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REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 8.23

RADIATION SAFETY SURVEYS AT MEDICAL INSTITUTIONS

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 that licensee to comply with the regulations in Part 20. As used in Part 20, the term "survey" means 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 identifies the types and frequencies of surveys that are acceptable to the NRC staff for use in medical institutions licensed by the NRC to use radioactive materials for purposes of diagnosis, therapy, or human research involving the administration of radioactive materials or radiation to patients or the use of radioactive materials for patient services.

B. DISCUSSION

Surveys are considered to be part of a comprehensive protection program established by the licensee consistent with the philosophy and principles of Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable" (Ref. 1). 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 Measurement (Refs. 2-9), the International Atomic Energy Agency (Refs. 10-14), and the International Commission on Radiological Protection (Refs. 15-17). Other publications (Refs. 17- 34) contain additional information for use in establishing radiation survey programs and selecting methods and equipment for their implementation.

Surveys[1] are a necessary supplement to personnel monitoring, which measures individual radiation exposures by the use of devices worn by the workers (Refs. 4, 6, 12, 14, and 16).

C. REGULATORY POSITION

Methods and procedures in this guide are acceptable to the NRC staff for establishing survey programs in accordance with the as low as is reasonably achievable (ALARA) philosophy. Generally, medical institutions licensed by the NRC should have a health physics staff available for consultation to design a survey program appropriate to the institution's use of radioactive material. Nothing in this guide should be construed to preclude or discourage the design of survey programs containing provisions other than those in this guide, when such programs are accepted by the NRC licensing staff as providing ALARA exposure conditions for a particular institution.

1. Types of Surveys

1.1 General Description

Surveys performed in compliance with §20.201 of 10 CFR Part 20 should include those necessary to evaluate external exposure to personnel, surface contamination levels, and concentrations of airborne radioactive materials in the facility and in effluents from the facility.

Environmental monitoring is beyond the scope of this guide. 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 Part 20. In many medical institutions, surveys of effluents or calculations to ensure that permissible concentration limits are not exceeded are included as a regular part of the health physics survey

*Lines indicate substantive changes from the February 1979 version that was issued for public comment.

[1]The word "survey," often used synonymously with "surveillance," "monitoring," or "area monitoring," is used in this guide to connote the personal inspection of various locations in a facility using radioactive materials, with or without accompanying measurements, to determine the effectiveness of measures to protect against exposure to radiation.

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Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience. This guide was revised as a result of substantive comments received from the pu 'ic and additional staff review.

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program. Often these calculations may be made by estimating the amounts of radioactive material washed down designated sinks and dividing them by the quantities of sewage released from the hospital, as indicated on the hospital's water or sewage bills. This procedure normally suffices to show compliance with the effluent limits of Part 20. Amounts of radioactive material released in air within hospitals or exhausted to the outside from hospitals are generally small, but these amounts may sometimes be estimated by calculational techniques if not by air-monitoring procedures. Appendix A to this guide describes surveys to be made of radioactive xenon-133 releases.

Radiation protection programs should include the types of surveys discussed below.

1.2 Surveys of External Radiation Exposure Levels

Areas to be surveyed should include any locations where individuals may be exposed to radiation intensities that might cause the occupational radiation dose to exceed 10 percent of the limits of paragraph 20.101(a) in any calendar quarter or where an individual is working with any radiation source that could produce radiation levels greater than 1.0 mR/h at 1 meter. These areas typically include shipping and receiving areas; radionuclide laboratories in nuclear medicine; diagnostic areas in nuclear medicine; intracavitary source preparation areas in radiation therapy; patients' rooms where treatments are given with intracavitary, interstitial, or radiopharmaceutical therapy sources; operating rooms; control (console) areas for teletherapy equipment rooms; waste packaging and disposal areas; radiation instrument calibration areas; and any other areas where persons might be exposed (e.g., areas occupied by technologists, nursing staff, visitors, patients, or any other persons who may be exposed to radioactive materials handled by others).

Preoperational, routine, and special surveys of these areas should be performed by the radiation protection staff as described in Section C.2 of this guide. Results of these surveys should be recorded as described in Section C.3. In addition to this survey program, the Radiation Safety Officer should institute and maintain a program of surveys performed by workers other than health physics personnel who may be exposed to external radiation levels that could exceed any of the limits of paragraph 20.101(a). Surveys by such workers may consist of no more than occasional instrument observations during work with radioactive materials. These personal surveys are particularly appropriate in nuclear medicine activities. Personnel should be properly instructed in conducting such surveys and should perform the surveys each day during and after work with radioactive materials, as necessary to determine the need to limit worktime and to use protective procedures to reduce exposures as far below the paragraph 20.101(a) limits as is reasonably achievable. The survey results obtained by these workers need not be recorded. However, the Radiation Safety Officer should maintain records to show that the appropriate training for, and implementation of, the worker survey program has been provided and is a continuing part of the survey program. Workers should be instructed to report unusual survey findings to the Radiation Safety Officer.

