DOE-HDBK-1130-2008

DOE HANDBOOK
Radiological Worker Training
DOE-HDBK-1130-2008

Overheads

December 2008
Reaffirmed 2013

Regulatory Documents

Objectives:

- **Identify the hierarchy of regulatory documents.**
- **Define the purposes of 10 CFR Parts 820, 830 and 835.**
- **Define the purpose of the DOE Radiological Control Standard.**

Regulatory Documents
(cont.)

Objectives:

- **Define the terms "shall" and "should" as used in the above documents.**
- **Describe the role of the Defense Nuclear Facilities Safety Board (DNFSB) at DOE sites and facilities.**

DOE Radiological Health and Safety Policy

- Conduct oversight to ensure compliance and that appropriate radiological work practices are implemented.
- Ensure accurate and appropriately made measurements.
- Incorporate measures to minimize contamination that are ALARA.
- Establish and maintain line management involvement and accountability.

DOE Radiological Health and Safety Policy (cont.)

- Establish and maintain a system of regulatory policy and guidance.
- Ensure appropriate training and the technical competence of the DOE workforce.
- Conduct radiological operations that control the spread of radioactive materials and are ALARA.

Written Standards

- **10 CFR Part 835**
- ***DOE Radiological Control Standard***

Hierarchy of Requirements

Two parallel hierarchies:

- **Rules and/or regulations**
- ***DOE* Orders**

Rules and Regulations

- Price-Anderson Amendments Act (PAAA) of 1988
- 10 CFR Part 820:
  - Civil penalties
  - Criminal penalties
- 10 CFR Part 830:
  - Nuclear Safety Management
- DOE Nuclear Safety Requirements

10 CFR Part 835

- Purpose: Codification of radiation protection requirements
- Prescriptive language
- Emphasis on ALARA
- Radiation Protection Program requirements
- Federal law
- Criminal and civil penalties for violations

Radiation Protection Program

- Required by 10 CFR Part 835
- Noncompliance may lead to PAAA enforcement

Guidance Documents (10 CFR Part 835)

Two types:

- **Implementation guides**
- **Technical positions**

10 CFR 835 vs. 10 CFR 20

10 CFR Part 835:

- DOE sites and facilities
- Unique activities

10 CFR Part 20:

- NRC

DOE Radiological Control Standard

- **Originally promulgated as the Radiological Control Manual with DOE Notice 5480.6 (July 1992)**
- **<u>Purpose:</u> provides guidance for comprehensive radiological control program - not a regulation**
- **Notice which made the Radiological Control Manual a requirement was cancelled by N441.1 (Sept 1995):**
  - **May still be be contractual requirement**
  - **Updated in 2008**

10 CFR 835 vs. DOE Radiological Control Standard

10 CFR Part 835:

- HS-40 enforces
- "Shall" statements (mandatory requirements)
- Program Offices audit

DOE Radiological Control Standard:

- Program Offices audit contractual agreements
- Mostly "should" statements (recognizes site- or facility-specific attributes)

Conflicts

10 CFR 835 requirements take precedence over DOE Radiological Control Standard

Unlikely the two will conflict, one may have provisions that are not in other

DOE Standards

- Some DOE Standards are requirements for certain sites: for example, DOELAP
- Others provide guidance
- As part of assessment, need to review site requirements documents

Defense Nuclear Facilities Safety Board

- Five-member board:
  - Reviews and evaluates standards
  - Investigates any event or practice at DOE nuclear facilities that the Board determines has (or may) adversely affect public health and safety
  - May establish reporting requirements for the Secretary of Energy

DNFSB Recommendations

91-6:

- **Radiological protection performance**

92-7:

- **Enhance radiological qualification**

98-1:

- **Resolution of audit findings**

99-1:

- **Safe storage of fissionable material**

10 CFR Part 835, Background and Focus

Objectives:

- **Describe the contents of 10 CFR Part 835.**
- **Identify the site requirements of 10 CFR Part 835.**

