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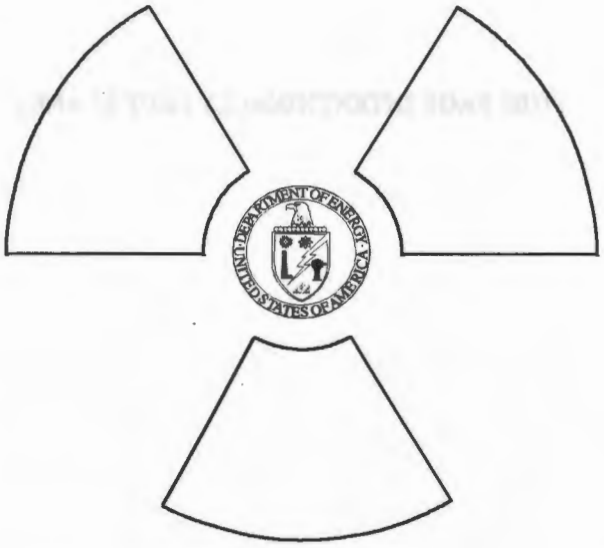
RADIATION-GENERATING DEVICES GUIDE

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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CONTENTS

ACRONYMS

AEC	U.S. 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
NCRP	National Council on Radiation Protection and Measurements
NRC	U.S. Nuclear Regulatory Commission
RCS	DOE-STD-1098-99, RADIOLOGICAL CONTROL
RGD	radiation-generating device

RADIATION-GENERATING DEVICES

1. PURPOSE AND APPLICABILITY

This Guide provides an acceptable methodology for establishing and operating a radiation-generating devices (RGD) 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. For completeness, this Guide also cites detailed guidance found in DOE-STD-1098-99, RADIOLOGICAL CONTROL (DOE 1999a), hereinafter referred to as the RCS, and secondary documents (American National Standards Institute (ANSI) Standards, etc.)

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).

Considerations of facility size and sophistication may result in difficulties in applying the guidance provided in this Guide to those high-energy particle accelerators that are subject to the requirements of DOE O 420.2, SAFETY OF ACCELERATOR FACILITIES (DOE 1998b), even though the requirements of 10 CFR 835 may apply to such installations. Management of these facilities should carefully consider the guidance provided in this Guide and implement this guidance to the extent that such measures will facilitate compliance with 10 CFR 835.

Except for requirements established 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 to 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 1993). The words "should" and "may" are used to represent 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.

Cabinet X-ray system: An X-ray system with the X-ray tube installed in an enclosure (hereinafter termed "cabinet") which, independently of existing architectural structures except the floor on which it may be placed, is intended to contain at least that portion of a material being irradiated, provide radiation attenuation, and exclude individuals from its interior during generation of X-radiation. Included are all the X-ray systems designed primarily for inspection of carry-on baggage at airline, railroad, and bus terminals, and in similar facilities. An X-ray tube used within a shielded part of a building or X-ray equipment which may temporarily or occasionally incorporate portable shielding is not considered a cabinet X-ray system.

Interlock: A device for precluding access to an area of radiation hazard by either preventing entry or by automatically removing the hazard. One example is an electro-mechanical control mechanism that interrupts the beam of ionizing radiation or shuts down the radiation installation whenever the interlock is challenged.

Irradiator: Any gamma- or neutron-emitting sealed radioactive material that has the potential to create a radiation level exceeding 500 rads (5 grays) in 1 hour at 1 meter and is operated within the requirements of an RGD installation.

Modification: Any alteration of the shielding configuration, device or installation operating practices, or the replacement of the original RGD (or component part thereof) with another that has not been previously evaluated, inspected, monitored, and documented by the radiological control organization. This definition also includes the collocation of additional or multiple unevaluated RGDs within a previously evaluated installation.

Normal operation: Operation under conditions as recommended by the manufacturer of the RGD with recommended shielding and barriers in place, and as specified in the operating procedures and requirements for the RGD installation.

Occupied (occupiable) area: An area or location that may be physically accessible by individuals (or body parts thereof) while a radiation-generating device is in operation.