Surveys are not acceptable for routine compliance with the personnel monitoring requirements of §20.202. However, in the event of accidental loss of personnel dosimetry data, e.g., as a result of losing the dosimeter or chemical or physical damage to the dosimeter, the best alternative means of estimating the exposure may be to use survey data in conjunction with appropriate occupancy factors. In such case, the estimate, including the survey data used, should be documented and retained indefinitely (see paragraph 20.401(c)(2)(ii)). Survey results should be reviewed carefully by the Radiation Safety Officer to identify potentially hazardous situations and unfavorable trends.

1.3 Measurements of Radioactive Material Concentrations In Air

It may often be sufficient in medical institutions to show by calculation, together with monitoring of ventilation rates, that air concentrations are well below levels that would require routine air sampling. However, concentrations of radioactive material in air should be measured at frequencies described in Section C.2 and specified in Table 1 for areas where operations could at any time expose workers to 10 percent or more of the concentration values given in Table 1, Column 1, of Appendix B to 10 CFR Part 20. Special requirements for such monitoring may also be made a condition of the license.

Air samples obtained in accordance with §20.103 should be representative of the air in the workers' breathing zones. In cases where breathing zone sampling is not accomplished, air samples taken outside the breathing zone closer to the source, where the concentration of radioactive material can be or is expected to be equal to or greater than the concentration in the breathing zone, are acceptable. When measuring the quantity of radioactive material deposited on an air sample filter, corrections should be made for absorption of alpha or beta particles by the filter media and by material collected on the filter. The quantity of air that has passed through the filter should be accurately measured and corrections made for any loss of flow rate caused by the accumulation of material on the filter.

Continuous breathing zone or general air sampling should be conducted while the work is in progress unless experience with sample results or calculations has demonstrated that the concentration of radioactive material in the breathing zone is not likely to exceed 25 percent of the values given in Table 1, Column 1, of Appendix B to 10 CFR Part 20. The use of personal (lapel) samplers is acceptable for breathing zone sampling. If the air sampling is not continuous, the frequency and the times selected for the sampling should be based on the nature of the process involved and the probability that the airborne radioactive material will be present. When assessing this probability is difficult, frequencies based on information given in Section C.2 and Table 1 of this guide are acceptable.

1.4 Surface Contamination Surveys

Regular surveys for radioactive contamination that could be present on surfaces of floors, walls, furnishings, and

equipment are a necessary part of the survey program. Any surveys carried out in accordance with NRC license conditions will be considered consistent with the level of safety provided by recommendations in this guide.

Control of surface contamination is necessary to limit external dose rates and the resuspension in air of loose radioactive materials that may enter the body through inhalation, ingestion, or skin absorption.

1.4.1 Removable Contamination

For the purposes of this guide, removable contamination means radioactivity that can be transferred from a surface to a smear test paper by rubbing with moderate pressure. Information is available on the selection and use of instruments for performing removable surface contamination surveys appropriate to the radionuclides used in medical institutions (Refs. 2, 4-7, 10, and 13). Methods and instruments used in surface contamination surveys should be sufficiently sensitive to detect the nuclides being monitored (Refs. 22 and 25). For optimum detection of low-energy beta emitters (e.g., H-3 and C-14) as well as of alpha emitters and low-energy x- or gamma-ray emitters (e.g., I-125), liquid scintillation counting or internal proportional counting is normally necessary with the use of appropriate constancy checks on counter efficiency.

The collection of smear samples may be preceded by a rapid survey with a portable thin-end-window detector in order (a) to ensure that gross contamination levels are not already too high for counting with sensitive equipment, (b) to minimize (in some cases) the chance for inadvertent spread of contamination by the contamination survey or other activities to be performed in the meantime, and (c) to determine which areas require greater attention in smear testing. The instrument used for this purpose should (a) have a short enough time constant to facilitate detection or (b) be provided with a speaker for aural indication of count-rate.

A standardized method for smear testing of a relatively uniform area should be used in order to allow comparison of relative levels of contamination at different times and places. A dry smear taken from an area of about 100 cm^2 is acceptable to indicate levels of removable contamination.

A layout diagram for each laboratory routinely surveyed is helpful for recording survey results in a uniform manner to aid review and observation of trends and for satisfying regulatory requirements for availability of survey records. On these diagrams, it is helpful to specify key locations that are smear tested at each survey and also to provide space reminding the recorder to include:

a. Contamination levels converted to radioactivity units specified in 10 CFR Part 20,

b. Make and model number of the instruments used in the survey and in counting the smear samples,

c. Disintegration rate of each instrument test or calibration source,

d. Sample, background, and test counts and times, and

e. Signatures and dates at the bottom of each page.

Provision should also be made on the diagram for recording an instrument check with an appropriate check or calibration source for each batch of smear samples counted.

The surveys discussed above are regularly scheduled and recorded on the survey diagrams. In addition, it may be necessary to conduct more frequent, informal, and unrecorded surveys in nuclear medicine areas or other areas where loose radioactive contamination may occur. Such surveys can be made with a thin-end-window (less than 2 mg/cm^2) detector held close to a dry smear sample immediately after it is taken in the work area. When ambient external radiation levels in the laboratory are low enough to maintain external radiation exposures below the limits of paragraph 20.101(a), any appreciable surface contamination can be detected by simply holding the detector in a fixed position and moving the smear sample close to and away from the detector several times. This method may be used for the vast majority of radionuclides used in diagnostic and therapeutic medical practice.

