports may be obtained from Pergamon Press, Maxwell House, Fairview Park, Elmsford, New York 10523.

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