10 CFR Part 835

A — General Provisions

B — Management and Administrative Requirements

C — Standards for Internal and External Exposure

D — Reserved

E — Monitoring of Individuals and Areas

F — Entry Control Program

G — Posting and Labeling

10 CFR Part 835 (cont.)

H — Records

I — Reports to Individuals

J — Radiation Safety Training

K — Design and Control

L — Radioactive Contamination Control

M — Sealed Radioactive Source Control

N — Emergency Exposure Situations

Exclusions from 10 CFR Part 835

- Activities regulated by the NRC
- Activities under authority of the Director, Naval Nuclear Propulsion Program
- Specified activities conducted under the Nuclear Explosives and Weapons Surety Program
- DOE activities in certain foreign countries
- Background radiation
- Radioactive material on or within material, equipment, and real property which is approved for release when the radiological conditions of the material, equipment, and real property have been documented to comply with the criteria for release set forth in a DOE authorized limit which has been approved by a Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.
- Radioactive material transportation not performed by DOE or a DOE contractor.

Exclusions from 10 CFR Part 835 (Cont.)

Occupational doses received as a result of excluded activities and radioactive material transportation, as listed above, shall be considered when determining compliance with the occupational dose limits (835.202 and 835.207), and with the limits for the embryo/fetus (835.206).

Included in the RPP

- Formal plans and measures for applying ALARA to occupational exposures
- Existing and anticipated operational tasks
- Each requirement in Part 835
- Plans, schedules, and other compliance measures

Standards for Internal and External Exposure

Addresses limits for:

- **General employees (occupational)**
- **Embryos/fetus**
- **Occupationally exposed minors**
- **Members of public in controlled area**
- **Planned special exposures**
- **Nonuniform exposures of the skin**
- **Concentrations of radioactive material in air**

Summary of Dose Limits

	Exposed Individual	Annual Limit
General Employee:	Whole Body (internal and external)	5.0 rem
“ “	Lens of Eye	15.0 rem
“ “	Extremity (below elbow and knees) and skin	50.0 rem

Summary of Dose Limits
(cont.)

Exposed Individual		Annual Limit
General Employee:	Any Organ or Tissue (other than lens of eye)	50.0 rem
Declared Pregnant Worker:	Embryo/Fetus (gestation period)	0.5 rem
Occupationally exposed minors: (also have limit of 10% of other General Employee limits)		0.1 rem
Members of the Public in Controlled Areas:		0.1 rem

Planned Special Exposures

- Advance approval of DOE
- Informed employee consent

DACs

DACs are listed in appendices A and C of 10 CFR 835.

For intakes, they are the airborne concentration that equals the annual limit on intake (ALI) divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 m^3).

Monitoring of Individuals and Areas

- Demonstrate compliance with Part 835
- Document radiological conditions
- Detect changes in conditions
- Detect the gradual buildup of radioactive material
- Verify effectiveness of engineering and process controls
- Identify and control potential radiation sources and/or radioactive material

Instrumentation

- Periodically maintained and calibrated
- Reviewed for appropriateness:
  - Types, levels, and energies of radiation
  - Environmental conditions
- Routinely tested for operability

Individual Monitoring – External

Dosimetry provided to and used by:

- **Radiological Workers**
- **Declared Pregnant Workers**
- **Occupationally exposed minors and members of the public in controlled area**
- **Persons entering High or Very High Radiation Areas**

Individual Monitoring – Internal

Conducted for:

- **Radiological Workers**
- **Declared Pregnant Workers**
- **Occupationally exposed minors and members of the public in a controlled area**

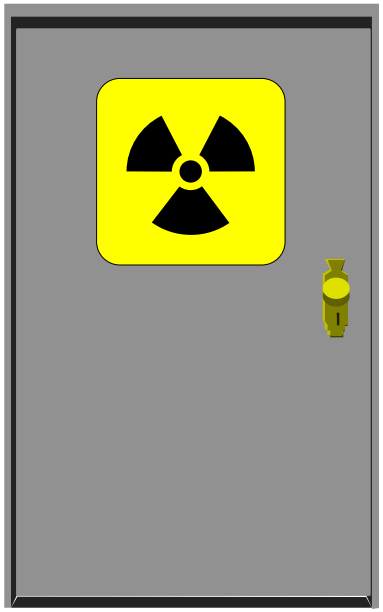
Receipt of Packages Containing Radioactive Material