Part 20 does not specify limits for surface contamination. Each applicant may propose and justify the levels of removable surface contamination that will be allowable before decontamination must be performed. These limits should be based on the need to avoid transfer of significant amounts of contamination to unrestricted areas and to maintain exposures as low as is reasonably achievable. The contamination limits for restricted areas presented on line 2 of Table 2 of this guide are acceptable to the NRC staff and need not be justified by the licensee or applicant.

1.4.2 Fixed Contamination

For the purposes of this guide, fixed contamination means radioactivity remaining on a surface after repeated decontamination attempts fail to significantly reduce the contamination level. A total contamination survey using instruments suitable for the radionuclides involved should be conducted simultaneously with each removable contamination survey. The applicant may propose and justify the levels of total contamination that will be allowable for both restricted and unrestricted areas before decontamination must be performed. The limits appearing on lines 1 and 2 of Table 2, multiplied by a factor of 5, are acceptable to the NRC staff and need not be justified by the licensee or applicant.

1.5 Protective and Personal Clothing Contamination Surveys

Individuals working in areas where a potential for skin or clothing contamination exists should be provided with suitable protective clothing. Laboratory coats and protective gloves, as described in References 5 and 6, are usually adequate for any procedures in medical institutions. Protective clothing should be surveyed by the wearer after use if

significant contamination is possible. Contaminated protective clothing should be removed and placed in special laundry containers before leaving a restricted work area. Disposable gloves should be discarded in radioactive waste containers. After gloves are removed, hands should be washed and surveyed.

When protective clothing contamination levels may be expected to exceed preselected limits, workers should be instructed to take care to avoid dispersal of contamination and to report the situation to the Radiation Safety Office. A member of the radiation safety staff should then make surveys and supervise any necessary decontamination or clothing disposal. The applicant may propose and justify protective clothing contamination limits considered adequate for use in each restricted area. The limits on line 4 of Table 2 are acceptable to the NRC staff and need not be justified by the licensee or applicant.

Contamination levels observed and procedures followed during the survey and decontamination of personal clothing should be recorded. The written record should include the names of persons surveyed, a description of prior work activities, the probable causes, steps taken to reduce further incidence of contamination, times and dates, and the surveyor's signature. This information may be entered in a logbook. Workers' surveys of themselves need not be routinely recorded unless the limits on line 4 of Table 2 are exceeded. The radiation safety staff should conduct spot checks monthly to ensure that the workers continue their own personal contamination surveys.

In restricted areas with little potential for surface contamination, personal clothing is often worn beneath protective clothing. Such personal clothing should be surveyed by the wearer before he or she leaves the restricted area. (However, this is neither practicable nor necessary for employees working with only microcurie quantities of tritium or carbon-14.) Workers should be instructed to report the situation to the Radiation Safety Office when personal clothing contamination levels exceed preselected limits. A member of the radiation safety staff should then make surveys and supervise any necessary decontamination or clothing disposal. The applicant or licensee may propose and justify personal clothing contamination limits; the limits given on line 3 of Table 2 are acceptable to the NRC staff and need not be justified by the applicant or licensee. Records should be maintained in the same manner as those for protective clothing contamination.

1.6 Personal Surveys

Although personal contamination in excess of the value given on line 5 of Table 2 is unusual in medical institutions, individuals who work in restricted areas under conditions in which they may become contaminated should survey all exposed areas of the body before donning personal clothing or leaving the restricted area. Particular attention should be paid to the body, hair, bottoms of the shoes or feet, and the hands. Workers should be instructed to report the detection of contamination on the body to the Radiation Safety Officer. Decontamination attempts under the direction of Radiation Safety Office personnel or a medical consultant should be repeated until (a) such attempts cease to effect significant reductions or (b) such attempts threaten to irritate or harm the skin.[2] When decontamination attempts are terminated, there should be no further concern if the residual contamination does not exceed preselected levels. Such levels may be proposed and justified by the applicant or licensee. The limits given on line 5 of Table 2 will be accepted without justification. If residual contamination exceeds the selected limits, the affected individual may be released (since his contamination is now relatively fixed and not likely to enter the body), but periodic surveys should be made until the limits are no longer exceeded. The resulting dose should be determined and entered in the individual's personnel dosimetry record. Complete records should be maintained of each incident of this nature.

Since medical personnel may often handle open vials or containers with millicurie or higher levels of volatile forms of certain nuclides such as I-125 or I-131, which in certain forms may concentrate in the thyroid or other body organs, bioassay monitoring is sometimes made a condition of the license. Acceptable criteria for such programs are published in Regulatory Guides 8.20, "Applications of Bioassay for I-125 and I-131," and 8.26, "Applications of Bioassay for Fission and Activation Products." Additionally, guidance on bioassay monitoring is available from the Material Licensing Branch, Office of Nuclear Material Safety and Safeguards. In addition to these programs, placing the detector against the neck close to the thyroid is often useful for monitoring for internal deposition of these nuclides during surveys for skin contamination; however, for I-125, a thin-crystal scintillation probe would be needed to obtain adequate sensitivity. In this way, appropriate personnel may be more frequently monitored for internal exposure while they are also being monitored for external contamination. Any positive indications of exposure or contamination from these types of surveys should be recorded in the radiation safety logs. Indications of internal depositions should be reported to the Radiation Safety Office.

