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Subject: DOE Guide 441.1.9 Rad Contam Control Guide.pdf - Adobe Reader
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Hearing Identifier: Powertech_Uranium_Dewey_Burdock_LA_Public
Email Number: 96

Mail Envelope Properties (44CD2E65B0FF0E499CB32BC30CF781F0108E913C17)

Subject: DOE Guide 441.1.9 Rad Contam Control Guide.pdf - Adobe Reader
Sent Date: 8/24/2010 5:26:56 PM
Received Date: 8/24/2010 5:27:25 PM
From: Burrows, Ronald

Created By: Ronald.Burrows@nrc.gov

Recipients:
"Burrows, Ronald" <Ronald.Burrows@nrc.gov>
Tracking Status: None

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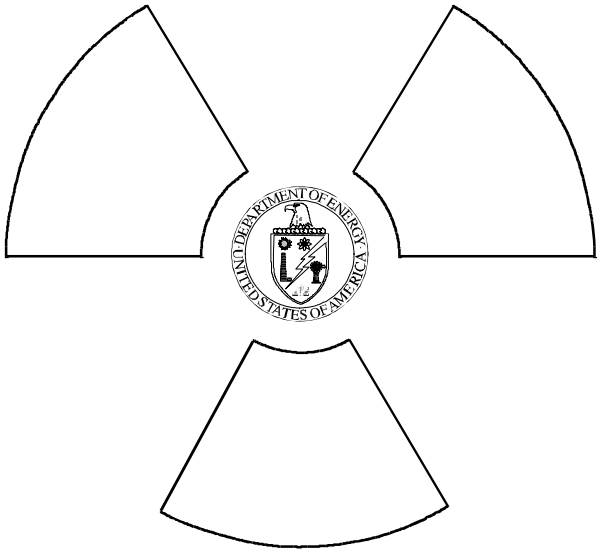
Files	Size	Date & Time
MESSAGE	3	8/24/2010 5:27:25 PM
DOE Guide 441.1.9 Rad Contam Control Guide.pdf	107011	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

DOE G 441.1-9
06-17-99

RADIOACTIVE CONTAMINATION CONTROL GUIDE

for use with
Title 10, Code of Federal Regulations, Part 835, Occupational Radiation Protection



Assistant Secretary for Environment, Safety and Health

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ACRONYMS

AEC	Atomic Energy Commission
ALARA	as low as is reasonably achievable
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE G	DOE Guide
DOE O	DOE Order
DOE-STD	DOE Standard
HEPA	high efficiency particulate air (filter)
NCRP	National Council on Radiation Protection and Measurements
NRC	U.S. Nuclear Regulatory Commission
RCS	RADIOLOGICAL CONTROL, DOE-STD-1098-99
RCT	radiological control technician

ABBREVIATIONS

cm	centimeter(s)

RADIOACTIVE CONTAMINATION CONTROL

1. PURPOSE AND APPLICABILITY

This Guide provides an acceptable methodology for establishing and implementing a contamination control program that will comply with U.S. Department of Energy (DOE) requirements specified in Title 10 of the Code of Federal Regulations (CFR), Part 835, Occupational Radiation Protection (DOE 1998a), hereinafter referred to as 10 CFR 835. In particular, this IG provides guidance for achieving compliance with certain provisions of Subparts E, K, and L of 10 CFR 835. For completeness, this IG also provides cross-references to detailed guidance provided in DOE-STD-1098-99, RADIOLOGICAL CONTROL (DOE 1999a), hereinafter referred to as the RCS.

This Guide amplifies the regulatory requirements of 10 CFR 835, which are enforceable under the provisions of Sections 223(c) and 234A of the Atomic Energy Act of 1954, as amended (AEC 1954).

Except for requirements mandated by a regulation, a contract, or by administrative means, the provisions in this Guide are DOE's views on acceptable methods of program implementation and are not mandatory. Conformance with this Guide will, however, create an inference of compliance with the related regulatory requirements. Alternate methods that are demonstrated to provide an equivalent or better level of protection are acceptable. DOE encourages its contractors to go beyond the minimum requirements and pursue excellence in their programs.

The word "shall" is used in this Guide to designate requirements from 10 CFR 835. Compliance with 10 CFR 835 is mandatory, except to the extent an exemption has been granted pursuant to 10 CFR 820, Procedural Rules for DOE Nuclear Activities (DOE 1997). The words "should" and "may" are used to denote optional program recommendations and allowable alternatives, respectively.

This Guide is applicable to all DOE activities that are subject to the requirements of 10 CFR 835.

2. DEFINITIONS

Terms defined in 10 CFR 835 are used in this Guide consistent with their regulatory definitions.

Contaminated area: Any area meeting the definition of "contamination area," "high contamination area," or "airborne radioactivity area" provided in 10 CFR 835.2(a).

Fixed contamination: Radioactive material that cannot be readily removed from surfaces by nondestructive means, such as casual contact, wiping, or brushing.

Frisk or frisking: Process of monitoring individuals or surfaces for contamination by directly scanning the surface with a suitable radiation detector.

Hot particles: Small, discrete, highly radioactive particles that can cause extremely high dose rates to a localized area.

Removable contamination: Radioactive material that can be removed from surfaces by nondestructive means, such as casual contact, wiping, or brushing.