Off-normal operation: An event or condition that adversely affects, potentially affects, or indicates degradation in the safety, security, environmental, or health-protection performance or operation of an RGD installation.

Qualified expert: An individual having the knowledge, training, and recognition of such by management to measure ionizing radiation, to evaluate safety techniques, to design RGD installations, and to provide advice on radiation protection requirements.

Radiation-generating device (RGD): Collective term for devices which produce ionizing radiation, including, certain sealed radioactive sources, small particle accelerators used for *single purpose* applications which produce ionizing radiation (e.g., radiography), and electron generating devices that produce X-rays incidentally.

Radiography: Examination of the structure of materials by nondestructive methods, using a RGD.

RGD Custodian: An individual who is trained and designated to maintain cognizance over accountability and control of radiation-generating devices assigned to him or her.

RGD installation: The sum of the radiation source (e.g., sealed radioactive material or x-ray tube), the associated equipment and component items, and the space in which they are operated.

Five types of installations are defined as follows:

(1) **Shielded installations** are those designed to use the room-within-a-room concept to limit access to the RGD beam and to place more emphasis on distance as opposed to shielding for radiation protection and include shielded, exempt shielded, and cabinet x-ray installations;

(2). **Unattended installations** are those designed for a specific purpose and that do not require personnel in attendance for operation and include unattended gauge and other unattended installations;

(3) **Open installations** are those designed to accommodate a specimen that is so large as to make an exempt shielded installation impractical;

(4) **X-ray diffraction & fluorescence analysis equipment**, including both open and closed beam installations; and

(5) **Incidental**, including devices that emit low levels of ionizing radiation as a byproduct of their normal function, such as electron beam welders, electronic microscopes, and pulse generators.

RGD Operator: An individual who is trained and deemed qualified to use a radiation-generating device.

Useful beam: That part of the primary and secondary radiation beam that passes through the aperture, cone, or other device used for collimation.

3. DISCUSSION

The RGDs addressed in this Guide may be classified as either devices that must be electrically energized to produce ionizing radiation or sealed radioactive sources that emit radiation continuously. RGDs are used at DOE sites with a great variety of configurations and operating characteristics and in a wide spectrum of applications. This Guide addresses RGDs used for industrial and research applications, but does not address RGDs used for patient diagnostic or therapeutic medical applications. Medical RGDs should be registered with the cognizant regulatory agency which typically is a Federal, state or local level authority.

Specific examples of RGDs addressed by this Guide include: sealed photon- or neutron-emitting radioactive sources; X-ray producing radiography equipment; research and analytical X-ray or electron beam machines; sealed radioactive sources used as irradiators; particle accelerators; neutron generators; Van de Graff generators; electromagnetic pulse generators (if capable of producing ionizing radiation); electron microscopes; electron arc welders; microwave cavities that produce X-rays incidentally, and cabinet X-ray machines used for security applications.

Note that sealed radioactive sources are specifically addressed in DOE G 441.1-13, SEALED RADIOACTIVE SOURCE ACCOUNTABILITY AND CONTROL GUIDE (DOE 1999b). The guidance provided in this Guide should be considered in addition to that provided in DOE G 441.1-13 for those sealed radioactive sources that produce radiation fields exceeding 100 millirem in one hour at a distance of 30 centimeters from the source.

4. IMPLEMENTATION GUIDANCE

10 CFR 835 must be generic to cover the wide spectrum of facilities and activities within the DOE complex. To ensure an adequate level of radiological safety and compliance with 10 CFR 835, the requirements and guidance provided in the following secondary documents should be implemented, to the extent appropriate to site-specific activities and hazards. Note that, for those facilities that are subject to the requirements of DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards (DOE 1984) the requirements of these documents may be mandatory.

- 10 CFR 34, Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations (NRC 1992);
- ANSI N43.3, *American National Standard For General Radiation Safety - Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies Up to 10 MeV* (which updates ANSI N543-1974) (ANSI 1993);
- ANSI N43.2, *Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment* (ANSI 1989a); and
- ANSI N43.5, *Radiological Safety Standard for the Design of Radiographic and Fluoroscopic Industrial X-Ray Equipment* (Formerly called N537) (ANSI 1989b).