1.7 Surveys of Equipment Prior to Release to Unrestricted Areas

Before the uncontrolled release of potentially contaminated medical instruments or equipment from restricted to unrestricted areas, surface contamination surveys should be conducted on such instruments and equipment for both removable and fixed contamination. If contamination is detected, decontamination procedures should be instituted and repeated until additional efforts do not significantly reduce contamination levels. The applicant or licensee may propose and justify total and removable contamination limits below which uncontrolled release of equipment is permitted. The limits given in Table 3 of this guide, as

[2] Decontamination attempts without supervision or instruction from the licensee's medical consultant should be restricted to washing with mild soap and water unless other safe procedures have already been approved and personnel have been properly instructed in using them. If such attempts do not reduce the contamination to acceptable levels, the aid of the licensee's medical consultant should be obtained.

adapted from Table 1 of Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," are acceptable to the NRC staff and need not be justified by the licensee or applicant. Decontamination guidelines are available from the Material Licensing Branch, Office of Nuclear Material Safety and Safeguards.

1.8 Ingestion

Surveillance should be included in the radiation safety program to ensure that workers properly observe rules to prevent ingestion of radionuclides, e.g., rules against eating, drinking, or smoking in work areas or while wearing potentially contaminated clothing; storing foods in work areas; pipetting by mouth; and wearing contaminated laboratory coats to the cafeteria or other unrestricted areas. Water fountains close to work areas where radioactive materials are used should be smear tested regularly.

1.9 Surveys of Packages Received and Packages Prepared for Shipment

External radiation measurements and tests of external surfaces of packages received or packaged for shipment should be carried out near the receiving or packaging point to avoid unwarranted radiation exposures and inadvertent contamination of personnel or the hospital. Surveys and labeling must comply with the NRC's regulations (see §§20.203, 20.205, 32.19, and 32.70 through 32.74 of 10 CFR Parts 20 and 32) and with any specific license conditions. Delivery of packages within the hospital should also be monitored. Any delivered containers of radioactive material must be labeled as required by paragraph 20.203(f). All packages bearing yellow II or yellow III Department of Transportation (DOT) labels should be transported by cart. Only adequately shielded sources should be transported. Internal containers of packages containing significant amounts of radioactive materials should not be opened until the containers have been placed in the appropriate protective facility (e.g., hood).

All personnel, including security guards, should be adequately instructed in performing at least an initial inspection survey for leakage or damage before transporting any packages of radioactive materials through hospital areas. The written instructions should clearly indicate which packages should be transported by cart rather than hand-carried.

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

The radiation safety staff should perform surveillance during the surveys described in Table 1 to ensure that signs, labels, radiation alarm signals, other access controls, and 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; Inspections," and Part 20 or by license conditions. Radiation alarm signals should be routinely tested for operation by use of appropriate check sources to ensure proper functioning of the alarms. Microswitches on which these instruments depend for operation should also be tested to ensure that they will function reliably in normal operations or as expected under emergency conditions. Care should be taken to minimize exposure to personnel from the tests themselves. Any signs, labels, or notices found to be missing should be promptly provided. Temporary signs, signals, or barriers, together with appropriate worker notification and instruction, may be used in the interim when items specified in Parts 19 and 20 are not available, but acceptable corrections should be provided as soon as practicable.

1.11 Leak Tests of Sources

Sealed sources containing (a) more than 100 microcuries of a byproduct material with a half-life of more than 30 days (except iridium-192 seeds encased in nylon ribbon) (see paragraph 35.14(b)(5)) or (b) more than 10 microcuries of an alpha emitter (see paragraph 31.5(c)(2)(ii)) must be leak tested for contamination or leakage at intervals not to exceed 6 months unless a different interval is specified for a particular manufactured source under the provisions of paragraph 32.74(b) of 10 CFR Part 32, "Specific Domestic Licenses to Manufacture or Transfer Certain Items Containing Byproduct Material." Further provisions and exceptions to leak-testing requirements are established in paragraphs 35.14(b) and 35.14(c)(1) of 10 CFR Part 35. Any specific license conditions must also be followed.

1.12 Calibration and Source Checks of Radiation Survey Instruments[3]

An adequate calibration of survey instruments cannot be performed with built-in check sources. Electronic calibrations that do not involve a source of radiation are also not adequate to determine the proper functioning and response of all components of an instrument.

Daily constancy checks of survey instruments should be made before and after each use and should be supplemented at least every 12 months with a battery check and two-point calibration (at about 1/3 and 2/3 of full scale) on each scale of the instrument to be used for radiation protection surveys. Survey instruments should also be calibrated after repair or maintenance that may affect the calibration of the instrument.

A survey instrument may be considered properly calibrated at one point when the exposure rate measured by the instrument differs from the true exposure rate by less than 10 percent.