3. DISCUSSION

Work with unsealed quantities of radioactive material creates the potential for generating radioactive contamination. 10 CFR 835 requires, in part, a contamination control program sufficient to provide warning of the presence of surface contamination and to prevent the inadvertent transfer of contamination at levels exceeding specified values outside of radiological areas under normal operating conditions.

An acceptable contamination control program incorporates two types of control: (1) Physical design features, including engineering control, and (2) administrative control. Contamination monitoring is part of and verifies the effectiveness of the contamination control program.

In implementing a contamination control program, physical design features that control contamination at the source are the most important element. Physical design features incorporated into older facilities may not be sufficient to meet modern contamination control standards. The physical design features used in a contamination control program may include engineering controls, including containment and ventilation, which may be the primary methods of controlling airborne radioactivity and internal exposures to workers in older facilities, during relatively short-term operations and maintenance, and in other situations in which permanent physical design features are unavailable or inadequate. For example, a permanently installed high efficiency particulate air (HEPA)-filtered ventilation system may be included as a physical design feature in a facility to control airborne radioactive material concentrations during routine operations, but a temporary HEPA-filtered ventilation system may be used as an engineering control during certain maintenance activities. Similarly, a drain system may be included as a physical design feature to route contaminated fluids to a controlled collection point, but temporary drains may be installed as engineering controls during system breach. Finally, administrative controls, including access restrictions and the use of specific work practices designed to minimize contamination transfer, should be used as the tertiary method to control exposure to contamination hazards. These elements of a contamination control program are not independent. The permanent physical design features included in a facility will dictate the types and levels of administrative controls and engineering controls that are possible and necessary.

A contamination control program is an essential element of a comprehensive radiological control program. In this Guide, when another element of a radiological control program interfaces with the contamination control program, the appropriate implementation guide is referenced and the topic of interest is listed as it applies to contamination control. Because of these interfaces, individuals involved with the contamination control program should interact with personnel working in other elements of the radiological control program, particularly with individuals involved in instrument calibration, posting and labeling, air monitoring, internal and external dosimetry, As Low As Is Reasonably Achievable (ALARA), training, and record-keeping programs.

Some DOE contractors have developed specific guidance addressing various aspects of contamination control, including radiological engineering, contamination containment design and construction, and radiological work practices. DOE is evaluating these documents to determine their complex-wide applicability and the potential impact of issuing them as DOE technical standards. In the interim, DOE encourages its contractors to review the guidance provided in these documents and to include it in site-specific programs, to the extent that the guidance is applicable to site hazards and controls.

Detailed information on contamination controls applicable to specific radiological hazards is provided:

- for tritium facilities, in DOE-HDBK-1129-99, TRITIUM HANDLING AND SAFE STORAGE (DOE 1999b);

- for plutonium facilities, in DOE-STD-1128-98, GUIDE TO GOOD PRACTICES FOR OCCUPATIONAL RADIATION PROTECTION IN PLUTONIUM FACILITIES (DOE 1998b); and

- for uranium facilities, in the *Health Physics Manual of Good Practices for Uranium Facilities* (DOE 1988).

This Guide provides references to detailed guidance provided in the RCS. The referenced guidance provides acceptable methods of achieving and maintaining compliance with related provisions of 10 CFR 835.

4. IMPLEMENTATION GUIDANCE

Activities that have the potential to generate surface contamination should be evaluated to ensure appropriate controls are established. To the extent practicable, contamination controls should be consistent to facilitate effective implementation by affected individuals. This section describes methods for establishing and operating an acceptable contamination control program. The discussion is divided into the following topics:

- Contamination Control Program Management;
- Physical Design Features;
- Administrative Control; and
- Contamination Monitoring.

Note that the requirements of 10 CFR 835.1101-1102 and the values provided in 10 CFR 835 Appendix D (Surface Contamination Values) apply only to radioactive material that is present in the form of surface contamination. The storage, movement, and use of radioactive material in other forms (e.g., material that is intrinsically radioactive or that has been made radioactive through activation processes) should be controlled consistent with applicable requirements in 10 CFR 835, including the training requirements under 10 CFR 835.901, the ALARA controls required under 10 CFR 835.101 and 835.1001- 1003, and the controlled area maximum yearly dose expectation provided in 10 CFR 835.602 .

4.1 CONTAMINATION CONTROL PROGRAM MANAGEMENT

Common characteristics of effective contamination control programs include:

- strong, written upper management commitment to control of contamination in the workplace;
- consistent line management implementation of required controls through established procedures, training, and frequent supervision;
- detailed work planning, including effective hazards analysis, pre-job briefings, and post-job debriefings; and
- consistent program support by affected individuals.

Management commitment should be established in a written policy which may be included in the ALARA Policy statement or other policy-level document. The policy should be implemented by written procedures, technical work documents, and radiological work permits commensurate with the hazards and required controls and sufficient to ensure consistent program implementation given the education, training, and skills of the affected individuals. Guidance on developing written procedures and on ensuring the appropriate education, training, and skills of affected individuals is provided in DOE G 441.1-1, MANAGEMENT AND ADMINISTRATION OF RADIATION PROTECTION PROGRAMS GUIDE (DOE 1999c). Guidance on radiation safety training is provided in DOE G 441.1-12, RADIATION SAFETY TRAINING GUIDE (DOE 1999d). The radiological control manager should be responsible for the development of the contamination control program, including associated design reviews.