Applicable to certain types of packages:

- **Requires monitoring**
- **Specifies time limit for monitoring; within 8 hours after start of next working day**

Entry Control Program

- Radiological Areas
- High Radiation Areas
- Very High Radiation Areas



Methods to Ensure Control

- Signs and barricades
- Control devices on entrances
- Alarms
- Locked entrances
- Administrative controls

Radiological Area Egress

- No control(s) shall be installed at any radiological area exit that would prevent rapid evacuation of personnel under emergency conditions.

High Radiation Areas

- Where an individual could exceed an equivalentdose of 0.1 rem in one hour, measured 30 cm from the source or from any surface that the radiation penetrates
- If individual could receive a dose > 1.0 rem in an hour require one or more of the following:
  - Control devices
  - Alarms
  - Surveillance to prevent entry
  - Locks

Very High Radiation Areas

- Dose in excess of 500 rad in one hour at 1 meter from source or from any surface that the radiation penetrates

Very High Radiation Areas (Cont.)

- In addition to the requirements for a High Radiation Area, additional measures shall be implemented to ensure individuals are not able to gain unauthorized access to Very High Radiation Areas.

- "No control(s) shall be established in a High or Very High Radiation Area that would prevent rapid evacuation of personnel."

Signs

- Yellow background
- Black or magenta radiation symbol
- Clear and conspicuous signs

Records Requirements Include:

- Demonstrate compliance with 10 CFR 835
- Individual monitoring
- Sealed source inventory and control
- Results of surveys:
  - Release of material and equipment
  - Radiation and radioactive material in the workplace
- Maintenance and calibration of instruments
- Internal audits
- Radiation safety training

Reports to Individuals Include:

- Annual report of dose
- Employment termination record of exposure

Radiation Safety Training

- Based on:
  - Area access
  - Receiving occupational dose
  - Assignment as Radiological Worker
- Requirements:
  - Examination for certain level (e.g., Radiological Worker Training)
  - Training intervals of twenty four months or less
  - Specifies topics
  - Provision for allowing use of escorts

Design and Control

- Facility design and modifications:
  - Optimization methods shall be used
  - Maintain dose rates below 0.5 mrem/hour
  - Avoid release of airborne radioactivity
  - Facilitate operations, maintenance, decontamination, and decommissioning

Workplace Controls

- Engineered and administrative controls shall provide:
  - Occupational dose to general employees not exceed the limits
  - ALARA process is utilized

Radioactive Contamination Control

- To controlled areas (Part 835)
- To uncontrolled areas (DOE O 5400.5)
- Monitor contamination level
- Provisions to release to controlled area items with fixed contamination
- Requires personnel monitoring
- Requires protective clothing

Sealed Radioactive Source Control

- **Sealed radioactive sources shall be used, handled and stored in a manner commensurate with the hazard.**

Emergency Exposure Situations

Addresses:

- **Employees who have exceeded dose limits as a result of an authorized emergency exposure**
- **Nuclear accident dosimetry**

Nuclear Accident Dosimetry

- Required for installations possessing potential critical mass
- Method to conduct initial screening
- Method and equipment to analyze biological materials
- A system of fixed nuclear accident dosimeters
- Personal nuclear accident dosimeters

Objectives

- Identify the radiological controlled areas a person should be allowed to enter after successfully completing General Employee Radiological Training, Radiological Worker I training, and Radiological Worker II training.
- List five actions used to increase the awareness level of workers relating to proper radiological work practices.

Objectives (cont.)

- Identify three conditions when a “Stop Radiological Work” should be initiated.
- Identify the actions that should be performed, prior to recommencement of work, after a “Stop Radiological Work” order has been initiated.
- Identify when termination bioassay monitoring should be conducted.