Each source used for calibration should be certified (Ref. 25) in radioactivity content to within 5 percent by the supplier. Alternatively, each source may be calibrated

[3] In order to keep personnel exposures ALARA, high-range scales (e.g., above 1R/h) should not be calibrated when they will not be needed in a particular installation. Also, a sufficient variety of instruments should be available and calibrated on all scales as needed for the types of radiation and the ranges of intensity or exposure to be measured. Item 9 of Regulatory Guide 10.8 (Ref. 29) specifies certain types of instruments generally required in a typical nuclear medicine laboratory and information on instrumentation to be submitted with a license application.

for dose rates at given distances. Each source should also be corrected for decay as of the day on which the source is used for survey instrument calibration. All decay corrections should be included in the radiation safety records system. A posted graph for each source is convenient, helpful in avoiding calculational errors, easily available for inspection, and acceptable for obtaining source intensity within the required accuracy. For automatic range-changing instruments or instruments with more than one decade on a logarithmic scale, a calibration near the mid range of each decade should be adequate, except that a two-point check should be used on at least one of the decade ranges.

Readings obtained from the calibration verifications should be recorded, preferably by plotting the reading on the instrument calibration curve where applicable. Other instruments should be calibrated at frequencies suggested by the manufacturer. Check sources should be used to check the continued accuracy of all instruments each time they are used in the field, preferably before and after each series of measurements. (See also Regulatory Guide 10.8, "Guide for the Preparation of Applications for Medical Programs" (Ref. 29).)

1.13 Surveys of Protective Clothing Before and After Laundry

Surveys of protective garments and linens should be performed prior to release to a conventional laundry. Garments and linens should be released to such a laundry only if contamination levels do not exceed those given on line 3 of Table 2. Items contaminated with short-half-life material that exceeds the levels given on line 3 of Table 2 should be contained in leakproof bags and transported in carts to controlled storage areas for decay. Items contaminated with long-half-life material may be disposed of as radioactive waste or sent for decontamination to a laundry licensed by the NRC or by an Agreement State.

1.14 Ventilation Surveys

Where enclosures such as fume hoods are necessary to protect workers from unencapsulated radioactive material, measurements of the face velocity at the enclosure entrance should be made quarterly to ensure that the airflow is adequate.[4] Such measurements should be made by using a properly calibrated thermoanemometer or velometer to determine whether the airflow has been reduced to unacceptable levels by filter loading or by the malfunction of blowers, fans, etc. The minimum average face velocity for a fume hood with the sash in the operating position or for an opening in a special enclosure should be 100 ft/min as determined from at least five different measurement points. Airflow monitoring devices such as inclined manometers should also be available for the user to check for proper airflow during each use. Corrective action should be taken as soon as possible when the face velocity is found to be deficient. Records should be kept of airflow measurements and any corrective actions.

[4]Where filtered exhausts are employed, devices such as U-tube manometers should be provided to indicate the pressure drop across the filters, thus affording an early indication of airflow loss at enclosures.

1.15 Surveys in In-Hospital Unrestricted Areas

Unrestricted areas should be surveyed periodically to ensure that radiation and radioactive material are adequately confined in restricted areas, except in cases where these materials must be transported between areas. Recommendations in References 4, 5, 11, and 14 should be followed when transporting radioactive materials or patients emitting radiation from licensed radioactive materials through hallways or other unrestricted areas of the hospital. Such transportation should be surveyed and planned with a member of the radiation safety staff.

1.15.1 Surface Contamination Surveys

Removable surface contamination surveys in unrestricted areas in which unencapsulated radioactive materials are used or where contamination may be likely to occur should be performed and recorded at frequencies consistent with the potential for spreading contamination but no less frequently than quarterly. Random smear testing of floors alone is acceptable for most unrestricted areas. In cafeterias and snack bars, furniture and equipment, as well as floors, should also be surveyed. If such surveys reveal that radioactive contamination is being transferred out of restricted areas, immediate corrective action should be taken to eliminate such transfers. Decontamination efforts should be repeated until it is evident that subequent efforts would not significantly reduce contamination levels. If contamination is found, unrestricted areas should be surveyed more frequently (e.g., daily or weekly) until a trend of negative results is again established. The applicant or licensee may propose and justify permissible contamination levels following decontamination efforts described above for unrestricted areas. The limits given on line 1 of Table 2 are acceptable to the NRC staff and need not be justified by the licensee or applicant.

1.15.2 Radiation Surveys

Radiation surveys in unrestricted areas adjacent to restricted areas should be performed and recorded at frequencies consistent with the types and quantities of material in use but no less frequently than quarterly. These surveys should be made in areas adjacent to restricted areas and, when exposures may occur, in all areas through which radioactive materials are transferred and temporarily stored before shipment. Radiation levels in these areas should be evaluated to determine whether they comply with the requirements of § 20.105 of 10 CFR Part 20.