Contamination control is the responsibility of everyone involved in radiological activities. All individuals working with radioactive material should follow established procedures that meet or exceed the guidance provided in this Guide and applicable DOE Orders and regulations. Line managers should be responsible for overseeing program implementation by their subordinates.

Guidance on effective planning for work with radiological hazards is provided in DOE G 441.1-2, OCCUPATIONAL ALARA PROGRAM GUIDE (DOE 1999e) and Chapter 3 of the RCS.

4.2 PHYSICAL DESIGN FEATURES

Appropriate controls that prevent the inadvertent transfer of removable contamination to locations outside of radiological areas under normal operating conditions shall be maintained and verified (10 CFR 835.1102(a)). 10 CFR 835.1001 requires measures to be taken to maintain radiation exposure as low as is reasonably achievable through physical design features and administrative controls. The primary methods used shall be physical design features (e.g., confinement, ventilation, remote handling, and shielding). Administrative controls shall be employed only as supplemental methods to control radiation exposure (10 CFR 835.1001(a)).

DOE recognizes the fact that the design and operating history of its facilities and the nature of existing contamination hazards may make control of contamination problematic, particularly in outdoor areas where legacy contamination may exist. Therefore, DOE regulations do not require that the controls implemented to prevent the transfer of removable contamination be impervious to ensure regulatory compliance. However, the controls should be appropriate to the extent of the hazard and the potential adverse effects that may result from such transfer. Should the potential exist for radioactive contamination to be transferred outside of posted or controlled radiological areas (i.e., as a result of human or animal intrusion, containment or system failures, planned work activities, or natural forces), enhanced monitoring and control programs should be developed and implemented to identify affected ares and ensure timely detection of the transfer and institution of appropriate controls over the affected area as required by 10 CFR 835 and further explained in this Guide.

Radiological control is affected by human performance and engineered design features. General and radiological design criteria for new facilities and major modifications to existing facilities are provided in 10 CFR 835, DOE O 420.1, FACILITY SAFETY (DOE 1995), and the RCS. The design of facilities currently under construction or modification should be planned and evaluated for adherence to the applicable criteria. The effectiveness of design features should be evaluated through performance of area and individual monitoring. See Section 4.4 of this Guide and Chapter 5 of the RCS for further information regarding contamination monitoring.

Physical design features that should be considered to enhance control of workplace contamination include:

- containment of process materials to the maximum practicable extent;
- components and materials that minimize leakage across seals;
- catch basins and controlled drains from potential leakage points;
- use of multiple barriers as necessary to control the spread of contamination. (For instance, a room, system or vessel that contains radioactive material should be designed and operated to retain that material, and should also be equipped as necessary with drain and ventilation systems to direct any leakage that may occur to appropriate collection systems);
- adequate working space around serviceable components to facilitate maintenance and repairs;
- filtered ventilation from areas of lower to areas of higher contamination levels;

- adequate space for donning and removal of protective clothing and individual frisking in low-background areas; and

- location of office and break areas away from radiological areas.

In addition to the above, facility design, including materials selected, shall include features that facilitate operations, maintenance, decontamination, and decommissioning (10 CFR 835.1002(d)). These activities should be facilitated by limiting the size of any contaminated areas and the magnitude of the contamination levels within those areas. To the maximum possible extent, materials used should be readily decontaminated using non-hazardous compounds, particularly water or steam. Smooth, corrosion resistant surfaces and rounded edges also facilitate decontamination. More detailed information on design features is provided in DOE G 441.1-2, OCCUPATIONAL ALARA PROGRAM GUIDE and Chapter 3 of the RCS.

When permanent physical design features are not sufficient to prevent the spread of contamination in the workplace, temporary physical design features in the form of engineering controls, such as containment devices and portable or auxiliary ventilation, should be installed. These circumstances arise frequently during maintenance, modifications, and decontamination and decommissioning. Planning for such activities should include evaluation of the potential for contamination spread and the effectiveness of engineering controls to reduce such potential, and, to the extent that engineering controls will not be effective, prescription of administrative controls to limit the spread of contamination.

Temporary containment devices may be particularly useful in controlling contamination spread resulting from system leaks and from maintenance that requires contaminated system breach. These devices range in complexity from simple plastic catch-basins suspended below leakage points to complex portable buildings used to enclose an entire work area. Many commercially-available designs include provisions for glove and equipment ports, ventilation, and contamination reduction exit portals.

Portable air handling systems used in contaminated areas, including vacuum cleaners, should be equipped with HEPA filtered exhausts or have their exhausts directed to installed systems that are so equipped. These provisions may not be necessary in areas where only tritium or radioactive noble gases are present or when the material to be vacuumed is wet enough to preclude resuspension after entry into the system collection chamber. Improper use of vacuum cleaners and portable air-handling equipment may result in the generation of airborne radioactive material or removable surface contamination. Extended use of air handling equipment may result in a significant build-up of radioactive material in the ductwork and filters. Periodic monitoring of the exhausted air and accessible equipment surfaces should be performed to assess the radiological impact of equipment operation. Chapter 4 of the RCS provides more detailed information regarding use of portable ventilation units and vacuum cleaners.