Radiological Training

Ensure that personnel responsible for performing radiological work activities are trained through:

- **GERT**
- **Rad Worker I and II**
- **Radiological Control Technician**

Radiological Controls Program

Purpose of training:

- **Guidance for personnel interactions**
- **Guidance for factual emphasis**
- **Fundamentals of communicating risks**
- **Importance of informing management**

Radiological Operations

Conduct radiological operations emphasizing:

- **Good ALARA practices**
- **Rules and guidelines for workers to minimize exposure and control radioactivity**
- **Radiological controls improvement**

Radiological Operations
(cont.)

- Identify radiological control deficiencies and concerns <u>promptly.</u>
- Recognize the need for sensitivity of radiological work practices.
- Periodically review ongoing jobs.
- Identify conditions that could lead to or promote the spread of contamination.

"Stop Radiological Work" Authority

- Inadequate radiological controls
- Radiological controls NOT being implemented
- Radiological control hold points NOT being satisfied
- Job scope changed
- Area conditions changed

Radiological Measurements

Ensure exposure monitoring and measurements are accurately obtained and appropriately documented.

Bioassay Analyses Indicators

- Facial or nasal contamination is detected
- Airborne monitoring indicates the potential of 100 mrem or more committed effective dose
- Any contaminated wound

Bioassay Analyses Indicators (Cont.)

- Contamination on protective clothing, skin or facial area or unplanned spread of contamination
- Detectable contamination inside a respirator after its removal
- When an intake is suspected

Maintenance and Modification Plans

Identify and incorporate radiological requirements, such as:

- **Engineered controls**
- **Dose reduction considerations**
- **Contamination reduction considerations**

Radiological Performance

Establish and maintain line management involvement and accountability for radiological performance involving:

- **Radiological performance goals**
- **Performance indicators**

Objectives

- Identify ways to verify employee- and operation-specific training requirements for personnel.
- Identify methods to determine an employee's dose status.
- Describe how the Lifetime Control Level is calculated for radiological workers.

Objectives (cont.)

- Describe the requirements in order for a female worker to be considered a declared pregnant worker.
- Identify the dose limits established for a declared pregnant worker.
- List the three main conditions an employee must meet in order to be issued respiratory protection equipment.

Objectives (cont.)

- Identify the actions that should be taken if intakes of radioactive materials are indicated that could result in a committed effective dose greater than 100 mrem.
- Describe the conditions that can induce heat stress and other adverse physical conditions for radiological workers.

Objectives (cont.)

- **Describe the actions that should be taken if a worker exhibits systems of heat stress or other adverse stress conditions while working in a radiological area.**

Training/Qualification

Radiological workers should be qualified to:

- **Recognize deteriorating radiological conditions**
- **Seek advice**

Training requirements are established to:

- **Ensure that personnel have the training to work safely**
- **Maintain individual exposures ALARA**

Lifetime Occupational Dose

- N = person's age
- Special control level = 1 rem/year
- Not to exceed N rem

Worker Responsibilities

- **Notify radiological control personnel of offsite exposures so that individual records can be updated**

Declared Pregnant Worker

- Notifies employer in writing
- Embryo/fetus dose limit for gestation period shall be 500 mrem
- Avoids exceeding a dose of 50 mrem/month

Respirator Use Requirements

Three main requirements before respirator use:

- **Trained**
- **Fitted**
- **Medically qualified**

Training and qualification testing performed annually

Airborne Radiation Exposure

If unplanned intakes indicate a committed effective dose of 100 mrem or more:

- **Identify personnel potentially exposed.**
- **Determine the duration of potential exposure to airborne radioactivity.**
- **Have dose evaluated prior to permitting the worker to return to radiological work.**

Heat Stress

May result from:

- **Working in areas of high temperature, humidity, and radiant heat**
- **Working in protective clothing**
- **Using respirators**

Heat Stress (cont.)