1.16 Surveillance

1.16.1 Surveillance by Individual Performing Surveys

The term "surveillance," as used in this section, refers to observations of radiological working conditions in restricted areas made by the person who performs the routine radiation and contamination surveys. Such surveillance is one of the more important aspects of a radiation protection program. Through surveillance, radiation safety personnel acquire detailed knowledge of each operation as necessary

(a) to identify ways of preventing or minimizing occupational exposures, (b) to select appropriate times for making radiation safety measurements, and (c) to adequately prepare for emergency conditions. Radiation safety personnel should be sufficiently familiar with each activity to explain it in detail, to describe potential hazards and the precautions taken to minimize exposures, and to discuss how this knowledge of procedures within each activity has influenced the selection of appropriate times for performing radiation safety measurements.

1.16.2 Regular Inventory of Radioactive Material, Audit of Procedures, and Instruction of Personnel.

The surveillance program includes the following:

a. Regular inventory of radioactive materials and their locations,

b. Frequent audits of radiation safety procedures and the uses and amounts of material in process compared to licensed possession limits, and

c. Discussions with personnel to ensure their continued awareness of safety procedures and the appropriateness of their instruction and training for the tasks they are performing.

These surveillance activities may be performed during the performance of other survey measurements or tests. The surveillance should be performed at least annually by the Radiation Safety Officer in the presence of a management representative as a management audit. The management audit should be comprehensive enough to provide management with an awareness of the nature and importance of activities conducted for personnel protection and hospital safety. A sample checklist that can be useful in auditing as well as in carrying out radiation surveys is presented in Appendix B.

2. Frequency of Surveys

The frequency of routine surveys depends on the nature, quantity, and use of radioactive materials, as well as the specific protective facilities, equipment, and procedures that are designed to protect the worker from external and internal exposure.

Generally, surveys should be performed before radioactive materials are used in a new procedure and area in order to establish a baseline of background radiation levels and radioactivity from natural sources, including structural components of the facility, and any already existing operations with radiation sources in nearby rooms or facilities. These baseline surveys should be performed under the various conditions to be expected in routine hospital procedures.

Surveys should be repeated after routine procedures begin with normal levels of radioactive material and with potentially exposed persons present and carrying out their functions. Surveys should also be conducted after significant changes in the quantities of radioactive material handled, in the quantities present at any one time, or in protective equipment or procedures.

Although the frequencies of routine surveys depend on many factors, as stated above, and should be designed for the specific medical practices and facilities involved to maintain exposures as low as is reasonably achievable, minimum frequencies acceptable to the NRC staff for meeting the requirements of §20.201 of 10 CFR Part 20 are given in Table 1 of this guide.

3. Records of Surveys

Reference should be made to §§20.401 and 30.51 and to 10 CFR Parts 31-35 for recordkeeping requirements regarding surveys related to the receipt, use, packaging, transfer, and disposal of byproduct material. Section 20.401 requires that licensees maintain records in the same units used in Part 20 (see Table 4). Thus, external exposure rates should be recorded in estimated maximum dose equivalent units to relevant parts of the body as specified in Part 20. Air concentration measurement results should be recorded in units of μCi/ml, and surface contamination measurement results should be recorded in units of dpm/100cm^2 or μCi/100cm^2 (or as in §20.5).

Record retention requirements are specified in the regulations cited above. Paragraph 20.401(c)(2) requires that survey records be preserved for 2 years, except that records of air monitoring and (in the absence of personnel monitoring data) records of surveys to determine external radiation dose (see paragraph 20.401(c)(2)(ii)) are to be maintained until the NRC authorizes their disposition.

Records may be maintained in logbooks or on special forms as long as they are clear, legible, understandable, and authenticated by authorized personnel. Survey records should include the model and serial numbers of instruments used and efficiencies of counting where appropriate. The signature of the person making the record and the date should be on the same page as the record and should immediately follow 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.

Except in those cases in which the applicant or licensee proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the methods described herein after April 1, 1981, in evaluating applications for specific materials licenses for medical institutions or (in conjunction with inspections of performance) for evaluating survey programs established by licensees.

If an applicant or licensee wishes to use the method described in this regulatory guide on or before June 1, 1981, the pertinent portions of the application or the licensee's performance will be evaluated on the basis of this guide.

Table 1

SURVEY FREQUENCIES

1. All elution, preparation, and injection areas should be surveyed daily with a survey meter and decontaminated if necessary.

2. Laboratory areas where only small quantities of radioactive material (less than 200 μCi at any one time) are used should be surveyed monthly.

3. All other laboratory areas should be surveyed weekly.

4. The weekly and monthly surveys should consist of the following:

   a. A measurement of radiation levels with a survey meter sufficiently sensitive to detect 0.1 mR/h.

   b. A series of smear tests to measure contamination levels. The method for performing smear tests should be sufficiently sensitive to detect the limits in Table 2 to one significant digit.

   c. Any air sample measurements necessary to determine compliance with § 20.103 of 10 CFR Part 20 in cases where calculations alone are not sufficient.