Should any conflict exist between the requirements and guidance provided in these standards and the requirements of 10 CFR 835, then the requirements of 10 CFR 835 take precedence. This Guide provides guidance that supplements that provided by the ANSI Standards discussed above.

4.1 ADMINISTRATIVE ORGANIZATION AND CONTROLS

RGD control should be maintained by individuals responsible for RGD operations. Overview for radiological safety should be provided by the independent radiological control organization. Within smaller organizations, where one individual may be responsible for multiple roles (such as RGD custodian, qualified expert, and radiological control staff), independent oversight of that individual's activities should be provided to ensure the ongoing quality of the RGD program.

4.1.1 Contractor Management

To implement their responsibilities, management should perform the following:

- appoint a RGD Custodian for each RGD;
- exercise supervision to ensure safe RGD operation;
- review RGD procedures and operational and maintenance logs;
- schedule periodic inspections and monitoring;

- approve operating and emergency procedures;
- schedule and otherwise provide for training to ensure that RGD Custodians and RGD Operators are trained and re-certified (see Section 4.2.4 for guidance concerning training of personnel); and
- promptly terminate the operation of any unsafe RGD installation.

4.1.2 RGD Custodian

The appointed RGD Custodian should provide direct control over RGD installations and operations. The RGD Custodian should ensure that the RGD installation is operated and maintained safely and in accordance with the requirements of the site-specific RPP. Specific responsibilities of the RGD Custodian should include the following:

- controlling the keys to RGD installations, RGDs, and/or RGD storage facilities and authorizing the operation of the RGD installation;
- ensuring that RGD Operators follow applicable operating procedures;
- ensuring that RGD Operators follow the applicable Radiological Work Permit (RWP), or other written authorization;
- ensuring that required dosimeters are properly worn;
- ensuring that inspections of RGD interlocks, warning lights, and other safety features are performed and documented;
- ensuring that all required monitoring is performed and documented;
- ensuring that all RGD Operators are trained;
- reviewing and approving materials used for training RGD Operators, in cooperation with the radiological control staff;
- ensuring that accountability records of assigned RGDs are maintained;
- notifying the radiological control staff of changes in shielding configuration, use, storage, disposal, or loss of a RGD;
- ensuring proper disposition of unneeded RGDs;
- ensuring that sealed radioactive source integrity tests are performed; and

- maintaining schematics (mechanical and electrical), safety device wiring diagrams, manufacturer provided instruction manuals, and operations and maintenance records.

4.1.3 RGD Operator

RGD Operators are those individuals authorized by the RGD Custodian to use the RGD.

The RGD Operator should:

- ensure proper control of the RGD installation and/or area;
- ensure that inspections and monitoring are performed and documented;
- ensure that required dosimeters are worn properly by all individuals in the vicinity of RGD operations;
- follow the applicable RWP, or alternative authorization, and ensures that other individuals also adhere to the requirements of those documents;
- establish control of all adjacent areas where individuals could receive a dose approaching administrative limits and ensure that those areas are unoccupied during RGD operations;
- maintain access control over the actual RGD exposure area;
- follow all applicable operating procedures; and
- promptly terminate unsafe RGD operations.

4.1.4 Qualified Expert

A qualified expert(s) should be appointed by management. To ensure technical qualification, the qualified expert should be approved by the radiological control manager. The qualified expert should have knowledge and training necessary to: (1) measure ionizing radiations; (2) analyze the significance and evaluate the potential health effects of monitoring results; and (3) advise on matters related to radiological control as it pertains to installations covered by this Guide. The qualified expert should have in-depth knowledge of characteristics associated with RGDs, RGD installations, and applicable Rules, Manuals, Orders, and Standards.

The qualified expert should periodically review the following areas and provide recommendations to the radiological control manager:

- the design or modification of RGD installations;
- the results of pre-operational inspections and radiological monitoring;
- the engineered safety features and administrative controls;
- the need for and adequacy of the personnel monitoring program for the installation; and

- the training materials used for the RGD Custodians and Operators.