Although use of the devices discussed above has been proven effective in reducing contamination spread and the associated decontamination costs, these benefits must be weighed against the potential costs. Use of engineering controls may require expenditure of worker dose to set up, work in, maintain, and remove the device. There may be financial costs associated with device purchase or manufacture, training, possible reduced productivity, and device or component set-up, maintenance, and disposal. These factors are considered in implementation of an effective ALARA program, which is discussed in more detail in DOE G 441.1-2, OCCUPATIONAL ALARA PROGRAM GUIDE.

4.3 ADMINISTRATIVE CONTROL

When the use of physical design features (including engineering controls) to limit individual exposures is impractical, administrative controls shall be implemented to maintain exposures ALARA (10 CFR 835.1001(b)). To control the spread of contamination and limit individual exposures, a graded, multiple-tier system should be used in and around contaminated areas. The effectiveness of the controls should be verified through the conduct of contamination monitoring, as discussed in Section 4.4 of this Guide and Chapter 5 of the RCS.

4.3.1 Work Authorizations

Guidance on the use of work authorizations is provided in DOE G 441.1-2, OCCUPATIONAL ALARA PROGRAM GUIDE, and Chapter 3 of the RCS.

4.3.2 Access Control

Control of entry to contaminated areas is necessary to ensure that personnel entering the area are informed of the radiological status and potential hazards and are provided with the appropriate protective apparel and equipment. Control of egress from contaminated areas ensures that radioactive material is not inadvertently removed from the area by personnel or equipment. Efforts should be made to limit the size and number of contaminated areas in the facility, thereby limiting the need for use of protective clothing and the undesirable side effects of restricted access to facility equipment, heat stress, and radioactive waste generation.

4.3.2.1 Entry Controls

Protective clothing shall be required for entry into contaminated areas where removable contamination levels exceed the values provided in Appendix D of 10 CFR 835 (10 CFR 835.1102(e)). The type of protective clothing required should be prescribed based upon considerations of contamination levels, chemical and physical form of the contaminant, activities to be performed, and area accessibility. Other area and activity hazards, such as heat, flame, hazardous chemicals, physical obstructions, electrical shock, and limited visibility, should be considered when prescribing protective clothing. Appendix C "Compliance Guidelines" of 29 CFR 1910.120 (OSHA 1974) provides guidance on these considerations as follows:

> *The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. However, over-protection, as well as under-protection, can be hazardous and should be avoided where possible.*
>
> *Two basic objectives of any PPE program should be to protect the wearer from safety and health hazards, and to prevent injury to the wearer from incorrect use and/or malfunction of the PPE. To accomplish these goals, a comprehensive PPE program should include hazard identification, medical monitoring, environmental surveillance, selection, use, maintenance, and decontamination of PPE and its associated training.*
>
> *The written PPE program should include policy statements, procedures, and guidelines. Copies should be made available to all employees, and a reference copy should be made available at the worksite. Technical data on equipment, maintenance manuals, relevant regulations, and other essential information should also be collected and maintained.*

Multiple layers of protective clothing should be prescribed for areas in which the removable contamination levels exceed 10 times the values provided in Appendix D of 10 CFR 835, consistent with the consideration provided above. When penetration of the protective clothing by the contaminant is likely, such as during activities likely to induce heavy sweating or otherwise wet the individual, an additional layer of impenetrable clothing should be considered. In some cases, provision of an impenetrable plastic sheet for sitting or kneeling will be adequate and will reduce the hazards of heat stress. Additional guidance is provided in Chapter 3 of the RCS.

Prior to unescorted access to radiological areas (including contaminated areas) and prior to performing unescorted radiological work, each individual shall complete radiation safety training commensurate with the hazards in the area and the required controls (10 CFR 835.901(b)). Guidance on radiation safety training is provided in DOE G 441.1-12, RADIATION SAFETY TRAINING GUIDE and Chapters 3 and 6 of the RCS.

4.3.2.2 Egress Controls

Exits from contaminated areas should include provisions to facilitate retention of contamination in the area and for monitoring of individuals and the area to ensure control has been maintained. Undress methods should be prescribed to minimize the potential for contamination spread. When complex methods are necessary for removal of multiple layers of protective clothing, assistance should be provided.

Individuals exiting contaminated areas shall be monitored, as appropriate, for the presence of surface contamination (10 CFR 835.1102(d)). At a minimum, individuals exiting contaminated areas should perform a whole body frisk, using either portable or automated devices. The use of automated whole body frisking devices should be considered due to the consistency of results achievable with such devices. For individuals exiting areas where the only contaminated areas are laboratory bench surfaces or fume hoods, or where contamination potential is limited to specific portions of the body, the frisking should concentrate on affected areas. Exiting individuals should be trained to frisk any personal items carried into the area. Personal items include papers, pens, jewelry, security badges, dosimeters, and other items commonly used within the area. Necessary monitoring of tools or other material and equipment should be performed by trained radiological control personnel. See Section 4.4.3 of this Guide for information concerning necessary monitoring of material and equipment.

The instruments and techniques used for contamination monitoring shall be appropriate for the types, levels, and energies of the radiations encountered and for the existing environmental conditions, be periodically calibrated and maintained, and be routinely tested for operability (10 CFR 835.401(b)). Detailed guidance on selecting, calibrating, and using portable contamination control instruments is provided in DOE G 441.1-7, PORTABLE MONITORING INSTRUMENT CALIBRATION GUIDE (DOE 1999f), and Chapter 5 of the RCS.