Table 2

RECOMMENDED ACTION LEVELS FOR REMOVABLE SURFACE CONTAMINATION IN MEDICAL INSTITUTIONS*

		Type of Radioactive Material**					
		Alpha Emitters		Beta or X-Ray Emitters		Low-Risk Beta or X-Ray Emitters	
	Type of Surface	(μCi/cm²)	(dpm/100cm²)	(μCi/cm²)	(dpm/100cm²)	(μCi/cm²)	(dpm/100cm²)
1.	Unrestricted areas	10^{-7}	22	10^{-6}	220	10^{-5}	2,200
2.	Restricted areas	10^{-6}	220	10^{-5}	2,200	10^{-4}	22,000
3.	Personal clothing worn outside restricted areas	10^{-7}	22	10^{-6}	220	10^{-5}	2,200
4.	Protective clothing worn only in restricted areas	10^{-6}	220	10^{-5}	2,200	10^{-4}	22,000
5.	Skin	10^{-6}	220	10^{-6}	220	10^{-5}	2,200

* As adapted from Table I of Reference 10. Averaging is acceptable over nonliving areas of up to 300 cm² or, for floors, walls, and ceiling, 100 cm². Averaging is also acceptable over 100 cm² for skin or, for the hands, over the whole area of the hand, nominally 300 cm².

** Beta- or x-ray emitter values are applicable for all beta- or x-ray emitters other than those considered low risk. Low-risk nuclides include C-14, H-3, S-35, Tc-99m, and others whose beta energies are less than 0.2 MeV maximum, whose gamma- or x-ray emission is less than 0.1 R/h at 1 meter per curie, and whose permissible concentration in air (see 10 CFR Part 20, Appendix B, Table 1) is greater than 10^{-6} μCi/ml.

Table 3*

ACCEPTABLE SURFACE CONTAMINATION LEVELS FOR UNCONTROLLED RELEASE OF EQUIPMENT

Nuclide[a]	Average[b,c]	Maximum[b,d]	Removable[b,c]
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, 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, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

*Adapted from Regulatory Guide 1.86 (Ref. 30).

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-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 of 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 cm^2.

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, 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 proportionately and the entire surface should be wiped.

Table 4*

CONVERSION FACTORS FROM OLD TO NEW RADIATION UNITS

Quantity	Old Unit	Symbol	New Unit	Symbol	Conversion Factor
Activity	curie	Ci	becquerel	Bq	1 Ci = 3.7×10^{10} Bq
Absorbed dose	rad	rad	gray	Gy	1 rad = 1cGy = 10^{-2} Gy = 10^{-2} J/kg
Dose Equivalent	rem	rem	sievert	Sv	1 rem = 1cSv = 10^{-2} Sv
Exposure	roentgen	R	-	-	1 R = 2.58×10^{-4} C/kg

*Conversion to the new SI units provided in this table will now be considered in compliance with this guidance.

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APPENDIX A

SURVEYS OF RADIOACTIVE XENON-133 RELEASES

Surveys associated with the use of xenon-133 should be sufficient to show compliance with requirements for protection of persons in restricted and unrestricted areas (see §§20.103 and 20.106) and with the terms and conditions of the NRC Materials License. Surveys may consist of either measurements of airborne radioactivity or of calculations supported by records of xenon-133 used and measurements of pertinent ventilation and air effluent volumes. The procedures outlined below are acceptable for surveying xenon-133 concentrations in medical institutions.

Acceptable surveys would be indicated by records of the following information, procedures, or conditions:

1. Quantities Used

a. Verify that patient information records (Items 1-3 below) are in order; compare with similar information submitted to NRC in support of request for xenon-133.

(1) Number of studies per week.

(2) Activity administered to each patient.

(3) Comparison of number of studies and average activity administered to each patient with information submitted in application.

b. Verify that possession limits are controlled and corrected for differences in calibration date and date of use; compare with possession limits stated in license.

2. Survey Records for Use and Storage Areas

Check ventilation quarterly in all areas in which xenon-133 is used and stored to ensure that airflow rates are maintained in accordance with statements made in the license application.

3. Procedures for Routine Use

a. Check to determine that procedures being followed for routine use of xenon-133 are in accordance with procedures described in license application. Check to determine that all personnel using xenon-133 have been trained in these procedures for routine use of xenon-133.

b. Check to determine that special apparatus for administration and collection of xenon-133 is being used as specified in the license application.

c. Check to determine that special procedures are being used to reduce leakage (e.g., use of nose clamps or special enclosures) as specified in the license application.

4. Emergency Procedures

Check to determine that all personnel using xenon-133 have been trained in the established emergency procedures to be followed in case of an accidental release of xenon-133.

5. Air Concentrations of Xenon-133 in Restricted Areas

Check to determine that air concentrations of xenon-133 in restricted areas meet the requirements of §20.103. This may be done by making physical measurements. Alternatively, this may be done by reviewing the use of xenon-133 (Item 1.a above), checking the ventilation rate in each area, and performing calculations similar to those submitted with the license application (see Regulatory Guide 10.8, "Guide for the Preparation of Applications for Medical Programs"). If the results of the calculations indicate that air concentrations of xenon-133 (as averaged over one calendar quarter) approach or exceed 1×10^{-5} microcurie per milliliter, the licensee should consider and implement methods of increasing ventilation rates or of reducing patient load.