When worker begins to feel symptoms:

- Notify nearest coworker.
- Exit area.
- Remove personal protective equipment.
- Notify supervisor.
- Rest in cool area.

Objectives

- Identify the components of a communication process model.
- Describe filters/barriers which distort the communication process.
- Identify active listening behaviors.
- Describe the various portions of a conflict resolution model presented in class.

Objectives (cont.)

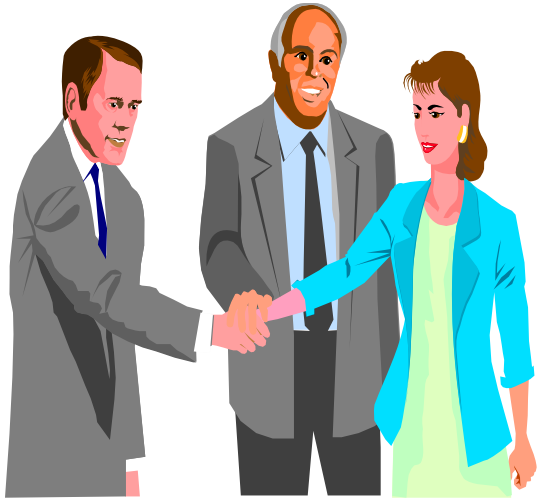
- Describe some of the key elements in communicating radiation risks to workers.
- Identify the skills required to conduct a pre-job briefing.
- Identify the benefits of a successful critique/lessons learned program as described in the *Radiological Control Standard.*

Five Types of Communication Barriers

- Social barriers
- Physical barriers
- Psychological barriers
- Individual barriers
- Neurological barriers

Styles of Conflict Management

- Avoidance
- Accommodation
- Competition
- Compromise
- Collaboration



Conflict Resolution

- Impartial party
- Agree on problem
- Restate other's position
- Agree on criteria for resolution

Motivation for Excellence

Advanced planning:

- **Maximizes benefits**
- **Minimizes risk**

Reducing doses

- **Reassures people**
- **Reduces prospects of litigation**

Motivation for Excellence (cont.)

Effects of reducing doses:

- **Increases efficiency**
- **Decreases incidents**

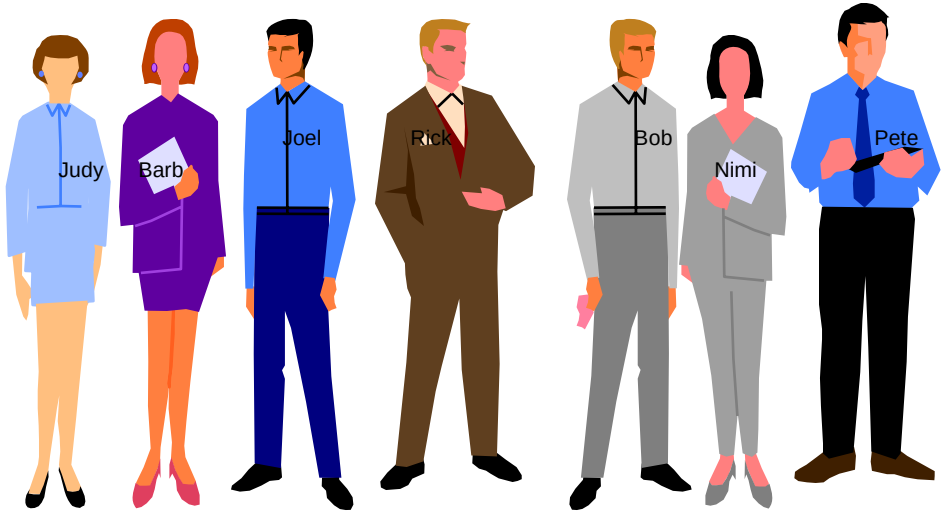
Radiological Control Program

Reducing risk includes:

- **Training for workers' jobs**
- **Records and reports**
- **Development of plans**

Meetings/Briefings/ Critiques

- Running an effective meeting
- Pre-job briefings
- Post-job evaluations



Critiques

- Conducted for successes and abnormal events
- Facilitated by trained critique leaders
- Conducted as soon as practical
- Minutes kept
- All who can contribute should attend
- Supporting materials

Objectives

- Identify problems or decisions faced by supervisors of radiological workers.
- Identify components of decision making.