Because skin contamination by certain radioisotopes, such as tritium, cannot be reliably detected by currently available hand-held or automated monitoring instrumentation, individual frisking is not an appropriate means of detecting skin contamination, as discussed in 10 CFR 835.1102(d). When individual exposure to such contamination hazards is possible, additional emphasis should be placed on radiobioassay programs and routine contamination and air monitoring programs. Detailed guidance on radiobioassay and air monitoring programs is provided in DOE G 441.1-3, INTERNAL DOSIMETRY PROGRAM GUIDE (DOE 1999g) and DOE G 441.1-8, AIR MONITORING GUIDE (DOE 1999h), respectively.

If background radiation levels or other conditions at the exit point preclude performance of personnel frisking, the exit point should be relocated to an area of lower background levels. If relocation of the exit point is not practicable, individuals should proceed directly from the exit point to an appropriate area to perform a whole body frisk. The travel path should be monitored frequently for contamination spread during use and after the detection of any contamination at the frisking station.

The instruments used for frisking should be capable of detecting contamination at or below the total surface contamination values provided in Appendix D of 10 CFR 835. Individuals should be trained in proper frisking techniques, including detector speed and distance, and proper techniques should be enforced through frequent line management observation. Frisking for skin contamination while wearing protective clothing will not generally provide detection capability adequate to ensure compliance with 10 CFR 835. Frisking for hot particles may require special techniques and should reflect considerations of source to detector size effects. Such factors should be included in radiation safety training and reinforced through line management attention.

4.3.3 Posting And Labeling

Guidance on area posting and contaminated item labeling is provided in DOE G 441.1-10, POSTING AND LABELING FOR RADIOLOGICAL CONTROL (DOE 1999i), and Chapters 2 and 4 of the RCS.

4.3.4 Areas of Fixed Contamination

The control measures discussed above have been proven effective in minimizing the generation and spread of removable contamination. However, these measures may not be appropriate for implementation in areas having only fixed contamination. When surfaces with fixed contamination are located within a radiological area, the radiological area posting and entry control requirements provide for adequate control of entry and egress. Additional control measures may be necessary to prevent inadvertent or unauthorized removal of the fixed contamination by methods that disturb the surface. 10 CFR 835 establishes specific requirements for controlling such locations outside of radiological areas. Although fixative coatings may be used to bind the contamination to the surface, such usage should be minimized and removable contamination levels should be reduced to levels that are ALARA prior to application of the coating.

When located outside of radiological areas, accessible areas in which only the fixed contamination levels exceed the total surface radioactivity values provided in Appendix D of 10 CFR 835 (i.e., removable contamination levels are below the Appendix D removable surface radioactivity values) shall (10 CFR 835.1102(c)):

- **undergo routine monitoring to ensure removable surface contamination levels remain below the Appendix D values**. Monitoring should be conducted in and around the area using techniques discussed in Section 4.4 of this IG; and

- **display conspicuous markings to warn individuals of the contaminated status**. The marking may consist of stencils on affected surfaces or postings established at each access point. The marking should include the radiation warning trefoil and the words "Caution, Fixed Contamination" and should provide radiation protection instructions sufficient to prevent inadvertent removal of the contamination.

Additional guidance on labeling of items having only fixed contamination is provided in DOE G 441.1-10, POSTING AND LABELING FOR RADIOLOGICAL CONTROL. Additional information on control of fixed contamination is provided in Chapter 2 of the RCS.

4.3.5 Conduct of Radiological Work

Work in contaminated areas should be conducted in a manner that minimizes the spread of contamination to adjacent surfaces, individuals in the area, and the workplace atmosphere. The following controls and techniques should be included in work planning and employee training:

- minimization of individuals and materials entering contaminated areas;

- a dedicated contaminated tool program, if justified by the extent of contaminated area work activities;

- proven work techniques to minimize contamination spread, including techniques to minimize the release of hot particles;

- judicious use of stop-work authority to correct radiological problems before they escalate;

- judicious work area monitoring to detect, and decontamination to reduce, contamination spread; and

- priority repair of leaks to minimize the spread of contamination.

Chapter 3 of the RCS provides more information on these issues.

4.3.6 Personnel and Material Decontamination

Two types of personnel contaminations can occur: skin (or personal clothing) contamination and wound contamination. In this context, personal clothing includes work clothing provided by the employer, but does not include protective clothing provided solely for contamination control purposes. Potential internal contamination caused by exposure to airborne radioactive material is discussed in DOE G 10 441.1-3, INTERNAL DOSIMETRY PROGRAM, and Chapter 5 of the RCS.

4.3.6.1 Skin and Clothing Contamination

When individuals detect skin (or personal clothing) contamination, they should notify the radiological control organization to ensure adequate characterization of the potential for significant skin dose. A qualified radiological control organization representative should:

- assess the extent of the contamination;
- retain samples of the contamination as necessary to perform a detailed dose assessment. Levels of contamination that trigger the need for dose assessments should be established for site-specific radionuclides. These trigger levels should not exceed 100 millirem (shallow dose equivalent); and
- initiate decontamination procedures that minimize skin abrasion and changes in pore size.