6. Methods of Xenon-133 Disposal

a. Dilution through exhaust systems

Licensees who dispose of xenon-133 by release to the atmosphere through an air exhaust system are required to perform surveys (i.e., measurements or calculations) to ensure that they are in compliance with paragraph 20.1(c) and §20.106 of 10 CFR Part 20. Paragraph 20.1(c) requires that the concentrations of xenon-133 in effluents to unrestricted areas be as low as is reasonably achievable by the current state of technology, and §20.106 requires that the concentrations averaged over a period of 1 year should not exceed 3×10^{-7} microcurie per milliliter.

Make physical measurements to determine compliance with §20.106 and paragraph 20.1(c). Alternatively, measure ventilation rate and, using xenon-133 data from Item 1.a above, perform calculations similar to those submitted with the license application (See Regulatory Guide 10.8).

If the results indicate that air concentrations of xenon-133 (as averaged over 1 year) approach or exceed 3×10^{-7} microcurie per milliliter, the licensee should consider and implement methods of increasing ventilation rates, reducing patient load, or decreasing amount of xenon-133 released (e.g., through use of a charcoal trap).

If the exhaust is released to a restricted area, e.g., a roof to which access is controlled, surveys should include checks to determine the effectiveness and continued implementation of provisions submitted with the license application to do the following: control access to the

restricted area; post appropriate warning signs; instruct persons who may enter the area in accordance with §19.12 of 10 CFR Part 19; monitor personnel entering the area; and survey the area.

b. Adsorption onto charcoal traps

Surveys should be made to check leakage from charcoal trapping devices. If the exhaust is vented to the outdoors or other unrestricted area, check to determine that air concentrations of xenon-133 averaged over 1 year do not approach or exceed 3×10^{-7} microcurie per milliliter. See Item 6.a above.

Record measurements to check the efficiency and general performance of collection and trapping devices according to specifications, both initially and on a continuing basis at the frequency specified in the license application. Include monitoring of traps to determine when saturation occurs and when the filter must be replaced.

Check the procedures for handling saturated filters, including the provisions of adequate shielding and ventilation. Calculations should be made of average concentrations of xenon-133 in air at the exhaust and compared to the allowable limit.

USEFUL CONVERSIONS

$1\ mCi = 10^3\ \mu Ci$

$1\ ft^3 = 2.832 \times 10^{-2} m^3 = 2.832 \times 10^4 ml$

$1 ft^3/min = 1.699 \times 10^6\ ml/h$

$= 6.796 \times 10^7\ ml/40\text{-}h\ week$

$= 1.488 \times 10^{10}\ ml/yr$

$1\ week = 168\ h$

APPENDIX B

SAMPLE CHECKLIST FOR RADIATION SURVEYOR

. Initiate contamination survey report for each lab.

a. Check card for previous survey results, e.g., successive red circles, nobody in.
b. Fill in name of Authorized User, Department, Building and Room Number, and Survey Date.
c. Sketch floor plan.

2. Ask lab personnel (and record answers on report form):

a. What isotopes are being used? (Compare with what User is cleared for.)
b. Where in the lab are they used?
c. Where are isotopes stored?
d. What was last order? (Compare with card record.)
e. Is Authorized User available if needed? If not, give reason, e.g., on leave, out of country, terminated employment.
f. In what other labs are isotopes used? (Compare with card record.)
g. Where is waste stored and disposed of?

3. Check labeling.

a. Lab door—"Caution, Radioactive Material" (CRM)
b. Liquid waste sink—"Contaminated Liquid Waste" (survey card should indicate radioactive sink—RS). Is sink log posted? Is it being used?
c. Radioactive hood—"Caution, Radioactive Material" (survey card should indicate radioactive hood—RH). "Air Flow Check" white label with date no older than 4 months required.
d. Refrigerator and other storage areas—"CRM," including those in corridors.
e. Radioactive waste containers—"CRM" or "Contaminated Waste" should be lined with yellow plastic bag.
f. Any area with external radiation over 2.5 mR/h should be labeled with "Caution, Radiation Area" (CRA) and should be noted on survey form. (See paragraph 20.202(b)(2) and §20.203 of 10 CFR Part 20.)
g. 10 CFR Part 19 signs.

4. Observe general laboratory conditions:

a. Food and drink preparation and use in radioactive material areas?
b. Waste container overfilled?
c. Dosimeters being worn?
d. Mouth pipetting?

5. Conduct laboratory survey using portable survey meter.

a. Record external dose rate from accessible storage surfaces.
b. Record exposure rate from contaminated surfaces.

6. Conduct smear survey:

a. Take first smear near or in lab entrance.
b. Take several smears from floor and benches and equipment as indicated by answers to earlier questions.

7. Discuss 10 CFR Part 19 (Instructions to Workers) requirements.

8. Complete results:

a. Count smears and list results on survey form.
b. Notify lab personnel of contamination, and note on form who was called and date of notification.
c. Identify all abnormal radiation safety conditions on survey form.
d. Complete survey card, replace in file, and mail survey form copy to User.
e. If lab has contamination (significant), call User, request cleanup, and resmear.
f. Resmear when notified or call User if no resmear was called for.
g. File carbon copy of results form.