4.1.5 Radiological Control Manager

A radiological control manager should be designated to ensure independent overview of radiological operations, including RGDs. The radiological control manager's function is similar to that of the radiological protection supervisor or radiation protection officer, as described in the specific ANSI standards referenced in this Guide and publications of the National Council on Radiation Protection and Measurements (NCRP). Additional guidance for radiological control manager responsibilities is provided in RCS Articles 141and 142 and ANSI N43.3.

4.1.6 Radiological Control Organization

The radiological control organization (RCO) should provide support to managers and radiological workers. The radiological control staff should be established consistent with Chapter 1 of the RCS.

Radiological control staff should perform the following tasks to implement their functions described in RCS Articles 141 and 143:

- evaluate adherence to the RPP by conducting pre-operational and periodic inspections and radiation monitoring of RGD installations;
- under the direction of the radiological control manager, provide radiological support to line managers and RGD operations;
- ensure that all inspections and monitoring are performed and documented;
- perform radiation monitoring of open installations to verify proper posting and control of boundaries during operations and removal of hazards (and associated temporary postings and barriers) after operations;
- monitor all RGD installations for potential or actual unsafe operations or conditions and conformity to the site-specific RPP; and
- review the operational and maintenance logs maintained by RGD Custodians and Operators to ensure that controls are commensurate with existing or potential radiological hazards.

4.2 DEVELOPMENT OF SITE-SPECIFIC DOCUMENTS

10 CFR 835.104 requires that written procedures be developed and implemented as necessary to ensure compliance with that regulation, commensurate with the radiological hazards created by the activity and consistent with the education, training, and skills of the individuals exposed to the hazards (10 CFR 835.104). Written procedures should be developed and implemented as necessary to ensure proper implementation of the radiation protection program elements addressed in this Guide. Additional guidance is provided in DOE G 441.1-1, MANAGEMENT AND ADMINISTRATION OF RADIATION PROTECTION PROGRAMS GUIDE (DOE 1999c).

4.2.1 Radiological Monitoring

Radiological monitoring should be conducted to determine and document the integrity and adequacy of the

shielding and to verify that posting and access control requirements are satisfactory before the RGD is turned over to the RGD Custodian for routine operation and periodically thereafter. If there is a potential for exposure in accessible areas adjacent to the installation, then the adjacent areas should be monitored and should be vacated when pre-operational monitoring is performed.

Specifically, the pre-operational monitoring program should be designed to:

- determine dose rate or integrated dose received in any 1 hour as dependent upon the pulse capability of the RGD;
- evaluate the exposure potential of the RGD at the maximum value of applied voltage or current, *or at the maximum exposed position of the source for sealed radioactive source installations.* RGD(s) should be operated in steps of increasing beam strength until the highest values are achieved;
- include the use of mechanical or electrical devices that restrict beam orientation and magnitude, and determine the degree of beam restriction, with and without those devices;
- detect and measure potential leaks in the shielding and barriers; and
- encompass all geometries in which the useful beam can be directed.

Special monitoring should be conducted as follows:

- during the performance of maintenance and alignment procedures if the procedures require the presence of a primary beam;
- when any component in the system is disassembled or removed;
- any time an inspection of the components in the system reveals an abnormal condition;
- whenever personnel monitoring dosimeters or area monitoring show a significant increase over a previous monitoring period or are approaching administrative limits;
- following maintenance or calibration prior to restoration to fully operable status; and
- after any modification.

It is not necessary to perform radiological monitoring of electrically-energized RGDs (that is, those RGDs that do not contain radioactive material) during periods when they have been removed from service and placed in storage. However, when any RGD which has been in "storage" is being reactivated for use, functional and operational inspections and radiological monitoring should be performed prior to initial use.

For open installations, where irradiation configurations and boundary conditions are likely to change frequently, radiation monitoring shall be conducted in response to changing working parameters (10 CFR 835.401(a)).