Assessing Internal and External Environments

- Problem diagnosis
- Problem specification
- Problem framing
- Problem formation and reformation

Developing Strategy

Acceptable Standard Solution	→	Use it!
No Standard Solution	→	Develop Alternatives

Making the Decision

- Define alternative courses of action
- Assess consequences
- Assess probabilities
- Evaluate alternatives in terms of criteria
- Analyze optimal solutions for any adverse consequences
- Select most effective solution

Objectives

- Identify motivation issues faced by radiological worker supervisors.
- Identify several ways to motivate personnel.
- Identify several tools of motivation.

Maslow's Hierarchy of Needs

- Physiological
- Safety
- Belongingness
- Love
- Self-actualization

Job Enrichment Theory

- Skill variety
- Task identity
- Task significance
- Autonomy
- Feedback

Achievement Theory

- Evident personal responsibility
- Good chance of success
- Feedback
- Challenging
- Future consequences

Cognitive Theories

- Equity (justice) theory
- Expectancy (choice) theory
- Reinforcement theories

Why Goals Work

- Direction
- Intensity
- Persistence
- Strategy

Effective Motivators

- Goal difficulty
- Goal specificity
- Participation in goal setting
- Feedback

Steps Toward Empowerment

- Define empowerment
- Assess strategies
- Clarify mission
- Determine boundaries
- Assume participative decision making
- Decide whether required or voluntary

Steps Toward Empowerment (cont.)

- Communicate plan to managers and supervisors
- Get input
- Determine skills
- Communicate plan
- Provide training

Objectives

- Identify leadership issues faced by radiological worker supervisors.
- Identify characteristics of a good leader.
- Describe various types of power and influence in organizations.
- Identify several tools of leadership.

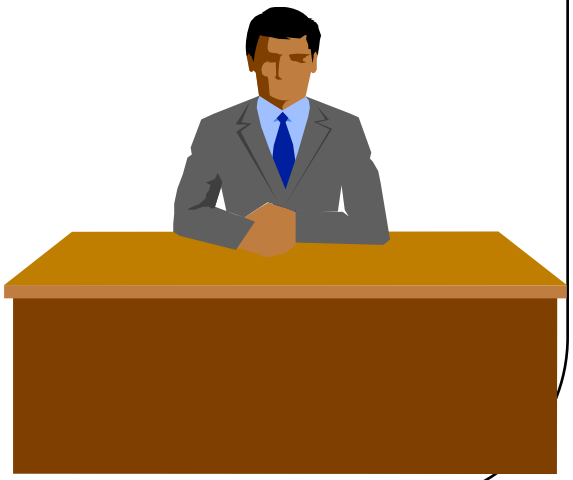
Characteristics of Good Leadership

Categories:

- **Leadership traits**
- **Motives of leaders**
- **Leadership skills**

Leadership Traits

- High energy level
- Stress tolerance
- Integrity
- Emotional maturity
- Self-confidence



Motives of Leaders

- Need for power
- Need for achievement
- Need for affiliation

Effective Leadership Skills

- Planning and organization
- Problem solving
- Clarifying and monitoring
- Informing
- Motivating and consulting

Effective Leadership Skills (cont.)

- Recognizing and supporting
- Team building, networking, and delegating
- Developing and mentoring
- Rewarding

Types of Power

- Legitimate power
- Coercive power
- Reward power
- Expert power

Influence Tactics

- Rational persuasion
- Inspirational appeals
- Consultation
- Ingratiating
- Personal appeals
- Upward appeals

Tools of Leadership

- Providing vision
- Coaching/mentoring
- Delegating
- Team building

Team Development Factors

- Communication
- Cohesion
- Developed norms
- Role clarity
- Cooperation
- Participation
- Conflict resolution