Skin decontamination methods should be established for site-specific radionuclides. Intrusive decontamination methods, such as tissue removal, require medical assistance. Contaminated personal clothing should be decontaminated by laundering or other appropriate methods, monitored, and returned to the owner or, if necessary, disposed of as radioactive waste.

4.3.6.2 Wound Contamination

Medical treatment of injuries takes precedence over radiological considerations. Emergency medical care should be administered immediately for injuries involving radioactive materials in accordance with National Council on Radiation Protection and Measurements Report Number 65, *Management of Persons Accidentally Contaminated with Radionuclides* (NCRP 1980).

4.3.6.3 Material and Area Decontamination

In general, water and steam are the preferred decontamination agents. Other cleaning agents should be selected based upon their effectiveness, hazardous properties, amount of waste generated, compatibility with the contaminated surface and other systems or items that may be contacted (including protective clothing and waste handling systems), and ease of disposal.

4.4 CONTAMINATION MONITORING

Comprehensive surveillance for contamination is the best available assurance of compliance with the requirements of 10 CFR 835. Frequent routine and special contamination monitoring should be performed in and around contaminated areas to verify the levels and locations of contamination and to alert personnel to changes in levels .

An effective contamination monitoring program includes the capability to calibrate instruments and perform appropriate operational tests, monitor for contamination, determine the lower detection limits both for field and laboratory instruments, and conduct the appropriate quality control checks to assure reliable instrument performance.

4.4.1 Contamination Control Values

Appendix D of 10 CFR 835 establishes values above which contamination controls, including posting, access controls, and radioactive material controls must be implemented. The contamination monitoring program should be sufficient to identify the location of surfaces having contamination at such levels. Contamination levels on surfaces outside of contaminated areas should be maintained below the applicable Appendix D values and as low as is reasonably achievable.

The footnotes to Appendix D of 10 CFR 835 provide guidance on appropriate means of determining the surface contamination levels and comparing these levels against the controlling values. Footnote 3 to Appendix D of 10 CFR 835 indicates that the total contamination levels may be averaged over an area of one square meter. When averaging total contamination levels over a square meter, the applicable Appendix D value shall be considered to have been exceeded if:

- the average contamination level in the one square meter area exceeds the applicable Appendix D value; or

- the sum of the activity in all isolated spots or particles in any 100 square centimeter (cm^2) area exceeds three times the applicable Appendix D value (10 CFR 835, App. D, Footnote 3). In practice, this condition may be determined by evaluating a number of 100 cm^2 grids and ensuring that the contamination level in any grid is less than three times the applicable Appendix D value.

There are two different scenarios under which combinations of radionuclides may be present as radioactive surface contamination:

- there may be a combination of radionuclides all of which are within the same 10 CFR 835 Appendix D category (e.g., one horizontal row of the Appendix D table, such as U-nat, U-235, U-238, and associated decay products); or

- there may be a combination of radionuclides in different 10 CFR 835 Appendix D categories (e.g., radionuclides in more than one horizontal row of the Appendix D table).

If a surface is contaminated with radionuclides all of which fall within the same 10 CFR 835 Appendix D category, then the contamination levels of the various radionuclides should be summed to determine if contamination levels in any area monitored exceeds the applicable Appendix D value. For example, if a surface is contaminated with both U-235 and U-238, then the contamination levels of both radionuclides should be summed to determine whether or not the applicable Appendix D value has been exceeded.

If a surface is contaminated with a combination of radionuclides in different 10 CFR 835 Appendix D categories, then the values provided in Appendix D of 10 CFR 835 may be considered to be independent of one another. It is not necessary to perform a sum of the fractions calculation to determine if the contamination levels in any area monitored exceed the applicable Appendix D value. For example, if a surface is contaminated with both U-235 and Sr-90, then the contamination levels of the two radionuclides may be compared independently to the applicable Appendix D values. Although it is permissible to do so, there is no need to sum the U-235 and Sr-90 contamination levels or their fractions relative to the applicable Appendix D values. In practice however, it is often more convenient to determine the sum of the contamination levels of the various radionuclides and to compare this figure to the most conservative applicable Appendix D value.

Footnote 5 to Appendix D of 10 CFR 835 discusses application of the listed surface contamination values for Sr-90. DOE recognizes that Sr-90 is typically present in equilibrium with its daughter, Y-90. Therefore, the values given for Sr-90 in Appendix D should be applied to the total activity from the Sr-90/Y-90 contamination. If the Sr-90 contamination resulted from processes involving the separation and purification of Sr-90, the lesser values (200

dpm/100 cm^2 - removable, 1,000 dpm/100 cm^2 - total) should be applied. If the Sr-90 contamination is present as a constituent of a mixture of fission products, the higher values should be applied (1,000 dpm/100 cm^2 - removable, 5,000 dpm/100 cm^2 - total).

If contamination by a radionuclide not listed in 10 CFR 835 Appendix D is suspected or verified, the actual contamination level should be compared to the Appendix D value(s) for radionuclides most similar to the contaminant(s) (i.e., radiological and chemical properties). Appropriate actions (e.g., posting, labeling, access controls) should be based on the results of these comparisons.