After the initial assessment, independent inspections and monitoring should be conducted as necessary to verify: 1) that RGD operations continue to remain safe; 2) that during the operation of any open installation, the proper

location and posting of boundaries is maintained; and 3) that after any modification or removal from storage of a RGD installation, the effectiveness and operability of safety features are adequate. Additional guidance on area monitoring is provided in DOE G 441.1-4, EXTERNAL DOSIMETRY PROGRAM GUIDE (DOE 1999d).

4.2.2 Sealed Radioactive Source Leak Testing

A program of sealed radioactive source accountability and leak testing for radioactive contamination and encapsulation integrity shall be implemented (10 CFR 835.1202). Guidance for this program is provided in DOE G 441.1-13, SEALED RADIOACTIVE SOURCE ACCOUNTABILITY AND CONTROL GUIDE.

4.2.3 Area Posting

4.2.3.1 Radiological Conditions

Guidance for posting radiological hazards is provided in Guide DOE G 441.1-10, POSTING AND LABELING FOR RADIOLOGICAL CONTROL GUIDE (DOE 1999e).

4.2.3.2 Operational Status

Posting should be used to signify the presence of an intermittent radiation condition. The posting should also express the method used to convey that a radiation field is present. An example of such a sign is:

"CAUTION:
RADIATION BEING PRODUCED OR RADIATION AREA EXISTS WHEN RED LIGHT IS ON"

4.2.3.3 Maintenance Status

Any time an installation requires maintenance, the entrance to the area in which the installation is located and the inside of the installation should be conspicuously posted to indicate the maintenance status of the installation. Posting should be established:

- during the performance of maintenance and alignment procedures if the procedures require the presence of radiation; and

- any time an inspection or monitoring reveals a deficient condition for any safety device.

When a safety device or interlock has been approved to be by-passed or is awaiting repair, the entrance to the installation and the RGD enclosure should be posted with a prominent sign bearing the words **"SAFETY DEVICE NOT FUNCTIONING"** or a similar message.

4.2.4 Training

Guidance for radiation safety training is provided in DOE G 441.1-12, RADIATION SAFETY TRAINING GUIDE (DOE 1999f). This training should be augmented with pertinent material provided in DOE-HDBK-1108-97, RADIOLOGICAL SAFETY TRAINING FOR ACCELERATOR FACILITIES (DOE 1997a) and DOE-HDBK-1109-97, RADIATION SAFETY TRAINING FOR RADIATION-PRODUCING (X-RAY) DEVICES (DOE

1997b). Additional training guidance is provided in Chapters 3 and 6 of the RCS and DOE G 441.1-1, MANAGEMENT AND ADMINISTRATION OF RADIATION PROTECTION PROGRAMS GUIDE.

4.2.5 Records

Guidance for generation and maintenance of records sufficient to meet the requirements of 10 CFR 835 are provided in DOE G 441.1-11, OCCUPATIONAL RADIATION PROTECTION RECORD-KEEPING AND REPORTING GUIDE (DOE 1999g).

4.3 ENGINEERED SAFETY CONTROLS

10 CFR 835.1001 requires that measures be taken to maintain radiation exposures in controlled areas ALARA. The primary method used shall be physical design features (e.g., confinement, ventilation, remote handling, and shielding); administrative controls shall be incorporated only as supplemental methods and for specific activities where physical design features are demonstrated to be impractical (10 CFR 835.1001). 10 CFR 835.1003 further requires that during routine operations, the combination of design features and administrative controls shall provide that the anticipated occupational dose to general employees does not exceed regulatory limits and that the ALARA process is utilized for personnel exposures to ionizing radiation. Physical design features typically include features that are used to control the work environment, such as permanent structures, systems, and controls, including shielding, filtered ventilation systems, remote controls, containment devices, and the use of designs and materials that facilitate operations, maintenance, and other activities. Physical design features may also include engineering controls (e.g., temporary shielding, confinement and ventilation systems) that are typically used to facilitate short-term or emergent operations when the installed physical design features do not provide the desired level of protection. Administrative controls typically include controls that are implemented by the individual at the work site, including written procedures, technical work documents, work authorizations, and other controls that are used to guide individual actions in a manner that will facilitate implementation of the ALARA process (10 CFR 835.1001).