4.4.2 Monitoring

Individual and area monitoring shall be performed to demonstrate compliance with 10 CFR 835, document radiological conditions in the workplace, detect changes in radiological conditions, detect the gradual buildup of radioactive materials in the workplace, verify the effectiveness of engineering and process controls in containing radioactive materials and identify and control potential sources of individual exposure to radiation and/or radioactive material (10 CFR 835.401(a)). Monitoring frequencies should be based on potential and actual radiological conditions, probability of change in conditions, and area occupancy factors. The contamination monitoring program should incorporate the following features:

- scheduled routine monitoring for removable contamination and, where feasible, fixed contamination. Schedules should be adjusted to reflect changes in conditions, activities, and previous results;

- special monitoring as necessary to accommodate planned events, such as maintenance and repairs, barrier breach or leakage, material movement, and unplanned events such as spills;

- sample analysis and monitoring using instruments and techniques capable of detecting contamination below the values specified in Appendix D of 10 CFR 835. To provide for early warning of changes, a sample of smears taken from areas surrounding contaminated areas should be analyzed for contamination at levels below the Appendix D values;

- documentation of survey results;

- timely documented review of results for trends and changes and the need for further action, such as decontamination, posting, changes in monitoring frequency, and access controls; and

- provision of results for use by individuals planning work in or entering the area.

Monitoring for removable contamination should be conducted using conventional smear techniques for quantitative analyses and, where practicable, large-area smears for qualitative analyses. The use of large-area smears, adhesive pads or adhesive rollers is also helpful in identifying hot particles. Direct frisking is necessary for detecting fixed contamination; however, the application of direct frisking may be limited by such items as; background radiation levels, frisking surface characteristics (smooth/rough, wet/dry), frisking detector capabilities, frisking speed and distance, and type and energy of radiation being detected. Monitoring techniques should be developed and documented to ensure that the collected data are representative of the entire surface, with special attention paid to likely points for collection of contamination, such as leakage points, rough surface areas, areas that are infrequently cleaned, current work areas, and high traffic areas.

Conventional dry smear monitoring techniques may prove to be ineffective in the detection of tritium contamination. If tritium contamination is likely, monitoring should be performed using wet smears or direct frisking techniques or a combination of these methods. The monitoring method should be selected with due consideration of the characteristics of the radiation emitted by tritium.

Under certain conditions, radioactive contaminants may tend to penetrate the contaminated surface and then return to the surface over an extended period of time. This phenomenon is often encountered when dealing with tritium contamination (off-gassing) and when handling items that are stored or used under water (leaching), such as high level waste storage and shipping casks. When such conditions are likely, enhanced contamination monitoring methods that are capable of detecting changes in contamination levels as a result of leaching or off-gassing should be used .

Because of difficulties in implementing conventional removable contamination monitoring techniques (e.g., smear surveys), the presence of radioactive contamination in or on soil or other surfaces contaminated with granular solids may present significant challenges to the contamination monitoring program. Although the measurement of contamination levels in the granular solid (on a quantity of radioactive material per weight or volume basis) may be relatively straightforward, it may be difficult to compare the results of such measurements to the 10 CFR 835 Appendix D values, which are provided in units of contamination levels per unit area. Such comparisons are necessary to ensure compliance with the 10 CFR 835 requirements for posting and area and material control. DOE recognizes the difficulties associated with such measures. To ensure compliance, an assessment should be performed to determine the likelihood that radioactive contamination may be dispersed from the surface in question to surrounding areas or to items or individuals who may come in contact with the surface. The assessment may include a review of the operating history to determine whether significant contamination dispersion has occurred in the past, calculations based on realistic dispersion scenarios, performance of tests to determine the magnitude of contamination dispersion under actual operating conditions, or other technically defensible measures. If the results of the assessment indicate that contamination at levels exceeding the 10 CFR 835 Appendix D values is likely to be dispersed from the contaminated surface to surrounding or contacting surfaces, then the surface in question should be considered contaminated at levels exceeding the Appendix D values. If the surface in question is considered contaminated at levels exceeding the Appendix D values appropriate protective measures shall be implemented (10 CFR 835.1001(a)). See the hierarchy of controls discussion in Section 4.2 of this Guide.

10 CFR 835.401(b) requires that instruments and equipment used for monitoring be appropriate for the types, levels, and energies of the radiation(s) encountered. The effectiveness of the contamination monitoring techniques discussed in this section may be limited due to the physical conditions and specific characteristics (chemical and radiological) of radionuclides present in some DOE facilities. For example, common frisking and smear counting techniques and instruments may not be effective in detecting certain low-energy radiations. Detailed technical guidance for performing monitoring under these conditions is outside the scope of this Guide. Monitoring under these conditions should be conducted in accordance with applicable DOE Technical Standards and other documents, including those referenced in Section 3 of this Guide.

Other scientific standards (e.g., ANSI or Health Physics Society Standards or International Commission on Radiological Protection (ICRP) or National Council on Radiation Protection and Measurement (NCRP) publications) should also be considered.

Additional information regarding requirements for instruments and documentation is provided in DOE G 441.1-7, PORTABLE MONITORING INSTRUMENT CALIBRATION, and DOE G 441.1-11, OCCUPATIONAL RADIATION PROTECTION RECORD-KEEPING AND REPORTING (DOE 1999j), respectively and in Chapters 5 and 7 of the RCS.

4.4.3 Control of Material and Equipment

Release of material and equipment from contaminated areas presents special challenges. Many items have surfaces that are inaccessible, making adequate monitoring of surface contamination difficult. Monitoring of large items and vehicles can be time consuming and difficult in inclement weather. For these reasons, to the maximum extent practical, materials and equipment that enter contaminated areas should be retained there.

Except as noted below, any material and equipment that enters contaminated areas shall be retained there if (10 CFR 835.1101(a)):

- monitoring of accessible surfaces indicate the presence of removable surface contamination at levels exceeding the removable surface contamination values provided in Appendix D of 10 CFR 835; or

- prior use of the material and equipment indicates that removable surface contamination levels on inaccessible surfaces are likely to exceed these levels.

Material and equipment control programs should include features that:

- provide for assessment of the likelihood of material and equipment contamination through documentation of material and equipment location and use, monitoring of material and equipment surfaces, or a combination of these techniques;

- where monitoring is necessary, include monitoring for both fixed and removable contamination;

- for materials and equipment with inaccessible surfaces that are likely to be contaminated, require disassembly to the extent necessary to perform monitoring on those surfaces;

- require reduction of surface contamination before release to levels that are as low as reasonably achievable; and

- require retention of materials and equipment having contamination levels in excess of the values provided in Appendix D of 10 CFR 835.

A prospective and retrospective assessment of the likelihood of material and equipment contamination should consider:

- the nature of the material and equipment;

- radiological conditions in the locations in which it will be or was stored and used;

- controls established to reduce the likelihood of contamination transfer (wrapping or taping);

- the degree of assurance that exists regarding knowledge of the material’s and equipment's storage and use; and

- material and equipment properties that are or were likely to preclude contamination transfer or enhance the likelihood of contamination transfer (e.g., surface irregularities, installed fans and air inlets).

Under certain circumstances, materials and equipment having removable surface contamination levels in excess of the values provided in Appendix D of 10 CFR 835 may be released to controlled areas. Materials and equipment having either removable or total contamination levels in excess of these values may be released for movement to another radiological area. Appropriate monitoring and controls shall be implemented (10 CFR 835.1101(b)) and should include:

- determining the contamination levels before movement;

- wrapping or containing the material and equipment to prevent the spread of contamination;

- applying appropriate labels to the material and equipment and postings at the destination;

- selecting the transport path to minimize the potential for contamination spread; and

- monitoring the transport path as necessary after movement to ensure that contamination has not been spread.

Materials and equipment having fixed contamination (in either accessible or inaccessible locations) in excess of the total surface radioactivity values provided in Appendix D of 10 CFR 835 may be released for use in controlled areas. Release of such materials and equipment shall require that (10 CFR 835.1101(c)):

- removable contamination levels be below the values provided in Appendix D. Contamination levels should be assessed in accordance with the guidance provided in this Guide;

- routine monitoring be conducted. The monitoring should be adequate to ensure that the radiological hazard resulting from the release is fully characterized and that appropriate posting, labeling, and access control measures are implemented; and

- the material and equipment is clearly marked or labeled. Guidance for material and equipment labeling is provided in Guide DOE G 441.1-10, POSTING AND LABELING FOR RADIOLOGICAL CONTROL, and Chapter 4 of the RCS.

Written records of material and equipment release monitoring are required (10 CFR 835.703(c)). These records should include:

- a description of the material and equipment. Where large quantities are involved, a simple entry such as "box of nails" or "tool box full of hand tools" is adequate;

- monitoring date;

- identity of individual performing the monitoring;

- survey meter type and identification number; and

- monitoring results.

The provisions of 10 CFR 835 do not apply to release of materials and equipment from controlled areas. These activities are subject to DOE standards for protection of the environment.

4.4.4 Portal Monitors, Laundry Monitors, and Tool Monitors

DOE encourages the use of automated monitoring devices for evaluating material and equipment for release to controlled areas. Automated monitoring devices are typically large gas proportional or plastic scintillation detectors arranged in a shielded counting chamber into which objects may be placed. The monitor counts the object using a count time sufficient to achieve the desired confidence level and compares the net count rate from the object with a pre-determined alarm set point.

Automated monitoring devices are appropriate for monitoring of the external surfaces of non-porous, industrially clean objects. Objects with potential internal contamination should be surveyed using portable survey instruments. In general, automated monitoring devices are not appropriate for releasing porous material that has been contaminated in depth (e.g., wood, concrete) or in volume (e.g., activated material, smelted contaminated material). However, such devices may have limited application to monitoring of items contaminated in depth or volume by radioisotopes that emit high energy gamma radiation.

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UNITED STATES
DEPARTMENT OF ENERGY

Office of Worker Protection Programs and Hazards Management (EH-52/270CC)
19901 Germantown Road, Germantown, MD 20874-1290

Request for Changes to
RADIOACTIVE CONTAMINATION CONTROL GUIDE
(Use Multiple Pages as Necessary)

Page No. _____

Section No. _____

Paragraph No. _____

_____
Facility Requesting Change

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Contact Person

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Telephone Number - Fax Number

Description of Change Request:

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Suggested Specific Word Changes:

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EH-52 Technical Staff Contact:	EH-52 Guidance Program Contact:
Peter V. O'Connell	Joel L. Rabovsky
(301) 903-5641	(301) 903-2135