ANSI N43.3 and N43.2 provide specific guidance that should be considered for exempt shielded (including cabinet X-ray), shielded, unattended, and open installations. As discussed in the introduction to Section 4 of this Guide, not all of the ANSI guidance for shielded, unattended, and open installations meet the requirements of 10 CFR 835. If the design of the facility cannot be upgraded in a practical manner to meet the 10 CFR 835 exposure rate criteria, then the alternative is the implementation of additional access and occupancy controls to meet the design objectives.

4.3.1 Shielding, Controls, & Safety Devices

4.3.1.1 Shielding

Permanent shielding should be designed and installed consistent with the guidance provided in ANSI N43.3.

The effect of temporary shielding should be evaluated prior to its installation. The installation, use, and removal of temporary shielding should be controlled by procedures and in accordance with RCS 314.

4.3.1.2 Access Control and Safety Devices

10 CFR 835.501 establishes requirements for maintaining control over entries into radiological areas. 10 CFR 835.502 establishes supplemental requirements for entry controls for high and very high radiation areas. Viewed

collectively, these provisions establish a hierarchy of controls, with general, flexible requirements for all radiological areas and more specific and stringent requirements for areas of greater hazard.

Guidance for establishing appropriate signs and barricades as required by 10 CFR 835.501 is provided in this Guide and in DOE 441.1-10, POSTING AND LABELING FOR RADIOLOGICAL CONTROL GUIDE. Guidance for establishing appropriate administrative controls is provided in DOE 441.1-2, OCCUPATIONAL ALARA PROGRAM GUIDE (DOE 1999h), and DOE 441.1-9, RADIOACTIVE CONTAMINATION CONTROL GUIDE (DOE 1999i). The RCS provides additional guidance for all three of these Guides. The remainder of this section provides guidance for implementing the physical controls required by 10 CFR 835.501 and 502.

The purpose of access control devices is to prevent unauthorized or inadvertent entry into a radiological area and/or to warn of a hazard.

If locked entryways are used, the keys used for one RGD installation or storage facility should not provide access to another RGD installation or storage facility.

Additional measures shall be implemented to ensure individuals are not able to gain unauthorized or inadvertent access to very high radiation areas (10 CFR 835.502(c)). Such measures (i.e., physical constraints) should include locking or securing service doors and panels with tamper resistant fasteners or the use of multiple and redundant access controls.

Due to the lack of intrinsic shielding and the nature of use, access to a very high radiation area could be possible for an "open" installation. Additional measures (e.g., interlocked "photoelectric eye" light beams) should be established to meet this requirement.

4.3.1.3 Interlocks

Doors and/or access panels in exempt shielded, shielded, and unattended installations should be equipped with one or more fail-safe safety interlocks to prevent irradiation of an individual (ANSI N43.3(6.5.2)).

If an area radiation monitor is incorporated into a safety interlock system, the circuitry should be such that a failure of the monitor shall either prevent normal access into the area or operation of the RGD.

4.3.1.4 Device Controls

One or more physical control devices should be used to secure the RGD to prevent unauthorized access and use. The control system governing the production of radiation should be equipped with a lock and key to prevent unauthorized use. The key controlling the production of radiation in one RGD should not control the production in another.

Control devices used to limit RGD time, position (irradiation geometry), current, voltage, beam intensity, or control panel lights or system indicators should be fail-safe.

4.3.1.5 Run-Safe and Emergency Shutdown Devices

Administrative procedures should be implemented to ensure that the RGD installation and the RGD safety interlock control devices are such that:

- radiation cannot be produced until the interlock system logic has been completely satisfied;
- production of radiation cannot be resumed by merely reestablishing the interlock circuit at the location where an interlock was tripped; and
- the safety circuit cannot be re-energized or reestablished automatically (i.e., there should be a manual safety circuit reset on or near the main control console).

For each area designated as a high radiation area or very high radiation area, 10 CFR 835.502 provides an option that permits a control device to automatically generate audible or visible alarm signals to alert individuals and the cognizant RGD Operator of a potential entry into the area before it occurs. In order to meet ANSI N43.3 guidance, warning devices should be provided as an addition to any other access control feature in accordance with the installation specific requirements delineated in *Section 4.3.2, Guidance for Specific RGD Installations*, of this Guide. These warning devices are typically warning lights.

All RGD warning lights should be red or magenta for consistency. A sufficient number of lights should be installed so that at least one light is easily visible from all reasonably occupied areas that may have dangerous radiation levels and from reasonable avenues of approach to such areas.

However, warning lights (even though interlocked to fail-safe if burnt out) are only passive in nature. When operating, they generally do not prevent an individual from physical access to a radiation beam unless they are used as part of a photosensitive circuit. Such a circuit would remove the radiation beam or field if any individual intercepted the light beam.

Due to the passiveness (i.e., reliance on worker attention and action) of this safety feature and the potential for failure, at least one interlocked warning light should be used in all circumstances. The interlocked warning light should be used to provide visual indication that radiation is being produced, and should be used in conjunction with any interlocked safety device which restricts physical access to a radiation beam or field. This is recommended above and beyond the installation specific requirements in this Guide, or the minimum required by 10 CFR 835.502. When used in this fashion, the RGD should not be operable when the warning light is out.

It should not be possible to override the operation of any warning device activated by a fail-safe function without positive actions by the operator such as resetting controls at the control console.

4.3.1.6 Monitoring Instruments

Requirements and guidance for instruments used to measure radiation are given in 10 CFR 835.401(b) and DOE G 441.1-7, PORTABLE MONITORING INSTRUMENT CALIBRATION GUIDE (DOE 1999j), respectively.

4.3.2 Guidance for Specific RGD Installations

In addition to the general guidance in this Guide, there is specific guidance cited from ANSI N43.3 and N43.2 for each of the primary RGD installations and the open and shielded beam analytical RGDs. The analytical RGD installations may enclose one or more X-ray devices and/or sealed radioactive sources.

The ANSI standards specify dose rates that are to be used for installation categorization only and are not to be interpreted as permissible levels.

4.3.2.1 Accelerators

Small (low voltage, less than or equal to 10 MeV) accelerators used for radiography, ion implantation, or the production of incidental photons or particles (e.g., neutron generators) in exempt shielded, shielded, or open installations should be operated in accordance with the guidance specified by this Guide and the applicable ANSI standards. When accelerators are used outside of exempt shielded or shielded installations, requirements for open-air radiography prevail.

When used within shielded installations, determination must be made whether the requirements for the exempt shielded or shielded installations prevail. Although the basic radiological control program requirements discussed in this guide are generally applicable to the large multi-purpose research accelerators, the complexities associated with these facilities may require additional consideration beyond the scope of this guide. Additional requirements for those RGDs with particle energies exceeding 10 MeV are provided in DOE Order 420.2, Safety of Accelerator Facilities.

4.3.2.2 Electron Devices that Generate X-Rays Incidentally

These devices are usually shielded to attenuate the emission of X-rays. Requirements for the exempt shielded or shielded installations prevail. Examples include electron beam welders, electronic microscopes, pulse generators, etc., and microwave cavities if used as beam guides.

Preoperational inspections and monitoring should be performed initially upon receipt. However, the requirement for the routine semiannual inspections and monitoring may be modified at the discretion of the radiological control manager.

4.3.2.3 Cabinet X-Ray Systems

Since these RGDs are used primarily in security applications and are commercially available, manufacturer requirements for these RGDs are delineated in 21 CFR Part 1020.40.

These RGDs should be procured, categorized, inventoried, operated, inspected and monitored, and decommissioned in accordance with this Guide to ensure compliance with 10 CFR 835.1001& 1003). Inspections and surveys should be performed as specified in *Section 4.3.2.2, Electron Devices that Generate X-Rays Incidentally*, of this Guide.

If not commercially obtained, the requirements for an exempt shielded installation prevail.

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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
RADIATION-GENERATING DEVICES GUIDE

(Use multiple pages as necessary.)

Page No. _____	Facility Requesting Change:_____
Section No. _____	Contact Person:_____
Paragraph No. _____	Telephone No./Fax No.:_____

Description of Change Request:

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Suggested Specific Word Changes:

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